# RF and Microwave Designer's Handbook

WATKINS-JOHNSON COMPANY 1993-1994

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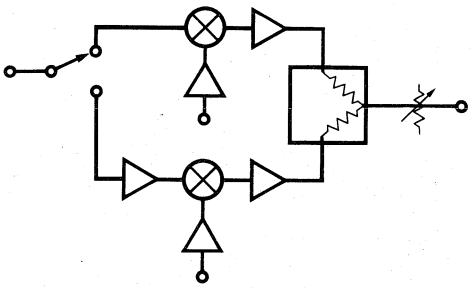
# Products Manufactured by Watkins-Johnson Company

- Amplifiers
  - Solid State
  - TO-8
  - Cascaded
- Antennas & Antenna Systems
- Attenuators
- Converters
- Chemical-Vapor-Deposition Systems
- Detectors
- Direction-Finding Systems
- Drivers
- ECM Subsystems
- ESM Systems
- Filters (YIG)
- Frequency Converters
- Frequency Doublers
- Frequency Generators
- Frequency Memory Loops
- Frequency Synchronizers & Synthesizers
- Frequency Translators
- Hi-Reliability Components
- Image Reject Mixers
- Integrated Front Ends
- Limiters
- Limiting Amplifiers
- Logarithmic Amplifiers
- Mixers
- Modulators/Demodulators
- Multipliers
- Oscillators
- Pin Diode Switches
- Power Dividers
- Receiver Front Ends
- Receivers
- Sampling Mixers
- Signal-Analysis Equipment
- Simulation Systems
- Space Qualified Components
- Switch Matrices
- Tuners
- YIG Devices



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# Watkins-Johnson Company
## *An Overview*

**Watkins-Johnson Company, now in its fourth decade of growth, is a diversified corporation specializing in defense electronics manufacturing, commercial equipment production and environmental consulting services, with annual sales of more than $264 million.**

Today, more than 2,240 people are employed by the Company, whose corporate headquarters are located in Palo Alto, California. Additional manufacturing facilities are operated in Scotts Valley and San Jose, California; Gaithersburg and Columbia, Maryland; and Windsor, England. Sales offices are located throughout the United States and in England, Italy and Germany. The Company also has distributors throughout the free world.

Watkins-Johnson's excellent technical staff and extensive production facilities enable the Company to respond quickly to customers' needs. Utilizing in-house capabilities to the fullest assures complete quality control of key components and expedites delivery on quantity production runs.

Many of W-J's thousands of superior catalog items are available from stock for early delivery. In addition, the Company will either modify an existing product or design and fabricate new units to meet unusual applications. Important to many such projects is the Company's provision for secure areas which allow the undertaking of rigidly classified assignments of wide scope and complexity.

The Company's Defense Group produces electronic products ranging from gallium-arsenide semiconductor devices to fully integrated turnkey systems for signal collection and analysis.

The Microwave Products Division in Palo Alto develops and manufactures microwave semiconductor and millimeter-wave devices, integrated circuits, solid-state signal-processing components and integrated subsystems.

Voltage-controlled, digitally tuned and backward-wave oscillators are also produced for a wide range of military and commercial applications.

A manufacturing facility in Windsor, England, produces radio-frequency simulation equipment and provides support for all Watkins-Johnson products in the British Isles.

Watkins-Johnson plants in San Jose, California, and Gaithersburg, Maryland, design and manufacture RF through millimeter-wave receivers, tuners, antennas, simulation and related support equipment for reconnaissance, surveillance, electronic countermeasures and EMI/EMC investigations.

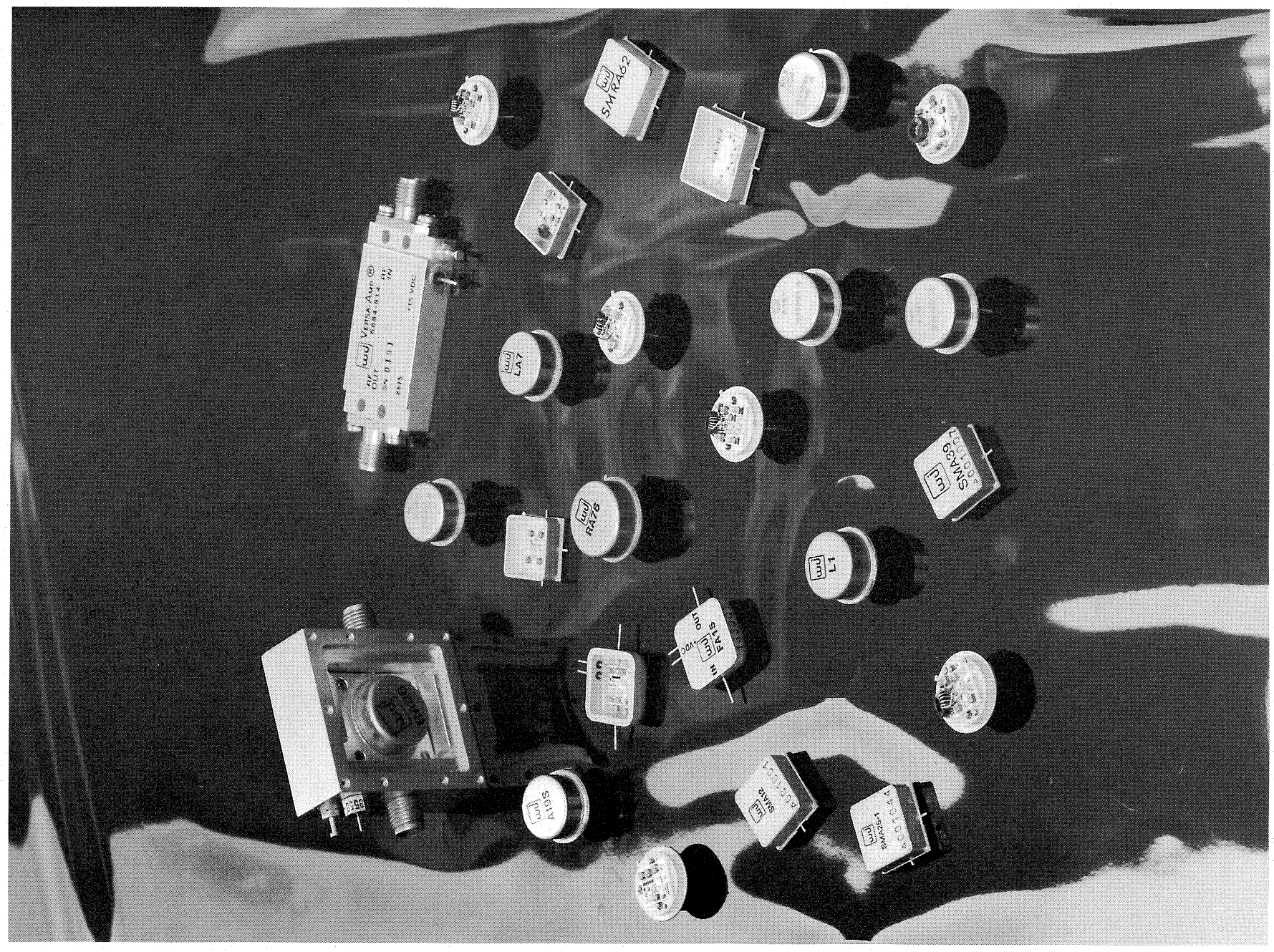
Total systems integration is performed at the Company's Columbia, Maryland, and San Jose, California, locations.

The company's Commercial Group, located in Scotts Valley, California, produces atmospheric-pressure chemical-vapor-deposition (CVD) equipment for high-volume semiconductor manufacturing. W-J captured top honors for customer satisfaction among semiconductor process-equipment manufacturers in the 1991 VLSI Research Inc. Ten Best Awards competition.

W-J Environmental, Inc. (WJE) offers technical expertise in hydrogeology and related resource sciences. Professional services range from the exploration, development and utilization of groundwater resources to the detection and remediation of aquifer contamination. WJE offices are located in Santa Ana and Palo Alto, California; and Denver, Colorado.

# *Thin Film Products*





# RELIABILITY AND SCREENING

Watkins-Johnson Company's proven product line and experienced high-reliability team can give maximum quality per dollar, reduce risks, and minimize the required amount of interface effort to get an order placed and shipped.

Our technical and management personnel have a thorough understanding of the importance and complexities of quality and high-reliability requirements. To make it easy to meet reliability, cost, and schedule needs we offer several approaches to select from to satisfy any particular application:

**1. Standard Product Line**

**2. "S Series" Standard W-J Screening**

**3. Standard Hi-Rel Options**

**4. Custom Developed Programs**

# HIGH QUALITY STANDARD PRODUCT LINE

**THE NUMBER ONE PRIORITY IN WATKINS-JOHNSON'S CASCADABLE AMPLIFIER PRODUCT LINE IS SUPERIOR PERFORMANCE AND QUALITY.** Quality and reliability are designed and built in, not added on. Industry budget objectives are met through standardization, automation, and efficiency of operations, not by taking compromising short cuts in the design or manufacture of the product.

Our standard line of thin-film cascadable amplifiers is designed and manufactured to meet the reliability and screening requirements of MIL-M-38510 and MIL-STD-883 (Class B of test method 5008)[1] for RF hybrid microcircuits. Standardization of product flows and high levels of quality monitoring allow the amplifiers to be manufactured with all the consideration desired for high-reliability applications.

The construction of the Watkins-Johnson Company amplifier series involves the highest levels of thin-film and hybrid microcircuit design and construction technology. The thin-film metalization is produced by using a computer-controlled, high-vacuum, multi-target RF sputtering system for both resistor and conductor metalizations. A residual gas analyzer is utilized for added process control on every run.

All conductor traces are gold metalization. The thin-film resistors are formed from tantalum nitride and are passivated at high temperatures to yield excellent long-term stability. The resistor composition is such that there is less than 150 ppm/°C of change in resistor value over the full operating temperature range.

Thin-film circuitry offers very precise control of resistor and circuit patterns. Thin-film inductors, etched on the substrate, yield a high degree of repeatability from unit to unit.

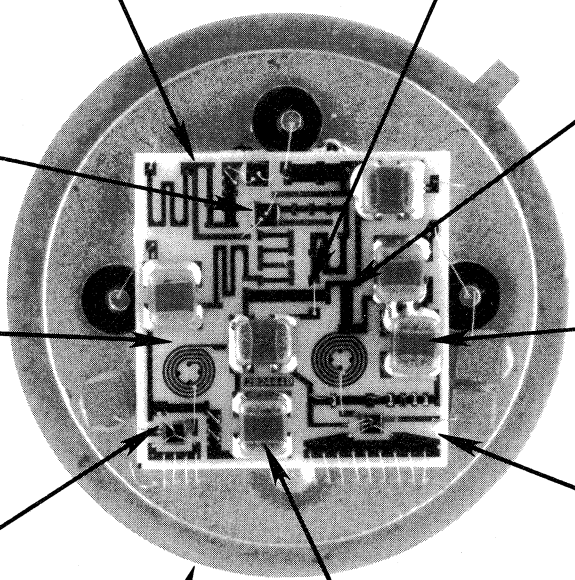
All RF transistors are bonded to the substrate using a specially developed gold/silicon eutectic die attach process. This process eliminates the need for scrubbing the thin-film gold and results in superior adhesion and more uniform contact which, in turn, gives better reliability and heat transfer.

The wire interconnects are made utilizing thermocompression and thermosonic gold-ball wire bonding processes. The RF die wire bonding equipment is custom designed by W-J to obtain superior quality over that produced by standard commercial bonders.

*1 The actual screening and reliability requirements differ slightly from Mil-STD-883 as specified on page 7.

# QUALITY AND RELIABILITY ARE DESIGNED AND BUILT IN





**Sputtered Gold Metalization**
RF sputtered thin-film gold for optimum adhesion, repeatability, and conductivity.

**Wire Bonds**
All wire bonds are gold ball thermocompression or thermosonic to eliminate intermetallic failure modes.

**Transistor Bonds**
Gold transistor pads are not subject to corrosion and provide maximum reliability with gold wire interconnections by eliminating bimetallic interfaces.

**Thin-Film Resistors**
Stabilized and passivated tantalum nitride resistors giving high accuracy.

**Thin-Film Inductors**
Line resolutions typically within 0.2 mils for high circuit-to-circuit repeatability.

**Capacitor Attach**
Capacitors are adhesively attached utilizing SPC procedures.

**Substrate Attach**
Polished alumina substrate is eutectically attached in a forming gas environment utilizing a gold/tin preform to provide excellent adhesion and ground plane contact.

**Transistor Attach**
All RF die are Au/Si eutectically attached with a specially developed process and equipment that results in superior adhesion and uniform electrical contact.

**Package**
High quality gold-plated kovar header with a hermetically welded solid nickle can.

**Chip Capacitors**
Ceramic chip capacitors provide minimum thermal expansion mismatch with the alumina substrate, preventing solder joint fatigue during power and thermal cycling.

# PROGRAM MANAGEMENT AND ENGINEERING TEAM

***DEDICATED PROGRAM SUPPORT IS THE RULE, NOT THE EXCEPTION***

Watkins-Johnson's Cascadable Amplifier Product Line has a full-time staff of program managers and technical and administrative support personnel. This dedicated group has the experience and capabilities for supporting your program and high reliability needs. Every program and customer has an assigned program manager and engineer who are responsible for the proposal and for managing and carrying out all of the contract commitments. This continuity greatly minimizes risks, miscommunications, and customer costs. The specific responsibilities of the program management group include: customer support for program and technical needs; technical quality and engineering feedback to the standard product line; contract administration; program management; and customer interface during the contract.

# PRODUCT LINE QUALIFICATION PROGRAM

In addition to quality conformance inspections performed for many of Watkins-Johnson's specific customer contracts, Group B, C and D inspections per Method 5008 (modified) of MIL-STD-883 are performed as an ongoing part of the product line's qualification program. These QCI inspections are an integral part of the MIL-STD-883 and MIL-M-38510 product line qualification requirements and provide generic data to satisfy many customers' program qualification needs without the normal expense. This data also provides an important source of technical feedback to the design and production departments where it is utilized to continually upgrade the quality of the product.

# RELIABILITY OPTIONS

**S Series**
Watkins-Johnson Company's standard screened line of thin-film TO-8 amplifiers ("S Series") provides a cost- and time-effective approach to meeting the requirements commonly found on airborne applications and high MTBF ground equipment. The screening is per MIL-STD-883, Method 5008, as detailed on the following page. All standard TO-8 and TO-5 models are also available in the "S Series" version. These units also serve well in developmental phases of higher scope programs.

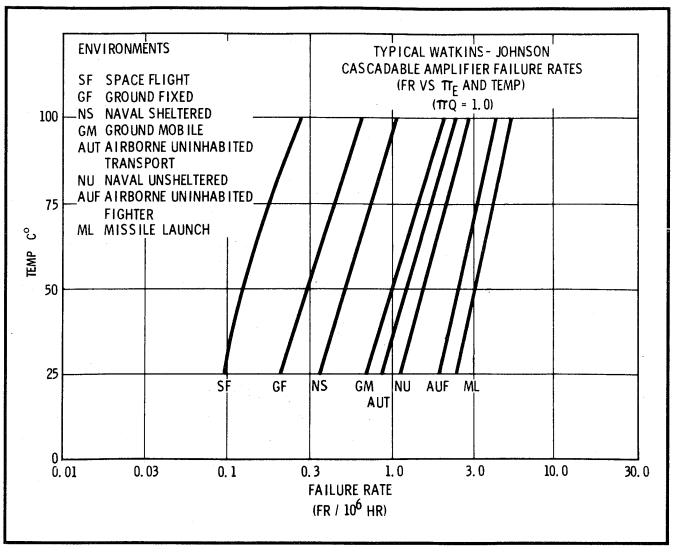
**Custom Hi-Rel Programs**
In applications involving more difficult software/system requirements and critical schedules, the Hi-Rel Engineering Group is available to establish and carry out all program requirements. As described above, they have extensive experience in supporting specialized and high-scope needs. This expertise can also supply screened cascaded amps with SMA connectors for high-reliability programs. Our experience includes extensive programs for full space requirements.

**Standard Hi-Rel Options**
When requirements call for more than "S Series", cost and schedule can still be improved by taking advantage of our standard Hi-Rel options. Some of the many options that are available include: transistor SEM; screened piece parts; 100% nondestruct bond pull; preburn-in electricals; mechanical shock; X-ray; PIND; extended burn-in; Delta calculations; and lot quality conformance testing (Groups A, B, C, and D).

**Screened Piece Parts Program**
Watkins-Johnson Company maintains a large standardized inventory of Hi-Rel screened piece parts because of our leadership in space programs and consequent large volume of Hi-Rel business. Three to five months of lead time can be saved by utilizing this inventory. There is also the advantage of piece parts with a large extensive test data base and a proven record of reliability. The screening performed meets or exceeds the device evaluation requirements of S-level screening of Method 5008. Amortization of the sample testing across the large quantities that are regularly processed maximizes cost effectiveness for high-level programs.

# TYPICAL AMPLIFIER MTBF

Reliability is built into every Watkins-Johnson amplifier. The table to the right presents sample calculated MTBF predictions for a representative W-J TO-8 amplifier. The calculations are based on an S Series level of screening. Other amplifiers in the product line do not typically vary by more than a factor of 2. There are several variables in the MIL-HDBK-217 formula that are open to manufacturer's assumptions and interpretations. W-J's predictions are conservatively safe, and you can be assured that our design and manufacturing technology provide the best reliability available.

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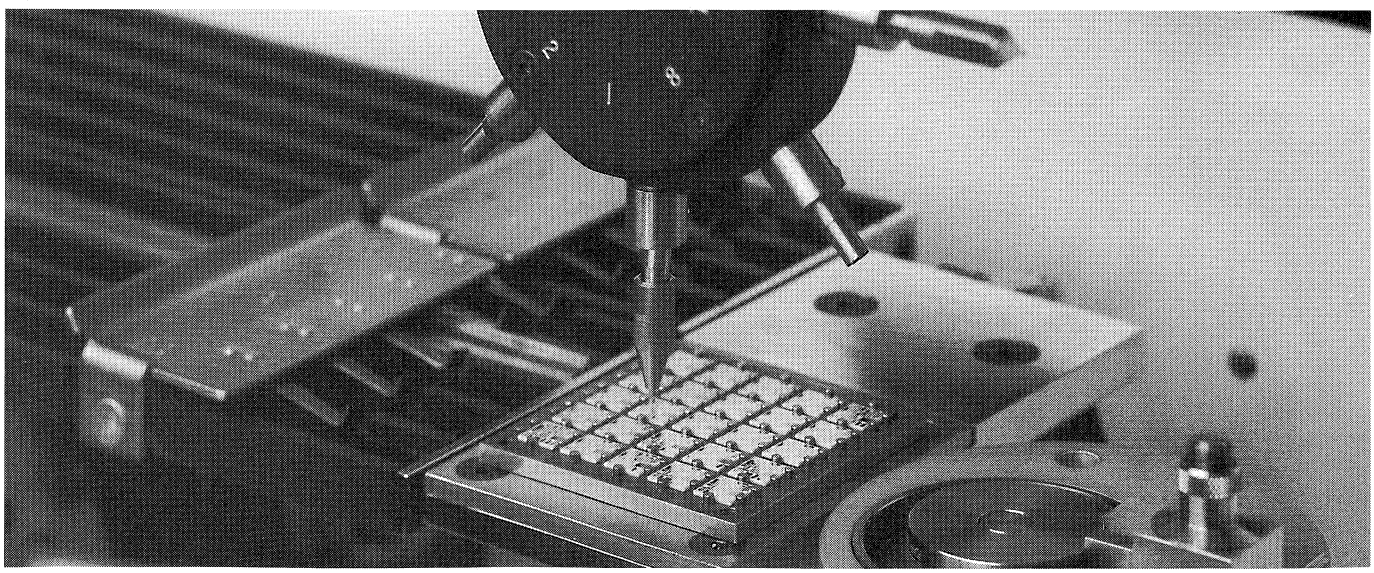
## W-J "S Series" Screening (Methods refer to MIL-STD-883)[2]

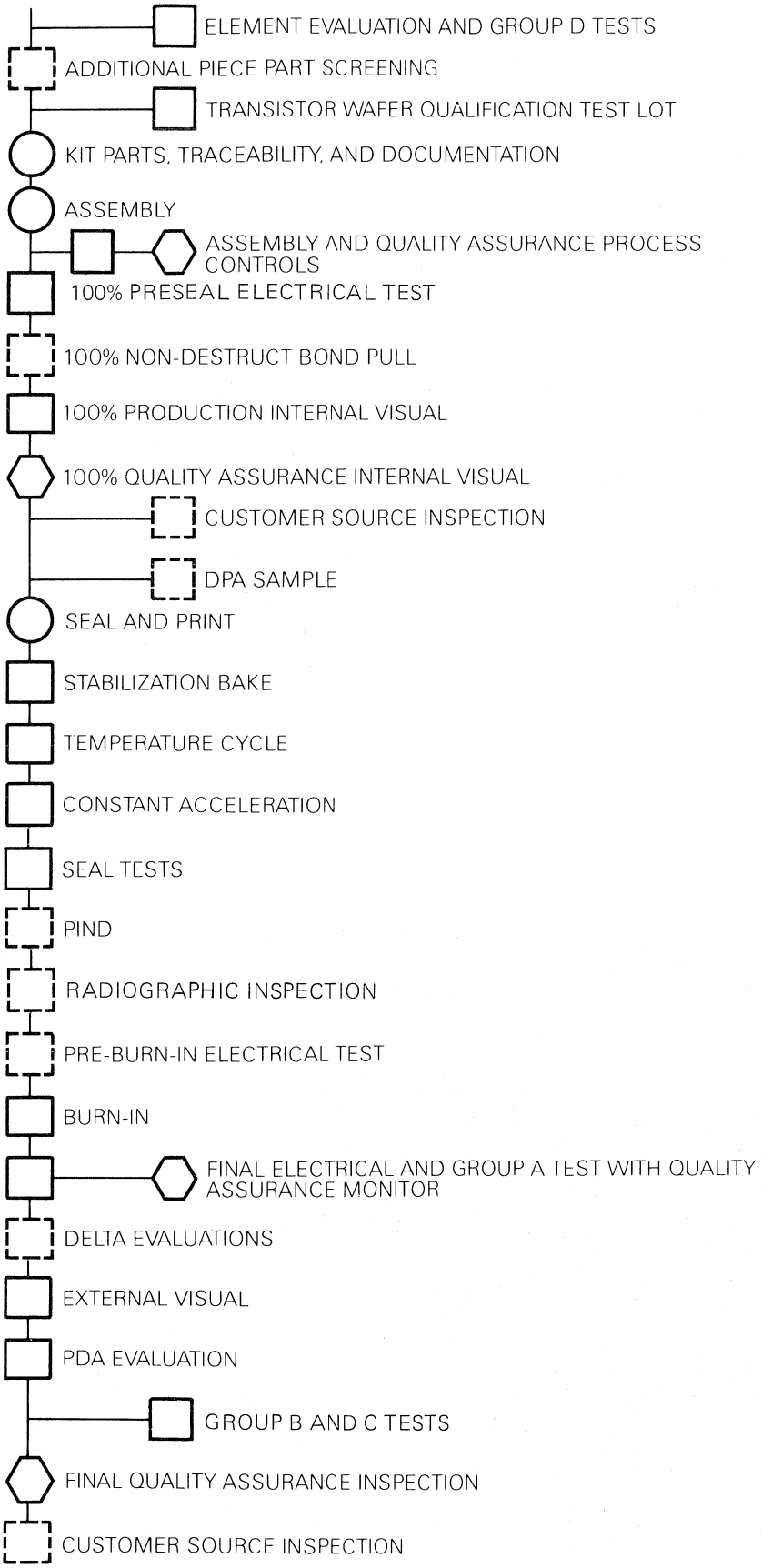
| Test | Method | Condition |
|---|---|---|
| Element Evaluation & Group D Test | 5008 | Sample [1] |
| Transistor Wafer Qualification Test Lot | | All Lots [1] |
| Process Control and Monitors | 5008, 2011 ; 2019 | Sample [1] |
| Preseal Electrical Test | Per Applicable Document | |
| Production Internal Visual | WJ-146505 | 100% B[1] |
| Quality Assurance Internal Visual | WJ-146505 | 100% B[1] |
| Stabilization Bake | 1008 | B; 24 hrs., +125°C |
| Temperature Cycle | 1010 | B; -55°C to +125°C |
| Constant Acceleration | 2001 | B; 10,000 g's, $Y_1$ axis |
| Seal Tests | 1014 | A & C; 100% |
| Burn-In | 1015 | B; 160 hrs., $T_C$ = +71°C to +125°C |
| Final Electrical and Group A Test | Per Applicable Document | |
| External Visual | 2009 | 100% |
| PDC Evaluation | WJ -136948 | |
| QCI-Group B and C Tests | 5008 | Sample [1] |

NOTES:
1. As defined or modified by W-J standard procedures for microwave hybrid microcircuits.
2. The S Series screening process differs from MIL-STD-883, Class B as follows: 1) Internal visual inspection is performed in accordance with W-J 146505 instead of Method 2017; 2) Stabilization bake and temperature cycling are conducted per Condition B instead of Condition C of the respective methods 3) Constant acceleration is conducted per Condition B instead of Condition E of Method 2001; and 4) The 96 hour time constraint between burn-in and final electrical testing per Method 1015 is not guaranteed.



# MANUFACTURING AND SCREENING FLOW CHART FOR HIGH RELIABILITY PROGRAMS

OPTIONAL SCREENING BEYOND "S SERIES" ARE REPRESENTED BY DOTTED ENTRIES



# SPECIFYING HIGH-REL MIXERS AND AMPLIFIERS



While the subject of this article is a slight departure from that of the usual Tech-notes topic, it is, nevertheless, important to acquaint the reader with high reliability– a subject that is very much a part of the microwave industry. The specifying of high-reliability (hi-rel) items may sometimes be a mystifying process to vendor and equipment user alike, but it is important that designers, manufacturers, buyers and end users of microwave electronic equipment be aware of the various methods used to specify hi-rel products, what documented specifications entail in the way of testing, and the risks, in time and cost, of over- or under-specification. This article deals mainly with the specifying of mixers and RF hybrid amplifiers.

A hi-rel part is generally specified to ensure that its failure rate satisfies its intended use. The 1979 Environmental Stress Screening of Electronic Hardware Conference (ESSEH) concluded that failures could be mainly attributed to improperly constructed hardware and misapplication of the product. The goal of stress screening is to find flaws before a part is included in a sophisticated spacecraft, weapons system, or other high-performance electronic hardware. Since there is presently no universal standard for testing every type of microwave component and subsystem, and since there is no authoritative data base with which to compare test results, designers have developed their own set of rules and procedures from which are selected those that best describe the desired screening tests. These rules and procedures are often dictated by the designer's client and/or mandated by various military standards (MIL-STDs).

MIL-STDs have been established to standardize test methods and screening levels for general types of hardware (see Table 1). Unfortunately, they frequently become outdated or fail to cover a specific hardware type. Military standards are not "hard and fast" rules for testing, but, instead, are written to allow some latitude in the methods and levels of testing. For example, MIL-STD-883B, Method 5004.4 states: "This method establishes screening of microelectronics to assist in achieving levels of quality and reliability commensurate with the intended application."

There are three distinct levels of screening tests: Class S, Class B, and Class C. Class S represents the most stringent testing and Class C the least stringent. MIL-STD-883B, Method 5004.4, also states: "Since it is not possible to prescribe an absolute level of quality or reliability which would result from a particular screening level or to make a precise value judgment on the cost of a failure in an anticipated application the method provides flexibility in the choice of conditions and stress levels to allow the screens to be further tailored to a particular source, product or application based on user experience."

| MIL Specifications | Purpose and Application |
|---|---|
| MIL-STD-883 Test Methods and Procedures for Microelectronics | Standardizes environmental screens for IC's and hybrids and suggests series of tests for 100-percent screening and sample testing for qualification and production lot acceptance testing (QC1) |
| MI L-STD-202 Test Methods for Electronic and Electrical Parts | Standardizes environmental screens for general electronic components |
| MIL-M-38510 General Specification for Microcircuits | Establishes guidelines for hybrid physical design and the environment within which the hybrid is manufactured, including documentation |
| MI L-M-2883 7 General Specification for RF Mixers | Standardizes general requirements for RF mixers including manufacturing and qualification requirements |
| MIL-S-19500 General Specification for Semiconductor Devices | Defines product assurance levels for JAN, JANTX, JANTXV, and JANS semiconductor devices |
| MIL-HDBK-217C Reliability Prediction of Electronic Equipment | Provides formulas and data for calculating the failure rate/ MTBF of electronic components and systems |

**Table 1. Primary mixer and hybrid amplifier military specifications.**

### Users Must Request Proper Screens

Users of hi-rel parts must provide the proper tailoring of screening methods and levels when making a hi-rel request. Often, a hi-rel request specifies more than is needed for the intended application, resulting in high costs for unnecessary screening. It was pointed out in the 1979 ESSEH that the manufacturer is in the best position to determine what screens will be most effective for his type of hardware. It is risky for a vendor to change his fabrication process simply to meet customer specfications. Such a change means a departure from familiar construction techniques to procedures whose results are not yet proven. The customer should be flexible in his hi-rel requests. Also, a design engineer knowledgeable in hi-rel can be influential in determining realistic needs, and in making recommendations to both customer and manufacturer.

### Screening and Reliability Relationships

A screening test causes a flaw to become a failure, but quality assurance and process control should be aimed toward preventing and finding potential failures before they enter the screening process. Screening increases the expected mean time between failure (MTBF) of the final product (see Figure 1), but at some level (point B), the return on investment begins to decline. The specifier must decide when the increased reliability warrants the added expense. Screening the completed items yields a higher return than testing piece parts (individual components) or subassemblies. Overstressing a part can reduce its MTBF

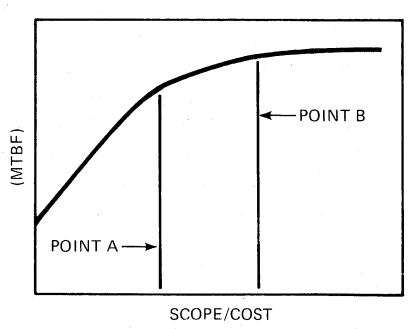



**Figure 1. Screening increases the expected MTBF of the final product.**

(see Figure 2). Screening tests which exceed the design limits of a piece of hardware may weaken some part of the assembly. The resulting MTBF figures fail to indicate the component's reliability in the intended environment, thus needlessly adding cost and time.

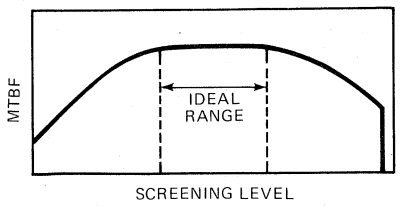



**Figure 2. Overstressing a part can reduce its MTBF.**

An optimum screening level exists for each hi-rel item, which will minimize total system cost (see Figure 3). A typical $100 part may require $50 in testing to reach point A, but an additional $250 to reach point B. The relationship shown in Figure 3 is similar to that shown in Figure 1, but determining the screening level also depends on the expense of locating and repairing a system failure, which includes lost business, reduced mission effectiveness and fixed overhead costs.

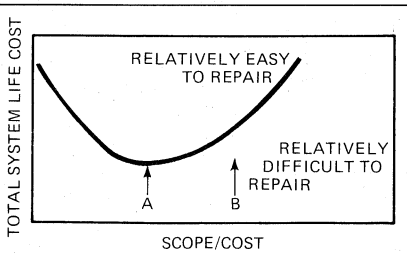



**Figure 3. An optimum screening level exists for each hi-rel item, which will minimize total system cost.**

Screening must maximize potential failures to control the cost of a hi-rel part. The proper sequence must be determined through empirical data developed by the vendor (see Figure 4). Also, costs can be minimized by using the vendor's in-house standards rather than implementing new and untried fabrication methods and test procedures.

### Specifying Hi-rel Hybrid Microcircuits

The trend in the design of RF components and thin-film RF and microwave mixers is to use hybrid microcircuit construction and manufacturing techniques. These circuits, which are called MICs (microwave integrated circuits) by many manufacturers, are being procured with an increased interest in reliability. In spite of the well-established use of the hybrids, the best way to maximize cost/quality value while minimizing manufacturing and procurement cycles is still unknown.

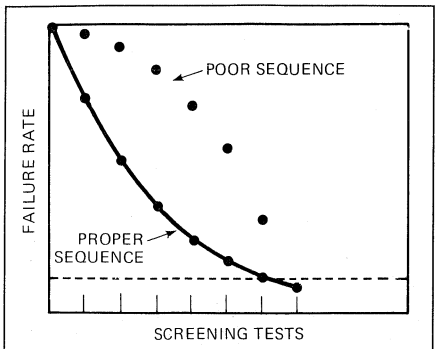



**Figure 4. Screening must maximize potential failures to control the cost of a hi-rel part.**

A hybrid microcircuit consists of a single-package electronic subsystem utilizing a substrate, with film interconnects and some film passive components, onto which unpackaged discrete active and passive components are attached. Low-frequency linear and digital hybrids have been popular since the late 1960's, even for nonmilitary applications.

Because of the microwave industry's specialized nature, it has been isolated from the general semiconductor component developments from which the hybrid has evolved. As a result, it has taken more time to adapt the new manufacturing technology. In addition, the design of hybrids for microwave applications are difficult to modify for optimum manufacturing. Unlike low-frequency components in which parasitic effects can be neglected, the performance of an MIC depends more on its physical configuration.

Today, most of the hurdles have been overcome and an increased number of new designs are using microcircuit techniques with increasing advantage and confidence.

Figure 5 shows a typical cascadable amplifier arrangement. Hybrids of this type are inherently more compatible with high-reliability applications than their printed circuit counterparts. Most significantly, the number of interconnects (potential weak links in the reliability chain) is reduced by a factor of two to four. Furthermore, all of the components in a hybrid are in a small, common, hermetic package. The same production facilities used for a standard product line can also produce high-reliability units. The best manufacturing philosophy establishes a high quality base on the standard line. Most high-reliability requirements should be able to be met through additional processing or testing rather than changes in the manufacturing procedures.

### Hybrid Screening

Since the hybrid microcircuit extends from the semiconductor industry, two previous MIL-STD documents are used by all experienced hybrid customers and manufacturers: MIL-STD-883, "Test Method and Procedures for Microcircuits," and MIL-M-38510, "General Specifications for Microcircuits." Since "883" and "38510" provide such appropriate industry standards, less applicable documents (such as

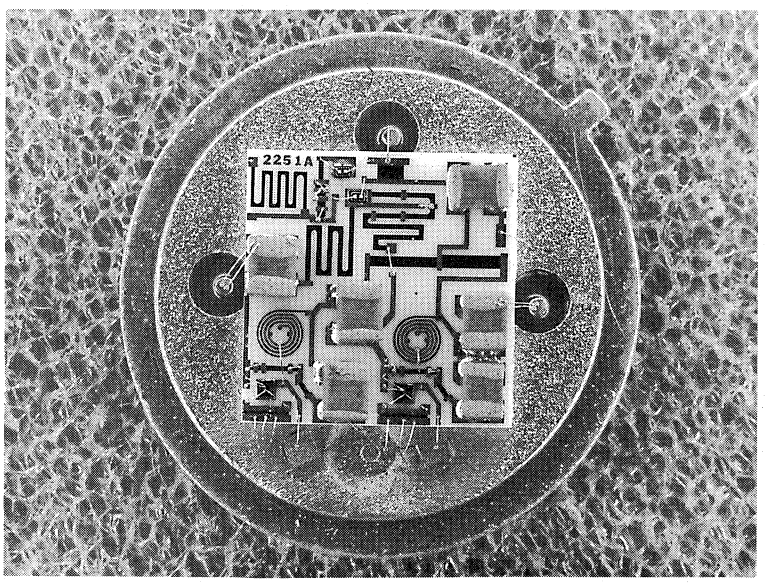



**Figure 5. Typical cascadable amplifier arrangement.**

MIL-STD-202 and MIL-STD-750) merely add time and cost to the specifying/ manufacturing cycle. MIL-STD-883 compiles the many environmental tests, electrical tests, and process controls to which any semiconductor-based electronic component may be subjected to detect quality and reliability problems. Methods 5004 and 5008 of this standard suggest tests to be performed on a 100-percent basis (testing of each and every part) to screen potential failures. In particular, Method 5008, the more current section, is being adopted by the hybrid industry.

Ninety percent of all hi-rel hybrid microcircuits are currently screened to the Class B level of Method 5004 or 5008, with minor variations according to the specified product and application. Because of the widespread use of the hybrids and the resultant standardization of screening, both customer and manufacturer benefit with lower costs and better test correlation. For these reasons, the continued use of MIL-STD-883 is very important.

Screening, and monitoring of fabrication processes can be applied during three stages of production: on the individual parts (piece parts) that go into the assembly, during manufacture, and after a unit is sealed and functionally complete. The relative costs usually decrease for these successive stages, unless a well identified yield or reliability problem exists that can be best addressed at a lower level.

Because the extremely small hybrid piece parts, such as silicon chip bipolar transistors (see Figure 6) and multilayer chip capacitors, have no attached leads or packages, screening at this level is very expensive. Due to the uniqueness of small, unpackaged and leadless devices, the customer needs to be especially well informed about the necessity of screen requirements at this level of manufacture.

Chip transistors can be tested by scanning electron microscope inspection, 100-percent visual inspection, 100-percent DC probing, visual and sheer-strength testing of die attachability, wire bonding test, and burn-in or life tests. The sample testing is performed on a wafer or on a wafer diffusion lot for qualification.

Chip capacitors can be screened by 100-percent electrical testing (dielectric withstanding voltage, insulation resistance, and dissipation factor), 100-percent visual inspection, and sample bondability testing. Life and burn-in tests can be performed, but these are expensive and time-consuming. Delamination and voiding problems can be detected through destructive physical analysis.

Piece-part screening usually extends schedules by three to five months. Since many programs cannot tolerate this type of delay, hybrid manufacturers should establish standard in-house specifications, for additional screening on their standard parts inventory, based on their customers' most common needs. They should also maintain an in-house stock of screened piece parts. Customers must assist by forecasting upcoming needs as early as possible.

Screening can also be applied during manufacture. This type of screening includes pre- and post-process destruct sample monitoring, and post-process, 100-percent nondestruct screening of component attachment and wire bonding. Hybrid manufacturers have a responsibility to provide their customers with an established level of process quality control based on the best known common denominator of customer needs. Screens which are more stringent than those established by the manufacturer will, therefore, be expensive.

The third and best stage to screen a hybrid is after it has been sealed. Screening at this point produces the highest mean time before failure per dollar ratio. The most cost-effective screens are a manufacturer's own adaptation of Method 5004 or 5008 of MIL-STD-883 (as shown in Table 2).

MIL-STD-883 leads to several standardized screens including: internal visual in-spection, bake tests, temperature cycle tests, centrifuge tests, fine and gross leak tests, burn-in, and external visual inspection. Method 5004 states: "The user is cautioned to collect experience data so that a legitimate value judgment can be made with regard to the specification of screening level." Again, the manufacturer usually has the best experience data.

| Test | Method | Condition |
|---|---|---|
| Internal visual | 2017 | B modified |
| Stabilization bake | 1008 | B; 24 hrs. 125°C |
| Temperature cycle | 1010 | B;-55°C to +125°C |
| Acceleration | 2001 | B; 10,000 Gs, Y1 |
| Seal, fine and gross | 1014 | A, C; 5 x $10^{-8}$ at mcc/sec |
| Burn in | 1015 | B; 160 hrs. $T_c$=85 to 125°C |
| Final electrical | App. Doc. | Per applicable document |
| External visual | 2009 | |

**Table 2. Typical RF hybrid basic screening per method 5008 of MIL-STD-883.**

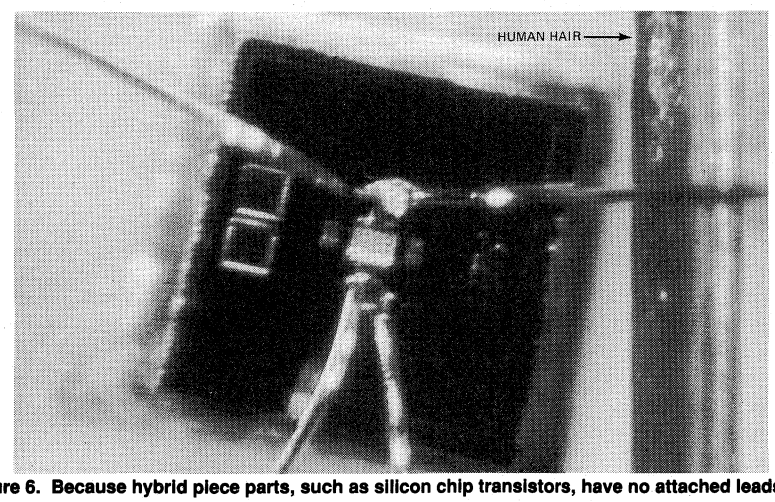



**Figure 6. Because hybrid piece parts, such as silicon chip transistors, have no attached leads or packages and are extremely small, screening at this level is very expensive.**

Although internal visual inspection is the only screen in this sequence prior to seal, it is performed after completion of an otherwise functional unit. Method 2017, the only appropriate MIL-STD internal visual specification for hybrid microcircuits, is comprehensively written for a "typical" unit. It must be modified and amended for unique piece parts and other aspects of specific applications. The detail specifications should call for internal visual inspection according to the manufacturer's approved standards in compliance with the intent of 2017.

Stabilization bake and temperature cycle tests are listed in Methods 5004 and 5008 with test condition level C ( 150° C and -65°

to +150°C, respectively ). Level A (75°C and -55°C to +85°C) or level B (+125°C and -55°C to +125°C) should be specified for most hybrids with multilayer chip capacitors or other large components, substrates and packages, and relatively hard attachment alloys.

The general screening levels, which were somewhat arbitrarily chosen for MIL-STD-883, originally addressed only monolithic circuits which do not possess the special conditions of hybrids. Similarly, a suggested constant acceleration level of 30,000 G (Condition E) was originally selected only for stressing wire bonds on monolithics without large mass components. Hybrids should only be stressed at 5,000 or 10,000 G (Condition A and B, respectively)., Excessive stress testing can actually reduce the MTBF of the components.

For cost considerations, pre-burn-in electrical tests should only be specified if a critical parameter drift is of concern. Burn-in temperature commensurate with a maximum operating junction tem-perature of the highest stressed active device must be selected. A typical burn-in time for hybrids is 160 hours (one week) the less common Class S level testing requires 240 hours!

**Differences Between RF Hybrids and Non-RF IC's**

It is vital to understand the electrical and manufacturing construction differences between non-RF integrated circuits and RF hybrids relative to cost and type of testing. For example, a lot of non-RF integrated circuits may only require 30 minutes for complete testing. One lot of 100 RF hybrids with a similar number of tested parameters and with customer specified (rather than manufacturer standard) electrical testing takes two days of senior technician time plus supervision and engineering consultation. To maximize product value, customers should utilize the manufacturer's standard testing or, at least, carefully select the number and type of test points.

Radiographic (X-ray) inspection, which is specified by approximately 15 percent of RF hybrid users, is relatively inexpensive to perform but can produce very expensive yield losses, since radiographic detail may vaguely show possible flaws that will not affect the operation of the part under test. Strict adherence to X-ray inspection rejection standards will often cause many good parts to be scrapped. Since it can very effectively determine catastrophic damage occurring after internal visual inspection, X-ray testing is generally performed near the end of the screening sequence. Because of the ambiguous nature of X-ray images, the inspection parameters and accept/reject levels should be sparingly and carefully chosen. This exemplifies the need to prevent misapplication of standards which could result in a very poor MTBF return per invested dollar.

Particle impact noise detection (PIND) testing, one of the newest screens, is now being specified more often. PIND detects loose particles within sealed units by electronic monitoring through an acoustic coupler while the device is vibrated and mechanically shocked.

The buyer (customer) of electronics parts will sometimes request a customer source inspection, in which the buyer sends his own inspector to observe certain phases of the fabrication process and to inspect test data and observe the taking of test data.

Customer source inspection is recommended only when the buyer has no experience with a particular manufacturer's product or knows of recent problems that warrant monitoring. Government source inspection (similar to customer source inspection, but with government inspectors) seldom contributes to the quality of the product if customer source inspection has already been performed, and can significantly contribute to schedule delay and costs.

Table 3 summarizes the costs and schedule impact of most of the standard screens for both mixers and RF hybrid microcircuits. A detailed description of the screens and their purposes is shown in Table 4.

**Specifying Hybrid Microcircuits**

The other appropriate document that should be applied in specifying hybrid microcircuits is MIL-M-38510. It establishes guidelines for the design and manufacturing environments. This specification is intended to be broad and comprehensive in its interpretation. The scope paragraph states: "Detail requirements, specific characteristics of microcircuits, and other provisions which are sensitive to the particular use intended shall be specified in the applicable device specification." Because of its general nature, MIL-M-38510 should never be specified without supplemental detail.

**Interpretation of MIL-M-38510**

Some areas of MIL-M-38510 frequently need further definition. Design is the first of these. Most hybrid manufacturers use epoxy in some stage of construction. MIL-M-38510 states: "No organic or polymeric materials shall be used inside the micro-circuit package...unless other wise specified." The supplier should not assume that his epoxy will be approved. The customer should state in his detail specification which epoxies can be accepted, and the supplier must state in his quotation what epoxy he proposes to use.

Paragraph 3.7.1 (Rework Restrictions) of MIL-M-38510 is frequently overlooked. A manufacturer rarely imposes MIL-M-38510 rework restrictions on his standard product line. Although most manufacturers will not experience a serious cost impact from the minor yield loss caused by such restrictions, the labor required to keep track of all the rework on unserialized and unsealed circuits can be substantial. This area should be addressed in some detail with the manufacturer before the specification is written.

Documentation helps maintain and insure reliability, but it can also create unnecessary additional costs if it isn't properly utilized and interpreted. More than $100,000 can be added to the average hybrid manufacturer's documentation system if MIL-M-38510 is directly and literally applied, because it is of such a general nature. Nevertheless, some hybrid customers consistently attempt to apply the full interpretation of MIL-M-38510 to contracts. In many cases, a customer only intends to use Appendix A (defines documentation requirements), which is a good general guide line. In such cases, the specification should state that the supplier's documentation should meet the general intent of Appendix A and "shall be subject to review and approval." That simple statement can save money, problems, and rebid cycles.

**Qualification**

Qualification (also called "first-article testing") requires a set of sample environmental tests, many of which are destructive, that establish the reliability of a design. Qualification of a product type can be accomplished in any of the following ways:

- A vendor can perform qualification testing before or during the delivery

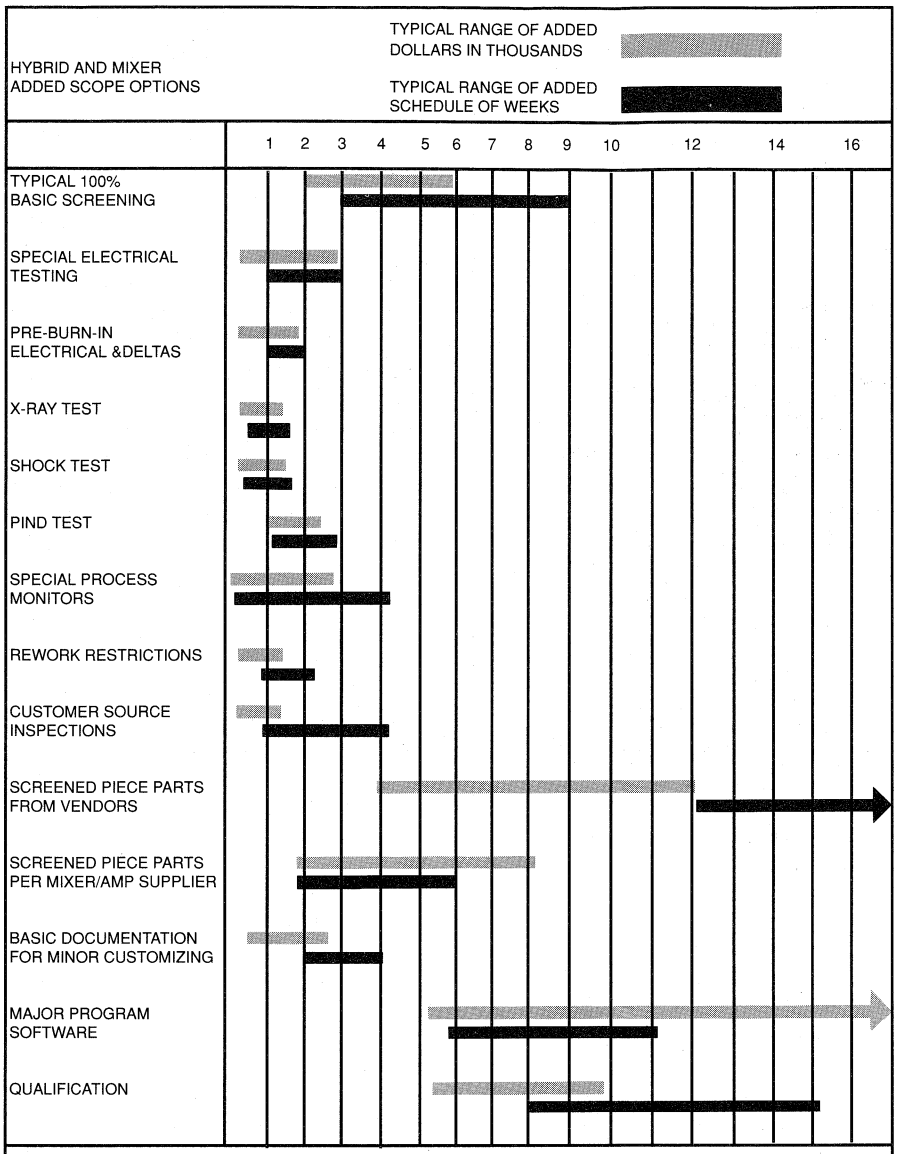



**Table 3. Cost and schedule impact of standard screens (based on a typical lot of up to 75 shippable devices).**

of the first product hardware.

- The procuring organization can perform qualification of the first production hardware before and/or after it is in the system.
- If qualification testing has been previously performed on the same or a similar design, the vendor can provide the procuring activity with a duplicate of or access to the data and history (qualification by similarity).

Qualification by similarity (which is specifically allowed by MIL-STD-883) represents the most cost- and schedule effective approach to verifying mechanical and electrical integrity. If new testing is definitely needed, sample sizes should be carefully discussed with the vendor, since hybrids can be two orders of magnitude more expensive than the monolithic ICs for which most of the traditional sample sizes have been established.

Nondestructive testing levels should be selected carefully and modified to be consistent with, and not to exceed, those chosen for 100-percent production acceptance screening. The specific tests performed in sample lot acceptance testing or quality conformance inspection can be similar, or even identical, to those performed in qualification. However, qual-ification is intended to verify a design, whereas sample lot acceptance testing identifies lot-oriented flaws resulting from production processes and materials.

Because of normal schedule constraints, hybrid production quality conformance inspection almost always serves to satisfy qualification requirements if qualification by similarity is unacceptable. Qualification and/or quality conformance inspection for amplifiers and mixer hybrids is performed according to MIL-STD-883, Method 5008, Groups A through D.

Group A, electrical testing, which frequently duplicates and occurs concurrently with final production electrical testing, is customized for the particular device and application. Groups B, C, and D are generally performed without major modification to the MIL-STD. Frequently, tests can be omitted to reduce costs in these should be discussed with the manufacturer before specifying. Included in the tests that may be omitted are PIND testing (Method 2020), internal water-vapor content (Method 1018), and salt atmosphere testing (Method 1009).

### Specifying Hi-rel Mixers

Because of the variety of military / OEM (original equipment manufacturer) systems applications which employ RF and microwave mixers, a great demand has developed for high-reliability programs of vastly varying scope. Several approaches may be selected for hi-rel RF and microwave mixer programs for the military/OEM market:

- "Off-the-shelf" catalog products can be screened to customer requirements ("screened standard").
- A catalog design can be specified with hi-rel manufacturing controls (including assembly by certified personnel) and screening.
- A custom design can be specified with hi-rel manufacturing controls and screening.
- Mixers can be specified according to MIL-M-28837.
- Mixers qualified under Mil-M-28837 can be purchased off the shelf.

The first, screened-standard option offers quickest delivery at the lowest cost. In many cases, the catalog model may be a stock item and only lead time (generally, the length of time from when an item is ordered to the time that it is shipped) for the specified environmental screening

**Stabilization bake**

- A redistribution process for impurity atoms, following assembly and seal.
- Believed to be most effective when followed by thermal shock and burn in.
- A low-cost screen.

**Temperature cycle/thermal shock**

- Temperature cycling allows for an ambient dwell period between extremes; thermal shock has no
- Intended to produce stress due to differences in thermal expansion of the materials in the assembly.
- Exercise solder joints, welds, bonds and package seals. Also test adhesive quality of interface between trace and dielectric material an microstrip/stripline designs.
- A low cost screen.

**Constant acceleration**

- Hybrid screen to detect weak bonds, poor component mountings, and poor substrate attach.
- A moderate cost screen.

**Hermeticity**

- For gross leak, a fluorocarbon immersion technique is used (1X10-5 atm cc/sec). For a fine leak, a helium tracer gas is detected with a mass spectrometer (1 X 10 ' atm cc/sec. typical),
- Both tests performed on hermetic designs to screen hardware which could have moisture or other package contaminants.
- A moderate cost screen.

**PIND testing (particle impact noise detection)**

- Vibration of the packaging while monitoring both visually (oscilloscope) and audibly for loose particles inside the package.
- Sensitivity standards for particle size yet undefined in the industry and test results are frequently non-repeatable and ambiguous.
- Detection of both conductive and nonconductive particles causes many reliable devices to be rejected,
- Discussion with the vendor recommended to determine program impact.
- A very expensive screen,

**Mechanical shock**

- Performed to demonstrate mechanical integrity and to verify design in worst-case handling conditions.
- Typically specified as a qualification test or sample test; may be considered a destructive test
- An expensive screen.

**High frequency vibration**

- Demonstrates mechanical integrity; verifies ability of a design to withstand vibration levels encountered in aircraft missiles, and tanks.
- Typically specified as a qualification test or sample test; may be considered a destructive test.
- A very expensive screen.

**Random vibration (unmonitored)**

- For lumped element and microstrip/stripline designs; very effective in locating weak solder joints and poor epoxy bonds.
- Specified in lieu of acceleration for lumped element and microstrip/stripline designs.
- A moderate cost screen.

**Burn-in**

- Stresses the semiconductors, indicates parameter stabilization, and identifies marginal metallization defects and potential oxide shorts.
- Marginal units and infant mortalities detected in the electrical test following burn in.
- A moderate cost screen.

**Radiographic inspection (X-ray)**

- One radiograph taken and inspected for particles or contaminants (greater than a predefined diameter and for cracked or broken connections and components.
- Radiographs verify adequate coverage of solder for chip and substrate attach.
- Either the vendor's certified inspector should perform the review or assist an inspector certified by the procuring agency,
- Value of test depends upon design, package, and seal techniques. (X-ray is often a cost driver due to subjectivity of the inspection, reduction in manufacturing yields and, therefore, higher unit costs.)
- Program impact and details of accept/reject criteria should be discussed with vendor.
- An expensive screen.

**Table 4. Standard screening tests and their purposes.**

and/or selected electrical testing will be required. Costs of the screened-standard option consist of the catalog model unit price, plus the yield factor (associated with the screening or the electrical selection) and a lot charge determined by the magnitude of the screening program. Lot charges can range from $2,000 to $5,000 and are often amortized over the quantity of units in a screening lot. Deliveries of screened catalog items can range from four weeks (if the item is in stock) to nine weeks.

A hi-rel program utilizing a catalog design, the second program option, offers the customer a wide range of flexibility. If a reliability-proven catalog design can be used, all other aspects of the program can be tailored to the needs of the customer. A hi-rel specialist can recommend the most effective screening options, and a program can be proposed to meet the cost, delivery, and performance guidelines specified. In some cases, trade-offs on specified performance versus cost and delivery are considered, and a unique program is defined to meet critical requirements.

The magnitude of the hi-rel program, including cost and delivery, is determined by any or all of the following factors:

- Utilization of screened internal components.
- Hi-rel assembly by certified assemblers at laminar flow benches (work benches with a filtered air system) in a controlled area.
- Hi-rel documentation (i.e., acceptance and qualification test documents, assembly procedure, electrical test procedure, screened internal component, etc.).
- Design reviews.
- Customer and government source inspections.
- Acceptance testing.
- Qualification testing.

Specifying screened internal components has a major impact on cost and delivery. For example, hi-rel diode quads which are used in many mixers, can range from $75 to $175 in small quantities, and require lead times from 12 to 20 weeks. Recently, lead times on "special" order or hi-rel SMA connectors have become extremely high, requiring up to 30 weeks. If screened internal components are required, delivery of the mixers can range from 24 to 30 weeks after completion of acceptance testing (excluding "special" connector procurements).

If a customer requires mechanical and/or electrical characteristics which cannot be satisfied by a catalog design, a custom design (the third program option) can be proposed. This option is constrained by the high cost and long lead time associated with new designs and prototype tooling and machining. A risk factor is also involved with qualifying a new design. A custom design can require 6 to 12 months for first-article delivery, and non-recurring engineering (NRE - a one-time design cost) charges can run $15,000 to $30,000 or more. Any or all hi-rel options of a preestablished design are also available with a custom design.

The MIL-M-28837 mixer specification has fostered the fourth program option. Since the military system designer must use MIL standard parts when available, a military specification to govern the design and performance characteristics of RF and microwave mixers has been needed. With the availability of MIL-M-28837 (which includes addendum's or "slash sheets" to detail the mechanical and electrical characteristics for each previously provided mixer), the system designer can specify any existing component and be assured that a non-standard parts request will not be required.

Although a qualified "off-the-shelf" device may not be available, a customer can specify: "The subject mixer shall be capable of meeting the requirements of MIL-M-28837." A nonstandard parts request must continue to be submitted to the military for any mixer not qualified to an existing slash sheet or having its own slash sheet. In summary, MIL-M-28837 will provide end users and manufacturers with the following advantages:

- An option to procure qualified parts without nonstandard parts request - saving time, dollars and effort.
- "Off-the-shelf" availability of MIL-M-28837 qualified screened or unscreened mixers.
- An industry standard for mixers allowing specification uniformity.
- Lower costs due to higher volume of standard units and deletion of qualification testing.

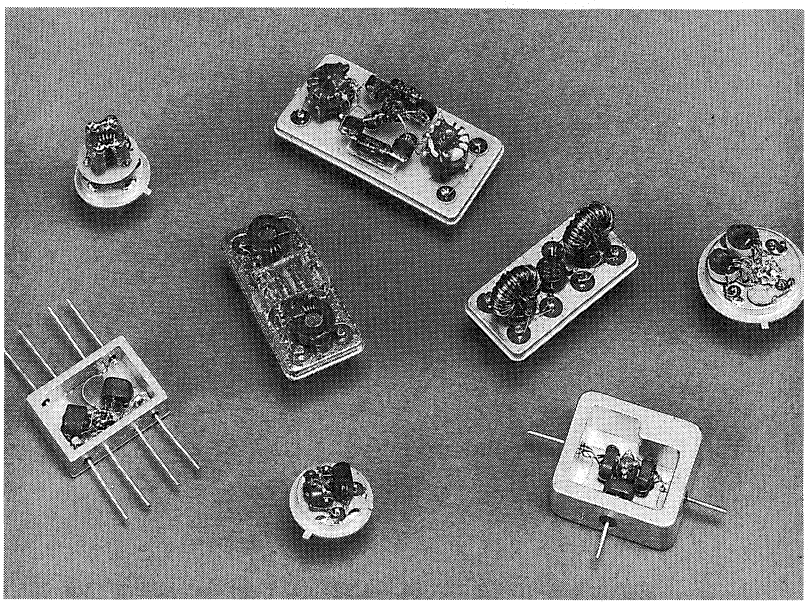


**Figure 7. Lumped element mixers with toroidal transformers are applied at frequent below 3 GHz.**

- "Plug-in"replacement availability from all qualified vendors.
- Elimination of "special" procurement documentation and associated cost.

**Mixer Design Technologies**

The three mixer design technologies now available in industry vary in frequency capabilities. In some cases the technologies can be interchanged to produce performance as well as reliability advantages, but the recommended screening for each will remain quite different. The most effective screening program is not only determined by the system environment, but also by the design technology used.

Lumped element mixers with toroidal transformers are applied at frequencies below 3 GHz (see Figure 7). One or two monolithic diode ring quads (hermetic or epoxy encapsulated) are combined with discrete resistors, capacitors, and diodes. This type of mixer is constructed in a variety of packages with highly adhesive, low-outgassing epoxies, and has bi-, tri-, or quadfilar wired assemblies. MIL-STD-202 screening is most applicable to this technology.

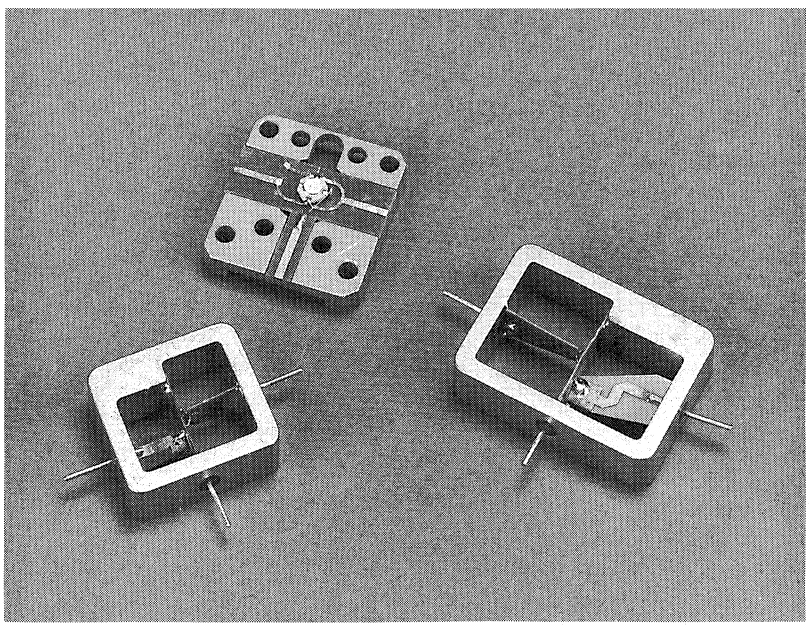


**Figure 8. Microstrip and stripline mixers find application between 3 and 18.5 GHz.**

Microstrip and stripline mixers find application between 3 and 18.5 GHz (see Figure 8). The low-loss, printed transmission lines offer consistent circuit repeatability. One or two monolithic diode quads are used, each in epoxy-encapsulated or hermetically sealed ceramic packages. Since this construction uses fewer components and solder connections, it produces higher MTBF than lumped element designs. Highly adhesive, low outgassing epoxies are used in the microstrip/stripline as well as the coaxial packages. MIL-STD-202 is also appropriate for screening these mixers.

Thin-film technology produces mixers for use between 10 MHz and 18.5 GHz with the lowest loss characteristics and the highest circuit repeatability (see Figure 9). Below 3 GHz, designs usually include a ceramic (alumina) substrate with printed tantalum nitride resistors, chip capacitors and diodes, and toroidal coupling. Such mixers use solder reflow or gold epoxy for component attachment, and TO-8 or flatpack hermetic packaging.

At higher frequencies, alumina (3 to 18.5 GHz) and quartz (above 8 GHz) substrates are used and are brazed to a gold-plated carrier assembly. Beam lead diodes and capacitors predominate and are attached through thermocompression. The carrier assembly is normally housed in a non-hermetic coaxial housing with SMA connectors. Of the three technologies, thin film requires the highest investment and the longest lead times. It is covered by MIL-STD-833.

Because of the significant differences in mixer design technologies, one screening program can't suffice for all devices. With the exception of thin-film mixers, all other designs adapt directly to MIL-STD-202 ("Test methods and procedures for microelectronics") . The earlier screening discussion for thin-film hybrid products applies to thin-film mixers as well. In addition to improperly specifying MIL-STD-883 for lumped element and micro-strip/stripline mixers, there are several other misconceptions concerning high reliability screening for mixers.

Time and money can be saved by adhering to the following suggestions:

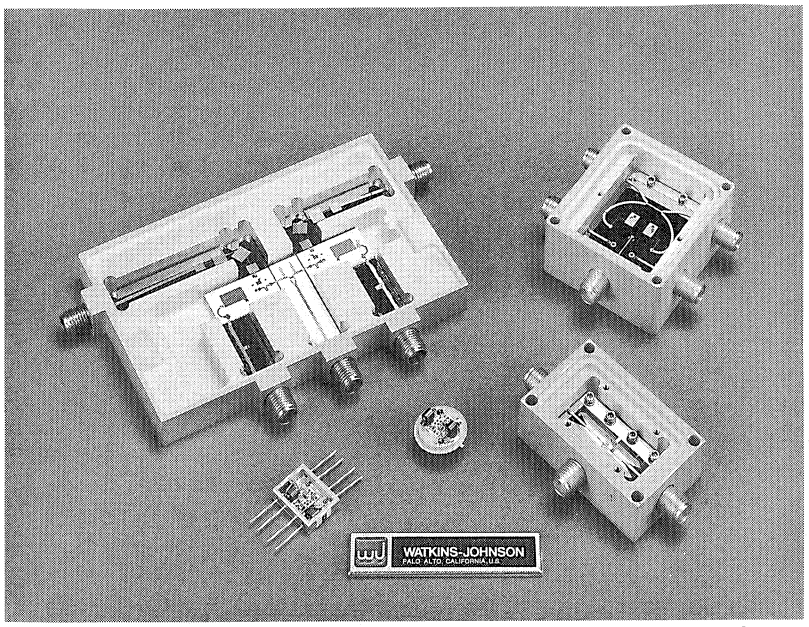



**Figure 9. Thin-Film technology produces mixers for use between 10 MHz and 18.5 GHZ.**

- Don't specify hermetically, humidity, and salt spray tests on non-hermetic packages.

- Don't specify fine-leak hermetically testing on packages with coaxial (SMA) connectors. (There are solutions to this problem; discuss this with the vendor before specifying.)

- Recognize that utilization of connectors greatly reduces MTBF.

- Realize that most mixer designs are not repairable. (Discuss this matter with the vendor before specifying repair clauses.)

- Don't specify burn-in with an RF source due to the cost impact of committing expensive test equipment. (A burn-in requirement can be easily satisfied by injecting a 60-Hz signal into the I port of the mixer. While the diodes are repeatedly switched on and off, the junction is heated to the maximum recommended temperature.)

- Don't specify large samples for "destructive" testing. A typical sample of two units serves to verify design integrity while minimizing costs.

- Don't specify operating temperatures above 100°C. (Most mixer designs carry a 100°C maximum operating temperature with maximum storage temperatures to 125°C. However, for ease of specification, a 100°C maximum for storage and operating is common.)

- Don't specify acceleration tests for the lumped element or microstrip/ stripline technologies unless truly applicable. (In most cases, vibration is a much more effective and applicable screen.)

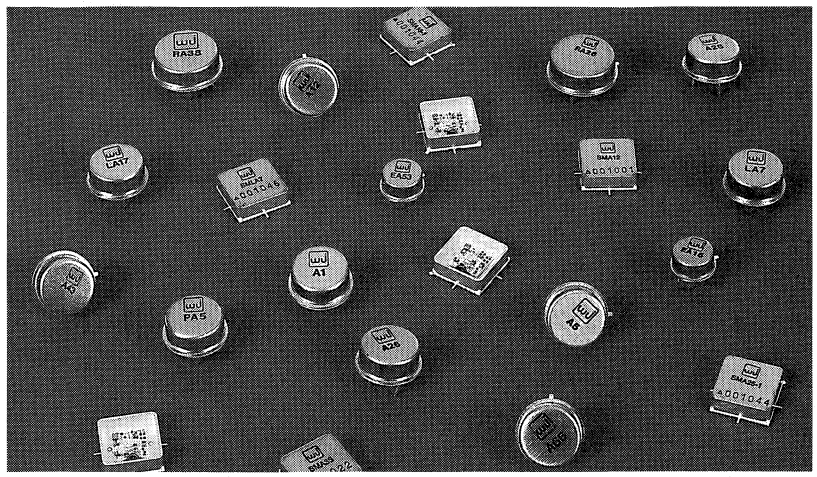
**Mixer Tests Undefined**

No military test specification exists which clearly defines qualification and acceptance tests for lumped element and microstrip/ stripline mixers. Although MIL-STD-202 delineates many screening tests applicable to mixers, this specification was not prepared specifically with mixers in mind. Consequently, numerous discrep-ancies are created when only test condi-tions guide general specifications, they must be modified for different designs and environments.

As stated earlier, qualification testing is performed specifically to demonstrate design integrity, while acceptance testing (Group A) demonstrates lot integrity. If specified, temperature (Group B) and mechanical (Group C) tests are performed for proving lot acceptability.

Qualification tests can cost from $5,000 to $10,000 and involve lead times from 10 to 15 weeks. The costs of acceptance testing (through Group A) typically ranges from $3,000 to $6,000, with the magnitude of the electrical test program determining the higher cost. Delivery upon completion of Group A testing requires five to seven weeks after completion of assembly, pre-seal visual inspection, electrical testing, and seal. Group B and Group C testing can add $4,000 to $6,000 to the cost, depending on the extent of the electrical and mechanical screening, and requires another five weeks following completion of Group A.

# CASCADABLE AMPLIFIERS





The RF and Microwave Frequency Range is well covered from 2 MHz through 8000 MHz by Watkins-Johnson's extensive line of cascadable amplifiers. These amplifiers have been designed to offer the system or subsystem designer maximum flexibility in performance options.

A predominantly hybrid approach using thin-film technology is used throughout the product line to obtain the highest levels of electrical performance, repeatability, stability, quality and reliability. Most recently, the product line has been emphasizing the utilization of the most recent advances in bi-polar and GaAs FET technology to obtain the highest gain per stage, the lowest noise figures, the highest output power and the widest bandwidths. In addition, much emphasis has been placed on improving the efficiency for power consumption limited applications. Using thin-film hybrid construction techniques coupled with ferrite core material and optimizing the electrical circuits, the maximum in efficiency is obtained.

The units are designed for maximum ease of cascading in a 50-ohm system. The designer may select an appropriate low-noise module for his first stage followed by as many gain blocks as required for his design. Cascaded power output will be determined by the final stage, where the output level will be unchanged, provided sufficient drive from the preceding amplifiers is available.

Each of these thin-film cascadable amplifiers is a complete amplifier in itself, including stable DC biasing circuitry and internal power supply decoupling. In addition to a good ground plane connection, the use of an external decoupling capacitor of at least 0.1 μf should be added.

Intended to cover a maximum number of applications, these amplifiers offer noise figures as low as 1.5 dB for narrow band applications, frequency coverage from 2 MHz to 8000 MHz, and power output in excess of +27 dBm. Most of these units are designed for a positive 15 volt supply voltage, while some may accept 12 volts or 5 volts. Overall, these universal modules can be characterized by stable and repeatable performance over a very broad range of frequencies, temperature and supply voltages.

The construction of the Watkins-Johnson amplifier series involves the highest levels of thin-film technology. The thin-film metalization is performed by using a high-vacuum RF sputtering system for both resistor and conductor metalizations. All conductor traces are gold metalization. The thin-film resistors are formed from tantalum nitride and are passivated at high temperature to yield excellent long-term stability. The resistor composition is such that there is less than 150 ppm/°C of change in resistor value over the full operating temperature range.

Thin-film circuitry offers very precise control of resistor and circuit patterns. Thin-film inductors, etched on the substrate, yield a high degree of repeatability from unit to unit. This is particularly important when repeatable gain, VSWR and phase characteristics are required.

All RF transistors are bonded to the substrate using a gold-silicon eutectic-die-attach process. This eliminates the need for scrubbing the thin-film gold and results in superior adhesion and more uniform contact which, in turn, gives better reliability and heat transfer.

The Watkins-Johnson cascadable amplifer provides the system designer with a reliable, low-cost, ultraminiature approach to his circuit design and allows him to concentrate on the complexities of the system without worrying about the intricacies of the RF transistor amplifier design.

A plot of the highest gain in a single TO-8 as a function of frequency is given in Figure 1. Over 35 dB is currently available up to 250 MHz, in excess of 24 dB up to 2000 MHz, and 20 dB up to 6000 MHz.

The lowest typical noise figure available versus frequency is shown in Figure 2, with 2.5 dB up to 1000 MHz, 3.5 dB up to 2000 MHz, and 3.5 dB up to 6000 MHz.

The highest output power available versus frequency is shown in Figure 3, with typically greater than +26 dBm up to 500 MHz, greater than +24 dBm to 2000 MHz, and greater than +15 dBm to 4000 MHz.

Several accessory components that further enhance the versatility of this approach are the TO-8 packaged passive limiters and gain control modules. A combination of up to eight TO-8 modules may be integrated in a W-J metal housing with SMA connectors. Other complementary signal processing components available from Watkins-Johnson include high quality mixers, detectors, switches, hybrids and transformers which may be integrated with the amplifier series into a number of useful subassemblies (see Index).

*Note*: Application information on using TO-8 amplifiers and further technical discussion on the circuit description of these amplifiers follows the technical data sheets in this handbook.

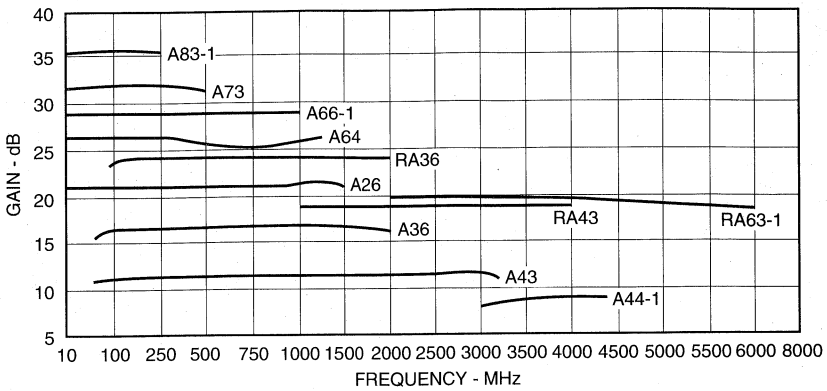



**FIGURE 1. GAIN PERFORMANCE VS. FREQUENCY**

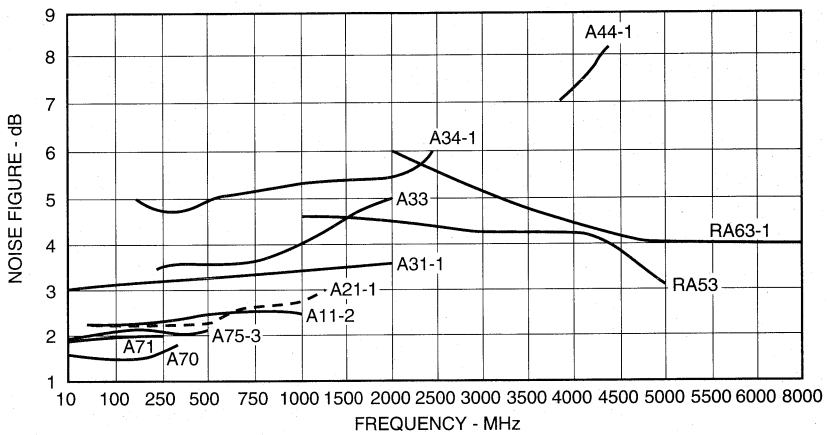



**FIGURE 2. NOISE PERFORMANCE VS. FREQUENCY OUTPUT**

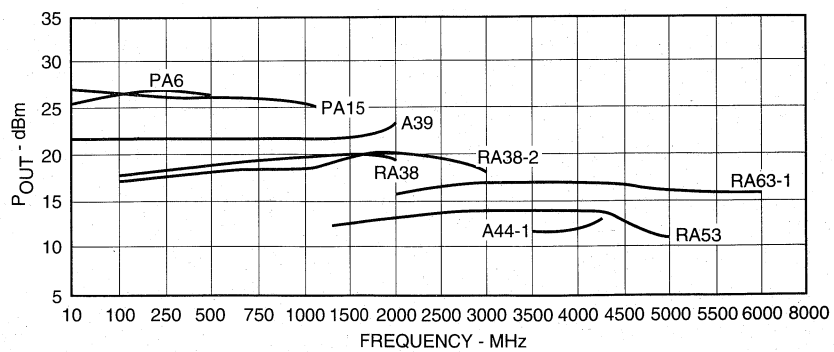



**FIGURE 3. OUTPUT POWER PERFORMANCE VS. FREQUENCY**

# SELECTION TIPS

The following groupings of Watkins-Johnson Cascadable Amplifiers have been provided for the purpose of increasing the awareness for the design engineer regarding differences between the amplifier families. With the gargantuan list of amplifiers that follows in the Selection Chart, the task of choosing the optimum amplifier for the given application has become increasingly difficult. It is intended that this additional information will help ease the task.



**Full Performance • Passive Bias**
**A3/A5/A7/A9/A19 Series**

These are full performance, no compromise amplifiers all designed using passive bias, and, except for the A32, all use choke decoupling. The A5 offers extremely low gain variation over temperature with a typical performance of less than ± 2 dB from -54°C to +100°C. In addition, these models that use choke decoupling provide very wide power supply ranges with the minimum effect on gain variation.

**Full Performance • Single-Stage Gain Blocks**
**A5-5/A5-6/A12/A25-1 /A35/A75 Series**

These amplifiers all provide medium output level of +7 dBm minimum using active bias circuits with resistive decoupling from the power supply. They will all operate effectively at lower than their rated 15- volt power supply with virtually no change in gain, NF or VSWR characteristics on 12-volt supplies. At 5 volts $V_{CC}$ , this series of amplifiers will draw typically about 9 mA of current and provide approximately 0 dBm of output power with an attendant gain drop of only about 1 dB. From 15V down to +10V $V_{CC}$ , the drop in output power is about 0.67 dB/volt. Below 10 volts, the output power drop is closer to 0.8 dB per volt. The low frequency range of this group is typically flat down to 1 MHz.

**High Gain • Two Stages • Full Performance**
**A80/A80-1/A73/A74/A74-1/A76/A64/A66/A66-1/A24 Series**

These are full performance amplifiers that offer 20 to 30 dB of gain using two common emitter RF stages complete with active bias housed in a single TO-8 package. These amplifiers have their rated specifications at 15 volts $V_{CC}$ , but, with the exception of the A73, will all operate with typically less than 10% loss of gain on power supply voltages as low as 5 volts. By combining two RF stages into a single package, the performance of two separate TO-8 single-stage amplifiers is very nearly achieved. Reliability is improved since the total parts count is reduced. The WJ-A80 is a new 20 to 500 MHz amplifier that provides 29 dB of gain, less than 2.5 dB noise figure, and greater than +14 dBm of output power for a new level of high performance in a single TO-8 package.

**Performance Cost Leaders**
**A51/A53/A54/A55/A56/A57 Series**

This group of amplifiers has been designed using totally passive bias and without the use of ferrites for the purpose of minimizing cost and, at the same time, maximizing performance within these constraints. Noise figures, for example, are typically only about 0.5 dB higher than a conventional full performance, active bias design. The A54 and the A56 are two-stage common emitter designs which offer a higher dB of gain per dollar ratio than is typically available using other design approaches. One trade off that accompanies the approach used in this series is that because of the relatively low $V_{CE}$ used, it is generally not recommended that they be operated on $V_{CC}$ supplies of less than 12 volts.

**High Output Level • Full Performance • Choke Decoupling**
**A77/A77-1/A18-1/A17/A27/A28/A37 Series**

The use of ferrite decoupling in this series allows for maximum bandwidth, gain, and output signal level for the collector current used. The active bias used controls the collector current to within ± 3% of the nominal value over the full MIL-STD temperature range of -54°C to +85°C. This series provides typically +14 to +15 dBm of output power at 15 volts $V_{CC}$ and will work well on power supplies as low as 5 volts with an attendant output power near +2 dBm while drawing only 9 to 13 mA of DC current.

**High Output Level • Low Intermod Series**
**A78/A79/A58/A59/A59-1/A19-1/A29-1/A38 A38-1/A39**

This group represents single-stage, bipolar designs that all have +22 dBm or +19 dBm typical output power at 15V $V_{CC}$ and have been designed to offer the minimum noise figure generally obtainable using conventional feedback for this output level. They all incorporate a single RF choke using a toroidal ferrite for excellence in design simplicity while maintaining high performance. The bias points on the transistors have been chosen for optimum third-order, two-tone suppression within the constraint of providing better than +20 dBm of output power on the models that have a "9" as the second digit. The single toroid/single substrate approach used in these designs also has improved reliability compared to multi-transformer or lossless feedback approaches. This group of amplifiers will operate effectively on 5 volts with typically less than 1 dB reduction in gain and will provide typically between 8 and 12 dBm of output power.

**High Gain • Two RF Stages • 100 Milliwatt Output Power**
**RA69/RA89/RA89-1 Series**

The WJ-RA38 through RA89-1 is a high gain series of amplifiers that typically offers in excess of +20 dBm output power in a 6-inch diameter TO-8 package. Most amplifiers that offer +20 dBm of output power are limited to less than 15 dB of gain while the RA89-1 typically provides 30.5 dB of gain. This group of amplifiers is designed using the traditional full performance active bias approach used in the W-J lower output power amplifiers, such as the A76, A66 and A26 amplifiers.

**High Gain • Three RF Stages • 25 Milliwatt Output Power**
**RA76/RA66/RA26/RA36/RA43/RA53**

The WJ-RA76 through RA43 are the highest gain series of amplifiers that typically offers +15 dBm output power in a 0.6 inch diameter TO-8 package. The RA76 typically provides 40.5 dB of gain up to 500 MHz while the RA53 provides 21 dB of gain to 5000 MHz. This group of amplifiers is designed using the traditional full performance active bias approach used in many lower gain amplifiers.

**Medium Power Class A • > 200 Milliwatts**
**PA2/PA3/PA3-1/PA5/PA6/PA10/PA10-1/PA15/PA30/PA32/PA38-2//PA48 Series**

Each of the WJ-PA series of amplifiers offers over 200 milliwatts of output power, covering 5 MHz to 4000 MHz, with the PA48 providing over 25 dBm of output power. The PA38-2 amplifier is the leader in dynamic range within this series by providing typically +24 dBm output, 9 dB of gain with a noise figure of less than 5 dB. Its dynamic range calculates to +122 dBm for a 1 MHz bandwidth. The PA15 provides typically 0.5 watt to 500 MHz and 0.35 watt to 1000 MHz with 13.5 dB of gain.

**Low Noise • Low Level • Active Bias**
**A1/A11/A11-2/A21-1/A31-1/A71 Series**

This series of amplifiers is designed for minimum broadband noise figures, biased typically with 5 mA of collector current, and uses little or no emitter feedback resistance. Because of the low collector bias current, these amplifiers operate best at their design $V_{CC}$ of 15 volts and are not recommended for operation on supplies of less than 12 volts. At 12 volts $V_{CC}$ , this series will typically lose about 1.5 dB of gain compared to less than 0.2 dB loss for other W-J full performance amplifiers that provide 7.0 dBm or greater output power at 15 volts $V_{CC}$. The low frequency range of this group is typically flat down to 1 MHz.

**Low Noise • High Dynamic Range • High Efficiency**
**A70/A70-1 /A70-2/A70-3 Series**

The WJ-A70 through A70-3 series offers noise figures from as low as 1.5 dB with an attendant output power of +9.0 dBm to an output power of as high as +23 dBm (+33 dBm Third Order IM Point) with an attendant noise figure of only 2.8 dB. This series is designed for the lowest possible noise figure consistent with the highest possible dynamic range. For example, the WJ-A70-3 has a dynamic range of +123.7 dBm in a 1 MHz bandwidth.

**Low Noise • High Efficiency • High Reverse Isolation**
**A81/A81-1/A81-2/A81-3/A82/A82-1 Series**

The WJ-A81 through A82-1 series is designed for the ultimate in efficiency and very high reverse isolation (> 35 dB). They are also designed for low noise figures (less than 3 dB) and output levels (> 15 dBm). This series has the highest efficiency index of the cascadable amplifiers that is attributable to the unique cascade circuit configuration used. The cascade design consists of driving a common emitter stage into a common base stage where the common base acts as a non-phase inverting impedance transformer, which allows a much smaller amount of resistive feedback to be used, which in turn improves the reverse isolation and decreases the degradation in noise figure.

**High Efficiency • Transformer Coupled**
**A87/A87-1/A87-2/A67/A67-1 /A86 Series**

This series of amplifiers uses transformer coupled collector circuits for the purpose of minimizing the shunt loading on the output. This increases the effective output power obtainable from a given collector current thereby increasing the DC to RF conversion efficiency. For example, the A87-1 yields +17 dBm of output power drawing 33 mA of current compared with +16.5 of output power for the A77, which draws 50 mA of current. For the ultimate in efficiency improvement, the A86 provides 9 dBm of output power using a 5- volt $V_{CC}$ and draws 21 mA of current. Compared to the A74 amplifier, this represents about a 700% savings in total DC power consumption. The compromise that accompanies this approach is some loss of gain and bandwidth over straight choke decoupling.

**GaAs FET Amplifiers**
**A32/A32-1/A41/A41-1/RA43/A45/A45-1/RA46/RA53/A61-1/RA62/RA63/RA63-1**

This series of GaAs FET amplifiers is designed for maximum bandwidth such as 1 to 4 GHz and 2 to 8 GHz using resistive feedback. The amplifiers are available with one, two, or three stages of amplification depending on the model. These devices have an average of 7 dB per stage and noise figures of 4 to 6 dB. These amplifiers operate off either a 12 or 5 volt supply.

# THIN FILM PRODUCTS SELECTION CHART

## Typical and Guaranteed Specifications

### RF AMPLIFIERS

| | Model | Frequency Range MHZ | Small Signal Gain dB Typ. | Small Signal Gain dB Min. 0/50C | Small Signal Gain dB Min. -54/85C | Gain Flatness ±dB Max. 0/50C | Gain Flatness ±dB Max. -54/85C | Noise Figure dB Typ. | Noise Figure dB Max. 0/50C | Noise Figure dB Max. -54/85C | Power Output @ 1 dB Compression dBm Typ. | Power Output @ 1 dB Compression dBm Min. 0/50C | Power Output @ 1 dB Compression dBm Min. -54/85C | Intercept Point dBm Typ. | VSWR In/out Max. 0/50 | VSWR In/out Max. -54/85C | DC Volts Nom | DC mA Typ. | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **10 TO 250 MHz * LOW NOISE * HIGH DYNAMIC RANGE * HIGH EFFICIENCY** | | | | | | | | | | | | | | | | | | |
| | A70* | 10-250 | 8.0 | 7.5 | 7.0 | 0.5 | 0.7 | 1.8 | 2.3 | 2.8 | 8.5 | 7.5 | 7.0 | 21 | 2.1 | 2.3 | 15 | 10 | TO-8 |
| | A70-1* | 10-250 | 8.0 | 7.5 | 7.0 | 0.5 | 0.7 | 1.8 | 2.3 | 2.8 | 14.0 | 13.0 | 12.5 | 28 | 2.1 | 2.3 | 15 | 15 | TO-8 |
| | A70-2* | 10-250 | 7.0 | 6.5 | 6.0 | 0.8 | 1.0 | 2.2 | 2.7 | 3.2 | 19.0 | 18.0 | 17.5 | 35 | 2.1 | 2.3 | 15 | 25 | TO-8 |
| | A70-3* | 20-250 | 7.0 | 6.5 | 5.5 | 0.5 | 1.0 | 2.5 | 3.0 | 3.5 | 21.0 | 20.5 | 20.0 | 34 | 2.1 | 2.3 | 15 | 37 | TO-8 |
| | **20 TO 500 MHz * LOW NOISE * HIGH EFFICIENCY * HIGH REVERSE ISOLATION** | | | | | | | | | | | | | | | | | | |
| NEW | **A80-1*** | **10-200** | **27.3** | **26.0** | **25.0** | **0.7** | **1.0** | **2.0** | **2.5** | **3.0** | **16.0** | **14.5** | **14.0** | **28** | **1.8** | **2.0** | **15** | **30** | **TO-8** |
| | A86-1* | 10-200 | 28.0 | 27.0 | 26.5 | 0.6 | 0.8 | 2.8 | 3.5 | 4.0 | 16.0 | 15.0 | 14.5 | 28 | 1.9 | 2.0 | 15 | 47 | TO-8 |
| | A81* | 20-250 | 24.0 | 23.5 | 23.0 | 0.5 | 0.7 | 3.5 | 4.0 | 4.5 | 17.0 | 16.0 | 15.5 | 30 | 1.9 | 2.0 | 15 | 35 | TO-8 |
| | A81-1* | 20-250 | 24.5 | 23.5 | 23.0 | 0.5 | 0.7 | 2.5 | 3.2 | 3.7 | 12.5 | 11.5 | 11.0 | 23 | 1.9 | 2.0 | 15 | 25 | TO-8 |
| | A82* | 20-250 | 22.5 | 21.5 | 21.0 | 0.7 | 1.0 | 4.0 | 4.5 | 5.0 | 20.0 | 19.0 | 18.0 | 32 | 2.0 | 2.0 | 15 | 50 | TO-8 |
| | A82-1* | 20-250 | 18.0 | 16.5 | 16.0 | 0.7 | 1.0 | 4.0 | 4.5 | 5.0 | 15.5 | 14.0 | 13.5 | 28 | 1.9 | 2.0 | 15 | 50 | TO-8 |
| NEW | **A80*** | **20-500** | **29.0** | **27.5** | **26.5** | **0.7** | **1.0** | **2.3** | **3.0** | **3.4** | **14.3** | **13.0** | **12.5** | **27** | **2.1** | **2.3** | **15** | **45** | **TO-8** |
| | A81-2* | 20-300 | 22.0 | 21.5 | 21.0 | 0.5 | 0.7 | 3.5 | 4.0 | 4.5 | 15.0 | 14.0 | 13.5 | 28 | 1.8 | 2.0 | 15 | 29 | TO-8 |
| | | 20-500 | 22.0 | 21.5 | 21.0 | 0.5 | 0.7 | 4.0 | 4.5 | 5.0 | 15.0 | 14.0 | 13.5 | 28 | 1.8 | 2.0 | 15 | 29 | |
| | A81-3* | 20-300 | 17.0 | 16.0 | 15.5 | 0.5 | 0.7 | 3.6 | 4.0 | 4.5 | 8.0 | 7.5 | 7.0 | 20 | 1.8 | 2.0 | 15 | 29 | TO-8 |
| | | 20-500 | 17.0 | 16.0 | 15.5 | 0.5 | 0.7 | 4.0 | 4.5 | 5.0 | 8.0 | 7.5 | 7.0 | 20 | 1.8 | 2.0 | 15 | 29 | |
| | **5 TO 700 MHz * HIGH EFFICIENCY * 15 VDC BIAS** | | | | | | | | | | | | | | | | | | |
| | A87* | 10-400 | 12.5 | 12.0 | 11.5 | 0.5 | 0.7 | 4.7 | 5.5 | 6.0 | 17.0 | 16.0 | 16.0 | 32 | 2.0 | 2.0 | 15 | 31 | TO-8 |
| | A87-1* | 10-400 | 15.5 | 14.5 | 14.0 | 0.7 | 1.0 | 3.6 | 4.5 | 5.0 | 17.0 | 15.5 | 15.0 | 31 | 2.0 | 2.0 | 15 | 33 | TO-8 |
| | A67* | 10-800 | 14.0 | 13.0 | 12.5 | 0.6 | 0.7 | 4.0 | 4.3 | 4.5 | 16.0 | 15.5 | 15.0 | 30 | 2.0 | 2.2 | 15 | 32 | TO-8 |
| | | 10-800 | 12.5 | 11.5 | 11.0 | 0.5 | 0.7 | 4.3 | 5.0 | 5.5 | 15.5 | 15.0 | 14.0 | 28 | 2.0 | 2.2 | 15 | 32 | |
| | **A67-1*** | 10-600 | 15.0 | 14.0 | 13.5 | 0.5 | 0.7 | 4.0 | 4.3 | 4.5 | 17.0 | 16.5 | 16.0 | 30 | 2.0 | 2.0 | 15 | 32 | TO-8 |
| | **5 TO 1500 MHz * HIGH EFFICIENCY * ULTRA LOW POWER CONSUMPTION * 5 VDC BIAS** | | | | | | | | | | | | | | | | | | |
| | A86* | 10-200 | 28.0 | 27.0 | 26.0 | 0.8 | 1.0 | 3.8 | 4.5 | 5.0 | 9.0 | 7.5 | 7.0 | 20 | 1.9 | 2.0 | 5 | 21 | TO-8 |
| | A83-1* | 10-250 | 35.5 | 34.0 | 33.0 | 0.5 | 0.8 | 2.5 | 3.0 | 3.5 | -1.5 | -2.5 | -3.5 | 9 | 1.8 | 2.0 | 5 | 13 | TO-8 |
| | A87-2* | 10-300 | 15.5 | 15.0 | 14.5 | 0.5 | 0.8 | 3.0 | 3.5 | 4.0 | 9.5 | 9.0 | 8.5 | 23 | 1.8 | 2.0 | 5 | 14.5 | TO-8 |
| | A83* | 10-500 | 30.0 | 29.0 | 28.0 | 0.5 | 0.8 | 3.0 | 3.5 | 4.0 | -1.0 | -2.0 | -4.0 | 10 | 1.8 | 2.0 | 5 | 13 | TO-8 |
| NEW | **A76-1*** | **5-500** | **27.5** | **26.0** | **25.0** | **0.8** | **1.0** | **2.8** | **4.0** | **4.5** | **13.0** | **12.0** | **11.0** | **25** | **1.9** | **2.0** | **5** | **47** | **TO-8** |
| | A74-2* | 5-500 | 26.0 | 25.0 | 24.0 | 1.0 | 1.2 | 3.8 | 4.3 | 4.8 | -1.0 | -2.0 | -2.0 | 10 | 2.0 | 2.0 | 5 | 13 | TO-8 |
| | A72* | 5-500 | 14.7 | 14.0 | 13.5 | 0.7 | 1.0 | 4.0 | 5.0 | 5.5 | 12.5 | 11.5 | 11.0 | 27 | 1.7 | 1.8 | 5 | 30 | TO-8 |
| | A66-3* | 10-1000 | 26.0 | 24.5 | 24.0 | 0.8 | 1.1 | 3.0 | 3.5 | 4.0 | 3.0 | 1.5 | 1.0 | 13 | 1.8 | 2.0 | 5 | 16 | TO-8 |
| | A16-2* | 10-1200 | 13.0 | 12.0 | 11.5 | 0.5 | 0.7 | 3.5 | 4.0 | 4.5 | 6.0 | 5.0 | 4.5 | 18 | 1.9 | 2.0 | 5 | 15 | TO-8 |
| | A28-2* | 10-1000 | 14.0 | 13.0 | 12.5 | 0.5 | 1.0 | 3.5 | 4.5 | 5.0 | 10.5 | 9.5 | 8.5 | 24 | 1.9 | 2.0 | 5 | 27 | TO-8 |
| | | 10-1500 | 14.0 | 13.0 | 12.5 | 0.5 | 1.0 | 3.5 | 4.5 | 5.0 | 10.0 | 7.5 | 7.0 | 24 | 1.9 | 2.0 | 5 | 27 | |
| | **5 TO 300 MHz** | | | | | | | | | | | | | | | | | | |
| | A71* | 5-200 | 18.0 | 16.5 | 16.0 | 0.8 | 1.0 | 2.1 | 2.5 | 2.8 | -2.5 | -3.0 | -3.5 | 10 | 1.9 | 2.0 | 15 | 9 | TO-8 |
| NEW | **A181*** | **10-250** | **16.5** | **15.5** | **14.5** | **0.7** | **0.8** | **3.8** | **4.5** | **5.0** | **22.0** | **20.0** | **19.5** | **35** | **1.9** | **1.9** | **15** | **95** | **TO-8** |
| | A75-2* | 5-250 | 21.0 | 20.0 | 19.0 | 0.7 | 1.0 | 4.2 | 4.5 | 5.0 | 8.0 | 7.0 | 7.0 | 19 | 1.7 | 2.0 | 15 | 24 | TO-8 |
| | A74-1* | 5-250 | 31.0 | 30.0 | 29.0 | 0.7 | 1.0 | 4.5 | 5.0 | 5.5 | 8.5 | 7.0 | 7.0 | 21 | 1.7 | 2.0 | 15 | 40 | TO-8 |
| | A88-1* | 5-300 | 18.5 | 17.5 | 17.0 | 0.6 | 0.8 | 3.8 | 5.0 | 5.5 | 18.5 | 17.0 | 16.5 | 30 | 1.7 | 1.9 | 15 | 52 | TO-8 |
| | A78* | 5-300 | 14.0 | 13.0 | 12.5 | 0.7 | 1.0 | 4.5 | 5.5 | 6.0 | 19.5 | 180 | 17.5 | 33 | 1.9 | 2.0 | 15 | 65 | TO-8 |
| | A79* | 5-250 | 13.5 | 13.0 | 12.5 | 0.7 | 1.0 | 5.2 | 6.5 | 7.0 | 22.0 | 20.0 | 19.5 | 36 | 1.8 | 2.0 | 15 | 88 | TO-8 |
| | **5 TO 400 MHz** | | | | | | | | | | | | | | | | | | |
| | A51* | 10-400 | 15.0 | 14.0 | 13.0 | 0.7 | 1.0 | 2.7 | 3.0 | 3.5 | -3.0 | -3.5 | -3.5 | 10 | 1.7 | 2.0 | 15 | 7 | TO-8 |
| | A54* | 5-400 | 27.5 | 26.0 | 24.0 | 0.8 | 1.0 | 4.5 | 5.5 | 6.0 | 8.0 | 6.5 | 5.5 | 19 | 2.0 | 2.0 | 15 | 34 | TO-8 |
| | A56* | 5-400 | 26.0 | 24.0 | 23.0 | 1.0 | 1.0 | 5.5 | 7.0 | 7.5 | 13.5 | 12.5 | 12.0 | 27 | 2.0 | 2.0 | 15 | 69 | TO-8 |
| | **5 TO 800 MHz** | | | | | | | | | | | | | | | | | | |
| | A1* | 5-500 | 16.0 | 15.0 | 14.5 | 0.7 | 1.0 | 2.4 | 3.0 | 3.5 | -1.0 | -2.0 | -3.0 | 11 | 1.8 | 2.0 | 15 | 9 | TO-8 |
| | A75-3* | 10-500 | 20.5 | 19.5 | 18.5 | 0.7 | 1.0 | 2.3 | 2.5 | 3.0 | 3.5 | 2.0 | 1.5 | 15 | 1.8 | 2.0 | 15 | 14 | TO-8 |
| | A75* | 5-500 | 21.0 | 20.0 | 19.0 | 0.7 | 1.0 | 2.6 | 3.0 | 3.5 | 9.0 | 7.0 | 7.0 | 21 | 1.8 | 2.0 | 15 | 24 | TO-8 |
| | A53* | 10-500 | 15.0 | 14.0 | 13.5 | 0.8 | 1.0 | 3.0 | 3.5 | 4.0 | 3.5 | 2.0 | 1.5 | 16 | 2.0 | 2.0 | 15 | 12 | TO-8 |
| | A3* | 5-500 | 15.5 | 14.0 | 13.5 | 0.7 | 1.0 | 3.3 | 4.0 | 4.5 | -1.0 | -2.0 | -3.0 | 11 | 1.7 | 2.0 | 15 | 9 | TO-8 |
| | A5-5* | 5-500 | 15.5 | 14.0 | 13.5 | 0.5 | 0.7 | 4.0 | 5.0 | 5.5 | 9.0 | 7.0 | 7.0 | 21 | 1.5 | 1.6 | 15 | 24 | TO-8 |

Notes: 1. Specifications guaranteed to +71°C.
*Also available in Surface-Mount

# Typical and Guaranteed Specifications

| Model | Frequency Range MHZ | Small Signal Gain dB | | | Gain Flatness +dB | | Noise Figure dB | | | Power Output @ 1 dB Compression dBm | | | Intercept Point dBm | VSWR In/out | | DC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Typ. | Min. 0/50C | Min. -54/85C | Max. 0/50C | Max. -54/85C | Typ. | Max. 0/50C | Max. -54/85 | Typ. | Min. 0/50C | Min. -54/85C | Typ. | Max. 0/50 | Max. -54/85C | Volts Nom | mA Typ. | Package Type |
| **5 TO 800 MHz Continued** | | | | | | | | | | | | | | | | | | |
| A5* | 5-500 | 14.8 | 14.0 | 13.5 | 0.7 | 0.7 | 4.5 | 5.5 | 6.0 | 8.5 | 7.0 | 7.0 | 22 | 1.8 | 2.0 | 15 | 25 | TO-8 |
| A5-6* | 5-600 | 16.0 | 15.0 | 14.5 | 0.7 | 0.7 | 4.5 | 5.5 | 6.0 | 8.5 | 7.0 | 6.5 | 21 | 1.8 | 2.0 | 15 | 24 | TO-8 |
| A71* | 5-500 | 14.9 | 14.0 | 13.5 | 0.7 | 1.0 | 5.5 | 6.5 | 6.5 | 14.0 | 13.0 | 12.5 | 26 | 1.8 | 2.0 | 24 | 43 | TO-8 |
| NEW **A180*** | **10-500** | **16.5** | **16.0** | **15.5** | **0.7** | **0.8** | **3.4** | **4.0** | **4.5** | **18.0** | **16.0** | **15.0** | **33** | **2.0** | **2.0** | **15** | **63** | **TO-8** |
| A55* | 10-500 | 14.7 | 14.0 | 13.5 | 0.8 | 1.0 | 5.0 | 6.0 | 6.5 | 11.0 | 9.0 | 8.0 | 24 | 2.0 | 2.0 | 15 | 30 | TO-8 |
| A57* | 10-500 | 14.7 | 14.0 | 13.0 | 0.8 | 1.0 | 4.8 | 6.0 | 6.5 | 14.0 | 13.0 | 12.5 | 28 | 2.0 | 2.0 | 15 | 44 | TO-8 |
| A77* | 5-500 | 16.5 | 16.0 | 15.0 | 0.7 | 1.0 | 5.0 | 6.0 | 6.5 | 16.5 | 15.0 | 14.5 | 30 | 1.7 | 2.0 | 15 | 50 | TO-8 |
| A77-1* | 5-600 | 16.0 | 15.0 | 14.5 | 0.7 | 1.0 | 5.0 | 6.5 | 7.0 | 16.5 | 15.0 | 14.5 | 30 | 1.8 | 2.0 | 15 | 50 | TO-8 |
| A58* | 5-500 | 11.5 | 10.0 | 9.5 | 0.7 | 1.0 | 4.8 | 6.0 | 6.5 | 19.0 | 18.0 | 17.5 | 35 | 1.9 | 2.0 | 15 | 65 | TO-8 |
| A59* | 5-500 | 11.5 | 10.0 | 9.5 | 0.7 | 1.0 | 5.5 | 6.5 | 7.0 | 22.0 | 20.0 | 20.0 | 38 | 1.9 | 2.0 | 15 | 88 | TO-8 |
| A88* | 5-500 | 18.7 | 18.0 | 17.5 | 0.5 | 0.7 | 6.5 | 7.5 | 8.0 | 20.5 | 19.5 | 19.0 | 30 | 1.8 | 2.0 | 15 | 79 | TO-8 |
| A91* | 5-500 | 11.0 | 10.0 | 9.5 | 1.0 | 1.0 | 8.0 | 10.0 | 10.5 | 22.0 | 20.0 | 20.0 | 35 | 2.0 | 2.0 | 24 | 110 | TO-8 |
| A59-1* | 10-700 | 10.5 | 9.5 | 9.0 | 0.8 | 1.0 | 6.0 | 7.5 | 8.0 | 22.0 | 20.0 | 20.0 | 36 | 1.9 | 2.0 | 15 | 88 | TO-8 |
| A89* | 100-800 | 22.0 | 21.0 | 20.5 | 0.8 | 1.0 | 4.5 | 5.5 | 6.0 | 17.5 | 16.5 | 16.0 | 30 | 2.0 | 2.2 | 15 | 42 | TO-8 |
| **5 TO 500 MHz * HIGH GAIN * MULTI-STAGE** | | | | | | | | | | | | | | | | | | |
| A73* | 5-500 | 32.0 | 30.0 | 29.0 | 0.7 | 1.0 | 3.5 | 4.0 | 4.5 | 1.5 | 1.0 | 0.5 | 15 | 1.8 | 2.0 | 15 | 20 | TO-8 |
| A74* | 5-500 | 30.0 | 28.0 | 27.0 | 0.7 | 1.0 | 4.7 | 5.5 | 6.0 | 8.5 | 7.0 | 7.0 | 20 | 1.8 | 2.0 | 15 | 40 | TO-8 |
| A76* | 5-500 | 28.0 | 27.0 | 26.0 | 1.0 | 1.0 | 4.7 | 5.5 | 6.0 | 15.0 | 14.0 | 13.5 | 28 | 1.9 | 2.0 | 15 | 62 | TO-8 |
| RA89* | 5-500 | 26.5 | 25.5 | 25.0 | 0.7 | 1.0 | 3.7 | 4.5 | 5.0 | 21.5 | 20.5 | 20.0 | 35 | 1.8 | 2.0 | 15 | 130 | TO-8B |
| RA89-1* | 10-500 | 30.0 | 29.0 | 28.0 | 0.7 | 1.0 | 3.2 | 4.5 | 5.0 | 21.5 | 20.0 | 20.0 | 36 | 1.8 | 2.0 | 15 | 130 | TO-8B |
| RA76* | 10-500 | 40.5 | 38.5 | 37.5 | 0.9 | 1.2 | 3.0 | 3.8 | 4.3 | 15.0 | 13.3 | 12.3 | 26 | 1.8 | 2.0 | 15 | 81 | TO-8B |
| **5 TO 1000 MHz** | | | | | | | | | | | | | | | | | | |
| A11-2* | 5-1000 | 16.0 | 15.0 | 14.0 | 0.9 | 1.0 | 2.5 | 3.0 | 3.5 | -1.0 | -3.0 | -3.5 | 10 | 1.9 | 2.0 | 15 | 9 | TO-8 |
| A11* | 5-1000 | 14.7 | 14.0 | 13.5 | 1.0 | 1.2 | 3.1 | 3.5 | 4.0 | -2.0 | -3.0 | -4.0 | 10 | 1.8 | 2.0 | 15 | 9 | TO-8 |
| A12* | 10-1000 | 16.0 | 15.0 | 14.5 | 0.7 | 1.0 | 2.8 | 3.5 | 3.9 | 8.0 | 7.0 | 6.5 | 22 | 1.9 | 2.0 | 15 | 22 | TO-8 |
| A63* | 5-1000 | 16.0 | 15.0 | 14.5 | 1.0 | 1.0 | 3.0 | 4.0 | 4.5 | 4.0 | 2.0 | 2.0 | 15 | 1.9 | 2.0 | 15 | 14 | TO-8 |
| A18-1* | 10-1000 | 14.7 | 14.0 | 13.5 | 0.5 | 1.0 | 3.8 | 5.0 | 5.5 | 16.0 | 15.0 | 14.5 | 30 | 1.8 | 2.0 | 15 | 44 | TO-8 |
| A65* | 10-1000 | 10.5 | 9.5 | 9.0 | 0.7 | 0.8 | 6.0 | 7.5 | 8.0 | 10.0 | 8.0 | 8.0 | 24 | 1.9 | 2.0 | 15 | 30 | TO-8 |
| A17* | 10-1000 | 12.0 | 10.5 | 10.0 | 0.7 | 1.0 | 6.0 | 7.5 | 8.0 | 15.3 | 14.0 | 13.5 | 27 | 1.8 | 2.0 | 15 | 44 | TO-8 |
| A-19-1* | 30-600 | 11.5 | 10.5 | 10.0 | 0.6 | 0.8 | 6.0 | 7.0 | 7.5 | 22.5 | 20.5 | 20.0 | 35 | 1.7 | 2.0 | 15 | 90 | TO-8 |
| | 10-1000 | 11.5 | 10.5 | 10.0 | 0.6 | 0.8 | 6.5 | 8.0 | 8.5 | 22.5 | 20.5 | 20.0 | 35 | 1.7 | 2.0 | 15 | 90 | |
| A19* | 10-1000 | 7.5 | 6.0 | 5.5 | 1.0 | 1.3 | 9.0 | 10.5 | 11.0 | 21.0 | 20,0 | 19.0 | 34 | 2.2 | 2.2 | 15 | 100 | TO-8 |
| **10 TO 1200 MHz * HIGH GAIN * MULTI-STAGE** | | | | | | | | | | | | | | | | | | |
| A66-3* | 10-1000 | 26.0 | 24.5 | 24.0 | 0.8 | 1.1 | 3.0 | 3.5 | 4.0 | 3.0 | 1.5 | 1.0 | 13 | 1.8 | 2.0 | 5 | 16 | TO-8 |
| A66-1* | 10-500 | 27.5 | 26.0 | 25.5 | 0.7 | 1.0 | 2.7 | 3.5 | 4.0 | 15.0 | 14.5 | 14.0 | 27 | 1.8 | 2.0 | 15 | 65 | TO-8 |
| | 10-1000 | 27.5 | 26.0 | 25.5 | 0.7 | 1.0 | 3.0 | 4.0 | 4.5 | 15.0 | 14.5 | 14.0 | 27 | 1.8 | 2.0 | 15 | 65 | |
| RA69* | 10-1000 | 25.0 | 24.0 | 23.0 | 0.7 | 1.0 | 4.5 | 5.5 | 6.0 | 23.0 | 20.0 | 20.0 | 34 | 2.0 | 2.0 | 15 | 130 | TO-8B |
| A64* | 10-1000 | 26.0 | 24.0 | 23.0 | 0.8 | 1.0 | 3.0 | 3.8 | 4.3 | 8.0 | 7.0 | 6.5 | 20 | 1.7 | 1.8 | 15 | 35 | TO-8 |
| | 10-1200 | 26.0 | 24.0 | 23.0 | 0.8 | 1.0 | 3.4 | 4.3 | 4.8 | 8.0 | 7.0 | 6.5 | 20 | 1.9 | 2.0 | 15 | 35 | |
| A66* | 10-1200 | 23.5 | 22.0 | 21.0 | 0.7 | 1.0 | 4.0 | 5.0 | 5.5 | 15.0 | 14.0 | 13.5 | 28 | 1.6 | 1.8 | 15 | 64 | TO-8 |
| RA66* | 10-1000 | 37.0 | 35.0 | 34.0 | 1.0 | 1.3 | 3.5 | 4.5 | 5.0 | 15.5 | 14.0 | 13.0 | 30 | 1.8 | 2.0 | 15 | 81 | TO-8B |
| **2 TO 1500 MHz** | | | | | | | | | | | | | | | | | | |
| A21-1* | 5-1200 | 15.0 | 14.0 | 13.5 | 0.5 | 1.0 | 2.8 | 3.5 | 3.9 | -1.0 | -2.0 | -3.0 | 10 | 1.9 | 2.0 | 15 | 10 | TO-8 |
| A24* | 5-1500 | 20.0 | 19.0 | 18.0 | 0.8 | 1.0 | 4.2 | 5.3 | 5.8 | 8.0 | 7.0 | 6.5 | 20.5 | 2.0 | 2.0 | 15 | 34 | TO-8 |
| A25-1* | 10-600 | 13.5 | 13.0 | 12.5 | 0.5 | 0.7 | 3.0 | 3.5 | 4.0 | 9.0 | 8.0 | 7.5 | 22 | 2.0 | 2.0 | 15 | 24 | TO-8 |
| | 2-1500 | 13.5 | 13.0 | 12.5 | 0.5 | 0.7 | 3.8 | 4.5 | 5.0 | 9.0 | 8.0 | 7.5 | 22 | 2.0 | 2.0 | 15 | 24 | |
| A25* | 5-1500 | 10.0 | 9.0 | 8.0 | 0.6 | 1.0 | 6.0 | 7.5 | 8.0 | 9.0 | 7.0 | 6.5 | 21 | 2.0 | 2.0 | 15 | 24 | TO-8 |
| A26* | 10-1500 | 20.5 | 19.0 | 18.5 | 0.6 | 0.8 | 5.0 | 5.5 | 6.0 | 14.0 | 13.0 | 12.5 | 27 | 1.7 | 2.0 | 15 | 64 | TO-8 |
| A27* | 10-1500 | 8.5 | 7.5 | 7.0 | 0.6 | 1.0 | 7.5 | 9.0 | 9.5 | 15.5 | 14.0 | 13.5 | 28 | 1.9 | 2.0 | 15 | 50 | TO-8 |
| A28* | 10-1500 | 11.0 | 10.0 | 9.5 | 0.6 | 1.0 | 6.0 | 7.0 | 7.5 | 15.0 | 14.0 | 13.5 | 29 | 2.0 | 2.0 | 15 | 45 | TO-8 |
| A29-1* | 30-1000 | 9.0 | 8.5 | 7.5 | 0.5 | 1.0 | 7.0 | 8.5 | 9.0 | 22.0 | 20.0 | 19.0 | 32 | 2.0 | 2.0 | 15 | 90 | TO-8 |
| | 10-1500 | 9.0 | 8.5 | 7.5 | 0.5 | 1.0 | 8.0 | 9.0 | 9.5 | 22.0 | 20.0 | 19.0 | 32 | 2.0 | 2.0 | 15 | 90 | |
| A29* | 10-1500 | 6.5 | 5.5 | 5.0 | 0.5 | 0.7 | 9.0 | 10.0 | 10.5 | 22.0 | 20.0 | 19.5 | 34 | 2.0 | 2.0 | 15 | 105 | TO-8 |
| RA26* | 10-1500 | 27.5 | 26.0 | 25.0 | 0.8 | 1.2 | 5.5 | 6.0 | 6.5 | 14.5 | 13.5 | 12.5 | 27 | 2.0 | 2.0 | 15 | 82 | TO-8B |

Notes: 1. Specifications guaranteed to 71°C.
*Also available in Surface-Mount

# Typical and Guaranteed Specifications

| Model | Frequency Range MHZ | Small Signal Gain dB Typ. | Min. 0/50C | Min. -54/85C | Gain Flatness +dB Max. 0/50C | Max. -54/85C | Noise Figure dB Typ. | Max. 0/50C | Max. -54/85C | Power Output @1 dB Compression dBm Typ. | Min. 0/50C | Min. -54/85C | Intercept Point dBm Typ. | VSWR In/out Max. 0/50 | Max. -54/85C | DC Volts Nom | DC mA Typ. | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10 TO 2000 MHz** | | | | | | | | | | | | | | | | | | |
| A31-1* | 10-2000 | 11.5 | 11.0 | 10.5 | 0.7 | 1.0 | 3.5 | 4.0 | 4.5 | -2.0 | -4.0 | -4.5 | 9 | 2.0 | 2.0 | 15 | 9 | TO-8 |
| A33* | 500-2000 | 9.5 | 8.5 | 8.0 | 0.6 | 0.8 | 4.5 | 5.5 | 6.0 | 3.0 | 2.0 | 2.0 | 15 | 2.0 | 2.0 | 15 | 14 | TO-8 |
| | 10-2000 | 9.5 | 8.5 | 8.0 | 0.8 | 1.0 | 4.5 | 5.5 | 6.0 | 3.0 | 2.0 | 2.0 | 15 | 2.0 | 2.0 | 15 | 14 | |
| A34* | 100-2000 | 16.0 | 15.0 | 14.0 | 0.7 | 1.0 | 5.5 | 6.5 | 7.0 | 7.0 | 6.0 | 5.0 | 18 | 1.9 | 2.0 | 15 | 35 | TO-8 |
| A35* | 500-2000 | 10.0 | 9.0 | 8.5 | 0.6 | 0.8 | 5.0 | 6.5 | 7.0 | 9.0 | 7.0 | 6.5 | 21 | 2.2 | 2.2 | 15 | 24 | TO-8 |
| | 10-2000 | 10.0 | 9.0 | 8.5 | 0.8 | 1.0 | 5.0 | 6.5 | 7.0 | 9.0 | 7.0 | 6.5 | 21 | 2.2 | 2.2 | 15 | 24 | |
| RA36* | 100-2000 | 24.0 | 23.0 | 22.0 | 0.9 | 1.0 | 5.5 | 6.5 | 7.0 | 13.0 | 12.0 | 11.5 | 22 | 1.8 | 2.0 | 15 | 76 | TO-8B |
| A36* | 100-2000 | 16.5 | 15.5 | 14.5 | 0.8 | 1.0 | 5.5 | 7.0 | 7.5 | 12.0 | 11.0 | 11.0 | 23 | 2.0 | 2.0 | 15 | 63 | TO-8 |
| RA38* | 200-1800 | 16.0 | 14.5 | 13.5 | 1.0 | 1.2 | 6.0 | 6.7 | 7.0 | 18.5 | 17.5 | 16.5 | 25 | 2.3 | 2.3 | 15 | 127 | TO-8B |
| | 200-2000 | 16.0 | 14.5 | 13.5 | 1.0 | 1.2 | 6.8 | 7.5 | 8.0 | 17.0 | 16.0 | 15.5 | 25 | 2.3 | 2.3 | 15 | 127 | |
| A37* | 500-2000 | 9.3 | 8.0 | 7.0 | 0.6 | 0.8 | 6.5 | 8.0 | 8.5 | 15.5 | 14.0 | 13.5 | 26 | 2.2 | 2.2 | 15 | 45 | TO-8 |
| | 10-2000 | 9.3 | 8.0 | 7.0 | 0.8 | 1.0 | 6.5 | 8.0 | 8.5 | 15.5 | 14.0 | 13.5 | 26 | 2.2 | 2.2 | 15 | 45 | |
| A38[1]* | 10-1500 | 7.5 | 6.5 | 6.0 | 0.7 | 1.0 | 6.5 | 7.7 | 8.2 | 18.0 | 17.0 | 16.5 | 30 | 2.2 | 2.2 | 15 | 65 | TO-8 |
| | 1500-2000 | 7.5 | 6.5 | 6.0 | 0.7 | 1.0 | 7.5 | 9.0 | 9.5 | 19.0 | 18.0 | 17.5 | 30 | 2.2 | 2.2 | 15 | 65 | |
| A38-1* | 10-2000 | 9.5 | 8.5 | 7.5 | 0.7 | 1.0 | 6.5 | 7.5 | 8.0 | 18.0 | 17.0 | 16.5 | 30 | 2.1 | 2.2 | 15 | 65 | TO-8 |
| A39* | 10-1500 | 7.5 | 6.5 | 6.0 | 0.7 | 1.0 | 8.0 | 9.0 | 9.5 | 22.0 | 20.0 | 19.5 | 34 | 2.2 | 2.2 | 15 | 90 | TO-8 |
| | 1500-2000 | 7.5 | 6.5 | 6.0 | 0.7 | 1.0 | 8.5 | 9.5 | 10.0 | 22.0 | 20.0 | 19.5 | 34 | 2.2 | 2.2 | 15 | 90 | |
| **2 TO 3200 MHz** | | | | | | | | | | | | | | | | | | |
| A33-1* | 2-2400 | 9.0 | 8.2 | 7.8 | 0.6 | 0.8 | 4.5 | 5.8 | 6.3 | 6.0 | 4.5 | 4.0 | 19 | 1.9 | 2.0 | 15 | 19 | TO-8 |
| A35-1* | 2-2400 | 9.0 | 8.5 | 8.0 | 0.6 | 0.8 | 5.0 | 5.8 | 6.3 | 9.5 | 8.5 | 8.0 | 23 | 1.9 | 2.0 | 15 | 28 | TO-8 |
| A34-1* | 1500-2300 | 14.5 | 13.7 | 12.5 | 0.6 | 0.8 | 5.7 | 6.8 | 7.3 | 8.0 | 6.5 | 6.0 | 20 | 2.0 | 2.0 | 15 | 34 | TO-8 |
| A36-1* | 100-2300 | 16.2 | 15.0 | 14.0 | 0.7 | 1.0 | 6.0 | 7.0 | 7.5 | 12.0 | 11.0 | 11.0 | 23 | 2.0 | 2.0 | 15 | 63 | TO-8 |
| A36-2* | 100-2000 | 15.0 | 14.0 | 13.0 | 0.7 | 1.0 | 6.0 | 7.0 | 7.5 | 12.0 | 11.0 | 11.0 | 30 | 2.2 | 2.2 | 15 | 63 | TO-8 |
| | 2000-2600 | 15.0 | 14.0 | 13.0 | 0.7 | 1.0 | 6.0 | 7.0 | 7.5 | 14.0 | 12.5 | 12.0 | 30 | 2.2 | 2.2 | 15 | 63 | |
| A43* | 100-3200 | 11.5 | 10.5 | 9.8 | 0.7 | 1.0 | 6.7 | 7.2 | 7.7 | 8.5 | 7.0 | 6.5 | 21 | 2.3 | 2.4 | 15 | 45 | TO-8 |
| **5 TO 500 MHz MEDIUM POWER CLASS A AMPLIFIERS** | | | | | | | | | | | | | | | | | | |
| PA2[1]* | 10-300 | 12.5 | 11.5 | 11.0 | 0.8 | 1.0 | 8.0 | 9.5 | 10.0 | 25.0 | 24.0 | 23.5 | 38 | 2.0 | 2.2 | 24 | 95 | TO-8 |
| PA3* | 5-500 | 14.5 | 13.5 | 13.0 | 0.7 | 1.0 | 7.5 | 9.0 | 9.5 | 24.5 | 23.0 | 22.5 | 34 | 2.0 | 2.0 | 15 | 130 | TO-8 |
| PA5* | 10-70 | 9.4 | 8.5 | 8.0 | 0.7 | 1.0 | 8.5 | 9.5 | 10.0 | 25.0 | 23.5 | 23.5 | 35 | 1.7 | 2.0 | 15 | 130 | TO-8 |
| | 70-500 | 9.4 | 8.5 | 8.0 | 0.7 | 1.0 | 7.8 | 8.8 | 9.3 | 25.0 | 23.5 | 23.5 | 35 | 1.7 | 2.0 | 15 | 130 | |
| PA6* | 10-100 | 9.5 | 8.5 | 8.0 | 0.5 | 1.0 | 8.5 | 9.5 | 10.0 | 26.5 | 25.0 | 25.0 | 35 | 1.7 | 2.0 | 20 | 150 | TO-8 |
| | 100-500 | 9.5 | 8.5 | 8.0 | 0.5 | 1.0 | 7.8 | 8.8 | 9.3 | 26.5 | 25.0 | 25.0 | 35 | 1.7 | 2.0 | 20 | 150 | |
| **10 TO 4000 MHz MEDIUM POWER CLASS A AMPLIFIERS** | | | | | | | | | | | | | | | | | | |
| PA15* | 10-500 | 13.5 | 12.5 | 12.0 | 0.5 | 0.7 | 6.0 | 7.0 | 7.5 | 27.0 | 26.0 | 25.5 | 38 | 2.3 | 2.3 | 15 | 216 | TO-8 |
| | 500-1000 | 13.5 | 12.5 | 12.0 | 0.5 | 0.7 | 7.0 | 8.5 | 9.0 | 25.5 | 23.5 | 23.0 | 38 | 2.3 | 2.3 | 15 | 216 | |
| PA10* | 10-1000 | 10.0 | 9.5 | 9.0 | 0.5 | 0.7 | 8.5 | 9.5 | 10.0 | 22.5 | 20.0 | 20.0 | 36 | 2.0 | 2.0 | 15 | 95 | TO-8 |
| PA12-1* | 10-1200 | 9.0 | 8.5 | 8.0 | 0.5 | 0.7 | 8.5 | 9.5 | 10.0 | 22.0 | 20.0 | 19.5 | 32 | 2.0 | 2.0 | 12 | 97 | TO-8 |
| PA12* | 10-1200 | 9.5 | 9.0 | 8.5 | 0.5 | 0.7 | 8.5 | 9.5 | 10.0 | 24.5 | 23.0 | 22.5 | 35 | 2.0 | 2.0 | 20 | 130 | TO-8 |
| PA12* | 10-1200 | 9.5 | 9.0 | 8.5 | 0.5 | 0.7 | 8.5 | 9.5 | 10.0 | 22.5 | 20.0 | 19.5 | 35 | 2.0 | 2.0 | 15 | 95 | TO-8 |
| NEW **PA30*** | **500-2000** | **14.5** | **13.5** | **13.0** | **0.5** | **0.7** | **5.5** | **6.0** | **6.5** | **24.5** | **23.0** | **22.5** | **32** | **1.9** | **2.0** | **12** | **155** | **TO-8** |
| NEW **PA32*** | **500-2000** | **9.0** | **8.5** | **8.0** | **0.7** | **1.0** | **10.0** | **10.5** | **11.0** | **27.5** | **27.0** | **26.5** | **30** | **1.9** | **2.0** | **10** | **340** | **TO-8** |
| PA38* | 200-2000 | 10.0 | 8.5 | 8.0 | 0.7 | 1.0 | 4.0 | 4.7 | 5.2 | 23.0 | 21.5 | 21.0 | 34 | 1.9 | 2.0 | 15 | 150 | TO-8 |
| PA38-2* | 200-2600 | 8.5 | 7.5 | 7.0 | 0.7 | 1.0 | 4.5 | 5.5 | 6.0 | 23.5 | 22.0 | 21.4 | 33 | 2.0 | 2.2 | 15 | 150 | TO-8 |
| PA48* | 1000-4000 | 16.0 | 14.0 | 13.5 | 0.7 | 0.8 | 5.5 | 7.0 | 7.5 | 24.0 | 22.5 | 21.5 | 34 | 2.0 | 2.2 | 15 | 225 | TO-8B |
| **ECONOMY AMPLIFIERS** | | | | | | | | | | | | | | | | | | |
| EA1 | 5-400 | 15.0 | 14.0 | 13.0 | < 0.5 (Typ.) | | 4.3 (Typ.) | | | -0.5 | -2.5 | -3.0 | 13 | < 1.9 (Typ.) | | 15 | 10 | TO-5 |
| EA2 | 5-400 | 14.0 | 13.0 | 12.5 | < 0.3 (Typ.) | | 5.7 (Typ.) | | | 9.0 | 6.5 | 6.0 | 21 | < 1.8 (Typ.) | | 15 | 27 | TO-5 |
| EA5[2] | 200 kHz-500 MHz | | | | | | | | | | | | | | | | | |
| EA7 | 5-250 | 9.5 | 8.5 | 8.0 | 0.8 | 1.0 | 6.0 | 6.5 | 7.0 | 16.0 | 15.0 | 14.0 | 28 | 2.0 | 2.1 | 15 | 60 | TO-5 |
| EA54-3 | 5-300 | 36.5 | 35.0 | 34.0 | 0.7 | 0.8 | 2.7 | 3.6 | 4.0 | 9.0 | 7.5 | 6.5 | 20 | 1.8 | 1.9 | 15 | 33 | TO-5 |
| EA53-2 | 5-500 | 19.0 | 18.5 | 17.5 | 0.5 | 1.0 | 3.6 | 4.0 | 4.5 | 11.0 | 10.0 | 9.0 | 24 | 2.0 | 2.0 | 15 | 33 | TO-5 |
| EA54-2 | 5-500 | 29.5 | 28.5 | 27.5 | 0.8 | 1.0 | 4.5 | 5.0 | 5.5 | 9.5 | 8.0 | 6.0 | 20 | 2.0 | 2.1 | 15 | 55 | TO-5 |

Notes: 1. Specifications guaranteed to +71°C. 2. Electrical specifications are the same as EA2 except thre external capacitors are required for 200 kHz to 500 MHz frequency response.
*Also available in Surface-Mount

# Typical and Guaranteed Specifications

| Model | Frequency Range MHZ | Small Signal Gain dB Typ. | Small Signal Gain dB Min. 0/50C | Small Signal Gain dB Min. -54/85C | Gain Flatness +dB Max. 0/50C | Gain Flatness +dB Max. -54/85C | Noise Figure dB Typ. | Noise Figure dB Max. 0/50C | Noise Figure dB Max. -54/85C | Power Output @ 1 dB Compression dBm Typ. | Power Output @ 1 dB Compression dBm Min. 0/50C | Power Output @ 1 dB Compression dBm Min. -54/85C | Intercept Point dBm Typ. | VSWR In/out Max. 0/50 | VSWR In/out Max. -54/85C | DC Volts Nom | DC mA Typ. | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ECONOMY AMPLIFIERS * 5 VDC BIAS** | | | | | | | | | | | | | | | | | | |
| EA51 | 5-250 | 17.0 | 16.0 | 15.5 | 0.7 | 1.0 | 3.0 | 3.5 | 4.0 | 1.8 | 1.0 | -1.0 | 13 | 2.0 | 2.0 | 5 | 13 | TO-5 |
| EA53 | 5-250 | 22.0 | 20.5 | 19.5 | 0.9 | 1.0 | 2.0 | 2.8 | 3.2 | 4.5 | 2.5 | 2.0 | 16 | 1.8 | 2.0 | 5 | 15 | TO-5 |
| EA54 | 10-250 | 27.0 | 25.0 | 24.0 | 1.0 | 1.2 | 3.8 | 4.5 | 5.0 | 5.0 | 4.0 | 2.0 | 16 | 1.7 | 1.8 | 5 | 30 | TO-5 |
| **100 TO 6000 MHz GaAs FET AMPLIFIERS** | | | | | | | | | | | | | | | | | | |
| A32* | 0.1 -2 | 10.0 | 9.0 | 8.5 | 0.7 | 1.0 | 3.5 | 4.0 | 4.5 | 21.0 | 19.0 | 18.0 | 32 | 2.1 | 2.3 | 15 | 94 | TO-8 |
| A32-1* | 0.1 -2 | 10.0 | 9.0 | 8.5 | 0.7 | 1.0 | 3.0 | 3.5 | 4.0 | 13.0 | 11.5 | 11.0 | 25 | 2..1 | 2.3 | 5 | 44 | TO-8 |
| A41* | 1-4 | 8.5 | 7.0 | 6.5 | 0.7 | 0.9 | 4.0 | 5.0 | 5.5 | 12.0 | 11.0 | 10.5 | 25 | 2.1 | 2.2 | 5 | 35 | TO-8 |
| A41-1* | 1-4 | 9.0 | 8.0 | 7.5 | 0.7 | 1.0 | 3.5 | 4.7 | 5.2 | 19.0 | 17.0 | 16.5 | 30 | 2.0 | 2.1 | 12 | 70 | TO-8 |
| EA41 | 1-4 | 8.0 | 7.0 | 6.5 | 0.7 | 0.9 | 3.5 | 5.0 | 5.5 | 12.0 | 11.0 | 10.5 | 23 | 2.1 | 2.2 | 5 | 35 | TO-5 |
| EA41-1 | 1-4 | 9.0 | 8.0 | 7.5 | 0.7 | 0.9 | 3.5 | 5.0 | 5.5 | 19.0 | 17.5 | 17.0 | 30 | 2.0 | 2.1 | 8 | 68 | TO-5 |
| RA43* | 1-4 | 21.0 | 19.5 | 18.0 | 0.9 | 1.2 | 4.5 | 5.3 | 5.8 | 12.0 | 10.5 | 9.5 | 22 | 2.0 | 2.0 | 5 | 115 | TO-8B |
| A45* | 1-4 | 17.5 | 16.5 | 15.5 | 0.8 | 1.0 | 4.5 | 5.5 | 6.0 | 19.5 | 18.0 | 17.0 | 29 | 2.1 | 2.2 | 15 | 120 | TO-8 |
| A45-1* | 1-4 | 17.5 | 16.5 | 15.5 | 0.8 | 1.0 | 4.1 | 5.0 | 5.5 | 13.0 | 12.5 | 12.0 | 26 | 1.9 | 2.0 | 5 | 65 | TO-8 |
| A40* | 0.5 -4 | 14.5 | 13.0 | 12.0 | 0.7 | 1.0 | 4.5 | 6.0 | 6.5 | 15.0 | 13.5 | 13.0 | 25 | 2.0 | 2.1 | 12 | 69 | TO-8 |
| RA46* | 1-4 | 25.5 | 24.0 | 23.5 | 0.8 | 1.0 | 4.5 | 5.2 | 5.7 | 19.0 | 17.0 | 16.5 | 30 | 2.0 | 2.1 | 12 | 175 | TO-8B |
| RA53* | 1-5 | 21.0 | 19.5 | 18.0 | 0.9 | 1.2 | 4.5 | 5.3 | 5.8 | 11.5 | 10.5 | 9.5 | 22 | 2.1 | 2.3 | 5 | 115 | TO-8B |
| A61* | 2-6 | 7.5 | 6.5 | 6.0 | 0.7 | 0.9 | 3.2 | 4.3 | 4.8 | 12.5 | 11.0 | 10.5 | 25 | 2.0 | 2.1 | 5 | 35 | TO-8 |
| A61-1* | 2-6 | 8.0 | 7.0 | 6.5 | 0.7 | 0.8 | 3.4 | 4.2 | 4.7 | 20.0 | 18.5 | 18.0 | 30 | 2.0 | 2.1 | 8 | 70 | TO-8 |
| RA62* | 2-6 | 16.0 | 14.0 | 13.5 | 0.7 | 1.0 | 4.0 | 5.0 | 5.5 | 13.0 | 12.0 | 11.5 | 28 | 2.0 | 2.0 | 5 | 65 | TO-8B |
| RA63* | 2-6 | 18.5 | 16.5 | 15.5 | 1.0 | 1.2 | 5.5 | 7.0 | 7.5 | 13.0 | 10.0 | 9.5 | 25 | 2.2 | 2.3 | 5 | 120 | TO-8B |
| RA63-1* | 2-6 | 19.5 | 16.5 | 15.5 | 1.0 | 1.2 | 5.5 | 7.0 | 7.5 | 16.0 | 13.0 | 12.5 | 32 | 2.2 | 2.3 | 5 | 120 | TO-8B |

## VOLTAGE CONTROLLED ATTENUATORS

| Model | Frequency Range MHZ | Insertion Loss dB Typ. | Insertion Loss dB Max. | Attenuation dB Typ. | Attenuation dB Max. | VSWR Max. | Switching Speed (µSEC) 10-90% Typ. | Switching Speed (µSEC) 100% Max. | Control V | Control I(mA) | Bias V | Bias I(mA) | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5 TO 4000 MHz** | | | | | | | | | | | | | |
| G1* | 5-500 | 2.0 | 2.5 | 36 | 31 | 2.2:1 | 6.0 | 125 | 0-15 | 0-7 | 15 | 15 | TO-8 |
| | 500-1000 | 2.0 | 2.5 | 30 | 25 | 2.2:1 | 6.0 | 125 | 0-15 | 0-7 | 15 | 15 | |
| | 1000-2000 | 2.5 | 3.0 | 23 | 18 | 2.2:1 | 6.0 | 125 | 0-15 | 0-7 | 15 | 15 | |
| G2* | 5-500 | 2.5 | 3.0 | 35 | 31 | 1.8:1 | 4.0 | 75 | 0-15 | 0-7 | 5 | 15 | TO-8 |
| | 500-1000 | 2.5 | 3.0 | 29 | 25 | 1.8:1 | 4.0 | 75 | 0-15 | 0-7 | 5 | 15 | |
| | 1000-2000 | 2.8 | 3.5 | 23 | 18 | 2.5:1 | 4.0 | 75 | 0-15 | 0-7 | 5 | 15 | |
| G30* | 100-500 | 2.3 | 2.8 | 45 | 40 | 1.8:1 | 0.2 | 6 | 0-15 | 0-10 | 15 | 10 | TO-8 |
| | 500-1000 | 2.5 | 3.0 | 40 | 35 | 1.8:1 | 0.2 | 6 | 0-15 | 0-10 | 15 | 10 | |
| | 1000-2000 | 3.0 | 3.5 | 30 | 25 | 2.2:1 | 0.2 | 6 | 0-15 | 0-10 | 15 | 10 | |
| G34* | 500-1000 | 2.5 | 3.0 | 40 | 35 | 1.8:1 | 0.5 | 4 | 0-15 | 0-10 | 15 | 10 | TO-8 |
| | 1000-2000 | 3.0 | 3.5 | 35 | 30 | 1.8:1 | 0.5 | 4 | 0-15 | 0-10 | 15 | 10 | |
| | 2000-2400 | 3.3 | 4.0 | 30 | 25 | 2.0:1 | 0.5 | 4 | 0-15 | 0-10 | 15 | 10 | |
| G40* | 500-2000 | 2.0 | 2.5 | 33 | 28 | 2.2:1 | 0.5 | 4 | 0-15 | 0-10 | 15 | 12 | TO-8 |
| | 500-4000 | 3.0 | 3.5 | 28 | 23 | 2.2:1 | 0.5 | 4 | 0-15 | 0-10 | 15 | 12 | |
| NEW **RG20*** | **10-1000** | **2.7** | **3.5** | **26.5** | **24.5** | **2.0:1** | **75** | **125** | **0 -10** | **0-20** | **±15** | **35** | **TO-8B** |
| | 1000-2000 | 3.7 | 4.5 | 23 | 22 | 2.0:1 | 75 | 125 | 0 -10 | 0-20 | ±15 | 35 | |

Note: 1. Preliminary specifications.
*Also available in Surface-Mount.

# Typical and Guaranteed Specifications

## ATTENUATOR LINEARIZERS

| Model | | Typical Current Drain Min. Attenuation V- | V+ | Vcon | Max. Attenuation V- | V+ | Vcon | Linearity Specifications 25°C Typ. | Max. | -54°C to +85°C Typ. | Max. | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LG1* | Linearizer (Specifications apply to LGI used in conjunction with GI attenuator) | 5 mA | 31 mA | 15 mA | 5 mA | 21 mA | 2.5 mA | <±1 dB | ±1.5dB | <±1.5dB | ±2dB | TO-8 |
| LG30* | Linearizer (Specifications apply to LG30 used in conjunction with G30 attenuator) | 3 mA | 12 mA | 6 mA | 15 mA | 21 mA | 12 mA | <±1 dB | ±1.5dB | <±1.5dB | ±2dB | TO-8 |

*Also available in Surface-Mount.

## LIMITING AMPLIFIERS

| Model | Frequency Range MHz | Small Signal Gain dB Typ. | Min. 0/50C | Min. -54/85C | Gain Flatness ±dB Max. 0/50C | Max. -54/85C | Noise Figure dB Typ. | Max. 0/50C | Max. -54/B5C | Power Output At 1 dB Compression dBm Typ. | Min. 0/50C | Min. -54/85C | VSWR In/Out Max. 0/50C | Max. -54/85C | DC Volts Nom. | mA Typ. | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10 TO 4000 MHz** | | | | | | | | | | | | | | | | | |
| AL7* | 50-300 | 13.0 | 12.0 | 11.0 | 0.5 | 0.7 | 5.0 | 6.0 | 6.5 | -1.5 | -5.0 | -7.0 | 1.7/2.0:1 | 1.7/2.0:1 | 15 | 54 | TO-8 |
| | 300-500 | 13.0 | 12.0 | 11.0 | 0.5 | 0.7 | 5.5 | 6.5 | 7.0 | -1.5 | -5.0 | -7.0 | 1.7/2.0:1 | 1.7/2.0:1 | 15 | 54 | |
| LA7* | 50-300 | 12.6 | 12.0 | 11.0 | 0.5 | 0.7 | 7.0 | 8.0 | 8.5 | 12.0 | 11.0 | 8.0 | 1.7:1 | 2.0:1 | 15 | 54 | TO-8 |
| | 300-500 | 12.6 | 12.0 | 11.0 | 0.5 | 0.7 | 7.5 | 8.5 | 9.0 | 11.5 | 10.0 | 7.0 | 1.7:1 | 2.0:1 | 15 | 54 | |
| LA88* | 10-500 | 16.5 | 16.0 | 15.0 | 0.5 | 0.7 | 6.0 | 6.5 | 7.0 | 17.0 | 15.0 | 13.0 | 1.9:1 | 2.0:1 | 15 | 89 | TO-8 |
| LA17* | 10-1000 | 11.5 | 10.5 | 9.5 | 0.5 | 0.7 | 5.8 | 6.7 | 7.2 | 10.0 | 7.0 | 5.0 | 1.9:1 | 2.0:1 | 15 | 55 | TO-8 |
| LA45* | 1000-4000 | 11.5 | 10.0 | 9.0 | 0.8 | 1.0 | 8.0 | 9.5 | 10.0 | 14.0 | 12.5 | 11.5 | 2.1:1 | 2.2:1 | 15 | 110 | TO-8 |
| LA45-1* | 1000-4000 | 14.0 | 13.0 | 12.0 | 0.8 | 1.0 | 7.5 | 9.0 | 9.5 | 17.0 | 15.5 | 14.5 | 2.1:1 | 2.2:1 | 15 | 110 | TO-8 |

## SIGNAL LIMITERS

| Model | Frequency Range MHz | Insertion Loss[1] dB Typ. | Max. | Limiting Level (Typ.) dBm 20V | 15V | I0V | VSWR Max. | Bias Voltage | Package Type |
|---|---|---|---|---|---|---|---|---|---|
| **50 TO 4000 MHz** | | | | | | | | | |
| L1* | 50-1000 | 2.0 | 3.0 | 2.0 | 0 | -2.0 | 2.0:1 | 5 to 20 V | TO-8 |
| | 1000-3000 | 3.0 | 4.5 | 2.5 | 1.8 | 0 | 2.3:1 | 5 to 20 V | |
| L42* | 50-3000 | 3.5 | 4.5 | 2.5 | 1.8 | 0 | 2.3:1 | 5 to 20 V | TO-8 |
| | 3000-4000 | | 5.0 | 7.5 | 6.5 | 2.5 | 2.3:1 | 5 to 20 V | |

Note: 1 For bias levels ≥+15 VDC. *Also available in Surface-Mount.

## POWER LIMITER

| Model | Frequency Range MHz | Insertion Loss dB Typ. | Max. | Limiting Threshold Typ. | -54/85C | VSWR Typ. | Max. | Package Type |
|---|---|---|---|---|---|---|---|---|
| PL30* | 100-2000 | <0.9 | 1.0 | 10 dBm | 7.5dBm | 1:2:1 | 1.71 | TO-8 |

## DIRECTIONAL LEVEL DETECTORS

| Model | Frequency Range MHz | Insertion Loss Typ. | Max. | DC Output[1] Mv $P_{IN}$ =+10 Typ. | Max. | $P_{IN}$= +6 Typ. | Max. | Directivity[1,2] dB $P_{IN}$ = +4 Typ. | Min. | Isolation[1] dB In→ Typ. | DC Out Min. | Out→ Typ. | DC out Min. | VSWR | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10 TO 2000 MHz** | | | | | | | | | | | | | | | |
| D2 | 10-1000 | 3.4 | 3.8 | 135 | 90 | 55 | 25 | > 30 | 20 | > 35 | 28 | > 40 | 32 | < 1.3:1 | TO-5 |
| | 1000-2000 | 3.7 | 4.5 | 135 | 90 | 55 | 25 | > 20 | 10 | > 28 | 22 | > 32 | 26 | < 1.3:1 | |

Notes: 1. Measured with 50 KW dB output load 2. Directivity = 20 log (forward DC output/reverse DC output.

## TANGENTIAL TO-8 LEVEL DETECTORS

| Model | Frequency Range MHz | DC Output[1] mV Typ. | Flatness[2] mV Typ. | Input Impedance | Offset Voltage MV Typ. | Package Type |
|---|---|---|---|---|---|---|
| **10 TO 1000MHz** | | | | | | |
| D3-1* | 10-1000 | -50 | ±2 | 300Ω | 230 | TO-8 |
| D3* | 10-1000 | 100 | ±7 | 50Ω | 230 | TO-8 |

Notes: 1 Measured with 10 KW output load, 50 mA detector bias and $P_{IN}$, -10 dBm. 2. $P_{IN}$ = -20 dBm, *Also available in Surface-Mount.

# Miniature Flatpack Amplifiers

For stripline or microstrip designs, W-J offers the performance of most of its TO-8 amplifiers in an optional hermetically sealed MIC flatpack, For ordering purposes these modules use an "F" prefix to denote this package style. For example, an A5 becomes an FA5, and Ll becomes an FL1, etc. The following is a list of models currently available in the flatpack package. For any model not listed, please consult Watkins-Johnson Company directly.

## Flatpack Cascadable Amplifier Devices

| Model | Model | Model | Model | Model | Model | Model |
|---|---|---|---|---|---|---|
| A1 | A18-1 | A32-1 | A54 | A70-2 | A83 | G34 |
| A3 | A21-1 | A33 | A55 | A71 | A83-1 | Ll |
| A5 | A24 | A33-1 | A56 | A72 | A86 | L2 |
| A5-5 | A25 | A34 | A57 | A73 | A87 | L34 |
| A5-6 | A25-1 | A34-1 | A63 | A74 | A87-1 | LA7 |
| A11 | A27 | A35 | A64 | A74-1 | A87-2 | LA17 |
| A11-2 | A28 | A35-1 | A65 | A74-2 | AL7 | LG1 |
| A12 | A28-2 | A37 | A66-3 | A75 | G1 | LG30 |
| A16-2 | A31-2 | A51 | A70 | A75-2 | G2 | PL30 |
| A17 | A32 | A53 | A70-1 | A75-3 | G30 | RA36 |
| | | | | | | A77 |

1

# Mounting Instructions

Along with good RF grounding, good thermal conduction must exist between the TO-8 amplifier and the microstrip board on which it is mounted.

Thermal conduction is most efficient when the TO-8 is mounted onto a printed wiring board having a ground plane that is heat sunk to the enclosure. TO-8 amplifiers that draw high levels of current such as W-J power amplifiers, which dissipate higher levels of heat, must be heat sunk in this manner.

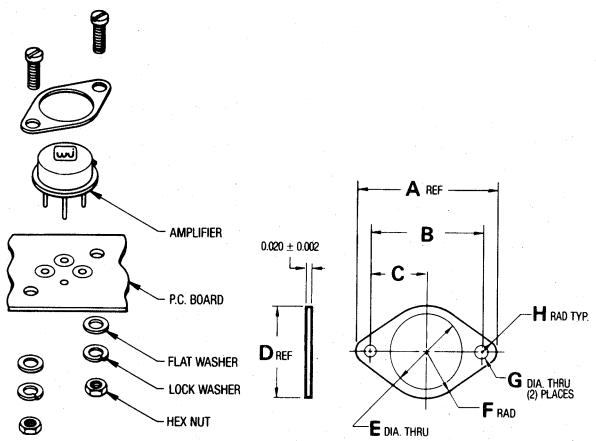
Watkins-Johnson Company employs two methods of mounting TO-8 packaged devices. These methods are mounting brackets or epoxy preforms. Mounting bracket kits are supplied at no charge with all TO-8, TO-8B and TO-5 amplifiers, attenuators, limiters, and similar components. (See Figure 1.)

An alternative method for mounting our products is the use of a conductive epoxy preform that is currently used in our cascaded amplifier products (see Figure 2). The preform is made of a conductive material and must be ordered directly from Ablestik Laboratories, 20021 Susana Rd., Rancho Dominguez, California 90221. Telephone: (310) 764-4600.

Preform Part Numbers:
TO-8 P/N 209851-002
TO-5 Preforms - Not Available
TO-8B P/N 209851-005

Epoxy preforms have the advantage over mounting brackets of being more space efficient and are able to conform to the TO-8 to PWB interface, offering the best possible grounding connection.

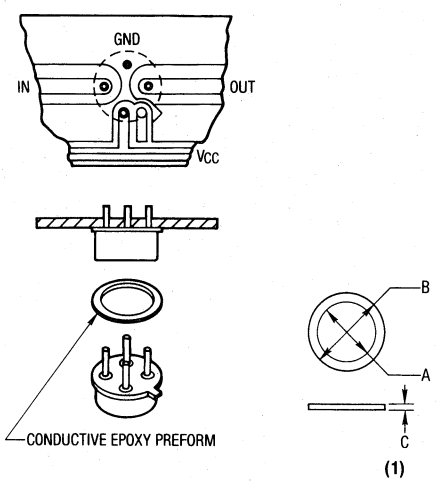
**Figure 1. TO-8 Mounting kit for standard TO-8 packaged devices. Similar mounting kits supplied with TO-5 and TO-8 B type products.**




Dimensions are in inches (millimeters)

| Package Type | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| **TO-8** | **0.859** | **0.687** | **0.343** | **0.520** | **0.455** | **0.260** | **0.078** | **0.086** |
| **TO-8B** | 1.095 | 0.875 | 0.437 | 0.660 | 0.557 | 3.330 | 0.078 | 0.110 |
| **TO-5** | 0.750 | 0.580 | 0.290 | 0.390 | 0.330 | 0.195 | 0.070 | 0.085 |

**Figure 2.Epoxy preform mounting procedure for TO-8 and TO-8B type amplifiers.**



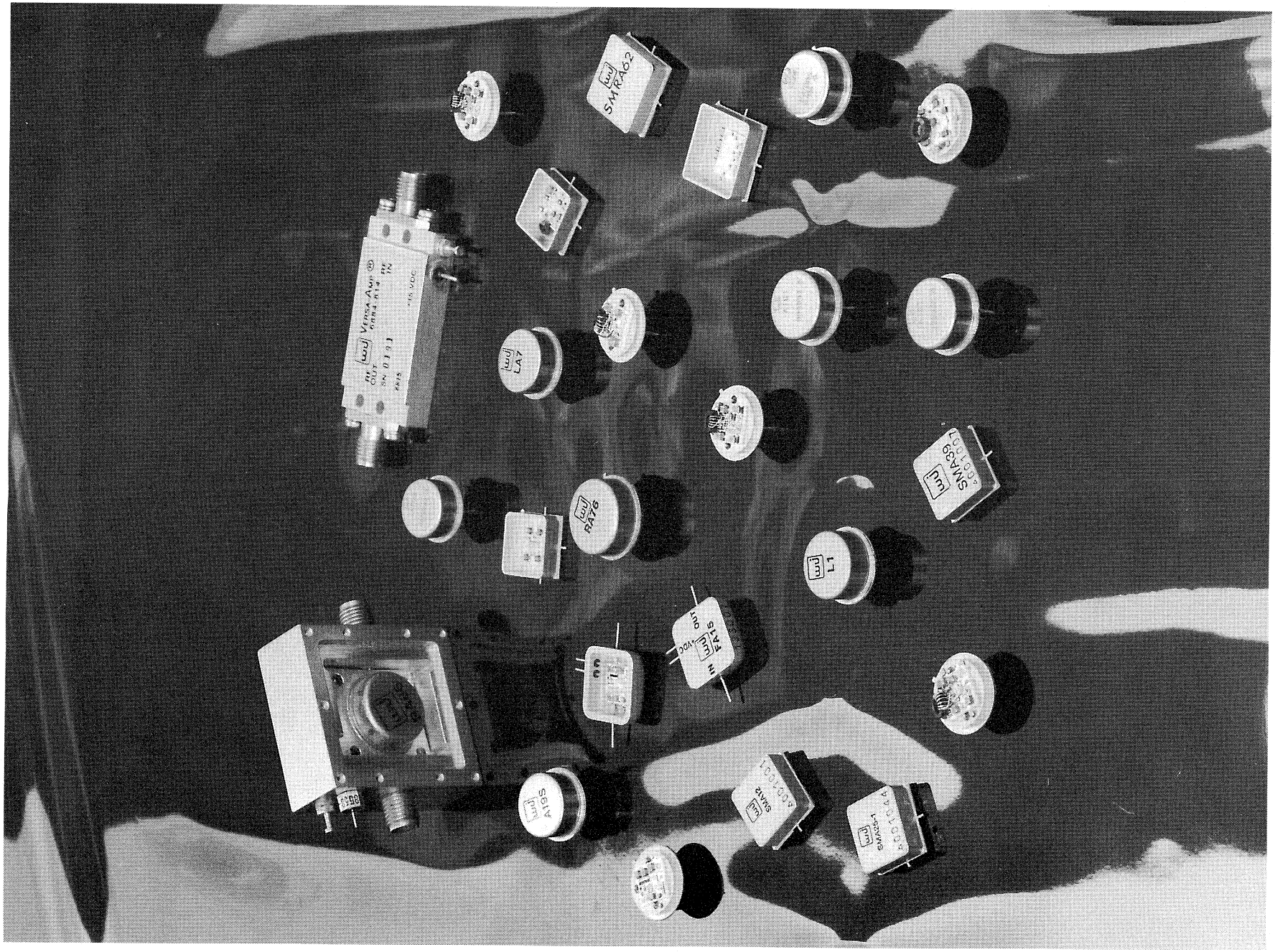

(1)

Clamp amplifiers to board with a minimum force of 20 to 30 lbs. while curing the preform at 125°C for two hours. Do not solder leads until after the epoxy is cured.

| Package Type | A | B | C | Drawing |
|---|---|---|---|---|
| **TO-8** | 0.43" | 0.53" | .006 | (1) |
| **TO-8B** | 0.53" | 0.63" | .006 | (1) |

# *Cascadable Amplifiers*

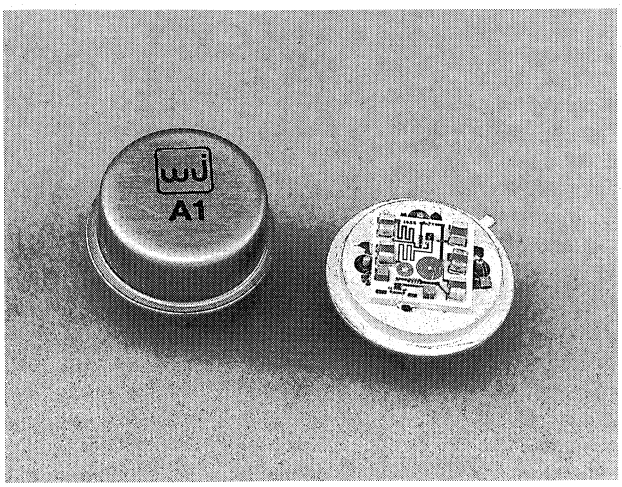




# WJ-A1 / SMA1

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.4 dB (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ HIGH GAIN: 16 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 16 dB | 15 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.4 dB | 3.0 dB | 3.5 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dBm | -2.0 dBm | -3.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8 :1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 12 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA1 is a standard WJ-A1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+15 dBm (Typ.)
Second Order Two Tone Intercept Point.....+10 dBm (Typ.)
Third Order Two Tone Intercept Point.....+11 dBm (Typ.)

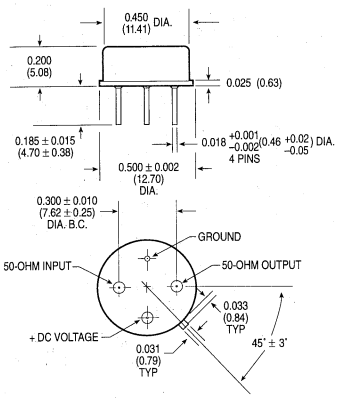
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts ( 1 Minute Max.)
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

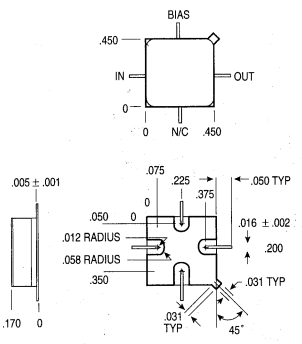
## Outline Drawings

A1



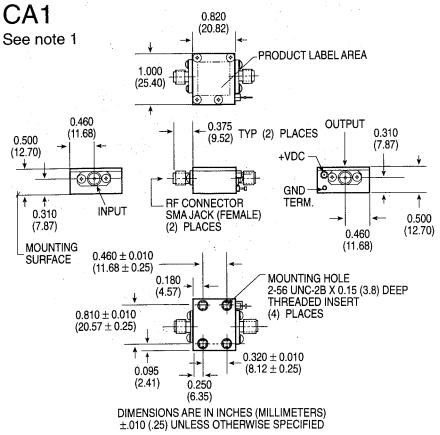

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

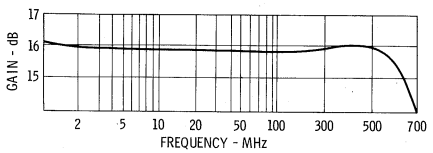
CA1
See note 1

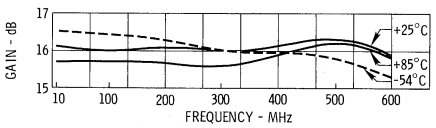



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

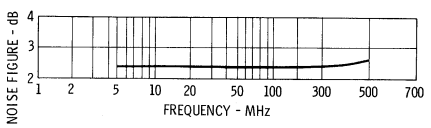
## Typical Performance at 25°C

### Gain

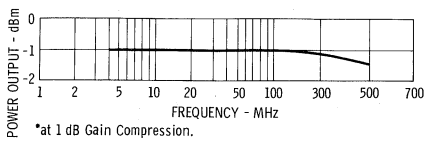



### Noise Figure

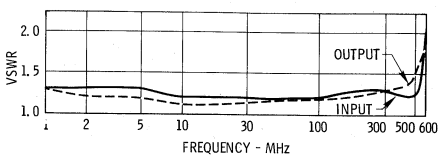



### Power Output*




*at 1 dB Gain Compression.

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.5 | 1.8 | 16.5 |
| 2.0 | 1.4 | 1.4 | 17.1 |
| 5.0 | 1.4 | 1.4 | 17.0 |
| 10.0 | 1.4 | 1.4 | 16.8 |
| 50.0 | 1.3 | 1.3 | 16.9 |
| 100.0 | 1.4 | 1.4 | 16.7 |
| 200.0 | 1.3 | 1.3 | 16.6 |
| 300.0 | 1.3 | 1.3 | 16.5 |
| 400.0 | 1.3 | 1.3 | 16.4 |
| 500.0 | 1.2 | 1.2 | 16.5 |
| 600.0 | 1.4 | 1.2 | 16.6 |
| 700.0 | 1.6 | 1.1 | 16.1 |

### Linear S-Parameters

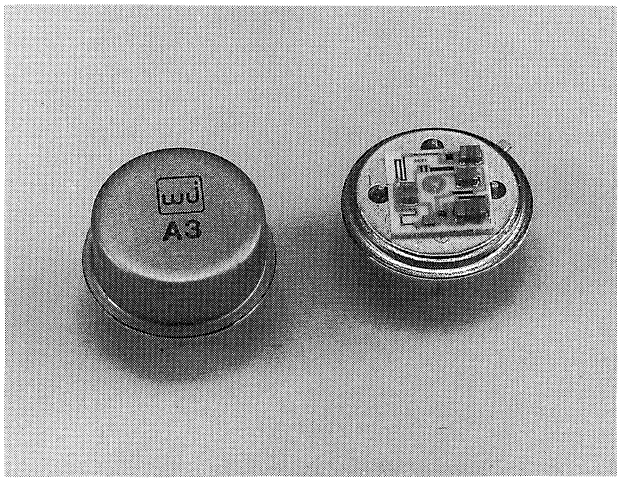
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.425 | –98 | 6.71 | –170.0 | 0.08 | 11.8 | 0.292 | –176 |
| 2.0 | 0.167 | –148 | 7.13 | –169.8 | 0.09 | 9.3 | 0.153 | –146 |
| 5.0 | 0.171 | –172 | 7.06 | –177.1 | 0.09 | 3.0 | 0.181 | –170 |
| 10.0 | 0.169 | –175 | 6.94 | 178.8 | 0.09 | 0.1 | 0.167 | –172 |
| 50.0 | 0.139 | 155 | 6.98 | 168.1 | 0.09 | –4.4 | 0.122 | 155 |
| 100.0 | 0.157 | 138 | 6.87 | 155.5 | 0.09 | –7.3 | 0.156 | 151 |
| 200.0 | 0.147 | 106 | 6.78 | 132.7 | 0.09 | –14.1 | 0.135 | 139 |
| 300.0 | 0.138 | 66 | 6.71 | 109.7 | 0.09 | –22.2 | 0.121 | 120 |
| 400.0 | 0.130 | 19 | 6.63 | 86.1 | 0.10 | –29.8 | 0.114 | 109 |
| 500.0 | 0.109 | –45 | 6.69 | 60.9 | 0.10 | –42.3 | 0.106 | 92 |
| 600.0 | 0.153 | –117 | 6.72 | 32.7 | 0.11 | –55.3 | 0.103 | 68 |
| 700.0 | 0.243 | 163 | 6.36 | –0.6 | 0.11 | –69.6 | 0.069 | 17 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.068 W
Junction Temperature Rise Above Case $T_{jc}$ ... 3°C

# WJ-A3 / SMA3

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.3 dB (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ LOW DC CURRENT: 9 mA (TYP.) @ 15 VDC

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 4-550 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 15.5 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.3 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dBm | -2.0 dBm | -3.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 12 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA3 is a standard WJ-A3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+17 dBm (Typ.)
Second Order Two Tone Intercept Point.....+12 dBm (Typ.)
Third Order Two Tone Intercept Point.....+11 dBm (Typ.)

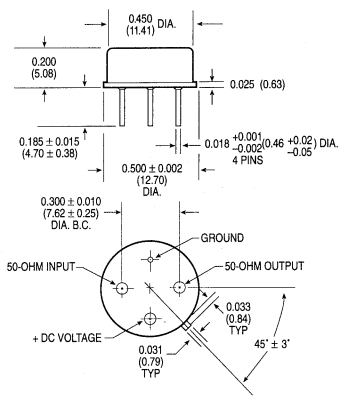
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power.....0.5 Watt (3μ Sec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

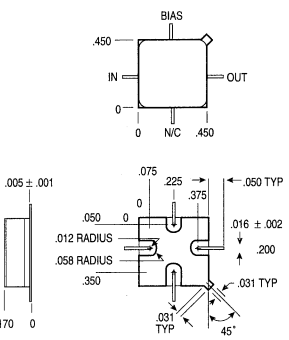
## Outline Drawings

A3



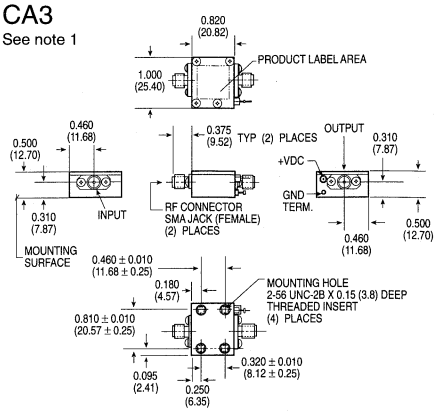

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

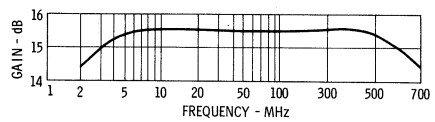
CA3
See note 1

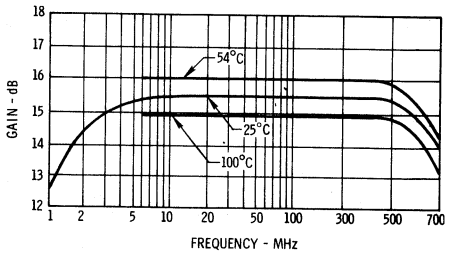



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

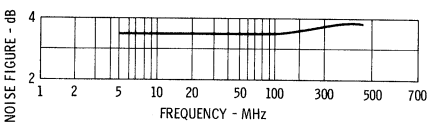
## Typical Performance at 25°C

### Gain

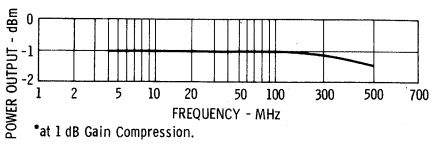



### Noise Figure

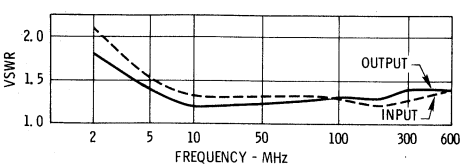



### Power Output*




*at 1 dB Gain Compression.

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.5 | 2.3 | 15.1 |
| 5.0 | 1.6 | 1.6 | 16.1 |
| 10.0 | 1.5 | 1.4 | 16.2 |
| 50.0 | 1.3 | 1.3 | 16.4 |
| 100.0 | 1.4 | 1.3 | 16.2 |
| 200.0 | 1.4 | 1.3 | 16.1 |
| 300.0 | 1.4 | 1.3 | 16.2 |
| 400.0 | 1.4 | 1.3 | 16.2 |
| 500.0 | 1.4 | 1.3 | 16.1 |
| 600.0 | 1.5 | 1.4 | 15.6 |
| 700.0 | 1.3 | 2.3 | 13.9 |

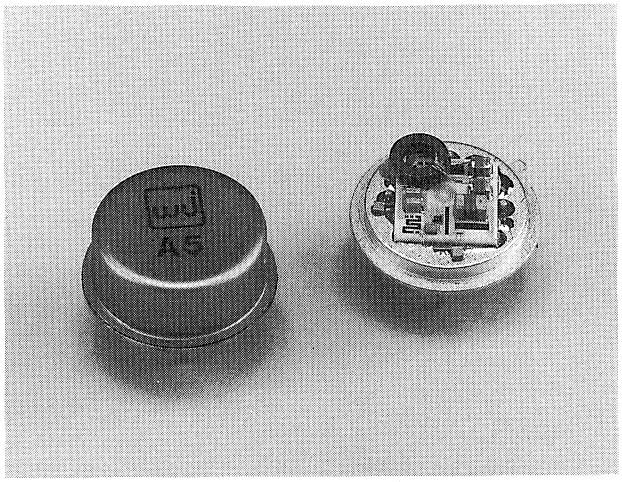
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | 0.434 | –79 | 5.70 | –147.6 | 0.13 | –21.4 | 0.397 | –81 |
| 5.0 | 0.236 | –123 | 6.37 | –167.8 | 0.10 | –14.7 | 0.234 | –127 |
| 10.0 | 0.194 | –147 | 6.49 | –175.9 | 0.09 | –9.1 | 0.180 | –150 |
| 50.0 | 0.138 | 161 | 6.59 | 167.8 | 0.09 | –3.2 | 0.114 | 148 |
| 100.0 | 0.161 | 138 | 6.49 | 152.8 | 0.09 | –3.0 | 0.147 | 126 |
| 200.0 | 0.162 | 101 | 6.40 | 126.1 | 0.10 | –5.2 | 0.123 | 77 |
| 300.0 | 0.171 | 62 | 6.42 | 98.6 | 0.11 | –10.7 | 0.135 | 27 |
| 400.0 | 0.183 | 22 | 6.43 | 69.7 | 0.11 | –16.6 | 0.129 | –11 |
| 500.0 | 0.172 | –19 | 6.38 | 37.7 | 0.12 | –23.7 | 0.112 | –22 |
| 600.0 | 0.188 | –62 | 6.03 | 1.4 | 0.13 | –31.7 | 0.175 | 7 |
| 700.0 | 0.144 | –97 | 4.98 | –37.3 | 0.14 | –42.2 | 0.392 | –9 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.055 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A5 / SMA5



## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ FLAT BANDWIDTH: ±.2 dB (TYP.)
- ◆ LOW VSWR: < 1.2:1 INPUT, < 1.5:1 OUTPUT (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +20 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +100°C |
|---|---|---|---|
| Frequency (Min.) | 3-550 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 14.8 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±0.7 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7 dBm | +7 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 25 mA | 28 mA | 30 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA5 is a standard WJ-A5 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+41 dBm (Typ.)
Second Order Two Tone Intercept Point.....+36 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

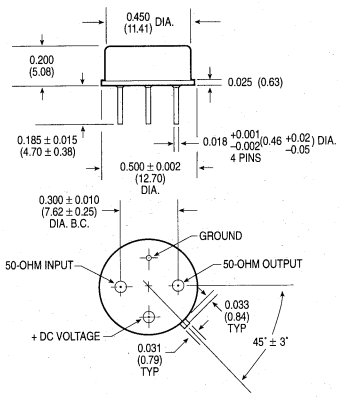
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+21 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 μ sec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

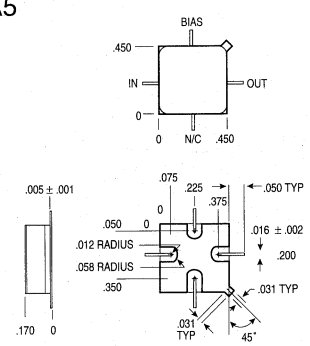
## Outline Drawings

A5



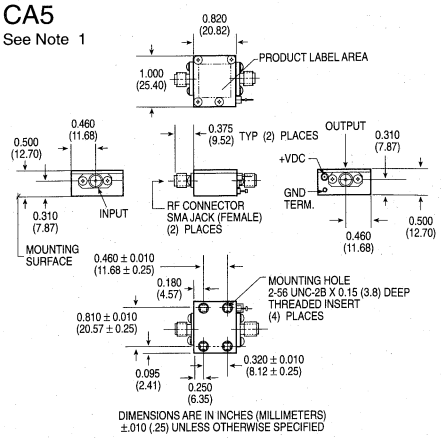

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA5




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

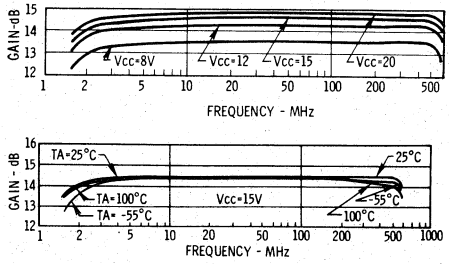
CA5
See Note 1



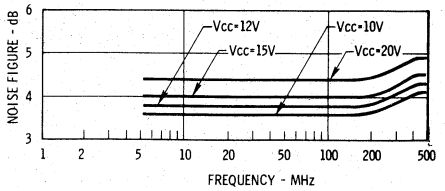

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

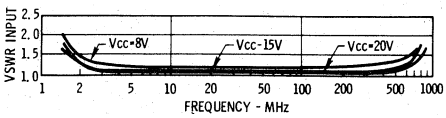
### Gain



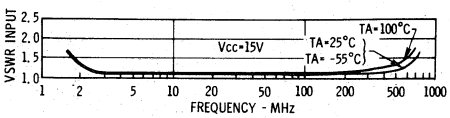

### Noise Figure



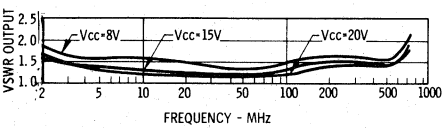

### Input VSWR



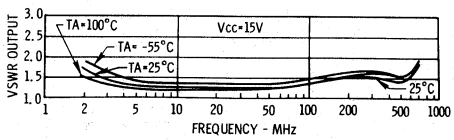

### Input VSWR Over Temperature



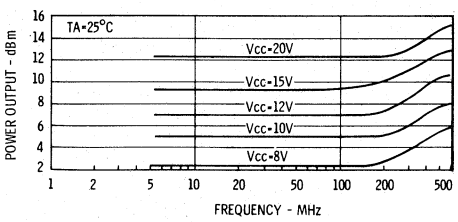

### Output VSWR




### Output VSWR Over Temperature

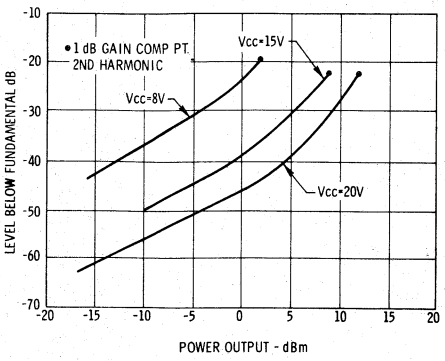



### Power Output*

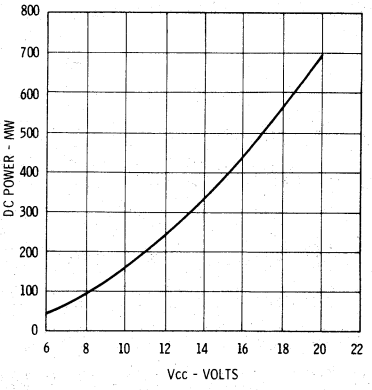



*at 1 dB Gain Compression

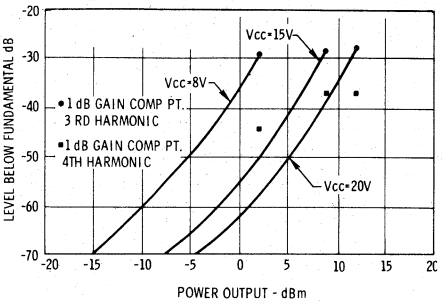
### Second Harmonic Suppression vs. Power Out



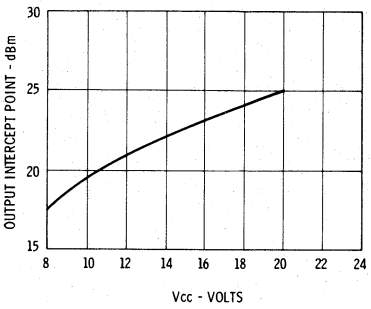

### DC Power Drain vs. Supply Voltage




### Third Harmonic Suppression vs. Power Out




### Two-Tone Third Order Output Intercept Point vs. Supply Voltage




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.8 | 1.0 | 15.3 |
| 5.0 | 1.4 | 1.1 | 15.1 |
| 10.0 | 1.3 | 1.1 | 15.0 |
| 50.0 | 1.2 | 1.1 | 15.2 |
| 100.0 | 1.3 | 1.2 | 15.0 |
| 200.0 | 1.2 | 1.3 | 14.9 |
| 300.0 | 1.2 | 1.4 | 15.0 |
| 400.0 | 1.2 | 1.4 | 15.2 |
| 500.0 | 1.1 | 1.4 | 15.5 |
| 600.0 | 1.2 | 1.3 | 15.7 |
| 700.0 | 1.2 | 1.3 | 15.4 |

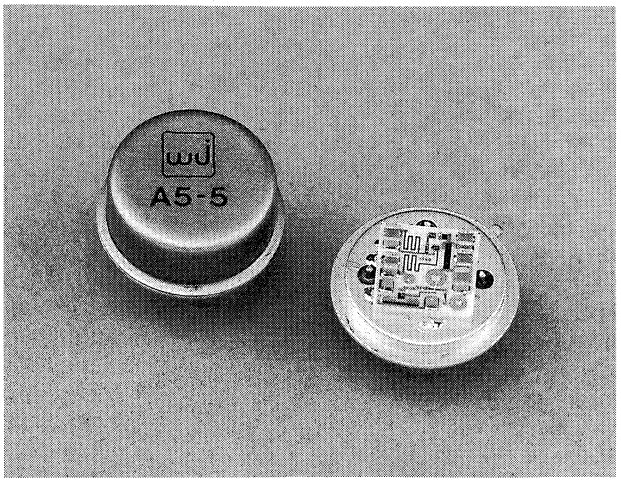
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | 0.284 | –104 | 5.82 | –158.9 | 0.11 | –1.8 | 0.023 | –156 |
| 5.0 | 0.162 | –143 | 5.69 | –172.7 | 0.11 | –1.9 | 0.056 | –172 |
| 10.0 | 0.145 | –156 | 5.60 | –178.2 | 0.11 | –1.5 | 0.043 | –165 |
| 50.0 | 0.102 | 163 | 5.72 | 169.4 | 0.11 | –2.1 | 0.066 | 76 |
| 100.0 | 0.118 | 151 | 5.63 | 158.2 | 0.11 | –3.2 | 0.086 | 81 |
| 200.0 | 0.103 | 135 | 5.58 | 137.9 | 0.12 | –7.0 | 0.112 | 51 |
| 300.0 | 0.088 | 105 | 5.65 | 116.7 | 0.12 | –10.8 | 0.151 | 21 |
| 400.0 | 0.075 | 66 | 5.79 | 95.7 | 0.13 | –14.5 | 0.166 | –10 |
| 500.0 | 0.054 | 23 | 5.96 | 71.3 | 0.13 | –20.6 | 0.165 | –47 |
| 600.0 | 0.082 | –25 | 6.10 | 44.5 | 0.13 | –26.5 | 0.139 | –95 |
| 700.0 | 0.100 | –54 | 5.91 | 15.0 | 0.14 | –31.4 | 0.126 | –168 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.198 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A5-5 / SMA5-5




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ FLAT BANDWIDTH: ±.1 dB (TYP.)
- ◆ LOW VSWR: .1.2:1 (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS
- ◆ EXCELLENT PHASE LINEARITY: < ± .8° (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-650 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 15.5 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.1 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +9 dBm | +7 dBm | +7 dBm |
| VSWR (Max.) Input/Output | 1.2:1 | 1.5:1 | 1.6:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA5-5 is a standard WJ-A5-5 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

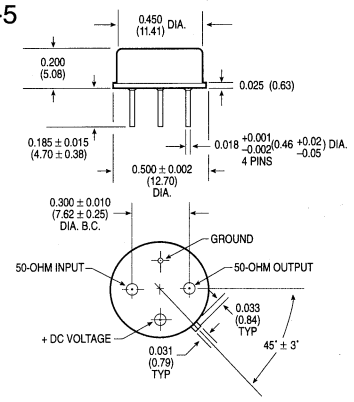
## Absolute Maximum Ratings

Storage Temperature .....-62° C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

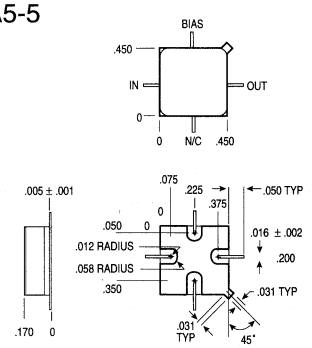
## Outline Drawings

A5-5



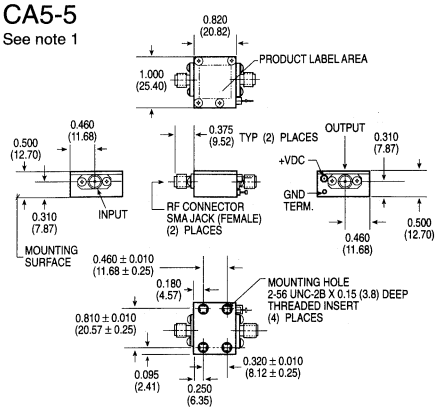

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA5-5




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

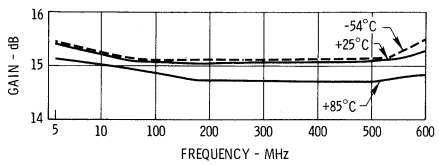
CA5-5
See note 1



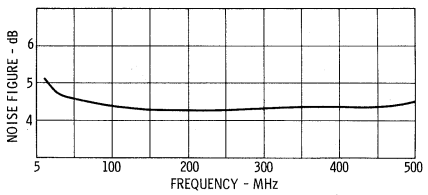

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

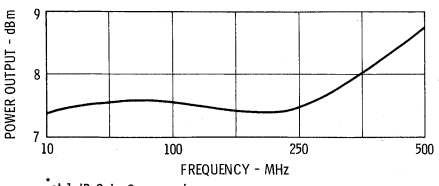
### Gain




### Noise Figure

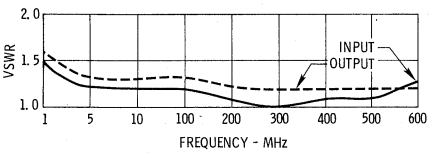



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.5 | 15.9 |
| 2.0 | 1.1 | 1.1 | 16.6 |
| 5.0 | 1.0 | 1.1 | 16.6 |
| 10.0 | 1.1 | 1.1 | 16.4 |
| 50.0 | 1.1 | 1.1 | 16.5 |
| 100.0 | 1.0 | 1.1 | 16.3 |
| 200.0 | 1.1 | 1.1 | 16.2 |
| 300.0 | 1.1 | 1.0 | 16.1 |
| 400.0 | 1.2 | 1.1 | 16.1 |
| 500.0 | 1.2 | 1.1 | 16.1 |
| 600.0 | 1.4 | 1.0 | 16.2 |
| 700.0 | 1.5 | 1.0 | 16.2 |

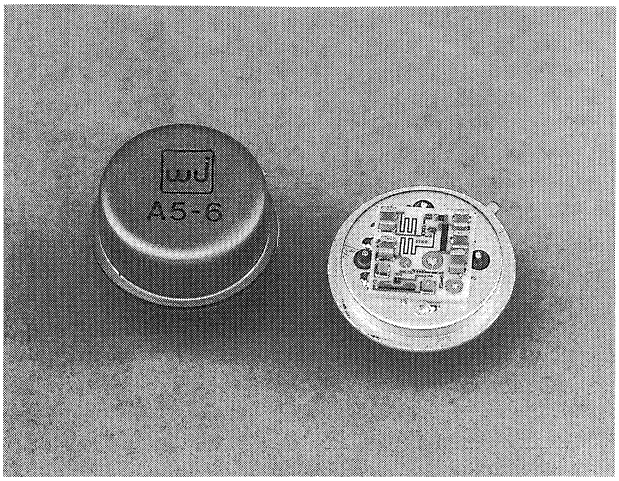
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.331 | –79 | 6.26 | –162.6 | 0.09 | 9.6 | 0.203 | –179 |
| 2.0 | 0.044 | –47 | 6.73 | –167.6 | 0.08 | 5.5 | 0.068 | –132 |
| 5.0 | 0.022 | –46 | 6.77 | –176.4 | 0.08 | 2.3 | 0.069 | –160 |
| 10.0 | 0.027 | –65 | 6.58 | 179.5 | 0.08 | 0.5 | 0.061 | –151 |
| 50.0 | 0.039 | 5 | 6.66 | 168.5 | 0.09 | –4.7 | 0.029 | 109 |
| 100.0 | 0.024 | 9 | 6.52 | 156.8 | 0.09 | –9.1 | 0.044 | 143 |
| 200.0 | 0.030 | –39 | 6.48 | 134.8 | 0.09 | –17.4 | 0.028 | 169 |
| 300.0 | 0.047 | –58 | 6.40 | 112.5 | 0.09 | –24.7 | 0.020 | –154 |
| 400.0 | 0.070 | –81 | 6.42 | 90.8 | 0.09 | –32.4 | 0.029 | –145 |
| 500.0 | 0.106 | –116 | 6.41 | 67.5 | 0.09 | –40.9 | 0.036 | –144 |
| 600.0 | 0.150 | –137 | 6.42 | 44.2 | 0.09 | –50.7 | 0.020 | –158 |
| 700.0 | 0.197 | –165 | 6.43 | 19.4 | 0.09 | –59.7 | 0.010 | –57 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.173 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A5-6 / SMA5-6




## 5 to 600 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ FLAT BANDWIDTH: ±.2 dB (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-700 MHz | 5-600 MHz | 5-600 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 15.0 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±0.7 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7 dBm | +6.5 dBm |
| VSWR (Max.) Input/Output | 1.3 :1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA5-6 is a standard WJ-A5-6 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

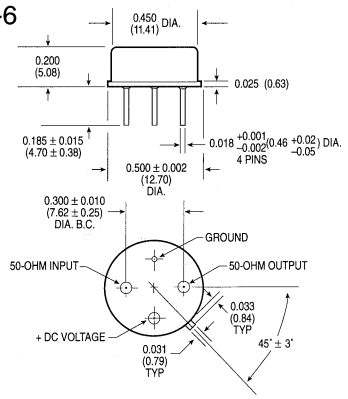
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power..... 50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

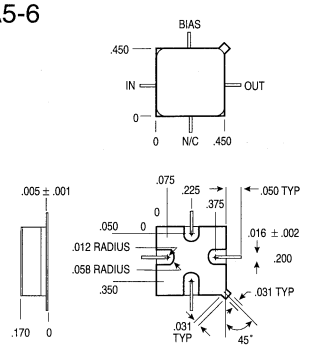
## Outline Drawings

A5-6



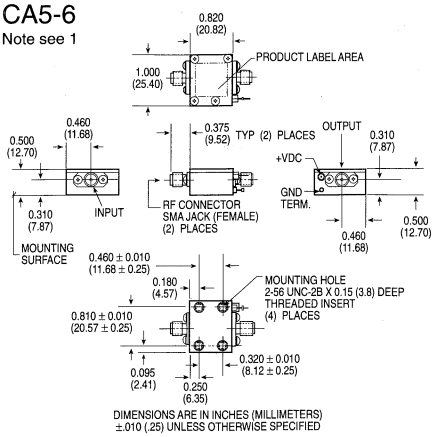

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA5-6




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

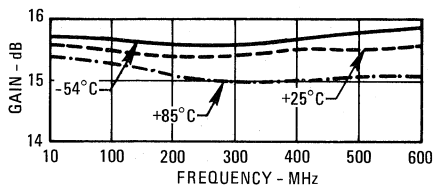
CA5-6
Note see 1



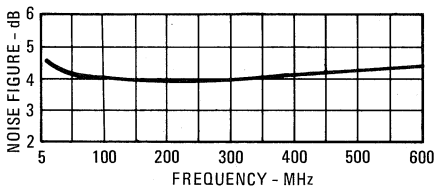

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

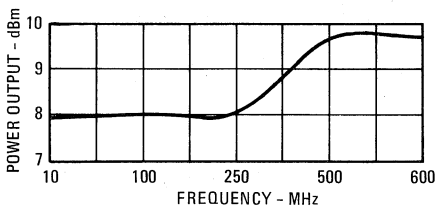
### Gain




### Noise Figure

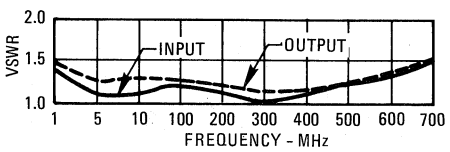



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.7 | 16.5 |
| 2.0 | 1.1 | 1.3 | 17.1 |
| 5.0 | 1.0 | 1.3 | 17.0 |
| 10.0 | 1.1 | 1.3 | 16.7 |
| 50.0 | 1.0 | 1.2 | 16.9 |
| 100.0 | 1.0 | 1.3 | 16.8 |
| 200.0 | 1.0 | 1.3 | 16.7 |
| 300.0 | 1.1 | 1.3 | 16.7 |
| 400.0 | 1.2 | 1.3 | 16.8 |
| 500.0 | 1.3 | 1.4 | 17.0 |
| 600.0 | 1.5 | 1.5 | 17.0 |
| 700.0 | 1.7 | 1.6 | 17.0 |

### Linear S-Parameters

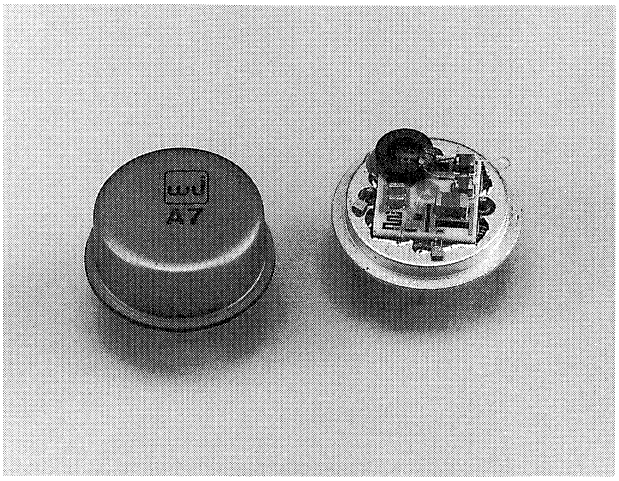
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.344 | –85 | 6.66 | –167.4 | 0.09 | 8.5 | 0.256 | 179 |
| 2.0 | 0.036 | –94 | 7.14 | –169.5 | 0.08 | 6.3 | 0.140 | –152 |
| 5.0 | 0.019 | –142 | 7.07 | –177.0 | 0.08 | 1.5 | 0.143 | –171 |
| 10.0 | 0.026 | –131 | 6.88 | 179.0 | 0.08 | –0.1 | 0.128 | –170 |
| 50.0 | 0.018 | 33 | 6.99 | 168.9 | 0.08 | –4.5 | 0.093 | 149 |
| 100.0 | 0.011 | 82 | 6.92 | 157.5 | 0.08 | –7.8 | 0.124 | 147 |
| 200.0 | 0.015 | –72 | 6.85 | 136.2 | 0.09 | –15.0 | 0.117 | 136 |
| 300.0 | 0.041 | –78 | 6.86 | 114.7 | 0.09 | –20.7 | 0.120 | 120 |
| 400.0 | 0.078 | –96 | 6.93 | 92.4 | 0.09 | –27.9 | 0.134 | 108 |
| 500.0 | 0.139 | –128 | 7.06 | 68.5 | 0.09 | –36.4 | 0.154 | 95 |
| 600.0 | 0.198 | –150 | 7.09 | 43.9 | 0.10 | –45.5 | 0.196 | 80 |
| 700.0 | 0.257 | 180 | 7.05 | 17.4 | 0.10 | –55.0 | 0.228 | 61 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.173 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A7 / SMA7

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER



- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT POWER: +14 dBm (TYP.)
- ◆ INTERCEPT POINT: +26 dBm (TYP.)
- ◆ LOW VSWR: < 1.2:1 INPUT; < 1.5:1 OUTPUT
- ◆ FLAT BANDWIDTH: ±.2 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +71°C |
|---|---|---|---|
| Frequency (Min.) | 3-550 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 14.9 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 6.5 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +14 dBm | +13 dBm | +12.5 dBm |
| VSWR (Max.) Input/Output | 1.3 :1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 24 Volts | 43 mA | 45mA | 47 mA |

*Measured in a 50-ohm system at +24 Vdc Nominal.
Notes:
1. WJ-CA7 is a standard WJ-A7 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25° C

Second Order Harmonic Intercept Point.....+47 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+26 dBm (Typ.)

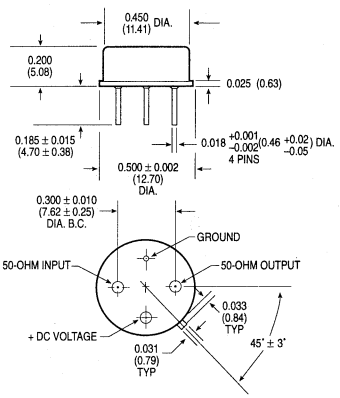
## Absolute Maximum Ratings

Storage Temperature .....-62°C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +25 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

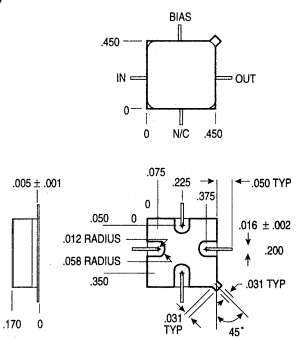
## Outline Drawings

A7



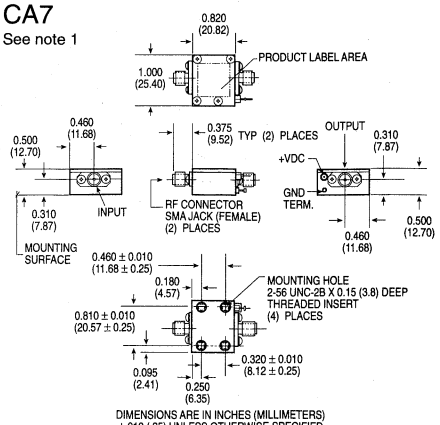

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA7




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

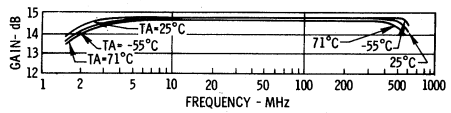
CA7
See note 1

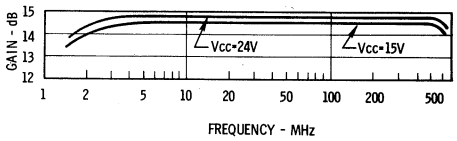



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

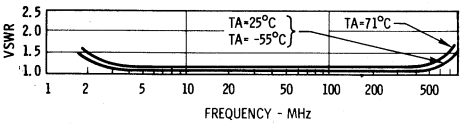
# Typical Performance at 25°C

### Gain

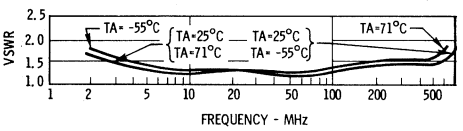


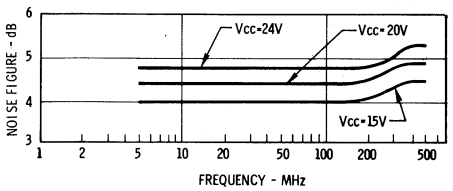

### Input VSWR



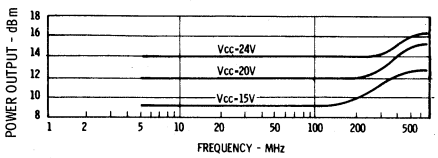

### Output VSWR




### Noise Figure

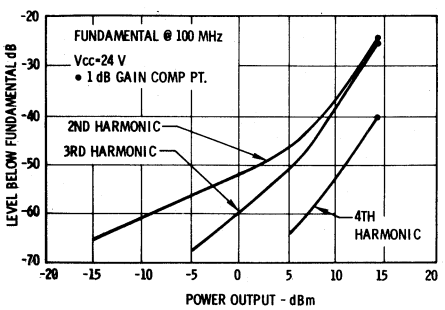



### Power Output *




*at 1 dB Gain Compression

### Harmonic Suppression vs. Power Out




# Typical Automatic Test Data

### $V_{CC}$ = 24.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.8 | 1.1 | 15.5 |
| 5.0 | 1.3 | 1.1 | 15.4 |
| 10.0 | 1.3 | 1.1 | 15.3 |
| 50.0 | 1.2 | 1.1 | 15.5 |
| 100.0 | 1.2 | 1.2 | 15.2 |
| 200.0 | 1.2 | 1.2 | 15.2 |
| 300.0 | 1.1 | 1.3 | 15.3 |
| 400.0 | 1.1 | 1.4 | 15.7 |
| 500.0 | 1.0 | 1.6 | 15.9 |
| 600.0 | 1.2 | 1.8 | 16.0 |
| 700.0 | 1.3 | 2.2 | 15.3 |

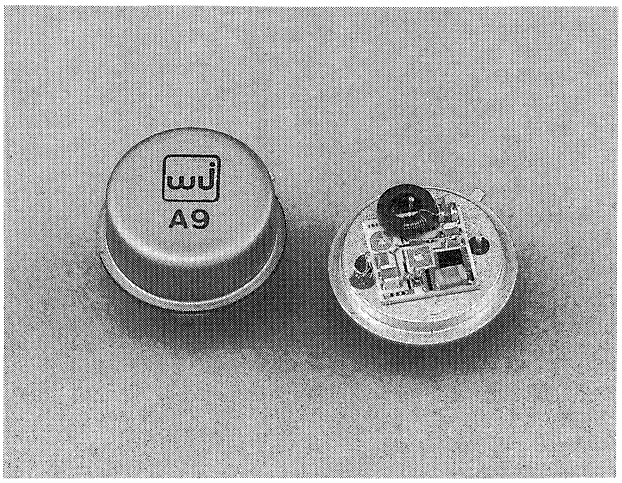
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | 0.278 | –99 | 5.95 | –158.3 | 0.11 | 0.0 | 0.048 | 146 |
| 5.0 | 0.148 | –138 | 5.89 | –172.5 | 0.11 | –1.2 | 0.054 | 172 |
| 10.0 | 0.131 | –152 | 5.79 | –178.1 | 0.11 | –0.9 | 0.039 | –171 |
| 50.0 | 0.086 | 168 | 5.93 | 169.3 | 0.11 | –3.1 | 0.061 | 72 |
| 100.0 | 0.101 | 158 | 5.76 | 157.8 | 0.11 | –5.2 | 0.075 | 78 |
| 200.0 | 0.091 | 152 | 5.77 | 136.9 | 0.11 | –10.4 | 0.096 | 37 |
| 300.0 | 0.067 | 129 | 5.85 | 115.8 | 0.12 | –16.3 | 0.139 | –4 |
| 400.0 | 0.041 | 89 | 6.07 | 92.9 | 0.11 | –20.9 | 0.178 | –45 |
| 500.0 | 0.024 | 19 | 6.24 | 66.7 | 0.11 | –27.8 | 0.229 | –92 |
| 600.0 | 0.078 | –40 | 6.30 | 37.4 | 0.11 | –32.9 | 0.293 | –144 |
| 700.0 | 0.130 | –64 | 5.80 | 4.4 | 0.11 | –34.7 | 0.373 | 162 |

# Thermal Data: $V_{CC}$ = 24 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.510 W
Junction Temperature Rise Above Case $T_{jc}$ ... 23°C

# WJ-A9 / SMA9




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +35 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +15 TO +24 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +71°C |
| Frequency (Min.) | 3-550 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 11 dB | 10 dB | 9.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±1.0 dB | ±1.0 dB |
| Noise Figure (Max.) | 8.0 dB | 10 dB | 10.5 dB |
| Power Output at 1 dB Compression (Min.) | +22 dBm | +20 dBm | +20 dBm |
| VSWR (Max.) Input/Output | 1.4 :1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 24 Volts | 110 mA | 121 mA | 127 mA |

*Measured in a 50-ohm system at +24 Vdc Nominal.
Notes:
1. WJ-CA9 is a standard WJ-A9 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+55 dBm (Typ.)
Second Order Two Tone Intercept..... +53 dBm (Typ.)
Third Order Two Tone Intercept Point.....+35 dBm (Typ.)

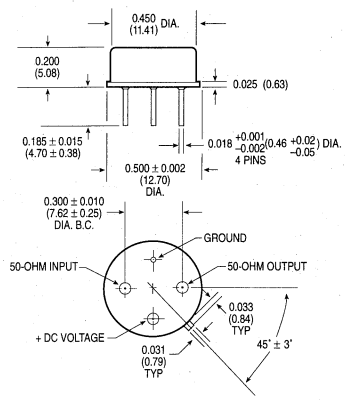
## Absolute Maximum Ratings

Storage Temperature .....-65°C to + 125°C
Maximum Case Temperature ..... 85°C
Maximum DC Voltage.....+25 Volts
Maximum Continuous RF Input Power .....+15 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S"Series Burn-in Temperature (Case) .....85°C
Proper heat sinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

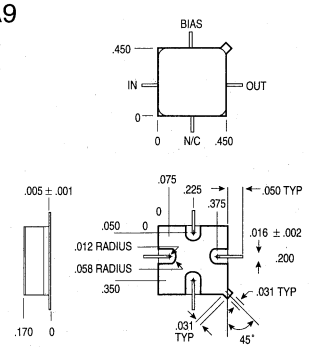
## Outline Drawings

A9



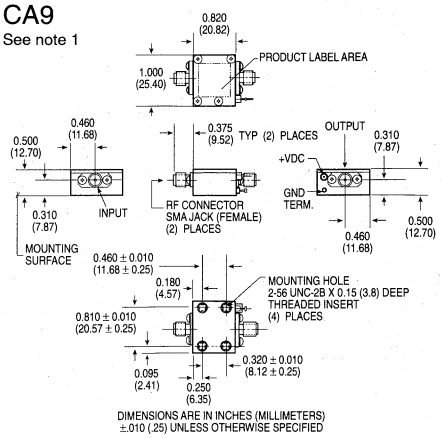

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA9




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

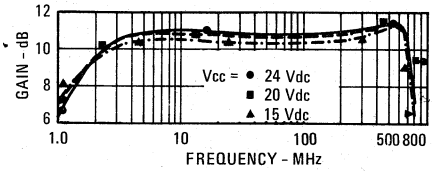
CA9
See note 1

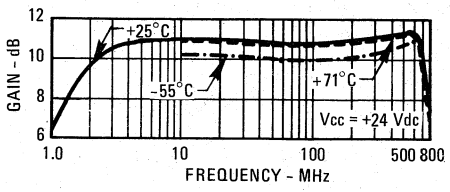



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

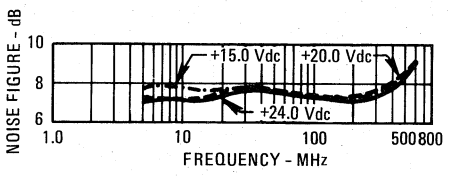
# Typical Performance at 25°C

### Gain

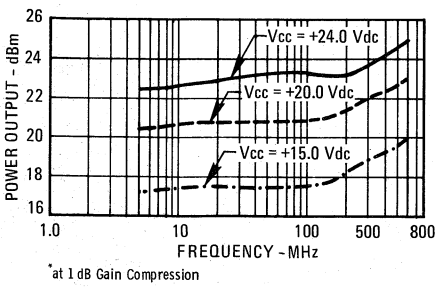



### Noise Figure

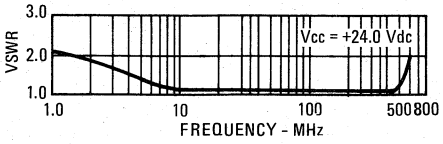



### Power Output*

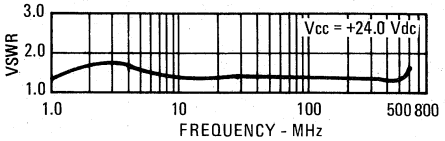



*at 1 dB Gain Compression

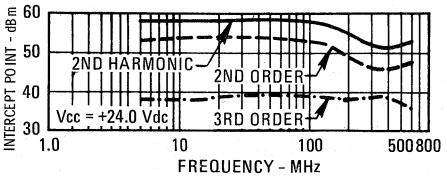
### Input VSWR

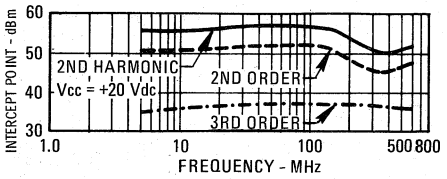


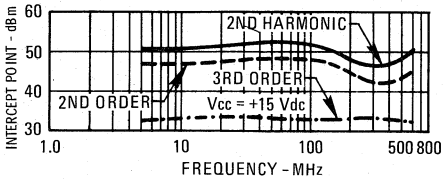

### Output VSWR




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 24.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 11.1 |
| 2.0 | 1.2 | 1.4 | 11.1 |
| 5.0 | 1.1 | 1.4 | 11.2 |
| 10.0 | 1.1 | 1.4 | 11.2 |
| 50.0 | 1.1 | 1.4 | 11.2 |
| 100.0 | 1.1 | 1.4 | 11.1 |
| 200.0 | 1.2 | 1.5 | 11.1 |
| 300.0 | 1.2 | 1.5 | 11.2 |
| 400.0 | 1.3 | 1.5 | 11.6 |
| 500.0 | 1.1 | 1.3 | 11.9 |
| 600.0 | 1.2 | 1.1 | 12.1 |
| 700.0 | 2.1 | 1.6 | 11.5 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.5 | 10.7 |
| 2.0 | 1.2 | 1.5 | 10.7 |
| 5.0 | 1.1 | 1.5 | 10.8 |
| 10.0 | 1.1 | 1.5 | 10.8 |
| 50.0 | 1.1 | 1.5 | 10.8 |
| 100.0 | 1.1 | 1.5 | 10.8 |
| 200.0 | 1.2 | 1.5 | 10.8 |
| 300.0 | 1.3 | 1.5 | 10.9 |
| 400.0 | 1.3 | 1.4 | 11.4 |
| 500.0 | 1.2 | 1.3 | 11.9 |
| 600.0 | 1.3 | 1.4 | 12.1 |
| 700.0 | 2.4 | 2.2 | 11.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .116 | –75 | 3.590 | –168 | .128 | –2 | .180 | –2 |
| 2.0 | .106 | –76 | 3.609 | –169 | .128 | –2 | .175 | –2 |
| 5.0 | .060 | –79 | 3.633 | –177 | .126 | –2 | .166 | –1 |
| 10.0 | .037 | –77 | 3.636 | 172 | .126 | –3 | .167 | –0 |
| 50.0 | .033 | –83 | 3.629 | 161 | .127 | –6 | .173 | –2 |
| 100.0 | .046 | –91 | 3.602 | 148 | .128 | –10 | .181 | –5 |
| 200.0 | .076 | –107 | 3.592 | 130 | .130 | –16 | .195 | –14 |
| 300.0 | .106 | –125 | 3.613 | 106 | .135 | –24 | .204 | –30 |
| 400.0 | .113 | –146 | 3.788 | 80 | .143 | –34 | .190 | –55 |
| 500.0 | .065 | 177 | 3.947 | 50 | .153 | –47 | .133 | –90 |
| 600.0 | .081 | –21 | 4.045 | 17 | .163 | –64 | .059 | 168 |
| 700.0 | .346 | –61 | 3.767 | –22 | .164 | –85 | .223 | 63 |

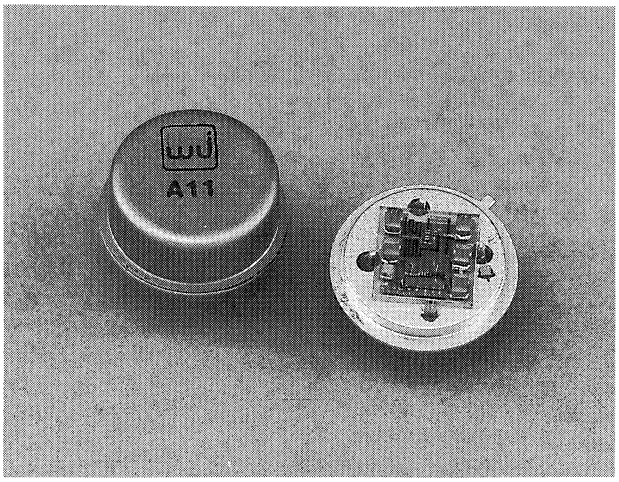
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .103 | –80 | 3.418 | –169 | .127 | –3 | .208 | –5 |
| 2.0 | .093 | –82 | 3.435 | –171 | .127 | –3 | .204 | –4 |
| 5.0 | .052 | –87 | 3.462 | –178 | .126 | –2 | .197 | –3 |
| 10.0 | .032 | –103 | 3.467 | 172 | .126 | –3 | .197 | –4 |
| 50.0 | .033 | –92 | 3.473 | 161 | .126 | –5 | .200 | –8 |
| 100.0 | .050 | –101 | 3.449 | 148 | .128 | –8 | .202 | –14 |
| 200.0 | .076 | –112 | 3.453 | 130 | .132 | –13 | .206 | –25 |
| 300.0 | .112 | –133 | 3.502 | 105 | .140 | –21 | .202 | –45 |
| 400.0 | .119 | –160 | 3.723 | 78 | .153 | –31 | .181 | –77 |
| 500.0 | .081 | 144 | 3.931 | 48 | .170 | –45 | .135 | –131 |
| 600.0 | .140 | –1 | 4.027 | 11 | .185 | –65 | .170 | 132 |
| 700.0 | .417 | –57 | 3.584 | –31 | .181 | –89 | .367 | 63 |

## Thermal Data: $V_{CC}$ = 24 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 1.494 W
Junction Temperature Rise Above Case $T_{jc}$ ... 67°C

# WJ-A11 / SMA11




## 5 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.1 dB (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ FLAT BANDWIDTH: < ±0.25 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1100 MHz | 5-1000 MHz | 5-1000 MHz |
| Small Signal Gain (Min.) | 14.7 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.25 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | 3.1 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | -2.0 dBm | -3.0 dBm | -4.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 12 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA11 is a standard WJ-A11 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+15 dBm (Typ.)
Second Order Two Tone Intercept Point.....+10 dBm (Typ.)
Third Order Two Tone Intercept Point..... +10 dBm (Typ.)

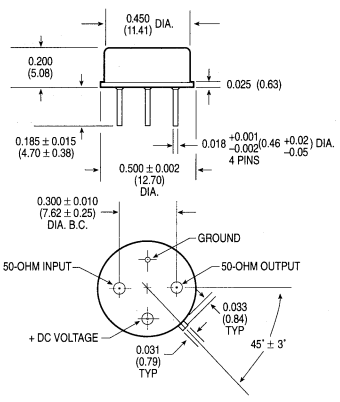
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power ..... +13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

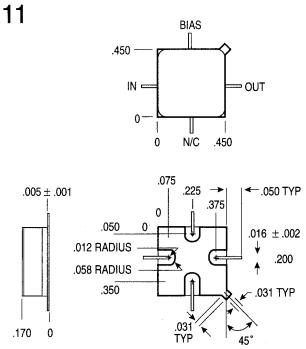
## Outline Drawings

A11



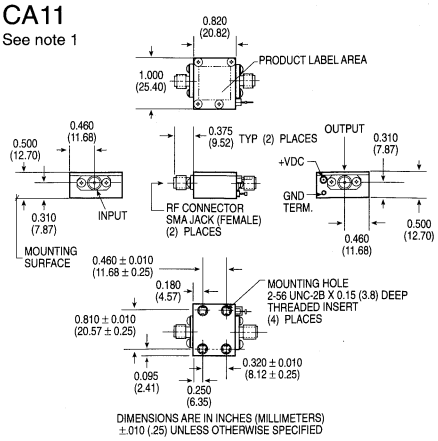

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA11




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

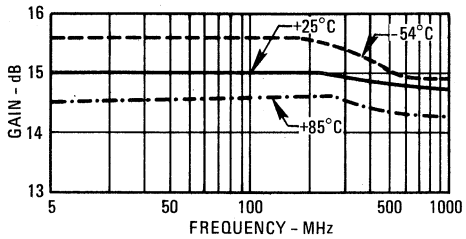
CA11
See note 1



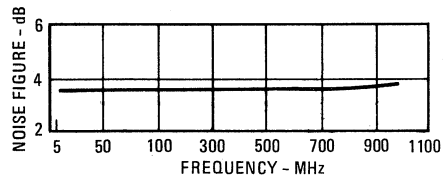

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

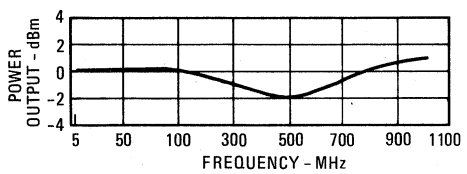
### Gain




### Noise Figure

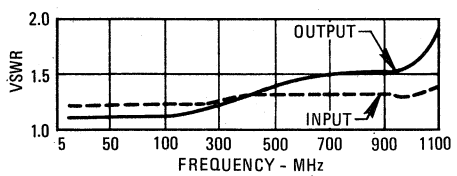



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.0 | 1.1 | 15.2 |
| 2.0 | 1.0 | 1.1 | 15.2 |
| 5.0 | 1.0 | 1.1 | 15.2 |
| 10.0 | 1.0 | 1.1 | 15.1 |
| 50.0 | 1.0 | 1.1 | 15.1 |
| 100.0 | 1.0 | 1.1 | 14.9 |
| 200.0 | 1.1 | 1.1 | 14.9 |
| 300.0 | 1.1 | 1.1 | 14.9 |
| 400.0 | 1.2 | 1.2 | 15.0 |
| 500.0 | 1.2 | 1.2 | 15.2 |
| 600.0 | 1.3 | 1.3 | 15.3 |
| 700.0 | 1.2 | 1.3 | 15.4 |
| 800.0 | 1.2 | 1.3 | 15.4 |
| 900.0 | 1.1 | 1.3 | 15.4 |
| 1000.0 | 1.3 | 1.4 | 15.1 |
| 1100.0 | 1.7 | 1.5 | 14.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .010 | –124 | 5.779 | –179 | .105 | 3 | .039 | –168 |
| 2.0 | .010 | –143 | 5.751 | –179 | .105 | 2 | .039 | –171 |
| 5.0 | .007 | –153 | 5.749 | 178 | .105 | 0 | .036 | 175 |
| 10.0 | .005 | –169 | 5.688 | 172 | .105 | –3 | .034 | 151 |
| 50.0 | .011 | 46 | 5.670 | 164 | .105 | –7 | .033 | 121 |
| 100.0 | .013 | 23 | 5.582 | 155 | .105 | –11 | .033 | 89 |
| 200.0 | .030 | –28 | 5.556 | 141 | .105 | –18 | .038 | 40 |
| 300.0 | .057 | –60 | 5.540 | 124 | .104 | –27 | .053 | –19 |
| 400.0 | .087 | –87 | 5.650 | 105 | .103 | –36 | .076 | –68 |
| 500.0 | .111 | –117 | 5.737 | 85 | .101 | –45 | .096 | –104 |
| 600.0 | .114 | –136 | 5.833 | 64 | .099 | –54 | .113 | –131 |
| 700.0 | .109 | –159 | 5.863 | 42 | .097 | –63 | .126 | –161 |
| 800.0 | .089 | 166 | 5.921 | 19 | .096 | –72 | .133 | 162 |
| 900.0 | .057 | 89 | 5.890 | –6 | .098 | –80 | .141 | 115 |
| 1000.0 | .119 | –2 | 5.699 | –33 | .099 | –90 | .165 | 62 |
| 1100.0 | .267 | –50 | 5.148 | –63 | .102 | –103 | .212 | 7 |

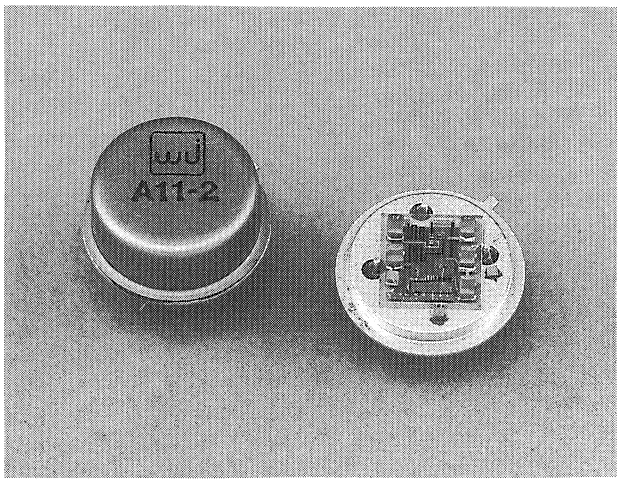
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.048 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A11-2 / SMA11-2

## 5 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.5 dB (TYP.)
- ◆ HIGH GAIN: 16 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1100 MHz | 5-1000 MHz | 5-1000 MHz |
| Small Signal Gain (Min.) | 16 dB | 15 dB | 14 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.9 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.5 dB | 3.0 dB | 3.5 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dB | -3.0 dB | -3.5 dB |
| VSWR (Max.) Input/Output | < 1.4:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 12mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA11-2 is a standard WJ-A11-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+15 dBm (Typ.)
Second Order Two Tone Intercept Point.....+10 dBm (Typ.)
Third Order Two Tone Intercept Point.....+10 dBm (Typ.)

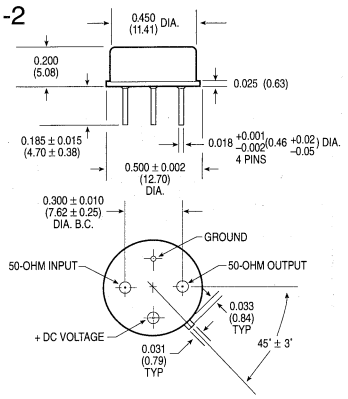
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

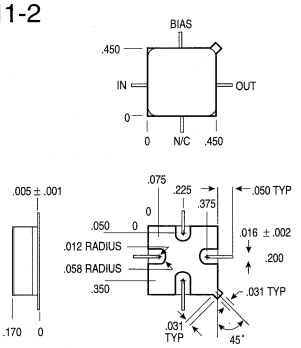
## Outline Drawings

A11-2



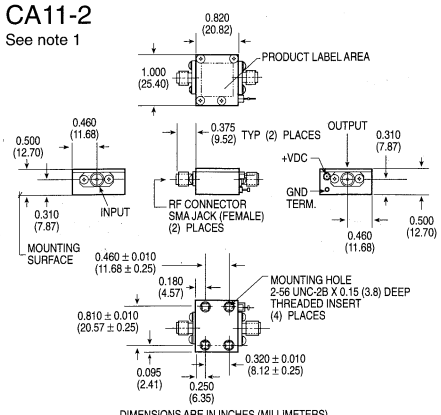

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA11-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

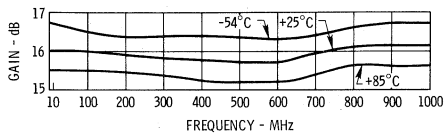
CA11-2
See note 1



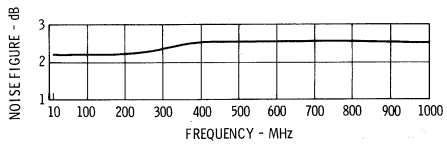

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

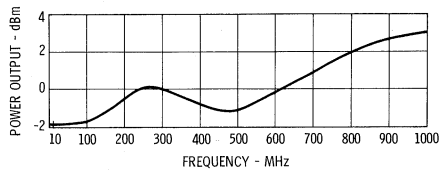
### Gain




### Noise Figure

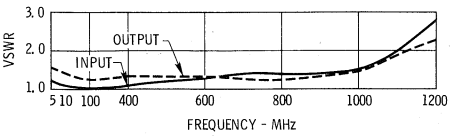



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.3 | 17.1 |
| 2.0 | 1.2 | 1.3 | 17.1 |
| 5.0 | 1.2 | 1.3 | 17.1 |
| 10.0 | 1.2 | 1.3 | 17.0 |
| 50.0 | 1.2 | 1.3 | 16.9 |
| 100.0 | 1.2 | 1.3 | 16.8 |
| 200.0 | 1.1 | 1.3 | 16.7 |
| 300.0 | 1.0 | 1.3 | 16.5 |
| 400.0 | 1.1 | 1.3 | 16.6 |
| 500.0 | 1.2 | 1.3 | 16.7 |
| 600.0 | 1.3 | 1.3 | 16.6 |
| 700.0 | 1.3 | 1.2 | 16.6 |
| 800.0 | 1.4 | 1.1 | 16.6 |
| 900.0 | 1.5 | 1.2 | 16.7 |
| 1000.0 | 1.6 | 1.6 | 16.4 |
| 1100.0 | 2.3 | 2.2 | 15.2 |

### Linear S-Parameters

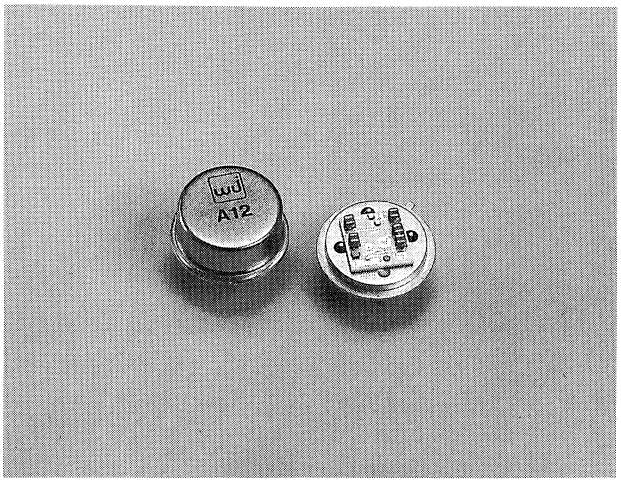
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .107 | –175 | 7.183 | –179 | .088 | 3 | .131 | –177 |
| 2.0 | .107 | –176 | 7.186 | –179 | .088 | 3 | .131 | –179 |
| 5.0 | .107 | 177 | 7.136 | 178 | .088 | 1 | .128 | 174 |
| 10.0 | .097 | 168 | 7.070 | 171 | .088 | –2 | .125 | 158 |
| 50.0 | .092 | 148 | 7.027 | 162 | .089 | –5 | .124 | 137 |
| 100.0 | .082 | 133 | 6.898 | 150 | .089 | –9 | .125 | 115 |
| 200.0 | .056 | 112 | 6.802 | 135 | .090 | –15 | .127 | 83 |
| 300.0 | .016 | 29 | 6.702 | 114 | .089 | –23 | .129 | 44 |
| 400.0 | .047 | –85 | 6.796 | 93 | .089 | –32 | .123 | 9 |
| 500.0 | .088 | –122 | 6.806 | 70 | .087 | –41 | .118 | –20 |
| 600.0 | .116 | –148 | 6.749 | 46 | .084 | –50 | .113 | –46 |
| 700.0 | .144 | –177 | 6.745 | 23 | .082 | –58 | .091 | –67 |
| 800.0 | .165 | 143 | 6.792 | –3 | .081 | –67 | .051 | –58 |
| 900.0 | .188 | 89 | 6.833 | –30 | .084 | –77 | .094 | –6 |
| 1000.0 | .239 | 17 | 6.634 | –63 | .085 | –91 | .226 | –22 |
| 1100.0 | .388 | –55 | 5.786 | –100 | .086 | –110 | .377 | –56 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.057 W
Junction Temperature Rise Above Case $T_{jc}$ ... 3°C

# WJ-A12 / SMA12

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.8 dB (TYP.)
- ◆ HIGH GAIN: 16 dB (TYP.)
- ◆ MEDIUM OUTPUT POWER: +8.0 dBm (TYP.)
- ◆ LOW VSWR: <1.6:1 (TYP.)

## Specifications*

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1000 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 15.0 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.8 dB | 3.5 dB | 3.9 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +7.0 dBm | +6.5 dBm |
| VSWR (Max.) Input/Output | <1.6:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 22 mA | 25 mA | 27 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA12 is a standard WJ-A12 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+32 dBm (Typ.)
Second Order Two Tone Intercept Point.....+25 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

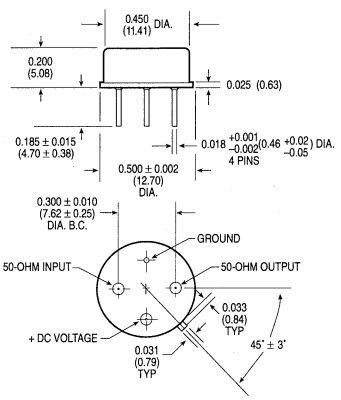
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +17 Volts
Maximum Continuous RF Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

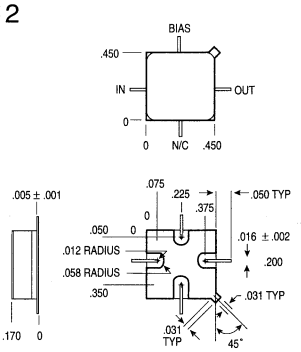
## Outline Drawings

A12



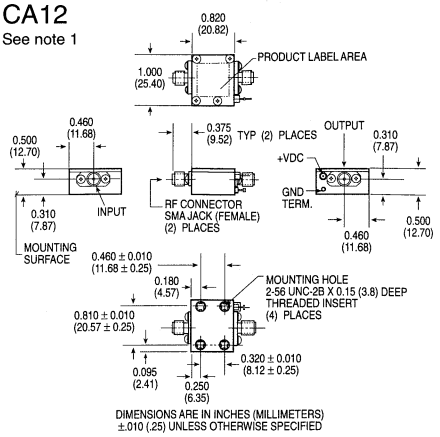

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA12




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

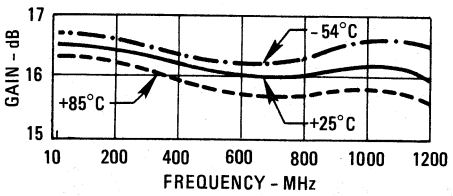
CA12
See note 1



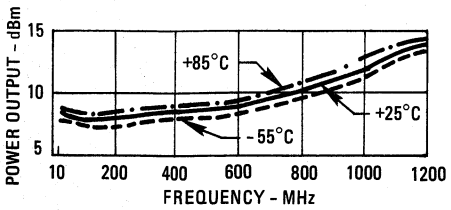

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

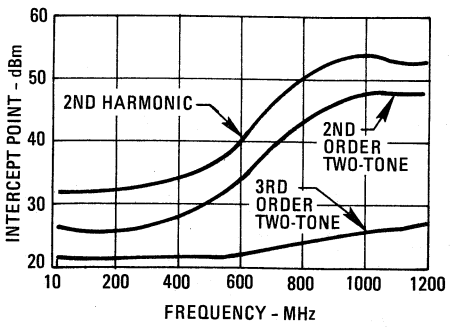



### Power Output*

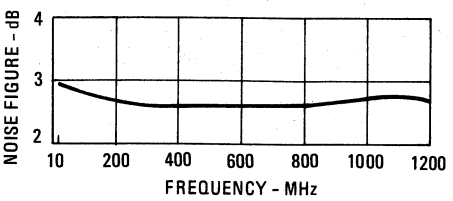



*at 1 dB Gain Compression

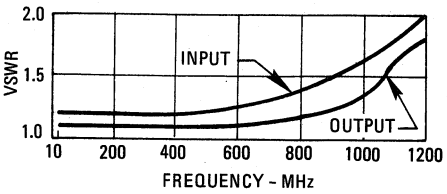
### Intercept Point




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 1.2 | 16.2 |
| 2.0 | 1.1 | 1.2 | 16.2 |
| 5.0 | 1.1 | 1.2 | 16.2 |
| 10.0 | 1.1 | 1.2 | 16.1 |
| 50.0 | 1.1 | 1.2 | 16.0 |
| 100.0 | 1.0 | 1.2 | 15.9 |
| 200.0 | 1.0 | 1.1 | 15.8 |
| 300.0 | 1.1 | 1.1 | 15.8 |
| 400.0 | 1.2 | 1.1 | 15.9 |
| 500.0 | 1.2 | 1.1 | 16.0 |
| 600.0 | 1.3 | 1.2 | 16.0 |
| 700.0 | 1.3 | 1.2 | 16.0 |
| 800.0 | 1.3 | 1.3 | 16.1 |
| 900.0 | 1.3 | 1.4 | 16.1 |
| 1000.0 | 1.5 | 1.5 | 15.6 |
| 1100.0 | 2.1 | 1.6 | 14.5 |

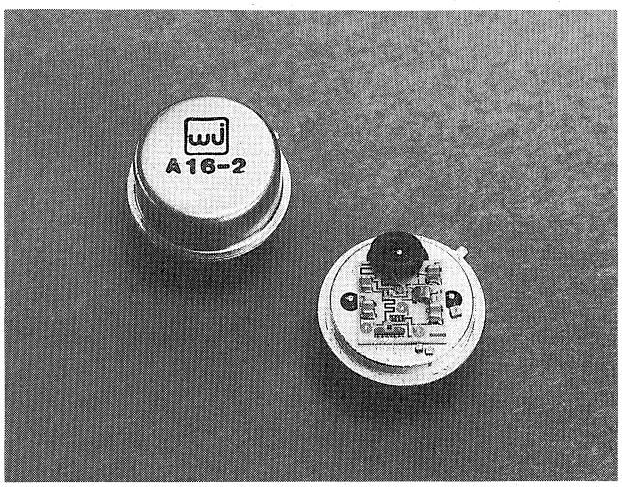
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .041 | –171 | 6.488 | –179 | .082 | 2 | .098 | –178 |
| 2.0 | .043 | –171 | 6.462 | –179 | .082 | 2 | .099 | –178 |
| 5.0 | .046 | –178 | 6.425 | 178 | .083 | 0 | .100 | 177 |
| 10.0 | .046 | 173 | 6.369 | 171 | .083 | –2 | .098 | 166 |
| 50.0 | .035 | 154 | 6.321 | 163 | .083 | –5 | .092 | 150 |
| 100.0 | .024 | 147 | 6.226 | 153 | .083 | –9 | .082 | 134 |
| 200.0 | .007 | 169 | 6.166 | 139 | .084 | –15 | .061 | 109 |
| 300.0 | .034 | –91 | 6.134 | 119 | .083 | –23 | .027 | 59 |
| 400.0 | .078 | –109 | 6.256 | 99 | .084 | –31 | .026 | –83 |
| 500.0 | .107 | –135 | 6.307 | 78 | .082 | –40 | .056 | –128 |
| 600.0 | .119 | –156 | 6.325 | 55 | .080 | –48 | .081 | –151 |
| 700.0 | .130 | –179 | 6.328 | 33 | .078 | –55 | .105 | –179 |
| 800.0 | .128 | 146 | 6.352 | 8 | .080 | –63 | .127 | 146 |
| 900.0 | .138 | 87 | 6.351 | –18 | .083 | –70 | .150 | 101 |
| 1000.0 | .202 | 14 | 6.059 | –49 | .086 | –81 | .184 | 50 |
| 1100.0 | .360 | –43 | 5.333 | –81 | .090 | –95 | .230 | –5 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.180 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A16-2 / SMA16-2




## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.5 dB (TYP.)
- ◆ HIGH EFFICIENCY: 15 mA (TYP.) AT 5 VOLTS
- ◆ GOOD DYNAMIC RANGE: 102.5 dB (TYP.) IN 1 MHz BW
- ◆ LOW VSWR: <1.5:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5 - 1300 MHz | 10 - 1200 MHz | 10 - 1200 MHz |
| Small Signal Gain (Min.) | 13.0 dB | 12.0 dB | 11.5 dB |
| Gain Flatness (Max.) | ±.2 dB | ±.5 dB | ±.7 dB |
| Noise Figure (Max.) | 3.5 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +6.0 dBm | +5.0 dBm | +4.5 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +5 Volts | 15 mA | 17 mA | 18 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA16-2 is a standard WJ-A16-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+34 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+28 dBm (Typ.)
Third Order Two-Tone Intercept Point ..... +18 dBm (Typ.)

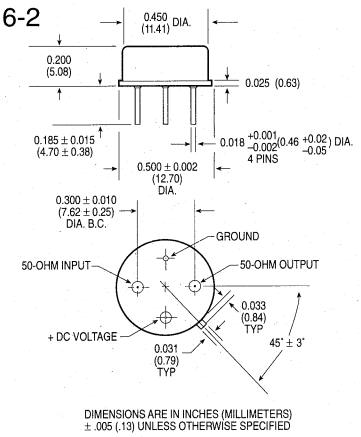
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....+125°C
Maximum DC Voltage..... +8 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

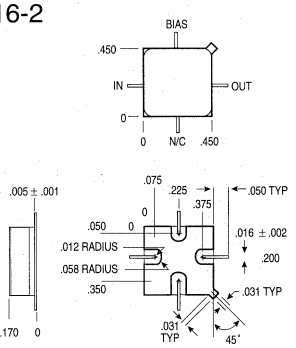
## Outline Drawings

A16-2



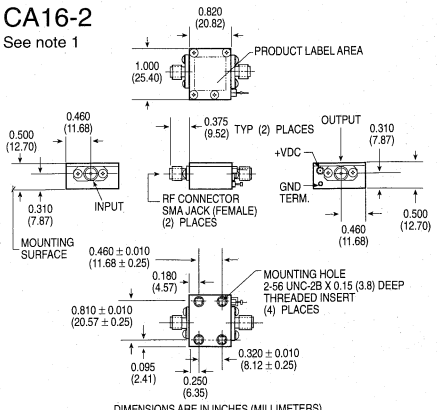

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA16-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

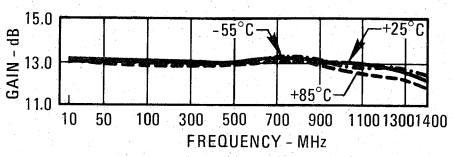
CA16-2
See note 1



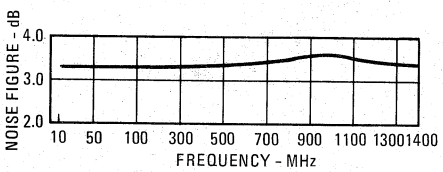

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

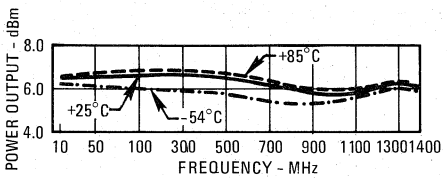
### Gain




### Noise Figure

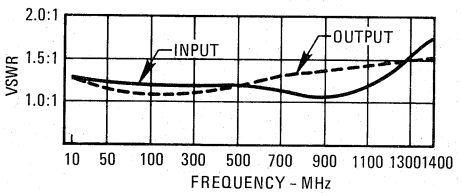



### Power Output*

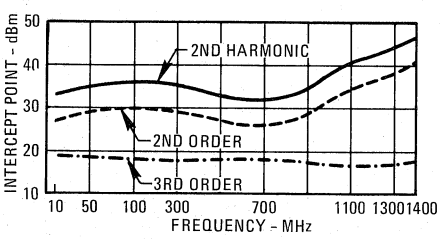



* at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.2 | 13.6 |
| 2.0 | 1.3 | 1.2 | 13.6 |
| 5.0 | 1.3 | 1.1 | 13.6 |
| 10.0 | 1.3 | 1.1 | 13.6 |
| 50.0 | 1.2 | 1.1 | 13.6 |
| 100.0 | 1.2 | 1.1 | 13.5 |
| 200.0 | 1.2 | 1.1 | 13.4 |
| 300.0 | 1.2 | 1.1 | 13.3 |
| 400.0 | 1.2 | 1.2 | 13.5 |
| 500.0 | 1.3 | 1.3 | 13.6 |
| 600.0 | 1.4 | 1.4 | 13.6 |
| 700.0 | 1.4 | 1.5 | 13.6 |
| 800.0 | 1.4 | 1.6 | 13.6 |
| 900.0 | 1.4 | 1.5 | 13.6 |
| 1000.0 | 1.3 | 1.4 | 13.6 |
| 1100.0 | 1.3 | 1.2 | 13.5 |
| 1200.0 | 1.7 | 1.1 | 13.2 |
| 1300.0 | 2.5 | 1.4 | 12.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .123 | −146 | 4.781 | −177 | .118 | 4 | .088 | 130 |
| 2.0 | .124 | −149 | 4.808 | −177 | .118 | 4 | .082 | 130 |
| 5.0 | .114 | −164 | 4.798 | 179 | .118 | 1 | .062 | 138 |
| 10.0 | .115 | −175 | 4.781 | 173 | .119 | −2 | .048 | 137 |
| 50.0 | .103 | 174 | 4.773 | 165 | .119 | −7 | .044 | 119 |
| 100.0 | .095 | 169 | 4.716 | 156 | .119 | −11 | .043 | 94 |
| 200.0 | .085 | 172 | 4.677 | 143 | .120 | −18 | .047 | 48 |
| 300.0 | .082 | −175 | 4.641 | 125 | .120 | −26 | .069 | −7 |
| 400.0 | .103 | −166 | 4.732 | 107 | .120 | −36 | .104 | −51 |
| 500.0 | .139 | −175 | 4.763 | 88 | .119 | −46 | .142 | −82 |
| 600.0 | .153 | 169 | 4.779 | 68 | .118 | −56 | .178 | −107 |
| 700.0 | .157 | 153 | 4.789 | 48 | .116 | −66 | .206 | −131 |
| 800.0 | .157 | 135 | 4.795 | 28 | .116 | −76 | .217 | −155 |
| 900.0 | .150 | 106 | 4.772 | 8 | .116 | −86 | .204 | 179 |
| 1000.0 | .119 | 62 | 4.782 | −15 | .117 | −97 | .167 | 152 |
| 1100.0 | .125 | −6 | 4.723 | −38 | .120 | −109 | .094 | .118 |
| 1200.0 | .248 | −61 | 4.592 | −65 | .124 | −123 | .050 | −24 |
| 1300.0 | .426 | −102 | 4.240 | −94 | .125 | −141 | .183 | −87 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.2 | 13.2 |
| 2.0 | 1.2 | 1.1 | 13.2 |
| 5.0 | 1.2 | 1.1 | 13.2 |
| 10.0 | 1.1 | 1.0 | 13.2 |
| 50.0 | 1.1 | 1.0 | 13.2 |
| 100.0 | 1.1 | 1.0 | 13.1 |
| 200.0 | 1.1 | 1.1 | 13.0 |
| 300.0 | 1.1 | 1.1 | 13.0 |
| 400.0 | 1.2 | 1.2 | 13.2 |
| 500.0 | 1.3 | 1.3 | 13.3 |
| 600.0 | 1.4 | 1.4 | 13.4 |
| 700.0 | 1.5 | 1.5 | 13.5 |
| 800.0 | 1.5 | 1.5 | 13.6 |
| 900.0 | 1.5 | 1.4 | 13.6 |
| 1000.0 | 1.4 | 1.3 | 13.7 |
| 1100.0 | 1.3 | 1.3 | 13.7 |
| 1200.0 | 1.6 | 1.5 | 13.5 |
| 1300.0 | 2.3 | 2.0 | 12.9 |

### Linear S-Parameters

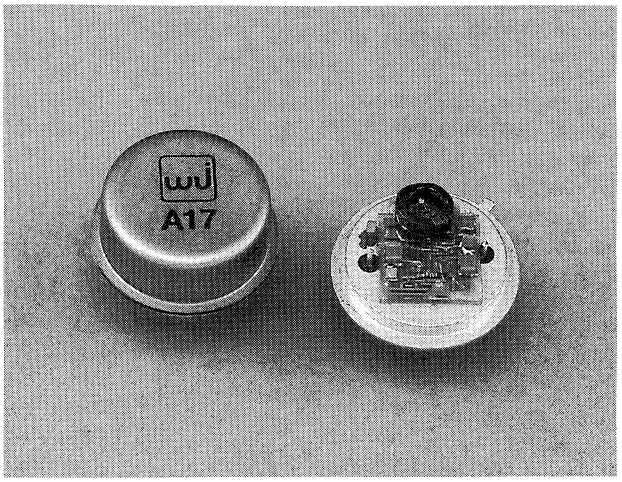
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .092 | −132 | 4.569 | −177 | .123 | 4 | .073 | 112 |
| 2.0 | .089 | −136 | 4.574 | −177 | .124 | 4 | .066 | 113 |
| 5.0 | .077 | −152 | 4.594 | 179 | .124 | 1 | .043 | 112 |
| 10.0 | .067 | −169 | 4.590 | 173 | .125 | −2 | .023 | 103 |
| 50.0 | .057 | 174 | 4.576 | 166 | .126 | −6 | .019 | 80 |
| 100.0 | .057 | −177 | 4.509 | 157 | .125 | −11 | .021 | 48 |
| 200.0 | .054 | −167 | 4.489 | 144 | .126 | −17 | .032 | 1 |
| 300.0 | .065 | −142 | 4.459 | 127 | .126 | −25 | .062 | −42 |
| 400.0 | .100 | −139 | 4.573 | 110 | .127 | −35 | .101 | −78 |
| 500.0 | .148 | −154 | 4.630 | 91 | .128 | −44 | .137 | −104 |
| 600.0 | .174 | −172 | 4.686 | 71 | .127 | −54 | .166 | −127 |
| 700.0 | .192 | 175 | 4.743 | 52 | .127 | −64 | .186 | −150 |
| 800.0 | .201 | 154 | 4.778 | 31 | .129 | −74 | .193 | −175 |
| 900.0 | .190 | 127 | 4.809 | 11 | .133 | −84 | .177 | 154 |
| 1000.0 | .160 | 92 | 4.864 | −11 | .136 | −96 | .145 | 114 |
| 1100.0 | .123 | 32 | 4.854 | −35 | .142 | −109 | .116 | 47 |
| 1200.0 | .216 | −46 | 4.755 | −62 | .147 | −125 | .192 | −32 |
| 1300.0 | .401 | −96 | 4.397 | −92 | .147 | −144 | .336 | −81 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.051 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A17 / SMA17

## 10 to1000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +15.3 dB (TYP.)
- ◆ HIGH THIRD ORDER I.P. +27 dBm (TYP.)
- ◆ LOW VSWR: < 1.3:1 (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85°C |
| Frequency (Min.) | 2-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 12 dB | 10.5 dB | 10 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.5 dB | 8.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +15.3 dBm | +14 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | < 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 44 mA | 47 mA | 49 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA17 is a standard WJ-A17 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+48 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+49 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+27 dBm (Typ.)

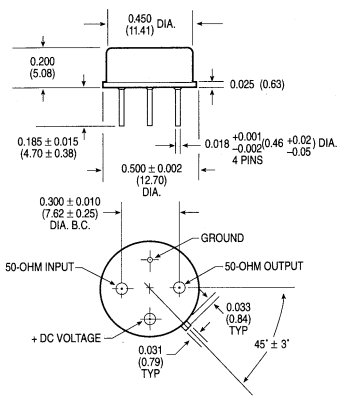
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

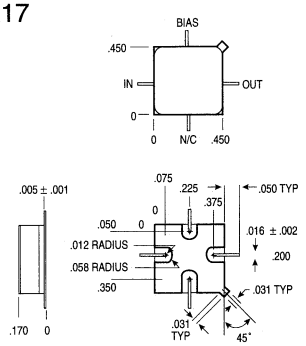
## Outline Drawings

A17



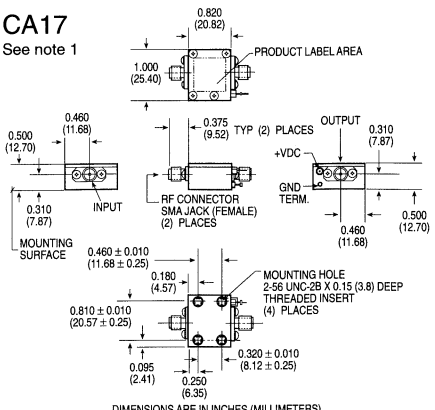

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA17




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

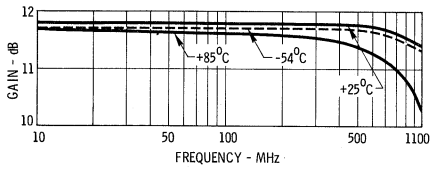
CA17
See note 1



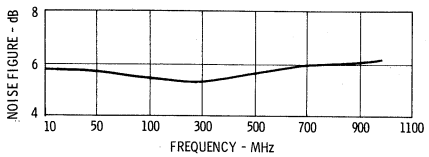

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

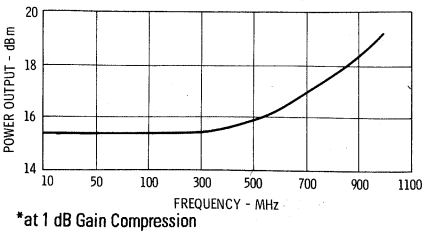
### Gain




### Noise Figure

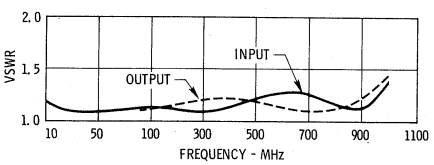



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 1.2 | 12.8 |
| 2.0 | 1.1 | 1.2 | 12.8 |
| 5.0 | 1.1 | 1.2 | 12.9 |
| 10.0 | 1.1 | 1.1 | 12.9 |
| 50.0 | 1.1 | 1.1 | 12.8 |
| 100.0 | 1.0 | 1.1 | 12.7 |
| 200.0 | 1.0 | 1.1 | 12.7 |
| 300.0 | 1.0 | 1.1 | 12.6 |
| 400.0 | 1.1 | 1.1 | 12.7 |
| 500.0 | 1.2 | 1.1 | 12.9 |
| 600.0 | 1.2 | 1.1 | 12.9 |
| 700.0 | 1.2 | 1.1 | 12.9 |
| 800.0 | 1.2 | 1.1 | 12.9 |
| 900.0 | 1.2 | 1.2 | 12.9 |
| 1000.0 | 1.1 | 1.3 | 13.0 |
| 1100.0 | 1.2 | 1.4 | 13.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .067 | –112 | 4.374 | –175 | .132 | 7 | .101 | 146 |
| 2.0 | .059 | –117 | 4.372 | –175 | .133 | 6 | .097 | 147 |
| 5.0 | .043 | –136 | 4.397 | –180 | .133 | 3 | .078 | 150 |
| 10.0 | .036 | –167 | 4.406 | 174 | .135 | –1 | .063 | 150 |
| 50.0 | .027 | 148 | 4.373 | 166 | .134 | –3 | .058 | 140 |
| 100.0 | .016 | 126 | 4.314 | 157 | .135 | –7 | .057 | 126 |
| 200.0 | .005 | 86 | 4.306 | 145 | .136 | –10 | .052 | 99 |
| 300.0 | .022 | –48 | 4.258 | 129 | .139 | –17 | .044 | 59 |
| 400.0 | .051 | –83 | 4.338 | 112 | .143 | –23 | .031 | 8 |
| 500.0 | .073 | –118 | 4.392 | 95 | .146 | –31 | .028 | –44 |
| 600.0 | .090 | –136 | 4.409 | 76 | .148 | –39 | .038 | –86 |
| 700.0 | .100 | –159 | 4.405 | 58 | .151 | –47 | .046 | –127 |
| 800.0 | .111 | 177 | 4.423 | 39 | .154 | –57 | .056 | –174 |
| 900.0 | .104 | 140 | 4.437 | 20 | .159 | –67 | .075 | 134 |
| 1000.0 | .069 | 93 | 4.463 | –1 | .161 | –79 | .117 | 86 |
| 1100.0 | .086 | –18 | 4.468 | –24 | .164 | –94 | .183 | 42 |

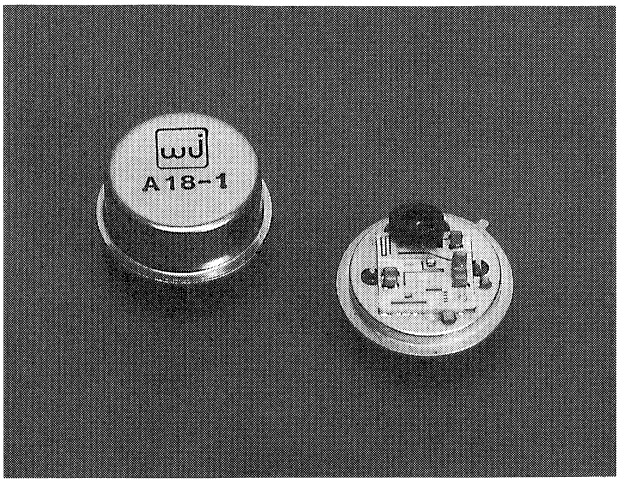
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.384 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-A18-1 / SMA18-1

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE
- ◆ HIGH OUTPUT POWER: +16 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)
- ◆ LOW NOISE: 3.8 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed - 54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 14.7 dB | 14 dB | 13.5 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.5 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.8 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +16 dBm | +15 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 44 mA | 46 mA | 48 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1 WJ-CA18 is a standard WJ-A18 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+42 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

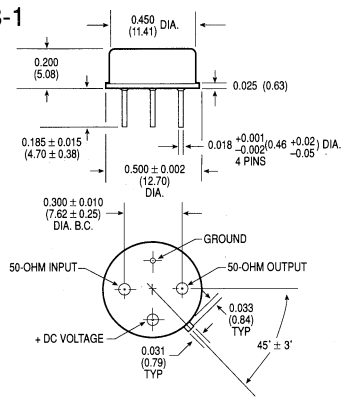
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power ..... +13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.) max.

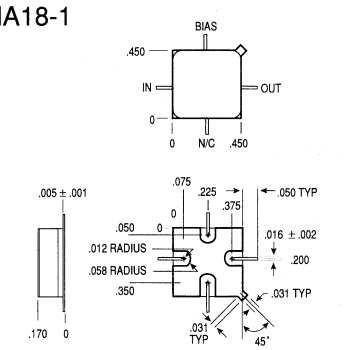
## Outline Drawings

A18-1



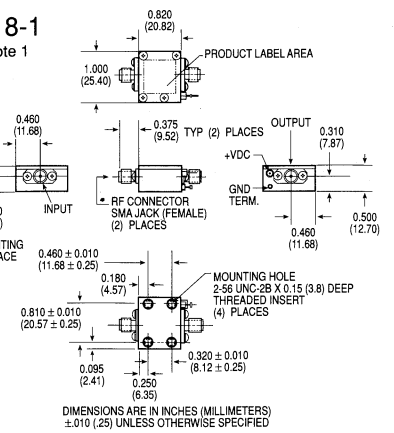

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA18-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

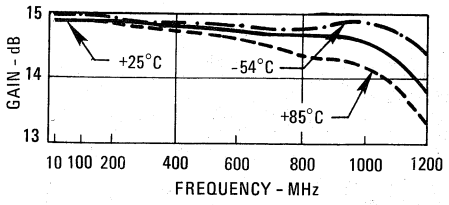
CA18-1
See note 1



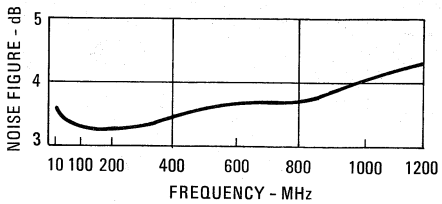

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

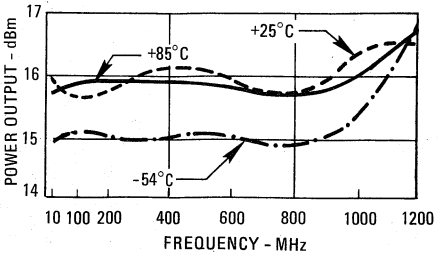
### Gain




### Noise Figure

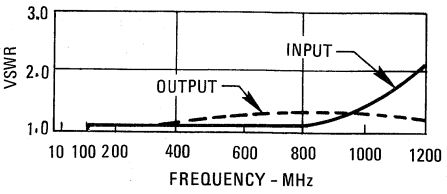



### Power Output*

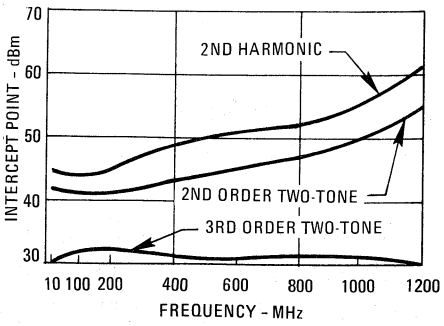



* at 1 dB Gain Compression

### VSWR




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.2 | 14.8 |
| 2.0 | 1.1 | 1.2 | 14.8 |
| 5.0 | 1.1 | 1.1 | 14.9 |
| 10.0 | 1.0 | 1.0 | 14.9 |
| 50.0 | 1.0 | 1.0 | 14.8 |
| 100.0 | 1.1 | 1.0 | 14.7 |
| 200.0 | 1.1 | 1.0 | 14.6 |
| 300.0 | 1.1 | 1.1 | 14.6 |
| 400.0 | 1.2 | 1.1 | 14.8 |
| 500.0 | 1.2 | 1.2 | 15.0 |
| 600.0 | 1.2 | 1.2 | 15.1 |
| 700.0 | 1.2 | 1.3 | 15.2 |
| 800.0 | 1.1 | 1.3 | 15.3 |
| 900.0 | 1.1 | 1.4 | 15.4 |
| 1000.0 | 1.2 | 1.5 | 15.4 |
| 1100.0 | 1.6 | 1.6 | 15.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .078 | –65 | 5.517 | –174 | .107 | 8 | .078 | 110 |
| 2.0 | .068 | –64 | 5.511 | –175 | .107 | 7 | .071 | 110 |
| 5.0 | .038 | –61 | 5.543 | –179 | .109 | 3 | .046 | 100 |
| 10.0 | .016 | –44 | 5.529 | 175 | .110 | –1 | .022 | 73 |
| 50.0 | .022 | 9 | 5.513 | 167 | .111 | –4 | .015 | 42 |
| 100.0 | .028 | 9 | 5.443 | 159 | .111 | –7 | .014 | 12 |
| 200.0 | .040 | –5 | 5.377 | 147 | .112 | –11 | .020 | –28 |
| 300.0 | .055 | –28 | 5.361 | 132 | .113 | –18 | .037 | –74 |
| 400.0 | .077 | –51 | 5.495 | 116 | .117 | –25 | .066 | –113 |
| 500.0 | .075 | –76 | 5.610 | 100 | .119 | –33 | .089 | –147 |
| 600.0 | .075 | –92 | 5.711 | 81 | .121 | –41 | .101 | –175 |
| 700.0 | .077 | –110 | 5.758 | 63 | .124 | –49 | .117 | 158 |
| 800.0 | .066 | –141 | 5.836 | 44 | .127 | –58 | .139 | 127 |
| 900.0 | .035 | 143 | 5.916 | 24 | .131 | –68 | .166 | 93 |
| 1000.0 | .078 | 39 | 5.890 | 1 | .134 | –79 | .196 | 55 |
| 1100.0 | .216 | –8 | 5.651 | –24 | .134 | –93 | .223 | 12 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.3 | 13.2 |
| 2.0 | 1.4 | 1.3 | 13.2 |
| 5.0 | 1.3 | 1.3 | 13.2 |
| 10.0 | 1.3 | 1.3 | 13.3 |
| 50.0 | 1.3 | 1.3 | 13.2 |
| 100.0 | 1.3 | 1.3 | 13.1 |
| 200.0 | 1.3 | 1.3 | 13.0 |
| 300.0 | 1.3 | 1.3 | 13.0 |
| 400.0 | 1.4 | 1.4 | 13.1 |
| 500.0 | 1.3 | 1.5 | 13.2 |
| 600.0 | 1.3 | 1.5 | 13.3 |
| 700.0 | 1.3 | 1.5 | 13.4 |
| 800.0 | 1.3 | 1.6 | 13.3 |
| 900.0 | 1.4 | 1.6 | 13.2 |
| 1000.0 | 1.7 | 1.6 | 12.8 |
| 1100.0 | 2.2 | 1.6 | 12.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .158 | –24 | 4.554 | –174 | .120 | 8 | .122 | 50 |
| 2.0 | .153 | –23 | 4.581 | –175 | .121 | 7 | .118 | 45 |
| 5.0 | .139 | –18 | 4.587 | –179 | .122 | 3 | .115 | 26 |
| 10.0 | .127 | –18 | 4.607 | 174 | .123 | –1 | .119 | 2 |
| 50.0 | .133 | –21 | 4.582 | 166 | .123 | –4 | .120 | –14 |
| 100.0 | .134 | –35 | 4.537 | 158 | .123 | –7 | .120 | –28 |
| 200.0 | .140 | –54 | 4.478 | 145 | .124 | –11 | .127 | –46 |
| 300.0 | .145 | –79 | 4.446 | 129 | .126 | –18 | .143 | –73 |
| 400.0 | .150 | –106 | 4.539 | 112 | .131 | –24 | .169 | –103 |
| 500.0 | .146 | –137 | 4.582 | 95 | .135 | –32 | .188 | –132 |
| 600.0 | .137 | –168 | 4.632 | 75 | .139 | –41 | .201 | –161 |
| 700.0 | .128 | 157 | 4.651 | 56 | .144 | –50 | .211 | 172 |
| 800.0 | .128 | 112 | 4.624 | 35 | .148 | –60 | .224 | 141 |
| 900.0 | .170 | 63 | 4.557 | 14 | .153 | –71 | .233 | 107 |
| 1000.0 | .251 | 17 | 4.345 | –9 | .152 | –84 | .236 | 70 |
| 1100.0 | .371 | –22 | 3.970 | –33 | .151 | –96 | .225 | 29 |

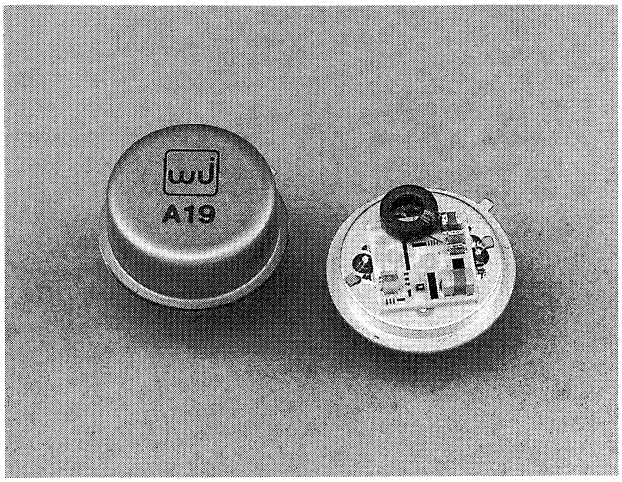
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.407 W
Junction Temperature Rise Above Case $T_{jc}$ ... 18°C

# WJ-A19 / SMA19

## 10 TO 1000 MHZ
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +21 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +34 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1050 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 7.5 dB | 6.0 dB | 5.5 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±1.0 dB | ±1.3 dB |
| Noise Figure (Max.) | 9.0 dB | 10.5 dB | 11.0 dB |
| Power Output at 1 dB Compression (Min.) | +21 dBm | +20 dBm | +19 dBm |
| VSWR (Max.) Input/Output | < 1.8:1 | 2.2:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 100 mA | 109 mA | 114 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA19 is a standard WJ-A19 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+40 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+34 dBm (Typ.)

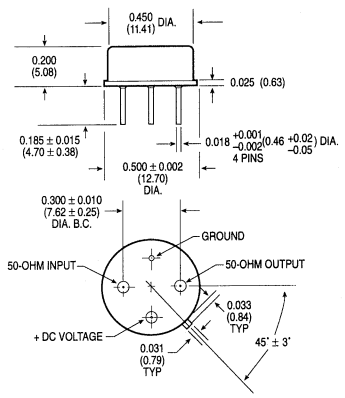
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+ 17 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power.....100 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

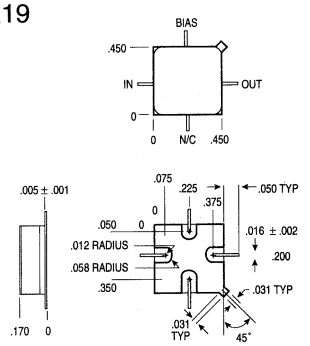
## Outline Drawings

A19



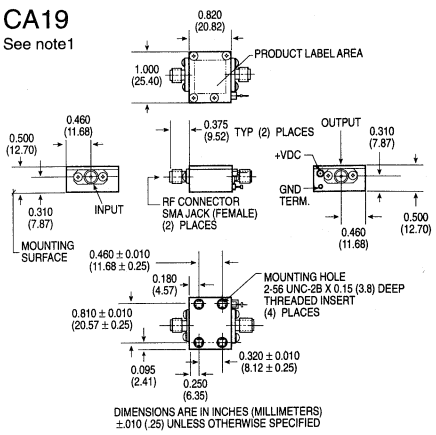

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA19




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

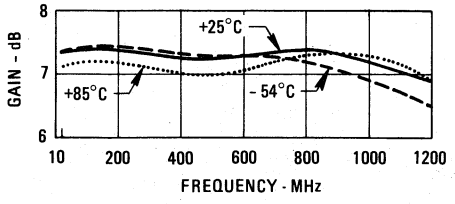
CA19
See note1



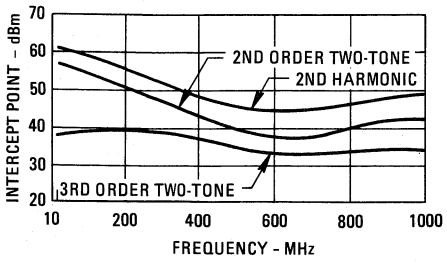

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

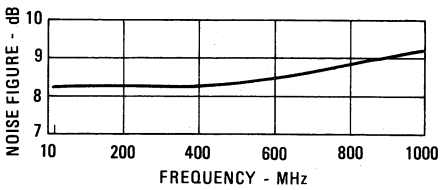
### Gain



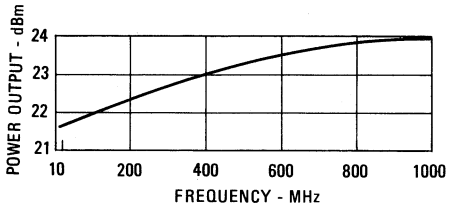

### Intercept Point




### Noise Figure

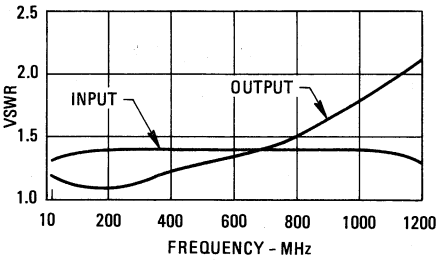



### Power Output*




* at 1 dB Gain Compression

### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.4 | 6.8 |
| 2.0 | 1.1 | 1.3 | 6.8 |
| 5.0 | 1.1 | 1.3 | 6.9 |
| 10.0 | 1.1 | 1.4 | 7.0 |
| 50.0 | 1.0 | 1.4 | 7.0 |
| 100.0 | 1.1 | 1.4 | 6.9 |
| 200.0 | 1.1 | 1.4 | 6.8 |
| 300.0 | 1.2 | 1.4 | 6.7 |
| 400.0 | 1.2 | 1.5 | 6.8 |
| 500.0 | 1.3 | 1.5 | 6.9 |
| 600.0 | 1.4 | 1.6 | 7.1 |
| 700.0 | 1.4 | 1.6 | 7.2 |
| 800.0 | 1.5 | 1.6 | 7.2 |
| 900.0 | 1.6 | 1.6 | 7.2 |
| 1000.0 | 1.7 | 1.6 | 7.2 |
| 1100.0 | 1.9 | 1.5 | 6.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .079 | –78 | 2.195 | –169 | .165 | 3 | .151 | 35 |
| 2.0 | .069 | –79 | 2.198 | –170 | .165 | 3 | .148 | 32 |
| 5.0 | .044 | –78 | 2.216 | –177 | .166 | 2 | .146 | 19 |
| 10.0 | .025 | –86 | 2.227 | 176 | .168 | –0 | .151 | 6 |
| 50.0 | .022 | –88 | 2.226 | 167 | .168 | –2 | .154 | –2 |
| 100.0 | .035 | –101 | 2.203 | 159 | .168 | –4 | .157 | –8 |
| 200.0 | .054 | –116 | 2.181 | 147 | .170 | –6 | .164 | –17 |
| 300.0 | .075 | –135 | 2.169 | 132 | .174 | –10 | .179 | –30 |
| 400.0 | .101 | –155 | 2.199 | 116 | .180 | –14 | .196 | –47 |
| 500.0 | .131 | 180 | 2.218 | 99 | .185 | –18 | .209 | –65 |
| 600.0 | .155 | 156 | 2.264 | 83 | .191 | –23 | .222 | –83 |
| 700.0 | .174 | 133 | 2.284 | 66 | .199 | –28 | .230 | –102 |
| 800.0 | .194 | 110 | 2.295 | 48 | .207 | –34 | .233 | –122 |
| 900.0 | .232 | 85 | 2.289 | 32 | .220 | –39 | .227 | –143 |
| 1000.0 | .269 | 58 | 2.282 | 13 | .230 | –46 | .217 | –167 |
| 1100.0 | .301 | 32 | 2.221 | –5 | .242 | –53 | .200 | 169 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.4 | 6.8 |
| 2.0 | 1.2 | 1.4 | 6.8 |
| 5.0 | 1.1 | 1.3 | 6.8 |
| 10.0 | 1.1 | 1.4 | 6.9 |
| 50.0 | 1.0 | 1.4 | 6.9 |
| 100.0 | 1.1 | 1.4 | 6.8 |
| 200.0 | 1.1 | 1.4 | 6.7 |
| 300.0 | 1.2 | 1.4 | 6.7 |
| 400.0 | 1.2 | 1.5 | 6.8 |
| 500.0 | 1.3 | 1.5 | 6.9 |
| 600.0 | 1.4 | 1.5 | 7.0 |
| 700.0 | 1.4 | 1.6 | 7.1 |
| 800.0 | 1.5 | 1.6 | 7.1 |
| 900.0 | 1.6 | 1.5 | 7.1 |
| 1000.0 | 1.8 | 1.5 | 7.0 |
| 1100.0 | 1.9 | 1.4 | 6.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .074 | –76 | 2.178 | –169 | .165 | 3 | .153 | 33 |
| 2.0 | .071 | –77 | 2.180 | –171 | .165 | 3 | .150 | 29 |
| 5.0 | .040 | –78 | 2.197 | –177 | .166 | 1 | .149 | 18 |
| 10.0 | .026 | –95 | 2.207 | 176 | .168 | –0 | .154 | 4 |
| 50.0 | .023 | –92 | 2.208 | 167 | .168 | –2 | .158 | –3 |
| 100.0 | .030 | –103 | 2.187 | 159 | .169 | –4 | .160 | –10 |
| 200.0 | .053 | –115 | 2.169 | 147 | .170 | –6 | .165 | –19 |
| 300.0 | .081 | –135 | 2.153 | 131 | .175 | –9 | .178 | –33 |
| 400.0 | .102 | –155 | 2.190 | 115 | .181 | –13 | .193 | –51 |
| 500.0 | .133 | 180 | 2.203 | 99 | .187 | –18 | .205 | –69 |
| 600.0 | .158 | 155 | 2.246 | 82 | .194 | –22 | .214 | –87 |
| 700.0 | .179 | 133 | 2.276 | 65 | .203 | –27 | .219 | –107 |
| 800.0 | .204 | 109 | 2.277 | 47 | .213 | –33 | .219 | –127 |
| 900.0 | .243 | 84 | 2.263 | 31 | .227 | –39 | .212 | –150 |
| 1000.0 | .278 | 57 | 2.246 | 12 | .237 | –46 | .199 | –175 |
| 1100.0 | .309 | 30 | 2.179 | –6 | .249 | –53 | .181 | 160 |

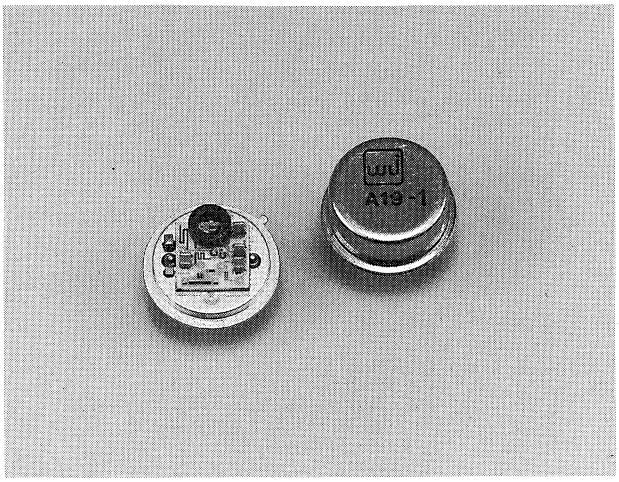
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.944 W
Junction Temperature Rise Above Case $T_{jc}$ ... 42°C

# WJ-A19-1 / SMA19-1

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P. +35 dBm (TYP.)
- ◆ MEDIUM NOISE FIGURE: 6.0 dB (TYP.)




## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.5 dB | 10.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.6 dB | ±0.8 dB |
| Noise Figure (Max.) | | | |
| 30-600 MHz | 6.0 dB | 7.0 dB | 7.5 dB |
| 10-1000 MHz | 6.5 dB | 8.0 dB | 8.5 dB |
| Power Output at | | | |
| 1 dB Compression (Min.) | +22.5 dBm | +20.5 dBm | +20.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 90 mA | 94 mA | 99 mA |

*Measured in a 50-ohm system at 15 Vdc Nominal.
Notes:
1. WJ-CA19-1 is a standard WJ-A19-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+58 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+51 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+35 dBm (Typ.)

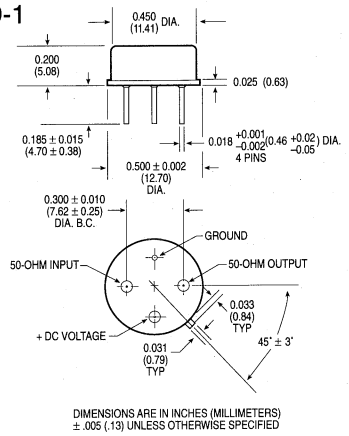
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 minute max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

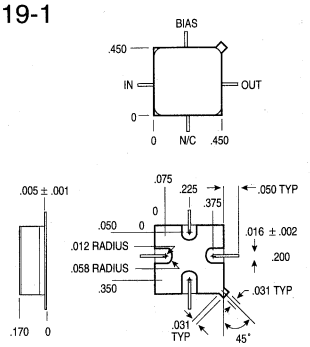
## Outline Drawings

A19-1



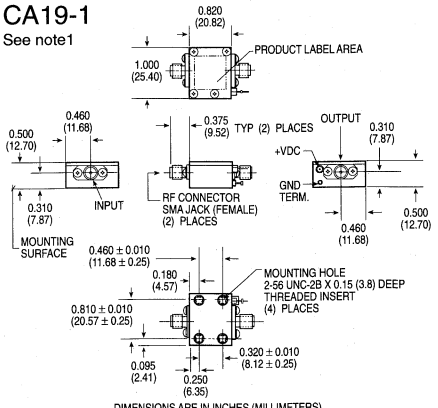

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA19-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

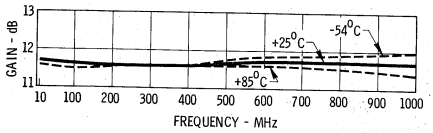
CA19-1
See note1



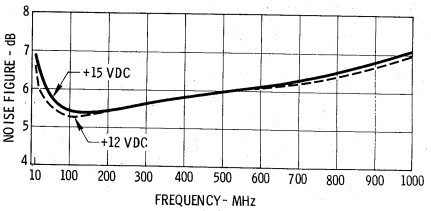

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

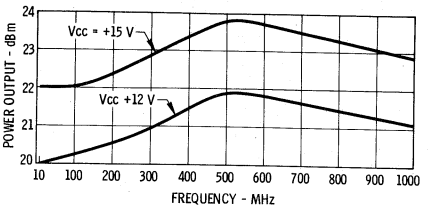
### Gain




### Noise Figure

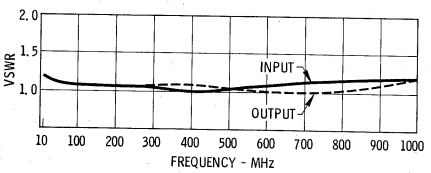



### Power Output*

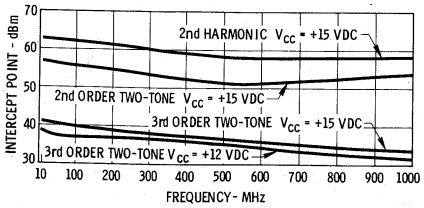



* at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### Vcc = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 1.2 | 11.9 |
| 2.0 | 1.1 | 1.1 | 11.9 |
| 5.0 | 1.0 | 1.1 | 12.0 |
| 10.0 | 1.0 | 1.1 | 12.0 |
| 50.0 | 1.0 | 1.1 | 12.0 |
| 100.0 | 1.0 | 1.1 | 11.9 |
| 200.0 | 1.1 | 1.0 | 11.9 |
| 300.0 | 1.1 | 1.0 | 11.8 |
| 400.0 | 1.2 | 1.1 | 12.0 |
| 500.0 | 1.2 | 1.1 | 12.1 |
| 600.0 | 1.3 | 1.1 | 12.3 |
| 700.0 | 1.2 | 1.2 | 12.3 |
| 800.0 | 1.3 | 1.2 | 12.3 |
| 900.0 | 1.3 | 1.2 | 12.3 |
| 1000.0 | 1.2 | 1.3 | 12.3 |
| 1100.0 | 1.3 | 1.3 | 12.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .034 | −138 | 3.947 | −167 | .139 | 14 | .077 | −153 |
| 2.0 | .033 | −140 | 3.946 | −169 | .140 | 12 | .069 | −156 |
| 5.0 | .024 | −151 | 3.978 | −176 | .141 | 6 | .046 | −172 |
| 10.0 | .023 | −164 | 3.994 | 176 | .143 | 0 | .034 | 169 |
| 50.0 | .015 | 172 | 3.978 | 168 | .143 | −4 | .030 | 156 |
| 100.0 | .014 | −137 | 3.930 | 160 | .143 | −7 | .026 | 145 |
| 200.0 | .029 | −126 | 3.917 | 149 | .144 | −12 | .017 | 121 |
| 300.0 | .044 | −118 | 3.903 | 134 | .146 | −18 | .003 | −35 |
| 400.0 | .078 | −124 | 3.996 | 119 | .150 | −25 | .030 | −103 |
| 500.0 | .100 | −146 | 4.043 | 103 | .153 | −33 | .052 | −128 |
| 600.0 | .114 | −164 | 4.102 | 86 | .155 | −41 | .067 | −147 |
| 700.0 | .110 | −178 | 4.118 | 69 | .159 | −50 | .081 | −167 |
| 800.0 | .123 | 159 | 4.134 | 51 | .163 | −58 | .093 | 166 |
| 900.0 | .116 | 124 | 4.137 | 33 | .168 | −68 | .103 | 132 |
| 1000.0 | .099 | 75 | 4.132 | 13 | .172 | −78 | .119 | 93 |
| 1100.0 | .116 | 9 | 4.070 | −7 | .177 | −90 | .146 | 47 |

### Vcc = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 1.2 | 11.9 |
| 2.0 | 1.1 | 1.1 | 11.9 |
| 5.0 | 1.0 | 1.1 | 11.9 |
| 10.0 | 1.1 | 1.1 | 12.0 |
| 50.0 | 1.0 | 1.0 | 11.9 |
| 100.0 | 1.0 | 1.0 | 11.8 |
| 200.0 | 1.1 | 1.0 | 11.8 |
| 300.0 | 1.1 | 1.0 | 11.8 |
| 400.0 | 1.2 | 1.1 | 12.0 |
| 500.0 | 1.2 | 1.1 | 12.1 |
| 600.0 | 1.3 | 1.2 | 12.2 |
| 700.0 | 1.3 | 1.2 | 12.2 |
| 800.0 | 1.3 | 1.3 | 12.2 |
| 900.0 | 1.3 | 1.3 | 12.2 |
| 1000.0 | 1.3 | 1.4 | 12.2 |
| 1100.0 | 1.4 | 1.5 | 12.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .034 | −143 | 3.914 | −167 | .139 | 14 | .074 | −150 |
| 2.0 | .032 | −142 | 3.929 | −169 | .140 | 12 | .066 | −154 |
| 5.0 | .023 | −147 | 3.954 | −176 | .141 | 6 | .042 | −170 |
| 10.0 | .026 | −158 | 3.970 | 176 | .142 | 1 | .030 | 172 |
| 50.0 | .013 | −178 | 3.940 | 168 | .143 | −3 | .024 | 163 |
| 100.0 | .015 | −137 | 3.912 | 160 | .143 | −7 | .021 | 158 |
| 200.0 | .031 | −120 | 3.893 | 148 | .144 | −11 | .013 | 157 |
| 300.0 | .060 | −124 | 3.872 | 134 | .147 | −17 | .014 | −119 |
| 400.0 | .081 | −130 | 3.959 | 118 | .152 | −24 | .044 | −125 |
| 500.0 | .110 | −153 | 4.014 | 102 | .155 | −32 | .069 | −145 |
| 600.0 | .120 | −171 | 4.063 | 84 | .159 | −40 | .086 | −163 |
| 700.0 | .124 | 169 | 4.081 | 67 | .163 | −48 | .102 | 176 |
| 800.0 | .129 | 146 | 4.088 | 48 | .169 | −57 | .120 | 150 |
| 900.0 | .127 | 111 | 4.094 | 30 | .176 | −67 | .139 | 118 |
| 1000.0 | .124 | 59 | 4.059 | 10 | .181 | −78 | .164 | 83 |
| 1100.0 | .162 | −0 | 3.974 | −10 | .185 | −90 | .199 | 42 |

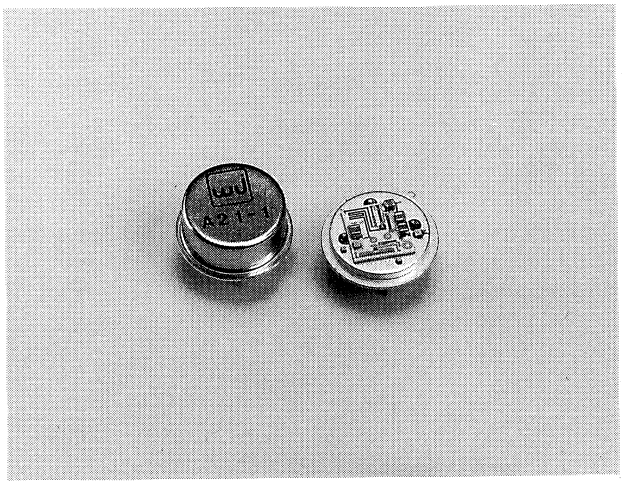
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.886 W
Junction Temperature Rise Above Case $T_{jc}$ ... 40°C

# WJ-A21-1 / SMA21-1

## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: < 2.8 dB (TYP.)
- ◆ LOW VSWR: 1.5:1 (TYP.)
- ◆ HIGH SINGLE STAGE GAIN: 15 dB (TYP.)



## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1300 MHz | 10-1200 MHz | 10-1200 MHz |
| Small Signal Gain (Min.) | 15.0 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±1.0 dB |
| Noise Figure (Max.) | < 2.8 dB | 3.5 dB | 3.9 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dBm | -2.0 dBm | -3.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 1.9:1 | 2.0 :1 |
| DC Current (Max.) at 15 Volt | 10 mA | 11 mA | 12 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA21-1 is a standard WJ-A21-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+16 dBm (Typ.)
Second Order Two Tone Intercept Point.....+11 dBm (Typ.)
Third Order Two Tone Intercept Point.....+10 dBm (Typ.)

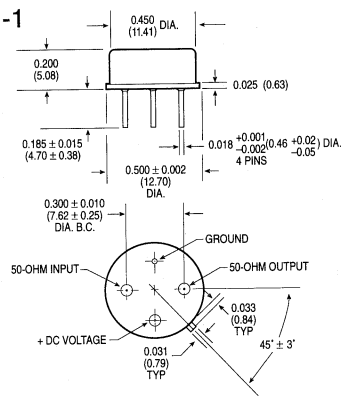
## Absolute Maximum Ratings

Storage Temperature .....-62°C to+125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S"Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

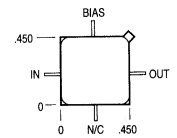
## Outline Drawings

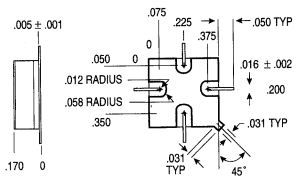
A21-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

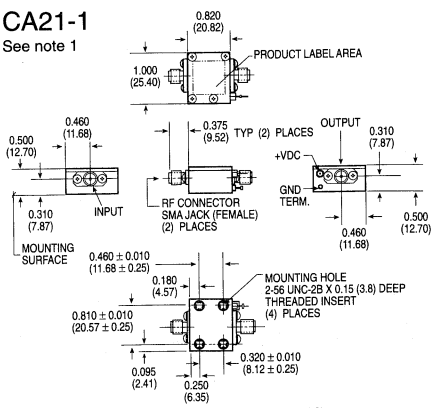
SMA21-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

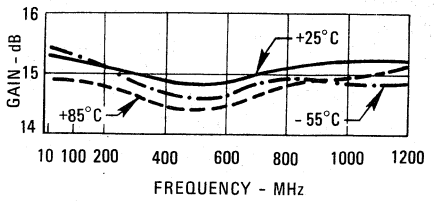
CA21-1
See note 1



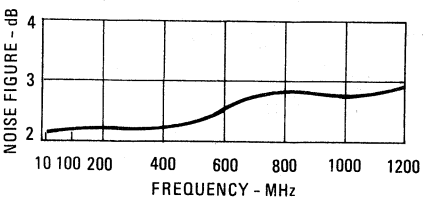

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

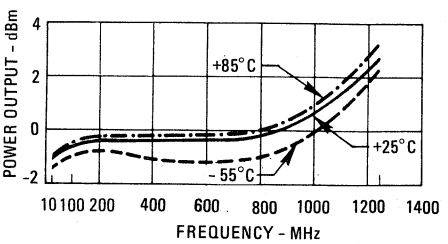
### Gain




### Noise Figure

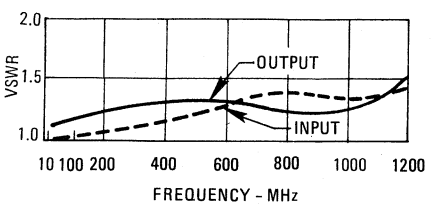



### Power Output*

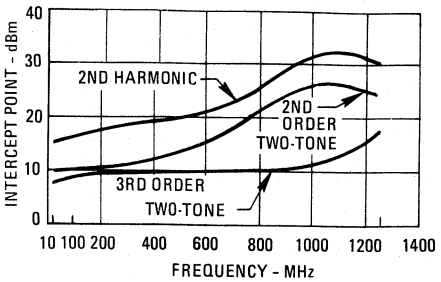



* at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 14.7 |
| 2.0 | 1.3 | 1.3 | 14.8 |
| 5.0 | 1.2 | 1.3 | 14.8 |
| 10.0 | 1.2 | 1.2 | 14.8 |
| 50.0 | 1.2 | 1.2 | 14.8 |
| 100.0 | 1.2 | 1.2 | 14.7 |
| 200.0 | 1.2 | 1.2 | 14.5 |
| 300.0 | 1.2 | 1.2 | 14.5 |
| 400.0 | 1.3 | 1.2 | 14.6 |
| 500.0 | 1.4 | 1.2 | 14.7 |
| 600.0 | 1.4 | 1.2 | 14.7 |
| 700.0 | 1.5 | 1.2 | 14.8 |
| 800.0 | 1.5 | 1.2 | 14.8 |
| 900.0 | 1.5 | 1.1 | 14.9 |
| 1000.0 | 1.4 | 1.1 | 15.0 |
| 1100.0 | 1.4 | 1.2 | 14.9 |
| 1200.0 | 1.6 | 1.5 | 14.6 |
| 1300.0 | 2.2 | 1.9 | 13.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .142 | −128 | 5.442 | −160 | .102 | 23 | .173 | −131 |
| 2.0 | .117 | −150 | 5.489 | −170 | .105 | 12 | .127 | −151 |
| 5.0 | .102 | −167 | 5.501 | −177 | .107 | 5 | .111 | −170 |
| 10.0 | .098 | −174 | 5.502 | −180 | .107 | 2 | .108 | −178 |
| 50.0 | .097 | 178 | 5.474 | 171 | .108 | −3 | .104 | 159 |
| 100.0 | .086 | 171 | 5.437 | 161 | .108 | −7 | .101 | 137 |
| 200.0 | .087 | −175 | 5.329 | 144 | .109 | −14 | .093 | 96 |
| 300.0 | .102 | −168 | 5.280 | 127 | .108 | −22 | .084 | 58 |
| 400.0 | .128 | −170 | 5.369 | 110 | .108 | −30 | .072 | 18 |
| 500.0 | .170 | 179 | 5.427 | 93 | .107 | −38 | .071 | −18 |
| 600.0 | .182 | 161 | 5.457 | 74 | .105 | −46 | .078 | −52 |
| 700.0 | .188 | 146 | 5.482 | 55 | .103 | −54 | .083 | −85 |
| 800.0 | .188 | 127 | 5.504 | 36 | .102 | −62 | .073 | −118 |
| 900.0 | .185 | 101 | 5.567 | 16 | .103 | −70 | .051 | −162 |
| 1000.0 | .167 | 67 | 5.612 | −6 | .104 | −79 | .040 | 109 |
| 1100.0 | .159 | 14 | 5.571 | −30 | .106 | −88 | .091 | 29 |
| 1200.0 | .237 | −45 | 5.389 | −56 | .110 | −101 | .196 | −16 |
| 1300.0 | .375 | −94 | 4.874 | −84 | .109 | −117 | .317 | −51 |

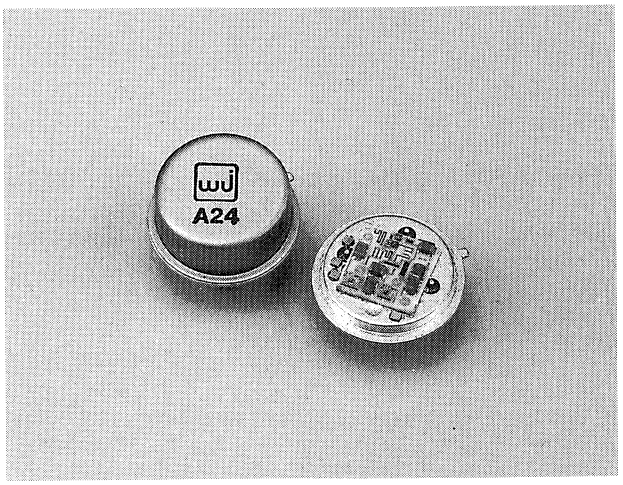
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.056 W
Junction Temperature Rise Above Case $T_{jc}$ ... 3°C

# WJ-A24 / SMA24

## 5 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 20.0 dB (TYP.)
- ◆ ULTRA LOW PHASE DEVIATION FROM LINEARITY: < ±2.5°, 100-1500 MHz
- ◆ LOW VSWR: <1.4:1 (TYP.)
- ◆ MEDIUM LEVEL OUTPUT: +8 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 10° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-1700 MHz | 5-1500 MHz | 5-1500 MHz |
| Small Signal Gain (Min.) | 20.0 dB | 19.0 dB | 18.0 dB |
| Gain Flatness (Max.) | < ±0.4 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.2 dB | 5.3 dB | 5.8 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +7.0 dBm | +6.5 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 34 mA | 38 mA | 40 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA24 is a standard WJ-A24 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+47 dBm (Typ.)
Second Order Two Tone Intercept Point.....+42 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20.5 dBm (Typ.)

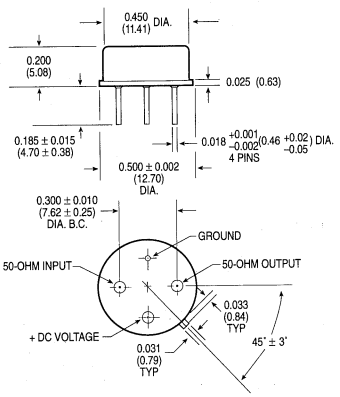
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+20 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term RF Input Power.....32 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight 2.27 grams (0.08 oz.) max.

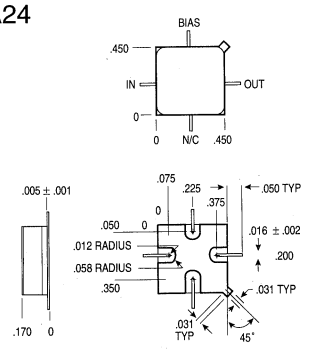
## Outline Drawings

A24



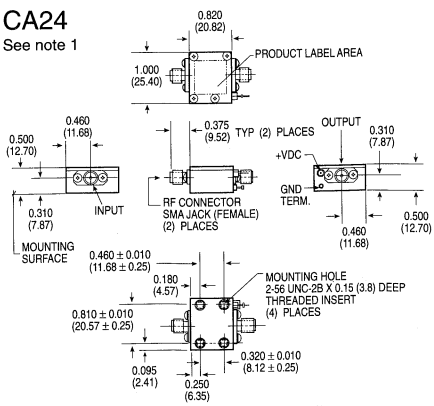

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA24




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

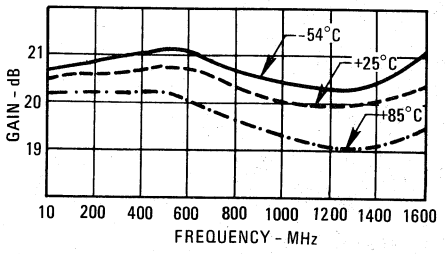
CA24
See note 1



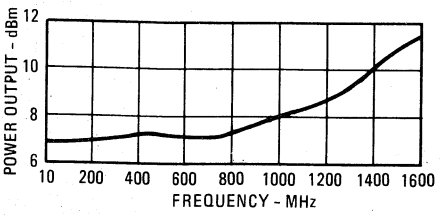

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

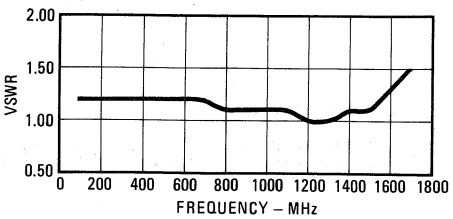



### Power Output*

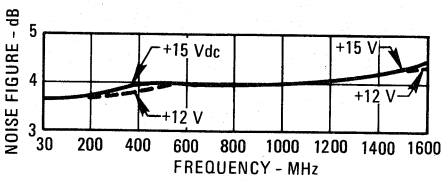



*at 1 dB Gain Compression

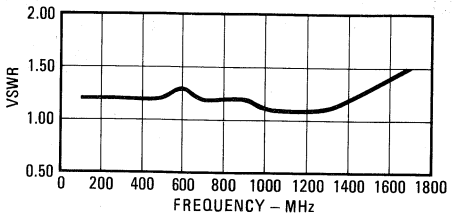
### VSWR Input



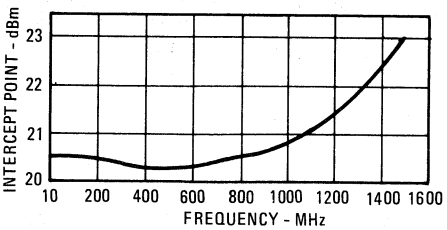

### Noise Figure




### VSWR Output




### Intercept Point, 3rd Order Two Tone




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.4 | 20.3 |
| 2.0 | 1.2 | 1.2 | 20.4 |
| 5.0 | 1.1 | 1.1 | 20.5 |
| 10.0 | 1.0 | 1.1 | 20.5 |
| 50.0 | 1.0 | 1.1 | 20.6 |
| 100.0 | 1.0 | 1.2 | 20.7 |
| 200.0 | 1.1 | 1.2 | 20.8 |
| 300.0 | 1.0 | 1.3 | 20.7 |
| 400.0 | 1.1 | 1.2 | 20.3 |
| 500.0 | 1.1 | 1.2 | 20.2 |
| 600.0 | 1.2 | 1.2 | 20.4 |
| 700.0 | 1.2 | 1.2 | 20.6 |
| 800.0 | 1.3 | 1.2 | 20.7 |
| 900.0 | 1.4 | 1.2 | 20.8 |
| 1000.0 | 1.4 | 1.2 | 21.0 |
| 1100.0 | 1.5 | 1.2 | 21.0 |
| 1200.0 | 1.5 | 1.2 | 20.9 |
| 1300.0 | 1.6 | 1.1 | 21.0 |
| 1400.0 | 1.5 | 1.1 | 21.0 |
| 1500.0 | 1.5 | 1.2 | 21.1 |
| 1600.0 | 1.5 | 1.4 | 21.1 |
| 1700.0 | 1.7 | 1.7 | 21.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .187 | –64 | 10.404 | 22 | .028 | 18 | .155 | –97 |
| 2.0 | .092 | –77 | 10.517 | 11 | .024 | 4 | .092 | –117 |
| 5.0 | .029 | –68 | 10.627 | 3 | .023 | 3 | .061 | –146 |
| 10.0 | .019 | –36 | 10.633 | 0 | .024 | 2 | .056 | –161 |
| 50.0 | .019 | –49 | 10.680 | –10 | .024 | 0 | .061 | –173 |
| 100.0 | .021 | –65 | 10.786 | –21 | .024 | –1 | .073 | 179 |
| 200.0 | .028 | –128 | 11.014 | –45 | .026 | –4 | .101 | 152 |
| 300.0 | .014 | –173 | 10.824 | –69 | .027 | –10 | .117 | 119 |
| 400.0 | .034 | –29 | 10.407 | –91 | .028 | –18 | .108 | 83 |
| 500.0 | .068 | –72 | 10.193 | –111 | .028 | –26 | .084 | 55 |
| 600.0 | .091 | –101 | 10.483 | –132 | .026 | –33 | .076 | 37 |
| 700.0 | .110 | –115 | 10.678 | –154 | .026 | –37 | .083 | 15 |
| 800.0 | .131 | –129 | 10.894 | –177 | .025 | –42 | .090 | –13 |
| 900.0 | .152 | –148 | 11.004 | 160 | .025 | –46 | .096 | –39 |
| 1000.0 | .176 | –165 | 11.176 | 136 | .025 | –52 | .093 | –69 |
| 1100.0 | .196 | 176 | 11.215 | 112 | .024 | –59 | .092 | –100 |
| 1200.0 | .204 | 158 | 11.139 | 88 | .025 | –64 | .083 | –130 |
| 1300.0 | .219 | 137 | 11.184 | 64 | .024 | –68 | .063 | –171 |
| 1400.0 | .212 | 114 | 11.236 | 38 | .026 | –74 | .057 | 122 |
| 1500.0 | .198 | 79 | 11.415 | 12 | .027 | –82 | .089 | 54 |
| 1600.0 | .203 | 32 | 11.414 | –18 | .030 | –90 | .164 | 8 |
| 1700.0 | .246 | –27 | 11.279 | –50 | .035 | –101 | .246 | –30 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 19.8 |
| 2.0 | 1.2 | 1.2 | 19.9 |
| 5.0 | 1.1 | 1.1 | 20.0 |
| 10.0 | 1.1 | 1.1 | 20.0 |
| 50.0 | 1.1 | 1.1 | 20.1 |
| 100.0 | 1.1 | 1.2 | 20.1 |
| 200.0 | 1.1 | 1.2 | 20.3 |
| 300.0 | 1.1 | 1.3 | 20.2 |
| 400.0 | 1.1 | 1.2 | 19.9 |
| 500.0 | 1.2 | 1.2 | 19.7 |
| 600.0 | 1.2 | 1.2 | 20.0 |
| 700.0 | 1.3 | 1.2 | 20.1 |
| 800.0 | 1.3 | 1.2 | 20.3 |
| 900.0 | 1.4 | 1.2 | 20.4 |
| 1000.0 | 1.5 | 1.2 | 20.5 |
| 1100.0 | 1.5 | 1.2 | 20.6 |
| 1200.0 | 1.5 | 1.1 | 20.5 |
| 1300.0 | 1.6 | 1.1 | 20.5 |
| 1400.0 | 1.6 | 1.1 | 20.5 |
| 1500.0 | 1.5 | 1.3 | 20.7 |
| 1600.0 | 1.6 | 1.5 | 20.6 |
| 1700.0 | 1.8 | 1.8 | 20.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .146 | –64 | 9.783 | 22 | .028 | 18 | .157 | -98 |
| 2.0 | .091 | –65 | 9.923 | 11 | .026 | 6 | .094 | -119 |
| 5.0 | .043 | –38 | 10.019 | 3 | .024 | 3 | .063 | –148 |
| 10.0 | .040 | –15 | 10.024 | 0 | .024 | 2 | .058 | –162 |
| 50.0 | .038 | –32 | 10.071 | –10 | .025 | 0 | .063 | –175 |
| 100.0 | .039 | –43 | 10.174 | –21 | .025 | –1 | .074 | 177 |
| 200.0 | .045 | –92 | 10.345 | –45 | .027 | –4 | .098 | 151 |
| 300.0 | .025 | –98 | 10.226 | –69 | .028 | –11 | .112 | 119 |
| 400.0 | .042 | –61 | 9.851 | –91 | .029 | –17 | .104 | 84 |
| 500.0 | .084 | –90 | 9.659 | –111 | .028 | –26 | .079 | 55 |
| 600.0 | .110 | –109 | 9.947 | –132 | .027 | –31 | .070 | 37 |
| 700.0 | .124 | –122 | 10.146 | –155 | .027 | –36 | .075 | 14 |
| 800.0 | .147 | –137 | 10.362 | –178 | .026 | –40 | .079 | –14 |
| 900.0 | .168 | –155 | 10.490 | 159 | .026 | –47 | .082 | –41 |
| 1000.0 | .187 | –175 | 10.599 | 135 | .026 | –52 | .077 | –71 |
| 1100.0 | .207 | 168 | 10.655 | 111 | .025 | –56 | .072 | –104 |
| 1200.0 | .215 | 150 | 10.596 | 86 | .025 | –62 | .062 | –139 |
| 1300.0 | .226 | 128 | 10.626 | 62 | .026 | –68 | .045 | 165 |
| 1400.0 | .226 | 102 | 10.647 | 36 | .028 | –74 | .060 | 89 |
| 1500.0 | .213 | 66 | 10.780 | 9 | .029 | –81 | .113 | 36 |
| 1600.0 | .226 | 19 | 10.719 | –21 | .033 | –91 | .196 | –3 |
| 1700.0 | .282 | –37 | 10.402 | –54 | .037 | –105 | .277 | –38 |

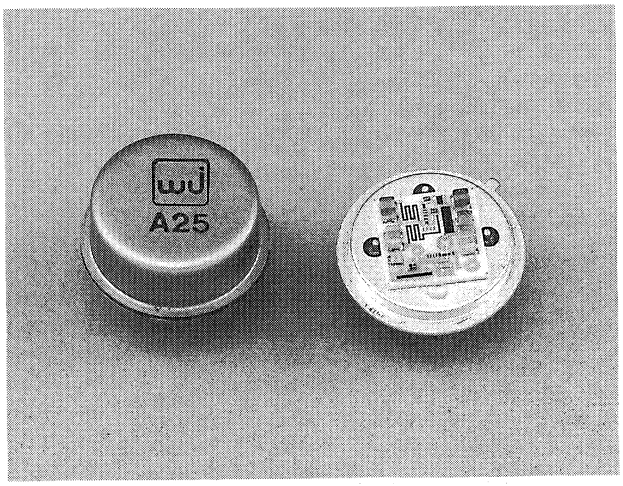
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.116 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A25 / SMA25

## 5 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT LEVEL: +9 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1600 MHz | 5-1500 MHz | 5-1500 MHz |
| Small Signal Gain (Min.) | 10 dB | 9.0 dB | 8.0 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.6 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.5 dB | 8.0 dB |
| Power Output at 1 dB Compression (Min.) | +9 dBm | +7 dBm | +6.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA25 is a standard WJ-A25 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+33 dBm (Typ.)
Third Order Two Tone Intercept Point..... +21 dBm (Typ.)

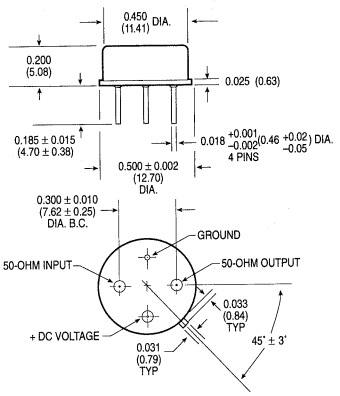
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

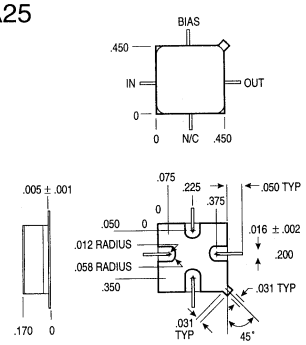
## Outline Drawings

A25



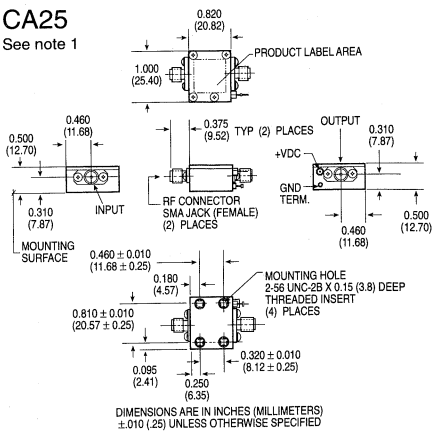

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA25




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

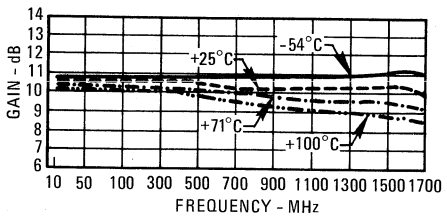
CA25
See note 1



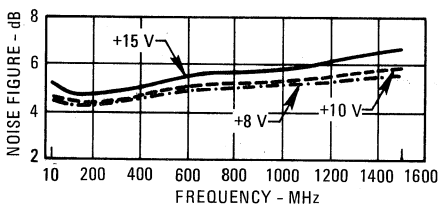

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

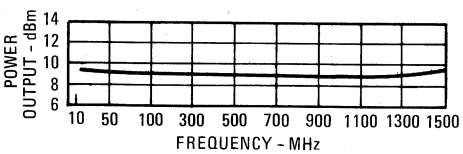
### Gain




### Noise Figure

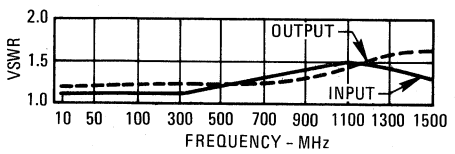



### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.6 | 10.8 |
| 2.0 | 1.1 | 1.4 | 11.0 |
| 5.0 | 1.1 | 1.3 | 11.1 |
| 10.0 | 1.1 | 1.3 | 11.0 |
| 50.0 | 1.1 | 1.3 | 10.9 |
| 100.0 | 1.1 | 1.3 | 10.8 |
| 200.0 | 1.1 | 1.3 | 10.7 |
| 300.0 | 1.1 | 1.2 | 10.6 |
| 400.0 | 1.2 | 1.1 | 10.7 |
| 500.0 | 1.3 | 1.1 | 10.7 |
| 600.0 | 1.3 | 1.0 | 10.7 |
| 700.0 | 1.4 | 1.0 | 10.7 |
| 800.0 | 1.5 | 1.1 | 10.7 |
| 900.0 | 1.5 | 1.1 | 10.7 |
| 1000.0 | 1.5 | 1.2 | 10.8 |
| 1100.0 | 1.5 | 1.2 | 10.8 |
| 1200.0 | 1.4 | 1.3 | 11.0 |
| 1300.0 | 1.3 | 1.3 | 11.2 |
| 1400.0 | 1.2 | 1.4 | 11.3 |
| 1500.0 | 1.4 | 1.4 | 11.4 |
| 1600.0 | 1.7 | 1.6 | 11.1 |
| 1700.0 | 2.4 | 1.7 | 10.6 |

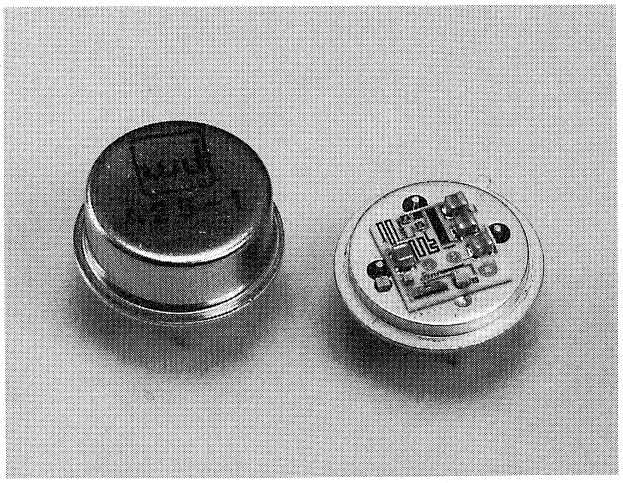
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .117 | −128 | 3.472 | −157 | .141 | 21 | .218 | −143 |
| 2.0 | .068 | −149 | 3.566 | −169 | .139 | 9 | .161 | −161 |
| 5.0 | .048 | −159 | 3.576 | −177 | .137 | 4 | .141 | −173 |
| 10.0 | .047 | −166 | 3.553 | −180 | .138 | 2 | .140 | −178 |
| 50.0 | .046 | −177 | 3.510 | 173 | .139 | −2 | .137 | 168 |
| 100.0 | .038 | 178 | 3.482 | 165 | .140 | −5 | .130 | 156 |
| 200.0 | .045 | −149 | 3.445 | 151 | .140 | −10 | .114 | 134 |
| 300.0 | .068 | −143 | 3.399 | 137 | .141 | −15 | .092 | 116 |
| 400.0 | .095 | −147 | 3.436 | 123 | .143 | −21 | .066 | 103 |
| 500.0 | .132 | −158 | 3.445 | 109 | .143 | −27 | .046 | 90 |
| 600.0 | .148 | −172 | 3.441 | 94 | .143 | −33 | .023 | 62 |
| 700.0 | .160 | 178 | 3.426 | 80 | .142 | −39 | .009 | −60 |
| 800.0 | .186 | 162 | 3.426 | 65 | .144 | −45 | .033 | −126 |
| 900.0 | .203 | 148 | 3.425 | 52 | .146 | −51 | .055 | −153 |
| 1000.0 | .203 | 130 | 3.458 | 37 | .147 | −58 | .079 | −179 |
| 1100.0 | .195 | 111 | 3.485 | 22 | .148 | −65 | .101 | 159 |
| 1200.0 | .175 | 87 | 3.539 | 7 | .151 | −72 | .114 | 133 |
| 1300.0 | .134 | 55 | 3.613 | −9 | .154 | −80 | .129 | 99 |
| 1400.0 | .093 | −1 | 3.660 | −28 | .159 | −89 | .152 | 64 |
| 1500.0 | .158 | −74 | 3.707 | −47 | .166 | −101 | .184 | 24 |
| 1600.0 | .261 | −123 | 3.581 | −70 | .168 | −116 | .229 | −15 |
| 1700.0 | .420 | −158 | 3.392 | −92 | .162 | −134 | .272 | −54 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.183 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A25-1 / SMA25-1



## 2 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: < 3.4 dB (TYP.)
- ◆ MEDIUM POWER OUT: +9.0 dBm (TYP.)
- ◆ LOW VSWR: < 1.7:1 VSWR (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 to +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1600 MHz | 2-1500 MHz | 2-1500 MHz |
| Small Signal Gain (Min.) | 13.5 dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 10-600 | < 3.0 dB | 3.5 dB | 4.0 dB |
| 2-1500 | < 3.8 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +9.0 dBm | +8.0 dBm | +7.5 dBm |
| VSWR (Max.) Input/Output | < 1.7:1/1.2:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 28 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA25-1 is a standard WJ-A25-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+36 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

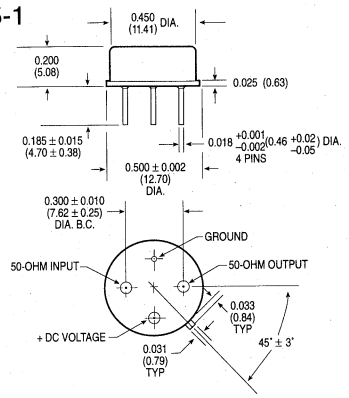
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+ 18 volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term R F Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

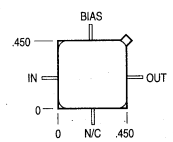
## Outline Drawings

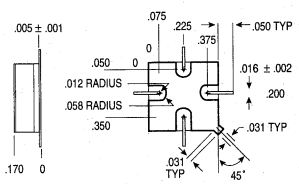
A25-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

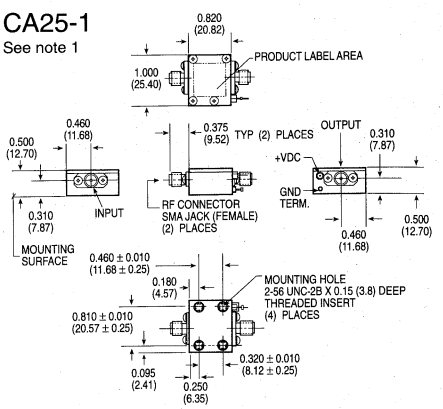
SMA25-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

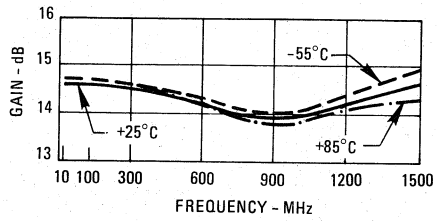
CA25-1
See note 1



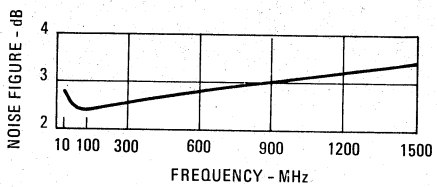

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

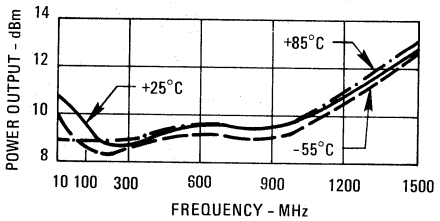
### Gain




### Noise Figure

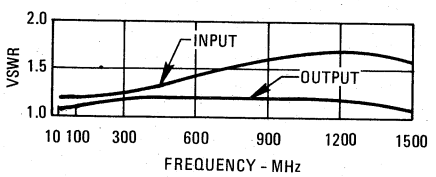



### Power Output*

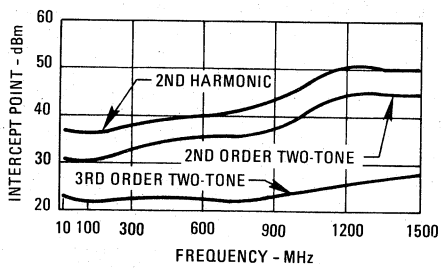



* at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.5 | 14.5 |
| 2.0 | 1.1 | 1.3 | 14.7 |
| 5.0 | 1.0 | 1.3 | 14.6 |
| 10.0 | 1.0 | 1.3 | 14.6 |
| 50.0 | 1.0 | 1.3 | 14.5 |
| 100.0 | 1.0 | 1.3 | 14.4 |
| 200.0 | 1.0 | 1.2 | 14.3 |
| 300.0 | 1.1 | 1.2 | 14.1 |
| 400.0 | 1.1 | 1.1 | 14.2 |
| 500.0 | 1.1 | 1.1 | 14.3 |
| 600.0 | 1.1 | 1.0 | 14.3 |
| 700.0 | 1.2 | 1.1 | 14.3 |
| 800.0 | 1.2 | 1.1 | 14.3 |
| 900.0 | 1.2 | 1.2 | 14.3 |
| 1000.0 | 1.2 | 1.2 | 14.3 |
| 1100.0 | 1.2 | 1.3 | 14.4 |
| 1200.0 | 1.2 | 1.3 | 14.5 |
| 1300.0 | 1.2 | 1.3 | 14.6 |
| 1400.0 | 1.2 | 1.3 | 14.6 |
| 1500.0 | 1.4 | 1.3 | 14.4 |
| 1600.0 | 1.8 | 1.2 | 13.6 |
| 1700.0 | 2.4 | 1.2 | 12.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .090 | −122 | 5.326 | −157 | .104 | 20 | .197 | −148 |
| 2.0 | .029 | −137 | 5.440 | −169 | .101 | 9 | .135 | −163 |
| 5.0 | .022 | −136 | 5.401 | −177 | .101 | 4 | .124 | −173 |
| 10.0 | .020 | −165 | 5.372 | 180 | .102 | 2 | .123 | −179 |
| 50.0 | .021 | 143 | 5.303 | 173 | .102 | −2 | .119 | 165 |
| 100.0 | .022 | 111 | 5.233 | 165 | .103 | −5 | .111 | 150 |
| 200.0 | .017 | 19 | 5.162 | 151 | .104 | −11 | .094 | 123 |
| 300.0 | .024 | −13 | 5.083 | 138 | .105 | −18 | .071 | 100 |
| 400.0 | .046 | −56 | 5.131 | 124 | .106 | −24 | .044 | 80 |
| 500.0 | .054 | −83 | 5.194 | 111 | .105 | −31 | .027 | 53 |
| 600.0 | .062 | −98 | 5.179 | 96 | .104 | −38 | .023 | −20 |
| 700.0 | .080 | −105 | 5.173 | 82 | .104 | −45 | .039 | −79 |
| 800.0 | .092 | −126 | 5.172 | 67 | .102 | −52 | .061 | −113 |
| 900.0 | .104 | −142 | 5.182 | 53 | .103 | −58 | .081 | −139 |
| 1000.0 | .111 | −165 | 5.210 | 38 | .102 | −66 | .102 | −164 |
| 1100.0 | .109 | 178 | 5.263 | 23 | .101 | −73 | .120 | 175 |
| 1200.0 | .095 | 144 | 5.317 | 7 | .100 | −80 | .127 | 154 |
| 1300.0 | .083 | 104 | 5.385 | −11 | .098 | −88 | .129 | 128 |
| 1400.0 | .090 | 38 | 5.383 | −31 | .099 | −94 | .127 | 103 |
| 1500.0 | .172 | −26 | 5.245 | −52 | .100 | −102 | .115 | 76 |
| 1600.0 | .280 | −65 | 4.787 | −75 | .102 | −112 | .101 | 53 |
| 1700.0 | .409 | −97 | 4.130 | −98 | .104 | −121 | .089 | 43 |

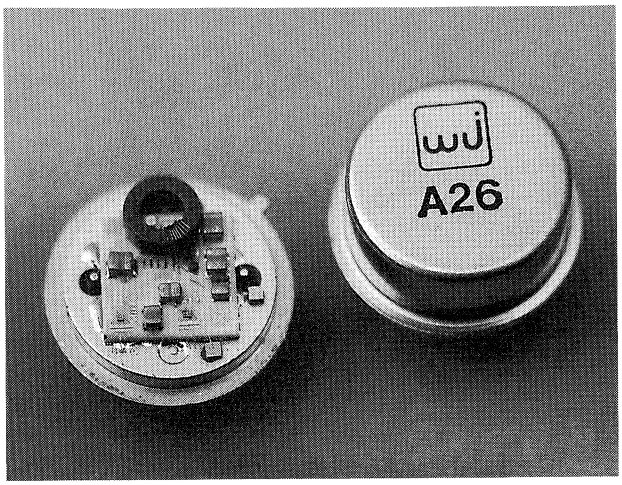
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.183 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A26 / SMA26

## 10 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 20.5 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +15 dBm (TYP.)
- ◆ LOW VSWR: < 1.4:1 (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50° C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-1600 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 20.5 dB | 19.0 dB | 18.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.6 dB | ±0.8 dB |
| Noise Figure (Max.) | 5.0 dB | 5.5 dB | 6.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 10-1000 MHz | +14.0 dBm | +13.0 dBm | +12.5 dBm |
| 1000-1500 MHz | +16.0 dBm | +15.0 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 64 mA | 67 mA | 70 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA26 is a standard WJ-A26 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+51 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+27 dBm (Typ.)

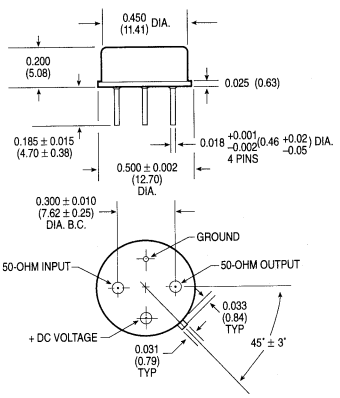
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power.....100 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

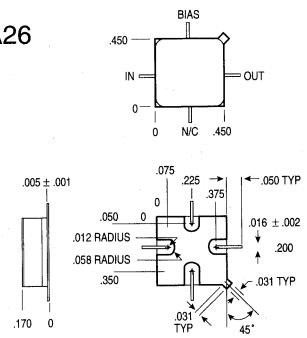
## Outline Drawings

A26



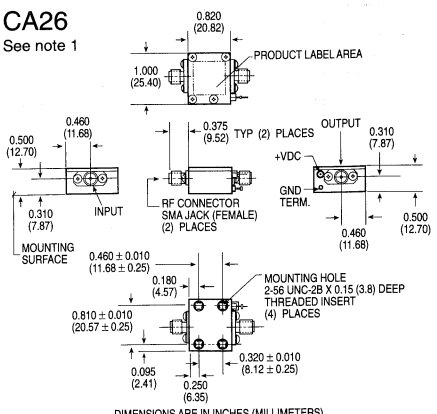

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA26




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

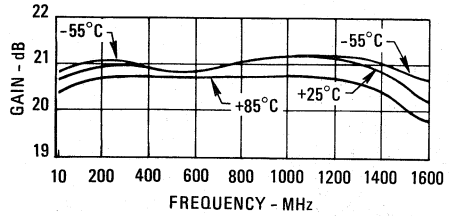
CA26
See note 1



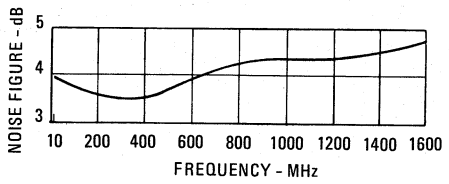

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

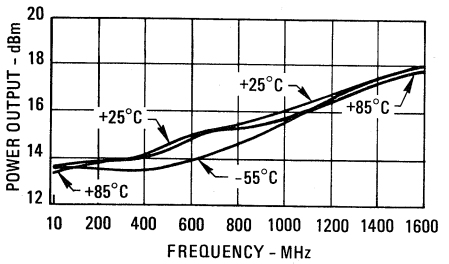
### Gain




### Noise Figure

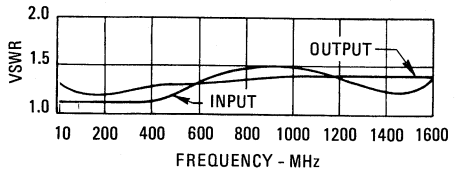



### Power Output*

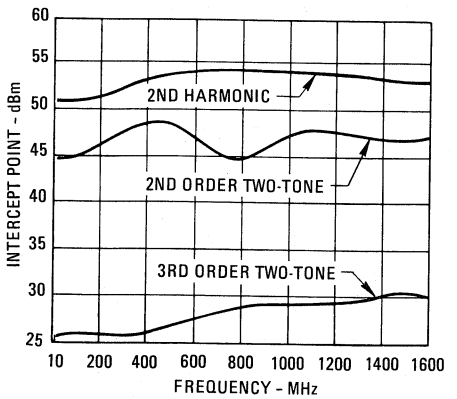



*@ 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.5 | 2.1 | 16.5 |
| 2.0 | 1.8 | 1.9 | 18.4 |
| 5.0 | 1.3 | 1.3 | 20.4 |
| 10.0 | 1.2 | 1.2 | 20.7 |
| 50.0 | 1.2 | 1.0 | 21.0 |
| 100.0 | 1.2 | 1.1 | 21.1 |
| 200.0 | 1.2 | 1.1 | 21.2 |
| 300.0 | 1.2 | 1.1 | 21.0 |
| 400.0 | 1.1 | 1.1 | 20.7 |
| 500.0 | 1.0 | 1.0 | 20.5 |
| 600.0 | 1.0 | 1.1 | 20.9 |
| 700.0 | 1.0 | 1.1 | 21.1 |
| 800.0 | 1.1 | 1.1 | 21.4 |
| 900.0 | 1.1 | 1.1 | 21.6 |
| 1000.0 | 1.1 | 1.1 | 21.7 |
| 1100.0 | 1.1 | 1.1 | 21.6 |
| 1200.0 | 1.2 | 1.1 | 21.5 |
| 1300.0 | 1.2 | 1.1 | 21.3 |
| 1400.0 | 1.3 | 1.0 | 21.1 |
| 1500.0 | 1.5 | 1.2 | 20.9 |
| 1600.0 | 1.9 | 1.5 | 20.5 |
| 1700.0 | 2.9 | 1.8 | 19.7 |

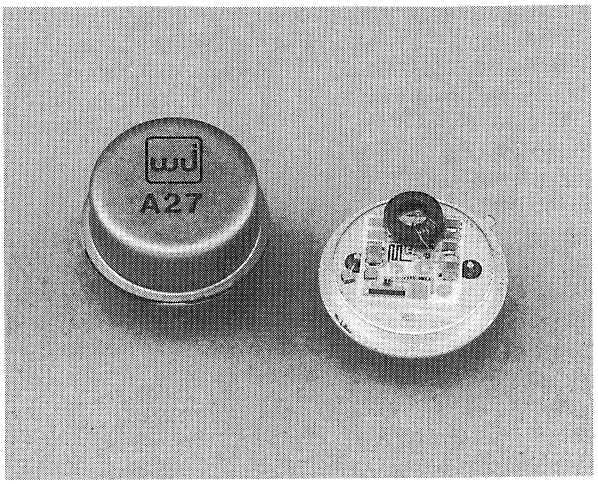
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .432 | –117 | 6.646 | 35 | .020 | –33 | .357 | –149 |
| 2.0 | .287 | –172 | 8.319 | 31 | .009 | 58 | .313 | 163 |
| 5.0 | .123 | 156 | 10.498 | 14 | .022 | 25 | .146 | 116 |
| 10.0 | .082 | 161 | 10.892 | 6 | .024 | 13 | .076 | 96 |
| 50.0 | .073 | 178 | 11.230 | –9 | .025 | 3 | .016 | –18 |
| 100.0 | .076 | 171 | 11.317 | –22 | .026 | 2 | .030 | –100 |
| 200.0 | .091 | 159 | 11.499 | –47 | .028 | –1 | .054 | –160 |
| 300.0 | .092 | 127 | 11.257 | –73 | .030 | –5 | .061 | 157 |
| 400.0 | .063 | 82 | 10.798 | –96 | .032 | –13 | .041 | 121 |
| 500.0 | .020 | 60 | 10.607 | –116 | .031 | –21 | .018 | 141 |
| 600.0 | .008 | 101 | 11.030 | –139 | .030 | –27 | .029 | 142 |
| 700.0 | .013 | –50 | 11.374 | –163 | .030 | –31 | .031 | 99 |
| 800.0 | .028 | –118 | 11.712 | 173 | .030 | –36 | .029 | 46 |
| 900.0 | .041 | –135 | 11.987 | 147 | .030 | –41 | .037 | –2 |
| 1000.0 | .060 | –166 | 12.121 | 121 | .030 | –45 | .042 | –43 |
| 1100.0 | .069 | 166 | 12.084 | 94 | .031 | –52 | .051 | –85 |
| 1200.0 | .075 | 133 | 11.912 | 67 | .031 | –58 | .052 | –111 |
| 1300.0 | .086 | 95 | 11.662 | 40 | .032 | –64 | .031 | –127 |
| 1400.0 | .116 | 46 | 11.378 | 11 | .035 | –71 | .017 | –33 |
| 1500.0 | .191 | 2 | 11.153 | –18 | .038 | –80 | .085 | –33 |
| 1600.0 | .315 | –38 | 10.632 | –52 | .042 | –93 | .186 | –61 |
| 1700.0 | .489 | –76 | 9.669 | –88 | .047 | –110 | .291 | –98 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{JC}$ ..... 45°C/W
Transistor Power Dissipation $P_D$ ..... 0.367 W
Junction Temperature Rise Above Case $T_{JC}$ ... 17°C

# WJ-A27 / SMA27




## 10 to1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +15.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +28 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1600 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 8.5 dB | 7.5 dB | 7.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.6 dB | ±1.0 dB |
| Noise Figure (Max.) | 7.5 dB | 9.0 dB | 9.5 dB |
| Power Output at 1 dB Compression (Min.) | +15.5 dBm | +14 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 50 mA | 54 mA | 57 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA27 is a standard WJ-A27 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+46 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

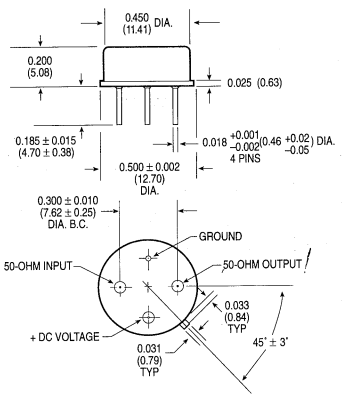
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

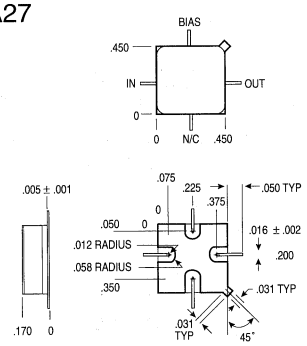
## Outline Drawings

A27



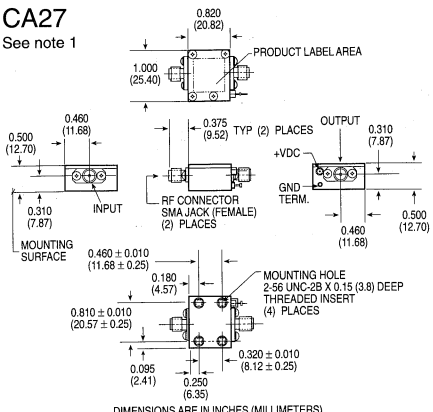

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA27




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

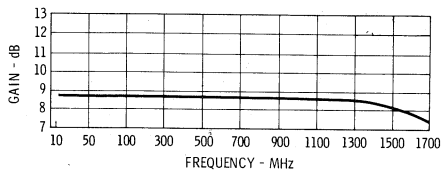
CA27
See note 1



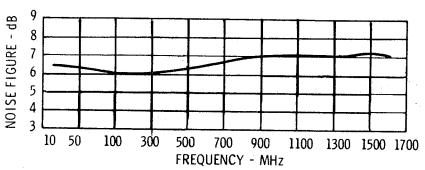

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

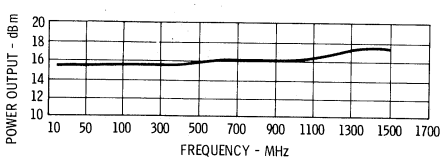
### Gain




### Noise Figure

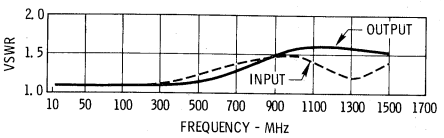



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.7 | 8.2 |
| 5.0 | 1.2 | 1.2 | 8.2 |
| 10.0 | 1.1 | 1.1 | 8.2 |
| 50.0 | 1.0 | 1.0 | 8.3 |
| 100.0 | 1.0 | 1.0 | 8.2 |
| 200.0 | 1.1 | 1.0 | 8.1 |
| 300.0 | 1.1 | 1.1 | 8.1 |
| 400.0 | 1.1 | 1.1 | 8.2 |
| 500.0 | 1.1 | 1.2 | 8.3 |
| 600.0 | 1.1 | 1.2 | 8.4 |
| 700.0 | 1.1 | 1.3 | 8.4 |
| 800.0 | 1.2 | 1.4 | 8.5 |
| 900.0 | 1.1 | 1.4 | 8.4 |
| 1000.0 | 1.1 | 1.5 | 8.4 |
| 1100.0 | 1.1 | 1.5 | 8.3 |
| 1200.0 | 1.1 | 1.5 | 8.2 |
| 1300.0 | 1.1 | 1.5 | 8.1 |
| 1400.0 | 1.2 | 1.5 | 7.8 |
| 1500.0 | 1.3 | 1.5 | 7.7 |
| 1600.0 | 1.5 | 1.5 | 7.3 |
| 1700.0 | 1.7 | 1.4 | 7.0 |

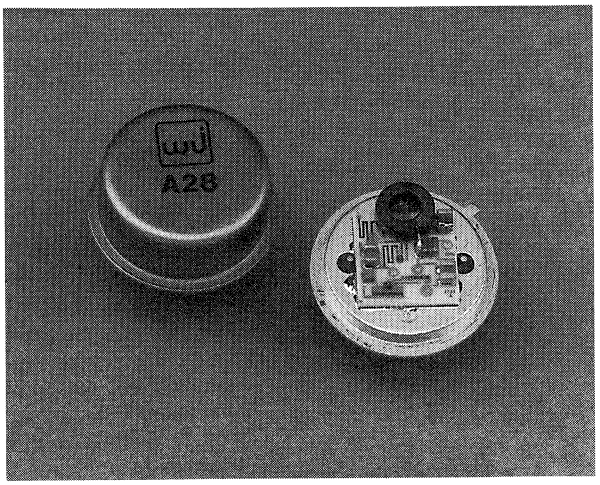
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .238 | −63 | 2.573 | −154 | .176 | 30 | .259 | 125 |
| 5.0 | .095 | −65 | 2.570 | −171 | .190 | 11 | .096 | 118 |
| 10.0 | .055 | −61 | 2.574 | −176 | .192 | 5 | .057 | 120 |
| 50.0 | .021 | −23 | 2.591 | 174 | .195 | −1 | .017 | 121 |
| 100.0 | .023 | −11 | 2.572 | 167 | .195 | −4 | .007 | 119 |
| 200.0 | .030 | −34 | 2.548 | 154 | .196 | −9 | .007 | −74 |
| 300.0 | .038 | −60 | 2.532 | 142 | .198 | −13 | .028 | −84 |
| 400.0 | .052 | −68 | 2.579 | 130 | .202 | −19 | .059 | −105 |
| 500.0 | .047 | −97 | 2.592 | 117 | .204 | −24 | .085 | −122 |
| 600.0 | .056 | −102 | 2.627 | 103 | .205 | −29 | .109 | −136 |
| 700.0 | .061 | −111 | 2.638 | 90 | .208 | −35 | .132 | −150 |
| 800.0 | .071 | −125 | 2.651 | 76 | .211 | −41 | .155 | −166 |
| 900.0 | .069 | −138 | 2.639 | 63 | .215 | −46 | .174 | 178 |
| 1000.0 | .066 | −147 | 2.634 | 49 | .218 | −52 | .193 | 161 |
| 1100.0 | .051 | −151 | 2.606 | 35 | .222 | −59 | .208 | 144 |
| 1200.0 | .039 | −128 | 2.569 | 22 | .226 | −66 | .211 | 126 |
| 1300.0 | .049 | −111 | 2.532 | 7 | .230 | −73 | .215 | 104 |
| 1400.0 | .082 | −99 | 2.467 | −8 | .235 | −80 | .212 | 83 |
| 1500.0 | .137 | −99 | 2.420 | −22 | .240 | −89 | .202 | 59 |
| 1600.0 | .187 | −116 | 2.323 | −38 | .244 | −97 | .189 | 33 |
| 1700.0 | .264 | −126 | 2.244 | −53 | .245 | −107 | .168 | 8 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.435 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-A28 / SMA28




## 10 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +15 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +29 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1600 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 11 dB | 10 dB | 9.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.6 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.0 dB | 7.5 dB |
| Power Output at 1 dB Compression (Min.) | +15 dBm | +14 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 45 mA | 50 mA | 53 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA28 is a standard WJ-A28 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+49 dBm (Typ.)
Second Order Two Tone Intercept Point.....+44 dBm (Typ.)
Third Order Two Tone Intercept Point.....+29 dBm (Typ.)

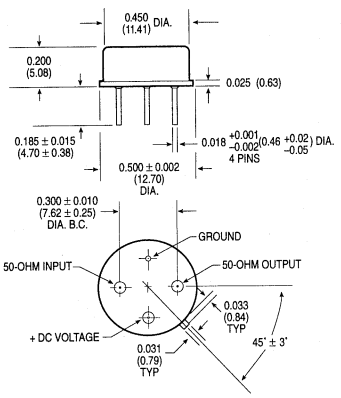
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S"Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

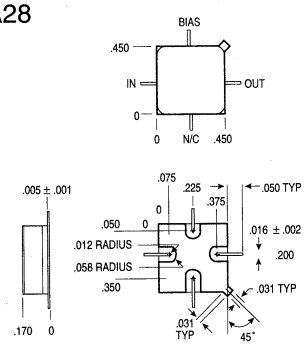
## Outline Drawings

A28



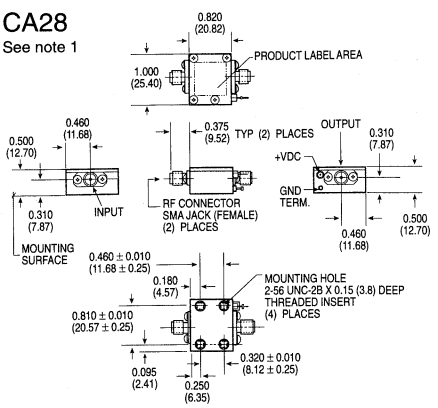

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA28




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

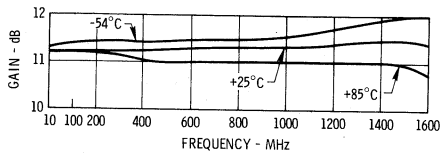
CA28
See note 1



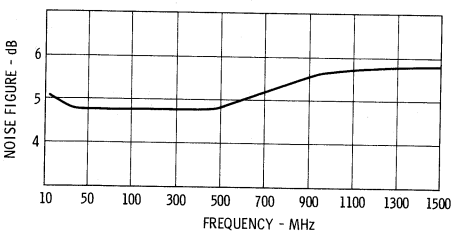

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

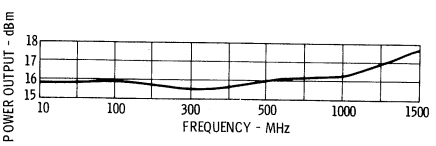
### Gain




### Noise Figure

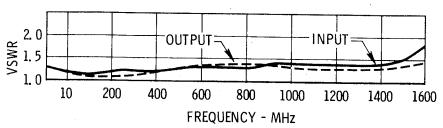



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{cc}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.5 | 6.8 |
| 2.0 | 1.7 | 2.1 | 9.7 |
| 5.0 | 1.2 | 1.2 | 11.1 |
| 10.0 | 1.1 | 1.1 | 11.2 |
| 50.0 | 1.1 | 1.1 | 11.3 |
| 100.0 | 1.1 | 1.1 | 11.2 |
| 200.0 | 1.1 | 1.1 | 11.1 |
| 300.0 | 1.2 | 1.1 | 11.1 |
| 400.0 | 1.2 | 1.1 | 11.4 |
| 500.0 | 1.3 | 1.2 | 11.5 |
| 600.0 | 1.3 | 1.2 | 11.6 |
| 700.0 | 1.4 | 1.2 | 11.7 |
| 800.0 | 1.4 | 1.2 | 11.8 |
| 900.0 | 1.4 | 1.3 | 11.8 |
| 1000.0 | 1.4 | 1.3 | 11.9 |
| 1100.0 | 1.4 | 1.2 | 11.9 |
| 1200.0 | 1.3 | 1.2 | 12.0 |
| 1300.0 | 1.2 | 1.2 | 12.0 |
| 1400.0 | 1.2 | 1.3 | 11.9 |
| 1500.0 | 1.5 | 1.5 | 11.8 |
| 1600.0 | 2.0 | 1.7 | 11.1 |
| 1700.0 | 3.0 | 1.8 | 10.2 |

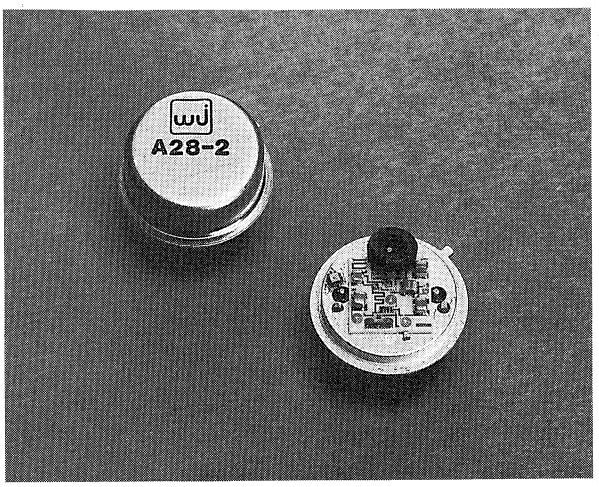
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .224 | –5 | 2.185 | –167 | .096 | 14 | .431 | –135 |
| 2.0 | .271 | –46 | 3.057 | –150 | .121 | 31 | .355 | 147 |
| 5.0 | .103 | –52 | 3.609 | –171 | .147 | 11 | .108 | 108 |
| 10.0 | .068 | –40 | 3.647 | –176 | .150 | 5 | .060 | 97 |
| 50.0 | .045 | –7 | 3.685 | 174 | .153 | –1 | .026 | 46 |
| 100.0 | .053 | –6 | 3.647 | 167 | .153 | –5 | .026 | 27 |
| 200.0 | .062 | –26 | 3.609 | 154 | .154 | –10 | .036 | 4 |
| 300.0 | .080 | –41 | 3.597 | 141 | .155 | –15 | .049 | –25 |
| 400.0 | .104 | –58 | 3.695 | 129 | .159 | –22 | .063 | –60 |
| 500.0 | .112 | –80 | 3.738 | 115 | .161 | –28 | .075 | –86 |
| 600.0 | .131 | –95 | 3.809 | 101 | .163 | –34 | .087 | –105 |
| 700.0 | .152 | –106 | 3.842 | 86 | .167 | –41 | .099 | –126 |
| 800.0 | .173 | –126 | 3.883 | 72 | .171 | –47 | .108 | –147 |
| 900.0 | .176 | –145 | 3.899 | 58 | .176 | –54 | .112 | –171 |
| 1000.0 | .180 | –165 | 3.932 | 42 | .180 | –62 | .113 | 162 |
| 1100.0 | .159 | 175 | 3.943 | 27 | .186 | –70 | .109 | 133 |
| 1200.0 | .135 | 146 | 3.962 | 11 | .189 | –79 | .098 | 94 |
| 1300.0 | .094 | 109 | 3.982 | –6 | .195 | –89 | .109 | 44 |
| 1400.0 | .076 | 11 | 3.945 | –25 | .201 | –100 | .138 | –5 |
| 1500.0 | .190 | –48 | 3.870 | –44 | .205 | –111 | .192 | –49 |
| 1600.0 | .325 | –83 | 3.603 | –66 | .205 | –125 | .248 | –89 |
| 1700.0 | .494 | –113 | 3.248 | –88 | .198 | –141 | .290 | –126 |

## Thermal Data: $V_{cc}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.449 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-A28-2 / SMA28-2




## 10 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.5 dB (TYP.)
- ◆ HIGH EFFICIENCY: 27 mA (TYP.) @ 5 VDC
- ◆ GOOD DYNAMIC RANGE: 105 dB (TYP.) IN 1 MHz BW
- ◆ LOW VSWR: < 1.4:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1600 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 14.0 dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | ±.3 dB | ±.5 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.5 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 10 - 1500 MHz | +10.0 dBm | +7.5 dBm | +7.0 dBm |
| 10 - 1000 MHz | +10.5 dBm | +9.5 dBm | +8.5 dBm |
| VSWR (Max.) | | | |
| Input | < 1.3:1 | 1.8:1 | 1.9:1 |
| output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +5 V | 27 mA | 30 mA | 32 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.

Notes:

1. WJ-CA28-2 is a standard WJ-A28-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+34 dBm (Typ.)
Third Order Two Tone Intercept Point.....+24 dBm (Typ.)

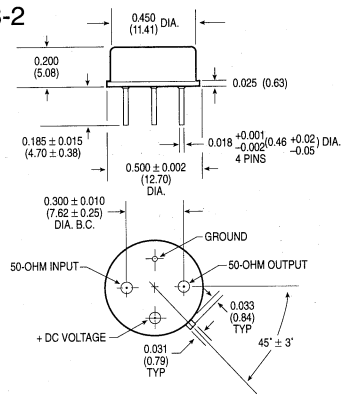
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....+125°C
Maximum DC Voltage .....+8 volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

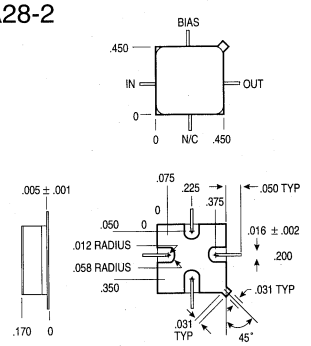
## Outline Drawings

A28-2



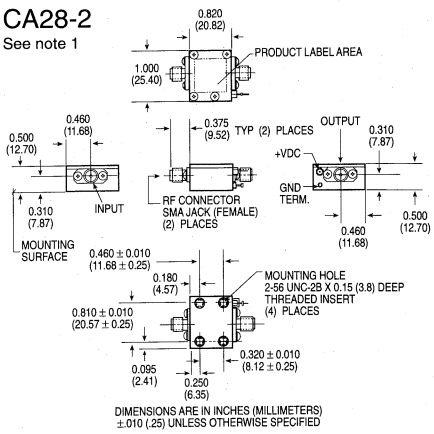

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA28-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

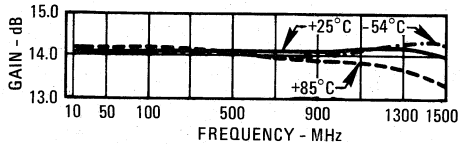
CA28-2
See note 1



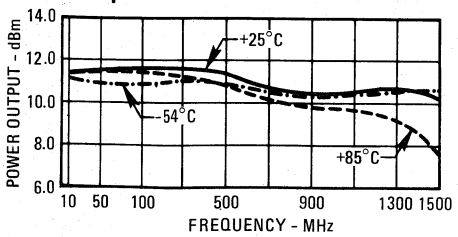

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

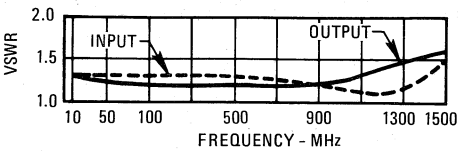



### Power Output*

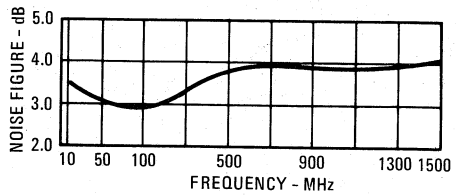



*@ 1 dB Gain Compression

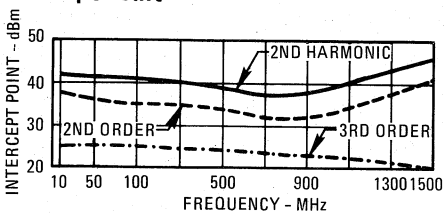
### VSWR




### Noise Figure




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 1.7 | 14.4 |
| 5.0 | 1.4 | 1.3 | 14.3 |
| 10.0 | 1.3 | 1.3 | 14.3 |
| 50.0 | 1.3 | 1.2 | 14.3 |
| 100.0 | 1.3 | 1.2 | 14.1 |
| 200.0 | 1.2 | 1.3 | 14.0 |
| 300.0 | 1.2 | 1.3 | 13.9 |
| 400.0 | 1.3 | 1.4 | 14.0 |
| 500.0 | 1.3 | 1.4 | 14.2 |
| 600.0 | 1.3 | 1.5 | 14.2 |
| 700.0 | 1.3 | 1.5 | 14.2 |
| 800.0 | 1.3 | 1.5 | 14.2 |
| 900.0 | 1.3 | 1.4 | 14.1 |
| 1000.0 | 1.3 | 1.4 | 14.2 |
| 1100.0 | 1.3 | 1.3 | 14.1 |
| 1200.0 | 1.3 | 1.2 | 14.0 |
| 1300.0 | 1.3 | 1.1 | 13.9 |
| 1400.0 | 1.2 | 1.0 | 13.8 |
| 1500.0 | 1.3 | 1.1 | 13.5 |
| 1600.0 | 1.3 | 1.2 | 13.2 |
| 1700.0 | 1.6 | 1.2 | 12.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .260 | –112 | 5.262 | –166 | .109 | 16 | .249 | 133 |
| 5.0 | .152 | –143 | 5.168 | –175 | .115 | 6 | .136 | 145 |
| 10.0 | .135 | –161 | 5.167 | –179 | .116 | 3 | .113 | 154 |
| 50.0 | .127 | 177 | 5.163 | 173 | .117 | –2 | .099 | 147 |
| 100.0 | .120 | 169 | 5.097 | 165 | .117 | –6 | .104 | 127 |
| 200.0 | .110 | 168 | 5.011 | 152 | .118 | –12 | .123 | 92 |
| 300.0 | .105 | 170 | 4.977 | 139 | .120 | –18 | .143 | 65 |
| 400.0 | .115 | 172 | 5.031 | 126 | .121 | –25 | .157 | 44 |
| 500.0 | .134 | 166 | 5.128 | 112 | .121 | –33 | .175 | 24 |
| 600.0 | .142 | 154 | 5.143 | 98 | .120 | –40 | .193 | 3 |
| 700.0 | .133 | 146 | 5.132 | 83 | .120 | –47 | .201 | –18 |
| 800.0 | .136 | 137 | 5.127 | 69 | .121 | –55 | .196 | –38 |
| 900.0 | .140 | 128 | 5.094 | 54 | .122 | –62 | .181 | –58 |
| 1000.0 | .139 | 119 | 5.104 | 39 | .122 | –70 | .152 | –78 |
| 1100.0 | .142 | 107 | 5.076 | 23 | .122 | –78 | .120 | –98 |
| 1200.0 | .133 | 89 | 5.001 | 7 | .121 | –86 | .080 | –113 |
| 1300.0 | .126 | 69 | 4.970 | –9 | .122 | –94 | .032 | –117 |
| 1400.0 | .109 | 36 | 4.876 | –26 | .123 | –102 | .019 | –10 |
| 1500.0 | .115 | –9 | 4.757 | –44 | .125 | –111 | .061 | –7 |
| 1600.0 | .130 | –55 | 4.551 | –64 | .128 | –122 | .093 | –21 |
| 1700.0 | .221 | –93 | 4.323 | –84 | .131 | –133 | .097 | –35 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 1.6 | 14.2 |
| 5.0 | 1.3 | 1.3 | 14.0 |
| 10.0 | 1.3 | 1.2 | 14.0 |
| 50.0 | 1.2 | 1.2 | 14.0 |
| 100.0 | 1.2 | 1.2 | 13.9 |
| 200.0 | 1.2 | 1.2 | 13.8 |
| 300.0 | 1.2 | 1.2 | 13.7 |
| 400.0 | 1.2 | 1.3 | 13.9 |
| 500.0 | 1.3 | 1.3 | 14.0 |
| 600.0 | 1.3 | 1.3 | 14.2 |
| 700.0 | 1.3 | 1.3 | 14.2 |
| 800.0 | 1.4 | 1.3 | 14.2 |
| 900.0 | 1.4 | 1.3 | 14.2 |
| 1000.0 | 1.4 | 1.2 | 14.2 |
| 1100.0 | 1.4 | 1.1 | 14.2 |
| 1200.0 | 1.4 | 1.1 | 14.1 |
| 1300.0 | 1.4 | 1.2 | 14.0 |
| 1400.0 | 1.3 | 1.3 | 13.9 |
| 1500.0 | 1.4 | 1.4 | 13.7 |
| 1600.0 | 1.4 | 1.5 | 13.2 |
| 1700.0 | 1.7 | 1.5 | 12.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .246 | –108 | 5.111 | –165 | .113 | 16 | .239 | 127 |
| 5.0 | .134 | –138 | 5.018 | –175 | .118 | 6 | .118 | 138 |
| 10.0 | .115 | –157 | 5.003 | –179 | .119 | 3 | .092 | 149 |
| 50.0 | .105 | 177 | 5.007 | 173 | .121 | –2 | .075 | 144 |
| 100.0 | .099 | 171 | 4.945 | 166 | .122 | –5 | .079 | 125 |
| 200.0 | .093 | 173 | 4.894 | 152 | .122 | –11 | .093 | 91 |
| 300.0 | .087 | –178 | 4.842 | 140 | .124 | –17 | .107 | 66 |
| 400.0 | .099 | –176 | 4.936 | 127 | .126 | –24 | .113 | 47 |
| 500.0 | .122 | 177 | 5.038 | 114 | .126 | –31 | .124 | 31 |
| 600.0 | .137 | 167 | 5.103 | 99 | .127 | –38 | .136 | 11 |
| 700.0 | .138 | 160 | 5.106 | 85 | .128 | –45 | .140 | –7 |
| 800.0 | .155 | 152 | 5.133 | 70 | .130 | –53 | .132 | –23 |
| 900.0 | .158 | 140 | 5.126 | 55 | .133 | –60 | .116 | –37 |
| 1000.0 | .171 | 129 | 5.133 | 40 | .134 | –68 | .090 | –46 |
| 1100.0 | .174 | 114 | 5.117 | 24 | .135 | –76 | .067 | –46 |
| 1200.0 | .176 | 94 | 5.085 | 8 | .136 | –84 | .065 | –26 |
| 1300.0 | .169 | 73 | 5.030 | –9 | .138 | –92 | .098 | –11 |
| 1400.0 | .147 | 43 | 4.929 | –26 | .141 | –101 | .139 | –17 |
| 1500.0 | .153 | –3 | 4.825 | –45 | .145 | –111 | .183 | –32 |
| 1600.0 | .166 | –46 | 4.568 | –65 | .149 | –122 | .209 | –50 |
| 1700.0 | .260 | –87 | 4.323 | –85 | .154 | –135 | .203 | –72 |

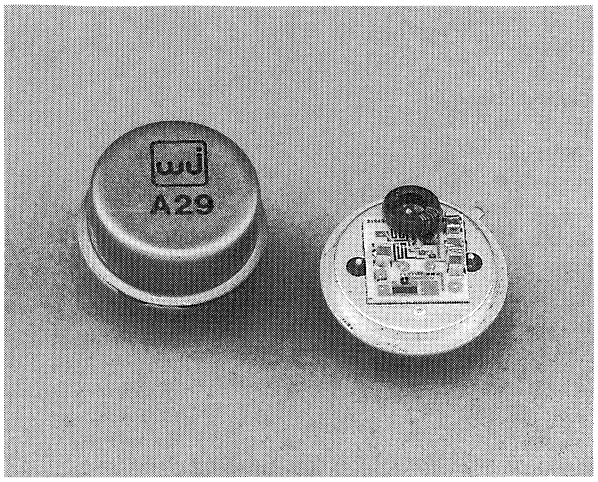
## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.094 W
Junction Temperature Rise Above Case $T_{jc}$ ... 4°C

# WJ-A29 / SMA29

## 10 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +34 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +10 TO +18 VOLTS




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1700 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 6.5 dB | 5.5 dB | 5.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 9.0 dB | 10.0 dB | 10.5 dB |
| Power Output at 1 dB Compression (Min.) | +22.0 dBm | +20.0 dBm | +19.5 dBm |
| VSWR (Max.) Input/Output | < 1.7:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 105 mA | 107 mA | 109 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA29 is a standard WJ-A29 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept point .....>+45 dBm (Typ.)
Second Order Two Tone Intercept point .....>+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

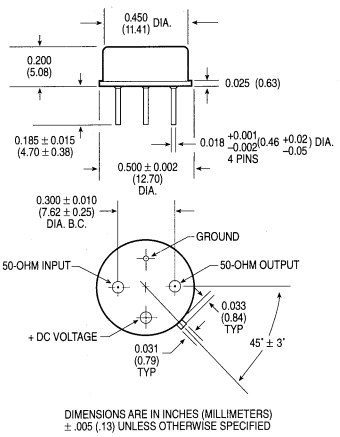
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+19 dBm
Maximum Short Term RF Input Power.....125 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

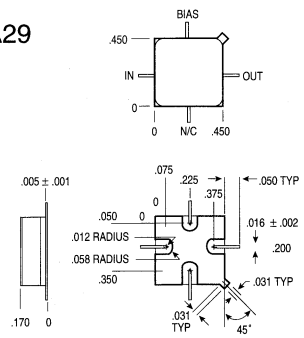
## Outline Drawings

A29



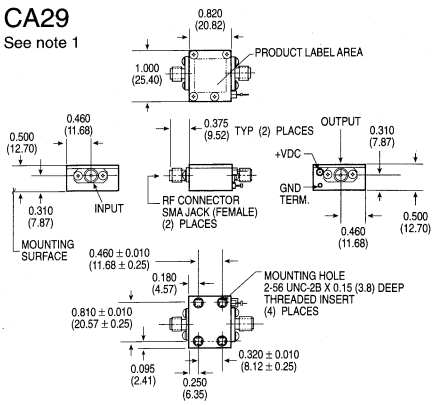

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA29




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

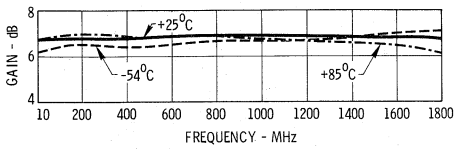
CA29
See note 1



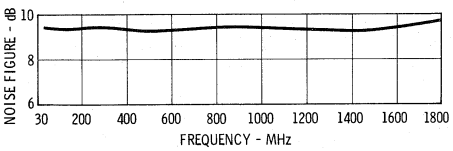

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

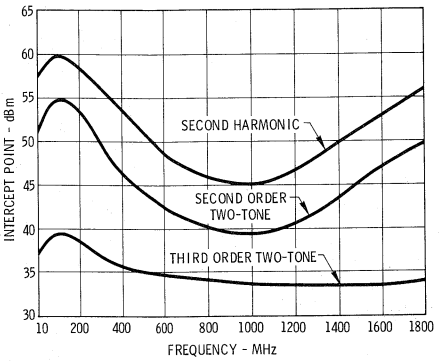
### Gain



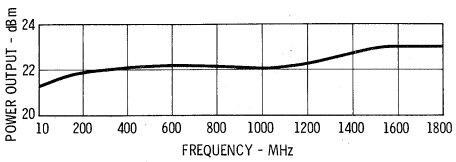

### Noise Figure

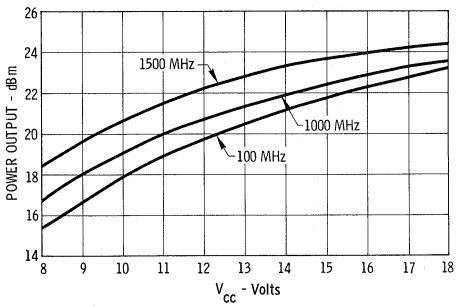



### Intercept Point



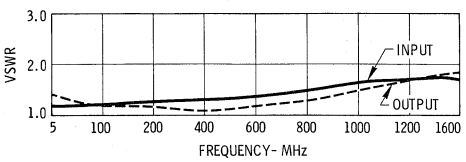

### Power Output *




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.9 | 6.1 |
| 5.0 | 1.3 | 1.4 | 6.4 |
| 10.0 | 1.2 | 1.3 | 6.5 |
| 50.0 | 1.2 | 1.2 | 6.6 |
| 100.0 | 1.2 | 1.2 | 6.5 |
| 200.0 | 1.2 | 1.2 | 6.4 |
| 300.0 | 1.2 | 1.2 | 6.4 |
| 400.0 | 1.2 | 1.1 | 6.5 |
| 500.0 | 1.2 | 1.1 | 6.7 |
| 600.0 | 1.3 | 1.1 | 6.8 |
| 700.0 | 1.3 | 1.1 | 6.9 |
| 800.0 | 1.3 | 1.1 | 6.9 |
| 900.0 | 1.3 | 1.2 | 7.0 |
| 1000.0 | 1.3 | 1.2 | 7.1 |
| 1100.0 | 1.3 | 1.3 | 7.1 |
| 1200.0 | 1.4 | 1.4 | 7.0 |
| 1300.0 | 1.4 | 1.4 | 6.9 |
| 1400.0 | 1.4 | 1.5 | 6.8 |
| 1500.0 | 1.5 | 1.5 | 6.7 |
| 1600.0 | 1.6 | 1.6 | 6.4 |
| 1700.0 | 1.9 | 1.6 | 6.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .242 | –94 | 2.020 | –152 | .197 | 32 | .302 | 150 |
| 5.0 | .121 | –129 | 2.097 | –170 | .207 | 12 | .152 | 152 |
| 10.0 | .098 | –150 | 2.113 | –176 | .209 | 6 | .123 | 160 |
| 50.0 | .092 | –178 | 2.132 | 174 | .212 | –1 | .103 | 165 |
| 100.0 | .086 | 174 | 2.116 | 167 | .212 | –5 | .099 | 159 |
| 200.0 | .082 | 173 | 2.100 | 154 | .211 | –11 | .089 | 144 |
| 300.0 | .084 | 173 | 2.088 | 142 | .212 | –16 | .076 | 132 |
| 400.0 | .089 | 175 | 2.119 | 129 | .214 | –21 | .056 | 128 |
| 500.0 | .101 | 166 | 2.150 | 117 | .213 | –28 | .042 | 133 |
| 600.0 | .111 | 155 | 2.181 | 103 | .213 | –34 | .033 | 150 |
| 700.0 | .117 | 145 | 2.202 | 89 | .211 | –40 | .038 | 173 |
| 800.0 | .123 | 135 | 2.220 | 76 | .211 | –46 | .059 | 178 |
| 900.0 | .133 | 120 | 2.244 | 62 | .212 | –51 | .083 | 169 |
| 1000.0 | .145 | 99 | 2.254 | 48 | .210 | –58 | .111 | 156 |
| 1100.0 | .147 | 81 | 2.252 | 34 | .210 | –64 | .136 | 142 |
| 1200.0 | .157 | 53 | 2.245 | 20 | .210 | –70 | .155 | 125 |
| 1300.0 | .158 | 28 | 2.226 | 6 | .211 | –76 | .175 | 106 |
| 1400.0 | .172 | –3 | 2.194 | –10 | .213 | –82 | .193 | 88 |
| 1500.0 | .201 | –37 | 2.155 | –26 | .217 | –89 | .206 | 68 |
| 1600.0 | .242 | –65 | 2.080 | –42 | .220 | –97 | .218 | 48 |
| 1700.0 | .313 | –93 | 1.999 | –58 | .223 | –105 | .221 | 31 |

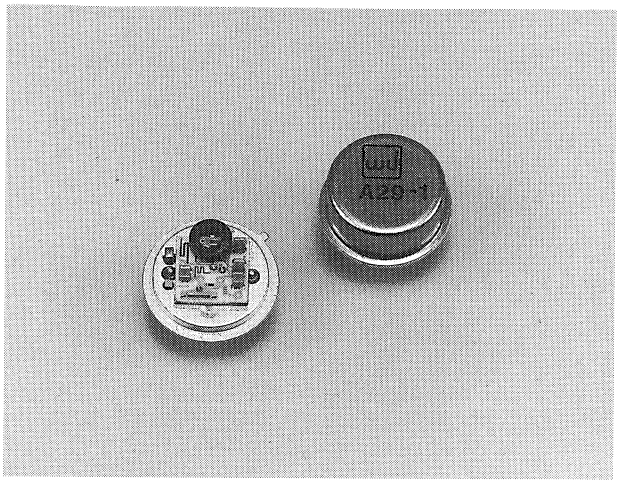
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.031 W
Junction Temperature Rise Above Case $T_{jc}$ ... 46°C

# WJ-A29-1 / SMA29-1

## 10 to 1500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +32 dBm (TYP.)




## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-1600 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.5 dB | 7.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 30-1000 MHz | 7.0 dB | 8.5 dB | 9.0 dB |
| 10-1500 MHz | 8.0 dB | 9.0 dB | 9.5 dB |
| Power Output at 1 dB Compression (Min.) | +22.0 dBm | +20.0 dBm | +19.0 dBm |
| VSWR (Max.) Input/Output | 1.6:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 90 mA | 94 mA | 99 mA |

* Measured in a 50-ohm system at 15 Vdc Nominal.

Notes:

1. WJ-CA29-1 is a standard WJ-A29-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+57 dBm (Typ.)
Second Order Two Tone Intercept Point.....+49 dBm (Typ.)
Third Order Two Tone Intercept Point.....+32 dBm (Typ.)

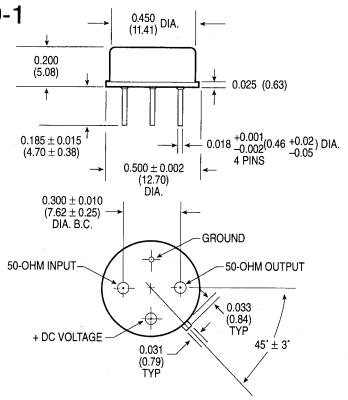
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....15.5 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

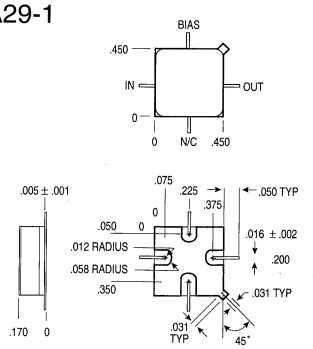
## Outline Drawings

A29-1



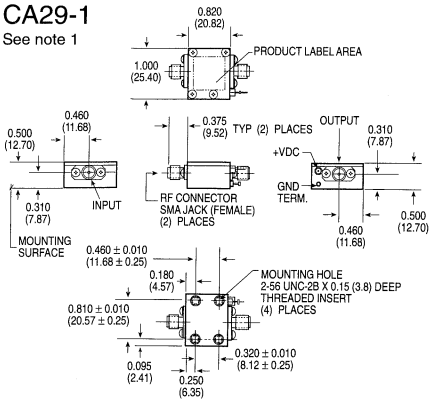

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA29-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

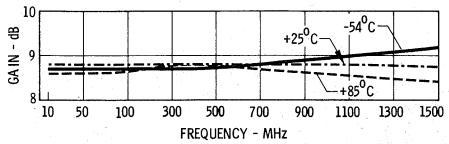
CA29-1
See note 1



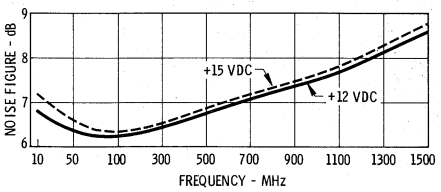

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

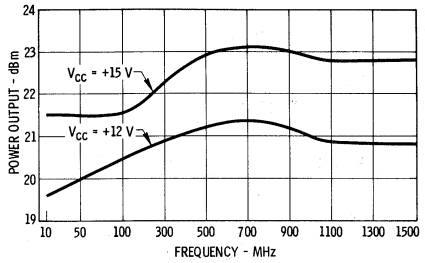
## Gain




## Noise Figure

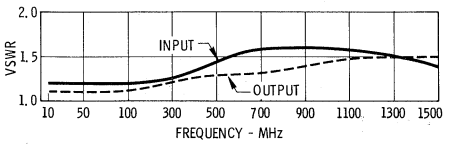



## Power Output*

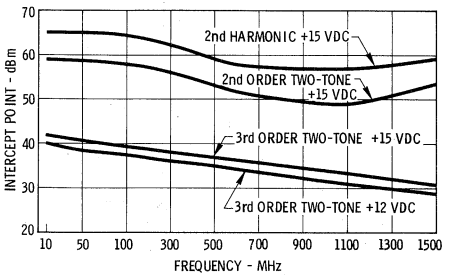



* at 1 dB Gain Compression

## VSWR




## Intercept Point




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 2.2 | 8.7 |
| 5.0 | 1.5 | 1.6 | 9.7 |
| 10.0 | 1.4 | 1.5 | 9.8 |
| 50.0 | 1.4 | 1.5 | 9.9 |
| 100.0 | 1.4 | 1.5 | 9.8 |
| 200.0 | 1.4 | 1.4 | 9.8 |
| 300.0 | 1.3 | 1.4 | 9.8 |
| 400.0 | 1.3 | 1.4 | 9.9 |
| 500.0 | 1.3 | 1.3 | 10.1 |
| 600.0 | 1.2 | 1.3 | 10.2 |
| 700.0 | 1.2 | 1.3 | 10.3 |
| 800.0 | 1.2 | 1.2 | 10.4 |
| 900.0 | 1.2 | 1.2 | 10.4 |
| 1000.0 | 1.2 | 1.2 | 10.4 |
| 1100.0 | 1.2 | 1.2 | 10.4 |
| 1200.0 | 1.3 | 1.2 | 10.5 |
| 1300.0 | 1.3 | 1.3 | 10.5 |
| 1400.0 | 1.4 | 1.3 | 10.3 |
| 1500.0 | 1.6 | 1.4 | 10.1 |
| 1600.0 | 1.8 | 1.5 | 9.6 |
| 1700.0 | 2.2 | 1.5 | 9.1 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .236 | –105 | 2.731 | –154 | .141 | 27 | .376 | 171 |
| 5.0 | .192 | –149 | 3.072 | –171 | .161 | 11 | .235 | 168 |
| 10.0 | .181 | –164 | 3.102 | –176 | .163 | 5 | .215 | 171 |
| 50.0 | .182 | 173 | 3.122 | 174 | .166 | –1 | .198 | 168 |
| 100.0 | .175 | 165 | 3.102 | 167 | .167 | –4 | .192 | 161 |
| 200.0 | .157 | 153 | 3.082 | 155 | .169 | –8 | .180 | 146 |
| 300.0 | .146 | 142 | 3.073 | 143 | .172 | –13 | .165 | 133 |
| 400.0 | .127 | 131 | 3.142 | 131 | .175 | –19 | .150 | 124 |
| 500.0 | .124 | 122 | 3.204 | 119 | .176 | –24 | .142 | 114 |
| 600.0 | .105 | 112 | 3.252 | 105 | .178 | –30 | .128 | 100 |
| 700.0 | .088 | 98 | 3.269 | 91 | .180 | –36 | .114 | 88 |
| 800.0 | .078 | 97 | 3.303 | 77 | .183 | –42 | .102 | 79 |
| 900.0 | .077 | 96 | 3.319 | 63 | .187 | –48 | .095 | 71 |
| 1000.0 | .085 | 85 | 3.330 | 49 | .189 | –55 | .094 | 64 |
| 1100.0 | .094 | 64 | 3.324 | 35 | .193 | –62 | .097 | 55 |
| 1200.0 | .112 | 43 | 3.350 | 20 | .197 | –68 | .107 | 37 |
| 1300.0 | .121 | 14 | 3.332 | 5 | .202 | –76 | .127 | 18 |
| 1400.0 | .160 | –14 | 3.263 | –12 | .206 | –85 | .145 | –3 |
| 1500.0 | .222 | –43 | 3.196 | –29 | .210 | –94 | .170 | –29 |
| 1600.0 | .281 | –70 | 3.013 | –47 | .213 | –104 | .192 | –56 |
| 1700.0 | .377 | –96 | 2.851 | –65 | .214 | –116 | .201 | –87 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.931 W
Junction Temperature Rise Above Case $T_{jc}$ ... 42°C

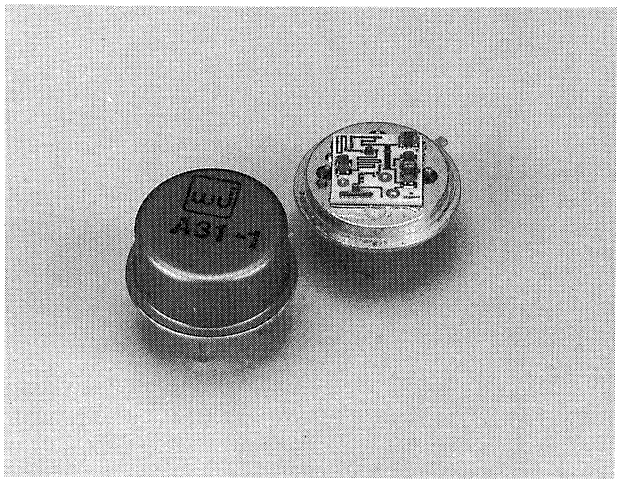
## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 2.1 | 8.8 |
| 5.0 | 1.5 | 1.6 | 9.7 |
| 10.0 | 1.4 | 1.5 | 9.8 |
| 50.0 | 1.4 | 1.5 | 9.9 |
| 100.0 | 1.4 | 1.5 | 9.8 |
| 200.0 | 1.4 | 1.4 | 9.7 |
| 300.0 | 1.3 | 1.4 | 9.7 |
| 400.0 | 1.3 | 1.4 | 9.9 |
| 500.0 | 1.3 | 1.3 | 10.1 |
| 600.0 | 1.3 | 1.3 | 10.2 |
| 700.0 | 1.2 | 1.3 | 10.3 |
| 800.0 | 1.2 | 1.3 | 10.4 |
| 900.0 | 1.2 | 1.3 | 10.4 |
| 1000.0 | 1.2 | 1.3 | 10.5 |
| 1100.0 | 1.2 | 1.3 | 10.4 |
| 1200.0 | 1.3 | 1.4 | 10.5 |
| 1300.0 | 1.4 | 1.4 | 10.4 |
| 1400.0 | 1.5 | 1.5 | 10.2 |
| 1500.0 | 1.7 | 1.6 | 10.0 |
| 1600.0 | 1.9 | 1.7 | 9.4 |
| 1700.0 | 2.4 | 1.7 | 8.8 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .237 | –108 | 2.766 | –155 | .144 | 27 | .357 | 171 |
| 5.0 | .189 | –150 | 3.059 | –171 | .161 | 11 | .227 | 169 |
| 10.0 | .182 | –165 | 3.085 | –176 | .164 | 5 | .208 | 171 |
| 50.0 | .177 | 174 | 3.108 | 174 | .166 | –1 | .192 | 169 |
| 100.0 | .173 | 165 | 3.086 | 167 | .167 | –3 | .186 | 162 |
| 200.0 | .159 | 154 | 3.059 | 155 | .169 | –8 | .175 | 149 |
| 300.0 | .144 | 141 | 3.063 | 143 | .173 | –12 | .162 | 137 |
| 400.0 | .125 | 133 | 3.139 | 131 | .176 | –18 | .151 | 130 |
| 500.0 | .124 | 124 | 3.196 | 119 | .178 | –23 | .148 | 121 |
| 600.0 | .115 | 113 | 3.237 | 104 | .180 | –29 | .139 | 110 |
| 700.0 | .093 | 102 | 3.268 | 90 | .183 | –35 | .131 | 99 |
| 800.0 | .084 | 102 | 3.296 | 76 | .187 | –41 | .125 | 91 |
| 900.0 | .092 | 95 | 3.321 | 62 | .192 | –47 | .126 | 81 |
| 1000.0 | .101 | 82 | 3.333 | 48 | .195 | –53 | .132 | 72 |
| 1100.0 | .105 | 69 | 3.326 | 33 | .201 | –61 | .140 | 58 |
| 1200.0 | .130 | 40 | 3.348 | 18 | .206 | –68 | .154 | 40 |
| 1300.0 | .153 | 17 | 3.320 | 2 | .211 | –76 | .179 | 20 |
| 1400.0 | .190 | –16 | 3.232 | –15 | .217 | –84 | .202 | –2 |
| 1500.0 | .256 | –44 | 3.154 | –32 | .222 | –94 | .229 | –28 |
| 1600.0 | .317 | –71 | 2.952 | –50 | .225 | –105 | .251 | –55 |
| 1700.0 | .411 | –98 | 2.760 | 68 | .226 | –117 | .257 | –85 |

# WJ-A31-1 / SMA31-1



## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: < 3.5 dB (TYP.)
- ◆ LOW VSWR : 1.5.1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 11.0 dB | 10.5 dB |
| Gain Flatness (Max.) | < ±0.4 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | < 3.5 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | -2.0 dBm | -4.0 dBm | -4.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 2.0:1 | 2.0:1 |
| output | 1.3:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 12 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA31-1 is a standard WJ-A31-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+15 dBm (Typ.)
Second Order Two Tone Intercept Point.....+10 dBm (Typ.)
Third Order Two Tone Intercept Point.....+9 dBm (Typ.)

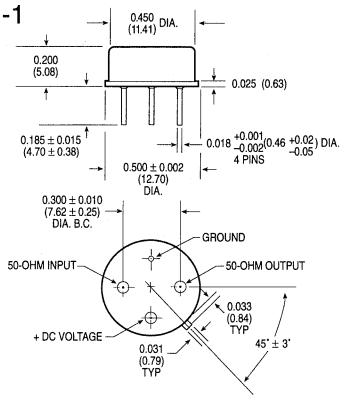
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S"Series Burn-in Temperature.(Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

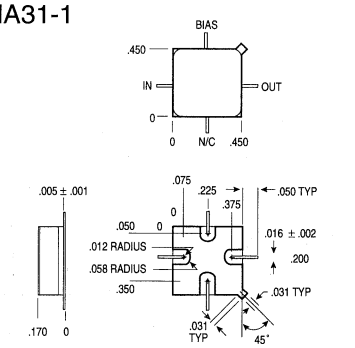
## Outline Drawings

A31-1



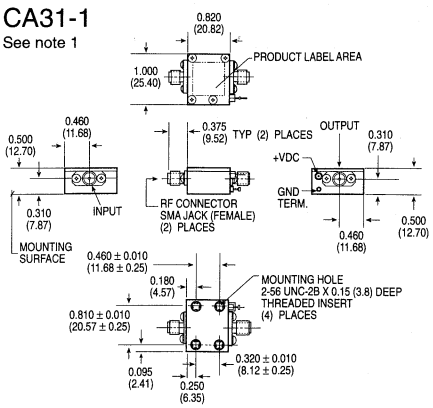

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA31-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

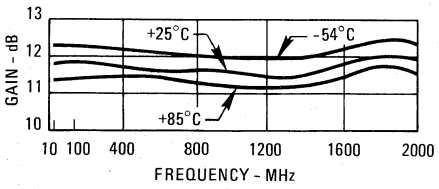
CA31-1
See note 1



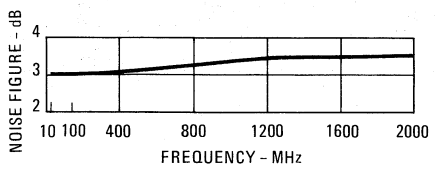

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

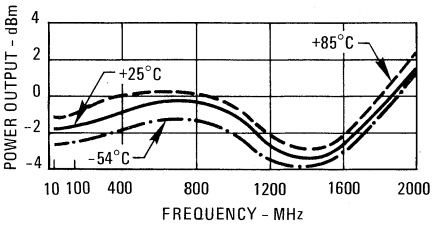
### Gain




### Noise Figure

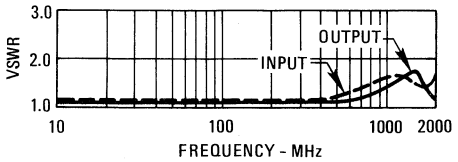



### Power Output*

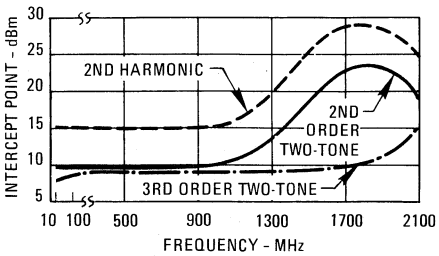



* at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.7 | 1.5 | 11.9 |
| 2.0 | 1.4 | 1.4 | 12.0 |
| 5.0 | 1.3 | 1.4 | 12.0 |
| 10.0 | 1.3 | 1.4 | 12.0 |
| 50.0 | 1.3 | 1.4 | 11.9 |
| 100.0 | 1.2 | 1.4 | 11.8 |
| 200.0 | 1.2 | 1.3 | 11.7 |
| 300.0 | 1.2 | 1.3 | 11.6 |
| 400.0 | 1.1 | 1.2 | 11.7 |
| 500.0 | 1.2 | 1.2 | 11.8 |
| 600.0 | 1.2 | 1.2 | 11.8 |
| 700.0 | 1.2 | 1.2 | 11.8 |
| 800.0 | 1.2 | 1.3 | 11.8 |
| 900.0 | 1.3 | 1.3 | 11.8 |
| 1000.0 | 1.3 | 1.4 | 11.8 |
| 1100.0 | 1.3 | 1.5 | 11.8 |
| 1200.0 | 1.4 | 1.5 | 11.8 |
| 1300.0 | 1.4 | 1.5 | 11.8 |
| 1400.0 | 1.3 | 1.6 | 12.0 |
| 1500.0 | 1.3 | 1.5 | 12.0 |
| 1600.0 | 1.3 | 1.5 | 12.2 |
| 1700.0 | 1.2 | 1.5 | 12.4 |
| 1800.0 | 1.0 | 1.4 | 12.3 |
| 1900.0 | 1.1 | 1.3 | 12.3 |
| 2000.0 | 1.5 | 1.2 | 12.1 |
| 2100.0 | 2.0 | 1.4 | 11.6 |
| 2200.0 | 3.0 | 1.6 | 10.4 |

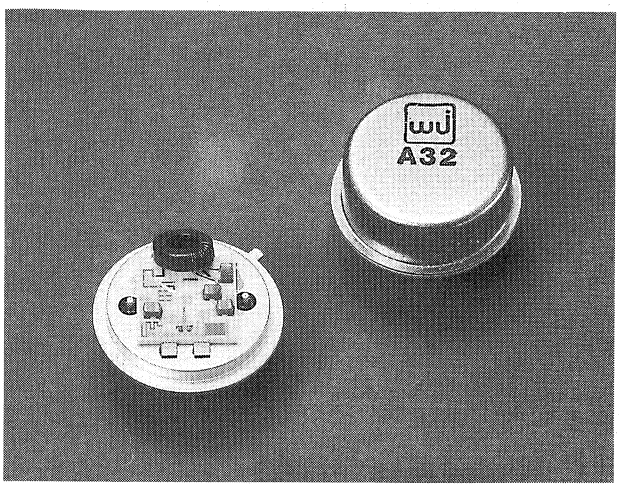
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .256 | –93 | 3.936 | –170 | .133 | 12 | .200 | 160 |
| 2.0 | .162 | –124 | 3.960 | –175 | .136 | 6 | .175 | 167 |
| 5.0 | .128 | –153 | 3.987 | –179 | .138 | 3 | .165 | 172 |
| 10.0 | .120 | –166 | 3.963 | 180 | .139 | 1 | .161 | 173 |
| 50.0 | .116 | 176 | 3.933 | 174 | .140 | –2 | .154 | 164 |
| 100.0 | .106 | 167 | 3.908 | 167 | .140 | –4 | .149 | 151 |
| 200.0 | .099 | 163 | 3.856 | 155 | .141 | –9 | .135 | 126 |
| 300.0 | .079 | 167 | 3.809 | 144 | .143 | –14 | .117 | 102 |
| 400.0 | .070 | 179 | 3.864 | 133 | .143 | –21 | .098 | 80 |
| 500.0 | .090 | 176 | 3.896 | 122 | .142 | –26 | .089 | 52 |
| 600.0 | .089 | 174 | 3.907 | 109 | .140 | –32 | .089 | 15 |
| 700.0 | .098 | 178 | 3.888 | 97 | .139 | –37 | .099 | –22 |
| 800.0 | .111 | 176 | 3.896 | 85 | .138 | –44 | .116 | –54 |
| 900.0 | .123 | 170 | 3.872 | 73 | .138 | –48 | .138 | –80 |
| 1000.0 | .137 | 162 | 3.889 | 61 | .136 | –54 | .159 | –105 |
| 1100.0 | .145 | 155 | 3.901 | 49 | .136 | –60 | .184 | –126 |
| 1200.0 | .151 | 144 | 3.883 | 36 | .133 | –66 | .202 | –145 |
| 1300.0 | .154 | 134 | 3.905 | 24 | .131 | –71 | .209 | –163 |
| 1400.0 | .148 | 127 | 3.959 | 10 | .130 | –77 | .217 | 179 |
| 1500.0 | .128 | 115 | 3.998 | –3 | .128 | –83 | .214 | 161 |
| 1600.0 | .116 | 105 | 4.065 | –17 | .128 | –88 | .205 | 142 |
| 1700.0 | .082 | 89 | 4.149 | –32 | .129 | –94 | .195 | 124 |
| 1800.0 | .023 | 87 | 4.118 | –48 | .132 | –100 | .172 | 109 |
| 1900.0 | .066 | –128 | 4.128 | –66 | .135 | –108 | .138 | 103 |
| 2000.0 | .185 | –151 | 4.049 | –85 | .136 | –117 | .110 | 116 |
| 2100.0 | .333 | –168 | 3.797 | –107 | .134 | –128 | .150 | 135 |
| 2200.0 | .494 | 169 | 3.311 | –128 | .125 | –138 | .230 | 134 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.051 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A32 / SMA32




## 100 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE FIGURE: 3.5 dB (TYP.)
- ◆ HIGH THIRD ORDER IP: +32 dBm (TYP.)
- ◆ HIGH OUTPUT LEVEL: +21.0 dBm (TYP.)
- ◆ LOW VSWR : 1.8:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10 - 2000 MHz | 100 - 2000 MHz | 100 - 2000 MHz |
| Small Signal Gain (Min.) | 10.0 dB | 9.0 dB | 8.5 dB |
| Gain Flatness (Max.) | ±.3 dB | ±.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.5 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +21.0 dBm | +19.0 dBm | +18.0 dBm |
| VSWR (Max.) Input/Output | 1.8:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volt | 94 mA | 98 mA | 100 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA32 is a standard WJ-A32 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+32 dBm (Typ.)

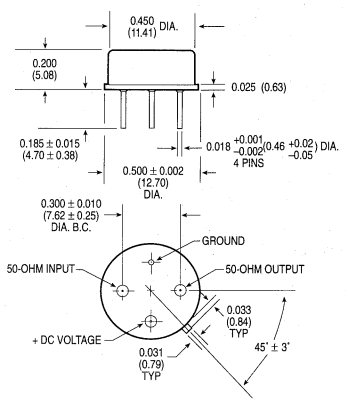
## Absolute Maximum Ratings

Storage Temperature .....-62° C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

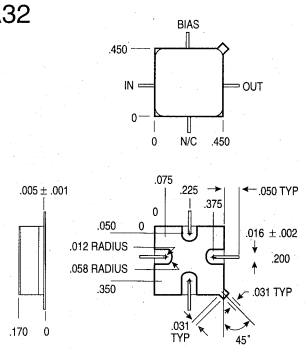
## Outline Drawings

A32



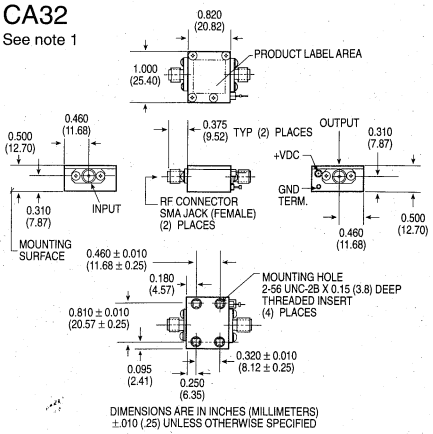

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA32




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

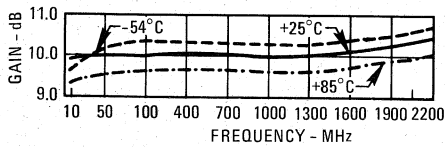
CA32
See note 1



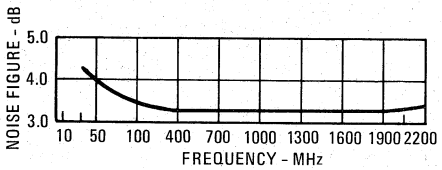

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

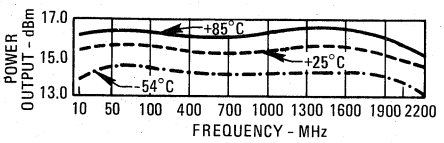
### Gain




### Noise Figure

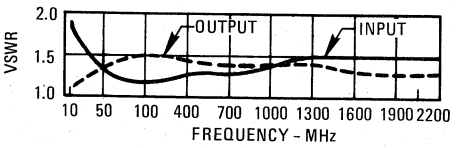



### Power Output*

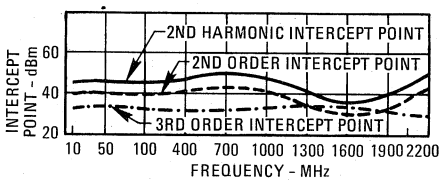



* at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.6 | 1.1 | 7.4 |
| 10.0 | 2.6 | 1.2 | 7.6 |
| 50.0 | 2.2 | 1.5 | 10.2 |
| 100.0 | 1.8 | 1.7 | 11.7 |
| 200.0 | 1.6 | 1.7 | 12.3 |
| 300.0 | 1.6 | 1.7 | 12.3 |
| 400.0 | 1.6 | 1.7 | 12.3 |
| 500.0 | 1.6 | 1.7 | 12.6 |
| 600.0 | 1.5 | 1.8 | 12.5 |
| 700.0 | 1.5 | 1.8 | 12.4 |
| 800.0 | 1.5 | 1.8 | 12.4 |
| 900.0 | 1.5 | 1.8 | 12.4 |
| 1000.0 | 1.4 | 1.8 | 12.3 |
| 1100.0 | 1.4 | 1.8 | 12.2 |
| 1200.0 | 1.4 | 1.8 | 12.2 |
| 1300.0 | 1.3 | 1.8 | 12.1 |
| 1400.0 | 1.3 | 1.9 | 11.9 |
| 1500.0 | 1.3 | 1.9 | 11.9 |
| 1600.0 | 1.2 | 1.9 | 11.7 |
| 1700.0 | 1.2 | 2.0 | 11.7 |
| 1800.0 | 1.2 | 1.9 | 11.8 |
| 1900.0 | 1.2 | 1.9 | 11.8 |
| 2000.0 | 1.3 | 1.9 | 12.0 |
| 2100.0 | 1.4 | 1.9 | 12.1 |
| 2200.0 | 1.5 | 1.9 | 12.1 |

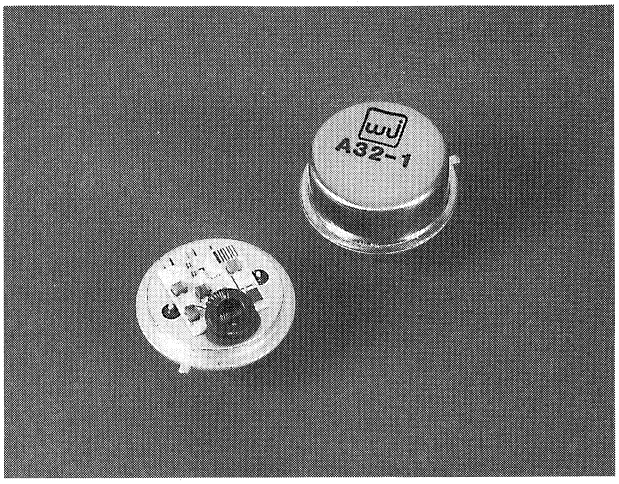
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .443 | –11 | 2.337 | –156 | .119 | 22 | .049 | 12 |
| 10.0 | .440 | –9 | 2.409 | –164 | .120 | 8 | .102 | –19 |
| 50.0 | .366 | –22 | 3.254 | –166 | .107 | –11 | .203 | –106 |
| 100.0 | .288 | –28 | 3.837 | –176 | .090 | –15 | .253 | –150 |
| 200.0 | .243 | –32 | 4.109 | 167 | .080 | –13 | .267 | 170 |
| 300.0 | .231 | –37 | 4.126 | 156 | .080 | –13 | .261 | 148 |
| 400.0 | .237 | –45 | 4.143 | 145 | .082 | –15 | .249 | 133 |
| 500.0 | .223 | –54 | 4.242 | 136 | .083 | –19 | .271 | 118 |
| 600.0 | .209 | –63 | 4.230 | 124 | .083 | –21 | .276 | 101 |
| 700.0 | .206 | –70 | 4.191 | 113 | .084 | –24 | .276 | 84 |
| 800.0 | .201 | –83 | 4.172 | 102 | .086 | –27 | .277 | 70 |
| 900.0 | .191 | –91 | 4.148 | 92 | .088 | –30 | .278 | 55 |
| 1000.0 | .177 | –101 | 4.102 | 82 | .089 | –34 | .280 | 42 |
| 1100.0 | .168 | –111 | 4.052 | 72 | .093 | –38 | .280 | 29 |
| 1200.0 | .152 | –122 | 4.064 | 62 | .094 | –43 | .284 | 15 |
| 1300.0 | .140 | –136 | 4.038 | 52 | .097 | –49 | .293 | 4 |
| 1400.0 | .131 | –150 | 3.956 | 42 | .098 | –54 | .299 | –7 |
| 1500.0 | .124 | –164 | 3.932 | 32 | .100 | –60 | .307 | –18 |
| 1600.0 | .110 | 177 | 3.832 | 21 | .103 | –65 | .318 | –28 |
| 1700.0 | .102 | 150 | 3.849 | 11 | .104 | –72 | .322 | –38 |
| 1800.0 | .096 | 121 | 3.894 | 0 | .105 | –77 | .321 | –49 |
| 1900.0 | .108 | 81 | 3.905 | –12 | .107 | –83 | .320 | –61 |
| 2000.0 | .127 | 55 | 3.968 | –21 | .111 | –89 | .316 | –74 |
| 2100.0 | .161 | 20 | 4.030 | –33 | .114 | –96 | .307 | –88 |
| 2200.0 | .186 | –1 | 4.017 | –45 | .116 | –103 | .299 | –103 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 160.5°C/W
Transistor Power Dissipation $P_d$ ..... 0.180 W
Junction Temperature Rise Above Case $T_{jc}$ ... 29°C

# WJ-A32-1 / SMA32-1




## 100 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE FIGURE: 3.0 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: 13.0 dBm (TYP.)
- ◆ MEDIUM THIRD ORDER I.P.: 25.0 dBm (TYP.)
- ◆ GaAs FET DESIGN

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 100 - 2000 MHz | 100 - 2000 MHz | 100 - 2000 MHz |
| Small Signal Gain (Min.) | 10.0 dB | 9.0 dB | 8.5 dB |
| Gain Flatness (Max.) | ±.3 dB | ±.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | +13 dBm | +11.5 dBm | +11.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.8:1 | 2.1:1 | 2.3:1 |
| Output | 1.8:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 5 Volt | 44 mA | 50 mA | 52 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA32-1 is a standard WJ-A32-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+37 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+25 dBm (Typ.)

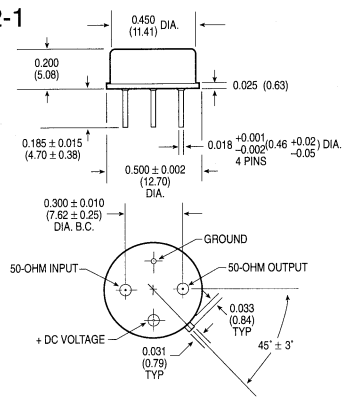
## Absolute Maximum Ratings

Storage Temperature .....-62° C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....8 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

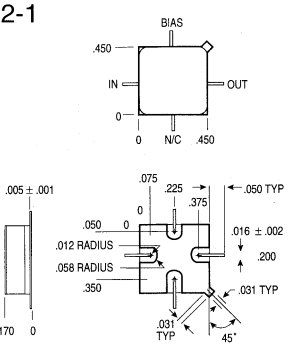
## Outline Drawings

A32-1



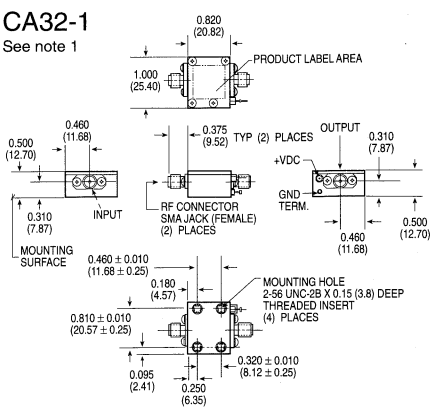

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA32-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

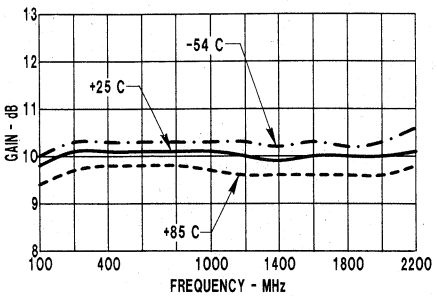
CA32-1
See note 1



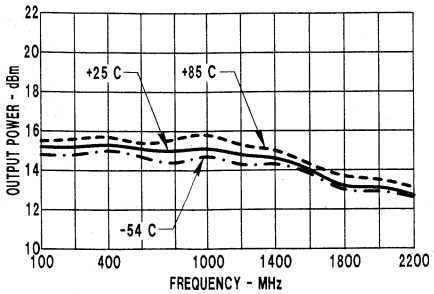

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

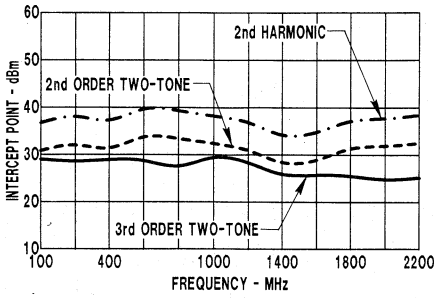
### Gain




### Output Power*

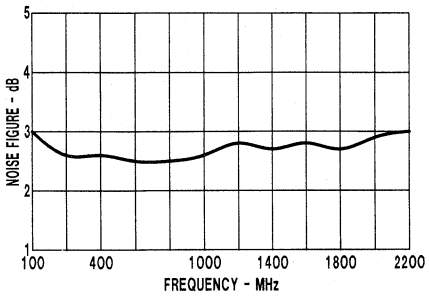



### Intercept Point

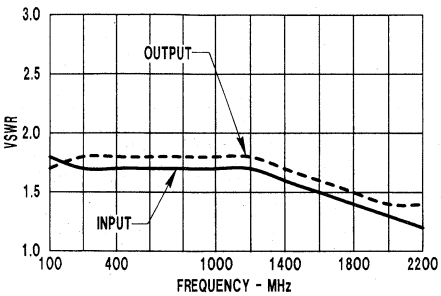



* at 1 dB Gain Compression

### Noise Figure




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 3.0 | 1.4 | 3.8 |
| 10.0 | 3.0 | 1.5 | 4.6 |
| 50.0 | 2.1 | 1.7 | 9.5 |
| 100.0 | 1.8 | 1.8 | 10.6 |
| 200.0 | 1.7 | 1.7 | 10.9 |
| 300.0 | 1.7 | 1.7 | 11.0 |
| 400.0 | 1.7 | 1.7 | 11.0 |
| 500.0 | 1.6 | 1.7 | 11.2 |
| 600.0 | 1.6 | 1.7 | 11.3 |
| 700.0 | 1.6 | 1.7 | 11.2 |
| 800.0 | 1.6 | 1.7 | 11.2 |
| 900.0 | 1.5 | 1.7 | 11.2 |
| 1000.0 | 1.5 | 1.7 | 11.2 |
| 1100.0 | 1.5 | 1.6 | 11.1 |
| 1200.0 | 1.5 | 1.6 | 11.1 |
| 1300.0 | 1.4 | 1.6 | 11.1 |
| 1400.0 | 1.3 | 1.6 | 11.0 |
| 1500.0 | 1.3 | 1.6 | 11.0 |
| 1600.0 | 1.2 | 1.6 | 10.9 |
| 1700.0 | 1.2 | 1.6 | 11.1 |
| 1800.0 | 1.2 | 1.6 | 11.2 |
| 1900.0 | 1.3 | 1.5 | 11.2 |
| 2000.0 | 1.5 | 1.4 | 11.3 |
| 2100.0 | 1.8 | 1.4 | 11.2 |
| 2200.0 | 2.2 | 1.4 | 11.0 |

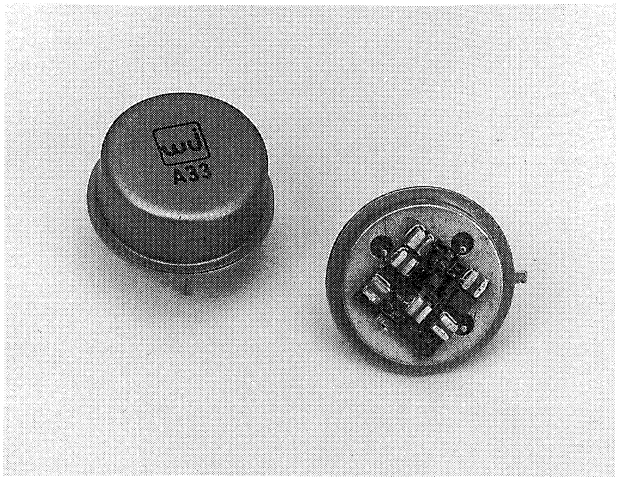
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .502 | –10 | 1.555 | –152 | .143 | 19 | .166 | 2 |
| 10.0 | .496 | –11 | 1.701 | –154 | .142 | 6 | .205 | –21 |
| 50.0 | .364 | –26 | 2.975 | –162 | .114 | –14 | .262 | –112 |
| 100.0 | .284 | –25 | 3.387 | –176 | .096 | –14 | .273 | –152 |
| 200.0 | .253 | –27 | 3.526 | 169 | .089 | –11 | .268 | 175 |
| 300.0 | .251 | –31 | 3.529 | 158 | .090 | –11 | .256 | 158 |
| 400.0 | .245 | –38 | 3.554 | 150 | .092 | –14 | .249 | 152 |
| 500.0 | .232 | –46 | 3.648 | 140 | .093 | –17 | .269 | 137 |
| 600.0 | .232 | –51 | 3.653 | 130 | .094 | –20 | .265 | 123 |
| 700.0 | .228 | –58 | 3.637 | 119 | .096 | –22 | .261 | 109 |
| 800.0 | .223 | –68 | 3.636 | 110 | .098 | –25 | .255 | 97 |
| 900.0 | .215 | –74 | 3.642 | 100 | .101 | –28 | .251 | 83 |
| 1000.0 | .205 | –85 | 3.611 | 91 | .103 | –32 | .249 | 71 |
| 1100.0 | .190 | –95 | 3.582 | 82 | .108 | –37 | .243 | 58 |
| 1200.0 | .185 | –105 | 3.596 | 73 | .111 | –42 | .239 | 44 |
| 1300.0 | .159 | –117 | 3.585 | 64 | .115 | –47 | .242 | 30 |
| 1400.0 | .143 | –129 | 3.542 | 54 | .119 | –53 | .240 | 16 |
| 1500.0 | .120 | –147 | 3.561 | 45 | .123 | –59 | .242 | 1 |
| 1600.0 | .097 | –168 | 3.518 | 35 | .128 | –66 | .244 | –14 |
| 1700.0 | .075 | 150 | 3.572 | 25 | .130 | –73 | .235 | –30 |
| 1800.0 | .079 | 105 | 3.628 | 14 | .134 | –80 | .218 | –48 |
| 1900.0 | .125 | 52 | 3.645 | 2 | .137 | –88 | .199 | –70 |
| 2000.0 | .194 | 28 | 3.657 | –8 | .142 | –97 | .180 | –96 |
| 2100.0 | .292 | 0 | 3.636 | –20 | .142 | –107 | .169 | –128 |
| 2200.0 | .370 | –21 | 3.538 | –32 | .141 | –118 | .172 | –160 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 165°C/W
Transistor Power Dissipation $P_d$ ..... 0.111 W
Junction Temperature Rise Above Case $T_{jc}$ ... 16.2°C

# WJ-A33 / SMA33




## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE FIGURE: 4.5 dB (TYP.)
- ◆ +3 dBm OUTPUT LEVEL (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 9.5 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | | | |
| 500-2000 MHz | < ±0.3 dB | ±0.6 dB | ±0.8 dB |
| 10-2000 MHz | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +3.0 dBm | +2.0 dBm | +2.0 dBm |
| VSWR (Max.) Input/Output | < 1.7:1 | 2.0:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 14 mA | 16 mA | 17 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA33 is a standard WJ-A33 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+28 dBm (Typ.)
Second Order Two Tone Intercept Point.....+22 dBm (Typ.)
Third Order Two Tone Intercept Point.....+15 dBm (Typ.)

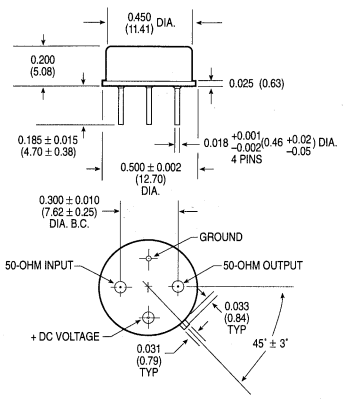
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatt (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

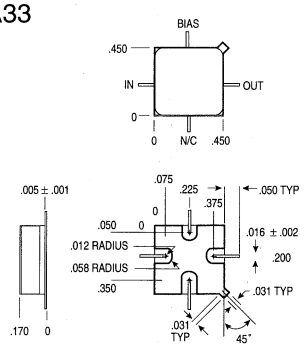
## Outline Drawings

A33



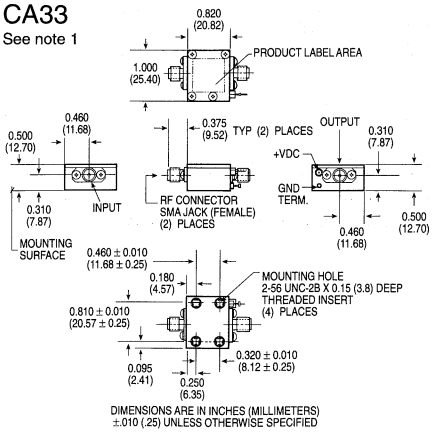

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA33




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

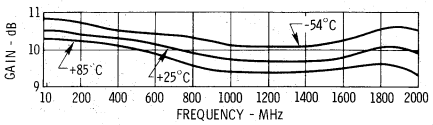
CA33
See note 1



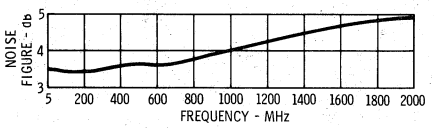

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

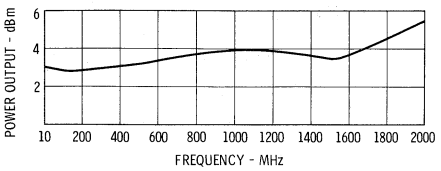
### Gain




### Noise Figure

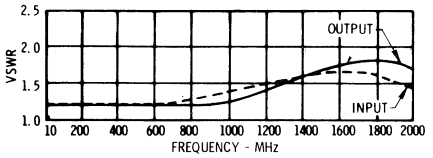



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.6 | 9.9 |
| 2.0 | 1.3 | 1.4 | 10.0 |
| 5.0 | 1.2 | 1.4 | 10.1 |
| 10.0 | 1.2 | 1.4 | 10.0 |
| 50.0 | 1.2 | 1.4 | 10.0 |
| 100.0 | 1.2 | 1.4 | 9.9 |
| 200.0 | 1.2 | 1.3 | 9.8 |
| 300.0 | 1.2 | 1.3 | 9.7 |
| 400.0 | 1.1 | 1.3 | 9.8 |
| 500.0 | 1.2 | 1.2 | 9.9 |
| 600.0 | 1.2 | 1.2 | 9.9 |
| 700.0 | 1.2 | 1.2 | 9.9 |
| 800.0 | 1.3 | 1.2 | 9.9 |
| 900.0 | 1.3 | 1.2 | 9.9 |
| 1000.0 | 1.3 | 1.2 | 9.9 |
| 1100.0 | 1.4 | 1.2 | 9.9 |
| 1200.0 | 1.4 | 1.3 | 9.9 |
| 1300.0 | 1.4 | 1.2 | 10.0 |
| 1400.0 | 1.4 | 1.2 | 10.0 |
| 1500.0 | 1.3 | 1.2 | 10.0 |
| 1600.0 | 1.2 | 1.2 | 10.0 |
| 1700.0 | 1.1 | 1.2 | 10.1 |
| 1800.0 | 1.1 | 1.2 | 10.0 |
| 1900.0 | 1.2 | 1.2 | 9.9 |
| 2000.0 | 1.5 | 1.1 | 9.7 |
| 2100.0 | 1.9 | 1.1 | 9.2 |
| 2200.0 | 2.6 | 1.2 | 8.4 |

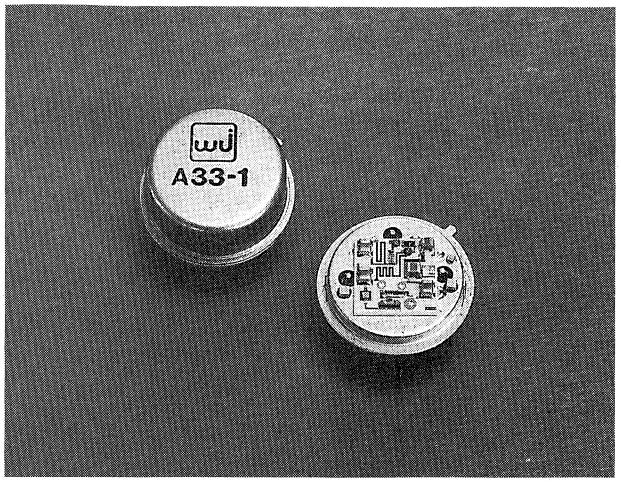
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .185 | −128 | 3.119 | −161 | .154 | 23 | .226 | −134 |
| 2.0 | .113 | −146 | 3.173 | −171 | .158 | 11 | .179 | −154 |
| 5.0 | .103 | −165 | 3.181 | −177 | .158 | 5 | .163 | −171 |
| 10.0 | .099 | −173 | 3.170 | −180 | .159 | 2 | .160 | −177 |
| 50.0 | .096 | 174 | 3.145 | 174 | .160 | −1 | .156 | 168 |
| 100.0 | .089 | 170 | 3.120 | 168 | .160 | −4 | .152 | 154 |
| 200.0 | .079 | 170 | 3.098 | 155 | .161 | −9 | .142 | 131 |
| 300.0 | .075 | 175 | 3.069 | 144 | .163 | −13 | .129 | 110 |
| 400.0 | .069 | 176 | 3.107 | 133 | .164 | −18 | .114 | 90 |
| 500.0 | .087 | −180 | 3.128 | 121 | .164 | −24 | .106 | 69 |
| 600.0 | .096 | 178 | 3.143 | 109 | .164 | −29 | .100 | 41 |
| 700.0 | .101 | 176 | 3.134 | 96 | .163 | −34 | .096 | 12 |
| 800.0 | .124 | 174 | 3.141 | 84 | .164 | −39 | .094 | −18 |
| 900.0 | .135 | 161 | 3.129 | 73 | .165 | −44 | .097 | −46 |
| 1000.0 | .149 | 153 | 3.139 | 60 | .165 | −49 | .099 | −74 |
| 1100.0 | .161 | 143 | 3.144 | 48 | .165 | −54 | .107 | −102 |
| 1200.0 | .161 | 130 | 3.142 | 36 | .165 | −59 | .112 | −124 |
| 1300.0 | .161 | 116 | 3.150 | 23 | .165 | −65 | .109 | −147 |
| 1400.0 | .151 | 107 | 3.161 | 10 | .164 | −69 | .107 | −172 |
| 1500.0 | .125 | 87 | 3.175 | −3 | .166 | −75 | .099 | 162 |
| 1600.0 | .106 | 74 | 3.173 | −17 | .169 | −81 | .091 | 131 |
| 1700.0 | .069 | 47 | 3.191 | −31 | .174 | −86 | .093 | 100 |
| 1800.0 | .030 | −42 | 3.151 | −46 | .179 | −93 | .087 | 69 |
| 1900.0 | .086 | −122 | 3.125 | −62 | .185 | −101 | .073 | 39 |
| 2000.0 | .192 | −157 | 3.048 | −78 | .187 | −110 | .052 | −9 |
| 2100.0 | .307 | −175 | 2.891 | −95 | .186 | −120 | .045 | −87 |
| 2200.0 | .449 | 164 | 2.627 | −113 | .180 | −129 | .088 | −143 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.165 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-A33-1 / SMA33-1




## 2 to 2400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRAWIDE BANDWIDTH: 1 - 2600 MHz (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +6 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50° C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1 - 2600 MHz | 2 - 2400 MHz | 2 - 2400 MHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.2 dB | 7.8 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.6 dB | ±.8 dB |
| Noise Figure (Max.) | | | |
| 10 - 1500 MHz | 4.0 dB | 5.0 dB | 5.5 dB |
| 10 - 2400 MHz | 4.5 dB | 5.8 dB | 6.3 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +6.0 dBm | +4.5 dBm | +4.0 dBm |
| VSWR (Max.) | | | |
| Input | < 1.6:1 | 1.9:1 | 2.0:1 |
| output | < 1.4:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 19 mA | 21 mA | 23 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA33-1 is a standard WJ-A33-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+29 dBm (Typ.)
Third Order Two Tone Intercept Point..... +19 dBm (Typ.)

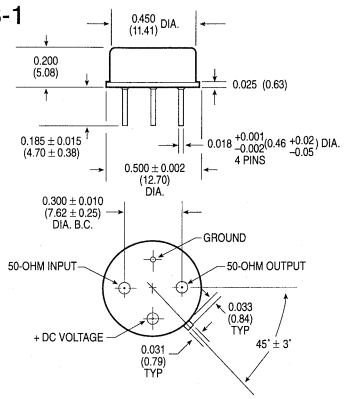
## Absolute Maximum Ratings

Storage Temperature .....-62°C to 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....+50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

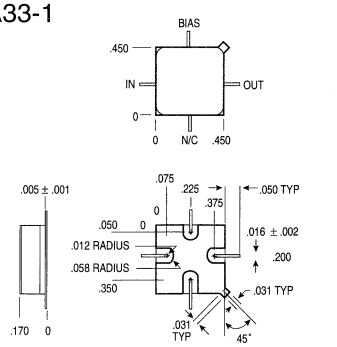
## Outline Drawings

A33-1



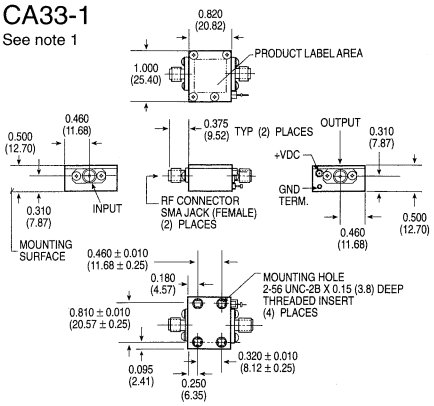

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA33-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

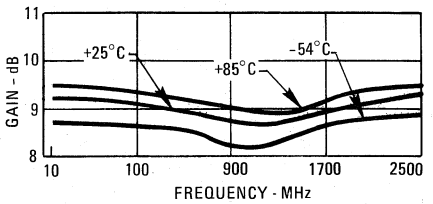
CA33-1
See note 1



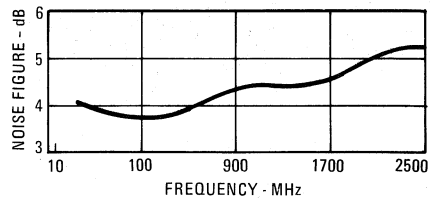

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

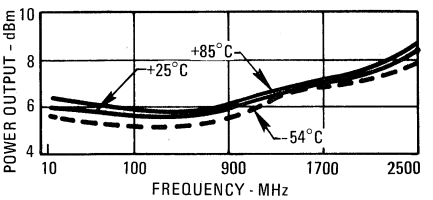
### Gain




### Noise Figure

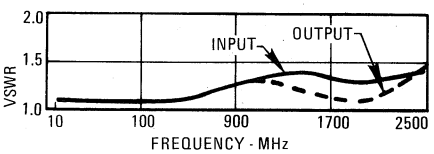



### Power Output*

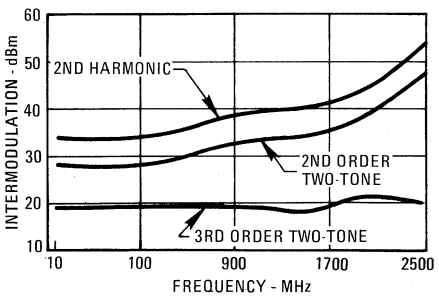



* at 1 dB Gain Compression

### VSWR




### Intermodulation




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 9.4 |
| 2.0 | 1.1 | 1.2 | 9.6 |
| 5.0 | 1.0 | 1.1 | 9.6 |
| 10.0 | 1.0 | 1.1 | 9.6 |
| 50.0 | 1.0 | 1.1 | 9.5 |
| 100.0 | 1.0 | 1.1 | 9.4 |
| 200.0 | 1.0 | 1.1 | 9.3 |
| 300.0 | 1.0 | 1.1 | 9.2 |
| 400.0 | 1.0 | 1.1 | 9.3 |
| 500.0 | 1.1 | 1.1 | 9.4 |
| 600.0 | 1.1 | 1.1 | 9.4 |
| 700.0 | 1.1 | 1.1 | 9.4 |
| 800.0 | 1.1 | 1.2 | 9.4 |
| 900.0 | 1.1 | 1.2 | 9.4 |
| 1000.0 | 1.1 | 1.2 | 9.4 |
| 1100.0 | 1.1 | 1.2 | 9.4 |
| 1200.0 | 1.1 | 1.2 | 9.4 |
| 1300.0 | 1.1 | 1.2 | 9.4 |
| 1400.0 | 1.1 | 1.2 | 9.4 |
| 1500.0 | 1.1 | 1.2 | 9.4 |
| 1600.0 | 1.2 | 1.1 | 9.4 |
| 1700.0 | 1.2 | 1.1 | 9.5 |
| 1800.0 | 1.2 | 1.1 | 9.5 |
| 1900.0 | 1.2 | 1.1 | 9.5 |
| 2000.0 | 1.2 | 1.1 | 9.6 |
| 2100.0 | 1.3 | 1.1 | 9.7 |
| 2200.0 | 1.3 | 1.0 | 9.7 |
| 2300.0 | 1.4 | 1.0 | 9.6 |
| 2400.0 | 1.6 | 1.1 | 9.5 |
| 2500.0 | 1.8 | 1.2 | 9.3 |
| 2600.0 | 2.1 | 1.3 | 8.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .111 | –119 | 2.939 | –162 | .171 | 21 | .150 | –124 |
| 2.0 | .040 | –119 | 3.007 | –171 | .172 | 9 | .088 | –146 |
| 5.0 | .014 | –120 | 3.032 | –177 | .168 | 3 | .062 | –165 |
| 10.0 | .012 | –133 | 3.016 | –180 | .168 | 2 | .060 | –173 |
| 50.0 | .010 | 133 | 2.986 | 174 | .170 | –2 | .060 | 163 |
| 100.0 | .013 | 111 | 2.963 | 168 | .170 | –5 | .059 | 144 |
| 200.0 | .006 | –86 | 2.926 | 157 | .170 | –10 | .058 | 111 |
| 300.0 | .011 | –95 | 2.893 | 147 | .171 | –16 | .054 | 85 |
| 400.0 | .022 | –88 | 2.926 | 137 | .173 | –22 | .048 | 66 |
| 500.0 | .027 | –121 | 2.949 | 126 | .172 | –28 | .051 | 48 |
| 600.0 | .029 | –141 | 2.964 | 115 | .172 | –33 | .058 | 22 |
| 700.0 | .031 | –131 | 2.952 | 104 | .171 | –39 | .065 | –1 |
| 800.0 | .044 | –157 | 2.955 | 93 | .172 | –45 | .072 | –22 |
| 900.0 | .052 | –175 | 2.951 | 82 | .173 | –51 | .078 | –39 |
| 1000.0 | .054 | 167 | 2.958 | 71 | .173 | –57 | .079 | –56 |
| 1100.0 | .052 | 149 | 2.953 | 60 | .173 | –63 | .083 | –75 |
| 1200.0 | .058 | 128 | 2.941 | 49 | .173 | –69 | .088 | –88 |
| 1300.0 | .063 | 109 | 2.961 | 37 | .173 | –76 | .083 | –99 |
| 1400.0 | .068 | 100 | 2.955 | 26 | .173 | –82 | .078 | –111 |
| 1500.0 | .064 | 75 | 2.967 | 15 | .172 | –89 | .071 | –120 |
| 1600.0 | .072 | 72 | 2.964 | 3 | .174 | –95 | .058 | –129 |
| 1700.0 | .085 | 51 | 2.998 | –9 | .174 | –102 | .045 | –145 |
| 1800.0 | .093 | 37 | 2.991 | –21 | .174 | –109 | .038 | –165 |
| 1900.0 | .095 | 17 | 2.995 | –34 | .178 | –116 | .033 | 173 |
| 2000.0 | .106 | –1 | 3.027 | –46 | .179 | –124 | .029 | 154 |
| 2100.0 | .128 | –31 | 3.049 | –59 | .180 | –132 | .029 | 132 |
| 2200.0 | .125 | –60 | 3.069 | –73 | .180 | –141 | .020 | 110 |
| 2300.0 | .174 | –79 | 3.028 | –88 | .179 | –149 | .014 | 49 |
| 2400.0 | .222 | –102 | 2.980 | –103 | .176 | –159 | .031 | –28 |
| 2500.0 | .286 | –125 | 2.902 | –121 | .170 | –168 | .074 | –57 |
| 2600.0 | .365 | –143 | 2.700 | –137 | .163 | –178 | .142 | –70 |

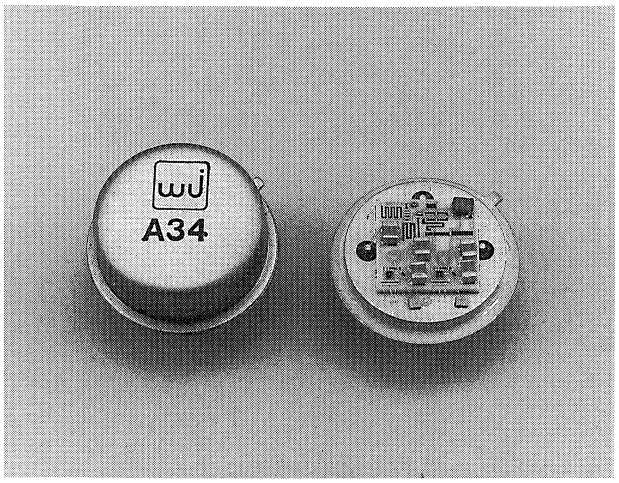
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.120 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A34 / SMA34

## 100 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 16 dB (TYP.)
- ◆ ULTRALOW PHASE DEVIATION FROM LINEARITY: < ±3° ; 500-2000 MHz
- ◆ LOW VSWR: < 1.5:1 (TYP.)
- ◆ MEDIUM LEVEL OUTPUT: +7 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 30-2100 MHz | 100-2000 MHz | 100-2000 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 15.0 dB | 14.0 dB |
| Gain Flatness (Max.) | < ±0.5 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +7 dBm | +6 dBm | +5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 35 mA | 39 mA | 41 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal

Notes:

1. WJ-CA34 is a standard WJ-A34 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25 ° C

Second Order Harmonic Intercept Point.....+46 dBm (Typ.)
Second Order Two Tone Intercept Point..... +42 dBm (Typ.)
Third Order Two Tone Intercept Point..... +18 dBm (Typ.)

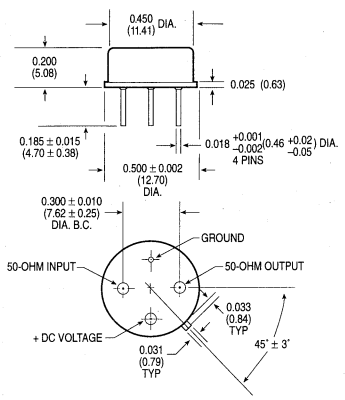
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +20 Volts
Maximum Continuous RF Input Power ..... +10 dBm
Maximum Short Term Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S"Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz)

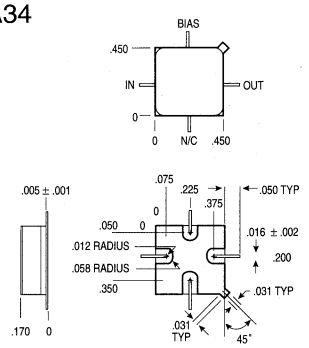
## Outline Drawings

A34



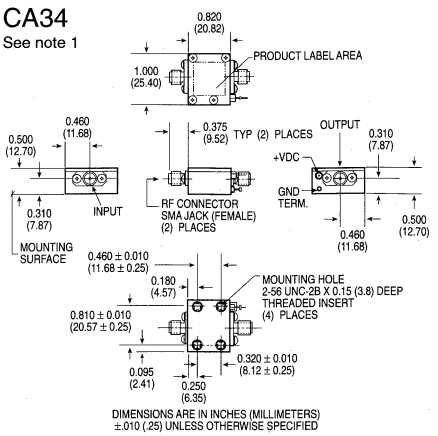

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA34




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

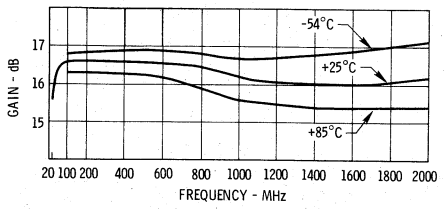
CA34
See note 1



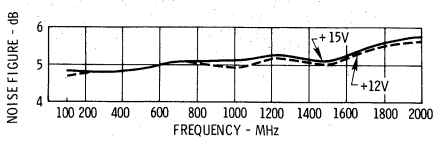

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

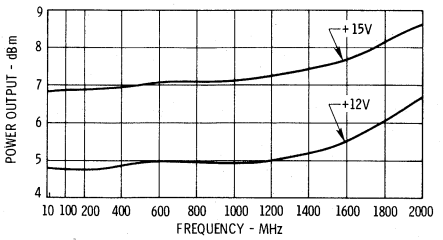
## Gain




## Noise Figure

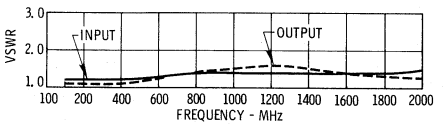



## Power Output*




*at 1 dB Gain Compression

## VSWR




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.9 | 2.5 | 12.0 |
| 50.0 | 1.3 | 1.2 | 15.7 |
| 100.0 | 1.2 | 1.1 | 16.0 |
| 200.0 | 1.1 | 1.0 | 16.3 |
| 300.0 | 1.0 | 1.1 | 16.3 |
| 400.0 | 1.1 | 1.2 | 16.1 |
| 500.0 | 1.1 | 1.2 | 16.0 |
| 600.0 | 1.1 | 1.2 | 16.1 |
| 700.0 | 1.2 | 1.3 | 16.1 |
| 800.0 | 1.2 | 1.4 | 16.2 |
| 900.0 | 1.3 | 1.4 | 16.2 |
| 1000.0 | 1.3 | 1.4 | 16.3 |
| 1100.0 | 1.3 | 1.5 | 16.2 |
| 1200.0 | 1.3 | 1.5 | 16.2 |
| 1300.0 | 1.4 | 1.5 | 16.2 |
| 1400.0 | 1.4 | 1.5 | 16.1 |
| 1500.0 | 1.3 | 1.5 | 16.0 |
| 1600.0 | 1.4 | 1.4 | 15.9 |
| 1700.0 | 1.4 | 1.4 | 16.0 |
| 1800.0 | 1.4 | 1.4 | 15.8 |
| 1900.0 | 1.5 | 1.3 | 15.7 |
| 2000.0 | 1.6 | 1.4 | 15.6 |
| 2100.0 | 2.0 | 1.4 | 15.4 |
| 2200.0 | 2.6 | 1.4 | 15.1 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .486 | –58 | 3.977 | 68 | .017 | 89 | .434 | –62 |
| 50.0 | .139 | –89 | 6.106 | 9 | .029 | 22 | .107 | –68 |
| 100.0 | .074 | –109 | 6.335 | –8 | .031 | 10 | .056 | –65 |
| 200.0 | .043 | –148 | 6.528 | –31 | .033 | –1 | .010 | –16 |
| 300.0 | .024 | 139 | 6.505 | –52 | .035 | –9 | .046 | 56 |
| 400.0 | .032 | 21 | 6.370 | –71 | .035 | –20 | .083 | 34 |
| 500.0 | .041 | –40 | 6.293 | –88 | .034 | –29 | .099 | 15 |
| 600.0 | .060 | –73 | 6.352 | –105 | .032 | –36 | .111 | 4 |
| 700.0 | .080 | –88 | 6.407 | –124 | .032 | –43 | .131 | –6 |
| 800.0 | .102 | –111 | 6.452 | –142 | .032 | –49 | .152 | –17 |
| 900.0 | .114 | –133 | 6.448 | –160 | .031 | –54 | .172 | –30 |
| 1000.0 | .131 | –157 | 6.523 | –179 | .030 | –63 | .183 | –43 |
| 1100.0 | .146 | 179 | 6.490 | 163 | .029 | –71 | .196 | –59 |
| 1200.0 | .149 | 157 | 6.460 | 144 | .028 | –78 | .207 | –73 |
| 1300.0 | .153 | 138 | 6.453 | 125 | .027 | –86 | .210 | –87 |
| 1400.0 | .150 | 115 | 6.376 | 107 | .025 | –94 | .207 | –103 |
| 1500.0 | .145 | 93 | 6.318 | 89 | .025 | –102 | .196 | –118 |
| 1600.0 | .149 | 63 | 6.255 | 70 | .024 | –107 | .180 | –135 |
| 1700.0 | .156 | 30 | 6.288 | 51 | .024 | –116 | .161 | –157 |
| 1800.0 | .169 | –7 | 6.164 | 31 | .024 | –121 | .150 | 178 |
| 1900.0 | .192 | –41 | 6.090 | 11 | .024 | –127 | .146 | 152 |
| 2000.0 | .245 | –76 | 6.023 | –9 | .023 | –135 | .151 | 126 |
| 2100.0 | .340 | –107 | 5.905 | –30 | .023 | –141 | .163 | 101 |
| 2200.0 | .440 | –140 | 5.675 | –52 | .024 | –145 | .171 | 77 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.180 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

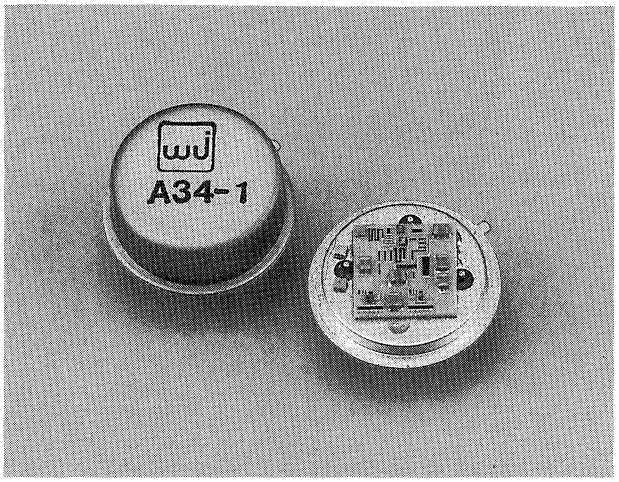
## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.9 | 2.5 | 11.6 |
| 50.0 | 1.3 | 1.2 | 15.3 |
| 100.0 | 1.1 | 1.1 | 15.6 |
| 200.0 | 1.1 | 1.0 | 15.9 |
| 300.0 | 1.0 | 1.1 | 15.8 |
| 400.0 | 1.0 | 1.2 | 15.6 |
| 500.0 | 1.1 | 1.2 | 15.5 |
| 600.0 | 1.1 | 1.2 | 15.7 |
| 700.0 | 1.2 | 1.3 | 15.7 |
| 800.0 | 1.2 | 1.3 | 15.8 |
| 900.0 | 1.3 | 1.4 | 15.8 |
| 1000.0 | 1.3 | 1.4 | 15.8 |
| 1100.0 | 1.4 | 1.5 | 15.8 |
| 1200.0 | 1.4 | 1.5 | 15.7 |
| 1300.0 | 1.4 | 1.5 | 15.7 |
| 1400.0 | 1.4 | 1.5 | 15.6 |
| 1500.0 | 1.4 | 1.4 | 15.5 |
| 1600.0 | 1.4 | 1.4 | 15.4 |
| 1700.0 | 1.4 | 1.3 | 15.4 |
| 1800.0 | 1.5 | 1.3 | 15.3 |
| 1900.0 | 1.6 | 1.3 | 15.1 |
| 2000.0 | 1.8 | 1.3 | 15.0 |
| 2100.0 | 2.3 | 1.3 | 14.8 |
| 2200.0 | 3.0 | 1.4 | 14.4 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .483 | –57 | 3.818 | 67 | .017 | 89 | .435 | –61 |
| 50.0 | .137 | –83 | 5.832 | 9 | .029 | 21 | .109 | –68 |
| 100.0 | .069 | –98 | 6.037 | –8 | .031 | 9 | .057 | –65 |
| 200.0 | .040 | –133 | 6.222 | –32 | .033 | –1 | .012 | –22 |
| 300.0 | .015 | –173 | 6.201 | –53 | .035 | –10 | .044 | 53 |
| 400.0 | .021 | –8 | 6.047 | –72 | .036 | –19 | .080 | 33 |
| 500.0 | .045 | –63 | 5.967 | –89 | .034 | –29 | .095 | 13 |
| 600.0 | .069 | –83 | 6.065 | –107 | .033 | –36 | .108 | 2 |
| 700.0 | .085 | –102 | 6.078 | –125 | .032 | –42 | .126 | –8 |
| 800.0 | .110 | –123 | 6.139 | –144 | .032 | –49 | .146 | –19 |
| 900.0 | .118 | –144 | 6.134 | –162 | .031 | –56 | .164 | –31 |
| 1000.0 | .140 | –168 | 6.158 | 179 | .029 | –62 | .172 | –45 |
| 1100.0 | .156 | 172 | 6.164 | 160 | .029 | –71 | .184 | –61 |
| 1200.0 | .157 | 149 | 6.098 | 141 | .029 | –77 | .194 | –75 |
| 1300.0 | .159 | 128 | 6.074 | 122 | .027 | –86 | .194 | –89 |
| 1400.0 | .163 | 104 | 6.024 | 103 | .026 | –92 | .188 | –104 |
| 1500.0 | .151 | 76 | 5.967 | 85 | .026 | –99 | .177 | –120 |
| 1600.0 | .161 | 50 | 5.899 | 66 | .025 | –106 | .157 | –137 |
| 1700.0 | .174 | 17 | 5.900 | 47 | .024 | –112 | .137 | –160 |
| 1800.0 | .190 | –17 | 5.798 | 27 | .025 | –118 | .126 | 173 |
| 1900.0 | .232 | –50 | 5.714 | 6 | .025 | –125 | .122 | 145 |
| 2000.0 | .290 | –82 | 5.624 | –14 | .026 | –132 | .128 | 117 |
| 2100.0 | .386 | –111 | 5.490 | –35 | .026 | –138 | .141 | 91 |
| 2200.0 | .494 | –144 | 5.234 | –58 | .026 | –143 | .152 | 67 |

# WJ-A34-1 / SMA34-1




## 1.5 to 2.3 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 14.5 dB (TYP.)
- ◆ LOW PHASE DEVIATION FROM LINEARITY: < ±3.0°, 1500-2300 MHz
- ◆ MEDIUM LEVEL OUTPUT: +8 dBm (TYP.)
- ◆ ULTRA WIDE TYPICAL BANDWIDTH: 0.1 TO 2.4 GHz

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 0.1-2.4 GHz | 1.5-2.3 GHz | 1.5-2.3 GHz |
| Small Signal Gain (Min.) | 14.5 dB | 13.7 dB | 12.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.6 dB | ±0.8 dB |
| Noise Figure (Max.) | 5.7 dB | 6.8 dB | 7.3 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +6.5 dBm | +6.0 dBm |
| VSWR (Max.) Input/Output | 1.6:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 34 mA | 38 mA | 40 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA34-1 is a standard WJ-A34-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+41 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20 dBm (Typ.)

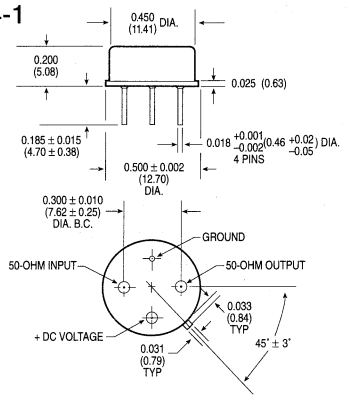
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power.....+10 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0. 5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

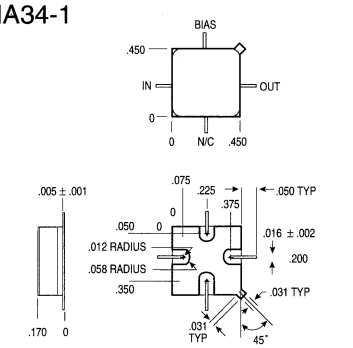
## Outline Drawings

A34-1



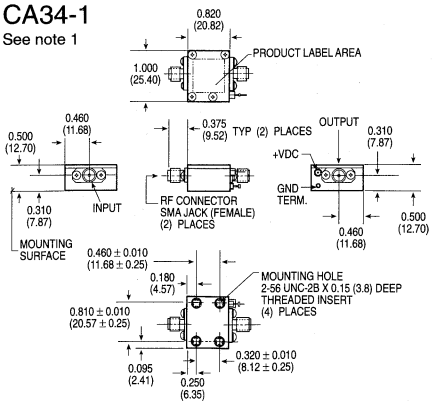

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA34-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

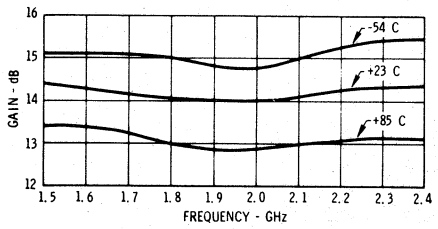
CA34-1
See note 1



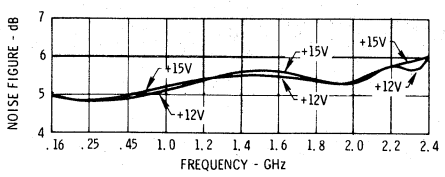

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

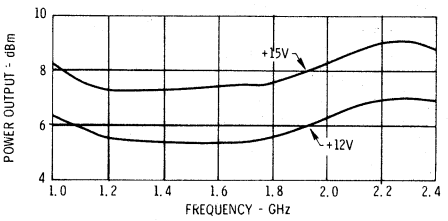
### Gain




### Noise Figure

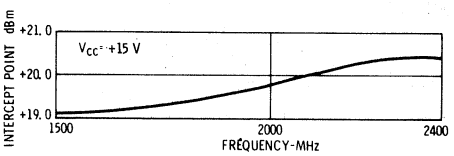



### Power Output*




*at 1 dB Gain Compression

### Third Order Two Tone Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 100.0 | 1.2 | 1.1 | 14.6 |
| 200.0 | 1.2 | 1.1 | 14.8 |
| 300.0 | 1.1 | 1.1 | 14.8 |
| 400.0 | 1.1 | 1.1 | 14.7 |
| 500.0 | 1.1 | 1.2 | 14.6 |
| 600.0 | 1.1 | 1.2 | 14.7 |
| 700.0 | 1.2 | 1.2 | 14.8 |
| 800.0 | 1.2 | 1.3 | 14.8 |
| 900.0 | 1.3 | 1.4 | 14.9 |
| 1000.0 | 1.4 | 1.4 | 14.9 |
| 1100.0 | 1.5 | 1.5 | 14.9 |
| 1200.0 | 1.6 | 1.6 | 14.8 |
| 1300.0 | 1.6 | 1.6 | 14.7 |
| 1400.0 | 1.6 | 1.6 | 14.6 |
| 1500.0 | 1.7 | 1.6 | 14.6 |
| 1600.0 | 1.7 | 1.6 | 14.5 |
| 1700.0 | 1.7 | 1.5 | 14.6 |
| 1800.0 | 1.6 | 1.5 | 14.5 |
| 1900.0 | 1.6 | 1.4 | 14.5 |
| 2000.0 | 1.5 | 1.4 | 14.6 |
| 2100.0 | 1.5 | 1.4 | 14.7 |
| 2200.0 | 1.4 | 1.4 | 14.8 |
| 2300.0 | 1.5 | 1.4 | 14.9 |
| 2400.0 | 1.7 | 1.5 | 15.0 |
| 2500.0 | 2.0 | 1.5 | 14.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.0 | .085 | –144 | 5.392 | –9 | .036 | 8 | .038 | –111 |
| 200.0 | .079 | –173 | 5.513 | –31 | .039 | –2 | .028 | 173 |
| 300.0 | .062 | 162 | 5.496 | –50 | .040 | –9 | .048 | 114 |
| 400.0 | .031 | 144 | 5.433 | –68 | .041 | –19 | .065 | 80 |
| 500.0 | .026 | –147 | 5.362 | –84 | .040 | –28 | .070 | 59 |
| 600.0 | .047 | –137 | 5.446 | –102 | .038 | –34 | .085 | 48 |
| 700.0 | .071 | –137 | 5.480 | –119 | .037 | –40 | .109 | 35 |
| 800.0 | .107 | –147 | 5.520 | –137 | .037 | –47 | .135 | 20 |
| 900.0 | .136 | –164 | 5.533 | –154 | .036 | –53 | .161 | 5 |
| 1000.0 | .170 | 178 | 5.529 | –172 | .035 | –59 | .181 | –10 |
| 1100.0 | .195 | 162 | 5.530 | 171 | .034 | –66 | .199 | –27 |
| 1200.0 | .217 | 145 | 5.497 | 153 | .033 | –74 | .219 | –43 |
| 1300.0 | .233 | 131 | 5.456 | 136 | .031 | –80 | .231 | –58 |
| 1400.0 | .235 | 113 | 5.380 | 118 | .029 | –87 | .235 | –74 |
| 1500.0 | .246 | 98 | 5.431 | 101 | .028 | –93 | .235 | –89 |
| 1600.0 | .249 | 81 | 5.281 | 85 | .028 | –98 | .225 | –104 |
| 1700.0 | .250 | 62 | 5.343 | 67 | .027 | –104 | .208 | –123 |
| 1800.0 | .245 | 48 | 5.295 | 50 | .026 | –109 | .195 | –143 |
| 1900.0 | .226 | 26 | 5.286 | 32 | .027 | –114 | .181 | –165 |
| 2000.0 | .214 | 5 | 5.400 | 14 | .027 | –121 | .175 | 170 |
| 2100.0 | .196 | –23 | 5.447 | –4 | .027 | –126 | .174 | 145 |
| 2200.0 | .181 | –57 | 5.524 | –23 | .027 | –131 | .173 | 121 |
| 2300.0 | .203 | –97 | 5.576 | –44 | .029 | –134 | .177 | 96 |
| 2400.0 | .247 | –134 | 5.592 | –66 | .029 | –141 | .185 | 67 |
| 2500.0 | .328 | –168 | 5.435 | –90 | .032 | –143 | .192 | 35 |

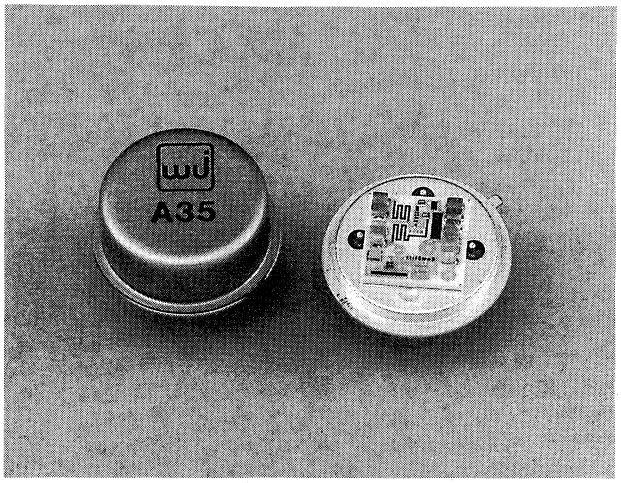
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.247 W
Junction Temperature Rise Above Case $T_{jc}$ ... 11°C

# WJ-A35 / SMA35

## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT LEVEL: +9 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO + 20 VOLTS




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 10.0 dB | 9.0 dB | 8.5 dB |
| Gain Flatness (Max.) | | | |
| 500-2000 MHz | < ±0.3 dB | ±0.6 dB | ±0.8 dB |
| 10-2000 MHz | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.0 dB | 6.5 dB | 7.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +9 dBm | +7 dBm | +6.5 dBm |
| VSWR (Max.) | | | |
| Input | < 1.5:1 | 2.0:1 | 2.2:1 |
| output | < 1.5:1 | 2.2:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 29 mA |

Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA35 is a standard WJ-A35 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+33 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

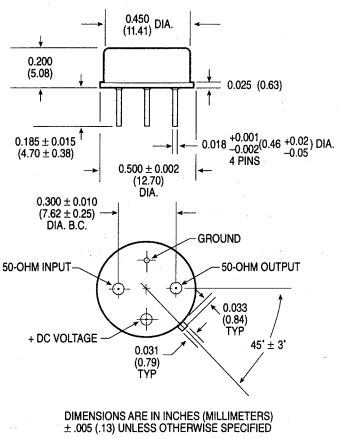
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+21 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatt (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 0z.)

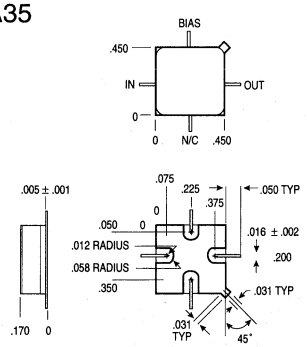
## Outline Drawings

A35



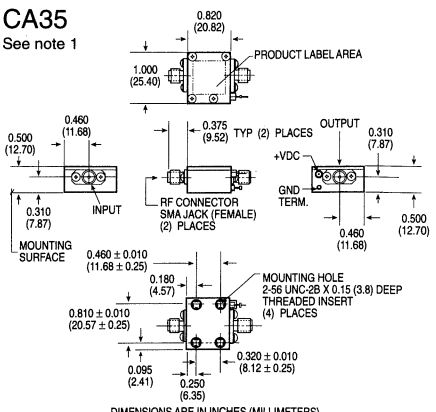

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA35




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

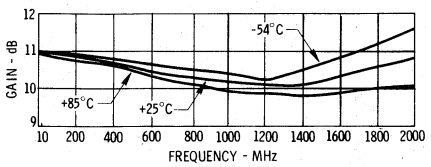
CA35
See note 1



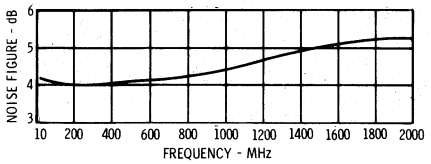

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

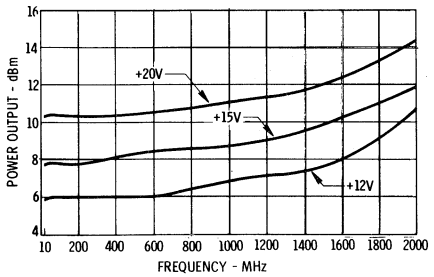
### Gain




### Noise Figure

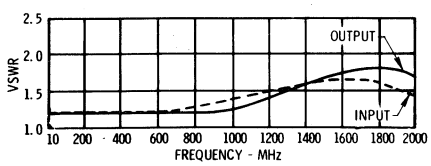



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.7 | 9.9 |
| 2.0 | 1.2 | 1.5 | 10.2 |
| 5.0 | 1.2 | 1.4 | 10.2 |
| 10.0 | 1.2 | 1.4 | 10.2 |
| 50.0 | 1.2 | 1.4 | 10.1 |
| 100.0 | 1.2 | 1.4 | 10.0 |
| 200.0 | 1.2 | 1.4 | 9.9 |
| 300.0 | 1.1 | 1.3 | 9.9 |
| 400.0 | 1.1 | 1.2 | 10.0 |
| 500.0 | 1.2 | 1.2 | 10.0 |
| 600.0 | 1.2 | 1.1 | 10.0 |
| 700.0 | 1.2 | 1.1 | 10.0 |
| 800.0 | 1.3 | 1.1 | 10.0 |
| 900.0 | 1.4 | 1.1 | 9.9 |
| 1000.0 | 1.4 | 1.1 | 9.9 |
| 1100.0 | 1.5 | 1.2 | 9.9 |
| 1200.0 | 1.5 | 1.3 | 9.9 |
| 1300.0 | 1.5 | 1.3 | 9.9 |
| 1400.0 | 1.5 | 1.3 | 9.9 |
| 1500.0 | 1.5 | 1.4 | 10.0 |
| 1600.0 | 1.5 | 1.4 | 10.1 |
| 1700.0 | 1.4 | 1.4 | 10.2 |
| 1800.0 | 1.3 | 1.4 | 10.2 |
| 1900.0 | 1.3 | 1.3 | 10.3 |
| 2000.0 | 1.4 | 1.2 | 10.3 |
| 2100.0 | 1.7 | 1.1 | 10.1 |
| 2200.0 | 2.3 | 1.1 | 9.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .177 | –123 | 3.135 | –158 | .148 | 22 | .253 | –138 |
| 2.0 | .103 | –150 | 3.223 | –169 | .149 | 11 | .199 | –157 |
| 5.0 | .089 | –165 | 3.236 | –177 | .148 | 4 | .182 | –171 |
| 10.0 | .091 | –171 | 3.219 | –179 | .149 | 2 | .181 | –177 |
| 50.0 | .089 | 174 | 3.192 | 174 | .150 | –1 | .178 | 170 |
| 100.0 | .087 | 166 | 3.170 | 167 | .150 | –4 | .171 | 159 |
| 200.0 | .071 | 168 | 3.139 | 155 | .152 | –8 | .154 | 140 |
| 300.0 | .067 | 175 | 3.113 | 144 | .153 | –12 | .134 | 124 |
| 400.0 | .063 | –178 | 3.152 | 132 | .155 | –18 | .110 | 111 |
| 500.0 | .073 | –173 | 3.172 | 120 | .155 | –23 | .091 | 96 |
| 600.0 | .089 | –175 | 3.169 | 107 | .154 | –28 | .066 | 73 |
| 700.0 | .105 | –173 | 3.161 | 95 | .155 | –33 | .042 | 38 |
| 800.0 | .135 | –178 | 3.148 | 83 | .155 | –38 | .028 | –23 |
| 900.0 | .153 | 170 | 3.131 | 71 | .157 | –43 | .040 | –85 |
| 1000.0 | .178 | 158 | 3.130 | 58 | .156 | –48 | .063 | –122 |
| 1100.0 | .189 | 147 | 3.114 | 47 | .157 | –54 | .091 | –145 |
| 1200.0 | .206 | 132 | 3.111 | 35 | .156 | –58 | .112 | –163 |
| 1300.0 | .211 | 117 | 3.112 | 23 | .155 | –63 | .127 | 177 |
| 1400.0 | .216 | 102 | 3.122 | 9 | .155 | –68 | .142 | 158 |
| 1500.0 | .211 | 82 | 3.154 | –3 | .155 | –74 | .149 | 138 |
| 1600.0 | .201 | 66 | 3.192 | –16 | .159 | –79 | .153 | 116 |
| 1700.0 | .179 | 42 | 3.231 | –30 | .162 | –85 | .160 | 96 |
| 1800.0 | .140 | 10 | 3.245 | –44 | .170 | –91 | .154 | 75 |
| 1900.0 | .128 | –37 | 3.292 | –60 | .179 | –99 | .131 | 55 |
| 2000.0 | .154 | –102 | 3.257 | –76 | .185 | –110 | .088 | 29 |
| 2100.0 | .264 | –144 | 3.210 | –94 | .186 | –121 | .026 | –18 |
| 2200.0 | .400 | –179 | 2.987 | –114 | .177 | –133 | .066 | –158 |

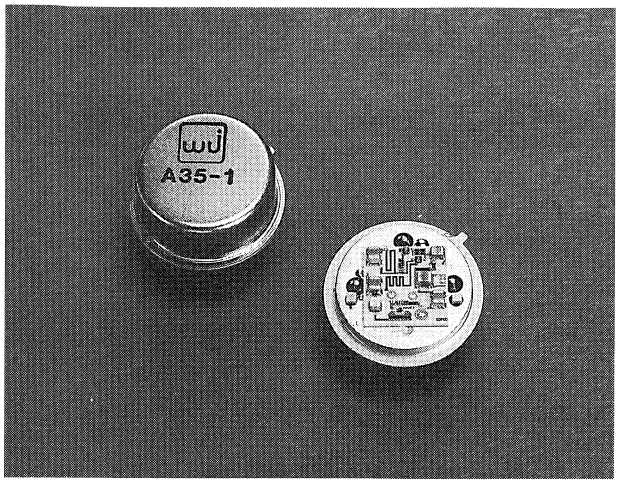
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.188 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A35-1 / SMA35-1

## 2 to 2400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA WIDE BANDWIDTH: 1 - 2600 MHz (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +9.5 dBm (TYP.)




## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1 - 2600 MHz | 2 - 2400 MHz | 2 - 2400 MHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.6 dB | ±.8 dB |
| Noise Figure (Max.) | | | |
| 2-1500 | 4.2 dB | 5.0 dB | 5.5 dB |
| 2 - 2400 | < 5.0 dB | 5.8 dB | 6.3 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +9.5 dBm | +8.5 dBm | +8.0 dBm |
| VSWR (Max.) | | | |
| Input/Output | < 1.4:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 28 mA | 31mA | 33 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA35-1 is a standard WJ-A35-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+34 dBm (Typ.)
Third Order Two Tone Intercept Point..... +23 dBm (Typ.)

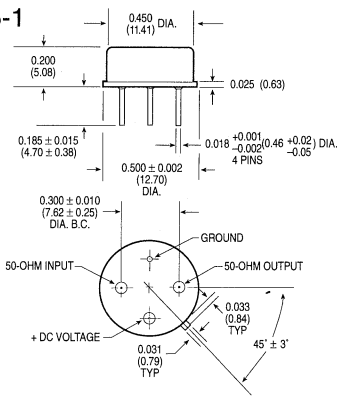
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+21 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (I Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

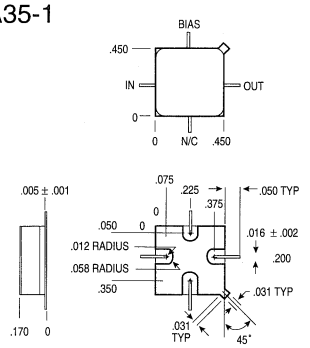
## Outline Drawings

A35-1



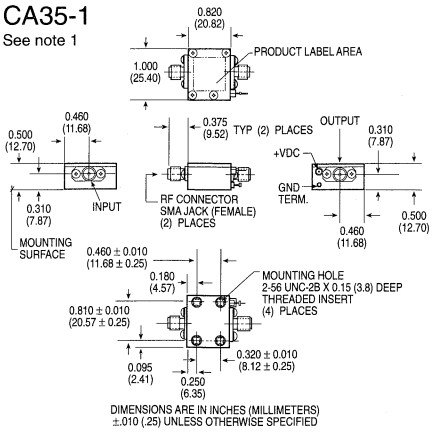

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA35-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

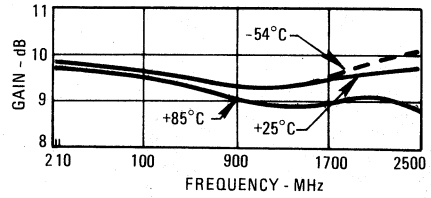
CA35-1
See note 1



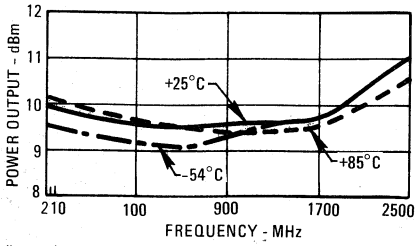

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

**Gain**

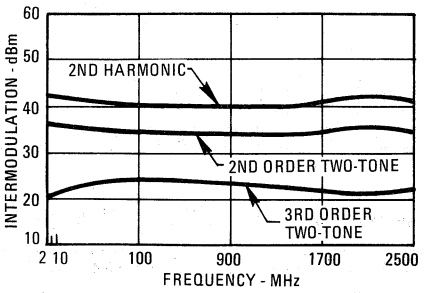



**Power Output***

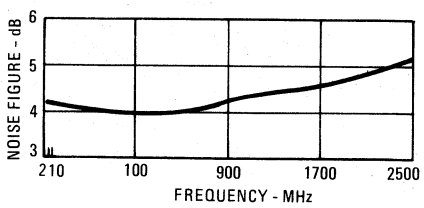



* at 1 dB Gain Compression

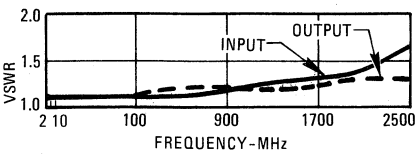
**Intermodulation**




**Noise Figure**




**VSWR**




## Typical Automatic Test Data

**$V_{CC}$ = 15.0 V**

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.5 | 8.9 |
| 2.0 | 1.2 | 1.3 | 9.2 |
| 5.0 | 1.1 | 1.2 | 9.5 |
| 10.0 | 1.1 | 1.2 | 9.4 |
| 50.0 | 1.1 | 1.2 | 9.3 |
| 100.0 | 1.1 | 1.2 | 9.2 |
| 200.0 | 1.1 | 1.2 | 9.1 |
| 300.0 | 1.0 | 1.2 | 9.0 |
| 400.0 | 1.0 | 1.1 | 9.1 |
| 500.0 | 1.0 | 1.1 | 9.2 |
| 600.0 | 1.0 | 1.1 | 9.2 |
| 700.0 | 1.1 | 1.1 | 9.3 |
| 800.0 | 1.1 | 1.1 | 9.3 |
| 900.0 | 1.1 | 1.1 | 9.3 |
| 1000.0 | 1.2 | 1.2 | 9.3 |
| 1100.0 | 1.2 | 1.2 | 9.3 |
| 1200.0 | 1.2 | 1.3 | 9.2 |
| 1300.0 | 1.3 | 1.3 | 9.2 |
| 1400.0 | 1.3 | 1.3 | 9.3 |
| 1500.0 | 1.3 | 1.3 | 9.3 |
| 1600.0 | 1.3 | 1.3 | 9.4 |
| 1700.0 | 1.4 | 1.4 | 9.5 |
| 1800.0 | 1.3 | 1.4 | 9.3 |
| 1900.0 | 1.4 | 1.5 | 9.4 |
| 2000.0 | 1.3 | 1.5 | 9.5 |
| 2100.0 | 1.3 | 1.5 | 9.5 |
| 2200.0 | 1.2 | 1.5 | 9.7 |
| 2300.0 | 1.3 | 1.5 | 9.7 |
| 2400.0 | 1.4 | 1.5 | 9.7 |
| 2500.0 | 1.7 | 1.5 | 9.6 |
| 2600.0 | 1.9 | 1.5 | 9.1 |

**Linear S-Parameters**

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .150 | –129 | 2.771 | –158 | .174 | 23 | .213 | –134 |
| 2.0 | .088 | –156 | 2.878 | –168 | .174 | 9 | .143 | –160 |
| 5.0 | .045 | –176 | 2.973 | –176 | .164 | 2 | .103 | –175 |
| 10.0 | .042 | –170 | 2.956 | –179 | .164 | 1 | .103 | –176 |
| 50.0 | .050 | 165 | 2.920 | 175 | .166 | –2 | .105 | 168 |
| 100.0 | .045 | 144 | 2.893 | 169 | .167 | –5 | .102 | 155 |
| 200.0 | .028 | 135 | 2.861 | 159 | .168 | –10 | .089 | 132 |
| 300.0 | .023 | 119 | 2.827 | 149 | .168 | –16 | .075 | 112 |
| 400.0 | .009 | 21 | 2.861 | 140 | .170 | –21 | .059 | 99 |
| 500.0 | .008 | –53 | 2.895 | 130 | .169 | –27 | .050 | 78 |
| 600.0 | .012 | –76 | 2.899 | 119 | .169 | –33 | .044 | 40 |
| 700.0 | .038 | –80 | 2.901 | 108 | .169 | –39 | .045 | –2 |
| 800.0 | .052 | –108 | 2.919 | 98 | .169 | –45 | .054 | –40 |
| 900.0 | .057 | –122 | 2.904 | 88 | .170 | –50 | .069 | –67 |
| 1000.0 | .072 | –138 | 2.910 | 77 | .169 | –56 | .083 | –90 |
| 1100.0 | .094 | –157 | 2.911 | 67 | .170 | –63 | .104 | –111 |
| 1200.0 | .098 | –171 | 2.896 | 56 | .168 | –69 | .120 | –126 |
| 1300.0 | .117 | 173 | 2.895 | 46 | .168 | –76 | .129 | –142 |
| 1400.0 | .130 | 159 | 2.908 | 35 | .167 | –82 | .140 | –158 |
| 1500.0 | .121 | 143 | 2.907 | 25 | .165 | –89 | .145 | –174 |
| 1600.0 | .146 | 128 | 2.935 | 14 | .164 | –96 | .148 | 170 |
| 1700.0 | .155 | 112 | 2.969 | 3 | .161 | –102 | .158 | 152 |
| 1800.0 | .142 | 94 | 2.929 | –8 | .159 | –108 | .170 | 136 |
| 1900.0 | .155 | 73 | 2.939 | –19 | .159 | –115 | .184 | 122 |
| 2000.0 | .147 | 54 | 2.970 | –30 | .158 | –122 | .194 | 108 |
| 2100.0 | .131 | 24 | 2.987 | –42 | .157 | –129 | .205 | 95 |
| 2200.0 | .109 | –5 | 3.046 | –55 | .155 | –136 | .203 | 82 |
| 2300.0 | .121 | –53 | 3.048 | –69 | .152 | –144 | .200 | 67 |
| 2400.0 | .159 | –92 | 3.056 | –83 | .148 | –151 | .197 | 48 |
| 2500.0 | .246 | –129 | 3.004 | –100 | .143 | –158 | .185 | 24 |
| 2600.0 | .307 | –152 | 2.866 | –116 | .136 | –164 | .196 | –4 |

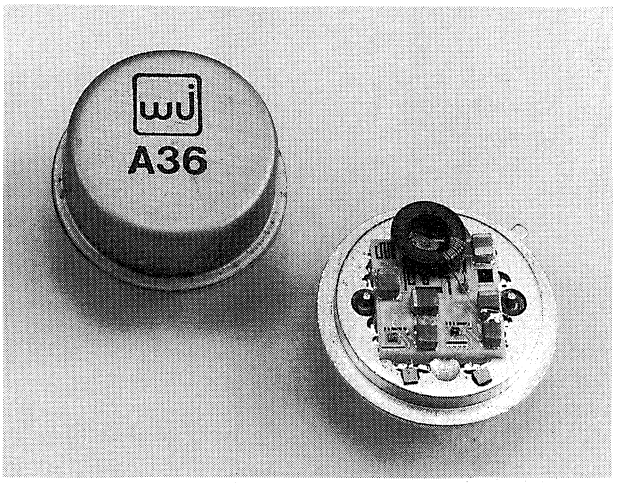
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.152 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-A36 / SMA36

## 100 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 16.5 dB (TYP.)
- ◆ LOW VSWR: < 1.5:1 (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +12.0 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 80-2000 MHz | 100-2000 MHz | 100-2000 MHz |
| Small Signal Gain (Min.) | 16.5 dB | 15.5 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 7.0 dB | 7.5 dB |
| Power Output at 1 dBCompression (Min.) | +12.0 dBm | +11.0 dBm | +11.0 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max) at 15 Volts | 63 mA | 64 mA | 67 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA36 is a standard WJ-A36 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point .....+23 dBm (Typ.)

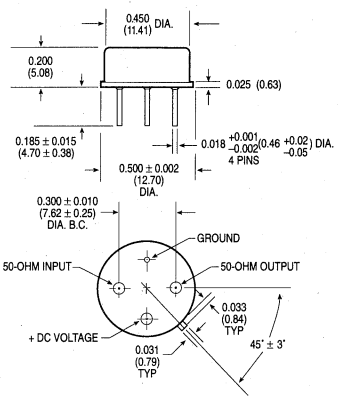
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

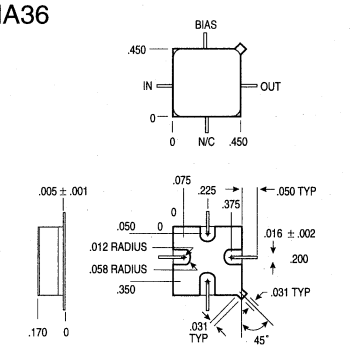
## Outline Drawings

A36



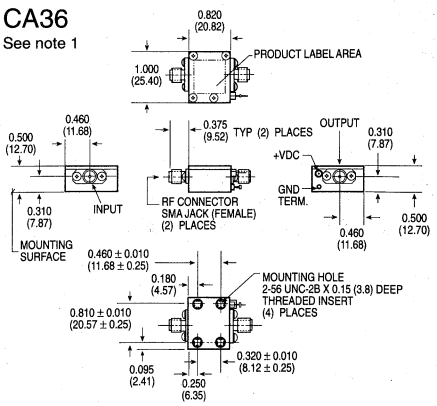

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA36




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

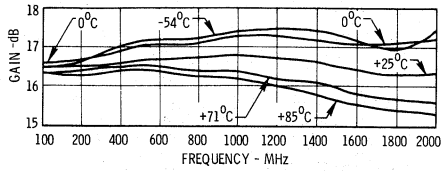
CA36
See note 1



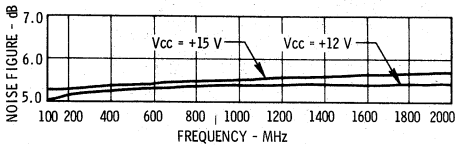

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

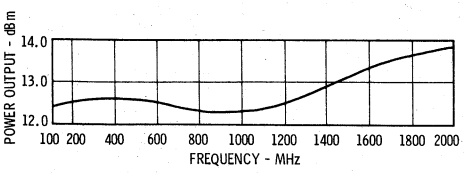
## Gain




## Noise Figure

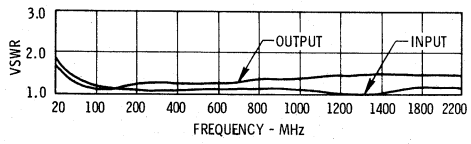



## Power Output*

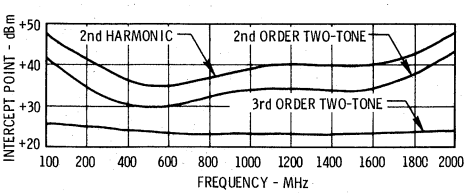



*@ 1 dB GAIN COMPRESSION

## VSWR




## Intercept Point




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 3.1 | 2.3 | 12.0 |
| 50.0 | 1.3 | 1.2 | 16.5 |
| 100.0 | 1.3 | 1.2 | 16.9 |
| 200.0 | 1.2 | 1.2 | 17.1 |
| 300.0 | 1.2 | 1.2 | 17.2 |
| 400.0 | 1.2 | 1.3 | 17.0 |
| 500.0 | 1.2 | 1.3 | 16.8 |
| 600.0 | 1.2 | 1.3 | 16.9 |
| 700.0 | 1.2 | 1.3 | 17.0 |
| 800.0 | 1.2 | 1.3 | 17.1 |
| 900.0 | 1.2 | 1.4 | 17.1 |
| 1000.0 | 1.2 | 1.4 | 17.2 |
| 1100.0 | 1.3 | 1.4 | 17.2 |
| 1200.0 | 1.2 | 1.5 | 17.3 |
| 1300.0 | 1.3 | 1.5 | 17.3 |
| 1400.0 | 1.3 | 1.5 | 17.2 |
| 1500.0 | 1.3 | 1.5 | 17.1 |
| 1600.0 | 1.3 | 1.5 | 16.9 |
| 1700.0 | 1.3 | 1.4 | 16.9 |
| 1800.0 | 1.3 | 1.4 | 16.8 |
| 1900.0 | 1.4 | 1.4 | 16.6 |
| 2000.0 | 1.4 | 1.4 | 16.5 |
| 2100.0 | 1.5 | 1.4 | 16.3 |
| 2200.0 | 1.6 | 1.4 | 16.2 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .515 | –53 | 3.959 | 82 | .017 | 56 | .396 | –91 |
| 50.0 | .131 | –42 | 6.721 | 13 | .028 | 26 | .082 | –150 |
| 100.0 | .112 | –39 | 6.959 | –4 | .030 | 13 | .073 | –178 |
| 200.0 | .093 | –51 | 7.197 | –24 | .033 | 3 | .088 | 144 |
| 300.0 | .073 | –56 | 7.207 | –42 | .034 | –4 | .111 | 111 |
| 400.0 | .091 | –51 | 7.058 | –59 | .035 | –12 | .119 | 79 |
| 500.0 | .099 | –73 | 6.936 | –73 | .035 | –21 | .114 | 55 |
| 600.0 | .105 | –89 | 7.005 | –88 | .033 | –25 | .118 | 38 |
| 700.0 | .101 | –103 | 7.042 | –102 | .033 | –29 | .130 | 22 |
| 800.0 | .111 | –121 | 7.124 | –118 | .033 | –34 | .145 | 5 |
| 900.0 | .102 | –139 | 7.160 | –133 | .033 | –38 | .159 | –10 |
| 1000.0 | .109 | –159 | 7.235 | –149 | .032 | –44 | .168 | –25 |
| 1100.0 | .112 | 180 | 7.264 | –164 | .031 | –49 | .177 | –42 |
| 1200.0 | .108 | 159 | 7.294 | 180 | .031 | –56 | .191 | –58 |
| 1300.0 | .116 | 144 | 7.291 | 164 | .030 | –60 | .198 | –72 |
| 1400.0 | .118 | 120 | 7.212 | 148 | .030 | –67 | .199 | –87 |
| 1500.0 | .122 | 102 | 7.163 | 133 | .029 | –71 | .200 | –102 |
| 1600.0 | .139 | 80 | 7.030 | 117 | .029 | –78 | .190 | –117 |
| 1700.0 | .143 | 56 | 7.038 | 101 | .029 | –83 | .178 | –134 |
| 1800.0 | .146 | 40 | 6.885 | 85 | .029 | –88 | .170 | –155 |
| 1900.0 | .169 | 16 | 6.738 | 68 | .030 | –93 | .164 | –174 |
| 2000.0 | .181 | 1 | 6.672 | 53 | .030 | –100 | .164 | 164 |
| 2100.0 | .203 | –20 | 6.527 | 37 | .031 | –108 | .163 | 146 |
| 2200.0 | .226 | –40 | 6.437 | 22 | .032 | –114 | .159 | 129 |

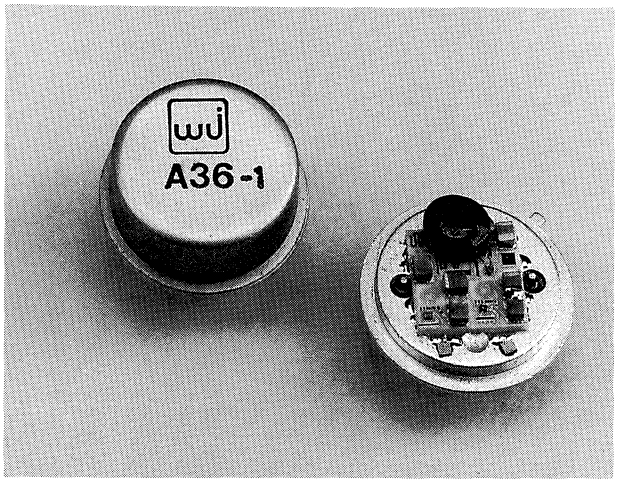
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.394 W
Junction Temperature Rise Above Case $T_{jc}$ ... 18°C

# WJ-A36-1 / SMA36-1

## 100 to 2300 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 16.2 dB (TYP.)
- ◆ LOW VSWR: < 1.6:1 (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +12.0 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 80-2400 MHz | 100-2300 MHz | 100-2300 MHz |
| Small Signal Gain (Min.) | 16.2 dB | 15.0 dB | 14.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.0 dB | 7.5 dB |
| Power Output at 1 dB Compression (Min.) | +12.0 dBm | +11.0 dBm | +11.0 dBm |
| VSWR (Max.) Input/Output | < 1.6:1 | 2.0:1 | 2.0:1 |
| DC Current (Max) at 15 Volts | 63 mA | 64 mA | 67 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA36-1 is a standard WJ-A36-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+33 dBm (Typ.)
Third Order Two Tone Intercept Point.....+23 dBm (Typ.)

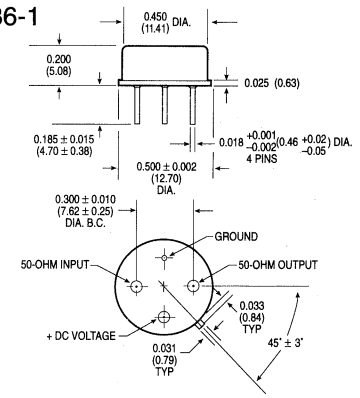
## Absolute Maximum Ratings

Storage Temperature .....-62° C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+10 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

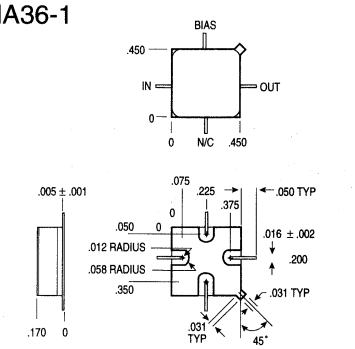
## Outline Drawings

A36-1



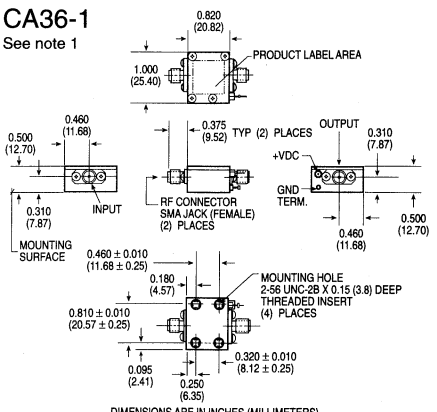

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA36-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

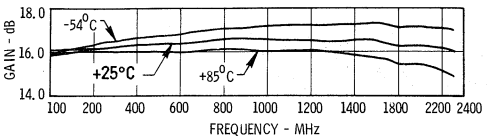
CA36-1
See note 1



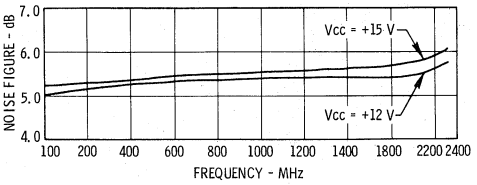

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

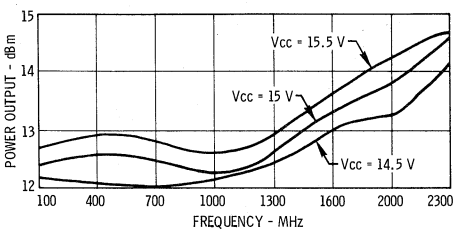
### Gain




### Noise Figure

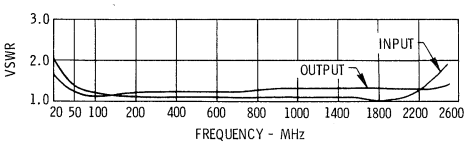



### Power Output*

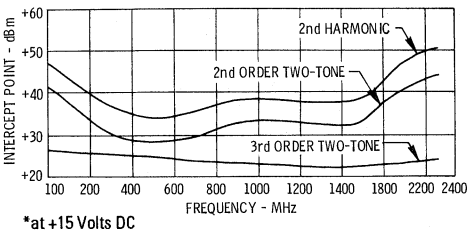



* @1 dB GAIN COMPRESSION

### VSWR

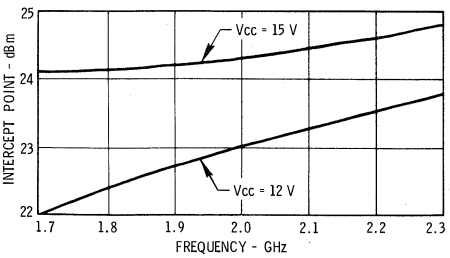



### Intercept Point*




*at +15 Volts DC

### Two Tone Third Order Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 3.6 | 2.3 | 10.8 |
| 50.0 | 1.2 | 1.2 | 15.8 |
| 100.0 | 1.1 | 1.1 | 16.0 |
| 200.0 | 1.1 | 1.1 | 16.2 |
| 300.0 | 1.1 | 1.2 | 16.3 |
| 400.0 | 1.1 | 1.2 | 16.4 |
| 500.0 | 1.1 | 1.2 | 16.4 |
| 600.0 | 1.0 | 1.3 | 16.4 |
| 700.0 | 1.0 | 1.3 | 16.4 |
| 800.0 | 1.0 | 1.4 | 16.4 |
| 900.0 | 1.1 | 1.4 | 16.5 |
| 1000.0 | 1.1 | 1.4 | 16.5 |
| 1100.0 | 1.1 | 1.5 | 16.6 |
| 1200.0 | 1.1 | 1.5 | 16.7 |
| 1300.0 | 1.1 | 1.5 | 16.8 |
| 1400.0 | 1.1 | 1.5 | 16.8 |
| 1500.0 | 1.1 | 1.5 | 16.8 |
| 1600.0 | 1.2 | 1.4 | 16.7 |
| 1700.0 | 1.2 | 1.4 | 16.8 |
| 1800.0 | 1.2 | 1.3 | 16.7 |
| 1900.0 | 1.2 | 1.3 | 16.6 |
| 2000.0 | 1.2 | 1.3 | 16.6 |
| 2100.0 | 1.3 | 1.3 | 16.4 |
| 2200.0 | 1.4 | 1.3 | 16.3 |
| 2300.0 | 1.5 | 1.3 | 16.1 |
| 2400.0 | 1.7 | 1.3 | 15.9 |
| 2500.0 | 1.9 | 1.3 | 15.7 |

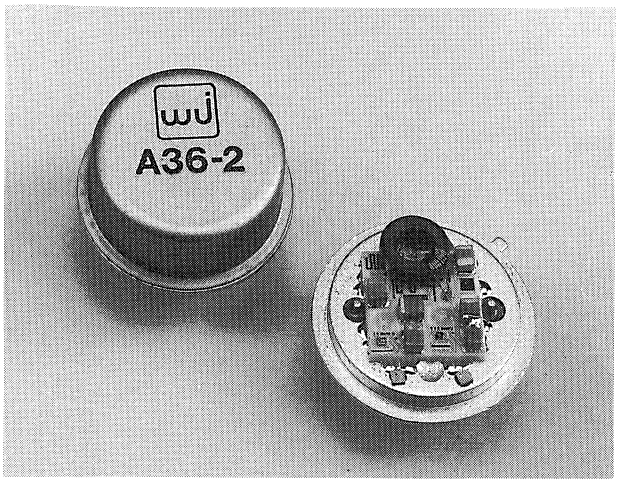
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .563 | –59 | 3.458 | 84 | .017 | 56 | .395 | –94 |
| 50.0 | .094 | –85 | 6.168 | 14 | .028 | 26 | .073 | –167 |
| 100.0 | .053 | –82 | 6.328 | –4 | .030 | 11 | .059 | 162 |
| 200.0 | .034 | –95 | 6.468 | –24 | .031 | –1 | .065 | 126 |
| 300.0 | .027 | –112 | 6.534 | –41 | .031 | –8 | .079 | 104 |
| 400.0 | .026 | –117 | 6.593 | –57 | .031 | –13 | .093 | 87 |
| 500.0 | .026 | –142 | 6.589 | –73 | .032 | –19 | .107 | 71 |
| 600.0 | .023 | –167 | 6.606 | –88 | .032 | –25 | .123 | 54 |
| 700.0 | .019 | 159 | 6.603 | –104 | .032 | –29 | .138 | 39 |
| 800.0 | .020 | 160 | 6.643 | –120 | .032 | –35 | .154 | 23 |
| 900.0 | .025 | 114 | 6.669 | –135 | .032 | –40 | .170 | 8 |
| 1000.0 | .031 | 108 | 6.719 | –150 | .033 | –46 | .180 | –5 |
| 1100.0 | .039 | 91 | 6.779 | –165 | .032 | –52 | .188 | –21 |
| 1200.0 | .038 | 70 | 6.841 | 179 | .032 | –58 | .196 | –36 |
| 1300.0 | .047 | 60 | 6.881 | 163 | .032 | –63 | .200 | –50 |
| 1400.0 | .046 | 36 | 6.885 | 147 | .031 | –69 | .194 | –66 |
| 1500.0 | .056 | 25 | 6.948 | 131 | .032 | –74 | .189 | –82 |
| 1600.0 | .076 | 11 | 6.867 | 115 | .031 | –80 | .177 | –97 |
| 1700.0 | .084 | –5 | 6.929 | 99 | .031 | –86 | .156 | –116 |
| 1800.0 | .078 | –16 | 6.828 | 82 | .031 | –93 | .139 | –141 |
| 1900.0 | .096 | –24 | 6.763 | 64 | .031 | –99 | .129 | –166 |
| 2000.0 | .107 | –33 | 6.730 | 48 | .031 | –106 | .125 | 165 |
| 2100.0 | .133 | –52 | 6.605 | 32 | .030 | –113 | .131 | 138 |
| 2200.0 | .154 | –65 | 6.533 | 15 | .030 | –120 | .134 | 114 |
| 2300.0 | .200 | –81 | 6.402 | –2 | .029 | –128 | .140 | 90 |
| 2400.0 | .246 | –99 | 6.260 | –19 | .030 | –134 | .147 | 65 |
| 2500.0 | .320 | –116 | 6.129 | –37 | .028 | –141 | .148 | 39 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.394 W
Junction Temperature Rise Above Case $T_{jc}$ ... 18°C

# WJ-A36-2 / SMA36-2




## 100 to 2600 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA-WIDE BANDWIDTH: 100-2600 MHz
- ◆ HIGH GAIN -TWO STAGES: 15.0 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +14 dBm, 2000-2600 MHz (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 80-2700 MHz | 100-2600 MHz | 100-2600 MHz |
| Small Signal Gain (Min.) | 15.0 dB | 14.0 dB | 13.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.0 dB | 7.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 100-2000 MHz | +12.0 dBm | +11.0 dBm | +11.0 dBm |
| 2000-2600 MHz | +14.0 dBm | +12.5 dBm | +12.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.0:1 | 2.0:1 |
| output | 1.7:1 | 2.2:1 | 2.2:1 |
| DC Current (Max) at 15 Volts | 63 mA | 64 mA | 67 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA36-2 is a standard WJ-A36-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+37 dBm (Typ.)
Second Order Two Tone Intercept Point.....+32 dBm (Typ.)
Third Order Two Tone InterceptPoint.....+30 dBm (Typ.)

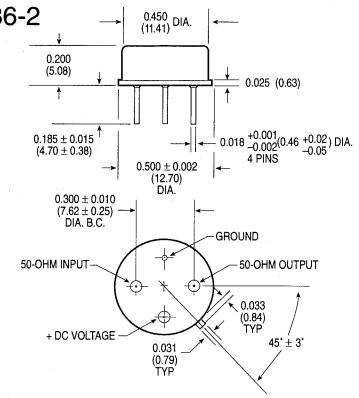
## Absolute Maximum Ratings

Storage Temperature.....-62° to 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+10 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watts (3 µsec Max.)
"S" Series Burn-In Temperature .....125°C

Weight approximately 2.0 grams (0.07 oz.)

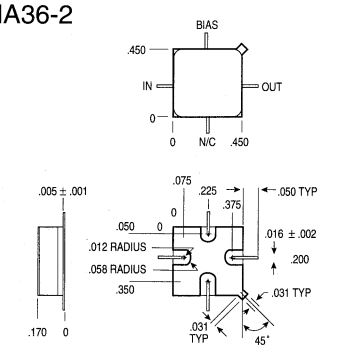
## Outline Drawings

A36-2



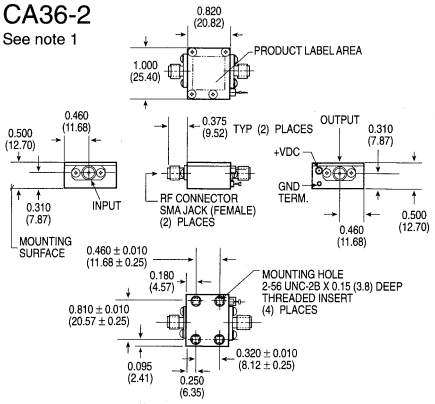

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA36-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

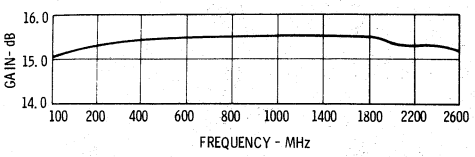
CA36-2
See note 1



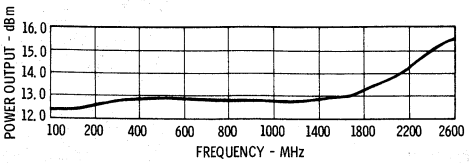

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

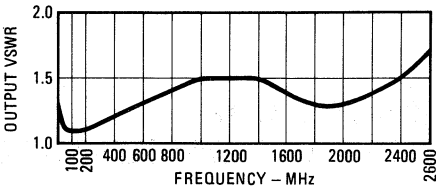



### Power Output*

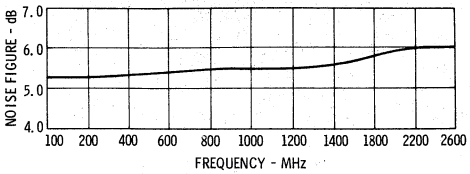



*at 1 dB Gain Compression

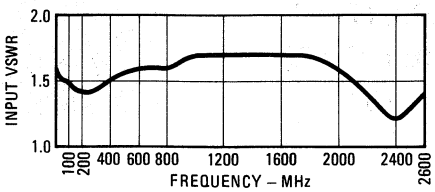
### VSWR



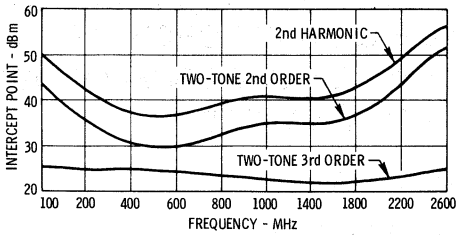

### Noise Figure




### VSWR




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 3.3 | 2.2 | 10.3 |
| 50.0 | 1.4 | 1.2 | 14.8 |
| 100.0 | 1.3 | 1.1 | 15.0 |
| 200.0 | 1.3 | 1.2 | 15.2 |
| 300.0 | 1.3 | 1.2 | 15.3 |
| 400.0 | 1.4 | 1.3 | 15.3 |
| 500.0 | 1.4 | 1.3 | 15.3 |
| 600.0 | 1.4 | 1.4 | 15.3 |
| 700.0 | 1.4 | 1.4 | 15.3 |
| 800.0 | 1.4 | 1.5 | 15.3 |
| 900.0 | 1.4 | 1.5 | 15.3 |
| 1000.0 | 1.4 | 1.6 | 15.3 |
| 1100.0 | 1.4 | 1.6 | 15.3 |
| 1200.0 | 1.4 | 1.6 | 15.4 |
| 1300.0 | 1.4 | 1.6 | 15.5 |
| 1400.0 | 1.4 | 1.6 | 15.4 |
| 1500.0 | 1.4 | 1.6 | 15.5 |
| 1600.0 | 1.4 | 1.5 | 15.4 |
| 1700.0 | 1.4 | 1.5 | 15.5 |
| 1800.0 | 1.4 | 1.4 | 15.4 |
| 1900.0 | 1.3 | 1.4 | 15.3 |
| 2000.0 | 1.3 | 1.3 | 15.3 |
| 2100.0 | 1.3 | 1.3 | 15.2 |
| 2200.0 | 1.2 | 1.3 | 15.2 |
| 2300.0 | 1.2 | 1.3 | 15.1 |
| 2400.0 | 1.2 | 1.2 | 15.1 |
| 2500.0 | 1.3 | 1.2 | 15.0 |
| 2600.0 | 1.4 | 1.3 | 14.8 |
| 2700.0 | 1.5 | 1.3 | 14.4 |
| 2800.0 | 1.8 | 1.4 | 13.9 |

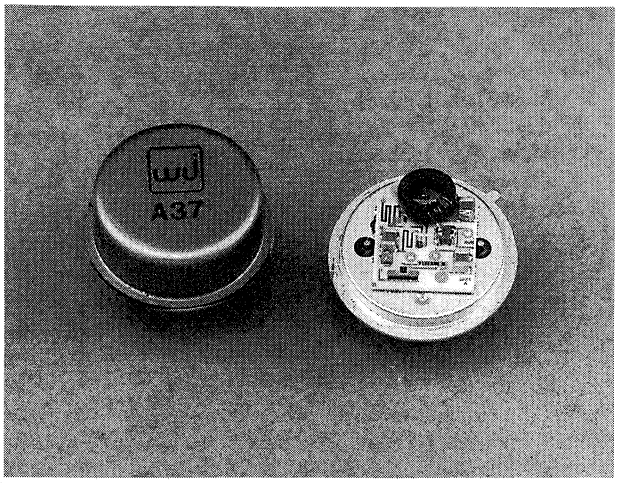
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .534 | –50 | 3.268 | 83 | .019 | 51 | .381 | –89 |
| 50.0 | .158 | –32 | 5.483 | 13 | .028 | 23 | .081 | –151 |
| 100.0 | .143 | –29 | 5.651 | –4 | .030 | 10 | .068 | 170 |
| 200.0 | .149 | –43 | 5.783 | –25 | .031 | –1 | .076 | 126 |
| 300.0 | .142 | –56 | 5.791 | –42 | .032 | –8 | .095 | 101 |
| 400.0 | .154 | –68 | 5.843 | –58 | .032 | –14 | .114 | 82 |
| 500.0 | .155 | –87 | 5.819 | –74 | .032 | –19 | .132 | 64 |
| 600.0 | .152 | –99 | 5.821 | –89 | .032 | –24 | .152 | 47 |
| 700.0 | .156 | –109 | 5.796 | –105 | .032 | –29 | .171 | 31 |
| 800.0 | .164 | –125 | 5.806 | –120 | .032 | –35 | .190 | 15 |
| 900.0 | .160 | –141 | 5.791 | –136 | .033 | –39 | .209 | 0 |
| 1000.0 | .173 | –155 | 5.806 | –151 | .033 | –44 | .221 | –14 |
| 1100.0 | .175 | –167 | 5.842 | –166 | .033 | –50 | .231 | –30 |
| 1200.0 | .174 | 178 | 5.897 | 178 | .032 | –56 | .241 | –45 |
| 1300.0 | .179 | 163 | 5.938 | 163 | .032 | –62 | .244 | –59 |
| 1400.0 | .176 | 148 | 5.920 | 147 | .031 | –66 | .238 | –75 |
| 1500.0 | .170 | 136 | 5.924 | 132 | .031 | –72 | .231 | –91 |
| 1600.0 | .168 | 120 | 5.881 | 116 | .031 | –77 | .215 | –106 |
| 1700.0 | .151 | 106 | 5.944 | 100 | .031 | –84 | .193 | –124 |
| 1800.0 | .155 | 94 | 5.885 | 84 | .030 | –88 | .173 | –146 |
| 1900.0 | .147 | 80 | 5.829 | 67 | .031 | –93 | .156 | –168 |
| 2000.0 | .139 | 64 | 5.844 | 51 | .031 | –99 | .143 | 167 |
| 2100.0 | .122 | 45 | 5.778 | 35 | .032 | –105 | .136 | 142 |
| 2200.0 | .093 | 29 | 5.758 | 19 | .032 | –111 | .125 | 118 |
| 2300.0 | .093 | –14 | 5.712 | 2 | .032 | –119 | .114 | 92 |
| 2400.0 | .079 | –53 | 5.656 | –15 | .032 | –125 | .104 | 64 |
| 2500.0 | .125 | –96 | 5.602 | –33 | .031 | –133 | .094 | 29 |
| 2600.0 | .179 | –126 | 5.467 | –52 | .032 | –140 | .114 | –9 |
| 2700.0 | .211 | –147 | 5.226 | –70 | .034 | –148 | .144 | –34 |
| 2800.0 | .288 | –166 | 4.947 | –89 | .034 | –155 | .171 | –56 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.426 W
Junction Temperature Rise Above Case $T_{jc}$ ... 19°C

# WJ-A37 / SMA37




## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +15.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +26 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 9.3 dB | 8.0 dB | 7.0 dB |
| Gain Flatness (Max.) | | | |
| 500-2000 MHz | <±0.4 dB | ±0.6 dB | ±0.8 dB |
| 10-2000 MHz | <±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.5 dB | 8.0 dB | 8.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +15.5 dBm | +14 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | < 1.7:1 | 2.2:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 45 mA | 50 mA | 53 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA37 is a standard WJ-A37 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+52 dBm (Typ.)
Second Order Two Tone Intercept Point .....+49 dBm (Typ.)
Third Order Two Tone Intercept Point .....+26 dBm (Typ.)

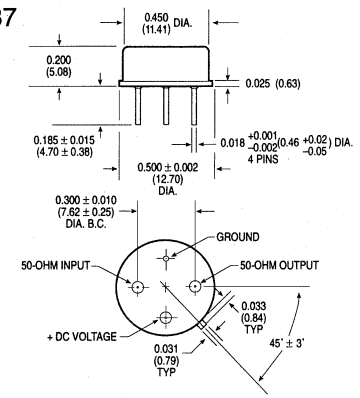
## Absolute Maximum Ratings

Storage Temperature. .....-62°C to+125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S"Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

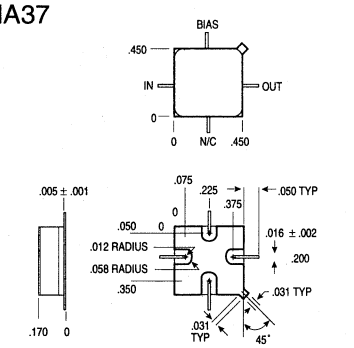
## Outline Drawings

A37



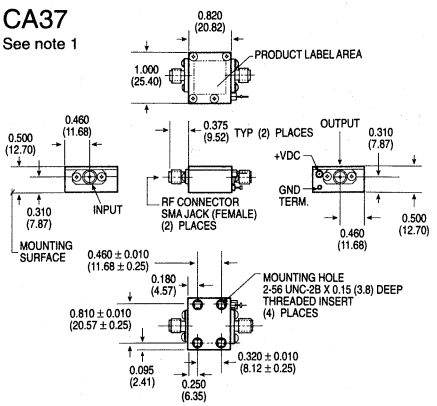

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA37




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

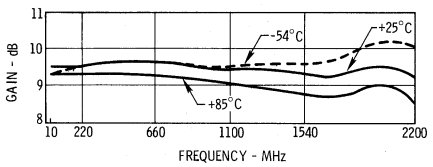
CA37
See note 1



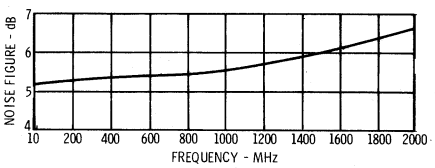

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

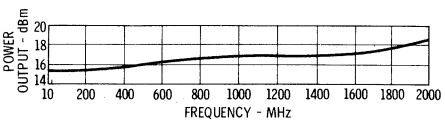
### Gain




### Noise Figure

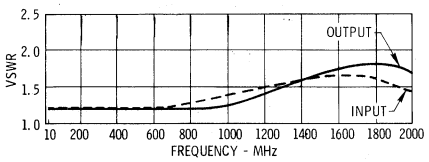



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.440 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

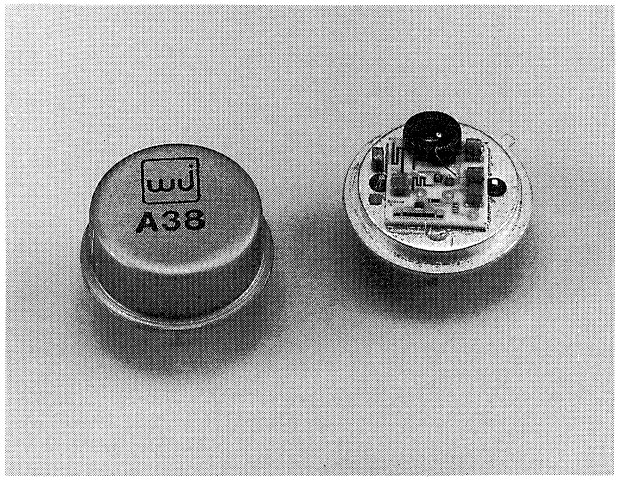
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 2.7 | 5.7 |
| 2.0 | 1.5 | 2.0 | 8.3 |
| 5.0 | 1.3 | 1.4 | 9.3 |
| 10.0 | 1.3 | 1.3 | 9.3 |
| 50.0 | 1.3 | 1.3 | 9.4 |
| 100.0 | 1.2 | 1.3 | 9.4 |
| 200.0 | 1.2 | 1.3 | 9.4 |
| 300.0 | 1.2 | 1.3 | 9.4 |
| 400.0 | 1.2 | 1.2 | 9.6 |
| 500.0 | 1.1 | 1.2 | 9.6 |
| 600.0 | 1.1 | 1.2 | 9.6 |
| 700.0 | 1.1 | 1.1 | 9.7 |
| 800.0 | 1.2 | 1.1 | 9.8 |
| 900.0 | 1.2 | 1.1 | 9.8 |
| 1000.0 | 1.3 | 1.1 | 9.9 |
| 1100.0 | 1.4 | 1.1 | 10.0 |
| 1200.0 | 1.4 | 1.1 | 10.0 |
| 1300.0 | 1.5 | 1.1 | 10.0 |
| 1400.0 | 1.5 | 1.2 | 10.0 |
| 1500.0 | 1.5 | 1.2 | 10.0 |
| 1600.0 | 1.5 | 1.2 | 10.0 |
| 1700.0 | 1.4 | 1.3 | 10.0 |
| 1800.0 | 1.3 | 1.2 | 10.1 |
| 1900.0 | 1.3 | 1.2 | 10.0 |
| 2000.0 | 1.5 | 1.2 | 9.8 |
| 2100.0 | 2.0 | 1.3 | 9.2 |
| 2200.0 | 2.9 | 1.4 | 7.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .139 | –45 | 1.918 | –162 | .116 | 21 | .453 | –139 |
| 2.0 | .214 | –90 | 2.594 | –154 | .149 | 28 | .329 | 164 |
| 5.0 | .129 | –140 | 2.911 | –172 | .171 | 10 | .161 | 162 |
| 10.0 | .115 | –159 | 2.929 | –177 | .173 | 5 | .141 | 167 |
| 50.0 | .115 | 179 | 2.964 | 175 | .175 | –1 | .126 | 165 |
| 100.0 | .106 | 169 | 2.951 | 168 | .176 | –5 | .124 | 155 |
| 200.0 | .103 | 166 | 2.960 | 156 | .176 | –9 | .123 | 134 |
| 300.0 | .096 | 159 | 2.968 | 145 | .177 | –14 | .120 | 112 |
| 400.0 | .074 | 148 | 3.007 | 132 | .180 | –19 | .109 | 91 |
| 500.0 | .059 | 150 | 3.013 | 121 | .183 | –24 | .097 | 68 |
| 600.0 | .048 | 161 | 3.036 | 108 | .185 | –30 | .081 | 42 |
| 700.0 | .046 | –167 | 3.054 | 96 | .188 | –36 | .065 | 16 |
| 800.0 | .077 | –155 | 3.092 | 83 | .191 | –42 | .052 | –18 |
| 900.0 | .104 | –162 | 3.107 | 71 | .196 | –47 | .043 | –57 |
| 1000.0 | .133 | –172 | 3.128 | 58 | .199 | –54 | .037 | –106 |
| 1100.0 | .158 | 177 | 3.149 | 45 | .203 | –60 | .044 | –154 |
| 1200.0 | .180 | 165 | 3.158 | 32 | .205 | –67 | .051 | 167 |
| 1300.0 | .197 | 150 | 3.156 | 18 | .208 | –74 | .063 | 127 |
| 1400.0 | .208 | 136 | 3.148 | 4 | .210 | –81 | .081 | 96 |
| 1500.0 | .201 | 118 | 3.156 | –9 | .214 | –88 | .094 | 67 |
| 1600.0 | .204 | 100 | 3.145 | –24 | .219 | –95 | .107 | 37 |
| 1700.0 | .181 | 72 | 3.175 | –39 | .224 | –103 | .114 | 12 |
| 1800.0 | .146 | 36 | 3.183 | –54 | .234 | –111 | .105 | –21 |
| 1900.0 | .130 | –24 | 3.150 | –72 | .245 | –122 | .086 | –67 |
| 2000.0 | .194 | –90 | 3.073 | –90 | .250 | –135 | .095 | –131 |
| 2100.0 | .333 | –131 | 2.872 | –110 | .243 | –149 | .135 | 173 |
| 2200.0 | .493 | –164 | 2.495 | –130 | .222 | –162 | .183 | 137 |

# WJ-A38 / SMA38

## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +19 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)
- ◆ WIDE BANDWIDTH: 10-2000 MHz

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 7.5 dB | 6.5 dB | 6.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-1500 MHz | 6.5 dB | 7.7 dB | 8.2 dB |
| 1500-2000 MHz | 7.5 dB | 9.0 dB | 9.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 10-1500 MHz | +18.0 dBm | +17.0 dBm | +16.5 dBm |
| 1500-2000 MHz | +19.0 dBm | +18.0 dBm | +17.5 dBm |
| VSWR (Max.) Input/Output | 1.8:1 | 2.2:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 65 mA | 69 mA | 72 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA38 is a standard WJ-A38 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25° C

Second Order Harmonic Intercept Point.....+52 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

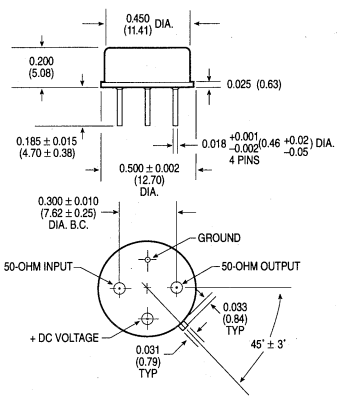
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term CW Input .....100 Milliwatt (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

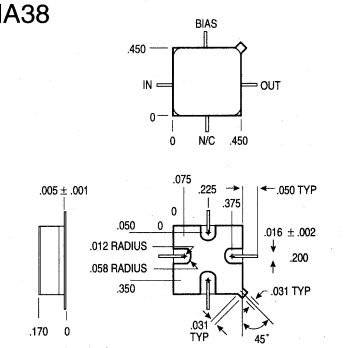
## Outline Drawings

A38



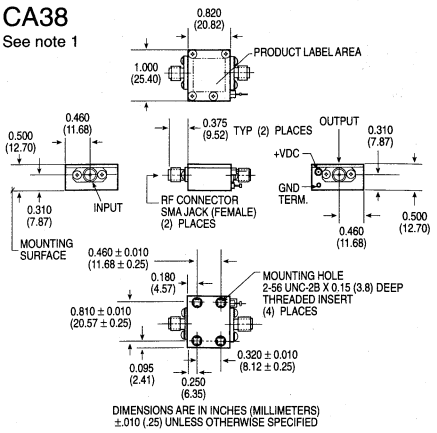

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA38




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

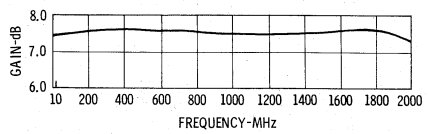
CA38
See note 1

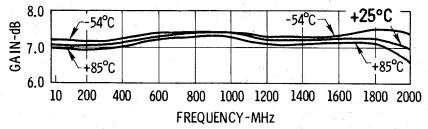


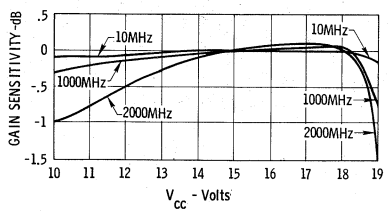

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

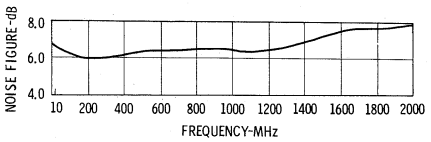
## Gain



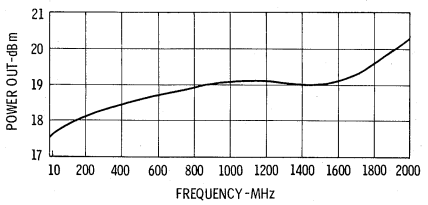



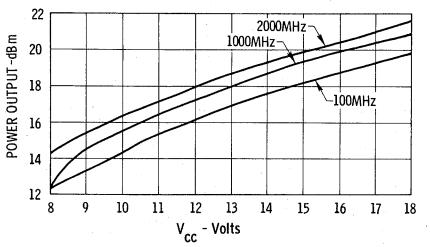




## Noise Figure



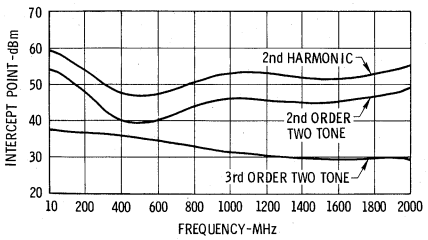

## Power Output *



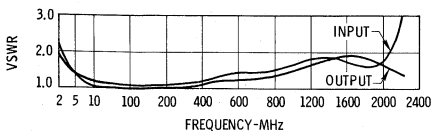




*at 1 dB Gain Compression

## Intercept Point




## VSWR




# Typical Automatic Test Data

## $V_{cc}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.8 | 5.9 |
| 2.0 | 1.6 | 2.1 | 8.3 |
| 5.0 | 1.4 | 1.5 | 9.2 |
| 10.0 | 1.4 | 1.5 | 9.3 |
| 50.0 | 1.4 | 1.4 | 9.4 |
| 100.0 | 1.4 | 1.4 | 9.3 |
| 200.0 | 1.4 | 1.4 | 9.4 |
| 300.0 | 1.3 | 1.4 | 9.4 |
| 400.0 | 1.3 | 1.4 | 9.5 |
| 500.0 | 1.2 | 1.3 | 9.5 |
| 600.0 | 1.2 | 1.3 | 9.6 |
| 700.0 | 1.1 | 1.2 | 9.6 |
| 800.0 | 1.0 | 1.2 | 9.7 |
| 900.0 | 1.0 | 1.1 | 9.8 |
| 1000.0 | 1.1 | 1.1 | 9.8 |
| 1100.0 | 1.1 | 1.1 | 9.9 |
| 1200.0 | 1.2 | 1.1 | 9.9 |
| 1300.0 | 1.3 | 1.2 | 9.9 |
| 1400.0 | 1.3 | 1.2 | 9.9 |
| 1500.0 | 1.3 | 1.2 | 9.8 |
| 1600.0 | 1.3 | 1.2 | 9.8 |
| 1700.0 | 1.3 | 1.3 | 9.8 |
| 1800.0 | 1.2 | 1.3 | 9.6 |
| 1900.0 | 1.1 | 1.3 | 9.4 |
| 2000.0 | 1.2 | 1.2 | 9.1 |
| 2100.0 | 1.5 | 1.2 | 8.8 |
| 2200.0 | 2.0 | 1.1 | 8.4 |

## Linear S-Parameters

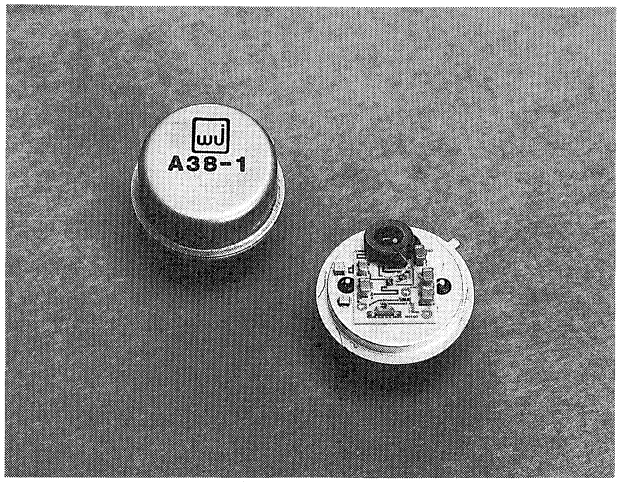
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .219 | –83 | 1.966 | –151 | .118 | 31 | .479 | –148 |
| 2.0 | .222 | –107 | 2.604 | –155 | .149 | 27 | .344 | 171 |
| 5.0 | .178 | –150 | 2.896 | –171 | .168 | 10 | .210 | 169 |
| 10.0 | .170 | –165 | 2.913 | –176 | .171 | 5 | .192 | 172 |
| 50.0 | .173 | 174 | 2.935 | 176 | .173 | –1 | .179 | 168 |
| 100.0 | .166 | 165 | 2.928 | 170 | .173 | –4 | .176 | 160 |
| 200.0 | .154 | 153 | 2.936 | 159 | .173 | –8 | .172 | 143 |
| 300.0 | .148 | 138 | 2.937 | 149 | .175 | –12 | .166 | 125 |
| 400.0 | .122 | 124 | 2.982 | 139 | .177 | –16 | .153 | 108 |
| 500.0 | .108 | 108 | 2.979 | 129 | .179 | –21 | .136 | 90 |
| 600.0 | .084 | 93 | 3.010 | 118 | .181 | –25 | .114 | 69 |
| 700.0 | .049 | 66 | 3.024 | 107 | .182 | –30 | .094 | 48 |
| 800.0 | .020 | 45 | 3.059 | 96 | .184 | –35 | .072 | 22 |
| 900.0 | .015 | –85 | 3.078 | 85 | .187 | –40 | .060 | –12 |
| 1000.0 | .045 | –131 | 3.100 | 73 | .188 | –46 | .048 | –53 |
| 1100.0 | .064 | –151 | 3.112 | 62 | .191 | –51 | .051 | –99 |
| 1200.0 | .087 | –166 | 3.130 | 50 | .193 | –57 | .061 | –132 |
| 1300.0 | .116 | 177 | 3.136 | 38 | .193 | –63 | .070 | –163 |
| 1400.0 | .141 | 165 | 3.122 | 26 | .194 | –69 | .088 | 169 |
| 1500.0 | .138 | 147 | 3.103 | 14 | .194 | –75 | .101 | 146 |
| 1600.0 | .145 | 134 | 3.086 | 1 | .195 | –81 | .109 | 124 |
| 1700.0 | .127 | 113 | 3.090 | –12 | .195 | –88 | .122 | 105 |
| 1800.0 | .096 | 100 | 3.007 | –25 | .195 | –94 | .126 | 90 |
| 1900.0 | .033 | 88 | 2.967 | –39 | .200 | –102 | .119 | 77 |
| 2000.0 | .071 | –141 | 2.852 | –53 | .200 | –111 | .106 | 65 |
| 2100.0 | .187 | –157 | 2.760 | –67 | .194 | –120 | .082 | 57 |
| 2200.0 | .328 | 179 | 2.644 | –82 | .186 | –128 | .029 | 49 |

# Thermal Data: $V_{cc}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.652 W
Junction Temperature Rise Above Case $T_{jc}$ ... 29°C

# WJ-A38-1 / SMA38-1

## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +18 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)
- ◆ WIDE BANDWIDTH: 10 - 2000 MHz

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5 - 2050 MHz | 10 - 2000 MHz | 10 - 2000 MHz |
| Small Signal Gain (Min.) | 9.5 dB | 8.5 dB | 7.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10 -1500 | 5.5 dB | 6.0 dB | 6.5 dB |
| 10- 2000 | 6.5 dB | 7.5 dB | 8.0 dB |
| Power Output at 1 dB Compression (Min.) | +18.0 dBm | +17.0 dBm | +16.5 dBm |
| VSWR (Max.) | | | |
| Input/Output | 1.6:1 | 2.1:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 65 mA | 70 mA | 74 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA38-1 is a standard WJ-A38-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+52 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

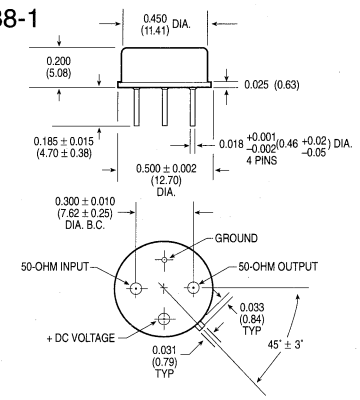
## Absolute Maximum Ratings

Storage Temperature .....-62°C to 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power. .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

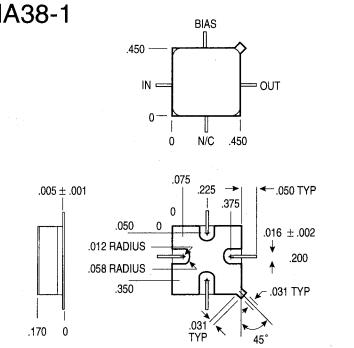
## Outline Drawings

A38-1



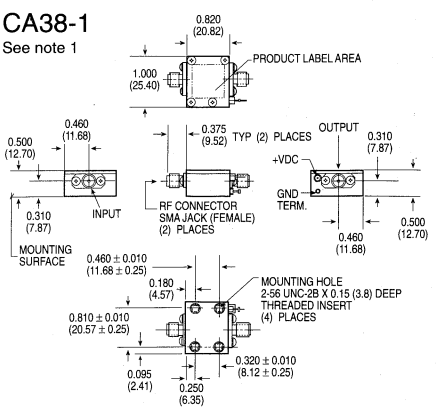

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA38-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

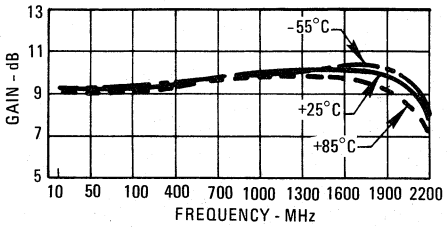
CA38-1
See note 1



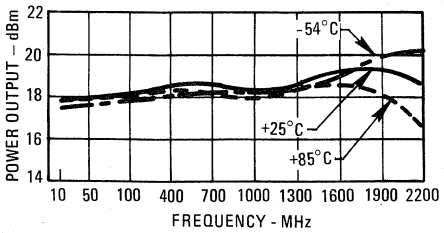

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

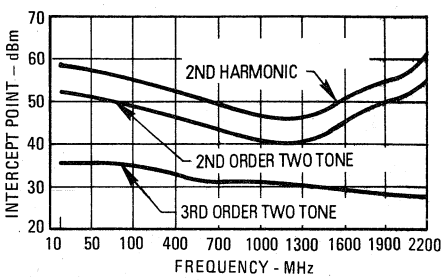



### Power Output*

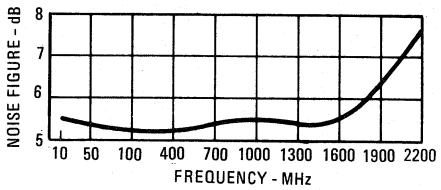



* at 1 dB Gain Compression

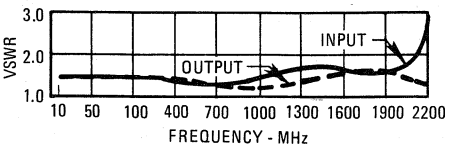
### Intermodulation




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.9 | 3.0 | 6.2 |
| 5.0 | 1.8 | 1.7 | 8.8 |
| 10.0 | 1.5 | 1.5 | 9.1 |
| 50.0 | 1.4 | 1.3 | 9.2 |
| 100.0 | 1.3 | 1.3 | 9.2 |
| 200.0 | 1.3 | 1.3 | 9.2 |
| 300.0 | 1.3 | 1.3 | 9.3 |
| 400.0 | 1.2 | 1.2 | 9.4 |
| 500.0 | 1.2 | 1.2 | 9.4 |
| 600.0 | 1.1 | 1.1 | 9.6 |
| 700.0 | 1.0 | 1.1 | 9.6 |
| 800.0 | 1.0 | 1.1 | 9.7 |
| 900.0 | 1.1 | 1.1 | 9.8 |
| 1000.0 | 1.2 | 1.1 | 9.9 |
| 1100.0 | 1.2 | 1.2 | 10.0 |
| 1200.0 | 1.3 | 1.2 | 10.0 |
| 1300.0 | 1.4 | 1.3 | 10.1 |
| 1400.0 | 1.4 | 1.3 | 10.1 |
| 1500.0 | 1.4 | 1.4 | 10.1 |
| 1600.0 | 1.4 | 1.4 | 10.1 |
| 1700.0 | 1.4 | 1.4 | 10.2 |
| 1800.0 | 1.2 | 1.4 | 10.0 |
| 1900.0 | 1.1 | 1.3 | 9.8 |
| 2000.0 | 1.2 | 1.3 | 9.4 |
| 2100.0 | 1.7 | 1.2 | 9.1 |
| 2200.0 | 2.2 | 1.1 | 8.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .489 | –64 | 2.045 | –134 | .120 | 47 | .495 | 172 |
| 5.0 | .274 | –106 | 2.759 | –161 | .165 | 21 | .248 | 151 |
| 10.0 | .189 | –134 | 2.838 | –171 | .172 | 10 | .184 | 157 |
| 50.0 | .157 | –176 | 2.896 | 177 | .175 | –0 | .149 | 164 |
| 100.0 | .145 | 172 | 2.888 | 171 | .175 | –4 | .144 | 158 |
| 200.0 | .145 | 161 | 2.893 | 160 | .176 | –9 | .137 | 141 |
| 300.0 | .136 | 147 | 2.912 | 150 | .178 | –13 | .127 | 123 |
| 400.0 | .108 | 130 | 2.960 | 139 | .179 | –18 | .108 | 106 |
| 500.0 | .093 | 125 | 2.966 | 129 | .181 | –23 | .088 | 87 |
| 600.0 | .060 | 116 | 3.003 | 118 | .182 | –28 | .063 | 63 |
| 700.0 | .019 | 111 | 3.029 | 107 | .183 | –34 | .040 | 30 |
| 800.0 | .024 | –150 | 3.070 | 95 | .185 | –40 | .029 | –36 |
| 900.0 | .055 | –152 | 3.095 | 84 | .188 | –45 | .044 | –91 |
| 1000.0 | .080 | –160 | 3.125 | 73 | .188 | –51 | .065 | –127 |
| 1100.0 | .102 | –164 | 3.149 | 61 | .189 | –57 | .090 | –151 |
| 1200.0 | .132 | –178 | 3.163 | 50 | .190 | –63 | .108 | –168 |
| 1300.0 | .149 | 167 | 3.182 | 37 | .190 | –69 | .124 | 171 |
| 1400.0 | .170 | 154 | 3.188 | 25 | .190 | –75 | .143 | 152 |
| 1500.0 | .174 | 138 | 3.205 | 12 | .190 | –82 | .152 | 135 |
| 1600.0 | .180 | 121 | 3.203 | –1 | .192 | –88 | .154 | 117 |
| 1700.0 | .154 | 99 | 3.221 | –14 | .192 | –95 | .158 | 102 |
| 1800.0 | .105 | 73 | 3.162 | –27 | .193 | –102 | .152 | 90 |
| 1900.0 | .055 | –4 | 3.096 | –43 | .198 | –110 | .139 | 84 |
| 2000.0 | .106 | –101 | 2.966 | –57 | .195 | –120 | .126 | 80 |
| 2100.0 | .247 | –140 | 2.836 | –71 | .187 | –130 | .106 | 78 |
| 2200.0 | .380 | –167 | 2.747 | –86 | .177 | –138 | .070 | 104 |

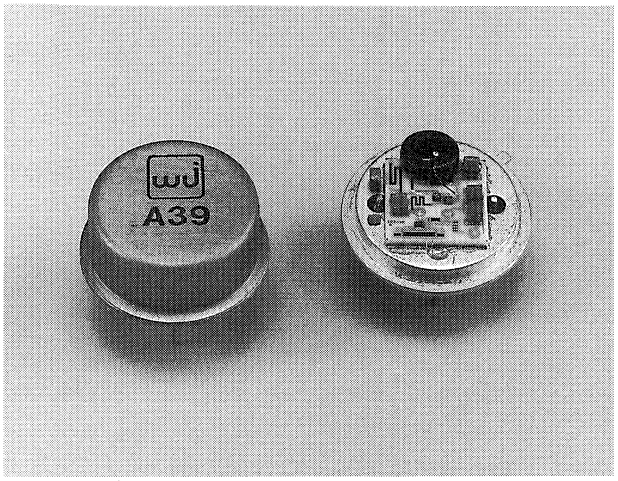
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.652 W
Junction Temperature Rise Above Case $T_{jc}$ ... 29°C

# WJ-A39 / SMA39

## 10 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +34 dBm (TYP.)
- ◆ WIDE BANDWIDTH: 10-2000 MHz




## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-2050 MHz | 10-2000 MHz | 10-2000 MHz |
| Small Signal Gain (Min.) | 7.5 dB | 6.5 dB | 6.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-1500 MHz | < 8.0 dB | 9.0 dB | 9.5 dB |
| 1500-2000 MHz | 8.5 dB | 9.5 dB | 10.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +22 dBm | +20 dBm | +19.5 dBm |
| VSWR (Max.) Input/Output | 1.6:1 | 2.2:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 90 mA | 94 mA | 98 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA39 is a standard WJ-A39 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +55 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

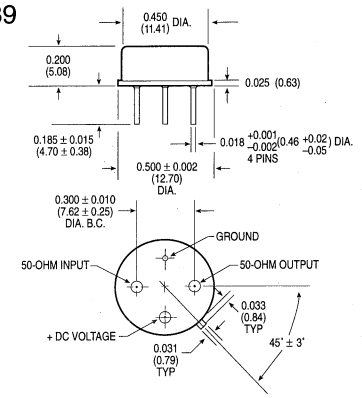
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature. .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+50 Milliwatts
Maximum Short Term RF Input Power .....100 Milliwatt (1 Minute Max.)
Maximum Peak Power .....0.5 Watts (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

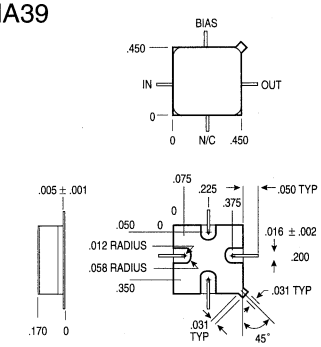
## Outline Drawings

A39



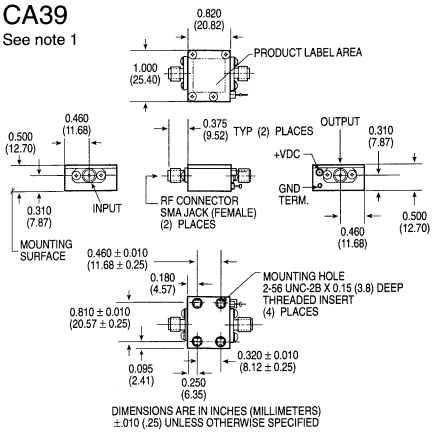

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA39




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

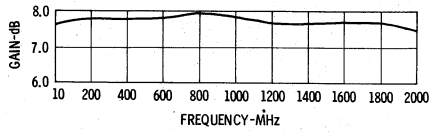
CA39
See note 1

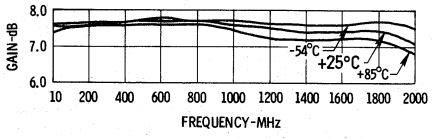


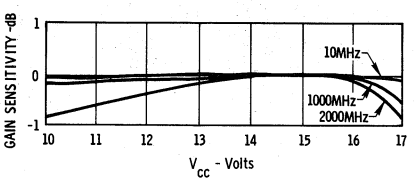

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

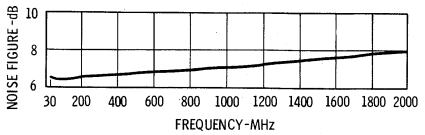
### Gain



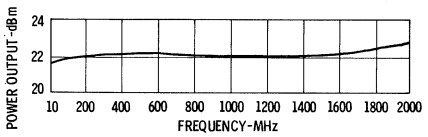



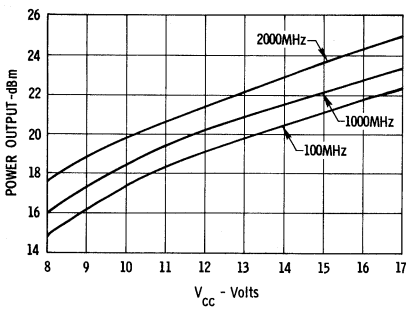




### Noise Figure



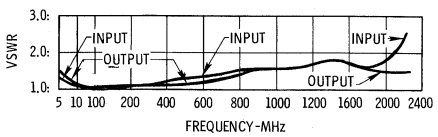

### Power Output *



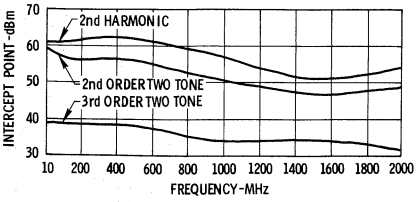




*at 1 dB Gain Compression

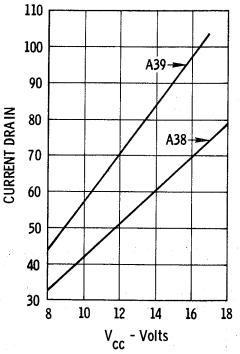
### VSWR




### Intercept Point




### Current Drain vs. $V_{CC}$




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.8 | 2.3 | 7.6 |
| 5.0 | 1.7 | 1.8 | 8.3 |
| 10.0 | 1.7 | 1.7 | 8.4 |
| 50.0 | 1.7 | 1.7 | 8.5 |
| 100.0 | 1.7 | 1.7 | 8.5 |
| 200.0 | 1.7 | 1.7 | 8.5 |
| 300.0 | 1.6 | 1.6 | 8.5 |
| 400.0 | 1.6 | 1.6 | 8.7 |
| 500.0 | 1.5 | 1.5 | 8.7 |
| 600.0 | 1.5 | 1.4 | 8.8 |
| 700.0 | 1.4 | 1.3 | 8.9 |
| 800.0 | 1.4 | 1.2 | 9.0 |
| 900.0 | 1.5 | 1.1 | 9.0 |
| 1000.0 | 1.5 | 1.1 | 9.1 |
| 1100.0 | 1.6 | 1.1 | 9.2 |
| 1200.0 | 1.6 | 1.2 | 9.2 |
| 1300.0 | 1.7 | 1.3 | 9.2 |
| 1400.0 | 1.7 | 1.4 | 9.1 |
| 1500.0 | 1.7 | 1.5 | 9.0 |
| 1600.0 | 1.8 | 1.6 | 9.0 |
| 1700.0 | 1.7 | 1.8 | 8.9 |
| 1800.0 | 1.5 | 1.9 | 8.6 |
| 1900.0 | 1.4 | 1.9 | 8.5 |
| 2000.0 | 1.1 | 1.9 | 8.1 |
| 2100.0 | 1.3 | 1.8 | 7.6 |
| 2200.0 | 1.7 | 1.7 | 7.4 |

### Linear S-Parameters

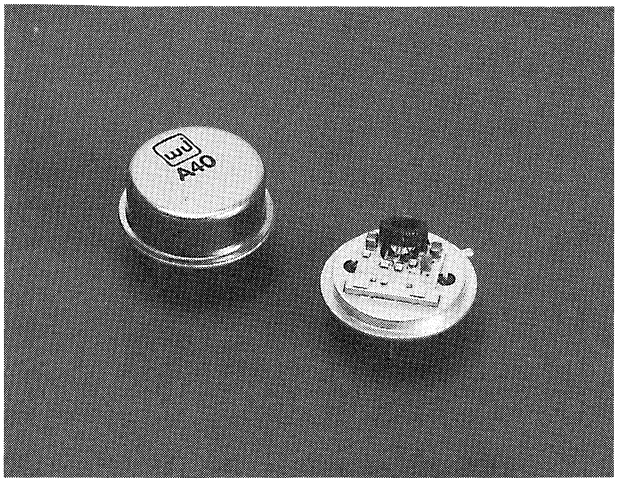
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .294 | −122 | 2.389 | −155 | .160 | 28 | .386 | −179 |
| 5.0 | .264 | −156 | 2.612 | −171 | .176 | 11 | .285 | 176 |
| 10.0 | .259 | −168 | 2.632 | −176 | .179 | 5 | .272 | 176 |
| 50.0 | .265 | 178 | 2.664 | 176 | .181 | −1 | .260 | 170 |
| 100.0 | .252 | 171 | 2.652 | 170 | .181 | −3 | .255 | 162 |
| 200.0 | .246 | 166 | 2.667 | 159 | .181 | −8 | .247 | 146 |
| 300.0 | .238 | 158 | 2.669 | 150 | .182 | −11 | .237 | 130 |
| 400.0 | .220 | 151 | 2.717 | 139 | .185 | −16 | .217 | 114 |
| 500.0 | .212 | 146 | 2.723 | 129 | .186 | −20 | .192 | 97 |
| 600.0 | .195 | 142 | 2.743 | 118 | .187 | −24 | .159 | 79 |
| 700.0 | .174 | 143 | 2.774 | 107 | .188 | −29 | .125 | 60 |
| 800.0 | .180 | 144 | 2.807 | 96 | .191 | −35 | .086 | 36 |
| 900.0 | .187 | 143 | 2.828 | 85 | .193 | −39 | .055 | −2 |
| 1000.0 | .198 | 139 | 2.860 | 73 | .194 | −44 | .037 | −71 |
| 1100.0 | .216 | 135 | 2.869 | 61 | .195 | −49 | .064 | −133 |
| 1200.0 | .239 | 128 | 2.872 | 50 | .195 | −54 | .098 | −161 |
| 1300.0 | .255 | 122 | 2.868 | 38 | .194 | −59 | .135 | 173 |
| 1400.0 | .260 | 113 | 2.853 | 25 | .192 | −64 | .178 | 152 |
| 1500.0 | .264 | 101 | 2.832 | 13 | .193 | −69 | .213 | 133 |
| 1600.0 | .273 | 89 | 2.818 | 1 | .195 | −74 | .244 | 113 |
| 1700.0 | .249 | 74 | 2.787 | −12 | .197 | −79 | .278 | 96 |
| 1800.0 | .212 | 58 | 2.706 | −24 | .202 | −84 | .299 | 79 |
| 1900.0 | .156 | 33 | 2.671 | −38 | .212 | −91 | .304 | 64 |
| 2000.0 | .058 | −2 | 2.541 | −51 | .214 | −99 | .303 | 49 |
| 2100.0 | .119 | −147 | 2.399 | −63 | .213 | −109 | .294 | 33 |
| 2200.0 | .252 | 176 | 2.340 | −76 | .207 | −115 | .270 | 11 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.932 W
Junction Temperature Rise Above Case $T_{jc}$ ... 42°C

# WJ-A40 / SMA40

## 500 TO 4000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA-WIDE BANDWIDTH: 500-4000 MHz
- ◆ HIGH GAIN -TWO STAGES: 14.5 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +15.0 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 300-4200 MHz | 500-4000 MHz | 500-4000 MHz |
| Small Signal Gain (Min.) | 14.5 dB | 13.0 dB | 12.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 6.0 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +15.0 dBm | +13.5 dBm | +13.0 dBm |
| VSWR (Max.) Input/Output | <1.7:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +12 Volts | 69 mA | 77 mA | 82 mA |

* Measured in a 50-ohm system at +12 Vdc Nominal.
Notes:
1. WJ-CA40 is a standard WJ-A40 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+25.0 dBm (Typ.)

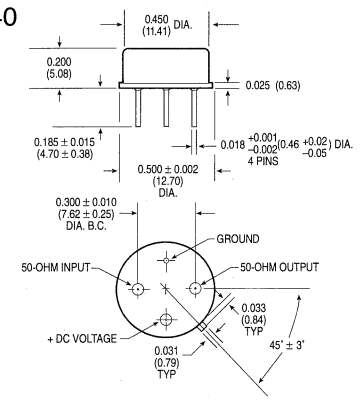
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+14 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

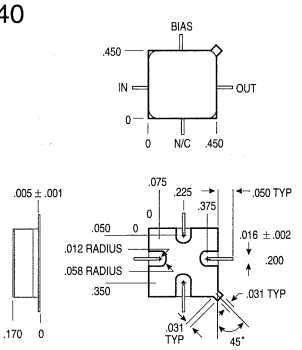
## Outline Drawings

A40



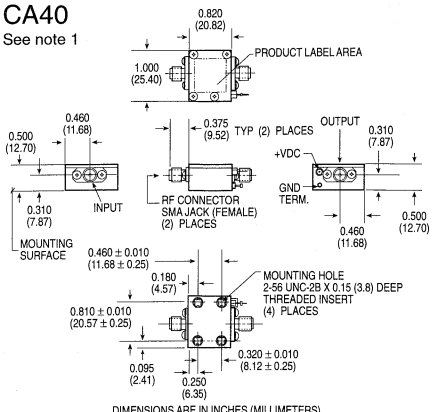

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA40




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

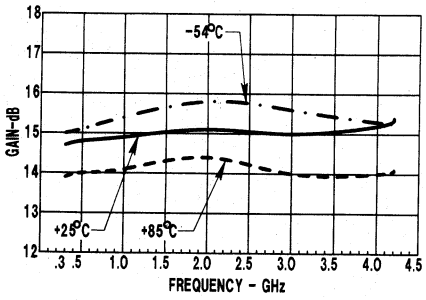
CA40
See note 1



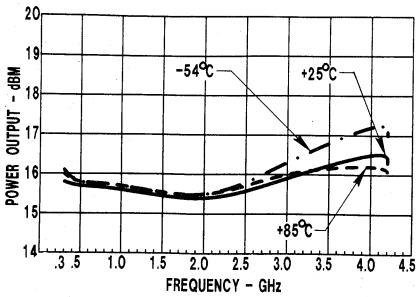

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

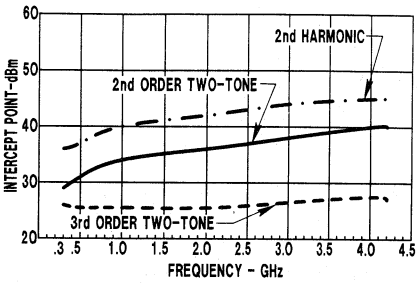



### Power Output*

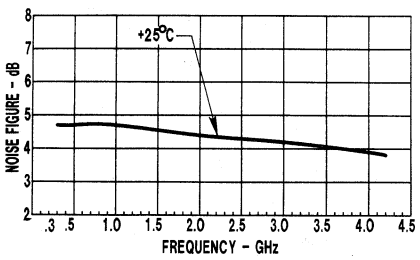



*at 1 dB Gain Compression

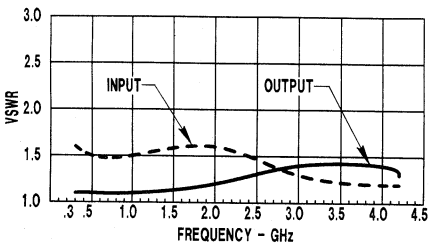
### Intercept Point




### Noise Figure




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 300.0 | 1.8 | 1.1 | 15.1 |
| 400.0 | 1.5 | 1.1 | 15.1 |
| 500.0 | 1.4 | 1.1 | 15.1 |
| 600.0 | 1.3 | 1.1 | 15.1 |
| 700.0 | 1.2 | 1.1 | 15.1 |
| 800.0 | 1.2 | 1.1 | 15.1 |
| 900.0 | 1.2 | 1.1 | 15.1 |
| 1000.0 | 1.2 | 1.1 | 15.1 |
| 1100.0 | 1.3 | 1.1 | 15.2 |
| 1200.0 | 1.3 | 1.1 | 15.2 |
| 1300.0 | 1.3 | 1.1 | 15.2 |
| 1400.0 | 1.4 | 1.1 | 15.3 |
| 1500.0 | 1.4 | 1.1 | 15.3 |
| 1600.0 | 1.4 | 1.1 | 15.3 |
| 1700.0 | 1.4 | 1.1 | 15.3 |
| 1800.0 | 1.4 | 1.1 | 15.3 |
| 1900.0 | 1.5 | 1.1 | 15.4 |
| 2000.0 | 1.4 | 1.2 | 15.4 |
| 2100.0 | 1.4 | 1.2 | 15.4 |
| 2200.0 | 1.4 | 1.2 | 15.5 |
| 2300.0 | 1.4 | 1.3 | 15.5 |
| 2400.0 | 1.4 | 1.3 | 15.5 |
| 2500.0 | 1.4 | 1.4 | 15.6 |
| 2600.0 | 1.4 | 1.4 | 15.5 |
| 2700.0 | 1.4 | 1.4 | 15.5 |
| 2800.0 | 1.3 | 1.5 | 15.4 |
| 2900.0 | 1.4 | 1.5 | 15.4 |
| 3000.0 | 1.3 | 1.5 | 15.3 |
| 3100.0 | 1.3 | 1.4 | 15.3 |
| 3200.0 | 1.3 | 1.4 | 15.3 |
| 3300.0 | 1.4 | 1.4 | 15.3 |
| 3400.0 | 1.4 | 1.3 | 15.4 |
| 3500.0 | 1.4 | 1.3 | 15.6 |
| 3600.0 | 1.4 | 1.2 | 15.7 |
| 3700.0 | 1.5 | 1.2 | 15.8 |
| 3800.0 | 1.5 | 1.2 | 15.9 |
| 3900.0 | 1.5 | 1.3 | 15.9 |
| 4000.0 | 1.5 | 1.3 | 16.0 |
| 4100.0 | 1.4 | 1.4 | 15.9 |
| 4200.0 | 1.4 | 1.4 | 16.0 |

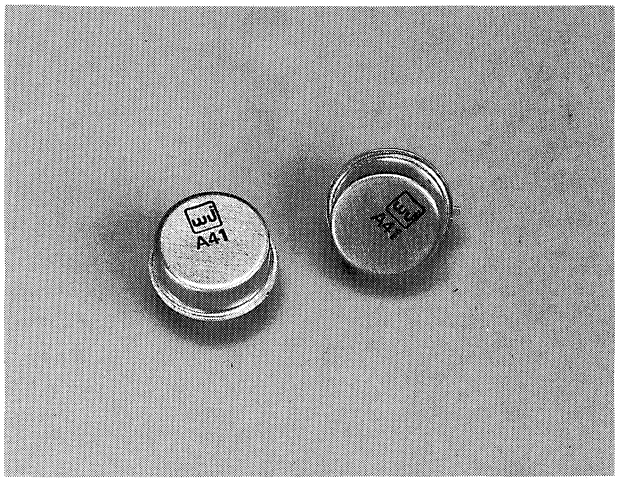
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 300.0 | .281 | −114 | 5.666 | −75 | .014 | −48 | .063 | 34 |
| 400.0 | .198 | −130 | 5.697 | −105 | .016 | −71 | .054 | 6 |
| 500.0 | .151 | −143 | 5.681 | −133 | .017 | −92 | .048 | −14 |
| 600.0 | .118 | −146 | 5.675 | −162 | .016 | −119 | .040 | −30 |
| 700.0 | .100 | −151 | 5.675 | 170 | .015 | −141 | .034 | −40 |
| 800.0 | .094 | −155 | 5.682 | 142 | .017 | −162 | .032 | −44 |
| 900.0 | .103 | −159 | 5.691 | 114 | .016 | 173 | .029 | −50 |
| 1000.0 | .107 | −168 | 5.694 | 86 | .017 | 150 | .032 | −54 |
| 1100.0 | .124 | 179 | 5.727 | 58 | .016 | 125 | .033 | −63 |
| 1200.0 | .136 | 163 | 5.759 | 30 | .015 | 108 | .038 | −76 |
| 1300.0 | .143 | 146 | 5.786 | 2 | .015 | 90 | .038 | -96 |
| 1400.0 | .159 | 131 | 5.796 | −26 | .017 | 61 | .039 | −124 |
| 1500.0 | .171 | 109 | 5.815 | −54 | .018 | 42 | .036 | −155 |
| 1600.0 | .172 | 89 | 5.814 | −82 | .017 | 14 | .033 | 171 |
| 1700.0 | .182 | 70 | 5.819 | −109 | .017 | −5 | .037 | 132 |
| 1800.0 | .183 | 49 | 5.826 | −137 | .017 | −25 | .043 | 94 |
| 1900.0 | .186 | 28 | 5.864 | −165 | .017 | −51 | .056 | 63 |
| 2000.0 | .172 | 6 | 5.873 | 167 | .017 | −74 | .073 | 40 |
| 2100.0 | .174 | −17 | 5.886 | 139 | .017 | −92 | .088 | 17 |
| 2200.0 | .166 | −40 | 5.943 | 110 | .017 | −119 | .105 | −5 |
| 2300.0 | .179 | −61 | 5.957 | 82 | .018 | −142 | .122 | −27 |
| 2400.0 | .175 | −83 | 5.973 | 54 | .018 | −166 | .143 | −47 |
| 2500.0 | .172 | −109 | 5.995 | 26 | .016 | 169 | .161 | −68 |
| 2600.0 | .165 | −129 | 5.967 | −3 | .018 | 148 | .173 | −88 |
| 2700.0 | .162 | −151 | 5.941 | −31 | .019 | 133 | .181 | −107 |
| 2800.0 | .149 | −174 | 5.899 | −59 | .019 | 106 | .185 | −127 |
| 2900.0 | .150 | 157 | 5.868 | −88 | .018 | 86 | .189 | −147 |
| 3000.0 | .142 | 134 | 5.838 | −116 | .018 | 56 | .186 | −165 |
| 3100.0 | .141 | 108 | 5.820 | −143 | .020 | 33 | .181 | 174 |
| 3200.0 | .138 | 79 | 5.835 | −172 | .020 | 8 | .175 | 150 |
| 3300.0 | .152 | 53 | 5.851 | 161 | .019 | −24 | .161 | 126 |
| 3400.0 | .158 | 22 | 5.914 | 132 | .018 | −41 | .143 | 98 |
| 3500.0 | .163 | −3 | 6.018 | 104 | .018 | −70 | .123 | 67 |
| 3600.0 | .174 | −33 | 6.062 | 75 | .020 | −93 | .108 | 28 |
| 3700.0 | .186 | −60 | 6.132 | 46 | .018 | −118 | .098 | −15 |
| 3800.0 | .193 | −86 | 6.213 | 18 | .016 | −145 | .107 | −59 |
| 3900.0 | .187 | −113 | 6.212 | −12 | .015 | −168 | .121 | −100 |
| 4000.0 | .187 | −138 | 6.319 | −41 | .015 | 163 | .142 | −134 |
| 4100.0 | .176 | −163 | 6.271 | −71 | .016 | 150 | .159 | −165 |
| 4200.0 | .173 | 175 | 6.285 | −101 | .014 | 129 | .166 | 166 |

# Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97°C/W
Transistor Power Dissipation $P_d$ ..... 0.240 W
Junction Temperature Rise Above Case $T_{jc}$ ... 23.3°C

# WJ-A41 / SMA41




## 1 to 4 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 1-4 GHz
- ◆ MEDIUM OUTPUT LEVEL: +12 dBm (TYP.)
- ◆ LOW NOISE: 4.0 dB (TYP.)
- ◆ GaAs FET DESIGN

## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85° C |
|---|---|---|---|
| Frequency (Min.) | .9-4.2 GHz | 1-4 GHz | 1-4 GHz |
| Small Signal Gain (Min.) | 8.5 dB | 7.0 dB | 6.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.7 dB | ±.9 dB |
| Noise Figure (Max.) | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output | | | |
| at 1 dBCompression (Min.) | +12.0 dBm | +11.0 dBm | +10.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.1:1 | 2.2:1 |
| output | 1.4:1 | 2.1:1 | 2.2:1 |
| DC Current (Max.) at + 5 Volts | 35 mA | 40 mA | 42 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA41 is a standard WJ-A41 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+25 dBm (Typ.)

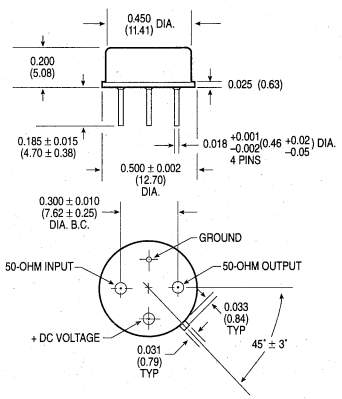
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+ 6 Volts
Maximum Continuous RF Input Power .....+12 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.25 Watts (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

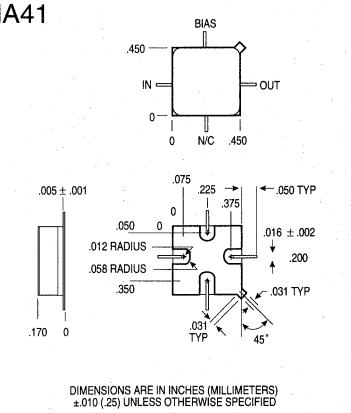
## Outline Drawings

A41



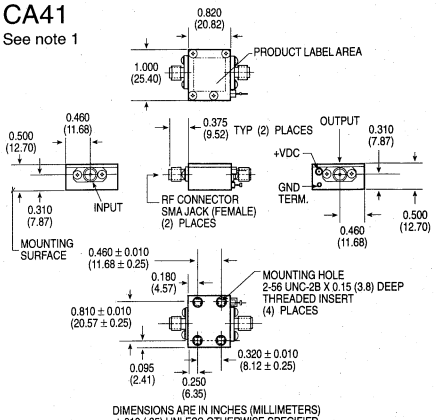

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA41




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

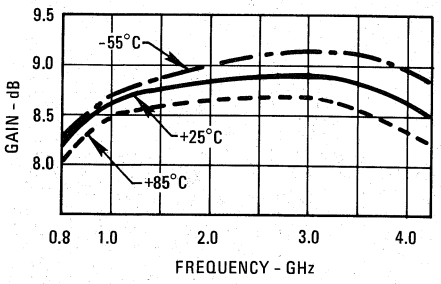
CA41
See note 1



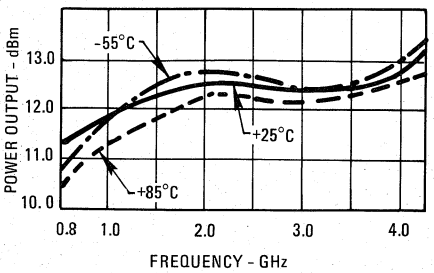

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

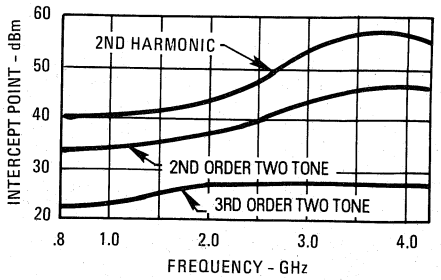



### Power Output*

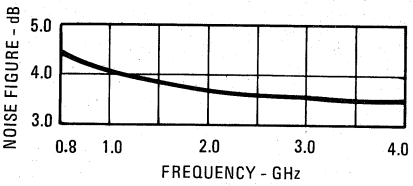



*at 1 dB Gain Compression

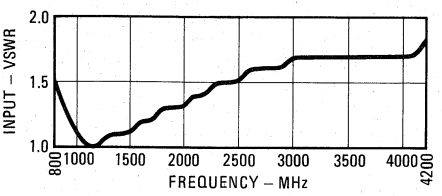
### Intercept Point

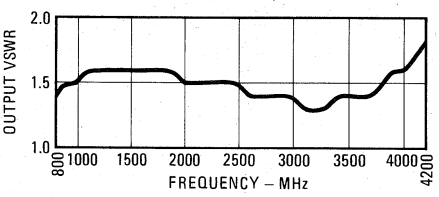



### Noise Figure




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.2 | 1.5 | 8.1 |
| 900.0 | 1.0 | 1.6 | 8.3 |
| 1000.0 | 1.1 | 1.7 | 8.4 |
| 1100.0 | 1.2 | 1.7 | 8.4 |
| 1200.0 | 1.3 | 1.7 | 8.5 |
| 1300.0 | 1.3 | 1.7 | 8.5 |
| 1400.0 | 1.3 | 1.7 | 8.5 |
| 1500.0 | 1.4 | 1.6 | 8.5 |
| 1600.0 | 1.4 | 1.6 | 8.6 |
| 1700.0 | 1.4 | 1.6 | 8.6 |
| 1800.0 | 1.4 | 1.6 | 8.5 |
| 1900.0 | 1.4 | 1.6 | 8.6 |
| 2000.0 | 1.4 | 1.6 | 8.5 |
| 2100.0 | 1.4 | 1.6 | 8.5 |
| 2200.0 | 1.4 | 1.6 | 8.6 |
| 2300.0 | 1.5 | 1.7 | 8.5 |
| 2400.0 | 1.5 | 1.7 | 8.5 |
| 2500.0 | 1.5 | 1.7 | 8.5 |
| 2600.0 | 1.4 | 1.7 | 8.4 |
| 2700.0 | 1.4 | 1.7 | 8.3 |
| 2800.0 | 1.4 | 1.7 | 8.3 |
| 2900.0 | 1.5 | 1.7 | 8.2 |
| 3000.0 | 1.5 | 1.7 | 8.2 |
| 3100.0 | 1.5 | 1.6 | 8.2 |
| 3200.0 | 1.5 | 1.5 | 8.2 |
| 3300.0 | 1.6 | 1.5 | 8.1 |
| 3400.0 | 1.6 | 1.4 | 8.2 |
| 3500.0 | 1.7 | 1.3 | 8.2 |
| 3600.0 | 1.7 | 1.3 | 8.1 |
| 3700.0 | 1.8 | 1.2 | 8.1 |
| 3800.0 | 1.9 | 1.1 | 8.1 |
| 3900.0 | 1.9 | 1.1 | 7.9 |
| 4000.0 | 2.0 | 1.1 | 8.0 |
| 4100.0 | 2.0 | 1.1 | 7.7 |
| 4200.0 | 2.1 | 1.2 | 7.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .074 | 60 | 2.529 | 79 | .150 | –92 | .204 | 56 |
| 900.0 | .015 | 139 | 2.594 | 41 | .150 | –126 | .236 | 15 |
| 1000.0 | .058 | 167 | 2.618 | 8 | .148 | –157 | .250 | –18 |
| 1100.0 | .096 | 145 | 2.641 | –23 | .146 | 175 | .258 | –47 |
| 1200.0 | .117 | 124 | 2.654 | –53 | .144 | 148 | .257 | –74 |
| 1300.0 | .128 | 101 | 2.676 | –82 | .145 | 122 | .251 | –101 |
| 1400.0 | .140 | 81 | 2.669 | –110 | .144 | 95 | .246 | –128 |
| 1500.0 | .159 | 58 | 2.671 | –138 | .143 | 71 | .236 | –155 |
| 1600.0 | .162 | 32 | 2.677 | –165 | .142 | 47 | .226 | 178 |
| 1700.0 | .164 | 13 | 2.680 | 168 | .142 | 22 | .222 | 152 |
| 1800.0 | .166 | –13 | 2.674 | 141 | .141 | –2 | .217 | 124 |
| 1900.0 | .170 | –35 | 2.687 | 114 | .140 | –26 | .222 | 95 |
| 2000.0 | .177 | –63 | 2.675 | 88 | .139 | –49 | .230 | 68 |
| 2100.0 | .178 | –86 | 2.664 | 62 | .139 | –73 | .237 | 41 |
| 2200.0 | .181 | –111 | 2.680 | 36 | .139 | –96 | .245 | 15 |
| 2300.0 | .187 | –131 | 2.663 | 10 | .136 | –119 | .255 | –11 |
| 2400.0 | .184 | –154 | 2.655 | –16 | .136 | –142 | .265 | –35 |
| 2500.0 | .190 | –179 | 2.660 | –42 | .134 | –166 | .269 | –58 |
| 2600.0 | .182 | 160 | 2.626 | –67 | .134 | 171 | .271 | –80 |
| 2700.0 | .173 | 138 | 2.606 | –93 | .135 | 150 | .272 | –102 |
| 2800.0 | .172 | 112 | 2.594 | –118 | .133 | 126 | .266 | –122 |
| 2900.0 | .187 | 91 | 2.584 | –143 | .133 | 103 | .257 | –142 |
| 3000.0 | .189 | 66 | 2.571 | –169 | .133 | 81 | .246 | –162 |
| 3100.0 | .196 | 45 | 2.566 | 166 | .133 | 58 | .232 | 178 |
| 3200.0 | .193 | 20 | 2.557 | 140 | .133 | 36 | .213 | 157 |
| 3300.0 | .223 | –0 | 2.550 | 115 | .134 | 13 | .191 | 136 |
| 3400.0 | .233 | –23 | 2.563 | 90 | .134 | –10 | .165 | 115 |
| 3500.0 | .254 | –46 | 2.558 | 64 | .136 | –33 | .140 | 93 |
| 3600.0 | .269 | –71 | 2.547 | 38 | .137 | –56 | .112 | 69 |
| 3700.0 | .284 | –95 | 2.543 | 12 | .136 | –79 | .086 | 40 |
| 3800.0 | .301 | –120 | 2.527 | –13 | .137 | –102 | .068 | 3 |
| 3900.0 | .319 | –144 | 2.495 | –39 | .136 | –125 | .056 | –42 |
| 4000.0 | .339 | –170 | 2.500 | –65 | .136 | –149 | .057 | –90 |
| 4100.0 | .339 | 164 | 2.440 | –91 | .135 | –172 | .067 | –130 |
| 4200.0 | .357 | 136 | 2.420 | –117 | .136 | 165 | .079 | –162 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-A41-1 / SMA41-1

## 1 to 4 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH
- ◆ HIGH OUTPUT LEVEL: +19.0 dBm (TYP.)
- ◆ LOW NOISE: 3.5 dB (TYP.)

## Specifications*

| Characteristics | Typical. | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 0.9-4.2 GHz | 1-4 GHz | 1-4 GHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.0 dB | 7.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.5 dB | 4.7 dB | 5.2 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +19.0 dBm | +17.0 dBm | +16.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.0:1 | 2.1:1 |
| output | 1.4:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at 12 Volts | 70 mA | 75 mA | 77 mA |

*Measured in a 50-ohm system at +12 Vdc Nominal.
Notes:
1. WJ-CA41-1 is a standard WJ-A41-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+44 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

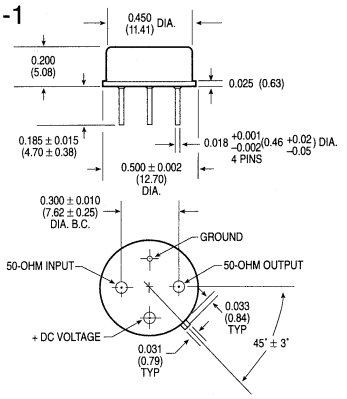
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+13 Volts
Maximum Continuous RF Input Power .....+14 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power ..... 0.25 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....85°C

Weight approximately 2.0 grams (0.07 oz.)

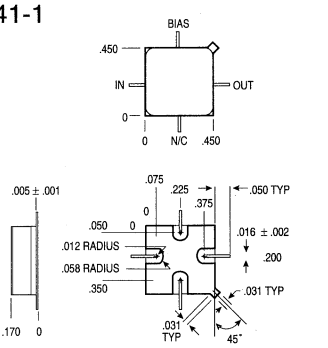
## Outline Drawings

A41-1



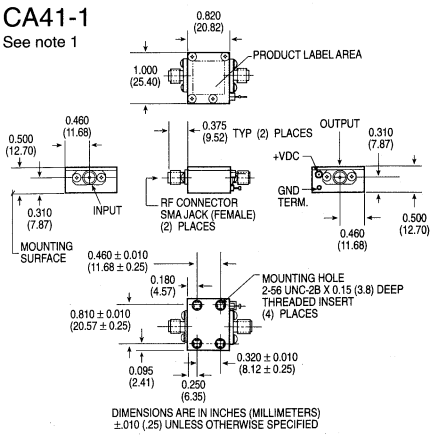

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA41-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

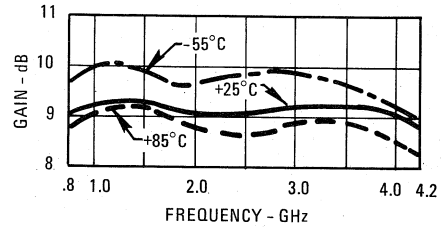
CA41-1
See note 1



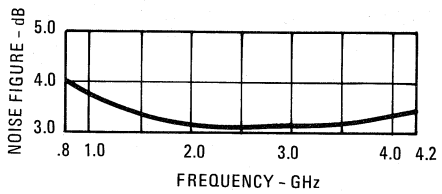

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

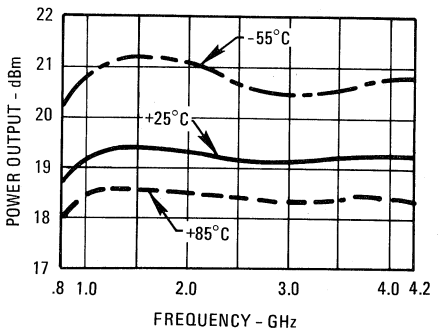
### Gain




### Noise Figure

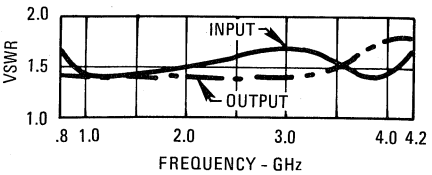



### Power Output*

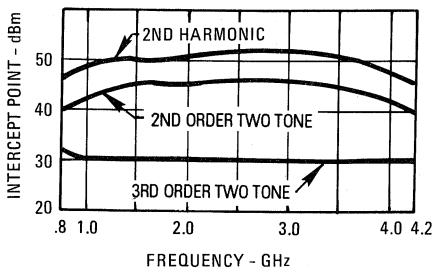



* at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.9 | 1.3 | 8.5 |
| 900.0 | 1.6 | 1.3 | 8.8 |
| 1000.0 | 1.5 | 1.3 | 8.9 |
| 1100.0 | 1.4 | 1.4 | 9.0 |
| 1200.0 | 1.3 | 1.4 | 9.1 |
| 1300.0 | 1.2 | 1.4 | 9.1 |
| 1400.0 | 1.2 | 1.4 | 9.2 |
| 1500.0 | 1.2 | 1.4 | 9.2 |
| 1600.0 | 1.2 | 1.4 | 9.2 |
| 1700.0 | 1.2 | 1.4 | 9.2 |
| 1800.0 | 1.2 | 1.4 | 9.1 |
| 1900.0 | 1.2 | 1.4 | 9.1 |
| 2000.0 | 1.2 | 1.4 | 9.1 |
| 2100.0 | 1.2 | 1.5 | 9.1 |
| 2200.0 | 1.3 | 1.5 | 9.1 |
| 2300.0 | 1.3 | 1.6 | 9.0 |
| 2400.0 | 1.3 | 1.6 | 9.0 |
| 2500.0 | 1.3 | 1.6 | 9.0 |
| 2600.0 | 1.3 | 1.7 | 9.0 |
| 2700.0 | 1.3 | 1.7 | 8.9 |
| 2800.0 | 1.4 | 1.7 | 8.9 |
| 2900.0 | 1.4 | 1.7 | 8.9 |
| 3000.0 | 1.4 | 1.7 | 8.9 |
| 3100.0 | 1.4 | 1.7 | 8.8 |
| 3200.0 | 1.5 | 1.7 | 8.9 |
| 3300.0 | 1.5 | 1.6 | 8.9 |
| 3400.0 | 1.5 | 1.6 | 9.0 |
| 3500.0 | 1.6 | 1.5 | 9.1 |
| 3600.0 | 1.6 | 1.5 | 9.1 |
| 3700.0 | 1.7 | 1.4 | 9.2 |
| 3800.0 | 1.7 | 1.4 | 9.2 |
| 3900.0 | 1.7 | 1.4 | 9.2 |
| 4000.0 | 1.7 | 1.4 | 9.4 |
| 4100.0 | 1.6 | 1.4 | 9.2 |
| 4200.0 | 1.7 | 1.4 | 9.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .307 | –55 | 2.654 | 50 | .144 | –105 | .135 | 137 |
| 900.0 | .240 | –87 | 2.749 | 16 | .146 | –138 | .129 | 74 |
| 1000.0 | .204 | –113 | 2.786 | –15 | .149 | –167 | .140 | 25 |
| 1100.0 | .158 | –141 | 2.821 | –44 | .149 | 165 | .155 | –14 |
| 1200.0 | .130 | –171 | 2.848 | –73 | .150 | 137 | .165 | –48 |
| 1300.0 | .105 | 160 | 2.866 | –100 | .148 | 111 | .167 | –80 |
| 1400.0 | .091 | 127 | 2.868 | –128 | .148 | 86 | .165 | –111 |
| 1500.0 | .088 | 98 | 2.874 | –156 | .146 | 60 | .162 | –142 |
| 1600.0 | .082 | 55 | 2.879 | 177 | .146 | 36 | .157 | –171 |
| 1700.0 | .088 | 29 | 2.872 | 151 | .144 | 11 | .159 | 158 |
| 1800.0 | .085 | –10 | 2.855 | 125 | .144 | –13 | .158 | 126 |
| 1900.0 | .099 | –33 | 2.864 | 99 | .142 | –37 | .166 | 95 |
| 2000.0 | .109 | –65 | 2.843 | 73 | .141 | –61 | .179 | 66 |
| 2100.0 | .110 | –88 | 2.839 | 47 | .139 | –84 | .190 | 38 |
| 2200.0 | .126 | –112 | 2.843 | 21 | .138 | –108 | .204 | 11 |
| 2300.0 | .128 | –129 | 2.830 | –5 | .136 | –131 | .217 | –13 |
| 2400.0 | .140 | –151 | 2.832 | –30 | .135 | –155 | .232 | –36 |
| 2500.0 | .149 | –175 | 2.827 | –56 | .133 | –178 | .243 | –58 |
| 2600.0 | .147 | 168 | 2.805 | –81 | .130 | 159 | .253 | –80 |
| 2700.0 | .144 | 150 | 2.798 | –107 | .130 | 135 | .263 | –100 |
| 2800.0 | .149 | 128 | 2.781 | –132 | .128 | 114 | .268 | –120 |
| 2900.0 | .161 | 109 | 2.775 | –157 | .125 | 91 | .270 | –140 |
| 3000.0 | .163 | 87 | 2.776 | 177 | .127 | 68 | .269 | –160 |
| 3100.0 | .181 | 65 | 2.766 | 152 | .128 | 46 | .266 | 179 |
| 3200.0 | .184 | 44 | 2.776 | 127 | .125 | 22 | .257 | 157 |
| 3300.0 | .204 | 20 | 2.789 | 102 | .127 | 0 | .245 | 135 |
| 3400.0 | .214 | –3 | 2.811 | 76 | .126 | –23 | .230 | 111 |
| 3500.0 | .229 | –26 | 2.836 | 50 | .126 | –46 | .210 | 86 |
| 3600.0 | .236 | –52 | 2.846 | 24 | .126 | –69 | .192 | 58 |
| 3700.0 | .247 | –78 | 2.873 | –2 | .127 | –91 | .174 | 28 |
| 3800.0 | .249 | –104 | 2.897 | –28 | .128 | –115 | .167 | –6 |
| 3900.0 | .248 | –132 | 2.895 | –55 | .128 | –139 | .159 | –40 |
| 4000.0 | .257 | –159 | 2.936 | –81 | .128 | –163 | .163 | –76 |
| 4100.0 | .245 | 172 | 2.894 | –108 | .127 | 174 | .170 | –109 |
| 4200.0 | .246 | 141 | 2.891 | –135 | .125 | 151 | .175 | –140 |

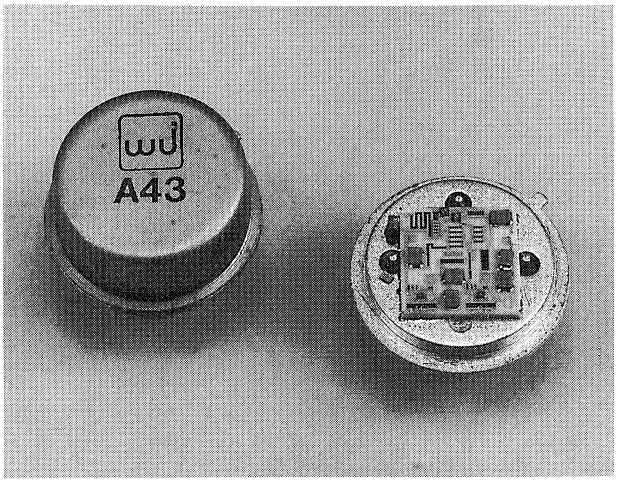
## Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 108.9°C/W
Transistor Power Dissipation $P_d$ ..... 0.504 W
Junction Temperature Rise Above Case $T_{jc}$ ... 55°C

# WJ-A43 / SMA43

## 100 to 3200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA-WIDE BANDWIDTH: 100-3200 MHz
- ◆ EXCELLENT GAIN BLOCK: 11.5 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8.5 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 80-3200 MHz | 100-3200 MHz | 100-3200 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.5 dB | 9.8 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.7 dB | 7.2 dB | 7.7 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7.0 dBm | +6.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.0:1 | 2.2:1 |
| output | 1.8:1 | 2.3:1 | 2.4:1 |
| DC Current (Max) at 15 Volts | 45 mA | 48 mA | 50 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA43 is a standard WJ-A43 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

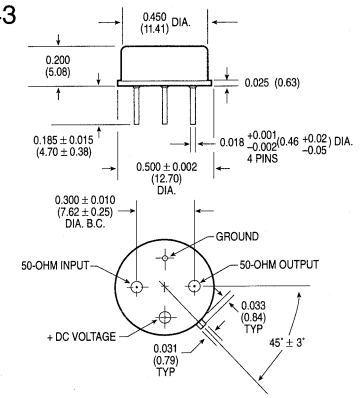
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

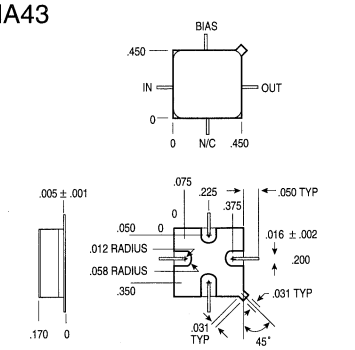
## Outline Drawings

A43



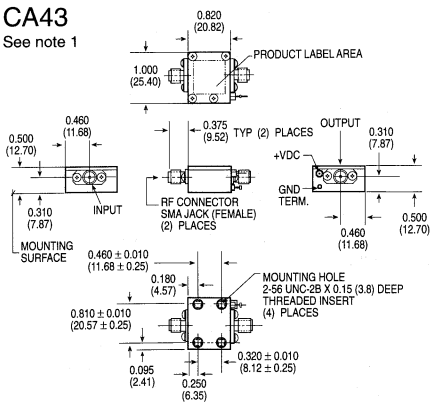

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA43




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

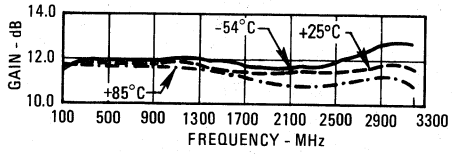
CA43
See note 1



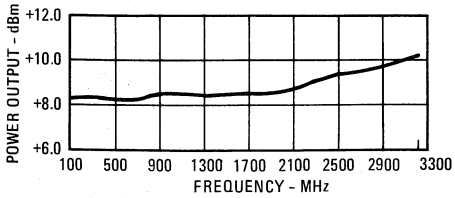

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

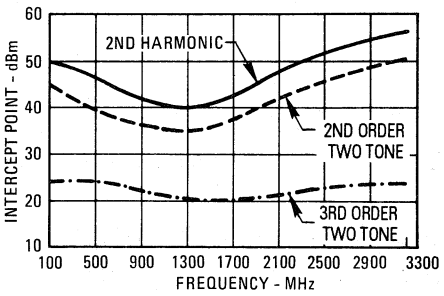



### Power Output*

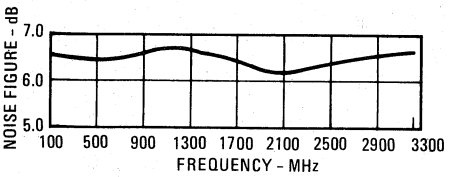



* at 1 dB Gain Compression

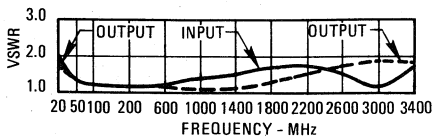
### Intercept Point




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 100.0 | 1.1 | 1.2 | 12.3 |
| 200.0 | 1.1 | 1.1 | 12.3 |
| 300.0 | 1.1 | 1.2 | 12.3 |
| 400.0 | 1.1 | 1.2 | 12.3 |
| 500.0 | 1.1 | 1.2 | 12.3 |
| 600.0 | 1.1 | 1.3 | 12.3 |
| 700.0 | 1.2 | 1.3 | 12.3 |
| 800.0 | 1.2 | 1.3 | 12.3 |
| 900.0 | 1.2 | 1.4 | 12.3 |
| 1000.0 | 1.2 | 1.4 | 12.2 |
| 1100.0 | 1.3 | 1.4 | 12.2 |
| 1200.0 | 1.3 | 1.4 | 12.3 |
| 1300.0 | 1.3 | 1.4 | 12.3 |
| 1400.0 | 1.3 | 1.4 | 12.2 |
| 1500.0 | 1.3 | 1.4 | 12.2 |
| 1600.0 | 1.4 | 1.5 | 12.2 |
| 1700.0 | 1.3 | 1.5 | 12.1 |
| 1800.0 | 1.4 | 1.5 | 12.1 |
| 1900.0 | 1.4 | 1.5 | 12.1 |
| 2000.0 | 1.4 | 1.4 | 12.1 |
| 2100.0 | 1.4 | 1.4 | 12.2 |
| 2200.0 | 1.4 | 1.3 | 12.2 |
| 2300.0 | 1.4 | 1.2 | 12.2 |
| 2400.0 | 1.4 | 1.2 | 12.2 |
| 2500.0 | 1.4 | 1.1 | 12.2 |
| 2600.0 | 1.3 | 1.2 | 12.1 |
| 2700.0 | 1.3 | 1.3 | 12.1 |
| 2800.0 | 1.3 | 1.4 | 12.0 |
| 2900.0 | 1.3 | 1.6 | 11.9 |
| 3000.0 | 1.4 | 1.8 | 11.8 |
| 3100.0 | 1.4 | 1.9 | 11.6 |
| 3200.0 | 1.5 | 2.0 | 11.4 |
| 3300.0 | 1.6 | 2.1 | 11.1 |
| 3400.0 | 1.8 | 2.2 | 10.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.0 | .069 | −90 | 4.108 | −21 | .040 | −8 | .071 | −163 |
| 200.0 | .050 | −103 | 4.132 | −58 | .041 | −38 | .062 | 128 |
| 300.0 | .050 | −130 | 4.110 | −91 | .041 | −62 | .075 | 84 |
| 400.0 | .051 | −131 | 4.123 | −124 | .042 | −87 | .092 | 50 |
| 500.0 | .063 | −157 | 4.116 | −155 | .041 | −110 | .108 | 22 |
| 600.0 | .068 | −173 | 4.113 | 173 | .041 | −135 | .123 | −6 |
| 700.0 | .076 | 163 | 4.112 | 141 | .041 | −157 | .135 | −32 |
| 800.0 | .083 | 146 | 4.104 | 110 | .041 | −179 | .148 | −58 |
| 900.0 | .097 | 123 | 4.115 | 77 | .038 | 157 | .156 | −87 |
| 1000.0 | .104 | 106 | 4.085 | 46 | .038 | 135 | .162 | −115 |
| 1100.0 | .112 | 85 | 4.092 | 14 | .039 | 112 | .163 | −144 |
| 1200.0 | .123 | 65 | 4.097 | −18 | .038 | 88 | .167 | −173 |
| 1300.0 | .133 | 40 | 4.100 | −49 | .038 | 64 | .170 | 155 |
| 1400.0 | .134 | 21 | 4.077 | −80 | .038 | 42 | .175 | 125 |
| 1500.0 | .137 | 0 | 4.070 | −112 | .038 | 20 | .182 | 94 |
| 1600.0 | .155 | −24 | 4.053 | −143 | .037 | −4 | .184 | 64 |
| 1700.0 | .147 | −44 | 4.048 | −174 | .037 | −26 | .187 | 36 |
| 1800.0 | .161 | −67 | 4.039 | 155 | .037 | −49 | .191 | 8 |
| 1900.0 | .156 | −90 | 4.037 | 124 | .037 | −71 | .187 | −17 |
| 2000.0 | .169 | −115 | 4.049 | 93 | .037 | −94 | .172 | −41 |
| 2100.0 | .166 | −136 | 4.052 | 61 | .036 | −117 | .154 | −64 |
| 2200.0 | .164 | −159 | 4.069 | 30 | .036 | −141 | .132 | −85 |
| 2300.0 | .156 | 179 | 4.064 | −1 | .035 | −162 | .101 | −100 |
| 2400.0 | .150 | 155 | 4.065 | −33 | .037 | 175 | .071 | −104 |
| 2500.0 | .150 | 131 | 4.071 | −65 | .036 | 152 | .060 | −85 |
| 2600.0 | .133 | 102 | 4.049 | −97 | .035 | 127 | .087 | −72 |
| 2700.0 | .132 | 73 | 4.026 | −129 | .035 | 104 | .132 | −80 |
| 2800.0 | .140 | 42 | 3.977 | −161 | .035 | 82 | .178 | −97 |
| 2900.0 | .142 | 16 | 3.938 | 167 | .036 | 61 | .226 | −118 |
| 3000.0 | .162 | −18 | 3.891 | 134 | .037 | 38 | .275 | −140 |
| 3100.0 | .182 | −46 | 3.797 | 102 | .036 | 12 | .308 | −163 |
| 3200.0 | .212 | −76 | 3.704 | 69 | .036 | −8 | .334 | 171 |
| 3300.0 | .245 | −107 | 3.608 | 37 | .036 | −31 | .358 | 146 |
| 3400.0 | .273 | −134 | 3.496 | 3 | .038 | −52 | .372 | 120 |

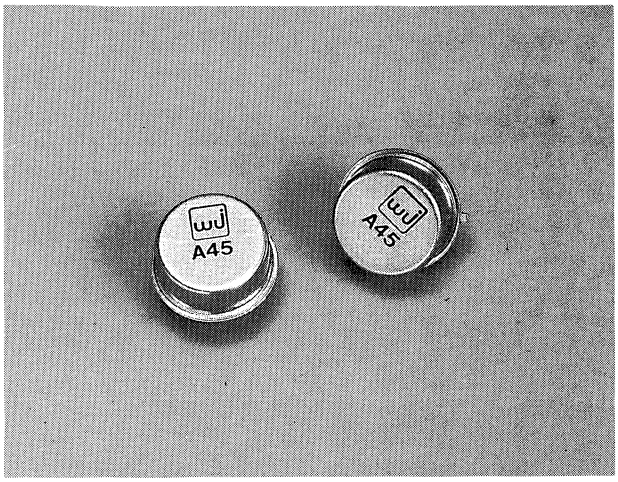
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.187 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A45 / SMA45

## 1 to 4 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN 17.5 dB (TYP.)
- ◆ LOW NOISE 4.5 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +19.5 dBm (TYP.)
- ◆ GaAs FET DESIGN




## Specifications*

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -55° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-4 GHz | 1-4 GHz | 1-4 GHz |
| Small Signal Gain (Min.) | 17.5 dB | 16.5 dB | 15.5 dB |
| Gain Flatness (Max.) | ±0.6 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 1-2 GHz | 4.5 dB | 5.5 dB | 6.0 dB |
| 2-4 GHz | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output | | | |
| at 1dB Compression (Min.) | +19.5 dBm | +18 dBm | +17 dBm |
| VSWR (Max.) Input | 1.8:1 | 2.1:1 | 2.2:1 |
| VSWR (Max.) Output | 1.7:1 | 2.1:1 | 2.2:1 |
| DC Current (Max.) at +15 volts | 120 mA | 125 mA | 130 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA45 is a standard WJ-A45 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+44 dBm (Typ.)
Second Order Two Tone Intercept Point.....+39 dBm (Typ.)
Third Order Two Tone Intercept Point.....+29 dBm (Typ.)

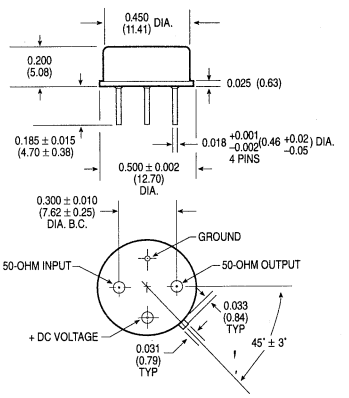
## Absolute Maximum Ratings

Storage Temperature .....-65°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watts (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

Weight approximately 2.0 grams (0.07 oz.)

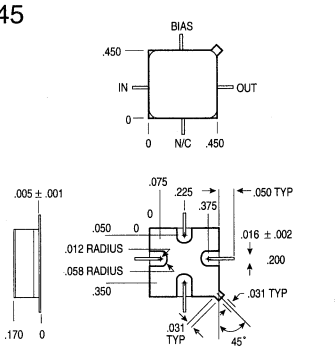
## Outline Drawings

A45



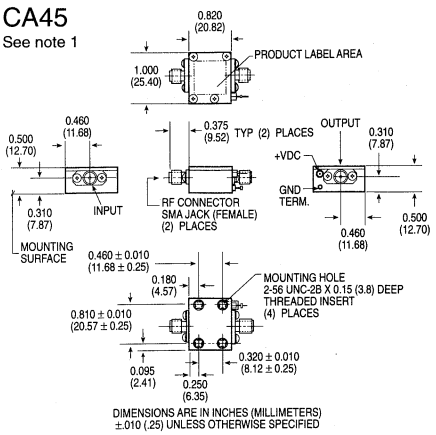

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA45




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

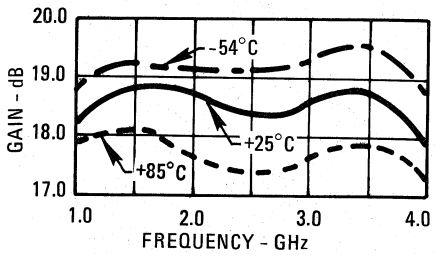
CA45
See note 1



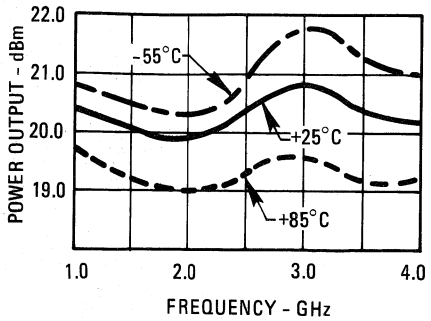

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

**Gain**

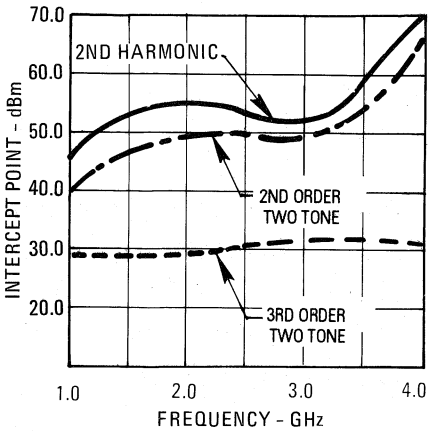



**Power Output***

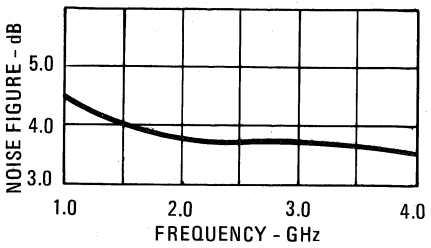



*at 1 dB Gain Compression

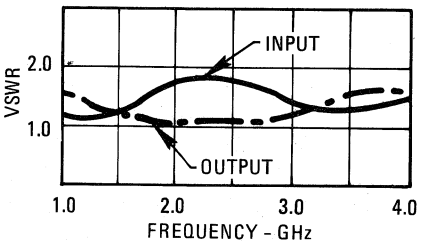
**Intercept Point**




**Noise Figure**




**VSWR**




# Typical Automatic Test Data

**$V_{CC}$ = 15.0 V**

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.3 | 1.2 | 19.5 |
| 900.0 | 1.4 | 1.3 | 19.1 |
| 1000.0 | 1.4 | 1.5 | 18.9 |
| 1100.0 | 1.4 | 1.5 | 18.9 |
| 1200.0 | 1.3 | 1.6 | 19.0 |
| 1300.0 | 1.2 | 1.6 | 19.2 |
| 1400.0 | 1.2 | 1.6 | 19.3 |
| 1500.0 | 1.1 | 1.6 | 19.4 |
| 1600.0 | 1.1 | 1.6 | 19.5 |
| 1700.0 | 1.1 | 1.5 | 19.6 |
| 1800.0 | 1.1 | 1.5 | 19.6 |
| 1900.0 | 1.2 | 1.4 | 19.7 |
| 2000.0 | 1.2 | 1.4 | 19.7 |
| 2100.0 | 1.3 | 1.3 | 19.6 |
| 2200.0 | 1.4 | 1.3 | 19.6 |
| 2300.0 | 1.4 | 1.2 | 19.6 |
| 2400.0 | 1.5 | 1.2 | 19.5 |
| 2500.0 | 1.5 | 1.1 | 19.4 |
| 2600.0 | 1.6 | 1.1 | 19.3 |
| 2700.0 | 1.6 | 1.1 | 19.2 |
| 2800.0 | 1.5 | 1.1 | 19.1 |
| 2900.0 | 1.5 | 1.1 | 19.0 |
| 3000.0 | 1.5 | 1.2 | 18.9 |
| 3100.0 | 1.5 | 1.2 | 18.8 |
| 3200.0 | 1.5 | 1.3 | 18.7 |
| 3300.0 | 1.5 | 1.4 | 18.6 |
| 3400.0 | 1.5 | 1.4 | 18.6 |
| 3500.0 | 1.5 | 1.5 | 18.6 |
| 3600.0 | 1.5 | 1.6 | 18.5 |
| 3700.0 | 1.5 | 1.6 | 18.5 |
| 3800.0 | 1.5 | 1.6 | 18.5 |
| 3900.0 | 1.5 | 1.7 | 18.5 |
| 4000.0 | 1.5 | 1.7 | 18.6 |
| 4100.0 | 1.5 | 1.7 | 18.7 |
| 4200.0 | 1.5 | 1.6 | 18.9 |

**Linear S-Parameters**

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .138 | 149 | 9.451 | –98 | .019 | –24 | .084 | –103 |
| 900.0 | .178 | 119 | 9.018 | –144 | .018 | –65 | .147 | –166 |
| 1000.0 | .176 | 91 | 8.803 | 176 | .016 | –104 | .184 | 151 |
| 1100.0 | .155 | 65 | 8.849 | 139 | .015 | –140 | .210 | 113 |
| 1200.0 | .133 | 41 | 8.962 | 104 | .016 | –167 | .225 | 79 |
| 1300.0 | .107 | 14 | 9.083 | 70 | .016 | 166 | .234 | 48 |
| 1400.0 | .074 | –7 | 9.226 | 36 | .015 | 136 | .237 | 19 |
| 1500.0 | .043 | –13 | 9.354 | 2 | .016 | 113 | .233 | –8 |
| 1600.0 | .027 | –13 | 9.459 | –31 | .016 | 89 | .228 | –34 |
| 1700.0 | .037 | 33 | 9.523 | –63 | .014 | 62 | .213 | –58 |
| 1800.0 | .056 | 26 | 9.580 | –95 | .014 | 32 | .197 | –81 |
| 1900.0 | .083 | 10 | 9.613 | –127 | .015 | 10 | .177 | –102 |
| 2000.0 | .099 | –19 | 9.623 | –159 | .014 | –16 | .155 | –124 |
| 2100.0 | .132 | –42 | 9.598 | 169 | .015 | –37 | .135 | –145 |
| 2200.0 | .150 | –68 | 9.584 | 138 | .013 | –68 | .116 | –165 |
| 2300.0 | .175 | –88 | 9.506 | 107 | .014 | –91 | .095 | 174 |
| 2400.0 | .192 | –111 | 9.414 | 77 | .014 | –118 | .076 | 155 |
| 2500.0 | .210 | –134 | 9.372 | 46 | .013 | –135 | .063 | 135 |
| 2600.0 | .219 | –159 | 9.231 | 15 | .012 | –158 | .051 | 110 |
| 2700.0 | .218 | 178 | 9.140 | –15 | .014 | 170 | .049 | 80 |
| 2800.0 | .211 | 155 | 9.010 | –45 | .013 | 143 | .052 | 44 |
| 2900.0 | .215 | 131 | 8.922 | –75 | .015 | 125 | .062 | 9 |
| 3000.0 | .203 | 105 | 8.828 | –105 | .014 | 98 | .082 | –22 |
| 3100.0 | .204 | 83 | 8.724 | –135 | .012 | 74 | .106 | –47 |
| 3200.0 | .194 | 59 | 8.657 | –165 | .013 | 46 | .128 | –70 |
| 3300.0 | .197 | 36 | 8.555 | 165 | .015 | 19 | .155 | –92 |
| 3400.0 | .202 | 12 | 8.527 | 135 | .013 | 2 | .180 | –114 |
| 3500.0 | .203 | –12 | 8.506 | 105 | .013 | –32 | .203 | –134 |
| 3600.0 | .206 | –37 | 8.437 | 75 | .012 | –51 | .220 | –155 |
| 3700.0 | .212 | –60 | 8.421 | 45 | .013 | –76 | .235 | –176 |
| 3800.0 | .212 | –85 | 8.439 | 16 | .013 | –101 | .244 | 163 |
| 3900.0 | .205 | –111 | 8.421 | –15 | .013 | –133 | .252 | 141 |
| 4000.0 | .213 | –135 | 8.536 | –45 | .014 | –159 | .251 | 119 |
| 4100.0 | .202 | –160 | 8.579 | –75 | .014 | 172 | .249 | 95 |
| 4200.0 | .202 | 176 | 8.807 | –107 | .015 | 143 | .245 | 70 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.497 W
Junction Temperature Rise Above Case $T_{jc}$ ... 49°C

# WJ-A45-1 / SMA45-1

## 1 to 4 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH
- ◆ HIGH GAIN 17.5 dB (TYP.)
- ◆ LOW NOISE: 4.1 dB (TYP.)
- ◆ GaAs FET DESIGN

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50° | Guaranteed -55° to +85°C |
|---|---|---|---|
| Frequency (Min.) | .8-4.2 GHz | 1-4 GHz | 1-4 GHz |
| Small Signal Gain (Min.) | 17.5 dB | 16.5 dB | 15.5 dB |
| Gain Flatness (Max.) | ±0.6 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.1 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +13.0 dBm | +12.5 dBm | +12.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.8:1 | 1.9:0 | 2.0:1 |
| Output | 1.8:1 | 1.9:0 | 2.0:1 |
| DC Current (Max.) at 5.0 Volts | 65 mA | 75 mA | 80 mA |

*Measured in a 50-ohm system at +5.0 Vdc Nominal.

Notes:

1. WJ-CA45-1 is a standard WJ-A45-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+33 dBm (Typ.)
Third Order Two Tone Intercept Point.....+26 dBm (Typ.)

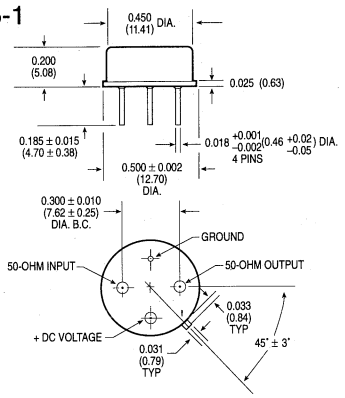
## Absolute Maximum Ratings

Storage Temperature .....-65° C to +125°C
Maximum Case Temperature. .....125°C
Maximum DC Voltage.....6.0 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

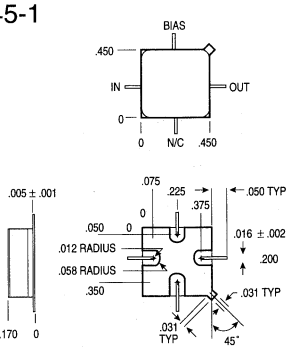
## Outline Drawings

A45-1



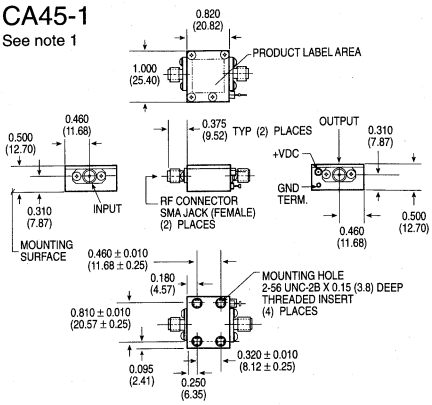

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA45-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

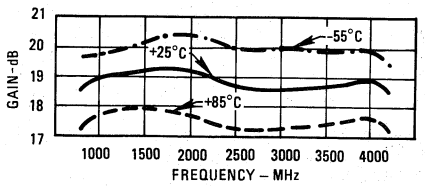
CA45-1
See note 1



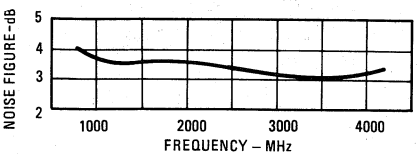

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

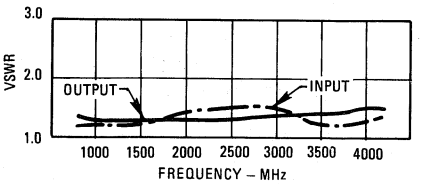
### Gain



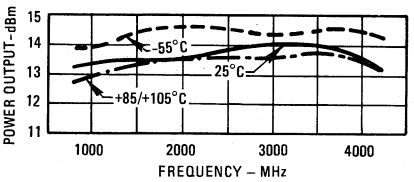

### Noise Figure




### VSWR

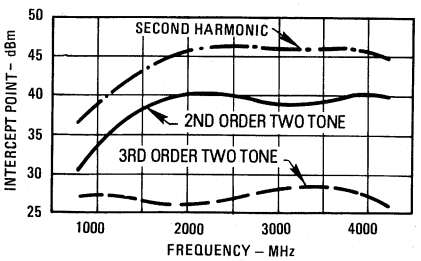



### Power Output*




*at 1 dB Gain Compression

### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.8 | 1.1 | 18.6 |
| 900.0 | 1.6 | 1.1 | 18.4 |
| 1000.0 | 1.5 | 1.1 | 18.4 |
| 1100.0 | 1.4 | 1.2 | 18.4 |
| 1200.0 | 1.3 | 1.3 | 18.4 |
| 1300.0 | 1.3 | 1.3 | 18.5 |
| 1400.0 | 1.3 | 1.3 | 18.5 |
| 1500.0 | 1.2 | 1.3 | 18.5 |
| 1600.0 | 1.2 | 1.3 | 18.5 |
| 1700.0 | 1.3 | 1.3 | 18.4 |
| 1800.0 | 1.3 | 1.3 | 18.4 |
| 1900.0 | 1.3 | 1.3 | 18.4 |
| 2000.0 | 1.3 | 1.3 | 18.4 |
| 2100.0 | 1.4 | 1.3 | 18.3 |
| 2200.0 | 1.4 | 1.2 | 18.3 |
| 2300.0 | 1.4 | 1.2 | 18.3 |
| 2400.0 | 1.5 | 1.2 | 18.3 |
| 2500.0 | 1.5 | 1.1 | 18.3 |
| 2600.0 | 1.5 | 1.1 | 18.2 |
| 2700.0 | 1.5 | 1.1 | 18.2 |
| 2800.0 | 1.5 | 1.1 | 18.1 |
| 2900.0 | 1.5 | 1.2 | 18.1 |
| 3000.0 | 1.4 | 1.3 | 18.1 |
| 3100.0 | 1.4 | 1.3 | 18.1 |
| 3200.0 | 1.4 | 1.4 | 18.1 |
| 3300.0 | 1.4 | 1.4 | 18.0 |
| 3400.0 | 1.3 | 1.5 | 18.0 |
| 3500.0 | 1.3 | 1.5 | 18.1 |
| 3600.0 | 1.3 | 1.5 | 18.1 |
| 3700.0 | 1.3 | 1.5 | 18.2 |
| 3800.0 | 1.3 | 1.5 | 18.3 |
| 3900.0 | 1.3 | 1.4 | 18.4 |
| 4000.0 | 1.3 | 1.3 | 18.5 |
| 4100.0 | 1.3 | 1.2 | 18.5 |
| 4200.0 | 1.4 | 1.2 | 18.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .284 | 95 | 8.472 | –99 | .014 | –38 | .028 | 10 |
| 900.0 | .244 | 64 | 8.362 | –143 | .013 | –73 | .033 | 165 |
| 1000.0 | .210 | 35 | 8.285 | 178 | .014 | –112 | .070 | 127 |
| 1100.0 | .178 | 3 | 8.308 | 142 | .013 | –146 | .096 | 94 |
| 1200.0 | .142 | –30 | 8.350 | 107 | .013 | –167 | .112 | 65 |
| 1300.0 | .126 | –66 | 8.382 | 73 | .013 | 169 | .125 | 38 |
| 1400.0 | .114 | –108 | 8.383 | 40 | .011 | 137 | .132 | 14 |
| 1500.0 | .105 | –151 | 8.380 | 7 | .013 | 112 | .139 | –9 |
| 1600.0 | .108 | 172 | 8.379 | –25 | .012 | 93 | .141 | –32 |
| 1700.0 | .125 | 133 | 8.358 | –56 | .014 | 62 | .138 | –53 |
| 1800.0 | .128 | 100 | 8.357 | –87 | .013 | 36 | .139 | –72 |
| 1900.0 | .144 | 69 | 8.352 | –118 | .013 | 11 | .130 | –92 |
| 2000.0 | .144 | 39 | 8.302 | –148 | .013 | –10 | .122 | –112 |
| 2100.0 | .157 | 4 | 8.247 | –178 | .012 | –31 | .114 | –136 |
| 2200.0 | .166 | –21 | 8.247 | 152 | .012 | –58 | .102 | –157 |
| 2300.0 | .184 | –49 | 8.225 | 122 | .012 | –81 | .089 | 179 |
| 2400.0 | .196 | –75 | 8.191 | 93 | .013 | –104 | .073 | 153 |
| 2500.0 | .201 | –103 | 8.210 | 63 | .012 | –133 | .059 | 124 |
| 2600.0 | .204 | –126 | 8.152 | 33 | .013 | –151 | .049 | 89 |
| 2700.0 | .200 | –153 | 8.157 | 4 | .011 | –170 | .052 | 46 |
| 2800.0 | .191 | –179 | 8.076 | –26 | .012 | 158 | .067 | 11 |
| 2900.0 | .186 | 155 | 8.047 | –55 | .013 | 133 | .090 | –23 |
| 3000.0 | .173 | 131 | 8.023 | –85 | .014 | 117 | .115 | –52 |
| 3100.0 | .170 | 104 | 8.000 | –114 | .011 | 89 | .138 | –76 |
| 3200.0 | .149 | 79 | 7.996 | –143 | .011 | 69 | .157 | –100 |
| 3300.0 | .149 | 54 | 7.962 | –173 | .012 | 40 | .175 | –122 |
| 3400.0 | .143 | 25 | 7.988 | 158 | .012 | 18 | .193 | –143 |
| 3500.0 | .135 | –3 | 8.027 | 128 | .013 | –1 | .207 | –165 |
| 3600.0 | .129 | –34 | 8.045 | 98 | .011 | –34 | .211 | 171 |
| 3700.0 | .130 | –63 | 8.142 | 68 | .011 | –46 | .207 | 146 |
| 3800.0 | .125 | –93 | 8.216 | 38 | .012 | –70 | .189 | 119 |
| 3900.0 | .124 | –129 | 8.287 | 8 | .012 | –99 | .171 | 91 |
| 4000.0 | .133 | –162 | 8.426 | –24 | .011 | –131 | .139 | 60 |
| 4100.0 | .134 | 160 | 8.407 | –55 | .011 | –161 | .111 | 21 |
| 4200.0 | .154 | 136 | 8.484 | –88 | .010 | –176 | .092 | –29 |

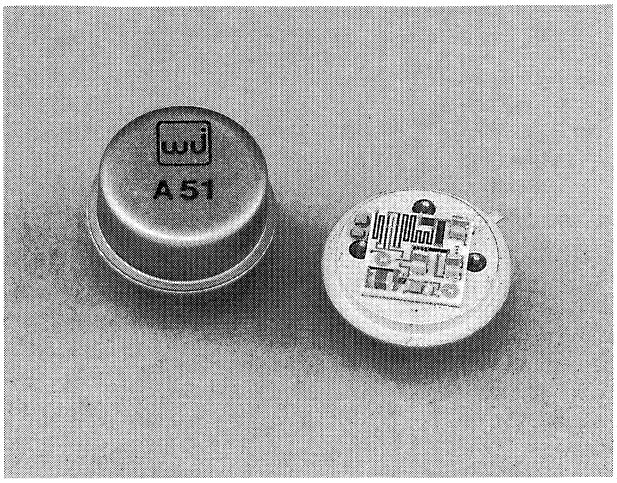
## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-A51 / SMA51

## 10 to 400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.7 dB (TYP.)
- ◆ LOW VSWR: < 1.3:1 (TYP.)
- ◆ FLAT BANDWIDTH: ±0.2 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-500 MHz | 10-400 MHz | 10-400 MHz |
| Small Signal Gain (Min.) | 15.0 dB | 14.0 dB | 13.0 dB |
| Gain Flatness (Max.) | < ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.7 dB | 3.0 dB | 3.5 dB |
| Power Output at 1 dB Compression (Min.) | -3.0 dBm | -3.5 dBm | -3.5 dBm |
| VSWR (Max.) Input/Output | < 1.3:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 7 mA | 9 mA | 11 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA51 is a standard WJ-A51 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+15 dBm (Typ.)
Second Order Two Tone Intercept Point.....+9 dBm (Typ.)
Third Order Two Tone Intercept Point..... +10 dBm (Typ.)

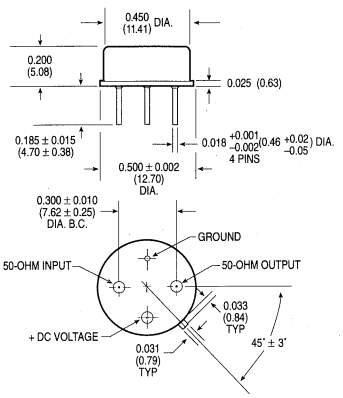
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

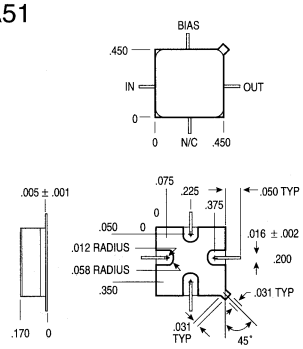
## Outline Drawings

A51



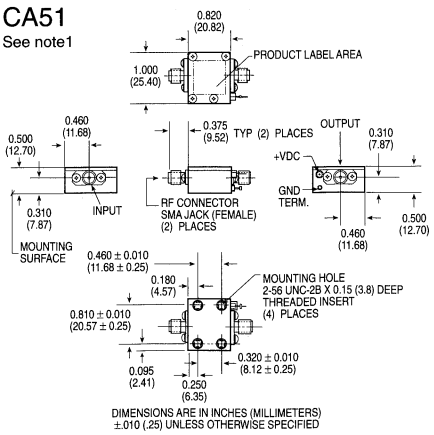

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA51




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

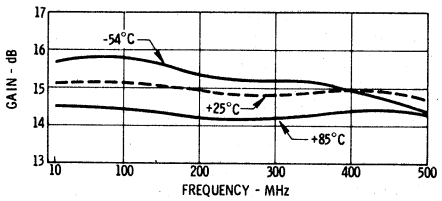
CA51
See note1



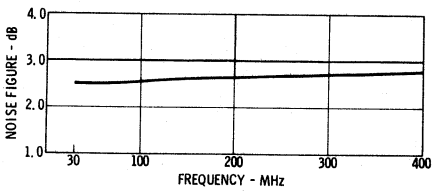

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

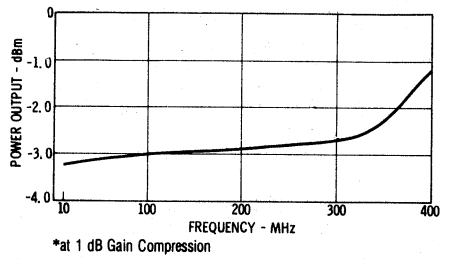
### Gain




### Noise Figure

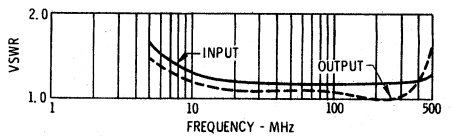



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 3.0 | 2.2 | 13.6 |
| 5.0 | 1.7 | 1.5 | 15.6 |
| 10.0 | 1.3 | 1.3 | 16.1 |
| 50.0 | 1.1 | 1.2 | 16.4 |
| 100.0 | 1.0 | 1.2 | 16.3 |
| 200.0 | 1.1 | 1.2 | 16.4 |
| 300.0 | 1.1 | 1.2 | 16.4 |
| 400.0 | 1.1 | 1.4 | 16.4 |
| 500.0 | 1.2 | 1.8 | 16.2 |
| 600.0 | 2.1 | 2.5 | 14.5 |
| 700.0 | 4.1 | 3.4 | 10.8 |

### Linear S-Parameters

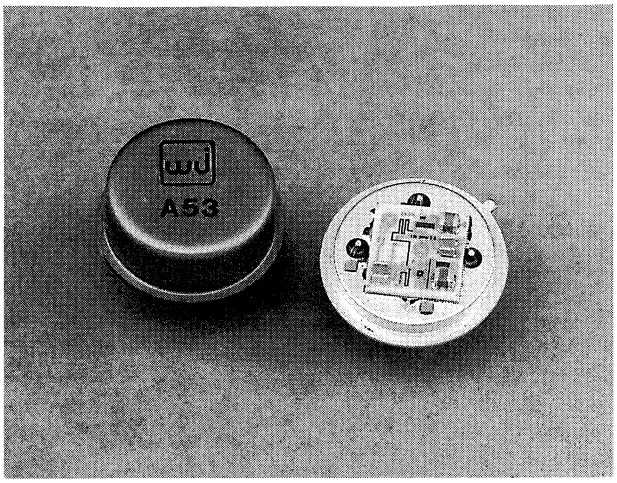
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .503 | -49 | 4.773 | -138 | .128 | -18 | .377 | -60 |
| 5.0 | .263 | -71 | 6.037 | -161 | .100 | -15 | .213 | -96 |
| 10.0 | .146 | -86 | 6.401 | -172 | .091 | -10 | .146 | -125 |
| 50.0 | .031 | -131 | 6.586 | 165 | .087 | -7 | .109 | -177 |
| 100.0 | .007 | 176 | 6.558 | 147 | .087 | -12 | .099 | 167 |
| 200.0 | .037 | -54 | 6.570 | 112 | .090 | -22 | .079 | 155 |
| 300.0 | .069 | -83 | 6.573 | 76 | .094 | -34 | .095 | 159 |
| 400.0 | .049 | -113 | 6.645 | 37 | .101 | -49 | .170 | 137 |
| 500.0 | .080 | -10 | 6.445 | -7 | .110 | -68 | .286 | 88 |
| 600.0 | .349 | -45 | 5.282 | -58 | .109 | -94 | .436 | 26 |
| 700.0 | .604 | -87 | 3.473 | -103 | .093 | -119 | .544 | -30 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.055 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A53 / SMA53

## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.0 dB (TYP.)
- ◆ MEDIUM THIRD ORDER I.P.: +16 dBm (TYP.)
- ◆ MEDIUM GAIN 15.0 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 15.0dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | +3.5 dBm | +2.0 dBm | +1.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 12 mA | 15 mA | 17 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA53 is a standard WJ-A53 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+28 dBm (Typ.)
Second Order Two Tone Intercept Point.....+22 dBm (Typ.)
Third Order Two Tone Intercept Point.....+16 dBm (Typ.)

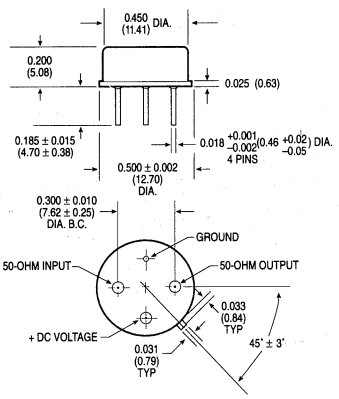
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

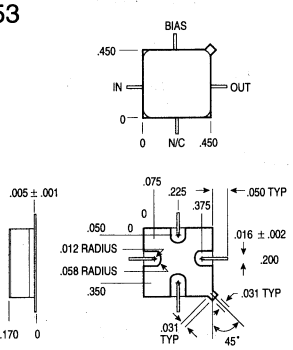
## Outline Drawings

A53



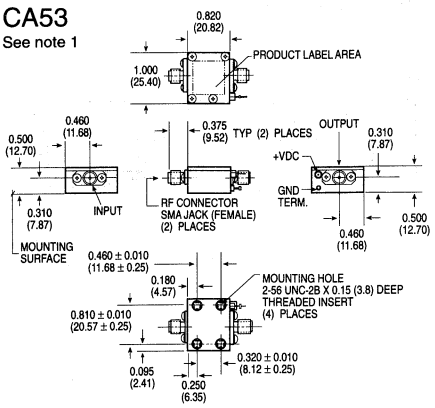

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA53




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

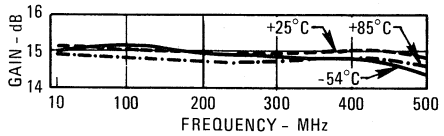
CA53
See note 1



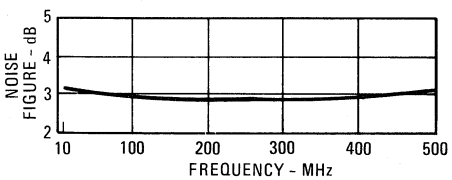

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

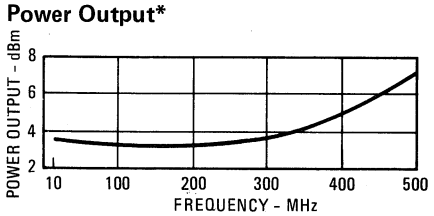
### Gain




### Noise Figure

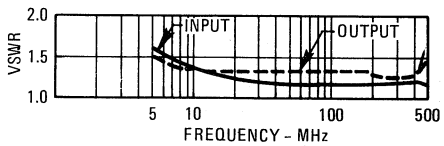



### Power Output*

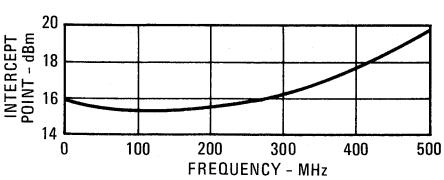



*at 1 dB Gain Compression

### VSWR




### 3rd Order Two Tone Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.6 | 2.0 | 12.3 |
| 5.0 | 1.6 | 1.6 | 14.2 |
| 10.0 | 1.3 | 1.5 | 14.7 |
| 50.0 | 1.2 | 1.5 | 14.9 |
| 100.0 | 1.2 | 1.5 | 14.8 |
| 200.0 | 1.4 | 1.5 | 14.8 |
| 300.0 | 1.4 | 1.5 | 14.7 |
| 400.0 | 1.4 | 1.5 | 14.8 |
| 500.0 | 1.4 | 1.6 | 14.5 |
| 600.0 | 2.2 | 2.1 | 13.6 |
| 700.0 | 4.5 | 3.1 | 11.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .438 | –55 | 4.130 | –141 | .143 | –18 | .334 | –77 |
| 5.0 | .230 | –85 | 5.149 | –162 | .111 | –15 | .237 | –121 |
| 10.0 | .132 | –110 | 5.430 | –173 | .101 | –10 | .210 | –148 |
| 50.0 | .072 | 150 | 5.554 | 167 | .096 | –7 | .202 | 180 |
| 100.0 | .108 | 100 | 5.520 | 151 | .097 | –11 | .197 | .169 |
| 200.0 | .156 | 49 | 5.481 | 121 | .102 | –20 | .188 | 153 |
| 300.0 | .179 | 15 | 5.455 | 91 | .108 | –32 | .191 | 134 |
| 400.0 | .173 | –5 | 5.482 | 58 | .116 | –47 | .201 | 105 |
| 500.0 | .168 | 8 | 5.333 | 23 | .125 | –66 | .233 | 55 |
| 600.0 | .365 | 7 | 4.788 | –18 | .125 | –89 | .345 | –8 |
| 700.0 | .634 | –23 | 3.686 | –57 | .107 | –114 | .511 | –63 |

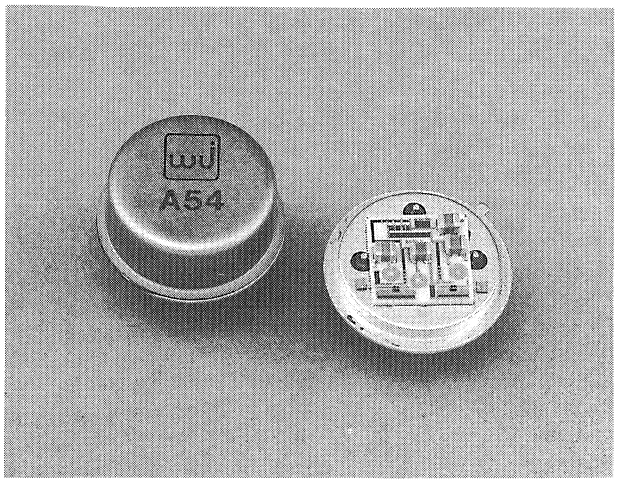
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.111 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A54 / SMA54

## 5 to 400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 27.5 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8 dBm (TYP.)
- ◆ LOW VSWR: < 1.4:1 (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-500 MHz | 5-400 MHz | 5-400 MHz |
| Small Signal Gain (Min.) | 27.5 dB | 26.0 dB | 24.0 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +6.5 dBm | +5.5 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 34 mA | 37 mA | 39 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA54 is a standard WJ-A54 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+39.5 dBm (Typ.)
Second Order Two Tone Intercept Point .....+32.5 dBm (Typ.)
Third Order Two Tone Intercept Point.....+19 dBm (Typ.)

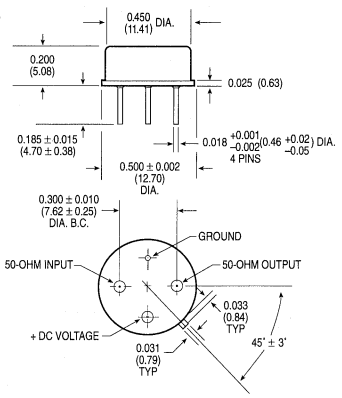
## Absolute Maximum Ratings

Storage Temperature .....-62°C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+12 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams(0.07oz.)

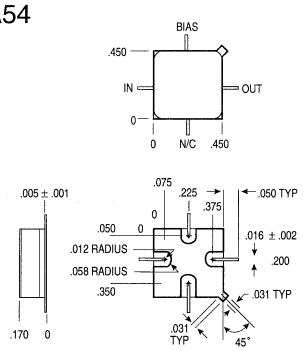
## Outline Drawings

A54



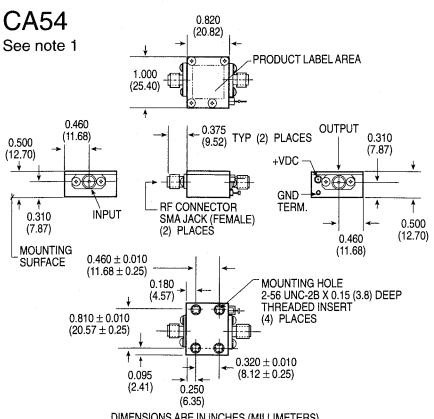

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA54




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

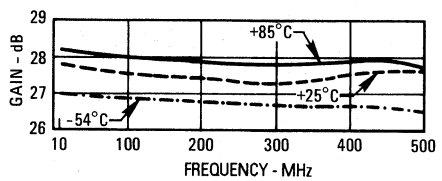
CA54
See note 1



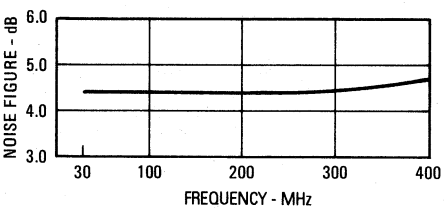

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

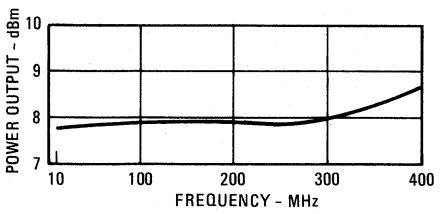
### Gain




### Noise Figure

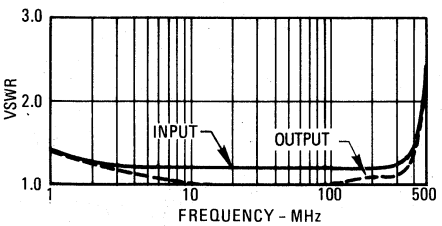



### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 28.3 |
| 2.0 | 1.2 | 1.3 | 28.4 |
| 5.0 | 1.2 | 1.2 | 28.5 |
| 10.0 | 1.2 | 1.2 | 28.5 |
| 50.0 | 1.2 | 1.2 | 28.5 |
| 100.0 | 1.1 | 1.2 | 28.5 |
| 200.0 | 1.1 | 1.1 | 28.4 |
| 300.0 | 1.1 | 1.2 | 28.2 |
| 400.0 | 1.2 | 1.3 | 28.4 |
| 500.0 | 1.7 | 2.2 | 28.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .137 | –50 | 25.903 | 24 | .005 | 23 | .183 | –50 |
| 2.0 | .105 | –33 | 26.332 | 12 | .005 | 14 | .122 | –36 |
| 5.0 | .088 | –15 | 26.497 | 3 | .006 | 6 | .098 | –18 |
| 10.0 | .083 | –11 | 26.517 | –2 | .006 | 2 | .094 | –12 |
| 50.0 | .074 | –14 | 26.603 | –21 | .006 | 4 | .088 | –15 |
| 100.0 | .069 | –15 | 26.493 | –42 | .006 | 12 | .081 | –24 |
| 200.0 | .051 | –40 | 26.201 | –86 | .008 | 10 | .069 | –43 |
| 300.0 | .031 | –82 | 25.616 | –129 | .009 | 7 | .074 | –80 |
| 400.0 | .071 | –158 | 26.165 | –173 | .012 | 2 | .144 | –137 |
| 500.0 | .268 | 153 | 27.910 | 137 | .017 | –18 | .366 | 167 |

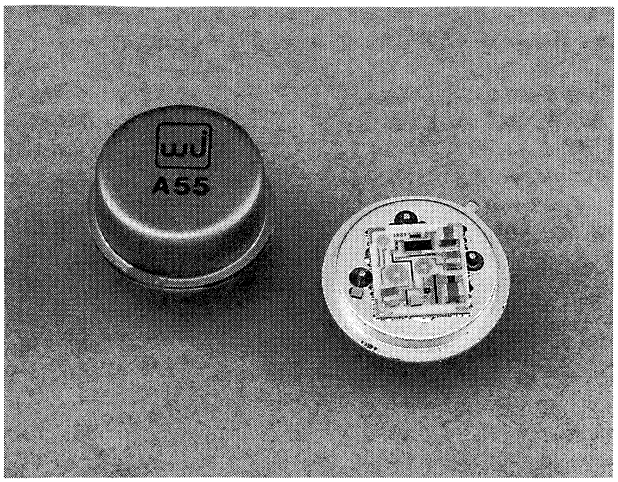
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.088 W
Junction Temperature Rise Above Case $T_{jc}$ ... 4°C

# WJ-A55 / SMA55

## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT LEVEL: +11 dBm (TYP.)
- ◆ MEDIUM THIRD ORDER I.P.: +24 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 14.7 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.0 dB | 6.0 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +11.0 dBm | +9.0 dBm | +8.0 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 30 mA | 35 mA | 37 mA |

Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA55 is a standard WJ-A55 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point..... +37 dBm (Typ.)
Third Order Two Tone Intercept Point.....+24 dBm (Typ.)

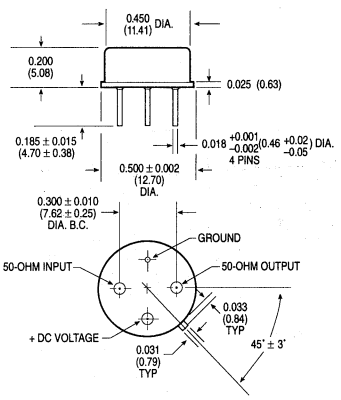
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+13dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

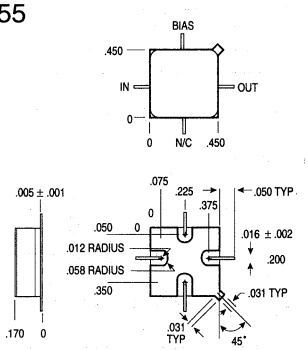
## Outline Drawings

A55



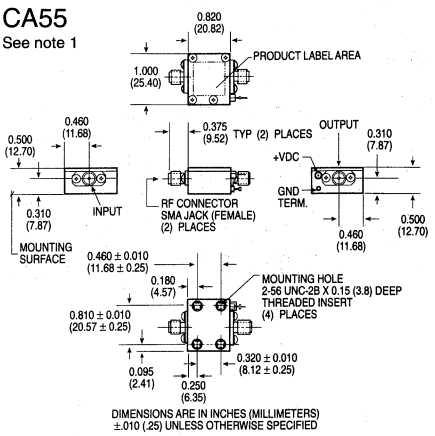

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA55




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

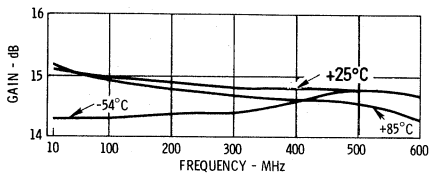
CA55
See note 1



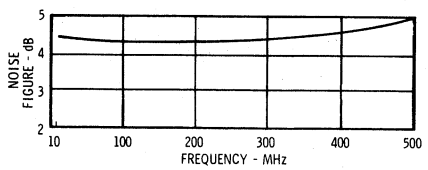

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

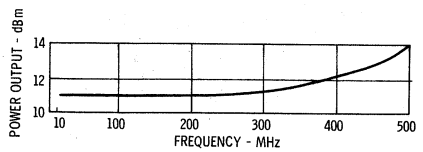
### Gain




### Noise Figure

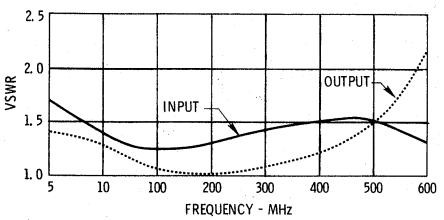



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.6 | 1.8 | 11.6 |
| 5.0 | 1.7 | 1.4 | 14.4 |
| 10.0 | 1.3 | 1.2 | 15.0 |
| 50.0 | 1.1 | 1.1 | 15.3 |
| 100.0 | 1.1 | 1.1 | 15.2 |
| 200.0 | 1.1 | 1.1 | 15.1 |
| 300.0 | 1.2 | 1.2 | 15.0 |
| 400.0 | 1.2 | 1.3 | 15.0 |
| 500.0 | 1.4 | 1.4 | 14.9 |
| 600.0 | 2.1 | 1.6 | 14.8 |
| 700.0 | 3.7 | 2.1 | 14.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .439 | –38 | 3.810 | –138 | .110 | –11 | .298 | –53 |
| 5.0 | .248 | –57 | 5.235 | –159 | .092 | –11 | .174 | –86 |
| 10.0 | .137 | –63 | 5.643 | –171 | .085 | –7 | .110 | –113 |
| 50.0 | .041 | –22 | 5.792 | 170 | .082 | –5 | .069 | –160 |
| 100.0 | .046 | 14 | 5.757 | 155 | .083 | –7 | .063 | –164 |
| 200.0 | .069 | –7 | 5.675 | 129 | .085 | –13 | .065 | –147 |
| 300.0 | .087 | –40 | 5.608 | 104 | .088 | –21 | .088 | –135 |
| 400.0 | .099 | –93 | 5.602 | 78 | .092 | –29 | .120 | –133 |
| 500.0 | .181 | –158 | 5.578 | 50 | .097 | –41 | .153 | –128 |
| 600.0 | .347 | 153 | 5.514 | 18 | .101 | –55 | .218 | –122 |
| 700.0 | .570 | 108 | 5.090 | –18 | .098 | –76 | .365 | –126 |

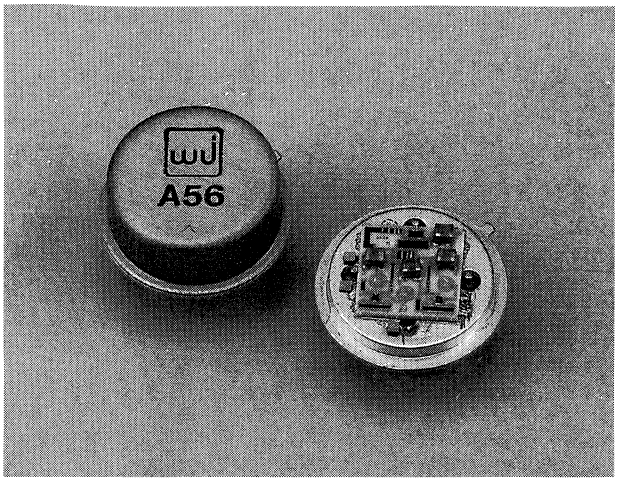
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.194 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A56 / SMA56

## 5 to 400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 26 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +13.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +27 dBm (TYP.)




## Specification*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-500 MHz | 5-400 MHz | 5-400 MHz |
| Small Signal Gain (Min.) | 26.0 dB | 24.0 dB | 23.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±1.0 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 7.0 dB | 7.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +13.5 dBm | +12.5 dBm | +12.0 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 69 mA | 75 mA | 79 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA56 is a standard WJ-A56 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+54 dBm (Typ.)
Second Order Two Tone Intercept Point.....+48 dBm (Typ.)
Third Order Two Tone Intercept Point.....+27 dBm (Typ.)

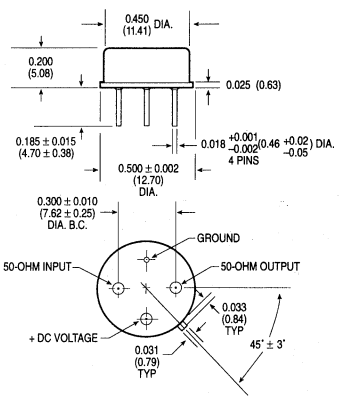
## Absolute Maximum Ratings

Storage Temperature .....-62° to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+12 dBm
Maximum ShortTerm RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

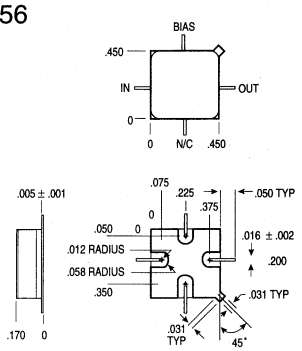
## Outline Drawings

A56



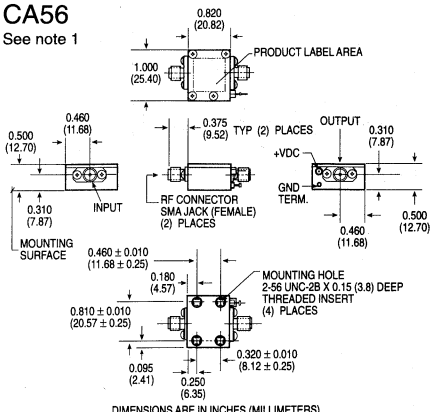

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA56




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

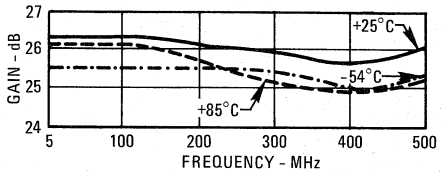
CA56
See note 1



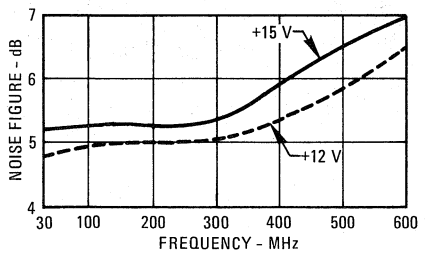

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

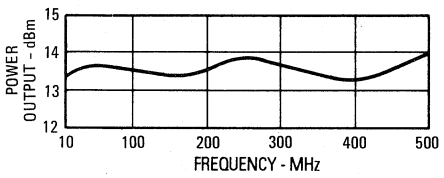
### Gain




### Noise Figure

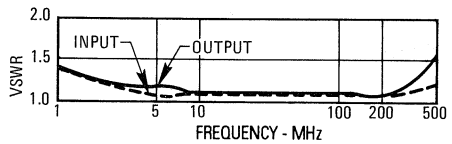



### Power Output*

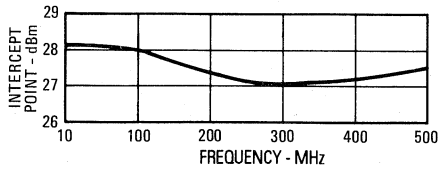



* at 1 dB Gain Compression

### VSWR




### 3rd Order Two Tone Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.3 | 25.6 |
| 2.0 | 1.2 | 1.2 | 25.9 |
| 5.0 | 1.2 | 1.1 | 25.9 |
| 10.0 | 1.1 | 1.1 | 26.0 |
| 50.0 | 1.1 | 1.1 | 26.0 |
| 100.0 | 1.2 | 1.1 | 26.0 |
| 200.0 | 1.2 | 1.1 | 26.0 |
| 300.0 | 1.3 | 1.2 | 25.9 |
| 400.0 | 1.4 | 1.4 | 26.0 |
| 500.0 | 1.4 | 1.9 | 26.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .150 | –102 | 19.062 | 30 | .007 | 26 | .143 | –60 |
| 2.0 | .102 | –123 | 19.622 | 15 | .007 | 12 | .087 | –44 |
| 5.0 | .074 | –154 | 19.811 | 4 | .007 | 5 | .067 | –21 |
| 10.0 | .068 | –170 | 19.893 | –1 | .007 | 4 | .065 | –13 |
| 50.0 | .067 | 157 | 19.940 | –20 | .007 | 2 | .061 | –15 |
| 100.0 | .076 | 125 | 19.899 | –41 | .008 | 7 | .060 | –25 |
| 200.0 | .086 | 69 | 19.938 | –83 | .008 | 1 | .062 | –39 |
| 300.0 | .120 | 18 | 19.720 | –125 | .010 | –2 | .087 | –58 |
| 400.0 | .177 | –24 | 20.025 | –167 | .012 | –12 | .156 | –89 |
| 500.0 | .176 | –54 | 21.581 | 150 | .016 | –27 | .319 | –126 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.3 | 25.0 |
| 2.0 | 1.2 | 1.2 | 25.2 |
| 5.0 | 1.1 | 1.1 | 25.3 |
| 10.0 | 1.1 | 1.1 | 25.4 |
| 50.0 | 1.1 | 1.1 | 25.4 |
| 100.0 | 1.1 | 1.1 | 25.4 |
| 200.0 | 1.2 | 1.1 | 25.4 |
| 300.0 | 1.3 | 1.2 | 25.3 |
| 400.0 | 1.4 | 1.4 | 25.4 |
| 500.0 | 1.4 | 1.9 | 26.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .168 | –93 | 17.807 | 30 | .007 | 26 | .145 | –60 |
| 2.0 | .088 | –114 | 18.294 | 15 | .007 | 13 | .089 | –44 |
| 5.0 | .057 | –143 | 18.489 | 4 | .007 | 5 | .069 | –21 |
| 10.0 | .049 | –163 | 18.538 | –1 | .007 | 4 | .066 | –13 |
| 50.0 | .053 | 157 | 18.569 | –20 | .008 | 1 | .062 | –15 |
| 100.0 | .054 | 119 | 18.538 | –41 | .008 | 3 | .060 | –24 |
| 200.0 | .070 | 62 | 18.563 | –83 | .009 | 2 | .063 | –39 |
| 300.0 | .111 | 12 | 18.369 | –124 | .011 | 0 | .087 | –58 |
| 400.0 | .167 | –29 | 18.684 | –166 | .013 | –13 | .154 | –87 |
| 500.0 | .165 | –59 | 20.183 | 151 | .017 | –30 | .314 | –124 |

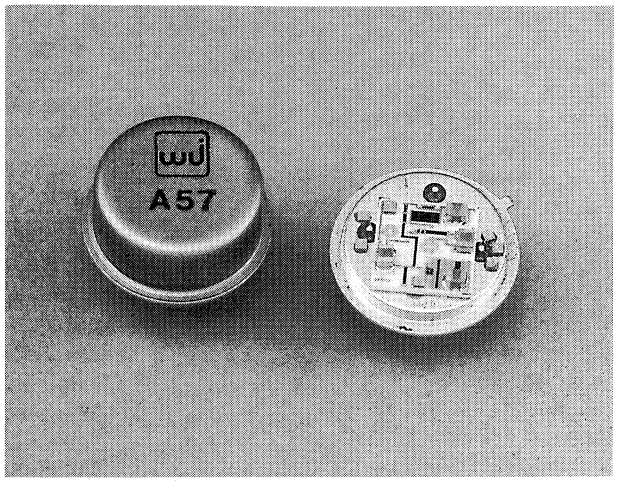
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.159 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-A57 / SMA57

## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT LEVEL: +14 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +28.0 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 14.7 dB | 14.0 dB | 13.0 dB |
| Gain Flatness (Max.) | < ±0.25 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.8 dB | 6.0 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +14 dBm | +13 dBm | +12.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 44 mA | 49 mA | 51 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA57 is a standard WJ-A57 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+46 dBm (Typ.)
Second Order Two Tone Intercept Point.....+41 dBm (Typ.)
Third Order Two Tone Intercept Point ..... +28 dBm (Typ.)

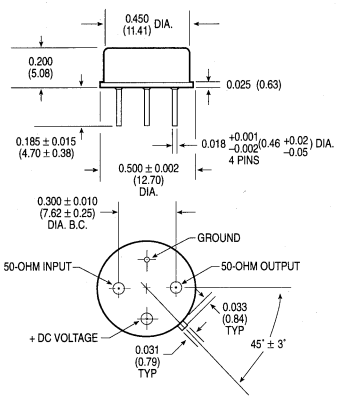
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power. .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

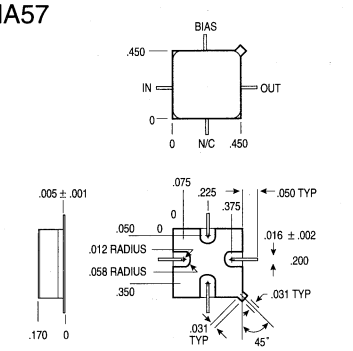
## Outline Drawings

A57



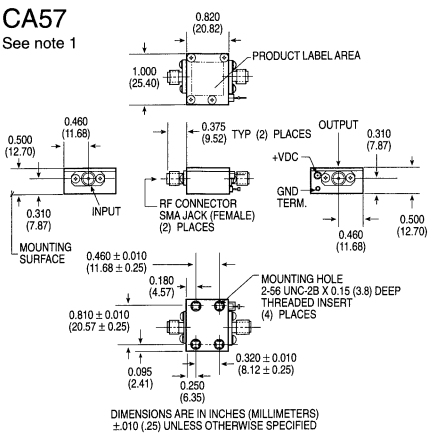

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA57




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

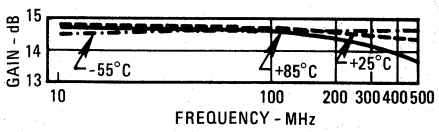
CA57
See note 1



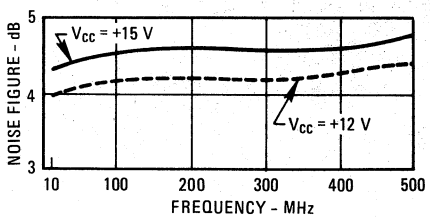

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

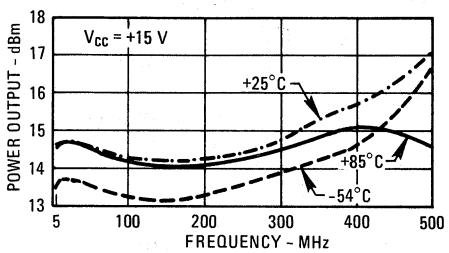
### Gain

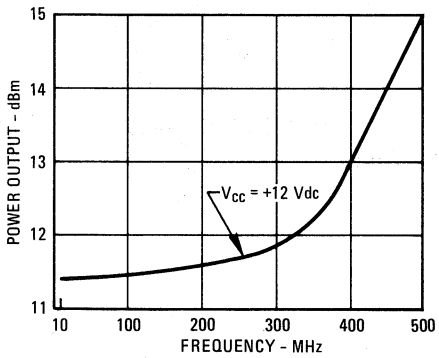



### Noise Figure



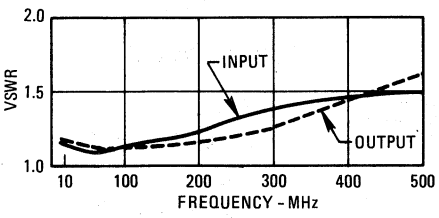

### Power Output*



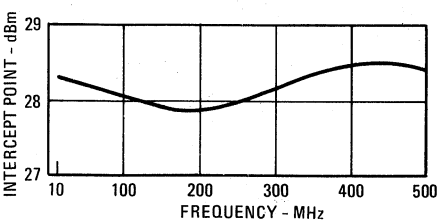




* at 1 dB Gain Compression

### VSWR




### 3rd Order Two Tone Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.6 | 2.0 | 8.2 |
| 2.0 | 2.1 | 1.7 | 11.6 |
| 5.0 | 1.5 | 1.4 | 14.2 |
| 10.0 | 1.3 | 1.3 | 14.9 |
| 50.0 | 1.2 | 1.2 | 15.1 |
| 100.0 | 1.1 | 1.2 | 15.0 |
| 200.0 | 1.1 | 1.2 | 15.1 |
| 300.0 | 1.3 | 1.2 | 15.1 |
| 400.0 | 1.4 | 1.3 | 15.3 |
| 500.0 | 1.5 | 1.5 | 15.1 |
| 600.0 | 1.4 | 1.7 | 14.1 |
| 700.0 | 1.4 | 2.1 | 11.6 |

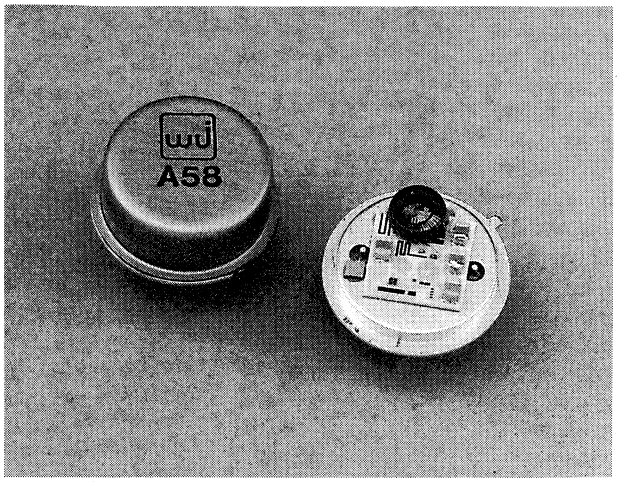
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .448 | –29 | 2.568 | –135 | .126 | –11 | .326 | –38 |
| 2.0 | .352 | –49 | 3.822 | –143 | .112 | –14 | .269 | –60 |
| 5.0 | .206 | –83 | 5.142 | –161 | .092 | –13 | .173 | –102 |
| 10.0 | .128 | –112 | 5.531 | –172 | .084 | –8 | .131 | –133 |
| 50.0 | .072 | –171 | 5.669 | 167 | .081 | –4 | .108 | –176 |
| 100.0 | .055 | 178 | 5.649 | 150 | .083 | –4 | .099 | 173 |
| 200.0 | .051 | –140 | 5.675 | 119 | .090 | –9 | .086 | 171 |
| 300.0 | .114 | –138 | 5.701 | 86 | .098 | –16 | .098 | 174 |
| 400.0 | .179 | –164 | 5.799 | 51 | .110 | –26 | .145 | 161 |
| 500.0 | .213 | 155 | 5.675 | 13 | .123 | –40 | .197 | 125 |
| 600.0 | .154 | 87 | 5.080 | –31 | .135 | –60 | .259 | 67 |
| 700.0 | .177 | –37 | 3.804 | –75 | .128 | –83 | .345 | 1 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.223 W
Junction Temperature Rise Above Case $T_{jc}$ ... 10°C

# WJ-A58 / SMA58




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE: +114 dBm (1 MHz BAND)
- ◆ HIGH OUTPUT POWER: +19 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +35 dBm (TYP.)
- ◆ LOW NOISE: 4.8 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85° C |
| Frequency (Min.) | 2-700 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.0 dB | 9.5 dB |
| Gain Flatness (Max.) | < ±0.3dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.8 dB | 6.0 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +19.0 dBm | +18.0 dBm | +17.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 65 mA | 69 mA | 72 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA58 is a standard WJ-A58 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +57 dBm (Typ.)
Second Order Two Tone Intercept Point.....+55 dBm (Typ.)
Third Order Two Tone Intercept Point .....+35 dBm (Typ.)

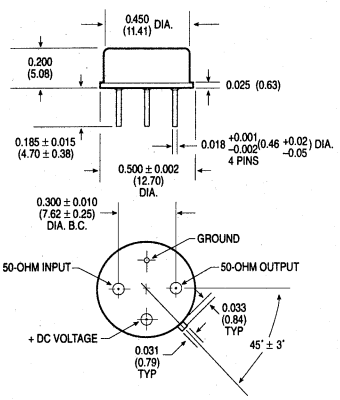
## Absolute Maximum Ratings

Storage Temperature. .....-62°C to +125°C
Maximum Case Temperature. .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....+100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

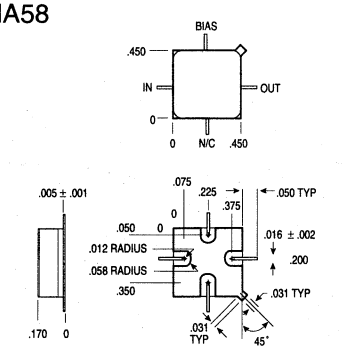
## Outline Drawings

A58



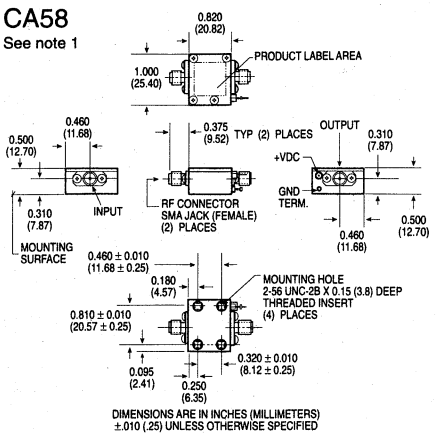

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA58




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

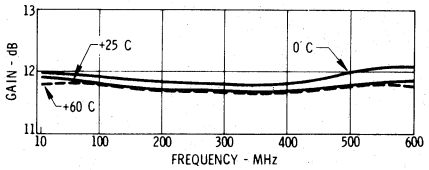
CA58
See note 1

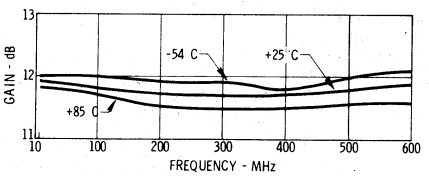



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

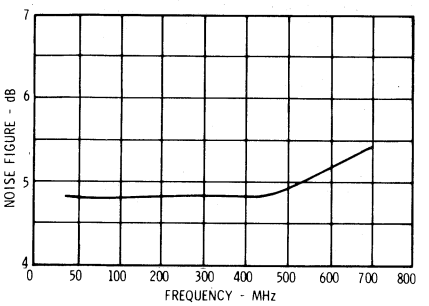
# Typical Performance at 25°C

## Gain

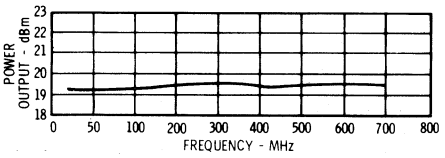



## Noise Figure

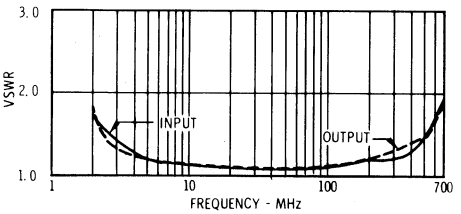



## Power Output*

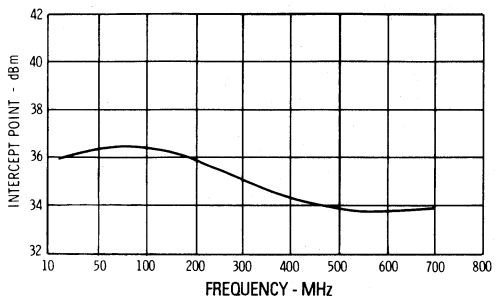



*at 1 dB Gain Compression

## VSWR




## 3rd Order Two Tone Intercept Point




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.2 | 2.2 | 10.2 |
| 2.0 | 1.5 | 1.5 | 11.2 |
| 5.0 | 1.2 | 1.2 | 11.1 |
| 10.0 | 1.1 | 1.1 | 11.1 |
| 50.0 | 1.1 | 1.0 | 11.1 |
| 100.0 | 1.1 | 1.0 | 11.1 |
| 200.0 | 1.1 | 1.0 | 11.1 |
| 300.0 | 1.2 | 1.1 | 11.0 |
| 400.0 | 1.2 | 1.1 | 11.0 |
| 500.0 | 1.3 | 1.3 | 10.9 |
| 600.0 | 1.4 | 1.4 | 10.9 |
| 700.0 | 1.5 | 1.6 | 10.7 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .369 | –71 | 3.251 | –152 | .110 | 19 | .381 | 152 |
| 2.0 | .193 | –96 | 3.622 | –167 | .145 | 14 | .188 | 118 |
| 5.0 | .091 | –125 | 3.591 | –176 | .153 | 5 | .073 | 116 |
| 10.0 | .068 | –144 | 3.590 | –179 | .154 | 2 | .043 | 123 |
| 50.0 | .060 | –173 | 3.592 | 172 | .155 | –2 | .018 | 138 |
| 100.0 | .055 | –177 | 3.579 | 163 | .155 | –5 | .011 | 132 |
| 200.0 | .067 | –161 | 3.570 | 146 | .155 | –10 | .006 | –31 |
| 300.0 | .091 | –159 | 3.551 | 130 | .155 | –14 | .029 | –66 |
| 400.0 | .106 | –153 | 3.564 | 112 | .157 | –19 | .067 | –89 |
| 500.0 | .145 | –167 | 3.511 | 95 | .158 | –24 | .114 | –109 |
| 600.0 | .180 | 178 | 3.492 | 77 | .161 | –29 | .167 | –129 |
| 700.0 | .192 | 157 | 3.437 | 58 | .165 | –34 | .219 | –150 |

## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.2 | 10.3 |
| 2.0 | 1.5 | 1.4 | 11.1 |
| 50.0 | 1.2 | 1.1 | 11.0 |
| 10.0 | 1.1 | 1.1 | 11.0 |
| 50.0 | 1.1 | 1.0 | 11.0 |
| 100.0 | 1.1 | 1.0 | 11.0 |
| 200.0 | 1.2 | 1.0 | 10.9 |
| 300.0 | 1.2 | 1.1 | 10.8 |
| 400.0 | 1.3 | 1.2 | 10.8 |
| 500.0 | 1.4 | 1.3 | 10.6 |
| 600.0 | 1.5 | 1.4 | 10.5 |
| 700.0 | 1.5 | 1.6 | 10.3 |

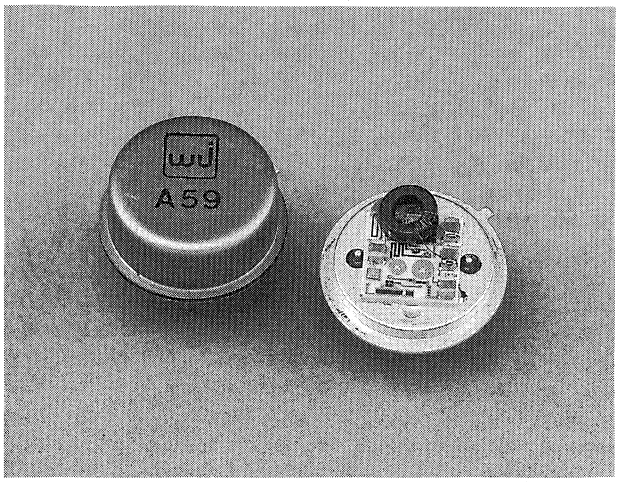
## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .361 | –73 | 3.275 | –153 | .111 | 20 | .365 | 149 |
| 2.0 | .189 | –96 | 3.601 | –168 | .146 | 13 | .178 | 114 |
| 5.0 | .089 | –123 | 3.567 | –176 | .153 | 5 | .067 | 109 |
| 10.0 | .069 | –143 | 3.566 | –179 | .154 | 2 | .037 | 112 |
| 50.0 | .063 | –169 | 3.565 | 172 | .155 | –2 | .009 | 121 |
| 100.0 | .057 | –167 | 3.550 | 163 | .155 | –4 | .001 | –153 |
| 200.0 | .083 | –156 | 3.517 | 145 | .155 | –9 | .018 | –73 |
| 300.0 | .109 | –157 | 3.487 | 128 | .156 | –13 | .044 | –86 |
| 400.0 | .127 | –163 | 3.485 | 110 | .158 | –18 | .083 | –103 |
| 500.0 | .170 | –176 | 3.400 | 93 | .161 | –22 | .128 | –121 |
| 600.0 | .190 | 164 | 3.358 | 74 | .165 | –27 | .180 | –139 |
| 700.0 | .203 | 143 | 3.280 | 55 | .171 | –33 | .230 | –159 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.674 W
Junction Temperature Rise Above Case $T_{jc}$ ... 30°C

# WJ-A59 / SMA59




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE: +117 dBm (1 MHz BAND)
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +38 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications *

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to+85°C |
| Frequency (Min.) | 2-700 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.0 dB | 9.5 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +22 dBm | +20 dBm | +20 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 88 mA | 93 mA | 98 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA59 is a standard WJ-A59 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+47 dBm (Typ.)
Second Order Two Tone Intercept Point .....+43 dBm (Typ.)
Third Order Two Tone Intercept Point.....+38 dBm (Typ.)

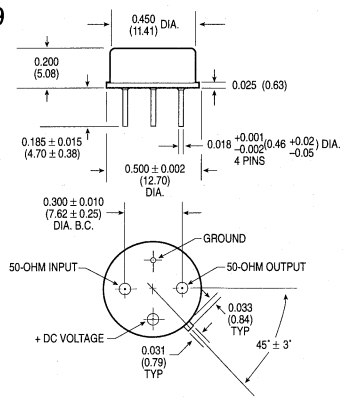
## Absolute Maximum Ratings

Storage Temperature .....- 62°C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....+100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

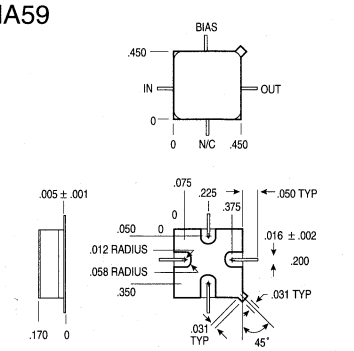
## Outline Drawings

A59



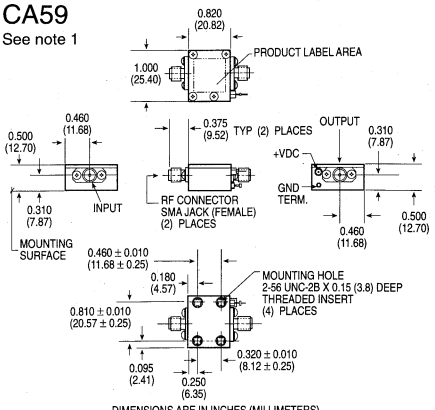

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA59




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

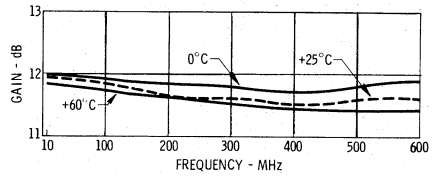
CA59
See note 1

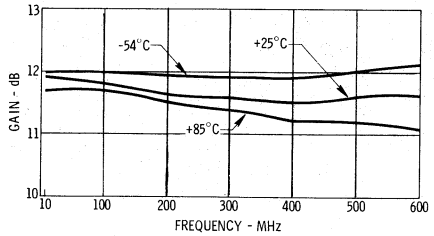



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

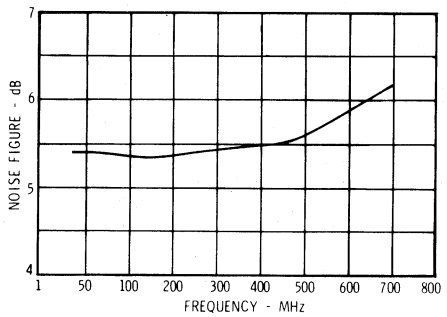
# Typical Performance at 25°C

### Gain

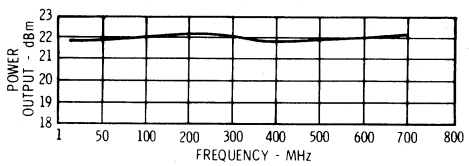



### Noise Figure

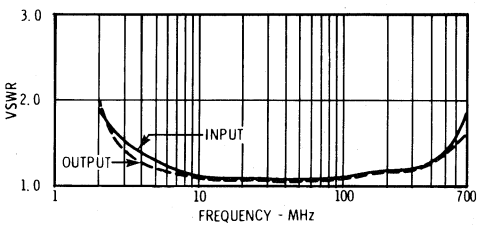



### Power Output*

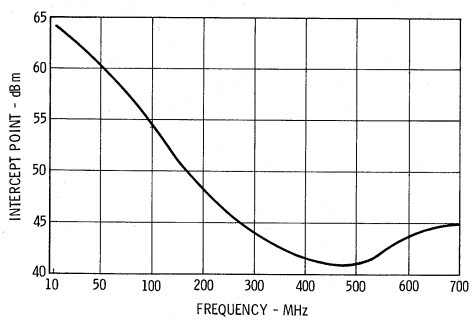



*at 1 dB Gain Compression

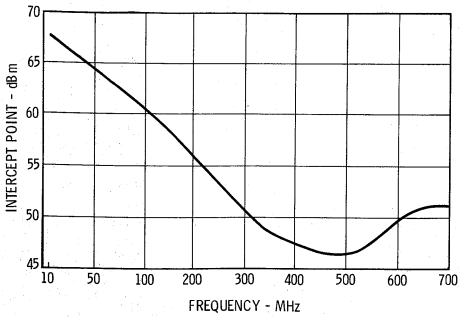
### VSWR



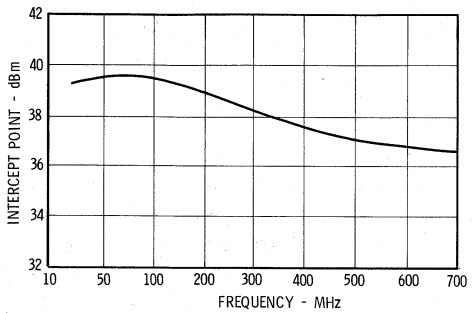

### Second-Order Two-Tone Intercept Point




### Second Harmonic Intercept Point




### 3rd Order Two Tone Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.3 | 2.7 | 11.0 |
| 2.0 | 1.7 | 1.7 | 11.9 |
| 5.0 | 1.4 | 1.4 | 11.9 |
| 10.0 | 1.4 | 1.3 | 11.9 |
| 50.0 | 1.4 | 1.3 | 11.9 |
| 100.0 | 1.4 | 1.3 | 11.9 |
| 200.0 | 1.3 | 1.2 | 11.9 |
| 300.0 | 1.2 | 1.2 | 11.9 |
| 400.0 | 1.2 | 1.1 | 12.0 |
| 500.0 | 1.2 | 1.1 | 12.0 |
| 600.0 | 1.3 | 1.2 | 12.0 |
| 700.0 | 1.4 | 1.4 | 11.8 |

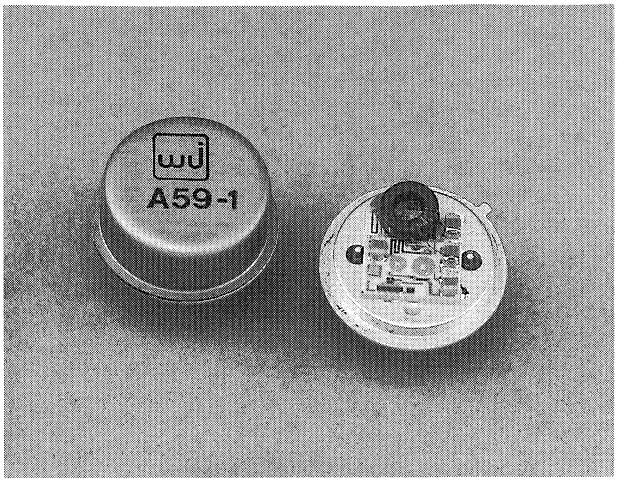
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .394 | –81 | 3.537 | –152 | .099 | 19 | .453 | 163 |
| 2.0 | .256 | –118 | 3.926 | –166 | .132 | 14 | .261 | 144 |
| 5.0 | .181 | –151 | 3.916 | –176 | .142 | 6 | .159 | 156 |
| 10.0 | .167 | –166 | 3.914 | –179 | .143 | 3 | .141 | 164 |
| 50.0 | .168 | 174 | 3.928 | 172 | .144 | –2 | .129 | 163 |
| 100.0 | .152 | 166 | 3.917 | 163 | .145 | –5 | .122 | 152 |
| 200.0 | .134 | 157 | 3.935 | 146 | .145 | –10 | .106 | 128 |
| 300.0 | .108 | 151 | 3.952 | 129 | .146 | –16 | .082 | 100 |
| 400.0 | .078 | 160 | 3.995 | 110 | .147 | –21 | .044 | 58 |
| 500.0 | .101 | 175 | 3.967 | 92 | .147 | –27 | .036 | –48 |
| 600.0 | .132 | 172 | 3.964 | 72 | .148 | –33 | .090 | –106 |
| 700.0 | .158 | 154 | 3.886 | 52 | .151 | –38 | .152 | –138 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.814 W
Junction Temperature Rise Above Case $T_{jc}$ ... 37°C

# WJ-A59-1 / SMA59-1




## 10 to 700 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE: +117 dBm (1 MHz BAND)
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +36 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-800 MHz | 10-700 MHz | 10-700 MHz |
| Small Signal Gain (Min.) | 10.5 dB | 9.5 dB | 9.0 dB |
| Gain Flatness (Max.) | < ±0.4 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 7.5 dB | 8.0 dB |
| Power Output at 1 dB Compression (Min.) | +22 dBm | +20 dBm | +20 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 88 mA | 98 mA | 98 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA59-1 is a standard WJ-A59-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+64 dBm (Typ.)
Second Order Two Tone Intercept Point.....+62 dBm (Typ.)
Third Order Two Tone Intercept Point.....+36 dBm (Typ.)

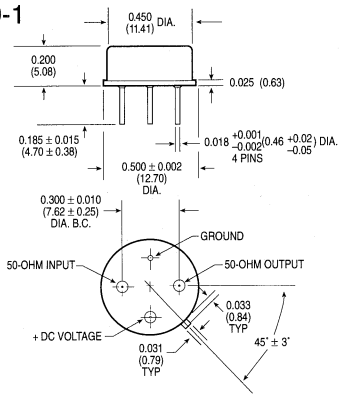
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams(0.07oz.)

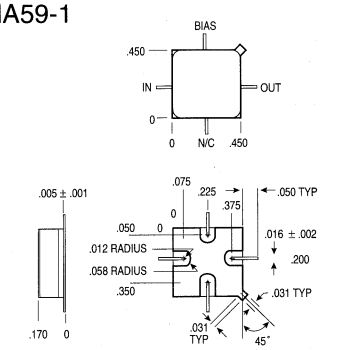
## Outline Drawings

A59-1



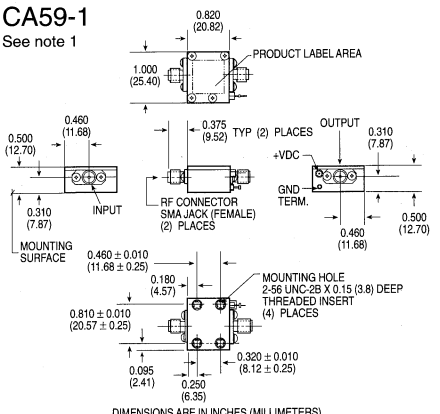

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA59-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

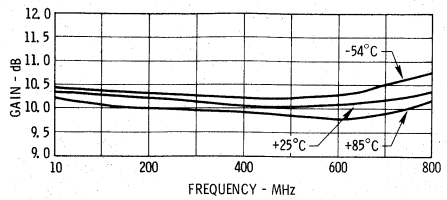
CA59-1
See note 1



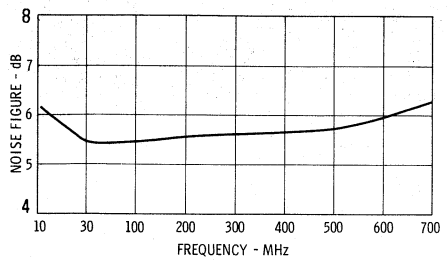

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

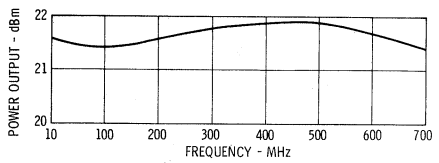
## Gain




## Noise Figure

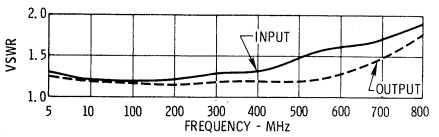



## Power Output*




*at 1 dB Gain Compression

## VSWR




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.4 | 2.6 | 9.9 |
| 2.0 | 1.8 | 1.9 | 10.6 |
| 5.0 | 1.7 | 1.6 | 10.8 |
| 10.0 | 1.6 | 1.5 | 10.9 |
| 50.0 | 1.6 | 1.5 | 10.9 |
| 100.0 | 1.6 | 1.4 | 10.8 |
| 200.0 | 1.6 | 1.4 | 10.9 |
| 300.0 | 1.5 | 1.4 | 10.9 |
| 400.0 | 1.4 | 1.3 | 11.0 |
| 500.0 | 1.3 | 1.2 | 10.9 |
| 600.0 | 1.3 | 1.1 | 10.9 |
| 700.0 | 1.3 | 1.1 | 10.8 |
| 800.0 | 1.4 | 1.2 | 10.5 |
| 900.0 | 1.6 | 1.3 | 9.9 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .403 | –98 | 3.117 | –155 | .113 | 17 | .447 | 168 |
| 2.0 | .291 | –130 | 3.402 | –167 | .140 | 13 | .307 | 156 |
| 5.0 | .248 | –159 | 3.479 | –175 | .151 | 5 | .217 | 163 |
| 10.0 | .242 | –170 | 3.490 | –179 | .153 | 3 | .199 | 169 |
| 50.0 | .239 | 174 | 3.493 | 174 | .153 | 0 | .188 | 167 |
| 100.0 | .232 | 164 | 3.485 | 167 | .154 | –2 | .182 | 158 |
| 200.0 | .219 | 152 | 3.499 | 153 | .156 | –3 | .168 | 139 |
| 300.0 | .198 | 139 | 3.500 | 140 | .158 | –6 | .150 | 119 |
| 400.0 | .165 | 128 | 3.536 | 126 | .160 | –8 | .120 | 98 |
| 500.0 | .136 | 122 | 3.524 | 112 | .162 | –11 | .082 | 73 |
| 600.0 | .119 | 130 | 3.526 | 97 | .164 | –14 | .041 | 26 |
| 700.0 | .126 | 141 | 3.476 | 81 | .163 | –17 | .040 | –79 |
| 800.0 | .178 | 143 | 3.354 | 65 | .164 | –20 | .089 | –129 |
| 900.0 | .245 | 132 | 3.141 | 50 | .165 | –22 | .133 | –158 |

## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.2 | 2.4 | 10.2 |
| 2.0 | 1.8 | 1.8 | 10.7 |
| 5.0 | 1.6 | 1.5 | 10.8 |
| 10.0 | 1.6 | 1.5 | 10.8 |
| 50.0 | 1.6 | 1.4 | 10.8 |
| 100.0 | 1.6 | 1.4 | 10.8 |
| 200.0 | 1.6 | 1.4 | 10.8 |
| 300.0 | 1.5 | 1.3 | 10.8 |
| 400.0 | 1.4 | 1.2 | 10.8 |
| 500.0 | 1.4 | 1.2 | 10.7 |
| 600.0 | 1.3 | 1.1 | 10.7 |
| 700.0 | 1.4 | 1.1 | 10.5 |
| 800.0 | 1.5 | 1.2 | 10.1 |
| 900.0 | 1.7 | 1.3 | 9.5 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .377 | –101 | 3.233 | –157 | .119 | 19 | .414 | 163 |
| 2.0 | .287 | –133 | 3.421 | –168 | .143 | 12 | .274 | 155 |
| 5.0 | .245 | –161 | 3.455 | –176 | .151 | 5 | .204 | 164 |
| 10.0 | .239 | –171 | 3.457 | –179 | .153 | 2 | .190 | 169 |
| 50.0 | .236 | 174 | 3.467 | 174 | .154 | 0 | .179 | 168 |
| 100.0 | .232 | 166 | 3.453 | 166 | .155 | –1 | .173 | 160 |
| 200.0 | .220 | 155 | 3.456 | 152 | .156 | –3 | .159 | 142 |
| 300.0 | .202 | 143 | 3.457 | 139 | .158 | –5 | .140 | 125 |
| 400.0 | .173 | 133 | 3.472 | 124 | .160 | –7 | .110 | 110 |
| 500.0 | .157 | 131 | 3.445 | 110 | .162 | –9 | .072 | 96 |
| 600.0 | .147 | 133 | 3.418 | 95 | .165 | –12 | .025 | 93 |
| 700.0 | .157 | 136 | 3.350 | 79 | .167 | –15 | .031 | –156 |
| 800.0 | .208 | 136 | 3.203 | 63 | .169 | –18 | .081 | –162 |
| 900.0 | .272 | 126 | 2.981 | 48 | .174 | –20 | .124 | –180 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.814 W
Junction Temperature Rise Above Case $T_{jc}$ ... 37°C

# WJ-A61 / SMA61

## 2 to 6 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 2-6 GHz
- ◆ MEDIUM OUTPUT LEVEL: +12.5 dBm (TYP.)
- ◆ LOW NOISE: 3.2 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0°C to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1.8-6.2 GHz | 2-6 GHz | 2-6 GHz |
| Small Signal Gain (Min.) | 7.5 dB | 6.5 dB | 6.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±0.9 dB |
| Noise Figure (Max.) | 3.2 dB | 4.3 dB | 4.8 dB |
| Power Output at 1 dBCompression (Min.) | +12.5 dBm | +11.0 dBm | +10.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 2.0:1 | 2.1 :1 |
| output | 1.5:1 | 2.0:1 | 2.1 :1 |
| DC Current (Max.) at +5 Volts | 35 mA | 40 mA | 42 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA61 is a standard WJ-A61 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+37 dBm (Typ.)
Third Order Two Tone Intercept Point .....+25 dBm (Typ.)

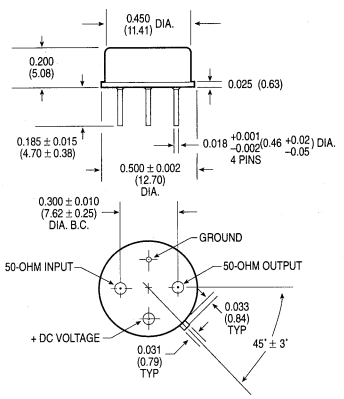
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....6 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

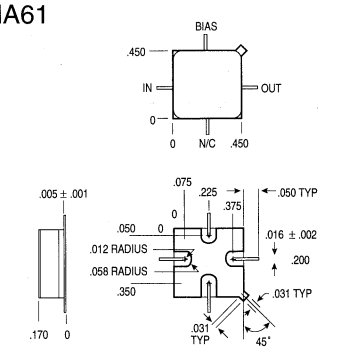
## Outline Drawings

A61



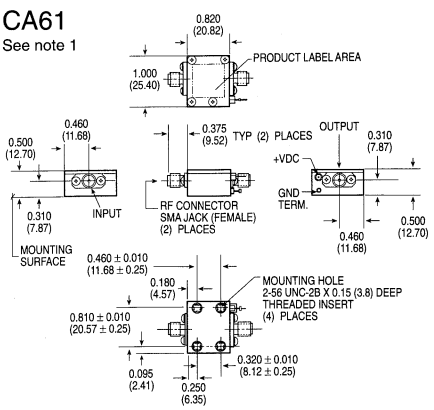

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA61




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

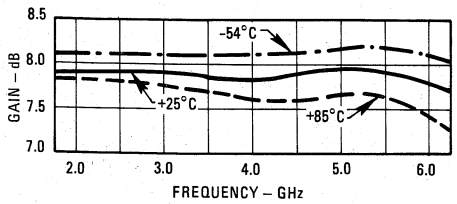
CA61
See note 1



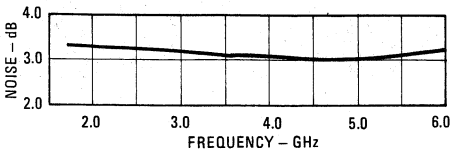

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

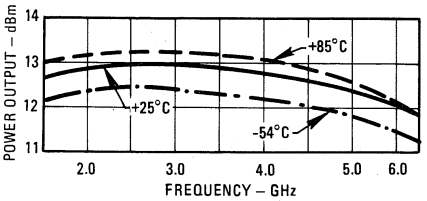
### Gain




### Noise Figure

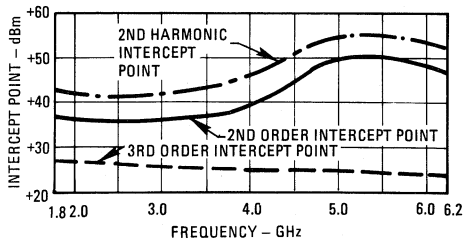



### Power Output*

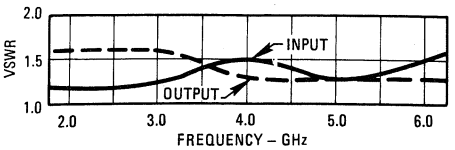



* at 1 dB Gain Compression

### Intercept Point




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1600.0 | 1.3 | 1.7 | 7.6 |
| 1800.0 | 1.2 | 1.7 | 7.5 |
| 2000.0 | 1.2 | 1.8 | 7.5 |
| 2200.0 | 1.3 | 1.8 | 7.5 |
| 2400.0 | 1.4 | 1.9 | 7.5 |
| 2600.0 | 1.4 | 1.8 | 7.5 |
| 2800.0 | 1.5 | 1.6 | 7.5 |
| 3000.0 | 1.6 | 1.4 | 7.5 |
| 3200.0 | 1.7 | 1.3 | 7.5 |
| 3300.0 | 1.8 | 1.2 | 7.5 |
| 3400.0 | 1.8 | 1.1 | 7.5 |
| 3600.0 | 1.9 | 1.2 | 7.4 |
| 3800.0 | 2.0 | 1.2 | 7.3 |
| 4000.0 | 2.0 | 1.3 | 7.3 |
| 4200.0 | 1.9 | 1.3 | 7.3 |
| 4400.0 | 1.9 | 1.2 | 7.2 |
| 4600.0 | 1.8 | 1.2 | 7.2 |
| 4800.0 | 1.8 | 1.2 | 7.3 |
| 5000.0 | 1.7 | 1.2 | 7.4 |
| 5200.0 | 1.5 | 1.2 | 7.4 |
| 5400.0 | 1.3 | 1.3 | 7.4 |
| 5600.0 | 1.2 | 1.4 | 7.3 |
| 5800.0 | 1.1 | 1.5 | 7.3 |
| 6000.0 | 1.1 | 1.6 | 7.2 |
| 6200.0 | 1.1 | 1.6 | 7.1 |
| 6400.0 | 1.2 | 1.6 | 7.0 |

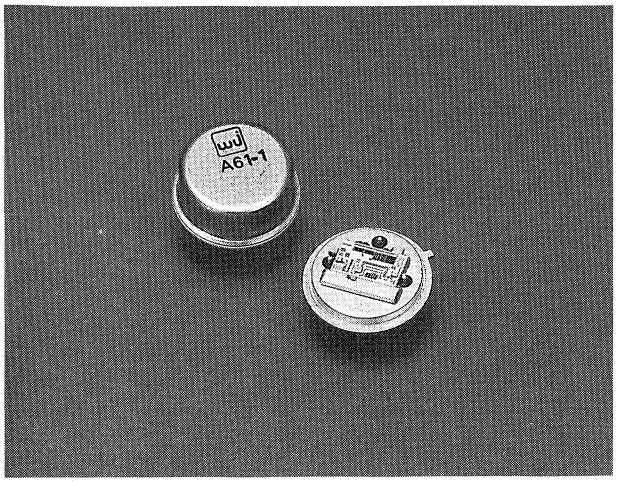
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1600.0 | .115 | 108 | 2.398 | –173 | .142 | 52 | .254 | 148 |
| 1800.0 | .107 | 48 | 2.381 | 136 | .138 | 5 | .263 | 86 |
| 2000.0 | .110 | –8 | 2.382 | 85 | .139 | –41 | .287 | 29 |
| 2200.0 | .138 | –60 | 2.384 | 35 | .140 | –85 | .298 | –26 |
| 2400.0 | .165 | –97 | 2.371 | –15 | .140 | –130 | .301 | –75 |
| 2600.0 | .180 | –138 | 2.366 | –65 | .140 | –175 | .287 | –122 |
| 2800.0 | .204 | –171 | 2.368 | –115 | .142 | 142 | .241 | –170 |
| 3000.0 | .230 | 152 | 2.373 | –164 | .145 | 97 | .178 | 143 |
| 3200.0 | .258 | 116 | 2.379 | 146 | .145 | 52 | .116 | 91 |
| 3300.0 | .278 | 96 | 2.364 | 121 | .147 | 30 | .090 | 57 |
| 3400.0 | .295 | 75 | 2.361 | 96 | .147 | 8 | .068 | 12 |
| 3600.0 | .318 | 35 | 2.347 | 46 | .148 | –37 | .071 | –83 |
| 3800.0 | .332 | –6 | 2.325 | –3 | .149 | –81 | .093 | –139 |
| 4000.0 | .328 | –45 | 2.308 | –52 | .152 | –126 | .115 | 178 |
| 4200.0 | .316 | –77 | 2.310 | –101 | .156 | –170 | .113 | .137 |
| 4400.0 | .305 | –107 | 2.295 | –151 | .158 | 145 | .102 | 107 |
| 4600.0 | .297 | –137 | 2.298 | 160 | .163 | 101 | .104 | 74 |
| 4800.0 | .281 | –170 | 2.315 | 111 | .168 | 56 | .093 | 26 |
| 5000.0 | .255 | 153 | 2.345 | 60 | .175 | 10 | .081 | –23 |
| 5200.0 | .199 | 113 | 2.351 | 9 | .181 | –36 | .095 | –87 |
| 5400.0 | .141 | 72 | 2.355 | –41 | .186 | –82 | .127 | –155 |
| 5600.0 | .084 | 36 | 2.327 | –93 | .189 | –128 | .155 | 145 |
| 5800.0 | .053 | 15 | 2.314 | –144 | .197 | –175 | .198 | 94 |
| 6000.0 | .038 | 20 | 2.302 | 164 | .199 | 137 | .228 | 39 |
| 6200.0 | .044 | 27 | 2.264 | 112 | .202 | 89 | .237 | –20 |
| 6400.0 | .074 | 24 | 2.242 | 59 | .202 | 40 | .236 | –77 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-A61-1 / SMA61-1




## 2 to 6 GHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 1-6 GHz (TYP.)
- ◆ HIGH POWER: +20 dBm (TYP.)
- ◆ LOW NOISE: 3.4 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-6 GHz | 2-6 GHz | 2-6 GHz |
| Small Signal Gain (Min.) | 8.0 dB | 7.0 dB | 6.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±0.8 dB |
| Noise Figure (Max.) | 3.4 dB | 4.2 dB | 4.7 dB |
| Power Output | | | |
| at 1 dBCompression (Min.) | +20.0 dBm | +18.5 dBm | +18.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.0:1 | 2.1:1 |
| output | 1.5:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +8 Volts | 70 mA | 75 mA | 79 mA |

*Measured in a 50-ohm system at +8 Vdc Nominal.
Notes:
1. WJ-CA61-1 is a standard WJ-A61-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point .....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

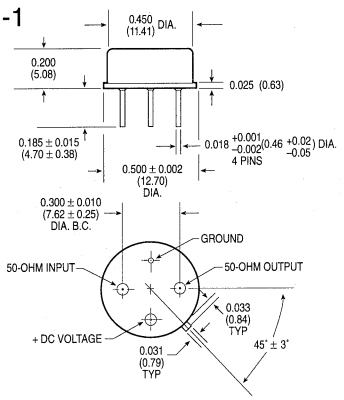
## Absolute Maximum Ratings

Storage Temperature .....-62°C to 125°C
Maximum Case Temperature .....+85°C
Maximum DC Voltage ..... +9 volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power ..... 0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

Weight approximately 2.0 grams (0.07 oz.)

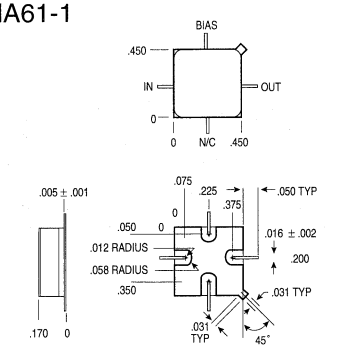
## Outline Drawings

A61-1



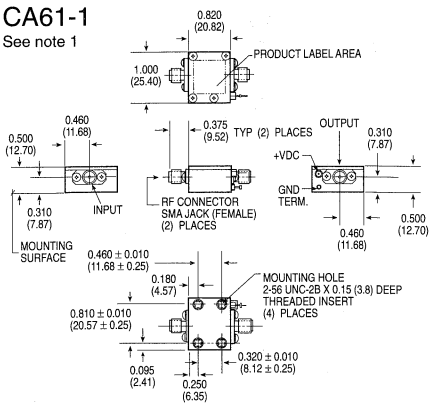

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA61-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

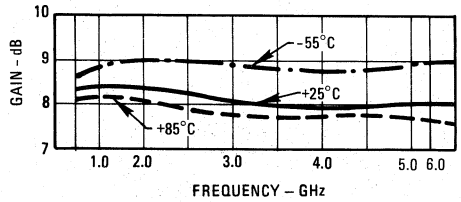
CA61-1
See note 1



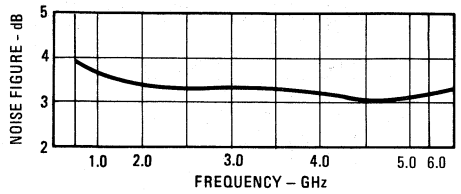

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

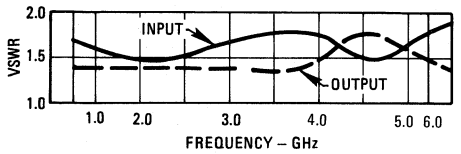
### Gain



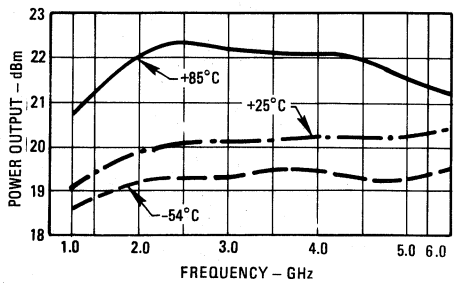

### Noise Figure




### VSWR

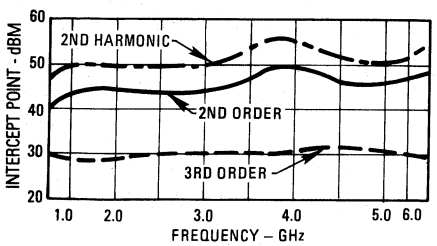



### Power Output*




* at 1 dB Gain Compression

### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 600.0 | 2.5 | 1.7 | 7.5 |
| 800.0 | 1.5 | 1.3 | 8.5 |
| 1000.0 | 1.2 | 1.3 | 8.7 |
| 1200.0 | 1.2 | 1.4 | 8.8 |
| 1400.0 | 1.2 | 1.3 | 8.7 |
| 1600.0 | 1.3 | 1.3 | 8.7 |
| 1800.0 | 1.4 | 1.3 | 8.6 |
| 2000.0 | 1.5 | 1.4 | 8.6 |
| 2200.0 | 1.5 | 1.5 | 8.5 |
| 2400.0 | 1.6 | 1.5 | 8.4 |
| 2600.0 | 1.6 | 1.5 | 8.3 |
| 2800.0 | 1.6 | 1.4 | 8.3 |
| 3000.0 | 1.6 | 1.3 | 8.3 |
| 3200.0 | 1.7 | 1.2 | 8.2 |
| 3400.0 | 1.8 | 1.1 | 8.2 |
| 3600.0 | 1.9 | 1.1 | 8.2 |
| 3800.0 | 1.9 | 1.1 | 8.2 |
| 4000.0 | 1.9 | 1.2 | 8.3 |
| 4200.0 | 1.8 | 1.3 | 8.3 |
| 4400.0 | 1.7 | 1.4 | 8.2 |
| 4600.0 | 1.6 | 1.5 | 8.2 |
| 4800.0 | 1.6 | 1.6 | 8.3 |
| 5000.0 | 1.5 | 1.6 | 8.4 |
| 5200.0 | 1.6 | 1.6 | 8.4 |
| 5400.0 | 1.7 | 1.5 | 8.5 |
| 5600.0 | 1.8 | 1.5 | 8.4 |
| 5800.0 | 1.9 | 1.5 | 8.3 |
| 6000.0 | 2.0 | 1.5 | 8.3 |
| 6200.0 | 2.2 | 1.4 | 8.2 |
| 6400.0 | 2.4 | 1.4 | 8.1 |

### Linear S-Parameters

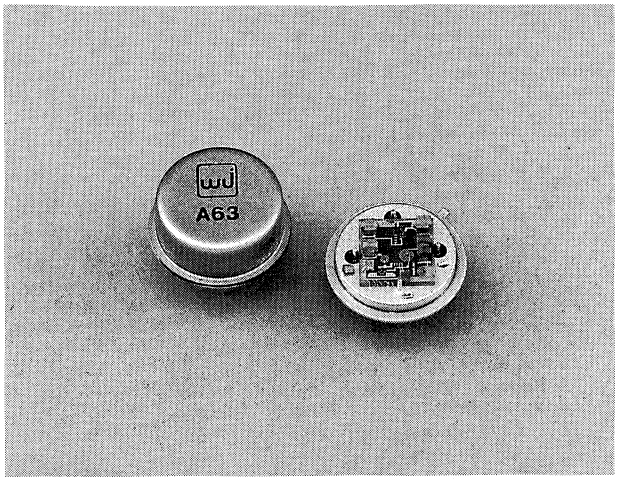
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 600.0 | .423 | 1 | 2.366 | 124 | .145 | –30 | .252 | –114 |
| 800.0 | .214 | –66 | 2.672 | 51 | .162 | –105 | .128 | 115 |
| 1000.0 | .110 | –135 | 2.724 | –12 | .161 | –167 | .135 | 2 |
| 1200.0 | .077 | 135 | 2.745 | –69 | .158 | 139 | .150 | –75 |
| 1400.0 | .090 | 67 | 2.725 | –123 | .155 | 88 | .143 | –148 |
| 1600.0 | .129 | 8 | 2.718 | –175 | .151 | 39 | .135 | 140 |
| 1800.0 | .156 | –37 | 2.694 | 134 | .146 | –9 | .148 | 73 |
| 2000.0 | .186 | –83 | 2.676 | 83 | .142 | –56 | .178 | 15 |
| 2200.0 | .206 | –121 | 2.660 | 33 | .139 | –102 | .197 | –38 |
| 2400.0 | .220 | –157 | 2.643 | –17 | .134 | –147 | .200 | –84 |
| 2600.0 | .224 | 166 | 2.614 | –66 | .128 | 168 | .194 | –126 |
| 2800.0 | .232 | 130 | 2.596 | –115 | .126 | 123 | .160 | –167 |
| 3000.0 | .240 | 95 | 2.591 | –164 | .124 | 79 | .117 | 158 |
| 3200.0 | .255 | 61 | 2.581 | 147 | .118 | 34 | .083 | 125 |
| 3400.0 | .286 | 25 | 2.582 | 98 | .115 | –10 | .049 | 80 |
| 3600.0 | .310 | –15 | 2.580 | 49 | .113 | –54 | .025 | 22 |
| 3800.0 | .320 | –53 | 2.583 | 1 | .110 | –98 | .042 | –59 |
| 4000.0 | .321 | –93 | 2.599 | –49 | .106 | –141 | .082 | –112 |
| 4200.0 | .294 | –130 | 2.599 | –98 | .103 | 176 | .117 | –153 |
| 4400.0 | .265 | –162 | 2.585 | –147 | .102 | 133 | .167 | 170 |
| 4600.0 | .239 | 159 | 2.578 | 164 | .099 | 91 | .206 | 127 |
| 4800.0 | .218 | 114 | 2.596 | 115 | .098 | 48 | .217 | 83 |
| 5000.0 | .205 | 70 | 2.623 | 65 | .098 | 5 | .224 | 40 |
| 5200.0 | .216 | 17 | 2.632 | 15 | .098 | –37 | .225 | –12 |
| 5400.0 | .252 | –33 | 2.653 | –36 | .099 | –80 | .206 | –67 |
| 5600.0 | .274 | –81 | 2.639 | –87 | .099 | –123 | .198 | –121 |
| 5800.0 | .305 | –126 | 2.614 | –138 | .100 | –165 | .208 | –178 |
| 6000.0 | .332 | –170 | 2.591 | 171 | .103 | 151 | .201 | 125 |
| 6200.0 | .369 | 148 | 2.562 | 120 | .106 | 109 | .177 | 72 |
| 6400.0 | .419 | 103 | 2.537 | 67 | .107 | 63 | .158 | 15 |

## Thermal Data: $V_{CC}$ = 8 Vdc

Thermal Resistance $\theta_{jc}$ ..... 108.9°C/W
Transistor Power Dissipation $P_d$ ..... 0.504 W
Junction Temperature Rise Above Case $T_{jc}$ ... 55°C

# WJ-A63 / SMA63

## 5 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.0 dB (TYP.)
- ◆ MEDIUM THIRD ORDER I.P.: +15 dBm (TYP.)
- ◆ HIGH GAIN: 16 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-1100 MHz | 5-1000 MHz | 5-1000 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 15.0 dB | 14.5 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±1.0 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.0 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +4.0 dBm | +2.0 dBm | +2.0 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 14 mA | 16 mA | 18 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA63 is a standard WJ-A63 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+25 dBm (Typ.)
Second Order Two Tone Intercept Point.....+20 dBm (Typ.)
Third Order Two Tone Intercept Point.....+15 dBm (Typ.)

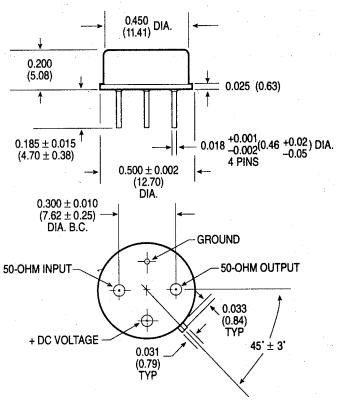
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

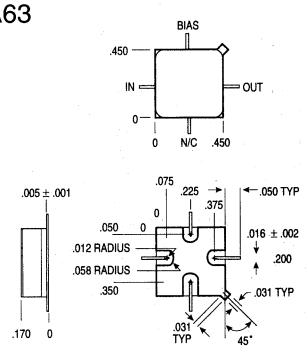
## Outline Drawings

A63



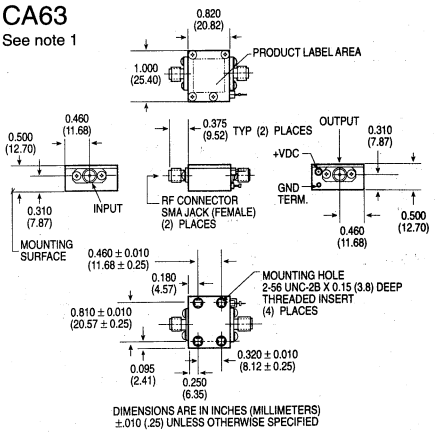

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA63




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

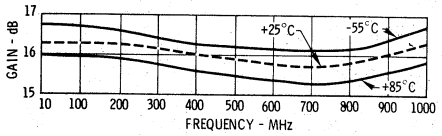
CA63
See note 1



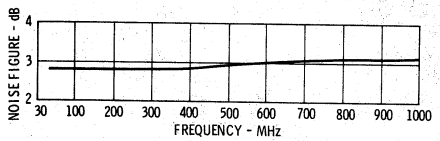

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

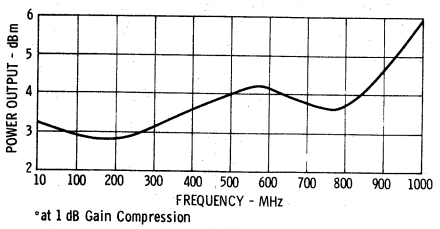
### Gain




### Noise Figure

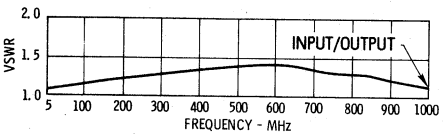



### Power Output*

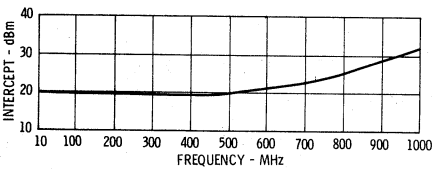



*at 1 dB Gain Compression

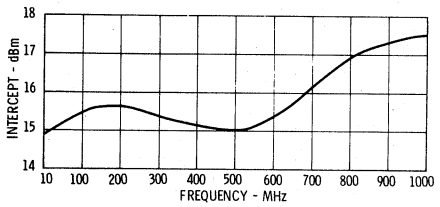
### VSWR




### Second Order Two Tone Intercept Point




### Third Order Two Tone Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.1 | 16.4 |
| 2.0 | 1.2 | 1.1 | 16.4 |
| 5.0 | 1.2 | 1.1 | 16.4 |
| 10.0 | 1.2 | 1.1 | 16.4 |
| 50.0 | 1.2 | 1.1 | 16.3 |
| 100.0 | 1.2 | 1.1 | 16.2 |
| 200.0 | 1.2 | 1.1 | 16.2 |
| 300.0 | 1.2 | 1.2 | 16.1 |
| 400.0 | 1.3 | 1.2 | 16.1 |
| 500.0 | 1.3 | 1.3 | 16.0 |
| 600.0 | 1.4 | 1.3 | 16.1 |
| 700.0 | 1.3 | 1.3 | 16.2 |
| 800.0 | 1.4 | 1.3 | 16.3 |
| 900.0 | 1.4 | 1.3 | 16.3 |
| 1000.0 | 1.6 | 1.4 | 16.0 |
| 1100.0 | 2.0 | 1.7 | 15.3 |
| 1200.0 | 2.9 | 2.1 | 13.8 |

### Linear S-Parameters

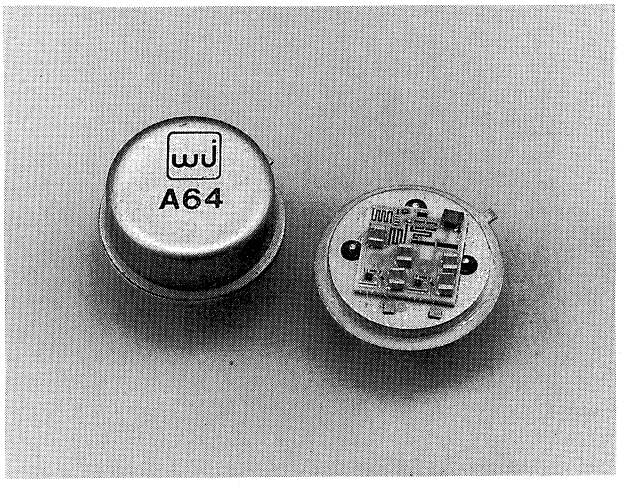
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .076 | –47 | 6.601 | –162 | .091 | 18 | .056 | –69 |
| 2.0 | .079 | –10 | 6.613 | –172 | .091 | 9 | .050 | –26 |
| 5.0 | .078 | –6 | 6.601 | –178 | .091 | 3 | .052 | –10 |
| 10.0 | .078 | –4 | 6.569 | 180 | .092 | 1 | .052 | –6 |
| 50.0 | .082 | –6 | 6.541 | 170 | .092 | –4 | .055 | –6 |
| 100.0 | .084 | –11 | 6.485 | 160 | .091 | –9 | .059 | –13 |
| 200.0 | .096 | –36 | 6.433 | 139 | .091 | –17 | .069 | –32 |
| 300.0 | .104 | –57 | 6.350 | 120 | .090 | –25 | .080 | –56 |
| 400.0 | .126 | –77 | 6.364 | 100 | .089 | –33 | .096 | –84 |
| 500.0 | .143 | –105 | 6.286 | 80 | .088 | –42 | .112 | –112 |
| 600.0 | .150 | –135 | 6.363 | 59 | .088 | –50 | .123 | –142 |
| 700.0 | .148 | –167 | 6.446 | 37 | .088 | –58 | .126 | –175 |
| 800.0 | .153 | 149 | 6.523 | 13 | .089 | –67 | .123 | 142 |
| 900.0 | .168 | 92 | 6.526 | –11 | .094 | –78 | .133 | 85 |
| 1000.0 | .227 | 32 | 6.346 | –40 | .096 | –92 | .182 | 25 |
| 1100.0 | .329 | –25 | 5.836 | –70 | .097 | –109 | .269 | –27 |
| 1200.0 | .484 | –73 | 4.898 | –102 | .095 | –130 | .362 | –71 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.097 W
Junction Temperature Rise Above Case $T_{jc}$ ... 4°C

# WJ-A64 / SMA64

## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 3.0 dB (TYP.)
- ◆ HIGH GAIN - TWO STAGES: 26 dB (TYP.)
- ◆ ULTRA LOW PHASE DEVIATION FROM LINEARITY: < ±2°,100-1000 MHz
- ◆ LOW VSWR: 1.2:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-1250 MHz | 10-1200 MHz | 10-1200 MHz |
| Small Signal Gain (Min.) | 26.0 dB | 24.0 dB | 23.0 dB |
| Gain Flatness (Max.) | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-1000 MHz | 3.0 dB | 3.8 dB | 4.3 dB |
| 10-1200 MHz | 3.4 dB | 4.3 dB | 4.8 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +7.0 dBm | +6.5 dBm |
| VSWR (Max.) Input/Output | | | |
| 10-1000 | 1.2:1 | 1.7:1 | 1.8:1 |
| 10-1200 | 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 35 mA | 38 mA | 40 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA64 is a standard WJ-A64 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+47 dBm (Typ.)
Second Order Two Tone Intercept Point.....+41 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20 dBm (Typ.)

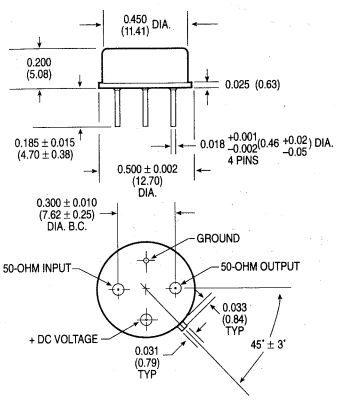
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

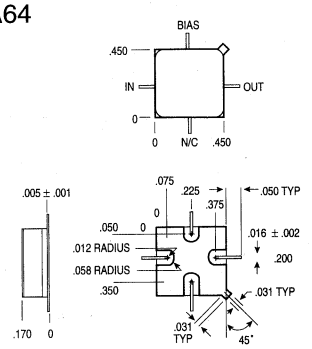
## Outline Drawings

A64



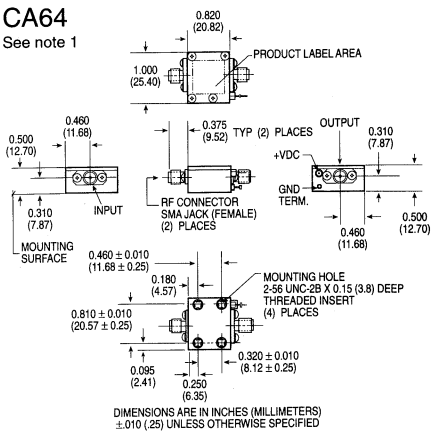

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA64




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

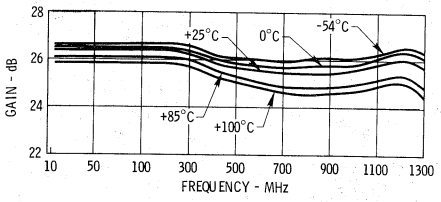
CA64
See note 1



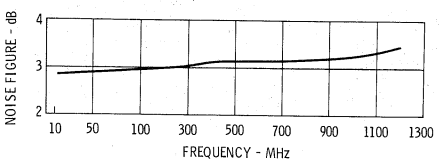

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

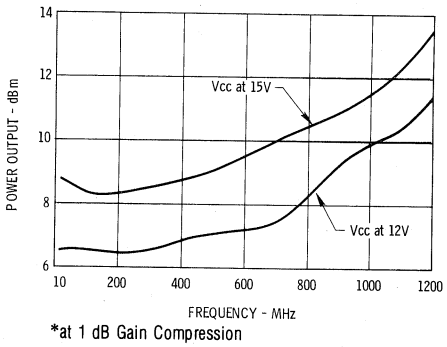
## Gain




## Noise Figure

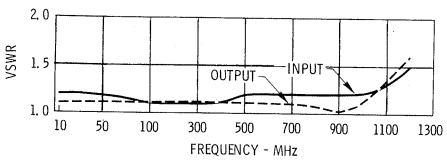



## Power Output*

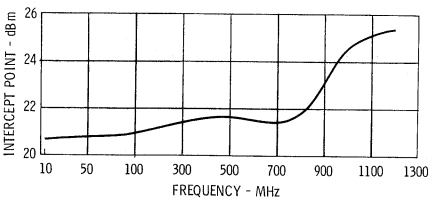



*at 1 dB Gain Compression

## VSWR




## 3rd Order Two Tone Intercept Point




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.7 | 1.4 | 25.5 |
| 2.0 | 1.4 | 1.2 | 25.5 |
| 5.0 | 1.3 | 1.1 | 25.6 |
| 10.0 | 1.3 | 1.1 | 25.6 |
| 50.0 | 1.3 | 1.1 | 25.7 |
| 100.0 | 1.3 | 1.1 | 25.7 |
| 200.0 | 1.3 | 1.0 | 25.7 |
| 300.0 | 1.3 | 1.0 | 25.7 |
| 400.0 | 1.3 | 1.1 | 25.7 |
| 500.0 | 1.3 | 1.1 | 25.6 |
| 600.0 | 1.3 | 1.1 | 25.7 |
| 700.0 | 1.4 | 1.1 | 25.7 |
| 800.0 | 1.3 | 1.1 | 25.8 |
| 900.0 | 1.2 | 1.1 | 25.9 |
| 1000.0 | 1.2 | 1.2 | 25.9 |
| 1100.0 | 1.3 | 1.4 | 25.8 |
| 1200.0 | 1.6 | 1.6 | 25.5 |
| 1300.0 | 2.2 | 2.0 | 24.9 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .256 | –98 | 18.769 | 25 | .018 | 19 | .157 | –55 |
| 2.0 | .176 | –129 | 18.873 | 12 | .016 | 5 | .093 | –58 |
| 5.0 | .137 | –162 | 19.020 | 4 | .015 | 4 | .047 | –40 |
| 10.0 | .123 | –175 | 19.112 | 0 | .015 | 3 | .040 | –24 |
| 50.0 | .122 | 164 | 19.195 | –12 | .016 | 0 | .036 | –25 |
| 100.0 | .122 | 150 | 19.201 | –25 | .016 | –3 | .033 | –43 |
| 200.0 | .117 | 121 | 19.272 | –52 | .016 | –7 | .024 | –88 |
| 300.0 | .124 | 91 | 19.198 | –78 | .017 | –11 | .022 | –152 |
| 400.0 | .135 | 57 | 19.283 | –104 | .017 | –16 | .030 | 154 |
| 500.0 | .136 | 27 | 19.125 | –130 | .017 | –21 | .040 | 120 |
| 600.0 | .140 | –5 | 19.176 | –157 | .017 | –25 | .045 | 89 |
| 700.0 | .150 | –40 | 19.242 | 176 | .018 | –33 | .048 | 71 |
| 800.0 | .132 | –76 | 19.538 | 148 | .018 | –37 | .052 | 60 |
| 900.0 | .106 | –112 | 19.705 | 120 | .019 | –44 | .068 | 55 |
| 1000.0 | .081 | –176 | 19.760 | 89 | .019 | –52 | .102 | 49 |
| 1100.0 | .113 | 98 | 19.407 | 57 | .021 | –63 | .156 | 32 |
| 1200.0 | .225 | 42 | 18.931 | 23 | .021 | –73 | .233 | 7 |
| 1300.0 | .383 | 0 | 17.643 | –13 | .022 | –87 | .324 | –20 |

## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 1.4 | 24.9 |
| 2.0 | 1.4 | 1.2 | 25.0 |
| 5.0 | 1.3 | 1.1 | 25.1 |
| 10.0 | 1.2 | 1.1 | 25.1 |
| 50.0 | 1.2 | 1.1 | 25.1 |
| 100.0 | 1.2 | 1.1 | 25.1 |
| 200.0 | 1.2 | 1.0 | 25.2 |
| 300.0 | 1.2 | 1.0 | 25.1 |
| 400.0 | 1.2 | 1.1 | 25.2 |
| 500.0 | 1.3 | 1.1 | 25.2 |
| 600.0 | 1.3 | 1.1 | 25.2 |
| 700.0 | 1.3 | 1.1 | 25.3 |
| 800.0 | 1.3 | 1.1 | 25.5 |
| 900.0 | 1.2 | 1.2 | 25.6 |
| 1000.0 | 1.2 | 1.3 | 25.6 |
| 1100.0 | 1.4 | 1.5 | 25.4 |
| 1200.0 | 1.8 | 1.8 | 25.0 |
| 1300.0 | 2.5 | 2.1 | 24.2 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .237 | –97 | 17.551 | 25 | .019 | 19 | .151 | –58 |
| 2.0 | .156 | –125 | 17.742 | 12 | .017 | 7 | .088 | –60 |
| 5.0 | .113 | –159 | 17.899 | 4 | .016 | 3 | .044 | –42 |
| 10.0 | .098 | –174 | 17.965 | 0 | .016 | 2 | .037 | –26 |
| 50.0 | .095 | 166 | 18.062 | –12 | .016 | 0 | .033 | –26 |
| 100.0 | .096 | 148 | 18.023 | –25 | .017 | –3 | .030 | –42 |
| 200.0 | .095 | 121 | 18.100 | –52 | .017 | –7 | .022 | –82 |
| 300.0 | .104 | 87 | 18.078 | –78 | .017 | –11 | .019 | –147 |
| 400.0 | .111 | 52 | 18.195 | –104 | .017 | –18 | .026 | 161 |
| 500.0 | .117 | 20 | 18.146 | –130 | .018 | –21 | .033 | 129 |
| 600.0 | .123 | –16 | 18.236 | –157 | .018 | –25 | .037 | 103 |
| 700.0 | .130 | –49 | 18.429 | 176 | .018 | –32 | .042 | 91 |
| 800.0 | .120 | –86 | 18.755 | 148 | .019 | –37 | .053 | 84 |
| 900.0 | .102 | –136 | 18.962 | 118 | .020 | –43 | .080 | 72 |
| 1000.0 | .102 | 156 | 18.989 | 87 | .021 | –54 | .128 | 60 |
| 1100.0 | .159 | 86 | 18.563 | 54 | .022 | –65 | .192 | 37 |
| 1200.0 | .276 | 37 | 17.805 | 20 | .023 | –76 | .276 | 9 |
| 1300.0 | .435 | –5 | 16.236 | –17 | .023 | –89 | .364 | –22 |

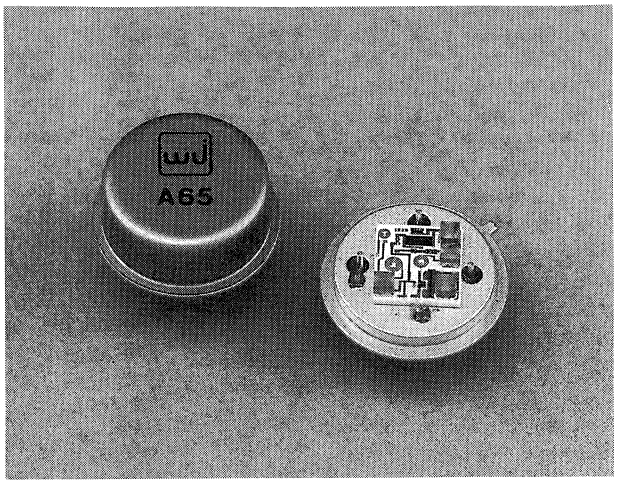
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.175 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A65 / SMA65

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ MEDIUM OUTPUT LEVEL: +10 dBm (TYP.)
- ◆ MEDIUM THIRD ORDER I.P.: +24 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 10.5 dB | 9.5 dB | 9.0 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.7 dB | ±0.8 dB |
| Noise Figure (Max.) | 6.0 dB | 7.5 dB | 8.0 dB |
| Power Output at 1 dB Compression (Min.) | +10.0 dBm | +8.0 dBm | +8.0 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 30 mA | 35 mA | 37 mA |

*measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA65 is a standard WJ-A65 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+44 dBm (Typ.)
Second Order Two Tone Intercept Point.....+39 dBm (Typ.)
Third Order Two Tone Intercept Point.....+24 dBm (Typ.)

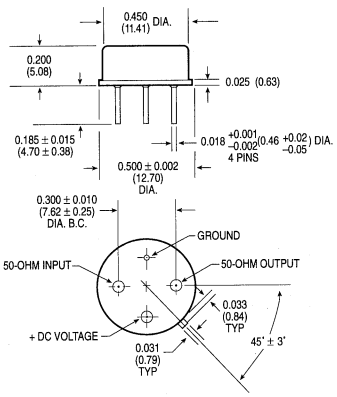
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+20 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

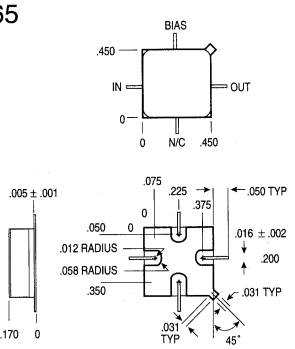
## Outline Drawings

A65



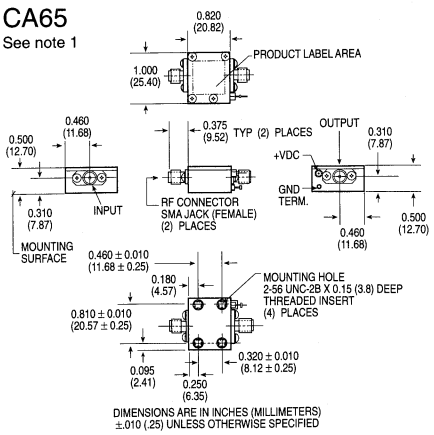

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA65




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

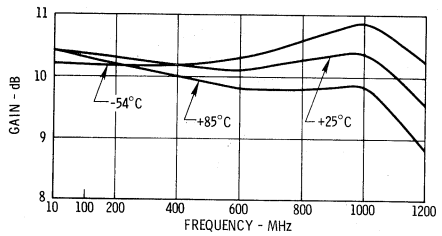
CA65
See note 1



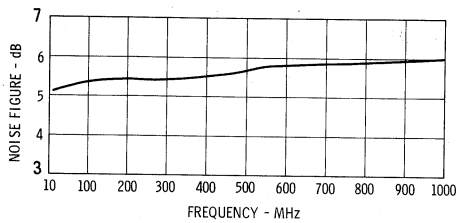

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

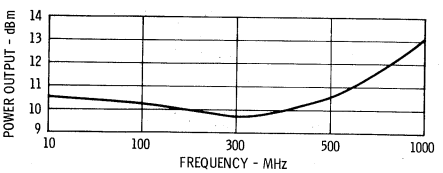
### Gain




### Noise Figure

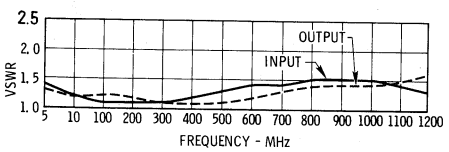



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.4 | 1.8 | 5.3 |
| 2.0 | 1.8 | 1.6 | 8.4 |
| 5.0 | 1.4 | 1.3 | 10.1 |
| 10.0 | 1.2 | 1.3 | 10.5 |
| 50.0 | 1.1 | 1.3 | 10.6 |
| 100.0 | 1.1 | 1.3 | 10.6 |
| 200.0 | 1.0 | 1.3 | 10.5 |
| 300.0 | 1.0 | 1.4 | 10.4 |
| 400.0 | 1.1 | 1.4 | 10.3 |
| 500.0 | 1.1 | 1.4 | 10.2 |
| 600.0 | 1.1 | 1.4 | 10.1 |
| 700.0 | 1.2 | 1.5 | 10.0 |
| 800.0 | 1.2 | 1.5 | 10.1 |
| 900.0 | 1.2 | 1.5 | 10.1 |
| 1000.0 | 1.3 | 1.4 | 10.3 |
| 1100.0 | 1.4 | 1.4 | 10.4 |
| 1200.0 | 1.6 | 1.4 | 10.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .418 | –35 | 1.848 | –133 | .181 | –10 | .283 | –51 |
| 2.0 | .296 | –55 | 2.622 | –147 | .159 | –13 | .221 | –78 |
| 5.0 | .151 | –85 | 3.216 | –165 | .136 | –9 | .149 | –123 |
| 10.0 | .085 | –107 | 3.348 | –173 | .129 | –6 | .127 | –150 |
| 50.0 | .042 | –163 | 3.395 | 173 | .127 | –4 | .119 | 168 |
| 100.0 | .032 | 170 | 3.380 | 163 | .128 | –5 | .121 | 146 |
| 200.0 | .024 | 173 | 3.355 | 146 | .129 | –10 | .133 | 111 |
| 300.0 | .015 | –165 | 3.310 | 129 | .131 | –15 | .150 | 82 |
| 400.0 | .027 | –120 | 3.268 | 112 | .134 | –21 | .160 | 57 |
| 500.0 | .048 | –132 | 3.222 | 96 | .137 | –27 | .170 | 33 |
| 600.0 | .063 | –146 | 3.195 | 80 | .141 | –33 | .178 | 11 |
| 700.0 | .072 | –175 | 3.171 | 64 | .144 | –40 | .184 | –10 |
| 800.0 | .092 | 162 | 3.190 | 47 | .149 | –47 | .187 | –30 |
| 900.0 | .110 | 128 | 3.198 | 31 | .153 | –55 | .187 | –47 |
| 1000.0 | .127 | 89 | 3.267 | 13 | .156 | –63 | .181 | –65 |
| 1100.0 | .157 | 49 | 3.328 | –6 | .158 | –70 | .172 | –82 |
| 1200.0 | .224 | 8 | 3.321 | –27 | .162 | –78 | .161 | –95 |

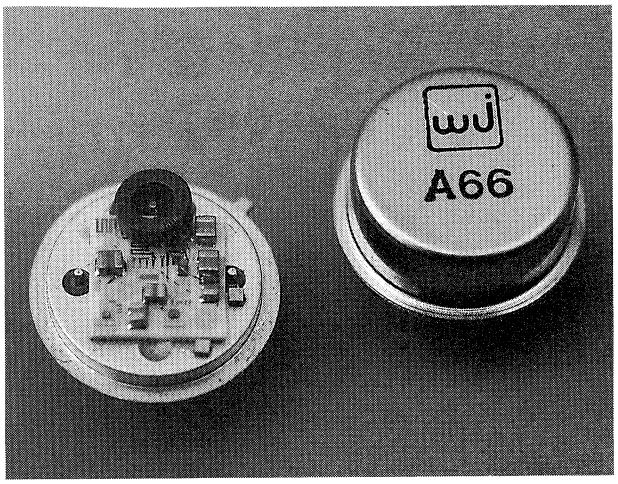
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.194 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A66 / SMA66

## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 23.5 dB (TYP.)
- ◆ LOW NOISE: 4.0 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +15 dBm (TYP.)
- ◆ ULTRA LOW PHASE DEVIATION FROM LINEARITY: < ±2°, 100 - 1000 MHz




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1250 MHz | 10-1200 MHz | 10-1200 MHz |
| Small Signal Gain (Min.) | 23.5 dB | 22.0 dB | 21.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +15.0 dBm | +14.0 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.6:1 | 1.8:1 |
| DC Current at 15 Volts | 64 mA | 67 mA | 70 mA |

*Measured in a 50-ohm system at 15 Vdc Nominal.
Notes:
1. WJ-CA66 is a standard WJ-A66 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+53 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+47 dBm (Typ.)
Third Order Two-Tone Intercept Point ..... +28 dBm (Typ.)

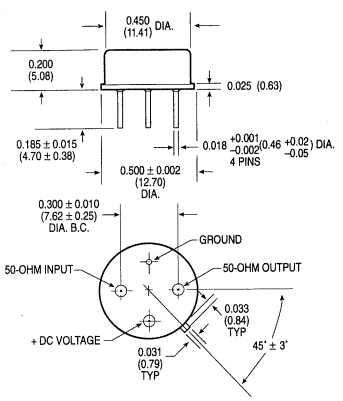
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short-Term RF Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec. Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

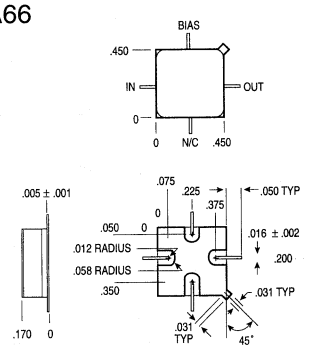
## Outline Drawings

A66



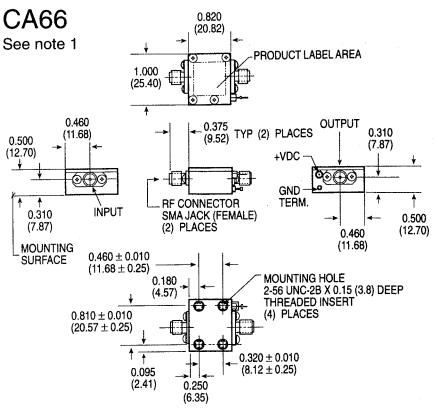

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA66




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

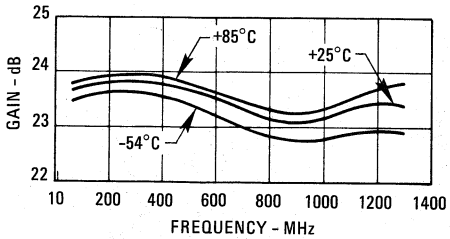
CA66
See note 1



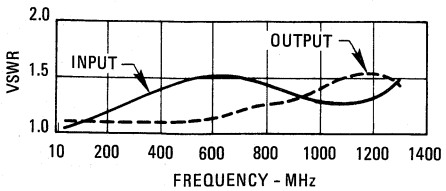

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

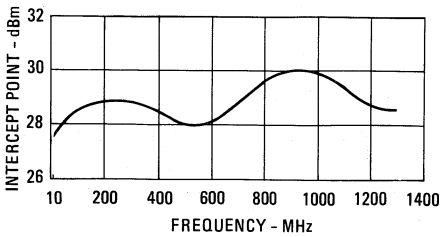
### Gain



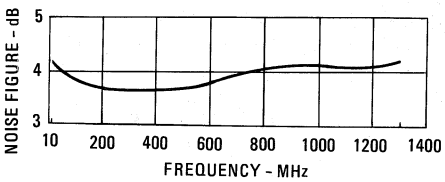

### VSWR



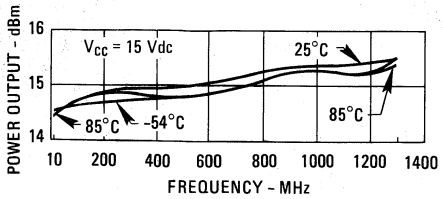

### 3rd Order Two Tone Intercept Point

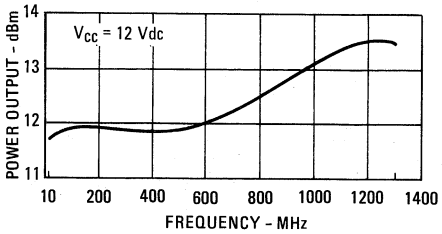



### Noise Figure

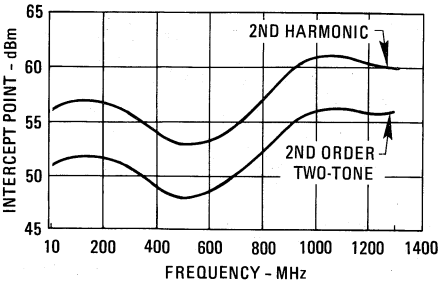



### Power Output*




### Intercept Point




1

# Typical Automatic Test Data

* at 1 dB Gain Compression

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.9 | 18.4 |
| 2.0 | 1.3 | 2.0 | 21.6 |
| 5.0 | 1.2 | 1.4 | 23.1 |
| 10.0 | 1.1 | 1.3 | 23.3 |
| 50.0 | 1.1 | 1.2 | 23.5 |
| 100.0 | 1.1 | 1.2 | 23.5 |
| 200.0 | 1.2 | 1.2 | 23.5 |
| 300.0 | 1.2 | 1.3 | 23.4 |
| 400.0 | 1.2 | 1.3 | 23.4 |
| 500.0 | 1.2 | 1.4 | 23.3 |
| 600.0 | 1.2 | 1.4 | 23.3 |
| 700.0 | 1.2 | 1.3 | 23.4 |
| 800.0 | 1.2 | 1.3 | 23.5 |
| 900.0 | 1.3 | 1.3 | 23.6 |
| 1000.0 | 1.3 | 1.2 | 23.6 |
| 1100.0 | 1.3 | 1.2 | 23.5 |
| 1200.0 | 1.4 | 1.3 | 23.2 |
| 1300.0 | 1.6 | 1.6 | 22.8 |
| 1400.0 | 1.9 | 2.3 | 21.9 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.7 | 2.9 | 18.1 |
| 2.0 | 1.3 | 2.0 | 21.3 |
| 5.0 | 1.2 | 1.4 | 22.8 |
| 10.0 | 1.2 | 1.3 | 23.1 |
| 50.0 | 1.2 | 1.2 | 23.3 |
| 100.0 | 1.2 | 1.2 | 23.2 |
| 200.0 | 1.2 | 1.2 | 23.2 |
| 300.0 | 1.2 | 1.3 | 23.2 |
| 400.0 | 1.2 | 1.3 | 23.2 |
| 500.0 | 1.2 | 1.3 | 23.2 |
| 600.0 | 1.2 | 1.3 | 23.2 |
| 700.0 | 1.2 | 1.3 | 23.3 |
| 800.0 | 1.3 | 1.2 | 23.4 |
| 900.0 | 1.3 | 1.2 | 23.5 |
| 1000.0 | 1.3 | 1.1 | 23.5 |
| 1100.0 | 1.4 | 1.2 | 23.3 |
| 1200.0 | 1.4 | 1.4 | 23.0 |
| 1300.0 | 1.6 | 1.8 | 22.6 |
| 1400.0 | 2.0 | 2.5 | 21.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .241 | −147 | 8.293 | 49 | .008 | 75 | .489 | −158 |
| 2.0 | .147 | 150 | 12.005 | 34 | .015 | 53 | .338 | 163 |
| 5.0 | .078 | 76 | 14.265 | 14 | .019 | 23 | .171 | 146 |
| 10.0 | .066 | 35 | 14.689 | 6 | .020 | 12 | .118 | 150 |
| 50.0 | .066 | −12 | 15.027 | −11 | .021 | 1 | .083 | 168 |
| 100.0 | .066 | −35 | 14.978 | −25 | .021 | −1 | .088 | 170 |
| 200.0 | .078 | −75 | 14.913 | −52 | .020 | −5 | .110 | 157 |
| 300.0 | .092 | −100 | 14.785 | −78 | .021 | −7 | .130 | 136 |
| 400.0 | .092 | −124 | 14.784 | −104 | .022 | −10 | .144 | 113 |
| 500.0 | .094 | −146 | 14.641 | −129 | .022 | −14 | .151 | 87 |
| 600.0 | .097 | −156 | 14.625 | −155 | .023 | −19 | .151 | 56 |
| 700.0 | .088 | −164 | 14.707 | 179 | .024 | −23 | .146 | 23 |
| 800.0 | .099 | −176 | 14.957 | 152 | .024 | −27 | .137 | −14 |
| 900.0 | .115 | 169 | 15.098 | 124 | .026 | −32 | .124 | −56 |
| 1000.0 | .131 | 146 | 15.159 | 94 | .028 | −37 | .101 | −109 |
| 1100.0 | .140 | 118 | 14.947 | 63 | .030 | −44 | .093 | 180 |
| 1200.0 | .166 | 78 | 14.451 | 31 | .034 | −52 | .129 | 101 |
| 1300.0 | .219 | 33 | 13.837 | −3 | .038 | −64 | .239 | 39 |
| 1400.0 | .316 | −15 | 12.511 | −41 | .043 | −79 | .387 | −15 |

### Linear S-Parameters

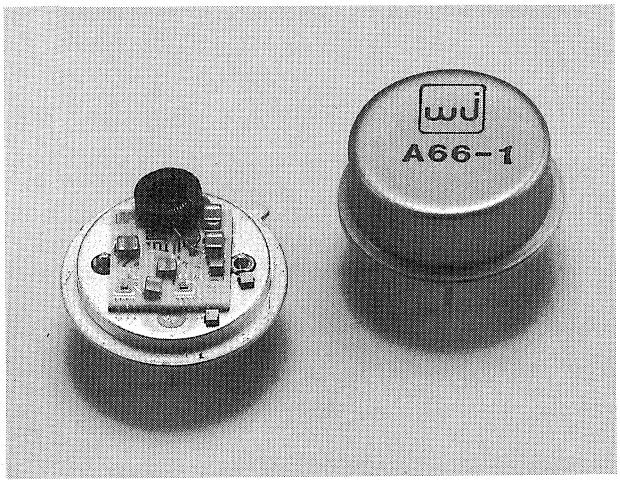
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .262 | −145 | 8.057 | 49 | .008 | 76 | .483 | −158 |
| 2.0 | .136 | 148 | 11.661 | 34 | .015 | 52 | .333 | 163 |
| 5.0 | .082 | 68 | 13.830 | 14 | .019 | 23 | .166 | 145 |
| 10.0 | .075 | 31 | 14.254 | 6 | .020 | 12 | .115 | 150 |
| 50.0 | .071 | −10 | 14.557 | −11 | .021 | 1 | .080 | 168 |
| 100.0 | .076 | −32 | 14.514 | −25 | .021 | −2 | .085 | 170 |
| 200.0 | .087 | −67 | 14.468 | −51 | .021 | −4 | .104 | 157 |
| 300.0 | .094 | −96 | 14.431 | −77 | .022 | −8 | .122 | 137 |
| 400.0 | .103 | −115 | 14.516 | −103 | .022 | −12 | .134 | 114 |
| 500.0 | .106 | −138 | 14.406 | −129 | .022 | −14 | .136 | 89 |
| 600.0 | .105 | −152 | 14.443 | −155 | .023 | −18 | .132 | 59 |
| 700.0 | .101 | −160 | 14.576 | 179 | .025 | −23 | .121 | 26 |
| 800.0 | .118 | −171 | 14.826 | 151 | .026 | −26 | .105 | −13 |
| 900.0 | .133 | 170 | 14.948 | 123 | .027 | −31 | .085 | −60 |
| 1000.0 | .147 | 145 | 14.980 | 92 | .030 | −38 | .064 | −132 |
| 1100.0 | .159 | 112 | 14.674 | 61 | .032 | −46 | .089 | 144 |
| 1200.0 | .182 | 75 | 14.186 | 29 | .036 | −54 | .163 | 80 |
| 1300.0 | .235 | 30 | 13.486 | −5 | .041 | −67 | .292 | 28 |
| 1400.0 | .327 | −18 | 11.913 | −44 | .044 | −82 | .435 | −22 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.409 W
Junction Temperature Rise Above Case $T_{jc}$ ... 18°C

# WJ-A66-1 / SMA66-1

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 27.5 dB (TYP.)
- ◆ LOW NOISE: < 3.0 dB (TYP.)
- ◆ HIGH POWER OUTPUT: 15.0 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: 5 VOLTS TO 15 VOLTS

## Specifications*

| Characteristics | Typical. | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1200 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 27.5 dB | 26.0 dB | 25.5 dB |
| Gain Flatness (Max.) | ±0.4dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-500 MHz | 2.7 dB | 3.5 dB | 4.0 dB |
| 10-1000 MHz | 3.0 dB | 4.0 dB | 4.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +15.0 dBm | +14.5 dBm | +14.0 dBm |
| VSWR (Max.) | | | |
| Input | <1.5:1 | 1.8:1 | 2.0:1 |
| output | <1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 65 mA | 69 mA | 72 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Note:

1. WJ-CA66-1 a standard WJ-A66-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+27 dBm (Typ.)

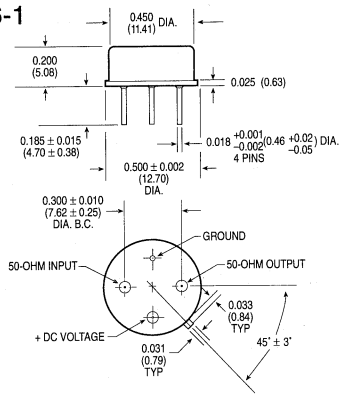
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

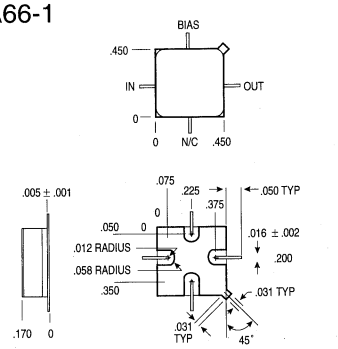
## Outline Drawings

A66-1



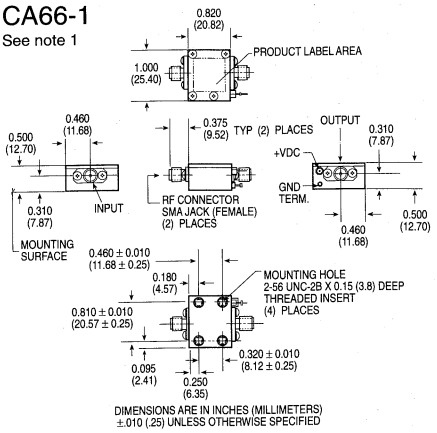

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA66-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

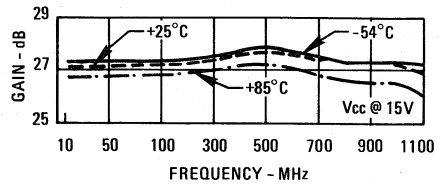
CA66-1
See note 1

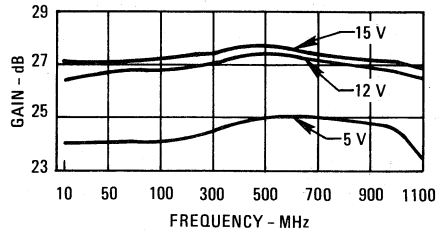



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

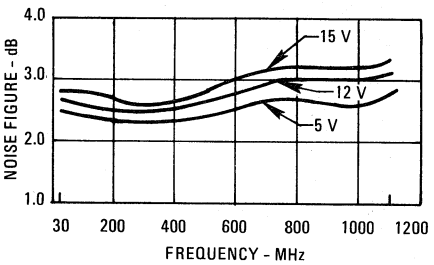
# Typical Performance at 25°C

## Gain

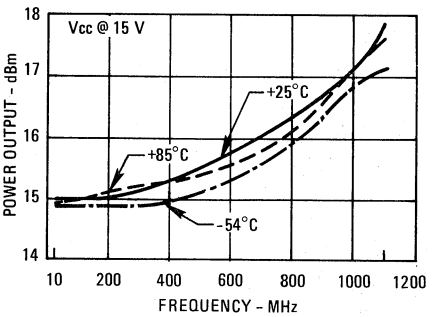


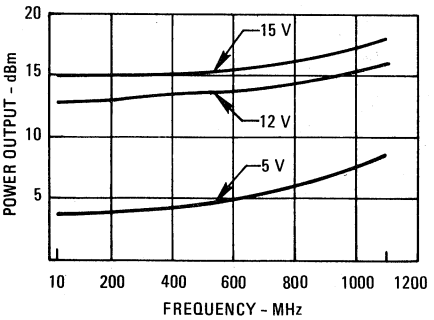




## Noise Figure



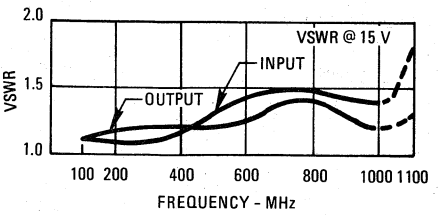

## Power Output*

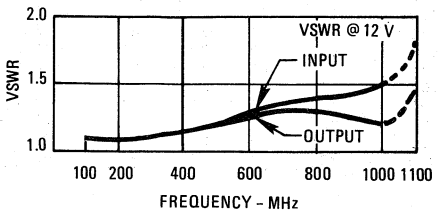


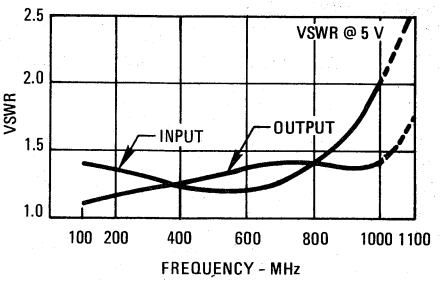




* at 1 dB Gain Compression

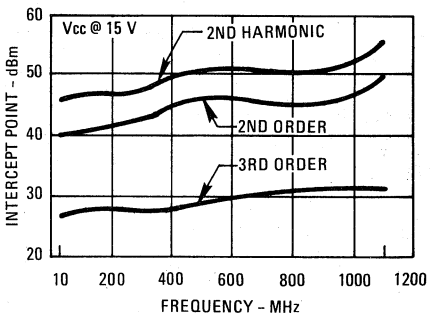
## VSWR

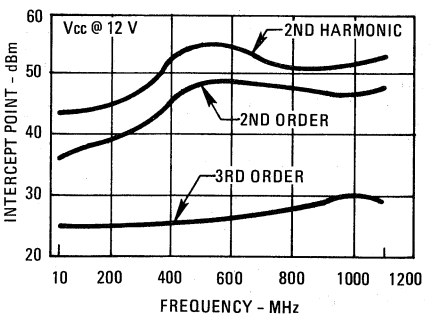


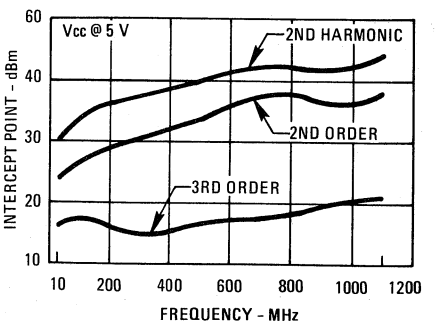



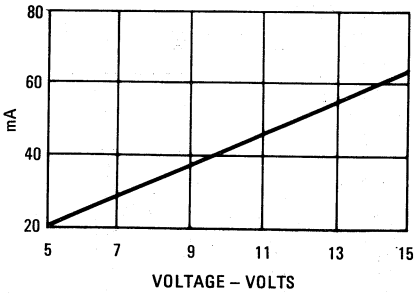

## Intercept Point




## Current Drain




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.7 | 22.3 |
| 2.0 | 1.3 | 3.0 | 23.9 |
| 5.0 | 1.0 | 1.3 | 27.1 |
| 10.0 | 1.0 | 1.1 | 27.2 |
| 50.0 | 1.0 | 1.0 | 27.4 |
| 100.0 | 1.1 | 1.1 | 27.3 |
| 200.0 | 1.2 | 1.1 | 27.4 |
| 300.0 | 1.2 | 1.1 | 27.4 |
| 400.0 | 1.2 | 1.2 | 27.4 |
| 500.0 | 1.2 | 1.1 | 27.2 |
| 600.0 | 1.1 | 1.1 | 27.2 |
| 700.0 | 1.1 | 1.0 | 27.1 |
| 800.0 | 1.2 | 1.0 | 27.2 |
| 900.0 | 1.3 | 1.1 | 27.2 |
| 1000.0 | 1.3 | 1.2 | 27.2 |
| 1100.0 | 1.5 | 1.4 | 27.1 |
| 1200.0 | 2.4 | 2.2 | 26.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .231 | –88 | 13.077 | 23 | .009 | 19 | .460 | –124 |
| 2.0 | .146 | –159 | 15.614 | 46 | .008 | 37 | .498 | 164 |
| 5.0 | .016 | 123 | 22.630 | 14 | .013 | 17 | .136 | 111 |
| 10.0 | .002 | 84 | 22.870 | 5 | .014 | 8 | .065 | 104 |
| 50.0 | .023 | –100 | 23.319 | –13 | .014 | 0 | .004 | –129 |
| 100.0 | .049 | –111 | 23.295 | –29 | .014 | –4 | .027 | –125 |
| 200.0 | .088 | –139 | 23.569 | –60 | .014 | –10 | .054 | –158 |
| 300.0 | .109 | –166 | 23.469 | –92 | .014 | –13 | .069 | 177 |
| 400.0 | .098 | 174 | 23.449 | –123 | .015 | –20 | .072 | 150 |
| 500.0 | .074 | 160 | 22.975 | –154 | .015 | –24 | .060 | 124 |
| 600.0 | .047 | 162 | 22.797 | 174 | .015 | –30 | .034 | 93 |
| 700.0 | .047 | –161 | 22.775 | 142 | .016 | –38 | .004 | 55 |
| 800.0 | .087 | –159 | 22.912 | 108 | .017 | –45 | .022 | –152 |
| 900.0 | .117 | 172 | 22.860 | 73 | .018 | –54 | .038 | 148 |
| 1000.0 | .133 | 121 | 22.814 | 35 | .020 | –67 | .078 | 77 |
| 1100.0 | .184 | 39 | 22.517 | –7 | .022 | –84 | .184 | 16 |
| 1200.0 | .420 | –37 | 20.806 | –57 | .023 | –108 | .381 | –40 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.7 | 2.7 | 21.9 |
| 2.0 | 1.3 | 3.0 | 23.6 |
| 5.0 | 1.0 | 1.3 | 26.7 |
| 10.0 | 1.1 | 1.1 | 26.8 |
| 50.0 | 1.1 | 1.0 | 27.0 |
| 100.0 | 1.1 | 1.1 | 27.0 |
| 200.0 | 1.2 | 1.1 | 27.1 |
| 300.0 | 1.2 | 1.2 | 27.1 |
| 400.0 | 1.2 | 1.2 | 27.2 |
| 500.0 | 1.2 | 1.1 | 27.0 |
| 600.0 | 1.1 | 1.1 | 27.0 |
| 700.0 | 1.1 | 1.1 | 27.0 |
| 800.0 | 1.2 | 1.1 | 27.1 |
| 900.0 | 1.3 | 1.1 | 27.1 |
| 1000.0 | 1.4 | 1.3 | 27.0 |
| 1100.0 | 1.6 | 1.7 | 26.8 |
| 1200.0 | 2.7 | 2.7 | 25.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .246 | –86 | 12.486 | 23 | .010 | 22 | .462 | –124 |
| 2.0 | .125 | –159 | 15.145 | 46 | .008 | 37 | .497 | 163 |
| 5.0 | .019 | 45 | 21.679 | 14 | .014 | 16 | .133 | 113 |
| 10.0 | .025 | 2 | 21.882 | 5 | .014 | 8 | .064 | 111 |
| 50.0 | .035 | –60 | 22.283 | –13 | .014 | 1 | .009 | –173 |
| 100.0 | .050 | –88 | 22.313 | –29 | .014 | –4 | .029 | –139 |
| 200.0 | .092 | –126 | 22.607 | –60 | .014 | –8 | .055 | –160 |
| 300.0 | .101 | –152 | 22.670 | –91 | .014 | –13 | .070 | 177 |
| 400.0 | .097 | –173 | 22.794 | –122 | .015 | –18 | .076 | 155 |
| 500.0 | .087 | 175 | 22.429 | –153 | .015 | –23 | .067 | 134 |
| 600.0 | .064 | 176 | 22.397 | 175 | .015 | –29 | .046 | 114 |
| 700.0 | .066 | –165 | 22.451 | 142 | .017 | –38 | .027 | 116 |
| 800.0 | .108 | –166 | 22.587 | 108 | .018 | –45 | .033 | 137 |
| 900.0 | .139 | 165 | 22.579 | 73 | .019 | –54 | .060 | 106 |
| 1000.0 | .162 | 112 | 22.497 | 34 | .021 | –68 | .125 | 60 |
| 1100.0 | .220 | 34 | 21.987 | –9 | .024 | –87 | .253 | 9 |
| 1200.0 | .460 | –40 | 19.653 | –59 | .025 | –113 | .457 | –44 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.8 | 19.3 |
| 2.0 | 1.1 | 2.9 | 21.3 |
| 5.0 | 1.3 | 1.3 | 24.2 |
| 10.0 | 1.3 | 1.1 | 24.2 |
| 50.0 | 1.3 | 1.0 | 24.3 |
| 100.0 | 1.3 | 1.1 | 24.4 |
| 200.0 | 1.4 | 1.1 | 24.5 |
| 300.0 | 1.5 | 1.1 | 24.6 |
| 400.0 | 1.5 | 1.1 | 24.7 |
| 500.0 | 1.5 | 1.1 | 24.7 |
| 600.0 | 1.5 | 1.1 | 24.8 |
| 700.0 | 1.6 | 1.2 | 24.9 |
| 800.0 | 1.7 | 1.2 | 24.9 |
| 900.0 | 1.8 | 1.4 | 25.1 |
| 1000.0 | 2.0 | 1.7 | 24.9 |
| 1100.0 | 2.5 | 2.3 | 24.3 |
| 1200.0 | 4.2 | 3.3 | 22.2 |

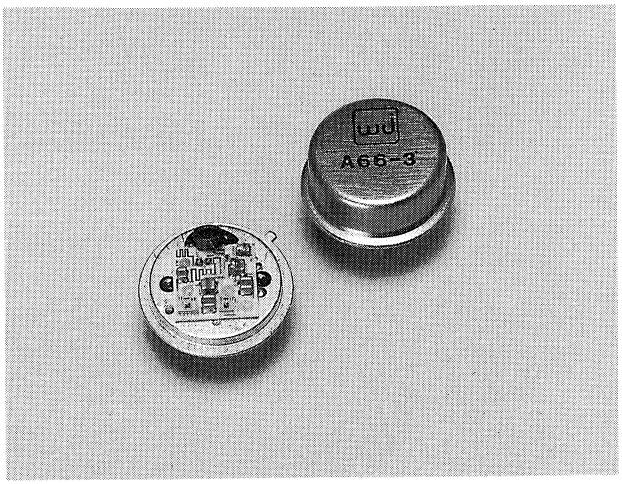
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .238 | –52 | 9.182 | 21 | .012 | 18 | .475 | –124 |
| 2.0 | .035 | –56 | 11.681 | 45 | .010 | 34 | .493 | 162 |
| 5.0 | .135 | 5 | 16.127 | 13 | .016 | 15 | .126 | 119 |
| 10.0 | .141 | –1 | 16.243 | 4 | .017 | 7 | .066 | 123 |
| 50.0 | .146 | –20 | 16.483 | –13 | .017 | 0 | .023 | 167 |
| 100.0 | .147 | –41 | 16.510 | –29 | .017 | –5 | .030 | –166 |
| 200.0 | .172 | –78 | 16.812 | –60 | .017 | –9 | .042 | –173 |
| 300.0 | .188 | –108 | 17.022 | –91 | .017 | –15 | .049 | 176 |
| 400.0 | .198 | –130 | 17.252 | –123 | .018 | –20 | .052 | 169 |
| 500.0 | .208 | –151 | 17.168 | –155 | .018 | –26 | .051 | 165 |
| 600.0 | .214 | –167 | 17.287 | 172 | .019 | –32 | .054 | 169 |
| 700.0 | .227 | 179 | 17.516 | 139 | .020 | –40 | .074 | 162 |
| 800.0 | .255 | 159 | 17.674 | 103 | .022 | –51 | .108 | 140 |
| 900.0 | .287 | 124 | 17.907 | 66 | .025 | –62 | .158 | 101 |
| 1000.0 | .330 | 75 | 17.661 | 24 | .028 | –80 | .249 | 54 |
| 1100.0 | .433 | 10 | 16.386 | –22 | .030 | –104 | .392 | –1 |
| 1200.0 | .613 | –56 | 12.924 | –74 | .029 | –133 | .536 | –56 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.412 W
Junction Temperature Rise Above Case $T_{jc}$ ... 19°C

# WJ-A66-3 / SMA66-3




## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 26.0 dB (TYP.)
- ◆ LOW NOISE: < 3.0 dB (TYP.)
- ◆ HIGH EFFICIENCY: 16 mA (TYP.) AT 5 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed - 54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 26.0 dB | 24.5 dB | 24.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.1 dB |
| Noise Figure (Max.) | < 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | +3.0 dBm | +1.5 dBm | +1.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.3:1 | 1.8:1 | 2.0:1 |
| output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 5 Volts | 16 mA | 18 mA | 19 mA |

*Measured in a 60-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA66-3 is a standard WJ-A66-3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+30 dBm (Typ.)
Second Order Two Tone Intercept Point.....+25 dBm (Typ.)
Third Order Two Tone Intercept Point.....+13 dBm (Typ.)

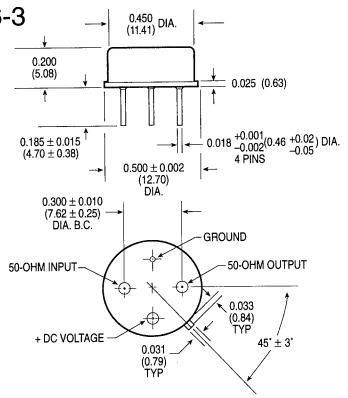
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+10 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

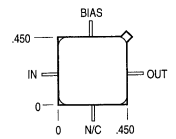
## Outline Drawings

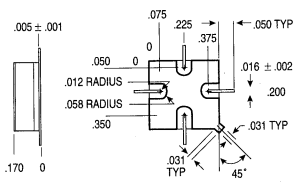
A66-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

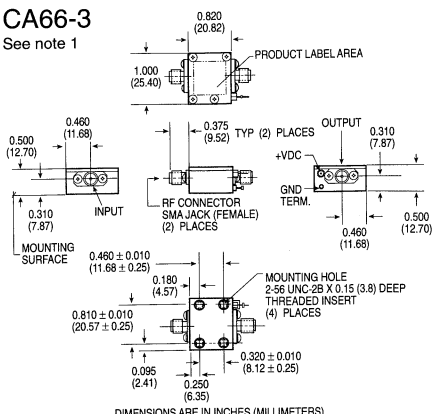
SMA66-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

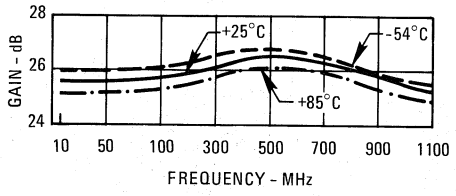
CA66-3
See note 1



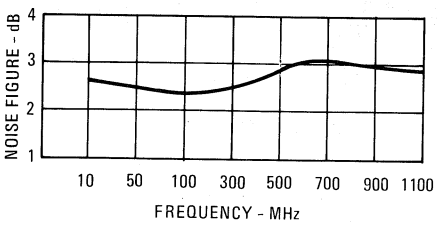

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

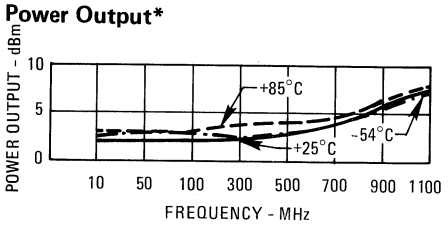
### Gain




### Noise Figure

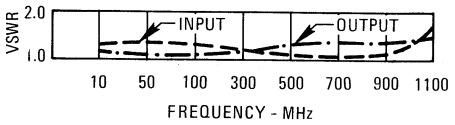



### Power Output*

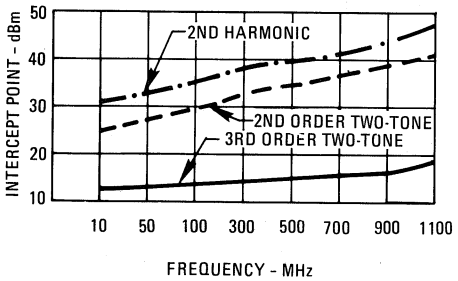



* at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.6 | 1.4 | 24.6 |
| 5.0 | 1.3 | 1.1 | 26.2 |
| 10.0 | 1.2 | 1.0 | 26.3 |
| 50.0 | 1.2 | 1.0 | 26.4 |
| 100.0 | 1.2 | 1.0 | 26.4 |
| 200.0 | 1.2 | 1.1 | 26.6 |
| 300.0 | 1.1 | 1.1 | 26.6 |
| 400.0 | 1.1 | 1.2 | 26.7 |
| 500.0 | 1.1 | 1.3 | 26.6 |
| 600.0 | 1.1 | 1.3 | 26.7 |
| 700.0 | 1.1 | 1.4 | 26.7 |
| 800.0 | 1.1 | 1.4 | 26.7 |
| 900.0 | 1.1 | 1.3 | 26.5 |
| 1000.0 | 1.4 | 1.3 | 26.2 |
| 1100.0 | 2.1 | 1.5 | 25.4 |

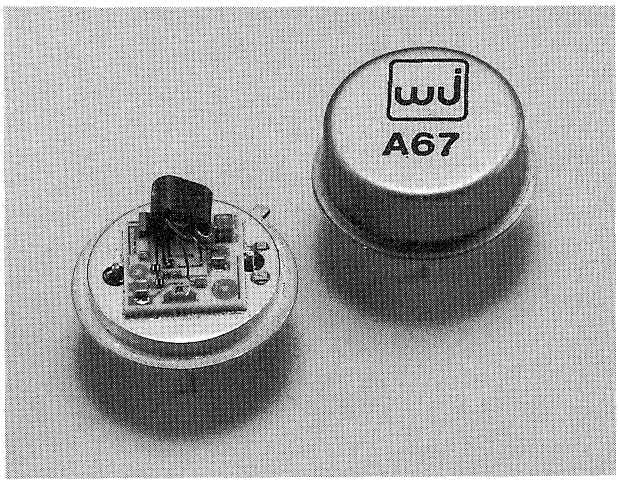
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .445 | −79 | 17.077 | 50 | .006 | 5 | .174 | 136 |
| 5.0 | .125 | −55 | 20.372 | 17 | .014 | 17 | .037 | 53 |
| 10.0 | .103 | −28 | 20.566 | 6 | .014 | 7 | .024 | 33 |
| 50.0 | .093 | −22 | 20.876 | −13 | .015 | −1 | .023 | 6 |
| 100.0 | .096 | −33 | 20.949 | −29 | .015 | −7 | .021 | 10 |
| 200.0 | .076 | −79 | 21.288 | −60 | .014 | −12 | .032 | 27 |
| 300.0 | .044 | −126 | 21.473 | −92 | .015 | −19 | .056 | 14 |
| 400.0 | .025 | 164 | 21.678 | −124 | .014 | −26 | .084 | −13 |
| 500.0 | .030 | 79 | 21.499 | −156 | .014 | −31 | .115 | −43 |
| 600.0 | .051 | 25 | 21.669 | 171 | .013 | −38 | .147 | −74 |
| 700.0 | .058 | −16 | 21.740 | 137 | .014 | −45 | .166 | −107 |
| 800.0 | .036 | −62 | 21.679 | 101 | .014 | −48 | .164 | −143 |
| 900.0 | .040 | 111 | 21.229 | 63 | .015 | −55 | .133 | 169 |
| 1000.0 | .166 | 70 | 20.323 | 23 | .016 | −64 | .112 | 88 |
| 1100.0 | .364 | 31 | 18.544 | −22 | .019 | −81 | .200 | −1 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.036 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A67 / SMA67




## 10 to 800 MHz
## TO - 8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH EFFICIENCY: +16.0 dBm (TYP.) OUTPUT POWER @ 32 mA (TYP.)
- ◆ LOW NOISE FIGURE: < 4.0 dB (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: 5 VOLTS TO 15 VOLTS

## Specifications*

| Characteristics | Typical. | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-900 MHz | 10-800 MHz | 10-800 MHz |
| Small Signal Gain (Min.) | 14.0 dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.6 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 10-800 MHz | <4.0 dB | 4.3 dB | 4.5 dB |
| Power Output | | | |
| at 1 dBCompression (Min.) | | | |
| 15Vdc | +16.0 dBm | +15.5 dBm | +15.0 dBm |
| 12 Vdc | +14.0 dBm | +13.5 dBm | +13.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.8:1 | 1.9:1 | 2.0:1 |
| output | 2.0:1 | 2.0:1[2] | 2.2:1[3] |
| DC Current (Max.) at 15 Volts | 32 mA | 34 mA | 35 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA67 is a standard WJ-A67 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. Output VSWR above 350 MHz is 2.2:1.
3. Output VSWR above 350 MHz is 2.4:1.

## Typical Intermodulation Performance at 25°C

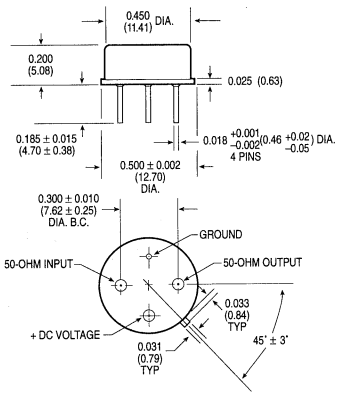
Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C
Weight approximately 2.0 grams (0.07 oz.)

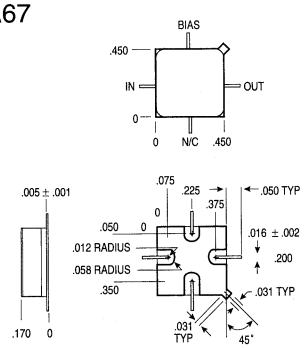
## Outline Drawings

A67



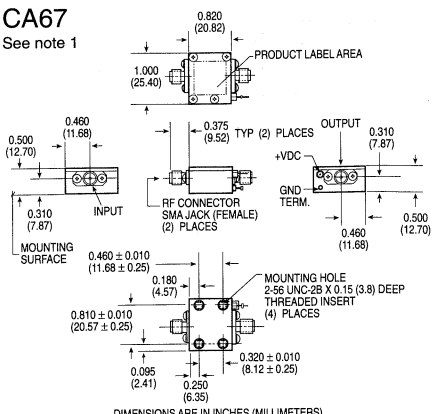

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA67




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

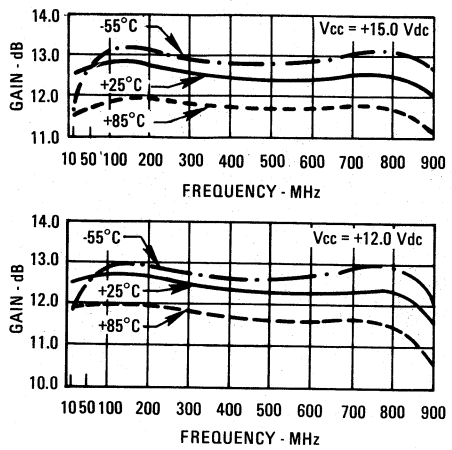
CA67
See note 1



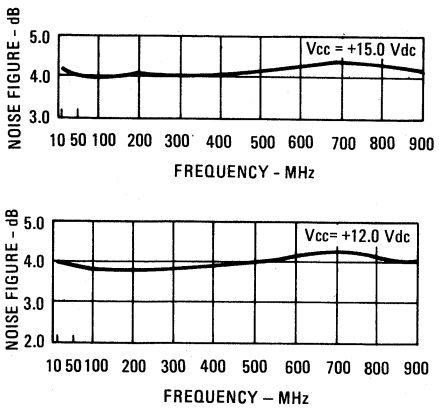

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

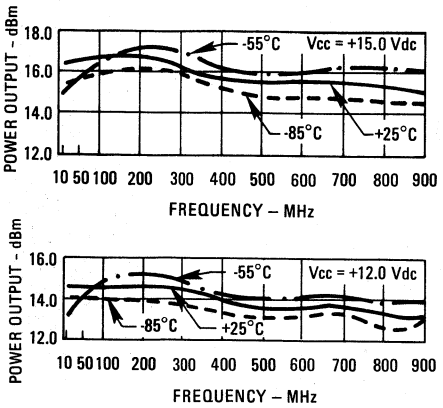
### Gain




### Noise Figure

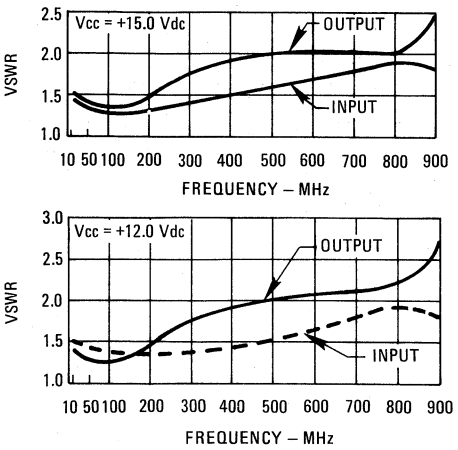



### Power Output*

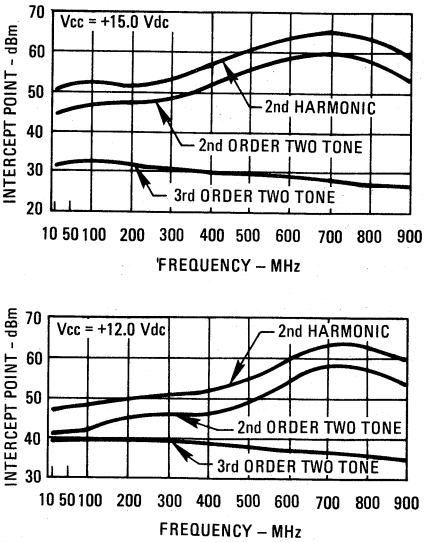



* at 1 dB Gain Compression

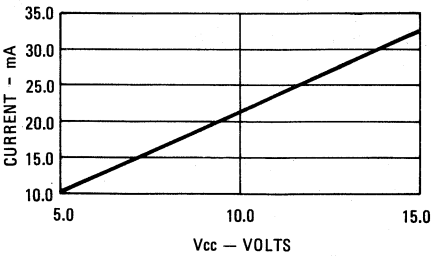
### VSWR




### Intercept Point




### Current Drain




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.7 | 1.8 | 12.2 |
| 10.0 | 1.5 | 1.5 | 12.7 |
| 50.0 | 1.3 | 1.3 | 12.8 |
| 100.0 | 1.3 | 1.4 | 12.9 |
| 200.0 | 1.3 | 1.5 | 12.8 |
| 300.0 | 1.3 | 1.7 | 12.7 |
| 400.0 | 1.4 | 1.9 | 12.6 |
| 500.0 | 1.4 | 2.0 | 12.6 |
| 600.0 | 1.5 | 1.9 | 12.6 |
| 700.0 | 1.6 | 1.9 | 12.6 |
| 800.0 | 1.9 | 2.0 | 12.4 |
| 900.0 | 1.9 | 2.6 | 11.9 |

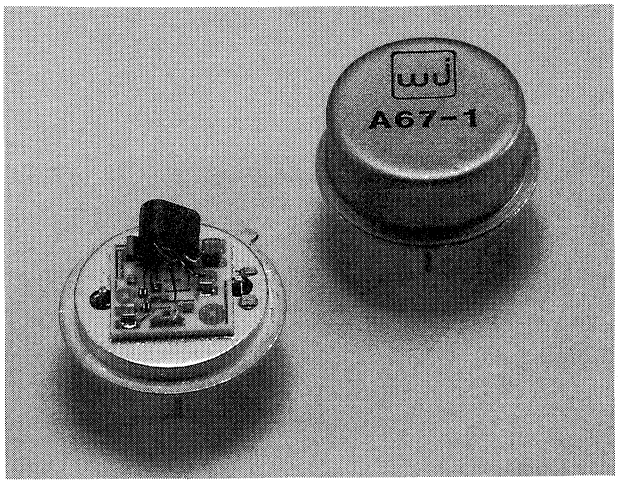
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.848 | –12 | 2.68 | –114 | 0.13 | –85 | 0.728 | –168 |
| 2.0 | 0.474 | –39 | 3.52 | –143 | 0.04 | 14 | 0.496 | 159 |
| 5.0 | 0.258 | –42 | 4.09 | –162 | 0.10 | 2 | 0.292 | 142 |
| 10.0 | 0.107 | –36 | 4.32 | –171 | 0.10 | 6 | 0.202 | 142 |
| 50.0 | 0.127 | –24 | 4.38 | 175 | 0.10 | –7 | 0.134 | 173 |
| 100.0 | 0.122 | –18 | 4.40 | 164 | 0.12 | –16 | 0.150 | –176 |
| 200.0 | 0.119 | –30 | 4.36 | 143 | 0.10 | –25 | 0.192 | –170 |
| 300.0 | 0.143 | –40 | 4.31 | 124 | 0.12 | –35 | 0.270 | –175 |
| 400.0 | 0.161 | –50 | 4.26 | 105 | 0.11 | –45 | 0.302 | 174 |
| 500.0 | 0.172 | –64 | 4.29 | 82 | 0.11 | –54 | 0.325 | 162 |
| 600.0 | 0.196 | –86 | 4.24 | 64 | 0.11 | –62 | 0.308 | 135 |
| 700.0 | 0.231 | –104 | 4.28 | 39 | 0.13 | –71 | 0.316 | 98 |
| 800.0 | 0.312 | –125 | 4.17 | 16 | 0.14 | –22 | 0.343 | 64 |
| 900.0 | 0.383 | –153 | 3.92 | –11 | 0.13 | –98 | 0.445 | 11 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{JC}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.269 W
Junction Temperature Rise Above Case $T_{JC}$ ... 12°C

# WJ-A67-1 / SMA67-1




## 10 to 600 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH EFFICIENCY: +17.0 dBm (TYP.) OUTPUT POWER @ 32 mA (TYP.)
- ◆ LOW NOISE FIGURE: < 4.0 dB (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 Vdc to +15 Vdc

## Specifications*

| Characteristics | Typical. | Guaranteed 0° to +50°C | Guaranteed -54 to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-700 MHz | 10-600 MHz | 10-600 MHz |
| Small Signal Gain (Min.) | 15.0 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | < 4.0 dB | 4.3 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +17.0 dBm | +16.5 dBm | +16.0 dBm |
| VSWR (Max.) | | | |
| Input | < 1.7:1 | 2.0:1 | 2.0:1 |
| Output | < 1.7:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 32 mA | 34 mA | 35 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA67-1 is a standard WJ-A67-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+52 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

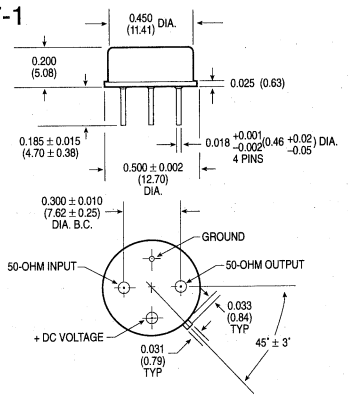
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Temperature .....17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts(1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

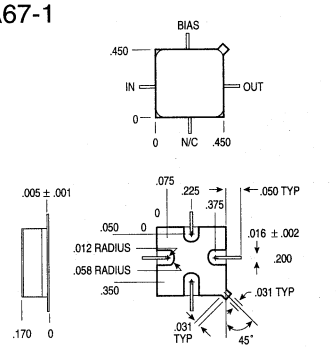
## Outline Drawings

A67-1



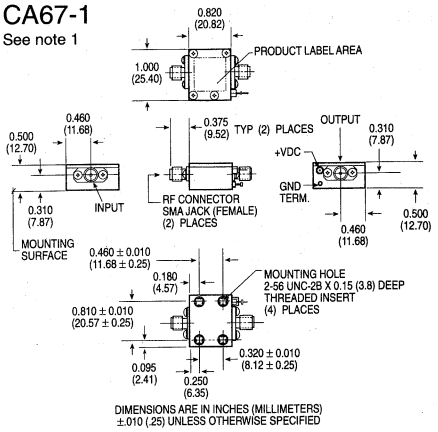

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA67-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

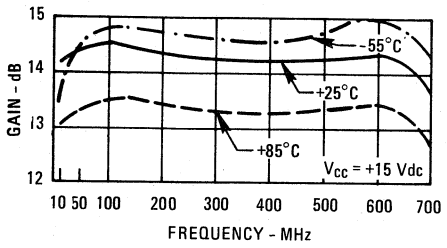
CA67-1
See note 1

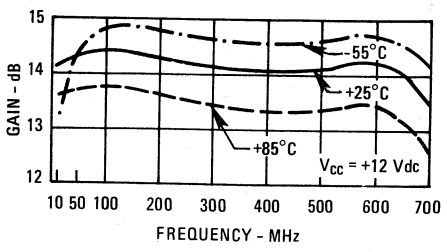


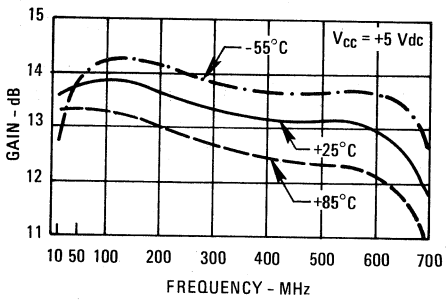

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

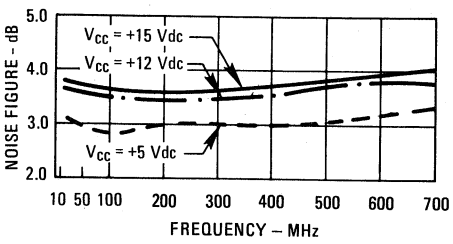
## Gain



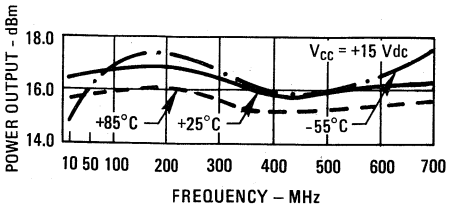



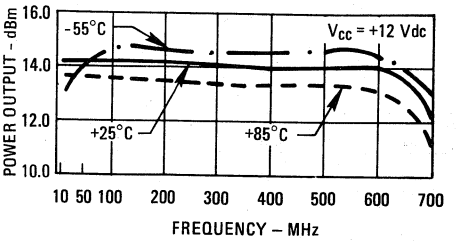



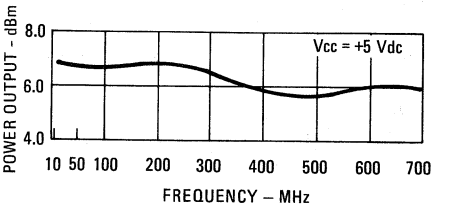

## Noise Figure




## Power Output*

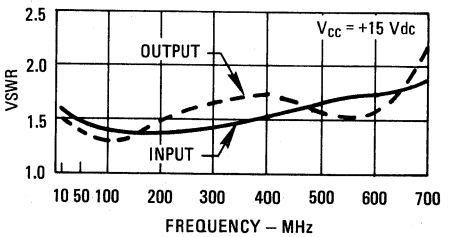


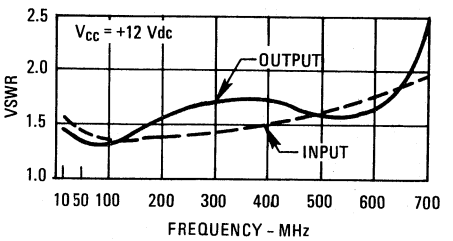



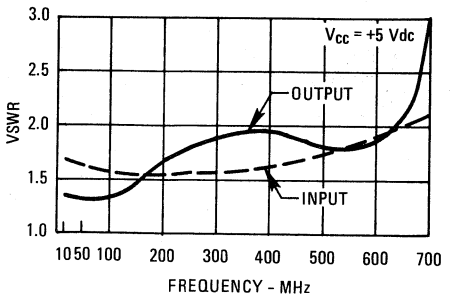




*at 1 dB Gain Compression

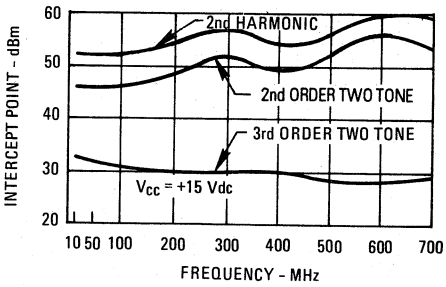
## VSWR

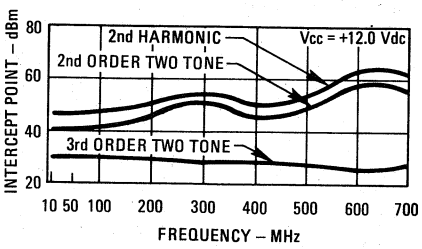


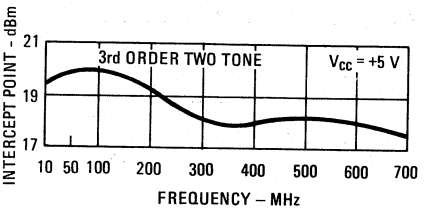



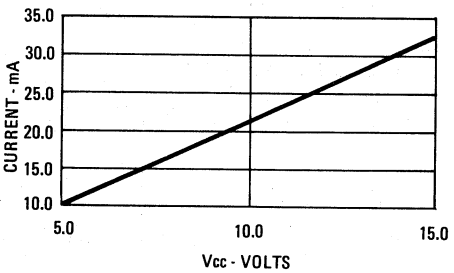

## Intercept Point




## Current Drain




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.0 | 1.9 | 13.1 |
| 10.0 | 1.7 | 1.5 | 13.9 |
| 50.0 | 1.4 | 1.2 | 14.4 |
| 100.0 | 1.4 | 1.3 | 14.5 |
| 200.0 | 1.3 | 1.4 | 14.3 |
| 300.0 | 1.4 | 1.7 | 14.3 |
| 400.0 | 1.4 | 1.7 | 14.3 |
| 500.0 | 1.4 | 1.7 | 14.2 |
| 600.0 | 1.5 | 1.5 | 14.1 |
| 700.0 | 1.8 | 2.1 | 13.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.951 | –6 | 2.62 | –108 | 0.12 | –102 | 0.738 | –163 |
| 2.0 | 0.547 | –33 | 3.77 | –139 | 0.03 | –25 | 0.516 | 163 |
| 5.0 | 0.333 | –35 | 4.54 | –159 | 0.07 | 8 | 0.322 | 139 |
| 10.0 | 0.248 | –36 | 4.96 | –168 | 0.09 | 9 | 0.204 | 134 |
| 50.0 | 0.165 | –25 | 5.27 | 175 | 0.09 | –14 | 0.085 | 174 |
| 100.0 | 0.151 | –16 | 5.29 | 161 | 0.10 | –15 | 0.114 | –158 |
| 200.0 | 0.146 | –29 | 5.19 | 137 | 0.09 | –28 | 0.181 | –160 |
| 300.0 | 0.161 | –46 | 5.18 | 113 | 0.10 | –35 | 0.249 | –172 |
| 400.0 | 0.162 | –58 | 5.17 | 89 | 0.10 | –48 | 0.270 | 164 |
| 500.0 | 0.169 | –88 | 5.14 | 60 | 0.11 | –62 | 0.247 | 125 |
| 600.0 | 0.214 | –134 | 5.07 | 34 | 0.12 | –93 | 0.206 | 60 |
| 700.0 | 0.277 | –180 | 4.91 | 0 | 0.10 | –110 | 0.346 | –3 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.9 | 1.9 | 13.2 |
| 10.0 | 1.6 | 1.5 | 13.9 |
| 50.0 | 1.4 | 1.2 | 14.5 |
| 100.0 | 1.4 | 1.3 | 14.5 |
| 200.0 | 1.4 | 1.5 | 14.4 |
| 300.0 | 1.4 | 1.7 | 14.3 |
| 400.0 | 1.4 | 1.8 | 14.3 |
| 500.0 | 1.4 | 1.7 | 14.3 |
| 600.0 | 1.5 | 1.7 | 14.2 |
| 700.0 | 1.8 | 2.3 | 13.5 |

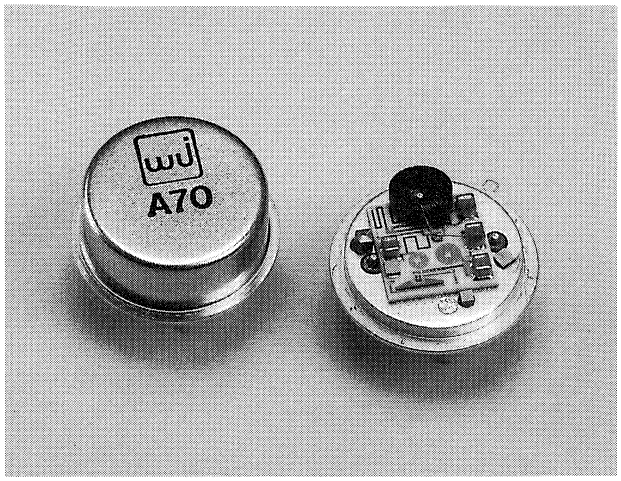
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | 0.863 | –17 | 3.03 | –114 | 0.11 | –61 | 0.694 | –167 |
| 2.0 | 0.510 | –35 | 3.88 | –144 | 0.04 | –8 | 0.475 | 161 |
| 5.0 | 0.319 | –35 | 4.59 | –161 | 0.07 | 5 | 0.300 | 141 |
| 10.0 | 0.242 | 31 | 4.96 | –169 | 0.08 | 4 | 0.187 | 131 |
| 50.0 | 0.166 | –24 | 5.33 | 174 | 0.10 | –9 | 0.079 | 175 |
| 100.0 | 0.157 | –20 | 5.29 | 160 | 0.09 | –19 | 0.112 | –163 |
| 200.0 | 0.153 | –25 | 5.25 | 136 | 0.10 | –26 | 0.187 | –158 |
| 300.0 | 0.151 | –46 | 5.18 | 112 | 0.10 | –35 | 0.247 | –176 |
| 400.0 | 0.160 | –63 | 5.17 | 87 | 0.10 | –49 | 0.276 | 160 |
| 500.0 | 0.172 | –93 | 5.20 | 59 | 0.10 | –75 | 0.266 | 127 |
| 600.0 | 0.215 | –140 | 5.13 | 32 | 0.12 | –87 | 0.259 | 60 |
| 700.0 | 0.289 | 176 | 4.74 | –2 | 0.12 | –100 | 0.399 | –5 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.275 W
Junction Temperature Rise Above Case $T_{jc}$ ... 12°C

# WJ-A70 / SMA70




**10 to 250 MHz**
**TO-8 CASCADABLE AMPLIFIER**

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ VERY LOW NOISE: 1.8 dB (TYP.)
- ◆ HIGH EFFICIENCY: +8.5 dBm (TYP.) OUTPUT POWER @ 10 mA (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to -50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-300 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min.) | 8.0 dB | 7.5 dB | 7.0 dB |
| Gain Flatness (Max.) | +0.3 dB | +0.5 dB | +0.7 dB |
| Noise Figure (Max.) | 1.8 dB | 2.3 dB | 2.8 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7.5 dBm | +7.0 dBm |
| VSWR (Max.) Input/Output | 1.9:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 10.0 mA | 11.0 mA | 13.0 mA |

*Measured in a 50 -ohm system at +15 Vdc nominal.
Notes:
1. WJ-CA70 is a standard WJ-A70 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tons Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

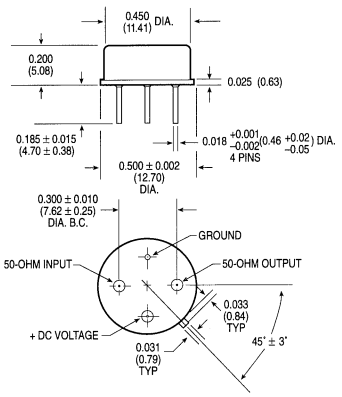
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

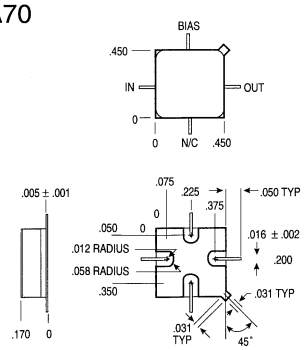
## Outline Drawings

A70



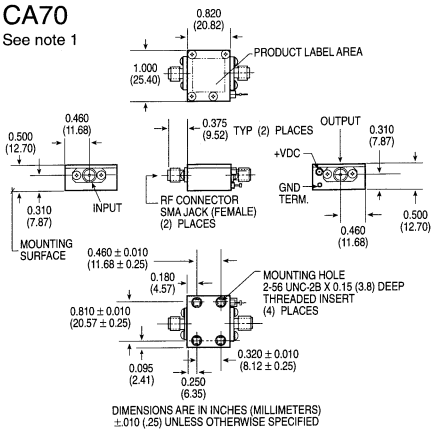

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA70




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

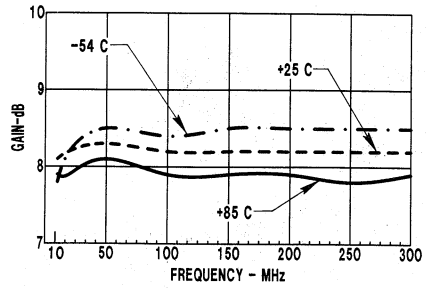
CA70
See note 1



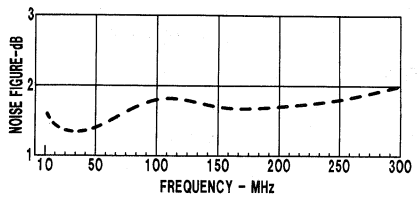

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

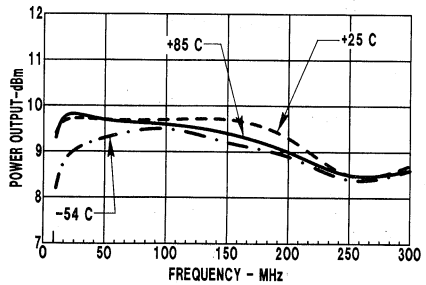
### Gain vs. Frequency




### Noise Figure

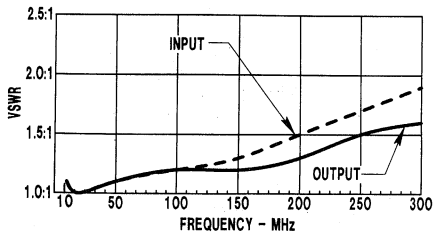



### Power Output *

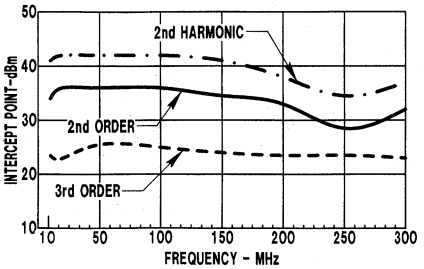



*at 1 dB Gain Compression

### Input/Output VSWR




### Intercept Points




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.1 | 1.1 | 8.1 |
| 10.0 | 1.1 | 1.1 | 8.2 |
| 50.0 | 1.1 | 1.1 | 8.2 |
| 100.0 | 1.2 | 1.2 | 8.2 |
| 150.0 | 1.3 | 1.3 | 8.3 |
| 200.0 | 1.4 | 1.4 | 8.5 |
| 250.0 | 1.6 | 1.5 | 8.6 |
| 300.0 | 1.9 | 1.7 | 8.8 |
| 350.0 | 2.2 | 2.0 | 9.0 |
| 400.0 | 2.6 | 2.4 | 9.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .037 | −132 | 2.536 | 8 | .288 | 8 | .049 | −136 |
| 10.0 | .029 | −137 | 2.573 | 3 | .291 | 3 | .034 | −145 |
| 50.0 | .055 | −132 | 2.577 | −8 | .288 | −7 | .049 | −135 |
| 100.0 | .084 | −132 | 2.571 | −17 | .285 | −15 | .078 | −133 |
| 150.0 | .127 | −137 | 2.594 | −26 | .280 | −22 | .112 | −137 |
| 200.0 | .174 | −144 | 2.653 | −35 | .274 | −30 | .154 | −144 |
| 250.0 | .231 | −156 | 2.697 | −45 | .263 | −39 | .203 | −152 |
| 300.0 | .304 | −167 | 2.762 | −55 | .253 | −47 | .264 | −163 |
| 350.0 | .372 | −180 | 2.809 | −67 | .235 | −57 | .337 | −175 |
| 400.0 | .448 | 166 | 2.912 | −78 | .216 | −66 | .417 | 173 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.1 | 1.1 | 8.0 |
| 10.0 | 1.0 | 1.1 | 8.1 |
| 50.0 | 1.1 | 1.1 | 8.1 |
| 100.0 | 1.2 | 1.2 | 8.1 |
| 150.0 | 1.3 | 1.3 | 8.2 |
| 200.0 | 1.4 | 1.4 | 8.4 |
| 250.0 | 1.6 | 1.6 | 8.5 |
| 300.0 | 1.9 | 1.8 | 8.7 |
| 350.0 | 2.2 | 2.1 | 8.8 |
| 400.0 | 2.6 | 2.6 | 9.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .034 | −109 | 2.504 | 8 | .284 | 8 | .040 | −126 |
| 10.0 | .021 | −113 | 2.537 | 3 | .288 | 3 | .025 | −129 |
| 50.0 | .045 | −119 | 2.546 | −8 | .286 | −7 | .046 | −120 |
| 100.0 | .079 | −124 | 2.542 | −17 | .282 | −15 | .080 | −124 |
| 150.0 | .124 | −132 | 2.568 | −27 | .277 | −22 | .119 | −130 |
| 200.0 | .175 | −140 | 2.617 | −36 | .271 | −30 | .164 | −139 |
| 250.0 | .227 | −153 | 2.653 | −46 | .261 | −39 | .219 | −149 |
| 300.0 | .301 | −165 | 2.721 | −57 | .249 | −47 | .285 | −161 |
| 350.0 | .375 | −179 | 2.759 | −69 | .231 | −57 | .362 | −174 |
| 400.0 | .450 | 166 | 2.857 | −81 | .212 | −66 | .447 | 173 |

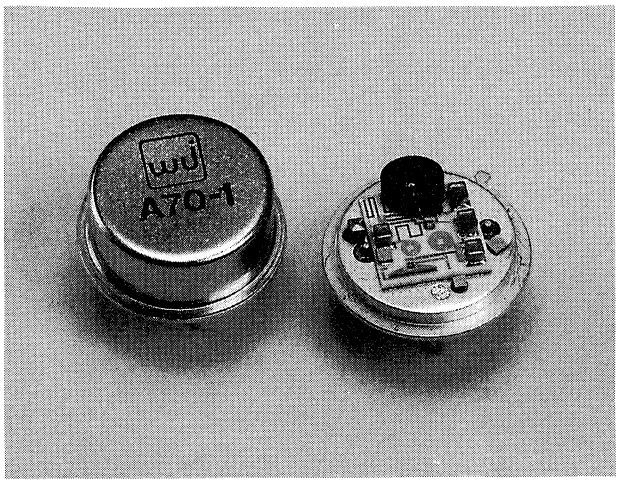
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jC}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.065 W
Junction Temperature Rise Above Case $T_{jC}$ ... 3°C

# WJ-A70-1 / SMA70-1

## 10 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 1.8 dB (TYP.)
- ◆ HIGH EFFICIENCY: +14 dBm (TYP.) OUTPUT POWER @ 15 mA (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-300 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min.) | 8.0 dB | 7.5 dB | 7.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 1.8 dB | 2.3 dB | 2.8 dB |
| Power Output at 1 dB Compression (Min.) | +14.0 dBm | +13.0 dBm | +12.5 dBm |
| VSWR (Max.) Input/Output | 1.9:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 15 mA | 17 mA | 19 mA |

* Measured in a 50 - ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA70-1 is a standard WJ-A70-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+ 44 dBm (Typ.)
Second Order Two Tone Intercept Point.....+38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

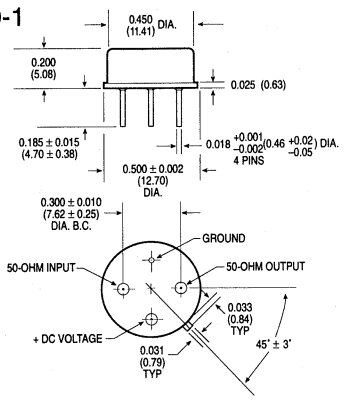
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power ..... +13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

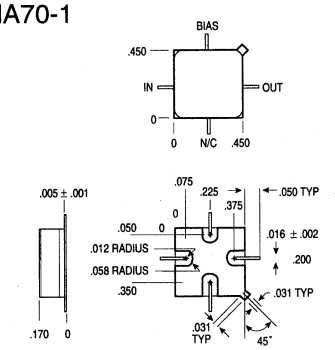
## Outline Drawings

A70-1



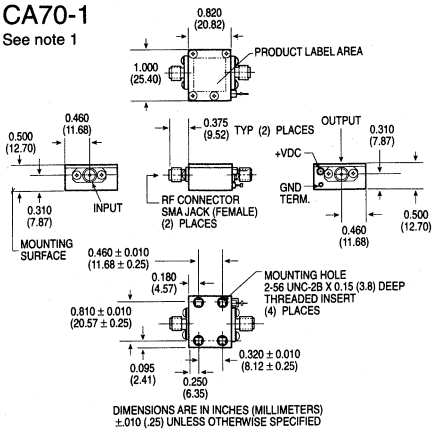

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA70-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

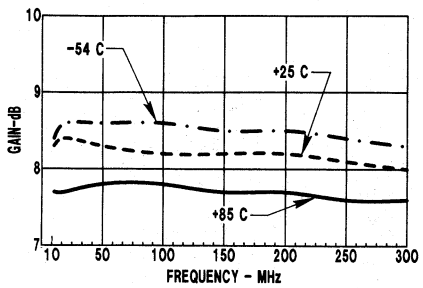
CA70-1
See note 1



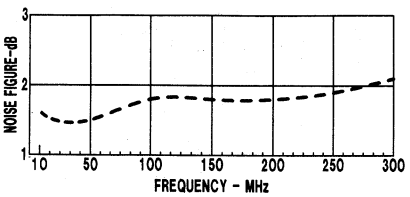

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

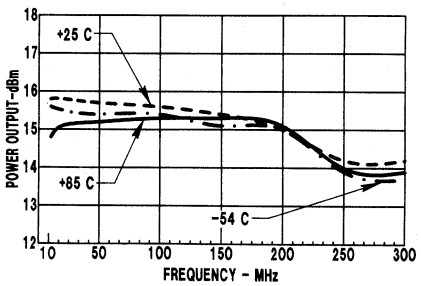
### Gain vs. Frequency vs. Temperature




### Noise Figure

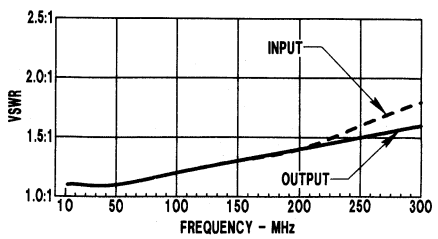



### Power Output *

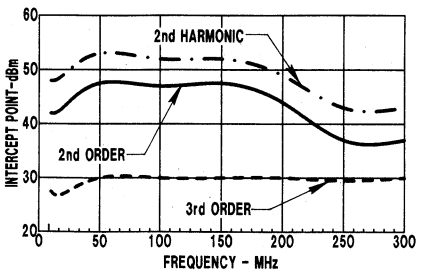



*at 1 dB Gain Compression

### Input/Output VSWR




### Intercept Points




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.0 | 2.1 | 8.1 |
| 10.0 | 1.3 | 1.4 | 8.2 |
| 50.0 | 1.1 | 1.1 | 8.4 |
| 100.0 | 1.1 | 1.1 | 8.5 |
| 150.0 | 1.2 | 1.2 | 8.6 |
| 200.0 | 1.3 | 1.3 | 8.8 |
| 250.0 | 1.5 | 1.4 | 8.8 |
| 300.0 | 1.7 | 1.6 | 9.0 |
| 350.0 | 2.0 | 1.8 | 9.1 |
| 400.0 | 2.4 | 2.1 | 9.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .323 | 117 | 2.540 | 32 | .293 | 33 | .362 | 125 |
| 10.0 | .143 | 123 | 2.556 | 13 | .290 | 13 | .163 | 124 |
| 50.0 | .058 | 159 | 2.622 | -5 | .294 | -4 | .051 | 141 |
| 100.0 | .060 | -159 | 2.654 | -15 | .294 | -14 | .039 | -165 |
| 150.0 | .095 | -143 | 2.687 | -25 | .290 | -23 | .071 | -147 |
| 200.0 | .141 | -144 | 2.741 | -35 | .286 | -31 | .113 | -152 |
| 250.0 | .195 | -154 | 2.763 | -45 | .277 | -41 | .162 | -161 |
| 300.0 | .265 | -165 | 2.818 | -55 | .269 | -49 | .220 | -172 |
| 350.0 | .340 | -177 | 2.839 | -67 | .253 | -60 | .288 | 175 |
| 400.0 | .411 | 169 | 2.916 | -79 | .239 | -70 | .361 | 162 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.0 | 2.2 | 8.0 |
| 10.0 | 1.3 | 1.4 | 8.1 |
| 50.0 | 1.1 | 1.1 | 8.3 |
| 100.0 | 1.1 | 1.1 | 8.4 |
| 150.0 | 1.2 | 1.2 | 8.5 |
| 200.0 | 1.3 | 1.3 | 8.7 |
| 250.0 | 1.5 | 1.4 | 8.8 |
| 300.0 | 1.7 | 1.6 | 8.9 |
| 350.0 | 2.1 | 1.9 | 9.0 |
| 400.0 | 2.5 | 2.3 | 9.2 |

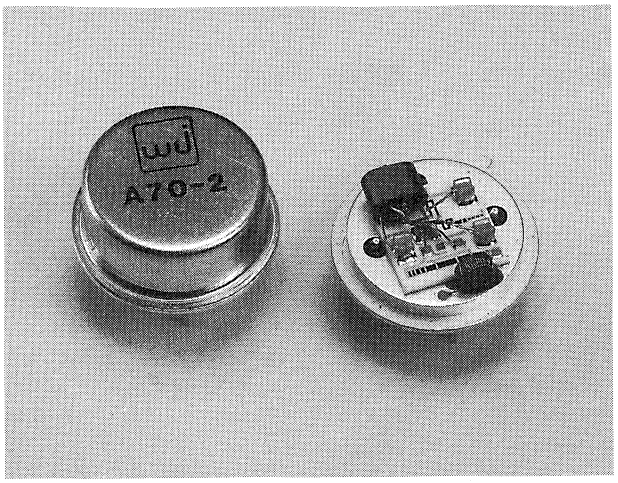
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .326 | 116 | 2.513 | 33 | .291 | 33 | .375 | 124 |
| 10.0 | .142 | 120 | 2.546 | 13 | .289 | 14 | .164 | 120 |
| 50.0 | .051 | 154 | 2.604 | -5 | .291 | -4 | .044 | 138 |
| 100.0 | .056 | -151 | 2.637 | -16 | .292 | -14 | .038 | -154 |
| 150.0 | .098 | -139 | 2.668 | -26 | .289 | -23 | .076 | -140 |
| 200.0 | .149 | -143 | 2.720 | -36 | .284 | -31 | .122 | -147 |
| 250.0 | .202 | -153 | 2.740 | -46 | .275 | -41 | .175 | -158 |
| 300.0 | .271 | -165 | 2.796 | -56 | .265 | -50 | .236 | -170 |
| 350.0 | .347 | -178 | 2.813 | -69 | .250 | -61 | .308 | 176 |
| 400.0 | .421 | 169 | 2.888 | -81 | .234 | -71 | .385 | 163 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.113 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A70-2 / SMA70-2




## 10 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.2 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +19 dBm (TYP.)
- ◆ HIGH THIRD ORDER IP: +35 dBm (TYP.)
- ◆ LOW DC CURRENT: 25 mA (TYP.) @ +15 Vdc

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85°C |
| Frequency (Min.) | 10-300 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min.) | | | |
| 10-50 MHz | 7.0 dB | 6.5 dB | 6.0 dB |
| 50-250 MHz | 7.5 dB | 7.0 dB | 6.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.2 dB | 2.7 dB | 3.2 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +19.0 dBm | +18.0 dBm | +17.5 dBm |
| VSWR (Max.) Input/Output | 1.9:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 25 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA70-2 is a standard WJ-A70-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+35 dBm (Typ.)

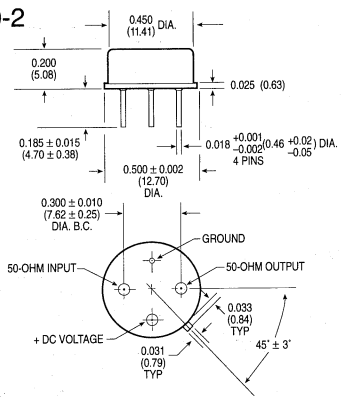
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.)..... +17 dBm
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature .....125°C

Weight approximately 2.0 grams (0.07oz.)

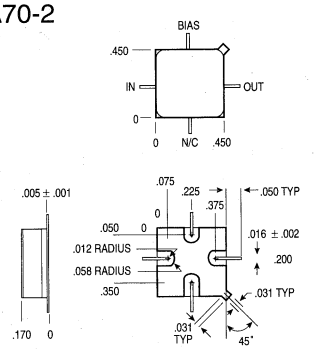
## Outline Drawings

A70-2



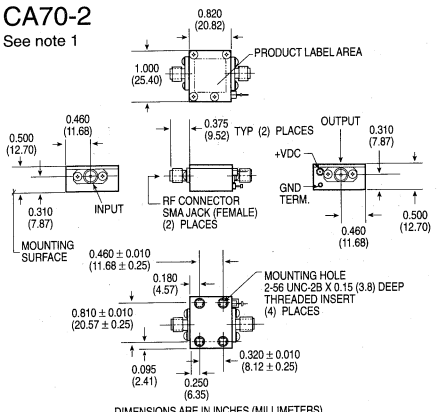

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA70-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

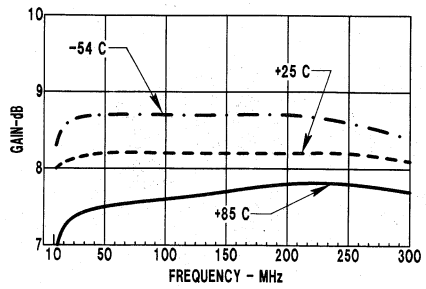
CA70-2
See note 1



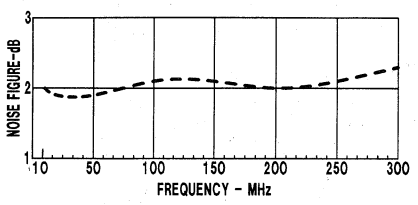

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

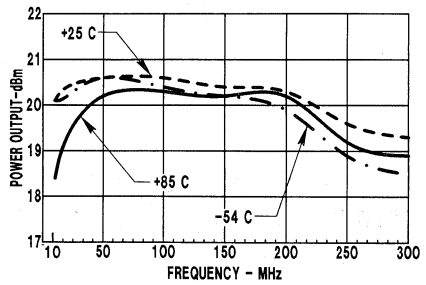
### Gain vs. Frequency vs. Temperature




### Noise Figure

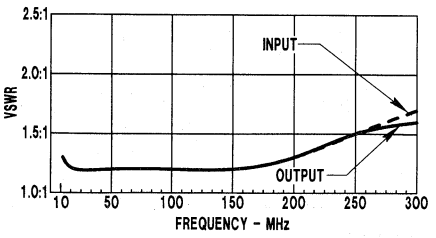



### Power Output *

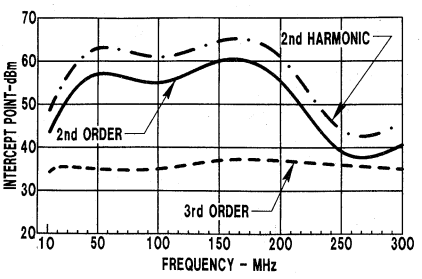



*at 1 dB Gain Compression

### Input/Output VSWR




### Intercept Points




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.5 | 1.6 | 7.5 |
| 10.0 | 1.3 | 1.3 | 7.9 |
| 50.0 | 1.2 | 1.2 | 8.1 |
| 100.0 | 1.3 | 1.3 | 8.1 |
| 150.0 | 1.5 | 1.4 | 8.0 |
| 200.0 | 1.6 | 1.5 | 8.0 |
| 250.0 | 1.8 | 1.7 | 7.9 |
| 300.0 | 2.1 | 1.9 | 8.0 |
| 350.0 | 2.3 | 2.0 | 7.8 |
| 400.0 | 2.4 | 2.1 | 7.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .204 | 142 | 2.384 | 20 | .272 | 21 | .220 | 148 |
| 10.0 | .137 | 149 | 2.470 | 9 | .279 | 9 | .146 | 149 |
| 50.0 | .098 | –173 | 2.536 | –9 | .285 | –9 | .093 | 178 |
| 100.0 | .134 | –153 | 2.528 | –22 | .282 | –22 | .122 | –171 |
| 150.0 | .189 | –151 | 2.516 | –34 | .277 | –34 | .166 | –175 |
| 200.0 | .243 | –154 | 2.526 | –47 | .272 | –45 | .213 | 174 |
| 250.0 | .292 | –162 | 2.483 | –59 | .262 | –58 | .259 | 160 |
| 300.0 | .346 | –174 | 2.501 | –71 | .256 | –69 | .300 | 146 |
| 350.0 | .385 | 174 | 2.445 | –84 | .245 | –82 | .337 | 132 |
| 400.0 | .405 | 160 | 2.486 | –98 | .241 | –94 | .358 | 119 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.2 | 1.2 | 8.0 |
| 10.0 | 1.2 | 1.2 | 8.1 |
| 50.0 | 1.2 | 1.2 | 8.2 |
| 100.0 | 1.3 | 1.3 | 8.1 |
| 150.0 | 1.5 | 1.4 | 8.1 |
| 200.0 | 1.7 | 1.6 | 8.1 |
| 250.0 | 1.9 | 1.7 | 7.9 |
| 300.0 | 2.1 | 1.9 | 7.9 |
| 350.0 | 2.3 | 2.1 | 7.7 |
| 400.0 | 2.4 | 2.2 | 7.9 |

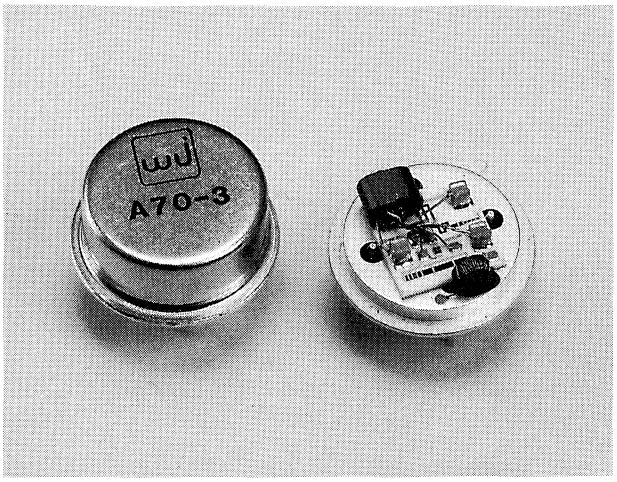
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .097 | 166 | 2.506 | 12 | .284 | 12 | .101 | 172 |
| 10.0 | .082 | 173 | 2.554 | 4 | .288 | 4 | .081 | 174 |
| 50.0 | .096 | –155 | 2.570 | –11 | .289 | –10 | .085 | –162 |
| 100.0 | .141 | –147 | 2.555 | –23 | .285 | –23 | .128 | –160 |
| 150.0 | .195 | –145 | 2.529 | –36 | .279 | –35 | .176 | –169 |
| 200.0 | .257 | –152 | 2.533 | –48 | .273 | –47 | .225 | 178 |
| 250.0 | .313 | –162 | 2.475 | –60 | .262 | –59 | .271 | 164 |
| 300.0 | .362 | –173 | 2.488 | –73 | .257 | –70 | .313 | 149 |
| 350.0 | .402 | 174 | 2.432 | –86 | .244 | –83 | .349 | 135 |
| 400.0 | .417 | 159 | 2.470 | –100 | .239 | –96 | .372 | 121 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.024 W
Junction Temperature Rise Above Case $T_{jc}$ ... 1°C

# WJ-A70-3 / SMA70-3




## 20 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +21 dBm (TYP.)
- ◆ LOW NOISE: 2.5 dB (TYP.)
- ◆ HIGH THIRD ORDER IP: +34 dBm
- ◆ LOW DC CURRENT: 37 mA (TYP.) @+15 Vdc

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 15-300 MHz | 20-250 MHz | 20-250 MHz |
| Small Signal Gain (Min.) | | | |
| 20-50 MHz | 7.0 dB | 6.5 dB | 5.5 dB |
| 50-250 MHz | 7.5 dB | 7.0 dB | 6.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.5 dB | 3.0 dB | 3.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +21.0 dBm | +20.5 dBm | +20.0 dBm |
| VSWR (Max.) Input/Output | 1.9:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 37 mA | 40 mA | 42 mA |

* Measured in a 50 - ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA70-3 is a standard WJ-A70-3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point ..... +34 dBm (Typ.)

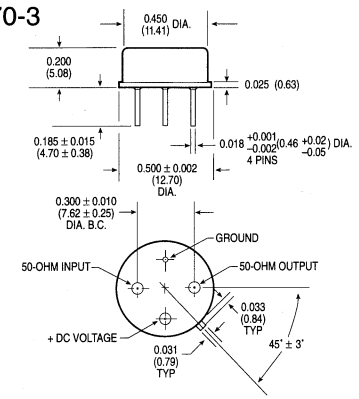
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +17 Volts
Maximum Continuous RF Input Power .....+15 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

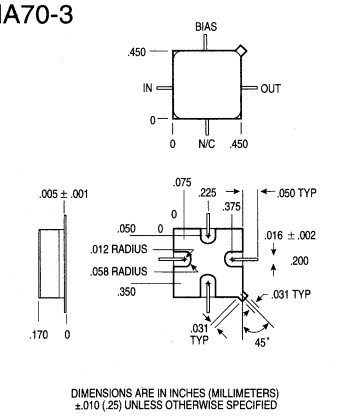
## Outline Drawings

A70-3



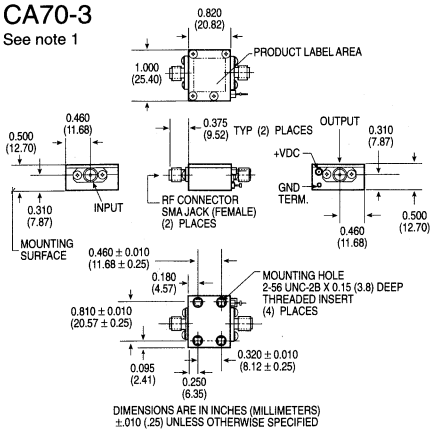

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA70-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

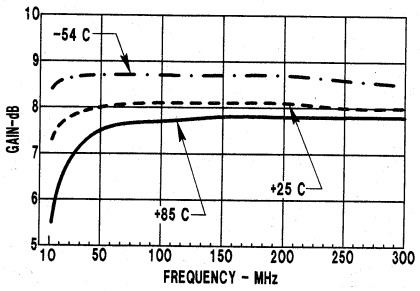
CA70-3
See note 1



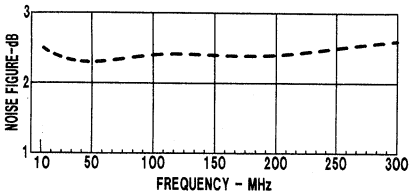

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

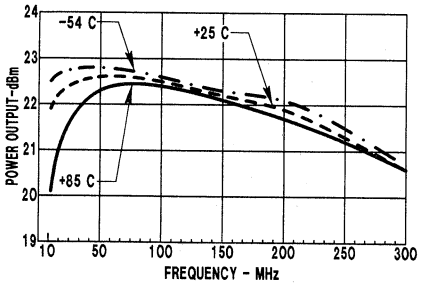
### Gain vs. Frequency vs. Temperature




### Noise Figure

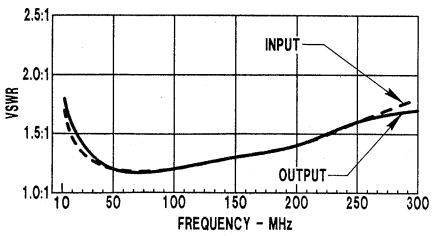



### Power Output *

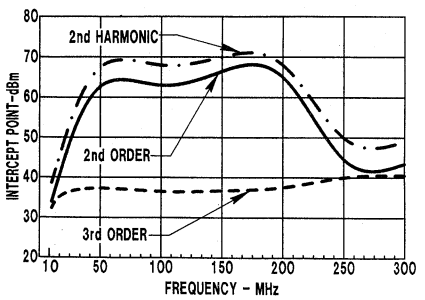



*at 1 dB Gain Compression

### Input/Output VSWR




### Intercept Points




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 1.9 | 2.1 | 7.2 |
| 20.0 | 1.5 | 1.5 | 7.7 |
| 50.0 | 1.3 | 1.3 | 8.0 |
| 100.0 | 1.3 | 1.2 | 8.0 |
| 150.0 | 1.4 | 1.3 | 8.1 |
| 200.0 | 1.6 | 1.4 | 8.2 |
| 250.0 | 1.8 | 1.6 | 8.2 |
| 300.0 | 2.1 | 1.8 | 8.3 |
| 350.0 | 2.6 | 2.0 | 8.2 |
| 400.0 | 3.1 | 2.4 | 8.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .321 | 133 | 2.295 | 23 | .263 | 23 | .348 | 136 |
| 20.0 | .198 | 138 | 2.425 | 10 | .275 | 10 | .208 | 135 |
| 50.0 | .125 | 160 | 2.506 | –3 | .283 | –2 | .116 | 150 |
| 100.0 | .128 | –172 | 2.526 | –14 | .283 | –13 | .100 | 179 |
| 150.0 | .171 | –163 | 2.537 | –24 | .277 | –23 | .126 | –167 |
| 200.0 | .229 | –165 | 2.570 | –33 | .273 | –32 | .167 | –165 |
| 250.0 | .287 | –172 | 2.563 | –43 | .263 | –41 | .216 | –168 |
| 300.0 | .362 | 179 | 2.601 | –53 | .254 | –50 | .275 | –175 |
| 350.0 | .442 | 168 | 2.577 | –64 | .236 | –61 | .340 | 176 |
| 400.0 | .510 | 154 | 2.600 | –75 | .222 | –71 | .409 | 166 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 1.3 | 1.4 | 7.8 |
| 20.0 | 1.3 | 1.3 | 8.0 |
| 50.0 | 1.2 | 1.2 | 8.1 |
| 100.0 | 1.3 | 1.3 | 8.1 |
| 150.0 | 1.5 | 1.3 | 8.1 |
| 200.0 | 1.6 | 1.5 | 8.2 |
| 250.0 | 1.9 | 1.6 | 8.2 |
| 300.0 | 2.2 | 1.9 | 8.2 |
| 350.0 | 2.7 | 2.2 | 8.1 |
| 400.0 | 3.2 | 2.6 | 8.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .145 | 149 | 2.468 | 10 | .280 | 10 | .152 | 150 |
| 20.0 | .115 | 161 | 2.502 | 3 | .282 | 3 | .115 | 158 |
| 50.0 | .109 | –178 | 2.531 | –6 | .285 | –6 | .095 | 178 |
| 100.0 | .138 | –161 | 2.535 | –16 | .283 | –16 | .111 | –164 |
| 150.0 | .187 | –157 | 2.538 | –26 | .277 | –24 | .145 | –158 |
| 200.0 | .242 | –162 | 2.566 | –35 | .271 | –33 | .190 | –160 |
| 250.0 | .305 | –170 | 2.557 | –45 | .260 | –43 | .242 | –166 |
| 300.0 | .381 | 179 | 2.583 | –55 | .251 | –52 | .304 | –174 |
| 350.0 | .455 | 167 | 2.551 | –66 | .232 | –63 | .371 | 176 |
| 400.0 | .527 | 154 | 2.571 | –77 | .216 | –73 | .440 | 165 |

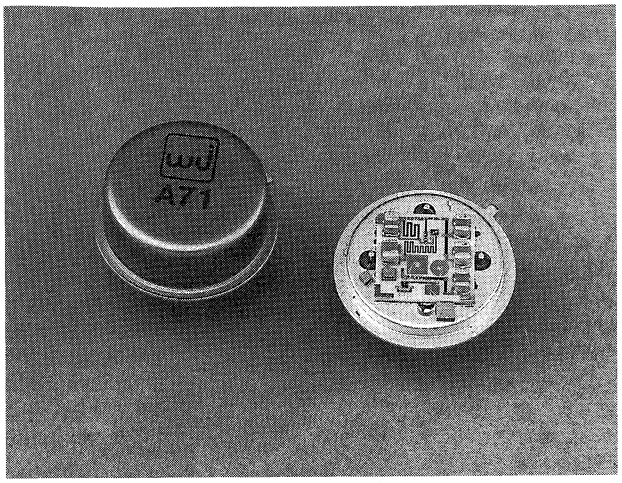
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.403 W
Junction Temperature Rise Above Case $T_{jc}$ 18°C

# WJ-A71 / SMA71

## 5 to 200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE: 2.1 dB (TYP.)
- ◆ HIGH GAIN: 18 dB (TYP.)
- ◆ LOW VSWR: < 1.4:1 (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-300 MHz | 5-200 MHz | 5-200 MHz |
| Small Signal Gain (Min.) | 18.0 dB | 16.5 dB | 16.0 dB |
| Gain Flatness (Max.) | < ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.1 dB | 2.5 dB | 2.8 dB |
| Power Output at 1 dB Compression (Min.) | -2.5 dBm | -3.0 dBm | -3.5 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 9 mA | 11 mA | 13 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA71 is a standard WJ-A71 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+18.5 dBm (Typ.)
Second Order Two Tone Intercept Point.....+11.5 dBm (Typ.)
Third Order Two Tone Intercept Point.....+10 dBm (Typ.)

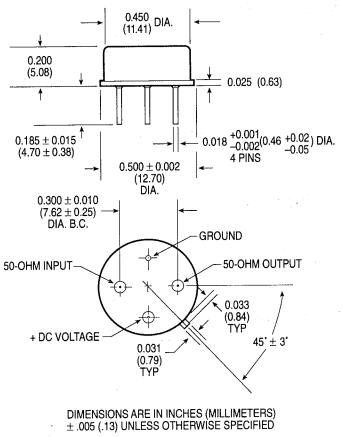
## Absolute Maximum Ratings

StorageTemperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0grams (0.07oz.)

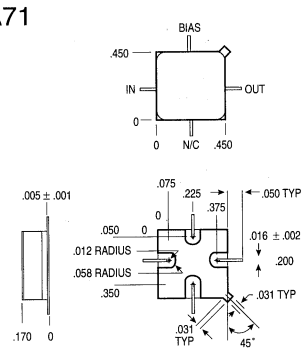
## Outline Drawings

A71



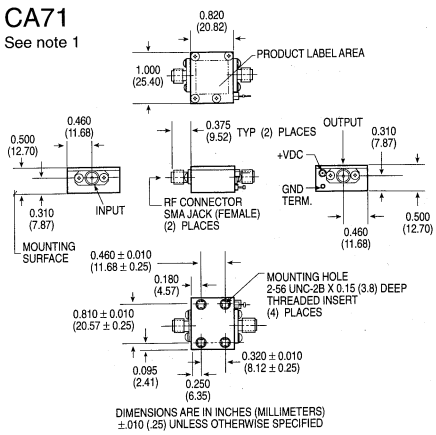

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA71




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

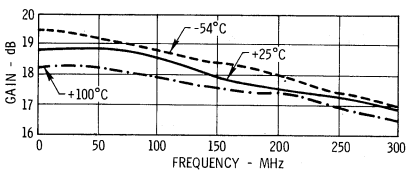
CA71
See note 1



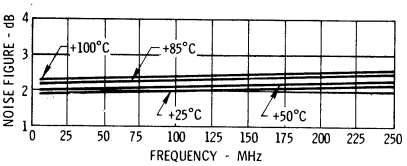

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

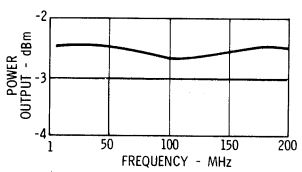
### Gain




### Noise Figure

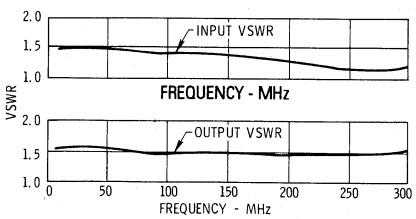



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.1 | 18.3 |
| 2.0 | 1.2 | 1.1 | 18.3 |
| 5.0 | 1.2 | 1.1 | 18.3 |
| 10.0 | 1.2 | 1.1 | 18.3 |
| 50.0 | 1.2 | 1.1 | 18.3 |
| 100.0 | 1.3 | 1.1 | 18.3 |
| 150.0 | 1.4 | 1.1 | 18.5 |
| 200.0 | 1.4 | 1.2 | 18.8 |
| 250.0 | 1.6 | 1.4 | 18.9 |
| 300.0 | 1.7 | 1.7 | 18.9 |
| 350.0 | 1.9 | 2.3 | 18.2 |
| 400.0 | 1.9 | 2.9 | 17.2 |

### Linear S-Parameters

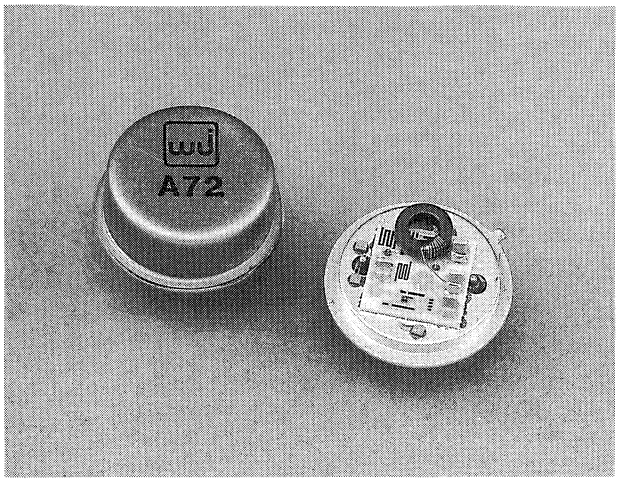
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .082 | –35 | 8.218 | –163 | .080 | 19 | .062 | –56 |
| 2.0 | .099 | –5 | 8.229 | –172 | .080 | 9 | .059 | –20 |
| 5.0 | .103 | –5 | 8.194 | –179 | .081 | 4 | .064 | –7 |
| 10.0 | .105 | –6 | 8.176 | 178 | .081 | 1 | .066 | –6 |
| 50.0 | .111 | –25 | 8.176 | 164 | .081 | –3 | .067 | –22 |
| 100.0 | .126 | –45 | 8.244 | 147 | .080 | –8 | .064 | –51 |
| 150.0 | .157 | –63 | 8.411 | 130 | .080 | –11 | .068 | –96 |
| 200.0 | .182 | –83 | 8.675 | 111 | .078 | –14 | .098 | –143 |
| 250.0 | .222 | –98 | 8.798 | 91 | .078 | –17 | .168 | 177 |
| 300.0 | .262 | –112 | 8.851 | 68 | .077 | –20 | .268 | 145 |
| 350.0 | .300 | –126 | 8.157 | 43 | .078 | –22 | .389 | 115 |
| 400.0 | .316 | –142 | 7.221 | 17 | .079 | –25 | .490 | 87 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.053 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-A72 / SMA72

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW POWER DRAIN: 30 mA (TYP.) @ +5 Vdc
- ◆ HIGH OUTPUT LEVEL WITH LOW Vcc: +12 dBm (TYP.) @ 5 Vdc
- ◆ HIGH THIRD ORDER I.P.: +31 dBm (TYP.) @ Vcc = +8 Vdc

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°c | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-650 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 14.7 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | < ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| Vcc = 5 V | +12.5 dBm | +11.5 dBm | +11.0 dBm |
| Vcc = 8 V | +16.5 dBm | +15.0 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | < 1.3:1 | 1.7:1 | 1.8 :1 |
| DC Current (Max.) at 5 Volts | 30 mA | 33 mA | 35 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA72 is a standard WJ-A72 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+46 dBm (Typ.), 5 V
+50 dBm (Typ.), 8 V
Second Order Two Tone Intercept Point .....+40 dBm (Typ.), 5 V
+44 dBm (Typ.), 8 V
Third Order Two Tone Intercept Point .....+27 dBm (Typ.), 5 V
+31 dBm (Typ.), 8 V

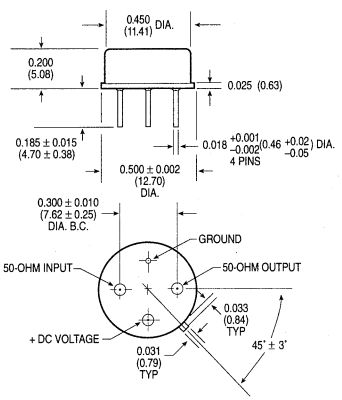
## Absolute Maximum Rating

Storage Temperature .....-62° to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+9 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

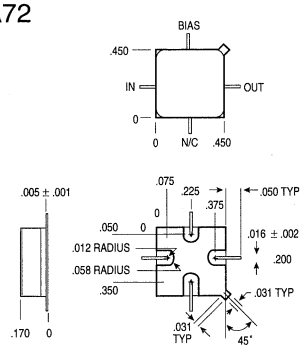
## Outline Drawings

A72



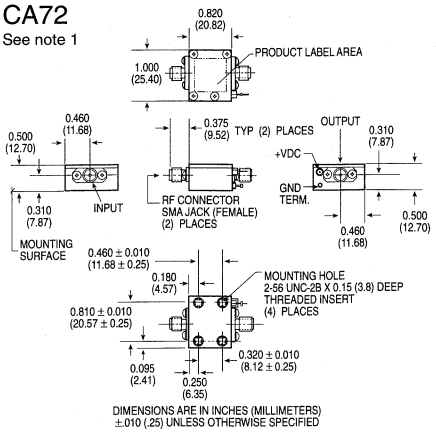

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA72




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

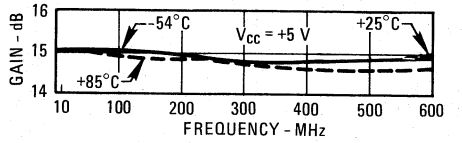
CA72
See note 1

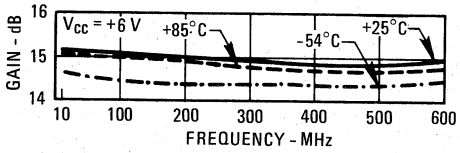


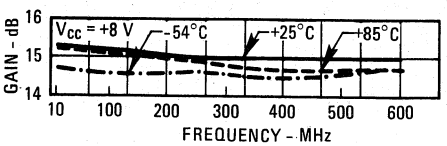

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

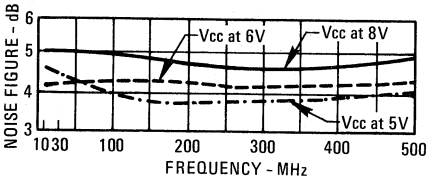
### Gain



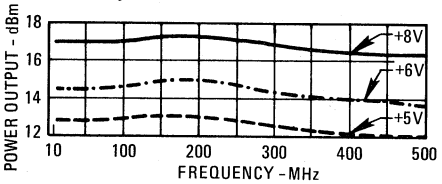




### Noise Figure

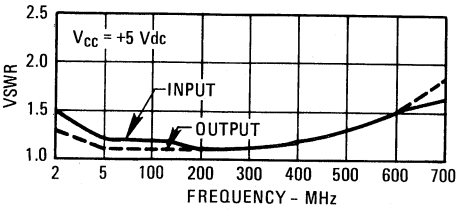



### Power Output*

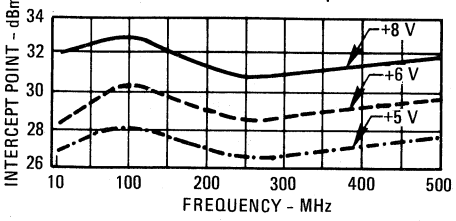



* at 1 dB Gain Compression

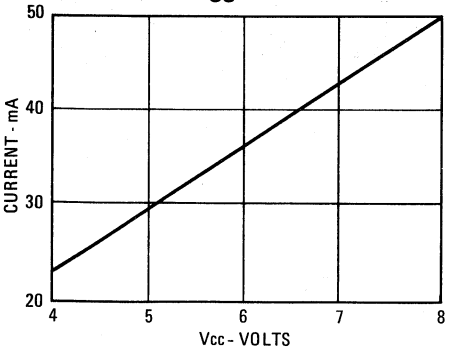
### VSWR




### 3rd Order Two Tone Intercept Point




### Current Drain vs. $V_{CC}$




## Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 2.4 | 12.6 |
| 2.0 | 1.5 | 1.6 | 14.7 |
| 5.0 | 1.2 | 1.2 | 15.2 |
| 10.0 | 1.1 | 1.1 | 15.3 |
| 50.0 | 1.0 | 1.0 | 15.3 |
| 100.0 | 1.0 | 1.1 | 15.3 |
| 200.0 | 1.1 | 1.1 | 15.3 |
| 300.0 | 1.1 | 1.1 | 15.3 |
| 400.0 | 1.2 | 1.1 | 15.4 |
| 500.0 | 1.2 | 1.0 | 15.6 |
| 600.0 | 1.3 | 1.1 | 15.8 |
| 700.0 | 1.4 | 1.3 | 16.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .342 | –50 | 4.265 | –136 | .076 | 45 | .411 | –173 |
| 2.0 | .205 | –74 | 5.432 | –155 | .097 | 26 | .228 | 140 |
| 5.0 | .081 | –89 | 5.746 | –171 | .103 | 10 | .089 | 116 |
| 10.0 | .044 | –96 | 5.794 | –176 | .104 | 5 | .051 | 110 |
| 50.0 | .017 | 163 | 5.849 | 172 | .105 | –3 | .024 | 86 |
| 100.0 | .023 | 94 | 5.824 | 163 | .105 | –9 | .029 | 75 |
| 200.0 | .037 | 68 | 5.796 | 145 | .105 | –18 | .043 | 60 |
| 300.0 | .057 | 49 | 5.815 | 128 | .103 | –27 | .051 | 43 |
| 400.0 | .087 | 17 | 5.892 | 111 | .103 | –36 | .039 | 23 |
| 500.0 | .109 | –11 | 6.000 | 92 | .100 | –46 | .009 | 0 |
| 600.0 | .134 | –46 | 6.194 | 72 | .097 | –57 | .048 | 166 |
| 700.0 | .157 | –91 | 6.334 | 49 | .090 | –68 | .142 | 140 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.4 | 12.3 |
| 2.0 | 1.5 | 1.6 | 14.5 |
| 5.0 | 1.2 | 1.2 | 15.0 |
| 10.0 | 1.1 | 1.1 | 15.0 |
| 50.0 | 1.0 | 1.0 | 15.1 |
| 100.0 | 1.0 | 1.0 | 15.1 |
| 200.0 | 1.1 | 1.0 | 15.0 |
| 300.0 | 1.1 | 1.0 | 15.0 |
| 400.0 | 1.1 | 1.0 | 15.2 |
| 500.0 | 1.2 | 1.1 | 15.2 |
| 600.0 | 1.2 | 1.2 | 15.4 |
| 700.0 | 1.3 | 1.5 | 15.5 |

### Linear S-Parameters

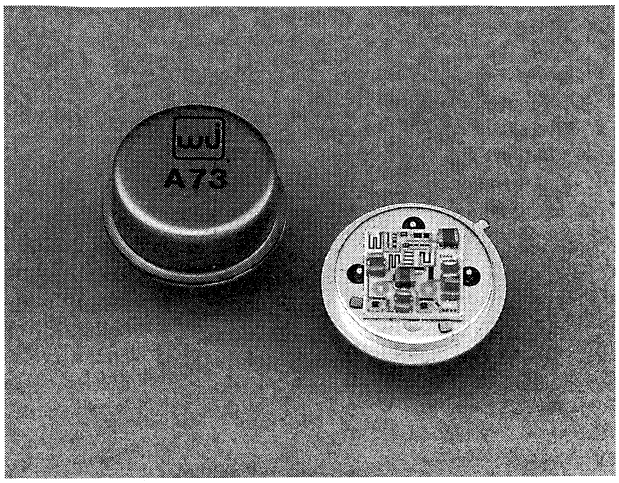
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .362 | –51 | 4.115 | –136 | .077 | 45 | .407 | –174 |
| 2.0 | .213 | –70 | 5.293 | –154 | .099 | 26 | .227 | 136 |
| 5.0 | .082 | –78 | 5.604 | –171 | .105 | 10 | .086 | 104 |
| 10.0 | .044 | –77 | 5.651 | –177 | .106 | 5 | .048 | 90 |
| 50.0 | .003 | 98 | 5.707 | 172 | .107 | –3 | .023 | 42 |
| 100.0 | .019 | 67 | 5.674 | 163 | .107 | –8 | .021 | 31 |
| 200.0 | .025 | 36 | 5.648 | 145 | .106 | –17 | .020 | 37 |
| 300.0 | .041 | 39 | 5.647 | 127 | .105 | –25 | .016 | 53 |
| 400.0 | .064 | 7 | 5.738 | 109 | .105 | –34 | .015 | 128 |
| 500.0 | .076 | –21 | 5.775 | 91 | .103 | –43 | .049 | 145 |
| 600.0 | .096 | –56 | 5.889 | 70 | .100 | –53 | .106 | 136 |
| 700.0 | .119 | –99 | 5.929 | 47 | .095 | –62 | .195 | 118 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.120 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A73 / SMA73

## 5 to 500 MHz
## TO -8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN-TWO STAGES: 32 dB (TYP.)
- ◆ LOW NOISE: 3.5 dB (TYP.)
- ◆ +15 dBm THIRD ORDER I.P. (TYP.)
- ◆ LOW VSWR: < 1.4:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 32.0 dB | 30.0 dB | 29.0 dB |
| Gain Flatness (Max.) | < ±0.25 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.5 dB | 4.0dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +1.5 dBm | +1.0 dBm | +0.5 dBm |
| VSWR (Max.) Input/Output | <1.4:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 20 mA | 23 mA | 25 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA73 is a standard WJ-A73 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+26 dBm (Typ.)
Second Order Two Tone Intercept Point.....+19.5 dBm (Typ.)
Third Order Two Tone Intercept Point.....+15 dBm (Typ.)

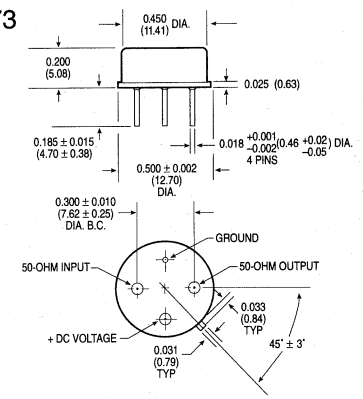
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Maximum).....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

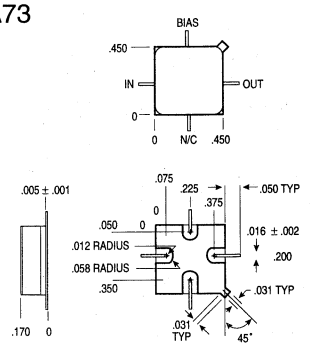
## Outline Drawings

A73



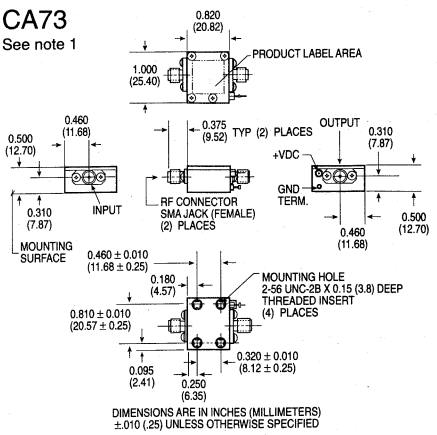

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA73




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

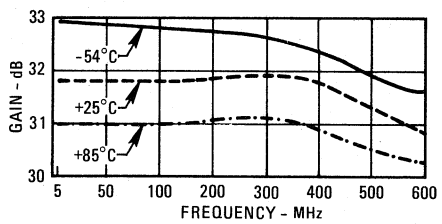
CA73
See note 1



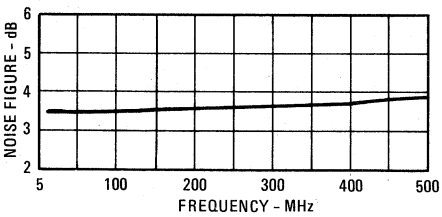

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

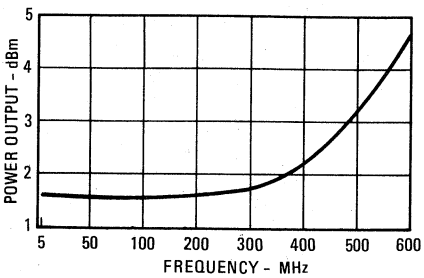
### Gain




### Noise Figure

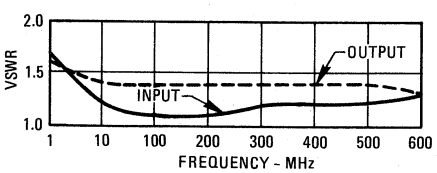



### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.5 | 30.6 |
| 2.0 | 1.3 | 1.4 | 30.7 |
| 5.0 | 1.1 | 1.3 | 30.8 |
| 10.0 | 1.1 | 1.3 | 30.7 |
| 50.0 | 1.1 | 1.4 | 30.7 |
| 100.0 | 1.2 | 1.4 | 30.8 |
| 200.0 | 1.3 | 1.5 | 30.8 |
| 300.0 | 1.3 | 1.5 | 30.8 |
| 400.0 | 1.2 | 1.5 | 30.7 |
| 500.0 | 1.4 | 1.5 | 30.6 |
| 600.0 | 2.1 | 2.1 | 30.2 |
| 700.0 | 3.9 | 3.7 | 28.9 |

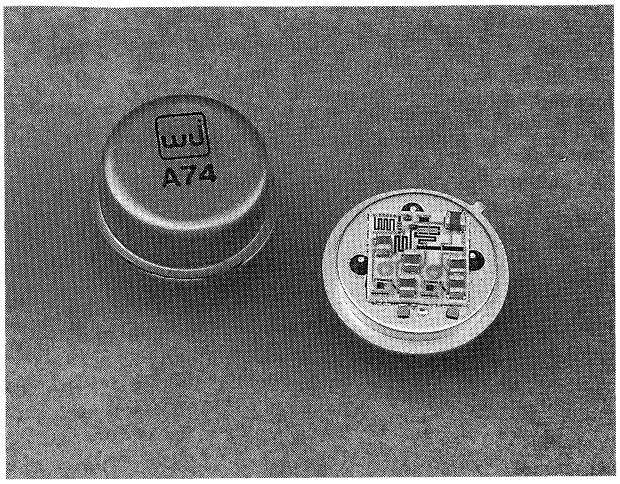
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .199 | –88 | 34.035 | 26 | .010 | 20 | .201 | –120 |
| 2.0 | .126 | –122 | 34.270 | 13 | .010 | 9 | .162 | –146 |
| 5.0 | .067 | –154 | 34.499 | 4 | .011 | 5 | .142 | –166 |
| 10.0 | .055 | –165 | 34.439 | –1 | .011 | 6 | .138 | –172 |
| 50.0 | .058 | –162 | 34.412 | –16 | .011 | 2 | .149 | –173 |
| 100.0 | .078 | –156 | 34.482 | –33 | .011 | 1 | .170 | –175 |
| 200.0 | .113 | –176 | 34.707 | –68 | .012 | 2 | .205 | 169 |
| 300.0 | .121 | 153 | 34.477 | –102 | .013 | –2 | .216 | 145 |
| 400.0 | .104 | 94 | 34.435 | –138 | .015 | –7 | .191 | 105 |
| 500.0 | .154 | 6 | 33.971 | –175 | .018 | –20 | .189 | 35 |
| 600.0 | .346 | –58 | 32.520 | 142 | .018 | –38 | .345 | –38 |
| 700.0 | .590 | –108 | 27.964 | 98 | .017 | –57 | .573 | –88 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.100 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5°C

# WJ-A74 / SMA74




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 30.0 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8.5 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS
- ◆ LOW VSWR: < 1.3:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 30.0 dB | 28.0 dB | 27.0 dB |
| Gain Flatness (Max.) | < ±0.25 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.0 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7.0 dBm | +7.0 dBm |
| VSWR (Max.) Input/Output | < 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 40 mA | 42 mA | 44 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA74 is a standard WJ-A74 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+36 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+33 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+20 dBm (Typ.)

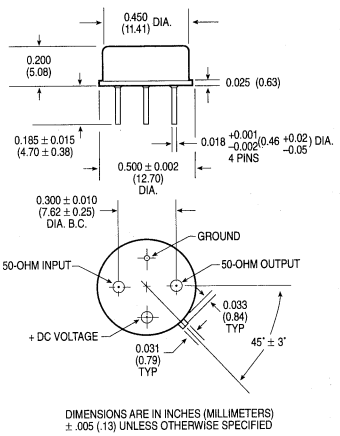
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

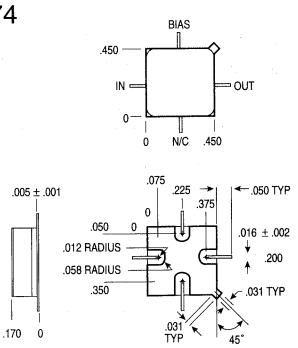
## Outline Drawings

A74



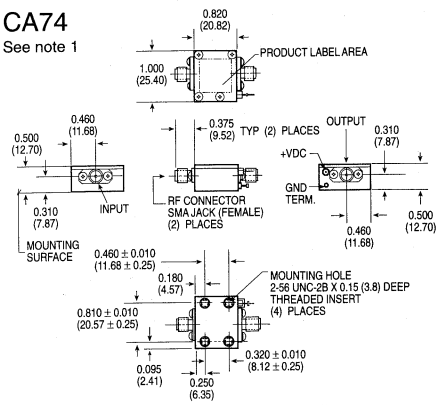

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA74




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

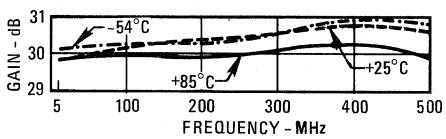
CA74
See note 1



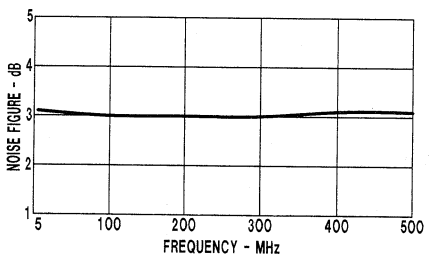

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

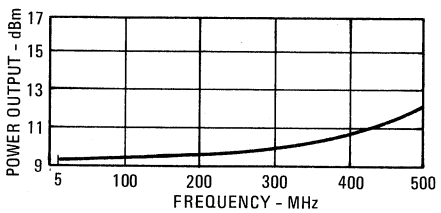
### Gain




### Noise Figure

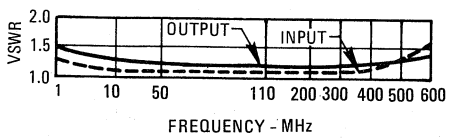



### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.7 | 31.9 |
| 2.0 | 1.5 | 1.4 | 31.6 |
| 5.0 | 1.1 | 1.3 | 31.5 |
| 10.0 | 1.0 | 1.3 | 31.5 |
| 50.0 | 1.0 | 1.3 | 31.7 |
| 100.0 | 1.0 | 1.3 | 31.8 |
| 200.0 | 1.0 | 1.4 | 32.0 |
| 300.0 | 1.1 | 1.3 | 32.0 |
| 400.0 | 1.3 | 1.2 | 31.8 |
| 500.0 | 1.5 | 1.2 | 31.4 |
| 600.0 | 1.8 | 1.2 | 31.2 |
| 700.0 | 2.6 | 1.4 | 31.1 |

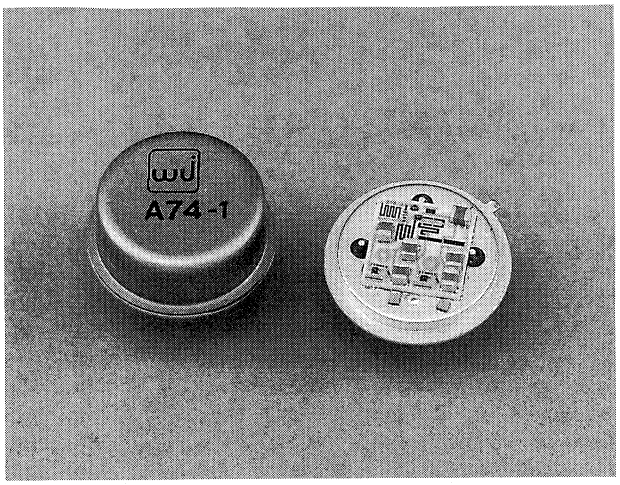
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .332 | –48 | 39.522 | 19 | .013 | 5 | .249 | –79 |
| 2.0 | .190 | –75 | 37.847 | 8 | .010 | –5 | .175 | –114 |
| 5.0 | .059 | –96 | 37.395 | 2 | .009 | –2 | .131 | –152 |
| 10.0 | .017 | –60 | 37.752 | –1 | .009 | 2 | .117 | –166 |
| 50.0 | .018 | –1 | 38.435 | –17 | .009 | 2 | .120 | –174 |
| 100.0 | .020 | –15 | 38.952 | –36 | .010 | 0 | .136 | –179 |
| 200.0 | .017 | 44 | 39.852 | –74 | .010 | 3 | .151 | 162 |
| 300.0 | .054 | 39 | 39.624 | –114 | .010 | 2 | .141 | 141 |
| 400.0 | .116 | 1 | 38.720 | –154 | .011 | 3 | .107 | 123 |
| 500.0 | .187 | –34 | 37.269 | 167 | .012 | 0 | .076 | 118 |
| 600.0 | .291 | –72 | 36.516 | 125 | .012 | 0 | .084 | 107 |
| 700.0 | .444 | –110 | 36.015 | 78 | .016 | –2 | .153 | 58 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.192 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A74-1 / SMA74-1




## 5 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 31.0 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8.5 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS
- ◆ LOW VSWR: < 1.3:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-300 MHz | 5-250 MHz | 5-250 MHz |
| Small Signal Gain (Min.) | 31.0 dB | 30.0 dB | 29.0 dB |
| Gain Flatness (Max.) | < ±0.2dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +8.5 dBm | +7.0 dBm | +7.0 dBm |
| VSWR (Max.) Input/Output | <1.3:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 40 mA | 42 mA | 44 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA74-1 is a standard WJ-A74-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+34 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

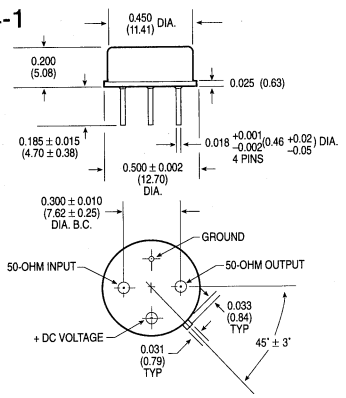
## Absolute Maximum Ratings

Storage Temperature .....-62°C to+125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

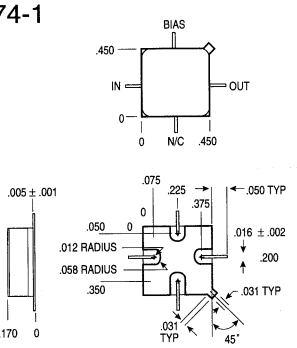
Weight approximately 2.0 grams (0.07 oz.)

## Outline Drawings

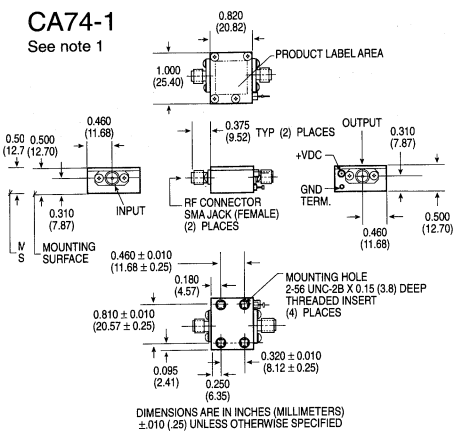
A74-1




SMA74-1

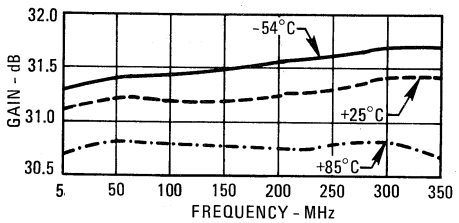



CA74-1
See note 1

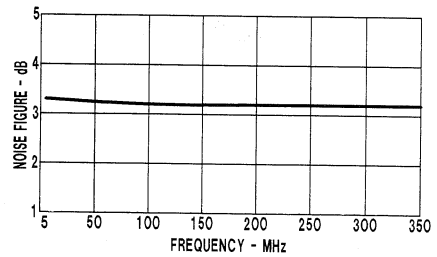


## Typical Performance at 25°C

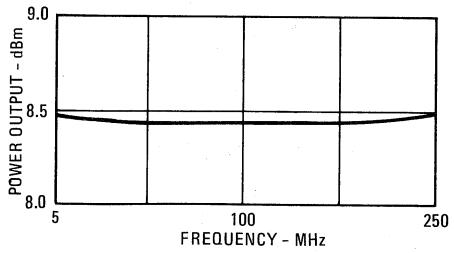
### Gain




### Noise Figure

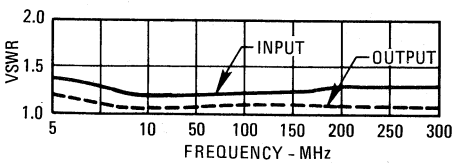



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.4 | 1.8 | 32.8 |
| 2.0 | 1.6 | 1.5 | 32.1 |
| 5.0 | 1.2 | 1.3 | 31.9 |
| 10.0 | 1.1 | 1.2 | 32.0 |
| 50.0 | 1.0 | 1.2 | 32.2 |
| 100.0 | 1.0 | 1.3 | 32.3 |
| 150.0 | 1.0 | 1.3 | 32.4 |
| 200.0 | 1.1 | 1.4 | 32.5 |
| 250.0 | 1.1 | 1.4 | 32.3 |
| 300.0 | 1.1 | 1.3 | 32.3 |
| 350.0 | 1.2 | 1.3 | 32.1 |
| 400.0 | 1.3 | 1.3 | 32.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .419 | –48 | 43.443 | 17 | .014 | 1 | .293 | –67 |
| 2.0 | .228 | –82 | 40.114 | 7 | .010 | –11 | .196 | –105 |
| 5.0 | .084 | –122 | 39.250 | 2 | .008 | –5 | .132 | –148 |
| 10.0 | .032 | –143 | 39.804 | –1 | .008 | 2 | .108 | –165 |
| 50.0 | .011 | –156 | 40.647 | –17 | .008 | 3 | .109 | –171 |
| 100.0 | .018 | 157 | 41.096 | –36 | .009 | 3 | .128 | –176 |
| 150.0 | .024 | 150 | 41.462 | –55 | .009 | 3 | .144 | 175 |
| 200.0 | .033 | 124 | 42.012 | –74 | .010 | 2 | .153 | 163 |
| 250.0 | .046 | 91 | 41.438 | –94 | .009 | 7 | .153 | 152 |
| 300.0 | .060 | 66 | 41.306 | –113 | .010 | 5 | .148 | 139 |
| 350.0 | .084 | 40 | 40.412 | –133 | .010 | 4 | .134 | 127 |
| 400.0 | .118 | 11 | 39.887 | –153 | .011 | 6 | .114 | 116 |

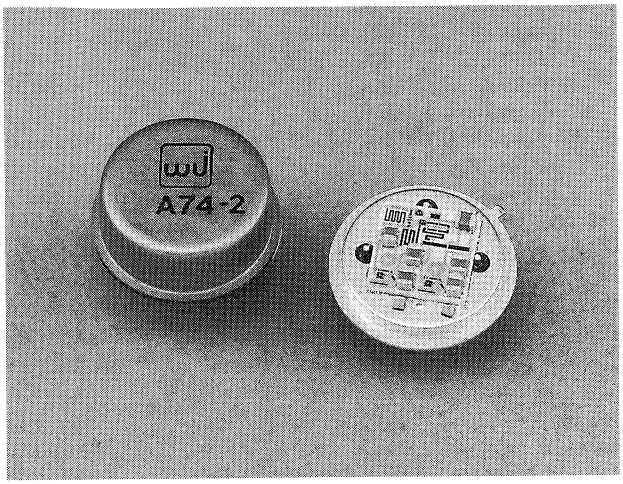
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.185 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A74-2 / SMA74-2

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES - 26 dB (TYP.)
- ◆ LOW POWER DRAIN: 65 mW @ 5 VOLTS




## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-550 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 26.0 dB | 25.0 dB | 24.0 dB |
| Gain Flatness (Max.) | ±0.8 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | 3.8 dB | 4.3 dB | 4.8 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dBm | -2.0 dBm | -2.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 5 Volts | 13 mA | 16 mA | 18 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA74-2 is a standard WJ-A74-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +20 dBm (Typ.)
Second Order Two Tone Intercept Point.....+16 dBm (Typ.)
Third Order Two Tone Intercept Point .....+10 dBm (Typ.)

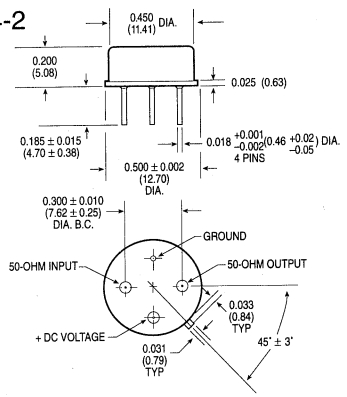
## Absolute Maximum Ratings

Storage Temperature .....- 62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +7 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.26 grams (0.08 oz.) max.

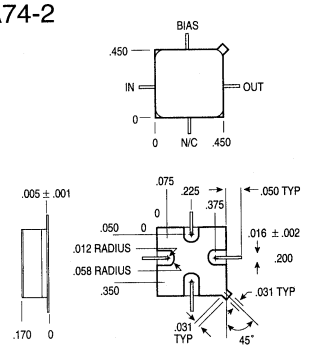
## Outline Drawings

A74-2



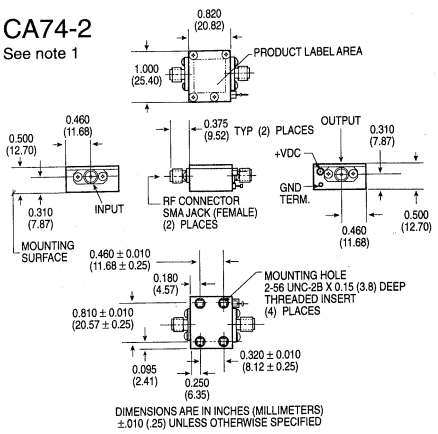

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA74-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

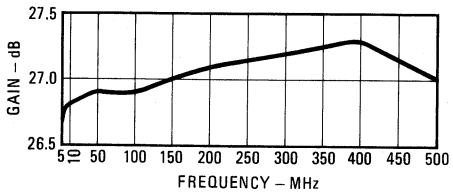
CA74-2
See note 1



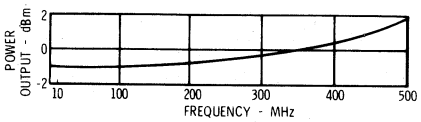

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

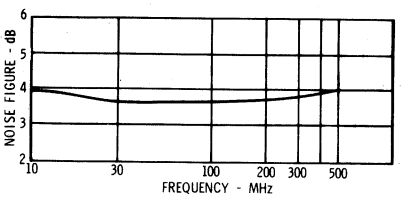



### Power Output*

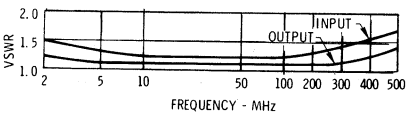



*at 1 dB Gain Compression

### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.7 | 1.5 | 26.1 |
| 2.0 | 1.3 | 1.2 | 26.2 |
| 5.0 | 1.1 | 1.1 | 26.3 |
| 10.0 | 1.1 | 1.1 | 26.4 |
| 50.0 | 1.1 | 1.0 | 26.5 |
| 100.0 | 1.1 | 1.0 | 26.5 |
| 200.0 | 1.1 | 1.0 | 26.5 |
| 300.0 | 1.1 | 1.1 | 26.4 |
| 400.0 | 1.3 | 1.2 | 26.3 |
| 500.0 | 1.4 | 1.3 | 26.0 |
| 600.0 | 1.7 | 1.5 | 25.6 |
| 700.0 | 2.0 | 2.0 | 24.9 |

### Linear S-Parameters

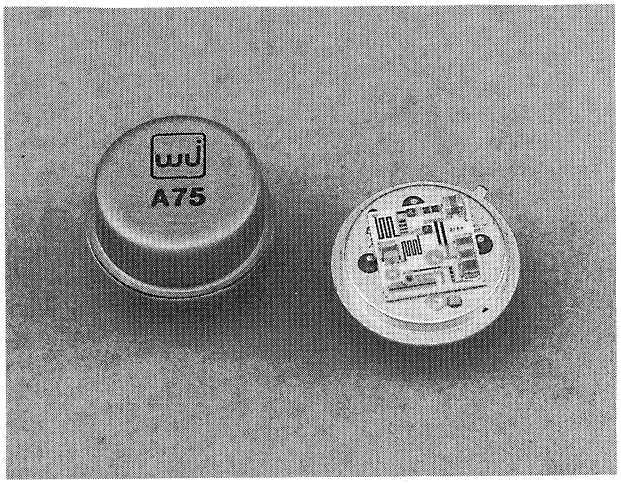
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .263 | –75 | 20.237 | 24 | .016 | 12 | .196 | –64 |
| 2.0 | .141 | –104 | 20.454 | 12 | .014 | 2 | .107 | –73 |
| 5.0 | .067 | –144 | 20.699 | 4 | .013 | 2 | .041 | –70 |
| 10.0 | .048 | –164 | 20.902 | 0 | .013 | 1 | .025 | –51 |
| 50.0 | .042 | 156 | 21.056 | –17 | .013 | –1 | .019 | –49 |
| 100.0 | .044 | 114 | 21.086 | –35 | .013 | 1 | .018 | –79 |
| 200.0 | .047 | 60 | 21.234 | –71 | .013 | 2 | .023 | –136 |
| 300.0 | .067 | 5 | 20.979 | –108 | .013 | –1 | .040 | –172 |
| 400.0 | .117 | –37 | 20.607 | –145 | .014 | 1 | .072 | 167 |
| 500.0 | .169 | –77 | 19.884 | 178 | .015 | 1 | .126 | 145 |
| 600.0 | .248 | –109 | 19.070 | 138 | .017 | 0 | .208 | 117 |
| 700.0 | .336 | –141 | 17.578 | 95 | .019 | –4 | .324 | 84 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.023 W
Junction Temperature Rise Above Case $T_{jc}$ ... 1°C

# WJ-A75 / SMA75

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 21 dB (TYP.)
- ◆ LOW NOISE: 2.6 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +9 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +20 V0LTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 21.0 dB | 20.0 dB | 19.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.6 dB | 3.0 dB | 3.5 dB |
| Power Output at 1 dB Compression (Min.) | +9 dBm | +7 dBm | +7 dBm |
| VSWR (Max.) Input/Output | < 1.4:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA75 is a standard WJ-A75 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

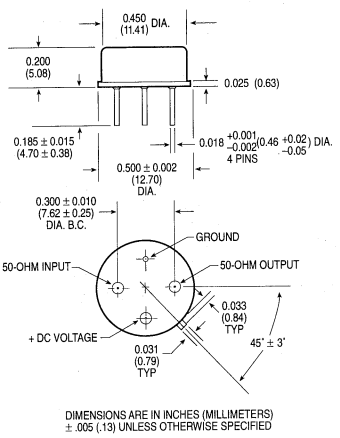
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+21 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

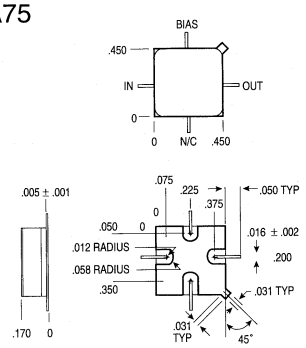
## Outline Drawings

A75



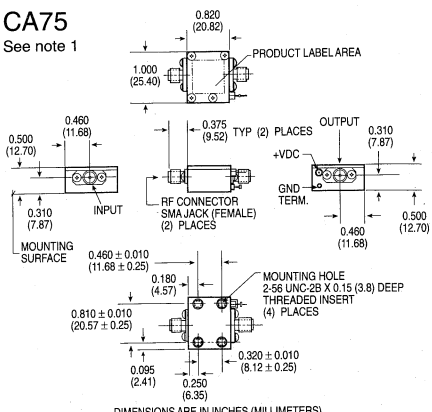

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA75




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

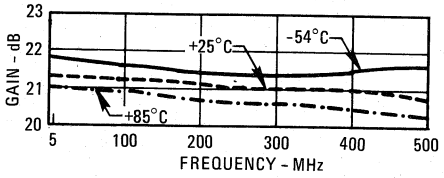
CA75
See note 1



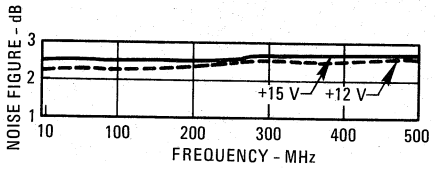

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

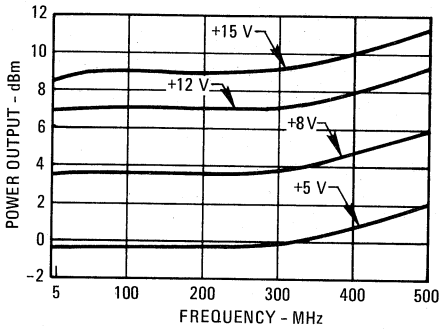
### Gain




### Noise Figure

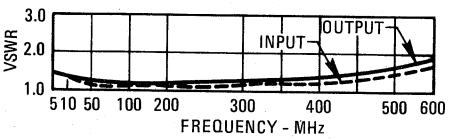



### Power Output*




* at 1 dB Gain Compression

### VSWR




### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.2 | 18.2 |
| 2.0 | 1.3 | 1.3 | 18.2 |
| 5.0 | 1.3 | 1.3 | 18.2 |
| 10.0 | 1.3 | 1.3 | 18.1 |
| 50.0 | 1.3 | 1.3 | 18.1 |
| 100.0 | 1.3 | 1.4 | 18.0 |
| 200.0 | 1.4 | 1.6 | 18.0 |
| 300.0 | 1.5 | 1.8 | 18.0 |
| 400.0 | 1.7 | 1.9 | 18.1 |
| 500.0 | 2.2 | 1.7 | 17.6 |
| 600.0 | 2.7 | 1.8 | 16.0 |
| 700.0 | 2.7 | 2.8 | 13.1 |

## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.3 | 20.7 |
| 2.0 | 1.3 | 1.1 | 20.9 |
| 5.0 | 1.2 | 1.1 | 20.8 |
| 10.0 | 1.2 | 1.1 | 20.7 |
| 50.0 | 1.2 | 1.1 | 20.7 |
| 100.0 | 1.2 | 1.1 | 20.6 |
| 200.0 | 1.2 | 1.1 | 20.6 |
| 300.0 | 1.1 | 1.3 | 20.7 |
| 400.0 | 1.1 | 1.4 | 20.9 |
| 500.0 | 1.4 | 1.4 | 20.9 |
| 600.0 | 2.0 | 1.6 | 19.9 |
| 700.0 | 2.5 | 2.7 | 16.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .159 | −158 | 10.862 | −156 | .058 | 19 | .126 | −159 |
| 2.0 | .115 | −167 | 11.030 | −169 | .056 | 9 | .063 | −168 |
| 5.0 | .106 | −174 | 10.974 | −177 | .057 | 4 | .053 | −169 |
| 10.0 | .108 | 180 | 10.895 | 179 | .057 | 2 | .053 | −173 |
| 50.0 | .106 | 159 | 10.817 | 166 | .057 | −3 | .049 | −176 |
| 100.0 | .100 | 133 | 10.736 | 152 | .057 | −7 | .046 | −164 |
| 200.0 | .075 | 91 | 10.744 | 124 | .057 | −14 | .069 | −136 |
| 300.0 | .042 | 30 | 10.820 | 96 | .057 | −21 | .123 | −146 |
| 400.0 | .060 | −97 | 11.120 | 65 | .058 | −26 | .167 | −176 |
| 500.0 | .183 | −166 | 11.101 | 29 | .064 | −33 | .158 | 125 |
| 600.0 | .335 | 139 | 9.884 | −15 | .072 | −47 | .226 | 16 |
| 700.0 | .424 | 89 | 6.983 | −57 | .070 | −67 | .462 | −57 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.2 | 20.3 |
| 2.0 | 1.2 | 1.1 | 20.4 |
| 5.0 | 1.1 | 1.0 | 20.4 |
| 10.0 | 1.1 | 1.0 | 20.3 |
| 50.0 | 1.1 | 1.1 | 20.3 |
| 100.0 | 1.1 | 1.1 | 20.2 |
| 200.0 | 1.1 | 1.2 | 20.2 |
| 300.0 | 1.1 | 1.4 | 20.3 |
| 400.0 | 1.2 | 1.5 | 20.5 |
| 500.0 | 1.5 | 1.4 | 20.5 |
| 600.0 | 2.1 | 1.7 | 19.3 |
| 700.0 | 2.5 | 2.8 | 16.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .136 | −145 | 10.370 | −158 | .060 | 18 | .086 | −151 |
| 2.0 | .070 | −159 | 10.514 | −170 | .059 | 9 | .032 | −153 |
| 5.0 | .065 | −168 | 10.456 | −178 | .059 | 4 | .023 | −153 |
| 10.0 | .067 | −179 | 10.396 | 179 | .060 | 1 | .023 | −158 |
| 50.0 | .066 | 152 | 10.375 | 166 | .060 | −3 | .027 | −140 |
| 100.0 | .063 | 126 | 10.271 | 152 | .060 | −7 | .045 | −123 |
| 200.0 | .045 | 70 | 10.279 | 125 | .059 | −15 | .098 | −127 |
| 300.0 | .029 | −28 | 10.347 | 96 | .060 | −21 | .153 | −148 |
| 400.0 | .091 | −117 | 10.622 | 65 | .062 | −27 | .191 | 177 |
| 500.0 | .213 | −171 | 10.559 | 29 | .068 | −34 | .179 | 116 |
| 600.0 | .354 | 138 | 9.257 | −15 | .075 | −50 | .248 | 14 |
| 700.0 | .433 | 89 | 6.562 | −56 | .073 | −70 | .473 | −58 |

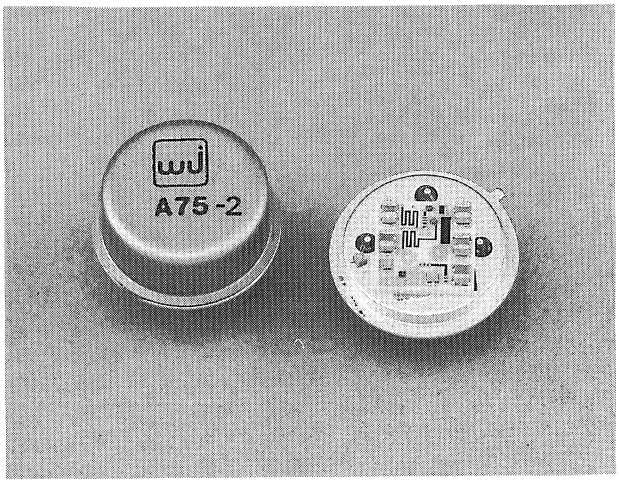
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .101 | −15 | 8.112 | −163 | .073 | 16 | .106 | −12 |
| 2.0 | .134 | −4 | 8.109 | −172 | .073 | 8 | .130 | −5 |
| 5.0 | .136 | −4 | 8.096 | −178 | .073 | 3 | .135 | −5 |
| 10.0 | .132 | −5 | 8.079 | 179 | .073 | 1 | .136 | −8 |
| 50.0 | .135 | −16 | 8.041 | 166 | .073 | −3 | .146 | −34 |
| 100.0 | .138 | −31 | 7.989 | 151 | .073 | −7 | .170 | −64 |
| 200.0 | .163 | −64 | 7.969 | 123 | .074 | −15 | .236 | −110 |
| 300.0 | .206 | −103 | 7.945 | 94 | .076 | −21 | .288 | −149 |
| 400.0 | .270 | −140 | 8.050 | 61 | .083 | −29 | .303 | 168 |
| 500.0 | .378 | 176 | 7.626 | 24 | .092 | −43 | .260 | 105 |
| 600.0 | .453 | 130 | 6.339 | −17 | .096 | −63 | .295 | 11 |
| 700.0 | .459 | 88 | 4.494 | −55 | .086 | −84 | .479 | −60 |

## Thermal Data: $V_{CC}$ =15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.173 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A75-2 / SMA75-2




## 5 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 21.0 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8.0 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-300 MHz | 5-250 MHz | 5-250 MHz |
| Small Signal Gain (Min.) | 21.0 dB | 20.0 dB | 19.0 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.2 dB | 4.5 dB | 5.0 dB |
| Power Output at 1 dB Compression (Min.) | +8.0 dBm | +7.0 dBm | +7.0 dBm |
| VSWR (Max.) Input/Output | 1.4:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 24 mA | 26 mA | 28 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA75-2 is a standard WJ-A75-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+30 dBm (Typ.)
Second Order Two Tone Intercept Point.....+26 dBm (Typ.)
Third Order Two Tone Intercept Point.....+19 dBm (Typ.)

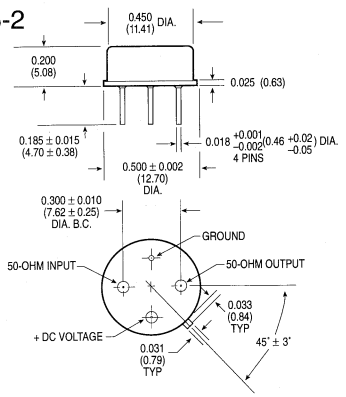
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

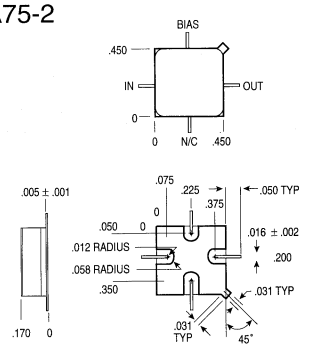
## Outline Drawings

A75-2



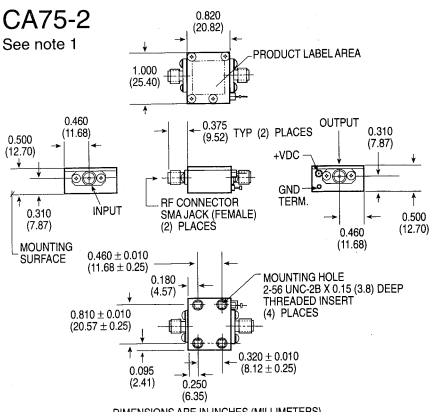

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA75-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

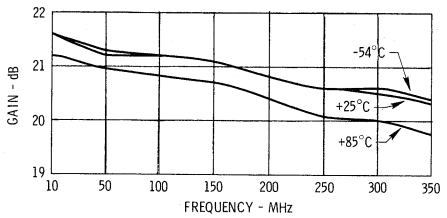
CA75-2
See note 1



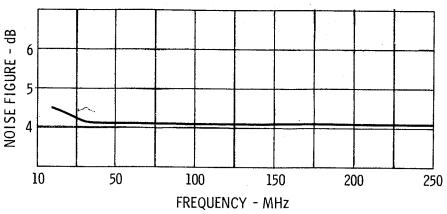

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

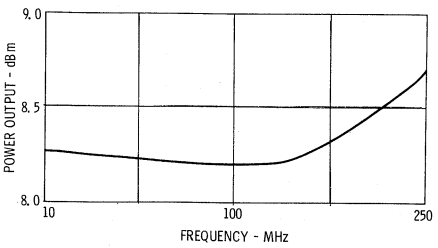
### Gain




### Noise Figure

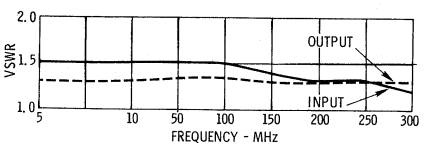



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.7 | 23.6 |
| 2.0 | 1.5 | 1.3 | 24.1 |
| 5.0 | 1.4 | 1.2 | 24.0 |
| 10.0 | 1.4 | 1.2 | 23.8 |
| 50.0 | 1.3 | 1.2 | 23.6 |
| 100.0 | 1.3 | 1.1 | 23.5 |
| 150.0 | 1.2 | 1.1 | 23.3 |
| 200.0 | 1.2 | 1.1 | 23.2 |
| 250.0 | 1.3 | 1.2 | 23.0 |
| 300.0 | 1.5 | 1.2 | 22.8 |
| 350.0 | 1.8 | 1.1 | 22.4 |
| 400.0 | 2.2 | 1.0 | 21.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .330 | −166 | 15.074 | −147 | .040 | 18 | .269 | −178 |
| 2.0 | .202 | 171 | 16.008 | −164 | .035 | 6 | .140 | 159 |
| 5.0 | .151 | 177 | 15.883 | −177 | .034 | 4 | .083 | 168 |
| 10.0 | .154 | 178 | 15.515 | 178 | .035 | 2 | .084 | 175 |
| 50.0 | .140 | 167 | 15.154 | 160 | .035 | −2 | .076 | 168 |
| 100.0 | .113 | 158 | 14.919 | 140 | .036 | −5 | .053 | 167 |
| 150.0 | .070 | 161 | 14.653 | 120 | .037 | −7 | .037 | −168 |
| 200.0 | .072 | −158 | 14.475 | 100 | .038 | −11 | .051 | −139 |
| 250.0 | .124 | −140 | 14.122 | 79 | .038 | −14 | .074 | −140 |
| 300.0 | .203 | −144 | 13.746 | 57 | .041 | −17 | .080 | −155 |
| 350.0 | .296 | −160 | 13.217 | 34 | .044 | −24 | .058 | −178 |
| 400.0 | .377 | −178 | 12.311 | 9 | .048 | −30 | .016 | 32 |

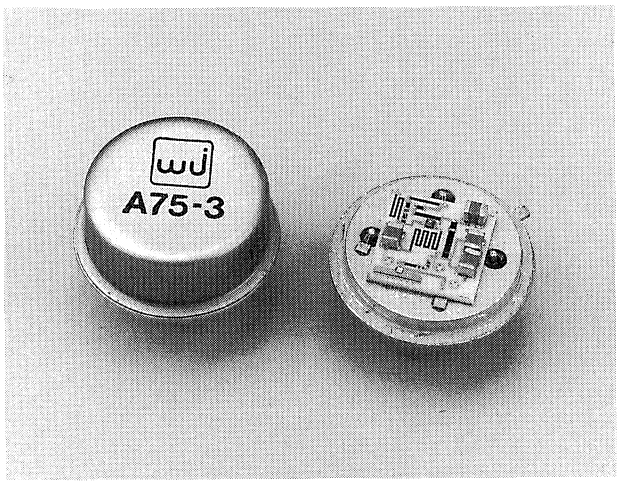
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.191 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A75-3 / SMA75-3

## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 20.5 dB (TYP.)
- ◆ LOW NOISE: 2.3 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85°C |
| Frequency (Min.) | 1 -600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 20.5 dB | 19.5 dB | 18.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.3 dB | 2.5 dB | 3.0 dB |
| Power Output at 1 dB Compression (Min.) | +3.5 dBm | +2.0 dBm | +1.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 14 mA | 16 mA | 18 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA75-3 is a standard WJ-A75-3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+30 dBm (Typ.)
Second Order Two Tone Intercept Point.....+25 dBm (Typ.)
Third Order Two Tone Intercept Point.....+15 dBm (Typ.)

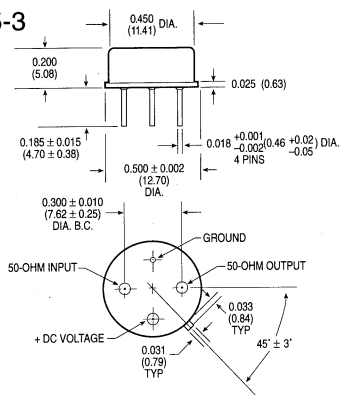
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+21 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watts (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

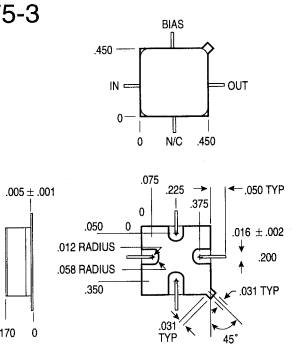
## Outline Drawings

A75-3



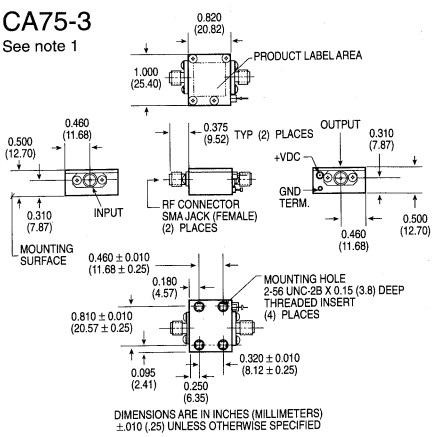

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA75-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

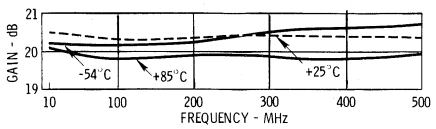
CA75-3
See note 1



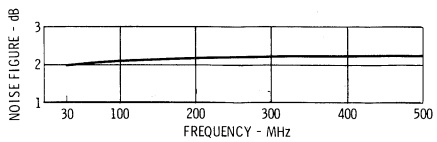

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

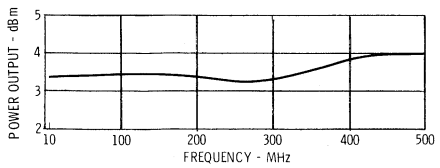
### Gain




### Noise Figure

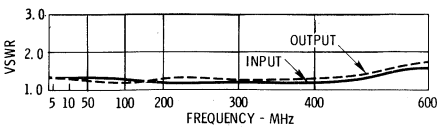



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.2 | 20.6 |
| 2.0 | 1.1 | 1.1 | 20.7 |
| 5.0 | 1.1 | 1.1 | 20.6 |
| 10.0 | 1.1 | 1.1 | 20.5 |
| 50.0 | 1.1 | 1.1 | 20.4 |
| 100.0 | 1.1 | 1.0 | 20.3 |
| 200.0 | 1.1 | 1.0 | 20.2 |
| 300.0 | 1.1 | 1.1 | 20.2 |
| 400.0 | 1.1 | 1.3 | 20.4 |
| 500.0 | 1.2 | 1.3 | 20.5 |
| 600.0 | 1.6 | 1.5 | 20.2 |
| 700.0 | 2.6 | 2.2 | 18.1 |

### Linear S-Parameters

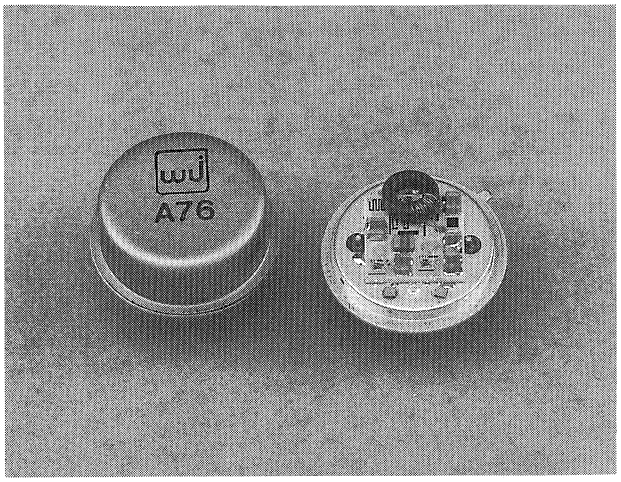
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .141 | –164 | 10.775 | –155 | .051 | 14 | .100 | –169 |
| 2.0 | .067 | 179 | 10.865 | –169 | .048 | 7 | .035 | –173 |
| 5.0 | .066 | –173 | 10.664 | –178 | .048 | 4 | .031 | –163 |
| 10.0 | .068 | –178 | 10.554 | 179 | .049 | 1 | .034 | –172 |
| 50.0 | .065 | 165 | 10.437 | 165 | .049 | –5 | .029 | 168 |
| 100.0 | .057 | 146 | 10.333 | 150 | .049 | –11 | .019 | 161 |
| 200.0 | .034 | 146 | 10.260 | 120 | .049 | –23 | .021 | –97 |
| 300.0 | .025 | 172 | 10.201 | 90 | .049 | –33 | .065 | –119 |
| 400.0 | .043 | 165 | 10.459 | 57 | .050 | –44 | .112 | –157 |
| 500.0 | .098 | 111 | 10.631 | 22 | .052 | –57 | .143 | 148 |
| 600.0 | .232 | 45 | 10.254 | –22 | .057 | –75 | .210 | 64 |
| 700.0 | .450 | –13 | 8.056 | –71 | .057 | –100 | .376 | –12 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.095 W
Junction Temperature Rise Above Case $T_{jc}$ ... 4°C

# WJ-A76 / SMA76

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 28 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +15 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +28 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 28.0 dB | 27.0 dB | 26.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±1.0 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.7 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +15.0 dBm | +14.0 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 62 mA | 65 mA | 68 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA76 is a standard WJ-A76 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +49 dBm (Typ.)
Second Order Two Tone Intercept Point.....+44 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

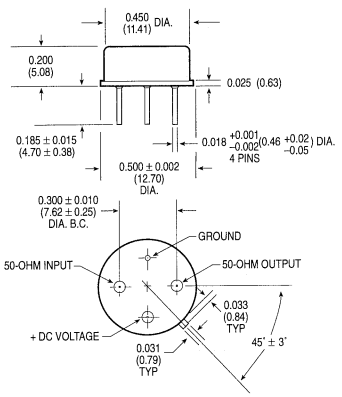
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....40 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

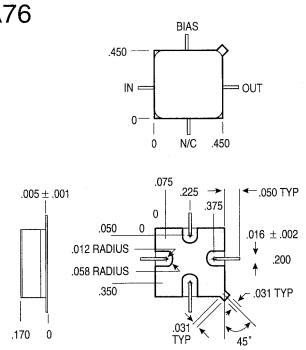
## Outline Drawings

A76



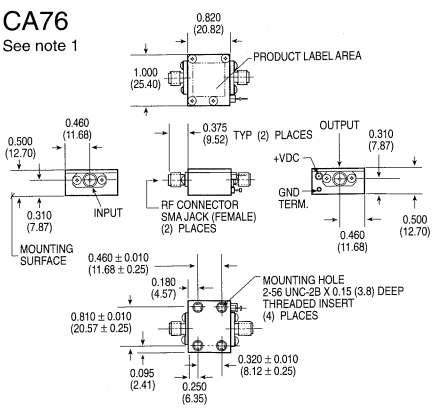

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA76




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

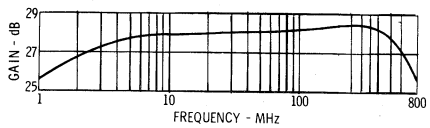
CA76
See note 1

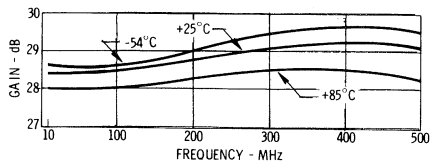



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

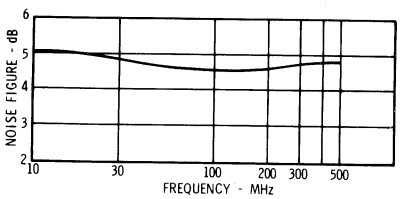
## Typical Performance at 25°C

### Gain

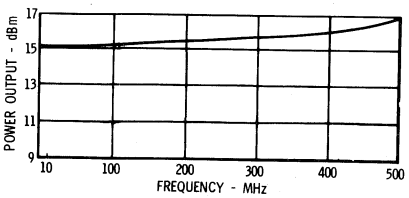



### Noise Figure

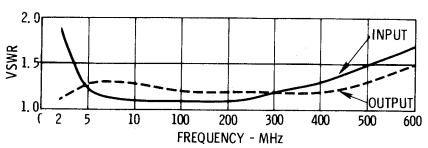



### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.5 | 28.9 |
| 2.0 | 1.2 | 1.2 | 29.2 |
| 5.0 | 1.1 | 1.1 | 29.3 |
| 10.0 | 1.1 | 1.1 | 29.3 |
| 50.0 | 1.0 | 1.1 | 29.6 |
| 100.0 | 1.1 | 1.1 | 29.6 |
| 200.0 | 1.1 | 1.1 | 29.8 |
| 300.0 | 1.2 | 1.2 | 29.7 |
| 400.0 | 1.3 | 1.3 | 29.5 |
| 500.0 | 1.5 | 1.3 | 29.0 |
| 600.0 | 1.8 | 1.4 | 28.3 |
| 700.0 | 2.2 | 1.5 | 27.5 |

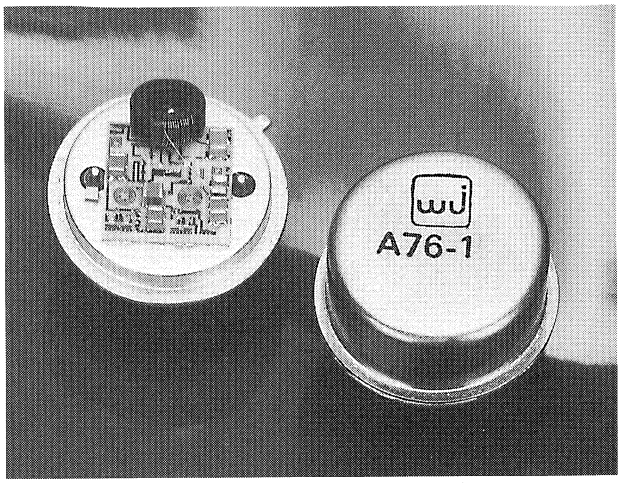
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .202 | –155 | 27.717 | 45 | .011 | 53 | .199 | 141 |
| 2.0 | .093 | –177 | 28.997 | 21 | .013 | 26 | .084 | 87 |
| 5.0 | .066 | 162 | 29.007 | 7 | .013 | 10 | .044 | 36 |
| 10.0 | .053 | 140 | 29.188 | 2 | .013 | 3 | .036 | 8 |
| 50.0 | .022 | 85 | 30.029 | –13 | .013 | 1 | .030 | –46 |
| 100.0 | .030 | 60 | 30.266 | –29 | .013 | 4 | .032 | –90 |
| 200.0 | .046 | 22 | 30.874 | –61 | .013 | 9 | .048 | –164 |
| 300.0 | .079 | –16 | 30.711 | –93 | .015 | 7 | .083 | 145 |
| 400.0 | .135 | –42 | 29.915 | –127 | .016 | 9 | .120 | 107 |
| 500.0 | .189 | –77 | 28.070 | –160 | .018 | 7 | .148 | 74 |
| 600.0 | .276 | –106 | 25.983 | 167 | .020 | 6 | .173 | 46 |
| 700.0 | .371 | –134 | 23.796 | 134 | .022 | 2 | .193 | 24 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.436 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-A76-1/SMA76-1




## 5 TO 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN-TWO STAGES: 27.5 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +13 dBm (TYP.)
- ◆ LOW NOISE FIGURE: 2.8 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 27.5 dB | 26.0 dB | 25.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.8 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +13.0 dBm | +12.0 dBm | +11.0 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 1.9:1 | 2.0:1 |
| DC Current at +5 Volts (Max.) | 47 mA | 50 mA | 53 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
WJ-CA76-1 is a standard WJ-A76-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point ..... +46 dBm (Typ.)
Second Order Two Tone Intercept Point ..... +41 dBm (Typ.)
Third Order Two Tone Intercept Point ..... +25 dBm (Typ.)

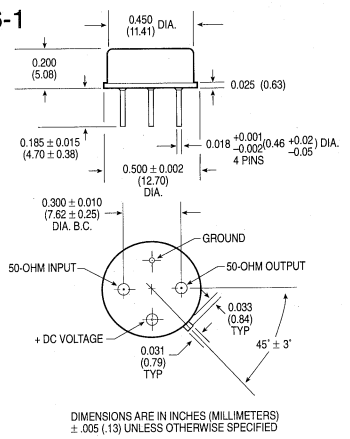
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Voltage ..... 10 Volts
Maximum Continuous RF Input Power ..... 6 dBm
Maximum Short Term RF Input Power (1 Minute Max.) ..... 40 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3µsec. Max.)
"S" Series Burn-In Temperature (Case) ..... 125°C

Weight: 2.0 Grams (0.07 oz.)

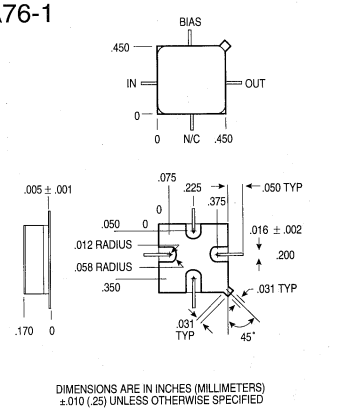
## Outline Drawings

A76-1



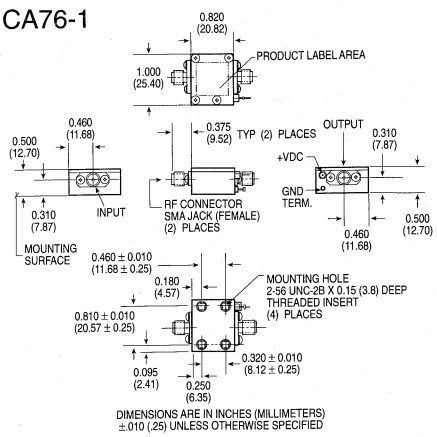

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA76-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

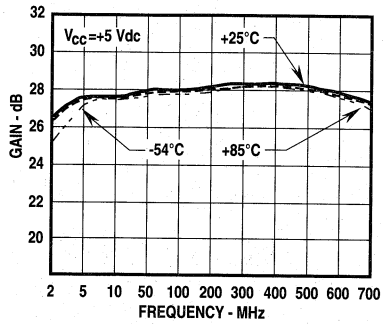
CA76-1



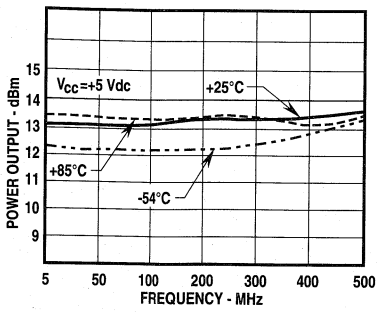

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

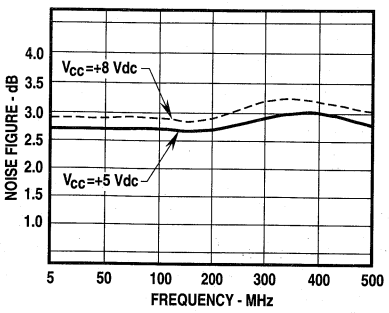
### Gain



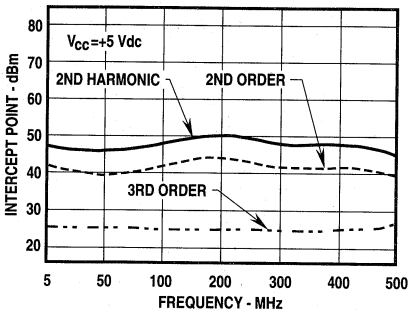

### Power Output (1 dB Compression)



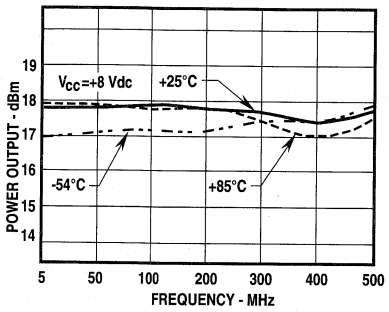

### Noise Figure



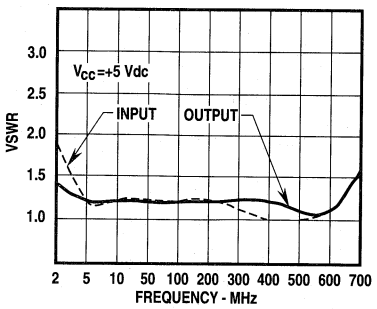

### Intercept Point




### Power Output (1 dB Compression)




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 5.7 | 4.0 | 23.9 |
| 2.0 | 2.3 | 1.4 | 27.5 |
| 5.0 | 1.2 | 1.2 | 28.9 |
| 10.0 | 1.1 | 1.2 | 29.1 |
| 50.0 | 1.1 | 1.2 | 29.2 |
| 100.0 | 1.1 | 1.2 | 29.3 |
| 200.0 | 1.1 | 1.2 | 29.4 |
| 300.0 | 1.1 | 1.2 | 29.6 |
| 400.0 | 1.1 | 1.2 | 29.5 |
| 500.0 | 1.2 | 1.1 | 29.2 |
| 600.0 | 1.1 | 1.1 | 28.8 |
| 700.0 | 1.2 | 1.4 | 28.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .703 | –47 | 15.658 | 143 | .006 | 67 | .597 | –83 |
| 2.0 | .397 | –86 | 23.648 | 75 | .005 | 70 | .178 | –96 |
| 5.0 | .090 | –82 | 27.841 | 29 | .010 | 33 | .075 | –30 |
| 10.0 | .047 | –52 | 28.531 | 12 | .011 | 17 | .082 | –11 |
| 50.0 | .038 | –3 | 28.866 | –13 | .012 | 2 | .093 | –12 |
| 100.0 | .047 | 5 | 29.114 | –31 | .012 | 2 | .092 | –22 |
| 200.0 | .043 | 1 | 29.579 | –64 | .012 | 1 | .095 | –40 |
| 300.0 | .031 | 20 | 30.030 | –99 | .013 | –2 | .097 | –58 |
| 400.0 | .054 | 37 | 29.890 | –134 | .014 | –8 | .090 | –78 |
| 500.0 | .074 | 14 | 28.818 | –171 | .017 | –15 | .063 | –90 |
| 600.0 | .063 | –42 | 27.564 | 151 | .020 | –24 | .046 | –31 |
| 700.0 | .111 | –144 | 25.807 | 111 | .023 | –43 | .172 | –16 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 4.9 | 4.3 | 20.9 |
| 2.0 | 1.9 | 1.4 | 26.6 |
| 5.0 | 1.2 | 1.2 | 27.6 |
| 10.0 | 1.2 | 1.2 | 27.7 |
| 50.0 | 1.2 | 1.2 | 28.0 |
| 100.0 | 1.2 | 1.2 | 28.1 |
| 200.0 | 1.2 | 1.2 | 28.2 |
| 300.0 | 1.1 | 1.2 | 28.4 |
| 400.0 | 1.0 | 1.2 | 28.4 |
| 500.0 | 1.0 | 1.1 | 28.3 |
| 600.0 | 1.1 | 1.1 | 27.9 |
| 700.0 | 1.6 | 1.6 | 27.4 |

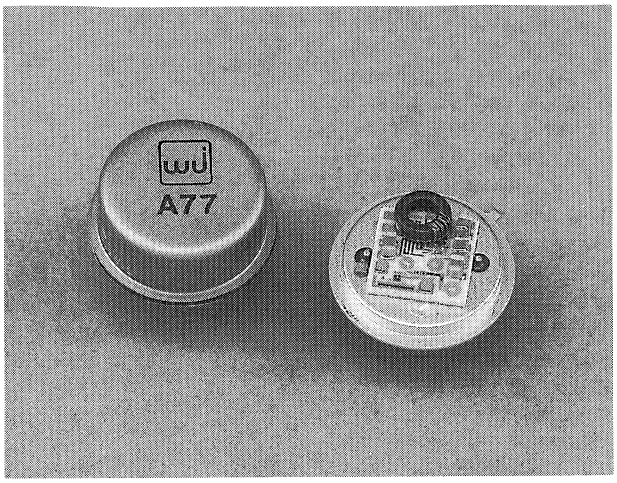
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .659 | –59 | 11.141 | 139 | .004 | 83 | .623 | –77 |
| 2.0 | .305 | –77 | 21.341 | 72 | .007 | 75 | .179 | –93 |
| 5.0 | .107 | –46 | 23.856 | 27 | .011 | 31 | .080 | –40 |
| 10.0 | .097 | –21 | 24.312 | 11 | .012 | 17 | .073 | –20 |
| 50.0 | .102 | –10 | 25.234 | –14 | .012 | 5 | .078 | –13 |
| 100.0 | .102 | –19 | 25.421 | –32 | .012 | 2 | .078 | –21 |
| 200.0 | .088 | –45 | 25.809 | –66 | .013 | 0 | .082 | –38 |
| 300.0 | .056 | –75 | 26.240 | –102 | .015 | –2 | .089 | –59 |
| 400.0 | .021 | –109 | 26.344 | –139 | .017 | –7 | .082 | 86 |
| 500.0 | .012 | –104 | 25.867 | –177 | .019 | –16 | .045 | –118 |
| 600.0 | .069 | –139 | 24.892 | 144 | .023 | –28 | .051 | 43 |
| 700.0 | .233 | 179 | 23.438 | 101 | .027 | –46 | .236 | 2 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.119 W
Junction Temperature Rise Above Case $T_{jc}$ ... 5.4°C

# WJ-A77 / SMA77




## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 16.5 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +16.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 16.5 dB | 16.0 dB | 15.0 dB |
| Gain Flatness (Max.) | < ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.0 dB | 6.0 dB | 6.5 dB |
| Power Output at 1 dB Compression (Min.) | +16.5 dBm | +15.0 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 50 mA | 53 mA | 56 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA77 is a standard WJ-A77 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+49 dBm (Typ.)
Second Order Two Tone Intercept Point.....+43 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

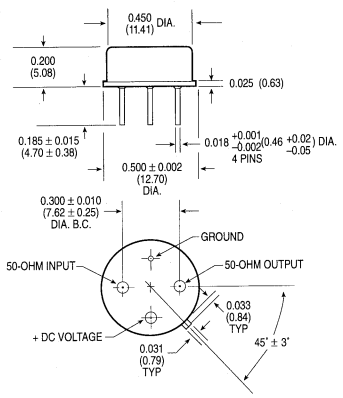
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

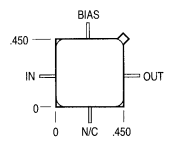
## Outline Drawings

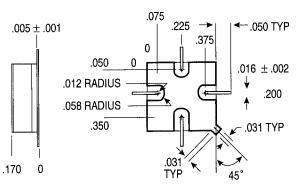
A77




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

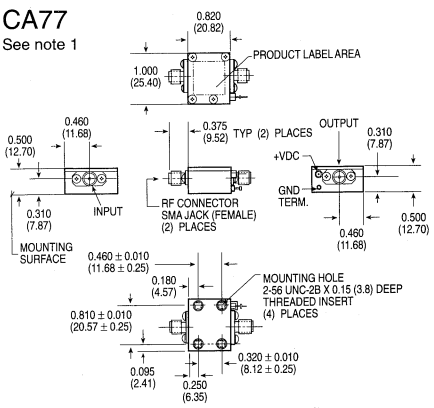
SMA77




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

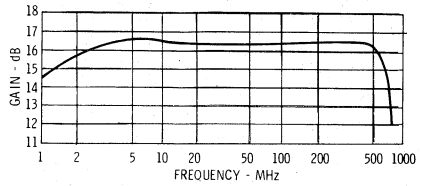
CA77
See note 1

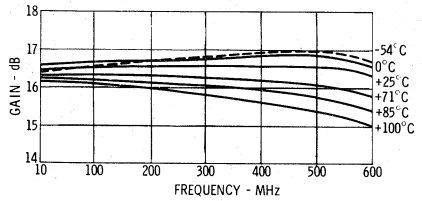



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

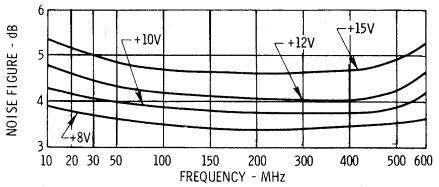
# Typical Performance at 25°C

## Gain

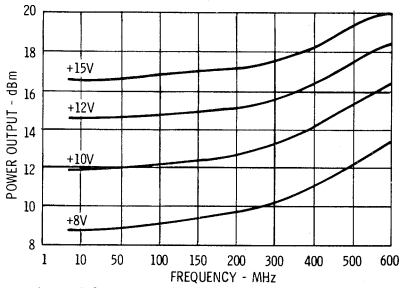



## Noise Figure

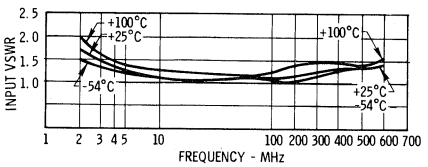


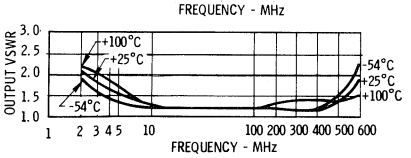

## Power Output*



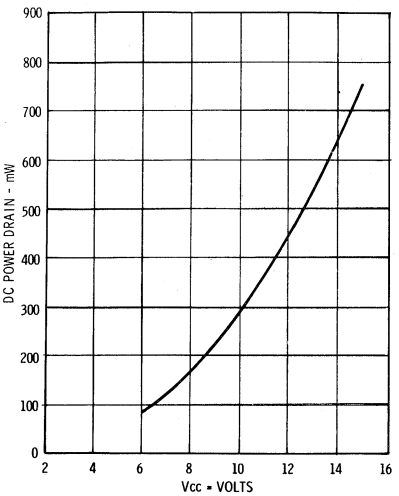

*at 1 dB Gain Compression

## VSWR




## DC Power Drain vs. Supply Voltage




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 2.1 | 13.2 |
| 2.0 | 1.6 | 1.5 | 16.7 |
| 5.0 | 1.3 | 1.2 | 17.0 |
| 10.0 | 1.3 | 1.2 | 17.1 |
| 50.0 | 1.2 | 1.2 | 17.2 |
| 100.0 | 1.2 | 1.2 | 17.1 |
| 200.0 | 1.2 | 1.3 | 17.1 |
| 300.0 | 1.2 | 1.3 | 17.1 |
| 400.0 | 1.2 | 1.3 | 17.2 |
| 500.0 | 1.3 | 1.3 | 17.1 |
| 600.0 | 1.9 | 1.6 | 16.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .336 | –14 | 4.556 | –152 | .058 | 27 | .358 | –154 |
| 2.0 | .218 | –44 | 6.803 | –158 | .083 | 24 | .204 | 113 |
| 5.0 | .125 | –27 | 7.108 | –173 | .089 | 8 | .097 | 52 |
| 10.0 | .114 | –18 | 7.139 | –178 | .090 | 4 | .087 | 27 |
| 50.0 | .099 | –3 | 7.226 | 169 | .092 | –1 | .098 | –18 |
| 100.0 | .106 | –6 | 7.148 | 156 | .093 | –5 | .103 | –48 |
| 200.0 | .107 | –24 | 7.135 | 132 | .096 | –11 | .120 | –97 |
| 300.0 | .098 | –49 | 7.123 | 108 | .104 | –18 | .130 | –140 |
| 400.0 | .098 | –101 | 7.232 | 82 | .114 | –27 | .132 | 172 |
| 500.0 | .145 | 178 | 7.187 | 54 | .128 | –40 | .135 | 102 |
| 600.0 | .316 | 120 | 6.856 | 23 | .140 | –58 | .234 | 24 |

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.1 | 12.3 |
| 2.0 | 1.7 | 1.6 | 16.0 |
| 5.0 | 1.4 | 1.3 | 15.5 |
| 10.0 | 1.4 | 1.3 | 16.5 |
| 50.0 | 1.3 | 1.3 | 16.6 |
| 100.0 | 1.3 | 1.3 | 16.6 |
| 200.0 | 1.3 | 1.4 | 16.5 |
| 300.0 | 1.3 | 1.5 | 16.6 |
| 400.0 | 1.3 | 1.5 | 16.8 |
| 500.0 | 1.6 | 1.6 | 16.8 |
| 600.0 | 2.5 | 1.9 | 16.3 |

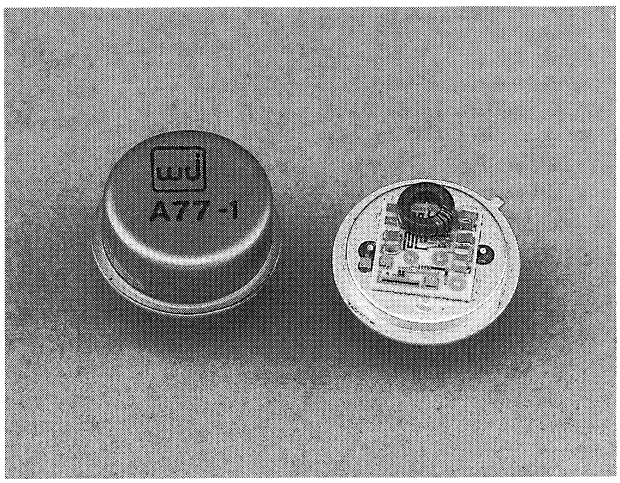
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .359 | –16 | 4.125 | –153 | .059 | 25 | .345 | –151 |
| 2.0 | .256 | –37 | 6.327 | –156 | .087 | 25 | .230 | 105 |
| 5.0 | .164 | –20 | 6.658 | –173 | .093 | 9 | .134 | 39 |
| 10.0 | .154 | –13 | 6.683 | –178 | .094 | 4 | .127 | 18 |
| 50.0 | .143 | –9 | 6.770 | 169 | .096 | –1 | .141 | –20 |
| 100.0 | .142 | –15 | 6.730 | 156 | .097 | –4 | .149 | –50 |
| 200.0 | .134 | –43 | 6.711 | 132 | .103 | –9 | .172 | –98 |
| 300.0 | .130 | –74 | 6.777 | 107 | .113 | –16 | .194 | –143 |
| 400.0 | .139 | –126 | 6.938 | 80 | .129 | –26 | .210 | 169 |
| 500.0 | .230 | 168 | 6.912 | 51 | .147 | –40 | .227 | 106 |
| 600.0 | .428 | 115 | 6.494 | 17 | .159 | –61 | .322 | 33 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.447 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-A77-1 / SMA77-1




## 5 to 600 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +16.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)
- ◆ EXTENDED BANDWIDTH: 5-600 MHz
- ◆ WIDE POWER SUPPLY RANGE: +8 TO +15 VOLTS

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85° C |
|---|---|---|---|
| Frequency (Min.) | 2-700 MHz | 5-600 MHz | 5-600 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 15.0 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.0 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +16.5 dBm | +15.0 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 50 mA | 53 mA | 56 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA77-1 is a standard WJ-A77-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+49 dBm (Typ.)
Second Order Two Tone Intercept Point.....+43 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

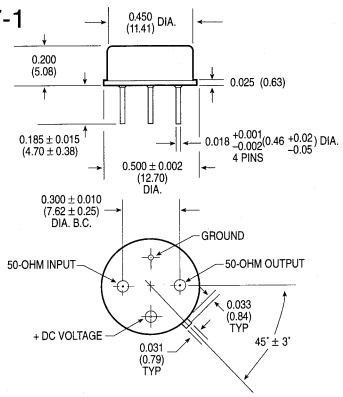
## Absolute Maximum Ratings

Storage Temperature .....-62°C to + 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

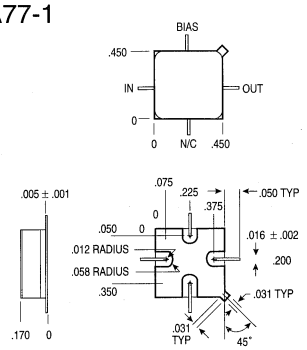
## Outline Drawings

A77-1



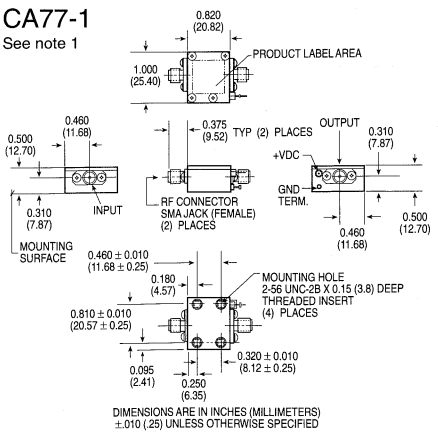

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA77-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

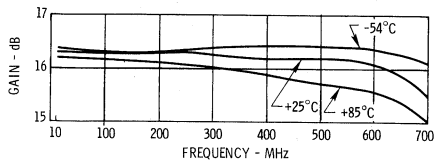
CA77-1
See note 1



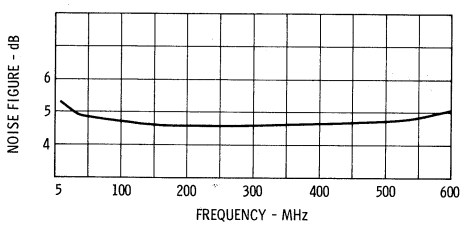

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

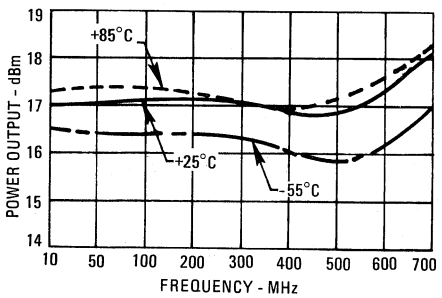
### Gain




### Noise Figure

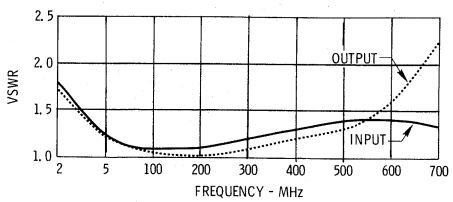



### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 2.4 | 12.4 |
| 2.0 | 1.5 | 1.6 | 15.8 |
| 5.0 | 1.2 | 1.2 | 16.3 |
| 10.0 | 1.1 | 1.1 | 16.3 |
| 50.0 | 1.1 | 1.0 | 16.4 |
| 100.0 | 1.1 | 1.1 | 16.3 |
| 200.0 | 1.2 | 1.1 | 16.3 |
| 300.0 | 1.2 | 1.2 | 16.3 |
| 400.0 | 1.2 | 1.2 | 16.3 |
| 500.0 | 1.3 | 1.1 | 16.3 |
| 600.0 | 1.4 | 1.1 | 16.4 |
| 700.0 | 1.9 | 1.6 | 15.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .185 | –37 | 4.158 | –153 | .061 | 26 | .413 | –148 |
| 2.0 | .199 | –83 | 6.137 | –156 | .086 | 26 | .243 | 141 |
| 5.0 | .079 | –123 | 6.524 | –173 | .093 | 9 | .076 | 125 |
| 10.0 | .059 | –148 | 6.550 | –178 | .094 | 4 | .045 | 131 |
| 50.0 | .056 | 151 | 6.614 | 169 | .095 | –2 | .015 | –166 |
| 100.0 | .061 | 110 | 6.560 | 156 | .097 | –7 | .031 | –130 |
| 200.0 | .079 | 53 | 6.520 | 131 | .100 | –15 | .062 | –134 |
| 300.0 | .092 | 4 | 6.497 | 107 | .104 | –23 | .084 | –148 |
| 400.0 | .103 | –47 | 6.560 | 82 | .112 | –33 | .093 | –166 |
| 500.0 | .114 | –114 | 6.551 | 55 | .123 | –45 | .065 | 165 |
| 600.0 | .150 | 164 | 6.575 | 24 | .136 | –60 | .044 | 23 |
| 700.0 | .310 | 88 | 6.256 | –9 | .143 | –82 | .227 | –39 |

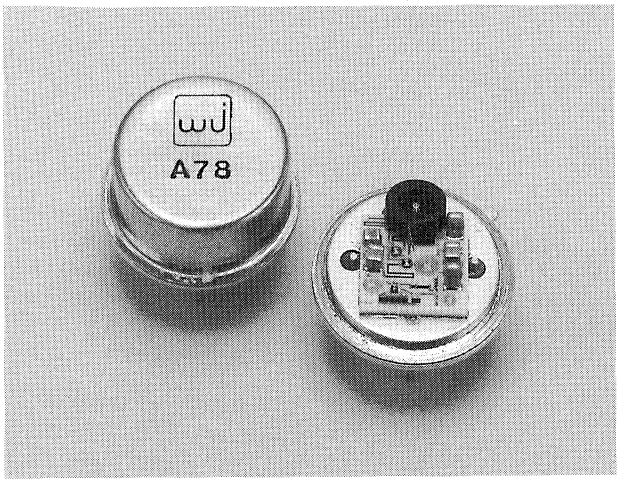
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.442 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-A78 / SMA78

## 5 to 300 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE: +114 dB/1 MHz
- ◆ HIGH OUTPUT: +19.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER IP: +33 dBm (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-350 MHz | 5-300 MHz | 5-300 MHz |
| Small Signal Gain (Min.) | 14.0 dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +19.5 dBm | +18.0 dBm | +17.5 dBm |
| VSWR (Max.) Input/Output | <1.7:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 65 mA | 69 mA | 72 mA |

* Measured In a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA78 is a standard WJ-A78 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+33 dBm (Typ.)

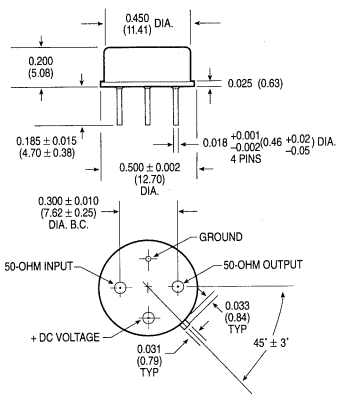
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....100 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

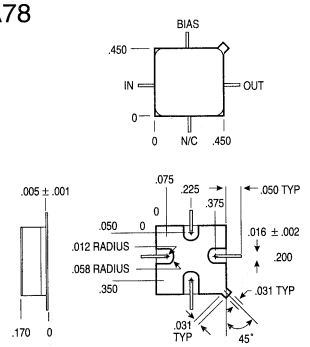
## Outline Drawings

A78



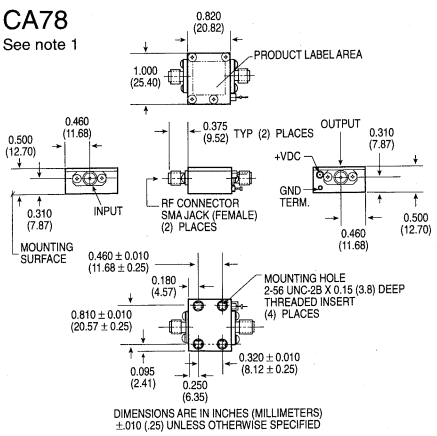

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA78




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

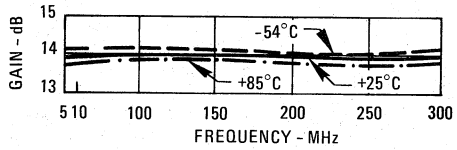
CA78
See note 1



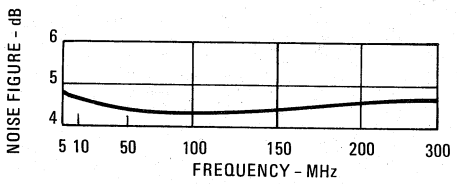

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

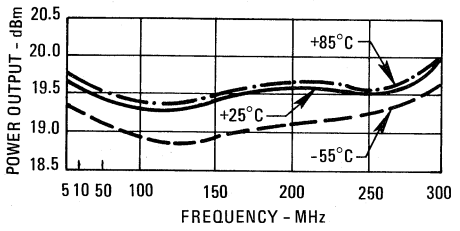
### Gain




### Noise Figure

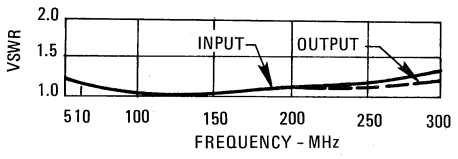



### Power Output*

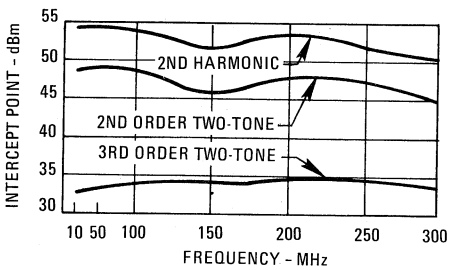



* at 1 dB Gain Compression

### VSWR




### Intercept Point




### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.9 | 2.1 | 12.1 |
| 2.0 | 1.4 | 1.5 | 13.3 |
| 5.0 | 1.2 | 1.2 | 13.3 |
| 10.0 | 1.1 | 1.2 | 13.3 |
| 50.0 | 1.2 | 1.2 | 13.2 |
| 100.0 | 1.3 | 1.2 | 13.1 |
| 150.0 | 1.5 | 1.2 | 13.0 |
| 200.0 | 1.7 | 1.2 | 12.8 |
| 250.0 | 1.9 | 1.3 | 12.6 |
| 300.0 | 2.2 | 1.3 | 12.3 |
| 350.0 | 2.5 | 1.4 | 12.0 |
| 400.0 | 2.8 | 1.4 | 11.7 |

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.2 | 12.6 |
| 2.0 | 1.5 | 1.5 | 13.9 |
| 5.0 | 1.2 | 1.2 | 13.9 |
| 10.0 | 1.1 | 1.1 | 13.9 |
| 50.0 | 1.1 | 1.0 | 13.9 |
| 100.0 | 1.2 | 1.0 | 13.9 |
| 150.0 | 1.2 | 1.1 | 13.9 |
| 200.0 | 1.3 | 1.1 | 13.9 |
| 250.0 | 1.4 | 1.1 | 13.8 |
| 300.0 | 1.5 | 1.2 | 13.9 |
| 350.0 | 1.7 | 1.2 | 13.8 |
| 400.0 | 1.8 | 1.3 | 13.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .353 | –60 | 4.264 | –151 | .085 | 15 | .383 | 154 |
| 2.0 | .187 | –87 | 4.967 | –166 | .114 | 14 | .207 | 108 |
| 5.0 | .081 | –112 | 4.957 | –176 | .121 | 6 | .076 | 85 |
| 10.0 | .060 | –129 | 4.979 | –179 | .123 | 3 | .042 | 67 |
| 50.0 | .052 | –145 | 4.983 | 171 | .125 | 1 | .023 | –10 |
| 100.0 | .071 | –137 | 4.942 | 162 | .126 | 0 | .023 | –62 |
| 150.0 | .096 | –130 | 4.931 | 153 | .128 | 0 | .028 | –107 |
| 200.0 | .135 | –136 | 4.956 | 143 | .132 | 0 | .038 | –144 |
| 250.0 | .173 | –138 | 4.924 | 134 | .136 | –1 | .056 | –173 |
| 300.0 | .211 | –144 | 4.938 | 125 | .143 | –2 | .075 | 162 |
| 350.0 | .255 | –151 | 4.911 | 115 | .148 | –5 | .098 | 143 |
| 400.0 | .296 | –157 | 4.913 | 105 | .155 | –6 | .122 | 125 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.2 | 12.6 |
| 2.0 | 1.5 | 1.5 | 13.9 |
| 5.0 | 1.2 | 1.2 | 13.8 |
| 10.0 | 1.1 | 1.1 | 13.8 |
| 50.0 | 1.1 | 1.1 | 13.9 |
| 100.0 | 1.2 | 1.1 | 13.8 |
| 150.0 | 1.2 | 1.1 | 13.8 |
| 200.0 | 1.4 | 1.1 | 13.8 |
| 250.0 | 1.5 | 1.1 | 13.7 |
| 300.0 | 1.6 | 1.2 | 13.7 |
| 350.0 | 1.8 | 1.3 | 13.6 |
| 400.0 | 2.0 | 1.3 | 13.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .346 | –59 | 4.275 | –151 | .086 | 15 | .373 | 151 |
| 2.0 | .185 | –86 | 4.931 | –166 | .114 | 14 | .202 | 104 |
| 5.0 | .082 | –109 | 4.900 | –176 | .122 | 6 | .077 | 76 |
| 10.0 | .058 | –123 | 4.917 | –179 | .123 | 3 | .047 | 53 |
| 50.0 | .056 | –138 | 4.940 | 171 | .125 | 1 | .035 | –16 |
| 100.0 | .076 | –131 | 4.883 | 161 | .126 | 1 | .036 | –60 |
| 150.0 | .106 | –127 | 4.890 | 151 | .129 | 1 | .042 | –100 |
| 200.0 | .155 | –134 | 4.884 | 142 | .133 | 0 | .052 | –134 |
| 250.0 | .198 | –139 | 4.825 | 132 | .138 | –1 | .069 | –164 |
| 300.0 | .238 | –145 | 4.819 | 122 | .145 | –1 | .089 | 171 |
| 350.0 | .288 | –153 | 4.793 | 112 | .151 | –4 | .114 | 150 |
| 400.0 | .327 | –160 | 4.782 | 102 | .159 | –6 | .138 | 131 |

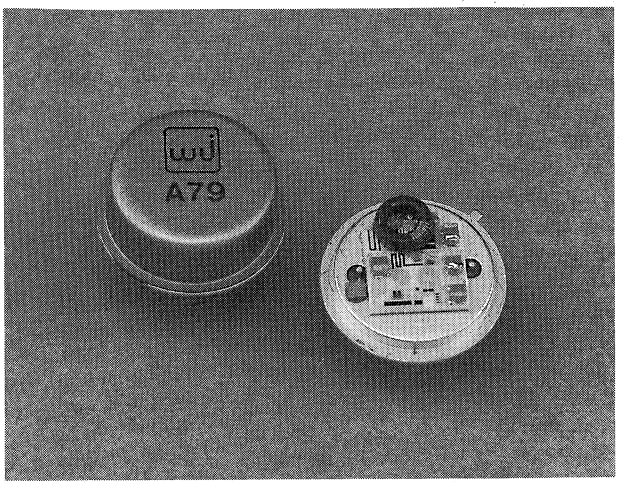
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .320 | –59 | 4.049 | –151 | .090 | 17 | .346 | 144 |
| 2.0 | .181 | –77 | 4.634 | –167 | .119 | 14 | .197 | 89 |
| 5.0 | .077 | –82 | 4.600 | –176 | .126 | 6 | .098 | 48 |
| 10.0 | .049 | –87 | 4.604 | –180 | .127 | 3 | .082 | 24 |
| 50.0 | .076 | –102 | 4.578 | 169 | .129 | 2 | .083 | –22 |
| 100.0 | .128 | –112 | 4.526 | 156 | .132 | 2 | .084 | –57 |
| 150.0 | .191 | –121 | 4.456 | 145 | .137 | 2 | .089 | –91 |
| 200.0 | .262 | –133 | 4.380 | 133 | .145 | 2 | .097 | –123 |
| 250.0 | .320 | –144 | 4.250 | 122 | .151 | 0 | .111 | –153 |
| 300.0 | .374 | –155 | 4.141 | 110 | .161 | –1 | .129 | 179 |
| 350.0 | .434 | –165 | 3.983 | 98 | .167 | –5 | .151 | 155 |
| 400.0 | .473 | –175 | 3.864 | 87 | .177 | –7 | .172 | 134 |

# Thermal Data: $V_{CC}$ =15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.637 W
Junction Temperature Rise Above Case $T_{jc}$ ... 29°C

# WJ-A79 / SMA79




## 5 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH DYNAMIC RANGE: +114 dB/1 MHz
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +36 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-300 MHz | 5-250 MHz | 5-250 MHz |
| Small Signal Gain (Min.) | 13.5 dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | < ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.2 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +22.0 dBm | +20.0 dBm | +19.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 88 mA | 93 mA | 98 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA79 is a standard WJ-A79 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+56 dBm (Typ.)
Second Order Two Tone Intercept Point.....+52 dBm (Typ.)
Third Order Two Tone Intercept Point.....+36 dBm (Typ.)

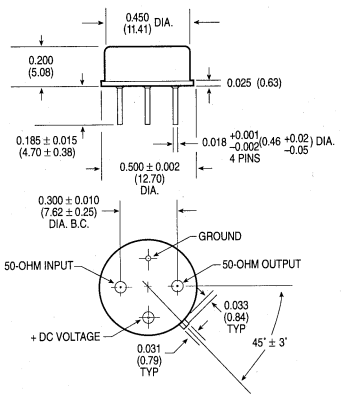
## Absolute Maximum Ratings

Storage Temperature .....-62°C to+125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

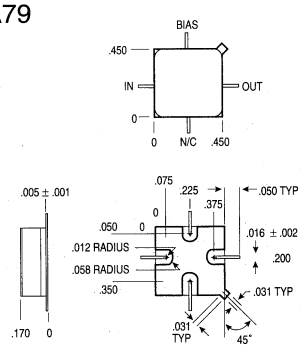
## Outline Drawings

A79



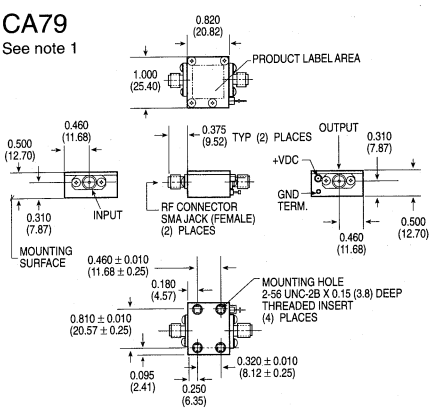

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA79




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

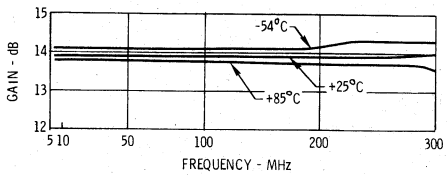
CA79
See note 1



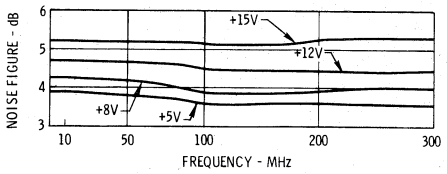

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

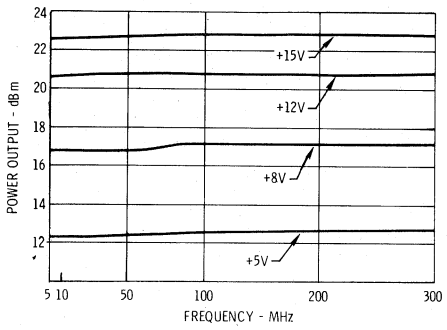
## Gain




## Noise Figure

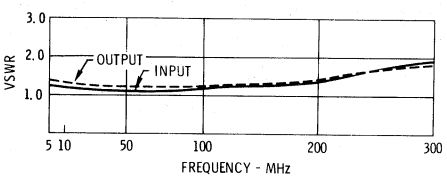



## Power Output*

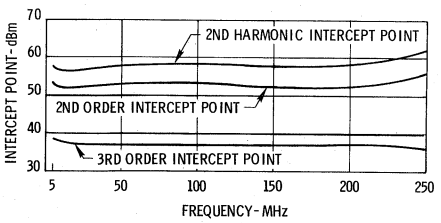



*at 1 dB Gain Compression

## VSWR




## Third-Order Intercept Point




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.2 | 2.5 | 12.2 |
| 2.0 | 1.6 | 1.7 | 13.9 |
| 5.0 | 1.2 | 1.2 | 14.0 |
| 10.0 | 1.1 | 1.1 | 14.0 |
| 50.0 | 1.1 | 1.1 | 14.0 |
| 100.0 | 1.2 | 1.1 | 13.9 |
| 150.0 | 1.2 | 1.1 | 13.9 |
| 200.0 | 1.4 | 1.1 | 13.9 |
| 250.0 | 1.5 | 1.1 | 13.8 |
| 300.0 | 1.6 | 1.1 | 13.8 |
| 350.0 | 1.8 | 1.1 | 13.7 |
| 400.0 | 1.9 | 1.1 | 13.6 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .382 | –60 | 4.086 | –145 | .075 | 16 | .428 | 158 |
| 2.0 | .220 | –83 | 4.978 | –162 | .105 | 17 | .261 | 107 |
| 5.0 | .095 | –107 | 5.018 | –174 | .116 | 7 | .104 | 69 |
| 10.0 | .063 | –123 | 4.993 | –179 | .118 | 4 | .069 | 45 |
| 50.0 | .054 | –142 | 5.025 | 171 | .119 | 1 | .056 | –4 |
| 100.0 | .078 | –130 | 4.978 | 161 | .121 | 1 | .051 | –29 |
| 150.0 | .110 | –129 | 4.974 | 151 | .124 | 1 | .044 | –54 |
| 200.0 | .154 | –132 | 4.974 | 141 | .128 | 0 | .035 | –82 |
| 250.0 | .196 | –139 | 4.923 | 132 | .131 | 0 | .029 | –126 |
| 300.0 | .239 | –144 | 4.890 | 122 | .137 | –1 | .032 | –178 |
| 350.0 | .278 | –152 | 4.834 | 112 | .142 | –3 | .047 | 145 |
| 400.0 | .322 | –160 | 4.799 | 101 | .149 | –5 | .065 | 120 |

## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.4 | 12.4 |
| 2.0 | 1.5 | 1.7 | 13.9 |
| 5.0 | 1.2 | 1.2 | 13.9 |
| 10.0 | 1.1 | 1.2 | 13.9 |
| 50.0 | 1.1 | 1.1 | 14.0 |
| 100.0 | 1.2 | 1.1 | 13.9 |
| 150.0 | 1.3 | 1.1 | 13.8 |
| 200.0 | 1.4 | 1.1 | 13.8 |
| 250.0 | 1.5 | 1.1 | 13.7 |
| 300.0 | 1.7 | 1.1 | 13.6 |
| 350.0 | 1.9 | 1.2 | 13.5 |
| 400.0 | 2.1 | 1.2 | 13.4 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .347 | –61 | 4.162 | –146 | .076 | 17 | .416 | 155 |
| 2.0 | .214 | –85 | 4.947 | –163 | .106 | 17 | .248 | 103 |
| 5.0 | .092 | –109 | 4.964 | –175 | .116 | 7 | .105 | 62 |
| 10.0 | .061 | –125 | 4.960 | –179 | .117 | 4 | .075 | 37 |
| 50.0 | .060 | –138 | 4.990 | 171 | .120 | 1 | .067 | –10 |
| 100.0 | .083 | –131 | 4.939 | 160 | .121 | 1 | .063 | –37 |
| 150.0 | .121 | –129 | 4.910 | 150 | .124 | 2 | .058 | –66 |
| 200.0 | .170 | –134 | 4.911 | 140 | .129 | 2 | .053 | –96 |
| 250.0 | .212 | –139 | 4.846 | 130 | .133 | 1 | .053 | –133 |
| 300.0 | .260 | –147 | 4.804 | 120 | .140 | 0 | .058 | –170 |
| 350.0 | .308 | –155 | 4.739 | 110 | .146 | –2 | .073 | 159 |
| 400.0 | .352 | –162 | 4.684 | 99 | .154 | –4 | .091 | 134 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.827 W
Junction Temperature Rise Above Case $T_{jc}$ ... 37°C

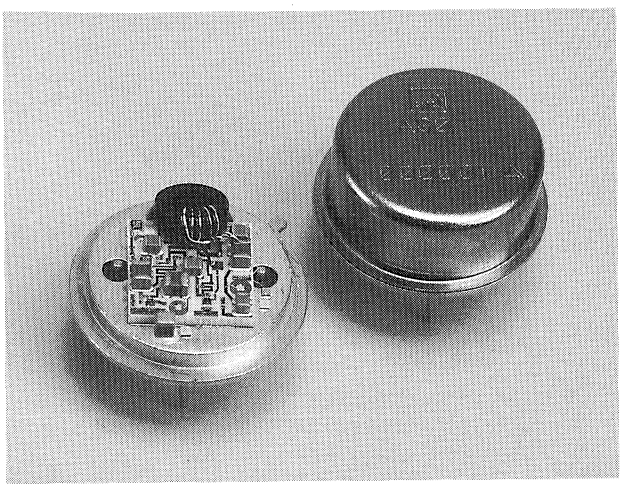
## $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.3 | 12.2 |
| 2.0 | 1.5 | 1.6 | 13.4 |
| 5.0 | 1.2 | 1.3 | 13.4 |
| 10.0 | 1.1 | 1.2 | 13.4 |
| 50.0 | 1.2 | 1.2 | 13.4 |
| 100.0 | 1.3 | 1.2 | 13.3 |
| 150.0 | 1.5 | 1.2 | 13.1 |
| 200.0 | 1.7 | 1.2 | 13.0 |
| 250.0 | 2.0 | 1.2 | 12.6 |
| 300.0 | 2.2 | 1.3 | 12.4 |
| 350.0 | 2.5 | 1.3 | 12.0 |
| 400.0 | 2.8 | 1.4 | 11.6 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .359 | –62 | 4.057 | –147 | .079 | 20 | .388 | 146 |
| 2.0 | .198 | –81 | 4.700 | –164 | .110 | 16 | .238 | 90 |
| 5.0 | .084 | –95 | 4.700 | –175 | .118 | 7 | .125 | 44 |
| 10.0 | .054 | –104 | 4.699 | –179 | .120 | 4 | .106 | 22 |
| 50.0 | .078 | –110 | 4.692 | 168 | .122 | 3 | .106 | –20 |
| 100.0 | .133 | –119 | 4.622 | 156 | .126 | 3 | .103 | –51 |
| 150.0 | .196 | –125 | 4.543 | 144 | .131 | 4 | .103 | –81 |
| 200.0 | .271 | –137 | 4.448 | 132 | .139 | 4 | .104 | –112 |
| 250.0 | .328 | –147 | 4.273 | 120 | .145 | 2 | .110 | –143 |
| 300.0 | .383 | –158 | 4.158 | 109 | .155 | 1 | .119 | –172 |
| 350.0 | .436 | –167 | 3.969 | 97 | .162 | –2 | .136 | 162 |
| 400.0 | .480 | –178 | 3.821 | 85 | .171 | –5 | .152 | 138 |

# WJ-A80/SMA80



## 20 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: 39 dB (TYP.)
- ◆ VERY LOW NOISE: 2.3 dB (TYP.)
- ◆ HIGH GAIN: 29 dB (TYP.)
- ◆ MEDIUM LEVEL OUTPUT: +14.3 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-550 MHz | 20-500 MHz | 20-500 MHz |
| Small Signal Gain (Min.) | 29.0 dB | 27.5 dB | 26.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.3 dB | 3.0 dB | 3.4 dB |
| Power Output at 1 dB Compression (Min.) | +14.3 dBm | +13.0 dBm | +12.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.4:1 | 1.8:1 | 2.0:1 |
| Output | 1.8:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 45 mA | 49 mA | 52 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
WJ-CA80 is a standard WJ-A80 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+40 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+33 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+27 dBm (Typ.)

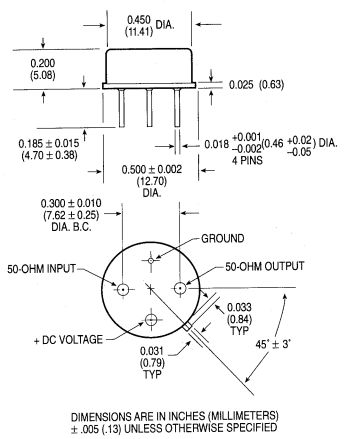
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short-Term RF Input Power (1 Minute Max.) .....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight: 2.0 Grams (0.07 oz.)

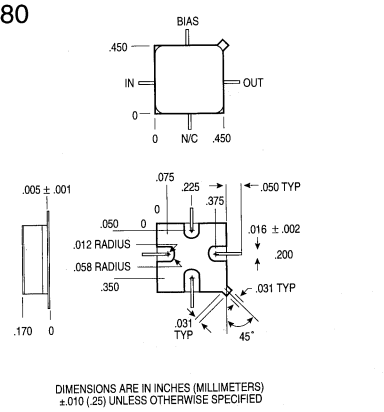
## Outline Drawings

A80



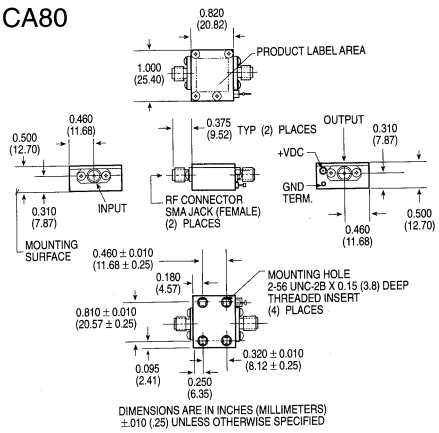

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA80




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

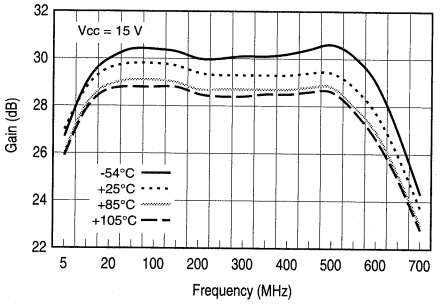
CA80



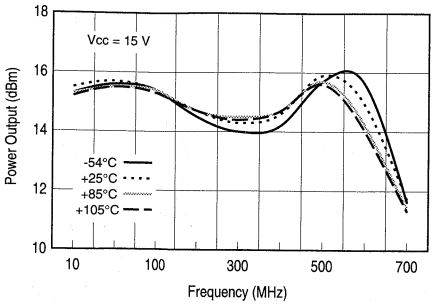

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

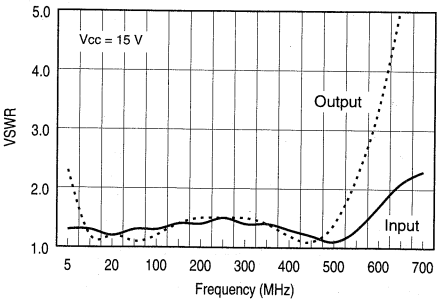
## Gain



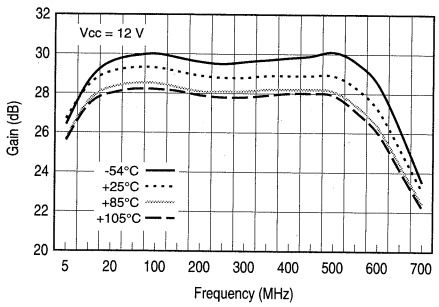

## Power Output (1 dB Gain Compression)



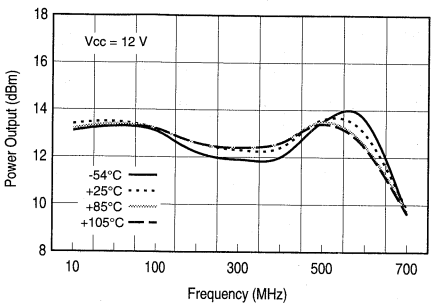

## VSWR



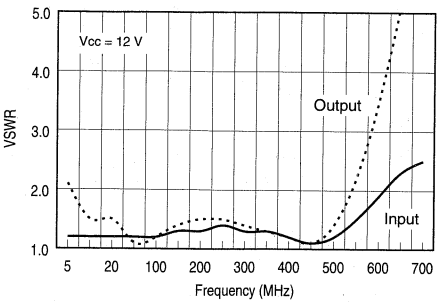

## Gain



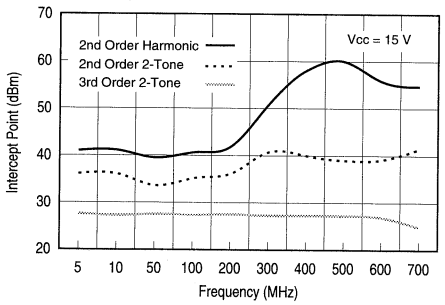

## Power Output (1 dB Gain Compression)



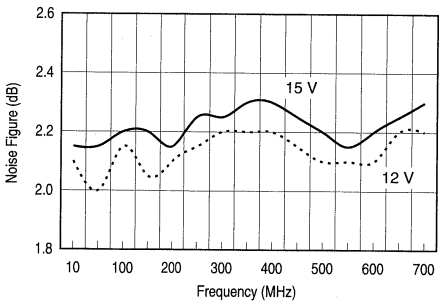

## VSWR



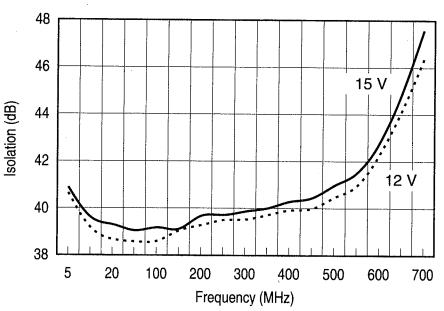

## Intercept Point



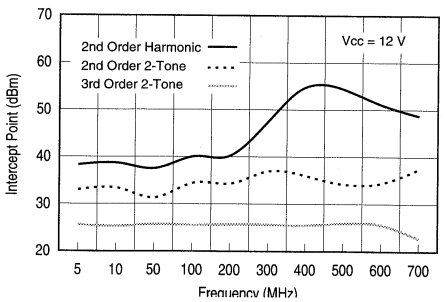

## Noise Figure




## Reverse Isolation




## Intercept Point



# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.3 | 2.3 | 27.0 |
| 10.0 | 1.3 | 1.5 | 28.8 |
| 20.0 | 1.2 | 1.2 | 29.6 |
| 50.0 | 1.3 | 1.1 | 29.8 |
| 100.0 | 1.3 | 1.2 | 29.8 |
| 200.0 | 1.4 | 1.5 | 29.4 |
| 300.0 | 1.4 | 1.5 | 29.3 |
| 400.0 | 1.3 | 1.2 | 29.3 |
| 500.0 | 1.1 | 1.4 | 29.4 |
| 600.0 | 1.7 | 3.4 | 27.7 |
| 700.0 | 2.3 | 7.3 | 23.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .115 | −129 | 22.41 | 49 | .01 | 1 | .388 | 142 |
| 10.0 | .114 | −149 | 27.49 | 24 | .01 | −7 | .199 | 125 |
| 20.0 | .109 | −161 | 30.22 | 6 | .01 | −5 | 110 | 64 |
| 50.0 | .112 | −164 | 30.96 | −16 | .01 | −14 | .055 | 165 |
| 100.0 | .135 | −163 | 30.80 | −41 | .01 | −21 | .108 | −103 |
| 200.0 | .176 | −175 | 29.51 | −88 | .01 | −37 | .195 | −139 |
| 300.0 | .180 | 161 | 29.03 | −132 | .01 | −54 | .187 | −166 |
| 400.0 | .146 | 121 | 29.21 | −179 | .01 | −77 | .083 | 164 |
| 500.0 | .068 | 4 | 29.35 | 126 | .01 | −115 | .083 | −28 |
| 600.0 | .260 | −100 | 24.15 | 62 | .01 | −166 | .548 | −73 |
| 700.0 | .391 | −150 | 15.29 | 3 | .01 | 133 | .758 | −110 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.2 | 2.1 | 26.7 |
| 10.0 | 1.2 | 1.5 | 28.4 |
| 20.0 | 1.2 | 1.5 | 29.1 |
| 50.0 | 1.2 | 1.1 | 29.3 |
| 100.0 | 1.2 | 1.2 | 29.3 |
| 200.0 | 1.3 | 1.5 | 28.9 |
| 300.0 | 1.3 | 1.4 | 28.8 |
| 400.0 | 1.2 | 1.2 | 28.9 |
| 500.0 | 1.2 | 1.4 | 28.9 |
| 600.0 | 1.9 | 3.5 | 27.2 |
| 700.0 | 2.5 | 7.3 | 23.1 |

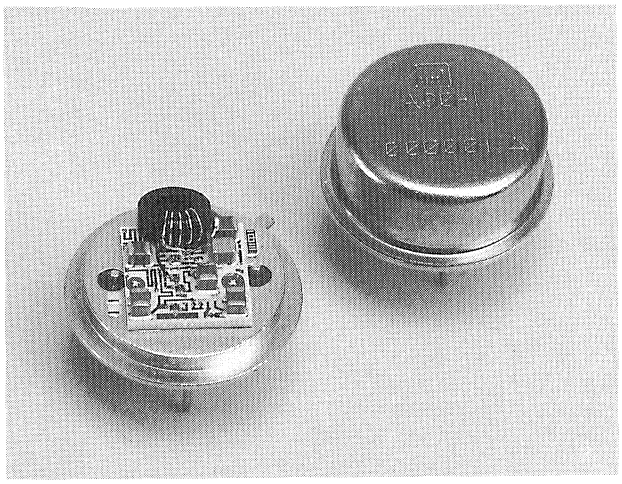
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .087 | −125 | 21.65 | 48 | .01 | 1 | .357 | 141 |
| 10.0 | .078 | −141 | 26.26 | 23 | .01 | −5 | .199 | 123 |
| 20.0 | .070 | −157 | 28.57 | 6 | .01 | −3 | .188 | 112 |
| 50.0 | .075 | −155 | 29.02 | −16 | .01 | −15 | .051 | 143 |
| 100.0 | .101 | −152 | 29.07 | −42 | .01 | −23 | .102 | −113 |
| 200.0 | .143 | −165 | 27.86 | −88 | .01 | −38 | .184 | −140 |
| 300.0 | .146 | 168 | 27.42 | −133 | .01 | −56 | .181 | −165 |
| 400.0 | .106 | 123 | 27.93 | 179 | .01 | −84 | .079 | 165 |
| 500.0 | .084 | −25 | 27.74 | 124 | .01 | −118 | .181 | −29 |
| 600.0 | .303 | −100 | 22.82 | 60 | .01 | −170 | .555 | −73 |
| 700.0 | .423 | −147 | 14.28 | 1 | .01 | 128 | .760 | −110 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.270 W
Junction Temperature Rise Above Case $T_{jc}$ ... 12.2°C

# WJ-A80-1/SMA80-1



## 10 to 200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: >32 dB (TYP.)
- ◆ VERY LOW NOISE: 2.0 dB (TYP.)
- ◆ HIGH GAIN: 27.3 dB (TYP.)
- ◆ HIGH EFFICIENCY: 29 mA at 15 VOLTS (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-200 MHz | 10-200 MHz | 10-200 MHz |
| Small Signal Gain (Min.) | 27.3 dB | 26.0 dB | 25.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.0 dB | 2.5 dB | 3.0 dB |
| Power Output at 1 dB Compression (Min.) | +16.0 dBm | +14.5 dBm | +14.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 1.8:1 | 2.0:1 |
| Output | 1.8:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at 15 Volts | 30 mA | 32 mA | 34 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
WJ-CA80-1 is a standard WJ-A80-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+39 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+33 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+28 dBm (Typ.)

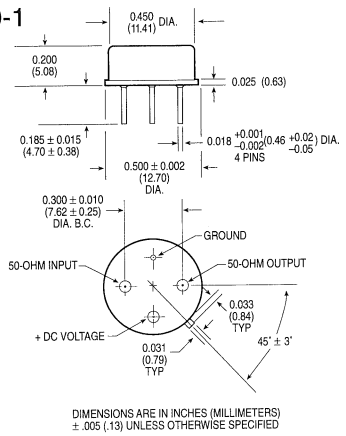
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short-Term RF Input Power (1 Minute Max.) .....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight: 2.0 Grams (0.07 oz.)

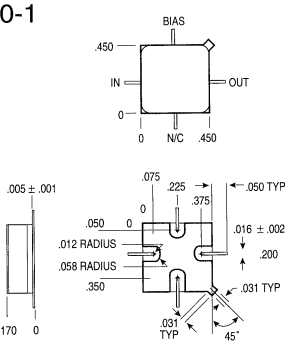
## Outline Drawings

A80-1



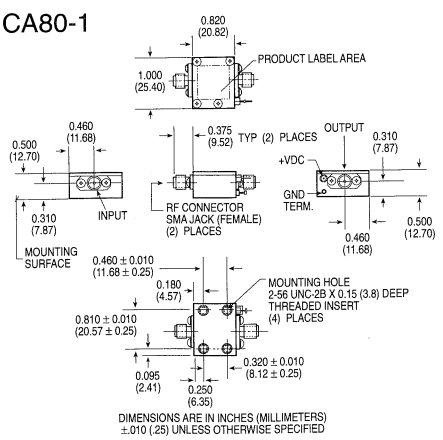

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA80-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

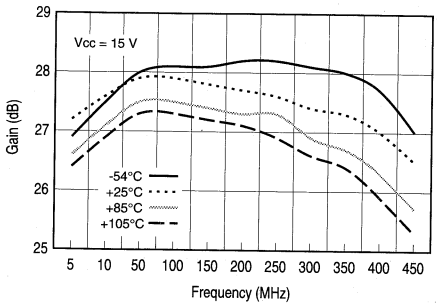
CA80-1



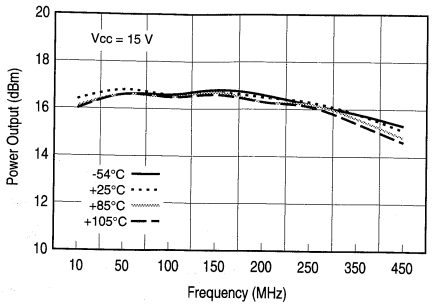

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

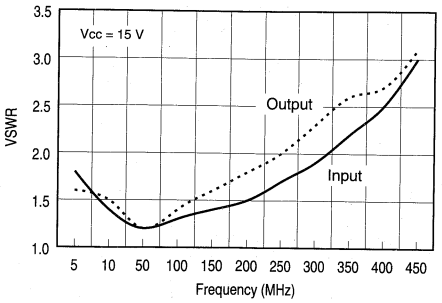
## Gain



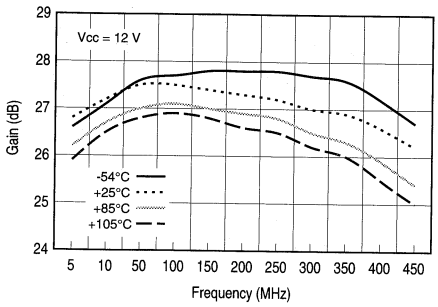

## Power Output (1 dB Gain Compression)



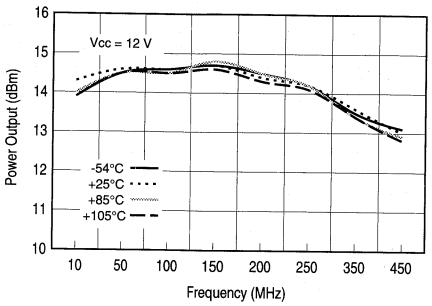

## VSWR



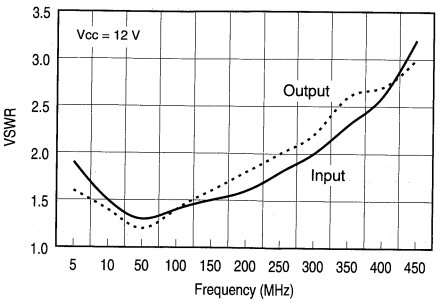

## Gain



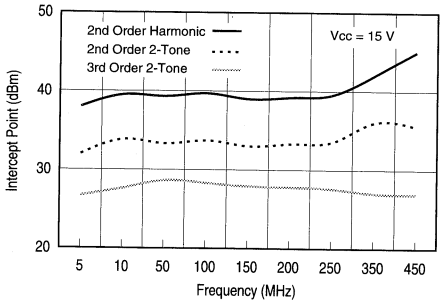

## Power Output (1 dB Gain Compression)



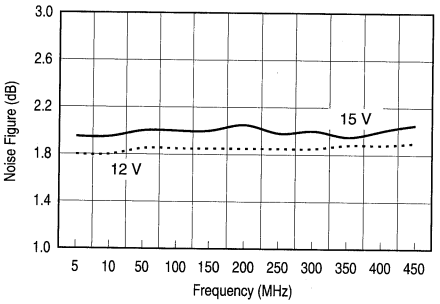

## VSWR



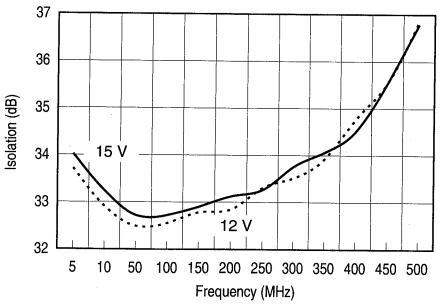

## Intercept Point



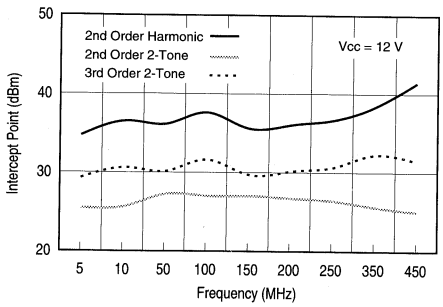

## Noise Figure




## Reverse Isolation




## Intercept Point



# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.8 | 1.6 | 27.2 |
| 10.0 | 1.4 | 1.5 | 27.6 |
| 50.0 | 1.2 | 1.2 | 27.9 |
| 100.0 | 1.3 | 1.4 | 27.9 |
| 200.0 | 1.5 | 1.8 | 27.7 |
| 300.0 | 1.9 | 2.3 | 27.4 |
| 400.0 | 2.5 | 2.7 | 27.0 |
| 500.0 | 3.2 | 3.1 | 25.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .279 | –49 | 22.94 | –157 | .02 | 12 | .229 | 118 |
| 10.0 | .183 | –46 | 23.98 | –169 | .02 | 3 | .185 | 106 |
| 50.0 | .110 | –36 | 24.82 | 169 | .02 | –10 | .099 | 50 |
| 100.0 | .125 | –41 | 24.94 | 152 | .02 | –23 | .164 | 42 |
| 200.0 | .205 | –63 | 24.16 | 122 | .02 | –42 | .227 | 14 |
| 300.0 | .302 | –75 | 23.55 | 90 | .02 | –62 | .387 | –21 |
| 400.0 | .423 | –87 | 22.51 | 58 | .02 | –87 | .464 | –61 |
| 500.0 | .527 | –101 | 19.72 | 24 | .02 | –114 | .516 | –107 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.9 | 1.6 | 26.8 |
| 10.0 | 1.5 | 1.4 | 27.2 |
| 50.0 | 1.3 | 1.2 | 27.5 |
| 100.0 | 1.4 | 1.4 | 27.5 |
| 200.0 | 1.6 | 1.8 | 27.3 |
| 300.0 | 2.0 | 2.2 | 27.0 |
| 400.0 | 2.6 | 2.7 | 26.6 |
| 500.0 | 3.6 | 3.1 | 25.6 |

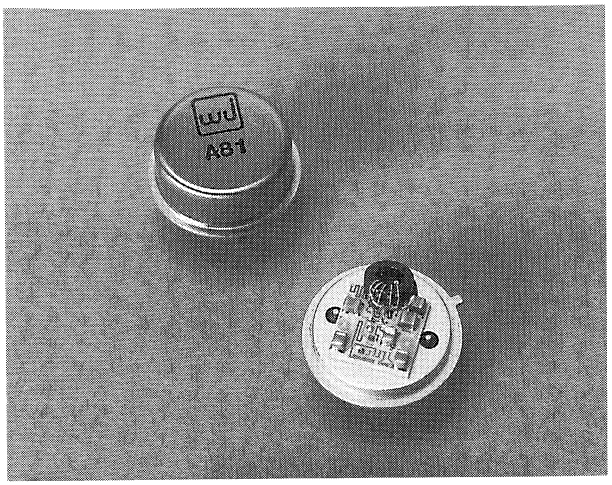
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .299 | –44 | 21.91 | –156 | .02 | 13 | .226 | 116 |
| 10.0 | .208 | –39 | 22.91 | –168 | .02 | 3 | .158 | 97 |
| 50.0 | .142 | –30 | 23.72 | 170 | .02 | –10 | .110 | 31 |
| 100.0 | .157 | –38 | 23.79 | 153 | .02 | –23 | .170 | 29 |
| 200.0 | .236 | –61 | 23.08 | 122 | .02 | –43 | .278 | 9 |
| 300.0 | .335 | –75 | 22.49 | 91 | .02 | –63 | .383 | –25 |
| 400.0 | .449 | –88 | 21.50 | 58 | .02 | –87 | .464 | –64 |
| 500.0 | .561 | –102 | 19.03 | 25 | .02 | –116 | .513 | –110 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.270 W
Junction Temperature Rise Above Case $T_{jc}$ ... 12.2°C

# WJ-A81 / SMA81




## 20 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: >30 dB (TYP.)
- ◆ HIGH GAIN: 24 dB (TYP.)
- ◆ HIGH LEVEL OUTPUT: +17 dBm (TYP.)
- ◆ LOW NOISE: 3.5 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85° |
|---|---|---|---|
| Frequency (Min.) | 10-300 MHz | 20-250 MHz | 20-250 MHz |
| Small Signal Gain (Min.) | 24.0 dB | 23.5 dB | 23.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 3.5 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +17.0 dBm | +16.0 dBm | +15.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 1.9:1 | 2.0:1 |
| Output | 1.4:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 35 mA | 37 mA | 39 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA81 is a standard WJ-A81 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

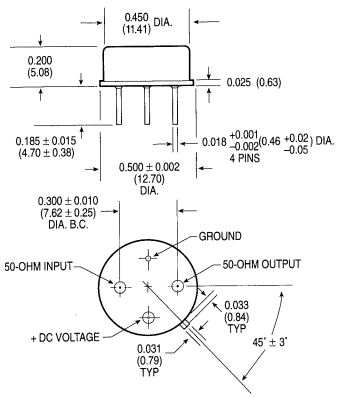
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

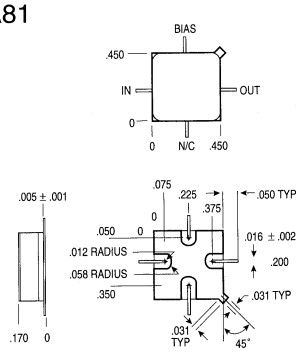
## Outline Drawings

A81



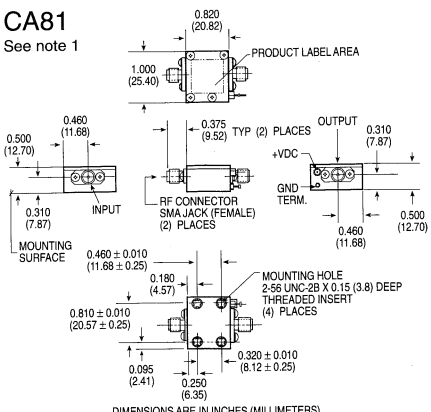

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA81




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

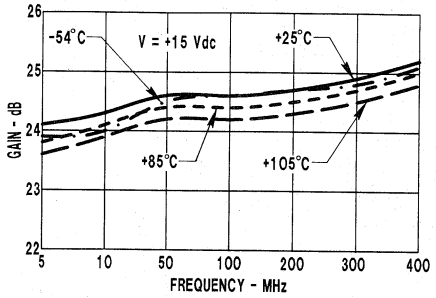
CA81
See note 1

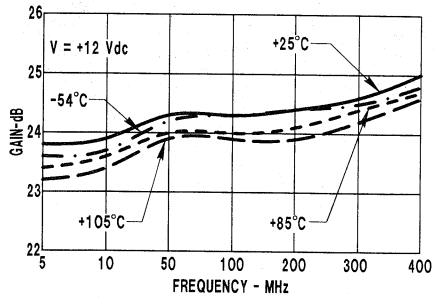



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

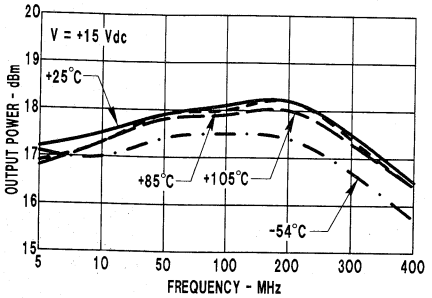
# Typical Performance at 25°C

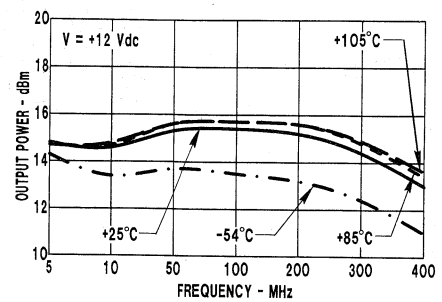
### Gain



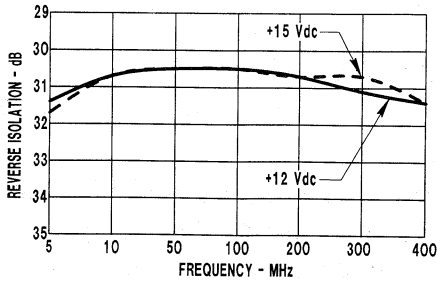

### Output Power*



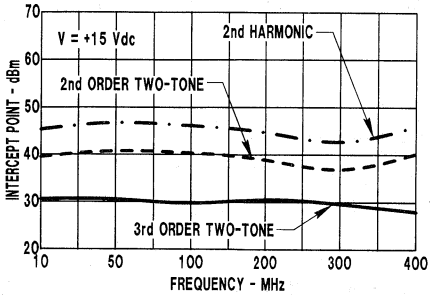



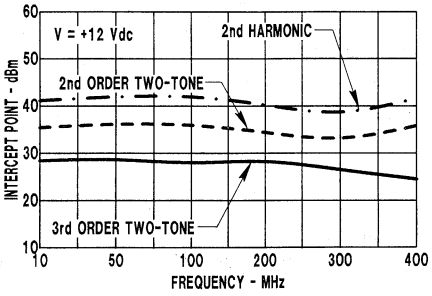

* at 1 dB Gain Compression

### Reverse Isolation

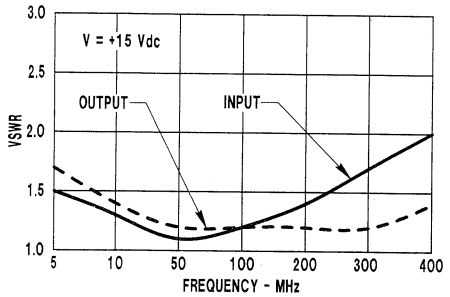


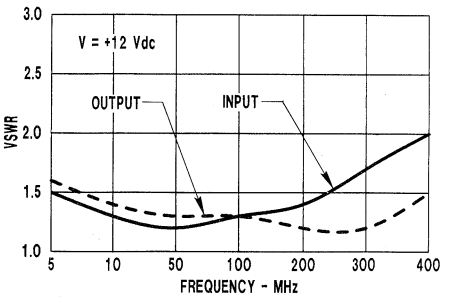

### Intercept Point



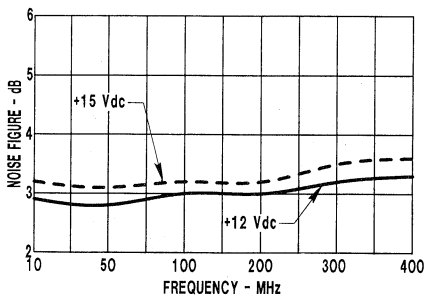




### VSWR




### Noise Figure




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.6 | 1.8 | 24.0 |
| 10.0 | 1.4 | 1.4 | 24.2 |
| 20.0 | 1.3 | 1.4 | 24.4 |
| 50.0 | 1.2 | 1.4 | 24.5 |
| 100.0 | 1.3 | 1.3 | 24.5 |
| 150.0 | 1.4 | 1.3 | 24.5 |
| 200.0 | 1.4 | 1.3 | 24.6 |
| 250.0 | 1.5 | 1.3 | 24.7 |
| 300.0 | 1.7 | 1.3 | 24.9 |
| 350.0 | 1.8 | 1.3 | 25.2 |
| 400.0 | 2.0 | 1.4 | 25.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .227 | −47 | 15.800 | −157 | .025 | 21 | .273 | 106 |
| 10.0 | .152 | −35 | 16.209 | −170 | .027 | 11 | .179 | 71 |
| 20.0 | .120 | −24 | 16.560 | −178 | .028 | 3 | .156 | 42 |
| 50.0 | .102 | −1 | 16.836 | 169 | .029 | −7 | .151 | 13 |
| 100.0 | .124 | 15 | 16.801 | 154 | .029 | −18 | .147 | −5 |
| 150.0 | .155 | 14 | 16.818 | 140 | .028 | −27 | .139 | −17 |
| 200.0 | .177 | 14 | 16.911 | 126 | .028 | −38 | .130 | −29 |
| 250.0 | .208 | 7 | 17.146 | 112 | .028 | −49 | .120 | −45 |
| 300.0 | .249 | 2 | 17.554 | 98 | .027 | −58 | .112 | −69 |
| 350.0 | .290 | −10 | 18.300 | 82 | .027 | −72 | .120 | −109 |
| 400.0 | .343 | −26 | 19.034 | 65 | .026 | −86 | .168 | −151 |

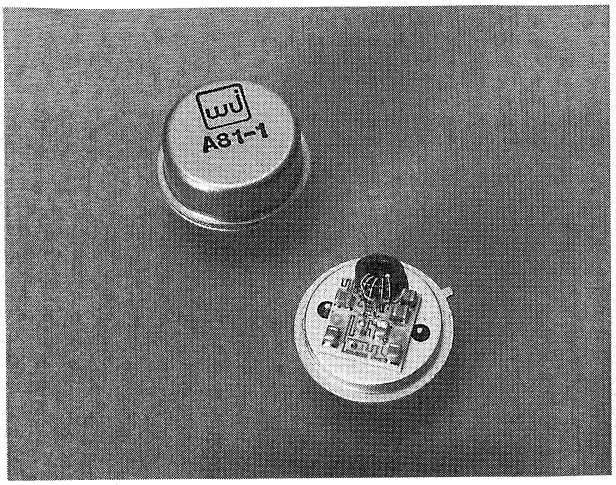
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.164 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-A81-1 / SMA81-1

## 20 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: >30.0 dB (TYP.)
- ◆ LOW NOISE: 2.5 dB (TYP.)
- ◆ HIGH GAIN: 24.5 dB (TYP.)
- ◆ HIGH EFFICIENCY: 25 mA @ +15 VDC (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-300 MHz | 20-250 MHz | 20-250 MHz |
| Small Signal Gain (Min.) | 24.5 dB | 23.5 dB | 23.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 2.5 dB | 3.2 dB | 3.7 dB |
| Power Output at 1 dB Compression (Min.) | +12.5 dBm | +11.5 dBm | +11.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 1.9:1 | 2.0:1 |
| Output | 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 25 mA | 27 mA | 29 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA81-1 is a standard WJ-A81-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+32 dBm (Typ.)
Third Order Two Tone Intercept Point.....+23 dBm (Typ.)

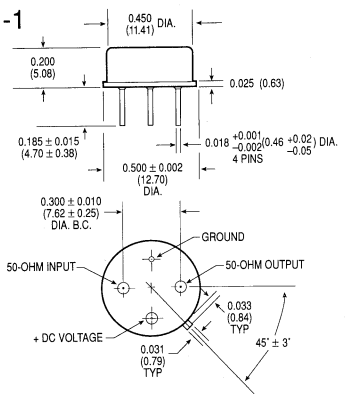
## Absolute Maximum Ratings

Storage Temperature. .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

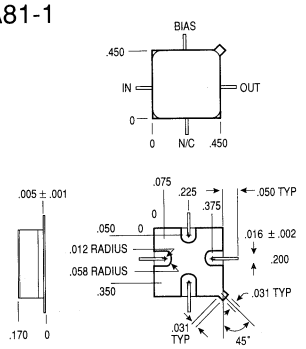
## Outline Drawings

A81-1



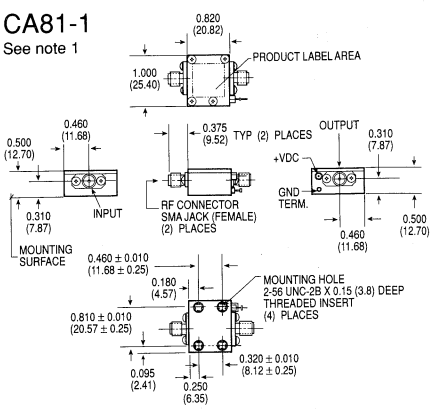

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA81-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

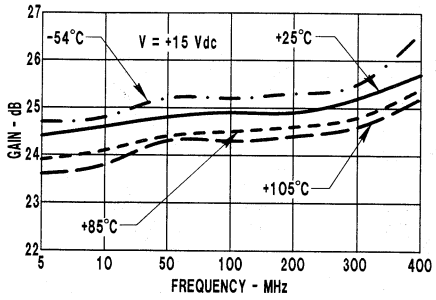
CA81-1
See note 1

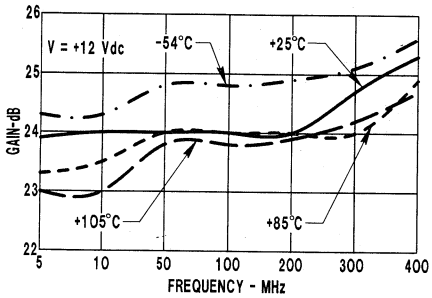



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

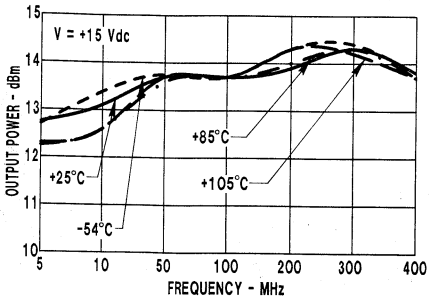
# Typical Performance at 25°C

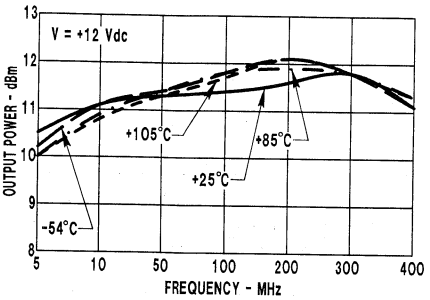
### Gain



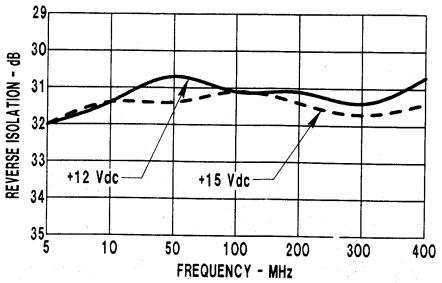

### Output Power*



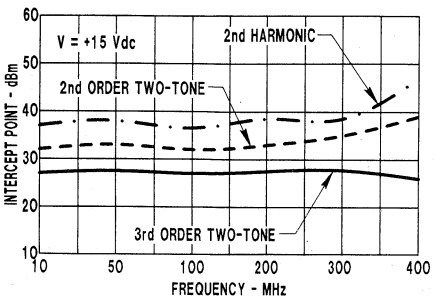



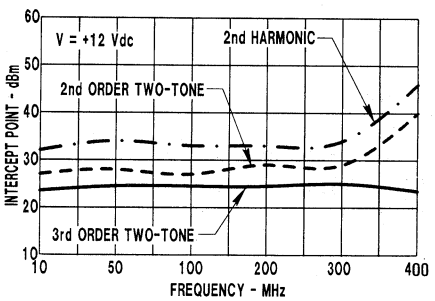

* at 1 dB Gain Compression

### Reverse Isolation

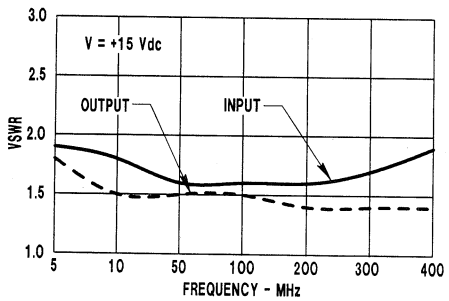


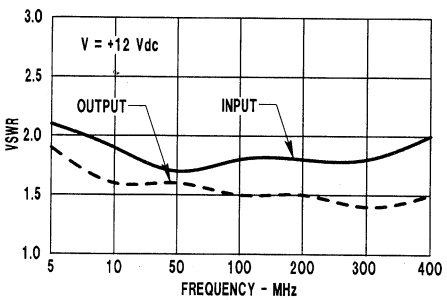

### Intercept Point



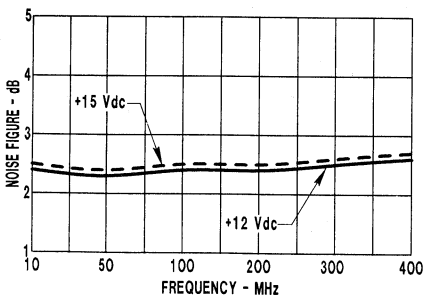




### VSWR




### Noise Figure




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.7 | 1.9 | 23.6 |
| 10.0 | 1.5 | 1.5 | 23.8 |
| 20.0 | 1.4 | 1.5 | 24.1 |
| 50.0 | 1.3 | 1.5 | 24.3 |
| 100.0 | 1.3 | 1.5 | 24.3 |
| 150.0 | 1.3 | 1.4 | 24.3 |
| 200.0 | 1.3 | 1.4 | 24.4 |
| 250.0 | 1.4 | 1.4 | 24.6 |
| 300.0 | 1.5 | 1.3 | 24.8 |
| 350.0 | 1.7 | 1.2 | 25.2 |
| 400.0 | 2.1 | 1.4 | 25.5 |

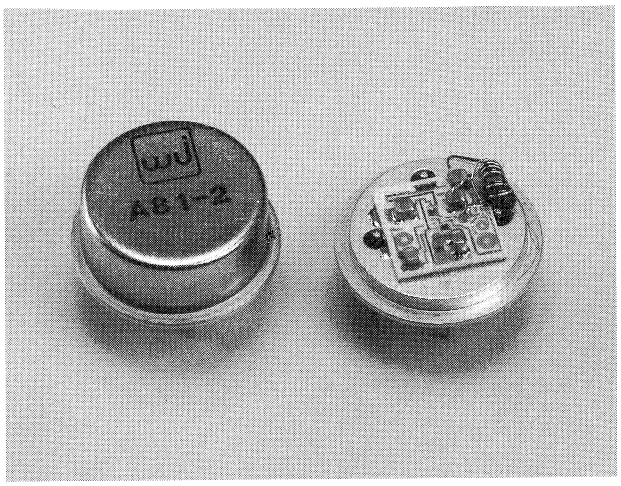
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .267 | –42 | 15.173 | –154 | .025 | 25 | .314 | 107 |
| 10.0 | .192 | –33 | 15.557 | –168 | .027 | 12 | .207 | 74 |
| 20.0 | .156 | –24 | 16.024 | –177 | .029 | 5 | .187 | 45 |
| 50.0 | .130 | –14 | 16.449 | 170 | .029 | –5 | .188 | 17 |
| 100.0 | .131 | –11 | 16.388 | 155 | .029 | –17 | .187 | 2 |
| 150.0 | .138 | –12 | 16.446 | 141 | .029 | –26 | .183 | –7 |
| 200.0 | .136 | –12 | 16.597 | 127 | .029 | –36 | .174 | –18 |
| 250.0 | .157 | –11 | 16.953 | 113 | .029 | –46 | .154 | –33 |
| 300.0 | .194 | –13 | 17.372 | 99 | .028 | –57 | .123 | –61 |
| 350.0 | .259 | –17 | 18.196 | 82 | .028 | –69 | .106 | –120 |
| 400.0 | .349 | –29 | 18.831 | 63 | .027 | –85 | .182 | 176 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A81-2 / SMA81-2




## 20 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +15.0 dBm (TYP.)
- ◆ HIGH EFFICIENCY: 29 mA @ + 15 VDC (TYP.)
- ◆ LOW NOISE 3.6 dB (TYP.)
- ◆ HIGH GAIN: >22.0 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85°C |
| Frequency (Min.) | 10-500 MHz | 20-500 MHz | 20-500 MHz |
| Small Signal Gain (Min.) | 22.0 dB | 21.5dB | 21.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 20-300 MHz | 3.5 dB | 4.0 dB | 4.5 dB |
| 300-500 MHz | 4.2 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +15.0 dBm | +14.0 dBm | +13.5 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 29 mA | 31 mA | 33 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal

Notes:

1. WJ-CA81-2 is a standard WJ-A81-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

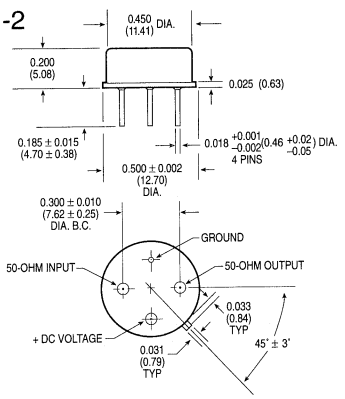
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage ..... +17 volts
Maximum Continuous RF Input Power ..... +10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

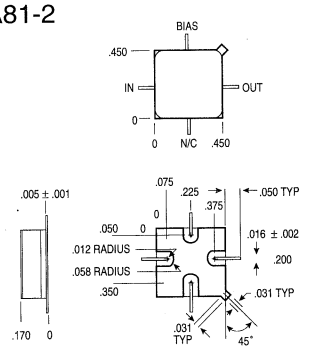
## Outline Drawings

A81-2



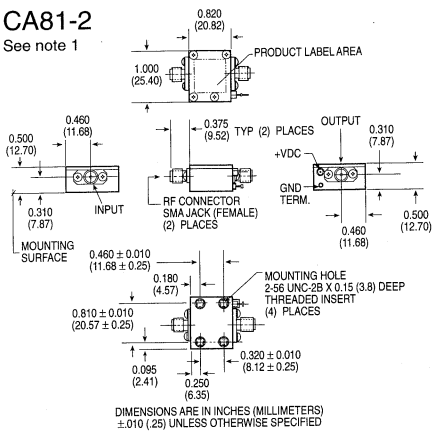

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA81-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

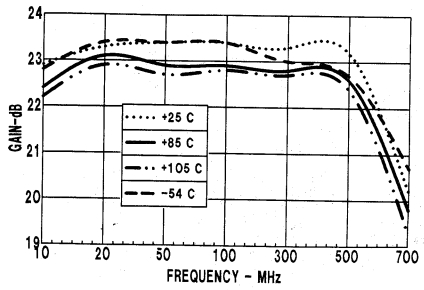
CA81-2
See note 1



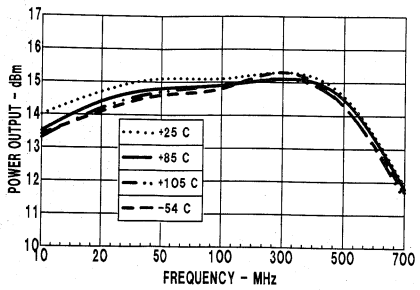

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

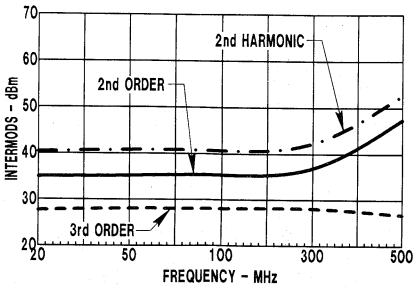



### Power Output*

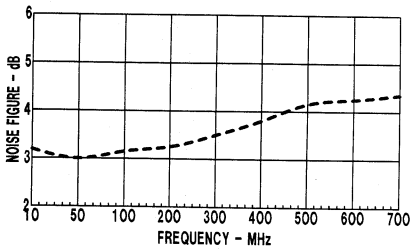



*at 1 dB Gain Compression

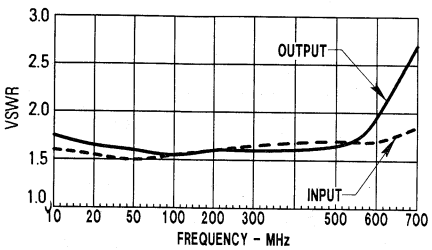
### Intermodulation




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.7 | 2.4 | 22.1 |
| 10.0 | 1.3 | 1.7 | 22.7 |
| 20.0 | 1.2 | 1.4 | 23.0 |
| 50.0 | 1.0 | 1.2 | 23.4 |
| 100.0 | 1.2 | 1.2 | 23.4 |
| 200.0 | 1.3 | 1.2 | 23.4 |
| 300.0 | 1.4 | 1.2 | 23.5 |
| 400.0 | 1.4 | 1.1 | 23.7 |
| 500.0 | 1.4 | 1.4 | 23.2 |
| 600.0 | 1.9 | 2.1 | 21.4 |
| 700.0 | 2.7 | 3.1 | 18.6 |

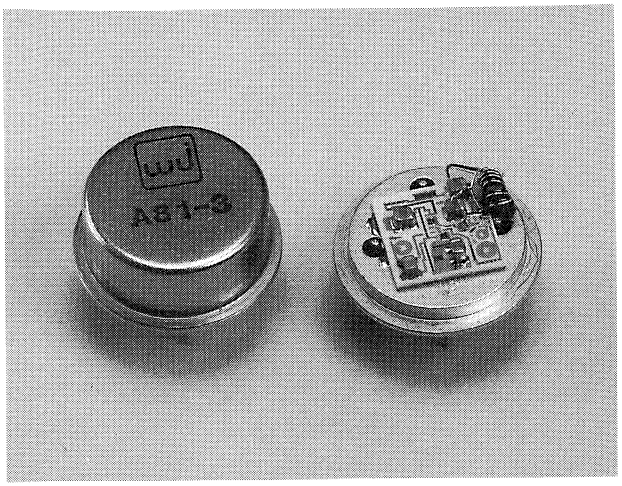
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .250 | –64 | 12.784 | –151 | .026 | 29 | .409 | 141 |
| 10.0 | .137 | –71 | 13.580 | –166 | .028 | 15 | .258 | 135 |
| 20.0 | .070 | –82 | 14.191 | –175 | .030 | 6 | .178 | 129 |
| 50.0 | .016 | 118 | 14.724 | 170 | .031 | –3 | .107 | 125 |
| 100.0 | .080 | 74 | 14.724 | 154 | .031 | –14 | .090 | 118 |
| 200.0 | .141 | 50 | 14.802 | 125 | .029 | –31 | .091 | 93 |
| 300.0 | .166 | 34 | 15.048 | 96 | .027 | –47 | .072 | 68 |
| 400.0 | .162 | 27 | 15.371 | 62 | .024 | –63 | .030 | 136 |
| 500.0 | .175 | 46 | 14.446 | 25 | .021 | –77 | .172 | 149 |
| 600.0 | .304 | 50 | 11.806 | –14 | .017 | –87 | .355 | 115 |
| 700.0 | .452 | 33 | 8.473 | –49 | .014 | –99 | .510 | 84 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.063 W
Junction Temperature Rise Above Case $T_{jc}$ ... 3°C

# WJ-A81-3 / SMA81-3




## 20 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: >35 dBm (TYP.)
- ◆ EXCEPTIONAL OUTPUT VSWR: 1.1:1 (TYP.)
- ◆ LOW NOISE: 3.6 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +8.0 dBm (TYP.)

## Specifications *

| Characteristics | Typical | 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-500 MHz | 20-500 MHz | 20-500 MHz |
| Small Signal Gain (Min.) | 17.0 dB | 16.0 dB | 15.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 20-300 MHz | 3.6 dB | 4.0 dB | 4.5 dB |
| 300-500 MHz | 4.0 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +8.0 dBm | +7.5 dBm | +7.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 1.8:1 | 2.0:1 |
| Output | 1.1:1 | 1.3:1 | 1.3:1 |
| DC Current (Max.) at 15 Volts | 29 mA | 31 mA | 33 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CA81-3 is a standard WJ-A81-3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+32 dBm (Typ.)
Second Order Two Tone Intercept Point.....+28 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20 dBm (Typ.)

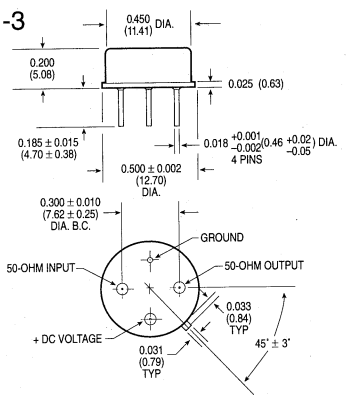
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Power.....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

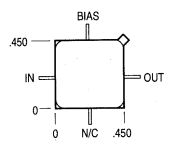
## Outline Drawings

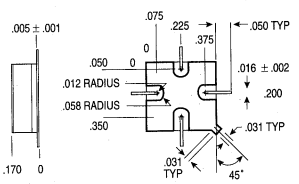
A81-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

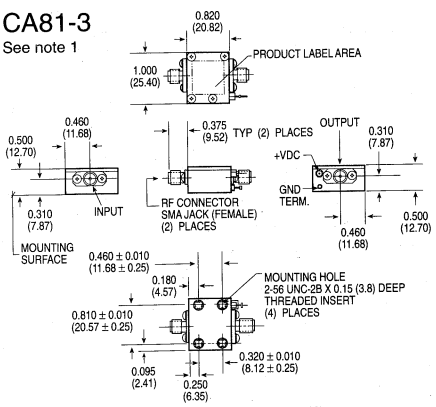
SMA81-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

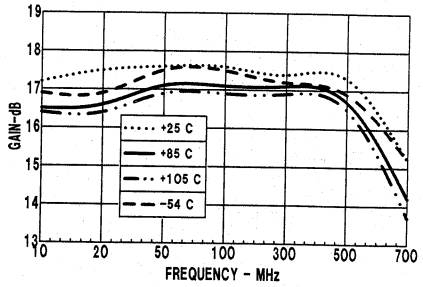
CA81-3
See note 1



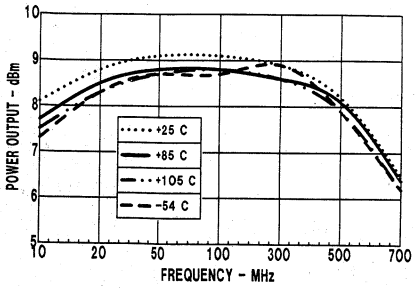

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Gain

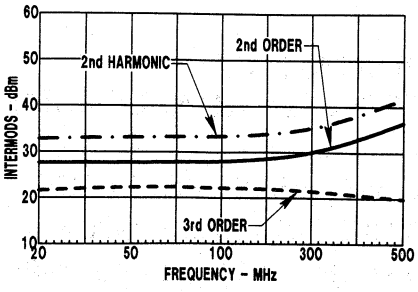



### Power Output*

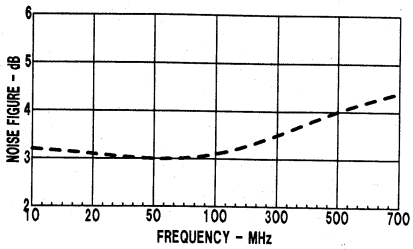



*at 1 dB Gain Compression

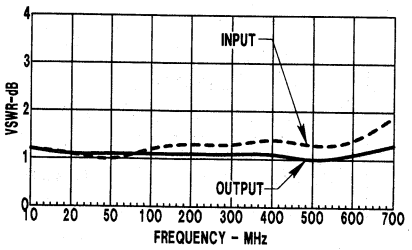
### Intercept Point




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.7 | 1.2 | 15.7 |
| 10.0 | 1.3 | 1.1 | 16.4 |
| 20.0 | 1.2 | 1.1 | 16.9 |
| 50.0 | 1.0 | 1.1 | 17.2 |
| 100.0 | 1.1 | 1.1 | 17.3 |
| 200.0 | 1.2 | 1.1 | 17.5 |
| 300.0 | 1.2 | 1.1 | 17.8 |
| 400.0 | 1.2 | 1.1 | 18.1 |
| 500.0 | 1.3 | 1.1 | 17.5 |
| 600.0 | 1.5 | 1.2 | 16.0 |
| 700.0 | 1.9 | 1.3 | 13.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .256 | –58 | 6.124 | –148 | .012 | 32 | .093 | 127 |
| 10.0 | .146 | –66 | 6.635 | –164 | .014 | 17 | .056 | 105 |
| 20.0 | .078 | –71 | 6.995 | –173 | .014 | 8 | .041 | 80 |
| 50.0 | .011 | –59 | 7.285 | 173 | .015 | –1 | .033 | 47 |
| 100.0 | .050 | 49 | 7.333 | 159 | .015 | –10 | .035 | 32 |
| 200.0 | .095 | 22 | 7.514 | 134 | .015 | –21 | .042 | 18 |
| 300.0 | .107 | –16 | 7.804 | 109 | .013 | –33 | .041 | –8 |
| 400.0 | .099 | –74 | 7.995 | 78 | .011 | –44 | .028 | –71 |
| 500.0 | .118 | –164 | 7.469 | 46 | .009 | –44 | .044 | –175 |
| 600.0 | .216 | 132 | 6.277 | 14 | .009 | –43 | .088 | 131 |
| 700.0 | .317 | 94 | 4.933 | –14 | .009 | –44 | .134 | 98 |

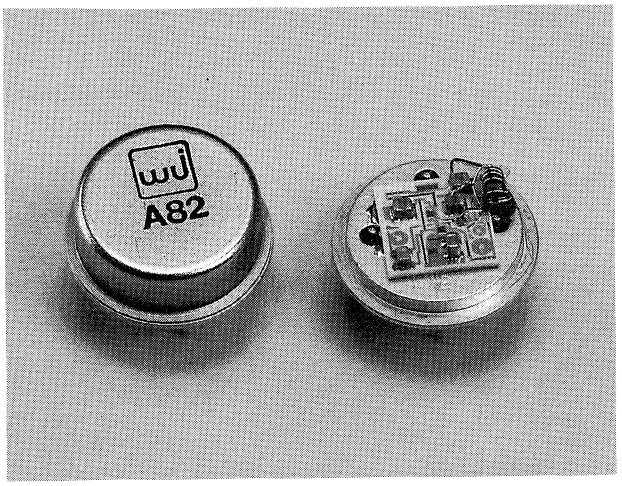
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.157 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-A82 / SMA82

## 20 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: > 28.5 dB (TYP.)
- ◆ HIGH LEVEL OUTPUT: +20 dBm (TYP.)
- ◆ HIGH GAIN: 22.5 dB (TYP.)




## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 20-300 MHz | 20-250 MHz | 20-250 MHz |
| Small Signal Gain (Min.) | 22.5 dB | 21.5 dB | 21.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 4.5 dB | 5.0 dB |
| Power Output at 1 dB Compression (Min.) | +20.0 dBm | +19.0 dBm | +18.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.0:1 | 2.0:1 |
| Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 50 mA | 52 mA | 54 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:
1. WJ-CA82 is a standard WJ-A82 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point..... +40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+32 dBm (Typ.)

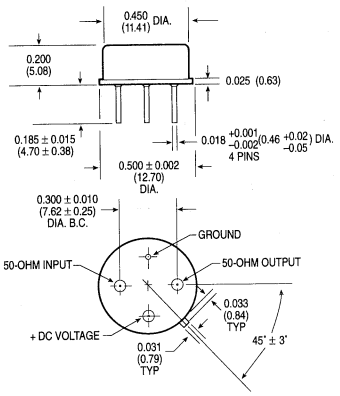
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power ..... +10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

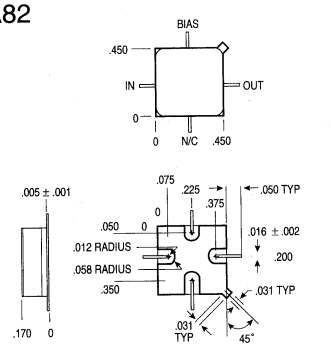
## Outline Drawings

A82



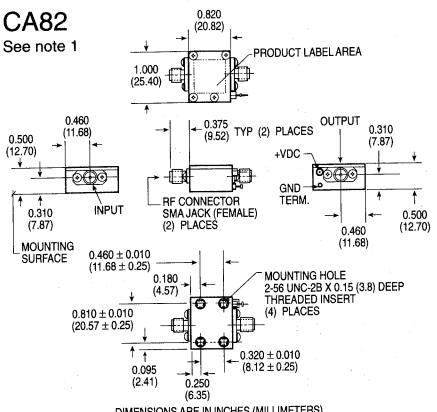

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA82




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

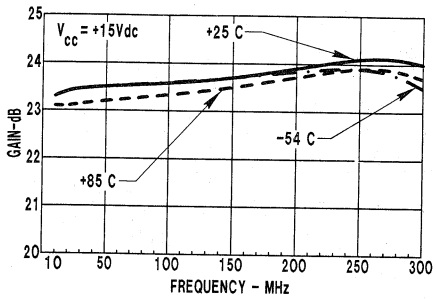
CA82
See note 1

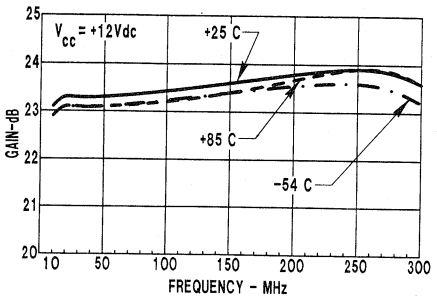



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

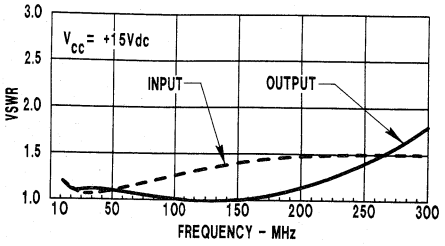
# Typical Performance at 25°C

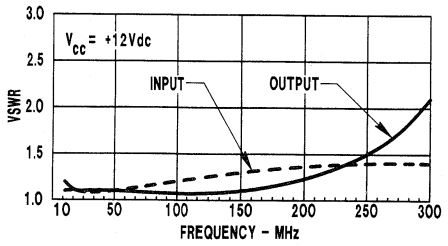
### Gain vs. Temperature



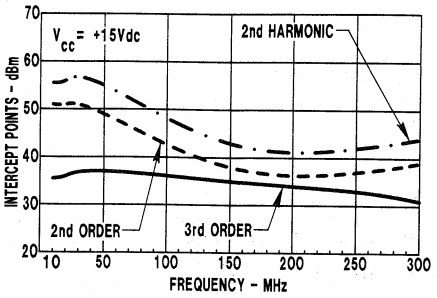




### Input/Output VSWR



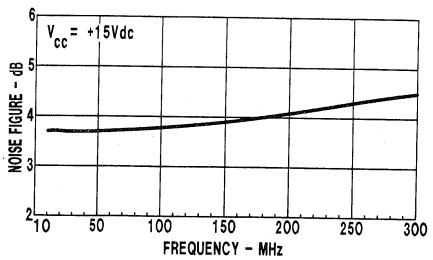

### Intercept Points




1

## Typical Automatic Test Data

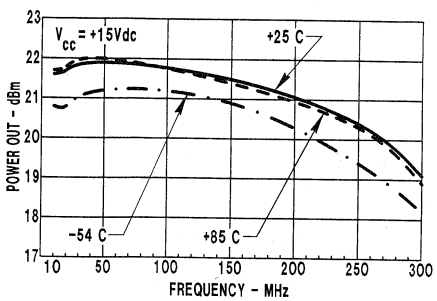
### Noise Figure

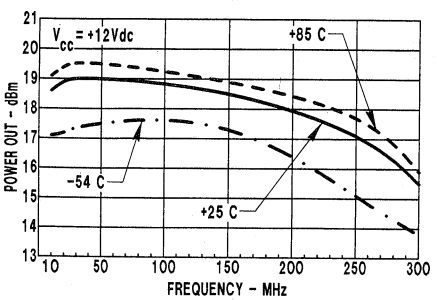



### $V_{cc}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.2 | 2.6 | 22.0 |
| 5.0 | 1.4 | 1.5 | 23.2 |
| 10.0 | 1.2 | 1.2 | 23.3 |
| 20.0 | 1.1 | 1.1 | 23.4 |
| 50.0 | 1.1 | 1.1 | 23.4 |
| 100.0 | 1.1 | 1.1 | 23.6 |
| 150.0 | 1.2 | 1.2 | 23.8 |
| 200.0 | 1.2 | 1.3 | 24.1 |
| 250.0 | 1.2 | 1.5 | 24.3 |
| 300.0 | 1.2 | 2.0 | 24.3 |
| 350.0 | 1.2 | 2.6 | 23.7 |
| 400.0 | 1.3 | 3.5 | 22.8 |

### Output Power vs. Temperature*




*at 1 dB Gain Compression

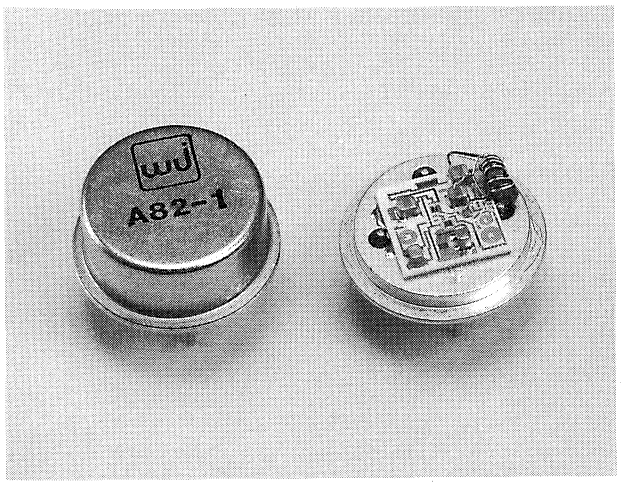
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .368 | –68 | 12.610 | –137 | .032 | 41 | .440 | 145 |
| 5.0 | .151 | –101 | 14.459 | –165 | .038 | 16 | .189 | 105 |
| 10.0 | .086 | –125 | 14.586 | –174 | .039 | 7 | .103 | 86 |
| 20.0 | .056 | –156 | 14.714 | 179 | .040 | 2 | .064 | 62 |
| 50.0 | .055 | 152 | 14.868 | 168 | .040 | –4 | .046 | 19 |
| 100.0 | .068 | 100 | 15.065 | 153 | .039 | –12 | .054 | –26 |
| 150.0 | .079 | 61 | 15.462 | 138 | .037 | –17 | .079 | –66 |
| 200.0 | .083 | 29 | 15.974 | 122 | .035 | –23 | .129 | –100 |
| 250.0 | .090 | –12 | 16.356 | 104 | .032 | –25 | .212 | –132 |
| 300.0 | .089 | –56 | 16.369 | 84 | .030 | –24 | .323 | –163 |
| 350.0 | .103 | –112 | 15.274 | 61 | .030 | –22 | .449 | 168 |

## Thermal Data: $V_{cc}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.240 W
Junction Temperature Rise Above Case $T_{jc}$ ... 11°C

# WJ-A82-1 / SMA82-1




## 20 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: > 34 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +15.5 dBm (TYP.)
- ◆ HIGH GAIN: 18 dB (TYP)
- ◆ LOW OUTPUT VSWR : 1.1:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° - 50°C | Guaranteed -54°C - +85°C |
|---|---|---|---|
| Frequency (Min.) | 20-300 MHz | 20-250 MHz | 20-250 MHz |
| Small Signal Gain (Min.) | 18 dB | 16.5 dB | 16.0 dB |
| Gain Flatness (Max.) | +0.5 dB | +0.7 dB | +1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +15.5 dBm | +14.0 dBm | +13.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 1.9:1 | 2.0:1 |
| Output | 1.1:1 | 1.3:1 | 1.3:1 |
| DC Current (Max.) at +15 Volts | 50 mA | 52 mA | 54 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:
1. WJ-CA82-1 is a standard WJ-A82-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....38 dBm (Typ.)
Second Order Two Tone Intercept Point .....30 dBm (Typ.)
Third Order Two Tone Intercept Point.....28 dBm (Typ.)

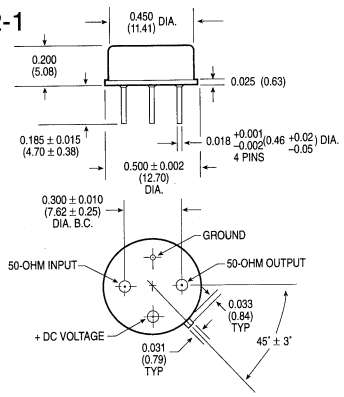
## Absolute Maximum Ratings

Storage Temperature .....-62°C to 125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

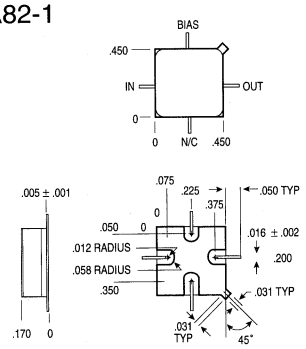
## Outline Drawings

A82-1



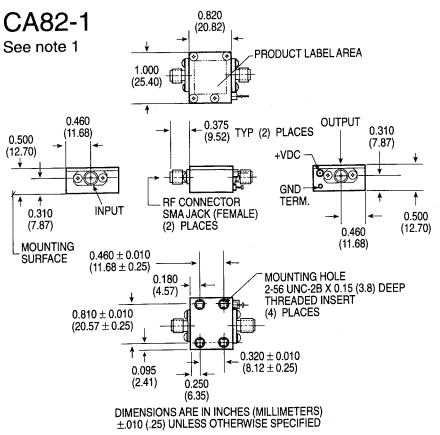

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA82-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

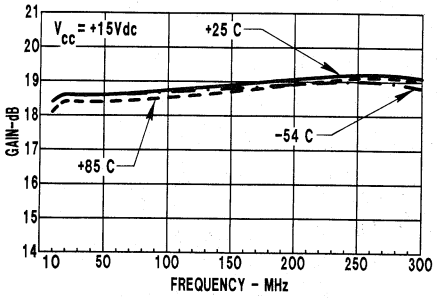
CA82-1
See note 1

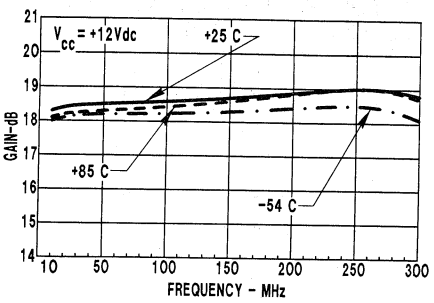



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

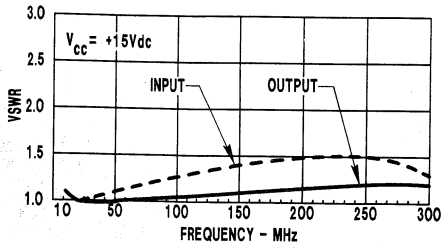
# Typical Performance at 25°C

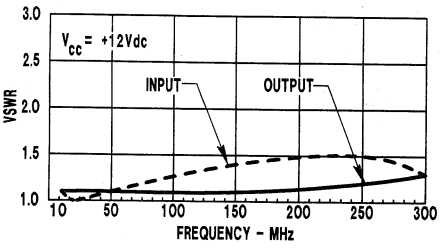
### Gain vs. Temperature



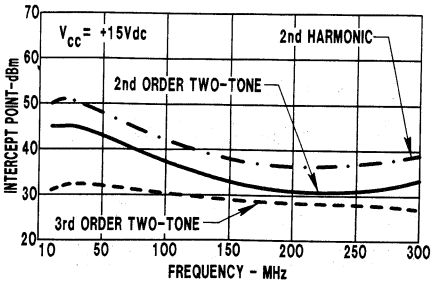




### Input/Output VSWR




### Intercept Points



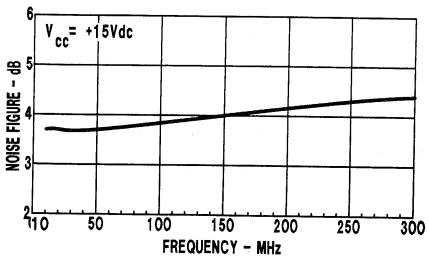

1

## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.1 | 1.3 | 18.2 |
| 5.0 | 1.3 | 1.1 | 19.5 |
| 10.0 | 1.2 | 1.1 | 19.6 |
| 20.0 | 1.1 | 1.1 | 19.7 |
| 50.0 | 1.1 | 1.1 | 19.8 |
| 100.0 | 1.1 | 1.1 | 19.8 |
| 150.0 | 1.2 | 1.1 | 20.0 |
| 200.0 | 1.3 | 1.1 | 20.0 |
| 250.0 | 1.4 | 1.1 | 19.7 |
| 300.0 | 1.5 | 1.2 | 19.1 |
| 350.0 | 1.6 | 1.3 | 18.0 |
| 400.0 | 1.6 | 1.5 | 16.7 |

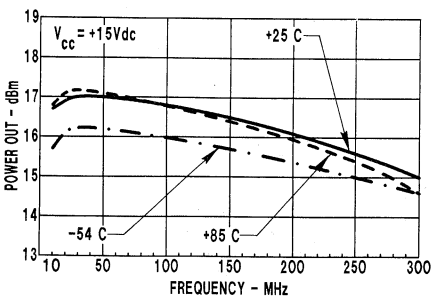
### Noise Figure

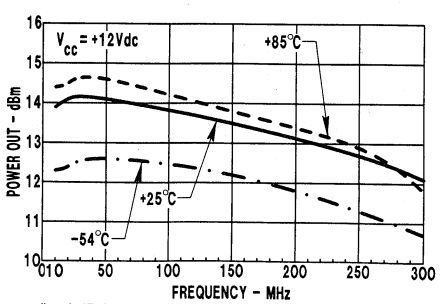



### Linear S-Parameters

| Frequency MHz | S11 MAG | S11 ANG | S21 MAG | S21 ANG | S12 MAG | S12 ANG | S22 MAG | S22 ANG |
|---|---|---|---|---|---|---|---|---|
| 2.0 | .360 | –65 | 8.133 | –136 | .014 | 41 | .139 | 142 |
| 5.0 | .141 | –94 | 9.458 | –164 | .018 | 16 | .066 | 93 |
| 10.0 | .072 | –113 | 9.561 | –174 | .019 | 8 | .042 | 66 |
| 20.0 | .042 | –142 | 9.632 | 179 | .019 | 2 | .035 | 41 |
| 50.0 | .035 | 129 | 9.754 | 166 | .019 | –5 | .034 | 16 |
| 100.0 | .065 | 65 | 9.822 | 149 | .018 | –13 | .037 | –3 |
| 150.0 | .096 | 19 | 9.943 | 131 | .017 | –21 | .038 | –33 |
| 200.0 | .131 | –17 | 9.994 | 112 | .015 | –26 | .040 | –80 |
| 250.0 | .164 | –55 | 9.684 | 92 | .014 | –26 | .059 | –135 |
| 300.0 | .196 | –90 | 9.037 | 70 | .012 | –24 | .097 | –177 |
| 350.0 | .228 | –123 | 7.944 | 49 | .012 | –16 | .147 | 153 |
| 400.0 | .244 | –151 | 6.804 | 30 | .013 | –10 | .192 | 128 |

### Output Power vs. Temperature *



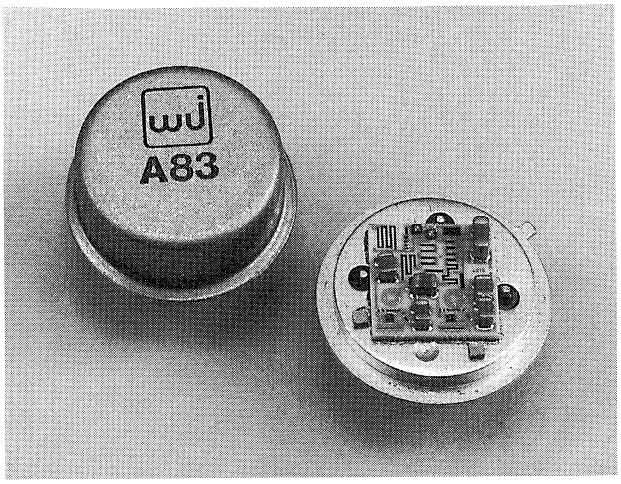




*at 1 dB Gain Compression

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.167 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-A83 / SMA83




## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 30 dB (TYP.)
- ◆ LOW POWER DRAIN: 65 mW @ 5 VOLTS (TYP.)
- ◆ VOLTAGE CONTROLLED GAIN:
  27 dB TO 34 dB @ Vcc = 3 TO 12 VOLTS
- ◆ LOW VSWR 1.3:1 (TYP.)

## Specifications*

| Characteristic | Typical | Guaranteed 0° to 50° | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 30.0 dB | 29.0 dB | 28.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.8 dB |
| Noise Figure (Max.) | 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | -1.0 dBm | -2.0 dBm | -4.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 5 Volts | 13.0 mA | 15.0 mA | 16.0 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

Notes:
1. WJ-CA83 is a standard WJ-A83 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+20 dBm (Typ.)
Second Order Two Tone Intercept Point.....+14 dBm (Typ.)
Third Order Two Tone Intercept Point.....+10 dBm (Typ.)

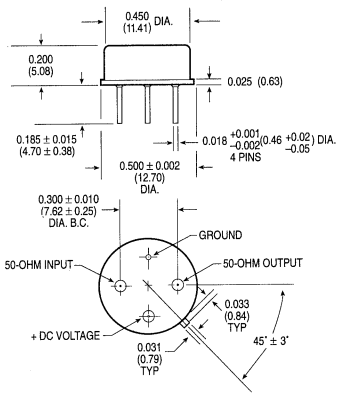
## Absolute Maximum Ratings

Storage Temperature .....-62°C to+125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+13 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

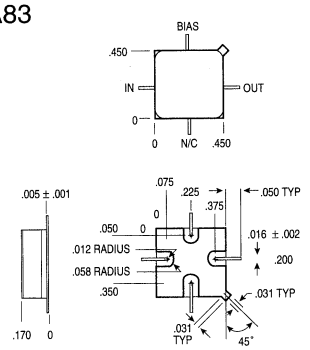
## Outline Drawings

A83



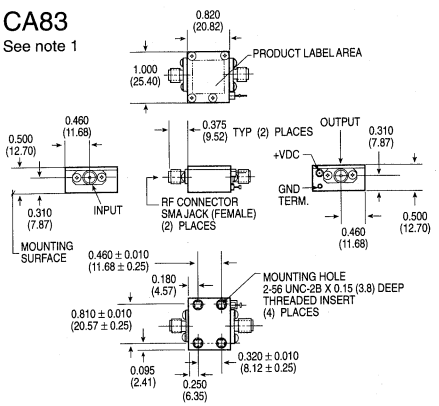

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA83




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

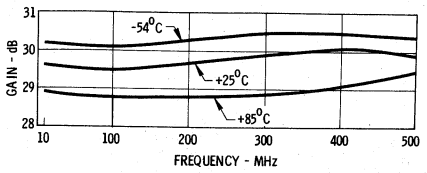
CA83
See note 1

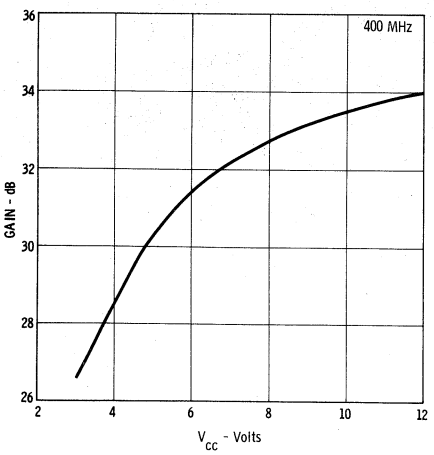



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

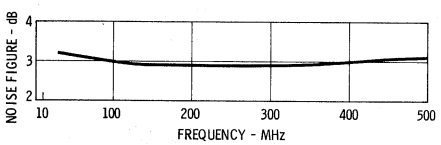
# Typical Performance at 25°C

### Gain

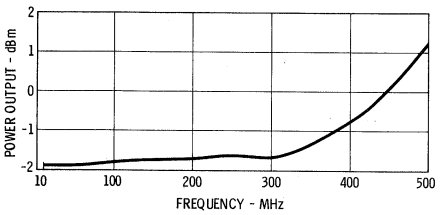


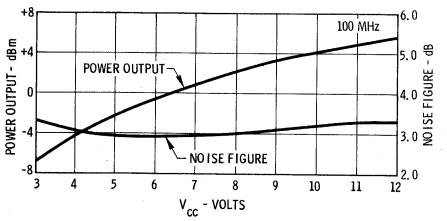




### Noise Figure



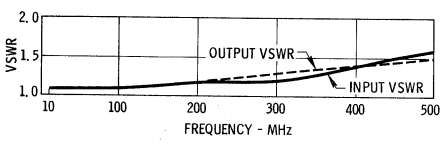

### Power Output *



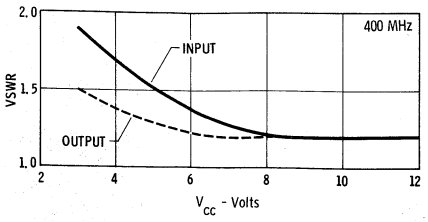




* at 1 dB Gain Compression

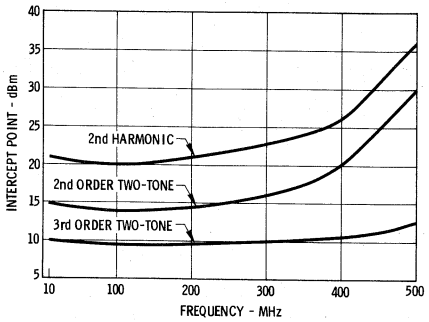
### VSWR




### VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{cc}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.4 | 1.4 | 30.2 |
| 2.0 | 1.2 | 1.2 | 30.4 |
| 5.0 | 1.1 | 1.2 | 30.6 |
| 10.0 | 1.0 | 1.2 | 30.6 |
| 20.0 | 1.0 | 1.2 | 30.6 |
| 50.0 | 1.0 | 1.2 | 30.8 |
| 100.0 | 1.0 | 1.2 | 30.8 |
| 150.0 | 1.0 | 1.3 | 30.9 |
| 200.0 | 1.1 | 1.3 | 31.0 |
| 250.0 | 1.1 | 1.3 | 30.9 |
| 300.0 | 1.1 | 1.3 | 31.0 |
| 350.0 | 1.1 | 1.4 | 30.8 |
| 400.0 | 1.1 | 1.3 | 30.8 |

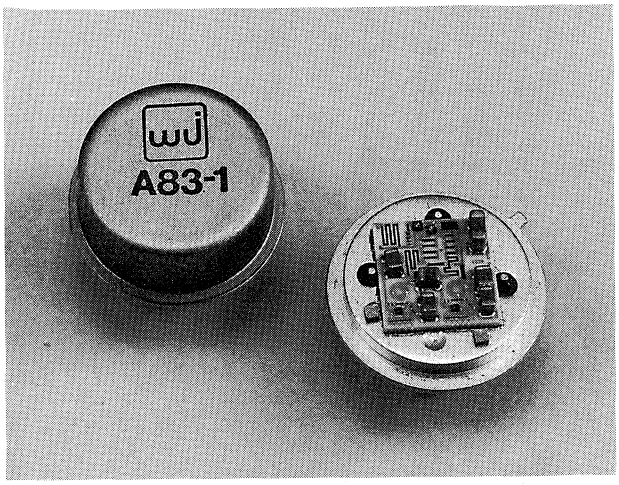
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .177 | –85 | 32.370 | 29 | .009 | 30 | .167 | –98 |
| 2.0 | .091 | –102 | 33.220 | 14 | .010 | 14 | .105 | –119 |
| 5.0 | .035 | –132 | 33.713 | 4 | .010 | 7 | .076 | –145 |
| 10.0 | .020 | –154 | 33.900 | 0 | .009 | 3 | .073 | –157 |
| 20.0 | .015 | –163 | 34.050 | –6 | .009 | 2 | .075 | –161 |
| 50.0 | .016 | –166 | 34.514 | –19 | .009 | 1 | .088 | –159 |
| 100.0 | .018 | –173 | 34.782 | –39 | .010 | 1 | .109 | –160 |
| 150.0 | .023 | –178 | 35.074 | –60 | .009 | 1 | .128 | –164 |
| 200.0 | .027 | 158 | 35.513 | –82 | .010 | 0 | .140 | –170 |
| 250.0 | .032 | 125 | 35.273 | –103 | .010 | 2 | .148 | –177 |
| 300.0 | .029 | 85 | 35.295 | –125 | .010 | 1 | .148 | 177 |
| 350.0 | .041 | 39 | 34.777 | –147 | .010 | 0 | .150 | 172 |
| 400.0 | .063 | –5 | 34.663 | –169 | .011 | 1 | .146 | 168 |

# Thermal Data: $V_{cc}$ =5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.193 W
Junction Temperature Rise Above Case $T_{jc}$ ... 9°C

# WJ-A83-1 / SMA83-1




## 10 to 250 MHz
## TO -8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 35.5 dB (TYP.)
- ◆ LOW POWER DRAIN: 65 mW @ 5 VOLTS (TYP.)
- ◆ VOLTAGE CONTROLLED GAIN:
  29 dB TO 39 dB @ Vcc = 3 TO 12 VOLTS
- ◆ LOW VSWR OVER FULL CONTROL RANGE: < 1.5:1 (TYP.)

## Specifications *

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed - 54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-300 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min.) | 35.5 dB | 34.0 dB | 33.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.8 dB |
| Noise Figure (Max.) | 2.5 dB | 3.0 dB | 3.5 dB |
| Power Output at 1 dB Compression (Min.) | -1.5 dBm | -2.5 dBm | -3.5 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 5 Volts | 13.0 mA | 15.0 mA | 16.0 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA83-1 is a standard WJ-A83-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25° C

Second Order Harmonic Intercept Point.....+18 dBm (Typ.)
Second Order Two Tone Intercept Point.....+12 dBm (Typ.)
Third Order Two Tone Intercept Point.....+9 dBm (Typ.)

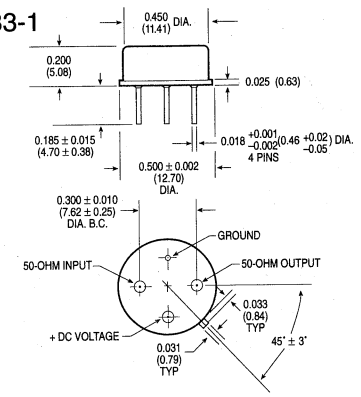
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+13 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt ( 3µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

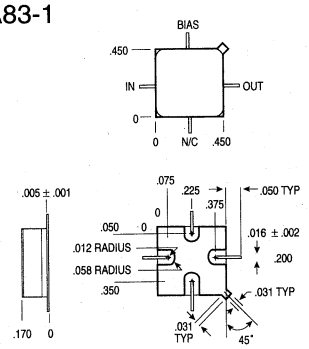
## Outline Drawings

A83-1



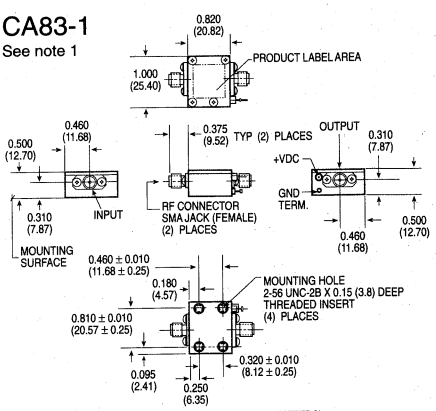

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA83-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

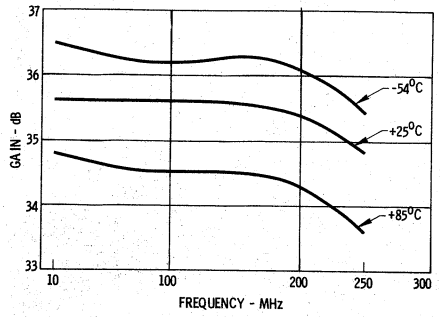
CA83-1
See note 1

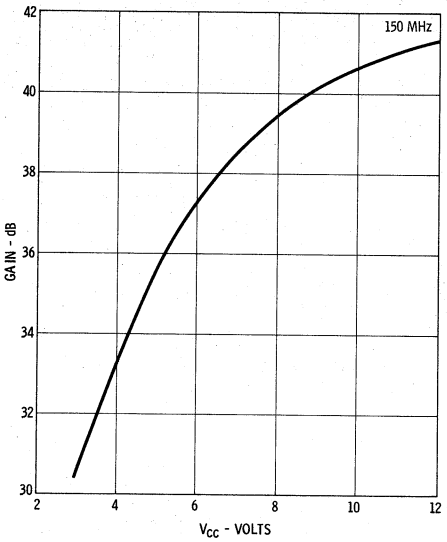



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

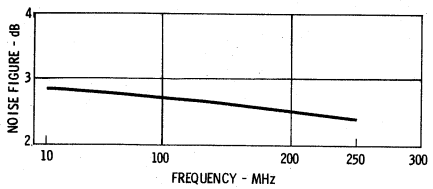
# Typical Performance at 25°C

## Gain

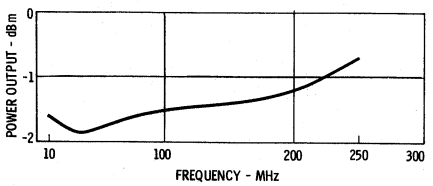


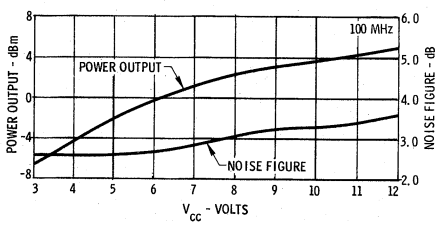




## Noise Figure



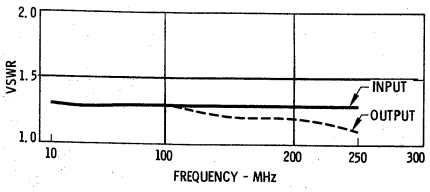

## Power Output *

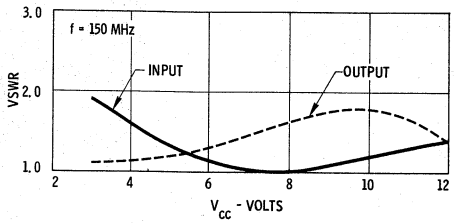


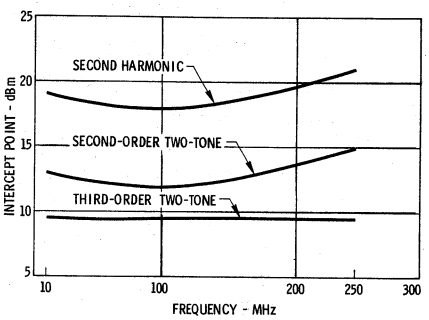

* at 1 dB Gain Compression

## VSWR




## Intercept Point




# Typical Automatic Test Data

### Vcc = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 1.6 | 34.3 |
| 2.0 | 1.3 | 1.4 | 34.5 |
| 5.0 | 1.2 | 1.3 | 34.6 |
| 10.0 | 1.2 | 1.3 | 34.7 |
| 20.0 | 1.2 | 1.3 | 34.8 |
| 50.0 | 1.2 | 1.3 | 35.0 |
| 100.0 | 1.2 | 1.3 | 35.1 |
| 150.0 | 1.2 | 1.3 | 35.1 |
| 200.0 | 1.2 | 1.3 | 35.2 |
| 250.0 | 1.2 | 1.2 | 34.8 |
| 300.0 | 1.3 | 1.3 | 34.4 |
| 350.0 | 1.4 | 1.4 | 33.8 |
| 400.0 | 1.5 | 1.6 | 33.3 |

### Linear S-Parameters

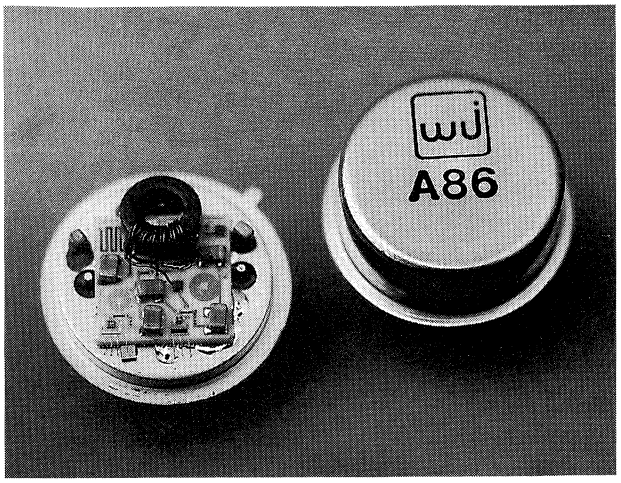
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .230 | –56 | 52.089 | 23 | .006 | 9 | .223 | –103 |
| 2.0 | .120 | –45 | 53.157 | 12 | .005 | 5 | .152 | –129 |
| 5.0 | .085 | –16 | 53.976 | 3 | .005 | 2 | .126 | –156 |
| 10.0 | .094 | –5 | 54.421 | –2 | .005 | 2 | .123 | –166 |
| 20.0 | .095 | –5 | 54.806 | –8 | .005 | 1 | .126 | –172 |
| 50.0 | .096 | –11 | 56.019 | –24 | .005 | –1 | .135 | –177 |
| 100.0 | .095 | –21 | 56.879 | –50 | .005 | 5 | .142 | 173 |
| 150.0 | .083 | –27 | 57.164 | –77 | .005 | 6 | .138 | 164 |
| 200.0 | .091 | –34 | 57.458 | –105 | .006 | 10 | .119 | 159 |
| 250.0 | .106 | –34 | 54.918 | –134 | .005 | 13 | .106 | 164 |
| 300.0 | .131 | –45 | 52.779 | –162 | .006 | 15 | .119 | 175 |
| 350.0 | .164 | –56 | 48.899 | 170 | .006 | 18 | .165 | 175 |
| 400.0 | .210 | –70 | 46.220 | 143 | .007 | 20 | .225 | 164 |

# Thermal Data: $V_{CC}$ =5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.022 W
Junction Temperature Rise Above Case $T_{jc}$ ... 1°C

# WJ-A86 / SMA86

## 10 to 200 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -TWO STAGES: 28 dB (TYP.)
- ◆ HIGH EFFICIENCY: 21 mA @ 5 VDC (TYP.)
- ◆ LOW NOISE: 3.8 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +9.0 dBm (TYP.)

## Specifications *

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-250 MHz | 10-200 MHz | 10-200 MHz |
| Small Signal Gain (Min.) | 28 dB | 27 dB | 26 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.8 dB | 4.5 dB | 5.0 dB |
| Power Output at 1 dB Compression (Min.) | +9.0 dBm | +7.5 dBm | +7.0 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 1.9:1 | 2.0:1 |
| DC Current at (Max.) 5 Volts | 21 mA | 23 mA | 25 mA |

*Measured in a 50 ohm system at +5 Vdc.

Notes:
1. WJ-CA86 is a standard WJ-A86 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+36 dBm (Typ.)
Second Order Two Tone Intercept Point.....+32 dBm (Typ.)
Third-Order Two Tone Intercept Point .....+20 dBm (Typ.)

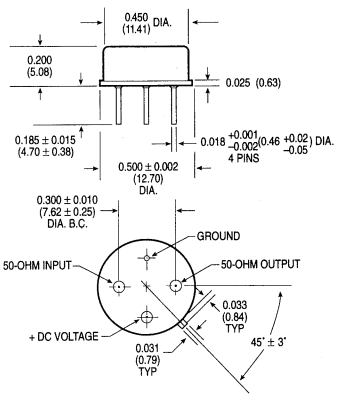
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....8 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 mW
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

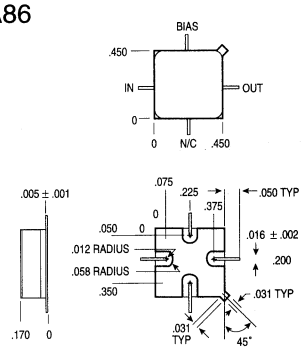
## Outline Drawings

A86



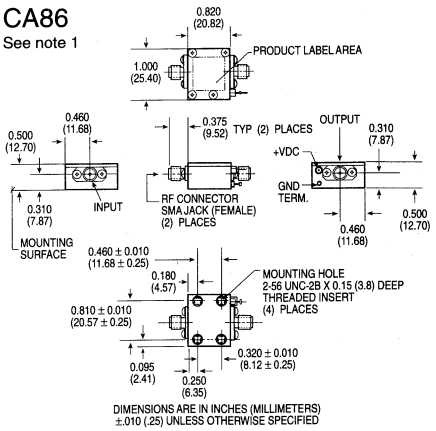

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA86




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

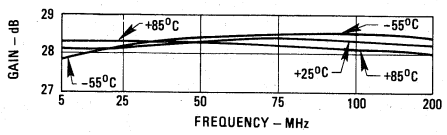
CA86
See note 1



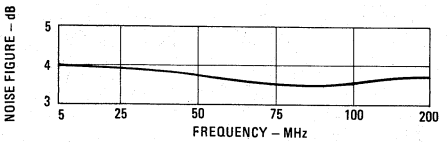

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

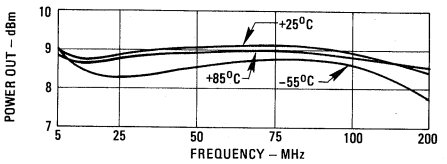
### Gain




### Noise Figure

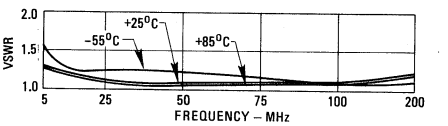



### Power Output*

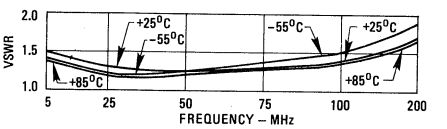



*at 1 dB Gain Compression

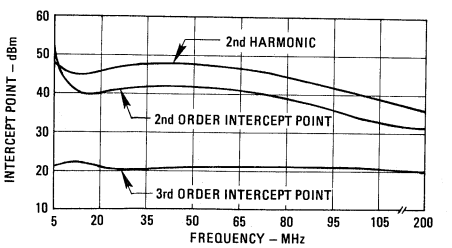
### Input–VSWR




### Output–VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 3.2 | 27.6 |
| 5.0 | 1.3 | 1.5 | 27.8 |
| 10.0 | 1.2 | 1.3 | 27.8 |
| 50.0 | 1.1 | 1.3 | 28.1 |
| 100.0 | 1.1 | 1.2 | 28.1 |
| 150.0 | 1.1 | 1.2 | 28.1 |
| 200.0 | 1.1 | 1.4 | 28.0 |
| 250.0 | 1.1 | 1.8 | 27.6 |
| 300.0 | 1.1 | 2.5 | 27.1 |

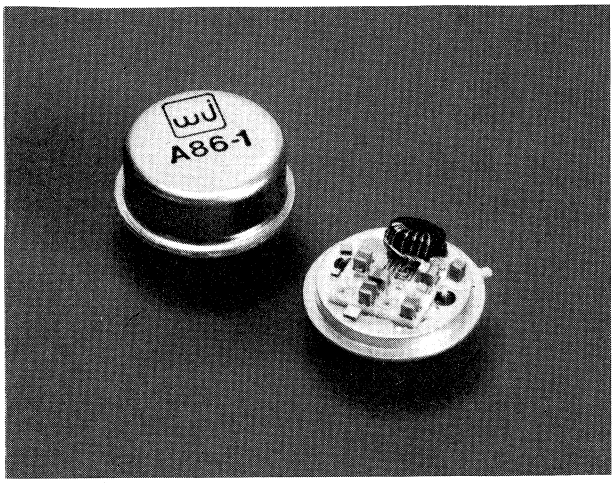
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .250 | 159 | 23.926 | 45 | .008 | 41 | .528 | 121 |
| 5.0 | .117 | 147 | 24.540 | 15 | .012 | 12 | .206 | 65 |
| 10.0 | .084 | 149 | 24.630 | 5 | .012 | 5 | .145 | 39 |
| 50.0 | .057 | 143 | 25.393 | –19 | .013 | –3 | .116 | –19 |
| 100.0 | .049 | 116 | 25.494 | –42 | .012 | –6 | .079 | –69 |
| 150.0 | .036 | 81 | 25.436 | –65 | .012 | –11 | .082 | –152 |
| 200.0 | .031 | 16 | 25.239 | –89 | .012 | –14 | .169 | 156 |
| 250.0 | .046 | –36 | 23.947 | –113 | .012 | –21 | .293 | 128 |
| 300.0 | .065 | –69 | 22.683 | –139 | .012 | –24 | .424 | 105 |

# Thermal Data: $V_{CC}$ =5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.027 W
Junction Temperature Rise Above Case $T_{jc}$ ... 1°C

# WJ-A86-1 / SMA86-1




## 10 to 200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: TWO STAGES 28 dB (TYP.)
- ◆ LOW NOISE: 2.8 dB (TYP.)
- ◆ HIGH OUTPUT LEVEL: +16.0 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +28 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-250 MHz | 10-200 MHz | 10-200 MHz |
| Small Signal Gain (Min.) | 28 dB | 27.0 dB | 26.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.6 dB | ±0.8 dB |
| Noise Figure (Max.) | 2.8 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | +16.0 dBm | +15.0 dBm | +14.5 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 44.0 mA | 47.0 mA | 49.5 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA86-1 is a standard WJ-A86-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+41 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

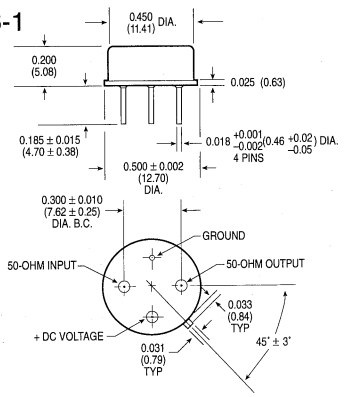
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 μsec. Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

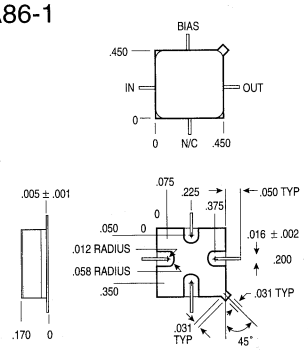
## Outline Drawings

A86-1



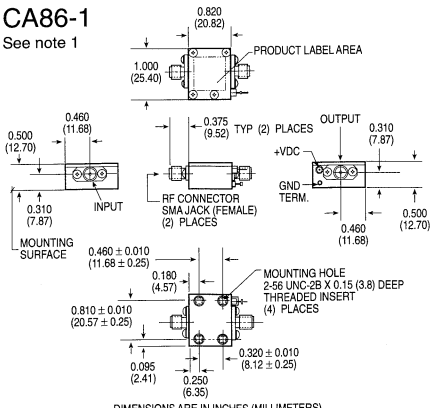

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA86-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

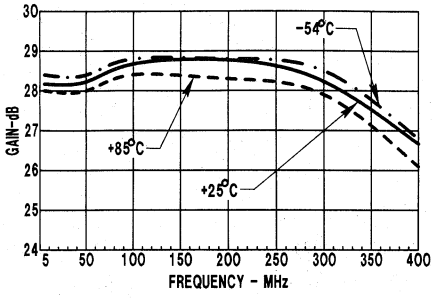
CA86-1
See note 1



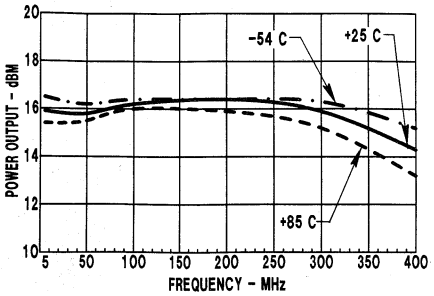

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

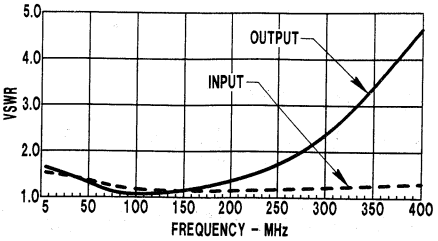
### Gain

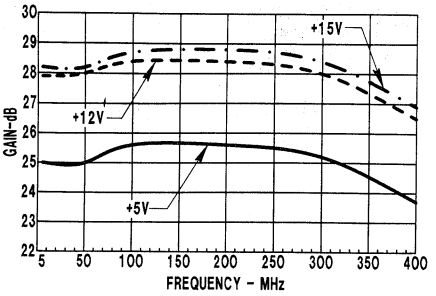


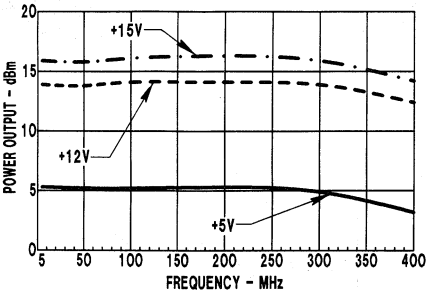

### Power Output*



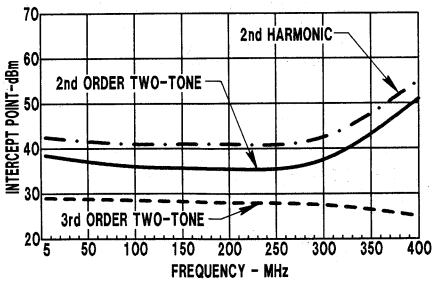

### VSWR



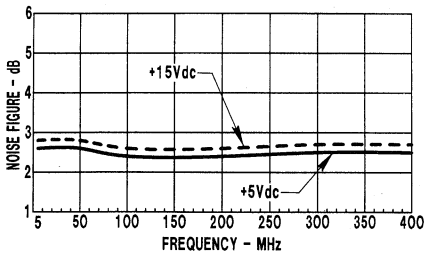




### Intercept Point




### Noise Figure




*at 1 dB Gain Compression

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.246 W
Junction Temperature Rise Above Case $T_{jc}$ ... 11°C

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.0 | 2.3 | 28.0 |
| 5.0 | 1.5 | 1.4 | 28.2 |
| 10.0 | 1.4 | 1.2 | 28.4 |
| 50.0 | 1.3 | 1.2 | 28.7 |
| 100.0 | 1.2 | 1.1 | 28.8 |
| 150.0 | 1.2 | 1.1 | 28.8 |
| 200.0 | 1.1 | 1.4 | 28.8 |
| 250.0 | 1.1 | 1.7 | 28.5 |
| 300.0 | 1.1 | 2.3 | 28.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .323 | 170 | 25.122 | 37 | .007 | 26 | .401 | 123 |
| 5.0 | .191 | 160 | 25.852 | 13 | .012 | 11 | .159 | 77 |
| 10.0 | .150 | 161 | 26.203 | 4 | .012 | 4 | .105 | 50 |
| 50.0 | .122 | 155 | 27.197 | –19 | .012 | –3 | .074 | –7 |
| 100.0 | .108 | 134 | 27.477 | –41 | .012 | –9 | .027 | –50 |
| 150.0 | .083 | 115 | 27.619 | –63 | .012 | –14 | .057 | 155 |
| 200.0 | .052 | 91 | 27.649 | –87 | .013 | –20 | .158 | 128 |
| 250.0 | .033 | 41 | 26.694 | –110 | .012 | –26 | .271 | 110 |
| 300.0 | .025 | –39 | 25.840 | –135 | .011 | –29 | .389 | 93 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.8 | 2.3 | 27.8 |
| 5.0 | 1.4 | 1.4 | 27.9 |
| 10.0 | 1.3 | 1.2 | 28.0 |
| 50.0 | 1.2 | 1.1 | 28.3 |
| 100.0 | 1.2 | 1.0 | 28.4 |
| 150.0 | 1.1 | 1.1 | 28.4 |
| 200.0 | 1.1 | 1.4 | 28.4 |
| 250.0 | 1.1 | 1.8 | 28.1 |
| 300.0 | 1.1 | 2.3 | 27.9 |

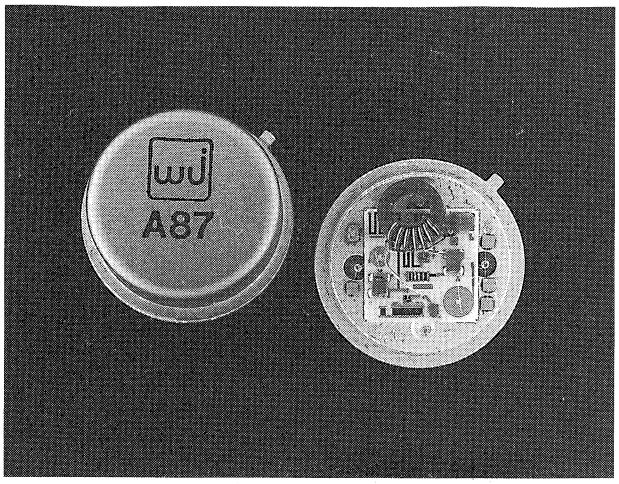
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .288 | 167 | 24.410 | 36 | .008 | 29 | .400 | 123 |
| 5.0 | .160 | 157 | 24.819 | 12 | .012 | 11 | .155 | 79 |
| 10.0 | .126 | 157 | 25.119 | 4 | .013 | 4 | .100 | 53 |
| 50.0 | .099 | 151 | 26.023 | –18 | .013 | –3 | .066 | –5 |
| 100.0 | .086 | 130 | 26.272 | –41 | .013 | –9 | .019 | –52 |
| 150.0 | .064 | 103 | 26.431 | –63 | .012 | –15 | .062 | 151 |
| 200.0 | .037 | 64 | 26.435 | –86 | .013 | –19 | .160 | 127 |
| 250.0 | .034 | 4 | 25.534 | –110 | .012 | –25 | .273 | 110 |
| 300.0 | .046 | –55 | 24.771 | –134 | .012 | –31 | .391 | 93 |

# WJ-A87 / SMA87

## 10 to 400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +17 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +32 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS




## Specifications *

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed - 54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-450 MHz | 10-400 MHz | 10-400 MHz |
| Small Signal Gain (Min.) | 12.5 dB | 12.0 dB | 11.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 4.7 dB | 5.5 dB | 6.0 dB |
| Power Output at 1 dB Compression (Min.) | +17.0 dBm | +16.0 dBm | +16.0 dBm |
| VSWR (Max.) | | | |
| Input | < 1.3:1 | 1.7:1 | 2.0:1 |
| Output | < 1.6:1 | 2.0:1[1] | 2.01[2] |
| DC Current (Max.) at 15 Volts | 31 mA | 35 mA | 37 mA |

*Meausured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA87 is a standard WJ-A87 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. Up to 350 MHz; 2.2:1 Max. from 350 to 400 MHz.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+52 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+32 dBm (Typ.)

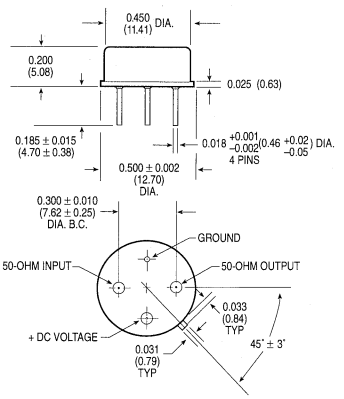
## Absolute Maximum Ratings

Storage Temperature. .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

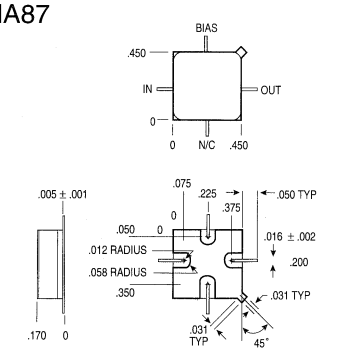
## Outline Drawings

A87



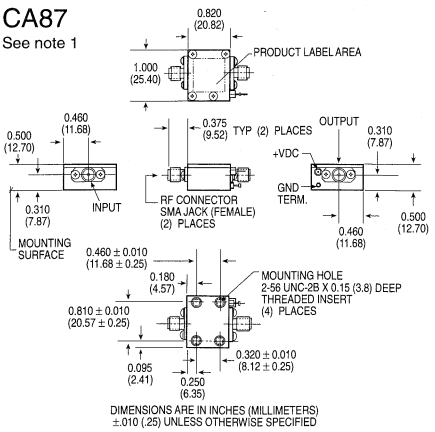

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA87




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CA87
See note 1

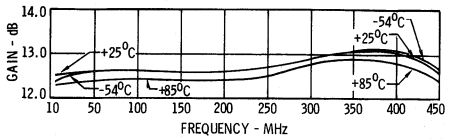



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

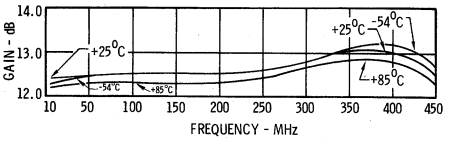
# Typical Performance at 25°C

## Gain

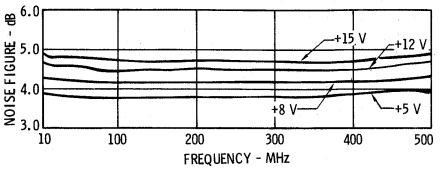
### $V_{CC}$ = 15 V



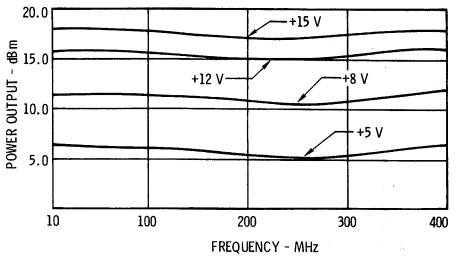

### $V_{CC}$ = 12 V



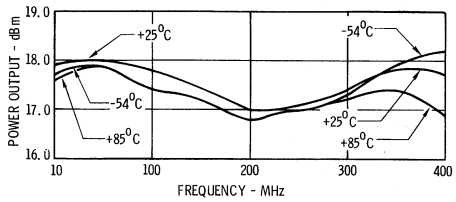

## Noise Figure



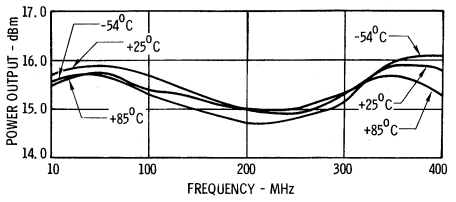

## Power Output *




### $V_{CC}$ = 15 V

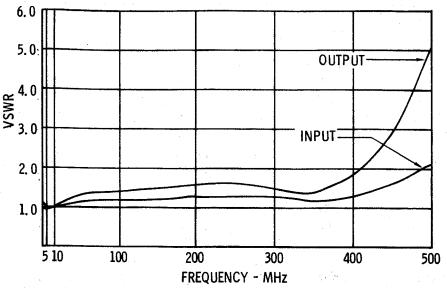



### $V_{CC}$ = 12 V

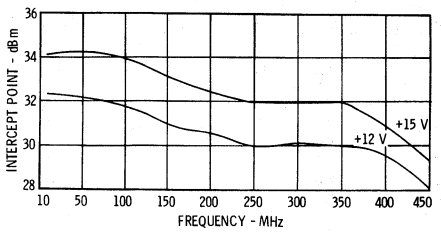



*at 1 dB Gain Compression

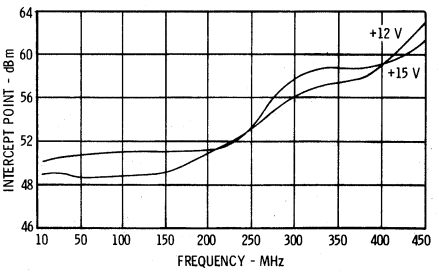
## VSWR



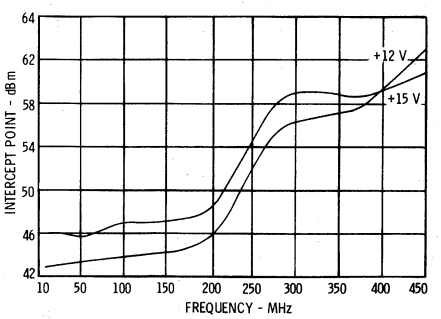

## Third Order Two Tone Intercept Point



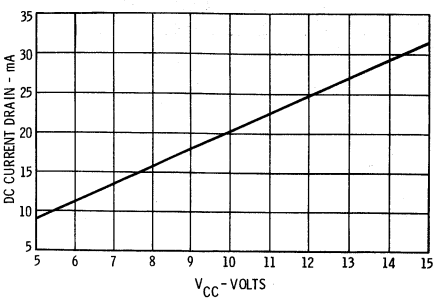

## Second Order Harmonic Intercept Point




## Second Order Two Tone Intercept Point




## Current Drain vs. Control Voltage



# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.1 | 13.4 |
| 5.0 | 1.2 | 1.3 | 13.2 |
| 10.0 | 1.1 | 1.2 | 13.1 |
| 50.0 | 1.1 | 1.1 | 13.3 |
| 100.0 | 1.0 | 1.1 | 13.3 |
| 150.0 | 1.0 | 1.2 | 13.3 |
| 200.0 | 1.1 | 1.2 | 13.4 |
| 250.0 | 1.1 | 1.3 | 13.5 |
| 300.0 | 1.1 | 1.4 | 13.7 |
| 350.0 | 1.1 | 1.6 | 13.7 |
| 400.0 | 1.1 | 1.8 | 14.0 |
| 450.0 | 1.1 | 2.2 | 13.8 |
| 500.0 | 1.1 | 2.7 | 13.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .264 | –86 | 4.682 | –157 | .108 | 21 | .355 | 126 |
| 5.0 | .098 | –96 | 4.549 | –173 | .121 | 7 | .141 | 119 |
| 10.0 | .059 | –108 | 4.533 | –178 | .123 | 3 | .084 | 124 |
| 50.0 | .032 | –155 | 4.624 | 168 | .126 | –6 | .029 | 177 |
| 100.0 | .021 | –178 | 4.604 | 155 | .125 | –14 | .052 | –163 |
| 150.0 | .017 | –143 | 4.615 | 142 | .123 | –21 | .079 | –175 |
| 200.0 | .028 | –141 | 4.679 | 129 | .123 | –28 | .105 | 168 |
| 250.0 | .037 | –137 | 4.715 | 116 | .121 | –35 | .135 | 149 |
| 300.0 | .047 | –139 | 4.823 | 102 | .120 | –42 | .172 | 128 |
| 350.0 | .055 | –144 | 4.870 | 87 | .119 | –50 | .220 | 107 |
| 400.0 | .055 | –153 | 4.991 | 70 | .117 | –58 | .283 | 83 |
| 450.0 | .051 | –170 | 4.891 | 54 | .115 | –67 | .365 | 59 |
| 500.0 | .045 | 179 | 4.833 | 35 | .109 | –76 | .466 | 34 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.1 | 13.3 |
| 5.0 | 1.2 | 1.3 | 13.1 |
| 10.0 | 1.1 | 1.2 | 13.1 |
| 50.0 | 1.1 | 1.1 | 13.2 |
| 100.0 | 1.0 | 1.1 | 13.2 |
| 150.0 | 1.0 | 1.2 | 13.2 |
| 200.0 | 1.1 | 1.3 | 13.3 |
| 250.0 | 1.1 | 1.3 | 13.3 |
| 300.0 | 1.1 | 1.5 | 13.6 |
| 350.0 | 1.1 | 1.6 | 13.6 |
| 400.0 | 1.1 | 1.9 | 13.8 |
| 450.0 | 1.1 | 2.3 | 13.6 |
| 500.0 | 1.1 | 2.9 | 13.5 |
| 550.0 | 1.0 | 3.9 | 12.8 |
| 600.0 | 1.1 | 5.5 | 12.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .263 | –85 | 4.647 | –157 | .109 | 22 | .360 | 124 |
| 5.0 | .098 | –94 | 4.510 | –172 | .121 | 7 | .139 | 117 |
| 10.0 | .059 | –101 | 4.503 | –178 | .124 | 3 | .080 | 120 |
| 50.0 | .026 | –157 | 4.570 | 168 | .126 | –6 | .025 | –174 |
| 100.0 | .019 | –165 | 4.560 | 155 | .126 | –14 | .054 | –156 |
| 150.0 | .015 | –129 | 4.555 | 142 | .124 | –20 | .084 | –170 |
| 200.0 | .031 | –130 | 4.626 | 129 | .123 | –28 | .113 | 172 |
| 250.0 | .038 | –128 | 4.634 | 115 | .123 | –34 | .146 | 152 |
| 300.0 | .051 | –131 | 4.765 | 101 | .121 | –42 | .185 | 130 |
| 350.0 | .060 | –143 | 4.793 | 86 | .121 | –50 | .237 | 108 |
| 400.0 | .058 | –149 | 4.893 | 70 | .119 | –58 | .301 | 84 |
| 450.0 | .061 | –170 | 4.807 | 53 | .116 | –66 | .386 | 59 |
| 500.0 | .049 | –177 | 4.705 | 34 | .111 | –75 | .485 | 34 |

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.2 | 13.2 |
| 5.0 | 1.2 | 1.3 | 12.9 |
| 10.0 | 1.1 | 1.2 | 12.9 |
| 50.0 | 1.0 | 1.0 | 13.0 |
| 100.0 | 1.0 | 1.1 | 12.9 |
| 150.0 | 1.0 | 1.2 | 13.0 |
| 200.0 | 1.1 | 1.3 | 13.1 |
| 250.0 | 1.1 | 1.4 | 13.1 |
| 300.0 | 1.1 | 1.5 | 13.3 |
| 350.0 | 1.2 | 1.7 | 13.3 |
| 400.0 | 1.2 | 2.0 | 13.5 |
| 450.0 | 1.2 | 2.4 | 13.2 |
| 500.0 | 1.1 | 3.1 | 12.9 |
| 550.0 | 1.1 | 4.2 | 12.2 |
| 600.0 | 1.0 | 5.9 | 11.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .269 | –82 | 4.567 | –156 | .111 | 23 | .369 | 122 |
| 5.0 | .098 | –86 | 4.419 | –172 | .124 | 8 | .136 | 110 |
| 10.0 | .053 | –87 | 4.405 | –178 | .126 | 3 | .074 | 111 |
| 50.0 | .018 | –121 | 4.458 | 168 | .128 | –6 | .018 | –141 |
| 100.0 | .013 | –108 | 4.439 | 154 | .128 | –13 | .058 | –141 |
| 150.0 | .024 | –84 | 4.455 | 141 | .126 | –20 | .094 | –161 |
| 200.0 | .038 | –110 | 4.515 | 128 | .126 | –27 | .126 | 178 |
| 250.0 | .053 | –112 | 4.505 | 114 | .125 | –34 | .164 | 156 |
| 300.0 | .066 | –126 | 4.606 | 100 | .125 | –41 | .206 | 133 |
| 350.0 | .077 | –134 | 4.622 | 84 | .124 | –49 | .262 | 109 |
| 400.0 | .078 | –143 | 4.715 | 68 | .123 | –57 | .330 | 84 |
| 450.0 | .077 | –162 | 4.567 | 51 | .121 | –66 | .416 | 58 |
| 500.0 | .064 | –175 | 4.431 | 32 | .115 | –74 | .515 | 33 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.8 | 2.3 | 12.8 |
| 5.0 | 1.2 | 1.3 | 12.5 |
| 10.0 | 1.1 | 1.2 | 12.5 |
| 50.0 | 1.1 | 1.1 | 12.6 |
| 100.0 | 1.1 | 1.1 | 12.6 |
| 150.0 | 1.1 | 1.2 | 12.5 |
| 200.0 | 1.1 | 1.3 | 12.7 |
| 250.0 | 1.2 | 1.4 | 12.6 |
| 300.0 | 1.2 | 1.6 | 12.8 |
| 350.0 | 1.2 | 1.8 | 12.7 |
| 400.0 | 1.2 | 2.1 | 12.8 |
| 450.0 | 1.2 | 2.6 | 12.5 |
| 500.0 | 1.2 | 3.4 | 12.1 |

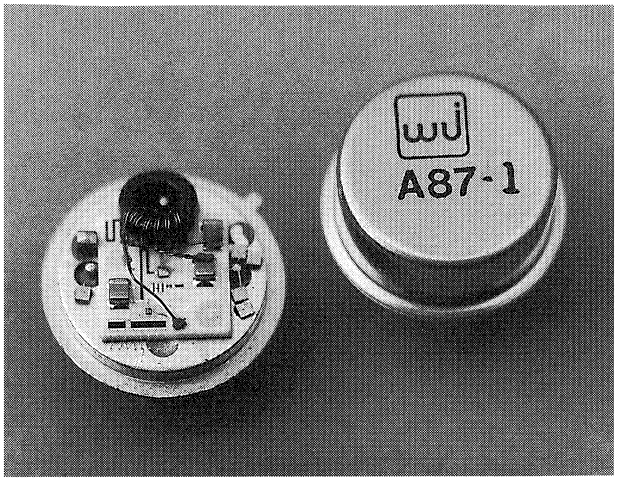
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .276 | –76 | 4.386 | –155 | .115 | 24 | .387 | 118 |
| 5.0 | .102 | –70 | 4.232 | –172 | .128 | 8 | .134 | 99 |
| 10.0 | .064 | –60 | 4.215 | –178 | .130 | 3 | .070 | 91 |
| 50.0 | .030 | –49 | 4.279 | 168 | .132 | –6 | .025 | –70 |
| 100.0 | .035 | –49 | 4.254 | 154 | .132 | –13 | .068 | –120 |
| 150.0 | .051 | –62 | 4.235 | 140 | .131 | –20 | .106 | –148 |
| 200.0 | .066 | –88 | 4.311 | 126 | .130 | –27 | .143 | –173 |
| 250.0 | .083 | –101 | 4.278 | 112 | .130 | –33 | .184 | 162 |
| 300.0 | .095 | –114 | 4.376 | 97 | .130 | –41 | .230 | 137 |
| 350.0 | .103 | –127 | 4.336 | 81 | .130 | –48 | .289 | 112 |
| 400.0 | .107 | –137 | 4.382 | 64 | .129 | –56 | .362 | 85 |
| 450.0 | .107 | –155 | 4.196 | 47 | .127 | –65 | .446 | 58 |
| 500.0 | .095 | –167 | 4.042 | 28 | .122 | –74 | .543 | 32 |

## Thermal Data: $V_{CC}$ =15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.278 W
Junction Temperature Rise Above Case $T_{jc}$ ... 13°C

# WJ-A87-1 / SMA87-1




## 10 to 400 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT LEVEL: +17 dBm (TYP.)
- ◆ HIGH EFFICIENCY: 33 mA @ +15 VDC (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +31 dBm (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +15 VOLTS

## Specifications*

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-450 MHz | 10-400 MHz | 10-400 MHz |
| Small Signal Gain (Min.) | 15.5 dB | 14.5 dB | 14.0 dB |
| Gain Flatness (Max.) | ±.5 dB | ±.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.6 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| Vcc = +15 Volts | +17.0 dBm | +15.5 dBm | +15.0 dBm |
| Vcc = +12 Volts | +15.0 dBm | +13.7 dBm | +13.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current at (Max.) 15 Volts | 33 mA | 35 mA | 37 mA |

*Measured in a 50 ohm system at +15 Vdc.
Notes:
1. WJ-CA87-1 is a standard WJ-A87-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....>+47 dBm (Typ.)
Second Order Two Tone Intercept Point .....>+42 dBm (Typ.)
Third-Order Two Tone Intercept Point .....>+31 dBm (Typ.)

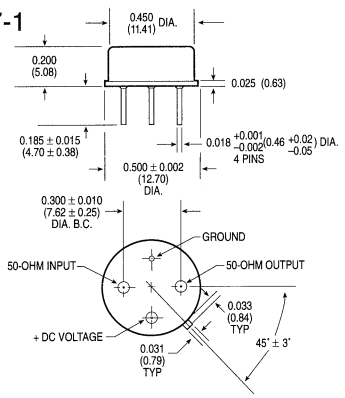
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+ 17 Vdc
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 milliwatts
Maximum Peak Power ..... 0.5 Watts (3 µsec Max.)
"S"Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

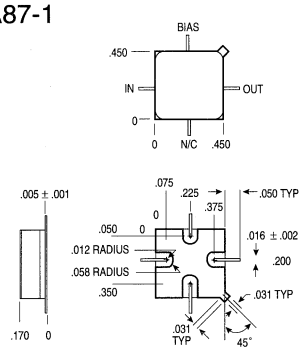
## Outline Drawings

A87-1



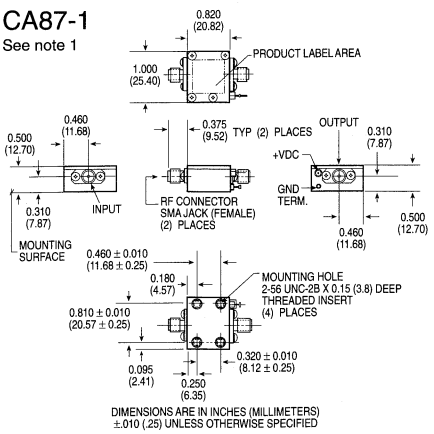

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA87-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

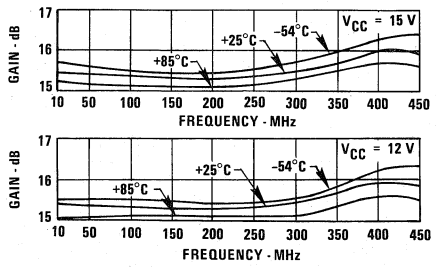
CA87-1
See note 1



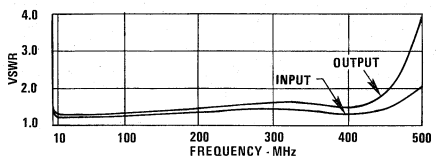

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

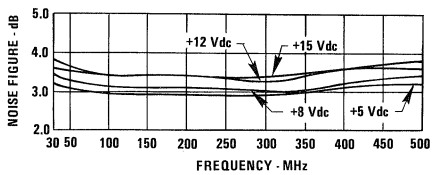
### Gain



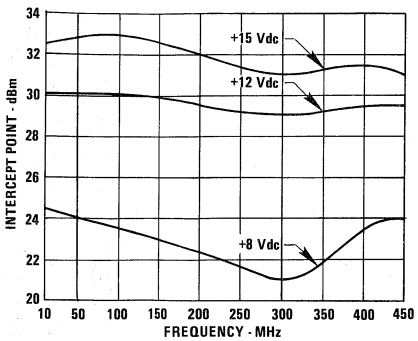

### VSWR



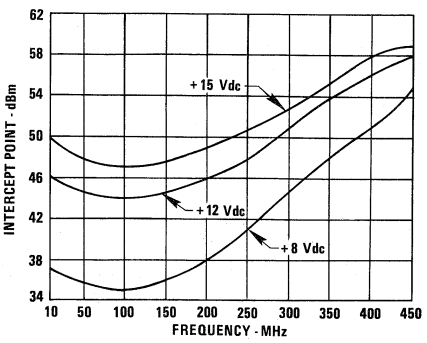

### Noise Figure



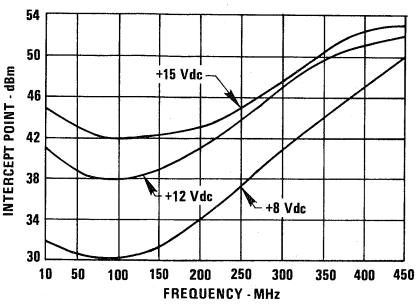

### Third Order Two-Tone Intercept Point



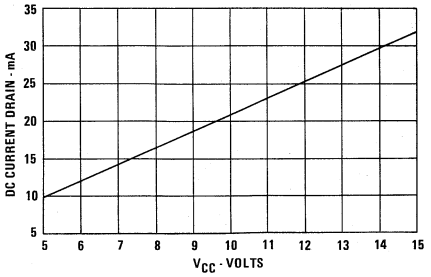

### Second Order Harmonic Intercept Point



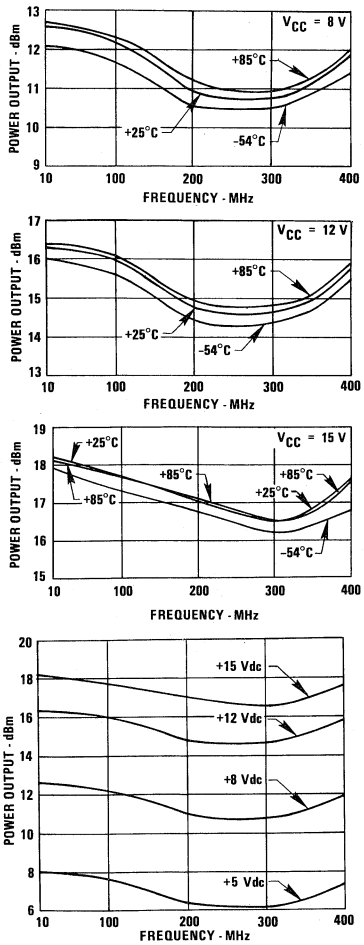

### Second Order Two-Tone Intercept Point




### Current Drain




### Power Output*




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.0 | 16.5 |
| 5.0 | 1.2 | 1.4 | 16.2 |
| 10.0 | 1.1 | 1.2 | 16.2 |
| 50.0 | 1.1 | 1.2 | 16.3 |
| 100.0 | 1.1 | 1.3 | 16.2 |
| 150.0 | 1.1 | 1.4 | 16.2 |
| 200.0 | 1.1 | 1.5 | 16.2 |
| 250.0 | 1.2 | 1.6 | 16.1 |
| 300.0 | 1.2 | 1.7 | 16.3 |
| 350.0 | 1.3 | 1.7 | 16.4 |
| 400.0 | 1.3 | 1.7 | 16.7 |
| 450.0 | 1.3 | 1.6 | 16.7 |
| 500.0 | 1.4 | 1.7 | 16.8 |
| 550.0 | 1.3 | 2.0 | 16.5 |
| 600.0 | 1.2 | 2.9 | 15.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .259 | –98 | 6.708 | –161 | .086 | 18 | .323 | 133 |
| 5.0 | .105 | –118 | 6.475 | –174 | .094 | 6 | .151 | 139 |
| 10.0 | .070 | –137 | 6.459 | –179 | .096 | 3 | .109 | 151 |
| 50.0 | .060 | 158 | 6.529 | 168 | .098 | –6 | .086 | –164 |
| 100.0 | .064 | 114 | 6.486 | 154 | .097 | –14 | .128 | –152 |
| 150.0 | .063 | 72 | 6.421 | 140 | .095 | –21 | .173 | –156 |
| 200.0 | .062 | 37 | 6.452 | 127 | .094 | –27 | .210 | –165 |
| 250.0 | .074 | 4 | 6.413 | 113 | .093 | –34 | .238 | –177 |
| 300.0 | .094 | –28 | 6.545 | 100 | .092 | –40 | .252 | 168 |
| 350.0 | .116 | –53 | 6.583 | 86 | .092 | –47 | .259 | 151 |
| 400.0 | .137 | –76 | 6.826 | 70 | .092 | –54 | .251 | 128 |
| 450.0 | .148 | –102 | 6.834 | 53 | .093 | –62 | .239 | 95 |
| 500.0 | .158 | –129 | 6.947 | 35 | .093 | –71 | .256 | 50 |
| 550.0 | .139 | –156 | 6.717 | 14 | .092 | –83 | .342 | 1 |
| 600.0 | .092 | 179 | 6.208 | –9 | .085 | –95 | .493 | –38 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.0 | 15.7 |
| 5.0 | 1.2 | 1.3 | 15.4 |
| 10.0 | 1.1 | 1.1 | 15.3 |
| 50.0 | 1.0 | 1.1 | 15.4 |
| 100.0 | 1.1 | 1.3 | 15.3 |
| 150.0 | 1.2 | 1.5 | 15.2 |
| 200.0 | 1.2 | 1.7 | 15.1 |
| 250.0 | 1.3 | 1.9 | 15.0 |
| 300.0 | 1.3 | 1.9 | 15.1 |
| 350.0 | 1.4 | 2.0 | 15.1 |
| 400.0 | 1.5 | 1.9 | 15.4 |
| 450.0 | 1.6 | 1.9 | 15.2 |
| 500.0 | 1.6 | 2.0 | 15.2 |
| 550.0 | 1.5 | 2.4 | 14.8 |
| 600.0 | 1.4 | 3.5 | 13.8 |

### Linear S-Parameters

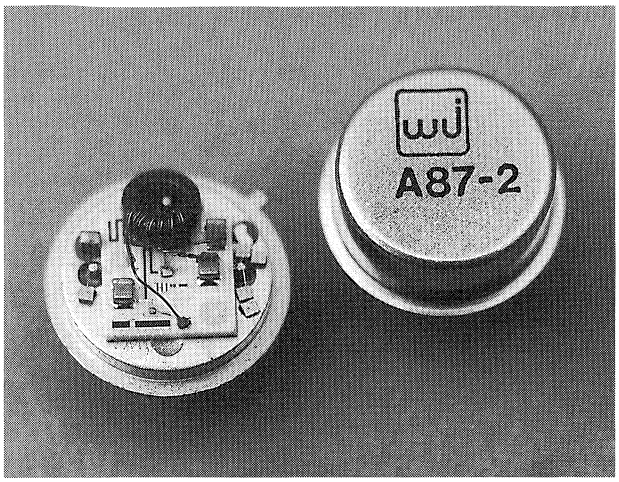
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .259 | –80 | 6.085 | –159 | .094 | 19 | .325 | 121 |
| 5.0 | .097 | –74 | 5.859 | –173 | .102 | 7 | .119 | 114 |
| 10.0 | .055 | –66 | 5.849 | –178 | .104 | 3 | .060 | 118 |
| 50.0 | .020 | 11 | 5.911 | 167 | .106 | –6 | .062 | –112 |
| 100.0 | .046 | 25 | 5.820 | 152 | .105 | –14 | .145 | –124 |
| 150.0 | .077 | 3 | 5.729 | 138 | .103 | –20 | .212 | –140 |
| 200.0 | .092 | –18 | 5.695 | 124 | .102 | –26 | .264 | –156 |
| 250.0 | .120 | –38 | 5.630 | 110 | .101 | –32 | .301 | –172 |
| 300.0 | .145 | –56 | 5.701 | 97 | .101 | –39 | .320 | 170 |
| 350.0 | .175 | –76 | 5.667 | 81 | .103 | –45 | .329 | 150 |
| 400.0 | .203 | –93 | 5.857 | 66 | .104 | –52 | .321 | 125 |
| 450.0 | .219 | –116 | 5.765 | 49 | .108 | –60 | .312 | 91 |
| 500.0 | .227 | –138 | 5.773 | 29 | .108 | –71 | .331 | 47 |
| 550.0 | .205 | –161 | 5.465 | 8 | .108 | –84 | .415 | 0 |
| 600.0 | .155 | 177 | 4.906 | –14 | .101 | –97 | .552 | –39 |

## Thermal Data: $V_{CC}$ =15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.248 W
Junction Temperature Rise Above Case $T_{jc}$ ... 11°C

*at 1 dB Gain Compression

# WJ-A87-2 / SMA87-2




## 10 to 300 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW NOISE FIGURE: 3.0 dB (TYP.)
- ◆ LOW VSWR: <1.5.1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-350 MHz | 10-300 MHz | 10-300 MHz |
| Small Signal Gain (Min.) | 15.5 dB | 15.0 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.8 dB |
| Noise Figure (Max.) | 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +9.5 dBm | +9.0 dBm | +8.5 dBm |
| VSWR (Max.) | | | |
| Input/Output | <1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at +5 Volts | 14.5 mA | 17 mA | 18 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-CA87-2 is a standard WJ-A87-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+37 dBm (Typ.)
Second Order Two Tone Intercept Point.....+31 dBm (Typ.)
Third Order Two Tone Intercept Point.....+23 dBm (Typ.)

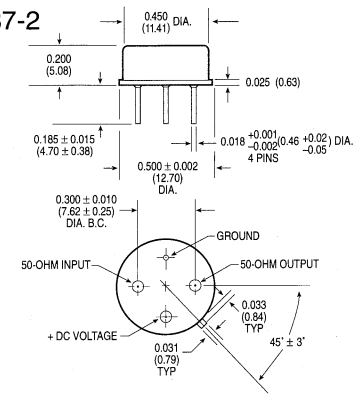
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+10 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S"Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

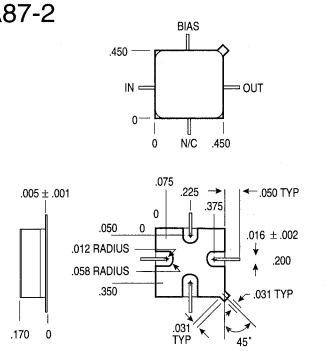
## Outline Drawings

A87-2



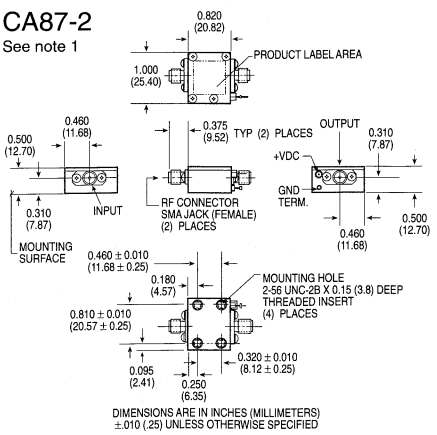

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA87-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

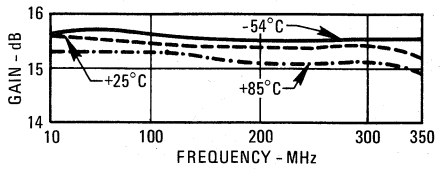
CA87-2
See note 1



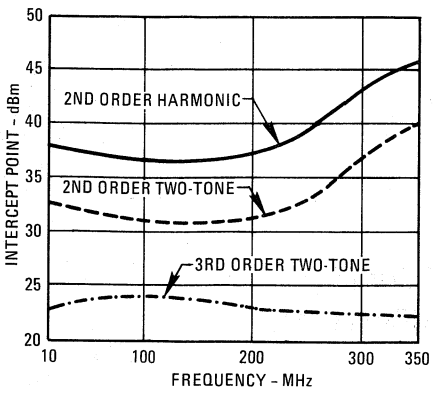

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

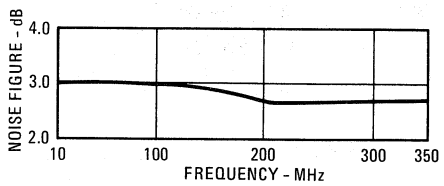
### Gain



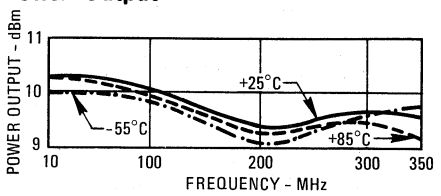

### Intercept Point




### Noise Figure

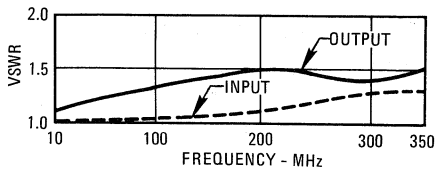



### Power Output*




*at 1 dB Gain Compression

### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.0 | 2.4 | 16.4 |
| 5.0 | 1.3 | 1.3 | 16.2 |
| 10.0 | 1.1 | 1.2 | 16.1 |
| 50.0 | 1.1 | 1.1 | 16.2 |
| 100.0 | 1.1 | 1.3 | 16.1 |
| 150.0 | 1.1 | 1.3 | 16.1 |
| 200.0 | 1.1 | 1.3 | 16.2 |
| 250.0 | 1.2 | 1.2 | 16.3 |
| 300.0 | 1.4 | 1.3 | 16.3 |
| 350.0 | 1.6 | 2.0 | 16.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .335 | –82 | 6.584 | –153 | .079 | 26 | .406 | 128 |
| 5.0 | .119 | –98 | 6.445 | –172 | .092 | 8 | .146 | 115 |
| 10.0 | .063 | –109 | 6.412 | –178 | .094 | 3 | .075 | 122 |
| 50.0 | .027 | 149 | 6.459 | 162 | .095 | –10 | .055 | –133 |
| 100.0 | .033 | 68 | 6.410 | 143 | .095 | –21 | .116 | –141 |
| 150.0 | .038 | –2 | 6.360 | 125 | .094 | –32 | .144 | –161 |
| 200.0 | .050 | –62 | 6.470 | 105 | .095 | –43 | .131 | 174 |
| 250.0 | .088 | –108 | 6.522 | 85 | .096 | –56 | .081 | 122 |
| 300.0 | .156 | –151 | 6.559 | 61 | .097 | –71 | .132 | 13 |
| 350.0 | .237 | 168 | 6.348 | 34 | .092 | –90 | .339 | –36 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.1 | 2.5 | 16.1 |
| 5.0 | 1.3 | 1.3 | 15.9 |
| 10.0 | 1.1 | 1.1 | 15.8 |
| 50.0 | 1.0 | 1.1 | 15.9 |
| 100.0 | 1.1 | 1.3 | 15.8 |
| 150.0 | 1.1 | 1.4 | 15.7 |
| 200.0 | 1.2 | 1.4 | 15.8 |
| 250.0 | 1.3 | 1.2 | 15.9 |
| 300.0 | 1.4 | 1.3 | 15.9 |
| 350.0 | 1.7 | 2.1 | 15.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .677 | –51 | 5.386 | –116 | .014 | 47 | .824 | 172 |
| 2.0 | .350 | –77 | 6.369 | –151 | .080 | 27 | .424 | 125 |
| 5.0 | .121 | –86 | 6.254 | –172 | .095 | 8 | .143 | 105 |
| 10.0 | .061 | –83 | 6.188 | –178 | .097 | 3 | .066 | 105 |
| 50.0 | .007 | 62 | 6.243 | 162 | .098 | –9 | .060 | –112 |
| 100.0 | .039 | 22 | 6.160 | 142 | .098 | –21 | .131 | –134 |
| 150.0 | .064 | –16 | 6.115 | 123 | .097 | –32 | .166 | –157 |
| 200.0 | .080 | –62 | 6.197 | 104 | .098 | –43 | .156 | 174 |
| 250.0 | .116 | –104 | 6.222 | 83 | .100 | –55 | .108 | 124 |
| 300.0 | .175 | –144 | 6.259 | 58 | .102 | –70 | .146 | 23 |
| 350.0 | .246 | 173 | 6.007 | 31 | .099 | –90 | .356 | –33 |

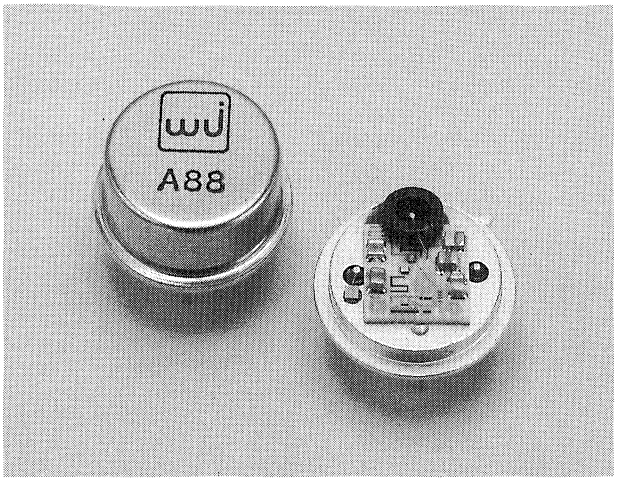
# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.033 W
Junction Temperature Rise Above Case $T_{jc}$ ... 1°C

# WJ-A88 / SMA88

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 18.7 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +20.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)




## Specifications*

| Characteristics | Typical | 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 2-500 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 18.7 dB | 18.0 dB | 17.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| Vcc= +15 V | 6.5 dB | 7.5 dB | 8.0 dB |
| Vcc= +12 V | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +20.5 dBm | +19.5 dBm | +19.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 79 mA | 83 mA | 87 mA |

*Measured in a 50-ohm system at 15 Vdc.

Notes:
1. WJ-CA88 is a standard WJ-A88 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+41 dBm (Typ.)
Second Order Two Tone Intercept Point..... +38 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

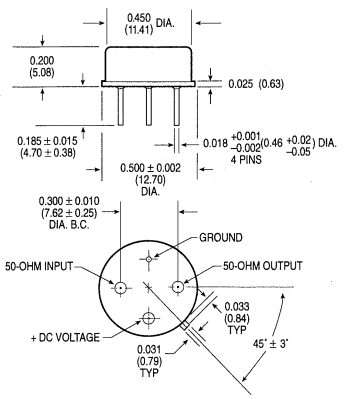
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage..... +17 Volts
Maximum Continuous RF Power ..... +13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07oz.)

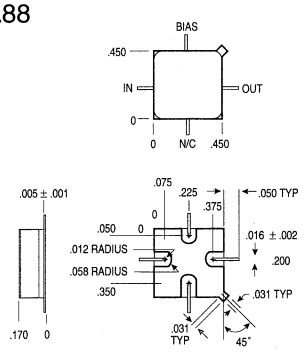
## Outline Drawings

A88



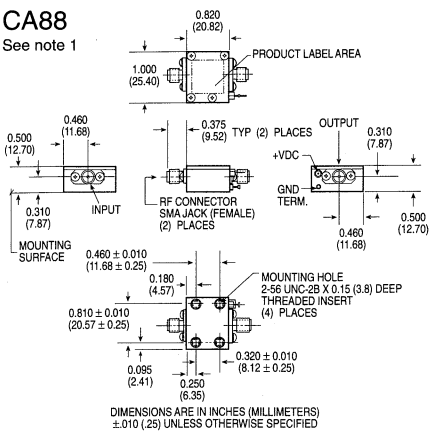

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA88




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

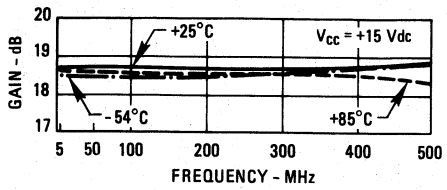
CA88
See note 1

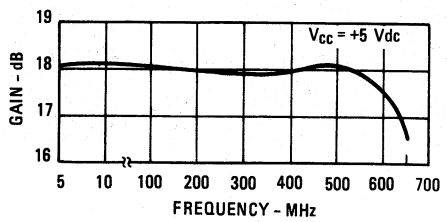



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

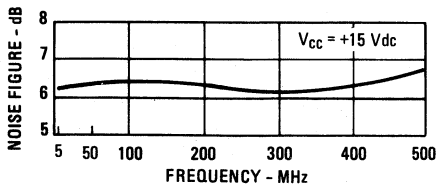
# Typical Performance at 25°C

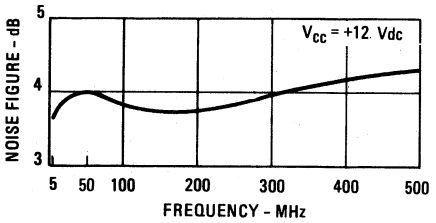
### Gain

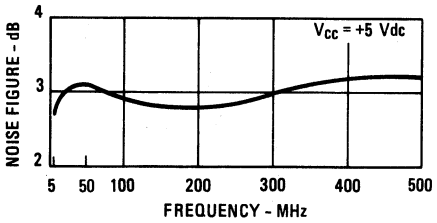


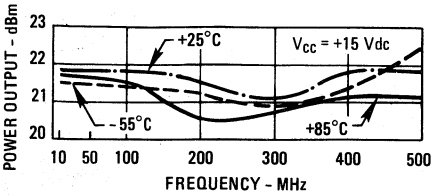

### Noise Figure

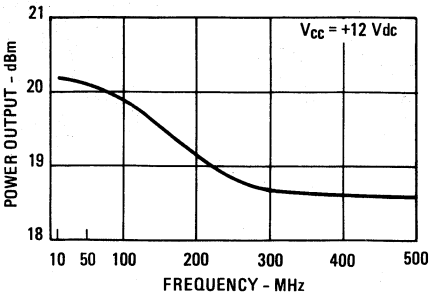


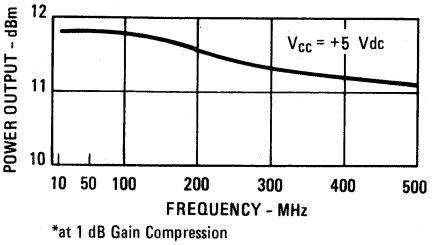




### Power Output*

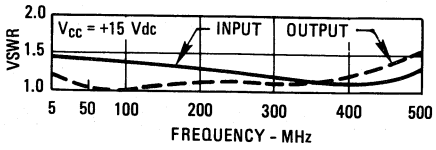


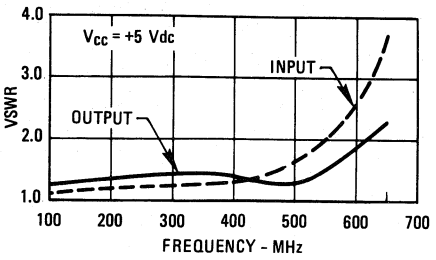



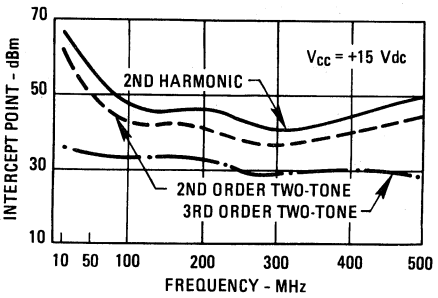

*at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### Vcc = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 2.0 | 17.7 |
| 2.0 | 1.5 | 1.4 | 18.6 |
| 5.0 | 1.3 | 1.1 | 18.7 |
| 10.0 | 1.3 | 1.1 | 18.7 |
| 50.0 | 1.3 | 1.0 | 18.7 |
| 100.0 | 1.2 | 1.0 | 18.6 |
| 200.0 | 1.2 | 1.0 | 18.6 |
| 300.0 | 1.1 | 1.1 | 18.7 |
| 400.0 | 1.1 | 1.2 | 18.8 |
| 500.0 | 1.2 | 1.4 | 19.0 |
| 600.0 | 1.3 | 1.9 | 18.8 |

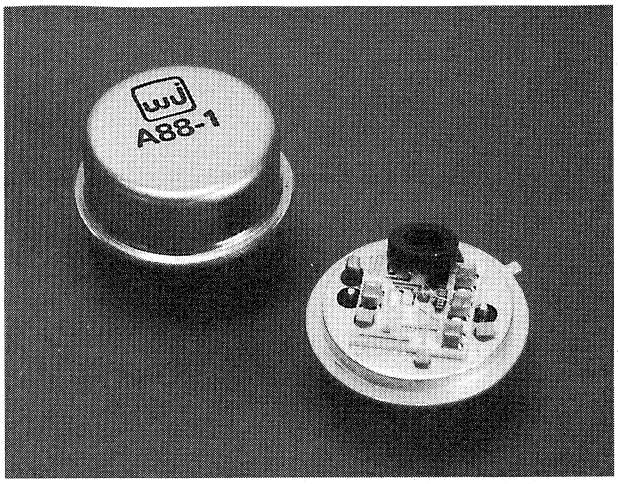
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .327 | –86 | 7.630 | –139 | .062 | 45 | .341 | 166 |
| 2.0 | .199 | –121 | 8.491 | –161 | .072 | 22 | .155 | 127 |
| 5.0 | .130 | –153 | 8.562 | –174 | .073 | 8 | .059 | 115 |
| 10.0 | .121 | –168 | 8.572 | –179 | .073 | 4 | .033 | 117 |
| 50.0 | .119 | 161 | 8.592 | 167 | .073 | –2 | .010 | 126 |
| 100.0 | .107 | 135 | 8.528 | 154 | .074 | –6 | .008 | 146 |
| 200.0 | .083 | 93 | 8.521 | 127 | .077 | –14 | .016 | 159 |
| 300.0 | .052 | 35 | 8.574 | 100 | .080 | –22 | .038 | 140 |
| 400.0 | .042 | –61 | 8.751 | 72 | .085 | –31 | .084 | 117 |
| 500.0 | .071 | –154 | 8.877 | 41 | .093 | –42 | .168 | 83 |
| 600.0 | .117 | 117 | 8.742 | 6 | .102 | –58 | .322 | 46 |

# Thermal Data: $V_{CC}$ =15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.706 W
Junction Temperature Rise Above Case $T_{jc}$ ... 32°C

# WJ-A88-1 / SMA88-1




## 5 to 300 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN: 18.5 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +18.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +30 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to +50°C | -54° to +85°C |
| Frequency (Min.) | 2-300 MHz | 5-300 MHz | 5-300 MHz |
| Small Signal Gain (Min.) | 18.5 dB | 17.5 dB | 17.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.6 dB | ±0.8 dB |
| Noise Figure (Max.) | 3.8 dB | 5.0 dB | 5.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +18.5 dBm | +17.0 dBm | +16.5 dBm |
| VSWR (Max.) | | | |
| Input/Output | 1.4:1 | 1.7:1 | 1.9:1 |
| DC Current (Max.) at +15 Volts | 52 mA | 54.5 mA | 56.5 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CA88-1 is a standard WJ-A88-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+48 dBm (Typ.)
Second Order Two Tone Intercept Point.....+42 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

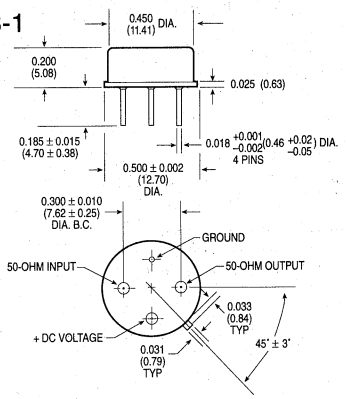
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°

Weight approximately 2.0 grams (0.07 oz.)

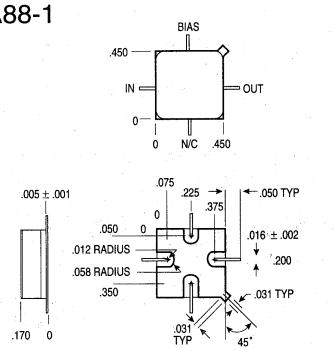
## Outline Drawings

A88-1



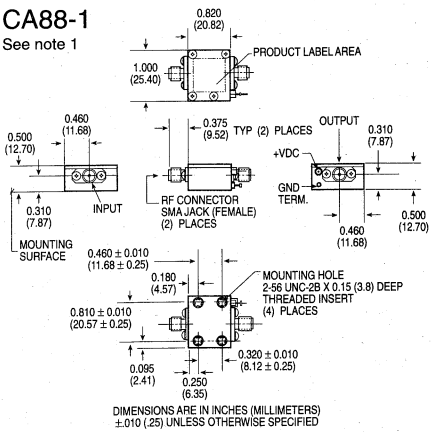

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA88-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

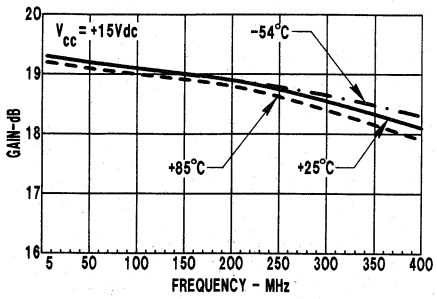
CA88-1
See note 1

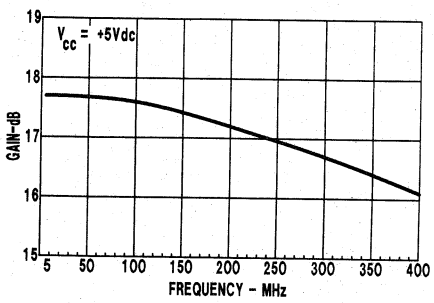



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

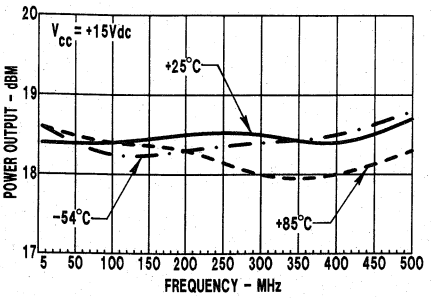
## Typical Performance at 25°C

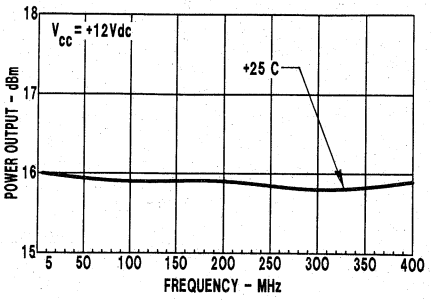
### Gain



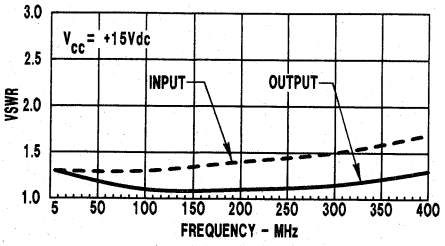



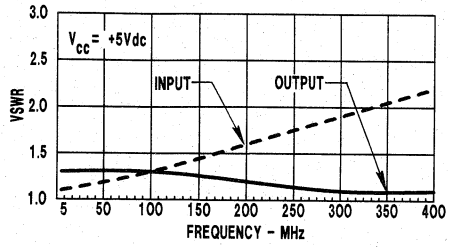

### Power Output*



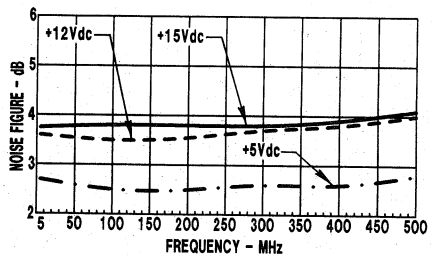



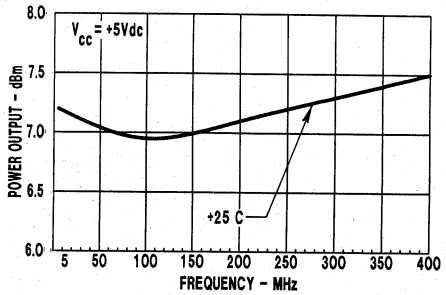

### VSWR



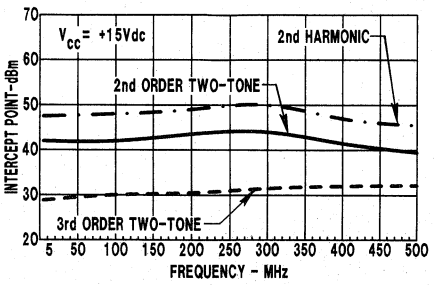

### Noise Figure




*at 1 dB Gain Compression

### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.7 | 18.6 |
| 2.0 | 1.5 | 1.2 | 19.3 |
| 5.0 | 1.3 | 1.1 | 19.3 |
| 10.0 | 1.3 | 1.1 | 19.3 |
| 50.0 | 1.3 | 1.1 | 19.4 |
| 100.0 | 1.3 | 1.1 | 19.3 |
| 150.0 | 1.3 | 1.1 | 19.2 |
| 200.0 | 1.4 | 1.1 | 19.0 |
| 250.0 | 1.4 | 1.2 | 18.9 |
| 300.0 | 1.5 | 1.2 | 18.7 |
| 350.0 | 1.5 | 1.2 | 18.5 |
| 400.0 | 1.6 | 1.3 | 18.4 |
| 450.0 | 1.6 | 1.3 | 18.1 |
| 500.0 | 1.7 | 1.3 | 17.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .333 | –92 | 8.516 | –141 | .061 | 43 | .270 | 164 |
| 2.0 | .194 | –129 | 9.227 | –162 | .067 | 20 | .110 | 125 |
| 5.0 | .143 | –156 | 9.268 | –174 | .067 | 8 | .043 | 108 |
| 10.0 | .132 | –166 | 9.276 | –178 | .068 | 4 | .027 | 100 |
| 50.0 | .132 | –177 | 9.314 | 171 | .068 | 0 | .025 | 71 |
| 100.0 | .132 | –177 | 9.186 | 161 | .069 | –1 | .039 | 62 |
| 150.0 | .135 | –173 | 9.078 | 152 | .070 | –2 | .053 | 56 |
| 200.0 | .154 | –172 | 8.942 | 142 | .071 | –3 | .067 | 47 |
| 250.0 | .168 | –171 | 8.767 | 133 | .072 | –5 | .079 | 40 |
| 300.0 | .187 | –172 | 8.590 | 124 | .074 | –6 | .094 | 33 |
| 350.0 | .203 | –175 | 8.440 | 115 | .075 | –8 | .106 | 24 |
| 400.0 | .218 | –175 | 8.275 | 106 | .078 | –9 | .117 | 14 |
| 450.0 | .244 | 179 | 8.045 | 98 | .080 | –12 | .129 | 5 |
| 500.0 | .265 | 177 | 7.840 | 89 | .082 | –14 | .141 | –5 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.393 W
Junction Temperature Rise Above Case $T_{jc}$ ... 18°C

# Typical Automatic Test Data

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.0 | 1.7 | 18.4 |
| 2.0 | 1.5 | 1.2 | 19.1 |
| 5.0 | 1.3 | 1.1 | 19.2 |
| 10.0 | 1.3 | 1.1 | 19.2 |
| 50.0 | 1.3 | 1.1 | 19.2 |
| 100.0 | 1.3 | 1.1 | 19.1 |
| 150.0 | 1.3 | 1.1 | 19.0 |
| 200.0 | 1.4 | 1.1 | 18.8 |
| 250.0 | 1.4 | 1.1 | 18.7 |
| 300.0 | 1.5 | 1.2 | 18.5 |
| 350.0 | 1.6 | 1.2 | 18.3 |
| 400.0 | 1.6 | 1.2 | 18.2 |
| 450.0 | 1.7 | 1.2 | 17.9 |
| 500.0 | 1.8 | 1.3 | 17.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .341 | –93 | 8.352 | –141 | .062 | 43 | .267 | 161 |
| 2.0 | .188 | –126 | 9.035 | –162 | .068 | 20 | .106 | 115 |
| 5.0 | .131 | –155 | 9.079 | –174 | .068 | 8 | .041 | 86 |
| 10.0 | .126 | –166 | 9.095 | –178 | .068 | 4 | .028 | 67 |
| 50.0 | .125 | –174 | 9.136 | 171 | .069 | 0 | .029 | 38 |
| 100.0 | .125 | –173 | 8.998 | 161 | .070 | –1 | .038 | 38 |
| 150.0 | .131 | –168 | 8.878 | 151 | .070 | –2 | .047 | 38 |
| 200.0 | .155 | –166 | 8.759 | 142 | .072 | –3 | .058 | 34 |
| 250.0 | .174 | –167 | 8.591 | 133 | .073 | –4 | .066 | 31 |
| 300.0 | .192 | –169 | 8.391 | 124 | .075 | –5 | .078 | 26 |
| 350.0 | .216 | –171 | 8.267 | 115 | .077 | –7 | .088 | 20 |
| 400.0 | .232 | –174 | 8.082 | 105 | .080 | –9 | .097 | 11 |
| 450.0 | .259 | –180 | 7.832 | 97 | .082 | –11 | .108 | 4 |
| 500.0 | .287 | 177 | 7.662 | 88 | .084 | –13 | .120 | –5 |

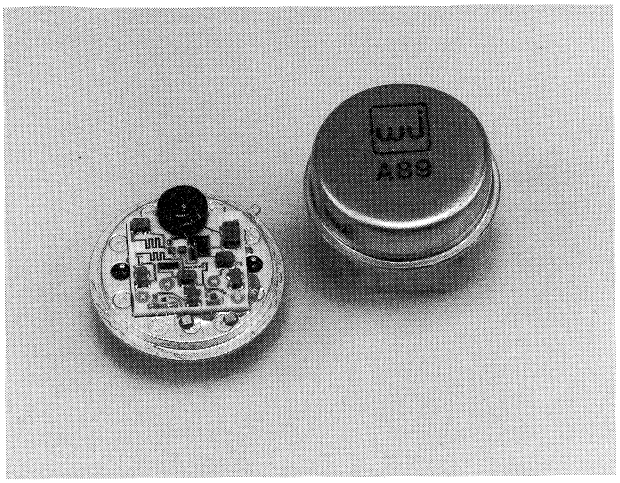
### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.9 | 1.7 | 17.2 |
| 2.0 | 1.3 | 1.4 | 17.8 |
| 5.0 | 1.1 | 1.3 | 17.8 |
| 10.0 | 1.1 | 1.3 | 17.8 |
| 50.0 | 1.1 | 1.3 | 17.9 |
| 100.0 | 1.2 | 1.3 | 17.7 |
| 150.0 | 1.3 | 1.3 | 17.5 |
| 200.0 | 1.5 | 1.2 | 17.4 |
| 250.0 | 1.6 | 1.2 | 17.1 |
| 300.0 | 1.8 | 1.2 | 16.9 |
| 350.0 | 2.0 | 1.2 | 16.7 |
| 400.0 | 2.1 | 1.1 | 16.4 |
| 450.0 | 2.3 | 1.1 | 16.1 |
| 500.0 | 2.4 | 1.1 | 15.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .303 | –77 | 7.225 | –140 | .071 | 43 | .270 | 138 |
| 2.0 | .129 | –91 | 7.781 | –162 | .077 | 19 | .151 | 67 |
| 5.0 | .050 | –98 | 7.775 | –174 | .078 | 7 | .123 | 26 |
| 10.0 | .035 | –96 | 7.797 | –178 | .078 | 4 | .122 | 13 |
| 50.0 | .056 | –110 | 7.808 | 170 | .079 | 0 | .128 | –6 |
| 100.0 | .095 | –115 | 7.678 | 159 | .080 | –1 | .125 | –17 |
| 150.0 | .146 | –119 | 7.541 | 149 | .081 | –2 | .118 | –28 |
| 200.0 | .201 | –133 | 7.389 | 139 | .083 | –2 | .109 | –38 |
| 250.0 | .245 | –140 | 7.197 | 129 | .085 | –4 | .097 | –47 |
| 300.0 | .285 | –150 | 6.984 | 119 | .087 | –5 | .084 | –54 |
| 350.0 | .326 | –159 | 6.850 | 110 | .090 | –8 | .071 | –62 |
| 400.0 | .347 | –166 | 6.634 | 100 | .094 | –9 | .060 | –66 |
| 450.0 | .385 | –176 | 6.381 | 91 | .097 | –12 | .048 | –66 |
| 500.0 | .418 | 176 | 6.174 | 82 | .100 | –15 | .043 | –59 |

# WJ-A89 / SMA89




## 100 to 800 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: > 29 dB (TYP.)
- ◆ LOW INPUT VSWR: 1.4:1 (TYP.)
- ◆ HIGH LEVEL OUTPUT: +17.5 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50° C | -54° to +85°C |
| Frequency (Min.) | 50-800 MHz | 100-800 MHz | 100-800 MHz |
| Small Signal Gain (Min.) | 22.0 dB | 21.0 dB | 20.5 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +17.5 dBm | +16.5 dBm | +16.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.4:1 | 1.8:1 | 2.0:1 |
| Output | 1.7:1 | 2.0:1 | 2.2:1 |
| DC Current (Max.) at 15 V | 42 mA | 48 mA | 50 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:
1. WJ-CA89 is a standard WJ-A89 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third-Order Two Tone Intercept Point .....+30 dBm (Typ.)

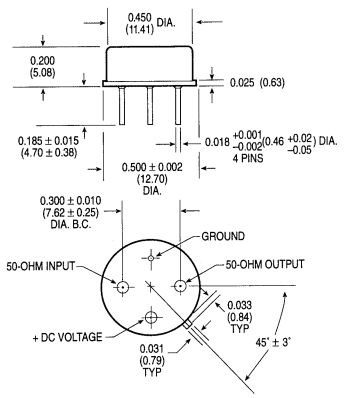
## Absolute Maximum Ratings

Storage Temperature. .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

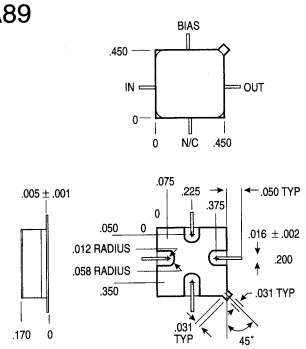
## Outline Drawings

A89



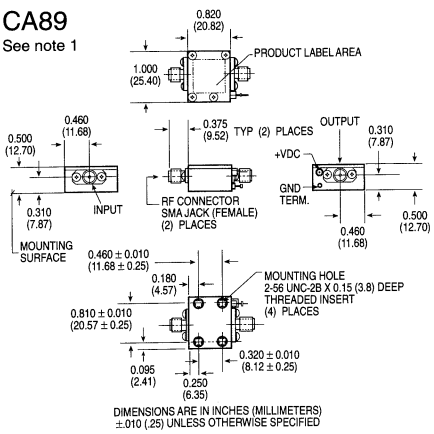

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMA89




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

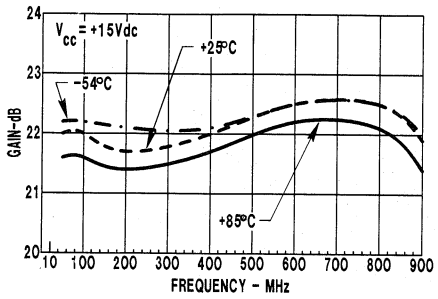
CA89
See note 1

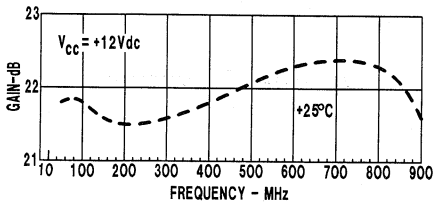



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

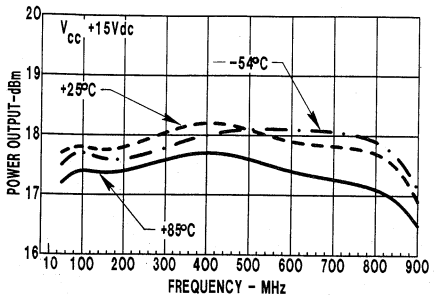
# Typical Performance at 25°C

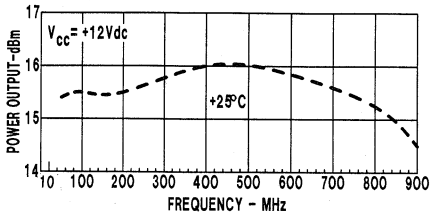
### Gain vs. Temperature vs. Frequency



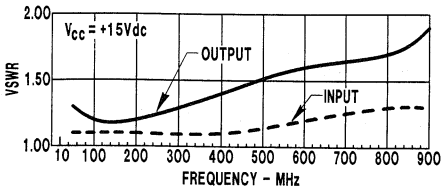

### Power Output*

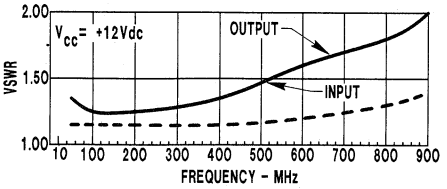


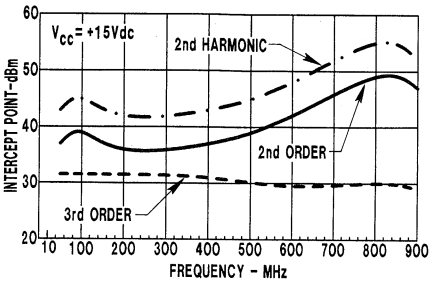

*at 1 dB Gain Compression

### Input/Output VSWR

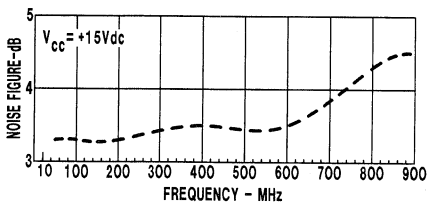



### Intercept Point




### Noise Figure




## Thermal Data: $V_{cc}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.294 W
Junction Temperature Rise Above Case $T_{jc}$ ... 13°C

# Typical Automatic Test Data

### $V_{cc}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 3.0 | 2.4 | 21.5 |
| 10.0 | 1.5 | 1.8 | 21.9 |
| 50.0 | 1.1 | 1.3 | 22.8 |
| 100.0 | 1.0 | 1.2 | 22.8 |
| 200.0 | 1.0 | 1.2 | 22.7 |
| 300.0 | 1.0 | 1.2 | 22.8 |
| 400.0 | 1.1 | 1.3 | 23.3 |
| 500.0 | 1.2 | 1.6 | 23.5 |
| 600.0 | 1.2 | 1.8 | 23.6 |
| 700.0 | 1.2 | 1.7 | 23.5 |
| 800.0 | 1.3 | 1.6 | 22.9 |
| 900.0 | 1.4 | 2.0 | 21.7 |
| 1000.0 | 1.8 | 3.0 | 19.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .501 | –59 | 11.881 | –148 | .012 | 100 | .410 | 132 |
| 10.0 | .213 | –74 | 12.414 | –162 | .019 | 21 | .280 | 136 |
| 50.0 | .045 | –135 | 13.842 | 172 | .025 | –1 | .132 | 135 |
| 100.0 | .024 | 160 | 13.787 | 157 | .025 | –8 | .106 | 127 |
| 200.0 | .007 | 78 | 13.656 | 130 | .026 | –21 | .078 | 83 |
| 300.0 | .019 | –40 | 13.880 | 105 | .027 | –33 | .073 | –7 |
| 400.0 | .045 | –69 | 14.549 | 78 | .027 | –48 | .141 | –85 |
| 500.0 | .082 | –110 | 14.915 | 49 | .027 | –66 | .228 | –135 |
| 600.0 | .107 | –137 | 15.217 | 17 | .026 | –83 | .278 | 178 |
| 700.0 | .105 | –159 | 14.956 | –17 | .024 | –102 | .270 | 124 |
| 800.0 | .112 | –165 | 14.044 | –54 | .023 | –125 | .238 | 47 |
| 900.0 | .168 | –168 | 12.174 | –93 | .020 | –153 | .329 | –45 |
| 1000.0 | .275 | 169 | 9.480 | –132 | .016 | 174 | .502 | –114 |

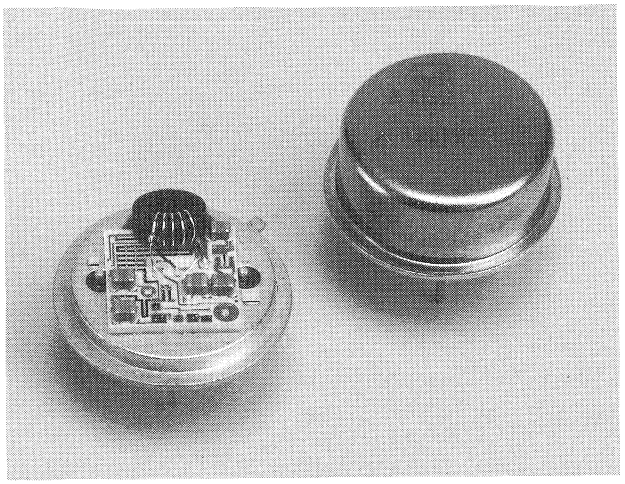
### $V_{cc}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.9 | 2.4 | 21.1 |
| 10.0 | 1.6 | 1.8 | 21.6 |
| 50.0 | 1.1 | 1.3 | 22.6 |
| 100.0 | 1.0 | 1.2 | 22.6 |
| 200.0 | 1.0 | 1.1 | 22.5 |
| 300.0 | 1.1 | 1.1 | 22.7 |
| 400.0 | 1.2 | 1.3 | 23.1 |
| 500.0 | 1.2 | 1.6 | 23.3 |
| 600.0 | 1.3 | 1.8 | 23.5 |
| 700.0 | 1.3 | 1.8 | 23.4 |
| 800.0 | 1.3 | 1.7 | 22.8 |
| 900.0 | 1.5 | 2.1 | 21.5 |
| 1000.0 | 1.9 | 3.2 | 19.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .481 | –56 | 11.349 | –147 | .011 | 89 | .414 | 134 |
| 10.0 | .217 | –69 | 12.058 | –162 | .020 | 21 | .280 | 136 |
| 50.0 | .041 | –112 | 13.502 | 172 | .026 | 0 | .123 | 133 |
| 100.0 | .003 | –166 | 13.425 | 157 | .026 | –9 | .096 | 127 |
| 200.0 | .020 | –27 | 13.305 | 130 | .026 | –21 | .067 | 84 |
| 300.0 | .039 | –56 | 13.589 | 105 | .027 | –34 | .064 | –16 |
| 400.0 | .070 | –73 | 14.232 | 78 | .027 | –50 | .139 | –92 |
| 500.0 | .107 | –105 | 14.652 | 49 | .026 | –66 | .226 | –141 |
| 600.0 | .128 | –133 | 14.963 | 16 | .025 | –84 | .278 | 172 |
| 700.0 | .133 | –158 | 14.728 | –18 | .025 | –104 | .274 | 117 |
| 800.0 | .148 | –164 | 13.773 | –55 | .023 | –128 | .256 | 40 |
| 900.0 | .206 | –172 | 11.829 | –94 | .020 | –157 | .362 | –49 |
| 1000.0 | .312 | 166 | 9.140 | –134 | .015 | 170 | .528 | –115 |

# WJ-A180/SMA180



## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: 22 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +18 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 16.5 dB | 16 dB | 15.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.4 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | +18 dBm | +16 dBm | +15 dBm |
| VSWR (Max.) | | | |
| Input | 1.4:1 | 1.9:1 | 2.1:1 |
| Output | 1.5:1 | 2.1:1 | 2.2:1 |
| DC Current (Max.) at 15 Volts | 63 mA | 69 mA | 75 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
WJ-CA180 is a standard WJ-A180 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+51 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+45 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+33 dBm (Typ.)

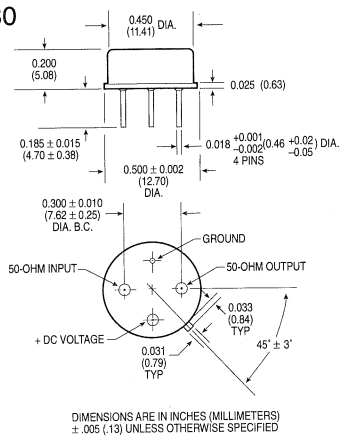
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+15 dBm
Maximum Short-Term RF Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight: 2.0 Grams (0.07 oz.)

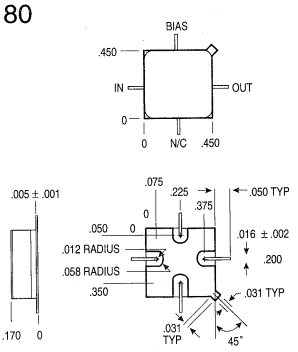
## Outline Drawings

A180



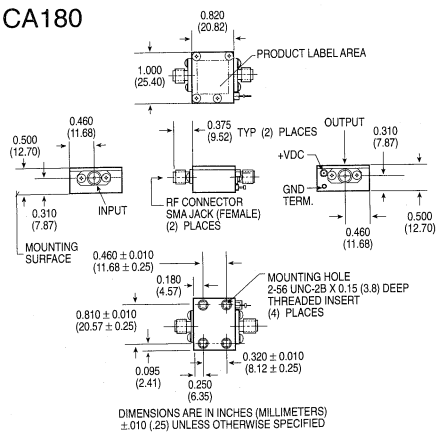

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA180




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

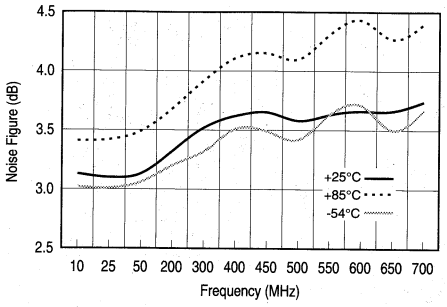
CA180



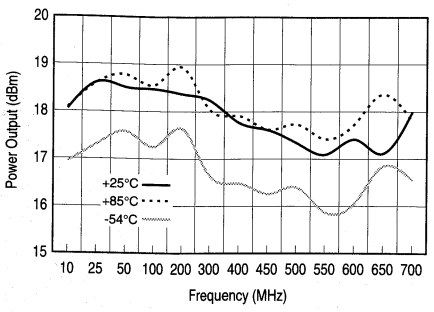

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

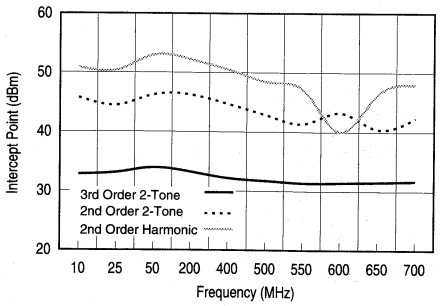
### Noise Figure



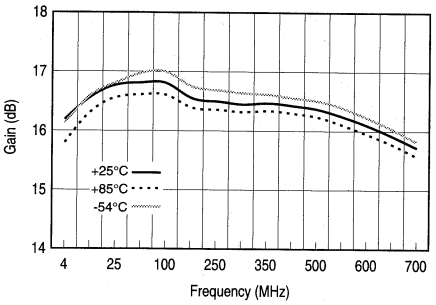

### Power Output (1dB Gain Compression)



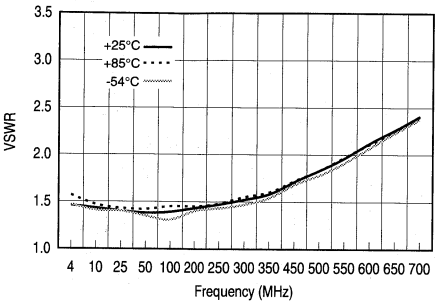

### Intercept Point



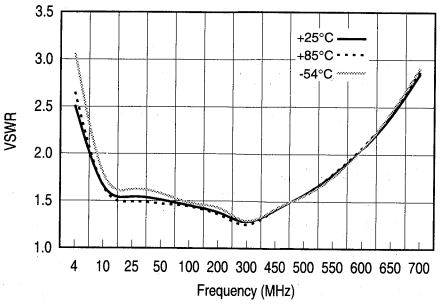

### Gain



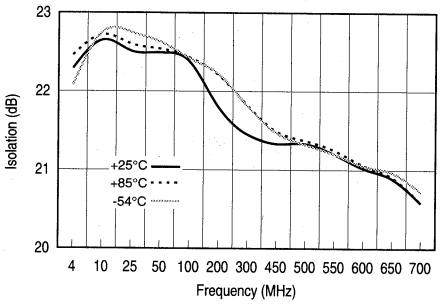

### Output VSWR




### Input VSWR




### Reverse Isolation




## Typical Automatic Test Data

**$V_{CC}$ = 15.0 V**

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.4 | 1.7 | 16.1 |
| 10.0 | 1.7 | 1.4 | 16.3 |
| 50.0 | 1.6 | 1.4 | 16.5 |
| 100.0 | 1.5 | 1.4 | 16.5 |
| 150.0 | 1.5 | 1.4 | 16.4 |
| 200.0 | 1.4 | 1.4 | 16.3 |
| 250.0 | 1.4 | 1.4 | 16.3 |
| 300.0 | 1.4 | 1.5 | 16.2 |
| 350.0 | 1.3 | 1.5 | 16.3 |
| 400.0 | 1.3 | 1.6 | 16.3 |
| 450.0 | 1.4 | 1.7 | 16.3 |
| 500.0 | 1.5 | 1.8 | 16.2 |
| 550.0 | 1.7 | 2.0 | 16.1 |
| 600.0 | 2.0 | 2.2 | 16.0 |
| 650.0 | 2.3 | 2.3 | 15.8 |
| 700.0 | 2.7 | 2.5 | 15.6 |

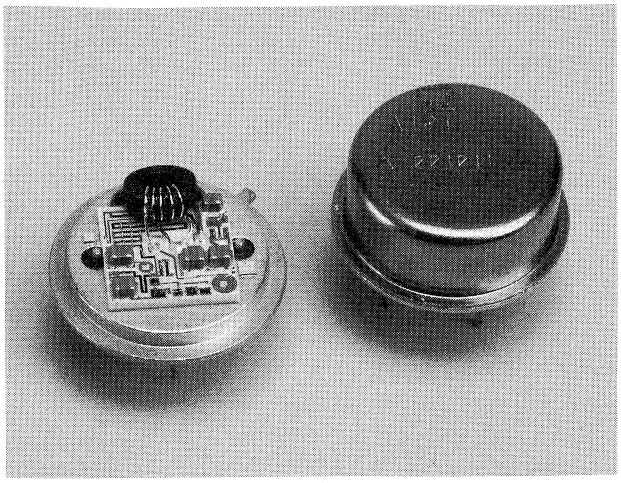
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .427 | −101 | 6.42 | −148 | .065 | 9 | .264 | 176 |
| 10.0 | .282 | −132 | 6.57 | −166 | .072 | 4 | .199 | 175 |
| 50.0 | .235 | −179 | 6.73 | 171 | .075 | −1 | .172 | 177 |
| 100.0 | .228 | 162 | 6.68 | 158 | .076 | −3 | .173 | 178 |
| 150.0 | .214 | 147 | 6.63 | 146 | .077 | −6 | .178 | 178 |
| 200.0 | .198 | 133 | 6.56 | 135 | .078 | −8 | .183 | 177 |
| 250.0 | .182 | 117 | 6.54 | 123 | .079 | −11 | .192 | 177 |
| 300.0 | .167 | 98 | 6.52 | 112 | .080 | −13 | .204 | 177 |
| 350.0 | .158 | 76 | 6.53 | 101 | .082 | −16 | .221 | 176 |
| 400.0 | 1.61 | 50 | 6.56 | 89 | .083 | −20 | .244 | 174 |
| 450.0 | .186 | 25 | 6.55 | 77 | .084 | −23 | .271 | 171 |
| 500.0 | .224 | 1 | 6.50 | 65 | .086 | −26 | .301 | 166 |
| 550.0 | .272 | −17 | 6.42 | 53 | .086 | −29 | .335 | 161 |
| 600.0 | .333 | −34 | 6.32 | 40 | .088 | −32 | .374 | 153 |
| 650.0 | .402 | −49 | 6.19 | 28 | .089 | −35 | .408 | 145 |
| 700.0 | .463 | −61 | 6.04 | 16 | .092 | −38 | .438 | 137 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.509 W
Junction Temperature Rise Above Case $T_{jc}$ ... 22.9°C

# WJ-A181/SMA181



## 10 to 250 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH REVERSE ISOLATION: 22 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +35 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-400 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min.) | 16.5 dB | 15.5 dB | 14.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±0.8 dB |
| Noise Figure (Max.) | 3.8 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +22.0 dBm | +20 dBm | +19.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.4:1 | 1.7:1 | 1.9:1 |
| Output | 1.4:1 | 1.9:1 | 2.1:1 |
| DC Current (Max.) at 15 Volts | 95 mA | 104 mA | 113 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
WJ-CA181 is a standard WJ-A181 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+54 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+48 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+35 dBm (Typ.)

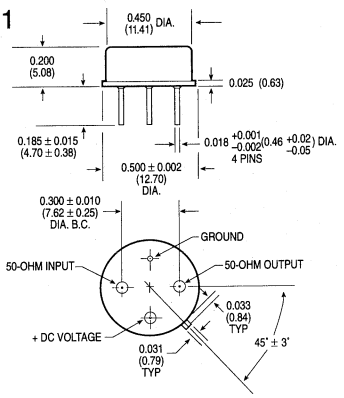
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage .....+17 Volts
Maximum Continuous RF Input Power .....+15 dBm
Maximum Short-Term RF Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

Weight: 2.0 Grams (0.07 oz.)

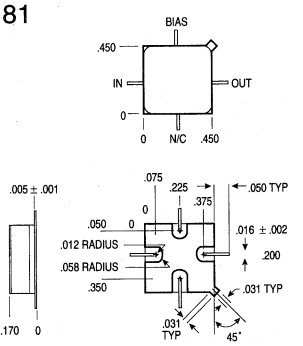
## Outline Drawings

A181



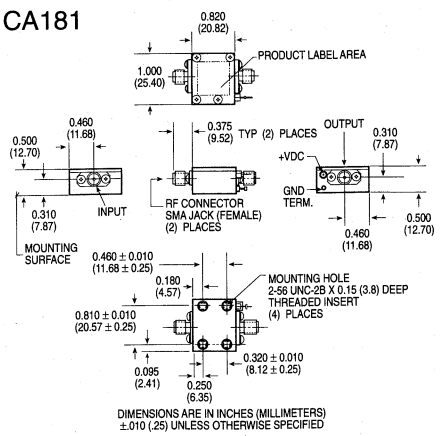

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMA181




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

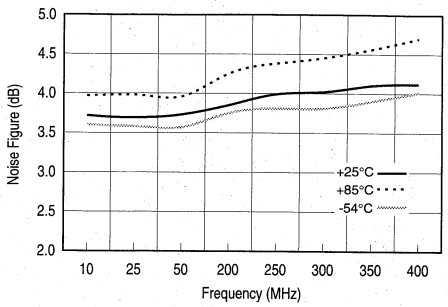
CA181



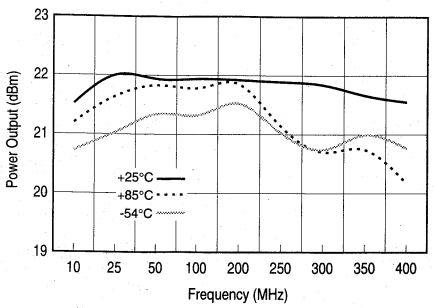

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

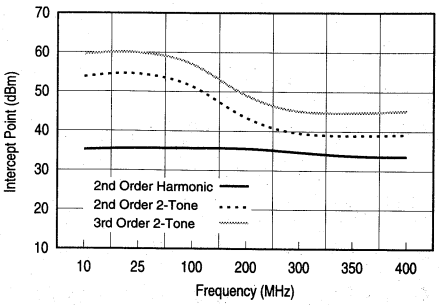
### Noise Figure



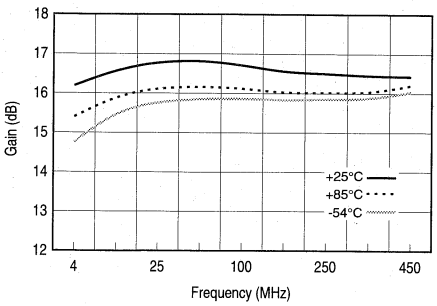

### Power Output (1dB Gain Compression)



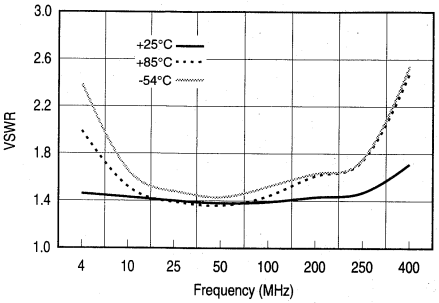

### Intercept Point



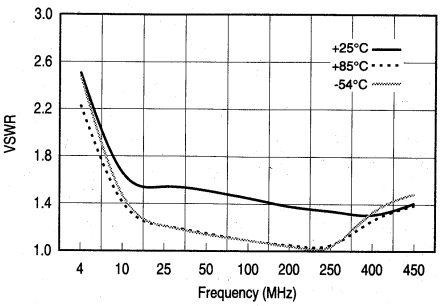

### Gain



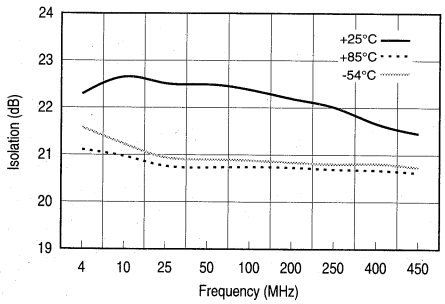

### Output VSWR




### Input VSWR




### Reverse Isolation




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.2 | 2.2 | 15.2 |
| 10.0 | 1.4 | 1.6 | 15.5 |
| 50.0 | 1.1 | 1.3 | 15.8 |
| 100.0 | 1.1 | 1.4 | 15.7 |
| 150.0 | 1.1 | 1.5 | 15.7 |
| 200.0 | 1.1 | 1.6 | 15.7 |
| 250.0 | 1.0 | 1.7 | 15.7 |
| 300.0 | 1.0 | 1.8 | 15.8 |
| 350.0 | 1.1 | 2.0 | 15.9 |
| 400.0 | 1.1 | 2.2 | 16.0 |
| 450.0 | 1.3 | 2.5 | 16.1 |

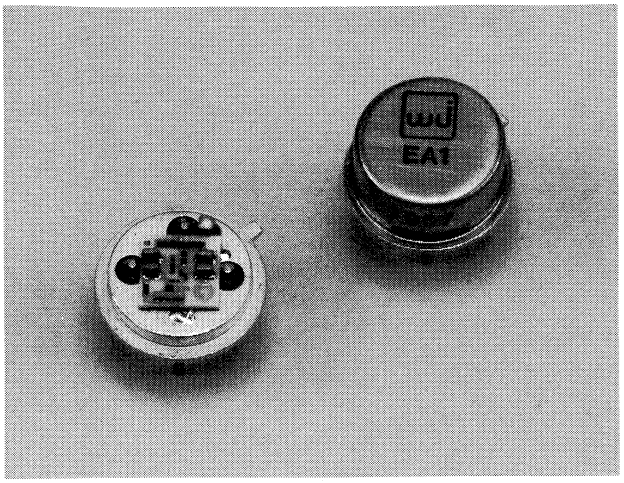
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .379 | –78 | 5.81 | –146 | .075 | 18 | .383 | 162 |
| 10.0 | .189 | –99 | 5.97 | –165 | .089 | 9 | .235 | 159 |
| 50.0 | .083 | –159 | 6.16 | 172 | .094 | 0 | .165 | 179 |
| 100.0 | .175 | 174 | 6.14 | 159 | .095 | –5 | .180 | –170 |
| 150.0 | .063 | 154 | 6.13 | 148 | .095 | –8 | .206 | –167 |
| 200.0 | .051 | 135 | 6.10 | 137 | .095 | –11 | .237 | –167 |
| 250.0 | .041 | 107 | 6.13 | 136 | .095 | –14 | .270 | –169 |
| 300.0 | .040 | 67 | 6.18 | 115 | .095 | –17 | .305 | –172 |
| 350.0 | .058 | 29 | 6.25 | 104 | .095 | –20 | .346 | –176 |
| 400.0 | .088 | 4 | 6.35 | 93 | .095 | –23 | .389 | 178 |
| 450.0 | .131 | –11 | 6.45 | 81 | .095 | –26 | .434 | 171 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.820 W
Junction Temperature Rise Above Case $T_{jc}$ ... 36.9°C

# WJ-EA1 / EA4




## 5 to 400 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ LOW COST
- ◆ VERY SMALL SIZE T0-5 PACKAGE
- ◆ MEDIUM GAIN: 14.0 dB (TYP.)

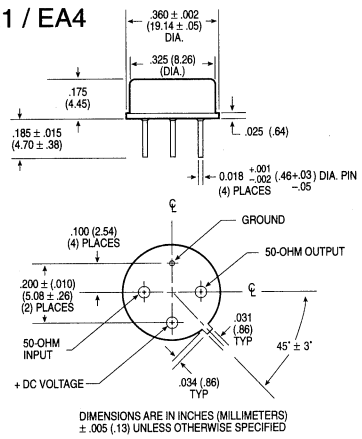
## Specifications *

| Characteristics | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|
| Frequency (Min.) | 5-400 MHz | 5-400 MHz |
| Small Signal Gain (Min.) | 14.0 dB | 13.0 dB |
| Gain Flatness (Typ.) | ±0.5 dB | |
| Noise Figure (Typ.) | 4.3 dB | |
| Power Output | | |
| at 1 dB Compression (Min.) | -4.5 dBm | -7.5 dBm |
| VSWR (Typ.) | | |
| Input | 2.0:1 | |
| Output | 1.9:1 | |
| DC Current at +15 Volts | 10 mA | |

* Measured in a 50-ohm system at 15 Vdc Nominal.

## Outline Drawings

EA1 / EA4




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+19 dBm (Typ.)
Second Order Two Tone Intercept Point.....+15 dBm (Typ.)
Third Order Two Tone Intercept Point.....+13 dBm (Typ.)

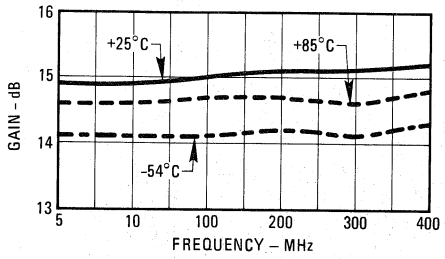
## Absolute Maximum Ratings

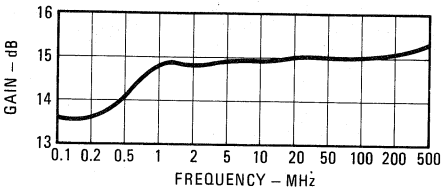
Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximatey 1.0 grams (0.04 oz.)

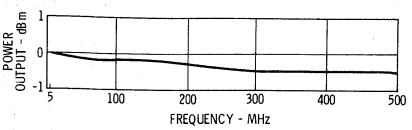
# Typical Performance at 25°C

### Gain



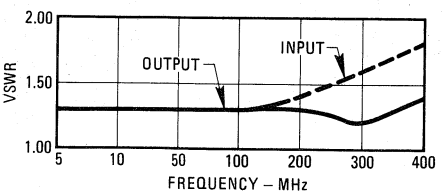




### Power Output*

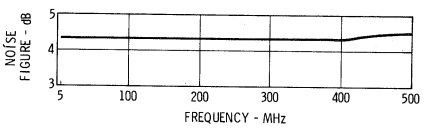



*at 1 dB Gain Compression

### VSWR




### Noise Figure




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.3 | 15.0 |
| 2.0 | 1.5 | 1.2 | 15.2 |
| 5.0 | 1.4 | 1.2 | 15.3 |
| 10.0 | 1.4 | 1.2 | 15.3 |
| 50.0 | 1.4 | 1.2 | 15.3 |
| 100.0 | 1.5 | 1.2 | 15.3 |
| 150.0 | 1.6 | 1.1 | 15.2 |
| 200.0 | 1.8 | 1.1 | 15.2 |
| 250.0 | 2.0 | 1.1 | 15.1 |
| 300.0 | 2.3 | 1.2 | 15.0 |
| 350.0 | 2.6 | 1.4 | 14.8 |
| 400.0 | 3.0 | 1.6 | 14.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .212 | –132 | 5.617 | –159 | .081 | 21 | .111 | –39 |
| 2.0 | .186 | –155 | 5.728 | –170 | .083 | 11 | .104 | –18 |
| 5.0 | .179 | –169 | 5.794 | –177 | .084 | 5 | .103 | –7 |
| 10.0 | .178 | –173 | 5.818 | –180 | .084 | 2 | .104 | –4 |
| 50.0 | .181 | –171 | 5.822 | 170 | .085 | 1 | .101 | –6 |
| 100.0 | .195 | –166 | 5.791 | 159 | .087 | 1 | .087 | –10 |
| 150.0 | .219 | –160 | 5.783 | 148 | .088 | 1 | .066 | –8 |
| 200.0 | .278 | –160 | 5.772 | 136 | .093 | 1 | .048 | 13 |
| 250.0 | .329 | –162 | 5.702 | 125 | .096 | –1 | .057 | 54 |
| 300.0 | .389 | –166 | 5.642 | 113 | .101 | –2 | .102 | 67 |
| 350.0 | .446 | –172 | 5.504 | 101 | .103 | –6 | .160 | 64 |
| 400.0 | .506 | –179 | 5.328 | 88 | .108 | –8 | .222 | 56 |

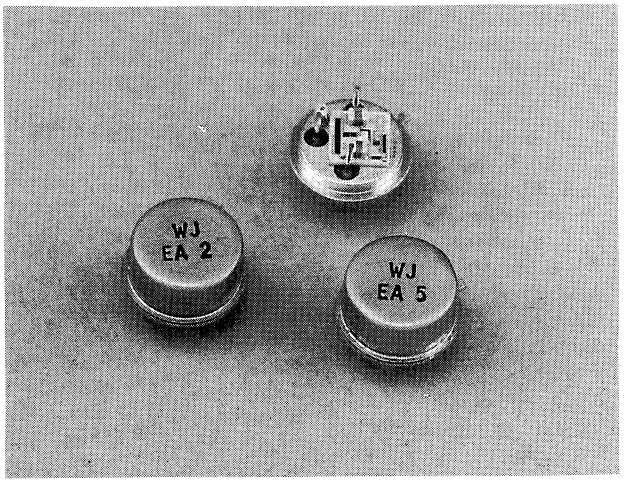
# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.001 W
Junction Temperature Rise Above Case $T_{jc}$ ... 0°C

# WJ-EA2 / EA5

## 5 to 400 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ LOW COST
- ◆ MEDIUM OUTPUT LEVEL: +9 dBm (TYP.)
- ◆ VERY SMALL SIZE—T0-5 PACKAGE



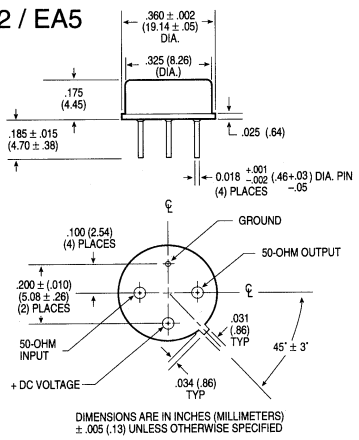

## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | | 5-400 MHz | 5-400 MHz |
| Small Signal Gain (Min.) | 13.5dB | 13.0 dB | 12.5 dB |
| Gain Flatness (Max.) | < ±0.3 dB | | |
| Noise Figure (Max.) | 5.7 dB | | |
| Power Output at 1 dB Compression (Min.) | +9.0 dBm | +6.5 dBm | +6.0 dBm |
| VSWR (Max.) Input/Output | < 1.8:1 | | |
| DC Current at 15 Volts (Max.) | | 27 mA | 29 mA |

* Measured in a 50-ohm system at 15 Vdc ±1% Nominal.
Note: The EA5 is the same as the EA2 except three external capacitors are required which allows an increase of the low frequency bandwidth.

## Outline Drawings

EA2 / EA5




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+33 dBm (Typ.)
Second Order Two Tone Intercept Point.....+28 dBm (Typ.)
Third Order Two Tone Intercept Point.....+21 dBm (Typ.)

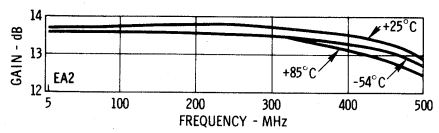
## Absolute Maximum Ratings

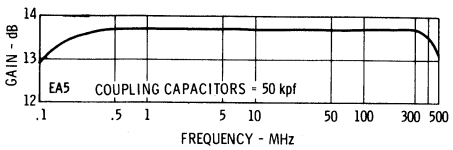
Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....125°C
Maximum DC Voltage.....+17 Volts
Maximum Case Temperature.....125°C
Maximum Continuous RF Input Power.....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 1.0 grams (0.04 oz.)

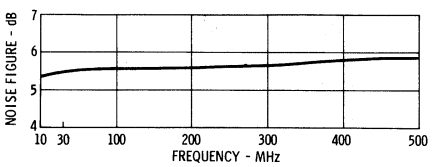
## Typical Performance at 25°C

### Gain

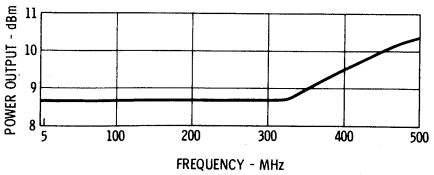



### Noise Figure

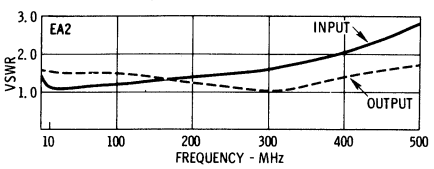


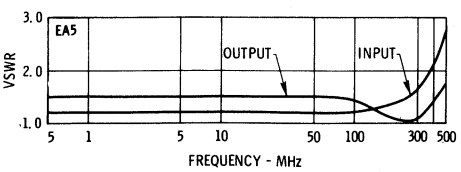

### Power Output*




*at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.5 | 1.4 | 14.0 |
| 2.0 | 1.3 | 1.5 | 14.1 |
| 5.0 | 1.2 | 1.5 | 14.1 |
| 10.0 | 1.2 | 1.5 | 14.1 |
| 50.0 | 1.2 | 1.5 | 14.1 |
| 100.0 | 1.2 | 1.5 | 14.1 |
| 150.0 | 1.2 | 1.5 | 14.1 |
| 200.0 | 1.3 | 1.4 | 14.1 |
| 250.0 | 1.3 | 1.4 | 14.1 |
| 300.0 | 1.4 | 1.4 | 14.1 |
| 350.0 | 1.5 | 1.3 | 14.2 |
| 400.0 | 1.5 | 1.3 | 14.2 |
| 450.0 | 1.6 | 1.3 | 14.2 |
| 500.0 | 1.8 | 1.3 | 14.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .202 | –118 | 5.004 | –160 | .073 | 21 | .181 | –16 |
| 2.0 | .126 | –142 | 5.077 | –170 | .075 | 10 | .188 | –7 |
| 5.0 | .109 | –164 | 5.094 | –177 | .075 | 4 | .192 | –2 |
| 10.0 | .106 | –170 | 5.093 | –180 | .075 | 2 | .194 | –2 |
| 50.0 | .104 | –173 | 5.078 | 173 | .075 | 1 | .194 | –5 |
| 100.0 | .103 | –171 | 5.052 | 166 | .076 | 1 | .192 | –11 |
| 150.0 | .106 | –166 | 5.075 | 158 | .077 | 0 | .187 | –17 |
| 200.0 | .126 | –158 | 5.065 | 151 | .078 | 1 | .181 | –22 |
| 250.0 | .140 | –157 | 5.075 | 144 | .080 | 1 | .171 | –27 |
| 300.0 | .163 | –158 | 5.085 | 136 | .082 | 0 | .160 | –31 |
| 350.0 | .189 | –158 | 5.126 | 129 | .084 | –1 | .148 | –35 |
| 400.0 | .210 | –157 | 5.137 | 121 | .087 | –1 | .138 | –38 |
| 450.0 | .245 | –163 | 5.116 | 113 | .090 | –3 | .125 | –38 |
| 500.0 | .291 | –166 | 5.108 | 105 | .093 | –4 | .118 | –36 |

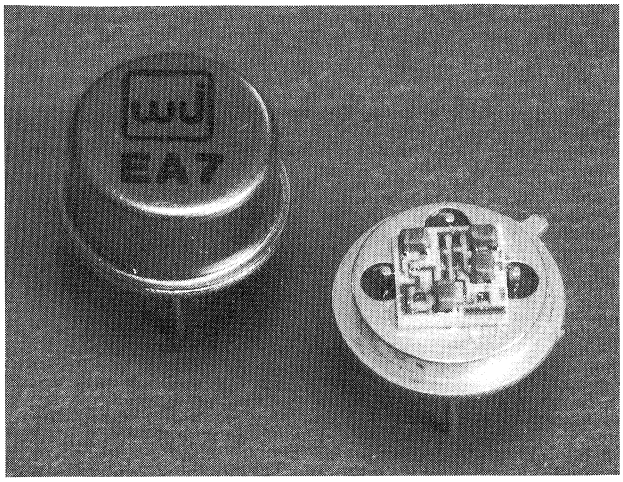
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.068 W
Junction Temperature Rise Above Case $T_{jc}$ ... 3°C

# WJ-EA7

## 5 to 250 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ HIGH OUTPUT LEVEL: +16 dBm (TYP)
- ◆ LOW OUTPUT VSWR: 1.5:1 (TYP)
- ◆ WIDE SUPPLY RANGE: 12 TO 15 VOLTS



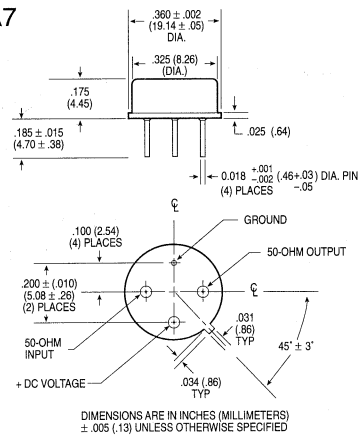

## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1-250 MHz | 5-250 MHz | 5-250 MHz |
| Small Signal Gain (Min.) | 9.5 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±.5 dB | ±.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 6.0 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +16.0 dBm | +15.0 dBm | +14.0 dBm |
| VSWR (Max.) Input | 1.4:1 | 1.8:1 | 2.1:1 |
| VSWR (Max.) Output | 1.5:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at 15 Volts | 60 mA | 64 mA | 67 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.

## Outline Drawings

EA7




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+33 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

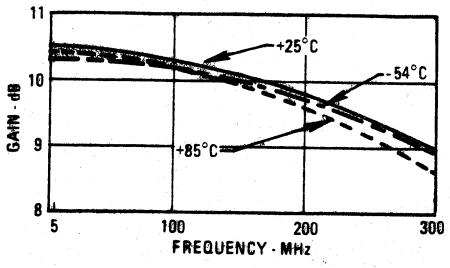
## Absolute Maximum Ratings

Storage Temperature .....-62° C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power.....50 Milliwatts (1 Minute Max.)
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

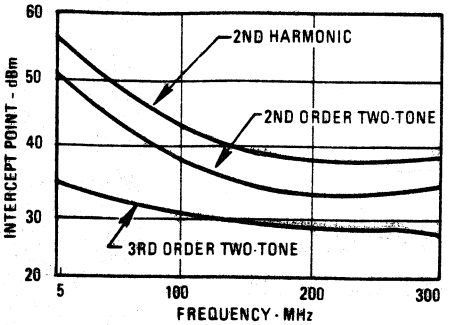
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

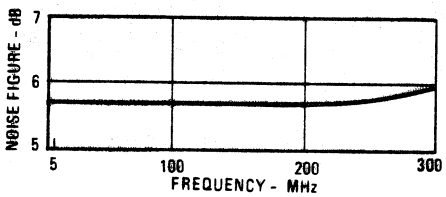
### Gain



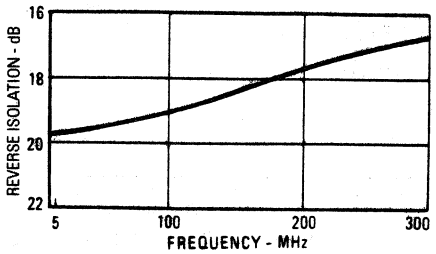

### Intercept Point



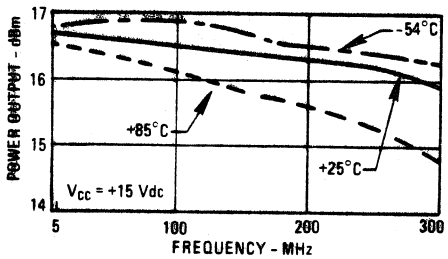

### Noise Figure

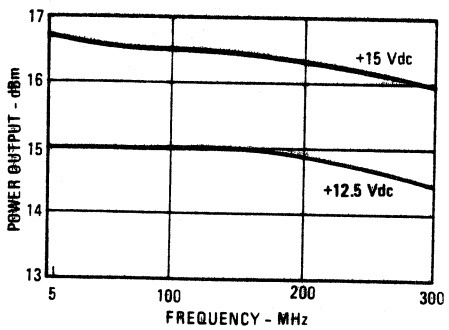



### Reverse Isolation



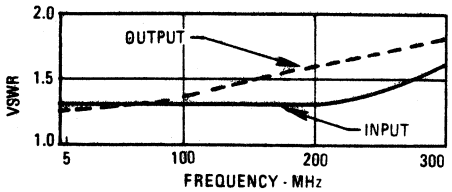

### Power Output*




* at 1 dB Gain Compression

### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.3 | 10.4 |
| 2.0 | 1.2 | 1.2 | 10.5 |
| 5.0 | 1.2 | 1.2 | 10.6 |
| 10.0 | 1.2 | 1.2 | 10.6 |
| 50.0 | 1.1 | 1.2 | 10.5 |
| 100.0 | 1.1 | 1.3 | 10.4 |
| 150.0 | 1.2 | 1.4 | 10.1 |
| 200.0 | 1.3 | 1.5 | 9.9 |
| 250.0 | 1.4 | 1.6 | 9.6 |
| 300.0 | 1.6 | 1.8 | 9.2 |
| 350.0 | 1.8 | 1.9 | 8.7 |
| 400.0 | 2.0 | 2.0 | 8.3 |

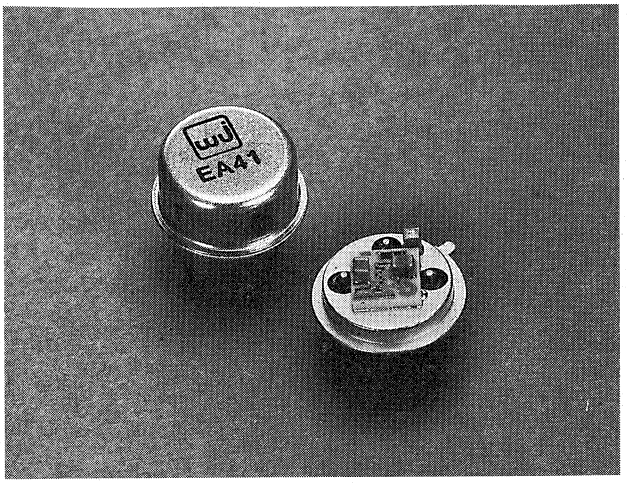
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .123 | –47 | 3.327 | –162 | .092 | 18 | .136 | –44 |
| 2.0 | .084 | –34 | 3.361 | –171 | .093 | 9 | .108 | –26 |
| 5.0 | .073 | –20 | 3.378 | –178 | .093 | 4 | .100 | –14 |
| 10.0 | .070 | –17 | 3.380 | 180 | .093 | 2 | .099 | –13 |
| 50.0 | .067 | –43 | 3.364 | 169 | .095 | 3 | .109 | –38 |
| 100.0 | .067 | –83 | 3.294 | 157 | .100 | 5 | .135 | –66 |
| 150.0 | .081 | –128 | 3.217 | 146 | .106 | 6 | .170 | –88 |
| 200.0 | .123 | –163 | 3.131 | 135 | .114 | 6 | .205 | –106 |
| 250.0 | .166 | 169 | 3.007 | 124 | .122 | 3 | .241 | –122 |
| 300.0 | .217 | 147 | 2.873 | 115 | .130 | 0 | .273 | –135 |
| 350.0 | .279 | 128 | 2.732 | 103 | .135 | –4 | .302 | –148 |
| 400.0 | .326 | 111 | 2.589 | 94 | .142 | –8 | .330 | –159 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.156 W
Junction Temperature Rise Above Case $T_{jc}$ ... 7°C

# WJ-EA41




## 1000 to 4000 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ WIDE BANDWIDTH: 1000 TO 4000 MHz
- ◆ MEDIUM OUTPUT POWER: +12 dBm (TYP.)
- ◆ LOW NOISE: 3.5 dB (TYP.)
- ◆ MEDIUM THIRD ORDER INTERCEPT POINT: +23 dBm (TYP.)
- ◆ VERY SMALL SIZE: TO-5 PACKAGE

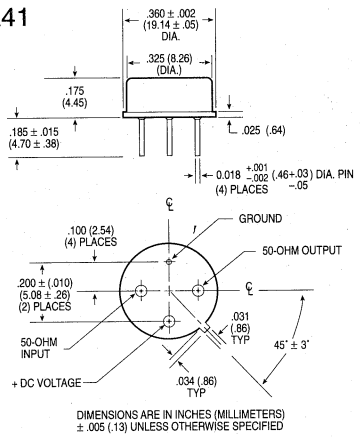
## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-4200 MHz | 1000-4000 MHz | 1000-4000 MHz |
| Small Signal Gain (Min.) | 8.0 dB | 7.0 dB | 6.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.7 dB | ±.9 dB |
| Noise Figure (Max.) | 3.5 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +12.0 dBm | +11.0 dBm | +10.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.1:1 | 2.2:1 |
| Output | 1.6:1 | 2.1:1 | 2.2:1 |
| DC Current (Max.) at +5 Volts | 35 mA | 40 mA | 42 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.

## Outline Drawings

EA41




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+23 dBm (Typ.)

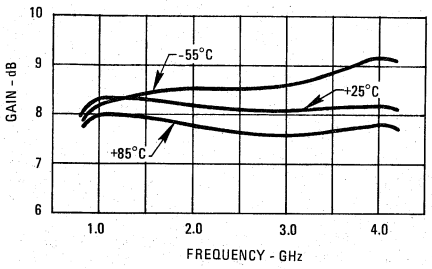
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power .....+14 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

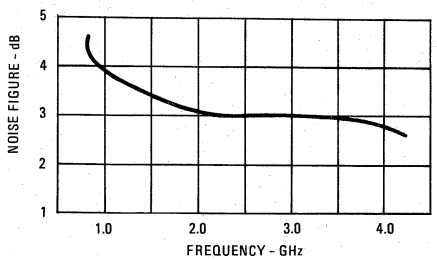
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

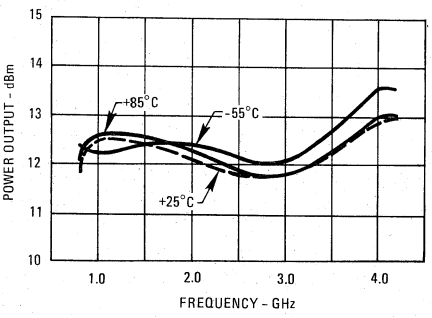
### Gain




### Noise Figure

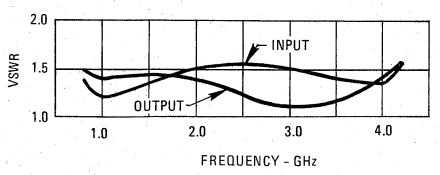



### Power Output*

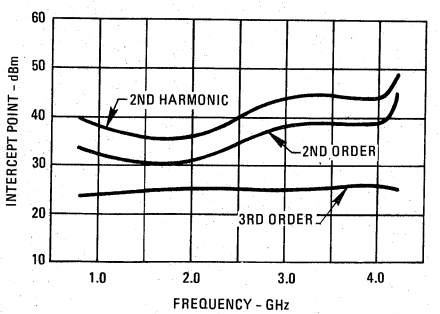



*at 1 dB Gain Compression

### VSWR




### Intercept Point




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.4 | 1.6 | 8.8 |
| 900.0 | 1.2 | 1.7 | 9.0 |
| 1000.0 | 1.1 | 1.7 | 8.9 |
| 1100.0 | 1.1 | 1.7 | 8.9 |
| 1200.0 | 1.1 | 1.7 | 8.9 |
| 1300.0 | 1.2 | 1.7 | 8.9 |
| 1400.0 | 1.3 | 1.6 | 8.9 |
| 1500.0 | 1.3 | 1.6 | 8.9 |
| 1600.0 | 1.3 | 1.5 | 8.8 |
| 1700.0 | 1.4 | 1.4 | 8.7 |
| 1800.0 | 1.4 | 1.4 | 8.7 |
| 1900.0 | 1.4 | 1.3 | 8.7 |
| 2000.0 | 1.5 | 1.3 | 8.7 |
| 2100.0 | 1.4 | 1.3 | 8.7 |
| 2200.0 | 1.4 | 1.3 | 8.7 |
| 2300.0 | 1.4 | 1.2 | 8.7 |
| 2400.0 | 1.4 | 1.2 | 8.7 |
| 2500.0 | 1.3 | 1.2 | 8.7 |
| 2600.0 | 1.3 | 1.2 | 8.7 |
| 2700.0 | 1.3 | 1.2 | 8.7 |
| 2800.0 | 1.3 | 1.2 | 8.7 |
| 2900.0 | 1.2 | 1.2 | 8.8 |
| 3000.0 | 1.2 | 1.1 | 8.8 |
| 3100.0 | 1.2 | 1.1 | 8.8 |
| 3200.0 | 1.1 | 1.1 | 8.8 |
| 3300.0 | 1.1 | 1.1 | 8.8 |
| 3400.0 | 1.0 | 1.0 | 8.8 |
| 3500.0 | 1.1 | 1.1 | 8.8 |
| 3600.0 | 1.2 | 1.2 | 8.7 |
| 3700.0 | 1.3 | 1.3 | 8.7 |
| 3800.0 | 1.5 | 1.4 | 8.5 |
| 3900.0 | 1.7 | 1.6 | 8.3 |
| 4000.0 | 1.9 | 1.8 | 8.1 |
| 4100.0 | 2.1 | 1.9 | 7.8 |
| 4200.0 | 2.3 | 2.1 | 7.6 |

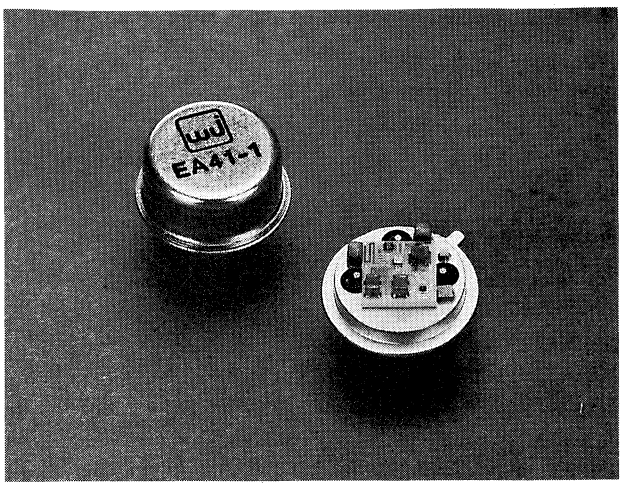
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .158 | 107 | 2.766 | 140 | .140 | −18 | .243 | 134 |
| 900.0 | .077 | 72 | 2.803 | 111 | .139 | −43 | .264 | 103 |
| 1000.0 | .042 | 19 | 2.772 | 86 | .138 | −66 | .268 | 79 |
| 1100.0 | .046 | −45 | 2.773 | 62 | .136 | −87 | .268 | 59 |
| 1200.0 | .065 | −81 | 2.787 | 41 | .133 | −105 | .262 | 41 |
| 1300.0 | .090 | −96 | 2.783 | 20 | .131 | −123 | .246 | 24 |
| 1400.0 | .115 | −120 | 2.782 | 0 | .128 | −140 | .230 | 8 |
| 1500.0 | .130 | −136 | 2.774 | −20 | .128 | −157 | .216 | −6 |
| 1600.0 | .147 | −149 | 2.762 | −39 | .125 | −173 | .198 | −21 |
| 1700.0 | .160 | −167 | 2.734 | −58 | .124 | 172 | .179 | −34 |
| 1800.0 | .177 | 180 | 2.734 | −76 | .122 | 157 | .163 | −50 |
| 1900.0 | .182 | 162 | 2.722 | −94 | .121 | 141 | .144 | −60 |
| 2000.0 | .190 | 150 | 2.710 | −112 | .119 | 127 | .131 | −74 |
| 2100.0 | .183 | 137 | 2.710 | −130 | .118 | 112 | .122 | −92 |
| 2200.0 | .175 | 127 | 2.714 | −148 | .118 | 97 | .117 | −110 |
| 2300.0 | .167 | 114 | 2.714 | −165 | .119 | 83 | .107 | −130 |
| 2400.0 | .150 | 102 | 2.715 | 178 | .116 | 68 | .099 | −147 |
| 2500.0 | .148 | 88 | 2.732 | 160 | .115 | 54 | .093 | −166 |
| 2600.0 | .137 | 78 | 2.722 | 143 | .115 | 39 | .093 | 180 |
| 2700.0 | .132 | 68 | 2.738 | 126 | .115 | 25 | .091 | 159 |
| 2800.0 | .116 | 57 | 2.733 | 108 | .113 | 10 | .091 | 140 |
| 2900.0 | .109 | 47 | 2.745 | 91 | .113 | −4 | .082 | 122 |
| 3000.0 | .097 | 33 | 2.741 | 73 | .114 | −18 | .068 | 105 |
| 3100.0 | .083 | 19 | 2.756 | 56 | .113 | −32 | .058 | 89 |
| 3200.0 | .056 | −1 | 2.752 | 38 | .113 | −48 | .045 | 70 |
| 3300.0 | .031 | −34 | 2.762 | 20 | .113 | −63 | .028 | 33 |
| 3400.0 | .022 | −119 | 2.765 | 2 | .113 | −78 | .024 | −54 |
| 3500.0 | .052 | −167 | 2.762 | −16 | .110 | −93 | .054 | −109 |
| 3600.0 | .091 | 169 | 2.732 | −34 | .113 | −108 | .091 | −134 |
| 3700.0 | .138 | 153 | 2.712 | −52 | .110 | −122 | .132 | −154 |
| 3800.0 | .192 | 139 | 2.668 | −70 | .109 | −138 | .174 | −167 |
| 3900.0 | .246 | 123 | 2.609 | −89 | .106 | −153 | .225 | 178 |
| 4000.0 | .301 | 110 | 2.545 | −107 | .106 | −169 | .274 | 163 |
| 4100.0 | .350 | 96 | 2.458 | −125 | .102 | 177 | .318 | 149 |
| 4200.0 | .394 | 84 | 2.388 | −142 | .101 | 163 | .355 | 135 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-EA41-1




## 1000 to 4000 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ WIDE BANDWIDTH: 1000-4000 MHz
- ◆ HIGH OUTPUT POWER: +19 dBm (TYP.)
- ◆ LOW NOISE: 3.5 dB (TYP.)
- ◆ HIGH THIRD ORDER INTERCEPT POINT: +30 dBm (TYP.)
- ◆ VERY SMALL SIZE: TO-5 PACKAGE

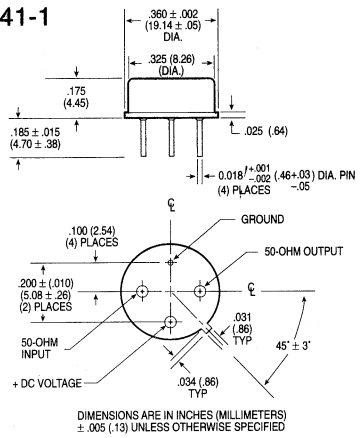
## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-4200 MHz | 1000-4000 MHz | 1000-4000 MHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.0 dB | 7.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.7 dB | ±.9 dB |
| Noise Figure (Max.) | 3.5 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +19.0 dBm | +17.5 dBm | +17.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.0:1 | 2.1:1 |
| Output | 1.4:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +8 Volts | 68 mA | 76 mA | 78 mA |

* Measured in a 50-ohm system at +8 Vdc Nominal.

## Outline Drawings

EA41-1




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

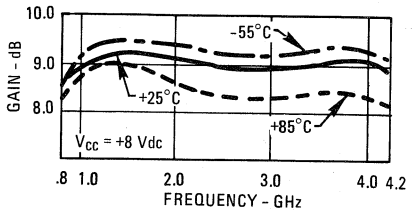
## Absolute Maximum Ratings

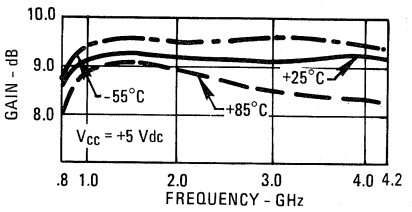
Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage .....+9 volts
Maximum Continuous RF Input Power .....+14 dBm
Maximum Short Term RF Input Power .....50 Milliwatts (1 Minute Max.)
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....85°C

Weight approximately 1.0 grams (0.04 oz.)

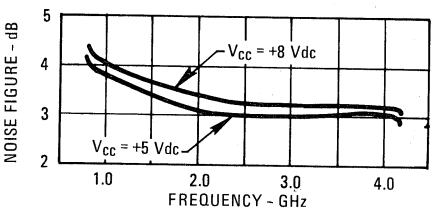
# Typical Performance at 25°C

## Gain

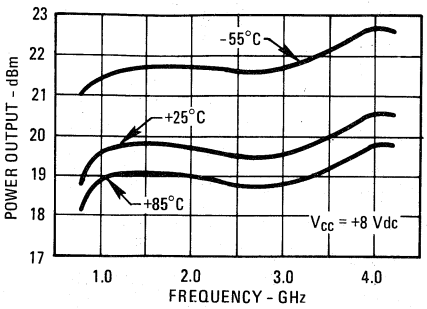


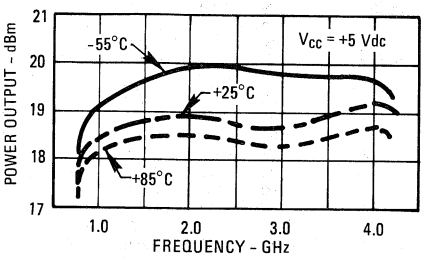




## Noise Figure



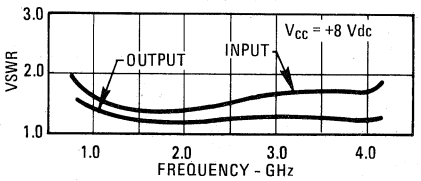

## Power Output*

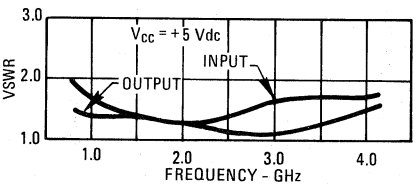


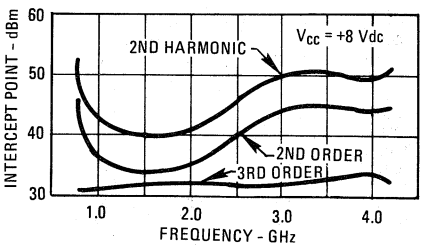

*at 1 dB Gain Compression

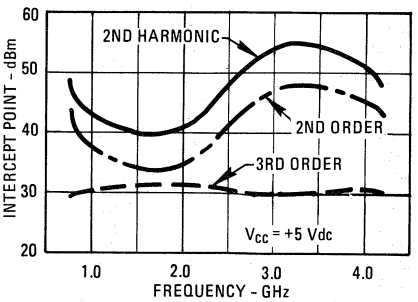
## VSWR




## Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 8.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.9 | 1.5 | 8.5 |
| 900.0 | 1.6 | 1.5 | 8.9 |
| 1000.0 | 1.5 | 1.5 | 8.9 |
| 1100.0 | 1.4 | 1.5 | 9.1 |
| 1200.0 | 1.3 | 1.5 | 9.1 |
| 1300.0 | 1.3 | 1.4 | 9.2 |
| 1400.0 | 1.3 | 1.4 | 9.2 |
| 1500.0 | 1.3 | 1.4 | 9.2 |
| 1600.0 | 1.3 | 1.3 | 9.1 |
| 1700.0 | 1.3 | 1.3 | 9.0 |
| 1800.0 | 1.4 | 1.3 | 9.0 |
| 1900.0 | 1.4 | 1.3 | 9.0 |
| 2000.0 | 1.5 | 1.2 | 8.9 |
| 2100.0 | 1.5 | 1.2 | 8.9 |
| 2200.0 | 1.4 | 1.2 | 8.9 |
| 2300.0 | 1.5 | 1.2 | 8.9 |
| 2400.0 | 1.4 | 1.2 | 8.9 |
| 2500.0 | 1.4 | 1.2 | 8.9 |
| 2600.0 | 1.4 | 1.2 | 8.9 |
| 2700.0 | 1.4 | 1.2 | 8.9 |
| 2800.0 | 1.4 | 1.2 | 8.8 |
| 2900.0 | 1.4 | 1.2 | 8.9 |
| 3000.0 | 1.4 | 1.2 | 8.8 |
| 3100.0 | 1.4 | 1.2 | 8.8 |
| 3200.0 | 1.4 | 1.2 | 8.8 |
| 3300.0 | 1.4 | 1.2 | 8.8 |
| 3400.0 | 1.4 | 1.2 | 8.8 |
| 3500.0 | 1.4 | 1.3 | 8.7 |
| 3600.0 | 1.5 | 1.3 | 8.6 |
| 3700.0 | 1.5 | 1.3 | 8.6 |
| 3800.0 | 1.6 | 1.4 | 8.5 |
| 3900.0 | 1.7 | 1.4 | 8.3 |
| 4000.0 | 1.8 | 1.5 | 8.2 |
| 4100.0 | 2.0 | 1.6 | 8.0 |
| 4200.0 | 2.2 | 1.6 | 7.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .304 | 16 | 2.669 | 127 | .147 | –28 | .206 | –136 |
| 900.0 | .237 | –4 | 2.776 | 102 | .150 | –54 | .194 | 179 |
| 1000.0 | .192 | –24 | 2.796 | 79 | .152 | –75 | .195 | 146 |
| 1100.0 | .158 | –44 | 2.838 | 58 | .153 | –95 | .192 | 117 |
| 1200.0 | .133 | –66 | 2.863 | 38 | .152 | –114 | .187 | 93 |
| 1300.0 | .121 | –88 | 2.879 | 19 | .151 | –131 | .178 | 73 |
| 1400.0 | .125 | –115 | 2.878 | 0 | .148 | –149 | .166 | 57 |
| 1500.0 | .122 | –144 | 2.869 | –19 | .146 | –165 | .159 | 42 |
| 1600.0 | .132 | –163 | 2.863 | –37 | .144 | 179 | .144 | 28 |
| 1700.0 | .143 | 171 | 2.830 | –54 | .142 | 163 | .129 | 19 |
| 1800.0 | .163 | 154 | 2.825 | –72 | .139 | 147 | .114 | 8 |
| 1900.0 | .172 | 134 | 2.808 | –89 | .136 | 133 | .112 | 4 |
| 2000.0 | .185 | 118 | 2.791 | –105 | .134 | 117 | .108 | –5 |
| 2100.0 | .186 | 102 | 2.784 | –122 | .132 | 103 | .098 | –16 |
| 2200.0 | .182 | 87 | 2.781 | –139 | .131 | 89 | .090 | –27 |
| 2300.0 | .186 | 70 | 2.781 | –155 | .128 | 74 | .083 | –36 |
| 2400.0 | .183 | 56 | 2.781 | –172 | .127 | 60 | .083 | –45 |
| 2500.0 | .172 | 44 | 2.786 | 172 | .125 | 45 | .083 | –59 |
| 2600.0 | .176 | 30 | 2.772 | 155 | .122 | 30 | .086 | –78 |
| 2700.0 | .170 | 17 | 2.781 | 139 | .122 | 17 | .082 | –94 |
| 2800.0 | .168 | 5 | 2.768 | 122 | .119 | 2 | .078 | –111 |
| 2900.0 | .162 | –11 | 2.771 | 106 | .119 | –11 | .080 | –125 |
| 3000.0 | .165 | –27 | 2.769 | 89 | .116 | –25 | .090 | –137 |
| 3100.0 | .163 | –39 | 2.756 | 73 | .114 | –40 | .096 | –152 |
| 3200.0 | .167 | –59 | 2.745 | 56 | .112 | –54 | .100 | –168 |
| 3300.0 | .159 | –78 | 2.742 | 39 | .111 | –69 | .102 | –178 |
| 3400.0 | .157 | –97 | 2.741 | 22 | .109 | –83 | .105 | 176 |
| 3500.0 | .175 | –119 | 2.733 | 5 | .107 | –97 | .115 | 172 |
| 3600.0 | .190 | –138 | 2.701 | –12 | .105 | –111 | .127 | 164 |
| 3700.0 | .202 | –158 | 2.681 | –29 | .102 | –124 | .140 | 157 |
| 3800.0 | .235 | –178 | 2.656 | –46 | .101 | –139 | .150 | 153 |
| 3900.0 | .266 | 162 | 2.606 | –63 | .096 | –153 | .166 | 150 |
| 4000.0 | .297 | 145 | 2.578 | –80 | .095 | –166 | .193 | 145 |
| 4100.0 | .333 | 129 | 2.499 | –96 | .091 | 180 | .220 | 138 |
| 4200.0 | .367 | 113 | 2.453 | –113 | .090 | 166 | .241 | 130 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.8 | 1.4 | 8.7 |
| 900.0 | 1.6 | 1.5 | 9.0 |
| 1000.0 | 1.4 | 1.5 | 9.1 |
| 1100.0 | 1.4 | 1.5 | 9.2 |
| 1200.0 | 1.3 | 1.5 | 9.3 |
| 1300.0 | 1.3 | 1.5 | 9.4 |
| 1400.0 | 1.3 | 1.4 | 9.4 |
| 1500.0 | 1.2 | 1.4 | 9.4 |
| 1600.0 | 1.3 | 1.4 | 9.3 |
| 1700.0 | 1.3 | 1.3 | 9.3 |
| 1800.0 | 1.3 | 1.3 | 9.2 |
| 1900.0 | 1.4 | 1.2 | 9.2 |
| 2000.0 | 1.4 | 1.2 | 9.2 |
| 2100.0 | 1.4 | 1.1 | 9.1 |
| 2200.0 | 1.4 | 1.1 | 9.1 |
| 2300.0 | 1.4 | 1.1 | 9.1 |
| 2400.0 | 1.4 | 1.1 | 9.1 |
| 2500.0 | 1.4 | 1.0 | 9.1 |
| 2600.0 | 1.4 | 1.0 | 9.1 |
| 2700.0 | 1.4 | 1.0 | 9.1 |
| 2800.0 | 1.4 | 1.0 | 9.1 |
| 2900.0 | 1.4 | 1.0 | 9.1 |
| 3000.0 | 1.4 | 1.0 | 9.1 |
| 3100.0 | 1.4 | 1.0 | 9.1 |
| 3200.0 | 1.4 | 1.1 | 9.1 |
| 3300.0 | 1.4 | 1.1 | 9.0 |
| 3400.0 | 1.4 | 1.1 | 9.0 |
| 3500.0 | 1.4 | 1.2 | 9.0 |
| 3600.0 | 1.4 | 1.2 | 8.9 |
| 3700.0 | 1.5 | 1.3 | 8.9 |
| 3800.0 | 1.6 | 1.4 | 8.7 |
| 3900.0 | 1.7 | 1.5 | 8.5 |
| 4000.0 | 1.8 | 1.7 | 8.4 |
| 4100.0 | 2.0 | 1.8 | 8.1 |
| 4200.0 | 2.2 | 1.9 | 7.8 |

### Linear S-Parameters

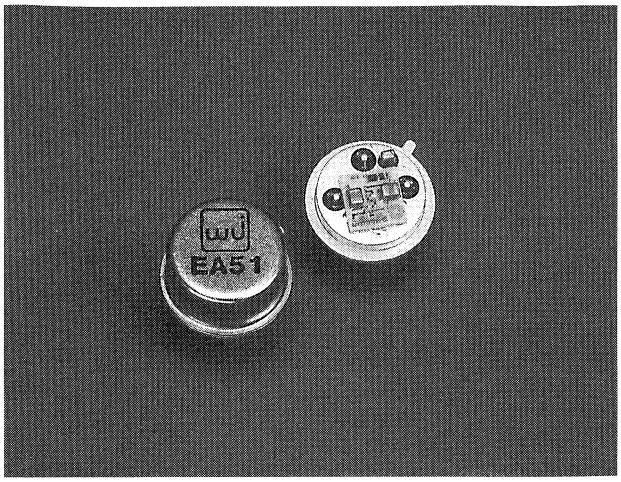
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .298 | 14 | 2.728 | 127 | .141 | –29 | .180 | –150 |
| 900.0 | .234 | –7 | 2.832 | 102 | .145 | –53 | .186 | 163 |
| 1000.0 | .182 | –27 | 2.856 | 80 | .147 | –74 | .195 | 131 |
| 1100.0 | .152 | –46 | 2.894 | 58 | .147 | –93 | .204 | 102 |
| 1200.0 | .124 | –67 | 2.924 | 38 | .145 | –111 | .201 | 79 |
| 1300.0 | .114 | –89 | 2.937 | 20 | .144 | –129 | .194 | 59 |
| 1400.0 | .111 | –115 | 2.941 | 1 | .144 | –146 | .182 | 40 |
| 1500.0 | .111 | –145 | 2.936 | –18 | .141 | –162 | .171 | 23 |
| 1600.0 | .121 | –165 | 2.927 | –36 | .141 | –178 | .153 | 7 |
| 1700.0 | .133 | 170 | 2.903 | –53 | .139 | 167 | .134 | –6 |
| 1800.0 | .146 | 152 | 2.897 | –71 | .136 | 151 | .115 | –22 |
| 1900.0 | .160 | 130 | 2.893 | –88 | .134 | 136 | .098 | –28 |
| 2000.0 | .167 | 116 | 2.875 | –104 | .132 | 122 | .084 | –41 |
| 2100.0 | .173 | 98 | 2.861 | –121 | .131 | 108 | .069 | –55 |
| 2200.0 | .171 | 82 | 2.865 | –138 | .129 | 93 | .055 | –73 |
| 2300.0 | .172 | 67 | 2.861 | –154 | .128 | 79 | .040 | –88 |
| 2400.0 | .169 | 53 | 2.852 | –171 | .127 | 65 | .027 | –94 |
| 2500.0 | .164 | 41 | 2.860 | 173 | .126 | 50 | .022 | –107 |
| 2600.0 | .165 | 27 | 2.849 | 156 | .123 | 36 | .024 | –119 |
| 2700.0 | .155 | 13 | 2.854 | 140 | .123 | 23 | .018 | –141 |
| 2800.0 | .163 | 0 | 2.843 | 123 | .121 | 8 | .013 | –173 |
| 2900.0 | .161 | –12 | 2.848 | 107 | .120 | –6 | .009 | –158 |
| 3000.0 | .154 | –26 | 2.845 | 90 | .121 | –19 | .012 | –116 |
| 3100.0 | .152 | –42 | 2.845 | 74 | .118 | –34 | .020 | .133 |
| 3200.0 | .153 | –60 | 2.835 | 57 | .117 | –49 | .025 | –138 |
| 3300.0 | .155 | –80 | 2.829 | 40 | .117 | –62 | .033 | –129 |
| 3400.0 | .155 | –97 | 2.831 | 23 | .115 | –76 | .052 | –132 |
| 3500.0 | .160 | –120 | 2.819 | 6 | .115 | –90 | .078 | –143 |
| 3600.0 | .176 | –141 | 2.789 | –11 | .113 | –104 | .106 | –154 |
| 3700.0 | .193 | –161 | 2.770 | –28 | .112 | –119 | .136 | –165 |
| 3800.0 | .225 | 178 | 2.729 | –45 | .111 | –133 | .164 | –173 |
| 3900.0 | .259 | 158 | 2.666 | –62 | .107 | –147 | .204 | 177 |
| 4000.0 | .290 | 142 | 2.622 | –79 | .106 | –161 | .246 | 166 |
| 4100.0 | .332 | 124 | 2.529 | –96 | .103 | –176 | .288 | 153 |
| 4200.0 | .369 | 109 | 2.467 | –113 | .100 | 171 | .320 | 142 |

## Thermal Data: $V_{CC}$ = 8 Vdc

Thermal Resistance $\theta_{jc}$ ..... 108.9°C/W
Transistor Power Dissipation $P_d$ ..... 0.504 W
Junction Temperature Rise Above Case $T_{jc}$ ... 55°C

# WJ-EA51

## 5 to 250 MHz
## TO-5 CASCADABLE AMPLIFIER




- ◆ LOW NOISE: 3.0 dB (TYP.)
- ◆ HIGH GAIN: 17.0 dB (TYP.)
- ◆ LOW OUTPUT VSWR: 1.2:1 (TYP.)
- ◆ HIGH EFFICIENCY: 12.5 mA (TYP.) @ +5 Vdc
- ◆ VERY SMALL SIZE: TO-5 PACKAGE

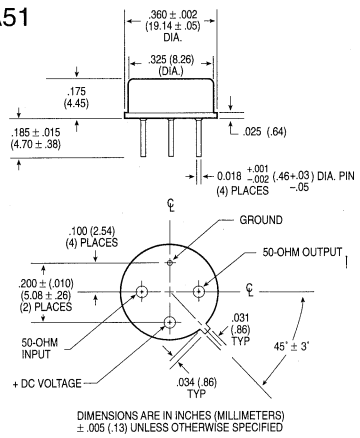
## Specifications *

| Characteristics | Typical | Guaranteed 0°C to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1 - 300 MHz | 5 - 250 MHz | 5 - 250 MHz |
| Small Signal Gain (Min.) | 17 dB | 16 dB | 15.5 dB |
| Gain Flatness (Max.) | ± .4 dB | ± .7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.0 dB | 3.5 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | -1.8 dBm | -1.0 dBm | -1.0 dBm |
| VSWR (Max.) Input[1] | 1.5:1 | 2.0:1 | 2.0:1 |
| VSWR (Max.) Output | 1.2:1 | 1.6:1 | 1.7:1 |
| DC Current (Max.) at 5 Volts | 12.5 mA | 14.5 mA | 16.5 mA |

*Measured in a 50-ohm system at +5 Vdc Nominal.
Notes: 1. Input VSWR 2.2:1 max. above 200 MHz.

## Outline Drawings

EA51




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+20 dBm (Typ.)
Second Order Two Tone Intercept Point.....+14 dBm (Typ.)
Third Order Two Tone Intercept Point.....+13 dBm (Typ.)

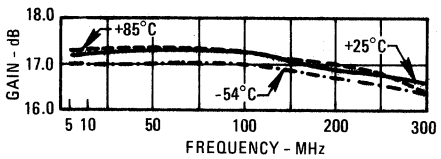
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+9 volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature .....125°C

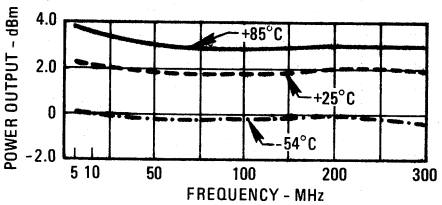
Weight approximately 1.0 grams (0.04 oz.) .

## Typical Performance at 25°C

**Gain**

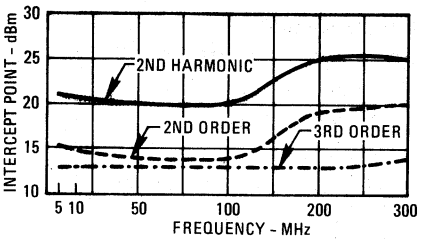



**Power Output***

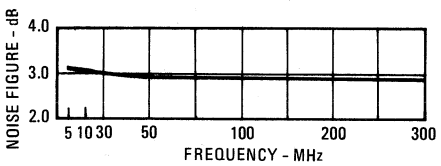



*at 1 dB Gain Compression

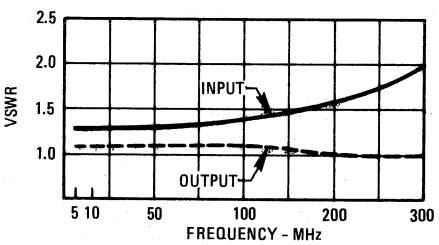
**Intercept Point**




**Noise Figure**




**VSWR**




## Typical Automatic Test Data

**$V_{CC}$ = 5.0 V**

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.2 | 17.1 |
| 2.0 | 1.3 | 1.2 | 17.2 |
| 5.0 | 1.3 | 1.1 | 17.3 |
| 10.0 | 1.3 | 1.1 | 17.3 |
| 50.0 | 1.3 | 1.1 | 17.3 |
| 100.0 | 1.4 | 1.1 | 17.1 |
| 150.0 | 1.5 | 1.1 | 17.1 |
| 200.0 | 1.7 | 1.1 | 17.0 |
| 250.0 | 1.8 | 1.0 | 16.8 |
| 300.0 | 2.0 | 1.0 | 16.6 |
| 350.0 | 2.3 | 1.0 | 16.4 |
| 400.0 | 2.5 | 1.1 | 16.1 |

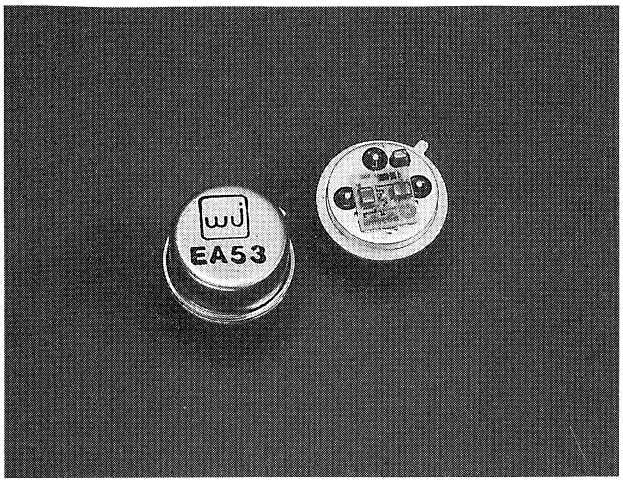
**Linear S-Parameters**

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .134 | –41 | 7.194 | –162 | .058 | 19 | .103 | –55 |
| 2.0 | .119 | –15 | 7.258 | –171 | .059 | 10 | .076 | –31 |
| 5.0 | .121 | –9 | 7.291 | –177 | .059 | 4 | .069 | –13 |
| 10.0 | .120 | –10 | 7.293 | 180 | .059 | 2 | .069 | –8 |
| 50.0 | .125 | –32 | 7.288 | 171 | .060 | 2 | .067 | –10 |
| 100.0 | .161 | –57 | 7.203 | 161 | .060 | 3 | .062 | –19 |
| 150.0 | .196 | –76 | 7.120 | 151 | .063 | 4 | .052 | –29 |
| 200.0 | .246 | –95 | 7.045 | 142 | .065 | 4 | .039 | –35 |
| 250.0 | .292 | –109 | 6.902 | 132 | .067 | 4 | .022 | –39 |
| 300.0 | .343 | –121 | 6.727 | 123 | .069 | 4 | .007 | 17 |
| 350.0 | .389 | –133 | 6.575 | 113 | .073 | 2 | .022 | 83 |
| 400.0 | .432 | –144 | 6.390 | 104 | .076 | 2 | .043 | 80 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.036 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-EA53




## 5 to 250 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ LOW NOISE: 2.0 dB (TYP.)
- ◆ HIGH GAIN: 22 dB (TYP.)
- ◆ LOW OUTPUT VSWR: 1.2:1 (TYP.)
- ◆ HIGH EFFICIENCY: 15 mA (TYP.) @ +5 Vdc
- ◆ VERY SMALL SIZE: TO-5 PACKAGE.

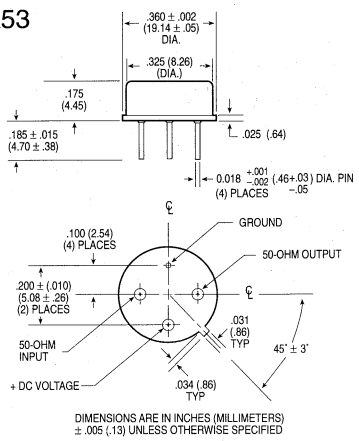
## Specifications*

| Characteristics | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to -50°C | -54° to +85°C |
| Frequency (Min.) | 1 - 300 MHz | 5 - 250 MHz | 5 - 250 MHz |
| Small Signal Gain (Min.) | 22.0 dB | 20.5 dB | 19.5 dB |
| Gain Flatness (Max.) | ±.6 dB | ±.9 dB | ±1.0 dB |
| Noise Figure (Max.) | 2.0 dB | 2.8 dB | 3.2 dB |
| Power Output at 1 dB Compression (Min.) | +4.5 dBm | +2.5 dBm | +2.0 dBm |
| VSWR (Max.) Input | 1.5:1 | 1.8:1 | 2.0:1 |
| VSWR (Max.) Output | 1.2:1 | 1.5:1 | 1.7:1 |
| DC Current (Max.) at 5 Volts | 15 mA | 18 mA | 20 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

## Outline Drawings

EA53




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+23 dBm (Typ.)
Second Order Two Tone Intercept Point.....+18 dBm (Typ.)
Third Order Two Tone Intercept Point.....+16 dBm (Typ.)

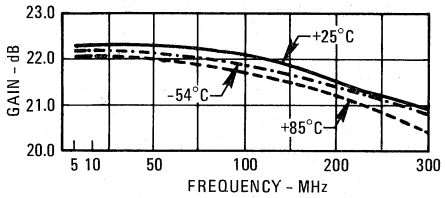
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Voltage .....+9 volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.)..... 50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

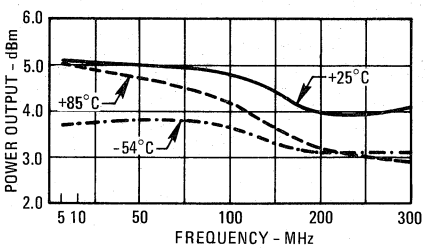
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

### Gain

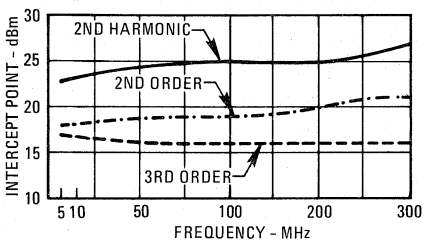



### Power Output*

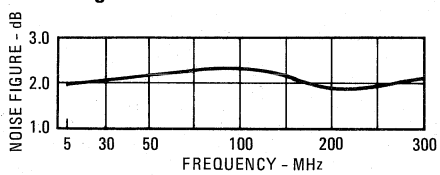



*at 1 dB Gain Compression

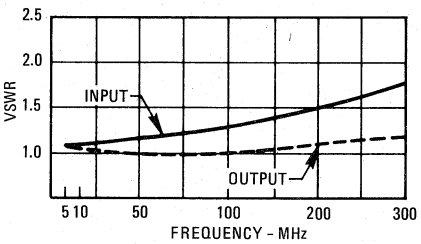
### Intercept Point




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 1.2 | 22.6 |
| 2.0 | 1.1 | 1.1 | 22.7 |
| 5.0 | 1.1 | 1.0 | 22.8 |
| 10.0 | 1.1 | 1.0 | 22.8 |
| 50.0 | 1.1 | 1.0 | 22.7 |
| 100.0 | 1.2 | 1.0 | 22.4 |
| 150.0 | 1.3 | 1.0 | 22.1 |
| 200.0 | 1.5 | 1.0 | 21.7 |
| 250.0 | 1.6 | 1.0 | 21.2 |
| 300.0 | 1.7 | 1.1 | 20.7 |
| 350.0 | 1.8 | 1.1 | 20.2 |
| 400.0 | 1.9 | 1.1 | 19.7 |

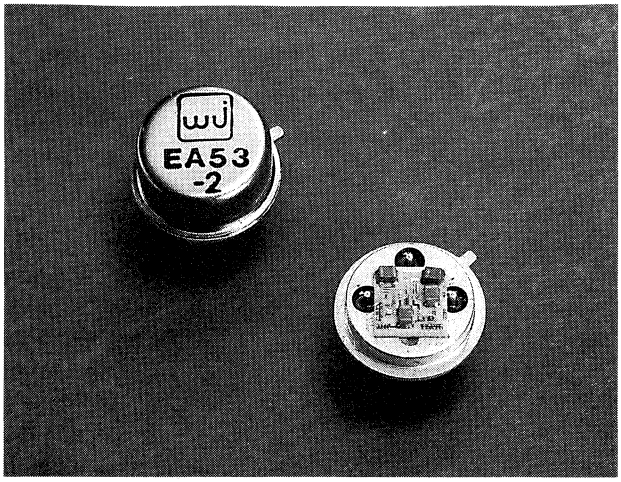
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .097 | −67 | 13.565 | −160 | .036 | 22 | .094 | −100 |
| 2.0 | .055 | −52 | 13.690 | −170 | .037 | 11 | .041 | −96 |
| 5.0 | .044 | −27 | 13.744 | −177 | .037 | 5 | .014 | −83 |
| 10.0 | .043 | −25 | 13.742 | 180 | .037 | 3 | .007 | −61 |
| 50.0 | .062 | −63 | 13.610 | 169 | .037 | 3 | .006 | 27 |
| 100.0 | .099 | −88 | 13.255 | 158 | .038 | 5 | .007 | 40 |
| 150.0 | .147 | −106 | 12.754 | 148 | .039 | 7 | .008 | 74 |
| 200.0 | .195 | −121 | 12.205 | 138 | .040 | 8 | .012 | 83 |
| 250.0 | .227 | −132 | 11.511 | 129 | .041 | 9 | .019 | 93 |
| 300.0 | .265 | −142 | 10.879 | 120 | .042 | 11 | .027 | 90 |
| 350.0 | .290 | −153 | 10.240 | 111 | .045 | 10 | .035 | 87 |
| 400.0 | .316 | −161 | 9.690 | 103 | .047 | 11 | .041 | 80 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.045 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-EA53-2




## 5 to 500 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ HIGH GAIN: 19 dB (TYP.)
- ◆ MEDIUM OUTPUT POWER: +11 dBm (TYP.)
- ◆ VERY SMALL SIZE: TO-5 PACKAGE

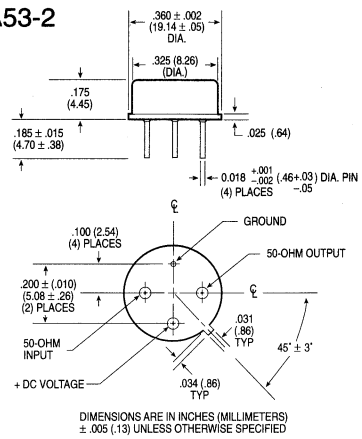
## Specifications*

| Characteristic | Typical | Guaranteed | |
|---|---|---|---|
| | | 0° to 50°C | -54° to +85°C |
| Frequency (Min.) | 2-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 19.0 dB | 18.5 dB | 17.5 dB |
| Gain Flatness (Max.) | ±.2 dB | ±.5 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.6 dB | 4.0 dB | 4.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +11.0 dBm | +10.0 dBm | +9.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 33 mA | 37 mA | 40 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.

## Outline Drawings

EA53-2




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+46 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+24 dBm (Typ.)

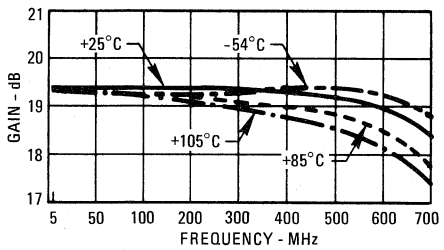
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

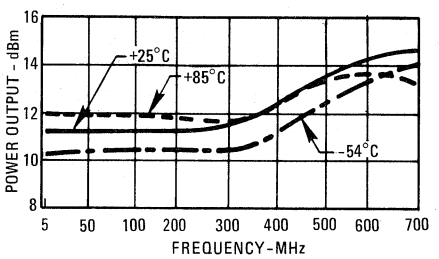
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

### Gain

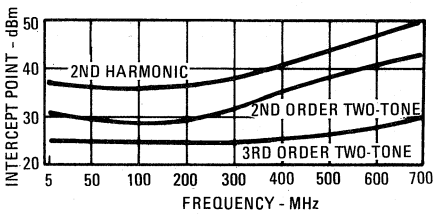



### Power Output*

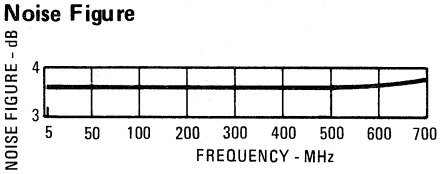



*at 1 dB Gain Compression

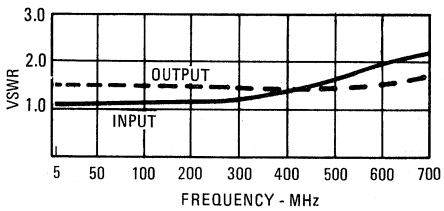
### Intercept Point



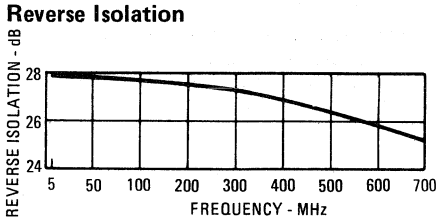

### Noise Figure




### VSWR




### Reverse Isolation




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.3 | 1.4 | 19.8 |
| 2.0 | 1.1 | 1.4 | 19.9 |
| 5.0 | 1.1 | 1.4 | 19.9 |
| 10.0 | 1.1 | 1.5 | 19.9 |
| 50.0 | 1.1 | 1.5 | 19.9 |
| 100.0 | 1.1 | 1.5 | 19.8 |
| 200.0 | 1.2 | 1.4 | 19.8 |
| 300.0 | 1.3 | 1.4 | 19.7 |
| 400.0 | 1.4 | 1.5 | 19.7 |
| 500.0 | 1.6 | 1.6 | 19.5 |
| 600.0 | 1.8 | 1.9 | 19.2 |
| 700.0 | 2.0 | 2.3 | 18.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .134 | –112 | 9.809 | –163 | .037 | 20 | .174 | –17 |
| 2.0 | .066 | –123 | 9.867 | –172 | .037 | 9 | .179 | –7 |
| 5.0 | .042 | –149 | 9.870 | –178 | .037 | 4 | .183 | –3 |
| 10.0 | .038 | –164 | 9.896 | 180 | .038 | 2 | .185 | –4 |
| 50.0 | .043 | –156 | 9.850 | 170 | .038 | 1 | .185 | –15 |
| 100.0 | .049 | –151 | 9.774 | 161 | .038 | 0 | .185 | –29 |
| 200.0 | .097 | –138 | 9.727 | 141 | .039 | 0 | .182 | –62 |
| 300.0 | .139 | –150 | 9.621 | 121 | .040 | –1 | .181 | –100 |
| 400.0 | .180 | –159 | 9.655 | 100 | .043 | –3 | .201 | –142 |
| 500.0 | .234 | –177 | 9.464 | 79 | .047 | –5 | .243 | 174 |
| 600.0 | .291 | 165 | 9.103 | 55 | .050 | –12 | .309 | 131 |
| 700.0 | .324 | 144 | 8.255 | 29 | .053 | –21 | .393 | 91 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.187 W
Junction Temperature Rise Above Case $T_{jc}$ ... 8°C

# WJ-EA54

## 10 to 250 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ TWO STAGES: 27 dB GAIN (TYP.)
- ◆ LOW VSWR: 1.2:1 (TYP.)
- ◆ VERY SMALL SIZE: TO-5 PACKAGE.

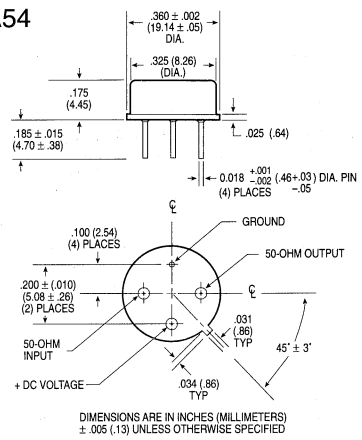
## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-350 MHz | 10-250 MHz | 10-250 MHz |
| Small Signal Gain (Min,) | 27.0 dB | 25 dB | 24 dB |
| Gain Flatness (Max.) | ±.7 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | 3.8 dB | 4.5 dB | 5.0 dB |
| Power Output at 1 dB Compression (Min.) | +5.0 dBm | +4.0 dBm | +2.0 dBm |
| VSWR (Max.) Input/Output | 1.2:1 | 1.7:1 | 1.8:1 |
| DC Current (Max.) at 5 Volts | 30 mA | 33 mA | 36 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

## Outline Drawings

EA54




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+33 dBm (Typ.)
Second Order Two Tone Intercept Point.....+28 dBm (Typ.)
Third Order Two Tone Intercept Point.....+16 dBm (Typ.)

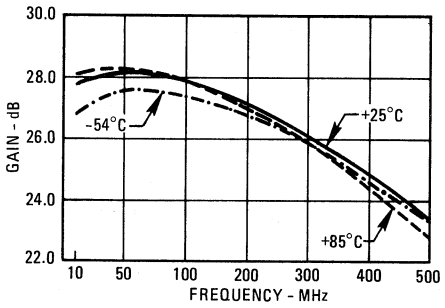
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+7 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

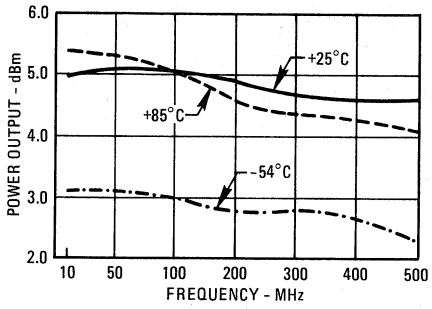
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

### Gain

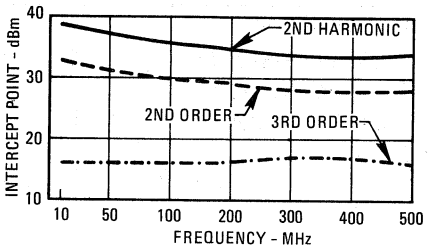



### Power Output*

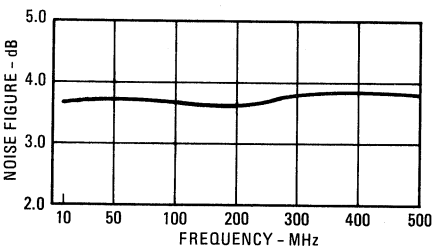



*at 1 dB Gain Compression

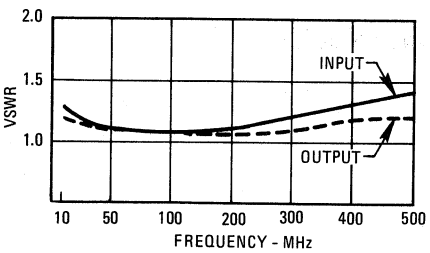
### Intercept Point




### Noise Figure




### VSWR




## Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.9 | 1.9 | 25.3 |
| 5.0 | 1.3 | 1.3 | 26.9 |
| 10.0 | 1.2 | 1.1 | 27.1 |
| 50.0 | 1.1 | 1.1 | 27.2 |
| 100.0 | 1.1 | 1.1 | 27.0 |
| 150.0 | 1.1 | 1.1 | 26.8 |
| 200.0 | 1.2 | 1.1 | 26.5 |
| 250.0 | 1.2 | 1.1 | 26.1 |
| 300.0 | 1.3 | 1.1 | 25.6 |
| 350.0 | 1.3 | 1.1 | 25.0 |
| 400.0 | 1.3 | 1.1 | 24.4 |

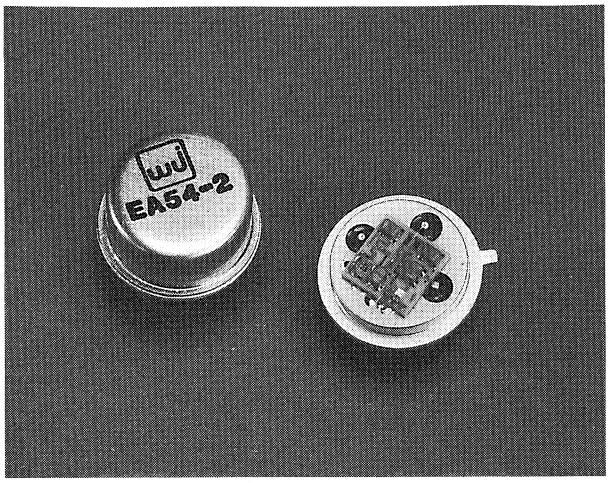
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .310 | –80 | 18.425 | 75 | .004 | 69 | .315 | –83 |
| 5.0 | .131 | –92 | 22.043 | 29 | .006 | 30 | .123 | –92 |
| 10.0 | .074 | –105 | 22.657 | 13 | .006 | 17 | .065 | –101 |
| 50.0 | .043 | –144 | 22.888 | –10 | .006 | 12 | .026 | –131 |
| 100.0 | .044 | –133 | 22.449 | –24 | .006 | 13 | .029 | –140 |
| 150.0 | .059 | –131 | 21.857 | –37 | .006 | 19 | .034 | –148 |
| 200.0 | .078 | –137 | 21.137 | –50 | .006 | 22 | .039 | –153 |
| 250.0 | .090 | –144 | 20.102 | –62 | .007 | 29 | .045 | –160 |
| 300.0 | .112 | –150 | 19.019 | –74 | .007 | 31 | .051 | –167 |
| 350.0 | .125 | –159 | 17.840 | –86 | .008 | 33 | .056 | –174 |
| 400.0 | .134 | –164 | 16.667 | –96 | .008 | 37 | .058 | –178 |

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.047 W
Junction Temperature Rise Above Case $T_{jc}$ ... 2°C

# WJ-EA54-2




## 5 to 500 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ TWO STAGE: 29.5 dB GAIN (TYP.)
- ◆ MEDIUM OUTPUT POWER: +9.5 dBm (TYP.)
- ◆ VERY SMALL SIZE: TO-5 PACKAGE

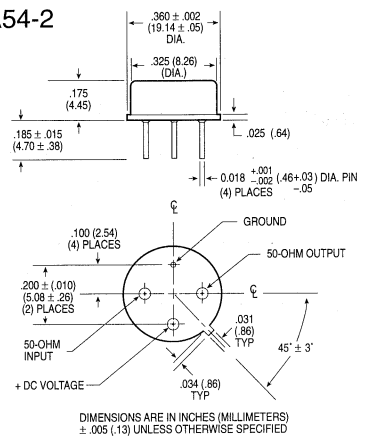
## Specifications*

| Characteristics | Typ. | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 29.5 dB | 28.5 dB | 27.5 dB |
| Gain Flatness (Max.) | ±.4 dB | ±.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.0 dB | 5.5 dB |
| Power Output at 1 dB Compression (Min.) | +9.5 dBm | +8.0 dBm | +6.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.3:1 | 1.8:1 | 2.0:1 |
| Output | 1.6:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +15 Volts | 55 mA | 59 mA | 62 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.

## Outline Drawing

EA54-2




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+34 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20 dBm (Typ.)

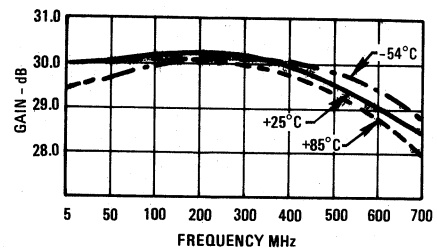
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+12 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

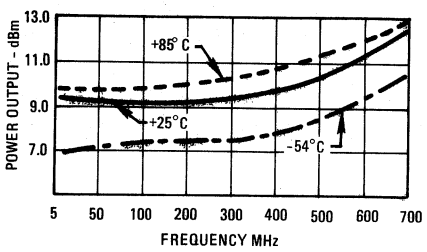
Weight approximately 1.0 grams (0.04 oz.)

## Typical Performance at 25°C

**Gain**

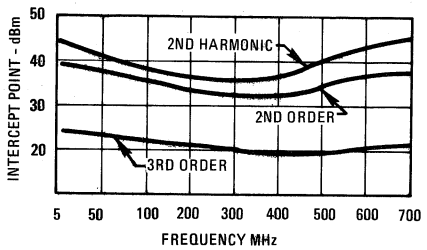



**Power Output***

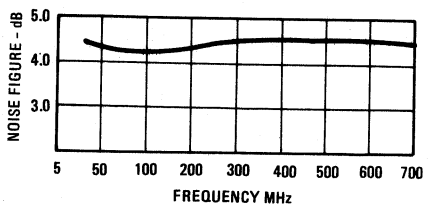



*at 1 dB Gain Compression

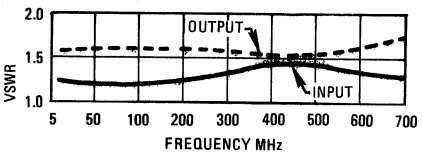
**Intercept Point**




**Noise Figure**




**VSWR**




## Typical Automatic Test Data

**$V_{cc}$ = 15.0 V**

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 2.0 | 2.0 | 29.2 |
| 5.0 | 1.4 | 1.6 | 30.3 |
| 10.0 | 1.2 | 1.5 | 30.4 |
| 50.0 | 1.2 | 1.5 | 30.5 |
| 100.0 | 1.2 | 1.4 | 30.5 |
| 200.0 | 1.2 | 1.4 | 30.6 |
| 300.0 | 1.3 | 1.4 | 30.7 |
| 400.0 | 1.3 | 1.3 | 30.7 |
| 500.0 | 1.4 | 1.3 | 30.3 |
| 600.0 | 1.3 | 1.4 | 29.7 |
| 700.0 | 1.2 | 1.5 | 28.8 |

**Linear S-Parameters**

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .339 | –81 | 28.821 | 60 | .002 | 60 | .342 | –41 |
| 5.0 | .150 | –103 | 32.557 | 24 | .003 | 29 | .226 | –28 |
| 10.0 | .094 | –123 | 33.180 | 10 | .003 | 14 | .196 | –18 |
| 50.0 | .077 | –163 | 33.681 | –8 | .003 | 15 | .188 | –16 |
| 100.0 | .075 | –165 | 33.440 | –21 | .003 | 18 | .180 | –26 |
| 200.0 | .107 | –169 | 33.983 | –44 | .004 | 35 | .170 | –51 |
| 300.0 | .136 | 172 | 34.180 | –67 | .004 | 37 | .154 | –81 |
| 400.0 | .147 | 148 | 34.309 | –93 | .005 | 48 | .143 | –119 |
| 500.0 | .150 | 123 | 32.893 | –119 | .006 | 49 | .141 | –165 |
| 600.0 | .131 | 94 | 30.720 | –146 | .007 | 48 | .157 | 147 |
| 700.0 | .096 | 60 | 27.543 | –172 | .008 | 46 | .199 | 106 |

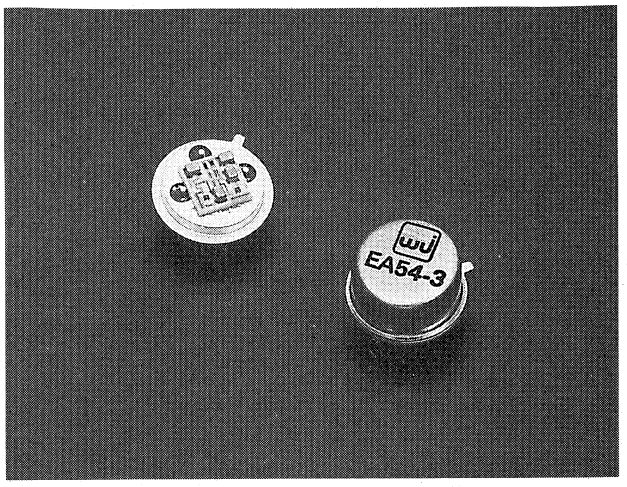
## Thermal Data: $V_{cc}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.330 W
Junction Temperature Rise Above Case $T_{jc}$ ... 15°C

# WJ-EA54-3

## 5 to 300 MHz
## TO-5 CASCADABLE AMPLIFIER

- ◆ LOW NOISE: 2.7 dB (TYP.)
- ◆ VERY HIGH GAIN: 36.5 dB (TYP.)
- ◆ LOW COST
- ◆ VERY SMALL SIZE: TO-5 PACKAGE



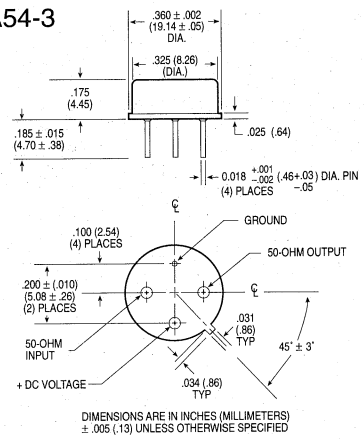

## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-350 MHz | 5-300 MHz | 5-300 MHz |
| Small Signal Gain (Min.) | 36.5 dB | 35.0 dB | 34.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±0.8 dB |
| Noise Figure (Max.) | 2.7 dB | 3.6 dB | 4.0 dB |
| Power Output at 1 dB Compression (Min.) | +9.0 dBm | +7.5 dBm | +6.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 1.8:1 | 1.9:1 |
| Output | 1.4:1 | 1.8:1 | 1.9:1 |
| DC Current (Max.) at +15 Volts | 33.0 mA | 36.0 mA | 37.0 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.

## Outline Drawings

EA54-3




WJ-CA package is not available for TO-5's.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+33.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+28.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+20.0 dBm (Typ.)

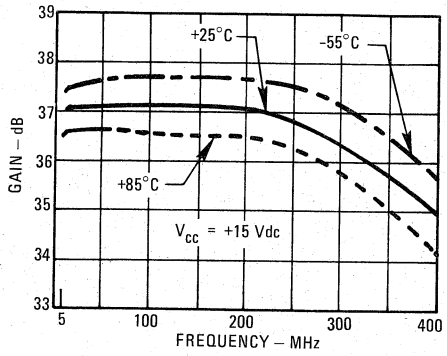
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

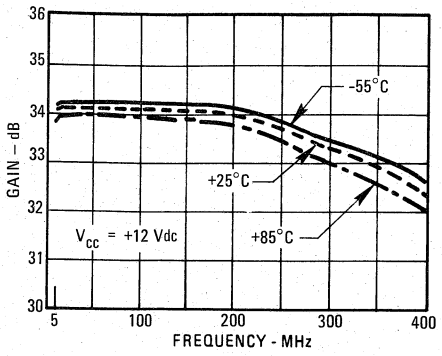
Weight approximately 1.0 grams (0.04 oz.)

# Typical Performance at 25°C

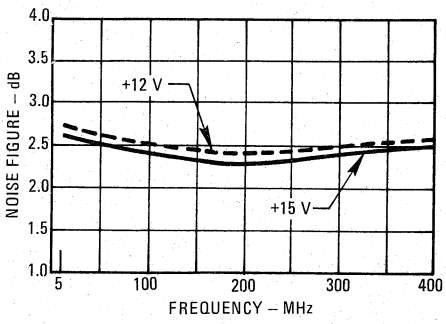
### Gain




### Gain

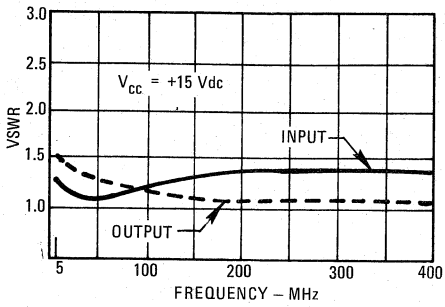



### Noise Figure vs. Frequency

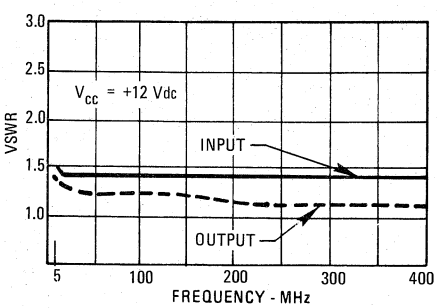



1

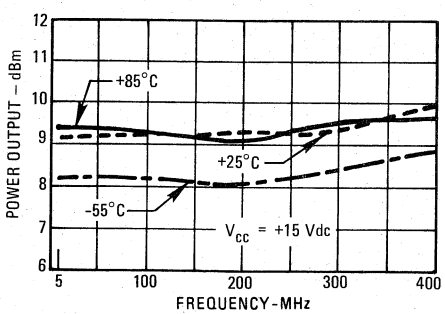
### VSWR




### VSWR

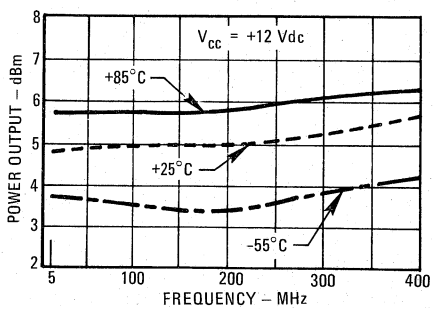



### Power Output*



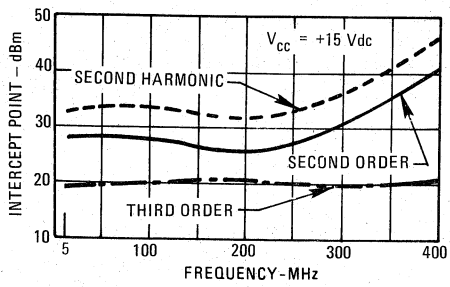

*at 1 dB Gain Compression

### Power Output*

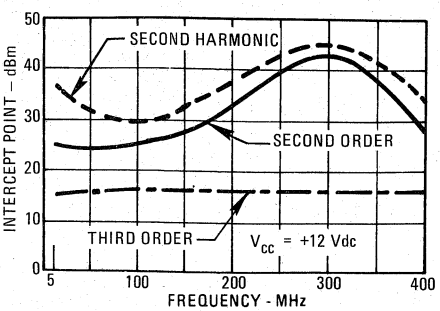



*at 1 dB Gain Compression

### Intercept Point




### Intercept Point



# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.8 | 2.5 | 33.5 |
| 2.0 | 1.7 | 2.0 | 35.9 |
| 5.0 | 1.3 | 1.5 | 36.6 |
| 10.0 | 1.2 | 1.4 | 36.7 |
| 50.0 | 1.1 | 1.4 | 37.0 |
| 100.0 | 1.2 | 1.3 | 36.8 |
| 150.0 | 1.4 | 1.3 | 36.9 |
| 200.0 | 1.5 | 1.2 | 36.9 |
| 250.0 | 1.7 | 1.2 | 36.8 |
| 300.0 | 1.8 | 1.2 | 36.5 |
| 350.0 | 1.8 | 1.2 | 36.0 |
| 400.0 | 1.8 | 1.2 | 35.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .469 | –68 | 47.573 | 109 | .003 | 106 | .429 | –44 |
| 2.0 | .253 | –69 | 62.189 | 54 | .003 | 57 | .332 | –38 |
| 5.0 | .125 | –70 | 67.257 | 21 | .004 | 26 | .211 | –33 |
| 10.0 | .076 | –69 | 68.246 | 8 | .003 | 13 | .171 | –23 |
| 50.0 | .067 | –108 | 70.518 | –13 | .004 | 15 | .159 | –23 |
| 100.0 | .108 | –113 | 69.269 | –29 | .004 | 15 | .139 | –39 |
| 150.0 | .161 | –131 | 69.804 | –45 | .004 | 21 | .123 | –56 |
| 200.0 | .215 | –145 | 70.010 | –61 | .004 | 32 | .107 | –78 |
| 250.0 | .251 | –165 | 69.149 | –79 | .005 | 31 | .087 | –106 |
| 300.0 | .285 | 180 | 66.826 | –96 | .005 | 40 | .075 | –144 |
| 350.0 | .296 | 163 | 63.429 | –114 | .006 | 47 | .078 | 175 |
| 400.0 | .287 | 146 | 58.620 | –132 | .007 | 44 | .092 | 141 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.3 | 2.8 | 31.4 |
| 2.0 | 1.7 | 2.1 | 33.2 |
| 5.0 | 1.5 | 1.5 | 33.8 |
| 10.0 | 1.4 | 1.4 | 33.9 |
| 50.0 | 1.3 | 1.3 | 34.1 |
| 100.0 | 1.4 | 1.3 | 33.9 |
| 150.0 | 1.4 | 1.2 | 33.9 |
| 200.0 | 1.5 | 1.2 | 33.9 |
| 250.0 | 1.6 | 1.2 | 33.8 |
| 300.0 | 1.6 | 1.1 | 33.5 |
| 350.0 | 1.6 | 1.1 | 33.2 |
| 400.0 | 1.6 | 1.1 | 32.7 |

### Linear S-Parameters

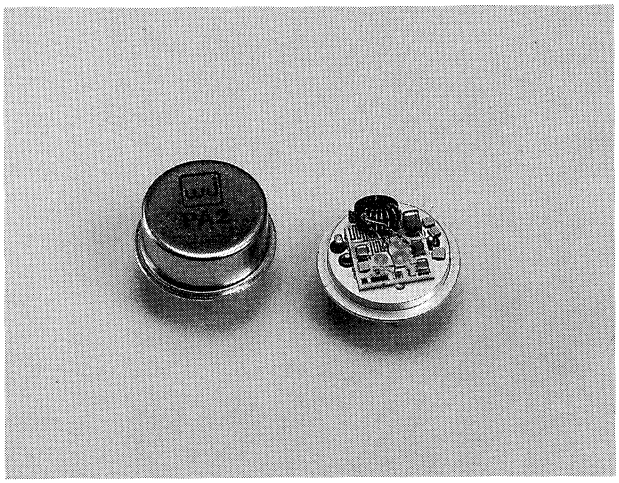
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .395 | –58 | 37.252 | 98 | .003 | 97 | .479 | –41 |
| 2.0 | .264 | –40 | 45.633 | 49 | .004 | 48 | .347 | –44 |
| 5.0 | .189 | –28 | 48.898 | 19 | .004 | 19 | .198 | –39 |
| 10.0 | .169 | –20 | 49.548 | 7 | .004 | 13 | .150 | –28 |
| 50.0 | .143 | –31 | 50.648 | –13 | .005 | 3 | .133 | –20 |
| 100.0 | .162 | –52 | 49.757 | –28 | .005 | 8 | .118 | –32 |
| 150.0 | .180 | –75 | 49.814 | –44 | .005 | 23 | .104 | –44 |
| 200.0 | .205 | –96 | 49.702 | –60 | .005 | 21 | .089 | –61 |
| 250.0 | .218 | –117 | 48.955 | –76 | .005 | 30 | .070 | –81 |
| 300.0 | .228 | –135 | 47.497 | –92 | .005 | 34 | .052 | –110 |
| 350.0 | .230 | –151 | 45.606 | –109 | .006 | 35 | .042 | –156 |
| 400.0 | .227 | –167 | 43.057 | –125 | .007 | 42 | .050 | 160 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.216 W
Junction Temperature Rise Above Case $T_{jc}$ ... 10°C

# WJ-PA2 / SMPA2

## 10 to 300 MHz
## TO-8 CASCADABLE AMPLIFIER



- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +25 dBm (TYP.) @ +24 V
- ◆ HIGH EFFICIENCY
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +24 VOLTS

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-350 MHz | 10-300 MHz | 10-300 MHz |
| Small Signal Gain (Min.) | 12.5 dB | 11.5 dB | 11.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| $V_{CC}$ = +24 Volts | 8.0 dB | 9.5 dB | 10.0 dB |
| $V_{CC}$ = +15 Volts | 7.5 dB | 9.0 dB | 9.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| $V_{CC}$ = +24 Volts | +25 dBm | +24 dBm | +23.5 dBm |
| $V_{CC}$ = +15 Volts | +21 dBm | +19.5 dBm | +19.0 dBm |
| VSWR (Max.) | | | |
| Input | <1.5:1 | 1.8:1 | 2.0:1 |
| Output | <1.7:1 | 2.0:1 | 2.2:1 |
| DC Current | | | |
| At +24 Volts (Max.) | 95 mA | 100 mA | 105 mA |
| At +15 Volts (Max.) | 58 mA | 61 mA | 64 mA |

* Measured in a 50-ohm system at +24 Vdc Nominal.
Notes:
1. WJ-CPA2 is a standard WJ-PA2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C (At +24 Vdc)

Second Order Harmonic Intercept Point.....+63 dBm (Typ.)
Second Order Two Tone Intercept Point.....+56 dBm (Typ.)
Third Order Two Tone Intercept Point.....+38 dBm (Typ.)

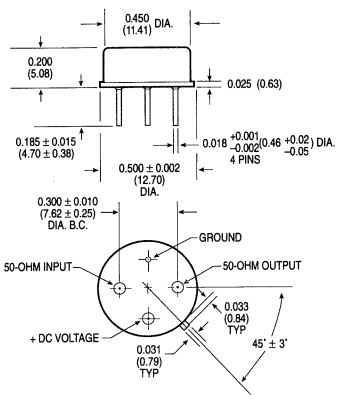
## Absolute Maximum Ratings (At +24 Vdc)

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+25 Volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....85°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz)

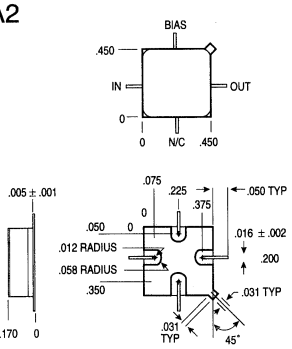
## Outline Drawings

PA2



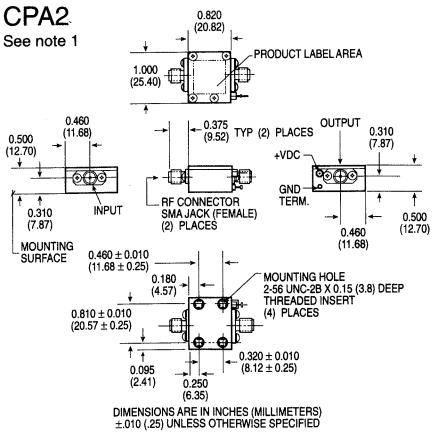

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

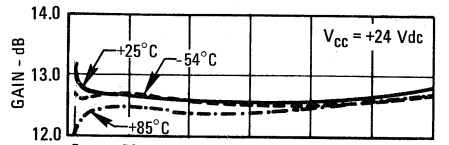
CPA2
See note 1

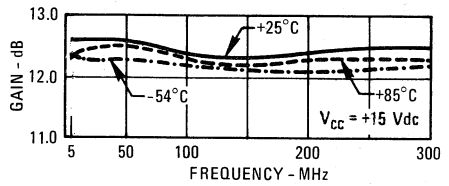


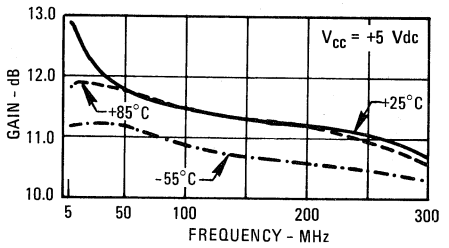

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

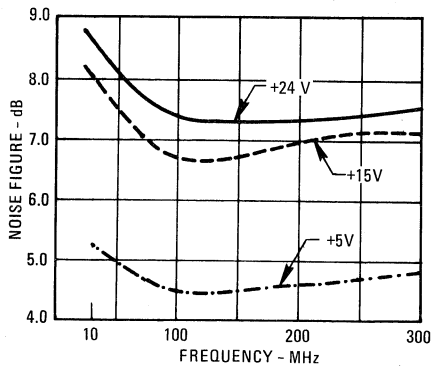
## Gain



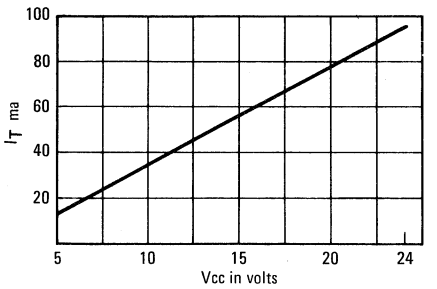



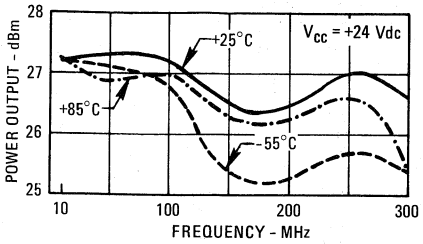

## Noise Figure

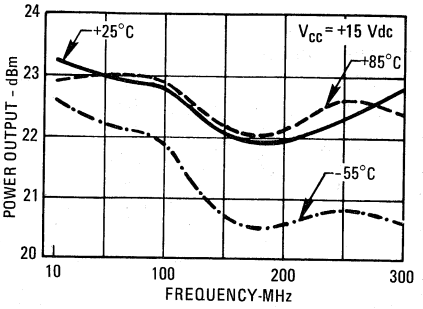


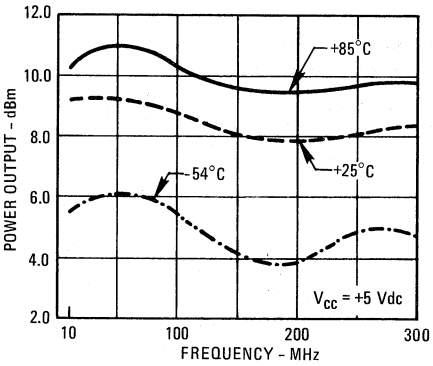

## $I_t$ vs Vcc




## Power Output*

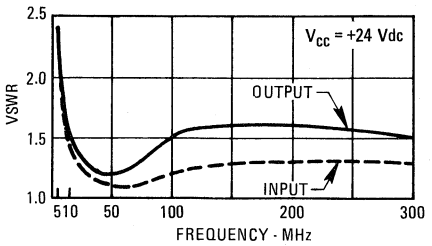


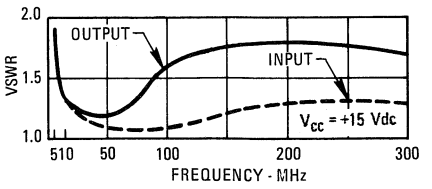



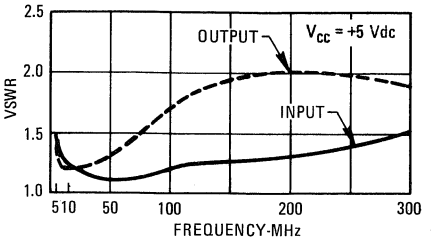




* at 1 dB Gain Compression

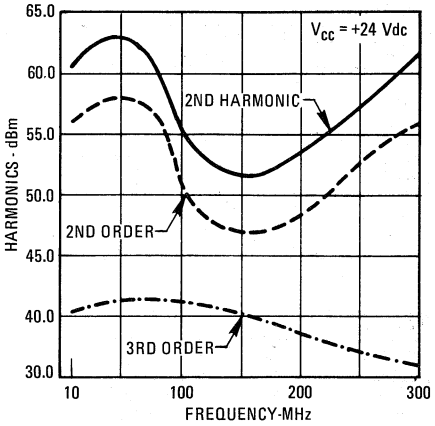
## VSWR

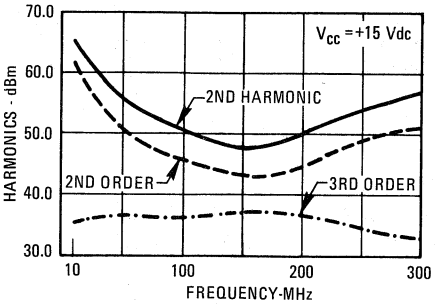


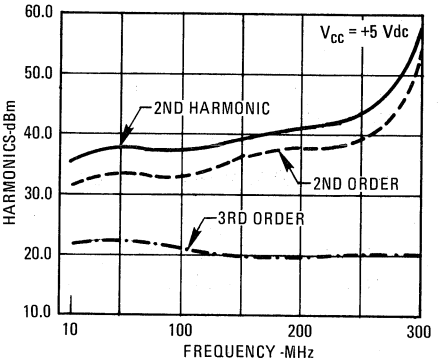




## Harmonics




1

# Typical Automatic Test Data

### $V_{CC}$ = 24.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.5 | 1.6 | 13.2 |
| 10.0 | 1.2 | 1.3 | 13.1 |
| 50.0 | 1.1 | 1.2 | 13.3 |
| 100.0 | 1.0 | 1.4 | 13.1 |
| 150.0 | 1.1 | 1.5 | 12.8 |
| 200.0 | 1.2 | 1.6 | 12.8 |
| 250.0 | 1.3 | 1.6 | 12.7 |
| 300.0 | 1.5 | 1.5 | 12.9 |
| 350.0 | 1.7 | 1.4 | 12.8 |
| 400.0 | 1.7 | 1.7 | 12.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .191 | –87 | 4.564 | –169 | .116 | 10 | .221 | 125 |
| 10.0 | .100 | –110 | 4.509 | –177 | .124 | 4 | .127 | 138 |
| 50.0 | .035 | –173 | 4.615 | 163 | .130 | –8 | .107 | –166 |
| 100.0 | .005 | 180 | 4.497 | 143 | .129 | –20 | .154 | –159 |
| 150.0 | .041 | –56 | 4.386 | 124 | .128 | –29 | .199 | –169 |
| 200.0 | .085 | –78 | 4.387 | 106 | .128 | –39 | .221 | 176 |
| 250.0 | .140 | –93 | 4.302 | 88 | .130 | –49 | .220 | 153 |
| 300.0 | .200 | –111 | 4.394 | 67 | .131 | –59 | .191 | 121 |
| 350.0 | .249 | –133 | 4.368 | 46 | .136 | –72 | .173 | 67 |
| 400.0 | .268 | –154 | 4.233 | 20 | .138 | –86 | .255 | 2 |

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.4 | 1.4 | 12.9 |
| 10.0 | 1.2 | 1.2 | 12.9 |
| 50.0 | 1.1 | 1.2 | 13.0 |
| 100.0 | 1.0 | 1.4 | 12.8 |
| 150.0 | 1.1 | 1.6 | 12.6 |
| 200.0 | 1.2 | 1.7 | 12.6 |
| 250.0 | 1.3 | 1.7 | 12.4 |
| 300.0 | 1.5 | 1.6 | 12.6 |
| 350.0 | 1.7 | 1.5 | 12.5 |
| 400.0 | 1.8 | 1.8 | 12.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .158 | –94 | 4.440 | –171 | .119 | 9 | .180 | 125 |
| 10.0 | .090 | –114 | 4.421 | –177 | .125 | 4 | .104 | 139 |
| 50.0 | .040 | –175 | 4.487 | 162 | .129 | –8 | .100 | –155 |
| 100.0 | .013 | 177 | 4.389 | 142 | .128 | –19 | .166 | –152 |
| 150.0 | .037 | –66 | 4.278 | 123 | .127 | –29 | .220 | –166 |
| 200.0 | .086 | –83 | 4.257 | 105 | .127 | –38 | .248 | 177 |
| 250.0 | .138 | –99 | 4.182 | 86 | .129 | –47 | .250 | 152 |
| 300.0 | .200 | –116 | 4.248 | 66 | .132 | –57 | .225 | 119 |
| 350.0 | .251 | –136 | 4.209 | 43 | .138 | –71 | .213 | 67 |
| 400.0 | .278 | –158 | 4.044 | 18 | .141 | –85 | .292 | 4 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 1.3 | 1.3 | 12.0 |
| 10.0 | 1.2 | 1.1 | 12.1 |
| 50.0 | 1.1 | 1.2 | 12.1 |
| 100.0 | 1.1 | 1.5 | 11.8 |
| 150.0 | 1.2 | 1.8 | 11.5 |
| 200.0 | 1.3 | 1.9 | 11.3 |
| 250.0 | 1.5 | 2.0 | 11.0 |
| 300.0 | 1.7 | 1.8 | 10.9 |
| 350.0 | 2.0 | 1.8 | 10.6 |
| 400.0 | 2.0 | 2.1 | 9.8 |

### Linear S-Parameters

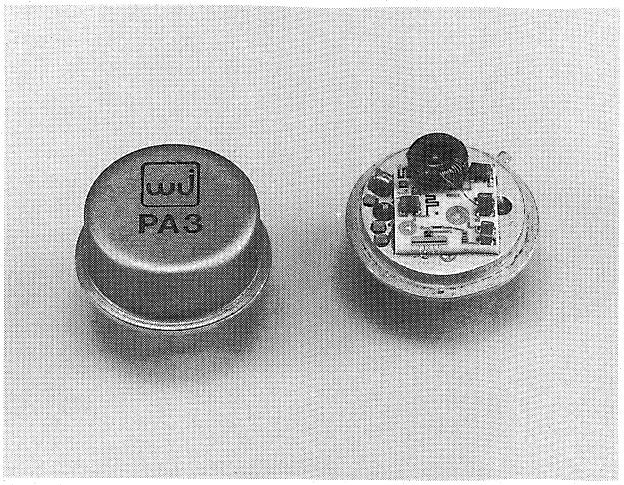
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .125 | –82 | 3.994 | –170 | .129 | 11 | .123 | 111 |
| 10.0 | .070 | –90 | 4.014 | –178 | .131 | 5 | .054 | 111 |
| 50.0 | .030 | –116 | 4.018 | 160 | .134 | –8 | .099 | –112 |
| 100.0 | .039 | –91 | 3.874 | 138 | .132 | –18 | .209 | –134 |
| 150.0 | .088 | –81 | 3.738 | 117 | .131 | –27 | .284 | –158 |
| 200.0 | .144 | –98 | 3.670 | 97 | .134 | –35 | .320 | 178 |
| 250.0 | .204 | –114 | 3.539 | 76 | .139 | –45 | .324 | 150 |
| 300.0 | .271 | –132 | 3.519 | 54 | .146 | –55 | .298 | 114 |
| 350.0 | .323 | –150 | 3.375 | 30 | .154 | –69 | .289 | 62 |
| 400.0 | .339 | –171 | 3.101 | 3 | .159 | –85 | .364 | 3 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 1.565 W
Junction Temperature Rise Above Case $T_{jc}$ ... 70°C

# WJ-PA3 / SMPA3

## 5 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +24.5 dBm (TYP.) @ +15Vdc
- ◆ HIGH THIRD ORDER INTERCEPT POINT: +34 dBm (TYP.)
- ◆ MEDIUM GAIN: 14.5 dB (TYP.)
- ◆ LOW VSWR: < 1.5:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to-50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3-600 MHz | 5-500 MHz | 5-500 MHz |
| Small Signal Gain (Min.) | 14.5 dB | 13.5 dB | 13.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 7.5 dB | 9.0 dB | 9.5 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| $V_{CC}$ = +15 Volts | +24.5 dBm | +23.0 dBm[2] | +22.5 dBm[3] |
| $V_{CC}$ = +12 Volts | +23.0 dBm | +20.0 dBm | +20.0 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) | | | |
| $V_{CC}$ = +15 Volts | 130 mA | 134 mA | 141 mA |
| $V_{CC}$ = +12 Volts | 98 mA | 100 mA | 105 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CPA3 is a standard WJ-PA3 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. +22.5 dBm: 400-500 MHz.
3. +22.0 dBm: 400-500 MHz.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

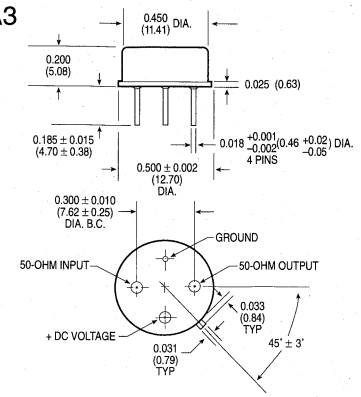
## Absolute Maximum Ratings (At +15 Vdc)

Storage Temperature .....-62° to +125°
Maximum Case Temperature[4].....85°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt ( 3 μ sec Max.)
"S" Series Burn-In Temperature (Case).....85°C
Proper heatsinking is required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

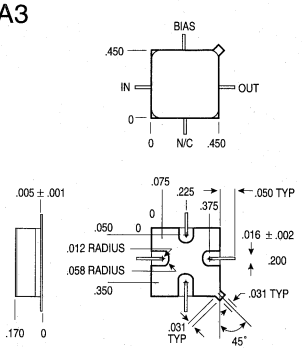
## Outline Drawings

PA3



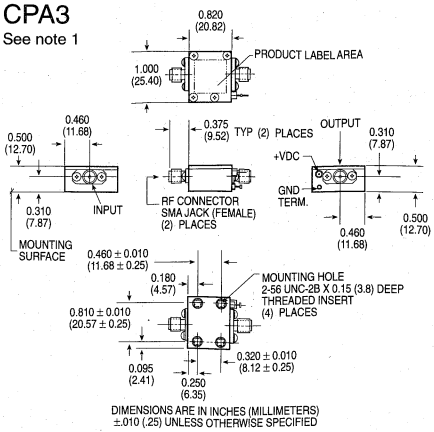

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

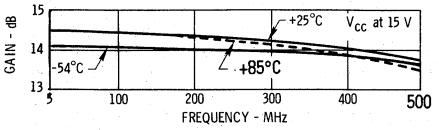
CPA3
See note 1

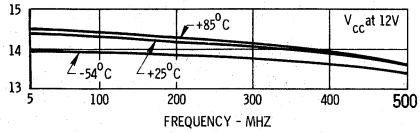



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

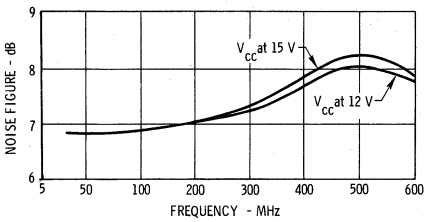
# Typical Performance at 25°C

### Gain

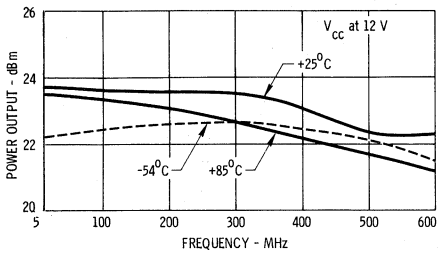


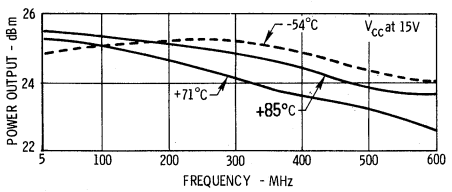




### Noise Figure



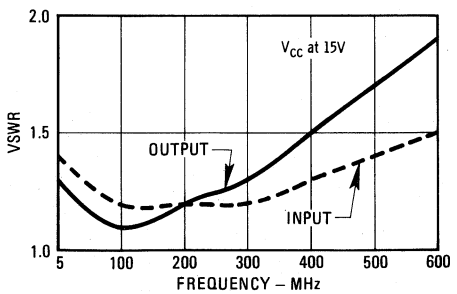

### Power Output*



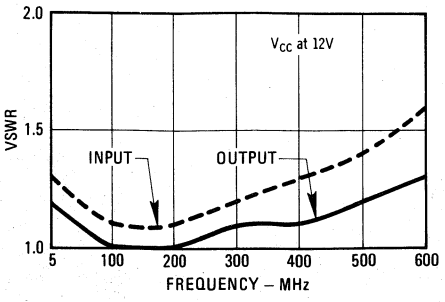




* at 1 dB Gain Compression

### VSWR




### VSWR




## Typical Automatic Test Data

### $V_{cc}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.1 | 2.5 | 12.7 |
| 2.0 | 1.5 | 1.4 | 14.4 |
| 5.0 | 1.2 | 1.2 | 14.5 |
| 10.0 | 1.1 | 1.1 | 14.5 |
| 50.0 | 1.1 | 1.1 | 14.5 |
| 100.0 | 1.1 | 1.1 | 14.5 |
| 200.0 | 1.2 | 1.1 | 14.4 |
| 300.0 | 1.3 | 1.1 | 14.3 |
| 400.0 | 1.3 | 1.2 | 14.4 |
| 500.0 | 1.5 | 1.4 | 14.3 |
| 600.0 | 1.7 | 1.6 | 14.3 |
| 700.0 | 2.3 | 2.0 | 13.9 |

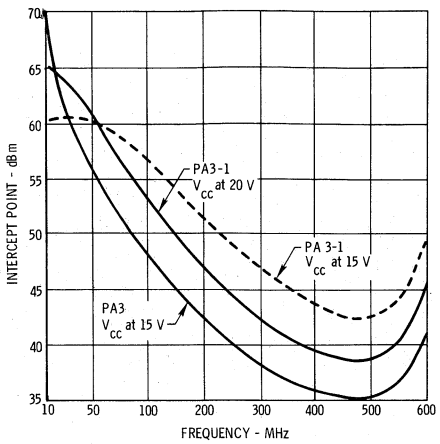
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .362 | –68 | 4.333 | –129 | .085 | 52 | .429 | 173 |
| 2.0 | .184 | –95 | 5.249 | –157 | .107 | 25 | .181 | 115 |
| 5.0 | .079 | –118 | 5.304 | –172 | .109 | 9 | .071 | 72 |
| 10.0 | .057 | –139 | 5.307 | –178 | .109 | 4 | .048 | 44 |
| 50.0 | .050 | –166 | 5.319 | 170 | .110 | –3 | .038 | –12 |
| 100.0 | .055 | –166 | 5.280 | 159 | .111 | –7 | .041 | –42 |
| 200.0 | .087 | –168 | 5.243 | 137 | .113 | –14 | .048 | –100 |
| 300.0 | .123 | 173 | 5.191 | 115 | .118 | –23 | .069 | –151 |
| 400.0 | .146 | 147 | 5.220 | 93 | .125 | –32 | .110 | 172 |
| 500.0 | .200 | 117 | 5.213 | 70 | .132 | –44 | .163 | 137 |
| 600.0 | .270 | 83 | 5.190 | 44 | .140 | –58 | .236 | 102 |
| 700.0 | .394 | 46 | 4.977 | 14 | .143 | –76 | .327 | 63 |

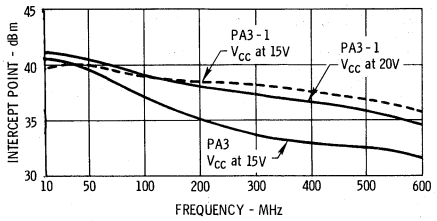
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 1.328 W
Junction Temperature Rise Above Case $T_{jc}$ ... 60°C

### Second Order Intercept Point



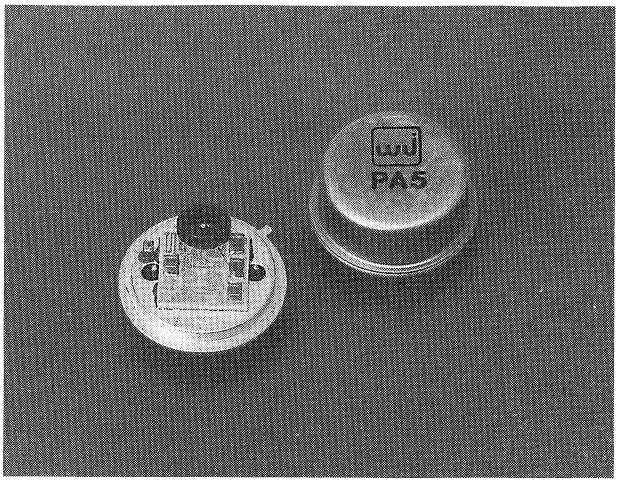

### Third Order Intercept Point




1

# WJ-PA5 / SMPA5

## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH THIRD ORDER I.P.: +35 dBm (TYP.)
- ◆ HIGH OUTPUT POWER: +25 dBm (TYP.)
- ◆ LOW VSWR: < 1.5:1 (TYP.)
- ◆ OPERATION FROM +12 Vdc TO +15 Vdc

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-500 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 9.4 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-70 MHz | 8.5 dB | 9.5 dB | 10.0 dB |
| 70-500 MHz | 7.8 dB | 8.8 dB | 9.3 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +25.0 dBm | +23.5 dBm | +23.5 dBm |
| VSWR (Max.) | | | |
| Input/Output | 1.5:1 | 1.7:1 | 2.0:1 |
| DC Current at +15 Volts (Max.) | 130 mA | 133 mA | 136 mA |

* Measured in a 50-ohm system at +15 Vdc nominal.
Notes:
1. WJ-CPA5 is a standard WJ-PA5 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+60 dBm (Typ.)
Second Order Two Tone Intercept Point.....+54 dBm (Typ.)
Third Order Two Tone Intercept Point.....+35 dBm (Typ.)

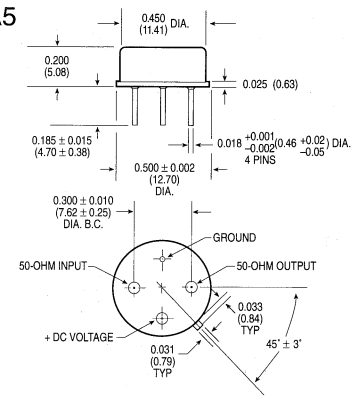
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+22 Volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power .....0.5 Watt (3 μ sec Max.)
"S" Series Burn-In Temperature (Case) .....85°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

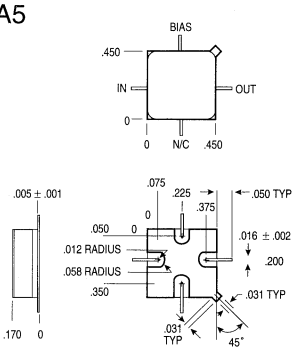
## Outline Drawings

PA5



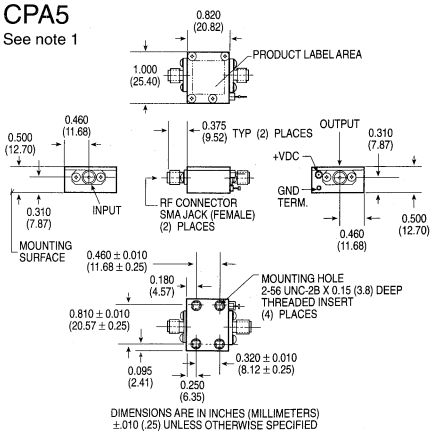

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA5




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

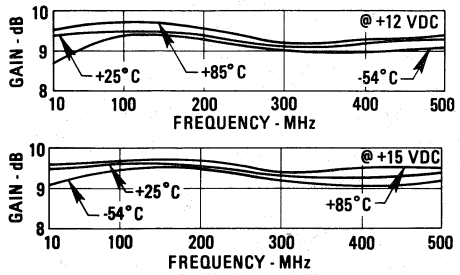
CPA5
See note 1



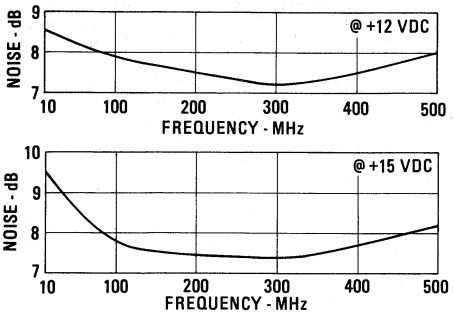

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

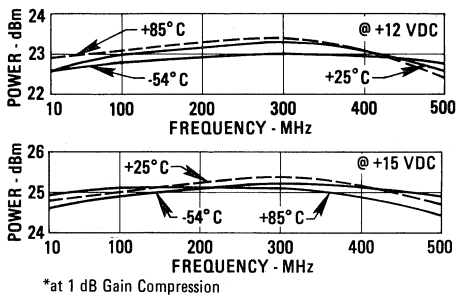
### Gain




### Noise Figure

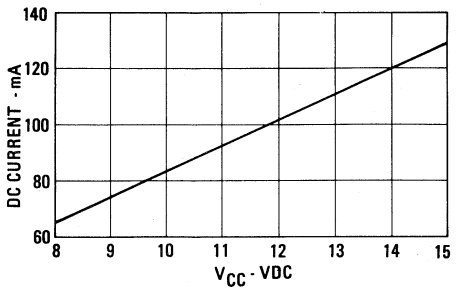



### Power Output*

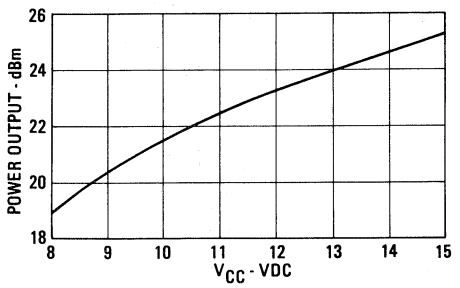



*at 1 dB Gain Compression

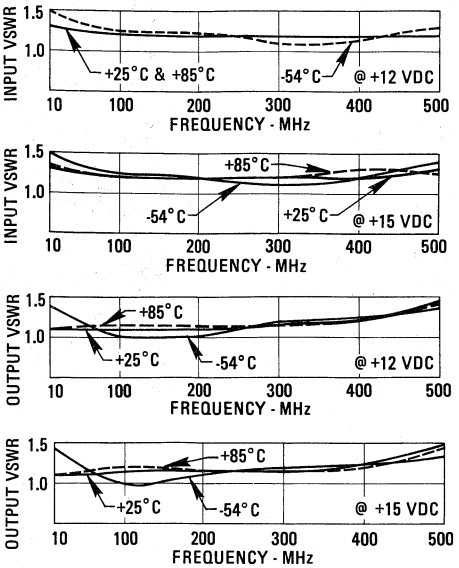
### Current vs. Voltage



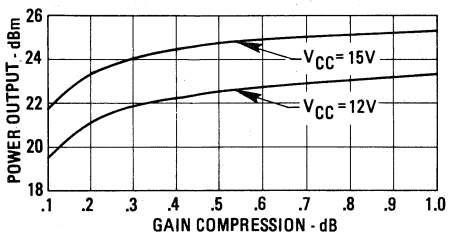

### Power Output vs. Voltage



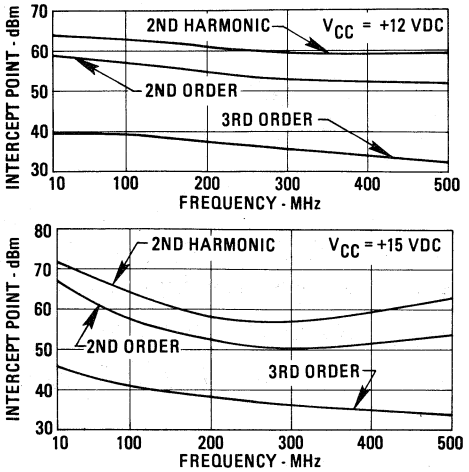

### VSWR



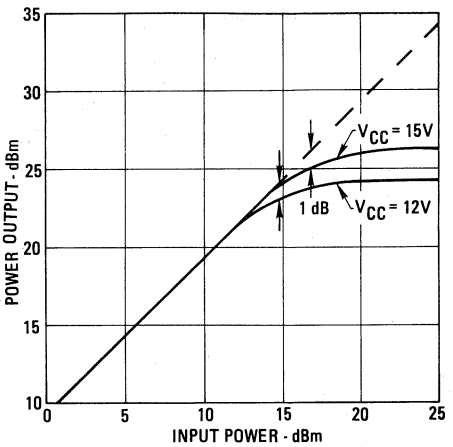

### Power Output vs. Gain Compression




### Intercept Point




### Power Output vs. Power Input




## Typical Automatic Test Data

### VCC = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.9 | 1.3 | 8.3 |
| 5.0 | 1.4 | 1.1 | 9.9 |
| 10.0 | 1.2 | 1.1 | 10.4 |
| 50.0 | 1.2 | 1.0 | 10.6 |
| 100.0 | 1.1 | 1.0 | 10.5 |
| 200.0 | 1.1 | 1.1 | 10.4 |
| 300.0 | 1.0 | 1.1 | 10.2 |
| 400.0 | 1.1 | 1.1 | 10.2 |
| 500.0 | 1.2 | 1.1 | 10.2 |
| 600.0 | 1.4 | 1.2 | 10.7 |
| 700.0 | 1.4 | 1.4 | 11.3 |

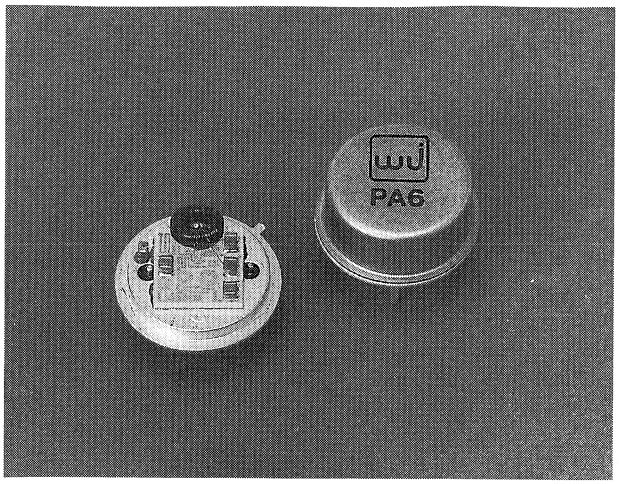
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .302 | –62 | 2.612 | –145 | .184 | 18 | .144 | 63 |
| 5.0 | .166 | –90 | 3.141 | –163 | .168 | 3 | .045 | –35 |
| 10.0 | .107 | –118 | 3.314 | –172 | .160 | 0 | .025 | –98 |
| 50.0 | .070 | 180 | 3.393 | 172 | .157 | –4 | .019 | 156 |
| 100.0 | .062 | 153 | 3.361 | 160 | .157 | –9 | .021 | 114 |
| 200.0 | .042 | 127 | 3.300 | 140 | .157 | –18 | .030 | 60 |
| 300.0 | .021 | 58 | 3.226 | 121 | .157 | –28 | .037 | 21 |
| 400.0 | .052 | –45 | 3.229 | 102 | .155 | –40 | .043 | –20 |
| 500.0 | .106 | –93 | 3.252 | 83 | .147 | –52 | .063 | –57 |
| 600.0 | .161 | –134 | 3.412 | 63 | .132 | –64 | .101 | –90 |
| 700.0 | .175 | 170 | 3.664 | 38 | .106 | –70 | .169 | –125 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.940 W
Junction Temperature Rise Above Case $T_{jc}$ ... 42°C

# WJ-PA6 / SMPA6




## 10 to 500 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH THIRD ORDER I.P.: +35 dBm (TYP.)
- ◆ HIGH OUTPUT POWER: +26.5 dBm (TYP.)
- ◆ LOW VSWR: 1.5:1 (TYP.)
- ◆ OPERATION FROM +12 Vdc TO +20 Vdc

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-500 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 9.5 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 10-100 MHz | 8.5 dB | 9.5 dB | 10.0 dB |
| 100-500 MHz | 7.8 dB | 8.8 dB | 9.3 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +26.5 dBm | +25 dBm | +25 dBm |
| VSWR (Max.) | | | |
| Input/Output | 1.5:1 | 1.7:1 | 2.0:1 |
| DC Current at +20 Volts (Max.) | 150 mA | 154 mA | 158 mA |

* Measured in a 50-ohm system at +20 Vdc Nominal.
Notes:
1. WJ-CPA6 is a standard WJ-PA6 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+60 dBm (Typ.)
Second Order Two Tone Intercept Point.....+55 dBm (Typ.)
Third Order Two Tone Intercept Point.....+35 dBm (Typ.)

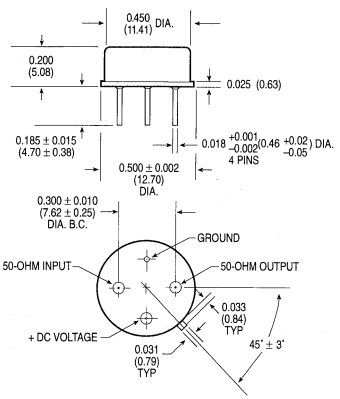
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature (At +20 Vdc).....85°C
Maximum DC Voltage.....+22 Volts
Maximum Continuous RF Input Power.....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power.....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) (At +20 Vdc).....85°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

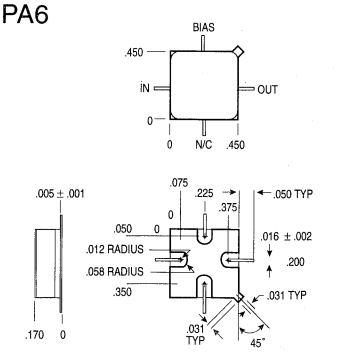
## Outline Drawings

PA6



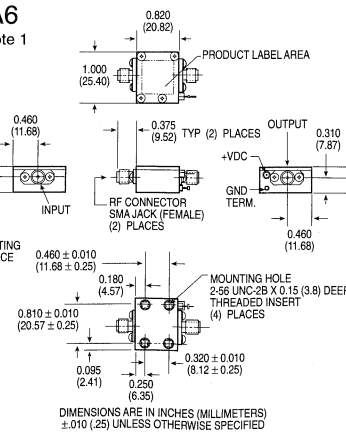

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA6




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

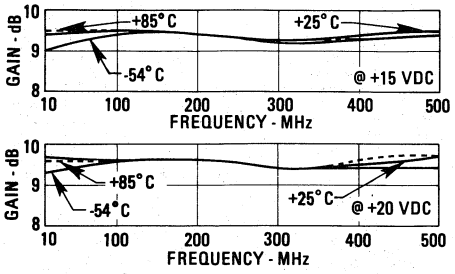
CPA6
See note 1



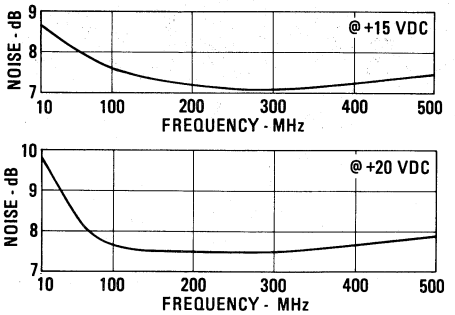

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

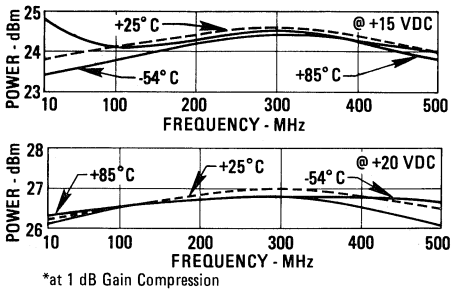
### Gain




### Noise Figure

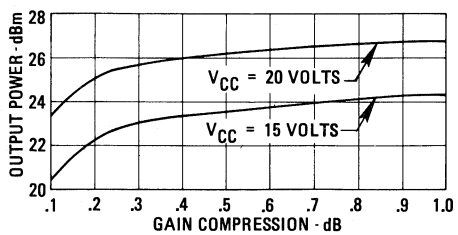



### Power Output*

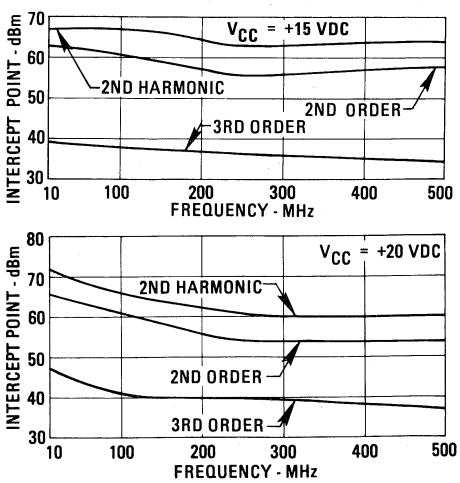



*at 1 dB Gain Compression

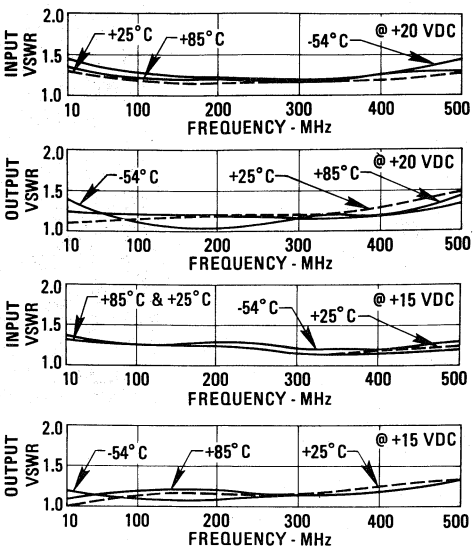
### Output Power vs. Gain Compression



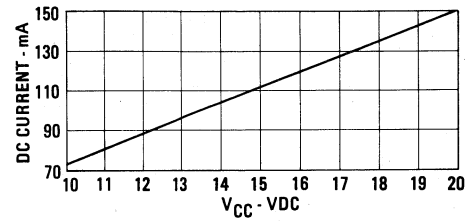

### Intercept Point



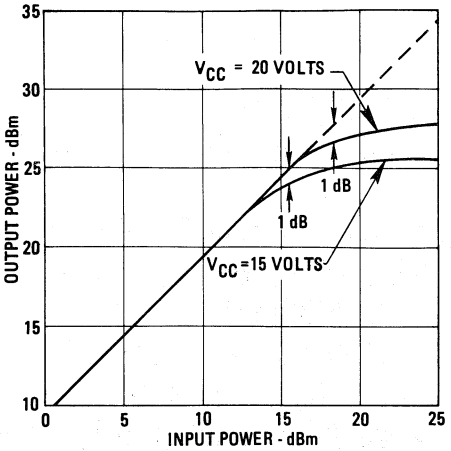

### VSWR



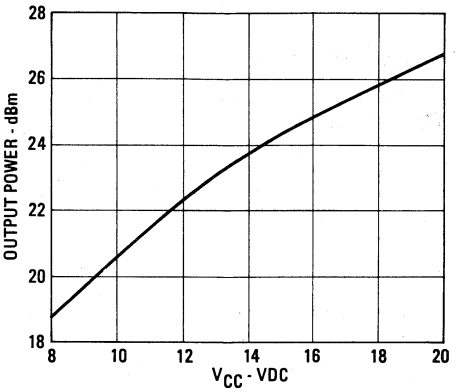

### Current vs. Voltage




### Output Power vs. Input Power




### Output Power vs. Voltage




## Typical Automatic Test Data

### $V_{CC}$ = 20.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.9 | 1.3 | 8.0 |
| 5.0 | 1.4 | 1.1 | 9.6 |
| 10.0 | 1.2 | 1.1 | 10.0 |
| 50.0 | 1.1 | 1.1 | 10.2 |
| 100.0 | 1.1 | 1.1 | 10.2 |
| 200.0 | 1.1 | 1.1 | 10.1 |
| 300.0 | 1.1 | 1.1 | 10.0 |
| 400.0 | 1.2 | 1.2 | 10.1 |
| 500.0 | 1.2 | 1.4 | 10.1 |
| 600.0 | 1.2 | 1.5 | 10.3 |
| 700.0 | 1.1 | 1.7 | 10.5 |

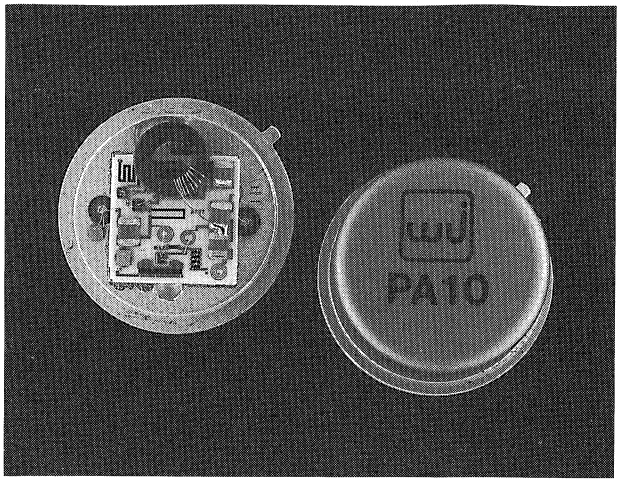
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .302 | –63 | 2.513 | –143 | .185 | 19 | .140 | 72 |
| 5.0 | .160 | –91 | 3.010 | –163 | .168 | 3 | .035 | –41 |
| 10.0 | .101 | –118 | 3.162 | –172 | .161 | 0 | .027 | –117 |
| 50.0 | .064 | 174 | 3.236 | 172 | .158 | –3 | .028 | –166 |
| 100.0 | .063 | 138 | 3.218 | 161 | .159 | –6 | .029 | –162 |
| 200.0 | .059 | 94 | 3.182 | 141 | .162 | –13 | .042 | –151 |
| 300.0 | .059 | 46 | 3.147 | 122 | .166 | –20 | .069 | –158 |
| 400.0 | .080 | –2 | 3.184 | 102 | .172 | –27 | .110 | –172 |
| 500.0 | .088 | –39 | 3.190 | 83 | .179 | –36 | .154 | 170 |
| 600.0 | .091 | –72 | 3.274 | 61 | .189 | –45 | .205 | 149 |
| 700.0 | .065 | –108 | 3.361 | 38 | .200 | –56 | .263 | 123 |

## Thermal Data: $V_{CC}$ = 20 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.425 W
Junction Temperature Rise Above Case $T_{jc}$ ... 19°C

# WJ-PA10 / SMPA10




## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +24.5 dBm (TYP.) @ +20 Vdc
- ◆ WIDE POWER SUPPLY RANGE: +12 TO +20 VOLTS
- ◆ WIDE BANDWIDTH: 10 TO 1000 MHz
- ◆ LOW VSWR: < 1.5:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C[2] |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 10.0 dB | 9.5 dB | 9.0 dB[2] |
| Gain Flatness (Max.) | < ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 8.5 dB | 9.5 dB | 10.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| $V_{CC}$ = +15 Volts | +22.5 dBm | +20.0 dBm | +20.0 dBm |
| $V_{CC}$ = +20 Volts[2] | +24.5 dBm | +23.0 dBm | +23.0 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) | | | |
| At +15 Volts | 95 mA | 100 mA | 105 mA |
| At +20 Volts[2] | 130 mA | 132 mA | 134 mA |

* Measured in a 50-ohm system with Vcc = 15 Vdc Nominal.
Notes:
1. WJ-CPA10 is a standard WJ-PA10 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. +71°C max. case temperature when Vcc = 20 Vdc.

## Typical Intermodulation Performance at 25°C (Typ. +15 Vdc)

Second Order Harmonic Intercept Point.....> +50 dBm
Second Order Two Tone Intercept Point.....+45 dBm
Third Order Two Tone Intercept Point.....+36 dBm

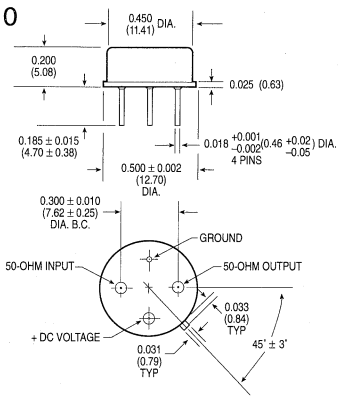
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature (At 15 Vdc) .....125°C
Maximum DC Voltage.....+22 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) (At 15 Vdc) .....125°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

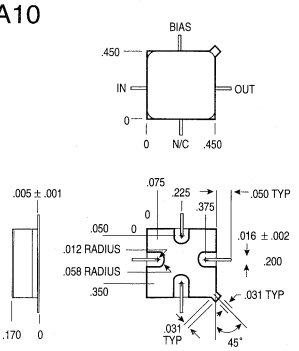
## Outline Drawings

PA10



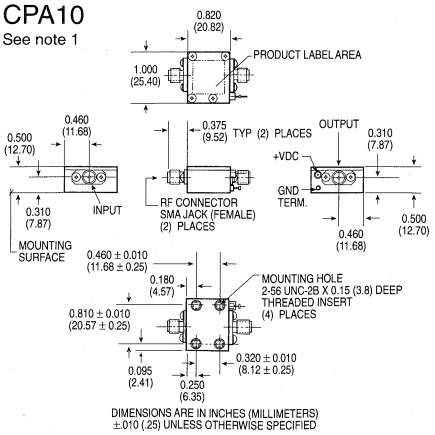

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA10




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CPA10
See note 1

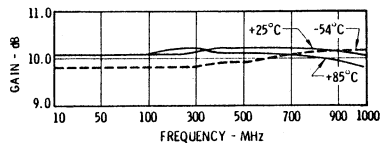



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

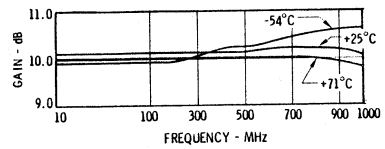
# Typical Performance at 25°C

## Gain

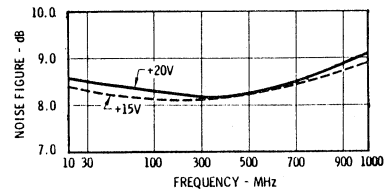
### +15 V



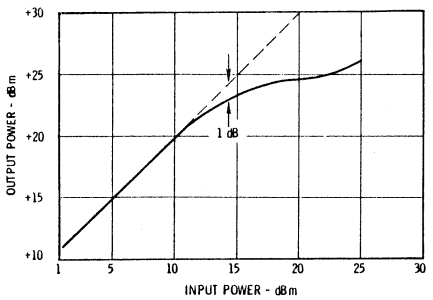

### +20 V



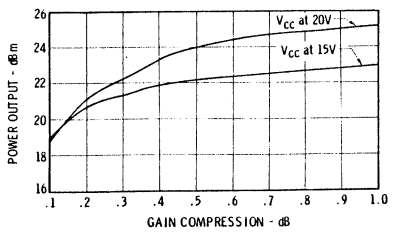

## Noise Figure




## Output Power vs. Input Power

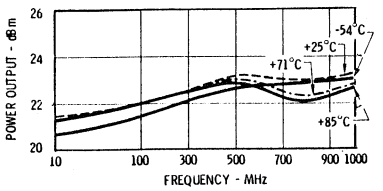



## Output Power vs. Gain Compression




## Power Output*

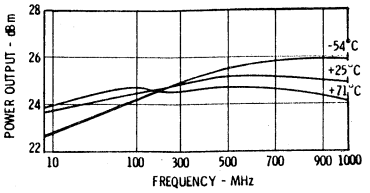
### +15 V




*at 1 dB Gain Compression

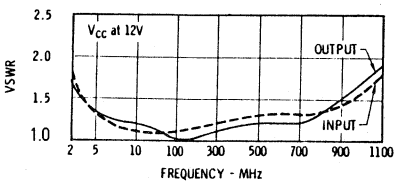
## Power Output*

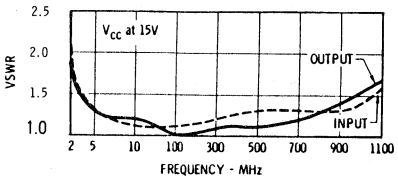
### +20 V

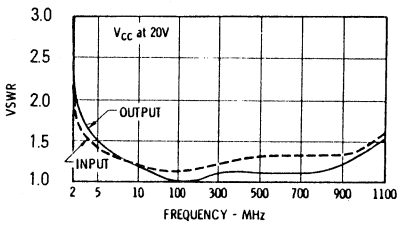



*at 1 dB Gain Compression

## VSWR

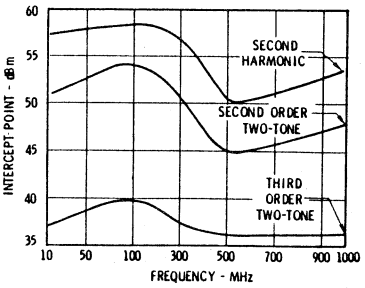


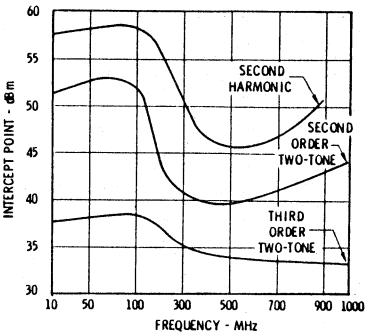




## Intercept Point

### +20 V




### +15 V




# Typical Automatic Test Data

## $V_{CC}$ = 20.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.9 | 10.4 |
| 5.0 | 1.2 | 1.3 | 10.7 |
| 10.0 | 1.1 | 1.1 | 10.7 |
| 50.0 | 1.1 | 1.0 | 10.8 |
| 100.0 | 1.1 | 1.0 | 10.8 |
| 200.0 | 1.1 | 1.0 | 10.7 |
| 300.0 | 1.2 | 1.1 | 10.6 |
| 400.0 | 1.3 | 1.1 | 10.7 |
| 500.0 | 1.3 | 1.1 | 10.5 |
| 600.0 | 1.4 | 1.1 | 10.5 |
| 700.0 | 1.4 | 1.2 | 10.5 |
| 800.0 | 1.4 | 1.2 | 10.4 |
| 900.0 | 1.5 | 1.2 | 10.2 |
| 1000.0 | 1.7 | 1.2 | 10.1 |
| 1100.0 | 1.8 | 1.2 | 9.7 |
| 1200.0 | 2.2 | 1.2 | 9.2 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .239 | –78 | 3.296 | –150 | .140 | 32 | .321 | 131 |
| 5.0 | .095 | –101 | 3.414 | –170 | .149 | 12 | .118 | 113 |
| 10.0 | .057 | –117 | 3.441 | –176 | .150 | 6 | .065 | 110 |
| 50.0 | .043 | –157 | 3.475 | 173 | .152 | –2 | .022 | 103 |
| 100.0 | .042 | –158 | 3.456 | 165 | .152 | –6 | .019 | 85 |
| 200.0 | .070 | –151 | 3.436 | 149 | .151 | –12 | .023 | 56 |
| 300.0 | .093 | –163 | 3.406 | 134 | .151 | –18 | .032 | 26 |
| 400.0 | .111 | –180 | 3.410 | 118 | .151 | –24 | .037 | –17 |
| 500.0 | .133 | 167 | 3.369 | 103 | .152 | –30 | .047 | –54 |
| 600.0 | .151 | 147 | 3.366 | 86 | .152 | –37 | .062 | –86 |
| 700.0 | .164 | 124 | 3.346 | 70 | .152 | –43 | .074 | –115 |
| 800.0 | .183 | 102 | 3.315 | 53 | .152 | –51 | .085 | –141 |
| 900.0 | .210 | 74 | 3.249 | 37 | .154 | –57 | .089 | –167 |
| 1000.0 | .249 | 44 | 3.181 | 19 | .152 | –65 | .091 | 166 |
| 1100.0 | .290 | 15 | 3.053 | 1 | .152 | –72 | .087 | 141 |
| 1200.0 | .368 | –13 | 2.885 | –17 | .155 | –79 | .072 | 112 |

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.8 | 10.3 |
| 5.0 | 1.2 | 1.2 | 10.5 |
| 10.0 | 1.1 | 1.1 | 10.6 |
| 50.0 | 1.1 | 1.0 | 10.7 |
| 100.0 | 1.1 | 1.0 | 10.7 |
| 200.0 | 1.1 | 1.0 | 10.6 |
| 300.0 | 1.2 | 1.0 | 10.6 |
| 400.0 | 1.2 | 1.0 | 10.6 |
| 500.0 | 1.3 | 1.1 | 10.6 |
| 600.0 | 1.3 | 1.1 | 10.6 |
| 700.0 | 1.3 | 1.2 | 10.6 |
| 800.0 | 1.4 | 1.2 | 10.6 |
| 900.0 | 1.5 | 1.2 | 10.5 |
| 1000.0 | 1.6 | 1.3 | 10.3 |
| 1100.0 | 1.8 | 1.3 | 10.0 |
| 1200.0 | 2.1 | 1.3 | 9.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .223 | –82 | 3.272 | –152 | .141 | 30 | .292 | 128 |
| 5.0 | .088 | –103 | 3.368 | –170 | .148 | 11 | .109 | 110 |
| 10.0 | .054 | –122 | 3.396 | –176 | .149 | 5 | .060 | 104 |
| 50.0 | .046 | –159 | 3.433 | 174 | .151 | –1 | .015 | 79 |
| 100.0 | .040 | –160 | 3.413 | 165 | .152 | –5 | .009 | 47 |
| 200.0 | .066 | –155 | 3.403 | 150 | .151 | –11 | .007 | 2 |
| 300.0 | .088 | –168 | 3.381 | 135 | .152 | –16 | .011 | –38 |
| 400.0 | .095 | –176 | 3.407 | 119 | .154 | –22 | .023 | –88 |
| 500.0 | .119 | 169 | 3.384 | 104 | .155 | –28 | .040 | –115 |
| 600.0 | .140 | 149 | 3.402 | 88 | .158 | –34 | .060 | –137 |
| 700.0 | .148 | 127 | 3.406 | 72 | .160 | –41 | .079 | –162 |
| 800.0 | .169 | 104 | 3.389 | 55 | .162 | –48 | .096 | 174 |
| 900.0 | .205 | 79 | 3.347 | 39 | .165 | –56 | .106 | 148 |
| 1000.0 | .238 | 49 | 3.282 | 21 | .166 | –63 | .119 | 120 |
| 1100.0 | .279 | 19 | 3.150 | 3 | .168 | –71 | .125 | 92 |
| 1200.0 | .360 | –10 | 2.988 | –16 | .170 | –80 | .125 | 59 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.5 | 1.8 | 10.2 |
| 5.0 | 1.2 | 1.2 | 10.5 |
| 10.0 | 1.1 | 1.1 | 10.5 |
| 50.0 | 1.1 | 1.0 | 10.6 |
| 100.0 | 1.1 | 1.0 | 10.6 |
| 200.0 | 1.1 | 1.0 | 10.5 |
| 300.0 | 1.2 | 1.0 | 10.5 |
| 400.0 | 1.2 | 1.1 | 10.6 |
| 500.0 | 1.3 | 1.1 | 10.5 |
| 600.0 | 1.3 | 1.2 | 10.6 |
| 700.0 | 1.4 | 1.2 | 10.6 |
| 800.0 | 1.4 | 1.3 | 10.5 |
| 900.0 | 1.5 | 1.3 | 10.4 |
| 1000.0 | 1.6 | 1.4 | 10.2 |
| 1100.0 | 1.8 | 1.4 | 9.8 |
| 1200.0 | 2.1 | 1.4 | 9.4 |

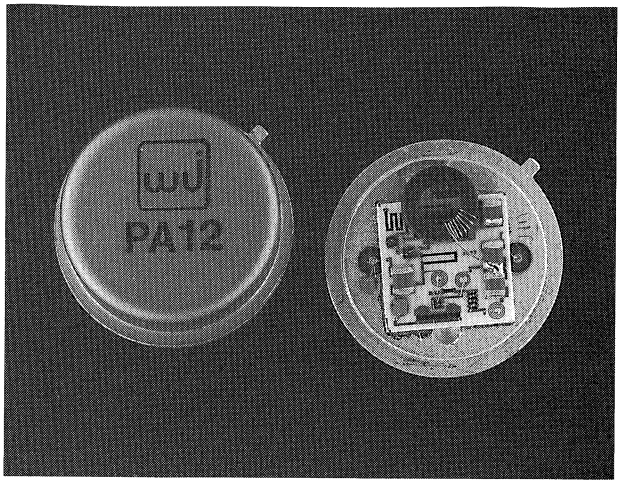
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .212 | –83 | 3.254 | –153 | .141 | 29 | .275 | 126 |
| 5.0 | .089 | –106 | 3.336 | –170 | .148 | 11 | .102 | 106 |
| 10.0 | .058 | –123 | 3.356 | –176 | .150 | 5 | .056 | 96 |
| 50.0 | .043 | –159 | 3.399 | 174 | .151 | –1 | .015 | 47 |
| 100.0 | .045 | –164 | 3.375 | 165 | .151 | –5 | .012 | –10 |
| 200.0 | .064 | –155 | 3.365 | 149 | .151 | –10 | .015 | –68 |
| 300.0 | .088 | –166 | 3.347 | 135 | .153 | –15 | .021 | –96 |
| 400.0 | .106 | –178 | 3.380 | 119 | .155 | –21 | .040 | –120 |
| 500.0 | .128 | 167 | 3.354 | 104 | .159 | –26 | .060 | –139 |
| 600.0 | .141 | 149 | 3.371 | 88 | .161 | –33 | .082 | –158 |
| 700.0 | .157 | 127 | 3.376 | 72 | .165 | –39 | .105 | 180 |
| 800.0 | .177 | 104 | 3.356 | 55 | .168 | –47 | .126 | 157 |
| 900.0 | .211 | 76 | 3.309 | 38 | .173 | –54 | .142 | 132 |
| 1000.0 | .244 | 48 | 3.234 | 20 | .175 | –62 | .160 | 105 |
| 1100.0 | .295 | 18 | 3.089 | 2 | .178 | –71 | .171 | 78 |
| 1200.0 | .364 | –10 | 2.937 | –17 | .182 | –80 | .178 | 47 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.928 W
Junction Temperature Rise Above Case $T_{jc}$ ... 42°C

# WJ-PA12 / SMPA12




## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +24.5 dBm (TYP.) @ +20 Vdc
- ◆ WIDE POWER SUPPLY RANGE: +12 TO +20 VOLTS
- ◆ WIDE BANDWIDTH: 10 TO 1200 MHz
- ◆ LOW VSWR: < 1.5:1 (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to -50°C | Guaranteed -54° to 85°C[2] |
|---|---|---|---|
| Frequency (Min.) | 5-1300 MHz | 10-1200 MHz | 10-1200 MHz |
| Small Signal Gain (Min.) | 9.5 dB | 9.0 dB | 8.5 dB |
| Gain Flatness (Max.) | <±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 8.5 dB | 9.5 dB | 10.0 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| $V_{CC}$ = +15 Volts | +22.5 dBm | +20.0 dBm | +19.5 dBm |
| $V_{CC}$ = +20 Volts[2] | +24.5 dBm | +23.0 dBm | +22.5 dBm |
| VSWR (Max.) Input/Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) | | | |
| At +15 Volts | 95 mA | 100 mA | 105 mA |
| At +20 Volts[2] | 130 mA | 132 mA | 134 mA |

* Measured in a 50-ohm system with Vcc = +15 V Nominal.
Notes:
1. WJ-CPA12 is a standard WJ-PA12 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. +71° max case temperature when VCC= 20V.

## Typical Intermodulation Performance at 25°C (Typ. +15 Vdc)

Second Order Harmonic Intercept Point.....> +45 dBm
Second Order Two Tone Intercept Point.....+45 dBm
Third Order Two Tone Intercept Point.....+35 dBm

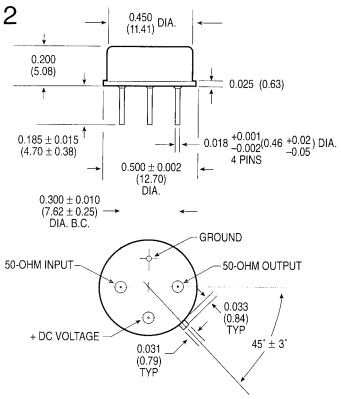
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature (At +15 Vdc).....125°C
Maximum DC Voltage.....+22 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0. 5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) (At +15 Vdc).....125°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

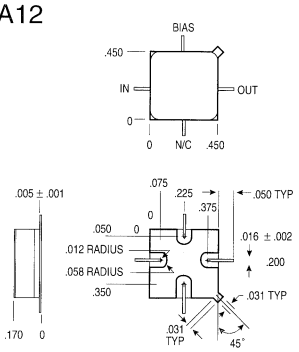
## Outline Drawings

PA12



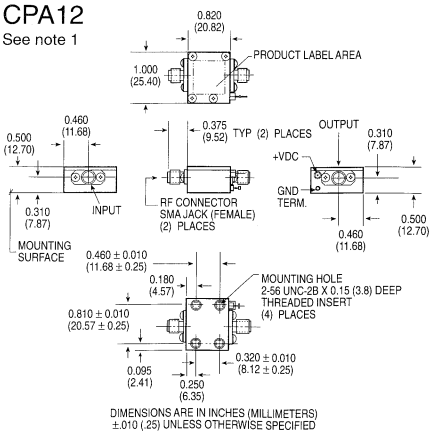

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA12




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CPA12
See note 1

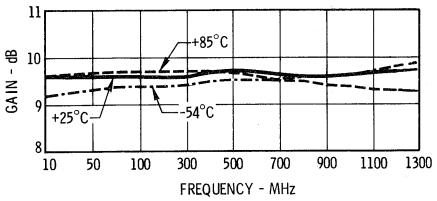



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

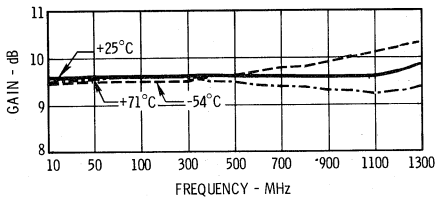
# Typical Performance at 25°C

## Gain

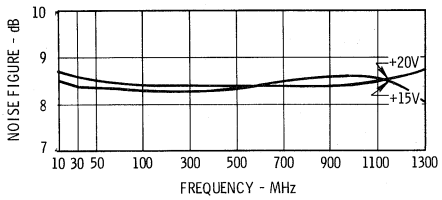
### +15 V




### +20 V

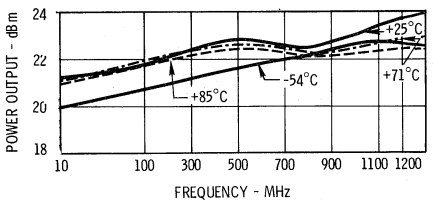



## Noise Figure

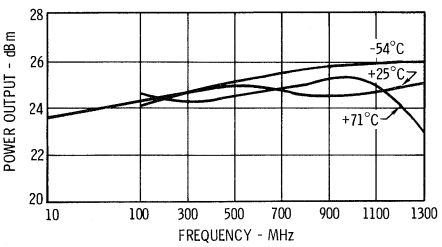



## Power Output*

### +15 V

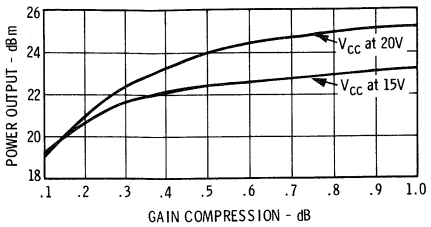



### +20 V

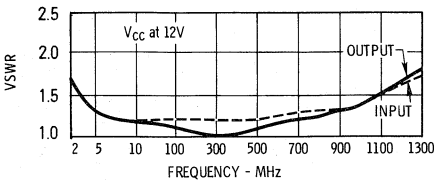


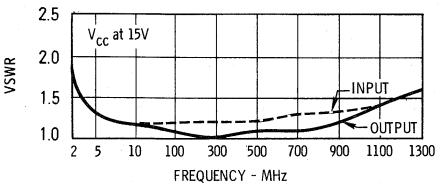

*at 1 dB Gain Compression

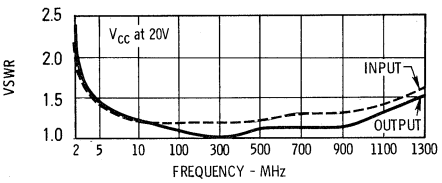
## Output Power vs. Gain Compression




## VSWR

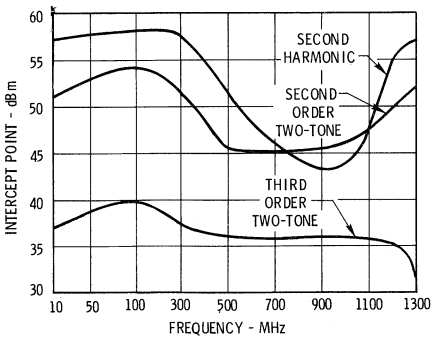


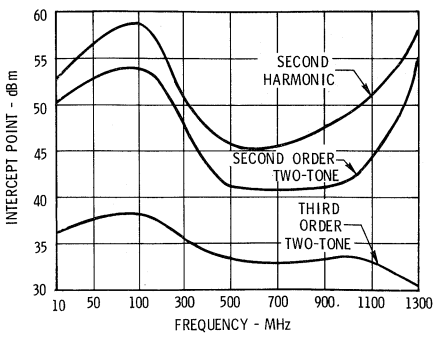




## Intercept Point

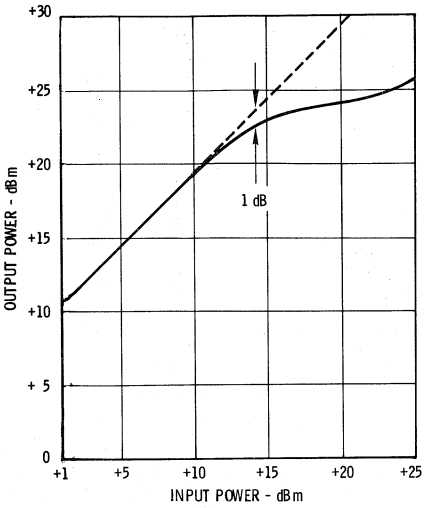
### +15 V




### +20 V




## Output Power vs. Input Power




1

# Typical Automatic Test Data

### $V_{CC}$ = 20.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.8 | 9.5 |
| 5.0 | 1.3 | 1.3 | 9.8 |
| 10.0 | 1.2 | 1.2 | 9.8 |
| 50.0 | 1.2 | 1.2 | 10.0 |
| 100.0 | 1.2 | 1.2 | 9.9 |
| 200.0 | 1.2 | 1.2 | 9.9 |
| 300.0 | 1.3 | 1.1 | 9.9 |
| 400.0 | 1.3 | 1.1 | 9.9 |
| 500.0 | 1.3 | 1.1 | 9.8 |
| 600.0 | 1.3 | 1.1 | 9.8 |
| 700.0 | 1.4 | 1.1 | 9.8 |
| 800.0 | 1.4 | 1.2 | 9.8 |
| 900.0 | 1.4 | 1.3 | 9.7 |
| 1000.0 | 1.4 | 1.3 | 9.7 |
| 1100.0 | 1.4 | 1.4 | 9.6 |
| 1200.0 | 1.3 | 1.4 | 9.4 |
| 1300.0 | 1.4 | 1.4 | 9.1 |
| 1400.0 | 1.5 | 1.4 | 8.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .239 | –97 | 2.992 | –152 | .147 | 31 | .291 | 145 |
| 5.0 | .129 | –132 | 3.086 | –170 | .156 | 12 | .138 | 146 |
| 10.0 | .108 | –151 | 3.107 | –176 | .157 | 6 | .106 | 153 |
| 50.0 | .109 | –176 | 3.151 | 174 | .160 | –1 | .082 | 157 |
| 100.0 | .103 | 179 | 3.139 | 166 | .160 | –4 | .077 | 148 |
| 200.0 | .110 | –176 | 3.134 | 151 | .160 | –10 | .071 | 123 |
| 300.0 | .122 | –179 | 3.118 | 137 | .160 | –15 | .063 | 94 |
| 400.0 | .121 | 176 | 3.130 | 122 | .162 | –20 | .046 | 60 |
| 500.0 | .134 | 169 | 3.105 | 108 | .162 | –26 | .035 | 7 |
| 600.0 | .146 | 162 | 3.106 | 94 | .164 | –32 | .044 | –56 |
| 700.0 | .149 | 153 | 3.107 | 79 | .165 | –37 | .065 | –99 |
| 800.0 | .157 | 143 | 3.100 | 63 | .167 | –43 | .092 | –129 |
| 900.0 | .166 | 124 | 3.070 | 49 | .169 | –49 | .115 | –154 |
| 1000.0 | .166 | 106 | 3.055 | 33 | .172 | –55 | .137 | –180 |
| 1100.0 | .149 | 81 | 3.014 | 16 | .173 | –61 | .155 | 157 |
| 1200.0 | .146 | 47 | 2.943 | 0 | .178 | –68 | .161 | 133 |
| 1300.0 | .159 | 2 | 2.856 | –17 | .182 | –75 | .162 | 107 |
| 1400.0 | .209 | –40 | 2.708 | –35 | .189 | –83 | .157 | 83 |

### $V_{CC}$ = 12.0 V

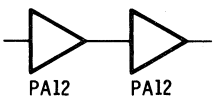
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.7 | 9.4 |
| 5.0 | 1.3 | 1.3 | 9.6 |
| 10.0 | 1.3 | 1.2 | 9.6 |
| 50.0 | 1.2 | 1.1 | 9.7 |
| 100.0 | 1.2 | 1.1 | 9.7 |
| 200.0 | 1.3 | 1.1 | 9.7 |
| 300.0 | 1.3 | 1.1 | 9.6 |
| 400.0 | 1.3 | 1.0 | 9.7 |
| 500.0 | 1.3 | 1.0 | 9.6 |
| 600.0 | 1.4 | 1.1 | 9.7 |
| 700.0 | 1.4 | 1.2 | 9.6 |
| 800.0 | 1.4 | 1.2 | 9.6 |
| 900.0 | 1.4 | 1.3 | 9.6 |
| 1000.0 | 1.4 | 1.4 | 9.5 |
| 1100.0 | 1.4 | 1.4 | 9.3 |
| 1200.0 | 1.4 | 1.5 | 9.1 |
| 1300.0 | 1.4 | 1.5 | 8.8 |
| 1400.0 | 1.6 | 1.5 | 8.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .227 | –101 | 2.936 | –153 | .148 | 30 | .263 | 142 |
| 5.0 | .127 | –135 | 3.007 | –170 | .155 | 11 | .119 | 142 |
| 10.0 | .112 | –153 | 3.030 | –176 | .157 | 6 | .088 | 150 |
| 50.0 | .108 | –175 | 3.072 | 174 | .159 | –1 | .063 | 159 |
| 100.0 | .107 | –179 | 3.054 | 166 | .160 | –4 | .057 | 155 |
| 200.0 | .117 | –178 | 3.051 | 151 | .160 | –9 | .049 | 141 |
| 300.0 | .131 | 178 | 3.037 | 137 | .161 | –13 | .038 | 126 |
| 400.0 | .124 | 172 | 3.057 | 122 | .164 | –18 | .021 | 138 |
| 500.0 | .146 | 167 | 3.032 | 108 | .166 | –23 | .021 | –165 |
| 600.0 | .153 | 158 | 3.046 | 93 | .170 | –28 | .045 | –150 |
| 700.0 | .153 | 151 | 3.035 | 78 | .173 | –34 | .075 | –162 |
| 800.0 | .168 | 139 | 3.031 | 63 | .178 | –40 | .106 | –178 |
| 900.0 | .175 | 121 | 3.012 | 48 | .184 | –46 | .132 | 163 |
| 1000.0 | .172 | 102 | 2.984 | 31 | .189 | –52 | .160 | 142 |
| 1100.0 | .160 | 72 | 2.921 | 15 | .194 | –59 | .183 | 121 |
| 1200.0 | .161 | 37 | 2.859 | –1 | .203 | –67 | .194 | 97 |
| 1300.0 | .183 | –3 | 2.759 | –18 | .209 | –75 | .208 | 71 |
| 1400.0 | .232 | –43 | 2.596 | –37 | .217 | –85 | .211 | 46 |

### TYPICAL CASCADED $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.7 | 9.4 |
| 5.0 | 1.3 | 1.3 | 9.7 |
| 10.0 | 1.2 | 1.2 | 9.7 |
| 50.0 | 1.3 | 1.2 | 9.9 |
| 100.0 | 1.2 | 1.1 | 9.8 |
| 200.0 | 1.3 | 1.1 | 9.8 |
| 300.0 | 1.3 | 1.1 | 9.8 |
| 400.0 | 1.3 | 1.1 | 9.8 |
| 500.0 | 1.3 | 1.0 | 9.8 |
| 600.0 | 1.3 | 1.1 | 9.8 |
| 700.0 | 1.3 | 1.1 | 9.8 |
| 800.0 | 1.4 | 1.2 | 9.8 |
| 900.0 | 1.4 | 1.3 | 9.7 |
| 1000.0 | 1.4 | 1.3 | 9.7 |
| 1100.0 | 1.4 | 1.4 | 9.6 |
| 1200.0 | 1.3 | 1.4 | 9.4 |
| 1300.0 | 1.4 | 1.5 | 9.1 |
| 1400.0 | 1.5 | 1.5 | 8.7 |



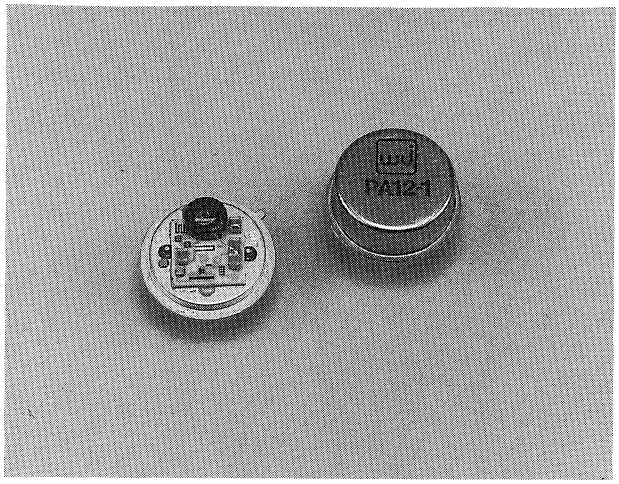

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .232 | –99 | 2.964 | –152 | .148 | 30 | .273 | 144 |
| 5.0 | .126 | –133 | 3.042 | –170 | .155 | 11 | .125 | 144 |
| 10.0 | .109 | –153 | 3.064 | –176 | .157 | 6 | .095 | 151 |
| 50.0 | .113 | –175 | 3.111 | 174 | .159 | –1 | .070 | 158 |
| 100.0 | .103 | 179 | 3.092 | 166 | .159 | –4 | .064 | 152 |
| 200.0 | .115 | 179 | 3.088 | 152 | .160 | –9 | .058 | 133 |
| 300.0 | .123 | 176 | 3.077 | 138 | .161 | –14 | .047 | 111 |
| 400.0 | .124 | 170 | 3.095 | 123 | .163 | –19 | .025 | 92 |
| 500.0 | .132 | 166 | 3.078 | 109 | .165 | –24 | .001 | –57 |
| 600.0 | .146 | 161 | 3.092 | 94 | .167 | –30 | .030 | –119 |
| 700.0 | .142 | 154 | 3.096 | 79 | .170 | –35 | .061 | –141 |
| 800.0 | .160 | 141 | 3.090 | 64 | .174 | –41 | .091 | –161 |
| 900.0 | .163 | 127 | 3.069 | 49 | .178 | –47 | .117 | 178 |
| 1000.0 | .160 | 107 | 3.062 | 33 | .182 | –53 | .144 | 156 |
| 1100.0 | .153 | 81 | 3.004 | 17 | .187 | –60 | .165 | 134 |
| 1200.0 | .148 | 47 | 2.953 | 1 | .192 | –67 | .174 | 109 |
| 1300.0 | .163 | 5 | 2.855 | –16 | .199 | –75 | .185 | 83 |
| 1400.0 | .208 | –38 | 2.718 | –35 | .206 | –84 | .185 | 57 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.968 W
Junction Temperature Rise Above Case $T_{jc}$ ... 44°C

# WJ-PA12-1 / SMPA12-1




## 10 to 1200 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER: +22 dBm (TYP.) @ +12 VOLTS[2]
- ◆ WIDE BANDWIDTH: 10-1200 MHz
- ◆ LOW VSWR: < 1.5:1 (TYP.)
- ◆ WIDE POWER SUPPLY RANGE: +5 TO +14 VOLTS

## Specifications *

| Characteristics | Typical | Guaranteed 0° to -50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1300 MHz | 10-1200 MHz | 10-1200 MHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 8.5 dB | 9.5 dB | 10.0 dB |
| Power Output at 1 dB Compression (Min.) | +22.0 dBm | +20.0 dBm | +19.5 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +12 Volts | 97 mA | 101 mA | 106 mA |

* Measured in a 50-ohm system at +12 Vdc Nominal.
Notes:
1. WJ-CPA12-1 is a standard WJ-PA12-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. The WJ-PA12-1 is similar to the WJ-PA12 except its DC bias has been designed for +12 volt operation to yield +20 dBm minimum output power as opposed to +15 Volts required on the WJ-PA12.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two-Tone Intercept Point .....+39 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+32 dBm (Typ.)

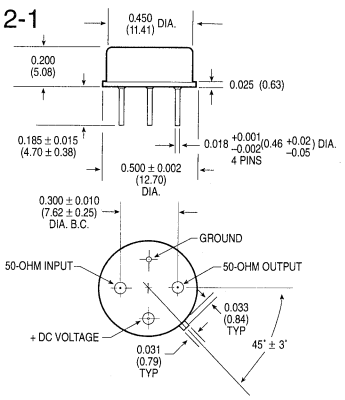
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....+125°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

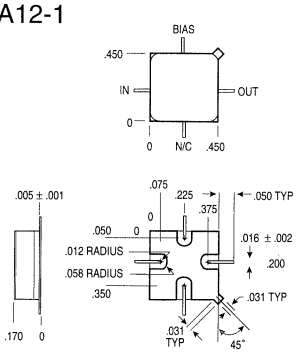
## Outline Drawings

PA12-1



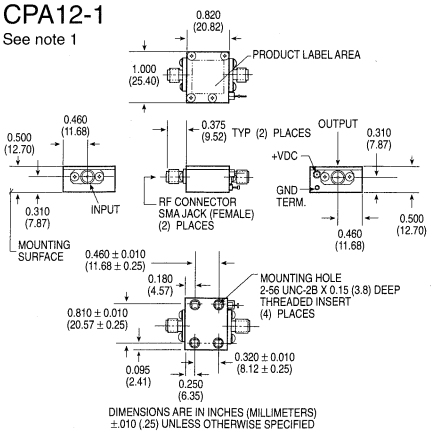

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA12-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

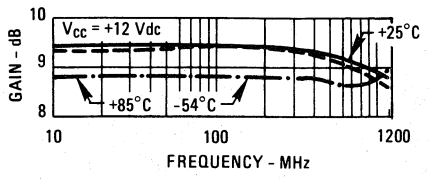
CPA12-1
See note 1

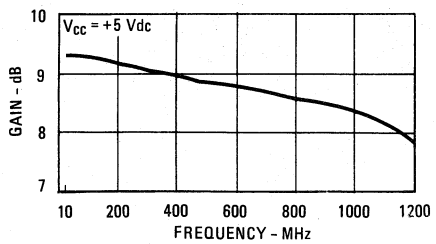



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

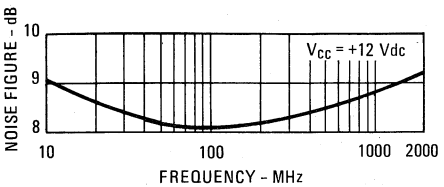
# Typical Performance at 25°C

### Gain

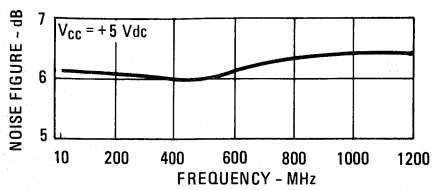


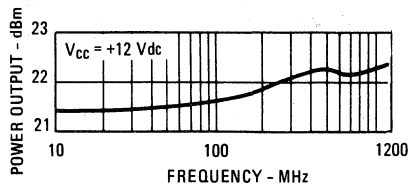

### Noise Figure

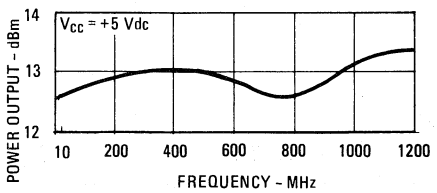



### Noise Figure



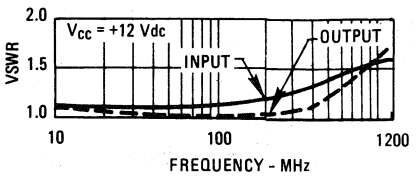

### Power Output*

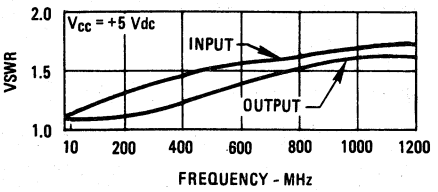


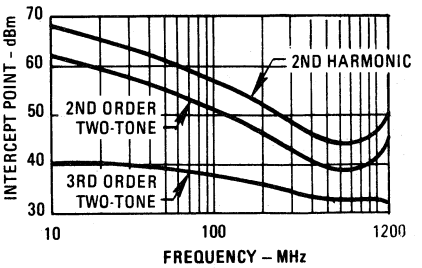

*at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.7 | 2.0 | 8.4 |
| 5.0 | 1.3 | 1.4 | 8.9 |
| 10.0 | 1.3 | 1.3 | 9.0 |
| 50.0 | 1.3 | 1.2 | 9.2 |
| 100.0 | 1.3 | 1.2 | 9.1 |
| 200.0 | 1.3 | 1.2 | 9.1 |
| 300.0 | 1.3 | 1.2 | 9.1 |
| 400.0 | 1.3 | 1.1 | 9.2 |
| 500.0 | 1.3 | 1.1 | 9.3 |
| 600.0 | 1.3 | 1.1 | 9.4 |
| 700.0 | 1.3 | 1.2 | 9.4 |
| 800.0 | 1.3 | 1.3 | 9.5 |
| 900.0 | 1.3 | 1.3 | 9.6 |
| 1000.0 | 1.3 | 1.5 | 9.6 |
| 1100.0 | 1.2 | 1.6 | 9.5 |
| 1200.0 | 1.2 | 1.7 | 9.4 |
| 1300.0 | 1.2 | 1.8 | 9.2 |
| 1400.0 | 1.4 | 1.8 | 8.7 |

### Linear S-Parameters

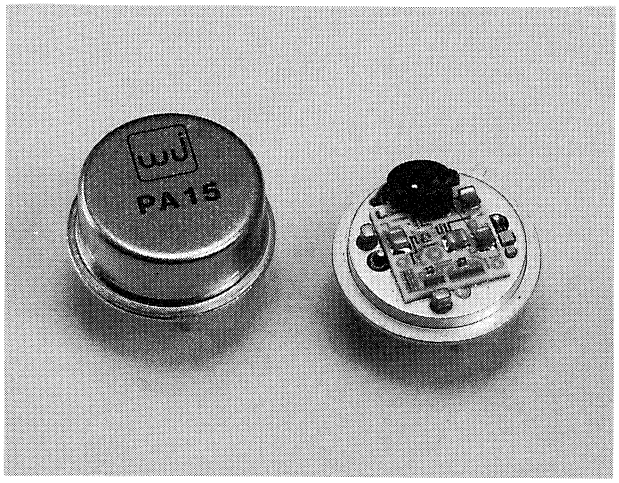
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .267 | –94 | 2.617 | –147 | .148 | 36 | .343 | 154 |
| 5.0 | .149 | –132 | 2.787 | –168 | .160 | 14 | .165 | 151 |
| 10.0 | .127 | –152 | 2.823 | –175 | .163 | 7 | .129 | 157 |
| 50.0 | .125 | –178 | 2.872 | 174 | .166 | –1 | .102 | 167 |
| 100.0 | .118 | 176 | 2.845 | 167 | .165 | –5 | .101 | 162 |
| 200.0 | .120 | 174 | 2.857 | 153 | .166 | –10 | .095 | 147 |
| 300.0 | .118 | 172 | 2.867 | 139 | .168 | –15 | .081 | 134 |
| 400.0 | .114 | 166 | 2.900 | 124 | .170 | –21 | .062 | 131 |
| 500.0 | .116 | 165 | 2.903 | 111 | .172 | –26 | .048 | 140 |
| 600.0 | .119 | 163 | 2.935 | 96 | .175 | –32 | .050 | 166 |
| 700.0 | .120 | 158 | 2.964 | 81 | .178 | –38 | .076 | 173 |
| 800.0 | .130 | 151 | 2.989 | 65 | .182 | –45 | .112 | 166 |
| 900.0 | .136 | 140 | 3.008 | 50 | .188 | –52 | .148 | 152 |
| 1000.0 | .128 | 122 | 3.010 | 33 | .191 | –59 | .188 | 134 |
| 1100.0 | .104 | 99 | 2.970 | 16 | .196 | –67 | .223 | 115 |
| 1200.0 | .078 | 57 | 2.944 | –1 | .203 | –75 | .251 | 92 |
| 1300.0 | .081 | –21 | 2.871 | –20 | .209 | –85 | .279 | 67 |
| 1400.0 | .165 | –73 | 2.718 | –40 | .215 | –96 | .289 | 42 |

# Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.758 W
Junction Temperature Rise Above Case $T_{jc}$ ... 34°C

# WJ-PA15 / SMPA15

## 10 to 1000 MHz
## TO-8 CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH OUTPUT POWER +27.0 dBm (TYP.) 10-500 MHz
- ◆ HIGH THIRD-ORDER I.P. +38 dBm (TYP.)
- ◆ MEDIUM GAIN: 13.5 dB (TYP.)
- ◆ HIGH DYNAMIC ARTICULATION +118 dB

## Specifications *

| Characteristics | Typical | 0° to -50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 13.5 dB | 12.5 dB | 12.0 dB |
| Gain Flatness (Max.) | <±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 30-500 MHz | 6.0 dB | 7.0 dB | 7.5 dB |
| 10-1000 MHz | 7.0 dB | 8.5 dB | 9.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 10-500 MHz | +27.0 dBm | +26.0 dBm | +25.5 dBm |
| 500-1000 MHz | +25.5 dBm | +23.5 dBm | +23.0 dBm |
| VSWR (Max.) | | | |
| Input | < 1.5:1 | 2.0:1 | 2.0:1 |
| Output | < 2.0:1 | 2.3:1 | 2.3:1 |
| DC Current (Max.) at +15 Volts | 216 | 225 mA | 227 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes: 1. WJ-CPA15 is a standard WJ-PA15 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....> +45 dBm (Typ.)
Second Order Two Tone Intercept Point .....> +40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+38 dBm (Typ.)

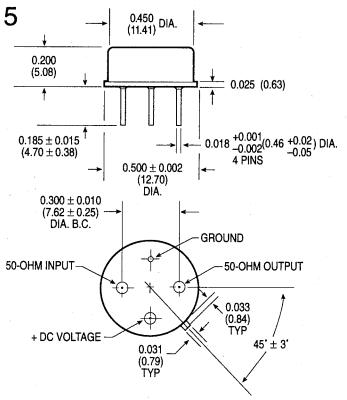
## Absolute Maximum Ratings

Storage Temperature .....-62° C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power ..... 0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C
Proper heatsinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

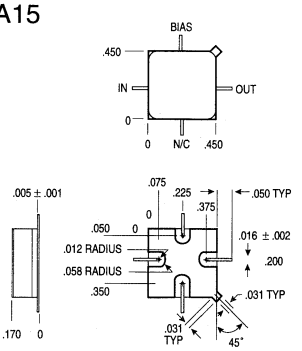
## Outline Drawings

PA15



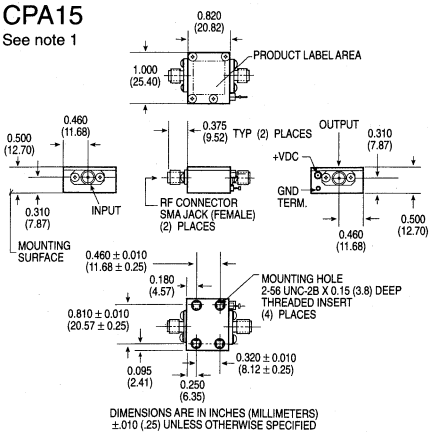

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA15




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

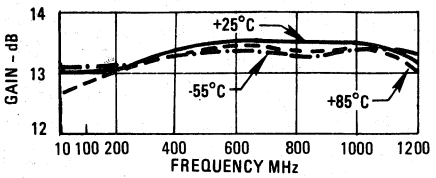
CPA15
See note 1



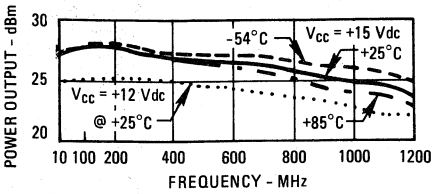

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

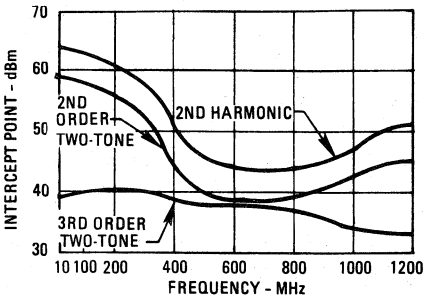



### Power Output*

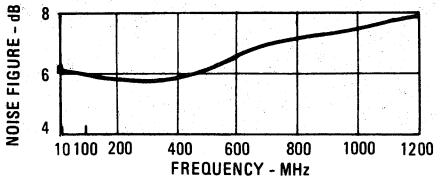



* at 1 dB Gain Compression

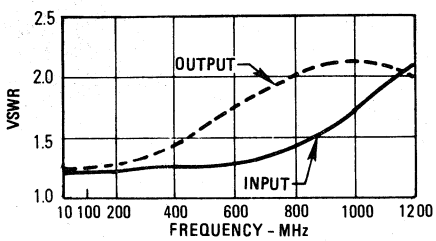
### Intercept Point




### Noise Figure




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.4 | 2.9 | 9.8 |
| 2.0 | 2.0 | 2.1 | 12.2 |
| 5.0 | 1.5 | 1.4 | 13.6 |
| 10.0 | 1.4 | 1.3 | 13.8 |
| 50.0 | 1.4 | 1.3 | 13.8 |
| 100.0 | 1.4 | 1.3 | 13.8 |
| 200.0 | 1.4 | 1.3 | 13.8 |
| 300.0 | 1.4 | 1.3 | 13.8 |
| 400.0 | 1.4 | 1.3 | 14.0 |
| 500.0 | 1.5 | 1.3 | 14.0 |
| 600.0 | 1.5 | 1.4 | 14.2 |
| 700.0 | 1.6 | 1.4 | 14.3 |
| 800.0 | 1.6 | 1.6 | 14.3 |
| 900.0 | 1.6 | 1.8 | 14.3 |
| 1000.0 | 1.6 | 2.0 | 14.0 |
| 1100.0 | 1.6 | 2.4 | 13.5 |
| 1200.0 | 1.5 | 2.8 | 13.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .415 | –57 | 3.083 | –145 | .075 | 51 | .486 | –154 |
| 2.0 | .328 | –83 | 4.055 | –153 | .104 | 35 | .351 | 169 |
| 5.0 | .212 | –129 | 4.796 | –169 | .124 | 14 | .176 | 157 |
| 10.0 | .177 | –152 | 4.876 | –175 | .124 | 6 | .148 | 167 |
| 50.0 | .164 | 180 | 4.908 | 175 | .125 | 0 | .141 | 168 |
| 100.0 | .162 | 171 | 4.894 | 168 | .125 | –2 | .137 | 160 |
| 200.0 | .173 | 164 | 4.893 | 154 | .127 | –5 | .134 | 145 |
| 300.0 | .178 | 152 | 4.915 | 141 | .129 | –9 | .133 | 132 |
| 400.0 | .180 | 141 | 5.009 | 128 | .131 | –12 | .134 | 124 |
| 500.0 | .202 | 127 | 5.027 | 115 | .134 | –16 | .139 | 119 |
| 600.0 | .215 | 114 | 5.129 | 100 | .136 | –20 | .151 | 114 |
| 700.0 | .225 | 98 | 5.173 | 85 | .138 | –25 | .183 | 109 |
| 800.0 | .234 | 83 | 5.180 | 69 | .140 | –30 | .225 | 100 |
| 900.0 | .237 | 66 | 5.166 | 53 | .142 | –35 | .275 | 85 |
| 1000.0 | .237 | 47 | 4.996 | 36 | .142 | –40 | .340 | 76 |
| 1100.0 | .224 | 29 | 4.729 | 20 | .143 | –45 | .406 | 61 |
| 1200.0 | .197 | 14 | 4.478 | 4 | .144 | –50 | .476 | 45 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 2.4 | 2.7 | 10.1 |
| 2.0 | 2.0 | 2.0 | 12.3 |
| 5.0 | 1.5 | 1.4 | 13.6 |
| 10.0 | 1.4 | 1.3 | 13.7 |
| 50.0 | 1.4 | 1.3 | 13.7 |
| 100.0 | 1.4 | 1.3 | 13.7 |
| 200.0 | 1.4 | 1.3 | 13.8 |
| 300.0 | 1.4 | 1.3 | 13.8 |
| 400.0 | 1.5 | 1.3 | 13.9 |
| 500.0 | 1.5 | 1.4 | 14.0 |
| 600.0 | 1.6 | 1.4 | 14.0 |
| 700.0 | 1.6 | 1.6 | 14.1 |
| 800.0 | 1.7 | 1.7 | 14.0 |
| 900.0 | 1.7 | 1.9 | 13.9 |
| 1000.0 | 1.7 | 2.3 | 13.5 |
| 1100.0 | 1.6 | 2.6 | 12.9 |
| 1200.0 | 1.6 | 3.1 | 12.4 |

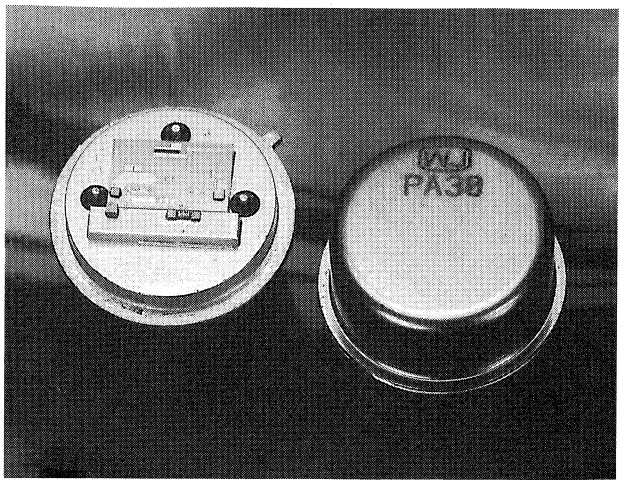
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .417 | –57 | 3.181 | –145 | .078 | 51 | .466 | –157 |
| 2.0 | .323 | –85 | 4.140 | –154 | .108 | 34 | .324 | 167 |
| 5.0 | .205 | –130 | 4.784 | –170 | .125 | 13 | .164 | 159 |
| 10.0 | .171 | –153 | 4.830 | –176 | .125 | 6 | .143 | 168 |
| 50.0 | .160 | 180 | 4.869 | 174 | .125 | 0 | .137 | 169 |
| 100.0 | .159 | 172 | 4.865 | 167 | .126 | –2 | .133 | 162 |
| 200.0 | .170 | 166 | 4.875 | 153 | .128 | –5 | .131 | 150 |
| 300.0 | .182 | 155 | 4.877 | 140 | .130 | –8 | .135 | 139 |
| 400.0 | .191 | 144 | 4.956 | 126 | .133 | –12 | .141 | 133 |
| 500.0 | .208 | 132 | 4.986 | 112 | .135 | –15 | .156 | 127 |
| 600.0 | .233 | 117 | 5.036 | 97 | .139 | –19 | .179 | 121 |
| 700.0 | .242 | 100 | 5.049 | 82 | .141 | –25 | .220 | 112 |
| 800.0 | .250 | 84 | 4.999 | 65 | .143 | –30 | .269 | 100 |
| 900.0 | .259 | 68 | 4.956 | 49 | .146 | –35 | .321 | 87 |
| 1000.0 | .258 | 50 | 4.732 | 33 | .144 | –40 | .388 | 73 |
| 1100.0 | .238 | 31 | 4.431 | 17 | .145 | –45 | .451 | 57 |
| 1200.0 | .219 | 16 | 4.185 | 1 | .146 | –50 | .512 | 41 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.999 W
Junction Temperature Rise Above Case $T_{jc}$ ... 45°C

# WJ-PA30/SMPA30




## 0.5 TO 2.0 GHz
## TO-8 GaAs FET AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 0.3 TO 2.2 GHz (TYP.)
- ◆ HIGH OUTPUT POWER: 25 dBm (TYP.)
- ◆ MODERATE GAIN: 14.5 dB ( TYP.)
- ◆ MODERATE NOISE FIGURE: 5.5 dB (TYP.)
- ◆ LOW DC CURRENT: 155 mA at +12 VOLTS Vdc
- ◆ GaAs FET DESIGN

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 0.3-2.2 GHz | 0.5-2.0 GHz | 0.5 -2.0 GHz |
| Small Signal Gain (Min.) | 14.5 dB | 13.5 dB | 13.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 5.5 dB | 6.0 dB | 6.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 1.0 to 2.0 GHz | +25.0 dBm | +23.5 dBm | +23.0 dBm |
| 0.5 to 2.0 GHz | +24.5 dBm | +23.0 dBm | +22.5 dBm |
| VSWR | | | |
| Input/Output (Max.) | 1.7:1 | 1.9:1 | 2.0:1 |
| DC Current at 12 Volts (Max.) | 155 mA | 170 mA | 180 mA |

*Measured in a 50-ohm system at +12 Vdc Nominal.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point .....+55 dBm (Typ.)
Second Order Two Tone Intercept Point .....+50 dBm (Typ.)
Third Order Two-Tone Intercept Point .....+32 dBm (Typ.)

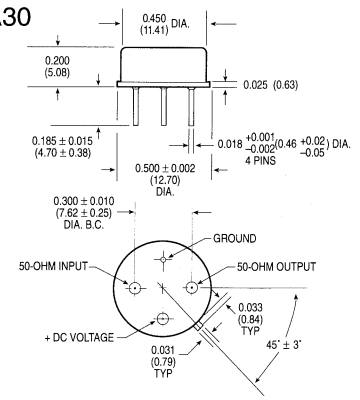
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....100°C
Maximum DC Voltage .....15 Volts
Maximum Continuous RF Input Power .....20 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....200 Milliwatts
Maximum Peak Power .....1/4 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) .....100°C

Weight: 3.0 grams (0.11 oz.)

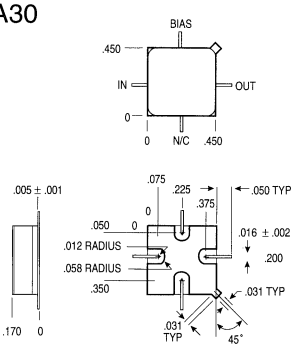
## Outline Drawings

PA30



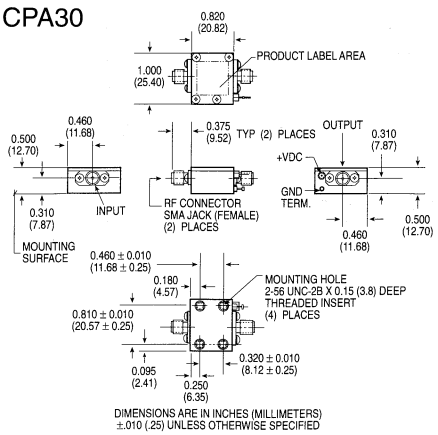

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA30




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

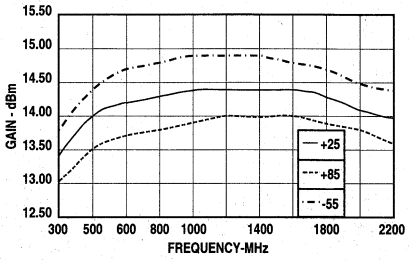
CPA30



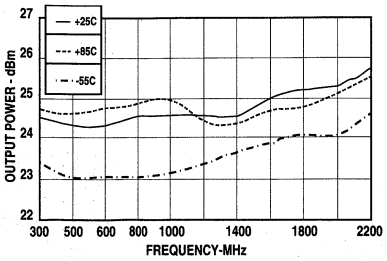

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

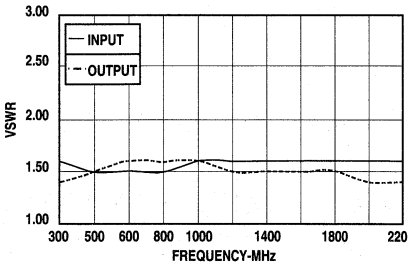
### Gain




### Power Output

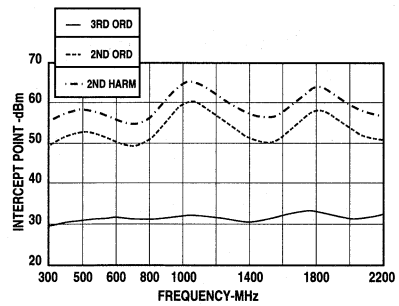



### VSWR

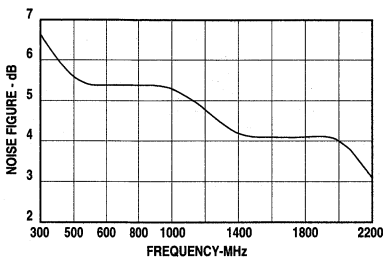



1

### Intercept Point




### Noise Figure




# Typical Automatic Test Data

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 300.0 | 1.6 | 1.4 | 13.4 |
| 500.0 | 1.5 | 1.5 | 14.1 |
| 600.0 | 1.5 | 1.6 | 14.2 |
| 800.0 | 1.5 | 1.6 | 14.4 |
| 1000.0 | 1.6 | 1.6 | 14.4 |
| 1200.0 | 1.6 | 1.5 | 14.5 |
| 1400.0 | 1.6 | 1.5 | 14.4 |
| 1600.0 | 1.6 | 1.5 | 14.4 |
| 1800.0 | 1.6 | 1.5 | 14.3 |
| 2000.0 | 1.6 | 1.4 | 14.1 |
| 2200.0 | 1.6 | 1.4 | 14.1 |

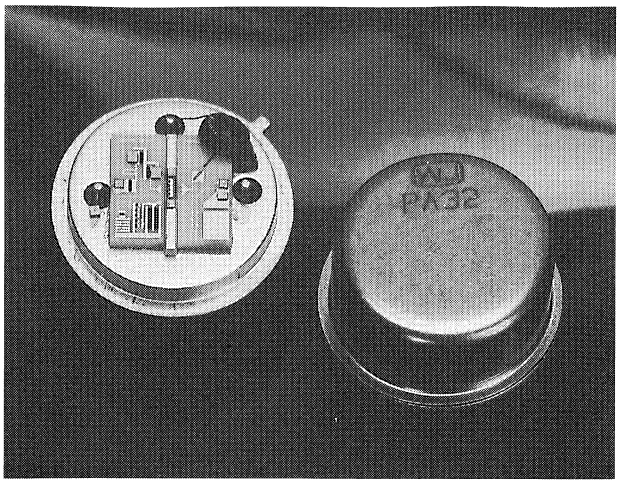
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 300.0 | .228 | –77 | 4.688 | –158 | .010 | 85 | .178 | 14 |
| 500.0 | .207 | –90 | 5.064 | 179 | .016 | 89 | .207 | –14 |
| 600.0 | .205 | –98 | 5.108 | 172 | .020 | 91 | .219 | –25 |
| 800.0 | .210 | –117 | 5.271 | 161 | .028 | 91 | .225 | –43 |
| 1000.0 | .217 | –136 | 5.243 | 153 | .037 | 90 | .217 | –61 |
| 1200.0 | .225 | –157 | 5.313 | 144 | .045 | 89 | .212 | –80 |
| 1400.0 | .230 | 179 | 5.275 | 138 | .054 | 87 | .203 | –99 |
| 1600.0 | .228 | 154 | 5.220 | 130 | .062 | 85 | .191 | –120 |
| 1800.0 | .220 | 125 | 5.198 | 124 | .069 | 84 | .191 | –142 |
| 2000.0 | .217 | 89 | 5.065 | 115 | .077 | 81 | .178 | –165 |
| 2200.0 | .235 | 47 | 5.048 | 107 | .086 | 78 | .172 | –167 |

## Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 82°C/W
Transistor Power Dissipation $P_d$ ..... 1.35 W
Junction Temperature Rise Above Case $T_{jc}$ ... 110°C

# WJ-PA32/SMPA32



## 0.5 TO 2.0 GHz
## TO-8 GaAs FET AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 0.3 TO 2.2 GHz (TYP.)
- ◆ HIGH OUTPUT POWER: +28 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 0.3-2.2 GHz | 0.5-2.0 GHz | 0.5-2.0 GHz |
| Small Signal Gain (Min.) | 9.0 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.75 dB | ±1.0 dB |
| Noise Figure (Max.) | 10 dB | 10.5 dB | 11.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 1.0 to 2.0 GHz | +28.5 dBm | +28.0 dBm | +27.5 dBm |
| 0.5 to 2.0 GHz | +27.5 dBm | +27.0 dBm | +26.5 dBm |
| VSWR (Max.) | | | |
| Input/Output | 1.8:1.0 | 1.9:1.0 | 2.0:1.0 |
| DC Current at +10 Volts (Max.) | 340 mA | 365 mA | 370 mA |

*Measured in a 50-ohm system at +10 Vdc Nominal.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+50 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two-Tone Intercept Point.....+30 dBm (Typ.)

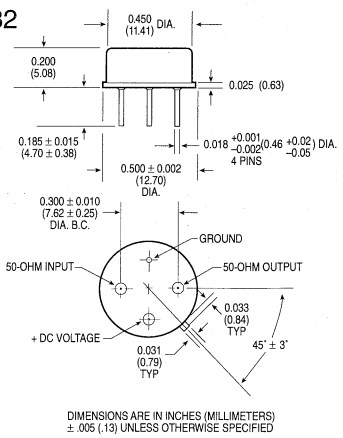
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+13 Volts
Maximum Continuous RF Input Power .....+14 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....300 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....85°C

Weight: 2.0 Grams (0.7 oz.)

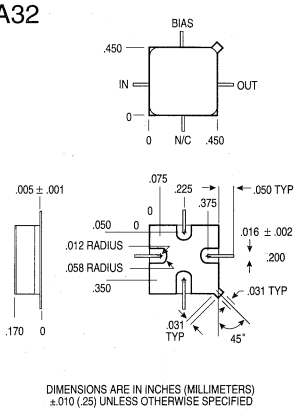
## Outline Drawings

PA32



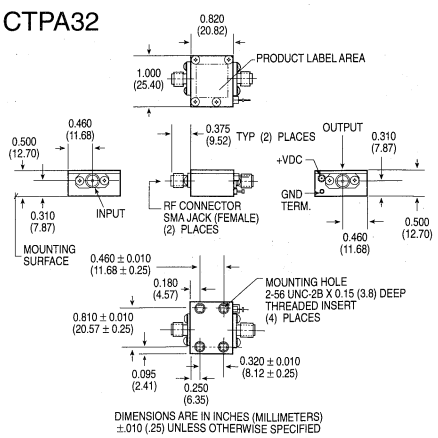

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA32




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

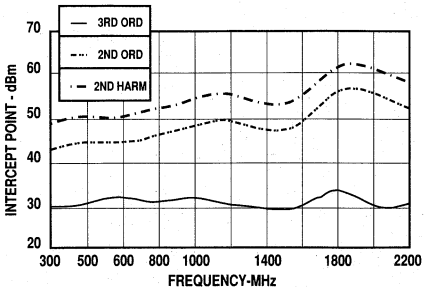
CTPA32



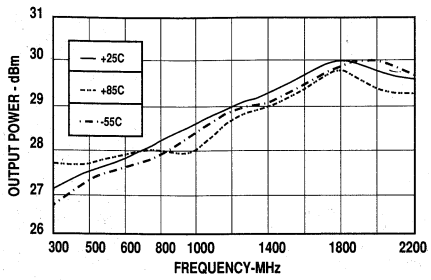

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

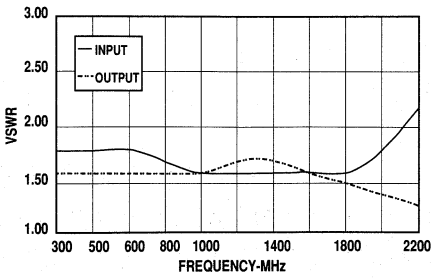
### Gain



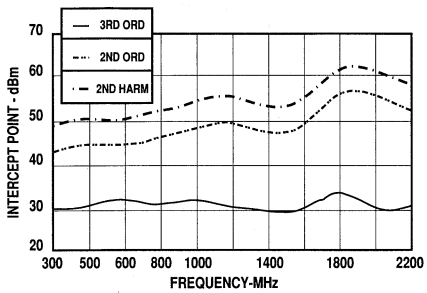

### Power Output (1 dB Compression)



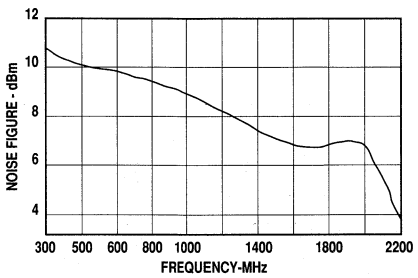

### VSWR




### Intercept Point




### Noise Figure




# Typical Automatic Test Data

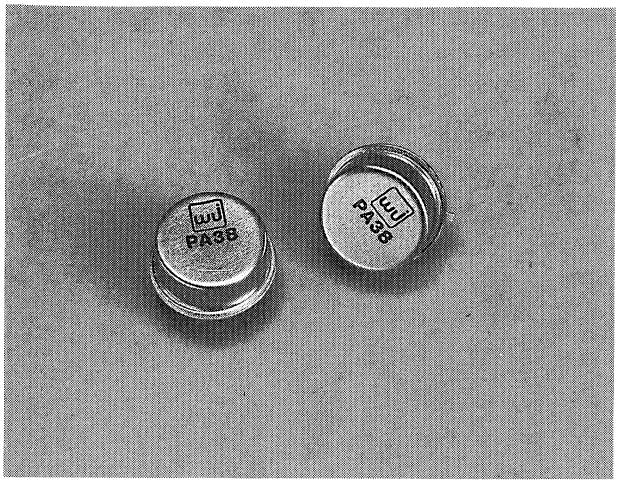
### $V_{CC}$ = 10.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 300.0 | 1.8 | 1.6 | 9.0 |
| 500.0 | 1.8 | 1.6 | 9.7 |
| 600.0 | 1.7 | 1.6 | 9.6 |
| 800.0 | 1.7 | 1.6 | 9.5 |
| 1000.0 | 1.6 | 1.6 | 9.6 |
| 1200.0 | 1.6 | 1.7 | 9.3 |
| 1400.0 | 1.5 | 1.6 | 9.6 |
| 1600.0 | 1.5 | 1.6 | 9.4 |
| 1800.0 | 1.6 | 1.5 | 9.7 |
| 2000.0 | 1.8 | 1.4 | 9.3 |
| 2200.0 | 2.2 | 1.3 | 9.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 300.0 | .296 | –47 | 2.817 | –172 | .009 | 48 | .231 | –90 |
| 500.0 | .278 | –55 | 3.047 | 168 | .010 | 50 | .221 | –123 |
| 600.0 | .270 | –60 | 3.033 | 161 | .012 | 56 | .225 | –164 |
| 800.0 | .262 | –74 | 2.993 | 149 | .015 | 58 | .229 | –154 |
| 1000.0 | .241 | –89 | 3.007 | 140 | .017 | 57 | .245 | –172 |
| 1200.0 | .225 | –109 | 2.916 | 132 | .021 | 57 | .251 | 176 |
| 1400.0 | .210 | –136 | 3.011 | 124 | .024 | 55 | .244 | 163 |
| 1600.0 | .210 | –171 | 2.960 | 115 | .027 | 49 | .237 | 152 |
| 1800.0 | .236 | 150 | 3.056 | 105 | .029 | 42 | .212 | 146 |
| 2000.0 | .294 | 109 | 2.923 | 93 | .031 | 32 | .168 | 143 |
| 2200.0 | .372 | 75 | 2.838 | 80 | .032 | 22 | .139 | 155 |

# WJ-PA38 / SMPA38




## 200 to 2000 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 200-2400 MHz (TYP.)
- ◆ HIGH OUTPUT LEVEL: +23.0 dBm (TYP.)
- ◆ LOW NOISE FIGURE: 4.0 dB (TYP.)
- ◆ HIGH THIRD ORDER INTERCEPT POINT: +34 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 200-2400 MHz | 200-2000 MHz | 200-2000 MHz |
| Small Signal Gain (Min.) | 10.0 dB | 8.5 dB | 8.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 4.7 dB | 5.2 dB |
| Power Output at 1 dB Compression (Min.) | +23.0 dBm | +21.5 dBm | +21.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 1.9:1 | 2.0:1 |
| Output | 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 150 mA | 158 mA | 160 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CPA38 is a standard WJ-PA38 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+60 dBm (Typ.)
Second Order Two Tone Intercept Point.....+55 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

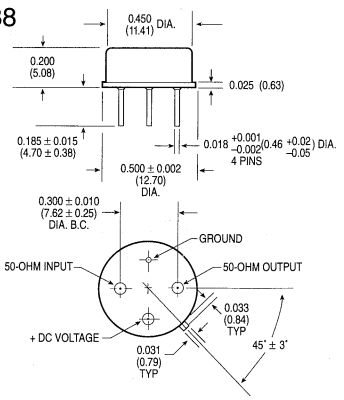
## Absolute Maximum Ratings

Storage Temperature.....-62°C to +125°C
Maximum Case Temperature.....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power.....1 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case).....85°C

Weight approximately 2.0 grams (0.07 oz.)

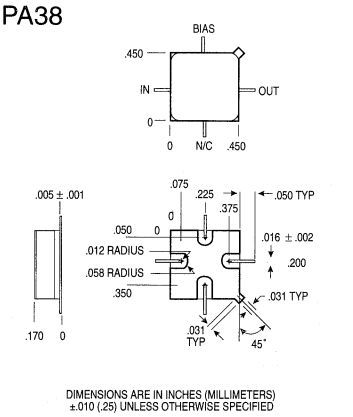
## Outline Drawings

PA38



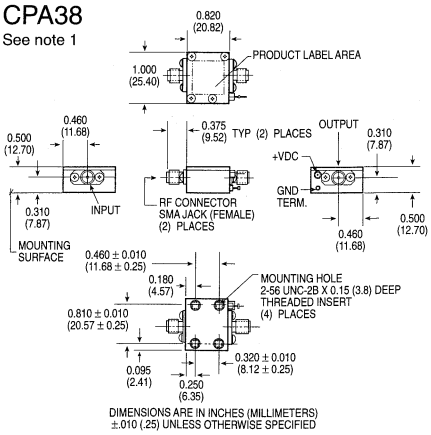

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA38




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

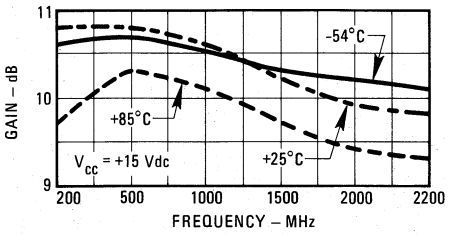
CPA38
See note 1

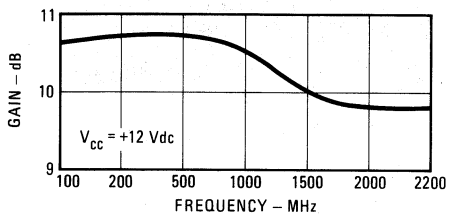



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

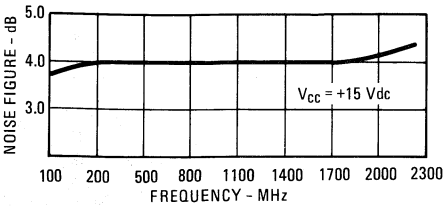
# Typical Performance at 25°C

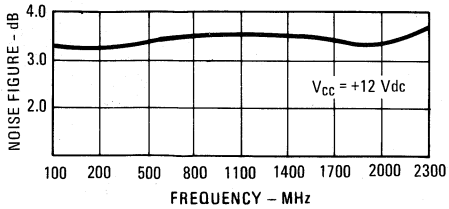
### Gain



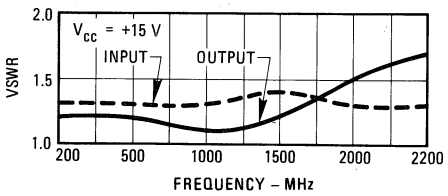




### Noise Figure

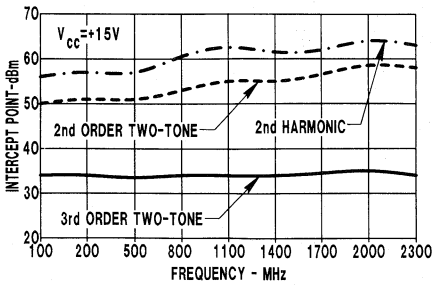


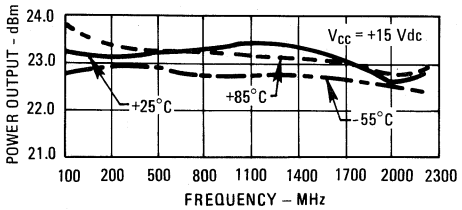

### VSWR




### Intercept Point




### Power Output




## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 3.2 | 1.6 | .5 |
| 5.0 | 2.6 | 1.3 | 2.8 |
| 10.0 | 2.4 | 1.5 | 4.0 |
| 50.0 | 1.7 | 1.4 | 8.8 |
| 100.0 | 1.4 | 1.3 | 9.7 |
| 200.0 | 1.3 | 1.2 | 10.1 |
| 300.0 | 1.3 | 1.2 | 10.1 |
| 400.0 | 1.3 | 1.2 | 10.3 |
| 500.0 | 1.3 | 1.2 | 10.3 |
| 600.0 | 1.4 | 1.2 | 10.4 |
| 700.0 | 1.5 | 1.2 | 10.4 |
| 800.0 | 1.5 | 1.2 | 10.4 |
| 900.0 | 1.5 | 1.2 | 10.4 |
| 1000.0 | 1.5 | 1.2 | 10.4 |
| 1100.0 | 1.5 | 1.2 | 10.4 |
| 1200.0 | 1.5 | 1.3 | 10.3 |
| 1300.0 | 1.5 | 1.3 | 10.3 |
| 1400.0 | 1.5 | 1.3 | 10.2 |
| 1500.0 | 1.4 | 1.3 | 10.1 |
| 1600.0 | 1.4 | 1.3 | 10.0 |
| 1700.0 | 1.3 | 1.3 | 10.1 |
| 1800.0 | 1.3 | 1.3 | 10.1 |
| 1900.0 | 1.3 | 1.3 | 10.3 |
| 2000.0 | 1.4 | 1.3 | 10.4 |
| 2100.0 | 1.4 | 1.3 | 10.5 |
| 2200.0 | 1.5 | 1.4 | 10.4 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 3.1 | 1.4 | 1.1 |
| 5.0 | 2.6 | 1.4 | 2.9 |
| 10.0 | 2.4 | 1.6 | 4.1 |
| 50.0 | 1.7 | 1.4 | 8.8 |
| 100.0 | 1.4 | 1.3 | 9.7 |
| 200.0 | 1.3 | 1.3 | 10.1 |
| 300.0 | 1.3 | 1.3 | 10.1 |
| 400.0 | 1.4 | 1.3 | 10.3 |
| 500.0 | 1.4 | 1.3 | 10.3 |
| 600.0 | 1.4 | 1.3 | 10.3 |
| 700.0 | 1.5 | 1.2 | 10.4 |
| 800.0 | 1.5 | 1.2 | 10.4 |
| 900.0 | 1.5 | 1.2 | 10.4 |
| 1000.0 | 1.5 | 1.2 | 10.4 |
| 1100.0 | 1.5 | 1.2 | 10.4 |
| 1200.0 | 1.5 | 1.2 | 10.3 |
| 1300.0 | 1.5 | 1.3 | 10.3 |
| 1400.0 | 1.5 | 1.3 | 10.2 |
| 1500.0 | 1.4 | 1.3 | 10.1 |
| 1600.0 | 1.4 | 1.3 | 10.0 |
| 1700.0 | 1.4 | 1.3 | 10.1 |
| 1800.0 | 1.3 | 1.3 | 10.1 |
| 1900.0 | 1.3 | 1.3 | 10.3 |
| 2000.0 | 1.4 | 1.3 | 10.4 |
| 2100.0 | 1.4 | 1.4 | 10.5 |
| 2200.0 | 1.4 | 1.5 | 10.4 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 147.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.525 W
Junction Temperature Rise Above Case $T_{jc}$ ... 78°C

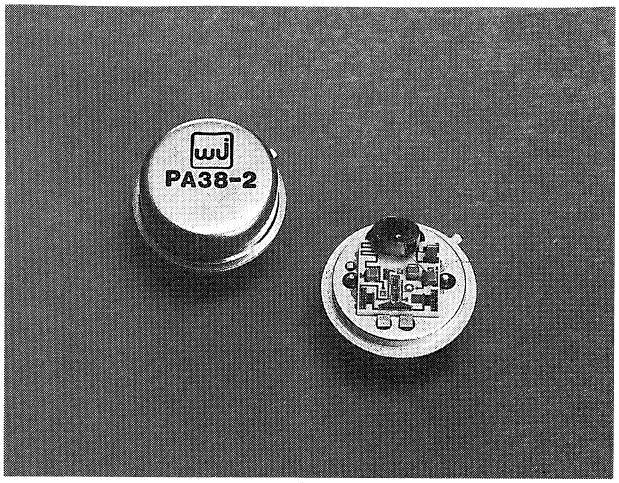
### Linear S-Parameters

| Frequency MHz | S11 MAG | S11 ANG | S21 MAG | S21 ANG | S12 MAG | S12 ANG | S22 MAG | S22 ANG |
|---|---|---|---|---|---|---|---|---|
| 2.0 | .528 | –23 | 1.063 | –122 | .142 | 62 | .238 | –122 |
| 5.0 | .445 | –16 | 1.381 | –147 | .178 | 24 | .144 | 24 |
| 10.0 | .419 | –18 | 1.593 | –152 | .181 | 8 | .212 | –8 |
| 50.0 | .260 | –37 | 2.752 | –164 | .153 | –9 | .166 | –90 |
| 100.0 | .172 | –38 | 3.064 | –178 | .139 | –11 | .132 | –132 |
| 200.0 | .134 | –33 | 3.187 | 167 | .134 | –13 | .109 | –168 |
| 300.0 | .133 | –30 | 3.195 | 156 | .134 | –17 | .100 | –180 |
| 400.0 | .144 | –33 | 3.277 | 146 | .133 | –23 | .107 | 174 |
| 500.0 | .149 | –38 | 3.282 | 136 | .132 | –28 | .106 | 164 |
| 600.0 | .166 | –44 | 3.297 | 124 | .130 | –32 | .103 | 157 |
| 700.0 | .187 | –52 | 3.303 | 114 | .128 | –37 | .102 | 154 |
| 800.0 | .198 | –66 | 3.319 | 104 | .127 | –42 | .100 | 148 |
| 900.0 | .199 | –76 | 3.315 | 94 | .126 | –47 | .099 | 141 |
| 1000.0 | .206 | –87 | 3.330 | 83 | .124 | –51 | .106 | 134 |
| 1100.0 | .208 | –101 | 3.306 | 73 | .123 | –57 | .110 | 126 |
| 1200.0 | .197 | –115 | 3.285 | 63 | .122 | –63 | .111 | 113 |
| 1300.0 | .198 | –129 | 3.265 | 53 | .120 | –69 | .117 | 97 |
| 1400.0 | .186 | –147 | 3.228 | 42 | .118 | –74 | .123 | 80 |
| 1500.0 | .171 | –163 | 3.210 | 31 | .116 | –79 | .125 | 63 |
| 1600.0 | .168 | 175 | 3.175 | 20 | .115 | –85 | .129 | 42 |
| 1700.0 | .144 | 154 | 3.191 | 10 | .111 | –90 | .131 | 21 |
| 1800.0 | .139 | 129 | 3.202 | 0 | .108 | –94 | .131 | 1 |
| 1900.0 | .139 | 97 | 3.259 | –13 | .107 | –98 | .127 | –21 |
| 2000.0 | .162 | 66 | 3.294 | –24 | .107 | –102 | .132 | –45 |
| 2100.0 | .172 | 32 | 3.333 | –37 | .108 | –107 | .146 | –71 |
| 2200.0 | .198 | 6 | 3.300 | –51 | .111 | –112 | .180 | –96 |

### Linear S-Parameters

| Frequency MHz | S11 MAG | S11 ANG | S21 MAG | S21 ANG | S12 MAG | S12 ANG | S22 MAG | S22 ANG |
|---|---|---|---|---|---|---|---|---|
| 2.0 | .511 | –23 | 1.140 | –126 | .153 | 58 | .166 | –116 |
| 5.0 | .437 | –15 | 1.391 | –149 | .180 | 21 | .171 | 11 |
| 10.0 | .416 | –17 | 1.600 | –153 | .181 | 7 | .227 | –14 |
| 50.0 | .256 | –37 | 2.747 | –165 | .150 | –10 | .177 | –94 |
| 100.0 | .178 | –37 | 3.056 | –178 | .137 | –11 | .146 | –136 |
| 200.0 | .139 | –33 | 3.182 | 167 | .131 | –13 | .124 | –171 |
| 300.0 | .137 | –29 | 3.201 | 156 | .131 | –17 | .116 | 176 |
| 400.0 | .151 | –33 | 3.275 | 146 | .130 | –22 | .120 | 168 |
| 500.0 | .152 | –39 | 3.271 | 136 | .129 | –27 | .119 | 158 |
| 600.0 | .169 | –45 | 3.284 | 125 | .128 | –31 | .114 | 150 |
| 700.0 | .188 | –53 | 3.294 | 115 | .127 | –36 | .110 | 145 |
| 800.0 | .205 | –66 | 3.303 | 104 | .126 | –40 | .105 | 139 |
| 900.0 | .200 | –77 | 3.309 | 94 | .125 | –45 | .103 | 131 |
| 1000.0 | .208 | –89 | 3.304 | 84 | .124 | –49 | .107 | 124 |
| 1100.0 | .210 | –101 | 3.293 | 74 | .124 | –54 | .108 | 116 |
| 1200.0 | .206 | –114 | 3.283 | 64 | .123 | –60 | .109 | 103 |
| 1300.0 | .199 | –129 | 3.261 | 53 | .121 | –66 | .115 | 86 |
| 1400.0 | .196 | –144 | 3.226 | 42 | .121 | –72 | .121 | 70 |
| 1500.0 | .174 | –160 | 3.210 | 32 | .119 | –77 | .124 | 52 |
| 1600.0 | .163 | 179 | 3.168 | 21 | .117 | –82 | .129 | 31 |
| 1700.0 | .150 | 156 | 3.202 | 11 | .116 | –87 | .134 | 10 |
| 1800.0 | .140 | 129 | 3.213 | 1 | .114 | –92 | .134 | –11 |
| 1900.0 | .146 | 98 | 3.256 | –11 | .113 | –96 | .133 | –35 |
| 2000.0 | .157 | 66 | 3.293 | –22 | .115 | –100 | .139 | –58 |
| 2100.0 | .164 | 33 | 3.348 | –36 | .116 | –106 | .156 | –84 |
| 2200.0 | .183 | 10 | 3.306 | –50 | .118 | –110 | .190 | –106 |

# WJ-PA38-2 / SMPA38-2




## 200 to 2600 MHz
## TO-8 CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BANDWIDTH: 200-2800 MHz (TYP.)
- ◆ HIGH OUTPUT LEVEL: +23.5 dBm (TYP.)
- ◆ GaAs FET AMPLIFIER
- ◆ HIGH THIRD ORDER INTERCEPT POINT: +33 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to -50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 200-2800 MHz | 200-2600 MHz | 200-2600 MHz |
| Small Signal Gain (Min.) | 8.5 dB | 7.5 dB | 7.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| 200-2600 | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| 200-2000 MHz | +23.5 dBm | +22.0 dBm | +21.4 dBm |
| 2000-2600 MHz | +22.5 dBm | +20.5 dBm | +20.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.2:1 | 1.9:1 | 2.0:1 |
| Output | 1.5:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 150 mA | 158 m | 160 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CPA38-2 is a standard WJ-PA38-2 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+55 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+33 dBm (Typ.)

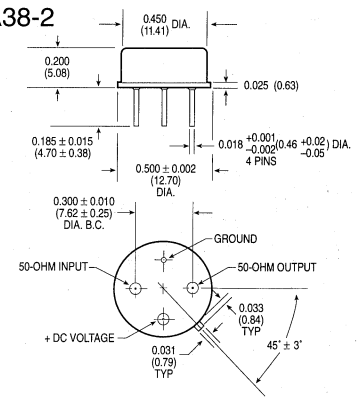
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....1 Watt (3 μ sec Max.)
"S" Series Burn-In Temperature (Case) .....85°C
Proper heat sinking required to insure reliable performance.

Weight approximately 2.0 grams (0.07 oz.)

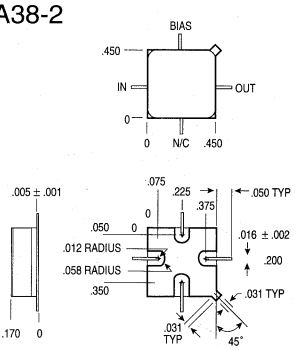
## Outline Drawings

PA38-2



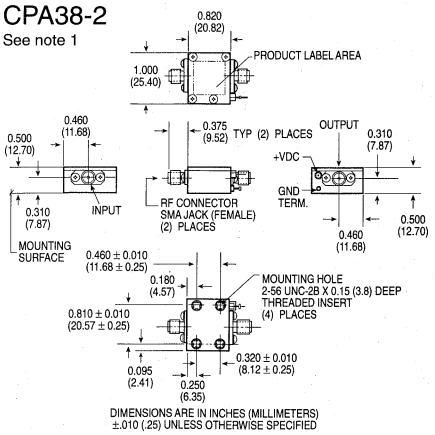

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPA38-2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

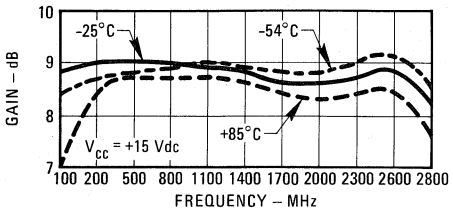
CPA38-2
See note 1

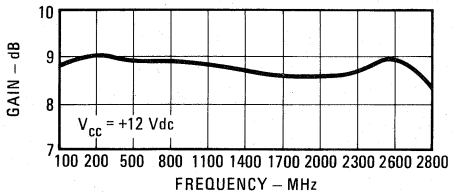



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

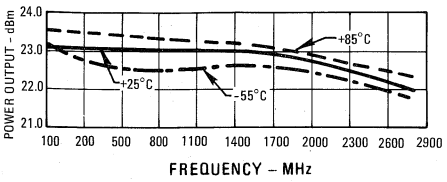
# Typical Performance at 25°C

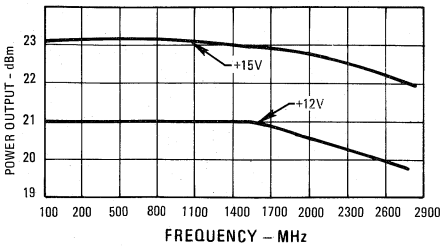
## Gain



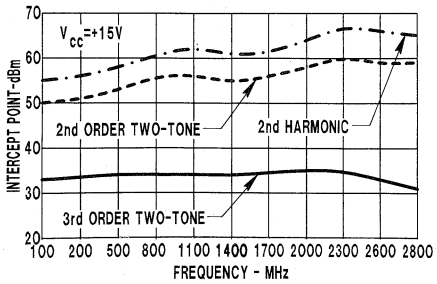

## Power Output*



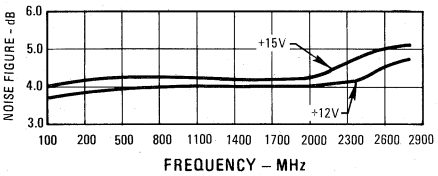




*at 1 dB Gain Compression

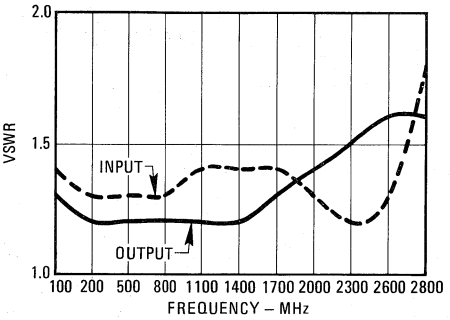
## Intercept Point




## Noise Figure




## VSWR




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.1 | 1.4 | 3.2 |
| 50.0 | 1.4 | 1.5 | 8.0 |
| 100.0 | 1.2 | 1.5 | 8.8 |
| 200.0 | 1.1 | 1.4 | 9.0 |
| 300.0 | 1.1 | 1.4 | 9.1 |
| 400.0 | 1.1 | 1.4 | 9.3 |
| 500.0 | 1.2 | 1.4 | 9.3 |
| 600.0 | 1.2 | 1.3 | 9.3 |
| 700.0 | 1.3 | 1.3 | 9.3 |
| 800.0 | 1.4 | 1.3 | 9.3 |
| 900.0 | 1.4 | 1.3 | 9.3 |
| 1000.0 | 1.5 | 1.3 | 9.3 |
| 1100.0 | 1.5 | 1.3 | 9.3 |
| 1200.0 | 1.5 | 1.3 | 9.2 |
| 1300.0 | 1.6 | 1.3 | 9.1 |
| 1400.0 | 1.5 | 1.3 | 9.0 |
| 1500.0 | 1.5 | 1.3 | 9.0 |
| 1600.0 | 1.5 | 1.3 | 9.0 |
| 1700.0 | 1.5 | 1.3 | 9.1 |
| 1800.0 | 1.5 | 1.3 | 9.0 |
| 1900.0 | 1.4 | 1.3 | 9.1 |
| 2000.0 | 1.4 | 1.3 | 9.1 |
| 2100.0 | 1.3 | 1.2 | 9.2 |
| 2200.0 | 1.2 | 1.2 | 9.4 |
| 2300.0 | 1.1 | 1.1 | 9.3 |
| 2400.0 | 1.1 | 1.0 | 9.4 |
| 2500.0 | 1.2 | 1.1 | 9.4 |
| 2600.0 | 1.4 | 1.3 | 9.2 |
| 2700.0 | 1.7 | 1.4 | 8.9 |
| 2800.0 | 2.0 | 1.5 | 8.5 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.1 | 1.4 | 3.2 |
| 50.0 | 1.4 | 1.5 | 8.0 |
| 100.0 | 1.2 | 1.5 | 8.8 |
| 200.0 | 1.1 | 1.5 | 9.0 |
| 300.0 | 1.1 | 1.5 | 9.1 |
| 400.0 | 1.1 | 1.4 | 9.3 |
| 500.0 | 1.2 | 1.4 | 9.3 |
| 600.0 | 1.2 | 1.4 | 9.3 |
| 700.0 | 1.3 | 1.3 | 9.3 |
| 800.0 | 1.4 | 1.3 | 9.3 |
| 900.0 | 1.4 | 1.3 | 9.3 |
| 1000.0 | 1.5 | 1.3 | 9.3 |
| 1100.0 | 1.5 | 1.3 | 9.3 |
| 1200.0 | 1.5 | 1.3 | 9.2 |
| 1300.0 | 1.6 | 1.3 | 9.1 |
| 1400.0 | 1.6 | 1.3 | 9.0 |
| 1500.0 | 1.6 | 1.3 | 9.1 |
| 1600.0 | 1.6 | 1.3 | 9.0 |
| 1700.0 | 1.5 | 1.3 | 9.1 |
| 1800.0 | 1.5 | 1.3 | 9.0 |
| 1900.0 | 1.4 | 1.2 | 9.2 |
| 2000.0 | 1.4 | 1.2 | 9.2 |
| 2100.0 | 1.3 | 1.2 | 9.3 |
| 2200.0 | 1.2 | 1.1 | 9.4 |
| 2300.0 | 1.1 | 1.0 | 9.4 |
| 2400.0 | 1.1 | 1.1 | 9.5 |
| 2500.0 | 1.3 | 1.2 | 9.4 |
| 2600.0 | 1.4 | 1.4 | 9.2 |
| 2700.0 | 1.6 | 1.5 | 8.9 |
| 2800.0 | 2.1 | 1.6 | 8.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .350 | –27 | 1.441 | –149 | .211 | 8 | .157 | –22 |
| 50.0 | .175 | –61 | 2.506 | –165 | .169 | –10 | .193 | –123 |
| 100.0 | .082 | –73 | 2.743 | –178 | .153 | –11 | .196 | –158 |
| 200.0 | .034 | –68 | 2.831 | 167 | .149 | –13 | .184 | 176 |
| 300.0 | .033 | –20 | 2.839 | 157 | .150 | –17 | .170 | 164 |
| 400.0 | .055 | –17 | 2.902 | 147 | .148 | –22 | .167 | 158 |
| 500.0 | .075 | –14 | 2.903 | 137 | .147 | –27 | .156 | 150 |
| 600.0 | .104 | –26 | 2.909 | 127 | .146 | –31 | .142 | 145 |
| 700.0 | .137 | –40 | 2.917 | 117 | .145 | –36 | .129 | 143 |
| 800.0 | .159 | –58 | 2.928 | 107 | .144 | –41 | .119 | 142 |
| 900.0 | .173 | –72 | 2.930 | 98 | .144 | –46 | .114 | 142 |
| 1000.0 | .192 | –90 | 2.928 | 87 | .142 | –51 | .120 | 142 |
| 1100.0 | .199 | –103 | 2.912 | 78 | .142 | –56 | .128 | 141 |
| 1200.0 | .213 | –118 | 2.883 | 68 | .140 | –63 | .133 | 135 |
| 1300.0 | .216 | –134 | 2.861 | 59 | .138 | –68 | .139 | 125 |
| 1400.0 | .215 | –147 | 2.825 | 49 | .136 | –74 | .144 | 116 |
| 1500.0 | .210 | –163 | 2.823 | 39 | .134 | –80 | .142 | 108 |
| 1600.0 | .211 | –180 | 2.820 | 30 | .132 | –85 | .138 | 98 |
| 1700.0 | .198 | 164 | 2.842 | 20 | .130 | –90 | .137 | 90 |
| 1800.0 | .191 | 147 | 2.822 | 11 | .125 | –95 | .133 | 83 |
| 1900.0 | .165 | 131 | 2.851 | 0 | .123 | –99 | .127 | 77 |
| 2000.0 | .153 | 115 | 2.865 | –10 | .124 | –104 | .120 | 71 |
| 2100.0 | .115 | 95 | 2.900 | –21 | .124 | –109 | .101 | 67 |
| 2200.0 | .091 | 82 | 2.937 | –32 | .126 | –114 | .074 | 60 |
| 2300.0 | .054 | 26 | 2.933 | –45 | .127 | –120 | .040 | 58 |
| 2400.0 | .050 | –46 | 2.958 | –58 | .127 | –126 | .015 | 145 |
| 2500.0 | .108 | –105 | 2.967 | –72 | .129 | –131 | .069 | –175 |
| 2600.0 | .183 | –128 | 2.893 | –87 | .129 | –138 | .118 | –179 |
| 2700.0 | .250 | –147 | 2.798 | –102 | .131 | –145 | .163 | 168 |
| 2800.0 | .340 | –170 | 2.658 | –118 | .132 | –152 | .213 | 153 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .348 | –27 | 1.445 | –150 | .210 | 7 | .175 | –28 |
| 50.0 | .175 | –60 | 2.509 | –165 | .167 | –11 | .207 | –124 |
| 100.0 | .092 | –71 | 2.739 | –178 | .151 | –11 | .210 | –158 |
| 200.0 | .035 | –54 | 2.827 | 167 | .146 | –12 | .198 | 175 |
| 300.0 | .037 | –25 | 2.837 | 157 | .147 | –16 | .185 | 164 |
| 400.0 | .061 | –12 | 2.904 | 147 | .147 | –21 | .181 | 156 |
| 500.0 | .080 | –16 | 2.908 | 138 | .145 | –26 | .170 | 147 |
| 600.0 | .107 | –26 | 2.920 | 127 | .144 | –30 | .155 | 141 |
| 700.0 | .141 | –43 | 2.918 | 117 | .144 | –35 | .141 | 138 |
| 800.0 | .158 | –56 | 2.929 | 107 | .143 | –40 | .127 | 136 |
| 900.0 | .174 | –73 | 2.925 | 98 | .143 | –44 | .122 | 135 |
| 1000.0 | .191 | –87 | 2.929 | 88 | .141 | –49 | .123 | 134 |
| 1100.0 | .206 | –104 | 2.904 | 78 | .141 | –54 | .127 | 132 |
| 1200.0 | .215 | –117 | 2.887 | 69 | .140 | –60 | .129 | 127 |
| 1300.0 | .223 | –132 | 2.858 | 59 | .138 | –66 | .133 | 118 |
| 1400.0 | .223 | –147 | 2.835 | 49 | .137 | –72 | .137 | 109 |
| 1500.0 | .222 | –161 | 2.838 | 40 | .136 | –77 | .133 | 101 |
| 1600.0 | .221 | –179 | 2.811 | 30 | .134 | –82 | .127 | 90 |
| 1700.0 | .200 | 166 | 2.858 | 20 | .133 | –88 | .122 | 83 |
| 1800.0 | .200 | 152 | 2.832 | 11 | .129 | –92 | .117 | 76 |
| 1900.0 | .174 | 134 | 2.875 | 0 | .129 | –97 | .106 | 71 |
| 2000.0 | .156 | 117 | 2.878 | –10 | .130 | –102 | .097 | 67 |
| 2100.0 | .120 | 93 | 2.911 | –20 | .130 | –107 | .073 | 63 |
| 2200.0 | .104 | 75 | 2.944 | –32 | .132 | –112 | .045 | 61 |
| 2300.0 | .057 | 40 | 2.951 | –45 | .136 | –119 | .016 | 111 |
| 2400.0 | .055 | –48 | 2.969 | –58 | .136 | –125 | .045 | –179 |
| 2500.0 | .111 | –104 | 2.953 | –72 | .137 | –131 | .104 | –178 |
| 2600.0 | .180 | –129 | 2.881 | –86 | .139 | –139 | .151 | 174 |
| 2700.0 | .242 | –148 | 2.800 | –101 | .139 | –145 | .195 | 160 |
| 2800.0 | .346 | –170 | 2.651 | –116 | .139 | –153 | .240 | 147 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 147.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.525 W
Junction Temperature Rise Above Case $T_{jc}$ ... 78°C

# WJ-PA48/SMPA48

## 1.0 TO 4.0 GHz
## TO-8B[2] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRAWIDE BANDWIDTH: 0.8-4.2 GHz (TYP.)
- ◆ HIGH OUTPUT LEVEL: +24.0 dBm (TYP.)
- ◆ HIGH GAIN: 16.0 dB (TYP.)
- ◆ GaAs FET AMPLIFIER

## Specifications*

| Characteristics | Typical | 0° to -50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 0.8-4.2 GHz | 1.0-4.0 GHz | 1.0-4.0 GHz |
| Small Signal Gain (Min.) | 16.0 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±0.8 dB |
| Noise Figure (Max.) | 5.5 dB | 7.0 dB | 7.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +24.0 dBm | +22.5 dBm | +21.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.0:1 | 2.2:1 |
| Output | 1.6:1 | 1.9:1 | 2.1:1 |
| DC Current (Max.) at +15 Volts | 225 mA | 235 mA | 245 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-CPA48 is a standard WJ-PA48 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. WJ-PA48 amplifier TO-8B package is slightly larger than the standard TO-8 package.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+55 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

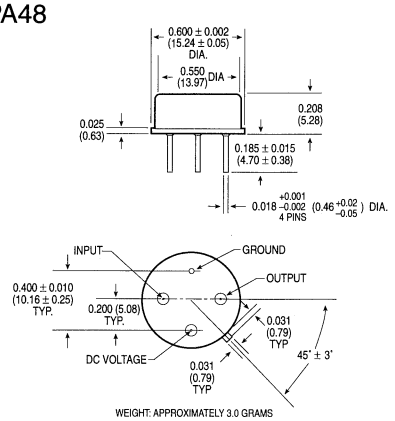
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 μ sec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

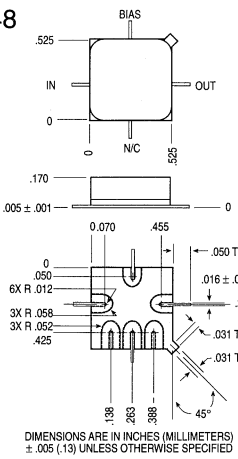
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

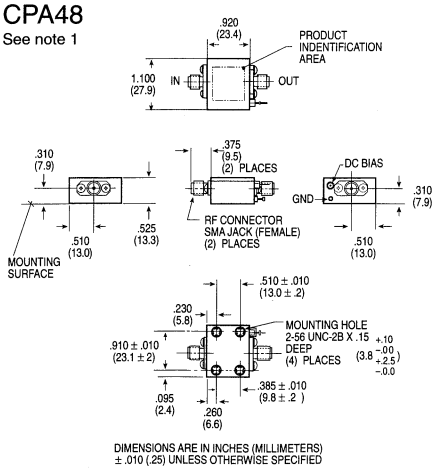
PA48




SMPA48

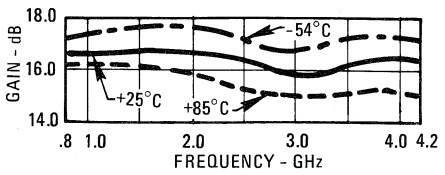



CPA48
See note 1

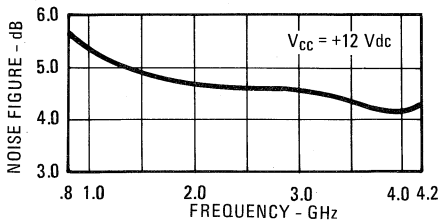


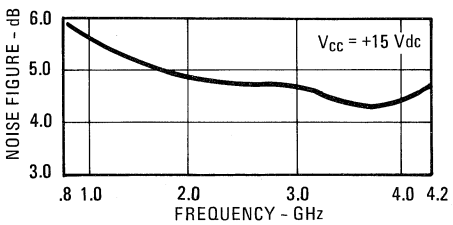
# Typical Performance at 25°C

### Gain

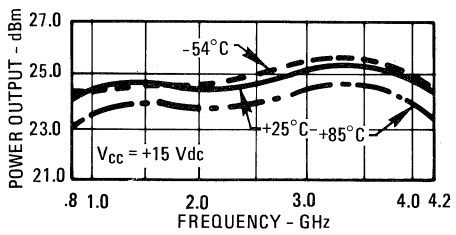


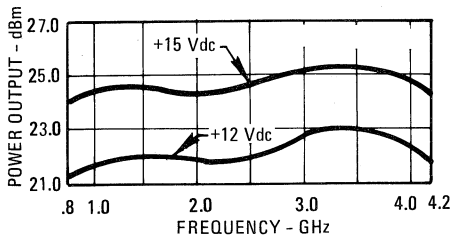

### Noise Figure



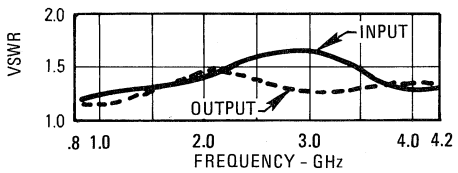

### Power Output*



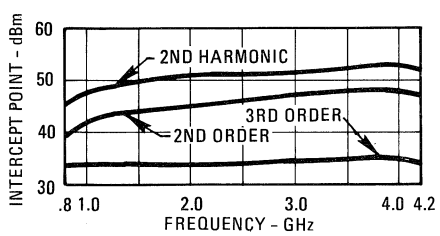




*at 1 dB Gain Compression

### VSWR




### Intercept Point




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.5 | 1.3 | 15.7 |
| 900.0 | 1.1 | 1.3 | 16.1 |
| 1000.0 | 1.2 | 1.3 | 16.1 |
| 1100.0 | 1.3 | 1.3 | 16.1 |
| 1200.0 | 1.4 | 1.3 | 16.2 |
| 1300.0 | 1.5 | 1.3 | 16.2 |
| 1400.0 | 1.5 | 1.3 | 16.2 |
| 1500.0 | 1.4 | 1.3 | 16.3 |
| 1600.0 | 1.4 | 1.3 | 16.4 |
| 1700.0 | 1.4 | 1.3 | 16.3 |
| 1800.0 | 1.4 | 1.3 | 16.4 |
| 1900.0 | 1.4 | 1.3 | 16.5 |
| 2000.0 | 1.3 | 1.4 | 16.5 |
| 2100.0 | 1.3 | 1.4 | 16.5 |
| 2200.0 | 1.2 | 1.4 | 16.6 |
| 2300.0 | 1.2 | 1.4 | 16.7 |
| 2400.0 | 1.3 | 1.4 | 16.8 |
| 2500.0 | 1.3 | 1.4 | 16.8 |
| 2600.0 | 1.3 | 1.4 | 16.8 |
| 2700.0 | 1.4 | 1.3 | 16.8 |
| 2800.0 | 1.4 | 1.3 | 16.7 |
| 2900.0 | 1.5 | 1.3 | 16.7 |
| 3000.0 | 1.5 | 1.2 | 16.7 |
| 3100.0 | 1.5 | 1.2 | 16.6 |
| 3200.0 | 1.5 | 1.2 | 16.6 |
| 3300.0 | 1.5 | 1.2 | 16.6 |
| 3400.0 | 1.4 | 1.3 | 16.6 |
| 3500.0 | 1.4 | 1.3 | 16.6 |
| 3600.0 | 1.3 | 1.3 | 16.5 |
| 3700.0 | 1.3 | 1.4 | 16.5 |
| 3800.0 | 1.2 | 1.4 | 16.4 |
| 3900.0 | 1.2 | 1.4 | 16.2 |
| 4000.0 | 1.2 | 1.4 | 16.1 |
| 4100.0 | 1.3 | 1.4 | 15.8 |
| 4200.0 | 1.3 | 1.4 | 15.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .210 | –76 | 6.062 | –96 | .020 | –48 | .127 | 76 |
| 900.0 | .061 | –85 | 6.360 | –144 | .022 | –94 | .135 | 25 |
| 1000.0 | .070 | –5 | 6.399 | 175 | .022 | –130 | .138 | –10 |
| 1100.0 | .125 | –22 | 6.406 | 137 | .020 | –163 | .137 | –37 |
| 1200.0 | .159 | –47 | 6.426 | 101 | .021 | 167 | .140 | –62 |
| 1300.0 | .184 | –71 | 6.455 | 67 | .021 | 132 | .140 | –87 |
| 1400.0 | .194 | –102 | 6.482 | 34 | .019 | 105 | .142 | –113 |
| 1500.0 | .182 | –129 | 6.505 | 1 | .019 | 77 | .141 | –138 |
| 1600.0 | .181 | –158 | 6.571 | –31 | .019 | 51 | .142 | –164 |
| 1700.0 | .179 | 172 | 6.568 | –63 | .021 | 23 | .146 | 170 |
| 1800.0 | .163 | 142 | 6.598 | –94 | .019 | –4 | .144 | 143 |
| 1900.0 | .157 | 110 | 6.651 | –125 | .020 | –31 | .146 | 115 |
| 2000.0 | .134 | 84 | 6.677 | –156 | .019 | –56 | .152 | 88 |
| 2100.0 | .116 | 44 | 6.711 | 173 | .019 | –82 | .154 | 63 |
| 2200.0 | .105 | 9 | 6.798 | 143 | .018 | –107 | .156 | 37 |
| 2300.0 | .109 | –30 | 6.841 | 112 | .018 | –137 | .155 | 11 |
| 2400.0 | .119 | –68 | 6.885 | 82 | .018 | –160 | .161 | –14 |
| 2500.0 | .131 | –107 | 6.948 | 51 | .018 | 172 | .160 | –38 |
| 2600.0 | .139 | –139 | 6.920 | 20 | .019 | 147 | .154 | –63 |
| 2700.0 | .167 | –170 | 6.913 | –11 | .018 | 118 | .143 | –84 |
| 2800.0 | .169 | 162 | 6.860 | –41 | .016 | 99 | .126 | –103 |
| 2900.0 | .184 | 135 | 6.829 | –72 | .016 | 77 | .113 | –116 |
| 3000.0 | .192 | 111 | 6.811 | –102 | .016 | 50 | .107 | –126 |
| 3100.0 | .202 | 88 | 6.773 | –133 | .017 | 30 | .102 | –137 |
| 3200.0 | .193 | 67 | 6.770 | –163 | .014 | 1 | .102 | –147 |
| 3300.0 | .193 | 46 | 6.737 | 166 | .015 | –21 | .103 | –153 |
| 3400.0 | .183 | 25 | 6.742 | 135 | .016 | –48 | .113 | –163 |
| 3500.0 | .176 | 7 | 6.761 | 105 | .015 | –75 | .129 | –175 |
| 3600.0 | .146 | –10 | 6.701 | 73 | .014 | –99 | .144 | 168 |
| 3700.0 | .121 | –24 | 6.665 | 42 | .015 | –120 | .155 | 150 |
| 3800.0 | .095 | –30 | 6.601 | 11 | .016 | –143 | .158 | 131 |
| 3900.0 | .078 | –17 | 6.453 | –21 | .016 | –172 | .160 | 112 |
| 4000.0 | .086 | –13 | 6.370 | –52 | .014 | 158 | .157 | 94 |
| 4100.0 | .116 | –9 | 6.197 | –83 | .015 | 142 | .152 | 78 |
| 4200.0 | .148 | –20 | 6.178 | –114 | .016 | 105 | .158 | 65 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 67.4°C/W
Transistor Power Dissipation $P_d$ ..... 1.280 W
Junction Temperature Rise Above Case $T_{jc}$ ... 86°C

# Typical Automatic Test Data

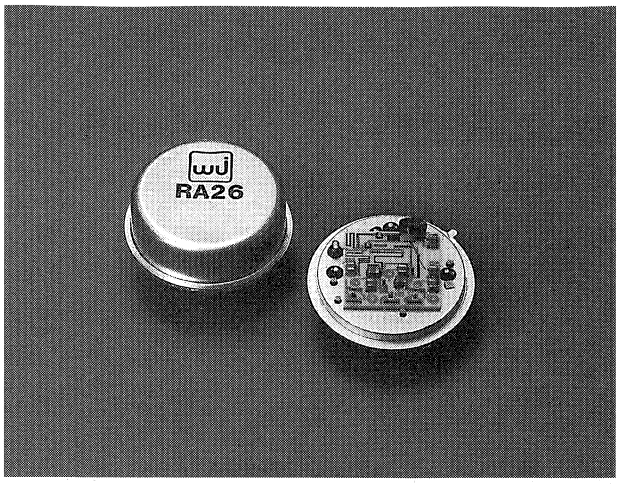
## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.5 | 1.4 | 16.1 |
| 900.0 | 1.1 | 1.4 | 16.3 |
| 1000.0 | 1.2 | 1.4 | 16.3 |
| 1100.0 | 1.3 | 1.4 | 16.3 |
| 1200.0 | 1.4 | 1.4 | 16.3 |
| 1300.0 | 1.5 | 1.4 | 16.4 |
| 1400.0 | 1.5 | 1.4 | 16.4 |
| 1500.0 | 1.5 | 1.4 | 16.5 |
| 1600.0 | 1.5 | 1.5 | 16.6 |
| 1700.0 | 1.5 | 1.5 | 16.6 |
| 1800.0 | 1.4 | 1.5 | 16.7 |
| 1900.0 | 1.4 | 1.5 | 16.8 |
| 2000.0 | 1.4 | 1.5 | 16.9 |
| 2100.0 | 1.3 | 1.5 | 16.9 |
| 2200.0 | 1.3 | 1.5 | 17.1 |
| 2300.0 | 1.3 | 1.6 | 17.2 |
| 2400.0 | 1.3 | 1.6 | 17.3 |
| 2500.0 | 1.3 | 1.6 | 17.4 |
| 2600.0 | 1.3 | 1.6 | 17.3 |
| 2700.0 | 1.4 | 1.5 | 17.4 |
| 2800.0 | 1.4 | 1.5 | 17.3 |
| 2900.0 | 1.5 | 1.4 | 17.3 |
| 3000.0 | 1.5 | 1.3 | 17.3 |
| 3100.0 | 1.5 | 1.2 | 17.2 |
| 3200.0 | 1.5 | 1.2 | 17.2 |
| 3300.0 | 1.5 | 1.1 | 17.1 |
| 3400.0 | 1.5 | 1.0 | 17.1 |
| 3500.0 | 1.5 | 1.1 | 17.1 |
| 3600.0 | 1.4 | 1.1 | 17.0 |
| 3700.0 | 1.3 | 1.2 | 16.9 |
| 3800.0 | 1.3 | 1.2 | 16.7 |
| 3900.0 | 1.2 | 1.3 | 16.5 |
| 4000.0 | 1.2 | 1.3 | 16.3 |
| 4100.0 | 1.2 | 1.4 | 16.0 |
| 4200.0 | 1.3 | 1.4 | 15.9 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .188 | –71 | 6.348 | –100 | .019 | –51 | .162 | 48 |
| 900.0 | .053 | –65 | 6.560 | –147 | .019 | –92 | .179 | 7 |
| 1000.0 | .079 | –6 | 6.540 | 173 | .019 | –128 | .180 | –24 |
| 1100.0 | .137 | –24 | 6.527 | 136 | .018 | –163 | .179 | –49 |
| 1200.0 | .166 | –47 | 6.561 | 101 | .019 | 166 | .179 | –75 |
| 1300.0 | .192 | –72 | 6.596 | 67 | .018 | 138 | .181 | –100 |
| 1400.0 | .199 | –99 | 6.637 | 34 | .018 | 108 | .182 | –125 |
| 1500.0 | .195 | –128 | 6.666 | 2 | .017 | 80 | .181 | –149 |
| 1600.0 | .188 | –156 | 6.757 | –30 | .017 | 54 | .185 | –175 |
| 1700.0 | .186 | 174 | 6.781 | –61 | .019 | 30 | .188 | 158 |
| 1800.0 | .176 | 147 | 6.839 | –92 | .018 | 6 | .188 | 132 |
| 1900.0 | .171 | 115 | 6.927 | –123 | .017 | –24 | .194 | 105 |
| 2000.0 | .150 | 89 | 6.975 | –154 | .018 | –48 | .204 | 79 |
| 2100.0 | .133 | 54 | 7.017 | 175 | .019 | –72 | .207 | 54 |
| 2200.0 | .120 | 21 | 7.159 | 145 | .020 | –94 | .212 | 27 |
| 2300.0 | .127 | –19 | 7.232 | 114 | .019 | –124 | .216 | 1 |
| 2400.0 | .125 | –57 | 7.307 | 83 | .019 | –150 | .222 | –25 |
| 2500.0 | .131 | –95 | 7.409 | 52 | .019 | 180 | .223 | –49 |
| 2600.0 | .148 | –126 | 7.367 | 21 | .018 | 159 | .221 | –76 |
| 2700.0 | .158 | –158 | 7.374 | –10 | .018 | 142 | .207 | –101 |
| 2800.0 | .171 | 174 | 7.352 | –40 | .020 | 109 | .188 | –125 |
| 2900.0 | .190 | 146 | 7.304 | –71 | .018 | 85 | .163 | –148 |
| 3000.0 | .189 | 119 | 7.299 | –102 | .018 | 57 | .137 | –169 |
| 3100.0 | .205 | 98 | 7.245 | –132 | .018 | 34 | .111 | 173 |
| 3200.0 | .203 | 75 | 7.226 | –163 | .017 | 11 | .081 | 154 |
| 3300.0 | .211 | 54 | 7.185 | 167 | .018 | –18 | .050 | 141 |
| 3400.0 | .200 | 32 | 7.170 | 135 | .019 | –37 | .023 | 169 |
| 3500.0 | .192 | 14 | 7.141 | 104 | .018 | –66 | .038 | –155 |
| 3600.0 | .170 | –3 | 7.040 | 73 | .019 | –90 | .066 | –161 |
| 3700.0 | .143 | –19 | 6.973 | 41 | .018 | –117 | .091 | –179 |
| 3800.0 | .118 | –30 | 6.863 | 10 | .019 | –139 | .108 | 164 |
| 3900.0 | .092 | –31 | 6.675 | –21 | .019 | –165 | .124 | 146 |
| 4000.0 | .088 | –23 | 6.519 | –53 | .019 | 168 | .137 | 129 |
| 4100.0 | .109 | –16 | 6.312 | –83 | .020 | 139 | .156 | 112 |
| 4200.0 | .141 | –22 | 6.232 | –114 | .019 | 113 | .182 | 93 |

# WJ-RA26/SMRA26




## 10 to 1500 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN -THREE STAGES:27.5 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +14.5 dBm (TYP.)
- ◆ HIGH THIRD-ORDER I.P.: +27 dBm (TYP.)
- ◆ HIGH REVERSE ISOLATION: >40 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1550 MHz | 10-1500 MHz | 10-1500 MHz |
| Small Signal Gain (Min.) | 27.5 dB | 26.0 dB | 25.0 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.8 dB | ±1.2 dB |
| Noise Figure (Max.) | | | |
| 10-1000 MHz | 4.5 dB | 5.0 dB | 5.5 dB |
| 1000-1500 MHz | 5.5 dB | 6.0 dB | 6.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +14.5 dBm | +13.5 dBm | +12.5 dBm |
| VSWR (Max.) Input/Output | 1.6:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 82 mA | 85 mA | 87 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.

Notes:

1. WJ-RA26 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA26 is a standard WJ-RA26 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+41 dBm (Typ.)
Second Order Two Tone Intercept Point.....+37 dBm (Typ.)
Third Order Two Tone Intercept Point.....+27 dBm (Typ.)

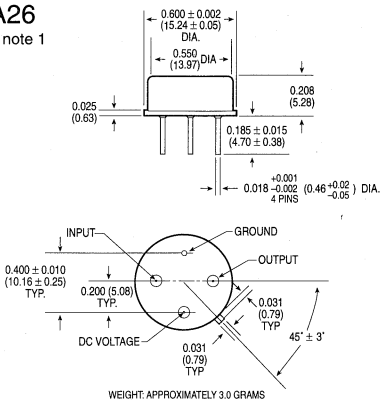
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 msec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

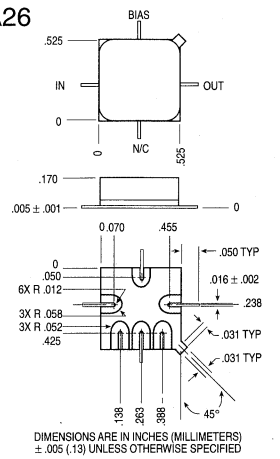
Weight approximately 2.0 grams (0.07 oz)

## Outline Drawings

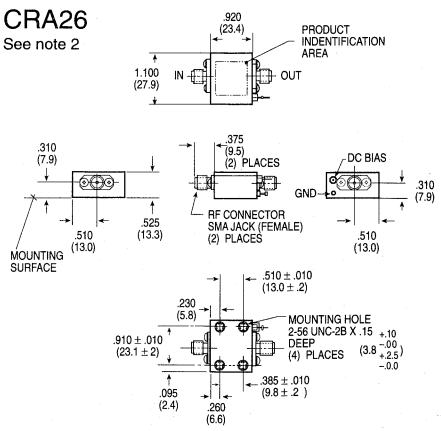
RA26
See note 1




SMRA26

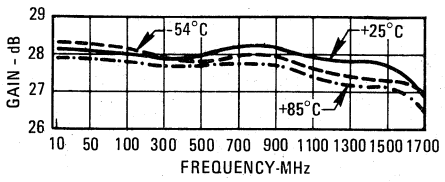



CRA26
See note 2

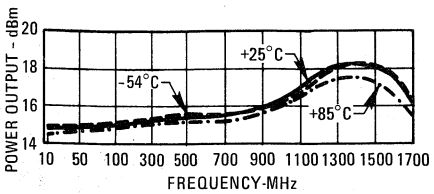


# Typical Performance at 25°C

### Gain

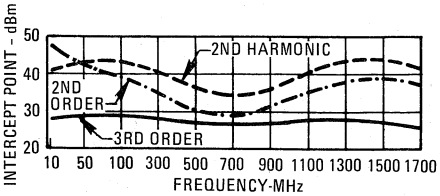



### Power Output*

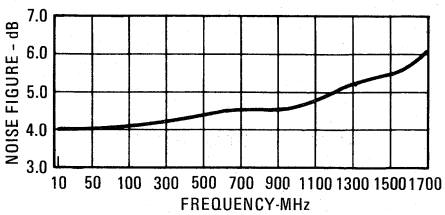



*at 1 dB Gain Compression

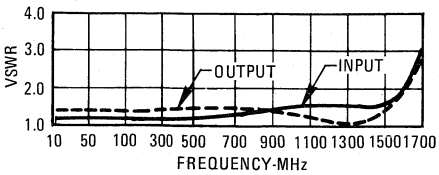
### Intercept Point



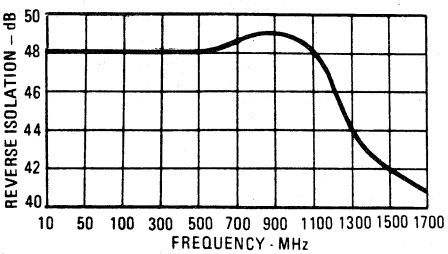

### Noise Figure




### VSWR




### Reverse Isolation




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 2.4 | 23.5 |
| 2.0 | 1.2 | 1.8 | 26.3 |
| 5.0 | 1.1 | 1.2 | 27.6 |
| 10.0 | 1.1 | 1.1 | 27.7 |
| 50.0 | 1.1 | 1.2 | 27.8 |
| 100.0 | 1.1 | 1.2 | 27.7 |
| 200.0 | 1.1 | 1.2 | 27.6 |
| 300.0 | 1.2 | 1.2 | 27.6 |
| 400.0 | 1.2 | 1.3 | 27.9 |
| 500.0 | 1.3 | 1.4 | 28.0 |
| 600.0 | 1.3 | 1.4 | 28.4 |
| 700.0 | 1.2 | 1.5 | 28.6 |
| 800.0 | 1.2 | 1.4 | 28.8 |
| 900.0 | 1.3 | 1.3 | 28.8 |
| 1000.0 | 1.4 | 1.3 | 28.8 |
| 1100.0 | 1.5 | 1.2 | 28.7 |
| 1200.0 | 1.5 | 1.1 | 28.5 |
| 1300.0 | 1.6 | 1.0 | 28.5 |
| 1400.0 | 1.5 | 1.1 | 28.5 |
| 1500.0 | 1.3 | 1.4 | 28.8 |
| 1600.0 | 1.3 | 2.0 | 28.8 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 2.4 | 23.0 |
| 2.0 | 1.3 | 1.8 | 25.8 |
| 5.0 | 1.1 | 1.2 | 27.2 |
| 10.0 | 1.1 | 1.1 | 27.3 |
| 50.0 | 1.1 | 1.2 | 27.3 |
| 100.0 | 1.1 | 1.2 | 27.2 |
| 200.0 | 1.2 | 1.2 | 27.1 |
| 300.0 | 1.2 | 1.2 | 27.2 |
| 400.0 | 1.2 | 1.3 | 27.4 |
| 500.0 | 1.3 | 1.4 | 27.5 |
| 600.0 | 1.3 | 1.4 | 27.8 |
| 700.0 | 1.3 | 1.5 | 28.1 |
| 800.0 | 1.3 | 1.4 | 28.2 |
| 900.0 | 1.3 | 1.3 | 28.3 |
| 1000.0 | 1.3 | 1.3 | 28.2 |
| 1100.0 | 1.4 | 1.2 | 28.1 |
| 1200.0 | 1.5 | 1.1 | 28.0 |
| 1300.0 | 1.5 | 1.0 | 28.0 |
| 1400.0 | 1.4 | 1.2 | 28.1 |
| 1500.0 | 1.3 | 1.5 | 28.3 |
| 1600.0 | 1.6 | 2.3 | 28.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .090 | –64 | 15.004 | –155 | .004 | 20 | .414 | –117 |
| 2.0 | .104 | –41 | 20.569 | –143 | .003 | 42 | .291 | 143 |
| 5.0 | .049 | –45 | 24.121 | –169 | .005 | 17 | .092 | 77 |
| 10.0 | .037 | –30 | 24.391 | –177 | .005 | 8 | .067 | 47 |
| 50.0 | .036 | –2 | 24.539 | 165 | .005 | –2 | .071 | 1 |
| 100.0 | .042 | –9 | 24.276 | 148 | .005 | –5 | .075 | –18 |
| 200.0 | .063 | –45 | 24.012 | 115 | .005 | –10 | .085 | –46 |
| 300.0 | .078 | –69 | 24.089 | 84 | .005 | –17 | .103 | –70 |
| 400.0 | .095 | –88 | 24.746 | 52 | .005 | –19 | .131 | –95 |
| 500.0 | .111 | –112 | 25.243 | 20 | .005 | –23 | .157 | –118 |
| 600.0 | .111 | –127 | 26.205 | –14 | .005 | –26 | .178 | –142 |
| 700.0 | .106 | –136 | 27.047 | –48 | .005 | –36 | .184 | –163 |
| 800.0 | .110 | –143 | 27.516 | –83 | .004 | –47 | .171 | 177 |
| 900.0 | .120 | –145 | 27.630 | –117 | .005 | –53 | .143 | 156 |
| 1000.0 | .155 | –151 | 27.505 | –152 | .004 | –67 | .114 | 142 |
| 1100.0 | .184 | –165 | 27.116 | 173 | .004 | –83 | .077 | 136 |
| 1200.0 | .209 | 178 | 26.724 | 138 | .004 | –99 | .043 | 140 |
| 1300.0 | .228 | 156 | 26.518 | 103 | .005 | –119 | .015 | 179 |
| 1400.0 | .196 | 128 | 26.678 | 66 | .006 | –133 | .052 | –95 |
| 1500.0 | .118 | 75 | 27.449 | 27 | .007 | –155 | .161 | –103 |
| 1600.0 | .143 | –43 | 27.561 | –18 | .009 | –177 | .339 | –129 |

### Linear S-Parameters

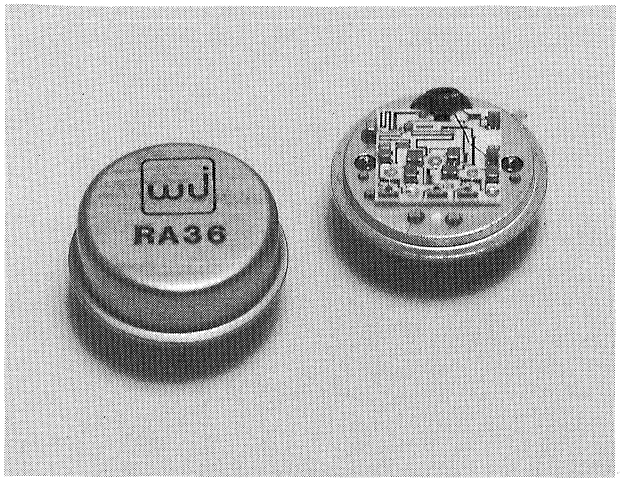
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .083 | –50 | 14.181 | –156 | .004 | 11 | .414 | –116 |
| 2.0 | .113 | –36 | 19.438 | –143 | .003 | 37 | .293 | 142 |
| 5.0 | .061 | –37 | 22.813 | –169 | .005 | 12 | .093 | 75 |
| 10.0 | .045 | –23 | 23.079 | –177 | .005 | 6 | .069 | 45 |
| 50.0 | .048 | –8 | 23.262 | 164 | .005 | 2 | .073 | 0 |
| 100.0 | .054 | –14 | 22.945 | 147 | .006 | –4 | .077 | –20 |
| 200.0 | .073 | –47 | 22.720 | 115 | .005 | –7 | .086 | –50 |
| 300.0 | .085 | –68 | 22.792 | 83 | .005 | –15 | .104 | –74 |
| 400.0 | .101 | –93 | 23.395 | 51 | .005 | –18 | .133 | –99 |
| 500.0 | .118 | –115 | 23.792 | 18 | .005 | –27 | .160 | –122 |
| 600.0 | .119 | –132 | 24.683 | –16 | .005 | –33 | .179 | –146 |
| 700.0 | .114 | –139 | 25.418 | –50 | .005 | –37 | .186 | –167 |
| 800.0 | .117 | –152 | 25.806 | –86 | .005 | –47 | .174 | 172 |
| 900.0 | .119 | –152 | 25.935 | –120 | .005 | –50 | .148 | 151 |
| 1000.0 | .141 | –161 | 25.808 | –156 | .005 | –67 | .116 | 133 |
| 1100.0 | .180 | –171 | 25.489 | 169 | .005 | –77 | .077 | 119 |
| 1200.0 | .199 | 171 | 25.221 | 134 | .005 | –98 | .035 | 104 |
| 1300.0 | .203 | 148 | 25.129 | 98 | .005 | –116 | .020 | –19 |
| 1400.0 | .175 | 114 | 25.378 | 60 | .006 | –135 | .085 | –71 |
| 1500.0 | .121 | 41 | 26.074 | 20 | .007 | –153 | .212 | –98 |
| 1600.0 | .226 | –59 | 25.240 | –27 | .010 | –180 | .399 | –130 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.292 W
Junction Temperature Rise Above Case $T_{jc}$ ... 13°C

# WJ-RA36/SMRA36

## 100 to 2000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN-THREE STAGES: 24.0 dB (TYP.)
- ◆ LOW VSWR: 1.4:1 (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +13.0 dBm (TYP.)
- ◆ WIDE BANDWIDTH: 50-2100 MHz (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 50-2100 MHz | 100-2000 MHz | 100-2000 MHz |
| Small Signal Gain (Min.) | 24.0 dB | 23.0 dB | 22.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.9 dB | ±1.0 dB |
| Noise Figure (Max.) | 5.5 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +13.0 dBm | +12.0 dBm | +11.5 dBm |
| VSWR (Max.) Input/Output | 1.4:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 76 mA | 81 mA | 85 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA36 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA36 is a standard WJ-RA36 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+40 dBm (Typ.)
Second Order Two Tone Intercept Point.....+34 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

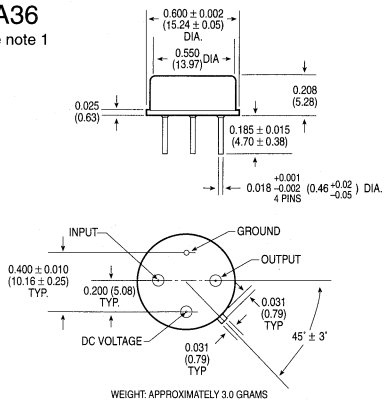
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125° C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+10 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 3.0 grams (0.11 oz.)

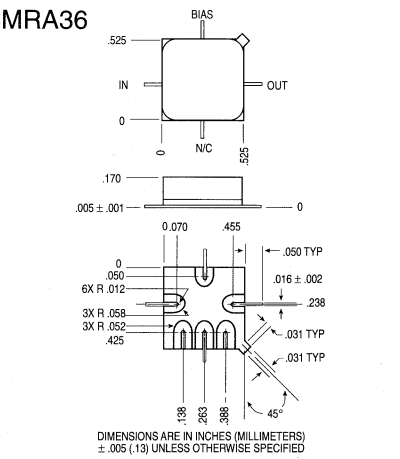
## Outline Drawings

RA36
See note 1



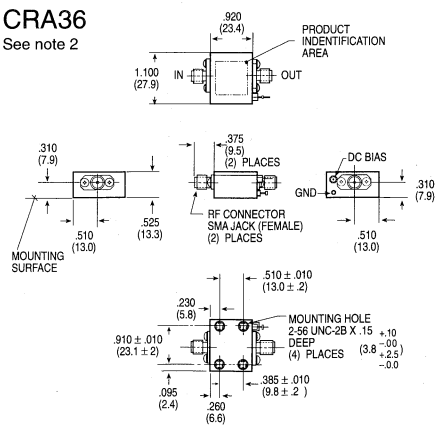

WEIGHT: APPROXIMATELY 3.0 GRAMS

SMRA36




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

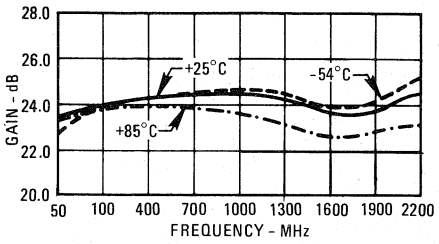
CRA36
See note 2



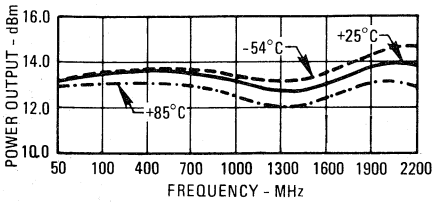

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Gain

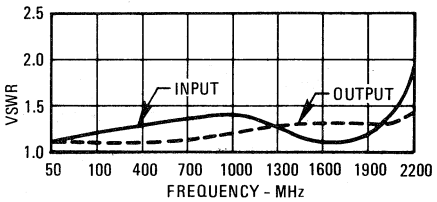



### Power Output*

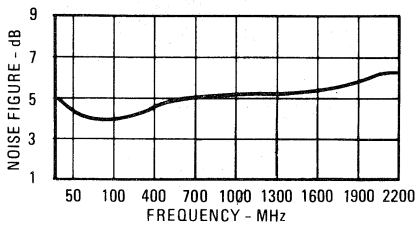



*at 1 dB Gain Compression

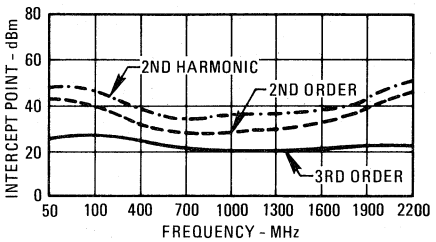
### VSWR




### Noise Figure




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.4 | 2.8 | 21.0 |
| 50.0 | 1.3 | 1.1 | 25.5 |
| 100.0 | 1.1 | 1.0 | 25.7 |
| 200.0 | 1.1 | 1.0 | 25.9 |
| 300.0 | 1.2 | 1.1 | 25.9 |
| 400.0 | 1.2 | 1.1 | 26.1 |
| 500.0 | 1.3 | 1.1 | 26.1 |
| 600.0 | 1.3 | 1.1 | 26.2 |
| 700.0 | 1.3 | 1.2 | 26.3 |
| 800.0 | 1.3 | 1.2 | 26.5 |
| 900.0 | 1.3 | 1.2 | 26.6 |
| 1000.0 | 1.3 | 1.2 | 26.7 |
| 1100.0 | 1.3 | 1.2 | 26.7 |
| 1200.0 | 1.3 | 1.2 | 26.7 |
| 1300.0 | 1.3 | 1.2 | 26.6 |
| 1400.0 | 1.4 | 1.3 | 26.5 |
| 1500.0 | 1.4 | 1.3 | 26.3 |
| 1600.0 | 1.3 | 1.3 | 26.1 |
| 1700.0 | 1.2 | 1.3 | 26.1 |
| 1800.0 | 1.1 | 1.3 | 25.9 |
| 1900.0 | 1.1 | 1.3 | 26.0 |
| 2000.0 | 1.3 | 1.3 | 26.1 |
| 2100.0 | 1.8 | 1.2 | 26.2 |
| 2200.0 | 2.5 | 1.2 | 26.0 |

### Linear S-Parameters

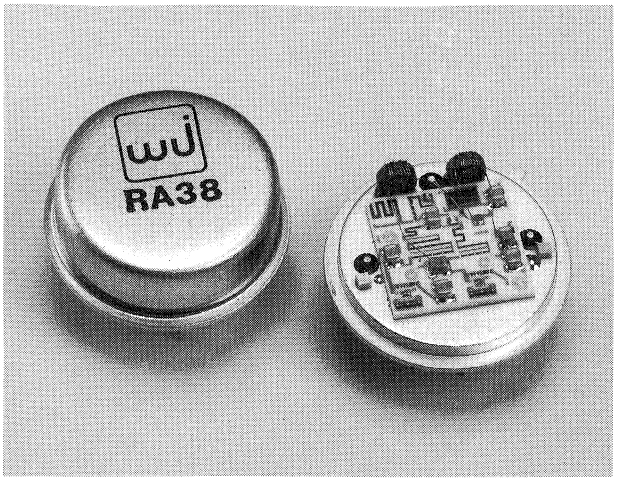
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .415 | –57 | 11.177 | –85 | .003 | 126 | .473 | –76 |
| 50.0 | .115 | –67 | 18.737 | –170 | .005 | 23 | .062 | –115 |
| 100.0 | .046 | –47 | 19.208 | 167 | .005 | 9 | .015 | –113 |
| 200.0 | .048 | 15 | 19.653 | 137 | .006 | –2 | .014 | –19 |
| 300.0 | .077 | 19 | 19.833 | 110 | .005 | –7 | .025 | –37 |
| 400.0 | .104 | 7 | 20.083 | 84 | .005 | –13 | .039 | –65 |
| 500.0 | .120 | –3 | 20.116 | 59 | .005 | –17 | .052 | –84 |
| 600.0 | .123 | –13 | 20.418 | 34 | .005 | –21 | .062 | –104 |
| 700.0 | .128 | –20 | 20.671 | 8 | .005 | –29 | .076 | –117 |
| 800.0 | .125 | –28 | 21.065 | –17 | .004 | –38 | .082 | –129 |
| 900.0 | .113 | –28 | 21.301 | –43 | .004 | –45 | .086 | –141 |
| 1000.0 | .117 | –34 | 21.559 | –70 | .004 | –38 | .094 | –154 |
| 1100.0 | .122 | –38 | 21.600 | –96 | .004 | –59 | .102 | –162 |
| 1200.0 | .139 | –40 | 21.564 | –123 | .003 | –64 | .107 | –171 |
| 1300.0 | .146 | –52 | 21.396 | –150 | .003 | –71 | .108 | 176 |
| 1400.0 | .155 | –64 | 21.079 | –177 | .003 | –77 | .113 | 163 |
| 1500.0 | .156 | –81 | 20.701 | 156 | .002 | –104 | .113 | 152 |
| 1600.0 | .125 | –94 | 20.272 | 129 | .002 | –116 | .111 | 139 |
| 1700.0 | .089 | –115 | 20.124 | 103 | .003 | –136 | .112 | 127 |
| 1800.0 | .043 | –148 | 19.800 | 76 | .003 | –150 | .113 | 117 |
| 1900.0 | .053 | 75 | 19.890 | 48 | .003 | –178 | .117 | 108 |
| 2000.0 | .144 | 35 | 20.147 | 19 | .004 | 174 | .118 | 98 |
| 2100.0 | .281 | 3 | 20.327 | –13 | .003 | 160 | .106 | 79 |
| 2200.0 | .421 | –24 | 20.056 | –48 | .004 | 140 | .073 | 43 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.288 W
Junction Temperature Rise Above Case $T_{jc}$ ... 13°C

# WJ-RA38/SMRA38

## 200 to 2000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN TWO STAGES: 16.0 dB (TYP.)
- ◆ LOW VSWR: < 1.8 (TYP.)
- ◆ HIGH OUTPUT LEVEL: +17.0 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 200-2000 MHz | 200-2000 MHz | 200-2000 MHz |
| Small Signal Gain (Min.) | 16.0 dB | 14.5 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | | | |
| 200-1750 MHz | 6.0 dB | 6.7 dB | 7.0 dB |
| 200-2000 MHz | 6.8 dB | 7.5 dB | 8.0 dB |
| Power Output at 1 dBCompression (Min.) | | | |
| 200-1800 MHz | +18.5 dBm | +17.5 dBm | +16.5 dBm |
| 1800-2000 MHz | +17.0 dBm | +16.0 dBm | +15.5 dBm |
| VSWR (Max.) Input/Output | <1.8:1 | 2.3:1 | 2.3:1 |
| DC Current at +15 Volts (Max.) | 127 mA | 132 mA | 133 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA38 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA38 is a standard WJ-RA38 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+39 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+25 dBm (Typ.)

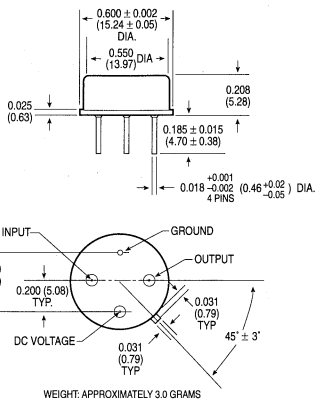
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

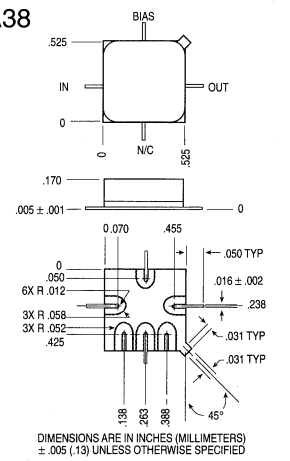
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

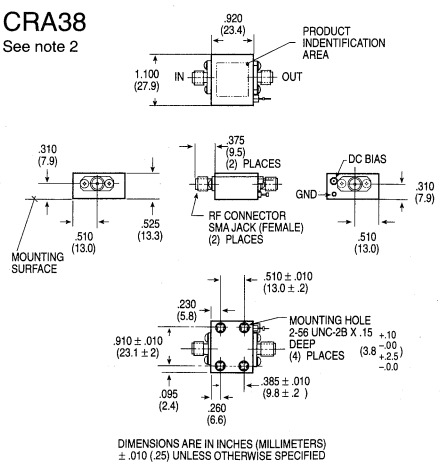
RA38
See note 1




SMRA38

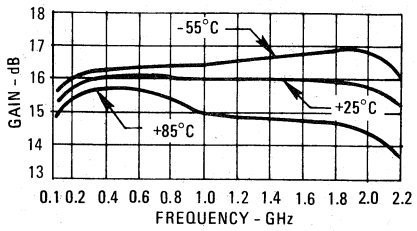



CRA38
See note 2

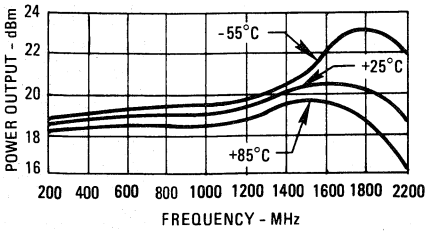


# Typical Performance at 25°C

### Gain

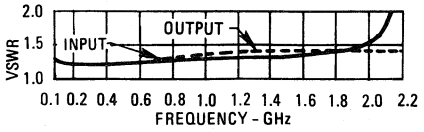



### Power Output*

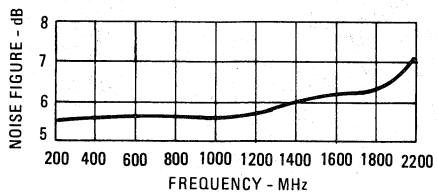



*at 1 dB Gain Compression

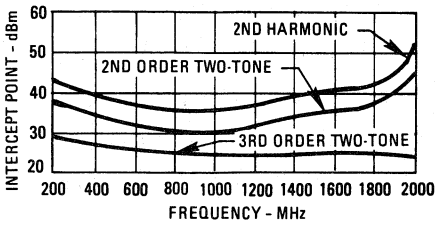
### VSWR




### Noise Figure




### Intercept Point




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 2.9 | 2.5 | 11.6 |
| 50.0 | 1.2 | 1.3 | 15.1 |
| 100.0 | 1.1 | 1.2 | 15.3 |
| 200.0 | 1.1 | 1.2 | 15.7 |
| 300.0 | 1.1 | 1.3 | 15.8 |
| 400.0 | 1.2 | 1.3 | 15.9 |
| 500.0 | 1.2 | 1.3 | 16.0 |
| 600.0 | 1.2 | 1.4 | 16.0 |
| 700.0 | 1.2 | 1.4 | 16.0 |
| 800.0 | 1.2 | 1.4 | 16.0 |
| 900.0 | 1.2 | 1.5 | 16.0 |
| 1000.0 | 1.2 | 1.4 | 15.9 |
| 1100.0 | 1.3 | 1.4 | 16.1 |
| 1200.0 | 1.3 | 1.4 | 16.1 |
| 1300.0 | 1.4 | 1.4 | 16.2 |
| 1400.0 | 1.4 | 1.3 | 16.2 |
| 1500.0 | 1.4 | 1.3 | 16.0 |
| 1600.0 | 1.5 | 1.3 | 15.7 |
| 1700.0 | 1.5 | 1.3 | 15.9 |
| 1800.0 | 1.5 | 1.4 | 15.9 |
| 1900.0 | 1.4 | 1.4 | 16.1 |
| 2000.0 | 1.5 | 1.5 | 16.1 |
| 2100.0 | 1.7 | 1.5 | 16.1 |
| 2200.0 | 2.3 | 1.4 | 15.7 |

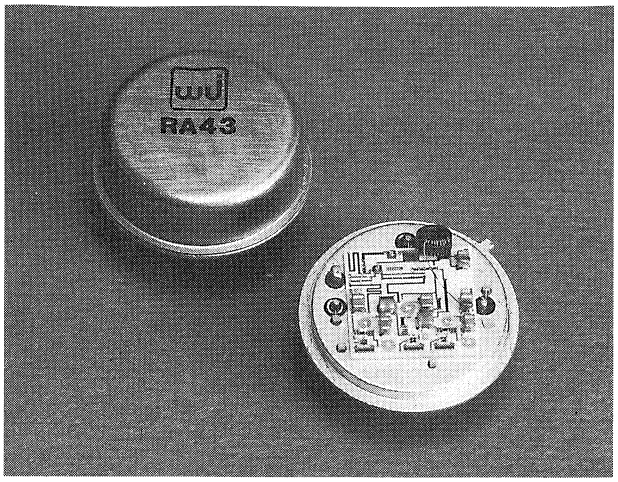
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .484 | –80 | 3.819 | 80 | .019 | 115 | .432 | –102 |
| 50.0 | .084 | –107 | 5.675 | 9 | .034 | 23 | .127 | –165 |
| 100.0 | .050 | –117 | 5.832 | –9 | .035 | 9 | .108 | 170 |
| 200.0 | .059 | –122 | 6.068 | –33 | .037 | –3 | .104 | 143 |
| 300.0 | .066 | –141 | 6.169 | –54 | .038 | –12 | .113 | 124 |
| 400.0 | .074 | –149 | 6.265 | –75 | .038 | –20 | .125 | 106 |
| 500.0 | .089 | –162 | 6.293 | –95 | .039 | –28 | .139 | 87 |
| 600.0 | .094 | –170 | 6.276 | –116 | .039 | –36 | .154 | 67 |
| 700.0 | .086 | –177 | 6.304 | –136 | .040 | –43 | .165 | 45 |
| 800.0 | .094 | 179 | 6.316 | –157 | .041 | –51 | .181 | 22 |
| 900.0 | .100 | 169 | 6.316 | –177 | .040 | –60 | .194 | –1 |
| 1000.0 | .111 | 172 | 6.239 | 163 | .040 | –68 | .182 | –24 |
| 1100.0 | .132 | 160 | 6.366 | 144 | .041 | –77 | .182 | –47 |
| 1200.0 | .141 | 151 | 6.390 | 123 | .041 | –85 | .175 | –71 |
| 1300.0 | .161 | 139 | 6.461 | 102 | .042 | –96 | .156 | –96 |
| 1400.0 | .164 | 128 | 6.445 | 80 | .042 | –104 | .133 | –125 |
| 1500.0 | .161 | 116 | 6.306 | 59 | .041 | –116 | .119 | –157 |
| 1600.0 | .194 | 103 | 6.082 | 39 | .040 | –123 | .118 | 161 |
| 1700.0 | .210 | 76 | 6.233 | 20 | .041 | –131 | .137 | 115 |
| 1800.0 | .194 | 49 | 6.253 | –2 | .043 | –140 | .160 | 77 |
| 1900.0 | .175 | 8 | 6.369 | –25 | .046 | –151 | .183 | 48 |
| 2000.0 | .186 | –42 | 6.382 | –48 | .049 | –162 | .191 | 23 |
| 2100.0 | .262 | –97 | 6.382 | –73 | .052 | –174 | .184 | –0 |
| 2200.0 | .388 | –140 | 6.084 | –101 | .053 | 171 | .176 | –20 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.708W
Junction Temperature Rise Above Case $T_{jc}$ ... 32°C

# WJ-RA43/SMRA43




## 1000 to 4000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA-WIDE BANDWIDTH: 0.8-4.0 GHz (TYP.)
- ◆ HIGH GAIN: 21.0 dB (TYP.)
- ◆ LOW NOISE: 4.5 dB (TYP.)
- ◆ MEDIUM OUTPUT POWER: +12.0 dBm (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0°C to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-4000 MHz | 1000-4000 MHz | 1000-4000 MHz |
| Small Signal Gain (Min.) | 21.0 dB | 19.5 dB | 18.0 dB |
| Gain Flatness (Max.) | ±0.7 dB | ±0.9 dB | ±1.2 dB |
| Noise Figure (Max.) | 4.5 dB | 5.3 dB | 5.8 dB |
| Power Output at 1 dB Compression (Min.) | +12.0 dBm | +10.5 dBm | +9.5 dBm |
| VSWR (Max.) Input/Output | 1.4:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +5 Volts | 115 mA | 140 mA | 155 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

Notes:
1. WJ-RA43 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA43 is a standard WJ-RA43 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+31 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

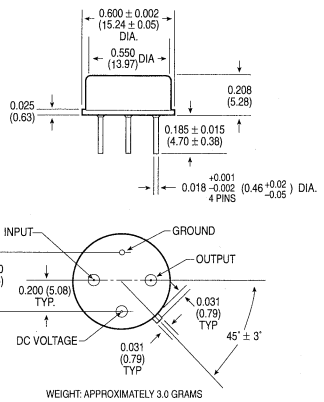
## Absolute Maximum Ratings

Storage Temperature .....-64°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

Weight approximately 3.0 grams (0.11 oz.)

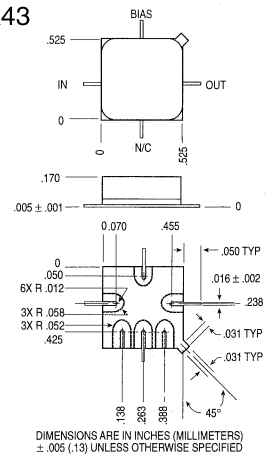
## Outline Drawings

RA43
See note 1



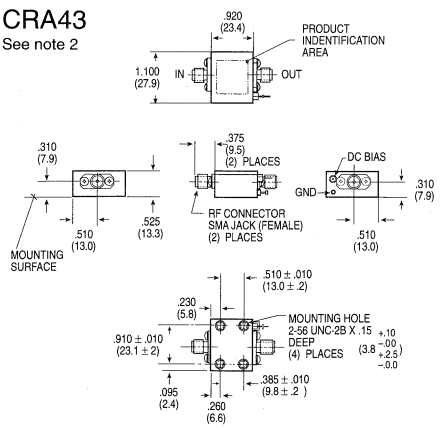

WEIGHT: APPROXIMATELY 3.0 GRAMS

SMRA43




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

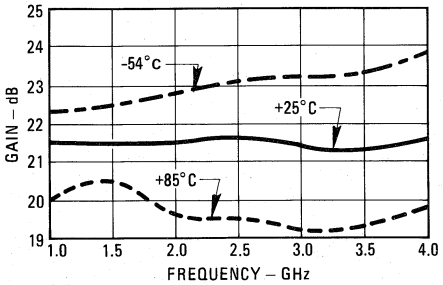
CRA43
See note 2



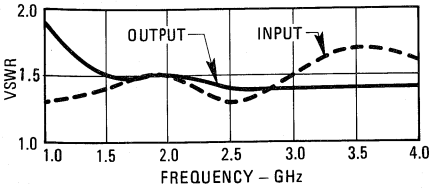

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

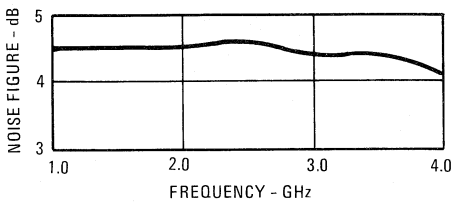
### Gain vs. Temperature



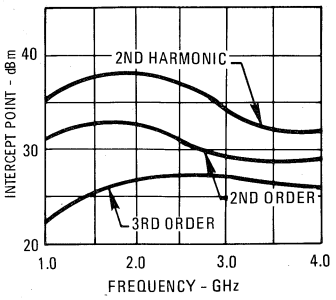

### VSWR



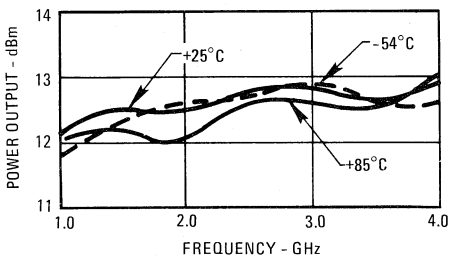

### Noise Figure




### Intercept Point




### Power Output* vs. Temperature




*at 1 dB Gain Compression

### Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.176 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# Typical Automatic Test Data

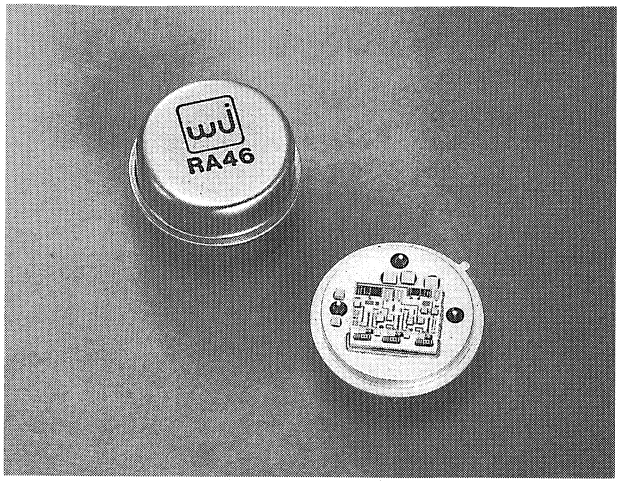
### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.2 | 1.7 | 23.7 |
| 900.0 | 1.1 | 1.6 | 23.6 |
| 1000.0 | 1.0 | 1.5 | 23.5 |
| 1100.0 | 1.1 | 1.4 | 23.5 |
| 1200.0 | 1.1 | 1.4 | 23.5 |
| 1300.0 | 1.1 | 1.3 | 23.5 |
| 1400.0 | 1.2 | 1.3 | 23.5 |
| 1500.0 | 1.2 | 1.2 | 23.6 |
| 1600.0 | 1.2 | 1.2 | 23.6 |
| 1700.0 | 1.1 | 1.1 | 23.6 |
| 1800.0 | 1.1 | 1.1 | 23.7 |
| 1900.0 | 1.1 | 1.1 | 23.7 |
| 2000.0 | 1.1 | 1.1 | 23.8 |
| 2100.0 | 1.1 | 1.1 | 23.9 |
| 2200.0 | 1.1 | 1.1 | 24.0 |
| 2300.0 | 1.2 | 1.1 | 24.1 |
| 2400.0 | 1.2 | 1.1 | 24.2 |
| 2500.0 | 1.2 | 1.1 | 24.3 |
| 2600.0 | 1.2 | 1.2 | 24.3 |
| 2700.0 | 1.2 | 1.2 | 24.4 |
| 2800.0 | 1.3 | 1.2 | 24.4 |
| 2900.0 | 1.3 | 1.2 | 24.4 |
| 3000.0 | 1.3 | 1.3 | 24.4 |
| 3100.0 | 1.4 | 1.3 | 24.4 |
| 3200.0 | 1.4 | 1.3 | 24.3 |
| 3300.0 | 1.4 | 1.3 | 24.3 |
| 3400.0 | 1.4 | 1.2 | 24.3 |
| 3500.0 | 1.4 | 1.2 | 24.3 |
| 3600.0 | 1.4 | 1.2 | 24.2 |
| 3700.0 | 1.4 | 1.2 | 24.2 |
| 3800.0 | 1.3 | 1.2 | 24.2 |
| 3900.0 | 1.3 | 1.1 | 24.1 |
| 4000.0 | 1.2 | 1.1 | 24.2 |
| 4100.0 | 1.2 | 1.1 | 24.0 |
| 4200.0 | 1.1 | 1.1 | 24.0 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .082 | 59 | 15.233 | 77 | .002 | –90 | .247 | 111 |
| 900.0 | .028 | 46 | 15.147 | 28 | .003 | –122 | .223 | 82 |
| 1000.0 | .019 | 125 | 15.000 | –16 | .003 | –144 | .197 | 57 |
| 1100.0 | .040 | 128 | 15.008 | –57 | .003 | –169 | .178 | 30 |
| 1200.0 | .055 | 108 | 15.023 | –97 | .003 | 152 | .154 | 6 |
| 1300.0 | .065 | 82 | 15.040 | –134 | .001 | 129 | .134 | –18 |
| 1400.0 | .070 | 66 | 15.041 | –171 | .003 | 155 | .112 | –42 |
| 1500.0 | .074 | 48 | 15.083 | 153 | .002 | 56 | .096 | –65 |
| 1600.0 | .070 | 24 | 15.117 | 117 | .003 | 62 | .081 | –86 |
| 1700.0 | .066 | 14 | 15.175 | 83 | .003 | 22 | .069 | –110 |
| 1800.0 | .068 | –7 | 15.233 | 48 | .003 | –1 | .055 | –134 |
| 1900.0 | .063 | –21 | 15.394 | 14 | .002 | –11 | .041 | –168 |
| 2000.0 | .055 | –47 | 15.492 | –19 | .003 | –39 | .030 | 155 |
| 2100.0 | .062 | –67 | 15.639 | –54 | .002 | –37 | .029 | 116 |
| 2200.0 | .067 | –85 | 15.867 | –87 | .001 | –44 | .029 | 70 |
| 2300.0 | .073 | –100 | 16.001 | –120 | .003 | –109 | .040 | 34 |
| 2400.0 | .082 | –121 | 16.172 | –154 | .001 | –137 | .053 | 5 |
| 2500.0 | .090 | –147 | 16.368 | 173 | .001 | –139 | .067 | –23 |
| 2600.0 | .105 | –164 | 16.408 | 139 | .002 | –162 | .080 | –53 |
| 2700.0 | .108 | 173 | 16.544 | 106 | .002 | –145 | .093 | –74 |
| 2800.0 | .117 | 150 | 16.537 | 73 | .002 | 176 | .097 | –93 |
| 2900.0 | .142 | 129 | 16.578 | 39 | .001 | 98 | .106 | –111 |
| 3000.0 | .145 | 104 | 16.562 | 6 | .000 | 176 | .115 | –131 |
| 3100.0 | .158 | 82 | 16.514 | –27 | .003 | 81 | .120 | –152 |
| 3200.0 | .157 | 61 | 16.471 | –60 | .001 | 108 | .118 | –175 |
| 3300.0 | .160 | 41 | 16.380 | –93 | .001 | 58 | .112 | 166 |
| 3400.0 | .168 | 23 | 16.409 | –126 | .002 | –10 | .103 | 148 |
| 3500.0 | .158 | 0 | 16.395 | –159 | .002 | 48 | .099 | 129 |
| 3600.0 | .150 | –19 | 16.264 | 168 | .002 | –28 | .094 | 109 |
| 3700.0 | .150 | –38 | 16.206 | 135 | .001 | –43 | .089 | 86 |
| 3800.0 | .138 | –62 | 16.169 | 102 | .001 | –71 | .078 | 58 |
| 3900.0 | .118 | –86 | 16.031 | 69 | .001 | –81 | .067 | 29 |
| 4000.0 | .104 | –112 | 16.133 | 37 | .000 | –107 | .058 | 2 |
| 4100.0 | .078 | –137 | 15.874 | 4 | .003 | –148 | .053 | –30 |
| 4200.0 | .059 | –180 | 15.888 | –29 | .001 | 143 | .053 | –57 |

# WJ-RA46/SMRA46




## 1000 to 4000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRA-WIDE BANDWIDTH: 0.8-4.2 GHZ (TYP.)
- ◆ HIGH GAIN: 25.5 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +19.0 dBm (TYP.)
- ◆ LOW NOISE: 4.5 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | .8-4.2 GHz | 1-4 GHz | 1-4 GHz |
| Small Signal Gain (Min.) | 25.5 dB | 24.0 dB | 23.5 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.2 dB | 5.7 dB |
| Power Output at 1 dB Compression (Min.) | +19.0 dBm | +17.0 dBm | +16.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.6:1 | 2.0:1 | 2.1:1 |
| Output | 1.5:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +12 Volts | 175 mA | 185 mA | 190 mA |

* Measured in a 50-ohm system at +12 Vdc Nominal.

Notes:

1. WJ-RA46 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA46 is a standard WJ-RA46 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+55 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

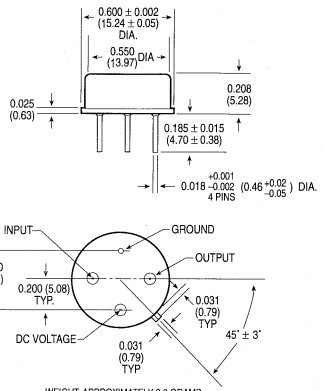
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+13 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt 3 µsec Max.)
"S" Series Burn-in Temperature (Case).....85°C

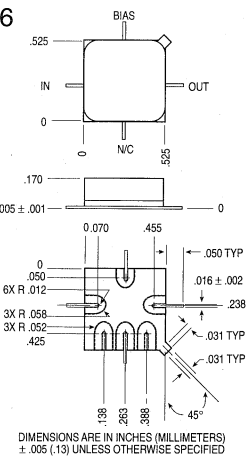
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

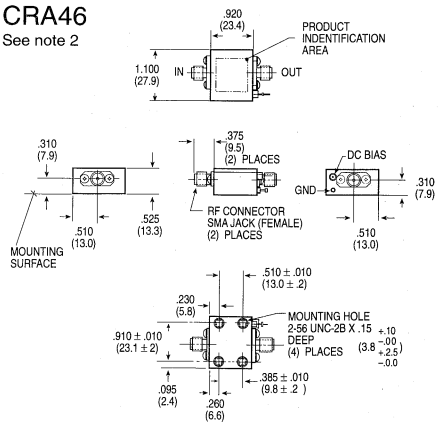
RA46
See note 1




SMRA46

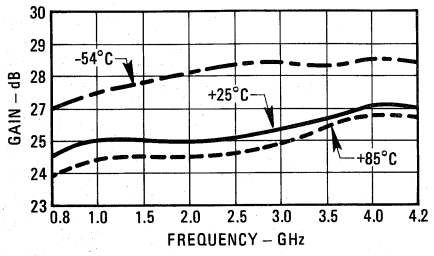



CRA46
See note 2

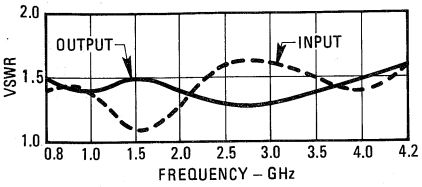


# Typical Performance at 25°C

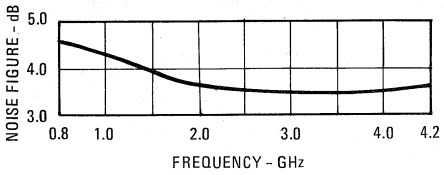
### Gain



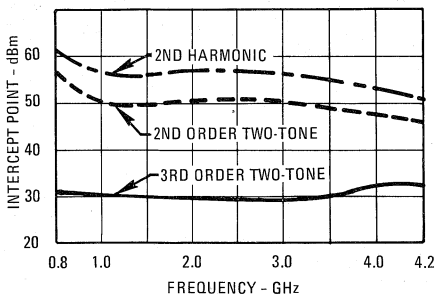

### VSWR



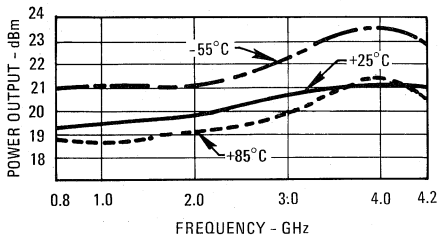

### Noise Figure




### Intercept Point




### Power Output*




*at 1 dB Gain Compression

## Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 108.9°C/W
Transistor Power Dissipation $P_d$ ..... 0.490 W
Junction Temperature Rise Above Case $T_{jc}$ ... 53°C

# Typical Automatic Test Data

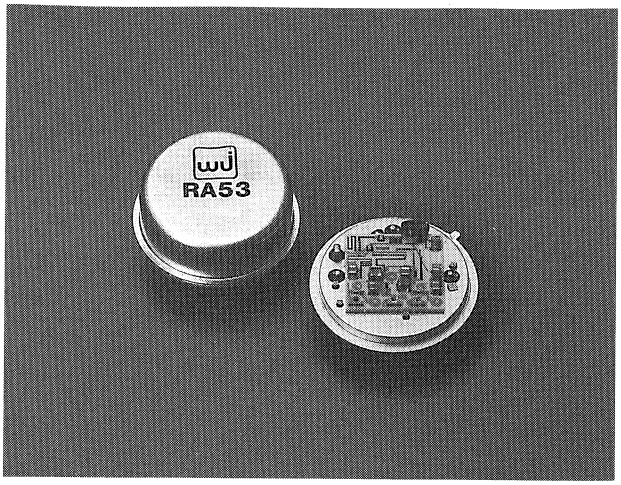
### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.5 | 1.3 | 25.5 |
| 900.0 | 1.4 | 1.2 | 25.9 |
| 1000.0 | 1.3 | 1.2 | 25.9 |
| 1100.0 | 1.2 | 1.2 | 26.0 |
| 1200.0 | 1.2 | 1.2 | 26.1 |
| 1300.0 | 1.2 | 1.2 | 26.1 |
| 1400.0 | 1.2 | 1.2 | 26.0 |
| 1500.0 | 1.2 | 1.2 | 26.0 |
| 1600.0 | 1.2 | 1.2 | 26.0 |
| 1700.0 | 1.2 | 1.2 | 26.1 |
| 1800.0 | 1.3 | 1.2 | 26.1 |
| 1900.0 | 1.3 | 1.2 | 26.2 |
| 2000.0 | 1.3 | 1.2 | 26.2 |
| 2100.0 | 1.3 | 1.2 | 26.2 |
| 2200.0 | 1.4 | 1.1 | 26.3 |
| 2300.0 | 1.4 | 1.1 | 26.4 |
| 2400.0 | 1.5 | 1.1 | 26.5 |
| 2500.0 | 1.5 | 1.0 | 26.5 |
| 2600.0 | 1.6 | 1.0 | 26.5 |
| 2700.0 | 1.6 | 1.0 | 26.5 |
| 2800.0 | 1.6 | 1.1 | 26.5 |
| 2900.0 | 1.7 | 1.1 | 26.4 |
| 3000.0 | 1.7 | 1.1 | 26.4 |
| 3100.0 | 1.7 | 1.1 | 26.3 |
| 3200.0 | 1.6 | 1.2 | 26.3 |
| 3300.0 | 1.6 | 1.2 | 26.2 |
| 3400.0 | 1.6 | 1.2 | 26.2 |
| 3500.0 | 1.5 | 1.2 | 26.2 |
| 3600.0 | 1.4 | 1.2 | 26.2 |
| 3700.0 | 1.4 | 1.2 | 26.2 |
| 3800.0 | 1.3 | 1.2 | 26.2 |
| 3900.0 | 1.2 | 1.2 | 26.1 |
| 4000.0 | 1.2 | 1.2 | 26.1 |
| 4100.0 | 1.3 | 1.2 | 25.9 |
| 4200.0 | 1.4 | 1.2 | 25.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .215 | –43 | 18.887 | 59 | .003 | –93 | .146 | –133 |
| 900.0 | .156 | –62 | 19.655 | 11 | .003 | –142 | .111 | –157 |
| 1000.0 | .115 | –72 | 19.828 | –33 | .004 | –146 | .096 | –174 |
| 1100.0 | .096 | –85 | 19.995 | –74 | .002 | 177 | .090 | 164 |
| 1200.0 | .088 | –99 | 20.086 | –113 | .003 | 162 | .089 | 142 |
| 1300.0 | .087 | –107 | 20.116 | –150 | .003 | 124 | .092 | 118 |
| 1400.0 | .090 | –131 | 20.066 | 173 | .003 | 82 | .100 | 93 |
| 1500.0 | .094 | –161 | 20.064 | 138 | .003 | 77 | .105 | 65 |
| 1600.0 | .094 | 175 | 20.062 | 103 | .004 | 18 | .104 | 36 |
| 1700.0 | .105 | 143 | 20.117 | 68 | .003 | 11 | .101 | 12 |
| 1800.0 | .112 | 113 | 20.186 | 34 | .001 | –1 | .101 | –14 |
| 1900.0 | .125 | 85 | 20.339 | 0 | .002 | –30 | .094 | –36 |
| 2000.0 | .130 | 59 | 20.424 | –33 | .002 | –22 | .083 | –58 |
| 2100.0 | .143 | 28 | 20.528 | –67 | .002 | –56 | .075 | –87 |
| 2200.0 | .154 | 2 | 20.769 | –101 | .003 | –76 | .065 | –110 |
| 2300.0 | .176 | –28 | 20.855 | –134 | .003 | –109 | .049 | –134 |
| 2400.0 | .192 | –53 | 21.014 | –167 | .003 | –112 | .030 | –150 |
| 2500.0 | .203 | –82 | 21.220 | 159 | .002 | 175 | .011 | –162 |
| 2600.0 | .219 | –106 | 21.197 | 125 | .003 | –152 | .013 | –96 |
| 2700.0 | .236 | –132 | 21.235 | 92 | .003 | –139 | .022 | –73 |
| 2800.0 | .243 | –155 | 21.113 | 58 | .001 | 158 | .031 | –73 |
| 2900.0 | .245 | 178 | 20.973 | 25 | .001 | 175 | .043 | –89 |
| 3000.0 | .246 | 158 | 20.889 | –9 | .002 | 117 | .062 | –103 |
| 3100.0 | .250 | 133 | 20.692 | –42 | .002 | 82 | .069 | –121 |
| 3200.0 | .240 | 114 | 20.664 | –75 | .001 | 89 | .071 | –138 |
| 3300.0 | .238 | 93 | 20.469 | –108 | .001 | 145 | .070 | –152 |
| 3400.0 | .229 | 72 | 20.429 | –142 | .002 | 41 | .078 | –164 |
| 3500.0 | .207 | 54 | 20.444 | –175 | .000 | –87 | .082 | –179 |
| 3600.0 | .181 | 37 | 20.318 | 151 | .002 | –67 | .091 | 164 |
| 3700.0 | .156 | 21 | 20.335 | 118 | .001 | –42 | .092 | 146 |
| 3800.0 | .121 | 10 | 20.339 | 84 | .001 | 135 | .086 | 125 |
| 3900.0 | .087 | 12 | 20.161 | 50 | .002 | –64 | .084 | 107 |
| 4000.0 | .080 | 30 | 20.151 | 15 | .001 | –141 | .080 | 87 |
| 4100.0 | .115 | 45 | 19.755 | –20 | .002 | 162 | .075 | 65 |
| 4200.0 | .176 | 43 | 19.522 | –55 | .001 | –94 | .071 | 40 |

# WJ-RA53/SMRA53




## 1000 to 5000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- AVAILABLE IN SURFACE MOUNT
- ULTRA-WIDE BANDWIDTH: 0.8-5.0 GHz (TYP.)
- HIGH GAIN: 21.0 dB (TYP.)
- LOW NOISE: 4.5 dB (TYP.)
- MEDIUM OUTPUT POWER: +11.5 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-5000 MHz | 1000-5000 MHz | 1000-5000 MHz |
| Small Signal Gain (Min.) | 21.0 dB | 19.5 dB | 18.0 dB |
| Gain Flatness (Max.) | ±0.7 dB | ±0.9 dB | ±1.2 dB |
| Noise Figure (Max.) | 4.5 dB | 5.3 dB | 5.8 dB |
| Power Output at 1 dB Compression (Min.) | +11.5 dBm | +10.5 dBm | +9.5 dBm |
| VSWR (Max.) Input/Output | 1.7:1 | 2.1:1 | 2.3:1 |
| DC Current (Max.) at +5 Volts | 115 mA | 140 mA | 150 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

Notes:
1. WJ-RA53 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA53 is a standard WJ-RA53 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+35 dBm (Typ.)
Second Order Two Tone Intercept Point.....+31 dBm (Typ.)
Third Order Two Tone Intercept Point.....+22 dBm (Typ.)

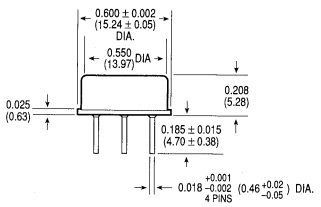
## Absolute Maximum Ratings

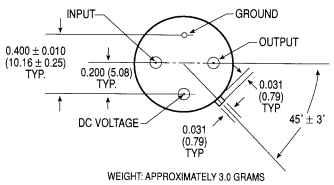
Storage Temperature .....-64°C to +125°C
Maximum Case Temperature .....85°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term Input Power (1 Minute Max.) .....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....85°C

Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

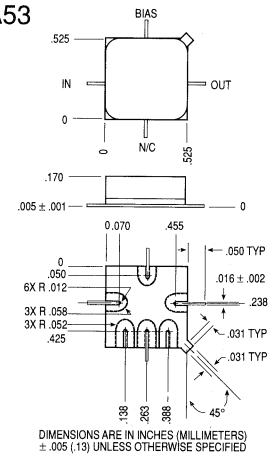
RA53
See note 1



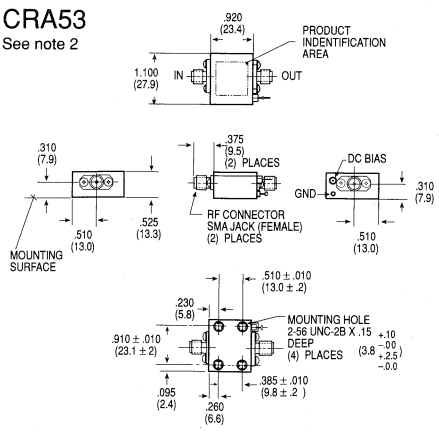

WEIGHT: APPROXIMATELY 3.0 GRAMS

SMRA53




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

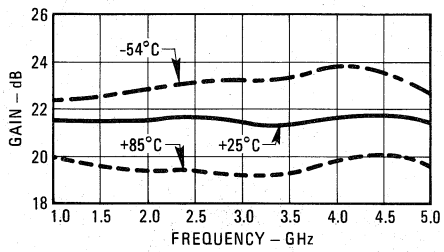
CRA53
See note 2



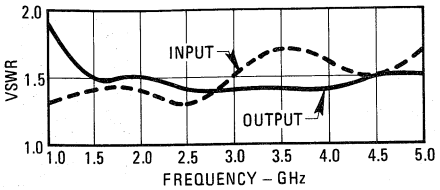

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

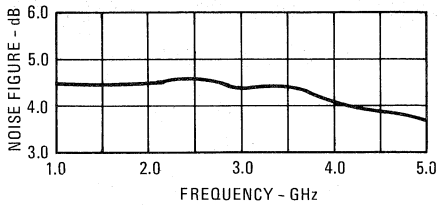
### Gain



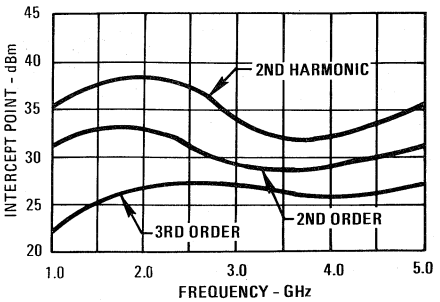

### VSWR



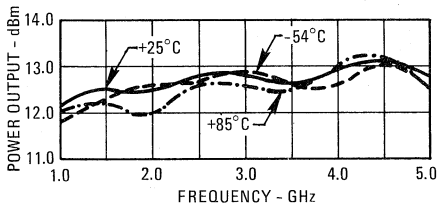

### Noise Figure




### Intercept Point




### Power Output*




*at 1 dB Gain Compression

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jC}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.176 W
Junction Temperature Rise Above Case $T_{jC}$ ... 17°C

# Typical Automatic Test Data

### $V_{CC}$ = +5 Vdc

### $V_{CC}$ = 5.0 V

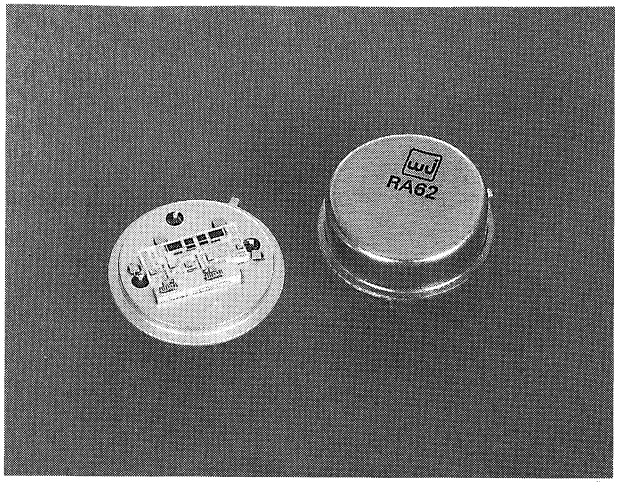
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 600.0 | 1.7 | 1.7 | 24.1 |
| 800.0 | 1.2 | 1.7 | 24.1 |
| 1000.0 | 1.0 | 1.5 | 24.1 |
| 1200.0 | 1.1 | 1.4 | 24.2 |
| 1400.0 | 1.1 | 1.3 | 24.3 |
| 1600.0 | 1.2 | 1.2 | 24.4 |
| 1800.0 | 1.2 | 1.1 | 24.5 |
| 2000.0 | 1.2 | 1.1 | 24.7 |
| 2200.0 | 1.3 | 1.1 | 24.9 |
| 2400.0 | 1.3 | 1.2 | 25.1 |
| 2600.0 | 1.4 | 1.2 | 25.1 |
| 2800.0 | 1.4 | 1.3 | 25.1 |
| 3000.0 | 1.4 | 1.3 | 25.0 |
| 3200.0 | 1.4 | 1.3 | 24.8 |
| 3400.0 | 1.4 | 1.2 | 24.8 |
| 3600.0 | 1.4 | 1.2 | 24.7 |
| 3800.0 | 1.3 | 1.1 | 24.6 |
| 4000.0 | 1.2 | 1.1 | 24.5 |
| 4200.0 | 1.1 | 1.1 | 24.4 |
| 4400.0 | 1.1 | 1.1 | 24.2 |
| 4600.0 | 1.2 | 1.1 | 24.2 |
| 4800.0 | 1.4 | 1.1 | 24.2 |
| 5000.0 | 1.5 | 1.2 | 24.3 |
| 5200.0 | 1.7 | 1.3 | 24.5 |
| 5400.0 | 1.9 | 1.4 | 24.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 600.0 | .257 | 104 | 16.109 | –169 | .001 | 18 | .254 | 161 |
| 800.0 | .098 | 35 | 16.032 | 74 | .002 | –72 | .255 | 109 |
| 1000.0 | .024 | –82 | 16.000 | –19 | .001 | –110 | .210 | 51 |
| 1200.0 | .050 | 159 | 16.248 | –101 | .004 | 161 | .166 | –4 |
| 1400.0 | .069 | 111 | 16.382 | –176 | .001 | 126 | .120 | –58 |
| 1600.0 | .088 | 67 | 16.631 | 111 | .002 | 114 | .085 | –108 |
| 1800.0 | .092 | 32 | 16.861 | 41 | .003 | 49 | .059 | –168 |
| 2000.0 | .102 | –9 | 17.198 | –28 | .001 | –29 | .048 | 108 |
| 2200.0 | .113 | –54 | 17.616 | –97 | .001 | –48 | .055 | 39 |
| 2400.0 | .137 | –95 | 17.896 | –165 | .003 | –84 | .081 | –18 |
| 2600.0 | .157 | –142 | 18.016 | 126 | .001 | –82 | .108 | –70 |
| 2800.0 | .168 | 173 | 17.934 | 59 | .003 | –175 | .119 | –114 |
| 3000.0 | .181 | 129 | 17.742 | –9 | .002 | –173 | .125 | –154 |
| 3200.0 | .181 | 87 | 17.468 | –75 | .002 | 71 | .121 | 163 |
| 3400.0 | .179 | 50 | 17.293 | –142 | .003 | 21 | .094 | 123 |
| 3600.0 | .166 | 14 | 17.088 | 152 | .002 | –39 | .070 | 90 |
| 3800.0 | .139 | –20 | 16.984 | 86 | .001 | –59 | .056 | 47 |
| 4000.0 | .103 | –50 | 16.837 | 19 | .001 | –147 | .036 | 11 |
| 4200.0 | .065 | –56 | 16.601 | –47 | .002 | 137 | .033 | –18 |
| 4400.0 | .060 | –38 | 16.308 | –114 | .000 | 125 | .041 | –71 |
| 4600.0 | .096 | –39 | 16.191 | 179 | .002 | 59 | .046 | –118 |
| 4800.0 | .154 | –60 | 16.209 | 111 | .002 | –2 | .069 | –151 |
| 5000.0 | .194 | –91 | 16.485 | 43 | .003 | –14 | .100 | 160 |
| 5200.0 | .250 | –121 | 16.843 | –28 | .002 | –103 | .127 | 112 |
| 5400.0 | .303 | –155 | 17.231 | –102 | .003 | –127 | .171 | 59 |

# WJ-RA62/SMRA62

## 2000 to 6000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRAWIDE BANDWIDTH: 1.5-6.2 GHz (TYP.)
- ◆ MEDIUM GAIN: 16.0 dB (TYP.)
- ◆ MEDIUM OUTPUT POWER: +13.0 dBm (TYP.)
- ◆ LOW NOISE FIGURE: 4.0 dB (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1.5-6.2 GHz | 2-6 GHz | 2-6 GHz |
| Small Signal Gain (Min.) | 16.0 dB | 14.0 dB | 13.5 dB |
| Gain Flatness (Max.) | ±0.4 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.0 dB | 5.0 dB | 5.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +13.0 dBm | +12.0 dBm | +11.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.5:1 | 2.0:1 | 2.0:1 |
| Output | 1.3:1 | 2.0:1 | 2.0:1 |
| DC Current (Max.) at +5 Volts | 65 mA | 72 mA | 74 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-RA62 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA62 is a standard WJ-RA62 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+45 dBm (Typ.)
Second Order Two Tone Intercept Point.....+40 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28 dBm (Typ.)

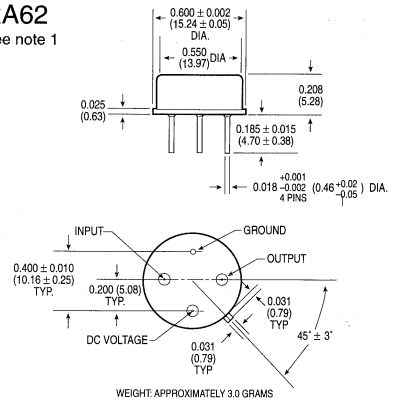
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power.....+7 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

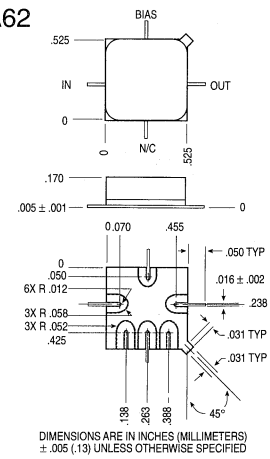
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

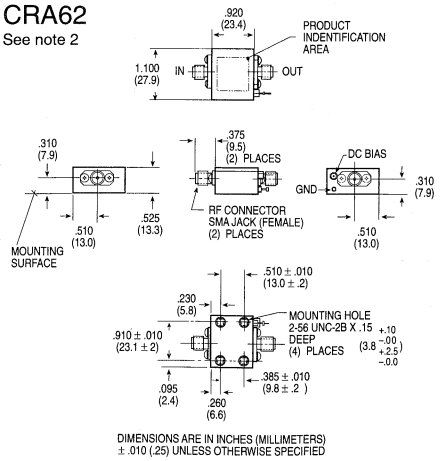
RA62
See note 1




SMRA62

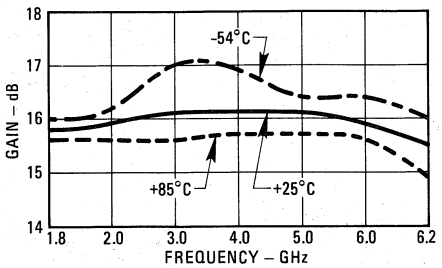



CRA62
See note 2

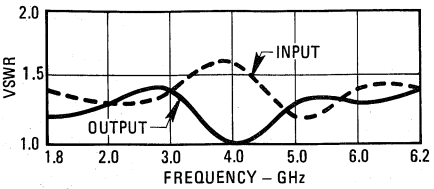


# Typical Performance at 25°C

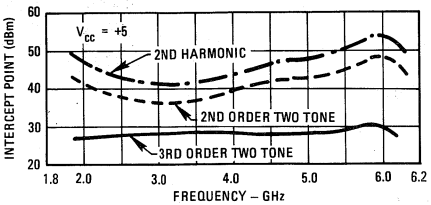
### Gain



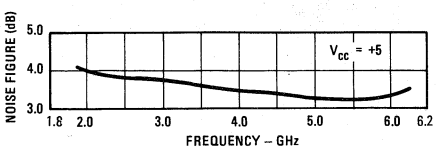

### VSWR



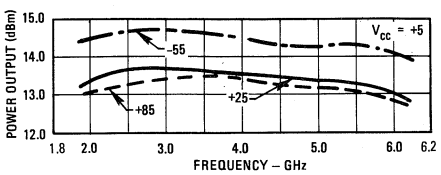

### Intercept Point




### Noise Figure




### Power Output*




*at 1 dB Gain Compression

## Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 92.2°C/W
Transistor Power Dissipation $P_d$ ..... 0.171 W
Junction Temperature Rise Above Case $T_{jc}$ ... 16°C

# Typical Automatic Test Data

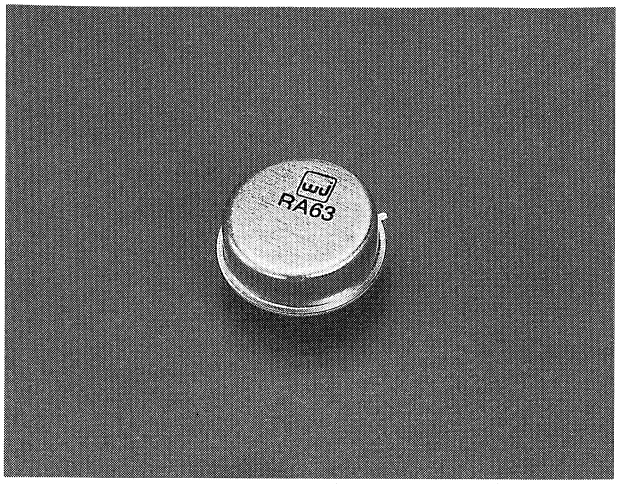
### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 600.0 | 3.1 | 1.5 | 14.6 |
| 800.0 | 2.5 | 1.5 | 15.0 |
| 1000.0 | 2.1 | 1.4 | 15.4 |
| 1200.0 | 1.8 | 1.4 | 15.8 |
| 1400.0 | 1.6 | 1.4 | 16.0 |
| 1600.0 | 1.4 | 1.4 | 16.2 |
| 1800.0 | 1.4 | 1.5 | 16.2 |
| 2000.0 | 1.3 | 1.6 | 16.2 |
| 2200.0 | 1.3 | 1.6 | 16.3 |
| 2400.0 | 1.4 | 1.7 | 16.3 |
| 2600.0 | 1.4 | 1.8 | 16.3 |
| 2800.0 | 1.4 | 1.7 | 16.3 |
| 3000.0 | 1.4 | 1.7 | 16.3 |
| 3200.0 | 1.5 | 1.6 | 16.3 |
| 3400.0 | 1.6 | 1.5 | 16.3 |
| 3600.0 | 1.7 | 1.4 | 16.4 |
| 3800.0 | 1.7 | 1.3 | 16.5 |
| 4000.0 | 1.7 | 1.3 | 16.7 |
| 4200.0 | 1.6 | 1.2 | 16.7 |
| 4400.0 | 1.6 | 1.2 | 16.7 |
| 4600.0 | 1.5 | 1.2 | 16.6 |
| 4800.0 | 1.4 | 1.1 | 16.6 |
| 5000.0 | 1.3 | 1.1 | 16.5 |
| 5200.0 | 1.3 | 1.1 | 16.4 |
| 5400.0 | 1.2 | 1.1 | 16.2 |
| 5600.0 | 1.1 | 1.2 | 16.0 |
| 5800.0 | 1.1 | 1.2 | 15.9 |
| 6000.0 | 1.1 | 1.3 | 15.9 |
| 6200.0 | 1.2 | 1.3 | 16.2 |
| 6400.0 | 1.7 | 1.3 | 16.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 600.0 | .514 | 31 | 5.397 | –54 | .021 | –16 | .213 | 56 |
| 800.0 | .434 | –20 | 5.594 | –133 | .021 | –89 | .206 | –14 |
| 1000.0 | .356 | –72 | 5.894 | 157 | .022 | –153 | .176 | –64 |
| 1200.0 | .279 | –126 | 6.172 | 92 | .023 | 148 | .163 | –104 |
| 1400.0 | .225 | –180 | 6.331 | 30 | .021 | 97 | .169 | –147 |
| 1600.0 | .184 | 126 | 6.420 | –31 | .022 | 47 | .179 | 166 |
| 1800.0 | .160 | 71 | 6.453 | –90 | .021 | –6 | .197 | 117 |
| 2000.0 | .146 | 18 | 6.484 | –148 | .020 | –57 | .224 | 66 |
| 2200.0 | .138 | –38 | 6.532 | 154 | .020 | –100 | .238 | 17 |
| 2400.0 | .152 | –86 | 6.555 | 97 | .020 | –149 | .263 | –30 |
| 2600.0 | .160 | –133 | 6.539 | 40 | .019 | 157 | .280 | –79 |
| 2800.0 | .163 | –173 | 6.508 | –17 | .018 | 115 | .273 | –125 |
| 3000.0 | .173 | 147 | 6.499 | –73 | .020 | 70 | .257 | –168 |
| 3200.0 | .193 | 112 | 6.512 | –129 | .021 | 23 | .235 | 149 |
| 3400.0 | .235 | 79 | 6.560 | 174 | .019 | –22 | .198 | 105 |
| 3600.0 | .252 | 43 | 6.621 | 117 | .021 | –72 | .167 | 62 |
| 3800.0 | .267 | 6 | 6.700 | 61 | .020 | –119 | .145 | 12 |
| 4000.0 | .260 | –27 | 6.801 | 4 | .021 | –165 | .121 | –43 |
| 4200.0 | .242 | –57 | 6.845 | –53 | .020 | 147 | .102 | –95 |
| 4400.0 | .224 | –87 | 6.809 | –112 | .021 | 98 | .097 | –149 |
| 4600.0 | .195 | –114 | 6.784 | –170 | .022 | 52 | .081 | 156 |
| 4800.0 | .166 | –142 | 6.752 | 132 | .021 | 5 | .052 | 117 |
| 5000.0 | .135 | –170 | 6.715 | 73 | .023 | –38 | .044 | 102 |
| 5200.0 | .113 | 160 | 6.585 | 14 | .024 | –90 | .045 | 75 |
| 5400.0 | .091 | 127 | 6.461 | –46 | .023 | –139 | .063 | 47 |
| 5600.0 | .064 | 87 | 6.296 | –105 | .026 | 176 | .091 | –9 |
| 5800.0 | .056 | 23 | 6.241 | –165 | .028 | 118 | .106 | –80 |
| 6000.0 | .038 | –78 | 6.251 | 134 | .030 | 65 | .113 | –153 |
| 6200.0 | .099 | –141 | 6.442 | 69 | .031 | 8 | .124 | 136 |
| 6400.0 | .250 | 162 | 6.497 | –2 | .030 | –57 | .132 | 42 |

# WJ-RA63/SMRA63




## 2000 to 6000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRAWIDE BANDWIDTH: 1.8-6.2 GHz (TYP.)
- ◆ HIGH GAIN: 18.5 dB (TYP.)
- ◆ MEDIUM OUTPUT POWER: +13.0 dBm (TYP.)
- ◆ LOW POWER SUPPLY VOLTAGE: +5 VDC

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1.8-6.2 GHz | 2-6 GHz | 2-6 GHz |
| Small Signal Gain (Min.) | 18.5 dB | 16.5 dB | 15.5 dB |
| Gain Flatness (Min.) | ±0.5 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | 5.5 dB | 7.0 dB | 7.5 dB |
| Power Output at 1 dB Compression (Min.) | +13.0 dBm | +10.0 dBm | +9.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.2:1 | 2.3:1 |
| Output | 1.7:1 | 2.2:1 | 2.3:1 |
| DC Current (Max.) at +5 Volts | 120 mA | 135 mA | 140 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.
Notes:
1. WJ-RA63 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA63 is a standard WJ-RA63 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+38 dBm (Typ.)
Second Order Two Tone Intercept Point.....+30 dBm (Typ.)
Third Order Two Tone Intercept Point.....+25 dBm (Typ.)

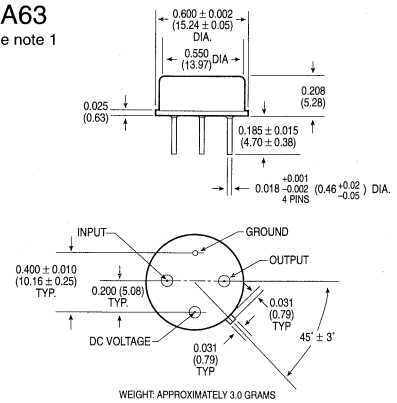
## Absolute Maximum Ratings

Storage Temperature .....-64°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

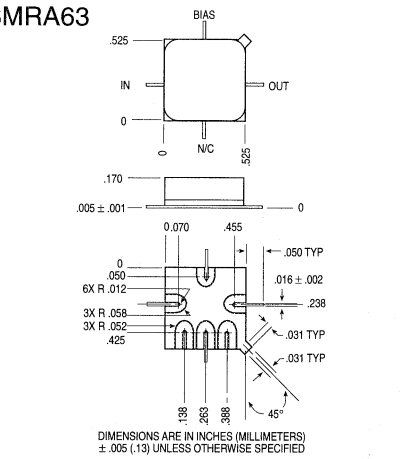
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

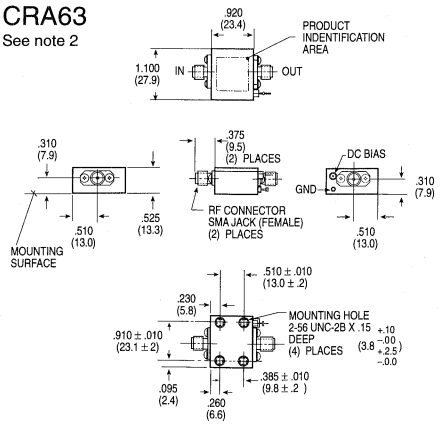
RA63
See note 1




SMRA63

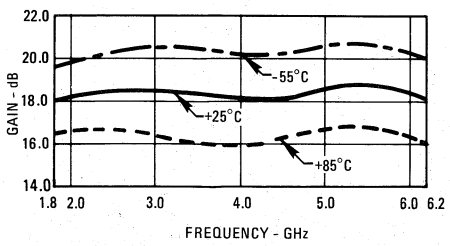



CRA63
See note 2

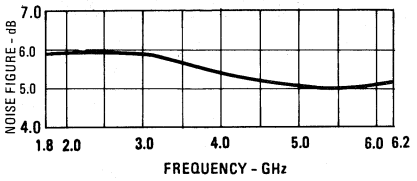


# Typical Automatic Test Data

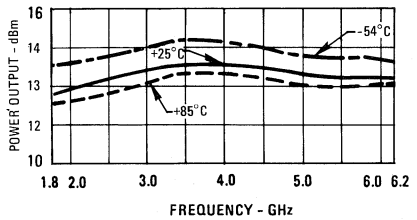
## Gain




## Noise Figure

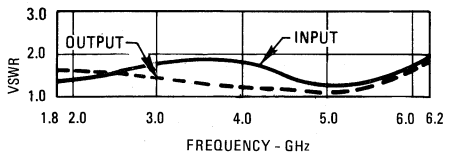



## Power Output*

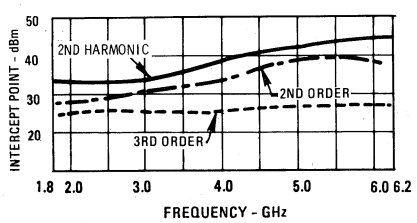



*at 1 dB Gain Compression

## VSWR




## Intercept Point




# Typical Performance at 25°C

## $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1000.0 | 2.1 | 1.7 | 18.8 |
| 1200.0 | 1.9 | 1.7 | 19.6 |
| 1400.0 | 1.7 | 1.7 | 20.1 |
| 1600.0 | 1.6 | 1.7 | 20.4 |
| 1800.0 | 1.4 | 1.6 | 20.7 |
| 2000.0 | 1.4 | 1.6 | 20.9 |
| 2200.0 | 1.4 | 1.6 | 21.1 |
| 2400.0 | 1.4 | 1.5 | 21.2 |
| 2600.0 | 1.4 | 1.4 | 21.2 |
| 2800.0 | 1.5 | 1.3 | 21.2 |
| 3000.0 | 1.5 | 1.3 | 21.1 |
| 3200.0 | 1.6 | 1.2 | 21.0 |
| 3400.0 | 1.6 | 1.2 | 20.9 |
| 3600.0 | 1.6 | 1.3 | 20.7 |
| 3800.0 | 1.5 | 1.3 | 20.7 |
| 4000.0 | 1.4 | 1.3 | 20.7 |
| 4200.0 | 1.4 | 1.3 | 20.7 |
| 4400.0 | 1.3 | 1.2 | 20.7 |
| 4600.0 | 1.4 | 1.1 | 20.7 |
| 4800.0 | 1.5 | 1.1 | 20.7 |
| 5000.0 | 1.7 | 1.1 | 20.7 |
| 5200.0 | 1.8 | 1.1 | 20.6 |
| 5400.0 | 1.9 | 1.1 | 20.4 |
| 5600.0 | 2.0 | 1.2 | 20.2 |
| 5800.0 | 2.1 | 1.3 | 19.9 |
| 6000.0 | 2.2 | 1.4 | 19.4 |
| 6200.0 | 2.3 | 1.5 | 18.9 |
| 6400.0 | 2.5 | 1.5 | 18.3 |

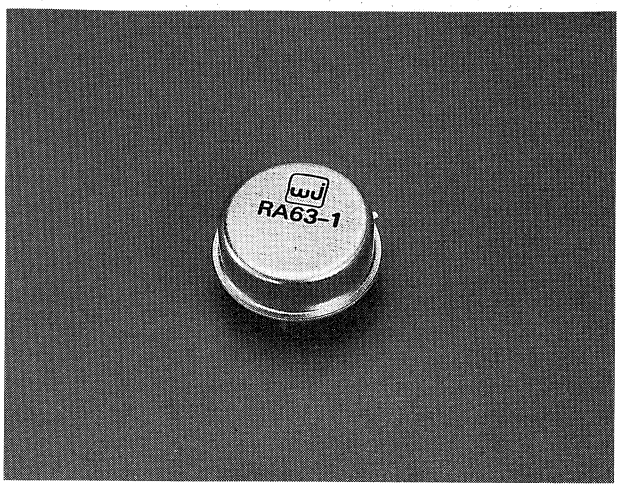
## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1000.0 | .360 | 127 | 8.677 | –2 | .005 | –178 | .265 | –153 |
| 1200.0 | .315 | 88 | 9.516 | –78 | .004 | 126 | .258 | 151 |
| 1400.0 | .262 | 50 | 10.068 | –149 | .004 | 46 | .256 | 97 |
| 1600.0 | .220 | 12 | 10.496 | 142 | .002 | 9 | .250 | 44 |
| 1800.0 | .182 | –21 | 10.804 | 76 | .004 | –49 | .244 | –4 |
| 2000.0 | .155 | –54 | 11.087 | 11 | .004 | –90 | .235 | –50 |
| 2200.0 | .153 | –88 | 11.306 | –53 | .002 | –115 | .221 | –97 |
| 2400.0 | .164 | –120 | 11.444 | –116 | .002 | 150 | .196 | –142 |
| 2600.0 | .179 | –160 | 11.488 | –179 | .001 | 126 | .173 | 176 |
| 2800.0 | .193 | 156 | 11.436 | 118 | .001 | –8 | .145 | 126 |
| 3000.0 | .209 | 112 | 11.312 | 56 | .001 | –21 | .114 | 70 |
| 3200.0 | .219 | 67 | 11.194 | –6 | .000 | –114 | .097 | 12 |
| 3400.0 | .232 | 26 | 11.030 | –68 | .001 | –75 | .106 | –51 |
| 3600.0 | .221 | –17 | 10.882 | –128 | .002 | –169 | .113 | –110 |
| 3800.0 | .209 | –61 | 10.832 | 171 | .002 | –180 | .115 | –158 |
| 4000.0 | .181 | –111 | 10.841 | 111 | .003 | 101 | .121 | 158 |
| 4200.0 | .150 | –168 | 10.818 | 50 | .002 | –42 | .113 | 106 |
| 4400.0 | .139 | 130 | 10.798 | –11 | .002 | –26 | .086 | 62 |
| 4600.0 | .159 | 68 | 10.801 | –72 | .001 | –159 | .066 | 15 |
| 4800.0 | .211 | 15 | 10.817 | –134 | .000 | 155 | .046 | –46 |
| 5000.0 | .247 | –27 | 10.809 | 164 | .001 | 117 | .026 | –161 |
| 5200.0 | .279 | –68 | 10.675 | 101 | .002 | 105 | .034 | 97 |
| 5400.0 | .307 | –105 | 10.502 | 37 | .002 | 74 | .059 | 35 |
| 5600.0 | .324 | –145 | 10.227 | –26 | .002 | –8 | .094 | –27 |
| 5800.0 | .348 | 175 | 9.872 | –91 | .001 | –36 | .127 | –91 |
| 6000.0 | .377 | 133 | 9.362 | –156 | .003 | –135 | .149 | –147 |
| 6200.0 | .390 | 90 | 8.768 | 140 | .003 | –167 | .184 | 163 |
| 6400.0 | .424 | 44 | 8.193 | 75 | .005 | 123 | .209 | 107 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 97.8°C/W
Transistor Power Dissipation $P_d$ ..... 0.207 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20°C

# WJ-RA63-1/ SMRA63-1




## 2000 to 6000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ ULTRAWIDE BANDWIDTH: 1.8-6.2 GHz (TYP.)
- ◆ HIGH GAIN: 19.5 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +16.0 dBm (TYP.)
- ◆ LOW POWER SUPPLY VOLTAGE: +5 VDC

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 1.8-6.2 GHz | 2-6 GHz | 2-6 GHz |
| Small Signal Gain (Min.) | 19.5 dB | 16.5 dB | 15.5 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±1.0 dB | ±1.2 dB |
| Noise Figure (Max.) | 5.5 dB | 7.0 dB | 7.5 dB |
| Power Output at 1 dB Compression (Min.) | +16.0 dBm | +13.0 dBm | +12.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.2:1 | 2.3:1 |
| Output | 1.7:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +5 Volts | 120 mA | 135 mA | 140 mA |

* Measured in a 50-ohm system at +5 Vdc Nominal.

Notes:

1. WJ-RA63-1 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA63-1 is a standard WJ-RA63-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+54 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+32 dBm (Typ.)

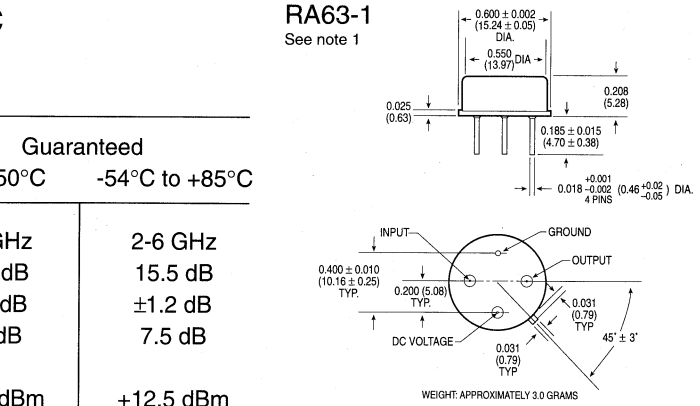
## Absolute Maximum Ratings

Storage Temperature .....-64°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+6 Volts
Maximum Continuous RF Input Power .....+7 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.25 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

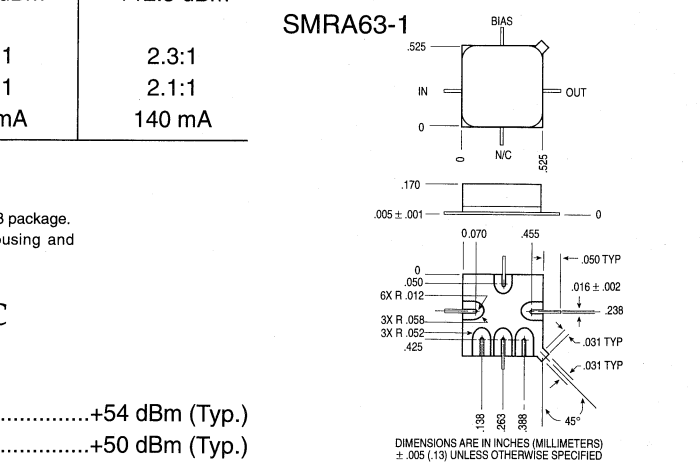
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

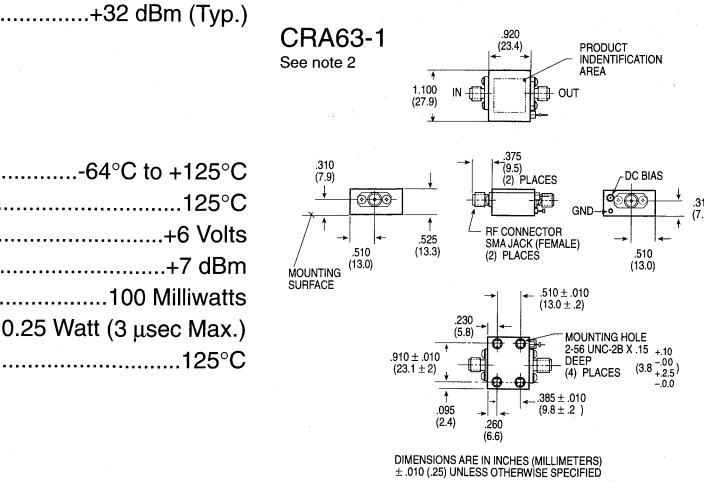
RA63-1
See note 1




SMRA63-1

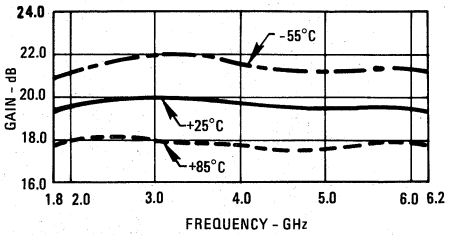



CRA63-1
See note 2

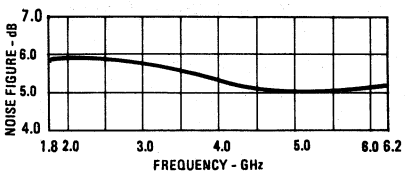


# Typical Automatic Test Data

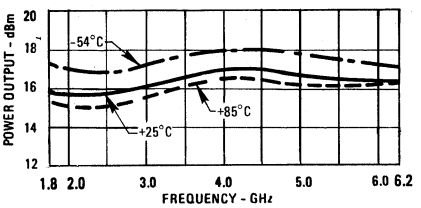
## Gain




## Noise Figure

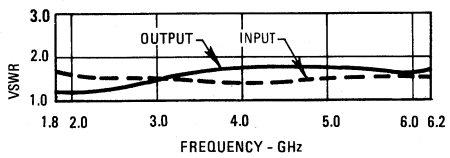



## Power Output*

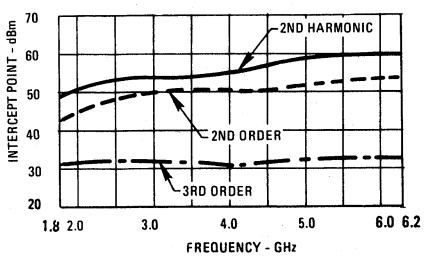



*at 1 dB Gain Compression

## VSWR




## Intercept Point




# Typical Performance at 25°C

## $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1000.0 | 1.5 | 1.4 | 20.4 |
| 1200.0 | 1.4 | 1.3 | 21.0 |
| 1400.0 | 1.3 | 1.3 | 21.3 |
| 1600.0 | 1.3 | 1.3 | 21.5 |
| 1800.0 | 1.2 | 1.3 | 21.5 |
| 2000.0 | 1.2 | 1.4 | 21.6 |
| 2200.0 | 1.2 | 1.4 | 21.6 |
| 2400.0 | 1.2 | 1.4 | 21.6 |
| 2600.0 | 1.2 | 1.4 | 21.5 |
| 2800.0 | 1.2 | 1.5 | 21.5 |
| 3000.0 | 1.2 | 1.4 | 21.4 |
| 3200.0 | 1.1 | 1.4 | 21.3 |
| 3400.0 | 1.1 | 1.4 | 21.3 |
| 3600.0 | 1.0 | 1.3 | 21.2 |
| 3800.0 | 1.1 | 1.3 | 21.2 |
| 4000.0 | 1.1 | 1.2 | 21.2 |
| 4200.0 | 1.1 | 1.2 | 21.2 |
| 4400.0 | 1.1 | 1.3 | 21.2 |
| 4600.0 | 1.1 | 1.3 | 21.2 |
| 4800.0 | 1.0 | 1.3 | 21.2 |
| 5000.0 | 1.1 | 1.4 | 21.3 |
| 5200.0 | 1.2 | 1.4 | 21.2 |
| 5400.0 | 1.4 | 1.4 | 21.2 |
| 5600.0 | 1.5 | 1.5 | 21.1 |
| 5800.0 | 1.6 | 1.5 | 21.1 |
| 6000.0 | 1.7 | 1.5 | 20.9 |
| 6200.0 | 2.0 | 1.5 | 20.4 |
| 6400.0 | 2.5 | 1.5 | 19.4 |

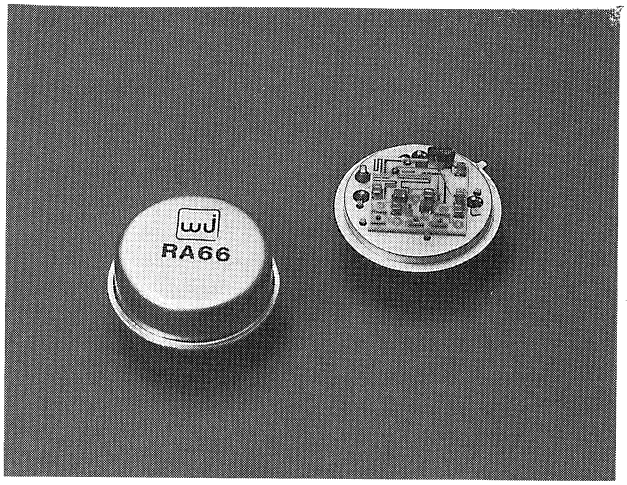
## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1000.0 | .212 | 81 | 10.514 | –28 | .003 | 176 | .158 | –97 |
| 1200.0 | .177 | 36 | 11.248 | –102 | .004 | 127 | .145 | –140 |
| 1400.0 | .146 | –13 | 11.621 | –171 | .003 | 86 | .142 | 173 |
| 1600.0 | .123 | –59 | 11.825 | 121 | .003 | 44 | .135 | 125 |
| 1800.0 | .106 | –117 | 11.934 | 56 | .003 | –1 | .137 | 81 |
| 2000.0 | .111 | –168 | 12.042 | –8 | .003 | –63 | .151 | 37 |
| 2200.0 | .108 | 148 | 12.070 | –72 | .002 | –83 | .151 | –6 |
| 2400.0 | .102 | 102 | 12.044 | –134 | .002 | –126 | .164 | –43 |
| 2600.0 | .097 | 55 | 11.927 | 163 | .003 | –170 | .179 | –83 |
| 2800.0 | .097 | 17 | 11.865 | 101 | .002 | 112 | .184 | –120 |
| 3000.0 | .084 | –18 | 11.768 | 39 | .002 | 78 | .183 | –155 |
| 3200.0 | .061 | –65 | 11.643 | –22 | .004 | 32 | .183 | 164 |
| 3400.0 | .030 | –117 | 11.599 | –84 | .002 | –22 | .164 | 124 |
| 3600.0 | .022 | 130 | 11.480 | –145 | .002 | –40 | .145 | 84 |
| 3800.0 | .041 | 56 | 11.462 | 154 | .001 | –100 | .129 | 37 |
| 4000.0 | .057 | 7 | 11.509 | 93 | .004 | –161 | .108 | –10 |
| 4200.0 | .064 | –35 | 11.502 | 32 | .002 | –177 | .102 | –54 |
| 4400.0 | .066 | –71 | 11.454 | –30 | .003 | 124 | .112 | –105 |
| 4600.0 | .040 | –124 | 11.503 | –92 | .003 | 92 | .116 | –150 |
| 4800.0 | .013 | 115 | 11.535 | –155 | .004 | 28 | .128 | 172 |
| 5000.0 | .055 | 19 | 11.559 | 141 | .002 | –22 | .152 | 129 |
| 5200.0 | .101 | –27 | 11.512 | 77 | .004 | –56 | .163 | 86 |
| 5400.0 | .165 | –73 | 11.478 | 12 | .002 | –119 | .178 | 47 |
| 5600.0 | .191 | –124 | 11.379 | –54 | .005 | –163 | .203 | 1 |
| 5800.0 | .222 | .178 | 11.327 | –121 | .005 | 158 | .202 | –46 |
| 6000.0 | .263 | 111 | 11.057 | 169 | .003 | 123 | .203 | –90 |
| 6200.0 | .326 | 43 | 10.412 | 96 | .004 | 81 | .214 | –133 |
| 6400.0 | .433 | –24 | 9.312 | 21 | .005 | 18 | .208 | –173 |

# Thermal Data: $V_{CC}$ = 5 Vdc

Thermal Resistance $\theta_{jc}$ ..... 200.4°C/W
Transistor Power Dissipation $P_d$ ..... 0.207 W
Junction Temperature Rise Above Case $T_{jc}$ ... 41.5°C

# WJ-RA66/SMRA66




## 10 to 1000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - THREE STAGES: 37.0 dB (TYP.)
- ◆ LOW NOISE: <3.5 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: > +15.5 dBm (TYP.)
- ◆ HIGH REVERSE ISOLATION: >50 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1000 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 37.0 dB | 35.0 dB | 34.0 dB |
| Gain Flatness (Max.) | ±0.6 dB | ±1.0 dB | ±1.3 dB |
| Noise Figure (Max.) | 3.5 dB | 4.5 dB | 5.0 dB |
| Power Output at 1 dB Compression (Min.) | +15.5 dBm | +14.0 dBm | +13.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 81 mA | 85 mA | 87 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA66 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA66 is a standard WJ-RA66 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+55 dBm (Typ.)
Second Order Two Tone Intercept Point.....+45 dBm (Typ.)
Third Order Two Tone Intercept Point.....+30 dBm (Typ.)

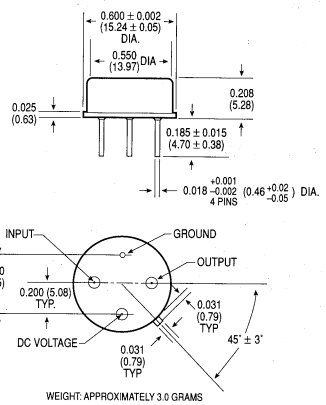
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

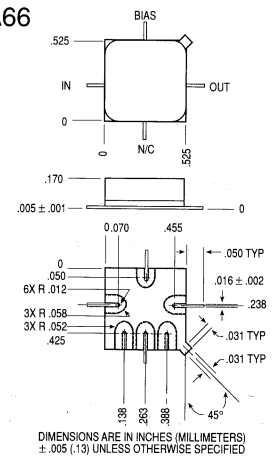
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

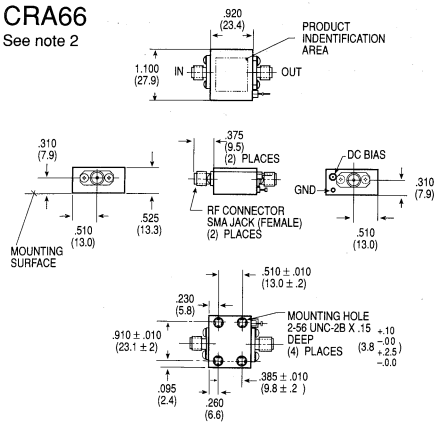
RA66
See note 1




SMRA66

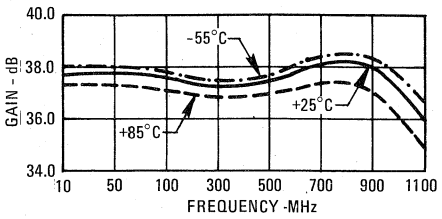



CRA66
See note 2

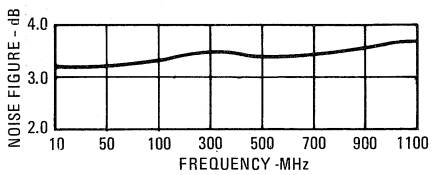


# Typical Performance at 25°C

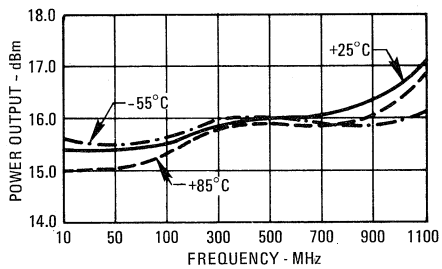
## Gain




## Noise Figure

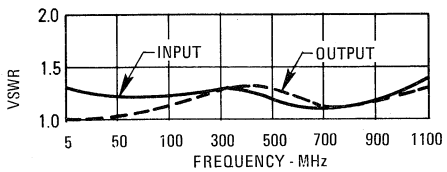



## Power Output*

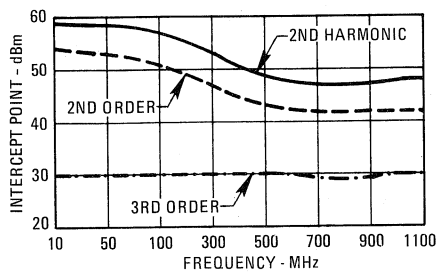



*at 1 dB Gain Compression

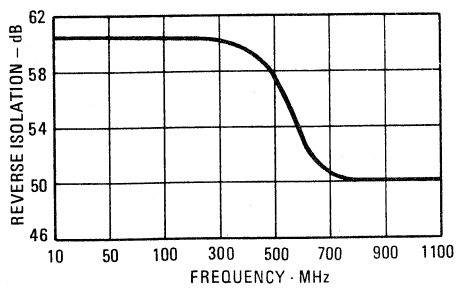
## VSWR




## Intercept Point




## Reverse Isolation




# Typical Automatic Test Data

## $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.7 | 35.2 |
| 2.0 | 1.4 | 1.4 | 36.8 |
| 5.0 | 1.2 | 1.1 | 36.8 |
| 10.0 | 1.2 | 1.1 | 36.8 |
| 50.0 | 1.2 | 1.1 | 36.7 |
| 100.0 | 1.1 | 1.2 | 36.5 |
| 200.0 | 1.1 | 1.2 | 36.3 |
| 300.0 | 1.1 | 1.3 | 36.3 |
| 400.0 | 1.2 | 1.3 | 36.6 |
| 500.0 | 1.3 | 1.4 | 36.8 |
| 600.0 | 1.4 | 1.4 | 37.3 |
| 700.0 | 1.5 | 1.5 | 37.7 |
| 800.0 | 1.4 | 1.5 | 37.6 |
| 900.0 | 1.4 | 1.4 | 37.1 |
| 1000.0 | 1.3 | 1.4 | 36.0 |
| 1100.0 | 1.2 | 1.4 | 34.4 |
| 1200.0 | 1.3 | 1.4 | 32.8 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .239 | –65 | 57.820 | –133 | .001 | 116 | .466 | 166 |
| 2.0 | .154 | –107 | 69.274 | –161 | .003 | 58 | .156 | 108 |
| 5.0 | .099 | –144 | 69.234 | –175 | .003 | 20 | .062 | 70 |
| 10.0 | .089 | –164 | 69.039 | –180 | .003 | 11 | .050 | 50 |
| 50.0 | .073 | 165 | 68.322 | 164 | .003 | 9 | .062 | 20 |
| 100.0 | .060 | 157 | 66.748 | 148 | .003 | 5 | .075 | 7 |
| 200.0 | .040 | –176 | 65.442 | 118 | .003 | 9 | .093 | –12 |
| 300.0 | .060 | –156 | 65.242 | 88 | .004 | 8 | .114 | –34 |
| 400.0 | .090 | –162 | 67.248 | 59 | .004 | 15 | .135 | –62 |
| 500.0 | .137 | –175 | 69.351 | 28 | .004 | 19 | .159 | –91 |
| 600.0 | .168 | 165 | 73.296 | –5 | .004 | 19 | .182 | –124 |
| 700.0 | .187 | 140 | 76.315 | –41 | .004 | 15 | .196 | –158 |
| 800.0 | .181 | 121 | 75.908 | –79 | .005 | 13 | .194 | 164 |
| 900.0 | .159 | 99 | 71.243 | –116 | .005 | 6 | .174 | 125 |
| 1000.0 | .121 | 96 | 62.792 | –154 | .006 | 1 | .160 | 87 |
| 1100.0 | .096 | 113 | 52.407 | 171 | .006 | –7 | .155 | 51 |
| 1200.0 | .132 | 131 | 43.565 | 140 | .007 | –23 | .175 | 12 |

## $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.6 | 2.7 | 34.5 |
| 2.0 | 1.4 | 1.4 | 36.1 |
| 5.0 | 1.2 | 1.1 | 36.1 |
| 10.0 | 1.2 | 1.1 | 36.1 |
| 50.0 | 1.1 | 1.1 | 36.0 |
| 100.0 | 1.1 | 1.2 | 35.8 |
| 200.0 | 1.1 | 1.2 | 35.7 |
| 300.0 | 1.1 | 1.2 | 35.6 |
| 400.0 | 1.2 | 1.3 | 35.9 |
| 500.0 | 1.3 | 1.4 | 36.2 |
| 600.0 | 1.4 | 1.4 | 36.6 |
| 700.0 | 1.4 | 1.5 | 36.9 |
| 800.0 | 1.4 | 1.5 | 36.7 |
| 900.0 | 1.3 | 1.4 | 36.1 |
| 1000.0 | 1.3 | 1.4 | 35.0 |
| 1100.0 | 1.3 | 1.4 | 33.5 |
| 1200.0 | 1.5 | 1.5 | 31.9 |

## Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .216 | –66 | 53.328 | –133 | .001 | 115 | .464 | 166 |
| 2.0 | .150 | –100 | 63.958 | –162 | .003 | 45 | .158 | 106 |
| 5.0 | .087 | –140 | 63.909 | –175 | .003 | 19 | .064 | 66 |
| 10.0 | .070 | –158 | 63.811 | 180 | .003 | 8 | .053 | 46 |
| 50.0 | .061 | 167 | 63.224 | 164 | .003 | 14 | .065 | 17 |
| 100.0 | .047 | 152 | 61.794 | 148 | .003 | 10 | .074 | 4 |
| 200.0 | .033 | –162 | 60.691 | 117 | .004 | 10 | .092 | –15 |
| 300.0 | .063 | –144 | 60.548 | 87 | .003 | 17 | .107 | –39 |
| 400.0 | .099 | –153 | 62.243 | 56 | .004 | 6 | .131 | –68 |
| 500.0 | .137 | –170 | 64.216 | 25 | .004 | 14 | .151 | –98 |
| 600.0 | .169 | 167 | 67.576 | –9 | .005 | 19 | .174 | –130 |
| 700.0 | .179 | 146 | 69.669 | –45 | .005 | 13 | .187 | –164 |
| 800.0 | .167 | 131 | 68.498 | –83 | .005 | 13 | .184 | 159 |
| 900.0 | .143 | 114 | 63.870 | –121 | .006 | 7 | .171 | 119 |
| 1000.0 | .131 | 114 | 56.229 | –159 | .006 | –2 | .161 | 83 |
| 1100.0 | .134 | 128 | 47.203 | 166 | .006 | –13 | .162 | 48 |
| 1200.0 | .190 | 129 | 39.368 | 135 | .007 | –20 | .190 | 10 |

# Typical Automatic Test Data

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.8 | 2.8 | 30.3 |
| 2.0 | 1.3 | 1.4 | 31.9 |
| 5.0 | 1.1 | 1.2 | 31.9 |
| 10.0 | 1.1 | 1.2 | 31.8 |
| 50.0 | 1.1 | 1.2 | 31.8 |
| 100.0 | 1.1 | 1.2 | 31.6 |
| 200.0 | 1.2 | 1.2 | 31.5 |
| 300.0 | 1.2 | 1.2 | 31.4 |
| 400.0 | 1.3 | 1.3 | 31.5 |
| 500.0 | 1.4 | 1.3 | 31.5 |
| 600.0 | 1.5 | 1.3 | 31.4 |
| 700.0 | 1.5 | 1.3 | 31.2 |
| 800.0 | 1.6 | 1.3 | 30.7 |
| 900.0 | 1.7 | 1.3 | 30.0 |
| 1000.0 | 2.0 | 1.3 | 29.0 |
| 1100.0 | 2.3 | 1.3 | 27.7 |
| 1200.0 | 2.7 | 1.4 | 26.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .282 | –50 | 32.618 | –136 | .002 | 111 | .478 | 164 |
| 2.0 | .146 | –67 | 39.233 | –163 | .004 | 48 | .178 | 97 |
| 5.0 | .061 | –65 | 39.146 | –176 | .004 | 21 | .088 | 47 |
| 10.0 | .035 | –54 | 39.093 | 180 | .004 | 11 | .079 | 28 |
| 50.0 | .025 | –23 | 38.863 | 162 | .004 | 5 | .087 | 1 |
| 100.0 | .037 | –38 | 38.126 | 145 | .004 | 4 | .092 | –13 |
| 200.0 | .071 | –78 | 37.531 | 110 | .004 | 8 | .096 | –35 |
| 300.0 | .102 | –107 | 37.098 | 77 | .005 | 6 | .103 | –60 |
| 400.0 | .132 | –127 | 37.514 | 42 | .004 | 10 | .115 | –88 |
| 500.0 | .163 | –148 | 37.433 | 8 | .005 | 9 | .123 | –118 |
| 600.0 | .188 | –165 | 37.353 | –29 | .005 | 0 | .129 | –149 |
| 700.0 | .205 | –178 | 36.354 | –66 | .005 | 9 | .127 | –177 |
| 800.0 | .227 | 169 | 34.305 | –104 | .006 | –2 | .117 | 153 |
| 900.0 | .265 | 157 | 31.459 | –140 | .007 | –10 | .111 | 120 |
| 1000.0 | .323 | 145 | 28.048 | –177 | .007 | –13 | .119 | 88 |
| 1100.0 | .386 | 131 | 24.314 | 148 | .008 | –24 | .134 | 52 |
| 1200.0 | .458 | 116 | 21.007 | 114 | .008 | –35 | .170 | 12 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.296 W
Junction Temperature Rise Above Case $T_{jc}$ ... 13°C

# WJ-RA69/SMRA69

## 10 to 1000 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABILITY IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 25.0 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +23.0 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +34 dBm (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1000 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 25.0 dB | 24.0 dB | 23.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 4.5 dB | 5.5 dB | 6.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| Vcc = +15 Volts | +23.0 dBm | +20.0 dBm | +20.0 dBm |
| Vcc = +12 Volts | +20.5 dBm | +18.0 dBm | +18.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current at +15 Volts | 130 mA | 138 mA | 145 mA |
| DC Current at +12 Volts | 104 mA | 110 mA | 114 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA69 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA69 is a standard WJ-RA69 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+60 dBm (Typ.)
Second Order Two Tone Intercept Point.....+55 dBm (Typ.)
Third Order Two Tone Intercept Point.....+34 dBm (Typ.)

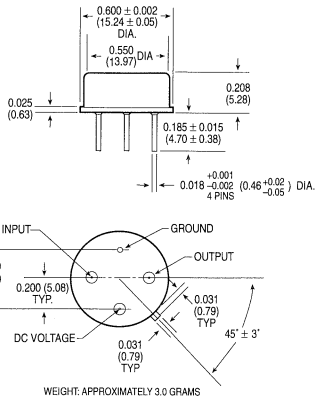
## Absolute Maximum Ratings (At 15 Vdc)

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

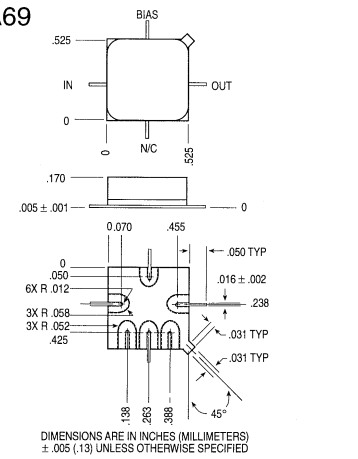
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

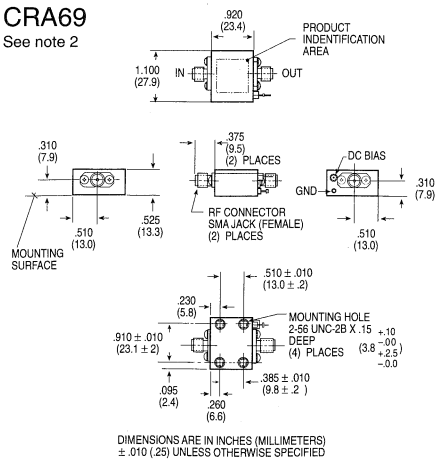
RA69
See note 1




SMRA69

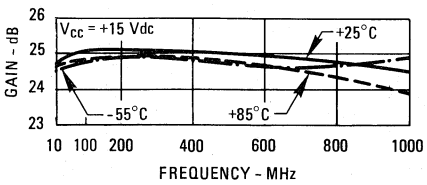


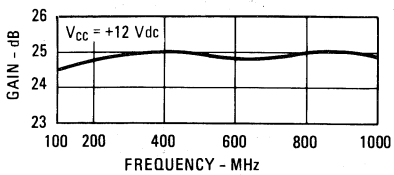

CRA69
See note 2



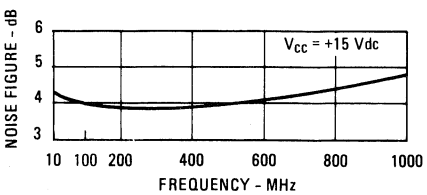
# Typical Performance at 25°C

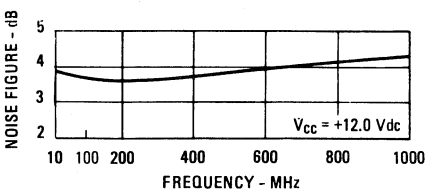
## Gain



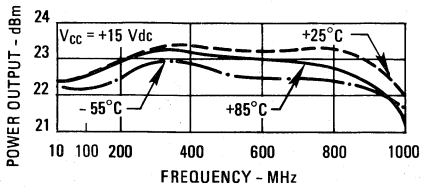



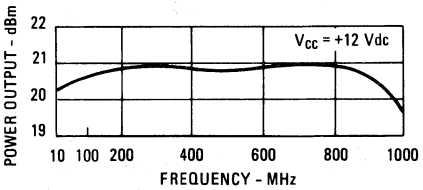

## Noise Figure



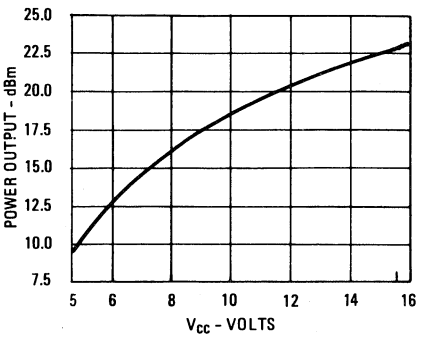




## Power Output*



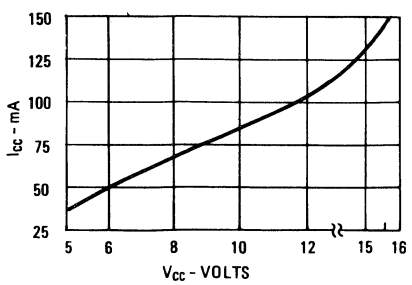




## Power Output* vs. $V_{CC}$ at 500 MHz

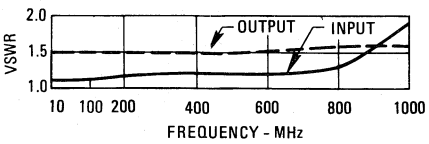



*at 1 dB Gain Compression

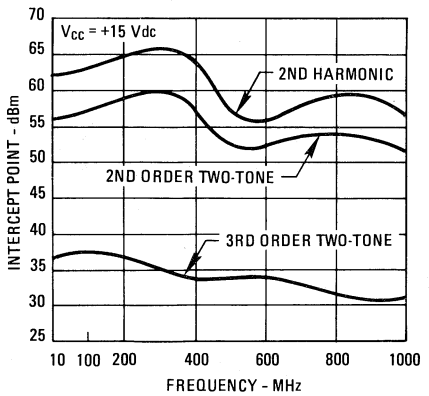
## $I_{CC}$ in mA vs. $V_{CC}$ in Volts

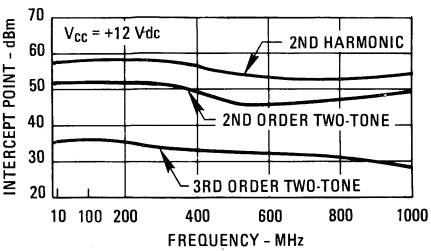



## VSWR




## Intercept Point



# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.3 | 1.8 | 26.4 |
| 5.0 | 1.4 | 1.2 | 26.2 |
| 10.0 | 1.4 | 1.1 | 26.2 |
| 50.0 | 1.4 | 1.1 | 26.2 |
| 100.0 | 1.4 | 1.1 | 26.2 |
| 200.0 | 1.3 | 1.1 | 26.3 |
| 300.0 | 1.3 | 1.1 | 26.3 |
| 400.0 | 1.3 | 1.1 | 26.3 |
| 500.0 | 1.3 | 1.1 | 26.2 |
| 600.0 | 1.3 | 1.1 | 26.2 |
| 700.0 | 1.4 | 1.1 | 26.1 |
| 800.0 | 1.3 | 1.1 | 26.2 |
| 900.0 | 1.1 | 1.2 | 26.2 |
| 1000.0 | 1.3 | 1.5 | 26.0 |
| 1100.0 | 2.0 | 2.1 | 25.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .125 | 26 | 20.901 | 24 | .013 | 27 | .287 | 105 |
| 5.0 | .156 | 7 | 20.337 | 8 | .015 | 10 | .103 | 84 |
| 10.0 | .161 | 2 | 20.322 | 2 | .015 | 4 | .058 | 69 |
| 50.0 | .159 | –7 | 20.461 | –12 | .015 | –2 | .032 | 17 |
| 100.0 | .151 | –9 | 20.463 | –26 | .015 | –4 | .029 | 4 |
| 200.0 | .144 | –23 | 20.625 | –54 | .015 | –9 | .033 | 3 |
| 300.0 | .127 | –28 | 20.619 | –81 | .016 | –17 | .041 | –10 |
| 400.0 | .128 | –31 | 20.616 | –109 | .016 | –21 | .050 | –35 |
| 500.0 | .131 | –34 | 20.326 | –136 | .017 | –28 | .061 | –62 |
| 600.0 | .142 | –40 | 20.313 | –165 | .018 | –35 | .064 | –93 |
| 700.0 | .157 | –53 | 20.231 | 167 | .019 | –44 | .062 | –130 |
| 800.0 | .126 | –75 | 20.354 | 137 | .020 | –53 | .051 | 171 |
| 900.0 | .047 | –81 | 20.443 | 105 | .022 | –68 | .083 | 83 |
| 1000.0 | .115 | 35 | 20.041 | 69 | .023 | –86 | .194 | 27 |
| 1100.0 | .334 | 7 | 18.334 | 31 | .023 | –108 | .354 | –20 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.3 | 1.7 | 26.2 |
| 5.0 | 1.4 | 1.2 | 26.0 |
| 10.0 | 1.4 | 1.1 | 26.0 |
| 50.0 | 1.4 | 1.1 | 26.0 |
| 100.0 | 1.4 | 1.1 | 26.0 |
| 200.0 | 1.4 | 1.1 | 26.1 |
| 300.0 | 1.3 | 1.1 | 26.1 |
| 400.0 | 1.3 | 1.1 | 26.1 |
| 500.0 | 1.3 | 1.1 | 26.0 |
| 600.0 | 1.3 | 1.1 | 26.0 |
| 700.0 | 1.3 | 1.1 | 26.0 |
| 800.0 | 1.2 | 1.2 | 26.0 |
| 900.0 | 1.0 | 1.3 | 26.1 |
| 1000.0 | 1.4 | 1.7 | 25.8 |
| 1100.0 | 2.4 | 2.5 | 24.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .137 | 23 | 20.415 | 23 | .013 | 24 | .270 | 104 |
| 5.0 | .164 | 7 | 19.879 | 7 | .015 | 10 | .098 | 84 |
| 10.0 | .167 | 1 | 19.853 | 2 | .015 | 5 | .056 | 69 |
| 50.0 | .164 | –8 | 20.011 | –12 | .015 | –1 | .031 | 16 |
| 100.0 | .166 | –12 | 19.997 | –27 | .015 | –4 | .028 | 2 |
| 200.0 | .151 | –25 | 20.137 | –54 | .016 | –8 | .030 | –3 |
| 300.0 | .135 | –31 | 20.128 | –82 | .017 | –14 | .036 | –17 |
| 400.0 | .134 | –36 | 20.192 | –110 | .017 | –19 | .046 | –44 |
| 500.0 | .129 | –40 | 19.907 | –138 | .017 | –26 | .056 | –74 |
| 600.0 | .141 | –45 | 19.880 | –167 | .019 | –35 | .063 | –108 |
| 700.0 | .146 | –60 | 19.876 | 164 | .020 | –43 | .068 | –152 |
| 800.0 | .105 | –86 | 20.031 | 133 | .022 | –53 | .076 | 147 |
| 900.0 | .019 | –173 | 20.144 | 100 | .024 | –68 | .136 | 80 |
| 1000.0 | .182 | 48 | 19.418 | 63 | .026 | –88 | .263 | 28 |
| 1100.0 | .411 | 7 | 17.190 | 23 | .024 | –112 | .426 | –21 |

## Thermal Data: $V_{CC}$ = 15 Vdc

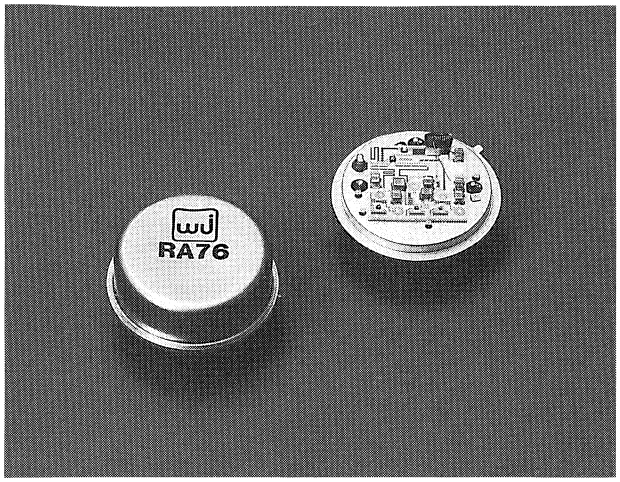
Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.765 W
Junction Temperature Rise Above Case $T_{jc}$ ... 34°C

## Thermal Data: $V_{CC}$ = 12 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.495W
Junction Temperature Rise Above Case $T_{jc}$ ... 22°C

# WJ-RA76/SMRA76

## 10 to 500 MHz
## TO-8B[1] CASCADABLE AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - THREE STAGES: 40.5 dB (TYP.)
- ◆ LOW NOISE: <3.0 dB (TYP.)
- ◆ MEDIUM OUTPUT LEVEL: +15.0 dBm (TYP.)
- ◆ HIGH REVERSE ISOLATION >50 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-550 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 40.5 dB | 38.5 dB | 37.5 dB |
| Gain Flatness (Max.) | ±0.6 dB | ±0.9 dB | ±1.2 dB |
| Noise Figure (Max.) | 3.0 dB | 3.8 dB | 4.3 dB |
| Power Output at 1 dB Compression (Min.) | +15.0 dBm | +13.3 dBm | +12.3 dBm. |
| VSWR (Max.) Input/Output | 1.3:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 81 mA | 85 mA | 87 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA76 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA76 is a standard WJ-RA76 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+42 dBm (Typ.)
Second Order Two Tone Intercept Point.....+35 dBm (Typ.)
Third Order Two Tone Intercept Point.....+26 dBm (Typ.)

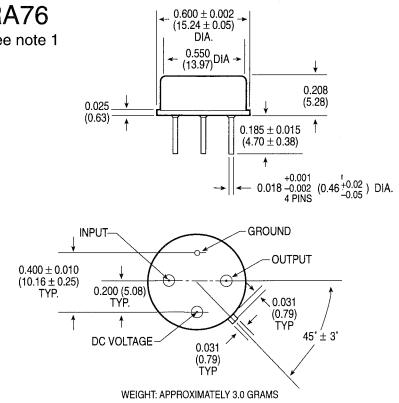
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +1 25°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+6 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C

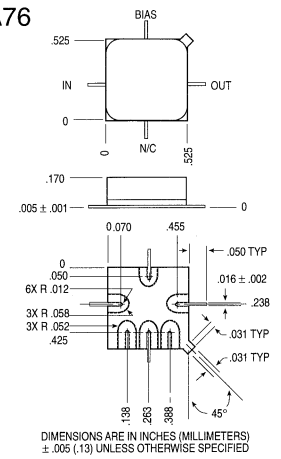
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

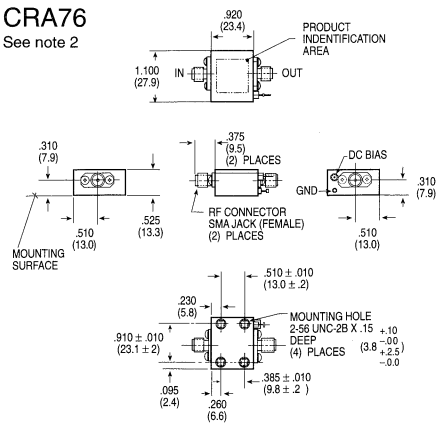
RA76
See note 1




SMRA76

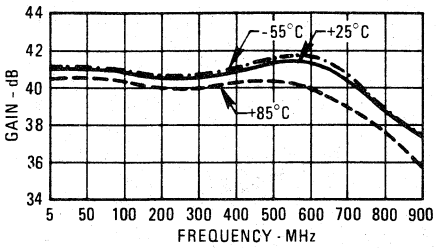



CRA76
See note 2

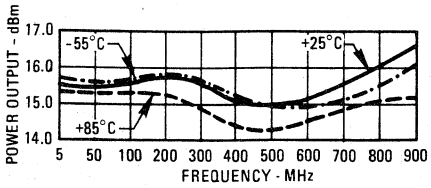


# Typical Performance at 25°C

### Gain

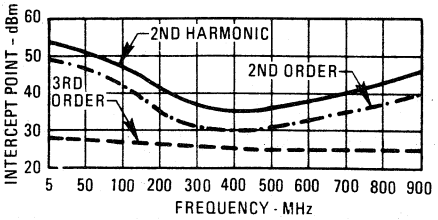



### Power Output*

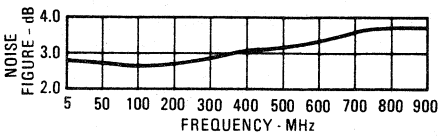



*at 1 dB Gain Compression

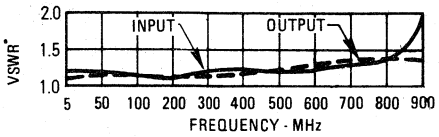
### Intercept Point



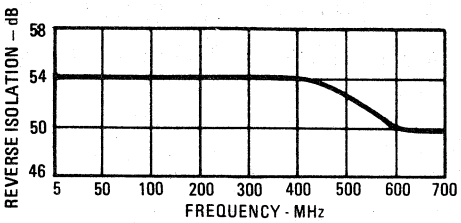

### Noise Figure




### VSWR




### Reverse Isolation




1

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 2.3 | 36.8 |
| 2.0 | 1.2 | 1.4 | 40.0 |
| 5.0 | 1.2 | 1.2 | 40.4 |
| 10.0 | 1.2 | 1.1 | 40.4 |
| 50.0 | 1.1 | 1.1 | 40.2 |
| 100.0 | 1.1 | 1.0 | 39.9 |
| 200.0 | 1.1 | 1.1 | 39.7 |
| 300.0 | 1.2 | 1.1 | 39.7 |
| 400.0 | 1.2 | 1.2 | 40.1 |
| 500.0 | 1.3 | 1.3 | 39.9 |
| 600.0 | 1.3 | 1.3 | 38.9 |
| 700.0 | 1.5 | 1.2 | 37.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .068 | −150 | 68.912 | −137 | .001 | 12 | .391 | −142 |
| 2.0 | .094 | −115 | 99.825 | −152 | .002 | 23 | .161 | 153 |
| 5.0 | .086 | −158 | 104.174 | −172 | .002 | 22 | .074 | 150 |
| 10.0 | .085 | −174 | 140.343 | −180 | .002 | 8 | .059 | 149 |
| 50.0 | .061 | 156 | 102.520 | 157 | .002 | 6 | .033 | 116 |
| 100.0 | .039 | 146 | 98.975 | 134 | .002 | 12 | .018 | 67 |
| 200.0 | .048 | −156 | 96.108 | 91 | .002 | 3 | .025 | −62 |
| 300.0 | .086 | −176 | 96.687 | 48 | .003 | 12 | .054 | −118 |
| 400.0 | .111 | 143 | 100.585 | 1 | .002 | 12 | .093 | −158 |
| 500.0 | .134 | 99 | 98.877 | −49 | .003 | 3 | .121 | 159 |
| 600.0 | .149 | 46 | 88.322 | −103 | .003 | −10 | .117 | 112 |
| 700.0 | .184 | 2 | 71.821 | −153 | .003 | −18 | .082 | 63 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.1 | 2.3 | 35.9 |
| 2.0 | 1.2 | 1.4 | 39.2 |
| 5.0 | 1.1 | 1.1 | 39.6 |
| 10.0 | 1.1 | 1.1 | 39.6 |
| 50.0 | 1.1 | 1.1 | 39.5 |
| 100.0 | 1.0 | 1.0 | 39.2 |
| 200.0 | 1.1 | 1.1 | 38.9 |
| 300.0 | 1.2 | 1.1 | 38.9 |
| 400.0 | 1.2 | 1.2 | 39.2 |
| 500.0 | 1.3 | 1.3 | 39.0 |
| 600.0 | 1.3 | 1.3 | 38.0 |
| 700.0 | 1.4 | 1.2 | 36.3 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .054 | −169 | 62.544 | −138 | .001 | −12 | .391 | −142 |
| 2.0 | .083 | −103 | 91.165 | −152 | .002 | 35 | .158 | 151 |
| 5.0 | .067 | −150 | 95.244 | −172 | .002 | 13 | .068 | 147 |
| 10.0 | .058 | −170 | 95.487 | −180 | .002 | 8 | .053 | 146 |
| 50.0 | .042 | 159 | 93.975 | 157 | .002 | 9 | .027 | 113 |
| 100.0 | .024 | 146 | 90.975 | 134 | .002 | 8 | .012 | 49 |
| 200.0 | .055 | −145 | 88.290 | 90 | .002 | 16 | .030 | −89 |
| 300.0 | .092 | −167 | 88.548 | 46 | .002 | 9 | .063 | −126 |
| 400.0 | .106 | 152 | 91.451 | −1 | .003 | 14 | .105 | −161 |
| 500.0 | .118 | 106 | 89.243 | −52 | .003 | 10 | .132 | 160 |
| 600.0 | .124 | 59 | 79.754 | −105 | .003 | −6 | .127 | 119 |
| 700.0 | .163 | 14 | 65.491 | −155 | .003 | −18 | .086 | 78 |

### $V_{CC}$ = 5.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.2 | 2.3 | 30.6 |
| 2.0 | 1.3 | 1.3 | 34.3 |
| 5.0 | 1.2 | 1.1 | 34.7 |
| 10.0 | 1.2 | 1.1 | 34.8 |
| 50.0 | 1.2 | 1.0 | 34.7 |
| 100.0 | 1.2 | 1.1 | 34.5 |
| 200.0 | 1.3 | 1.1 | 34.1 |
| 300.0 | 1.3 | 1.2 | 33.8 |
| 400.0 | 1.3 | 1.3 | 33.6 |
| 500.0 | 1.3 | 1.3 | 32.9 |
| 600.0 | 1.4 | 1.2 | 31.9 |
| 700.0 | 1.5 | 1.2 | 30.6 |

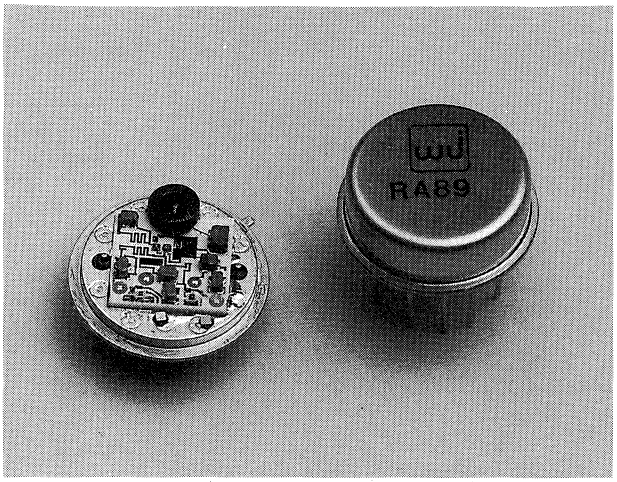
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .079 | −6 | 33.943 | −143 | .002 | −5 | .395 | −141 |
| 2.0 | .126 | −32 | 51.929 | −154 | .002 | 36 | .148 | 137 |
| 5.0 | .079 | −24 | 54.428 | −172 | .003 | 12 | .045 | 109 |
| 10.0 | .073 | −17 | 54.688 | −180 | .003 | 8 | .027 | 94 |
| 50.0 | .073 | −19 | 54.315 | 155 | .003 | 10 | .020 | 7 |
| 100.0 | .089 | −43 | 52.817 | 130 | .003 | 4 | .031 | −47 |
| 200.0 | .116 | −91 | 50.805 | 81 | .003 | 5 | .058 | −100 |
| 300.0 | .134 | −130 | 48.998 | 33 | .003 | 4 | .085 | −135 |
| 400.0 | .138 | −162 | 47.597 | −16 | .003 | −4 | .112 | −166 |
| 500.0 | .140 | 169 | 43.906 | −66 | .004 | −4 | .121 | 164 |
| 600.0 | .149 | 130 | 39.250 | −118 | .005 | −18 | .108 | 139 |
| 700.0 | .188 | 79 | 34.002 | −168 | .005 | −35 | .085 | 130 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.371 W
Junction Temperature Rise Above Case $T_{jc}$ ... 17°C

# WJ-RA89/SMRA89




## 5 to 500 MHz
## TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN - TWO STAGES: 26.5 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +21.5 dBm (TYP.)
- ◆ HIGH THIRD-ORDER I.P.: +35 dBm (TYP.)

## Specifications *

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 3 - 700 MHz | 5 - 500 MHz | 5 - 500 MHz |
| Small Signal Gain (Min.) | 26.5 dB | 25.5 dB | 25.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | 3.7 dB | 4.5 dB | 5.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | | | |
| Vcc = +15 Volts | +21.5 dBm | +20.5 dBm | +20.0 dBm |
| Vcc = +12 Volts | +19.5 dBm | +19.0 dBm | +18.0 dBm |
| VSWR (Max.) Input/Output | 1.5:1 | 1.8:1 | 2.0:1 |
| DC Current at +12 Volts | 102 mA | 108 mA | 111 mA |
| DC Current at +15 Volts | 130 mA | 136 mA | 139 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal,
Notes:
1. WJ-RA89 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA89 is a standard WJ-RA89 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Order Harmonic Intercept Point.....+65.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+55.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+35.0 dBm (Typ.)

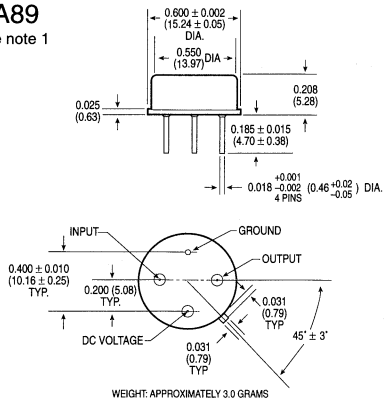
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

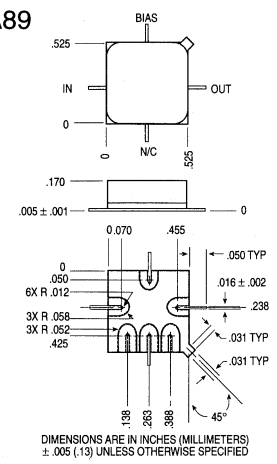
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

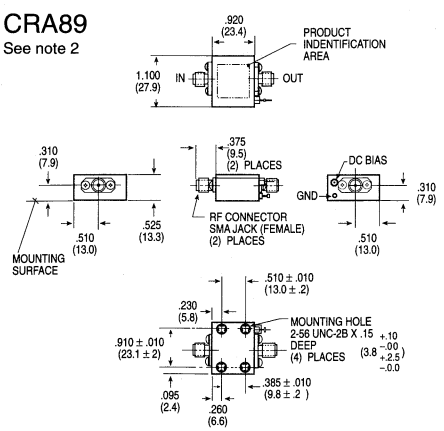
RA89
See note 1




SMRA89

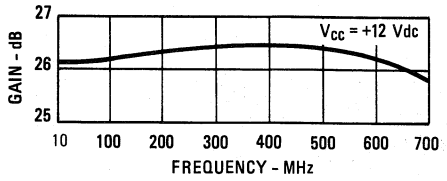


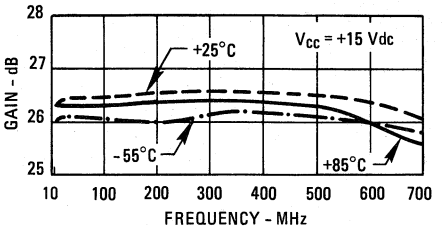

CRA89
See note 2



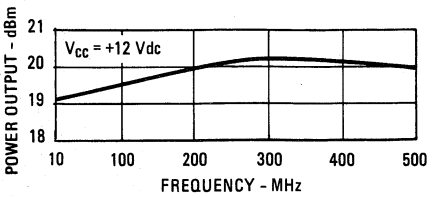
# Typical Performance at 25°C

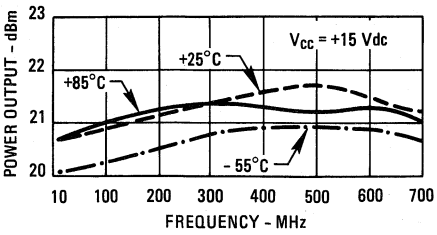
### Gain



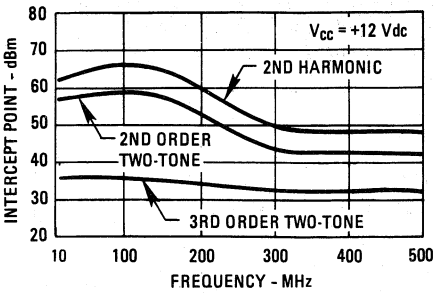

### Power Output*

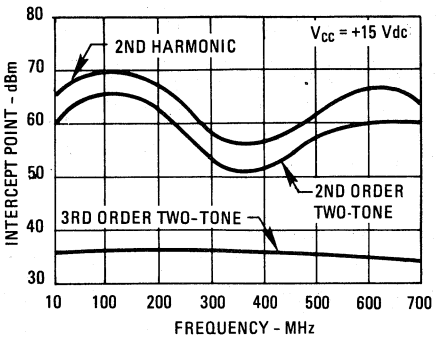


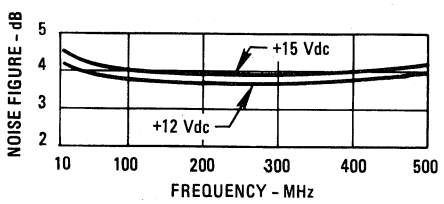

*at 1 dB Gain Compression

### Intercept Point

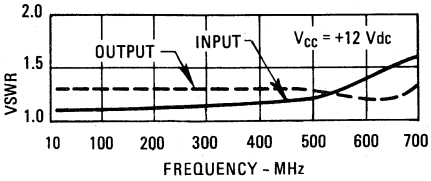


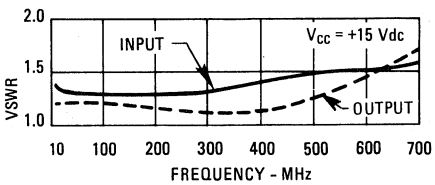




### Noise Figure




### VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.2 | 1.9 | 31.0 |
| 5.0 | 1.1 | 1.2 | 30.9 |
| 10.0 | 1.0 | 1.1 | 30.9 |
| 50.0 | 1.0 | 1.0 | 31.0 |
| 100.0 | 1.1 | 1.1 | 31.0 |
| 200.0 | 1.1 | 1.1 | 31.1 |
| 300.0 | 1.1 | 1.2 | 31.1 |
| 400.0 | 1.1 | 1.3 | 31.2 |
| 500.0 | 1.2 | 1.3 | 30.9 |
| 600.0 | 1.4 | 1.3 | 30.5 |
| 700.0 | 1.8 | 1.4 | 29.8 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.2 | 1.8 | 30.7 |
| 5.0 | 1.1 | 1.2 | 30.6 |
| 10.0 | 1.0 | 1.1 | 30.6 |
| 50.0 | 1.0 | 1.0 | 30.7 |
| 100.0 | 1.1 | 1.1 | 30.7 |
| 200.0 | 1.1 | 1.1 | 30.8 |
| 300.0 | 1.2 | 1.2 | 30.8 |
| 400.0 | 1.2 | 1.3 | 30.9 |
| 500.0 | 1.3 | 1.3 | 30.6 |
| 600.0 | 1.5 | 1.4 | 30.2 |
| 700.0 | 2.0 | 1.5 | 29.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .102 | 138 | 35.625 | 26 | .009 | 29 | .301 | 114 |
| 5.0 | .032 | 112 | 35.027 | 8 | .010 | 11 | .107 | 106 |
| 10.0 | .013 | 114 | 34.986 | 2 | .010 | 7 | .054 | 108 |
| 50.0 | .017 | −114 | 35.419 | −13 | .011 | 2 | .016 | −158 |
| 100.0 | .031 | −122 | 35.522 | −29 | .011 | 2 | .037 | −141 |
| 200.0 | .053 | −138 | 36.006 | −59 | .011 | −1 | .068 | −163 |
| 300.0 | .062 | −147 | 36.077 | −90 | .011 | −3 | .097 | 174 |
| 400.0 | .067 | −147 | 36.130 | −122 | .012 | −3 | .119 | 150 |
| 500.0 | .103 | −142 | 35.105 | −154 | .013 | −10 | .135 | 123 |
| 600.0 | .175 | −144 | 33.426 | 171 | .014 | −15 | .146 | 93 |
| 700.0 | .297 | −159 | 30.913 | 136 | .015 | −24 | .156 | 59 |

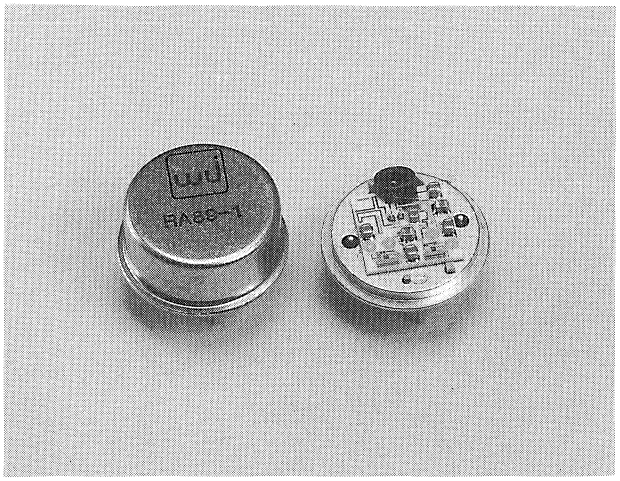
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .090 | 130 | 34.402 | 25 | .009 | 28 | .284 | 113 |
| 5.0 | .030 | 88 | 33.786 | 8 | .010 | 10 | .102 | 106 |
| 10.0 | .015 | 39 | 33.775 | 2 | .010 | 6 | .052 | 109 |
| 50.0 | .016 | −65 | 34.111 | −13 | .011 | 2 | .015 | −154 |
| 100.0 | .029 | −103 | 34.216 | −29 | .011 | 1 | .037 | −139 |
| 200.0 | .056 | −122 | 34.693 | −59 | .011 | 1 | .068 | −157 |
| 300.0 | .071 | −135 | 34.862 | −90 | .011 | −3 | .099 | −179 |
| 400.0 | .083 | −134 | 34.941 | −123 | .012 | −4 | .126 | 159 |
| 500.0 | .128 | −135 | 33.882 | −156 | .014 | −8 | .149 | 133 |
| 600.0 | .209 | −146 | 32.242 | 169 | .015 | −15 | .168 | 104 |
| 700.0 | .343 | −163 | 29.632 | 133 | .016 | −23 | .185 | 71 |

# Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.781 W
Junction Temperature Rise Above Case $T_{jc}$ ... 35°C

# WJ-RA89-1/ SMRA89-1



## 10 to 500 MHz TO-8B[1] CASCADABLE AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ HIGH GAIN-TWO STAGES: 30.0 dB (TYP.)
- ◆ HIGH OUTPUT POWER: +21.5 dBm (TYP.)
- ◆ HIGH THIRD ORDER I.P.: +36 dBm (TYP.)
- ◆ LOW VSWR: <1.5:1 (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 30.0 dB | 29.0 dB | 28.0 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.7 dB | ±1.0 dB |
| Noise Figure (Max.) | | | |
| +15 Volts | 3.2 dB | 4.5 dB | 5.0 dB |
| +12 Volts | 2.7 dB | 4.0 dB | 4.5 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| +15 Volts | +21.5 dBm | +20.0 dBm | +20.0 dBm |
| +12 Volts | +18.5 dBm | +18.0 dBm | +17.0 dBm |
| VSWR (Max.) Input/Output | <1.5:1 | 1.8:1 | 2.0:1 |
| DC Current (Max.) at | | | |
| +15 Volts | 130 mA | 137 mA | 140 mA |
| +12 Volts | 102 mA | 108 mA | 111 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-RA89-1 amplifier is in a TO-8B package which is slightly larger than the standard TO-8 package.
2. WJ-CRA89-1 is a standard WJ-RA89-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

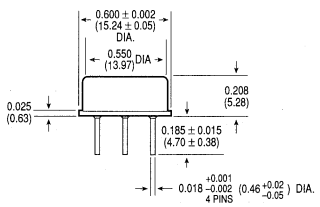
Second Order Harmonic Intercept Point.....+57 dBm (Typ.)
Second Order Two Tone Intercept Point.....+50 dBm (Typ.)
Third Order Two Tone Intercept Point.....+36 dBm (Typ.)

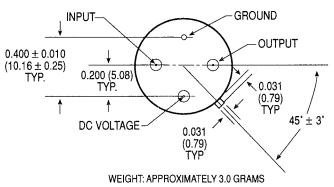
## Absolute Maximum Ratings (at +15 Vdc)

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous R F Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 msec Max.)
"S" Series Burn-in Temperature (Case).....125°C
Weight approximately 3.0 grams (0.11 oz.)

## Outline Drawings

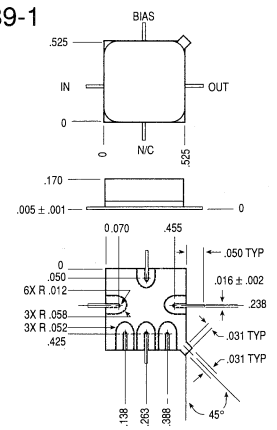
RA89-1
See note 1



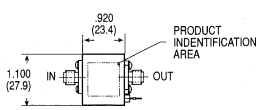

WEIGHT: APPROXIMATELY 3.0 GRAMS

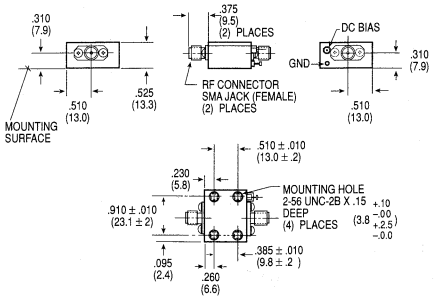
SMRA89-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

CRA89-1
See note 2

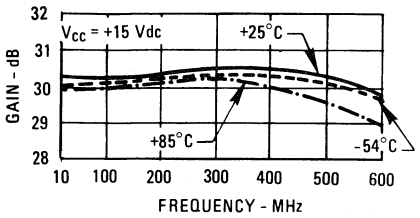


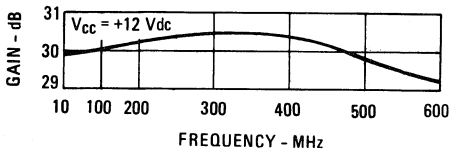




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

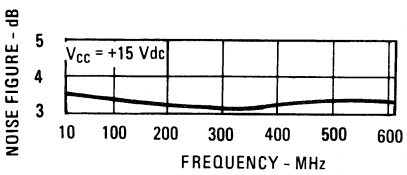
# Typical Performance at 25°C

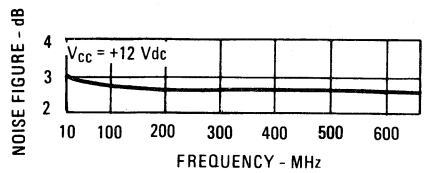
### Gain



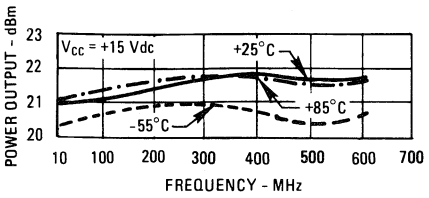



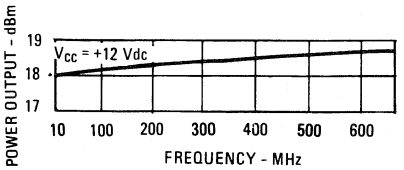

### Noise Figure

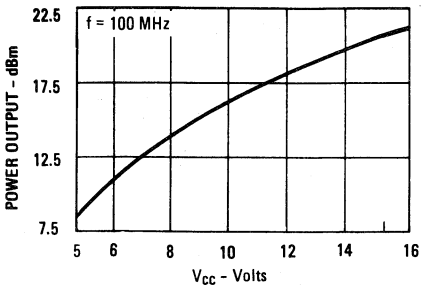



### Power Output*

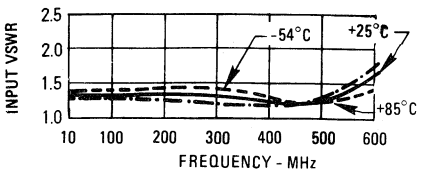


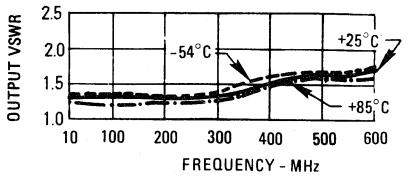



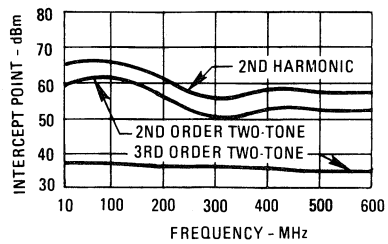

*at 1 dB Gain Compression

### VSWR

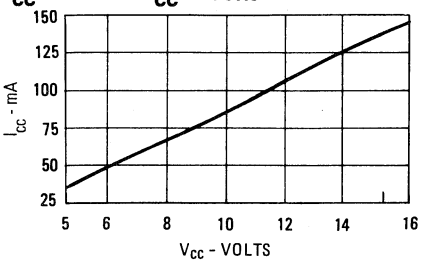



### Intercept Point




### $I_{cc}$ in mA vs. $V_{cc}$ in Volts




## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.754 W
Junction Temperature Rise Above Case $T_{jc}$ ... 34°C

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.5 | 1.9 | 30.2 |
| 5.0 | 1.4 | 1.4 | 30.1 |
| 10.0 | 1.4 | 1.3 | 30.1 |
| 50.0 | 1.4 | 1.3 | 30.3 |
| 100.0 | 1.4 | 1.3 | 30.3 |
| 200.0 | 1.4 | 1.3 | 30.3 |
| 300.0 | 1.3 | 1.3 | 30.4 |
| 400.0 | 1.2 | 1.4 | 30.4 |
| 500.0 | 1.1 | 1.4 | 30.2 |
| 600.0 | 1.1 | 1.4 | 29.9 |
| 700.0 | 1.5 | 1.4 | 29.5 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .211 | 177 | 32.432 | 27 | .009 | 31 | .317 | 91 |
| 5.0 | .163 | 176 | 32.063 | 9 | .010 | 11 | .154 | 51 |
| 10.0 | .155 | 177 | 32.123 | 3 | .011 | 6 | .128 | 28 |
| 50.0 | .154 | 174 | 32.631 | –13 | .011 | 2 | .124 | –14 |
| 100.0 | .160 | 164 | 32.571 | –28 | .011 | 1 | .123 | –39 |
| 200.0 | .151 | 150 | 32.869 | –58 | .012 | 1 | .126 | –76 |
| 300.0 | .140 | 131 | 32.946 | –87 | .012 | –1 | .138 | –112 |
| 400.0 | .097 | 111 | 33.043 | –118 | .013 | –3 | .153 | –145 |
| 500.0 | .045 | 109 | 32.306 | –149 | .014 | –6 | .162 | –177 |
| 600.0 | .068 | –144 | 31.409 | 177 | .015 | –11 | .163 | 150 |
| 700.0 | .194 | –155 | 29.699 | 143 | .016 | –19 | .157 | 115 |

### $V_{CC}$ = 12.0 V

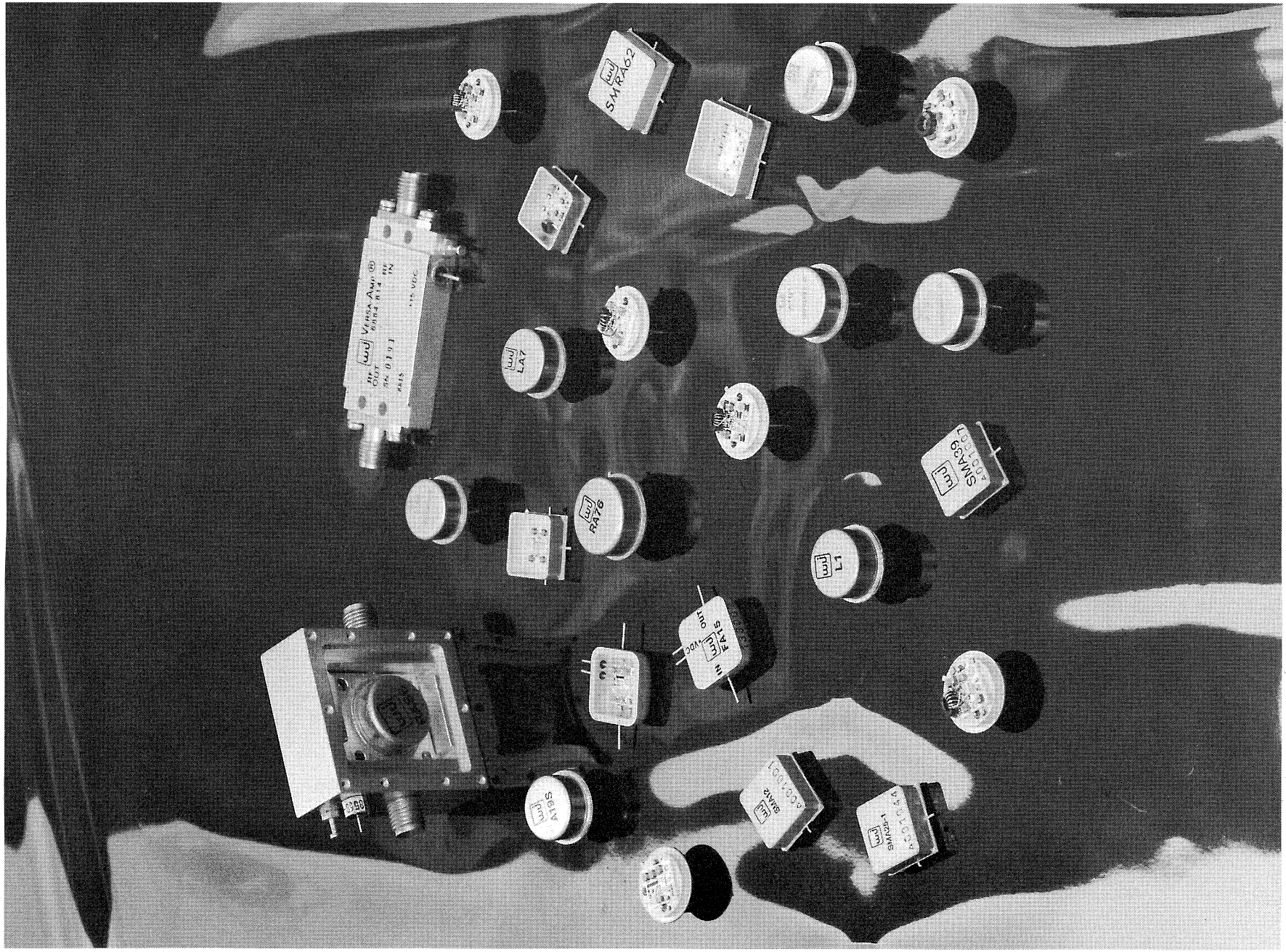
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.5 | 1.9 | 29.9 |
| 5.0 | 1.3 | 1.4 | 29.8 |
| 10.0 | 1.3 | 1.3 | 29.9 |
| 50.0 | 1.3 | 1.3 | 30.0 |
| 100.0 | 1.3 | 1.3 | 30.0 |
| 200.0 | 1.3 | 1.3 | 30.1 |
| 300.0 | 1.3 | 1.3 | 30.1 |
| 400.0 | 1.2 | 1.4 | 30.1 |
| 500.0 | 1.1 | 1.5 | 29.9 |
| 600.0 | 1.2 | 1.5 | 29.6 |
| 700.0 | 1.6 | 1.5 | 29.1 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .188 | 176 | 31.404 | 26 | .010 | 29 | .305 | 90 |
| 5.0 | .144 | 177 | 30.999 | 9 | .010 | 10 | .150 | 50 |
| 10.0 | .138 | 177 | 31.106 | 3 | .011 | 6 | .125 | 27 |
| 50.0 | .137 | 174 | 31.598 | –13 | .011 | 3 | .122 | –14 |
| 100.0 | .142 | 166 | 31.558 | –28 | .011 | 3 | .122 | –38 |
| 200.0 | .139 | 153 | 31.823 | –58 | .012 | 0 | .129 | –76 |
| 300.0 | .119 | 139 | 31.870 | –88 | .013 | –2 | .146 | –111 |
| 400.0 | .080 | 123 | 32.013 | –120 | .013 | –0 | .171 | –143 |
| 500.0 | .036 | 152 | 31.271 | –151 | .015 | –5 | .190 | –174 |
| 600.0 | .097 | –149 | 30.302 | 175 | .016 | –11 | .202 | 153 |
| 700.0 | .239 | –162 | 28.535 | 139 | .018 | –20 | .207 | 118 |

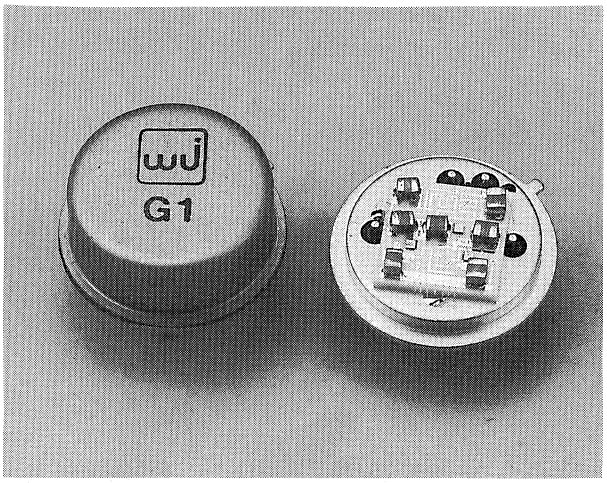
# *Attenuators*





# WJ-G1/SMG1

## 5 TO 2000 MHz TO-8 VOLTAGE-CONTROLLED ATTENUATOR MODULE




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW VSWR: < 1.8:1 (TYP.)
- ◆ LOW INSERTION LOSS: 2.0 dB to 1000 MHz (TYP.)
- ◆ LOW DISTORTION: -25 dBc (TYP.) AT $V_{CONTROL}$ = +15V

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 5 to 2200 MHz | 5 to 2000 MHz |
| Maximum Attenuation Available (Min.) | | |
| 5 - 500 MHz | 36 dB | 31 dB |
| 500 - 1000 MHz | 30 dB | 25 dB |
| 1000 - 2000 MHz | 23 dB | 18 dB |
| Insertion Loss ($V_{ctrl}$ = +15 V) (Max.) | | |
| 5 - 1000 MHz | 2.0 dB | 2.5 dB |
| 1000 - 2000 MHz | 2.5 dB | 3.0 dB |
| VSWR (Worst case in attenuation range) | | |
| 5 - 2000 MHz | ≤1.8:1 | 2.2:1 |
| Flatness Over Frequency (Max.) | | |
| (Attenuation = min. to 15db, 5 - 1000 MHz) | ±0.5 dB | ±1.0 dB |
| Bias Voltage | | +15V |
| Bias Current (Max.) | | 15 mA |
| Control Voltage | | 0 V to + 15V |
| Control Current (Max.) | | 7 mA |
| Switching Speed (Max.) | | |
| 10% - 90% | 60 µsec | 120 µsec |
| 0% - 100% | 75 µsec | 125 µsec |

*Measured in a 50-ohm system at +15.0 Vdc, guaranteed at 25°C.

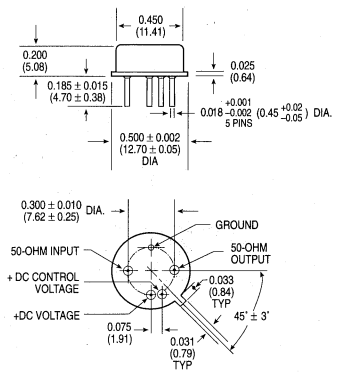
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Voltage ..... +18 Volts
Maximum Continuous RF Input Power ..... +20 dBm
Maximum Short Term RF Input Power (1 Minute Max.) ..... 200 Milliwatts
Maximum Peak Power ..... 1 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) ..... 125°C

Weight 2.27 grams (0.08 oz.) max.

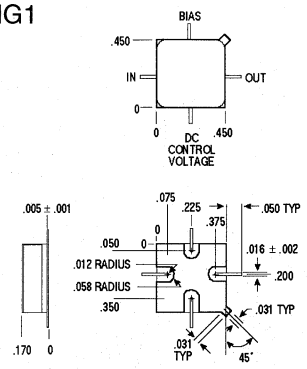
## Outline Drawing

G1



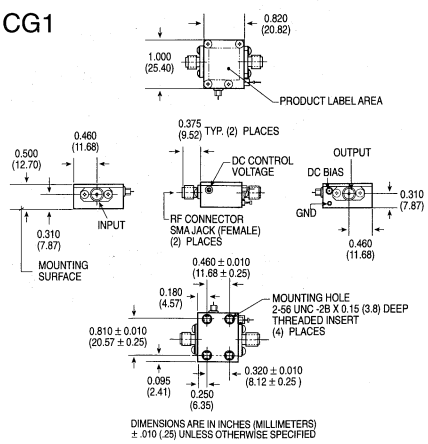

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMG1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

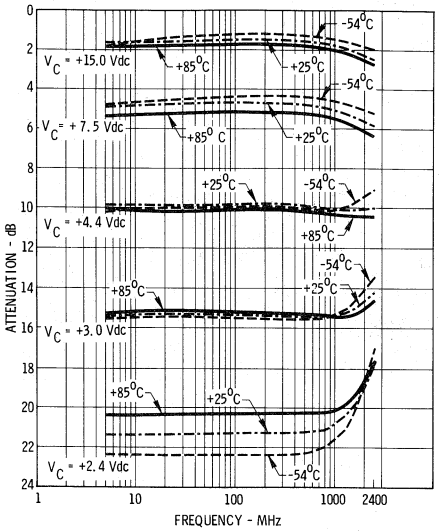
CG1



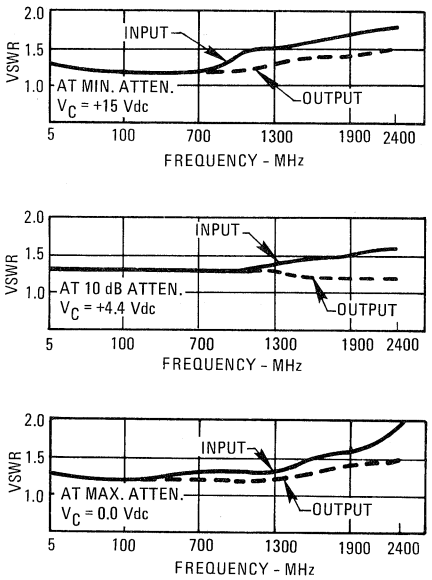

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

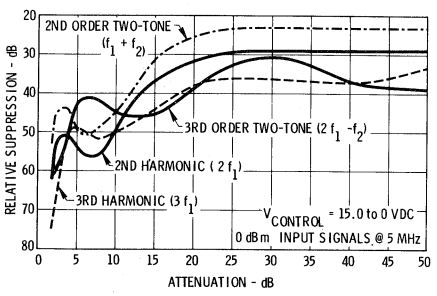
### Attenuation vs. Frequency



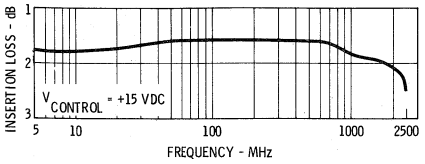

### VSWR vs. Frequency



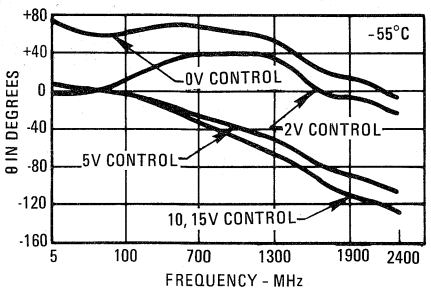

### Distortion Products

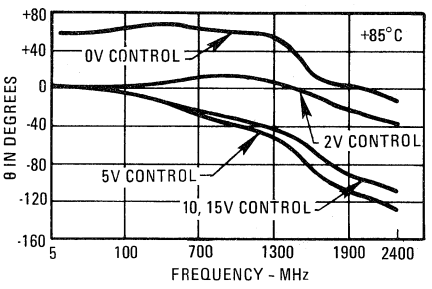


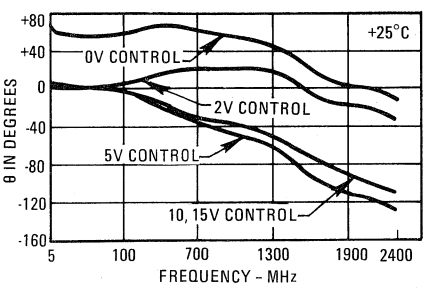

### Insertion Loss vs. Frequency at $V_{CONTROL}$ = 15 V



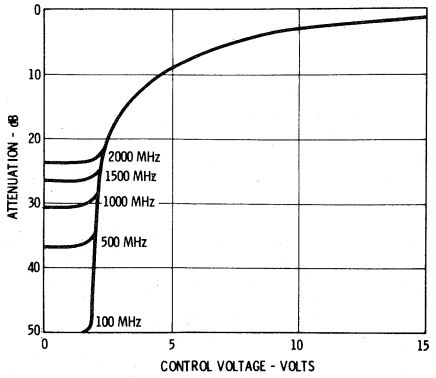

### Phase vs. $V_{CTL}$ vs. Frequency vs. Phase of the Moon



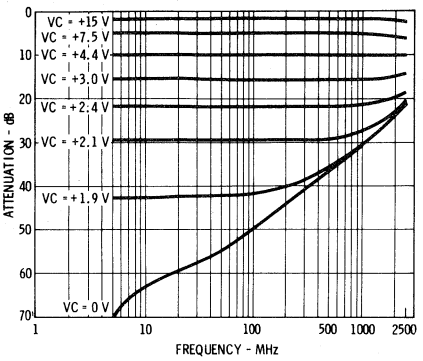



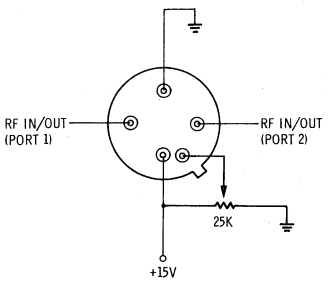

### Attenuation vs. Control Voltage




### Attenuation vs. $V_{CTL}$ vs. Frequency

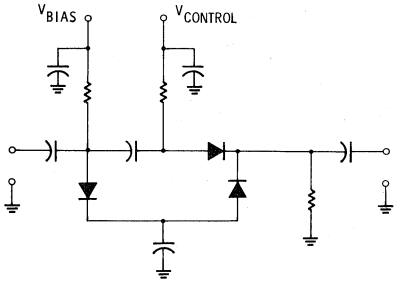



## Typical Test Circuit




BOTTOM VIEW

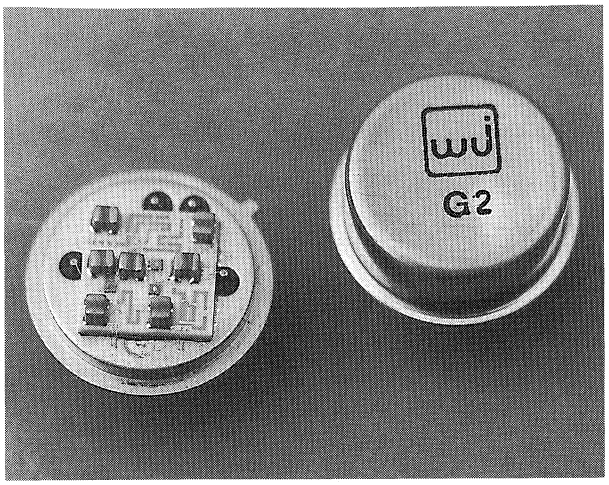
## Schematic Diagram




TT PAD ATTENUATOR

# WJ-G2/SMG2

## 5 TO 2000 MHz
## TO-8 VOLTAGE-CONTROLLED ATTENUATOR MODULE




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW VSWR < 1.5:1 (TYP.)
- ◆ LOW INSERTION LOSS: 2.5 dB TO 1000 MHz (TYP.)
- ◆ LOW DISTORTION > 50 dB (TYP.) HARMONIC SUPPRESSION AT $V_{CONTROL}$ = +15 V

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency Range (Min.) | 5 to 2200 MHz | 5 to 2000 MHz |
| Maximum Attenuation Available (Min.) | | |
| 5-500 MHz | 35 dB | 31 dB |
| 500-1000 MHz | 29 dB | 25 dB |
| 1000-2000 MHz | 23 dB | 18 dB |
| Insertion Loss (Vcntl = +15 V) (Max.) | | |
| 5-1000 MHz | 2.5 dB | 3.0 dB |
| 1000-2000 MHz | 2.8 dB | 3.5 dB |
| VSWR (Worst case in attenuation range) (Max.) | | |
| 5-1000 MHz | ≤ 1.3:1 | 1.8:1 |
| 1000-2000 MHz | ≤ 1.5:1 | 2.5:1 |
| Flatness Over Frequency (Max.) | | |
| (Attenuation = min. to 15db, 5 - 1000 MHz) | ±0.4 dB | ±1.0 dB |
| Bias Voltage | | +5V |
| Bias Current(Max.) | | 15 mA |
| Control Voltage | | 0 to +15V |
| Control Current (Max.) | | 7 mA |
| Switching Speed (Max.) | 75 µsec | 125 µsec |
| 0 to 100% | | |

*Measured in a 50-ohm system at +5.0 Vdc Nominal, guaranteed at 25°C,

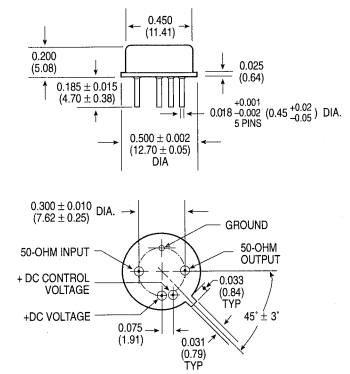
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Control Voltage ..... +18 Volts
Maximum DC Bias Voltage ..... +10 volts
Maximum Continuous RF Input Power ..... +20 dBm
Maximum Short Term RF Input Power (1 Minute Max.) ..... 200 Milliwatts
Maximum Peak Power ..... 1 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case) ..... 125°C

Weight 2.27 grams (0.08 oz.) max

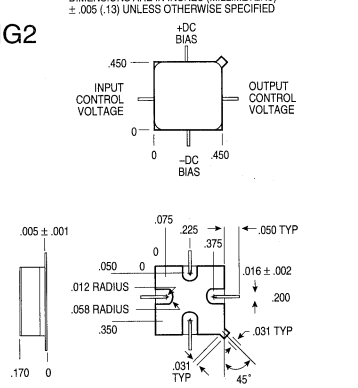
## Outline Drawing

G2



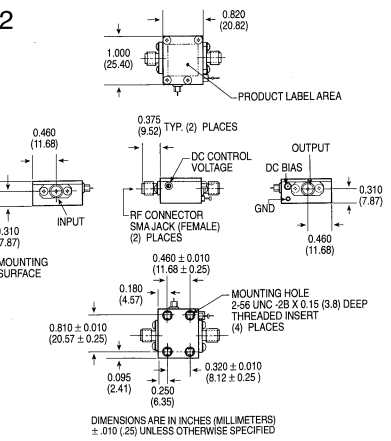

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMG2




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

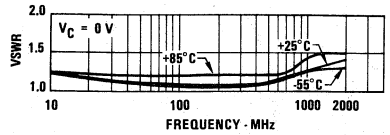
CG2

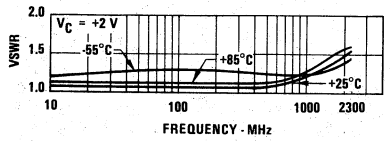


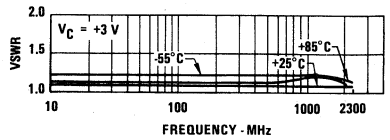

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

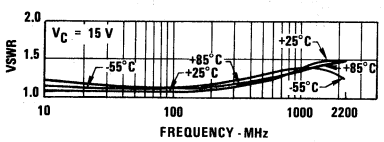
# Typical Performance at 25°C

### Input VSWR vs. Frequency

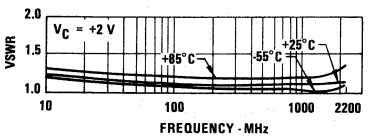


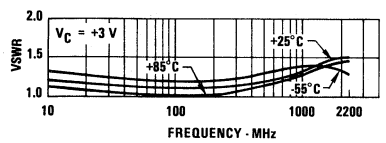



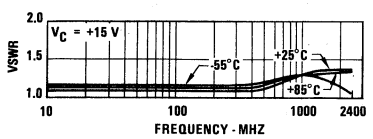



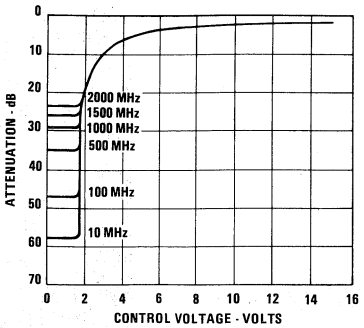

### Output VSWR vs. Frequency



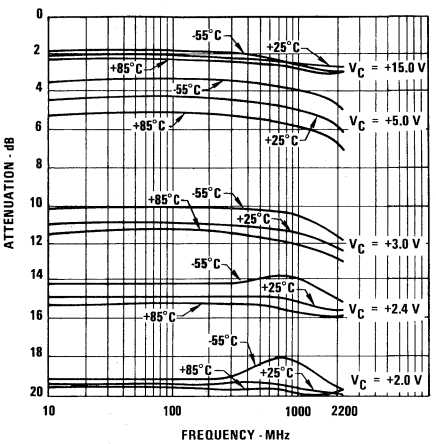



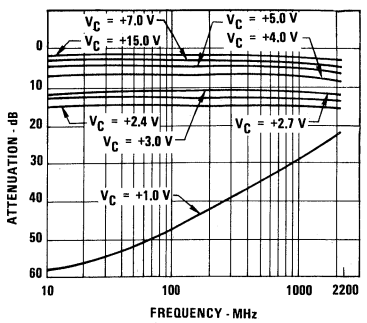

### Attenuation vs. Control Voltage



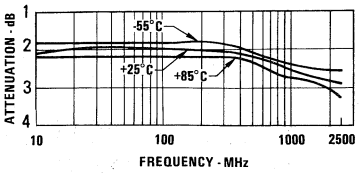

### Attenuation vs. Frequency



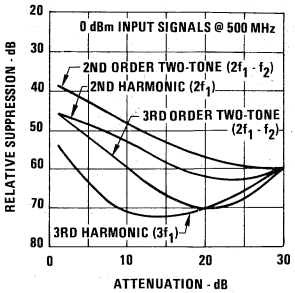

### Attenuation vs. $V_{CTL}$ vs. Frequency



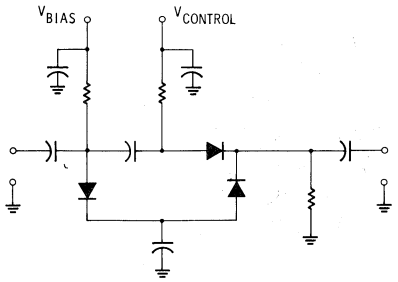

### Insertion Loss vs. Frequency




### Distortion Products

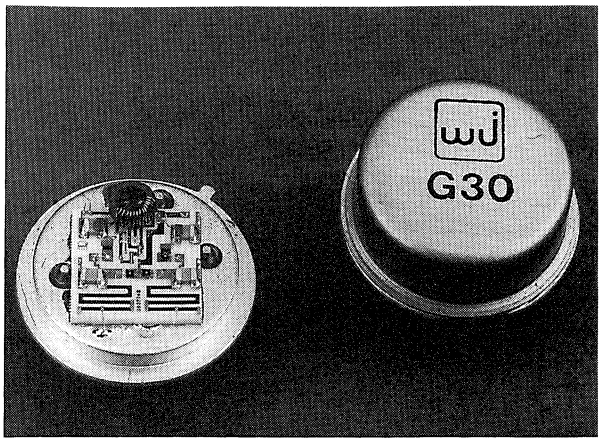



## Schematic Diagram




$\pi$ PAD ATTENUATOR

# WJ-G30/SMG30




## 100 TO 2000 MHz TO-8 VOLTAGE-CONTROLLED ATTENUATOR MODULE

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ FAST SWITCHING: < 200 nsec, 10 TO 90% (TYP.) < 3 µsec; 0 TO 100% (TYP.)
- ◆ HIGH DYNAMIC RANGE: 40 dB TO 1000 MHz (TYP.)
- ◆ LOW VSWR: 1.4:1 (TYP.)

## Guaranteed Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency Range (Min,) | 50 - 2300 MHz | 100 - 2000 MHz |
| Maximum Attenuation Available (Min.) | | |
| 100 - 500 MHz | >45 dB | 40 dB |
| 500 - 1000 MHz | >40 dB | 35 dB |
| 1000 - 2000 MHz | >30 dB | 25 dB |
| Insertion Loss (Max.) | | |
| 100-500 MHz | <2.3 dB | 2.8 dB |
| 500-1000 MHz | <2.5 dB | 3.0 dB |
| 1000-2000 MHz | <3.0 dB | 3.5 dB |
| VSWR (Max.) | | |
| 100 - 1000 MHz | <1.4:1 | 1.8:1 |
| 1000 - 2000 MHz | | |
| 0 - 25 dB Attenuation | 1.4 :1 | 2.0:1 |
| > 25 dB Attenuation | <1.7:1 | 2.2:1 |
| Flatness Over Frequency (Max.) | | |
| (Attenuation = min. to 25db) | | |
| 100 - 1000 MHz | ± 0.5 dB | ±1.0 dB |
| 1000 - 2000 MHz | ± 1.0 dB | ±1.5 dB |
| Switching Speed (Max.) | | |
| 10 to 90% | <200 nsec | 400 nsec |
| 0 to 100% | <3 µsec | 6 µsec |
| Bias Voltage | | +15 V |
| Bias Current (Max.) | 6.7 mA | 10 mA |
| Control Voltage | | 0 v to + 15 V |
| Control Current (Max.) | | 10 mA |

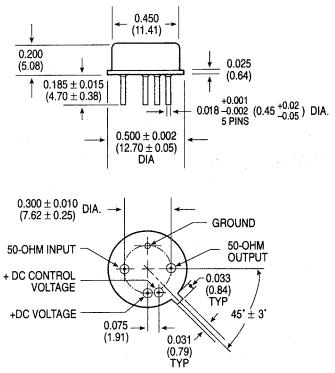
*Measured in a 50-ohm system, guaranteed at 25°C at +15.0 Vdc Nominal.

## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S" Series Burn-in Temperature (Case).....125°C
Weight 2.27 grams (0.08 oz.) max

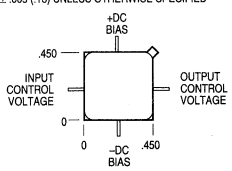
## Outline Drawing

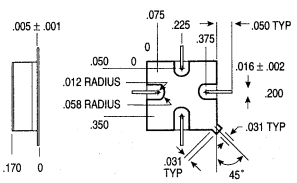
G30




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

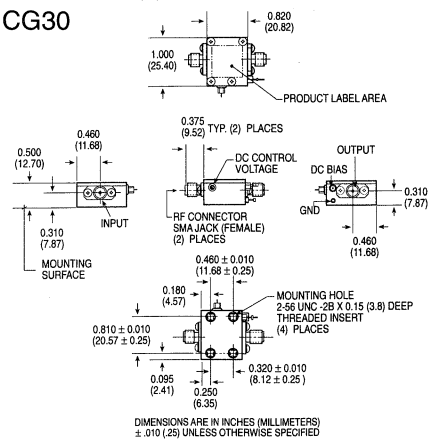
SMG30




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

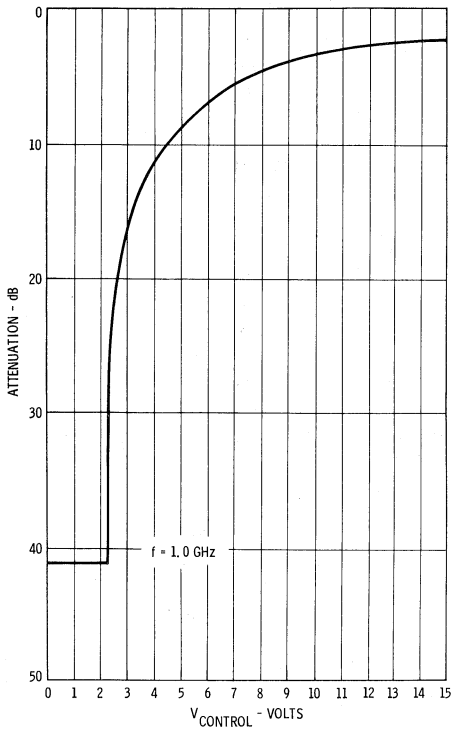
CG30



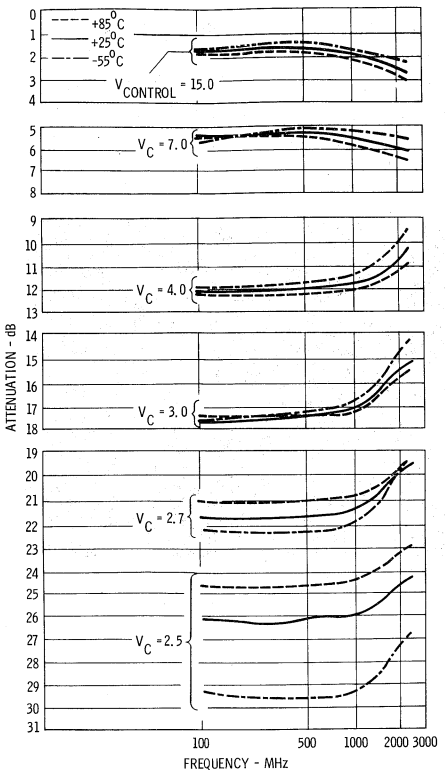

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

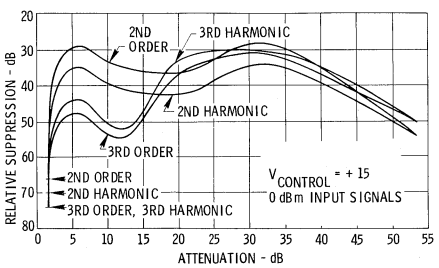
### Attenuation vs. Control Voltage



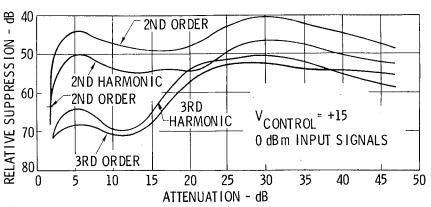

### Attenuation vs. $V_{CONTROL}$ vs. Frequency



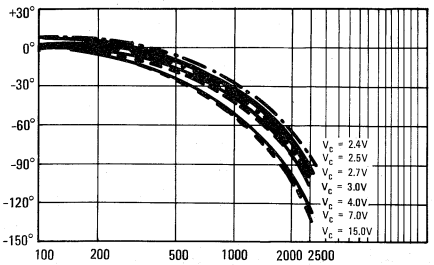

### Distortion Products vs. Attenuation at 100 MHz

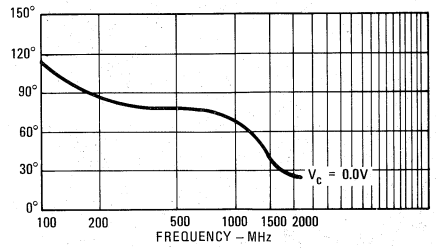



### Distortion Products vs. Attenuation at 500 MHz

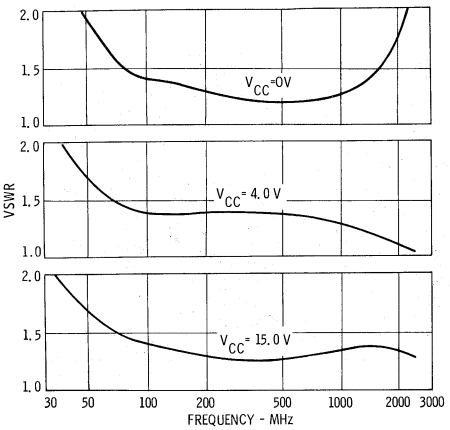



### Phase vs. $V_{CONTROL}$ vs. Frequency

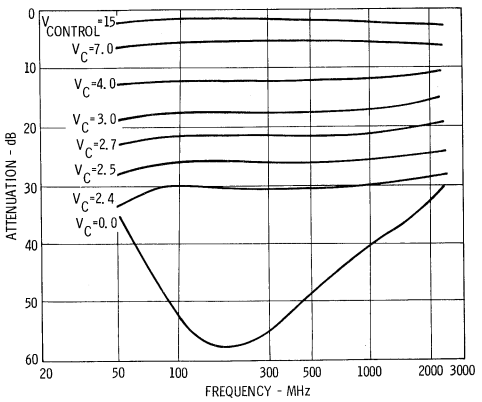



### VSWR (In/Out) vs. Frequency




### Attenuation vs. $V_{CONTROL}$ vs. Frequency




2

## Typical Switching Performance at 25°C

The switching speed of the WJ-G30 is shown in Figure 2 with the horizontal scale set at 50 µsec/div. The high speed of this attenuator is apparent, particularly when comparing it to the standard WJ-G1 attenuator shown in Figure 1. The G1 takes approximately 80 µsec to settle while the G30 takes less than 3 µsec. An expanded scale is shown in Figure 3 for the G30 with the horizontal scale set at 2 µsec/div.

The input level for Figures 1 through 3 was +7 dBm. These figures are representative of the switching characteristics. The switching speed can change to some degree as a function of attenuation and input levels.

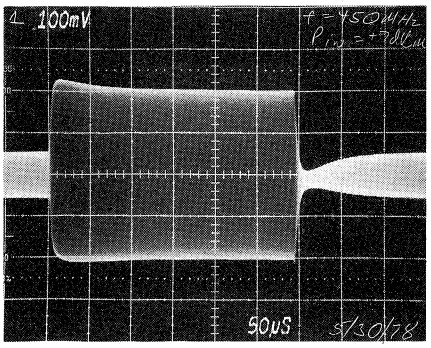



Fig. 1

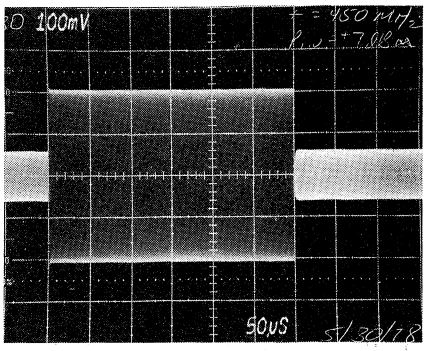



Fig. 2

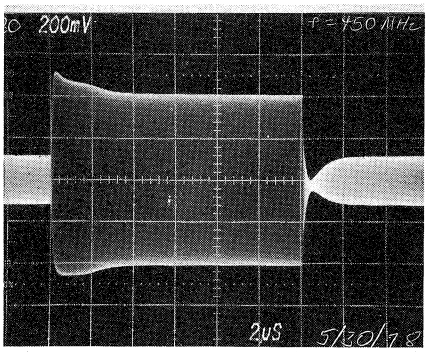
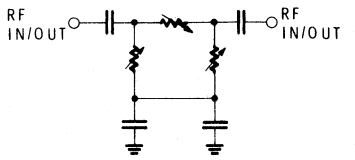


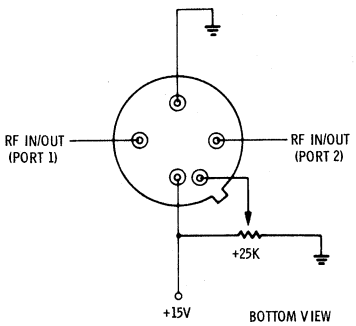

Fig. 3

## Functional Block Diagram

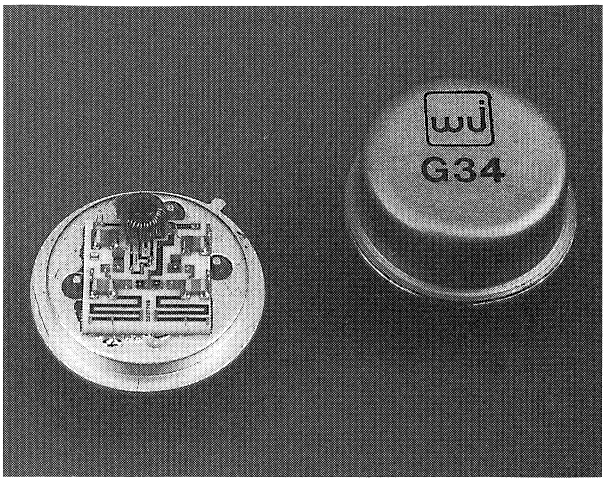



π PAD ATTENUATOR

## Typical Test Circuit



# WJ-G34/SMG34




## 500 TO 2400 MHz TO-8 VOLTAGE-CONTROLLED ATTENUATOR MODULE

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ FAST SWITCHING: < 500 nsec; 10 TO 90% (TYP.); < 2.0 µsec; 0 TO 100% (TYP.)
- ◆ HIGH DYNAMIC RANGE: 30 dB TO 2400 MHz (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ EXCELLENT FLATNESS OVER FREQUENCY: ± 0.5 dB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency Range (Min.) | 200 - 2600 MHz | 500 - 2400 MHz |
| Maximum Attenuation Available (Min.) | | |
| 500 - 1000 MHz | >40dB | 35 dB |
| 1000 - 2000 MHz | >35dB | 30 dB |
| 2000 - 2400 MHz | >30dB | 25 dB |
| Insertion Loss (Max.) | | |
| 500 - 1000 MHz | 2.5dB | 3.0 dB |
| 1000 - 2000 MHz | 3.0dB | 3.5 dB |
| 2000 - 2400 MHz | 3.3dB | 4.0 dB |
| VSWR (Max.) | | |
| 500 - 2000 MHz | < 1.3:1 | 1.8:1 |
| 2000 - 2400 MHz | < 1.5:1 | 2.0:1 |
| Flatness Over Frequency (Max.) | | |
| (Attenuation = min. to 25db, 500 - 2400 MHz) | ± 0.5dB | ±1.0 dB |
| Switching Speed (Max.) | | |
| 10 to 90% | < 500 nsec | 800 nsec |
| 0 to 100% | < 2.0 µsec | 4.0 µsec |
| Bias Voltage | | +15 V |
| Bias Current (Max.) | 6.5 mA | 10 mA |
| Control Voltage | | 0 V to +15 V |
| Control Current (Max.) | | 10 mA |

*Measured in a 50 - ohm system, guaranteed at 25°C at +15 Vdc Nominal.

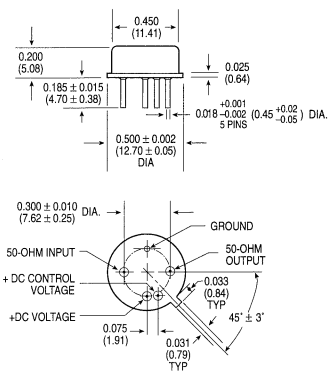
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage .....+18 volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

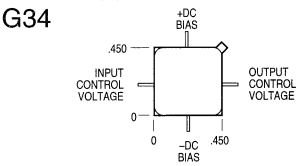
## Outline Drawing

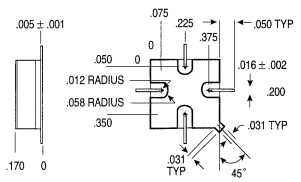
G34




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

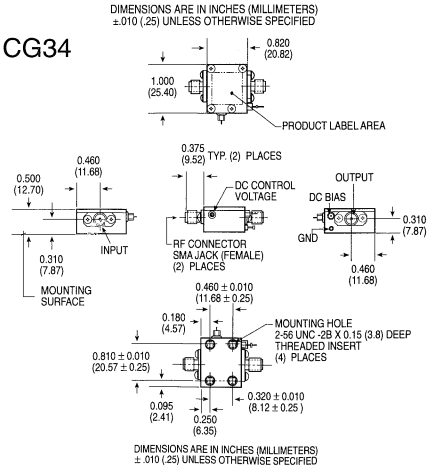
SMG34




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

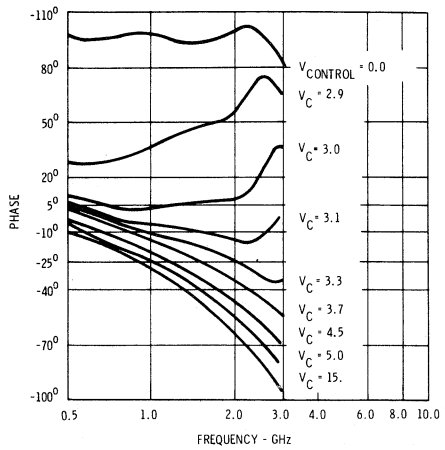
CG34



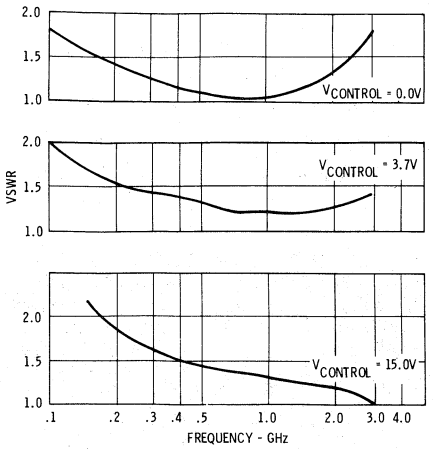

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

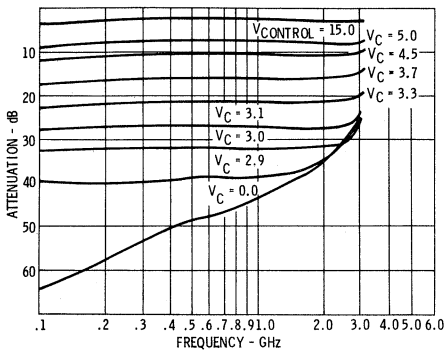
### Phase vs. Frequency vs. Attenuation



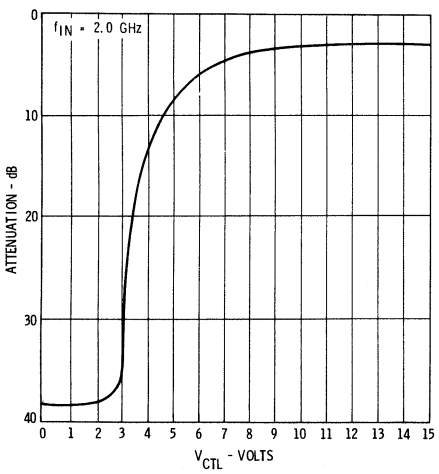

### VSWR (In/Out) vs. Frequency



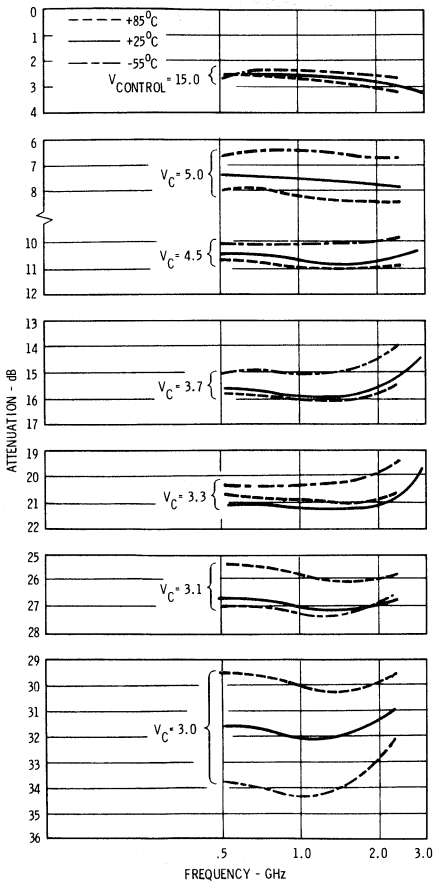

### Attenuation vs. $V_{CONTROL}$ vs. Frequency



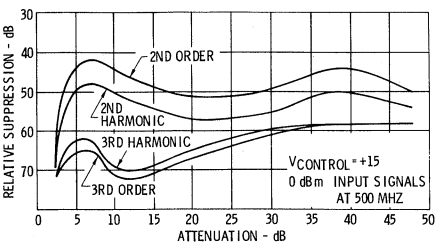

### Attenuation vs. $V_{CONTROL}$



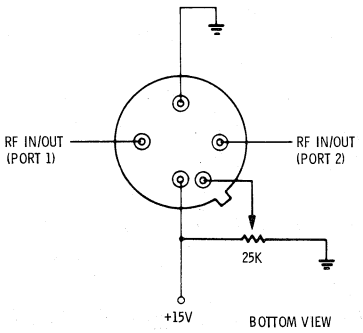

### Attenuation vs. $V_{CONTROL}$ vs. Frequency



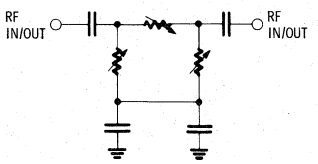

### Distortion Products vs. Frequency




# Typical Test Circuit




# Functional Block Diagram




π PAD ATTENUATOR

2

## Typical Switching Performance at 25°C

The switching speed of the WJ-G34 is shown in Figure 2 with the horizontal scale set at 2 μsec/div. The very high speed of this attenuator is apparent, and offers even quicker switching than the WJ-G30 attenuator shown in Figure 1. The G30 takes approximately 3 μsec to settle while the G34 switching is less than 1 μsec. An expanded scale is shown in Figure 3 for the G34 with the horizontal scale set at 500 μsec/div.

The input level for Figures 1 through 3 was +7 dBm. These figures are representative of the switching characteristics. The switching speed can change to some degree as a function of attenuation and input levels.

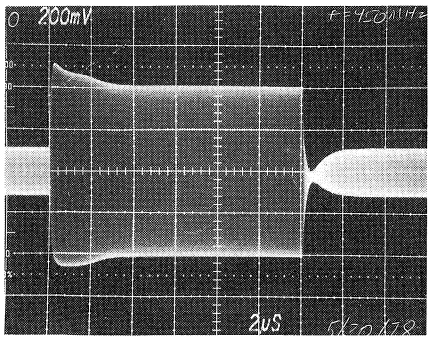



Fig. 1

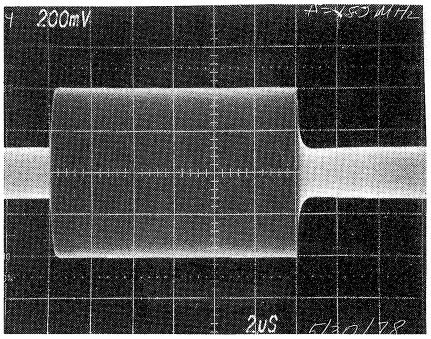



Fig. 2

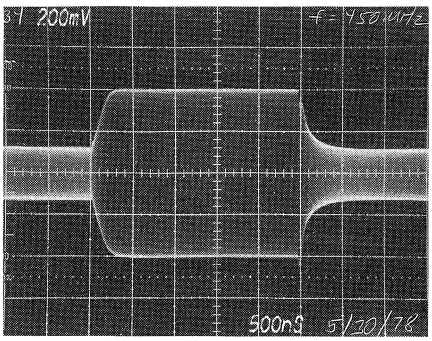



Fig. 3

# WJ-G40/SMG40

## 500 TO 4000 MHz TO-8 VOLTAGE-CONTROLLED ATTENUATOR MODULE

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE BAND PERFORMANCE
- ◆ EXCELLENT INSERTION LOSS: < 3.0 dB (TYP.)
- ◆ HIGH DYNAMIC RANGE: 30 dB TO 3000 MHz (TYP.)
- ◆ FAST SWITCHING: < 500 nsec 10 to 90% (TYP.) < 2 µsec 0 TO 100% (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency Range (Min.) | 500 - 4200 MHz | 500 - 4000 MHz |
| Maximum Attenuation Available (Min.) | | |
| 500 - 1000 MHz | > 39 dB | 34 dB |
| 1000 - 2000 MHz | > 33 dB | 28 dB |
| 2000 - 3000 MHz | > 30 dB | 25 dB |
| 3000 - 4000 MHz | > 28 dB | 23 dB |
| Insertion Loss (Max.) | | |
| 500 - 2000 MHz | 2.0 dB | 2.5 dB |
| 2000 - 4000 MHz | 3.0 dB | 3.5 dB |
| VSWR (Max.) | | |
| 500 - 3000 MHz | ≤ 1.5:1 | 2.2:1 |
| 3000 - 4000 MHz | ≤ 1.7:1 | 2.2:1 |
| Flatness Over Frequency (Max.) | | |
| Attenuation = min. to 20dB | | |
| 500 - 3000 MHz | ± 0.6 dB | ± 1.2 dB |
| 500 - 4000 MHz | ± 1.4 dB | ± 2.0 dB |
| Switching Speed (Max.) | | |
| 10 to 90% | < 500 nsec | 800 nsec |
| 0 to 100% | < 2 µsec | 4.0 µsec |
| Bias Voltage | | +15V |
| Bias Current (Max.) | 8.0 mA | 12 mA |
| Control Voltage | | 0V to +15V |
| Control Current (Max.) | 6.0 mA | 10 mA |

*Measured in a 50 - ohm system, guaranteed at 25°C at +15.0 Vdc Nominal.

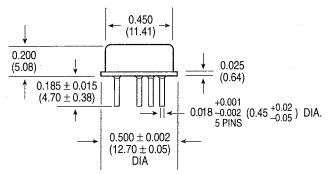
## Absolute Maximum Ratings

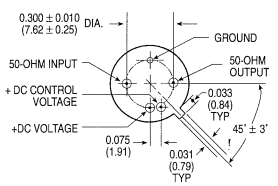
Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+18 Volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....200 Milliwatts
Maximum Peak Power .....(3 µsec Max.) 1 Watt
"S" Series Burn-In Temperature. (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

## Outline Drawing

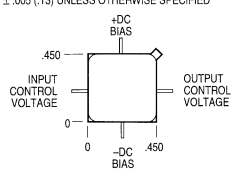
G40

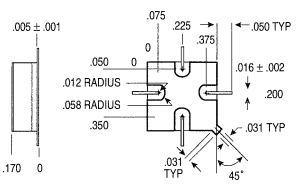



DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

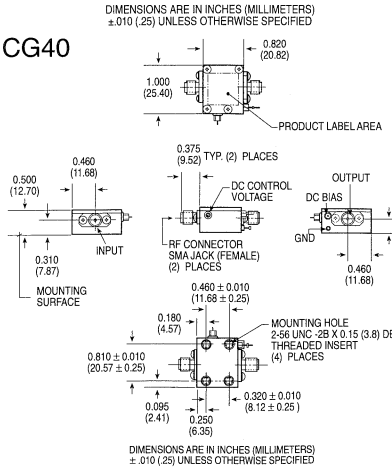
SMG40




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

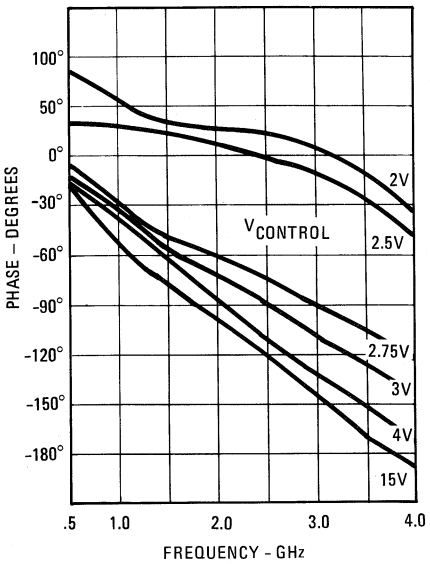
CG40



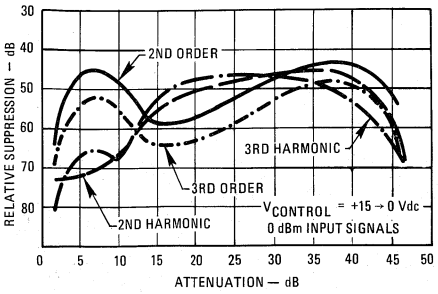

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

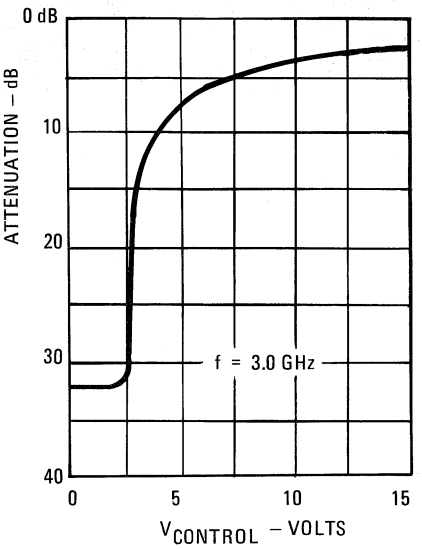
### Phase vs. $V_{Control}$ vs. Frequency



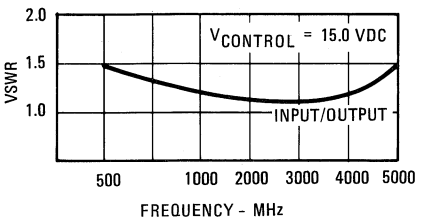

### Distortion Products vs. Attenuation at 500 MHz

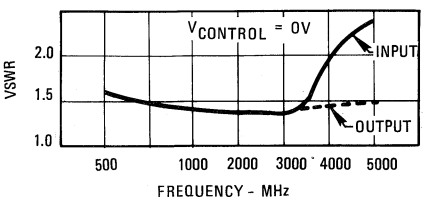



### Attenuation vs. Control Voltage

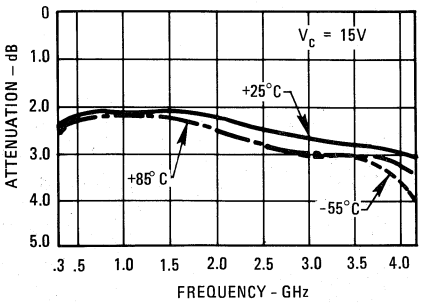


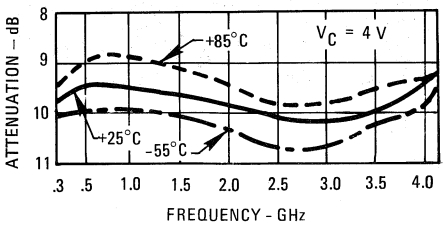

### VSWR

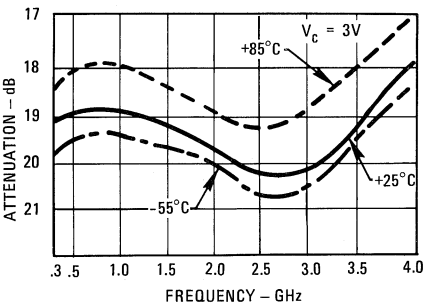


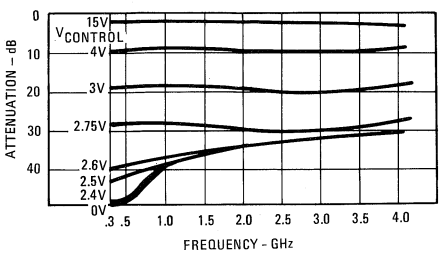




### Attenuation vs. $V_{Control}$ vs. Frequency




2

## Typical Switching Performance at 25°C

The switching speed of the WJ-G40 is shown in Figure 1 with the horizontal scale set at 2 μS. The very high speed of this attenuator is apparent and an expanded view of the switching is shown in Figure 2. Note the WJ-G40 settles in less than 1 μS.

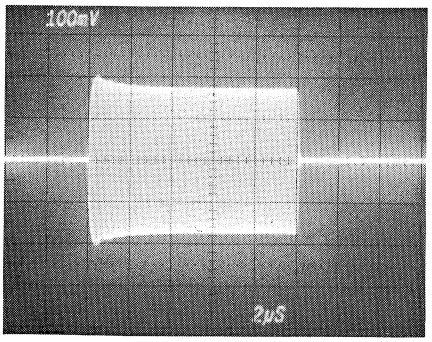



**Fig. 1**

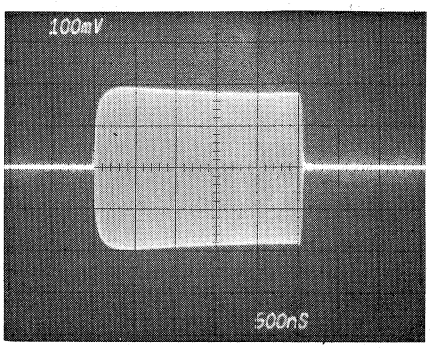
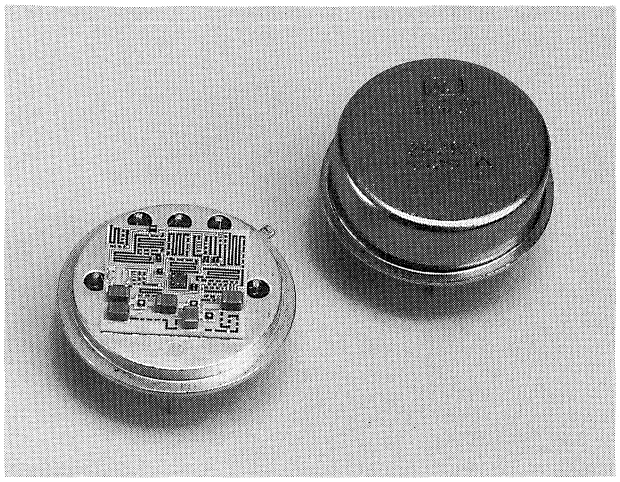



**Fig. 2**

# WJ-RG20/SMRG20



## 10 TO 2000 MHz
## TO-8B LINEARIZED VOLTAGE CONTROLLED ATTENUATOR

- ◆ ATTENUATOR AND LINEARIZER FULLY INTEGRATED IN ONE PACKAGE
- ◆ HIGH DYNAMIC RANGE
- ◆ WIDE BANDWIDTH
- ◆ LOW INSERTION LOSS

## Specifications*

| Characteristics | Typical | Guaranteed (-54°C to +85°C) |
|---|---|---|
| Frequency | 5-2200 MHz | 10-2000 MHz |
| Insertion Loss (Max.) | | |
| 10-1000 MHz | 2.7 dB | 3.5 dB |
| 1000-2000 MHz | 3.7 dB | 4.5 dB |
| Insertion Flatness (Max.) | ±0.7 dB | ±1.0 dB |
| Maximum Attenuation (Min.) | | |
| 10-1000 MHz | 26.5 dB | 24.5 dB |
| 1000-2000 MHz | 23 dB | 22 dB |
| Linearity from 0 to 25 dB (Max.) | ±1.3 dB | ±2.0 dB |
| Switching Speed 10-90% (Max.) | 75 µsec | 125 µsec |
| VSWR | | |
| Input | 1.6:1 | 2.7:1 |
| Output | 1.4:1 | 2.0:1 |
| Bias Current | | |
| V+ = +15 Vdc | | 35 mA |
| V- = -15 Vdc | | 5 mA |
| Control Current (0 to -10 Vdc) | 16 mA | 20 mA |

* Measured in a 50-ohm system at ±15 Vdc Nominal.

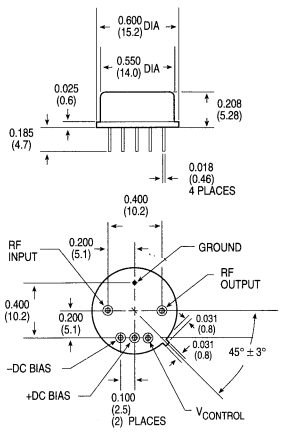
## Absolute Maximum Ratings

Storage Temperature ..... -55°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Voltage ..... +17 Volts
Maximum Continuous RF Input Power ..... 100 Milliwatts
Maximum Short-Term RF Input Power (1 Minute Max.) ..... 200 Milliwatts
Maximum Peak Power ..... 1 Watt(3 µsec Max.)
"S" Series Burn-In Temperature (Case) ..... 125°C

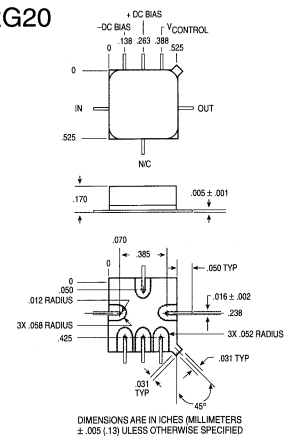
Weight: 3.0 grams (0.11 oz.)

## Outline Drawings

RG20



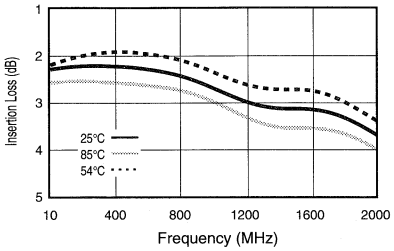

SMRG20



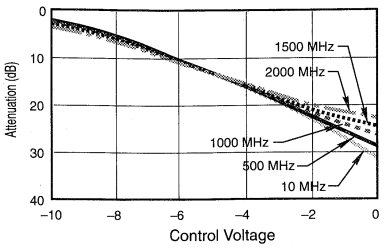

DIMENSIONS ARE IN ICHES (MILLIMETERS ± .005 (.13) ULESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

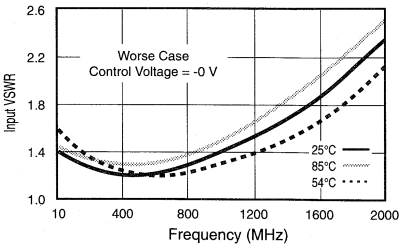
### Insertion Loss



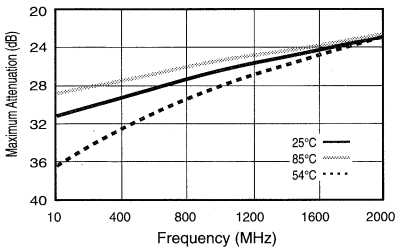

### Linearity Over Frequency



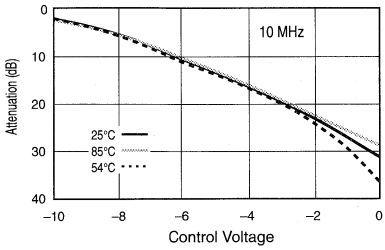

### Input VSWR



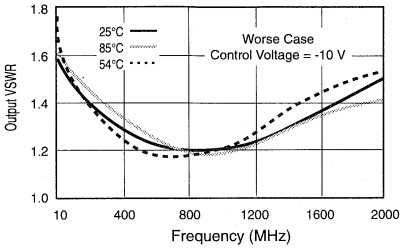

### Maximum Attenuation




### Linearity Over Temperature




### Output VSWR




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 1.6 | 1.6 | −2.3 |
| 500.0 | 1.3 | 1.2 | −2.2 |
| 1000.0 | 1.5 | 1.2 | −2.6 |
| 1500.0 | 1.9 | 1.4 | −3.1 |
| 2000.0 | 2.3 | 1.6 | −3.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 10.0 | .229 | −50 | .772 | 11 | .774 | 11 | .229 | −48 |
| 500.0 | .137 | −146 | .777 | −72 | .780 | −71 | .105 | −128 |
| 1000.0 | .201 | 98 | .738 | −142 | .732 | −141 | .088 | 86 |
| 1500.0 | .299 | −13 | .701 | 149 | .701 | 149 | .163 | −46 |
| 2000.0 | .388 | −123 | .655 | 78 | .640 | 80 | .221 | −146 |

### $V_{CC}$ = 15.0 V

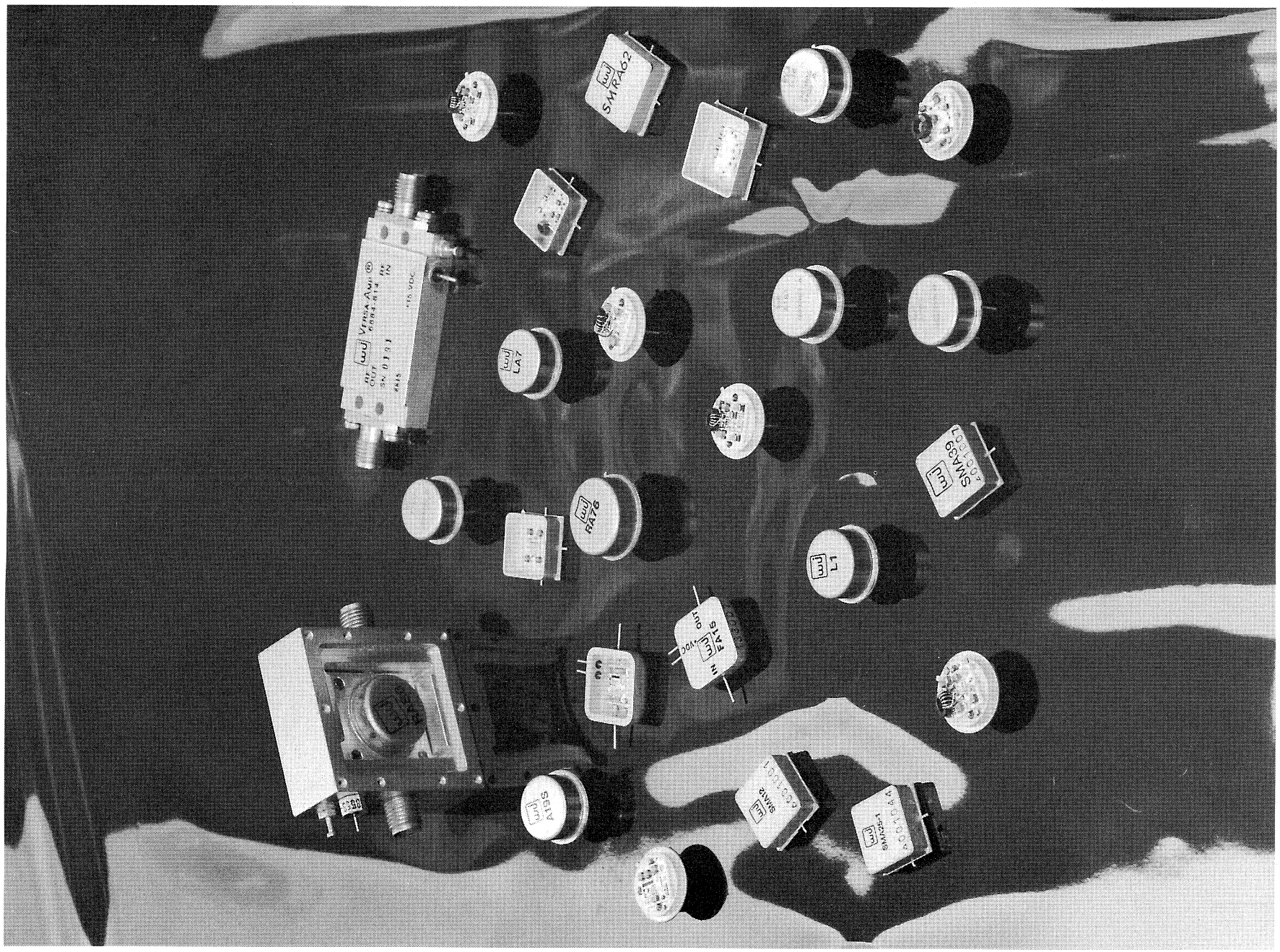
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 10.0 | 1.4 | 1.5 | −30.8 |
| 500.0 | 1.2 | 1.1 | −28.6 |
| 1000.0 | 1.4 | 1.1 | −26.2 |
| 1500.0 | 1.7 | 1.1 | −24.4 |
| 2000.0 | 2.3 | 1.1 | −22.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG3 | MAG | ANG | MAG | ANG |
| 10.0 | .180 | −75 | .029 | 3 | .028 | 3 | .185 | −65 |
| 500.0 | .075 | 171 | .037 | −35 | .037 | −35 | .028 | −64 |
| 1000.0 | .153 | 81 | .049 | −87 | .047 | −87 | .035 | −96 |
| 1500.0 | .259 | −20 | .060 | −145 | .060 | −144 | .059 | −146 |
| 2000.0 | .385 | −122 | .073 | 154 | .072 | 155 | .043 | 100 |

# *Linearizers*

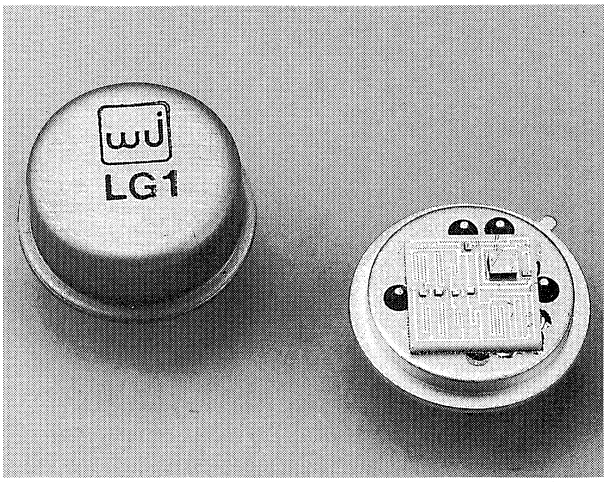




# WJ-LG1/SMLG1

## TO-8 THIN-FILM LINEARIZER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE TEMPERATURE OPERATION
- ◆ YIELDS LINEAR ATTENUATION (dB) FOR LINEAR CONTROL VOLTAGE




### Linearity Specifications*

| Temperature | Typ. | Guaranteed Max. |
|---|---|---|
| 25°C | < ±1.0 dB | ±1.5 dB |
| - 54°C to +85°C | < ±1.5 dB | ±2.0 dB |

### Typical Current Drain

| | Control Voltage = -10 V (Min. Attenuation) | Control Voltage = 0 V (Max. Attenuation) |
|---|---|---|
| V- | 5 mA | 5 mA |
| V+ | 24 mA | 11 mA |
| $V_{CON}$ | 15 mA | 2.5 mA |
| Combination of LGI Plus GI | | |
| V- | 5 mA | 5 mA |
| V+ | 31 mA | 21 mA |
| $V_{CON}$ | 15 mA | 2.5 mA |

*Frequency: 10 - 1000 MHz; attenuation range: 3 to 20 dB

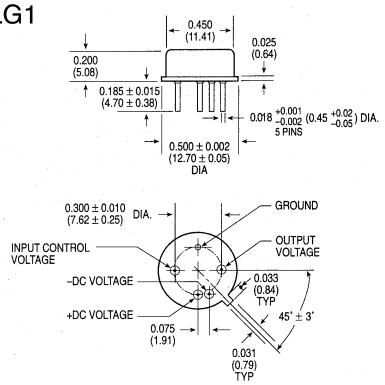
### Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
"S" Series Burn-in Temperature (Case).....125°C

Weight approximately 2.0 grams (0.07oz.)

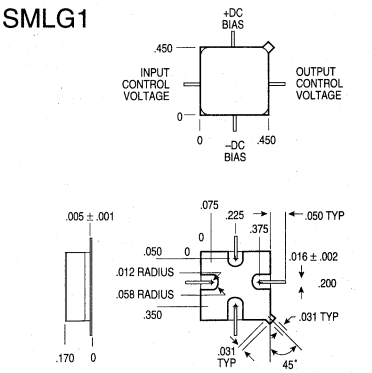
### Outline Drawing

LG1



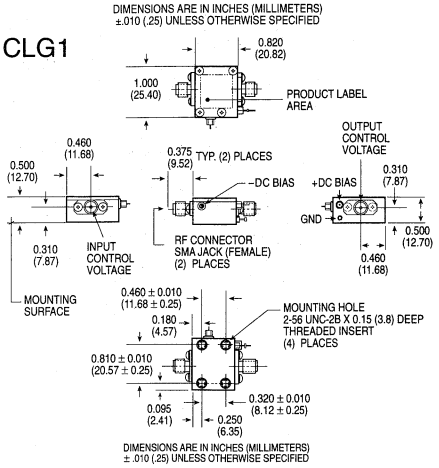

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMLG1

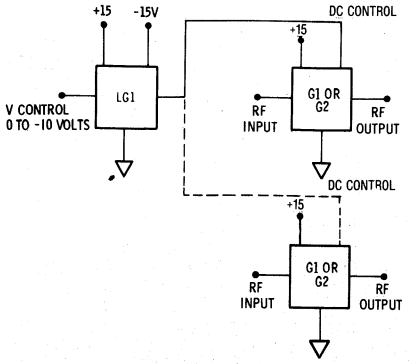



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CLG1

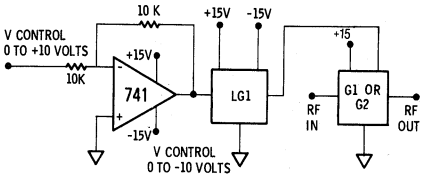



DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED



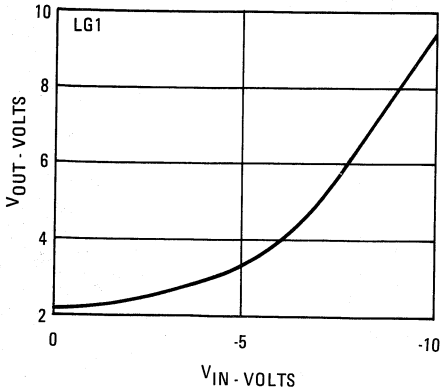

The LG1 can drive two G1's or G2's as shown above. The LG1 has a response time of 30 µs over its entire band of control voltage. The response time of the G1 or G2 is typically 60-100 µs.

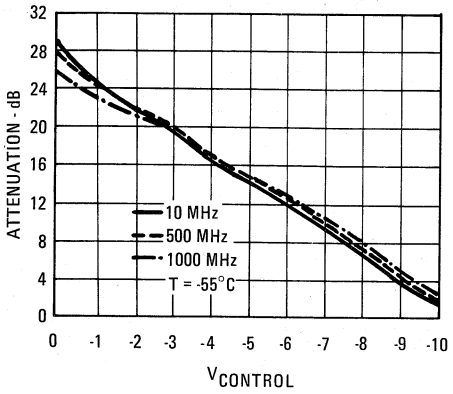
If a positive control voltage is desired the following circuit may be used. The op-amp buffer can also generate a very low source resistance in the order of thousands of an ohm.



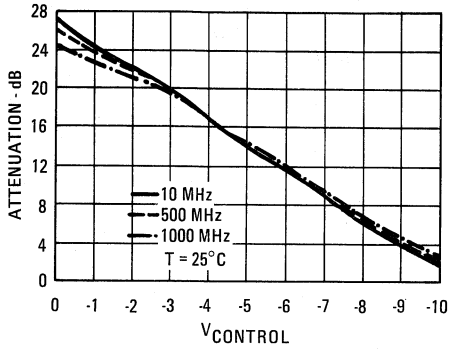

# Typical Performance at 25°C

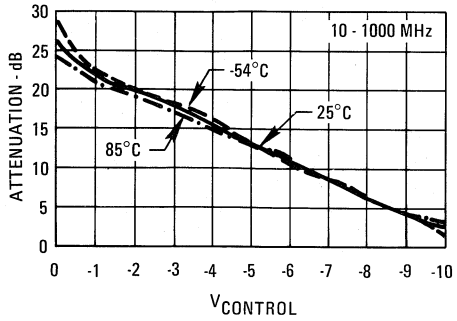
## Output Voltage vs. Input Voltage



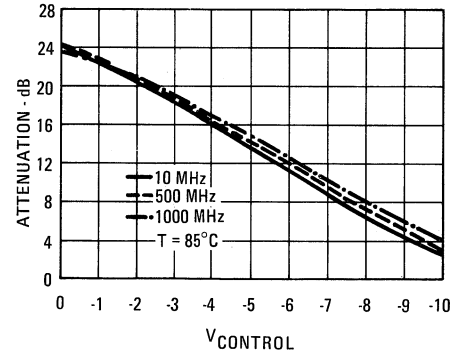



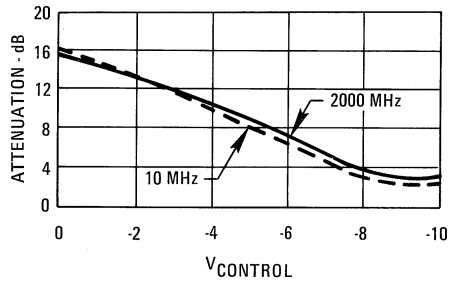

## Attenuation of LG1 and G1 in Cascade vs. Control Voltage




## Attenuation of LG1 and G2 in Cascade vs. Control Voltage

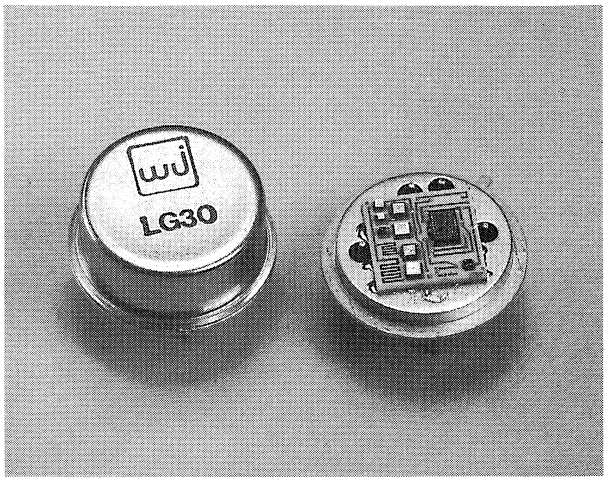



3

# WJ-LG30/SMLG30

## TO-8 THIN FILM LINEARIZER FOR THE WJ-G30




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ WIDE TEMPERATURE OPERATION
- ◆ YIELDS LINEAR ATTENUATION (dB) FOR LINEAR CONTROL VOLTAGE

### Linearity Specifications*

| Temperature | Typical | Guaranteed Maximum |
|---|---|---|
| 25° | ± 1.0 dB | ± 1.5 dB |
| -54°C to +85°C | < ± 1.5 dB | ± 2.0 dB |

*Frequency: 100-2000 MHz; attenuation range: 3 to 25 dB

Typical Current Drain

| | Control Voltage= 0 V (Max. Attenuation) | Control Voltage= 15 V (Min. Attenuation) |
|---|---|---|
| V- | 3 mA | 15 mA |
| V+ | 5 mA | 14 mA |
| $V_{CON}$ | 6 mA | 12 mA |
| Combination of LG30 Plus G30 | | |
| V- | 3 mA | 15 mA |
| V+ | 12 mA | 21 mA |
| $V_{CON}$ | 6 mA | 12 mA |

### Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
"S" Series Burn-in Temperature (Case).....125°C

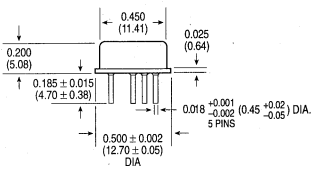
The WJ-G30 module is a voltage controlled voltage source. The WJ-LG30 is designed to drive the WJ-G30, a voltage controlled attenuator module. The combination of the LG30 and G30 modules has a typical attenuation characteristic which is linear with control voltage provided the following conditions are met:

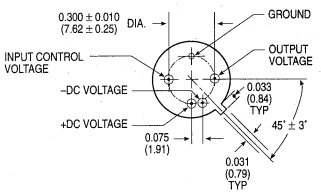
1. positive supply = 15V ± 1%
2. negative supply = -15V ± 1%
3. source resistance of variable supply ≤ 1 Ω

The LG30 has a response time of 2 µs over its entire band of control voltage. The response time of the G30 is typically .2µs.

### Outline Drawing

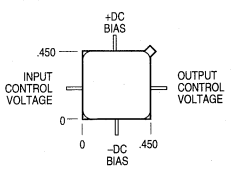
LG30

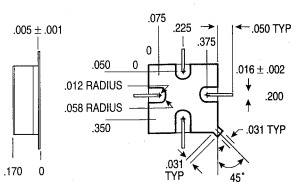



DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

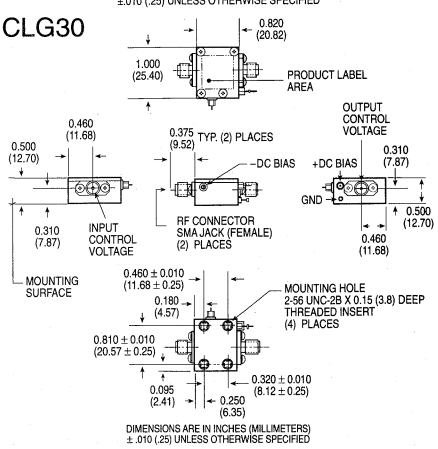
SMLG30




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

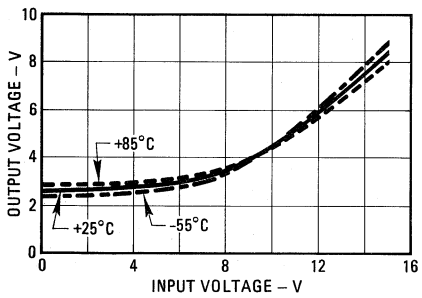
CLG30



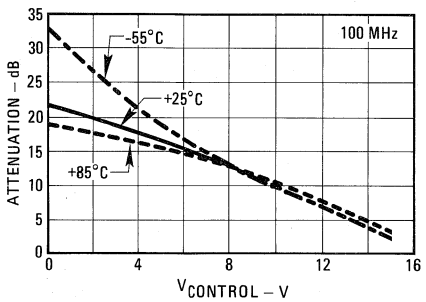

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

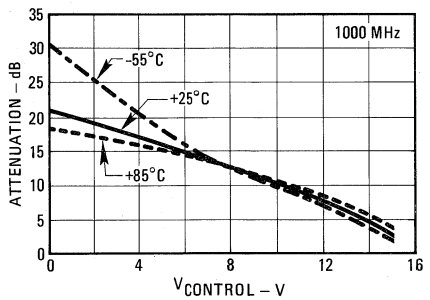
## Typical Performance at 25°C

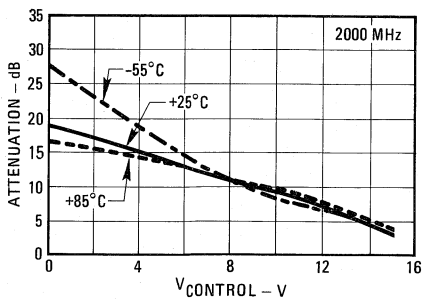
### $V_{Out}$ vs. $V_{Control}$




### Attenuation vs. $V_{Control}$

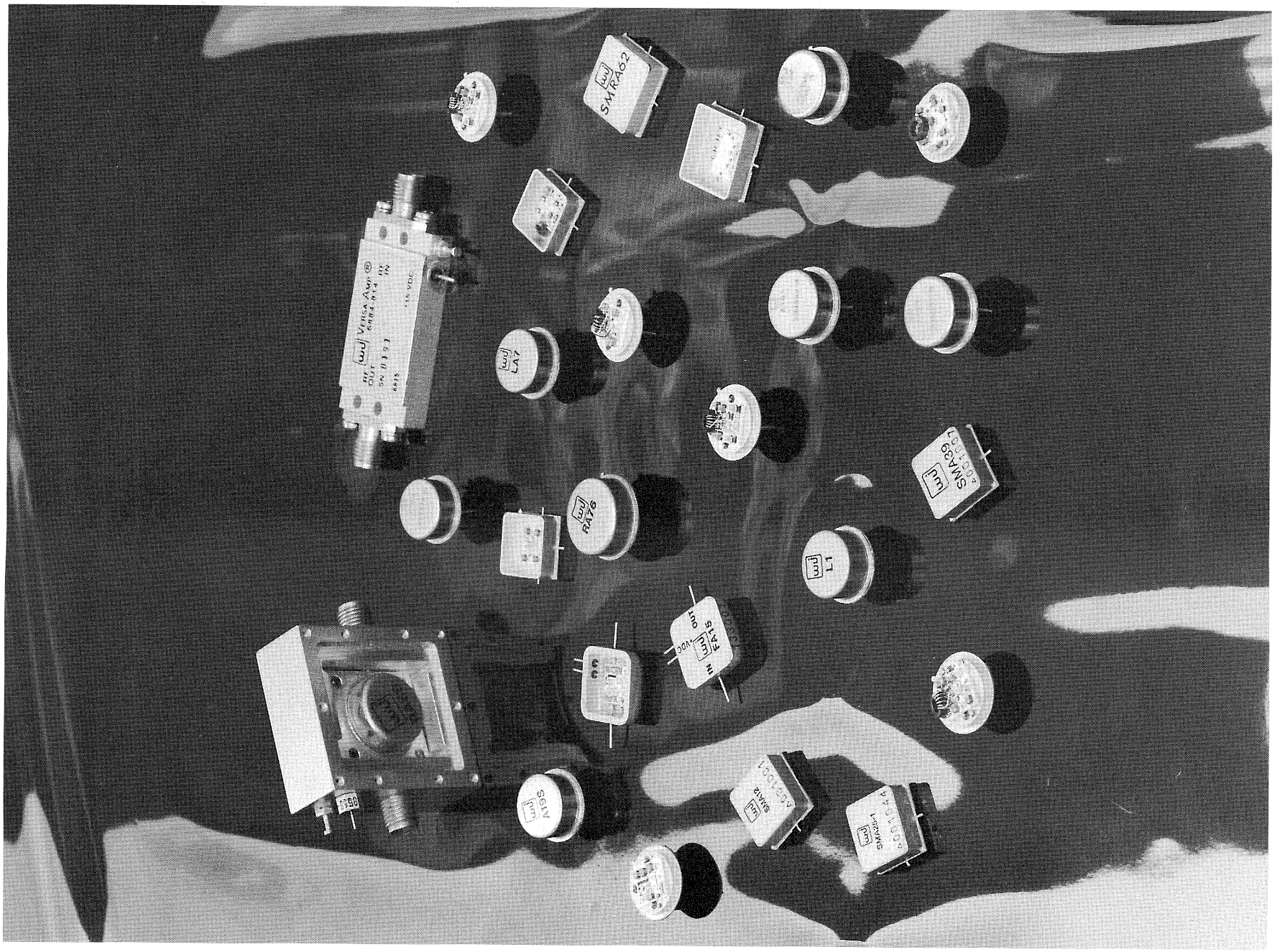


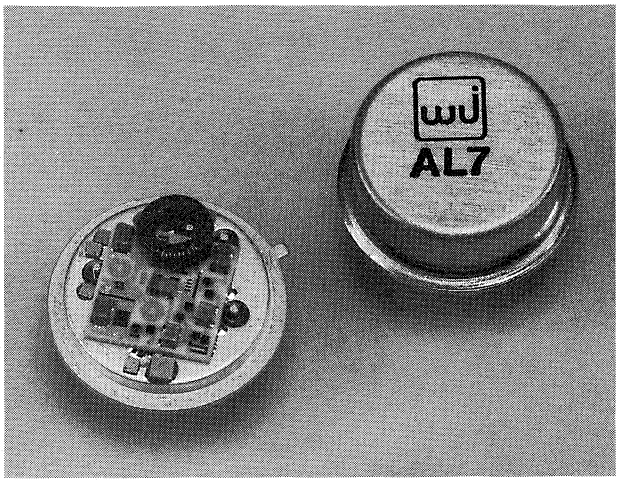
# *Limiting Amplifiers*





# WJ-AL7 / SMAL7

## 50 to 500 MHz
## TO-8 CASCADABLE
## LIMITING AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING: GOOD EVEN-ORDER SUPPRESSION
- ◆ HIGH GAIN: 13 dB (TYP.)
- ◆ LOW VSWR: < 1.5:1 (TYP.)
- ◆ FAST PULSE RECOVERY TIME: < 50 NSEC

### Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 20-550 MHz | 50-500 MHz | 50-500 MHz |
| Small Signal Gain (Min.) | 13.0 dB | 12.0 dB | 11.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.)[3] | | | |
| 50-300 MHz | 5.0 dB | 6.0 dB | 6.5 dB |
| 300-500 MHz | 5.5 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| 50-500 MHz | -1.5 dBm | -5.0 dBm | -7.0 dBm |
| Output Limiting Level (Max.) | | | |
| Pin = +10 dBm | +0.5 dBm | +1.5 dBm | +2.5 dBm |
| VSWR | | | |
| Input | 1.1:1 | 1.7:1 | 1.7:1 |
| Output | < 1.5:1 | 2.0:1 | 2.0:1 |
| DC Current at 15 Volts (Max.) | 54 mA | 57 mA | 59 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CAL7 is a standard WJ-AL7 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.
2. Third-Order I.P. (linear region) +20 dBm (Typ.)
3. Linear Region

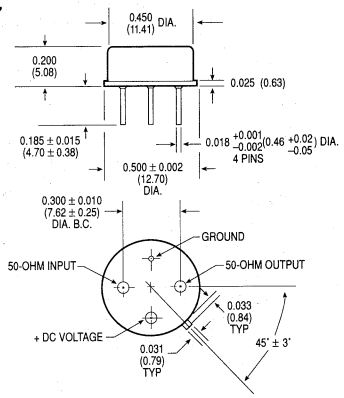
### Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+13 dBm
Maximum Short Term RF Input Power (1 Minute Max.)..... 50 Milliwatts
Maximum Peak Power .....0.5 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

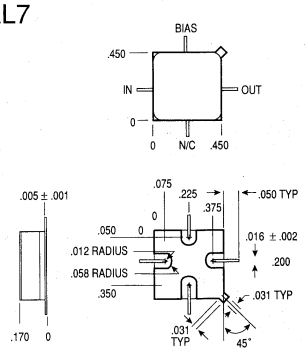
### Outline Drawings

AL7



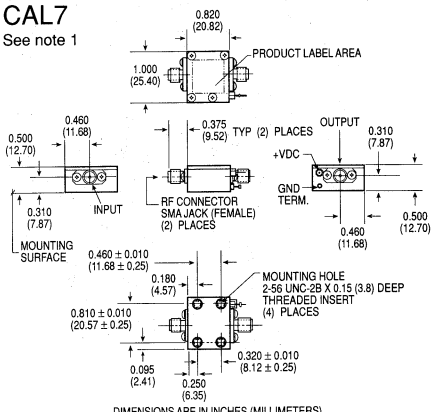

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMAL7




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CAL7
See note 1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

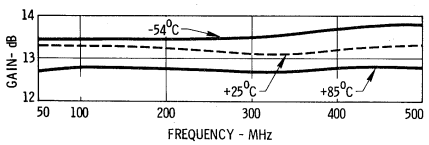
The model WJ-AL7 incorporates a balanced-bridge Schottky diode output limiter using thin-film assembly techniques integrated with a medium-level input 20-500 MHz, 14 dB gain amplifier. The balanced-bridge yields symmetrical clipping of the signal which reduces even-order harmonic distortion. Its functional schematic is shown in Figure 1. Diodes D1 through D4 are used to provide the primary limiting, while diodes D5 through D8 provide hard limiting.

The WJ-AL7 is vertually identical to the WJ-LA7 except that the amplifer is placed in front of the limiter as opposed to the limiter in front of the amplifier. The pulse-recovery time is therefore the same. (Under 50 nsec for a single unit).

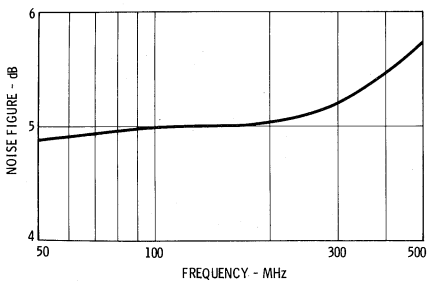
Reversing the positions results in an improved input noise figure and a reduced output power level.

The units are designed for cascaded operation with each additional stage offering approximatley 12 dB of increased limiting range.

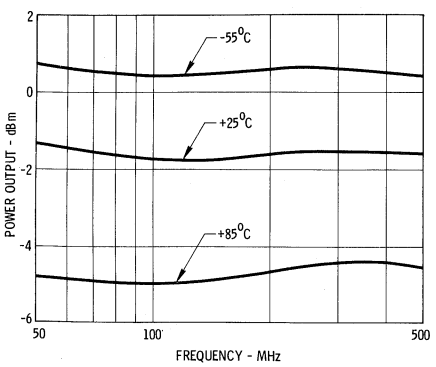
### Gain (Linear)




### Noise Figure

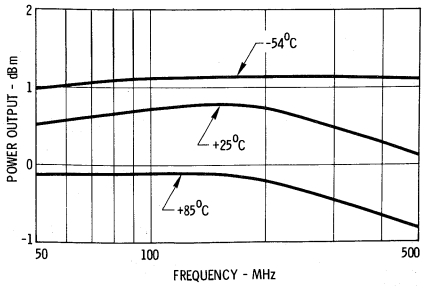



### Power Output*

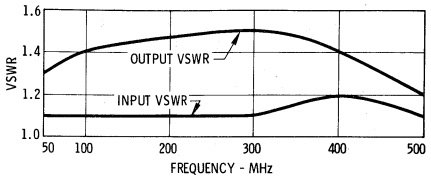



*at 1 dB Gain Compression

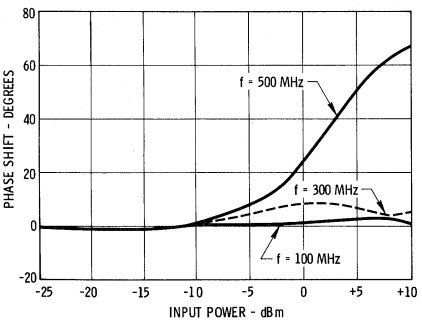
### Power Output in Saturation



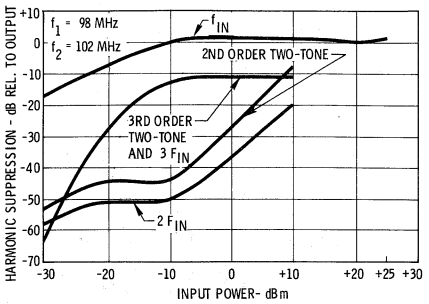

### VSWR



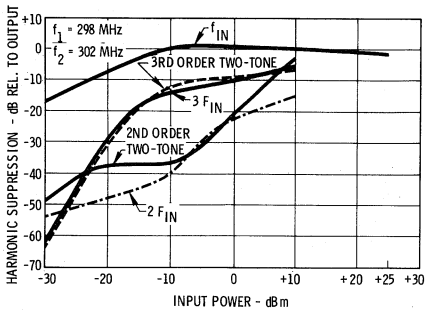

### Phase Shift



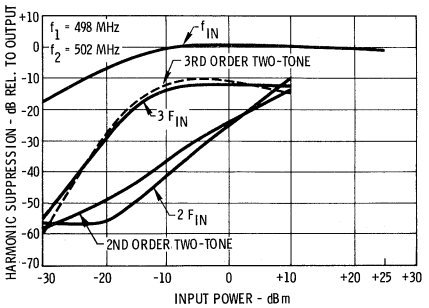

### Harmonic Suppression (Curve A)




### Harmonic Suppression (Curve B)




### Harmonic Suppression (Curve C)




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 3.1 | 3.1 | 12.7 |
| 5.0 | 1.2 | 2.1 | 13.2 |
| 10.0 | 1.1 | 1.6 | 13.7 |
| 50.0 | 1.1 | 1.4 | 13.9 |
| 100.0 | 1.1 | 1.4 | 13.8 |
| 200.0 | 1.2 | 1.4 | 13.7 |
| 300.0 | 1.3 | 1.4 | 13.6 |
| 400.0 | 1.3 | 1.5 | 13.8 |
| 500.0 | 1.4 | 1.4 | 13.9 |
| 600.0 | 1.8 | 1.4 | 13.9 |
| 700.0 | 3.2 | 1.4 | 13.1 |

### Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.560 W
Junction Temperature Rise Above Case $T_{jc}$ ... 25.2°C

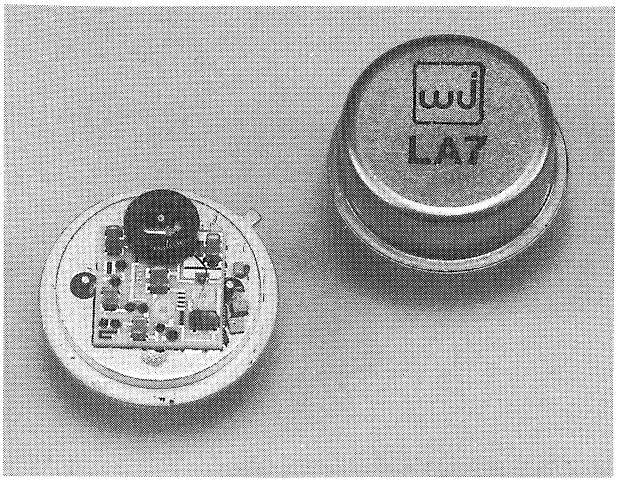
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .507 | -101 | 4.309 | -91 | .085 | 31 | .516 | -36 |
| 5.0 | .108 | -84 | 4.560 | -144 | .084 | 8 | .359 | -41 |
| 10.0 | .066 | -63 | 4.815 | -163 | .083 | 3 | .240 | -38 |
| 50.0 | .044 | -54 | 4.948 | 170 | .084 | -4 | .172 | -28 |
| 100.0 | .051 | -74 | 4.879 | 153 | .084 | -9 | .169 | -41 |
| 200.0 | .092 | -121 | 4.839 | 124 | .088 | -20 | .172 | -74 |
| 300.0 | .114 | -162 | 4.789 | 96 | .094 | -33 | .181 | -108 |
| 400.0 | .125 | 152 | 4.898 | 66 | .101 | -48 | .190 | -146 |
| 500.0 | .166 | 99 | 4.935 | 35 | .110 | -67 | .181 | 172 |
| 600.0 | .286 | 37 | 4.930 | -1 | .116 | -90 | .149 | 110 |
| 700.0 | .526 | -16 | 4.529 | -41 | .111 | -119 | .160 | 11 |

4

# WJ-LA7 / SMLA7

## 50 to 500 MHz
## TO-8 CASCADABLE
## LIMITING AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING, GOOD EVEN-ORDER SUPPRESSION
- ◆ HIGH OUTPUT LEVEL: +11.5 dBm (TYP.)
- ◆ HIGH THIRD-ORDER INTERCEPT POINT: +28 dBm (TYP.)
- ◆ FAST PULSE RECOVERY TIME: <50 NSEC

## Specifications *

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 20-550 MHz | 50-500 MHz | 50-500 MHz |
| Small Signal Gain (Min.) | 12.6 dB | 12.0 dB | 11.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | | | |
| 50-300 MHz | 7.0 dB | 8.0 dB | 8.5 dB |
| 300-500 MHz | 7.5 dB | 8.5 dB | 9.0 dB |
| Power Output at 1 dB Compression (Min.) | | | |
| 50-300 MHz | +12.0 dBm | +11.0 dBm | +8.0 dBm |
| 300-500 MHz | +11.5 dBm | +10.0 dBm | +7.0 dBm |
| Output Limiting Level (Max.) Pin = +20 dBm | +15.5 dBm | +16.0 dBm | +17.0 dBm |
| VSWR (Max.) Input/Output | 1.3:1 | 1.7:1 | 2.0:1 |
| DC Current (Max.) at 15 Volts | 54 mA | 56 mA | 58 mA |

* Measured in a 50-ohm system at 15 Vdc Nominal.

Notes:

1. WJ-CLA7 is a standard WJ-LA7 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Third Order Two Tone Intercept Point .....+28 dBm (Typ.) Linear Region Only

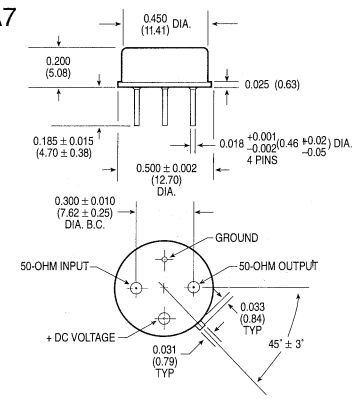
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+23 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....400 Milliwatts
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz)

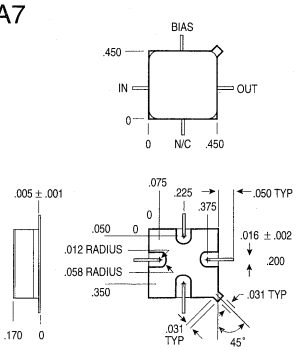
## Outline Drawings

LA7



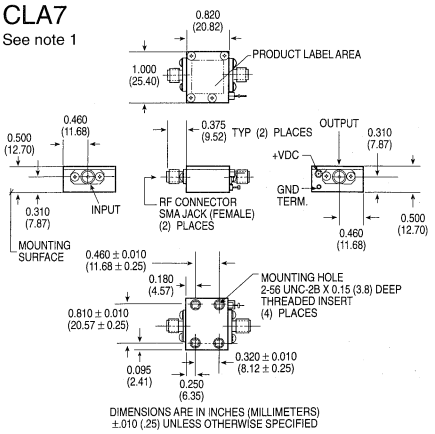

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMLA7




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

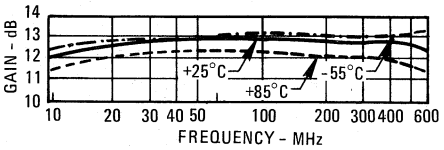
CLA7
See note 1



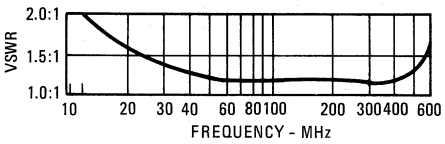

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

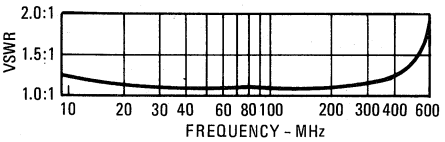
### Gain



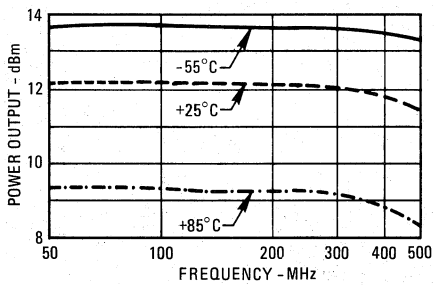

### VSWR Output




### VSWR Input

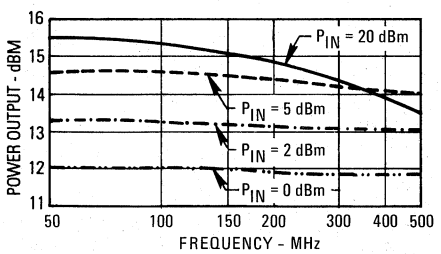



### Power Output Over Temperature*

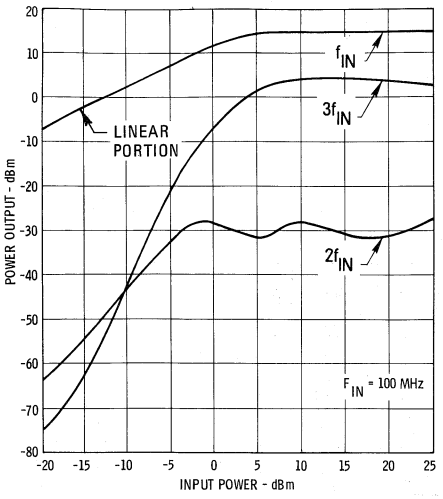


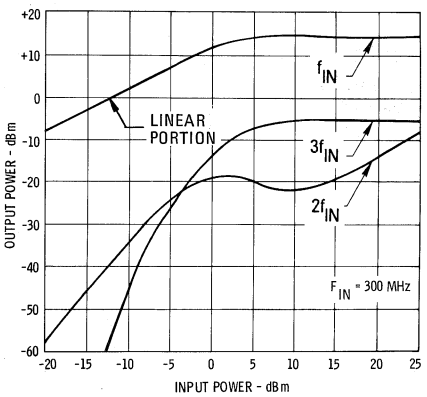

*at 1 dB Gain Compression

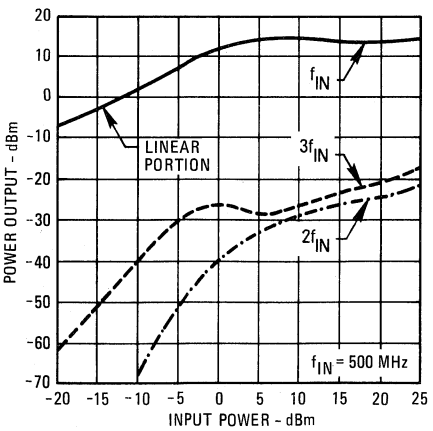
### Power Output vs. Frequency



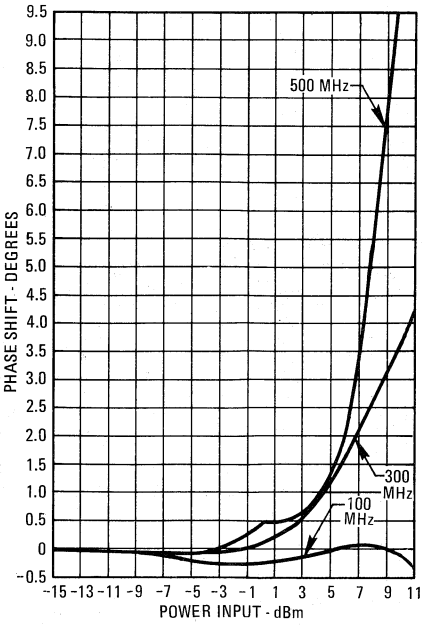

### Power Output and Distortion Products




### Phase Shift vs. Input Power




4

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.7 | 1.2 | 11.5 |
| 10.0 | 1.7 | 1.1 | 12.1 |
| 50.0 | 1.1 | 1.1 | 12.6 |
| 100.0 | 1.1 | 1.1 | 12.6 |
| 200.0 | 1.2 | 1.2 | 12.7 |
| 300.0 | 1.3 | 1.2 | 12.7 |
| 400.0 | 1.3 | 1.1 | 12.9 |
| 500.0 | 1.3 | 1.1 | 13.0 |
| 600.0 | 1.1 | 1.4 | 13.0 |
| 700.0 | 1.6 | 2.4 | 12.1 |

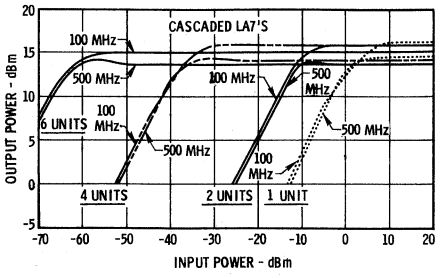
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .455 | −56 | 3.753 | −137 | .087 | 9 | .102 | 147 |
| 10.0 | .256 | −67 | 4.044 | −159 | .091 | 5 | .059 | 136 |
| 50.0 | .058 | −60 | 4.255 | 172 | .094 | −1 | .042 | 99 |
| 100.0 | .047 | −32 | 4.281 | 156 | .096 | −5 | .051 | 69 |
| 200.0 | .075 | −39 | 4.310 | 126 | .102 | −13 | .072 | 33 |
| 300.0 | .113 | −67 | 4.332 | 98 | .109 | −23 | .081 | 8 |
| 400.0 | .138 | −95 | 4.420 | 68 | .118 | −35 | .063 | −12 |
| 500.0 | .125 | −122 | 4.475 | 37 | .126 | −49 | .042 | 30 |
| 600.0 | .065 | −98 | 4.487 | 1 | .135 | −68 | .172 | 49 |
| 700.0 | .225 | −68 | 4.029 | −41 | .133 | −92 | .416 | 14 |

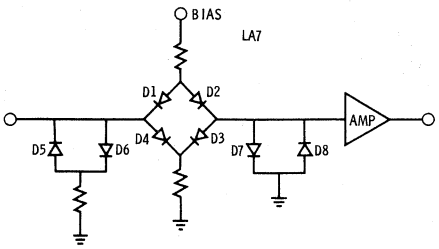
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.560 W
Junction Temperature Rise Above Case $T_{jc}$ ... 25.2°C

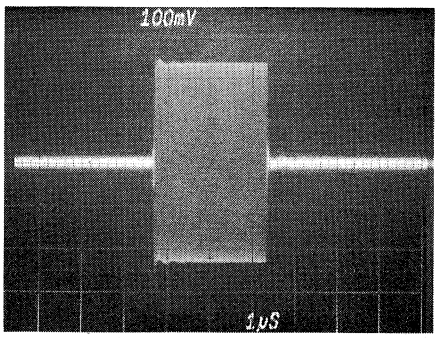
### Limiting Characteristics



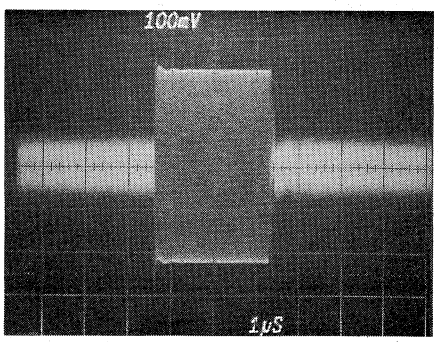

### Schematic Diagram




### Output Response, 6 Cascaded LA7's

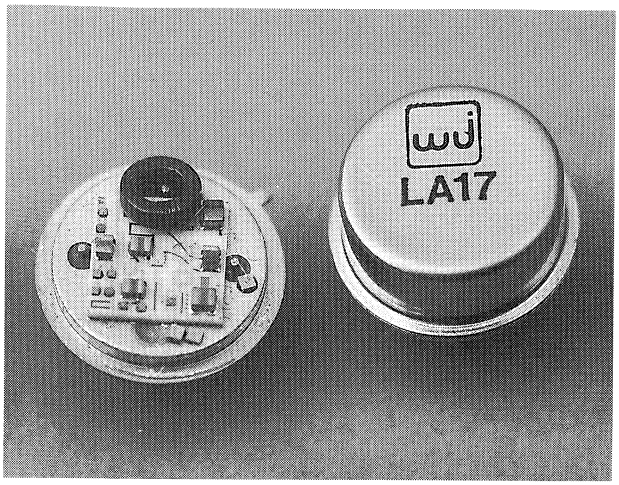



−45 dBm Input CW Pulse




+5 dBm Input CW Pulse

# WJ-LA17 / SMLA17




## 10 to 1000 MHz
## TO-8 CASCADABLE
## LIMITING AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING: GOOD EVEN-ORDER SUPPRESSION
- ◆ MEDIUM OUTPUT LEVEL: +10 dBm (TYP.)
- ◆ HIGH THIRD-ORDER INTERCEPT POINT: +28 dBm (TYP.)
- ◆ FAST PULSE RECOVERY TIME: <50 NSEC

## Specifications *

| Characteristic | Typical. | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 5-1100 MHz | 10-1000 MHz | 10-1000 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.5 dB | 9.5 dB |
| Gain Flatness (Max.) | ±0.3 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 5.8 dB | 6.7 dB | 7.2 dB |
| Power Output at 1 dB Compression (Min.) | +10.0 dBm | +7.0 dBm | +5.0 dBm |
| Output Limiting Level (Max.) Pin = +20 dBm | +15.0 dBm | +16.0 dBm | +17.0 dBm |
| VSWR (Max.) Input/Output | <1.7:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 55 mA | 57 mA | 59 mA |

*Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CLA17 is a standard WJ-LA17 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Third Order Two Tone Intercept Point.....+28 dBm (Typ.) Linear Region Only

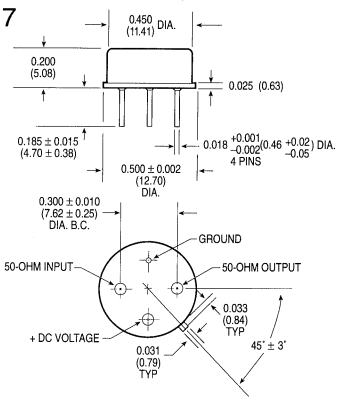
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power.....+23 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....400 Milliwatts
Maximum Peak Power .....1 Watt ( 3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

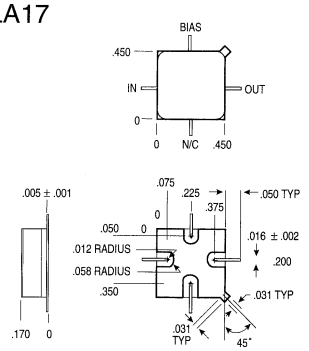
## Outline Drawings

LA17



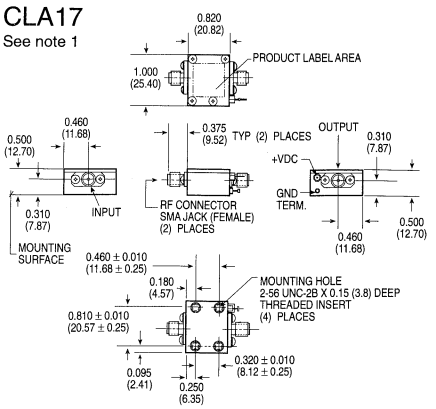

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

SMLA17




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

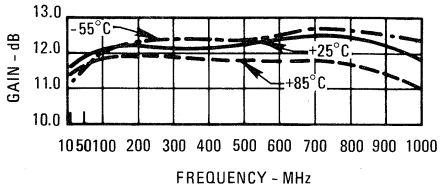
CLA17
See note 1



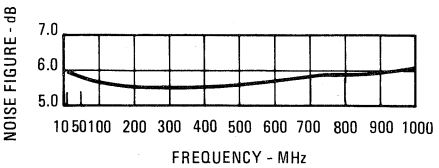

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

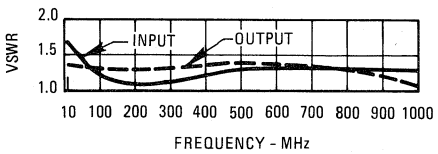
## Gain



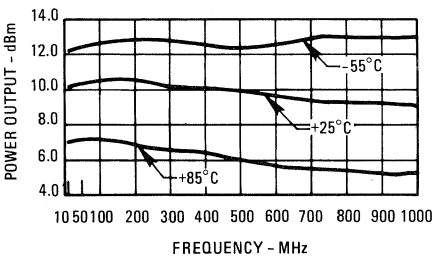

## Noise Figure




## VSWR

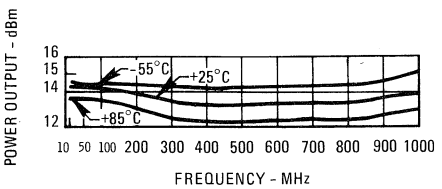



## Power Output*

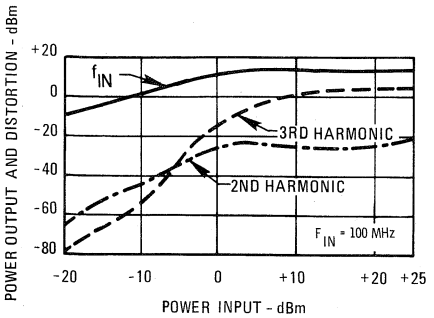


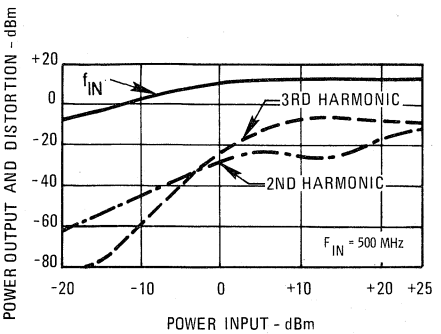

*at 1 dB Gain Compression

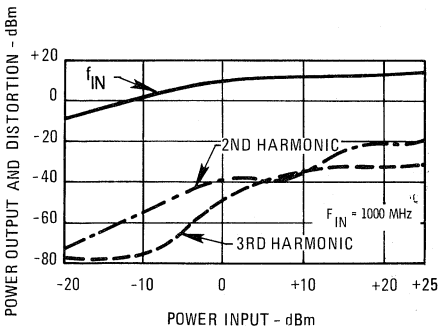
## Maximum Limiting @ $P_{IN}$ = +20 dBm



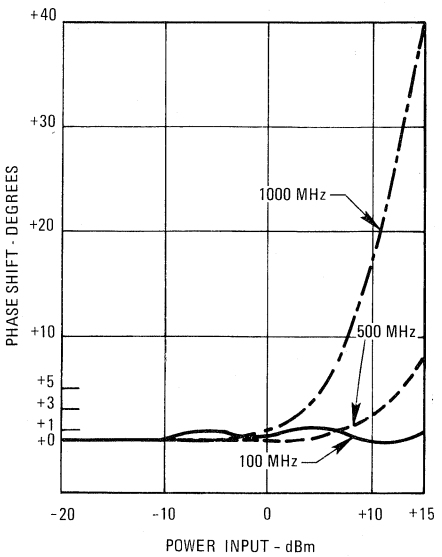

## Power Output and Distortion



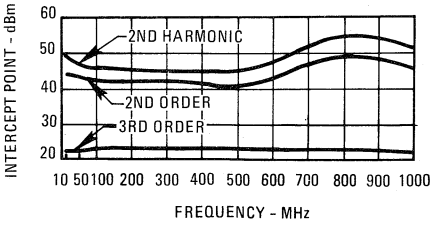



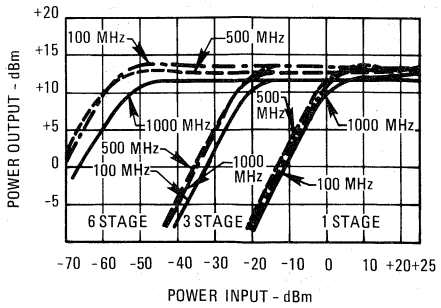

## Phase Shift vs Input Power



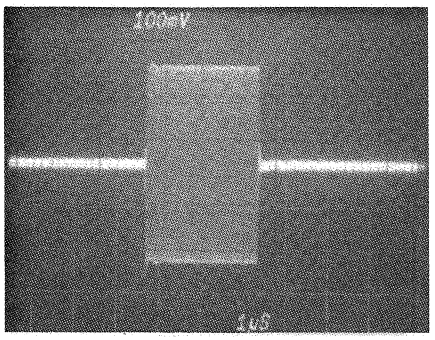

## Intercept Point



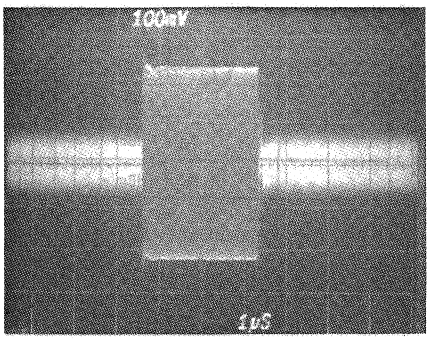

## Limiting Characteristics




## Output Response, 6 Cascaded LA17's




**–45 dBm Input CW Pulse**




**+5 dBm Input CW Pulse**

4

## Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 5.0 | 2.6 | 1.8 | 10.3 |
| 10.0 | 1.7 | 1.6 | 11.0 |
| 50.0 | 1.1 | 1.4 | 11.4 |
| 100.0 | 1.1 | 1.4 | 11.4 |
| 200.0 | 1.1 | 1.4 | 11.5 |
| 300.0 | 1.1 | 1.4 | 11.5 |
| 400.0 | 1.1 | 1.4 | 11.6 |
| 500.0 | 1.1 | 1.4 | 11.6 |
| 600.0 | 1.1 | 1.4 | 11.6 |
| 700.0 | 1.2 | 1.4 | 11.6 |
| 800.0 | 1.2 | 1.4 | 11.6 |
| 900.0 | 1.2 | 1.3 | 11.6 |
| 1000.0 | 1.3 | 1.3 | 11.5 |
| 1100.0 | 1.4 | 1.2 | 11.3 |
| 1200.0 | 1.6 | 1.2 | 10.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 5.0 | .448 | –57 | 3.267 | –141 | .081 | 11 | .296 | 172 |
| 10.0 | .247 | –67 | 3.554 | –161 | .091 | 7 | .219 | 167 |
| 50.0 | .058 | –63 | 3.698 | 177 | .096 | 1 | .183 | 160 |
| 100.0 | .040 | –41 | 3.708 | 167 | .097 | –1 | .175 | 146 |
| 200.0 | .030 | –44 | 3.750 | 150 | .100 | –4 | .171 | 118 |
| 300.0 | .030 | –33 | 3.764 | 134 | .104 | –8 | .174 | 94 |
| 400.0 | .044 | –28 | 3.791 | 118 | .108 | –12 | .173 | 70 |
| 500.0 | .050 | –40 | 3.793 | 102 | .112 | –16 | .173 | 46 |
| 600.0 | .058 | –49 | 3.796 | 86 | .117 | –21 | .171 | 22 |
| 700.0 | .071 | –53 | 3.794 | 69 | .122 | –27 | .166 | –2 |
| 800.0 | .078 | –65 | 3.808 | 52 | .127 | –33 | .159 | –25 |
| 900.0 | .092 | –67 | 3.782 | 35 | .133 | –39 | .147 | –46 |
| 1000.0 | .117 | –74 | 3.756 | 16 | .137 | –46 | .124 | –64 |
| 1100.0 | .167 | –86 | 3.673 | –3 | .144 | –53 | .097 | –80 |
| 1200.0 | .218 | –99 | 3.511 | –23 | .149 | –61 | .074 | –76 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.448 W
Junction Temperature Rise Above Case $T_{jc}$ ... 20.2°C

# WJ-LA45 / SMLA45

## 1000 to 4000 MHz
## TO-8 CASCADABLE
## LIMITING AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING: GOOD EVEN ORDER SUPPRESSION
- ◆ MEDIUM OUTPUT LEVEL: +14.0 dBm (TYP.)
- ◆ MEDIUM GAIN: 11.5 dB (TYP.)
- ◆ WIDE BANDWIDTH: 0.8-4.2 GHz (TYP.)

## Specifications *

| Characteristic | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-4200 MHz | 1000-4000 MHz | 1000-4000 MHz |
| Small Signal Gain (Min.) | 11.5 dB | 10.0 dB | 9.0 dB |
| Gain Flatness (Max.) | ±.6 dB | ±.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 8.0 dB | 9.5 dB | 10.0 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +14.0 dBm | +12.5 dBm | +11.5 dBm |
| Output Limiting Level (Max.) | | | |
| Pin = +17 dBm | +15.5 dBm | +17.0 dBm | +17.5 dBm |
| VSWR (Max.) | | | |
| Input | 1.7:1 | 2.1:1 | 2.2:1 |
| Output | 1.6:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) at +15 Volts | 110 mA | 115 mA | 120 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CLA45 is a standard WJ-LA45 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Harmonic Intercept Point.....+50.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+46.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+24.0 dBm (Typ.)

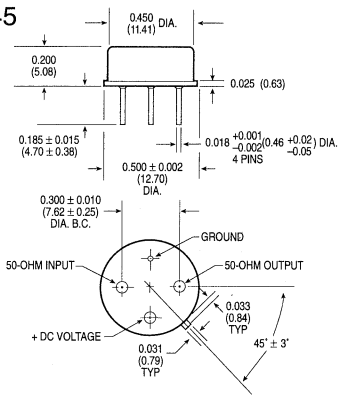
## Absolute Maximum Ratings

Storage Temperature.....-65°C to +125°C
Maximum Case Temperature.....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
"S" Series Burn-in Temperature (Case).....85°C

Weight approximately 2.0 grams (0.07 oz.)

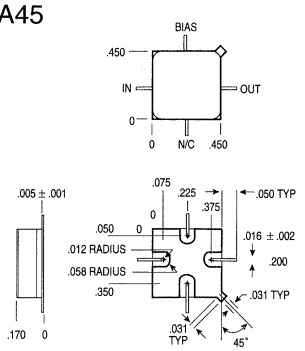
## Outline Drawings

LA45



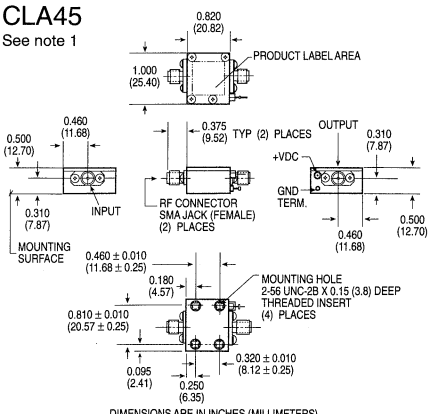

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMLA45




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

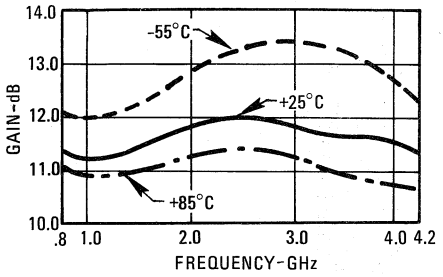
CLA45
See note 1



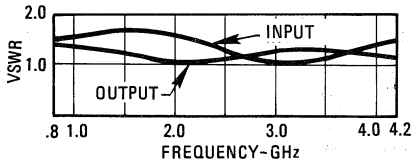

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

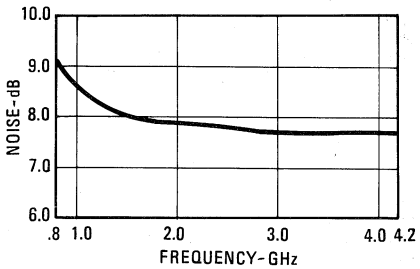
### Gain



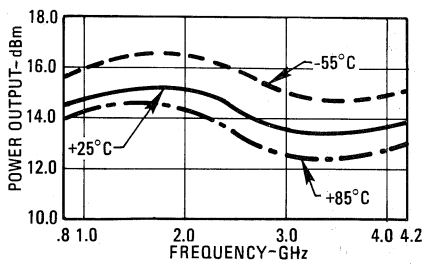

### VSWR

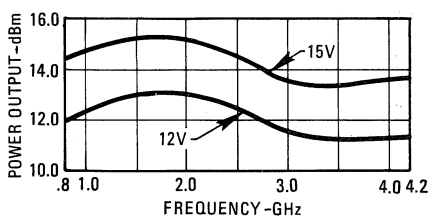



### Noise Figure



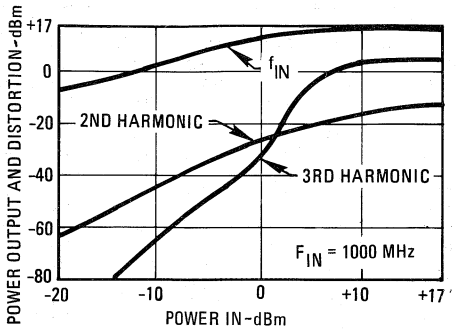

### Power Output*

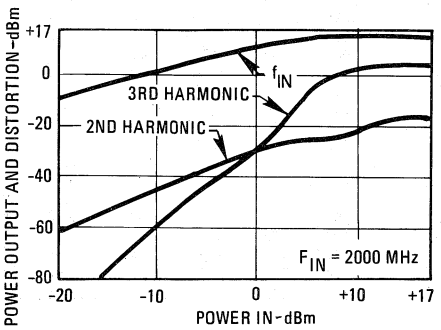


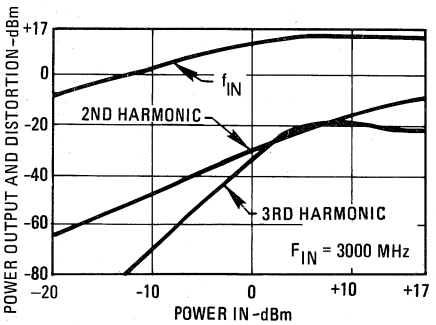



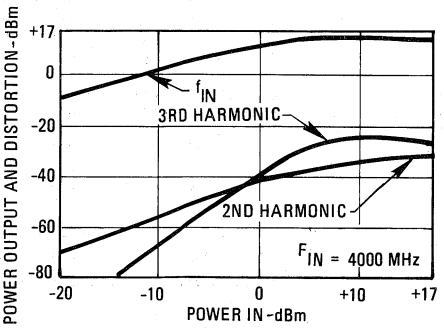

*at 1 dB Gain Compression

### Power Output and Distortion

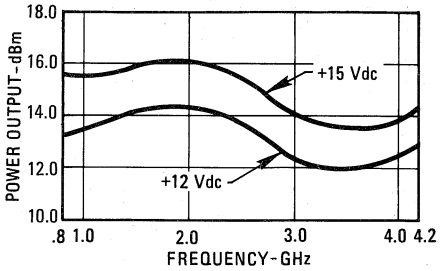


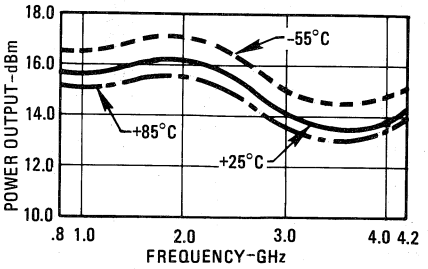



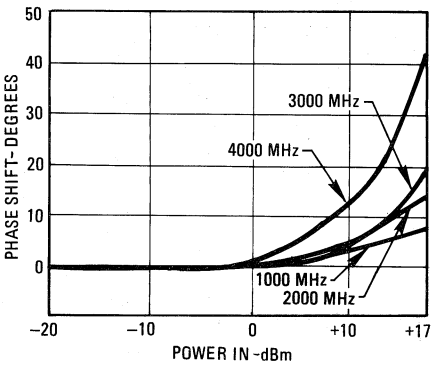




### Maximum Limiting Level @ Pin = +17 dBm

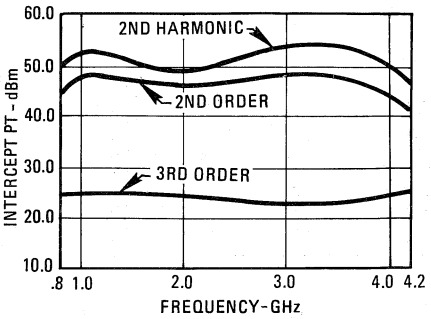



### Phase Shift vs. Input Power




### Intercept Point




4

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.1 | 1.2 | 12.2 |
| 900.0 | 1.1 | 1.2 | 11.8 |
| 1000.0 | 1.2 | 1.2 | 11.6 |
| 1100.0 | 1.3 | 1.2 | 11.5 |
| 1200.0 | 1.4 | 1.2 | 11.4 |
| 1300.0 | 1.4 | 1.3 | 11.4 |
| 1400.0 | 1.4 | 1.3 | 11.3 |
| 1500.0 | 1.5 | 1.3 | 11.3 |
| 1600.0 | 1.5 | 1.3 | 11.3 |
| 1700.0 | 1.5 | 1.3 | 11.3 |
| 1800.0 | 1.5 | 1.3 | 11.3 |
| 1900.0 | 1.5 | 1.3 | 11.3 |
| 2000.0 | 1.4 | 1.3 | 11.4 |
| 2100.0 | 1.4 | 1.3 | 11.4 |
| 2200.0 | 1.4 | 1.3 | 11.5 |
| 2300.0 | 1.3 | 1.3 | 11.5 |
| 2400.0 | 1.3 | 1.3 | 11.5 |
| 2500.0 | 1.3 | 1.3 | 11.6 |
| 2600.0 | 1.2 | 1.3 | 11.6 |
| 2700.0 | 1.2 | 1.4 | 11.6 |
| 2800.0 | 1.1 | 1.4 | 11.6 |
| 2900.0 | 1.1 | 1.5 | 11.5 |
| 3000.0 | 1.1 | 1.6 | 11.6 |
| 3100.0 | 1.1 | 1.6 | 11.5 |
| 3200.0 | 1.1 | 1.6 | 11.5 |
| 3300.0 | 1.1 | 1.6 | 11.5 |
| 3400.0 | 1.1 | 1.6 | 11.6 |
| 3500.0 | 1.2 | 1.6 | 11.7 |
| 3600.0 | 1.2 | 1.6 | 11.7 |
| 3700.0 | 1.2 | 1.6 | 11.8 |
| 3800.0 | 1.2 | 1.5 | 11.9 |
| 3900.0 | 1.2 | 1.4 | 11.9 |
| 4000.0 | 1.3 | 1.3 | 12.1 |
| 4100.0 | 1.3 | 1.3 | 12.1 |
| 4200.0 | 1.3 | 1.2 | 12.2 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .041 | –135 | 4.083 | –114 | .024 | –47 | .085 | –124 |
| 900.0 | .067 | –123 | 3.910 | –157 | .021 | –87 | .093 | –157 |
| 1000.0 | .102 | –138 | 3.799 | 165 | .022 | –126 | .093 | 165 |
| 1100.0 | .132 | –156 | 3.746 | 129 | .021 | –158 | .096 | 122 |
| 1200.0 | .150 | –177 | 3.714 | 95 | .021 | 170 | .102 | 83 |
| 1300.0 | .163 | 163 | 3.705 | 62 | .021 | 136 | .114 | 48 |
| 1400.0 | .183 | 144 | 3.680 | 30 | .020 | 111 | .125 | 17 |
| 1500.0 | .193 | 122 | 3.671 | –2 | .019 | 79 | .136 | –12 |
| 1600.0 | .194 | 100 | 3.662 | –34 | .019 | 52 | .144 | –40 |
| 1700.0 | .198 | 80 | 3.663 | –64 | .018 | 23 | .147 | –68 |
| 1800.0 | .191 | 59 | 3.675 | –94 | .019 | –3 | .147 | –93 |
| 1900.0 | .192 | 38 | 3.686 | –125 | .019 | –29 | .138 | –120 |
| 2000.0 | .170 | 16 | 3.698 | –155 | .017 | –57 | .127 | –149 |
| 2100.0 | .165 | –10 | 3.712 | 175 | .017 | –79 | .122 | 180 |
| 2200.0 | .152 | –31 | 3.741 | 145 | .018 | –108 | .115 | 149 |
| 2300.0 | .146 | –53 | 3.749 | 115 | .017 | –135 | .111 | 114 |
| 2400.0 | .136 | –76 | 3.766 | 86 | .016 | –160 | .113 | 77 |
| 2500.0 | .120 | –101 | 3.797 | 56 | .016 | 172 | .121 | 42 |
| 2600.0 | .106 | –123 | 3.793 | 26 | .015 | 149 | .134 | 8 |
| 2700.0 | .094 | –145 | 3.800 | –4 | .014 | 123 | .152 | –19 |
| 2800.0 | .068 | –171 | 3.787 | –33 | .015 | 91 | .170 | –44 |
| 2900.0 | .054 | 155 | 3.779 | –63 | .013 | 68 | .194 | –68 |
| 3000.0 | .034 | 125 | 3.787 | –92 | .012 | 50 | .216 | –90 |
| 3100.0 | .032 | 70 | 3.772 | –121 | .012 | 27 | .230 | –113 |
| 3200.0 | .032 | 19 | 3.776 | –151 | .011 | –5 | .238 | –136 |
| 3300.0 | .044 | –10 | 3.779 | –180 | .011 | –34 | .242 | –156 |
| 3400.0 | .055 | –36 | 3.795 | 150 | .011 | –46 | .242 | –177 |
| 3500.0 | .076 | –69 | 3.832 | 121 | .012 | –85 | .238 | 162 |
| 3600.0 | .080 | –91 | 3.839 | 91 | .011 | –110 | .233 | 139 |
| 3700.0 | .092 | –107 | 3.882 | 62 | .009 | –129 | .221 | 116 |
| 3800.0 | .108 | –134 | 3.917 | 32 | .010 | –159 | .194 | 90 |
| 3900.0 | .108 | –155 | 3.940 | 2 | .009 | 178 | .167 | 63 |
| 4000.0 | .118 | –171 | 4.008 | –28 | .008 | 153 | .142 | 35 |
| 4100.0 | .116 | 166 | 4.006 | –58 | .009 | 125 | .120 | 3 |
| 4200.0 | .117 | 143 | 4.056 | –89 | .007 | 111 | .108 | –35 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.1 | 1.1 | 11.7 |
| 900.0 | 1.2 | 1.1 | 11.4 |
| 1000.0 | 1.3 | 1.1 | 11.2 |
| 1100.0 | 1.3 | 1.1 | 11.1 |
| 1200.0 | 1.4 | 1.1 | 11.1 |
| 1300.0 | 1.4 | 1.2 | 11.1 |
| 1400.0 | 1.5 | 1.2 | 11.0 |
| 1500.0 | 1.5 | 1.2 | 11.0 |
| 1600.0 | 1.5 | 1.3 | 11.1 |
| 1700.0 | 1.5 | 1.3 | 11.1 |
| 1800.0 | 1.5 | 1.3 | 11.1 |
| 1900.0 | 1.5 | 1.2 | 11.1 |
| 2000.0 | 1.5 | 1.2 | 11.2 |
| 2100.0 | 1.4 | 1.2 | 11.2 |
| 2200.0 | 1.4 | 1.2 | 11.3 |
| 2300.0 | 1.4 | 1.2 | 11.3 |
| 2400.0 | 1.4 | 1.3 | 11.4 |
| 2500.0 | 1.3 | 1.3 | 11.4 |
| 2600.0 | 1.3 | 1.3 | 11.4 |
| 2700.0 | 1.2 | 1.4 | 11.5 |
| 2800.0 | 1.2 | 1.4 | 11.4 |
| 2900.0 | 1.1 | 1.5 | 11.4 |
| 3000.0 | 1.1 | 1.5 | 11.4 |
| 3100.0 | 1.1 | 1.6 | 11.4 |
| 3200.0 | 1.1 | 1.6 | 11.4 |
| 3300.0 | 1.1 | 1.6 | 11.4 |
| 3400.0 | 1.1 | 1.6 | 11.5 |
| 3500.0 | 1.1 | 1.5 | 11.5 |
| 3600.0 | 1.1 | 1.5 | 11.5 |
| 3700.0 | 1.2 | 1.5 | 11.6 |
| 3800.0 | 1.2 | 1.4 | 11.7 |
| 3900.0 | 1.2 | 1.3 | 11.7 |
| 4000.0 | 1.2 | 1.3 | 11.8 |
| 4100.0 | 1.2 | 1.2 | 11.8 |
| 4200.0 | 1.2 | 1.2 | 11.9 |

### Linear S-Parameters

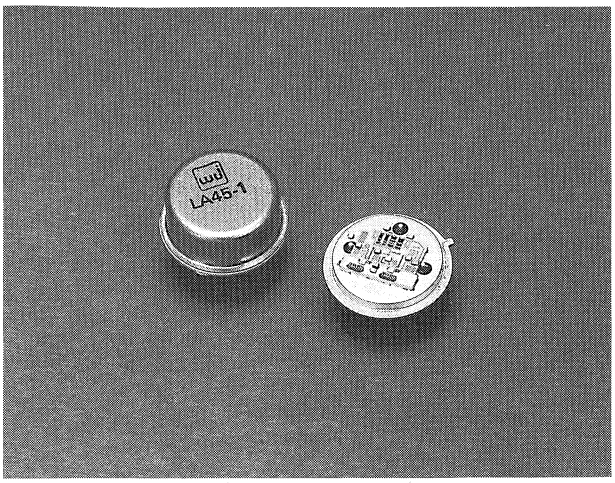
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .063 | –128 | 3.868 | –113 | .021 | –46 | .059 | –108 |
| 900.0 | .093 | –129 | 3.731 | –156 | .019 | –87 | .062 | –144 |
| 1000.0 | .119 | –141 | 3.646 | 166 | .020 | –125 | .055 | 171 |
| 1100.0 | .146 | –160 | 3.600 | 131 | .021 | –160 | .057 | 116 |
| 1200.0 | .170 | –178 | 3.592 | 97 | .019 | 172 | .066 | 69 |
| 1300.0 | .174 | 162 | 3.584 | 64 | .018 | 139 | .081 | 31 |
| 1400.0 | .193 | 144 | 3.566 | 32 | .018 | 109 | .091 | 0 |
| 1500.0 | .207 | 123 | 3.566 | 0 | .017 | 86 | .106 | –28 |
| 1600.0 | .206 | 102 | 3.579 | –32 | .018 | 55 | .113 | –55 |
| 1700.0 | .213 | 83 | 3.581 | –62 | .017 | 32 | .114 | –83 |
| 1800.0 | .199 | 61 | 3.581 | –92 | .019 | 4 | .116 | –109 |
| 1900.0 | .205 | 41 | 3.609 | –123 | .016 | –21 | .109 | –139 |
| 2000.0 | .184 | 20 | 3.627 | –152 | .018 | –54 | .099 | –170 |
| 2100.0 | .176 | –5 | 3.639 | 177 | .016 | –77 | .097 | 156 |
| 2200.0 | .167 | –26 | 3.670 | 148 | .017 | –100 | .095 | 123 |
| 2300.0 | .162 | –49 | 3.690 | 118 | .017 | –126 | .101 | 87 |
| 2400.0 | .151 | –70 | 3.700 | 88 | .016 | –154 | .113 | 50 |
| 2500.0 | .138 | –92 | 3.730 | 59 | .015 | –178 | .126 | 17 |
| 2600.0 | .126 | –113 | 3.728 | 29 | .015 | 156 | .144 | –14 |
| 2700.0 | .109 | –134 | 3.744 | –1 | .016 | 122 | .162 | –40 |
| 2800.0 | .087 | –157 | 3.718 | –30 | .016 | 106 | .180 | –62 |
| 2900.0 | .068 | 177 | 3.722 | –60 | .015 | 83 | .196 | –84 |
| 3000.0 | .050 | 146 | 3.726 | –89 | .013 | 59 | .215 | –105 |
| 3100.0 | .040 | 119 | 3.714 | –119 | .014 | 33 | .227 | –128 |
| 3200.0 | .029 | 70 | 3.724 | –148 | .013 | 1 | .229 | –149 |
| 3300.0 | .027 | 6 | 3.715 | –177 | .013 | –12 | .225 | –170 |
| 3400.0 | .036 | –25 | 3.740 | 153 | .013 | –34 | .221 | 169 |
| 3500.0 | .051 | –52 | 3.772 | 124 | .012 | –64 | .212 | 148 |
| 3600.0 | .067 | –79 | 3.777 | 94 | .011 | –90 | .200 | 125 |
| 3700.0 | .078 | –100 | 3.810 | 65 | .013 | –113 | .185 | 101 |
| 3800.0 | .089 | –126 | 3.844 | 35 | .010 | –133 | .160 | 73 |
| 3900.0 | .090 | –150 | 3.853 | 5 | .011 | –159 | .136 | 43 |
| 4000.0 | .105 | –165 | 3.907 | –25 | .010 | 174 | .111 | 9 |
| 4100.0 | .103 | 165 | 3.883 | –55 | .010 | 149 | .101 | –31 |
| 4200.0 | .106 | 145 | 3.924 | –86 | .010 | 124 | .102 | –71 |

## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{JC}$ ..... 108.9°C/W
Transistor Power Dissipation $P_D$ ..... 0.476 W
Junction Temperature Rise Above Case $T_{JC}$ ... 52°C

# WJ-LA45-1 / SMLA45-1

## 1000 to 4000 MHz TO-8 CASCADABLE LIMITING AMPLIFIER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING: GOOD EVEN ORDER SUPPRESSION
- ◆ HIGH OUTPUT LEVEL: +17 dBm (TYP.)
- ◆ MEDIUM GAIN: 14.0 dB (TYP.)
- ◆ WIDE BANDWIDTH: 0.8-4.2 GHz (TYP.)

## Specifications*

| Characteristic | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 800-4200 MHz | 1000-4000 MHz | 1000-4000 MHz |
| Small Signal Gain (Min.) | 14.0 dB | 13.0 dB | 12.0 dB |
| Gain Flatness (Max.) | ±0.5 dB | ±0.8 dB | ±1.0 dB |
| Noise Figure (Max.) | 7.5 dB | 9.0 dB | 9.5 dB |
| Power Output | | | |
| at 1 dB Compression (Min.) | +17.0 dBm | +15.5 dBm | +14.5 dBm |
| Output Limiting Level (Max.) | | | |
| Pin = +17 dBm | +18.5 dBm | +20.5 dBm | +21.0 dBm |
| VSWR (Max.) | | | |
| Input | 1.8:1 | 2.1:1 | 2.2:1 |
| Output | 1.6:1 | 2.0:1 | 2.1:1 |
| DC Current (Max.) | | | |
| at +15 Volts | 110 mA | 115 mA | 120 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CLA45-1 is a standard WJ-LA45-1 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

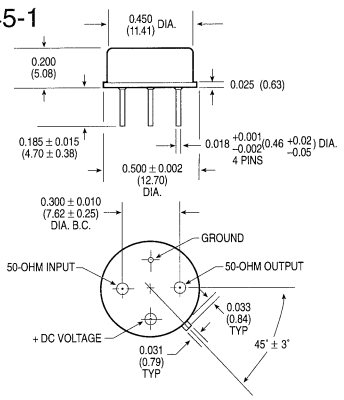
Second Harmonic Intercept Point.....+53.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+48.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+27.0 dBm (Typ.)

## Absolute Maximum Ratings

Storage Temperature.....-65°C to +125°C
Maximum Case Temperature.....85°C
Maximum DC Voltage.....+16 Volts
Maximum Continuous RF Input Power.....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
"S" Series Burn-In Temperature (Case).....85°C
Weight approximately 2.0 grams (0.07 oz.)

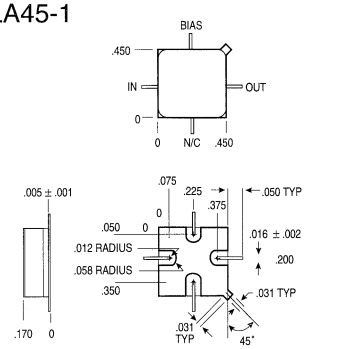
## Outline Drawings

LA45-1



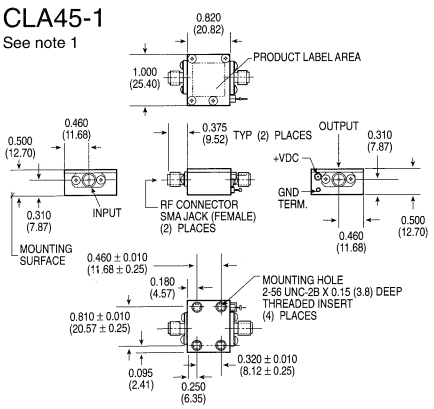

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMLA45-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

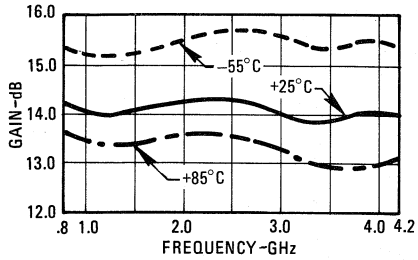
CLA45-1
See note 1



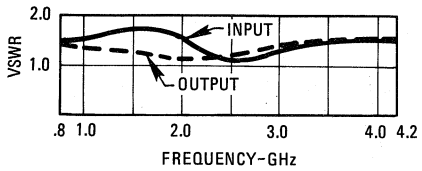

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

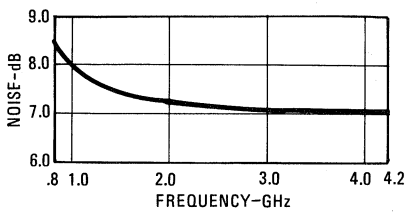
### Gain



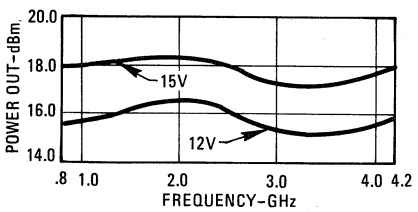

### VSWR

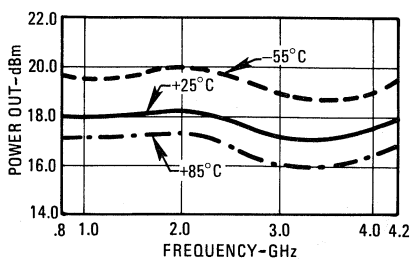



### Noise Figure



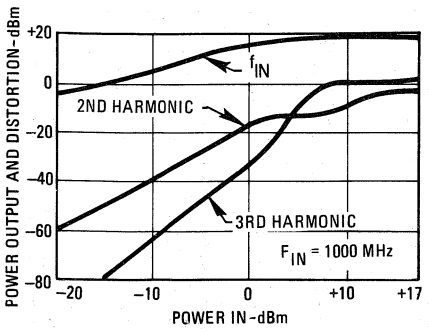

### Power Output*

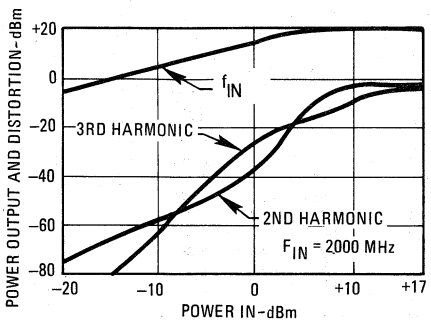


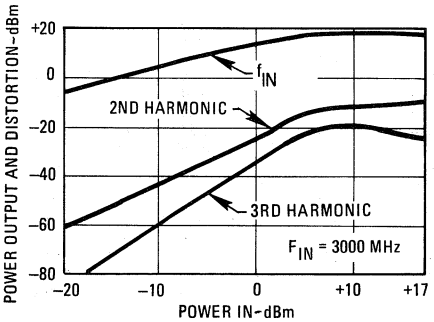



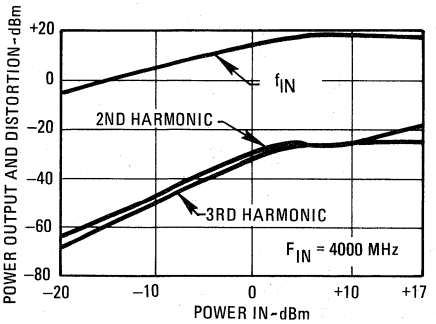

*at 1 dB Gain Compression

### Power Output and Distortion

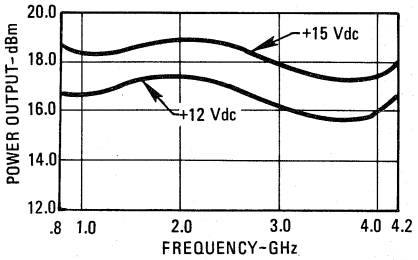


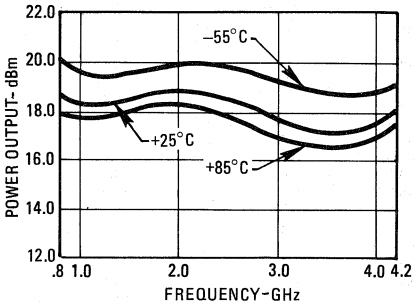



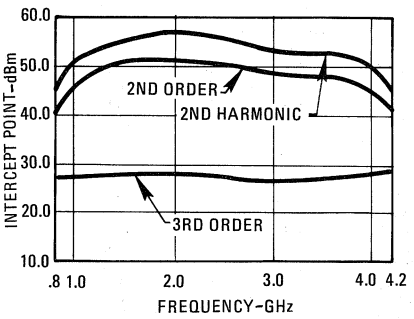




### Maximum Limiting Level @ Pin = +17 dBm

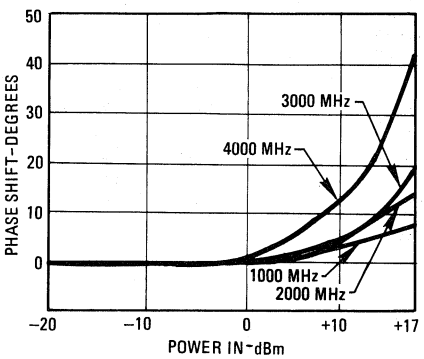



### Intercept Point




### Phase Shift vs. Input Power




4

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.0 | 1.5 | 14.1 |
| 900.0 | 1.1 | 1.4 | 14.3 |
| 1000.0 | 1.2 | 1.4 | 14.4 |
| 1100.0 | 1.3 | 1.3 | 14.6 |
| 1200.0 | 1.4 | 1.3 | 14.8 |
| 1300.0 | 1.4 | 1.3 | 14.9 |
| 1400.0 | 1.5 | 1.3 | 15.0 |
| 1500.0 | 1.5 | 1.2 | 15.1 |
| 1600.0 | 1.5 | 1.2 | 15.2 |
| 1700.0 | 1.5 | 1.2 | 15.2 |
| 1800.0 | 1.5 | 1.2 | 15.2 |
| 1900.0 | 1.5 | 1.1 | 15.3 |
| 2000.0 | 1.5 | 1.1 | 15.3 |
| 2100.0 | 1.5 | 1.0 | 15.3 |
| 2200.0 | 1.5 | 1.0 | 15.3 |
| 2300.0 | 1.4 | 1.1 | 15.3 |
| 2400.0 | 1.4 | 1.1 | 15.3 |
| 2500.0 | 1.4 | 1.1 | 15.3 |
| 2600.0 | 1.3 | 1.1 | 15.2 |
| 2700.0 | 1.3 | 1.1 | 15.1 |
| 2800.0 | 1.3 | 1.1 | 15.0 |
| 2900.0 | 1.2 | 1.1 | 15.0 |
| 3000.0 | 1.2 | 1.1 | 15.0 |
| 3100.0 | 1.2 | 1.1 | 14.9 |
| 3200.0 | 1.2 | 1.1 | 14.9 |
| 3300.0 | 1.2 | 1.1 | 14.8 |
| 3400.0 | 1.2 | 1.2 | 14.8 |
| 3500.0 | 1.2 | 1.2 | 14.8 |
| 3600.0 | 1.2 | 1.3 | 14.7 |
| 3700.0 | 1.2 | 1.3 | 14.6 |
| 3800.0 | 1.2 | 1.3 | 14.6 |
| 3900.0 | 1.2 | 1.3 | 14.6 |
| 4000.0 | 1.2 | 1.3 | 14.6 |
| 4100.0 | 1.1 | 1.2 | 14.5 |
| 4200.0 | 1.1 | 1.2 | 14.6 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .023 | 72 | 5.087 | −128 | .017 | −66 | .206 | −107 |
| 900.0 | .043 | −89 | 5.181 | −169 | .017 | −103 | .183 | −147 |
| 1000.0 | .083 | −125 | 5.251 | 154 | .017 | −138 | .159 | 175 |
| 1100.0 | .120 | −154 | 5.365 | 117 | .018 | −171 | .141 | 135 |
| 1200.0 | .150 | −178 | 5.479 | 82 | .017 | 157 | .127 | 94 |
| 1300.0 | .169 | 156 | 5.565 | 48 | .015 | 130 | .120 | 58 |
| 1400.0 | .188 | 133 | 5.624 | 14 | .015 | 95 | .115 | 25 |
| 1500.0 | .205 | 107 | 5.664 | −19 | .017 | 66 | .111 | −6 |
| 1600.0 | .205 | 83 | 5.723 | −52 | .015 | 37 | .104 | −34 |
| 1700.0 | .213 | 61 | 5.767 | −84 | .015 | 16 | .090 | −61 |
| 1800.0 | .205 | 34 | 5.785 | −116 | .016 | −17 | .075 | −85 |
| 1900.0 | .209 | 12 | 5.816 | −149 | .013 | −38 | .052 | −103 |
| 2000.0 | .192 | −16 | 5.825 | 180 | .013 | −65 | .030 | −116 |
| 2100.0 | .191 | −43 | 5.811 | 148 | .013 | −92 | .016 | −103 |
| 2200.0 | .187 | −68 | 5.837 | 117 | .012 | −121 | .022 | −71 |
| 2300.0 | .174 | −90 | 5.824 | 85 | .012 | −150 | .034 | −66 |
| 2400.0 | .169 | −116 | 5.814 | 54 | .011 | 179 | .047 | −74 |
| 2500.0 | .157 | −141 | 5.792 | 23 | .011 | 159 | .059 | −90 |
| 2600.0 | .141 | −167 | 5.738 | −8 | .012 | 137 | .066 | −108 |
| 2700.0 | .131 | 169 | 5.714 | −38 | .009 | 116 | .061 | −127 |
| 2800.0 | .115 | 142 | 5.653 | −69 | .010 | 84 | .049 | −144 |
| 2900.0 | .110 | 116 | 5.630 | −100 | .011 | 60 | .037 | −149 |
| 3000.0 | .092 | 83 | 5.604 | −130 | .010 | 29 | .030 | −130 |
| 3100.0 | .091 | 52 | 5.567 | −161 | .009 | 11 | .036 | −117 |
| 3200.0 | .086 | 23 | 5.539 | 168 | .009 | −19 | .047 | −115 |
| 3300.0 | .091 | −1 | 5.511 | 138 | .009 | −67 | .063 | −117 |
| 3400.0 | .088 | −30 | 5.487 | 107 | .009 | −70 | .083 | −129 |
| 3500.0 | .086 | −53 | 5.465 | 76 | .009 | −90 | .103 | −145 |
| 3600.0 | .086 | −78 | 5.428 | 45 | .007 | −117 | .116 | −165 |
| 3700.0 | .088 | −97 | 5.398 | 15 | .007 | −144 | .124 | 176 |
| 3800.0 | .086 | −119 | 5.373 | −16 | .007 | −155 | .121 | 159 |
| 3900.0 | .080 | −143 | 5.342 | −46 | .007 | −177 | .117 | 142 |
| 4000.0 | .082 | −161 | 5.373 | −77 | .006 | 147 | .112 | 122 |
| 4100.0 | .067 | 180 | 5.327 | −107 | .007 | 120 | .102 | 103 |
| 4200.0 | .067 | 159 | 5.387 | −138 | .007 | 107 | .087 | 78 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 800.0 | 1.0 | 1.4 | 14.1 |
| 900.0 | 1.1 | 1.3 | 14.2 |
| 1000.0 | 1.2 | 1.3 | 14.4 |
| 1100.0 | 1.3 | 1.2 | 14.6 |
| 1200.0 | 1.4 | 1.2 | 14.8 |
| 1300.0 | 1.4 | 1.2 | 14.9 |
| 1400.0 | 1.5 | 1.2 | 15.1 |
| 1500.0 | 1.5 | 1.2 | 15.2 |
| 1600.0 | 1.6 | 1.2 | 15.3 |
| 1700.0 | 1.6 | 1.2 | 15.3 |
| 1800.0 | 1.6 | 1.1 | 15.4 |
| 1900.0 | 1.6 | 1.1 | 15.5 |
| 2000.0 | 1.5 | 1.1 | 15.5 |
| 2100.0 | 1.5 | 1.1 | 15.5 |
| 2200.0 | 1.5 | 1.2 | 15.5 |
| 2300.0 | 1.5 | 1.2 | 15.5 |
| 2400.0 | 1.4 | 1.3 | 15.4 |
| 2500.0 | 1.4 | 1.3 | 15.4 |
| 2600.0 | 1.4 | 1.3 | 15.3 |
| 2700.0 | 1.3 | 1.3 | 15.2 |
| 2800.0 | 1.3 | 1.3 | 15.1 |
| 2900.0 | 1.2 | 1.3 | 15.0 |
| 3000.0 | 1.2 | 1.2 | 15.0 |
| 3100.0 | 1.2 | 1.2 | 14.9 |
| 3200.0 | 1.2 | 1.2 | 14.8 |
| 3300.0 | 1.2 | 1.1 | 14.8 |
| 3400.0 | 1.2 | 1.0 | 14.7 |
| 3500.0 | 1.2 | 1.0 | 14.7 |
| 3600.0 | 1.2 | 1.1 | 14.6 |
| 3700.0 | 1.2 | 1.1 | 14.6 |
| 3800.0 | 1.2 | 1.1 | 14.5 |
| 3900.0 | 1.2 | 1.1 | 14.4 |
| 4000.0 | 1.1 | 1.2 | 14.5 |
| 4100.0 | 1.1 | 1.2 | 14.4 |
| 4200.0 | 1.1 | 1.2 | 14.4 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 800.0 | .016 | 151 | 5.047 | −127 | .016 | −67 | .173 | −103 |
| 900.0 | .049 | −123 | 5.158 | −169 | .017 | −107 | .146 | −144 |
| 1000.0 | .094 | −137 | 5.240 | 154 | .016 | −136 | .120 | 175 |
| 1100.0 | .127 | −160 | 5.365 | 118 | .016 | −169 | .100 | 130 |
| 1200.0 | .162 | 175 | 5.479 | 83 | .016 | 157 | .090 | 83 |
| 1300.0 | .174 | 154 | 5.583 | 49 | .015 | 133 | .088 | 40 |
| 1400.0 | .199 | 132 | 5.659 | 15 | .015 | 103 | .087 | 2 |
| 1500.0 | .211 | 107 | 5.739 | −19 | .014 | 74 | .087 | −33 |
| 1600.0 | .216 | 84 | 5.817 | −52 | .015 | 45 | .082 | −67 |
| 1700.0 | .221 | 63 | 5.854 | −84 | .015 | 17 | .073 | −102 |
| 1800.0 | .221 | 37 | 5.887 | −116 | .015 | −8 | .059 | −140 |
| 1900.0 | .222 | 14 | 5.933 | −148 | .015 | −35 | .044 | 171 |
| 2000.0 | .204 | −12 | 5.940 | −180 | .014 | −61 | .045 | 106 |
| 2100.0 | .203 | −38 | 5.935 | 148 | .013 | −83 | .057 | 58 |
| 2200.0 | .193 | −62 | 5.970 | 116 | .013 | −110 | .075 | 18 |
| 2300.0 | .188 | −85 | 5.942 | 85 | .014 | −140 | .096 | −14 |
| 2400.0 | .179 | −111 | 5.916 | 54 | .012 | −167 | .116 | −40 |
| 2500.0 | .170 | −137 | 5.898 | 23 | .012 | 172 | .133 | −67 |
| 2600.0 | .150 | −158 | 5.801 | −9 | .014 | 140 | .143 | −91 |
| 2700.0 | .140 | 175 | 5.762 | −40 | .013 | 121 | .145 | −115 |
| 2800.0 | .114 | 146 | 5.698 | −70 | .013 | 95 | .137 | −137 |
| 2900.0 | .107 | 117 | 5.654 | −101 | .013 | 71 | .123 | −158 |
| 3000.0 | .090 | 89 | 5.612 | −132 | .010 | 42 | .108 | −176 |
| 3100.0 | .088 | 62 | 5.554 | −162 | .011 | 19 | .091 | 165 |
| 3200.0 | .074 | 28 | 5.521 | 167 | .010 | −6 | .072 | 144 |
| 3300.0 | .073 | 2 | 5.477 | 137 | .009 | −29 | .045 | 121 |
| 3400.0 | .077 | −30 | 5.460 | 106 | .009 | −61 | .018 | 107 |
| 3500.0 | .078 | −56 | 5.441 | 76 | .010 | −74 | .011 | −129 |
| 3600.0 | .079 | −80 | 5.381 | 44 | .011 | −116 | .030 | −129 |
| 3700.0 | .073 | −103 | 5.344 | 14 | .010 | −129 | .045 | −141 |
| 3800.0 | .072 | −127 | 5.325 | −17 | .009 | −151 | .058 | −149 |
| 3900.0 | .072 | −153 | 5.265 | −47 | .007 | 174 | .069 | −165 |
| 4000.0 | .067 | −171 | 5.285 | −78 | .010 | 152 | .083 | −179 |
| 4100.0 | .053 | 164 | 5.236 | −108 | .009 | 131 | .090 | 164 |
| 4200.0 | .059 | 142 | 5.278 | −139 | .009 | 114 | .087 | 148 |

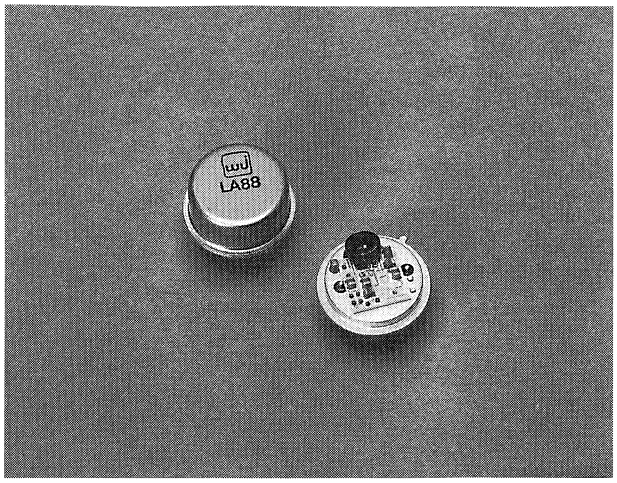
## Thermal Data: $V_{CC}$ = 15 Vdc

Thermal Resistance $\theta_{jc}$ ..... 108.9°C/W
Transistor Power Dissipation $P_d$ ..... 0.476 W
Junction Temperature Rise Above Case $T_{jc}$ ... 52°C

# WJ-LA88/SMLA88

## 10 to 500 MHz TO-8 CASCADABLE LIMITING AMPLIFIER

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ SYMMETRICAL CLIPPING: GOOD EVEN ORDER SUPPRESSION
- ◆ HIGH OUTPUT LEVEL: +17 dBm (TYP.)
- ◆ HIGH THIRD-ORDER INTERCEPT POINT +28 DBM (TYP.)




## Specifications*

| Characteristic | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10-600 MHz | 10-500 MHz | 10-500 MHz |
| Small Signal Gain (Min.) | 16.5 dB | 16.0 dB | 15.0 dB |
| Gain Flatness (Max.) | ±0.2 dB | ±0.5 dB | ±0.7 dB |
| Noise Figure (Max.) | 6.0 dB | 6.5 dB | 7.0 dB |
| Power Output at 1 dB Compression (Min.) | +17.0 dBm | +15.0 dBm | +13.0 dBm |
| Output Limiting Level (Max.) Pin = +20 dBm | +20.5 dBm | +21.0 dBm | +22.5 dBm |
| VSWR (Max.) Input/Output | 1.7:1 | 1.9:1 | 2.0:1 |
| DC Current (Max.) at +15 Volts | 89 mA | 91 mA | 93 mA |

* Measured in a 50-ohm system at +15 Vdc Nominal.
Notes:
1. WJ-CLA88 is a standard WJ-LA88 installed in a miniature SMA connector housing and guaranteed over 0°C to 50°C temperature range.

## Typical Intermodulation Performance at 25°C

Second Harmonic Intercept Point.....+42.0 dBm (Typ.)
Second Order Two Tone Intercept Point.....+37.0 dBm (Typ.)
Third Order Two Tone Intercept Point.....+28.0 dBm (Typ.)

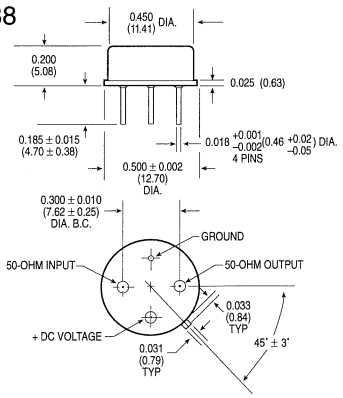
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+17 Volts
Maximum Continuous RF Input Power .....+23 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....400 Milliwatts
Maximum Peak Power.....1 watt (3 µsec Max.)
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

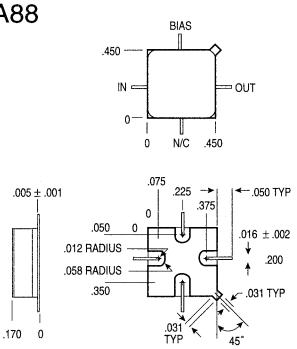
## Outline Drawings

LA88



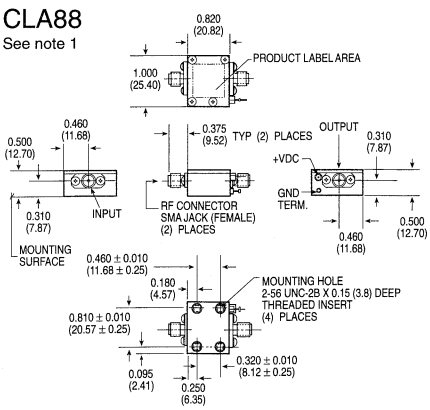

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMLA88




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

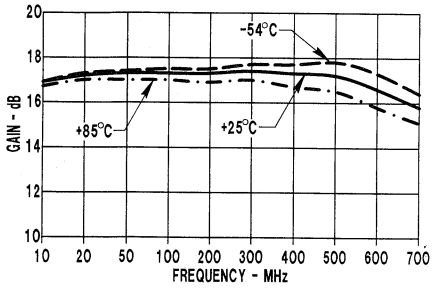
CLA88
See note 1



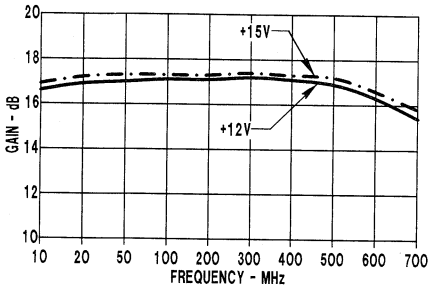

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

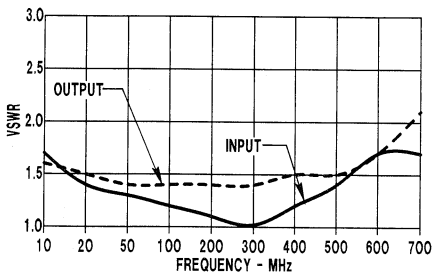
### Gain vs. Temperature



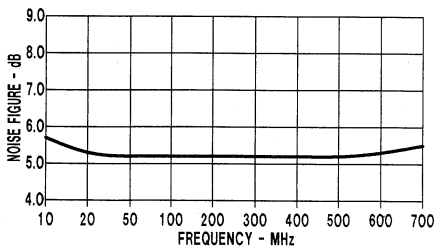

### Gain



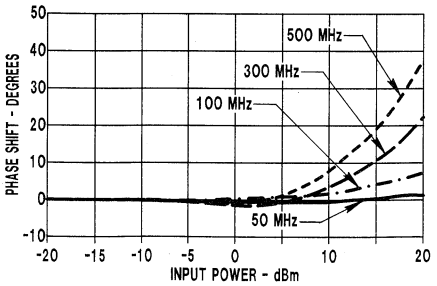

### VSWR



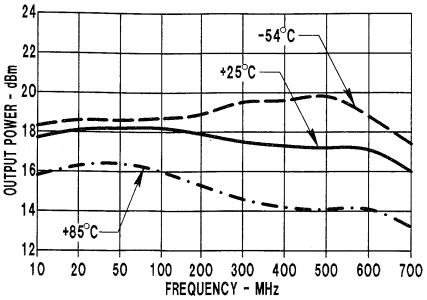

### Noise Figure




### Phase Shift vs. Input Power

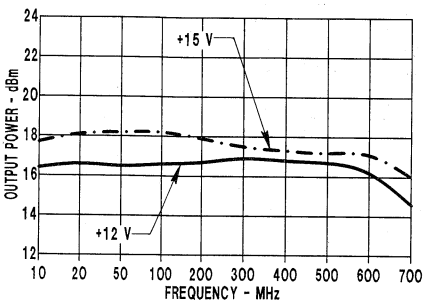



### Output Power vs. Temperature*



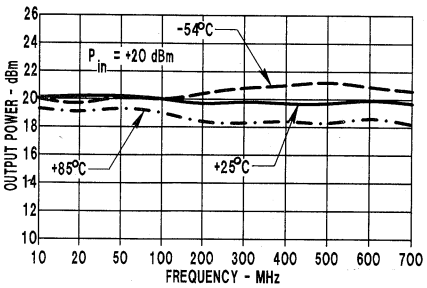

*at 1 dB Gain Compression

### Output Power*

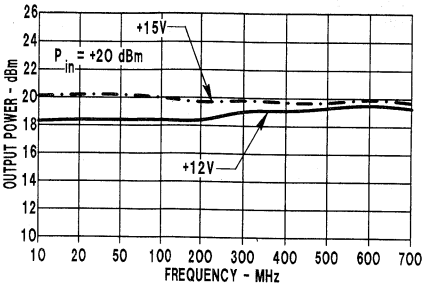



*at 1 dB Gain Compression

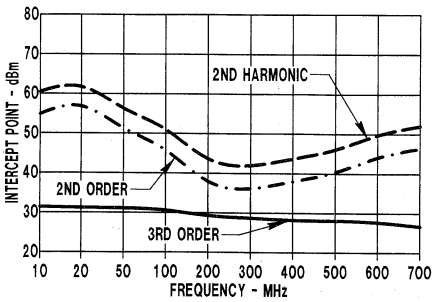
### Maximum Limiting vs. Temperature



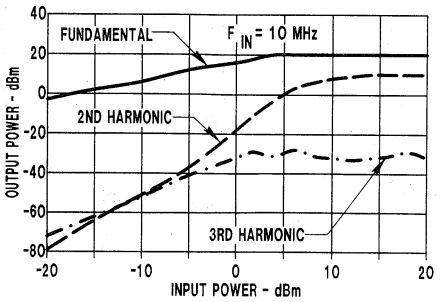

### Maximum Limiting Level

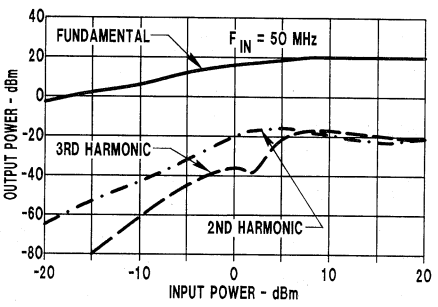


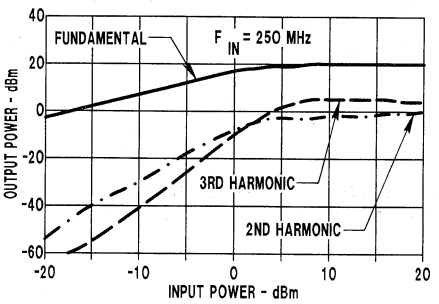

### Intercept Point

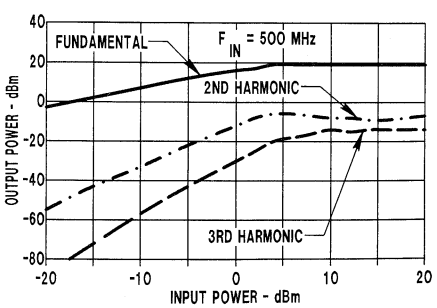



### Power Output and Distortion Products




4

# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.8 | 15.7 |
| 5.0 | 1.1 | 1.1 | 16.4 |
| 10.0 | 1.1 | 1.0 | 16.5 |
| 50.0 | 1.1 | 1.0 | 16.5 |
| 100.0 | 1.1 | 1.0 | 16.5 |
| 200.0 | 1.2 | 1.0 | 16.5 |
| 300.0 | 1.3 | 1.0 | 16.5 |
| 400.0 | 1.4 | 1.1 | 16.6 |
| 500.0 | 1.5 | 1.3 | 16.5 |
| 600.0 | 1.6 | 1.6 | 16.1 |
| 700.0 | 1.5 | 2.2 | 14.9 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .245 | –86 | 6.073 | –133 | .062 | 54 | .273 | –107 |
| 5.0 | .066 | –75 | 6.611 | –163 | .070 | 21 | .054 | –105 |
| 10.0 | .042 | –44 | 6.666 | –173 | .071 | 10 | .022 | –68 |
| 50.0 | .030 | 3 | 6.718 | 169 | .072 | 0 | .020 | –22 |
| 100.0 | .044 | 10 | 6.683 | 156 | .072 | –5 | .022 | –38 |
| 200.0 | .076 | –20 | 6.675 | 130 | .072 | –10 | .019 | –86 |
| 300.0 | .113 | –51 | 6.675 | 104 | .073 | –16 | .022 | –167 |
| 400.0 | .158 | –82 | 6.765 | 77 | .077 | –21 | .051 | 132 |
| 500.0 | .196 | –119 | 6.687 | 48 | .082 | –28 | .114 | 83 |
| 600.0 | .223 | –157 | 6.351 | 15 | .090 | –37 | .223 | 39 |
| 700.0 | .211 | 157 | 5.578 | –18 | .097 | –50 | .373 | –2 |

### $V_{CC}$ = 12.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 2.0 | 1.6 | 1.8 | 15.4 |
| 5.0 | 1.2 | 1.1 | 16.1 |
| 10.0 | 1.1 | 1.1 | 16.2 |
| 50.0 | 1.1 | 1.0 | 16.3 |
| 100.0 | 1.2 | 1.0 | 16.2 |
| 200.0 | 1.2 | 1.1 | 16.3 |
| 300.0 | 1.3 | 1.1 | 16.3 |
| 400.0 | 1.4 | 1.2 | 16.4 |
| 500.0 | 1.5 | 1.4 | 16.3 |
| 600.0 | 1.6 | 1.7 | 15.8 |
| 700.0 | 1.5 | 2.4 | 14.5 |

### Linear S-Parameters

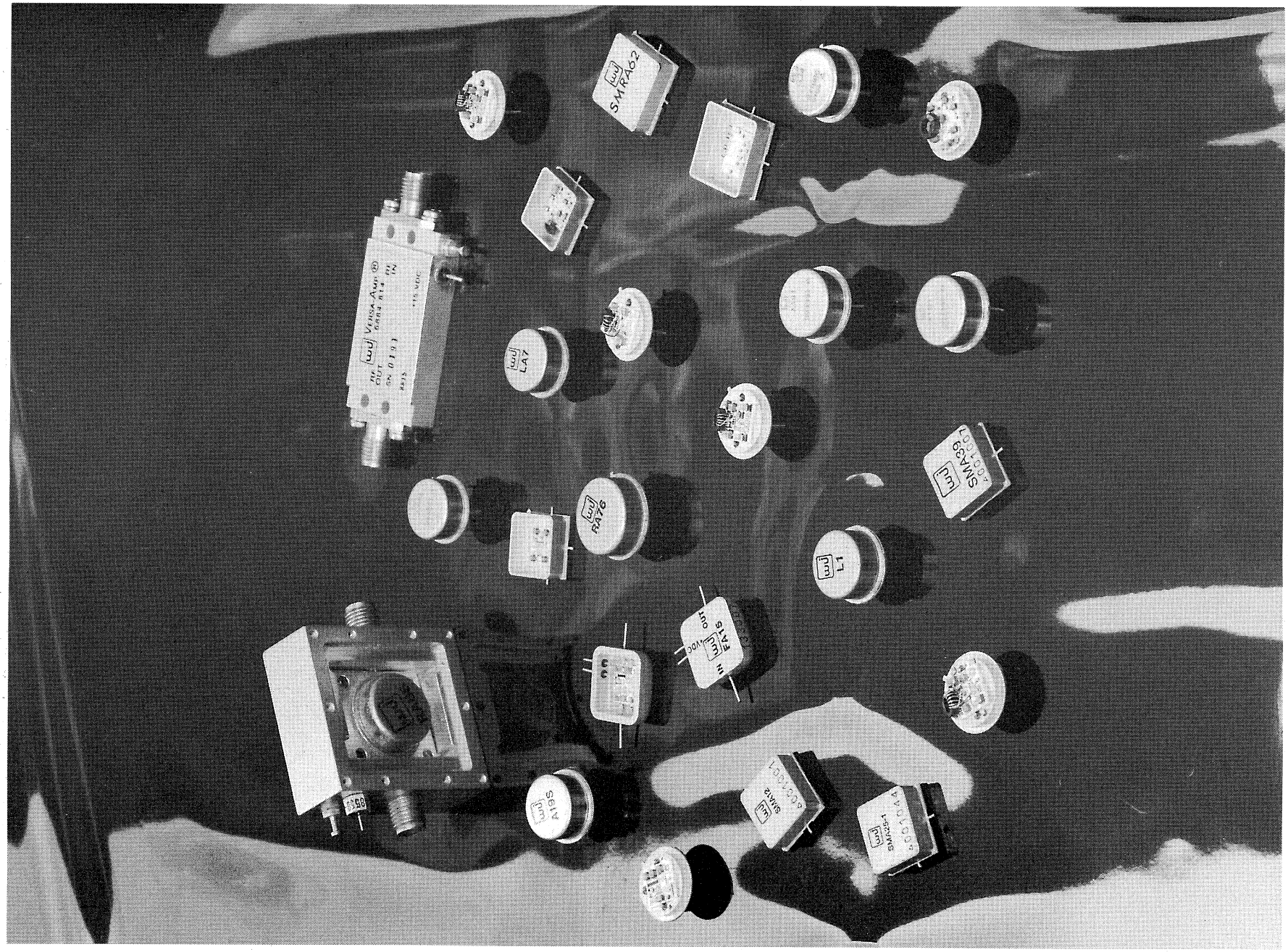
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .234 | –81 | 5.897 | –133 | .062 | 54 | .273 | –105 |
| 5.0 | .073 | –56 | 6.405 | –163 | .069 | 21 | .060 | –103 |
| 10.0 | .057 | –30 | 6.465 | –173 | .070 | 10 | .025 | –76 |
| 50.0 | .052 | –3 | 6.523 | 170 | .071 | 0 | .019 | –38 |
| 100.0 | .071 | 1 | 6.474 | 156 | .071 | –4 | .022 | –63 |
| 200.0 | .099 | –24 | 6.503 | 130 | .072 | –10 | .026 | –126 |
| 300.0 | .135 | –50 | 6.517 | 105 | .073 | –15 | .045 | 173 |
| 400.0 | .174 | –78 | 6.637 | 77 | .077 | –20 | .084 | 125 |
| 500.0 | .200 | –115 | 6.544 | 48 | .083 | –28 | .154 | 79 |
| 600.0 | .218 | –154 | 6.148 | 15 | .092 | –38 | .266 | 36 |
| 700.0 | .185 | 161 | 5.301 | –18 | .098 | –51 | .408 | –5 |

## Thermal Data: $V_{CC}$ = 15 Vdc

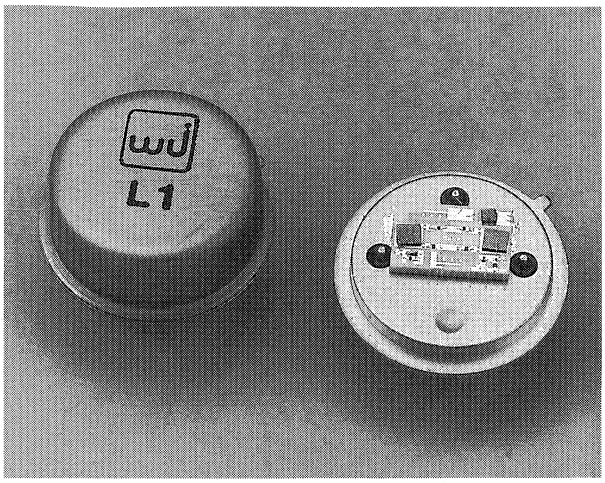
Thermal Resistance $\theta_{jc}$ ..... 45°C/W
Transistor Power Dissipation $P_d$ ..... 0.890 W
Junction Temperature Rise Above Case $T_{jc}$ ... 40°C

# *Signal Limiters*





# WJ-L1/SML1




## 5 TO 3000 MHz
## TO-8 THIN-FILM LIMITER MODULE

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ VOLTAGE VARIABLE LIMITING LEVEL: -10 TO 0 dBm
- ◆ LOW INSERTION LOSS AT LOW INPUT LEVELS: < 2.0 dB (TYP.)
- ◆ GOOD SUPPRESSION OF EVEN ORDER HARMONICS DUE TO BALANCED CIRCUIT DESIGN
- ◆ EXCELLENT PHASE RESPONSE 0.3 DEGREE/dB TO 160 MHz (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency (Min.) | 5 - 3200 MHz | 5 - 3000 MHz |
| Insertion Loss (Max.) | | |
| $P_{IN} \leq$ -20 dBm | | |
| 5 - 1000 MHz | 2.0 dB | 3.0 dB |
| 1000 - 3000 MHz | 3.0 dB | 4.5 dB |
| Input VSWR (Max.) | | |
| ($P_{IN}$ < -10 dBm, | | |
| +10 ≤ Bias ≤ +20 Volts) | 1.7:1 | 1.9:1 |
| Output VSWR (Max.) | | |
| ($P_{IN}$ < -10 dBm | | |
| +10 ≤ Bias ≤ +20 Volts) | | |
| 5 - 1000 MHz | 1.7:1 | 2.0:1 |
| 1000 - 3000 MHz | 2.0:1 | 2.3:1 |
| Output Limiting Level (Max.) | | |
| $P_{IN}$ = +20 dBm | | |
| 5 - 2000 MHz | 2.5 dBm | 4.0 dBm |
| 2000 - 3000 MHz | 6.5 dBm | 7.0 dBm |
| Bias Current (Max.) | | |
| At 15 Vdc | 7 mA | |
| At 20 Vdc | 10 mA | |

*Measured in a 50-ohm system at +15 Vdc Nominal guaranteed at 25°C.

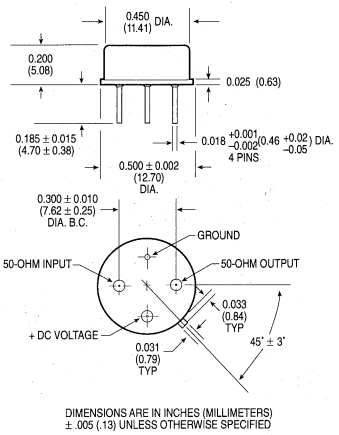
## Limiting and Insertion Loss Characteristics (25°C)

| Bias Voltage | Output Level at Limiting Threshold (1 dB Compression) Typ. | Max. output Limiting Level (+20 dBm Input) Typ. | Insertion Loss (500 MHz) Typ. | Insertion Loss (1000 MHz) Typ. |
|---|---|---|---|---|
| +20 Volts | -1 dBm | 2 dBm | 1.7 dB | 1.9 dB |
| +15 Volts | -2 dBm | 0 dBm | 1.9 dB | 2.1 dB |
| +10 volts | -5 dBm | -2 dBm | 2.3 dB | 2.5 dB |
| +5 Volts | -12 dBm | -5 dBm | 3.6 dB | 3.9 dB |

Weight approximately 2.0 grams (0.07 oz.)

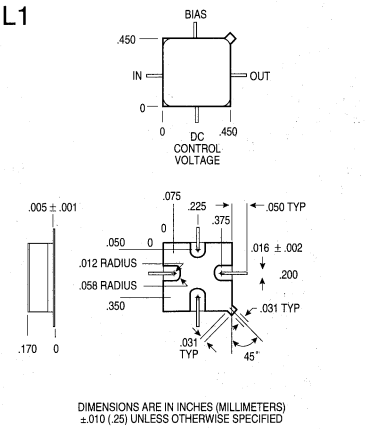
## Outline Drawing

L1



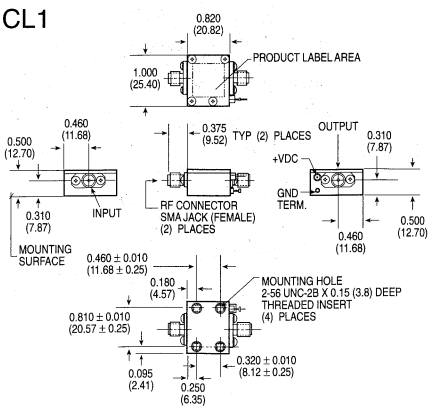

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SML1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CL1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Absolute Maximum Ratings

**Storage Temperature** . . . . . -62°C to +125°C

**Maximum Case Temperature.** . . . . . 125°C

**Maximum DC Voltage** . . . . . +25 Volts

**Maximum Continuous RF Input Power** . . . . . +20 dBm

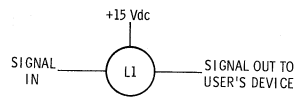
**Maximum Short Term RF Input Power (1 Minute Max.)** . . . . . 400 Milliwatts

**Maximum Peak Power** . . . . . 1 Watt (3 μsec Max.)

**"S" Series Burn-In Temperature (Case)** . . . . . 125°C

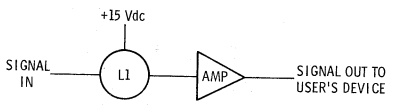
## Typical Applications

1. User wants to limit signal to his device to a level of 0 dBm.



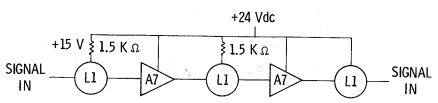

In this case the signal into the user's device will not exceed 0 dBm for incident signal levels to the WJ-L1 as high as +25 dBm.

2. User wants to limit signal to his device to a level above 0 dBm.




In this case the signal into the user's device will be limited to the output of the amplifier with a maximum of 0 dBm to the amplifier input. (Example: If a WJ-A7 is used with +24V DC bias an output signal of +14 dBm could be available to the user's device.)

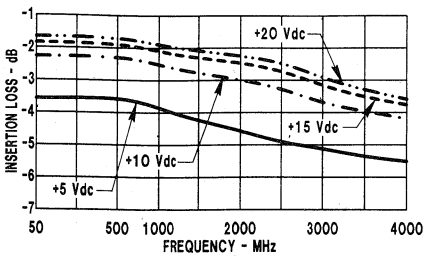
3. Wide input range with constant output.



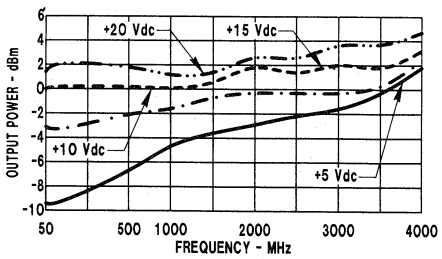

In this case the output signal level will be typically 0 dBm ±0.5 dBm for input level variation from –25 dBm to +25 dBm. Up to six pairs of limiters and amplifiers can be cascaded for extended dynamic range.

## Typical Performance at 25°C

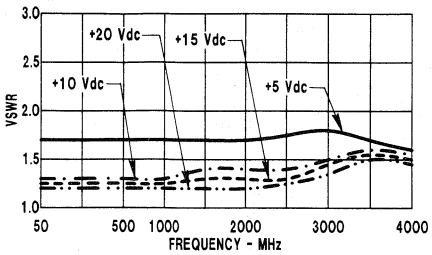
### Insertion Loss

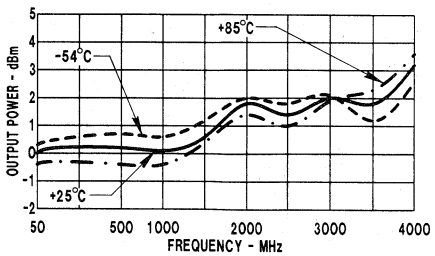



### Maximum Limiting Level

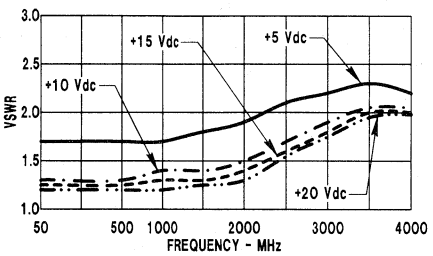



### Input VSWR vs. Frequency

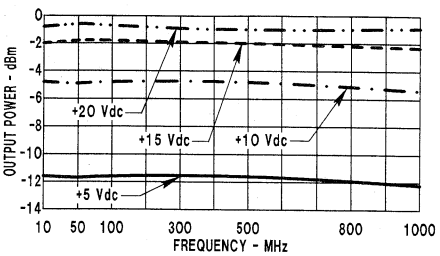



### Output VSWR vs. Frequency

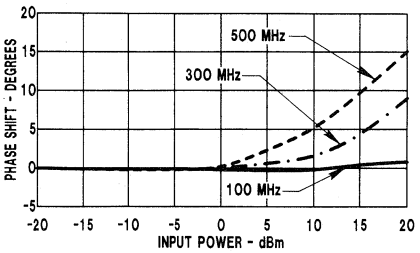


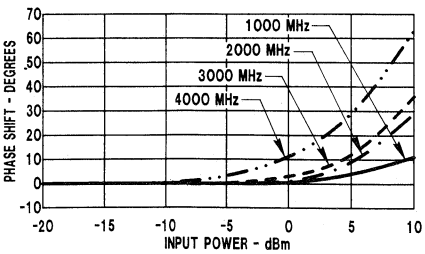

### Output Power*



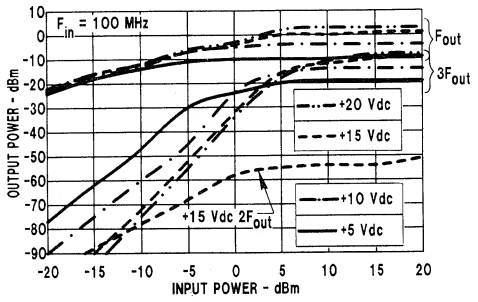

*at 1 dB Compression

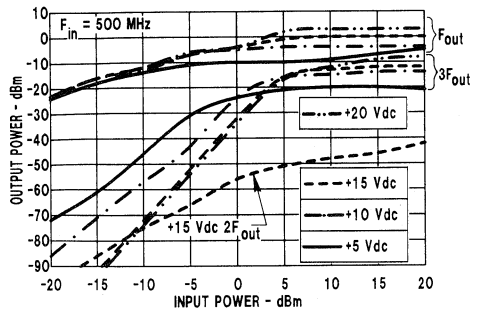
### Phase Shift vs. Input Power

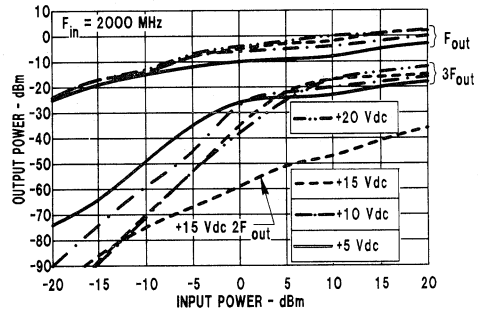


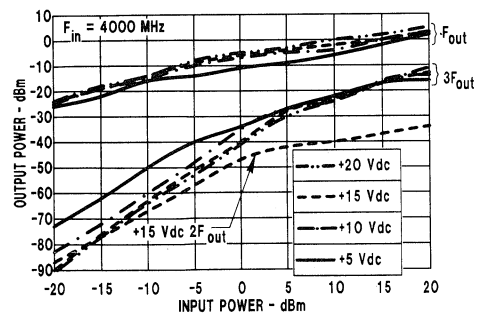



## Limiting Characteristics




# Typical Automatic Test Data

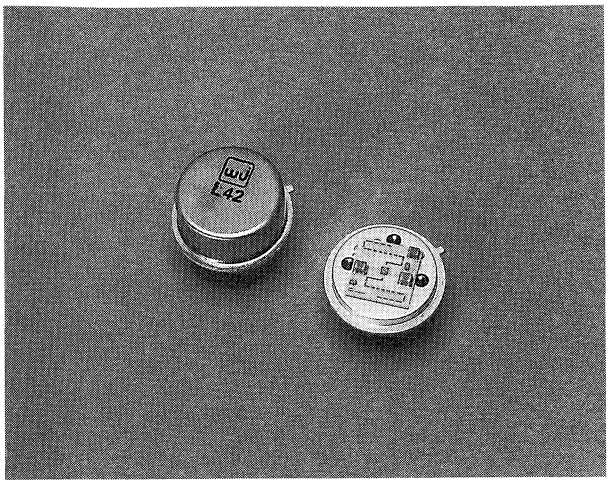
### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 1.0 | 1.8 | 1.8 | -2.0 |
| 2.0 | 1.4 | 1.4 | -1.7 |
| 5.0 | 1.2 | 1.2 | -1.6 |
| 10.0 | 1.2 | 1.2 | -1.6 |
| 50.0 | 1.2 | 1.2 | -1.6 |
| 100.0 | 1.2 | 1.2 | -1.6 |
| 200.0 | 1.2 | 1.2 | -1.7 |
| 300.0 | 1.2 | 1.2 | -1.8 |
| 400.0 | 1.2 | 1.2 | -1.7 |
| 500.0 | 1.2 | 1.2 | -1.8 |
| 600.0 | 1.2 | 1.2 | -1.8 |
| 700.0 | 1.2 | 1.3 | -1.7 |
| 800.0 | 1.2 | 1.3 | -1.8 |
| 900.0 | 1.2 | 1.3 | -1.9 |
| 1000.0 | 1.1 | 1.3 | -1.8 |
| 1100.0 | 1.1 | 1.3 | -1.8 |
| 1200.0 | 1.1 | 1.3 | -1.8 |
| 1300.0 | 1.1 | 1.3 | -1.8 |
| 1400.0 | 1.1 | 1.3 | -1.9 |
| 1500.0 | 1.1 | 1.4 | -1.9 |
| 1600.0 | 1.1 | 1.4 | -1.9 |
| 1700.0 | 1.0 | 1.4 | -1.9 |
| 1800.0 | 1.1 | 1.5 | -2.1 |
| 1900.0 | 1.1 | 1.5 | -2.3 |
| 2000.0 | 1.1 | 1.6 | -2.3 |
| 2100.0 | 1.2 | 1.6 | -2.4 |
| 2200.0 | 1.2 | 1.6 | -2.3 |
| 2300.0 | 1.2 | 1.7 | -2.4 |
| 2400.0 | 1.2 | 1.7 | -2.4 |
| 2500.0 | 1.2 | 1.8 | -2.4 |
| 2600.0 | 1.3 | 1.8 | -2.5 |
| 2700.0 | 1.3 | 1.8 | -2.3 |
| 2800.0 | 1.4 | 1.8 | -2.5 |
| 2900.0 | 1.4 | 1.9 | -2.7 |
| 3000.0 | 1.4 | 1.9 | -2.7 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 1.0 | .280 | -54 | .796 | 17 | .800 | 16 | .277 | -56 |
| 2.0 | .160 | -50 | .826 | 9 | .822 | 9 | .163 | -50 |
| 5.0 | .101 | -30 | .830 | 3 | .832 | 3 | .103 | -30 |
| 10.0 | .090 | -18 | .831 | 1 | .830 | 1 | .090 | -18 |
| 50.0 | .081 | -12 | .832 | -2 | .830 | -2 | .087 | -12 |
| 100.0 | .086 | -16 | .834 | -5 | .830 | -5 | .088 | -20 |
| 200.0 | .083 | -34 | .825 | -10 | .824 | -9 | .091 | -36 |
| 300.0 | .088 | -53 | .817 | -14 | .822 | -14 | .094 | -53 |
| 400.0 | .080 | -68 | .821 | -19 | .821 | -18 | .100 | -69 |
| 500.0 | .081 | -81 | .814 | -23 | .817 | -23 | .105 | -83 |
| 600.0 | .071 | -100 | .812 | -28 | .815 | -28 | .110 | -97 |
| 700.0 | .080 | -109 | .819 | -32 | .814 | -32 | .112 | -109 |
| 800.0 | .075 | -127 | .813 | -36 | .819 | -36 | .115 | -120 |
| 900.0 | .073 | -138 | .806 | -41 | .816 | -41 | .120 | -128 |
| 1000.0 | .068 | -146 | .813 | -45 | .813 | -46 | .123 | -137 |
| 1100.0 | .056 | -157 | .815 | -50 | .812 | -50 | .128 | -144 |
| 1200.0 | .057 | -164 | .811 | -55 | .804 | -55 | .133 | -151 |
| 1300.0 | .051 | 171 | .814 | -60 | .800 | -60 | .141 | -157 |
| 1400.0 | .047 | 173 | .802 | -64 | .797 | -65 | .149 | -164 |
| 1500.0 | .038 | 158 | .802 | -69 | .795 | -70 | .157 | -170 |
| 1600.0 | .032 | 156 | .801 | -74 | .792 | -74 | .167 | -176 |
| 1700.0 | .020 | 175 | .802 | -79 | .785 | -79 | .179 | 178 |
| 1800.0 | .026 | -172 | .783 | -83 | .784 | -83 | .191 | 171 |
| 1900.0 | .052 | 179 | .769 | -88 | .774 | -88 | .204 | 163 |
| 2000.0 | .043 | -160 | .766 | -94 | .776 | -93 | .217 | 155 |
| 2100.0 | .072 | -171 | .756 | -99 | .770 | -98 | .229 | 147 |
| 2200.0 | .075 | 174 | .765 | -103 | .764 | -103 | .242 | 138 |
| 2300.0 | .094 | 162 | .761 | -109 | .760 | -107 | .252 | 129 |
| 2400.0 | .108 | 147 | .761 | -112 | .754 | -112 | .261 | 120 |
| 2500.0 | .106 | 142 | .756 | -118 | .752 | -117 | .273 | 112 |
| 2600.0 | .129 | 130 | .753 | -123 | .745 | -122 | .278 | 103 |
| 2700.0 | .133 | 114 | .766 | -128 | .738 | -127 | .289 | 95 |
| 2800.0 | .167 | 109 | .753 | -133 | .736 | -132 | .295 | 86 |
| 2900.0 | .157 | 92 | .736 | -140 | .738 | -138 | .301 | 78 |
| 3000.0 | .182 | 77 | .729 | -146 | .711 | -144 | .303 | 70 |

# WJ-L42/SML42



## 50 TO 4000 MHz
## THIN FILM LIMITER MODULE

- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ VERY WIDE BANDWIDTH
- ◆ GOOD SUPPRESSION OF EVEN ORDER HARMONICS
- ◆ LOW INSERTION LOSS: 3.5 DB (TYP.)

## Specifications*

| Characteristics | Typical | Guaranteed |
|---|---|---|
| Frequency (Min.) | 5-4000 MHz | 50 - 4000 MHz |
| Insertion Loss (Max.) | | |
| $P_{IN} \leq$ -20 dBm | | |
| Bias ≤ +20 Vdc | | |
| 50 - 3000 MHz | 3.5 dB | 4.5 dB |
| 3000 - 4000 MHz | | 5.0 dB |
| Input VSWR (Max.) | 1.6:1 | 1.9:1 |
| $P_{IN} \leq$ -10 dBm, +10 ≤ Bias ≤ +20 Vdc | | |
| Output VSWR (Max.) | 2:0:1 | 2:3:1 |
| Pin ≤ -10 dBm +10 ≤ Bias ≤ +20 Vdc | | |
| Output Limiting Level (Max.) | | |
| Pin = +20 dBm +15 ≤ Bias ≤ +20 Vdc | | |
| 50 - 2000 MHz | 2.5 dBm | 4.0 dBm |
| 2000 - 4000 MHz | 6.5 dBm | 7.0 dBm |
| Bias | | |
| At +20 Vdc | 8.5 mA | |
| At +15 Vdc | 6.5 mA | |
| At +10 Vdc | 4.0 mA | |

*Measured in a 50-ohm system, guaranteed at 25°C at +15.0 Vdc nominal.

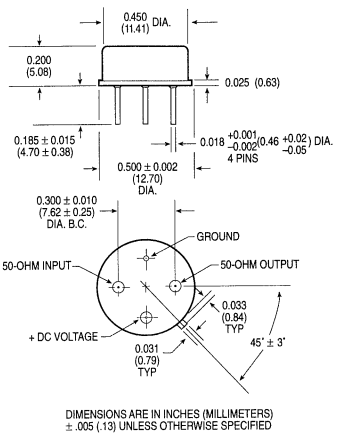
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum DC Voltage.....+25 Volts
Maximum Continuous RF Input Power .....+20 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....400 Milliwats
Maximum Peak Power .....1 Watt (3 µsec Max.)
"S" Series Burn-In Temperature (case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

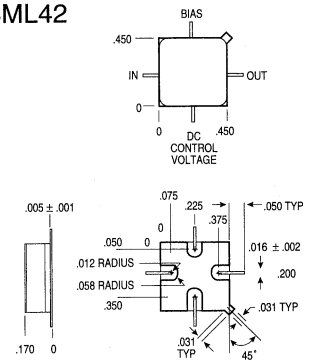
## Outline Drawing

L42



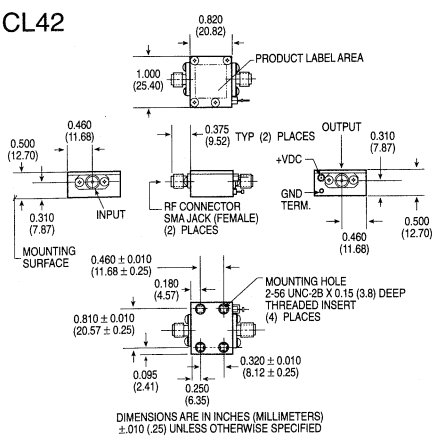

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SML42




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

CL42



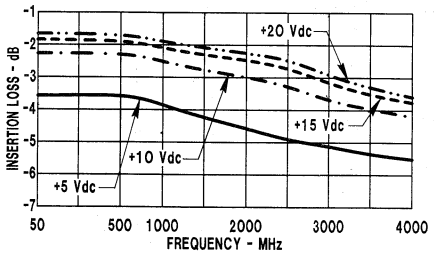

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Limiting and Insertion Loss Characteristics (25°)

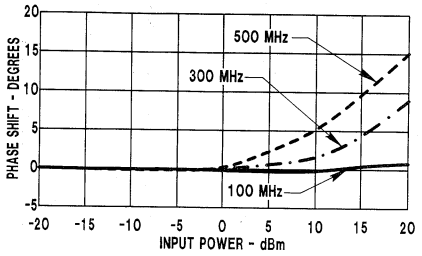
| Bias Voltage | Output Level at Limiting Threshold (1 dB Compression) Typ. | | | Output Limiting Level (+20 dBm Input) Typ. | | | Insertion Loss Typ. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1000 MHz | 2500 MHz | 4000 MHz | 1000 MHz | 2500 MHz | 4000 MHz | 1000 MHz | 2500 MHz | 4000 MHz |
| +20 Volts | -1.0 dBm | -2.5 dBm | -6.0 dBm | +1.5 dBm | +2.5 dBm | +7.5 dBm | 1.9 dB | 2.5 dB | 3.7 dB |
| +15 Volts | -2.0 dBm | -4.0 dBm | -6.2 dBm | 0 dBm | +1.8 dBm | +6.5 dBm | 2.1 dB | 2.8 dB | 3.8 dB |
| +10 Volts | -5.5 dBm | -7.0 dBm | -7.8 dBm | -1.8 dBm | 0 dBm | +2.5 dBm | 2.5 dB | 3.3 dB | 4.2 dB |
| +5 Volts | -12.0 dBm | -13.8 dBm | -12.0 dBm | -4.5 dBm | -2.0 dBm | +2.0 dBm | 3.9 dB | 5.0 dB | 5.5 dB |

## Typical Performance at 25°C

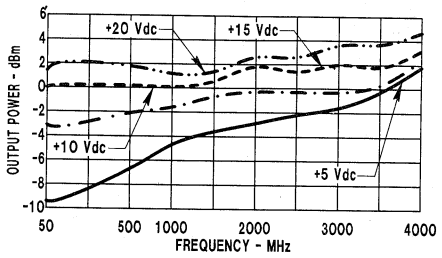
### Insertion Loss



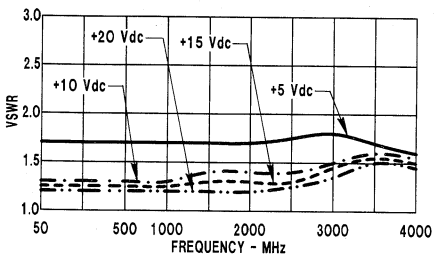

### Phase Shift vs. Input Power

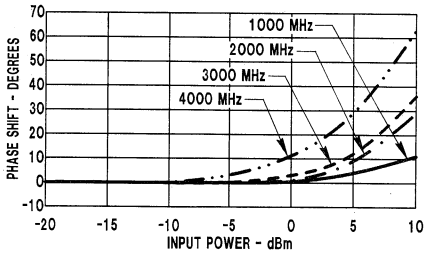


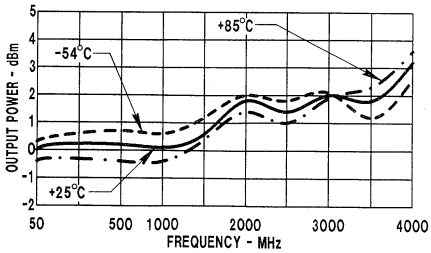

### Maximum Limiting Level



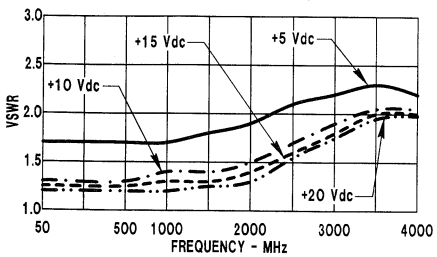

### Input VSWR vs. Frequency



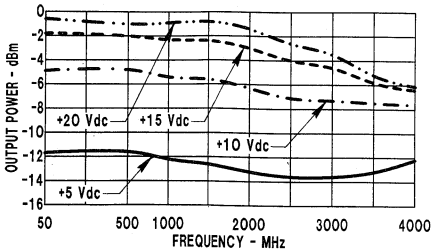




### Output VSWR vs. Frequency

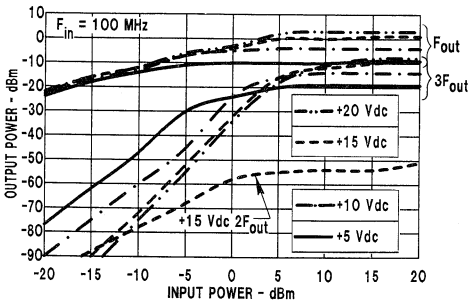



### Output Power*



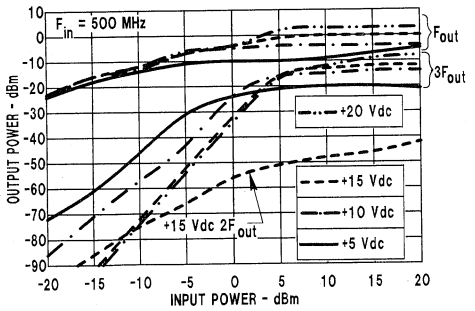

*at 1 dB Gain Compression

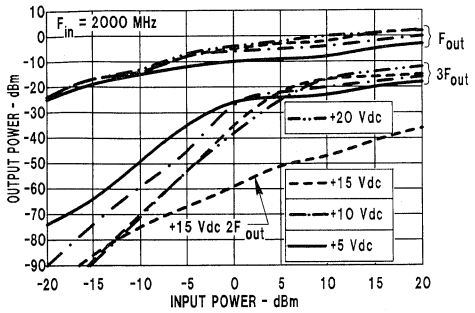
### Limiting Characteristics

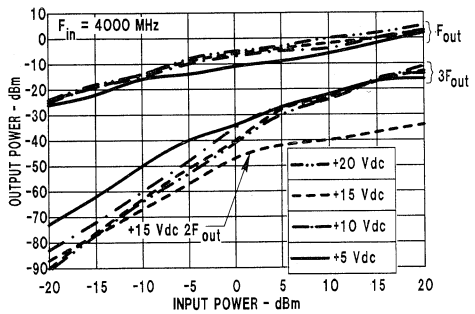


# Typical Performance at 25°C

### Limiting Characteristics




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

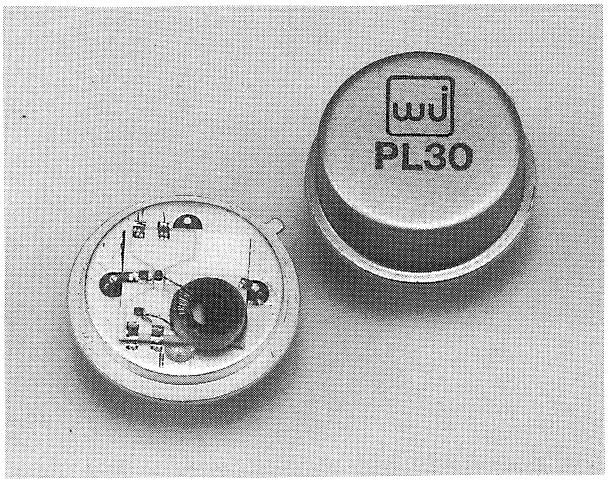
| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 50.0 | 1.2 | 1.2 | -1.8 |
| 100.0 | 1.3 | 1.2 | -1.8 |
| 200.0 | 1.2 | 1.2 | -1.9 |
| 400.0 | 1.2 | 1.2 | -1.9 |
| 600.0 | 1.2 | 1.2 | -1.9 |
| 800.0 | 1.2 | 1.3 | -2.0 |
| 1000.0 | 1.2 | 1.3 | -2.0 |
| 1200.0 | 1.2 | 1.3 | -2.1 |
| 1400.0 | 1.2 | 1.3 | -2.2 |
| 1600.0 | 1.2 | 1.3 | -2.2 |
| 1800.0 | 1.2 | 1.4 | -2.3 |
| 2000.0 | 1.2 | 1.4 | -2.3 |
| 2200.0 | 1.2 | 1.5 | -2.5 |
| 2400.0 | 1.2 | 1.5 | -2.5 |
| 2600.0 | 1.3 | 1.6 | -2.7 |
| 2800.0 | 1.4 | 1.7 | -2.7 |
| 3000.0 | 1.4 | 1.9 | -3.1 |
| 3200.0 | 1.5 | 1.9 | -3.3 |
| 3400.0 | 1.5 | 2.0 | -3.6 |
| 3600.0 | 1.5 | 2.0 | -3.8 |
| 3800.0 | 1.5 | 2.0 | -3.8 |
| 4000.0 | 1.4 | 1.9 | -3.8 |

### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 50.0 | .107 | -13 | .816 | –2 | .811 | -2 | .106 | -11 |
| 100.0 | .112 | -18 | .910 | –5 | .810 | -5 | .107 | –18 |
| 200.0 | .107 | -29 | .908 | –9 | .808 | -9 | .106 | –31 |
| 400.0 | .104 | -59 | .805 | –19 | .803 | –18 | .109 | –62 |
| 600.0 | .107 | -87 | .903 | -27 | .800 | -26 | .110 | -89 |
| 800.0 | .107 | -114 | .798 | -36 | .796 | -35 | .114 | -115 |
| 1000.0 | .108 | -144 | .791 | -45 | .795 | -45 | .118 | -141 |
| 1200.0 | .108 | -161 | .784 | -53 | .784 | -53 | .124 | -150 |
| 1400.0 | .104 | 173 | .779 | -62 | .777 | -61 | .131 | .179 |
| 1600.0 | .099 | 150 | .773 | -71 | .768 | -71 | .140 | .154 |
| 1800.0 | .100 | 141 | .767 | -79 | .761 | -79 | .149 | 151 |
| 2000.0 | .095 | 130 | .765 | -89 | .753 | -98 | .164 | 137 |
| 2200.0 | .093 | 126 | .751 | -98 | .743 | -97 | .186 | 128 |
| 2400.0 | .105 | 125 | .753 | -107 | .742 | -106 | .212 | 115 |
| 2600.0 | .126 | 110 | .736 | -115 | .730 | -114 | .241 | 101 |
| 2800.0 | .152 | 96 | .736 | -126 | .721 | -124 | .271 | 84 |
| 3000.0 | .174 | 82 | .703 | -134 | .710 | -133 | .294 | 69 |
| 3200.0 | .189 | 65 | .681 | -144 | .689 | -143 | .313 | 53 |
| 3400.0 | .199 | 49 | .663 | -153 | .682 | -151 | .327 | 35 |
| 3600.0 | .201 | 26 | .648 | -160 | .660 | -160 | .329 | 18 |
| 3800.0 | .190 | 6 | .649 | -168 | .656 | -169 | .325 | 1 |
| 4000.0 | .168 | -19 | .645 | -178 | .639 | -179 | .311 | -17 |

# WJ-PL30/SMPL30

## 100 TO 2000 MHz
## THIN-FILM
## PROTECTIVE POWER LIMITER




- ◆ AVAILABLE IN SURFACE MOUNT
- ◆ LOW INSERTION LOSS: ≤ 0.9 DB (TYP.)
- ◆ LOW INPUT AND OUTPUT VSWR: ≤ 1.2:1 (TYP.)
- ◆ HIGH CW INPUT POWER: +30 dBm

## Specifications*

| Characteristic | Typical | Guaranteed -54°C to 85°C |
|---|---|---|
| Frequency (Min.) | 10 - 2400 MHz | 100 - 2000 MHz |
| Insertion Loss at +20 dBm Input (Max.) | | |
| 100-1000 MHz | 0.3 dB | 0.5 dB |
| 1000-2000 MHz | 0.9 dB | 1.0 dB |
| Leakage Power (Input Power +30 dBm CW) (Max.) | +17 dBm | +20 dBm |
| Limiting Threshold (Input for 1 dB Compression) (Min.) | +10 dBm | +7.5 dBm |
| VSWR (Max.) Input/Output | | |
| $P_{IN}$ = +10 dBm | 1.2:1 | 1.7:1 |

*Measured in a 50-ohm system.

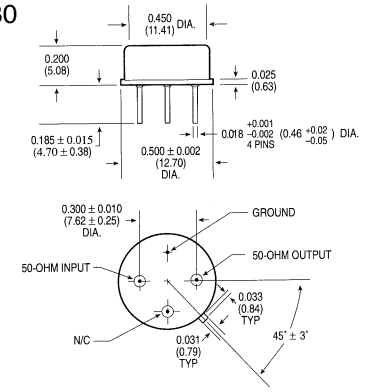
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Maximum Continuous RF Input Power .....+30 dBm
Maximum Short Term RF Input Power (1 Minute Max.) .....2.0 Watts
Maximum Peak Power.....50 Watt (1 µsec Pulse and 0.001 Duty Cycle Max.)
"S" Series Burn-In (No Applied Voltage) (Case).....125°C

Weight approximately 2.0 grams (0.07 oz.)

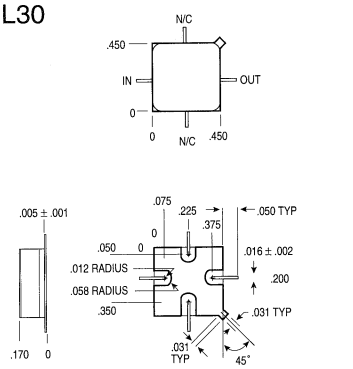
## Outline Drawing

PL30



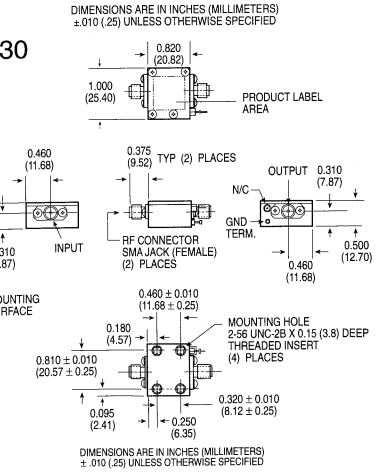

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

SMPL30




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

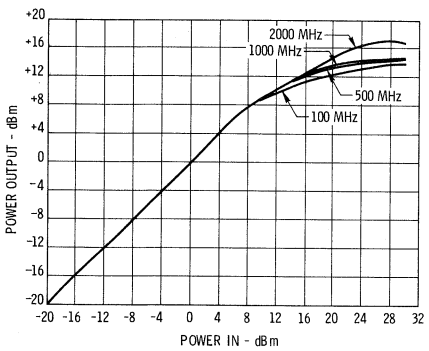
CPL30



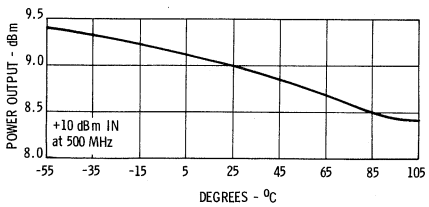

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

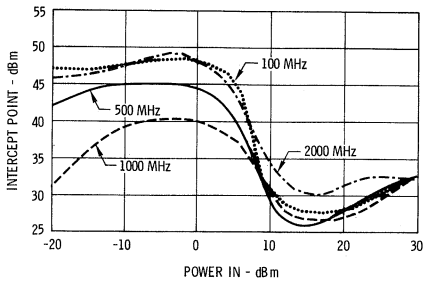
### Output Power vs. Input Power



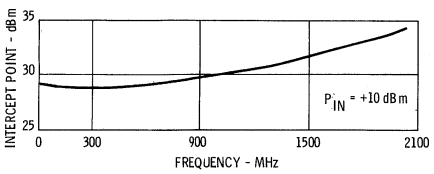

### Output Power vs. Temperature



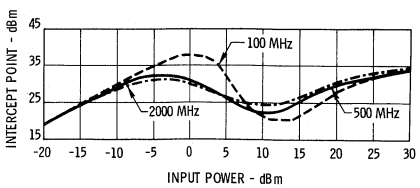

### 2nd Harmonic Intercept Point vs. Input Power



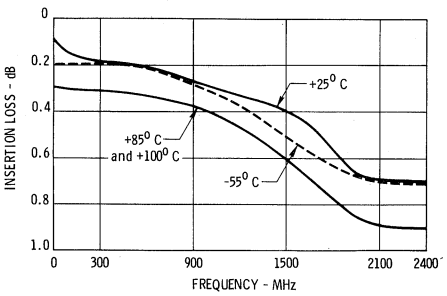

### 2nd Harmonic Intercept Point vs. Frequency



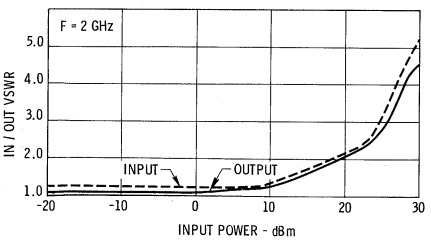

### 3rd Order Two Tone Intercept Point vs. Input Power




### Insertion Loss vs. Frequency



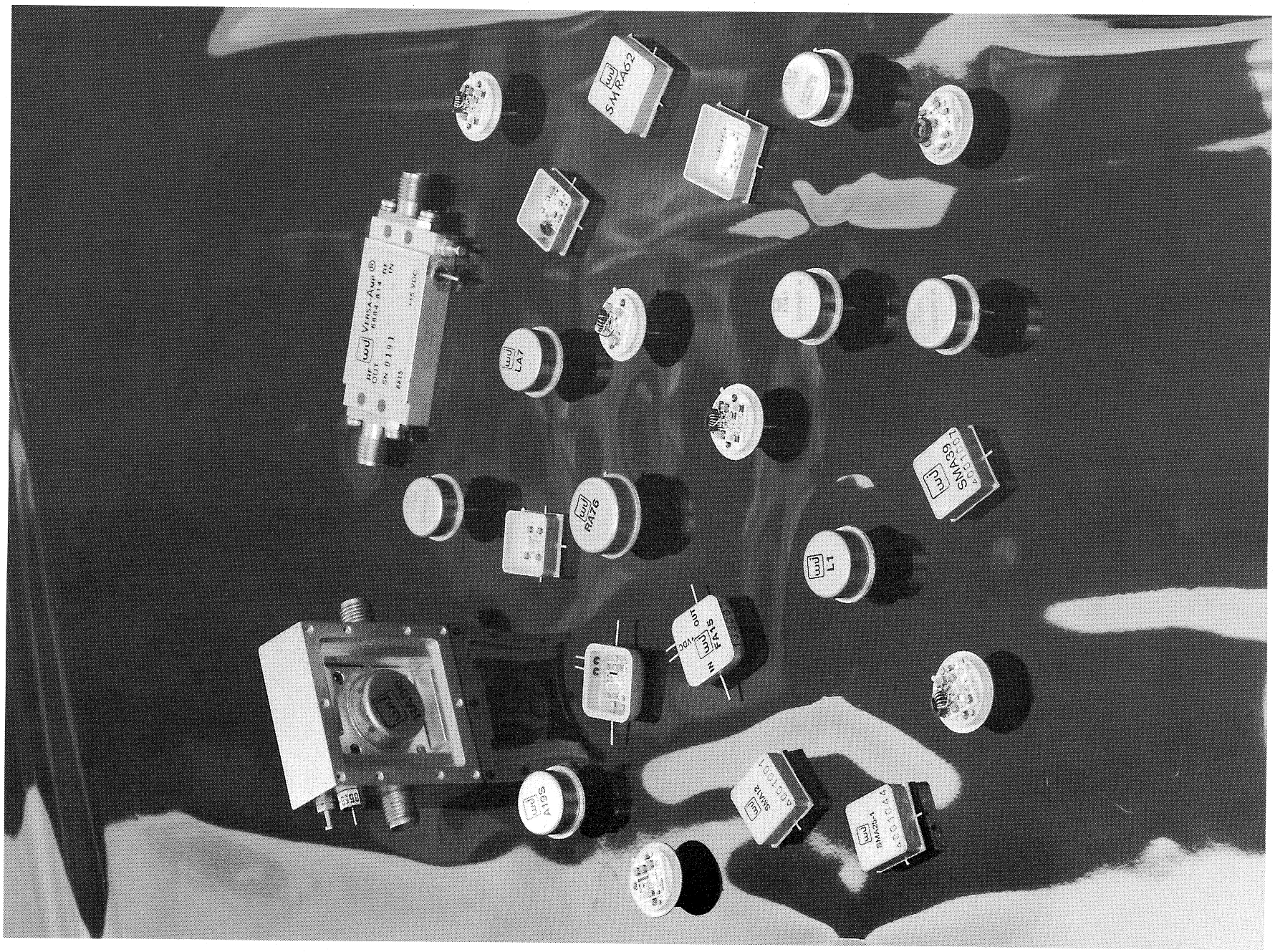

### VSWR




5

# *Level Detectors*

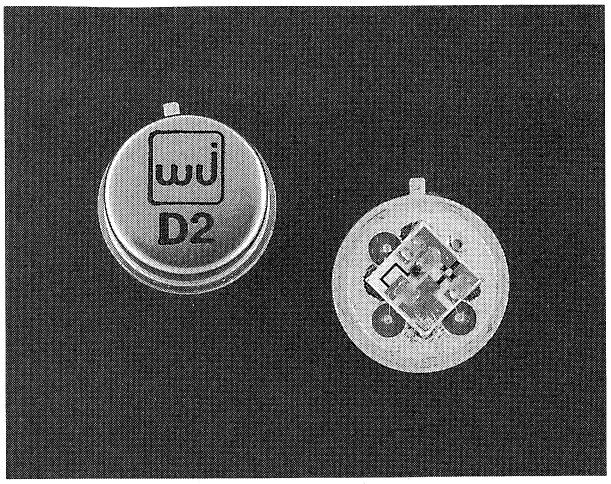




# WJ-D2

## 10 TO 2000 MHz TO-5 DIRECTIONAL LEVEL DETECTOR

- ◆ HIGH DIRECTIVITY: 30 dB (TYP.) AT PIN = +4 dBm
- ◆ HIGH ISOLATION: 30 dB (TYP.)
- ◆ LOW VSWR: 1.3:1 (TYP.)
- ◆ VERY SMALL SIZE



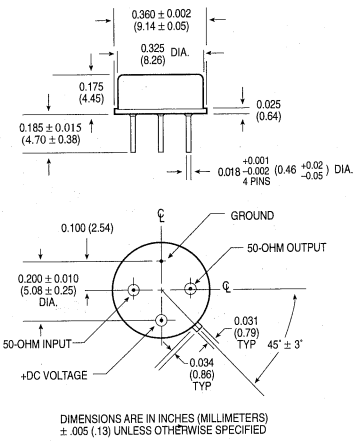

## Specifications*

| Characteristics | Typical | Guaranteed 0° to 50°C | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency Range | 10 - 2300 MHz | 10 - 2000 MHz | 10 - 2000 MHz |
| Insertion Loss (Max.) | | | |
| 10 - 1000 MHz | 3.4 dB | 3.8 dB | 3.8 dB |
| 1000 - 2000 MHz | 3.7 dB | 4.5 dB | 4.5 dB |
| DC Output[1] (Min.) | | | |
| At Pin = + 10 dBm | | | |
| 10 - 2000 MHz | 135 mV | 90 mV | 90 mV |
| At Pin + 6 dBm | | | |
| 10 - 2000 MHz | 51 mV | 25 mV | 25 mV |
| Directivity[1,2] (Min.) | | | |
| At Pin = + 4 dBm | | | |
| 10 - 250 MHz | >40 dB | 35 dB | 35 dB |
| 250 - 1000 MHz | >30 dB | 20 dB | 20 dB |
| 1000 - 2000 MHz | >20 dB | 10 dB | 10 dB |
| Isolation[1] (Min.) | | | |
| Input → DC Output | | | |
| 10 - 1000 MHz | >35 dB | 28 dB | 28 dB |
| 1000 - 2000 MHz | >28 dB | 22 dB | 22 dB |
| Output → DC Output | | | |
| 10 - 1000 MHz | >40 dB | 32 dB | 32 dB |
| 1000 - 2000 MHz | >32 dB | 26 dB | 26 dB |
| VSWR Input/Output | | | |
| 10 - 2000 MHz | <1.3:1 | 1.4:1 | 1.5:1 |

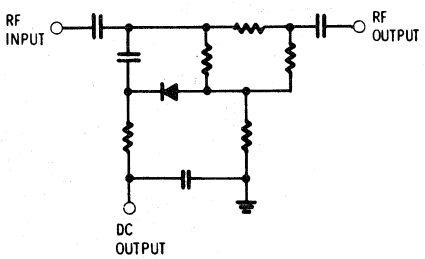
'Measured in a 50-ohm system.
Notes:
1. Measured with 50K ohm dc output load.
2. Directivity = 20 log (Forward dc output/Reverse dc output).
3. Video Bandwidth 10 kHz Typ.

## Outline Drawing

D2




## Schematic Diagram



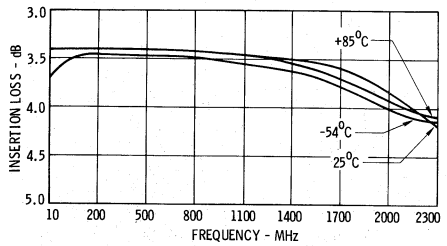

## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum CW Input Power ..... +17 dBm
Maximum Short Term RF Input Power (1 Minute Max.) ..... 100 Milliwatts
"S" Series Burn-In Temperature (Case) ..... 125°C

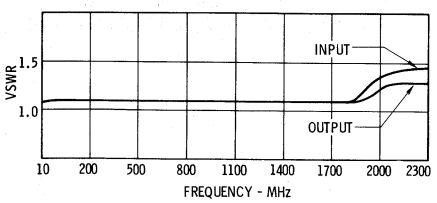
Weight approximately 1.0 grams (0.04 oz.)

# Typical Performance at 25°C

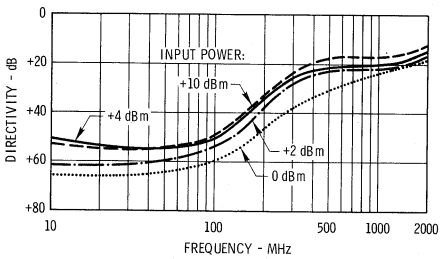
### Insertion Loss



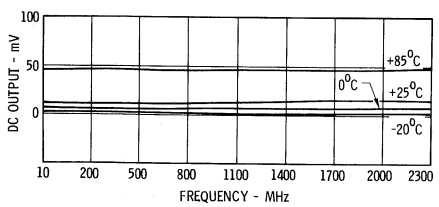

### VSWR



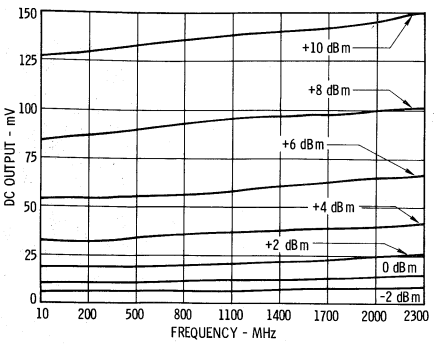

### Directivity (50KΩ Load)



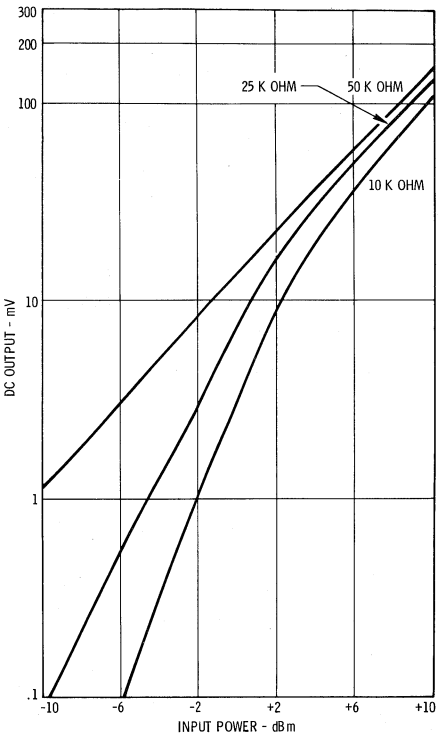

### DC Output
### PIN = 0 dBm (50KΩ Load)



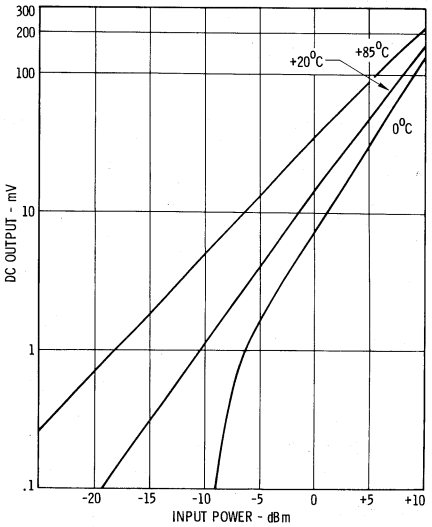

### DC Output (50KΩ Load)



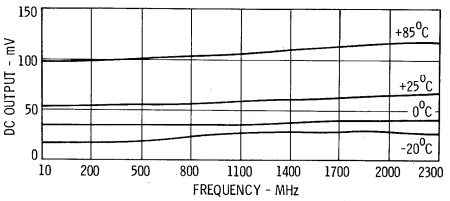

### DC Output vs. Input Power vs. DC Output Loading at 2000 MHz



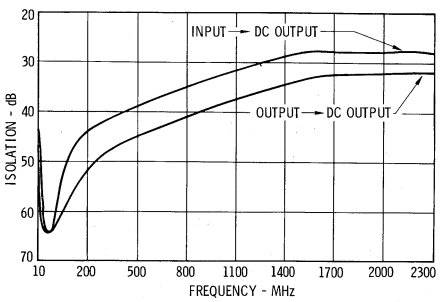

### DC Output vs. Input Power at 2000 MHz




### DC Output
### PIN = +6 dBm (50KΩ Load)




### Isolation (50KΩ Load)




# Typical Automatic Test Data

### $V_{CC}$ = 15.0 V

| Frequency MHz | VSWR IN | VSWR OUT | GAIN DB |
|---|---|---|---|
| 100.0 | 1.1 | 1.1 | 3.4 |
| 200.0 | 1.1 | 1.1 | 3.4 |
| 300.0 | 1.1 | 1.1 | 3.4 |
| 400.0 | 1.1 | 1.1 | 3.5 |
| 500.0 | 1.1 | 1.1 | 3.4 |
| 600.0 | 1.1 | 1.1 | 3.5 |
| 700.0 | 1.1 | 1.1 | 3.4 |
| 800.0 | 1.1 | 1.1 | 3.4 |
| 900.0 | 1.1 | 1.1 | 3.5 |
| 1000.0 | 1.2 | 1.1 | 3.5 |
| 1100.0 | 1.1 | 1.1 | 3.5 |
| 1200.0 | 1.1 | 1.1 | 3.6 |
| 1300.0 | 1.1 | 1.0 | 3.5 |
| 1400.0 | 1.1 | 1.0 | 3.5 |
| 1500.0 | 1.2 | 1.1 | 3.5 |
| 1600.0 | 1.2 | 1.1 | 3.5 |
| 1700.0 | 1.1 | 1.1 | 3.5 |
| 1800.0 | 1.2 | 1.2 | 3.6 |
| 1900.0 | 1.2 | 1.2 | 3.7 |
| 2000.0 | 1.2 | 1.3 | 3.9 |
| 2100.0 | 1.2 | 1.3 | 4.1 |
| 2200.0 | 1.2 | 1.3 | 4.2 |
| 2300.0 | 1.2 | 1.3 | 4.2 |

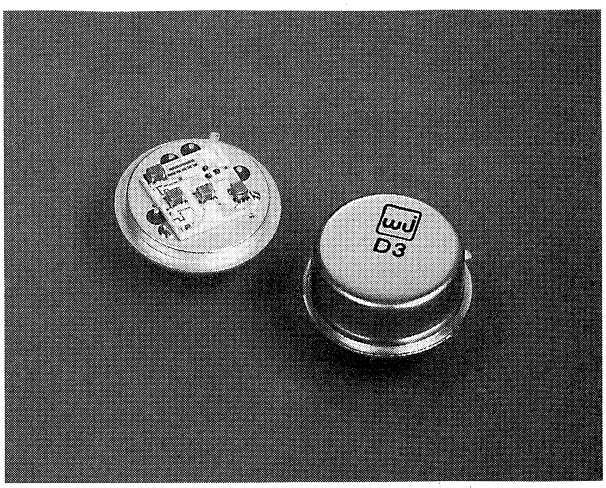
### Linear S-Parameters

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.0 | .04 | -124.2 | .67 | 12.6 | .68 | 12.8 | .04 | -136.0 |
| 200.0 | .03 | -83.4 | .67 | 21.8 | .68 | 21.8 | .03 | -112.7 |
| 300.0 | .04 | -108.1 | .68 | 32.9 | .68 | 32.4 | .04 | -113.0 |
| 400.0 | .03 | -74.6 | .67 | 42.6 | .67 | 42.9 | .03 | -98.3 |
| 500.0 | .06 | -64.7 | .68 | 53.0 | .67 | 52.6 | .05 | -77.1 |
| 600.0 | .05 | -66.1 | .67 | 63.4 | .67 | 63.3 | .05 | -74.9 |
| 700.0 | .06 | -31.1 | .67 | 73.8 | .67 | 73.7 | .05 | -53.2 |
| 800.0 | .07 | -34.8 | .67 | 83.9 | .67 | 84.0 | .06 | -43.1 |
| 900.0 | .06 | -9.6 | .67 | 94.9 | .67 | 94.1 | .05 | -43.3 |
| 1000.0 | .07 | -6.6 | .67 | 105.2 | .67 | 104.8 | .04 | -29.5 |
| 1100.0 | .06 | 0.8 | .67 | 115.7 | .67 | 115.5 | .04 | -31.0 |
| 1200.0 | .06 | 25.3 | .66 | 125.3 | .67 | 125.8 | .03 | 7.6 |
| 1300.0 | .07 | 32.2 | .67 | 135.7 | .66 | 136.0 | .02 | 49.6 |
| 1400.0 | .06 | 43.1 | .67 | 145.5 | .66 | 145.4 | .01 | 67.4 |
| 1500.0 | .07 | 65.0 | .67 | 156.1 | .67 | 155.5 | .04 | 124.2 |
| 1600.0 | .07 | 67.4 | .67 | 167.0 | .67 | 166.2 | .04 | 119.6 |
| 1700.0 | .07 | 107.8 | .66 | 177.7 | .67 | 176.6 | .07 | 155.7 |
| 1800.0 | .07 | 99.6 | .66 | -172.0 | .67 | -172.7 | .09 | 155.5 |
| 1900.0 | .07 | 117.5 | .65 | -162.7 | .66 | -163.2 | .08 | 165.5 |
| 2000.0 | .10 | 145.5 | .64 | -151.9 | .65 | -151.9 | .12 | 178.4 |
| 2100.0 | .09 | 144.5 | .62 | -143.3 | .64 | -142.8 | .12 | 173.4 |
| 2200.0 | .10 | 159.7 | .62 | -132.1 | .63 | -131.3 | .13 | -172.1 |
| 2300.0 | .11 | 163.4 | .62 | -122.6 | .63 | -122.0 | .15 | -171.7 |

# WJ-D3/SMD3

## 10 TO 1000 MHz
## TO-8 LEVEL DETECTOR

- ◆ 50-OHM INPUT IMPEDANCE
- ◆ RF INPUT, DC OUTPUT
- ◆ ACTIVE INPUT CIRCUITRY




## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50°C | Guaranteed -54° to +85° C |
|---|---|---|---|
| Frequency (Min.) | 10 - 1000 MHz | 10-1000 MHz | 10-1000 MHz |
| Detected Voltage[1, 2] | 100 mV | | |
| Variation Over Frequency[3] | ±7 mV | ±20 mV | |
| Variation Over Temperature[1, 3] | +110 mV | +120 mV | +130 mV |
| | -70 mV | -80 mV | -90 mV |
| Output Offset Voltage[1, 4] | 230 mV | | |
| VSWR (Max.) Input | 1.5:1 | 2.0:1 | 2.0:1 |
| Output Capacitance | 2.2 KpF | | 3.0 KpF |
| DC Current (Max.) at +15 Volts | 10 mA | 13 mA | 14 mA |

Notes:
*Measured in a 50-ohm system at +15.0 Vdc Nominal, 50 uA detector bias and 10 ohm load resistance.
1. Measured at 500 MHz
2. -10 dBm Input Power
3. -30 dBm Input Power
4. No RF Applied

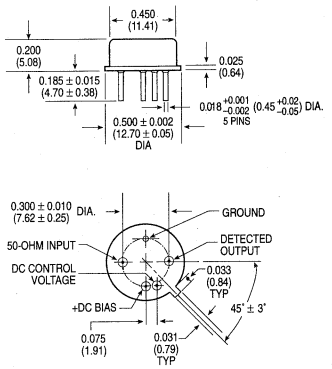
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Diode Bias Current ..... 1 mA
Maximum CW Input Power ..... +17 dBm
Maximum Short Term RF Input Power (1 Minute Max.) ..... 100 Milliwatts
"S" Series Burn-In Temperature (Case) ..... 125°C

Weight approximately 2.0 grams (0.07 oz.)

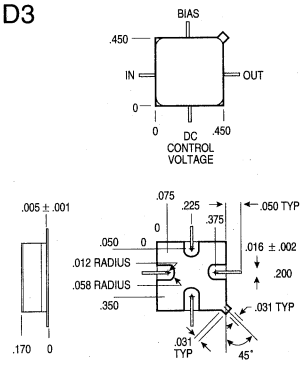
## Outline Drawing

D3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

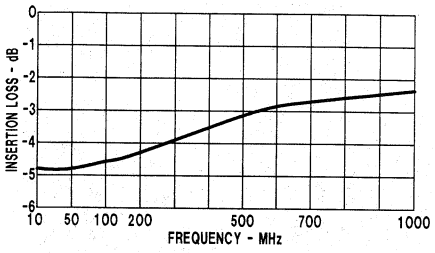
SMD3



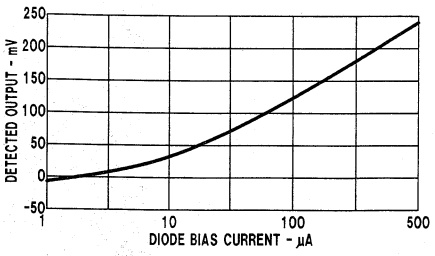

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

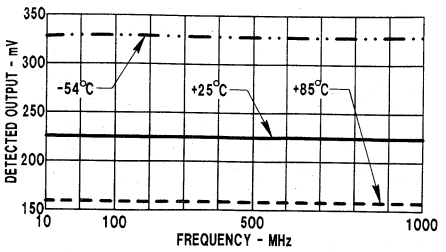
### Insertion Loss vs. Frequency①
### $P_{IN}$ = -10 dBm (10K Ω Load)



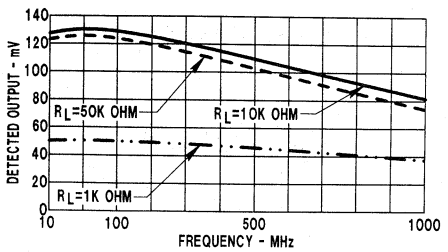

### Detected Output vs. Diode Bias Current, F = 500 MHz, $P_{IN}$ = -10 dBm (10K Ω Load)



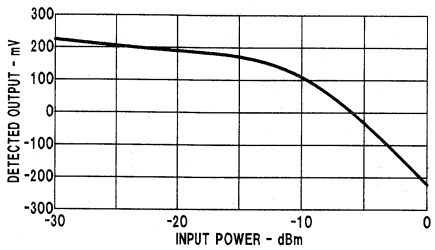

### Detected Output vs. Frequency $P_{IN}$ = -30 dBm (10K Ω Load)



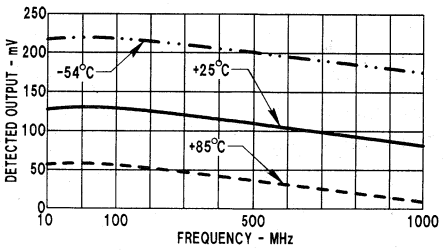

### Detected Output vs. Frequency vs. $R_L$, $P_{IN}$ = -10 dBm




### Detected Output vs. $P_{IN}$, F = 500 MHz (10K Ω Load)

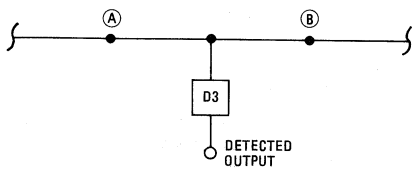



### Detected Output vs. Frequency $P_{IN}$ = -10 dBm (10K Ω Load)

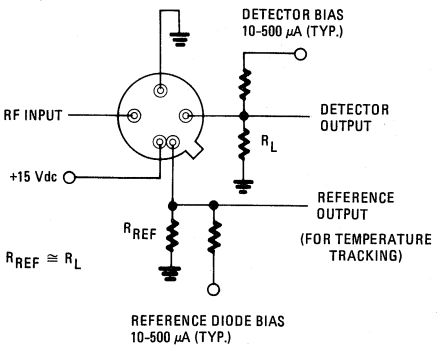



D3DV10

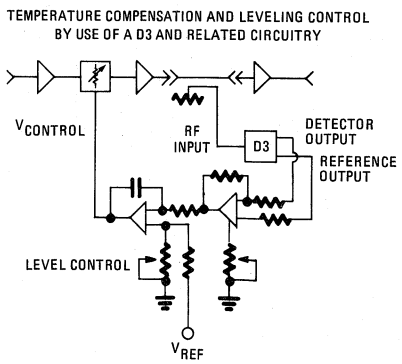
NOTES:
① INSERTION LOSS MEASURED BETWEEN POINTS Ⓐ AND Ⓑ ON A 50Ω TRANSMISSION LINE.




### Typical Test Circuit




### Typical Application Circuit

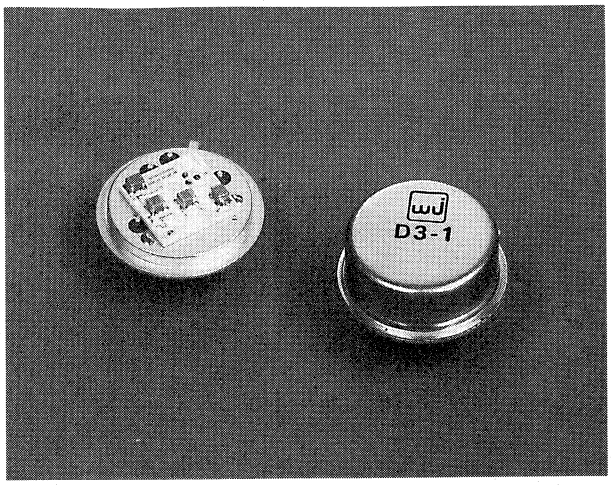



6

# WJ-D3-1/SMD3-1

## 10 TO 1000 MHz
## TO-8 LEVEL DETECTOR

- ◆ 300-OHM INPUT IMPEDANCE
- ◆ RF INPUT, DC OUTPUT
- ◆ ACTIVE INPUT CIRCUITRY




## Specifications*

| Characteristics | Typical | Guaranteed 0° to +50° | Guaranteed -54° to +85°C |
|---|---|---|---|
| Frequency (Min.) | 10 - 1000 MHz | 10 - 1000 MHz | 10 - 1000 MHz |
| Detected Voltage[1, 2] | - 50 mV | | |
| Variation Over Frequency[3] | ± 2 mV | ± 20 mV | |
| Variation Over Temperature[1, 3] | ± 90 mV | ± 100 mV | ± 110 mV |
| Output Offset Voltage[1, 4] | 230 mV | | |
| Input impedance | 300 Ω | | |
| Output Capacitance | 2.2 KpF | | 3.0 KpF |
| DC Current (Max.) at +15 Volts | 10 mA | 13 mA | 14 mA |

Notes:
*Measured in a 50-ohm system at +15.0 Vdc Nominal, 50 uA detector bias and 10 ohm load resistance.
1. Measured at 500 MHz
2. -10 dBm Input Power
3. -30 dBm Input Power
4. No RF Applied

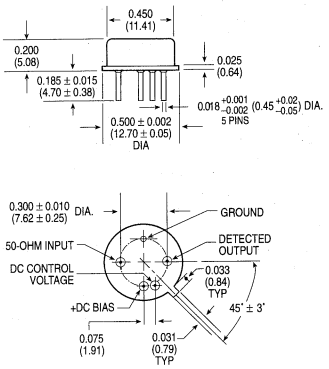
## Absolute Maximum Ratings

Storage Temperature .....-62°C to +125°C
Maximum Case Temperature .....125°C
Diode Bias Current .....1 mA
Maximum CW Input Power .....+17 dBm
Maximum Short Term RF Input Power (1 Minute Max.).....100 Milliwatts
"S" Series Burn-In Temperature (Case) .....125°C

Weight approximately 2.0 grams (0.07 oz.)

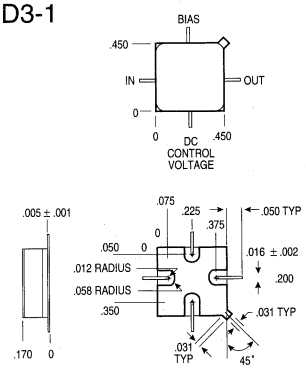
## Outline Drawing

D3-1




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .005 (.13) UNLESS OTHERWISE SPECIFIED

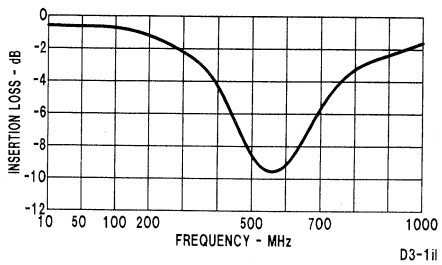
SMD3-1



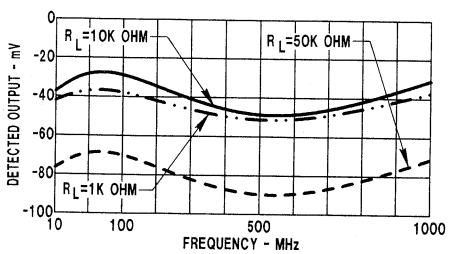

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.25) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

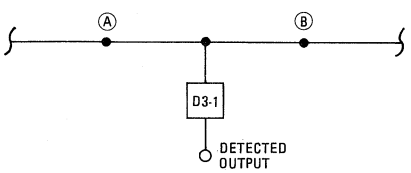
**Insertion Loss vs. Frequency①**
**$P_{IN}$ = -10 dBm (10KΩ Load)**



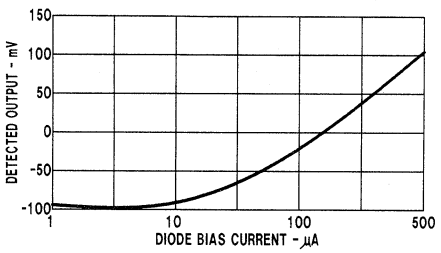

**Detected Output vs. Frequency vs. $R_L$, $P_{IN}$ = -10 dBm**



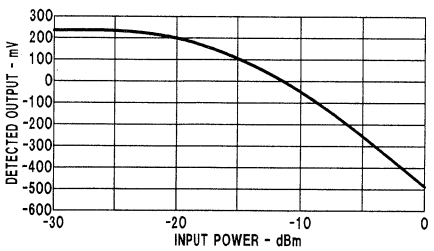

NOTES:
① INSERTION LOSS MEASURED BETWEEN POINTS Ⓐ AND Ⓑ ON A 50Ω TRANSMISSION LINE.



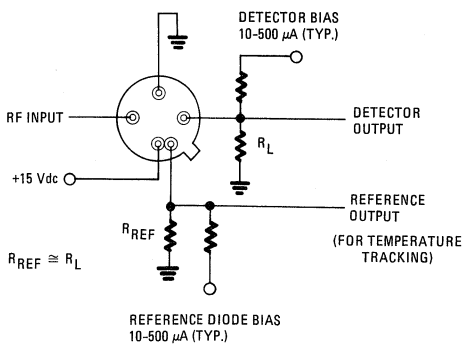

**Detected Output vs. Diode Bias Current, F = 500 MHz, $P_{IN}$ = -10 dBm, (10KΩ Load)**



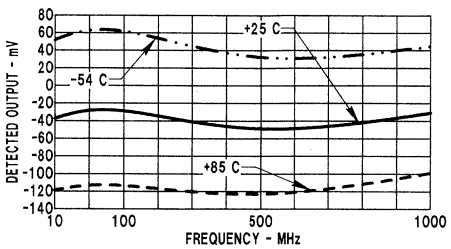

**Detected Output vs $P_{IN}$, F = 500 MHz (10K Ω Load)**



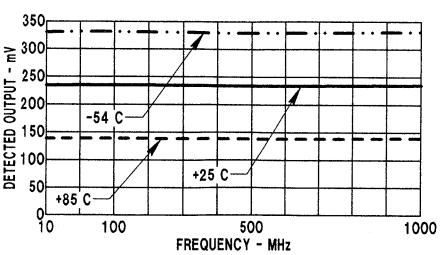

**Typical Test Circuit**




**Detected Output vs. Frequency $P_{IN}$ = -10 dBm (10KΩ Load)**

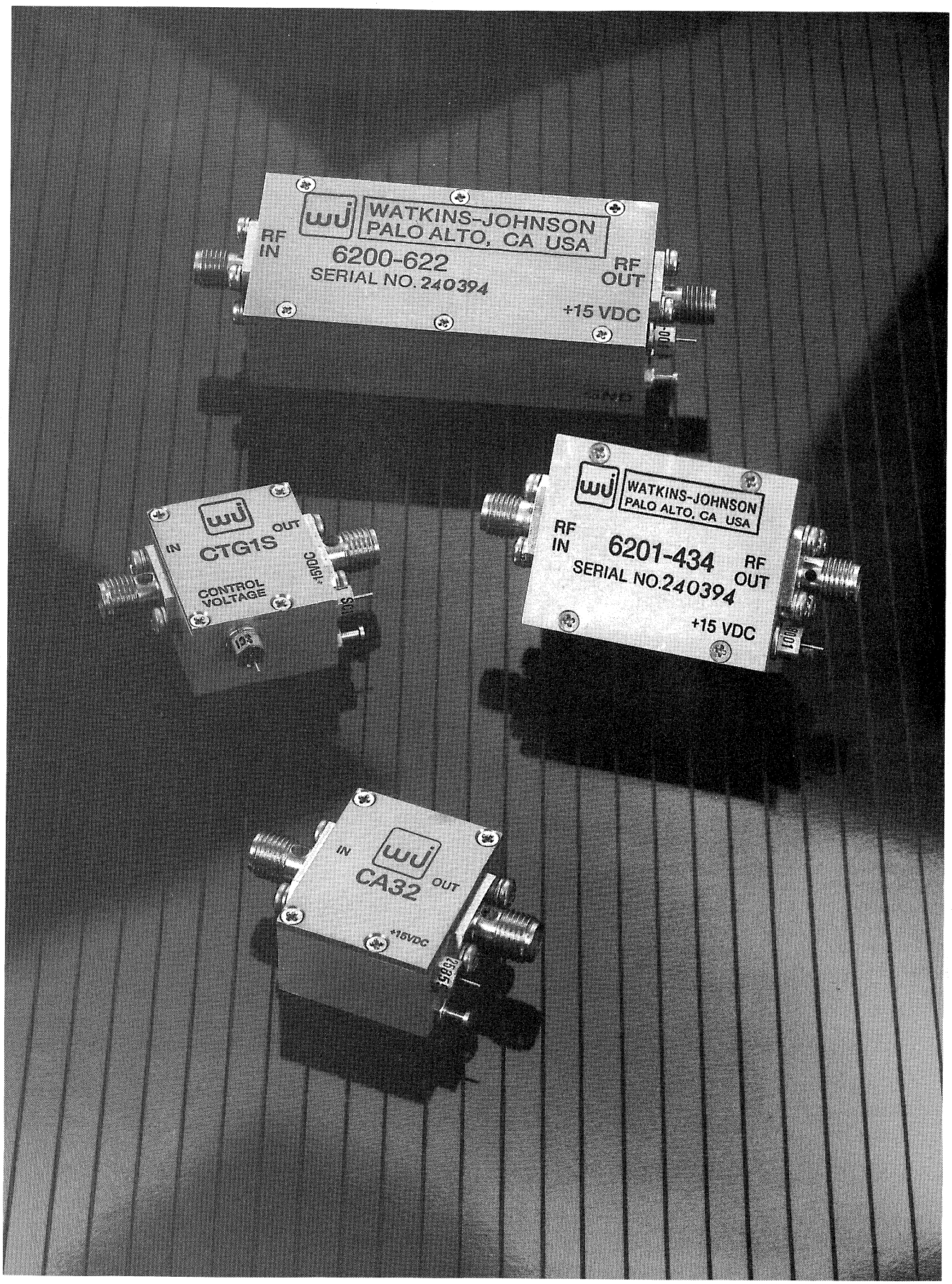



**Detected Output vs. Frequency $P_{IN}$ = -30 dBm (10K Ω Load)**



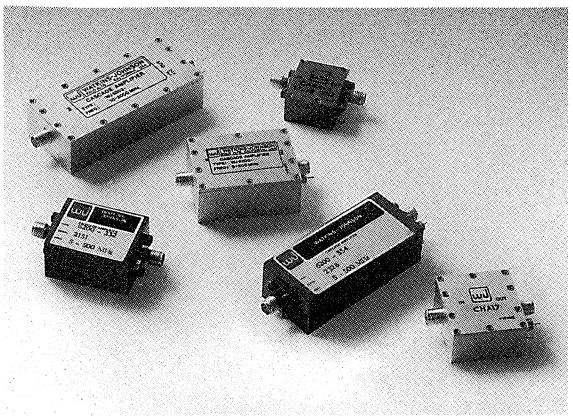

6

# Cascaded Amplifiers



# CASCADED AMPLIFIERS 2 TO 6000 MHz

- ◆ HF, VHF, UHF, L BAND, S BAND
- ◆ NOISE FIGURES STARTING FROM 2.5 dB
- ◆ OUTPUT POWERS AS HIGH AS +23 dBm
- ◆ GAINS AS HIGH AS 57 dB



## CA, CRA, CTA and CHA Series

Every TO-8 amplifier (as well as attenuator, limiter, and limiter/amplifier) is available in miniature SMA housings. For 0° to 50°C operation the CA housing affords the most economical approach to obtaining full TO-8 performance in a connectorized package.
Example: A customer wishing an A75 in this package would order a CA75 (L1 becomes CL1, G30 becomes CG30 and RA89 becomes CRA89).

For those applications where wider temperature ranges (up to -54°C/+85°C) will be encountered, W-J recommends the CTA option. (A75 becomes CTA75, L1 becomes CTL1 , G30 becomes CTG30 and RA89 becomes CTRA89).

In harsh environments where high reliability is required, W-J offers the rugged CHA housing. This package is designed to pass MIL-E-5400, Class II environmental testing. Usually a Hi-Rel "S" Series TO-8 amplifier (or equivalent) is used inside. Therefore, an A75S becomes a CHA75S, an L1S becomes a CHL1S, and a G30S becomes a CHG30S, etc.

**Common Environmental Specifications for Hi-Rel Cascaded Amplifiers**

| Environment | Method | Procedure |
|---|---|---|
| Humidity | MIL-STD-202 106 | |
| Thermal Shock | MIL-STD-202 107 | Condition A |
| | MIL-STD-810C 503.1 | |
| Vibration | MIL-STD-202 201 | |
| | MIL-STD-202 204 | Condition A, C, D |
| Shock | MIL-STD-202 213 | Condition C |
| | MIL-STD-810C 516.2 | Procedure I |
| Altitude | MIL-STD-202 105 | Condition C |
| High Temperature Testing | MIL-STD-810 501.IC | Procedure I,II |
| Low Temperature Testing | MIL-STD-810C 502.1 | Procedure 1 |

# Looking for the right amplifier to fit your needs?

When it comes to the variety of amplifiers that we offer, there are literally thousands of different combinations possible using our TO-8 modules.

W-J can usually tailor an amplifier to your specific needs. This is especially true if you require:

1. Specially Guaranteed Electrical Performance
2. +5 to +24 VDC Bias
3. Variable Gain (DC Controlled)
4. Limiting Amplifiers

Have questions? Give us a call and we'll be happy to discuss our standard 6200 Series or special models more suited to your needs.

Our Amplifier Applications Engineering group is located in Palo Alto, California, at 3333 Hillview Avenue, telephone (415) 493-4141, ext. 2638. Or contact your nearest W-J Field Sales Office.

# CASCADED AMPLIFIER SELECTION CHART

**Guaranteed Specifications at 25°C**

| Model | Noise Figure dB Max. | Gain dB Typ. | Gain dB Min. | Gain Flatness dB Typ. | Gain Flatness dB Max. | VSWR In/Out Typ. | VSWR In/Out Max. | Power output dBm Min. | 3rd Order Intercepts dBm Typ. | Supply voltage + volts Nom. | Current mA Typ. | Outline Drawing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5 TO 500 MHz** | | | | | | | | | | | | |
| **6200-622** | 2.5 | 58.0 | 55.5 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +15 | +29 | +15 | 88 | B |
| **6200-624** | 3.0 | 26.5 | 24.5 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +7 | +20 | +15 | 39 | A |
| **6200-628** | 3.0 | 35.5 | 33.5 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +20 | +32 | +15 | 154 | A |
| **6200-630** | 3.0 | 37.0 | 35.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +7 | +21 | +15 | 33 | A |
| **6200-631** | 3.0 | 37.5 | 36.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +15 | +29 | +15 | 74 | A |
| **6200-632** | 3.0 | 42.0 | 40.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +7 | +21 | +15 | 48 | A |
| **6200-637** | 3.0 | 47.0 | 44.5 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +22 | +32 | +15 | 189 | B |
| **6200-638** | 3.0 | 49.0 | 47.0 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +14 | +28 | +15 | 86 | A |
| **6200-640** | 3.0 | 51.0 | 48.0 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +7 | +20 | +15 | 64 | A |
| **6200-643** | 3.0 | 60.5 | 57.0 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +20 | +36 | +15 | 174 | B |
| **6200-647** | 5.5 | 29.5 | 27.5 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +20 | +32 | +15 | 155 | A |
| **6200-662** | 5.5 | 57.0 | 54.5 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +23 | +33 | +15 | 217 | B |
| **5 TO 1000 MHz** | | | | | | | | | | | | |
| 6201-434 | 4.0 | 32.0 | 29.5 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +7 | +22 | +15 | 41 | A |
| 6201-436 | 4.0 | 38.0 | 35.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +20 | +33 | +15 | 153 | B |
| 6201-437 | 4.0 | 42.0 | 39.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +7 | +20 | +15 | 49 | A |
| 6201-439 | 4.0 | 54.0 | 49.5 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +20 | +34 | +15 | 188 | B |
| 6201-444 | 4.3 | 52.0 | 48.0 | ±1.2 | ±2.0 | 1.5-2.0:1 | 2.2:1 | +7 | +20 | +15 | 70 | A |
| 6201-450 | 8.0 | 22.0 | 20.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.2:1 | +20 | +34 | +15 | 139 | A |
| **10 TO 2000 MHz** | | | | | | | | | | | | |
| 6203-414 | 4.5 | 31.0 | 28.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.5:1 | +11 | +24 | +15 | 78 | B |
| 6203-422 | 6.0 | 20.0 | 17.5 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.5:1 | +7 | +20 | +15 | 38 | A |
| 6203-425 | 6.0 | 35.5 | 32.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.5:1 | +13 | +27 | +15 | 124 | B |
| 6203-427[1] | 6.0 | 43.5 | 39.0 | ±0.8 | ±1.5 | 1.5-2.0:1 | 2.5:1 | +12 | +23 | +15 | 113 | B |

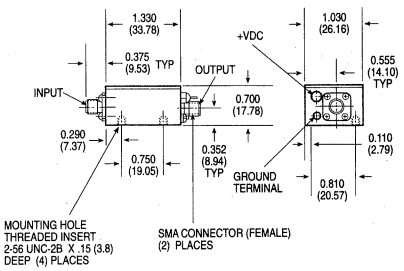
Note 1. 100-2000 MHz

# Outline Drawings

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.005 (.13) UNLESS OTHERWISE SPECIFIED

## WJ-6200 to WJ-6203 Series (Two-Stage)

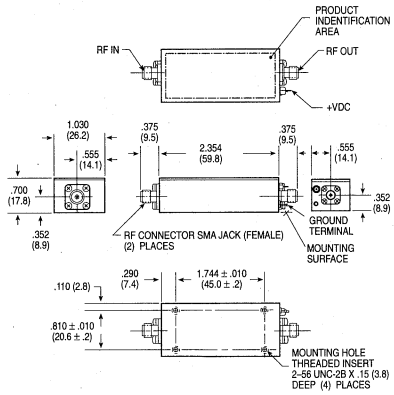
Drawing A




DIMENSIONS ARE IN INCHES (MILLIMETERS)
WEIGHT: APPROXIMATELY 2.0 OZ.

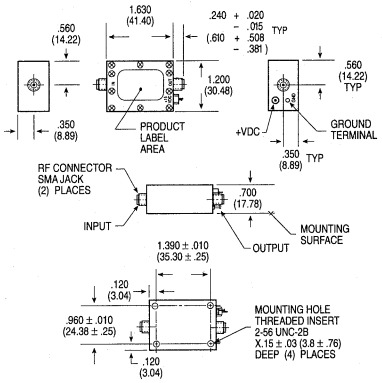
## WJ-6200 to WJ-6203 Series (Three- and Four-Stage)

Drawing B



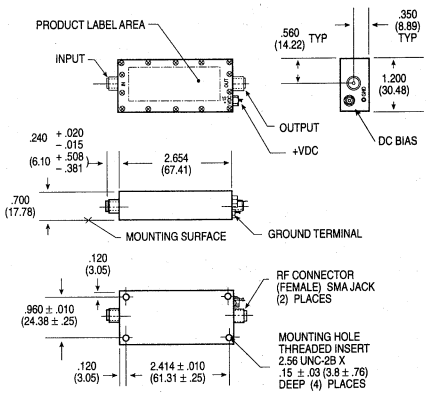

DIMENSIONS ARE IN INCHES (MILLIMETERS)
WEIGHT: APPROXIMATELY 2.0 OZ.

## WJ-6200 to WJ-6203 Hi-Rel Series (Two-Stage)



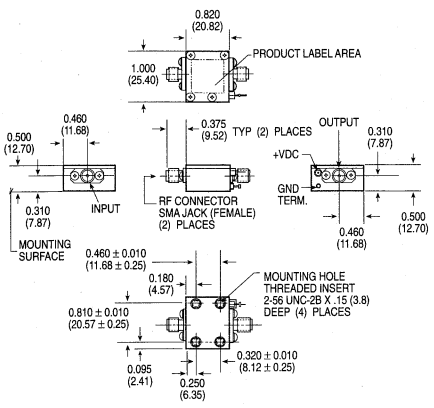

DIMENSIONS ARE IN INCHES (MILLIMETERS)
WEIGHT: APPROXIMATELY 2.0 OZ.

## WJ-6200 to WJ-6203 Hi-Rel Series (Three- and Four-Stage)



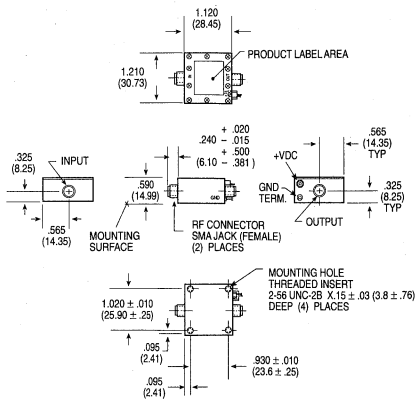

DIMENSIONS ARE IN INCHES (MILLIMETERS)
WEIGHT: APPROXIMATELY 2.5 OZ.

## CA and CTA Series



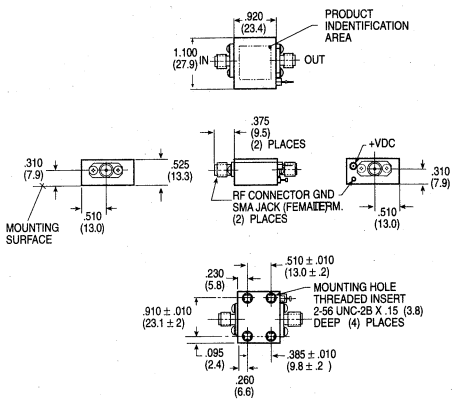

WEIGHT: APPROXIMATELY 0.71 OZ

## Hi-Rel CHA Series



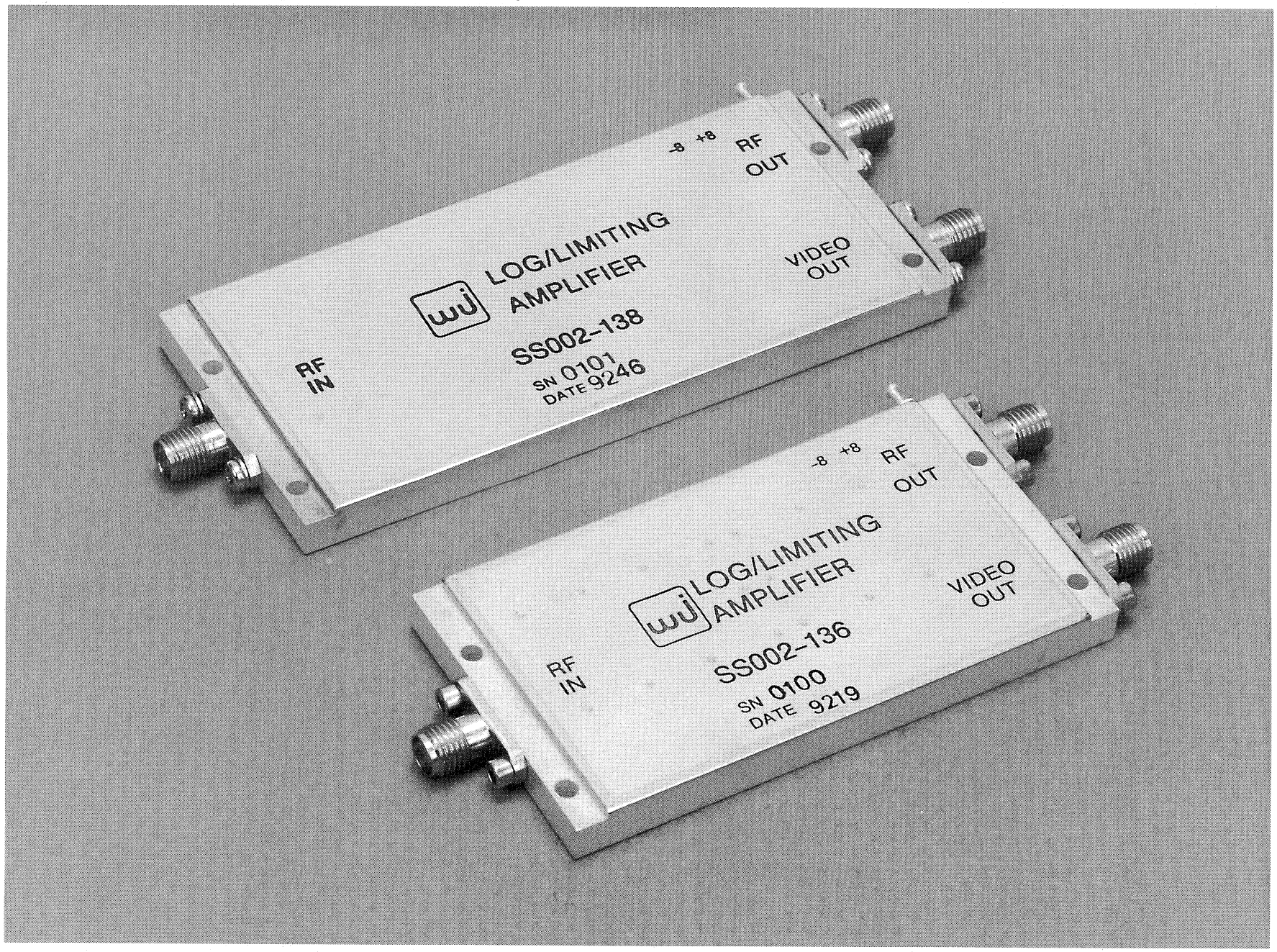

UNIT WEIGHT: 1.0 OUNCES MAX (20.0 GRAMS)

## CRA and CTRA Series



# *Logarithmic Amplifiers*

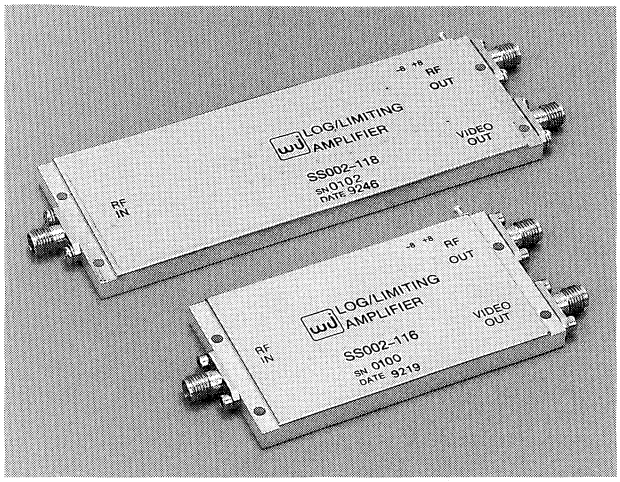




# WJ-SS002-116, -117, -118

## 0.75 to 1.25 GHz HIGH SPEED LOGARITHMIC/LIMITING AMPLIFIERS

- ◆ LOGGING RANGE: 56-75 dB (3 MODELS)
- ◆ RISE TIME: 3.0 ns (TYP.)
- ◆ RECOVERY TIME: 8.0 ns (TYP.)
- ◆ LOG SLOPE: 15 mV/dB
- ◆ LIMITED OUTPUT POWER: 2.5 ± 1.5 dBm




## Specifications*

| Characteristics | WJ-SS002-116 | WJ-SS002-117 | WJ-SS002-118 |
|---|---|---|---|
| Frequency | 0.75-1.25 GHz | 0.75-1.25 GHz | 0.75-1.25 GHz |
| Input Log Range | -51<P<+5 | -61<P<+5 | -70<P<+5 |
| Tangential Sensitivity (Typ.) | -52 dBm | -62 dBm | -71 dBm |
| Log Video Output (1 GHz) | | | |
| Input Level | -50 dBm | -55 dBm | -60 dBm |
| Nominal Output | 0.150 V | 0.225 V | 0.300 V |
| Input Level | 0 dBm | 0 dBm | 0 dBm |
| Nominal Output | 0.900 V | 1.050 V | 1.200 V |
| Log Slope (1 GHz) | 15 ± 0.5 mV/dB | 15 ± 0.5 mV/dB | 15 ± 0.5 mV/dB |
| Log Linearity (Best Fit Line at 1 GHz) | ±1.0 dB | ±1.0 dB | ±1.0 dB |
| Video Output vs. Frequency | ±2.0 dB | ±2.5 dB | ±2.5 dB |
| Input Power for Limited Output | -48<P<+5 dBm | -58<P<+5 dBm | -67<P<+5 dBm |
| Limited Output | +1<P<+4 dBm | +1<P<+4 dBm | +1<P<+4 dBm |
| Variation vs. Frequency | ±0.5 dB | ±0.5 dB | ±0.5 dB |
| Second Harmonic Suppression (Typ.) | -25 dBc | -25 dBc | -25 dBc |
| Third Harmonic Suppression (Typ.) | -10 dBc | -10 dBc | -10 dBc |
| Log Video Pulse Characteristics | | | |
| Rise Time | <4.0 ns | <4.0 ns | <4.0 ns |
| Overshoot | <1.5 dB | <1.5 dB | <1.5 dB |
| Setting Time (1 dB) | <20 ns | <20 ns | <20 ns |
| Recovery Time | <12 ns | <12 ns | <12 ns |
| Input Range for Recovery Time | +5 → -45 dBm | +5 → -50 dBm | +5 → -55 dBm |
| Noise Figure (Typ.) | 4.5 dB | 4.5 dB | 4.5 dB |
| RF Bandwidth at -3 dB (Typ.) | 2000 MHz | 600 MHz | 600 MHz |
| Video BW at -3 dB (Typ.) | 130 MHz | 130 MHz | 130 MHz |
| VSWR | 2.0:1 | 2.0:1 | 2.0:1 |
| DC Current | | | |
| +8 to +16.0 Volts | 490 mA | 560 mA | 630 mA |
| -8 to -16.0 Volts | 200 mA | 220 mA | 240 mA |

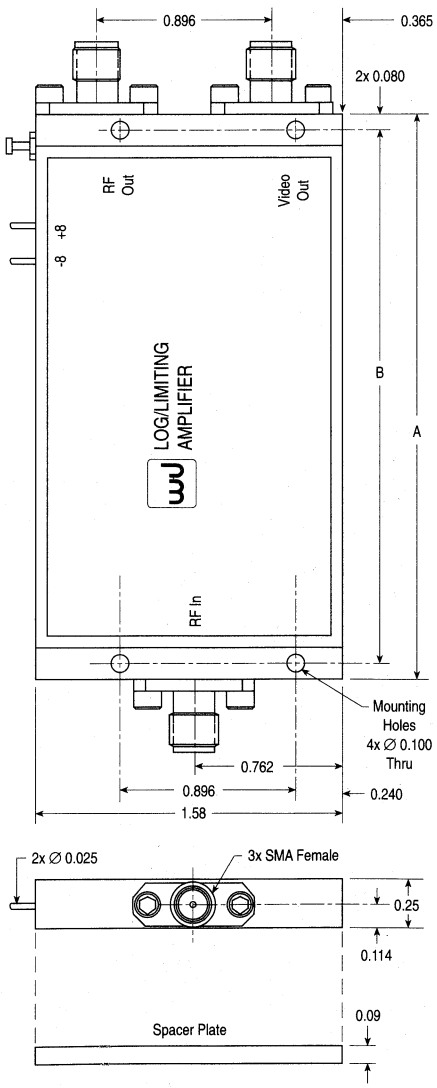
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Case Operating Temperature ..... -54°C to +85°C
Long-Term CW Input Level ..... +10 dBm
Short-Term (1 Hour) CW Input Level ..... +17 dBm
Peak Pulsed (10 µsec, 2%) Input Level ..... +23 dBm

Weight: WJ-SS002-117, -118: 142 Grams (5.0 oz.)
WJ-SS002-116: 99 Grams (3.5 oz.)

## Outline Drawings

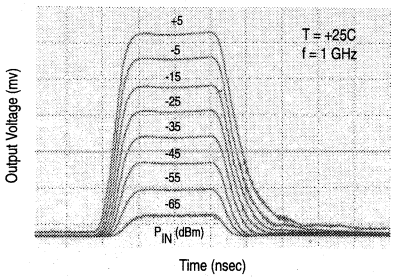
SS002



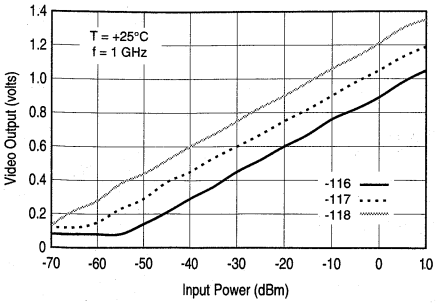

| WJ-SS002 | -116 | -117 | -118 |
|---|---|---|---|
| DIM A | 2.90 | 4.41 | 4.41 |
| DIM B | 2.738 | 4.248 | 4.248 |

# Typical Performance at 25°C

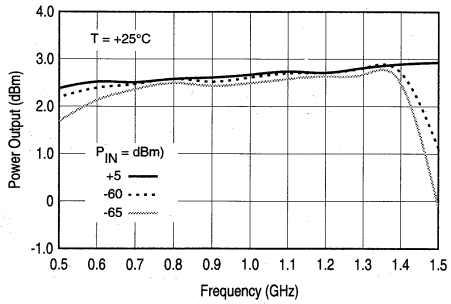
## -118 Pulse Response



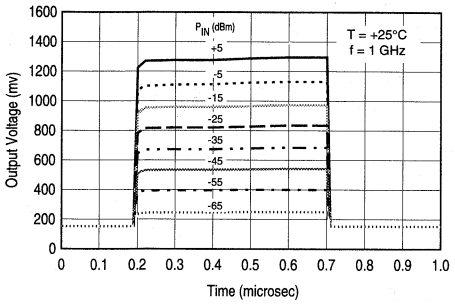

## Video Output



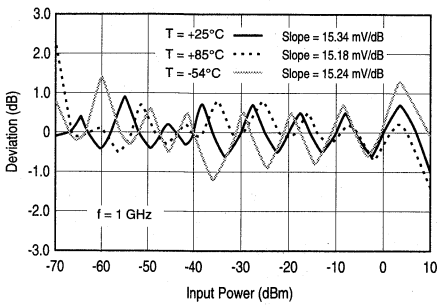

## -118 Power Output vs. Frequency



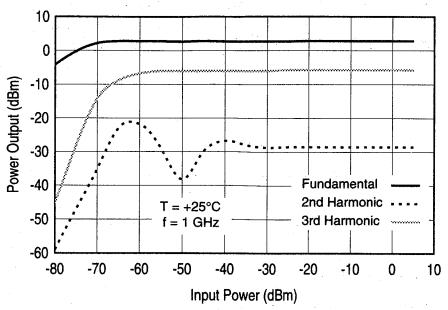

## -118 Pulse Response



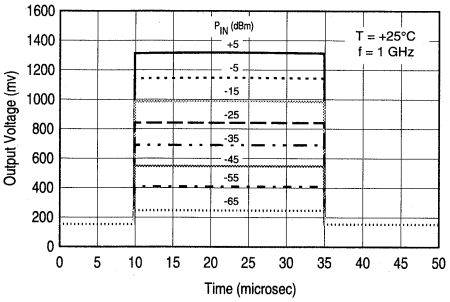

## -118 Video Output Linearity



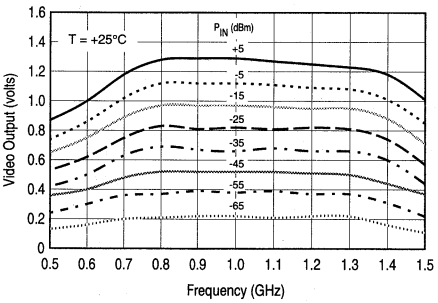

## -118 Power Output/Distortion Products



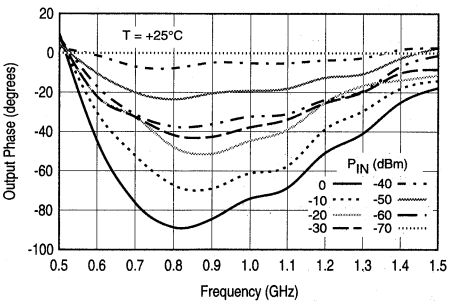

## -118 Pulse Response



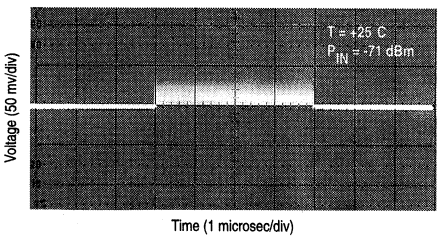

## -118 Video Output vs. Frequency



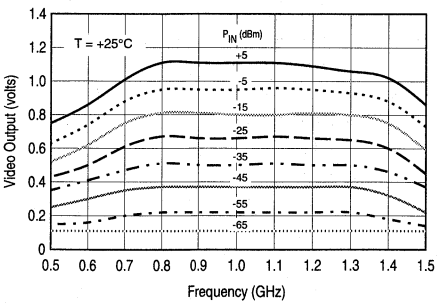

## -118 Output Phase vs. Input Signal Level



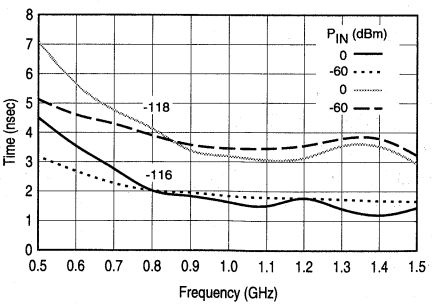

## -118 Gain Limited Tangential Sensitivity



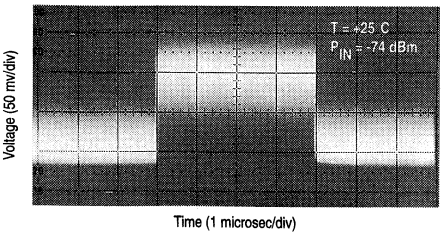

## -117 Video Output vs. Frequency




## Group Delay

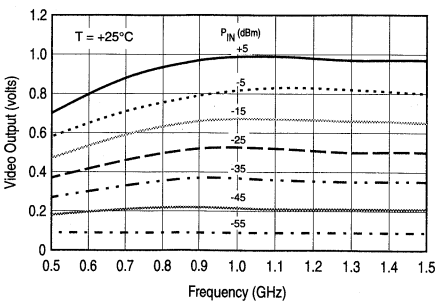



## -118 Noise Limited Tangential Sensitivity*




* Measured with preamplification of 10 dB and a NF = 3.5 dB.

## -116 Video Output vs. Frequency

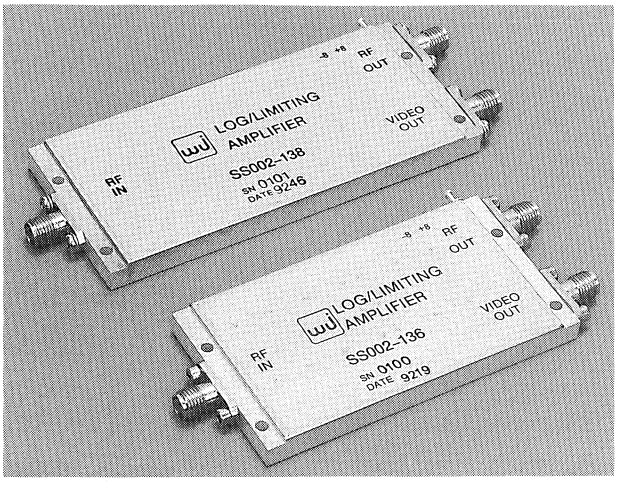



8

# WJ-SS002-136, -137, -138

## 0.75 to 2.0 GHz HIGH SPEED LOGARITHMIC/LIMITING AMPLIFIERS

- ◆ LOGGING RANGE: 56-75 dB (3 MODELS)
- ◆ RISE TIME: 3.0 ns (TYP.)
- ◆ RECOVERY TIME: 8.0 ns (TYP.)
- ◆ LOG SLOPE: 15 mV/dB
- ◆ LIMITED OUTPUT POWER: 2.5 ± 1.5 dBm




## Specifications*

| Characteristics | WJ-SS002-136 | WJ-SS002-137 | WJ-SS002-138 |
|---|---|---|---|
| Frequency | 0.75-2.00 GHz | 0.75-2.00 GHz | 0.75-2.00 GHz |
| Input Log Range | -51<P<+5 | -61<P<+5 | -69<P<+5 |
| Tangential Sensitivity (Typ.) | -52 dBm | -62 dBm | -70 dBm |
| Log Video Output (1 GHz) | | | |
| Input Level | -50 dBm | -55 dBm | -60 dBm |
| Nominal Output | 0.150 V | 0.225 V | 0.300 V |
| Input Level | 0 dBm | 0 dBm | 0 dBm |
| Nominal Output | 0.900 V | 1.050 V | 1.200 V |
| Log Slope (1 GHz) | 15 ± 0.5 mV/dB | 15 ± 0.5 mV/dB | 15 ± 0.5 mV/dB |
| Log Linearity (Straight Line at 1 GHz) | ±1.0 dB | ±1.0 dB | ±1.0 dB |
| Video Output vs. Frequency | ±3.5 dB | ±4.5 dB | ±5.0 dB |
| Input Power for Limited Output | -48<P<+5 dBm | -58<P<+5 dBm | --67<P<+5 dBm |
| Limited Output | +1<P<+4 dBm | +1<P<+4 dBm | +1<P<+4 dBm |
| Variation vs. Frequency | ±0.75 dB | ±0.75 dB | ±0.75 dB |
| Second Harmonic Suppression (Typ.) | -25 dBc | -25 dBc | -25 dBc |
| Third Harmonic Suppression (Typ.) | -10 dBc | -10 dBc | -10 dBc |
| Log Video Pulse Characteristics | | | |
| Rise Time | <4.0 ns | <4.0 ns | <4.0 ns |
| Overshoot | <1.5 dB | <1.5 dB | <1.5 dB |
| Setting Time (1 dB) | <20 ns | <20 ns | <20 ns |
| Recovery Time | <12 ns | <12 ns | <12 ns |
| Input Range for Recovery Time | +5 → -45 dBm | +5 → -50 dBm | +5 → -55 dBm |
| Noise Figure (Typ.) | 4.5 dB | 4.5 dB | 4.5 dB |
| RF Bandwidth at -3 dB (Typ.) | 2000 MHz | 2000 MHz | 2000 MHz |
| Video BW at -3 dB (Typ.) | 130 MHz | 130 MHz | 130 MHz |
| VSWR | 2.0:1 | 2.0:1 | 2.0:1 |
| DC Current | | | |
| +8 to +16.0 Volts | 490 mA | 560 mA | 630 mA |
| -8 to -16.0 Volts | 200 mA | 220 mA | 240 mA |

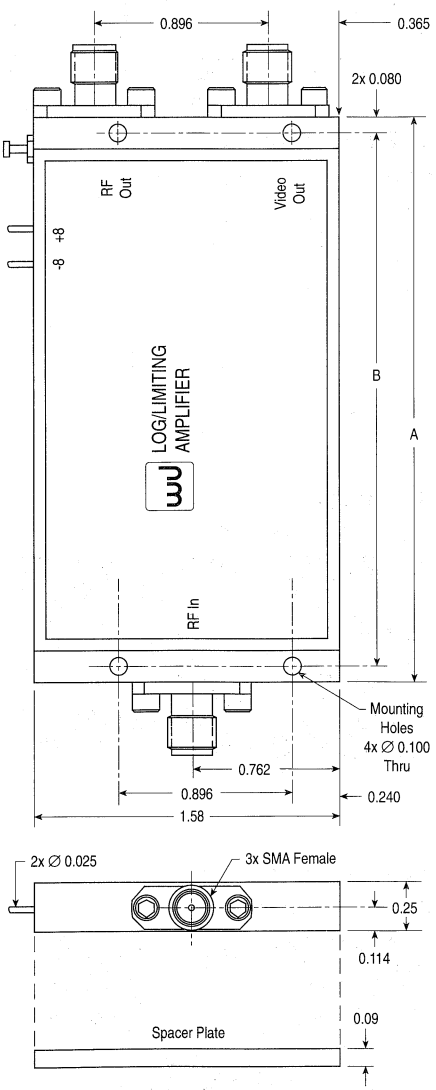
## Absolute Maximum Ratings

Storage Temperature ..... -62°C to +125°C
Case Operating Temperature ..... -54°C to +85°C
Long-Term CW Input Level ..... +10 dBm
Short-Term (1 Hour) CW Input Level ..... +17 dBm
Peak Pulsed (10 µsec, 2%) Input Level ..... +23 dBm

Weight: WJ-SS002-137, -138: 116 Grams (4.1 oz.)
WJ-SS002-136: 99 Grams (3.5 oz.)

## Outline Drawings

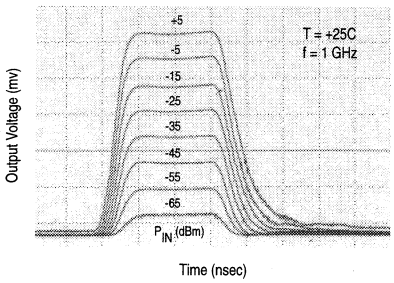
SS002



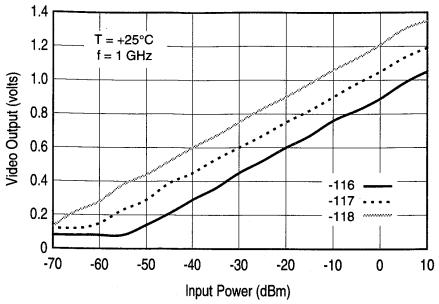

| WJ-SS002 | -136 | -137 | -138 |
|---|---|---|---|
| DIM A | 2.90 | 3.55 | 3.55 |
| DIM B | 2.738 | 3.388 | 3.388 |

# Typical Performance at 25°C

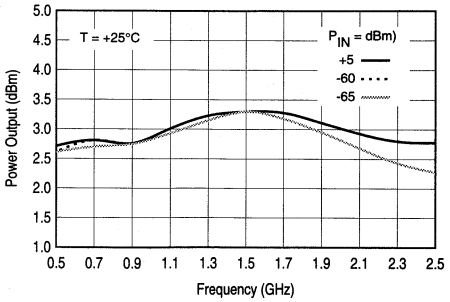
## -138 Pulse Response



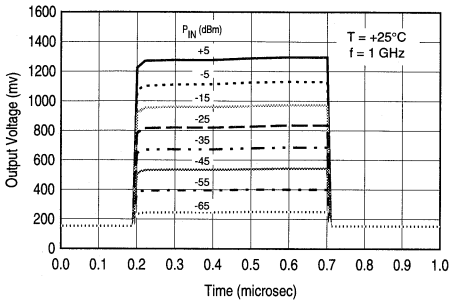

## Video Output



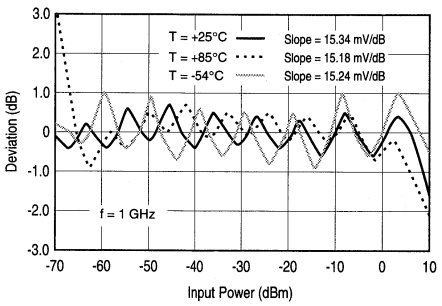

## -138 Power Output vs. Frequency



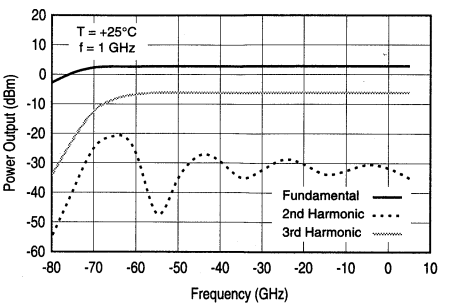

## -138 Pulse Response



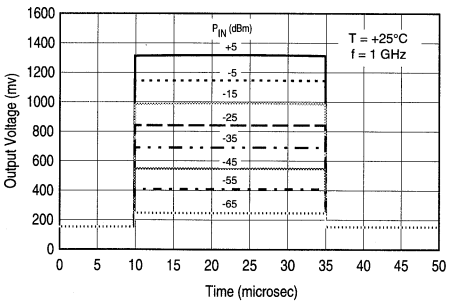

## -138 Video Output Linearity



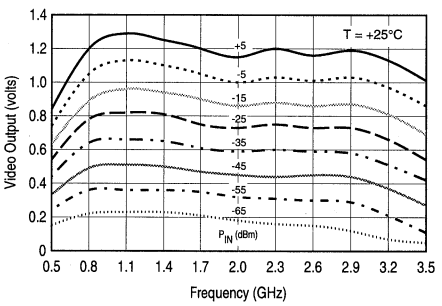

## -138 Power Output/Distortion Products



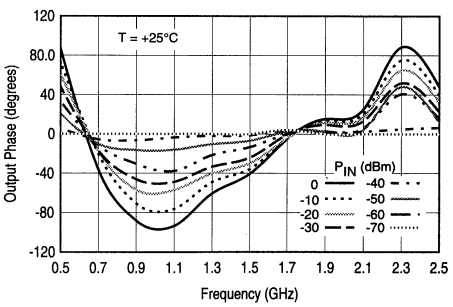

## -138 Pulse Response



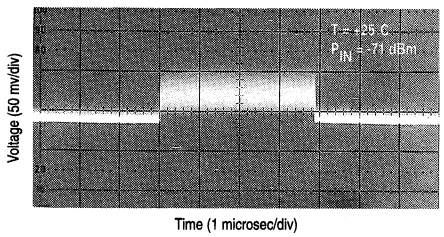

## -138 Video Output vs. Frequency



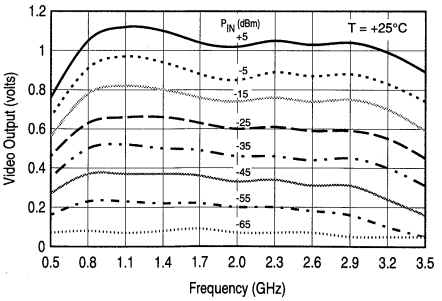

## -138 Output Phase vs. Input Signal Level



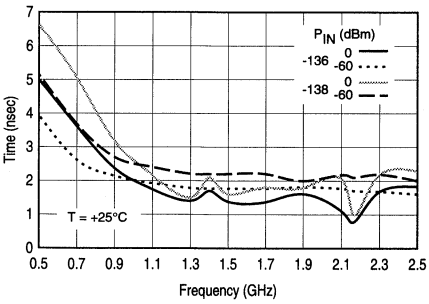

## -138 Gain Limted Tangential Sensitivity



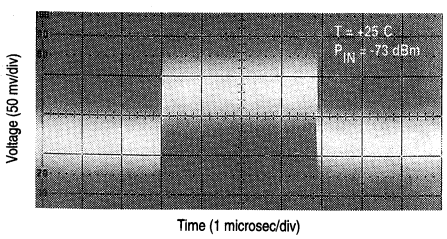

## -137 Video Output vs. Frequency



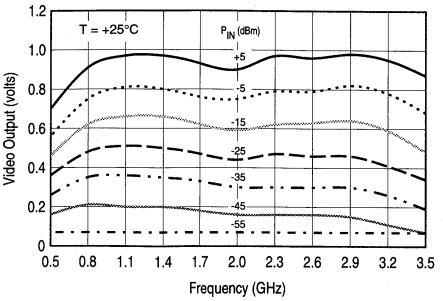

## -136, -138 Group Delay



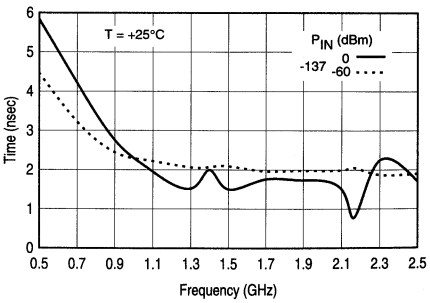

## -138 Noise Limited Tangential Sensitivity*




## -136 Video Output vs. Frequency




## -137 Group Delay

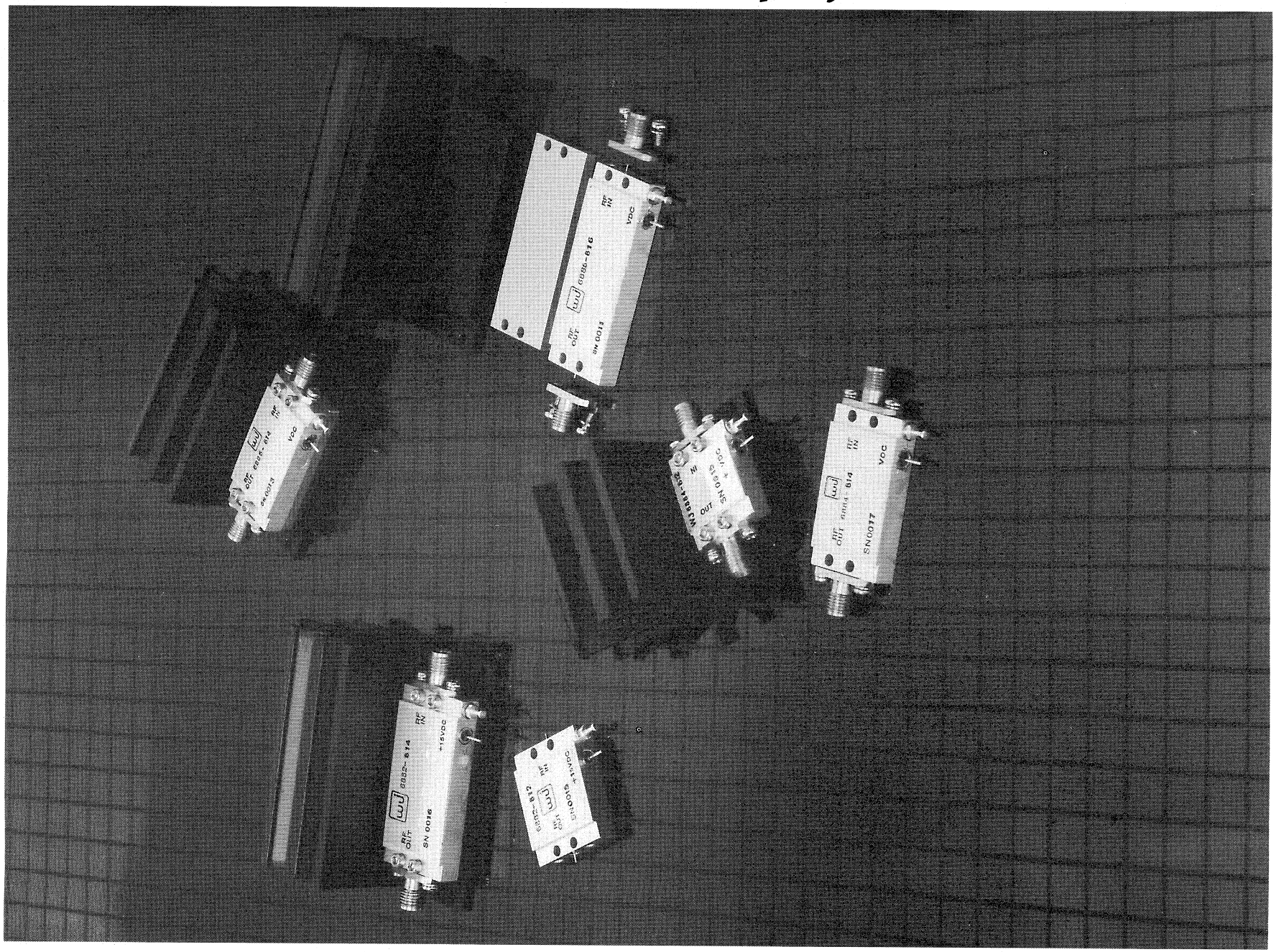



*Measured with preamplification of 10 dB and a NF = 3.5 dB.

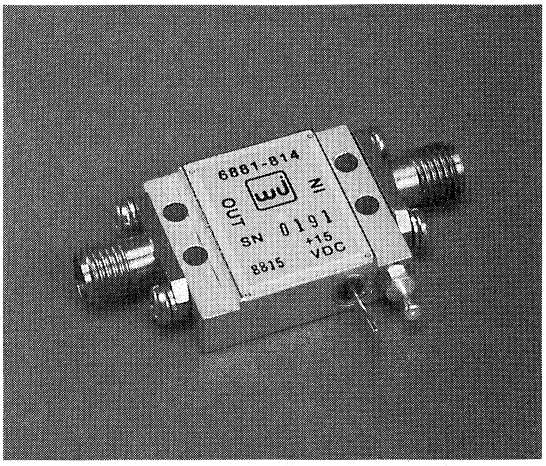
8

# *Multi-Stage Microwave Amplifiers*





# WJ-6881-812,-813, -814




## VERSA-AMP ®
## 0.5 -5.0 GHz
## MICROWAVE AMPLIERS

- GAIN 17 - 35 dB (3 MODELS)
- NOISE FIGURE: 3.5 dB (TYP.)
- OUTPUT POWER: +20 dBm (TYP.)
- INTERNAL VOLTAGE REGULATION

## Typical and Guaranteed Specifications (+25°C)

| WJ-6881 | -812 | -813 | -814 | Units |
|---|---|---|---|---|
| Frequency | 0.5-5.0 | 0.5-5.0 | 0.5-5.0 | GHz |
| RF Gain | | | | |
| Typical | 19 | 28 | 37 | dB |
| Minimum | 17 | 25 | 35 | dB |
| Gain Flatness (Maximum) | ±1.0 | ±1.0 | ±1.0 | dB |
| Noise Figure | | | | |
| Typical | 3.5 | 3.5 | 3.5 | dB |
| Maximum | 4.5 | 4.5 | 4.5 | dB |
| Power Output at 1 dB Compression (Min.) | +18 | +18 | +18 | dBm |
| Intercept Point (Typical) | | | | |
| 3rd Order Two Tone | +29 | +30 | +30 | dBm |
| 2nd Harmonic | +44 | +45 | +45 | dBm |
| VSWR (Maximum) | | | | |
| Input | 1.7:1 | 1.7:1 | 1.7:1 | |
| Output | 1.7:1 | 1.7:1 | 1.7:1 | |
| DC Current (Maximum) | 150 | 220 | 300 | mA |
| DC Operating Voltage | | | | |
| Minimum | +10.0 | +10.0 | +10.0 | Volts |
| Maximum | +18.0 | +18.0 | +18.0 | Volts |
| Output Drawing | 297016 | 297016 | 297016 | |

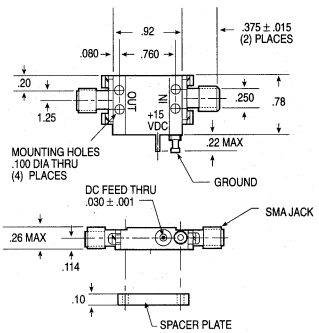
## Absolute Maximum Ratings

Case Operating Temperature .....-54° to +100°C
Storage Temperature.....-62° to +125°C
Short Therm (1 Hour) CW Input Level .....+18 dBm
Peak Pulsed (10 µsec) Input Level.....+23 dBm
DC Reverse Voltage.....-40 Volts

Weight 1.2 oz max.

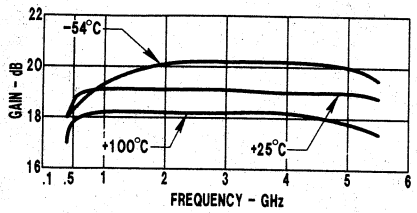
## Outline Drawings

297016

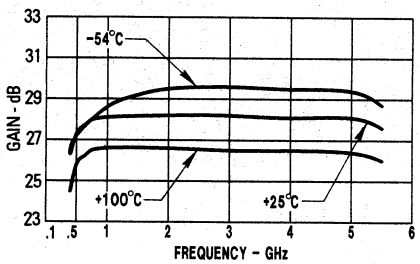


# Typical Performance

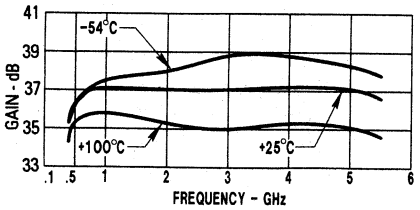
### Gain
### (–812)



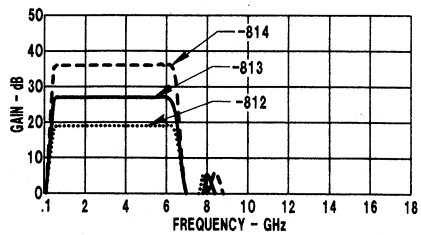

### (–813)



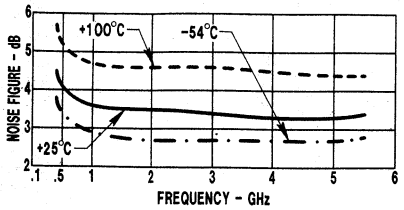

### (–814)



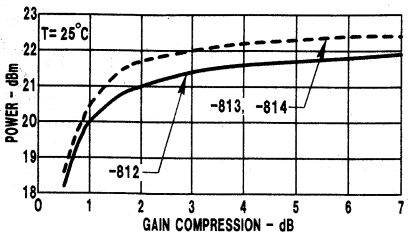

### Broadband Gain



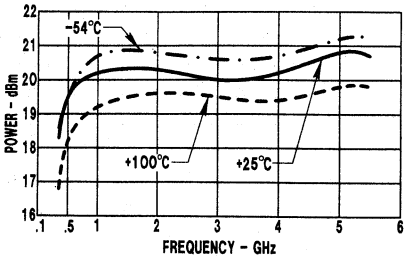

### Noise Figure
### (All Models)



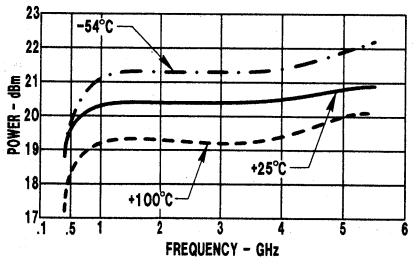

### Power Output




### $P_{out}$* (–812)

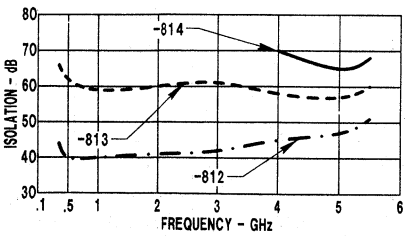



### $P_{out}$* (-813, -814)

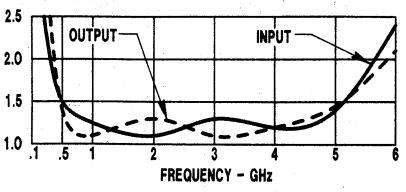



*at 1 dB Gain Compression

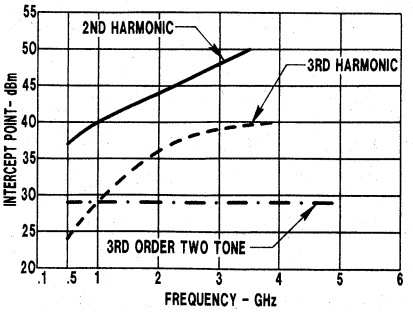
### Reverse Isolation



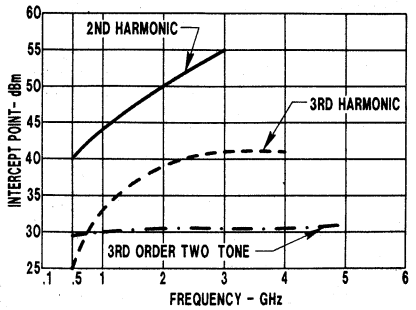

### VSWR
### (All Models)



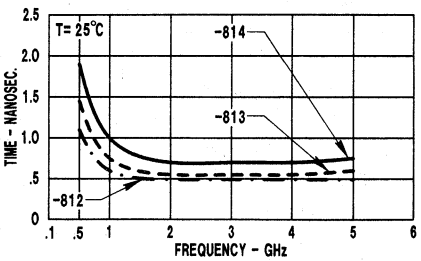

### Intercept Point
### (–812)



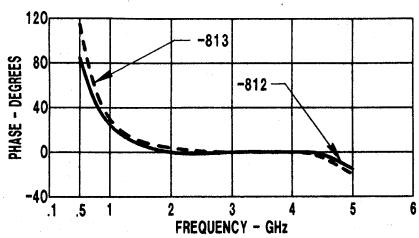

### (–813, –814)



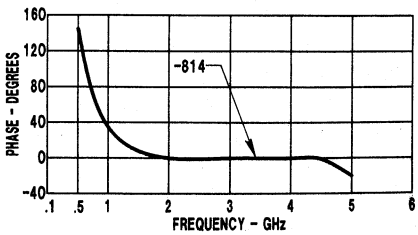

### Group Delay



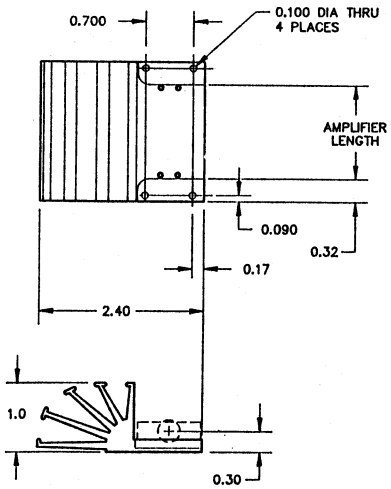

### Deviation from Linear Phase
### (-812, -813)




### (-814)

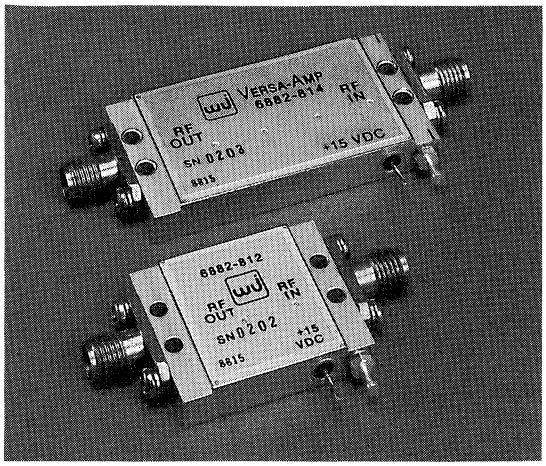



## Finned Heatsink




Notes:
Dimensions are in inches. Tolerances: X.XXX ± 0.005, X.XX ± 0.02 inches. Amplifiers are supplied with RF connectors installed and mounted on a heatsink. A spacer plate and mounting fasteners are provided for alternate mounting configurations. The heatsink is easily removed, but is recommended for incoming test and laboratory applications. RF connectors can be removed for "drop in" microstrip applications. RF pin dimensions: 0.015 dia. x 0.07 long.

# WJ-6882-812,-813, -814,-824




## VERSA-AMP ®
## 2 TO 8 GHz
## MICROWAVE AMPLIFIERS

- GAIN 22-44 dB (4 MODELS)
- NOISE FIGURE: 3.5 dB (TYP.)
- OUTPUT POWER: +21 and +25 dBm (TYP.)
- INTERNAL VOLTAGE REGULATION

## Typical and Guaranteed Specifications (+25°C)

| WJ-6882 | -812 | -813 | -814 | -824 | Units |
|---|---|---|---|---|---|
| Frequency | 2.0-8.0 | 2.0-8.0 | 2.0-8.0 | 2.0-8.0 | GHz |
| RF Gain | | | | | |
| Typical | 24 | 34 | 46 | 45 | dB |
| Minimum | 22 | 33 | 44 | 40 | dB |
| Gain Flatness (Maximum) | ±0.75 | ±1.0 | ±1.0 | ±1.0 | dB |
| Noise Figure | | | | | |
| Typical | 3.5 | 3.5 | 3.5 | 3.5 | dB |
| Maximum | 4.0 | 4.0 | 4.0 | 4.0 | dB |
| Power Output at 1 dB Compression (Min.) | +20 | +20 | +20 | +24 | dBm |
| Intercept Point (Typical) | | | | | |
| 3rd Order Two Tone | +30 | +30 | +30 | +36 | dBm |
| 2nd Harmonic | +48 | +48 | +48 | +54 | dBm |
| VSWR (Maximum) | | | | | |
| Input | 2.0:1 | 2.0:1 | 2.0:1 | 2.0:1 | |
| Output | 1.7:1 | 1.7:1 | 1.7:1 | 1.7:1 | |
| DC Current (Maximum) | 185 | 265 | 325 | 475 | mA |
| DC Operating Voltage | | | | | |
| Minimum | +12.0 | +12.0 | +12.0 | +12.0 | Volts |
| Maximum | +18.0 | +18.0 | +18.0 | +18.0 | Volts |
| Outline Drawing | 297023 | 297024 | 297024 | 297024 | |

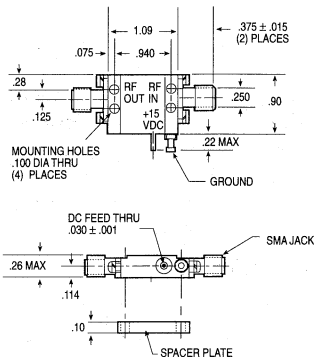
## Absolute Maximum Ratings

Case Operating Temperature*.....-54° to + 100°C
Storage Temperature ..... -62° to + 125°C
Short Therm (1 Hour) CW Input Level..... +20 dBm
Peak Pulsed (10 µsec) Input Level .....+24 dBm
DC Reverse Voltage.....-40 Volts
*+65°C max. for 6882-824

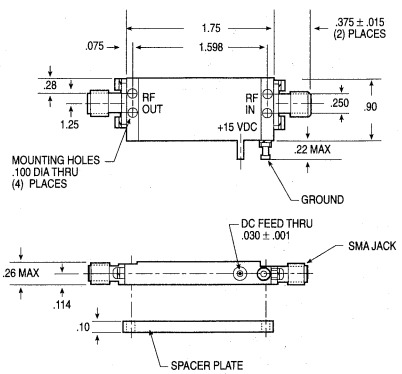
Weight 1.4 oz. max.

## Outline Drawings

297023

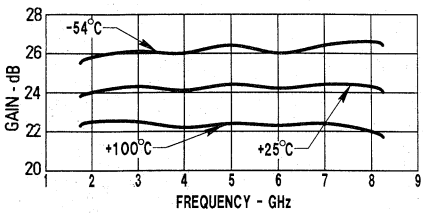



297024

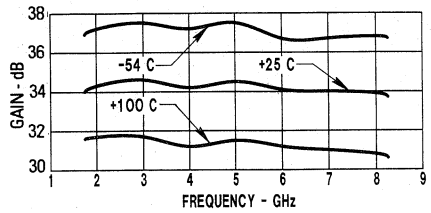


# Typical Performance

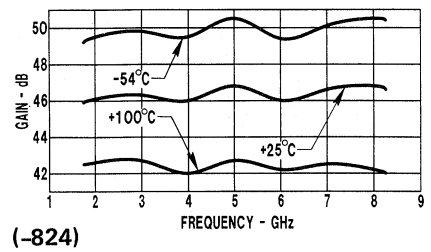
### Gain
### (-812)



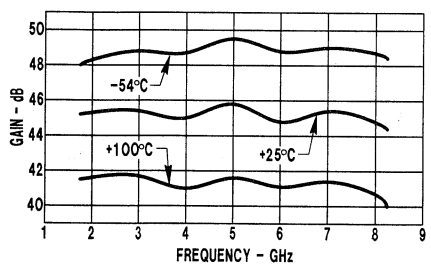

### (-813)



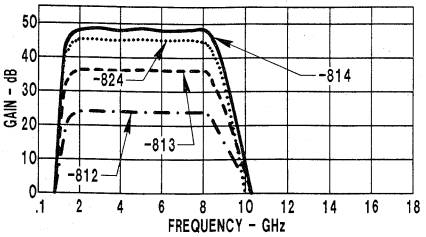

### (-814)



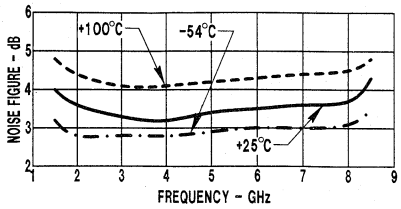

### (-824)



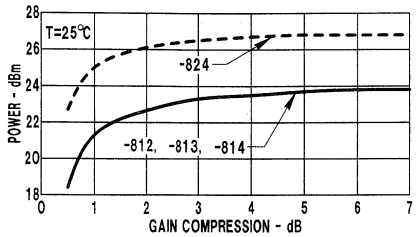

### Broadband Gain



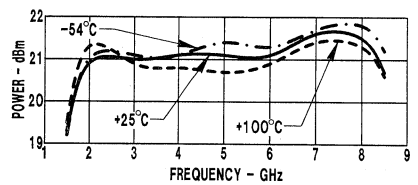

### Noise Figure
### (All Models)



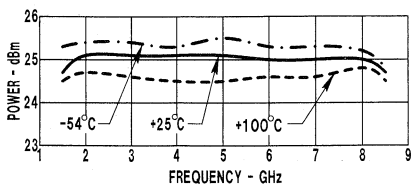

### Power Output




### $P_{out}$* (-812, -813, -814)

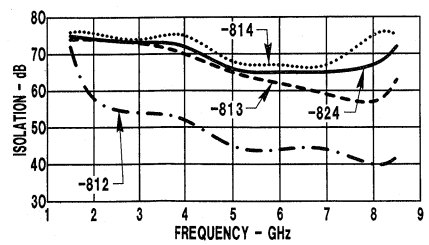



### $P_{out}$* (-824)

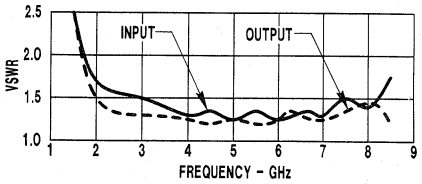



*at 1 dB Gain Compression

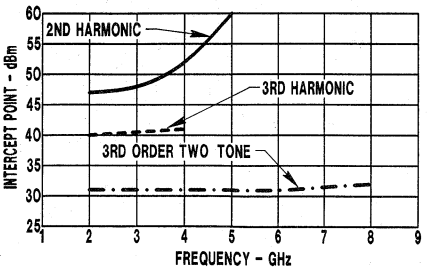
### Reverse Isolation



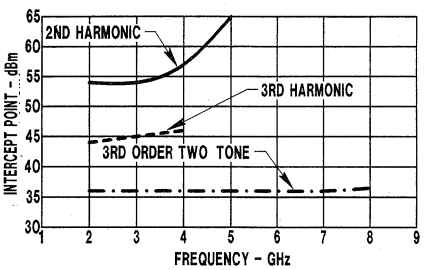

### VSWR
### (All Models)



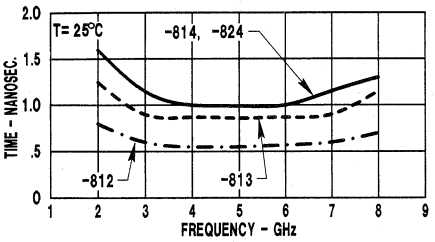

### Intercept Point
### (-812, -813, -814)



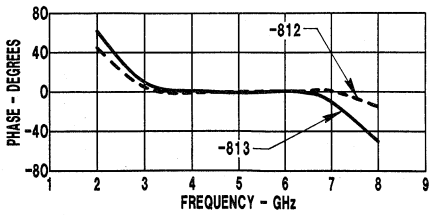

### (-824)



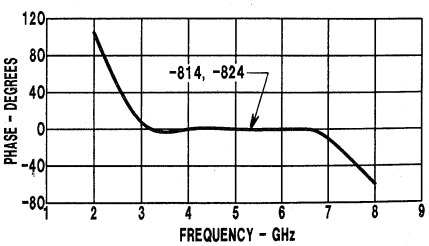

### Group Delay



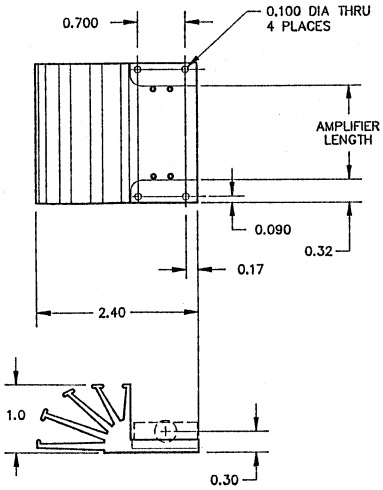

### Deviation from Linear Phase
### (-812, -813)




### (-814, -824)

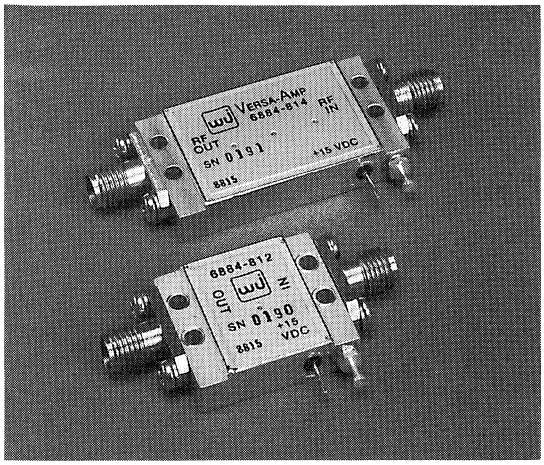



## Finned Heatsink




Notes:
Dimensions are in inches. Tolerances: X.XXX ± 0.005, X.XX ± 0.02 inches. Amplifiers are supplied with RF connectors installed and mounted on a heatsink. A spacer plate and mounting fasteners are provided for alternate mounting configurations. The heatsink is easily removed, but is recommended for incoming test and laboratory applications. RF connectors can be removed for "drop in" microstrip applications. RF pin dimensions: 0.015 dia. x 0.07 long.

# WJ-6884-812,-813, -814,-824




## VERSA-AMP ®
## 5 TO 12 GHz
## MICROWAVE AMPLIFIERS

- GAIN 16-34 dB (4 MODELS)
- NOISE FIGURE: 4.2 dB (TYP.)
- OUTPUT POWER: +19 and +24 dBm (TYP.)
- INTERNAL VOLTAGE REGULATION

### Typical and Guaranteed Specifications (+25°C)

| WJ-6884 | -812 | -813 | -814 | -824 | Units |
|---|---|---|---|---|---|
| Frequency | 5.0-12.0 | 5.0-12.0 | 5.0-12.0 | 5.0-12.0 | GHz |
| RF Gain | | | | | |
| Typical | 20 | 27 | 39 | 35 | dB |
| Minimum | 16 | 25 | 34 | 30 | dB |
| Gain Flatness (Maximum) | ±0.75 | ±0.75 | ±0.75 | ±1.0 | dB |
| Noise Figure | | | | | |
| Typical | 4.2 | 4.2 | 4.2 | 4.2 | dB |
| Maximum | 4.8 | 4.8 | 4.8 | 4.8 | dB |
| Power Output at 1 dB Compression (Min.) | +18 | +18 | +18 | +23 | dbm |
| Intercept Point (Typical) | | | | | |
| 3rd Order Two Tone | +28 | +28 | +28 | +33 | dBm |
| 2nd Harmonic | +35 | +35 | +35 | +40 | dBm |
| VSWR (Maximum) | | | | | |
| Input | 2.0:1 | 2.0:1 | 2.0:1 | 2.0:1 | |
| Output | 1.7:1 | 1.7:1 | 1.7:1 | 1.7:1 | |
| DC Current (Maximum) | 150 | 220 | 290 | 450 | mA |
| DC Operating Voltage | | | | | |
| Minimum | +12.0 | +12.0 | +12.0 | +12.0 | Volts |
| Maximum | +18.0 | +18.0 | +18.0 | +18.0 | Volts |
| Outline Drawing | 297016 | 297017 | 297017 | 297017 | |

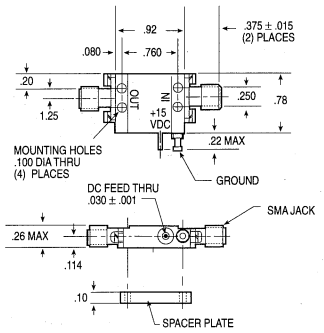
### Absolute Maximum Ratings

Case Operating Temperature*.....-54° to +100°C
Storage Temperature.....-62° to +125°C
Short Term (1 Hour) CW Input Level .....+18 dBm
Peak Pulsed (10 µsec) Input Level.....+23 dBm
DC Reverse Voltage.....-40 Volts
*+65°C max. for 6884-824

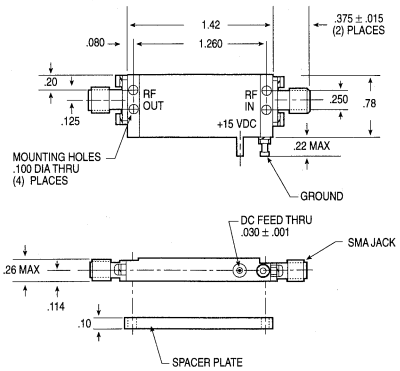
Weight 1.4 oz. max.

### Outline Drawings

297016

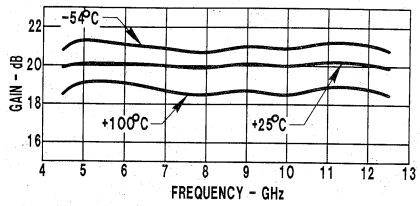



297017

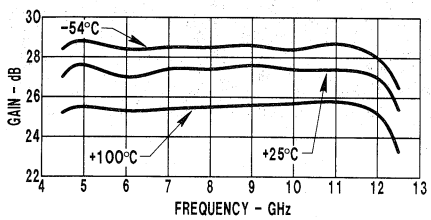


# Typical Performance

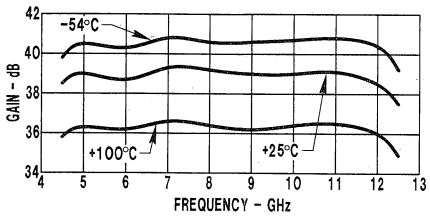
### Gain
### (-812)



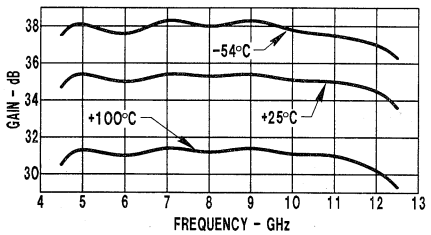

### (-813)



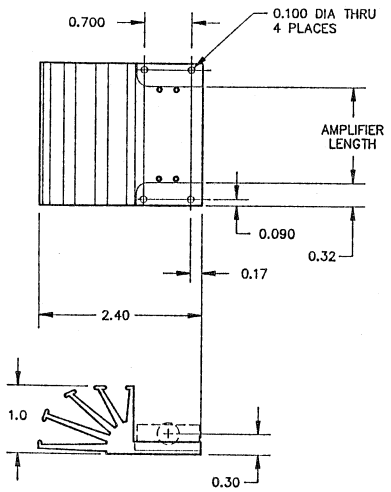

### (-814)



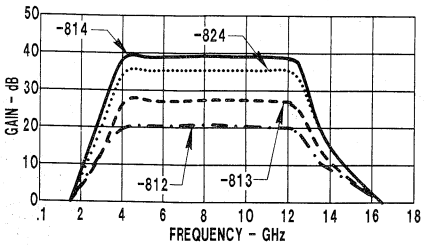

### (-824)



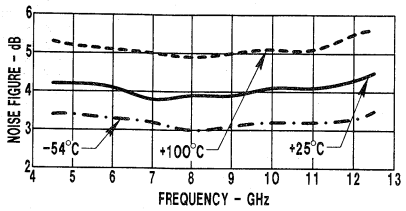

## Finned Heatsink



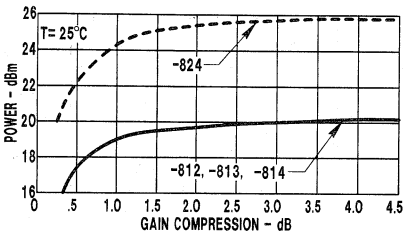

### Broadband Gain



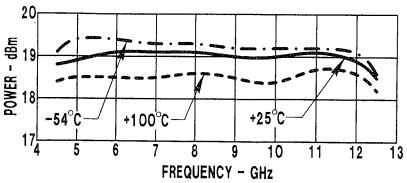

### Noise Figure
### (All Models)



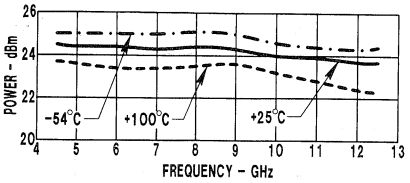

### Power Output




### $P_{out}$* (-812, -813, -814)

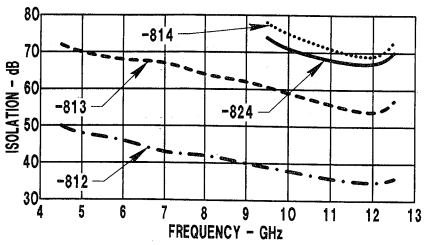



### $P_{out}$* (-824)

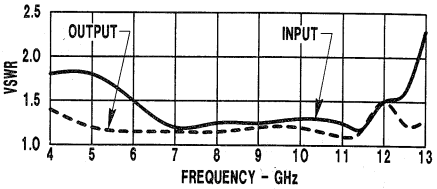



*at 1 dB Gain Compression

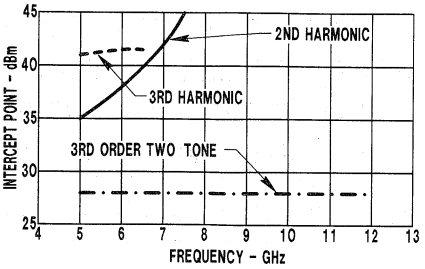
### Reverse Isolation



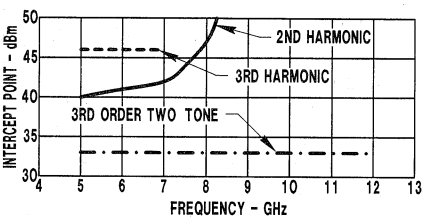

### VSWR
### (All Models)



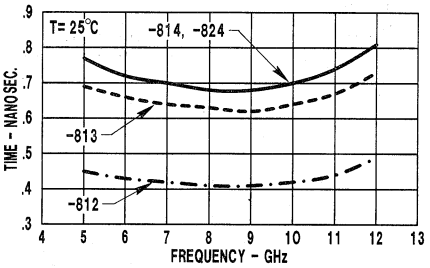

### Intercept Point
### (-812, -813, -814)



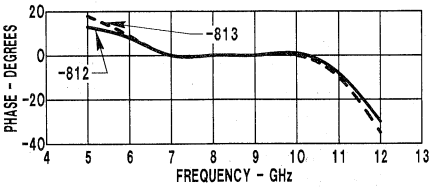

### (-824)



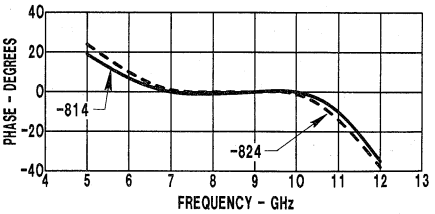

### Group Delay




### Deviation from Linear Phase
### (-812, -813)




### (-814, -824)




Notes:
Dimensions are in inches. Tolerances: X.XXX ± 0.005, X.XX ± 0.02 inches. Amplifiers are supplied with RF connectors installed and mounted on a heatsink. A spacer plate and mounting fasteners are provided for alternate mounting configurations. The heatsink is easily removed, but is recommended for incoming test and laboratory applications. RF connectors can be removed for "drop in" microstrip applications. RF pin dimensions: 0.015 dia. x 0.07 long.

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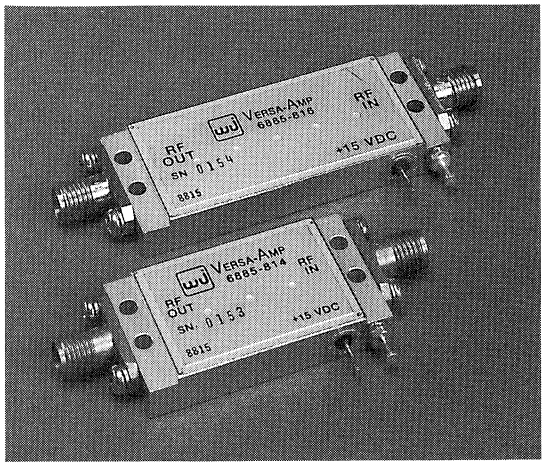
# WJ-6885-813,-814, -815,-816

## VERSA-AMP ®
## 6 TO 18 GHz
## MICROWAVE AMPLIFIERS

- GAIN 18 - 38 dB (4 MODELS)
- NOISE FIGURE: 5.5 dB (TYP.)
- OUTPUT POWER: +17.5 dBm (TYP.)
- INTERNAL VOLTAGE REGULATION




### Typical and Guaranteed Specifications (+25°C)

| WJ-6885 | -813 | -814 | -815 | -816 | Units |
|---|---|---|---|---|---|
| Frequency | 6.0-18.0 | 6.0-18.0 | 6.0-18.0 | 6.0-18.0 | GHz |
| RF Gain | | | | | |
| Typical | 20 | 28 | 33 | 41 | dB |
| Minimum | 18 | 25 | 30 | 38 | dB |
| Gain Flatness (Maximum) | ±1.0 | ±1.5 | ±1.5 | ±1.75 | dB |
| Noise Figure | | | | | |
| Typical | 5.5 | 5.5 | 5.5 | 5.5 | dB |
| Maximum | 6.0 | 6.0 | 6.0 | 6.0 | dB |
| Power Output at 1 dB Compression (Min.) | +15 | +15 | +15 | +15 | dBm |
| Intercept Point (Typical) | | | | | |
| 3rd Order Two Tone | +28 | +28 | +28 | +28 | dBm |
| 2nd Harmonic | +35 | +35 | +35 | +35 | dBm |
| VSWR (Maximum) | | | | | |
| Input | 2.0:1 | 2.0:1 | 2.0:1 | 2.0:1 | |
| Output | 2.0:1 | 2.0:1 | 2.0:1 | 2.0:1 | |
| DC Current (Maximum) | 210 | 250 | 310 | 360 | mA |
| DC Operating Voltage | | | | | |
| Minimum | +10.0 | +10.0 | +10.0 | +10.0 | Volts |
| Maximum | +18.0 | +18.0 | +18.0 | +18.0 | Volts |
| Output Drawing | 297017 | 297017 | 297014 | 297014 | |

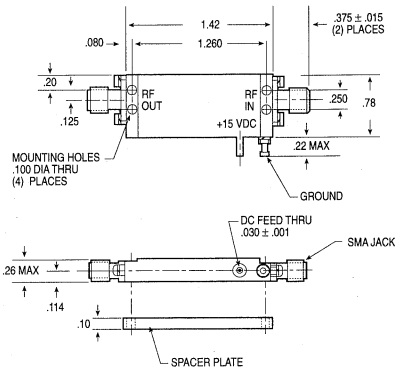
### Absolute Maximum Ratings

Case Operating Temperature ..... -54° to +100°C
Storage Temperature ..... -62° to +125°C
Short Therm (1 Hour) CW Input Level ..... +18 dBm
Peak Pulsed (10 µsec) Input Level ..... +23 dBm
DC Reverse Voltage ..... -40 Volts

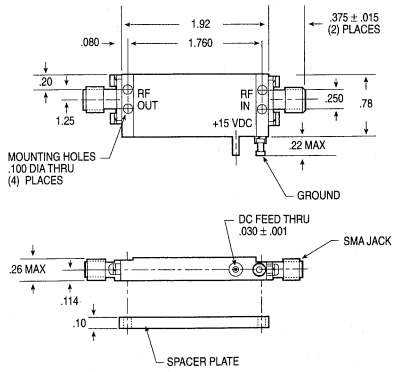
Weight 1.7 max

### Outline Drawings

297017

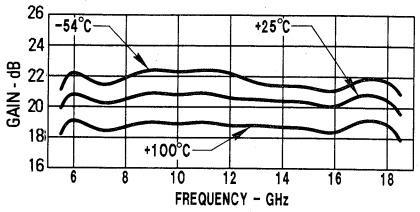



297014

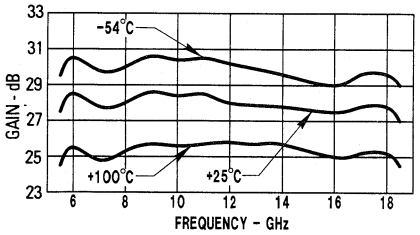


# Typical Performance

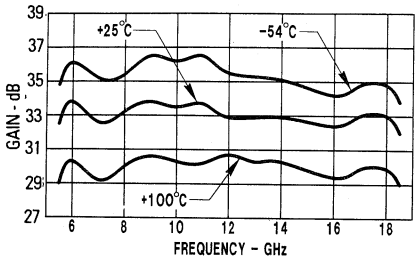
### Gain (-813)



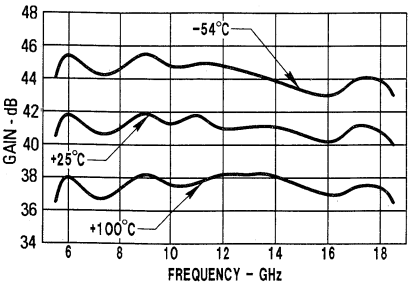

### (-814)



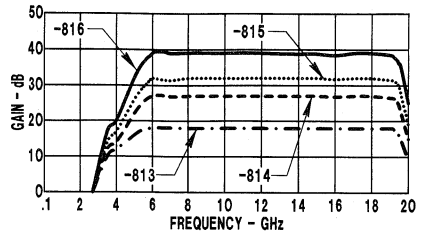

### (-815)



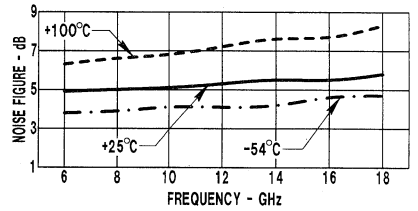

### Gain (-816)



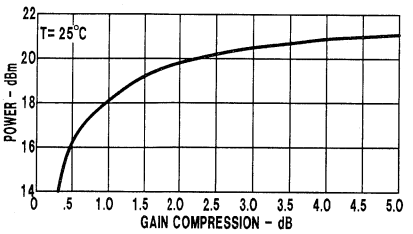

### Broadband Gain



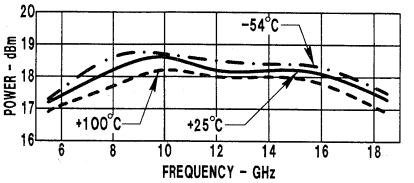

### Noise Figure (All Models)




### Power Output (All Models)

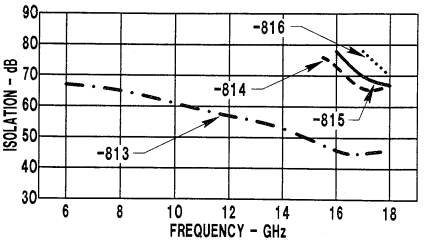



### $P_{out}$* (All Models)

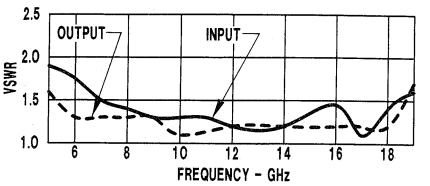



*at 1 dB Gain Compression

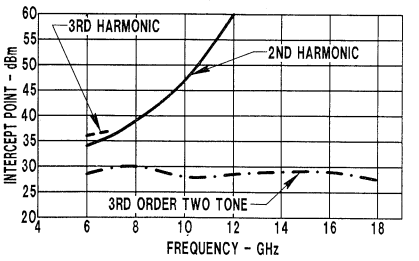
### Reverse Isolation



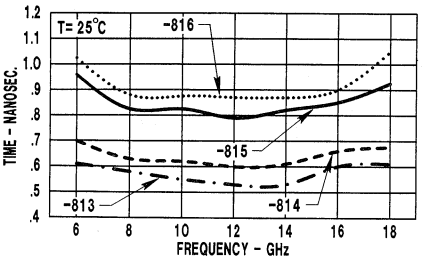

### VSWR (All Models)



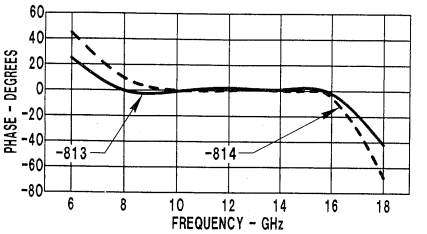

### Intercept Point (All Models)



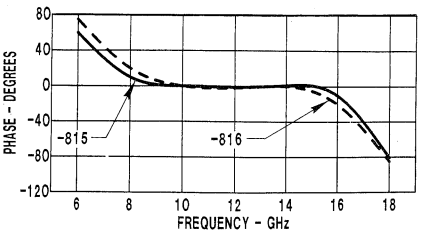

### Group Delay



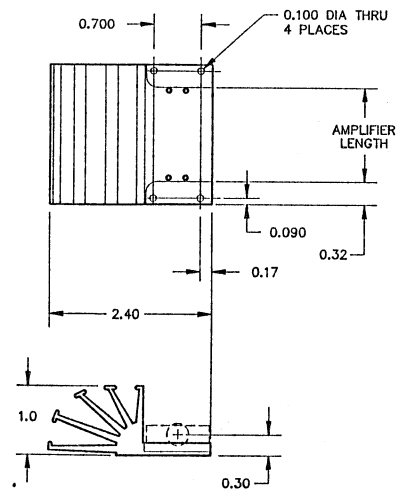

### Deviation from Linear Phase (-813, -814)




### (-815, -816)

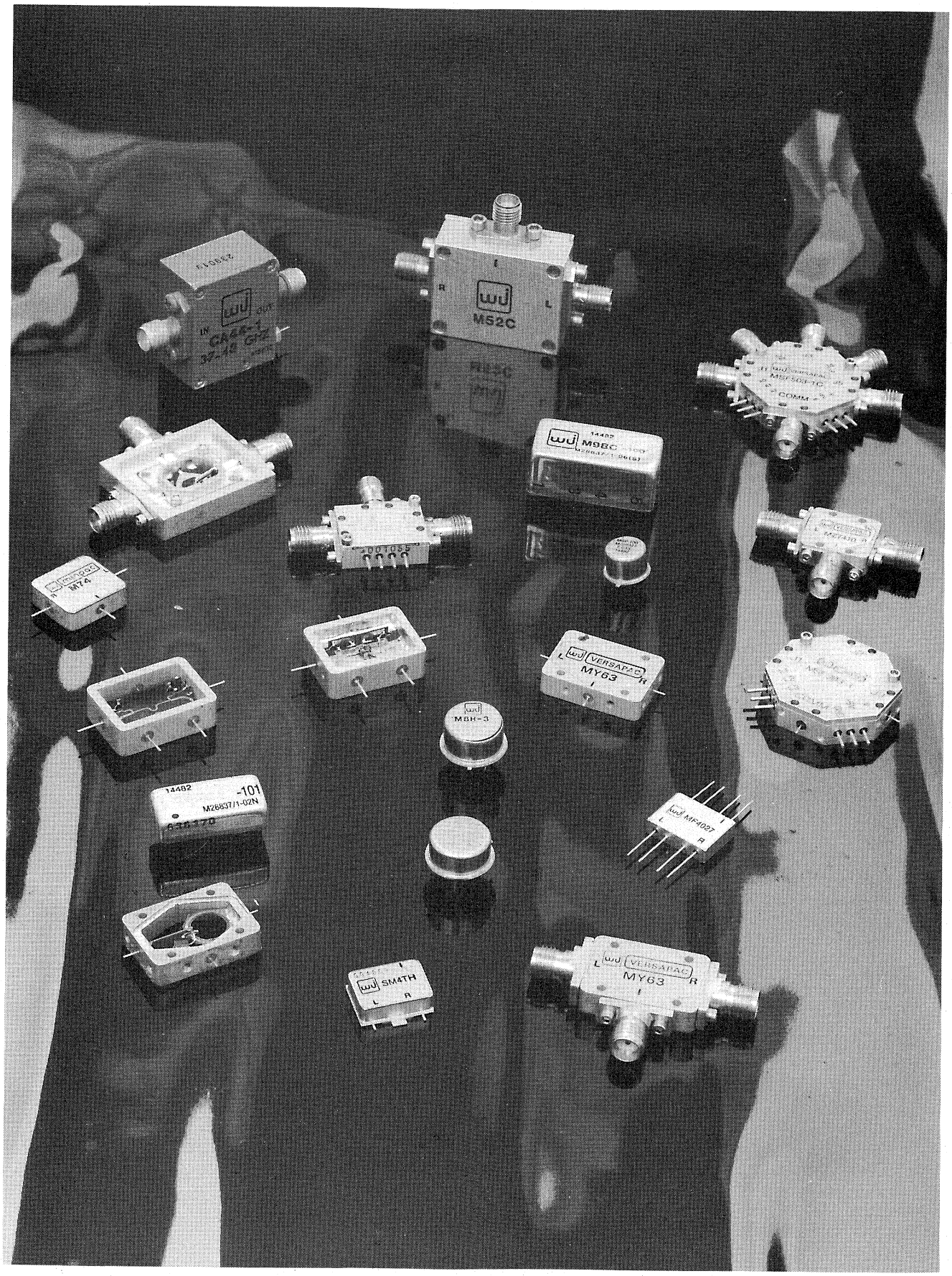



## Finned Heatsink



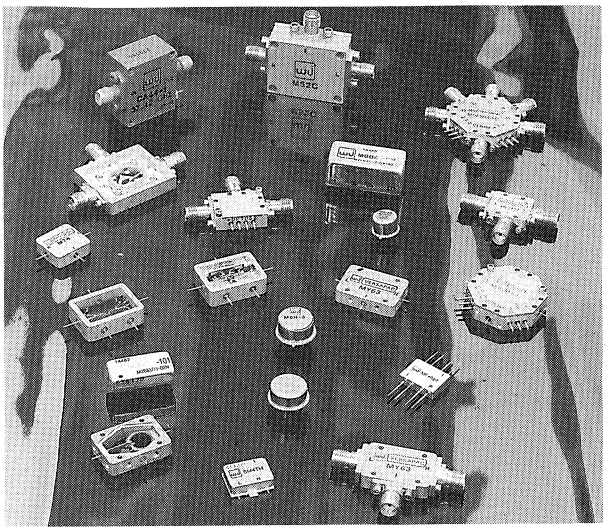

Notes:
Dimensions are in inches. Tolerances: X.XXX ± 0.005, X.XX ± 0.02 inches. Amplifiers are supplied with RF connectors installed and mounted on a heatsink. A spacer plate and mounting fasteners are provided for alternate mounting configurations. The heatsink is easily removed, but is recommended for incoming test and laboratory applications. RF connectors can be removed for "drop in" microstrip applications. RF pin dimensions: 0.015 dia. x 0.07 long.

# Mixer Products



# FREQUENCY MIXERS

- ◆ DC TO 24 GHz
- ◆ HIGH PERFORMANCE
- ◆ WIDEBAND OPERATION
- ◆ GUARANTEED SPECIFICATIONS
- ◆ HI-REL SCREENING AVAILABLE



**Description:** Watkins-Johnson provides a full line of high performance mixers covering frequency ranges as low as 10 kHz to 12 MHz and as broadband as 1 GHz to 24 GHz. Included in this line are both high level and low level mixers. Some mixers have been designed to be stripline compatable while others have been optimized for maximum performance and smallest possible size for PC board installation. There is even a series of mixers specially designed for the satellite communication bands (WJ-M62, M64, M65, M81, M79H).

W-J mixers are available in many sizes and package styles. Most connector versions come with BNC connectors if the operating frequency range is below 1 GHz while microwave mixers are normally supplied with SMA connectors.

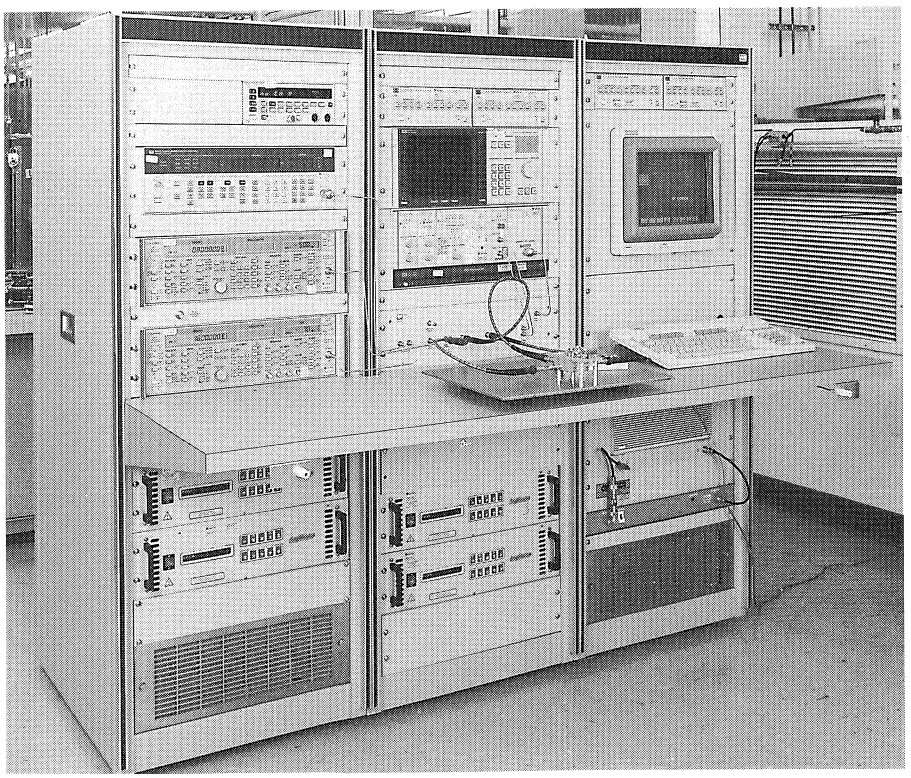
**Construction.** Single-balanced mixers incorporate two Schottky-barrier diodes and a wideband balanced transformer. Double-balanced, low-level mixers incorporate four Schottky-barrier diodes and two wideband transformers. High-level double-balanced mixers have additional diodes and/or matching resistors. The design objective in all units has been to match the diodes and construct the balanced transformers for optimum balance and minimum noise figure.

In order to improve performance and reliability while minimizing size, Watkins-Johnson has also developed a line of thin film mixers. In the low frequency range W-J provided the M9G and M9H high level mixers which operate to 1500 MHz.

To meet the demand of increased miniaturization, Watkins-Johnson has expanded the line of mixers available in the "Y" and "Z" style VERSAPAC® cases. Both designs feature low profiles and built in mounting holes. These design qualities allow the packages to be integrated into a system using a minimum amount of board space and height. In addition, the VERSAPAC® cases are hermetic and employ matched glass technology in their glass to metal seals, resulting in outstanding resistance to environmental extremes encountered in Hi-Rel programs. VERSAPAC® mixers are available with field replaceable SMA connectors or stripline compatible packaging.

**Environmental Performance:** All units are designed and constructed to meet their specifications over -54°C to +100°C and after exposure to any or all of the following tests per MIL-STD-202F.

**Special Reliability Testing:** Starting with the original design concept, quality is



**Mixer/Switch Test Station: Network Analyzer-based automated test station for mixer and switch testing. System can measure both phase and magnitude in the 40 MHz to 26.5 GHz range. Test data can be stored for later processing by a match and track program for matched sets.**

built into each mixer. With this advantage, W-J is uniquely ready to provide a higher degree of reliability than is normally available from a standard product for todays long-life satellite and other high MTBF systems.

**Three Approaches to Hi-Rel:** As a result of contributing to numerous hi-rel programs in recent years, W-J has found the need for three basic approaches to hi-rel production. While all hi-rel programs are designed to eliminate early failures, only the initial part cost versus failure consequence cost will determine which program should be specified.

**Ultra Hi-Rel:** On applications where extremely long life, very severe environments, or personnel safety is a concern, the customer may elect to perform a design review where all parts, materials, and processes are analyzed with the particular application in mind. Parts and materials are qualified prior to use, 100% pre-cap inspections are performed, full environmental screening is performed on the end item, and full qualification to near destructive levels is performed on a sample of the lot. This program is the most costly, but assures the highest level of quality.

**Hi-Rel Existing Design:** This type of program employs the same basic controls as the ultra hi-rel, except there is no design review with the customer and all controls are performed under existing Watkins-Johnson procedures. Once again, parts, materials, and processes used will be those developed and proven on earlier programs. Semiconductors may be prescreened, and devices built on a hi-rel dedicated line. The screening will again be performed on the end item and may also include a qualification program.

**Screened Standard:** The third and most cost-effective hi-rel program is commonly used on airborne applications and high- MTBF ground equipment. This procedure employs products from our standard finished goods inventory which are subjected to environmental screening, using the procedures found in MIL-STD- 202, MIL-STD-750, and/or MIL-STD-883.

Typical 100% Screening Programs are as follows:

| Test | Mixer (Per MIL-STD-202) Method | Condition |
|---|---|---|
| Bake | — | 24 hrs., 100°C |
| Thermal Shock | 107 | -65°C to +125°C, 5 cycles |
| Vibration | 214 | 22 1/2 g-rms, 15 min./axis |
| Seal Test | 112 | 1 x $10^{-8}$ cc/sec |
| Burn-in | — | 96 hrs., DC bias |
| Final Electrical | | Per applicable document |
| Final Visual | — | |

Guaranteed to withstand the following requirements:

| Exposure | Method | Test Condition |
|---|---|---|
| Temperature Cycle | 102A | C |
| Thermal Shock | 107D | B |
| Altitude | 105C | G |
| H.F. Vibration | 204C | D |
| Mechanical Shock | 213B | C |
| Random Vibration (15 minutes per axis) | 214 | IIF |
| Solderability | 208C | |
| Terminal Strength | 211A | C |
| Resistance to Soldering Heat | 210A | B |

Hermetically sealed units meet the requirements of Method 106D of MIL-STD-202F when exposed to humidity.

W-J Hi-Rel Team: W-J has found that a permanent dedicated hi-rel program group is needed to respond properly to the wide variety of program requirements. This group includes hi-rel engineering experts and specially qualified technicians and assemblers.

# Selecting the Right Mixer

Because Watkins-Johnson has such a broad line of frequency mixers it often appears that more than one mixer will fullfill the necessary requirements for a given application. In order to help you select the proper mixer we are providing easy-to-use mixer selection charts on the accompanying pages. Once the choice has been narrowed down it may be necessary to compare the detailed specifications and typical data presented on the detailed mixer technical data sheet.

A check list of important parameters is detailed below with helpful hints geared toward aiding you in the proper selection of mixers.

**Input Frequencies**: Select a mixer so the input frequencies are in the middle of the frequency range for the mixer. This will normally insure minimum noise figure and VSWR.

**IF Frequency**: Most W-J low frequency mixers coverage for DC to a few hundred MHz on the I-port. Many microwave mixers have broadband IF's up to 15 GHz.

**Single-Balanced vs. Double-Balanced**: In a double-balanced mixer all three ports are isolated from each other, In a single-balanced mixer only the L- port is isolated. For mixing applications where price is the ultimate factor and some sacrifice in IMD and isolation is acceptable, the single-balanced mixer is recommended, Phase detection is an important application for the single-balanced mixer since R to I isolation is not required.

**High Level or Low Level**: For most applications, a low-level (+7 dBm or +10 dBm LO drive) mixer is recommended. In the cases where the desired compression level, 3rd order two-tone performance, or harmonic intermodulation performance (harmonics of $f_R$ greater than or equal to 2) cannot be obtained with a low-level mixer, then a high level mixer is recommended.

**Conversion Loss/Noise Figure:** The typical specifications in the accompanying tables are conservative in nature to cover worst possible operating conditions. Actual conversion loss or noise figure is typically 0.5 dB better than these numbers, especially over narrow frequency ranges and at reduced operating temperatures. Check individual data pages for guaranteed performance.

**Package**: Small size is featured and a number of package styles are available. Miniature TO-5, TO-8 and flat pack 8-pin packages are available to 2.5 GHz. A PC mounted package is available. For MIC mounting, miniature flat pack carriers WJ-M15, M16 and M17 cover the 2.5 to 16 GHz range. The WJ-M15C through M17C connector versions are unique in that the flat pack carrier can be removed from the connector package and "dropped in" the MIC assembly once the breadboard design is completed. The "Y" and "Z" VERSAPAC® package styles feature low profiles and built in mounting holes to allow the system designer to use less board space and height in mixer integration. Low cost MINPAC™ mixers are also available for systems where board space is less critical. See further data on M50 to MZ9310 mixers on the following pages.

## Typical Specifications

| Model | Frequency Range RF | LO | IF | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | Isolation Typ. dB L-R | L-I | $f_R$ Level at 1 dB Compression Point Typ. dBm | Input Intercept Point Typ. dBm | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| **DC to 250** | **MHz** | **MHz** | **MHz** | | | | | | | |
| M6D-50 | 0.05-200 | 0.05-200 | DC-200 | 7 | 5.5 | 50 | 50 | -2 | 10 | PC |
| M6D | 0.05-200 | 0.05-200 | DC-200 | 7 | 5.5 | 50 | 50 | 0 | 13 | PC |
| SM6D | 0.05-200 | 0.05-200 | DC-200 | 7 | 5.5 | 50 | 50 | 0 | 13 | Surf. Mnt. |
| **DC to 500** | **MHz** | **MHz** | **MHz** | | | | | | | |
| M9E | 1-400 | 1-400 | DC-400 | 27 | 6.0 | 35 | 45 | 20 | 32 | PC |
| M9D | 2-400 | 2-500 | DC-800 | 20 | 6.0 | 45 | 40 | 15 | 30 | PC |
| M6KC | 5-400 | 5-400 | DC-400 | 7 | 6.0 | 30 | 25 | 0 | 13 | PC |
| M6E-50 | 5-500 | 5-500 | DC-500 | 7 | 6.5 | 50 | 45 | -2 | 10 | PC |
| M9C | 0.4-500 | 0.4-500 | DC-500 | 13 | 7.0 | 35 | 35 | 10 | 23 | PC |
| M9BC | 0.5-500 | 0.5-500 | DC-500 | 17 | 7.0 | 50 | 40 | 8 | 23 | PC |
| M1 | 0.2-500 | 0.2-500 | DC-500 | 7 | 6.0 | 40 | 33 | 0 | 17 | BNC/SMA |
| M6V | 0.4-500 | 0.4-500 | DC-500 | 7 | 5.5 | 50 | 30 | 0 | 13 | TO-5 |
| SM6V | 0.4-500 | 0.4-500 | DC-500 | 7 | 5.5 | 50 | 30 | 0 | 13 | Surf. Mnt. |
| M6E | 5-500 | 5-500 | DC-500 | 7 | 6.5 | 50 | 45 | 0 | 13 | PC |
| M6EH | 5-500 | 5-750 | DC-500 | 20 | 5.5 | 50 | 45 | 13 | 28 | PC |

## Typical Specifications (Continued)

| Model | Frequency Range RF | LO | IF | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | Isolation Typ. dB L-R | L-I | $f_R$ Level at 1 dB Compression Point Typ. dBm | Input Intercept Point Typ. dBm | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| **DC to 2000** | **MHz** | **MHz** | **MHz** | | | | | | | |
| M1A | 3-1000 | 3-1000 | DC-1000 | 7 | 6.0 | 35 | 30 | 0 | 15 | BNC/SMA |
| M6R | 10-1000 | 10-1200 | DC-1000 | 7 | 6.5 | 35 | 25 | 0 | 13 | TO-5 |
| M2E | 10-1000 | 10-1000 | DC-600 | 20 | 7.0 | 30 | 22 | 20 | 30 | TO-8 |
| SM2E | 10-1000 | 10-1000 | DC-600 | 20 | 7.0 | 30 | 22 | 20 | 30 | Surf. Mnt. |
| M2EC | 10-1000 | 10-1000 | DC-600 | 20 | 7.0 | 30 | 22 | 20 | 30 | SMA |
| NEW **MF4027** | **10-1000** | **10-1000** | **10-300** | **27** | **7.0** | **25** | **38** | **–** | **36** | **Flatpack** |
| M1A-11 | 3-1200 | 3-1200 | DC-1200 | 7 | 6.0 | 35 | 30 | 0 | 15 | BNC |
| M2A | 10-1500 | 10-1500 | DC-800 | 7 | 7.0 | 35 | 25 | 0 | 12 | TO-8 |
| M2AC | 10-1500 | 10-1500 | DC-800 | 7 | 7.0 | 35 | 25 | 0 | 12 | SMA |
| M4A | 10-1500 | 10-1500 | DC-1000 | 7 | 6.5 | 35 | 30 | 0 | 13 | Flatpack |
| SM4A | 10-1500 | 10-1500 | DC-1000 | 7 | 6.5 | 35 | 30 | 0 | 13 | Surf. Mnt. |
| M4B | 10-1500 | 10-1500 | DC-1000 | 13 | 7.5 | 35 | 30 | 7 | 22 | Flatpack |
| NEW **SM4B** | **10-1500** | **10-1500** | **DC-1000** | **13** | **7.5** | **35** | **30** | **7** | **22** | **Surf. Mnt.** |
| M2B | 10-1600 | 10-1600 | DC-1000 | 13 | 6.5 | 44 | 30 | 7 | 22 | TO-8 |
| M2BC | 10-1600 | 10-1600 | DC-1000 | 13 | 6.5 | 44 | 30 | 7 | 22 | SMA |
| M9H | 10-1500 | 10-1600 | DC-600 | 20 | 7.0 | 24 | 20 | 15 | 24 | TO-8 |
| M9HC | 10-1500 | 10-1600 | DC-600 | 20 | 7.0 | 24 | 20 | 15 | 24 | SMA |
| M2T | 10-2400 | 10-2400 | 1-1000 | 13 | 7.0 | 40 | 40 | 9 | 24 | TO-8 |
| M2TC | 10-2400 | 10-2400 | 1-1000 | 13 | 7.5 | 40 | 40 | 9 | 24 | SMA |
| M1J | 300-2000 | 300-2000 | DC-1000 | 7 | 6.5 | 45 | 30 | 0 | 15 | SMA |
| **0.5 to 4.5** | **GHz** | **GHz** | **GHz** | | | | | | | |
| M4G | 0.8-2.4 | 0.8-3.5 | DC-1.5 | 7 | 6.5 | 30 | 25 | 0 | 13 | Flatpack |
| SM4G | 0.8-2.4 | 0.8-3.5 | DC-1.5 | 7 | 6.5 | 30 | 25 | 0 | 13 | Surf. Mnt. |
| M2G | 1.0-2.2 | 0.8-3.5 | DC-1.5 | 7 | 6.5 | 35 | 30 | 1.5 | 12 | TO-8 |
| M2GC | 1.0-2.2 | 0.8-3.5 | DC-1.5 | 7 | 6.5 | 35 | 30 | 1.5 | 12 | SMA |
| M4T | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 10 | 7.0 | 35 | 35 | 7 | 18 | Flatpack |
| SM4T | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 10 | 7.0 | 35 | 35 | 7 | 18 | Surf. Mnt. |
| M4TH | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 23 | 7.5 | 35 | 35 | 17 | 29 | Flatpack |
| SM4TH | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 23 | 7.5 | 35 | 35 | 17 | 29 | Surf. Mnt. |
| M8T | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 10 | 7.0 | 40 | 40 | 7 | 18 | TO-8 |
| M8TC | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 10 | 7.5 | 40 | 40 | 7 | 18 | SMA |
| M8TH | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 23 | 7.5 | 35 | 35 | 17 | 29 | TO-8 |
| M8THC | 0.001-3.4 | 0.001-3.4 | 0.001-2.0 | 23 | 8.0 | 35 | 35 | 17 | 29 | SMA |
| M1K | 1.0-4.0 | 1.0-4.0 | DC-1.0 | 20 | 6.0 | 30 | 20 | 13 | 28 | SMA |
| M1G | 1.0-4.2 | 1.0-4.2 | DC-1.0 | 7 | 5.5 | 35 | 25 | 0 | 10 | SMA |
| M8H-3 | 3.7-4.2 | 2.0-6.0 | DC-2.0 | 7 | 4.5 | 40 | 21 | 0 | 13 | TO-8 |
| M8HC-3 | 3.7-4.2 | 2.0-6.0 | DC-2.0 | 7 | 4.5 | 40 | 21 | 0 | 13 | SMA |
| M62 | 3.7-4.2 | 2.6-5.35 | DC-1.45 | 9 | 5.2 | 40 | 30 | 3 | 11 | MINPAC |
| M62C | 3.7-4.2 | 2.6-5.35 | DC-1.45 | 9 | 5.2 | 40 | 30 | 3 | 11 | SMA |
| **0.5 to 12.0** | **GHz** | **GHz** | **GHz** | | | | | | | |
| M63 | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 9 | 5.4 | 40 | 27 | 2 | 11 | MINPAC |
| M63C | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 9 | 5.4 | 40 | 27 | 2 | 11 | SMA |
| NEW **MU6310** | **2.5-5.5** | **2.5-7.0** | **DC-1.5** | **10** | **6.5** | **45** | **30** | **3** | **15** | **MSCOMPAT*** |
| MY63 | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 9 | 5.4 | 40 | 27 | 2 | 11 | VERSAPAC |
| MY63C | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 9 | 5.4 | 40 | 27 | 2 | 11 | SMA |
| M63H | 2.5-6.5 | 2.5-7.5 | DC-1.5 | 20 | 6.0 | 37 | 21 | 14 | 22 | MINPAC |
| M63HC | 2.5-6.5 | 2.5-7.5 | DC-1.5 | 20 | 6.0 | 37 | 21 | 14 | 22 | SMA |
| MY63H | 2.5-6.5 | 2.5-7.5 | DC-1.5 | 20 | 6.0 | 37 | 21 | 14 | 22 | VERSAPAC |
| MY63HC | 2.5-6.5 | 2.5-7.5 | DC-1.5 | 20 | 6.0 | 37 | 21 | 14 | 22 | SMA |
| MZ6310 | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 10 | 6.5 | 45 | 35 | 3 | 15 | VERSAPAC |

* MSCOMPAT = Microstrip compatible

## Typical Specifications (Continued)

| Model | Frequency Range RF | LO | IF | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | Isolation Typ. dB L-R | L-I | $f_R$ Level at 1 dB Compression Point Typ. dBm | Input Intercept Point Typ. dBm | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| **0.5 to 12.0** | **GHz** | **GHz** | **GHz** | | | | | | | |
| MZ6310C | 2.5-5.5 | 2.5-7.0 | DC-1.5 | 10 | 6.5 | 45 | 35 | 3 | 15 | VERSAPAC |
| M8H-7 | 2.4-6.0 | 2.0-6.0 | DC-2.0 | 7 | 4,5 | 40 | 21 | 0 | 13 | TO-8 |
| M8HC-7 | 2.4-6.0 | 2.0-6.0 | DC-2.0 | 7 | 4.5 | 40 | 21 | 0 | 13 | SMA |
| M15 | 2.0-6.0 | 2.0-6.0 | DC-2.0 | 7 | 6.5 | 20 | 20 | 2 | 11 | MIC |
| M15C | 2.0-6.0 | 2.0-6.0 | DC-2.0 | 7 | 6.5 | 20 | 20 | 2 | 11 | SMA |
| M1H | 1.8-6.2 | 1.8-6.2 | DC-2.0 | 7 | 6.0 | 35 | 20 | 0 | 15 | SMA |
| M12 | 4.0-8.0 | 4.0-8.0 | 0.005-3.0 | 13 | 6.0 | 25 | 28 | 8 | 16 | SMA |
| M14 | 4.0-8.0 | 4.0-9.0 | DC-2.0 | 7 | 5.5 | 30 | 30 | 2 | 10 | SMA |
| M16 | 4.0-9.0 | 4.0-9.0 | DC-3.0 | 7 | 7.0 | 18 | 16 | 2 | 11 | M1C |
| M16C | 4.0-9.0 | 4.0-9.0 | DC-3.0 | 7 | 7.0 | 18 | 16 | 2 | 11 | SMA |
| M12A | 4.0-12.0 | 4.0-12.0 | 0.005-4.0 | 13 | 6.5 | 25 | 30 | 8 | 20 | SMA |
| M76 | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 10 | 5.8 | 35 | 22 | 3 | 13 | MINPAC |
| M76C | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 10 | 5.8 | 35 | 22 | 3 | 13 | SMA |
| MY76 | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 10 | 5.8 | 35 | 22 | 3 | 13 | VERSAPAC |
| MY76C | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 10 | 5.8 | 35 | 22 | 3 | 13 | SMA |
| M76H | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 20 | 6.5 | 35 | 26 | 15 | 24 | MINPAC |
| M76HC | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 20 | 6.5 | 35 | 26 | 15 | 24 | SMA |
| MY76H | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 20 | 6.5 | 35 | 26 | 15 | 24 | VERSAPAC |
| MY76HC | 4.5-9.5 | 2.5-11.5 | DC-2.0 | 20 | 6.5 | 35 | 26 | 15 | 24 | SMA |
| MY84 | 1.8-10.0 | 1.8-10.0 | DC-1.0 | 9 | 6.5 | 35 | 30 | 4 | 11 | VERSAPAC |
| MY84C | 1.8-10.0 | 1.8-10.0 | DC-1.0 | 9 | 6.5 | 35 | 30 | 4 | 11 | SMA |
| **6.0 to 18.0** | **GHz** | **GHz** | **GHz** | | | | | | | |
| M77 | 8.0-12.5 | 7.0-15.0 | DC-2.5 | 10 | 5.5 | 35 | 30 | 4 | 15 | MINPAC |
| M77C | 8 0-12.5 | 7.0-15.0 | DC-2.5 | 10 | 5.5 | 35 | 30 | 4 | 15 | SMA |
| MY77 | 8.0-12.5 | 7.0-15.0 | DC-2.5 | 10 | 5.5 | 35 | 30 | 4 | 15 | VERSAPAC |
| MY77C | 8.0-12.5 | 7.0-15.0 | DC-2.5 | 10 | 5.5 | 35 | 30 | 4 | 15 | SMA |
| M14A | 6.0-14.0 | 4.0-16.0 | DC-2.0 | 7 | 6.5 | 30 | 30 | 2 | 10 | SMA |
| M67 | 9.0-15.0 | 7.0-17.0 | DC-2.5 | 10 | 6.0 | 35 | 25 | 4 | 11 | MINPAC |
| M67C | 9.0-15.0 | 7.0-17.0 | DC-2.5 | 10 | 6.0 | 35 | 25 | 4 | 11 | SMA |
| M17 | 6.0-16.0 | 6.0-16.0 | DC-3.0 | 7 | 7.0 | 15 | 18 | 3 | 11 | MIC |
| M17C | 6.0-16.0 | 6.0-16.0 | DC-3.0 | 7 | 7.0 | 15 | 18 | 3 | 11 | SMA |
| MZ7407 | 6.0-18.0 | 4.0-18.0 | DC-3.0 | 7 | 6.5 | 34 | 28 | 3 | 10 | VERSAPAC |
| MZ7407C | 6.0-18.0 | 4.0-18.0 | DC-3.0 | 7 | 6.5 | 34 | 28 | 3 | 10 | SMA |
| M74 | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 10 | 6.2 | 35 | 25 | 4 | 11 | MINPAC |
| M74C | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 10 | 6.2 | 35 | 25 | 4 | 11 | SMA |
| NEW **MU7410** | **6.0-18.0** | **4.0-18.0** | **DC-3.0** | **10** | **6.5** | **34** | **29** | **3** | **13** | **MSCONPAT*** |
| MZ7410 | 6.0-18.0 | 4.0-18.0 | DC-3.0 | 10 | 6.5 | 34 | 35 | 4 | 14 | VERSAPAC |
| MZ7410C | 6.0-18.0 | 4.0-18.0 | DC-3.0 | 10 | 6.5 | 34 | 35 | 4 | 14 | SMA |
| MZ7420 | 6.0-18.0 | 5.0-18.0 | DC-3.0 | 20 | 7.5 | 30 | 30 | 15 | 21 | VERSAPAC |
| MZ7420C | 6.0-18.0 | 5.0-18.0 | DC-3.0 | 20 | 7.5 | 32 | 30 | 15 | 21 | SMA |
| M79 | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 10 | 6.2 | 32 | 29 | 4 | 14 | MINPAC |
| M79C | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 10 | 6.2 | 32 | 29 | 4 | 14 | SMA |
| M79H | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 20 | 7.5 | 33 | 30 | 15 | 24 | MINPAC |
| M79HC | 7.0-18.0 | 5.0-18.0 | DC-3.0 | 20 | 7.5 | 33 | 30 | 15 | 24 | SMA |
| M80L | 7.0-18.0 | 4.0-18.0 | DC-3.0 | 0 | 8.5 | 29 | 30 | -2 | 7 | MINPAC |
| M80LC | 7.0-18.0 | 4.0-18.0 | DC-3.0 | 0 | 8.5 | 29 | 30 | -2 | 7 | SMA |
| M80 | 6.0-18.0 | 3.5-18.0 | DC-3.0 | 7 | 6.5 | 34 | 32 | 3 | 10 | MINPAC |
| M80C | 6.0-18.0 | 3.5-18.0 | DC-3.0 | 7 | 6.5 | 34 | 32 | 3 | 10 | SMA |
| M86 | 6.0-18.0 | 3.5-18.0 | DC-3.0 | 7 | 6.5 | 34 | 30 | 3 | 10 | MINPAC |
| M86C | 6.0-18.0 | 3.5-18.0 | DC-3.0 | 7 | 6.5 | 34 | 30 | 3 | 10 | SMA |

* MSCOMPAT = Microstrip compatible

## Typical Specifications (Continued)

| Model | Frequency Range RF | LO | IF | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | Isolation Typ. dB L-R | L-I | $f_R$ Level at 1 dB Compression Point Typ. dBm | Input Intercept Point Typ. dBm | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| **0.5 to 26.0** | **GHz** | **GHz** | **GHz** | | | | | | | |
| M85 | 2.0-18.0 | 2.0-18.0 | DC-1.0 | 7 | 7.5 | 35 | 20 | 2 | 10 | MINPAC |
| M85C | 2.0-18.0 | 2.0-18.0 | DC-1.0 | 7 | 7.5 | 35 | 20 | 2 | 10 | SMA |
| MY85 | 2.0-18.0 | 2.0-18.0 | DC-1.0 | 7 | 7.5 | 35 | 20 | 2 | 10 | VERSAPAC |
| MY85C | 2.0-18.0 | 2.0-18.0 | DC-1.0 | 7 | 7.5 | 35 | 20 | 2 | 10 | SMA |
| M93 | 2.0-18.0 | 2.0-18.0 | 0.03-4.0 | 10 | 8.0 | 29 | 34 | 4 | 16 | MINPAC |
| M93C | 2.0-18.0 | 2.0-18.0 | 0.03-4.0 | 10 | 8.0 | 29 | 34 | 4 | 16 | SMA |
| NEW **MU9310** | **2.0-18.0** | **2.0-18.0** | **0.03-5.0** | **10** | **7.5** | **25** | **28** | **5** | **15** | **MSCOMPAT*** |
| MY93 | 2.0-18.0 | 2.0-18.0 | 0.03-4.0 | 10 | 8.0 | 29 | 34 | 4 | 16 | VERSAPAC |
| MY93C | 2.0-18.0 | 2.0-18.0 | 0.03-4.0 | 10 | 8.0 | 29 | 34 | 4 | 16 | SMA |
| MZ9310 | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 10 | 7.5 | 25 | 30 | 6 | 15 | VERSAPAC |
| MZ9310C | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 10 | 7.5 | 25 | 30 | 6 | 15 | SMA |
| MZ9313 | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 7.0 | 25 | 30 | 8 | 17 | VERSAPAC |
| MZ9313C | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 7.0 | 25 | 30 | 8 | 17 | SMA |
| M83 | 1.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 7.5 | 25 | 30 | 6 | 18 | MINPAC |
| M83C | 1.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 7.5 | 25 | 30 | 6 | 18 | SMA |
| MY82 | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 8.0 | 25 | 30 | 6 | 18 | VERSAPAC |
| MY82C | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 13 | 8.0 | 25 | 30 | 6 | 18 | SMA |
| MY83H | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 20 | 8.5 | 21 | 30 | 17 | 25 | VERSAPAC |
| MY83HC | 2.0-18.0 | 2.0-18.0 | 0.03-5.0 | 20 | 8.5 | 21 | 30 | 17 | 25 | SMA |
| M89 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 8.0 | 28 | 32 | 4 | 16 | MINPAC |
| M89C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 8.0 | 28 | 32 | 4 | 16 | SMA |
| MY89 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 8.0 | 28 | 32 | 4 | 16 | VERSAPAC |
| MY89C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 8.0 | 28 | 32 | 4 | 16 | SMA |
| MZ8810 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 7.5 | 25 | 28 | 6 | 14 | VERSAPAC |
| MZ8810C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 10 | 7.5 | 25 | 28 | 6 | 14 | SMA |
| M88 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 8.0 | 28 | 32 | 7 | 20 | MINPAC |
| M88C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 8.0 | 28 | 32 | 7 | 20 | SMA |
| NEW **MU8810** | **2.0-18.0** | **2.0-18.0** | **1.0-8.0** | **10** | **7.5** | **25** | **28** | **5** | **16** | **MSCOMPAT*** |
| MY88 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 8.0 | 28 | 32 | 7 | 20 | VERSAPAC |
| MY88C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 8.0 | 28 | 32 | 7 | 20 | SMA |
| MZ8813 | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 7.0 | 25 | 28 | 8 | 18 | VERSAPAC |
| MZ8813C | 2.0-18.0 | 2.0-18.0 | 1.0-8.0 | 13 | 7.0 | 25 | 28 | 8 | 18 | SMA |
| M88H | 2.0-18.0 | 2.0-18.0 | 2.0-8.0 | 21 | 8.0 | 28 | 32 | 17 | 25 | MINPAC |
| M88HC | 2.0-18.0 | 2.0-18.0 | 2.0-8.0 | 21 | 8.0 | 28 | 32 | 17 | 25 | SMA |
| MY88H | 2.0-18.0 | 2.0-18.0 | 2.0-8.0 | 21 | 8.0 | 28 | 32 | 17 | 25 | VERSAPAC |
| MY88HC | 2.0-18.0 | 2.0-18.0 | 2.0-8.0 | 21 | 8.0 | 28 | 32 | 17 | 25 | SMA |
| M87 | 0.5-19.0 | 0.5-19.0 | 0.03-5.0 | 13 | 8.5 | 25 | 32 | 8 | 17 | MINPAC |
| M87C | 0.5-19.0 | 0.5-19.0 | 0.03-5.0 | 13 | 8.5 | 25 | 32 | 8 | 17 | SMA |
| MY87 | 0.5-19.0 | 0.5-19.0 | 0.03-5.0 | 13 | 8.5 | 25 | 32 | 8 | 17 | VERSAPAC |
| MY87C | 0.5-19.0 | 0.5-19.0 | 0.03-5.0 | 13 | 8.5 | 25 | 32 | 8 | 17 | SMA |
| M52 | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 8.0 | 23 | 25 | 5 | 15 | MINPAC |
| M52C | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 8.0 | 23 | 25 | 5 | 15 | SMA |
| MY52 | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 8.0 | 23 | 25 | 5 | 15 | VERSAPAC |
| MY52C | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 8.0 | 23 | 25 | 5 | 15 | SMA |
| MZ5210 | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 9.0 | 20 | 25 | 5 | 15 | VERSAPAC |
| MZ5210C | 2.0-24.0 | 2.0-24.0 | 0.1-5.0 | 10 | 9.0 | 20 | 25 | 5 | 15 | SMA |
| M53 | 2.0-26.0 | 2.0-26.0 | 0.1-6.0 | 10 | 8.0 | 22 | 25 | 5 | 15 | MINPAC |
| M53C | 2.0-26.0 | 2.0-26.0 | 0.1-6.0 | 10 | 8.0 | 22 | 25 | 5 | 15 | SMA |

* MSCOMPAT = Microstrip compatible

## Typical Specifications (Continued)

| Model | Frequency Range RF | LO | IF | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | Isolation Typ. dB L-R | L-I | $f_R$ Level at 1 dB Compression Point Typ. dBm | Input Intercept Point Typ. dBm | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 to 26.0 | GHz | GHz | GHz | | | | | | | |
| M50A | 2.0-18.0 | 1.5-26.0 | 1.0-12.0 | 10 | 7.5 | 26 | 26 | 5 | 15 | MINPAC |
| M50AC | 2.0-18.0 | 1.5-26.0 | 1.0-12.0 | 10 | 7.5 | 26 | 26 | 5 | 15 | SMA |
| MY50A | 2.0-18.0 | 1.5-26.0 | 1.0-12.0 | 10 | 7.5 | 26 | 26 | 5 | 15 | VERSAPAC |
| MY50AC | 2.0-18.0 | 1.5-26.0 | 1.0-12.0 | 10 | 7.5 | 26 | 26 | 5 | 15 | SMA |
| M51 | 2.0-24.0 | 1.5-24.0 | 1.0-15.0 | 10 | 8.0 | 25 | 26 | 5 | 15 | MINPAC |
| M51C | 2.0-24.0 | 1.5-24.0 | 1.0-15.0 | 10 | 8.0 | 25 | 26 | 5 | 15 | SMA |
| MY51 | 2.0-24.0 | 1.5-24.0 | 1.0-15.0 | 10 | 8.0 | 25 | 26 | 5 | 15 | VERSAPAC |
| MY51C | 2.0-24.0 | 1.5-24.0 | 1.0-15.0 | 10 | 8.0 | 25 | 26 | 5 | 15 | SMA |
| M50 | 2.0-26.0 | 1.5-26.0 | 1.0-15.0 | 10 | 8.0 | 26 | 26 | 5 | 15 | MINPAC |
| M50C | 2.0-26.0 | 1.5-26.0 | 1.0-15.0 | 10 | 8.0 | 26 | 26 | 5 | 15 | SMA |
| MY50 | 2.0-26.0 | 1.5-26.0 | 1.0-15.0 | 10 | 8.0 | 26 | 26 | 5 | 15 | VERSAPAC |
| MY50C | 2.0-26.0 | 1.5-26.0 | 1.0-15.0 | 10 | 8.0 | 26 | 26 | 5 | 15 | SMA |
| MZ5010 | 2.0-26.0 | 2.0-26.0 | 1.0-15.0 | 10 | 9.0 | 35 | 25 | 5 | 16 | VERSAPAC |
| MZ5010C | 2.0-26.0 | 2.0-26.0 | 1.0-15.0 | 10 | 9.0 | 35 | 25 | 5 | 16 | SMA |

# Dual Mixers

## Typical Specifications

| Model | RF/LO Frequency (GHz) | IF Frequency (MHz) | LO Power Nominal (dBm) | Conversion Loss (Noise Figure) Typ. (dB) | Isolation Typ. (dB) L-R | L-I | $f_R$ Level at 1 dB Compresion Point Typ. (dBm) | Input Intercept Point Typ. (dBm) | Channel to-Channel | Conversion Loss Amplitude Match (dB) | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DM85 | 2-18 | DC-1000 | 10 | 6.5 | 30 | 20 | 3 | 9.5 | 35 | 0.5 | MINPAC |
| DM85C | 2-18 | DC-1000 | 10 | 6.5 | 30 | 20 | 3 | 9.5 | 35 | 0.5 | SMA |

# Frequency Doublers

## Typical Specifications

| Model | Input Frequency (GHz) | Input Power Nominal (dBm) | Conversion Loss Typical (dB) | Harmonic Suppression (db) $1 \times f_{in}$ | $3 \times f_{in}$ | Package Type |
|---|---|---|---|---|---|---|
| FD25 | 0.005-2.4 | 10 | 11.5 | 35 | 40 | TO-8 |
| SFD25 | 0.005-2.4 | 10 | 11.5 | 35 | 40 | Surf. Mnt. |
| FD25C | 0,005-2.4 | 10 | 11.5 | 35 | 40 | SMA |
| FD25E | 0.005-2.4 | 10 | 11.5 | 35 | 40 | FLATPAC |
| FD25H | 0,005-2.4 | 23 | 11.5 | 35 | 40 | TO-8 |
| FD25HC | 0.005-2.4 | 23 | 11.5 | 35 | 40 | SMA |
| FD93[1] | 2.0-9.0 | 12 | 11.5 | 25 | 40 | MINPAC |
| FD93C[1] | 2.0-9.0 | 12 | 11.5 | 25 | 40 | SMA |
| FD93H[1] | 2.0-9.0 | 20 | 11.5 | 26 | 40 | MINPAC |
| FD93HC[1] | 2.0-9.0 | 20 | 11.5 | 26 | 40 | SMA |

NOTE: 1. Harmonic Suppression is referenced to the input signal.

# Image Reject Mixers

## Typical Specifications

| | Model | RF Frequency GHz | Conversion Loss (Noise Figure) Typ. dB | IF Frequency MHz | Image Rejection Typ. dB | Sideband Suppression Typ. dB | Carrier Suppression Typ. dB | Isolation Typ. L-R | Isolation Typ. L-I | Package Type |
|---|---|---|---|---|---|---|---|---|---|---|
| | **IMAGE REJECT MIXERS AND IF QUADRATURE MIXERS** | | | | | | | | | |
| NEW | **M38D** | **6.0-18.0** | **6.5** | **10-500[1]** | **25** | **—** | **—** | **35** | **30** | **MINIPAC** |
| NEW | **M38DC** | **6.0-18.0** | **6.5** | **10-500[1]** | **25** | **—** | **—** | **35** | **30** | **SMA** |
| | M600D thru M1800D | 6.0-18.0[2] | 6.0 | 10-500[1] | 25 | — | — | 38 | 28 | MINIPAC |
| | M600DC thru M1800DC | 6.0-18.0[2] | 6.0 | 10-500[1] | 25 | — | — | 38 | 28 | SMA |
| | **SINGLE SIDEBAND UP-CONVERTERS AND IF QUADRATURE UP-CONVERTERS** | | | | | | | | | |
| NEW | **M38U** | **6.0-18.0** | **6.75** | **10-500[1]** | **—** | **25** | **25** | **—** | **—** | **MINIPAC** |
| NEW | **M38UC** | **6.0-18.0** | **6.75** | **10-500[1]** | **—** | **25** | **25** | **—** | **—** | **SMA** |
| | M600U thru M1800U | 6.0-18.0[2] | 6.5 | 10-500[1] | — | 25 | 25 | — | — | MINIPAC |
| | M600UC thru M1800UC | 6.0-18.0[2] | 6.5 | 10-500[1] | — | 25 | 25 | — | — | SMA |

NOTE: 1. IF bandwidth options are 10 to 20 MHz (-15), 20 to 40 MHz (-30), 40 to 80 MHz (-60), 80 to 160 MHz (-120), 1 00 to 200 MHz (-150), and 160 to 320 MHz (-240) and 300 to 500 MHz (-400). Special octave or narrower bandwidth IF options are also available between 4 and 500 MHz.
2. LO frequencies are 10% bandwidth within the 6-18GHz band as specified by the customer.

# Design Specifications
## Environmental Performance

All units are designed and constructed to meet their specifications over -54°C to +100°C* and after exposure to any or all of the tests listed in Table 1 per MIL-STD-202F.

*Unless specified otherwise on the individual technical data sheet.

**Table 1. Environmental Tests per MIL-STD-202F**

| Exposure | Method | Test Condition |
|---|---|---|
| Temperature Cycle | 102A | C |
| Thermal Shock | 107D | B |
| Altitude | 105C | G |
| H.F. Vibration | 204C | D |
| Mechanical Shock | 213B | C |
| Random Vibration (15 minutes per axis) | 214 | IIF |
| Solderability | 208C | |
| Terminal Strength | 211A | C |
| Resistance to Soldering Heat | 210A | B |

Hermetically sealed units meet the requirements of Method 106D of MIL-STD-202F when exposed to humidity.

## Typical MTBF

Watkins-Johnson mixers are recognized worldwide for their quality and reliability. Table 2 presents sample calculated MTBF data that applies to the vast majority of our mixer product line. Please note that these calculations are for unscreened devices and that improved MTBF's can be obtained through optional screening (Hi-Rel) procedures.

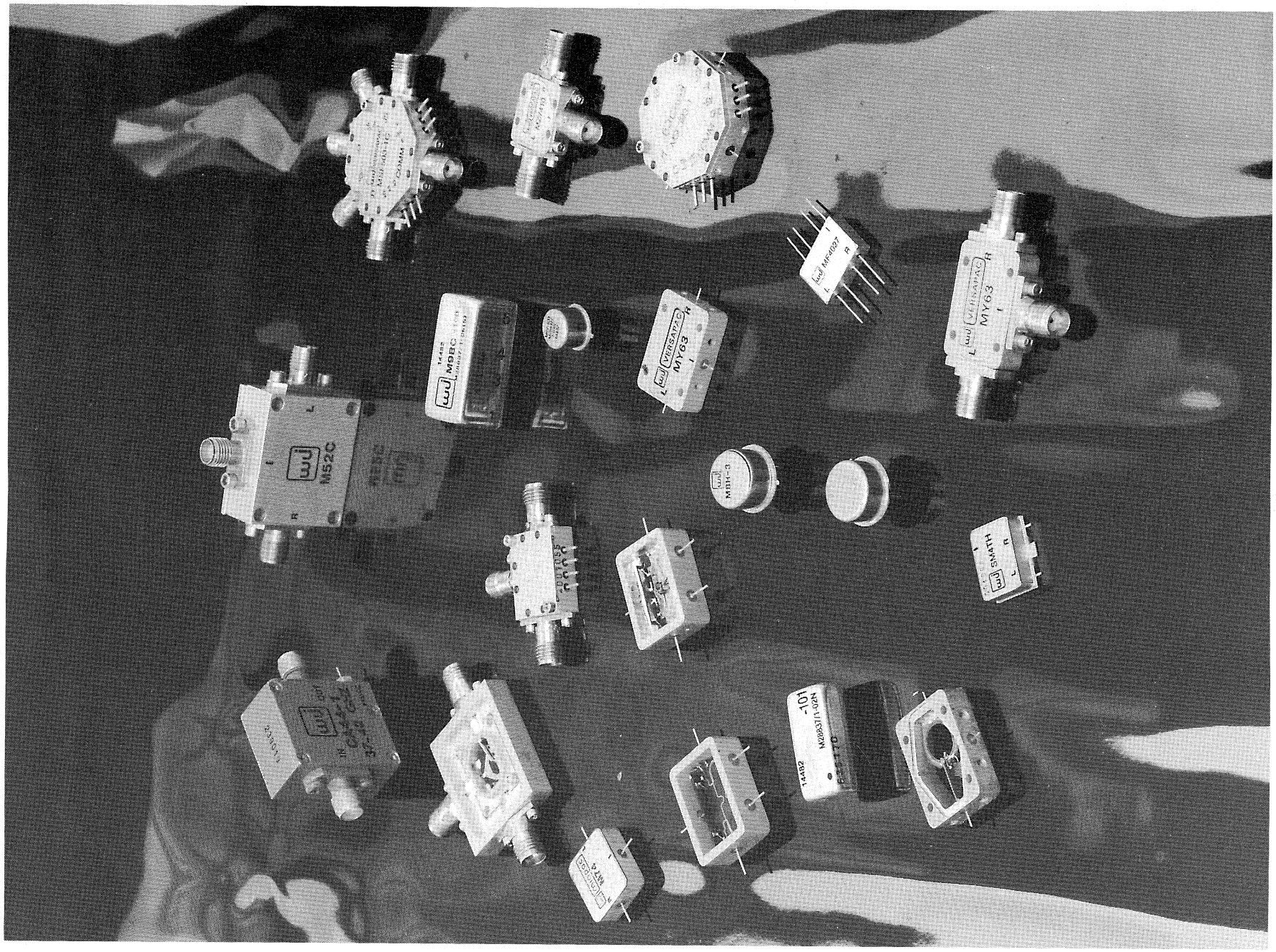
**Table 2. Sample Calculated* MTBF's per MIL-Handbook-217C**

| | Environment | |
|---|---|---|
| Mixer Type | +25°C Ground Fixed (GF) | +85°C Airborne Uninhabited (AUF) |
| Printed circuit mixers (M6D, M2A, etc.) | 3 Million Hours | 350 Thousand Hours |
| MINPAC™ MIC microwave mixers (M62, M88, etc.) | 4 Million Hours | 400 Thousand Hours |
| SMA connector microwave mixers (M14, M88C, etc.) | 1.5 Million Hours | 150 Thousand Hours |

*Calculations based on using group IV diode data.

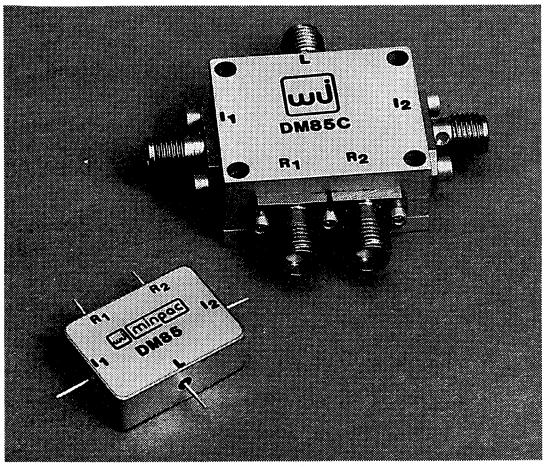
# *RF/Microwave Mixers*





# WJ-DM85/DM85C

## DOUBLE-BALANCED DUAL MIXER




- LO / RF } 2 TO 18 GHz
- IF DC TO 1000 MHz
- LO DRIVE +10 dBm (nominal)
- HIGH CHANNEL-TO-CHANNEL ISOLATION
- AMPLITUDE MATCHED

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

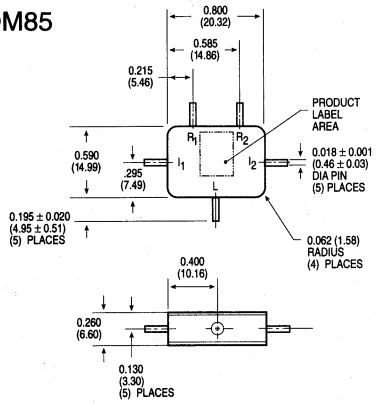
## Guaranteed Specifications

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 9.0 dB | $f_R$ = 2.0 -18 GHz<br>$f_L$ = 2.0-18 GHz<br>$f_I$ = DC -500 MHz |
| | | 7.0 dB | 10.0 dB | $f_R$ = 2.0 -18 GHz<br>$f_L$ = 2.0-18 GHz<br>$f_I$ = DC -1000 MHz |
| Isolation | | | | |
| L to R | 20 dB | 25 dB | | $f_L$ = 2.0-4.0 GHz |
| | 25 dB | 35 dB | | $f_L$ = 4.0-18.0 GHz |
| L to I | 8 dB | 10 dB | | $f_L$ = 2.0-3.5 GHz |
| | 15 dB | 20 dB | | $f_L$ = 3.5 - 9.0 GHz |
| | 20 dB | 25 dB | | $f_L$ = 9.0 -18 GHz |
| Channel-to-Channel | 25 dB | 30 dB | | $f_R$ = 2-3.5 GHz |
| | 30 dB | 42 dB | | $f_R$ = 3.5-18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +3 dBm |
| Third-Order Input Intercept Point | | +13 dBm | | $f_{R1}$ = 4.0 GHz<br>$f_{R2}$ = 4.01 GHz<br>both at -10 dBm<br>$f_L$ = 4.5 GHz<br>+10 dBm |
| Conversion Loss Amplitude Match | | 0.5 dB | 1.5 dB | $f_R$ = 2-18 GHz<br>$f_L$ = 2-18 GHz<br>$f_I$ = DC -1000 MHz |

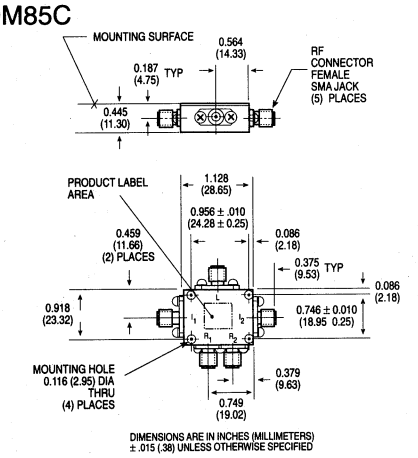
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified. The I-Port frequency range extends to DC for phase detection pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF. Typical values are measured at 25°C and are not guaranteed. They are based on the average value measured at the specified condition.

## Outline Drawings

DM85




DM85C



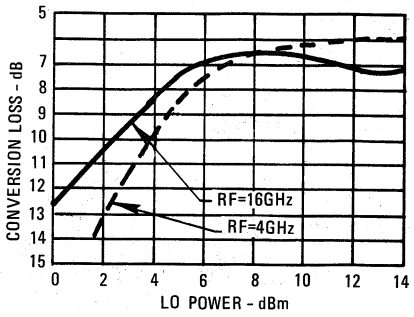

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C

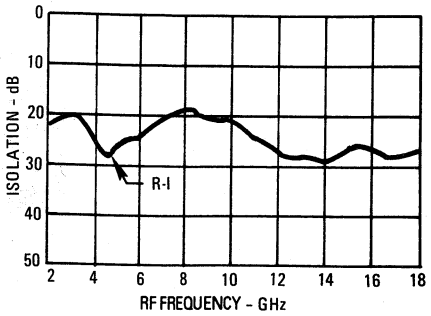
Weight DM85: 10.2 grams (0.36 oz.) max.
DM85C: 47.1 grams (0.166 oz.) max.

# Typical Performance at 25°C

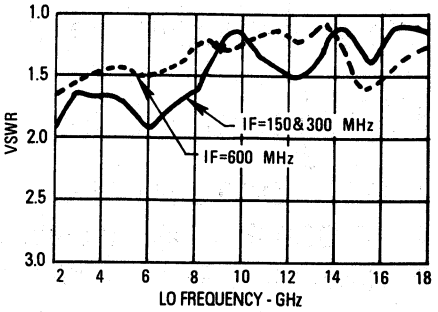
### Conversion Loss vs. LO Power



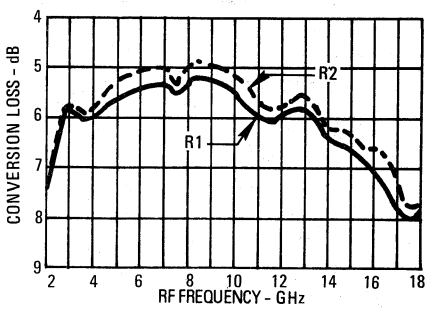

### Isolation vs. Frequency



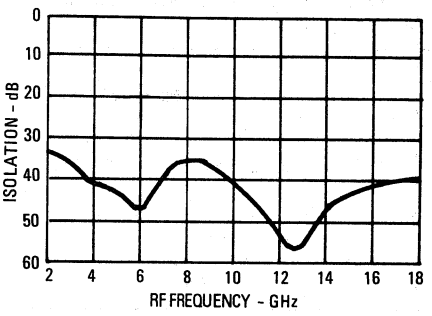

### I Port VSWR vs. LO Frequency



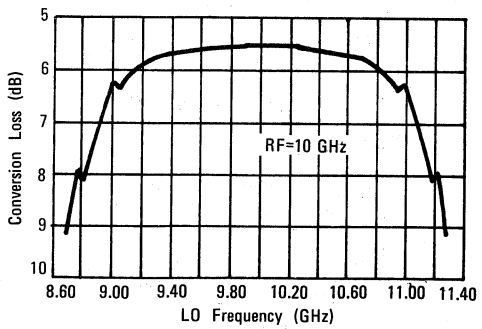

### Conversion Loss vs. Frequency



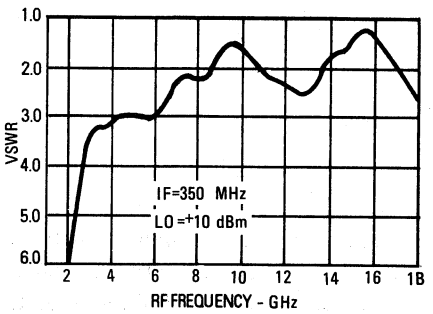

### Isolation vs. Frequency Cross Channel



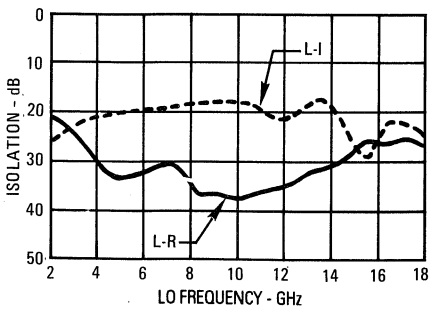

### IF Frequency Response



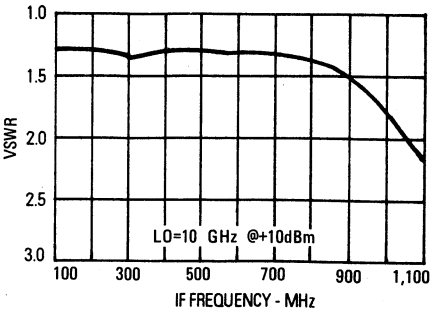

### R Port VSWR vs. Frequency




### Isolation vs. Frequency




### I Port VSWR vs. IF Frequency

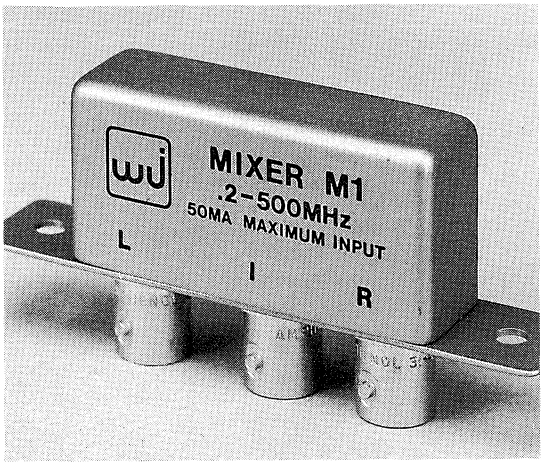



10

# WJ - M1

## DOUBLE-BALANCED MIXER

- LO, RF } 0.2 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 50 dB (TYP.)



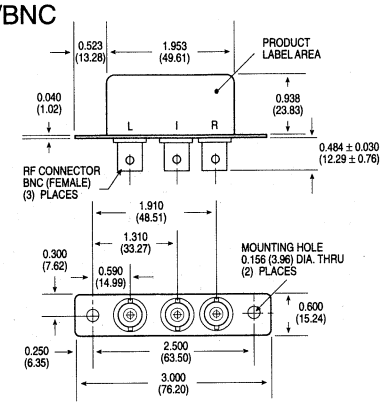

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB<br>7.0 dB | 6.5 dB<br>8.5 dB | $f_L$, $f_R$ & $f_I$ 1 MHz to 50 MHz<br>$f_L$, $f_R$ & $f_I$ 0.2 MHz to 500 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I<br><br>$f_L$ at R<br>$f_L$ at I | <br>45 dB<br>40 dB<br><br>35 dB<br>25 dB | <br>50 dB<br>45 dB<br><br>40 dB<br>30 dB | | <br>$f_L$, $f_R$ & $f_I$ 0.2 MHz to 50 MHz<br><br>$f_L$, $f_R$ & $f_I$ 50 MHz to 500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +1 dBm |
| Desensitization | | 1.0 dB | | $f_{R2}$ = +1 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

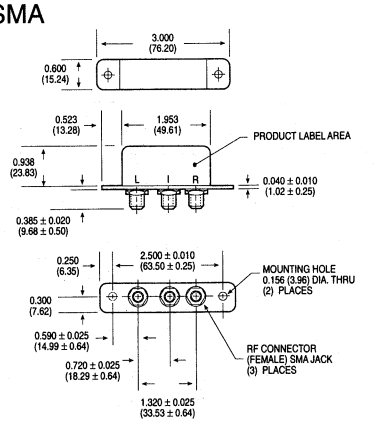
## Outline Drawings

M1/BNC




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±0.015 (0.38) UNLESS OTHERWISE SPECIFIED

M1/SMA




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Absolute Maximum Ratings

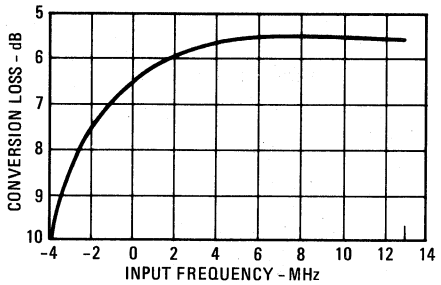
Operating Temperature
- 0.2 to 0.4 MHz .....-20°C to +100°C
- 0.4 to 500 MHz .....-54°C to +100°C

Storage Temperature .....-65°C to +100°C
Peak RF Input Power.....+17 dBm
Peak Input Current at 25°C .....50 mA DC

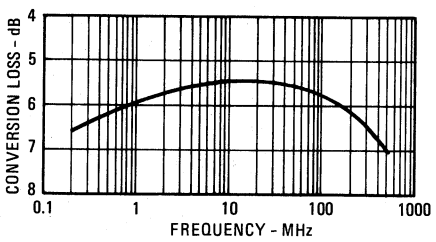
Weight 45 grams (1.6 oz. ) max.
Connectors BNC or SMA

## Typical Performance at 25°C

### Conversion Loss

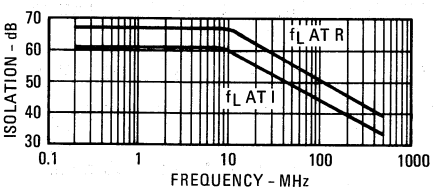



*Conversion Loss vs. Drive Level:* Conversion loss in an SSB system as a function of drive level ($f_L$ level), with $f_L$ and $f_R$ at approximately 50 MHz and $f_R$ level at -20 dBm.



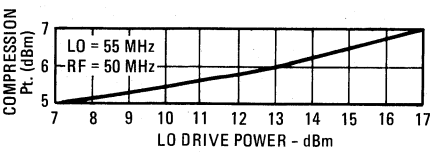

Conversion loss of the mixer when used in SSB system. The frequency ordinate refers to the inputs $f_L$ and $f_R$ with $f_I$ any frequency less than 500 MHz for conversion loss measurements.

### Isolation

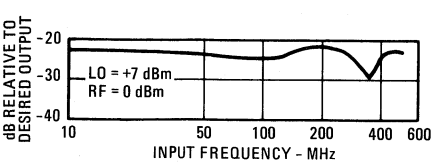



Level of the $f_L$ signal at the R-port and I-port with respect to the available power of +7 dBm from a 50-ohm source used for $f_L$.

### 1 dB Compression Point vs. LO



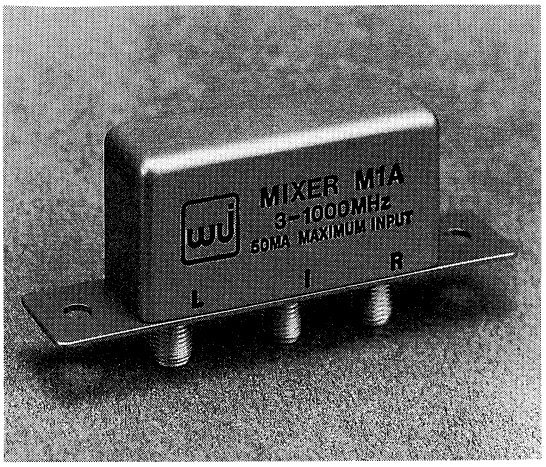

### Two-Tone Suppression vs. Frequency



# WJ-M1A

## DOUBLE-BALANCED MIXER

- LO, RF } 3 TO 1000 MHz
- IF DC TO 1000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 50 dB (TYP.)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.5 dB | $f_L$, $f_R$ & $f_I$ 10 to 100 MHz |
| | | 8.0 dB | 10.0 dB | $f_L$, $f_R$ & $f_I$ 3 to 1000 MHz |
| Mixer Isolation | | | | |
| $f_L$ at R | 40 dB | 50 dB | | $f_L$, $f_R$ & $f_I$ 3 to 100 MHz |
| $f_L$ at I | 40 dB | 50 dB | | |
| $f_L$ at R | 30 dB | 40 dB | | $f_L$, $f_R$ & $f_I$ 100 to 1000 MHz |
| $f_L$ at I | 20 dB | 30 dB | | |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

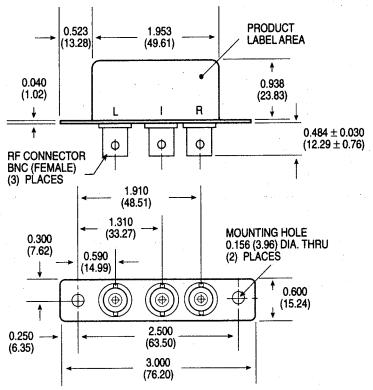
## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak RF Input Power ..... +17 dBm
Peak Input Current at 25°C ..... 50 mA DC

Weight 45 grams (1.6 oz.) max.
Connector BNC or SMA

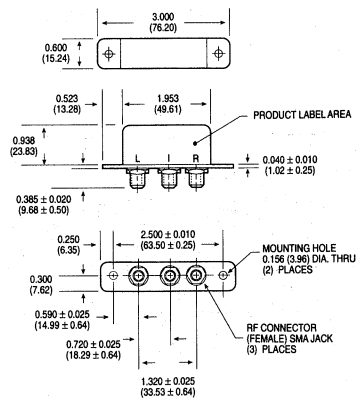
## Outline Drawings

M1A/BNC




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±0.015 (0.38) UNLESS OTHERWISE SPECIFIED

M1A/SMA

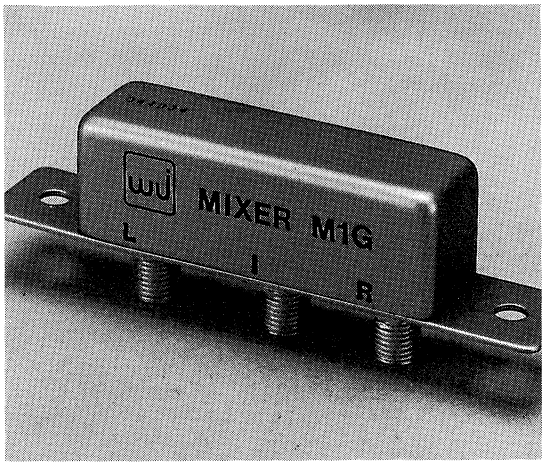



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-M1G

## DOUBLE-BALANCED MIXER

- LO / RF } 1.0 TO 4.2 GHz
- IF DC TO 1 GHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)



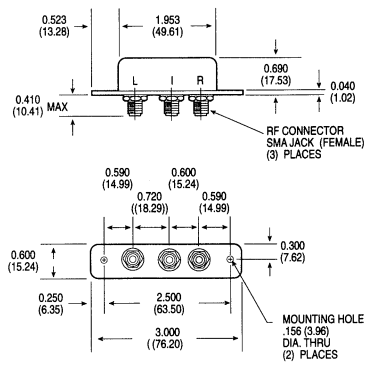

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB<br><br>7.5 dB | 8.5 dB<br><br>9.0 dB | $f_L$ & $f_R$ 1.5 to 4.2 GHz, $f_I$ 0.01 to 1 GHz<br><br>$f_L$ & $f_R$ 1.0 to 1.5 GHz, $f_I$ 10 to 500 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>30 dB<br>20 dB | <br>40 dB<br>30 dB | | <br>$f_L$ 1.0 to 4.2 GHz |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings

M1G



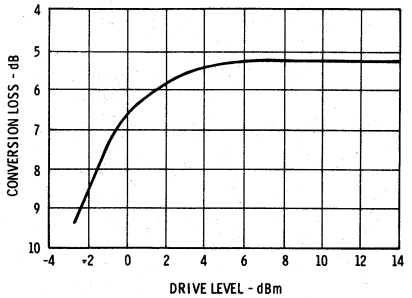

## Absolute Maximum Ratings

Storage Temperature .....-65°C to +100°C
Operating Temperature .....-54°C to +100°C
Peak RF Input Power.....+17 dBm
Peak Input Current at 25°C.....50 mA DC

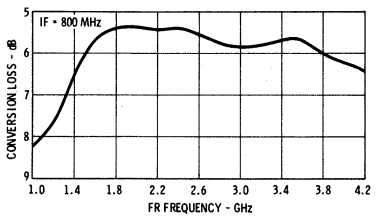
Weight 31 grams (1.1 oz.) max.

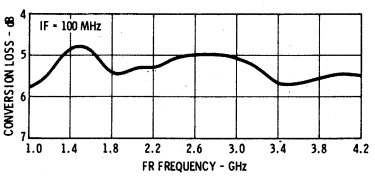
# Typical Performance at 25°C

### Conversion Loss



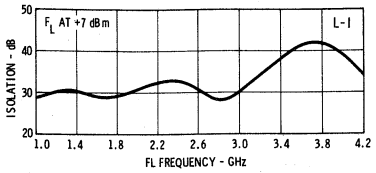

*Conversion Loss vs. LO Drive Level:* The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.

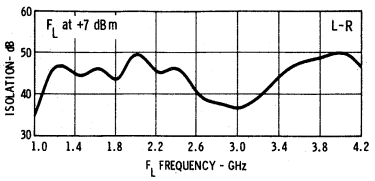



*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 100 MHz and 800 MHz. Data plotted with an $f_L$ level of +7 dBm.

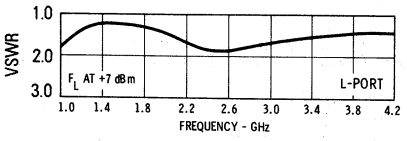
### Isolation

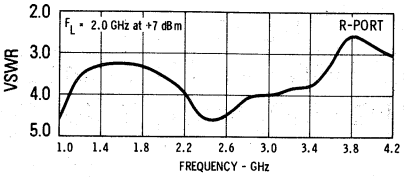


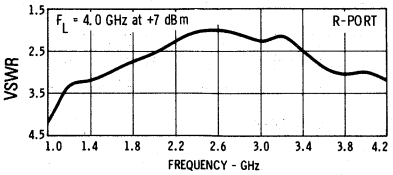



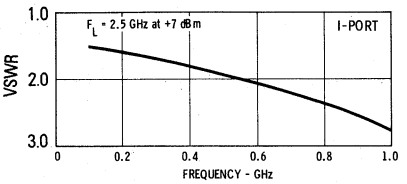

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




*VSWR vs. Frequency:* VSWR of the I- and R-ports in a 50-ohm system. Some variation in the R-port VSWR will occur as a function of the L-port frequency as shown above. Curves for R-port VSWR are plotted for L-port frequencies of 2 GHz and 4 GHz. For the best R-port VSWR, the $f_L$ frequency should be greater than the input frequency at the R-port. A plot of I-port VSWR is also shown with $f_R$ at 2 GHz and $f_L$ greater than $f_R$.

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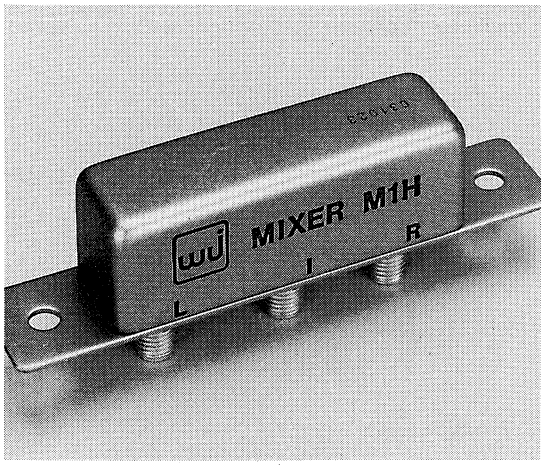
# WJ - M1H

## DOUBLE-BALANCED MIXER

- LO, RF } 1.8 TO 6.2 GHz
- IF DC TO 2 GHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 35 dB (TYP.)



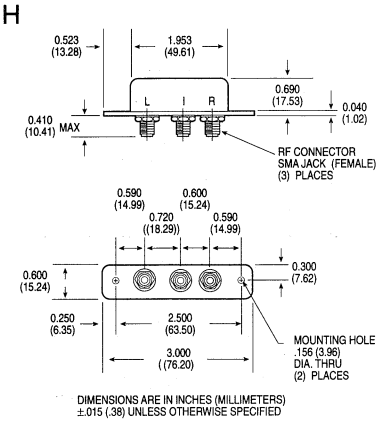

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| Conversion Loss and Noise Fixture | | 7.0 dB | 8.5 dB | $f_L$ & $f_R$ 1.8 to 4.2 GHz<br>$f_I$ 0.01 to 1 GHz |
| | | 8.5 dB | 9.5 dB | $f_L$ & $f_R$ 1.8 to 4.2 GHz<br>$f_I$ 0.01 to 2 GHz |
| | | 9.0 dB | 10.0 dB | $f_L$ & $f_R$ 1.8 to 6.2 GHz<br>$f_I$ 0.01 to 2 GHz |
| Isolation | | | | |
| $f_L$ at R | 25 dB | 40 dB | | $f_L$ 1.8 to 4.2 GHz |
| $f_L$ at I | 15 dB | 25 dB | | |
| $f_L$ at R | 18 dB | 25 dB | | $f_L$ 4.2 to 6.2 GHz |
| $f_L$ at I | 15 dB | 20 dB | | |
| Conversion Compression | | 1.0 dB | | $f_R$ = 0 dBm<br>$f_L$ at +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings

M1H



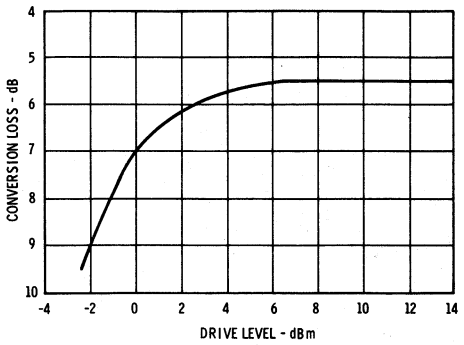

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak RF Input Power.....+17 dBm
Peak Input Current at 25°C .....50 MA DC

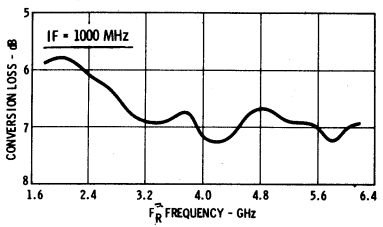
Weight 31 grams (1.1 oz.) max.

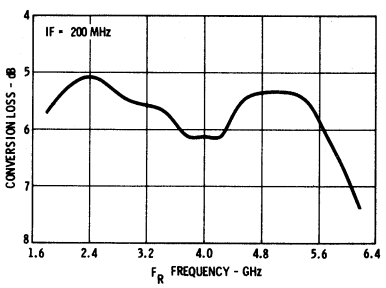
# Typical Performance at 25°C

### Conversion Loss



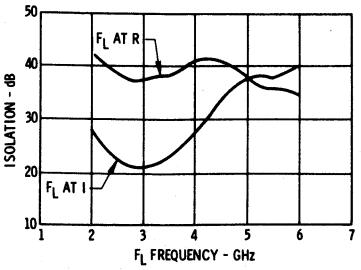

*Conversion Loss vs. Drive Level:* Conversion loss in an SSB system is a function of drive level ($f_L$ with $f_L$ and $f_R$ at approximately 3 GHz and $f_R$ level at -6 dBm.



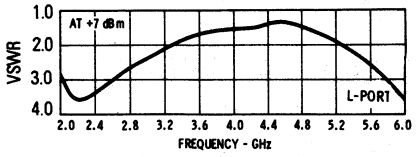

*Conversion Loss vs. Input Frequency:* The frequency ordinate refers to the report ($f_R$) with $f_I$ at 200 MHz and 1000 MHz, data plotted with $f_L$ at +7 dBm.

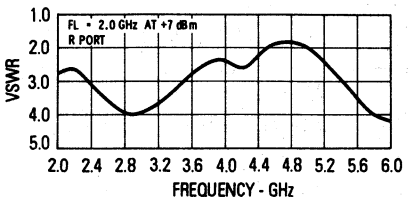
### Isolation

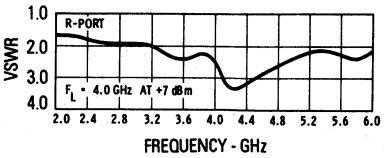


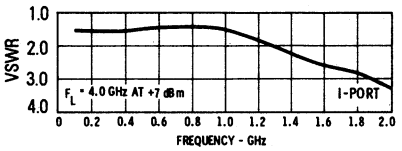

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




*VSWR vs. Frequency:* VSWR of the L- I- and R-ports in a 50-ohm system. Some variation in the R-port VSWR will occur as a function of the L-port frequency as shown above. Curves for R-port VSWR are plotted for L-port frequencies of 2 GHz and 4 GHz. A plot of I-port VSWR is also shown with $f_L$ at 4 GHz.

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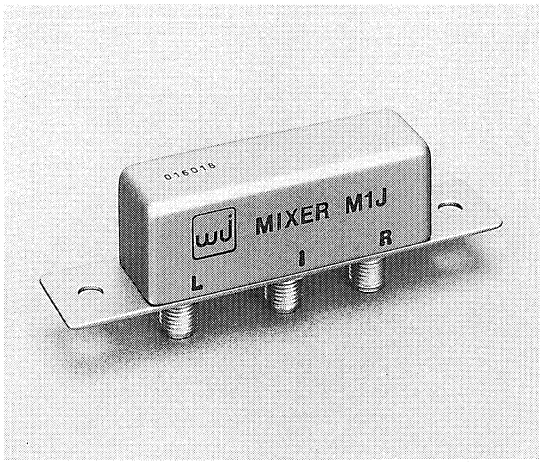
# WJ-M1J

## DOUBLE-BALANCED MIXER

- LO / RF } 300 TO 2000 MHz
- IF DC TO 1000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 50 dB (TYP.)



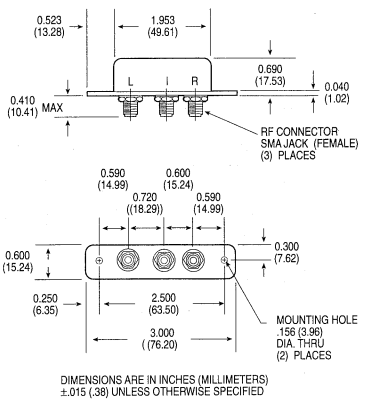

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Condition |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.5 dB | $f_L$ & $f_R$ = 1000 to 1700 MHz, $f_I$ = 10 to 500 MHz |
| | | 6.5 dB | 8.0 dB | $f_I$ = 500 to 1000 MHz |
| | | | | $f_L$ & $f_R$ = 600 to 2000 MHz |
| | | 8.0 dB | 9.0 dB | $f_I$ = 10 to 1000 MHz |
| | | | | $f_L$ & $f_R$ = 300 to 2000 MHz |
| | | 8.0 dB | 9.0 dB | $f_I$ = 10 to 450 MH |
| | | 9.5 dB | 10.0 dB | $f_I$ = 450 to 1000 MHz |
| Isolation | | | | |
| L to R | 40 dB | 45 dB | | $f_L$ 300 to 1000 MHz |
| L to I | 25 dB | 35 dB | | |
| L to R | 30 dB | 40 dB | | $f_L$ 1000 to 2000 MHz |
| L to I | 20 dB | 30 dB | | |
| Conversion Compression | | 1.0 dB | | $f_R$ level = 0 dBm |
| Desensitization | | 1.0 dB | | $f_{R_2}$ level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings

M1J



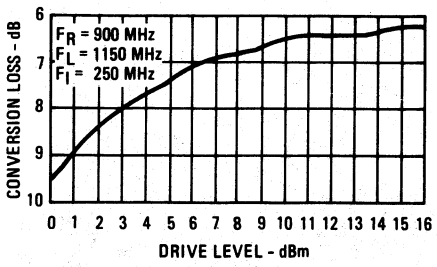

## Absolute Maximum Ratings

Storage Temperature .....-65°C to +100°C
Operating Temperature .....-54°C to +100°C
Peak RF Input Power ..... +26 dBm at +25°C, derate to +17 dBm at +100°C
Peak Input Current at 25°C .....50 mA DC

Weight 31 grams (1.1 oz.) max.

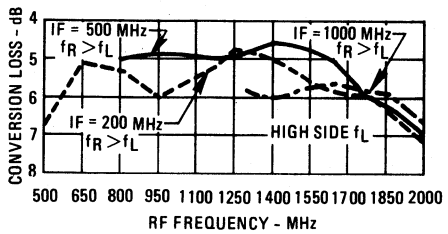
# Typical Performance at 25°C

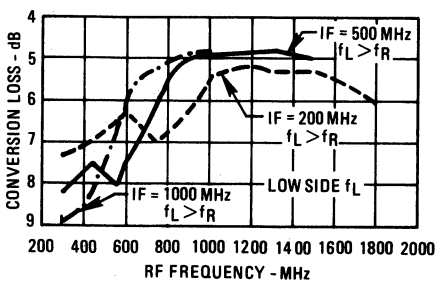
### Conversion Loss



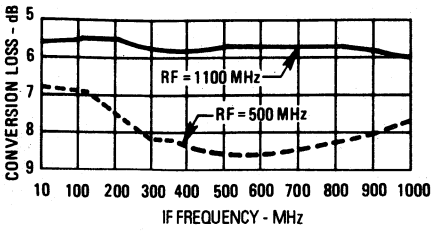

***Conversion Loss vs. LO Drive Level:*** The minimum recommended drive level is +5 dBm. A lower drive level will degrade the conversion loss and noise figure over the full temperature and frequency range. Operation at +5 dBm is recommended to reduce the level of the intermodulation products in the last two rows of the intermodulation chart. It will also minimize the output noise below 2 kHz.

The maximum recommended drive level is +13 dBm. A higher drive level will significantly increase the noise figure and also degrade isolation. Operation at +13 dBm is recommended to achieve best two-tone performance and suppression of the intermodulation products in the rows above the second row in the intermodulation chart.



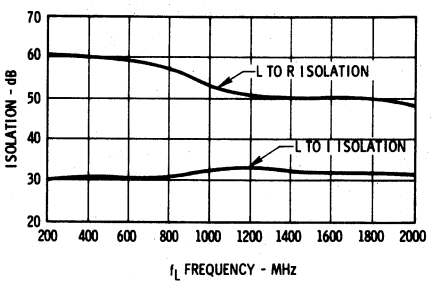




***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 200, 500, and 1000 MHz. Data plotted with an $f_L$ level of +7 dBm.



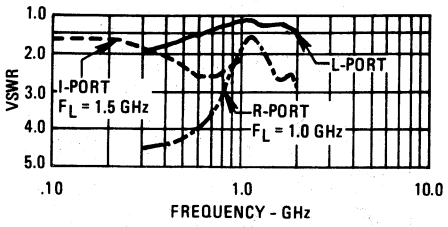

***Conversion Loss vs. $f_I$ Frequency:*** Conversion loss of the mixer when used in a SSB system. The frequency ordinate refers to the I-port when $f_I$ is swept from 510 to 1500 MHz with $f_R$ at 500 MHz and $f_L$ swept from 1110 to 2100 MHz with $f_R$ at 1100 MHz.

### Isolation




***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




***VSWR vs. Frequency:*** VSWR of the L-, I-, and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Some variation in the R-port VSWR will occur as a function of the L-port frequency.

### Harmonic Intermodulation

| | 0 | $f_L$ | $2f_L$ | $3f_L$ | $4f_L$ | $5f_L$ |
|---|---|---|---|---|---|---|
| $5f_R$ | >71 | >71 | >71 | >71 | >71 | >71 |
| | >71 | >71 | >71 | >71 | >71 | >71 |
| $4f_R$ | >71 | >71 | >71 | >71 | >71 | >71 |
| | >71 | >71 | >71 | >71 | >71 | >71 |
| $3f_R$ | >71 | 53 | 68 | 56 | 71 | 51 |
| | >71 | 63 | 67 | 61 | >71 | 69 |
| $2f_R$ | 61 | 50 | 65 | 50 | 67 | 66 |
| | 63 | 55 | 64 | 64 | 70 | 66 |
| $f_R$ | 28 | 0 | 40 | 12 | 41 | 26 |
| | 29 | 0 | 41 | 10 | 42 | 19 |
| | — | 7 | 43 | 29 | 54 | 30 |
| | — | 3 | 36 | 27 | 54 | 29 |

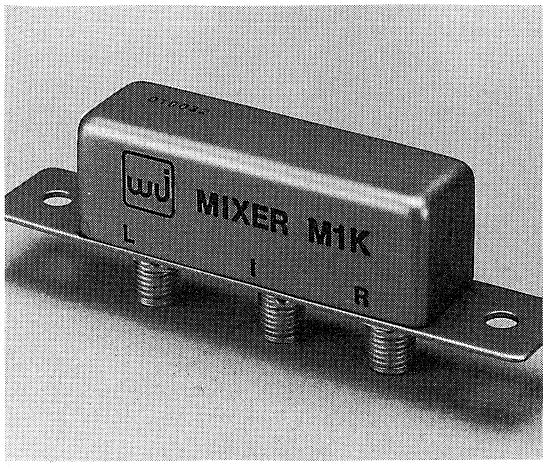
***Harmonic Intermodulation Products:*** Intermodulation signals which result from the mixing of mixer generated harmonics of the input signals are shown above. Mixing product suppression is indicated by the number of dB below the desired output level, $f_R - f_L$. Products are for the difference frequency $nf_L - mf_R$ and $mf_R - nf_L$. The performance was measured with $f_R$ at 300 MHz, –10 dBm, and $f_L$ = 299 MHz, +7 dBm for light area, +13 dBm for shaded area.

10

# WJ-M1K

## DOUBLE-BALANCED MIXER

- LO, RF } 1.0 TO 4.0 GHz
- IF DC TO 1000 MHz
- LO DRIVE +20 dBm (nominal)
- HIGH INTERCEPT POINT: +28 dBm (TYP.)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | | 9.0 dB | $f_L$ 1.2 to 4.0 GHz<br>$f_R$ 1.2 to 3.5 GHz<br>fI 10 to 500 MHz |
| | | | 11.0 dB | $f_L$ & $f_R$ 1.0 to 4.0 GHz<br>fI 10 to 1000 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>20 dB<br>10 dB<br>15 dB | <br>31 dB<br>19 dB<br>25 dB | | <br>$f_L$ 1.0 to 4.0 GHz<br>$f_L$ 1.0 to 2.0 GHz<br>$f_L$ 2.0 to 4.0 GHz |
| Conversion Compression | | 1.0 dB | | $f_L$ = +20 dBm<br>$f_R$ = +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

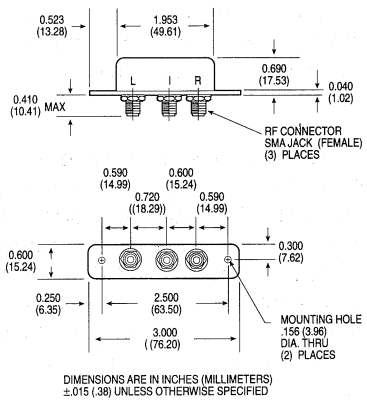
## Absolute Maximum Ratings

Storage Temperature ..... -65°C to +100°C
Operating Temperature
Without Specification Degradation ..... -54°C to +85°C
With 0.5 dB Noise Figure Degradation ..... -54°C to +100°C
Peak RF Input Power ..... +26 dBm, at +25°C

Weight 33 grams (1.164 oz.) max.

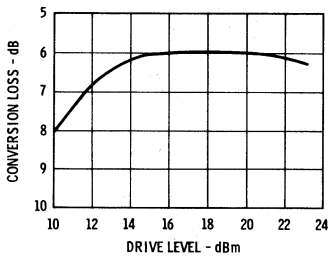
## Outline Drawings

M1K

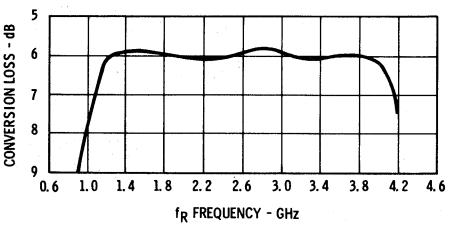


## Typical Performance at 25°C

### Conversion Loss

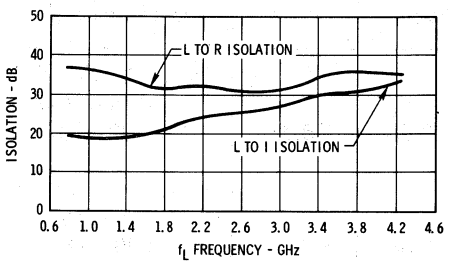



*Conversion Loss vs. LO Drive Power:* The minimum recommended drive level is +14 dBm. The maximum recommended drive level is +23 dBm.



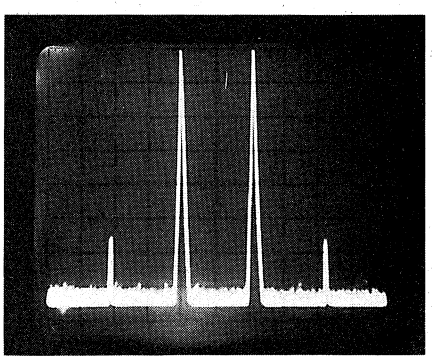

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 500 MHz and $f_L$ greater than $f_R$. Data plotted with an $f_L$ level of +20 dBm.

### Isolation




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

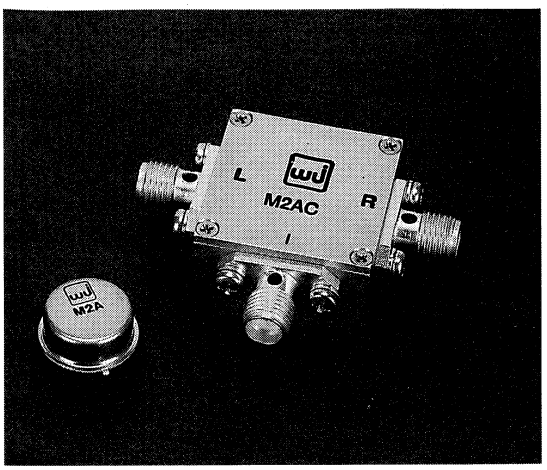
### Two-Tone Intermodulation



*Typical Two-Tone Intermodulation Performance:* $f_I$ = 500 MHz, $f_R$ = 2.5 GHz ± 1 MHz, $f_L > f_R$, $f_L$ = 3.0 GHz at +20 dBm, $f_R$ at -10 dBm vertical scale 10 dB/cm.

# WJ - M2A/M2AC

## DOUBLE-BALANCED MIXER




- LO, RF } 10 TO 1500 MHz
- IF DC TO 800 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 35 DdB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 7.5 dB | $f_R$ 20 to 600 MHz<br>$f_L$ 10 to 800 MHz<br>$f_I$ 1 to 200 MHz |
| | | 7.5 dB<br>8.0 dB | 8.5 dB<br>9.0 dB | $f_R$ 10 to 1500 MHz<br>$f_L$ 10 to 1500 MHz<br>$f_I$ 1 to 200 MHz<br>$f_I$ 1 to 800 MHz |
| Isolation | | | | |
| $f_L$ at R | 35 dB | 45 dB | | |
| $f_L$ at I | 30 dB | 40 dB | | $f_L$ 10 to 500 MHz |
| $f_L$ at R | 28 dB | 40 dB | | |
| $f_L$ at I | 20 dB | 30 dB | | $f_L$ 500 to 1200 MHz |
| $f_L$ at R | 25 dB | 35 dB | | |
| $f_L$ at I | 18 dB | 25 dB | | $f_L$ 1200 to 1500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R2}$ Level = -2 dBm |
| Third Order Intercept Point | | +12 dBm | | $f_L$ = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M2AC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

## Absolute Maximum Ratings

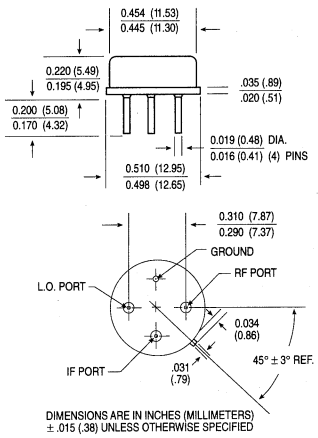
Operating Temperature
- 10 to 20 MHz .....-20°C to +100°C
- 20 to 1500 MHz .....-54°C to +100°C

Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm at +25°C, derate to +17 dBm at +100°C
Peak Input Current at 25°C .....50 mA DC

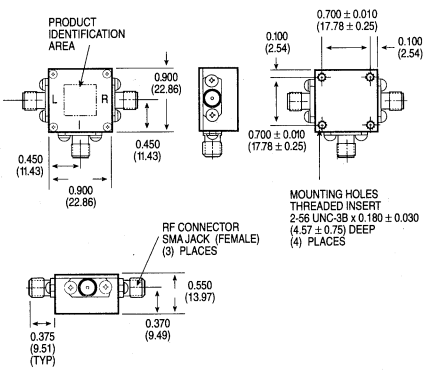
Weight M2A: 2 grams (0.07 oz.) max.
M2AC: 22 grams (0.78 oz.) max.

## Outline Drawings

M2A



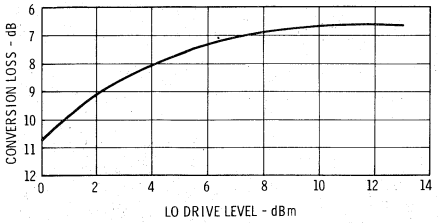

M2AC




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

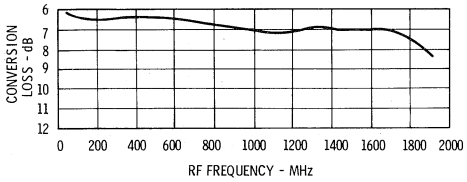
# Typical Performance at 25°C

### Conversion Loss



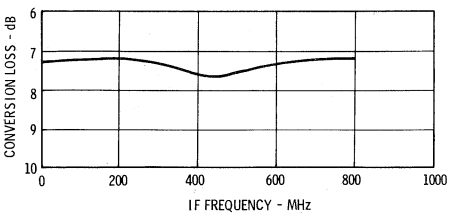

$F_R$ = 1000 MHz
$F_L$ = 1020 MHz
$F_I$ = 20 MHz

***Conversion Loss vs. LO Drive Level:*** The minimum recommended drive level is +5 dBm. The maximum recommended drive level is +13 dBm.



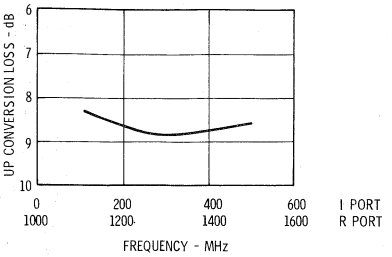

$F_{IF} = F_{LO} - F_{RF}$ = 20 MHz
$P_{LO}$ = +7 dBm
$P_{RF}$ = -10 dBm

***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ of 20 MHz. Data plotted with an $f_L$ level of +7 dBm.




***Conversion Loss vs. $f_I$ Frequency:*** Conversion loss of the mixer when used in a SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_R$ at 1000 MHz and $f_L$ swept from 1000 to 1800 MHz.

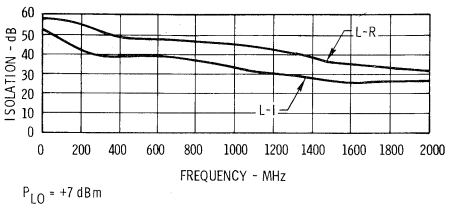
### Conversion Loss




$F_{LO}$ = 1000 MHz AT +7 dBm
$P_{IF}$ = -10 dBm

***Conversion Loss in Up Conversion Mode:*** The frequency coordinate refers to the frequencies fed into the I-port at -10 dBm. The LO frequency is 1000 MHz at +7 dBm input level. The output signal is at R-port.

### Isolation




$P_{LO}$ = +7 dBm

***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### Harmonic Intermodulation

**M2A MIXER HARMONIC INTERMODULATION**

| Harmonics of $f_{RF}$ | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 5 | | | >64 | >64 | >64 | >64 |
| 4 | | >64 | >64 | >64 | >64 | >64 |
| 3 | 55 | 56 | 54 | 60 | 60 | 54 |
| 2 | 61 | 47 | 64 | 48 | >64 | |
| 1 | 18 | 0 | 30 | 17 | 43 | |
| 0 | | 16 | 33 | 18 | | |

**Harmonics of $f_{LO}$**

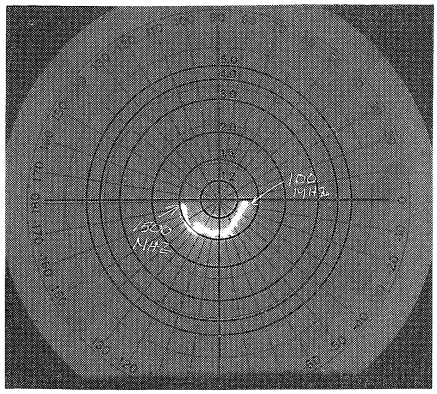
**$F_{RF}$ AND $F_{LO}$ AT 500 AND 520 MHz, RESPECTIVELY.**

**M2A HARMONICS OF $F_R$**

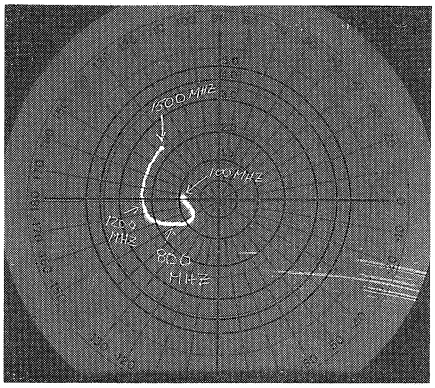
| | $F_R$ | dB SUPPRESSION |
|---|---|---|
| 5 | 1500 | 49 |
| 4 | 1200 | 36 |
| 3 | 900 | 24 |
| 2 | 600 | 21 |
| 1 | 300 | 0 |

TEST CONDITIONS:
LO SIGNAL IS 1000 MHz AT +7 dBm
IF SIGNAL IS 300 MHz AT −10 dBm
300 MHz SIGNAL FROM R PORT IS SET AS REFERENCE AND ITS HARMONICS DATA TAKEN.

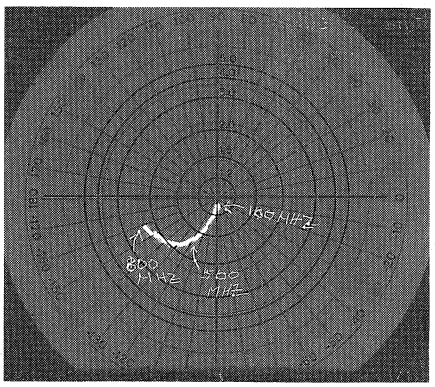
### VSWR



**M2A L-Port VSWR (0.1-1.5 GHz)**



**M2A R-Port VSWR (0.1-1.5 GHz)**



**M2A I-Port VSWR (0.1-0.8 GHz)**

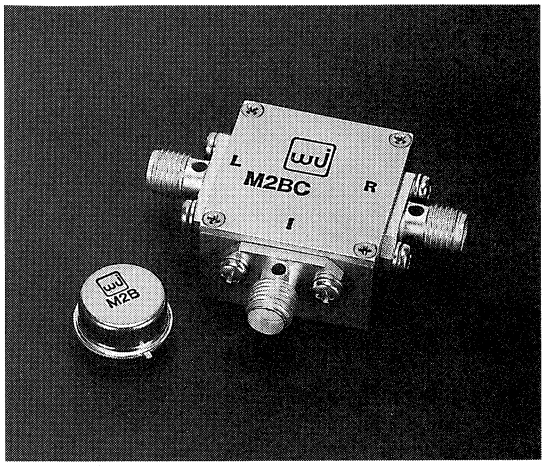
***Reflection Coefficient vs. Frequency:*** Reflection coefficient of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. R- and I-port reflection coefficient is plotted for $f_L$ at 1.0 GHz.

# WJ - M2B/M2BC

## DOUBLE-BALANCED MIXER

- LO, RF } 10 TO 1600 MHz
- IF DC TO 800 MHz
- LO DRIVE +13 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)



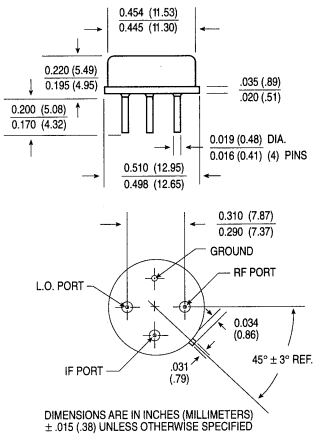

## Guaranteed Specifications [1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 8.0 dB | $f_R$ 20 to 600 MHz<br>$f_L$ 10 to 800 MHz<br>$f_I$ 0.4 to 200 MHz |
| | | 8.0 dB | 9.0 dB | $f_R$ 10 to 1600 MHz<br>$f_L$ 10 to 1600 MHz<br>$f_I$ 0.4 to 800 MHz |
| Isolation | | | | |
| $f_L$ at R | 40 dB | 50 dB | | |
| $f_L$ at I | 30 dB | 40 dB | | $f_L$ 10 to 700 MHz |
| $f_L$ at R | 30 dB | 45 dB | | |
| $f_L$ at I | 20 dB | 30 dB | | $f_L$ 700 to 1200 MHz |
| $f_L$ at R | 25 dB | 35 dB | | |
| $f_L$ at I | 18 dB | 25 dB | | $f_L$ 1200 to 1600 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ = +5 dBm |
| Third Order Intercept Point | | +22 dBm | | $f_L$ = +13 dBm |

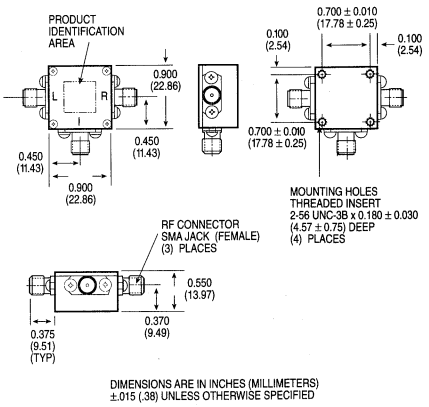
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M2BC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

## Outline Drawings

M2B




M2BC



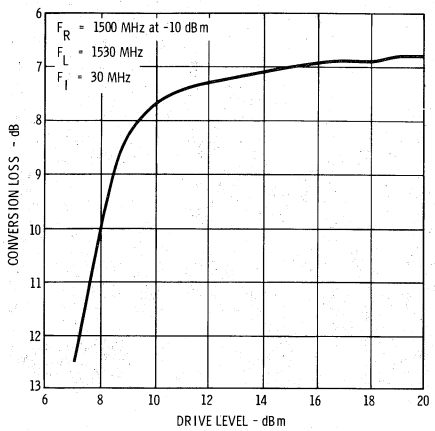

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm at +25°C, derate to +17 dBm +100°C
Peak Input Current at 25°C .....50 mA DC

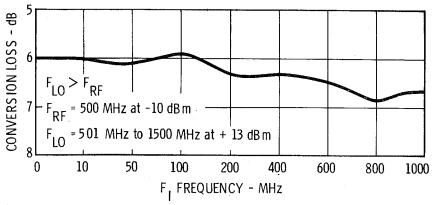
Weight M2B: 2 grams (0.07 oz.) max.
M2BC: 22 grams (0.78 oz.) max.

# Typical Performance at 25°C

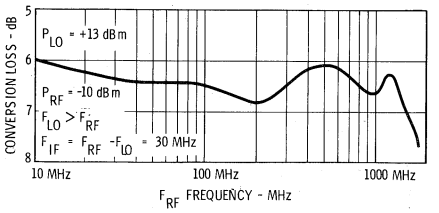
### Conversion Loss




*Conversion Loss vs. LO Drive Level:* The minimum recommended drive level is +11 dBm. The maximum recommended drive level is +17 dBm.

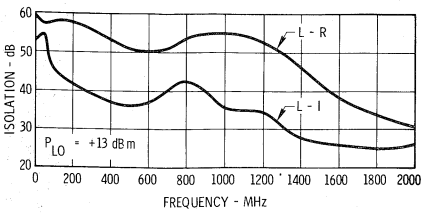



*Conversion Loss vs. $f_I$ Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_R$ at 500 MHz and $f_L$ from 501 to 1500 MHz.



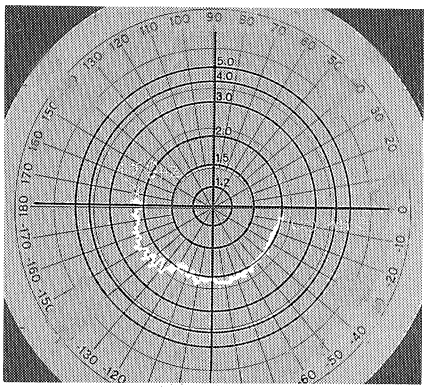

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 30 MHz. Data plotted with $f_L$ level of +13 dBm.

### Isolation

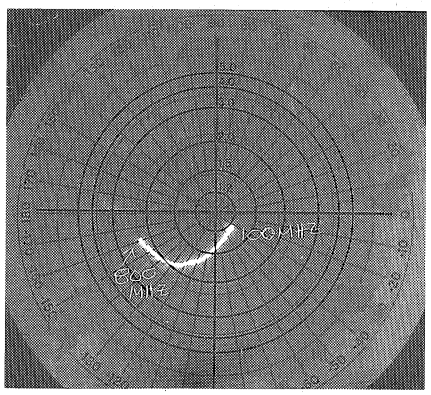



*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR

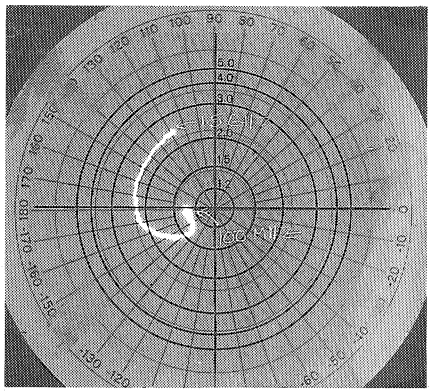


**L-Port (0.1-1.5 GHz)**



**I-Port (0.1-0.8 GHz)**

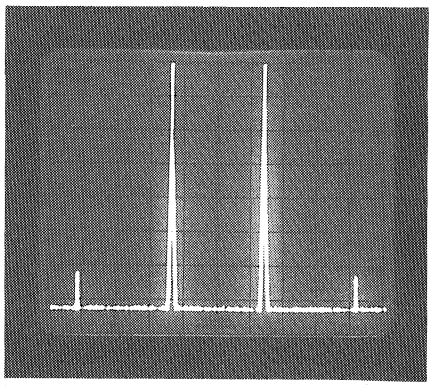
### VSWR



**R-Port (0.1-1.5 GHz)**

*Reflection Coefficient vs. Frequency:* Reflection coefficient of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +13 dBm. R- and I-port reflection coefficient is plotted for $f_L$ at 1.0 GHz.

### Two-Tone Intermodulation Performance



$f_{RF1}$ = 500 MHz $f_{RF2}$ = 505 MHz
$P_{RF1} = P_{RF2}$ = -5 dBm
$f_{LO}$ = 1150 MHz $P_{LO}$ = +13 dBm
$f_I$ = 641 MHz @ 10 dB/div.

*Two-Tone Intermodulation Performance:* The photo displays typical relative suppression of 3rd order two-tone measurement, with $P_{FR1}$ equal to $P_{FR2}$ at -5 dBm.

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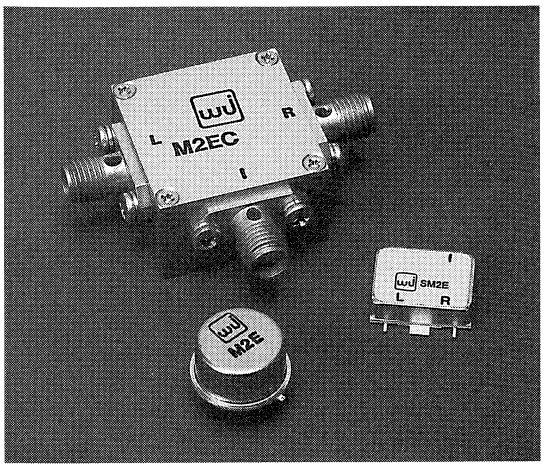
# WJ - M2E/M2EC/SM2E

## DOUBLE-BALANCED MIXER

- LO, RF } 10 TO 1000 MHz
- IF DC TO 600 MHz
- LO DRIVE +20 dBm (nominal)
- HIGH INTERCEPT POINT: +30 dBM (TYP.)
- HERMETICALLY SEALED
- AVAILABLE IN SURFACE MOUNT




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | | | $f_R$ 10 to 300 MHz<br>$f_L$ 10 to 300 MHz |
| | | 7.0 dB | 7.5dB | $f_I$ 10 to 200 VHz |
| | | 8.0 dB | 9.0 dB | $f_I$ 10 to 600 MHz |
| | | | | $f_R$ 10 to 1000 MHz |
| | | | | $f_L$ 10 to 1000 MHz |
| | | 8.5 dB | 9.5 dB | $f_I$ 10 to 200 MHz |
| | | 10.0 dB | 11.0 dB | $f_I$ 10 to 600 MHz |
| Isolation | | | | |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 10 to100 MHz |
| $f_L$ at I | 35 dB | 45 dB | | |
| $f_L$ at R | 25 dB | 35 dB | | $f_L$ 100 to 400 MHz |
| $f_L$ at I | 25 dB | 35 dB | | |
| $f_L$ at R | 18 dB | 25 dB | | $f_L$ 400 to 1000 MHz |
| $f_L$ at I | 14 dB | 20 dB | | |
| $f_R$ at I | | 20 dB | | $f_R$ 10 to 1000 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +20 dBm<br>$f_L$ = +25 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ = +18 dBm<br>$f_L$ = +25 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M2EC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

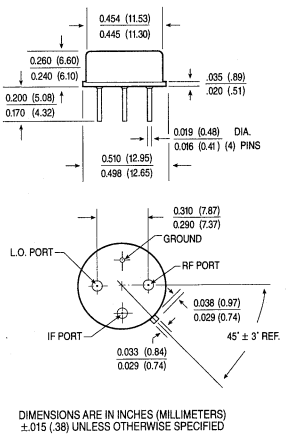
## Absolute Maximum Ratings

Operating Temperature.....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak RF Input Power at +85°C .....+27 dBm RMS, +30 dBm Peak
Peak Input Current at 25°C .....100 mA DC

Weight M2E: 2 grams (0.07 oz.) max.
M2EC: 22 grams (0.78 oz.) max.
SM2E: 3 grams (0.11 oz.) max.

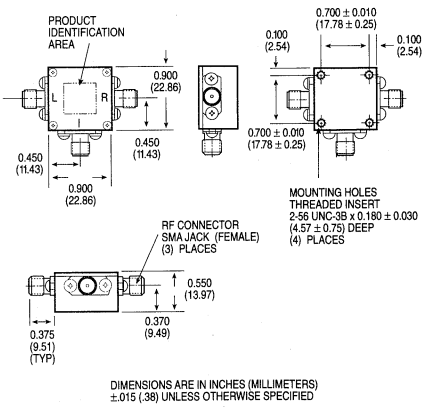
## Outline Drawings

M2E



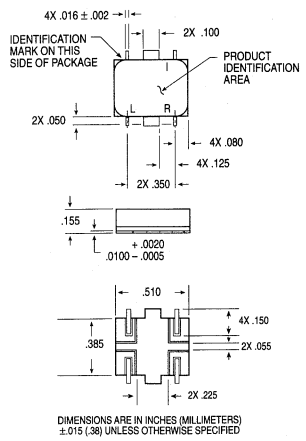

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M2EC



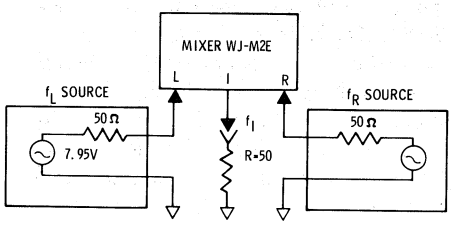

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

SM2E



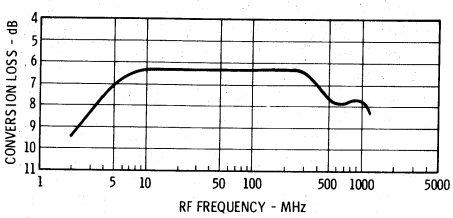

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

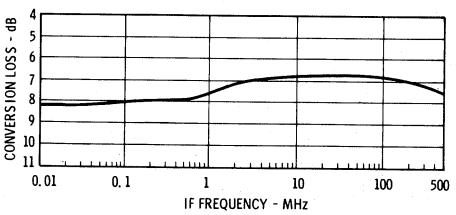



*Mixer Test Circuit:* When terminated as shown, the mixer impedance at the R- and I-ports is 50 ohms. The impedance at the L-port is nonlinear and is a function of the $f_L$ level. For most applications, the $f_L$ level should be as shown. This is equivalent to delivering 100 milliwatts (+20 dBm) into a 50 ohm load. The $f_R$ level should be below 39.8 milliwatts (+16 dBm) in order to avoid conversion compression with $f_L$ at +20 dBm.

### Conversion Loss vs. Frequency

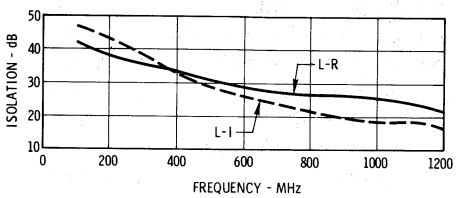


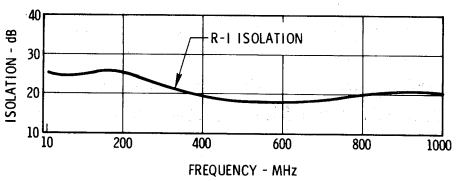

$f_{LO} > f_{RF}$
$P_{LO}$ = +20 dBm
$P_{RF}$ = -10 dBm
$f_{IF}$ = BETWEEN 1 MHz and 100 MHz




$f_{LO} > f_{RF}$
$P_{LO}$ = +20 dBm
$f_{RF}$ = 100 MHz @ -10 dBm

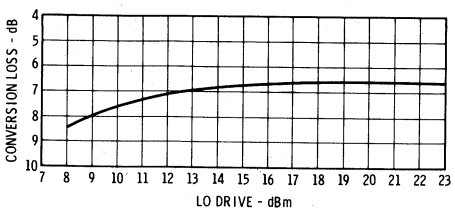
### Isolation




$f_{LO}$ = 700 MHz @ + 20 dBm
$P_{RF}$ = -10 dBm

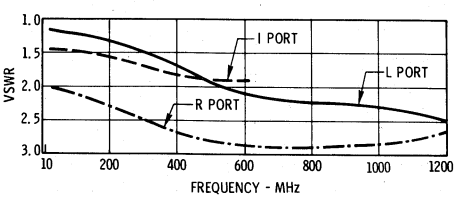
### Conversion Loss vs. LO Drive




$f_{LO}$ = 400 MHz
$f_{RF}$ = 300 MHz @ -10 dBm

*Drive Level:* The minimum recommended drive level is +14 dBm. The maximum recommended drive level is +25 dBm.

### VSWR




$P_{RF} = P_{IF}$ = -10 dBm
$P_{LO}$ = +20 dBm
$f_{LO}$ = 1000 MHz

10

## Typical Two-Tone Intermodulation Performance at 25°C

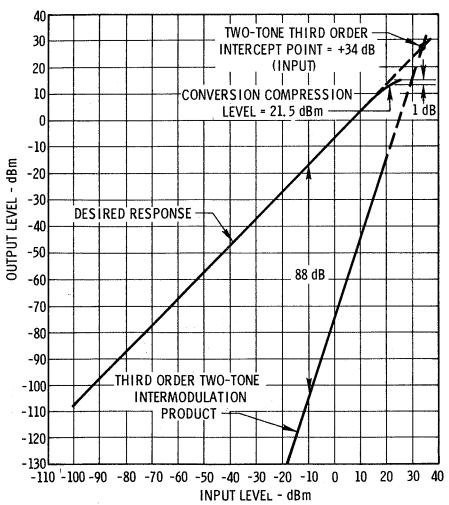
**Definition:** In a mixer application where the input must be wideband two signals ($f_{R1}$ and $f_{R2}$) may mix with the local oscillator signal ($f_L$) to produce in-band, two-tone third-order intermodulation products $[(2f_{R2} - f_{R1}) \pm f_L]$.

**Two-Tone Suppression vs. Input Level:** With each dB decrease in input level, the 3rd order product is decreased an additional 2 dB. As shown, the WJ-M2E will reduce third-order products typically 68 dB with both input signals at 0 dBm and 88 dB with both input signals at −10 dBm. The input intercept point for the WJ-M2E is +34 dBm. This is about 24 dB higher than the intercept point for a standard low-level double-balanced mixer. The 1 dB compression level is typically +21.5 dBm as shown by the graph. This yields a dynamic range in a 1 MHz bandwidth of +126 dB using the following relationship: Dynamic Range = $P_{input} - (-111$ dBm/MHz + B + NF) where; $P_{input}$ is the input level for 1 dB compression, B is the bandwidth relative to 1 MHz in dB and NF is the noise figure.

The spurious free dynamic range is given as follows:

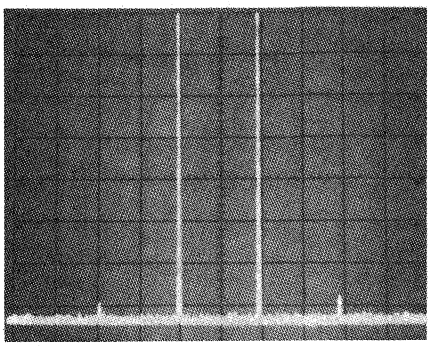
Spur free dynamic range = 2/3 (I.P. − (−111 dBm/MHz + B + NF)

$DR_{spur\ free}$ = 2/3 (34 + 111 − 6.5) = 92.3 dB in a 1 MHz bandwidth.




This performance represents the highest dynamic range achieved using passive components in an ultra small TO-8 package. The spectrum analyzer photos of Fig. 1 compare the M2E to the M9D mixer with the LO drive of each mixer at +23 dBm. The M2E provides nearly 70 dBm suppression to the third order at the 320 MHz frequencies.

**M2E**



**M9D**

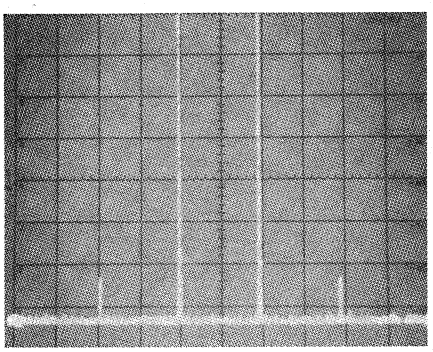


**Fig. 1**

The M2E is also compared with the pace setting WJ-M9E in Fig. 2. The M2E provided performance equal to the M9E with only +25 dBm LO drive compared with +27 dBm required on the M9E. In addition the frequency response of the M2E is extended to 1000 MHz, and it occupies only 1/10 the volume.

**M2E**

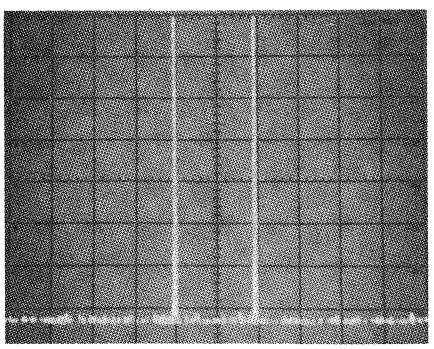


**Fig. 2**

**M9E**

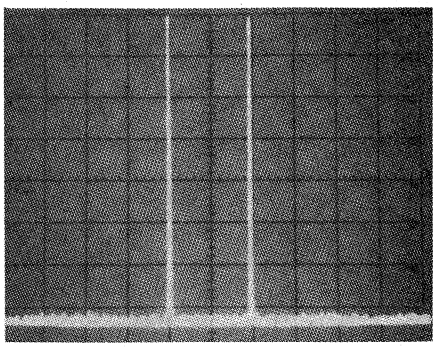


**Fig. 2 (continued)**

**Third Order Performance When Used With LO Drive Amplifier and IF Amplifier:** The third order IM intercept point is shown plotted in Fig. 3 compared using the WJ-PA2 as an LO drive amplifier to a padded LO source from a commercial test amplifier. Measured intercepts as high as +38 dBm were achieved both with and without the PA2. The WJ-PA2 is a TO-8 Amplifier that provides +25 dBm output power from 10 to 300 MHz with a nominal gain of 11 dB. The third order two-tone was equal to or better using the PA2 directly coupled to the LO port as compared to driving from a padded commercial source.

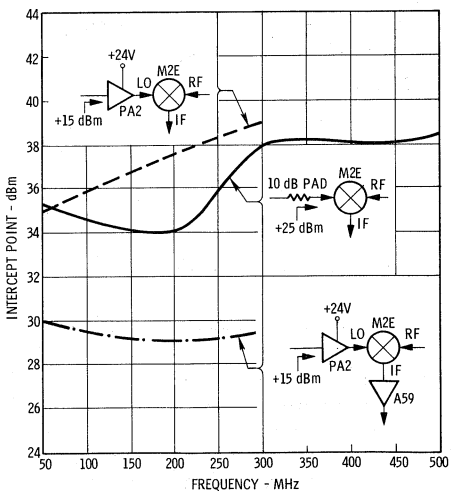



**Fig. 3 Third-Order Input Intercept Point vs. Frequency**

## Typical Two-Tone Intermodulation Performance at 25°C

The input IM point was also measured using the A59 on the IF port of the M2E and this curve is also plotted in Fig. 3. There was a 4 or 5 dB decrease in IM point which is attributable to the intercept of the A59 being approximately equal to the output intercept point of the M2E. To minimize the reduction there should be at least a 6 dB intercept margin between the output IM point of one unit to the input IM point of one unit to the input point of the following unit.

The third order of the M2E versus frequency out to 500 MHz is shown plotted in Fig. 4 of three different LO drive levels. The curves show that the IM point is more constant at the +25 dBm LO drive level than at lower levels. Occasionally a lower level may cause better IM suppression due to phasing in the mixer diodes which cause partial cancellation. In general, the IM can be expected to vary as a function of LO drive about 1 dBm per dB of LO drive. This result is plotted in Fig. 5.

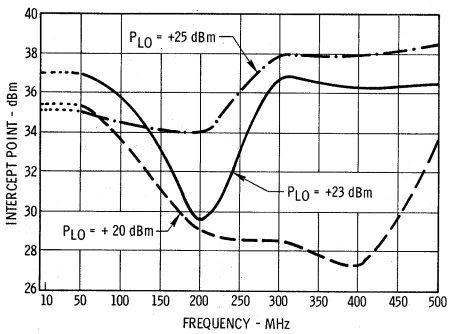



**Fig. 4 Third-Order IM Point vs. Frequency and LO Drive.**

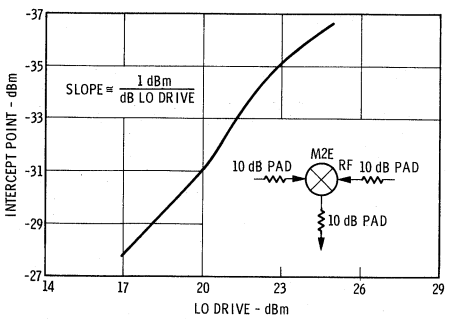



**Fig. 5 Intercept Point vs. LO Drive**

The output IM point is shown plotted in Fig. 6 for the PA driving the LO port for +15 dBm LO and +10 dBm LO levels with the A59 on the IF port.

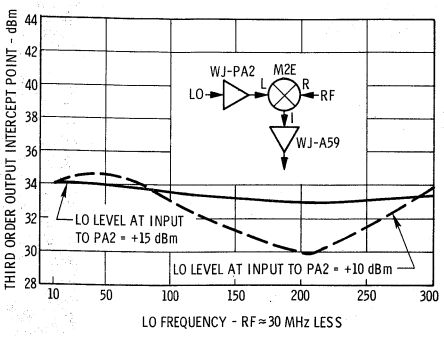



**Fig. 6 Third-Order Output IM Point vs. Frequency**

The output intercept is also plotted in Fig. 7 with an A59 on both the IF and RF ports for +15 dBm and +10 dBm to the input of the PA2.

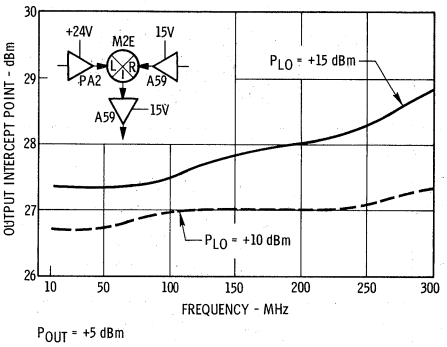
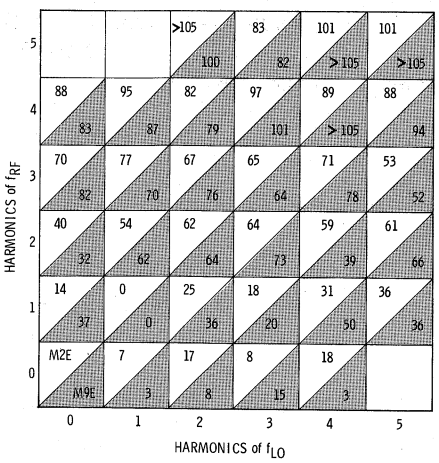



**Fig. 7 Output Intercept Point vs. Frequency**

**Single Tone IM Signal Levels:** Intermodulation signals resulting from the mixing of harmonics of the input signals are shown in Table 1 below for the WJ-M2E and WJ-M9E.




$f_{RF}$ and $f_{LO}$ at 300 and 310 MHz, respectively
LO drive +25 dBm
RF signal level +0 dBm

**Table 1**

The data for this table was obtained using the setup shown in Fig. 8 where the LO port was direct coupled to the output of the WJ-PA2 TO-8 amplifier. Similar performance should be expected from other LO drive sources provided reasonable match is provided.

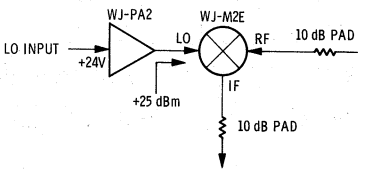



**Fig. 8**

Mixing products are indicated by the number of dB below the $f_L \pm f_R$ output. The typical performance in the table was obtained with $f_R$ and $f_L$ at 300 and 310 MHz respectively, $f_L$ at +25 dBm, $f_R$ at 0 dBm, and all resistive terminations.

For the odd $f_R$ and $f_L$ products and the even $f_R$ and $f_L$ products the two mixers are comparable. For the even $f_L$ mixing with the odd $f_R$ and the odd $f_L$ mixing with the even $f_R$, the M9E typically offers a few dB higher suppression. Improved performance is obtained at lower frequencies for the even mixing with odd and the even mixing with even products. The odd mixing with odd are not suppressed because of mixer balance and therefore are more constant with frequency.

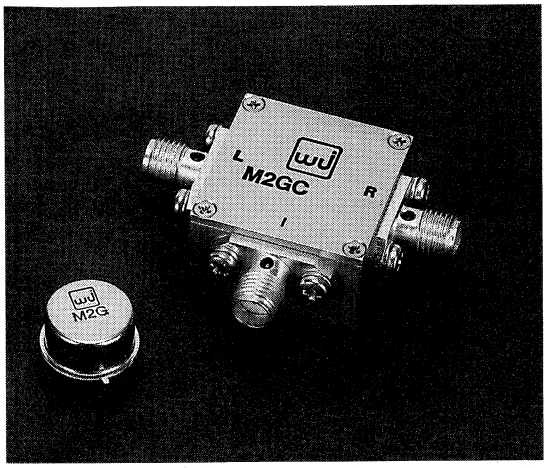
10

# WJ - M2G/M2GC

## DOUBLE-BALANCED MIXER

- LO 800 TO 3500 MHz
- RF 1000 TO 2200 MHz
- IF DC TO 1500 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 30 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications [1, 2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 8.0 dB | 9.5 dB | $f_L$ 800 to 3500 MHz<br>$f_R$ 1000 to 2200 MHz<br>$f_I$ 10 to 1500 MHz |
| Isolation | | | | |
| $f_L$ at R | 25 dB | 40 dB | | $f_L$ 800 to 2000 MHz |
| | 20 dB | 25 dB | | $f_L$ 2000 to 3000 MHz |
| | 17 dB | 20 dB | | $f_L$ 3000 to 3500 MHz |
| $f_L$ at I | 20 dB | 25 dB | | $f_L$ 800 to 3500 MHz |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range ext ends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M2GC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

## Absolute Maximum Ratings

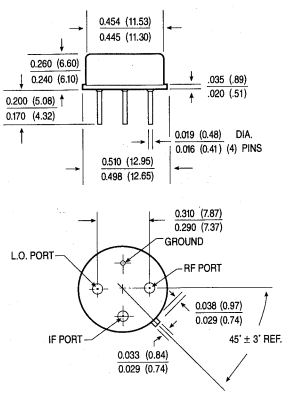
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak RF Input Power.....+23 dBm at +25°C, derate to +17 dBm at +100°C
Peak Input Current at 25°C .....50 mA DC

* For the SMA connector package operation within 0° to 50°C temperature range is recommended.

Weight M2G: 2 grams (0.07 oz.) max.
M2GC: 22 grams (0.78 oz.) max.

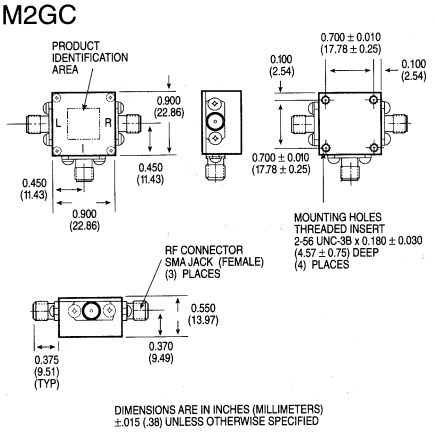
## Outline Drawings

M2G




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

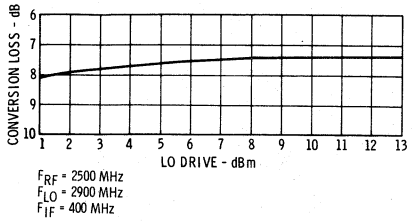
M2GC




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

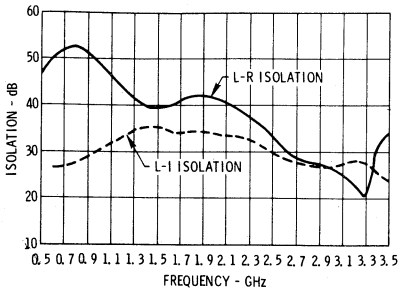
# Typical Performance at 25°C

### Conversion Loss



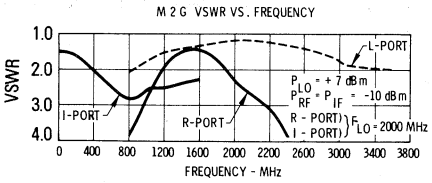

***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +5 dBm. The maximum recommended drive level is +13 dBm.

### Isolation

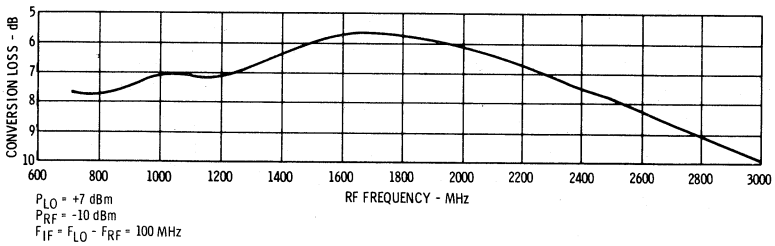



***Isolation vs. Frequency:*** Level of the $f_{LO}$ signal fed through to the R- and I-ports with respect to the level of the $f_{LO}$ signal at the L-port.

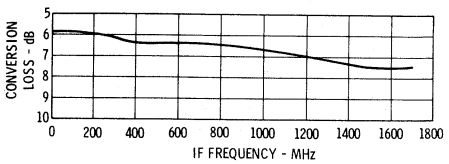
### VSWR



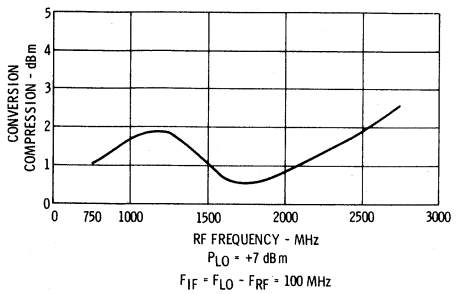

***VSWR vs. Frequency:*** VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Some variation in the R-port VSWR will occur as a function of the L-port frequency. R-port VSWR is plotted for $f_{LO}$ at 2.0 GHz. Also shown are the L-port VSWR and the I-port VSWR with $f_{LO}$ at 2.0 GHz.



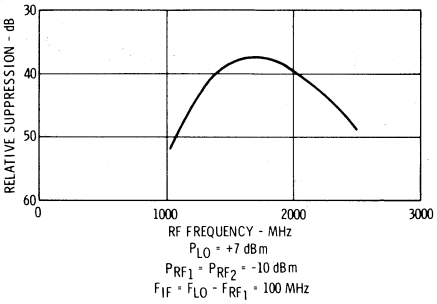

***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_{IF}$ of 100 MHz. Data plotted with an $f_L$ level of +7 dBm.




***Conversion Loss vs. $f_I$ Frequency:*** Conversion loss of the mixer when used in a SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_{RF}$ at 2000 MHz and $f_{LO}$ swept from 2000 to 3700 MHz.




***Conversion Compression (1 dB) vs. Frequency:*** The frequency coordinate refers to the frequencies fed into the RF port. The IF frequency is held constant at 100 MHz with the LO frequency on the high side.

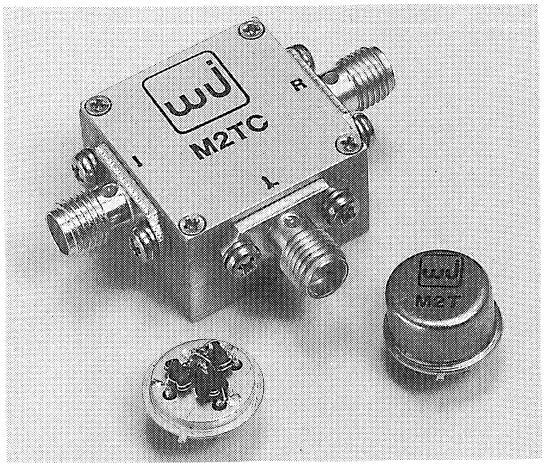



***Relative IM Suppression vs. Frequency:*** The curve displays typical relative suppression of 3rd order two-tone measurements. The frequency coordinate refers to one of the tones fed into the RF port. The other tone is 5 MHz higher than the first one. The IF frequency is at 100 MHz with the LO frequency on the high side.

10

# WJ - M2T/M2TC

## TRIPLE-BALANCED MIXER




- LO, RF } 10 TO 2400 MHz
- IF 10 TO 1000 MHz
- LO DRIVE +13 dBm (nominal)
- HIGH INTERCEPT +22 dBm (TYP.)
- HIGH ISOLATION 40 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss | | | | $f_R$ & $f_L$ 10 to 2400 MHz |
| | | 7.5 dB | 9.5 dB | $f_I$ = 50 to 1000 MHz |
| and | | 9.0 dB | 10.0 dB | $f_I$ =10 to 1000 MHz |
| SSB Noise Figure | | | | $f_R$ & $f_L$ 500 to 1500 MHz |
| | | 7.0 dB | 8.5 dB | $f_I$ =10 to 1000 MHz |
| Isolation | | | | |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 10 to 1200 MHz |
| $f_L$ at I | 35 dB | 40 dB | | |
| $f_L$ at R | 30 dB | 40 dB | | $f_L$ 1200 to 2400 MHz |
| $f_L$ at I | 30 dB | 40 dB | | |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = +11 dBm<br>$f_L$ Level = +13 dBm |
| Third Order Intercept Point | | +22 dBm | | $f_L$ Level = +16 dBm<br>$f_{R_1}$, $f_{R_2}$ Level = 0 dBm |

Notes
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.
2. Guaranteed conversion loss values for M2TC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

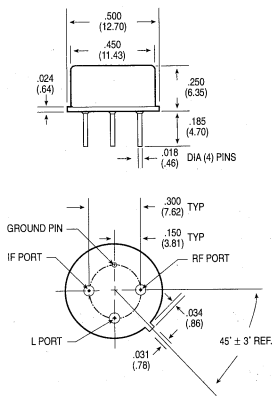
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+25 dBm at +25°C, derate at +4 dBm/°C
Peak Input Current at +25°C .....75 mA DC

Weight M2T: 2 grams (0.07 oz.) max.
M2TC: 22 grams (0.78 oz.) max.

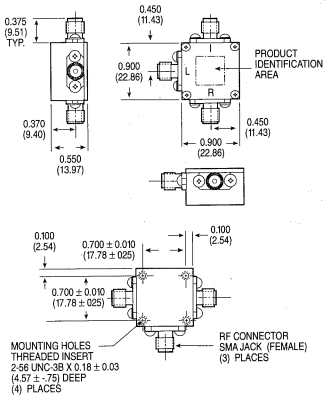
## Outline Drawings

M2T




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

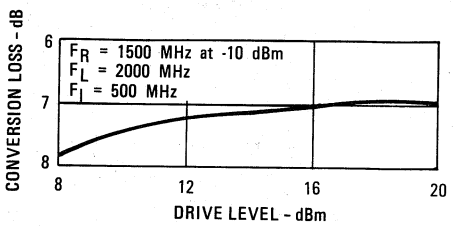
M2TC



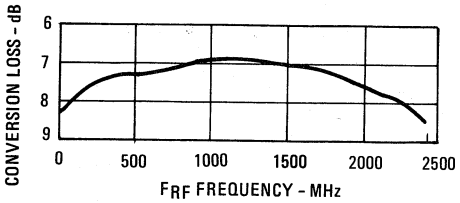

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

### Conversion Loss

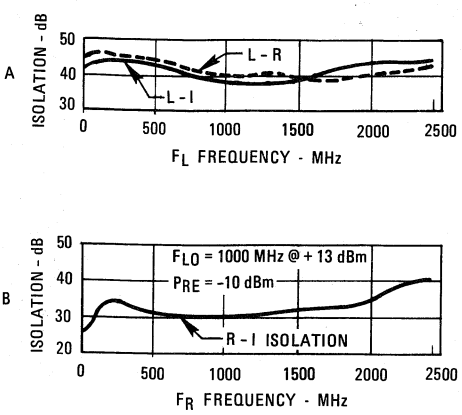



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +11 dBm. The maximum recommended drive level is +20 dBm.



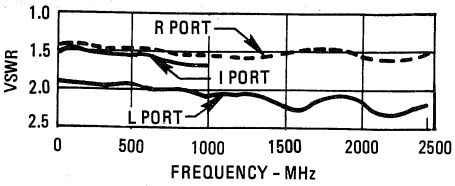

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 100 MHz. Data plotted with $f_L$ level of +13 dBm.

### Isolation




*Isolation vs. Frequency:* A) Level of the $f_L$ signal fed through the R- and I-ports with respect to the level of the $f_L$ signal at the L-port. Data plotted with $f_L$ level of +13 dBm. B) Level of the $f_R$ signal fed through to the I-Iport with respect to the level of the $f_R$ signal at the R-port.

### VSWR



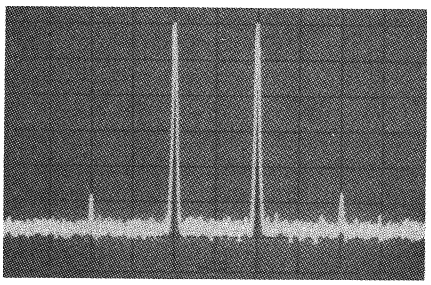

$P_{RF} = P_{IF}$ = -10 dBm

$P_{LO}$ = +13 dBm

$f_{LO}$ = 500 MHz

*VSWR vs. Frequency:* VSWR of the L-I- and R-ports in a 50-ohm system with $f_L$ at +13 dBm. Some variation in the R-port VSWR wil occur as a function of the L-port frequency. Both R-port and I-port VSWR are plotted for $f_L$ at 500 MHz. Also shown is the L-port VSWR.

### Two-Tone Intermodulation Performance



$f_{RF1}$ = 1100 MHz $f_{RF2}$ = 1110 MHz

$P_{RF1} = P_{RF2}$ = 0 dBm

$f_{LO}$ = 1600 MHz $P_{LO}$ = +16 dBm

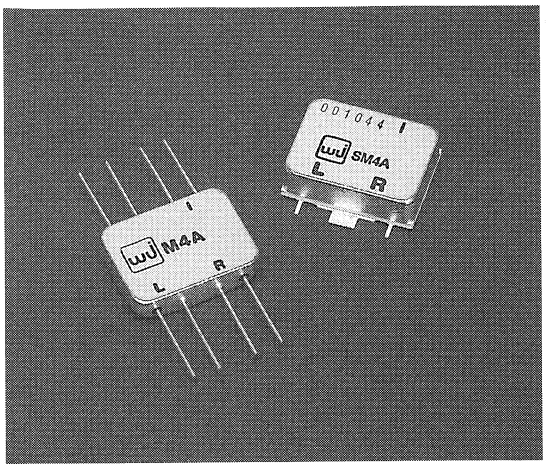
$f_I$ = 500 MHz @ 10 dB/div.

*Two-Tone Intermodulation Performance:* The photo displays typical relative suppresion of 3rd order two-tone measurement, with $P_{FR}1$ equal to $P_{FR2}$ at 0 dBm.

10

# WJ - M4A/SM4A

## DOUBLE-BALANCED MIXER




- LO, RF } 10 TO 1500 MHz
- IF DC TO 1000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 35 dB (TYP.)
- AVAILABLE IN SURFACE MOUNT
- QPL VERSION AVAILABLE!

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.0 dB | $f_R$ 20 to 600 MHz<br>$f_L$ 10 to 800 MHz<br>$f_I$ 1 to 200 MHz |
| | | 7.0 dB | 8.0 dB | $f_R$ 10 to 1200 MHz<br>$f_L$ 10 to 1400 MHz<br>$f_I$ 1 to 200 MHz |
| | | 7.5 dB<br>8.5 dB | 8.5 dB<br>9.5 dB | $f_R$ 10 to 1500 MHz<br>$f_L$ 10 to 1500 MHz<br>$f_I$ 1 to 200 MHz<br>$f_I$ 1 to 1000 MHz |
| Isolation | | | | |
| $f_L$ at R | 30 dB | 40 dB | | $f_L$ 10 to 600 MHz |
| $f_L$ at I | 25 dB | 40 dB | | |
| $f_L$ at R | 25 dB | 35 dB | | $f_L$ 600 to 1200 MHz |
| $f_L$ at I | 20 dB | 30 dB | | |
| $f_L$ at R | 25 dB | 30 dB | | $f_L$ 1200 to 1500 MHz |
| $f_L$ at I | 18 dB | 25 dB | | |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I- Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

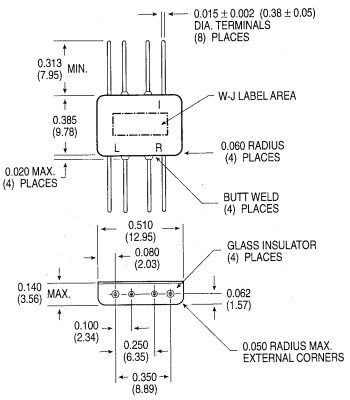
Operating Temperature
- 10 to 20 MHz ..... -20°C to +100°C
- 20 to 1500 MHz ..... -54°C to +100°C

Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +23 dBm at +25°C, derate to +17 dBm at +100°C
Peak Input Current at 25°C ..... 50 mA DC

Weight M4A: 2 grams (0.07 oz.) max.
SM4A: 3 grams (0.11 oz.) max.

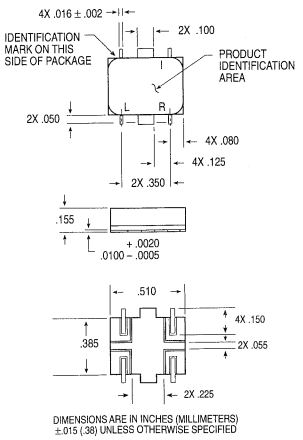
## Outline Drawings

M4A




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

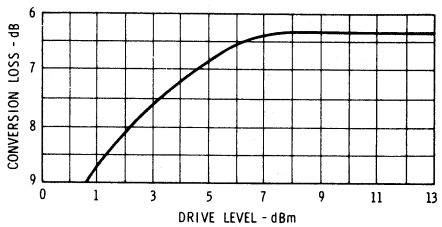
SM4A



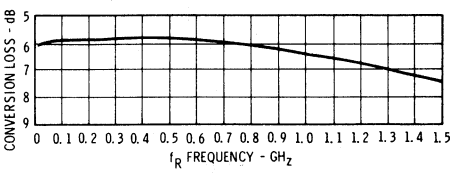

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

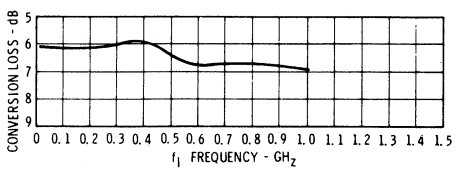
### Conversion Loss




***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +5 dBm. The maximum recommended drive level is +13 dBm.

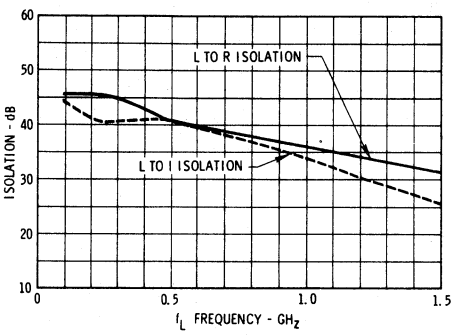



***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ less than 200 MHz. Data plotted with an $f_L$ level of +7 dBm.




***Conversion Loss vs. $f_I$ Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_R$ at 200 MHz and $f_L$ swept from 190 to 1200 MHz.

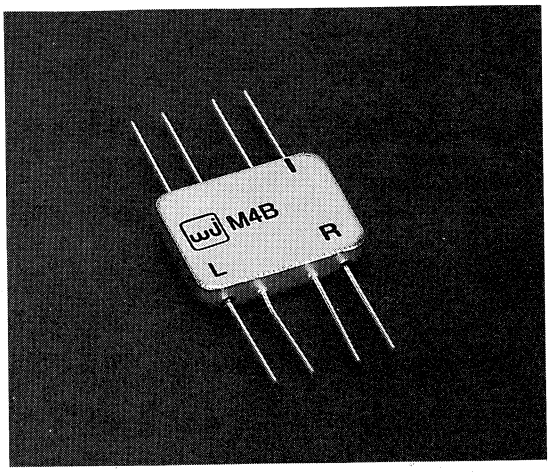
### Isolation




***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-port with respect to the level of the $f_L$ signal at the L-port.

# WJ - M4B/SM4B

## DOUBLE-BALANCED MIXER




- LO, RF } 10 TO 1500 MHz
- IF DC TO 1000 MHz
- LO DRIVE +13 dBm (nominal)
- AVAILABLE IN SURFACE MOUNT
- HIGH ISOLATION 35 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

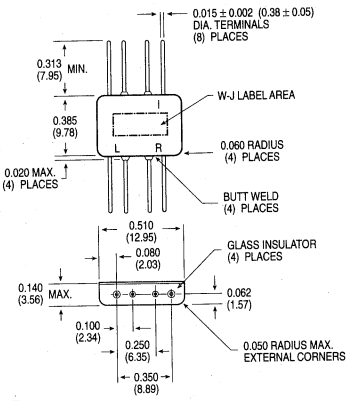
## Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 7.5 dB | $f_R$ 20 to 600 MHz<br>$f_L$ 10 to 800 MHz<br>$f_I$ 0.4 to 200 MHz |
| | | 7.0 dB | 8.0 dB | $f_R$ 10 to 1200 MHz<br>$f_L$ 10 to 1200 MHz<br>$f_I$ 0.4 to 200 MHz |
| | | 7.5 dB<br>8.5 dB | 8.5 dB<br>9.5 dB | $f_R$ 10 to 1500 MHz<br>$f_L$ 10 to 1500 MHz<br>$f_I$ 0.4 to 200 MHz<br>$f_I$ 0.4 to 1000 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I<br>$f_L$ at R<br>$f_L$ at I<br>$f_L$ at R<br>$f_L$ at I | <br>35 dB<br>30 dB<br>25 dB<br>25 dB<br>22 dB<br>18 dB | <br>40 dB<br>45 dB<br>35 dB<br>30 dB<br>28 dB<br>23 dB | | $f_L$ 10 to 600 MHz<br>$f_L$ 600 to 1200 MHz<br>$f_L$ 1200 to 1500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = +5 dBm |

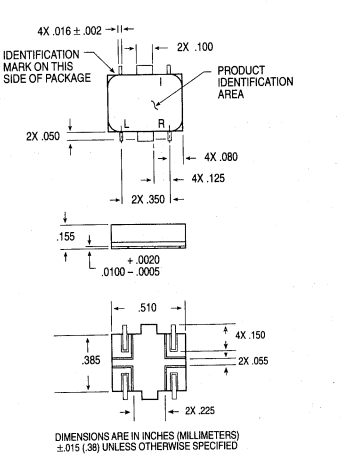
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings

M4B




SM4B



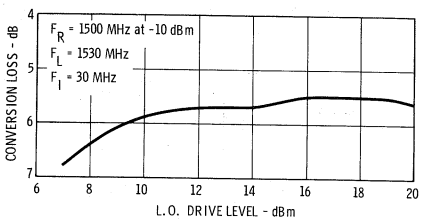

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak RF Input Power.....+23 dBm at +25°C, derate to + 17 dBm at +100°C
Peak Input Current at 25°C.....50 mA DC

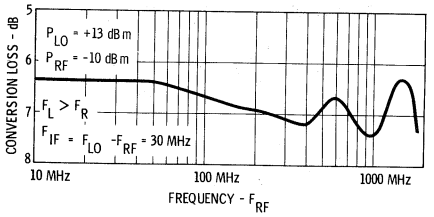
Weight M4B: 2 grams (0.07 oz.) max.
SM4B: 3 grams (0.11 oz.) max.

## Typical Performance at 25°C

### Conversion Loss

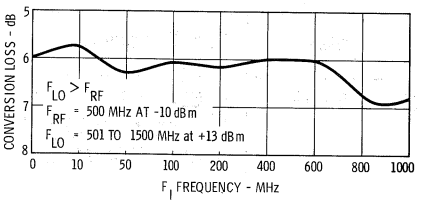



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +10 dBm. The maximum recommended drive level is +17 dBm.



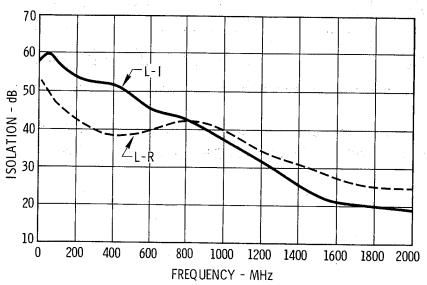

*Conversion Loss vs. Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 30 MHz. Data plotted with an $f_L$ level of +13 dBm.

### Conversion Loss



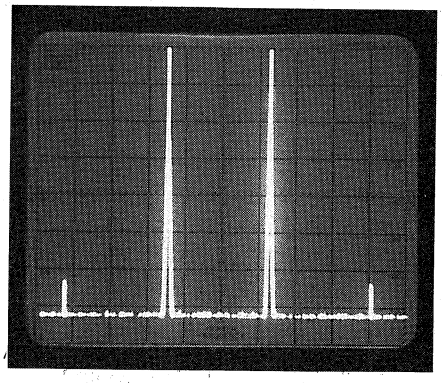

*Conversion Loss vs. $f_I$ Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port (fI) with fR at 500 MHz and fL from 501 to 1500 MHz.

### Isolation




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### Two-Tone Intermodulation Performance



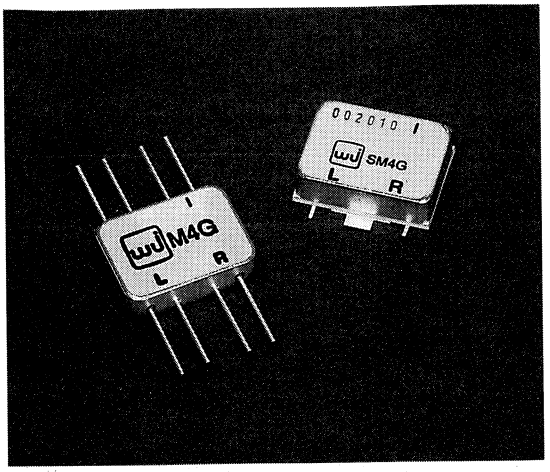
$f_{RF1}$ = 500 MHz $f_{RF2}$ = 500 MHz
$P_{RF1} = P_{RF2}$ = -5 dBm
$f_L$ = 1250 MHz $P_{LO}$ = +13 dBm
$f_I$ = 750 MHz @ 10 dB/div.

*Two-Tone Intermodulation Performance:* The photo displays typical relative suppression of 3rd order two-tone measurement with $P_{RF1}$ equal to $P_{FR2}$ at -5 dBm.

10

# WJ - M4G/SM4G

## DOUBLE-BALANCED MIXER




- LO 800 TO 3500 MHz
- RF 800 TO 2400 MHz
- IF DC TO 1500 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 30 dB (TYP.)
- AVAILABLE IN SURFACE MOUNT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 8.5 dB | $f_L$ 800 to 3500 MHz<br>$f_R$ 1300 to 2400 MHz<br>$f_I$ 10 to 1500 MHz |
| | | 8.0 dB | 9.0 dB | $f_L$ 800 to 3500 MHz<br>$f_R$ 800 to 2400 MHz<br>$f_I$ 10 to 1500 MHz |
| Isolation<br>$f_L$ at R<br><br>$f_L$ at I | <br>25 dB<br>20 dB<br>18 dB | <br>35 dB<br>28 dB<br>25 dB | | <br>$f_L$ 800 to 2000 MHz<br>$f_L$ 2000 to 3500 MHz<br>$f_L$ 800 to 3500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

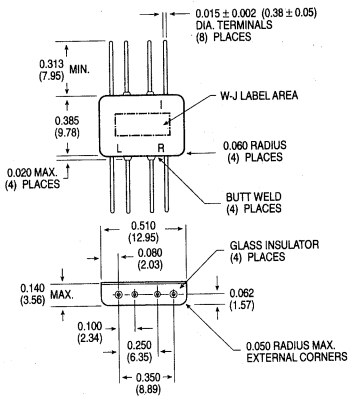
## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak RF Input Power ..... +23 dBm at +25°C, derate to + 17 dBm at +100°C
Peak Input Current at 25°C ..... 50 mA DC

Weight M4G: 2 grams (0.07 oz.) max.
SM4G: 3 grams (0.11 oz.) max.

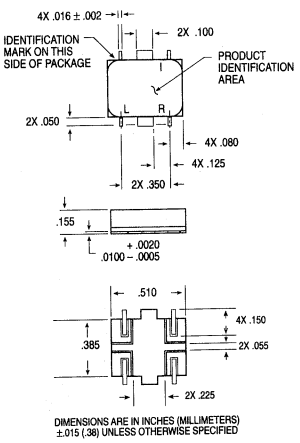
## Outline Drawings

M4G




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

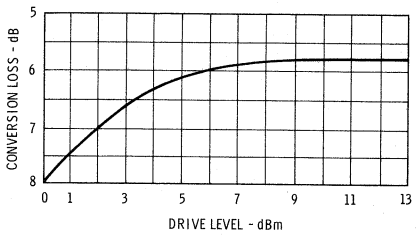
SM4G



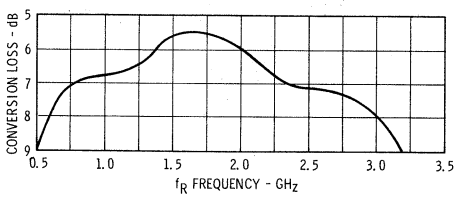

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

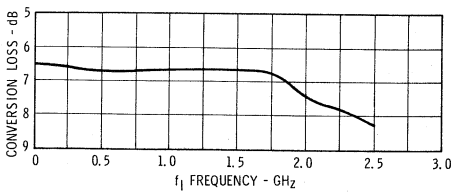
### Conversion Loss




***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +5 dBm. The maximum recommended drive level is +13 dBm.

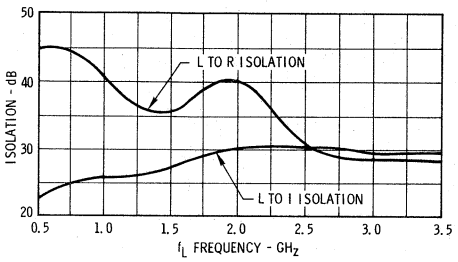



***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 120 MHz and $f_L$ less than $f_R$. Data plotted with an $f_L$ level of +7 dBm.




***Conversion Loss vs. $f_I$ Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_R$ at 1.2 GHz and $f_L$ swept from 1.2 to 3.7 GHz.

### Isolation



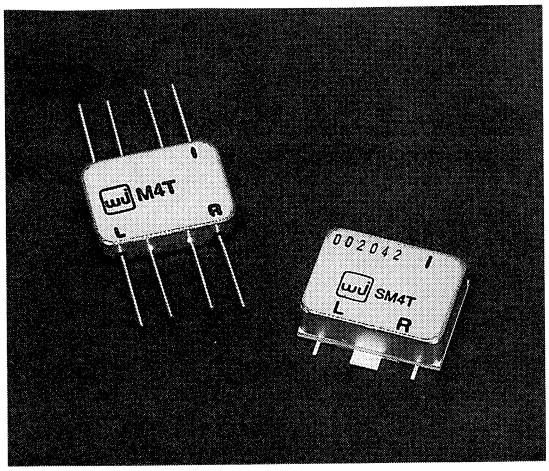

***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

# WJ - M4T/SM4T

## LOAD INSENSITIVE MIXER

- LO, RF } 1 TO 3400 MHz
- IF 1 TO 2000 MHz
- LO DRIVE +10 dBm (nominal)
- INSENSITIVE TO SYSTEM MISMATCH
- HIGH INTERCEPT +18 dBm (TYP.)
- AVAILABLE IN SURFACE MOUNT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)



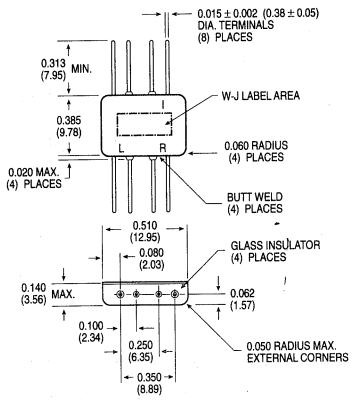

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 7.5 dB | $f_L$ & $f_R$: 5 to 1000 MHz, $f_I$ 1 to 500 MHz |
| | | 8.0 dB | 9.0 dB | $f_L$ & $f_R$ 1 to 3000 MHz, $f_I$ 1 to 1500 MHz |
| | | 9.0 dB | 10.5 dB | $f_L$ & $f_R$ 1 to 3400 MHz, $f_I$ 1 to 2000 MHz |
| Isolation | | | | |
| $f_L$ at I | 35 dB | 40 dB | | $f_L$ 10 to 1500 MHz |
| | 25 dB | 30 dB | | $f_L$ 10 to 3400 MHz |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 10 to 2500 MHz |
| | 25 dB | 30 dB | | $f_L$ 10 to 3400 MHz |
| $f_R$ at I | | 25 dB | | $f_R$ 1 to 3400 MHz |
| Third-Order intercept Point | | +18 dBm | | $f_L$ 2000 MHz, +10 dBm, $f_{R1}$ =1900 MHz, $f_{R2}$ = 1910 MHz both at -10 dBm |
| Conversion Compression | | 1.0 dB | | $f_R$ at +7 dBm, $f_L$ at +13 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ at +5 dBm |
| Third-Order Intermodulation Suppression Degradation | | 3 dB | | If VSWR ≤ 3:1 at I-Port |

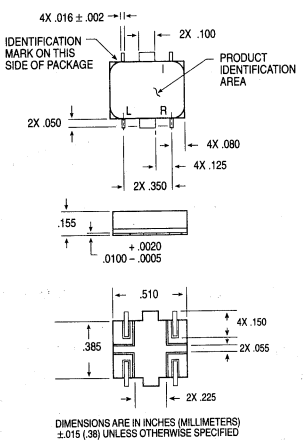
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

## Outline Drawings

M4T




SM4T



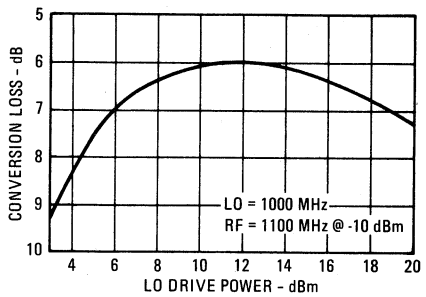

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+27 dBm max. at +25°C, +23 dBm max. at +100°C

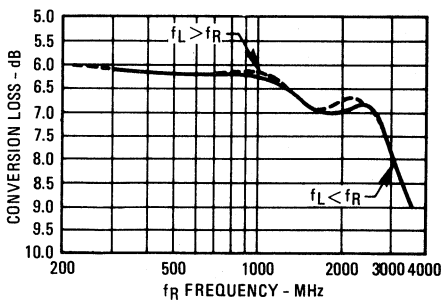
Weight M4T: 2 grams (0.07 oz.) max.
SM4T: 3 grams ( 0.11 oz.) max.

## Typical Performance at 25°C

### Conversion Loss

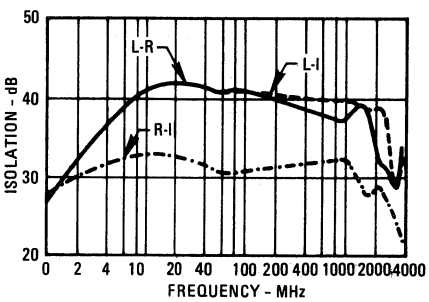



***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +7 dBm. The maximum recommended drive level is +18 dBm.



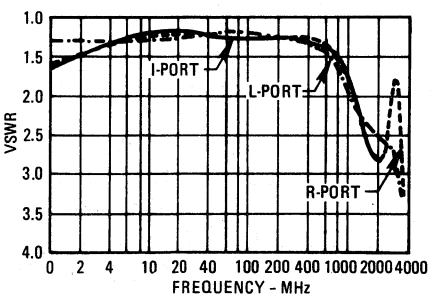

***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. Data plotted for a $f_I$ of 100 MHz with $f_L$ at +10 dBm.

### Isolation




***Isolation vs. Frequency:*** Level of $f_L$ signal fed through to R- and I-port with respect to the level of the $f_L$ signal at L-port. R-I Isolation plotted with $f_L$ at 1500 MHz.

### VSWR




***VSWR vs. Frequency:*** VSWR is the L-, I-, and R-ports in a 50 ohm system with $f_L$ at +10 dBm. R- and I-port VSWR plotted with $f_L$ at 1500 MHz.

## Typical Intermodulation Performance

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 4 | <70 | <70 | <70 | <70 | <70 | <70 | <70 | <70 | <70 |
| 3 | <70 | 67 | <70 | 61 | <70 | 58 | 69 | 57 | 69 |
| 2 | 55 | 65 | 64 | 63 | 68 | 62 | <70 | 63 | <70 |
| 1 | 41 | 0 | 31 | 11 | 34 | 17 | 37 | 22 | 39 |
| 0 | X | 19 | 20 | 27 | 34 | 34 | 43 | 39 | 45 |

HARMONICS OF $f_L$

### Test Conditions

$f_L$ = 200 MHz, +10 dBm
$f_R$ = 210 MHz, -10 dBm

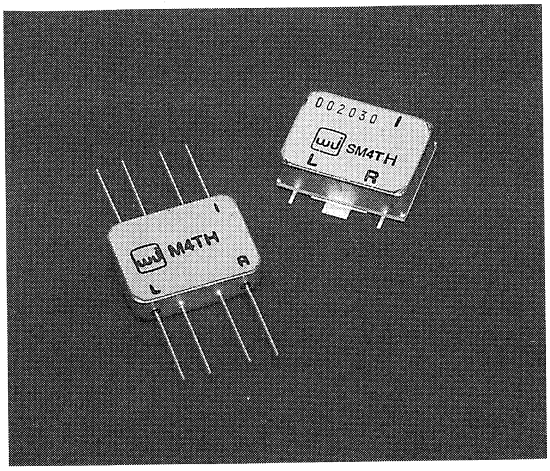
10

# WJ - M4TH/SM4TH

## WIDEBAND CLASS 4 MIXER
## LOAD INSENSITIVE MIXER

- LO, RF } 1 TO 3400 MHz
- IF 1 TO 2000 MHz
- LO DRIVE +23 dBm (nominal)
- INSENSITIVE TO SYSTEM MISMATCH
- HIGH INTERCEPT +29 dBm (TYP. )
- AVAILABLE IN SURFACE MOUNT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)



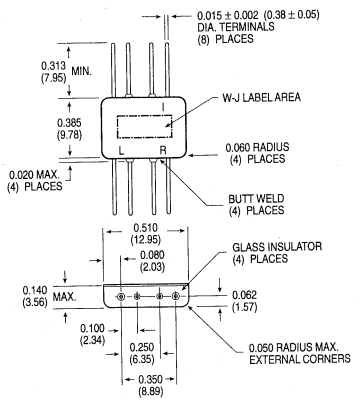

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 8.0 dB | $f_L$ & $f_R$: 5 to 2000 MHz, $f_I$ 1 to 500 MHz |
| | | 9.0 dB | 10.5 dB | $f_L$ & $f_R$: 1 to 3400 MHz, $f_I$ 1 to 2000 MHz |
| Isolation | | | | |
| $f_L$ at I | 30 dB | 40 dB | | $f_L$ 10 to 1500 MHz |
| | 25 dB | 35 dB | | $f_L$ 10 to 3400 MHz |
| $f_L$ at R | 30 dB | 35 dB | | $f_L$ 10 to 2500 MHz |
| | 22 dB | 35 dB | | $f_L$ 10 to 3400 MHz |
| $f_R$ at I | | 21 dB | | $f_R$ 1 to 3400 MHz |
| Third-Order Intercept Point | | +29 dBm | | $f_L$ 1900 MHz at +23 dBm, $f_{R_1}$ = 2000 MHz, $f_{R_2}$ = 2010 MHz both at 0 dBm |
| Conversion Compression | | 1.0 dB | | $f_R$ at + 17dBm, $f_L$ at +23 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R2}$ at +15 dBm |
| Third-Order Intermodulation Suppression Degradation | | 3 dB | | If VSWR ≤ 3:1 at I-Port |

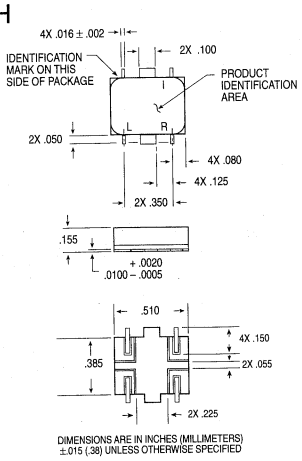
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

## Outline Drawings

M4TH




SM4TH



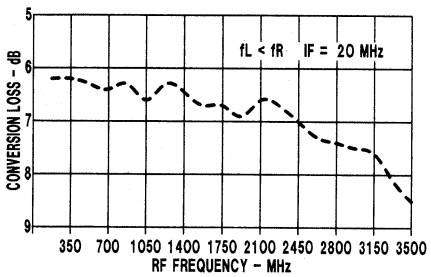

## Absolute Maximum Ratings

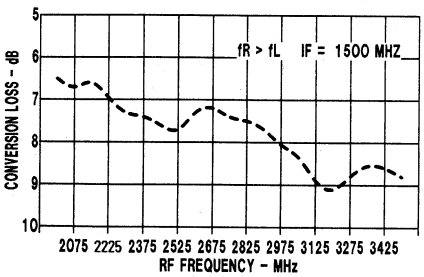
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power ..... +27 dBm max. at +25°C, +23 dBm max. at +100°C

Weight M4TH: 2 grams (0.07 oz.) max.
SM4TH: 3 grams ( 0.11 oz.) max.

## Typical Performance at 25°C

### Conversion Loss vs. Frequency

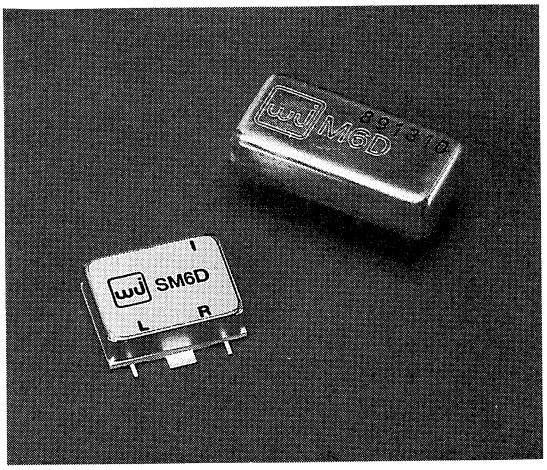


# WJ - M6D/SM6D

## DOUBLE-BALANCED MIXER

- LO, RF } 0.05 TO 200 MHz
- IF DC TO 200 MHz
- LO DRIVE +7 dBm (nominal)
- AVAILABLE IN SURFACE MOUNT
- QPL VERSION AVAILABLE!
- HIGH ISOLATION 45 dB (TYP.)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and Noise Figure | | 5.5 dB<br>7.5 dB<br>8.0 dB | 6.5 dB<br>8.0 dB<br>8.5 dB | $f_L$, $f_R$ & $f_I$ 0.2 to 50 MHz<br>$f_L$, $f_R$ & $f_I$ 50 to 200 MHz<br>$f_L$, $f_R$ & $f_I$ 0.05 to 0.2 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I<br>$f_L$ at R<br>$f_L$ at I | <br>45 dB<br>40 dB<br>35 dB<br>30 dB | <br>60 dB<br>55 dB<br>45 dB<br>40 dB | | <br>$f_L$ 0.05 to 30 MHz<br><br>$f_L$ 30 to 200 MHz |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

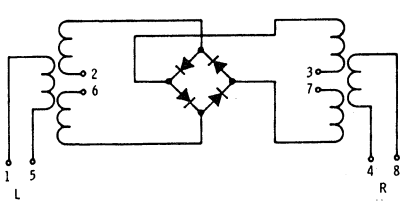
## Absolute Maximum Ratings

Operating Temperature* ..... -54°C to +100°C
Storage Temperature.. ..... -65°C to +100°C
Peak Input Power ..... +17 dBm
Peak Input Current at 25°C ..... 50 mA DC

*For input signals below 100 kHz, the temperature range is -20°C to +100°C.

Weight M6D: 5.0 grams (0.18 oz.) max.
SM6D: 2.5 grams (0.9 oz.) max.

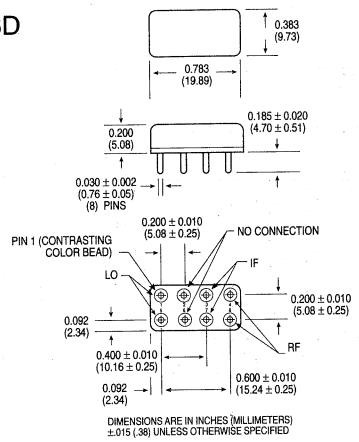
## Schematic Diagram



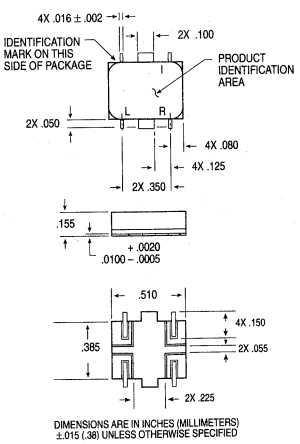

THE I -PORT IS FORMED BY EXTERNALLY CONNECTING PINS 2 AND 6 TOGETHER AND PINS 3 AND 7 TOGETHER. BEST PERFORMANCE IS OBTAINED BY GROUNDING THE 2, 6 SIDE.

## Outline Drawings

M6D

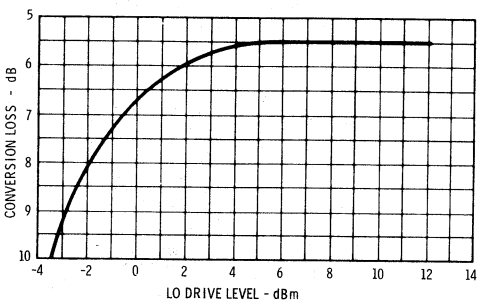



SM6D

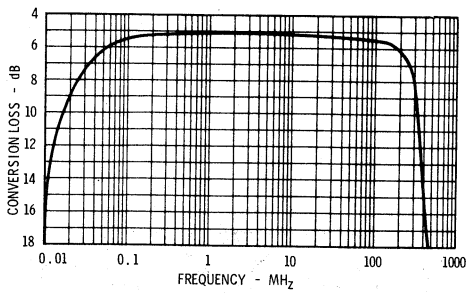


## Typical Performance at 25°C

### Conversion Loss

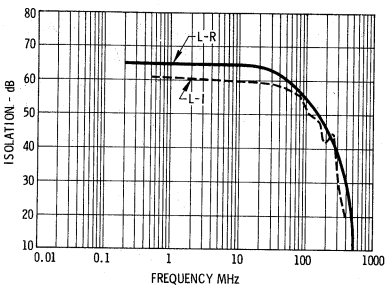



*Conversion Loss vs. LO Drive Level:* Conversion loss in an SSB system as a function of drive level ($f_L$ level), with $f_L$ and $f_R$ at approximately 50 MHz and $f_R$ level at -20 dBm.




*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the inputs $f_L$ and $f_R$ with $f_I$ at 20 MHz.

### Isolation




*Isolation vs. Frequency:* Level of the $f_L$ signal at the R- and I-port with respect to the available power of +7 dBm from a 50-ohm source used for $f_L$.

### Harmonic Intermodulation Products

**SINGLE-TONE INTERMODULATION DISTORTION**

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 5 | 82 | 80 | 78 | 72 | 80 | 67 |
| | 82 | 80 | 80 | 75 | 83 | 73 |
| 4 | 89 | 86 | >90 | 86 | 95 | 82 |
| | 89 | 82 | 90 | 82 | 90 | 80 |
| 3 | 58 | 56 | 63 | 54 | 68 | 50 |
| | 60 | 58 | 65 | 56 | 68 | 54 |
| 2 | 71 | 65 | 74 | 67 | 74 | 65 |
| | 71 | 64 | 74 | 65 | 74 | 63 |
| 1 | 16 | 0 | 28 | 11 | 34 | 22 |
| | 16 | 0 | 26 | 10 | 32 | 17 |
| 0 | | 26 | 34 | 37 | 45 | 36 |
| | | 24 | 30 | 37 | 41 | 34 |

**HARMONICS OF $f_L$**

0.05-200 MHz
CLASS I MIXER

$f_R$ = 49 MHz @ −10 dBm
$f_L$ = 50 MHz
$f_L$ = +10 dBm
$f_L$ = +7 dBm

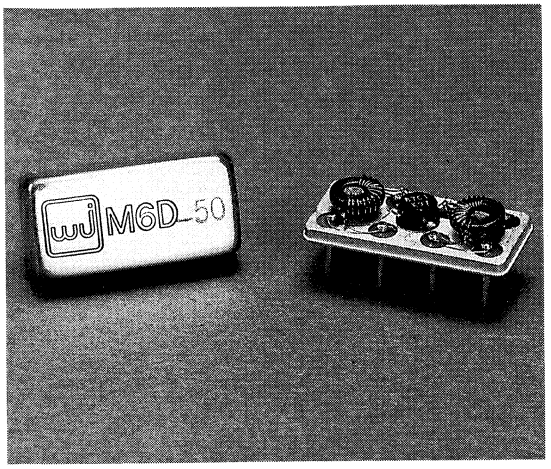
10

# WJ - M6D-50

## DOUBLE-BALANCED MIXER

- LO, RF } 0.05 TO 200 MHz
- IF DC TO 200 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 45 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 6.5 dB | $f_L$ & $f_R$ 0.2 to 50 MHz, $f_I$ DC to 50 MHz |
| | | 7.5 dB | 8.0 dB | $f_L$, $f_R$ & $f_I$ 50 to 200 MHz |
| | | 8.0 dB | 8.5 dB | $f_L$, $f_R$ & $f_I$ 0.05 to 0.2 MHz |
| Isolation | | | | |
| $f_L$ at R | 40 dB | 55 dB | | $f_L$ 0.05 to 30 MHz |
| $f_L$ at I | 35 dB | 50 dB | | |
| $f_L$ at R | 35 dB | 45 dB | | $f_L$ 30 to 200 MHz |
| $f_L$ at I | 30 dB | 35 dB | | |

**Notes:**

1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

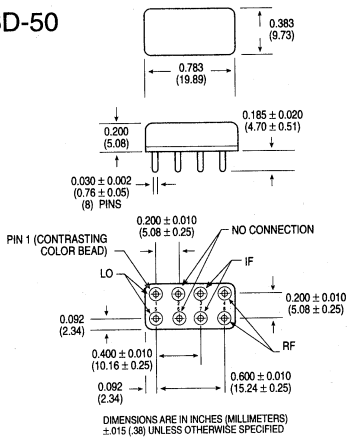
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+17 dBm
Peak Input Current at 25°C .....50 mA DC

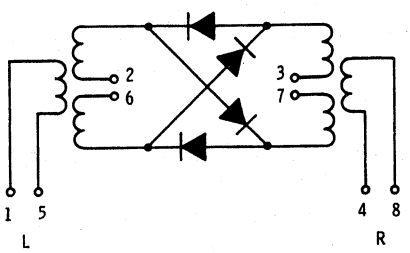
Weight 5.0 grams (0.18 oz.) max.

## Outline Drawings

M6D-50



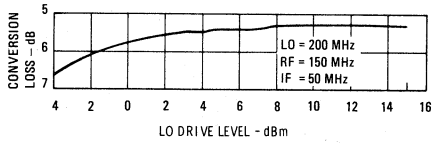

## Schematic Diagram



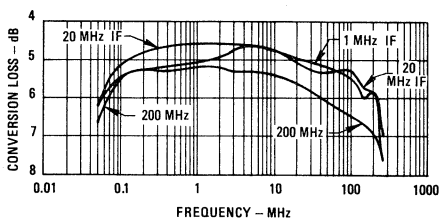

THE I -PORT IS FORMED BY EXTERNALLY CONNECTING PINS 2 AND 6 TOGETHER AND PINS 3 AND 7 TOGETHER. BEST PERFORMANCE IS OBTAINED BY GROUNDING THE 2,6 SIDE.

## Typical Performance at 25°C

### Conversion Loss

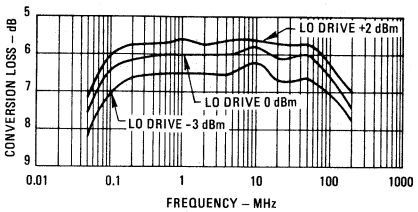



*Conversion Loss vs. LO Drive Level:* The minimum recommended drive level is 0 dBm. The maximum recommended drive level is +13 dBm.

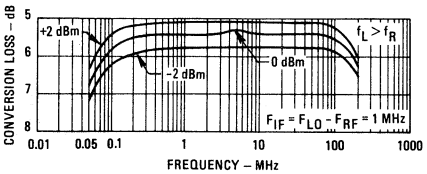



*Conversion Loss vs. Frequency*[1]*:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 1 MHz, 20 MHz and 200 MHz. Data plotted with an $f_L$ level of +7 dBm.

### Conversion Loss

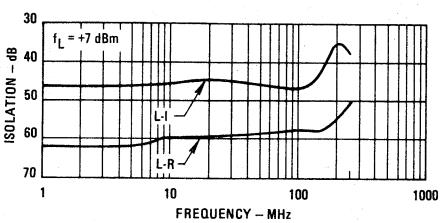


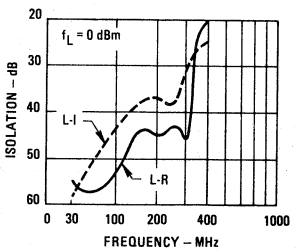

*Conversion Loss vs. Frequency*[2]*:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 200 MHz. Data plotted with an $f_L$ level of +2, 0, -3 dBm.




*Conversion Loss vs. Frequency*[3]*:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 1 MHz. Data plotted with an $f_L$ level of +2, 0, -2 dBm.

### Isolation



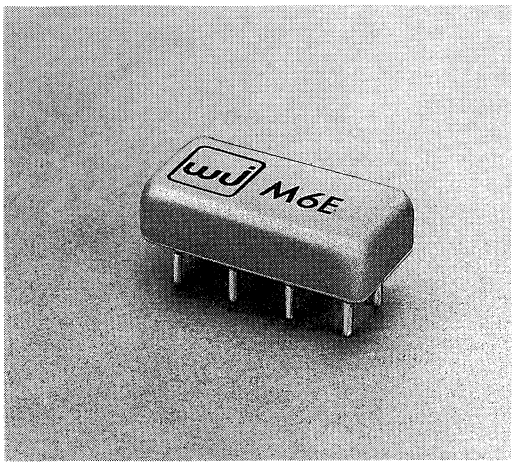

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

10

# WJ - M6E

## DOUBLE-BALANCED MIXER

- LO, RF } 5 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +7 dBm (nominal)
- QPL VERSION AVAILABLE!
- HIGH ISOLATION 45 dB (TYP.)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 7.0 dB | $f_L$ & $f_R$ & $f_I$ 10 to 100 MHz<br>$f_L$ & $f_R$ 100 to 200 MHz |
| | | 7.5 dB | 8.0 dB | $f_I$ 10 to 200 MHz<br>$f_L$ & $f_R$ 5 to 500 MHz |
| | | 8.5 dB | 9.0 dB | $f_I$ 0.5 to 500 MHz |
| Isolation | | | | |
| $f_L$ at R | 45 dB | 55 dB | | $f_L$ 5 to 50 MHz |
| $f_L$ at I | 40 dB | 60 dB | | |
| $f_L$ at R | 30 dB | 35 dB | | $f_L$ 50 to 500 MHz |
| $f_L$ at I | 25 dB | 35 dB | | |

**Notes:**

1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

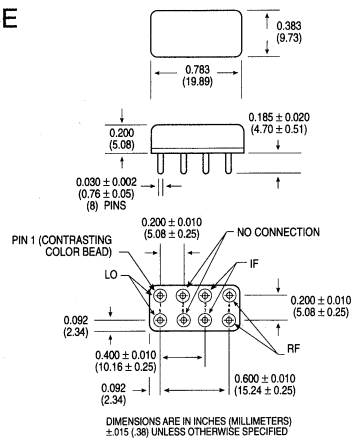
## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +17 dBm
Peak Input Current at 25°C ..... 50 mA DC

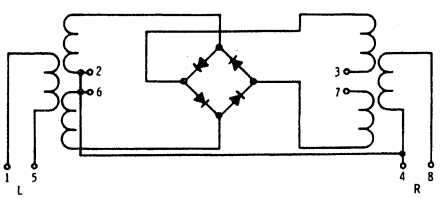
Weight 5.0 grams (0.18 oz.) max.

## Outline Drawings

M6E



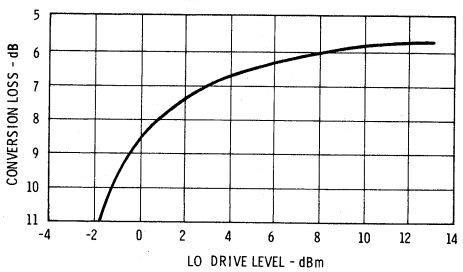

## Schematic Diagram



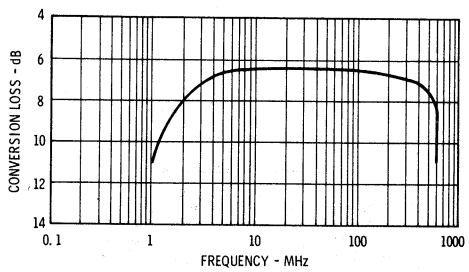

PINS 2, 4 AND 6 ARE INTERNALLY CONNECTED TO THE CASE. THE I-PORT IS FORMED BY EXTERNALLY CONNECTING PINS 3 AND 7 TOGETHER AND USING THE CASE FOR REFERENCE.

## Typical Performance at 25°C

### Conversion Loss

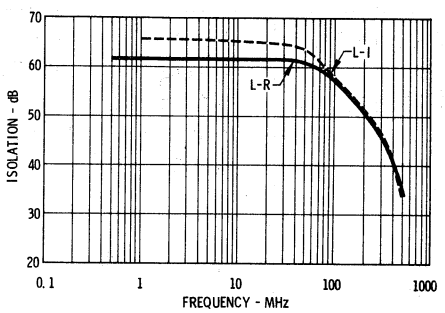



*Conversion Loss vs. LO Drive Level:* Conversion loss in an SSB system as a function of drive level ($f_L$ level), with $f_L$ and $f_R$ at approximately 50 MHz and $f_R$ level at -20 dBm.




*Conversion Loss vs. Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the inputs $f_L$ and $f_R$ with $f_I$ at 50 MHz.

### Isolation




*Isolation vs. Frequency – MHz:* Level of the $f_L$ signal at the R-port with respect to the available power of +7 dBm from a 50-ohm source used for $f_L$.

### Harmonic Intermodulation Products:

**SINGLE-TONE INTERMODULATION DISTORTION**

| HARMONICS OF $f_R$ | HARMONICS OF $f_L$ 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 5 | >90 | 83 | >90 | 78 | >90 | 74 |
| | >90 | 82 | >90 | 78 | >90 | 75 |
| 4 | >90 | >90 | >90 | >90 | >90 | >90 |
| | >90 | >90 | >90 | >90 | >90 | >90 |
| 3 | 65 | 62 | 68 | 54 | 72 | 53 |
| | 68 | 62 | 71 | 58 | 72 | 59 |
| 2 | 76 | 78 | 80 | 75 | 85 | 75 |
| | 78 | 77 | 83 | 75 | 86 | 74 |
| 1 | 24 | 0 | 40 | 13 | 43 | 28 |
| | 24 | 0 | 38 | 11 | 39 | 20 |
| 0 | | 34 | 37 | 47 | 57 | 52 |
| | | 32 | 33 | 44 | 48 | 46 |

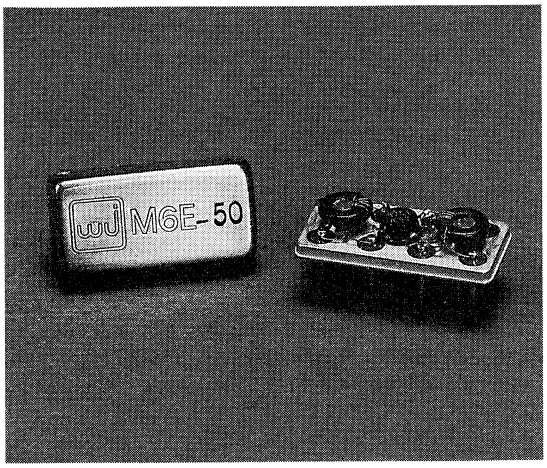
0.5 - 500 MHz
CLASS I MIXER
(TYPE 2)
$f_R$ = 49 MHz @ −10 dBm
$f_L$ = 50 MHz
$f_L$ = +10 dBm
$f_L$ = +7 dBm

10

# WJ - M6E-50

## DOUBLE-BALANCED MIXER

- LO, RF } 5 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 7.0 dB | $f_L$ & $f_R$ $f_I$ 10 to 100 MHz |
| | | | | $f_L$ & $f_R$ 100 to 200 MHz |
| | | 7.5 dB | 8.0 dB | $f_I$ 10 to 200 MHz |
| | | | | $f_L$ & $f_R$ 5 to 500 MHz |
| | | 8.5 dB | 9.0 dB | $f_I$ 0.5 to 500 MHz |
| Isolation | | | | |
| $f_L$ at R | 40 dB | 50 dB | | $f_L$ 5 to 50 MHz |
| $f_R$ at I | 35 dB | 45 dB | | |
| $f_L$ at R | 30 dB | 35 dB | | $f_L$ 50 to 500 MHz |
| $f_R$ at I | 25 dB | 30 dB | | |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

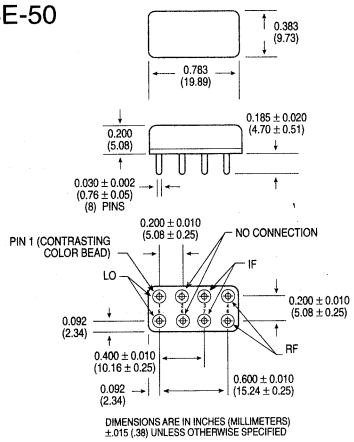
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+17 dBm
Peak Input Current at 25°C .....50 mA DC

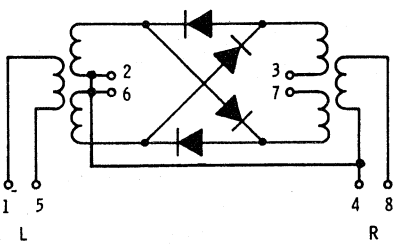
Weight 5.0 grams (0.18 oz.) max.

## Outline Drawings

M6E-50



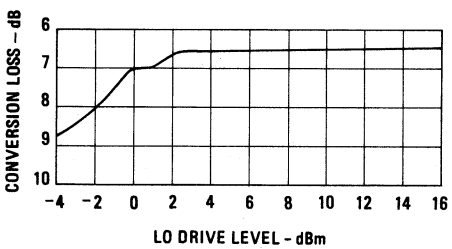

## Schematic Diagram



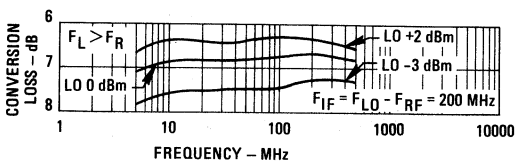

PINS 2, 4 AND 6 ARE INTERNALLY CONNECTED TO THE CASE. THE I-PORT IS FORMED BY EXTERNALLY CONNECTING PINS 3 AND 7 TOGETHER AND USING THE CASE FOR REFERENCE.

## Typical Performance at 25°C

### Conversion Loss

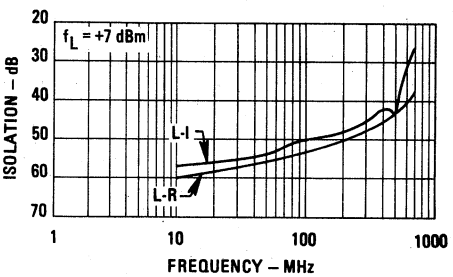


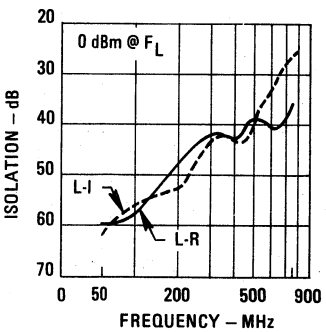

*Conversion Loss vs. LO Drive Level:* Conversion Loss in an SSB system as a function of drivel level ($f_L$ level). The minimum recommended drive level is 0 dBm. The maximum drive level is +13 dBm.




*Conversion Loss vs. Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ equal to 200 MHz. Data plotted with an $f_L$ level of +2, 0, -3 dBm.

### Isolation



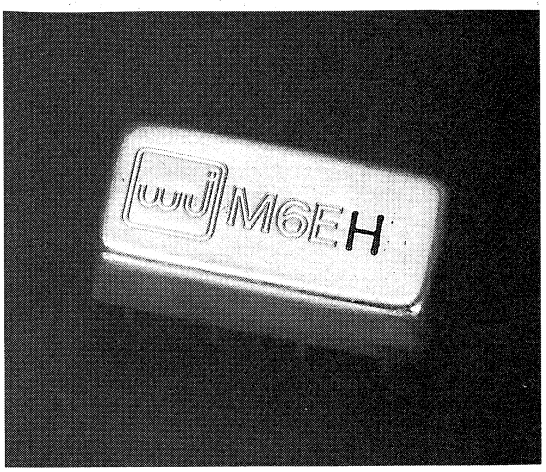




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

10

# WJ - M6EH

## DOUBLE-BALANCED MIXER




- LO 5 TO 750 MHz
- RF 5 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +20 dBm (nominal)
- HIGH INTERCEPT POINT (+28.5 dBm TYP).
- HIGH ISOLATION 45 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specification[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 7.0 dB | $f_L$, $f_R$,$f_I$ 10 to 100 MHZ |
| | | 6.0 dB | 7.5 dB | $f_L$,$f_R$= 100 to 250MHz<br>$f_I$ = 10 to 250 MHz |
| | | 6.5 dB | 8.5 dB | $f_L$ 5 to 750 MHz<br>$f_R$ 5 to 500 MHz<br>$f_I$ 0.5 to 500 MHz |
| Isolation | | | | |
| $f_L$ at R | 40 dB | 60 dB | | $f_L$ = 5 to 200 MHz |
| | 30 dB | 45 dB | | $f_L$ = 200 to 500 MHz |
| | 20 dB | 35 dB | | $f_L$ = 500 to 750 MHz |
| $f_L$ at I | 40 dB | 55 dB | | fL = 5 to 200 MHz |
| | 25 dB | 40 dB | | fL = 200 to 500 MHz |
| | 18 dB | 30 dB | | fL = 500 to 750 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +13 dBm<br>$f_L$ = +20 dBm |
| Third Order Input Intercept | | +28.5 dBm | | $f_L$ 300 MHz +20 dBm<br>$f_{R_1}$ 250 MHz 0 dBm<br>$f_{R_2}$ 260 MHz 0 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

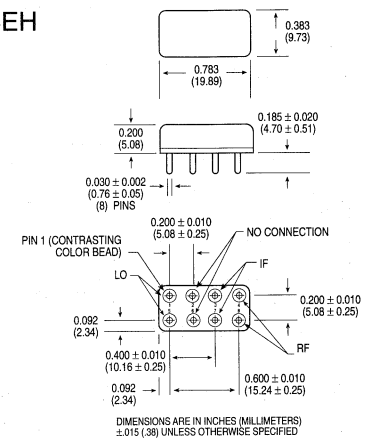
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm
Peak Input Current at 25°C .....100 mA DC

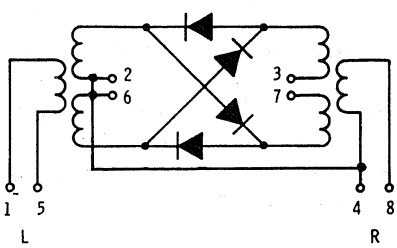
Weight M6EH 5.0 grams (0.18oz.) max.

## Outline Drawings

M6EH

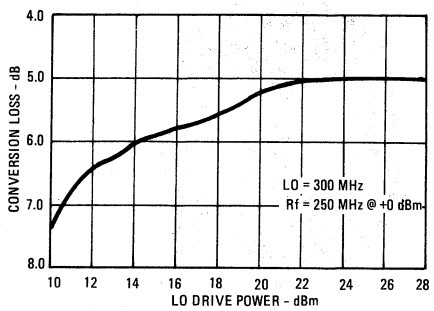



## Schematic Diagram

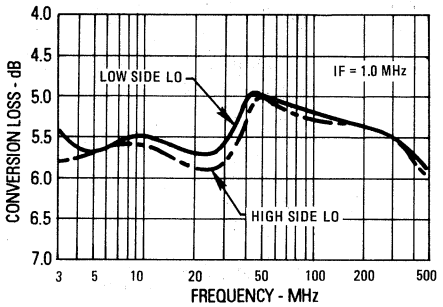


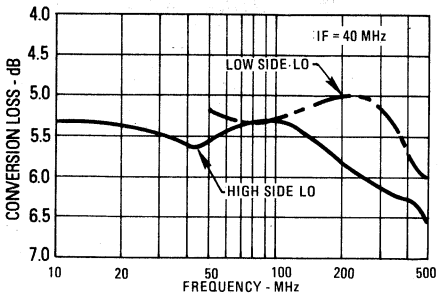

PINS 2, 4 AND 6 ARE INTERNALLY CONNECTED TO THE CASE. THE I-PORT IS FORMED BY EXTERNALLY CONNECTING PINS 3 AND 7 TOGETHER AND USING THE CASE FOR REFERENCE.

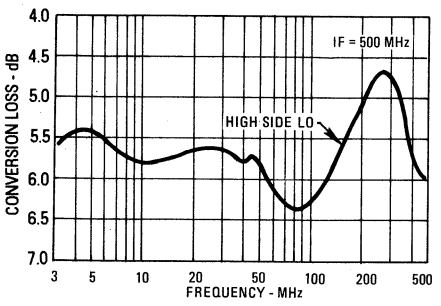
# Typical Performance at 25°C



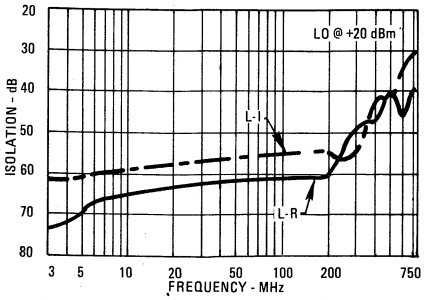

***Conversion Loss vs. LO Drive Level:*** The maximum recommended drive level is +26 dBm. The minimum recommended drive level is +17 dBm.

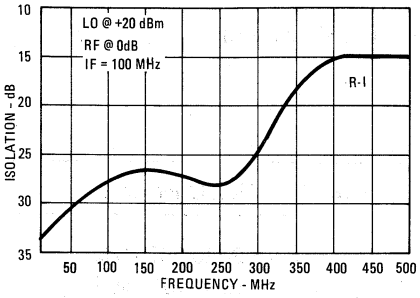


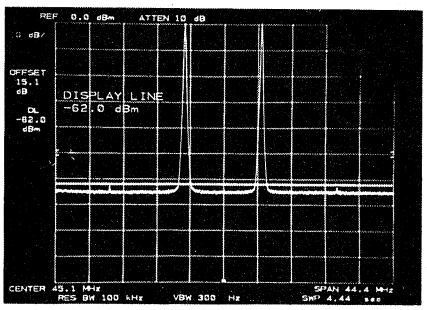




## Isolation

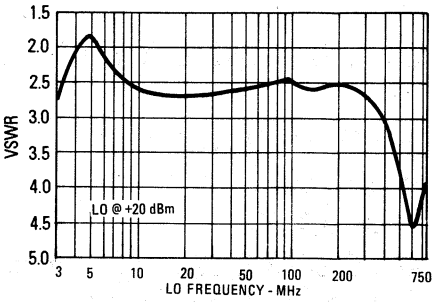


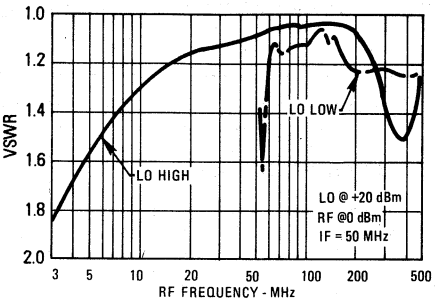

## Typical Two-Tone Intermodulation Performance:



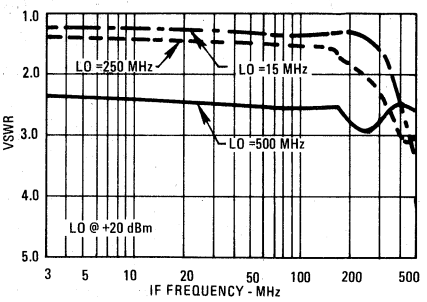

## L-Port VSWR




## R-Port VSWR




## I-Port VSWR

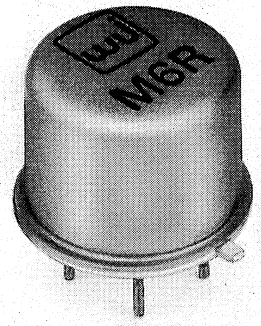



10

# WJ - M6R

## DOUBLE-BALANCED MIXER

- LO 10 TO 1200 MHz
- RF 10 TO 1000 MHz
- IF DC TO 1000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

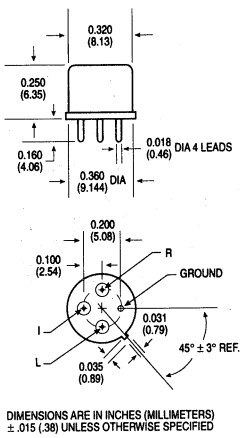
## Guaranteed Specifications [1]

M6R

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.0 dB | $f_R$ 20 to 600 MHz, $f_L$ 10 to 1000 MHz, $f_I$ 1 to 500 MHz |
| | | 7.5 dB | 8.5 dB | $f_R$ 10 to 1000 MHz, $f_L$ 10 to 1200 MHz, $f_I$ 1 to 200 MHz |
| | | 8.5 dB | 9.5 dB | $f_I$ 1 to 1000 MHz |
| Isolation | | | | |
| $f_L$ at R | 45 dB | 55 dB | | |
| $f_L$ at I | 30 dB | 40 dB | | $f_L$ 10 to 100 MHz |
| $f_L$ at R | 25 dB | 35 dB | | |
| $f_L$ at I | 20 dB | 25 dB | | $f_L$ 100 to 500 MHz |
| $f_L$ at R | 20 dB | 25 dB | | |
| $f_L$ at I | I5 dB | 20 dB | | $f_L$ 500 to 1000 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm, $f_L$ Level = +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

## Absolute Maximum Ratings

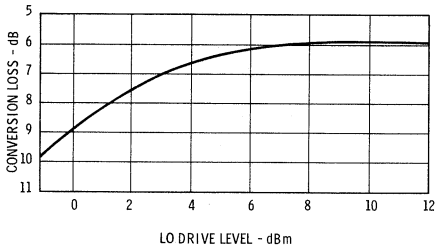
Operating Temperature* .....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak RF Input Power at .....+23 dBm at +25°C, derate to +17 dBm +100°C
Peak Input Current at 25°C .....50 mA DC

*For input signals below 20 MHz, the temperature range is -20°C to +100°C.

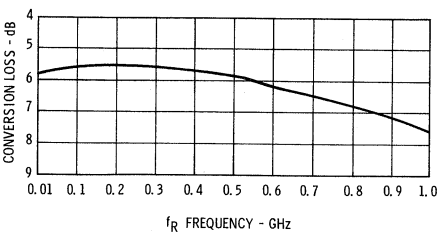
Weight 2 grams (0.07 oz.) max.

## Typical Performance at 25°C

### Conversion Loss

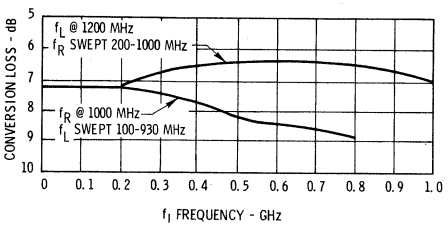



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.



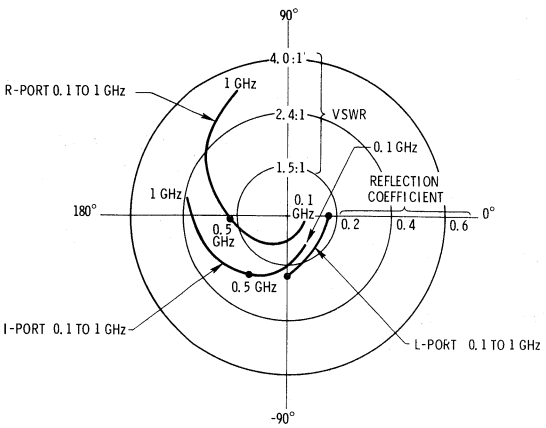

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 30 MHz. Data plotted with an $f_L$ level of +7 dBm.

### Conversion Loss



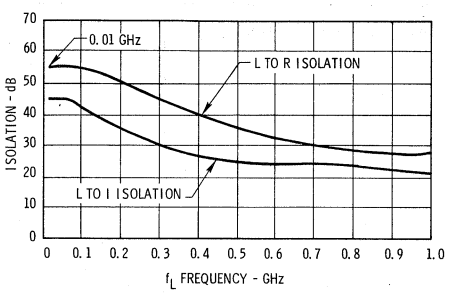

*Conversion Loss vs. $f_I$ Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$).

### VSWR




*Reflection Coefficient vs. Frequency:* Reflection coefficient of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. R- and I-port reflection coefficient is plotted for $f_L$ at 0.5 MHz. Also shown is the L-port VSWR.

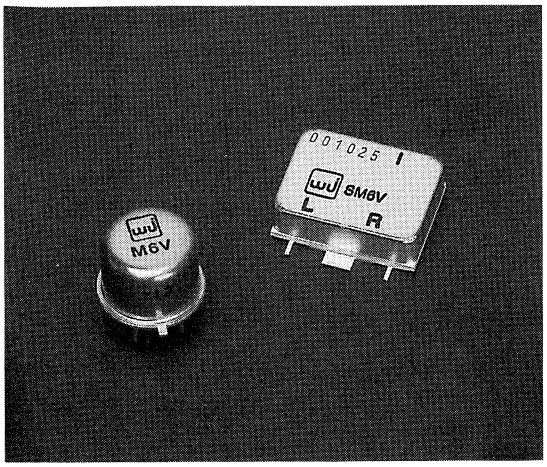
### Isolation




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

# WJ - M6V/SM6V

## DOUBLE-BALANCED MIXER




- LO, RF } 0.4 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +7 dBM (nominal)
- AVAILABLE IN SURFACE MOUNT
- QPL VERSION AVAILABLE! (See Section 7)
- HIGH ISOLATION 50 dB (TYP.)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB<br>7.0 dB | 6.5 dB<br>7.5 dB | $f_L, f_R$ & $f_I$ 1 to 200 MHz<br>$f_L, f_R$ & $f_I$ 0.4 to 500 MHz |
| Isolation | | | | |
| $f_L$ at R | 45 dB | 55 dB | | $f_L$ 0.4 to 60 MHz |
| $f_L$ at I | 30 dB | 45 dB | | |
| $f_L$ at R | 30 dB | 40 dB | | $f_L$ 60 to 500 MHz |
| $f_L$ at I | 20 dB | 30 dB | | |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm<br>$f_L$ Level = +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = -2 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

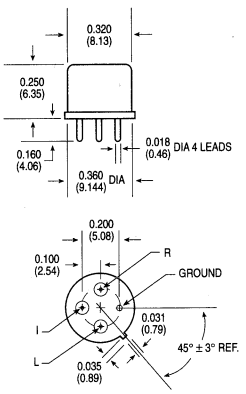
Operating Temperature* .....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak RF Input Power at .....+23 dBm at +25°C, derate to +17 dBm +100°C
Peak Input Current at 25°C .....50 mA DC

*For input signals below 1 MHz, the temperature range is -20°C to +100°C.

Weight M6V: 2 grams (0.07 oz.) max.
SM6V: 3 grams (0.11 oz.) max.

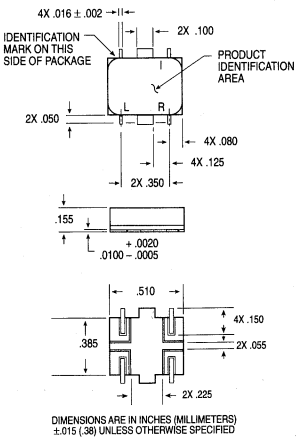
## Outline Drawings

M6V




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

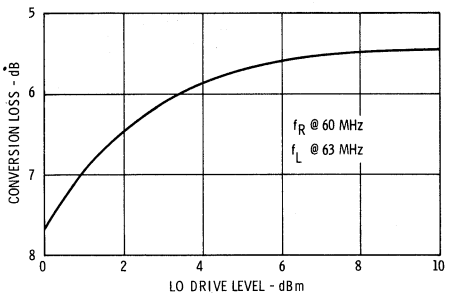
SM6V



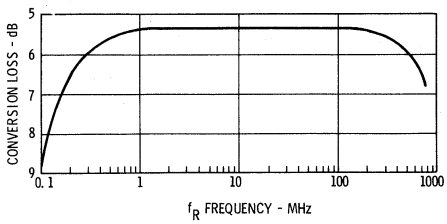

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

**Conversion Loss**

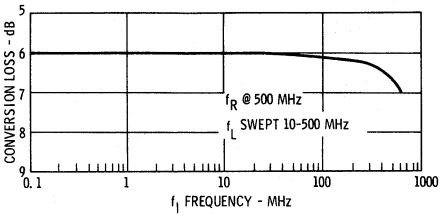



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.



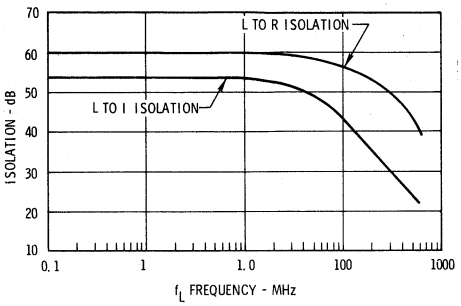

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm, $f_I$ at 50 MHz.

**Conversion Loss**



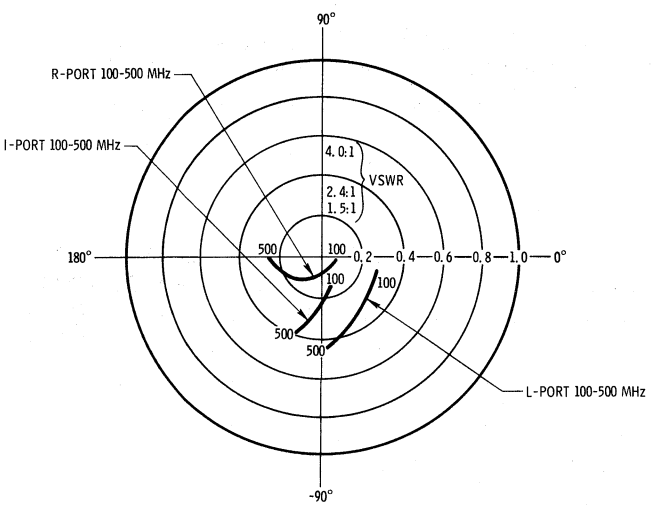

*Conversion Loss vs. $f_I$ Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$).

**Isolation**




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

**VSWR**




*Reflection Coefficient vs. Frequency:* Reflection coefficient of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. R- and I-port reflection coefficient is plotted for $f_L$ at 250 MHz.

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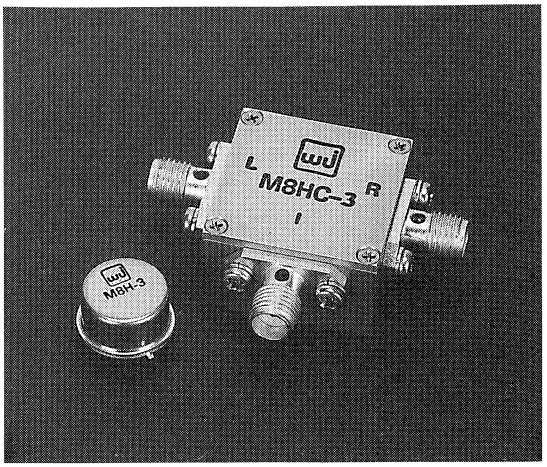
# WJ - M8H-3/M8HC-3

## DOUBLE-BALANCED MIXER

- LO 2.0 TO 6.0 GHz
- RF 3.7 TO 4.2 GHz
- IF DC TO 2000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.0 dB | 7.0 dB | $f_R$ = 3.7 to 4.2 GHz<br>$f_L$ = 2.0 to 6.0 GHz<br>$f_I$ = 30 to 2000 MHz |
| Isolation<br>$f_L$ at R<br><br>$f_L$ at I | <br>32 dB<br>25 dB<br>16 dB | <br>42 dB<br>37 dB<br>21 dB | | <br>$f_L$ 2.0 to 4.0 GHz<br>$f_L$ 4.0 to 6.0 GHz<br>$f_L$ 2.0 to 6.0 GHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level = 0 dBm<br>$f_L$ Level = +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = 2 dBm |
| Third-Order Intercept Point | | +13 dBm | | $f_L$ = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M8HC-3 are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

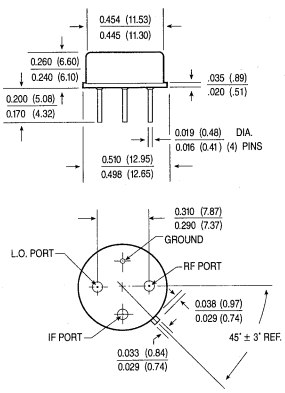
## Absolute Maximum Ratings

Operating Temperature.....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak RF Input Power at .....+23 dBm at +25°C, derate to +17 dBm +100°C
Peak Input Current at 25°C .....50 mA DC

Weight M8H-3: 2 grams (0.07 oz.) max.
M8HC-3: 22 grams (0.78 oz.) max.

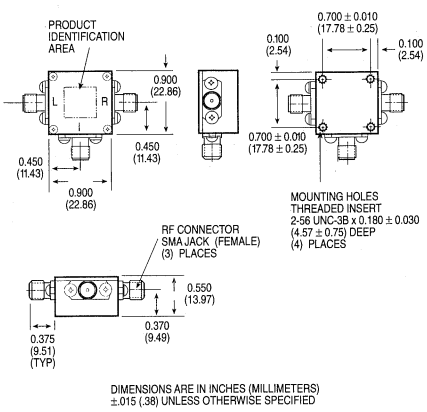
## Outline Drawings

M8H-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

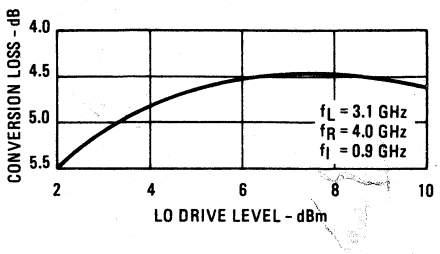
M8HC-3




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

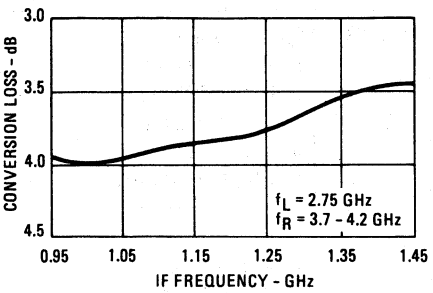
**Conversion Loss**




*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +4 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and noise figure over the full temperature and frequency range.

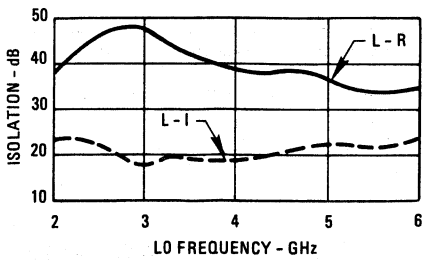
The maximum recommended drive level is +11 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation.

**Conversion Loss**



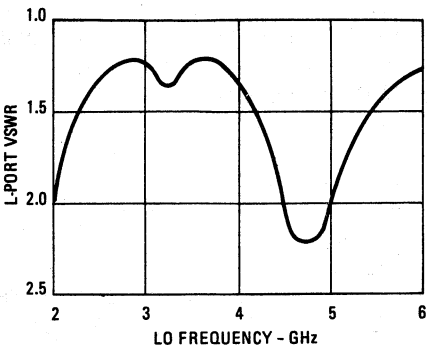

*Conversion Loss vs. $f_I$ Frequency:* Conversion loss the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_L$ at 2.75 GHz and $f_R$ swept from 3.7 to 4.2 GHz.

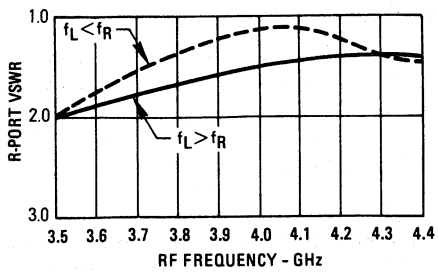
**Isolation**

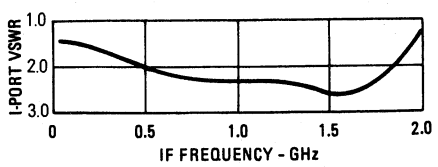



*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

**VSWR**



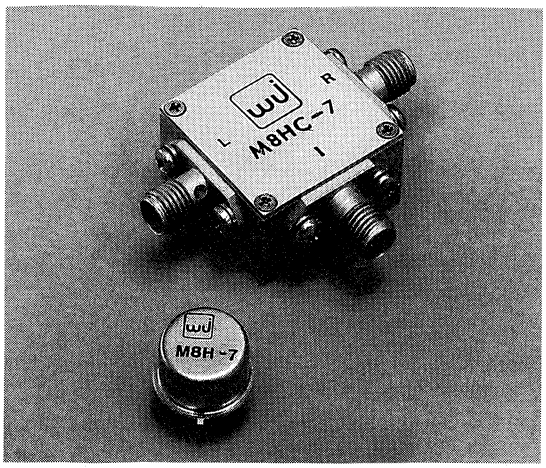




10

# WJ-M8H-7/M8HC-7

## DOUBLE-BALANCED MIXER

- LO 2.0 TO 6.0 GHz
- RF 2.4 TO 6.0 GHz
- IF DC to 2000 MHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION 40 dB (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section))

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.0 dB | 7.0 dB | $f_R$ 3.7 to 4.2 GHz<br>$f_L$ 2 to 6 GHz<br>$f_I$ 30 to 2000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 2.4 to 6 GHz<br>$f_L$ 2 to 6 GHz<br>$f_I$ 30 to 2000 MHz |
| Isolation | | | | |
| L to R | 32 dB | 42 dB | | $f_L$ 2 to 4 GHz |
| | 25 dB | 37 dB | | $f_L$ 4 to 6 GHz |
| L to I | 16 dB | 21 dB | | $f_L$ 2 to 6 GHz |
| Conversion Compression | | 1.0 dB | | $f_R$ Level 0 dBm<br>$f_L$ Level +7 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ Level = 2 dBm |
| Third-Order Intercept Point | | +13 dBm | | $f_L$ = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M8HC-7 are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

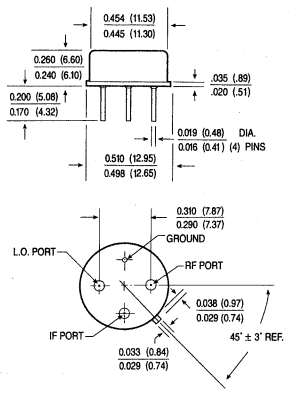
## Absolute Maximum Ratings

Operating Temperature.....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak Input Power.....+23 dBm at +25°C derate to +17 dBm at +100°C
Peak Input Current at 25°C.....50 mA DC

Weight M8H-7: 2 grams (0.07 oz.) max.
M8HC-7: 22 grams (0.78 oz.) max.

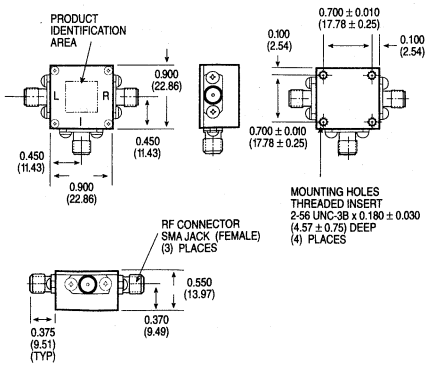
## Outline Drawings

M8H-7




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

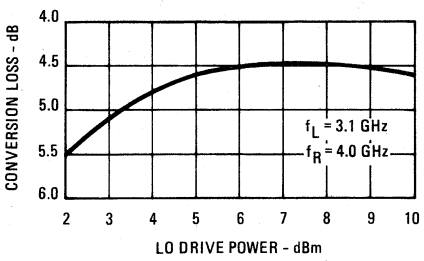
M8HC-7




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

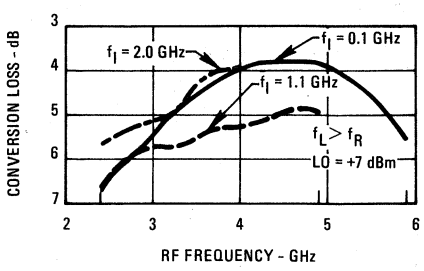
## Typical Performance at 25°C

### Conversion Loss

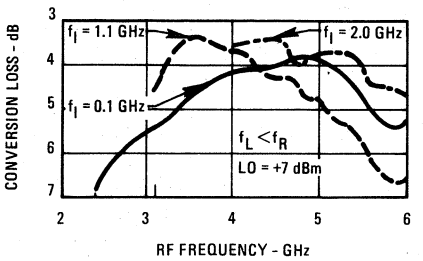



***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +4 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and noise figure over the full temperature and frequency range.

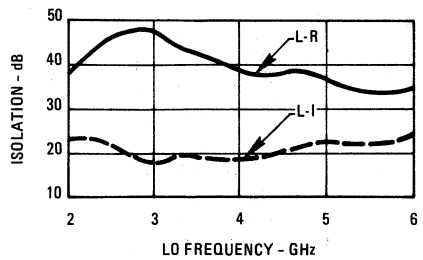
The maximum recommended drive level is +11 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation.




### Conversion Loss

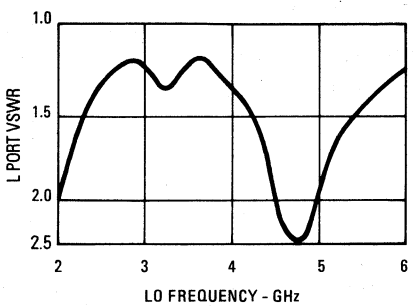


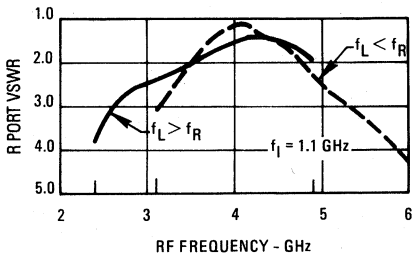

### Isolation

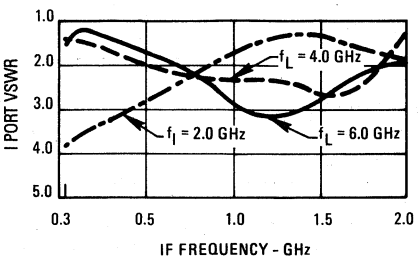



***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR



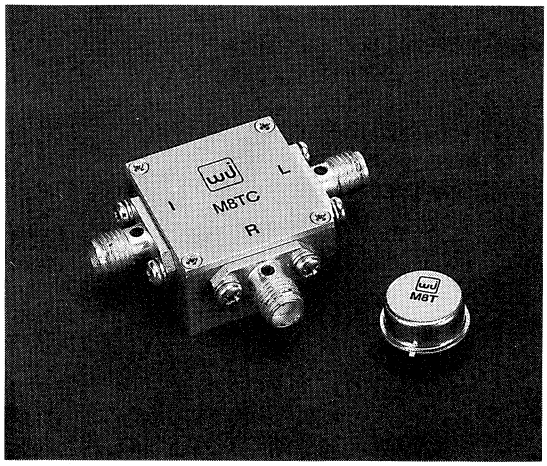



# WJ-M8T/M8TC

## LOAD INSENSITIVE MIXER

- LO, RF } 1 TO 3400 MHz
- IF 1 TO 2000 MHz
- LO DRIVE +10 dBm (nominal)
- INSENSITIVE TO SYSTEM MISMATCH
- HIGH INTERCEPT POINT +18 dBm (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_L$ & $f_R$ 5 to 1000 MHz, $f_I$ 1-500 MHz |
| | | 7.0 dB | 9.0 dB | $f_L$ & $f_R$ 1-3000 MHz, $f_I$ 1-1500 MHz |
| | | 8.0 dB | 10.5 dB | $f_L$ & $f_R$ 1-3400 MHz, $f_I$ 1-2000 MHz |
| Isolation | | | | |
| $f_L$ at I | 32 dB | 40 dB | | $f_L$ 10-1500 MHz |
| | 25 dB | 35 dB | | $f_L$ 10-3400 MHz |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 10-1500 MHz |
| | 25 dB | 35 dB | | $f_L$ 10-3400 MHz |
| $f_R$ at I | | 25 dB | | $f_R$ 10 to 3400 MHz |
| Third-Order Intercept Point | | +18 dBm | | $f_L$ 2000 MHz, +10 dBm, $f_{R_1}$ = 1900 MHz, $f_{R2}$ = 1910 MHz both at-10 dBm |
| Conversion Compression | | 1.0 dB | | $f_R$ at +7 dBm, $f_L$ at +13 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ at +5 dBm |
| Third-Order Intermodulation Suppression Degradation | | 3 dB | | If VSWR ≤ 3:1 at I-Port |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.
2. Guaranteed conversion loss values for M8TC unit are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

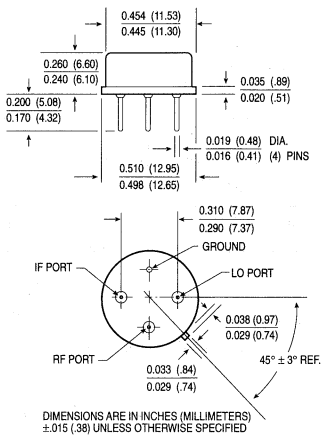
## Absolute Maximum Ratings

Operating Temperature .....-54° C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+27 dBm max, at +25°C, +23 dBm max. at +100°C

Weight M8T: 2 grams (0.07 oz.) max.
M8TC: 22 grams (0.078 oz.) max.

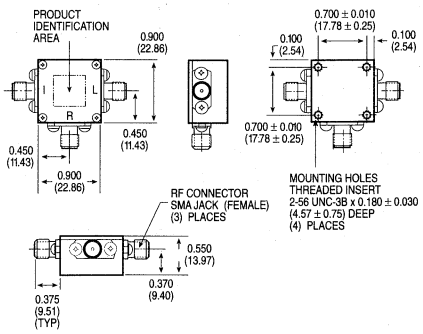
## Outline Drawings

M8T




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

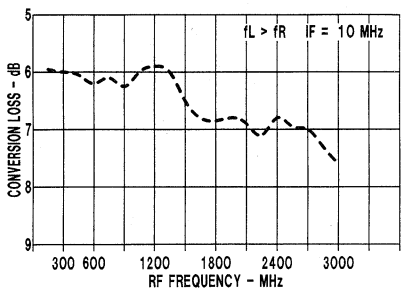
M8TC

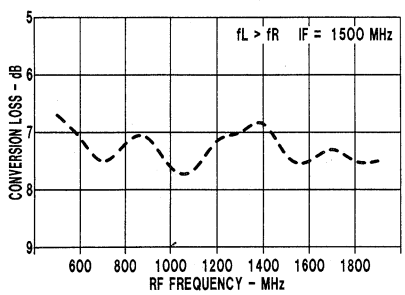



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

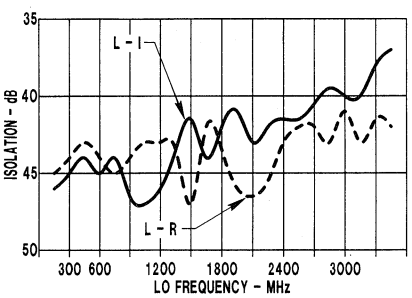
## Typical Performance at 25°C

### Conversion Loss vs. Frequency




### Isolation vs. Frequency

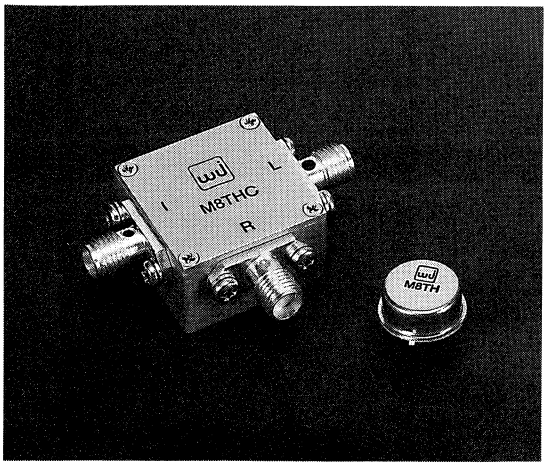



10

# WJ-M8TH/M8THC

## LOAD INSENSITIVE MIXER

- LO, RF } 1 TO 3400 MHz
- IF 1 TO 2000 MHz
- LO DRIVE +23 dBm (nominal)
- INSENSITIVE TO SYSTEM MISMATCH
- HIGH INTERCEPT +29 dBm (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB<br><br>8.5 dB | 8.0 dB<br><br>10.5 dB | $f_L$ & $f_R$: 5 to 2000 MHz<br>$f_I$ 1 to 500 MHz<br>$f_L$ & $f_R$ 1 to 3400 MHz<br>$f_I$ 1 to 2000 MHz |
| Isolation<br>$f_L$ at I<br><br>$f_L$ at R<br><br>$f_R$ at I | <br>30 dB<br>25 dB<br>30 dB<br>22 dB | <br>40 dB<br>35 dB<br>37 dB<br>35 dB<br>21 dB | | <br>$f_L$ 10 to 1500 MHz<br>$f_L$ 10 to 3400 MHz<br>$f_L$ 10 to 1500 MHz<br>$f_L$ 10 to 3400 MHz<br>$f_R$ 10 to 3400 MHz |
| Third-Order Intercept Point | | +29 dBm | | LO 1800 MHz at +22 dBm<br>$f_{R_1}$ = 1000 MHz,<br>$f_{R2}$ = 1010 MHz<br>both at 0 dbm |
| Conversion Compression | | 1.0 dB | | $f_R$ at +17 dBm<br>$f_L$ at +23 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ at +15 dBm |
| Third-Order Intermodulation Suppression Degradation | | 3 dB | | If VSWR ≤ 3:1 at I-Port |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.
2. Guaranteed conversion loss values for M8THC unit are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C termperature range only.

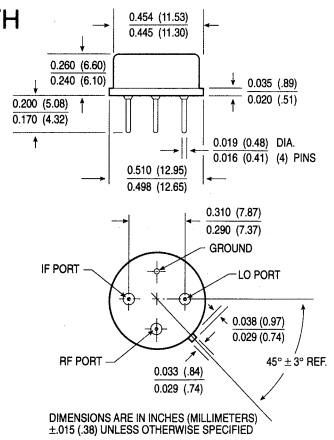
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+27 dBm max, at +25°C, +23 dBm max. at +100°C

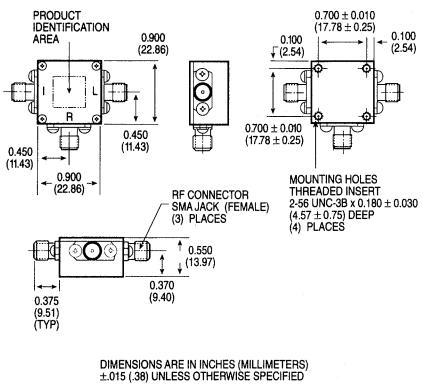
Weight M8TH: 2 grams (0.07 oz.) max.
M8THC: 22 grams (0.078 oz.) max.

## Outline Drawings

M8TH

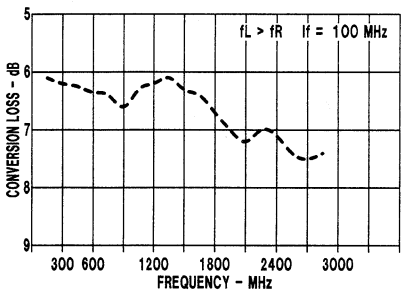



M8THC

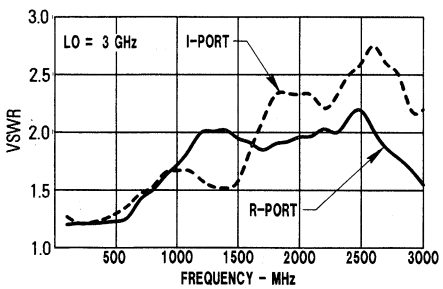


## Typical Performance at 25°C

### Conversion Loss vs. Frequency




### VSWR vs. Frequency

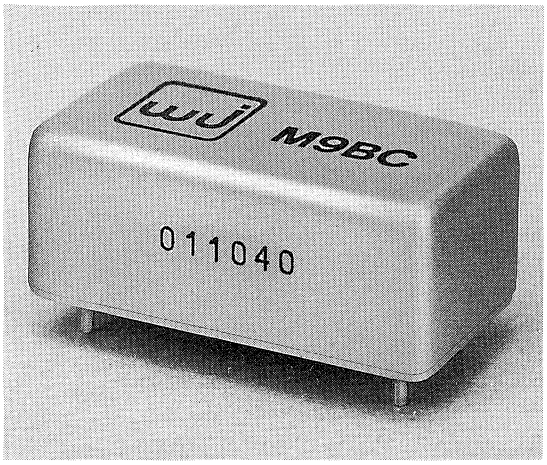



10

# WJ-M9BC

## DOUBLE-BALANCED MIXER

- LO, RF } 0.5 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +17 dBm (nominal)
- HIGH INTERCEPT POINT: +25 dBm (TYP.)
- QPL VERSION AVAILABLE!
- HIGH ISOLATION 50 dB (TYP.)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.0 dB | $f_L$ & $f_R$ 0.5 to 30 MHz<br>$f_I$ 0.4 to 30 MHz |
| | | 7.0 dB | 7.5 dB | $f_L$ &$f_R$ 30 to 100 MHz<br>$f_I$ 0.4 to 100 MHz |
| | | 8.0 dB | 9.0 dB | $f_L$ & $f_R$ 100 to 500 MHz<br>$f_I$ 0.4 to 500 MHz |
| Isolation | | | | |
| $f_L$ at R | 55 dB | 60 dB | | $f_L$ 0.5 to 30 MHz |
| $f_L$ at I | 45 dB | 55 dB | | |
| $f_L$ at R | 45 dB | 55 dB | | $f_L$ 30 to 100 MHz |
| $f_L$ at I | 35 dB | 45 dB | | |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 100 to 500 MHz |
| $f_L$ at I | 25 dB | 30 dB | | |
| $f_R$ at I | | 20 dB | | $f_R$ 0.5 to 500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +8 dBm<br>$f_L$ = +17 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ = +17 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

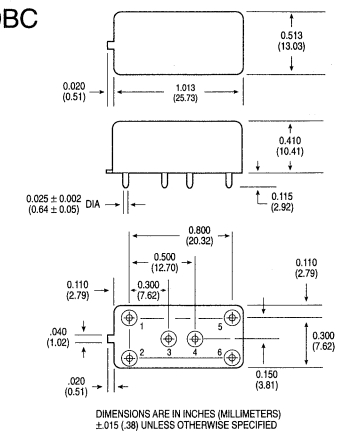
## Absolute Maximum Ratings

Operating Temperature .....-54°C to + 100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm
Peak Input Current at 25°C .....100 mA DC

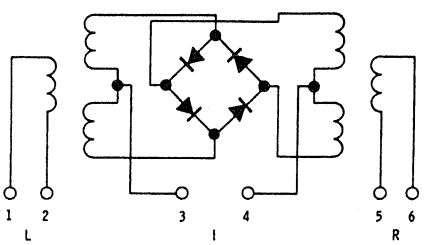
Weight 8 grams (0.28 oz.) max.

## Outline Drawings

M9BC




## Schematic Diagram

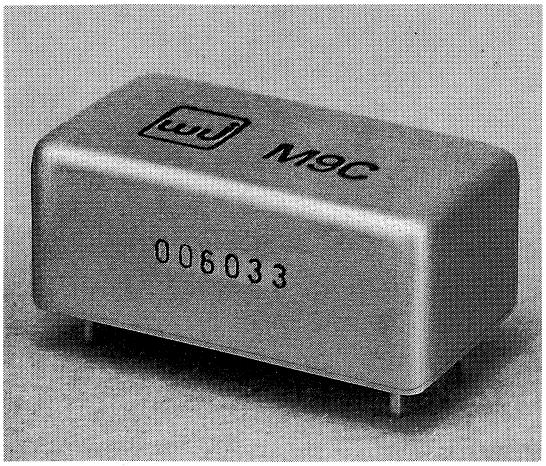



FOR BEST ISOLATION OF THE HIGH-LEVEL ($F_L$) SIGNAL,GROUND PIN 3.

# WJ - M9C

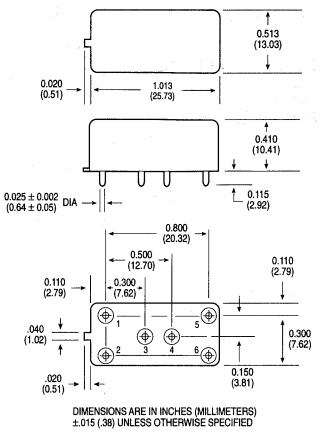
## DOUBLE-BALANCED MIXER

- LO, RF } 0.4 TO 500 MHz
- IF DC TO 500 MHz
- LO DRIVE +13 dBm (nominal)
- HIGH ISOLATION: 35 dB (TYP.)
- QPL VERSION AVAILABLE!
- HIGH INTERCEPT POINT: +25 dBm (TYP.)




## Outline Drawings

M9C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB<br><br>8.0 dB | 7.5 dB<br><br>9.0 dB | $f_L$ & $f_R$ 10 to 50 MHz<br>$f_I$ 1 to 50 MHz<br>$f_L$ & $f_R$ 0.4 to 500 MHz<br>$f_I$ 0.4 to 500 MHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I<br>$f_L$ at R<br>$f_L$ at I | <br>45 dB<br>40 dB<br>30 dB<br>25 dB | <br>50 dB<br>45 dB<br>40 dB<br>35 dB | | <br>$f_L$ 0.4 to 50 MHz<br><br>$f_L$ 50 to 500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +10 dBm<br>$f_L$ = +17 dBm |
| Desensitization Level | | 1.0 dB | | $f_{R_2}$ = +17 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

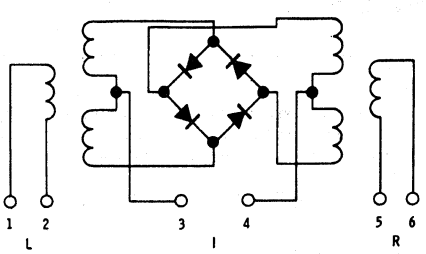
## Absolute Maximum Ratings

Operating Temperature* ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +23 dBm
Peak Input Current at 25°C ..... 100 mA DC

*For input signals below 100 kHz, the temperature range is -20°C to +100°C.

Weight 8 grams (0.28 oz.) max.

## Schematic Diagram



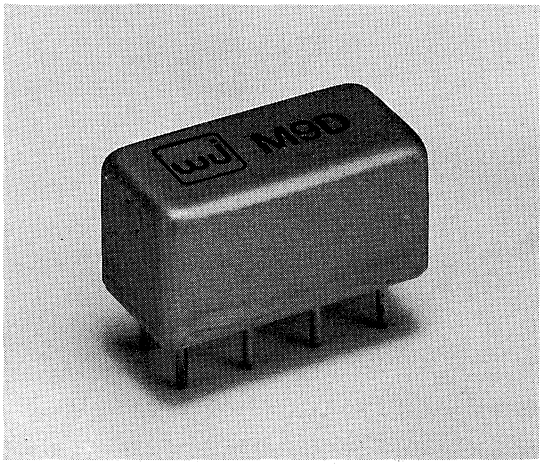

FOR BEST ISOLATION OF THE HIGH-LEVEL ($F_L$) SIGNAL, GROUND PIN 3.

10


505

# WJ-M9D

## DOUBLE-BALANCED MIXER



- LO 2 TO 500 MHz
- RF 2 TO 400 MHz
- IF DC TO 800 MHz
- LO DRIVE +20 dBm (nominal)
- HIGH INTERCEPT POINT: +30 dBm (TYP.)
- QPL VERSION AVAILABLE!

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | | | $f_L$ 5 to 200 MHz<br>$f_R$ 20 to 80 MHz |
| | | 6.0 dB | 6.5 dB | $f_I$ 5 to 80 MHz |
| | | 6.5 dB | 7.0 dB | $f_I$ 0.4 to 120 MHz |
| | | | | $f_L$ & $f_R$ 5 to 300 MHz |
| | | 6.0 dB | 7.0 dB | $f_I$ 5 to 80 MHz |
| | | 7.0 dB | 8.0 dB | $f_I$ 0.4 to 300 MHz |
| | | | | $f_L$ 5 to 470 MHz<br>$f_R$ 5 to 400 MHz |
| | | 6.5 dB | 7.5 dB | $f_I$ 5 to 80 MHz |
| | | | | $f_L$ 2 to 500 MHz<br>$f_R$ 2 to 400 MHz |
| | | 8.0 dB | 9.0 dB | $f_I$ 0.4 to 800 MHz |
| Isolation | | | | |
| $f_L$ at R | 40 dB | 60 dB | | |
| $f_L$ at I | 40 dB | 60 dB | | $f_L$ 2 to 32 MHz |
| $f_L$ at R | 35 dB | 50 dB | | |
| $f_L$ at I | 35 dB | 55 dB | | $f_L$ 32 to 100 MHz |
| $f_L$ at R | 25 dB | 40 dB | | |
| $f_L$ at I | 25 dB | 35 dB | | $f_L$ 100 to 500 MHz |
| $f_R$ at I | | 20 dB | | $f_R$ 2 to 400 MHz |
| Conversion Compression | | | | $f_R$ +15 dBm |
| | | 1.0 dB | | $f_L$ +23 dBm |
| Desensitization | | | | $f_{R2}$ +13 dBm |
| | | 1.0 dB | | |

Notes:

1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

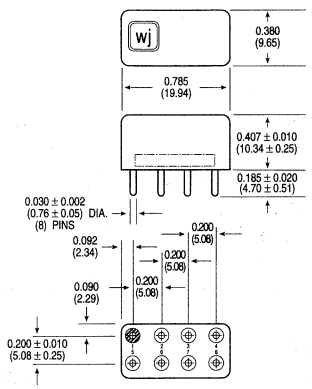
Operating Temperature
- within specification ..... -54°C to +85°C
- with 0.5 dB noise figure degradation ..... -54°C to +100°C

Storage Temperature ..... -65°C to +100°C
Peak Input Power for any Single Port ..... +23 dBm RMS, +26 dBm Peak
Total Input Power for all Ports ..... +24 dBm RMS, +27 dBm Peak
Peak Input Current at 25°C ..... 100 mA DC

Weight 6 grams (0.21 oz.) max.

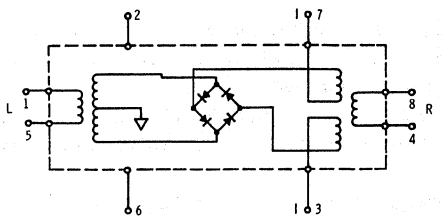
## Outline Drawings

M9D




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

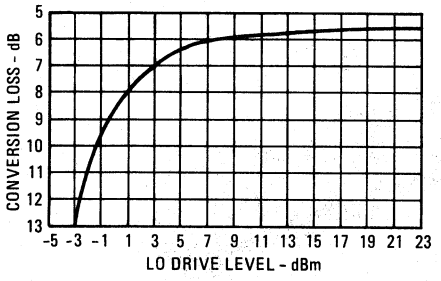
## Schematic Diagram



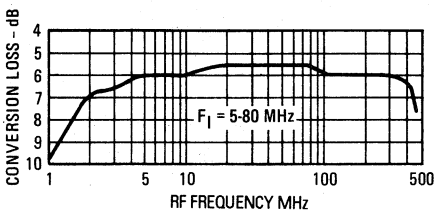

FOR BEST ISOLATION OF THE HIGH-LEVEL ($F_L$) SIGNAL,GROUND PIN 3.

# Typical Performance at 25°C

### Conversion Loss

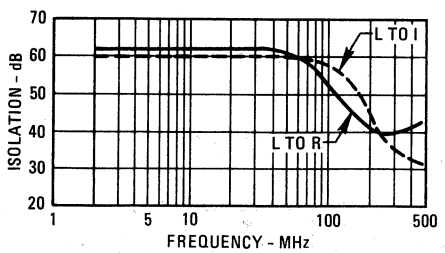



*Conversion Loss vs. LO Drive Level:* The minimum recommended drive level is +10 dBm. The maximum recommended drive level is +23 dBm.



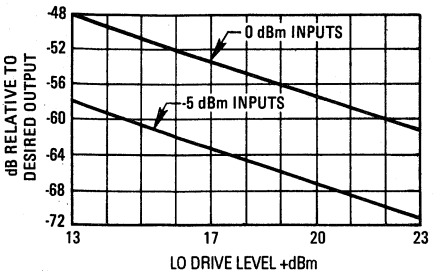

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ any frequency 5 – 80 MHz. Data plotted with an $f_L$ level of +20 dBm.

### Isolation

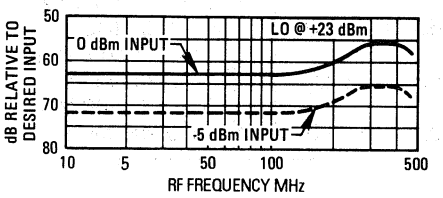



*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### Two-Tone Intermodulation

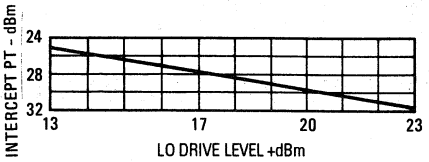



*Two-Tone Suppression vs. Drive Level:* The WJ-M9D is designed for superior two-tone performance with a low LO drive level. With only +20 dBm LO drive level, the third-order products will be reduced 68 dB with both input signals at -5 dBm.

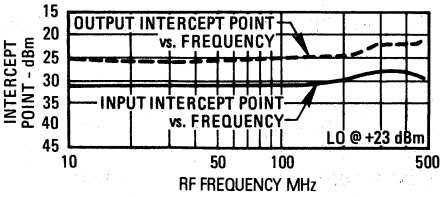



*Two-Tone Suppression vs. Input Frequency:* With each dB decrease in input level the third-order product is decreased an additional 2 dB. As shown, the WJ-M9D will reduce third-order products 62.5 dB with both input signals at 0 dB and 72 dB with both input signals at -5 dBm.

### Third-Order Intercept Point




*Input Intercept Point vs. Drive Level:* With only +20 dBm LO drive level, this mixer has a +30 dBm input third-order intercept point.



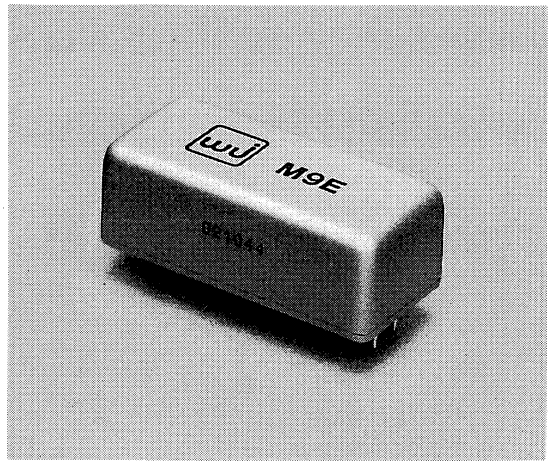

*Intercept Point vs. Frequency:* The input intercept point of the WJ-M9D is +30 dBm. This is 15 dB higher than the intercept point for a low level double-balanced mixer. The output intercept point is equal to the input intercept point minus the conversion loss.

10

# WJ-M9E

## DOUBLE-BALANCED MIXER

- LO } 1 TO 400 MHz
- RF }
- IF DC TO 400 MHz
- LO DRIVE +27 dBm (nominal)
- HIGH INTERCEPT POINT: +32.5 dBm (TYP.)




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 6.0 dB | $f_L$ & $f_R$ 2 to 50 MHz<br>$f_I$ 2 to 100 MHz |
| | | 7.0 dB | 7.5 dB | $f_L$ & $f_R$ 1 to 100 MHz<br>$f_I$ 0.4 to 400 MHz |
| | | 8.0 dB | 9.0 dB | $f_L$ & $f_R$ 1 to 400 MHz<br>$f_I$ 0.4 to 200 MHz |
| Isolation | | | | |
| $f_L$ at R | 45 dB | 50 dB | | $f_L$ 1 to 30 MHz |
| $f_L$ at I | 45 dB | 55 dB | | |
| $f_L$ at R | 35 dB | 40 dB | | $f_L$ 30 to 100 MHz |
| $f_L$ at I | 40 dB | 45 dB | | |
| $f_L$ at R | 25 dB | 30 dB | | $f_L$ 100 to 400 MHz |
| $f_L$ at I | 25 dB | 35 dB | | |
| $f_R$ at I | | 25 dB | | $f_R$ 1 to 400 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +20 dBm<br>$f_L$ = +27 dBm |
| Desensitization | | 1.0 dB | | $f_{R_2}$ = +18 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature *
- with +27 dBm LO Power ..... -54°C to +71°C
- with +24 dBm LO Power ..... -54°C to +100°C

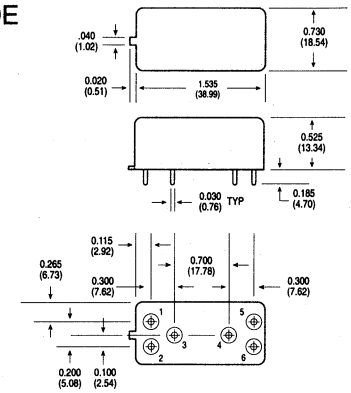
Storage Temperature ..... -65°C to +100°C
Peak Input Power for any Single Port ..... +30 dBm RMS, +33 dBm Peak
Total Input Power for all Ports ..... +31.5 dBm RMS, +34.5 dBm Peak
Peak Input Current at 25°C ..... 200 mA DC

The power rating is applicable over a -54°C to +71°C, Temperature range. Derate linearly to one–halfpower at 100°C.

Weight 21 grams (0.74 oz.) max.

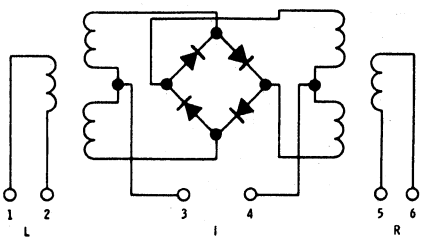
## Outline Drawings

M9E




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

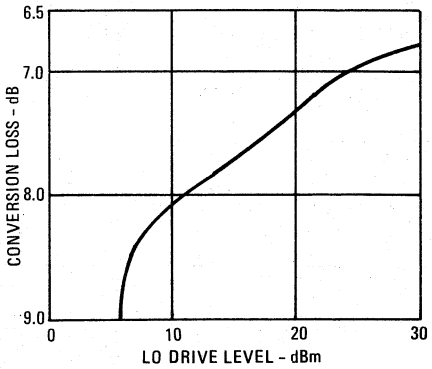
## Schematic Diagram



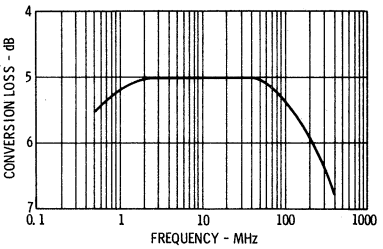

FOR BEST ISOLATION OF THE HIGH-LEVEL ($F_L$) SIGNAL,GROUND PIN 3.

# Typical Performance at 25°C

### Conversion Loss



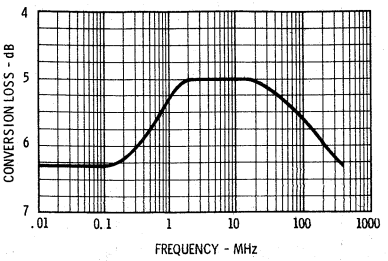

*Conversion Loss vs. LO Drive Level:* The minimum recommended drive level is +20 dBm. The maximum recommended drive level is +30 dBm.




*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the inputs $f_L$ and $f_R$ with $f_I$ at 20 MHz for conversion loss measurements. Data plotted with an $f_L$ level of +27 dBm.

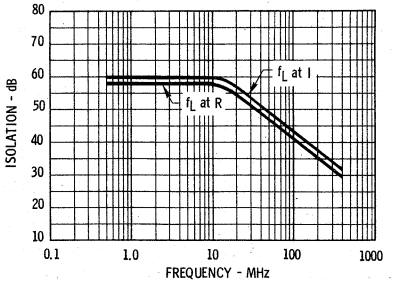
A 1 dB improvement in conversion loss can be made at 400 MHz by reversing the I- and R-ports i.e., by feeding the input signal into the I-port and taking the output from the R-port. At lower frequencies this performance improvement is not as significant. At 100 MHz, there is a 0.2 dB improvement while at 50 MHz and below there is no improvement.

### Conversion Loss




*Conversion Loss vs. Output Frequency:* The frequency ordinate refers to the output $f_I$ with $f_R$ at 50 MHz. Data plotted with an $f_L$ level of +27 dBm.

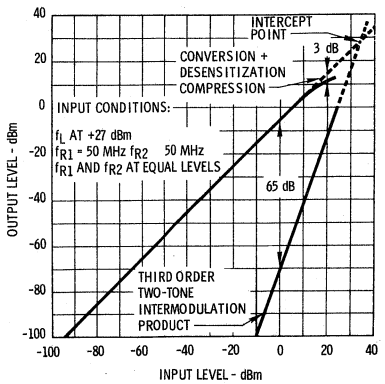
### Isolation



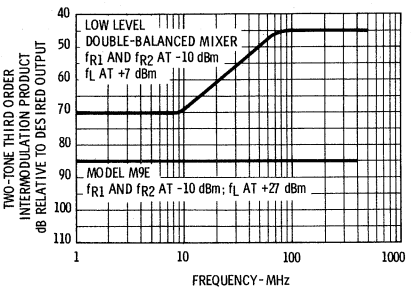

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port. Maximum isolation can be obtained between the input signals by feeding the input signal ($f_R$) into the I-port with some sacrifice in two-tone performance.

# Typical Two-Tone Performance at 25°C

*Definition:* In a mixer application where the input must be wideband, two signals ($f_{R1}$ and $f_{R2}$) may mix with the local oscillator signal ($f_L$) to produce in-band, two-tone third-order intermodulation products [$2f_{R2} - f_{R1}) \pm f_L$].

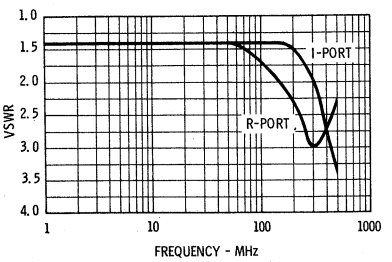



*Two-Tone Supression vs. Input Level:* With each dB decrease in input level, the third-order products 65 dB with both input signals at 0 dBm and 85 dB with both input signals at -10 dBm. The input intercept point for the WJ-M9E is at +32.5 dBm. This is 19 dB higher than the intercept point for a low-level double-balanced mixer like the WJ-M1. The 3 dB compression shown on the graph is a combination of both conversion compression and densensitization.




*Two-Tone Suppression vs. Input Frequency:* The two-tone performance of the WJ-M9E is constant across its frequency range. Other mixers, even other high level mixers, have a degradation in performance about 10 MHz.

### VSWR




*VSWR vs. Frequency:* VSWR of the R- and I-ports in a 50-ohm system with $f_L$ = 400 MHz at +27 dBm. Some variation in the I- and R-port VSWR will occur as a function of the L-port frequency. The L-port VSWR is typically less than 2.0 to 1 across its 1 to 400 MHz frequency band.

## Typical Intermodulation Performance at 25°C

***Intermodulation Signal Levels:*** Intermodulation signals resulting from the mixing of harmonics of the input signals are shown in the table below for the WJ-M9E. Mixing products are indicated by the number of dB below the $f_L \pm f_R$ output. The typical performance in the shaded portion of the table was obtained with $f_L$ and $f_R$ at approximately 50 MHz, $f_L$ at +27 dBm, $f_R$ at 0 dBm, and all resistive terminations. The typical performance in the other portion of the table was obtained under the same conditions as the shaded portion, but with $f_R$ at -10 dBm. Note the improvement in suppression, especially with the higher order products of $f_R$, when the $f_R$ level is reduced. Improved performance can also be achieved at lower frequencies.

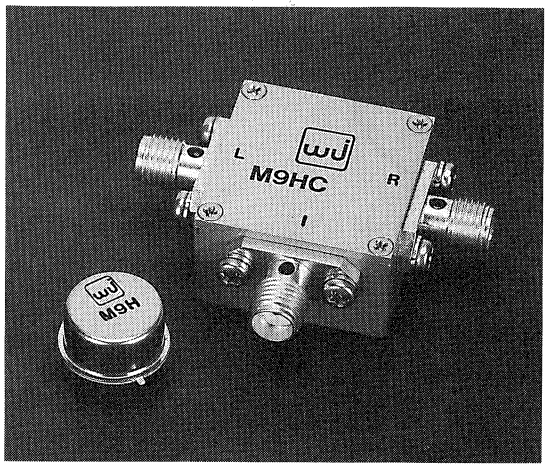
For best suppression of $f_R$ harmonics $\geq 2$, an $f_L$ level of +30 dBm is recommended. For best suppression of $f_R$ harmonics $<2$, an $f_L$ level less than +27 dBm but not less than +20 dB is recommended.

| Harmonics of $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 7 | >99 | >99 | >99 | >99 | >99 | >99 | >99 | >99 | >99 |
| | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 |
| 6 | >99 | >99 | >99 | 97 | >99 | >99 | >99 | >99 | >99 |
| | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 |
| 5 | >99 | 86 | >99 | 95 | >99 | >99 | >99 | 90 | >99 |
| | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 |
| 4 | 88 | 91 | >99 | 92 | 90 | 95 | 87 | 94 | 87 |
| | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 | >90 |
| 3 | 81 | 73 | 85 | 69 | 85 | 68 | 85 | 64 | 87 |
| | >90 | >90 | >90 | >90 | >90 | >90 | >90 | 89 | >90 |
| 2 | 64 | 71 | 62 | 70 | 63 | 70 | 61 | 62 | 64 |
| | 73 | 83 | 75 | 79 | 80 | 80 | 77 | 82 | 79 |
| 1 | 24 | 0 | 35 | 11 | 42 | 19 | 50 | 39 | 49 |
| | 24 | 0 | 34 | 11 | 42 | 18 | 49 | 37 | 49 |
| 0 | | 29 | 20 | 32 | 24 | 29 | 27 | 30 | 29 |
| | | 18 | 10 | 23 | 14 | 19 | 17 | 21 | 19 |

**Harmonics of $f_L$**

# WJ-M9H/M9HC

## DOUBLE-BALANCED MIXER




- LO 10 TO 1600 MHz
- RF 10 TO 1500 MHz
- IF DC TO 600 MHz
- LO DRIVE +20 dBm (nominal)
- HIGH INTERCEPT POINT: +30 dBm (TYP.) (UPCONV.): +24 dBm (TYP.) (DOWNCONV.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB<br>8.0 dB | 8.0 dB<br>9.0 dB | $f_R$ 20 to 400 MHz<br>$f_L$ 10 to 600 MHz<br>$f_I$ 2 to 200 MHz<br>$f_I$ 1 to 600 MHz |
| | | 8.5 dB<br>9.0 dB | 9.0 dB<br>9.5 dB | $f_R$ 10 to 1500 MHz<br>$f_L$ 10 to 1600 MHz<br>$f_I$ 2 to 200 MHz<br>$f_I$ 1 to 600 MHz |
| Isolation | | | | |
| $f_L$ at R | 28 dB | 35 dB | | $f_L$ 10 to 400 MHz |
| $f_L$ at I | 28 dB | 40 dB | | |
| $f_L$ at R | 23 dB | 30 dB | | $f_L$ 400 to 1000 MHz |
| $f_L$ at I | 16 dB | 22 dB | | |
| $f_L$ at R | 20 dB | 22 dB | | $f_L$ 1000 to 1500 MHz |
| $f_L$ at I | 13 dB | 18 dB | | |
| $f_R$ at I | | 20 dB | | $f_R$ 10 to 1000 MHz |
| $f_R$ at I | | 10 dB | | $f_R$ 1000 to 1500 MHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = +15 dBm<br>$f_L$ = +20 dBm |
| Desensitization | | 1.0 dB | | $f_{R2}$ = +14 dBm<br>$f_L$ = +23 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.
2. Guaranteed conversion loss values for M9HC are 0.5 dB worse than values listed and are guaranteed over 0°C to 50°C temperature range only.

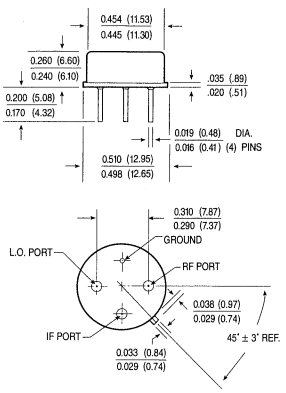
## Absolute Maximum Ratings

Operating Temperature
within Specification ..... -54°C to +85°C
with +24 dBm LO Power ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power for any Single Port ..... +23 dBm Peak
Peak Input Power for all Port ..... +24 dBm Peak
Peak Input Current at 25°C ..... 100 mA DC

Weight M9H: 2.0 grams (0.07 oz.) max.
M9HC: 22 grams (0.78 oz.) max.

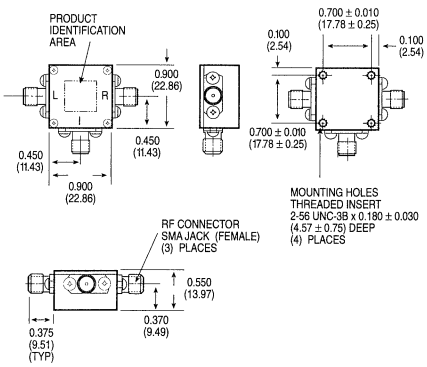
## Outline Drawings

M9H




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

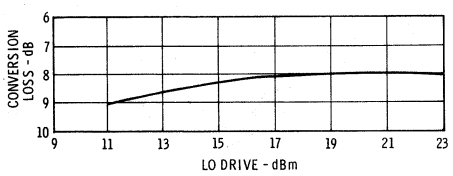
M9HC




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

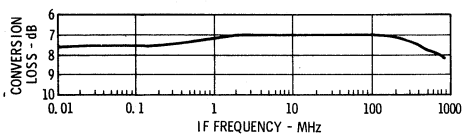
# Typical Performance at 25°C

### Conversion Loss vs. LO Drive

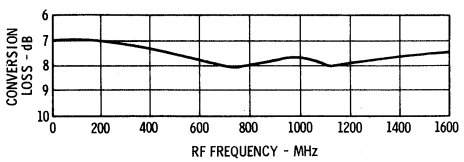



$F_{RF}$ = 1000 MHz AT -10 dBm
$F_{LO}$ = 1030 MHz

### Conversion Loss vs. Frequency

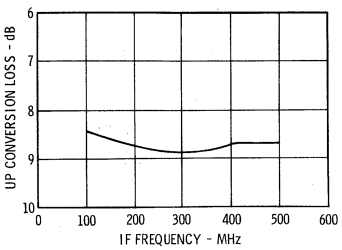



$F_{RF}$ = 1000 MHz AT -10 dBm
$P_{LO}$ = +20 dBm




$F_{IF} = F_{LO} - F_{RF}$ = 20 MHz
$P_{RF}$ = -10 dBm
$P_{LO}$ = +20 dBm

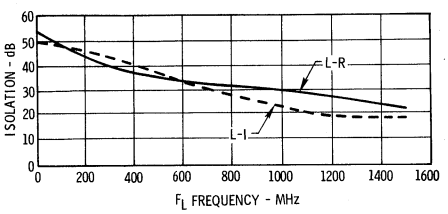
### Upconversion Loss vs. Frequency



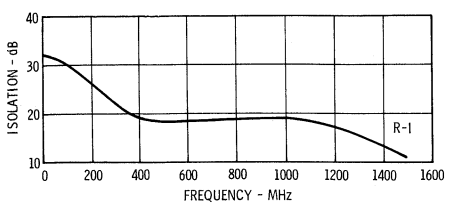

$F_{LO}$ = 100 MHz AT +20 dBm  $F_{RF} = F_{LO} + F_{IF}$
$P_{LO}$ = -10 dBm

*Conversion Loss in Upconversion Mode:* The input signal is at the I-port and the output signal is at the R-port. LO port is equal to 1000 MHz at +20 dBm.

### Isolation vs. Frequency

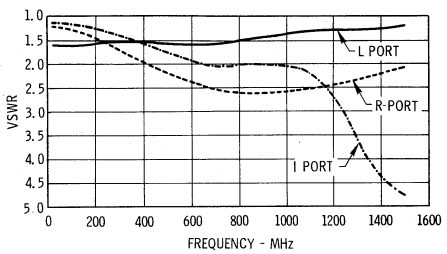



$P_{LO}$ = +20 dBm



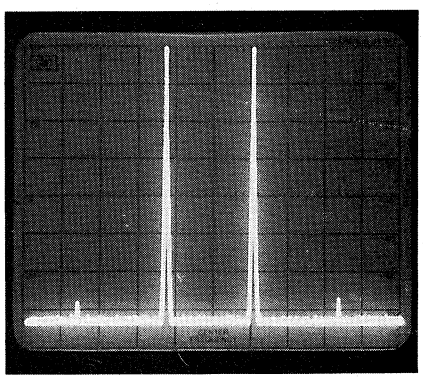

$F_{LO}$ = 1000 MHz AT +20 dBm

### VSWR




$P_{RF} = P_{IF}$ = -10 dBm
$P_{LO}$ = +20 dBm
$F_{LO}$ = 1000 MHz

### Two-Tone Intermodulation Performance



$f_{R1}$ = 430 MHz  $f_{R}2$ = 425 MHz
$P_{RF1} = P_{RF2}$ = -5 dBm
$f_L$ = 484 MHz  $P_{LO}$ = +20 dBm
$f_I$ = 54 MHz @ 10 dBm/div.

*Two-Tone Intermodulation Performance:* The photo displays typical relative suppression of 3rd order two-tone measurement, with $P_{RF1}$ equal to $P_{RF2}$ at -5 dBm.

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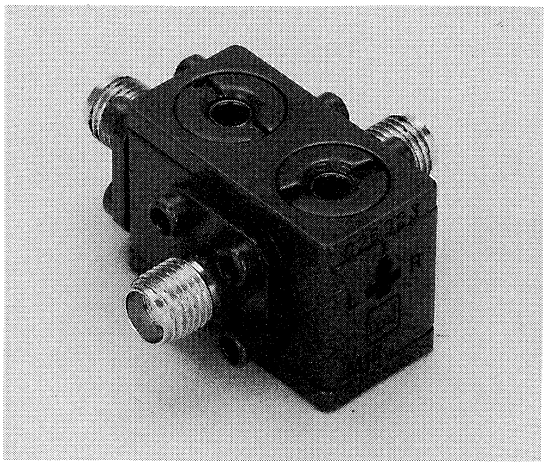
# WJ - M12

## DOUBLE-BALANCED MIXER



- LO, RF } 4 TO 8 GHz
- IF 5 MHz TO 3 GHz
- LO DRIVE +13 dBm (nominal)
- LOW NOISE FIGURE: 6.0 dB (TYP.)
- FLAT IF RESPONSE: ± 0.5 dB (TYP.)

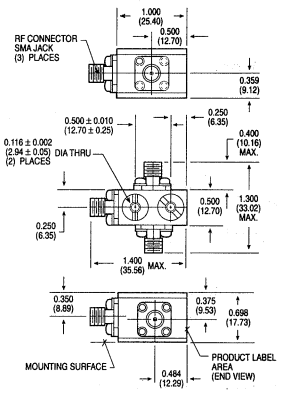
## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_L$ & $f_R$ 4 to 8 GHz<br>$f_I$ 5 MHz to 3 GHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>15 dB<br>18 dB | <br>25 dB<br>28 dB | | <br>$f_L$ 4 - 8 GHz<br>$f_L$ 4 - 8 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ at +8 dBm<br>$f_L$ at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications. I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Outline Drawings

M12




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

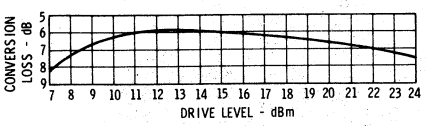
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

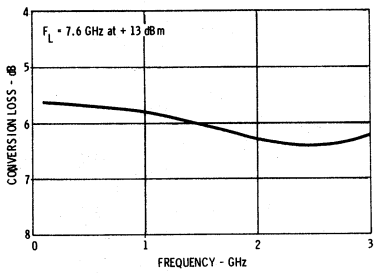
Weight 42.5 grams (1.5 oz.) max.
Connectors SMA Female

# Typical Performance at 25°C

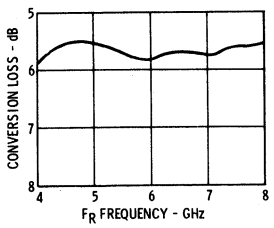
### Conversion Loss




***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +9 dBm. The maximum recommended drive level is +18 dBm.

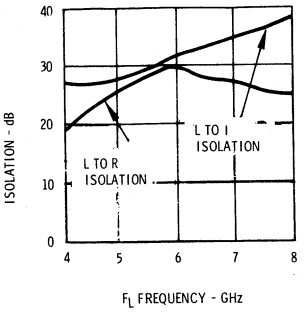



***Conversion Loss vs. $f_I$ Frequency (R- and I-Port Combined Frequency Responses).*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_L$ at 7.6 GHz and $f_R$ swept from 4.5 to 7.6 GHz.



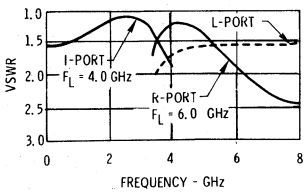

***Conversion Loss vs. Input Frequency (R-Port Frequency Response).*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 100 MHz and $f_L$ greater than $f_R$. Data plotted with an $f_L$ level of +13 dBm.

### Isolation



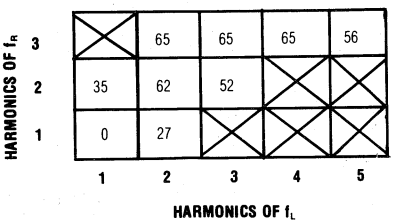

***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




***VSWR vs. Frequency:*** VSWR of the L- I- and R-ports in a 50-ohm system with $f_L$ at +13 dBm. R-port VSWR is plotted from 3.5 to 8 GHz with $f_L$ at 6.0 GHz. The R-port VSWR is practically independent of the L-port frequency. Also shown are the L-port VSWR and the I-port VSWR with $f_L$ at 4.0 GHz.

### Harmonic Intermodulation Products

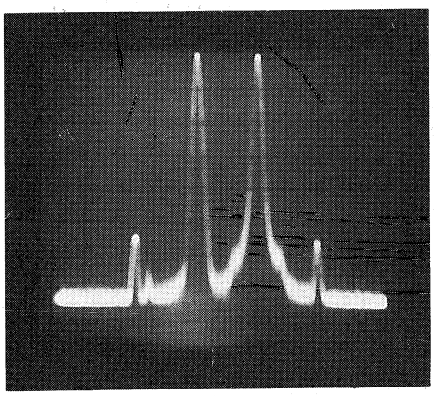



$f_I$ = 1.8 GHz
$f_L$ AND $f_R$ BETWEEN 3.6 AND 7.2 GHz
$f_L$ @ +13 dBm $f_R$ @ -10 dBm

(ALL VALUES EXPRESSED AS dB BELOW DESIRED OUTPUT)

***Harmonic Intermodulation Products:*** Intermodulation signals which result from the mixing of mixer generated harmonics of the input signals are shown. Mixing product suppression is indicated by the number of dB below the desired output level.

### Typical Two-Tone Intermodulation



***Typical Two-Tone Intermodulation Performance:*** $f_I$ = 1.5 GHz, $f_R$ = 6 GHz ± 1 MHz, $f_R$ at -10 dBm. $f_L > f_R$ $f_L$ = 7.5 GHz at +13 dBm. Vertical scale = 10 dB/cm.

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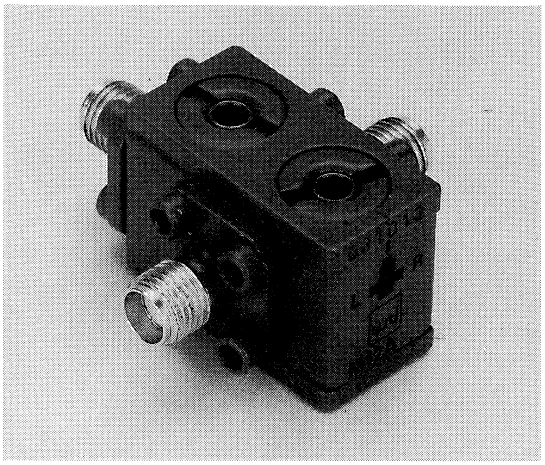
# WJ - M12A

## DOUBLE-BALANCED MIXER



- LO, RF } 4 TO 12 GHz
- IF 50 MHz TO 4 GHz
- LO DRIVE +13 dBm (nominal)
- LOW NOISE FIGURE: 6.5 dB (TYP.)
- FLAT IF RESPONSE: ± 0.5 dB (TYP.)

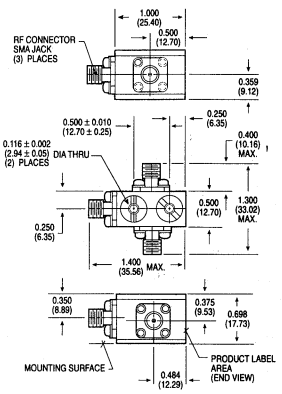
### Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 9.0 dB | $f_L$ & $f_R$ 4 to 12 GHz<br>$f_I$ 50 MHz to 4 GHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>15 dB<br>18 dB | <br>25 dB<br>30 dB | | <br>$f_L$ 4 to 12 GHz<br>$f_L$ 4 to 12 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ at +8 dBm<br>$f_L$ at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

### Outline Drawings

M12A




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

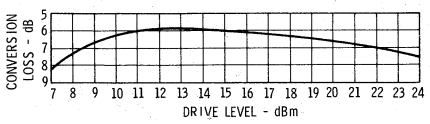
### Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C
Peak Input Current at 25°C .....100 mA DC

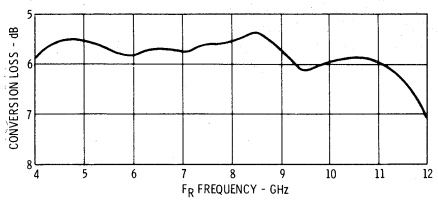
Weight 42.5 grams (1.5 oz.) max.
Connectors SMA Female

# Typical Performance at 25°C

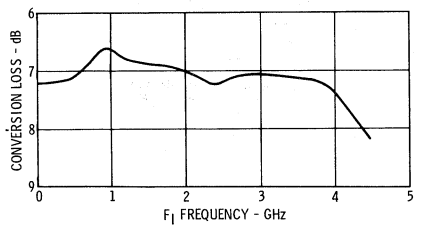
### Conversion Loss




***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +9 dBm. The maximum recommended drive level is +18 dBm.

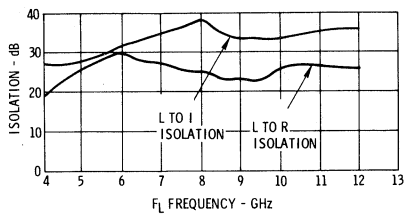



***Conversion Loss vs. Input Frequency (R-Port Frequency Response).*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$) with $f_I$ at 100 MHz and $f_L$ greater than $f_R$. Data plotted with an $f_L$ level of +13 dBm.



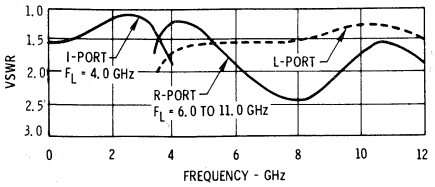

***Conversion Loss vs $f_I$ Frequency (I-Port Frequency Response).*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the I-port ($f_I$) with $f_R$ at 12 GHz and $f_L$ swept from 7.6 – 12 GHz.

### Isolation



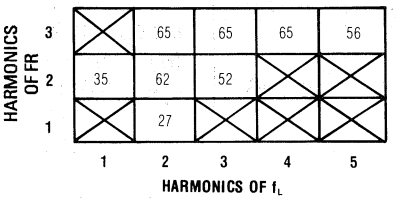

***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




***VSWR vs. Frequency:*** VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +13 dBm. R-port VSWR is plotted from 3.5 to 8 GHz with $f_L$ at 6.0 GHz and from 8.0 to 14.0 GHz with $f_L$ at 11 GHz. The R-port VSWR is practically independent of the L-port frequency. Also shown are the L-port VSWR and the I-port VSWR with $f_L$ at 4.0 GHz

### Harmonic Intermodulation Products




$f_I$ = 1.8 GHz
$f_L$ AND $f_R$ BETWEEN 3.6 AND 7.2 GHz
$f_L$ @ +13 dBm $f_R$ @ -10 dBm
(ALL VALUES EXPRESSED AS dB BELOW DESIRED OUTPUT)

***Harmonic Intermodulation Products:*** Intermodulation signals which result from the mixing of mixer generated harmonics of the input signals are shown. Mixing product suppresion is indicated by the number of dB below the desired output level.

### Typical Conversion Loss of WJ-M12A Mixer

**Final Test Report for WJ-M12A Mixer**
**Average Values of 83 Units**
**Conversion Loss (dB) (L.O. @ +13 dBm)**

| FRF (GHz) | FLO (GHz) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4.1 | 4.6 | 5.1 | 5.6 | 6.1 | 6.6 | 7.1 | 7.6 | 8.1 |
| 4.0 | 5.92 | 5.86 | 5.91 | 6.05 | 5.93 | 6.23 | 6.33 | | |
| 4.5 | 5.48 | 5.54 | 5.44 | 5.64 | 5.74 | 5.83 | 6.12 | 6.18 | |
| 5.0 | 5.19 | 6.00 | 5.57 | 5.35 | 5.60 | 5.85 | 6.25 | 6.42 | 6.69 |
| 5.5 | 5.19 | 5.56 | 6.07 | 5.74 | 5.74 | 5.89 | 6.15 | 6.37 | 6.54 |
| 6.0 | 5.20 | 5.44 | 5.62 | 6.30 | 5.84 | 5.66 | 5.67 | 6.00 | 6.17 |
| 6.5 | 5.16 | 5.42 | 5.84 | 5.87 | 5.79 | 5.68 | 5.96 | 5.78 | 5.85 |
| 7.0 | 5.18 | 5.18 | 5.54 | 5.81 | 5.83 | 5.93 | 5.78 | 5.75 | 5.66 |
| 7.5 | | 5.21 | 5.34 | 6.09 | 6.07 | 5.81 | 5.67 | 5.59 | 5.51 |
| 8.0 | | | 5.33 | 5.91 | 6.12 | 6.25 | 5.74 | 5.70 | 5.60 |
| 8.5 | | | | 5.52 | 5.62 | 5.80 | 5.51 | 5.09 | 5.39 |
| 9.0 | | | | 5.80 | 5.70 | 5.98 | 6.02 | 5.67 | 5.59 |
| 9.5 | | | | 6.69 | 6.13 | 6.04 | 6.21 | 6.22 | 6.19 |
| 10.0 | | | | 7.21 | 6.48 | 5.87 | 6.01 | 6.13 | 6.00 |
| 10.5 | | | | | 7.06 | 6.39 | 5.97 | 5.94 | 6.05 |
| 11.0 | | | | | | 7.25 | 6.35 | 6.15 | 5.92 |
| 11.5 | | | | | | | 7.34 | 6.65 | 6.42 |
| 12.0 | | | | | | | | 8.13 | 7.26 |

### Typical Conversion Loss of WJ-M12A Mixer

**Conversion Loss (dB) (L.O. @ +13 dBm)**

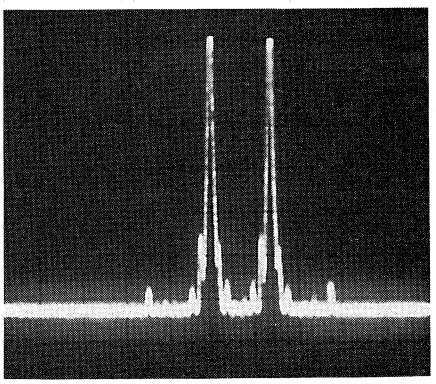
| FRF (GHz) | FLO (GHz) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8.6 | 9.1 | 9.6 | 10.1 | 10.6 | 11.1 | 11.6 | 12.1 | |
| 5.5 | 6.65 | 6.59 | 6.78 | 7.62 | | | | | |
| 6.0 | 6.43 | 6.35 | 6.20 | 6.30 | 7.27 | | | | |
| 6.5 | 6.16 | 6.40 | 6.36 | 6.18 | 6.32 | 7.35 | | | |
| 7.0 | 5.87 | 6.24 | 6.30 | 6.20 | 6.13 | 6.24 | 7.52 | | |
| 7.5 | 5.58 | 5.88 | 6.39 | 6.54 | 6.27 | 6.08 | 6.51 | 7.60 | |
| 8.0 | 5.68 | 5.89 | 6.27 | 6.47 | 6.56 | 6.04 | 6.09 | 6.41 | |
| 8.5 | 5.36 | 5.57 | 5.72 | 6.08 | 6.17 | 5.95 | 5.81 | 6.01 | |
| 9.0 | 5.77 | 5.73 | 5.97 | 5.98 | 6.28 | 6.26 | 6.26 | 6.11 | |
| 9.5 | 6.02 | 6.08 | 6.13 | 6.15 | 6.36 | 6.57 | 6.78 | 6.81 | |
| 10.0 | 5.89 | 5.72 | 5.78 | 5.97 | 6.14 | 6.17 | 6.60 | 6.74 | |
| 10.5 | 6.02 | 5.88 | 5.66 | 5.92 | 5.85 | 6.14 | 6.27 | 6.43 | |
| 11.0 | 6.18 | 6.03 | 5.89 | 5.66 | 5.98 | 5.92 | 6.17 | 6.46 | |
| 11.5 | 6.37 | 6.58 | 6.37 | 6.22 | 6.00 | 6.09 | 6.38 | 6.72 | |
| 12.0 | 7.12 | 7.03 | 7.21 | 6.95 | 6.86 | 6.57 | 7.17 | 7.18 | |

**Final Test Report for WJ-M12A Mixer**
**Standard Deviation from the Average Values of 83 Units**

| FRF (GHz) | FLO (GHz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4.1 | 4.6 | 5.1 | 5.6 | 6.1 | 6.6 | 7.1 | 7.6 | 8.1 | |
| 4.0 | .26 | .30 | .37 | .47 | .36 | .34 | .35 | | | |
| 4.5 | .27 | .25 | .34 | .37 | .44 | .34 | .31 | .29 | | |
| 5.0 | .28 | .24 | .23 | .31 | .35 | .46 | .34 | .31 | .30 | |
| 5.5 | .41 | .35 | .28 | .31 | .31 | .33 | .46 | .34 | .33 | |
| 6.0 | .34 | .46 | .39 | .32 | .22 | .25 | .27 | .43 | .33 | |
| 6.5 | .22 | .35 | .44 | .36 | .21 | .18 | .22 | .23 | .44 | |
| 7.0 | .23 | .25 | .36 | .43 | .31 | .25 | .24 | .27 | .28 | |
| 7.5 | | .27 | .26 | .41 | .45 | .31 | .29 | .27 | .31 | |
| 8.0 | | | .28 | .30 | .39 | .45 | .31 | .32 | .29 | |
| 8.5 | | | | .24 | .28 | .36 | .43 | .33 | .29 | |
| 9.0 | | | | .38 | .33 | .36 | .48 | .48 | .41 | |
| 9.5 | | | | .44 | .34 | .29 | .34 | .43 | .44 | |
| 10.0 | | | | .61 | .51 | .33 | .32 | .36 | .46 | |
| 10.5 | | | | | .68 | .46 | .32 | .29 | .37 | |
| 11.0 | | | | | | .69 | .42 | .36 | .34 | |
| 11.5 | | | | | | | .70 | .46 | .39 | |
| 12.0 | | | | | | | | .69 | .46 | |

| FRF (GHz) | FLO (GHz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 8.6 | 9.1 | 9.6 | 10.1 | 10.6 | 11.1 | 11.6 | 12.1 |
| 5.5 | .35 | .36 | .40 | .62 | | | | |
| 6.0 | .32 | .34 | .37 | .43 | .73 | | | |
| 6.5 | .32 | .30 | .33 | .49 | .47 | .77 | | |
| 7.0 | .45 | .36 | .34 | .38 | .42 | .51 | .75 | |
| 7.5 | .32 | .49 | .42 | .42 | .41 | .45 | .50 | .76 |
| 8.0 | .34 | .35 | .52 | .38 | .38 | .44 | .45 | .52 |
| 8.5 | .32 | .34 | .37 | .52 | .37 | .45 | .42 | .42 |
| 9.0 | .42 | .39 | .44 | .47 | .53 | .46 | .37 | .43 |
| 9.5 | .37 | .38 | .40 | .46 | .43 | .60 | .50 | .38 |
| 10.0 | .52 | .38 | .42 | .51 | .48 | .50 | .53 | .46 |
| 10.5 | .45 | .48 | .40 | .48 | .59 | .42 | .41 | .48 |
| 11.0 | .40 | .50 | .55 | .45 | .40 | .42 | .37 | .46 |
| 11.5 | .42 | .49 | .52 | .53 | .42 | .45 | .37 | .42 |
| 12.0 | .38 | .42 | .45 | .49 | .56 | .50 | .47 | .46 |

### Typical Two-Tone Intermodulation

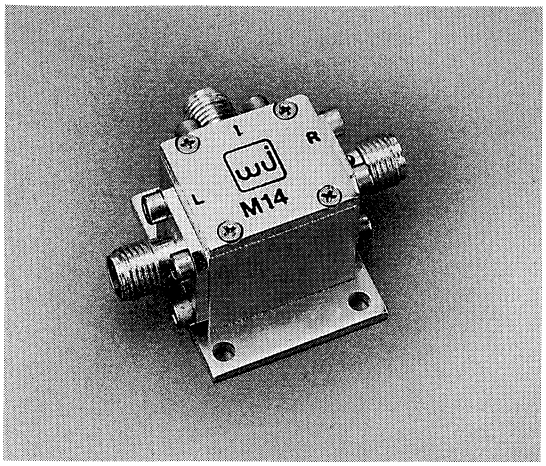


***Typical Two-Tone Intermodulation Performance:*** $f_I$ = 2 GHz, $f_R$ = 8 GHz ± 1 MHz, $f_R$ at –10 dBm. $f_L > f_R$, $f_L$ = 10 GHz at +13 dBm. Vertical scale = 10 dB/cm.

10

# WJ - M14

## DOUBLE-BALANCED MIXER




- LO 4 TO 8 GHz
- RF 4 TO 8 GHz
- IF DC to 2 GHz
- LO DRIVE +7 dBm (nominal)
- LOW VSWR: < 2.0:1 (TYP.)
- LOW NOISE FIGURE: < 5.0 dB (TYP.)
- HIGH ISOLATION 35 dB (TYP.)

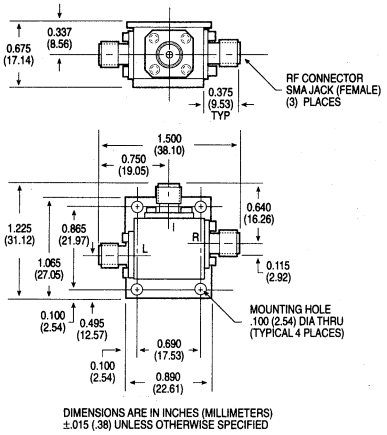
### Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.0 dB | 7.0 dB | $f_R$ 5 to 7 GHz<br>$f_L$ 4 to 8 GHz<br>$f_I$ 0.05 to 2 GHz |
| | | 6.0 dB | 8.0 dB | $f_R$ 4 to 8 GHz<br>$f_L$ 4 to 8 GHz<br>$f_I$ 0.05 to 2 GHz |
| Isolation | | | | |
| $f_L$ at R | 20 dB | 35 dB | | $f_L$ 4 to 6 GHz |
| | 20 dB | 30 dB | | $f_L$ 6 to 9 GHz |
| $f_L$ at I | 20 dB | 30 dB | | $f_L$ 4 to 6 GHz |
| | 25 dB | 35 dB | | $f_L$ 6 to 9 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +2 dBm<br>$f_L$ Level = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

### Outline Drawings

M14



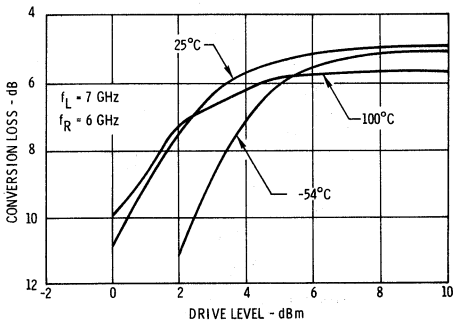

### Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+23 dBm max. at +25°C, +20 dBm max at +100°C
Peak Input Current at 25°C .....100 mA DC

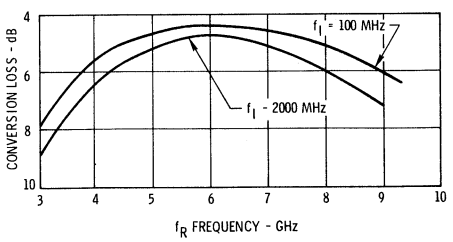
Weight 42.5 grams (1.5 oz.) max.
Connectors SMA Female

## Typical Performance at 25°C

### Conversion Loss

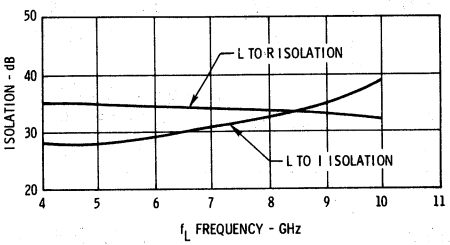



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +5 dBm. The maximum recommended drive level is +13 dBm.



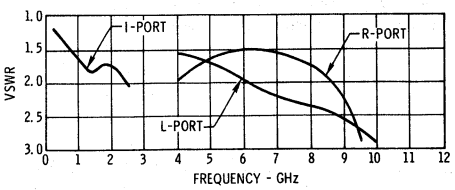

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm.

### Isolation



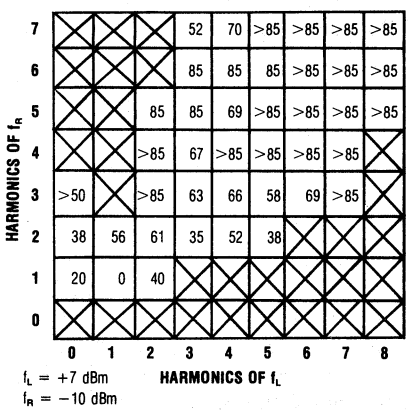

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




*VSWR vs. Frequency:* VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Only a small variation in the R-port VSWR will occur as a function of the L-port frequency.

### Typical Harmonic IM Signals (dB Below Designed Output)



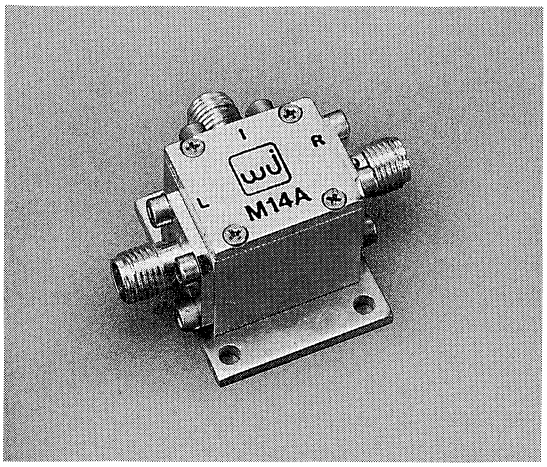

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 7 | | | | 52 | 70 | >85 | >85 | >85 | >85 |
| 6 | | | | 85 | 85 | 85 | >85 | >85 | >85 |
| 5 | | | 85 | 85 | 69 | >85 | >85 | >85 | >85 |
| 4 | | | >85 | 67 | >85 | >85 | >85 | >85 | |
| 3 | >50 | | >85 | 63 | 66 | 58 | 69 | >85 | |
| 2 | 38 | 56 | 61 | 35 | 52 | 38 | | | |
| 1 | 20 | 0 | 40 | | | | | | |
| 0 | | | | | | | | | |

*Harmonic Intermodulation Products:* Intermodulation signals which result from the mixing of mixer generated harmonics of the input signals are shown. Mixing product suppresion is indicated by the number of dB below the desired output level.

10

# WJ - M14A

## DOUBLE-BALANCED MIXER




- LO 4 TO 16 GHz
- RF 6 TO 14 GHz
- IF DC to 2 GHz
- LO DRIVE +7 dBm (nominal)
- HIGH ISOLATION: 35 dB (TYP.)
- LOW VSWR: < 2.0:1 (TYP.)
- LOW NOISE FIGURE: < 6.0 dB (TYP.)

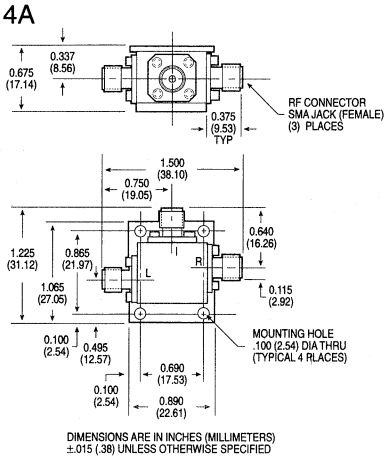
### Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 8.0 dB | $f_R$ 6 to 9 GHz<br>$f_L$ 5 to 10 GHz<br>$f_I$ 0.05 to 1GHz |
| | | 7.5 dB | 9.0 dB | $f_R$ 6 to 14 GHz<br>$f_L$ 4 to 16 GHz<br>$f_I$ 0.05 to 2 GHz |
| Isolation | | | | |
| $f_L$ at R | 20 dB | 35 dB | | $f_L$ 4 to 12 GHz |
| $f_L$ at I | 12 dB | 17 dB | | $f_L$ 4 to 6 GHz |
| | 23 dB | 35 dB | | $f_L$ 6 to 12 GHz |
| $f_L$ at R | 15 dB | 28 dB | | $f_L$ 12 to 16 GHz |
| $f_L$ at I | 28 dB | 40 dB | | $f_L$ 12 to 16 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +2 dBm<br>$f_L$ Level = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies

### Outline Drawings

M14A



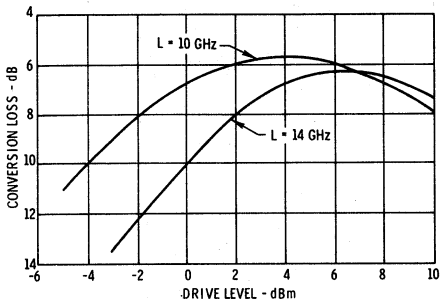

### Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+23 dBm max. at +25°C, +20 dBm max at +100°C
Peak Input Current at 25°C .....100 mA DC

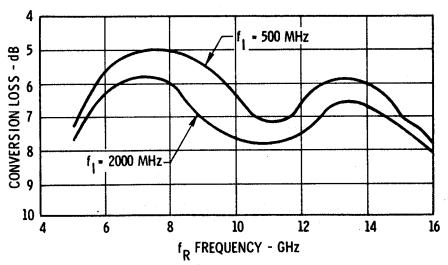
Weight 42.5 grams (1.5 oz.) max.
Connectors SMA Female

## Typical Performance at 25°C

### Conversion Loss

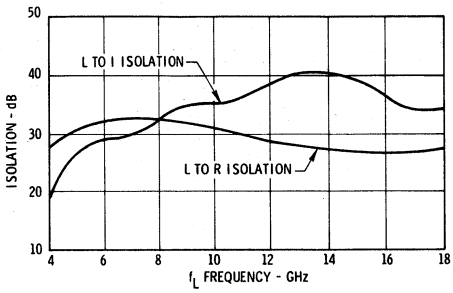



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +10 dBm.



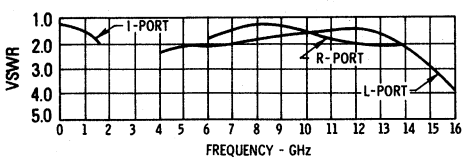

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm.

### Isolation



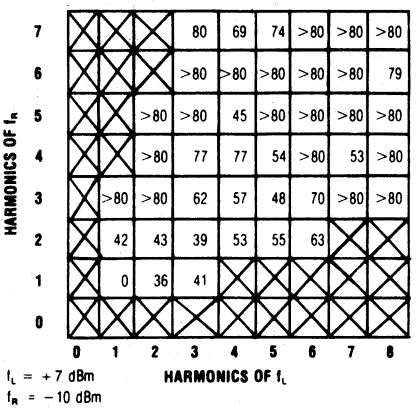

*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




*VSWR vs. Frequency:* VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Only a small variation in the R-port VSWR will occur as a function of the L-port frequency.

### Typical Harmonic IM Signals (dB Below Designed Output)

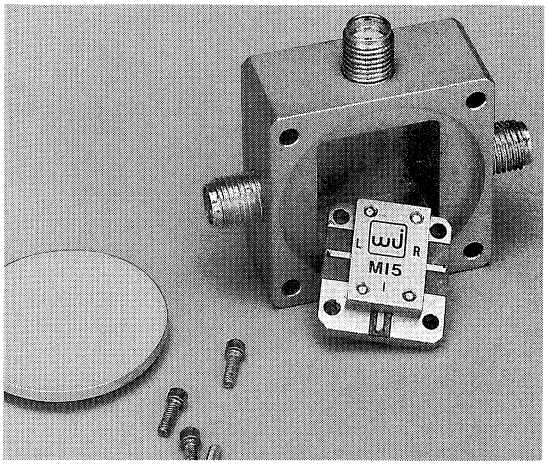



| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 7 | | | | 80 | 69 | 74 | >80 | >80 | >80 |
| 6 | | | | >80 | >80 | >80 | >80 | >80 | 79 |
| 5 | | | >80 | >80 | 45 | >80 | >80 | >80 | >80 |
| 4 | | | >80 | 77 | 77 | 54 | >80 | 53 | >80 |
| 3 | | >80 | >80 | 62 | 57 | 48 | 70 | >80 | >80 |
| 2 | | 42 | 43 | 39 | 53 | 55 | 63 | | |
| 1 | | 0 | 36 | 41 | | | | | |
| 0 | | | | | | | | | |

*Harmonic Intermodulation Products:* Intermodulation signals which result from the mixing of mixer generated harmonics of the input signals are shown. Mixing product suppresion is indicated by the number of dB below the desired output level.

# WJ - M15/M15C

## FLATPAC MIC
## DOUBLE-BALANCED MIXER




- LO 2 TO 6 GHz
- RF 2 TO 6 GHz
- IF DC to 1.5 GHz
- LO DRIVE +7 dBm (nominal)
- DIRECTLY INTEGRATABLE WITH MIC SUBASSEMBLIES
- LOW VSWR: < 2.0:1 (TYP.)
- LOW NOISE FIGURE: < 5.0 dB (TYP.)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 8.0 dB | $f_L$ & $f_R$ 2.5 to 5.0 GHz<br>$f_I$ 60 MHz to 500 MHz |
| | | 6.5 dB | 9.0 dB | $f_I$ 60 MHz to 1.0 GHz |
| | | 7.5 dB | 10.0 dB | $f_I$ 60 MHz to 1.5 GHz |
| | | 7.5 dB | 10.0 dB | $f_L$ & $f_R$ 2.0 - 6.0 GHz<br>$f_I$ 60 MHz to 1.5 GHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | 8 dB<br>10 dB | 20 dB<br>20 dB | | $f_L$ 2.0 to 6.0 GHz<br>$f_L$ 2.0 to 6.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +2 dBm<br>$f_L$ Level = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

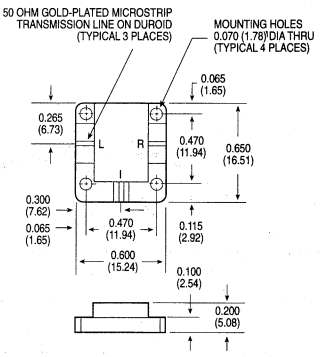
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M15: 2 grams (0.07 oz.) max.
M15C: 30 grams (1.06 oz.) max.

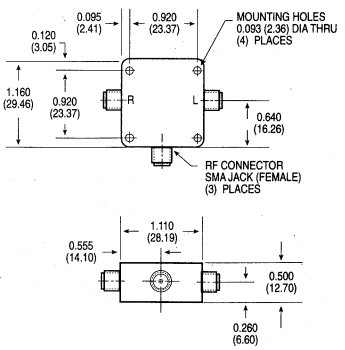
## Outline Drawings

M15




DIMENSIONS ARE IN INCHES (MILLIMETERS0
±.015 (.38) UNLESS OTHERWISE SPECIFIED

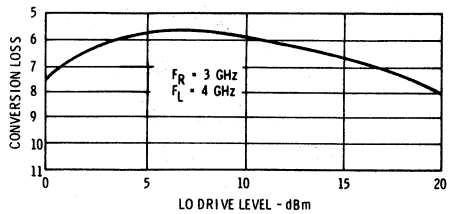
M15C



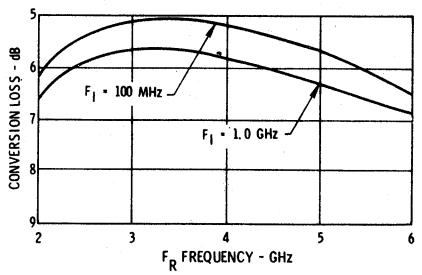

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

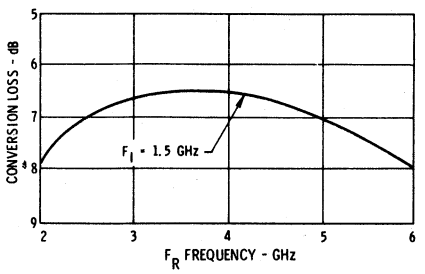
## Typical Performance at 25°C

### Conversion Loss



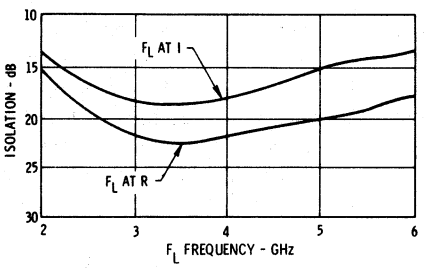

***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.



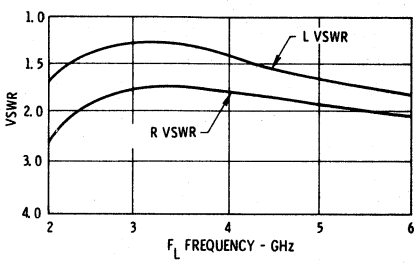

***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm.

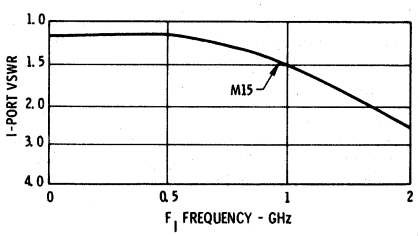
### Isolation




***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR



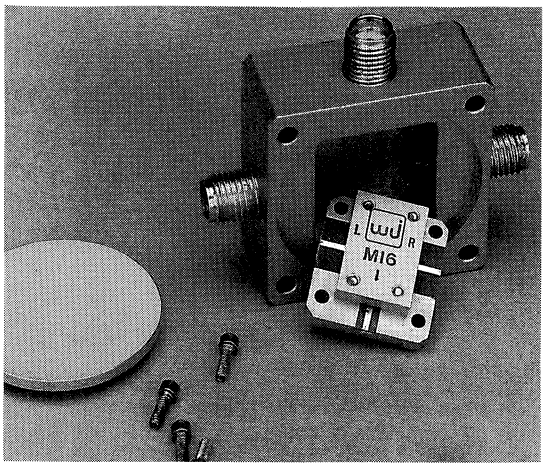




***VSWR vs. Frequency:*** VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Only a small variation in the R-port VSWR will occur as a function of the L-port frequency.

# WJ - M16/M16C

## FLATPAC MIC
## DOUBLE-BALANCED MIXER

- LO, RF } 4 TO 9 GHz
- IF DC TO 3 GHz
- LO DRIVE +7 dBm (nominal)
- DIRECTLY INTEGRABLE WITH MIC SUBASSEMBLIES




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB<br>7.0 dB<br>8.0 dB | 8.5 dB<br>9.0 dB<br>10.0 dB | $f_L$ & $f_R$ 4 to 9 GHz<br>$f_I$ 60 MHz to 1.0 GHz<br>$f_I$ 60 MHz to 2.0 GHz<br>$f_I$ 60 MHz to 3.0 GHz |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>9 dB<br>7 dB | <br>18 dB<br>16 dB | | <br>$f_L$ 4 to 9 GHz<br>$f_L$ 4 to 9 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +2 dBm<br>$f_L$ Level = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

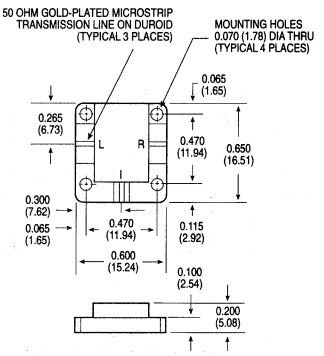
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power..... +23 dBm max. at +25°C, +20 dBm max at +100°C
Peak Input Current at 25°C ..... 100 mA DC

Weight M16: 2 grams (0.07 oz.) max.
M16C: 30 grams (1.06 oz.) max.

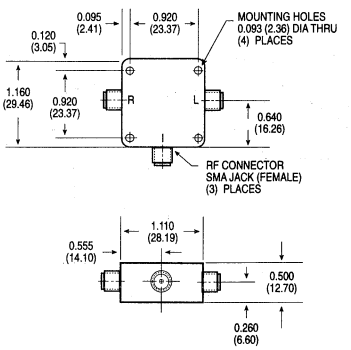
## Outline Drawings

M16




DIMENSIONS ARE IN INCHES (MILLIMETERS0
±.015 (.38) UNLESS OTHERWISE SPECIFIED

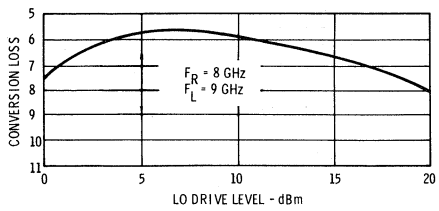
M16C



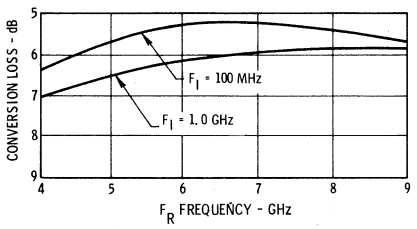

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

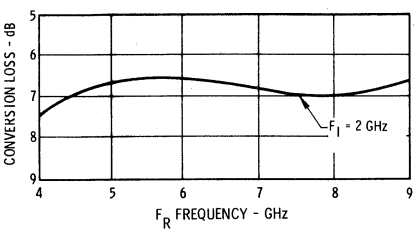
## Typical Performance at 25°C

### Conversion Loss

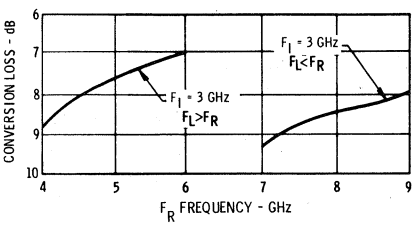



*Conversion Loss vs. Drive Level:* The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.



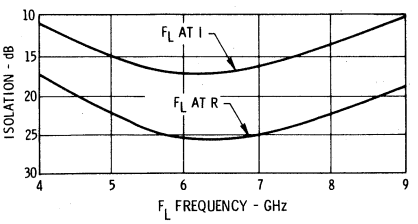




### Conversion Loss



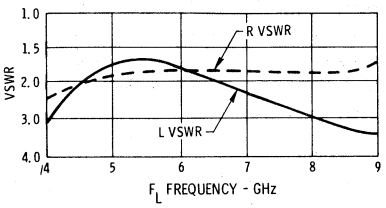

*Conversion Loss vs. Input Frequency:* Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm.

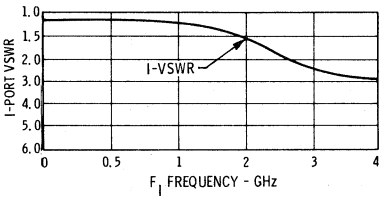
### Isolation




*Isolation vs. Frequency:* Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




*VSWR vs. Frequency:* VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Only a small variation in the R-port VSWR will occur as a function of the L-port frequency.

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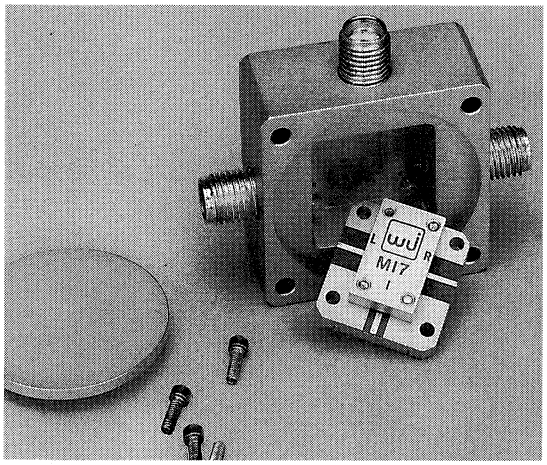
# WJ-M17/M17C

## FLATPAC MIC DOUBLE-BALANCED MIXER

- LO, RF } 6 TO 16 GHz
- IF DC TO 3 GHz
- LO DRIVE +7 dBm (nominal)
- DIRECTLY INTEGRABLE WITH MIC SUBASSEMBLIES
- LOW NOISE FIGURE: 7.0 dB (TYP.)



## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 8.0 dB | $f_L$ & $f_R$ 8 to 12 GHz, $f_I$ 0.06 to 1 GHz |
| | | 7.0 dB | 9.0 dB | $f_L$ & $f_R$ 7 to 14 GHz, $f_I$ 0.06 to 2 GHz |
| | | 8.0 dB | 10.5 dB | $f_L$ & $f_R$ 6 to 16 GHz, $f_I$ 0.06 to 3 GHz |
| Isolation | | | | |
| $f_L$ at R | 8 dB | 10 dB | | $f_L$ 6 to 7 GHz |
| | 10 dB | 15 dB | | $f_L$ 7 to 16 GHz |
| $f_L$ at I | 10 dB | 18 dB | | $f_L$ 6 to 16 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +3 dBm, $f_L$ Level = +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications,I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

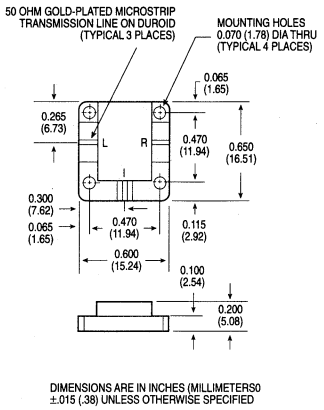
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature. .....-65°C to +100°C
Peak Input Power. .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C. .....100 mA DC

Weight M17: 2 grams (0.07 oz.) max.
M17C: 30 grams (1.06 oz.) max.

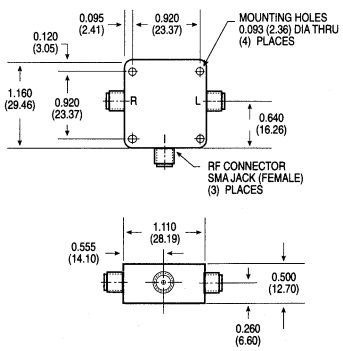
## Outline Drawings

M17




DIMENSIONS ARE IN INCHES (MILLIMETERS0
±.015 (.38) UNLESS OTHERWISE SPECIFIED

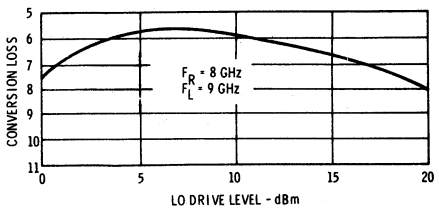
M17C



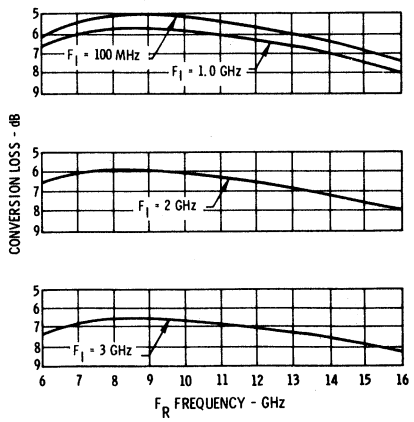

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

### Conversion Loss

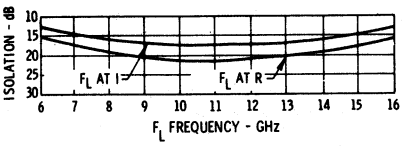



***Conversion Loss vs. Drive Level:*** The minimum recommended drive level is +4 dBm. The maximum recommended drive level is +13 dBm.



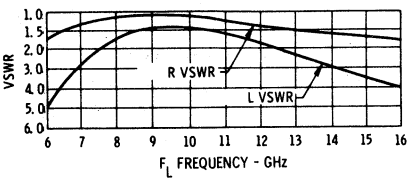

***Conversion Loss vs. Input Frequency:*** Conversion loss of the mixer when used in an SSB system. The frequency ordinate refers to the R-port ($f_R$). Data plotted with an $f_L$ level of +7 dBm.

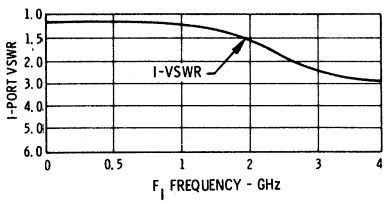
### Isolation




***Isolation vs. Frequency:*** Level of the $f_L$ signal fed through to the R- and I-ports with respect to the level of the $f_L$ signal at the L-port.

### VSWR




***VSWR vs. Frequency:*** VSWR of the L-, I- and R-ports in a 50-ohm system with $f_L$ at +7 dBm. Only a small variation in the R-port VSWR will occur as a function of the L-port frequency.

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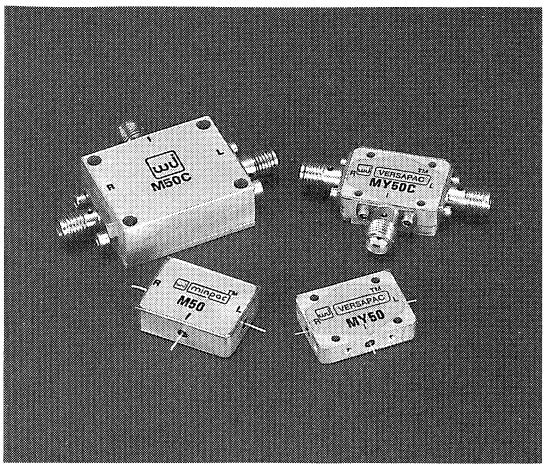
# WJ-M50/M50C
# WJ-MY50/MY50C

## TRIPLE-BALANCED MIXER
## (DOUBLE-DOUBLE BALANCED MIXER)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section))




- LO, RF } 2.0 TO 26.0 GHz
- IF 1.0 TO 15.0 GHz
- LO DRIVE +10 dBm (nominal)
- HIGH COMPRESSION POINT
- VERY WIDE BANDWIDTH

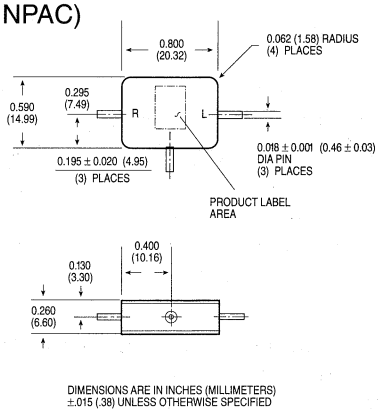
### Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | $f_R$ 2.5 to 18.0 GHz<br>$f_L$ 2.0 to 18.0 GHz<br>$f_I$ 2.0 to 10.0 GHz |
| | | 8.0 dB | 10.5 dB | fR 2.0 to 18.0 GHz<br>$f_L$ 2.0 to 26.0 GHz<br>$f_I$ 2.0 to 12.0 GHz |
| | | 9.0 dB | 11.5 dB | $f_R$ 2.0 to 26.0 GHz<br>$f_L$ 2.0 to 26.0 GHz<br>$f_I$ 1.0 to 12.0 GHz<br>1.0 to 15.0 GHz $f_L < f_R$ |
| Isolation<br>L to R | 20 dB<br>15 dB | 30 dB<br>22 dB | | $f_L$ 2.0 to 3.0 GHz<br>$f_L$ 3.0 to 26.0 GHz |
| L to I | 20 dB<br>15 dB | 30 dB<br>22 dB | | $f_L$ 2.0 to 7.0 GHz<br>$f_L$ 7.0 to 26.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +5.0 dBm<br>$f_L$ level +10.0 dBm |
| Third Order Input Intercept Point | | +15 dBm | | $f_{RI}$ = 5.00 GHz, $f_{R_2}$ = 5.01 GHz both at -6 dBm<br>$f_L$ = 8.0 GHz at +10.0 dBm |
| | | +15 dBm | | $f_{RI}$ = 25.00 GHz, $f_{R_2}$ = 25.01 GHz both at -6 dBm<br>$f_L$ = 15.0 GHz at +10.0 dBm |

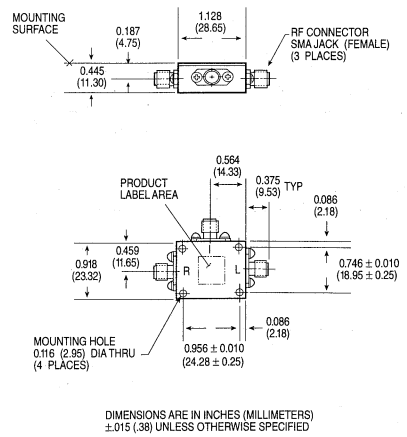
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

### Outline Drawings

M50
(MINPAC)




M50C
(CONNECTORIZED)

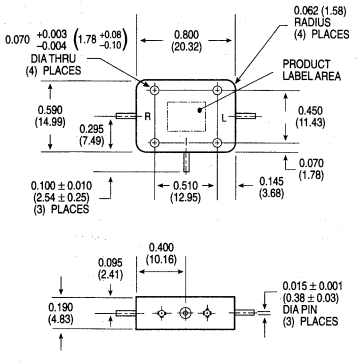



### Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+26 dBm at +25°C, +22 dBm at +100°C
Weight M50: 12 grams (0.42 oz.) max.
M50C: 40 grams (1.41 oz.) max.
MY50: 12 grams (0.42 oz.) max.
MY50C: 18 grams (0.63 oz.) max.

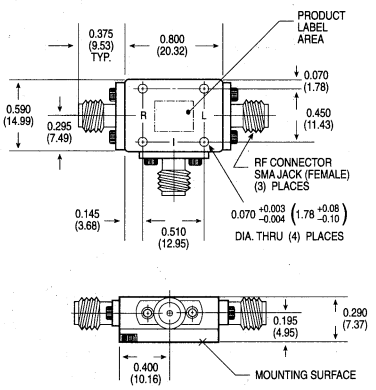
# Outline Drawings

## MY50 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

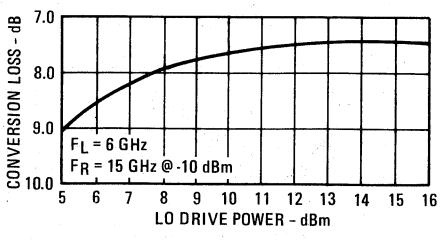
## MY50C (CONNECTORIZED)

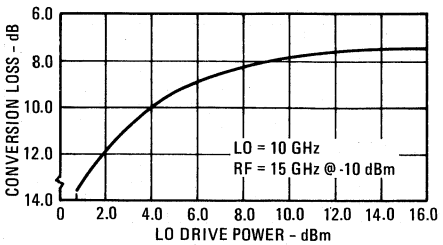



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C*

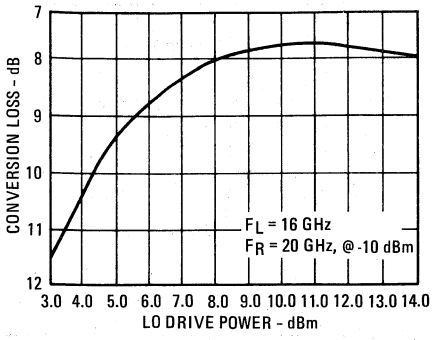
### Conversion Loss vs. LO Drive Level

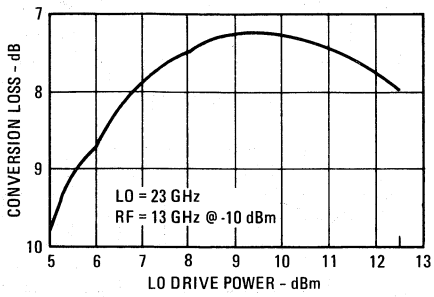



# Typical Performance at 25°C*

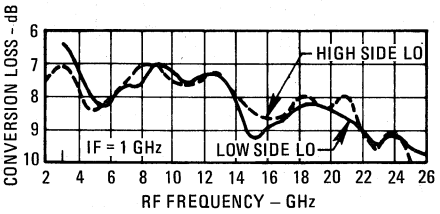
### Conversion Loss vs. LO Drive Level

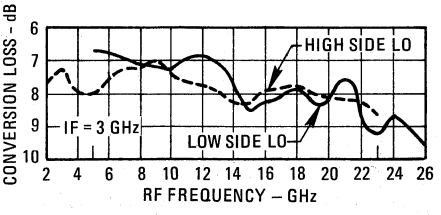


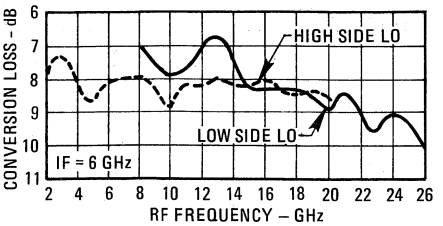




*Drive Level:* The maximum recommended drive level is +17 dBm.

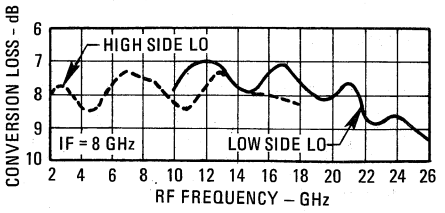
### Conversion Loss vs. Frequency

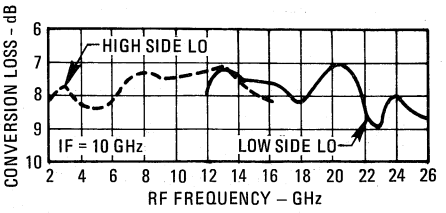


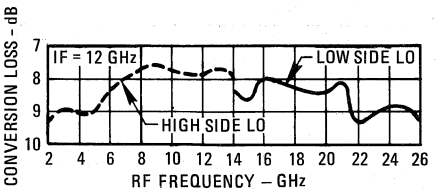



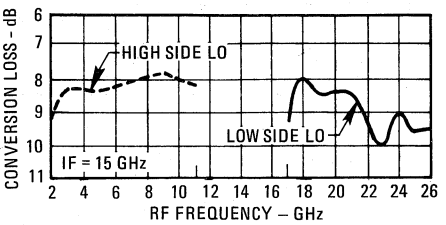




### Conversion Loss vs. Frequency

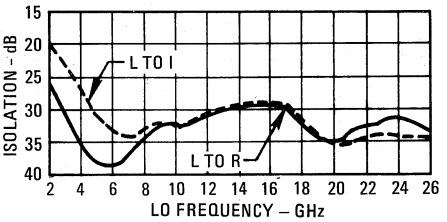


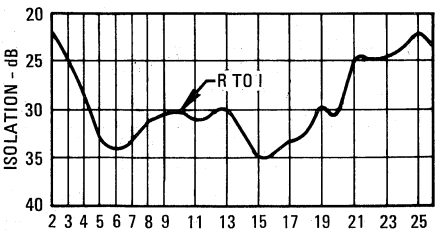



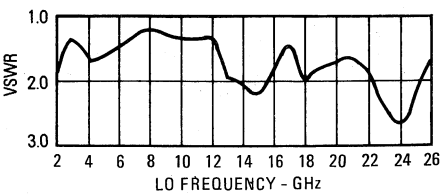




### Isolation vs. Frequency




### L-Port VSWR

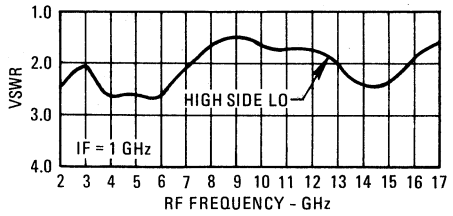


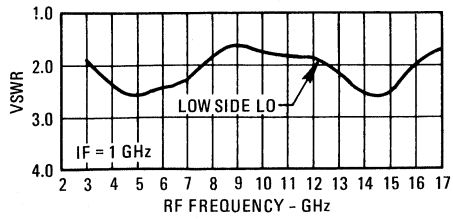

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

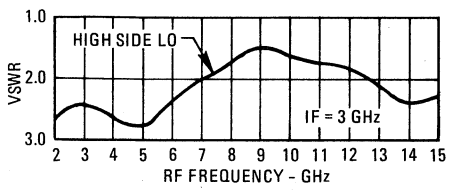
10

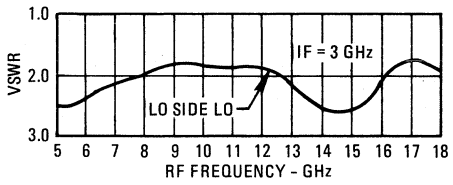
# Typical Performance at 25°C *

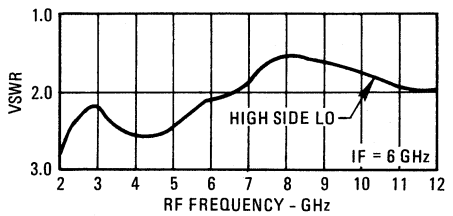
## R-Port VSWR

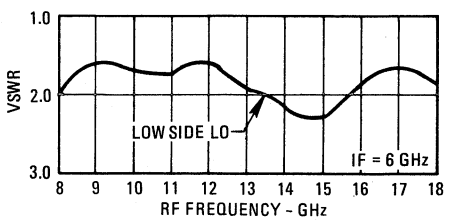


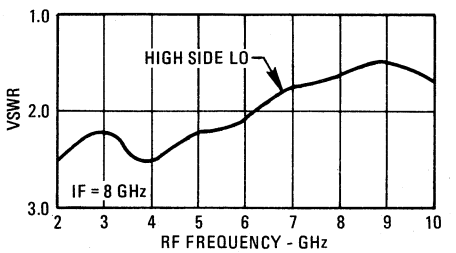



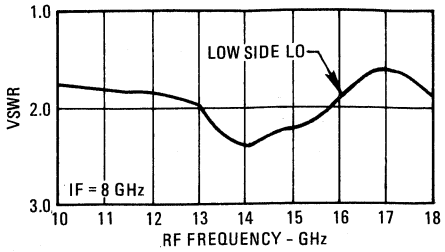



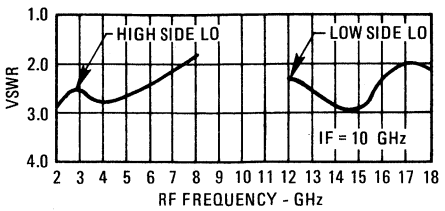



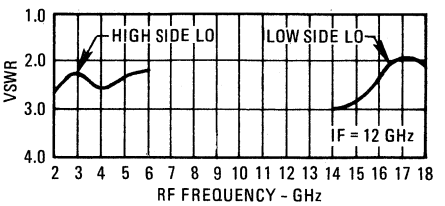



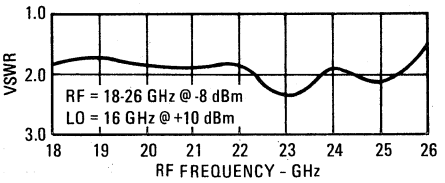



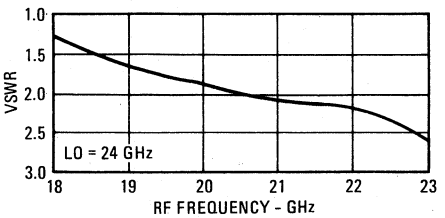

## R-Port VSWR

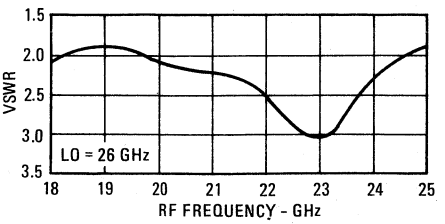


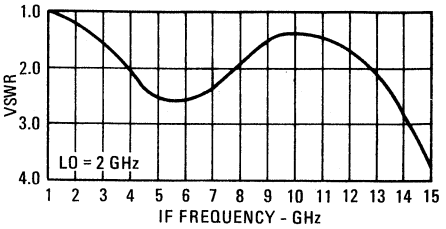



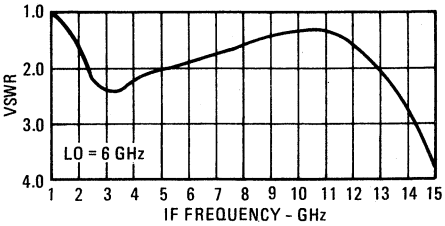



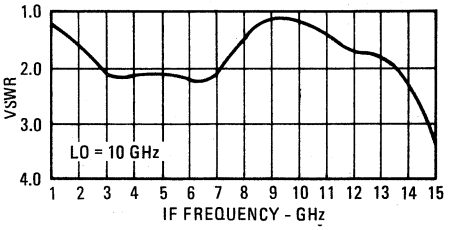



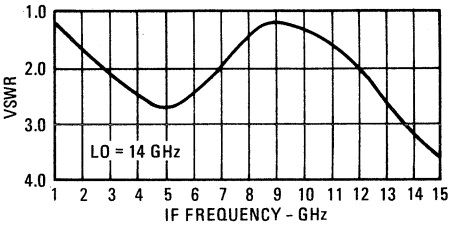



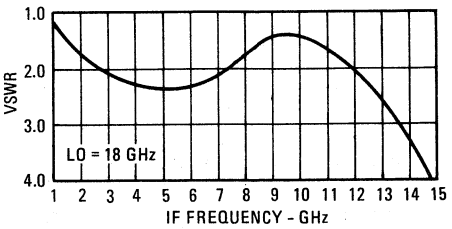

## I-Port VSWR

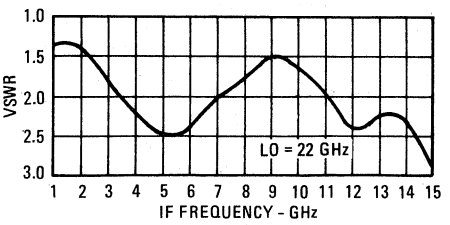


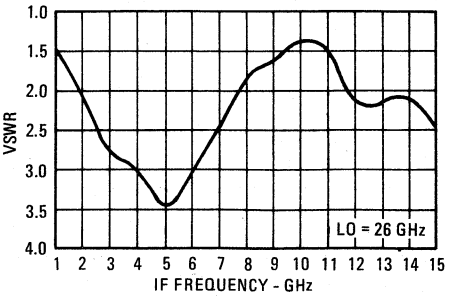




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

## Typical Performance at 25°C

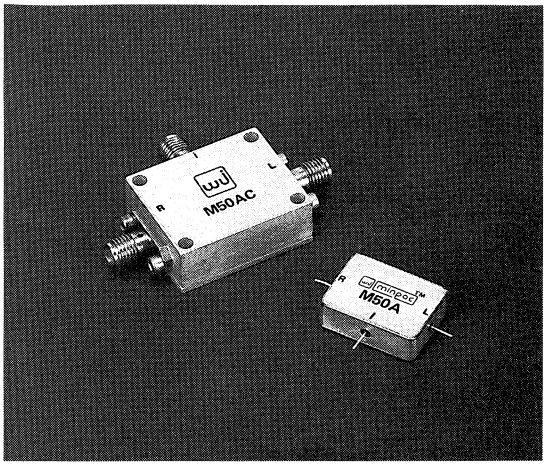
| Harmonics of $f_L$ | R - Port | I . Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -16 dBm | -l0 dBm | $f_L$ = 2 GHz at +10 dBm |
| 2 $f_L$ | -15 dBm | -23 dBm | |
| 3 $f_L$ | -24.5 dBm | -23 dBm | |
| 4 $f_L$ | -33 dBm | -41 dBm | |
| 5 $f_L$ | -33 dBm | -34 dBm | |
| 6 $f_L$ | -46 dBm | -45 dBm | |
| 7 $f_L$ | -41 dBm | -41 dBm | |
| 8 $f_L$ | -42 dBm | -48 dBm | |
| 9 $f_L$ | -47.2 dBm | -50 dBm | |
| 10 $f_L$ | -46 dBm | -51 dBm | |
| 11 $f_L$ | -49 dBm | -51 dBm | |
| $f_L$ | -30 dBm | -24 dBm | $f_L$ = 6 GHz at +10 dBm |
| 2 $f_L$ | -24 dBm | -34 dBm | |
| 3 $f_L$ | -30 dBm | -40 dBm | |
| $f_L$ | -22 dBm | -23 dBm | $f_L$ = 11 GHz at +10 dBm |
| 2 $f_L$ | -31 dBm | -28 dBm | |

| Single Tone IM | Typ· | Test Conditions |
|---|---|---|
| $f_L$ $f_R$ | | |
| 1 x 1 | 0 dB | $f_L$ = 2 GHz at +10 dBm |
| I x 2 | 44 dB | $f_R$ = 3.25 GHz at -10 dBm |
| I x 3 | > 65 dB | |
| 2 x 1 | 36 dB | |
| 2 x 2 | 50 dB | |
| 3 x 1 | 14 dB | |
| 3 x 2 | 48 dB | |
| 3 x 3 | 67 dB | |
| 4 x 1 | 35 dB | |
| 4 x 2 | 55 dB | |
| 5 X 1 | 28 dB | |
| 5 x 3 | —— | |
| 6 x 1 | —— | |
| 6 x 2 | 60 dB | |
| 7 x 1 | 33 dB | |
| 7 x 3 | > 65 dB | |
| $f_L$ $f_R$ | | |
| 1 x 1 | 0 dB | $f_L$ = 4.1 GHz at +10 dBm |
| 1 x 2 | 55 dB | $f_R$ = 6.0 GHz at -10 dBm |
| 1 x 3 | > 60 dB | |
| 2 x 1 | 35 dB | |
| 2 x 2 | 60 dB | |
| 3 x 1 | 19 dB | |
| 3 x 2 | > 58 dB | |
| 3 x 3 | 63 dB | |
| 4 x 1 | 41 dB | |
| 4 x 2 | > 62 dB | |
| 5 x 1 | 30 dB | |
| 5 x 3 | —— | |
| 6 x 1 | 45 dB | |
| 6 x 2 | 62 dB | |
| 7 x 1 | —— | |
| 7 x 3 | > 60 dB | |

# WJ-M50A/M50AC
# WJ-MY50A/MY50AC

## TRIPLE-BALANCED MIXER

- LO 2.0 TO 26.0 GHz
- RF 2.0 TO 18.0 GHz
- IF 1.0 TO 12.0 GHz
- LO DRIVE +10 dBm (nominal)
- VERY WIDEBAND IF 1 TO 12 GHz
- HIGH COMPRESSION POINT




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

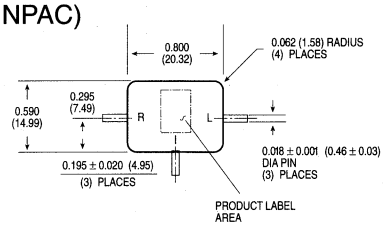
## Guaranteed Specifications[1]

| Characteristics | Min. | Typ.[2] | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | $f_R$ 2.5 to 18.0 GHz<br>$f_L$ 2.0 to 18.0 GHz<br>$f_I$ 1.0 to 10.0 GHz |
| | | 8.0 dB | 10.5 dB | fR 2.0 to 18.0 GHz<br>$f_L$ 2.0 to 26.0 GHz<br>$f_I$ 1.0 to 12.0 GHz |
| Isolation | | | | |
| L to R | 15 dB | 22 dB | | $f_L$ 2.0 to 3.0 GHz |
| | 20 dB | 30 dB | | $f_L$ 3.0 to 26.0 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ 7.0 to 26.0 GHz |
| | 15 dB | 22 dB | | $f_L$ 2.0 to 7.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +5.0 dBm<br>$f_L$ level +10.0 dBm |
| Third Order Input Intercept Point | | +15 dBm | | $f_{R1}$ = 5.00 GHz, $f_{R2}$ = 5.01 GHz both at - 6 dBm<br>$f_L$ = 8.0 GHz at +10.0 dBm |
| | | +12 dBm | | $f_{R1}$ = 15.00 GHz, $f_{R2}$ = 15.01 GHz both at -6 dBm<br>$f_L$ = 25.0 GHz at +10.0 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.
2. Typical values are measured at 25°C and are not guaranteed. They are based on the average value measured at the specified condition.Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC ® model.

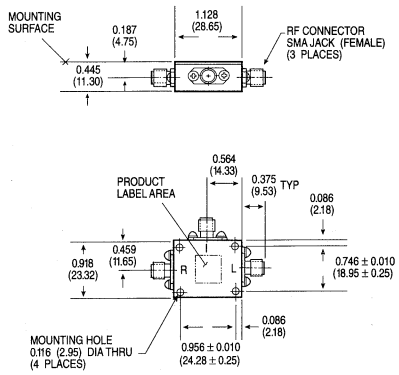
## Outline Drawings

M50A
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M50AC
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

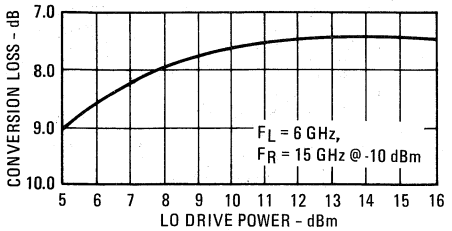
## Absolute Maximum Ratings

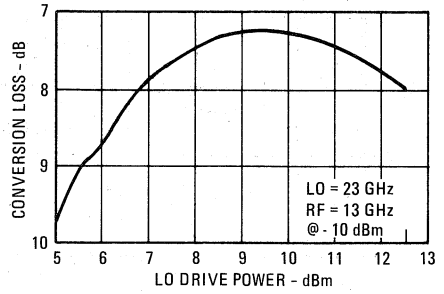
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C

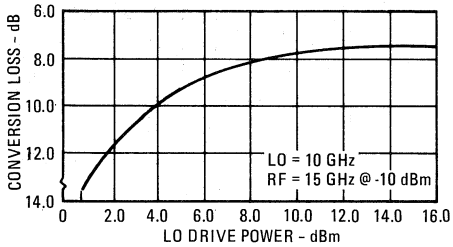
Weigh M50A: 12 grams (0.42 oz.) max. MY50A: 12 grams (0.42 oz.) max.
M50AC: 40 grams (1.41 oz.) max. MY50AC: 18 grams (0.63 oz.) max.

# Typical Performance at 25°C

### Drive Level

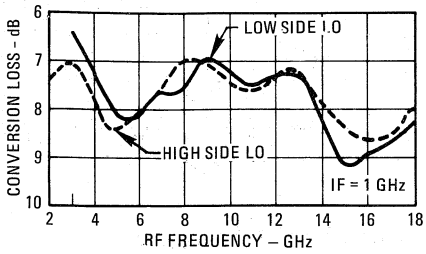


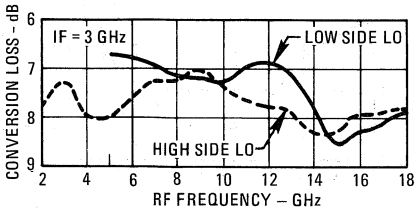



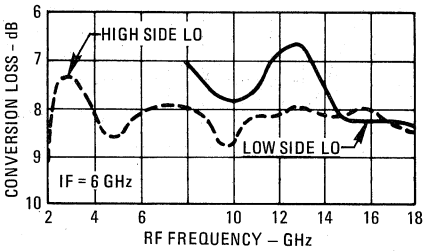



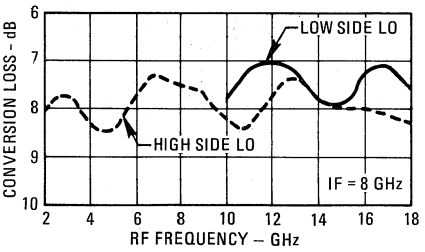

*Drive Level:* The maximum recommended drive level is +17 dBm.

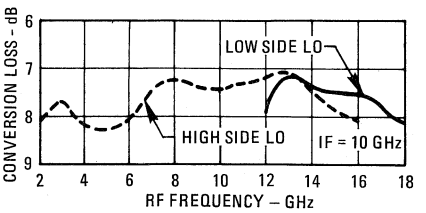
### Conversion Loss vs. Frequency LO @ +10 dBm

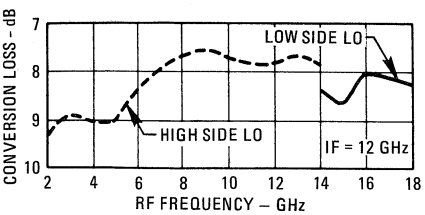


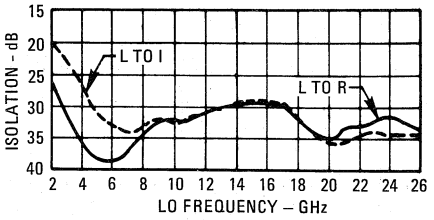



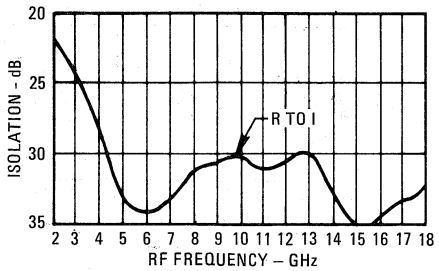



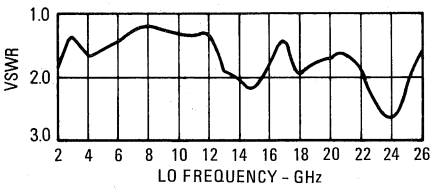




### Isolation vs. Frequency

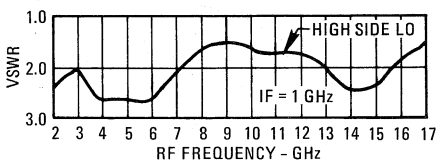


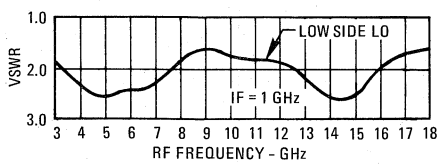



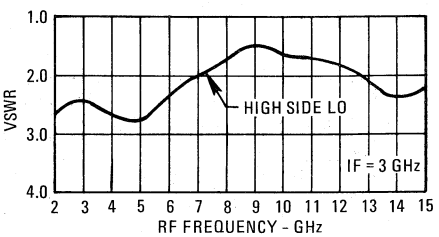

### L-Port VSWR



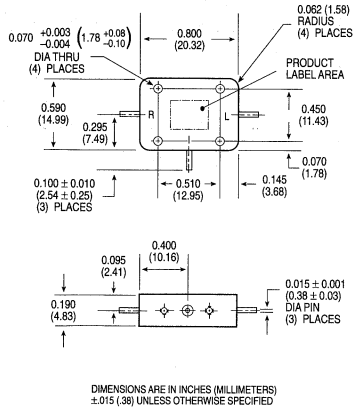

### R-Port VSWR LO @ +10 dBm




### MY50A

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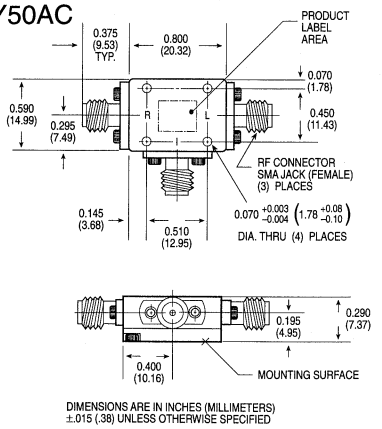
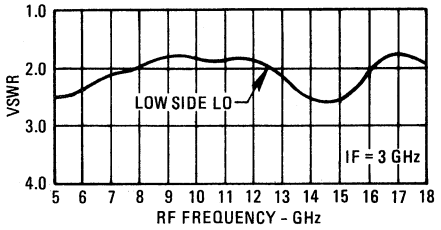
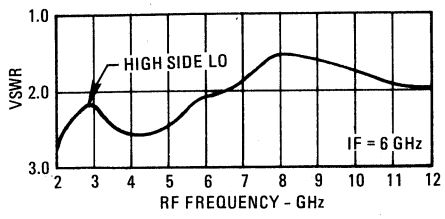


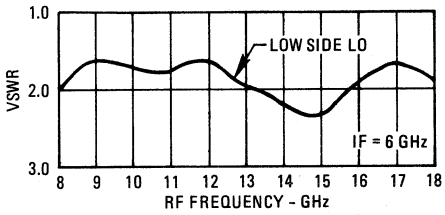

10

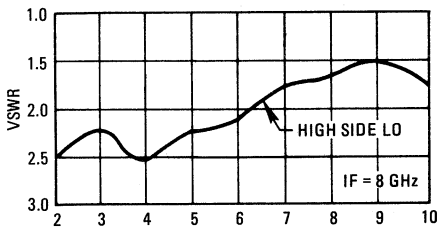
# Typical Performance at 25°C

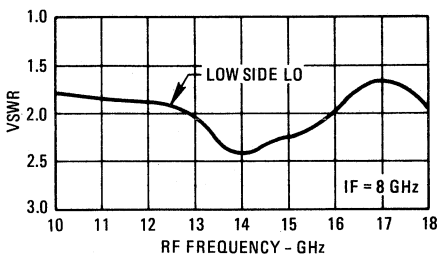
### R-Port VSWR

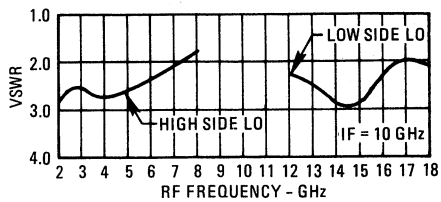


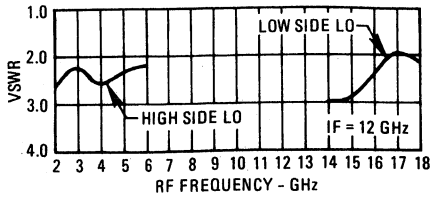



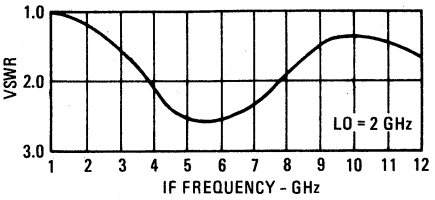



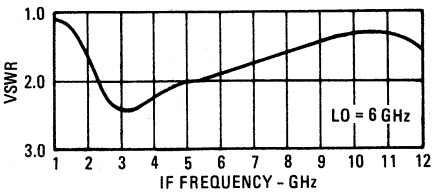



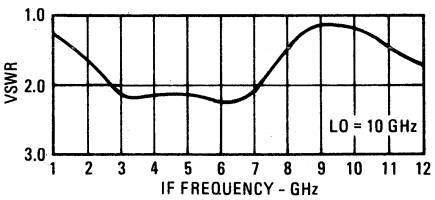

### R-Port VSWR



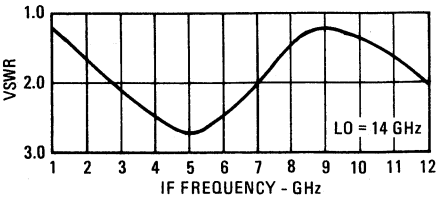

### I-Port VSWR vs. Frequency, LO @ +10 dBm

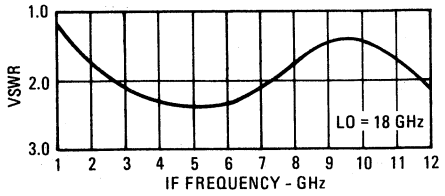


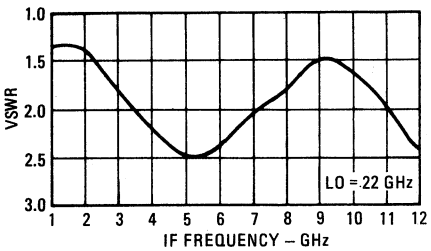



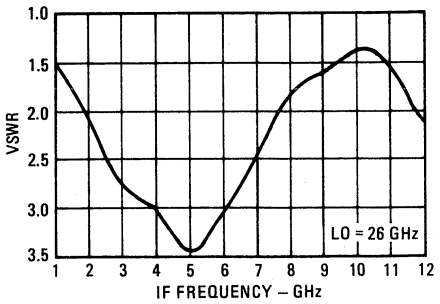




### I-Port VSWR



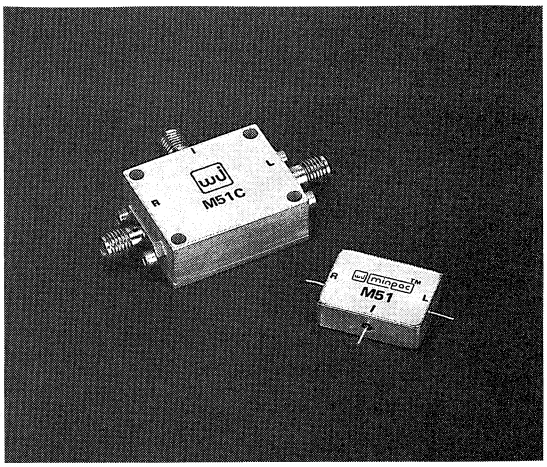
## Typical Performance at 25° C

| Harmonics of $f_L$ | R - Port | I . Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -16 dBm | -l0 dBm | $f_L$ = 2 GHz at +10 dBm |
| 2 $f_L$ | -15 dBm | -23 dBm | |
| 3 $f_L$ | -24.5 dBm | -23 dBm | |
| 4 $f_L$ | -33 dBm | -41 dBm | |
| 5 $f_L$ | -33 dBm | -34 dBm | |
| 6 $f_L$ | -46 dBm | -45 dBm | |
| 7 $f_L$ | -41 dBm | -41 dBm | |
| 8 $f_L$ | -42 dBm | -48 dBm | |
| 9 $f_L$ | -47.2 dBm | -50 dBm | |
| 10 $f_L$ | -46 dBm | -51 dBm | |
| 11 $f_L$ | -49 dBm | -51 dBm | |
| $f_L$ | -30 dBm | -24 dBm | $f_L$ = 6 GHz at +10 dBm |
| 2 $f_L$ | -24 dBm | -34 dBm | |
| 3 $f_L$ | -30 dBm | -40 dBm | |
| $f_L$ | -22 dBm | -23 dBm | $f_L$ = 11 GHz at +10 dBm |
| 2 $f_L$ | -31 dBm | -28 dBm | |

| Single Tone IM | Typ.[2] | Test Conditions |
|---|---|---|
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 2 GHz at +10 dBm |
| I x 2 | 44 dB | $f_R$ = 3.25 GHz at -10 dBm |
| I x 3 | > 65 dB | |
| 2 x 1 | 36 dB | |
| 2 x 2 | 50 dB | |
| 3 x 1 | 14 dB | |
| 3 x 2 | 48 dB | |
| 3 x 3 | 67 dB | |
| 4 x 1 | 35 dB | |
| 4 x 2 | 55 dB | |
| 5 X 1 | 28 dB | |
| 5 x 3 | —— | |
| 6 x 1 | —— | |
| 6 x 2 | 60 dB | |
| 7 x 1 | 33 dB | |
| 7 x 3 | > 65 dB | |
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 4.1 GHz at +10 dBm |
| 1 x 2 | 55 dB | $f_R$ = 6.0 GHz at -10 dBm |
| 1 x 3 | > 60 dB | |
| 2 x 1 | 35 dB | |
| 2 x 2 | 60 dB | |
| 3 x 1 | 19 dB | |
| 3 x 2 | > 58 dB | |
| 3 x 3 | 63 dB | |
| 4 x 1 | 41 dB | |
| 4 x 2 | > 62 dB | |
| 5 x 1 | 30 dB | |
| 5 x 3 | —— | |
| 6 x 1 | 45 dB | |
| 6 x 2 | 62 dB | |
| 7 x 1 | —— | |
| 7 x 3 | > 60 dB | |

# WJ-M51/M51C
# WJ-MY51/MY51C

## TRIPLE-BALANCED MIXER




- LO 2.0 TO 24.0 GHz
- RF 2.0 TO 24.0 GHz
- IF 1.0 TO 15.0 GHz
- LO DRIVE +10 dBm (nominal)
- VERY WIDE BANDWIDTH
- HIGH COMPRESSION POINT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

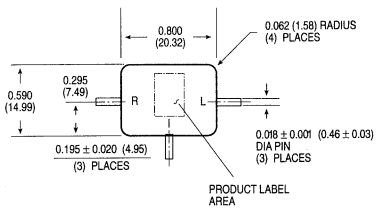
## Guaranteed Specifications[1]

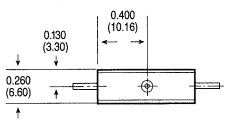
| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | $f_R$ 2.5 to 18.0 GHz<br>$f_L$ 2.0 to 18.0 GHz<br>$f_I$ 2.0 to 10.0 GHz |
| | | 8.0 dB | 10.5 dB | $f_R$ 2.0 to 18.0 GHz<br>$f_L$ 2.0 to 24.0 GHz<br>$f_I$ 1.0 to 12.0 GHz |
| | | 9.0 dB | 11.5 dB | $f_R$ 2.0 to 24.0 GHz<br>$f_L$ 2.0 to 24.0 GHz<br>$f_I$ 1.0 to 12.0 GHz<br>$f_I$ 1.0 to 15.0 GHz $f_L < f_R$ |
| ISOLATION | | | | |
| L to R | 15 dB | 20 dB | | $f_L$ 2.0 to 3.0 GHz |
| | 20 dB | 30 dB | | $f_L$ 3.0 to 24.0 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ 7.0 to 24.0 GHz |
| | 15 dB | 22 dB | | $f_L$ 2.0 to 7.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +5.0 dBm<br>$f_L$ level +10.0 dBm |
| Third Order Input Intercept | | +15 dBm | | $f_{R1}$ =5.00 GHz, $f_{R_2}$ = 5.01 GHz both at -6 dBm<br>$f_L$ = 8.0 GHz at +10.0 dBm |
| | | +15 dBm | | $f_{R1}$ = 16.00 GHz, $f_{R_2}$= 16.01 GHz both at -6 dBm<br>$f_L$ = 18.0 GHz at +10.0 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

## Outline Drawings

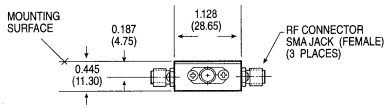
M51

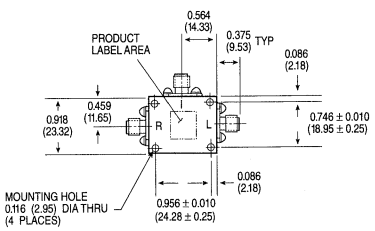



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M51C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

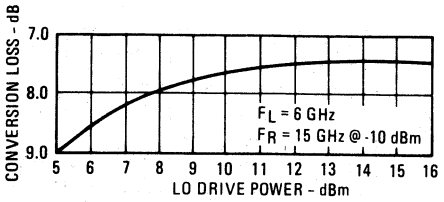
## Absolute Maximum Ratings

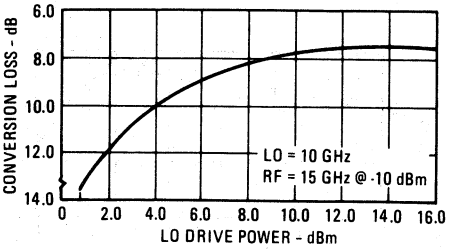
Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C

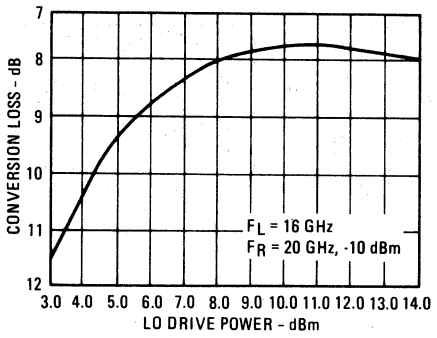
Weight M51: 12 grams (0.42 oz.) max. MY51: 12 grams (0.42 oz.) max.
M51C: 40 grams (1.41 oz.) max. MY51C: 18 grams (0.63 oz.) max.

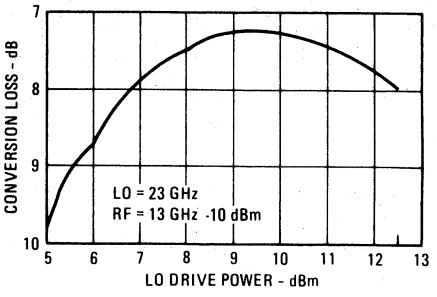
# Typical Performance at 25°C

### Drive Level



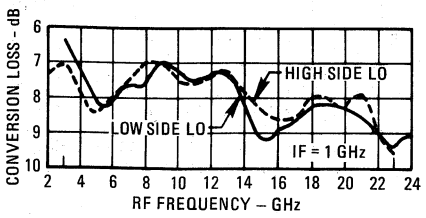



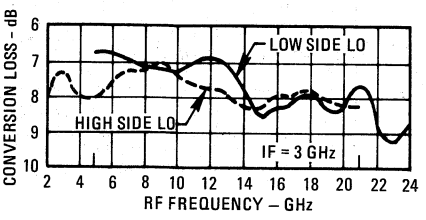



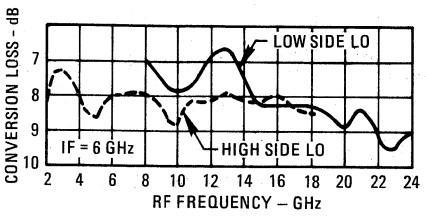



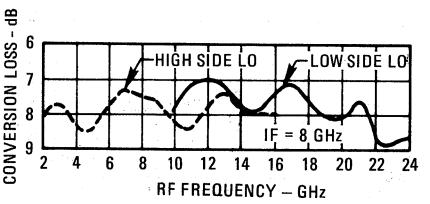

***Drive Level:*** The maximum recommended drive level is +17 dBm.

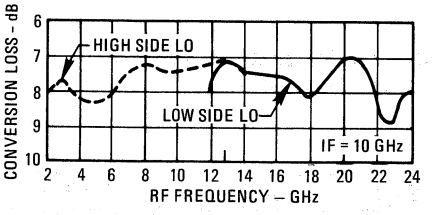
### Conversion Loss vs. Frequency LO @ +10 dBm



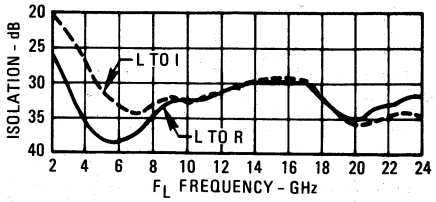



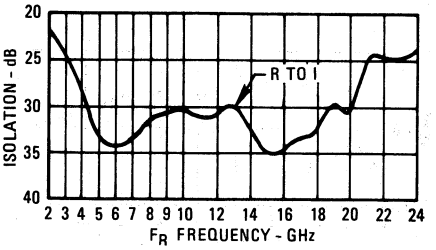



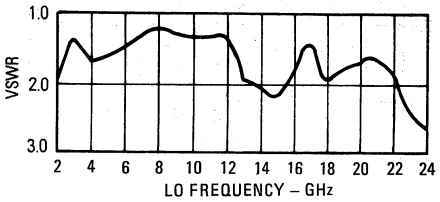




### Isolation vs. Frequency

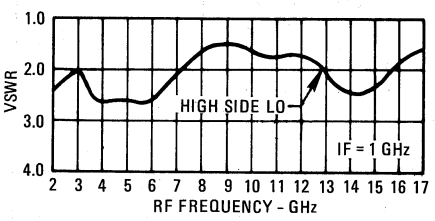


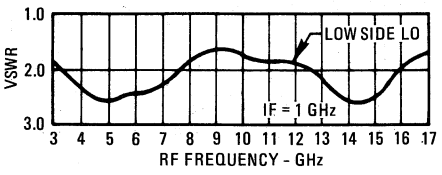



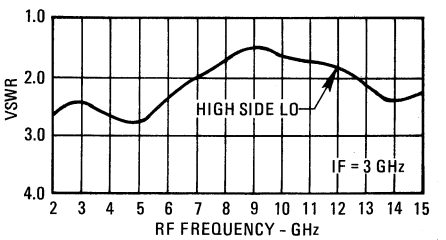

### L-Port VSWR




### R-Port VSWR LO @ +10 dBm

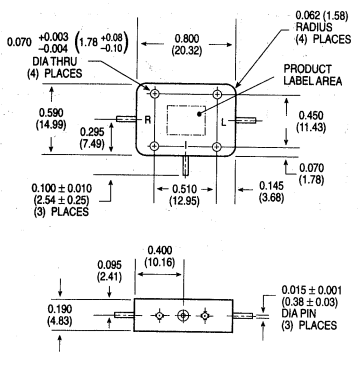


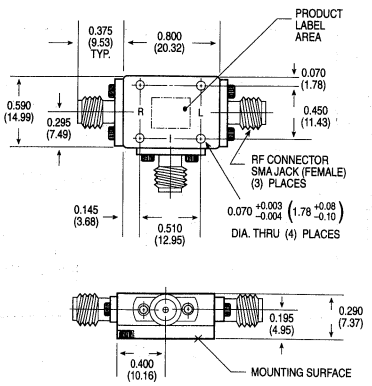

10

### MY51




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

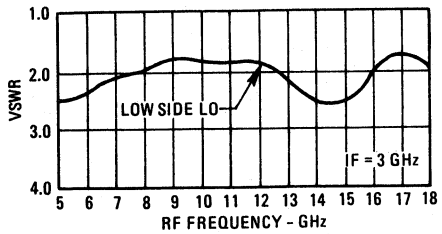
### MY51C

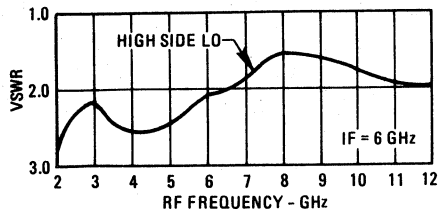


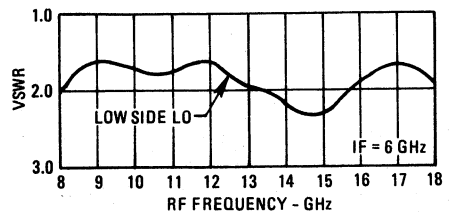

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

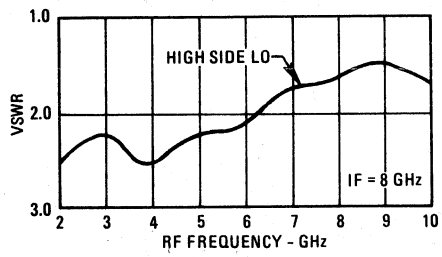
# Typical Performance at 25°C

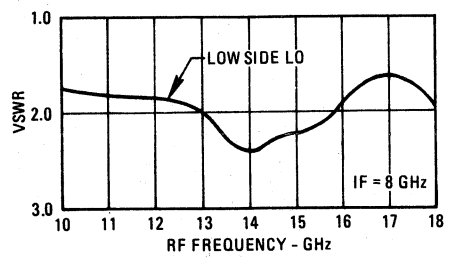
### R-Port VSWR



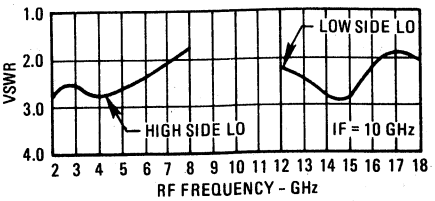



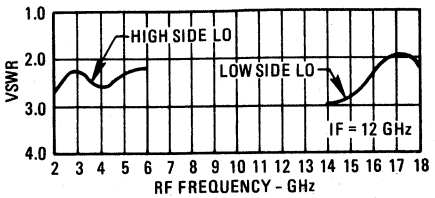



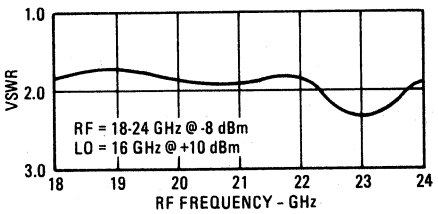



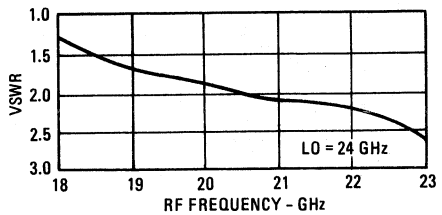




### R-Port VSWR

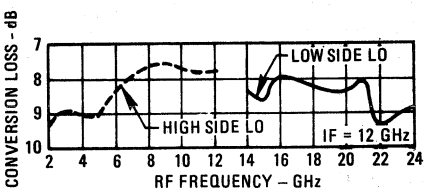


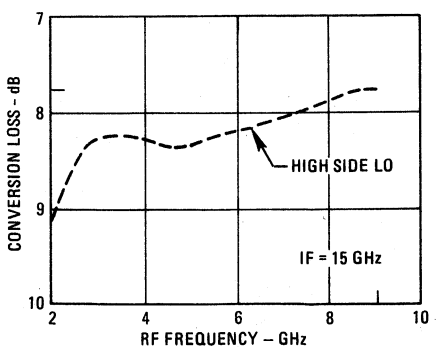



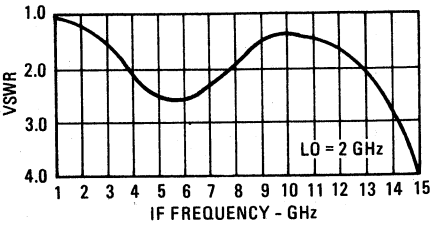



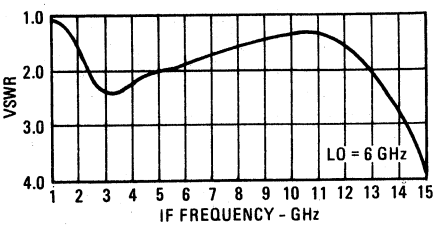

### Conversion Loss vs. Frequency
### LO @ +10 dBm

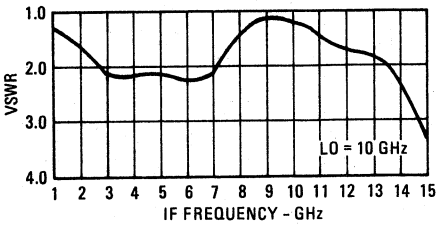


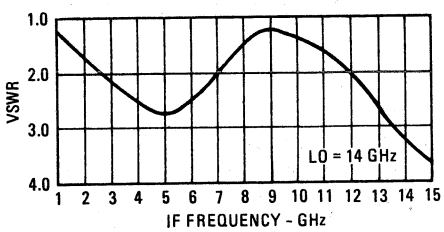



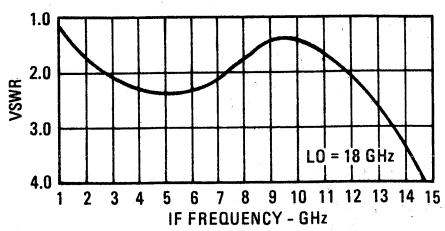

### I-Port VSWR

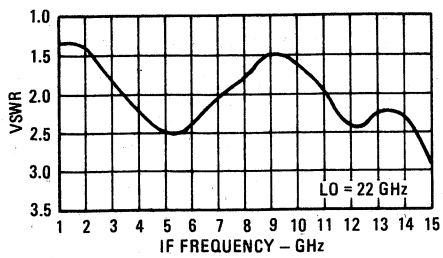


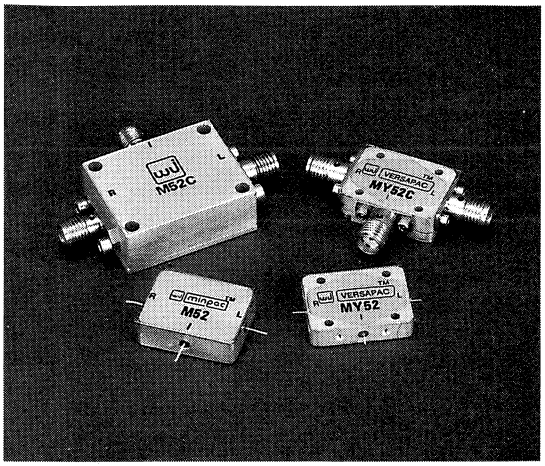
## Typical Performance at 25° C

| Harmonics of $f_L$ | R - Port | I . Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -16 dBm | -l0 dBm | $f_L$ = 2 GHz at +10 dBm |
| 2 $f_L$ | -15 dBm | -23 dBm | |
| 3 $f_L$ | -24.5 dBm | -23 dBm | |
| 4 $f_L$ | -33 dBm | -41 dBm | |
| 5 $f_L$ | -33 dBm | -34 dBm | |
| 6 $f_L$ | -46 dBm | -45 dBm | |
| 7 $f_L$ | -41 dBm | -41 dBm | |
| 8 $f_L$ | -42 dBm | -48 dBm | |
| 9 $f_L$ | -47.2 dBm | -50 dBm | |
| 10 $f_L$ | -46 dBm | -51 dBm | |
| 11 $f_L$ | -49 dBm | -51 dBm | |
| $f_L$ | -30 dBm | -24 dBm | $f_L$ = 6 GHz at +10 dBm |
| 2 $f_L$ | -24 dBm | -34 dBm | |
| 3 $f_L$ | -30 dBm | -40 dBm | |
| $f_L$ | -22 dBm | -23 dBm | $f_L$ = 11 GHz at +10 dBm |
| 2 $f_L$ | -31 dBm | -28 dBm | |

| Single Tone IM | Typ· | Test Conditions |
|---|---|---|
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 2 GHz at +10 dBm |
| I x 2 | 44 dB | $f_R$ = 3.25 GHz at -10 dBm |
| I x 3 | > 65 dB | |
| 2 x 1 | 36 dB | |
| 2 x 2 | 50 dB | |
| 3 x 1 | 14 dB | |
| 3 x 2 | 48 dB | |
| 3 x 3 | 67 dB | |
| 4 x 1 | 35 dB | |
| 4 x 2 | 55 dB | |
| 5 X 1 | 28 dB | |
| 5 x 3 | —— | |
| 6 x 1 | —— | |
| 6 x 2 | 60 dB | |
| 7 x 1 | 33 dB | |
| 7 x 3 | > 65 dB | |
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 4.1 GHz at +10 dBm |
| 1 x 2 | 55 dB | $f_R$ = 6.0 GHz at -10 dBm |
| 1 x 3 | > 60 dB | |
| 2 x 1 | 35 dB | |
| 2 x 2 | 60 dB | |
| 3 x 1 | 19 dB | |
| 3 x 2 | > 58 dB | |
| 3 x 3 | 63 dB | |
| 4 x 1 | 41 dB | |
| 4 x 2 | > 62 dB | |
| 5 x 1 | 30 dB | |
| 5 x 3 | —— | |
| 6 x 1 | 45 dB | |
| 6 x 2 | 62 dB | |
| 7 x 1 | —— | |
| 7 x 3 | > 60 dB | |

# WJ-M52/M52C
# WJ-MY52/MY52C

## TRIPLE BALANCED (DOUBLE-DOUBLE) MIXER




- LO / RF } 2.0 TO 24.0 GHZ
- IF 0.1 TO 5.0 GHz
- LO DRIVE +10 dBm (nominal)
- HIGH COMPRESSION POINT
- VERY WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

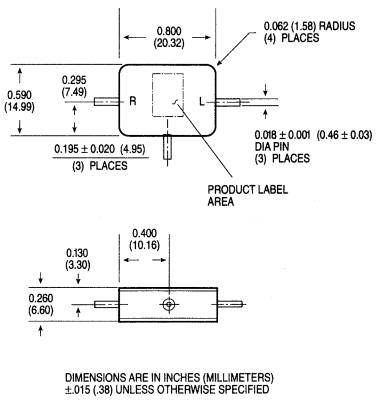
| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | RF = 8 to 18 GHz<br>LO = 8 to 18 GHz<br>IF = 0.1 to 4.0 GHz |
| | | 8.0 dB | 10.0 dB | RF = 2 to 8 GHz<br>LO = 2 to 8 GHz<br>IF = 1.0 to 4.0 GHz |
| | | 8.5 dB | 10.5 dB | RF = 2 to 18 G Hz<br>LO = 2 to 18 GHz<br>IF = 0.1 to 5.0 GHz |
| | | 9.5 dB | 12.5 dB | RF = 18 to 24 GHz<br>LO = 13 to 24 GHz<br>IF = 0.1 to 5.0 GHz |
| Isolation | | | | |
| L - R | 15dB | 18 dB | | LO = 2 to 24 GHz |
| | 20 dB | 25 dB | | LO = 4 to 19 GHz |
| L - I | 22 dB | 30 dB | | LO = 2 to 20 GHz |
| | 15 dB | 20 dB | | LO = 20 to 24 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +5.0 dBm<br>$f_L$ Level +10.0 dBm |
| Third-Order Input Intercept | | +16dB | | $RF_1$ 3.75 GHz -6 dBm<br>$RF_2$ 3.76 GHz -6 dBm<br>LO 4.0 GHz +10 dBm |
| | | +16dBm | | $RF_1$ 13.00 GHz -6 dbm<br>$RF_2$ 13.01 GHz -6 dbm<br>LO 11.0 GHz +10 dBm |
| | | +13dBm | | $RF_1$ 20.00 GHz -6 dbm<br>$RF_2$ 20.01 GHz -6 dBm<br>LO 24.0 GHz +10 dBm |

Notes:

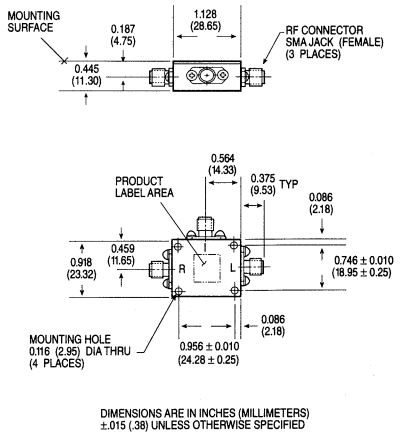
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

## Outline Drawings

M52




M52C

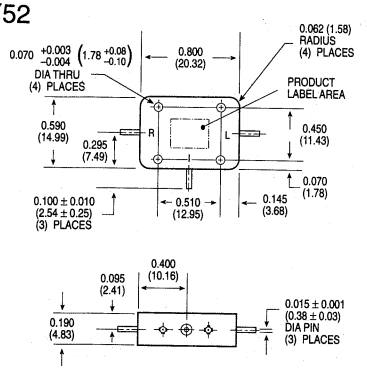



## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C
Weight M52: 12 grams (0.42 oz.) max. M52C: 40 grams (1.41 oz.) max.
MY52: 12 grams (0.42 oz.) max. MY52C: 18 grams (0.63 oz.) max.

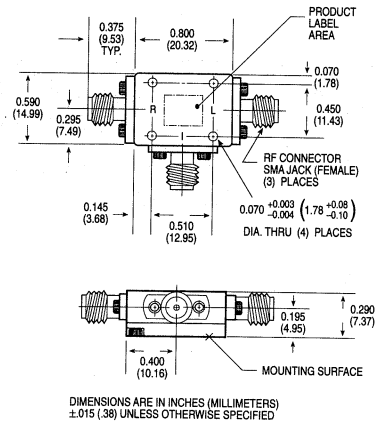
## Outline Drawings

MY52




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

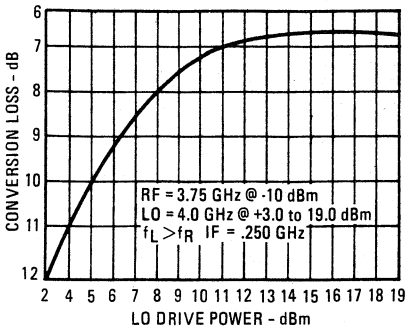
MY52C

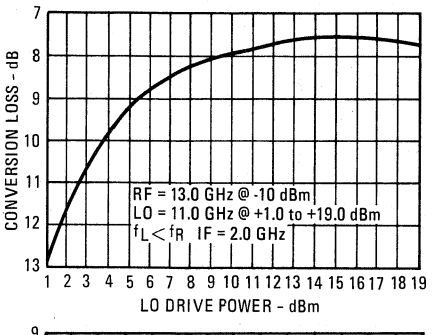


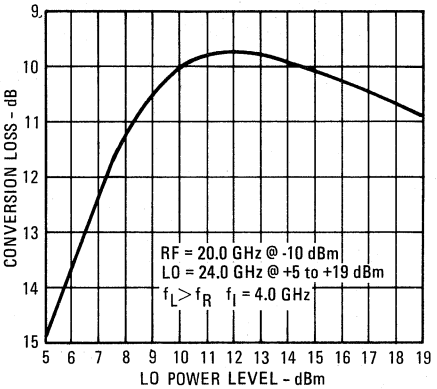

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C *

### Drive Level

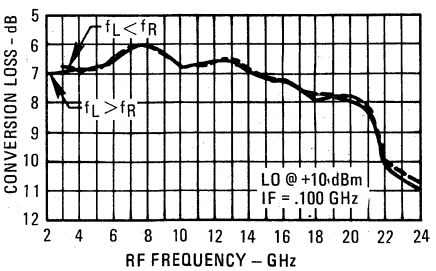


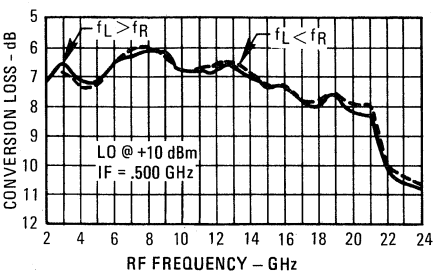



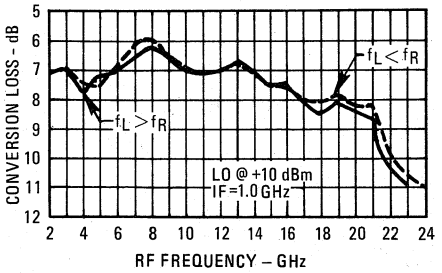

*Drive Level:* The maximum recommended drive level is +17 dBm.

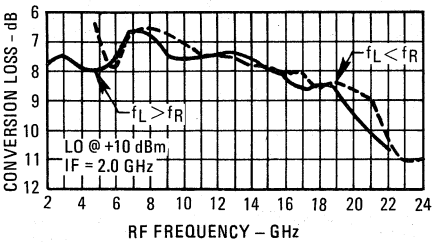
### Conversion Loss vs. Frequency

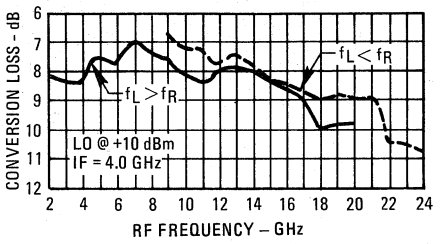


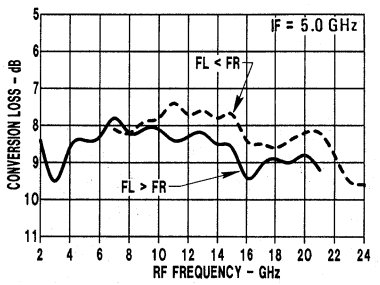




### Conversion Loss vs. Frequency

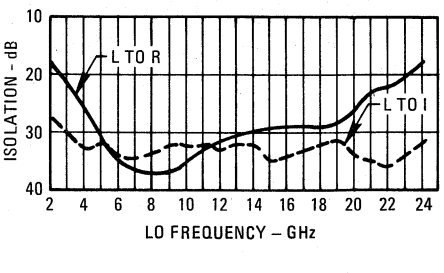


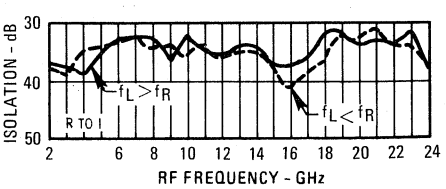




### Isolation vs. Frequency



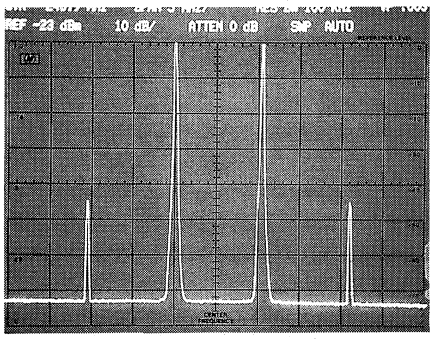




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

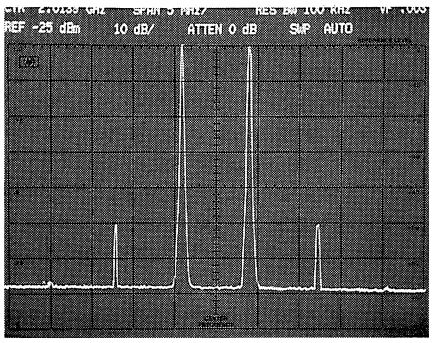
10

# Typical Performance at 25°C *

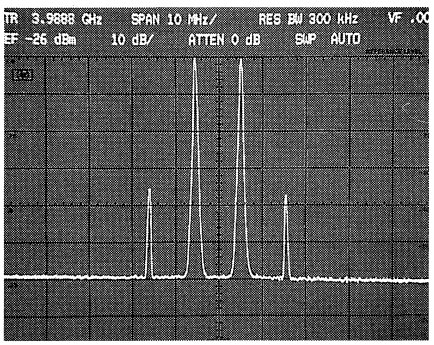
### Third-Order Intercept Input




$f_R$ = 3.75, 3.76 @ -6 dBm
LO = 4.0 GHz @ +10 dBm

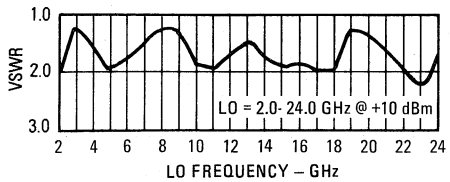



$f_R$ = 13 GHz, 13.01 GHz @ -6 dBm
LO = 11.0 GHz @ +10 dBm

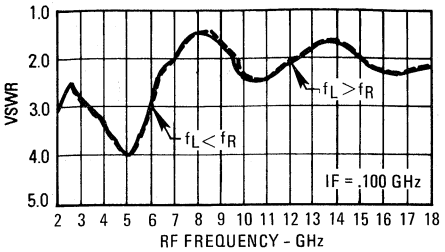


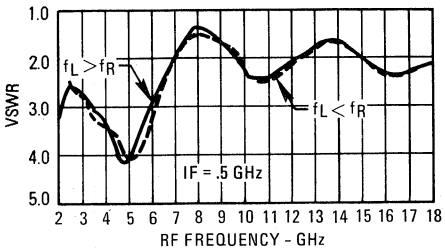

$f_R$ = 20 GHz, 20.01 GHz @ -6 dBm
LO = 24 GHz @ +10 dBm

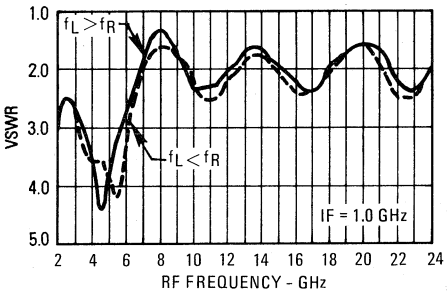
### L-Port VSWR

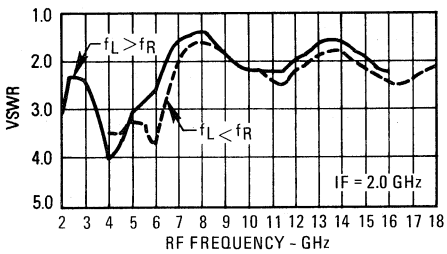


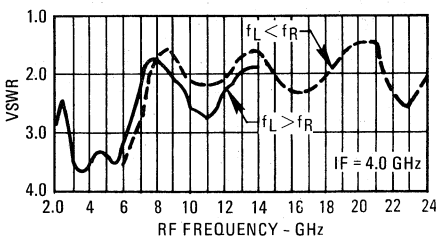

### R-Port VSWR



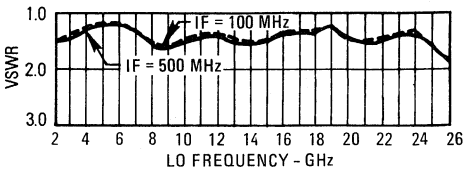



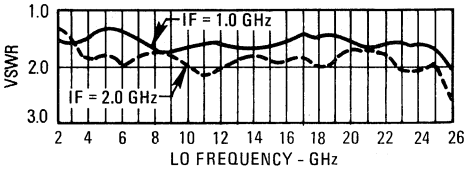



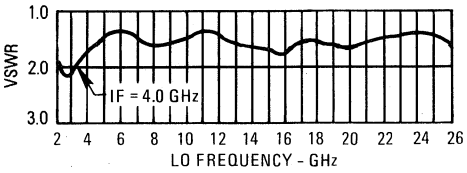




### I-Port VSWR




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

## Typical Performance at 25°C

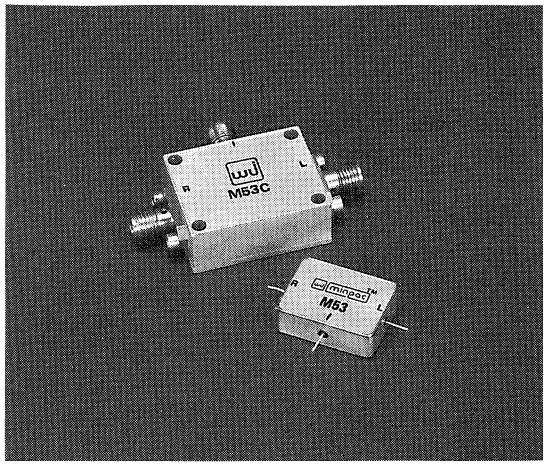
| Harmonics of $f_L$ | R - Port | I - Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -8 dBm | -16 dBm | $f_L$ = 2 GHz at +10 dBm |
| 2 $f_L$ | -27 dBm | -18 dBm | |
| 3 $f_L$ | -21 dBm | -34 dBm | |
| 4 $f_L$ | -31 dBm | -27 dBm | |
| 5 $f_L$ | -29 dBm | -41 dBm | |
| 6 $f_L$ | -49 dBm | -38 dBm | |
| 7 $f_L$ | -34 dBm | -46 dBm | |
| 8 $f_L$ | -49 dBm | -61 dBm | |
| 9 $f_L$ | -41 dBm | -53 dBm | |
| 10 $f_L$ | -54 dBm | -58 dBm | |
| 11 $f_L$ | -50 dBm | -58 dBm | |
| $f_L$ | -24 dBm | -24 dBm | $f_L$ = 6 GHz at +10 dBm |
| 2 $f_L$ | -25 dBm | -30 dBm | |
| 3 $f_L$ | -27 dBm | -32 dBm | |
| $f_L$ | -23 dBm | -22 dBm | $f_L$ = 11 GHz at +10 dBm |
| 2 $f_L$ | -38 dBm | -41 dBm | |

| Single Tone Im $f_L$ $f_R$ | Typical Suppression | Test Conditions |
|---|---|---|
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 2 GHz at+10 dBm |
| 1 x 2 | 39 dB | $f_R$ = 3.25 GHz at -10 dBm |
| 1 x 3 | 48 dB | |
| 2 x 1 | 33 dB | |
| 2 x 2 | 40 dB | |
| 3 x 1 | 14 dB | |
| 3 x 2 | 47 dB | |
| 3 x 3 | 65 dB | |
| 4 x 1 | 45 dB | |
| 4 x 2 | 43 dB | |
| 5 x 1 | 19 dB | |
| 5 x 3 | 62 dB | |
| 6 x 2 | 42 dB | |
| 7 x 3 | 55 dB | |
| **$f_L$ $f_R$** | | |
| 1 x 1 | 0 dB | $f_L$ = 4.1 GHz at +10 dBm |
| 1 x 2 | 56 dB | $f_R$ = 6.0 GHz at -10 dBm |
| 2 x 1 | 31 dB | |
| 2 x 2 | 48 dB | |
| 3 x 1 | 16 dB | |
| 3 x 2 | 51 dB | |
| 3 x 3 | 57 dB | |
| 4 x 1 | 43 dB | |
| 4 x 2 | 44 dB | |
| 5 x 3 | 54 dB | |
| 7 x 3 | 67 dB | |

# WJ-M53/M53C

## TRIPLE BALANCED (DOUBLE-DOUBLE) MIXER

- LO, RF } 2.0 TO 26.0 GHZ
- IF 0.1 TO 6.0 GHz
- LO DRIVE +10 dBm (nominal)
- HIGH COMPRESSION POINT
- VERY WIDE BANDWIDTH




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | RF = 8 to 18 GHz<br>LO = 8 to 18 GHz<br>IF = 0.1 to 4.0 GHz |
| | | 8.0 dB | 10.0 dB | RF = 2 to 8 GHz<br>LO = 2 to 8 GHz<br>IF = 1.0 to 4.0 GHz |
| | | 8.5 dB | 10.5 dB | RF = 2 to 18 G Hz<br>LO = 2 to 18 GHz<br>IF = 0.1 to 5.0 GHz |
| | | 9.5 dB | 12.5 dB | RF = 18 to 26 GHz<br>LO = 18 to 26 GHz<br>IF = 0.1 to 6.0 GHz |
| Isolation | | | | |
| L - R | 15 dB | 18 dB | | LO = 2 to 26 GHz |
| | 20 dB | 25 dB | | LO = 4 to 19 GHz |
| L - I | 22 dB | 30 dB | | LO = 2 to 20 GHz |
| | 15 dB | 20 dB | | LO = 20 to 26 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level + 5.0 dBm<br>$f_L$ Level + 10.0 dBm |
| | | +16 dBm | | $RF_1$ 3.75 GHz - 6 dBm<br>$RF_2$ 3.76 GHz - 6 dBm<br>LO 4.0 GHz + 10 dBm |
| Third-Order Input Intercept | | +16 dBm | | $RF_1$ 13.00 GHz - 6 dBm<br>$RF_2$ 13.01 GHi - 6 dBm<br>LO 11.0 GHz + 10 dBm |
| | | +13 dBm | | $RF_1$ 20.00 GHz - 6 dBm<br>$RF_2$ 20.01 GHz - 6 dBm<br>LO 24.0 GHz + 10 dBm |

Notes: 1. Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

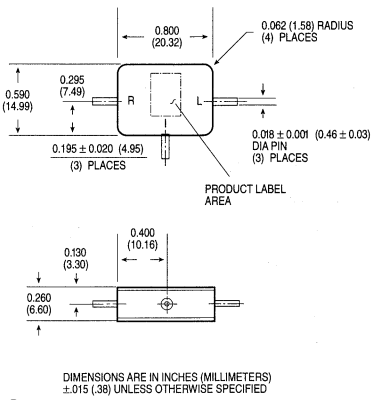
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C

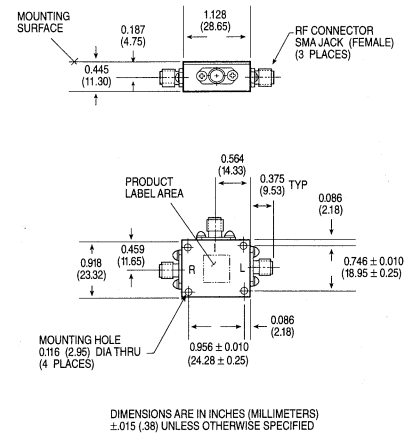
Weight M53: 12 grams (0.42 oz.) max.
M53C: 40 grams (1.41 oz.) max.

## Outline Drawings

M53

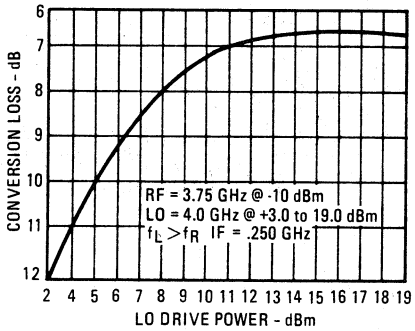


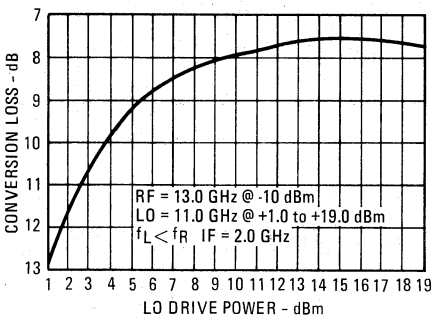

M53C

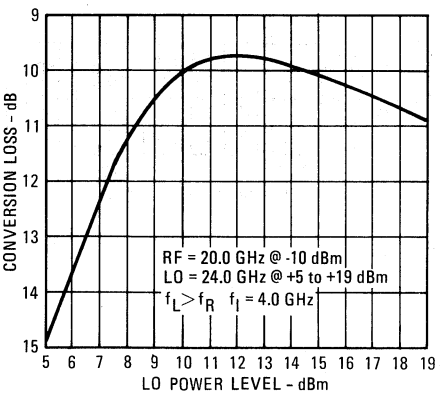


# Typical Performance at 25°C

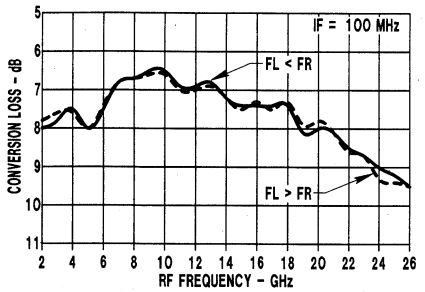
*Drive Level:* The maximum recommended drive level is +17 dBm.



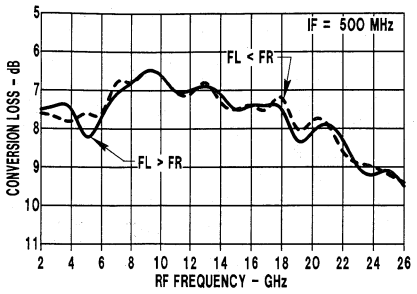



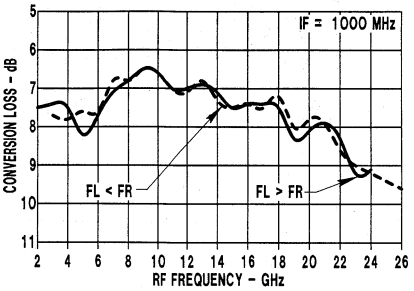



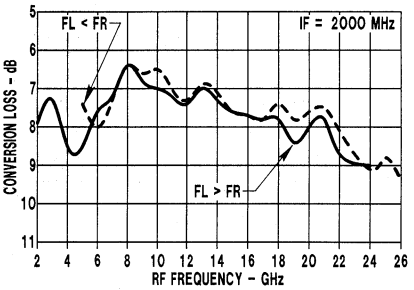

### Conversion Loss vs. Frequency

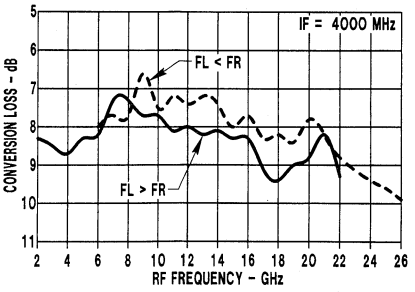


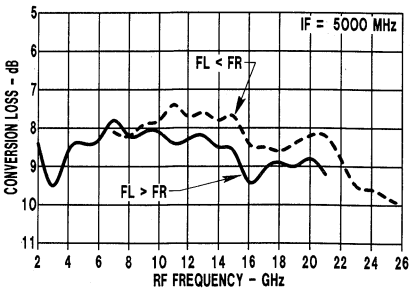

### Conversion Loss vs. Frequency



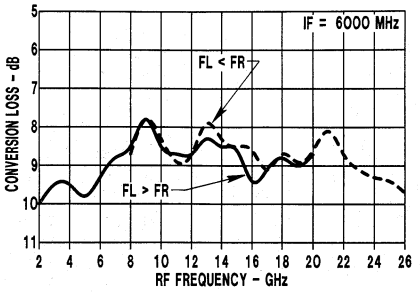



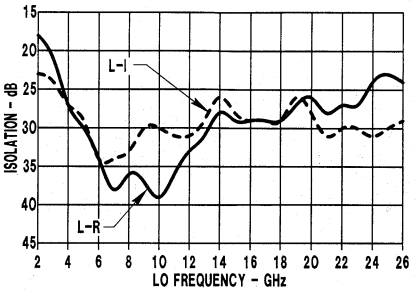



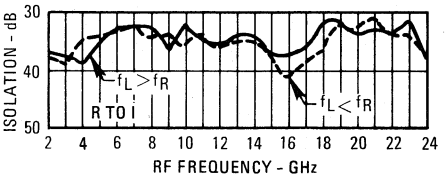




### Conversion Loss vs. Frequency

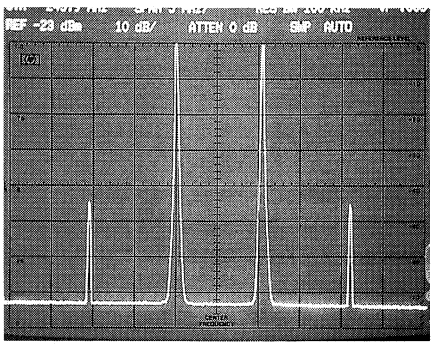



### Isolation vs. Frequency




### Third-Order Intercept Input

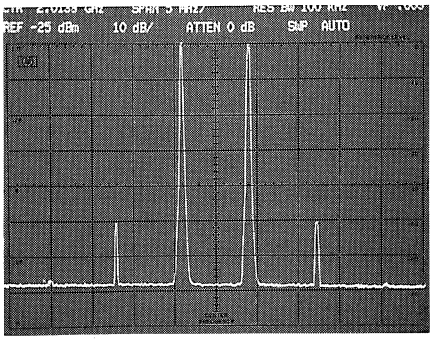



$f_R$ = 3.75, 3.76 at -6 dBm
LO = 4.0 GHz at +10 dBm

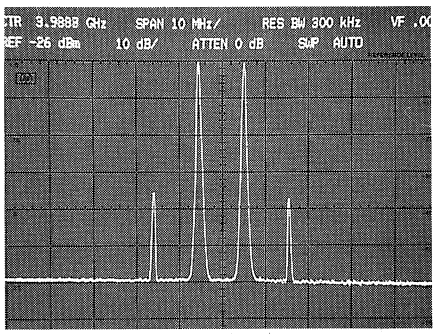
10

# Typical Performance at 25°C

### Third-Order Intercept Input

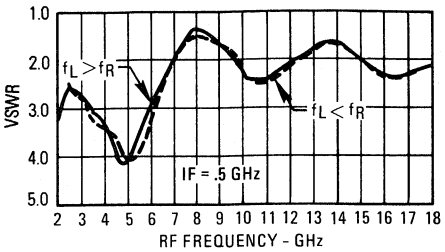


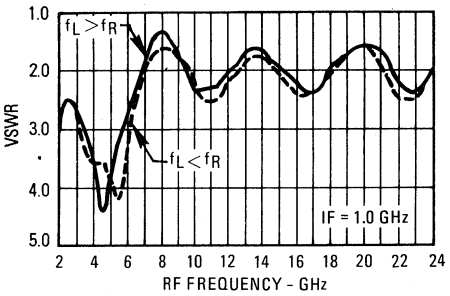

$f_R$ = 13 GHz, 13.01 GHz at -6 dBm
LO = 11.0 GHz at +10 dBm

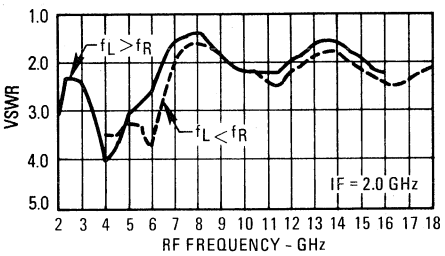



$f_R$ = 20 GHz, 20.01 GHz at -6 dBm
LO = 24 GHz at +10 dBm

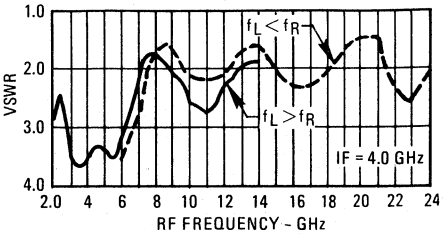
### R-Port VSWR



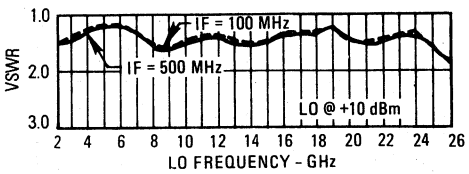



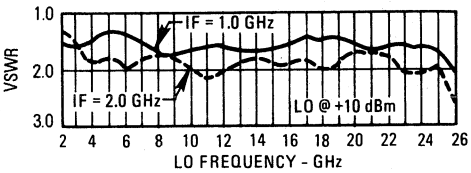



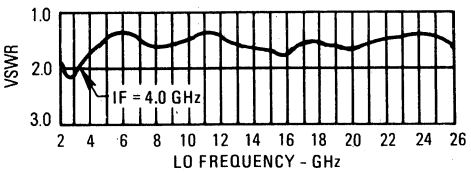

### R-Port VSWR



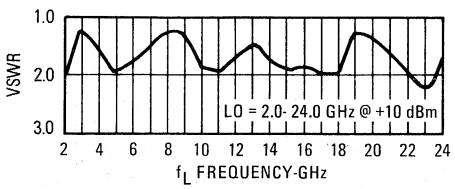

### I-Port VSWR



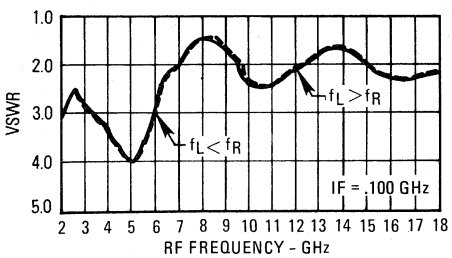




### L-Port VSWR




### R-Port VSWR



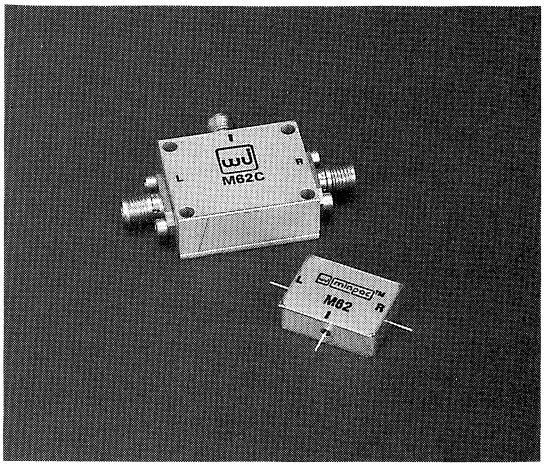
## Typical Performance at 25° C

| Harmonics of $f_L$ | R - Port | I - Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -8 dBm | -16 dBm | $f_L$ = 2 GHz at +10 dBm |
| 2 $f_L$ | -27 dBm | -18 dBm | |
| 3 $f_L$ | -21 dBm | -34 dBm | |
| 4 $f_L$ | -31 dBm | -27 dBm | |
| 5 $f_L$ | -29 dBm | -41 dBm | |
| 6 $f_L$ | -49 dBm | -38 dBm | |
| 7 $f_L$ | -34 dBm | -46 dBm | |
| 8 $f_L$ | -49 dBm | -61 dBm | |
| 9 $f_L$ | -41 dBm | -53 dBm | |
| 10 $f_L$ | -54 dBm | -58 dBm | |
| 11 $f_L$ | -50 dBm | -58 dBm | |
| $f_L$ | -24 dBm | -24 dBm | $f_L$ = 6 GHz at +10 dBm |
| 2 $f_L$ | -25 dBm | -30 dBm | |
| 3 $f_L$ | -27 dBm | -32 dBm | |
| $f_L$ | -23 dBm | -22 dBm | $f_L$ = 11 GHz at +10 dBm |
| 2 $f_L$ | -38 dBm | -41 dBm | |

| Single Tone Im $f_L$ $f_R$ | Typical Suppression | Test Conditions |
|---|---|---|
| $f_L$ $f_R$ | | |
| 1 x 1 | 0 dB | $f_L$ = 2 GHz at +10 dBm |
| 1 x 2 | 39 dB | $f_R$ 3.25 GHz at -10 dBm |
| 1 x 3 | 48 dB | |
| 2 x 1 | 33 dB | |
| 2 x 2 | 40 dB | |
| 3 x 1 | 14 dB | |
| 3 x 2 | 47 dB | |
| 3 x 3 | 65 dB | |
| 4 x 1 | 45 dB | |
| 4 x 2 | 43 dB | |
| 5 x 1 | 19 dB | |
| 5 x 3 | 62 dB | |
| 6 x 2 | 42 dB | |
| 7 x 3 | 55 dB | |
| $f_L$ $f_R$ | | |
| 1 x 1 | 0 dB | $f_L$ = 4.1 GHz at +10 dBm |
| 1 x 2 | 56 dB | $f_R$ = 6.0 GHz at -10 dBm |
| 2 x 1 | 31 dB | |
| 2 x 2 | 48 dB | |
| 3 x 1 | 16 dB | |
| 3 x 2 | 51 dB | |
| 3 x 3 | 57 dB | |
| 4 x 1 | 43 dB | |
| 4 x 2 | 44 dB | |
| 5 x 3 | 54 dB | |
| 7 x 3 | 67 dB | |

# WJ-M62/M62C

## DOUBLE-BALANCED MIXER




- LO 2.6 TO 5.35 GHz
- RF 3.7 TO 4.2 GHz
- IF DC TO 1450 MHz
- LO DRIVE + 9 dBm (nominal)
- LOW VSWR

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 4.9 dB<br>5.6 dB | 6.0 dB<br>6.5 dB | $f_R$ 3.7 to 4.2 GHz<br>$f_L$ 2.6 to 5.35 GHz<br>$f_I$ 30 to 1450 MHz $f_L < f_R$<br>$f_I$ 30 to 1450 MHz $f_R < f_L$ |
| Isolation<br>$f_L$ at R<br>$f_L$ at I | <br>25 dB<br>25 dB<br>20 dB<br>15 dB | <br>40 dB<br>30 dB<br>30 dB<br>25 dB | | <br>$f_L$ 2.6 to 5.35 GHz<br>$f_L$ 4.5 to 5.35 GHz<br>$f_L$ 3.6 to 4.5 GHz<br>$f_L$ 2.6 to 3.6 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level + 2 dBm<br>$f_L$ Level + 9 dBm |
| VSWR<br>L-Port<br>R-Port<br><br>I -Port | | <br>1.25:1<br>1.25:1<br>1.4:1<br>1.5: 1<br>1.3:1<br>1.8:1 | <br>2.0:1<br>2.0:1<br>2.0:1<br>2.0:1<br>2.0:1<br>2.5:1 | <br>$f_L$ 2.6 to 5.35 GHz<br>$f_R$ 3.7 to 4.2 GHz $f_L > f_R$<br>$f_R$ 3.7 to 4.2 GHz $f_L < f_R$<br>$f_I$ = 100 MHz<br>$f_I$ = 500 MHz<br>$f_I$ = 1450 MHz |
| Flatness | | | 0.2 dB peak-to-peak | Over any 40 MHz segment of $f_R$ = 3.7 to 4.2 GHz |
| Third Order Input Intercept | | +11 dBm | | $f_{R1}$ = 3.99 GHz $f_{R2}$ 3.96 GHz both at -10 dBm $f_L$ = 2.75 GHz at + 9 dBm |
| Group Time Delay | | 0.5 ns | 0.75 ns | $f_R$ 3.7 to 4.2 GHz |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

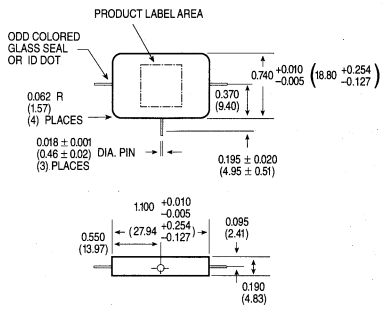
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +60°C
Peak Input Current at 25°C .....50 mA DC

Weight M62: 14 grams (0.5 oz.) max.
M62C: 45 grams (1.6 oz.) max.

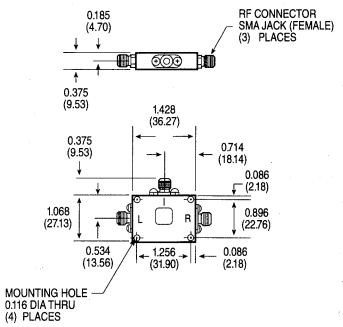
## Outline Drawings

M62
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

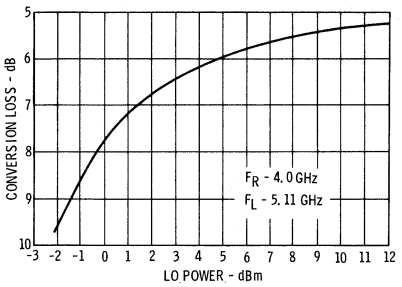
M62C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

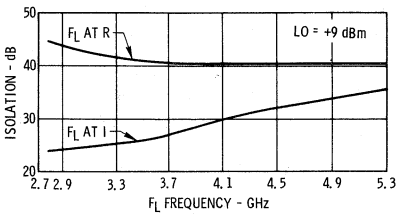
## Typical Performance at 25°C

### Conversion Loss vs. LO Power

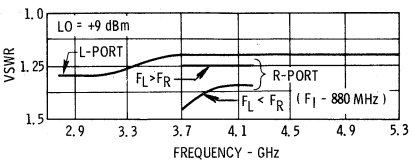


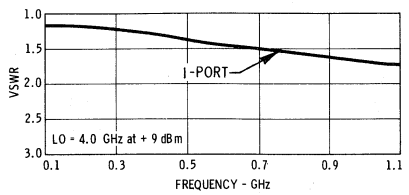

*Drive Level:* The maximum recommended drive level is +13 dBm.

### Isolation vs. Frequency

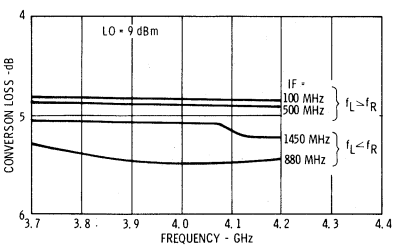



### VSWR vs. Frequency

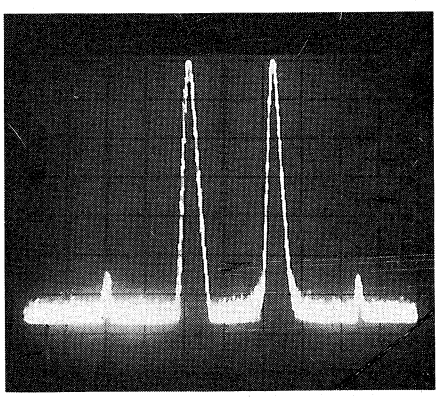



### Conversion Loss vs. Frequency




### Typical Two-Tone Intermodulation



*Typical Two-Tone Intermodulation Performance:* $f_I$ 550 MHz, $f_R$ = 3.95 GHz ± 1 MHz, $f_R$ @ -10 dBm, $f_L > f_R$ $f_L$ = 4.5 GHz @ +9 dBm. Vertical scale = 10 dB/cm.

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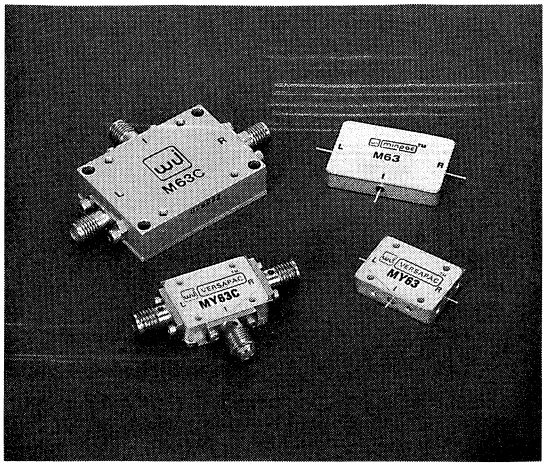
# WJ-M63/M63C
# WJ-MY63/MY63C

## DOUBLE-BALANCED MIXER




- ◆ LO 2.5 TO 7.0 GHz
- ◆ RF 2.5 TO 5.5 GHz
- ◆ IF DC TO 1.5 GHz
- ◆ LO DRIVE +9 dBm (nominal)
- ◆ LOW NOISE FIGURE: 5.8 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.0 dB | 6.0 dB | $f_R$ 3.0 to 5.0 GHz<br>$f_L$ 3.0 to 5.5 GHz<br>$f_I$ 0.03 to 0.5 GHz |
| | | 5.8 dB | 7.0 dB | $f_R$ 2.5 to 5.5 GHz<br>$f_L$ 2.5 to 7.0 GHzf<br>$f_I$ 0.03 to 1.5 GHz |
| Isolation | | | | |
| $f_L$ at R | 30 dB | 40 dB | | $f_L$ 2.5 to 7.0 GHz |
| $f_L$ at I | 17 dB | 25 dB | | $f_L$ 2.5 to 3.5 GHz |
| | 20 dB | 30 dB | | $f_L$ 3.5 to 7.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +2 dBm<br>$f_L$ level +9 dBm |
| Third Order Input Intercept Point | | +11 dBm | | $f_{R1}$ 4.00 GHz at -10 dBm<br>$f_{R2}$ 4.01 GHz at -10 dBm<br>$f_L$ 2.8 GHz at +9 dBm |
| VSWR | | | | |
| R-Port | | 1.5:1 | | $f_R$ 2.5 to 5.5 GHz |
| L-Port | | 1.5:1 | | $f_L$ 2.5 to 7.0 GHz |
| I-Port | | 2.0:1 | | $f_I$ .03 to 1.5 GHz |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

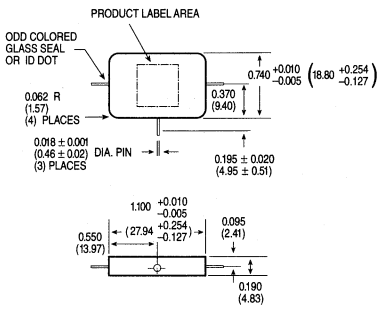
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C
Peak Input Current at 25°C .....100 mA DC

Weight
M63: 14 grams (0.5 oz.) max.
M63C: 45 grams (1.6 oz.) max.
MY63: 7.9 grams (0.28 oz.) max.
MY63C: 20.0 grams (0.70 oz.) max.

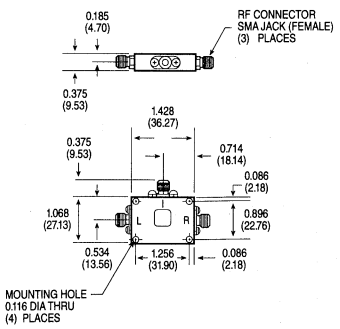
## Outline Drawings

### M63 (MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

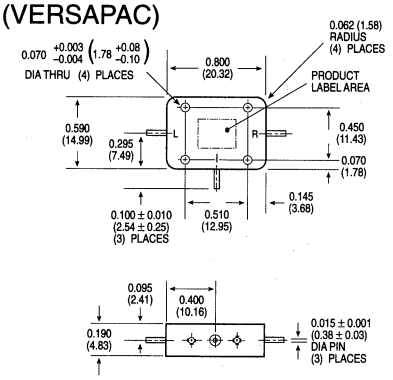
### M63C (CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

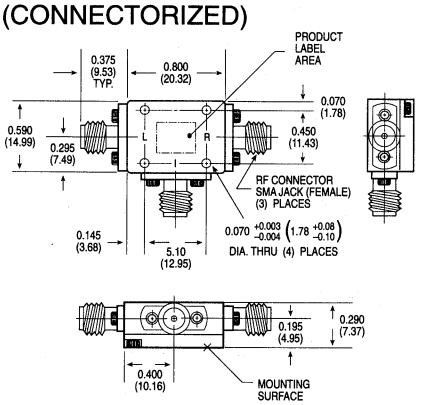
## Outline Drawings

### MY63 (VERSAPAC)



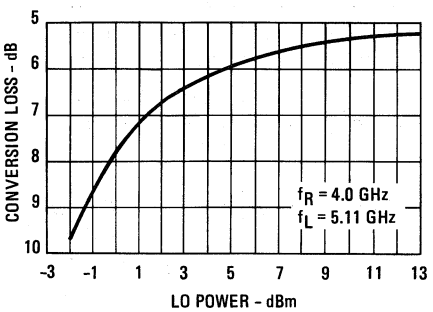

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

### MY63C (CONNECTORIZED)



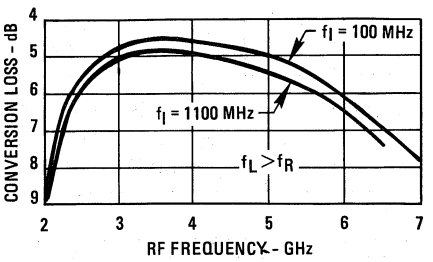

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C *

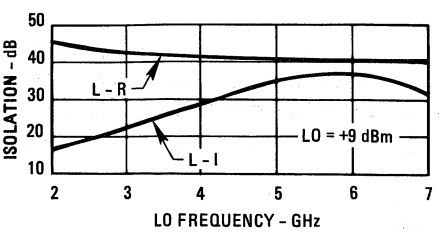



*Drive Level:* The maximum recommended drive level is +13 dBm.

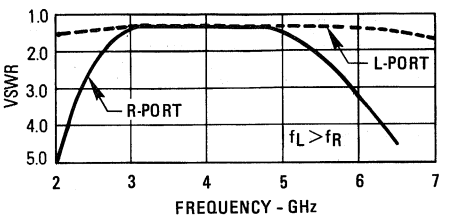
### Conversion Loss

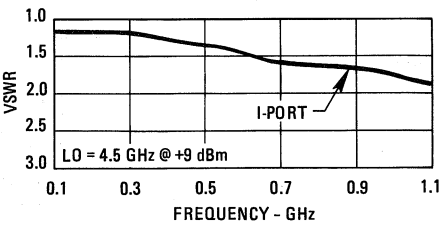



### Isolation

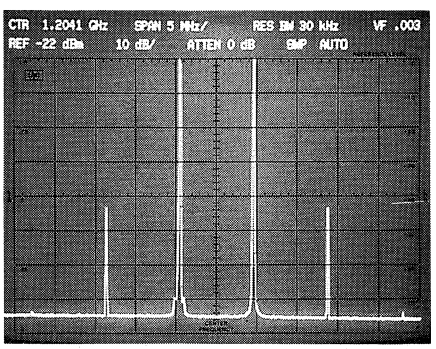



### VSWR




### Typical Two-Tone Intermodulation Performance



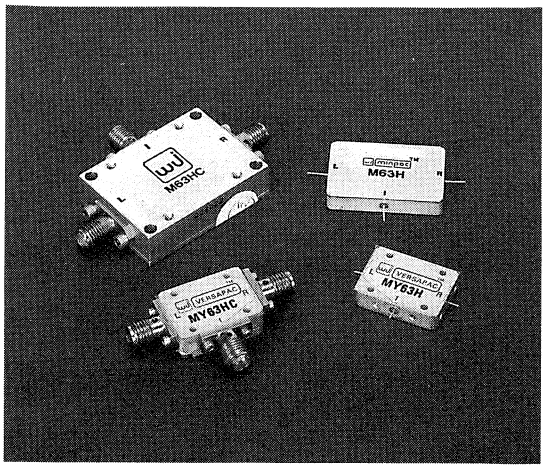

*Typical Two-Tone Intermodulation Performance:* $f_I$ = 1200 MHz, $f_R$ = 3.95 GHz ±10 MHz, $f_R$ @ -10 dBm $f_R > f_L$, $f_L$ = 2.75 GHz @ +9 dBm. Vertical scale = 10 dB/cm.

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

10

# WJ-M63H/M63HC
# WJ-MY63H/MY63HC

## DOUBLE-BALANCED MIXER




- LO 2.5 TO 7.5 GHz
- RF 2.5 TO 6.5 GHz
- IF DC TO 1.5 GHz
- LO DRIVE +20 dBm (nominal)
- HIGH THIRD-ORDER I.P.: +22 dBm (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.8 dB | 6.5 dB | $f_R$ 3.0 to 5.0 GHz<br>$f_L$ 3.0 to 5.5 GHz<br>$f_I$ 0.03 to 0.5 GHz |
| | | 6.0 dB | 7.5 dB | $f_R$ 2.5 to 6.5 GHz<br>$f_L$ 2.5 to 7.5 GHz<br>$f_I$ 0.03 to 1.5 GHz |
| Isolation | | | | |
| $f_L$ at R | 30 dB | 42 dB | | $f_L$ 2.5 to 6.5 GHz |
| | 26 dB | 32 dB | | $f_L$ 6.5 to 7.5 GHz |
| $f_L$ at I | 19 dB | 24 dB | | $f_L$ 3.0 to 5.5 GHz |
| | 13 dB | 18 dB | | $f_L$ 5.5 to 7.5 GHz |
| | 17 dB | 21 dB | | $f_L$ 2.5 to 3.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +14 dBm<br>$f_L$ Level +20 dBm |
| Third-Order Input Intercept Point | | +22 dBm | | $f_{R1}$ = 4.00 GHz - 0 dBm<br>$f_{R2}$ = 3.99 GHz - 0 dBm<br>$f_L$ = 5.0 GHz +20 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

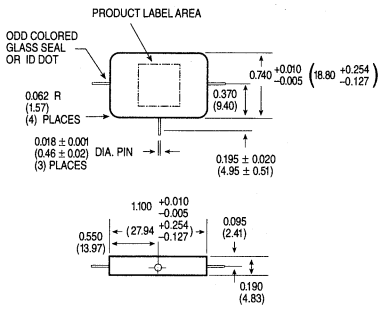
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak Input Power .....+24.7 dBm max. at +25°C, +20.9 dBm max. at +100°C
Peak Input Current at 25°C.....100 mA DC

Weight
M63H: 14 grams (0.5 oz.) max.
M63HC: 45 grams (1.6 oz.) max.
MY63H: 7.9 grams (0.28 oz.) max.
MY63HC: 20.0 grams (0.70 oz.) max.

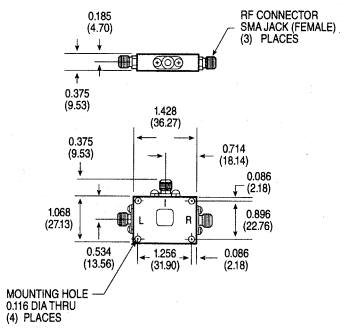
## Outline Drawings

M63H
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

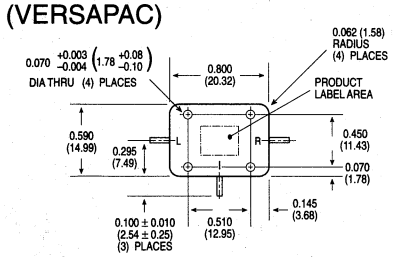
M63HC
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

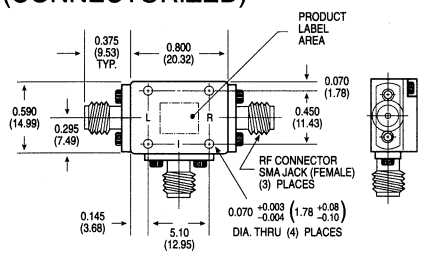
## Outline Drawings

### MY63H (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

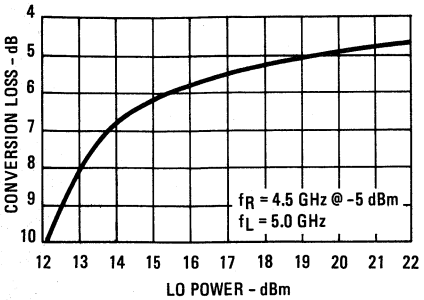
### MY63HC (CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

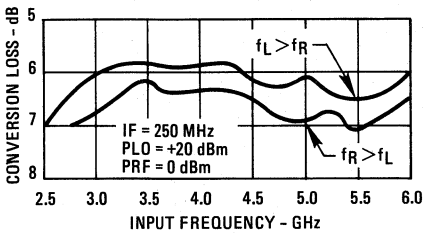
## Typical Performance at 25°C *

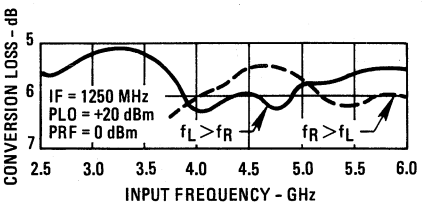
### Drive Level



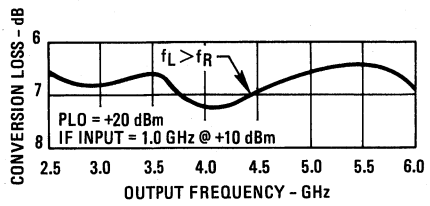

*Drive Level:* The maximum recommended drive level is +23 dBm.

### Conversion Loss

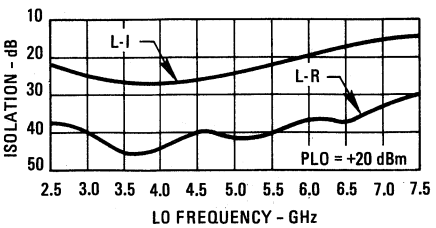


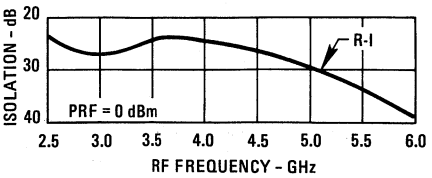




### Conversion Loss (Upconversion)

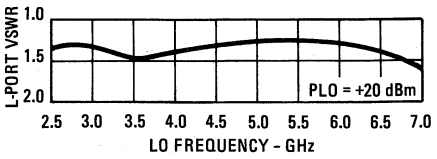


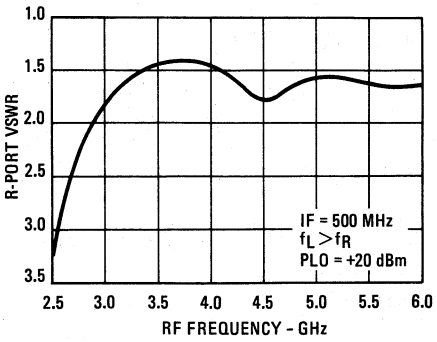

### Isolation

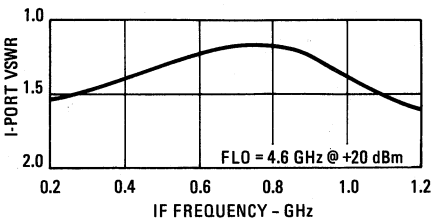


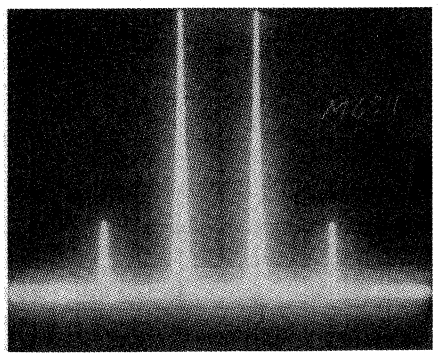

### VSWR




### Typical Two-Tone Intermodulation Performance



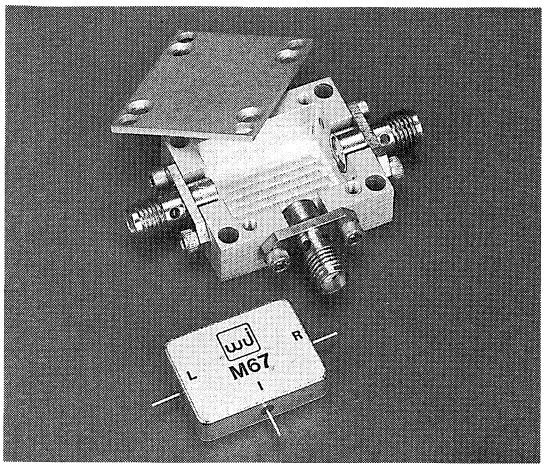
*Typical Two-Tone Intermodulcation Performance:* $f_I$ = 1.0 GHz, $f_L > f_R$, $f_L$ = 5.0 GHz @ +20 dBm, $f_R$ = 3.995 GHz ± 5 MHz @ 0 dBm. Vertical scale = 10 dB/cm.

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

10

# WJ-M67/M67C

## DOUBLE-BALANCED MIXER




- LO 7.0 TO 17.0 GHz
- RF 9.0 TO 15.0 GHz
- IF DC TO 2.5 GHz
- LO DRIVE +10 dBm (nominal)
- LOW NOISE FIGURE: 6.5 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 7.0 dB | $f_R$ 9.5 to 13 GHz, $f_L$ 9 to 13.5GHz, $f_I$ 30 to 500 MHz |
| | | 6.5 dB | 8.5 dB | $f_R$ 9 to 15 GHz, $f_L$ 8 to 16 GHz, $f_I$ 30 to 1000 MHz |
| | | 6.5 dB | 9.0 dB | $f_R$ 9 to 15 GHz, $f_L$ 7 to 17 GHz, $f_I$ 30 to 2000 MHz |
| | | 6.5 dB | 9.0 dB | $f_R$ 9.5 to 13.5 GHz, $f_L$ 7 to 16 GHz, $f_I$ 30 to 2500MHz |
| Isolation | | | | |
| L at R | 22 dB | 40 dB | | $f_L$ 7 to 15 GHz |
| | 10 dB | 30 dB | | $f_L$ 15 to 17 GHz |
| L at I | 15 dB | 25 dB | | $f_L$ 7 to 17 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +4 dBm, $f_L$ Level +10 dBm |
| Third Order Input Intercept | | +11 dBm | | $f_{R1}$ = 11.50 GHz, $f_{R2}$ = 11.51 GHz both at -6 dBm, $f_L$ = 12.0 GHz at +10 dBm |
| Single Tone IM Suppression | | | | $f_R$ 9 - 15 GHz at -10 dBm, $f_L$ 7 - 17GHz at +10 dBm |
| $f_L$ $f_R$ | | | | |
| 2 x 2 | | 50 dB | | |
| 3 x 3 | | 55 dB | | |
| 4 x 3 | | > 70 dB | | |
| 4 x 4 | | > 70 dB | | |
| 5 x 4 | | > 70 dB | | |
| 5 x 5 | | > 70 dB | | |

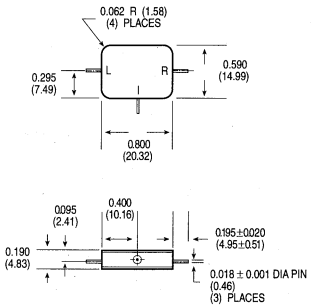
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+23 dBm max. at +25°C, +20 dBm max. at +60°C
Peak Input Current at 25°C .....50 mA DC
Weight M67: 14 grams (0.5 oz.) max. M67C: 45 grams (1.6 oz.) max.

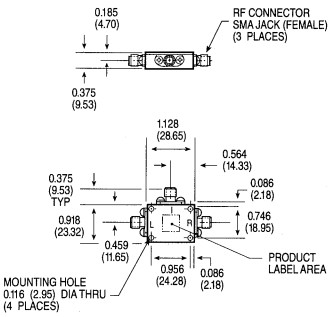
## Outline Drawings

M67
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

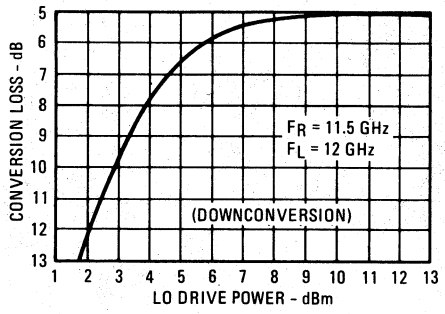
M67C
(CONNECTORIZED)



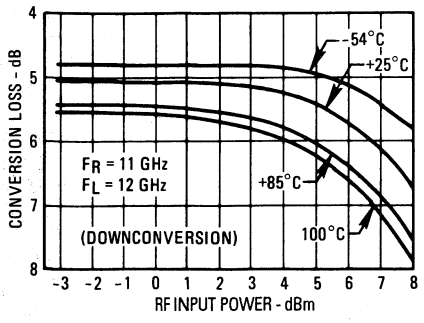

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

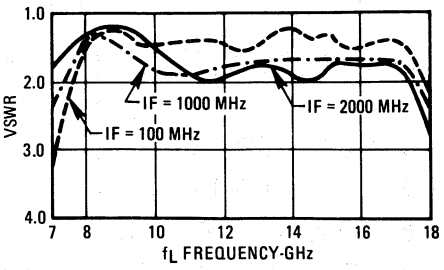
### Conversion Loss vs. LO Drive

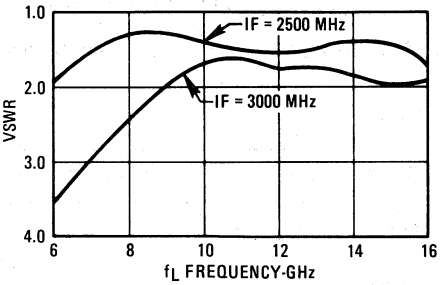



### Conversion Loss vs. RF Input Power

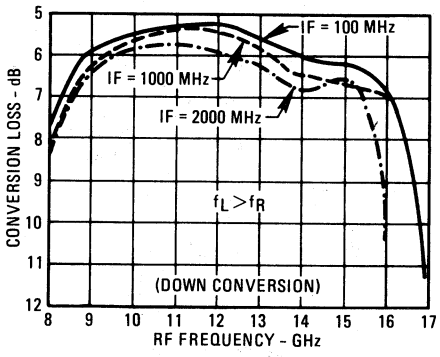


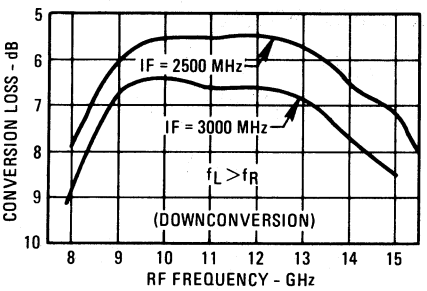

### I-Port VSWR vs. $f_L$



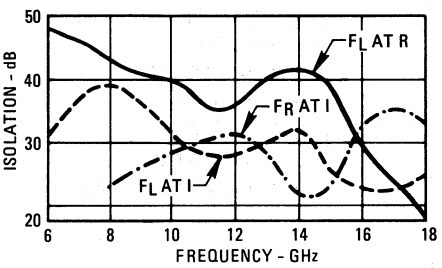




### Conversion Loss vs. Frequency

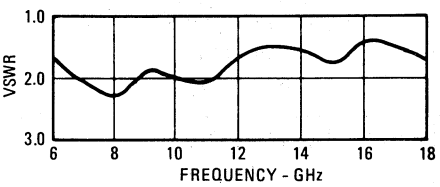


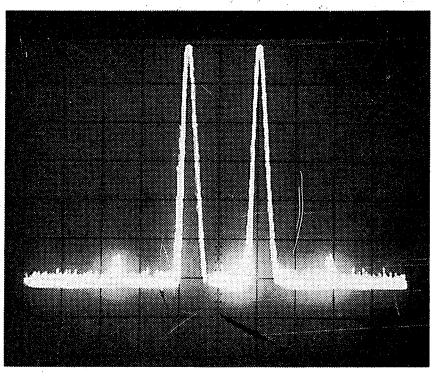

### Isolation vs. Frequency




### L-Port VSWR vs. Frequency

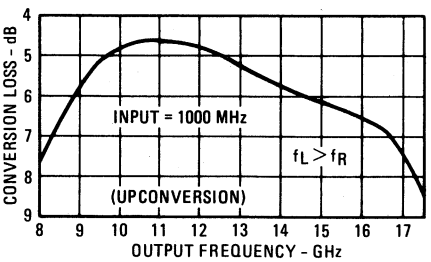



### Two-Tone Intermodulation Performance

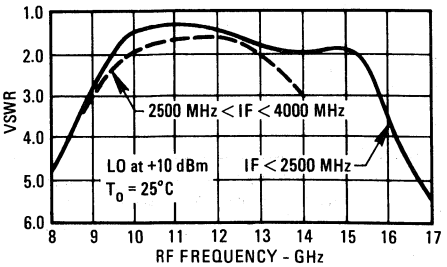


*Typical Two-Tone Intermodulation Performance:* $f_I$ = 1250 MHz, $f_R$ = 12.0 GHz ± 1 MHz at -10 dBm $f_L > f_R$ $f_L$ = 13.25 GHz at +10 dBm. Vertical scale = 10 dB/cm.

### Conversion Loss vs. Output Frequency



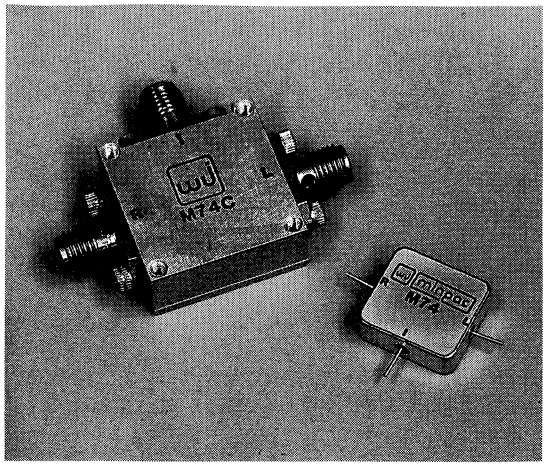

### R-Port VSWR vs. Frequency




10

# WJ-M74/M74C

## DOUBLE-BALANCED MIXER




- LO 5.0 TO 18.0 GHz
- RF 7.0 TO 18.0 GHz
- IF DC TO 3.0 GHz
- LO DRIVE +10 dBm (nominal)
- VERY SMALL PACKAGE

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 7.0 dB | $f_R$ 7 to 16 GHz, $f_L$ 6 to 17 GHz, $f_I$ 30 to 1000 MHz |
| | | 6.0 dB | 8.0 dB | $f_R$ 7 to 16 GHz, $f_L$ 5 to 18 GHz, $f_I$ 30 to 2000 MHz, $f_I$ 30 to 3000 GHz $f_L < f_R$ |
| | | 6.5 dB | 8.5 dB | $f_R$ 8 to 16 GHz, $f_L$ 5 to 16 GHz, $f_I$ 30 to 3000 GHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 16 to 18 GHz, $f_L$ 13 to 18 GHz, $f_I$ 30 to 3000 MHz $f_L > f_R$ |
| Isolation | | | | |
| L at R | 22 dB | 40 dB | | $f_L$ 5 to 14 GHz |
| | 10 dB | 30 dB | | $f_L$ 14 to 18 GHz |
| L at I | 15 dB | 25 dB | | $f_L$ 8 to 18 GHz |
| | 15 dB | 25 dB | | $f_L$ 5 to 8GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +4 dBm, $f_L$ Level +10 dBm |
| Third Order Input Intercept | | +11 dBm | | $f_{R1}$ = 13.00 GHz, $f_{R2}$ 13.01 GHz both at -6 dBm, $f_L$ = 14.0 GHz at +10 dBm |
| Single Tone IM Suppression | | | | $f_R$ = 8 to 13 GHz at -10 dBm |
| $f_L$ $f_R$ | | | | |
| 2 x 2 | | 60 dB | | |
| 2 x 3 | | > 70 dB | | |
| 3 x 2 | | 45 dB | | |
| 3 x 3 | | 60 dB | | |
| 3 x 4 | | > 70 dB | | |
| 4 x 3 | | > 70 dB | | |
| 4 x 4 | | > 70 dB | | |
| 5 x 5 | | > 70 dB | | |

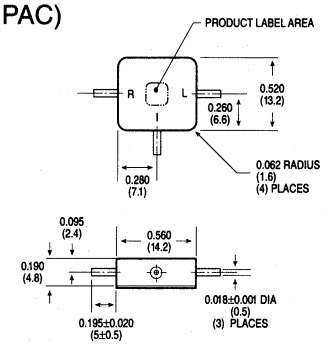
Notes: 1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified
The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC
Weight M74: 6 grams (0.21 oz.) max. M74C: 30 grams (1.6 oz.) max.

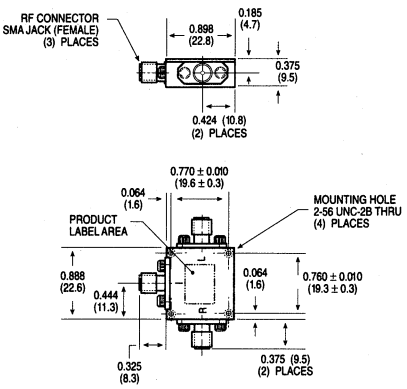
## Outline Drawings

M74
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

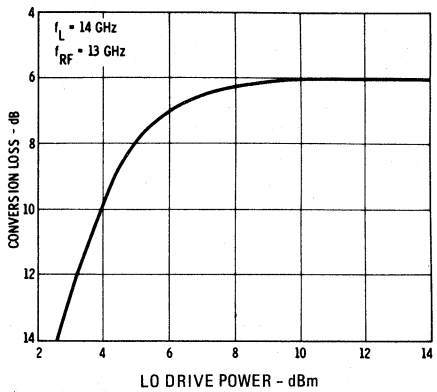
M74C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

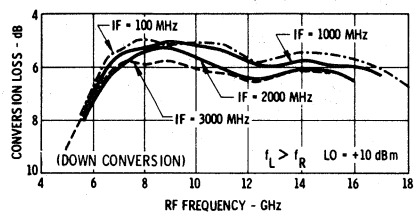
## Typical Performance at 25°C

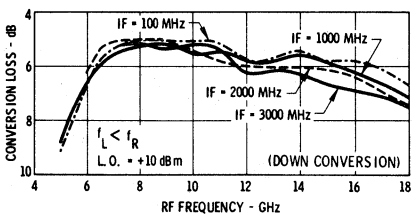
### Conversion Loss vs. LO Drive Power

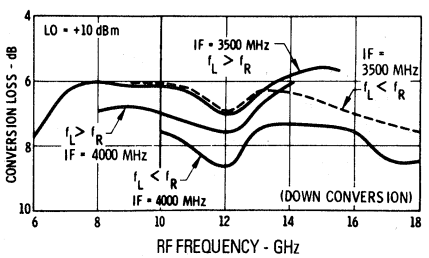


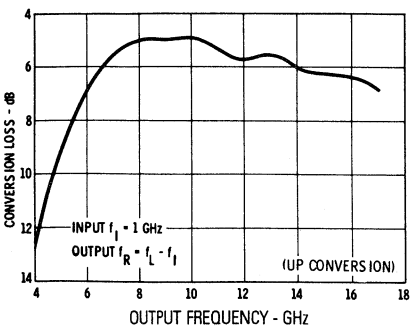

*Drive Level:* The maximum recommended drive level is +13 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +13 dBm is recommended to achieve best two-tone performance and best suppression of the intermodulation products.

### Conversion Loss vs. Frequency

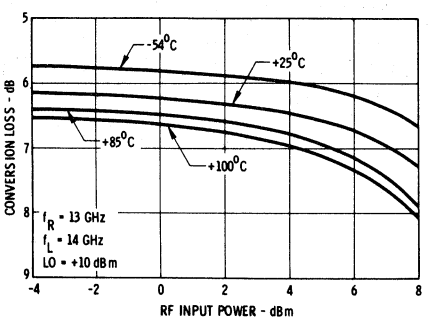


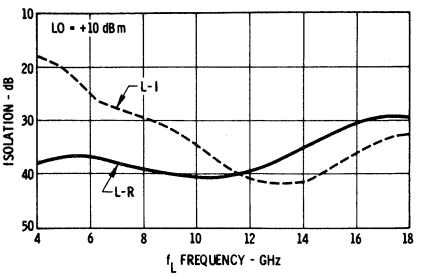



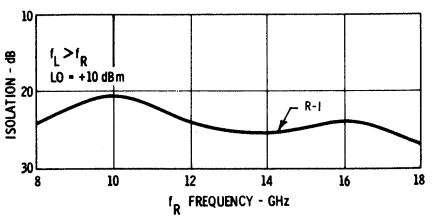




### Conversion Loss vs. Input Power and Temperature



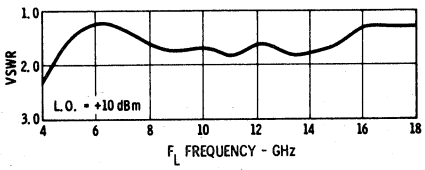

### Isolation



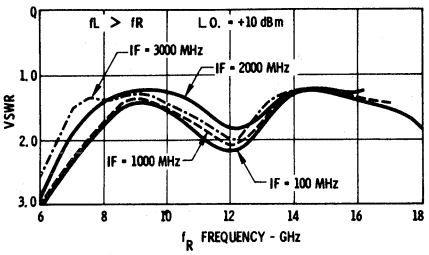



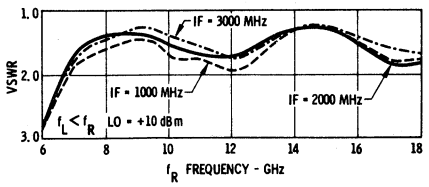
## Typical Performance at 25°C

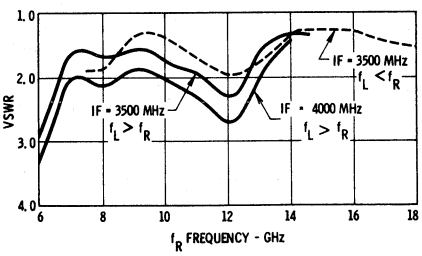
### L-Port VSWR



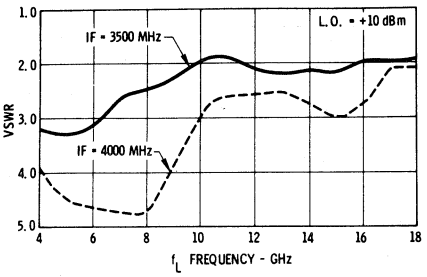

### R-Port VSWR

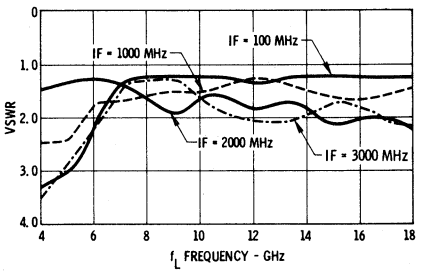



### I-Port VSWR



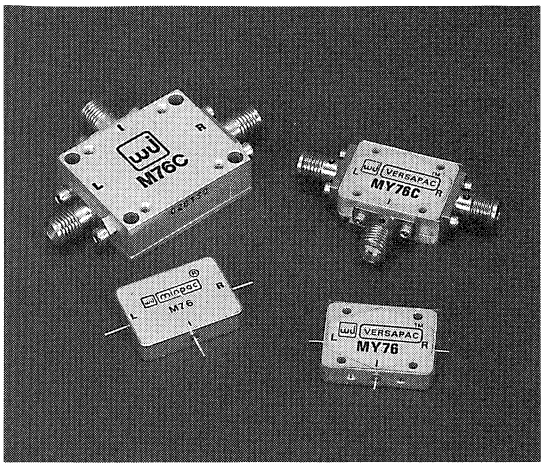



# WJ-M76/M76C
# WJ-MY76/MY76C

## DOUBLE-BALANCED MIXER

- LO 2.5 TO 11.5 GHz
- RF 4.5 TO 9.5 GHz
- IF DC TO 2.0 GHz
- LO DRIVE + 10 dBm (nominal)
- LOW NOISE FIGURE: 5.5 dB (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 7.0 dB | $f_R$ 6.0 to 8.0GHz<br>$f_L$ 4.0 to 9.0 GHz<br>$f_I$ 30 to 2000 MHz |
| | | 5.5 dB | 7.0 dB | $f_R$ 5.0 to 9.0 GHz<br>$f_L$ 4.0 to 9.0 GHz<br>$f_I$ 30 to 1000 MHz |
| | | 6.0 dB | 8.0 dB | $f_R$ 4.5 to 9.5 GHz<br>$f_L$ 2.5 to 11.5 GHz<br>$f_I$ 30 to 2000 MHz |
| Isolation | | | | |
| $f_L$ at R | 25 dB | 40 dB | | $f_L$ 2.5 to 9 GHz |
| | 20 dB | 30 dB | | $f_L$ 9.0 to 11.5 G Hz |
| $f_L$ at I | 15 dB | 25 dB | | $f_L$ 4.0 to 11.5 GHz |
| | 10 dB | 20 dB | | $f_L$ 2.5 to 4 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +3 dBm<br>$f_L$ level +10 dBm |
| Third Order Input Intercept Point | | +13 dBm | | $f_{R_1}$ = 7.00 GHz<br>$f_{R_2}$ = 7.01 GHz<br>both at -6 dBm<br>$f_L$ = 8.0 GHz at +10 dBm |
| Single Tone IM Suppression | | | | $f_R$ 4.5 to 9.5 GHz at -10 dBm<br>$f_L$ 2.5 to 11.5 GHz at +10 dBm |
| $f_L$ $f_R$ | | | | |
| 2 x 2 | | 56 dB | | |
| 2 x 3 | | >70 dB | | |
| 3 x 2 | | 37 dB | | |
| 3 x 3 | | 50 dB | | |
| 3 x 4 | | >70 dB | | |
| 4 x 3 | | >70 dB | | |

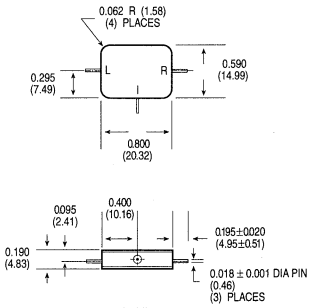
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications. I-Port VSWR degrades

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

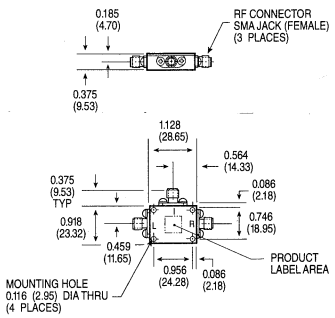
## Outline Drawings

M76
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M76C
(CONNECTORIZED)



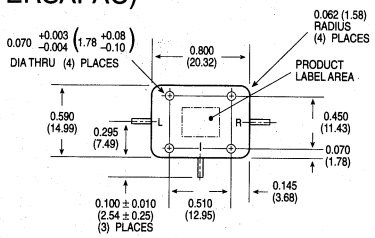

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

Weight

| | |
|---|---|
| M76: | 9 grams (0.32 oz.) max. |
| MY76: | 7.9 grams (0.28 oz.) max. |
| M76C: | 36 grams (1.27 oz.) max. |
| MY76C: | 20.0 grams (0.70 oz.) max. |

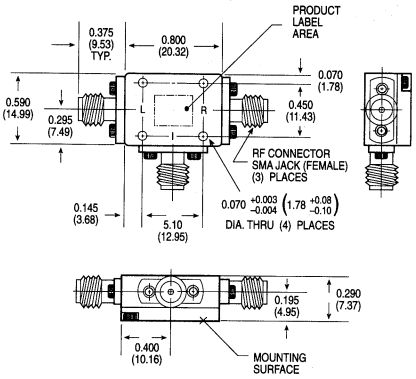
# Outline Drawings

## MY76 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

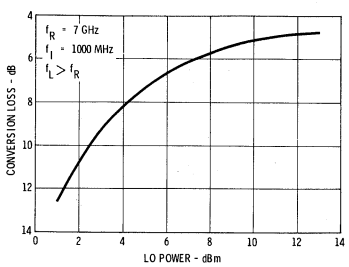
## MY76C (CONNECTORIZED)



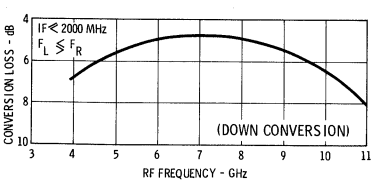

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C*

### Conversion Loss Vs. LO Drive

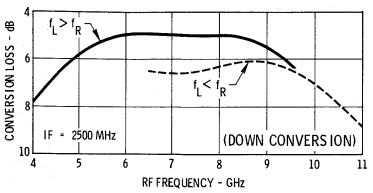


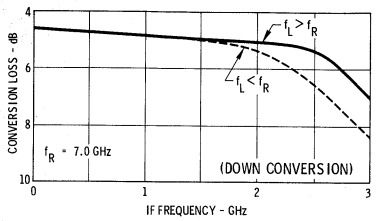

### Conversion Loss vs. Frequency



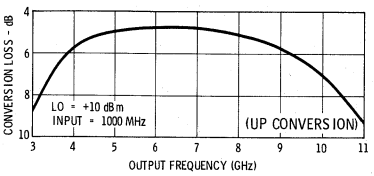

# Typical Performance at 25°C*

### Conversion Loss vs. Frequency

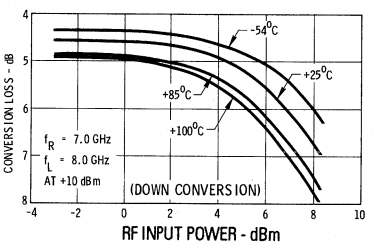


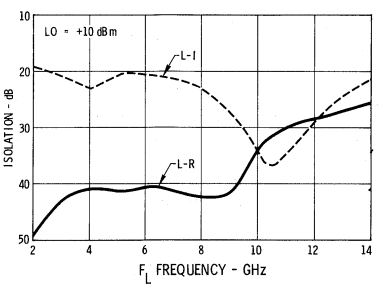

### Conversion Loss vs. Output Frequency

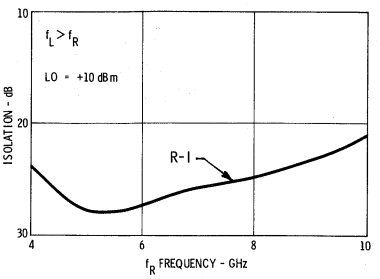



### Conversion Loss vs. RF Input Power

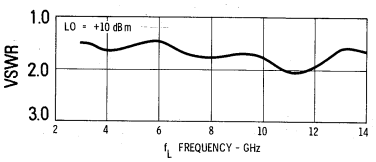



### Isolation vs. Frequency

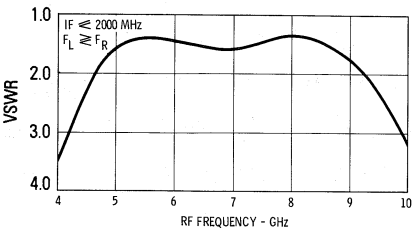


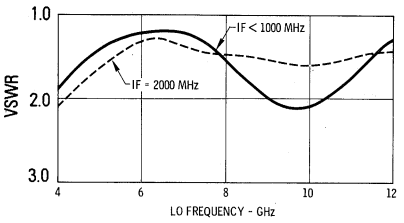

### L-Port VSWR vs. Frequency



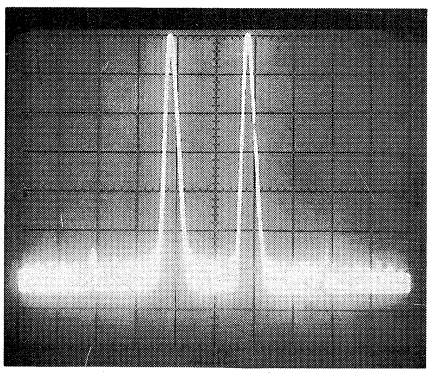

### R-Port VSWR vs. Frequency




### I-Port VSWR vs. $f_L$




### Typical Two-Tone Performance



*Typical Two-Tone Performance:** $f_I$ = 1.0 GHz, $f_L > f_R$, $f_L$ = 8.0 GHz @ +10 dBm, $f_R$ 7.0 GHz ± 1 MHz, $f_R$ @ -10 dBm. Vertical scale = 10 dB/cm.

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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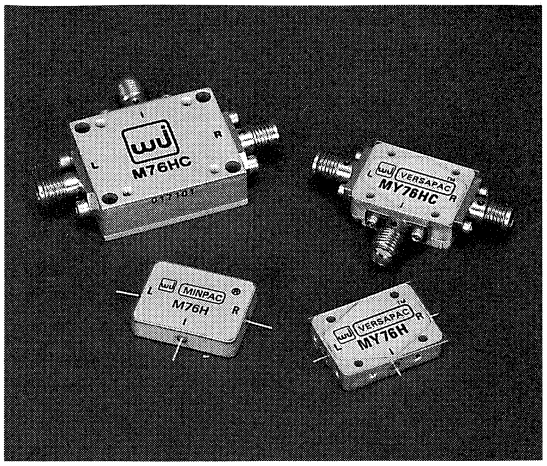
# WJ-M76H/M76HC
# WJ-MY76H/MY76HC

## DOUBLE-BALANCED MIXER




- ◆ LO 2.5 TO 11.5GHz
- ◆ RF 4.5 TO 9.5 GHz
- ◆ IF DC TO 2.0 GHz
- ◆ LO DRIVE +20 dBm (nominal)
- ◆ HIGH THIRD ORDER I.P.: +24 dBm (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.5 dB | 7.0 dB | $f_R$ = 4.5 to 8.0 GHz<br>$f_L$ = 2.5 to 10.0 GHz<br>$f_I$ = 30 to 2000 GHz |
| | | 6.5 dB | 8.0 dB | $f_R$ = 8.0 to 9.0 GHZ<br>$f_L$ = 6.5 to 10.5 GHz<br>$f_I$ = 30 to 1500 MHz |
| | | 8.0 dB | 9.5 dB | $f_R$ = 8.0 to 9.5 GHz<br>$f_L$ = 6.0 to 11.5 GHz<br>$f_I$ = 30 to 2000 MHz |
| Isolation | | | | |
| L to R | 22 dB | 35 dB | | $f_L$ = 2.5 to 11.5 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ = 6.5 to 11.5 GHz |
| | 15 dB | 22 dB | | $f_L$ = 2.5 to 6.5 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +15 dBm<br>$f_L$ level +20 dBm |
| Third Order Input Intercept | | +24 dBm | | $f_{R_1}$ = 6.12 GHz; $f_{R_2}$ = 6.18 GHz both at 0 dBm<br>$f_L$ =7.2 GHz at +20 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

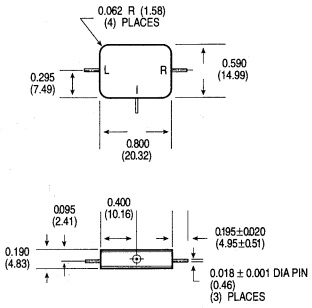
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+24.7 dBm max. at +25°C
Peak Input Current at 25°C .....100 mA DC

Weight
M76H: 9 grams (0.32 oz.) max.
M76HC: 36 grams (1.27 oz.) max.
MY76H: 7.9 grams (0.28 oz.) max.
MY76HC: 20.0 grams (0.70 oz.) max.

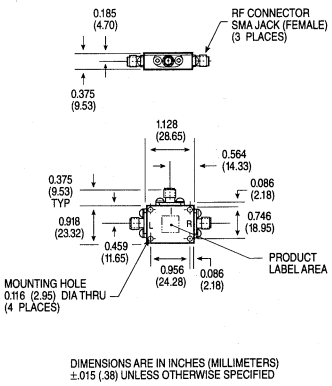
## Outline Drawings

M76H
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

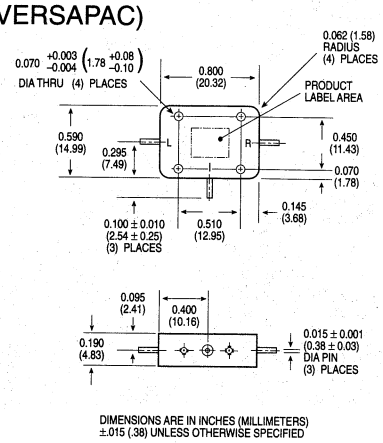
M76HC
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

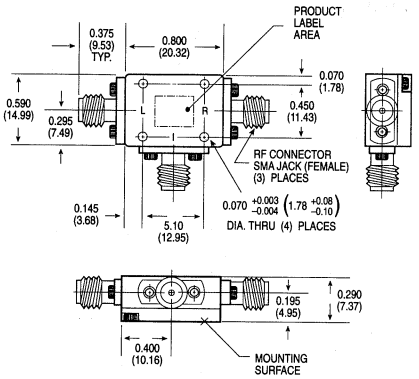
## Outline Drawings

### MY76H (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

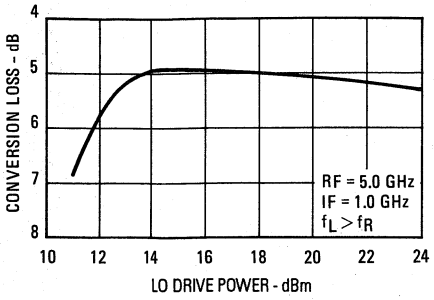
### MY76HC (CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

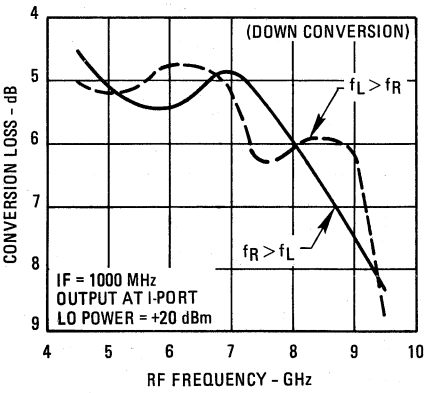
## Typical Performance at 25°C *

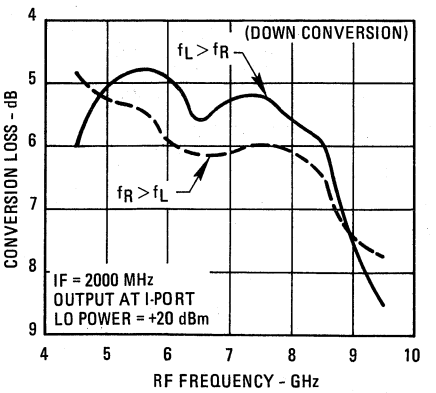
### Conversion Loss vs. LO Drive Power



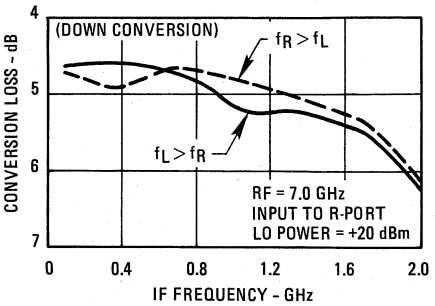

*Drive Level:* The maximum recommended drive level is +24 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +20 dBm is recommended to achieve best two-tone performance and best suppression of the intermodulation products.

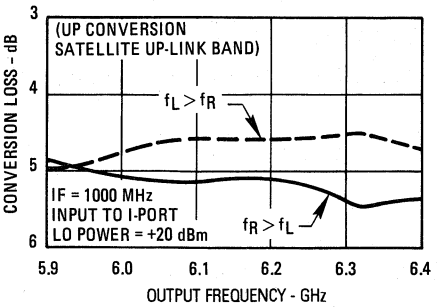
### Conversion Loss



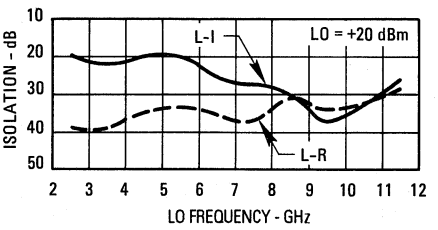




### Conversion Loss

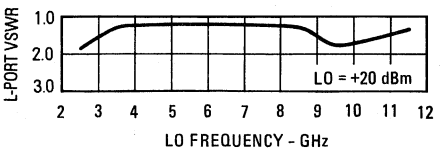


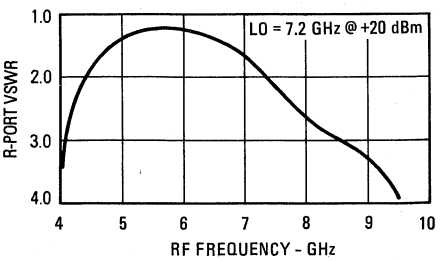



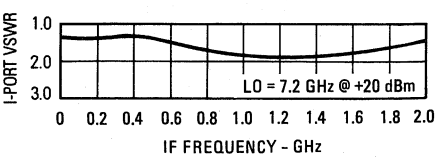

### Isolation




### VSWR




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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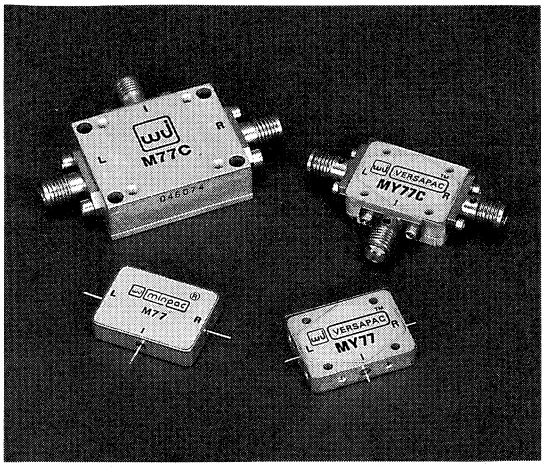
# WJ-M77/M77C
# WJ-MY77/MY77C

## DOUBLE-BALANCED MIXER

- LO 7.0 TO 15.0 GHz
- RF 8.0 TO 12.5 GHz
- IF DC TO 2500 MHz
- LO DRIVE +10 dBm (nominal)
- LOW NOISE FIGURE

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.0 dB | 7.0 dB | $f_R$ 8 to 12.5 GHz<br>$f_L$ 7 to 13.5 GHz<br>$f_I$ 30 to 1000 MHz |
| | | 5.5 dB | 7.5 dB | $f_R$ 8 to 12.5 GHz<br>$f_L$ 7 to 14.5 GHz<br>$f_I$ 1000 to 2000 MHz |
| | | 6.0 dB | 8.0 dB | $f_R$ 8 to 12.5 GHz<br>$f_L$ 7 to 15.0 GHz<br>$f_I$ 2000 to 2500 MHz |
| Isolation | | | | |
| L to R | 20 dB | 35 dB | | $f_L$ 7 to 15 GHz |
| L to I | 20 dB | 35 dB | | $f_L$ 8 to 12 GHz |
| | 15 dB | 30 dB | | $f_L$ 7 to 14 GHz |
| | 10 dB | 20 dB | | $f_L$ 14 to 15 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +4 dBm<br>$f_L$ level +10 dBm |
| Third Order Input Intercept Point | | +15 dBm | | $f_{R1}$ = 10.00 GHz; $f_{R2}$ = 10.01 GHz both at -6 dBm<br>$f_L$ = 11.0 GHz at +10 dBm |
| Single Tone IM Suppression | | | | $f_R$ 8 to 12.5 GHz at -10 dBm |
| $f_L$ $f_R$ | | | | |
| 2 x 2 | | 60 dB | | |
| 2 x 3 | | 70 dB | | |
| 3 x 2 | | 37 dB | | |
| 3 x 3 | | 59 dB | | |
| 3 x 4 | | > 70 dB | | |
| 4 x 3 | | > 70 dB | | |
| 4 x 4 | | > 70 dB | | |

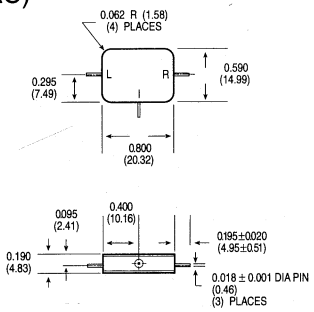
Notes:1. Measured in a 50-ohm system with nominal LO drive and dovvnconverter application only,unless otherwise specified. The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC
Weight M77: 9 grams (0.32 oz.) max. MY77: 7.9 grams (0.28 oz.) max.
M77C: 36 grams (1.27 oz.) max. MY77C: 20.0 grams (0.70 oz.) max.

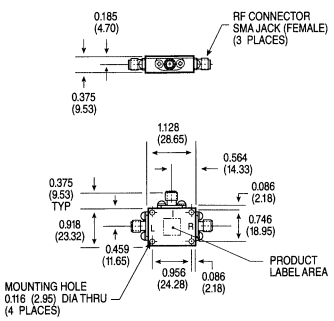
## Outline Drawings

M77
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

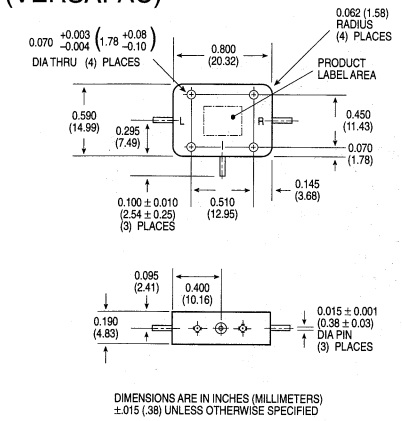
M77C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

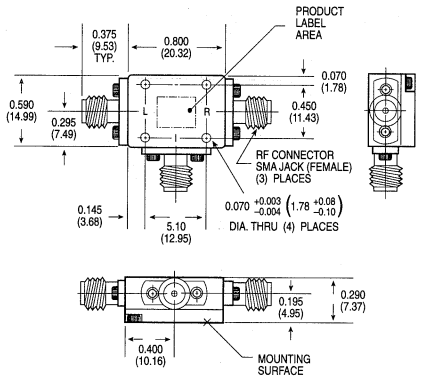
# Outline Drawings

## MY77 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

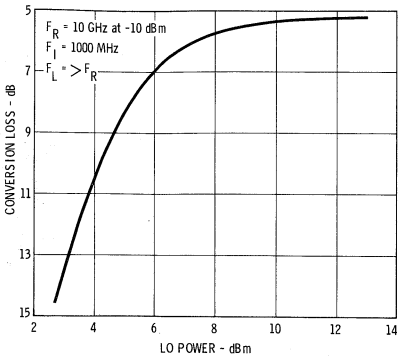
## MY77C (CONNECTORIZED)



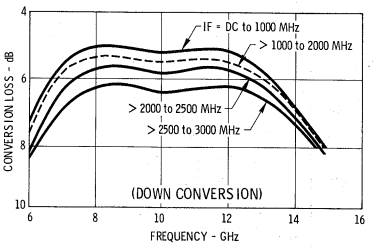

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C*

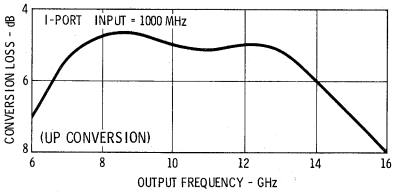
### Conversion Loss Vs. LO Drive



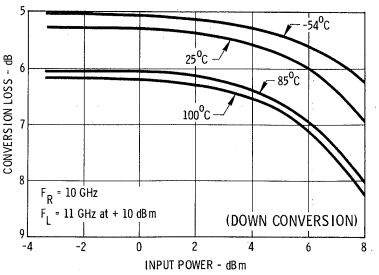

### Conversion Loss vs. Frequency



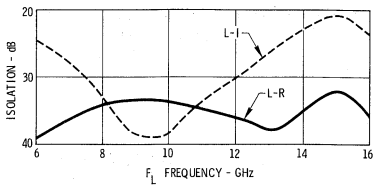

### Conversion Loss vs. Output Frequency



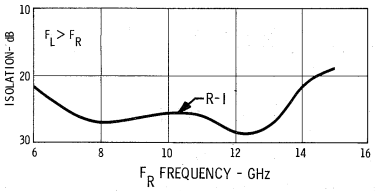

### Conversion Loss vs. RF Input Power



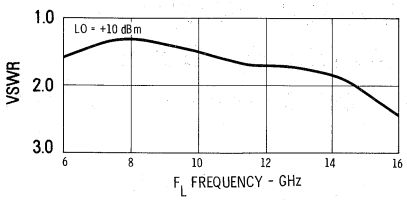

### Isolation vs. Frequency



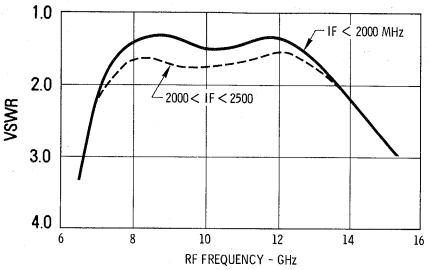

### Isolation vs. Frequency



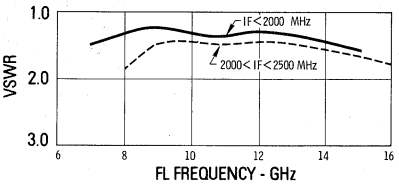

### L-Port VSWR vs. Frequency



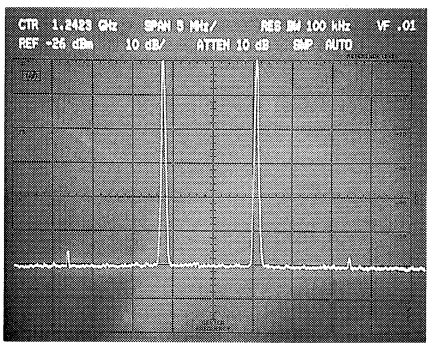

### R-Port VSWR vs. Frequency




### I-Port VSWR vs. $f_L$




### Typical Two-Tone Performance




*Typical Two-Tone Performance:* $f_I$ = 1250 MHz, $f_R$ = 10.25 GHz ± 1 MHz $f_R$ @ -10 dBm, $f_L > f_R$, $f_L$ = 11.5 GHz @ +10 dBm. Vertical scale = 10 dB/cm.

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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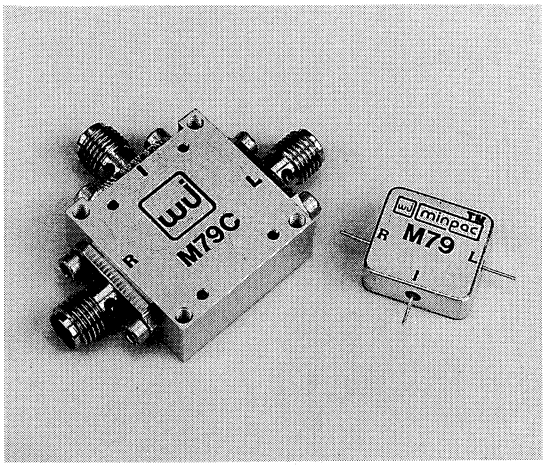
# WJ-M79/M79C

## DOUBLE-BALANCED MIXER

- LO 5 TO 18 GHz
- RF 7 TO 18 GHz
- IF DC TO 3000 MHz
- LO DRIVE +10 dBm (nominal)
- WIDE BANDWIDTH
- LOW NOISE FIGURE

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 5.7 dB | 7.5 dB | $f_R$ 7 to 16 GHz<br>$f_L$ 6 to 17 GHz<br>$f_I$ 30 to 1000 MHz |
| | | 6.0 dB | 8.0dB | $f_R$ 7 to 16 GHz<br>$f_L$ 5 to 18 GHz<br>$f_I$ 30 to 2000 MHz<br>$f_I$ 30 to 3000 MHz fL > fR |
| | | 6.0 dB | 8.0 dB | $f_R$ 8 to 16 GHz<br>$f_L$ 5 to 16 GHz<br>$f_I$ 30 to 3000 MHz fL < fR |
| | | 7.0 dB | 9.0 dB | $f_R$ 16 to 18 GHz<br>$f_L$ 13 to 18 GHz<br>$f_I$ 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 22 dB | 35 dB | | $f_L$ 5 to 14 GHz |
| | 15 dB | 33 dB | | $f_L$ 14 to 18 GHz |
| L to I | 22 dB | 34 dB | | $f_L$ 5 to 8 GHz |
| | 12 dB | 24 dB | | $f_L$ 8 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +4 dBm<br>$f_L$ level +10 dBm |
| Third Order Input Intercept Point | | +14 dBm | | $f_{R1}$ = 13.00 GHz, $f_{R2}$ = 13.01 GHz both at -6 dBm<br>$f_L$ = 14.0 GHz at +10 dBm |
| Single Tone IM Suppression | | | | $f_R$ 8 to 13 GHz at -10 dBm |
| fL fR | | | | |
| 2 x 2 | | 60 dB | | |
| 2 x 3 | | > 70 dB | | |
| 3 x 2 | | 45 dB | | |
| 3 x 3 | | 60 dB | | |
| 3 x 4 | | > 70 dB | | |
| 4 x 3 | | > 70 dB | | |
| 4 x 4 | | > 70 dB | | |
| 5 X 5 | | > 70 dB | | |

Notes:1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

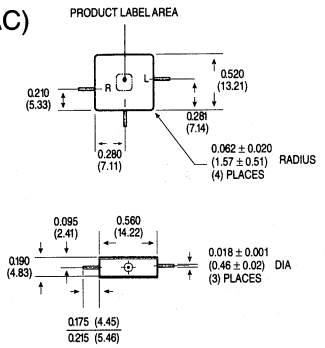
## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power..... +23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M79: 6 grams (0.21 oz.) max.
M79C: 30 grams (1.6 oz.) max.

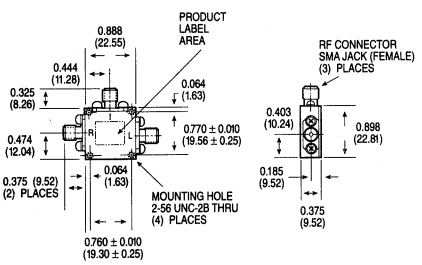
## Outline Drawings

M79
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

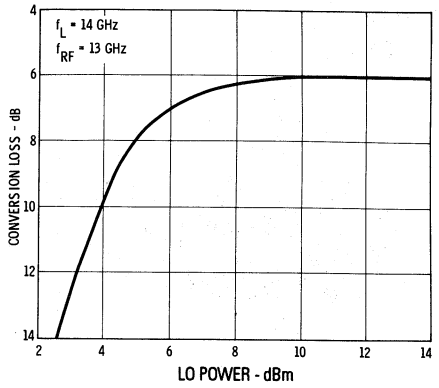
M79C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

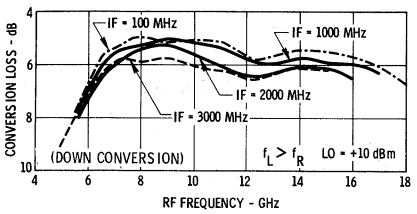
# Typical Performance at 25°C

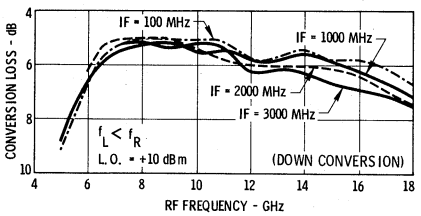
### Conversion Loss vs. LO Drive Power.

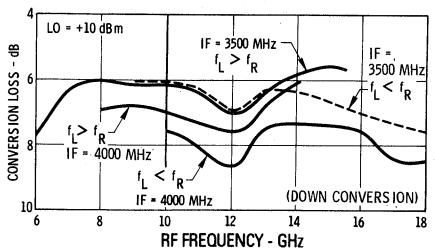



*Drive Level:* The maximum recommended drive level is +13 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +13 dBm is recommended to achieve best two-tone performance and best suppression of the intermodulation products.

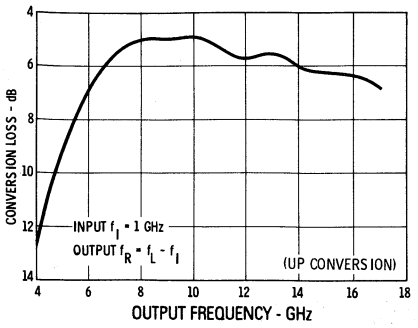
### Conversion Loss vs. Frequency.



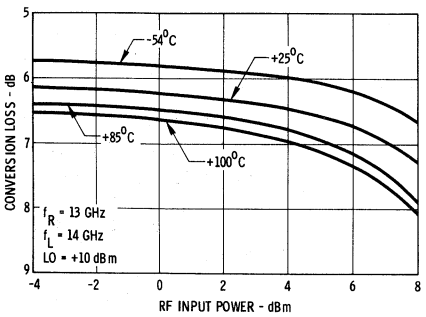



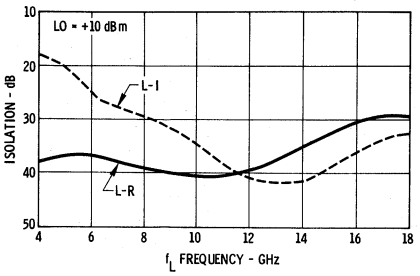

### Conversion Loss vs. Frequency

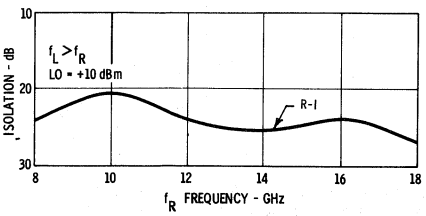



### Conversion Loss vs. Input Power and Temperature

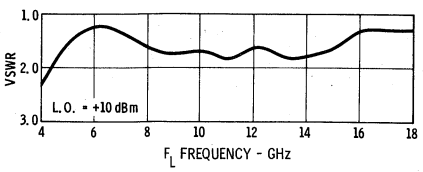



### Isolation

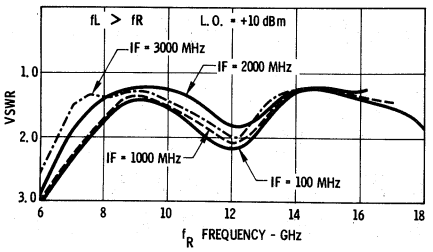


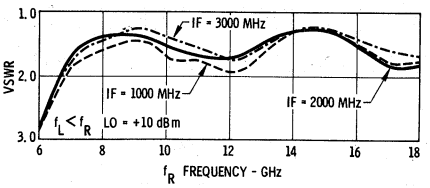



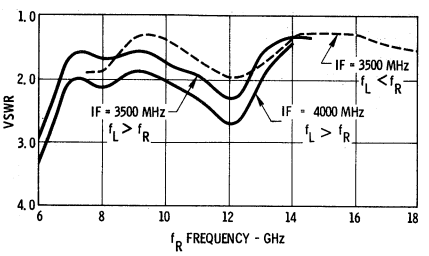

### L-Port VSWR



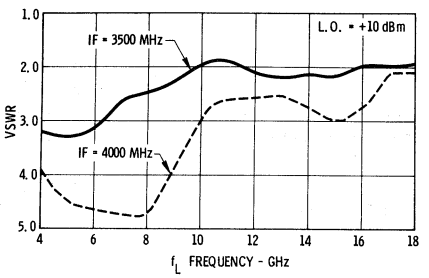

### R-Port VSWR

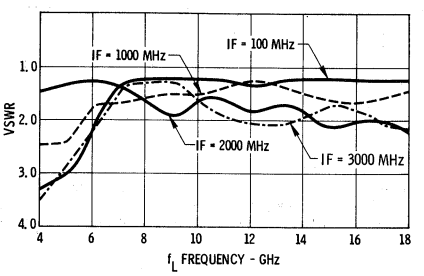



### I-Port VSWR



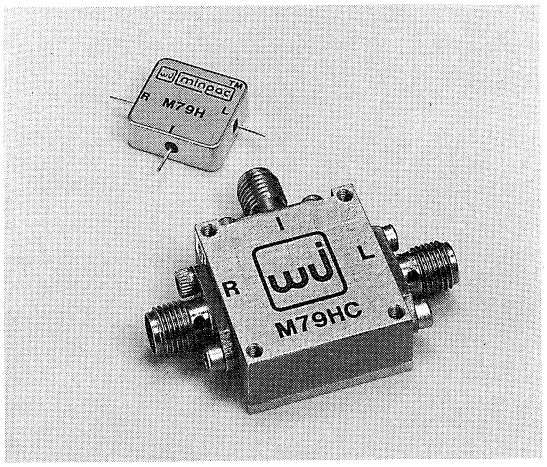

10

# WJ-M79H/M79HC

## DOUBLE-BALANCED MIXER

- LO 5 TO 18 GHz
- RF 7 TO 18 GHz
- IF DC TO 3000 MHz
- LO DRIVE +20 dBm (nominal)
- WIDE BANDWIDTH
- HIGH THIRD ORDER I.P.: +24 dBm (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications [1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 8.0 dB | $f_R$ = 7 to 15 GHz<br>$f_L$ = 6 to 15 GH<br>$f_I$ = 30 to 1000 MHz |
| | | 7.0 dB | 8.5 dB | $f_R$ =7 to 16 GHz<br>$f_L$ = 5 to 18 GHz<br>$f_I$ = 30 to 2000 MHz |
| | | 7.5 dB | 9.5 dB | $f_R$ = 7 to 16 GHz<br>$f_L$ = 5 to 18 GHz<br>$f_I$ = 30 to 3000 MH |
| | | 8.5 dB | 10.0 dB | $f_R$ = 16 to 18 GHz<br>$f_L$ = 5 to 15 GH<br>$f_I$ = 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 23 dB | 35 dB | | $f_L$ = 5 to 14 GHz |
| | 20 dB | 30 dB | | $f_L$ = 14 to 18 GHz |
| L to I | 17 dB | 27 dB | | $f_L$ = 5 to 9 GHz |
| | 25 dB | 35 dB | | $f_L$ = 9 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +15 dBm<br>$f_L$ Level = +20 dBm |
| Third Order Input Intercept Point | | +24 dBm | | $f_{R1}$ = 13.00 GHz<br>$f_{R2}$ = 13.01 GHz<br>both at 0 dBm<br>$f_L$ = 14.0 GHz<br>at +20 dBm |
| VSWR | | | | |
| L-Port | | 1.5:1 | | $f_L$ = 5 to 15 GHz |
| | | 2.0:1 | | $f_L$ = 15 to 18 GHz |
| R-Port | | 1.6:1 | | $f_R$ = 7 to 18 GHz |
| I-Port | | 1.7:1 | | $f_I$ = .1 to 3.0 GHz |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

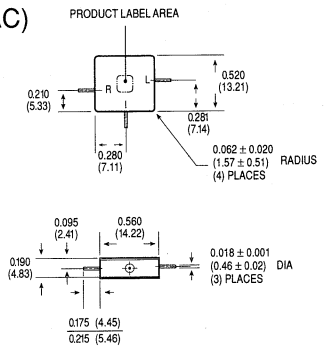
## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +24.7 dBm max. at +25°C, +20.7 dBm max. at +100°C
Peak Input Current at 25°C ..... 100 mA DC

Weight M79H: 6 grams (0.21 oz.) max.
M79HC: 30 grams (1.6 oz.) max.

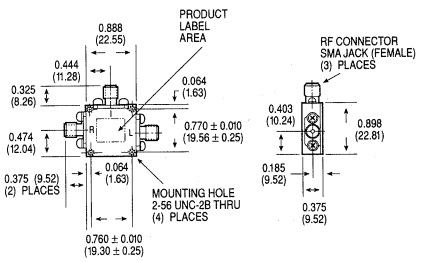
## Outline Drawings

M79H
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M79HC
(CONNECTORIZED)



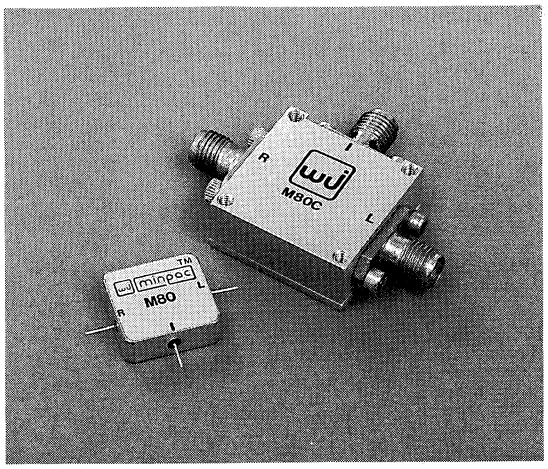

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-M80/M80C

## DOUBLE-BALANCED MIXER

- LO 4 TO 18 GHz
  RF 6 TO 18 GHz
- IF DC TO 3000 MHz
- LO DRIVE +7 dBm (nominal)
- WIDE BANDWIDTH
- LOW NOISE FIGURE

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_R$ = 6 to 16 GHz<br>$f_L$ = 5 to 17 GHz<br>$f_I$ = 30 to 1000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ = 6 to 18 GHz<br>$f_L$ = 4 to 18 GHz<br>$f_I$ = 1000 to 3000 MHz |
| Isolation | | | | |
| L to R | 23 dB | 36 dB | | $f_L$ = 3.5 to 14 G Hz |
| | 18 dB | 32 dB | | $f_L$ = 14 to 18 GHz |
| L to I | 16 dB | 28 dB | | $f_L$ = 3.5 to 9 GHz |
| | 23 dB | 38 dB | | $f_L$ = 9 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm<br>$f_L$ Level +7 dBm |
| Third-Order | | +10 dBm | | $f_{R1}$ = 13.00 GHz, $f_{R2}$ = 13.01 GHz both at -10 dBm<br>$f_L$ = 14.0 GHz at +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only,unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

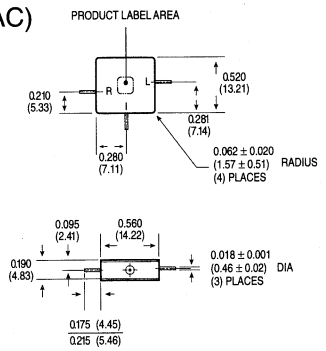
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M80: 6 grams (0.21 oz.) max.
M80C: 30 grams (1.06 oz.) max.

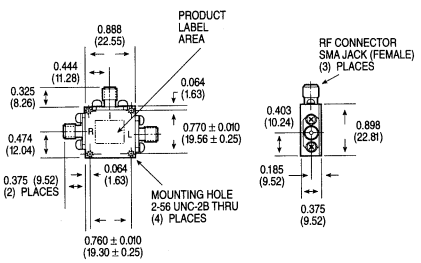
## Outline Drawings

M80
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

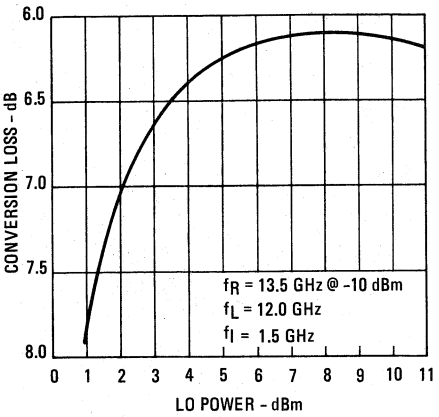
M80C
(CONNECTORIZED)



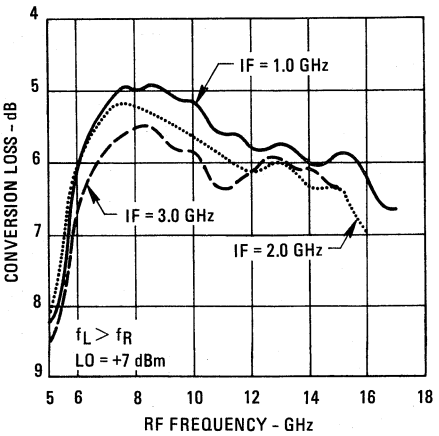

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

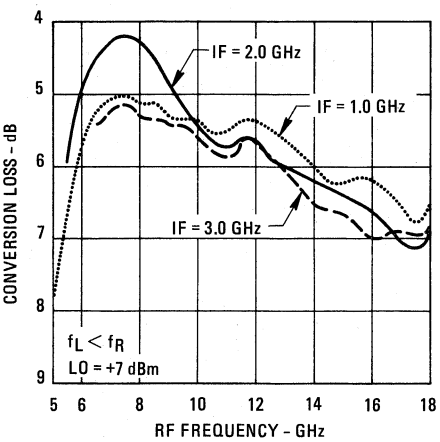
# Typical Performance at 25°C

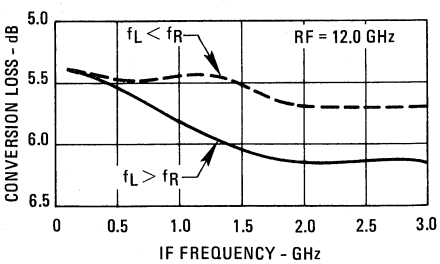
### Conversion Loss vs. LO Drive Power



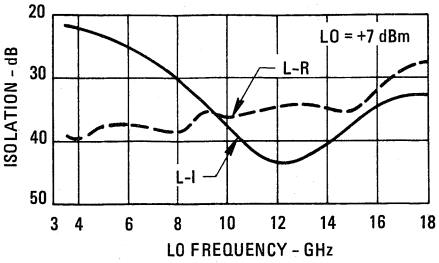

### Conversion Loss



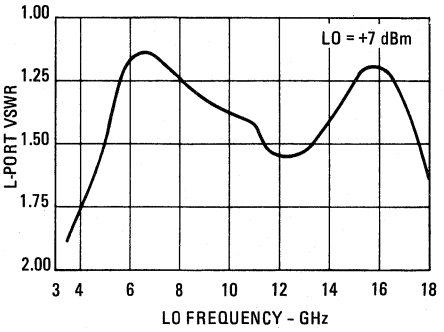



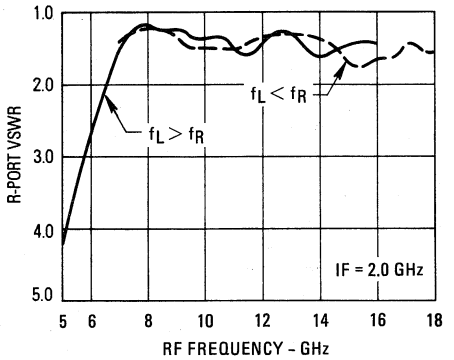




### Isolation

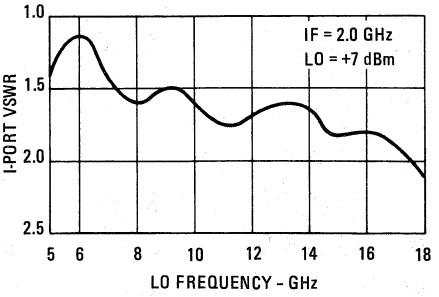


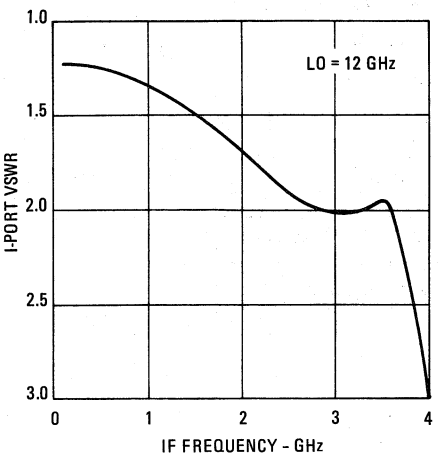

### VSWR



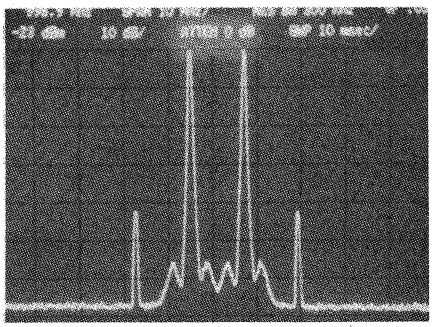




### VSWR




### Typical Two-Tone Intermodulation Performance



$f_I$ = 1.0 GHz
$f_{R1}$ = 13.00 GHz at -10 dBm
$f_{R2}$ = 13.01 GHz at -10 dBm
$f_L$ = 14.0 GHz at +7 dBm
Vertical Scale is 10 dB/Div.

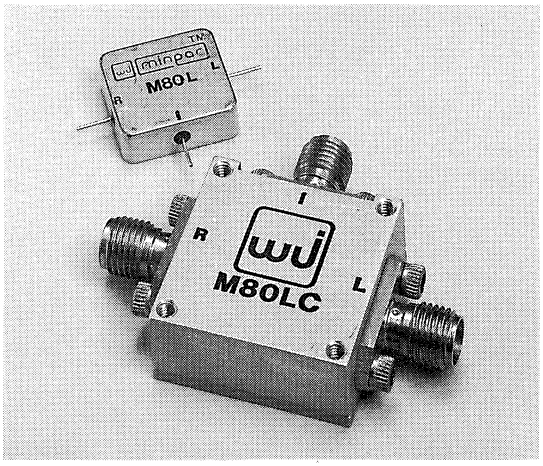
10

# WJ-M80L / M80LC

## DOUBLE-BALANCED MIXER

- LO 4 TO 18 GHz
- RF 7 TO 18 GHz
- IF DC TO 3000 MHz
- LO DRIVE +0 dBm (nominal)
- STARVED LO - 0 dBm LO POWER
- WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 8.0 dB | 10.0 dB | $f_R$ = 7 to 18 GHz<br>$f_L$ = 6 to 18 GHz<br>$f_I$ = 30 to 1000 MHz |
| | | 9.0 dB | 11.0 dB | $f_R$ = 7 to 18 GHz<br>$f_L$ = 4 to 18 GHz<br>$f_I$ = 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 22 dB | 31 dB | | $f_L$ = 4 to 15 GHz |
| | 19 dB | 27 dB | | $f_L$ = 15 to 18 GHz |
| L to I | 17 dB | 25 dB | | $f_L$ = 4 to 9 GHz |
| | 26 dB | 34 dB | | $f_L$ = 9 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level -2 dBm<br>$f_L$ Level 0 dBm |
| Third Order Input Intercept Point | | +7 dBm | | $f_{R_1}$ = 13.00 GHz, $f_{R_2}$ = 13.01 GHz both at -15 dBm<br>$f_L$ = 14.0 GHz at 0 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

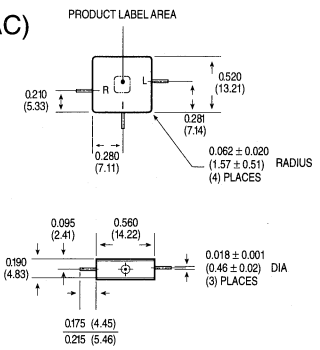
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+20 dBm max. at +25°C, +17 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M80L: 6.0 grams (0.21 oz.) max.
M80LC: 30.0 grams (1.06 oz.) max.

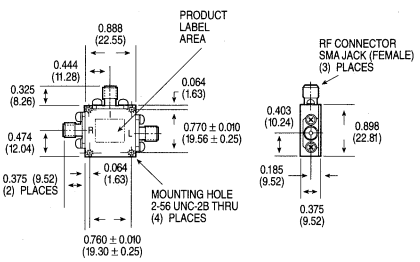
## Outline Drawings

M80L (MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

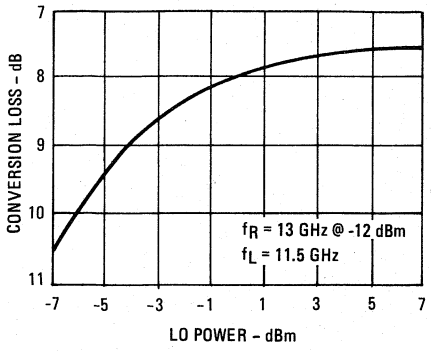
M80LC (CONNECTORIZED)



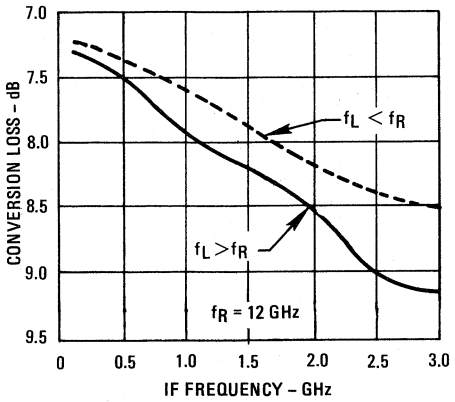

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

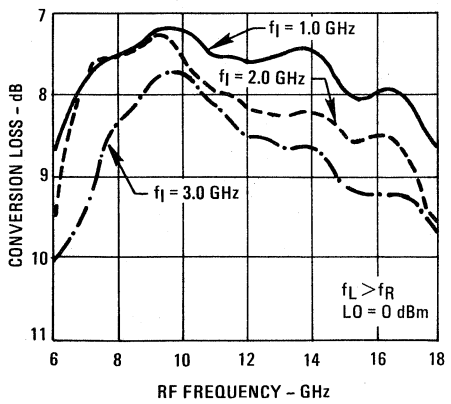
# Typical Performance at 25°C

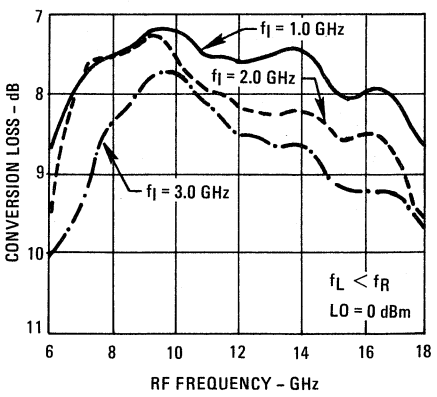
### Conversion Loss vs. LO Power



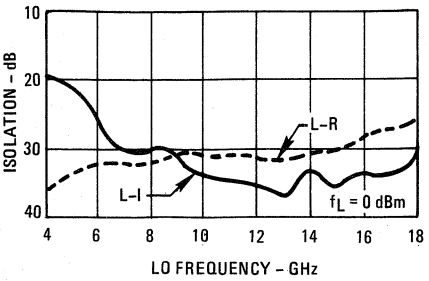

### Conversion Loss



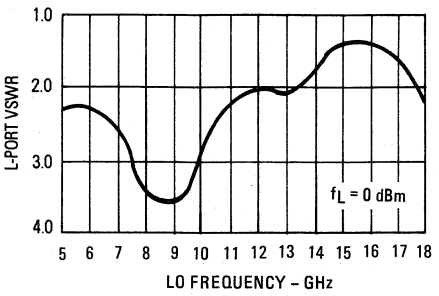



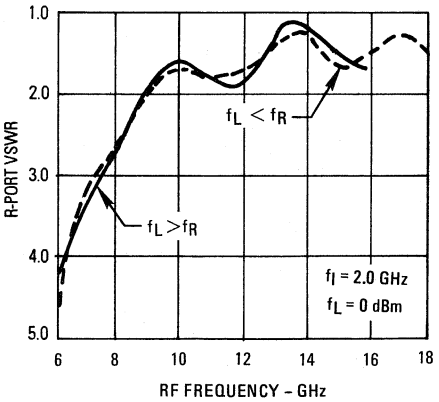



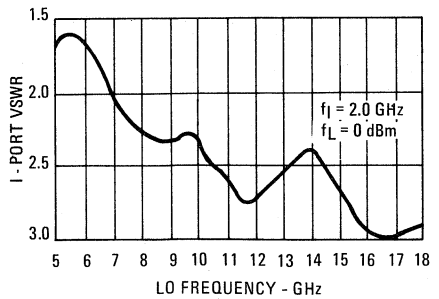

### Isolation



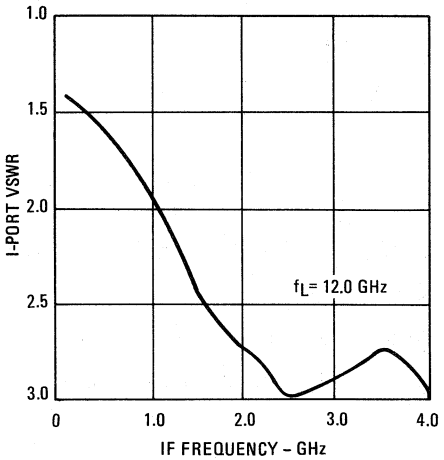

### VSWR



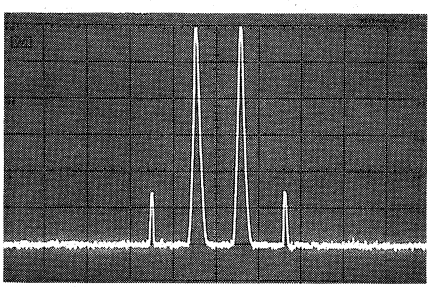




### VSWR




### Typical Two-Tone Intermodulation Performance



*Typical Two-Tone Intermodulation Performance:* $f_I$ = 1.0 GHz, $f_{R1}$ = 13.00 GHz at -15 dBm, $f_{R2}$ = 13.01 GHz at -15 dBm. $f_L$ = 14.0 GHz at 0 dBm. Vertical scale is 10 dB/Div.

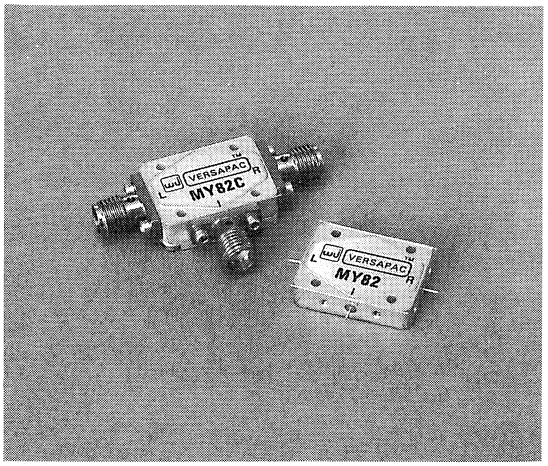
10

# WJ-MY82/MY82C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER

- LO / RF } 2 TO 18 GHz
- IF 0.03 TO 5 GHz
- LO DRIVE +13 dBm (nominal)
- WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.0 dB | $f_R$ = 2 to 18 GHz<br>$f_L$ = 2 to 18 GHz<br>$f_I$ =0.03 to 2 GHz |
| | | 8.0 dB | 10.5 dB | $f_R$ = 2 to 18 GHz<br>$f_L$ =2 to 18 GHz<br>$f_I$ = 2 to 5 GHz |
| Isolation | | | | |
| L to R | 16 dB | 20 dB | | $f_L$ = 2 to 3 GHz |
| | 18 dB | 30 dB | | $f_L$ =3 to 18 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ = 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level = +6 dBm<br>$f_L$ Level = +13 dBm |
| Third-Order Input Intercept Point | | +18 dBm | | $f_{R_1}$ = 6.00 GHz, $f_{R_2}$ = 6.01 GHz both at -3 dBm<br>$f_L$ = 8.0 GHz at +13 dBm |
| | | +19 dBm | | $f_{R_1}$ = 15.00 GHz,<br>$f_{R_2}$ = 15.01 GHz both at -3 dBm<br>$f_L$ = 18.0 GHz at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

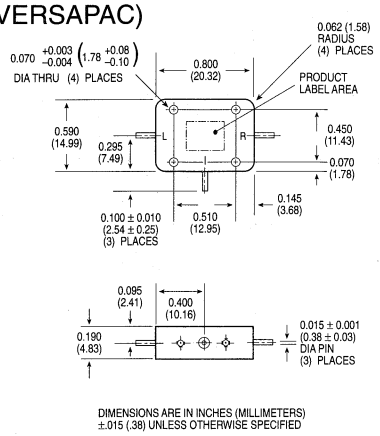
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight MY82: 6 grams (0.21 oz.) max.
MY82C: 30 grams (1.6 oz.) max.

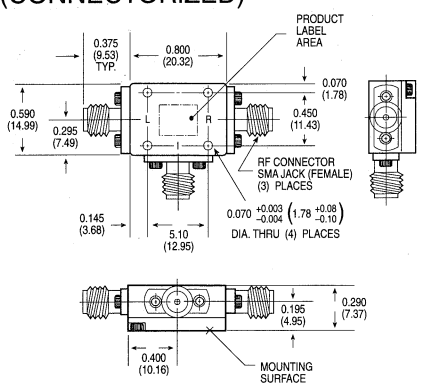
## Outline Drawings

MY82
(VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MY82C
(CONNECTORIZED)



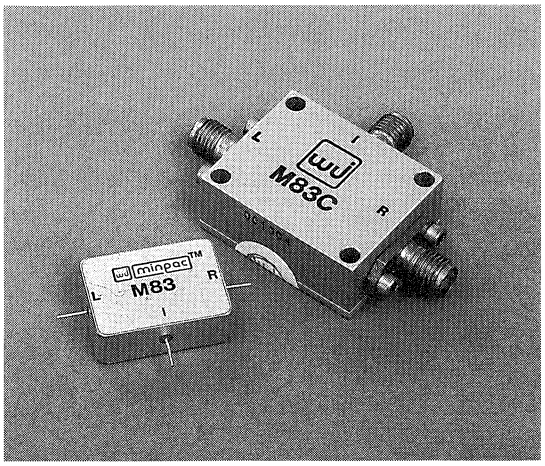

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-M83/M83C

## TRIPLE-BALANCED MIXER (DOUBLE-DOUBLE)

- ◆ LO 2 TO 18 GHz
- ◆ RF 1 TO I8 GHz
- ◆ IF 0.03 TO 5 GHz
- ◆ LO DRIVE +13 dBm (nominal)
- ◆ WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 8.0 dB | $f_R$ = 5 to 13 GHz<br>$f_L$ = 5 to 13 GHz<br>$f_I$ = 0.03 to 2 GHz |
| | | 7.5 dB | 9.0 dB | $f_R$ = 2 to 16 GHz<br>$f_L$ = 2 to 18 GHz<br>$f_I$ = 0.03 to 4 GHz |
| | | 8.5 dB | 10.0 dB | $f_R$ = 1 to 18 GHz<br>$f_L$ = 2 to 18 GHz<br>fI = 0.03 to 5 GHz |
| Isolation | | | | |
| L to R | 16 dB | 20 dB | | $f_L$ = 2 to 3 GHz |
| | 18 dB | 30 dB | | $f_L$ = 3 to 18 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ = 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +6 dBm<br>$f_L$ Level +13 dBm |
| Third-Order Input Intercept | | +18dBm | | $f_{R_1}$ = 6.00 GHz $f_{R_2}$ = 6.01 GHz both at-3 dBm<br>$f_L$ = 8.0 GHz at +13 dBm |
| | | +19dBm | | $f_{R_1}$ = 15.00 GHz,<br>$f_{R_2}$ = 15.01 GHz<br>both at -3 dBm<br>$f_L$ = 18.0 GHz at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

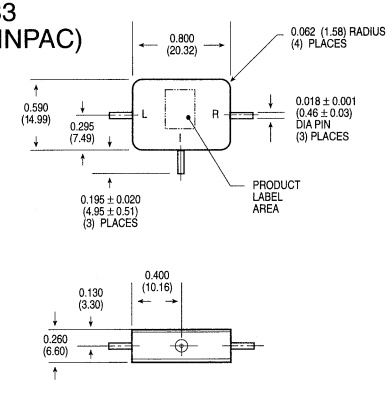
## Absolute Maximum Ratings

Operating Temperature.....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak Input Power.....+26 dBm max. at +25°C, +23 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M83: 12 grams (0.42 oz.) max.
M83C: 40 grams (1.41 oz.) max.

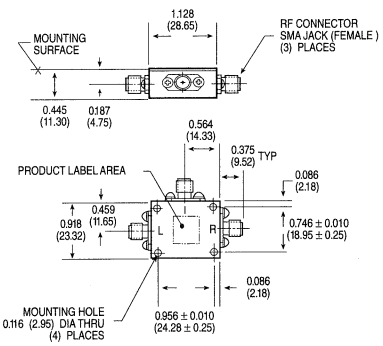
## Outline Drawings

M83
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

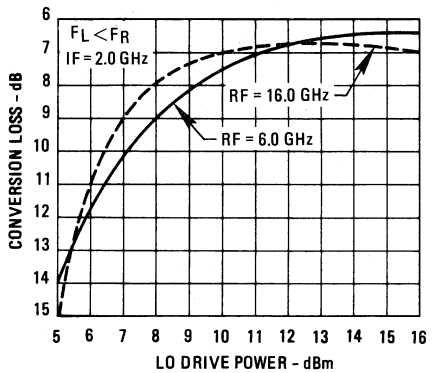
M83C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

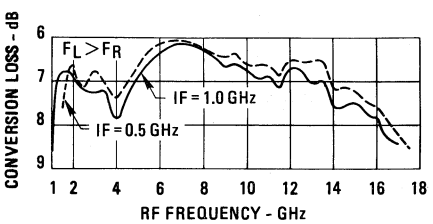
## Typical Performance at 25°C

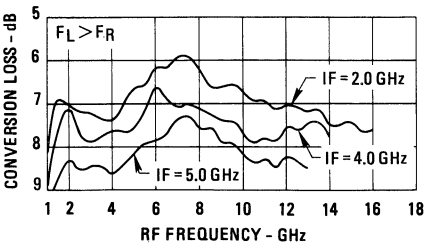
### Conversion Loss vs. LO Drive Power



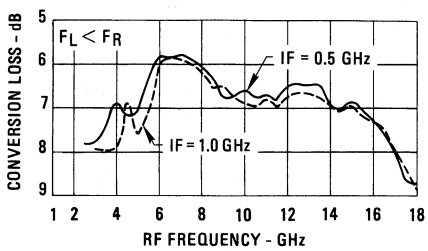

*Drive Level:* The maximum recommended drive level is +20 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +20 dBm is recommended to achieve best two-tone performance and best suppression of the intermodulation products.

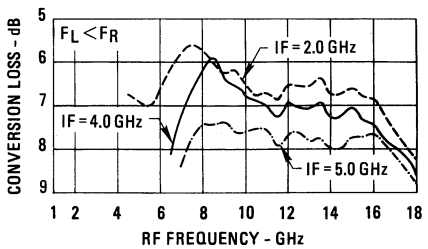
### Conversion Loss



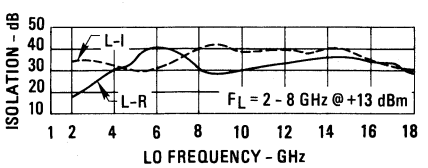




### Conversion Loss

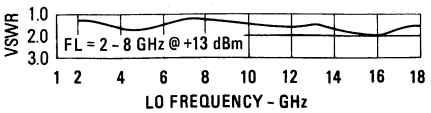


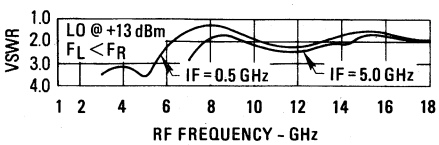

### Isolation

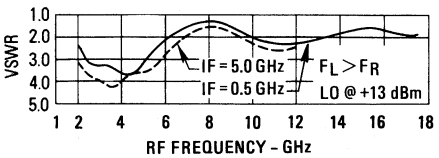



### L-Port VSWR

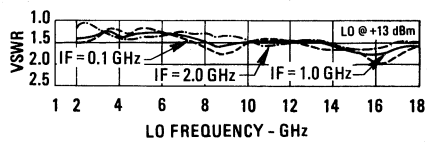


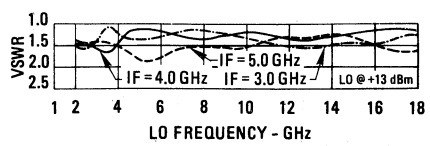

### R-Port VSWR




### I-Port VSWR

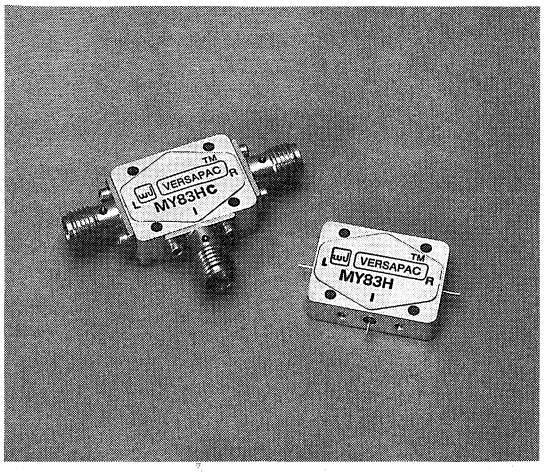



10

# WJ-MY83H/MY83HC

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- ◆ LO, RF } 2.0 TO 18.0 GHz
- ◆ IF 0.03 TO 5.0 GHz
- ◆ LO DRIVE +20 dBm (nominal)
- ◆ HIGH THIRD ORDER I.P.: +24 dBm (TYP.)
- ◆ WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 8.5 dB | 11.0 dB | $f_R$ = 2 to 18 GHz<br>$f_L$ = 2 to 18 GHz<br>$f_I$ = 0.03 to 5 GHz |
| Isolation | | | | |
| L to R | 12 dB | 16 dB | | $f_L$ = 2 to 3 GHz |
| | 16 dB | 25 dB | | $f_L$ = 3 to 18 GHz |
| L to I | 20 dB | 30 dB | | $f_L$ = 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +17 dBm<br>$f_L$ Level +20 dBm |
| Third-Order Input Intercept | | +26 dBm | | $f_{R_1}$ = 6.00 GHz<br>$f_{R_2}$ = 6.01 GHz<br>both at 0 dBm<br>$f_L$ = 8.0 GHz<br>at +20 dBm |
| | | +24 dBm | | $f_{R_1}$ = 14.00 GHz<br>$f_{R_2}$ = 14.01 GHz<br>both at 0 dBm<br>$f_L$ = 18.0 GHz<br>at +20 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

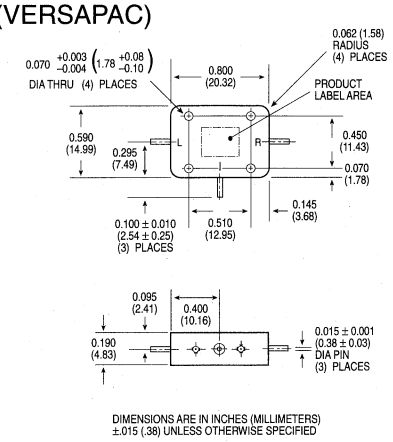
## Absolute Maximum Ratings

Operating Temperature.....-54°C to +100°C
Storage Temperature.....-65°C to +100°C
Peak Input Power.....+27 dBm max. at +25°C, +21 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight MY83H: 7.9 grams (0.28 oz.) max.
MY83HC: 20 grams (0.70 oz.) max.

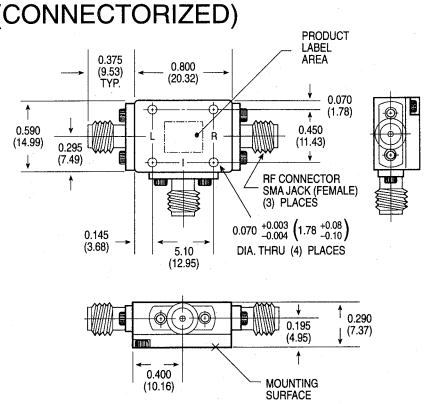
## Outline Drawings

MY83H
(VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MY83HC
(CONNECTORIZED)



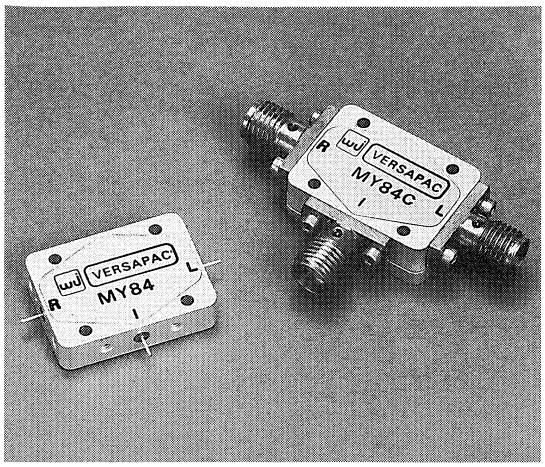

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-MY84/MY84C

## DOUBLE-BALANCED MIXER

- ◆ LO 1.8 TO 10 GHz
- ◆ RF 1.8 TO 10 GHz
- ◆ IF DC TO 1000 MHz
- ◆ LO DRIVE +9 dBm (nominal)
- ◆ LOW NOISE FIGURE

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristic | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss | | 6.0 dB | 7.5 dB | $f_R$ = 1.8 to 5.5 GHz<br>$f_L$ = 1.8 to 6.0 GHz<br>$f_I$ = 0.03 to 0.5 GHz |
| and SSB Noise Figure | | 6.5 dB | 8.5 dB | $f_R$ = 5.5 to 10.0 GHz<br>$f_L$ = 5.0 to 10.0 GHz<br>$f_I$ = 0.03 to 1.0 GHz |
| Isolation | | | | |
| $f_L$ to R | 30 dB | 45 dB | | $f_L$ = 1.8 to 6.0 GHz |
| | 20 dB | 32 dB | | $f_L$ = 6.0 to 10.0 GHz |
| $f_L$ to I | 18 dB | 30 dB | | $f_L$ = 1.8 to 10.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +4 dBm<br>$f_L$ level +9 dBm |
| Third Order Input Intercept | | +11 dBm | | $f_{R_1}$ 5.00 GHz at -10 dBm<br>$f_{R_2}$ 5.01 GHz at -10 dBm<br>$f_L$ = 5.5 GHz +9 dBm |

Notes
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

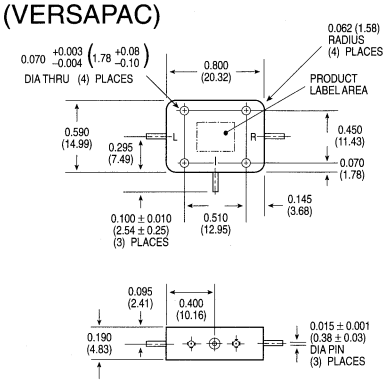
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight MY84: 6 grams (7.9 oz.) max.
MY84C: 30 grams (0.70 oz.) max.

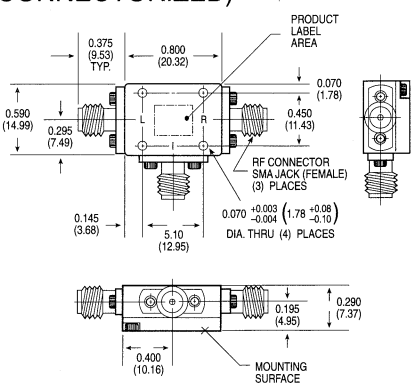
## Outline Drawings

MY84
(VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

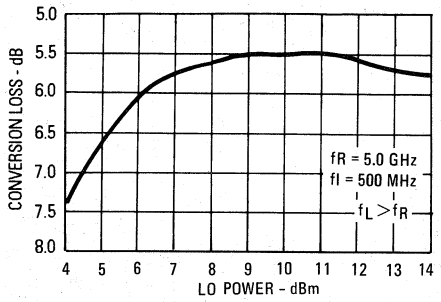
MY84C
(CONNECTORIZED)



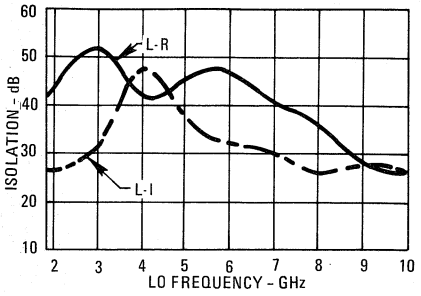

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

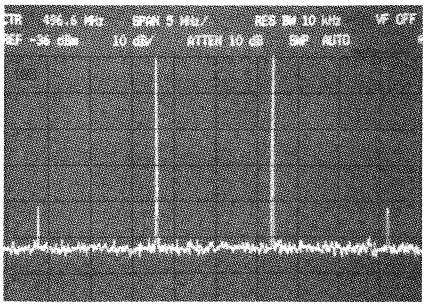
### Conversion Loss vs. LO Drive Power




### Isolation

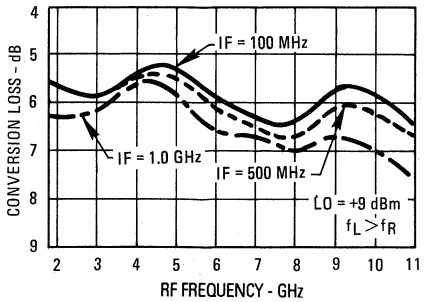


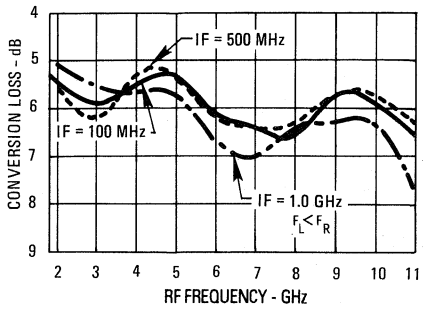

### Third-Order Intercept

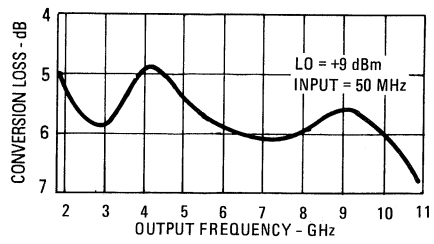


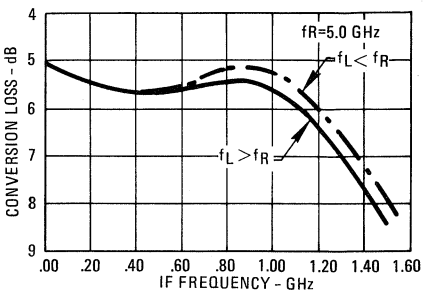
$f_R$ = 5.0 ± 0.01 GHz at -10 dBm
$f_L$ = 5.5 GHz at +9 dBm

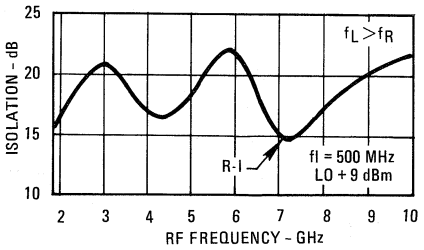
### Conversion Loss



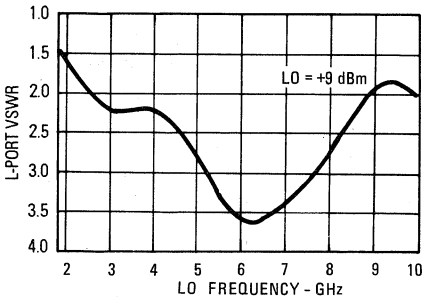



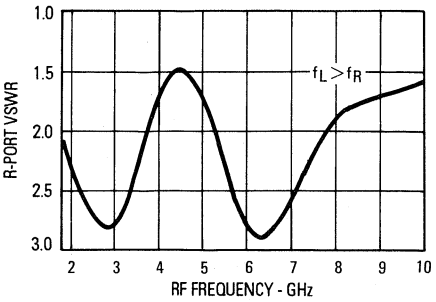



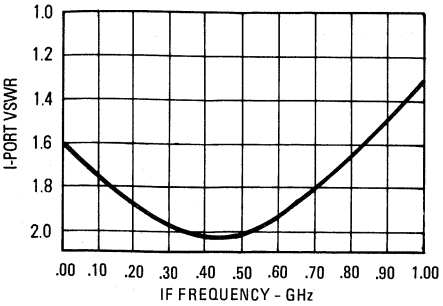




### VSWR



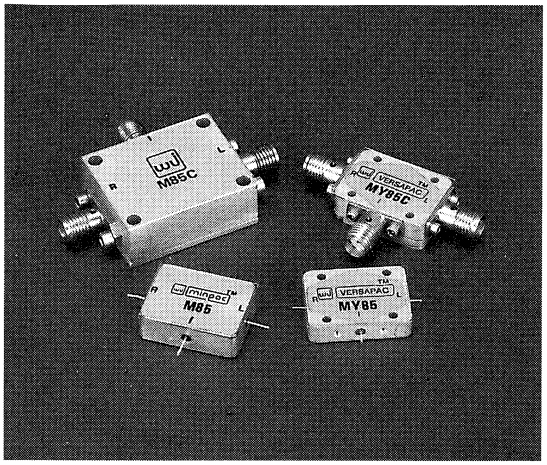

10

# WJ-M85/M85C
# WJ-MY85/MY85C

## DOUBLE-BALANCED MIXER

- ◆ LO, RF } 2 TO 18 GHz
- ◆ IF DC TO 1000 MHz
- ◆ LO DRIVE +7 dBm (nominal)
- ◆ DC COUPLED I-PORT
- ◆ WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 9.0 dB | $f_R$ 4 to 14 GHz<br>$f_L$ 3 to 15 GHz<br>$f_I$ DC to 1000 MHz |
| | | 8.5 dB | 10.5 dB | $f_R$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHzf<br>$f_I$ DC to 1000 MHz |
| Isolation | | | | |
| L to R | 22 dB | 35 dB | | $f_L$ 2 - 18 GHz |
| L to I | 15 dB | 20 dB | | $f_L$ 2 - 18 GHz |
| R to I | | 20 dB | | $f_R$ 2 - 18 GHz |
| Conversion Compression | | | | |
| $f_R$ at 5 GHz | | | 1.0 dB | $f_R$ level +1 dBm<br>$f_L$ level +7 dBm |
| $f_R$ at 15 GHz | | | 1.0 dB | $f_R$ level +3 dBm<br>$f_L$ level +7 dBm |
| Third Order Input Intercept Point | | +10 dBm | | $f_{R1}$ 5.00 GHz<br>$f_{R2}$ 5.01 GHz<br>Both at -10 dBm<br>$f_L$ 5.5 GHz at +7 dBm |
| | | +10 dBm | | $f_{R1}$ 15.00 GHz<br>$f_{R2}$ 15.01 GHz<br>Both at -10 dBm<br>$f_L$ 14.5 GHz at + 7 dBm |

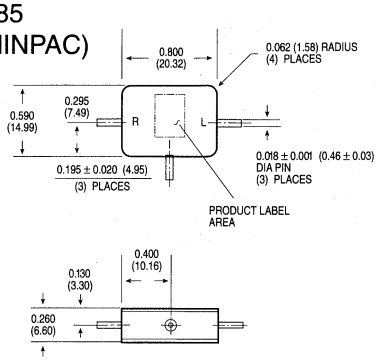
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC
Weight M85: 12 grams (0.42 oz.) max. MY85: 7.9 grams (0.28 oz.) max.
M85C: 40 grams (1.41 oz.) max. MY85C: 20.0 grams (0.70 oz.) max.

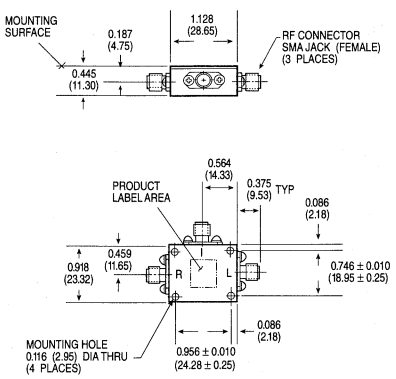
## Outline Drawings

M85
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

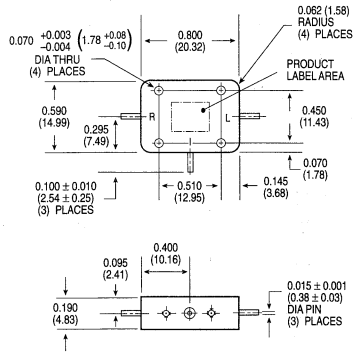
M85C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

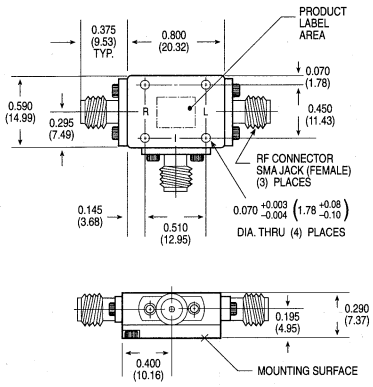
# Outline Drawings

## MY85 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

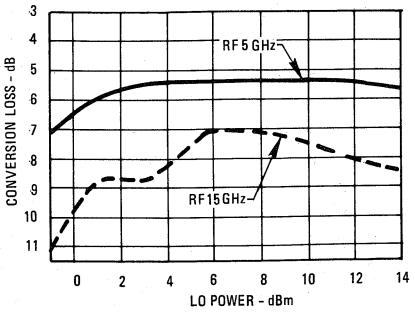
## MY85C (CONNECTORIZED)



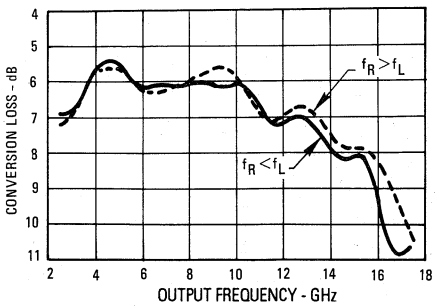

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C *

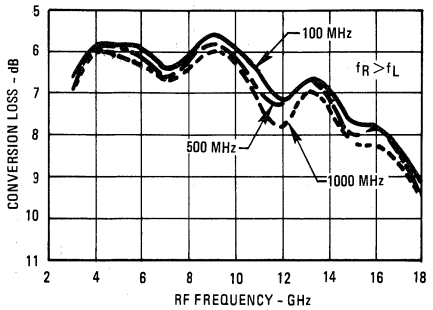
### Conversion Loss vs LO Power Level

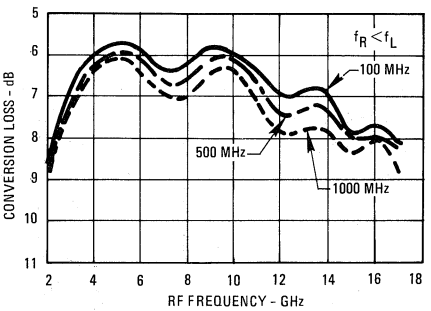



### Up Conversion Loss

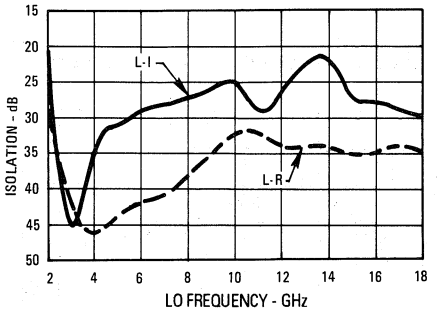


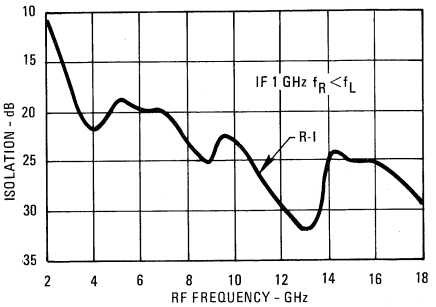

### Conversion Loss



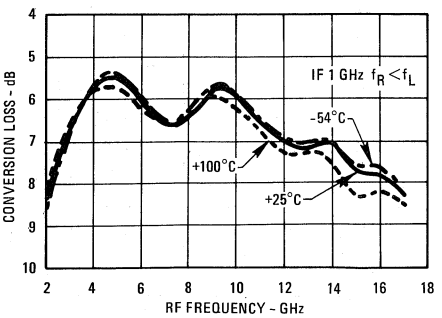




### Isolation

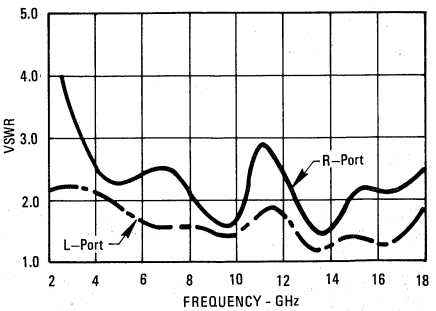


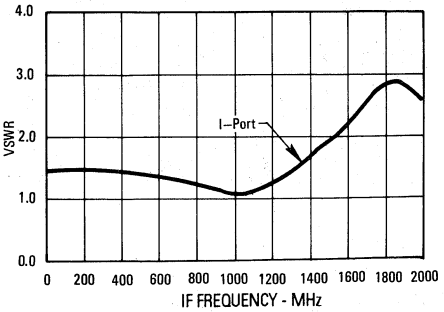




### Conversion Loss over Temperature




### VSWR




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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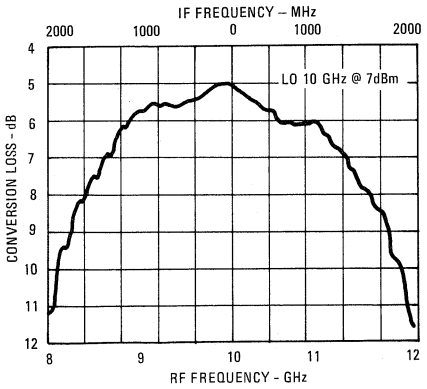
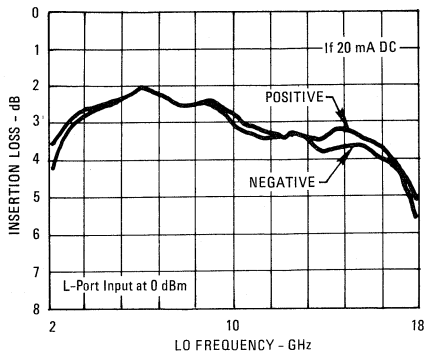
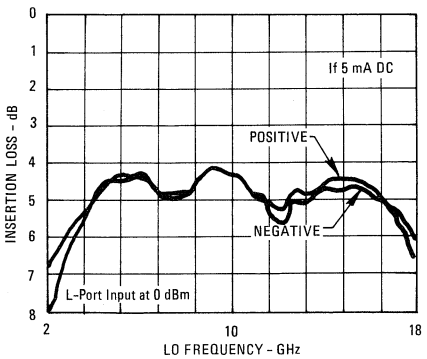
# Typical Performance at 25°C*

### I Port Bandwidth

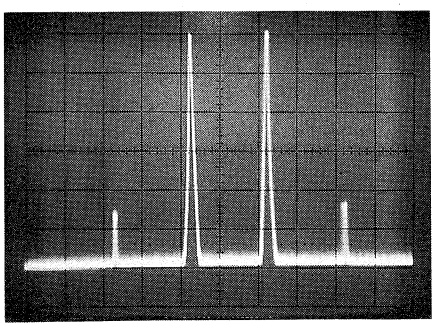



### Insertion Loss with DC Driven I-Port




### Third-Order Intercept Input



$f_{R1}$ 15.00 GHz at -10 dBm
$f_{R2}$ 15.02 GHz at -10 dBm
LO 14.5 GHz at +7 dBm
Vertical Scale is 10 dB/Div.

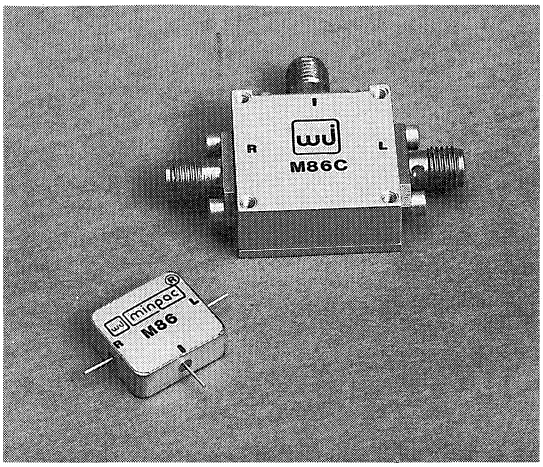
| Characteristic | Suppression (dBc) | | | Test Condition |
|---|---|---|---|---|
| **Single Tone IM** | **Input** 0 dBm | **Input** -5 dBm | **Input** -10 dBm | |
| $f_R$ x $f_L$ | | | | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ 2.0 GHz -10 dBm |
| 2 x 1 | 24 | 27 | 31 | |
| 2 x 2 | 41 | 43 | 45 | $f_L$ 2.6 GHz + 7 dBm |
| 3 x 2 | 38 | 45 | 55 | |
| 3 x 3 | 32 | 41 | 51 | |
| 4 x 3 | 41 | 52 | >60 | |
| 5 x 4 | 53 | >65 | >60 | |
| 6 x 3 | 59 | >65 | >60 | |
| 6 x 5 | 51 | >65 | >60 | |
| 1 x 1 | 0 | 0 | 0 | |
| 1 x 2 | 32 | 32 | 31 | $f_R$ 2.6 GHz -10 dBm |
| 2 x 2 | 49 | 57 | >65 | |
| 2 x 3 | 28 | 28 | 33 | $f_L$ 2.0 GHz + 7 dBm |
| 3 x 3 | >65 | >65 | >65 | |
| 3 x 4 | 48 | 56 | >65 | |
| 4 x 5 | 41 | 52 | >65 | |
| 4 x 6 | 53 | 63 | >65 | |
| 5 x 6 | 50 | 65 | >65 | |

| Characteristic Harmonics of $f_L$ | Output Power R-Port | Output Power I-Port | Test Conditions |
|---|---|---|---|
| $f_L$ | - 21 dBm | - 12 dBm | |
| 2 $f_L$ | - 8.5 dBm | - 26 dBm | |
| 3 $f_L$ | - 45 dBm | <-60 dBm | |
| 4 $f_L$ | - 24 dBm | - 45 dBm | $f_L$ 2 GHz @ +7 dBm |
| 5 $f_L$ | - 47 dBm | - 39 dBm | |
| 6 $f_L$ | - 38 dBm | <-60 dBm | |
| 7 $f_L$ | <-60 dBm | - 43 dBm | |
| 8 $f_L$ | - 38 dBm | <-60 dBm | |
| 9 $f_L$ | <-60 dBm | <-60 dBm | |
| $f_L$ | - 38 dBm | - 27 dBm | |
| 2 $f_L$ | - 18 dBm | - 39 dBm | $f_L$ 4 GHz @+7dBm |
| 3 $f_L$ | - 46 dBm | - 29 dBm | |
| 4 $f_L$ | - 33 dBm | <-60 dBm | |
| $f_L$ | - 29 dBm | - 20 dBm | |
| 2 $f_L$ | - 35 dBm | <-60 dBm | $f_L$ 9 GHz @+7 dBm |

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

# WJ-M86/M86C

## DOUBLE-BALANCED MIXER




- ◆ LO 3.5 TO 18 GHz
- ◆ RF 6 TO 18 GHz
- ◆ IF DC TO 3000 MHz
- ◆ LO DRIVE +7 dBm (nominal)
- ◆ WIDE BANDWIDTH
- ◆ DC COUPLED I-PORT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_R$ = 6 to 16 GHz<br>$f_L$ = 5 to 17 GHz<br>$f_I$ = 30 to 1000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ = 16 to 18 GHz<br>$f_L$ = 15 to 18 GHz<br>$f_I$ = 30 to 1000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ = 6 to 18 GHz<br>$f_L$ = 3.5 to 18 GHz<br>$f_I$ = 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 23 dB | 36 dB | | $f_L$ = 3.5 to 14 GHz |
| | 18 dB | 32 dB | | $f_L$ = 14 to 18 GHz |
| L to I | 16 dB | 28 dB | | $f_L$ = 3.5 to 9 GHz |
| | 23 dB | 38 dB | | $f_L$ = 9 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm<br>$f_L$ Level +7 dBm |
| Third-Order Input Intercept | | +10 dBm | | $f_{R_1}$ = 13.00 GHz, $f_{R_2}$ = 13.01 GHz both at -10 dBm<br>$f_L$ = 14.0 GHz at +7 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

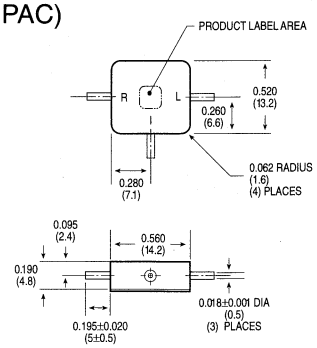
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M86: 6 grams (0.21 oz.) max.
M86C: 30 grams (1.06 oz.) max.

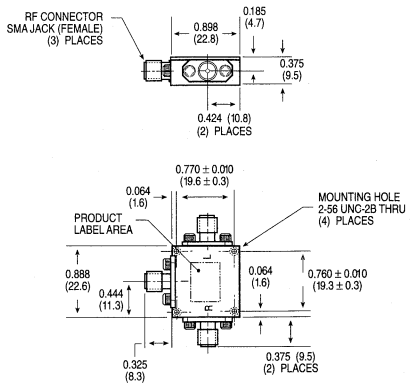
## Outline Drawings

M86
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

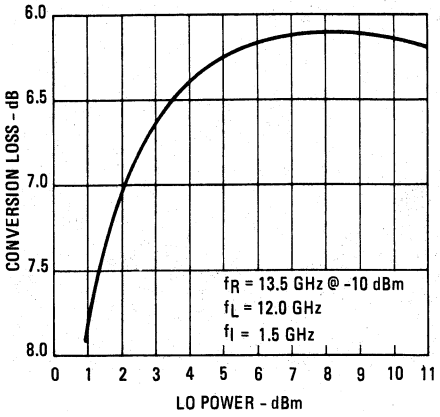
M86C
(CONNECTORIZED)

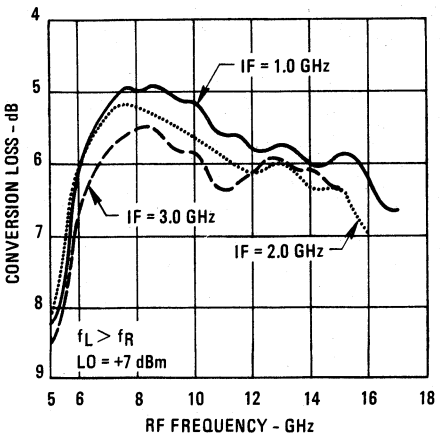



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

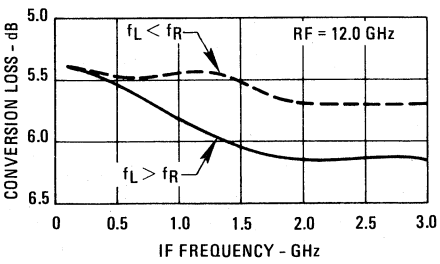
# Typical Performance at 25°C

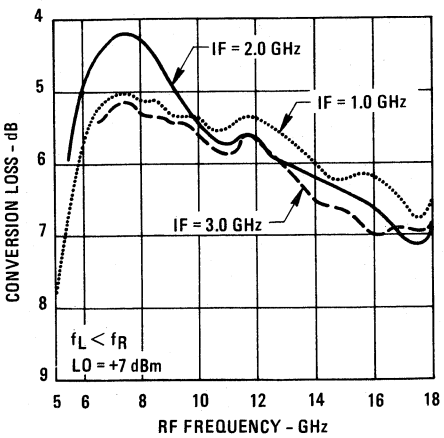
### Conversion Loss vs. LO Power



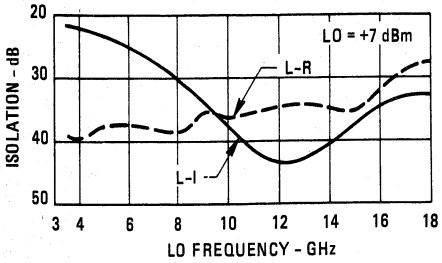




### Conversion Loss

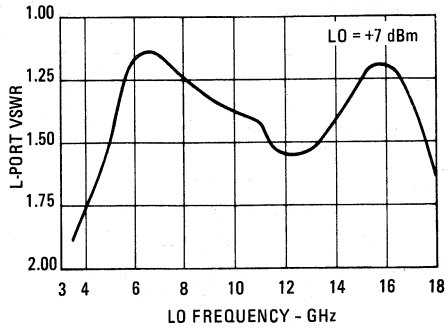


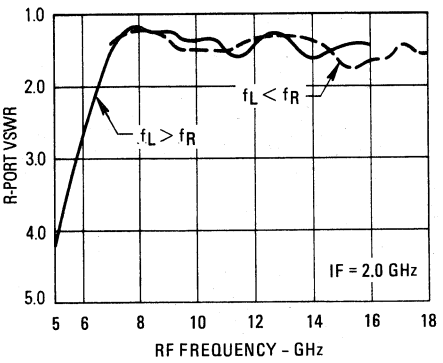



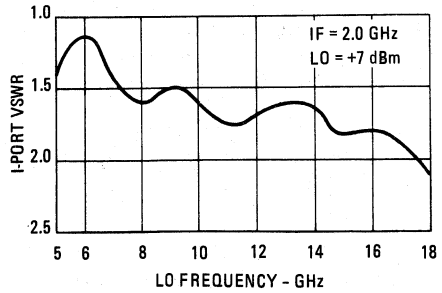

### Isolation



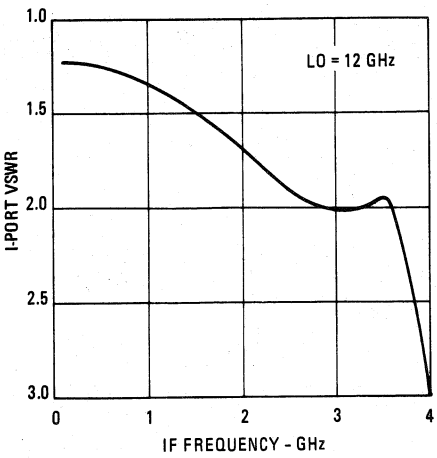

### VSWR



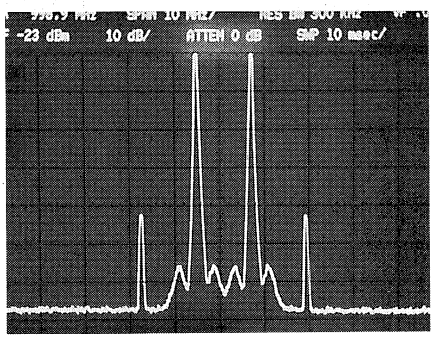




### VSWR




### Typical Two-Tone Intermodulation Performance

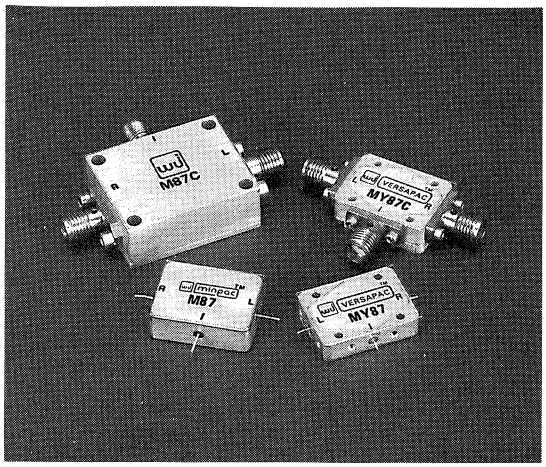



$f_I$ = 1.0 GHz
$f_{R1}$ = 13.00 GHz at -10 dBm
$f_{R2}$ = 13.01 GHz at -10 dBm
$f_L$ = 14.0 GHz at +7 dBm
Vertical Scale is 10 dB/Div.

10

# WJ-M87/M87C
# WJ-MY87/MY87C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER



- ◆ LO, ◆ RF } 0.5 TO 19 GHz
- ◆ IF 0.03 TO 5.0 GHz
- ◆ LO DRIVE +13 dBm (nominal)
- ◆ VERY WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min | Typ. | Max | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 10.5 dB | $f_R$ 1.0 to 18.0 GHz<br>$f_L$ 0.5 to 18.0 GHz<br>$f_I$ 0.03 to 3.0 GHz |
| | | 8.5 dB | 11.0 dB | $f_R$ 0.5 to 18.0 GHz<br>$f_L$ 0.5 to 18.0 GHz<br>$f_I$ 0.03 to 4.0 GHz |
| | | 10.5 dB | 12.0 dB | $f_R$ 0.7 to 19.0 GHz<br>$f_L$ 0.5 to 19.0 GHz<br>$f_I$ 0.03 to 5.0 GHz |
| Isolation | | | | |
| L-R | 10.0 dB | 17.0 dB | | $f_L$ = 0.5 to 3.0 GHz |
| | 20.0 dB | 30.0 dB | | $f_L$ = 3.0 to 19.0 GHz |
| L-I | 22.0 dB | 32.0 dB | | $f_L$ = 0.5 to 19.0 GHz |
| Conversion Compression | | | | |
| $f_R$ at 5 GHz | | | 1.0 dB | $f_R$ level +8.0 dBm, $f_L$ level +13 dBm |
| $f_R$ at 15 GHz | | | 1.0 dB | $f_R$ level +9.0 dBm, $f_L$ level +13 dBm |
| Third-Order Input Intercept Point | | +16.5 dBm | | $f_{R_1}$ = 5.00 GHz, $f_{R_2}$ = 5.01 GHz both at -6.0 dBm<br>$f_L$ =7.0 GHz at +13.0 dBm |
| | | + 18.0 dBm | | $f_{R1}$ =15.00 GHz, $f_{R_2}$ = 15.01 GHz both at -6.0 dBm<br>$f_L$ = 18.0 GHz at +13.0 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

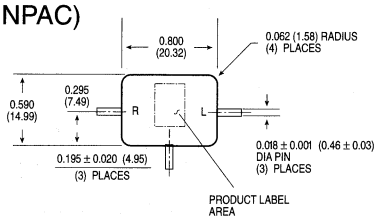
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M87: 12 grams (0.21 oz.) max. MY87: 7.9 grams (0.28 oz.) max.
M87C: 40 grams (1.41 oz.) max. MY87C: 20.0 grams (0.70 oz.) max.

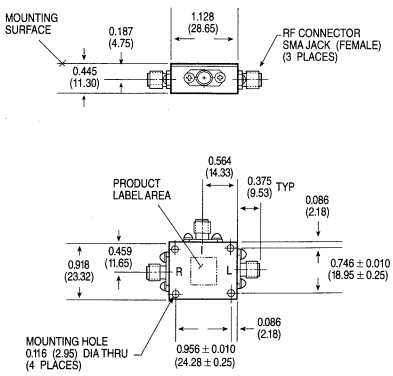
## Outline Drawings

M87
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

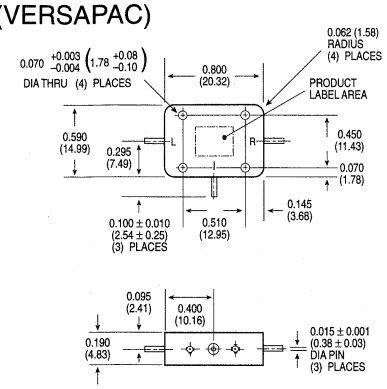
M87C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

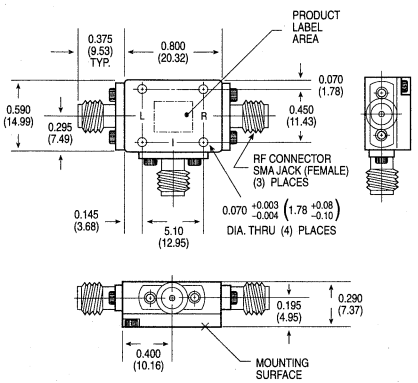
# Outline Drawings

## MY87 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

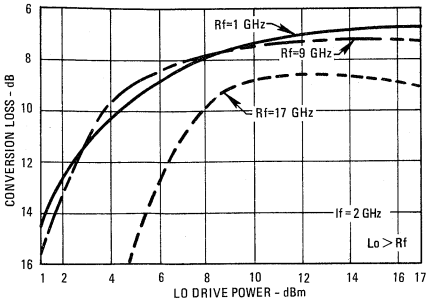
## MY87C (CONNECTORIZED)



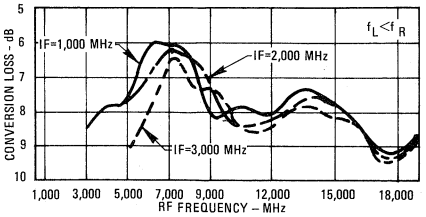

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

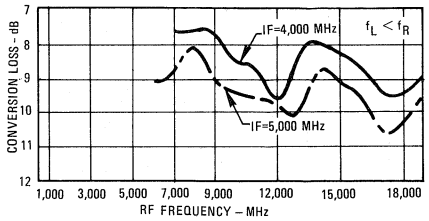
# Typical Performance at 25°C *

### Conversion Loss vs. LO Drive Power

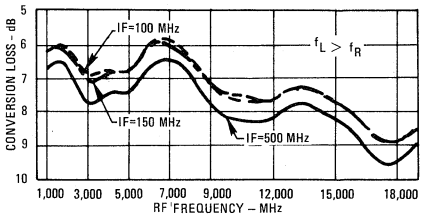


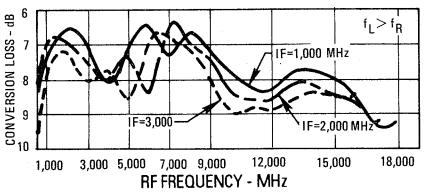

### Conversion Loss vs. Frequency LO @ +13 dBm

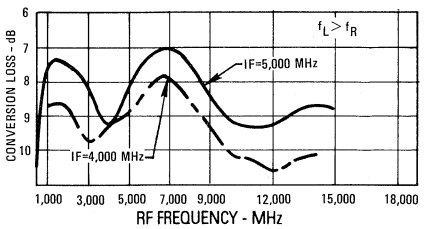


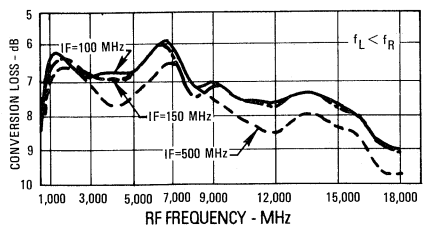




### Conversion Loss vs. Frequency LO @ +13 dBm

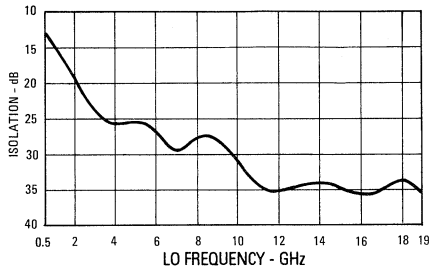


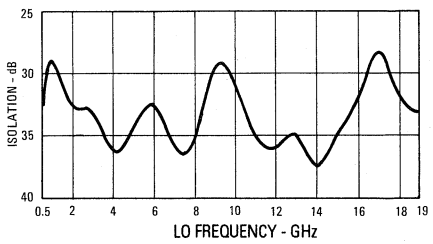




### L to R Port Isolation vs. Frequency



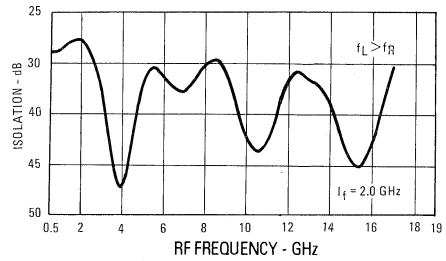

### L to I Port Isolation vs. Frequency

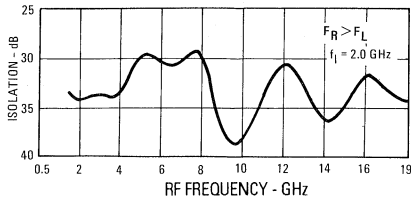



*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

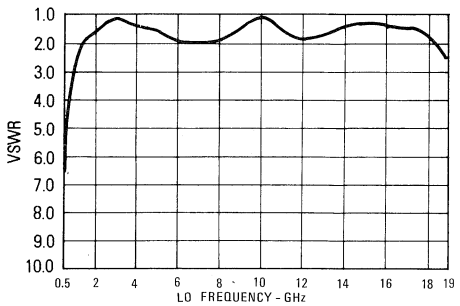
# Typical Performance at 25°C*

### R to I Port Isolation vs. Frequency

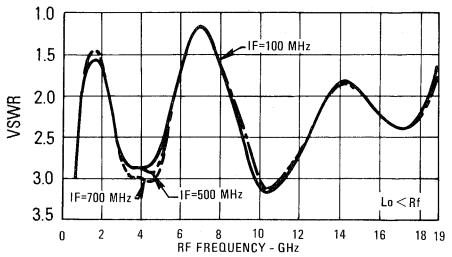


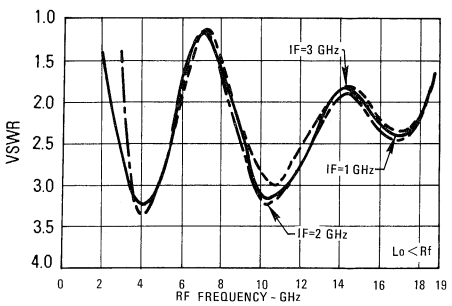




### L-PORT VSWR vs. Frequency

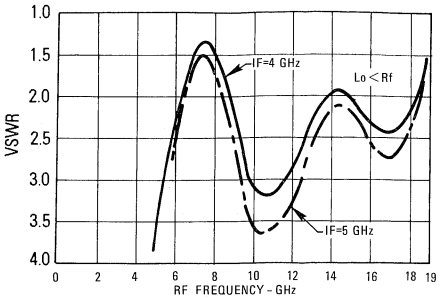


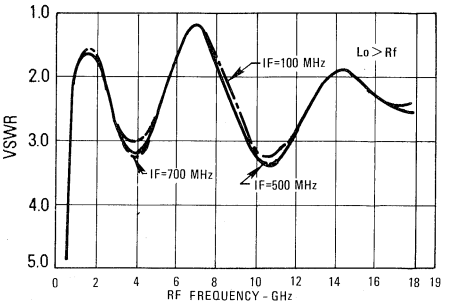

### R-Port VSWR vs. Frequency

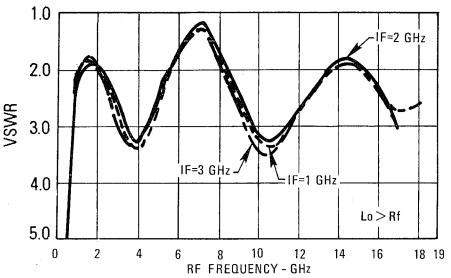


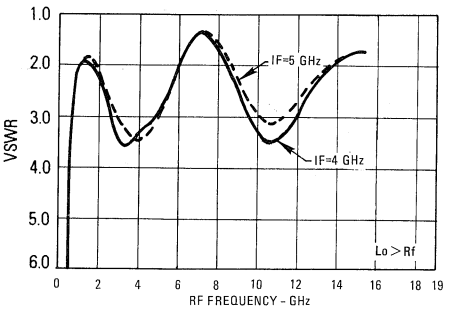




### R-Port VSWR vs. Frequency

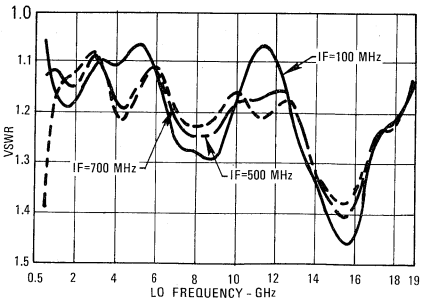


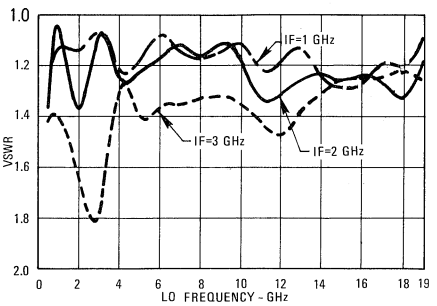



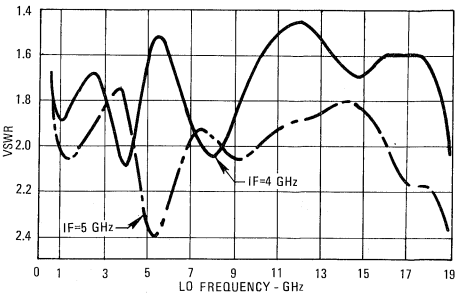




### I-Port VSWR vs. Frequency

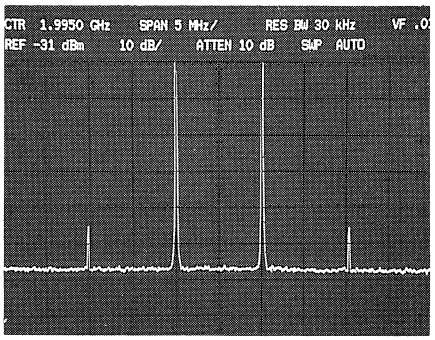



### I-Port VSWR vs. Frequency




### Typical Two-Tone Intermodulation




**Typical Two Tone Intermodulation Performance**

$f_I$ = 2.0 GHz

$f_R$ = 5.0 GHz ± 5.0 MHz @ -6.0 dBm

$f_L$ = 7.0 GHz @ +13.0 dBm

Vertical Scale = 10.0 dB/cm

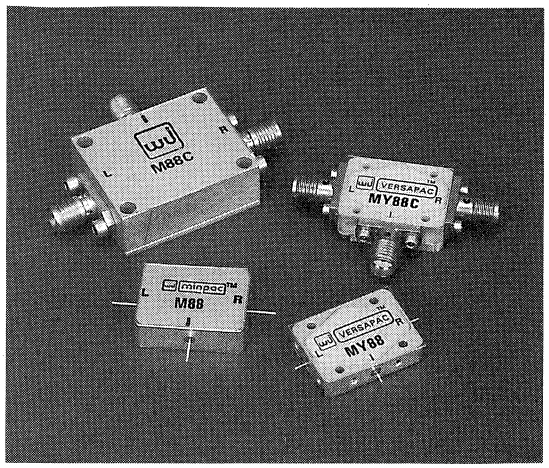
*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

## Typical Performance at 25° C

| Characteristics | Output Power | | Test Conditions |
|---|---|---|---|
| **Harmonics of $f_L$** | **R-Port** | **I-Port** | |
| $f_L$ | 0.0 dBm | -20.0 dBm | $f_L$ = 500 MHz at +13.0 dBm |
| 2 $f_L$ | -34.0 dBm | -15.0 dBm | |
| 3 $f_L$ | -20.0 dBm | -39.0 dBm | |
| 4 $f_L$ | -48.0 dBm | -32.0 dB m | |
| 5 $f_L$ | -43.0 dBm | -47.0 dBm | |
| $f_L$ | -7.0 dBm | -17.0 dBm | $f_L$ = 2.0 GHz at +13.0 dBm |
| 2 $f_L$ | -25.0 dBm | -13.0 dBm | |
| 3 $f_L$ | -19.0 dBm | | |
| 4 $f_L$ | -38.0 dBm | | |
| 5 $f_L$ | -29.0 dBm | | |
| $f_L$ | -17.0 dBm | | $f_L$ = 9.5 GHz at +13.0 dBm |
| 2 $f_L$ | -24.0 dBm | | |

# WJ-M88/M88C
# WJ-MY88/MY88C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- LO, RF } 2 TO 18 GHz
- IF 1 TO 8 GHz
- LO DRIVE +13 dBm (nominal)
- WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

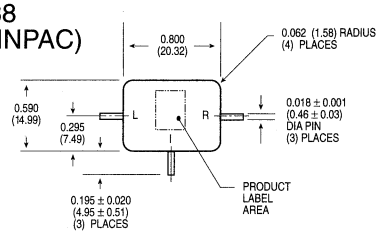
## Guaranteed Specifications[1]

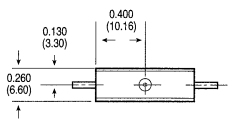
| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 10.0 dB | $f_R$ 2 to 10 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 1 to 8 GHz |
| | | 8.0 dB | 10.5 dB | $f_R$ 10 to 18 GHz<br>$f_L$ 10 to 18 GHz<br>$f_I$ 2 to 8 GHz |
| | | 8.0 dB | 11.0 dB | $f_R$ 10 to 18 GHz<br>$f_L$ 2 to 10 GHz<br>$f_I$ 2 to 8 GHz |
| Isolation | | | | |
| L to R | 15 dB | 28 dB | | $f_L$ 2 to 18 GHz |
| L to I | 16 dB | 32 dB | | $f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +7 dBm<br>$f_L$ level +13 dBm |
| Third-Order Input Intercept Point | | +18.5 dBm | | $f_{R1}$ = 6.00 GHz, $f_{R2}$ = 6.01 GHz both at -3 dBm<br>$f_L$ = 10.0 GHz at +13 dBm |
| | | +22 dBm | | $f_{R1}$ = 15.00 GHz, $f_{R2}$ = 15.01GHz both at -3 dBm<br>$f_L$ = 18.0 GHz at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Outline Drawings

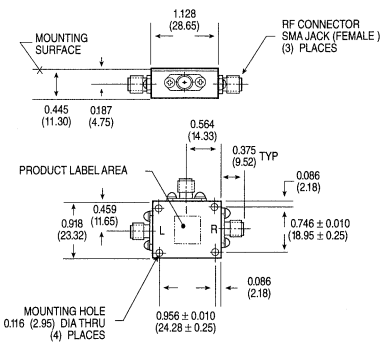
M88
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M88C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

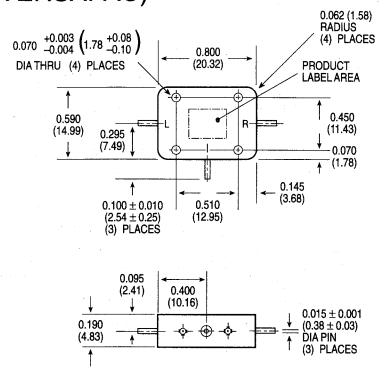
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+26 dBm max. at +25°C, +23 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M88: 12 grams (0.42 oz.) max. M88C: 40 grams (1.41 oz.) max.
MY88: 7.9 grams (0.28 oz.) max. MY88C: 20.0 grams (0.70 oz.) max.

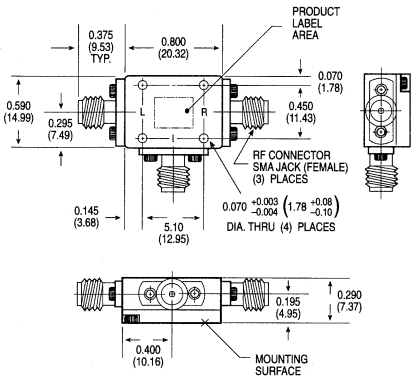
# Outline Drawings

## MY88 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

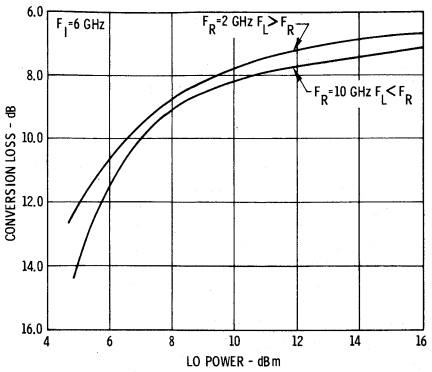
## MY88C (CONNECTORIZED)



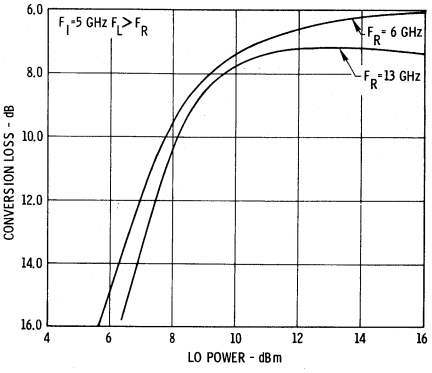

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

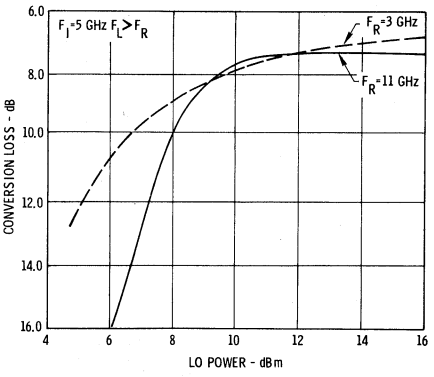
# Typical Performance at 25°C*

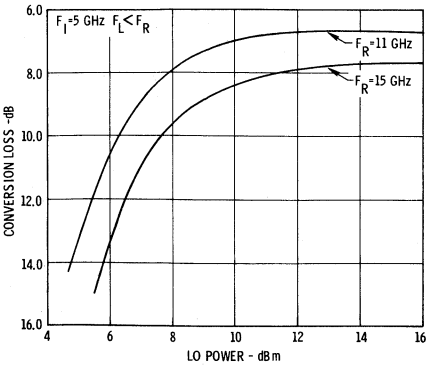
## Conversion Loss vs. Drive Power



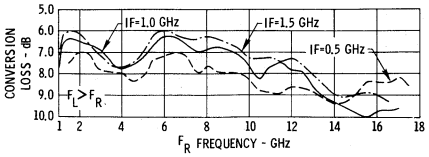

***Drive Level:*** The maximum recommended drive level is +20 dBm.

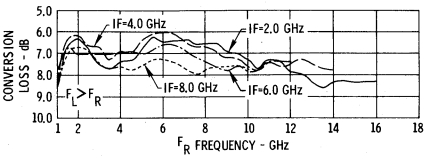


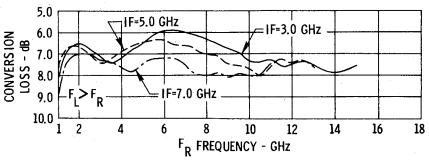



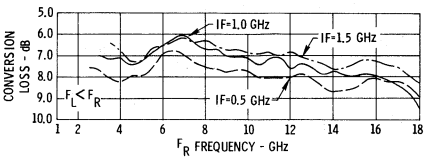



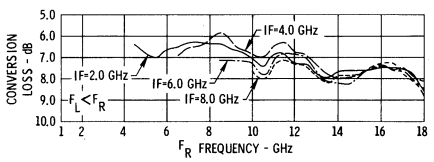

## Conversion Loss vs. Frequency, LO @ +13 dBm

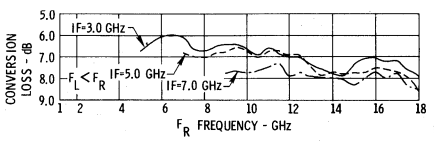


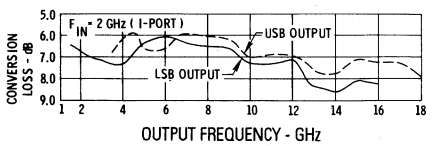



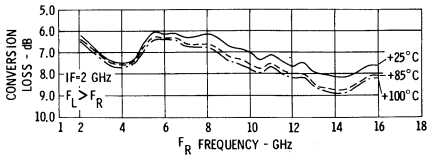




## Upconversion (Conversion Loss) LO @ +13 dBm




## Conversion Loss vs. Freqeuncy & Temperature LO @ +13 dBm




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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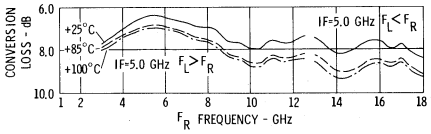
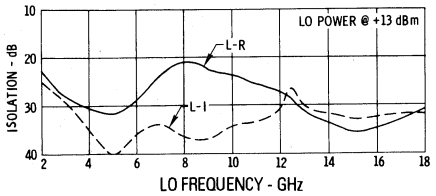
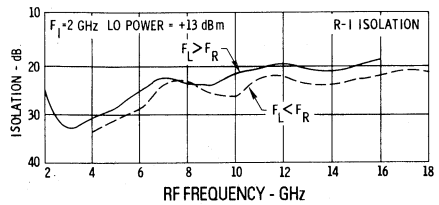
# Typical Performance at 25°C *

### Conversion Loss vs. Freqeuncy & Temperature LO @ +13 dBm

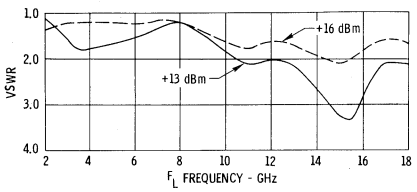



### Isolation vs Frequency

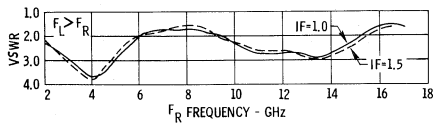


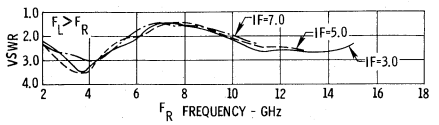



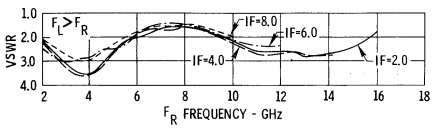

### L-Port VSWR

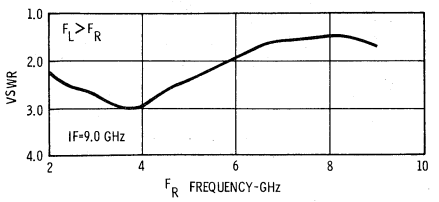



### R-Port VSWR LO @ + 13 dBm

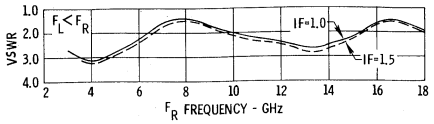


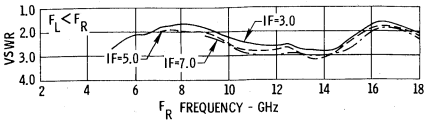



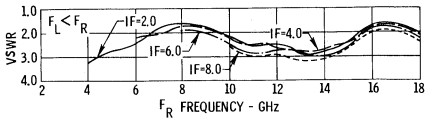



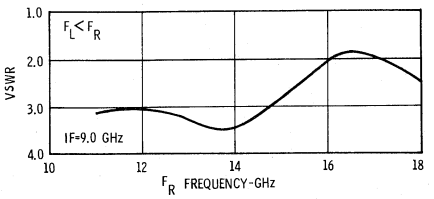




### R-Port VSWR LO @ +13 dBm

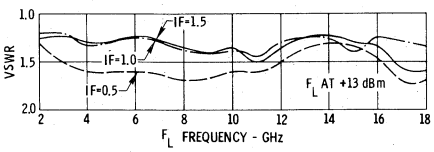


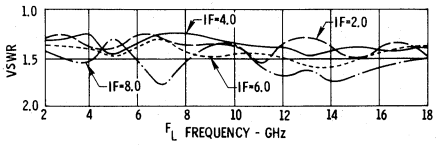




### I-Port VSWR vs. Frequency LO @ +13 dBm




| Characteristics | Output Power | | Test Conditions |
|---|---|---|---|
| **Harmonics of $f_L$** | **R-Port** | **I-Port** | |
| $f_L$ | -10 dBm | -12 dBm | $f_L$ = 2 GHz at +13 dBm |
| 2 $f_L$ | -18 dBm | -15 dBm | |
| 3 $f_L$ | -24 dBm | -21 dBm | |
| 4 $f_L$ | -30 dBm | -31 dBm | |
| 5 $f_L$ | -36 dBm | — | |
| $f_L$ | -18 dBm | | $f_L$ = 4.5 GHz at +13 dBm |
| 2 $f_L$ | -22 dBm | | |
| 3 $f_L$ | -34 dBm | | |
| 4 $f_L$ | -37 dBm | | |
| $f_L$ | -9 dBm | | $f_L$ = 9 GHz at +13 dBm |
| 2 $f_L$ | -29 dBm | | |
| $f_L$ | | -21 dBm | $f_L$ = 4 GHz at +13 dBm |
| 2 $f_L$ | | -21 dBm | |

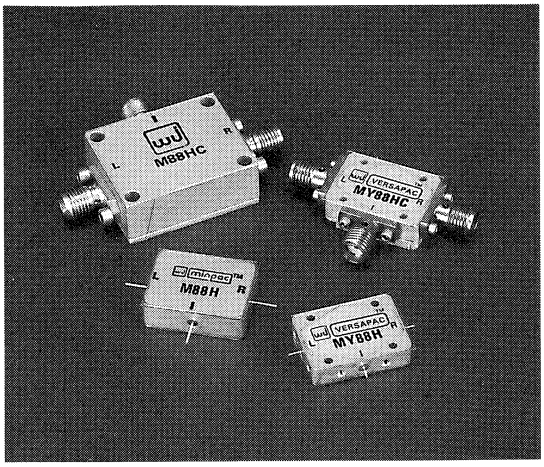
*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

## Typical Performance at 25° C

| Characteristic | Suppression | | | Test Conditions |
|---|---|---|---|---|
| **Single Tone IM** | **Input 0 dBm** | **Input -5 dBm** | **Input -10 dBm** | |
| $f_R$ $f_L$ | | | | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 2.0 GHz |
| 1 x 2 | 37 dB | 36 dB | 36 dB | $f_L$ = 4.1 GHz at +13 dBm |
| 2 x 2 | 46 dB | 50 dB | 55 dB | |
| 3 x 2 | 61 dB | 70 dB | >73 dB | |
| 3 x 1 | 43 dB | 54 dB | 64 dB | |
| 3 x 3 | 47 dB | 56 dB | >61 dB | |
| 4 x 1 | 59 dB | 69 dB | >69 dB | |
| 4 x 3 | 62 dB | 73 dB | >73 dB | |
| 4 x 4 | 66 dB | >66 dB | >66 dB | |
| 5 x 1 | 73 dB | >73 dB | >73 dB | |
| 5 x 2 | 81 dB | >83 dB | >83 dB | |
| 5 x 3 | 70 dB | >75 dB | >75 dB | |
| 5 x 4 | 72 dB | >72 dB | >72 dB | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 4.1 GHz |
| 1 x 3 | 17 dB | 18 dB | 18 dB | $f_L$ = 2.0 GHz at +13 dBm |
| 1 x 4 | 47 dB | 44 dB | 43 dB | |
| 1 x 5 | 44 dB | 44 dB | 43 dB | |
| 2 x 1 | 45 dB | 49 dB | 54 dB | |
| 2 x 2 | 42 dB | 46 dB | 51 dB | |
| 2 x 3 | 44 dB | 48 dB | 53 dB | |
| 2 x 5 | 43 dB | 47 dB | 52 dB | |
| 3 x 2 | 62 dB | 68 dB | >68 dB | |
| 3 x 3 | 56 dB | 63 dB | >64 dB | |
| 3 x 4 | 59 dB | 66 dB | 72 dB | |
| 3 x 5 | 55 dB | 62 dB | 67 dB | |
| 4 x 4 | 70 dB | >70 dB | >70 dB | |
| 4 x 5 | 69 dB | >70 dB | >70 dB | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 18 GHz |
| 1 x 2 | 31 dB | 30 dB | 30 dB | $f_L$= 10.1 GHz at+13 dBm |
| 2 x 3 | 56 dB | 60 dB | 61 dB | |
| 2 x 4 | 46 dB | 51 dB | 56 dB | |
| 3 x 5 | 49 dB | 60 dB | 67 dB | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 10.1 GHz |
| 2 x 1 | 46 dB | 52 dB | 58 dB | $f_L$ = 18 GHz at +13 dBm |
| 3 x 2 | 59 dB | 69 dB | >70 dB | |
| 4 x 2 | 72 dB | >75 dB | >75 dB | |
| 5 x 3 | 80 dB | >80 dB | >80 dB | |

# WJ-M88H/M88HC
# WJ-MY88H/MY88HC

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- ◆ LO, RF } 2 TO 18 GHz
- ◆ IF 2 TO 8 GHz
- ◆ LO DRIVE +21 dBm (nominal)
- ◆ WIDE BANDWIDTH
- ◆ HIGH THIRD ORDER I.P: +24 dBm (TYP.)

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 10.0 dB | $f_R$ 2 to 10 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 2 to 8 GHz |
| | | 8.0 dB | 10.5 dB | $f_R$ 10 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 2 to 8 GHz |
| Isolation | | | | |
| L to R | 15 dB | 28 dB | | $f_L$ 2 to 18 GHz |
| L to I | 17 dB | 32 dB | | $f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +17 dBm<br>$f_L$ level +21 dBm |
| Third-Order Input Intercept Point | | +26 dBm | | $f_{R1}$ = 6.00 GHz, $f_{R2}$ = 6.01 GHz both at 0 dBm<br>$f_L$ = 8.0 GHz at +20 dBm |
| | | +24 dBm | | $f_{R1}$ = 14.00 GHz, $f_{R2}$ = 14.01 GHz both at 0 dBm<br>$f_L$ = 10.0 GHz at +20 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

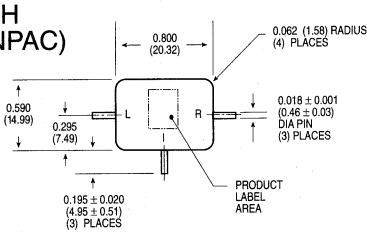
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+27 dBm max. at +25°C, +24 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC

Weight M88H: 12 grams (42 oz.) max. M88HC: 40 grams (141 oz.) max.
MY88H: 7.9 grams (0.28 oz.) MY88HC: 20.0 grams( (0.70 oz.) max.

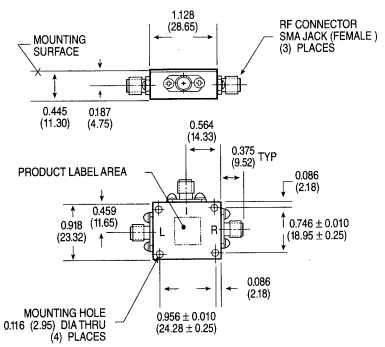
## Outline Drawings

M88H (MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

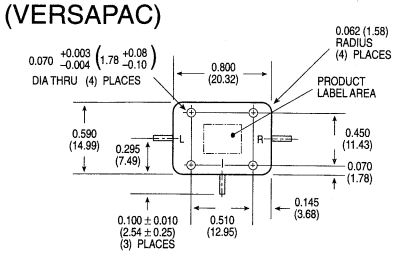
M88HC (CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

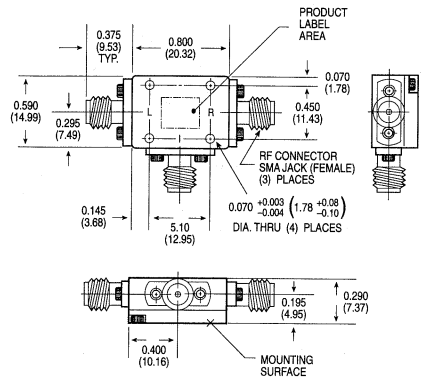
## Outline Drawings

### MY88H (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

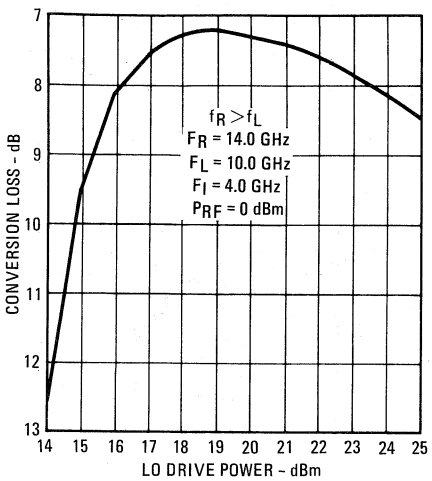
### MY88HC (CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

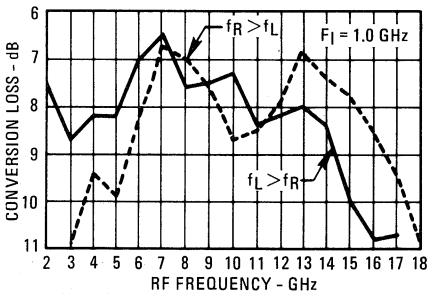
## Typical Performance at 25°C *

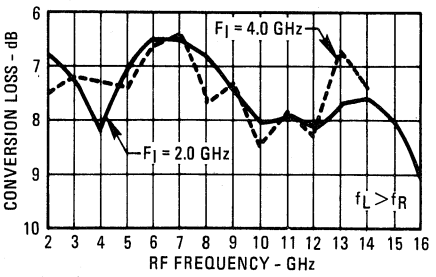
### Conversion Loss vs Lo Drive Power

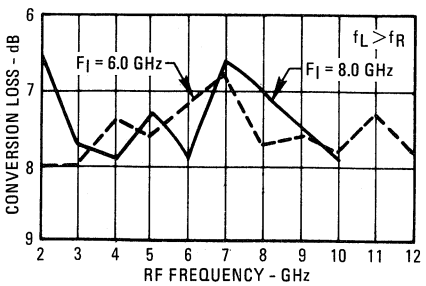



*Drive Level:* The maximum recommended drive level is +24 dBm.

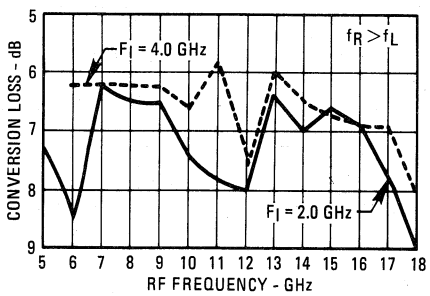
### Conversion Loss vs Input Frequency Lo @ + 21 dBm

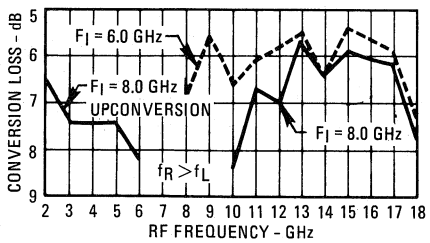


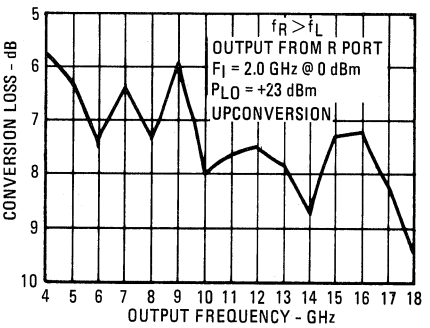



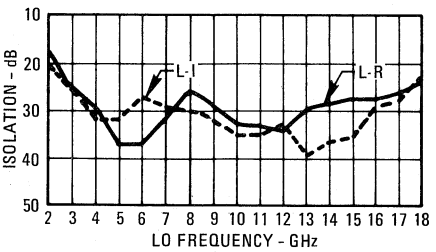

### Conversion Loss vs Input Frequency Lo @ + 21 dBm

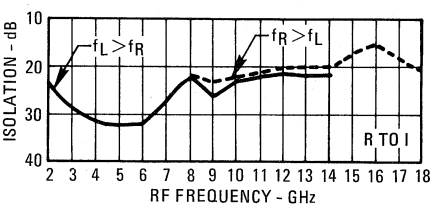



### Isolation vs Frequency

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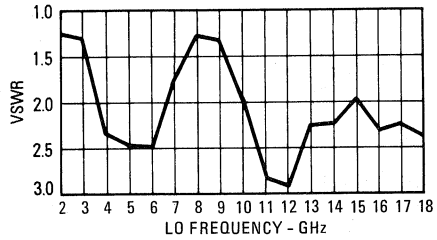
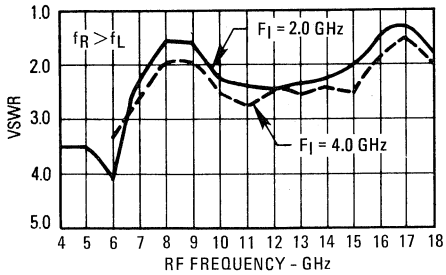
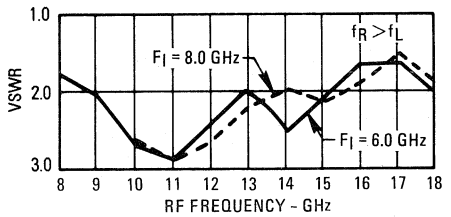
# Typical Performance at 25°C *

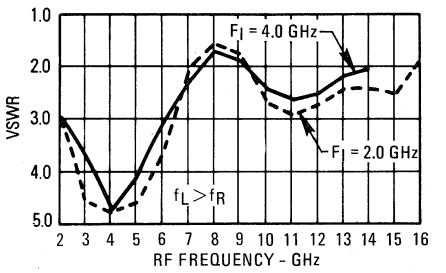
### L-Port VSWR @ + 21 dBm

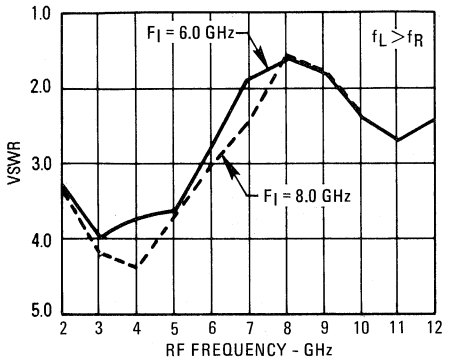



### R-Port VSWR Lo @ + 21 dBm

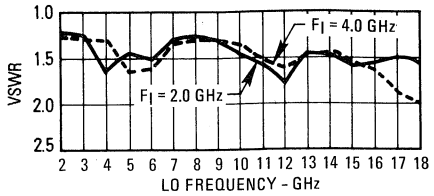


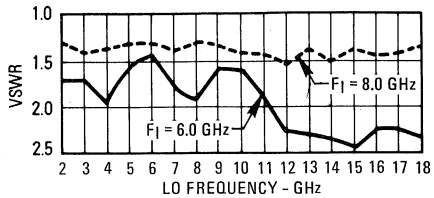




### I-PORT VSWR @ +21 dBm



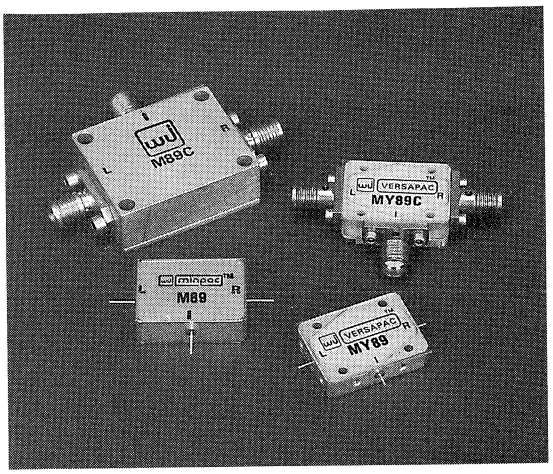




| Characteristics | Output Power | | Test Conditions |
|---|---|---|---|
| **Harmonics of $f_L$** | **R-Port** | **I-Port** | |
| $f_L$ | +.5 dBm | -.7 dBm | $f_L$ = 2 GHz at +20 dBm |
| 2 $f_L$ | -10 dBm | -6.7 dBm | |
| 3 $f_L$ | -11.5 dBm | -12.5 dBm | |
| 4 $f_L$ | -26.7 dBm | -20.5 dBm | |
| 5 $f_L$ | -24.5 dBm | -20 dBm | |
| $f_L$ | -7.7 dBm | -9.5 dBm | $f_L$ = 4.0 GHz at +20 dBm |
| 2 $f_L$ | -19.5 dBm | -16 dBm | |
| 3 $f_L$ | -15.7 dBm | -20.5 dBm | |
| 4 $f_L$ | -28.5 dBm | -34 dBm | |
| $f_L$ | -9 dBm | -8.7 dBm | $f_L$ = 8 GHz at +20 dBm |
| 2 $f_L$ | -11.7 dBm | -11.7 dBm | |

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

# WJ-M89/M89C
# WJ-MY89/MY89C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- LO, RF } 2 TO 18 GHz
- IF 1 TO 8 GHz
- LO DRIVE +10 dBm (nominal)
- WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss<br>and<br>SSB Noise Figure | | 7.5 dB<br><br>8.0 dB | 10.0 dB<br><br>10.5 dB | $f_R$ 2 to 10 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 1 to 8 GHz<br><br>$f_R$ 10 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 2 to 8 GHz |
| Isolation<br>L to R<br>L to I | <br>15 dB<br>16 dB | <br>28 dB<br>32 dB | | <br>$f_L$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level +4 dBm<br>$f_L$ level +10 dBm |
| Third-Order Input Intercept Point | | +14 dBm<br><br>+18.5 dBm | | $f_{R1}$ = 6.00 GHz, $f_{R2}$ 6.01 GHz both at -6 dBm<br>$f_L$ = 10.0 GHz at +10 dBm<br>$f_{R1}$ = 15.00 GHz, $f_{R2}$ = 15.01 GHz both at -6 dBm<br>$f_L$ = 18.0 GHz at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

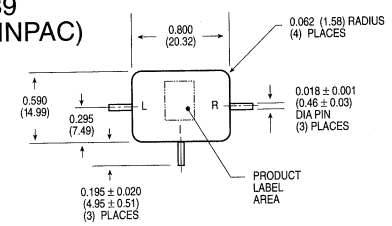
## Absolute Maximum Ratings

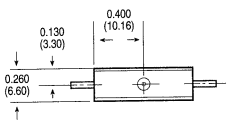
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C

Weight M89: 12 grams (0.42 oz.) max. M89C: 40 grams (1.41 oz.) max.
MY89: 7.0 grams (0.28 oz.) max. MY89C: 20.0 grams (0.70 oz.) max.

## Outline Drawings

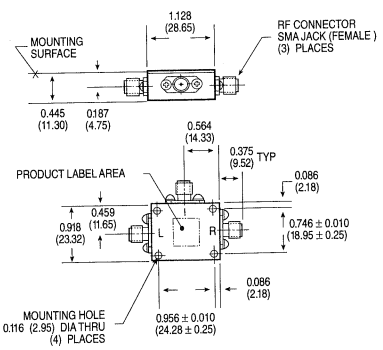
M89
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

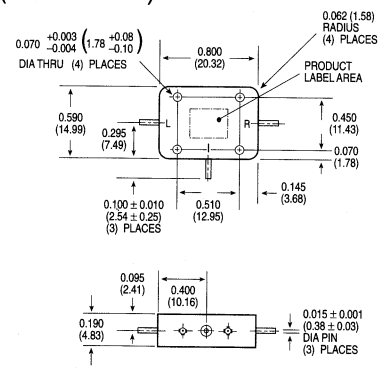
M89C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

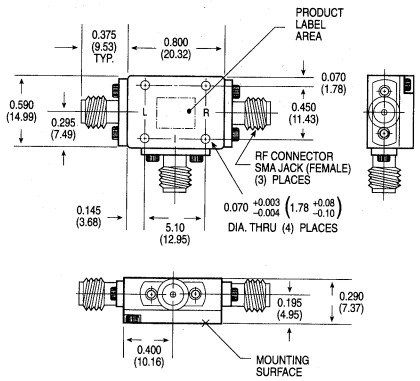
## Outline Drawings

MY89
(VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

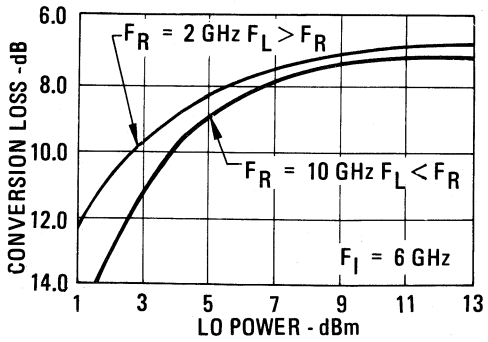
MY89C
(CONNECTORIZED)



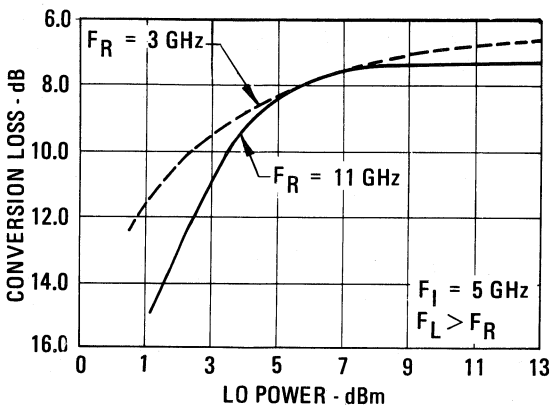

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

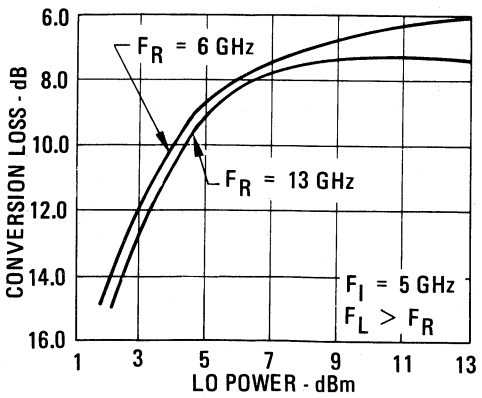
## Typical Performance at 25°C*

**Conversion Loss vs. LO Drive Power**




*Drive Level:* The maximum recommended drive level is +16 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +16 dBm is rcommended to achieve best two-tone performance and best suppression of the intermodulation products.




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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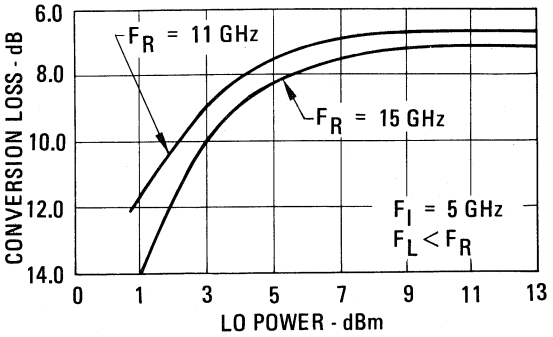
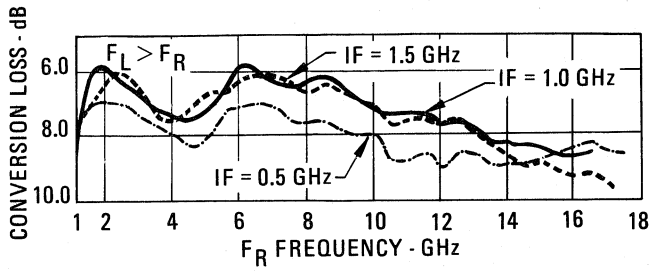
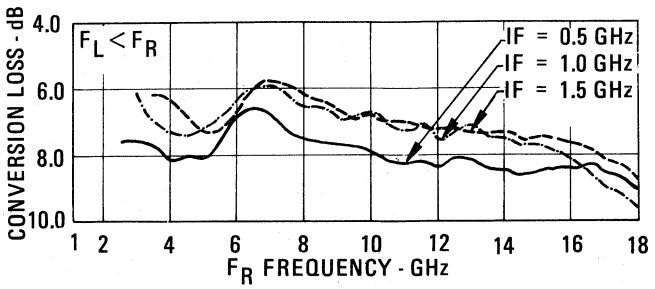
## Typical Performance at 25°C *

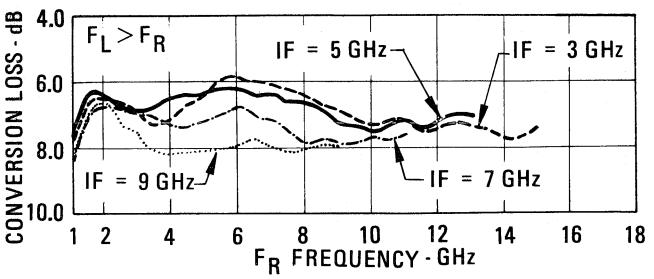
### Conversion Loss vs. LO Drive Power

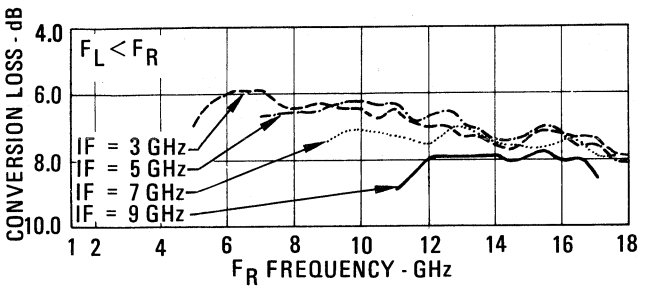


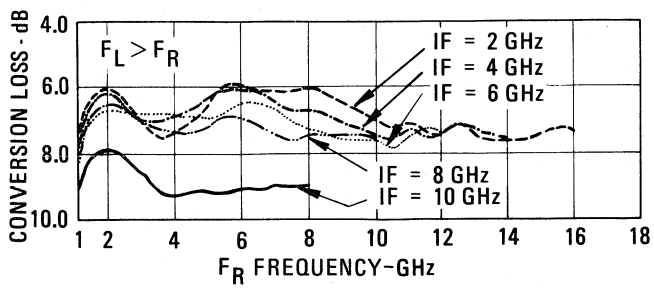

### Conversion Loss vs. Frequency, LO Power @ +10 dBm

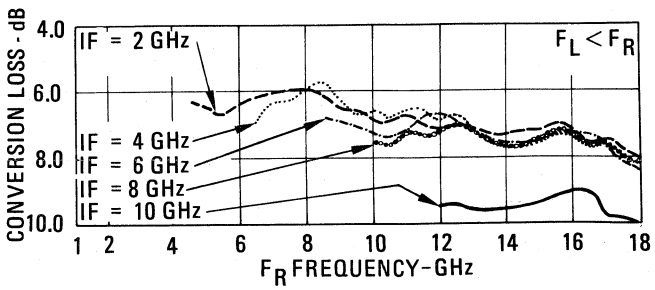


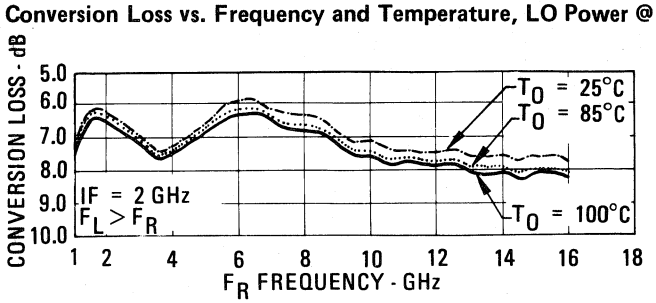



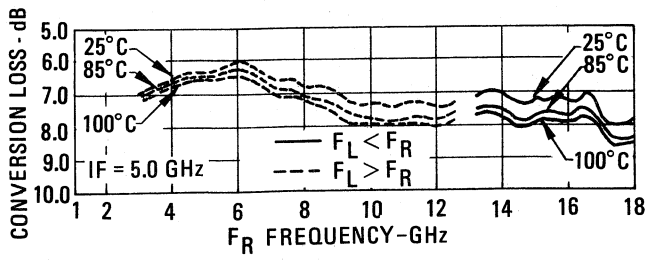




### Conversion Loss vs. Frequency and Temperature, LO Power @ +10 dBm

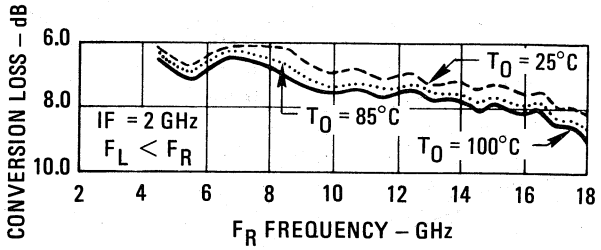


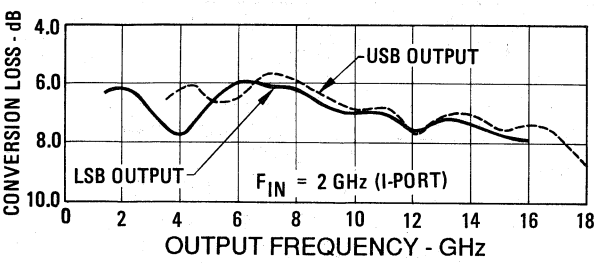

*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

# Typical Performance at 25°C*

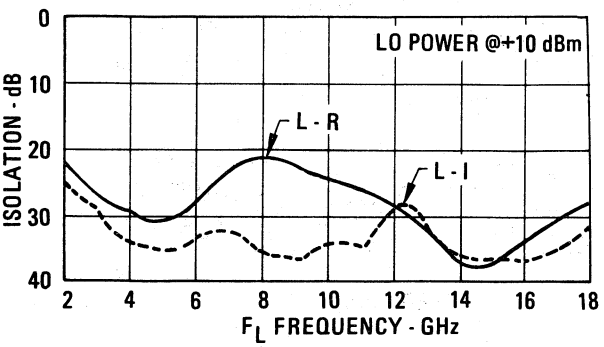
**Conversion Loss vs. Frequency and Temperature, LO Power @ +10 dBm**

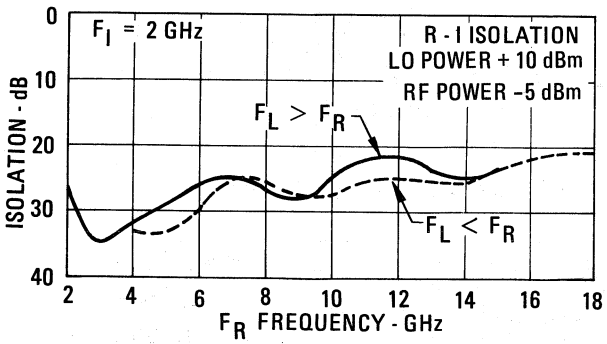



**Up Conversion Loss vs. Output Frequency LO Power @+10 dBm**




**Isolation vs. Frequency**

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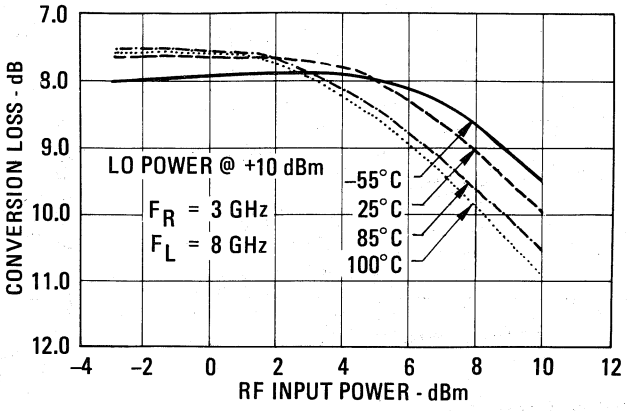
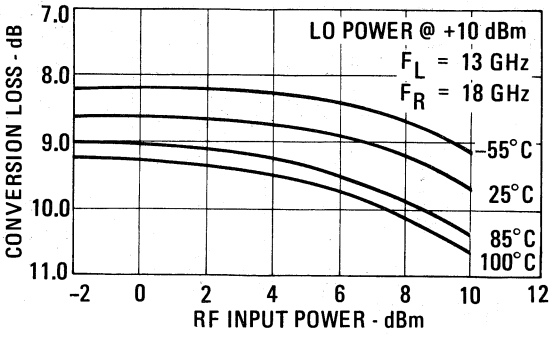
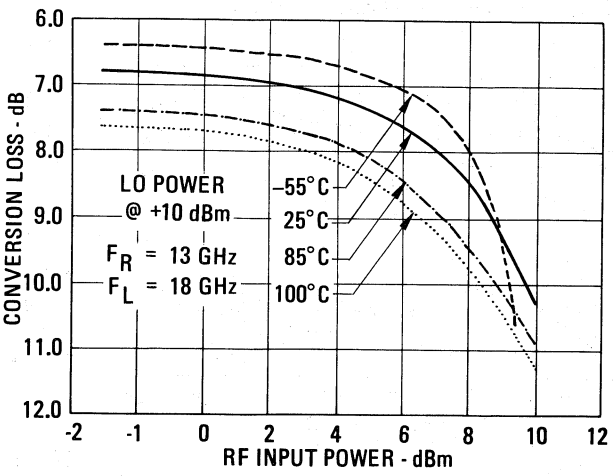
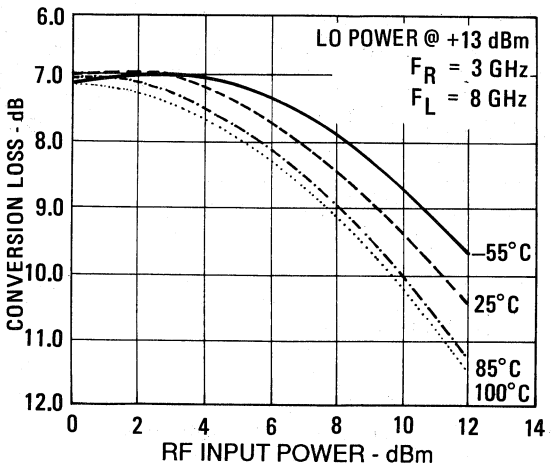
**Conversion Loss vs. Input Power and Temperature**

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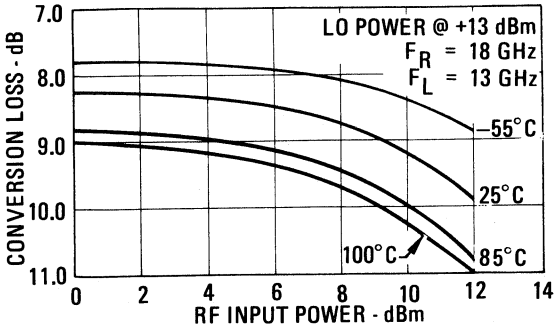
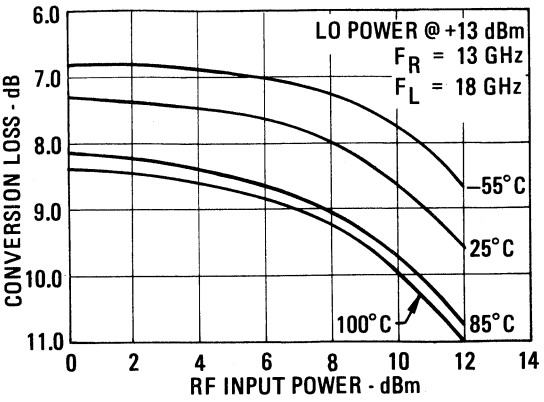
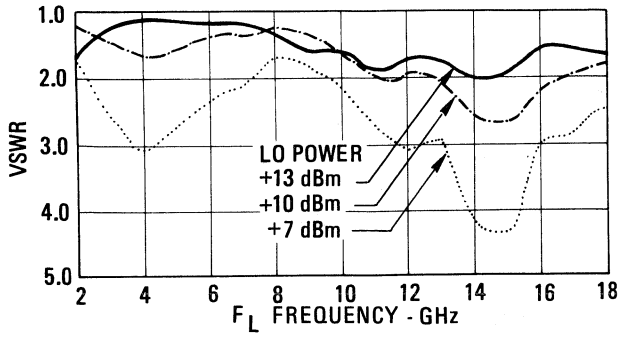
## Typical Performance at 25°C*

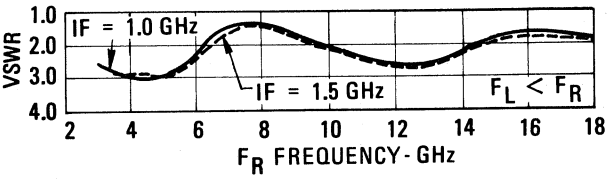
### Conversion Loss vs. Input Power and Temperature (cont.)

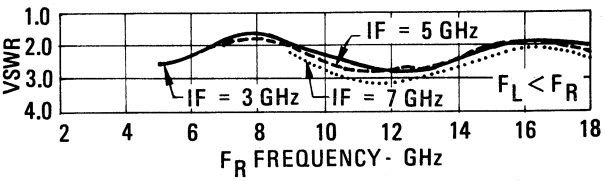


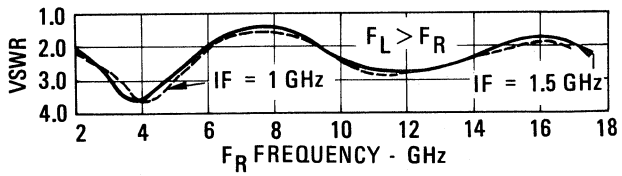

### L-Port VSWR vs. Frequency

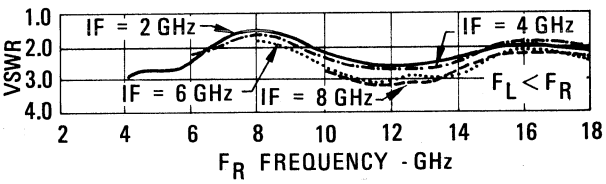


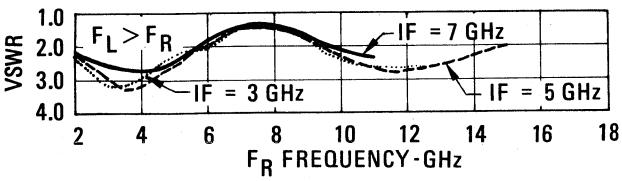



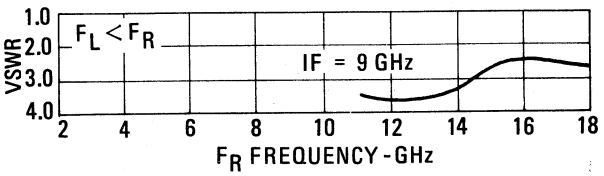



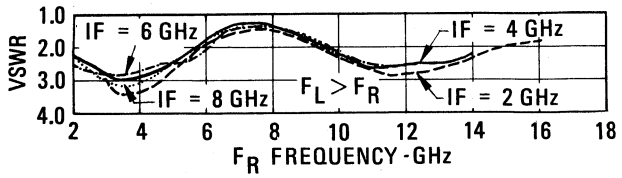

### R-Port VSWR vs. Frequency, LO Power @ +10 dBm



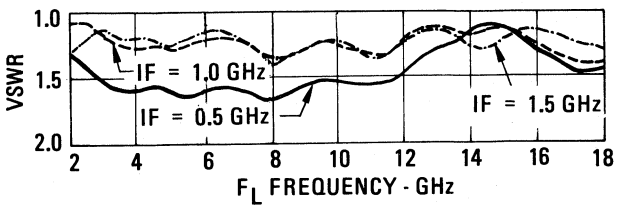



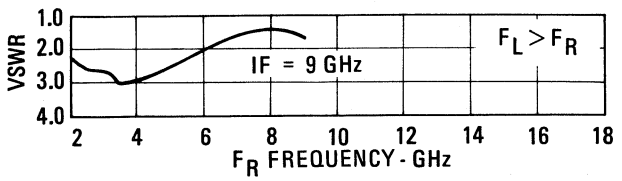



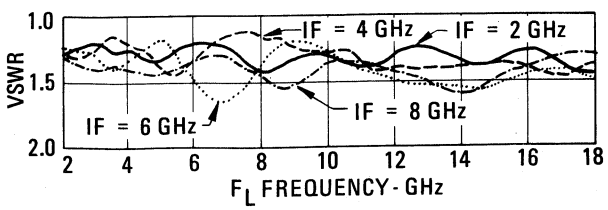




### I-Port VSWR vs. Frequency, LO Power @ +10 dBm




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

## Typical Performance at 25°C

| $f_L$ Characteristic Single Tone IM | Suppression (dB) Input 0 dBm | Input -5 dBm | Input -10 dBm | Test Conditions |
|---|---|---|---|---|
| $f_R$ $f_L$ | | | | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 2 GHz |
| 1 X 2 | 40.0 | 42.0 | 42.0 | $f_L$ = 4.1 GHz at |
| 2 X 2 | 42.0 | 49.0 | 54.0 | +10 dBm |
| 3 X 2 | 61.0 | 68.0 | >70.0 | |
| 3 X 1 | 42.0 | 52.0 | 62.0 | |
| 3 X 3 | 58.0 | 63.0 | 68.0 | |
| 4 X 1 | 77.0 | >80.0 | >80.0 | |
| 4 X 3 | 65.0 | 79.0 | >80.0 | |
| 4 X 4 | 63.0 | >68.0 | >70.0 | |
| 5 X 1 | 74.0 | >77.0 | >77.0 | |
| 5 X 2 | 72.0 | >76.0 | >76.0 | |
| 5 X 3 | 63.0 | >75.0 | >75.0 | |
| 5 X 4 | 75.0 | >75.0 | >75.0 | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 4.1 GHz |
| 1 X 3 | 18.0 | 18.0 | 18.0 | $f_L$ = 2.0 GHz at |
| 1 X 4 | 46.0 | 46.0 | 45.0 | +10 dBm |
| 1 X 5 | 35.0 | 40.0 | 41.0 | |
| 2 X 1 | 43.0 | 47.0 | 52.0 | |
| 2 X 2 | 44.0 | 46.0 | 51.0 | |
| 2 X 3 | 42.0 | 45.0 | 50.0 | |
| 2 X 5 | 41.0 | 44.0 | 44.0 | |
| 3 X 2 | 60.0 | >66.0 | >68.0 | |
| 3 X 3 | 56.0 | 67.0 | >67.0 | |
| 3 X 4 | 59.0 | 68.0 | >70.0 | |
| 3 X 5 | 57.0 | 62.0 | 67.0 | |
| 4 X 4 | 59.0 | >67.0 | >67.0 | |
| 4 X 5 | 63.0 | >69.0 | >69.0 | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 18 GHz |
| 1 X 2 | 30.0 | 30.0 | 29.0 | $f_L$ = 10.1 GHz at |
| 2 X 3 | 55.0 | 59.0 | 63.0 | +10 dBm |
| 2 X 4 | 43.0 | 48.0 | 52.0 | |
| 3 X 5 | 46.0 | 55.0 | 64.0 | |
| 1 x 1 | 0 | 0 | 0 | $f_R$ = 10.1 GHz |
| 2 X 1 | 44.0 | 49.0 | 55.0 | $F_L$ = 18 GHz at |
| 3 X 2 | 55.0 | 65.0 | >68.0 | +10 dBm |
| 4 X 2 | 59.0 | 74.0 | >76.0 | |
| 5 X 3 | 73.0 | >74.0 | >74.0 | |

| Characteristic Harmonics of $f_L$ | Output Power R- Port | I-Port | Test Conditions |
|---|---|---|---|
| $f_L$ | -12 dBm | -15 dBm | $f_L$ 2 GHz at +10 dBm |
| 2 $f_L$ | -22 dBm | -18 dBm | |
| 3 $f_L$ | -25 dBm | -24 dBm | |
| 4 $f_L$ | -31 dBm | -31 dBm | |
| 5 $f_L$ | -38 dBm | -31 dBm | |
| $f_L$ | -22 dBm | -28 dBm | $f_L$ 4.5 GHz at +10 dBm |
| 2 $f_L$ | -27 dBm | -25 dBm | |
| 3 $f_L$ | -41 dBm | | |
| 4 $f_L$ | -37 dBm | | |
| $f_L$ | -12 dBm | | $f_L$ 9 GHz at +10 dBm |
| 2 $f_L$ | -30 dBm | | |
| $f_L$ | -24 dBm | | $f_L$ 4 GHz at +10 dBm |
| 2 $f_L$ | -22 dBm | | |

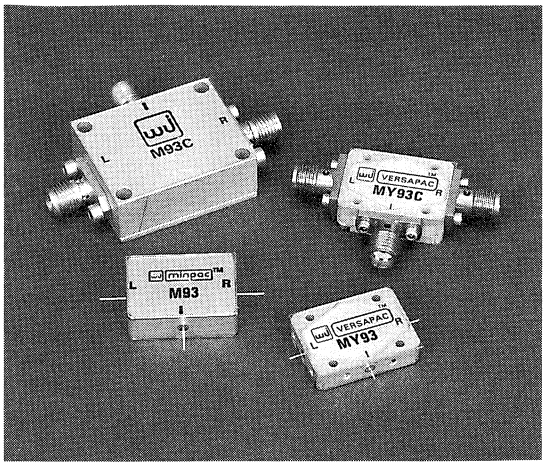
# Typical Performance at 25° C

LO Power =+10 dBm into L-Port
$f_{OUT}$ = 2 to 18 GHz at R-Port

| I-Port Input | (GHz) | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| fL (GHz) | | | | | | | | | | | |
| 2.0 | LSB | — | — | — | — | 6.91 | — | 7.29 | 6.48 | 7.60 | 10.02 |
| | USB | 6.60 | — | 6.92 | 6.64 | 6.40 | 6.74 | 7.03 | 7.95 | 8.88 | 9 76 |
| 2.5 | LSB | — | — | — | — | — | 7.01 | 7.42 | 7.25 | 7.75 | 8.32 |
| | USB | 7.04 | 6.23 | 6.31 | 6.84 | 6.30 | 6.65 | 7.34 | 7.43 | 8.78 | 9.78 |
| 3.0 | LSB | 6.04 | | | — | 6.27 | | 7.30 | 7.55 | — | 9.53 |
| | USB | 7.9 | 6.67 | — | 6.33 | 6.62 | 6.51 | 7.39 | 7.58 | 7.46 | 9.90 |
| 3.5 | LSB | 6.21 | — | — | — | — | 6.51 | — | 7.46 | 7.98 | 9.72 |
| | USB | 7.48 | 6.90 | 5.83 | 5.96 | 6.37 | 7.05 | 7.12 | 7.69 | 7.68 | 9.58 |
| 4.0 | LSB | 6.77 | 6.07 | — | — | — | 6.27 | 7.55 | — | 8.40 | 9.55 |
| | USB | 7.27 | 6.31 | 5.57 | — | 6.43 | 7.15 | 7.24 | 6.88 | 8.02 | 9.63 |
| 4.5 | LSB | 7.00 | 6.35 | — | — | — | — | 6.64 | 7.80 | — | 9.65 |
| | USB | 6.77 | 6.33 | 5.91 | 5.48 | 6.47 | 6.94 | 7.62 | 6.96 | 8.02 | 9.81 |
| 5.0 | LSB | 7.89 | 7.69 | 6.50 | — | — | — | 6.75 | 7.87 | 8.45 | — |
| | USB | 6.01 | 5.51 | 6.02 | 5.91 | — | 7.35 | 6.73 | 7.20 | 7.76 | 8.94 |
| 5.5 | LSB | 7.58 | 8.16 | 6.43 | — | — | — | — | 7.05 | 8.74 | 9.69 |
| | USB | 5.89 | 5.52 | 6.20 | 6.54 | 6.03 | 7.19 | 7.04 | 7.28 | 8.21 | 8.87 |
| 6.0 | LSB | 7.19 | 7.62 | 7.76 | 6.12 | — | — | — | 6.95 | 8.68 | 10.22 |
| | USB | 6.39 | 5.99 | 6.09 | 6.61 | 6.77 | — | 7.29 | 7.26 | 7.38 | 9.45 |
| 6.5 | LSB | 6.68 | 7.10 | 7.86 | 5.57 | — | — | — | — | 7.72 | 10.95 |
| | USB | 5.87 | 6.08 | 6.35 | 6.53 | 7.02 | 6.37 | 7.16 | 7.72 | 7.40 | 9.25 |
| 7.0 | LSB | 5.97 | 6.69 | 7.27 | 7.81 | 6.46 | — | — | — | 7.73 | 10.64 |
| | USB | 6.43 | 6.22 | 6.64 | 6.82 | 6.20 | 6.90 | — | 7.00 | 7.97 | 9.42 |
| 7.5 | LSB | 6.15 | 6.08 | 6.70 | 7.38 | 6.79 | — | — | — | — | 9.32 |
| | USB | 6.53 | 6.97 | 6.60 | 6.90 | 6.54 | 6.99 | 7.33 | 6.89 | 7.84 | 9.99 |
| 8.0 | LSB | 6.16 | 5.75 | 6.18 | 6.34 | 6.61 | 6.42 | — | — | — | 9.50 |
| | USB | 6.68 | 6.99 | 6.95 | 6.03 | 6.97 | 7.18 | 6.71 | — | 8.42 | 10.51 |
| 8.5 | LSB | 6.78 | 6.32 | 6.11 | 6.66 | 6.81 | 6.43 | — | — | — | — |
| | USB | 7.42 | 6.95 | 7.40 | 6.95 | 7.30 | 7.89 | 7.13 | 7.18 | 8.58 | — |
| 9.0 | LSB | 6.68 | 6.19 | 5.81 | 6.08 | 5.67 | 6.15 | 6.13 | — | — | — |
| | USB | 6.96 | 7.08 | 6.34 | 7.10 | 7.39 | 7.01 | 7.62 | 7.80 | — | — |
| 9.5 | LSB | 6.76 | 6.33 | 6.16 | 6.11 | 6.54 | 6.80 | 6.38 | | | |
| | USB | 7.25 | 7.72 | 7.12 | 7.32 | 7.64 | 7.08 | 7.66 | 8.21 | — | — |
| 10.0 | LSB | 6.62 | 6.38 | 6.15 | 5.94 | 6.30 | 5.88 | 6.34 | 5.89 | — | — |
| | USB | 7.50 | 6.46 | 7.22 | 7.39 | 6.89 | 7.56 | 8.09 | 8.88 | — | — |
| 10.5 | LSB | 7.29 | 6.74 | 6.34 | 6.05 | 6.41 | 6.85 | 7.15 | 6.41 | — | — |
| | USB | 7.97 | 7.07 | 7.59 | 7.67 | 7.08 | 7.45 | 8.08 | — | — | — |
| 11.0 | LSB | 7.30 | 6.65 | 6.66 | 6.14 | 6.10 | 6.57 | 6.41 | 6.71 | 6.46 | — |
| | USB | 6.50 | 7.20 | 7.36 | 6.92 | 7.51 | 7.84 | 8.62 | — | — | — |
| 11.5 | LSB | 7.66 | 7.41 | 6.89 | 6.58 | 6.37 | 6.64 | 7.33 | 7.69 | 7.13 | — |
| | USB | 7.30 | 7.70 | 7.81 | 7.32 | 7.53 | 8.13 | — | — | — | — |
| 12.0 | LSB | 7.62 | 7.25 | 6.82 | 6.71 | 6.26 | 6.17 | 6.75 | 6.43 | 7.33 | 7.97 |
| | USB | 7.39 | 7.29 | 6.94 | 7.51 | 7.86 | 8.66 | — | — | — | — |
| 12.5 | LSB | 7.89 | 7.28 | 7.54 | 7.01 | 6.64 | 6.39 | 6.79 | 7.38 | 8.01 | 8.40 |
| | USB | 7.63 | 7.72 | 7.34 | 7.48 | 8.19 | | | | — | — |
| 13.0 | LSB | 6.69 | 7.47 | 7.22 | 6.81 | 6.88 | 6.44 | 6.45 | 6.93 | 7.11 | 8.90 |
| | USB | 7.61 | 7.04 | 7.57 | 7.83 | 8.51 | — | — | — | — | — |
| 13.5 | LSB | 7.50 | 7.83 | 7.32 | 7.44 | 7.14 | 6.96 | 6.84 | 6.82 | 8.01 | 9.42 |
| | USB | 8.18 | 7.30 | 7.52 | 8.10 | — | — | — | — | — | — |
| 14.0 | LSB | 7.90 | 6.52 | 7.49 | 7.30 | 6.86 | 6.99 | 6.91 | 6.89 | 7.95 | 8.80 |
| | USB | 7.71 | 7.57 | 7.89 | 8.47 | — | — | — | — | — | — |
| 14.5 | LSB | 8.40 | 7.40 | 7.83 | 7.36 | 7.68 | 7.54 | 7.31 | 7.39 | 7.77 | 9.49 |
| | USB | 8.23 | 7.84 | 8.05 | — | — | — | — | — | — | — |
| 15.0 | LSB | 8.51 | 7.42 | 6.46 | 7.46 | 7.34 | 7.30 | 7.65 | 7.46 | 7.87 | 9.38 |
| | USB | 8.79 | 8.10 | 8.49 | — | — | — | ... | — | — | — |
| 15.5 | LSB | 8,93 | 7.84 | 7.28 | 7.78 | 7.54 | 7.80 | 7.99 | 7.39 | 7.91 | 9.29 |
| | USB | 9.11 | 8.35 | — | — | — | — | — | — | — | — |
| 16.0 | LSB | 8.27 | 7.60 | 7.30 | 6.47 | 7.76 | 7.74 | 7.82 | 7.90 | 7.94 | 9.55 |
| | USB | 9.49 | 8.80 | — | — | — | — | — | — | — | — |
| 16.5 | LSB | 9.09 | 7.98 | 7.71 | 7.36 | 7.85 | 7.74 | 7.92 | 7.83 | 7.77 | 9.01 |
| | USB | 10.18 | — | — | — | — | — | — | — | — | — |
| 17.0 | LSB | 9.19 | 7.20 | 7.48 | 7.48 | 6.73 | 7.96 | 8.06 | 7.53 | 8.39 | 9.13 |
| | USB | — | — | — | — | — | — | — | — | — | — |
| 17.5 | LSB | 9.63 | 7.74 | 8.21 | 7.77 | 7.55 | 7.97 | 7.82 | 8.00 | 8.15 | 9.13 |
| | USB | | | — | — | — | — | — | — | — | — |
| 18.0 | LSB | 9.62 | 7.83 | 7.23 | 7.59 | 7.52 | 6.88 | 7.93 | 8.09 | 8.02 | 9.78 |
| USB | — | — | — | — | — | — | — | — | — | — | |

# WJ-M93/M93C
# WJ-MY93/MY93C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- LO, RF } 2 TO 18 GHz
- IF 0.03 TO 4 GHz
- LO DRIVE +10 dBm (nominal)
- WIDE BANDWIDTH

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

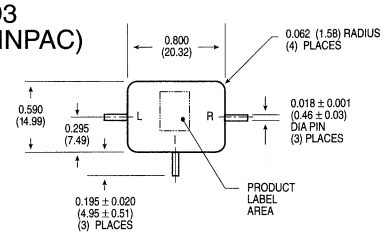
## Guaranteed Specifications[1]

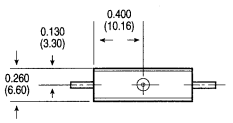
| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB<br><br><br>8.0 dB | 10.0 dB<br><br><br>11.0 dB | $f_R$ 2 - 10 GHz<br>$f_L$ 2 - 14 GHz<br>$f_I$ 0.03 - 4 GHz<br>$f_R$ = 10 - 18 GHz<br>$f_L$ 6 - 18 GHz<br>$f_I$ 0.03 - 4 GHz |
| Isolation<br>L to R<br>L to I | <br>15 dB<br>16 dB | <br>29 dB<br>34 dB | | <br>$f_L$ 2 - 18 GHz<br>$f_L$ 2 - 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ level = +4 dBm<br>$f_L$ level = +10 dBm |
| Third-Order Input Intercept Point | | <br><br><br>+14 dBm<br><br><br><br><br>+18 dBm | | $f_{R_1}$ = 6.00 GHz<br>$f_{R_2}$ = 6.01 GHz<br>both at -6 dBm<br>$f_L$ = 8.0 GHz at +10 dBm<br><br>$f_{R_1}$ = 15.00 GHz<br>$f_{R_2}$ = 15.01 GHz<br>both at -6 dBm<br>$f_L$ = 18.0 GHz at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Outline Drawings

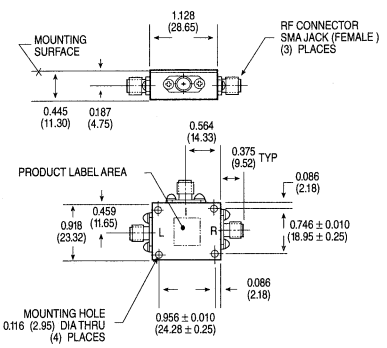
M93
(MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

M93C
(CONNECTORIZED)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

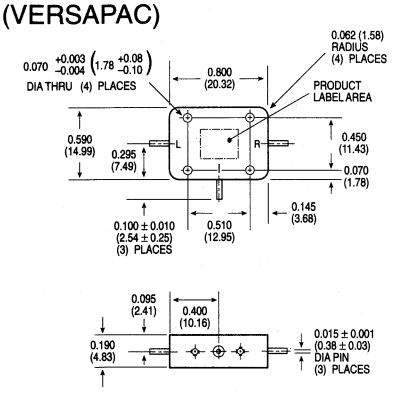
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C

Weight M93: 12 grams (0.42 oz.) max. MY93: 7.9 grams (0.28 oz.) max.
M93C: 40 grams (1.41 oz.) max. MY93C: 20.0 grams (0.70 oz.) max.

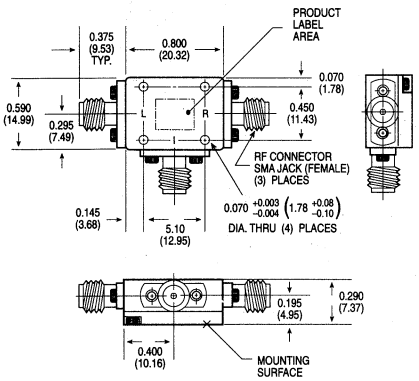
## Outline Drawings

### MY93 (VERSAPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

### MY93C (CONNECTORIZED)

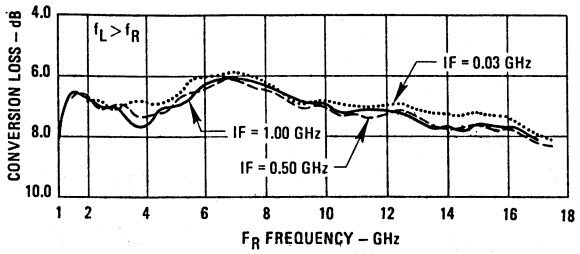


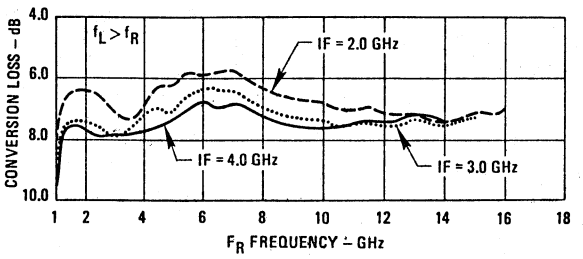

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

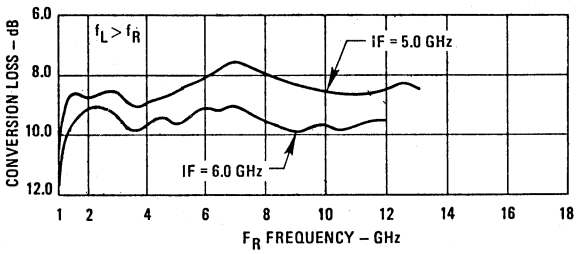
## Typical Performance at 25°C

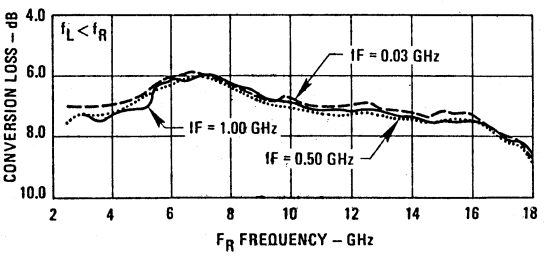
*Drive Level:* The maximum recommended drive level is +16 dBm. This upper level has been established by the desire to avoid a serious increase in noise figure and a loss of isolation. Operation at +16 dBm is rcommended to achieve best two-tone performance and best suppression of the intermodulation products.

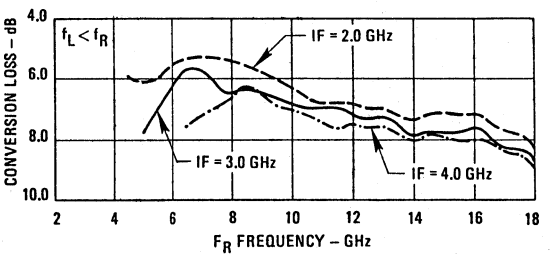
**Conversion Loss vs. Frequency, LO Power @ +10 dBm**

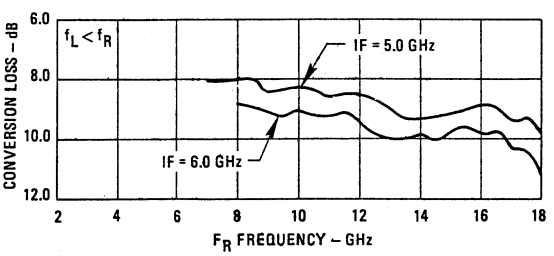



*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

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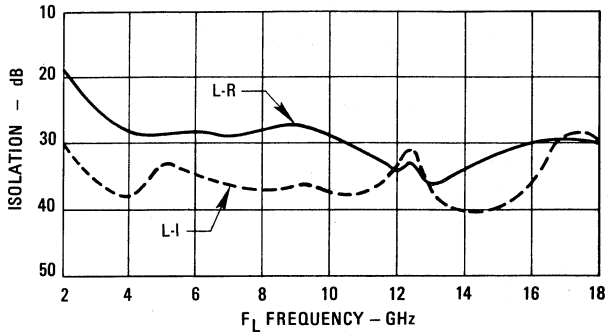
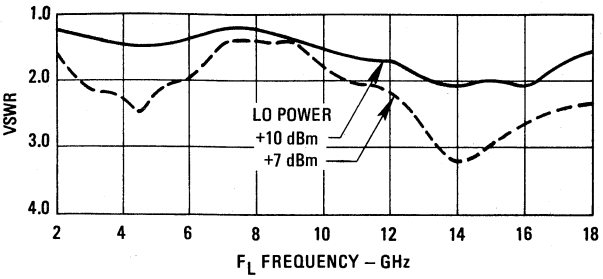
# Typical Performance at 25°C

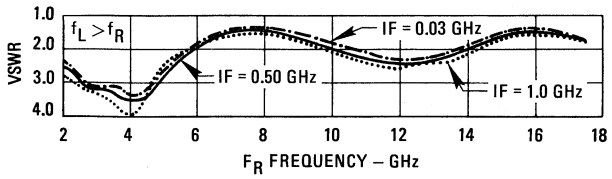
### Isolation vs. Frequency, LO Power @ +10 dBm

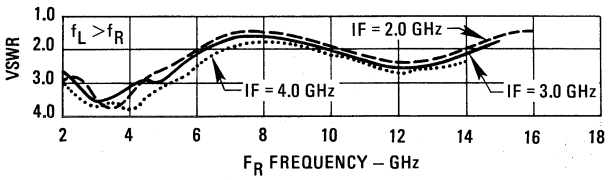


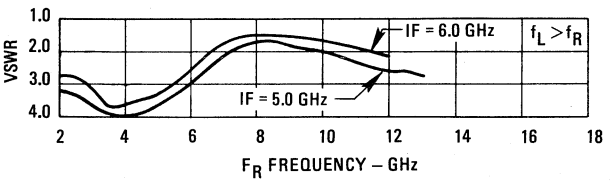

### L-Port VSWR vs. Frequency

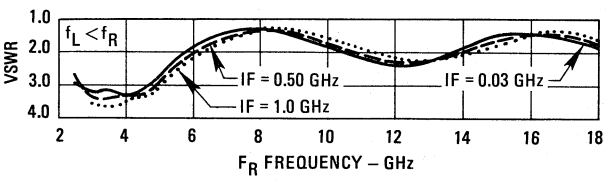


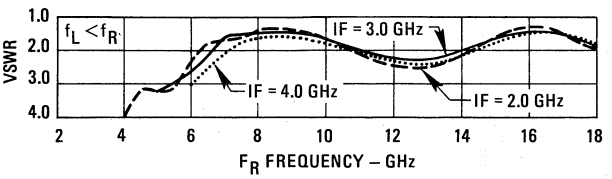

### R-Port VSWR vs. Frequency, LO Power @ +10 dBm

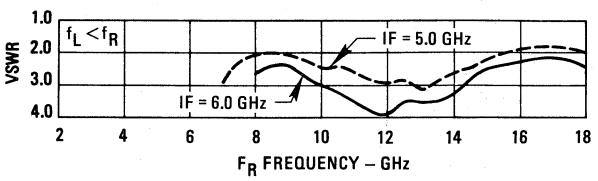


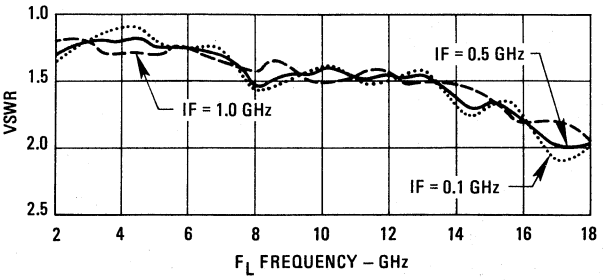



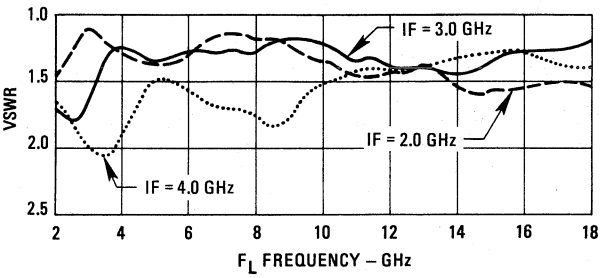



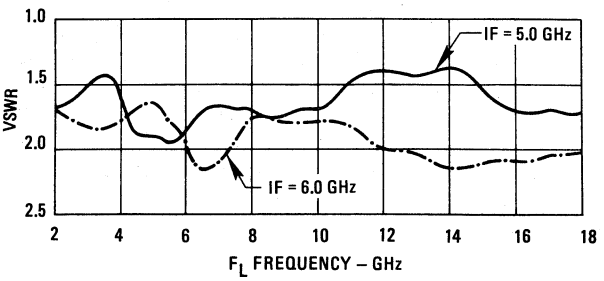




### I-Port VSWR vs. Frequency, LO Power @ +10 dBm



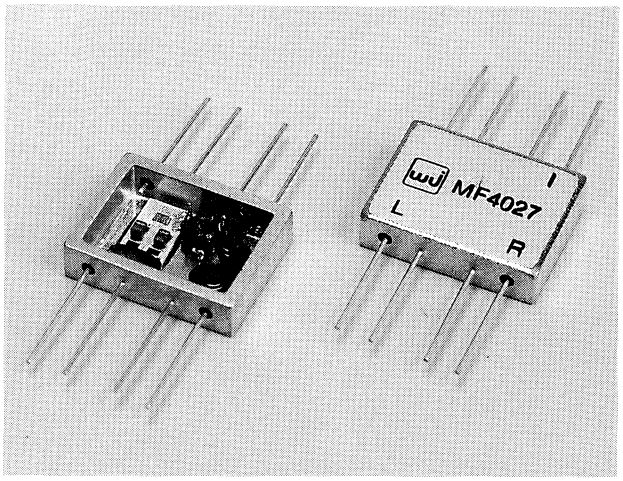




*Typical performance applies to the MINPAC™ model and does not necessarily reflect the performance of the VERSAPAC® model.

# WJ-MF4027

## HIGH DYNAMIC RANGE FET MIXER




- ◆ LO: 10 to 1000 MHz
- ◆ RF: 10 to 1000 MHz
- ◆ IF: 10 to 300 MHz
- ◆ LO DRIVE: +27 dBm (nominal)
- ◆ HIGH INTERCEPT POINT: +36 dBm (TYP.)
- ◆ HERMETICALLY-SEALED
- ◆ USES WJ GaAs MMIC TECHNOLOGY

*MIL-M-28837 Screening Available (See "QPL Mixers" Section)

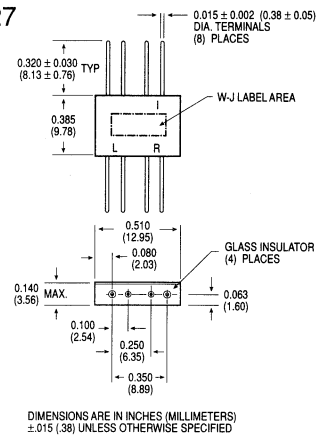
## Specifications*

| Characteristics | Typical | Guaranteed +25°C | Guaranteed -54°C to +85°C |
|---|---|---|---|
| Frequency Range (Min.) | | | |
| LO | | 10 to 1000 MHz | 10 to 1000 MHz |
| RF | | 10 to 1000 MHz | 10 to 1000 MHz |
| IF | | 10 to 300 MHz | 10 to 300 MHz |
| SSB Conversion Loss (Max.) | 7.0 dB | 9.0 dB | 10.0 dB |
| SSB Noise Figure | 10.0 dB | | |
| Second Order Input Intercept Point | +60 dBm | | |
| Third Order Input Intercept Point | +36 dBm | | |
| Port-to-Port Isolation (Min.) | | | |
| L-R | 25 dB | 19 dB | 18 dB |
| L-I | 38 dB | 32 dB | 28 dB |
| VSWR | | | |
| L-Port | 3.0:1 | | |
| R-Port | 2.0:1 | | |
| I-Port | 1.8:1 | | |

* Measured in a 50-ohm system with nominal LO drive and downconverter application only unless otherwise specified.

## Outline Drawings

MF4027




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

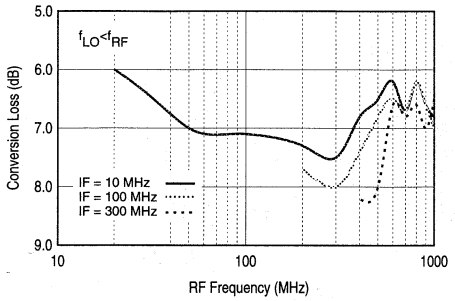
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +85°C
Storage Temperature .....-65°C to +100°C
Pin Temperature .....+260°C for 10 Seconds

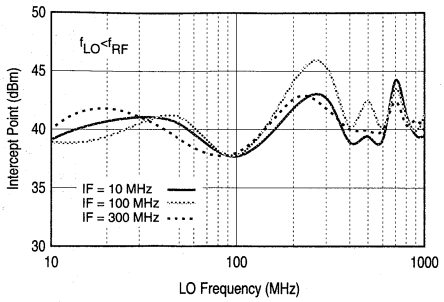
Weight: 2.0 Grams

# Typical Performance at 25°C

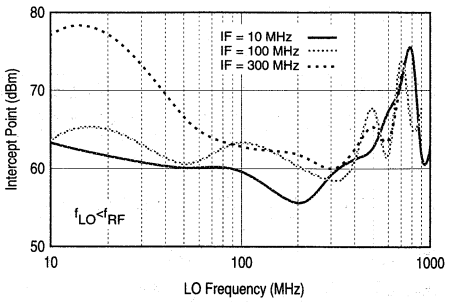
### Conversion Loss vs. Frequency



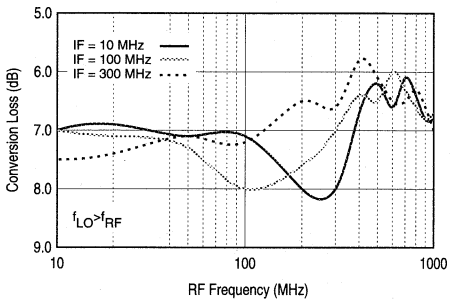

### 3IIP vs. Frequency



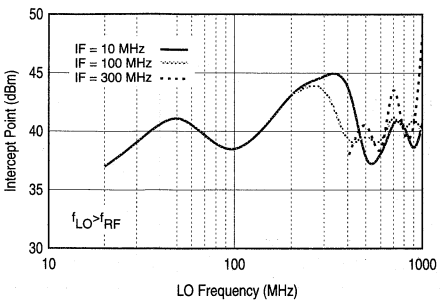

### 2IIP vs. Frequency



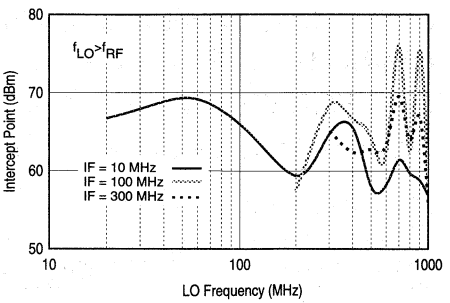

### Conversion Loss vs. Frequency



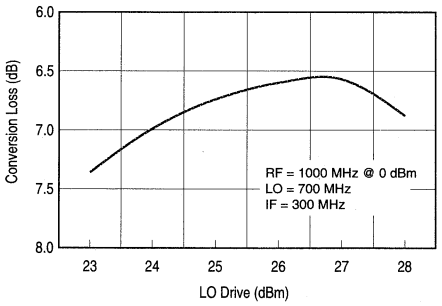

### 3IIP vs. Frequency



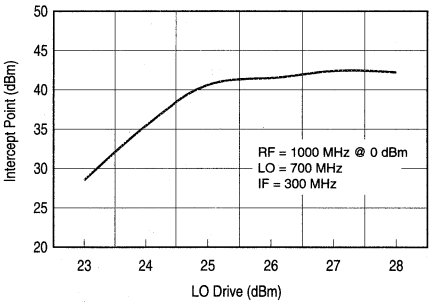

### 2IIP vs. Frequency



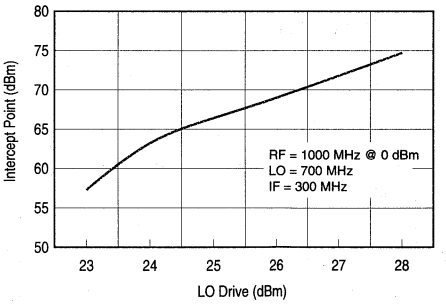

### Conversion Loss vs. LO Drive



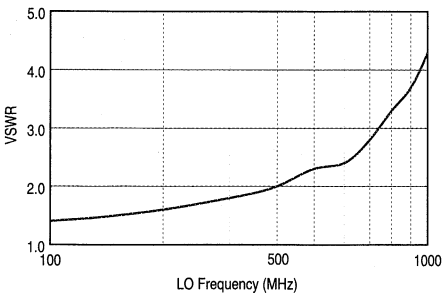

### 3IIP vs. LO Drive



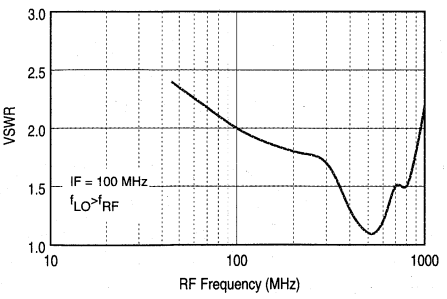

### 2IIP vs. LO Drive



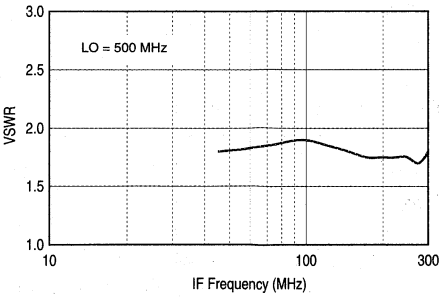

### L-Port VSWR vs. Frequency



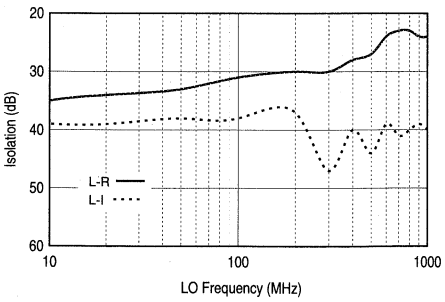

### R-Port VSWR vs. Frequency



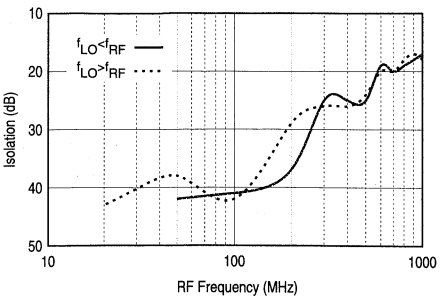

### I-Port VSWR vs. Frequency




### Isolation vs. Frequency




### Isolation (R-I) vs. Frequency




### Single-Tone IM Products Table

| Harmonics of $f_{RF}$ | Harmonics of $f_{LO}$ 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 18 | 27 | 21 | 33 | 30 | 29 | 24 | 35 | 44 | 34 |
| 8 | 31 | 33 | 33 | 25 | 34 | 40 | 35 | 31 | 35 | 37 |
| 7 | 67 | 64 | 64 | 70 | 71 | 67 | 65 | 66 | 69 | 71 |
| 6 | 91 | 81 | 89 | 82 | 86 | 84 | 86 | 80 | 83 | 87 |
| 5 | 99 | 101 | 103 | 104 | 103 | 106 | 100 | 104 | 101 | 105 |
| 4 | 102 | 102 | 105 | 105 | 103 | 102 | 106 | 105 | 100 | 107 |
| 3 | 88 | 86 | 99 | 81 | 91 | 84 | 94 | 82 | 89 | 82 |
| 2 | 63 | 63 | 76 | 65 | 66 | 65 | 70 | 65 | 65 | 70 |
| 1 | 34 | 0 | 32 | 12 | 32 | 14 | 32 | 27 | 33 | 20 |
| 0 | | 3 | 16 | 16 | 14 | 24 | 12 | 31 | 27 | 23 |

$f_{RF}$ = 100 MHz at 0 dBm. Mixing products are indicated by the number of dB below $f_{LO} \pm f_{RF}$ output.
$f_{LO}$ = 90 MHz at +27 dBm.

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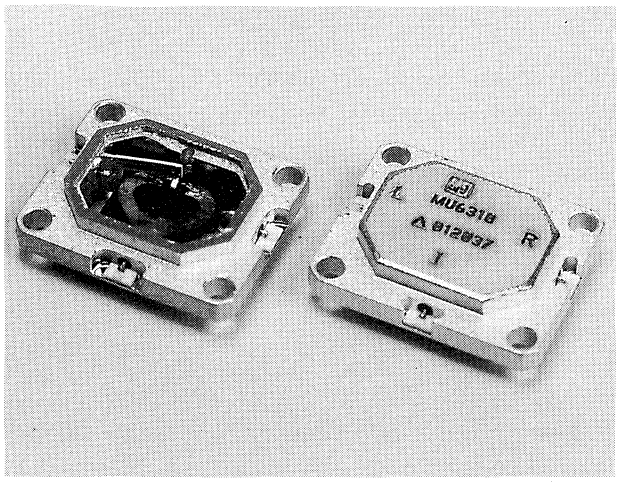
# WJ-MU6310

## MICROSTRIP COMPATIBLE DOUBLE-BALANCED MIXER




- ◆ MICROSTRIP INTERFACE
- ◆ LO: 2.5 to 7.0 GHz
- ◆ RF: 2.5 to 5.5 GHz
- ◆ IF: DC to 1.5 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ INTEGRATED MOUNTING HOLES

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Specifications*

| Characteristics | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.5 dB | $f_R$ 3.0 to 5.5 GHz<br>$f_L$ 2.5 to 7.0 GHz<br>$f_I$ DC to 1.5 GHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 2.5 to 3.0 GHz<br>$f_L$ 2.5 to 4.5 GHz<br>$f_I$ DC to 1.5 GHz |
| Isolation | | | | |
| L-R | 20 dB | 28 dB | | $f_L$ 2.5 to 4.0 GHz |
| | 32 dB | 45 dB | | $f_L$ 4.0 to 7.0 GHz |
| L-I | 12 dB | 16 dB | | $f_L$ 2.5 to 3.5 GHz |
| | 22 dB | 30 dB | | $f_L$ 3.5 to 7.0 GHz |
| R-I | 12 dB | 16 dB | | $f_L$ 2.5 to 3.5 GHz |
| | 14 dB | 18 dB | | $f_L$ 3.5 to 7.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm |
| Third Order Intercept Point | | +15 dBm | | $f_{R1}$ 4.00 GHz at -10 dBm<br>$f_{R2}$ 4.01 GHz at -10 dBm<br>$f_L$ 2.8 GHz at +10 dBm |

* Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.
Notes:
The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications; I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

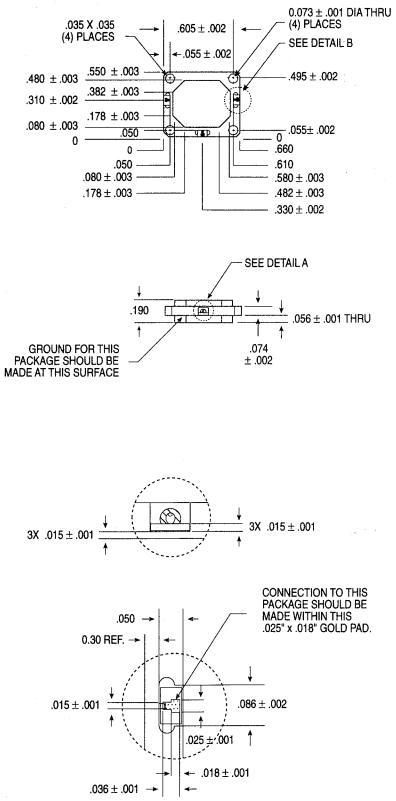
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm at 25°C, +20 dBm at 100°C

Weight: 3.5 grams (0.11 oz.)

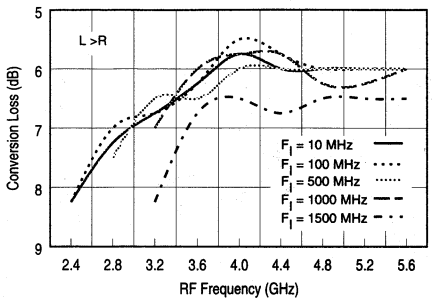
## Outline Drawings

MU6310

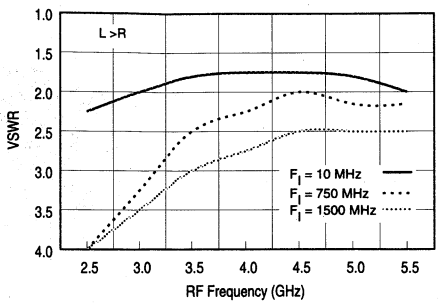


# Typical Performance at 25°C

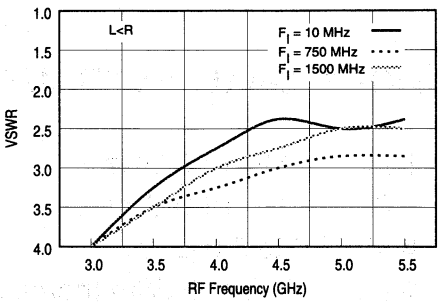
### Conversion Loss vs. Frequency



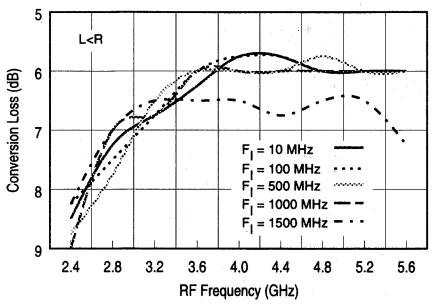

### R-Port VSWR vs. Frequency



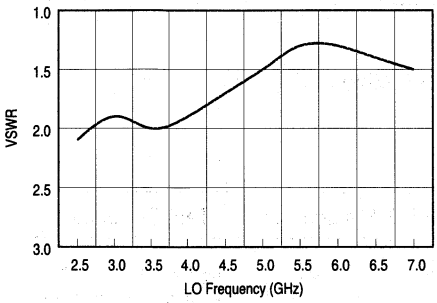

### R-Port VSWR vs. Frequency



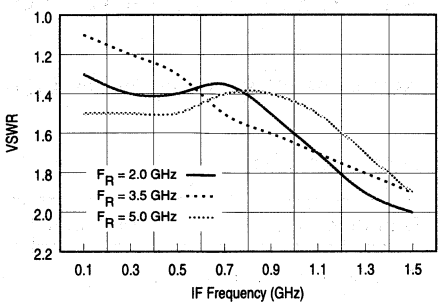

### Conversion Loss vs. Frequency



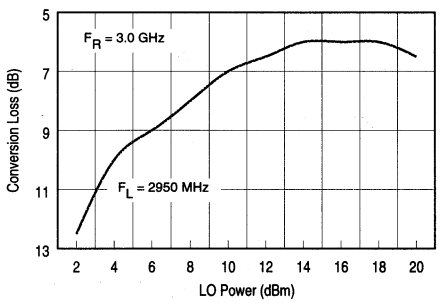

### L-Port VSWR vs. Frequency



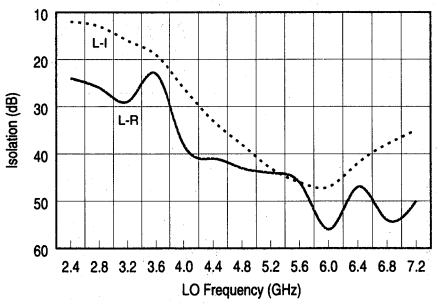

### I-Port VSWR vs. Frequency



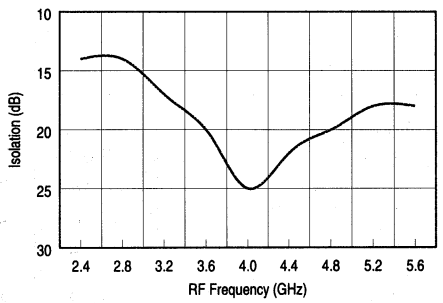

### Conversion Loss vs. LO Power




### Isolation vs. Frequency




### Isolation (R-I) vs. Frequency

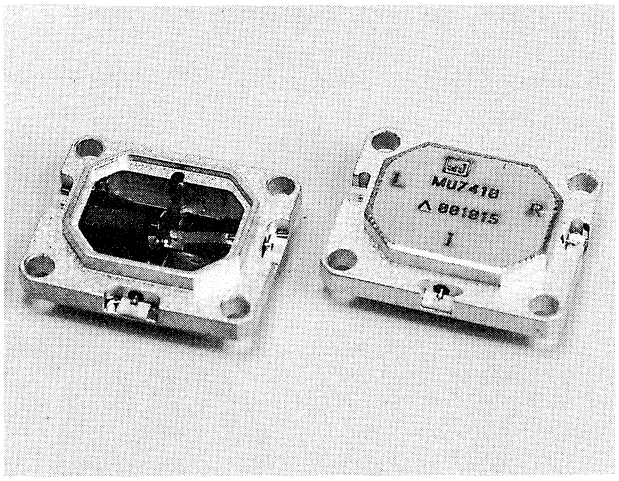



10

# WJ-MU7410

## DOUBLE-BALANCED MIXER

- LO: 4.0 to 18.0 GHz
- RF: 6.0 to 18.0 GHz
- IF: DC to 3.0 GHz
- LO DRIVE +10 dBm (nominal)
- MICROSTRIP INTERFACE
- INTEGRATED MOUNTING HOLES




*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Specifications*

| Characteristics | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 8.5 dB | $f_R$ 6.0 to 15.0 GHz<br>$f_L$ 4.0 to 16.0 GHz<br>$f_I$ 0.03 to 3.0 GHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 14.0 to 18.0 GHz<br>$f_L$ 12.0 to 18.0 GHz<br>$f_I$ 0.03 to 3.0 GHz |
| Isolation | | | | |
| L-R | 28 dB | 38 dB | | $f_L$ 4.0 to 16.0 GHz |
| | 24 dB | 30 dB | | $f_L$ 16.0 to 18.0 GHz |
| L-I | 20 dB | 26 dB | | $f_L$ 4.0 to 6.0 GHz |
| | 25 dB | 32 dB | | $f_L$ 6.0 to 18.0 GHz |
| R-I | 15 dB | 20 dB | | $f_R$ 4.0 to 8.0 GHz |
| | 19 dB | 24 dB | | $f_R$ 8.0 to 18.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm |
| Third Order Intercept Point | | +13 dBm | | $f_{R1}$ 13.00 GHz at -6 dBm<br>$f_{R2}$ 13.01 GHz at -6 dBm<br>$f_L$ 14.0 GHz at +10 dBm |

* Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.
Notes:
The I-Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications; I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

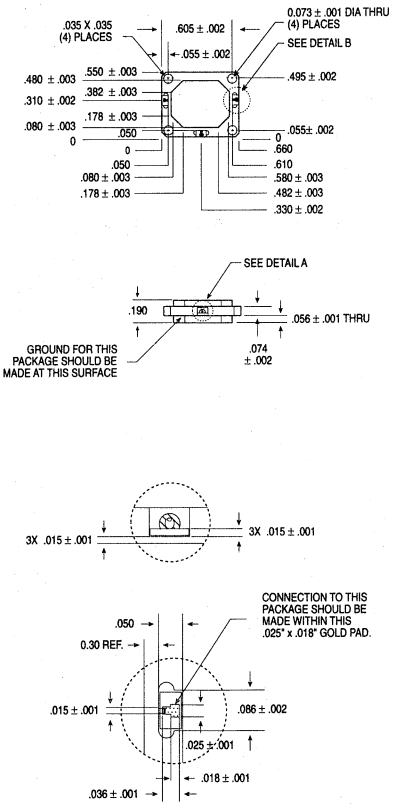
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm at 25°C,+ 20 dBm at 100°C

Weight: 3.5 grams (0.11 oz.)

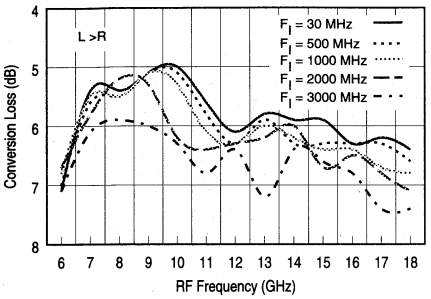
## Outline Drawings

MU7410

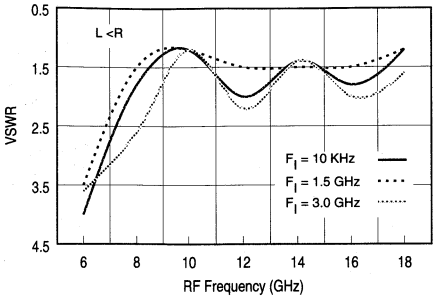


# Typical Performance at 25°C

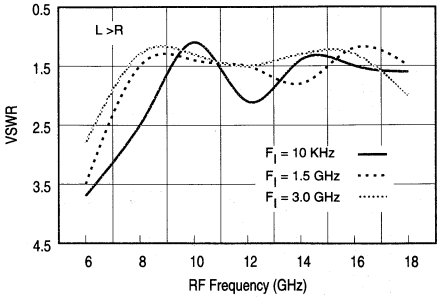
### Conversion Loss vs. Frequency



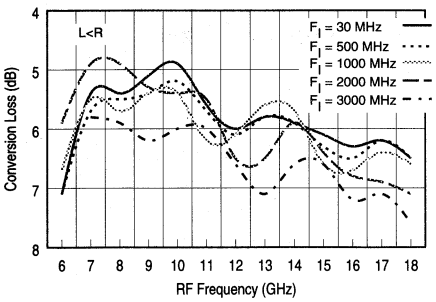

### R-Port VSWR vs. Frequency



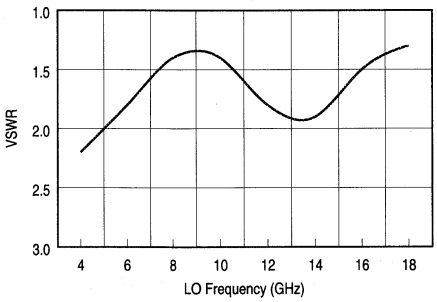

### R-Port VSWR vs. Frequency



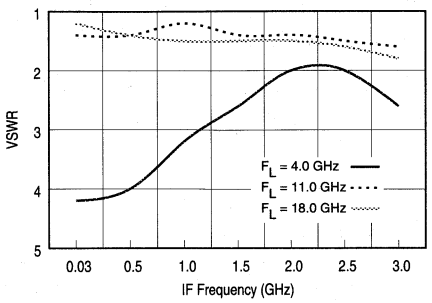

### Conversion Loss vs. Frequency



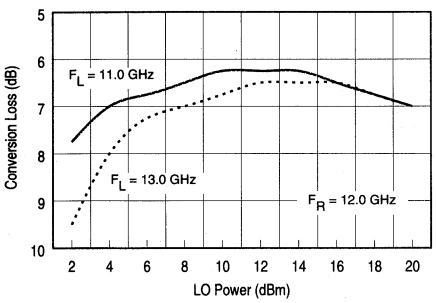

### L-Port VSWR vs. Frequency



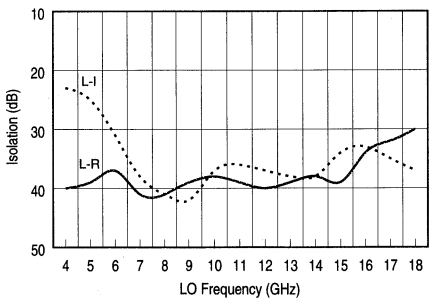

### I-Port VSWR vs. Frequency



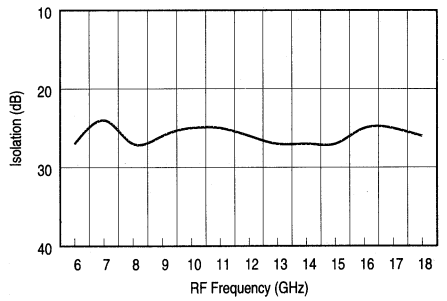

### Conversion Loss vs. LO Power




### Isolation vs. Frequency




### Isolation (R-I) vs. Frequency

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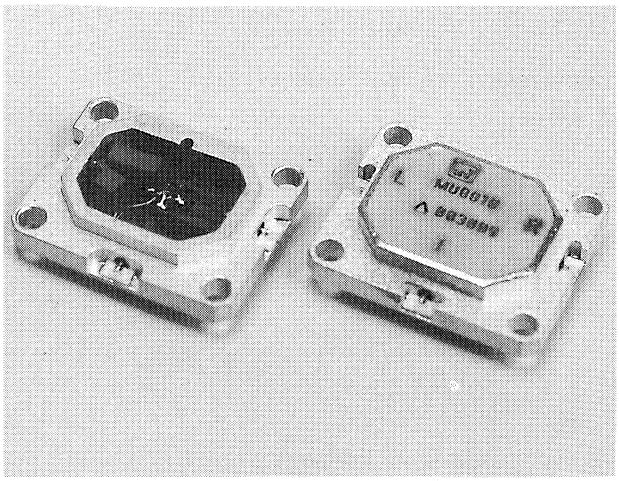
# WJ-MU8810

## TRIPLE-BALANCED MIXER (DOUBLE-DOUBLE)



- ◆ MICROSTRIP INTERFACE
- ◆ LO: 2.0 to 18.0 GHz
- ◆ RF: 2.0 to 18.0 GHz
- ◆ IF: 1.0 to 8.0 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ INTEGRATED MOUNTING HOLES

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

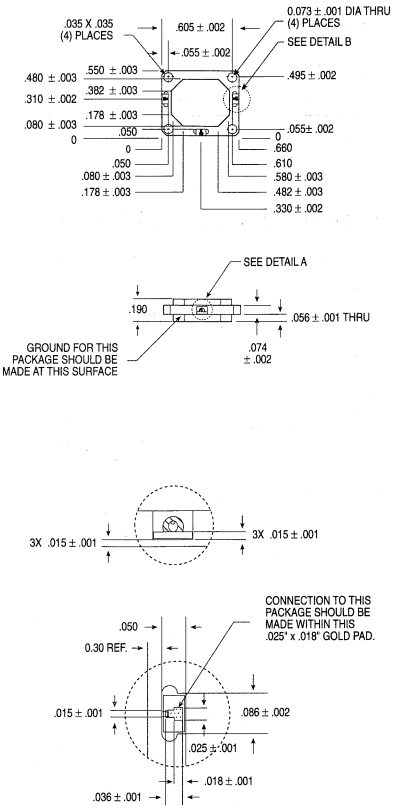
## Specifications*

| Characteristics | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 9.0 dB | $f_R$ 3.0 to 10.0 GHz<br>$f_L$ 2.0 to 15.0 GHz<br>$f_I$ 1.0 to 5.0 GHz |
| | | 8.0 dB | 10.5 dB | $f_R$ 2.0 to 18.0 GHz<br>$f_L$ 2.0 to 18.0 GHz<br>$f_I$ 1.0 to 8.0 GHz |
| Isolation | | | | |
| L-R | 15 dB | 25 dB | | $f_L$ 2.0 to 18.0 GHz |
| L-I | 16 dB | 28 dB | | $f_L$ 2.0 to 18.0 GHz |
| R-I | 14 dB | 24 dB | | $f_L$ 2.0 to 18.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +5 dBm |
| Third Order Intercept Point | | +16 dBm | | $f_{R1}$ 3.00 GHz at -10 dBm<br>$f_{R2}$ 3.01 GHz at -10 dBm<br>$f_L$ 5.0 GHz at +10 dBm |
| | | +14 dBm | | $f_{R1}$ 17.99 GHz at -10 dBm<br>$f_{R2}$ 18.00 GHz at -10 dBm<br>$f_L$ 14.0 GHz at +10 dBm |

* Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Outline Drawings

MU8810



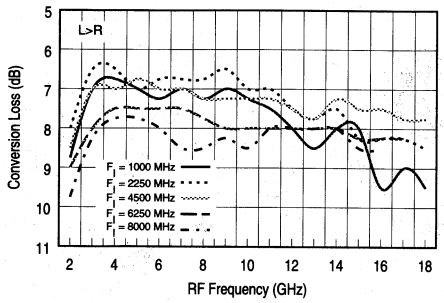

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm at 25°C, +23 dBm at 100°C

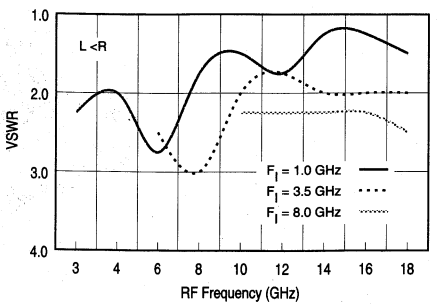
Weight: 3.5 grams (0.11 oz.)

# Typical Performance at 25°C

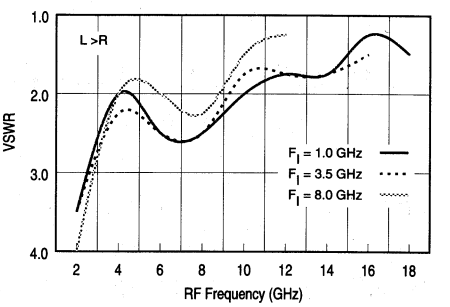
### Conversion Loss vs. Frequency



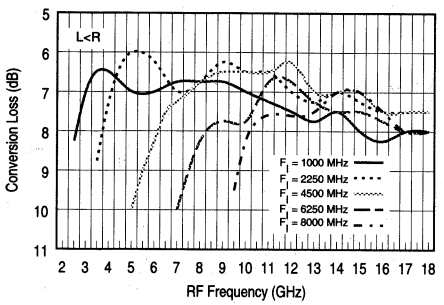

### R-Port VSWR vs. Frequency



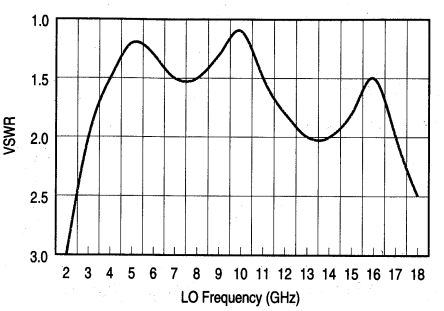

### R-Port VSWR vs. Frequency



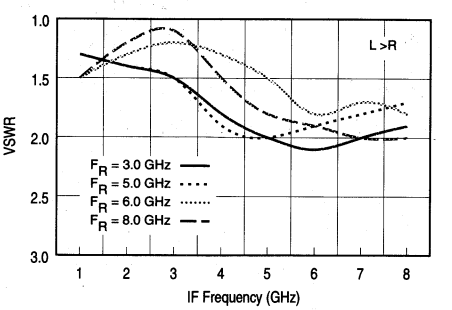

### Conversion Loss vs. Frequency



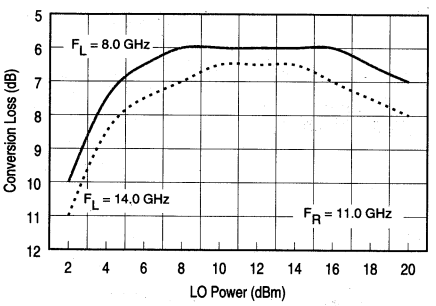

### L-Port VSWR vs. Frequency



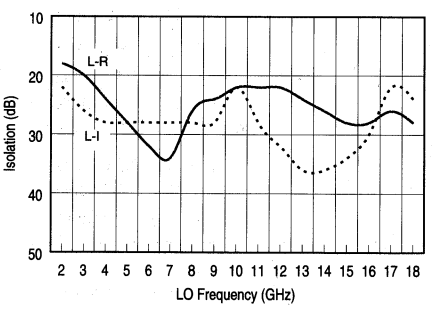

### I-Port VSWR vs. Frequency



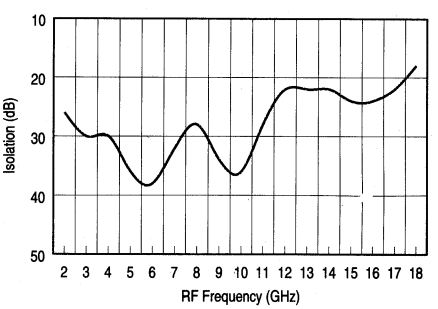

### Conversion Loss vs. LO Power




### Isolation vs. Frequency




### Isolation (R-I) vs. Frequency

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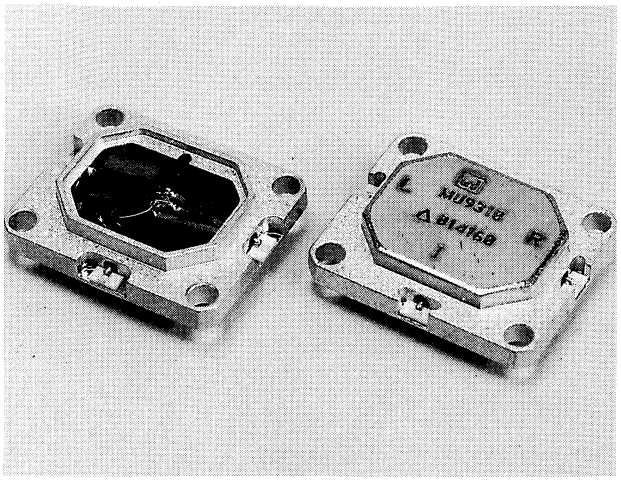
# WJ-MU9310

## TRIPLE-BALANCED MIXER (DOUBLE-DOUBLE)

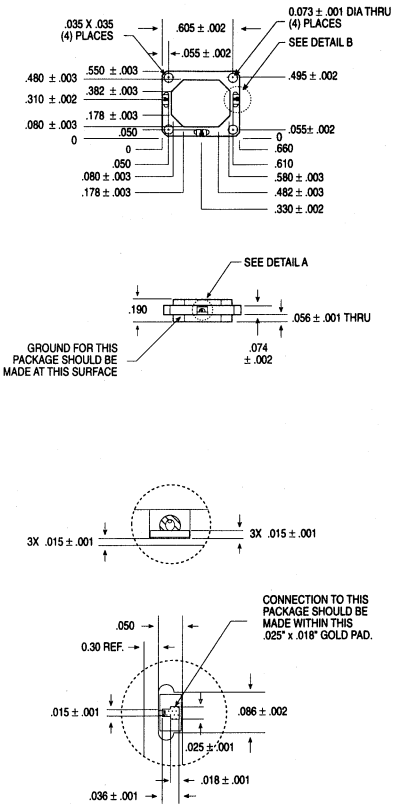
- ◆ MICROSTRIP INTERFACE
- ◆ LO: 2.0 to 18.0 GHz
- ◆ RF: 2.0 to 18.0 GHz
- ◆ IF: 0.03 to 5.0 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ INTEGRATED MOUNTING HOLES

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)



## Outline Drawings

MU9310




## Specifications*

| Characteristics | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 8.5 dB | $f_R$ 4.0 to 18.0 GHz<br>$f_L$ 4.0 to 18.0 GHz<br>$f_I$ 0.03 to 1.0 GHz |
| | | 7.5 dB | 9.5 dB | $f_R$ 3.0 to 18.0 GHz<br>$f_L$ 3.0 to 18.0 GHz<br>$f_I$ 0.03 to 2.0 GHz<br>$f_I$ 0.03 to 3.0 GHz $f_L<f_R$ |
| | | 8.5 dB | 10.5 dB | $f_R$ 2.0 to 18.0 GHz<br>$f_L$ 2.0 to 18.0 GHz<br>$f_I$ 0.03 to 5.0 GHz |
| Isolation | | | | |
| L-R | 12 dB<br>16 dB | 20 dB<br>25 dB | | $f_L$ 2.0 to 4.0 GHz<br>$f_L$ 4.0 to 18.0 GHz |
| L-I | 18 dB | 28 dB | | $f_L$ 2.0 to 18.0 GHz |
| R-I | 17 dB | 26 dB | | $f_L$ 2.0 to 18.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +5 dBm |
| Third Order Intercept Point | | +15 dBm | | $f_{R1}$ 3.00 GHz at -10 dBm<br>$f_{R2}$ 3.01 GHz at -10 dBm<br>$f_L$ 5.0 GHz at +10 dBm |
| | | +13.5 dBm | | $f_{R1}$ 17.99 GHz at -10 dBm<br>$f_{R2}$ 18.00 GHz at -10 dBm<br>$f_L$ 14.0 GHz at +10 dBm |

* Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

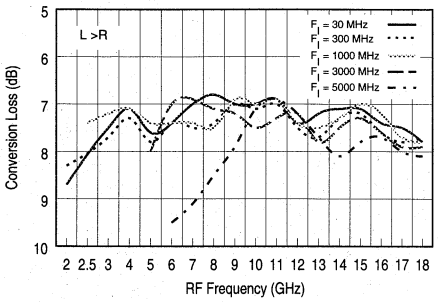
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm at 25°C, +23 dBm at 100°C

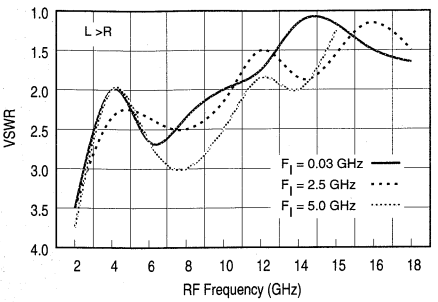
Weight: 3.5 grams (0.11 oz.).

# Typical Performance at 25°C

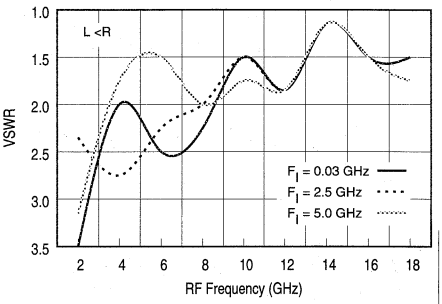
### Conversion Loss vs. Frequency



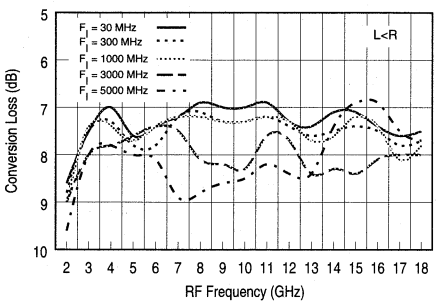

### R-Port VSWR vs. Frequency



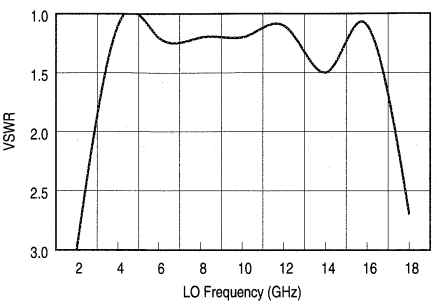

### R-Port VSWR vs. Frequency



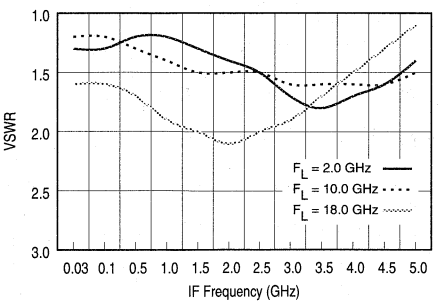

### Conversion Loss vs. Frequency



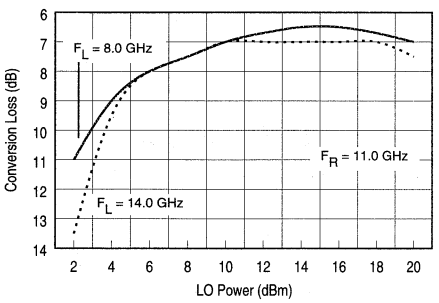

### L-Port VSWR vs. Frequency



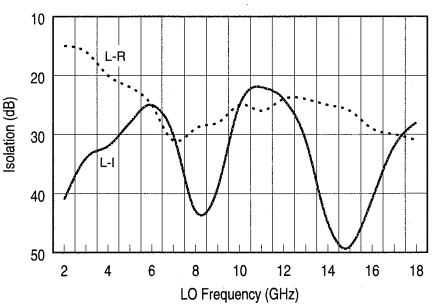

### I-Port VSWR vs. Frequency



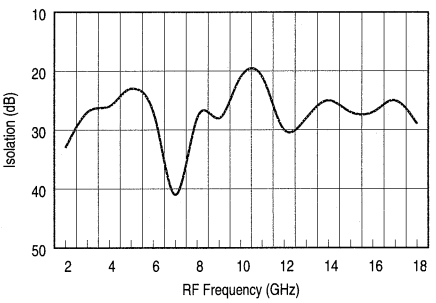

### Conversion Loss vs. LO Power




### Isolation vs. Frequency




### Isolation (R-I) vs. Frequency

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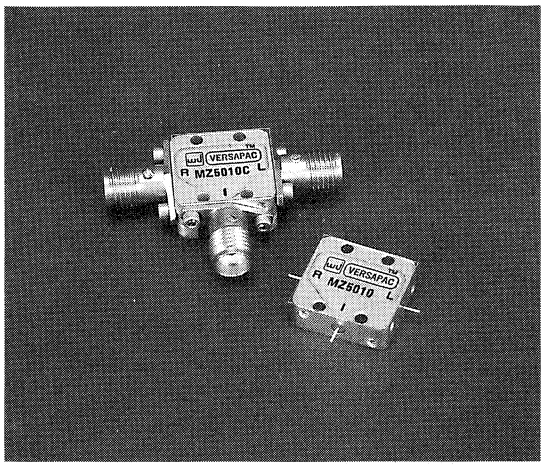
# WJ-MZ5010/ MZ5010C




## TRIPLE BALANCED (DOUBLE-DOUBLE) MIXER

- ◆ LO, RF } 2.0 TO 26.0 GHz
- ◆ IF 1.0 TO 15.0 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ VERY WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.5 dB | 9.5 dB | $f_R$ 3 to 18 GHz<br>$f_L$ 3.5 to 18 GHz<br>$f_I$ 4 to 12 GHz |
| | | 8.5 dB | 10.5 dB | $f_R$ 2.5 to 26 GHz<br>$f_L$ 2.5 to 24 GHz<br>$f_I$ 4 to 12 GHz<br>1to15 $f_L < f_R$ |
| | | 10.5 dB | 13.0 dB | $f_R$ 2 to 26 GHz<br>$f_L$ 2 to 26 GHz<br>$f_I$ 1 to 12 GHz<br>1 to 15 $f_L > f_R$ |
| Isolation | | | | |
| L - R | 15 dB | 30 | | $f_L$ 2 to 4 GHz |
| | 18 dB | 35 | | $f_L$ 4 to 26 GHz |
| L - I | 12 dB | 20 | | $f_L$ 2 to 4 GHz |
| | 17 dB | 35 | | $f_L$ 4 to 26 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +5 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Input Intercept | | +16.0 dBm | | $f_{R_1}$ = 18.00 GHz<br>$f_{R_2}$ = 18.01 GHz<br>both at -10 dBm<br>$f_L$ 14.0 GHz at +10 dBm |
| | | +16.0 dBm | | $f_{R_1}$ = 5.00 GHz<br>$f_{R_2}$ = 5.01GHz<br>both at -5 dBm<br>$f_L$ = 7.0 GHz at +10 dBm |

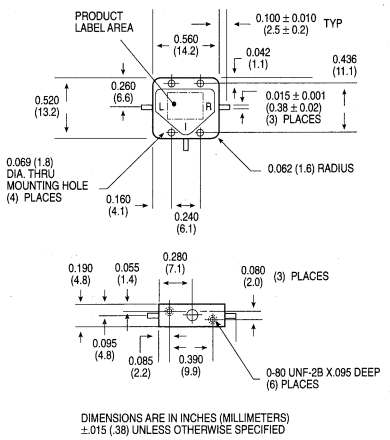
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C
Weight MZ5010: 6 grams (0.22 oz.) max.
MZ5010C: 12 grams (0.43 oz.) max.

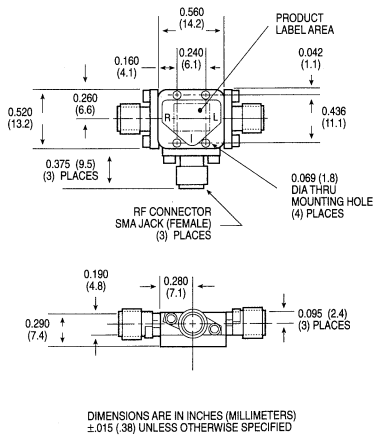
## Outline Drawings

MZ5010




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

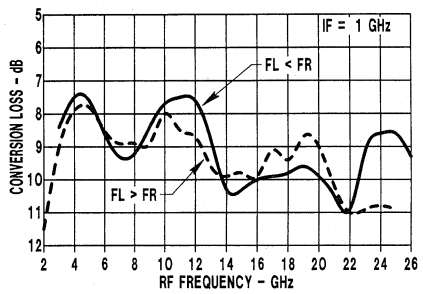
MZ5010C



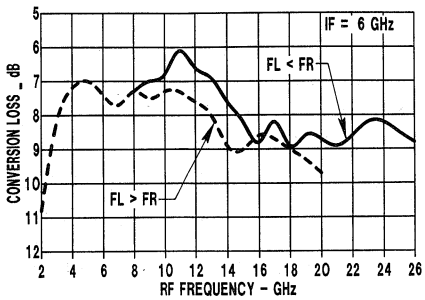

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

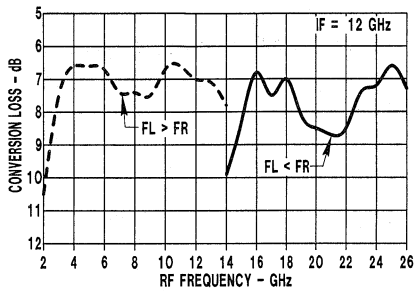
### Conversion Loss vs. Frequency

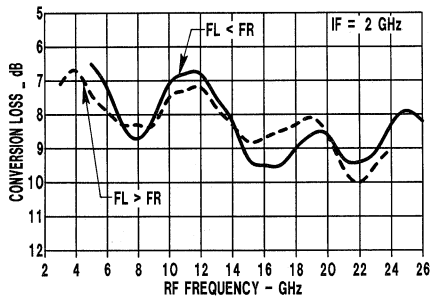


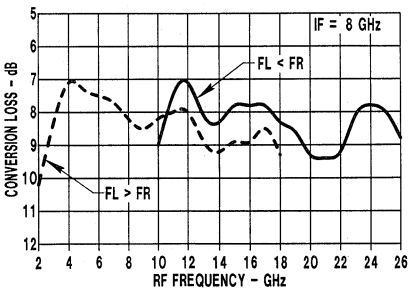

### Conversion Loss vs. Frequency

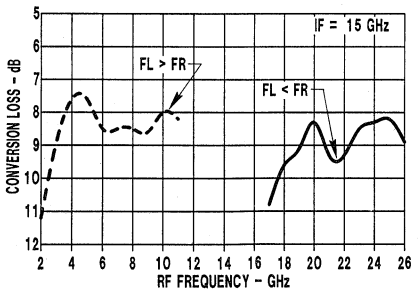


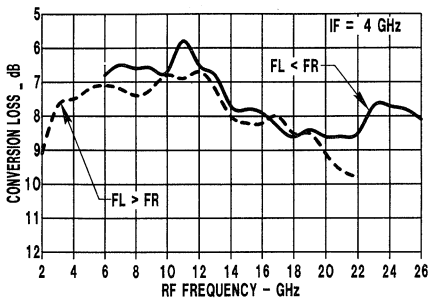

### Conversion Loss vs. Frequency

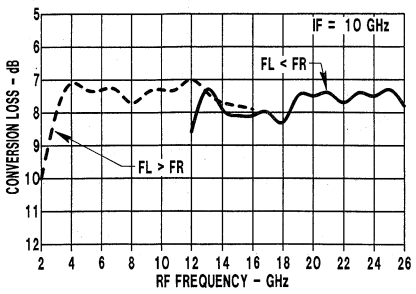


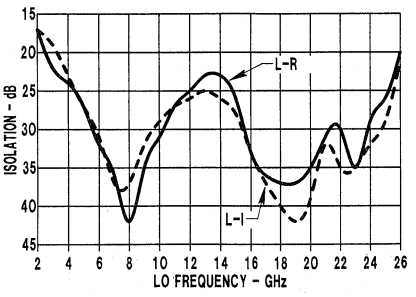



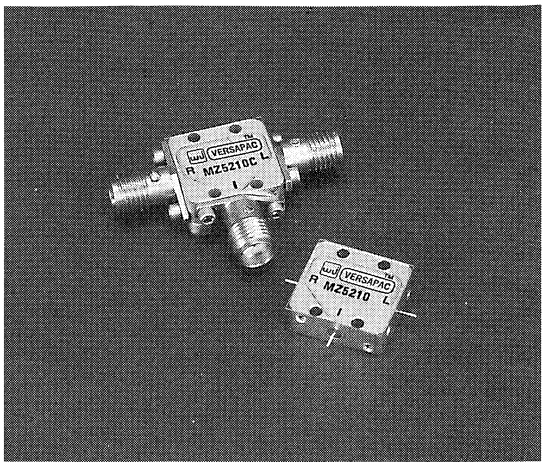

### Isolation




10

# WJ-MZ5210/ MZ5210C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- LO, RF } 2.0 TO 24.0 GHz
- IF 0.1 TO 5.0 GHz
- LO DRIVE +10 dBm (nominal)
- MINIATURE PACKAGE
- VERY WIDE BANDWIDTH
- AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 8.0 dB | 10. 5 dB | $f_R$, $f_L$ } 3 to 18 GHz<br>$f_I$ 0.1 to 2.0 GHz |
| | | 8.5 dB | 11.0 dB | $f_R$, $f_L$ } 3 to 18 GHz<br>$f_I$ 0.1 to 5.0 GHz |
| | | 10.0 dB | 12.0 dB | $f_R$, $f_L$ } 2 to 24 GHz<br>$f_I$ 0.1 to 5.0 GHz |
| Isolation | | | | |
| L - R | 12 dB | 15 dB | | $f_L$ 2 to 4 GHz |
| | 15 dB | 25 dB | | $f_L$ 4 to 24 GHz |
| L - I | 17 dB | 25 dB | | $f_L$ 2 to 24 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +4 dBm<br>$f_L$ level +10 dBm |
| Third-Order Input Intercept | | +16 dBm | | $f_{R_1}$ = 4.00 GHZ<br>$f_{R_1}$ = 4.01 GHZ<br>both at -10 dBm<br>$f_L$ = 5.0 GHz<br>at +10 dBm |
| | | +13 dBm | | $f_{R_1}$ = 17.99 GHz<br>$f_{R_2}$ = 18.00 GHz<br>both at -10 dBm<br>$f_L$ = 16.0 GHz<br>at +10 dBm |

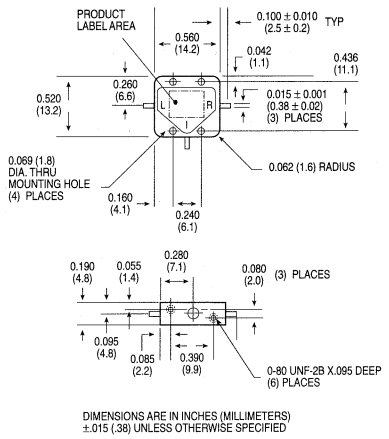
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +22 dBm max. at +100°C
Peak Input Current at 25°C .....100 mA DC
Weight MZ5210: 6 grams (0.22 oz.) max.
MZ5210C: 12 grams (0.43 oz.) max.

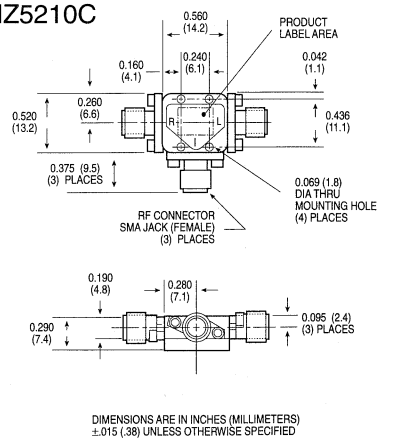
## Outline Drawings

MZ5210




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MZ5210C



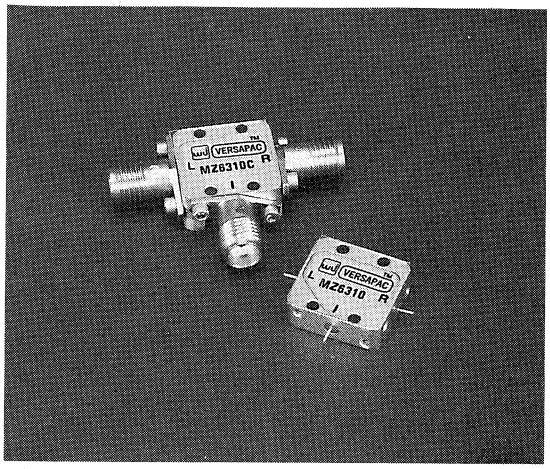

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-MZ6310/ MZ6310C

## DOUBLE-BALANCED MIXER

- LO 2.5 TO 7.0 GHz
- RF 2.5 TO 5.5 GHz
- IF DC TO 1.5 GHz
- LO DRIVE +10 dBm (nominal)
- MINIATURE PACKAGE
- LOW NOISE FIGURE: 6.0 dB (TYP.)
- AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)



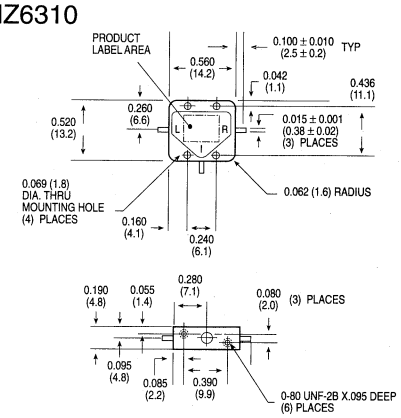

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 7.5 dB | $f_R$ 3.0 to 5.5 GHz<br>$f_L$ 2.5 to 7.0 GHz<br>$f_I$ DC to 1.5 GHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 2.5 to 3.0 GHz<br>$f_L$ 2.5 to 4.5 GHz<br>$f_I$ DC to 1.5 GHz |
| Isolation | | | | |
| L - R | 20 dB | 28 dB | | $f_L$ 2.5 to 4.0 GHz |
| | 30 dB | 45 dB | | $f_L$ 4.0 to 7.0 GHz |
| L - I | 12 dB | 18 dB | | $f_L$ 2.5 to 3.5 GHz |
| | 22 dB | 35 dB | | $f_L$ 3.5 to 7.0 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Intercept Point | | +15 dBm | | $f_{R1}$ 4.00 GHz, $f_{R2}$ 4.01 GHz both at -10 dBm<br>$f_L$ 2.8 GHz at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

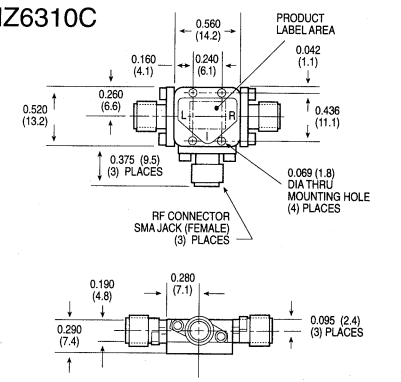
## Outline Drawings

MZ6310




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MZ6310C



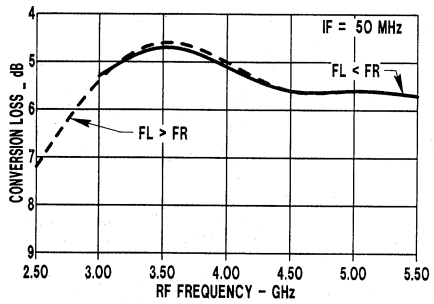

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Absolute Maximum Ratings

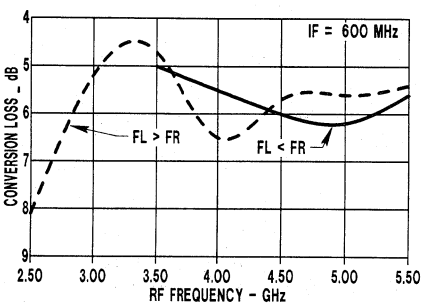
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Weight MZ6310: 4.5 grams (0.1 6 oz.) max.
MZ6310C: 11 grams (0.39 oz.) max.

## Typical Performance at 25°C

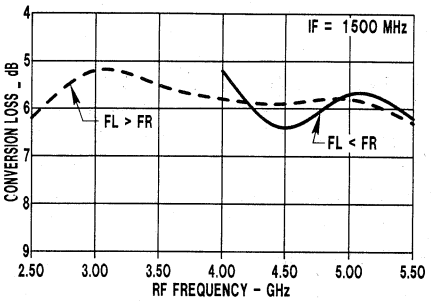
### Conversion Loss vs. Frequency

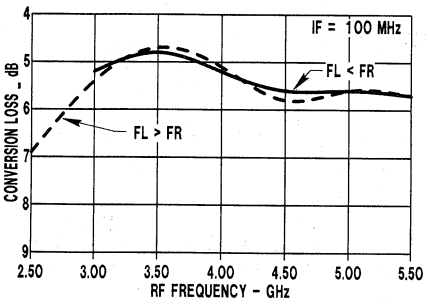


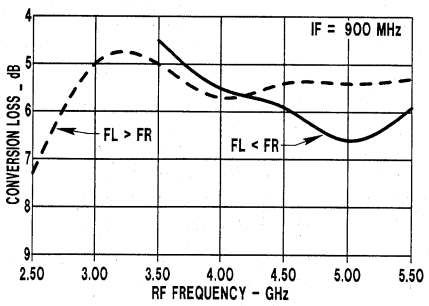

### Conversion Loss vs. Frequency



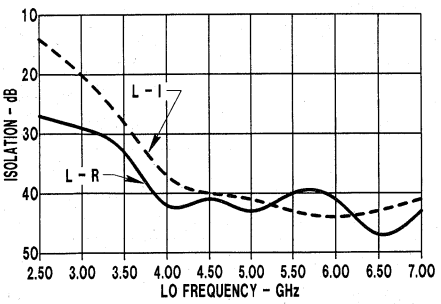

### Conversion Loss vs. Frequency

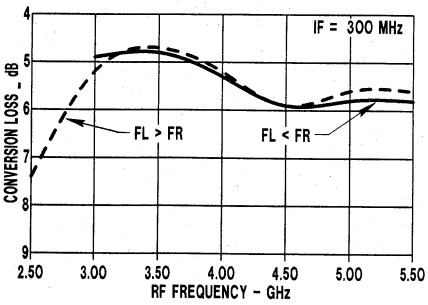


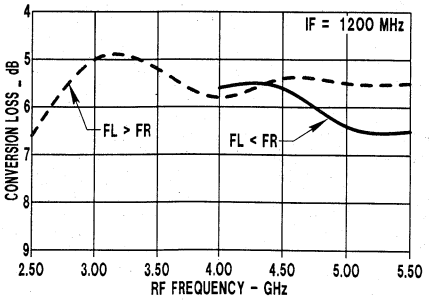




### Isolation vs. LO Frequency



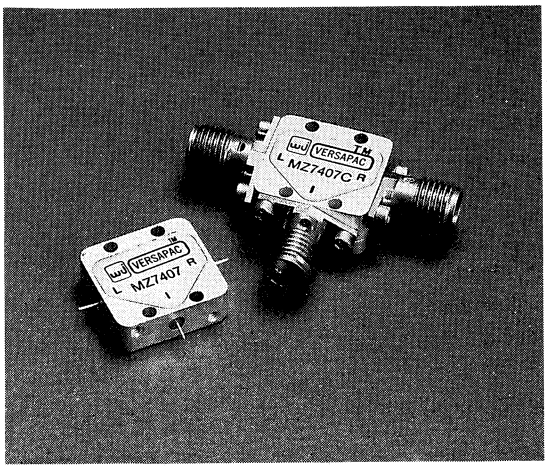




10

# WJ-MZ7407/MZ7407C

## DOUBLE-BALANCED MIXER




- ◆ LO 3.5 TO 18 GHz
- ◆ RF 6 TO 18 GHz
- ◆ IF DC TO 3000 MHz
- ◆ LO DRIVE +7 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_R$ 7 to 15 GHz<br>$f_L$ 6 to 13.5 GHz<br>$f_I$ 30 to 1000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 6 to 18 GHz<br>$f_L$ 4 to 18 GHz<br>$f_I$ 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 23 dB | 36 dB | | $f_L$ = 3.5 to 14 GHz |
| | 18 dB | 32 dB | | $f_L$ = 14 to 18 GHz |
| L to I | 16 dB | 25 dB | | $f_L$ = 3.5 to 8 GHz |
| | 23 dB | 35 dB | | $f_L$ = 8 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +3 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Input Intercept | | +10 dBm | | $f_{R1}$ = 13.00 GHz<br>$f_{R2}$ = 13.01 GHz<br>both at -10 dBm<br>$f_L$ = 14.0 GHz<br>at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

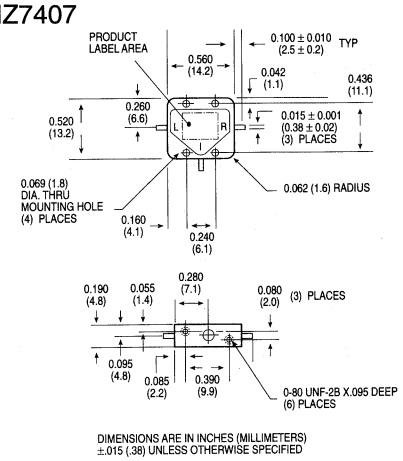
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C
Peak Input Current at 25°C .....100 mA DC

Weight MZ7407: 4.5 grams (0.16 oz.) max.
MZ7407C: 11 grams (0.39 oz.) max.

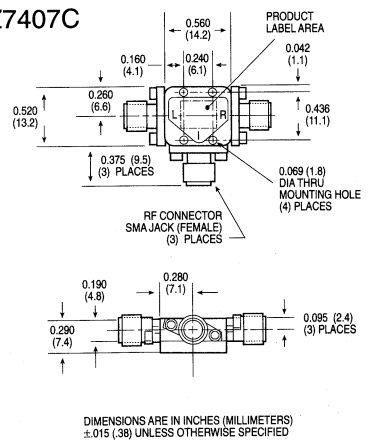
## Outline Drawings

MZ7407




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

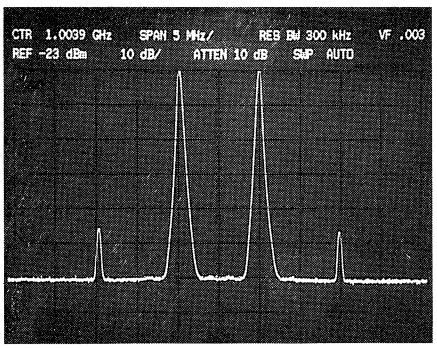
MZ7407C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

**Typical Two-Tone Intermodulation Performance**

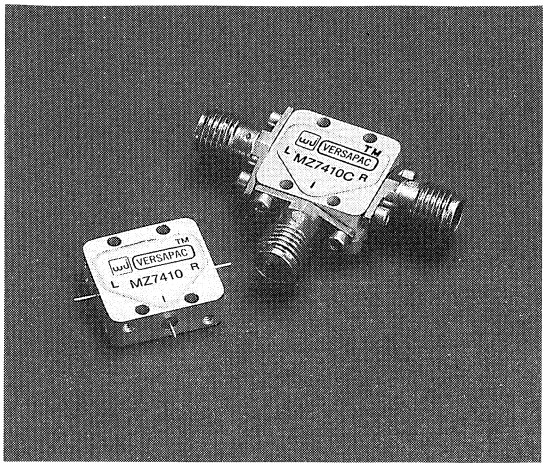



*Typical Two-Tone Intermodulation Performance:*

$f_I$ = 1000 MHz, $f_{RI}$ = 13.00 GHz
$f_{R2}$ = 13.01 GHz $f_R$ at -10 dBm
$f_L$ = 14.0 GHz at +10 dBm
Vertical Scale is 10 dB/Div.

# WJ-MZ7410/MZ7410C

## DOUBLE-BALANCED MIXER




- ◆ LO 4 TO 18 GHz
- ◆ RF 6 TO 18 GHz
- ◆ IF DC TO 3000 MHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

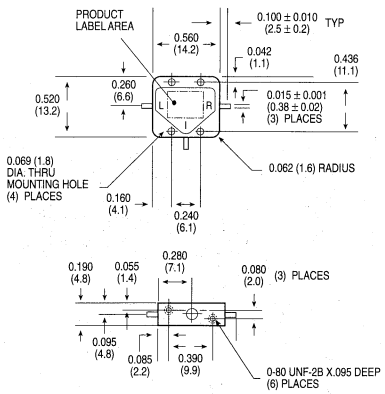
## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.0 dB | 8.0 dB | $f_R$ 6 to 15 GHz<br>$f_L$ 4 to 16 GHz<br>$f_I$ 30 to 3000 MHz |
| | | 7.0 dB | 9.0 dB | $f_R$ 14 to 18 GHz<br>$f_L$ 12 to 18 GHz<br>$f_I$ 30 to 3000 MHz |
| Isolation | | | | |
| L to R | 23 dB | 36 dB | | $f_L$ 4 to 14 GHz |
| | 18 dB | 32 dB | | $f_L$ = 14 to 18 GHz |
| L to I | 20 dB | 35 dB | | $f_L$ = 4 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +4 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Input Intercept | | +14 dBm | | $f_{R1}$ = 13.00 GHz<br>$f_{R2}$ = 13.01 GHz<br>both at - 6 dBm<br>$f_L$ = 14.0 GHz<br>at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

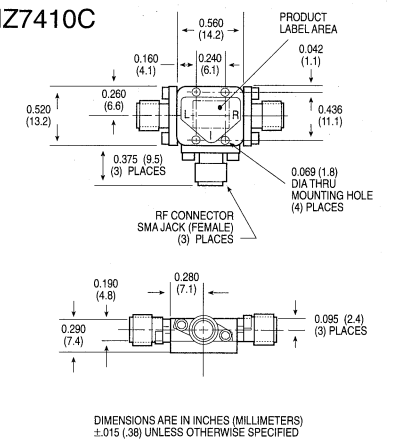
## Outline Drawings

MZ7410




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MZ7410C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

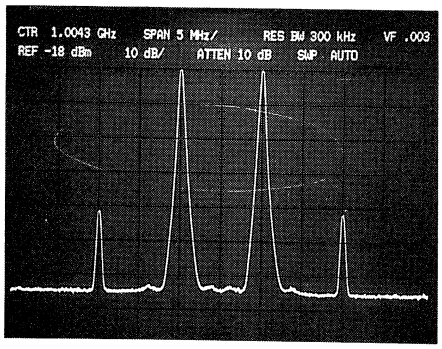
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C
Peak Input Current at 25°C .....100 mA DC

Weight WJ-MZ7410: 4.5 grams (0.16 oz.) max.
WJ-MZ7410C: 11 grams (0.39 oz.) max.

## Typical Performance at 25°C

### Typical Two-Tone Intermodulation Performance




*Typical Two-Tone Intermodulation Performance:*

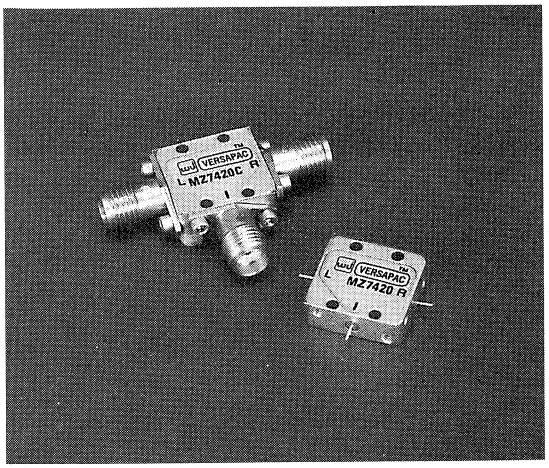
$f_I$ = 1000 MHz, $f_{RI}$ = 13.00 GHz
$f_{R2}$ = 13.01 GHz $f_R$ at -6 dBm
$f_L$ = 14.0 GHz at +10 dBm
Vertical Scale is 10 dB/Div.

# WJ-MZ7420/ MZ7420C

## DOUBLE-BALANCED MIXER

- ◆ LO 5 TO 18 GHz
- ◆ RF 6 TO 18 GHz
- ◆ IF DC TO 3000 MHz
- ◆ LO DRIVE +20 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ HIGH THIRD ORDER I.P.: +21 dBm (TYP.)
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 8.0 dB | $f_R$ = 7 to 15 GHz<br>$f_L$ = 6 to 15 GHz<br>$f_I$ = 30 to 1000 MHz |
| | | 7.0 dB | 8.5 dB | $f_R$ = 6 to 16 GHz<br>$f_L$ = 5 to 18 GHz<br>$f_I$ = 30 to 2000 MHz |
| | | 7.5 dB | 9.5 dB | $f_R$ = 6 to 16 GHz<br>$f_L$ = 5 to 18 GHz<br>$f_I$ = 30 to 3000 MHz |
| | | 8.5 dB | 10.0 dB | $f_R$ = 16 to 18 GHz<br>$f_L$ = 13 to 18 GHz<br>$f_I$ = 30 to 3000 MHz |
| Isolation<br>L – R<br><br>L – I | <br>23 dB<br>18 dB<br>17 dB<br>23 dB | <br>35 dB<br>30 dB<br>27 dB<br>35 dB | | <br>$f_L$ = 5 to 14 GHz<br>$f_L$ = 14 to 18 GHz<br>$f_L$ = 5 to 9 GHz<br>$f_L$ = 9 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ = +15 dBm<br>$f_L$ = +20 dBm |
| Third-Order Input Intercept | | +21 dBm | | $f_{RI}$ = 13.00 GHz<br>$f_{R2}$ = 13.01 GHz<br>both at - 6 dBm<br>$f_L$ = 14.0 GHz<br>at +20 dbm |

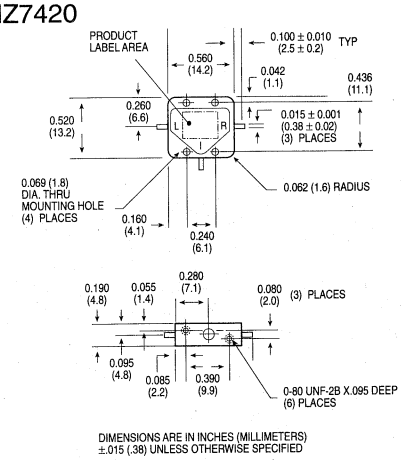
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified. The I -Port frequency range extends to DC for phase detection, pulse modulation, or attenuator applications, I-Port VSWR degrades from a 50-ohm system at low IF frequencies.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+24.7 dBm max. at +25°C, +20.8 dBm max. at +100°C
Weight MZ7420: 4.5 grams (0.16 oz.) max.
MZ7420C: 11 grams (0.39 oz.) max.

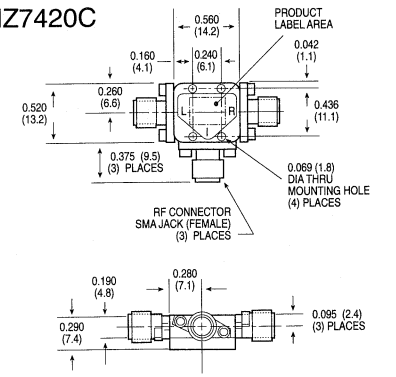
## Outline Drawings

MZ7420




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

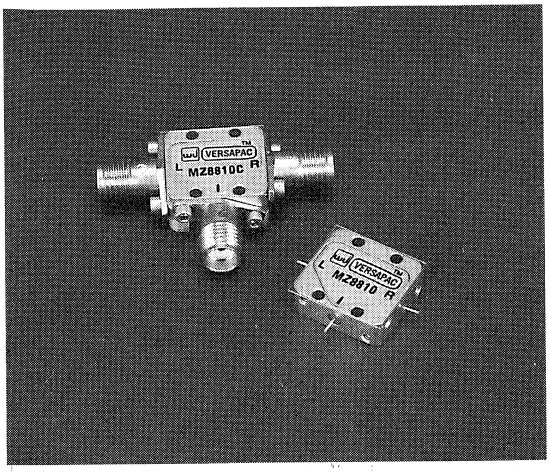
MZ7420C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# WJ-MZ8810/ MZ8810C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- ◆ LO, RF } 2 TO 18 GHz
- ◆ IF 1 TO 8 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | | 9.0 dB | $f_R$ 3 to 10 GHz<br>$f_L$ 2 to 15 GHz<br>$f_I$ 1 to 5 GHz |
| | | 7.5 dB | 11.0 dB | $f_R$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 1 to 8 GHz |
| Isolation | | | | |
| L - R | 15 dB | 25 dB | | $f_L$ 2 to 18 GHz |
| L - I | 16 dB | 28 dB | | $f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +6 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Input Intercept | | +15 dBm | | $f_{R1}$ 3.00 GHz, $f_{R2}$ 3.01 GHz both at -10 dBm<br>$f_L$ 5.0 GHz at +10 dBm |
| | | +13 dBm | | $f_{R1}$ 17.99 GHz, $f_{R2}$ 18.00 GHz both at -10 dBm<br>$f_L$ 14.0 GHz at +10 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

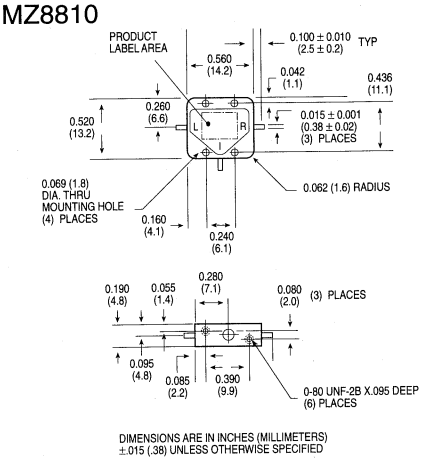
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C

Weight MZ8810: 4.5 grams (0.16 oz.) max.
MZ8810C: 11 grams (0.39 oz.) max.

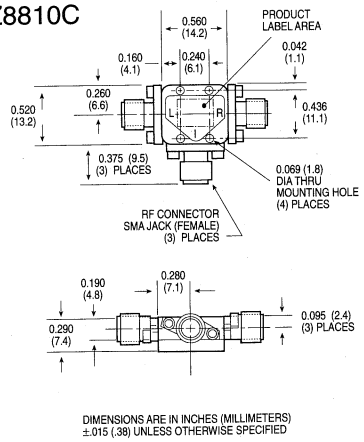
## Outline Drawings

MZ8810




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

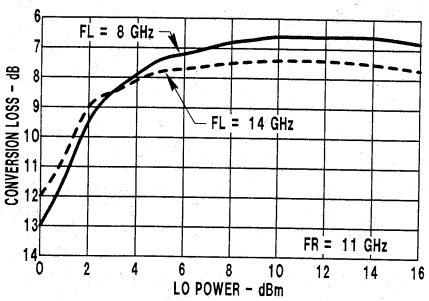
MZ8810C



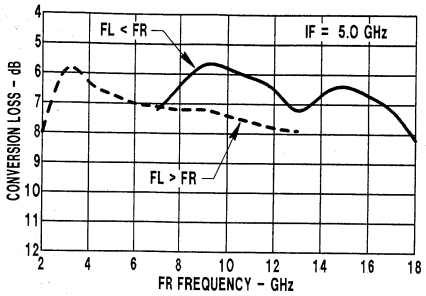

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

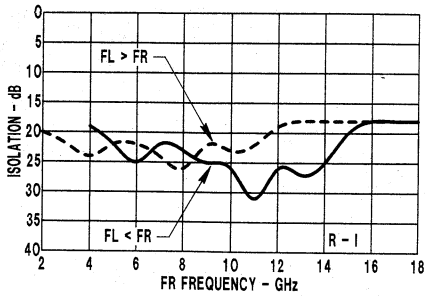
### Conversion Loss vs. LO Power



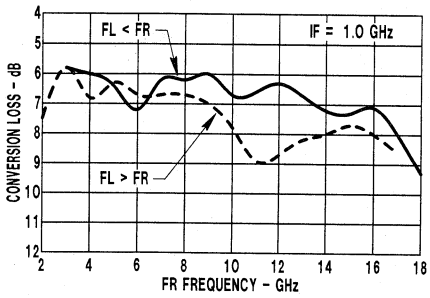

### Conversion Loss vs. Frequency

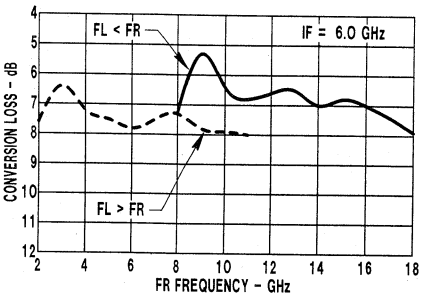



### Isolation vs. Frequency

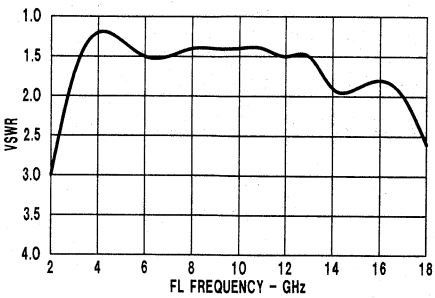


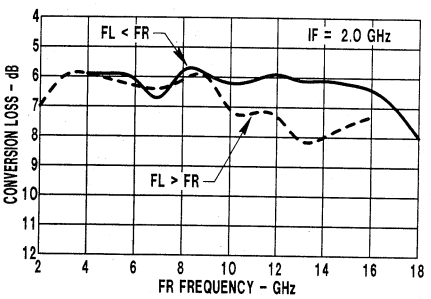

### Conversion Loss vs. Frequency

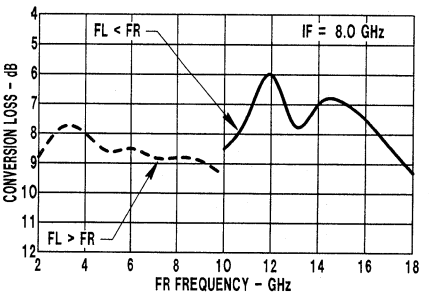


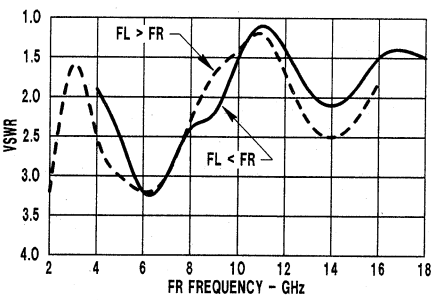

### L-Port vs. Frequency VSWR



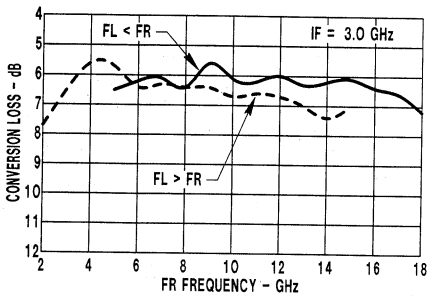



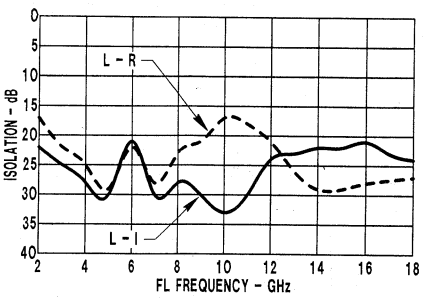




### R-Port VSWR vs. Frequency

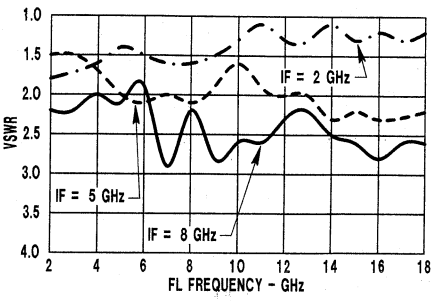



### Isolation vs. Frequency




### I-Port VSWR vs. Frequency

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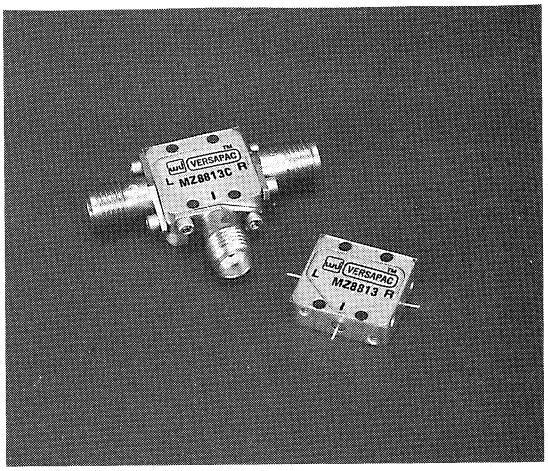
# WJ-MZ8813
# MZ8813C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- ◆ LO, RF } 2 TO 18 GHz
- ◆ IF 1 TO 8 GHz
- ◆ LO DRIVE +13 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications [1]

| Characteristics | Min. | Typ· | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB<br><br><br>7.5 dB | 9.0 dB<br><br><br>11.0 dB | $f_R$ 3 to 10 GHz<br>$f_L$ 2 to 15 GHz<br>$f_I$ 1 to 5 GHz<br>$f_R$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 1 to 8 GHz |
| Isolation<br>L - R<br>L - I | <br>15 dB<br>16 dB | <br>25 dB<br>28 dB | | <br>$f_L$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +8 dBm<br>$f_L$ Level +13 dBm |
| Third-Order Input Intercept | | +19 dBm<br><br><br>+16 dBm | | $f_{R_1}$ 3.00 GHz, $f_{R_2}$ 3.01 GHz both at -10 dBm<br>$f_L$ 5.0 GHz at +13 dBm<br>$f_{R_1}$ 17.99 GHz, $f_{R_2}$ 18.00 GHz both at -10 dBm<br>$f_L$ 14.0 GHz at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

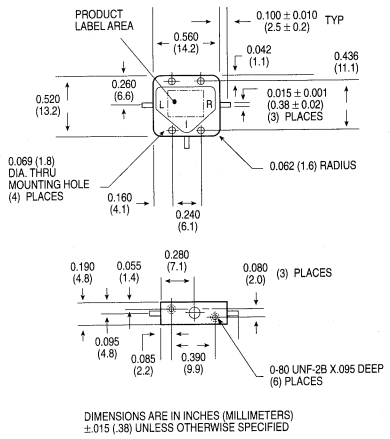
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C

Weight MZ8813: 4.5 grams (0.16 oz.) max.
MZ8813C: 11 grams (0.39 oz.) max.

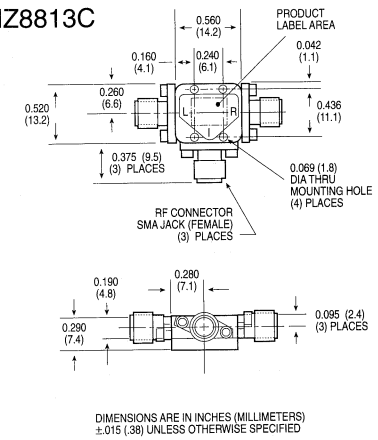
## Outline Drawings

MZ8813




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

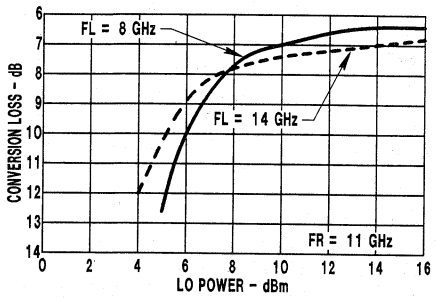
MZ8813C



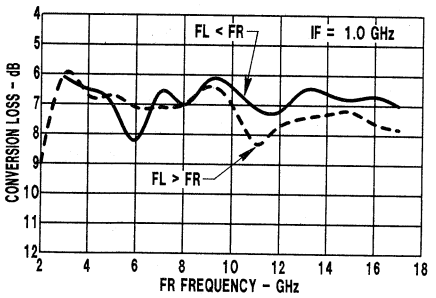

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

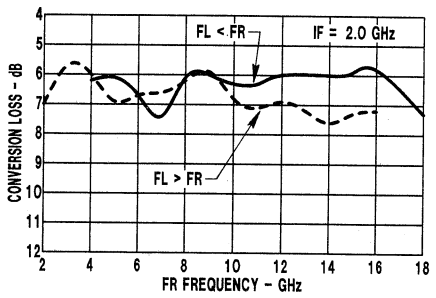
# Typical Performance at 25°C

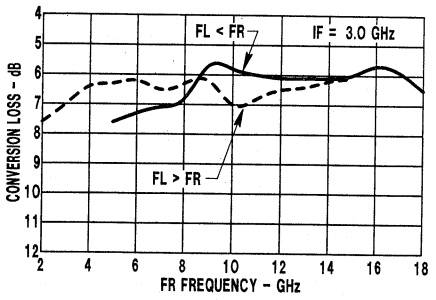
### Conversion Loss vs. LO Power



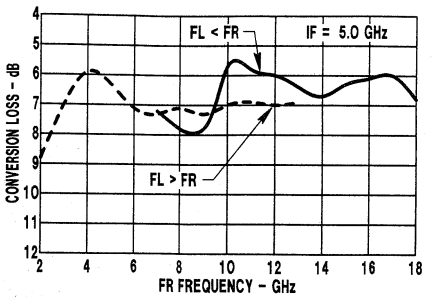

### Conversion vs. Frequency

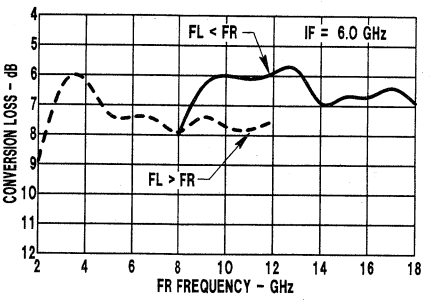


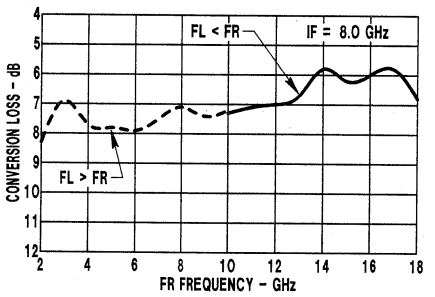



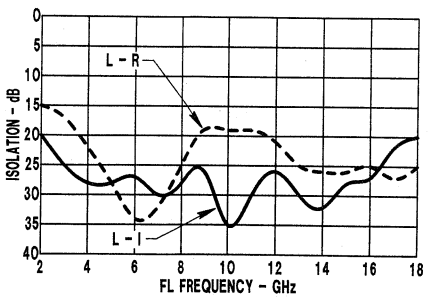

### Conversion vs. Frequency



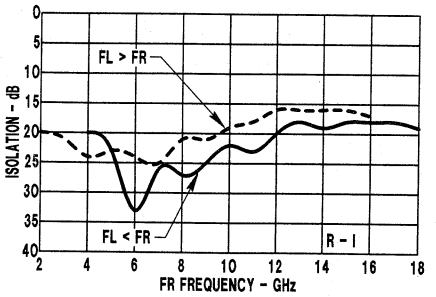



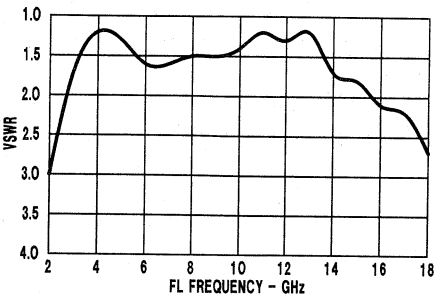

### Isolation vs. Frequency



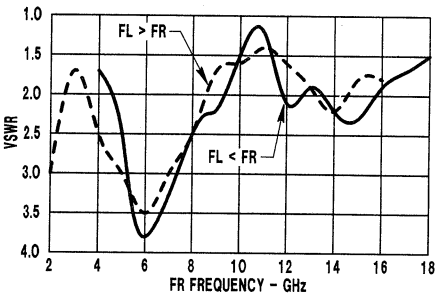

### Isolation vs. Frequency



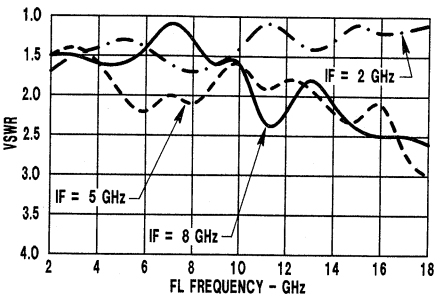

### L-Port VSWR vs. Frequency




### R-Port VSWR vs. Frequency




### I-Port VSWR vs. Frequency

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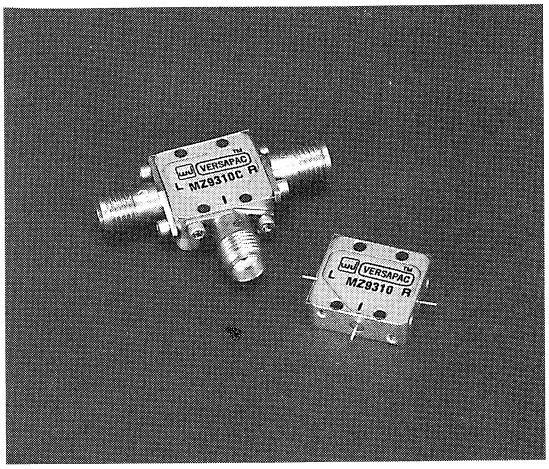
# WJ-MZ9310/ MZ9310C

## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER




- ◆ LO, RF } 2 TO 18 GHz
- ◆ IF 0.03 TO 5 GHz
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 7.0 dB | 8.5 dB | $f_R$ 4 to 18 GHz<br>$f_L$ 4 to 18 GHz<br>$f_I$ 0.03 to 1.0 GHz |
| | | 7.5 dB | 9.0 dB | $f_R$ 3 to 18 GHz<br>$f_L$ 3 to 18 GHz<br>$f_I$ 0.03 to 2.0 GHz<br>$f_I$ 0.03 to 3.0 GHz $f_L < f_R$ |
| | | 8.0 dB | 10.5 dB | $f_R$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 0.03 to 5 GHz |
| Isolation<br>L - R<br><br>L - I | 12 dB<br>16 dB<br>16dB | 20 dB<br>25 dB<br>30 dB | | $f_L$ 2 to 4 GHz<br>$f_L$ 4 to 18 GHz<br>$f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +6 dBm<br>$f_L$ Level +10 dBm |
| Third-Order Intercept Point | | +16dBm<br><br>+13 dBm | | $f_{R1}$ 3.00 GHz, $f_{R2}$ 3.01 GHz both at -10 dBm<br>$f_L$ 5.0 GHz at +10 dBm<br>$f_{R1}$ 17.99 GHz. $f_{R2}$ 18.00 GHz both at -10 dB<br>$f_L$ 14.0 GHz at +10 dBm |

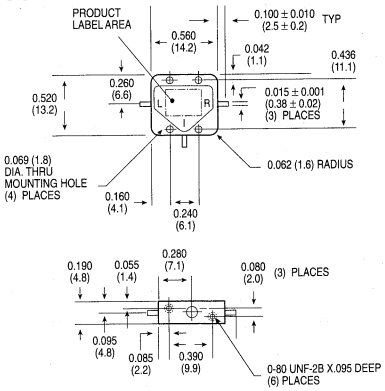
Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+26 dBm max. at +25°C, +23 dBm max. at +100°C
Weight MZ9310: 4.5 grams (0.16 oz.) max.
MZ9310C: 11 grams (0.39 oz.) max.

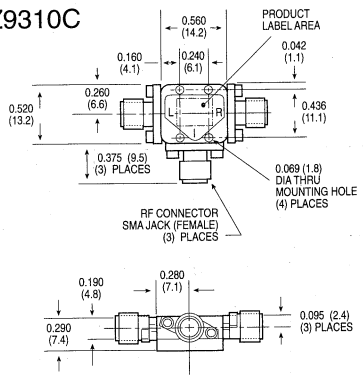
## Outline Drawings

MZ9310




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

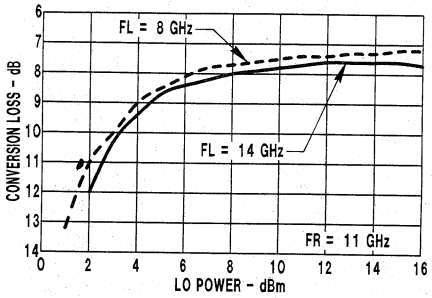
MZ9310C



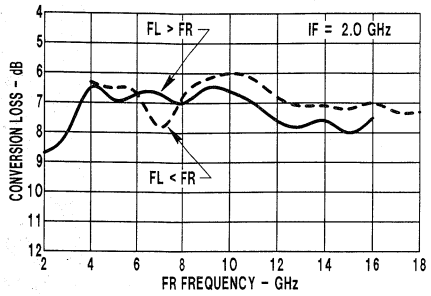

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

# Typical Performance at 25°C

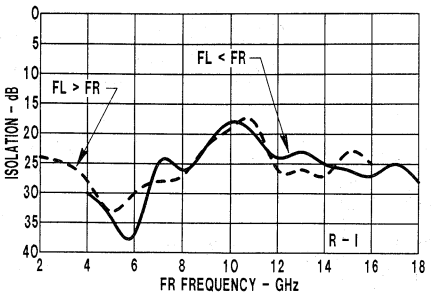
### Conversion Loss vs. LO Power



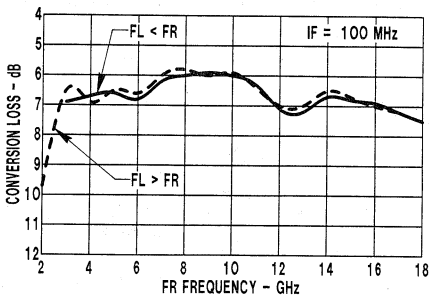

### Conversion Loss vs. Frequency

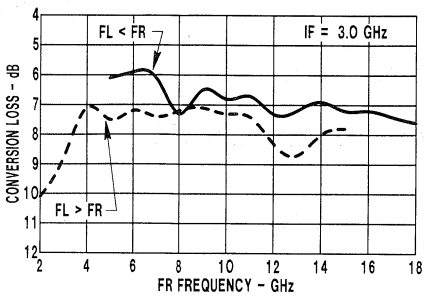



### Isolation vs. Frequency

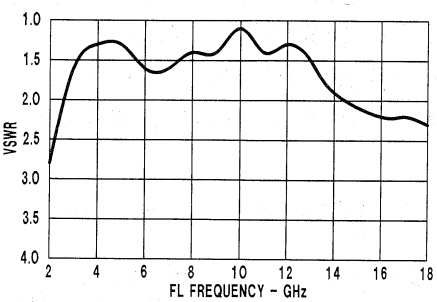


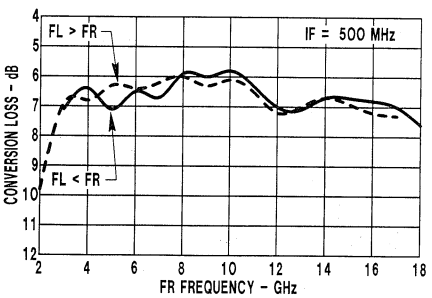

### Conversion Loss vs. Frequency

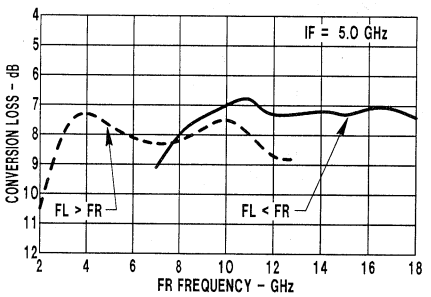


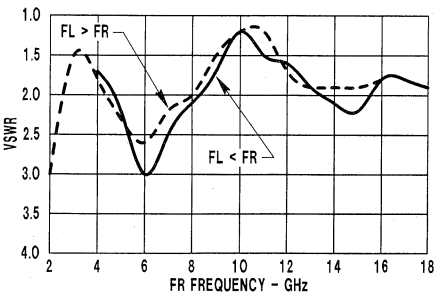

### L-Port VSWR vs. Frequency



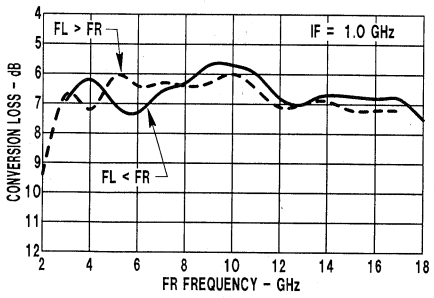



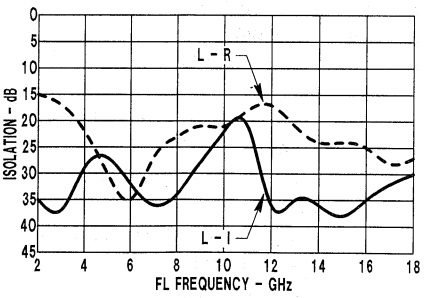




### R-Port VSWR vs. Frequency

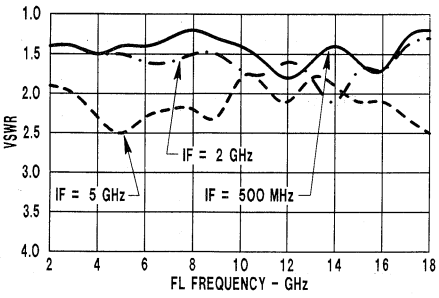



### Isolation vs. Frequency




### I-Port VSWR vs. Frequency

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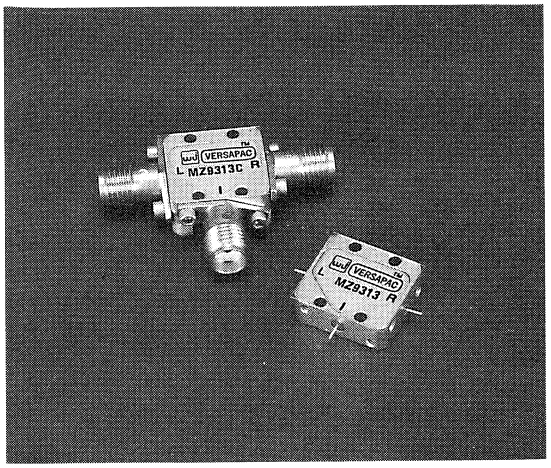
# WJ-MZ9313
# MZ9313C




## TRIPLE-BALANCED (DOUBLE-DOUBLE) MIXER

- ◆ LO } 2 TO 18 GHz
- ◆ RF }
- ◆ IF 0.03 TO 5 GHz
- ◆ LO DRIVE +13 dBm (nominal)
- ◆ MINIATURE PACKAGE
- ◆ WIDE BANDWIDTH
- ◆ AVAILABLE WITH FIELD REPLACEABLE CONNECTORS

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

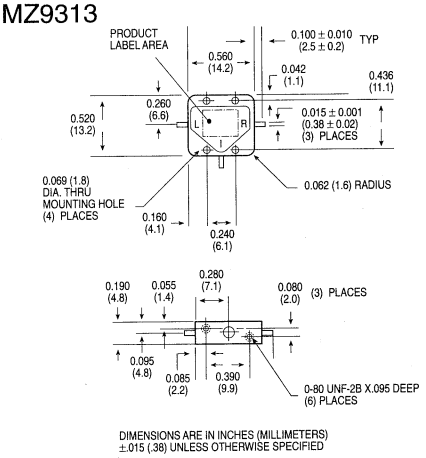
## Guaranteed Specification[1]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| SSB Conversion Loss and SSB Noise Figure | | 6.5 dB | 9.0 dB | $f_R$ 4 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 0.03 to 3 GHz |
| | | 7.5 dB | 10.5 dB | $f_R$ 2 to 18 GHz<br>$f_L$ 2 to 18 GHz<br>$f_I$ 0.03 to 5 GHz |
| Isolation | | | | |
| L - R | 12 dB | 17 dB | | $f_L$ 2 to 4 GHz |
| | 15 dB | 30 dB | | $f_L$ 4 to 18 GHz |
| L - I | 17 dB | 30 dB | | $f_L$ 2 to 18 GHz |
| Conversion Compression | | | 1.0 dB | $f_R$ Level +8 dBm<br>$f_L$ Level +13 dBm |
| Third-Order Input Intercept | | +19 dBm | | $f_{R1}$ 3.00 GHz, $f_{R2}$ 3.01 GHz both at -10 dBm<br>$f_L$ 5.0 GHz at +13 dBm |
| | | +15dBm | | $f_{R1}$ 17.99 GHz, $f_{R2}$ 18.00 GHz both at -10 dBm<br>$f_L$ 14.0 GHz at +13 dBm |

Notes:
1. Measured in a 50-ohm system with nominal LO drive and downconverter application only, unless otherwise specified.

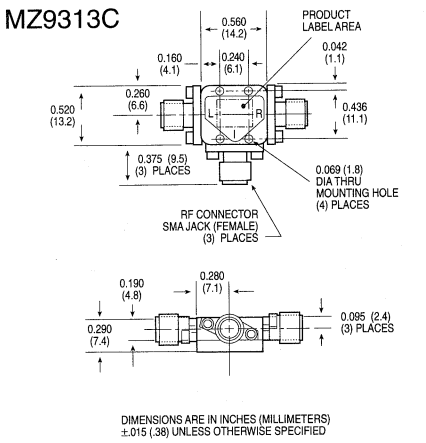
## Outline Drawings

MZ9313




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

MZ9313C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

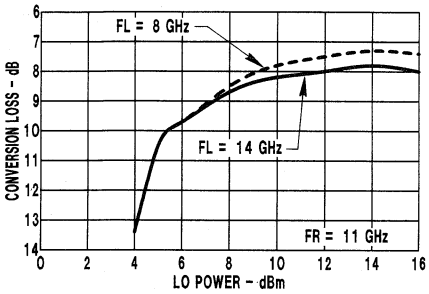
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+26 dBm max. at +25°C, +23 dBm max. at +100°C

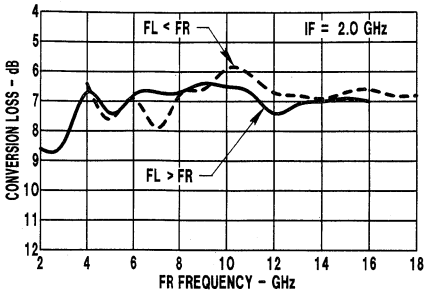
Weight MZ9313: 4.5 grams (0.16 oz.) max.
MZ9313C: 11 grams (0.39 oz.) max.

# Typical Performance at 25°C

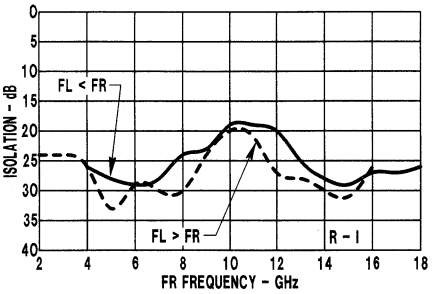
### Conversion vs. LO Power



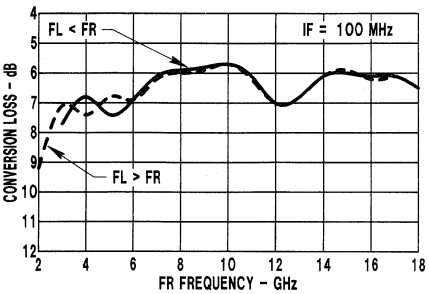

### Conversion vs. Frequency

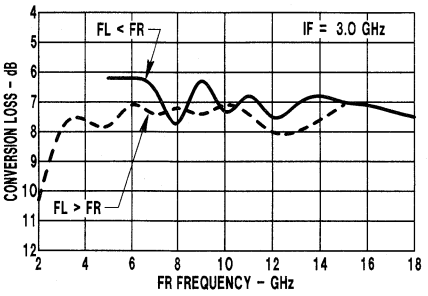



### Isolation vs. Frequency

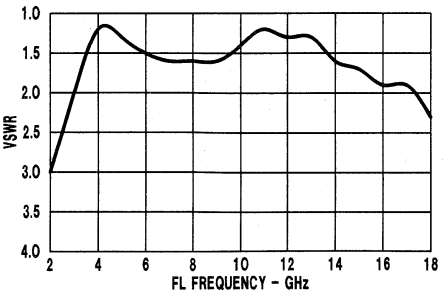


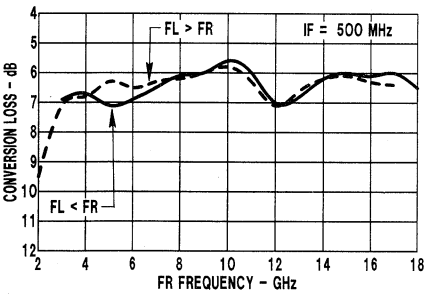

### Conversion vs. Frequency

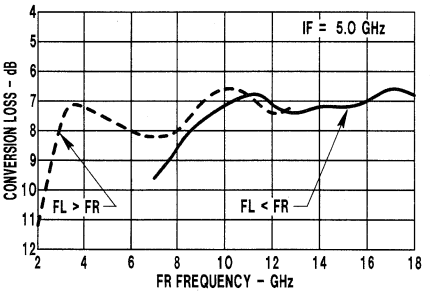


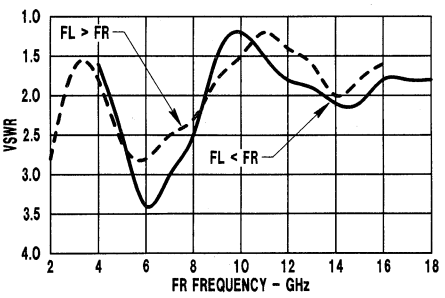

### L-Port VSWR vs. Frequency

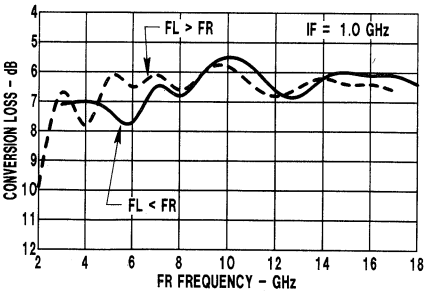


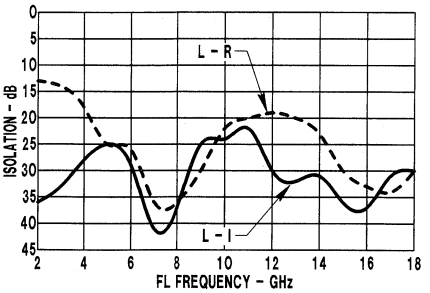




### R-Port VSWR vs. Frequency

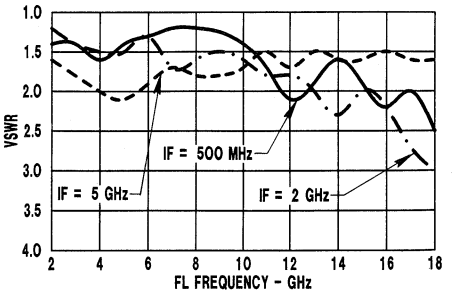



### Isolation vs. Frequency




### I-Port VSWR vs. Frequency

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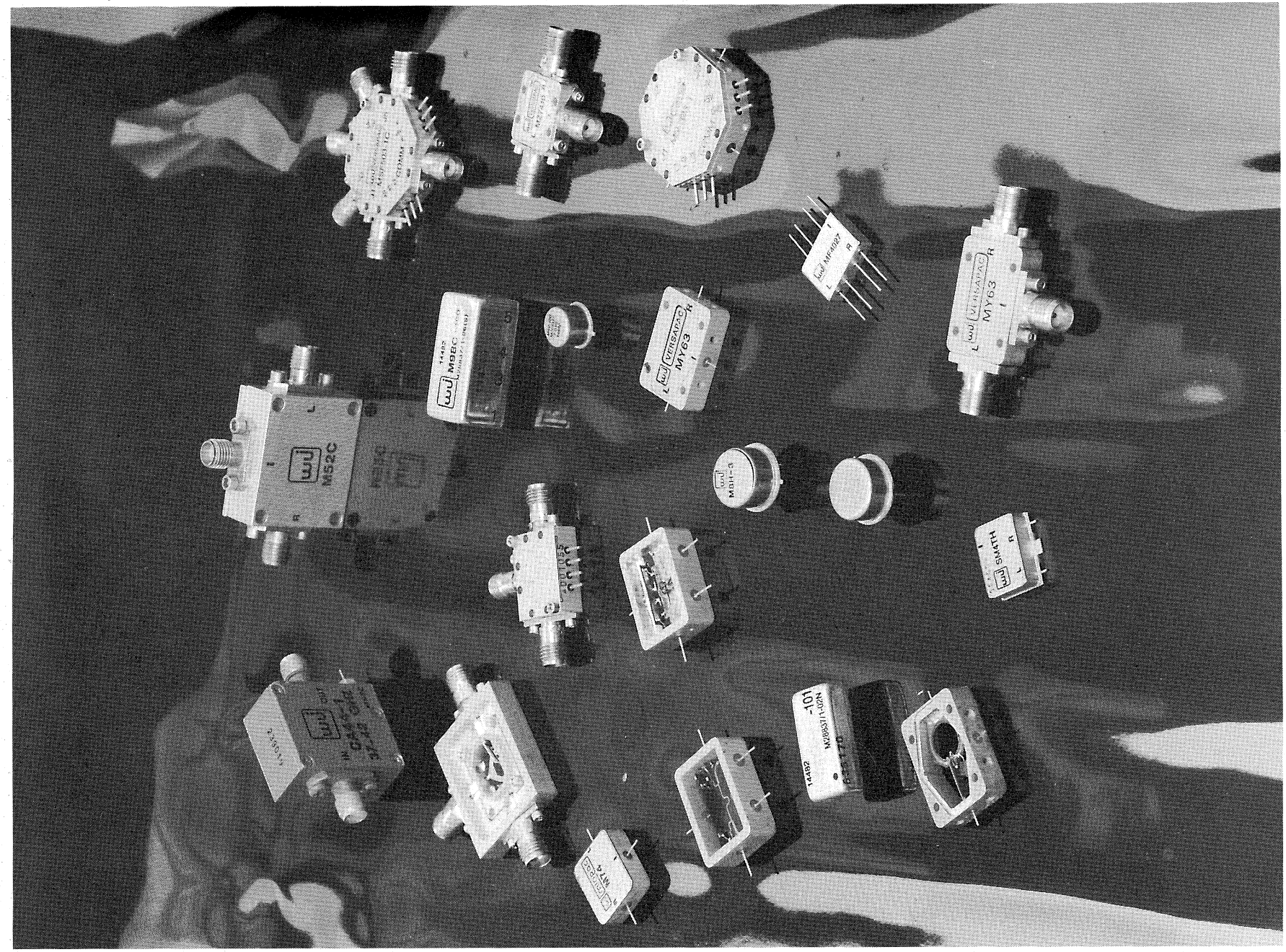
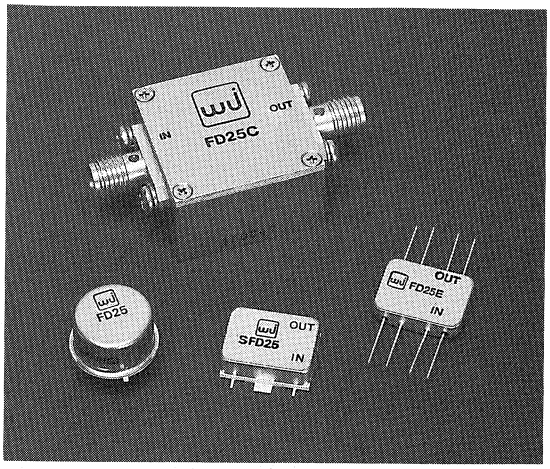
# *Frequency Doublers*





# WJ-FD25/FD25C
# FD25E/SFD25

## FREQUENCY DOUBLER




- INPUT FREQUENCY 5 TO 2400 MHz
- OUTPUT FREQUENCY 10 TO 4800 MHz
- INPUT DRIVE LEVEL +10 dBm (nominal)
- HERMETICALLY SEALED
- AVAILABLE IN SURFACE MOUNT

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| Conversion Loss | | 11.5 dB | 13.0 dB | $f_{in}$ 5 to 2400 MHz |
| Fundamental Suppression | 25 dBc<br>20 dBc<br>16 dBc | 35 dBc<br>25 dBc<br>20 dBc | | $f_{in}$ 5 to 1000 MHz<br>$f_{in}$ 1000 to 2000 MHz<br>$f_{in}$ 2000 to 2400 MHz |
| Third Harmonic Suppression | 40 dBc<br>30 dBc<br>25 dBc | 50 dBc<br>40 dBc<br>35 dBc | | $f_{in}$ 5 to 500 MHz<br>$f_{in}$ 500 to 1000 MHz<br>$f_{in}$ 1000 to 2400 MHz |
| Input VSWR | | 1.5:1 | | $f_{in}$ 5 to 2400 MHz |

Notes:
1. Measured in 50-ohm system with $f_{in}$ at +I0 dBm.
2. Guaranteed conversion loss values for FD25C are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

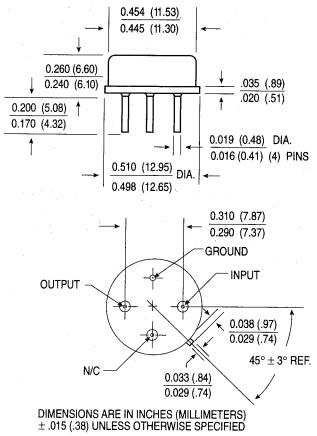
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak input Power.....+23 dBm at +25°C, +20 dBm at +100°C

Weight
FD25: 2 grams (0.07 oz.) max.
FD25C: 20.14 grams (0.71 oz.) max.
FD25E: 2 grams (0.07oz.) max.
SFD25: 2 grams ( 0.07oz.) max.

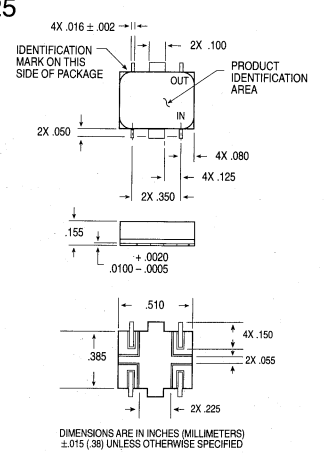
## Outline Drawings

FD25



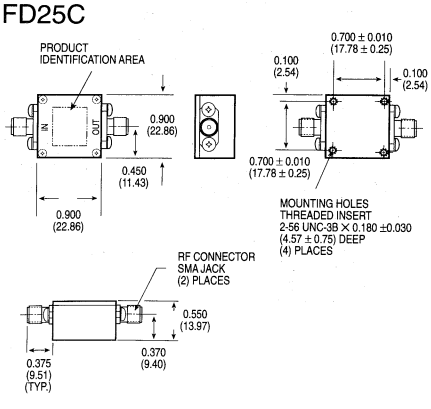

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

SFD25




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

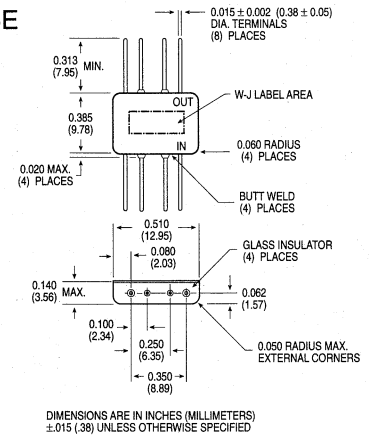
FD25C




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

## Outline Drawings

FD25E



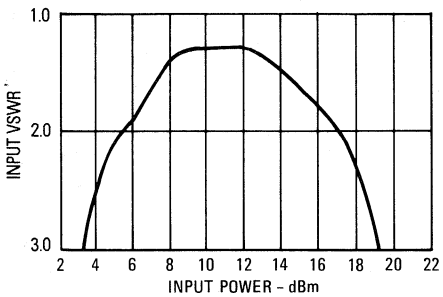

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

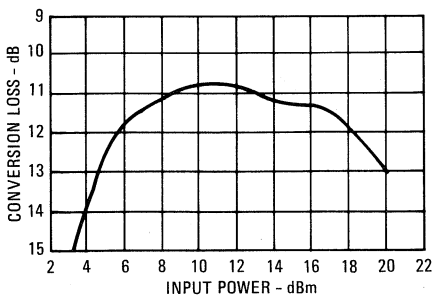
*Drive Level*: The minimum recommended drive level is +8 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and input VSWR over the full temperature and frequency range.

The maximum recommended drive level is +14 dBm. This upper level is recommended to avoid excessive input VSWR and conversion loss.

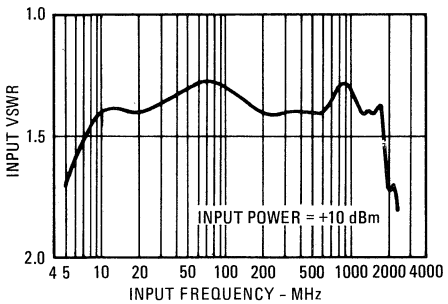
**Input VSWR vs. Input Power**



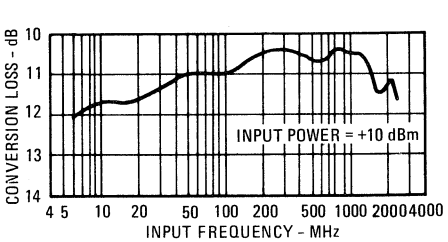

**Conversion Loss vs. Input Power**



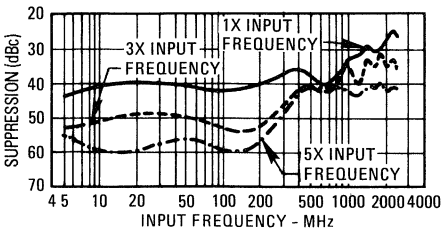

**Input VSWR vs. Input Frequency**




Conversion Loss vs. Frequency




**Suppression vs. Input Frequency**

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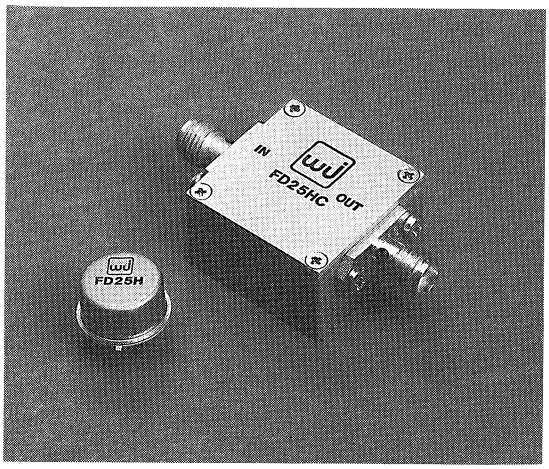
# WJ-FD25H/FD25HC

## FREQUENCY DOUBLER




- INPUT FREQUENCY 5 TO 2400 MHz
- OUTPUT FREQUENCY 10 TO 4800 MHz
- INPUT DRIVE LEVEL +23 dBm (nominal)
- HERMETICALLY SEALED

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| Conversion Loss | | 12.0 dB | 13.5 dB | $f_{in}$ 5 to 2400 MHz |
| Fundamental Suppression | 25 dBc<br>20 dBc<br>16 dBc | 35 dBc<br>25 dBc<br>20 dBc | | $f_{in}$ 5 to 1000 MHz<br>$f_{in}$ 1000 to 2000 MHz<br>$f_{in}$ 2000 to 2400 MHz |
| Third Harmonic Suppression | 30 dBc<br>25 dBc | 40 dBc<br>35 dBc | | $f_{in}$ 5 to 1000 MHz<br>fin 1000 to 2400 MHz |
| Input VSWR | | 1.5:1 | | $f_{in}$ 5 to 2400 MHz |

Notes:
1. Measured in 50-ohm system with $f_{in}$ at +23 dBm.
2. Guaranteed conversion loss values for FD25HC are 0.5 dB worse than values listed and guaranteed over 0°C to 50°C temperature range only.

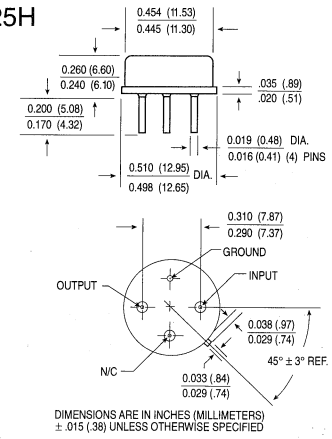
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+26 dBm at +25°C, +23 dBm at +100°C

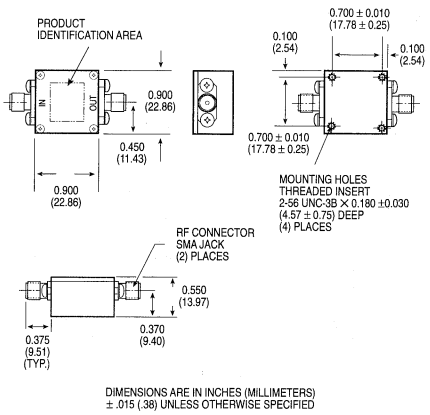
Weight FD25H: 2 grams (0.07 oz.) max.
FD25HC: 20.14 grams (0.71 oz.) max.

## Outline Drawings

FD25H




FD25HC

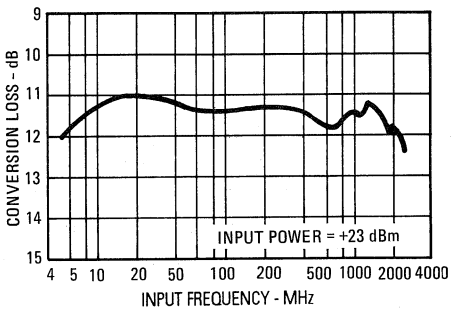


## Typical Performance at 25°C

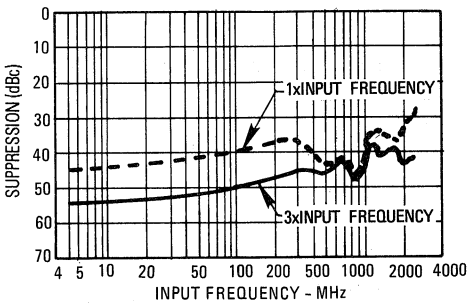
***Drive Level:*** The minimum recommended drive level is +21 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and input VSWR over the full temperature and frequency range.

The maximum recomended drive level is +26 dBm. This upper level is recommended to avoid excessive input VSWR and conversion loss.

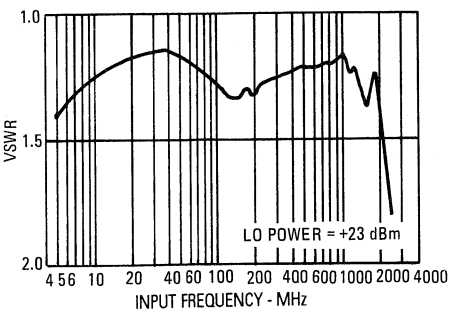
**Conversion Loss vs. Input Frequency**



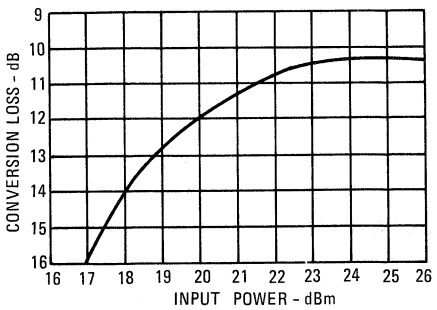

**Harmonic Suppression vs. Input Frequency**




**VSWR vs. Frequency**

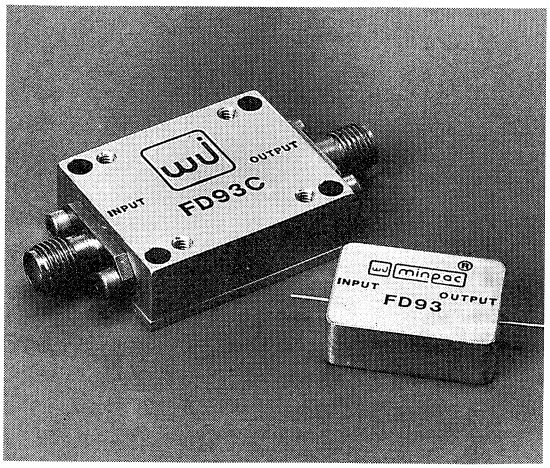



**Conversion Loss vs. Input Power**




11

# WJ-FD93/FD93C




## FREQUENCY DOUBLER

- INPUT FREQUENCY 2 TO 9 GHz
- OUTPUT FREQUENCY 4 TO 18 GHz
- INPUT DRIVE LEVEL +12 dBm (nominal)
- HERMETICALLY SEALED

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[1,2]

| Characteristics | Min. | Typ. | Max. | Test Conditions |
|---|---|---|---|---|
| Conversion Loss | | 10.0 dB<br>12.0 dB | 13.0 dB<br>14.0 dB | $F_{in}$ = 2 to 4 GHz<br>$F_{in}$ = 4 to 9 GHz |
| Fundamental Isolation | 18 dB | 25 dB | | $F_{in}$ = 2 to 9 GHz |
| Third Harmonic Suppression | 17 dBc | 25 dBc | | $F_{in}$ = 2 to 6 GHz |
| Input VSWR | | 1.5:1 | | $F_{in}$ = 2 to 9 GHz |

Notes:
1. Measured in 50-ohm system with $f_{in}$ at +12 dBm.
2. Fundamental isolation is referenced to the input signal.

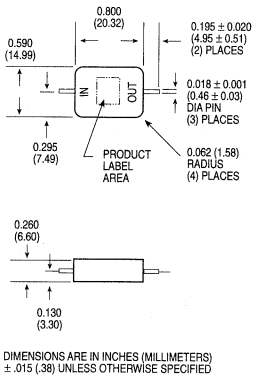
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power.....+23 dBm at +25°C, +20 dBm at +100°C

Weight FD93: 12 grams (0.42 oz.) max.
FD93C: 40 grams (1.41 oz.) max.

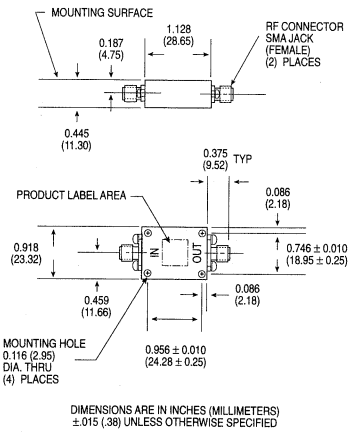
## Outline Drawings

FD93




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

FD93C



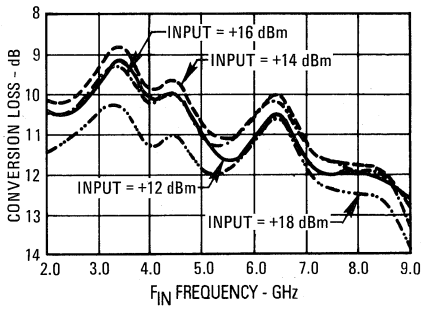

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

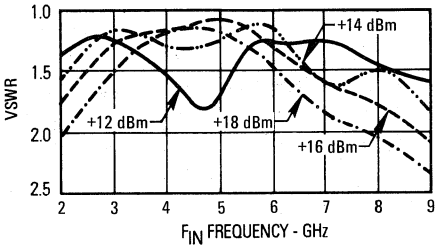
*Drive Level:* The minimum recommended drive level is +10 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and input VSWR over the full temperature and frequency range.

The maximum recomended drive level is +15 dBm. This upper level is recommended to avoid excessive input VSWR and conversion loss.

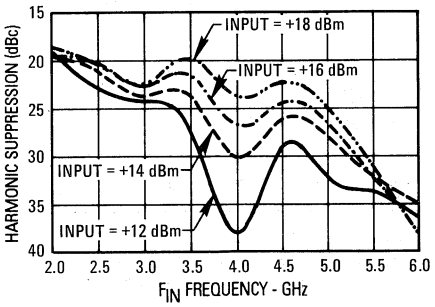
**Conversion Loss vs. Input Frequency**



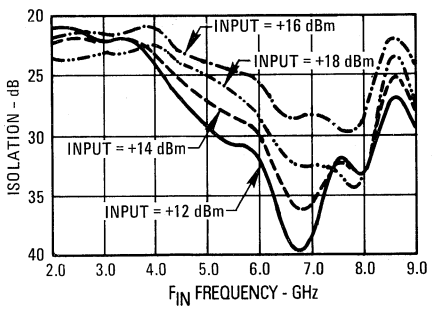

**VSWR vs. Frequency**



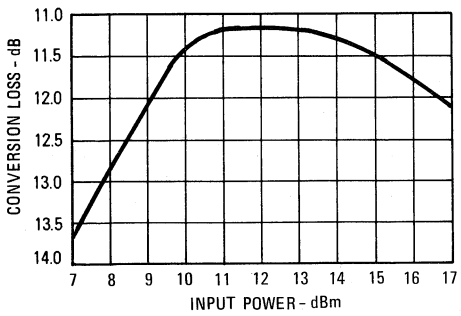

**Suppression vs. Input Frequency**




**Input/Output Isolation**




**Conversion Loss vs. Input Power**

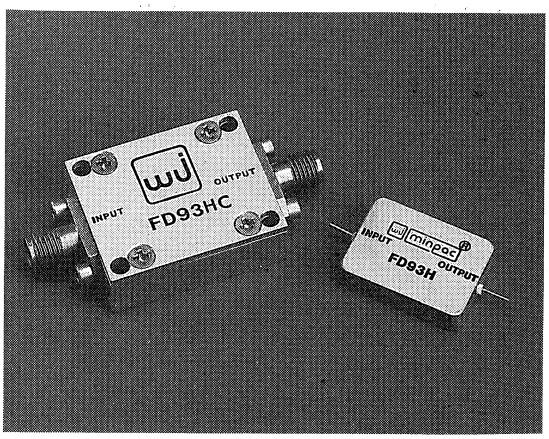


# WJ-FD93H/FD93HC

## FREQUENCY DOUBLER

- INPUT FREQUENCY 2 TO 9 GHz
- OUTPUT FREQUENCY 4 TO 18 GHz
- INPUT DRIVE LEVEL +19 dBm (nominal)
- HERMETICALLY SEALED

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[1,2]

| Characteristics | Min | Typ | Max | Test Conditions |
|---|---|---|---|---|
| Conversion Loss | | 11.0 dB<br>12.0 dB | 13.0 dB<br>14.0 dB | $F_{in}$ = 2 to 4 GHz<br>$F_{in}$ = 4 to 9 GHz |
| Fundamental Isolation | 18 dB | 25 dB | | $F_{in}$ = 2 to 9 GHz |
| Third Harmonic Suppression (dBc) | 16 dBc | 25 dBc | | $F_{in}$ = 2 to 6 GHz |
| Input VSWR | | 1.5:1 | | $F_{in}$ = 2 to 9 GHz |

Notes:
1. Measured in 50-Ohm system with $F_{in}$ at +19 dBm.
2. Fundamental isolation is referenced to the input signal.

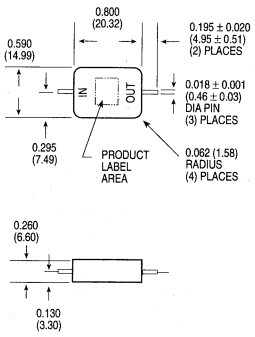
## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power..... +23 dBm at +25°C, +20 dBm at +100°C

Weight FD93H: 12 grams (0.42 oz.) max.
FD93HC: 40 grams (1.41 oz.) max.

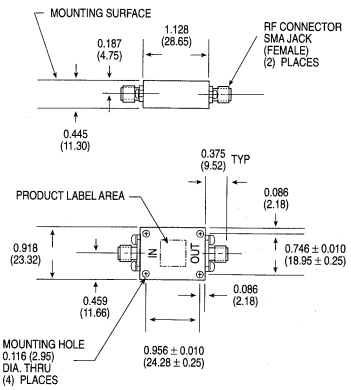
## Outline Drawings

FD93H




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

FD93HC



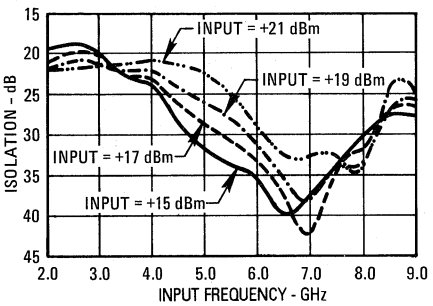

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

## Typical Performance at 25°C

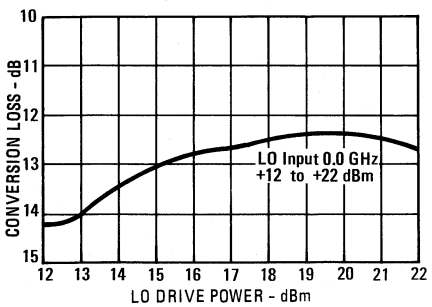
*Drive Level:* The minimum recommended drive level is +17 dBm. This level has been established on the premise that a lower drive level will degrade the conversion loss and input VSWR over the full temperature and frequency range.

The maximum recommended drive level is +21 dBm. This upper level is recommended to avoid excessive input VSWR and conversion loss.

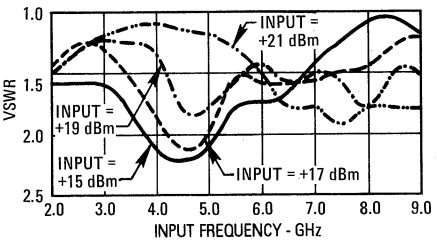
**Isolation vs. Frequency**



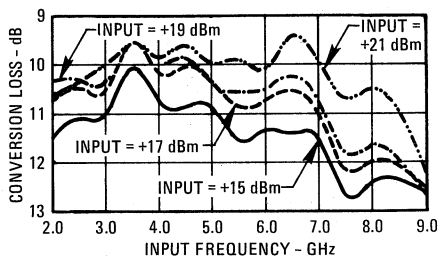

**Conversion Loss Vs. LO Drive Power**



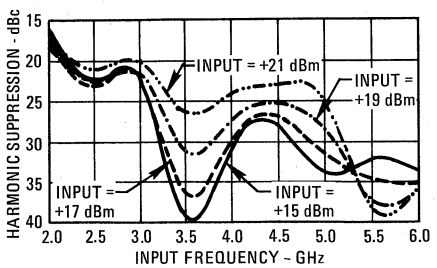

**VSWR vs. Frequency**



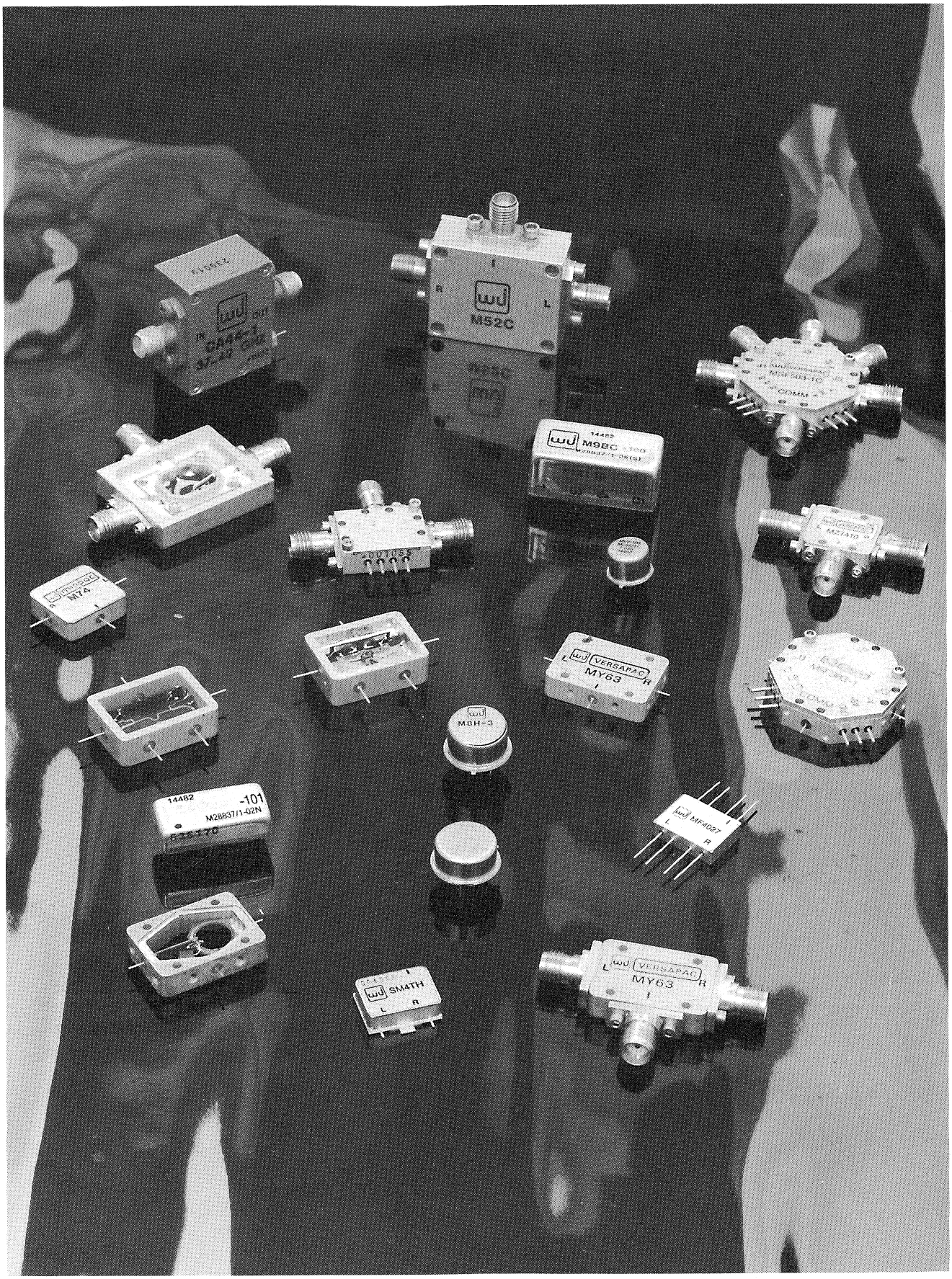

**Conversion Loss vs. Input Frequency**



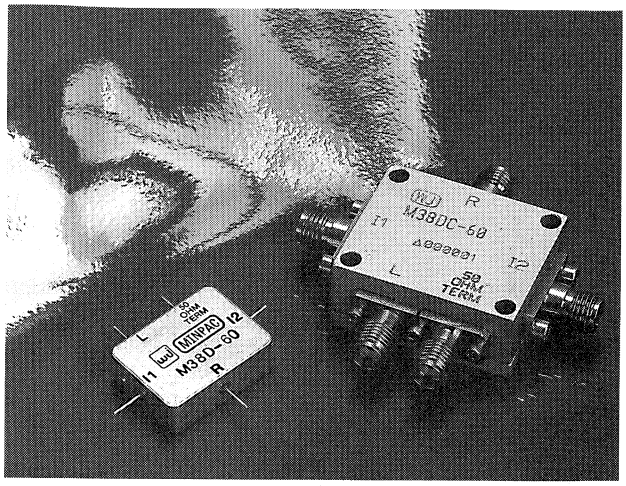

**Suppression vs. Input Frequency**



# Image Reject Mixers



# WJ-M38D
# WJ-M38DC



## WIDEBAND IMAGE REJECT MIXER/ QUADRATURE IF MIXER

- ◆ LO: 6 TO 18 GHz
- ◆ RF: 6 TO 18 GHz
- ◆ IF: 10 TO 500 MHz[1]
- ◆ SUPERIOR IMAGE REJECTION
- ◆ LOW CONVERSION LOSS
- ◆ HERMETICALLY-SEALED
- ◆ PIN OR CONNECTORIZED PACKAGE
- ◆ OCTAVE BANDWIDTH IF's[1]

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Specifications*

| Characteristics | | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|---|
| Conversion Loss | | | 6.5 dB | 8.0 dB<br>8.5 dB | 6-15 GHz<br>6-18 GHz |
| Image Rejection | | 17 dBc | 25 dBc | | 6-18 GHz |
| Isolation | L-R | 28 dB<br>18 dB | 40 dB<br>27 dB | | 6-15 GHz<br>6-18 GHz |
| | L-I | 20 dB<br>18 dB | 35 dB<br>29 dB | | 6-16 GHz<br>6-18 GHz |
| | R-I | | 35 dB | | 6-18 GHz |
| Conversion Compression | | | 1.0 dB | | $f_R$ = 11.6 GHz at +6.5 dBm |
| Third Order Input Intercept Point | | | +15 dBm | | $f_{R1}$ = -10 dBm<br>$f_{R2}$ = -10 dBm<br>$f_L$ = +10 dBm |

* Measured in a 50-ohm system at center IF frequency with the nominal LO drive of +10 dBm and RF power of -10 dBm.

Notes:

1. Denote the desired IF frequency band by replacing the -XXX with appropriate dash number. Options: 00 = No Hybrid, 15 = 10-20 MHz, 30 = 20-40 MHz, 60 = 40-80 MHz, 120 = 80-160 MHz, 150 = 100-200 MHz, 240 = 160-320 MHz, 400 = 300-500 MHz
2. Image Rejection is referenced to the desired output signal.
3. The 50 ohm terminations are not supplied.
4. Greater Sideband Suppression may be obtained by selection.

## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +23 dBm at +25°C, +20 dBm at +100°C

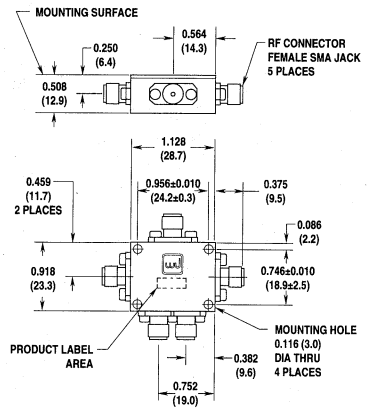
Weight: Non Connectorized, 12 Grams (0.42 oz.); Connectorized, 37 Grams (1.31 oz.)

## Quadrature IF UP Converter (-00)

| | | I1 | I2 |
|---|---|---|---|
| Phase Relationships for Sideband Selection | $f_R$ Out < $f_L$ In | -90° | 0° |
| | $f_R$ Out > $f_L$ In | 0° | -90° |

## Outline Drawings

M38DC
(CONNECTORIZED)




M38D
(MINPAC)

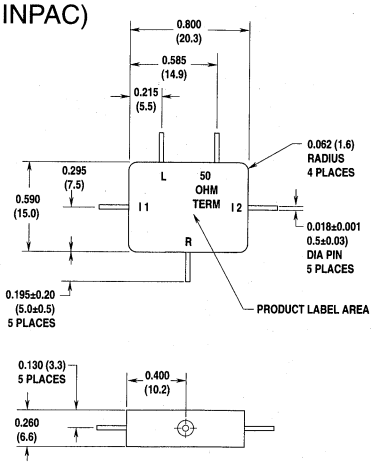
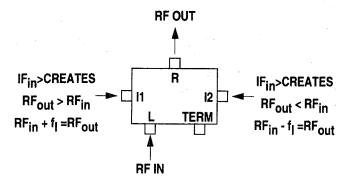


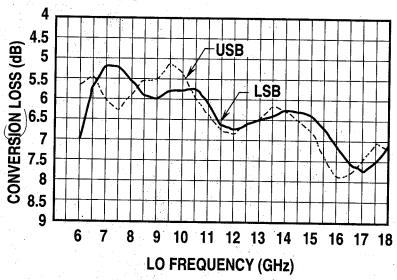

Image Reject Mixer Port Functions
(-15 Through -400)



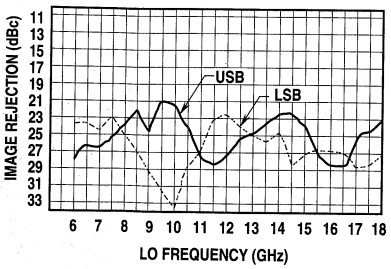
# Typical Performance at 25°C

## Performance at +10 dBm

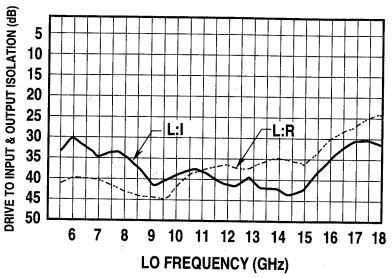
### Conversion Loss vs. LO Frequency




### Image Rejection vs. LO Frequency

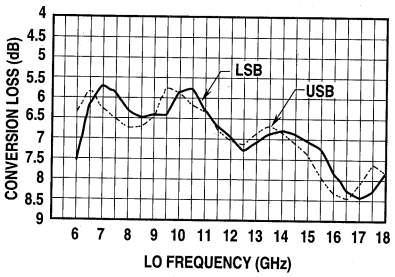



### Input/Output Isolation vs. LO Frequency

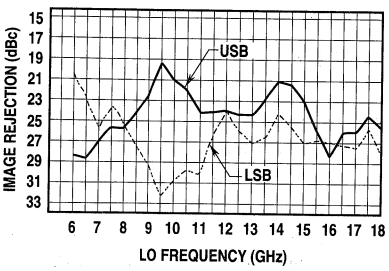



## Performance at +7 dBm

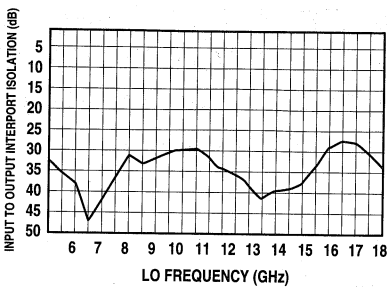
### Conversion Loss vs. LO Frequency



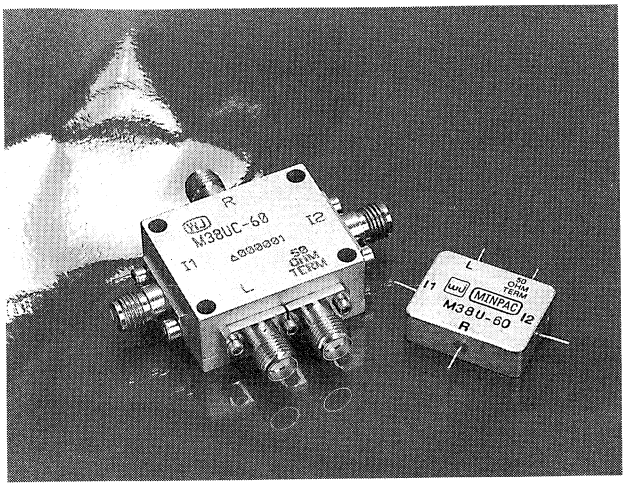

### Image Rejection vs. LO Frequency




### Input/Output Isolation vs. LO Frequency



# WJ-M38U
# WJ-M38UC



## WIDEBAND SINGLE SIDEBAND UP CONVERTER/QUADRATURE IF UP CONVERTER

- ◆ LO: 6 TO 18 GHz
- ◆ RF: 6 TO 18 GHz
- ◆ IF: 10 TO 500 MHz[1]
- ◆ SUPERIOR SIDEBAND AND CARRIER SUPPRESSION
- ◆ LOW CONVERSION LOSS
- ◆ HERMETICALLY-SEALED
- ◆ PIN OR CONNECTORIZED PACKAGE
- ◆ OCTAVE BANDWIDTH IF'S[1]

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Specifications*

| Characteristics | Minimum | Typical | Maximum | Test Conditions |
|---|---|---|---|---|
| Conversion Loss | | 6.75 dB | 8.0 dB<br>9.5 dB | 6.5-15 GHz<br>6-18 GHz |
| Sideband Suppression[2] | 17 dBc<br>15 dBc | 25 dBc | | 6.5-15 GHz<br>6-18 GHz |
| Carrier Suppression[2] | 20 dBc<br>15 dBc | 30 dBc<br>20 dBc | | 6-15 GHz<br>6-18GHz |
| Intermodulation Suppression[2]<br>fl ± 2fi<br>fl ± 3fi | <br>25 dBc<br>23 dBc | <br>40 dBc<br>35 dBc | | <br>6-18 GHz<br>6-18 GHz |

* Measured in a 50-ohm system at center IF frequency with the nominal LO drive of +10 dBm and IF power of 0 dBm. For the -00 option, specifications apply only when both signal inputs match within ±0.4 dB in amplitude and ±2° in quadrature phasing.

Notes:

1. Denote the desired IF frequency band by replacing the -XXX with appropriate dash number. Options: 00 = No Hybrid, 15 = 10-20 MHz, 30 = 20-40 MHz, 60 = 40-80 MHz, 120 = 80-160 MHz, 150 = 100-200 MHz, 240 = 160-320 MHz, 400 = 300-500 MHz
2. Sideband, Carrier, and Intermodulation Suppression are referenced to the desired output signal.
3. The 50 ohm terminations are not supplied.
4. Greater Sideband Suppression may be obtained by selection.

## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +100°C
Peak Input Power ..... +23 dBm at +25°C, +20 dBm at +100°C

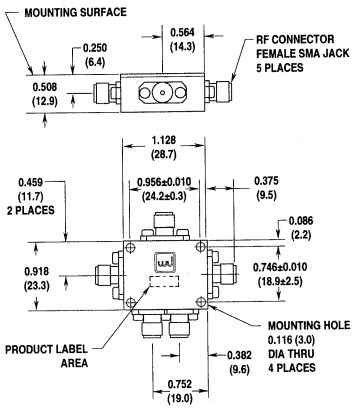
Weight: Non Connectorized, 12 Grams (0.42 oz.); Connectorized, 37 Grams (1.31 oz.)

## Quadrature IF UP Converter (-00)

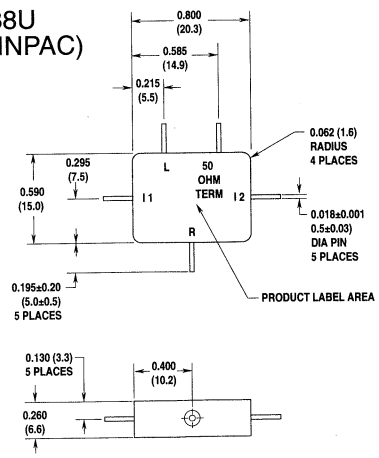
| | | I1 | I2 |
|---|---|---|---|
| Phase Relationships for Sideband Selection | $f_R$ Out < $f_L$ In | -90° | 0° |
| | $f_R$ Out > $f_L$ In | 0° | -90° |

## Outline Drawings

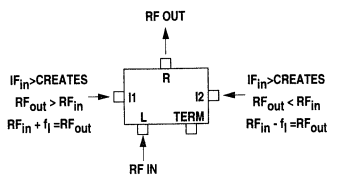
M38UC
(CONNECTORIZED)




M38U
(MINPAC)



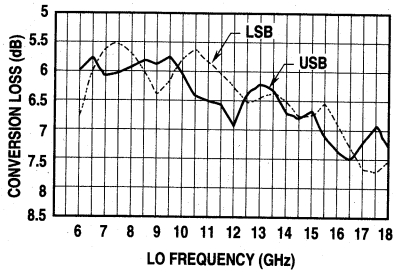

Single Sideband Up Converter Port Functions (-15 Through -400)



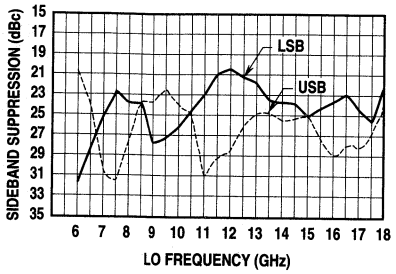
# Typical Performance at 25°C

## Performance at +10 dBm

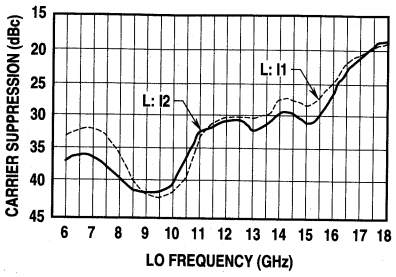
### Conversion Loss vs. LO Frequency




### Sideband Suppression vs. LO Frequency

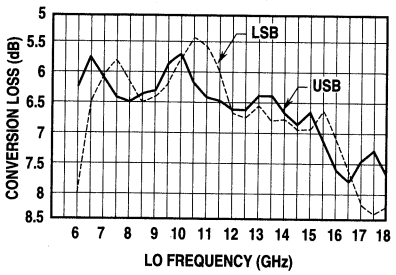



### Carrier Suppression vs. LO Frequency

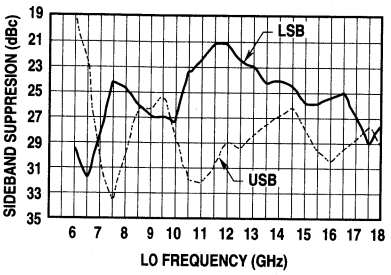



## Performance at +7 dBm

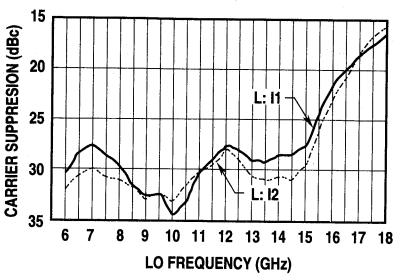
### Conversion Loss vs. LO Frequency




### Sideband Suppression vs. LO Frequency




### Carrier Suppression vs. LO Frequency



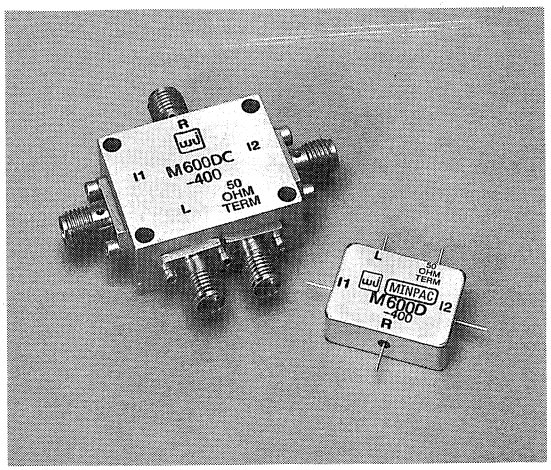

12

# WJ-M600D(C) thru M1800D(C)

## IMAGE REJECT MIXER/ QUADRATURE IF MIXER

- ◆ L0 6 TO 18 GHz 10% BANDWIDTH[1]
- ◆ RF 6 TO 18 GHz
- ◆ IF 10 TO 500 MHz[2]
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ SUPERIOR IMAGE REJECTION
- ◆ LOW CONVERSION LOSS
- ◆ OCTAVE BANDWIDTH IF's[2]

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)




## Guaranteed Specifications[3]

| Characteristics | Min. | Typ. | Max. | Test Conditions 10% Bandwidth |
|---|---|---|---|---|
| Conversion Loss | | 6.0 dB | 7.5 dB | 6 to 18 GHz |
| Image Rejection[4] | 20 dBc | 25 dBc | | 6 to 18 GHz |
| Isolations<br>L – R<br>L – I<br>R – I | <br>28 dB<br>20 dB | <br>38 dB<br>28 dB<br>32 dB | | <br>6 to 18 GHz<br>6 to 18 GHz<br>6 to 18 GHz |
| Conversion Compression | | 1.0 dB | | $f_R$ = 12.06 GHz at +6 dBm |
| Third-Order Input Intercept Point | | +17 dBm | | $f_{R_1}$ = 12.06 GHz -10 dBm<br>$f_{R_2}$ = 12.07 GHz -10 dBm<br>$f_L$ = 12.0 GHz at +10 dBm |

Notes:
1. 10% LO frequency bandwidth to be specified by the customer.
2. Denote the desired IF frequency band by replacing the "-XXX" with appropriate dash number. Options: -00 = no hybrid, -15 = 10-20 MHz 30 =20-40 MHz, -60 =40-80 MHz.-120 = 80-160 MHz,-150 = 100-200 MHz, -240 =160-320 MHz, -400 = 300-500 MHz.
3. Measured in a 50-ohm system at center IF frequency with the nominal LO drive, and RF power of 0 dBm at +25°C. For the -00 option, specifications apply only when both signal inputs match within ±0.4 dB in amplitude and ±2 degrees in quadrature phasing.
4. Image Rejection is referenced to the desired output signal.
5. The 50 ohm terminations are not supplied.

## Ordering Information

M 625 D C -XXX

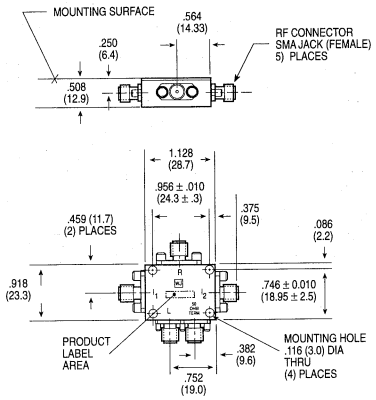
- -XXX — IF hybrid options. See Note 2.
- C — Add "C" if connectorized package is desired.
- D — Down Converter
- 625 — Model number designated by the center LO Frequency of the desired 10% band in GHz to the 100th place (Ex. 6.25 GHz).

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Weight Non Connectorized .....12 grams (0.42 oz.) max.
Connectorized .....37 grams (1.31 oz.) max.

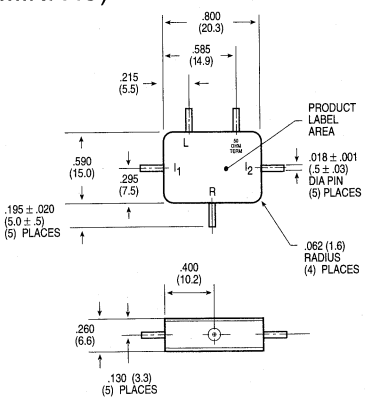
## Outline Drawings

### M600DC–M1800DC (CONNECTORIZED)



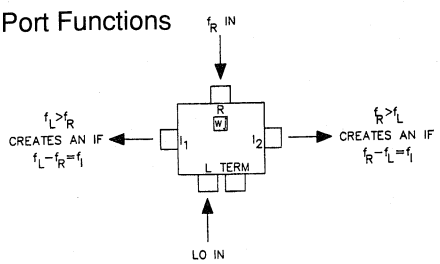

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

### M600D–M1800D (MINPAC)




DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

### Port Functions

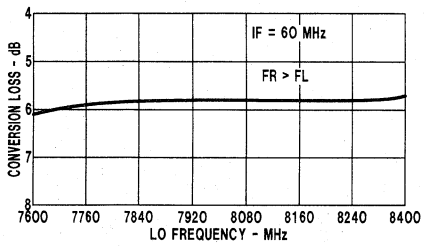



NOTE: THE UNUSED PORTS MUST BE TERMINATED WITH 50 OHM LOAD[5]

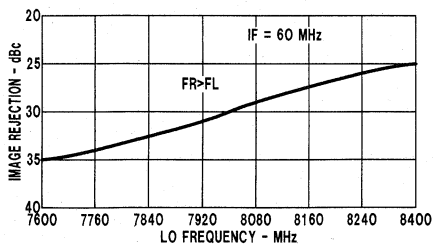
## Typical Performance at 25°C

**(M800DC-60)**

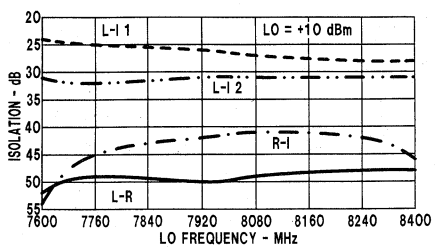
### Conversion Loss vs. LO Frequency




### Image Rejection vs. LO Frequency



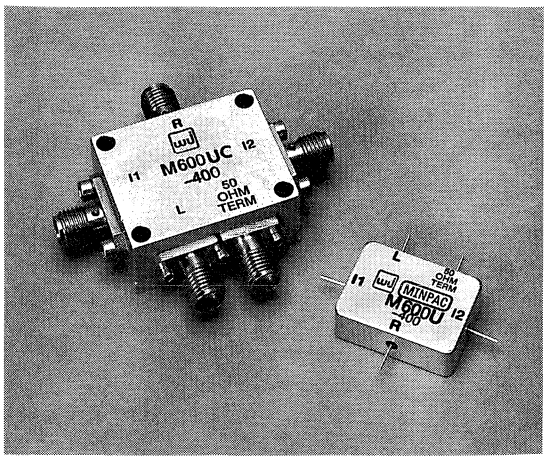

### Isolations vs. LO Frequency




12

# WJ-M600U(C) thru M1800U(C)

## SINGLE SIDEBAND UP CONVERTER QUADRATURE IF UP CONVERTER




- ◆ L0 6 TO 18 GHz 10% BANDWIDTH[1]
- ◆ RF 6 TO 18 GHz
- ◆ IF 10 TO 500 MHz[2]
- ◆ LO DRIVE +10 dBm (nominal)
- ◆ SUPERIOR SIDEBAND AND CARRIER SUPPRESSION
- ◆ LOW CONVERSION LOSS
- ◆ OCTAVE BANDWIDTH IF's[2]

*MIL–M–28837 Screening Available (See "QPL Mixers" Section)

## Guaranteed Specifications[3]

| Characteristics | Min. | Typ. | Max. | Test Conditions 10% Bandwidth |
|---|---|---|---|---|
| Conversion Loss | | 6.0 dB<br>6.5 dB<br>7.0 dB | 7.5 dB<br>8.0 dB<br>8.5 dB | 6 to 14 GHz<br>14 to 17 GHz<br>17 to 18 GHz |
| Sideband Suppression [4] | 20 dBc<br><br>18 dBc | 25 dBc<br><br>23 dBc | | 6 to 12 GHz<br>14 to 17 GHz<br>12 to 14 GHz<br>17 to 18 GHz |
| Carrier Suppression [4] | 20 dBc<br>15 dBc<br>18 dBc | 30 dBc<br>20 dBc<br>23 dBc | | 6 to 12 GHz<br>12 to 14 GHz<br>14 to 18 GHz |
| Intermodulation Suppression[4] $f_L \pm 2\,f_I$ and $f_L \pm 3\,f_I$ | 25 dBc | 35 dBc | | 6 to 18 GHz |

Notes:
1. 10% LO frequency bandwidth to be specified by the customer.
2. Denote the desired IF frequency band by replacing the "-XXX" with appropriate dash number. Options: -00 = no hybrid, -15 = 10-20 MHz 30 =20-40 MHz, -60 =40-80 MHz.-120 = 80-160 MHz,-150 -100-200 MHz, -240 =160-320 MHz, -400 = 300-500 MHz.
3. Measured in a 50-ohm system at center IF frequency with the nominal LO drive and IF power of 0 dBm at +25°C. For the -00 option, specifications apply only when both signal inputs match within ±0.4 dB in amplitude and ±2 degrees in quadrature phasing.
4. Sideband, Carrier and Intermodulation Suppression are referenced to the desired output signal.
5. The 50 ohm terminations are not supplied.

## Ordering Information

M 625 U C -XXX

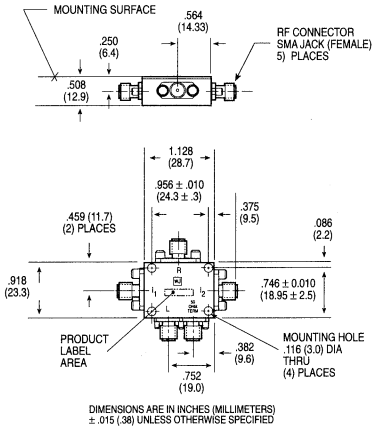
- -XXX — IF hybrid options. See Note 2.
- C — Add "C" if connectorized package is desired.
- U — Up Converter
- 625 — Model number designated by the center LO Frequency of the desired 10% band in GHz to the 100th place (Ex. 6.25 GHz).

## Absolute Maximum Ratings

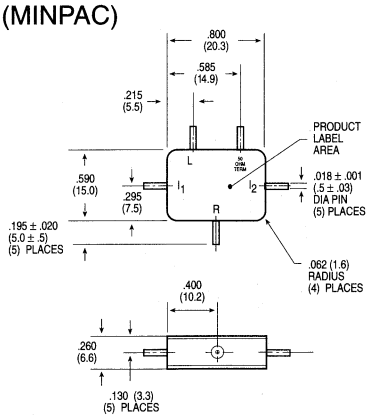
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-64°C to +100°C
Peak Input Power .....+23 dBm max. at +25°C, +20 dBm max. at +100°C
Weight Non Connectorized .....12 grams (0.42 oz.) max.
Connectorized .....37 grams (1.31 oz.) max.

## Outline Drawings

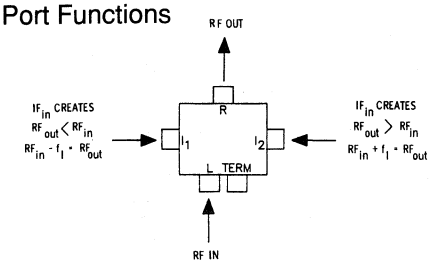
M600UC–M1800UC
(CONNECTORIZED)




M600U–M1800U
(MINPAC)




## Port Functions

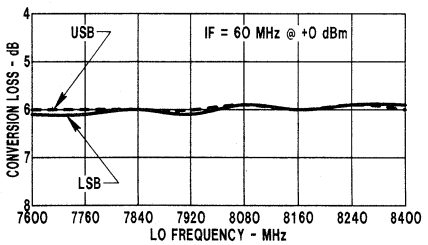



NOTE: THE UNUSED PORTS MUST BE TERMINATED WITH 50 OHM LOADS[5]

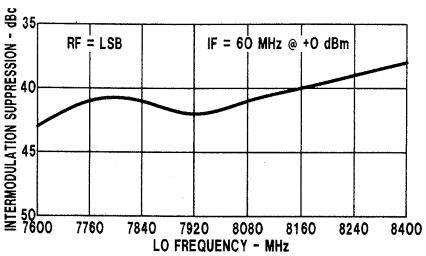
# Typical Performance at 25°C

**(M800UC-60)**

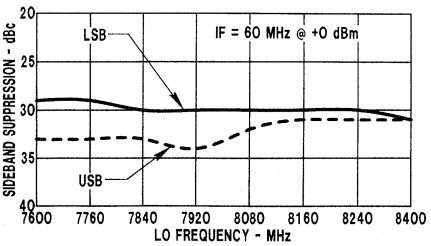
### Conversion Loss vs. LO Frequency



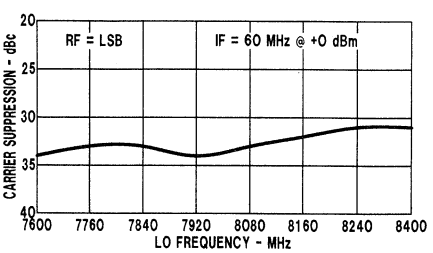

### 3 x 1 Intermodulation Supression vs. LO Frequency



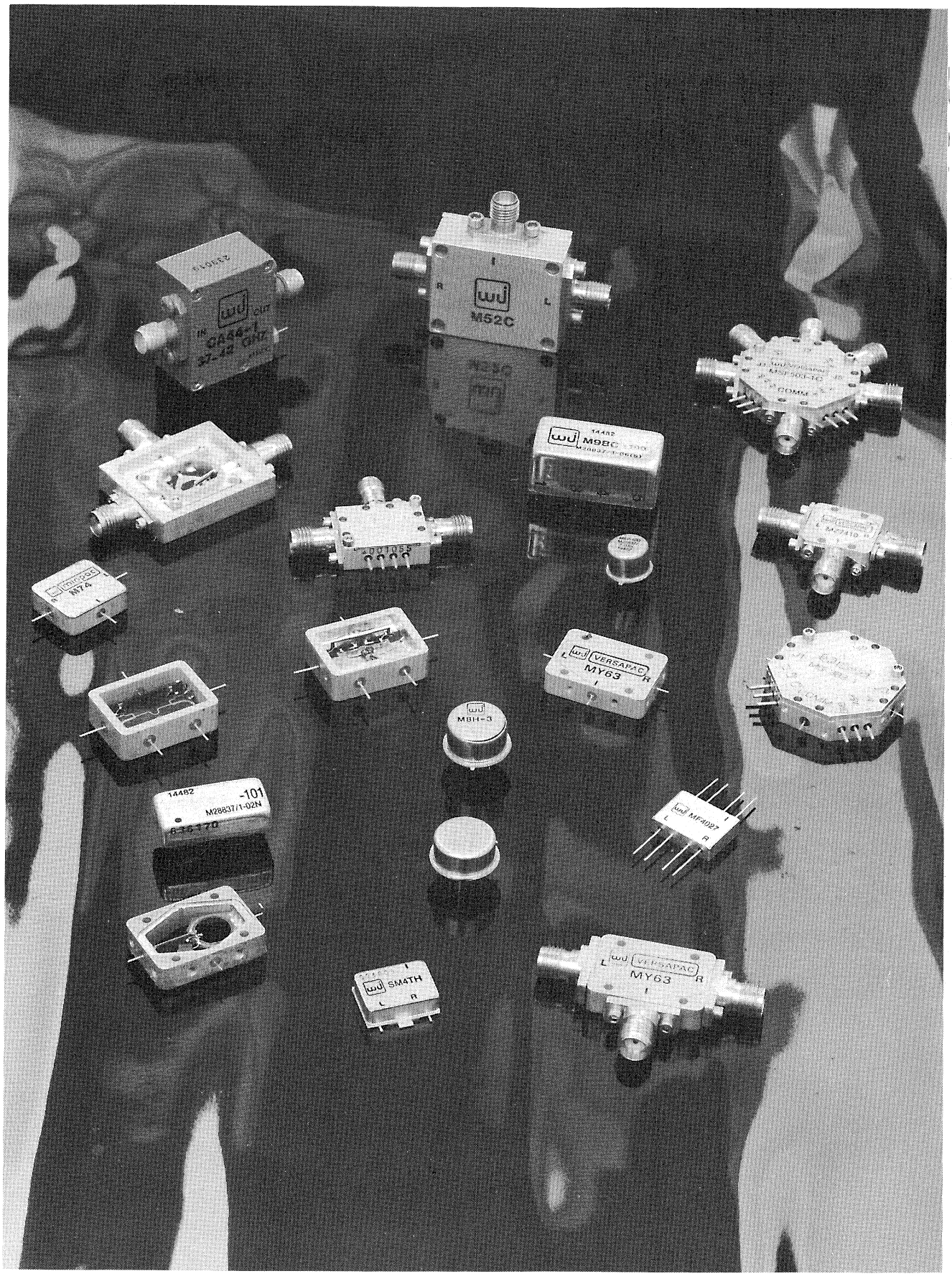

### Sideband Suppression vs. LO Frequency




### Carrier Suppression vs. LO Frequency



# QPL Mixers

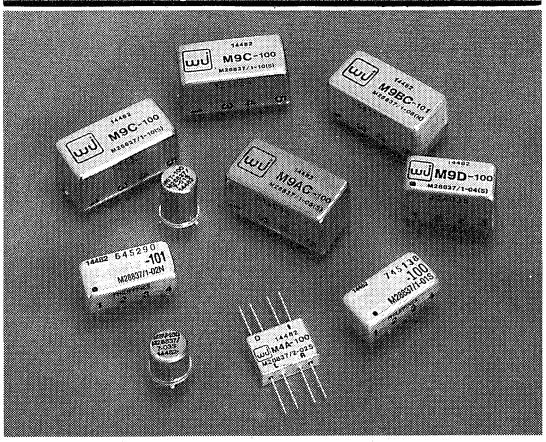

M52C
M98C
VERSAPAC
MY63
M8H-3
14482
-101
M28837/1-02N
SM4TH
VERSAPAC
MY63

# QUALIFIED TO MIL-M-28837!

QPL

**The *Cost Effective* Approach to Hi-Rel Programs**

*QPL mixers for ground, air and shipboard programs.*



## The Advantages In Specifying MIL-Qualified Mixers

- ◆ STOCK DELIVERIES
- ◆ NO ENGINEERING DOCUMENTATION REQUIRED
- ◆ NO NEED TO REQUEST NONSTANDARD PARTS APPROVAL
- ◆ MONITORED BY THE U.S. GOVERNMENT
- ◆ ATTRACTIVE PRICE
- ◆ AVAILABLE QUALIFICATION DATA

## Typical Specifications

| MIL-M-28837 | W-J Model | RF Frequency (MHz) | LO Power Nominal dBm | Conversion Loss (Noise Figure) Typ. dB | IF Frequency (MHz) | $f_R$ Level at 1 dB Compression Point Typ. dBm | Isolation Typ. dB L-R | Isolation Typ. dB L-I | Input Intercept Point Typ. dBm | Package Type | Hermetic Seal | Outline Drawing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| /1-01S | M6D-100 | 0.05-200 | 7 | 6.5 | DC-200 | 0 | 45 | 40 | 13 | PC | Yes | 298572 |
| /1-01N | M6D-101 | 0.05-200 | 7 | 6.5 | DC-200 | 0 | 45 | 40 | 13 | PC | Yes | 298572 |
| /1-02S | M6E-100 | 5-500 | 7 | 7.0 | DC-500 | 0 | 45 | 40 | 13 | PC | Yes | 298572 |
| /1-02N | M6E-101 | 5-500 | 7 | 7.0 | DC-500 | 0 | 45 | 40 | 13 | PC | Yes | 298572 |
| /2-02S | M4A-100 | 10-1500 | 7 | 7.0 | DC-1000 | 0 | 30 | 30 | 13 | Flatpack | Yes | 296960 |
| /2-02N | M4A-101 | 10-1500 | 7 | 7.0 | DC-1000 | 0 | 30 | 30 | 13 | Flatpack | Yes | 296960 |
| /7-03S | M6V-100 | 4-500 | 7 | 6.5 | DC-500 | 0 | 45 | 30 | 13 | TO-5 | Yes | 298643 |
| /7-03N | M6V-101 | 4-500 | 7 | 6.5 | DC-500 | 0 | 45 | 30 | 13 | TO-5 | Yes | 298643 |
| /1-04S | M9D-100 | 2400 | 20 | 6.5 | DC-800 | 15 | 40 | 40 | 30 | PC | Yes | 298500 |
| /1 -04N | M9D-101 | 2-400 | 20 | 6.5 | DC-800 | 15 | 40 | 40 | 30 | PC | Yes | 298500 |
| /1-06S | M9BC-100 | 0.5-500 | 17 | 7.0 | DC-500 | 8 | 55 | 45 | 23 | PC | Yes | 298640 |
| /1-06N | M9BC-101 | 0.5-500 | 17 | 7.0 | DC-500 | 8 | 55 | 45 | 23 | PC | Yes | 298640 |
| /1-10S | M9C-100 | 0.4-500 | 13 | 7.5 | DC-500 | 10 | 45 | 40 | 23 | PC | Yes | 298640 |
| /1-10N | M9C-101 | 0.4-500 | 13 | 7.5 | DC-500 | 10 | 45 | 40 | 23 | PC | Yes | 298640 |

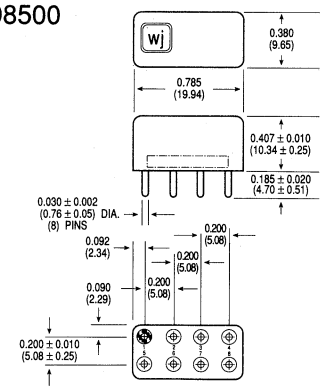
# QPL Screening

| Level "N" | Level "S" | Test | MIL-STD-202 Method | Condition | MILSTD-105 Level II AQL |
|---|---|---|---|---|---|
| | | **Prescreening** | | | |
| X | X | Preliminary Hermeticity | 112 | C, IIIA | 100% |
| | X | Bake | | 24 hrs @ +100°C | 1O0% |
| | X | Burn-in | | 96 hrs. | 100% |
| | X | Post Burn-in Electrical Test | (Note 1) | | 100% |
| | | **Subgroup I** | | | |
| X | X | Visual and Mechanical Inspection | | W-J in-house inspection criteria | 1.0 |
| X | X | Hermeticity | 112 | C, IIIA | 1.0 |
| X | X | Electrical Test | (Note 1) | | 1.0 |
| | | **Subgroup II** | | | |
| | X | Thermal Shock | 107 | B | 1.0 |
| | X | Vibration | 204 | D | 1.0 |
| | X | Hermeticity | 112 | C, IIIA | 1.0 |
| | X | Final Electrical Test | (Note 1) | | 1.0 |
| X | X | Final Quality Inspection | | W-J in-house inspection criteria | 100% |

NOTE: 1. Per the applicable MIL-M-28837 Slash Sheet.

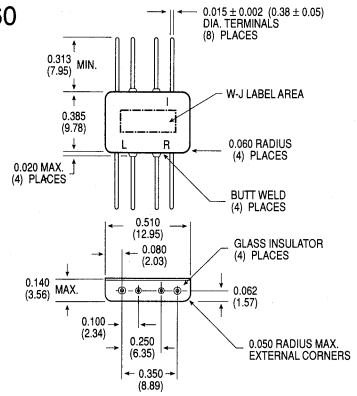
## Outline Drawings

298500



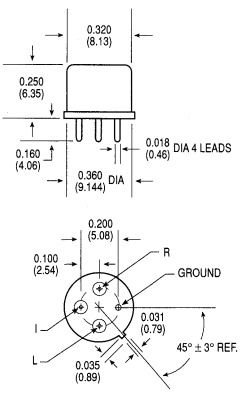

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

296960



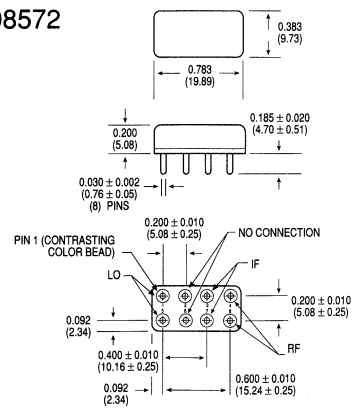

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

298643



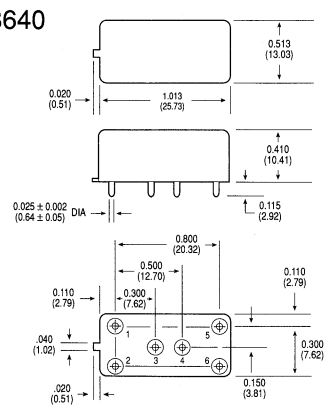

DIMENSIONS ARE IN INCHES (MILLIMETERS)
± .015 (.38) UNLESS OTHERWISE SPECIFIED

298572




DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

298640

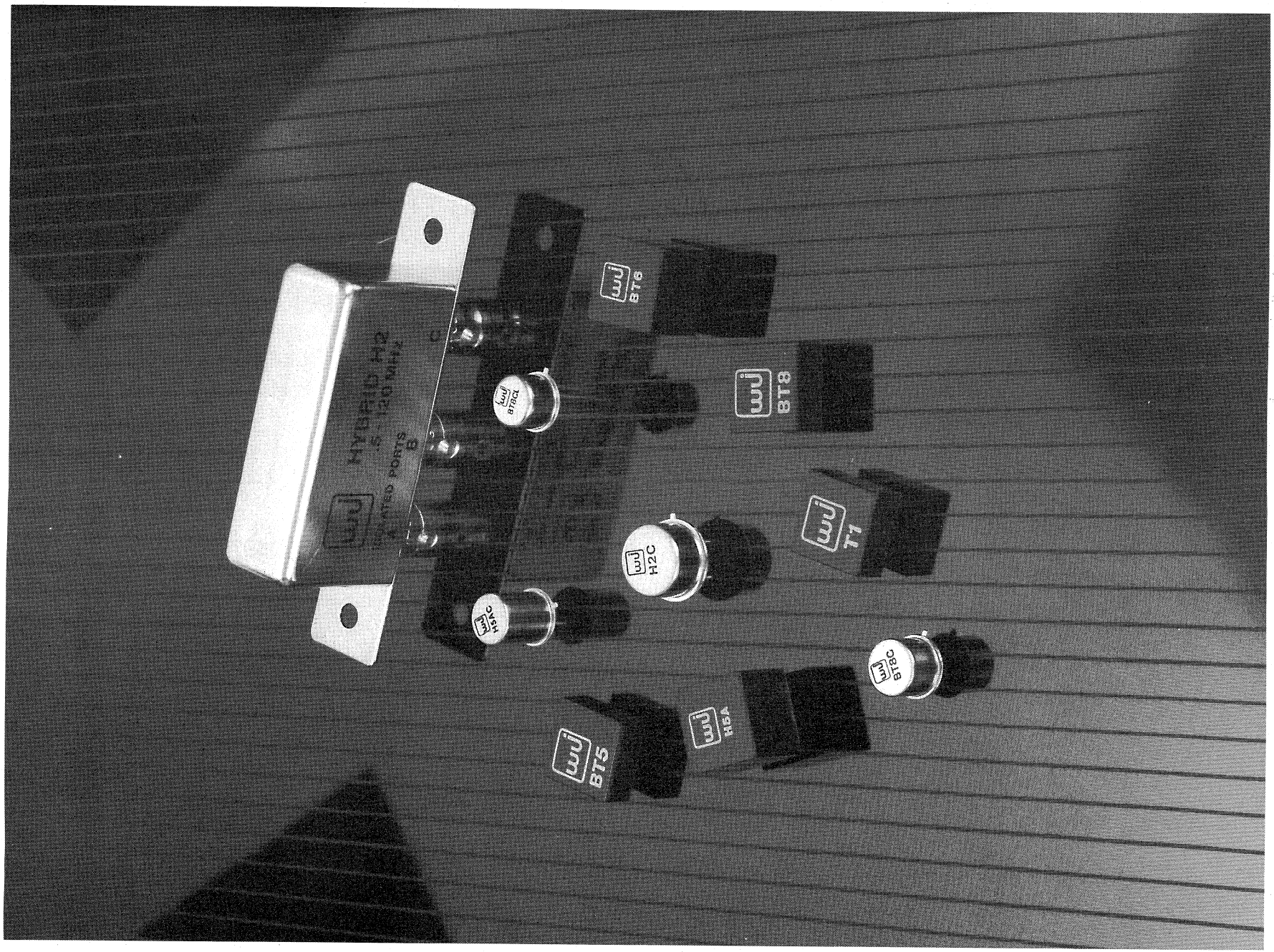



DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

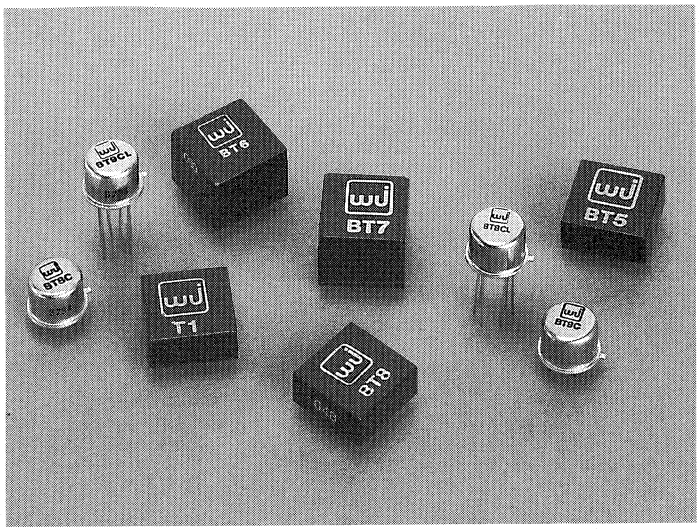
13

# *Transformers/Reactive Power Dividers/Heaters*





# Wide-Band Transformers




- ◆ LOW INSERTION LOSS
- ◆ WIDEBAND
- ◆ SMALL SIZE

**Description:** Miniature transformers are designed for low-loss operation over a very wide frequency range. They feature an insertion loss typically less than 0.5 dB, a frequency range 0.2 MHz to 700 MHz, and impedance levels from 25 ohms to 800 ohms. The BT series are balanced transformers.

## Specifications

| Model | Description | Frequency Range MHZ | Insertion Loss Max. dB | Amplitude Unbalance Max. dB | Phase Unbalance Max. Degrees | Package Type | Hermetic Seal | Outline Drawing |
|---|---|---|---|---|---|---|---|---|
| BT5 | 50 ohm-50 ohm<br>CT | 0.2-500<br>0.5-50 | 1.5<br>0.5 | 0.25<br>0.10 | - - -<br>- - - | PC | No | p |
| BT6 | 50 ohm-100 ohm<br>CT | 0.3-400<br>1-100 | 2.0<br>1.0 | 0.5<br>0.1 | - - - | PC | No | Q |
| BT7 | 50 ohm-200 ohm<br>CT, DC isolated* | 50-400<br>3-50 | 2.0<br>1.5 | 0.9<br>0.08 | 6.0<br>0.5 | PC | No | 0 |
| BT8, BT8C, BT8CL | 50 ohm-200 ohm<br>CT, DC isolated* | 50-250 | 1.5 | 0.9 | 6.0 | PC, TO-5, TO-5 | No, Yes, Yes | P, R, S |
| BT9, BT9C, BT9CL | 50-ohm-800 ohm<br>CT. DC isolated* | 1-100 | 3.0 | 0.4 | 2.6 | PC, TO-5, TO-5 | No, Yes, Yes | P, R, S |

*50 volts DC max.

## Absolute Maximum Ratings

Storage Temperature...-65°C to +100°C
Weight less than 0.2 oz.

## Maximum Input Power

1 watt rms
BT5, BT6 derate to $4f^2$ MHz Wrms below 0.5 MHz.

## Environmental

All units are guaranteed to meet their specifications over -54°C to +100°C and after exposure to any or all of the following tests per MIL-STD-202E.

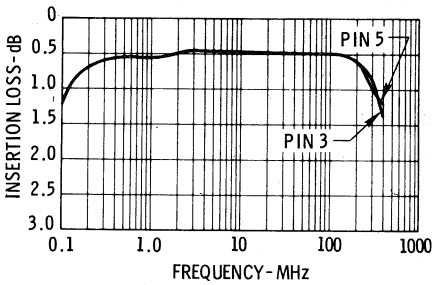
Hermetically sealed units meet the requirements of method 106D of MIL-STD-202E when exposed to humidity.

| EXPOSURE | METHOD | TEST CONDITION |
|---|---|---|
| Temperature Cycle | 102A | C |
| Thermal Shock | 107D | B |
| Altitude | 105C | G |
| H.F. Vibration | 204C | D |
| Mechanical Shock | 213B | C |
| Random Vibration (15 Minutes per axis) | 214 | IIF |
| Terminal Strength | 211A | C |
| Resistance to Soldering Heat | 210A | B |

## Typical Performance of Model BT6 at 25°C

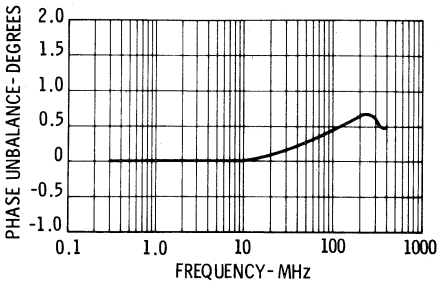
### FREQUENCY DOMAIN

**Insertion Loss**



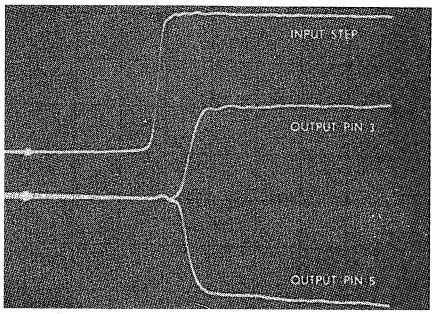

***Insertion Loss vs. Frequency:*** The BT6 has a frequency response which is typically flat to within 0.1 dB over the frequency range 0.3 MHz to 100 MHz. The amplitude balance is represented by the insertion loss difference between pins 3 and 5. For frequencies less than 100 MHz, the amplitude unbalance is typically less than 0.05 dB.

**Phase Unbalance (Deviation from 180°)**

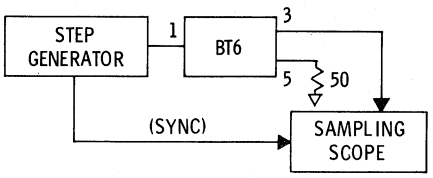



***Phase Unbalance vs. Frequency:*** The phase unbalance of the BT6 is represented by the deviation from a 180 degree phase difference between pins 3 and 5. For frequencies less than 20 MHz the phase unbalance is typically less than 0.1 degree.

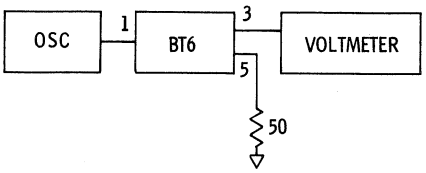
### TIME DOMAIN



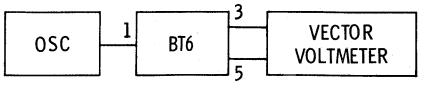

### PULSE RESPONSE TEST CIRCUIT




### INSERTION LOSS TEST CIRCUIT



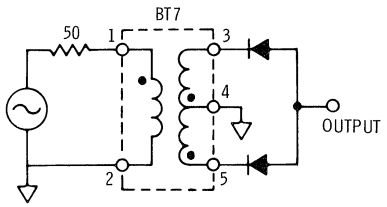

### PHASE UNBALANCE TEST CIRCUIT




***Pulse Response:*** The similarity between the input and output pulses illustrates the balance and time coherence of the BT6. With a 300 picosecond input pulse, the output pulses have rise times less than 800 picoseconds. Only the vertical position control of the oscilloscope was adjusted in recording the three traces.

## FREQUENCY DOUBLER

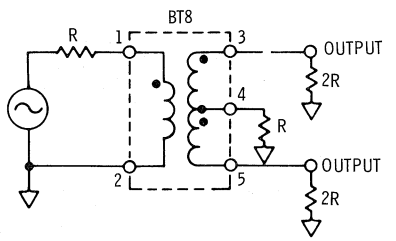
A frequency doubler can be constructed with a BT7 transformer and two matched Schottky barrier diodes. The excellent balance characteristics of the transformer will suppress the 1st and 3rd harmonics of the input 30 dB to 40 MHz and 20 dB to 300 MHz. Input frequency 5 to 300 MHz. Output frequency 10 to 600 MHz.




## 180° POWER DIVIDER

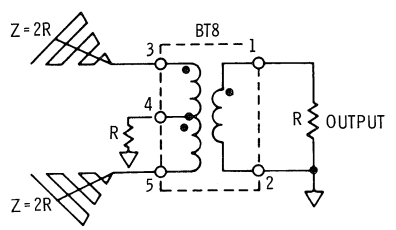
The BT8/BT8C is useful in hybrid junction applications. By applying the input to pins 1 and 2, out-of-phase outputs are available at pins 3 and 5. By applying the input to pin 4, in-phase outputs are available at pins 3 and 5. In both cases the outputs are isolated from each other.

A four-way power divider can be constructed by adding a BT5 balanced transformer to each output.



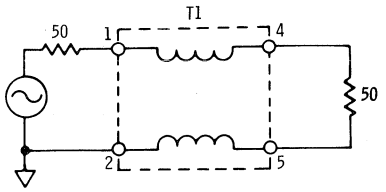

## 180° POWER COMBINER

The BT8/BT8C can be used as a power combiner. The vector sum of the inputs appears at pin 4 and the vector difference appears between pins 1 and 2. The inputs are isolated from each other.



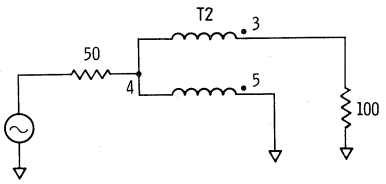

## UNBALANCED TO BALANCED DRIVE

The T1 allows an unbalanced source to drive an RF balanced load. Phase reversal is optional. It is an efficient way to suppress ground loop problems.



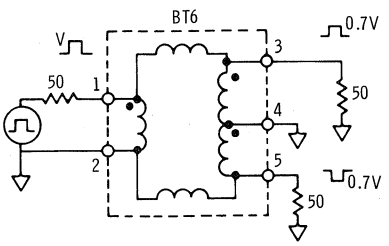

## IMPEDANCE TRANSFORMER

The T2 is useful in applications where a broadband 2:1 impedance transformation is needed and dc isolation is not required.



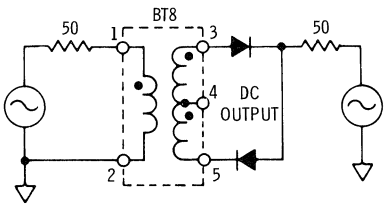

## PHASE SPLITTER

The BT6 can provide very closely matched out-of-phase signals. It is recommended in pulse applications where the rise time of the pulse must be as fast as 60 picoseconds. See typical pulse response curves on the previous page.



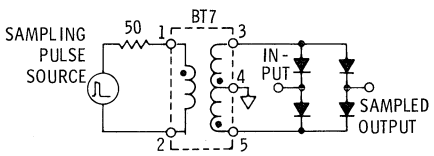

## PHASE DETECTOR

A phase detector can be constructed using a Model BT8/BT8C balanced transformer and two matched Schottky barrier diodes. The excellent balance of the transformer prevents crosstalk between the inputs. The dc output is proportional to the phase difference between inputs.




## SAMPLER

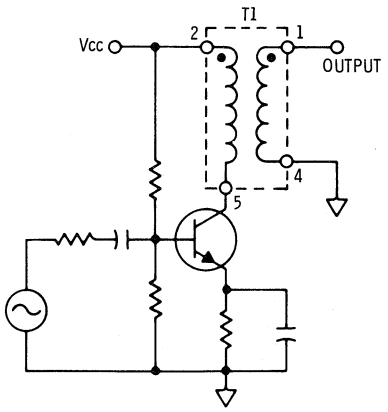
A very high frequency sampler can be constructed with a wideband balanced transformer and four sampling diodes. The Model BT7 is recommended since it has an extremely wide bandwidth and a 50 ohm to 200 ohm impedance transformation.



# Schematic Diagrams

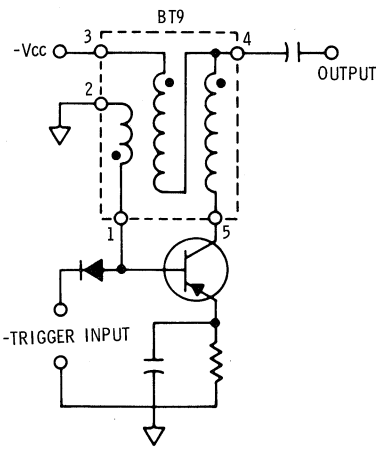
### WIDEBAND AMPLIFIER

To ac couple a wideband amplifier, a Model T1 single-ended transformer is recommended. It has dc isolation and a frequency range 0.3 MHz to 700 MHz.

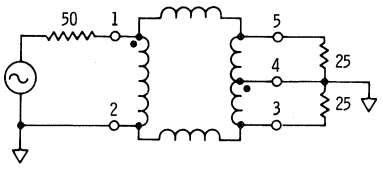



### BLOCKING OSCILLATOR

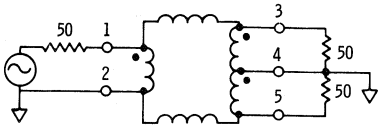
The pulse shape of a blocking oscillator can be improved with a balanced transformer. The high impedance transformation and wide frequency response of the Model BT9/BT9C make it an excellent choice.



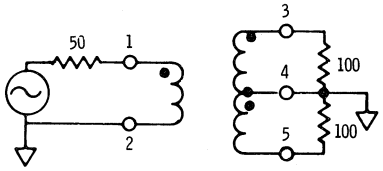

### BALANCED




**BT5**

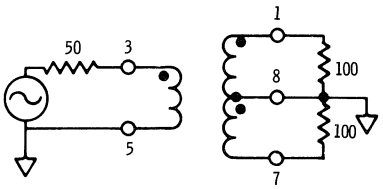



**BT6**

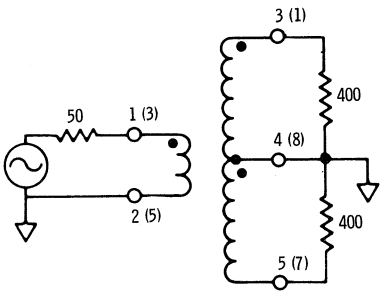



NOTE: PIN 1 AND 5 HAVE SAME POLARITY FOR BT7.

**BT7/BT8**




**BT8C**



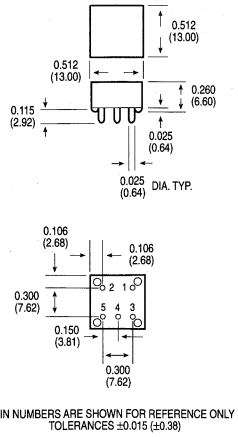

**BT9(BT9C)**

# Outline Drawings

NOTE: DIMENSIONS ARE IN INCHES (MILLIMETERS) ±.010 (.025) UNLESS OTHERWISE SPECIFIED.

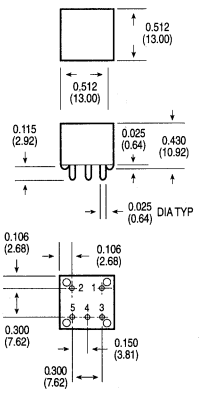
PIN NUMBERS ARE SHOWN FOR REFERENCE ONLY.

### PACKAGE P
### BT5/BT8/BT9




PIN NUMBERS ARE SHOWN FOR REFERENCE ONLY
TOLERANCES ±0.015 (±0.38)

### PACKAGE Q
### BT6/BT7




PIN NUMBERS ARE SHOWN FOR REFERENCE ONLY
TOLERANCES ± 0.015 (±0.38)

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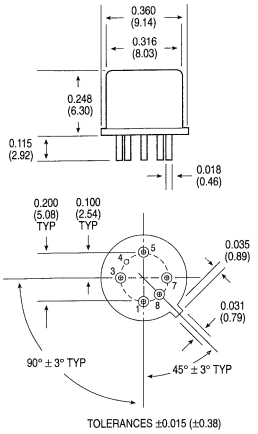
# Outline Drawings

NOTE: DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.010 (.025) UNLESS OTHERWISE SPECIFIED.

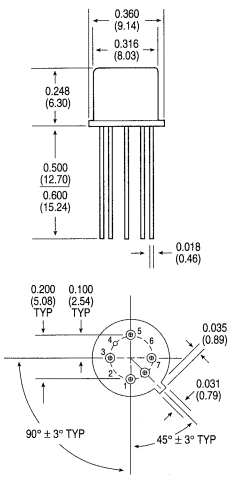
PIN NUMBERS ARE SHOWN FOR REFERENCE ONLY.

## PACKAGE R
## BT8C/BT9C



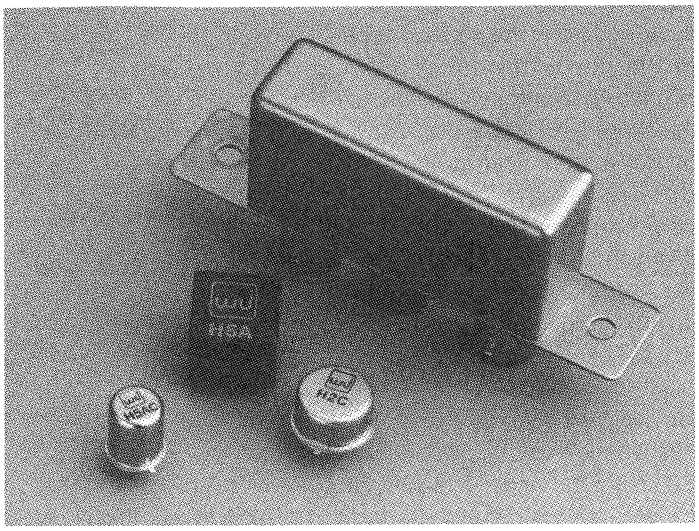

TOLERANCES ±0.015 (±0.38)

## PACKAGE S
## BT8CL/BT9CL




TOLERANCES ±0.015 (±0.38)

# Reactive Power Dividers 0.5 to 500 MHz



- ◆ HIGH ISOLATION
- ◆ LOW INSERTION LOSS
- ◆ EXCELLENT PHASE AND AMPLITUDE BALANCE
- ◆ BROADBAND
- ◆ SMALL SIZE

## Typical Specifications

| Model | Frequency MHz | Number of Ports | Nominal Phase Difference Between Output Ports | Port C PIN 4 | Impedance (Ohms) Δ A B D E - 1 2 5 6 | Minimum Isolation dB | Maximum Insertion Loss dB | Maximum Phase Unbalance Degrees | Maximum Amplitude Unbalance dB | Maximum VSWR (all ports) | Maximum Rated Power Splitter[2]/ Combiner (watts) | Package Type | Outline Drawing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2 | 0.5-120 | 3 | 0° | 50 | - 50 50 - - | 33<br>0.5-70 MHz<br>27<br>70-120 MHz | 0.6 | 1.5 | 0.2 | 1.30:1 | 1.00/<br>0.25 | BNC<br>SMA | A |
| H5A<br>H5 (AC)[1] | 0.5-120<br>(1.0-100) | 3 | 0° | 50 | - 50 50 - - | 35 (30)<br>1-60 (100) MHz<br>30<br>0.5-120 MHz | 0.5<br>(0.6) | 1.0 | 0.1 | 1.37:1 | 1.00<br>(0.50)/<br>0.25<br>(0.10) | PC Mounted<br>(TO-5) | D<br>(E) |
| H2C[1] | 10-500 | 3 | 0° | 50 | - 50 50 - - | 30<br>10-100 MHz<br>25<br>100-200 MHZ<br>20<br>200-500 MHz | 0.75 | 1.0 | 0.1 | 1.5:1<br>Port C<br>1.4:1<br>Port A, B | 1.00 | TO-8 | C |

NOTES:
1. Hermetically sealed.
2. See next page for power derating as a function of VSWR and ambient temperature.

***Description:*** Watkins-Johnson reactive power dividers have been designed for high performance over a wide frequency range. They feature an insertion loss typically less than 0.2 dB, an isolation typically greater than 40 dB, and a frequency range 0.5 MHz to 500 MHz. Amplitude balance is typically within 0.05 dB; phase balance is typically within 1.0 degrees. All the dividers are extremely linear. With two equal input signals of +10 dBm level, the third and fifth order distortion products are typically suppressed by greater than 100 dB.

**Operation**: When used as a signal splitter, multiple coherent output signals are provided with a known phase relation of equal amplitude having a power level down from the input level by the "coupling loss." Independent use of one signal by multiple loads is permitted by the high isolation between outputs. Loading effects, feedthrough, etc., are minimized. Equal power output ensures balanced feeding for applications such as multi-element antenna arrays.

When used as a signal combiner, the signal sources are isolation from each other and the output is the vector sum of the inputs reduced in amplitude by the "coupling loss." Interaction between inputs is prevented by the hybrid's high isolation.

Amplitude unbalance is the amplitude difference in dB between the outputs measured under matched impedance conditions as a signal splitter.

Phase unbalance is the phase difference (from nominal) between the outputs under matched impedance conditions as a signal splitter.

| Number of Output Ports | Coupling Loss (dB) |
|---|---|
| 2 | 3.01 |
| 3 | 4.77 |
| 4 | 6.02 |
| 5 | 6.99 |
| 6 | 7.78 |
| 7 | 8.45 |
| 8 | 9.03 |

Insertion loss is the power dissipated within the power divider under matched impedance conditions. It does not include the coupling loss. Coupling loss is the ratio between the power at the input and the power at output for an ideal power splitter under matched impedance conditions. Insertion loss must be added to the coupling loss to determine the exact output level. The coupling is a function of the number of power divider outputs.

Isolation is defined as the attenuation of "feedthrough" or "cross talk" between the isolated ports under matched impedance conditions. When there is a mismatch at the input port of the power divider, there will be degradation in isolation. Isolation degradation from a resistive mismatch at the common port is shown below the matched isolation values of ∞, 40 dB, 30 dB, and 25 dB. Values are "worst case" decibels, and have been computed on the assumption the internal resistive load is matched to the specified common port impedance. The isolated load impedances are 50 ohms.

Isolation Between Isolated Ports as a Function of the Resistive Termination at

| VSWR Input | ∞ | 40 db | 30 db | 25 db |
|---|---|---|---|---|
| 1.00 | ∞ | 40.0 | 30.0 | 25.0 |
| 1.01 | 52.1 | 38.1 | 29.3 | 24.6 |
| 1.03 | 42.6 | 35.2 | 28.2 | 23.9 |
| 1.05 | 38.2 | 33.0 | 27.2 | 23.3 |
| 1.10 | 32.4 | 29.4 | 25.1 | 21.9 |
| 1.15 | 29.1 | 26.9 | 23.5 | 20.8 |
| 1.20 | 26.8 | 25.0 | 22.2 | 19.8 |
| 1.30 | 23.6 | 22.4 | 20.2 | 18.2 |
| 1.50 | 19.9 | 19.1 | 17.5 | 16.0 |
| 1.70 | 17.6 | 17.0 | 15.8 | 14.6 |
| 2.00 | 15.6 | 15.0 | 14.0 | 13.0 |

the Common Port - For Matched Isolation Values of ∞, 40 dB, 30 dB, and 25 dB.

***Environmental:*** All units are guaranteed to meet their specifications over -54°C to +100°C, and after exposure to any or all of the following tests per MIL-STD-202E: Hermetically sealed units meet the requirements of method 106D of MIL-STD-202E when exposed to humidity.

| Exposure | Method | Test Condition |
|---|---|---|
| Temperature Cycle | 102A | C |
| Thermal Shock | 107D | B |
| Altitude | 105C | G |
| H.F. Vibration | 204C | D |
| Mechanical Shock | 213B | C |
| Random Vibration (15 Minutes per axis) | 214 | IIF |
| Terminal Strength | 211A | C |
| Resistance to Soldering Heat | 210A | B |

## Absolute Maximum Ratings

Storage Temperature: -65° C to + 100° C

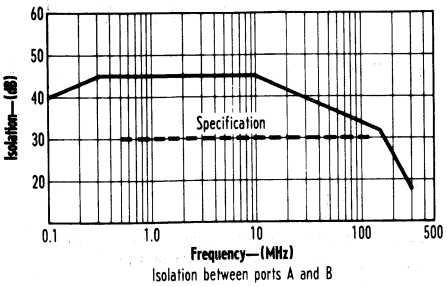
***Maximum Splitter Input Power.*** 3 Port Dividers: Rated power with load VSWRs of 1.50 or less; 0.12 rated power "worst case" with one output shorted and the other open. Applicable over temperature range -54°C to +71°C. Derate linearly to 0.5 power at +100°C.

***Maximum Combiner Input Power.*** 3 Port Combiners: Rated power with output load VSWR of 1.50 or less; 0.5 rated power with output shorted. Applicable over temperature range -54°C to +71°C. Derate linearly to 0.8 power at + 100°C.

## Typical Performance at 25°C

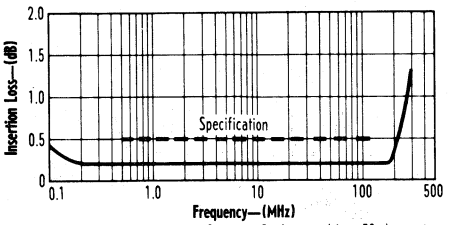
### TYPICAL PERFORMANCE OF MODEL H2 AT 25°

#### Isolation



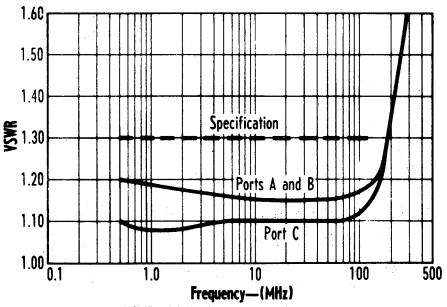
Isolation between ports A and B

#### Insertion Loss



Insertion loss of hybrid, port C to A or B when used in a 50-ohm system

#### VSWR



VSWR of hybrid ports in a 50-ohm system

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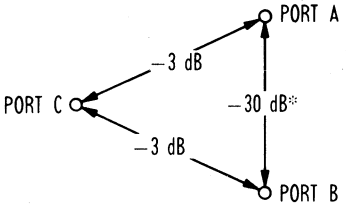
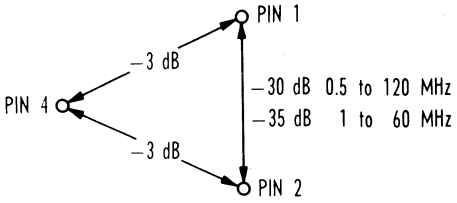
## Functional Diagrams




**(1) H2/H2C/H5AC**



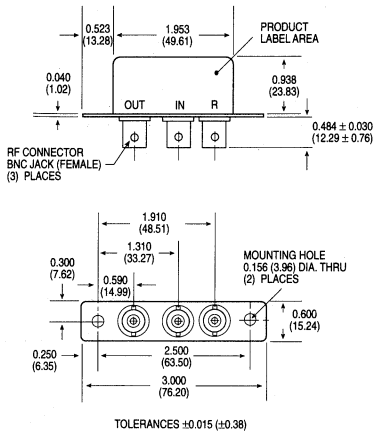

**(2) H5A**

Pins 3 and 5 are ground pins, and both must be used.

## Outline Drawings

NOTE: DIMENSIONS ARE IN INCHES (MILLIMETERS) ±.010 (.025) UNLESS OTHERWISE SPECIFIED.

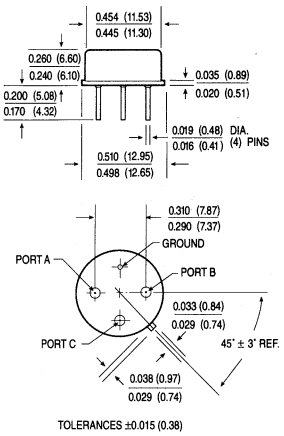
### PACKAGE A
### H2




NOTES:

1. **Connectors:** BNC Female. SMA connectors available on request.
2. **Weight:** 39.70 grams (1.4 oz.)

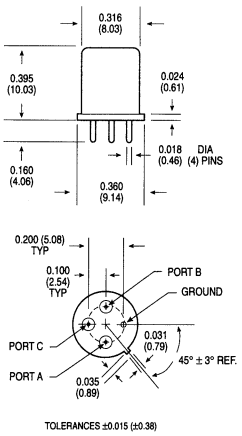
### PACKAGE C
### H2C




NOTE:

1. **Weight:** 2.0 grams (0.07 oz.)

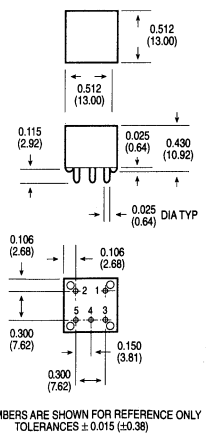
### PACKAGE E
### H5AC




NOTE:

2. **Weight:** 1.5 grams (0.05 oz.)

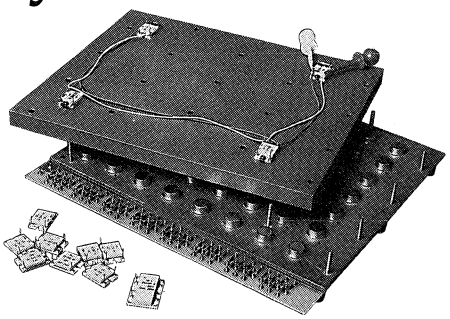
### PACKAGE D
### H5A

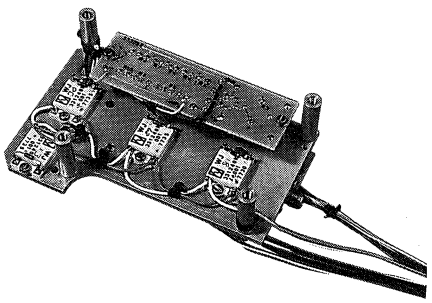



NOTES:

1. **Pin Numbers:** Shown for reference only.
2. **Weight:** 1.5 grams (0.05 oz.)

# Proportionally Controlled Heaters





**D.C.:** The WJ-331240-001 is a proportionally controlled integrated heater containing the heater, controller, voltage regulator, and automatic shutdown circuitry. The heater module is a completely self-contained hybrid circuit that can be programmed to control any surface temperature to within 10°C from 60°C to 100°C by means of a single external resistor. These modules operate from unregulated 28 volts (D.C.) power sources and provide up to 28 watts of heat. The operating temperature range for the heater module is from -54°C to +100°C with automatic shutdown at 120°C.

Each heater module is subject to the following reliability screening during manufacture:

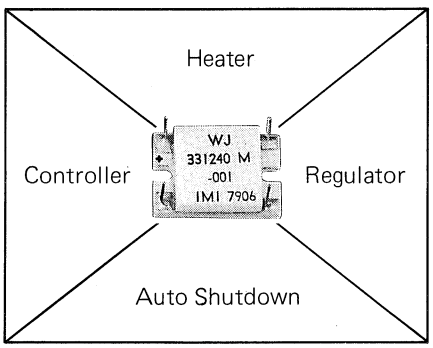
- Precap internal visual per MIL-STD-883, Method 2010, Test Condition B.
- High temperature stabilization bake per MIL-STD-883, Method 1008, Test Condition B, 48 hours.
- Temperature cycling per MIL-STD-883, Method 1010, Test Condition B.
- Constant acceleration per MIL-STD-883, Method 2001, Test Condition B, $Y_1$ axis only.

The heater circuit is floating so that currents will not affect system ground voltages. The WJ-331240-001 is protected against reverse voltages up to 50 Vdc.

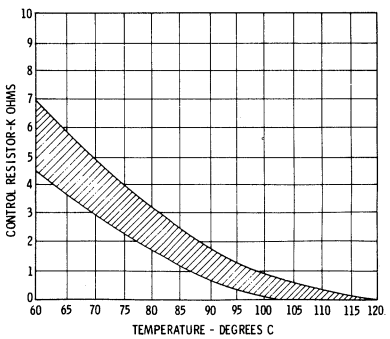
**A.C.:** The WJ-333189-001 is a proportionally controlled integrated A.C. heater containing all the features and performance characteristics of the D.C. models. The A.C. heater operates from 100 to 125 VAC, 50 to 400 Hz. Voltages from 0 to 150 VAC continuous can be sustained without damage to the unit. Package size for the A.C. heater is .985 x .760 x .180 inches (2.50 x 1.93 x .457 cm).

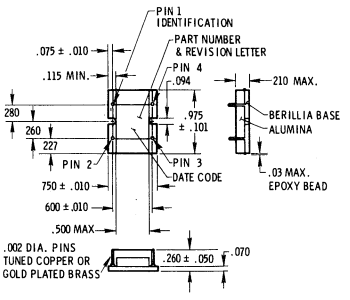
Each heater module is subject to the same reliability screening as are the D.C. heaters.

### Self-Contained



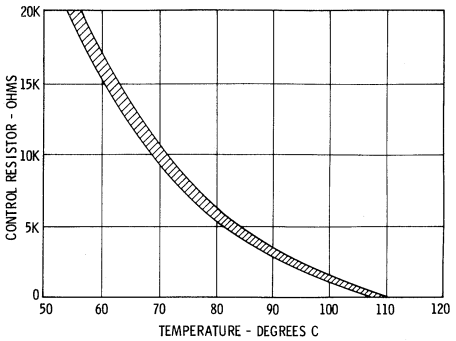

### (A.C. WJ-333189-001)

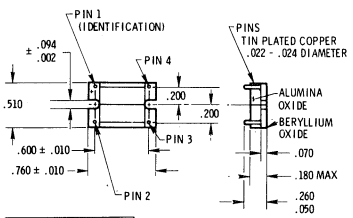



| PIN NO. | FUNCTION |
|---|---|
| 1 | 115 VAC |
| 2 | 115 VAC |
| 3 | CONTROL |
| 4 | CONTROL RTN |

### (D.C. WJ-331240-001)



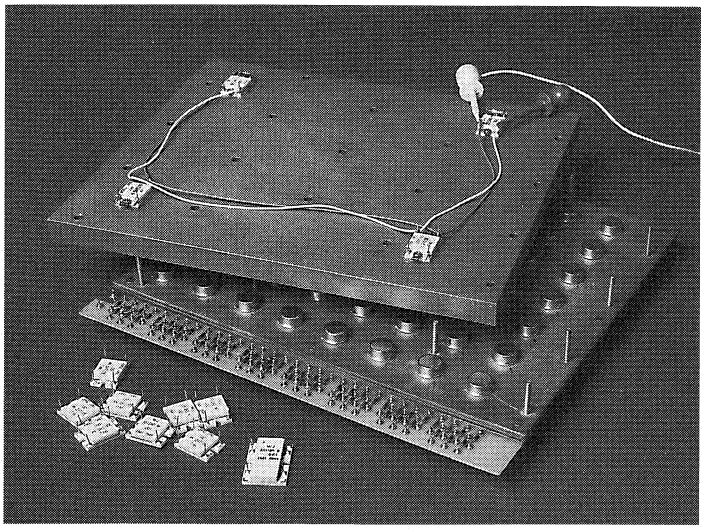

| PIN NO. | FUNCTION |
|---|---|
| 1 | +28 VDC |
| 2 | DC RETURN |
| 3 | CONTROL |
| 4 | CONTROL RTN |

Typical 1/8 watt control resistor values required to set heaters to a given temperature are illustrated by the graphs. With the control loads shorted, the unit temperature will not exceed 120°C.

# WJ-331240-001

## PROPORTIONALLY CONTROLLED DC HEATER MODULE

◆ (Hi-Rel version, WJ-331240-000 also available.)



## Guaranteed Specifications

**Temperature Regulation**

Control Range[1] .....+60°C to +100°C
Temperature Variation With Load .....10°C, Max.
Temperature Variation Over Operating Voltage Range (Constant Load) .....2°C, Max.
Automatic Shutdown Temperature
(Any Control Resistance, Any Voltage) .....120°C, Max.

**Electrical Requirements**

Operating Voltage Range.....24.0 to 28.5 Vdc
Voltage Limits[2] .....22.5 Vdc, Min.
34.0 Vdc, Max.
Operating Current, Steady-state .....0.015 to 1.00 amps
Turn-on Current Range .....0.85 to 1.00 amps

**Environment**

Temperature
Operating[3].....- 54°C to +100°C
Non-operating .....-65°C to +125°C
Altitude .....70,000 ft., Max.
Shock.....20G, Max.
Vibration .....50G at 2,000 Hz, Max.
Humidity[4].....Greater than 95 percent

**Reliability Screening**

Each heater module is subject to the following reliability screening during manufacture:

1. Precap internal visual per Mi L-STD-883, Method 2010, Test Condition B.
2. High temperature stabilization bake per MIL-STD-883, Method 1008, Test Condition B, 48 hours.
3. Temperature cycling per MIL-STD-883, Method 1010, Test Condition B.
4. Constant acceleration per MIL-STD-883, Method 2001, Test Condition B, $Y_1$ axis only.

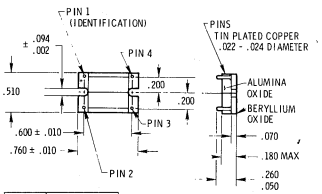
**Mechanical**

Markings .....Part Number, Mfg. Date Code, Pin No. 1 (Positive 28 Vdc)
Outline and Mounting Dimensions .....Per drawing

NOTES:
1. The WJ-331240-001 is protected against reverse voltages up to 50 Vdc.
2. Operation is possible over the range +100°C to +120°C, but electrical performance is not guaranteed. Input current decays to 15 mA at +120°C without damage to unit.
3. Heaters are hermetically sealed to meet MIL-STD-883, Method 1014, Test Condition C, Step 1, and Method 1014, Test Condition A or B. Maximum measured leak rate 1 x $10^{-6}$ atm-cc/sec.
4. Optimum thermal performance is obtained by using a heat sink compound such as Dow Corning 340 on the mounting surface.

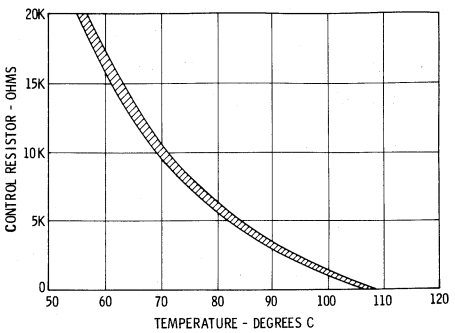
The WJ-331240-001 Heater Module is a self-contained hybrid circuit heater that can be programmed to control to any temperature from 60 to 100 degrees Celsius by means of a single external resistor. These modules operate from unregulated 28 volt (D.C.) power sources and provide up to 28 watts of heat through an electronically insulating ceramic mounting surface. Larger thermal loads may be accommodated by the use of several modules operated in parallel.

## Outline Drawing




| PIN NO. | FUNCTION |
|---|---|
| 1 | +28 VDC |
| 2 | DC RETURN |
| 3 | CONTROL |
| 4 | CONTROL RTN |

**Control Resistor Values**




Typical control resistor values required to set the WJ-331240-001 to a given temperature are given by the graph. With the control loads shorted, the unit temperature will not exceed 120°C.

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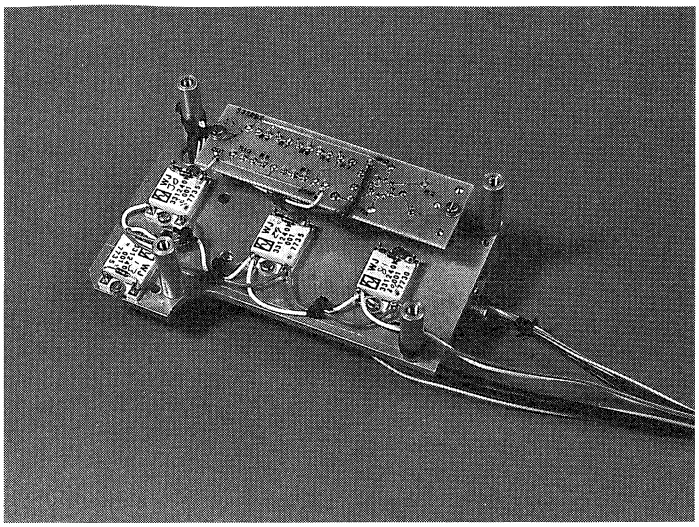
# WJ-333189-001

## PROPORTIONALLY CONTROLLED AC HEATER MODULE

◆(Hi-Rel version, WJ-333189-000 also available.)



## Guaranteed Specifications

### Temperature Regulation

Control Range[1] .....+60° to +100°C
Temperature Variation With Load[2] .....10°C, Max.
Temperature Variation Over Operating Voltage[3] .....2°C, Max.

### Electrical Requirements

Operating Voltage Range .....100 to 125 VAC, 50 Hz to 400 Hz
Voltage Limits[4] .....0 to 1% VAC
Operating Current, Steady-state .....015 to.30 Amps
Turn-on Current Range (at 115 VAC) .....25 to.30 Amps

### Environment

Temperature
Operating[5] .....-54° to +100°C
Non-operating .....-65° to +125° C
Altitude .....70,000 ft., Max.
Shock (11 ms half sine wave) .....20 G, Max.
Vibration .....50G at 2,000 Hz, Max.
Humidity[6] .....0 to 90 percent including condensation

### Reliability Screening

Each heater module is subjected to the following reliability screening during manufacture:

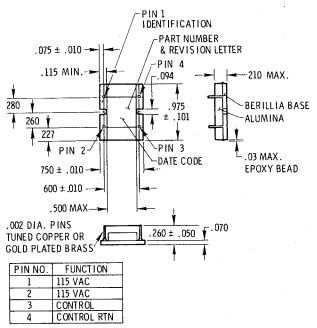
1. Precap internal visual per MIL-STD-883, Method 2010, Test Condition B.
2. High temperature stabilization bake per MIL-STD-883, Method 1008, Test Condition B, 48 hours.
3. Temperature cycling per MIL-STD-883, Method 1010, Test Condition B.
4. Constant acceleration per MIL-STD-883, Method 2001, Test Condition B, Y axis only.

NOTES:

1. Maximum temperature variation for current change from 20 mA to 95 percent of turn-on current at 115 VAC.
2. Maximum temperature variation for a voltage change from 100 to 125 VAC or frequency change from 60 to 400 Hz when the ambient temperature is constant and the current is between 20 mA and 95 percent of turn-on current.
3. Continuous application of voltages within this range will not damage the heater.
4. Operation is possible over the range +100°C to +120°C, but electrical performance is not guaranteed. Input current decays to 20 mA max. at +120°C without damage to unit as long as properly heat sunk.
5. Heaters are hermetically sealed to meet MI L-STD-883, Method 1014, Test Condition C, Step 1, and Method 1014, Test Condition A or B. Maximum measured leak rate 1 X $10^{-6}$ atm-cc/sec.
6. Optimum thermal performance is obtained by using a heat sink compound such as Dow Corning 340 on the mounting surface.

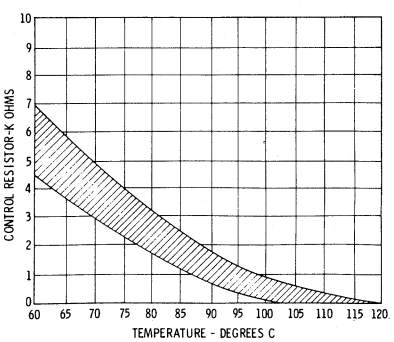
The WJ-333189-001 Heater Module is a self-contained hybrid circuit heater that can be programmed to control to any temperature from 60° to 100°C by means of a single external resistor. These modules operate from an unregulated 11 5 Volt (A.C.) power source and provide nominally 28 watts of heater power through an electrically insulated ceramic mounting surface. Larger thermal loads may be accommodated by the use of several modules operated in parallel.

## Outline Drawing




| PIN NO. | FUNCTION |
|---|---|
| 1 | 115 VAC |
| 2 | 115 VAC |
| 3 | CONTROL |
| 4 | CONTROL RTN |

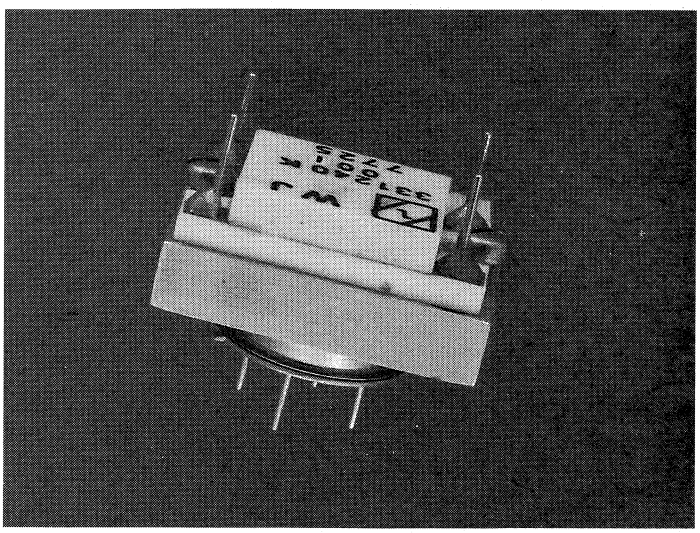
### Control Resistor Values




Typical control resistor values required to set the WJ-333189-001 to a given temperature are given by the graph. Minimum power rating of control resistor: 1/8 watt. Precise resistor values should be determined by measuring the mounting surface temperature.

# WJ-334334

## PROPORTIONALLY CONTROLLED TO-8 HEATER MODULE



## Guaranteed Specifications

**Temperature Regulation**

Control Range[1] .....+60°C to +100°C
Automatic Shutdown Temperature
(Any Control Resistance, Any Voltage) .....120°C

**Electrical Requirements**

Operating Voltage Range .....24.0 to 28.5 VDC
Voltage Limits[2].....22.5 VDC, Min. ; 34.0 VDC, Max.
Operating Current, Steady-state .....0.015 to 1.00 amps
Turn-on Current Range .....0.85 to 1.00 amps

**Environment**

Temperature
Operating .....54°C to +100°C
Non-operating .....-65°C to +125°C
Altitude .....70,000 feet, Max.
Shock.....20G, Max.
Vibration .....50G at 2,000 Hz, Max.
Humidity[4].....Greater than 95 percent

**Reliability Screening**

Each TO-8 heater module is subject to the following reliability screening during manufacture:

1. Precap internal visual per MI L-STD-883, Method 2010, Test Condition B.
2. High temperature stabilization bake per MI L-STD-883, Method 1008, Test Condition B, 48 hours.
3. Temperature cycling per MIL-STD-883, Method 1010, Test Condition B.
4. Constant acceleration per Mi L-STD-883, Method 2001, Test Condition B, Y1 axis only.

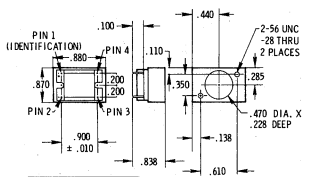
Mechanical

Markings.....Part Number, Mfg. Date Code, Pin No. 1 (Positive 28 VDC)
Outline and Mounting Dimensions .....Per drawing

NOTES:
1. The WJ-334334 is protected against reverse voltages up to 50 VDC.
2. Operation is possible over the range +100°C to +120°C, but electrical performance is not guaranteed. Input current decays to 15 mA at +120°C without damage to unit.
3. Heaters are hermetically sealed to meet MIL-STD-883, Method 1014, Test Condition C, Step 1, and Method 1014, Test Condition A or B. Maximum measured leak rate 1 x $10^{-6}$ atm-cc/sec.
4. Optimum thermal performance is obtained by using a heat sink compound such as Dow Corning 340 on the mounting surface.

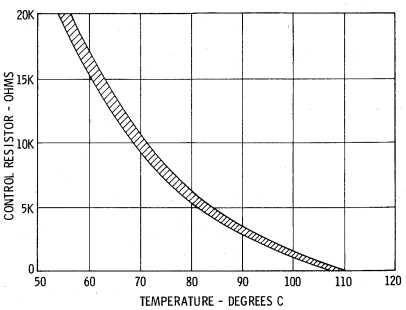
The WJ-334334 TO-8 Heater Module is a self-contained hybrid circuit heater than can be programmed to control to any temperature from 60° to 100° Celsius and mounts directly on top of a TO-8 component. These modules operate from unregulated 28 volt (D.C.) power sources and provide up to 28 watts of heat to control the component's temperature.

## Outline Drawing




| PIN NO. | FUNCTION |
|---|---|
| 1 | +28 VDC |
| 2 | DC RETURN |
| 3 | CONTROL |
| 4 | CONTROL RTN |

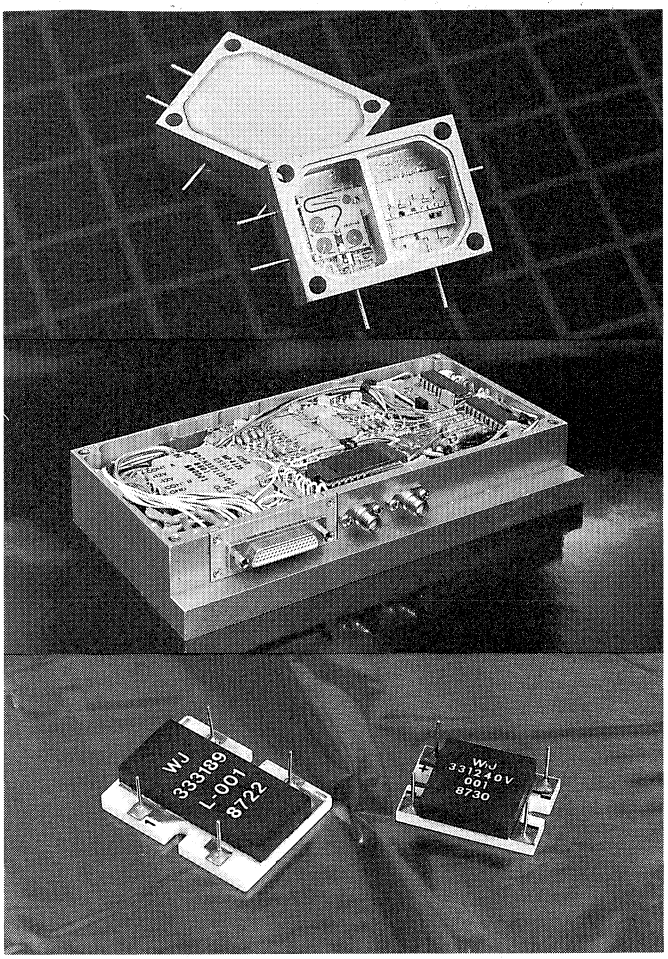
**Control Resistor Values**




Typical control resistor values required to set the WJ-334334 to a given temperature are given by the graph. With the control leads shorted, the unit temperature will not exceed 120°C.

14

# Voltage-Controlled Oscillators and Heaters




### Voltage-Controlled Oscillators

Watkins-Johnson Company offers a complete line of oscillators products: voltage-controlled oscillators (VCOs), digitally tuned oscillators, fixed-frequency oscillators (including dielectic resonator oscillators, or DROs), low-noise oscillators, phase-locked oscillators, comb generators/oscillator multipliers, and integrated oscillator subsystems.

These oscillators find application in EW systems, including ECM/ESM receivers and ECM jammers, guidance and fuse systems in missiles, radar systems, and communications systems.

Watkins-Johnson Company's VCO development and production facilities are at its Palo Alto, California, plant. Over 60,000 square feet are dedicated to the VCO product line and include extensive computer-controlled test facilities, environmental testing facilities, and MIL-STD-883C screening capability. In addition to maintaining a quality system which meets MIL-I-45208 and MIL-Q-9858, Watkins-Johnson has supplied hardware in compliance with WS6535 on specific major programs.

### Capabilities

For more than two decades Watkins-Johnson Company has maintained a complete product development laboratory and manufacturing facilities for voltage controlled oscillators. To meet the ever advancing technology requirements for VCOs substantial time and resources are continually invested to acquire highly sophisticated equipment and the most knowledgeable technical personnel.

To support oscillator design work and perform final acceptance tests, Watkins-Johnson maintains computer facilities at the Palo Alto Plant with a variety of design programs and extensive computer controlled test equipment. Such capability is essential to provide the performance improvements and extensive testing required for today's oscillators.

Training courses are conducted periodically to ensure that workmanship and soldering in the VCO products are of the highest quality. In addition, for the microwave circuits special workmanship standards have been implemented.

To insure that the VCO products are reliable, Watkins-Johnson maintains environmental test and screening facilities at the Palo Alto Plant to perform random and sine vibration, thermal shock, temperature cycling, and altitude tests.

### Heaters—AC, DC and TO-8

When your hardware or system has difficulty meeting specifications over a wide operating temperature range, Watkins-Johnson Company offers a very unique low cost AC or DC heater as the solution. Our AC heater module operates from 100 to 125 volts, 50 to 400 Hz, and the DC heater module operates from 28 volts. By means of an external control resistor, both devices can control their mounting surface at any temperature between +60°C and +100°C, within 10°C. These modules feature an automatic regulator, controller and heater; shutdown at +120°C; and, are designed for operation over the -54°C to +100°C temperature range. These heaters are available screened to MIL-STD-883. Please refer to Section 14 for technical information.

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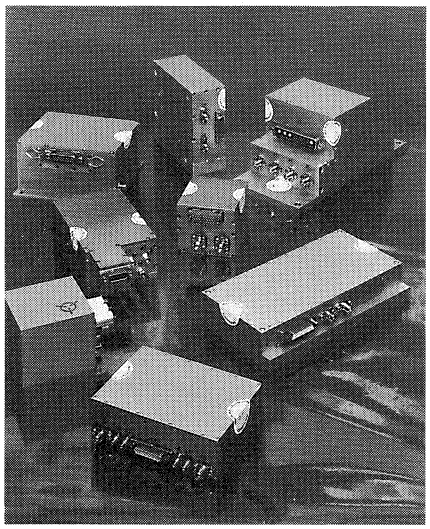
If we can be of any further assistance, please do not hesitate to contact our Voltage Controlled Oscillator Applications Engineering Department at (415) 493-4141 or our Watkins-Johnson Company Field Sales Engineer in your area.

# Voltage-Controlled Oscillators



A diverse number of VCOs are available, depending on the application, in the 0.5 to 18 GHz frequency range. Some of the options available include:

Varactor
- Hyperabrupt (0 to 20 Volts)
- Abrupt (0 to 60 Volts)

Active Device
- Bipolar transistor (low noise, low-post-tuning drift)

GaAs FET Buffer Amplifiers
Ferrite Isolators
Voltage Regulators
AC or DC Heaters
Linearizers (DC to 20 MHz)
Filters (Microwave)
Couplers for Multiple Outputs
BIT Outputs
PIN Diode Switches

Units may be optimized for post-tuning drift, modulation-sensitivity variation, and/or phase noise to meet a particular requirement.

### Digitally Tuned Oscillators (WJ-2850 Series)

Watkins-Johnson Company offers a wide variety of DTOs from 0.5 to 18 GHz. Each unit includes a hyperabrupt varactor-tuned oscillator, followed by GaAs FET amplifiers for load isolation and to increase the power output to the desired level. In addition, voltage regulators are included to reduce frequency pushing and to protect the sensitive microwave-active devices. Heaters are also included to limit the frequency drift over temperature.

A PROM corrected digital input circuit is often included to improve the frequency accuracy (nonlinearity and frequency drift over temperature) to less than ±10 MHz. In addition, modulation inputs may be provided that have bandwidths out to 40 MHz, including variable-gain amplifiers, which maintain the variation in modulation sensitivity within ±5%. The post-tuning drift from one microsecond to 100 milliseconds is typically 1-2 MHz.

### Fixed-Frequency Oscillators... Including DROs (WJ-2940 Series)

Many different fixed-frequency oscillators are available in the 1 to 20 GHz frequency range, including units with multiple oscillators, PIN diode switches, voltage regulators, and GaAs FET buffer amplifiers. These units are typically capable of operating over the full -55° to +85°C temperature range and maintaining frequency accuracies of ±1 MHz.

### Phase-Locked Oscillators (WJ-2910 Series)

Watkins-Johnson Company provides phase-locked oscillators operating at frequencies across the 0.5 to 20 GHz range. They are capable of excellent phase-noise characteristics typically less than -120 dBc/Hz at 100 Hz offset. In addition, these units may include internal crystal oscillators, GaAs FET T buffer amplifiers, and lock indicators.

### Comb Generators/Oscillators Multipliers (WJ-2950 Series)

Watkins-Johnson Company also offers comb generators and oscillator/ multipliers. The comb generators include a low-frequency crystal oscillator, followed by an amplifier, step-recovery diode, and output filter/matching circuit. These devices are capable of providing outputs every 100 MHz with a minimum of -30 dBm at 18 GHz.

The oscillator/multipliers include an oscillator followed by frequency-selective multiplier circuits to provide outputs at multiple frequencies.

### Integrated Oscillators Subsystems

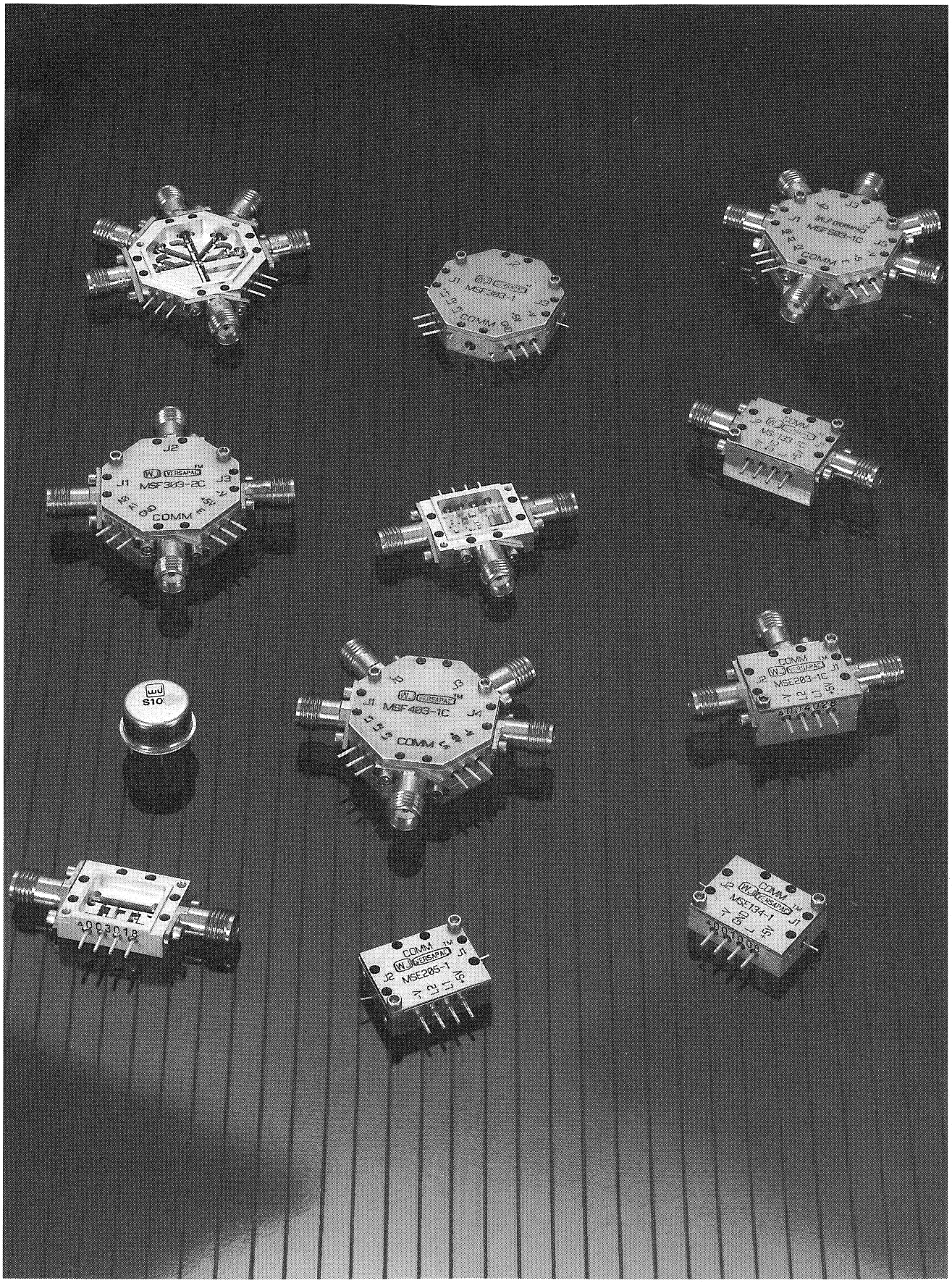
Watkins-Johnson Company is also capable of integrating various oscillator and related components, including oscillators, switches, amplifiers, couplers, filters, and complex input driver circuits. In addition, Watkins-Johnson Company can provide ramp generators, noise modulators, FM modulators, AM modulators, and digital attenuators in the oscillator assembly.

### Low-Noise Oscillators (WJ-2930 Series)

Watkins-Johnson Company offers the WJ-2930 series of miniature, low-noise oscillators. These units operate over the 1.0 to 8.0 GHz frequency range and exhibit very low phase-noise characteristics, typically -110 dBc/Hz at 100 kHz offset.

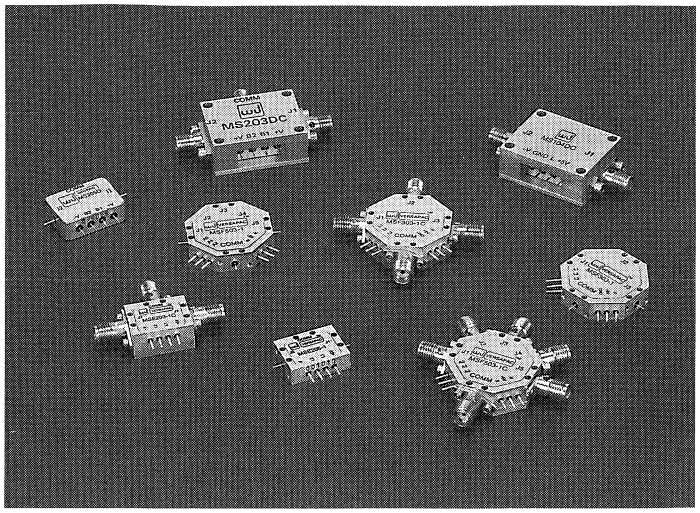
They are housed in a small 0.25" x 0.59" x 0.8" package and include an oscillator that employs a hyperabrupt varator followed by a three-stage feedback amplifier.

# Switches


MSF303-1
MSF303-2C
MSF403-1C
MSF503-1C
MSF133-1C
MSF203-1C
MSF134-1
MSF205-1
COMM
VERSAPAC

# Microwave PIN Diode Switches

- ◆ 0.5 TO 18 GHz
- ◆ SPST TO SP5T
- ◆ MINIATURE HERMETIC PACKAGES
- ◆ GUARANTEED PERFORMANCE



*Description:* Watkins-Johnson's "MS" series of microwave PIN diode switches covers the full 0.5 to 18 GHz frequency range in two primary bands: 0.5 to 4 GHz and 2 to 18 GHz. Within these two bands various models are offered which provide SPST through SP5T functions. Additionally, a SPDT .5-4 GHz nonreflective version is available. All switches are designed to achieve the optimum balance between low insertion loss and high isolation while maintaining the fastest possible switching time performance. Package options include the industry standard MINPAC® for the SPDT nonreflective model and Watkins-Johnson's VERSPAC® for SPST through SP5T functions.

*Construction:* The "MS" series is designed and manufactured for quality and reliability emphasizing high performance. Working in an ESD protected and cleanliness-controlled environment, assembly begins with attaching a low-loss, low-dielectric, soft substrate in a forming gas atmosphere. The soft-substrate, crucial to RF performance, allows for complete channelization of individual arms in the switch. All circuit interconnections are made using gold-gold thermosonic bonding which produces consitent bond strengths typically four times that required by Mil-Standards. The final product is 100% visually inspected before being hermetically sealed in a dry-nitrogen atmosphere.

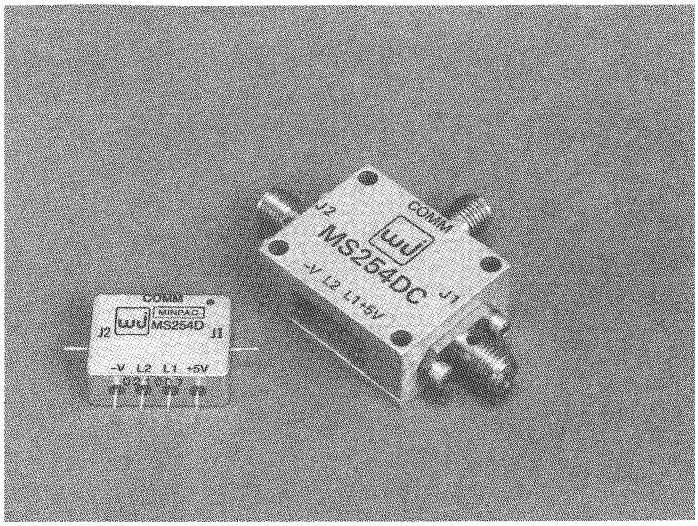
## Guaranteed Specifications[1] PIN Diode Switches

| Model | Description | Frequency Range (GHz) | Insertion Loss (dB) Max. | VSWR Max. | Isolation (dB) Min. | Switching Speed (nsec) Max.[2] | Outline Drawing |
|---|---|---|---|---|---|---|---|
| MSE133 | SPST, Reflective | 2-18 | 2.2 | 2.0:1 | 70 | 20 | 297511 |
| MSE134 | SPST, Reflective | 0.5-4 | 1.2 | 1.5:1 | 50 | 40 | 297511 |
| MSE203 | SPDT, Reflective | 2-18 | 2.7 | 2.0:1 | 55 | 25 | 297507 |
| MSE205 | SPDT, Reflective | 0.5-4 | 1.5 | 1.5:1 | 70 | 40 | 297507 |
| MS254 | SPDT, Non-reflective | 0.5-4 | 1.6 | 1.6:1 | 60 | 40 | 296841 |
| MSF303 | SP3T, Reflective | 2-18 | 3.1 | 2.2:1 | 55 | 25 | 297508 |
| MSF305 | SP3T, Reflective | 0.5-4 | 1.5 | 1.5:1 | 70 | 40 | 297508 |
| MSF403 | SP4T, Reflective | 2-18 | 3.3 | 2.3:1 | 70 | 25 | 297509 |
| MSF405 | SP4T, Reflective | 0.5-4 | 1.5 | 1.5:1 | 70 | 40 | 297509 |
| MSF503 | SP5T, Reflective | 2-18 | 3.3 | 2.3:1 | 70 | 25 | 297510 |
| MSF505 | SP5T, Reflective | 0.5-4 | 1.5 | 1.5:1 | 70 | 40 | 297510 |

NOTES:
1. Measured in a 50-ohm system and at +25°C case temperature.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.

# WJ-MS254

## SINGLE-POLE DOUBLE-THROW NON-REFLECTIVE PIN-DIODE SWITCH




- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ MINPAC™ , HERMETIC PACKAGE
- ◆ SMA CONNECTORIZED HOUSING
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to + 100°C |
|---|---|---|
| Frequency Range, Min. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | | |
| 0.5-4.0 GHz | 1.6 dB | 1.7 dB |
| Input/Output VSWR, Max. | | |
| 0.5-4.0 GHz | 1.6:1 | 1.7:1 |
| Isolation, Min. | | |
| 0.5-2.0 GHz | 65 dB | 63 dB |
| 2.0-4.0 GHz | 60dB | 58 dB |
| Switching Time[2] Max. | 40 nsec | 43 nsec |

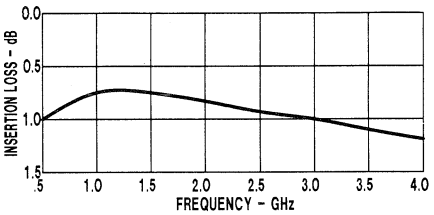
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +20 dBm minimum.

## Absolute Maximum Ratings

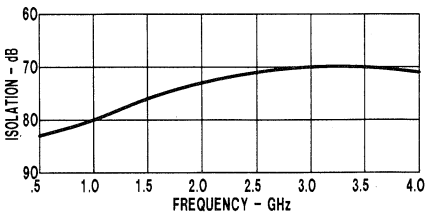
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight:
Connectorized.....29.5 grams (1.04 oz.) Max.
Non-Connectorized.....9.5 grams (0.34 oz.) Max.

## Typical Performance at 25°C

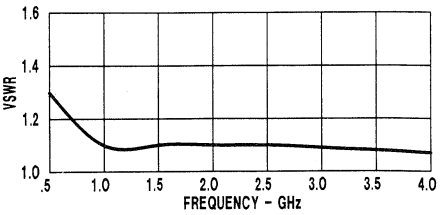
### Insertion Loss vs. Frequency



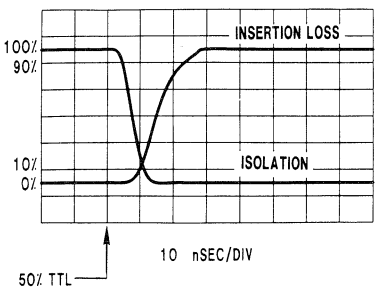

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



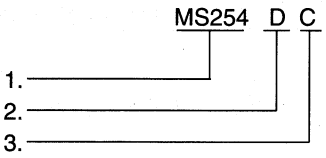
## Logic Table

| | Insertion Loss | Isolation |
|---|---|---|
| No Driver | -20 mA | +20 mA |
| Driver | TTL LO | TTL HI |

Driver Bias: +5.0 ±0.5 V at 100 mA maximum.
-11 to -15 V at 75 mA maximum.

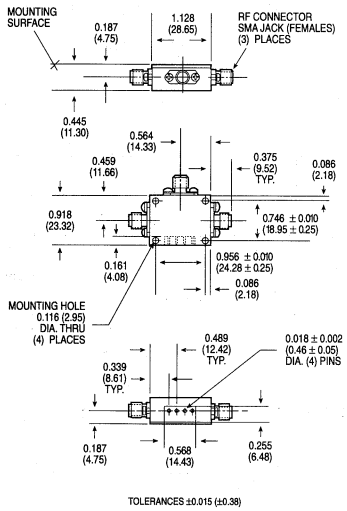
TTL Logic: TTL LO 0 to 0.8 at 1.6 mA maximum sink.
TTL HI 2.0 to 5.0 V at 40 µA maximum source.

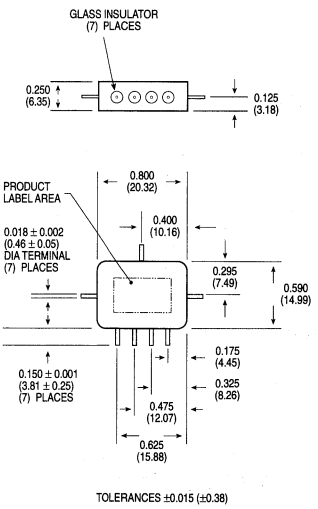
## Ordering Information




1. Designate model number.
2. Add "D" if integral driver is desired.
3. Add "C" if connectorized version is desired.

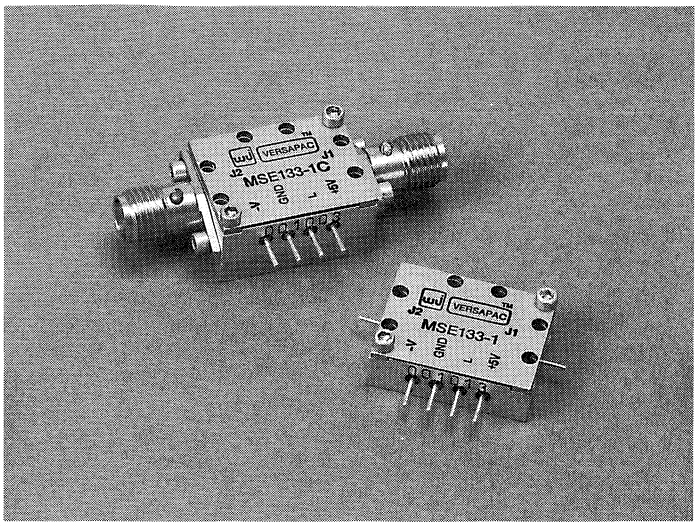
## Outline Drawings



# WJ-MSE133

## SINGLE-POLE SINGLE-THROW REFLECTIVE PIN DIODE SWITCH




- ◆ 2 TO 18 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Min. | 2.0-18.0 GHz | 2.0-18.0 GHz |
| Insertion Loss, Max. | | |
| 2.0-4.0 GHz | 1.0 dB | 1.3 dB |
| 4.0-8.0 GHz | 1.4 dB | 1.7 dB |
| 8.0-12.0 GHz | 1.8 dB | 2.1 dB |
| 12.0-18.0 GHz | 2.2 dB | 2.5 dB |
| Input/Output VSWR, Max. | 2.0:1 | 2.2:1 |
| Isolation, Min. | | |
| 2.0-4.0 GHz | 70 dB | 67 dB |
| 4.0-8.0 GHz | 80 dB | 77 dB |
| 8.0-12.0 GHz | 80 dB | 77 dB |
| 12.0-18.0 GHz | 75 dB | 72 dB |
| Switching Time[2], Max. | 20 nsec | 25 nsec |

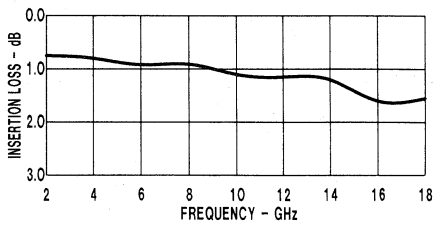
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

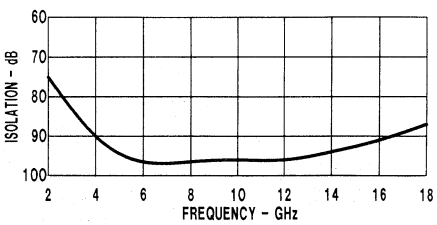
Operating Temperature .....-54°C to +100°C
Storage Temperature.....-65°C to +125°C
Weight:
Connectorized.....13.0 grams (0.46 oz.) Max.
Non-Connectorized .....8.0 grams (0.28 oz.) Max.

## Typical Performance at 25°C

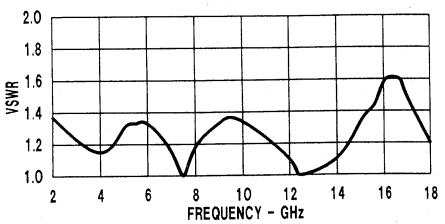
### Insertion Loss vs. Frequency



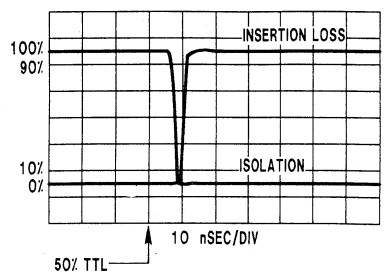

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

| DASH NO. | B | CONTROL INPUT L | J1-J2 |
|---|---|---|---|
| N/A | -5V<br>+20 mA | | I.L.<br>ISOL. |
| -1 | | TTL LO<br>TTL HI | I.L.<br>ISOL. |
| -2 | | TTL HI<br>TTL LO | I.L.<br>ISOL. |

Driver Bias: +5.0 ±0.5 V at 70 mA maximum.
-11 to -15 V at 25 mA maximum.

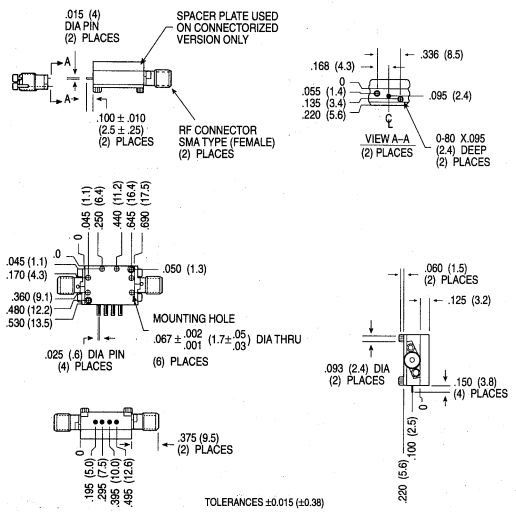
TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.

## Ordering Information

MSE133 -X C

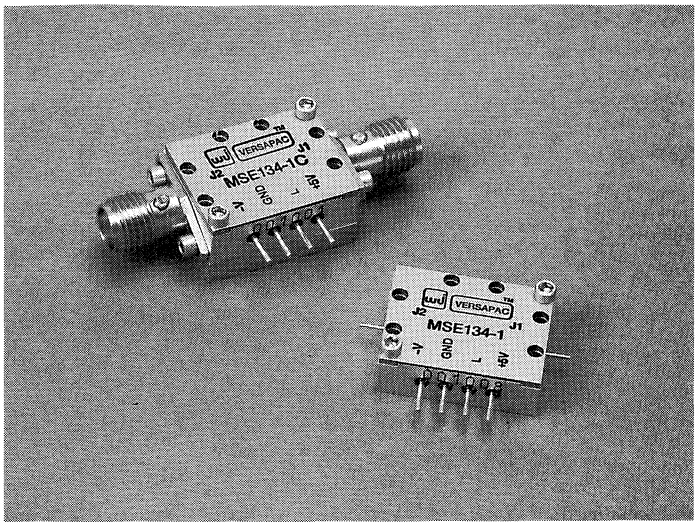
1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Outline Drawing



# WJ-MSE134

## SINGLE-POLE SINGLE-THROW REFLECTIVE PIN DIODE SWITCH




- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed | |
|---|---|---|
| | +25°C | -54°C to +100°C |
| Frequency Range, Min. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | | |
| 0.5-1.0 GHz | 1.0 dB | 1.1 dB |
| 1.0-2.0 GHz | 1.0 dB | 1.1 dB |
| 2.0-4.0 GHz | 1.2 dB | 1.3 dB |
| Input/Output VSWR, Max. | 1.5:1 | 1.6:1 |
| Isolation, Min. | | |
| 0.5-1.0 GHz | 50 dB | 48 dB |
| 1.0-2.0 GHz | 65 dB | 63 dB |
| 2.0-4.0 GHz | 80 dB | 78 dB |
| Switching Time[2], Max. | 40 nsec | 43 nsec |

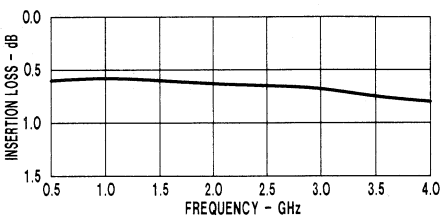
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

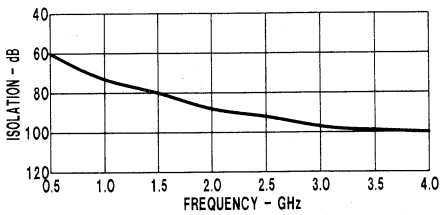
Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +125°C
Weight:
Connectorized ..... 13.0 grams (0.46 oz.) Max.
Non-Connectorized ..... 8.0 grams (0.28 oz.) Max.

## Typical Performance at 25° C

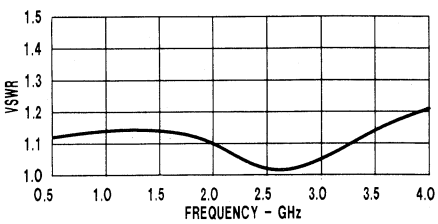
### Insertion Loss vs. Frequency



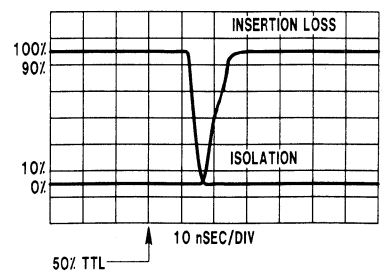

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



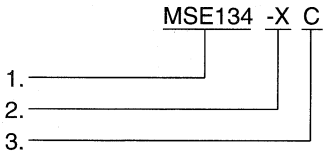
## Logic Table

| DASH NO. | CONTROL INPUT B | L | J1-J2 |
|---|---|---|---|
| N/A | -5 V<br>+30 mA | | I.L.<br>ISOL. |
| -1 | | TTL LO<br>TTL HI | I.L.<br>ISOL. |
| -2 | | TTL HI<br>TTL LO | I.L.<br>ISOL. |

Driver Bias: +5.0 ±0.5 V at 100 mA maximum.
-11 to -15 V at 25 mA maximum.

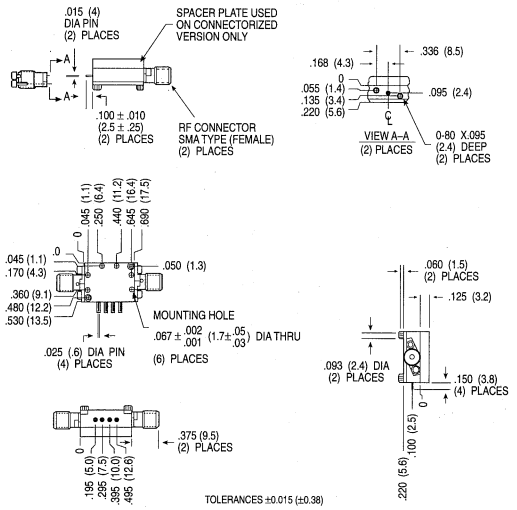
TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.

## Ordering Information



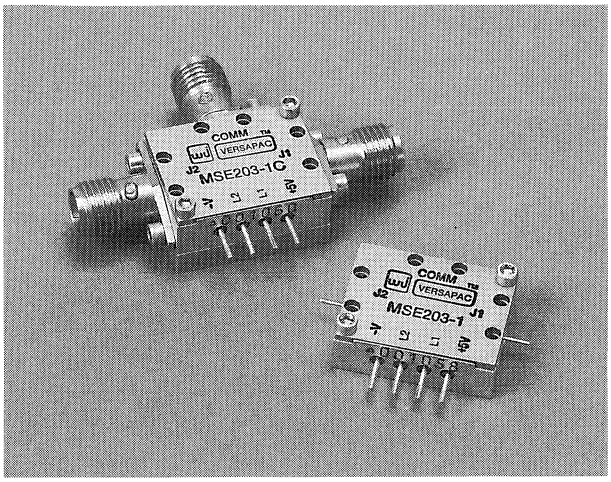

1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Outline Drawing



# WJ-MSE203

## SINGLE-POLE DOUBLE-THROW REFLECTIVE PIN-DIODE SWITCH




- ◆ 2 TO 18 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed | |
|---|---|---|
| | +25°C | -54°C to +100°C |
| Frequency Range, Min. | 2.0-18.0 GHz | 2.0-18.0 GHz |
| Insertion Loss, Max. | | |
| 2.0-4.0 GHz | 1.5 dB | 1.8 dB |
| 4.0-8.0 GHz | 1.8 dB | 2.1 dB |
| 8.0-12.0 GHz | 2.2 dB | 2.5 dB |
| 12.0-18.0 GHz | 2.7 dB | 3.0 dB |
| Input/Output VSWR, Max. | | |
| 2.0-18.0 GHz | 2.0:1 | 2.2:1 |
| Isolation, Min. | | |
| 2.0-4.0 GHz | 65 dB | 62 dB |
| 4.0-8.0 GHz | 60 dB | 57 dB |
| 8.0-12.0 GHz | 60 dB | 57 dB |
| 12.0-18.0 GHz | 55 dB | 52 dB |
| Switching Time[2], Max. | 25 nsec | 28 nsec |

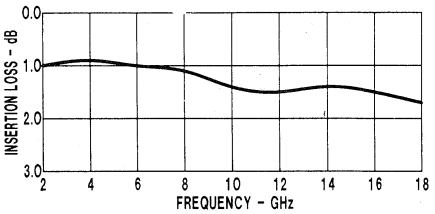
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

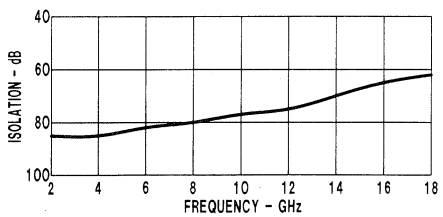
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight:
Connectorized .....14.5 grams (0.51 oz.) Max.
Non-Connectorized.....7.5 grams (0.27 oz.) Max.

## Typical Performance at 25° C

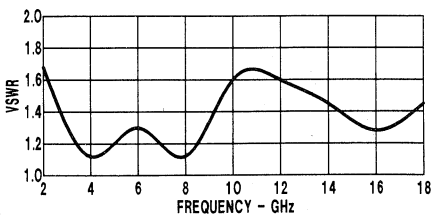
### Insertion Loss vs. Frequency



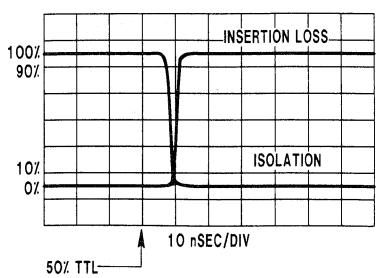

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

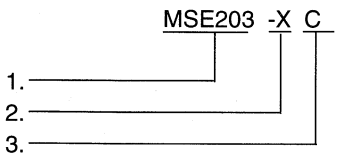
| DASH NO. | CONTROL INPUT B1 | B2 | L1 | L2 | L | COMM-J1 | COMM-J2 |
|---|---|---|---|---|---|---|---|
| N/A | -13 mA<br>+13 mA | +13 mA<br>-13 mA | | | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -1 | | | TTL LO<br>TTL HI | TTL HI<br>TTL LO | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -2 | | | TTL HI<br>TTL LO | TTL LO<br>TTL HI | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -3 | | | TTL LO<br>TTL HI | TTL LO<br>TTL HI | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -4 | | | TTL HI<br>TTL LO | TTL HI<br>TTL LO | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -5 | | | | | TTL LO<br>TTL HI | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -6 | | | | | TTL HI<br>TTL LO | I.L.<br>ISOL. | ISOL.<br>I.L. |

Driver Bias: +5.0 ±0.5 V at 100 mA maximum,
-11 to -15 at 50 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.

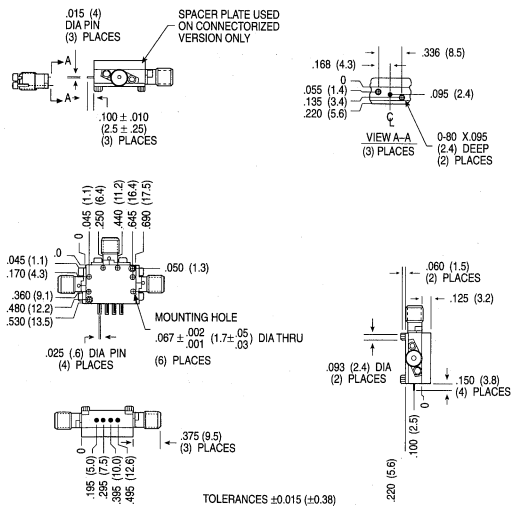
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Ordering Information



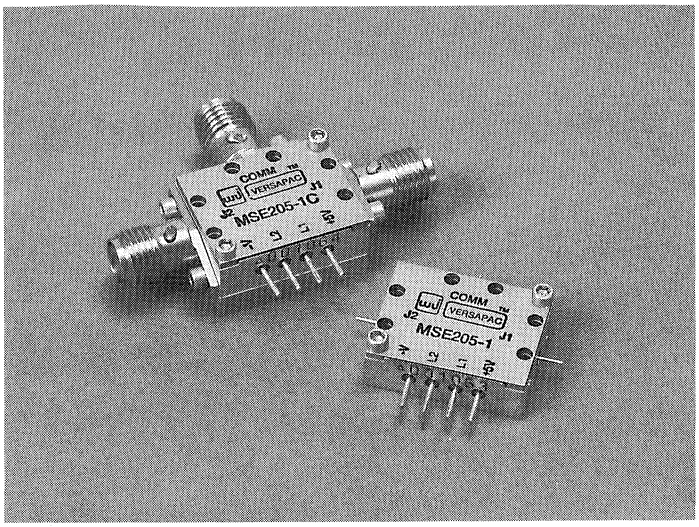

1. Designate model number.
2. Driver Option.
   See Logic Table.
3. Add "C" if connectorized version is desired.

## Outline Drawing



# WJ-MSE205

## SINGLE-POLE DOUBLE-THROW REFLECTIVE PIN-DIODE SWITCH




- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Min. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | 1.3 dB | 1.4 dB |
| Input/Output VSWR, Max. | 1.5:1 | 1.6:1 |
| Isolation, Min. | 70 dB | 68 dB |
| Switching Time[2], Max. | 40 nsec | 43 nsec |

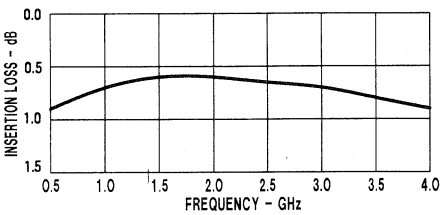
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

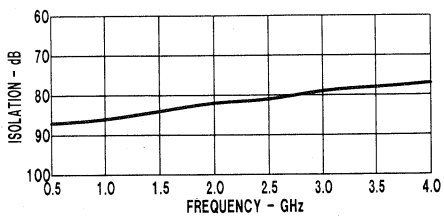
Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +125°C
Weight:
Connectorized ..... 14.5 grams (0.51 oz.) max.
Non-Connectorized ..... 7.5 grams (0.27 oz.) max.

## Typical Performance at 25° C

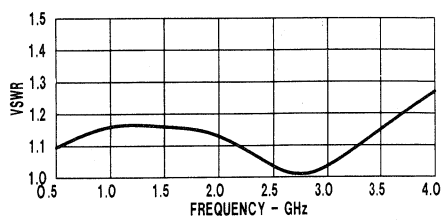
### Insertion Loss vs. Frequency



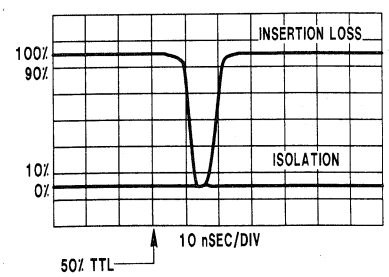

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

| DASH NO. | CONTROL INPUT B1 | B2 | L1 | L2 | L | COMM-J1 | COMM-J2 |
|---|---|---|---|---|---|---|---|
| N/A | -20 mA<br>+20 mA | +20 mA<br>-20 mA | | | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -1 | | | TTL LO<br>TTL HI | TTL HI<br>TTL LO | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -2 | | | TTL HI<br>TTL LO | TTL LO<br>TTL HI | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -3 | | | TTL LO<br>TTL HI | TTL LO<br>TTL HI | | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -4 | | | TTL HI<br>TTL LO | TTL HI<br>TTL LO | | I.L.<br>ISOL. | ISOL.<br>L. |
| -5 | | | | | TTL LO<br>TTL HI | I.L.<br>ISOL. | ISOL.<br>I.L. |
| -6 | | | | | TTL HI<br>TTL LO | I.L.<br>ISOL. | ISOL.<br>I.L. |

Driver Bias: +5.0 ±0.5 V at 85 mA maximum,
-11 to -15 at 45 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.

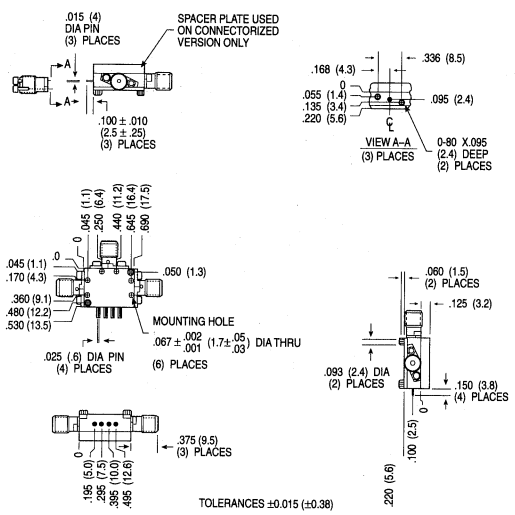
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Ordering Information

MSE205 -X C

1. Designate model number.
2. Driver Option.
   See Logic Table.
3. Add "C" if connectorized version is desired.

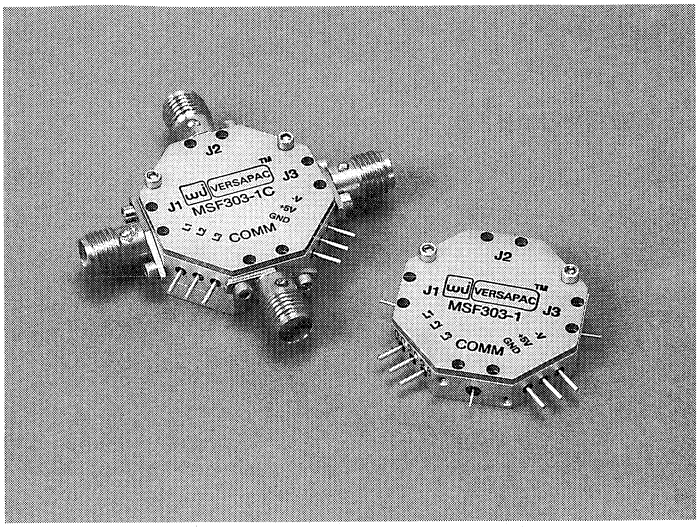
## Outline Drawing



# WJ-MSF303

## SINGLE-POLE THREE-THROW REFLECTIVE PIN-DIODE SWITCH

- ◆ 2 TO 18 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME




## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Min. | 2.0-18.0 GHz | 2.0-18.0 GHz |
| Insertion Loss, Max. | | |
| 2.0-4.0 GHz | 1.4 dB | 1.7 dB |
| 4.0-8.0 GHz | 2.0 dB | 2.3 dB |
| 8.0-12.0 GHz | 2.5 dB | 2.8 dB |
| 12.0-18.0 GHz | 3.1 dB | 3.4 dB |
| Input/Output VSWR, Max. | | |
| 2.0-12.0 GHz | 2.0:1 | 2.2:1 |
| 12.0-18.0 GHz | 2.2:1 | 2.3:1 |
| Isolation, Min. | | |
| 2.0-4.0 GHz | 70 dB | 67 dB |
| 4.0-8.0 GHz | 65 dB | 62 dB |
| 8.0-12.0 GHz | 60 dB | 57 dB |
| 12.0-18.0 GHz | 55 dB | 52 dB |
| Switching Time[2], Max. | 25 nsec | 30 nsec |

Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +125°C
Weight:
Connectorized ..... 26.5 grams (0.94 oz.) Max.
Non-Connectorized ..... 16.5 grams (0.59 oz.) Max.

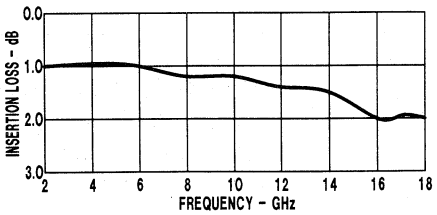
## Ordering Information

MSF303 -X C

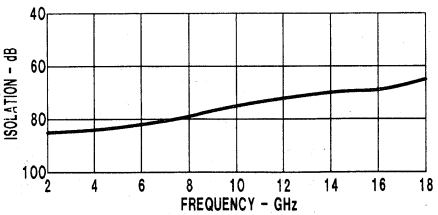
1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Typical Performance at 25° C

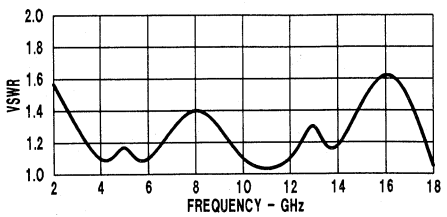
### Insertion Loss vs. Frequency



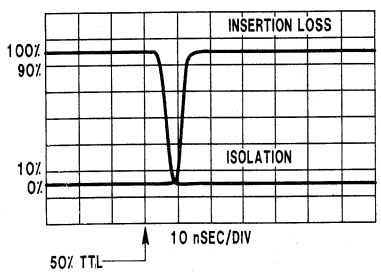

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

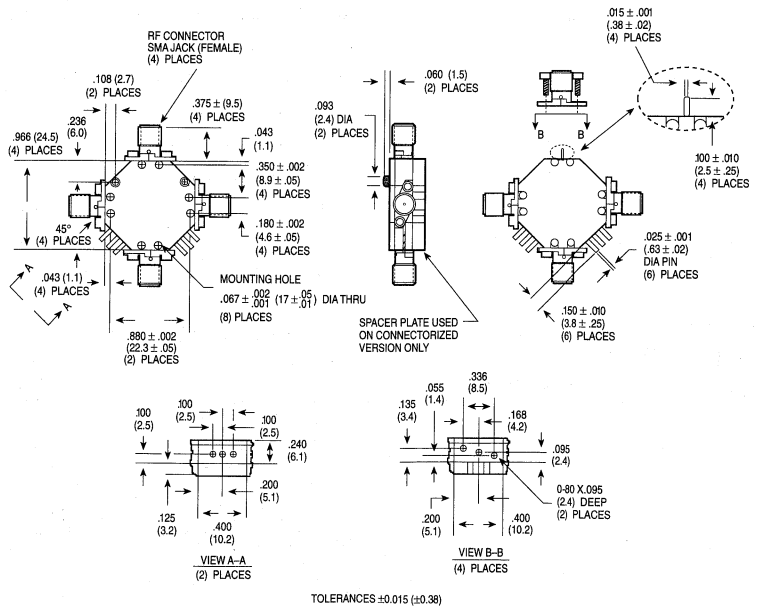
| DASH NO. | CONTROL INPUT | | | COMM-J1 | COMM-J2 | COMM-J3 |
|---|---|---|---|---|---|---|
| | B1 | B2 | B3 | | | |
| N/A | -13 mA | +13 mA | +13 mA | I.L. | ISOL. | ISOL. |
| | +13 mA | -13 mA | +13 mA | ISOL. | I.L. | ISOL. |
| | +13 mA | +13 mA | -13 mA | ISOL. | ISOL. | I.L. |
| | L1 | L2 | L3 | | | |
| -1 | TTL LO | TTL HI | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL LO | ISOL. | ISOL. | I.L. |
| -2 | TTL HI | TTL LO | TTL LO | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | ISOL. | I.L. | ISOL. |
| | TTL LO | TTL LO | TTL HI | ISOL. | ISOL. | I.L. |
| | A0 | A1 | E | | | |
| -3 | TTL HI | TTL LO | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL HI | ISOL. | ISOL. | I.L. |
| | X | X | TTL LO | | ALL PORTS OFF | |
| | A0 | A1 | A2 | E | | |
| -4 | TTL HI | TTL LO | TTL LO | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | ALL PORTS OFF | |

Driver Bias: +5.0 ±0.5V at 110 mA maximum.
-11 to -15 V at 65 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.
X = Don't care (either low or high logic level).

Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

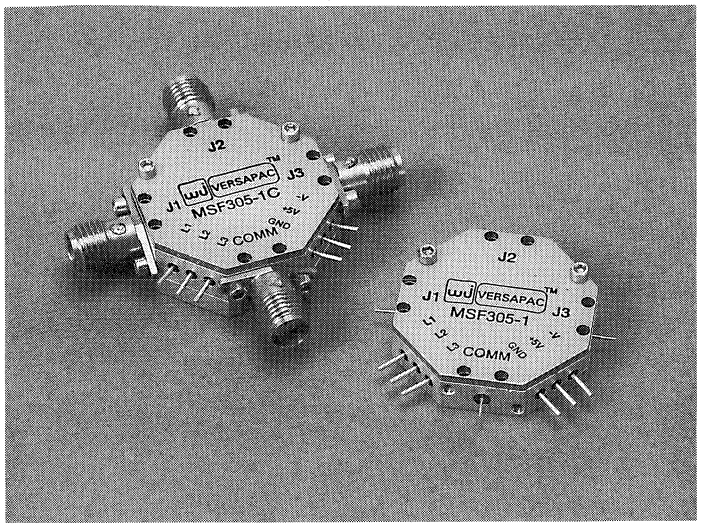
## Outline Drawing



# WJ-MSF305

## SINGLE-POLE THREE-THROW REFLECTIVE PIN DIODE SWITCH

- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME




## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range Min. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | 1.5 dB | 1.6 dB |
| Input/Output VSWR, Max. | 1.5:1 | 1.6:1 |
| Isolation, Min. | 70 dB | 68 dB |
| Switching Time[2], Max. | 40 nsec | 43 nsec |

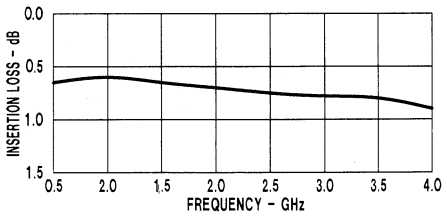
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

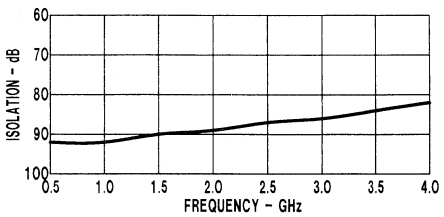
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight:
Connectorized .....26.5 grams (0.94 oz.) Max.
Non-Connectorized .....16.5 grams (0.59 oz.) Max.

## Typical Performance at 25° C

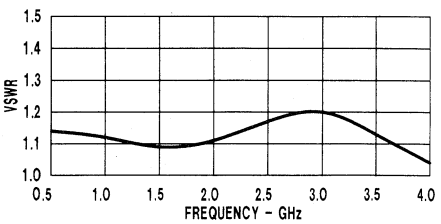
### Insertion Loss vs. Frequency



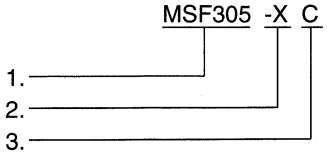

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency

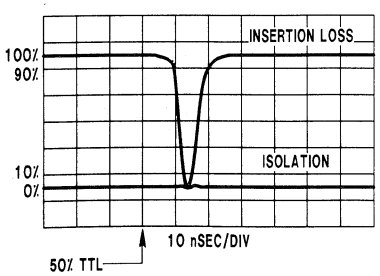



## Ordering Information




1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

### Switching Time vs. Time



## Logic Table

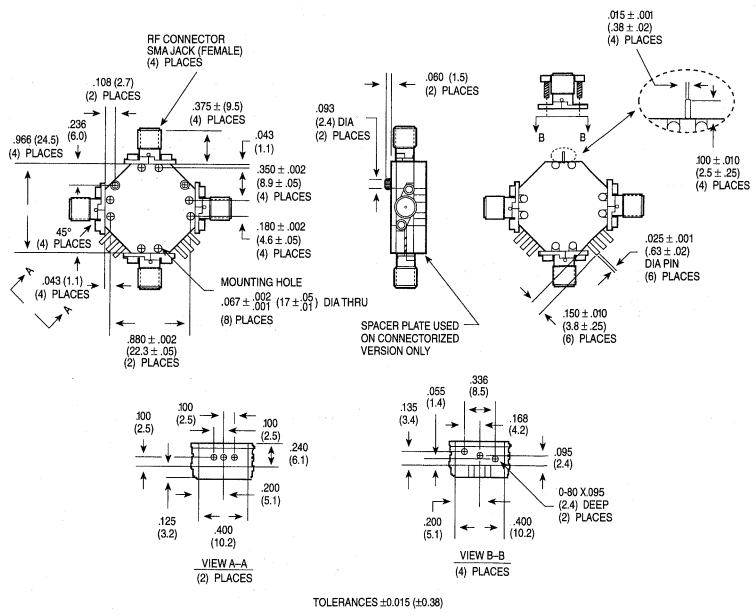
| DASH NO. | CONTROL INPUT B1 | B2 | B3 | COMM-J1 | COMM-J2 | COMM-J3 |
|---|---|---|---|---|---|---|
| N/A | -20 mA | +20 mA | +20 mA | I.L. | ISOL. | ISOL. |
| | +20 mA | -20 mA | +20 mA | ISOL. | I.L. | ISOL. |
| | +20 mA | +20 mA | -20 mA | ISOL. | ISOL. | I.L. |
| -1 | L1 | L2 | L3 | | | |
| | TTL LO | TTL HI | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL LO | ISOL. | ISOL. | I.L. |
| -2 | TTL HI | TTL LO | TTL LO | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | ISOL. | I.L. | ISOL. |
| | TTL LO | TTL LO | TTL HI | ISOL. | ISOL. | I.L. |
| | A0 | A1 | E | | | |
| -3 | TTL HI | TTL LO | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL HI | ISOL. | ISOL. | I.L. |
| | X | X | TTL LO | | ALL PORTS OFF | |
| | A0 | A1 | A2 | E | | |
| -4 | TTL HI | TTL LO | TTL LO | TTL HI | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | ALL PORTS OFF | |

Driver Bias: +5.0 ± 0.5 V at 150 mA maximum.
-11 to -15 V at 70 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.
X = Don't care (either low or high logic level).

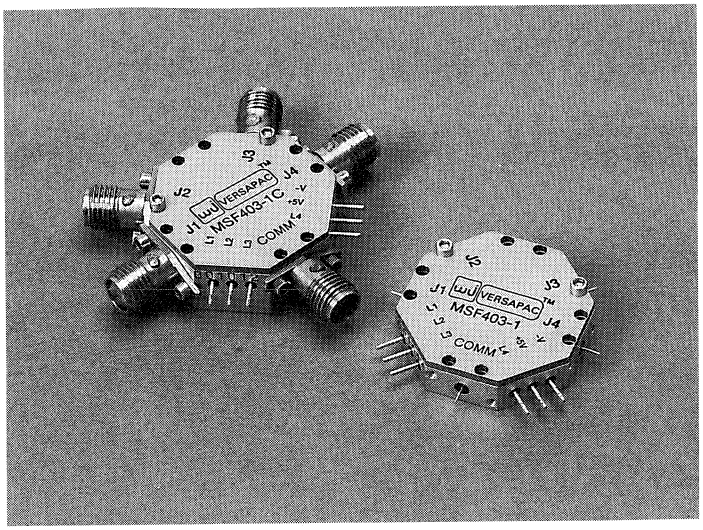
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Outline Drawing



# WJ-MSF403

## SINGLE-POLE FOUR-THROW REFLECTIVE PIN DIODE SWITCH




- ◆ 2 TO 18 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Min. | 2.0-18.0 GHz | 2.0-18.0 GHz |
| Insertion Loss, Max. | | |
| 2.0-4.0 GHz | 1.7 dB | 2.0 dB |
| 4.0-8.0 GHz | 2.2 dB | 2.5 dB |
| 8.0-12.0 GHz | 2.7 dB | 3.0 dB |
| 12.0-18.0 GHz | 3.3 dB | 3.7 dB |
| Input/Output VSWR, Max. | | |
| 2.0-6.0 GHz | 2.0:1 | 2.2:1 |
| 6.0-18.0 GHz | 2.3:1 | 2.5:1 |
| Isolation, Min. | | |
| 2.0-4.0 GHz | 85 dB | 82 dB |
| 4.0-8.0 GHz | 80 dB | 77 dB |
| 8.0-12.0 GHz | 75 dB | 72 dB |
| 12.0-18.0 GHz | 70 dB | 67 dB |
| Switching Time[2], Max. | 25 nsec | 30 nsec |

Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion compression is +27 dBm minimum.

## Absolute Maximum Ratings

Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +125°C
Weight:
Connectorized ..... 28.0 grams (0.99 oz.) Max.
Non-Connectorized ..... 16.0 grams (0.57 oz.) Max.

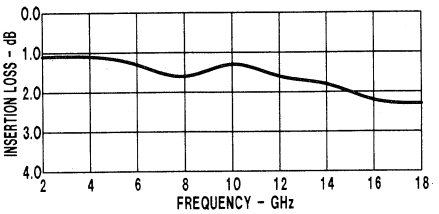
## Ordering Information

MSF403 -X C

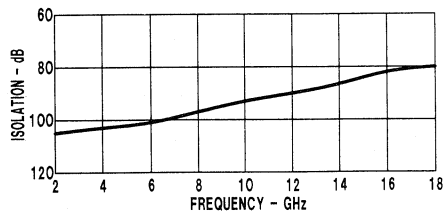
1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Typical Performance at 25°C

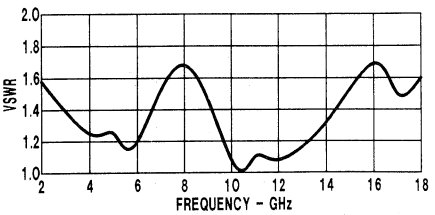
### Insertion Loss vs. Frequency



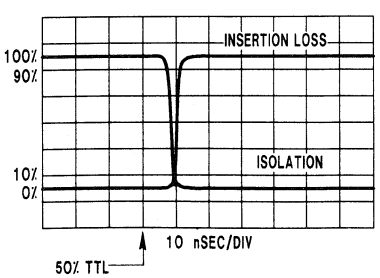

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

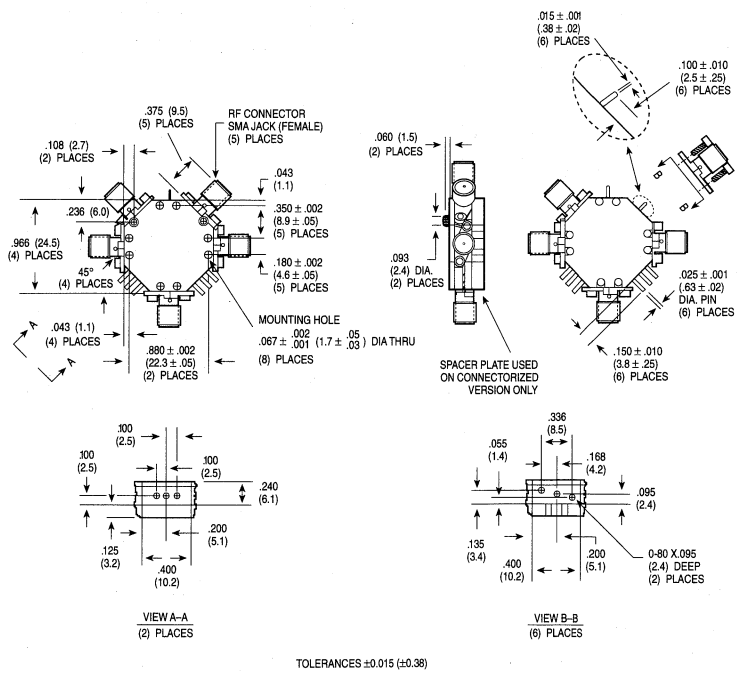
| DASH NO. | CONTROL INPUT B1 | B2 | B3 | B4 | COMM-J1 | COMM-J2 | COMM-J3 | COMM-J4 |
|---|---|---|---|---|---|---|---|---|
| N/A | -13 mA | +13 mA | +13 mA | +13 mA | I.L. | ISOL. | ISOL. | ISOL. |
| | +13 mA | -13 mA | +13 mA | +13 mA | ISOL. | I.L. | ISOL. | ISOL. |
| | +13 mA | +13 mA | -13 mA | +13 mA | ISOL. | ISOL. | I.L. | ISOL. |
| | +13 mA | +13 mA | +13 mA | -13 mA | ISOL. | ISOL. | ISOL. | I.L |
| | L1 | L2 | L3 | L4 | | | | |
| -1 | TTL LO | TTL HI | TTL HI | TTL HI | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL HI | TTL LO | ISOL. | ISOL. | ISOL. | I.L. |
| | AO | A1 | A2 | E | | | | |
| -3 | TTL HI | TTL LO | TTL LO | TTL HI | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | ALL PORTS OFF | | |

Driver Bias: +5.0 ± 0.5 V at 150 mA maximum.
-11 to -15 V at 75 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 at 40 µA maximum source.
X = Don't care (either low or high logic level).

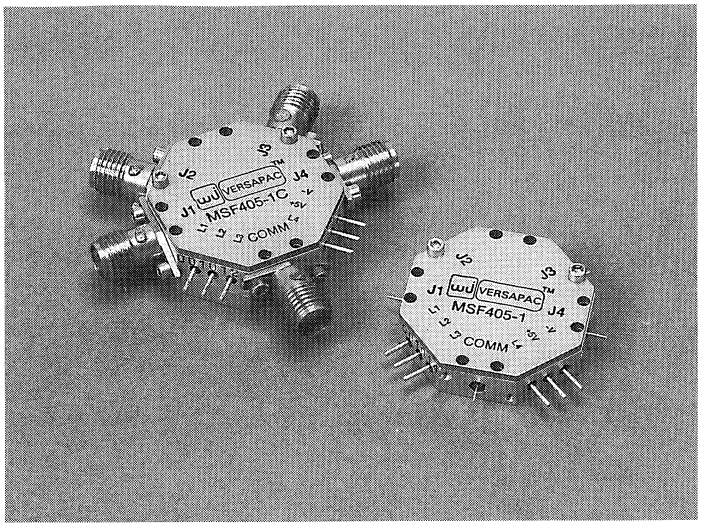
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Outline Drawing



# WJ-MSF405

## SINGLE-POLE FOUR-THROW REFLECTIVE PIN DIODE SWITCH




- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range Min. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | 1.5 dB | 1.6 dB |
| Input/Output VSWR, Max. | 1.5:1 | 1.6:1 |
| Isolation, Min. | 70 dB | 68 dB |
| Switching Time[2], Max. | 40 nsec | 43 nsec |

Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight:
Connectorized .....28.0 grams (0.99 oz.) Max.
Non-Connectorized.....16.0 grams (0.57 oz.) Max.

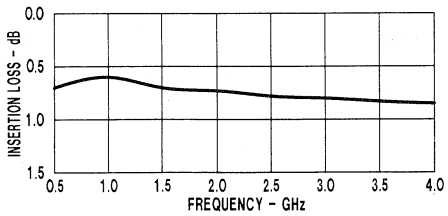
## Ordering Information

MSF405 -X C

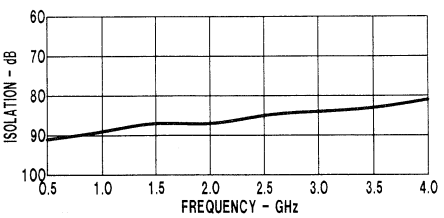
1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Typical Performance at 25° C

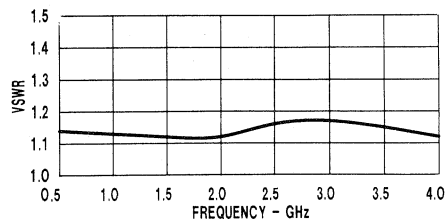
### Insertion Loss vs. Frequency



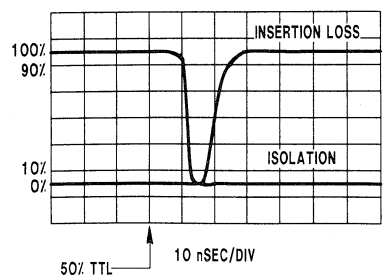

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

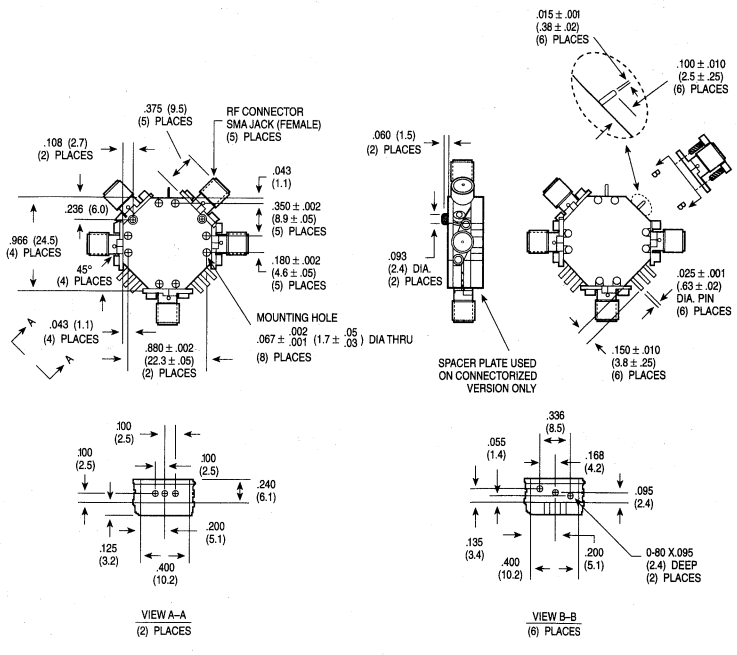
| DASH NO. | B1 | CONTROL INPUT B2 | B3 | B4 | COMM-J1 | COMM-J2 | COMM-J3 | COMM-J4 |
|---|---|---|---|---|---|---|---|---|
| N/A | -20 mA | +20 mA | +20 mA | +20 mA | I.L. | ISOL. | ISOL. | ISOL. |
| | +20 mA | -20 mA | +20 mA | +20 mA | ISOL. | I.L. | ISOL. | ISOL. |
| | +20 mA | +20 mA | -20 mA | +20 mA | ISOL. | ISOL. | I.L. | ISOL. |
| | +20 mA | +20 mA | +20 mA | -20 mA | ISOL. | ISOL. | ISOL. | I.L. |
| | L1 | L2 | L3 | L4 | | | | |
| -1 | TTL LO | TTL HI | TTL HI | TTL HI | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL HI | TTL HI | TTL LO | ISOL. | ISOL. | ISOL. | I.L. |
| | A0 | A1 | A2 | E | | | | |
| -3 | TTL HI | TTL LO | TTL LO | TTL HI | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | TTL HI | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | ISOL. | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | ALL PORTS OFF | | |

Driver Bias: +5.0 ± 0.5 V at 200 mA maximum.
-11 to -15 V at 85 mA maximum.

TTL Logic: TTL LO = 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 at 40 uA maximum source.
X = Don't care (either low or high logic level).

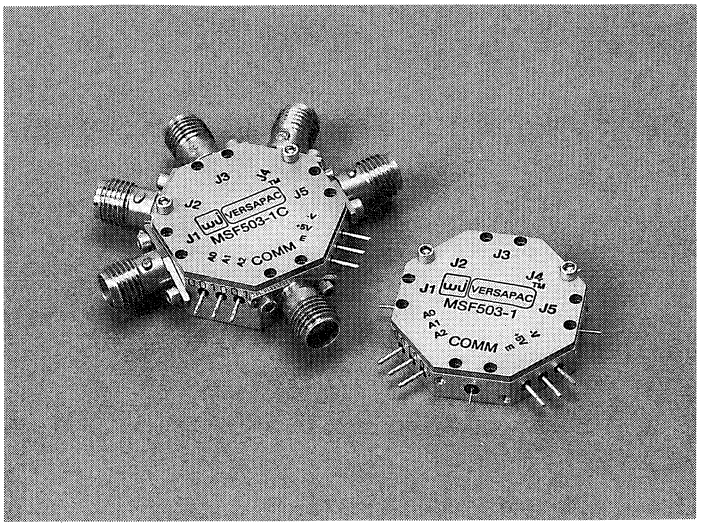
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Outline Drawing



# WJ-MSF503

## SINGLE-POLE FIVE-THROW REFLECTIVE PIN-DIODE SWITCH




- ◆ 2 TO 18 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameters | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range Min. | 2.0-18.0 GHz | 2.0-18.0 GHz |
| Insertion Loss, Max. | | |
| 2.0-4.0 GHz | 1.7 dB | 2.0 dB |
| 4.0-8.0 GHz | 2.2 dB | 2.5 dB |
| 8.0-12.0 GHz | 2.7 dB | 3.0 dB |
| 12.0-18.0 GHz | 3.3 dB | 3.7 dB |
| Input/Output VSWR, Max. | | |
| 2.0-6.0 GHz | 2.0:1 | 2.2:1 |
| 6.0-18.0 GHz | 2.3:1 | 2.5:1 |
| Isolation, Min. | | |
| 2.0-4.0 GHz | 85 dB | 82 dB |
| 4.0-8.0 GHz | 80 dB | 77 dB |
| 8.0-12.0 GHz | 75 dB | 72 dB |
| 12.0-18.0 GHz | 70 dB | 67 dB |
| Switching Time[2], Max. | 25 nsec | 30 nsec |

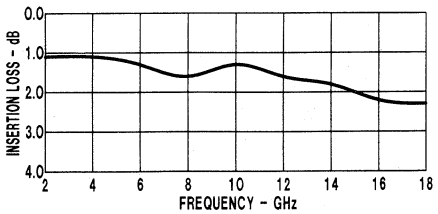
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

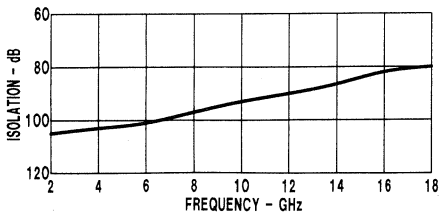
Operating Temperature ..... -54°C to +100°C
Storage Temperature ..... -65°C to +125°C
Weight:
Connectorized ..... 29.5 grams (1.04 oz.) Max.
Non-Connectorized ..... 16.0 grams (0.57 oz.) Max.

## Typical Performance at 25° C

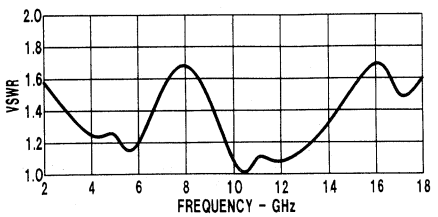
### Insertion Loss vs. Frequency



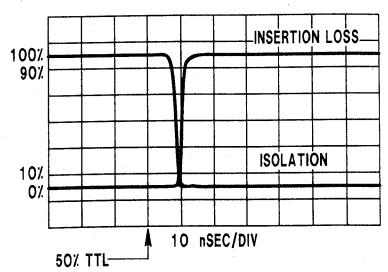

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

| DASH NO. | CONTROL INPUT B1 | B2 | B3 | B4 | B5 | COMM-J1 | COMM-J2 | COMM-J3 | COMM-J4 | COMM-J5 |
|---|---|---|---|---|---|---|---|---|---|---|
| N/A | -13 mA | +13 mA | +13 mA | +13 mA | +13 mA | I.L. | ISOL. | ISOL. | ISOL. | ISOL. |
| | +13 mA | -13 mA | +13 mA | +13 mA | +13 mA | ISOL. | I.L. | ISOL. | ISOL. | ISOL. |
| | +13 mA | +13 mA | -13 mA | +13 mA | +13 mA | ISOL. | ISOL. | I.L. | ISOL. | ISOL. |
| | +13 mA | +13 mA | +13 mA | -13 mA | +13 mA | ISOL. | ISOL. | ISOL. | I.L. | ISOL. |
| | +13 mA | +13 mA | +13 mA | +13 mA | -13 mA | ISOL. | ISOL. | ISOL. | ISOL. | I.L. |
| | A0 | A1 | A2 | E | | | | | | |
| -1 | TTL HI | TTL LO | TTL LO | TTL HI | | I.L. | ISOL. | ISOL. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | TTL HI | | ISOL. | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | | ISOL. | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL LO | TTL HI | TTL HI | | ISOL. | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | | ISOL. | ISOL. | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | | | ALL PORTS OFF | | |

Driver Bias: +5.0 ±0.5 V at 175 mA maximum.
-11 to -15 V at 85 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.
X = Don't care (either low or high logic level).

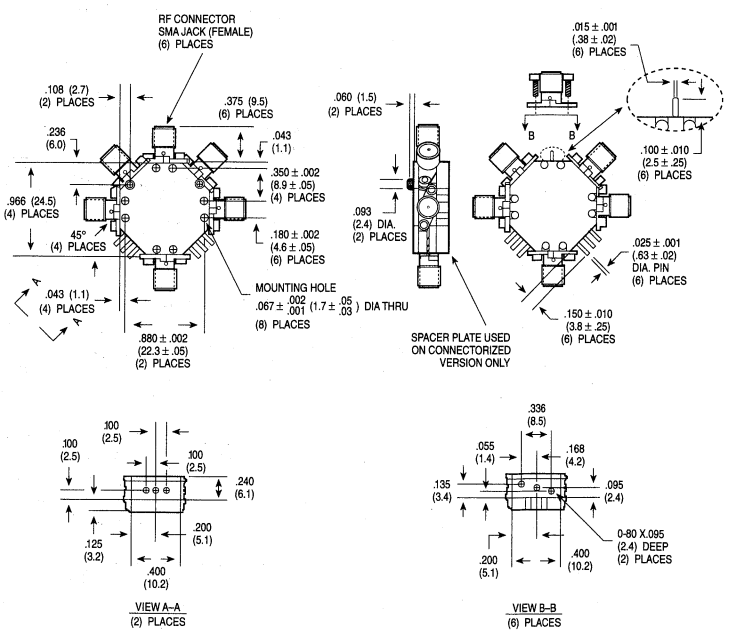
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Ordering Information

MSF503 -X C

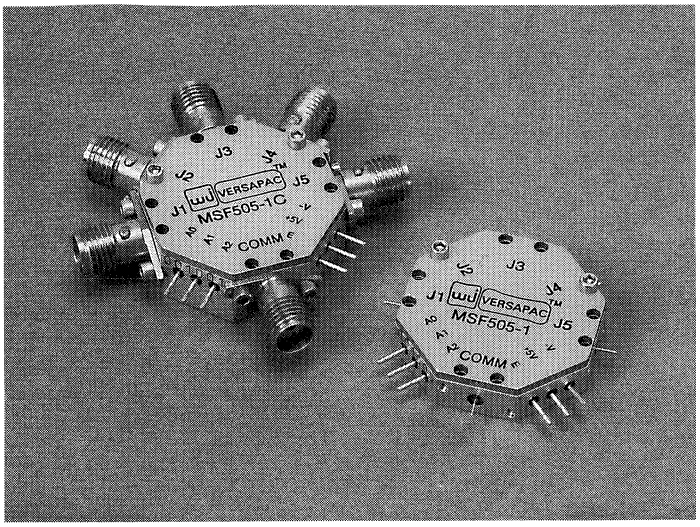
1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Outline Drawing



# WJ-MSF505

## SINGLE-POLE FIVE-THROW REFLECTIVE PIN DIODE SWITCH




- ◆ 0.5 TO 4 GHz FREQUENCY COVERAGE
- ◆ VERSAPAC™ , HERMETIC PACKAGE
- ◆ REMOVABLE SMA CONNECTORS
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Max. | 0.5-4.0 GHz | 0.5-4.0 GHz |
| Insertion Loss, Max. | 1.5 dB | 1.6 dB |
| Input/Output VSWR, Max. | 1.5:1 | 1.6:1 |
| Isolation, Min. | 70 dB | 68 dB |
| Switching Time[2], Max. | 40 nsec | 43 nsec |

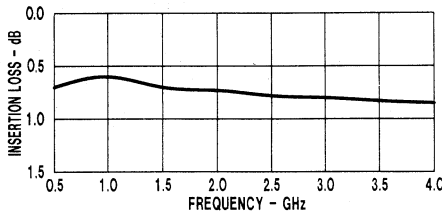
Notes:
1. Measured in a 50-ohm system.
2. Switching time is defined as 50% TTL input to 90% RF change including W-J driver delay.
3. Insertion Compression is +27 dBm minimum.

## Absolute Maximum Ratings

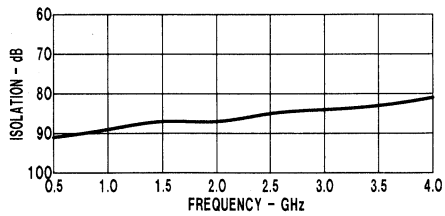
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight:
Connectorized .....29.5 grams (1.04 oz.) Max.
Non-Connectorized .....16.0 grams (0.57 oz.) Max.

## Typical Performance at 25° C

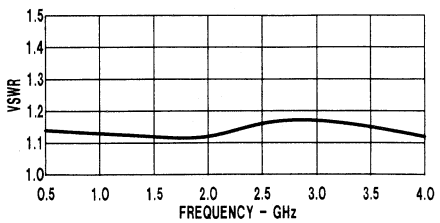
### Insertion Loss vs. Frequency



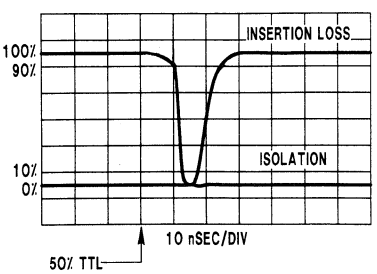

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Switching Time



## Logic Table

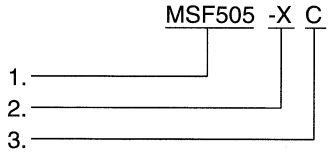
| DASH NO. | CONTROL INPUT B1 | B2 | B3 | B4 | B5 | COMM-J1 | COMM-J2 | COMM-J3 | COMM-J4 | COMM-J5 |
|---|---|---|---|---|---|---|---|---|---|---|
| N/A | -20 mA | +20 mA | +20 mA | +20 mA | +20 mA | I.L. | ISOL. | ISOL. | ISOL. | ISOL. |
| | +20 mA | -20 mA | +20 mA | +20 mA | +20 mA | ISOL. | I.L. | ISOL. | ISOL. | ISOL. |
| | +20 mA | +20 mA | -20 mA | +20 mA | +20 mA | ISOL. | ISOL. | I.L. | ISOL. | ISOL. |
| | +20 mA | +20 mA | +20 mA | -20 mA | +20 mA | ISOL. | ISOL. | ISOL. | I.L. | ISOL. |
| | +20 mA | +20 mA | +20 mA | +20 mA | -20 mA | ISOL. | ISOL. | ISOL. | ISOL. | I.L. |
| | A0 | A1 | A2 | E | | | | | | |
| -1 | TTL HI | TTL LO | TTL LO | TTL HI | | I.L. | ISOL. | ISOL. | ISOL. | ISOL. |
| | TTL LO | TTL HI | TTL LO | TTL HI | | ISOL. | I.L. | ISOL. | ISOL. | ISOL. |
| | TTL HI | TTL HI | TTL LO | TTL HI | | ISOL. | ISOL. | I.L. | ISOL. | ISOL. |
| | TTL LO | TTL LO | TTL HI | TTL HI | | ISOL. | ISOL. | ISOL. | I.L. | ISOL. |
| | TTL HI | TTL LO | TTL HI | TTL HI | | ISOL. | ISOL. | ISOL. | ISOL. | I.L. |
| | X | X | X | TTL LO | | ALL PORTS OFF | | | | |

Driver Bias: +5.0 ±0.5 V at 240 mA maximum.
-11 to -15 Vat 100 mA maximum.

TTL Logic: TTL LO = 0 to 0.8 V at 1.6 mA maximum sink.
TTL HI = 2.0 to 5.0 V at 40 µA maximum source.
X = Don't care (either low or high logic level).

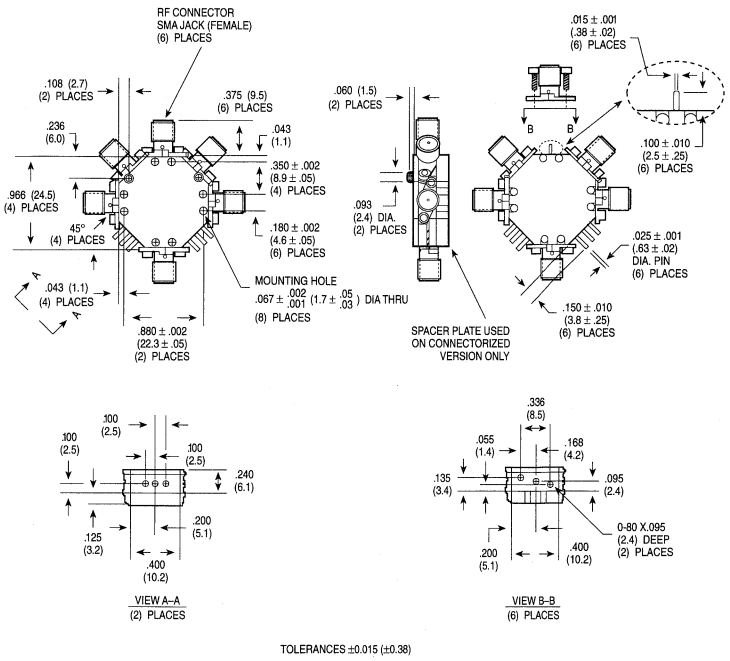
Notes:
1. Maximum current is specified with one arm in the insertion loss state.
2. Some degradation in isolation will occur in "all off" condition.

## Ordering Information




1. Designate model number.
2. Driver Option. See Logic Table.
3. Add "C" if connectorized version is desired.

## Outline Drawing



# Microwave GaAs FET MMIC Switch

- ◆ DC TO 5 GHz
- ◆ SPDT
- ◆ MINIATURE HERMETIC PACKAGE
- ◆ GUARANTEED PERFORMANCE

***Description:*** Complementing the 0.5 to 18 GHz frequency coverage of our PIN diode switch products, Watkins Johnson's MST201 switch provides SPDT switching function over the dc to 5 GHz frequency range. The basic switching element used in the MST201 is a Watkins-Johnson designed and manufactured GaAsFET monolithic microwave 'integrated circuit (MMIC). In addition to true "dc" signal operation, the GaAsFET technology provides RF performance comparable to PIN diode products with the advantages of low dc current draw, nanosecond switching time and low video transients. The device is supplied in a TO-5 package.

***Construction:*** Working in an ESD protected and cleanliness-controlled environment, assembly begins with substrate attach in a forming gas atmosphere. After attaching the MMIC chip, all circuit interconnections are made using thermosonic gold-gold bonding which produces bond strengths typically four times that required by Mil-Standards. The final product is 100% visually inspected before being hermetically sealed with a resistance weld in a dry-nitrogen atmosphere.

## Guaranteed Specifications[1]

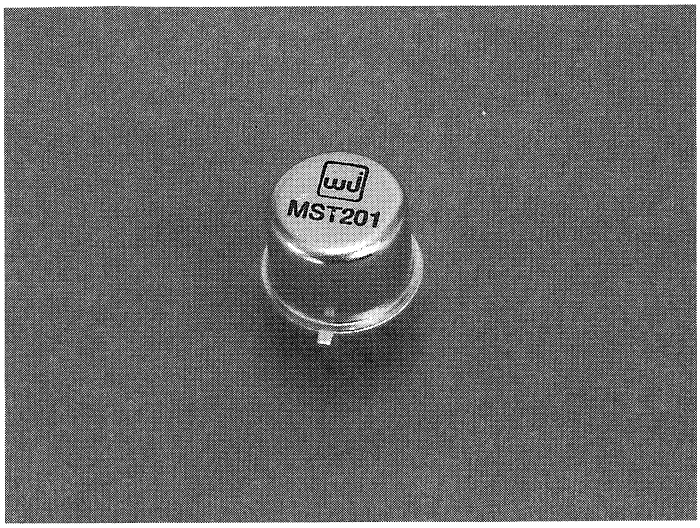
### GaAs FET Switch

| Model | Description | Frequency Range (GHz) | Insertion Loss (dB) Max. | VSWR Max. | Isolation (dB) Min. | Switching Speed[2] (nsec) TYP. | Outline Drawing |
|---|---|---|---|---|---|---|---|
| MST201 | SPDT, Reflective | DC-5 | 1.8 | 1.4:1 | 30 | 3 | 297537 |

NOTES:
1. Measured in a 50-ohm system and at +25°C case temperature.
2. Switching time is defined as 10% RF change to 90% RF change.

# WJ-MST201

## SINGLE-POLE DOUBLE-THROW REFLECTIVE GaAs FET SWITCH




- ◆ DC TO 5 GHz FREQUENCY COVERAGE
- ◆ TO-5, HERMETIC PACKAGE
- ◆ LOW INSERTION LOSS
- ◆ LOW VSWR
- ◆ HIGH ISOLATION
- ◆ FAST SWITCHING TIME
- ◆ LOW VIDEO LEAKAGE[4]

## Specifications[1]

| Parameter | Guaranteed +25°C | Guaranteed -54°C to +100°C |
|---|---|---|
| Frequency Range, Min. | DC-5.0 GHz | DC-5.0 GHz |
| Insertion Loss, Max. | | |
| DC-2.0 GHz | 1.3 dB | 1.4 dB |
| 2.0-5.0 GHz | 1.8 dB | 1.9 dB |
| Input/Output VSWR, Max. | 1.4:1 | 1.5:1 |
| Isolation, Min. | 30 dB | 28 dB |
| Switching Time[2], Typical | 3 nsec | 6 nsec |

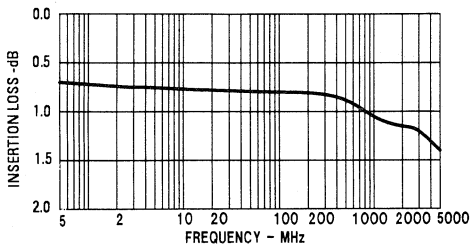
Notes:
1 Measured in a 50-ohm system at +25°C case temperature.
2. Switching time is defined as 10% RF change to 90% FRF change.
3. Insertion Compression (1 dB) is +20 dBm typical at 50 MHz and +30 dBm typical at 5 GHz with control voltages of -8 V and 0 V.
4. Typical video leakage is 10 mV.

## Absolute Maximum Ratings

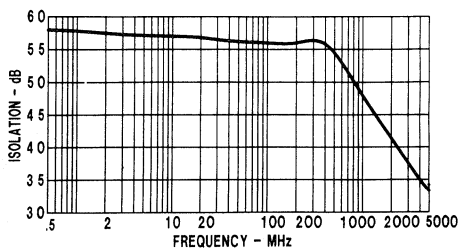
Operating Temperature .....-54°C to +100°C
Storage Temperature .....-65°C to +125°C
Weight .....1.0 grams (0.04 oz.) Max.

## Typical Performance at 25° C

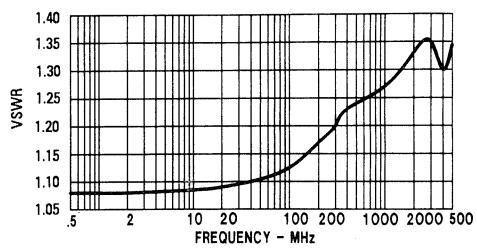
### Insertion Loss vs. Frequency



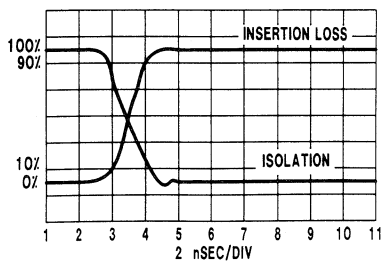

### Isolation vs. Frequency




### Input/Output VSWR vs. Frequency




### Rise/Fall Time



## Logic Table

| B1 | B2 | COMM-J1 | COMM-J2 |
|---|---|---|---|
| -V* | 0 V | Insertion Loss | Isolation |
| 0 V | -V* | Isolation | Insertion Loss |

Driver Bias: 0 V at 20 µA maximum.
-5 V at 100 µA maximum.
-8 V at 200 µA maximum.

* -V is defined as -5 Vdc to -8 Vdc.

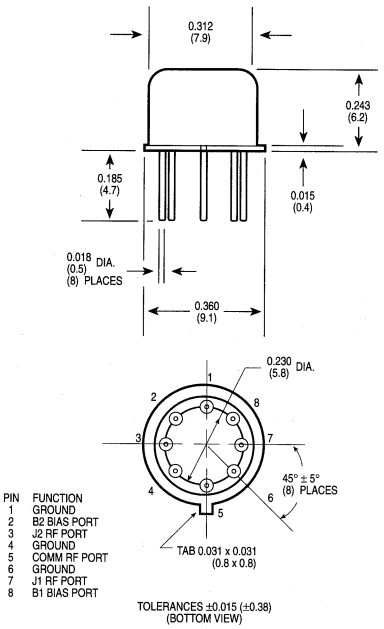
## Ordering Information

MST201

1.

**1. Designate Model Number.**

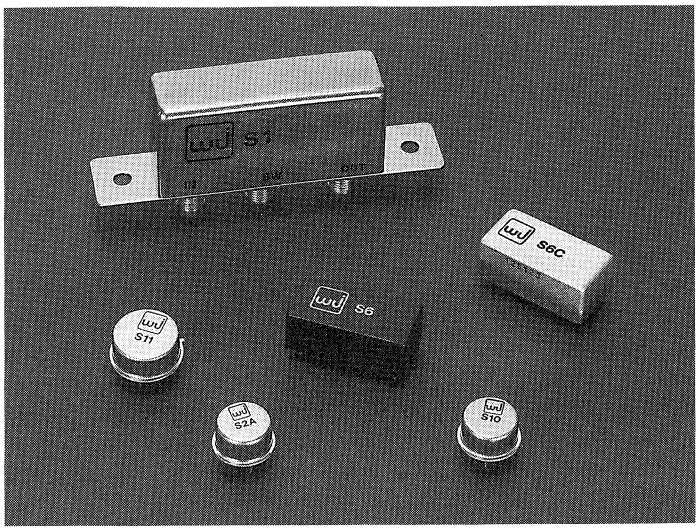
## Outline Drawing




| PIN | FUNCTION |
|---|---|
| 1 | GROUND |
| 2 | B2 BIAS PORT |
| 3 | J2 RF PORT |
| 4 | GROUND |
| 5 | COMM RF PORT |
| 6 | GROUND |
| 7 | J1 RF PORT |
| 8 | B1 BIAS PORT |

# RF SPST Switches

- ◆ HIGH ON-OFF RATIO
- ◆ EXCELLENT ISOLATION OF THE SWITCHING SIGNAL
- ◆ FAST SWITCHING SPEED




**Description:** The Watkins-Johnson line of solid-state switches is designed for transient-free operation over a wide frequency range. Utilizing a balanced construction, high frequency components of switching signal are typically suppressed 30 dB or greater. Schottky barrier diodes in the Models S1 and S6 permit switching speeds less than 2 nanoseconds with "on-off" ratios greater than 90 dB.

## Specifications at +25°C

| Model | Description | Frequency Range MHZ | On-Off Ratio,[2] Min. dB | MHz | Insertion Loss Max dB | MHz | Switching Signal Rejection[3] Min. dB | MHz | Switching Speed (nsec) Max. | Switching Condition On | Off | Weight (gms) | Package Type | Hermetic Seal | Outline Drawing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | SPST | 0.5-500 | 90<br>80<br>70<br>60 | 0.5-50<br>50-100<br>100-200<br>200-500 | 5.0<br>6.0<br>7.0 | 2-100<br>1-200<br>0.5-500 | 30 | 0.5-500 | 1.0 | +20 mA<br>≈+1.5V | -20 mA<br>≈-1.0V | 45.6 | SMA | No | I |
| S2A<br>(CS2A) | SPST | 10-1000 | 60<br>50<br>37<br>27 | 10-100<br>100-200<br>200-500<br>500-1000 | 5.0<br>5.5<br>7.0 | 10-200<br>200-500<br>500-1000 | 30<br>20<br>12 | 10-200<br>200-400<br>400-1000 | 2.0 | +20 mA | -20 mA | 2.3 | PC Mounted (SMA) | Yes<br>(Yes) | J<br>(K) |
| S6<br>(S6C) | SPST | 0.5-200 | 70<br>65<br>50<br>45 | 0.5-20<br>20-50<br>50-100<br>100-200 | 3.5<br>4.0 | 1-50<br>0.5-200 | 30 | 0.5-200 | 2.0 | +20 mA<br>≈+1.OV | -20 mA<br>≈ -1.0V | 3.6<br>(6.8) | PC<br>(PC) | No<br>(Yes) | M<br>(N) |
| S10<br>(S11[4]) | SPST | 10-500 | 65<br>60<br>45 | 10-100<br>100-300<br>300-500 | 1.7<br>2.0<br>2.5 | 10-100<br>100-300<br>300-500 | 45<br>30<br>45 | 10-100<br>100-300<br>300-500 | 5.0<br>S10<br>(20.0)<br>(S11) | +20 mA<br>=+1.0V<br>(TTL) | -20 mA<br>≈-1.0V<br>(TTL) | 2<br>(2.7) | TO-8<br>(TO-8B) | Yes<br>(Yes) | J<br>(P) |

NOTES:
1. Measured in a 50-ohm system with an input signal level of +4 dBm or less and with specified switching currents applied.
2. On-Off ratio is specified between ports A and B. Insertion loss is specified between port A and port B.
3. Sinusoidal switching signal of +17 dBm is applied to switching port and fundamental component of that signal is measured at output port.
4. S11 has an internal TTL driver circuit.

## Absolute Maximum Ratings

Operating Temperature.....-54 to +100°C
Storage Temperature.....-65°C to + 100°C
Peak Input Current
Model S1.....70 mA
Models S6, S6C, S10 and S11
.....200 mA
Peak Power
Modes Sl, S6, S6C, S10 and S11
.....+30 dBm

## Environmental

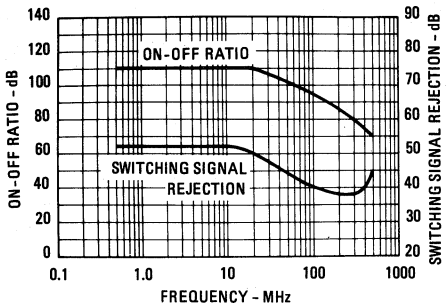
All units* are guaranteed to meet their specifications after exposure to any or all of the following tests per MIL-STD-202E:

| EXPOSURE | METHOD | TEST CONDITION |
|---|---|---|
| Temperature Cycle | 102A | C |
| Thermal Shock | 107D | B |
| Altitude | 105C | G |
| H.F. Vibration | 204C | D |
| Mechanical Shock | 213B | C |
| Random Vibration (15 minutes per axis) | 214 | IIF |
| Solderability | 208B | |
| Terminal Strength | 211A | C |
| Resistance to Soldering Heat | 210A | B |

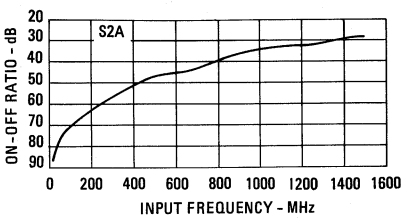
Hermetically sealed units meet the requirements of method 106D of MIL-STD-202E when exposed tp humidity.
*The temperature range for Model S1 is -20°C to +100°C for input frequencies below 1 MHz.

## Typical Performance at 25°C

**On-Off Ratio vs. Frequency:** The "on-off" ratio is defined as the ratio of the output voltage when the switch is turned "on" to the output voltage when the switch is turned "off." At lower frequencies, the "on-off" ratio is higher than it is at higher frequencies. The S1 has the best "on-off" ratio.

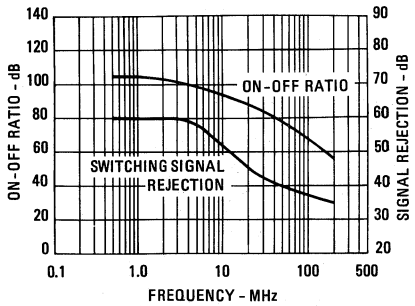



**MODEL S1**

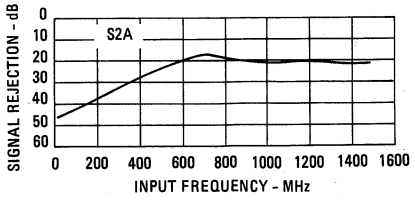



**MODEL S2A**

**Switching Signal Rejection vs. Frequency:** The switching signal rejection is defined as the amount of isolation between the switching input port and the output port. It is measured by applying a sinusoidal signal of +17 dBm to the SW port (pins 3 and 4, for pc switches) and measuring the fundamental component of the signal at the output. For transient-free switching, this rejection should be as high as possible.

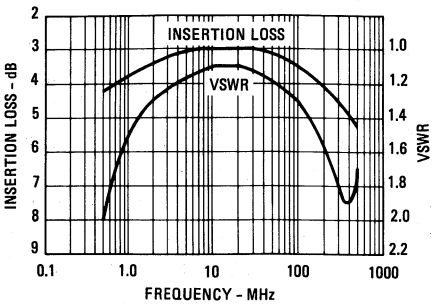



**MODEL S6/S6C**

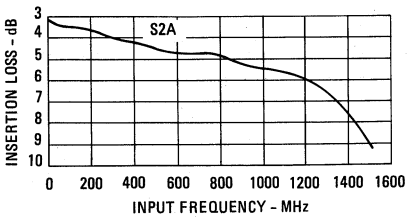



**MODEL S2A**

**Insertion Loss vs. Frequency:** The insertion loss is defined as the power loss from the input to the output with the switch turned on by the recommended minimum switching current. With a higher switching current some improvement in performance can be obtained as shown in the insertion loss vs. signal level curves.




**MODEL S1**

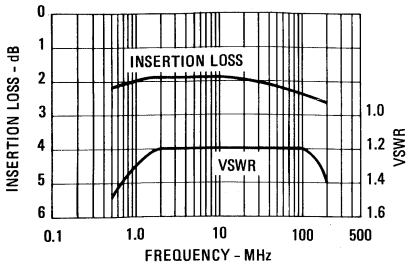



**MODEL S2A**

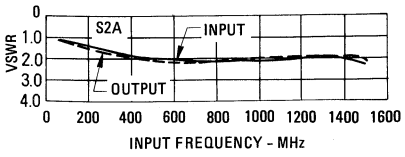
15

## Typical Performance at 25°C

**VSWR vs. Frequency:** The VSWR is defined as the VSWR of either the input or output port when the switch is turned "on" and the other port is terminated in 50 ohms. When the switch is in the "off" mode, the VSWR of the SPST switches is essentially that of an open circuit.

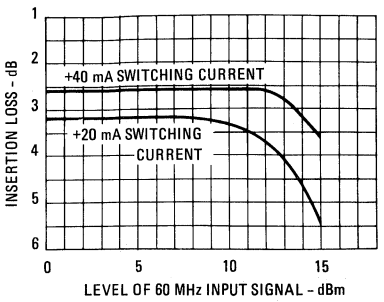



MODEL S6/S6C

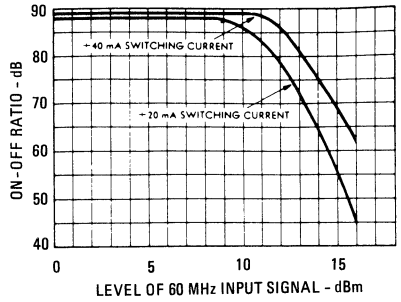



MODEL S2A

**Insertion Loss vs. Signal Level:** As the input signal level is increased above the maximum specified level of +4 dBm, the input signal starts to control the switch rather than the switching signal. The insertion loss of the switch for various input levels of a 60 MHz signal and switching currents is plotted for each switch.

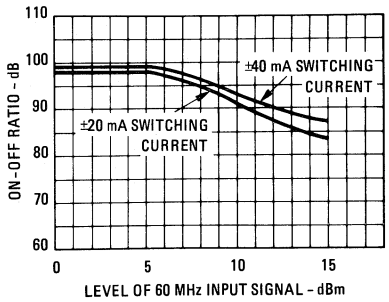



MODEL S1

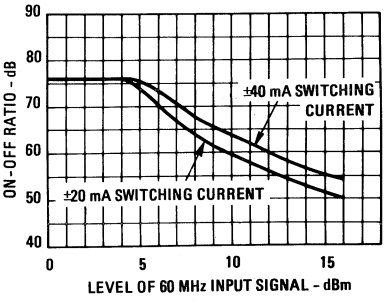



MODEL S6/S6C

**On-Off Ratio vs. Signal Level:** The loss of "on-off" ratio as a function of input level is plotted for a 60 MHz signal. An increase in the switching current improves the "on-off" ratio.



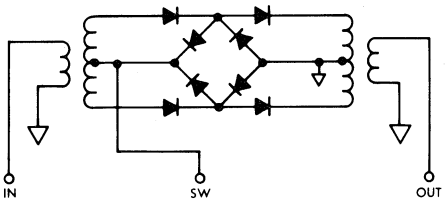

MODEL S1




MODEL S6/S6C

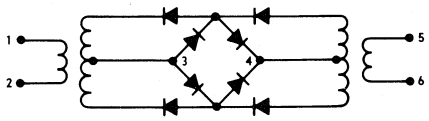
## Schematic Diagrams

**S1**




A biasing current of +20 mA into the SW port gives the on-condition, and -20 mA into the SW port gives the off condition. The corresponding voltages are approximately +1.5V for the switch "on" and -1.0V for the switch "off."

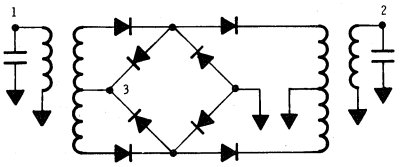
**S6/S6C**




The input signal is applied at Pins 5 and 6 and the output signal appears at Pins 1 and 2.

Bias is applied to Pins 3 and 4 with Pin 3 at signal ground, if there is a signal ground reference. A bias current of +20 mA into Pin 4 turns the switch "on," and a bias current of -20 mA out of Pin 4 turns the switch "off." For the S6/S6C, the corresponding voltages (Pin 4 to Pin 3) are approximately +1.0V for the switch "on" and -1.0V for the switch "off." Pin 3 is internally grounded to case on Model S6C.

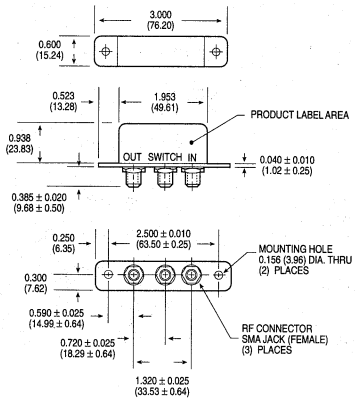
**S2A**




The input signal is applied at Pin 1 and the output signal is taken from Pin 2. The switching bias is applied to Pin 3. A bias current of +20 mA into Pin 3 turns the switch on, and a bias current of -20 mA out of Pin 3 turns the switch off. The corresponding voltages (Pin 3) are approximately +1.0V for the on condition and -1.0V for the off condition.

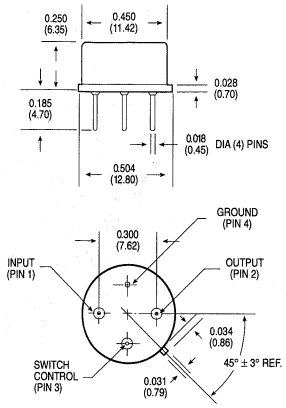
# Outline Drawings

## Package 1
## S1



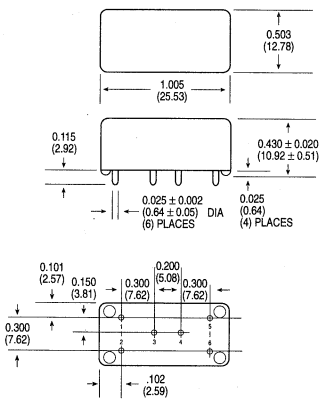

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (±.38) UNLESS OTHERWISE SPECIFIED

## Package J
## S2A/S10



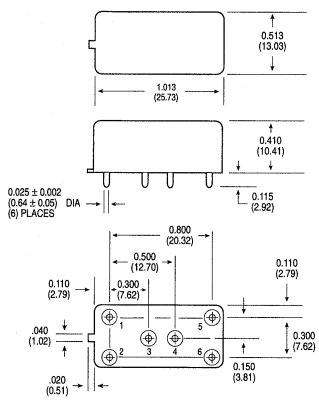

TOLERANCES ±0.015 (±0.38)

## Package M
## S6



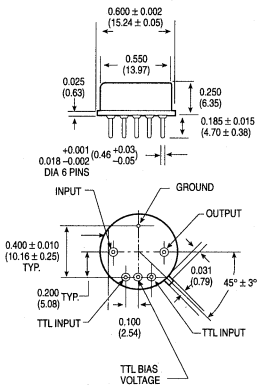

TOLERANCES ± 0.015 (±0.38)

## Package N
## S6C



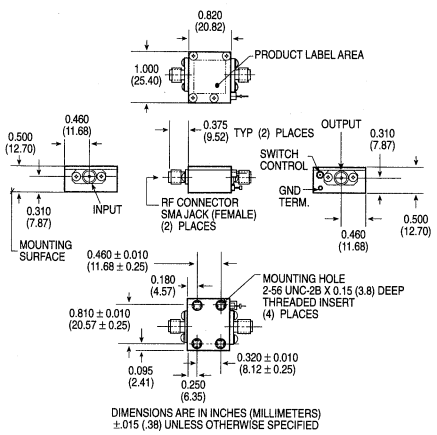

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (±.38) UNLESS OTHERWISE SPECIFIED

## Package P
## S11




TOLERANCES ±0.015 (±0.38)

## Package K
## CS2A



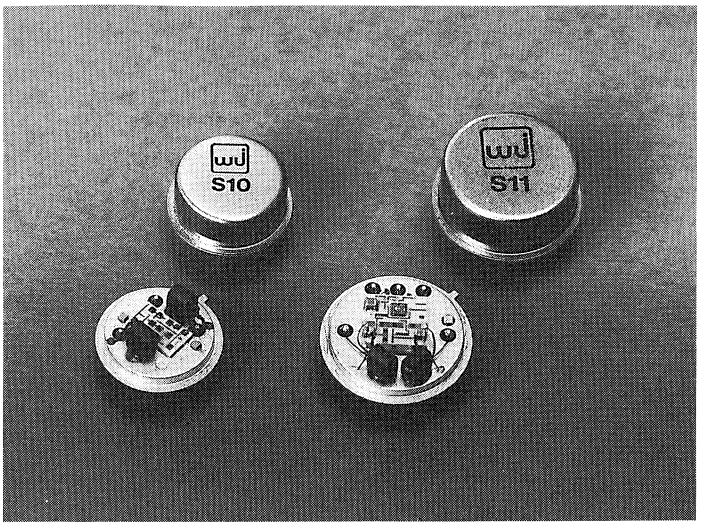

DIMENSIONS ARE IN INCHES (MILLIMETERS)
±.015 (.38) UNLESS OTHERWISE SPECIFIED

15

# WJ-S10/S11

## 10 TO 500 MHz
## THIN FILM SPST SWITCH

- ◆ LOW INSERTION Lbss: <2.5 dB (TYP.)
- ◆ HIGH ON/OFF RATIO: 60 dB (TYP.)
- ◆ LOW VSWR: 1.6: (TYP.)
- ◆ TTL COMPATIBLE S11
- ◆ HIGH SPEED SWITCHING: 2 nsec (TYP.) S10




### Guaranteed Specifications

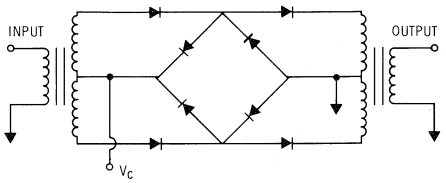
| Characteristic | Typical | 0° to 50°C | -54°C to +85°C |
|---|---|---|---|
| Insertion Loss (Max.) | | | |
| 10-100 MHz | < 1.7 dB | 2.3 dB | 2.7 dB |
| 100-300 MHz | < 2.0 dB | 2.6 dB | 3.0 dB |
| 300-500 MHz | < 2.5 dB | 4.0 dB | 4.5 dB |
| Isolation | | | |
| 10-100 MHz | >67 dB | 54 dB | 52 dB |
| 100-300 MHz | >62 dB | 50 dB | 48 dB |
| 300-500 M H z | >48 dB | 39 dB | 36 dB |
| VSWR (Max.) Input/Output (ON state) | | | |
| 10-500 MHz | 1.9:1 | 2.4:1 | 2.6:1 |
| Switching Speed (10 to 90%) | | | |
| S10 | 2 nsec | 5 nsec | 5 nsec |
| S11 | 8 nsec | 20 nsec | 20 nsec |

*Measured in a 50-ohm system, at +5 volts (S11.)

### Absolute Maximum Ratings

Ambient Operating Temperature ..... -54°C to +125°C
Storage Temperature ..... -62°C to +125°C
Maximum Case Temperature ..... 125°C
Maximum DC Voltage ..... +6 Volts
Maximum Continuous RF Input Power ..... +10 dBm
Maximum Short Term RF Input Power ..... 100 Milliwatts
Maximum Peak Power (1 Minute Max.) ..... 1 Watt (3 µsec Max.)
"S" Series Burn-in Temperature ..... 125°C

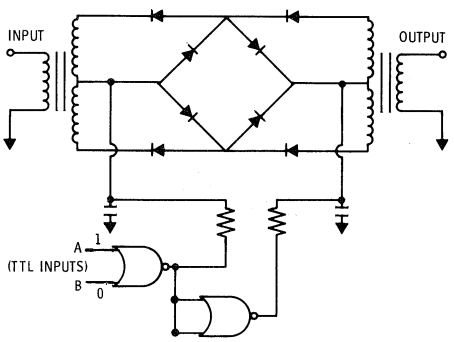
### Schematic Diagram




**SWITCHING CONDITIONS**

| ON | OFF |
|---|---|
| +20 mA | -20 mA |
| ≈+1.0V | ≈-1.0V |

### Schematic Diagram



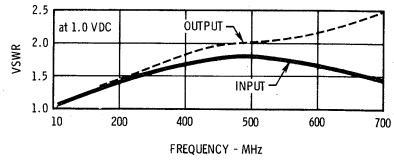

DC volts: 5 ± 1% nominal; DC current 45 mA
TTL logic inputs "0" = 0 volts
"1" = 5 volts nominal
2 volts minimum
6 volts maximum

**SWITCHING CONDITIONS**

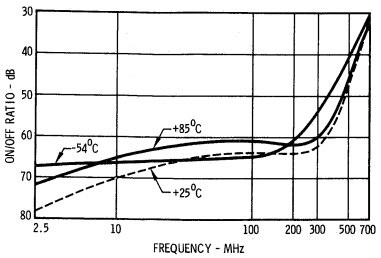
| Input Pins | ON State | OFF State | |
|---|---|---|---|
| A | 0 | 1 | 1 0 |
| B | 0 | 1 | 0 1 |

# Typical Performance at 25°C

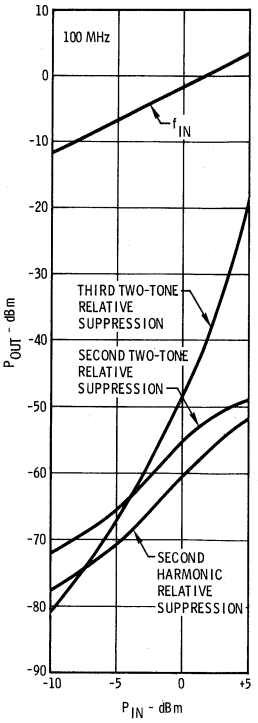
### VSWR (ON STATE)



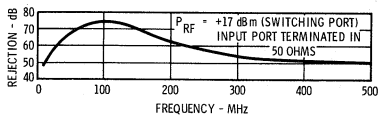

### Isolation



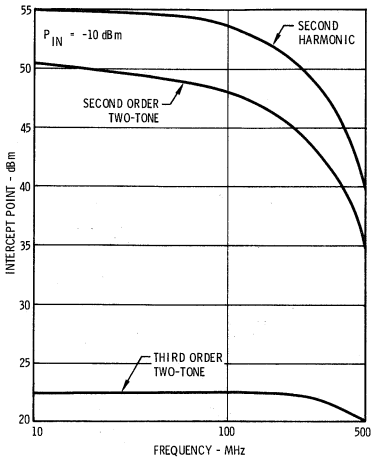

### Distortion Products vs. Input Power



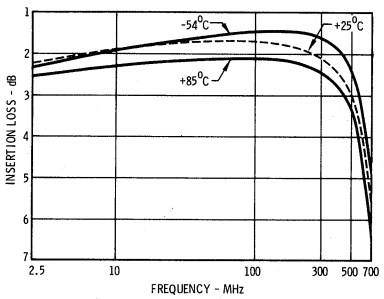

### Switching Signal Rejection




### Intercept Point




### Insertion Loss




# Typical Automatic Test Data

### Off State: S10

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100 | .84 | –25.7 | .00 | 127.7 | .00 | –167.2 | .84 | –24.9 |
| 200 | .83 | –52.3 | .00 | 104.7 | .00 | 74.6 | .83 | –50.7 |
| 300 | .81 | –80.9 | .00 | –176.9 | .00 | –179.2 | .81 | –80.5 |
| 400 | .80 | –112.0 | .00 | –119.8 | .00 | –117.0 | .78 | –114.0 |
| 500 | .78 | –145.3 | .00 | –109.1 | .00 | –106.3 | .75 | –149.5 |
| 600 | .76 | 176.4 | .01 | –115.0 | .01 | –116.1 | .74 | 169.8 |
| 700 | .74 | 134.5 | .01 | –147.3 | .01 | –146.6 | .73 | 126.1 |

### Off State: S11

| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100 | .82 | –22.2 | .00 | 71.4 | .00 | –118.9 | .83 | –27.3 |
| 200 | .81 | –45.2 | .00 | 137.4 | .00 | 98.4 | .83 | –55.0 |
| 300 | .80 | –70.7 | .00 | –147.9 | .00 | –141.4 | .82 | –85.8 |
| 400 | .78 | –98.9 | .00 | –122.5 | .00 | –119.2 | .80 | –118.8 |
| 500 | .76 | –130.0 | .00 | –120.7 | .00 | –120.8 | .78 | –152.2 |
| 600 | .75 | –166.4 | .01 | –131.5 | .01 | –129.7 | .79 | 170.7 |
| 700 | .74 | 151.6 | .02 | –146.4 | .02 | –145.0 | .79 | 129.8 |

### On State: S10

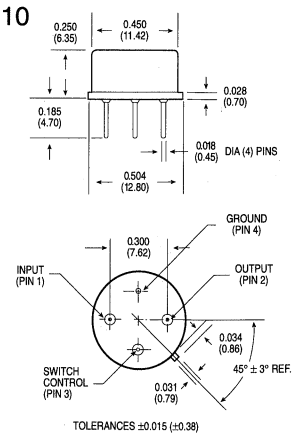
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100 | .04 | –86.6 | .81 | .7 | .81 | .9 | .04 | –86.6 |
| 200 | .09 | –122.7 | .79 | 1.7 | .79 | 1.7 | .10 | –122.2 |
| 300 | .16 | –154.2 | .77 | 1.4 | .77 | 1.1 | .17 | –152.1 |
| 400 | .25 | 173.4 | .74 | –.2 | .73 | –.5 | .26 | 177.2 |
| 500 | .36 | 140.0 | .70 | –3.3 | .70 | –2.6 | .37 | 145.8 |
| 600 | .47 | 106.9 | .62 | –8.1 | .62 | –7.2 | .48 | 113.9 |
| 700 | .55 | 71.4 | .48 | –10.0 | .48 | –9.0 | .55 | 78.1 |

### On State: S11

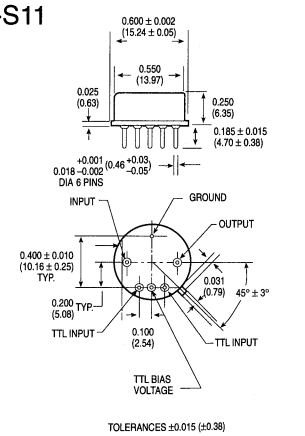
| Frequency | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| MHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100 | .03 | –90.6 | .81 | 2.2 | .81 | 2.3 | .04 | –86.7 |
| 200 | .07 | –124.5 | .80 | 4.6 | .80 | 4.4 | .08 | –120.0 |
| 300 | .13 | –153.1 | .78 | 5.4 | .78 | 5.1 | .15 | –147.9 |
| 400 | .21 | 176.4 | .76 | 5.1 | .75 | 5.1 | .24 | –177.8 |
| 500 | .32 | 145.2 | .73 | 3.4 | .72 | 3.9 | .35 | 150.7 |
| 600 | .44 | 114.4 | .66 | –.5 | .66 | .4 | .47 | 118.3 |
| 700 | .56 | 81.8 | .50 | –4.3 | .54 | –3.7 | .58 | 81.6 |

# Outline Drawings

### WJ-S10



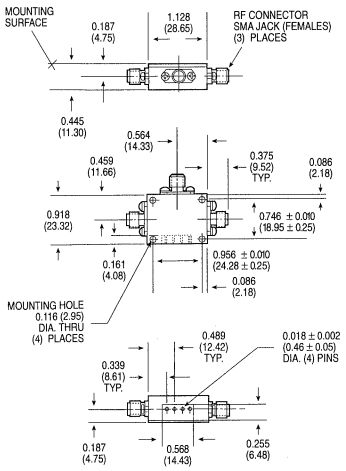

### WJ-S11




15

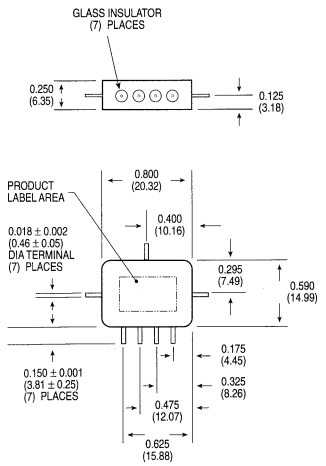
# Outline Drawings

## 296840



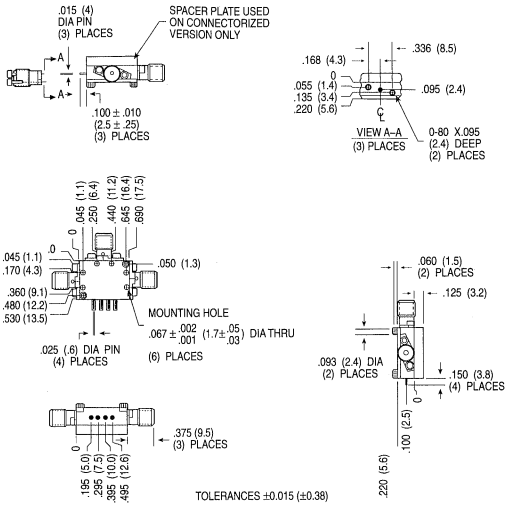

TOLERANCES ±0.015 (±0.38)

## 296841



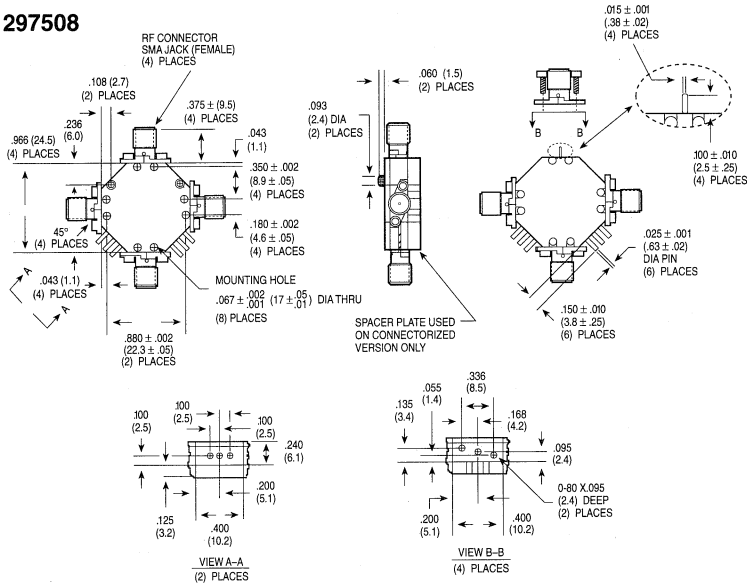

TOLERANCES ±0.015 (±0.38)

## 297507



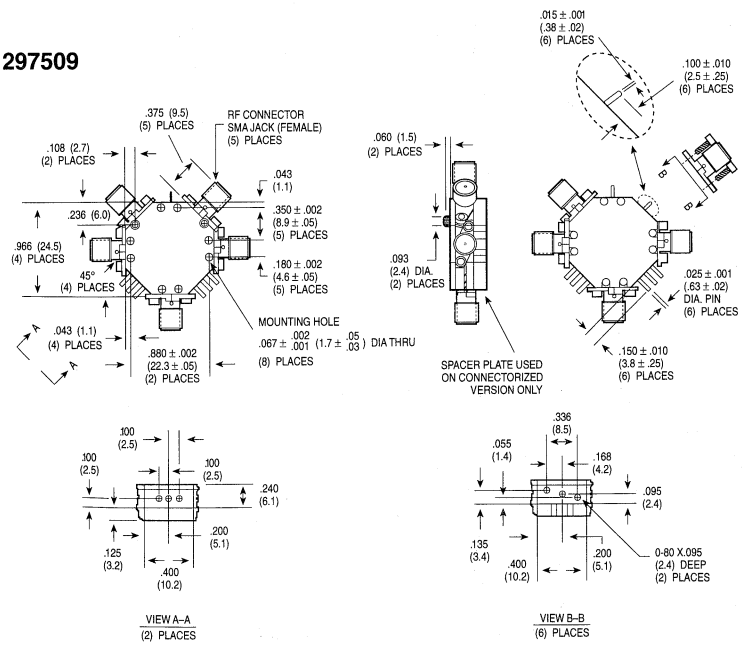

TOLERANCES ±0.015 (±0.38)

## 297508



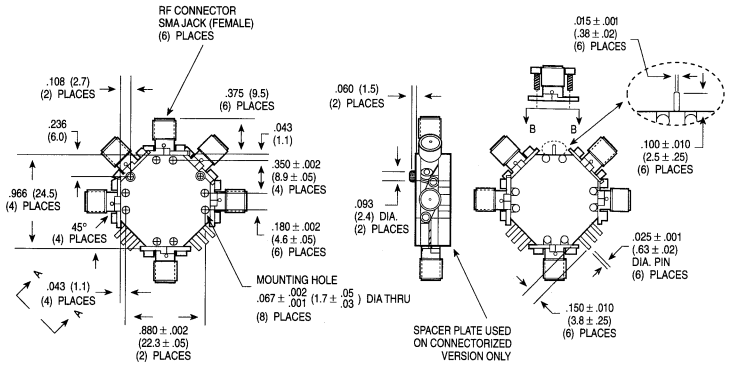

TOLERANCES ±0.015 (±0.38)

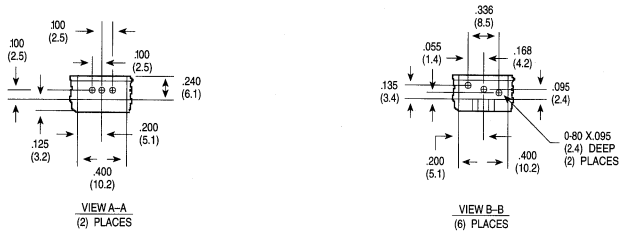
## 297509




TOLERANCES ±0.015 (±0.38)

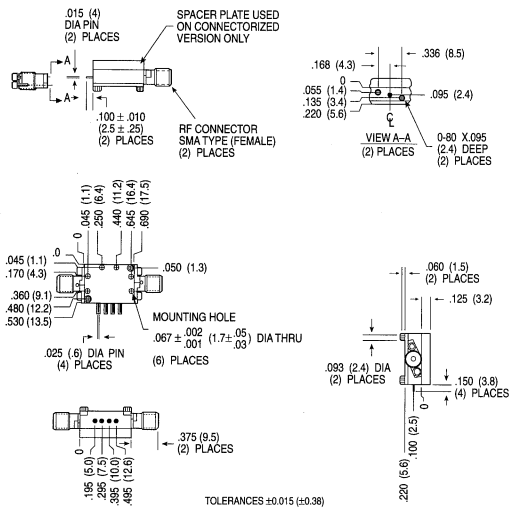
## 297510



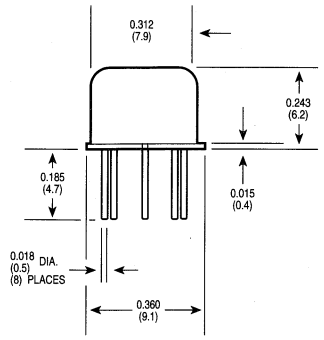

TOLERANCES ±0.015 (±0.38)

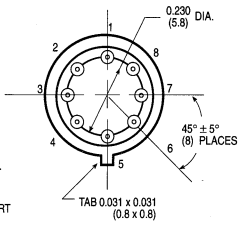
## 297511




TOLERANCES ±0.015 (±0.38)

## 297537



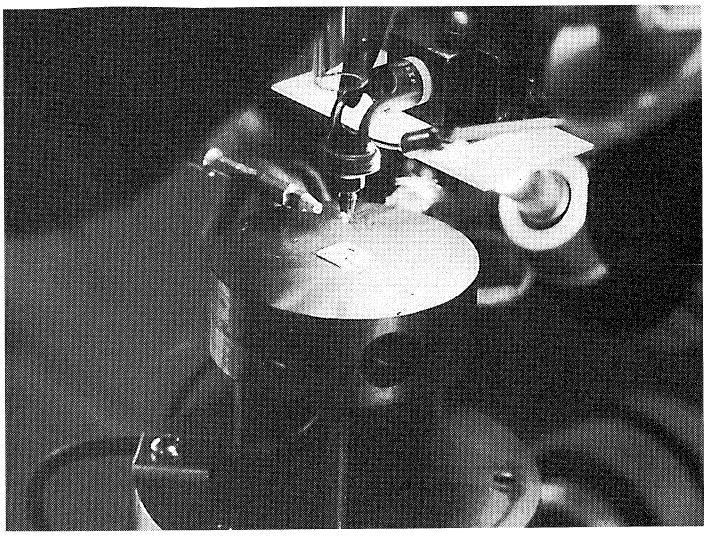




| PIN | FUNCTION |
|---|---|
| 1 | GROUND |
| 2 | B2 BIAS PORT |
| 3 | J2 RF PORT |
| 4 | GROUND |
| 5 | COMM RF PORT |
| 6 | GROUND |
| 7 | J1 RF PORT |
| 8 | B1 BIAS PORT |

TOLERANCES ±0.015 (±0.38)
(BOTTOM VIEW)

# *Application Notes/Conversion Tables*

# Application Information for Thin Film Cascadable Amplifiers



## INSIDE THE TO-8 AMPLIFIER: BASIC CIRCUIT CONCEPTS

This discussion covers the basic circuit concept behind the cascadable amplifier and details some of the techniques that are used to maintain hardware stability in the application of the units. The fundamental common denominator to most broadband cascadable amplifiers is collector-to-base, shunt-resistive feedback and series-emitter resistive feedback, as shown in Figure 1. There are some reactive feedback methods that have been employed both in combination with and without resistive feedback to reduce the degradation that the resistive feedback has on the noise figure. However, the consideration of these design schemes is beyond the scope of this article.

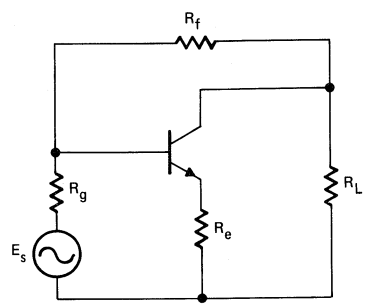



**Fig. 1—Resistive Feedback.**

The typical transducers used in the TO-8s are microwave bipolar transistors which have a nominal 6 dB/octave gain slope, as shown in Figure 2. The amplifier gain curve can be flattened using pure, resistive feedback with no reactive elements up to a frequency where the open loop gain is approximately 10 dB greater than the closed loop gain. Then, reactive elements must be used to provide input and output match and to "gain-peak" the amplifier to obtain the highest-gain bandwidth product. A typical RF circuit excluding DC biasing, coupling, and bypass capacitors is shown in Figure 3. The parasitic elements, such as header capacitance and bondwire induc-

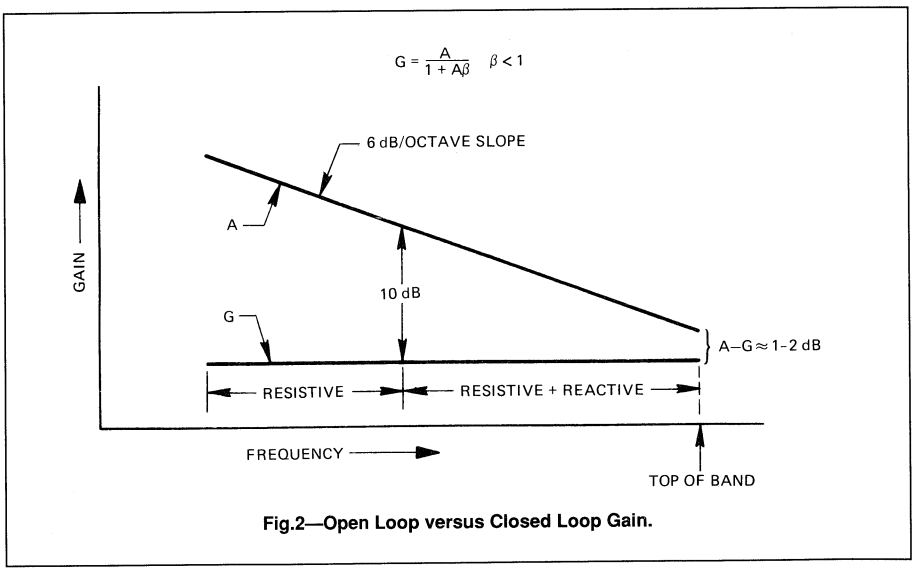



**Fig.2—Open Loop versus Closed Loop Gain.**

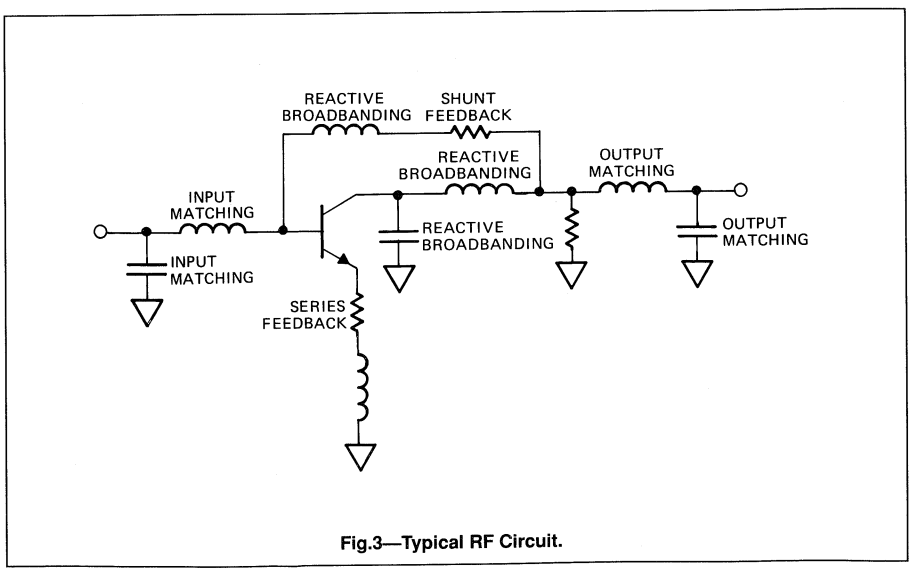



**Fig.3—Typical RF Circuit.**

tance, are absorbed into the circuit elements. Manual computer optimization is used on a specially developed W-J computer program that is specifically designed for analyzing cascadable amplifier circuits.

This program uses conventional matrix techniques to treat each circuit element and uses fixed topology. Single stage gain typically runs from 6 to 25 dB, with $R_e$ ranging from 20 to 0 ohms and $R_f$ ranging from 150 to 1000 ohms, as illustrated in Figure 4. For low noise circuits, $R_e$ usually goes to zero, since the transistor is normally biased for less than 10 mA collector current and the internal $R_e$, which can be approximately $.026/I_c$, acts as sufficient emitter feedback. The curves in Figure 5 show the gain, the input and output impedance as a function of $R_e$ with a fixed $R_f$. $R_e$ is fixed and $R_f$ varied in Figure 6, which

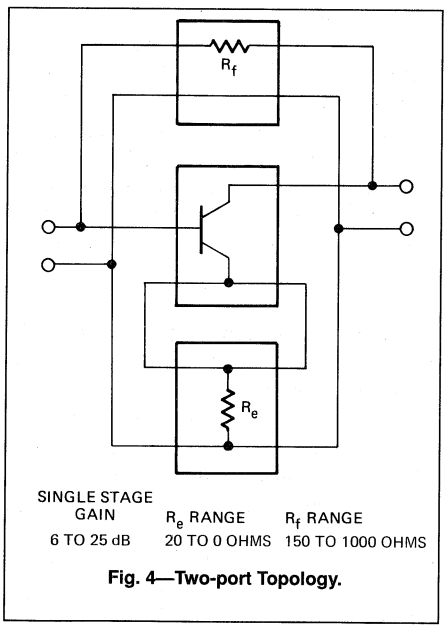



**Fig. 4—Two-port Topology.**

shows the inverse gain relationship between these two resistors. It is this property of the microwave bipolar transistor that allows various gain options to be realized. For a fixed value of $R_e$, to obtain as close to a 50-ohm input and output impedance as possible, a certain value of $R_f$

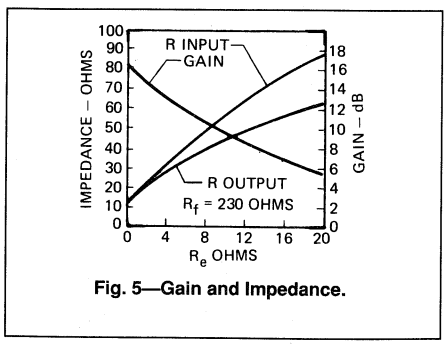



**Fig. 5—Gain and Impedance.**

that will dictate the gain is required. For higher gain, a lower value of $R_e$ is chosen, which requires an increase in the value of $R_f$. The gain that can be obtained at the top

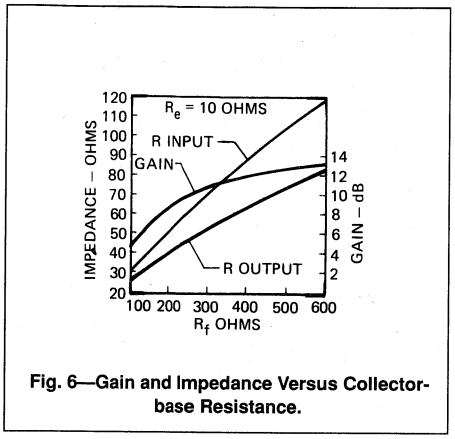



**Fig. 6—Gain and Impedance Versus Collector-base Resistance.**

of the band is typically within 2 dB of the transducer's open-loop gain. To obtain more than this gain from the device usually results in both lack of unconditional stability and increased input VSWR.

## Noise-Figure Degradation

For a rough first approximation of the quantitative degradation in noise figure that the resistive feedback elements cause, the following derivations may be used. The approximation excludes the actual transistor and its noise properties from the analysis. This contributes to the degree of accuracy of the approximation; but, its purpose is to obtain, by simple calculation, what degradation can be expected. This type of approximation is particularly useful when it is desired to determine the influence of changing the feedback elements on noise figure to obtain different gain levels.

When the gain of the bipolar transistor is significantly reduced by feedback,its open-loop noise characteristics change such that the amplifier does not respond as readily to changes in source impedance. The transistor will generally operate better

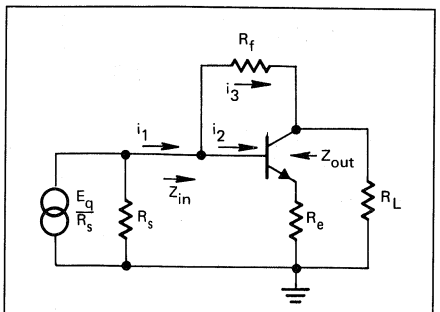



**Fig. 7—Noise Figure Degradation.**

when essentially matched to its input impedance. As discussed earlier, the cascadable amplifier must have close to a 50-ohm input and output impedance. For the purpose of the following analysis it will be assumed that the input and output impedance is 50 ohms.

The equivalent circuit for the transistor circuit in Figure 7 can be changed to that shown in Figure 8 for determining the

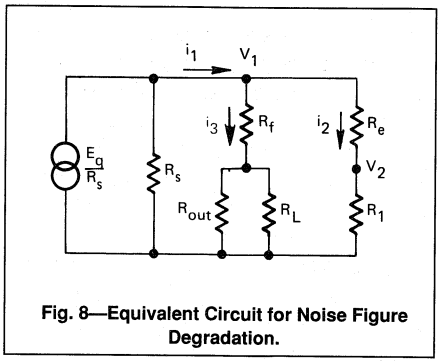



**Fig. 8—Equivalent Circuit for Noise Figure Degradation.**

resistive losses caused by the feedback elements. In effect, the emitter feedback resistor, $R_e$, can be considered a loss element in series with $R_1$, the effective input resistance of the transistor. The emitter resistor can be treated as a voltage-dividing element where the signal-to-noise ratio is increased by this voltage division.

Letting $Z_{in} = R_{out} = R_L = 50$ ohms and solving for $R_1$,

$$R_1 = \frac{(R_f + 25)\,50}{R_f - 25} - R_e \qquad (1)$$

The input power to the network when $Z_{in} = 50$ ohms is $50i^2$. The power delivered to $R_1$ is $R_1(i_2)^2$. Taking the ratio of delivered power to input power yields:

$$\text{Power ratio} = \frac{R_1\,(i_2)^2}{50(i_1)^2} \qquad (2)$$

Using current division, and solving for $i_2$, gives:

$$i_2 = \frac{i_1(R_f + 25)}{R_f + 25 + R_e + R_1} \qquad (3)$$

Substituting equation 3 into equation 2 yields:

$$\text{Power ratio} = 10 \log \frac{(R_f+25)^2\,R_1}{50(R_f+25+R_e+R_1)^2} \qquad (4)$$

For an amplifier with an $R_e$ of 12 ohms and $R_f$ of 240 ohms, the degradation of the noise figure calculates to 1.85 dB. At the other end of the scale a low noise amplifier might have an $R_f$ of 400 ohms and an $R_e$ of zero ohms, from which only 0.54-dB degradation is calculated.

Empirical data show that using equations 1 and 4 can be made slightly more accurate by adding a correction factor of 0 dB for a 20-dB or higher gain stage and 0.5 dB for a 7.5-dB gain stage, with linear interpolation in between.

## Output Power

The output power of the TO-8 feedback amplifier is a direct function of the collector current. The great majority of cascadable amplifiers use direct capacitively coupled outputs, i.e., circuits without impedance transforming devices and, as a result, are voltage-limited. Nonsymmetrical clipping occurs on the cutoff portion of the AC swing, as shown in Figure 9. The steep AC load line is a result of the direct coupling to the 50-ohm load impedance. For greater output power at a given collector current, the equivalent AC load impedance must be raised. This reduces the slope of the AC load line, thereby providing greater AC swing in the cutoff part of the cycle. This effect can be observed by comparing $V_p$ to $V_p'$ in Figure 9. For wideband operation and good impedance matching, it is generally not practical to use a transforming device, except for the VHF and lower UHF frequency ranges. The WJ-PA2 A87 series,A81 /A82 series and the A67 series use autoformers in the collector circuit for higher and more efficient output power, but are limited to below-800-MHz operation. Because of the sensitivity of the output power to the AC load line, the voltage limiting is a direct function of the load impedance. Higher than 50 ohms for the load will result in greater than the nominal output power, and lower than 50 ohms will reduce the available output power.

## DC Biasing

Depending on RF requirements and cost considerations, several schemes are used to provide the DC biasing in the cascadable amplifiers. In the low-cost scheme shown in Figure 10, the collector feedback resistor serves the dual purpose of providing base bias and collector-to-bases hunt feedback. This approach is used in TO-5 packages and is represented by the W-J EA series, such as the EA2 amplifier. Compromised performance results because the ultra-small size does not allow input or output matching. The unit operates essentially with resistive matching, except that a series peaking inductor is used in the collector line. In addition, the value of $R_1$ is typically less than 150 ohms, which causes substantial noise figure degradation because the value of $R_f$ must be chosen to set the gain and provide a reasonable input and output match. This requires that $R_1$ have a low enough value to enable it to pass the excess bleeder current. Since the compromised performance of the circuit shown in Figure 10 has no $R_3$, in comparison to the circuit shown Figure 11, the voltage at the base will be low, which also necessitates that $R_1$ be low. In order to reduce the current flow, $V_{CE}$ is set low, thereby reducing the maximum available gain in this type of design.

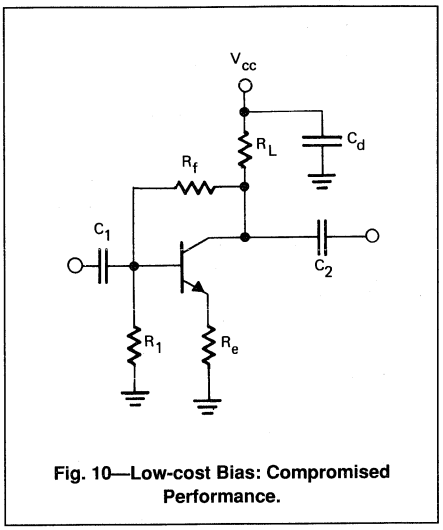



**Fig. 10—Low-cost Bias: Compromised Performance.**

The passive bias circuit shown in Figure 11 overcomes noise figure and gain problems by using a separate $R_f$ resistor and an emitter resistor to provide both DC feedback for temperature stability and to raise the voltage level at the base so that $R_1$ can be larger in value. The parallel combination of $R_1$ and $R_2$ provides a minimum amount of shunting and its accompanying noise figure increase and gain reduction.

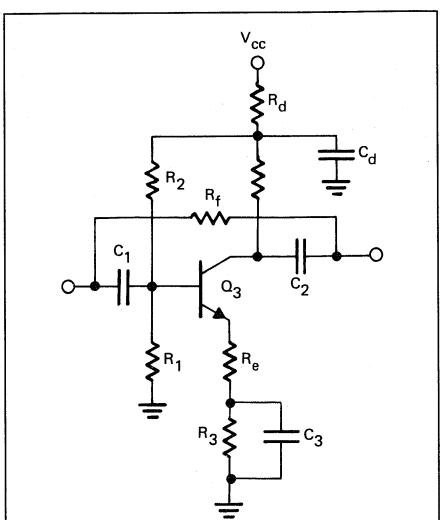



**Fig. 11—Passive Bias: Full Performance.**

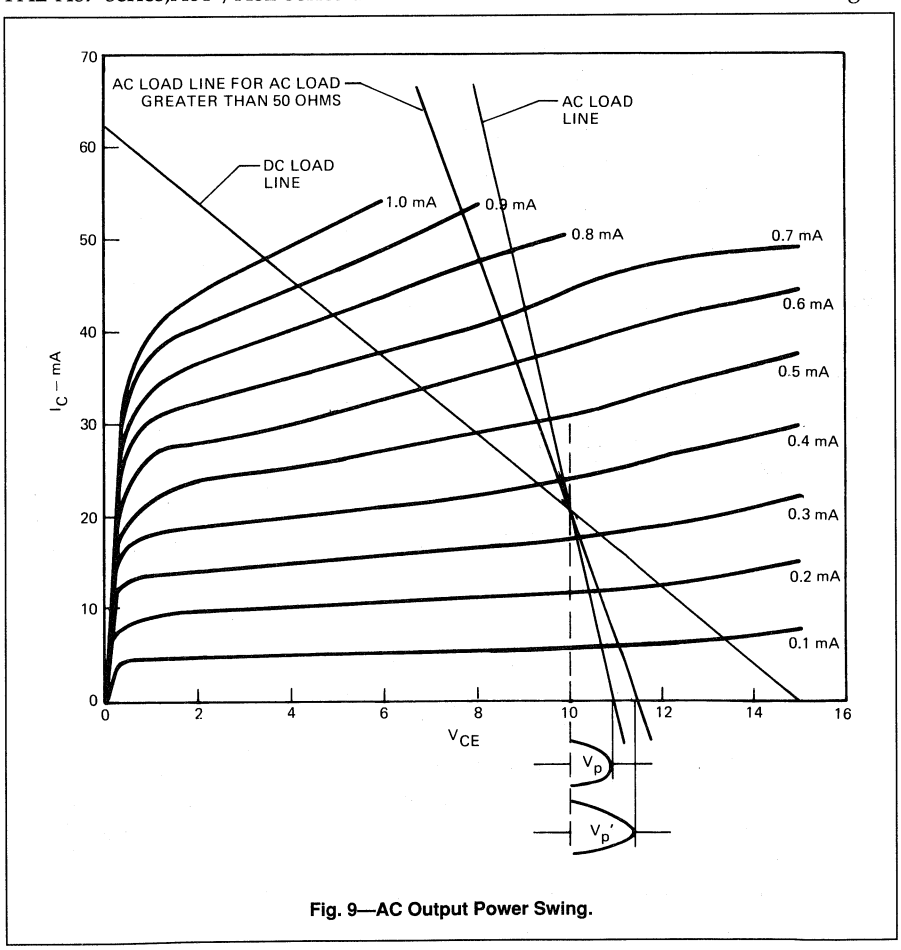



**Fig. 9—AC Output Power Swing.**

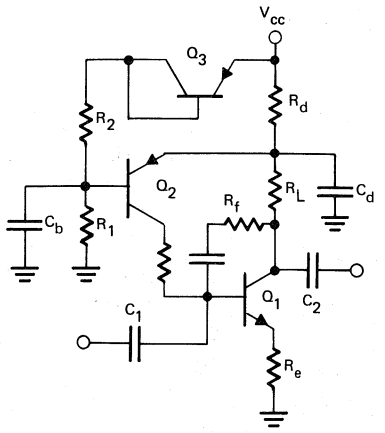



**Fig. 12—Active Bias: Full Performance.**

A third scheme uses a PNP low frequency transistor to bias the RF transistor, as shown in Figure 12. This approach virtually eliminates base shunting and, in addition, does not have an element in the emitter circuit which minimizes degeneration because of additional parasitic inductance in the emitter leg. This circuit is temperature-stable because if $I_c$ in the RF transistor goes up, the voltage across the sense resistor, $R_d$, will go up, causing $V_{BE}$ across $Q_2$ to go down. This action reduces the base drive to $Q_1$, causing $I_C$ to go down. When $R_d$ is less than about 300 ohms, it is usually necessary to include $Q_3$ to track the base-emitter voltage of $Q_2$ over temperature as the differential voltages on $R_d$ can become comparable in magnitude to the normal base-emitter voltage change that occurs as a function of temperature.

The circuit of Figure 13 is used for the higher-level cascadable amplifiers,which differ from the type shown in Figure 12 by the addition of an RF choke. The choke does not limit current, and for higher-level units, particularly if it is not desired to raise $V_{CC}$ above 15 volts, it does not shunt the output and absorb RF power. Most W-J amplifiers that provide +13 dBm or greater output power utilize an RF choke for power supply decoupling.

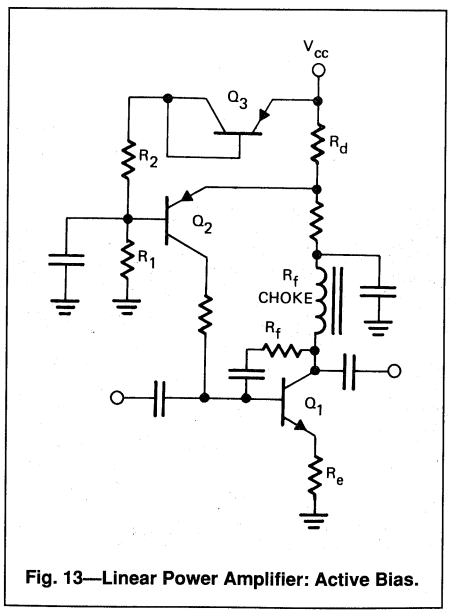



**Fig. 13—Linear Power Amplifier: Active Bias.**

One method of providing bias for two cascaded RF stages in a single TO-8 is demonstrated in Figure 14. Here, the active bias circuit of Figure 12 is expanded to provide bias from a single transistor for both RF transistors. The limitation of this circuit is that the collector current of each RF transistor ($Q_1$ and $Q_2$) must be close enough in value so that each transistor will receive its proportionate amount of correcting currents from $Q_3$ when the circuit is operated over wide temperature ranges.

To summarize these bias schemes, the circuit in Figure 10 is used where minimum cost and size are the dominant factors. The circuit in Figure 11 is used where higher performance is desired, but the frequency of operation is usually limited to 500 MHz or below. The circuit will be less sensitive to sub-band oscillators (see section on sub-band oscillations), since no active device is used in the bias circuit.

The bias circuit shown in Figure 12 is not frequency-limited, and offers the maximum gain obtainable from the RF transistor. The circuit of Figure 13 is used where it is desired to obtain higher power than possible from the circuit of Figure 12. The circuit of Figure 14 minimizes the area required for high-performance applications when two stages in a single TO-8 package are used.

## Performance Parameters Cascading Rules

The wide selection of amplifiers combined with the WJ-G1 gain control module, offers extensive flexibility in achieving any desired gain, frequency noise figure, VSWR and power output.

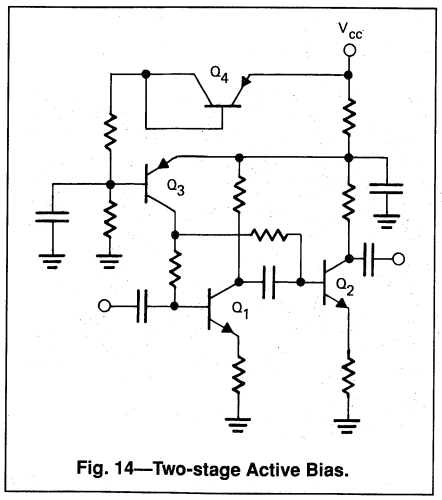



**Fig. 14—Two-stage Active Bias.**

The following sections give a few simple rules to use when cascading these amplifiers.

### Gain

The typical cascaded gain will be the sum of the individual unit typical gains. The overall gain specification should not exceed the sum of the minimum gains as specified for each unit. The cascaded gain of the A15, A17 and PA10 is shown in Figure 15. An overall gain of 37 ± 0.4 dB is achieved from 10-1000 MHz.

### Gain Flatness

Each cascadable amplifier is flat across its respective band to within ±0.3 dB.The cascaded gain flatness for up to 4 units typically will be less than ±1.0 dB. However, for a conservative specification, ±1.5 dB should be used when the full bandwidth is required.

The gain characteristics of three A5s in cascade are shown in Figure 16 for $V_{CC}$ values of 15 V, 12 V, 10 V, and 8 V. Note that the gain flatness remains virtually unchanged for voltages ranging from 8 to 15 volts. The total power drain for the three

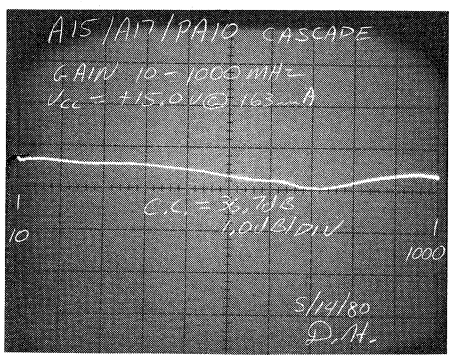



**Fig. 15—Gain of the A15, A17 and PA10 Cascade.**

units is only 288 mW at 8 volts compared to 1120 mW at 15 volts. This cascade is very useful in applications with limited power drain.

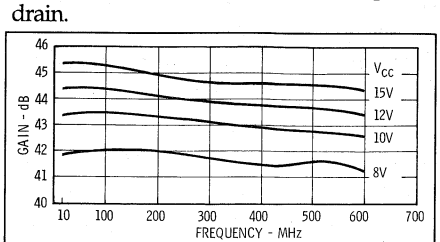



**Fig. 16—Gain Performance of Three A5 Amplifiers in Cascade for $V_{CC}$ Values of 15V, 12V, 10V and 8V.**

## Cascaded Noise Figure

The overall noise figure measured at the input amplifier of a cascade will increase due to the second stage contribution. The overall noise figure of a cascade can be calculated using the following equation:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \ldots + \frac{F_N - 1}{G_2 \ldots G_{N-1}}$$

where $F_N$ is the noise figure of the Nth stage of $G_N$ is the gain of the Nth stage. All terms are numeric ratios and are not in dB.

Table 1 gives the second stage contribution for the gains available from the cascadable amplifiers. For example, a typical cascade would be an A1 followed by two A5s. If both A5s have a 5.0 dB noise figure, from Table 1, the contribution of the second A5 to the first A5 is only 0.093 dB. In this example, the second stage contribution to the overall noise figure is virtually the same even if the A1 (first stage Noise Figure of 3 dB) is cascaded with one or more A5s. The contribution given from Table 1 is 0.146 dB. If the second stage were an A1 (3 dB Noise Figure) instead of an A5, then the contribution would be 0.068 dB or an improvement of only 0.08 dB.

The disadvantages of cascading two or more low noise amplifiers are lower input power for 1 dB gain compression and larger gain variation over temperature because of the low bias level on the transistor. For example, the individual data sheet on the low-level A3 amplifier shows a gain variation of approximately ±0.5 dB over a temperature range of -54°C to +100°C. The variation for the A5 over the same temperature range is typically less than ±0.3 dB. The main advantages of cascading low-level amplifiers are lower power drain and better limiting action to high-level signals.

## Impedance

The Watkins-Johnson Company cascadable amplifiers are designed for 50-ohm input and output impedance by using both collector-to-base and emitter resistive feedback. In addition, LC matching and reactive feedback compensation are used to obtain matching at the high end of the band. The photograph in Figure 17 shows the cascaded input and output impedance of an A11/A15 cascaded. In this case the cascaded VSWR is improved slightly over the unit VSWR. Most Watkins-Johnson cascadable amplifiers offer a bandwidth of 6-8 octaves. In general, the impedance is between 40-60 ohms and is essentially resistive below 1-1/2 octaves from the high end of the band.

Table 1—Second Stage Noise Figure Contribution—dB

| First Stage Gain dB | First Stage Noise Figure dB | Second Stage Noise Figure 3 dB | 5 dB | 8 dB | 10 dB | 12 dB | 15 dB | 20 dB |
|---|---|---|---|---|---|---|---|---|
| 20 dB | 8.0 | 0.007 | 0.015 | 0.040 | 0.060 | 0.100 | 0.206 | 0.633 |
| | 5.0 | 0.014 | 0.03 | 0.070 | 0.120 | 0.200 | 0.401 | 1.183 |
| | 3.0 | 0.022 | 0.05 | 0.110 | 0.190 | 0.310 | 0.620 | 1.750 |
| | 1.5 | 0.039 | 0.07 | 0.160 | 0.270 | 0.430 | 0.852 | 2.307 |
| 15 dB | 8.0 | 0.220 | 0.047 | 0.114 | 0.190 | 0.310 | 0.620 | 1.750 |
| | 5.0 | 0.043 | 0.093 | 0.225 | 0.370 | 0.600 | 1.160 | 2.989 |
| | 3.0 | 0.068 | 0.146 | 0.351 | 0.580 | 0.920 | 1.718 | 4.098 |
| | 1.5 | 0.096 | 0.205 | 0.488 | 0.800 | 1.250 | 2.267 | 5.074 |
| 10 dB | 8.0 | 0.07 | 0.150 | 0.350 | 0.580 | 0.920 | 1.718 | 4.098 |
| | 5.0 | 0.14 | 0.290 | 0.670 | 1.090 | 1.670 | 2.941 | 6.160 |
| | 3.0 | 0.21 | 0.450 | 1.030 | 1.620 | 2.420 | 4.039 | 7.754 |
| | 1.5 | 0.30 | 0.620 | 1.390 | 2.140 | 3.120 | 5.008 | 9.036 |
| 7 dB | 8.0 | 0.140 | 0.290 | 0.670 | 1.090 | 1.670 | 2.941 | 6.160 |
| | 5.0 | 0.270 | 0.560 | 1.260 | 1.950 | 2.870 | 4.672 | 8.601 |
| | 3.0 | 0.410 | 0.850 | 1.850 | 2.790 | 3.950 | 6.088 | 10.374 |
| | 1.5 | 0.570 | 1.160 | 2.430 | 3.560 | 4.910 | 7.264 | 11.756 |

## VSWR

The VSWR on most of the amplifiers is specified at a maximum of 2.0:1. The cascaded VSWR will be typically less than 2.0:1 across the entire band, but can be greater than 2.0:1 in certain cases. About 1-1/2 octaves below the high end of the band there is virtually no degradation when cascading, and the 2.0:1 cascaded specification can be easily achieved. In general, when covering the entire bandwidth, the cascaded VSWR should be specified 2.5:1 maximum,with amplifiers that have a 2.0:1 specification.

## Output Power

When cascading the cascadable amplifiers, there is no degradation in output power of the last stage provided that the driver stage provides sufficient power. Figure 18 shows the gain compression versus output power for various models. The curves extend from the uncompressed region of 2 dB of gain compression. The threshold compression point is defined as the 0.1-dB gain compression point and is the level of output power that the amplifier can deliver to the next stage without undergoing any significant loss of power output for the cascade.

The curves of Figure 18 show the additional compression that can be expected if the driving stage does not provide sufficient power. The necessary drive power is calculated by using the following equation:

$$P_D = P_o - G_o + 1$$

where $P_o$ is the output power and $G_o$, is the uncompressed gain of the stage being

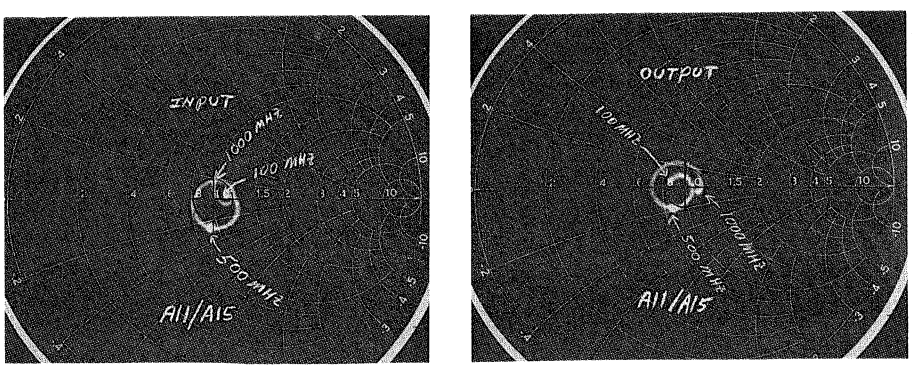



Fig. 17—Input and Output Impedance of an A11/A15 Cascade.

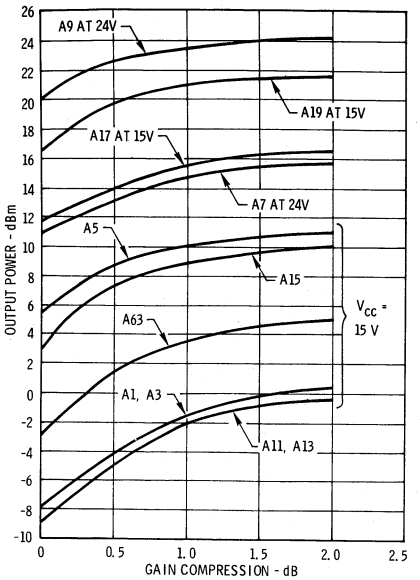



**Fig. 18 - Gain Compression Versus Output**

**Table 2 - Typical Threshold Compression Point**

| Model | $P_{Threshold}$ (0.1 dB Comp. Pt.) | $P_{Driver\ Min.}$ (0.1 dB Comp. Pt.) | $P_{Out\ Typ.}$ (1.0 dB Comp Pt.) |
|---|---|---|---|
| **PA10 & PA12** | +19.0 | +13.0 | +22.5 |
| **A9** | +21.0 | +11.5 | +22.0 |
| **A19** | +17.0 | +15.0 | +21.0 |
| **A17** | +12.5 | +4.0 | +15.0 |
| **A7** | +11.5 | 0 | +14.0 |
| **A5** | +6.5 | -6.0 | +8.0 |
| **A15** | +4.0 | -7.0 | +7.0 |
| **A63** | -2.0 | -12.0 | +3.0 |
| **A1 &A3** | -7.0 | -15.0 | -1.0 |
| **All** | -8.0 | -16.0 | -2.0 |
| **A79** | +20.7 | +9.4 | +22.4 |
| **A82** | +17.0 | +0.2 | +20.7 |
| **A87-2** | +6.3 | -4.7 | +10.3 |
| **A86** | +2.1 | -19.1 | +7.9 |
| **PA3** | +21.1 | +11.6 | +25.1 |
| **A59** | +20.6 | +12.4 | +22.4 |
| **RA89** | +19.5 | -2.3 | +21.2 |
| **A88** | +18.1 | +2.4 | +20.4 |
| **A58** | +18.2 | +9.2 | +19 .2 |
| **A72** | +12.7 | -0.7 | +13.3 |
| **A74** | +6.9 | -19.4 | +8.6 |
| **A83** | -4.6 | -29.8 | -0.8 |
| **PA15** | +22.4 | +14.3 | +26.8 |
| **A19-1** | +20.9 | +12.8 | +23.3 |
| **A66-1** | +12.1 | -10.1 | +15.9 |
| **A18-1** | +11.7 | +1.8 | +15.8 |
| **A12** | -0.7 | -6.5 | +8.5 |
| **A39** | +20.8 | +16.4 | +22.9 |
| **A38** | +18.8 | +14.3 | +20.8 |
| **A36-1** | +6.1 | +0.4 | +15.4 |

driven. The minimum $P_D$ is the threshold compression point as previously defined.

Typical threshold compression points for several Watkins-Johnson Company cascadable amplifiers are given in the first column of Table 2. The center columns show the threshold driving power required to obtain the output power listed in the right hand column. This table is generated by using the above equation. Table 2 shows that a PD of +11.5 dBm is required to drive the A9 to a $P_o$ of +22 dBm output power. The A7 provides this amount of power at its threshold compression point. The A19 requires +15 dBm. The A17 provides +15 dBm at its 1 dB compression point; hence, an output power reduction of 1 dB would typically result when cascading the A17 and A19. The A17 requires +4.0 dBm to obtain a +15 dBm output which is provided by the A15. If lower noise is needed, then the A63 should be used, which is compressed about 1 dB at the +4 dBm output level. Thus, the overall result when cascading the A63, A17 and A19 is approximately a 2 dB loss in output power. The measured output power of this cascade is shown in Figure 19. The output powers shown in Figure 18 were measured at 100 MHz. Generally, the output power increases as the high end of the band is approached because of the reactive matching effect.

The output power of a single stage is measured using a 50-ohm source and a 50-ohm load. The output power of the driving

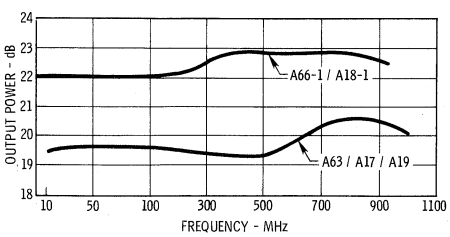



**Fig. 19—Power Output of the A66-1, A18-1, A63, A17 and A19 Cascade.**

amplifier can be affected by the load (input impedance of next stage) presented to it. This can cause some minor differences to occur that are not fully explained by considering compression alone. In general, if the effective load presented to the driver stage is greater than 50 ohms, then more output power can be obtained from the driver stage. Conversely, if the load presented is less than 50 ohms, then a reduction may result.

The WJ-A9 can be driven to provide 200-300 mW (+25 dBm) of output power with additional compression, and the A19 can be driven to provide 150-200 mW (+23 dBm) maximum. Beyond these limits, the bias current of the amplifiers will increase because the RF signal effect on the base bias tends to cause Class C operation. Because the gain of the A19 is lower than the A9, a larger RF signal will be present at the base, which causes the base bias to be affected at

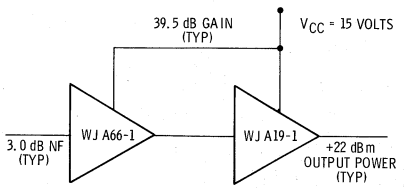



**Fig. 19A**

a lower output power than on the A9. For maximum reliability it is not recommended that the A9 or A19 be operated above these output power levels.

The A63/A17/A19 was introduced in late 1974 and has remained a state-of-the-art cascade for several years. Now there is a cascaded combination providing equal or superior results using only two TO-8 amplifiers as shown in Figure 19A.

The A66-1/A19-1 cascade provides about 3 dBm higher output power, equal NF to

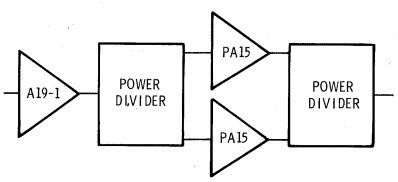



**Fig. 20 - Higher Output Power by Paralleled Amplifier Operation.**

the WJ-A63, and 4 dB higher gain. The primary reason for the higher output of this cascade is simply that the A19-1 requires about 4 dB less drive power (see gain compression curves in Figure 18) than the A19 because of its higher gain.

There are now units within the Watkins-Johnson product line of cascadable amplifier models that more than double the output power of the industry pace- setting A9 and A19 TO-8 amplifier. The WJ-PA3 will provide a minimum of 200 milliwatts at 15 volts and, in addition, offer 3.5 dB higher gain than the WJ-A9 amplifier.

For applications out to 1000 MHz,the WJ-PA10 will provide a minimum of 200 milliwatts of output power (@ 20V $V_{cc}$)

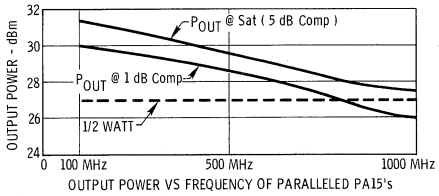



**Fig. 20A**

with a 3.5 dB more gain than the WJ-A19 amplifier. And now there is the WJ-PA15 TO-8 amplifier which provides 3.0 dB even higher gain (13.5 dB typically) out to 1000 MHz and 200 milliwatts minimum output power using only a 15 volt Vcc supply. In addition, the WJ-PA15 provides a typical output power of 0.5 watt out to 500 MHz.

When the output power required is higher than that which is provided by a single output stage, then the units can be paralleled using reactive power dividers as shown in Figure 20. Nearly 3 dB of additional output power can be obtained using this method. An example of paralleled output (saturated) power is shown in Fig. 20A.

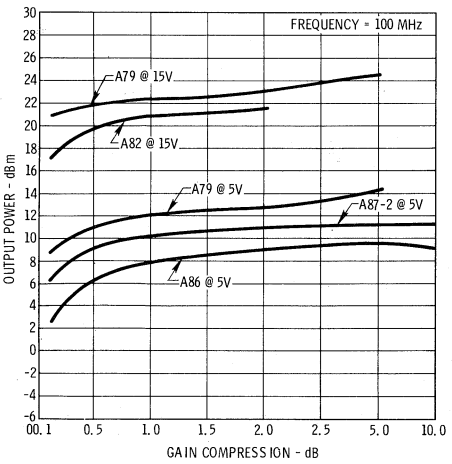



**Fig. 21-A**

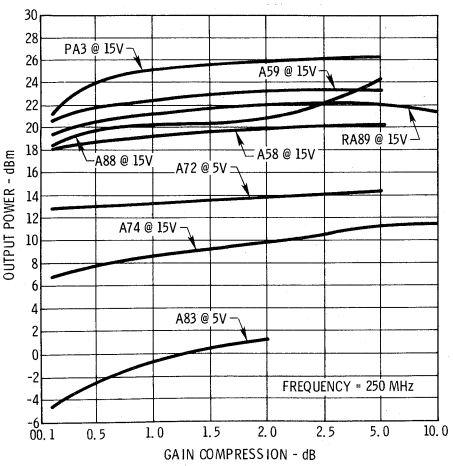



**Fig. 21B**

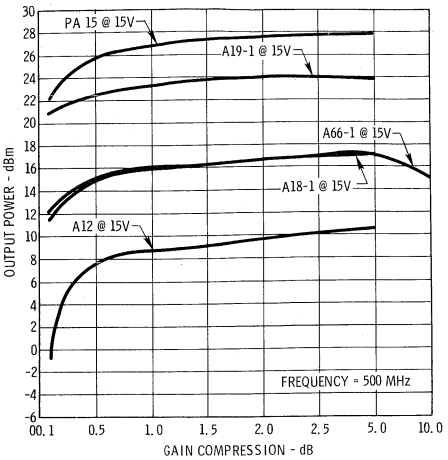



**Fig. 21C**

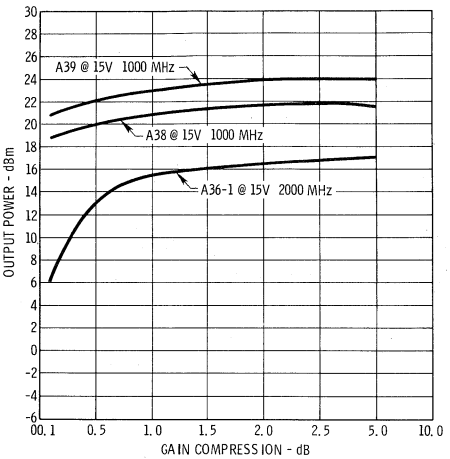



**Fig. 21D**

When the paralleled pair of PA15s is driven by a WJ-Al9-1 or WJ-PA10 amplifier, there is virtually no change in the output power.

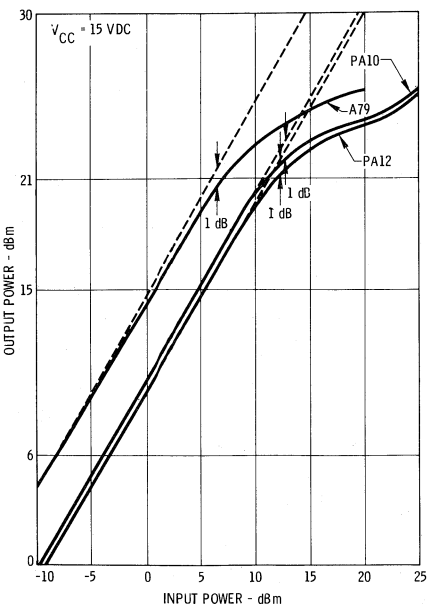



**Fig. 22A**

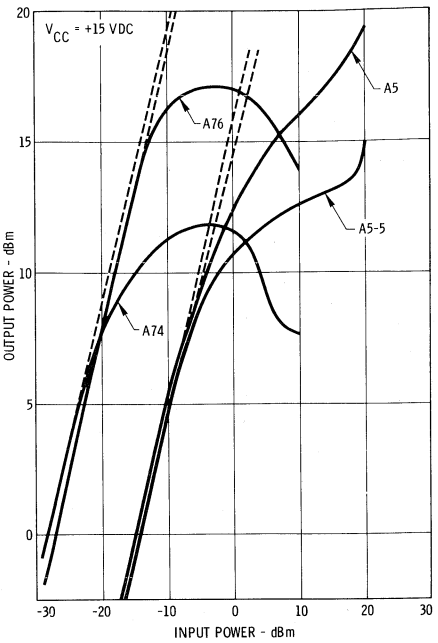



**Fig. 22B**

## Saturated Output Power

Several new amplifier gain-compression versus output-power curves have been added in Figures 21A through 21D. These curves show the gain compression characteristic for many newer-generation TO-8 amplifiers for input levels that cause the onset of compression to moderate levels of saturation where the gain compression is 5 to 10 dB.

These curves demonstrate a relatively monotonic characteristic of gain compression for moderate saturation levels.

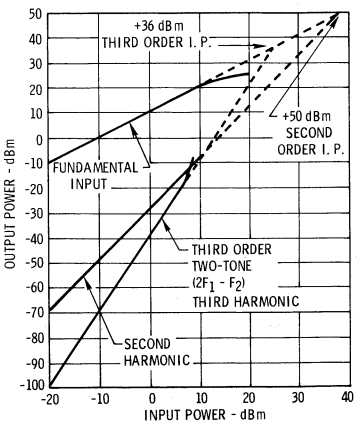



**Fig. 23—Output Power Versus Input Power of the WJ-A9 Amplifier.**

What happens when the W-J Cascadable Amplifiers are driven into heavy saturation depends on the bias design of the circuit and whether or not the units are single-stage or two-stage. Figures 22A and 22B give some exemplary curves of overdrive conditions.

## Distortion Products and Intercept Point

Due to the inherent nonlinearities of the amplifiers, intermodulation and harmonic distortion products are generated that limit the dynamic range. The level of the distortion product relative to the signal level can be calculated from the intercept point, or conversely, the intercept point can be calculated from the relative suppression. The intercept point (I.P.) is the theoretical point of intersection of the fundamental slope with the slope of the distortion product, and is shown in Figure 23 for the WJ-A9 amplifier. Third-order two-tone distortion is the mixing of two signals applied at the input of the amplifier. These third-order products will appear at the frequencies $2f_1 - f_2$, $2f_1 + f_2$, $2f_2 + f_1$ and $2f_2 - f_1$. Two-tone second-order products will appear at the frequencies $f_1 + f_2$ and $f_1 - f_2$. The intercept point can be calculated from equation 1 :

$$1)\ \text{I.P.} = \frac{R_{dB}}{n\text{-}1} + S\ \text{dBm}$$

where R is the relative suppression below the fundamental in dB, n is the order number and S is the absolute signal level in dBm. If the intercept point is known, the relative suppression can be calculated by equation 2:

$$2)\ R_{dB} = (n\text{-}1)\ (\text{I.P.-S})$$

The intercept point will be the output intercept point if S is the output signal level and it will be the input intercept point if S is the input signal level. For example, what is the typical third-order two-tone intercept point for the A9? From Figure 23, the value of R is 52 dB for an output power of +.10 dBm. Using equation 1 :

$$\text{I.P.} = \frac{52}{3\text{-}1} + 10 = +36\ \text{dBm}$$

Table 3 shows a summary of the second-order harmonic, third-order harmonic and third-order, two-tone intercept point for several amplifiers. The second-order two-tone intercept points are not shown since they are approximately equal to the second-order harmonic intercept points.

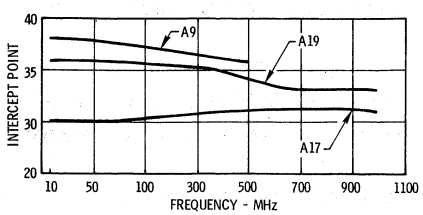



**Fig. 24—A9, A19 and A17 Output Third-Order**

The A9, A19, and A17 output third order two-tone intercept points versus frequency are shown in Figure 24. Note how the A17 I.P. approaches the Al9 I.P. at the high end of the band. When cascading amplifiers, if the driving amplifier output intercept point is equal to the input intercept point of the amplifier being driven, then each amplifier would contribute equally, causing a 3-dB reduction in the output intercept point of the output stage. If there is 6 dB of margin on the driver stage, then approximately 1 dB of degradation could result. As a rough rule of thumb, the output intercept point will be typically 12 dB higher than the output power on the Watkins-Johnson Company cascadable amplifiers. Any degradation in output power will generally cause degradation in the intercept point.

### Intercept Degradation

Distortion in RF Signal Processing is often a baffling problem for the designer. Basic understanding of what causes distortion, and how it propagates within the system will help optimize performance. Intermodulation distortion is of key interest in a newly developed system.

The two-tone intercept point is often used as a measure of intermodulation distortion in signal processing devices. When amplifiers are cascaded the degradation of the intercept point can be easily determined.

When a signal is amplified, the output is characterized by the primary frequencies, $f_1$ and $f_2$, and their intermodulation products (Table 1). To specify the level of distortion due to the intermodulation products, the intercept point definition was created which, simply stated, defines the nth order output intercept point as,

$$(1)\qquad n_{IP} = \frac{n_R}{(n\text{-}1)} + P_o$$

$n_R$ is the relative suppression of the nth order product in dB and $P_o$ is the total power output of the amplifier in dBm.

When two amplifiers are cascaded, the cascade intercept point is a function of the intercepts of the individual amplifiers and

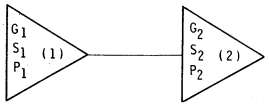



**Fig. 25**

the gain of the system. To understand the degradation of intercept point, the relative suppression of intermodulation products must be understood.

Relative suppression is the ratio of the total output power (mw) to the power level of an intermodulation spur. This is valid for all orders.

$$(2)\qquad n_r = \frac{P_o}{n_s}$$

In a two-amplifier system (see Figure 25), if the individual suppression characteristics are known, the total suppression can be determined.

Both amplifiers generate intermodulation products, ${}^nS_1$ and $nS_2$ respectively. The first product, ${}^nS_1$ is amplified by the gain of the second amplifier and then combines with ${}^nS_2$. If it is assumed that all input and output impedances match, then the intermodulation products' sum is,

(3)

The gain of the second amplifier is represented by $g_2$. With some mathematical manipulation, a formula for the total relative suppression ${}^nr_t$ can be obtained:

$$(3a)\qquad \frac{\sqrt{S_T^n}}{\sqrt{P_o}} = \frac{\sqrt{S_1^n X g_2}}{\sqrt{P_o}} + \frac{\sqrt{S_2^n}}{\sqrt{P_o}}$$

$$(3b)\qquad \frac{\sqrt{S_T^n}}{\sqrt{P_o}} = \frac{\sqrt{S_1^n X g_2}}{\sqrt{P_1 X g_2}} + \frac{\sqrt{S_2^n}}{\sqrt{P_o}}$$

$$(4)\qquad \frac{1}{\sqrt{r_T^n}} = \frac{1}{\sqrt{r_1^n}} + \frac{1}{\sqrt{r_2^n}}$$

$$(4a)\qquad r_T^{n\text{-}1/2} = r_1^{n\text{-}1/2} + r_2^{n\text{-}1/2}$$

**Table 3 - Second-Order Harmonic, Third-Order Harmonic and Third-Order, Two-Tone Intercept Points for Several Amplifiers**

| Model | Second-Order Harmonic I.P. | Third-Order Harmonic I.P. | Third-Order Two-Tone I.P |
|---|---|---|---|
| A5 | +40 dBm | +27 dBm | +22 dBm |
| A7 | +45 dBm | +30 dBm | +26 dBm |
| A9 | +50 dBm | +36 dBm | +36 dBm |
| A11 | +15 dBm | +13 dBm | +10 dBm |
| A15 | +35 dBm | +24 dBm | +20 dBm |
| A17 | +45 dBm | +32 dBm | +29 dBm |
| A19 | +46 dBm | +34 dBm | +34 dBm |

If the cascaded relative suppression is known, the degraded intercept point can be calculated:

$$(4b)\quad \left(r_T^n\right)^{\left(\frac{1}{n-1}\right)\frac{-(n-1)}{2}} = \left(r_1^n\right)^{\left(\frac{1}{n-1}\right)\frac{-(n-1)}{2}} + \left(r_2^n\right)^{\left(\frac{1}{n-1}\right)\frac{-(n-1)}{2}}$$

$$(4c)\quad \left[r_T^{n\left(\frac{1}{n-1}\right)} P_o\right]^{\frac{-(n-1)}{2}} = \left[\left(r_1^{n\left(\frac{1}{n-1}\right)}\right)^{\frac{-(n-1)}{2}} + \left(r_2^{n\left(\frac{1}{n-1}\right)} - \left(\frac{n-1}{2}\right)\right] P_o^{-\left(\frac{n-1}{2}\right)}$$

$$(4d)\quad \left[r_T^{n\left(\frac{1}{n-1}\right)} P_o\right]^{\frac{-(n-1)}{2}} = \left[\left(r_1^{n\left(\frac{1}{n-1}\right)} P_o\right)^{\frac{-(n-1)}{2}} + \left(r_2^{\left(\frac{1}{n-1}\right)} P_o\right)^{\frac{-(n-1)}{2}}\right]$$

$$(5)\quad \left[r_T^{n\left(\frac{1}{n-1}\right)} P_o\right]^{\frac{-(n-1)}{2}} = \left(r_1^{n\left(\frac{1}{n-1}\right)} P_1\, g_2\right)^{\frac{-(n-1)}{2}} + \left(r_2^{n\left(\frac{1}{n-1}\right)} P_2\right)^{-\left(\frac{n-1}{2}\right)}$$

If equation (1) is converted from dBm to mW, it can be substituted into (5) and a formula for cascaded intercept point can be obtained:

$$(1)\quad IP^n = \frac{R^n}{n-1} + P_o$$

$$(1a)\quad IP^n = {}^n r^{\left(\frac{1}{n-1}\right)} P_o$$

Rewriting (5) using (1a):

$$(6)\quad IP_T^{n\frac{-(n-1)}{2}} = \left(IP_1^n\, g_2\right)^{\frac{-(n-1)}{2}} + \left(IP_2^n\right)^{-\frac{(n-1)}{2}}$$

This can be generalized to the case of x amplifiers in cascade:

$$(7)\quad IP_T^{n\frac{-(n-1)}{2}} = \sum_{i=1}^{x}\left(IP_i^n\, g_{(i+1,x)}\right)^{\frac{-(n-1)}{2}}$$

The gain term represents the gain following the i th amplifier. This formula is valid for all orders. However, it gives worst case performance, assuming a perfect 50Ω system. If a severe mismatch occurs in the cascade, further degradation can result.

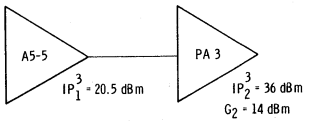



Fig. 26

This formula can be easily validated experimentally. Looking at the Watkins-Johnson A5-5 in cascade with the PA3 the intercept point at 33.0 dBm can be measured using the individual amplifier characteristics (see Figure 26) and the cascade formula, it can be seen that the 3 dB degradation, in third order intercept point is to be expected:

$IP_1^3$ = 20.5 dBm = 112 mW

$IP_2^3$ = 36.0 dBm = 3981 mW

$g_2$ = 14.7 dB = 29.5

$IP_T^{3\,-1} = [(112\text{ mW})(29.5)]^{-1} + [3981\text{ mW}]^{-1}$

$IP_T^3$ = 1808 mW = 32.6 dBm

The intercept formula can be used to introduce several rules of thumb for

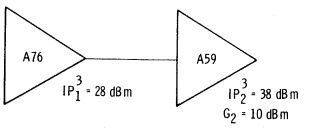



Fig. 27

$IP_1^3$ = 28 dBm = 630.0 mW

$IP_1^3$ = 38 dBm = 6309 mW

$g_2$ = 10 dB = 10

$IP_T^{3\,-1} = [(630.9\text{ mW})(10)]^{-1} + [6309\text{ mW}]^{-1}$

$IP_T^3$ = 3154 mW = 35.0 dBm

Δ ip = 3 dB

cascading amplifiers. The first rule applies (see Figure 27) when the output intercept point of the first amplifier equals the input intercept point of the second. Each amplifier will contribute equally to the intermodulation product, causing a 3 dB degradation in total output intercept point.

The second rule is demonstrated when the output intercept point of the first amplifier is much greater than the input intercept point of the second amplifier. (See Figure 28.)

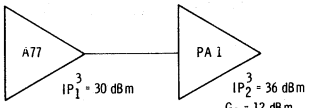



Fig. 28

$IP_1^3$ = 30 dBm = 1000 mW

$IP_2^3$ = 36 dBm = 3981 mW

$g_2$ = 12 dB = 15.8

$IP_T^{3\,-1} = [(1000\text{ mW})(15.8)]^{-1} + [(3981\text{ mW})]^{-1}$

$IP_T^3$ = 3182 mW = 35.0 dBm

Δ ip = 1 dB

In this case a 6-dB overlay causes a 1-dB degradation in intercept point. The third rule of thumb is that a mismatch of intercept point will cause degradation equal to or greater than the mismatch itself. In the last example, the output intercept point of the first amplifier is 6 dB less than the input intercept point of the second. (See Figure 29.)

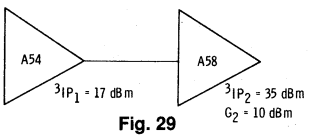



Fig. 29

$IP_1^3$ = 19 dBm = 79.4 mW

$IP_2^3$ = 35 dBm = 3162 mW

$g_2$ = 10 dB = 10

$IP_T^{3\,-1} = [(79.4\text{ mW})(10)]^{-1} + [3162\text{ mW}]^{-1}$

$IP_T^3$ = 634.8 mW = 28.0 dBm

Δ ip = 7 dBm

Intermodulation distortion can be reduced through careful design. The general cascade formula can be used to calculate degradation in intercept point. For quick estimation in cascading, the following three rules of thumb can be used:

1) If the output intercept point equals the input intercept point, a 3-dB degradation will result.

2) If the output intercept point is much greater (> 6 dB) than the input, IP less than 1 dB degradation can be expected.

3) If the output IP is much less (< 6 dB) than the input IP, degradation equal to the mismatch, or more, can be expected.

Through the use of the three rules and the general cascade formula, intermodulation distortion can be minimized.

### Intercept Degradation and Dynamic Range

The dynamic range (DR) of cascadable amplifiers for a single input signal can be defined as: the difference between the input signal level that causes 1 dB of gain compression and the minimum input signal level that can be detected above the amplifier's noise level. This minimum detectable signal (defined as 3 dB above the noise level) MDS, can be expressed in dBm by the equation:

$$MDS = -111\ dB/MHz + B + NF$$

where B is the bandwidth relative to 1 MHz in dB, and NF is the noise figure measured at the amplifier input. The input signal or drive power ($P_D$) that produces 1 dB of gain compression is given by the equation:

$$P_D = P_{output} - Gain + 1\ dB$$

where $P_{output}$ is the output power at the 1 dB compression point. The dynamic range, therefore, is the difference between $P_D$ and MDS:

$$DF = P_D - MDS$$

Using the data given in Figure 15 (A63, A17, A19) and a 1 MHz bandwidth, DR is calculated as:

$$DR = (P_{output} - Gain + 1\ dB) - (-111\ dBm/MHz + B + NF)$$
$$DR = (+19 - 35 + 1) - (-111 + 0 + 4)$$
$$DR = 92\ dB\ (1\ MHz\ bandwidth)$$

For a 500 MHz bandwidth there would be a 27 dB reduction in the overall dynamic range for the above example.

$$(10 \log \frac{500}{1} = 27\ dB)$$

Another definition of dynamic range is the "spurious-free" region which characterizes the effective performance of an amplifier with more than one signal applied to the input. For the case of input signals at equal level, the spurious free dynamic range, $DR_{spur\text{-}free}$, is given by the equation:

$$DR_{spur\text{-}free} = 2/3\ (I.P. - Gain - MDS)$$

where I.P. is the third order two-tone intercept point in dBm. Using the same example and an I.P. of +32 dBm for a A19 amplifier, the spurious-free dynamic range is:

$$DR_{spur\text{-}free} = 2/3\ (+32 - 35 - (-111 + 0 + 4.0)$$
$$DR_{spur\text{-}free} = 69\ dB\ (1\ MHz\ bandwidth)$$

**TABLE 4**

| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
|---|---|---|---|---|---|
| 100. | .24 | .00 | .12 | 14.91 | .50 |
| 200. | –.37 | –18.07 | .11 | 14.90 | .49 |
| 300. | –.10 | –35.28 | .11 | 14.89 | .47 |
| 400. | .40 | –52.21 | .07 | 14.85 | .49 |
| 500. | –.14 | –70.20 | –.12 | 14.67 | .50 |
| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
| 100. | –3.78 | .00 | .19 | 14.92 | .50 |
| 200. | –2.40 | –18.06 | .14 | 14.87 | .49 |
| 300. | –.30 | –35.41 | .16 | 14.89 | .48 |
| 400. | 2.01 | –52.54 | .08 | 14.81 | .49 |
| 500. | 3.42 | –70.57 | –.09 | 14.65 | .52 |
| 600. | 3.60 | –89.83 | –.16 | 14.58 | .55 |
| 700. | 3.08 | –109.79 | –.09 | 14.64 | .56 |
| 800. | 2.06 | –130.26 | –.05 | 14.68 | .61 |
| 900. | –1.61 | –153.37 | –.05 | 14.69 | .65 |
| 1000. | –6.08 | –177.28 | –.19 | 14.55 | .66 |

**TABLE 5**

| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
|---|---|---|---|---|---|
| 100. | –1.04 | .00 | .14 | 10.58 | .37 |
| 200. | –.75 | –13.24 | .06 | 10.50 | .37 |
| 300. | –.43 | –26.45 | .14 | 10.58 | .36 |
| 400. | .51 | –39.03 | .09 | 10.53 | .35 |
| 500. | 1.70 | –51.37 | .05 | 10.49 | .37 |
| 600. | 1.20 | –65.37 | –.10 | 10.34 | .39 |
| 700. | .51 | –79.61 | –.13 | 10.32 | .39 |
| 800. | .01 | –93.34 | –.10 | 10.35 | .39 |
| 900. | –.23 | –107.40 | –.14 | 10.30 | .41 |
| 1000. | –1.80 | –122.50 | –.12 | 10.32 | .42 |
| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
| 100. | –4.02 | .00 | .16 | 10.61 | .37 |
| 200. | –2.90 | –13.22 | .08 | 10.53 | .37 |
| 300. | –1.86 | –26.52 | .22 | 10.66 | .36 |
| 400. | –.17 | –39.16 | .10 | 10.54 | .35 |
| 500. | 1.68 | –51.65 | .01 | 10.46 | .37 |
| 600. | 2.12 | –65.55 | –.11 | 10.34 | .39 |
| 700. | 2.29 | –79.72 | –.14 | 10.31 | .39 |
| 800. | 2.92 | –93.42 | –.13 | 10.32 | .39 |
| 900. | 3.20 | –107.48 | –.17 | 10.28 | .40 |
| 1000. | 2.49 | –122.53 | –.15 | 10.29 | .41 |
| 1100. | 2.14 | –137.21 | –.03 | 10.42 | .41 |
| 1200. | 1.89 | –151.00 | –.04 | 10.41 | .42 |
| 1300. | .37 | –167.65 | –.05 | 10.39 | .47 |
| 1400. | –3.05 | –185.41 | –.11 | 10.33 | .50 |
| 1500. | –7.09 | –203.79 | –.22 | 10.23 | .51 |

### Phase Linearity and Group Delay

The Watkins-Johnson Company cascadable amplifiers offer excellent linearity and relatively constant group delay because of thin-film integrated construction. Phase linearity is the best fit straight line to the phase response curve and is expressed in degrees deviation. Computer printouts of phase linearities from an automatic network analysis system are shown in Tables 4 and 5. The first column shows the deviation from linear phase and the last column shows the group delay.

The phase linearity of the WJ-A5 is typically less than ± 2° across a 10-500 MHz band. The phase linearity of WJ-A15 is typically <±6° across its entire 5-1000 MHz band and the WJ-A25 is typically less than ±7° across its entire 5-1500 MHz band. Substantial improvement in phase linearity can be obtained by not using the upper end of the band. Table 4 compares the phase linearity of the A15 across the 110-510 MHz and 110-1010 MHz bands. The linearity across the 110-510 MHz band is typically within ±0.5°. The A25 phase linearity is typically ±1.8° up to 1000 MHz as shown in Table 5.

The cascaded phase linearity will be equal to or less than the sum of the individual stage linearity. Thus, two stages of A15s would typically have ±1.0° phase linearity

**TABLE 6**

| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
|---|---|---|---|---|---|
| 500. | .24 | .00 | .28 | 16.55 | .54 |
| 600. | –.48 | –19.40 | .36 | .16.63 | .52 |
| 700. | .16 | –37.45 | .33 | 16.60 | .50 |
| 800. | .97 | –55.32 | .21 | 16.48 | .52 |
| 900. | .30 | –74.68 | –.01 | 16.26 | .55 |
| 1000. | –.91 | –94.57 | –.17 | .16.10 | .53 |
| 1100. | –.41 | –112.75 | –.25 | .16.02 | .51 |
| 1200. | –.21 | –131.23 | –.36 | 15.91 | .52 |
| 1300. | –.70 | –150.41 | –.25 | 16.02 | .51 |
| 1400. | .22 | –168.16 | –.19 | 16.08 | .50 |
| 1500. | .81 | –186.26 | –.23 | 16.04 | .50 |

| FREQ. MHz | DEV LIN O DEG | REL O DEG | GAIN DEV dB | ABS GAIN dB | GROUP DELAY N—SEC |
|---|---|---|---|---|---|
| 100. | 2.09 | .00 | .28 | 16.58 | .61 |
| 200. | –.74 | –21.83 | .19 | 16.49 | .58 |
| 300. | –1.31 | –41.41 | .18 | 16.48 | .54 |
| 400. | –1.62 | –60.72 | .26 | 16.55 | .52 |
| 500. | –.89 | –79.00 | .23 | 16.52 | .51 |
| 600. | –.51 | –97.62 | .33 | 16.63 | .51 |
| 700. | .15 | –115.96 | .32 | 16.61 | .51 |
| 800. | .78 | –134.34 | .20 | 16.50 | .52 |
| 900. | .64 | –153.48 | –.00 | 16.30 | .55 |
| 1000. | –.48 | –173.60 | –.15 | 16.15 | .54 |
| 1100. | –.06 | –192.19 | –.19 | 16.11 | .52 |
| 1200. | .11 | –211.02 | –.00 | 16.00 | .53 |
| 1300. | .06 | –230.08 | –.29 | 16.00 | .51 |
| 1400. | 1.18 | –247.96 | –.23 | 16.07 | .50 |
| 1500. | 2.43 | –265.71 | –.28 | 16.01 | .52 |
| 1600. | 1.80 | –285.34 | –.33 | 15.97 | .55 |
| 1700. | .93 | –305.22 | –.27 | 16.03 | .55 |
| 1800. | .07 | –325.08 | –.16 | 16.14 | .56 |
| 1900. | –1.01 | –345.17 | –.21 | 16.09 | .58 |
| 2000. | –3.59 | –366.75 | –.06 | 16.24 | .60 |

up to 500 MHz, but would degrade to about ±12° up to 1000 MHz.

The phase linearity of the A34 is shown in Table 6. The A34 is a two-stage 100-2000 MHz unit which offers typically ±3.5° across its entire bandwidth. Also shown is the phase linearity for the 500-1500 MHz band for which the A34 yields typically < ± 1.0°

The group delay is defined as the rate of change of phase shift versus frequency

$$\frac{d\theta}{d\omega \text{ (omega)}}$$

The group delay is calculated by taking the phase difference over a given frequency band and then dividing by that frequency band. Both the phase and frequency are in radians. The group delay can be expressed in units of time by the mathematical relationship

$$t_d \text{ (seconds)} = \frac{\text{Phase (degrees)}}{\text{frequency (Hz)} \times 360°}$$

The group delay for the A25 amplifier is typically less than 0.5 nanoseconds up to 1000 MHz as shown from Table 5.

The excellent phase linearity and constant group delay properties of the A25 make it an ideal choice for Gigabit Data Rate

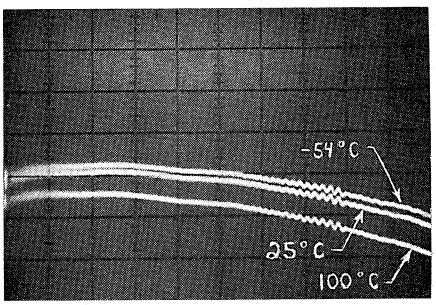



**Fig. 30–Phase Shift of the WJ-A15 Amplifier.**

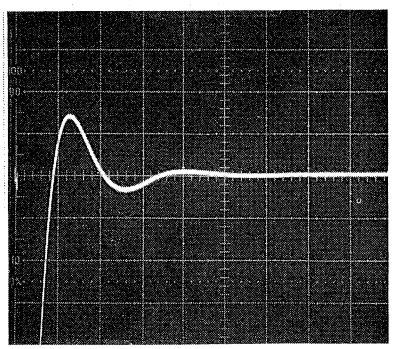


**Fig. 31–Single A5.**

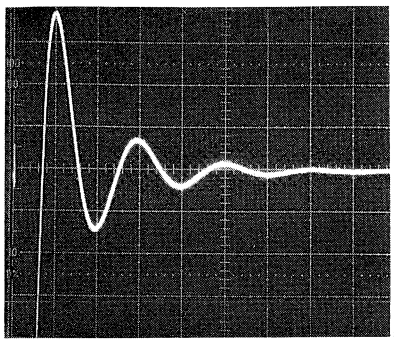


**Fig. 32—Two Cascaded A5s.**

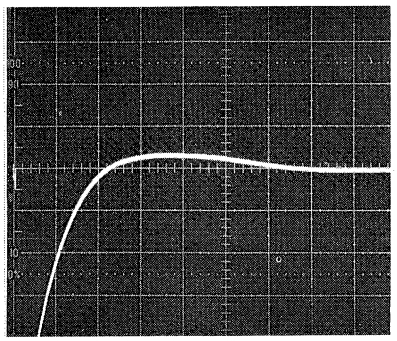


**Fig. 33—Single A15.**

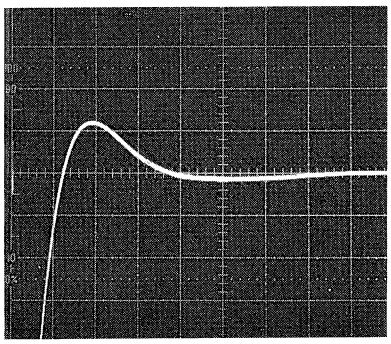


**Fig. 34—Two Cascaded A15s.**

**Table 7—Amplifier Recovery Time (To a 1 mV Setting Level) After a 50 nsec Input Pulse is Applied**

| Model | 0.1 Volt Input | 1.0 Volt Input |
|---|---|---|
| A3 | 0.8 µsec | 1.0 µsec |
| A5, A7 | 2.0 µsec | 2.5 µsec |
| A9 | 1.3 µsec | 1.5 µsec |
| A1,A11,A11-1,A15 | 3.0 µsec | 3.5 µsec |
| A17 | 2.5 µsec | 3.5 µsec |
| A19 | 0.8 µsec | 1.5 µsec |
| A25 | 2.0 µsec | 3.5 µsec |
| G1 | | 1.5 µsec |

Systems. A convenient carrier frequency for the quadriphase modulated phase shift keying (QPSK) is 1 GHz, where the A25 provides high phase linearity and constant group delay.

Figure 30 shows the phase shift of a WJ-A15 amplifier operating at 1) room temperature, 2) at -54°C and 3) at +100°C. There is virtually no change in linearity over this temperature range. Phase tracking is typically within ± 2° between units.

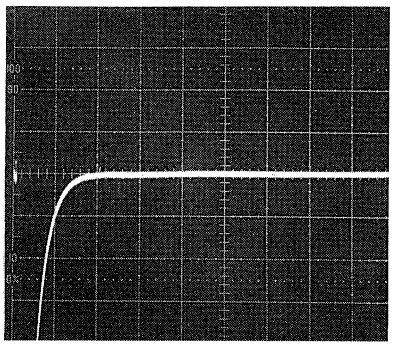


Fig. 35—Single A3.
Scales Common to Figures 9 to 14:
Vertical = 0.1 Volt/Div.
Horizontal = 0.5 μSec/Div.

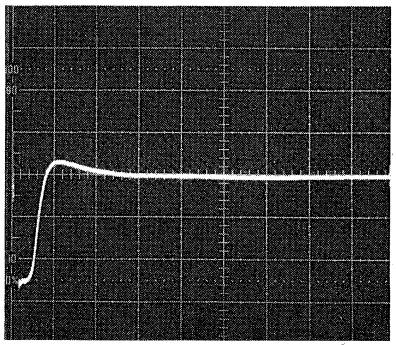


Fig. 36—Two Cascaded A3s.
Input Pulse:
Magnitude = 1.0 Volt
Width = 50 nsec.
Risetime = ~ 4nSec.

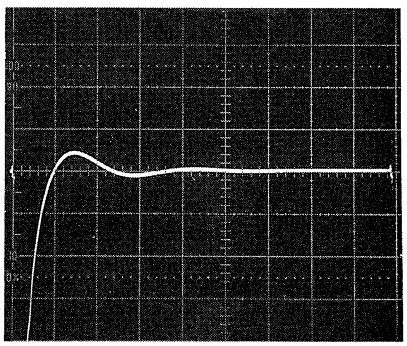


Fig. 37—Two Cascaded A5s with 50 pF Series Capacitor on Input.

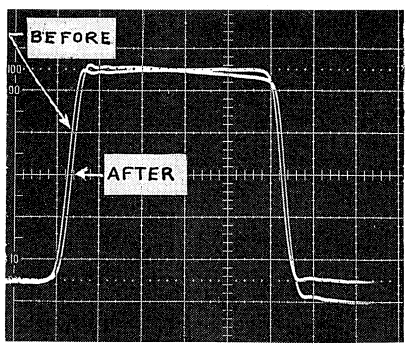



Fig. 38–Single A25.

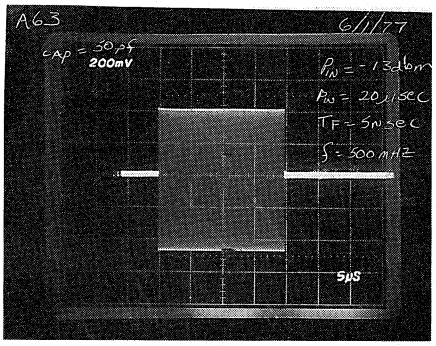



Fig. 39—A63 with 50 pF Series Capacitors on Input and Output at 1 dB Compression.

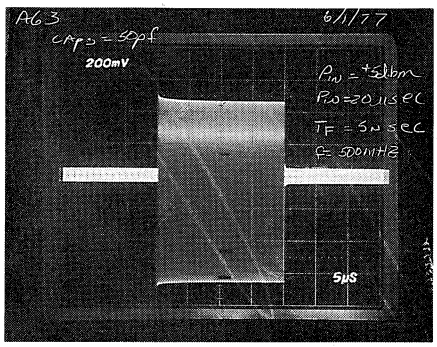



Fig. 39A—A63 with 50 pF Series Capacitors on Input and Output in Heavy Saturation.

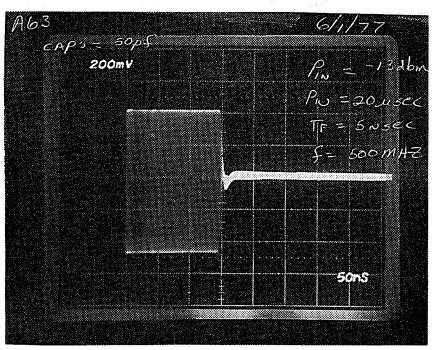



Fig. 40—A63 with 50 pF Series Capacitors on Input and Output at 1 dB Compression.

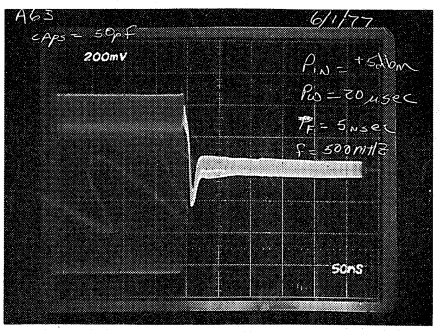



Fig. 40A–A63 with 50 pF Series Capacitors on Input and Output in Heavy Saturation.

## Pulse Response

The recovery time of the A5, A15 and A3 amplifiers to a 1 volt, 50 μsec video pulse are shown in Figures 31, 33 and 35 respectively; each amplifier consists of a single stage. Figures 31, 34 and 36 show the recovery time when the amplifier consists of two stages.

Each amplifier has a circuit feature that is different from the other two. Figures 31 and 32 represent the RF choke decoupling from the power supply (in addition to an RC network). Figures 33 and 34 represent active bias, and Figures 35 and 36 represent the resistive decoupling and passive emitter bias. The recovery time of the A5 is faster than the A15. The A3 yielded the lowest overshoot and the fastest recovery time. Table 7 shows the typical recovery time of each amplifier for various input pulse levels.

The overshoot and recovery time of the two cascaded A5s, shown in Figure 32, are reduced by adding a 50 pF capacitance in series with the input signal, and is shown in Figure 37. The recovery time is decreased from 3.5 μsec to approximately 1 μsec (to a 10 mV level). The response of the WJ-A25 to a 50 nsec, 0.1 video pulse is shown in Figure 38. The pulse is shown both before and after passing through the A25. The pulse droop is only 5%, indicating an excellent low frequency response down to approximately 1 MHz. Both the input pulse and the output pulse exhibit a rise time of approximately 4.5 nanoseconds, thus demonstrating the ultra-wide bandwidth property of the A25 amplifier.

A CW pulse will recover faster than a video pulse, as shown by Figure 39. Here a 500 MHz 20 μsec wide CW pulse is shown after passing through the WJ-A63. The input power level was sufficient to cause approximately 1 dB of compression. The input and output lines are AC coupled

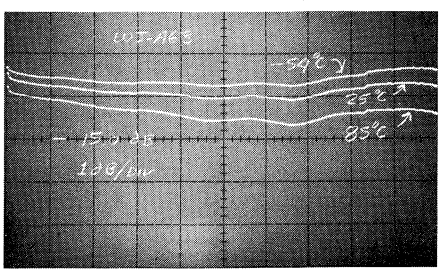


Fig. 41–WJ-A63 Temperature Performance.

with 50 pf capacitors which yield a recovery time as as shown by Figure 40 of approximately 20 nsec. Without the capacitors the recovery time (not shown) is 250-300 nsec.

When the unit is driven with a +5 dBm input signal, which is sufficient to cause heavy saturation, the recovery time increases to only approximately 25 nsec as shown by Figure 40A. When the 50 pf capacitors are not used, severe pulse distortion occurs and the recovery time in

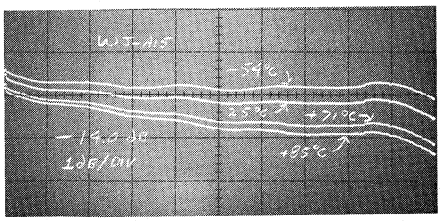


Fig. 42—WJ-A15 Temperature Performance.

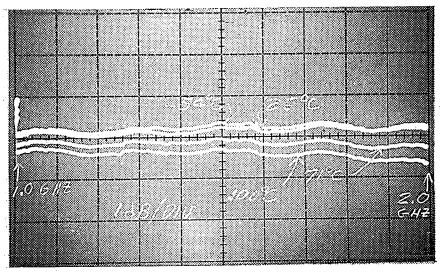


Fig. 43—WJ-A33 Temperature Performance.

the saturation mode extends to approximately 5 µsec.

## Temperature

Each Watkins-Johnson Company cascadable amplifier has been designed for optimum performance over a full temperature range. Typical gain changes over ambient temperature ranges of -54°C to +85°C are less than ±0.3 dB for the 5-500 MHz units, and less than ±1.0 dB for the higher frequency units. The actual temperature performance of an A63 amplifier over a 10 to 1000 MHz bandwidth is shown in Figure 41.

The A63 amplifier gain is typically 16 dB across its full bandwidth at 25°C, with less than 0.8 dB degradation at 85°C. The temperature performance of the WJ-A15 is shown in Figure 42. Again, there is only about a 0.8 dB loss of gain at 85°C. The temperatures are ambient with the 85°C temperature line representing a unit's case temperature of about 95°C on the A15. Figure 43 shows the WJ-A33 TO-8 amplifier temperature performance across the 1.0 to 2.0 GHz frequency range. Note at 100°C and 2 GHz the gain changed by only 0.9 dB, and by only 0.4 dB at 71°C. These photographs display the excellent temperature performance engineered into the Watkins-Johnson Company cascadable amplifiers.

Table 8 shows some actual amplifier case temperatures when the ambient temperature is at 25°C. In a typical application, the units are mounted with the case making good contact to the ground plane of the circuit board.

Because the A7, A9, and A19 dissipate 1 watt or more of power, 20 $in^2$ of area should be used for the A7, 30 $in^2$ for the A19 and 40 $in^2$ for the A9, to maintain less than a 10°C rise in case temperature above ambient.

**Table 8—Actual Amplifier Case Temperature When the Ambient Temperature is at 25°C**

| Model | T Case | $V_{CC}$ | Dissipation Watts | Thermal Impedance Case to Ambient with Circuit Board ()CS | Approx. Area of Circuit Board |
|---|---|---|---|---|---|
| **A5** | 32°C | 15V | 0.37 | 19°C/W | 10 $in^2$ |
| **A7** | 42°C | 24V | 1.00 | 17°C/W | 10 $in^2$ |
| **A17** | 36°C | 15V | 0.66 | 17°C/W | 10 $in^2$ |
| **A19** | 49°C | 15V | 1.5 | 16°C/W | 10 $in^2$ |
| **A9** | 34°C | 24V | 2.60 | 3.5°C/W | 40 $in^2$ |

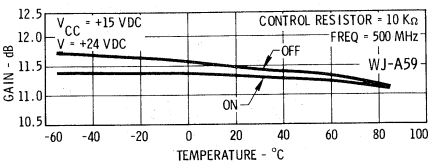



Fig. 46—Gain vs. Temperature.

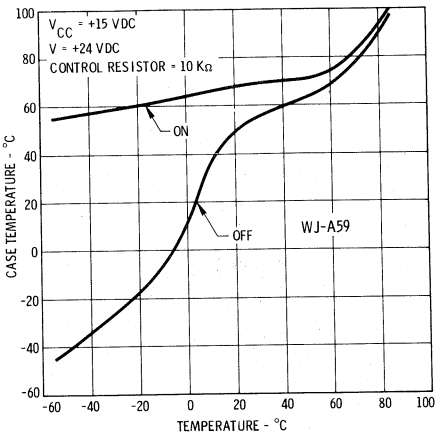



Fig. 47—Case Temperature vs. Ambient Temperature.

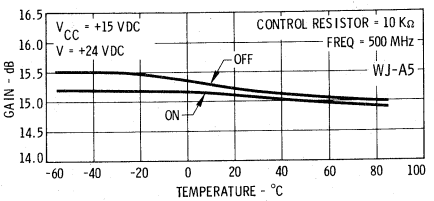



Fig. 44—Gain vs. Temperature.

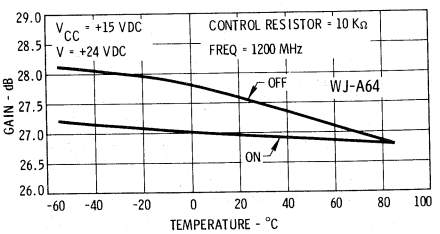



Fig. 48—Gain vs. Temperature.

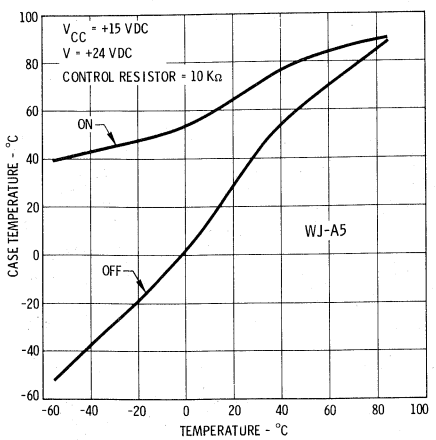



Fig. 45—Case Temperature vs. Ambient Temperature.

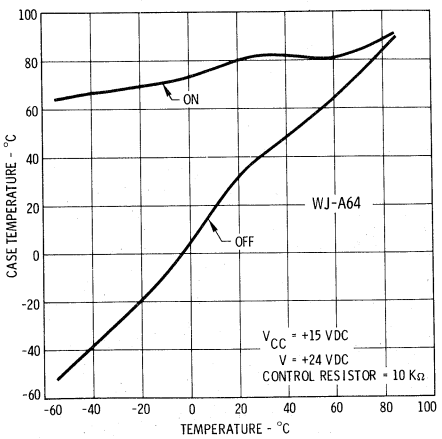



Fig. 49—Case Temperature Vs. Ambient Temperature.

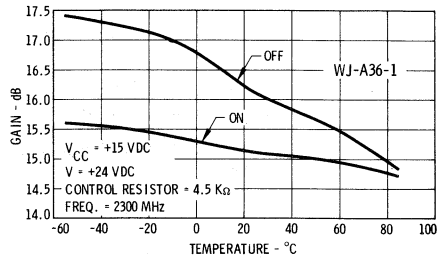



**Fig. 50—Gain vs. Temperature.**

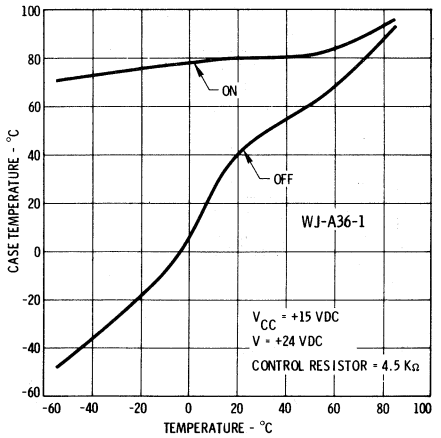



**Fig. 51—Case Temperature vs. Ambient Temperature.**

## Case Temperature Regulation

By using the WJ-331240 proportional controller, the case temperature on the TO-8 Amplifier can be held to a much narrower range than it would be without it. This, in turn, would reduce the gain variation as a function temperature. Many of the W-J TO-8s exhibit excellent gain stability as a function of temperature, and hence would not benefit as much as the controller.

Figures 44, 46, 48, and 50 are examples of gain temperature variation as a function of ambient temperature. Figures 45, 47, 49, and 51 are examples of case temperature variation with and without the controller. For example, the WJ-A5 at its worst case frequency (500 MHz) varies approximately .5 dB over the case temperature range of –54°C to +85°C without the controller. It decreases to .3 dB with the controller as shown in Figure 44. Figure 45 shows the change in case temperature for that range. The WJ-A59 amplifier shows a similar improvement in Figure 46.

A more substantial improvement can be obtained at the high end of the band on the two-stage high frequency amps such as the A64 and A36-1. At 1200 MHz which is worst case for the A64, the gain variation is reduced from 1.3 dB to .4 dB as shown in Figure 48. The worst case point on the A36-1 (2300 MHz) improved from 2.6 dB to .9 dB.

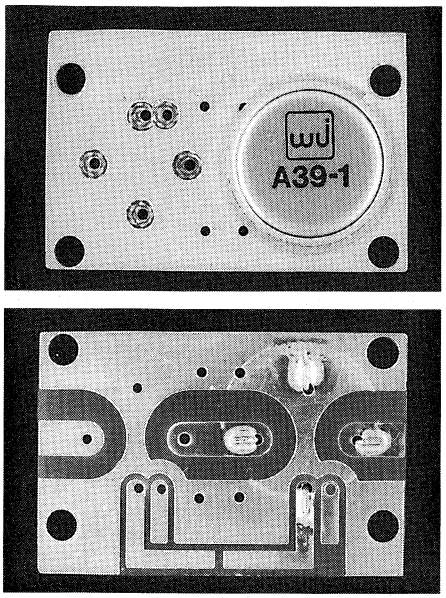



**Fig. 52—Typical TO-8 Circuit Board.**

## Frequency Stability

Each W-J cascadable amplifier has been designed to be unconditionally stable with load VSWR's of any phase angle. In order to realize inherent stability, certain installation procedures and methods must be employed.

Instability falls typically into two types: 1) Sub-band oscillations in the 100 kHz to 1 MHz region and, 2) out of-band oscillations above the frequency band. Occasionally in-hand oscillations can occur, but are much more rare and are usually related to poor circuit board grounding.

## Grounding

The necessity for good grounding cannot be overemphasized. The following measures provide acceptable grounding. First, the entire TO-8 case should be completely grounded across its entire surface to the circuit board. The circuit board, in turn, must be properly grounded on both sides. Shown in Figure 52 are both sides of a typical TO-8 circuit board used for mounting the TO-8's. The board ground planes are connected on the edges by the mounting screws and the case to which it is mounted. In addition, a series of small plated through-holes are placed parallel to the RF circuit trace for the purpose of reducing the inductive reactance between the two ground planes. Insufficient ground connections can result in midband or high-end out-of-band spurious responses. The W-J TO-8 mounting kit (No. 251050-001) is the preferred technique for holding the TO-8 to the ground plane. A conductive epoxy ring that fits around the periphery of the bottom of the case is also an acceptable method, where space is at a premium.

## Sub-band Instability

Much attention has been given to the problems of sub-band potential instability in recent years with improved techniques used in the design of biasing circuitry of the Watkins-Johnson line of cascadable amplifiers. This effort has resulted in a vastly reduced problem in using these amplifiers with any type of load or source condition over the full operating temperature range.

It is, however, still important to add an additional 0.05 to 0.1 μf decoupling capacitor to the $V_{CC}$ part for insured isolation from power supply related feed back. In addition, if the power supply bias lines are not properly shielded, radiation from these lines can occur causing instability. This is particularly important when high gain levels of 60 dB or higher are used.

## Radiative Feedback Oscillation

Radiative feedback oscillation can occur when a high gain chain is used where the RF output voltage is in phase with the input voltage (even number of stages), and the output signal radiates back to the input because of the antenna action of both the

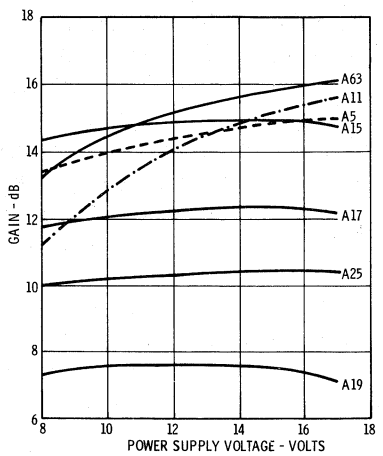



**Fig. 53—Gain Versus Power Supply Voltage.**

output and input circuit traces. The solution here is simply to keep output and input traces as short as possible and as far from each other as possible. For gain of over 60 dB, it is advisable to shield the input from the output by using a separate cavity for the input gain stages.

### Out-of-band High Frequency Oscillations

High frequency oscillations can occur as a result of poor circuit board and amplifier case grounding. In addition, if the grounding is marginal, the units may be more susceptible to oscillation under certain load conditions. A bare lead of only one-half inch in length used to connect the RF signal from its source to the input port of the amplifier may result in oscillations. It is much better to use a properly grounded circuit board with a microstrip transmission line or coax cable. Any open lines, whether on the

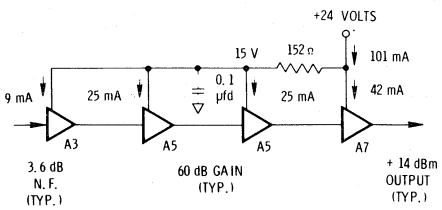



**Fig. 54—Typical Four Stage Cascade.**

$V_{CC}$ port or in the RF signal path may require ferrite beads to prevent them from acting as radiators or receptors.

### Power Supply Selection

The majority of Watkins-Johnson Company's cascadable amplifiers operate from a nominal 15 volt DC power supply. The gain versus power supply voltage for many amplifiers is shown in Figure 53. Low level amplifiers such as the Al, A3, and A11 are represented by the curve shown for the A11 amplifier. Because of the relatively low bias level on these amplifiers, the power supply should be regulated to within 0.5 volt of the nominal 15 volt level. The higher level amplifiers such as the A5, A15, and A17 are much

[1] D. L. Cheadle, "Measure Mixer Noise Figure with Your Power Meter", Microwaves, March 1975.

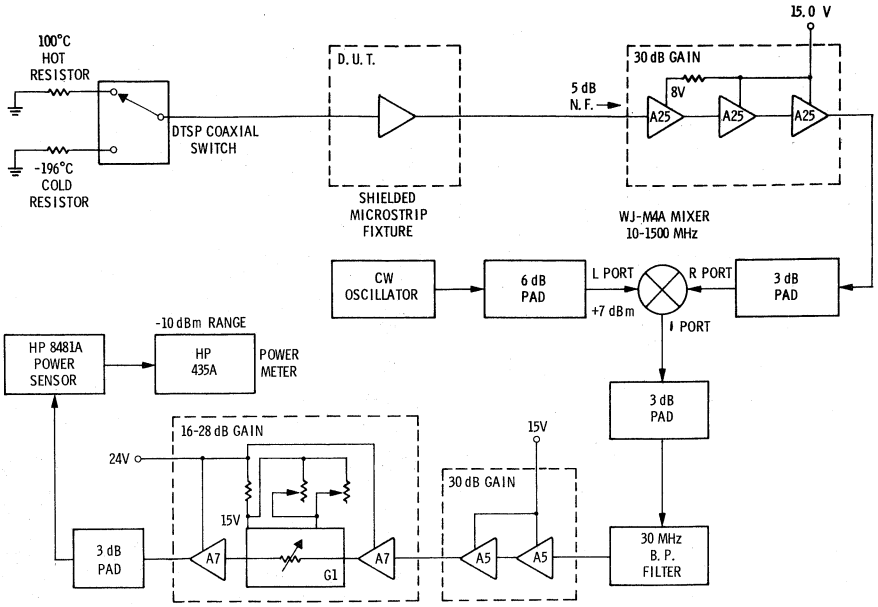



**Fig. 55—Hot-Cold Cascadable Amplifier Noise Set-Up.**

more tolerant and can be operated on a power supply voltage as low as 8 volts. The A15 and A25 amplifiers are extremely flat over the range of 8 to 16 volts. This extreme flatness results in an amplifier that is relatively immune to power supply ripple translating to changes in gain. In addition, 0.6 to 1.0 dB improvement in noise figure can be obtained by operating the A5, A15, or A25 at 8 volts.

Up to four stages may be cascaded in a common assembly without RF shielding between each unit. A typical four-stage assembly providing 60 dB of gain could be configured as shown in Figure 54. There is no bandwidth shrinkage when cascading the amplifiers because of the broadband feedback techniques employed.

In the assembly shown the WJ-A3 is used as the first stage followed by two WJ-A5s and one WJ-A7 as post amplifiers. The 0.1 μF capacitor is placed across the DC bias line to suppress any tendency toward sub-band oscillation.

### Noise Measurement

The noise figure that is measured on an amplifier depends to some degree on the system used to make the measurement. A few years ago the HP340B automatic system was very popular but has not been in close agreement with the more recent AILTECH type automatic system. The AIL

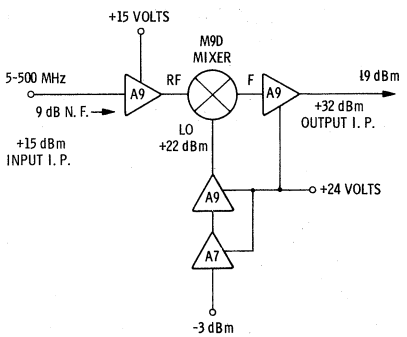



**Fig. 56—High Level Mixer-Amplifier.**

system, when used with a properly calibrated noise source, gives results that are typically within 0.2 dB of a hot/cold standard.

The test setup shown in Figure 55 shows one method of making NF measurements using W-J TO-8 cascadable amplifiers for gain blocks. This represents a very accurate, fast production method of noise measurement using the ratio of Hot noise power to Cold noise power called the P-factor.[1]

The G 1 is placed between the two A7s to provide gain adjust, which, in this case, is controlled using a coarse and fine pot for setting the reference on the power meter. The A7s are used to obtain maximum dynamic range. Using the hot resistor, a minimum of 20 dB above full scale is required by the output amplifier to

maintain linearity and not compress the noise peaks. Using the - 10 dBm range on the power meter requires +13 dBm output from the A7 in front of the 3 dB pad.
Using the three A33s as a post amplifier provides 30 dB of gain in front of the mixer which isolates the mixer so that the set-up is independent of the mixer noise figure.

### High Level Mixer-Amplifier

Using the WJ-M9D high level mixer, and A9 and A7 amplifiers, as shown in Figure 56, a very high level converter can be realized. The example requires only -3 dBm from an L.O. source and can handle signal levels up to +5 dBm on the input with a conversion gain of 17 dB. The input intercept point is typically +15 dBm with a 9 dB noise figure.

This would be ideal as a second stage converter section or could be used directly as an RF front end in a high signal level environment when maximum signal handling capability is required. This system can provide a single-tone dynamic range of 105 dB in a 1 MHz bandwidth and a spurious-free dynamic range of 78 dB for multiple input tones.

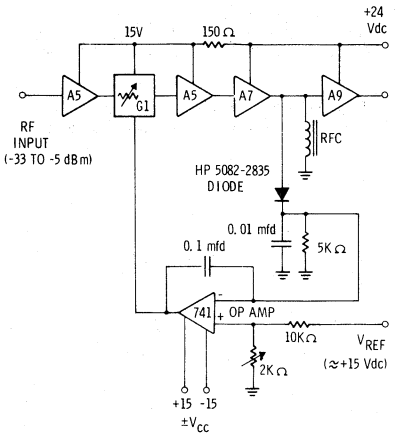



**Fig. 57—Automatic Gain Control Amplifier.**

### Automatic Gain Control Amplifier

A wideband high performance RF amplifier with AGC can be easily constructed using Watkins-Johnson Company TO-8 cascadable amplifiers, a WJ-G 1 gain control module and a few external components. A 50 to 300 MHz amplifier with the gain control set to provide +20 dBm output power and gain from 25 to 53 dB is shown in Figure 57. Table 9 gives the electrical performance characteristics of the amplifier.

**Table 9—AGC Amplifier Electrical Performance**

| Frequency | 50 to 300 MHz |
|---|---|
| **RF Output** | +20±1 dBm for RF Input of --33 to -5 dBm (High Levels Saturate the A5) |
| **VSWR In/Out** | <2.0:1 |
| **Harmonics** | >20 dB Down |
| **DC Supply** | 24V at 225 mA, ±15V at 20 mA |

The diode detects the RF power (about +10 dBm), resulting in a voltage which is compared to a reference voltage at the operational amplifier. Any difference voltage is amplified and used to control the G1 module, such that the power at the detector diode is held at +10 dBm. The diode is placed before the A9 to obtain 16 dB of isolation from variations in the output load. The WJ-A9 also amplifies the power to +20 dBm.

# A Revolutionary RF/Microwave "Surface-Mount" Product Line

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**Watkins-Johnson Company**
**Palo Alto, CA**

The emphasis on improving system performance by adding new features, while at the same time reducing overall system cost, continues to be an industry trend. Even with the use of MMICs, a large gap still exists when it comes to RF and microwave hybrid components that are needed to attain the required system performance.

The continual advance of surface-mount technology has enabled manufacturers to reduce system size and cost. The typical board size can be reduced as much as 40% by replacing conventional TO-8, TO-5, dual in-line and flat-pack packages with surface-mount components.

Conventional TO-8, TO-5, dual in-line and flat-pack style packages require very elaborate circuit boards and manual assembly techniques. Surface-mounted RF and microwave components are directly compatible with current-day automated-assembly equipment.

Watkins-Johnson Company continues to support the industry's requirements by introducing an extensive line of surface-mount RF and microwave amplifiers, attenuators and limiters. This new line of surface-mount products is a mirror image of the entire Watkins-Johnson Company's TO-8 (0.5" diameter) product line, covering a frequency range of 0.001 to 6.0 GHz.

Watkins-Johnson Company's new SMTO-8 line of surface-mount products allows system designers to transition into a surface-mounted system without being hampered by the lack of availability of various products. The performance already experienced by the system designer using TO-8 products can also be achieved with the new surface-mount products.

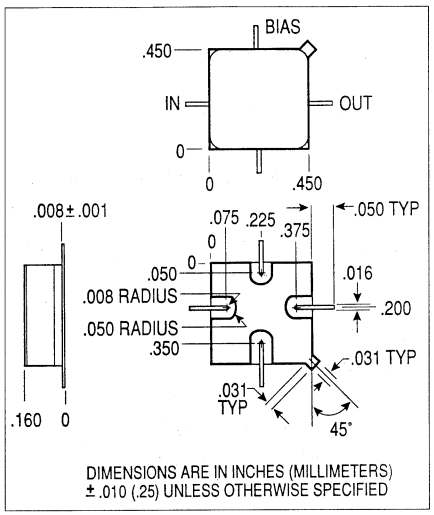



**Figure 1. SMTO-8 package dimensions.**

The SMTO-8 advantages are:
- Excellent RF and microwave performance to 6.0 GHz
- High Reliability
- Wide product selection
- Fully compatible with automated assembly techniques

## Package Construction

The SMTO-8 package evolved from the identification and implementation of several requirements essential for a successful surface-mount RF product. Attention was focused on size, performance, structural integrity for mechanical mounting, inspectable solder connections, and hermeticity.

The size of the SMTO-8 was held to a minimum while still accommodating all of Watkins-Johnson Company's TO-8 products, including RF and microwave amplifiers, attenuators, and limiters. The SMTO-8 package, shown in Figure 1, will allow the use of ferrite chokes and transformers while maintaining a height of 0.160 inches.

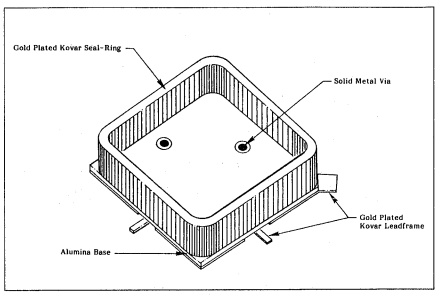



**Figure 2. Pictorial view of package.**

The internal-to-external RF feedthru design has resulted in RF performance virtually identical to existing Watkins-Johnson Company's TO-8 products. In addition, the bonding-pad pattern on the floor of the package is identical to the pin pattern on a TO-8 header. This makes the SMTO-8 package a direct replacement for the TO-8 header. In fact, the exact circuit layout and component orientation found in a TO-8 may be placed directly into a SMTO-8 package. This new SMTO-8 package allows the use of proven manufacturing techniques, thereby maintaining high manufacturing yields.

Built from the ground up, the SMTO-8 utilizes a kovar leadframe, an alumina base, and a kovar seal-ring, respectively (see Figure 2). When the three pieces are brazed together and electrically connected using solid metal vias in the alumina, a mechanically strong, temperature-resistant package is created. Along with mechanical strength, a square outline makes for easier handling by pick-and-place equipment; a great benefit for an automated assembly environment.

The SMTO-8 package construction also provides improved thermal performance compared to its TO-8 counterpart. The TO-8 header is made of kovar (0.061" thick), which has poor thermal conductivity. However, the SMTO-8 package uses a ceramic base and a kovar (0.008"

| Material Properties of Selected Printed-Wiring-Boards | | | | |
|---|---|---|---|---|
| Material | Board Thickness (In) | Dielectric Constant | Coefficient of Thermal Expansion (X $10^{-6}$/°C) | Thermal Conductivity (W/M/°C) |
| 96% $Al_2O_3$ | 0.015 | 9.6 | 6.2 | 25 |
| RT/Duroid® 6010 | 0.025 | 10.5 | X = 24<br>Y = 24<br>Z = 24 | 0.41 |
| RT/Duroid® 5880 | 0.031 | 2.2 | X = 31<br>Y = 48<br>Z = 237 | 0.26 |
| FR4/G-10 | 0.062 | 5.2 | 10-15 | 0.29 |
| RT/Duroid® is a registered trademark of Rogers Corporation. | | | | |

**Table 1. Material properties of selected printed wiring boards.**

thick) leadframe that lowers the thermal resistance by 15%.

A high-reliability market requires military specifications for visual criteria on soldered connections. For this reason, the SMTO-8 leads protrude 0.050" so that solder fillets may be easily inspected. If visible solder joints are not a requirement, the leads may be sheared flush with the base of the package in order to achieve a greater component density on the board. The thickness of the leadframe along with the channel around each lead (see Figure 1) allows flux to be easily washed away using flux removers.

Major concerns for package compliance with MIL-STD-883 are hermeticity, salt spray, and humidity. Failure in any of these three requirements can quite often be associated with damaged glass-to-metal seals. Since the SMTO-8 does not utilize glass-to-metal seals as do other conventional packages, compliance with MIL-STD-883 becomes much more consistent. Seam welding a solid nickel cover to the package yields a leak rate of less than 5 x $10^{-8}$ atm-cc/s.

## Mounting Considerations

Watkins-Johnson Company's SMTO-8 products can be mounted on a number of printed-wiring-board materials, including etched-copper board materials and thin/thick-film on ceramic materials. Ceramic materials, such as Alumina, closely match the package's thermal expansion coefficient with good electrical performance. However, most systems today are designed using etched copper-backed boards, such as G10/FR4 and Duroid™.

The use of surface-mount products places additional constraints on the system designer in the areas of thermal coefficient of expansion (TCE) mismatches and thermal conductivity of the board material selected. Table 1 compares the significant electrical, mechanical and thermal properties of various printed-wiring-board materials.

The metalization scheme must be carefully selected to prevent the phenomenon known as "scavenging." This occurs when gold migrates into the solder joint during reflow, which may cause embrittlement of the joint. However, several techniques can be used to minimize the effects of scavenging. By pretinning the package/leads with 63Sn/37Pb solder paste with RMA flux, the gold concentration is reduced, thereby producing a stronger solder joint. Alternately, Indium alloy solder pastes, which have a low tendency to dissolve gold, may also be used.

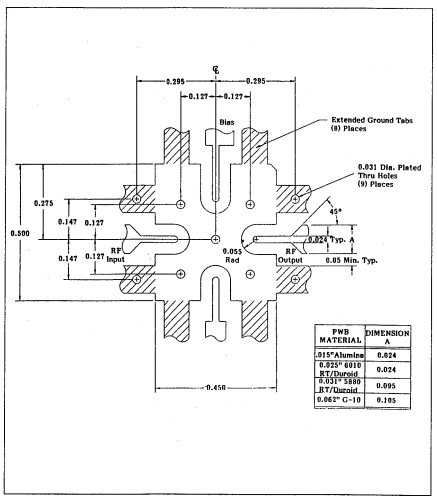



**Figure 3. Printed-wiring-board layout: 9-hole configuration.**

Watkins-Johnson Company has done extensive work in the area of surface-mount products in both the Systems and Devices groups of the Company. The outcome of all this work has been a universal printed-wiring-board (PWB) layout suitable for convection, IR, IR/Convection, vapor phase and wave solder reflow processes. Although Watkins-Johnson Company's recommended PWB layout was optimized for its IR/Convection process, it is also suitable for most manufacturing environments.

The PWB layout is designed such that the package aligns itself due to surface-tension effects during solder reflow. The layout has the same width as the package width to maintain proper alignment in the "x" direction. The "y" dimension on the layout is made larger to allow for an inspectable solder fillet. The lead pads serve to align the device in the "y" direction. Figure 3 shows the layout for a typical printed-wiring-board material. The input/output transmission lines vary in width as different dielectric materials are used.

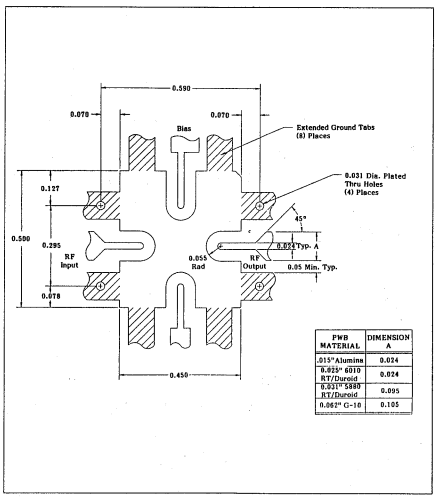



**Figure 5. Printed-wiring-board layout: 4-hole configuration.**

The electrical performance of Watkins-Johnson Company's SMTO-8 package (containing a 50 ohm thru) using this printed-wiring-board layout on various microstrip materials is shown in Figure 4. These layouts use a number of plated thru holes directly underneath the package to minimize the ground inductance, which limits the upper frequency performance of the device.

The use of plated thru holes underneath the package does present some difficulties with: 1) reduction in the solder fillet,

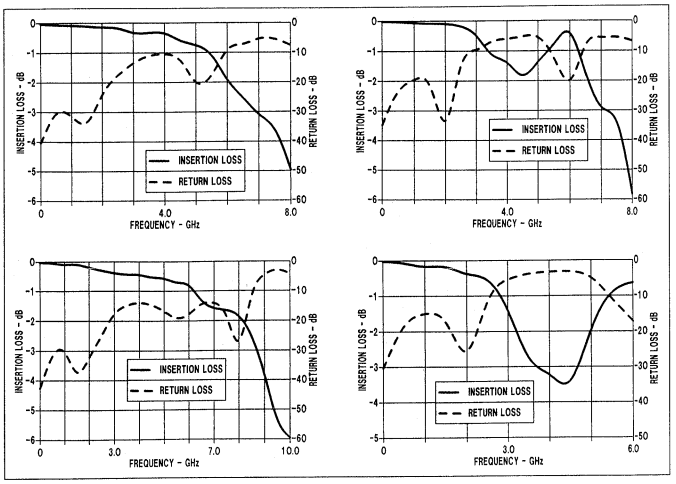



**Figure 4. Performance of the SMTO-8 package mounted on the 9-hole PWB configuration on: a) 0.062 in. G-10, b) 0.025 in. 6010 RT/Duroid, c) 0.031 in. 5880 RT/Duroid, and d) 0.015 in. 96 percent alumina.**

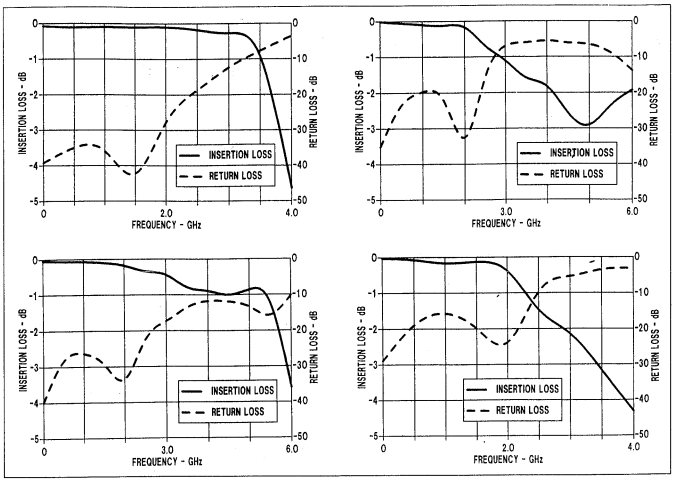



**Figure 6. Performance of the SMTO-8 package mounted on the 4-hole PWB configuration on: a) 0.062 in. G-10, b) 0.025 in. 6010 RT/Duroid, c) 0.031 in. 5880 RT/Duroid, and d) 0.015 in. 96 percent alumina.**

since solder flows into the plated thru holes during reflow. 2) rework is more difficult due to thick solder plugs formed in the plated thru holes.

Alternate printed-wiring-board layouts with plated thru holes located adjacent to the package is shown in Figure 5.

Electrical performance is degraded slightly when the ground vias are not located underneath the package, as shown in Figure 6. This degradation is caused by the increased ground inductance which, in turn, lowers the upper cut-off frequency.

## Electrical Considerations

Package Comparison

As with most new concepts, the SMTO-8 package evolved from its predecessors, the flat pack and TO-8 package. The TO-8 (0.5" diameter) package consists of a kovar header with glass feedthrus used as the interconnects. The mismatch loss associated with this design allows for operation up to 5.5 GHz with 1.0 dB insertion loss, 13.0 dB return loss (as shown in Figure 7), and a measured isolation of 28.0 dB. The impedance of this feedthru is typically around 32 ohms, which makes it difficult to use at higher frequencies.

The flat-pack package can be viewed as a combination of the TO-8 and SMTO-8 designs. It is square and has leads attached to the side of the package like the SMTO-8, but uses glass feedthrus like the TO-8. The advantage that this package has over the TO-8 package is its ability to be mounted flush to the PWB. However, for most applications, this requires either recessing the printed wiring board and/or bending the leads. These approaches are both time consuming, expensive, and a reliability risk (i.e., cracking of the glass seals). The feedthru design, coupled with other package parasitics, limits the upper cut-off frequency. As can be seen in Figure 8, the insertion loss is 1.0 dB at 2.0 GHz and the return loss is 8.0 dB. The measured isolation is 50.0 dB.

The new SMTO-8 package leads do not extend from the bottom of the package like those of the TO-8, thus eliminating the need for nonplated thru holes in the PWB. Nor do the leads extend from the middle of the wall of the package, like those of the flat pack, which eliminates the need to recess the PWB and/or bend the leads for mounting purposes. All of these features, coupled with the performance of 1.0 dB insertion loss at 5.5 GHz, 18.0 dB return loss (shown previously in Figure 4a) and 54.0 dB isolation, give the system designer a significant advantage.

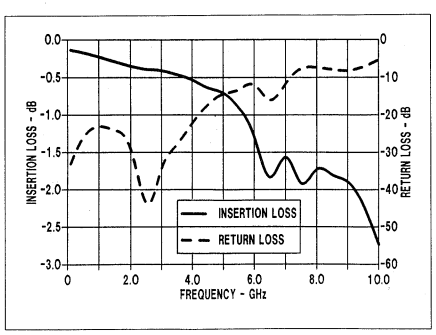



**Figure 7. Performance of the TO-8 package mounted on 0.062 in. G-10.**

## Package

The introduction of surface-mount components to the engineering community is not a new idea. Surface-mount digital ICs and passive devices have been in use for quite sometime. However, the introduction of surface-mount RF components has been more difficult. The transmission medium and device interconnections are of greater concern to the electrical engi-

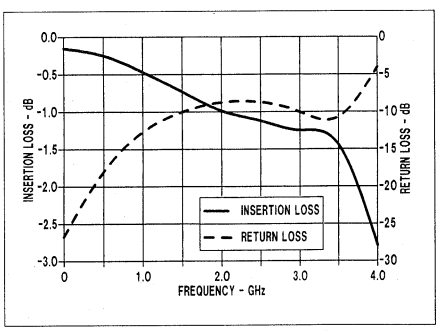



**Figure 8. Performance of the flatback package mounted on 0.062 in. G-10.**

neer, as these can limit the system performance. The mismatch loss between the various interconnections (i.e., the PWB, the package and the device) must be minimized to insure good frequency performance.

As with all devices, the SMTO-8 package can be modeled as a combination of series and shunt reactive elements. The construction of the package as illustrated in Figure 9a can be modeled as in Figure 9b. The inductance associated with the via hole ($L_{via}$) is directly related to the diameter of the via and is a limiting factor in the upper cut-off frequency of the

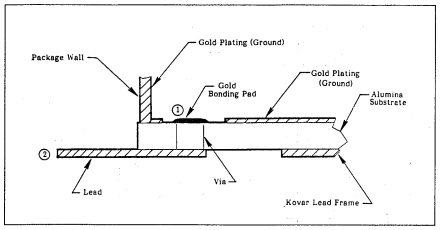



**Figure 9(a). A cross-section of the SMTO-8 package showing the lead-frame, ceramic base, metal via and Kovar wall.**

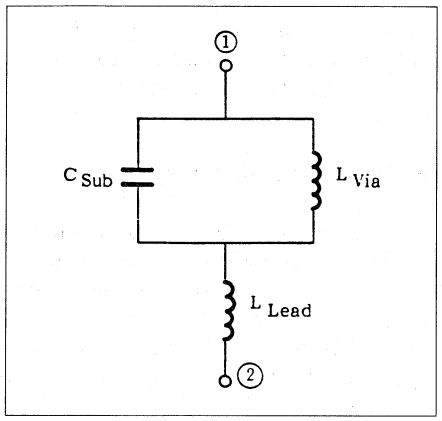



**Figure 9(b) An electrical model of the metal via, ceramic base and Kovar leadframe.**

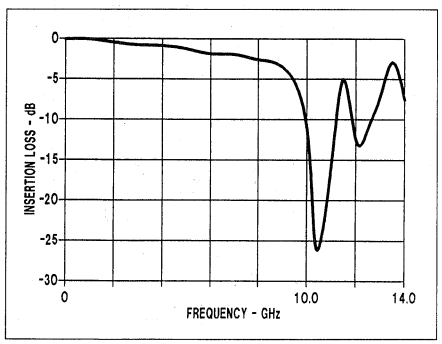



**Figure 10. The self-resonance of the SMTO-8 package is at 10.4 GHz.**

package. As the diameter is increased, the inductance is lowered and the package will exhibit less loss. However, the diameter is constrained by the size of the overall bonding area and the manufacturability of the part. In addition, the substrate capacitance ($C_{sub}$) needs to be minimized for the same basic reason. This is accomplished by the use of ground vias located as close as possible to the interconnect via. This approach decreases the capacitance by moving the ground plane on the bottom of the package closer to the one inside the base of the package. Finally, the lead inductance ($L_{lead}$) will have the same effect as the via inductance, but can be minimized with a good impedance match between the package and the mounting surface.

With the current dimensions and overall structure of the package, a self-resonance

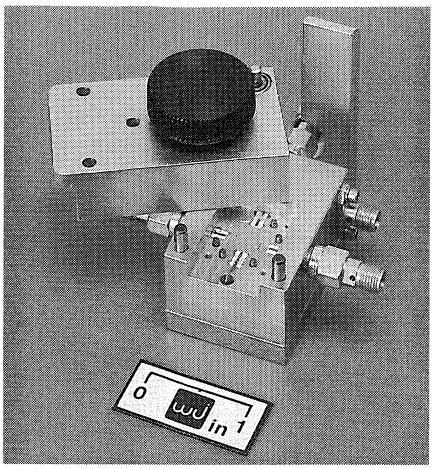


**Figure 11. Photograph of the compression loaded test fixture for the SMTO-8 package.**

is produced at 10.4 GHz, as shown in Figure 10.

In summary, the insertion loss of the package is improved by reducing the

Typical Performance at 25°C

| SMA36 | 100 - 2000 MHz | |
|---|---|---|
| Specification | TO-8 | SMTO-8 |
| Gain<br>Noise Figure<br>Output Power<br>IP3 | 16.5 dB (min.)<br>5.5 dB (max.)<br>12.0 dB (min.)<br>23.0 dBm | 16.7 dB (min.)<br>5.3 dB (max.)<br>12.5 dBm (min.)<br>22.0 dBm |
| **SMA70** | **10 - 250 MHz** | |
| Specification | TO-8 | SMTO-8 |
| Gain<br>Noise Figure<br>Output Power<br>IP3 | 8.0 dB (min.)<br>1.8 dB (max.)<br>8.5 dBm (min.)<br>21.0 dBm | 8.0 dB (min.)<br>1.8 dB (max.)<br>8.5 dBm (min.)<br>23.0 dBm |
| **SMA61** | **2.0 - 6.0 GHz** | |
| Specification | TO-8 | SMTO-8 |
| Gain<br>Noise Figure<br>Output Power | 7.0 dB (min.)<br>3.4 dB (max.)<br>12.0 dBm (min.) | 7.0 dB (min.)<br>3.5 dB (max.)<br>12.2 dBm (min.) |
| **SMA81-2** | **20 - 500 MHz** | |
| Specification | TO-8 | SMTO-8 |
| Gain<br>Noise Figure<br>Output Power<br>IP3 | 22.0 dB (min.)<br>4.0 dB (max.)<br>14.5 dBm (min.)<br>28.0 dBm | 22.8 dB (min.)<br>4.0 dB (max.)<br>14.5 dBm (min.)<br>28.0 dBm |
| **SMLA7** | **50 - 500 MHz** | |
| Specification | TO-8 | SMTO-8 |
| Gain<br>Noise Figure<br>Output Power<br>Maximum Limiting | 12.8 dB (min.)<br>7.0 dB (max.)<br>13.5 dBm (min.)<br>17.0 dBm (max.) | 13.2 dB (min.)<br>6.6 dB (max.)<br>14.0 dBm (min.)<br>16.0 dBm (max.) |

**Table 2. Comparison of typical performance of various products.**

shunt capacitance and series inductance, since both of these elements produce a low-pass frequency response and cause a higher frequency roll-off. By maintaining a good impedance match between the package and its mounting surface and the package interconnections, the return loss will be improved. Finally, the use of many ground vias inside the package and plated thru holes connecting the package to ground on the printed-wiring-board will insure a good RF connection, improve isolation, and reduce the possibility of oscillations in amplifiers.

## Fixturing

Once the internal capacitances and inductances of the package have been minimized, the problem of testing this new device becomes an issue. As with most devices, the fixturing and mismatches between the device and the test set-up need to be minimized in order to achieve good electrical response.

The test fixture, as shown in Figure 11, has two main areas of concern. The first is the interconnection between the test set and the fixture. This is usually accomplished with a transition from coax to microstrip, as illustrated in Figure 12. With this type of transition, there is a shunt capacitance introduced between the center conductor of the coaxial connector and the ground plane, through the dielectric of the filler substrate.

The second and most important interconnection is between the fixture and the package itself. This connection is accomplished by the transition of microstrip (the filler substrate) to stripline (a combination of the package and filler substrate), as illustrated in Figure 13. This transition, microstrip-to-stripline, is probably the most difficult transition to make, and is the main factor in determining the upper cut-off frequency of the test fixture. As shown in Figure 13, the ground plane directly under the package is too close to the lead (center conductor), and this produces a shunt capacitance or mismatch loss. This loss can be minimized by introducing a ground step or cavity directly after the filler substrate. In addition, the filler substrate should not extend past the lead as this will produce more ground-plane coupling and loss. This test fixture design operates up to 7.0 GHz with only 1.0 dB of loss.

By reducing the mismatch loss between the test set and the device, the upper cut-

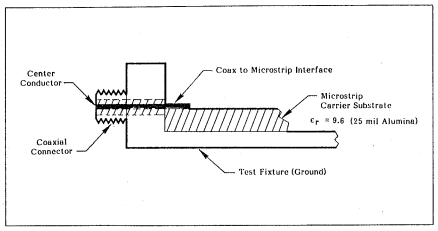



**Figure 12. A cross-sectional view of the coax (coaxial cable of test set) to microstrip (filler substrate of test fixture) transition.**

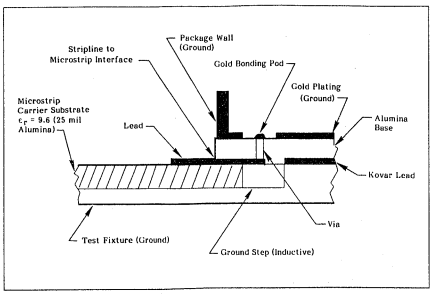



**Figure 13. A cross-sectional view of the microstrip (filler substrate of test fixture) to stripline (ceramic base [dielectric]) transition.**

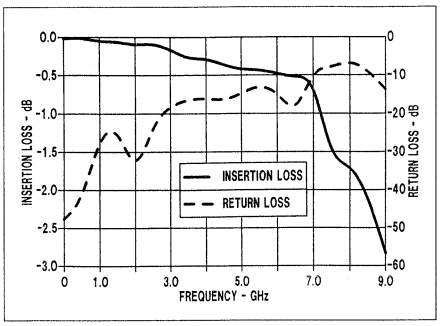



**Figure 14. Insertion and Return loss of the SMTO-8 package measured in the test fixture of Figure 11.**

off frequency of the set-up can be extended. With the use of proper calibration techniques and standards, the performance of the SMTO-8 package in the fixture illustrated in Figure 11 is that shown in Figure 14. As can be seen from the graph, the operational goal of 6.0 GHz was achieved.

## Electrical Comparison

The electrical performance of the new SMTO-8 package was tested and compared to the performance of the existing TO-8 (0.5" diameter) products using the same alignment configuration. The results obtained show that the TO-8 version and SMTO-8 counterpart were identical, thus making this package a drop-in replacement to any existing TO-8 and next generation surface-mount board. The design and development of the package has allowed the placement of the entire Watkins-Johnson Company's TO-8 product line in the SMTO-8 package with no degradation in performance. Since the TO-8 version has been established in the industry for years, the reliability of the SMTO-8 is at zero risk to the user.

The components tested in the new package included a low-noise amplifier, limiter, attenuator, power amplifier and limiting amplifier that cover the 5.0 MHz to 6.0 GHz frequency range. The data in Figures 15, 16 and Table 2 show a performance comparison of gain, VSWR, output power and noise figure of a few SMTO-8 models and the equivalent TO-8 version.

## Reliability and Screening

Watkins-Johnson Company's new line of surface-mount products is designed and manufactured to meet the stringent performance and quality requirements of MIL-STD-883, Method 5008. The package is capable of meeting the requirements of MIL-STD-883, Method 5008.1 packaging requirements per Table 3.

Watkins-Johnson Company's thin-film hybrid surface-mount products are

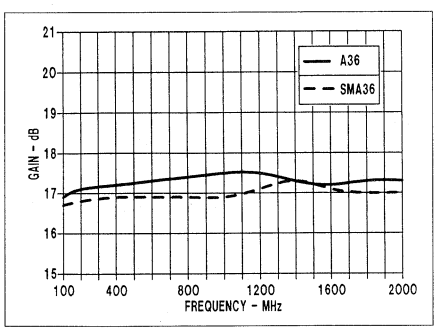



**Figure 15(a). Electrical test results of a standard TO-8 (0.5" dia.) A36 amplifier with a SMTO-8 (SMA36 amplifier) comparing: Gain.**

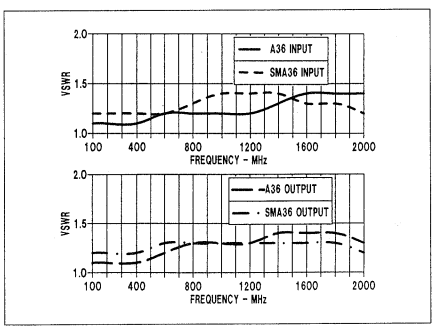



**Figure 15(b). Electrical test results of a standard TO-8 (0.5" dia.) A36 amplifier with a SMTO-8 (SMA36 amplifier) comparing: Input and Output VSWR.**

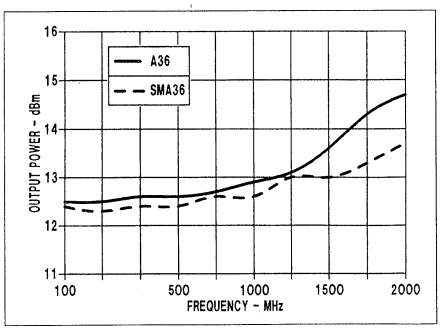



**Figure 15(c). Electrical test results of a standard TO-8 (0.5" dia.) A36 amplifier with a SMTO-8 (SMA36 amplifier) comparing: Output Power at 1.0 dB gain compression.**

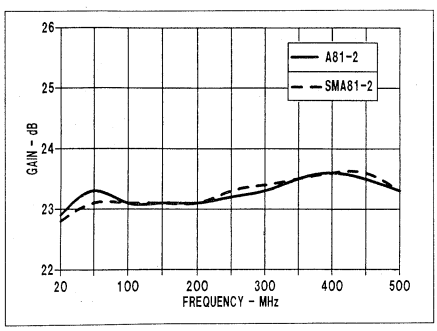



**Figure 16(a). Electrical test results of a standard TO-8 (0.5" dia.) A81-2 amplifier with a SMTO-8 (SMA81-2 amplifier) comparing: Gain.**

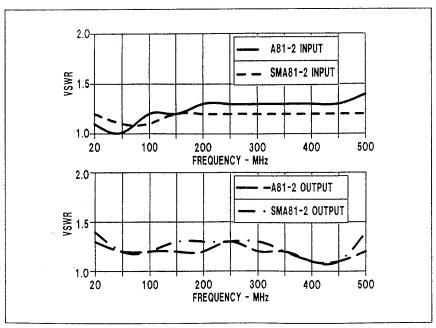



**Figure 16(b). Electrical test results of a standard TO-8 (0.5" dia.) A81-2 amplifier with a SMTO-8 (SMA81-2 amplifier) comparing: Input and Output VSWR.**

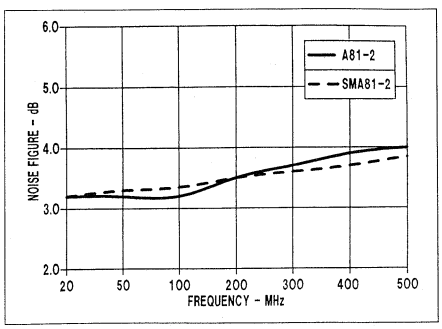



**Figure 16(c). Electrical test results of a standard TO-8 (0.5" dia.) A81-2 amplifier with a SMTO-8 (SMA81-2 amplifier) comparing: Noise Figure.**

| Package Testing Performed Successfully on SMTO-8 Packages | | |
|---|---|---|
| **Test (MIL-STD-883)** | **Method** | **Condition** |
| Thermal Shock | 1011 | C, -65° to +150°C |
| High Temperature Bake | 1008 | F, 300°C |
| Solderability | 2003 | |
| Hermeticity | 1014 | $A_4$ |
| Salt Atmosphere | 1009 | A, 24 Hours |
| Lead Integrity | 2004 | A, $B_2$ |

**Table 3. Environmental package screening.**

designed and manufactured with the same materials and assembly techniques already proven in its line of TO-8 products. This similarity in design and construction allows the system designer the same level of confidence of system integrity.

Watkins-Johnson Company offers all of its surface-mount products with a standardized environmental screening option designated "S" series. The "S" series provides a cost and time-effective approach to meeting the requirements commonly found on many airborne, ground mobile, shipboard, and missile applications. The screening is per MIL-STD-883, Method 5008, as outlined in Table 4. Customized reliability screening options and applications are offered.

## Conclusion

Watkins-Johnson Company continues to support the industry's needs by introducing a complete line of surface-mounted RF and microwave components. In designing the package, special attention was placed on RF performance, size, structural integrity for mounting, inspectable solder connections, and hermeticity. This package allows system designers the freedom to choose from a wide variety of Watkins-Johnson Company's TO-8 components.

| W-J "S Series" Screening per Method 5008 of MIL-STD-883 | | |
|---|---|---|
| **Test** | **Method** | **Condition** |
| Element Evaluation & Group D Test | 5008; 3.2 | All lots |
| Transistor Wafer Qualification Test Lot | | Sample |
| Process Control and Monitors | W-J internal documents | Sample |
| Preseal Electrical Test | Per applicable document | 100% |
| Production Internal Visual | W-J 146505 | |
| Quality Assurance Internal Visual | W-J 146505 | |
| Stabilization Bake | 1008 | B; 24 hrs., +125°C |
| Temperature Cycle | 1010 | B; 10 cycles, −55°C to +125°C |
| Constant Acceleration | 2001 | B; 10 Kgs, $Y_1$ axis |
| Seal Tests | 1014 | Conditions A1 & C |
| Burn-In | 1015 | B; 160 hrs., $T_C$ = +71°C to +125°C |
| Final Electrical and Group A Test | Per applicable document | |
| External Visual | 2009 | |
| PDC Evaluation | W-J 136948 | |

NOTE: 1. The S Series screening process differs from MIL-STD-883, Class B, as follows: ① Internal visual inspection is performed in accordance with W-J 146505 instead of Method 2017; ② Stabilization bake and temperature cycling are conducted per Condition B instead of Condition C of the respective methods. ③ Constant acceleration is conducted per Condition B instead of Condition E of Method 2001; and ④ The 96-hour time constraint between burn-in and final electrical testing per Method 1015 is not guaranteed.

**Table 4. W-J "S" series screening 5008.**

The SMTO-8 advantages are:

- Excellent RF and microwave performance to 6 GHz
- High Reliability
- Wide product selection
- Fully compatible with automated assembly techniques

# Mixer Application Information

The information contained below is applicable to all mixers in general and should be useful to those who might want to more fully understand mixer operation and achieve the most performance possible.

DEFINITIONS

**Conversion Loss** is the ratio of the output signal level to the low-level input signal level expressed in dB. In a single sideband system, only one sideband is used; therefore, 3 dB of the loss is theoretical. The additional loss is diode and transformer loss. These losses can be minimized by driving the diodes with sufficient current and operating in the best portion of the frequency band.

Conversion loss is specified in a 50-ohm system with an $f_L$ drive level of +7 dBm for low-level mixers. High-level mixers require more drive level power. A short circuit at the output port for the unwanted sideband will usually improve the conversion loss and noise figure by 0.5 dB if operation at the I-port is below 500 MHz.

**Noise Figure** is the signal-to-noise ratio at the input divided by the signal-to- noise ratio at the output expressed in dB. It does not include the noise figure of an IF amplifier or 1/f flicker noise.

The IF frequency range is normally specified from 400 kHz to the upper frequency range of the device. Appreciable noise contribution from 1/f noise is not noticeable above 10 kHz. Use of specially selected Schottky- Barrier diodes ensures extremely low 1/f noise for phase detection applications. With the recommended drive level the noise figure and conversion loss are essentially identical.

**Isolation** is the amount of "leakage" or "feedthru" between the mixer ports. The $f_L$ at R isolation is the amount of $f_L$ drive level signal is attenuated when measured at the R-port. The $f_L$ at I isolation is the amount the $f_L$ drive level signal is attenuated when measured at the I-port. Normally, only the $f_L$ isolation is specified since the $f_R$ signal level is much lower than the $f_L$ signal level and is not a problem. The $f_I$ at L and $f_R$ at L isolations are normally the same as the $f_L$ at I and $f_L$ at R isolations. At low frequencies, where diode parameters are matched and circuit parasitics are negligible, isolation greater than 60 dB is possible.

**Conversion Compression** is the $f_R$ input level above which the $f_R$ input vs. $f_I$ output curve deviates from linearity. Above this level additional increases in input level do not result in equal increases in output level. Conversion compression is not specified for all low-level mixers. However, low-level units normally have the same compression level, i.e., typically 0.3 dB deviation from linearity with an $f_R$ signal level of +2 dBm and a +7 dBm $f_L$ drive level. This $f_R$ level can be raised to +4 dBm if the drive level is increased to +13 dBm. Conversion compression for high- level mixers is specified since it sometimes provides an indication of the mixer's two-tone performance and it is likely to be important in high-level operation.

**Dynamic Range** is the amplitude range over which a mixer can operate without degradation of performance. It is dictated by the conversion compression point and the noise figure of the mixer.

Since the thermal noise of each mixer is about the same, the conversion compression point normally determines the mixer's dynamic range.

**Intercept Point** is the point at which the fundamental response and the 3rd-order spurious response curves intercept. It is often used to predict the 2-tone, 3rd-order suppression of a mixer. The higher the intercept point, the better the 3rd-order suppression. Relative to the input, the intercept point is typically 9 to 11 dB higher than the conversion compression point.

**Two-Tone, Third-Order Intermodulation Distortion** is the amount of 3rd-order distortion caused from a second received signal being present at the R-port. Mathematically, 3rd-order distortion is defined as $(2f_{R2} - f_{R1}) \pm f_L$ where $f_{R2}$ is the second signal. Usually the higher the conversion compression or intercept point of a mixer, the greater the suppression of this product. Normally this parameter is not specified as it is dependent on the input frequencies and terminating impedances.

**Desensitization** is the compression of the desired signal caused by a strong second interfacing signal. For a low-level mixer, this compression is typically less than 1.0 dB for an $f_{R2}$ signal level of +1 dBm and less than 10.0 dB for an $f_{R2}$ signal level of +10 dBm. The desensitization level is normally 3 dB below the conversion compression level.

APPLICATIONS

**Harmonic Intermodulation Distortion** results from the mixing of mixer generated harmonics of the input signals. Mathematically, it is expressed as $mf_L \pm nf_R$ where m and n represent the harmonic numbers of the input signals. Typical performance shown on page 693 is not normally specified since the relative level depends on input frequencies, input levels and terminating impedances.

**Cross Modulation Distortion** is the amount of modulation transferred from a modulated carrier to an unmodulated carrier when both signals are applied to the R-port of the mixer. The higher the conversion compression or intercept point of a mixer, the greater the attenuation of the cross modulation.

GENERAL APPLICATIONS

**Mixing**: When two signals are fed to the mixer, sum and difference frequencies are produced at the third port. Best isolation is usually achieved by feeding the LO signal to the L port. In downconverters the RF input signal is fed to the R port and the output is taken from the I port. For up-converting applications, feed the low frequency input signal to the I port and take the output from the R port.

**Drive Level**: Examples of recommended drive levels along with minimum and maximum levels are shown on the next page.

A minimum drive level is recommended when it is necessary to reduce the level of intermodulation products in the lower two rows of the intermodulation chart or minimize the 1/f output noise. A drive level below the minimum recommended level degrades the conversion loss and noise figure of the mixer over the full temperature and frequency range.

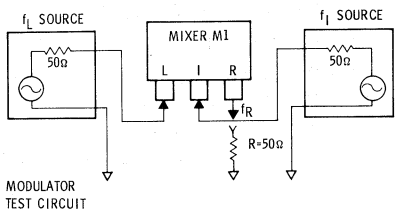
Operation at a high drive level is recommended to achieve best two-tone performance, best suppression of the intermodulation products in the rows above the second row in the intermodulation chart', and the best flatness of conversion loss as a function of frequency. A drive level above the recommended level will result in an increase in noise figure and an increase in $mf_L$ feedthrough.

**RF Input Level**: With the recommended $f_L$ level, and to avoid deviations from linearity by more than 1 dB, the $f_R$ level should not exceed the following levels:

| Mixer Type | $f_R$ Level dBm |
|---|---|
| Low Level | +1 to +4 |
| High Level | +10 to +14 |
| Ultra High Level (M9E Type) | +21 |

The $f_R$ signal level should be as low as possible when there is a problem with higher order $f_R$ intermodulation products.

PULSE, AMPLITUDE, AND BI-PHASE MODULATION

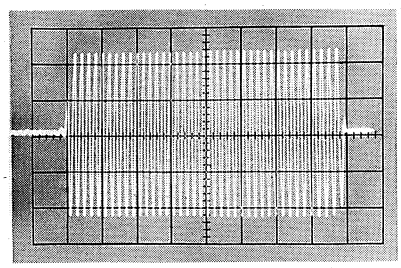



For amplitude modulation, apply a dc current along with the modulating signal at the I-port. The carrier signal is applied at the L-port and the modulated signal appears at the R-port. The dc current at the I-port controls the amount of carrier present in the output.

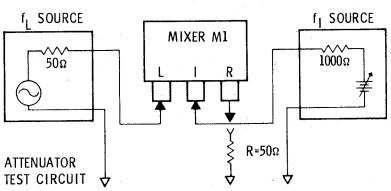
For pulse modulation, feed the unmodulated signal to the L-port and the modulating pulse to the I-port. No dc offset current should be used. Pulse lengths can be of unlimited length since the I-port is direct coupled. A 20 mA level is sufficient to fully turn on the diodes. Rise and fall times less than 1 nsec can be achieved. Zero current turns the diodes off. Either a positive or a negative pulse may be used.

The balanced construction of the mixer allows very little of the switching signal to feed through to the output. To obtain higher "on-off" ratios and improved suppression of the high frequency switching components, refer to pages 749-790.

For bi-phase modulation, reverse the polarity of the switching signal. Upon reversal, the output phase will shift by 180 degrees.

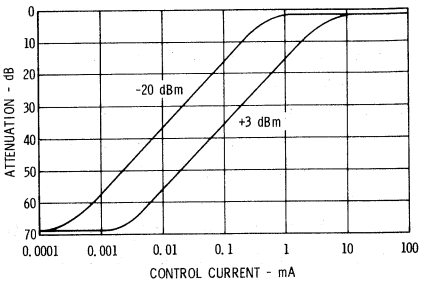


CURRENT-CONTROLLED ATTENUATION



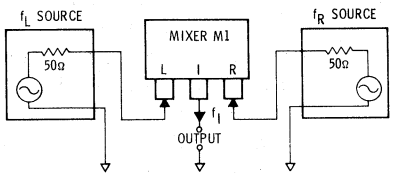

The amount of signal passing through the mixer from the L-port to the R-port is determined by the dc control current present at the I-port. Maximum attenuation is achieved with no dc current and corresponds to the isolation of the mixer. Minimum attenuation is achieved with a dc current of 20 mA or greater.

A plot showing the attenuation characteristics of the M1 is shown for a 10 MHz signal with signal levels of -20 dBm and +3 dBm. For input signal levels of -20 dBm or less, the attenuation is relatively independent of the signal level.

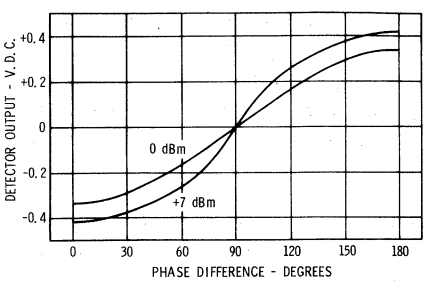



**Typical Attenuation vs. Control Current**

PHASE DETECTION




When used as a phase detector, excellent balance of the mixer eliminates null balance adjustments and minimizes interaction between the signal sources. With identical frequencies connected to the R- and L-ports, a dc output related to the phase difference between the two signals will appear at the I-port. The two inputs to the phase detector are normally the same level. The output is usually loaded with 1000 ohms or greater.



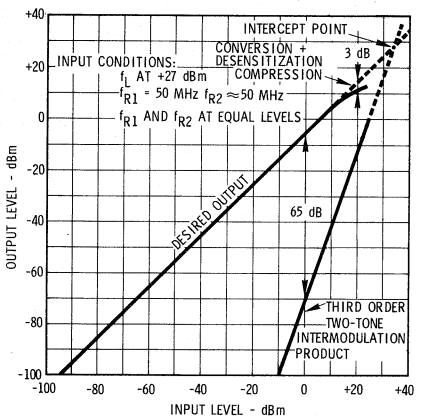

**Typical Phase Detector Output vs. Phase Difference**

| Mixer | Recommended Drive Level dBm | Minimum Drive Level dBm | Maximum Drive Level dBm |
|---|---|---|---|
| Low-Level Mixers | +7 | +4 to +6 | +13 |
| M12/M12A | +13 | +10 | +17 |
| M9/M9A | +13 | +7 | +17 |
| M9B | +17 | +10 | +20 |
| M9D | +20 | +10 | +23 |
| M1K | +20 | +14 | +23 |
| M9E | +27 | +10 | +30 |
| M67 | +10 | +7 | +14 |
| M76H | +20 | +14 | +23 |
| M80 | +7 | +4 | +12 |
| M83 | +13 | +10 | +17 |

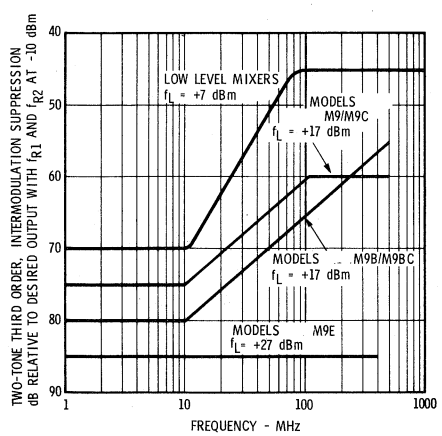
The sinusoidal output voltage shown below is from a phase detector in which the inputs are two sinusoidal signals of the same level and the output is loaded with 1000 ohms. The output voltage waveform as a function of phase difference is sinusoidal. With two square wave inputs the output voltage would be linear. Input levels of +7 dBm are recommended for best phase detection. A higher level introduces unbalance and a lower level results in a loss of output level.

## TYPICAL TWO-TONE PERFORMANCE AT 25°C

**Definition**: In a mixer application where the input must be wideband, two signals ($f_{R1}$ and $f_{R2}$) may mix with the local oscillator signal ($f_L$) to produce in-band, two-tone third-order intermodulation products ($2f_{R2} - f_{R1}$) ± $f_L$.

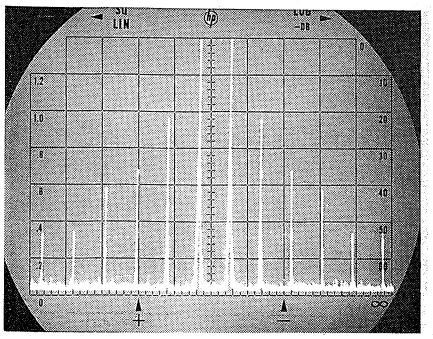



**Two-Tone Supression vs. Input Level:** With each dB decrease in $f_R$ input level, the third-order product is decreased an

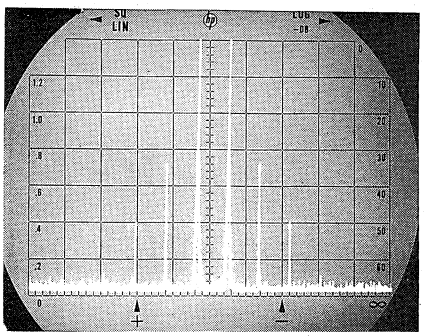



additional 2 dB. As shown above, the M9E will suppress third-order products 65 dB with both input signals as 0 dBm, and 85 dB with both input signals at -10 dBm. Relative to the output, the intercept point for the M9E is +27.5 dBm. Relative to the input, it is +32.5 dBm. This is 17 dB higher than the intercept point for a low-level, double-balanced mixer like the M1. The 3 dB compression shown on the graph is a combination of both conversion compression and desensitization.

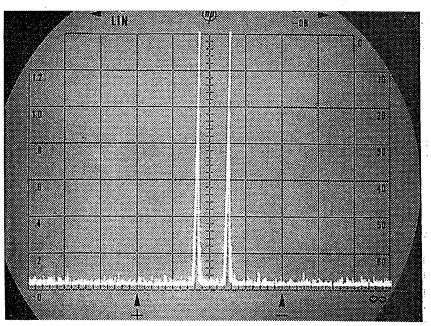
**Two-tone Suppression vs. Input Frequency**: The two-tone performance of the M9E is constant across its frequency range. Other mixers, even other high-level mixers (except the M9D), have a degradation in performance above 10 MHz.



**M1: With a +7 dBm $f_L$ drive level, the low-level $M_1$ suppresses many of the two-tone spurs. However, a number of relatively unsuppressed products remain.**



**M9BC: With a +17 dBm $f_L$ drive level, the M9BC provides an additional 12 dB of suppression of the third-order product.**

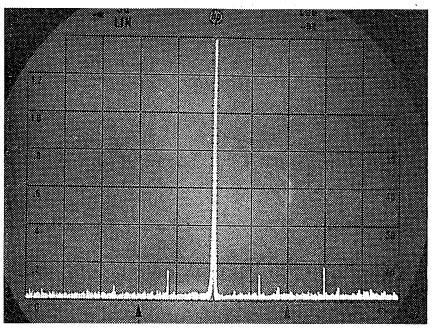


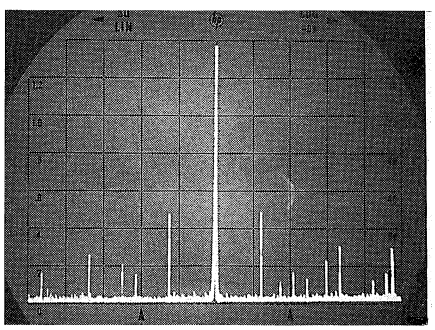
**M9E: With a +27 dBm $f_L$ drive level, the high-level M9E virtually eliminates all two-lone products from the 60 dB spectrum.**

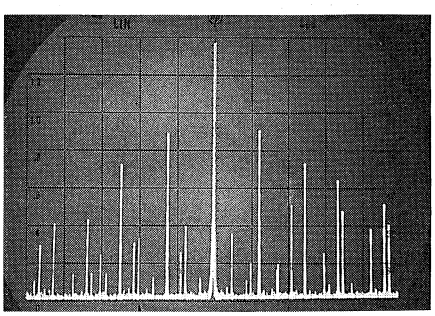
**Two-Tone Performance of High- Level, Double-Balanced Mixers:** In the spectrum analyzer photos, the high-level M9E is compared to the lower-level M9BC and low-level M1 under similar input conditions. The input conditions were as follows:

$f_L$ = 352 MHZ, $f_{R1}$ = 322 MHz at 0 dBm, $f_{R2}$ = 320 MHz at 0 dBm.
Horizontal Scale: 2.5 MHz/cm, centered at ≈ 31 MHz.
Vertical Scale: 10 db/cm.

The performance of M1/M9BC/M9E represents the Class I/Class II Type I/ Class III mixer, respectively.







## TYPICAL INTERMODULATION PERFORMANCE AT 25°C

**M1/M9BC/M9E**

| Harmonics of $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 79>99>99 | 69 79>99 | 80>99>99 | 74 78>99 | 83>99>99 | 63 78>99 | 78>99>99 | 60 81>99 | 71 99>99 |
| | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | 87>90>90 | >90>90>90 | >90>90>90 | >90>90>90 |
| 6 | 90>99>99 | 86>99>99 | 91>99>99 | 91>99 97 | 90>99>99 | 84>99>99 | 93>99>99 | 84>99>99 | 88>99 98 |
| | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 |
| 5 | 72 93>99 | 70 73 96 | 71 87>99 | 52 72 95 | 77 88>99 | 46 66>99 | 75 85>99 | 45 64 90 | 73 82>99 |
| | >90>90>90 | 80>90>90 | >90>90>90 | 71>90>90 | >90>90>90 | 68>90>90 | >90>90>90 | 65>90>90 | 88>90>90 |
| 4 | 80 96 88 | 79 80 91 | 82 96>99 | 77 80 92 | 82 95 90 | 76 82 95 | 77 98 87 | 72 78 94 | 77 90 87 |
| | 86>90>90 | >90>90>90 | 86>90>90 | 88>90>90 | 88>90>90 | 85>90>90 | 86>90>90 | 85>90>90 | >90>90>90 |
| 3 | 51 63 81 | 49 58 73 | 53 65 85 | 51 60 69 | 55 65 85 | 48 55 68 | 54 64 85 | 53 54 64 | 58 66 87 |
| | 67 87>90 | 64 77>90 | 69 87>90 | 50 78>90 | 77>90>90 | 47 75>90 | 74 85>90 | 44 77 89 | 74 88>90 |
| 2 | 69 68 64 | 72 67 71 | 79 76 62 | 67 67 70 | 75 80 63 | 66 66 70 | 77 82 61 | 68 66 62 | 75 83 64 |
| | 73 86 73 | 73 75 83 | 74 84 75 | 70 75 79 | 71 86 80 | 64 74 80 | 69 87 77 | 64 74 82 | 69 84 79 |
| 1 | 25 25 24 | 0 0 0 | 39 39 35 | 13 11 11 | 45 50 42 | 22 16 19 | 54 59 50 | 37 19 39 | 59 59 49 |
| | 24 23 24 | 0 0 0 | 35 39 34 | 13 11 11 | 40 46 42 | 24 14 18 | 45 62 49 | 28 19 37 | 49 53 49 |
| 0 | | 36 39 29 | 45 42 20 | 52 46 32 | 63 58 24 | 45 37 29 | 60 65 27 | 71 49 30 | 64 75 29 |
| | | 26 27 18 | 35 31 10 | 39 36 23 | 50 47 14 | 41 36 19 | 53 51 17 | 49 37 21 | |

**Harmonics Of $f_L$**

**MI/M9BC/M9E: $f_R$ at-10dBm; $f_L$ at +7/+17/+27 dBm respectively for the M1, M9BC and M9E.**

Intermodulation signals which result from the mixing of mixer-generated harmonics of the input signals are shown above for the M1, M9BC and M9E. Mixing product suppression is indicated by the number of dB below the $f_L \pm f$ output level. The performance was measured with $f_R$ at 49 MHz, $f_L$ at 50 MHz, and using the following input levels:

MI/M9BC/M9E: $f_R$ at 0 dBm; $f_L$ at +7/+17/+27 dBm respectively for the MI, M9BC and M9E.

Improved performance can be obtained at lower frequencies, and for harmonics of $f_R$>2, with $f_R$ at a lower level. The suppression figures shown above for the MI are also applicable for its pc equivalent, M6E. The MI suppression figures may be used for the M6D/ M6A if the input frequencies are assumed to be at 20 MHz rather than 50 MHz. The MI suppression may also be used for the M1A if the input frequencies are assumed to be 100 MHz rather than 50 MHz.

Mixer-generated intermods are shown for each model under the following conditions: Input signals: $f_{R1}$ - 45.6 MHz at -10 dBm, $f_{R2}$ = 27.8 MHz at -2 dBm, $f_{R3}$ = 26.6 MHz at -2 dBm, $f_L$= 50 MHz with the levels noted before. Horizontal Scale: 2 MHz/cm, centered at 95.6 MHz. Vertical: 10 dbm/cm.

Mixer-generated harmonic distortion is present in the output spectrum even when a well-balanced low-level mixer such as the MI is used. By substituting the M9BC high-level mixer, the "worst case" products can be reduced an additional 18 dB. However, these products can be reduced 40 dB, by substituting the M9E very high-level mixer.

# Mixers: Part 1 Characteristics and Performance

**Author: Bert C. Henderson**

The mixer is a critical component in modern RF systems. Since it is usually the first or second device from the RF input, the performance of the mixer is crucial to the overall operation of the system. Such important mixer parameters as dynamic range, conversion loss, bandwidth, noise figure, interport isolation and VSWR (voltage standing wave ratio) must be optimized to produce the type of device necessary for today's sophisticated RF systems. This article explores the basics of mixer operation, and is intended to give the reader a base on which to build further understanding of today's mixer technology. The systems designer will find portions of this article helpful when integrating various types of mixers into his or her systems.

### Mixer Defined

A mixer converts RF power at one frequency into power at another frequency to make signal processing easier and less expensive. Another, and perhaps more fundamental reason for frequency conversion, is to allow for the practical transmission of audio and other low-frequency information through free space. Audio signals have such long wavelengths that transmitting them directly would require a restrictively large antenna. But, by first converting the audio information up in frequency to center around a higher (carrier) frequency, antennas of practical size can be built to utilize the various channel characteristics of free space, such as ionospheric skip and atmospheric absorption, that depend on the carrier frequency. Receiving the transmitted signal involves capturing part of its electromagnetic energy and reconverting it down to the audio-frequency range to extract the original information. So, both the transmitting and receiving cases require the input signal to be converted; this is done through the mixing process.

Mixing the input signal having the desired information with a local oscillator signal yields upper and lower sidebands, each containing the identical information present in the input frequency. The upper sideband is the sum of the input and the local oscillator frequencies, and the lower sideband is the difference between the input and the local oscillator frequencies. The upper or lower sideband, whichever is selected for use, is called the intermediate frequency (IF). In most receiving systems, the lower sideband (the downconverted product) is used, whereas in transmitting systems the upper sideband (the upconverted product) is used.

Changing the frequency of a signal without altering the information it carries is necessary because signal processing components, such as amplifiers, are much less expensive and perform better when designed to operate at lower frequencies.

Since it is much less expensive to amplify a signal in the MHz range than in the GHz range, the incoming microwave signal is first downconverted in frequency and then processed. Likewise, in a transmitter it is less expensive to generate, modulate, and amplify a signal in the MHz range and then upconvert it in frequency into the GHz range.

Figure 1 shows the placement of a mixer in a receiver front end with the schematic symbol most commonly used for mixers. Sometimes X is used instead of I to denote the I-port. For testing purposes, attenuators are placed on all three ports for better matching [1] and to dampen intermodulation products exiting the mixer so that they are minimized in power level before the system reflects them back into the mixer to remix and cause further intermodulation products. When matching and intermodulation products are a problem in a system, isolators are used instead of attenuators on the R and I-ports so that system sensitivity is not degraded, and on the L-port if LO power is limited.

Since a mixer converts modulated power from one frequency to another, it is sometimes called a frequency converter, but the term frequency converter usually implies a mixer/amplifier or mixer/oscillator combination. The term mixer more closely describes the mechanism through which frequency conversion occurs. Two inputs are mixed by means of nonlinearities and switching to produce a group of signals having frequencies equal to the sums and differences of the harmonies of the two input signals. Nonlinearities and switching will be discussed at greater length later in this Tech-notes series.

The input signal to the mixer that has the desired information modulated onto it is called the received (input RF) signal, or $f_R$. The other input signal to the mixer, designated as $f_L$, is called the local oscillator (LO) signal, since it is generated by an oscillator physically located near the mixer in the system.

The LO signal is usually much stronger than the received signal; this causes the mixer to have better intermodulation suppression than would be possible if the LO and RF power levels were similar. The LO signal should be, in most cases, at least

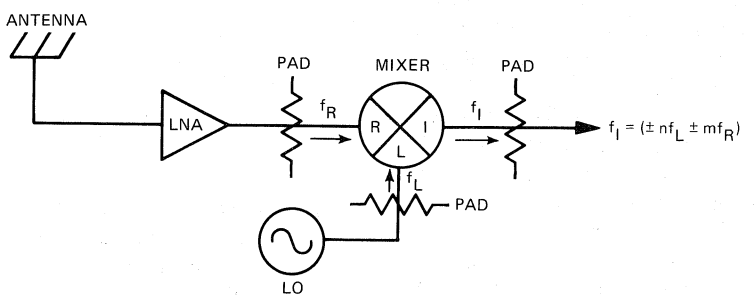



**Fig. 1—Schematic diagram showing mixer placement in a receiver front end.**

20 dB higher in power than the RF input. The mixer output signal is the intermediate frequency and is designated, $f_I$. The intermediate frequency is so termed because it falls between the RF and information frequencies. This is simply stated as:

$$f_I = \pm m\, f_R \pm n\, f_L$$

where,

$$m = 0, 1, 2, 3, \text{etc.}$$

$$n = 0, 1, 2, 3, \text{etc.}$$

The output products most generally desired are the sums and differences of the fundamentals of the received and LO signals. This is the case for which:

$$m = n = 1$$

giving,

$$f_I = \pm f_L \pm f_R$$

While this formula implies that negative frequency products occur, these can be ignored in practical mixer applications in much the same way as incorrect roots can be ignored when calculating quadratic equations. For the case where $f_L > f_R$, which is called high-side LO, $f_I = f_L \pm f_R$. When $f_L < f_R$, which is called low-side LO, $f_I = \pm f_L + f_R$.

Hereafter, in this discussion, the definition of the intermediate frequency products will be restricted to include only the four intermodulation products for which n = m = 1.

The higher-order products having m = 1, 2, 3, 4.... and n = 1, 2, 3, 4, . . . for which m and n are not simultaneously equal to 1, will be referred to as higher-order intermodulation products. Two other possible cases are m = 1,2,3, ..., n = 0 and m = 0, n = 1, 2, 3, .In these cases, the fundamental and harmonics of the received and local oscillator signals, respectively, leak through the mixer to appear at the IF output port. This is caused by finite interport isolation, and occurs to a varying extent in all mixers.

A mixer is a three-port device, having two input ports and one output port. The port through which the received signal enters the mixer is called the *R-port*, and the port through which the local oscillator signal enters the mixer is called the *L-port*. The port through which all the output products exit the mixer is called the *I-port*. A mixer can also be a four-port device if it uses a DC bias for *starved LO* operation, which generally means LO input power is in the range of 0 to +6 dBm. Normal mixers using only the LO power to turn on the diodes require +6 to +20 dBm of LO power.

Most mixers use Schottky barrier diodes, but GaAs diodes are sometimes utilized for operation in the millimeter-wave frequency range. Mixers also use bipolar transistors, J-FETs, and GaAs FETS, all of which require a fourth port for a DC voltage. There are many parameters to consider when choosing a mixer; an introduction to the most important of these follows.

### Single Sideband Conversion Loss

Since a mixer converts power from one frequency to another, perhaps the most fundamental parameter is the measure of how efficiently frequency conversion occurs. This parameter is called conversion loss, and is defined as the difference in dB between the received signal power entering the R-port and the output IF power of the desired IF sideband exiting the I-port. Both the up- and downconverted products, or sidebands, exit the I-port. Since normally only one of these products is desired, the other product is filtered out, causing half the downconverted power to be lost. Hence, there is an automatic 3-dB SSB (single sideband) conversion loss minimum. Further power losses during frequency conversion occur because some of the down-converted power is also lost in the form of unwanted higher-order mixing products, heat due to the series resistance of the diodes, and mismatches at the mixer. These all add to cause typical SSB conversion loss to range from 6 to 9 dB. Conversion loss is a strong function of LO power, which radically affects mismatch between the system and mixer.

### VSWR

VSWR is the measure of mismatch offered to the system by the mixer, and is usually specified over a given bandwidth as a function of LO power and temperature. It is calculated as follows:

$$\text{VSWR} = \frac{1 + |\rho|}{1 - |\rho|}$$

where

$$\rho = \frac{Z_L - Z_o}{Z_L + Z_o}$$

$\rho$ is the reflection coefficient.
$Z_L$ is the input impedance of the mixer.
$Z_o$ is the characteristic impedance of the system.

Since VSWR does not include the phase of the reflection coefficient, the system designer does not know if the input impedance is above or below the normal 50-ohms characteristic impedance. For example, if the L-port VSWR is 2:1, measured in a 50-ohm system, the system designer does not know if the L-port input impedance is 25 ohms or 100 ohms. Actually, the input impedance of a broadband mixer swept over a frequency range of an octave or more, usually rotates through the low and high impedances, roughly producing a circle centered at 50 ohms, as viewed on a Smith Chart. So, a given mixer having L-VSWR of 2:1 over an octave bandwidth will have an input impedance varying from 25 ohms to 100 ohms, passing through an infinite number of complex impedance combinations as the LO frequency changes. R, L, and I VSWRs are direct functions of LO power, which establishes the operating point of the diodes. Changing the LO power alters the diode operating point, resulting in a different impedance for all mixer ports, causing a corresponding change in VSWR. RF input power, which is at least 20 dB lower than LO input power, does not appreciably alter the diode bias point and, consequently, has little affect on VSWR. When the diode impedance changes, the input impedances of all three ports change. Hence, varying the LO power level will affect the VSWR of all three ports.

One mark of a good mixer design is that its VSWRs are optimized for the LO power that is in the middle of the normal operating power range of the mixer diodes used. This allows for good VSWRs over the maximum range of LO power levels. When designing a mixer, the L-VSWR is first optimized by adjusting the L- port circuit, allowing the LO power to properly bias the diodes and set the R- and I-port VSWRS. Then, the R- and I-port circuits are adjusted to properly match the diodes to the RF input and IF output loads.

### Isolation

Interport isolation is the measure of insertion loss between any two mixer ports. It is measured in dB and usually specified over a given bandwidth as a function of LO drive and temperature. Maximizing isolation between ports in mixers is necessary because unwanted signal feedthrough wastes RF power and can obscure the desired IF output, as well as cause electromagnetic interference. Normally, only the isolation between L and R, and L and I ports is specified, because the LO input power,

after leaking through the mixer, is comparable to the output IF power, whereas the RF input power usually is not. For instance, if the RF input power is -10 dBm and the R-to-I isolation is 20 dB (both are typical numbers), - 30 dBm of RF power leaks out the I-port. If SSB conversion loss is 6 dB, the desired IF signal level is - 16 dBm, which is 14 dB higher in power than the undesired RF feed through signal, also exiting the I-port. Such a relative power difference is usually sufficient. If LO power is +20 dBm and L-to-I isolation is 30 dB, -10 dBm of LO power leaks out the I-port, which is 6 dB higher in power than the –16 dBm IF product. If the LO frequency falls inside the IF band, this feedthrough can seriously obscure the desired IF output product. Hence, L-to-I isolation is more important to specify than R-to-I isolation. R-to-I isolation is specified only when the relative power level of RF feedthrough and IF output power is critical, and, only for mixers having broadband IF outputs, thus allowing the frequency of the RF feed through power to fall in the IF band.

If the LO input power is +20 dBm and the L-to-R isolation is 30 dB, -10 dBm of LO power leaks out the R-port to become incident at the amplifier or antenna feeding the R-port. When the R-port has no buffer between it and the receiving antenna, LO feedthrough power can radiate out the receiving antenna. Hence, L-to-R and L-to-I isolations are most important, and normally the only ones specified. Various factors such as diode match and circuit balance influence isolation in mixers, and will be explored in detail later.

## Dynamic Range

Dynamic range is measured in dB and is the input RF power range over which the mixer is useful. The lower limit of dynamic range is the noise floor, which depends on the mixer and system. The upper limit of dynamic range is generally taken to be the mixer 1-dB compression point. This is measured in dBm, and is the input RF power level at which conversion loss increases by 1 dB. Other definitions of dynamic range have been specified [2]. Beginning at the low end of the dynamic range, just enough input RF power is fed into the mixer to cause the IF signal to be barely discernable above the noise. Increasing the RF input power causes the IF output power to increase dB-for-dB of input power, continuing until the RF input power increases to a level at which the IF output power no longer increases dB-for-dB, but instead begins to roll off, causing an increase in conversion loss. The input power level at which the conversion loss increases by 1 dB is the 1-dB compression point.

The 1-dB compression point is generally taken to be the top of the dynamic range because the input RF power that is not converted into desired IF output power, is instead converted into heat and higher-order intermodulation products. The intermodulation products that begin to appear when RF power is increased beyond the 1-dB compression point can begin to obscure the desired IF output. Generally, the 1-dB compression point is 5-to-10 dB lower than the LO input power, so a high-level mixer has a higher 1-dB compression point than a low level mixer and, hence, a wider dynamic range. Table 1 shows the LO power levels generally associated with very high-, high-, medium- and low-level mixers. These power levels apply specifically to mixers using Schottky barrier diodes, but can also be applied in a more general way to mixers using other devices. The type and number of Schottky barrier diodes and resistor elements that may be used determine the level of LO input power.

| Level | LO Power Range (dBm) |
|---|---|
| Very High | +27 to +15 |
| High | +20 to +13 |
| Medium | +13 to +10 |
| Low | +10 to +6 |

**Table 1. Mixer LO power levels.**

## Intermodulation Products

Intermodulation (IM) products are undesirable mixer-generated output products exiting the mixer from any port. Two types exist: single-tone and multiple-tone. Intermodulation products are composed of a single input RF signal mixing with the LO, and have the following frequencies:

$$f = \pm m f_R \pm n f_L \qquad (1)$$

where,

$m = 1,2,3,\ldots$

$n = 1,2,3,\ldots$

Multiple-tone intermodulation products are composed of two or more input RF signals mixing with the LO, and have the following frequencies:

$$f = (\pm m_1 f_{R1} \pm m2 f_{R2} \pm m_3 f_{R3} \ldots) n f_L \qquad (2)$$

where,

$m_1, m_2, m_3, \ldots = 0, 1, 2, 3,\ldots$

$n = 0, 1, 2, 3,\ldots$

Multiple-tone intermodulation products for which all but one of the coefficients, m, are zero, resemble single-tone intermodulation products because their frequencies contain harmonics of the LO and harmonics of the one RF input that has the non-zero coefficient, m. Hence, single-tone intermodulation products can be present when multiple-input RF signals are incident at the R-port, because output products can be generated that have frequencies in the form of Equation (1). The level of output power of individual intermodulation products is very much affected by input LO and RF power levels and frequencies.

Charts exist that show trends in intermodulation suppression as a function of input power and frequency. Figure 2 is a single-tone intermodulation chart showing the power level of various intermodulation products relative to the IF output power. Intermodulation charts are not generally tabulated for multiple-tone intermodulation products because each coefficient ($m_1$, $M_2$, $m_3$.... and n) requires its own axis on the chart, whereas charts for single-tone intermodulation products require only two axes for m and n. Each box in an intermodulation chart represents one of the infinite integral harmonic combinations of $f_R$ and $f_L$. Each box in this particular chart contains two rows that each have three values of intermodulation signal suppression. In each row, the first value is for a Class 1 mixer (WJ-M1) having +7 dBm of LO drive; the second value is for a Class 2 mixer (WJ-M9BC) having +17 dBm of LO drive; and the third value is for a Class 3 mixer (WJ-M9E) having +27 dBm of LO drive. These classes of mixers are discussed more fully later in this Tech-notes series. The top row in each box gives intermodulation suppression for RF input power of 0 dBm; the bottom row gives intermodulation suppression for RF input power of - 10 dBm.Notice that the even-by-even intermodulation signals for which both m and n are even, are suppressed more than the odd-by-

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 7 | 79 >99 >99 | 69 79 >99 | 80 >99 >99 | 74 78 >99 | 83 >99 >99 | 63 78 >99 |
| | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | 87 >90 >90 |
| 6 | 90 >99 >99 | 86 >99 >99 | 91 >99 >99 | 91 >99 97 | 90 >99 >99 | 84 >99 >99 |
| | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 | >90 >90 >90 |
| 5 | 72 93 >99 | 70 73 96 | 71 87 >99 | 52 72 95 | 77 88 >99 | 46 66 >99 |
| | >90 >90 >90 | 80 >90 >90 | >90 >90 >90 | 71 >90 >90 | >90 >90 >90 | 68 >90 >90 |
| 4 | 80 96 83 | 79 80 91 | 82 96 >99 | 77 80 92 | 82 95 90 | 76 82 95 |
| | 86 >90 >90 | >90 >90 >90 | 86 >90 >90 | 88 >90 >90 | 88 >90 >90 | 85 >90 >90 |
| 3 | 51 63 81 | 49 58 73 | 53 65 85 | 51 60 69 | 55 65 85 | 48 55 68 |
| | 67 87 >90 | 64 77 >90 | 69 87 >90 | 50 78 >90 | 77 >90 >90 | 47 75 >90 |
| 2 | 69 68 64 | 72 67 71 | 79 76 62 | 67 67 70 | 75 80 63 | 66 66 70 |
| | 73 86 73 | 73 75 83 | 74 84 75 | 70 75 79 | 71 86 80 | 64 74 80 |
| 1 | 25 25 24 | 0 0 0 | 39 39 35 | 13 11 11 | 45 50 42 | 22 16 19 |
| | 24 23 24 | 0 0 0 | 35 39 34 | 13 11 11 | 40 46 42 | 24 14 18 |
| 0 | | 36 39 29 | 45 42 20 | 52 46 32 | 63 58 24 | 45 37 29 |
| | | 26 27 18 | 35 31 10 | 39 36 23 | 50 47 14 | 41 36 19 |

HARMONICS OF $f_L$

**Figure 2. Example of an intermodulation chart showing the power level of various intermodulation products relative to the IF output power.**

odd products. This is due to the circuit balance in double-balanced mixers. If diode match and mixer balance were perfect, only the odd-by-odd products would exit the I-port, and all other products would show infinite suppression on the chart. Notice also that the two bottom rows for m = 0 implicitly give L-to-I isolation for various harmonics of $f_L$, calculated as follows:

L-to-I isolation (dB) =
[LO drive level (dBm)
- RF drive level (dBm)]
+ [SSB conversion loss (dB)]
+ [Suppression from Chart (dBc)]

For example, for the Class 1 mixer with +7 dBm of LO drive, -10 dBm of RF drive and 6 dB of conversion loss, L-to-I isolation is:

L-to-I isolation = (+7 +10)
+ 6 + 26 = 49 dB

L-to-I isolation determined this way takes into account RF input power as well as that of the LO, and so may yield different results than the guaranteed L-to-I isolation specification, which is normally measured without any RF input power.

Intermodulation charts for a particular mixer reveal much about how it handles various input power levels. However, since intermodulation suppression is a function of many parameters, such as diode manufacturer and production lot, and mixer assembly and test, intermodulation charts should only be used to evaluate trends in intermodulation suppression, and not to specify it concretely. A more indepth discussion of this particular chart is given in the reference literature [3]

## Intercept Point

Intercept point, measured in dBm, is a figure of merit for intermodulation product suppression. A high intercept point is desirable. Two types are commonly specified: input and output intercept point (IIP and OIP, respectively). Input intercept point is the level of input RF power at which the output power levels of the undesired intermodulation products and IF products would be equal; that is, intercept each other if the mixer did not compress. This output power level is the output intercept point, and equals the input intercept point minus conversion loss. As input RF power increases, the mixer compresses before the power level of the intermodulation products can increase to equal the IF output power. So, input and output intercept points are theoretical and are calculated by extrapolating the output power of the intermodulation and IF products past the 1-dB compression point until they equal each other. A high intercept point is desirable because it means the mixer can handle more input RF power before causing undesired products to rival the desired IF output product, and essentially means the mixer has a greater dynamic range. Dynamic range, 1-dB compression point, and intercept point are all interrelated, but Cheadle has shown that, in general, no dB-for-dB rule of thumb exists to easily correlate 1-dB compression point with intercept point [3].

The concept of intercept point can be applied to any intermodulation product; however, it normally refers to two-tone, third-order intermodulation products. If two input RF signals are incident at the mixer R-port, they cause the mixer to generate the following two-tone intermodulation products:

$$(\pm m_1 f_{R_1} \pm m_2 f_{R2}) \pm n f_L$$

where, $m_1$, $m_2$, n = 0, 1, 2, 3, . . ., m and n are integers and can assume any value.Two-tone,third-order intermodulation products have the following frequencies:

$$(\pm 2f_{R_1} \pm f_{R_2}) \pm f_L$$
and
$$(\pm f_{R_1} \pm 2f_{R_2}) \pm f_L$$

They are called third-order products because the coefficients of $f_{R_1}$ and $f_{R_2}$ sum to equal 3. Notice that the order of intermodulation products refers only to coefficients of the RF inputs and does not include that of the LO. The order of the intermodulation product is important because a 1-dB change in the power level of each input RF signal causes the power level of each intermodulation product to change by an amount of dB equal to its order. A 1-dB change in power of each of the two input RF signals causes the power level of each two-tone, third-order product to change by 3 dB.

Input intercept point is normally associated with two-tone, third-order intermodulation products because the third-order product is closest in frequency to the desired IF output product of any two-tone intermodulation product. The even-order, two- tone intermodulation products that exit from double- and single-balanced mixers are suppressed far more than the odd-order products, due to mixer balance. Odd-order intermodulation products containing even-order LO harmonies are suppressed in double-,but not in single-balanced mixers. Third-order two-tone products follow the $(m_1 + m_2)$ dB of output power to 1-dB-of-input-power rule much more closely than the other higher-order, two-tone intermodulation products. Two-tone intermodulation products with orders greater than 7 are rarely a problem unless RF input power comes within a few dB of LO input power.

To illustrate the use and importance of intercept point, consider Figure 3, which shows two input RF signals, two output IF signals, and two output two-tone intermodulation products, given the following input frequencies: $f_R$, 410 MHZ, $f_{R_1}$ = 400 MHz and $f_L$ = 100 MHz. Assume the desired received signal is $f_{R_1}$, and that $f_{R_2}$ is an unwanted input signal. Desired signal $f_{R_1}$ mixes with $f_L$ to yield 310 MHz and 510 MHz outputs, and $f_{R_2}$mixes with $f_L$ to yield 300 and 500 MHz outputs. Signals $f_{R_1}$ and $f_{R_2}$ combine to intermodulate with the LO to produce outputs at 320 MHz, 520 MHz, 290 MHz and 490 MHz. Higher-order single- and multiple- tone intermodulation products are also produced. Changing input power levels of $f_{R_1}$ and $f_{R_2}$ affects the output power levels of the IF and intermodulation products differently. Initially, both $f_{R_1}$ and $f_{R_2}$ have -10 dbm of input power, causing IF products to have -16 dBm of output power, assuming SSB conversion loss for this mixer is 6 dB. This input power level of -10dBm causes third-order products for this particular mixer to have -62 dBm of power, which is 46 dBc; i.e., 46 dB down from the IF products. As input power for both $f_R$, and $f_{R_2}$ increases by 20 dB to become +10 dBm, the power level of both IF products increases by 20 dB to become +4 dBm.

The two, third-order intermodulation products, however, have increased by 60 dB to have -2 dBm of power, giving a smaller intermodulation suppression of only 6 dBc, as compared to 46 dBc when RF input powers were both -10 dBm. This highlights a key point: to specify intermodulation suppression, both the suppression (in dBc) and the input RF power levels must be specified because intermodulation suppression varies as a function of input RF power. Further increasing both input power levels by 3 dB brings them up to +13 dBm, causing a 3-dB increase in power for both IF products, bringing them each up to +7 dBm. This 3-dB increase in RF input power causes a 9-dB increase in output power for the intermodulation products, bringing them up to +7 dBm also. The IF and intermodulation power levels are equal here, so +7 dBm is the output intercept point, and +13 dBm is the input intercept point, because this is the power level of both input RF tones that would cause IF and intermodulation products to have the same output power if the mixer did not compress.

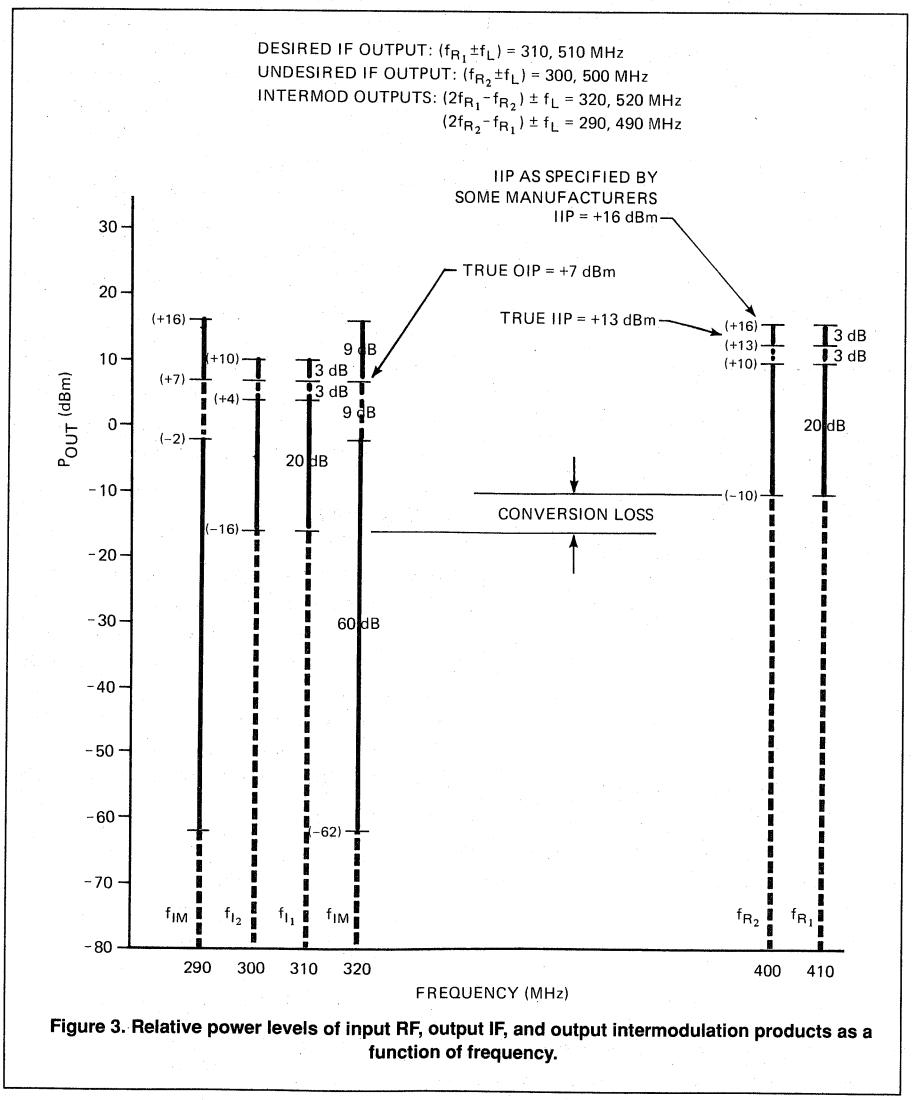



**Figure 3. Relative power levels of input RF, output IF, and output intermodulation products as a function of frequency.**

Intercept point is normally presented as shown in Figure 4. Input power is plotted along the horizontal axis, and output power is plotted along the vertical axis. Two lines are plotted: one relating IF output power to RF input power, and another relating intermodulation output power to RF input power. Two points on each line are required to plot them. Recall that for -10 dBm of input RF power, the IF output power is -16dBm, and intermodulation output power is -62 dBm. So, (-10, -16) is the first point for the IF line, and (-10, -62) is the first point for the intermodulation line. Also, recall that +10 dBm of input power causes the IF output power to be +4 dBm and intermodulation output power to be -2 dBm. So, (10, 4) is the second point on the IF line, and (10, -2) is the second point on the intermodulation line. The two lines can now be drawn. The point at which they intersect gives the input and output intercept points for the mixer at a particular set of input frequencies for a given LO power level and temperature.

The reason why so much effort is spent extrapolating out the intercept point instead of simply specifying the desired suppression and input RF power levels is that intercept point assumes intermodulation suppression to be zero dBc. This means that only one piece of information needs to be transferred between system designer and mixer manufacturer; namely, the input RF power level at which intermodulation suppression would be zero dBc, which is the input intercept point. So, instead of needing to specify two numbers, only one is necessary. This is the reason for using the intercept method.

A simple formula exists for calculating input intercept point, given the level of intermodulation suppression, the order of the intermodulation, and the input RF power levels giving rise to this level of suppression.

$$IIP = \frac{\text{Intermodulation Suppression (dBc)}}{\text{(order - 1)}} + [\text{input RF power (dBm)}]$$

For example, when each input tone has -10 dBm of power, the third-order, two-tone intermodulation suppression is 46 dBc. This gives:

$$IIP\ (dBm) = \frac{46}{3-1} + (-10\ dBm)$$

$$= +13\ dBm$$

This agrees with the +13 dBm IIP determined graphically.

Also, output and input intercept are related by the mixer conversion loss or gain (for active mixers):

$$OIP\ (dBm) = IIP\ (dBm) \begin{cases} -\text{mixer conversion loss (dB)} \\ \text{or} \\ +\text{mixer conversion gain (dB)} \end{cases}$$

Two more details need to be mentioned about intercept point. The first is that when determining intercept point, input RF power for each tone should be no greater than -20 dBm for Class 1 mixers, - 10 dBm for Class 2 mixers, and 0 dBm for Class 3 mixers [3].

If these RF input powers are exceeded, intermodulation output power as a function of input RF power deviates from the $(m_1 + m_2 + \ldots)$ dB output power to 1-dB-input-power rule, causing the wrong intercept point to be extrapolated. Secondly, one confusing aspect connected to intercept point is the way in which it is specified by different manufacturers. While most manufacturers specify intercept point as explained in this discussion, some manufacturers, in order to be able to publish a seemingly high value for the intercept point of their mixers, have a different interpretation. Their technique is to specify input intercept point as the power level at which the input RF and output intermodulation power levels are equal. Figures 3 and 4 show that if the input RF power level is increased from +13 dBm to +16 dBm, the power level of the intermodulation products theoretically increases 9 dB, to become +16 dBm also. Some mixer manufacturers would specify +16 dBm as the input intercept point for this mixer, allowing the customer to think he or she is buying a better mixer than an identical one specified correctly at +13 dBm. This method generates a value for input intercept point that is higher by half the mixer conversion loss than the true input intercept point. It also generates values for input and output intercept points that are equal.

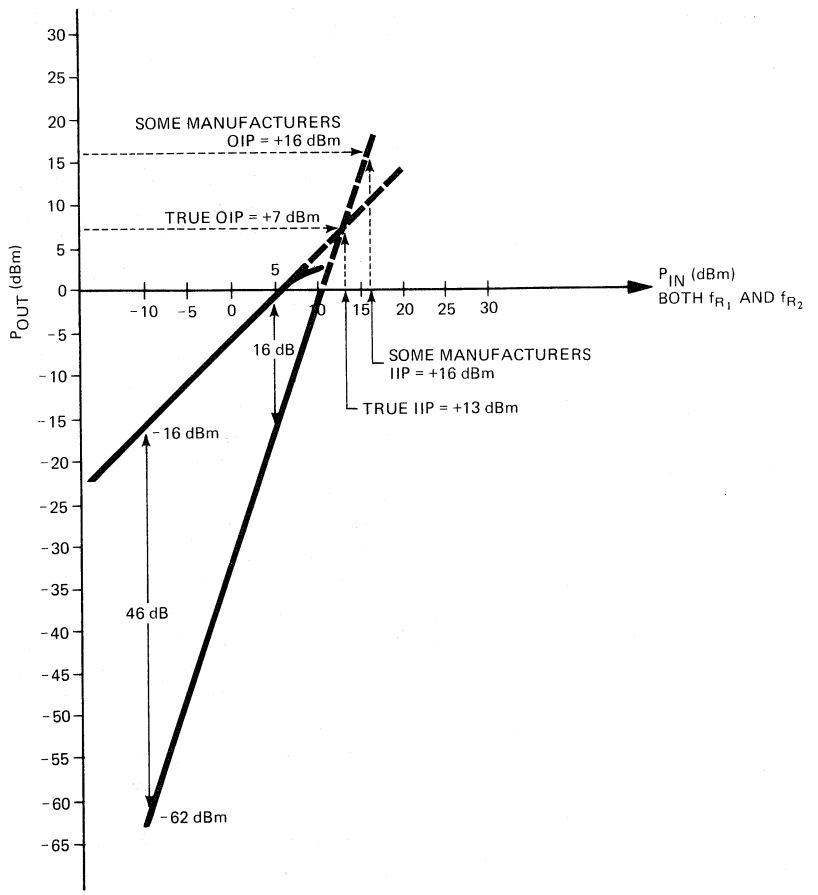



**Figure 4. Output power of IF and intermodulation products as a function of input RF power.**

When specifying intercept point for a mixer, it is advisable to:

1. Distinguish between input and output intercept point.
2. Specify the order of the intermodulation product, and number of input tones it has.
3. When measuring two-tone, third-order intercept point, keep both RF input power levels no greater than: (a) - 20 dBm for a Class 1 mixer(b)-10 dBm for a Class 2 mixer (c) 0 dBm for a Class 3 mixer
4. Check that input IP and output IP are not equal; if they are, the input IP value given is misleadingly higher than the correct one by half the mixer conversion loss.
5. Specify individual test frequencies instead of a test bandwidth, and specify all input power levels because intercept point changes as a function of frequency and input power.

## SSB Noise Figure

Mixer SSB noise figure is measured in dB, and is the amount of noise added by the mixer to the converted signal plus the SSB conversion loss. Noise figure is the difference in dB between the input RF signal-to-noise ratio and the output IF signal-to-noise ratio (IF power out includes either the up- or down-converted IF product).

$$SSB\ NF\ (dB) = 10 \log \frac{\text{RF PWR In}}{\text{Noise PWR In}} - 10 \log \frac{\text{IF PWR Out}}{\text{Noise PWR Out}} \quad (3)$$

$$= [\text{RF Power In (dBm)} - \text{IF Power Out (dBm)} + [\text{Noise Power Out (dBm)} - \text{Noise Power In (dBm)}]$$

SSB NF (dB) = [SSB Conversion Loss (dB)] + [Output-to-Input Noise Ratio (dB)] (4)

Like SSB conversion loss, SSB noise figure is normally specified instead of DSB (Double Sideband) noise figure, because the mixing process produces both up- and down-converted IF products, and normally only one of these products is desired, so the other product is discarded. This causes half the input power to be lost, making the SSB noise figure 3 dB higher than the DSB noise figure. This is why IF output power in Equation (3) includes either the up- or down-converted IF product, and not both. Simply adding 3 dB to the DSB noise figure assumes that the mixer generates both sidebands with equal conversion loss. This assumption is routinely made in specifying mixer SSB noise figure because DSB noise figure is sometimes easier to measure.

Additive noise has three main components: Johnson (thermal), shot, and flicker noise. Johnson noise is generated by Brownian motion of electrons in the series bulk resistance of the diode, causing random voltage fluctuations to appear across it. As diode temperature increases, the electrons move faster and over a longer distance, increasing the amplitude of the noise power generated. Another source of noise is the shot effect. This noise contribution is generated by random fluctuations in diode current. Both shot and thermal noise are generated randomly, and produce relatively constant noise power (white noise) over a given bandwidth. When calculating the amount of noise added by these two sources, it is important to specify the bandwidth over which the noise power is measured, since the noise power is proportional to bandwidth. Flicker noise is also generated in diodes. Its rms power is proportional to 1/frequency, so it becomes appreciable at lower frequencies. All W-J mixer diodes are normally sorted for noise figure in the GHz frequency range to determine the amount of shot and thermal noise they generate. When diodes are operated at much below 400 kHz, flicker noise may become a problem. Diodes for the WJ-M1K, WJ-M40, and other mixers are sorted for flicker noise. Thermal, shot, and flicker noise are always generated, and combine with SSB conversion loss to yield the overall mixer SSB noise figure. The SSB noise figure is usually about 0.5 dB higher than SSB conversion loss.

This discussion has presented the basics of mixer characteristics and performance. Part 2 of this Tech-notes series will go on to discuss mixer theory.

# Mixers: Part 2
# Theory and Technology

**Author: Bert C. Henderson**

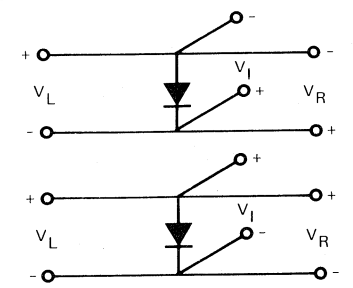



**Figure 2. Single-balanced mixer is composed of two single-ended mixers**

This article presents the practical aspects of mixer theory and technology. It discusses mixer circuits, the mixing process, baluns, diodes, and one W-J mixer design. An understanding of the material in parts 1 and 2 of this *Technotes* series will provide the foundation necessary to discuss and specify mixers.

### Mixer Circuits

There are basically four types of mixer circuits: single-ended (SE), single-balanced (SB), double-balanced (DB), and double double-balanced (DDB). Each has its own set of performance tradeoffs that must be considered to optimize system performance.

Single-ended mixers are the simplest type, since they use only one diode. Figure 1 shows that the L-, R- and I-ports are electrically the same, being only separated by filters that provide interport isolation. The bandwidths of the filters must not overlap if high isolation is required. Part 1 of this Technotes series outlined some of the important benefits of having good interport isolation. In addition, good isolation in SE mixers forces the LO and input RF currents into the diode, and the IF current out the I-port. All the possible intermodulation products $f_{Im,n}$ exit the I-port of SE mixers.

$$fI_{m,n} = \pm m \; f_R \pm n f_L \quad (1)$$

$$m,n = 0,1,2,3,\ldots$$

Coefficients m and n are integers and

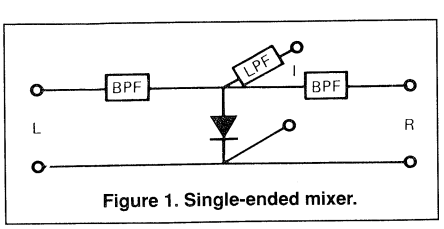



**Figure 1. Single-ended mixer.**

can assume any value. SE mixers can operate with very low LO power because only one diode is used. This is beneficial in systems that can deliver only a small LO power level. Low LO power. however, also means a small dynamic range because the 1-dB compression point, which is usually taken to be the top of the dynamic range, is typically 5 to 10 dB below the LO power level. If a greater dynamic range is required, two or more diodes can be placed in series to allow for more LO power. Other solutions for allowing more LO power to bias the diode are presented later in the section on Classes of Mixers. If the system is narrow-band and does not require great dynamic range, good IM suppression, and high isolation, an SE mixer may be the best choice, since it can be very inexpensive if the filter arrangements are simple. However, if a more broadband mixer that has better IM suppression is required, a balanced mixer is the better choice.

Single-balanced mixers are composed of two single-ended mixers (see Figure 2). Figure 3 shows two of the forms that SB mixers can take. The L-port balun balances the diodes and interfaces them with the unbalanced LO input. The most important characteristic about a balun is its ability to maintain phase angles with respect to ground, of ±90° at B, ± F90°at D, and 0° at C (if it has a center tap). When these angles are maintained, the balun is said to be well-balanced. Insertion loss, and output-to-input impedance ratios of baluns are also important. Many versions exist, some of which are discussed later.

Single-balanced mixers have good L- to-I and L-to-R isolation due to the balance of the balun and diode match. If the i-v (current-voltage) curves match with each other, and the parasitic reactances of all the diodes match, the diodes form a voltage divider, causing a virtual ground to appear at the junction between Dl and D2 in Figure 3. A virtual ground is a node having a 0° phase angle with respect to ground. The effect of the virtual ground is to null out the LO voltage to keep it from appearing at the R- and I-ports, thus isolating the L-port from the R- and I-ports. This is a broadband means of causing isolation, because balun balance and diode match are inherently less susceptible to frequency change than are filters. Actual baluns are never perfectly balanced, and actual diodes are never perfectly matched, so a finite amount of LO power becomes incident at the R- and I-port filters.

RF current in Figure 3 flows from cathode to anode in D2. A forward biased diode can be modeled as a switch that is either open or closed: a closed switch allows current flow in both directions. If the RF current through D2 is much smaller than the LO current biasing it on, D2 will appear to the RF current as a closed switch. The small-signal RF current flowing in D2 cancels a small part of the large-signal LO current, shifting the average operating point of D2 to a lower voltage. Similarly, the RF current flowing in D1 adds to the LO current, causing the average operating point of Dl to have a higher voltage. This is illustrated in Figure 4. If the RF and LO amplitudes are different by less than about 10 dB, alternate cycles of the RF signal cause one diode to almost completely bias off, and the other diode to bias on even harder, causing the mixer to become unbalanced, degrading isolation and IM suppression. Conversion loss degrades as well because the IF and RF current paths have higher time-averaged impedances due to the diodes biasing off on alternate RF cycles. Also,

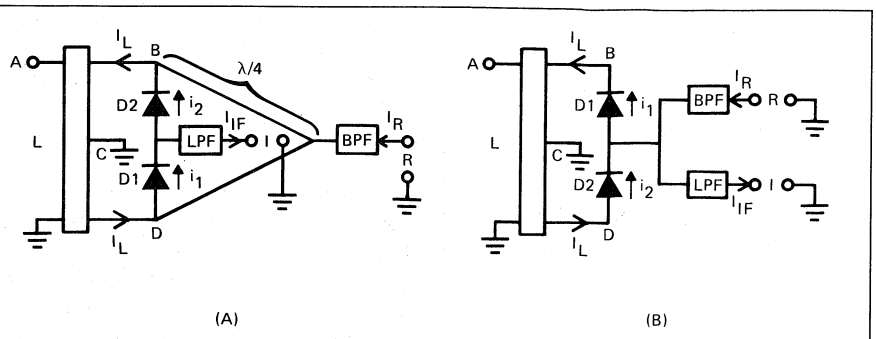



**Figure 3. Two versions of a single-balanced mixer.**

the diodes are forced to operate in the very nonlinear region of their i-v curve, increasing the potential for two-tone IM products to appear, should a second RF signal be incident at the R-port. R-to-L isolation in SB mixers is caused by the RF currents from Dl and D2 cancelling each other in the L-port balun. Recall that SB mixers also have good L-to-R isolation due to mixer balance. In general, such reciprocity (good L-to-R isolation and good R- to-L isolation) holds for interport isolation caused by mixer balance, but not necessarily for isolation resulting from filters, as R-to-I and I-to-R isolation is in SB mixers. Removal of the R-port filter degrades I-to-R isolation without affecting R-to-I isolation, because the I-port filter keeps RF current from exiting through the I-port.

Besides having better L-to-R and L-to-I isolation than SE mixers, SB mixers have better IM suppression. Half the possible IM products exiting the I- port are suppressed because those with even harmonics of the RF are cancelled due to circuit balance and diode match. Of course, cancellation is never perfect, so IM products with even harmonics Of $f_R$ do appear, but they are suppressed. Single-balanced mixers have twice as many diodes as SE mixers, so they require more LO power. More diodes allow SB mixers to have better IM suppression and isolation than SE mixers with the same amount of input RF power, because the RF voltage is dispersed across two diodes instead of one, thus causing half the deviation from average diode operating point than that of an SE mixer.

If the system requires suppression of IM products with even harmonics of $f_R$, high L-to-R and L-to-I isosation over a broad bandwidth, and non-overlapping R- and I-port bandwidths, an SB mixer is a better choice than an SE mixer. If the filter arrangements are simple, and the diodes are inexpensive, an SB mixer can be very cost effective.

Double-balanced mixers are composed of two SB mixers. Figures 5 and 6 show that combining two SB mixers results in either a ring or a star (cross) DB mixer, depending on which type of SB mixers are used. DB mixers are so termed because they use two baluns, whereas SB mixers use only one. L-to-R and L-to-I isolation in DB mixers is achieved in the same way as it is in SB mixers, except that the R-port balun causes the LO-generated voltage appearing at the R-port to equal the difference between the small voltages appearing at junctions $J_1$ and $J_2$ in Figure 5. Ideally, these small LO-generated voltages are nulled out as virtual grounds, but nonidealities in balun balance and diode match allow them to appear. The LO- generated voltage appearing at the I-port is the sum of the small voltages at $J_1$ and $J_2$.

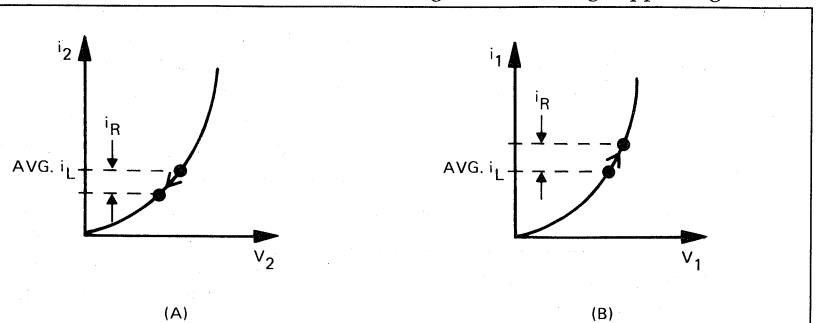



**Figure 4. The average operating point of Dl (A) is slightly lowered and of D2 (B) is slightly raised by RF input curren $i_R$.**

The I-port could be placed at the current return of the L-port balun instead of at the R-port balun (as shown in Figure 5), but L-to-I isolation would degrade for such reasons as: diode match is not used to help isolate the L- and I-ports; the L-port is not balanced as well, due to the loss of its ground return; and the I-port is more susceptible to receiving LO power radiated from the L-port if the two are nearer to each other.

R-to-I isolation in DB mixers is caused by the balance of the R-port balun. In both ring and star DB mixers, the I- port is a virtual ground with respect to the R-port input voltage. This voltage nulling effect is mainly dependent on the balance of the R-port balun in ring mixers, whereas in star mixers, it may also depend on the diode match if the I-port is taken to be the junction of the four diodes (as in Figure 6) and not the center tap of the R-port balun.

Double-balanced mixers theoretically generate only one quarter of the possible IM products; these have odd $f_R$ and odd $f_L$ harmonies. The other IM products are suppressed, the degree of which is a function of balun balance and diode match. Even-by-even IM products which have even $f_R$ and even $f_L$ harmonics are usually suppressed more than even-by-odd, or odd-by-even products.

LO power for DB mixers is typically 3 dB higher than that for SB mixers because DB mixers use twice as many diodes as SB mixers. Hence, the 1-dB compression point of a DB mixer is higher than that of an SB mixer, causing correspondingly greater dynamic range and IM suppression.

Ring DB mixers using soft-dielectric (PTFE) [1] technology (as opposed to thin-film) are generally more popular than star DB mixers using the same technology, because the state-of- the-art with soft-dielectric mixers is to use a ring quad, which has four Schottky-barrier diodes arranged in a ring. Ring quads have four leads, each of which is bonded to one of the four junctions between diodes. DB star mixers with ring quads use two quads, utilizing only half of each, and, hence, are less cost effective than ring mixers, which fully utilize one quad. Ring quads are quite small, being typically 0.100 to .045 inches square or in diameter [2]. Quads are preferred over

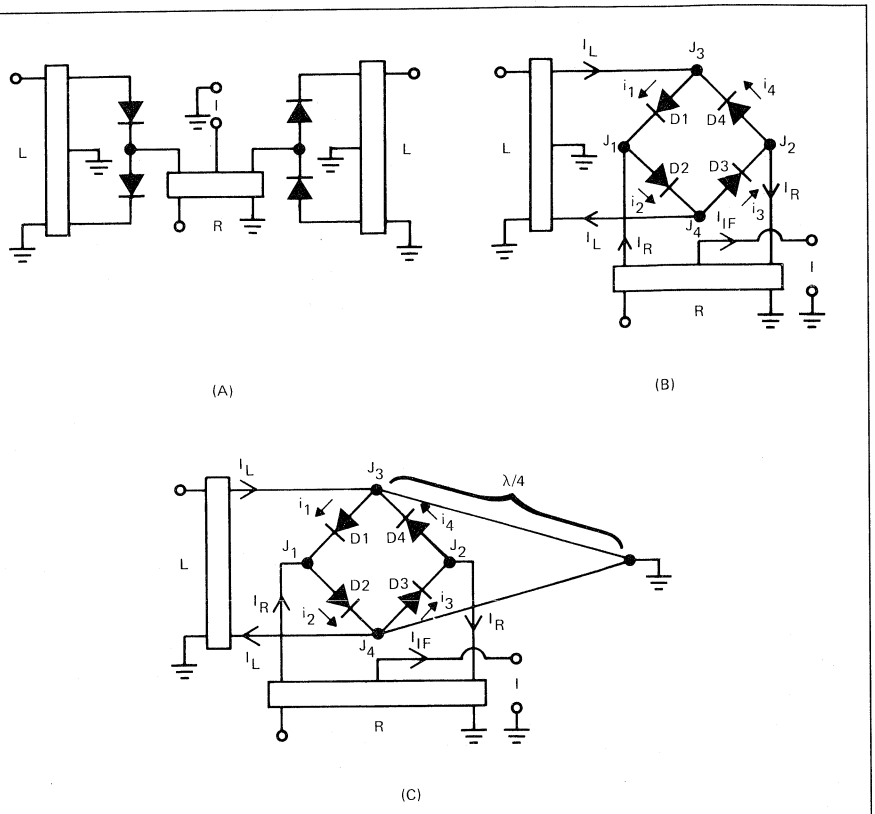



**Figure 5. The two versions of a double-balanced mixer in (B) and (C) are formed in (A) by combining the two single-balanced mixers of Figure 3(B).**

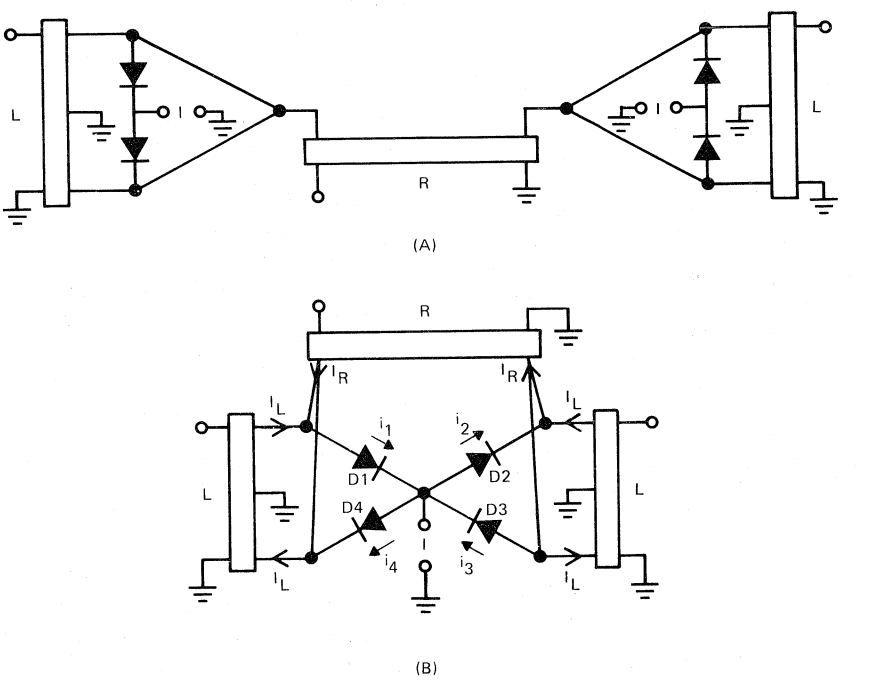



**Figure 6. The star double-balanced mixer (B) is formed in (A) by combining the two single-balanced mixers of Figure 3(A).**

individual glass-encapsulated diodes because parasitics in the latter limit the maximum operating frequency to about 5 GHz, whereas ring quads have been successfully operated at frequencies up to 26 GHz at Watkins- Johnson Company, and show promise of going even higher in frequency. Individual beam-lead Schottky-barrier diodes do not have extreme parasitics, as do individual glass-encapsulated diodes.

For most applications, double-balanced mixers, which are the industry standard, are usually by far the best choice over SB and SE mixers. However, an understanding of SB and SE mixers is important because they are the building blocks of which DB mixers are composed. The superior performance of DB mixers over SB mixers almost always far outweighs the minimal increase in price for the two extra diodes and balun. DB mixers have superior IM suppression and dynamic range, as well as low VSWR, low conversion loss, and low noise figure. These characteristics have been achieved over multiple-octave bandwidths.

Ground return paths for RF and IF currents must be present in any mixer. The RF current retum in DB mixers exists due to the time-averaged conductance of the diodes, which is mainly controlled by the LO, but also by the input RF if its power level is close to that of the LO. RF current in the mixers of Figure 5 splits: half of it passes through D2 and D3 and half passes through D1 and D4 to complete the RF circuit. The IF currents leave junctions $J_3$ and $J_4$ to retum to ground through either the L-port balun center tap to ground as in Figure 5B, or through the quarter wave-length lines as in Figure 5C. IF ground retum currents usually pass through the mixer case; increasing conversion loss by as much as 1 dB. Triple-balanced mixers, which have a balanced I-port, do not require IF currents to return to ground through the case, eliminating the effect of path losses through the case.

Triple-balanced mixers are so termed because the I-port, as well as the L-and R-ports are balanced as shown in Figure 7. Twice the number of diodes are present in TB mixers as in DB mixers, so more LO power is required, and the RF voltage is dispersed across twice as many diodes. These factors increase dynamic range and IM suppression. LO power required is typically in the +10 dBm to +13 dBm range for TB mixers with medium-barrier Schottky-barrier diodes, but some TB mixers can handle as much as +24 dBm of LO power, allowing for very high intercept points for both single- and two-tone IM products, much greater dynamic range, and good operation as upconverters because the mixer can handle more input power before compressing. This is significant because amplification is less expensive at the lower frequency before the signal is upconverted.

TB mixers are formed by combining two-star or two-ring DB mixers. A careful

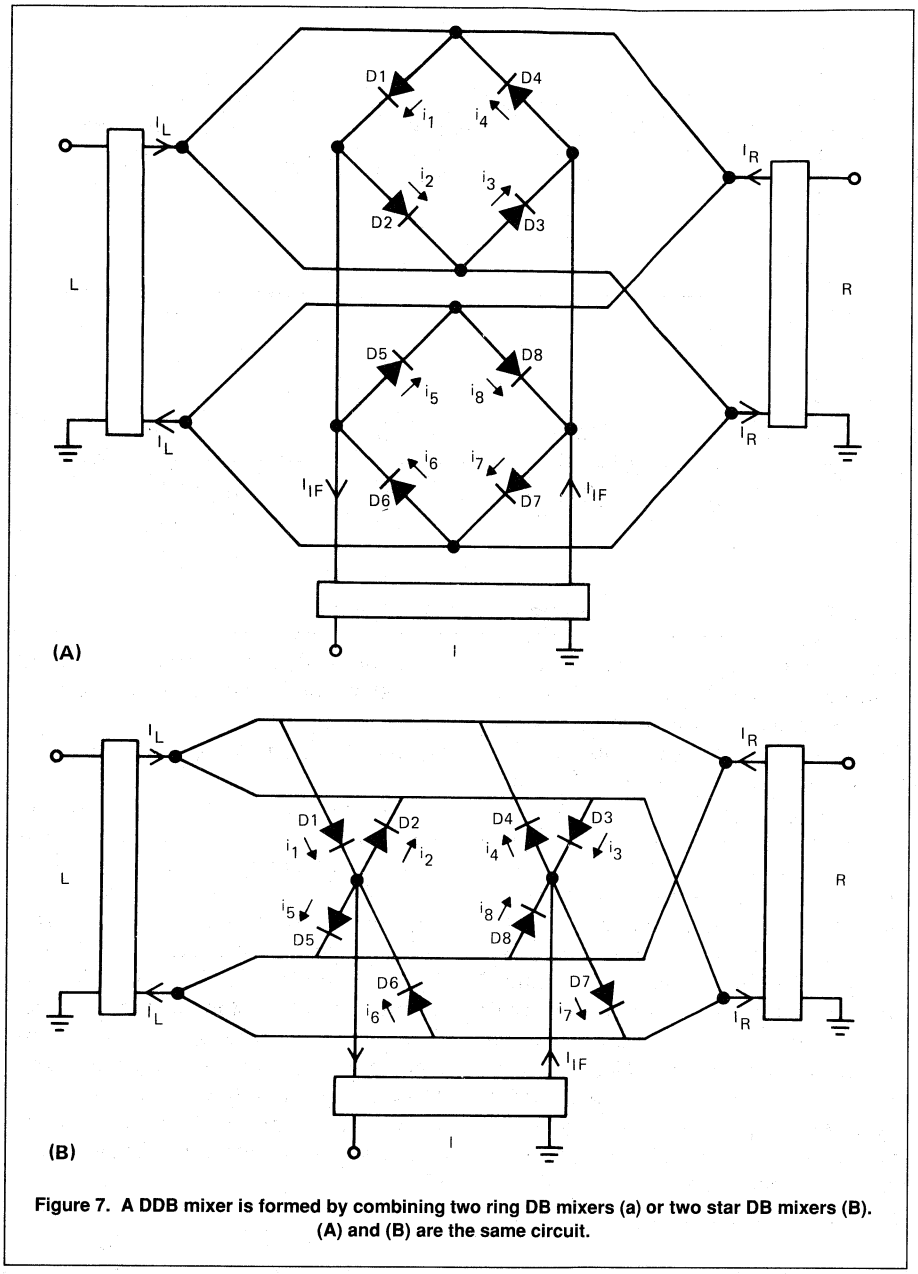



**Figure 7. A DDB mixer is formed by combining two ring DB mixers (a) or two star DB mixers (B). (A) and (B) are the same circuit.**

study of Figure 7 reveals that these two methods yield identical circuits, suggesting that a duality exists between ring and star DB mixers. They are, in fact, electrically identical.

Triple-balanced mixers usually offer greater dynamic range, better IM suppression and interport isolation, and broader I-port bandwidth than DB mixers. But, the disadvantages are the higher LO power requirement, and greater cost for the extra four diodes and the labor necessary to match eight diodes instead of only four.

Any of the three ports in SB, DB and TB mixers can be the R-, L- or I-port because these mixers are all composed of SE mixers, which have electrically identical L-, R- and I-ports (ignoring filters), which all appear in parallel across the SE diode.

Port selection is largely based on frequency requirements for $f_L$, $f_R$ and $f_L$ Essentially, port usage is that which optimizes system performance. This is why even though the R-, L- and I-ports may be designated for a given mixer, the system sometimes performs better with reversed R- and L-ports. Care must be taken, however,when reversing R- and L-ports because L-to-I isolation is typically better than R-to-I isolation in most DB mixers.

## The Mixing Process

Mixing can only be caused by devices which have current-voltage relationships that are non-linear or that change as a function of time (time-variant), or both [4]. Switches are time-variant because they form either a short or an open circuit as a function of time. Mixers require very fast switching (at the LO frequency), making mechanical switches impractical. Schottky-barrier diodes are usually used in mixers as switches because of their low noise figure and fast switching speed [5]. Diodes are nonlinear, so both their time-variant and non-linear properties are used to cause mixing.

Because diodes are nonlinear, they cause two or more signals applied simultaneously across them to mix, producing single and multiple-tone IM products. Two voltages applied in series across a diode cause the current through it to contain the IF and higher- order IM products of the two voltage inputs. This is shown by expanding the exponential diode i-v relationship into a power series for a forward biased diode:

$$I_D \cong I_O\, e^{(V_L+V_R)/V_T}$$

$$= I_O \sum_{n=0}^{\infty} \frac{(V_L+V_R)^n}{V_T^n\, n!}$$

where:

$V_L$ and $V_R$ are sinusoidal.
$I_O$ is the reverse bias saturation current.
$V_T$ is the $(q/NKT)^{-1}$ term.
$I_D$ is the diode current.

The n=0 term yields a dc current. The n=1 term yields the fundamentals.

The n=2 term yields the second harmonics of $f_L$ and $f_R$, plus the up- and down-converted IF products. The n=3 term yields the fundamentals, the third harmonics of $f_L$ and $f_R$, and the $2f_L \pm f_R$ and $\pm f_L + 2f_R$ intermodulation products. If all n terms were calculated, all the IF and higher-order intermodulation products would show up. Higher-order intermodulation products are caused by higher values of n, so they are severely attenuated by the term,

$$\frac{1}{n!}$$

This agrees with empirical observation, because higher-order IM products are suppressed more than lowerorder ones are.

Besides being caused by nonlinear devices, mixing is caused by devices that

are time-variant. Switches are time-variant because their two possible states, open or closed, change over time. Figures 8 and 9 illustrate how switching causes LO and RF signals to multiply each other to generate IF and intermodulation products.

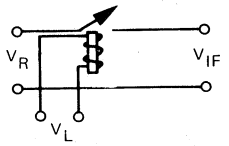



**Figure 8. Series switch controlled by VL gates $V_R$ to produce VIF.**

When $V_L$ is high, $V_{IF}$ equals $V_R$, and when VL is low, $V_{IF}$ equals zero. The high and low states of $V_L$ cause the switching waveform of the relay, $S_L$, to be one and zero, respectively. $V_{IF}$ is the product Of $S_L$ and $V_R$: when $V_L$ is high, $V_{IF} = (1) \cdot (V_R) = V_R$ and when $V_L$ is low, $V_{IF} = (0) \cdot (V_R) = 0$. Since $S_L$ is an odd square wave, it contains the odd harmonics of its base frequency, weighted by their individual Fourier coefficients. $V_L$ and $S_L$ have the same waveform, so their Fourier series are identical; however, their dimensions are different. All the harmonics Of $f_L$ in $S_L$ multiply with $V_R$, generating intermodulation products containing odd harmonies Of $f_L$, as illustrated by the following trigonometric identity:

$$\cos(n\,\omega_L t)\cos(\omega_R t) = \frac{1}{2}[\cos(n\omega_L + \omega_R)t + \cos(n\omega_L - \omega_R)t]$$

where,

$$n = 1, 3, 5, 7....$$

Figure 10 shows a simplified SE mixer, which is the basic building block in balanced mixers. It is identical to Figure 8 in that the large-signal $V_L$ periodically switches the diode on and off to gate $V_R$, but different in that the diode passes through a very nonlinear conduction region between its fully-on and fully-off states. $V_L$, which controls diode conductance, $G_L$ (analogous to $S_L$), causes current $I_L$ to flow through the diode. $I_L$ contains harmonics of $f_L$ due to the diode nonlinearity. $G_L$ equals $I_L$ divided by $V_L$; hence, $G_L$ also contains harmonies of $f_L$. These harmonics are especially prevalent in $G_L$ if the level of $V_L$ is high enough to make the diode

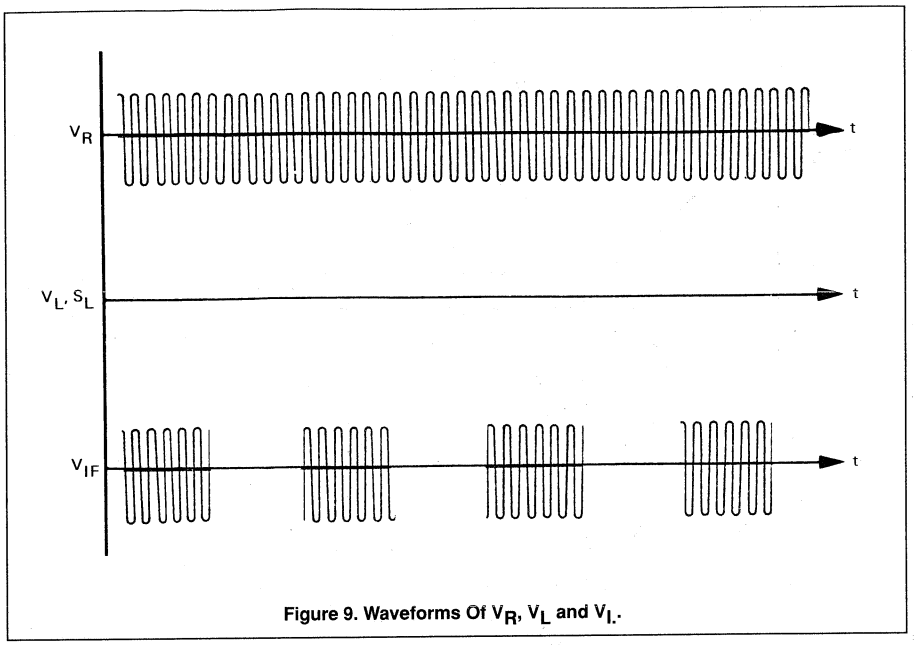



**Figure 9. Waveforms Of $V_R$, $V_L$ and $V_I$.**

clip, causing $I_L$ to approximate a squarewave. $V_R$, being a small signal, does not cause the diode to clip; hence, IM products, $\pm mf_R \pm f_L$ are usually suppressed more than $\pm f_R \pm nf_L$, where m and n are integers. $V_R$ causes current IR to flow through the diode. $I_R$ contains harmonics of $f_R$ because of diode nonlinearity, and generates $V_R$ across the diode series bulk and dynamic resistance. Since IR contains harmonics of $f_R$, $V_R$ does also. $V_R$ and $G_L$ are each expanded into a Fourier series to represent their respective harmonic content, as in equations 2 and 3. Multiplying the two expansions produces a double Fourier series expansion for $I_{IF}$, as shown in equation 4, that contains all the IM products generated when fL mixes with $f_R$ [6].

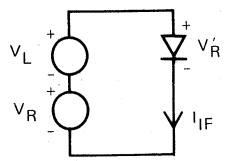



**Figure 10. Simplified single-ended mixer.**

$$G_L = \sum_{n=-\infty}^{\infty} g_n e^{jn\omega_L t} \quad (2)$$

$$V_R' = \sum_{m=-\infty}^{\infty} v_m e^{jm\omega_R t} \quad (3)$$

$$I_{IF} = \sum_{n=0}^{\infty}\sum_{m=0}^{\infty} g_n v_m e^{j(\pm n\,\omega_L \pm m\omega_R)t} \quad (9)$$

IF power, which is transferred from the mixer to the IF load by current, $I_{IF}$ contains these IM products. Multiple-tone IM products result when two or more input RF signals mix with the LO to produce the following frequencies:

$$f_{IM} = (\pm m_1 f_{R_1} \pm m_2 f_{R_2} \pm ...) \pm n f_L$$

Coefficients m and n are integers and can assume any value. The IM products, $f_{IM}$, are generated by two means: diode nonlinearity acting alone, and acting together with the diode switching property to remix products reflected back into the mixer. The multiple-tone IM products of most interest are the two-tone third-order ducts, $f_L m$, are generated by two products, $f_{IM_1}$ and $f_{IM_2}$. These are generated by the n=4 and n=6 (as well as higher-order) terms of the power series expansion for diode current [7]

$$f_{IM_1} = (\pm 2 f_{R_1} \pm f_{R_2}) \pm f_L$$
$$f_{IM_2} = (\pm f_{R_1} \pm 2 f_{R_2}) \pm f_L$$

Two-tone third-order IM products are also generated when the following IM products reflect back into the mixer to remix. This effect can change the intercept-point by as much as 3 dB or so.

**Single-Tone**

$$f = \pm 2 f_{R_{1,2}} \pm f_L$$
$$f = \pm f_{R_{1,2}} \pm 2 f_{R_{2,1}}$$

**Two-Tone**

$$f = \pm f_{R_1} \pm f_{R_1} \pm f_L$$

This method of generating multipletone IM products requires poor mismatch at the mixer ports, so its effect can be minimized by properly matching the ports. Operating the diodes in the more

linear part of their current-voltage curve by applying relatively high LO power and low input RF power will minimize multipletone IM products generated by diode nonlinearity. High-level mixers of the Class-2 and Class-3 variety require more LO power than Class-1 mixers, thus allowing for increased IM suppression.

### Classes of Mixers

Various classes of mixers have been defined that require increased LO power levels and have superior IM suppression [8]. A normal DB mixer which has a single diode in each leg of the ring is a Class 1 mixer. Class 2, type-1 mixers have a second series diode in each leg of the ring, for a total of eight diodes. This type of ring is now available in a small package, similar to ring quads, and is called an octal. Class 2, type-2 mixers have an added series resistor in each leg. Class 3, type-1 mixers have a series diode in series with a shunt RC combination in each leg of the ring. Class 3, type-2 and type-3 mixers are identical toClass 3, type-1 mixers except that they have two series diodes or two shunt diodes, respectively, in place of the single diode in the type-1 mixer. These classes are outlined in Table 1. Class 4 mixers have a network of hybrids that drive two sets of diodes, and two resistors that absorb certain IM products [9]. Adding more elements to the ring allows more input RF power to be applied to the mixer before the average operating points of the diodes in adjacent legs change enough to significantly unbalance the mixer, and also enter the more nonlinear region of the diode i-v curve. Such unbalancing degrades cancellation of IM products with even $f_L$ or $f_R$ harmonies. IM products with odd $f_R$ and odd $f_L$ harmonies theoretically are not affected by mixer balance. When unbalancing occurs, conversion loss increases because power that would otherwise help generate IF products, instead partially contributes to help generate the IM products that begin to appear. This, combined with the higher time averaged impedance in the IF and RF current paths, and generation of heat, cause conversion compression as input RF power increases.

Class-2 mixers have better IM suppression than Class-1 mixers because input RF voltage is dispersed across twice as many elements. Class-3 mixers, in turn, have better IM suppression than Class-2 mixers because the shunt RC combination self-biases the diode by charging up during the positive LO cycle and discharging slowly enough to keep input RF power from dominating the operating point when LO voltage goes through its zero crossing. Conversion-loss in Class-3 mixers does not significantly increase due to the extra RC combination because the capacitor skirts RF current around the resistor.

| MIXER CLASS | CIRCUIT | LO POWER FOR DB MIXERS (dBm) |
|---|---|---|
| Class 1 | | +7 to +13 |
| Class 2, Type 1 | | +13 to +24 |
| Class 2, Type 2 | | +13 to +24 |
| Class 3, Type 1 | | +20 to +30 |
| Class 3, Type 2 | | +20 to +30 |
| Class 3, Type 3 | | +20 to +30 |

**Table 1. The various classes of mixers with their approximate LO power ranges.**

### Baluns

Balanced mixers are composed of baluns and diodes. The balun balances the diodes and interfaces them with the unbalanced system. It also matches system and diode impedance, and helps provide interport isolation. If the balun is at the L-port, it must provide the IF current return path to ground. Currents in the two balanced leads of a balun are 180° apart in phase and ±90° and ∓90° out of phase with respect to ground.

Baluns are also used for applications other than mixers; in fact, many baluns used in mixers were borrowed from antenna applications [101]. Much has been written about baluns, and many clever versions have been developed [111], [12]. Mixers can be constructed using any type of balun, but certain ones are consistently used in most mixer designs. Most balun circuits can be realized using various technologies such as: waveguide, thin-film and softdielectric MIC (microwave integrated circuit), coaxial cable, or bifilar and core. These technologies are generally associated with specific frequency ranges [13]. Generally, MIC and waveguide baluns are used in the 0.5- to 100-GHz frequency range, coaxial and bifilar baluns are used in the dc to 8-GHz frequency range, and bifilar- core baluns are used in the dc to 4- GHz frequency range. Figure 11 shows a center-tapped transformer which is used in virtually all dc to 4-GHz balanced mixers. Broadband transformers of this type, having very good balance and various impedance ratios, are realized using bi-, tri- and quad-filar transmission lines wrapped around various shapes and types of ferrite cores [14]. The centertap-to-ground allows for good balance over a fairly broad bandwidth. The frequency dependence of the core permeability limits the bandwidth over which the balun is well balanced because electrical lengths of the windings change as frequency changes, causing a corresponding change in phase. Conversion loss in mixers using these baluns is typically 6.5 dB to 8 dB. Figure 11 is also used to represent baluns, as depicted in most mixer schematics, even though they may be realized completely differently than this figure suggests.

The balun in Figure 12, using a transmission line and quarter-wave line to ground, has been realized using thin film technology in the so-called coplanar balun of the WJ-M31, and other microwave mixers. When L is a quarter wavelength long, points B and D are ±90′ and ∓90°, respectively, out of phase with respect to ground. A fairly broadband balun can be realized by adjusting the lengths of L and the quarter-wave line so that they are a quarter-wave long at different frequencies. The impedance ratio of this balun is 1:1. When this balun is used on the L-port of a DB mixer, the quarter-wave line to ground provides the ground return path for the IF current.

Another version using transmission lines is shown in Figure 13. It is used in the WJ-M40 and other mixers. Node C is used as the I-port in these mixers.

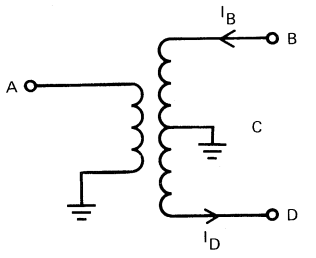



**Figure 11. Transformer with a grounded center tap is a balun.**

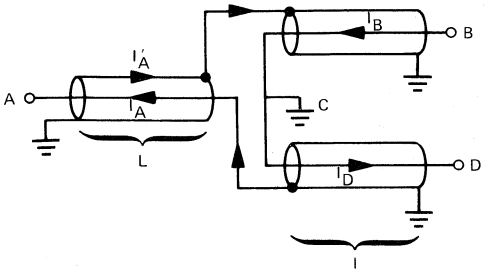



**Figure 13. Transmission line balun.**

Figure 14 shows another transmission line balun that uses a *shorting transformer* ($I_1$ and $I_2$) to provide the ground retum path for IF current. This balun, which is used in the WJ-M1K, and other mixers, is usually realized using two lengths of bifilar: one for L, and one for $I_1$ and $I_2$. $I_B$ and $I_D$ do not short to ground through $I_1$ and $I_2$ because $I_B$ and $I_D$ force equal currents through 11 and 12 that oppose each other if 11 and 12 are long, compared to the wavelength in use. When 11 and 12 are too short, $I_B$ and $I_D$ do short to ground; this limits the low frequency end of the balun bandwidth. The high frequency limit is determined by the series inductance of bifilar L.

## Diodes

Almost all mixers currently available use Schottky-barrier diodes to cause mixing. Other devices, such as transistors and FETs, have been used in active mixers [151, [16] that provide conversion gain and high interceptpoint; but, these mixers have high NF (noise figure), and are expensive, especially if GaAs FETs are used. Schottky-barrier diodes are relatively inexpensive, have low NF, and can be operated up to millimeter-wave frequencies [3], [5]. They usually require no dc power supply for normal operation because LO power is sufficient to switch them on and off.

The forward-biased properties of Schottky-barrier diodes are controlled by majority carriers, so these diodes can be switched quickly because minority carrier storage effects are not present. When the forward voltage drops to zero, the current stops almost instantly, and the reverse voltage can be established in a few picoseconds [2], [5].

Schottky-barrier quads are made by bonding four diodes arranged in a ring onto a. ceramic, fiberglass, or plastic substrate. A monolithic ring quad is preferred over one with individual diodes because the diodes in the monolithic quad match each other and track together over temperature much better than individual diodes. Rings with eight (octal) and twelve (duo-decca) diodes have recently become available for high-level mixer applications.

GaAs Schottky-barrier diodes typically have cutoff frequencies in the 400- to 1000-GHz frequency range, whereas silicon diodes cutoff in the 80- to 200-GHz frequency range. GaAs diodes have higher forward voltage, $V_f$, resulting in a higher LO power requirement. They are more expensive than silicon diodes and have higher flicker noise. $V_f$ for GaAs diodes with 1 mA of series current is typically .70 volts, compared to .30 volts for a medium-barrier silicon diode.

In order to optimize the noise figure of Schottky-barrier diodes, the following LO power levels should be applied per diode [5]:

| Barrier | LO Power Per Diode |
|---|---|
| High | +3 dBm or more |
| Medium | -3 dBm to +3 dBm |
| Low | -3 dBm or less |

The WJ-M1K mixer, which is a field-proven leader with low conversion loss and superior IM suppression, uses the balun in Figure 14 to interface the L-port with the diodes. The R-port balun is the same as that in Figure 13, with the I-port connected to node C. This is a Class 2, type-1 mixer, designed specifically for suppression of IM products.

## Analysis of Intermodulation Products

The IM products present in the IF output of an SE mixer are derived by using Equation (4). When SE mixers are combined to form a balanced mixer, some of these IM products are eliminated through cancellation. This is illustrated in the following analyses for SB, DB, and TB mixers. The analysis procedure used assumes diode conductance, $G_L$, is composed exclusively by harmonics of large-signal VL; because $V_R$ is a small-signal voltage, its effect on diode conductance can be ignored. It also assumes the diodes are identical, and the baluns are perfectly balanced. Diode currents $i_1$ and $i_2$ in the SB mixer of Figure 3A combine to give IF current, $I_{IF}$.

$$i_1 = \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} v_m g_n e^{j(\pm n \omega_L \pm m \omega_R)t} = K$$

$$i_2 = K e^{\pm jm\pi} = K(-1)^m$$

$$I_{IF} = i_1 - i_2 = K[1-(-1)^m]$$

The $e^{\pm jm\pi}$ term in $i_2$, which equals $(-1)^m$, is present because $I_R$ opposes $i_2$.

K represents the double Fourier series, the coefficients of which give the relative amplitudes of the IM products. Since the goal is to determine which IM products exit the I-port and not their relative

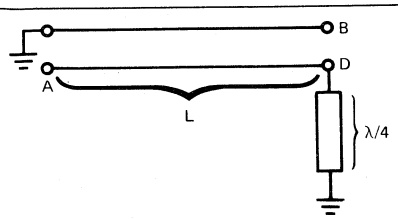



**Figure 12. Transmission line with quarter-wave line to ground is a balun.**

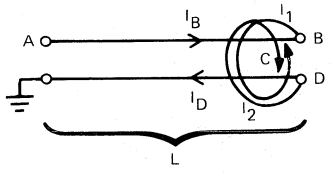



**Figure 14. Shorting transformer balun.**

amplitudes, the double Fourier series is dropped. This allows for quick determination of which IM products will exit the I-port of a given mixer circuit, because the cumbersome Fourier series expansions need not be written.

When m is even (m = 0, 2, 4,...) $I_{IF} = 0$; when m is odd (m =1, 3, 5,...) $I_{IF} = 0$, showing that IM products containing even harmonics of $f_R$ are suppressed in SB mixers and that all others exit the I-port.

Analysis of the ring DB mixer in Figure 5 is similar. Diode currents $i_1$, $i_2$, $i_3$ and $i_4$ combine to produce IF current, $I_{IF}$. Current $i_1$ has the $(-1)^m$ term because it opposes IR; $i_3$ opposes $I_L$, and $i_4$ opposes both $I_L$ and $I_R$.

$$i_1 = K(-1)^m$$
$$i_2 = K$$
$$i_3 = K(-1)^n$$
$$i_4 = K(-1)^{n+m}$$

$$I_{IF} = i_1 - i_2 + i_3 - i_4$$
$$= K[(-1)^m - 1 + (-1)^n - (-1)^{n+m}]$$
$$= K[(-1)^n - 1]\,[1 - (-1)^m]$$

$I_{IF} = 0$ if either n or m are even, so only the IM products with odd $f_L$ and odd $f_R$ harmonics exit the I-port.

The star DB mixer in Figure 6 has the same $I_F$ output as the ring DB mixer just analyzed. Its $I_F$ output current is calculated as follows:

$$I_{IF} = i_1 - i_2 + i_3 - i_4$$
$$= K[(-1)^n - 1]\,[(-=1)^m - 1]$$

Again, the odd-by-odd IM products are the only ones exiting the I-port.
The two TB mixers in Figure 7 are identical circuits. An analysis of both versions shows that only the odd-by- odd IM products exit the I-port.

$$I_{IF} = i_1 - i_2 + i_6 - i_5 = i_7 - i_8 + i_4 - i_3$$
$$= K[(-1)^n - 1]\,[(-1)m - 1]$$

Knowledge of *which* IM products exit the R- and L-ports is often required. Current leaving the R-port of the ring DB mixer in Figure 5 is $I_{Rout}$:

$$I_{Rout} = i_1 - i_2$$
$$= K[(-1)^m - 1]$$

IM products with odd $f_R$ and even $f_L$ harmonics exit the R-port. Current $I_L$out contains the IM products exiting the L-port:

$$I_{Lout} = i_4 - i_1$$
$$= K(-1)^m[(-1)^n - 1]$$

IM products with even $f_R$ and odd $f_L$ harmonics exit the L-port. A similar analysis of currents leaving the R- and L-ports of the TB mixer of Figure 7 shows that the odd $f_R$ by even $f_L$ IM products exit the R-port; the even $f_R$ by odd $f_L$ IM products exit the L-port. R- and L-ports must be well-matched to the system in order to keep these products from reflecting back into the mixer to remix and produce further IM products. Attenuators on the mixer ports enhance matching by attenuating unwanted products, thus lessening their effects on adjacent system components.

Harmonic mixers, as shown in Figure 15, use the second harmonic of the LO to generate the desired IF signal.

$$I_{IF} = i_1 + i_2 - i_3 + i_4$$
$$= K[-(-1)^m + 1 - (-1)^{n+m} + (-1)^n]$$
$$= K[1 - (-1)^m]\,[1 + (-1)^n]$$

IF output occurs for IM products having odd $f_R$ and even $f_L$ harmonics, which include the desired $\pm 2f_L \pm f_R$ products. Harmonic mixing allows the LO to operate with half the normally required frequency. These mixers have higher conversion loss and a more unstable IF output because frequency drift in the LO is doubled.

## Conclusion

This *Tech-notes* series has presented the basics of mixer characteristics, performance, theory, and technology: Part 1 discussed SSB conversion loss, VSWR, isolation, dynamic range, IM products, intercept point and SSB noise figure. Part 2 discussed mixer circuits, the mixing process, classes of mixers, baluns, diodes and one example of how baluns and diodes are combined to form a mixer. This foundational material should provide a good basis for the understanding of mixers.

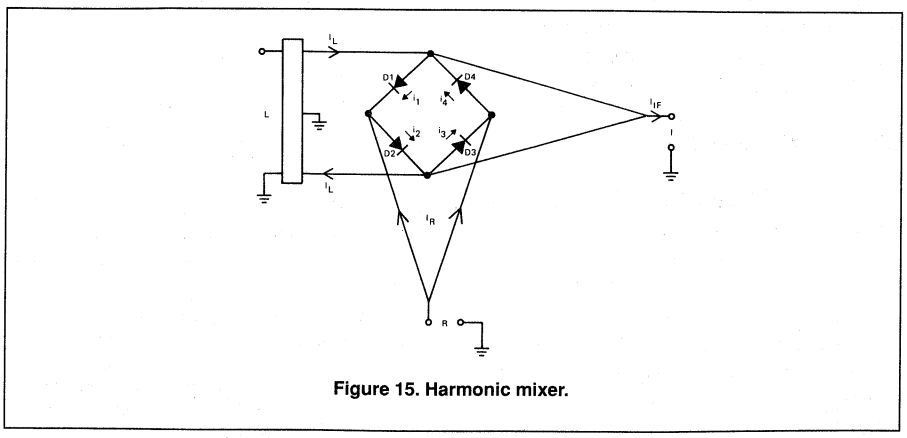



**Figure 15. Harmonic mixer.**

# Selecting Mixers for Best Intermod Performance (Part 1)

**Author: Dan Cheadle**

Single-tone intermodulation is considered under various input conditions for double-balanced mixers. It's important to select the mixer with the highest isolation over the frequency range of interest.

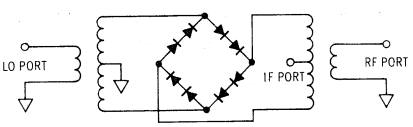
*This is the first of a two-part article that compares the three general classes of double-balanced mixers. Part II will cover third-order two- tone intermods for various LO drives and rf inputs. The pitfalls in using the intercept method in evaluating intermodulation will also be discussed.*

The choice, among the many types of double-balanced mixers, not only depends on cost, size, reliability and dynamic range, but also on an ability to suppress unwanted distortion products resulting from the non-linear characteristics of the mixer diode. Here's a tutorial discussion on the design of mixers and ways to evaluate them. Two types of distortion are considered-single-tone or harmonic intermodulation, and multiple or two-tone intermodulation. Harmonic intermod charts are used as a guide for choosing frequencies and predicting distortion product levels.

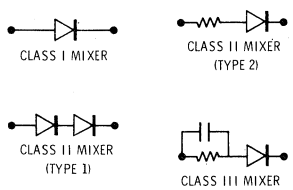
## Mixer Types and Classes

Mixers are placed into three general classes depending on the mixer's signal level handling ability. Most commercially-available double-balanced mixers are low-level (Class I) types. Low-level means the total combined input signal power is below -10 dBm. High level mixers are generally above this input threshold.

Class I mixers have 1 dB conversion compression points typically in the region of 0 dBm to +5 dBm with a nominal LO drive level of +7 dBm. Such mixers typically have one diode in each leg of the diode ring, but otherwise are similar in circuit configuration to Class II mixers, Fig. 1.




**1. A Class II, Type 1 mixer has two diodes in each leg. The 1 db compression point occurs from + 8 to + 12 dBm with nominal LO drives from + 13 to +20 dBm.**




**2. The various classes of mixers have different elements in their legs. A Class II, Type 2 mixer incorporates a precision series resistive element. Class III mixers offer best performance in suppressing higher-order intermods.**

High-level Class II mixers have 1-dB compression points at + 8 to + 12 d Bm and nominal LO drive levels from + 13 to +20 dBm. They are capable of handling two 0 dBm signals without conversion compression. Of the two Class II type mixers commercially available, Type 1 is least expensive and most common. It uses two diodes in each leg, Fig. 1. This mixer operates with a nominal LO drive of +13 dBm, but will generally give improved single-tone and two-tone IM suppression with a +17 dBm LO drive.

The Class II, Type 2 mixer has a series precision resistor in each leg, Fig. 2, and typically a 0.5 dB greater conversion loss than Type 1. It has a better balanced ring because of the precision resistive elements and, therefore, offers lower dc offset voltage, higher isolation and better suppression of the single-tone IM products-all of which depend on mixer balance. These resistive elements in an intermediate-level mixer serve to hold a larger reverse bias on the pairs of diodes during any non-conducting half cycle. This allows a larger rf signal voltage to be applied before conversion compression occurs. However, more LO power must be supplied to drive the diodes to the low dynamic resistance necessary for minimum conversion loss,

A third mixer class (Class III) is the very high-level class with a 1 -dB compression point at +15 dBm or higher and nominal LO drive levels from +20 to +27 dBm. These are the most expensive and the best performing high-level mixers in suppressing higher-order, single-tone, and third-order two-tone intermodulation distortion. The capacitor in parallel with the series resistive element (Fig. 2) charge to an average dc voltage when the LO drive signal is impressed. This voltage acts to hold a reverse bias on the opposite diodes of the ring so that when the LO voltage passes through its zero voltage transition region, the diodes remain reverse biased. Thus, a larger rf signal must be applied to overcome this reverse bias and turn on the diodes which raise the mixer's conversion compression point. The capacitor also acts as an rf bypass so rf-port signal power is not lost in the resistive elements. The conversion loss of a Class IIII mixer is a minimum and is typically only about 0.5 dB greater than for a Class I type.

The disadvantage of the Class III mixer is the additional complexity resulting in

increased cost. Also, the thermal noise in the resistive elements can raise the mixer's noise figure above its conversion loss. This thermal noise is worse at frequencies above 200 MHz and is generated principally in the resistive elements as a result of internal dissipation and environmental temperature. The Class III mixer is usually limited to those applications where the maximum operating temperature does not exceed +85°C.

### What Constitutes Distortion?

Single-tone (harmonic-intermodulation) distortion results when one signal is present at the rf port. The desired mixing term is a single-tone intermodulation product resulting from a beating of the local oscillator with the rf input signal. Because the local oscillator and its harmonics mix with the rf input signal and its harmonics, higher-order distortion products also result, Table 1.

Two-tone intermodulation occurs when two signals are applied to the mixer's input port, and results in the mixing between these two signals and the LO, (Part II of this article discusses two-tone distortion in more detail). Often, the single-lone IM products in Table 1 are called "spurious responses". This is correct if one considers only mixer produced products other than the desired sum or difference frequencies. Two-tone or multiple-tone IM distortion would also be correctly labeled "spurious responses" to the system. Confusion occurs when trying to distinguish between the products in Table 1 and two-tone distortion by referring to the former as "spurious responses"and the latter as "IM products", since both can correctly be called by either terminology.

From Table 1 it is evident that for the 3 $f_R$ row and higher $f_R$ products, the Class III mixer does a superior job of single-tone IM suppression. For the $2f_R$ and $f_R$ row, there is no improvement by using a high-level mixer. The bottom row shows a definite degradation-in the suppression for both Class II and Class III mixers.The bottom row represents harmonics of $f_L$; and because the $f_L$ signal level is higher in the high-level mixer, these harmonics are higher in magnitude.

Theoretically, the $nf_R$ product will decrease (n-1) dB for each dB the $f_R$ level is decreased relative to the desired $f_L \pm f_R$ output level. For example, the $3f_R$ products should decrease (3-1) dB or 2 dB for each dB that $f_R$ is decreased. This means the unshaded $3f_R$ row should show 20 dB greater suppression than the shaded $3f_R$ row since the input level for the unshaded rows is 10 dB less than the shaded rows.

The Class II and Class III mixers show about 20 dB improvement for the 10 dBm input signal, but the Class I mixer is not consistent here. Because the 0 dBm rf input signal is large enough to cause a small amount of conversion compression in the Class I mixer, severe uncancelled odd $f_R$ mixing occurs with odd $f_L$ products. Theoretically, all odd $f_R$ products (mixing with all odd $f_L$ products) are not suppressed because of balance in a doublebalanced mixer, but such suppression is dependent on the level produced by the diodes. This is shown in Table I for the Class I mixer, where the $3f_R$ products mixing with the odd $f_L$ products, show about 10 to 20 dB less suppression than the $3f_R$ products mixing with the evenorder $f_L$ products. The even $f_R$ products show about the same suppression when mixing with both the even and odd $f_L$ products. If the mixer balance were perfect, these products would be completely cancelled by the double-balanced circuit.

The odd $f_R$ products are the most predictable products in the charts. They typically vary less than ±5 dB from unit to unit of the same model and, unless conversion compression has taken place, they decrease fairly well according to the rule where $nf_R$ will decrease (n-l) dB relative to the desired output for each dB that rf input level is decreased. The even harmonics of $f_R$ vary as much as ± 15 dB from unit to unit of the same model; particularly for the $4f_R$ and higher even-order $f_R$ rows.

**Table 1**
**Single-Tone Intermodulation Distortion**

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 79>99>99 | 69 79>99 | 80>99>99 | 74 78>99 | 83>99>99 | 63 78>99 | 78>99>99 | 60 81>99 | 71 99>99 |
| | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90 90 | 87>90>90 | >90>90>90 | >90>90>90 | >90>90>90 |
| 6 | 90>99>99 | 86>99>99 | 91>99>99 | 91>99 97 | 90>99>99 | 84>99>99 | 93>99>99 | 84>99>99 | 88>99 98 |
| | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 |
| 5 | 72 93>99 | 70 73 96 | 71 87>99 | 52 72 95 | 77 88>99 | 46 66>99 | 75 85>99 | 45 64 90 | 73 82>99 |
| | >90>90>90 | 80>90>90 | >90>90>90 | 71>90>90 | >90>90>90 | 68>90>90 | >90>90>90 | 65>90>90 | 88>90>90 |
| 4 | 80 96 88 | 79 80 91 | 82 96>99 | 77 80 92 | 82 95 90 | 76 82 95 | 77 98 87 | 72 78 94 | 77 90 87 |
| | 86>90>90 | >90>90>90 | 86>90>90 | 88>90>90 | 88>90>90 | 85>90>90 | 86>90>90 | 85>90>90 | >90>90>90 |
| 3 | 51 63 81 | 49 58 73 | 53 65 85 | 51 60 69 | 55 65 85 | 48 55 68 | 54 64 85 | 53 54 64 | 58 66 87 |
| | 67 87>90 | 64 77>90 | 69 87>90 | 50 78>90 | 77>90>90 | 47 75>90 | 74 85>90 | 44 77 89 | 74 88>90 |
| 2 | 69 68 64 | 72 67 71 | 79 76 62 | 67 67 70 | 75 80 63 | 66 66 70 | 77 82 61 | 68 66 62 | 75 83 64 |
| | 73 86 73 | 73 75 83 | 74 84 75 | 70 75 79 | 71 86 80 | 64 74 80 | 69 87 77 | 64 74 82 | 69 84 79 |
| 1 | 25 25 24 | 0 0 0 | 39 39 35 | 13 11 11 | 45 50 42 | 22 16 19 | 54 59 50 | 37 19 39 | 59 59 49 |
| | 24 23 24 | 0 0 0 | 35 39 34 | 13 11 11 | 40 46 42 | 24 14 18 | 45 62 49 | 28 19 37 | 49 53 49 |
| 0 | A B C | 36 39 29 | 45 42 20 | 52 46 32 | 63 58 24 | 45 37 29 | 60 65 27 | 71 49 30 | 64 75 29 |
| | | 26 27 18 | 35 31 10 | 39 36 23 | 50 47 14 | 41 36 19 | 53 51 17 | 49 37 21 | 51 63 19 |

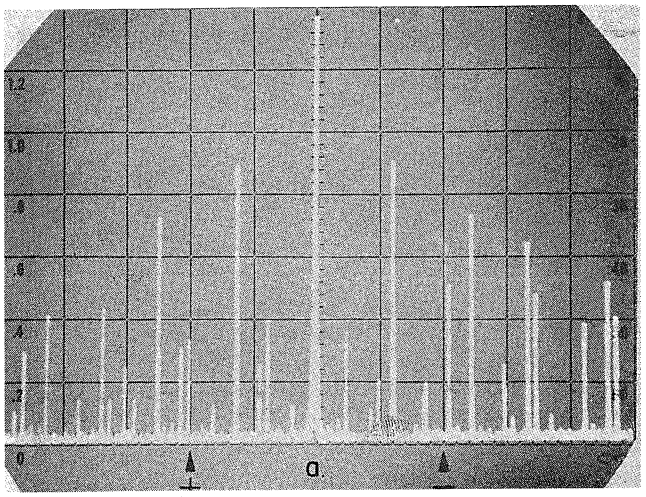
HARMONICS OF f

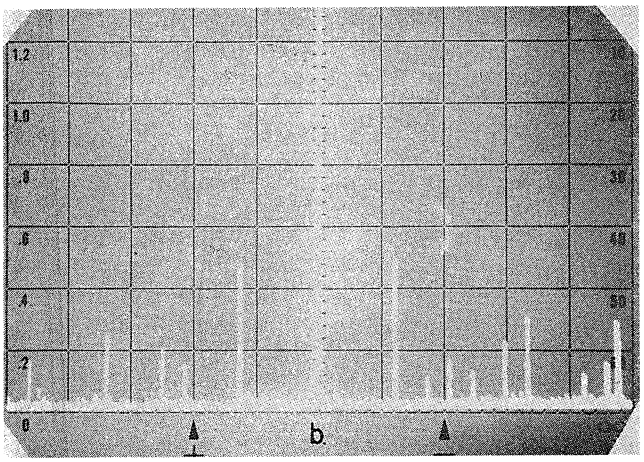
$f_R$ @ 0 dBm
$f_R$ @1 10 dBm
$f_R$ = 49 MHz
$f_L$ = 50 MHz

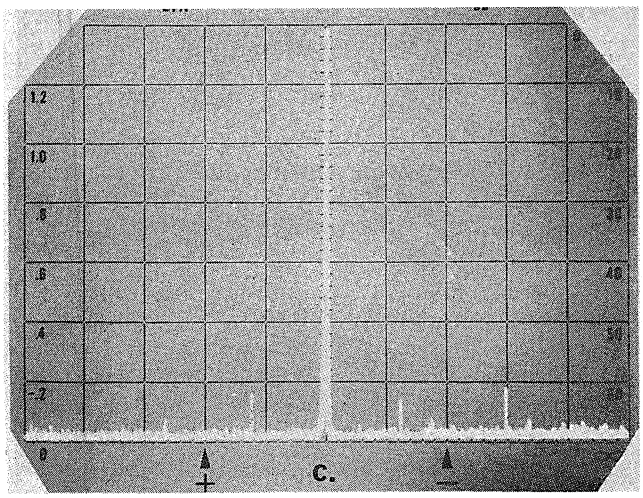
A: (M1)
0.2 – 500 MHz
CLASS I MIXER
LO = + 7 dBm

B: (M1D/M9BC)
0.5 – 500 MHz
CLASS II
(TYPE 2)
LO = +17 dBm

C: (M1E/M9E)
1.0 – 400 MHz
CLASS III
LO = +27 dBm




SINGLE-TONE INTERMODULATION DISTORTION

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 5 | | >90>90>90 | 83>90>90 | >90>90>90 | 84>90>90 | 90>90>90 | 79>90>90 | >90>90>90 | 76>90>90 | >90>90>90 |
| | | 86>90>90 | 73>90>90 | 87>90>90 | 70 87>90 | 84>90>90 | 67 82>90 | >90>90>90 | 67 83>90 | >90>90>90 |
| 4 | | 88>90>90 | >90>90>90 | 90>90>90 | 90>90>90 | 88>90>90 | 90>90>90 | >90>90>90 | >90>90>90 | 89>90>90 |
| | | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90>90>90 | >90 89>90 |
| 3 | | 73 86>90 | 64 85 85 | 69 78>90 | 56 67 73 | 69 76>90 | 57 64 80 | 71 80>90 | 55 63 77 | 69 76>90 |
| | | 69 80 90 | 71 70 77 | 64 73 89 | 51 59 68 | 65 73 90 | 48 56 79 | 69 77 90 | 45 55 73 | 68 75 88 |
| 2 | | 80 66 81 | 73 82 85 | 79 67 85 | 73 78 82 | 79 65 86 | 74 79 80 | 82 67 85 | 70 74 75 | 80 71 90 |
| | | 83 66 74 | 75 79 81 | 78 67 82 | 78 76 78 | 80 65 85 | 82 75 80 | 80 66 87 | 75 70 75 | 77 69 90 |
| 1 | | 22 22 28 | 0 0 0 | 38 38 45 | 10 11 10 | 46 44 52 | 15 17 13 | 47 47 56 | 23 25 18 | 45 45 57 |
| | | 21 21 29 | 0 0 0 | 36 36 44 | 13 13 10 | 40 41 52 | 29 26 14 | 43 44 57 | 28 31 19 | 45 45 60 |
| 0 | A B C | 26 31 23 | 29 35 23 | 36 38 38 | 40 42 38 | 37 41 40 | 49 47 47 | 37 40 38 | 48 43 50 | |
| | | 35 33 26 | 37 40 28 | 40 38 38 | 62 50 43 | 44 45 40 | 49 45 50 | 52 50 38 | 51 44 55 | |

HARMONICS OF $f_L$

LO DRIVE LEVELS + dBm

| A | B | C |
|---|---|---|
| 13 | 17 | 20 |
| 7 | 13 | 17 |

A: (M1) 0.2 - 500 MHz CLASS I MIXER

B: (M1B/M9C) 0.2 - 500 MHz CLASS II (TYPE 1)

C: (M1D/M9BC) 0.5 - 500 MHz CLASS II (TYPE 2)

$f_R$ = 49 MHz @ -10 dBm FOR ALL CONDITIONS
$f_L$ = 50 MHz

SINGLE-TONE INTERMODULATION DISTORTION

| HARMONICS OF $f_R$ | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 5 | | 82>90>90 | 80 83 87 | 78>90 90 | 72 78 74 | 80>90>90 | 67 74 71 |
| | | 82>90>90 | 80 82 90 | 80>90>90 | 75 78 82 | 83>90>90 | 73 75 78 |
| 4 | | 89>90>90 | 86>90>90 | >90>90>90 | 86>90>90 | 95>90>90 | 82>90>90 |
| | | 89>90>90 | 82>90>90 | 90>90>90 | 82>90>90 | 90>90>90 | 80>90>90 |
| 3 | | 58 65 69 | 56 62 74 | 63 68 76 | 54 54 57 | 68 72 76 | 50 53 53 |
| | | 60 68 72 | 58 62 76 | 65 71 78 | 56 58 61 | 68 72 78 | 54 59 59 |
| 2 | | 71 76 77 | 65 78 76 | 74 80 80 | 67 75 77 | 74 85 82 | 65 75 70 |
| | | 71 78 80 | 64 77 78 | 74 83 82 | 65 75 78 | 74 86 82 | 63 74 71 |
| 1 | | 16 24 30 | 0 0 0 | 28 40 40 | 11 13 13 | 34 43 44 | 22 28 25 |
| | | 16 24 30 | 0 0 0 | 26 38 40 | 10 11 11 | 32 39 44 | 17 20 20 |
| 0 | A B C | 26 34 32 | 34 37 36 | 37 47 44 | 45 57 60 | 36 52 51 | |
| | | 24 32 30 | 30 33 32 | 37 44 42 | 41 48 50 | 34 46 51 | |

HARMONICS OF $f_L$

$f_L$ @ +10 dBm

A B C $f_L$ @ +7 dBm

A: (M6D) 0.05-200 MHz CLASS I MIXER

B: (M6E) 5-500 MHz CLASS I MIXER

C: (M6F) 2-500 MHz CLASS I MIXER WITH BALUNS

$f_R$ = 49 MHz @ -10 dBm
$f_L$ = 50 MHz

**3. Spectrum analyzer display shows intermodulation products for (a) Class I mixer, +7 dBm LO drive; (b) Class 11 mixer, with + 17 dBm LO drive; and (c) Class III mixer with +27 dBm LO drive.**

## Select the Right-Class Mixer

Displays of mixer performance for each class, Fig. 3a, b, c, show $3f_R$ and higher order $3f_R$ products of the three rf-port input signals mixing with the LO drive signal. The Class II mixer reduces the strongest IM products about 20 dB more than the Class I mixer, and the Class III mixer reduces these products nearly 40 dB more than with the Class I mixer. If the displays had included products from the bottom three rows of Table 1, there would not have been total improved product suppression for the Class II and Class III mixers. Therefore, before an intelligent choice can be made on the class of mixer required, it is necessary to know what products are present in the output passband. In many critical applications, where $2f_R$ products occur in the output, the Class II, type 2 mixer is the best choice. If only $3f_R$ and higher products are

present, a Class III Mixer will give the maximum suppression. If the output includes still lower order products, then the best answer, if possible, is to change the system frequencies to eliminate these relatively strong products. If this is not possible, then a Class I Mixer with the best isolation should be used.

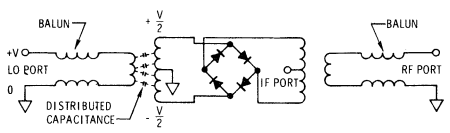
Table 2 shows the effects of increased LO drive level on single-tone IM suppression for 0.2-500 MHz Class 1, Class II, type 1, and Class II type 2 mixers. Note that for many of the $3f_R$ products, the Class II type 2 mixer has about 10 dB improvement over the Class II type 1 mixer. In general, for $3f_R$ and higher $f_R$ products, 0.5 to 2 dB additional suppression can be obtained for each dB increase in LO drive. The $2f_R$ or $f_R$ rows generally show little change with increased LO drive and the bottom two rows typically shows a degradation in suppression.

### Choosing the Right Frequency Range

What mixer should one use when the bands overlap significantly? As an example, consider operation near 50 MHz. One has a choice between a 0.05 to 200 MHz mixer and a 5 to 500 MHz mixer. The single-tone IM chart, Table 3, is based on 50 MHz and provides data for three different printed-circuit model Class I mixers. The average suppression for the $3f_R$ row for the 0.05 to 200 MHz unit is 58 dB with a + 7 dBm LO drive level. The 5 to 500 MHz unit has an average suppression of 62.3 dB on the $3f_R$ row. This unit has better high frequency isolation due to less distributed capacities in the fewer turns required on the transformers.

The effect of the distributed capacitance has been further reduced in the 2 to 500 MHz mixer. This has been accomplished by using baluns on both the LO and rf ports.

The balun tends to balance the voltage at the input to the transformer, thus causing more nearly equal current to flow in the distributed capacitance. This results in a better balanced output voltage from the transformer to the diode ring. This mixer, with baluns, Fig. 4, gives an average suppression on the $3f_R$ row of 67.5 dB, or 5 dB greater than without the baluns.




**4. A balun on the LO and rf ports of a mixer gives a better balanced output voltage from the transformer to the diode ring and results in better IM suppression.**

Table 4 compares distortion products of a 0.2 to 500 MHz Class I Mixer to those of 3 to 1000 MHz Class I mixers at approximately 300 MHz. Those products, which depend on mixer balance and which exclude only the odd $f_R$ mixing with the odd $f_R$ have better suppression in the higher frequency mixer because of the higher isolation.

In summary, for the best IM suppression one should select the mixer with highest isolation for the frequency range of interest.

## Table 4

SINGLE-TONE INTERMODULATION DISTORTION

(M1) A: 0.2 TO 500 MHz CLASS I MIXER
(M1A) B: 3 TO 1000 MHz CLASS I MIXER

| HARMONICS OF $f_R$ | 0 | $f_L$ | $2f_L$ | $3f_L$ | $4f_L$ | $5f_L$ |
|---|---|---|---|---|---|---|
| $5f_R$ | | | | | 90 90 | 88 89 |
| $4f_R$ | | | | 83 90 | 88 95 | 83 90 |
| $3f_R$ | | | 50 67 | 52 54 | 65 73 | |
| $2f_R$ | | 58 63 | 62 63 | 56 65 | | |
| $f_R$ | 23 24 | 0 0 | 35 33 | | | |
| 0 | A B | 18 18 | | | | |

$f_L \lesssim 300$ MHz @ +7 dBm
$f_R \lesssim 300$ MHz @ -10 dBm

HARMONICS OF $f_L$

## Table 5

SINGLE-TONE INTERMODULATION DISTORTION

INPUT FREQUENCIES

| A | B | |
|---|---|---|
| A | B | 300 MHz |
| A | B | 50 MHz |

| HARMONICS OF $f_R$ | 0 | $f_L$ | $2f_L$ | $3f_L$ | $4f_L$ | $5f_L$ |
|---|---|---|---|---|---|---|
| $5f_R$ | | | | | 90 86 | 92 93 |
| | | | | | 90 90 | 74 71 |
| $4f_R$ | | | | 79 90 | 84 92 | 81 90 |
| | | | | 90 90 | 90 90 | 90 90 |
| $3f_R$ | | | 57 68 | 59 61 | 59 62 | |
| | | | 68 76 | 54 57 | 72 76 | |
| $2f_R$ | | 65 72 | 61 67 | 66 69 | | |
| | | 78 76 | 80 80 | 75 77 | | |
| $f_R$ | 23 14 | 0 0 | 23 20 | | | |
| | 24 30 | 0 0 | 40 40 | | | |
| 0 | A B | 20 12 | | | | |
| | A B | 34 32 | | | | |

FREQUENCY RANGE OF MIXERS
(M6E) A: 5-500 MHz
(M6F) B: 2-500 MHz (with BALUNS

HARMONICS OF $f_L$

CLASS I MIXERS

### Different Input Frequencies and Distortion Products

Table 5 compares distortion products of two higher-frequency Class I mixers (that were included in Table 4) for 50 MHz and 300 MHz input signals. The output signals for 300 MHz input fall between 10 and 50 MHz on the center diagonal and are centered around 300 MHz on the two outside diagonals. Thus, all products are within the if-port frequency range. The even order $f_R$ products show typically 5-15 dB degradatiol at 300 MHz on most IM products that depend on mixer balance.

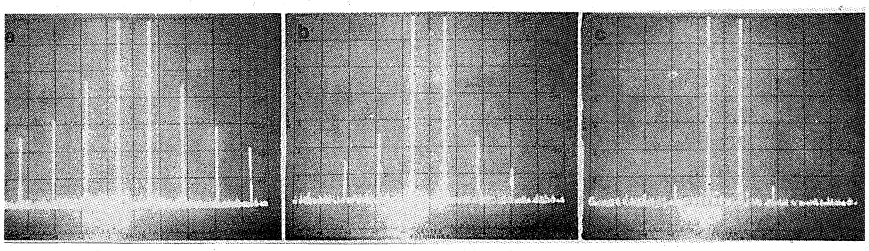
Products that do not depend on mixer balance, ($3f_R$ by $3f_L$ and $5f_R$ by $5f_L$) showed improved suppression at 300 MHz.

This is not always the case, but typically such products do not degrade appreciably at the higher frequencies.

When necessary to specify distortion products, it should be done with reference to broadband 50-ohm systems since any other system is unique and must be exactly duplicated in each test setup right down to the length and type of line between the mixer ports and driving sources and loads (particularly the if-port). Part II will show how different if-port filters affect third order two-tone products. Also, it is advisable to specify a definite set of frequencies for each IM product considered, rather than a band of frequencies, so that exact correlation between the manufacturer and customer can be obtained.

# Selecting Mixers for Best Intermod Performance (Part 2)

**Author: Daniel Cheadle**



**1. Spectrum of i-f and IM products** for (a) Class I mixer,13 dBm LO drive, (b) Class II mixer, 20 dBm LO drive and (c) Class Ill mixer, 23 dBm LO drive, show the equal spacing infrequency between the unwanted products. Horizontal scale is 0.5 MHZ/div. (centered at 30 MHz) and the vertical scale is 10 db/div.

Third-order two-tone intermodulation is a function of LO drive and RF input levels. In evaluating IM, it's important the mixer is operating in a truly linear region.

In many receiver applications, two input signals may enter a mixer and mix with the local oscillator signal to produce unwanted inband intermodulation products.

These third-order two-tone products can be particularly troublesome in a receiver because they are separated from the desired output signals by the same amount as the two input signals. Because of this equally-spaced relationship, it is very difficult to provide adequate filtering to remove the products without affecting the desired outputs.

Two methods that are used to reduce these two-tone products are:

- Increase the LO drive for low input signals so the diodes operate only briefly in the highly non-linear transition region.

- Increase the forward voltage drop in each diode leg. This is accomplished by placing additional diodes or resistive elements in each leg of the mixer ring and increasing the LO drive level.

The Class III mixer gives the best suppression of IM products over wide rf input levels when LO drives of + 17 dBm or more are provided. However, the performance for each class of mixer and their relative merits should be carefully weighted before selecting any type. LO levels should also be carefully evaluated for their effect on other parameters.

In addition to third-order two-tone product suppression, the tradeoffs between the 1 dB conversion compression point and the intercept point (where second and third-order IM products occur) in the various mixer types should also be considered. Interestingly enough, achieving a high compression point is no guarantee that maximum two-tone suppression has been achieved in a double-balanced mixer.

### Suppressing Third-order Products

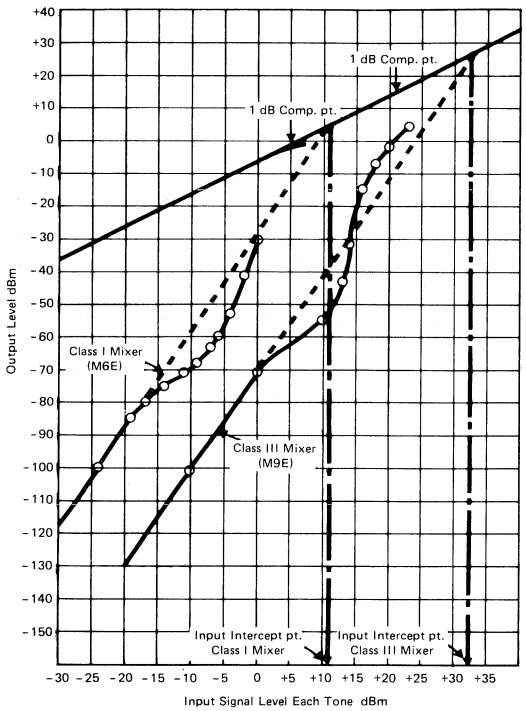
Consider the spectrum of the three classes of mixers in Fig. 1. The two rf input signals $f_{R1}$ and $f_{R2}$, are 0 dBm tones at 220 MHz and 220.5 MHz applied to the rf port of each of the mixers. The LO signal, $f_L$, set at 250 MHz, is driving each mixer at its maximum recommended LO drive level. The unwanted inband third-order two-tone modulation defined as $(2f_{R2} - f_{R1}) + f_L$ and $(2f_{R1} - f_{R2}) \pm f_L$, is shown in decreasing amounts for each mixer class.

Fig. 1 (a) shows the third, fifth, and seventh-order products for a Class I mixer. With 7 dB additional LO power, the Class II mixer, Fig. 1 (b) provides about 20 dB of increased suppression over the Class I mixer on the third order product. And with 10 dB more LO power, the Class III mixer, Fig. 2 (c) provides about 40 db of increased suppression on the third-order product. This additional suppression on the high level signal can be used to reduce distortion in receivers with large input signal levels and in multi-channel communication equipment. It is also very useful in spectrum analyzer i-f sections where a large dynamic range is required.

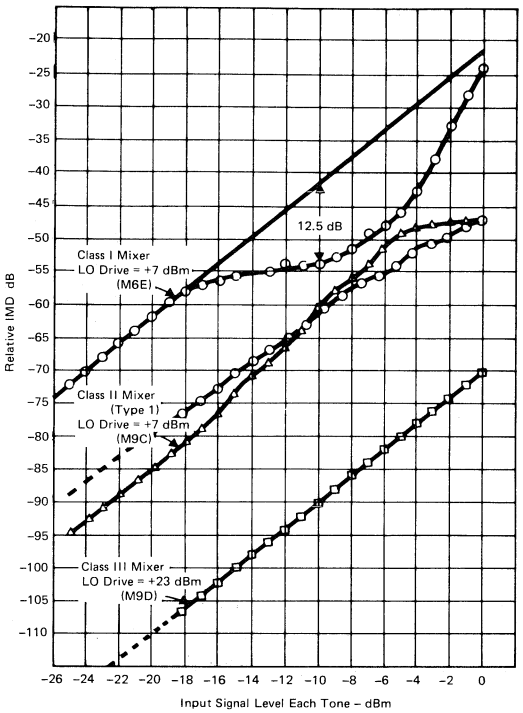
### Determining the Intercept Point

The intercept point used widely to predict the second and third-order distortion suppression in linear amplifiers is being increasingly applied as a specification for double-balanced mixers. It is defined as the intersection of the desired output curve and the curve of the distortion product of interest. The third-order two- tone curves in Fig. 2 for a Class I and Class III mixer show a 3:1 slope on an absolute log-log scale inter desired output curve which has a 1:1 slope. Their relative slope is then 2:1 which results in the 2 for 1 rule i.e., for each dB the input is reduced, the third order two-tone will be reduced 2 dB relative output.

For example, if the input level is reduced 10 dB, the additional suppression below




**2. Third-order two-tone modulation** curves may be used to define the intercept point of mixers. It demonstrates the 2 dB for 1 dB rule, that is for each dB the input is reduced, the third-order two-tone will be reduced 2 dB relative to the desired output.

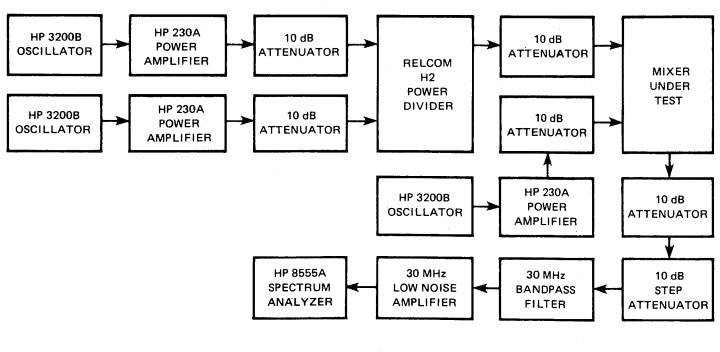



**4. A comparison of relative third-order two-tone intermodulation products** show non-linearities occurring for Class I and II mixers at - 18 dBm but not for the Class III mixer even at 0 dBm. The S-band Class II mixer shows a slight non-linearity at the signal levels increase above -16 dBm.

the desired output would increase by 20 dB. This rule holds only over the linear region of the third-order slope.

Instead of actually extrapolating the linear portion of the two-tone curve as in Fig. 2, a simpler method is to take the relative suppression (using the test setup of Fig. 3) divide by two and algebraically add the input level to this. For example, using this rule on the -20 dBm inputs for the Class I mixer in Fig. 4 yields 62/2 -20 = + 11 dBm as in the input intercept point. This is the true intercept point for this Class I mixer since the 20 dBm inputs is in the linear region. (Note that Fig. 2 verifies this + 11 dBm value).

However if the rule is used at the - 10 dBm input levels on the Class I mixer, the result is 54/2 - 10 = +17 dBm which is 6 dB higher than the true intercept point. The interesting fact here is that - 10 dBm is usually the most popular level for measuring two-tone distortion in a mixer. Unfortunately, at this level, the intercept simply is not valid for the Class I mixer. If the purpose of the intercept point is to provide a single specification to predict the IM suppression for a large range of input signal levels then it should be applied only to the linear region. For a Class I mixer, the region is up to about-20 dBm and it is up to about-10 dBm for Class II mixer. For a Class III mixer, the region extends to 0 dBm.




**3. Test setup for measuring relative two-tone IM** vs. rf input level shows test instruments used. Comparable manufacturers' test equipment works equally as well, For the test results shown in Fig. 4, LO frequency is 113 MHz and $f_{R1}$ and $f_{R2}$ is 43 and 63 MHz. The S-band mixer tested operates at a $f_R$ of 3.2 GHz and an LO frequency of 3.36 GHz at + 1 7 dBm.

## Third-Order IM Cancellations

When two diodes are used for simultaneous mixing in a mixer, cancellation can occur in the third order two-tone products if the diodes are biased at a different level. The different bias levels cause the fourth and sixth order coefficients of the polynomial that represents a diode characteristic curve to be opposite in sign to the fourth and sixth order coefficients of the other diode.

In a double-balanced mixer, which uses a ring quad arrangement, the two diodes are biased on by the LO signal during any half cycle. The rf signal passes through one of these conducting diodes in an opposing direction to the LO signal and in an aiding direction in the other conducting

diode. For low level input signals, this rf perturbation is small compared to the average LO bias level. At higher input levels, however, it causes the two diodes to be biased at slightly different levels at any instant in time. A sign reversal on either or both the fourth and sixth order coefficients between the two diodes will cause some degree of cancellation to occur. The extent of cancellation is 12.5 dB at -10 dBm input levels for the Class I mixer as shown in Fig. 4. The maximum cancellation using a +7 dBm LO signal occurs with two - 8 dBm input signals. As the input levels are increased still further, conversion compression effects occur in the mixer. Another type of cancellation in a double-balanced mixer is a relative phase shift between the IM products that are produced in each of the two conducting diodes. The IM distortion currents generated by each diode are summed in the i-f port of the mixer so that any phase shift between these currents will cause some cancellation in the IM distortion. By placing an open ended 50-ohm coaxial line directly in shunt on the i-f port of the mixer and adjusting the line length over several inches as much as 30 dB additional suppression can be provided.

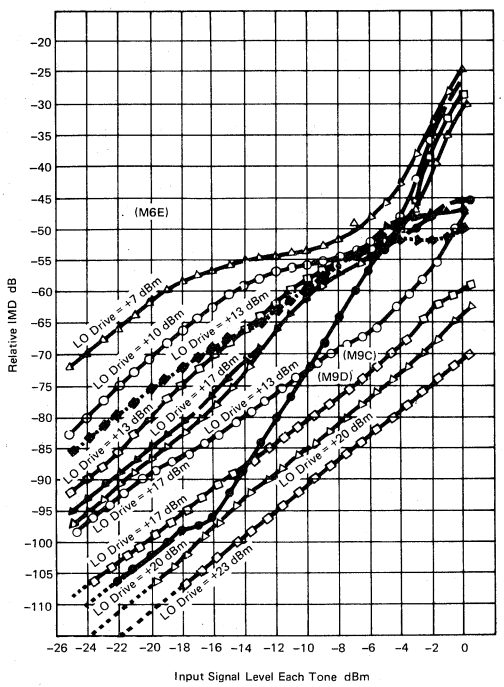
### Mixer Compression

The conversion compression in a mixer is unlike the gain compression in an amplifier. An amplifier compresses the signal when clipping of the waveform occurs as a result of the transistors being driven into saturation during one-half cycle or cutoff during the other half cycle or both. In a double-balanced mixer (see Figs. 1, 2; p.48 Nov. 1973 Microwaves,) the local oscillator alternately drives one half of the diode ring on while the other half is reversed biased by the "on" biased diodes. When the magnitude of the rf signal becomes sufficiently large it can also act as an LO signal and turn-on the diodes. When this happens, rf signal energy is lost in these diodes-resulting in conversion compression.

Conversion compression is also caused by the rf signal opposing the LO signal in one of the conducting diodes. This causes a shift in the average operating point towards a higher dynamic impedance, The rf signal then sees a relatively high impedance in one diode and a low dynamic impedance in the other. This effect unbalances the i-f currents through the LO transformer and causes partial loss of common mode cancellation. The rf signal then sees a higher impedance in the LO transformer-further increasing the conversion compression in the mixer. These effects have been found to be less significant than the rf signal acting as an LO source and can be overcome by maintaining a large LO signal to rf signal level ratio.

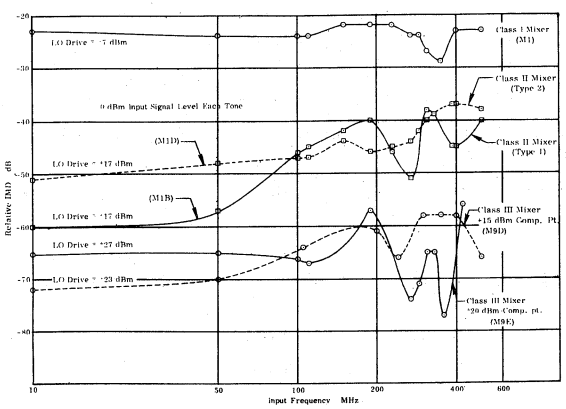
### Effects of LO Drive on IM

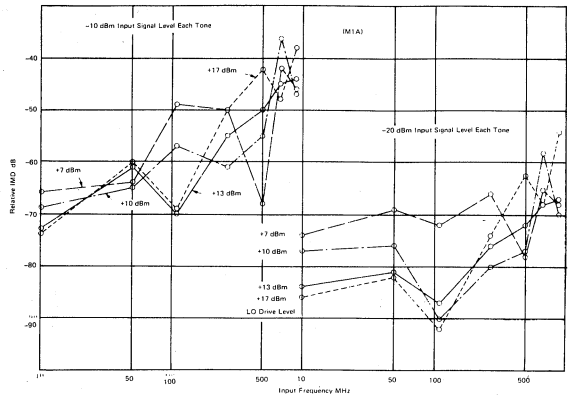
Improvements in third-order suppression also occur when the LO drive is optimized. This is seen in the Class I mixer performance in Fig. 5, which shows relative third-order two-tone IM suppression for four LO drive levels. It is not possible to extend the true linear region more than a few dB using increased LO drive. Note that the higher order coefficient cancellation occurring with the + 7 and + 1 0 dBm LO drive levels is virtually eliminated with the +13 dBm drive level. The +17 dBm drive level actually produces a reversed effect and degrades at a slightly faster rate than the 2:1 rate. This higher rate of degradation is also evident in the Class II mixer Fig. 5 (dashed lines) when driven at a +20 dBm LO level. In comparing the third-order suppression of the Class I and Class II mixers both driven with +13 dBm LO drive levels, it is seen that there is no apparent advantage for signal levels below - 10 dBm in using the Class II mixer to obtain better third-order two-tone suppression. The improvement in third order suppression with increased LO drive for low level input signals is the result of the diodes operating for a shorter period of time in the highly nonlinear transition region. One trade-off for driving a Class I mixer at a higher than nominal LO drive level can be an increase in noise figure for i-f frequencies below 10 MHz since the diodes are not screened for low 1/f noise at high current levels. This is important in phase detector applications. Also a slight loss of mixer isolation can occur since the diodes are not matched at the higher current levels. Most mixer manufacturers do not recommend that a Class I mixer be driven above +13 dBm on the LO port.



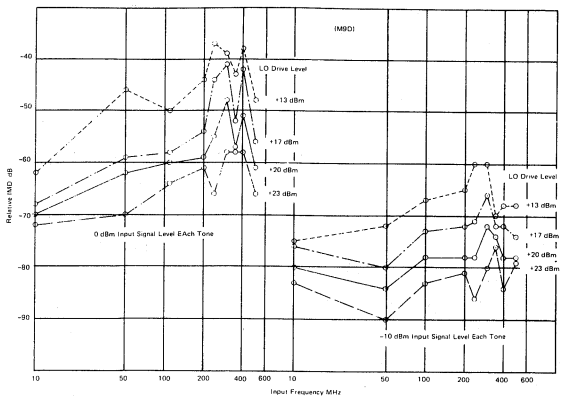

**5. LO drive heavily influences** third-order two-tone IM for a Class I mixer (black). This mixer type does not exhibit any phase cancellation so no crossovers in suppression occurs. A Class 11 mixer (in dash lines) offers no improvement in third-order IM suppression at a -13 dBm LO drive when signal levels below-lO dBm are used. Class III mixer offers the best IM suppression over wide rf input levels and LO drive levels.

**6. Third-order two-tone suppression** for the three classes of mixer has wide variations at the higher frequencies.






**7. Third-order two-tone suppression** for a 3 to 1000 MHz Class I mixer is not necessarily dependent on the LO drive. Phase cancellation is also a factor.




**8. Class III mixer** offers improved suppression of IM over Class II mixers but is still sensitive to frequency.

### Effects of RF Drive

The type of two-tone degradation occurring for rf input levels above +10 dBm on a Class I mixer demands that changes to the basic mixer circuit be made. This is required to obtain improved performance since increasing the LO has a negligible effect on IM performance. This is one reason that the Class II type 1 high-level mixer was developed, (See Fig. 2, Part I of this article, Nov. '73 p. 48). The extra diode in each leg of the mixer provides additional back bias on the "non-conducting" pair of diodes. The resultant compression effects prevent severe IM degradation on rf input signal levels up to 0 dBm.

For 0 dBm RF inputs, the Class II mixer gives 22 dB greater suppression than the Class I mixer when both mixers are driven at + 13 dBm on the LO port. When + 17 dBm or greater LO drive levels can be provided, the class III mixer, Fig. 5, (color tint) will give superior suppression for all rf input levels. This is caused by the capacitive elements in each diode leg in the mixer. Each capacitor holds a reverse bias on each pair of diodes during their non-conducting period even when the LO swings through its zero voltage transistor point. Reasonable linearity is maintained up to 0 dBm for LO drive levels of + 17 dBm and higher and up to –3 dBm for a +13 dBm LO drive level.

### What's the Effect with Frequency?

Third-order two-tone suppression maintains three distinct levels of suppression for each class of mixer. Across a 500 MHz band, as shown in Fig. 6, there is a 10-15 dB variation in suppression with frequency. The variation is most pronounced at the higher frequencies where a relatively small change in frequency can result in a large change in IM suppression.

The effect over frequency for -10 and -20 dBm input levels and four different LO drive levels is shown in Fig. 7. Notice that increasing the LO drive level does not always result in improved performance. In fact at 500 MHz with -10 dBm rf input levels, the best performance is obtained with +7 dBm drive. The suppression here is nearly 20 dB better than the suppression at 270 MHz and over 25 dB better than the suppression at 700 MHz. Increasing the LO drive level 6 dB, decreases the suppression at 500 MHz by 18 dB. This indicates that phase cancellation effects are responsible for the excessive suppressions at 500 MHz with the +7 dBm LO drive. The suppression improves only by 10 dB with a 10 dB reduction in the rf input levels which is only half the amount predicted using the 2 dB for 1 dB rule. Even with - 20 dBm input signals this point measured about 12 dB better than the 270 MHz and 700 MHz readings.

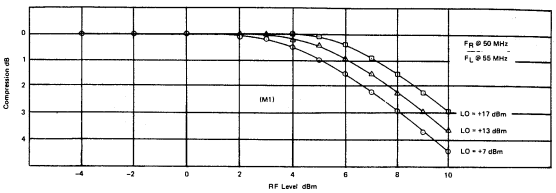
The Class III mixer gives improved performance across the entire frequency band with each increase in the LO drive level, Fig. 8. Because Class I and II mixers are not linear over the common rf input levels used for measurements and are particularly sensitive to phase cancellation, it is recommended that the intercept concept be used on these mixers with extreme caution.

### Compression and Intercept Points

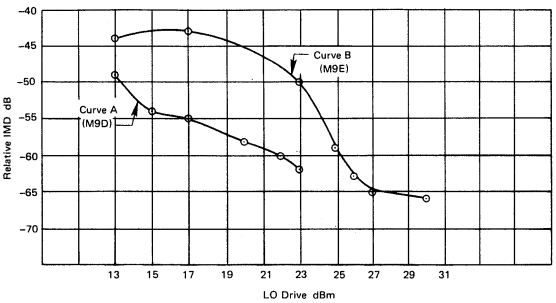
The 1 dB conversion compression point is often related erroneously to the intercept point on a one-for-one basis in mixers. Experimental data, however, shows that there is no direct dependence. For input levels below -18 dBm, the Class I mixer gave 25 dB of additional suppression when the LO drive is increased from +7 to + 17 dBm, Fig. 5. This is an intercept point increase of 12.5 dB. The 1 dB compression point, however, only increases from +5 dB to +7.2 dB, Fig. 9, because it takes an exponential increase in diode current to obtain a linear increase in diode voltage. Thus, very little additional back voltage can be developed to hold both of the "non-conducting" pair of diodes biased off.

Further evidence that the compression point and intercept point do not track with each other (especially when compression effects have not occurred inside the mixer) are illustrated by the two Class III mixers in Fig. 10. The higher level mixer (B) is designed for a +20 dBm guaranteed 1 dB compression point and maximum third-order, two-tone IM suppression with a nominal LO drive of +27 dBm. The lower level Class III mixer (A) is designed for maximum third-order two-tone IM suppression with a minimum LO drive. (The third-order, two-tone performance of these two mixers is shown in Fig 6). Note that even though the higher level Class III mixer has a 5 dB higher 1 db conversion compression point and is driven with a +27 dBm LO signal, the lower level unit gives about the same two- tone IM suppression with only +23 dBm LO drive.

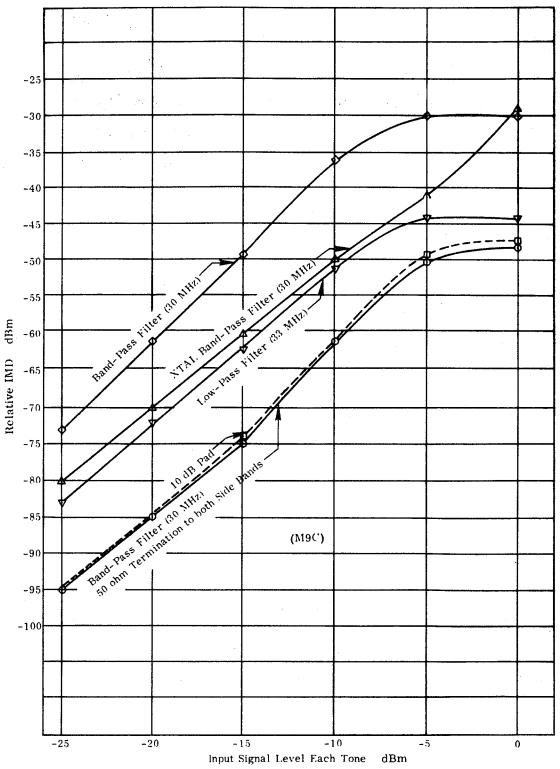
Back in the early development of high level double-balanced mixers, a group of special high barrier, hot-carrier diodes were put into a mixer to obtain a higher compression point. The compression point was raised a few dB, but the third-




**9. An intercept point** is not directly related to the compression point of a mixer.




**10. A higher 1 dB conversion compression point** does not necessarily insure better two-tone IM suppression




**11. It is important to terminate** the i-f port of mixer into 50 ohm or IMD increases.

order, two-tone IM suppression –especially for low level signals-was actually several dB worse even when the LO drive was adjusted to give the same average current level in the diodes. (A distortion analysis using numerical techniques on a computer generated sixth order polynominal to represent the diode characteristic curve revealed very large fourth and sixth order components exist as compared to the standard barrier diodes.)

In short, achieving a high compression point is no guarantee that maximum two-tone suppression has been achieved. In fact, there is no direct correspondence between compression point and third-order, two-tone IM suppression, in double-balanced mixers.

### IF Port Termination Reactive?

The figures presented up to this point are for a 50 ohm broad band system. Frequently, however, a limited i-f bandwidth is needed which requires filtering. In a typical downconverting application, this makes the filter look like 50 ohm at the lower (or desired sideband) but reactive to the upper side- band. As a result, the upper sideband is reflected back into the i-f port of the mixer, typically degrading the two-tone IM performance. It is necessary that an i-f port termination provide 50 ohm to both upper and lower sideband. If not degradation in third-order, two-tone suppression occurs as shown in Fig. 11. The dotted line shows the suppression with a 50 ohm broadband termination on the I-port. The bottom solid curve results when using a 30 MHz band- pass filter that provides a 50 ohm input impedance at 30 MHz and for frequencies above 45 MHz when terminated in 5ohms. The top curve shows that 25 dB degradation occurs by reversing the input and output ports on this filter with the undesired sidebands reflected back into the I-port of the mixer. The two center curves are obtained using a 30 MHz crystal filter and a 33 MHz low-pass filter connected directly to the I-port. The degradation for these two cases is not as severe as with 30 MHz bandpass filter with reversed input and output ports. The actual amount of degradation is a function of the relative phase of the reflected signal to the phase of the signals present in the mixer. In some cases, it's possible at any given frequency to obtain good or even better performance (than offered by a broadband 50 ohm termination) by using an adjustable line length. Of course, any adjustment for optimum suppression is frequency sensitive and can enhance or degrade the conversion loss by as much as 2 or 3 dB.

Another method for providing a 50 ohm termination to both upper and lower sidebands when the frequency separation will permit, is to use a diplexer on the I-Port. A typical application might be to provide a low-pass filter that cuts off above 70 MHz with R-Port frequencies from 225- 400 MHz. Diplexers for this have been built which have typically less than 0.2 dB insertion loss.

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# Predicting Intermodulation Suppression In Double-Balanced Mixers

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Predicting intermodulation (IM) suppression in double-balanced (DB) mixers continues to be extremely important in the design and operation of microwave and RF systems. IM products generated by the mixer can masquerade as the down-converted IF signal, thereby reducing system effectiveness. Fortunately, the threat of IM products can be avoided if their frequencies and power levels are known. Determination of IM frequencies is fairly simple, but knowledge of the exact power levels of IM products generated by mixers always requires careful measurement, which is time consuming and, thus, expensive. Approximate predictions of IM power levels are sometimes deducible from catalog data showing trends in typical IM suppression for a given mixer; but often, such data is unavailable. Various efforts have been made to mathematically predict IM suppression in single ended and single-balanced mixers[1,2], but to date no practical formulas for DB mixers have been made available. To help microwave and RF system designers predict single-tone IM suppression, some simple rule-of-thumb formulas that generally agree with measured data are presented in Table 1. The formulas in the right-hand column come from equation 1 (see page 5 and appendix), which is based on the switching characteristics of four ideal diodes. The formulas in Table 1 are unique in that they predict IM suppression, given only AP (the difference between RF and LO power levels).

Also included in this article is a practical four-step method to reduce the effect of intermodulation products (intermods) on the system by optimizing mixer usage. With a reliable approximation of suppression for a given IM product the system designer can better choose the mixer input and output frequencies that minimize the presence of poorly suppressed IM products in the IF output passband. Furthermore, distinguishing a particular IM product from others on a crowded spectrum analyzer display is easier when the approximate level of the desired product is known.

The expressions for IM suppression presented in Table 1 are calculated from equation 1 by using nominal values of balun imbalance, diode mismatch, and $V_F$ (diode turn-on voltage). Equation 1 represents the generalized formula for IM suppression for various values of these parameters. The derivation of the equation is based on the switching characteristic of an ideal diode and, as a result, mixing caused by normal diode nonlinearity is ignored. This approximation has been addressed in the literature[3], and is justified ostensibly by the close agreement between calculated and measured IM suppression, as long as the values of n and m are small, and $\Delta P$ is less than about -15 dB. The approximation is made in the analysis that the RF power is much less than the LO power. When n, which is the harmonic of the high-level (LO) input is less than 8, and m, which is the harmonic of the low-level (RF) input is less than 4, predicted results are accurate enough for most system design applications. For larger values of n and m, calculated suppression tends to be better than actual suppression. Evidently, approximations made in the derivation begin to cause inaccuracies for higher values of n and m.

| (LO) n | (RF) m | $S_{nm}$ Suppression (dBc) |
|---|---|---|
| 1 | 1 | 0 |
| 1 | 2 | ΔP-41 |
| 1 | 3 | 2ΔP-28 |
| 2 | 1 | -35 |
| 2 | 2 | ΔP-39 |
| 2 | 3 | 2ΔP-44 |
| 3 | 1 | -10 |
| 3 | 2 | ΔP-32 |
| 3 | 3 | 2ΔP-18 |
| 4 | 1 | -35 |
| 4 | 2 | ΔP-39 |
| 5 | 1 | -14 |
| 5 | 3 | 2ΔP-14 |
| 6 | 1 | -35 |
| 6 | 2 | ΔP-39 |
| 7 | 1 | -17 |
| 7 | 3 | 2ΔP-11 |

**Table 1. Formulas approximating suppression of certain IM products. n corresponds to the high-level (LO) input, and m corresponds to the low-level (RF) input. DP = $P_{RF(dBm)}$ - $P_{LO(dBm)}$.**

The expressions given in Table 1 are valid whether n and m are positive or negative. The frequencies of IM products in Table 1 are assumed to be within the mixer IF output bandwidth.

Table 1 is used as follows: Suppression of any product listed is approximated by subtracting the LO input power, in dBm, from the RF input power, in dBm, to get $\Delta P$, which is then used to calculate IM suppression. For example, when the LO power is +10 dBm and the RF power is -20 dBm,$\Delta P$ = -30 dB, and the $\pm nf_L \pm mf_R$ IM product, when both n and m equal 2, is suppressed by approximately {$\Delta P$ - 39} dBc, or -69 dBc. The suppression of the 2 x 1 product will be about -35 dBc. In the following paragraphs, $\pm nf_L \pm mf_R$ is abbreviated to n x m (referred to as, "n by m").

The formulas in Table 1 agree with the (m-l) rule[4]; namely, that decreasing RF input power by K dB results in an increase of suppression of any n x m product by K (m-l) dBc. The formulas in Table 1 also imply that the same is true for an increase in LO power because -SP becomes more negative when LO power is increased, as well as when RF power is decreased. But, in practice, IM suppression is more accurately predicted using the (m-1) rule for changes in RF power than for changes in LO power. As expected, calculated suppression of products with m=l remains fixed as $\Delta P$ varies.

The formulas in Table 1 are based on a double-balanced (DB) mixer with circuit balance and diode match that are generally representative of microwave mixers. Hence, IM suppression calculated using Table 1 is approximate, and may deviate from actual measurement depending on the mixer, the frequencies involved, and load conditions. To get a sense of accuracy of these formulas, measured values of IM suppression for various types of mixers are compared with calculated values.

### Comparison With Measured Data

Table 2 indicates that equation 1 and Table 1 are useful in predicting IM suppression because predicted values of suppression generally fall within the variance of measured suppression for the various classes of mixers.

### Odd x Odd IM Products

Table 2 shows that predicted suppression for, ΔP = -20 dB, generally agrees with measured data for various classes of mixers, especially for odd x odd and even x even IM products. For example, the 3 x 1 product is predicted to be -10 dBc, which agrees closely with measured values of -10 dBc to -12 dBc for the lower-frequency mixers, including the new Class IV[5] WJ-M[4]T mixer and the triple-balanced $(TB)_6$ WJ M2T mixer The new WJ M5OA[7] and WJ-M89, which are microwave TB mixers, have slightly higher suppression of the 3 x 1 product; i.e., -19 dBc and -16 dBc, respectively. These values probably would be closer to predicted values if a higher LO power were applied. Careful study of 3 x 1, 5 x 1, and 7 x 1 IM data, taken with a varying LO power level,[8] shows that these particular products are better suppressed when LO power is slightly lower than that required for optimum conversion-loss, but reducing LO power also degrades suppression of IM products when m ≥ 2. Hence, odd x odd products, especially with m = 1, should never be allowed inside the IF bandwidth because virtually nothing can be done to improve their suppression without degrading suppression of other products.

The 3 x 3 product is predicted to have suppression of -58 dBc, agreeing with measured values in Table 2, ranging from -65 dBc to -50 dBc. The 5 x 3 product is predicted to have suppression of -54 dBc, which is at least centered among measured values ranging from –47 dBc to -69 dBc.

| IM Product | | TB | | | Class IV | Class I | | Class II Type I | | Class II Type II | Class III | Predict. Values |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n | m | M50A | M89 | M2T | M4T | M79 | M6V | M9C | M79H | M9BC | M9E | (ΔP=-20) |
| 1 | 1 | 0 6 | 0 7 | 0 8 | 0 1 | 0 5 | 0 1 | 0 1 | 0 5 | 0 1 | 0 1 | 0 |
| 1 | 2 | 55 | 51 | 64 | 61 | 60 | 50 | 63 | 63 | 63 | 59 | 61 |
| 1 | 3 | >60 | >65 | 64 | 66 | 60 | 60 | 60 | 62 | 65 | 63 | 68 |
| 2 | 1 | 35 | 30 | 41 | 43 | 42 | 30 | 35 | 40 | 41 | 50 | 35 |
| 2 | 2 | 60 | 54 | 61 | 64 | 60 | 55 | 50 | 62 | 60 | 51 | 59 |
| 3 | 1 | 19 | 16 | 10 | 12 | 12 | 11 | 11 | 12 | 10 | 12 | 10 |
| 3 | 2 | >58 | 60 | 60 | 60 | 42 | 49 | 61 | 48 | 58 | 59 | 52 |
| 3 | 3 | 63 | 62 | 58 | 61 | >60 | 58 | 57 | 65 | 50 | 57 | 58 |
| 4 | 1 | 41 | 40 | 50 | 45 2 | 35 | 41 2 | 32 | 32 | 39 2 | 39 2 | 35 |
| 4 | 2 | >62 | 60 | 57 | 66 | — | 55 | 57 | — | 56 | 50 | 59 |
| 5 | 1 | 30 | 34 | 30 | 16 | 25 | 18 | 15 | 20 | 15 | 28 | 14 |
| 5 | 3 | — | 64 | 54 | 54 | >60 | 53 | 50 | 69 | 54 | 47 | 54 |
| 6 | 1 | 45 | — | 48 | 49 | — | 56 | 41 | — | 50 | 37 | 35 |
| 6 | 2 | 62 | 55 | 66 | 67 | — | 56 | 59 | — | 63 | 52 | 59 |
| 7 | 1 | 33 | 35 | 18 | 21 3 | 24 | 25 3 | 19 | 22 | 19 3 | 21 3 | 17 |
| 7 | 3 | >60 | >65 | 55 | 54 2 | — | 55 2 | 54 | — | 50 2 | 50 2 | 51 |
| | | $P_{LO}$=+10 dBm $P_{RF}$=-10 dBm | | | | | | $P_L$=+20 dBm $P_R$= 0 dBm | | | | |

| Notes | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $f_L$ (MHz) | 200 | 180 | 125 | 50 | 2900 (IF in) | 4100 | 2000 | 275 |
| $f_R$ (MHz) | 180 | 400 | 400 | 49 | 7100 | 6000 | 3250 | 200 |

**Table 2. Comparison of various IM products and classes of mixers.**

### Even x Even IM Products

Besides odd x odd products, calculated values of even x even IM suppression generally conform to measured data. Calculated suppression of 2 x 2 products for, ΔP = -20 dB, is -59 dBc, which generally agrees with data ranging from -50 dBc to -64 dBc. Suppression of 4 x 2 and 6 x 2 products is predicted to be the same as for 2 x 2 products; i.e., -59 dBc, which also agrees with measured values of -50 dBc to -66 dBc and -52 dBc to -67 dBc, respectively. Data in Table 2 indicates that suppression of even x even IM products in TB and Class IV mixers is generally better than in DB Class I, II and III mixers. This is because all three ports of TB and Class IV mixers are balanced, whereas only two ports, generally the L- and Reports, are balanced in DB mixers.

The excellent suppression of even x even products by the Class IV WJ-M4T mixer covering 10 to 3500 MHz is due to well-balanced circuitry, and the fact that even x even currents are terminated in two chip resistors before they can exit the mixer. The WJ-M4T has excellent conversion loss, typically 6 dB, which is not degraded by the resistors, because odd x odd currents are phased to skirt around the resistors and exit at the I-port.

### Even x Odd and Odd x Even IM Products

Calculated values of even x odd and odd x even suppression generally agree with measured values as well. 1 x 2 and 2 x 1 products are predicted to have -61 dBc and -35 dBc of suppression, respectively, which approximately agree with the measured values of -50 to -64 dBc and -30 to -50 dBc, respectively. Measured suppression of 2 x 1, 4 x 1, 6 x 1, etc. IM products are similar for a given mixer, as predicted. For example, the 2 x 1, 4 x 1 and 6 x 1 suppression for the M4T is -41 dBc, -45 dBc and 49 dBc, respectively.

### Generalized Equation for IM Suppression

The results in Table 1 were calculated using equation 1, which gives IM suppression in dBc for various values of circuit balance, diode match and RF and LO power levels.

The parameters alpha and beta in equation 1 are measures of L- and R-port imbalance, respectively. Beta is the ratio of the voltage-to-ground at the two points where the R-port balun ties to the diodes; alpha is the same for the L-port balun. Both alpha and beta ideally equal 1, but parasitics and other nonideal factors can cause alpha and beta to equal values ranging from 0.7 to 0.8, calculated from typical balun isolation of 10 to 15 dB, respectively, as shown in Figure 1 for beta. Results in Table 1 are based on alpha and beta both being equal to 0.7.

Besides balun imbalance, the analysis considers diode voltage mismatch as caused by impedance variations amongst the four diodes. This is due to differences in diode

**Equation 1**

$$S_{nm} \triangleq \text{IM Suppression (dBc)} \quad (1)$$

$$= (|m| - 1)\,\Delta P + 20 \log (|A_{nm}|)$$

$$A_{nm} = \frac{1}{B_{IF}\,|m|!}\left[\frac{\Gamma\left(\frac{|n|+|m|-1}{2}\right)}{\Gamma\left(\frac{|n|-|m|+3}{2}\right)}\frac{1}{2}\left\{\sin\frac{|n|\pi}{2}\sin\frac{|m|\pi}{2}B_{oo} + \cos\frac{|n|\pi}{2}\cos\frac{|m|\pi}{2}B_{ee}\right\} + \ldots\right.$$

$$\left. \ldots + \frac{\Gamma\left(\frac{|n|+|m|}{2}\right)}{\Gamma\left(\frac{|n|-|m|+2}{2}\right)}V_f\left\{\sin\frac{|n|\pi}{2}\cos\frac{|m|\pi}{2}B_{oe} + \cos\frac{|n|\pi}{2}\sin\frac{|m|\pi}{2}B_{eo}\right\}\right]$$

$\Gamma(k+1) = k\Gamma(k)$, $\quad V_f = V_F/V_L$

$B_{oo} = 1 + \delta_4 + \alpha(\delta_3 + \delta_2) - |m|\{\delta_4 - \delta_2 + \alpha(\delta_3 + \delta_2) - \beta(\delta_3 + \delta_4)\}$ ; odd x odd

$B_{ee} = -1 + \delta_4 - \alpha(\delta_3 - \delta_2) - |m|\{\delta_4 - \delta_2 - \alpha(\delta_3 - \delta_2) + \beta(\delta_3 - \delta_4)\}$ ; even x even

$B_{oe} = |m|\{-\delta_4 - \delta_2 + \alpha(\delta_3 + \delta_2) + \beta(\delta_4 - \delta_3)\}$ ; odd x even

$B_{eo} = |m|\{\delta_4 + \delta_2 + \alpha(\delta_3 - \delta_2) - \beta(\delta_4 + \delta_3)\}$ ; even x odd

$B_{IF} = B_{oo}$ with m=1

$\Delta P = P_{RF}\,(\text{dBm}) - P_{LO}\,(\text{dBm})$

$\delta_2 = \frac{V_2}{V_1}, \quad \delta_3 = \frac{V_3}{V_1}, \quad \delta_4 = \frac{V_4}{V_1}$ (See Figure 2)

L-Balun Isolation = 20 log (1 - $\alpha$)

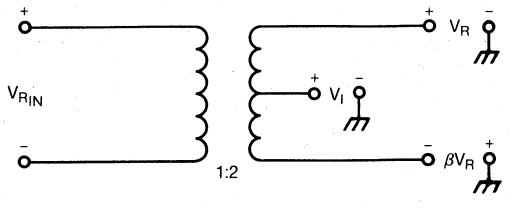
R-Balun Isolation = 20 log (1 - $\beta$) (See Figure 1)

capacitance, $C_T$, and series resistance, $R_T$, of each of the four diodes. These voltage differences are approximated by weighting each of the ideal diode voltages, with their respective values of diode impedance normalized with respect to the impedance of diode 1. Diode voltages $V_2$ through $V_4$ in Figure 2 are multiplied by $\delta_2$, through $\delta_4$, respectively, which are the ratios of the voltages across diodes 2 through 4, to the voltage across diode 1 (ideally, $\delta_2 = \delta_3 = \delta_4 = 1$). Table 1 is based on $\delta_2 = 0.85$ $\delta_3 = 0.95$ and $\delta_4 = 1.05$.

The formulas in Table 1 are calculated from equation 1 using the approximation that δ2, through δ4, and alpha and beta are constant as a function of frequency. This is reasonable because the IM products of most interest are close to the IF output frequency.

$V_F$, which equals $V_F/V_L$ ($V_L$ is the peak LO voltage), is present in the odd x even and even x odd portions of equation 1, but NOT in the odd x odd and even x even portions. This helps explain why measured values of odd x odd and even x even IM suppression tend to agree with calculated values better than odd x even and even x odd values: $V_f$ is an approximate value because both $V_L$, and especially, $V_F$, are approximate values. Table 1 is based on $V_f = 0.1$, assuming $V_F = 0.3$ volts, and $V_L$ = 3.0 volts corresponding to +20 dBm of LO power in a 50-ohm system.

$V_F$ affects suppression of all IM products because a higher $V_F$ allows more LO power to be applied to the mixer, increasing $\Delta P$, assuming RF power remains constant, and thus increasing suppression of all four types of IM products. Equation 1 indicates that increasing VF without commensurately increasing LO power will tend to reduce suppression of odd x even and even x odd products, but not affect odd x odd and even x even products. Thus, it is important to consider the interrelationship between LO power, diode forward voltage, and suppression of the various IM products.




ISOLATION $\triangleq$ 20 log ($V_I/V_R$) = 20 log (1-$\beta$)

**Figure 1. Balun imbalance as a function of B.**

*In many instances, high interport isolation also results from filtering and cross-polarization of LO, RF and IF fields, due to orthogonal MIC baluns.

To illustrate the use of equation 1, suppression of the 3 x -2 product is calculated:

**Example Calculation:**

Using $\alpha = \beta = 0.7$, $\delta_2 = 0.85$, $\delta_3 = 0.95$, $\delta_4 = 1.05$, $V_f = 0.1$, $B_{IF} = 3.25$

$B_{oe} = 1.14$

$|A_{nm}| = [1/(3.25)(2)][\Gamma(3/2)](0.1)(1.14)$

$= 0.026$

$S_{nm} = [\Delta P - 32]$ dBc

## Important Rules for IM Suppression

Equation 1 provides significant insight into the suppression of IM products. It agrees with the well-known fact that IM suppression is best when LO power is high and RF power is low i.e., when $|\Delta P|$ is maximum. Also, suppression of products with even harmonics is best when mixer circuitry is well-balanced and diodes are well matched, which is manifested by high interport isolation due to circuit balance.* Also, circuit balance and diode match must be commensurate with each other because IM suppression may not increase if the diode match is improved, while circuit balance remains poor.

Equation 1 confirms that even x even products are best suppressed when both L- and R-ports are well balanced and all four diodes are well matched. These same conditions minimize conversion loss (the 1 x 1 product), as well as suppression of odd x odd IM products. Odd x even products are best suppressed when the L-port balun is well balanced (a = 1) and the diodes across it are well matched ($\delta_3 = \delta_4$). Even x odd products are best suppressed when the R-port balun is well balanced (,B = 1) and the diodes across it are well matched ($\delta_2 = \delta_3$). The general rule-of-thumb to remember is that best suppression of odd x even and even x odd products is obtained when the LO and RF inputs, respectively, are injected into well balanced ports. The optimum arrangement is to inject both LO and RF signals into well-balanced ports to best suppress odd x even and even x odd products.

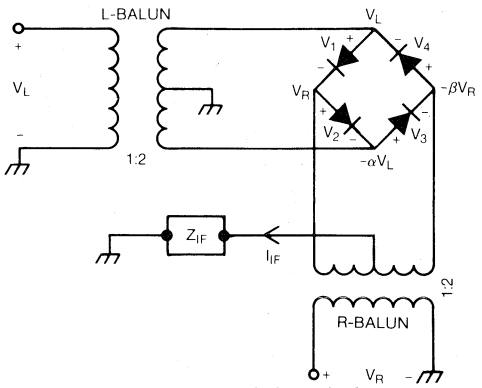



Figure 2. Double-balanced mixer.

| CASE 1 (f x F) | | | | CASE 2 (F x f) | | | |
|---|---|---|---|---|---|---|---|
| f | | F | Suppression | F | | f | Suppression |
| EVEN | x | ODD | Normal | ODD | x | EVEN | Normal |
| ODD | x | EVEN | Below Normal | EVEN | x | ODD | Below Normal |
| DB MIXER | | | | DB MIXER | | | |
| $f_{LO}$ → I R L → f x F; $F_{RF}$ | | | | $f_{RF}$ → I R L → F x f; $F_{LO}$ | | | |

Table 3. Mixer configurations for upconverting Cases I and 2. F is the High Frequency Input, and f Is the Low Frequency Input.

## Downconverting and Upconverting

In double-balanced mixers, two of the three ports are balanced at the diodes, and the third port which is unbalanced, almost always operates at lower frequencies to serve as the IF output. Therefore, injecting the LO and RF signals into the balanced ports generally corresponds to the downconverting case in which the bandwidths of two balanced ports are higher in frequency than the unbalanced IF output port. This explains why IM suppression is usually better when downconverting, as compared to upconverting, where either the RF or LO signal is injected into the unbalanced port. In the upconverting case, a low-frequency signal, injected into the unbalanced I-port is mixed with a second signal that is higher in frequency, and injected into the balanced R- or L-port. These two inputs produce an upconverted signal which exits the mixer via the third port.

## Four-Step Optimization Procedure

There are two possible ways to configure a DB mixer as an upconverter: Case 1, where the LO (high-level input) is injected into the mixer at the unbalanced I-port and, Case 2, where the LO is injected at the balanced R- or L-port, as depicted in Table 3. IM suppression for Cases 1 and 2 are different, so the mixer configuration must be chosen carefully to optimize overall IM suppression. A systematic procedure to choose between Cases 1 and 2 follows:

1. Choose the low input frequency, f, and the high input frequency, F.

2. Determine which IM products (n x m) will exist inside the IF-output passband. This is usually done with a computer-generated IM chart.

3. a) Determine suppression for Cases 1 and 2 using n and m from step 2 and Table 1.

b) Reduce predicted suppression by 10 dB for products having suppression that is below normal, as per Table 3. (The reduction factor of 10 dB causes measured upconversion IM suppression to agree with the predicted values, by taking into account the imbalance at the I-port.)

4. Decide whether Case 1 or Case 2 gives the best overall IM suppression.

## Case Study

Upconversion of a WJ-M79H is considered as a case study to illustrate this process. The WJ-M79H, a Class II, Type I DB mixer covering 6 to 18 GHz, is used as an upconverter. IM suppression is measured for Case 1 (the LO injected into the unbalanced I-port at the low frequency) and for Case 2 (the LO injected into the balanced R-port at the high frequency).

The LO level into the WJ-M79H for this measurement is +20 dBm and the RF level is 0 dBm, so, $\Delta P$ = -20 dB. The WJ-M79H will operate with LO power up to +23 dBm, with a 1-dB compression level of +20 dBm, and conversion loss of only 7.5 dB.

| (f) n | (F) m | Output Frequency (GHz) |
|---|---|---|
| 1 | 1 | 10.0-10.5 |
| 2 | 1 | 12.9-13.4 |
| -1 | 2 | 11.3-11.5 |
| -2 | 2 | 9.0-9.4 |
| -4 | 3 | 9.7-11.2 |
| 6 | -1 | 9.8-10.3 |

Table 4. Listing of IM products in or near the IF band for step 2.

### Step 1

The low frequency is chosen to be f = 2.9 GHz, and the high-frequency range is chosen to be F = 7.1 to 7.6 GHz. The IF output is, therefore, 10.0 to 10.5 GHz.

### Step 2

Using an in-house computer program, the IM products shown in Table 4 were found to he near the IF passband.

### Step 3

Calculated and measured values of IM suppression for Cases I and 2 are given

| | Suppression (dBc) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Case 1 | | | | Case 2 | | | |
| Frequency (GHz) | (f) n | (F) m | Calculated | Measured | (F) n | (f) m | Calculated | Measured |
| 10.0-10.5 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 11.3-11.5 | -1 | 2 | 51 | 50 | 2 | -1 | 25 | 26 |
| 12.9-13.4 | 2 | 1 | 35 | 40 | 1 | 2 | 61 | 63 |
| 9.0-9.4 | -2 | 2 | 59 | 61 | 2 | -2 | 59 | 63 |
| 9.7-11.2 | -4 | 3 | —— | >60 | 3 | -4 | —— | >60 |
| 9.8-10.3 | 6 | -1 | 35 | 42 | -1 | 6 | —— | >60 |

Table 5. Calculated and measured values of WJ-M79H IM suppression for step 3.

in Table 5. Note that calculated and measured values agree fairly closely.

### Step 4

Case 2 is chosen as having the best overall IM suppression because its -F + 6f product is much better suppressed (-60 dBc) than the 6f - F product (-42 dBc) in Class 1. This is important because the output frequency range of these two products is 9.8 to 10.3 GHz, which overlaps the IF bandwidth of 10.0 to 10.5 GHz. If the -F + 6f and 6f - F products did not overlap the IF bandwidth, Case 1 would probably be the best choice because the -f + 2F product in Case 1, close to the IF pass band at 11.3 to 11.5 GHz, is much better suppressed (-50 dBc) than the 2F - f product in Case 2 (-26 dBc). The -4f + 3F and 3F - 4f products are ignored because of their high suppression, even though they overlap the IF bandwidth.

Using this method, the system designer can quickly arrive at the optimum upconverter configuration. He should then confirm these results with measured data, if possible. A similar process can also be used to determine the optimum downconverter arrangement,with Step 3b omitted.

TB mixers, such as the WJ-M50A, M89, M88, M87, M83, M93 and M2T can also be used as upconverters. These mixers generally have better even x odd or odd x even suppression than DB mixers because their I-port is balanced, but they tend to be slightly more expensive than DB mixers. The WJ-83H, a new (high-level) Class 11 DDB 2-to- 18 GHz mixer, performs exceptionally well as an upconverter, operating with up to +26 dBm of LO power and about +20 dBm of RF power at the 1-dB compression point; it can deliver +12 dBm of upconverted output power.

### Conclusion

An analysis of DB mixers, based on the switching characteristic of an ideal diode, has been presented. The analysis predicts suppression of even x even, odd x even, even x odd, and odd x odd products. The effects of diode turn-on voltage, balun imbalance, diode mismatch, and RF and LO input power levels are considered. The analysis agrees with results already established by measured data; i.e., IM suppression is best when the mixer circuit is well balanced, the diodes are well matched, the LO power is highest, and the RF power is lowest.

Typical values of balun imbalance and diode mismatch are used to establish the simple rule-of-thumb expressions in Table 1 that predict suppression of various IM products, given only the difference between RF and LO power levels. Predicted IM suppression values are within the range of measured IM suppression values for the various classes of mixers, and thus are accurate enough for many system design applications. Their accuracy can be enhanced by more closely tailoring values of circuit imbalance, diode mismatch and Vf to a particular mixer application.

In addition, a four-step procedure to choose the optimum port usage in mixers has been presented.

The analysis presented and the resulting formulas should be helpful to microwave and RF system designers working to avoid the presence of poorly suppressed IM products in their system IF bandwidths. These formulas also lend themselves to usage in computer simulations to approximate system IM performance as input frequencies and power levels to various mixers in the system are varied.

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APPENDIX

### Summary of Derivation of Generalized Equation

The DB mixer in Figure 2 is analyzed by summing diode currents at the I-port[9] as in equation 2. Diode voltages are written in equation 3. When the voltage across a given diode exceeds VF, the diode is in the "on" state and current flows through it to the IF load. When biased "on," the diode is a short, so the conductance seen by the current is that of the IF load. Diode forward resistance is ignored because it is assumed to be small relative to the IF load impedance. When the diode voltage is less than VF, the diode is biased "off," so no current flows through it, causing conductance to equal zero. Equation 4 succinctly describes this: when the diode is "on," its conductance GD is normalized to 1, and when the diode is "off," conductance equals zero. Normalizing the "on" conductance to equal 1 simplifies subsequent algebra, and is valid because conductance cancels later in the derivation, assuming the load impedances at the IM and IF frequencies are equal when the ratio of IM-to-IF current is taken.

$$I_{IF} = i_1 - i_2 + i_3 - i_4 = V_1G_1 - V_2G_2 + V_3G_3 - V_4G_4 \tag{2}$$

$$V^1 = v_L - v_R \qquad V^2 = \delta_2 (v_R + \alpha v_L) \qquad V^3\ \delta_3(\beta v_R - \alpha 2) \qquad V^4 = -\delta_4 (\beta v_R + v_L) \tag{3}$$

$$G_D = \frac{1}{2} + \frac{1}{\pi}\int_0^{\infty} \frac{\sin (V_D - V_F)\lambda}{\lambda}\, d\lambda = \begin{cases} 1\ ;\ V_D > V_F \\ 0\ ;\ V_D < V_F \end{cases} \tag{4}$$

Equation 4 is based on equation 5[10], which was used by Bennett[11] to calculate levels of odd x odd IM products in a single-ended mixer assuming $V_F = 0$.

$$\int_0^{\infty} \frac{\sin m\lambda}{\lambda}\, d\lambda = \begin{cases} \pi/2\ ;\ m > 0 \\ -\pi/2\ ;\ m < 0 \end{cases} \tag{5}$$

His results for odd x odd products, as interpreted by Tucker agree with Table 1. The input LO and RF signals are both sinusoidal as in equation 6:

$$v_L = V_L \cos(\omega_L t + \theta_L) \quad V_L \cos x$$
$$v_R = V_R \cos(\omega R^t + \theta_R) \quad V_R \cos Y \tag{6}$$

Since $V_L$ and $V_R$ are periodic, IF current containing their IM products can be expanded into a double Fourier series in x and y as in equation 7:

$$I_{IF} = \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} [I_{nm} \cos(nx) \cos(my) + Bnm \sin(nx) \sin(my)] \tag{7}$$

Bnm = 0 because $v_L$ and $v_R$ are even functions of x and y[13]. $I_{nm}$, the current for the n x m IM product, is solved by integrating $I_{IF}$ over x and y in a double Fourier integral:

$$I_{nm} = \frac{2}{\pi^2} \int_0^{\pi}\int_0^{\pi} I_{IF} \cos(nx) \cos(my)\, dx\, dy \tag{8}$$

Equations 2, 3 and 4 are combined to yield IIF in equation 9:

$$I_{IF} = \left[ (v_L - v_R) \left\{ \frac{1}{2} + \frac{1}{\pi} \int_0^\infty \frac{\sin(v_L - v_R - V_F)\lambda}{\lambda} d\lambda \right\} - \delta_2 (\alpha v_L + v_R) \left\{ \frac{1}{2} + \ldots \right.\right.$$

$$\left. \ldots - \frac{1}{\pi} \int_0^\infty \frac{\sin[(\alpha v_L + v_R)\,\delta_2 - V_F]\lambda}{\lambda} d\lambda \right\} + \delta_3 (\beta v_R - \alpha v_L) \left\{ \frac{1}{2} + \ldots \right.$$

$$\left. \ldots - \frac{1}{\pi} \int_0^\infty \frac{\sin[(\beta v_R - \alpha v_L)\,\delta_3 - V_F]\lambda}{\lambda} d\lambda \right\} + \delta_4 (v_L + \beta v_R) \left\{ \frac{1}{2} - \ldots \right.$$

$$\left. \left. \ldots - \frac{1}{\pi} \int_0^\infty \frac{\sin[(v_L + \beta v_R)\,\delta_4 + V_F]\lambda}{\lambda} d\lambda \right\} \right] \qquad (9)$$

Equation 9 is inserted into equation 8, the order of integration is interchanged, and the approximation is made that $\alpha = B = \delta_2 = \delta_3 = \delta_4 = 1$ in the arguments of the resulting sin terms. $\alpha$, $\beta$, $\delta_2$ through $\delta 4$ remain unchanged elsewhere, however. Integration over x and y is accomplished using modified Bessel integrals[14]. The result is integrated over $\lambda$ by converting the sin and cosine terms into their Bessel function equivalents as in equation 10, and then using a triple Bessel function definite integral[15] to obtain $I_{nm}/V_R$.

Hypergeometric functions of two variables[16] result from the integration over $\lambda$, but

$$\sin(z) = \sqrt{\frac{\pi z}{2}}\, J_{1/2}(z) \qquad \cos(z) = \sqrt{\frac{\pi z}{2}}\, J_{-1/2}(z) \qquad (10)$$

are approximated as equal to unity because both $(V_R/V_L)^2$ and $(V_F\ /V_I)^2$ are taken to be much less than 1. The ratio of IM-to-IF current at the mixer output is calculated by dividing $(I_{nm}\ /V_R)$ by $(I_{11}/V_R)$. Intermodulation suppression is equated to the logarithm multiplied by 20, of $(1_{nm}/I_{ll})$, resulting in equation 1. The quantity, $\Delta P$, equals 20 log $(V_R/V_L)$. $(V_R/V_L)$ is present in the current ratio $(I_{nm}/I_{11})$.

# MIL-Specification Mixers

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Over the last fifteen years there has been a rising awareness of the need for standardization in the military electronics industry. The Defense Electronics Supply Center (DESC), located in Dayton, Ohio, was created in 1962 as a branch of the Defense Logistics Agency (then the Defense Supply Agency) to consolidate military procurement of commonly used electronic components within a single organization. DESC provides guidance to military system design engineers by encouraging the use of standard parts in new designs. This greatly enhances the maintainability of a new system by ensuring prompt deliveries, reasonable cost and reliable performance.

A standard part is a component which is defined by a military specification and which is qualified by DESC to the requirements of that specification. MIL-S19500, General Specification for Semiconductor Devices and MILC-39012, General Specification for Radio-Frequency Coaxial Connectors are two widely known examples of military standard parts specifications. In addition to standardization, these specifications are important because they describe appropriate environmental test methods for their respective technologies. This information is useful to the industry at large, even when standard parts are not being used. MIL-M-28837, General Specification for Radio-Frequency Mixer Stages, was written in 1977. Watkins-Johnson Company has had mixers qualified to MIL-M-28837 since April of 1981. MIL-M-28837 is important not only as a standardization tool, but also because it applies the test methods of MIL-STD-202 in a comprehensive screening program to mixer technology. Mixers use a variety of assembly techniques that range from lumped element to microstrip to thin film, making the application of other established screening programs such as MIL-STD-883 Method 5008, and MIL-M-38510 not entirely appropriate.

The Space and Naval Warfare Systems Command is one of the military organizations responsible for generating and maintaining general specifications for standard parts. DESC-ECT (Electronic Component and Tube branch) is the agent that establishes these documents. Information is gathered from interested manufacturers of the subject component and from users of that electronic component before the specification is issued. Manufacturers also provide a detailed description of individual parts, including military usage history, outline, environmental, and electrical data, to DESC-ECT to be included in the detail specification (referred to as a slash sheet) associated with the main document. It is only after this data has been incorporated into the slash sheets that a manufacturer may submit an application for approval to begin qualification testing. As part of the application, a Master Equipment List identifying all test equipment, and a copy of the manufacturer's internal documentation for qualification and production must be submitted for review and approval by DESC. DESC also audits manufacturers on a periodic basis a successful audit is a prerequisite to approval to begin qualification testing. Once a manufacturer has completed qualification testing and is approved by DESC, the qualified part is added to the Qualified Parts List (QPL) attached to the General Specification. There are several rules that qualified suppliers are required to follow. These conditions, listed below, protect the government from changes to parts after qualification and any attempt to use qualification as government endorsement

### Conditions Regarding Qualification Approval

1. Qualified Products List (QPL) listing does not guarantee acceptance of the product in any future purchase.

2. QPL listing does not constitute a waiver of any requirements of the specification or of the provisions of any contract.

3. Advertising of qualification information is permitted. Permission to use such information for advertising or publicity purposes is granted provided that such publicity or advertising does not state or imply that the product is the only product of that type qualified or that the Department of Defense in any way recommends or endorses the manufacturer's product.

4. The listing applies only to product manufactured in the plant(s) specified in the letter of notification.

5. The listing applies to future amendments or revisions of the specification, unless otherwise notified.

6. The listing applies only to products identical to that (those) qualified. The qualifying activity must be advised of any change to the product. Failure to notify the qualifying activity of a change in design is cause for removal from the Qualified Products List, regardless of the extent of the design change.

7. Continued qualification listing is dependent upon the manufacturer's compliance with the retention of qualification, verification of qualification, or periodic requalification requirements, as applicable, in the specification to which the manufacturer's products are qualified. For specifications not containing specific qualification verification or retention requirements, DD Form 1718 must be submitted at intervals to be specified by DESC.

### MIL-Specification Mixer Screening

Qualification testing per MILM-28837, as described in Table 1, is designed to verify that a specific mixer model meets the physical, environmental and electrical characteristics described in the slash sheets. The screening performed in Groups I and II is nearly identical to that required on each "screened" production lot, stressing the diodes (bumin) and mechanical construction of the mixer (thermal shock, vibration, mechanical shock, and seal). Group III is a series of tests designed to verify package integrity (solderability, terminal strength, resistance to solvents, and moisture resistance).

Mixer QPL production lots are screened per Group A of MIL-M-28837, as described in Table 2. Qualfied QPL parts are produced to two screening levels: screened (level "s") and nonscreened (level "n"). The nonscreened QPL Part is a basic commercial mixer which has been verified to meet the electrical and

mechanical description contained in the slash sheets. The screened QPL mixer is subjected to a preconditioning bake, 96-hour bum-in, and post burn-in electrical test on a 100% basis. The remaining tests are performed on an AQL of 1.0 per MIL-STD-105.

Qualification maintenance inspection per Group B of MIL-M-28837, as described in Table 3, requires mixers which have successfully completed level "s" screening to be subjected to the same tests described for initial qualification, with the exception of visual mechanical inspection, preconditioning bake, burn-in, and post burn-in electrical test (these screening operations were performed during production testing). To maintain a QPL listing, Group B inspection must be performed once every two years for each qualified part. Any updates to the Master Equipment List must also be submitted with the Group B report. The qualified manufacturer is subject to DESC audits at any time.

If any consumer of QPL qualified mixers identifies a serious quality problem with a particular part, the consumer may issue an alert or request DESC to issue an alert to the industry, identify the problem, the model(s) affected, and the manufacturers corrective action. All sales of the part(s) may be suspended until the alert is resolved. However, the stringent quality requirements placed on QPL-qualified parts are designed to minimize the frequency of alerts.

| Test | MIL-STD-202 Method | Condition |
|---|---|---|
| **Group I (4 Sample Units)** | | |
| Visual and Mechanical Inspection | | Manufacturer In-House Criteria |
| Bake | | 24 hours at +100°C |
| Burn-In | | 96 hours at +25°C |
| Post Burn-In Electrical Test | (Note 1) | |
| **Group II (2 Sample Units)** | | |
| Thermal Shock | 107 | B |
| Vibration | 204 | D |
| Mechanical Shock | 213 | A |
| Hermeticity | 112 | C, IIIA |
| Electrical Test | (Note 1) | |
| **Group III (2 Sample Units)** | | |
| Solderability | 208 | All Terminals |
| Resistance to Solvents | 215 | |
| Resistance to Soldering Heat | 210 | B |
| Electrical Test at Temperature Extremes | (Note 1) | |
| Terminal Strength | 211 | A, ½ pound applied |
| Moisture Resistance | 106 | |
| Electrical Test | (Note 1) | |

**Table 1. MIL-M-28837 qualification inspection[2].**

Notes:
[1]Per the applicable MIL-M-28837 slash sheet.
[2]All operations in this table may be modified by the appropriate slash sheet.

| Level "N" | Level "S" | Test | MIL-STD-202 Method | Condition | MIL-STD-105 Level II AQL |
|---|---|---|---|---|---|
| | | **Prescreening** | | | |
| X | X | Preliminary Hermeticity | 112 | C, IIIA | 100% |
| | X | Bake | | 25 hours at +100°C | 100% |
| | X | Burn-In | | 96 hours at +25°C | 100% |
| | X | Post Burn-In Electrical Test | (Note 1) | | 100% |
| | | **Subgroup I** | | | |
| X | X | Visual and Mechanical Inspection | | Manufacturer In-House Criteria | 1.0 |
| X | X | Hermeticity | 112 | C, IIIA | 1.0 |
| X | X | Electrical Test | (Note 1) | | 1.0 |
| | | **Subgroup II** | | | |
| | X | Thermal Shock | 107 | B | 1.0 |
| | X | Vibration | 204 | D | 1.0 |
| | X | Hermeticity | 112 | C, IIIA | 1.0 |
| | X | Final Electrical Test | (Note 1) | | 1.0 |
| X | X | Final Quality Inspection | | Manufacturer In-House Criteria | 100% |

**Table 2. MIL-M-28837 Group A inspection[2].**

Notes:
[1]Per the applicable MIL-M-28837 slash sheet.
[2]All operations in this table may be modified by the appropriate slash sheet.

## Advantages and Disadvantages

There are many advantages to procuring a QPL-qualified mixer over a nonqualified mixer. There is no need to create a specification or source control drawing for a qualified part. Simply buying to the military part number assigned by DESC, provided the mixer model and manufacturer are listed on the latest issue of the Qualified Products List, will secure a standard part all of whose aspects are described and controlled by MIL-M-28837. Another advantage is reduced delivery time, as the manufacturer has the option to build the QPL-listed items for stock, not to custom order. Prices are considerably less than for special Hi- Rel requirements due to the fact that there are many customers for a given QPL mixer, and the manufacturer is thus able to produce in volume. There are also no nonrecurring engineering (NRE) charges or lot charges involved in QPL procurement. Perhaps most important of all, however, is the knowledge that the quality of the part is constantly being monitored by DESC. Qualification data is available for review, as are qualification maintenance reports. QPL-qualified mixers are controlled so as to improve the maintainability of the systems in which they are used. Procuring spares is also an easy task with a QPL-qualified unit.

Disadvantages also exist for potential users of QPL mixers. The largest drawback is that a QPL part must be screened to exactly meet the requirements of MIL-M-28837, no more, no less. If a design engineer requires an electrical test not included in the slash sheets, or desires additional printing on the unit, or any such deviation, no matter how minor, the military part number must be removed from the mixer. This is mainly due to DESC's concern that an item printed with the military part number but having special requirements beyond those of MIL-M-28837 would not be able to be differentiated from a normal QPL part, and that when such a part is repaired or reordered it is probable that a normal QPL will be purchased without the additional screening. Another disadvantage is that the variety of mixers listed on the QPL list although it is growing constantly, cannot encompass the variety of catalog mixers currently available in the industry. In order to take advantage of QPL-qualified mixers, a system designer may have to redraw a board to accept the package style that is qualified. It should be noted that if a part with the desired electrical performance does not

| Test | MIL-STD-202 Method | Condition |
|---|---|---|
| **Subgroup I (2 Sample Units)** | | |
| Thermal Shock | 107 | B |
| Vibration | 204 | D |
| Mechanical Shock | 213 (Note 3) | A |
| Hermeticity | 112 | C, IIIA |
| Electrical Test | (Note 1) | |
| **Subgroup II (2 Sample Units)** | | |
| Solderability | 208 | All Terminals |
| Resistance to Solvents | 215 | |
| Resistance to Soldering Heat | 210 | B |
| Electrical Test at Temperature Extremes | (Note 1) | |
| Terminal Strength | 211 | A, ½ pound applied |
| Moisture Resistance | 106 | |
| Electrical Test | (Note 1) | |

**Table 3. MIL-M-28837 Group B inspection[2].**

Notes:

[1]Per the applicable MIL-M-28837 slash sheet.

[2]All operations in this table may be modified by the appropriate slash sheet.

[3]An alternate mechanical shock may be imposed per U.S.G.S. seismic activity magnitude 7.1 or greater.

appear on the Qualified Parts List, a qualified manufacturer such as Watkins-Johnson Company can screen any of its mixer models to the QPL equivalent level per Group A of MIL-M-28837. (These mixers may not be printed with a military part number unless qualification testing is performed on the first article produced for the contract.)

There are disadvantages for the manufacturer of QPL-qualified mixers as well. Any change in design of a currently qualified model must be approved by DESC, and if it is deemed necessary, a new qualification may be required. Even if further testing is not required, written approval may involve a wait of several months. Qualifying a mixer to MIL-M-28837 involves a substantial time, money, and energy investment on the part of the manufacturer. To add a model to the slash sheets, the appropriate data must be gathered and submitted to DESC-ECT. A wait of 9 to 24 months is typical prior to the incorporation of this data into the slash sheets. Another several months is consumed by DESC review of the manufacturer's application to perform qualification testing and the manufacturer's documentation. The actual qualification testing takes approximately two months to complete. Finally, there is another wait of several months for DESC to approve the qualification and add the model to the QPL list. This adds up to a minimum of two years' effort by the manufacturer to add a model to the Qualified Products List.

In spite of the time involved, many motivations exist for a manufacturer to expend the necessary effort to become qualified. The creation of a Hi-Rel "standard" eliminates many small volume programs which each require unique documentation and engineering attention. QPL listed mixers are produced in volume, leaving the engineer free to concentrate on manufacturing rather than documentation. The qualification also may be used to perform qualification by similarity for unique programs where qualification is required. This allows the qualified manufacturer to avoid duplication of labor-intensive qualification testing. The QPL listing also demonstrates that the manufacturer has a high quality production facility.

## Interpreting The Slash Sheets

Having clearly established the benefits of specifying QPL listed mixers, it is essential to gain a full understanding of the slash sheets. To determine if a mixer of a certain package type is described in the slash sheets, a quick scan is necessary. Each slash sheet contains a different package style. For example, slash sheet 1 describes plug-in outlines, slash sheet 2 describes packages with solderable leads, slash sheet 5 describes units with SMA female connectors, and slash sheet 7 describes mixers in TO-5 packages. Once an appropriate package style is located, the next task is to review the electrical description in the slash sheets to determine the desired dash number. The "substitutability data" table at the end of each slash sheet will provide a listing of manufacturers' codes for each dash number. This, however, does not mean that the part has been qualified. The Qualified Products List must be reviewed to determine if that part is qualified, and which manufacturer is qualified to produce it. The proper method of calling out a military part number is illustrated in Figure 2.

In 1972, the Department of Defense (DoD) chartered DESC as the first Military Parts Control Advisory Group (MPCAG) responsible for the Parts Control Program in accordance with MIL-STD-965. The program, covered by DoD Instruction 4120.19, became mandatory for all weapon systems procurements in August 1983. This instruction requires that electronic and mechanical parts be reviewed by technical consultants at DESC and the Defense Industrial Supply Center, respectively, prior to procurement and use in the system. These consultants aid designers in selection

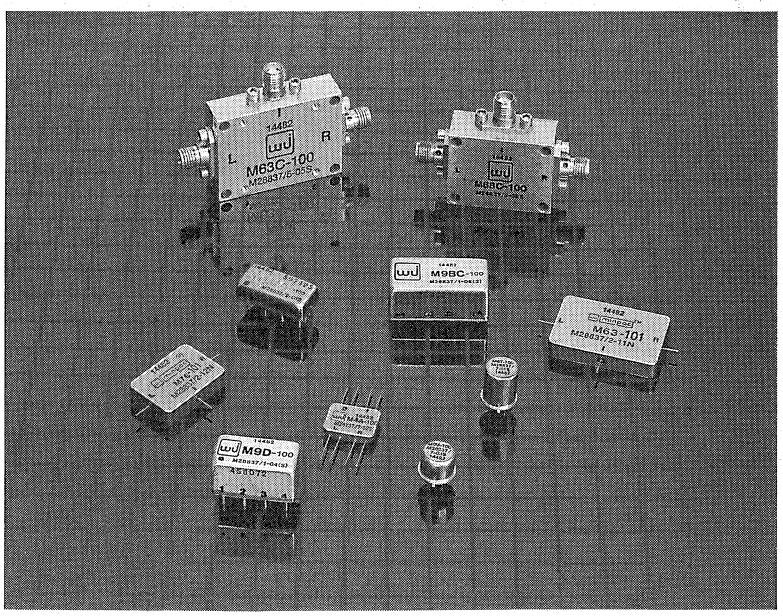
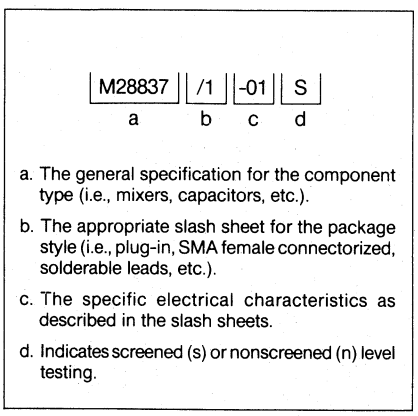



**Figure 1. The variety of OPL-qualified package styles.**

and application of components using the maximum number of standard parts possible. Under this program, nonstandard part approval requests must be submitted by the system contractor, reviewed by MPCAG, and approved by the military acquisition office for the system. This process is effectively reducing the number of new stock numbers in the Department of Defense, eliminating duplicate documentation, decreasing the cost of military systems, and improving the reliability of equipment. In the fiscal year ending 30 September 1987, the DESC Military Parts Control Advisory Group supported 934 contracts and has supported over 2,850 contracts since 1972.

There are many advantages to specifying QPL-qualified mixers including reduced cost, shortened delivery time and improved reliability. The manufacturer of QPL-qualified mixers may concentrate engineering efforts on maintaining a high-quality production line instead of creating documentation for a variety of virtually identical requirements. The systems manufacturer is relieved of the need to create a source or specification control drawing as the mixer is fully specified by its military part number. The creation of MIL-M-28837 has also filled a need in the military electronics industry for a comprehensive screening program applicable to mixer technology. Through the standardization efforts of the Department of Defense, both the systems designer and the components manufacturer reap benefits, thereby simplifying the process of military systems design and parts procurement.




a. The general specification for the component type (i.e., mixers, capacitors, etc.).

b. The appropriate slash sheet for the package style (i.e., plug-in, SMA female connectorized, solderable leads, etc.).

c. The specific electrical characteristics as described in the slash sheets.

d. Indicates screened (s) or nonscreened (n) level testing.

**Figure 2. How to interpret a military part number.**

# Microwave Switch Selection Techniques

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Pin-diode switches provide state-of-the-art switching performance in most present-day microwave systems, such as channelized receivers and electronic warfare systems. Yet, optimum system performance is not always realized, often because exact switching requirements are poorly communicated between the user and designer. Some parameters needed to specify pin-diode switches have several definitions in use within the control-products industry, and the interrelationships between these parameters are not always understood by the system designer. Microwave switches can be optimized for specific applications, but performance tradeoffs inherent in their design require the user to decide what parameters are most important for his needs. The purpose of this article, therefore, is twofold: to clearly define a set of parameters that characterize a pin-diode switch, and to discuss key performance tradeoffs, so as to develop a simple guide that will aid the switch user in selecting pin-diode switches.

## Isolation

Although many parameters are used to describe pin-diode switch performance, four are of fundamental importance to the designer because of their strong interdependence: isolation, insertion loss, switching time, and power handling. Isolation is usually the first parameter of interest; the desired isolation determines how many diodes must be used in the switch circuit. Conceptually, isolation is a measure of how effectively a switch is turned off. It is calculated by taking the difference between the power measured at the switch input and the power measured at the switch output with the switch off. Isolation [dB] = $P_{in}$ (dBm) - $P_{out_{off}}$ (dBm)

Note that isolation is a measure of the total power lost (reflected and attenuated) through the device when the switch is turned off. Since part of this isolation is due to transmission loss that is present within the device, whether the switch is turned on or off, it is often more meaningful for the switch user to specify isolation relative to the transmission loss. This normalized isolation is more commonly referred to as the on/off ratio, which can be calculated by taking the difference between the power measured at the switch output when the device is turned on, and the power measured at the switch output when the device is turned off. As can be seen, on/off ratio is actually the difference between isolation and transmission loss.

$$\begin{aligned}\text{On/Off ratio [dB]} &= P_{out\ on} - P_{out\ off} \\ &= (P_{in} - T_{loss}) - P_{out\ off} \\ &= (P_{in} - P_{out\ off}) - T_{loss} \\ &= \text{Isolation} - T_{loss}\end{aligned}$$

## Insertion Loss

The transmission loss term used in the last equation is measured and calculated in exactly the same manner as isolation, with the exception that the switch is turned on rather than off. A more common term used to denote transmission loss is insertion loss. The insertion loss of a pin-diode switch is often the most critical parameter for the system designer, since this loss may add directly to the noise figure of the system.

## Switching Time

Switching time is another parameter of special interest to the solid-state switch user; it is a measure of the time required for the switch to change state (i.e., on to off or off to on), and can range from several microseconds in high-power switches to a few nanoseconds in low power, high-speed devices. The most common definition of switching time is the time measured from 50% of the input control voltage (usually TTL[1]) to 90% of the final rf Power output (see Figure 1).

Notice in Figure 1 that two separate time intervals comprise the total switching time. The first period, from 50% TTL to 100% rf, denoted, td, is referred to as *delay time*, and is a function of both the propagation delay of the particular switch driver being used and the charge storage characteristics of the pin diodes in the switch circuit.[2] The second time interval, from 10% rf to 90% rf, denoted, $t_r$, is called *transition time* (or rise time), and is solely a function of the electrical characteristics of the pin diodes. As shown in Figure 1, delay time is usually the major factor contributing to switching time. Unfortunately, the transition time is frequently given as a device's switching time (which is especially common if the unit is supplied without a driver). Hence, when specifying switching time, a good practice is to preface the switching time specification with the desired interval over which it will be measured (e.g., 50% TTL to 90% rf or

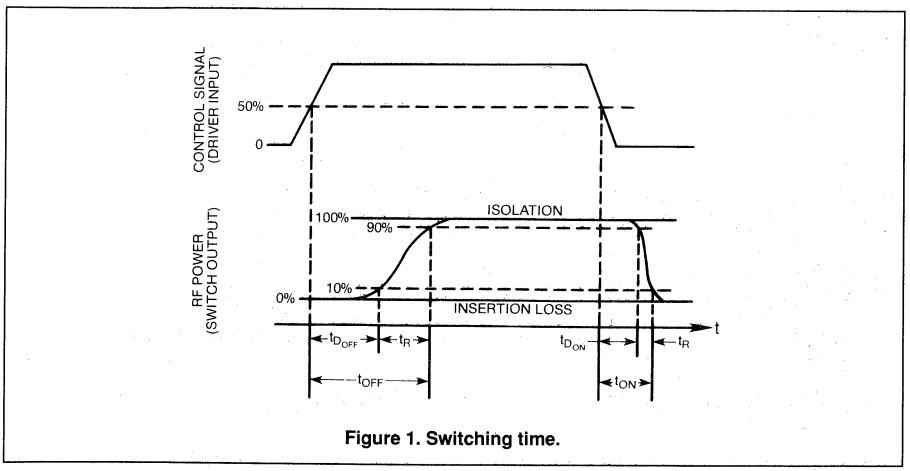



**Figure 1. Switching time.**

1. Standard TTL logic is defined as follows:

   Logic Low ("0"): $0V \le V_c \le 0.4V$ at 10 mA max.
   Logic High ("1"): $2.4V \le V_c \le 5.5V$ at 250 $\mu$A max.

   where $V_c$ is the control voltage.

2. Many commercially available switch drivers employ output current waveshaping ("current spiking") to compensate for the delay due to diode storage charge.

10% rf to 90% rf, etc.) One other important point about switching time is that although it is defined relative to the rf power, several techniques exist for measuring switching time that detect rf voltage. If rf voltage is used, the equivalent 50% TTL to 90% rf power switching time would be measured from 50% TTL to 95% rf voltage.

### Power Handling

Several definitions of the term, power handling, are used in the control products industry today. One definition is the maximum RF input power that the switch can withstand without any degradation in electrical performance. Another definition sometimes used is the rf input power below which no *permanent* degradation in switch performance will occur. The reason for the multiplicity of definitions is simple. Power handling, in a qualitative sense, specifies a limit to the amount of power that a switch can withstand; yet no standard criteria for that limit has ever been established. The confusion is eliminated by redesignating power handling in terms of two different parameters, each of which is consistent with the parameters already used to describe other passive components. The first is, *maximum rf power*, which is defined as the maximum rf input power that a switch (or any other device) can withstand with no permanent degradation in electrical performance. The second term is, *insertion compression point*, which is defined as the rf input power at which the insertion loss increases by 1 dB above the loss measured with the switch operating in its linear state. As can be seen, insertion compression point is exactly analogous to the 1-dB compression point, which is generally considered to be the upper limit of a device's dynamic range.

A summary of definitions of microwave switch parameters appears in Table 1.

### Categorizing Microwave Switches

To understand the basis for the trade-offs between key switching parameters, such as isolation and power handling, it is helpful to categorize microwave switches according to class, function, and diode configuration. All microwave switches fall into one of two distinct classes: *reflective* and *nonreflective*. Reflective switches reflect incident power back to the source when in the isolated state; nonreflective switches (or "matched switches," as they are sometimes called) are those devices which are designed to terminate any incident power when in the isolated state. Either type of switch will connect a source to a load when in the insertion-loss state.

Both switch categories can be divided into three groups, according to switch function: Single-pole single-throw (SPST), single-pole multithrow (SPMT), and transfer.[3] An SPST switch is a two-port device which either connects the source to the load (in the insertion-loss state) or isolates the source from the load (as shown in Figure 2). An SPMT switch is a multiport device which can connect (or isolate) a source and any one of a number of different loads. Figure 3 shows an SP4T switch connecting a generator, Gl, to a load, L2.

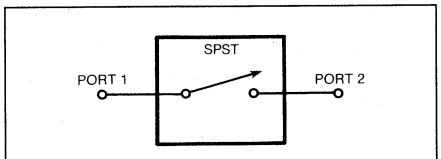


**Figure 2. Single-pole, single-throw switch.**

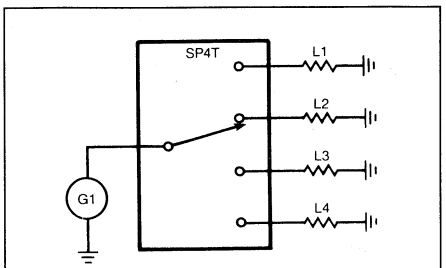
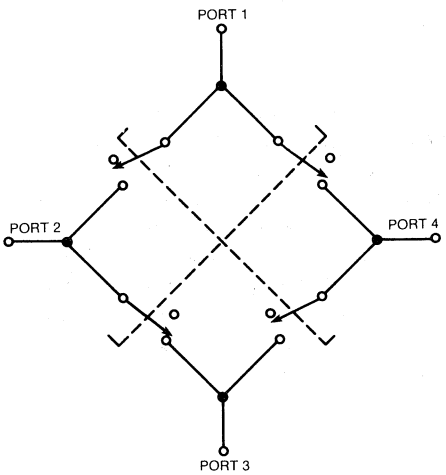


**Figure 3 Single-pole, multithrow switch.**

Loads Ll, L3 and L4 are isolated from each other and the generator. Transfer switches are four-port devices that have two states; the truth table in Figure 4 shows which pair of ports are connected and which are isolated in each state. Note that the insertion-loss port pair in state 1 is "transferred" to the isolated port pair in state 2.




| State | Insertion Loss Port Pairs | Isolation Port Pairs |
|---|---|---|
| 1 | 1-4<br>2-3 | 1-2<br>3-4 |
| 2 | 1-2<br>3-4 | 1-4<br>2-3 |

**Figure 4. Transfer switch.**

There are three principle diode configurations which can produce the SPST, SPMT and transfer functions: All shunt, all series, and series/shunt. Consider the reflective SP2T switch using the all-shunt diode configuration of Figure 5. The input is connected to output 1 when diode D2 is biased into the low-impedance state and diode D1 is biased into the high-impedance state. The low

| Term | Definition |
|---|---|
| Isolation | Total power lost through the switch in the off state. |
| Insertion Loss | Total power lost through the switch in the on state. |
| On/Off Ratio | Isolation referenced to (less) the insertion loss. |
| Switching Time | Total time elapsed from 50% of the input control voltage to 90% of the final rf output power. |
| Transition Time | Time elapsed from 10% of the final rf output power to 90% of the final rf output power. |
| Delay Time | Time elapsed from 50% of the input control voltage to 10% of the final rf output power. |
| Insertion Compression Point | rf input power at which the insertion loss increases by 1 dB. |
| Maximum rf Power | Maximum rf input power that the switch can withstand with no permanent degradation in electrical performance. |

**Table 1. Summary of definitions.**

3. Other configurations, such as double-pole, double-throw are merely combinations of switches from one or more of these groups.

impedance at D2 is transformed to a high impedance at the center junction through the quarter- wavelength transmission line. This transformed impedance is much greater than the impedance between the center junction and output l. Hence, the signal will flow to output 1, and output 2 will be isolated from the input.

A schematic for an SP2T switch employing the all-series diode configuration is shown in Figure 6. When Dl is biased into the low-impedance state and D2 is biased into the high-impedance state, the input is connected to output 1. Output 2 is isolated from the input because of the high impedance at D2. The SP2T switch in Figure 7 uses the series/shunt diode configuration. By biasing Dl and D4 into the low impedance state, and D2 and D3 into the high-impedance state, the input is connected to output 1. The amount of isolation from the input to output 2 is directly proportional to the impedance ratio between D3 and D4. These three diode configurations can each produce any of the three switch functions, but with markedly different electrical performance.

In general, determining the class and function of a pin-diode switch is fairly straightforward. For example, a system may have 4 sources which must be selected and connected to a single output, as in a multioctave sweeper. An SP4T switch would perform this function if the common arm was connected to the output of the sweeper, and each source was connected to one of the other switch arms. The class of the switch needed is determined by the sensitivity of the load and sources to reflection. A reflective switch, such as the WJ-MS403, can be used if the sources can withstand operation into a poor match when they are isolated from the sweeper output. Selecting the diode configuration, however, is considerably more difficult than choosing the class and function, because it involves numerous tradeoffs between isolation, transition time, power handing and bandwidth. [4]

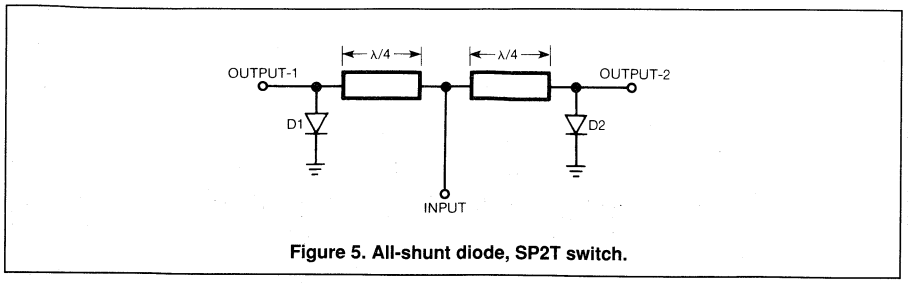


Figure 5. All-shunt diode, SP2T switch.

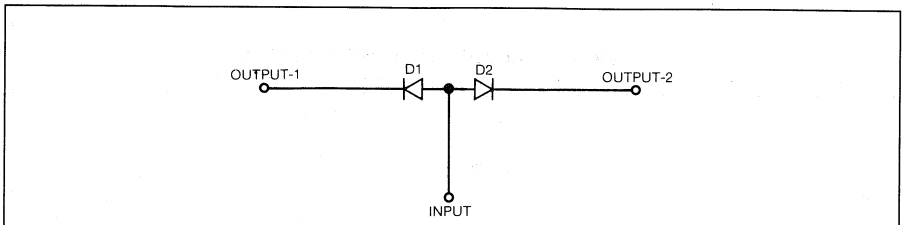


Figure 6. All-series diode, SP2T switch.

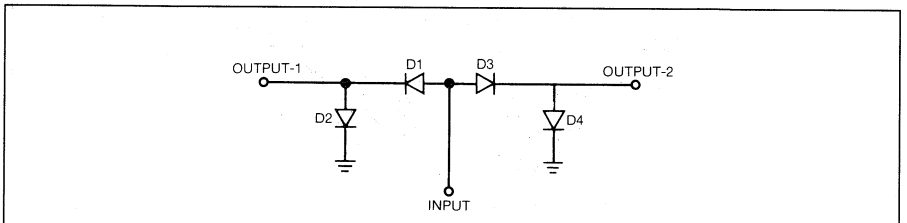


Figure 7. Series/shunt diode, SP2T switch.

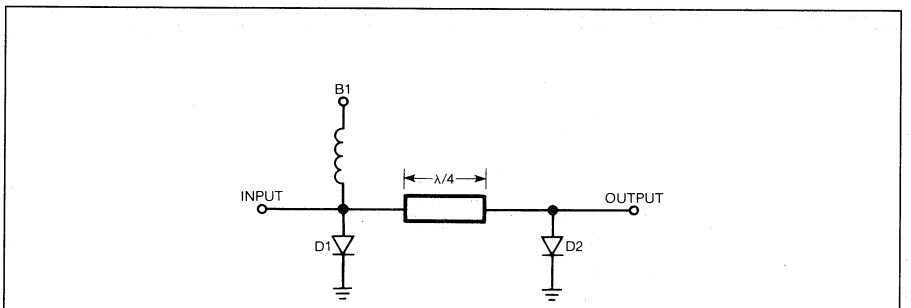


Figure 8. All-shunt diode, reflective SPST switch.

## Reflective Switches

Let's consider the all-shunt diode configuration for each of the three switch functions (see Figures 8, 9 and 10). In general, the all-shunt approach limits itself to octave bandwidths in the SPMT and transfer functions, because insertion loss changes drastically with frequency. The SPST function is not characterized by this same drastic change of insertion loss, and is, therefore, multioctave. Isolation in all three functions is high, but due to the electrical spacing between the diodes, it degrades as the frequency moves away from the quarter-wavelength frequency. In the insertion-loss state, a reverse dc voltage can be applied across the diodes that is limited only by their breakdown voltage. Thus, proper diode selection can provide insertion compression points of up to 10 watts, CW. However, a tradeoff exists between insertion compression point and transition time: Short to medium transition times can be realized for insertion compression points up to 2 watts, CW; for compression points up to 10 watts, diode lifetime must be increased, causing transition time to exceed 200 nanoseconds. A summary of these switching parameter tradeoffs is given in Table 2, along with term definitions in Table 3.

4. Insertion loss is also dependent on diode configuration, but to a much lesser degree. Generally, the greater the complexity of a solid-state switch (i.e., the number of components) the higher the insertion loss.

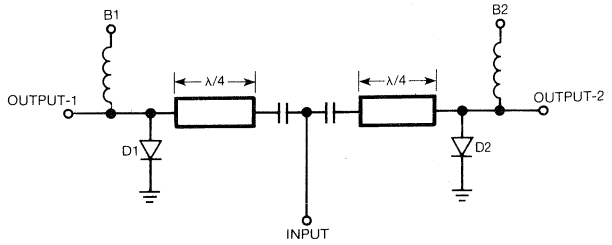



Figure 9. All-shunt diode, reflective SPMT switch.

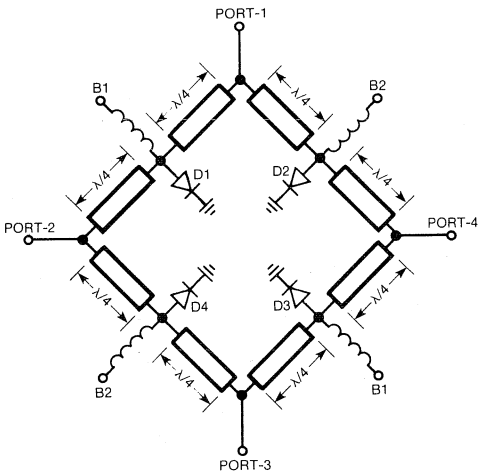



Figure 10. All-shunt diode, transfer switch.

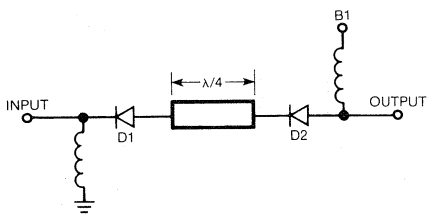



Figure 11. All-series diode, reflective SPST switch.

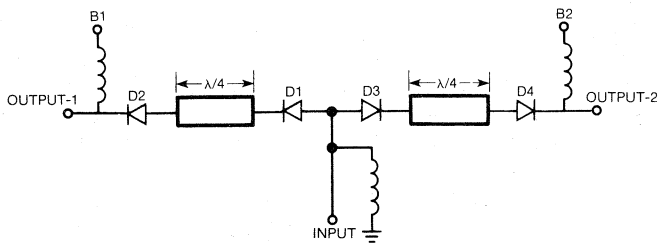



Figure 12. All-series diode, reflective SPMT switch.

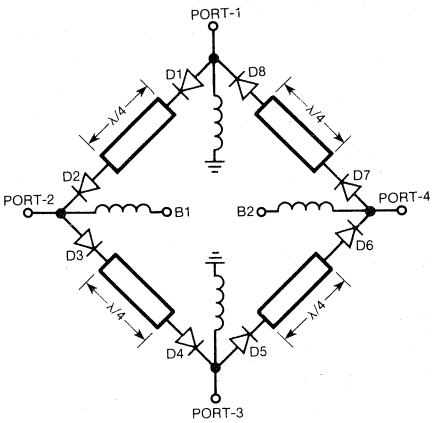



Figure 13. All-series diode.

Schematic diagrams of each switch function using the all-series diode configuration are shown in Figures 11, 12 and 13.

Bandwidth for all three functions is multioctave, and the insertion compression point is low. In the insertion-loss state, the diodes are on, and absorb rf energy as it passes through the switch. This absorbed power is the major factor limiting the maximum power capability. Also, due to the physical spacing of the diodes, isolation is frequently dependent. However, this frequency dependence is less severe than with the all-shunt diode configuration. The lowest isolation for the all-series approach usually occurs at the upper limit of the frequency range. Slow transition time is the major drawback of this diode configuration. When two or more diodes are in series, each cannot be connected directly to a low impedance dc source. Hence, for the diodes to be turned off, the stored charge in the I-layer of the pin diodes must recombine through another diode rather than directly through a dc source. This diode-to-diode recombination results in a net transition time that is much longer than that of either diode alone, and generally causes the transition time to fall into the "long" category. Since there is no stored charge in a diode that is turned off, the transition time from isolation (diodes off) to insertion loss (diodes on) can still be short. Once again, a summary of these performance tradeoffs is given in Table 2. Table 2 also indicates how the series/shunt diode configuration affects the four tradeoff parameters for each of the three switch functions shown in Figures 14, 15 and 16. This diode configuration, which is used in many high performance W-J switches,

| Function | Tradeoff Parameters | | | | | |
|---|---|---|---|---|---|---|
| | Diode Configuration | Isolation | Transition Time | Insertion Compression Point | Bandwidth | Figure |
| SPST | All Shunt | High (freq. dependent) | Short | High | Multioctave | 8 |
| | All Series | High (freq. dependent) | Long | Low | Multioctave | 11 |
| | Series/Shunt | High | Short | Low | Multioctave | 14 |
| SPMT | All Shunt | High | Short | High | Octave | 9 |
| | All Series | High (freq. dependent) | Long | Low | Multioctave | 12 |
| | Series/Shunt | High | Short | Low | Multioctave | 15 |
| TRANSFER* | All Shunt | High | Short | High | Octave | 10 |
| | All Series | High (freq. dependent) | Long | Low | Multioctave | 13 |
| | Series/Shunt | High | Short | Low | Multioctave | 16 |
| *Transfer switches are actually nonreflective due to the nature of their function. | | | | | | |

**Table 2. Tradeoff chart for reflective switches.**

| Term | Tradeoff Parameters | | |
|---|---|---|---|
| | Isolation | Transition Time | Insertion Compression Point |
| Low (Long) | 20 dB to 30 dB | ($t \geq 200$ ns) | 100 mW max. |
| Medium | 30 dB to 45 dB | 50 ns $\leq t <$ 200 ns | 100 mW to 2 Watts |
| High (Short) | 45 dB to 60 dB | (5 ns $\leq t <$ 50 ns) | 2 Watts to 10 Watts |

**Table 3. Term definition table.**

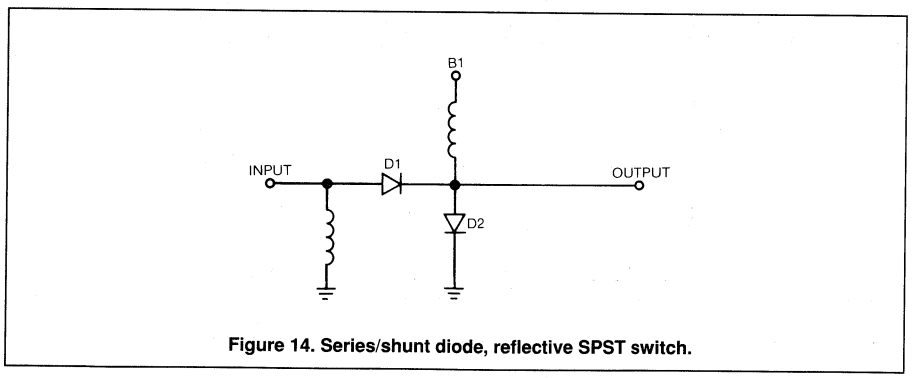



**Figure 14. Series/shunt diode, reflective SPST switch.**

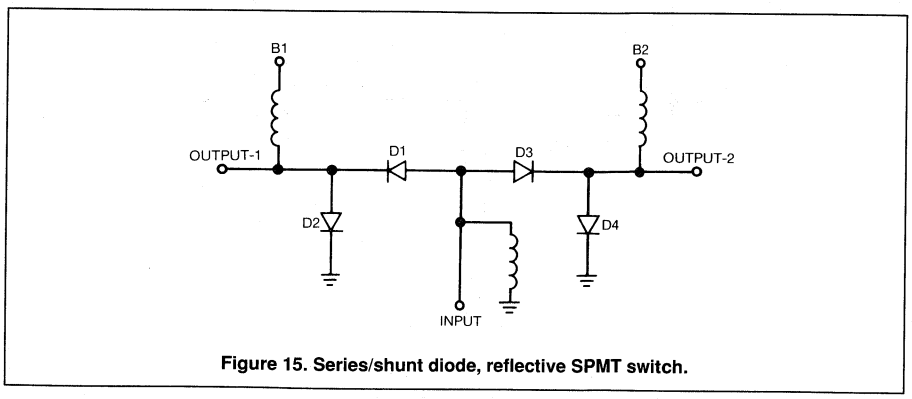



**Figure 15. Series/shunt diode, reflective SPMT switch.**

5. The SPST series/shunt nonreflective switch cannot be practically realized.

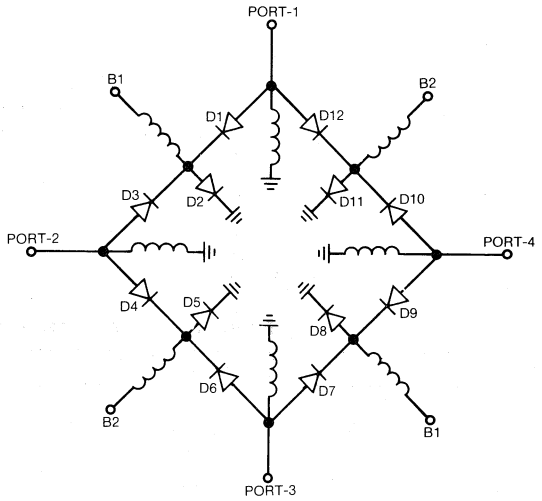



**Figure 16. Series/shunt diode, transfer switch.**

such as the 2 to 18 GHz MSE203 provides high isolation and short transition times over multioctave bandwidths. The only real drawback to the series/shunt configuration is its low power-handling capability. In the insertion-loss state, the shunt diodes are exposed to the peak rf voltage, yet the reverse dc voltage across these same diodes is limited, because of the forward voltage of the series diode. This small reverse bias allows the shunt diodes to be forward biased by a much smaller rf voltage than would be possible if the reverse voltage were high, and results in a lower insertion compression point. Despite its lower compression point, the series/shunt configuration provides the best overall performance for a given number of diodes, and is the most commonly used design approach for reflective switches.

## Nonreflective Switches

Any SPST[5] or SPMT reflective switch can be made nonreflective by adding a shunt diode in series with a resistor at the input to each arm (compare Figures 8, 9, 11, 12 and 15 with Figures 17, 18, 19,20 and 21, respectively). This diode resistor combination is designed to provide a 50-ohm load impedance to the system to absorb the rf energy when the switch is in the isolated state. Although diode configuration affects the four tradeoff parameters in exactly the same way as for reflective switches, the 50-ohm load has an additional effect on power handling and bandwidth. First, for any diode configuration or switch function, maximum rf power is limited to the power dissipation capabilities of the resistor, which usually limits the maxi-

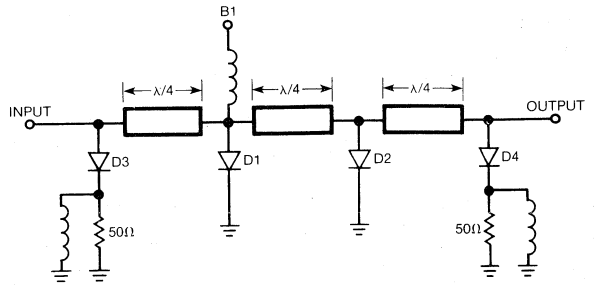



**Figure 17. All-shunt diode, nonreflective SPST switch.**

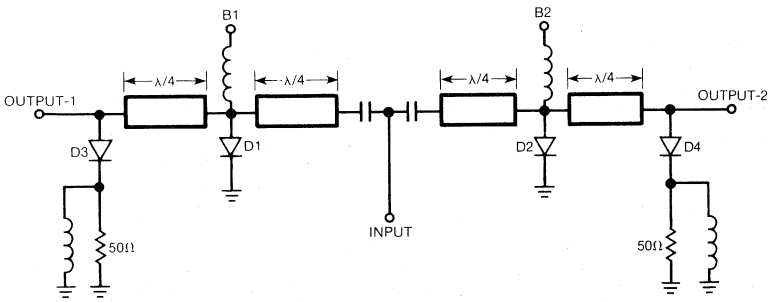



**Figure 18. All-shunt diode, nonreflective SPMT switch.**

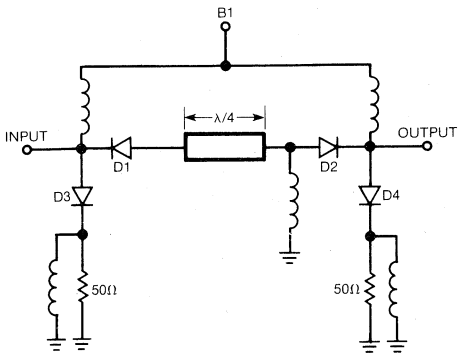



**Figure 19. All-series diode, nonreflective SPST switch.**

mum rf power of the switch to the "medium" category. Second, due to the quarter-wavelength spacing between the diode-resistor pair and any adjacent shunt diode, the bandwidth for both the all-shunt and series/shunt diode configurations will be reduced to an octave. A summary of the tradeoffs between isolation, transition time, insertion compression point, and bandwidth for nonreflective switches is given in Table 4.

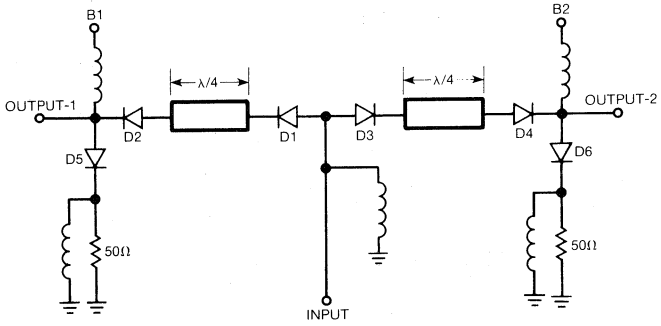



**Figure 20. All-series diode, nonreflective SPMT switch.**

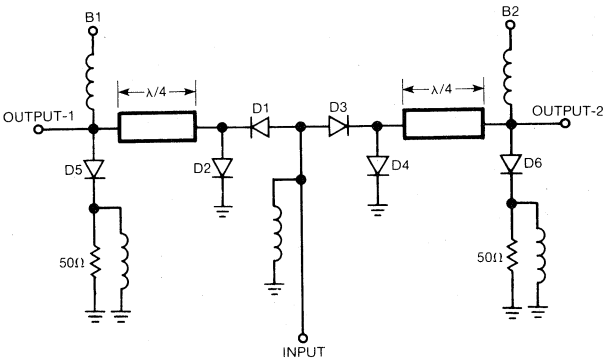



**Figure 21. Series/shunt diode, nonreflective SPMT switch.**

## Example

The use of the tradeoff charts is best illustrated with an example. Consider a system that has the following switch requirements:

| | |
|---|---|
| Function: | SP3T |
| Frequency Range: | 2.5 to 10.0 GHz |
| Isolation: | 40 dB (min.) |
| Insertion | |
| Compression Point: | +17 dBm |
| Maximum rf Power: | +30 dBm |
| Insertion Loss: | 3 dB (max.) |
| Switching Time: | 40 nsec (max.) |
| | [50% TTL to 90% rf] |
| VSWR: | 2.0:1 (max.) |
| | [Insertion Loss State] |

To assess the manufacturability of this switch, the first step is to convert the quantitative electrical specifications for isolation, transition time and insertion compression point to their corresponding qualitative ranges via Table 3. For the switch in this example, the isolation requirement of 40 dB falls into the "medi-

| Function | Tradeoff Parameters | | | | | |
|---|---|---|---|---|---|---|
| | Diode Configuration | Isolation | Transition Time | Insertion Compression Point | Bandwidth | Figure |
| SPST | All Shunt | High | Short | Medium | Octave | 17 |
| | All Series | High | Short | Low | Multioctave | 19 |
| | Series/Shunt | (See Note 5) | | | | |
| SPMT | All Shunt | High | Short | Medium | Octave | 18 |
| | All Series | High | Long | Low | Multioctave | 20 |
| | Series/Shunt | High | Short | Low | Octave | 21 |

**Table 4. Tradeoff chart for nonreflective switches.**

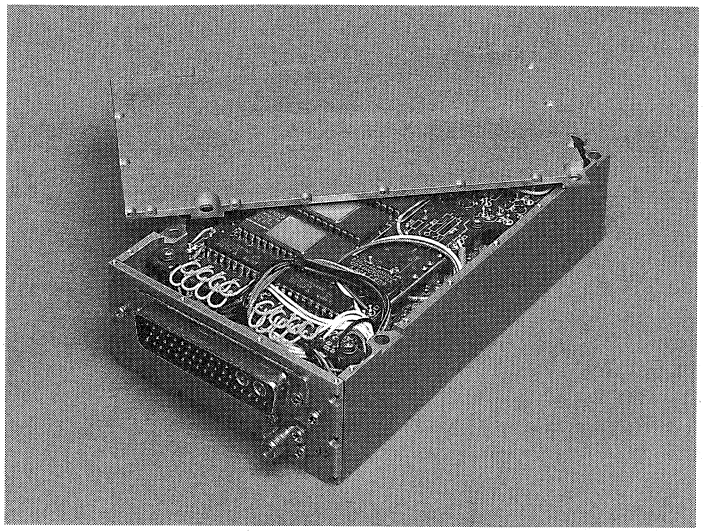
um" range, and the insertion compression point of +17 dBm is in the "low" range. Since the electrical specification calls for a switching time of 40 nsec, clearly, the transition time must be in the "short" category. Once these three numbers have been converted, the next step is to compare the desired switch performance with that of each of the 3 switch types from Table 2 or 4. The switch in our example is a reflective SPMT[6]; therefore, we will compare the specifications of our switch with those of the three SPMT switches in Table 2. The objective of this comparison is to determine if any of these three switches will meet (or exceed) the required performance specifications. If one or more do, it would be fairly certain that the specified switch performance could be readily achieved in practice. Looking at Table 2, an all-shunt SPMT switch would meet or exceed all electrical specifications, with the exception that this design is effective only over octave bandwidths, and, thus, would not be useful for the 4:1 bandwidth switch in our example. The all-series SPMT switch is multioctave, and meets or exceeds both the isolation and the insertion compression point for our switch requirement However, Table 2 also indicates that the transition time for this type of SPMT switch is long, which is not compatible with the short switching time needed. Comparing our switch specifications to those of the series/shunt SPMT switch in Table 2, we see that this design will meet or exceed all four switch requirements. Hence, we can conclude that our switch specifications are realizable.

## Conclusion

Several switching parameters have been defined with the intent of standardizing the terminology used to describe pin-diode switches. By utilizing terms that are standard throughout the control products industry, the system designer can comfortably specify the pin-diode switch required for the system. Also, four parameters isolation, transition time, insertion compression point and bandwidth were selected as key tradeoff parameters, because of their strong interdependence. The interaction between these four parameters was shown to stem from the particular diode configuration used for the switch circuit, and, ultimately, allowed us to develop charts which qualitatively and quantitatively compared the three switch types for each of the three diode configurations. Finally, an example was given to illustrate how the tradeoff charts could be used by a system designer as an aid in determining the most practical switch for the system.

6. Since no maximum VSWR is specified for the isolation state, we assume that the system is not affected by the VSWR of the isolated arms; therefore, a reflective switch can be used.

# How To Specify And Use A DTO/VCO



**Author: Ronald N. Buswell**

Modern EW systems require digitally tuned oscillators (DTOS) for use as local oscillators in receivers and in transmitters for jamming. Using PROM correction circuits, DTOs are now capable of excellent frequency accuracies. In addition, buffer amplifiers following the oscillator are capable of providing power levels in excess of 100 mW (+20 dBm), while reducing frequency pulling to typically less than 1 MHz. Also, voltage regulators internal to the DTO reduce pushing effects under 1 MHz/V.

However, DTOs exhibit several subtle characteristics that may affect system performance, including such factors as the set-on accuracy of a receiver, receiver sensitivity, and the power spectral density of a jammer. This article analyzes these factors and explains how and why DTOs affect such performance parameters.

### Receiver Applications

ECM receiver systems are often configured using a double conversion technique, as shown in Figure 1. A signal from 2 to 18 GHz is initially downconverted to a common 2-to-6 GHz band, and then a DTO is used to tune across the 2-to-6 GHz band.

The set-on accuracy of this system is affected by inaccuracies from the first LO., which are relatively small, and the DTO. For the DTO, the frequency accuracy is certainly the most significant factor affecting set-on accuracy. Using digital calibration techniques, the frequency accuracy (nonlinearity and drift over temperature) can be virtually eliminated; however, the effects of post-tuning drift and repeatability must still be considered.

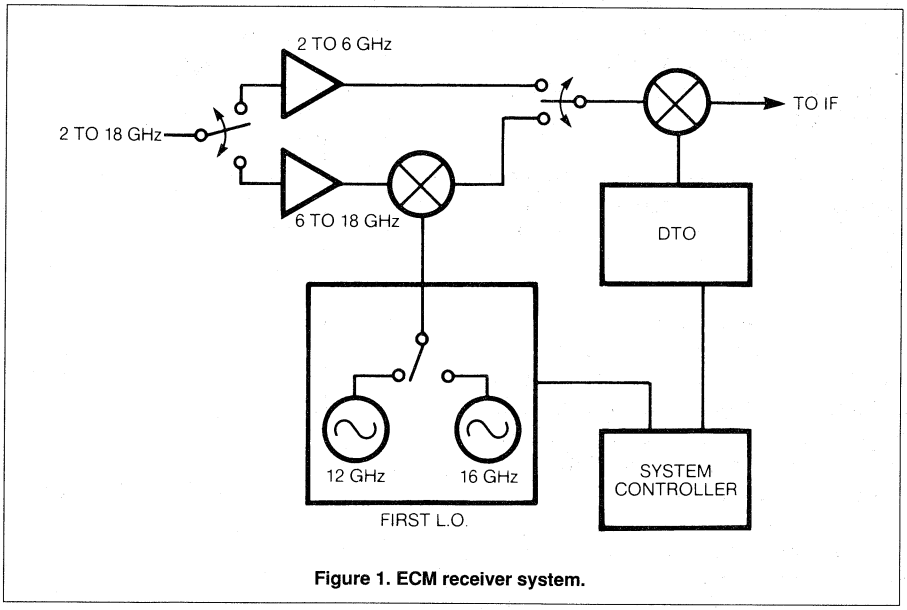



**Figure 1. ECM receiver system.**

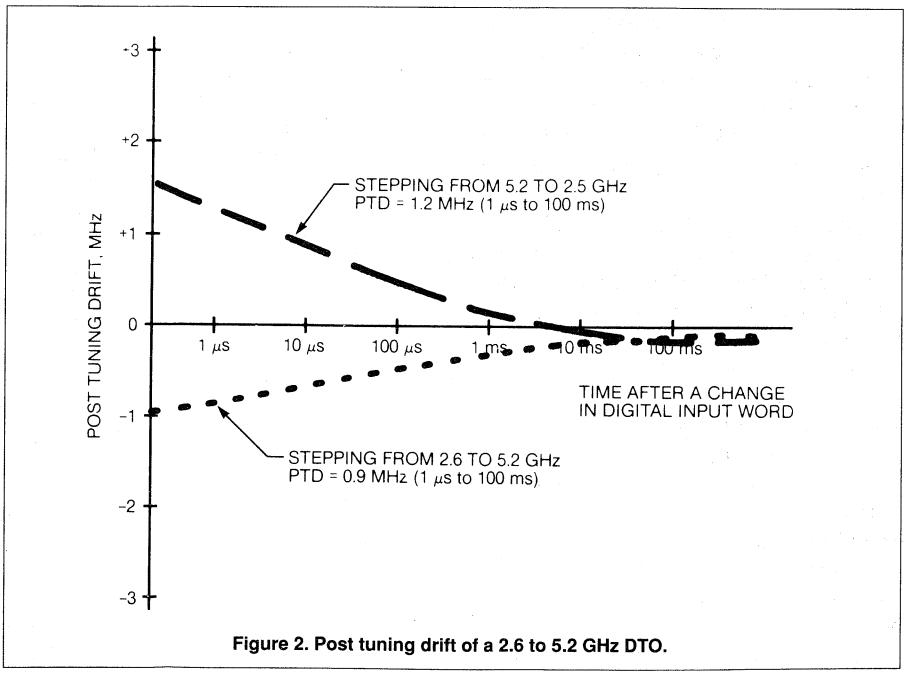



**Figure 2. Post tuning drift of a 2.6 to 5.2 GHz DTO.**

*Post-tuning drift* (PTD) for a DTO is defined as the shift in oscillator frequency output, as a function of time; after a change in digital input word, as shown in Figure 2, for a 2.6-to-5.2 GHz unit. The effect that causes this variation in frequency out to a few milliseconds after a step change in frequency is related to the temperature variation of the active devices in the oscillator, especially the varactor, and similar effects in the driver circuit. As the oscillator is tuned across the band, its active devices change their operating points due to variations in rf loading; and, as the temperature changes, the impedance changes, causing shifts in frequency. The rate of change of the frequency is associated with the thermal impedances of the active devices in the circuit. The thermal resistance directly affects the magnitude of the drift, and the thermal capacity affects the rate of change of the impedance and, therefore, the rate of frequency change.

Therefore, lowering the thermal impedances of critical active devices and operating them at bias points at which the junction temperatures remain more constant will reduce the PTD. Also, by using lower-power small-signal devices, such as bipolar junction transistors (compared to Gunn diodes), or by use of silicon transistors (compared to GaAs FETs), the PTD can be reduced. A comparison of typical PTD performance for various types of oscillators is shown in Figure 3.

The thermal effects usually end in a few milliseconds; however, DTOs exhibit other longer-term post-tuning- drift mechanisms. These are primarily associated with an effect called "varactor charging," in which ions on the surface of the varactor migrate across the junction over a period of time in the presence of an electric field that is caused by the reverse bias on the varactor. To reduce varactor charging, a special passivation has been developed that forms molecules with these ions so they will not migrate. A comparison of the PTD of a DTO with and without passivated varactors is shown in Figure 4.

*The repeatability* of a DTO defines how well the DTO will return to the same frequency while being switched to that frequency from many different frequencies, as shown in Figure 5, and includes the effects of post-tuning drift. It is also dependent on how long the DTO rests at either the desired fix, quency or the other frequencies.

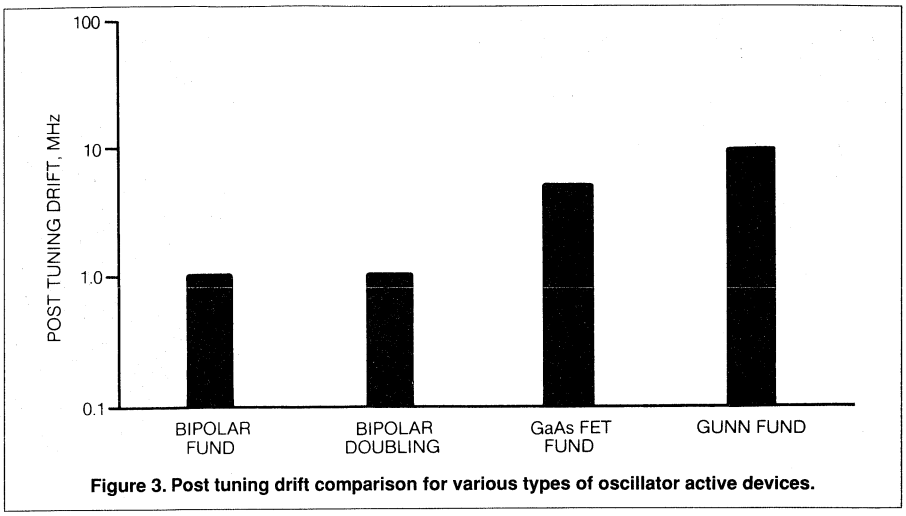



**Figure 3. Post tuning drift comparison for various types of oscillator active devices.**

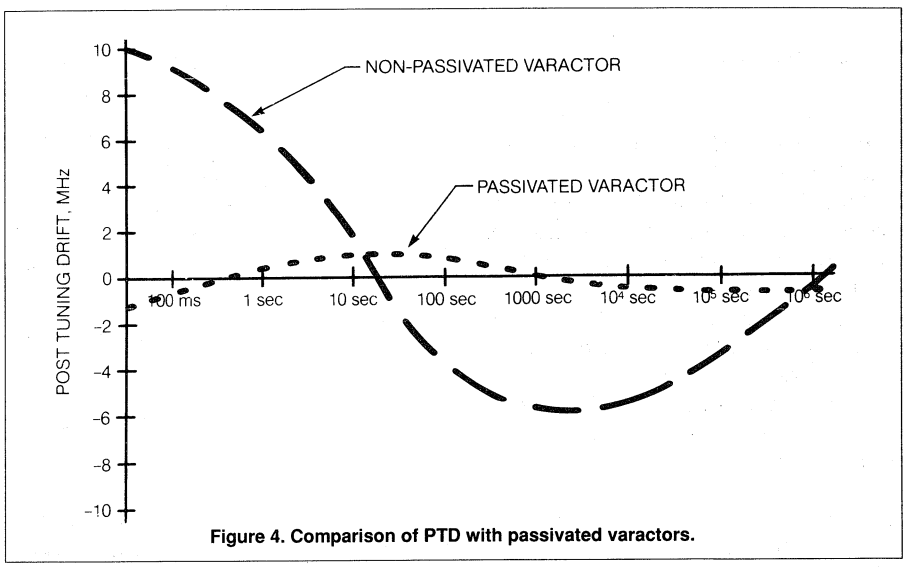



**Figure 4. Comparison of PTD with passivated varactors.**

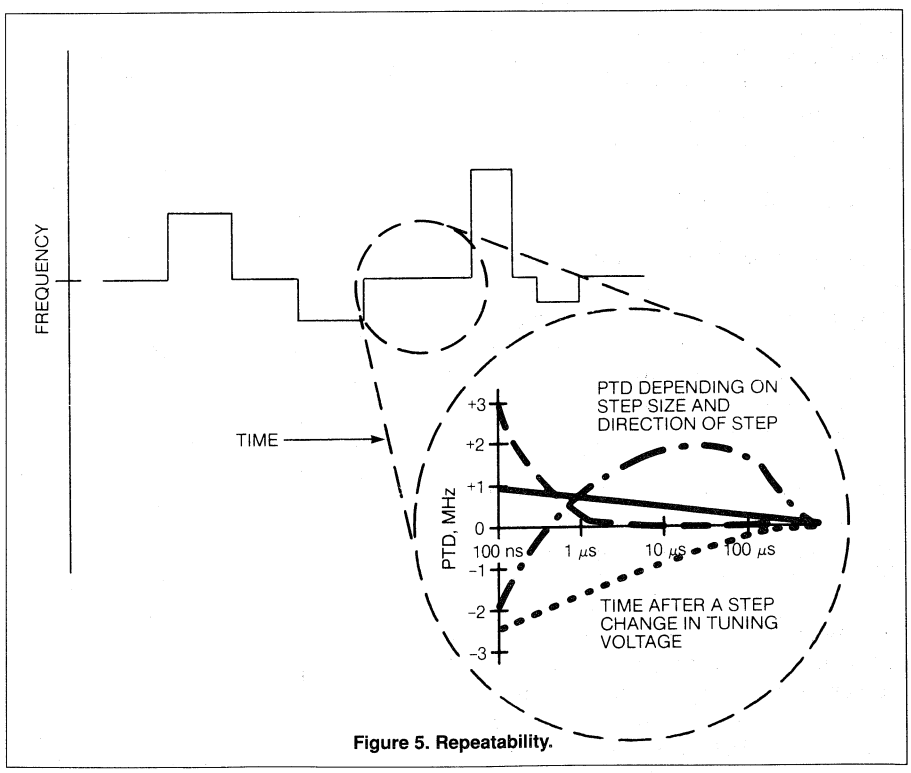



**Figure 5. Repeatability.**

The short-term repeatability (<10 milseconds) of a DTO can be improved, as is the case for PTD, by reducing the thermal impedances and operating critical active devices like the oscillator transistors and varactors at constant junction temperatures. Long-term repeatability (>10 milliseconds) can be improved by using the previously mentioned specially passivated varactors.

## SYSTEM SENSITIVITY

System sensitivity determines the lowest-level signal that can be received. Certainly, harmonic and spurious signals from the first L.O. and DTO will affect this. However, filtering can normally be used to achieve acceptable results. On the other hand, if the residual fm of the oscillators is too high, it may fill up the receiver IF so signals cannot be detected. The first L.O. residual fm can be made relatively low by using low-noise or phase-locked oscillators. DTOs, however, exhibit greater residual fm, especially when subjected to vibration and bias, and digital line noise.

The residual fm of a DTO is defined as the peak-to-peak deviation of the output signal as observed on a spectrum analyzer with a 1-kHz IF bandwidth at -3 dBc. Typically, the residual fm of a DTO using bipolar transistors in the oscillator is less than 100 kHz. This comes from the residual fm of the oscillator itself and the noise from the digital driver that frequency-modulates the oscillator. Gunn diode and FET oscillator DTOs exhibit much worse residual fm, typically 200 to 500 kHz. Receiver systems normally have a considerable amount of residual fm on the digital and bias lines. It is not uncommon to have 100 mV of noise from power supplies and digital clocks on these lines during normal system operation. This noise causes frequency modulation of the DTO. The normal 100 kHz of residual fm may be degraded to several MHz in the system. To reduce the effect of digital-line noise, buffers, latches, or other circuits that attenuate the digital-line noise are added to the digital input, as shown in tuning speed, so they must be selected with that in mind.

Bias-line noise also affects the residual fm of the DTO. To reduce this, LC filters may be added, as shown in Figure 7; but, in some cases, it is necessary to add a secondary regulator on the bias input

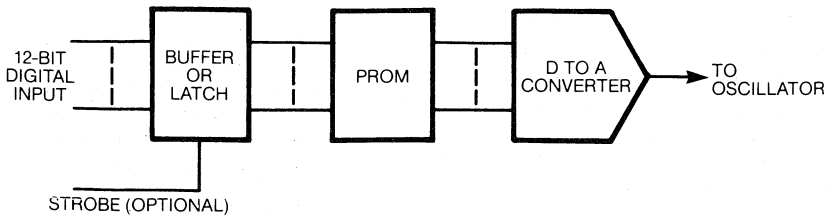



**Figure 6. Buffers on digital input.**

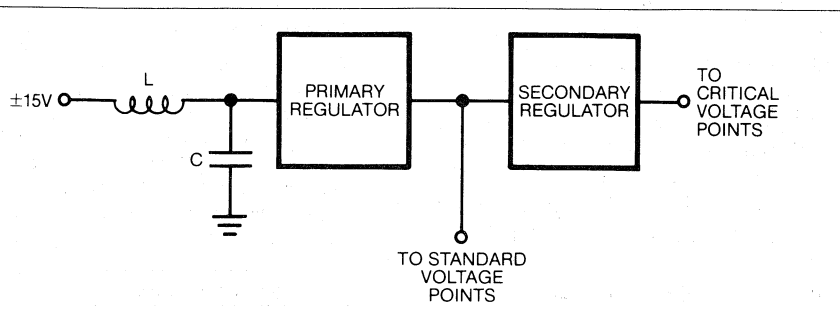



**Figure 7. Bias input filter/regulator circuitry.**

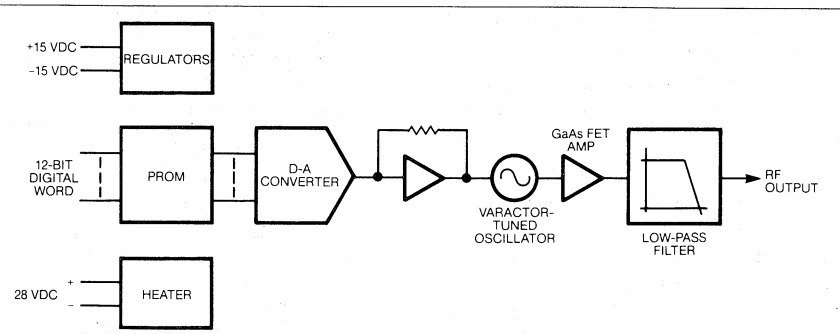



**Figure 8. DTO used in a receiver system local oscillator.**

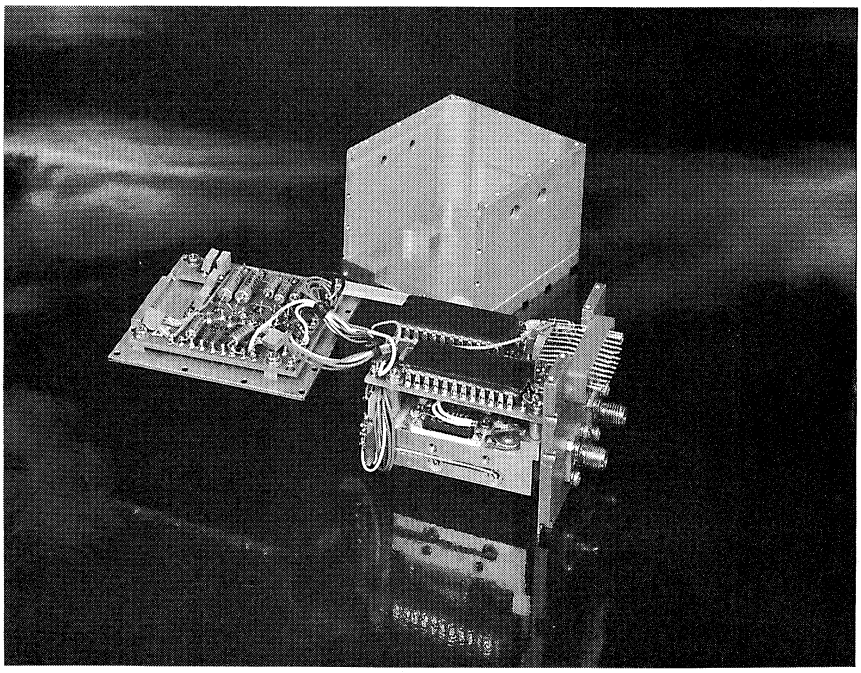


**Figure 9. WJ-2854-22 2.6 to 5.2 GHz DTO.**

to attenuate low-frequency noise. This has the disadvantage of reducing the voltage available for circuit operation, so the secondary output is used only on the most sensitive bias points. Using digital-line buffering and bias-line filtering, fm levels under 100 kHz can be achieved.

Residual fm in a system during vibration causes parts inside the unit to move. In the oscillator, this causes movement of bond wires and other parts, which results in an increase in the residual fm of the DTO. Careful design of the unit can minimize this effect. For example, the residual fm of a 2.6-to-5.2 GHz DTO exhibits an increase in fm from 100 kHz to 200 kHz, when subjected to 10 g's peak sine vibration from 10-to-2000 Hz.

## TYPICAL DTO FOR A RECEIVER APPLICATION

The block diagram of a DTO used in a receiver system is shown in Fum 8. The input to the DTO is driven by a 12-bit digital word to select the desired frequency. Internal to the DTO, a PROM is used to modify the digital address so it exactly matches the oscillator tuning characteristic. Using this technique, frequency accuracies of +/-5 MHz can be attained at room temperature, and +/-10 MHz can be attained over the -54° to +85° centigrade range. A picture of one of these oscillators covering the 2.6 to 5.2 GHz frequency range is shown in Figure 9, and the performance characteristics of this unit are summarized in Table 1.

## Jammer Applications

The digitally tuned oscillator used in a transmitter application is often configured with a modulation port, as shown in Figure 10. In the system, the digital lines are used to set the oscillator on the desired frequency, while the modulation port is used to modulate the oscillator for jamming purposes. As such, the bandwidth of the modulation port needs to be as wide as possible. Typical bandwidths today are in excess of 20 MHz. A picture of one of these oscillators covering the 6-to-12 GHz frequency range is shown in Figure 11, and the performance characteristics are summarize in Table II.

The primary purpose of a jammer is to put out the maximum amount of radiated energy over the desired frequency range. In other words, the power-spectral density must be maximized.

| **RF Characteristics**[1,2] | **Guaranteed** |
|---|---|
| Frequency Range | 2.6 to 5.2 GHz |
| Power Output, Minimum (J1 and J2 Ports) | +12 dBm |
| Power Output Variation, Maximum (J1 and J2 Ports) | 5 dB |
| Frequency Drift Over Temperature[3], Maximum | 0.25 MHz/°C |
| Spurious Output Suppression | |
| Harmonic ($nf_o$), Minimum | -15 dB |
| In-band, Non-harmonic, Minimum | -70 dB |
| Pushing Factor, Maximum | 1.5 MHz/V |
| Pulling Figure (3:1 VSWR), Maximum | 1.0 MHz |
| Isolation Between 2 RF Output Ports (J1 and J2), Minimum | 15 dB |
| **Tuning Characteristics** | |
| Tuning Resolution | 12-bit TTL Compatible |
| Digital Tuning Range[5] | 0 to 4095 |
| Non-linearity[4], Maximum | ±18 MHz |
| Post Tuning Drift (2.5 μsec to 50 μsec), Maximum | 1.8 MHz |
| Post Tuning Drift, 100 msec to 2 minutes | 1.0 MHz |
| Post Tuning Drift, 30 μsec to 100 msec | 1.0 MHz |
| Input Capacitance, Maximum | 150 pF |
| LSB, Maximum | 0.9 MHz |
| **Input Power Requirements** | |
| Oscillator Bias[6] | +15 Volts @ 400 mA, Maximum<br>-15 Volts @ 350 mA, Maximum<br>+5 Volts @ 300 mA, Maximum |
| Heater Voltage[7] | 28 Volts |
| Heater Current at Turn-on | 4.0 Amps, Maximum |
| Heater Current, Steady-state at -54°C | 4.0 Amps, Maximum |
| **Environmental Specifications** | |
| Operating Temperature[3] | -54°C to 85°C |
| Storage Temperature | -62°C to 95°C |
| **Mechanical Specifications** | |
| Package Dimensions Excluding Connectors and Mounting Flanges (LxWxH) | 2.12 x 2.28 x 1.73 inches |
| Weight, Maximum | 9.0 ounces |
| RF Output Connector (both ports) | SMA Jack |
| Tuning Input Connector | Multi-pin connector (RFI Protected) |
| Bias and Heater Connections | Multi-pin connector (RFI Protected) |
| W-J Outline Drawing Number | 337758 |

Notes:
1. The WJ-2854-22 is an rf oscillator employing varactors, bipolar transistors and field-effect transistors as the active elements. It also contains the following interface elements: isolation amplifier (active isolator), voltage regulator, proportionally controlled internal heater, D/A converter, PROM, and linearizer.
2. Unless otherwise noted, performance is specified for operation into a nominal matched load (VSWR ≤1.2:1) at laboratory ambient temperature.
3. Temperature is measured on the oscillator mounting surface.
4. The tuning non-linearity is the maximum deviation from linear tuning between the specified tuning word extremes and includes the effect of frequency drift over the operating temperature range.
5. The digital tuning range specifies the maximum range required to tune from minimum to maximum frequency.
6. Protective circuitry guards against damage due to overvoltage (up to 10 percent) and transient reverse voltages.
7. The heater is a self-regulating, proportionally controlled unit, isolated from bias and signal grounds.

**Table I. WJ-2854-22 digitally tuned oscillator.**

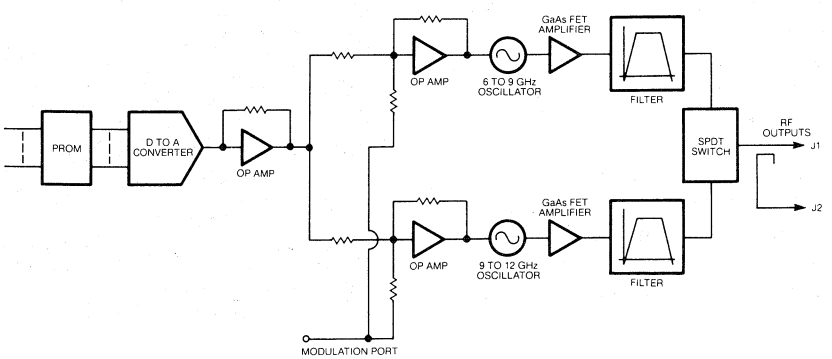



**Figure 10. DTO for a jammer application.**

Several key specifications for the DTO affect system performance, especially as they relate to power spectral density, including frequency accuracy, modulation-sensitivity variation, and modulation bandwidth.

## FREQUENCY ACCURACY

Frequency accuracy for a DTO is defined as the maximum deviation from the ideal frequency at a given digital input, including the effects of frequency change over temperature. The better the frequency accuracy of the DTO, the higher power density that can be achieved, because it is not necessary to modulate the oscillator over as broad a frequency range to ensure that the signal to be jammed is covered. Using PROMs at the digital input to the DTO, accuracies of ±10 MHz can be achieved over the -54° to +85° centigrade range. Other techniques may be used to achieve better accuracies, including the use of synthesizer techniques and calibration routines.

## MODULATION SENSITIVITY

The power spectral density is also affected by the variation in modulation sensitivity at the modulation port, as measured in MHZ/V. Given a constant amplitude modulation signal, if the modulation port is connected directly to the varactor, as shown in Figure 10, the deviation of the modulated signal and, therefore, the power density, will vary directly with the variation in modulation sensitivity of the oscillator itself. This variation is shown in Figure 12. As the output frequency of the oscillator increases, the modulation sensitivity decreases. Therefore, for a constant modulation signal, the deviation decreases and the power spectral density over the deviated spectrum increases. This effect is undesirable in transmitter applications and, therefore, designs have been developed to correct it.

The most straightforward technique is to place a linearizer circuit between the oscillator and modulation circuit, as shown in Figure 13. This reduces the variation in modulation sensitivity across the band, thereby making the power density and deviation more constant Overall variations of less than ±15% can be achieved using this technique. The disadvantage of the technique is that circuits having bandwidths greater than 10 MHz are very difficult to achieve.

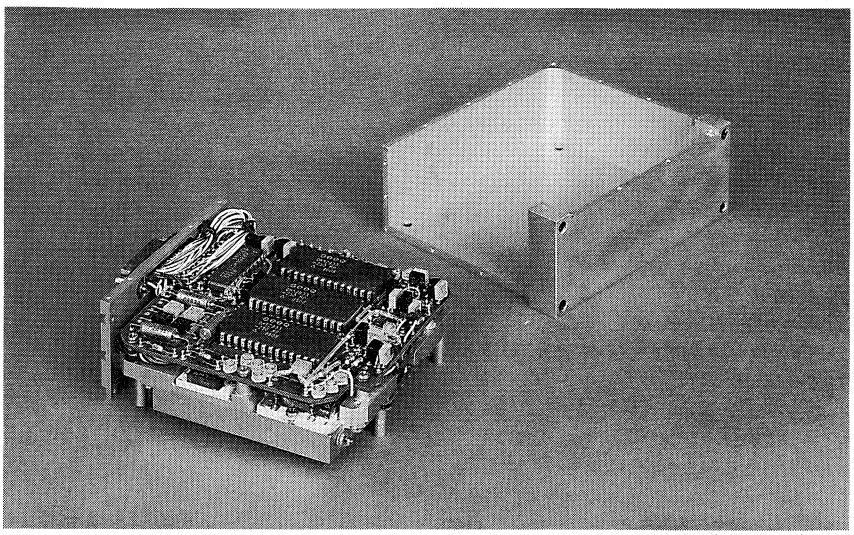


**Figure 11. WJ-2855-37 6 to 12 GHz DTO.**

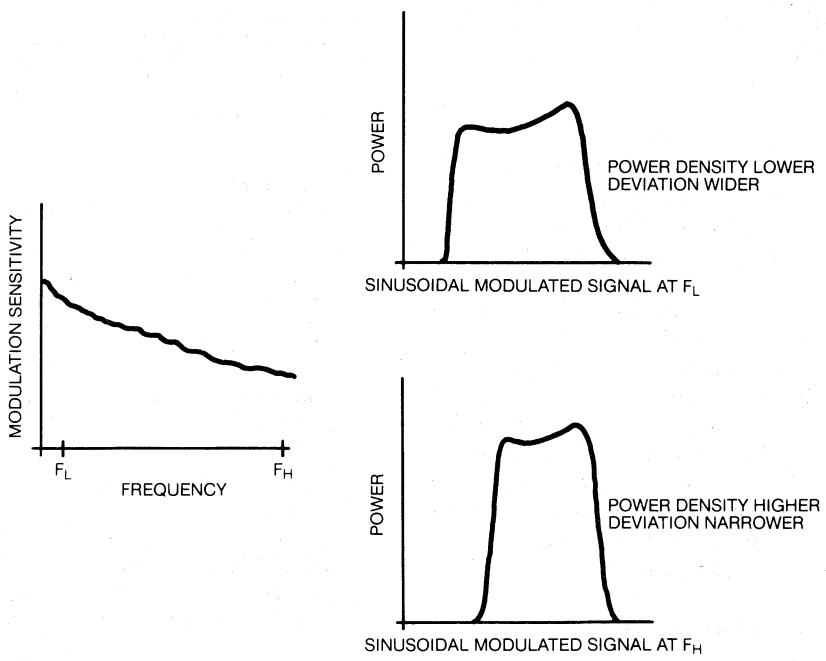



**Figure 12. Modulation sensitivity and modulated spectrum characteristics of the modulation port of a DTO.**

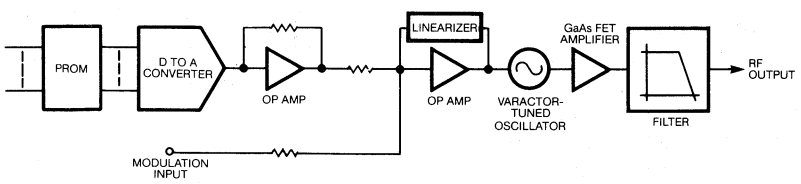



**Figure 13. DTO for jammer application with linearizer to reduce variation in modulation sensitivity.**

To achieve higher modulation bandwidths, another technique has been developed which uses a variable-gain amplifier, as shown in Figure 14. The gain of the amplifier is controlled by a PROM and D-to-A converter as the unit is tuned across the operating frequency range. Using the technique, the variation in modulation sensitivity and, therefore, variation in power density and deviation are less than ±5%. However, this technique, has one basic problem. The gain of the amplifier is set at one frequency, so when modulating the oscillator over frequencies for which the modulation sensitivity of the oscillator itself varies, the power density and deviation will vary. This is especially evident when the deviations become wide, e.g. 100 to 500 MHz. In addition, a fast change in the modulation sensitivity of the oscillator will show up in the modulated spectrum, as illustrated in Figure 15. By controlling the overall variation in modulation sensitivity of the oscillator and aligning out any fine-grain variations, this technique has proven to be superior to the linearizer technique.

One other effect to be considered is centroid shift. Due to the nonlinear characteristics of the modulation sensitivity, the center of the modulated spectrum shifts, compared to the location of the unmodulated carrier. The shift necessitates that the system be desiged to have slightly larger deviation to cover all threat frequencies. This also results in lower power density than if the modulation sensitivity were constant, as illustrated in Figure 16. This shift can be minimized by aligning the rf oscillator with minimum modulation sensitivity variation. The effect can be virtually eliminated if deviation information can be input to the variable gain amp PROM.

## MODULATION BANDWIDTH

The modulation bandwidth of a modulation port is defined as that modulation frequency at which the frequency deviation changes by ±(x)dB from its low-frequency values. Typically, (x) is specified in the range of 1 to 3 dB.

To achieve a certain power spectral density, it is necessary to modulate the oscillator over a broader deviation at low modulation frequencies to ensure the frequencies to be jammed are covered at higher modulation frequencies if the bandwidth decreases. This means that the overall power spectral density will be lower than if the modulation bandwidth were flatter.

| RF Characteristics[1,2] | Guaranteed |
|---|---|
| Frequency Range | 6.0 to 12.0 GHz |
| Power Output, Minimum (J1 Port) | +7.5 dBm |
| Power Output Variation, Maximum (J1 Port) | 4.5 dB |
| Power Output Variation, Maximum (J2 Port) | -20 to -10 dBm |
| Frequency Drift Over Temperature[3], Maximum | 40 MHz |
| Spurious Output Suppression | |
| Harmonic ($nf_o$), Minimum | 23 dB |
| Harmonic ($nf_o/2$)[4], Minimum | 23 dB |
| In-band, Non-harmonic, Minimum | 50 dB |
| Pushing Factor, Maximum | 0.25 MHz/V |
| Pulling Figure (2.0:1 VSWR), Maximum | 2 MHz |
| Pulling Figure (Infinite VSWR), Maximum | 5 MHz |
| **Tuning Characteristics** | |
| Tuning Resolution | 13-bit |
| Digital Tuning Range[6] | 545 to 7946 |
| Modulation Sensitivity Range, Maximum | 100 MHz/V |
| Modulation Sensitivity Range, Minimum | 60 MHz/V |
| Non-linearity[5], Maximum | ±10 MHz |
| Post Tuning Drift (1.7 μsec to 1.0 msec), Maximum | 5.0 MHz |
| Post Tuning Drift, 1.0 msec to 1 minute, Maximum | 3.0 MHz |
| Modulation Bandwidth (400 MHz deviation)[9], Minimum | 8 MHz |
| Nominal Step Size | 1 MHz ±50% |
| **Input Power Requirements** | |
| Oscillator Bias[7] | +15 Volts @ 500 mA, Maximum<br>-15 Volts @ 400 mA, Maximum<br>+5.2 Volts @ 600 mA, Maximum<br>-5.2 Volts @ 100 mA, Maximum |
| Heater Voltage[8] | 115 Volts AC |
| Heater Current at Turn-on | 1.5 Amps, Maximum |
| Heater Current, Steady-state at -54°C | 1.5 Amps, Maximum |
| **Environmental Specifications** | |
| Operating Temperature[3] | -54°C to 85°C |
| Storage Temperature | -54°C to 125°C |
| **Mechanical Specifications** | |
| Package Dimensions Excluding Connectors and Mounting Flanges (LxWxH) | 4.00 x 3.50 x 1.50 inches |
| Weight, Maximum | 20 ounces |
| RF Output Connector | SMA Jack |
| Tuning Input Connector | Multi-pin connector (RFI Protected) |
| Bias and Heater Connections | Multi-pin connector (RFI Protected) |
| W-J Outline Drawing Number | 337758 |

Notes:
1. The WJ-2855-37 is an rf oscillator employing varactors and bipolar transistors as the active elements. It also contains the following interface elements: isolation amplifier (active isolator), voltage regulator, proportionally controlled internal heater, D/A converter, PROM, and rf switch.
2. Unless otherwise noted, performance is specified for operation into a nominal matched load (VSWR ≤1.2:1) at laboratory ambient temperature.
3. Temperature is measured on the oscillator mounting surface.
4. The output of the WJ-2855-37 is taken from the second harmonic of the oscillation frequency, creating harmonically related ($nf_o/2$) spurious responses.
5. The tuning non-linearity is the maximum deviation from linear tuning between the specified tuning voltage extremes and includes the effect of frequency drift over the operating temperature range.
6. The tuning voltage range specifies the maximum voltage range required to tune from minimum to maximum frequency.
7. Protective circuitry guards against damage due to overvoltage (up to 10 percent) and transient reverse voltages.
8. The heater is a self-regulating, proportionally controlled unit, isolated from bias and signal grounds.
9. With the VCO tuning port modulated sinusoidally by a 50-ohm source, the modulation bandwidth is defined as that modulation frequency at which the frequency deviation decreases to 0.707 of its low frequency value.

**Table II. WJ-2855-37 digitally tuned oscillator.**

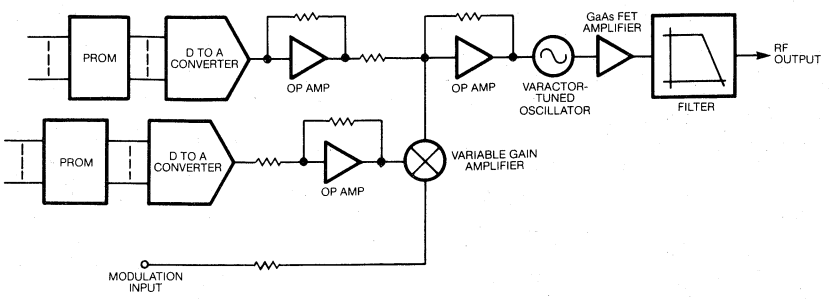



**Figure 14. DTO for jammer application with a digitally controlled variable-gain amplifier to reduce variation in modulation sensitivity.**

The modulation bandwidth also varies as a function of the DTO operating frequency. This, too, affects the power spectral density as the unit is tuned across the operation frequency range, especially at higher modulating frequencies.

## Conclusion

Digitally tuned oscillators provide EW systems with capabilities not previously available. Frequency accuracies comparable to YIG oscillators are now available with the tuningspeed advantages of a VCO. In addition, DTOs are capable of being modulated at rates above 20 MHz, with variations in deviation less then ±5% across the entire operating frequency range. Post-tuning drift and repeatability effects have been minimized to be in the range of 1 MHz.

Overall system performance has been significantly improved through the use of modem DTO technology. Power spectral densities are now higher and more constant, and the set-on accuracies have been enhanced.

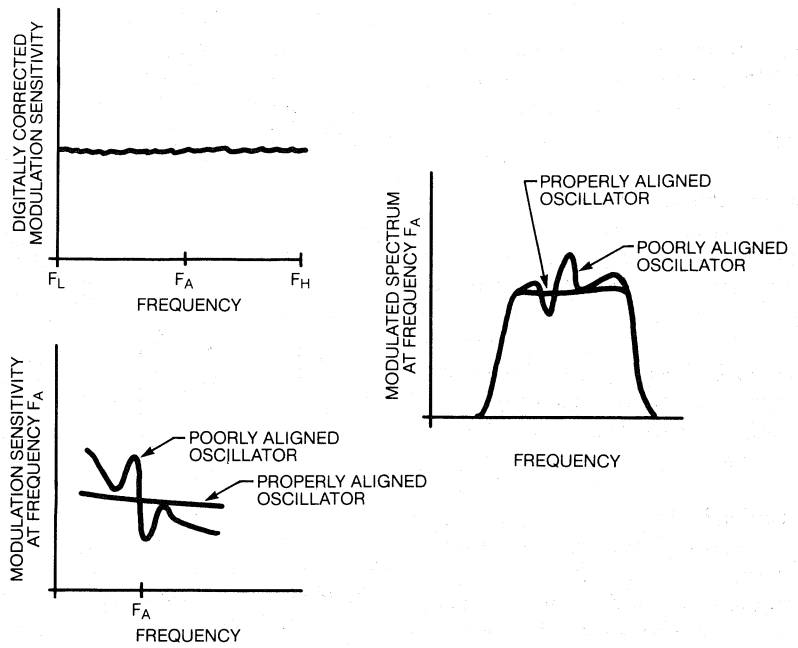



**Figure 15. Modulation characteristics of digitally corrected modulation port of a DTO.**

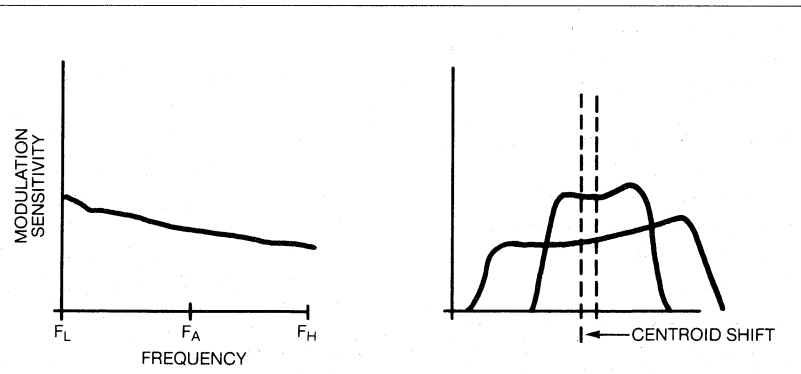



**Figure 16. Centroid shift.**

# TECHNICAL DEFINITIONS

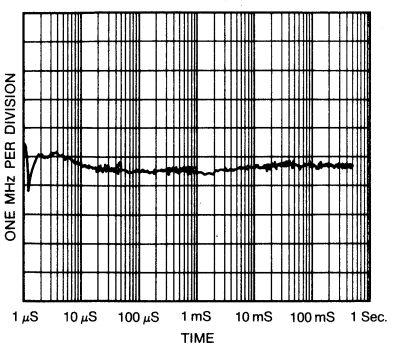
**Modulation Sensitivity:** The reciprocal of the slope of the tuning voltage vs. frequency graph, as measured in MHz/V.

**Frequency Pushing:** The change in operating frequency produced by a change in bias voltage (within the specified limits of bias voltage for the unit).

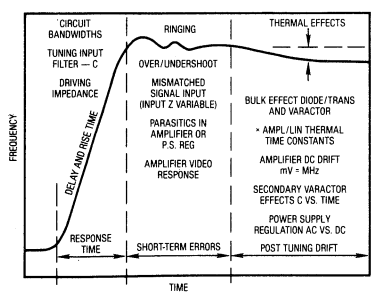
**Frequency Pulling:** The total frequency excursion observed as a load of the specified VSWR varies over 360 electrical degrees.

**Post Tuning Drift**
Post tuning drift is the most difficult performance parameter to specify. Post tuning drift is defined as the maximum frequency deviation from the reference frequency in a given time window after a step change in frequency. The reference frequency is defined as the frequency at the time when all transient tuning effects have subsided, typically 500 milliseconds. These effects include driver ringing and settling, thermal transient drift, long-term varactor charging mechanisms and repeatability due to different tuning duty cycles and steps sizes.

A typical post tuning drift specification would read 3 MHz maximum, from 300 nanoseconds to the reference frequency time.

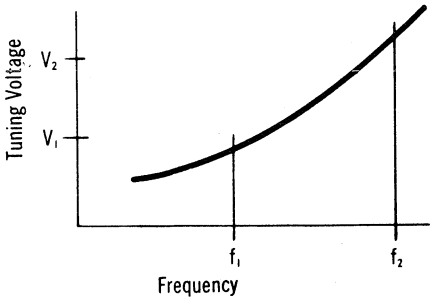



**TYPICAL POST TUNING DRIFT**




**POST TUNING DRIFT**

**Monotonicity:** A unit is monotonic if $V_2 (f_2) > V_1 (f_1)$ for $f_2 > f_1$ where f is frequency and V is voltage. See Figure 12.




**Frequency Accuracy:** The maximum deviation from a straight line drawn between two predetermined points on a tuning voltage vs. frequency graph, produced by the combined effects of tuning nonlinearity and frequency drift with temperature.

**Frequency Accuracy (DTO's)**
Frequency accuracy is defined as the deviation in MHz from the programmed frequency and includes the effects of ambient temperature variation, pushing and pulling. This specification may be combined with post tuning drift to define overall system accuracy.

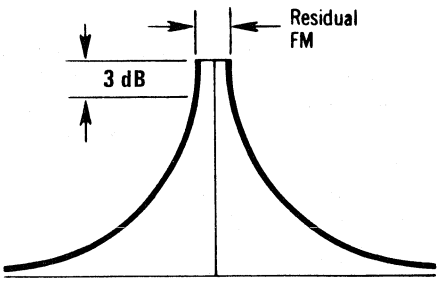
**Nonlinearity:** The maximum deviation from a straight line drawn between two predetermined points on a tuning voltage vs. frequency graph, expressed as a percentage of the absolute frequency.

**Frequency Drift with Temperature:** The change in operating frequency produced by a change in operating temperature. The operating temperature is measured on the baseplate.

**Harmonic Rejection:** The level of harmonically related signals relative to the desired output signal level, measured in dB.

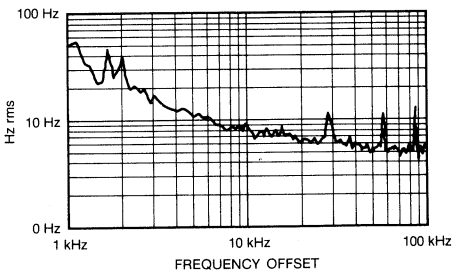
**Power Output Variation:** The extremes of output power (min. to max.) measured over the entire frequency range as measured into a specified VSWR (all phases). Temperature effects are not included.

**FM Noise**
***Residual FM**
The peak-to-peak deviation of the output signal as observed on a spectrum analyzer with a 1 kHz IF bandwidth at -3 dBc. This includes the effects of frequency pushing modulation due to noise injected on bias or digital lines.




Note: Bias and tuning voltages are to be filtered to eliminate ripple.

***SSB Phase Noise**
The sideband noise level, a specified distance from the center of the carrier, measured in Hz Rms or dB relative to the carrier in a specified measurement bandwidth.



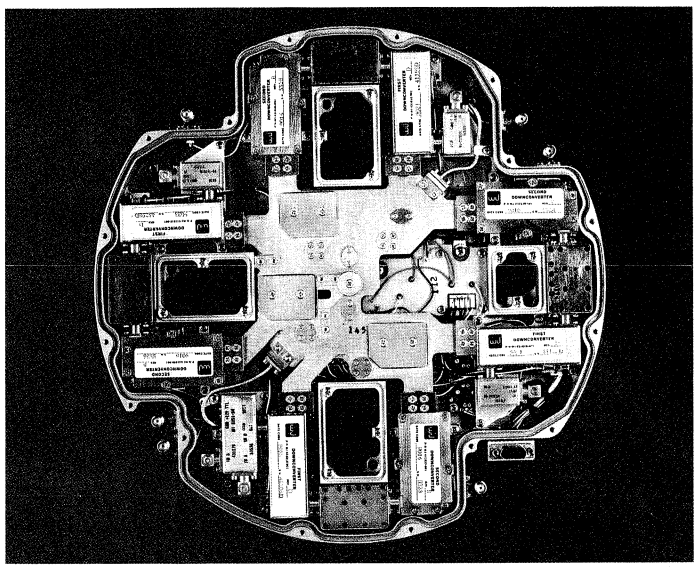

**PHASE NOISE**

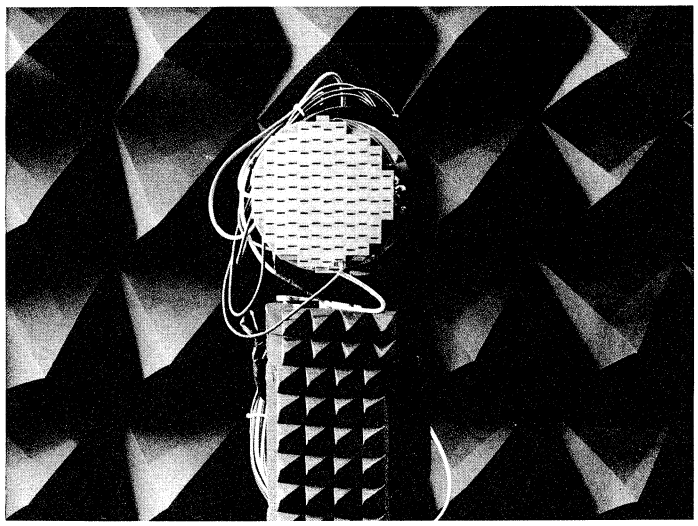
**Least Significant Bit Size (DTO's)**
The total frequency change for a LSB change in the tuning word any where within the tuning range. Typical specification minimum step size is 0 MHz (i.e., monotonic tuning). The maximum step size is twice the nominal LSB size.

**Modulation Bandwidth**
Modulation 3 dB bandwidth is defined as the maximum rate at which a VCO may be sinusoidally modulated from a 50 ohm source before its frequency deviation decreases to 0.707 of its low frequency deviation.

# Watkins-Johnson Subsystems Solutions for Microwave/Millimeter-Wave Requirements

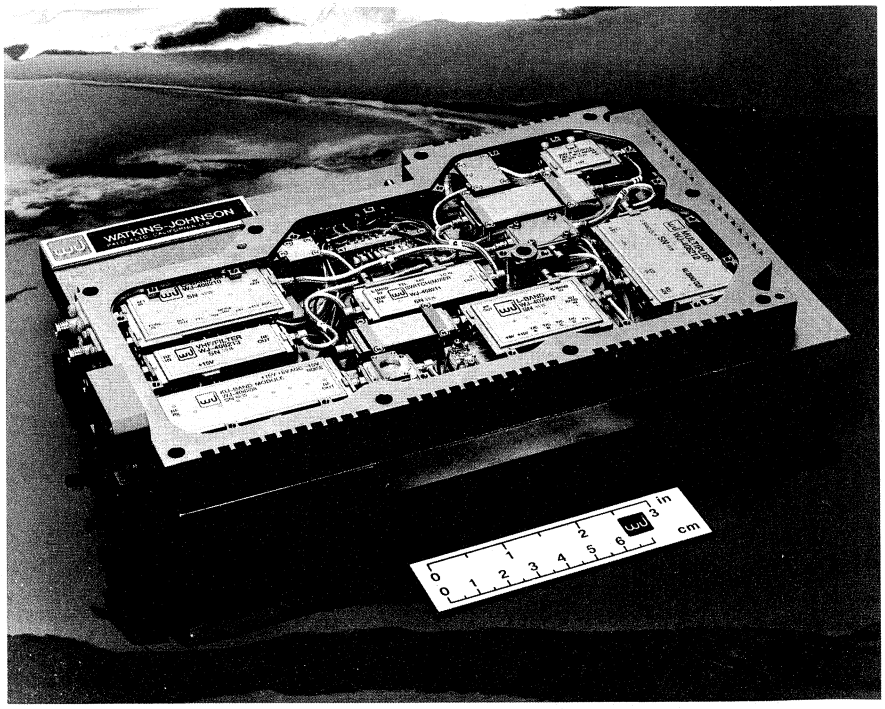
*EXPERIENCE • COMMITMENT • RESULTS* wj





- **Cost-Effective Manufacturing**
- **Vertical Integration**
- **Proven Engineering**

# Watkins-Johnson Company Subsystems




A supplier of critical items must offer far more than an exciting design or a claim of state-of-the-art performance. Experience, Commitment, and Results at Watkins-Johnson Company build on our technical prowess to conduct successful programs.

**Experience**
- A proven supplier of high-performance microwave hardware and services for over 30 years.

**Commitment**
- Substantial personnel, technology, capital resources
- Substantial annual investment in Research and Development

**Results**
- Thousands of subsystems supplied on numerous major programs
- Aggressive cost and schedule performance on volume requirements

# Comprehensive Business History

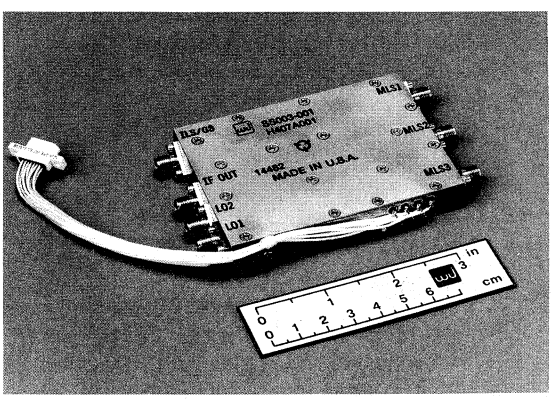
The Microwave Products Division of Watkins-Johnson Company has developed and manufactured hundreds of types of subsystems in support of a wide variety of missile, radar warning, test, ECM, communication, navigation, surveillance, satellite, commercial and other requirements.

**Typical Capabilities and Resources**

| | |
|---|---|
| MIL-I-45208 | ESD Protection |
| MIL-Q-9858A | Secure Facility |
| MIL-STD-461 | SPC |
| MIL-STD-883C | TQM |
| MIL-STD-2000 | |

**Typical W-J Subsystems Programs**

| | |
|---|---|
| ALR-62I | ARN-138 |
| ALQ-117/172 | AIM-120A |
| ALQ-126A/B | AGM-88C |
| ALQ-135 | RIM-66 |
| ALQ-161 | RIM-67C |
| ALQ-162 | SLQ-17 |
| ALQ-165 | SLQ-32 |
| ALQ-184 | USM-638 |
| APG-65 | TRC-170 |
| APR-38 | |



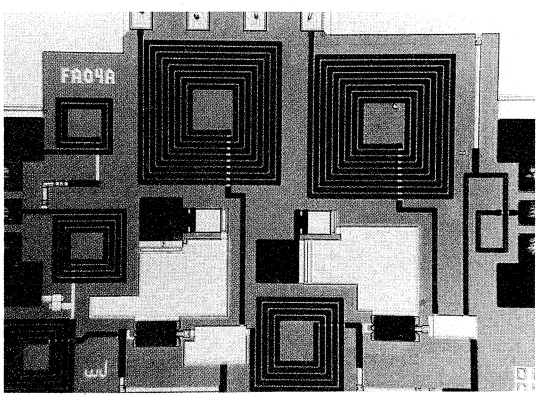
# Proven Engineering

The Microwave Products Division combines the extensive experience of over 200 professionals with the capability of computer-aided design (CAD) to enhance life-cycle benefits to the user. These professionals include:

- Electrical Engineers
- Mechanical Engineers
- Process Engineers
- Quality Engineers
- Physicists
- CAD/Software Engineers

Watkins-Johnson Company uses both standard and internally developed CAD programs. Among these are:

Autocad®
Supercompact®
COSMOS™/M
W-J Filter Analysis
Touchstone ®
Libra®
em™ (EM Field Solver)

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# Cost-Effective Manufacturing

Delivering specification-compliant, cost-effective units on time is the objective of Watkins-Johnson Company's Microwave Products Division. The manufacturing resources and experience to make Watkins-Johnson Company excel at meeting these objectives are in place to meet critical subsystems needs.

- Engineering/manufacturing interface from the outset of the program

- Dedicated program managers from proposal to delivery

- Advanced manufacturing capabilities:
  - Automatic pick and place
  - Automatic wire bonding
  - Automatic test stations
  - In-plant computer-controlled machining
  - Infrared scanning for thermal "hot spots"

- Linear flow
  - Continuous cost/value improvement
  - Statistical quality control

- Well-supported manufacturing/quality
  - Continuous Quality Improvement (CQI)
  - Cost of quality
  - Dedicated process control
  - Over 30 years of production experience ranging from hi-rel space to military to commercial applications

- Partnership with customers
  - Teaming
  - Nondisclosure
  - Build to print

# A Representative Engineering/CAD Flow Chart

R & D COMMITMENT

*REQUIREMENTS*

▼

*EVALUATION BY EE/ME/ PROCESS TEAM*

▼

*CONCEPTUAL DESIGN*

▼

*DETAILED DESIGN*
*ELECTRICAL CAD*
*MECHANICAL CAD*

▼

*DESIGN REVIEW*

▼

*PRE-PRODUCTION*
*AUTOMATIC TEST*
*PROCESS DEVELOPMENT*

▼

*DESIGN VERIFICATION*
*COST REDUCTION*

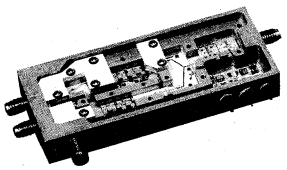
▼

*PRODUCTION*

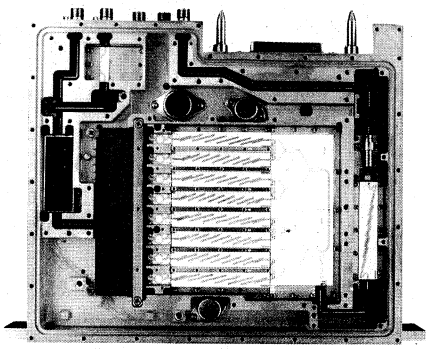
# Vertical Integration

Watkins-Johnson Company's Microwave Products Division draws upon a wide array of proven technologies and processes, then adds its electrical and mechanical integration expertise to ensure the delivery of subsystems which meet customers' needs.

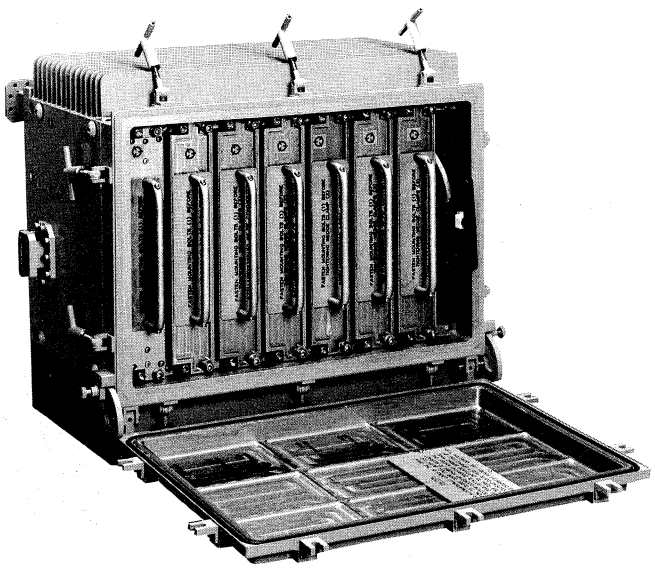
- GaAs FOUNDRY
  FET • MMIC
- SMT
- THIN FILM
- ACTIVE ATTENUATORS
- MIXERS
- LIMITERS
- AMPLIFIERS
- MULTIPLIERS
- OSCILLATORS
  VCO • YTO • PLO
- FILTERS
  THIN-FILM • COMBLINE
  SUSPENDED SUBSTRATE
- HOUSINGS
  HERMETIC • MOISTURE/EMI
- ANTENNAS
- ANTENNA
  RANGE/CHAMBER
- SWITCHES
- DETECTORS
- COUPLERS
- POWER DIVIDERS
- PHASE LOCKED CIRCUITS
- PHASE SHIFTERS



MULTI-FUNCTION MODULES

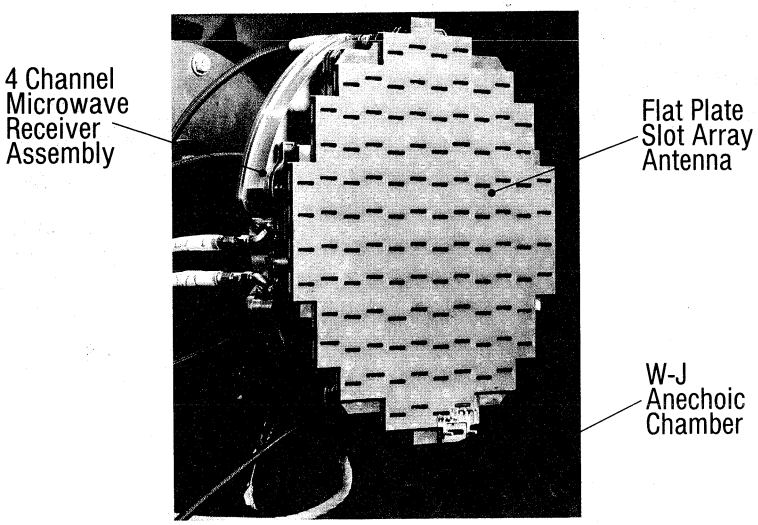


SUB-ASSEMBLIES



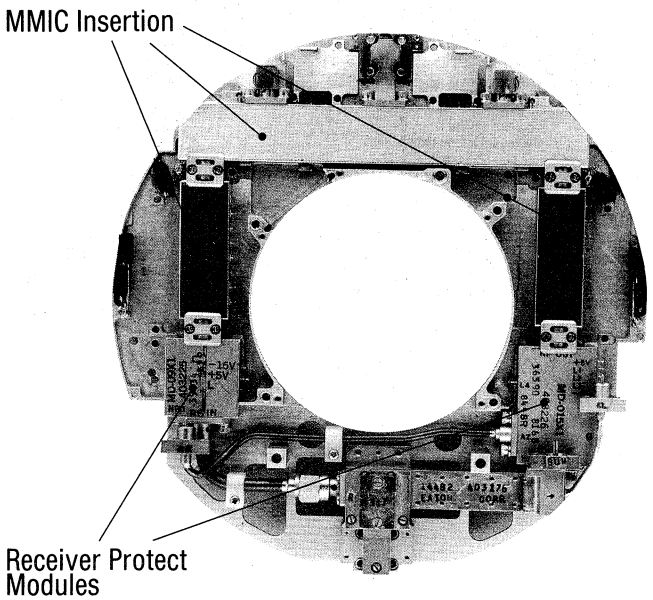
COMPLEX SUBSYSTEMS

# Integrated Front Ends




## Missile Seeker Assembly

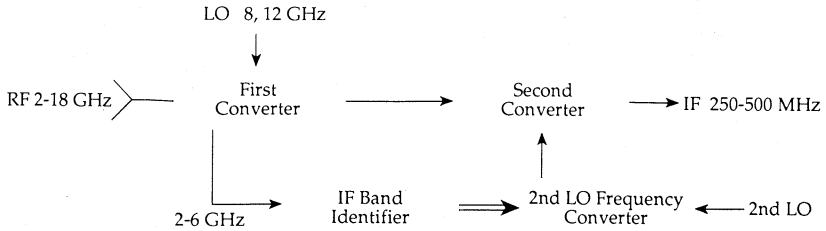
This four-channel receiver is a low-noise, dual down-conversion, amplitude and phase-matched receiver with saturation detection and gain control. Each of the four receiver channels includes a limiter module, a first downconverter module, a first IF filter and a second down-converter module.

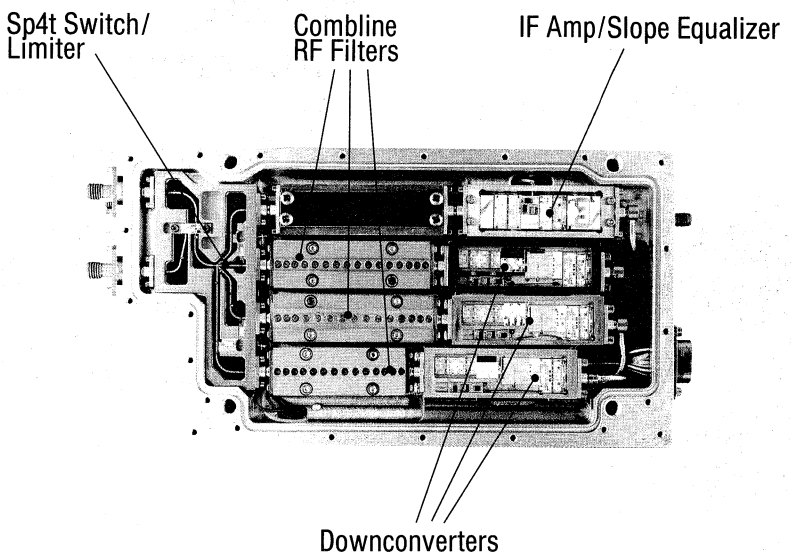



## Two-Channel RF Processor

This RF processor incorporates advanced integration and fabrication techniques which minimize the number of modules and the overall cost of the unit. Some examples of these techniques are GaAs MMICs, silicon LSI, advanced thin-film circuits and packaging technology.

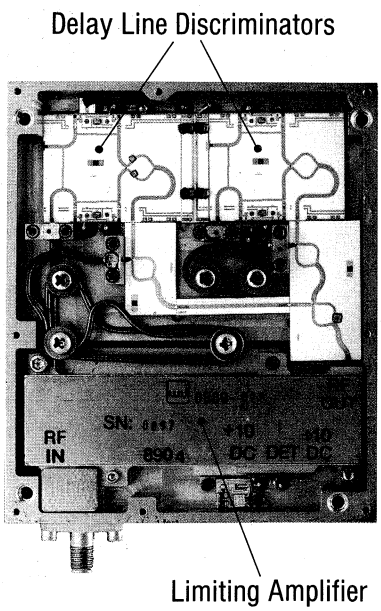
# Subsystem Radar Warning/ DRFM Microwave Front End




## First Converter

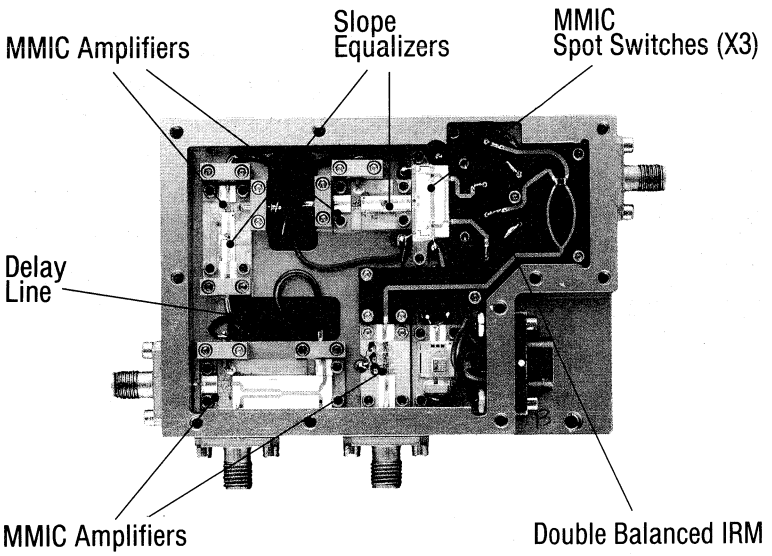
This broadband assembly used for the first conversion in modern RWRs features modular channels which utilize W-J filters, amplifiers and switches to convert inputs to a common 2-6 GHz first IF.




## IF Band Identifier

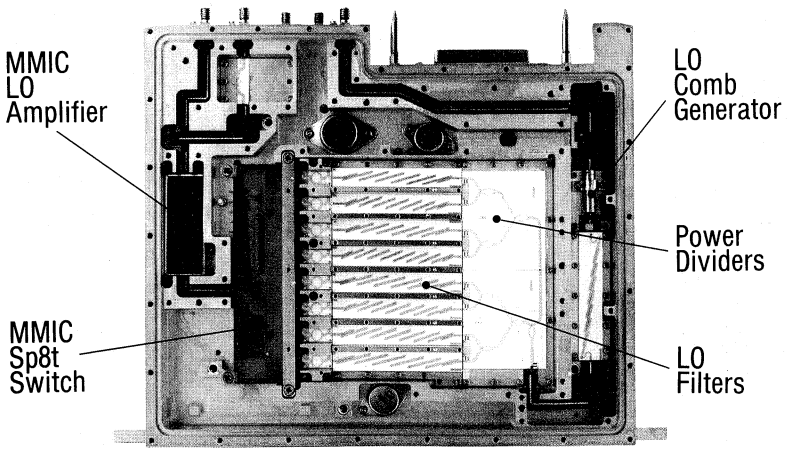
The IF band identifier employs a high-gain, hard limiting amplifier, a balanced phase discriminator, flash A/D converters and programmable array logic circuits. Its primary application is to command, in less than 30 nanoseconds, high-speed local oscillator selection for further downconversion of the 2-6 GHz first IF signal.

# Subsystems




## Second Converter

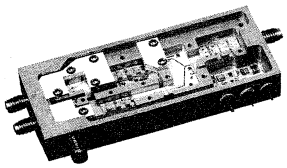
The second converter employs over 30 W-J MMICs and delays the first IF signal long enough for the LO to be set for proper downconversion into the 250-500 MHz second IF band.




## High-Speed 2nd LO Frequency Converter

The high-speed 2nd LO frequency converter features high isolation between channels, low video leakage and high switching speeds. The unit utilizes over 30 W-J GaAs MMICs, thin-film filters, power dividers and combiners.

# Extensive Subsystems Design and Manufacturing Experience to Meet Your Needs



MULTI-FUNCTION MODULES

The examples shown in this brochure are only a few of the many subsystems developed and delivered by the Microwave Products Division. Others include:

DUAL UP/DOWNCONVERTERS

DATA LINK PROCESSORS

GAIN AND PHASE-MATCHED IF CONVERTERS

BLOCK DOWNCONVERTERS

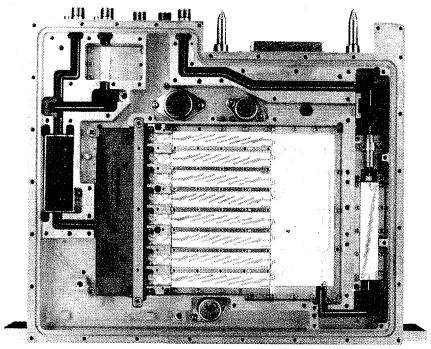
MULTIBAND LANDING SYSTEM RECEIVERS

SAMPLING DOWNCONVERTERS FOR PHASE-LOCK APPLICATIONS

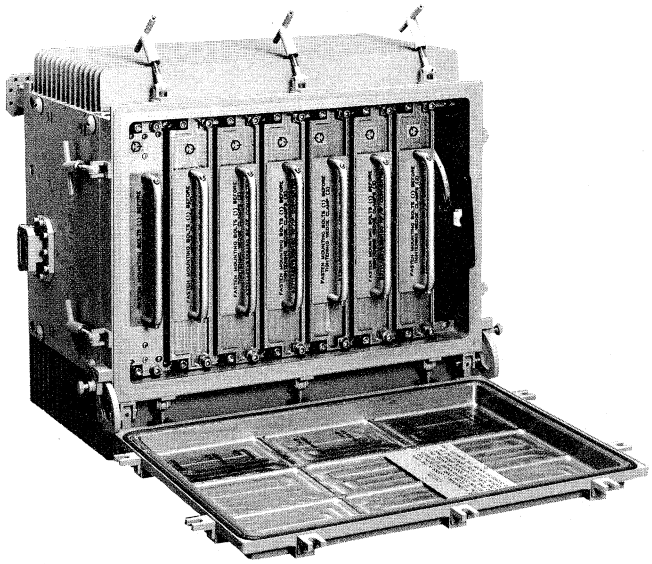
SUCCESSIVE DETECTION LOG LIMITING AMPLIFIERS

MICROWAVE AMPLIFIERS

SAT-COM TRANSCEIVERS



SUB-ASSEMBLIES

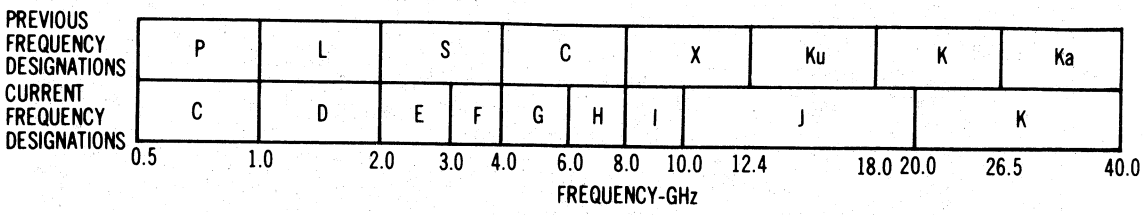


COMPLEX SUBSYSTEMS

*

*This space reserved for our solution to your need.

# FREQUENCY BAND DESIGNATIONS




# JOINT ELECTRONICS TYPE DESIGNATION SYSTEM

**1st Ltr. INSTALLATION**

- A - Airborne
- B - Submarine
- C - Air transportable
- D - Pilotless carrier
- F - Fixed
- G - Ground
- K - Amphibious
- M - Ground, mobile
- P - Pack or portable
- S - Surface craft
- T - Ground, transportable
- U - General utility
- V - Ground, vehicular
- W - Water, surface and underwater

**2nd Ltr. EQUIPMENT**

- A - Infrared
- B - Pigeon
- C - Carrier
- D - Radiac
- E - Nupac
- F - Photographic
- G - Telegraph teletype
- I - Interphone
- J - Electro-mechanical
- K - Telemetering
- L - Countermeasure
- M - Meterological
- N - Sound in air
- P - Radar
- Q - Sonar
- R - Radio
- S - Special Types
- T - Telephone (wire)
- V - Visible light
- W - Armament
- X - Facsimile or TV

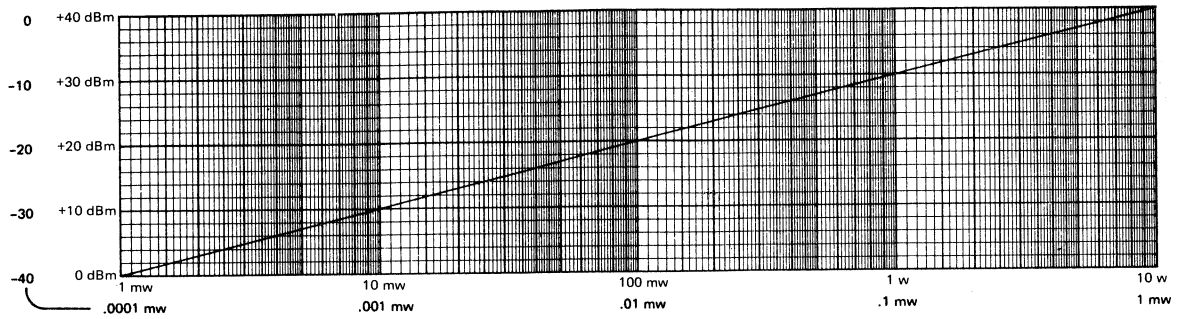
**3rd Ltr. PURPOSE**

- A - Auxiliary
- B - Bombing
- C - Communications
- D - Dir. finding/recon.
- E - Ejection/release
- F - Fire control
- H - Record-reproduce
- M - Maintenance/test
- N - Navigation aids
- Q - Special purposes
- R - Receiving
- S - Detect/range/bearing
- T - Transmitting
- W - Control
- X - Ident. and recognition

**Example: AN/ALR-47**

| | | |
|---|---|---|
| AN/ | = | Standard Prefix |
| A | = | Airborne |
| L | = | Countermeasure |
| R | = | Receiving |
| 47 | = | Design Number |

## POWER RATIO (watts vs. dBm)




## CONVERSION OF RETURN LOSS TO EQUIVALENT VSWR

| dB | VSWR |
|---|---|
| 46 | 1.01 |
| 40 | 1.02 |
| 37 | 1.03 |
| 34 | 1.04 |
| 32 | 1.05 |
| 30.4 | 1.06 |
| 29 | 1.07 |
| 28 | 1.08 |

| dB | VSWR |
|---|---|
| 27 | 1.09 |
| 26.4 | 1.10 |
| 26 | 1.11 |
| 25 | 1.12 |
| 24 | 1.13 |
| 23.5 | 1.14 |
| 23 | 1.15 |
| 22 | 1.17 |

| dB | VSWR |
|---|---|
| 21.5 | 1.18 |
| 20.7 | 1.20 |
| 20 | 1.22 |
| 19 | 1.25 |
| 17.7 | 1.30 |
| 17 | 1.33 |
| 16 | 1.38 |
| 15 | 1.43 |

| dB | VSWR |
|---|---|
| 14 | 1.50 |
| 13 | 1.58 |
| 12 | 1.67 |
| 11 | 1.78 |
| 10 | 1.92 |
| 9 | 2.10 |
| 8 | 2.32 |
| 7 | 2.61 |

| dB | VSWR |
|---|---|
| 6 | 3.01 |
| 5 | 3.57 |
| 4 | 4.42 |
| 3 | 5.85 |
| 2 | 8.72 |
| 1 | 17.40 |
| .5 | 34.78 |
| 0 | ∞ |

# THE EFFECT OF VSWR ON TRANSMITTED POWER

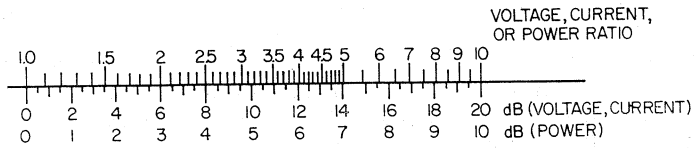
| VSWR | VSWR (dB) | RETURN LOSS (dB) | TRANS. LOSS (dB) | VOLT. REFL. COEFF. | POWER TRANS. (%) | POWER REFL. (%) |
|---|---|---|---|---|---|---|
| 1.00 | .0 | ∞ | .000 | .00 | 100.0 | .0 |
| 1.01 | .1 | 46.1 | .000 | .00 | 100.0 | .0 |
| 1.02 | .2 | 40.1 | .000 | .01 | 100.0 | .0 |
| 1.03 | .3 | 36.6 | .001 | .01 | 100.0 | .0 |
| 1.04 | .3 | 34.2 | .002 | .02 | 100.0 | .0 |
| 1.05 | .4 | 32.3 | .003 | .02 | 99.9 | .1 |
| 1.06 | .5 | 30.7 | .004 | .03 | 99.9 | .1 |
| 1.07 | .6 | 29.4 | .005 | .03 | 99.9 | .1 |
| 1.08 | .7 | 28.3 | .006 | .04 | 99.9 | .1 |
| 1.09 | .7 | 27.3 | .008 | .04 | 99.8 | .2 |
| 1.10 | .8 | 26.4 | .010 | .05 | 99.8 | .2 |
| 1.11 | .9 | 25.7 | .012 | .05 | 99.7 | .3 |
| 1.12 | 1.0 | 24.9 | .014 | .06 | 99.7 | .3 |
| 1.13 | 1.1 | 24.3 | .016 | .06 | 99.6 | .4 |
| 1.14 | 1.1 | 23.7 | .019 | .07 | 99.6 | .4 |
| 1.15 | 1.2 | 23.1 | .021 | .07 | 99.5 | .5 |
| 1.16 | 1.3 | 22.6 | .024 | .07 | 99.5 | .5 |
| 1.17 | 1.4 | 22.1 | .027 | .08 | 99.4 | .6 |
| 1.18 | 1.4 | 21.7 | .030 | .08 | 99.3 | .7 |
| 1.19 | 1.5 | 21.2 | .033 | .09 | 99.2 | .8 |
| 1.20 | 1.6 | 20.8 | .036 | .09 | 99.2 | .8 |
| 1.21 | 1.7 | 20.4 | .039 | .10 | 99.1 | .9 |
| 1.22 | 1.7 | 20.1 | .043 | .10 | 99.0 | 1.0 |
| 1.23 | 1.8 | 19.7 | .046 | .10 | 98.9 | 1.1 |
| 1.24 | 1.9 | 19.4 | .050 | .11 | 98.9 | 1.1 |
| 1.25 | 1.9 | 19.1 | .054 | .11 | 98.8 | 1.2 |
| 1.26 | 2.0 | 18.8 | .058 | .12 | 98.7 | 1.3 |
| 1.27 | 2.1 | 18.5 | .062 | .12 | 98.6 | 1.4 |
| 1.28 | 2.1 | 18.2 | .066 | .12 | 98.5 | 1.5 |
| 1.29 | 2.2 | 17.9 | .070 | .13 | 98.4 | 1.6 |
| 1.30 | 2.3 | 17.7 | .075 | .13 | 98.3 | 1.7 |
| 1.32 | 2.4 | 17.2 | .083 | .14 | 98.1 | 1.9 |
| 1.34 | 2.5 | 16.8 | .093 | .15 | 97.9 | 2.1 |
| 1.36 | 2.7 | 16.3 | .102 | .15 | 97.7 | 2.3 |
| 1.38 | 2.8 | 15.9 | .112 | .16 | 97.5 | 2.5 |
| 1.40 | 2.9 | 15.6 | .122 | .17 | 97.2 | 2.8 |
| 1.42 | 3.0 | 15.2 | .133 | .17 | 97.0 | 3.0 |
| 1.44 | 3.2 | 14.9 | .144 | .18 | 96.7 | 3.3 |
| 1.46 | 3.3 | 14.6 | .155 | .19 | 96.5 | 3.5 |
| 1.48 | 3.4 | 14.3 | .166 | .19 | 96.3 | 3.7 |
| 1.50 | 3.5 | 14.0 | .177 | .20 | 96.0 | 4.0 |
| 1.52 | 3.6 | 13.7 | .189 | .21 | 95.7 | 4.3 |
| 1.54 | 3.8 | 13.4 | .201 | .21 | 95.5 | 4.5 |
| 1.56 | 3.9 | 13.2 | .213 | .22 | 95.2 | 4.8 |
| 1.58 | 4.0 | 13.0 | .225 | .22 | 94.9 | 5.1 |
| 1.60 | 4.1 | 12.7 | .238 | .23 | 94.7 | 5.3 |
| 1.62 | 4.2 | 12.5 | .250 | .24 | 94.4 | 5.6 |
| 1.64 | 4.3 | 12.3 | .263 | .24 | 94.1 | 5.9 |
| 1.66 | 4.4 | 12.1 | .276 | .25 | 93.8 | 6.2 |
| 1.68 | 4.5 | 11.9 | .289 | .25 | 93.6 | 6.4 |
| 1.70 | 4.6 | 11.7 | .302 | .26 | 93.3 | 6.7 |
| 1.72 | 4.7 | 11.5 | .315 | .26 | 93.0 | 7.0 |
| 1.74 | 4.8 | 11.4 | .329 | .27 | 92.7 | 7.3 |
| 1.76 | 4.9 | 11.2 | .342 | .28 | 92.4 | 7.6 |
| 1.78 | 5.0 | 11.0 | .356 | .28 | 92.1 | 7.9 |
| 1.80 | 5.1 | 10.9 | .370 | .29 | 91.8 | 8.2 |
| 1.82 | 5.2 | 10.7 | .384 | .29 | 91.5 | 8.5 |
| 1.84 | 5.3 | 10.6 | .398 | .30 | 91.3 | 8.7 |
| 1.86 | 5.4 | 10.4 | .412 | .30 | 91.0 | 9.0 |
| 1.88 | 5.5 | 10.3 | .426 | .31 | 90.7 | 9.3 |
| 1.90 | 5.6 | 10.2 | .440 | .31 | 90.4 | 9.6 |
| 1.92 | 5.7 | 10.0 | .454 | .32 | 90.1 | 9.9 |
| 1.94 | 5.8 | 9.9 | .468 | .32 | 89.8 | 10.2 |
| 1.96 | 5.8 | 9.8 | .483 | .32 | 89.5 | 10.5 |
| 1.98 | 5.9 | 9.7 | .497 | .33 | 89.2 | 10.8 |
| 2.00 | 6.0 | 9.5 | .512 | .33 | 88.9 | 11.1 |
| 2.50 | 8.0 | 7.4 | .881 | .43 | 81.6 | 18.4 |
| 3.00 | 9.5 | 6.0 | 1.249 | .50 | 75.0 | 25.0 |
| 3.50 | 10.9 | 5.1 | 1.603 | .56 | 69.1 | 30.9 |
| 4.00 | 12.0 | 4.4 | 1.938 | .60 | 64.0 | 36.0 |
| 4.50 | 13.1 | 3.9 | 2.255 | .64 | 59.5 | 40.5 |
| 5.00 | 14.0 | 3.5 | 2.553 | .67 | 55.6 | 44.4 |
| 5.50 | 14.8 | 3.2 | 2.834 | .69 | 52.1 | 47.9 |
| 6.00 | 15.6 | 2.9 | 3.100 | .71 | 49.0 | 51.0 |
| 6.50 | 16.3 | 2.7 | 3.351 | .73 | 46.2 | 53.8 |
| 7.00 | 16.9 | 2.5 | 3.590 | .75 | 43.7 | 56.2 |
| 7.50 | 17.5 | 2.3 | 3.817 | .76 | 41.5 | 58.5 |
| 8.00 | 18.1 | 2.2 | 4.033 | .78 | 39.5 | 60.5 |
| 8.50 | 18.6 | 2.1 | 4.240 | .79 | 37.7 | 62.3 |
| 9.00 | 19.1 | 1.9 | 4.437 | .80 | 36.0 | 64.0 |
| 9.50 | 19.6 | 1.8 | 4.626 | .81 | 34.5 | 65.5 |
| 10.00 | 20.0 | 1.7 | 4.807 | .82 | 33.1 | 66.9 |
| 11.00 | 20.8 | 1.6 | 5.149 | .83 | 30.6 | 69.4 |
| 12.00 | 21.6 | 1.5 | 5.466 | .85 | 28.4 | 71.6 |
| 13.00 | 22.3 | 1.3 | 5.762 | .86 | 26.5 | 73.5 |
| 14.00 | 22.9 | 1.2 | 6.040 | .87 | 24.9 | 75.1 |
| 15.00 | 23.5 | 1.2 | 6.301 | .88 | 23.4 | 76.6 |
| 16.00 | 24.1 | 1.1 | 6.547 | .88 | 22.1 | 77.9 |
| 17.00 | 24.6 | 1.0 | 6.780 | .89 | 21.0 | 79.0 |
| 18.00 | 25.1 | 1.0 | 7.002 | .89 | 19.9 | 80.1 |
| 19.00 | 25.6 | .9 | 7.212 | .90 | 19.0 | 81.0 |
| 20.00 | 26.0 | .9 | 7.413 | .90 | 18.1 | 81.9 |
| 25.00 | 28.0 | .7 | 8.299 | .92 | 14.8 | 85.2 |
| 30.00 | 29.5 | .6 | 9.035 | .94 | 12.5 | 87.5 |

## CONVERSION OF VOLTAGE AND POWER RATIOS TO dB

The equation

$$dB = 20 \log \frac{E_1}{E_2} = 10 \log \frac{P_1}{P_2}$$

is frequently used to determine the effects of component and system inter-connections. This nomograph presents the equation in graphical form.



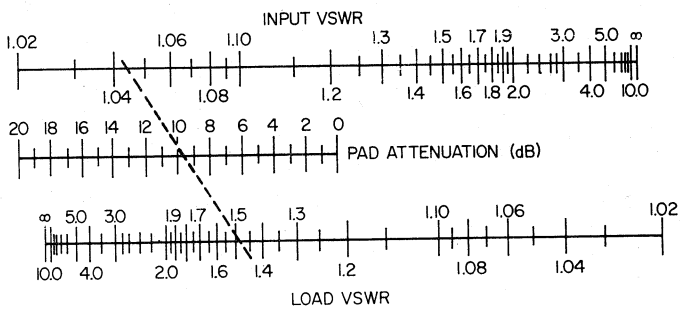

## EFFECT OF ATTENUATING PADS ON VSWR

In an electrically "long" transmission line that is not terminated in its characteristic impedance, the VSWR, S, is defined as

$$S = \frac{E_{max}}{E_{min}} = \frac{1 + \rho}{1 - \rho}$$

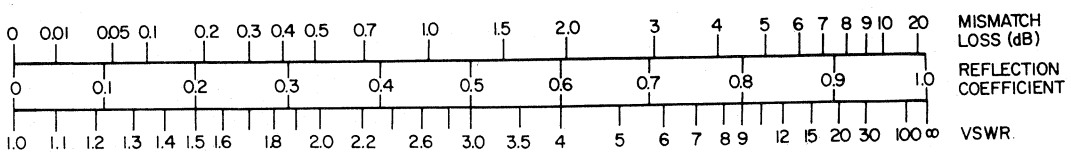
where $E$ is the voltage measured along the line, and $\rho$ is the termination voltage reflection coefficient. Insertion of an attenuator having the same characteristic impedance as that of the line will diminish both the incident wave to the load and the reflected wave returning to the input source, causing the VSWR at the input side to be diminished, as expressed by the equation

$$\frac{1}{S_1} = \tanh \left[ \alpha + \tanh^{-1} \frac{1}{S_2} \right]$$




where subscripts 1 and 2 refer to the input and load sides of the pad, respectively, and $\alpha$ is the pad attenuation in nepers. Determination of the attenuation required to reduce the VSWR to a desired value is facilitated by means of this nomograph.

## EFFECT OF IMPEDANCE MISMATCH ON VSWR AND TRANSMITTED POWER LOSS




It is often necessary to determine the power-mismatch loss that results when the load impedance is not matched to the line, which can be expressed as

$$\text{mismatch loss (dB)} = 10 \log \frac{P_m}{P} = 10 \log \frac{1}{1 - \rho^2} = 10 \log \frac{(S+1)^2}{4S}$$

where $P$ = power delivered to the load, and $P_m$ = power that would be delivered if the impedances were matched for maximum power transfer. These relationships are shown graphically in this nomograph.

# DECIBELS - VOLTS - WATTS CONVERSION TABLE
## 50-OHM SYSTEM TERMINATED

| dBm | V | $P_o$ |
|---|---|---|
| +53 | 100.0 | 200W |
| +50 | 70.7 | 100W |
| +49 | 64.0 | 80W |
| +48 | 58.0 | 64W |
| +47 | 50.0 | 50W |
| +46 | 44.5 | 40W |
| +45 | 40.0 | 32W |
| +44 | 32.5 | 25W |
| +43 | 32.0 | 20W |
| +42 | 28.0 | 16W |
| +41 | 26.2 | 12.5W |
| +40 | 22.5 | 10W |
| +39 | 20.0 | 8W |
| +38 | 18.0 | 6.4W |
| +37 | 16.0 | 5W |
| +36 | 14.1 | 4W |
| +35 | 12.5 | 3.2W |
| +34 | 11.5 | 2.5W |
| +33 | 10.0 | 2W |
| +32 | 9.0 | 1.6W |
| +31 | 8.0 | 1.25W |
| +30 | 7.10 | 1.0W |
| +29 | 6.40 | 800 mW |
| +28 | 5.80 | 640 mW |
| +27 | 5.00 | 500 mW |
| +26 | 4.45 | 400 mW |
| +25 | 4.00 | 320 mW |
| +24 | 3.55 | 250 mW |
| +23 | 3.20 | 200 mW |
| +22 | 2.80 | 160 mW |
| +21 | 2.52 | 125 mW |
| +20 | 2.25 | 100 mW |
| +19 | 2.00 | 80 mW |
| +18 | 1.80 | 64 mW |
| +17 | 1.60 | 50 mW |
| +16 | 1.41 | 40 mW |
| +15 | 1.25 | 32 mW |
| +14 | 1.15 | 25 mW |
| +13 | 1.00 | 20 mW |
| +12 | .90 | 16 mW |
| +11 | .80 | 12.5mW |
| +10 | .71 | 10 mW |
| +9 | .64 | 8 mW |
| +8 | .58 | 6.4 mW |
| +7 | .500 | 5 mW |
| +6 | .445 | 4 mW |
| +5 | .400 | 3.2 mW |
| +4 | .355 | 2.5 mW |
| +3 | .320 | 2.0 mW |
| +2 | .280 | 1.6 mW |
| +1 | .252 | 1.25 mW |

| dBm | V | $P_o$ |
|---|---|---|
| 0 | .225 | 1.0 mW |
| −1 | .200 | .80 mW |
| −2 | .180 | .64 mW |
| −3 | .160 | .50 mW |
| −4 | .141 | .40 mW |
| −5 | .125 | .32 mW |
| −6 | .115 | .25 mW |
| −7 | .100 | .20 mW |
| −8 | .090 | .16 mW |
| −9 | .080 | .125 mW |
| −10 | .071 | .10mW |
| −11 | .064 | |
| −12 | .058 | |
| −13 | .050 | |
| −14 | .045 | |
| −15 | .040 | |
| −16 | .0355 | |
| **dBm** | **mV** | |
| −17 | 31.5 | |
| −18 | 28.5 | |
| −19 | 25.1 | |
| −20 | 22.5 | .01 mW |
| −21 | 20.0 | |
| −22 | 17.9 | |
| −23 | 15.9 | |
| −24 | 14.1 | |
| −25 | 12.8 | |
| −26 | 11.5 | |
| −27 | 10.0 | |
| −28 | 8.9 | |
| −29 | 8.0 | |
| −30 | 7.1 | .001 mW |
| −31 | 6.25 | |
| −32 | 5.8 | |
| −33 | 5.0 | |
| −34 | 4.5 | |
| −35 | 4.0 | |
| −36 | 3.5 | |
| −37 | 3.2 | |
| −38 | 2.85 | |
| −39 | 2.5 | |
| −40 | 2.25 | .1 $\mu$W |
| −41 | 2.0 | |
| −42 | 1.8 | |
| −43 | 1.6 | |
| −44 | 1.4 | |
| −45 | 1.25 | |
| −46 | 1.18 | |
| −47 | 1.00 | |
| −48 | 0.90 | |

| dBm | mV | $P_o$ |
|---|---|---|
| −49 | 0.80 | |
| −50 | 0.71 | .01 $\mu$W |
| −51 | 0.64 | |
| −52 | 0.57 | |
| −53 | 0.50 | |
| −54 | 0.45 | |
| −55 | 0.40 | |
| −56 | 0.351 | |
| −57 | 0.32 | |
| −58 | 0.286 | |
| −59 | 0.251 | |
| −60 | 0.225 | .001 $\mu$W |
| −61 | 0.200 | |
| −62 | 0.180 | |
| −63 | 0.160 | |
| −64 | 0.141 | |
| **dBm** | **$\mu$V** | |
| −65 | 128 | |
| −66 | 115 | |
| −67 | 100 | |
| −68 | 90 | |
| −69 | 80 | |
| −70 | 71 | .1 nW |
| −71 | 65 | |
| −72 | 58 | |
| −73 | 50 | |
| −74 | 45 | |
| −75 | 40 | |
| −76 | 35 | |
| −77 | 32 | |
| −78 | 29 | |
| −79 | 25 | |
| −80 | 22.5 | .01 nW |
| −81 | 20.0 | |
| −82 | 18.0 | |
| −83 | 16.0 | |
| −84 | 11.1 | |
| −85 | 12.9 | |
| −86 | 11.5 | |
| −87 | 10.0 | |
| −88 | 9.0 | |
| −89 | 8.0 | |
| −90 | 7.1 | .001 nW |
| −91 | 6.1 | |
| −92 | 5.75 | |
| −93 | 5.0 | |
| −94 | 4.5 | |
| −95 | 4.0 | |
| −96 | 3.51 | |

| dBm | $\mu$V | $P_o$ |
|---|---|---|
| −97 | 3.2 | |
| −98 | 2.9 | |
| −99 | 2.51 | |
| −100 | 2.25 | .1 pW |
| −101 | 2.0 | |
| −102 | 1.8 | |
| −103 | 1.6 | |
| −104 | 1.41 | |
| −105 | 1.27 | |
| −106 | 1.18 | |
| **dBm** | **nV** | |
| −107 | 1000 | |
| −108 | 900 | |
| −109 | 800 | |
| −110 | 710 | .01 pW |
| −111 | 640 | |
| −112 | 580 | |
| −113 | 500 | |
| −114 | 450 | |
| −115 | 400 | |
| −116 | 355 | |
| −117 | 825 | |
| −118 | 285 | |
| −119 | 251 | |
| −120 | 225 | .001 pW |
| −121 | 200 | |
| −122 | 180 | |
| −123 | 160 | |
| −124 | 141 | |
| −125 | 128 | |
| −126 | 117 | |
| −127 | 100 | |
| −128 | 90 | |
| −129 | 80 | .1 fW |
| −130 | 71 | |
| −131 | 61 | |
| −132 | 58 | |
| −133 | 50 | |
| −134 | 45 | |
| −135 | 40 | |
| −136 | 35 | |
| −137 | 33 | |
| −138 | 29 | |
| −139 | 25 | |
| −140 | 23 | .01 fW |

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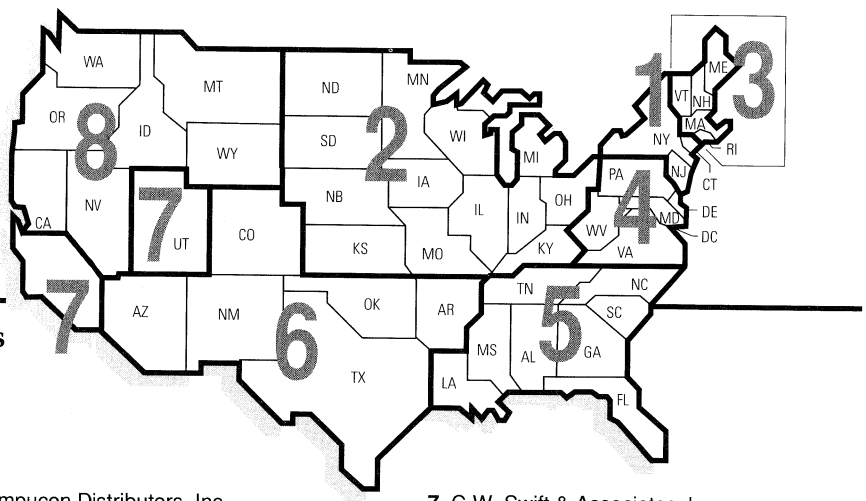


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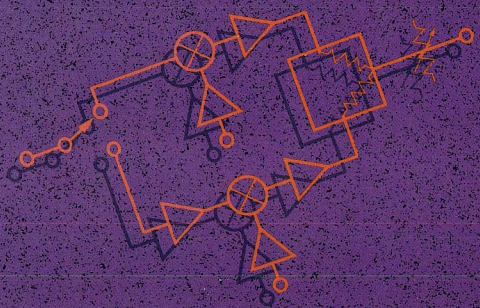

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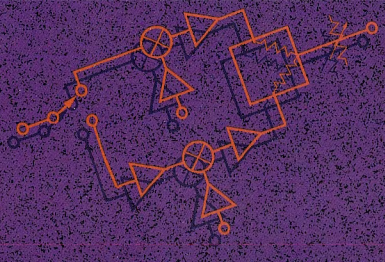
Designer's Handbook



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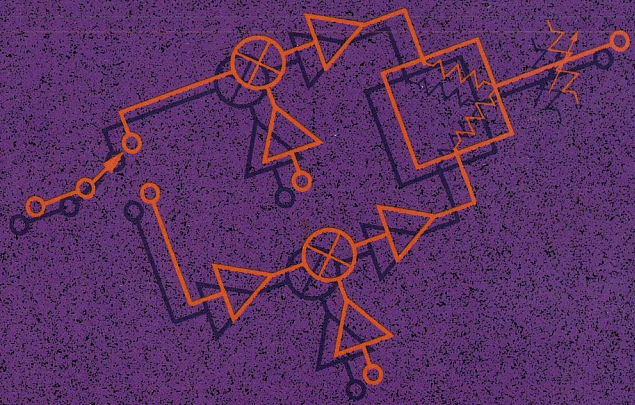

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