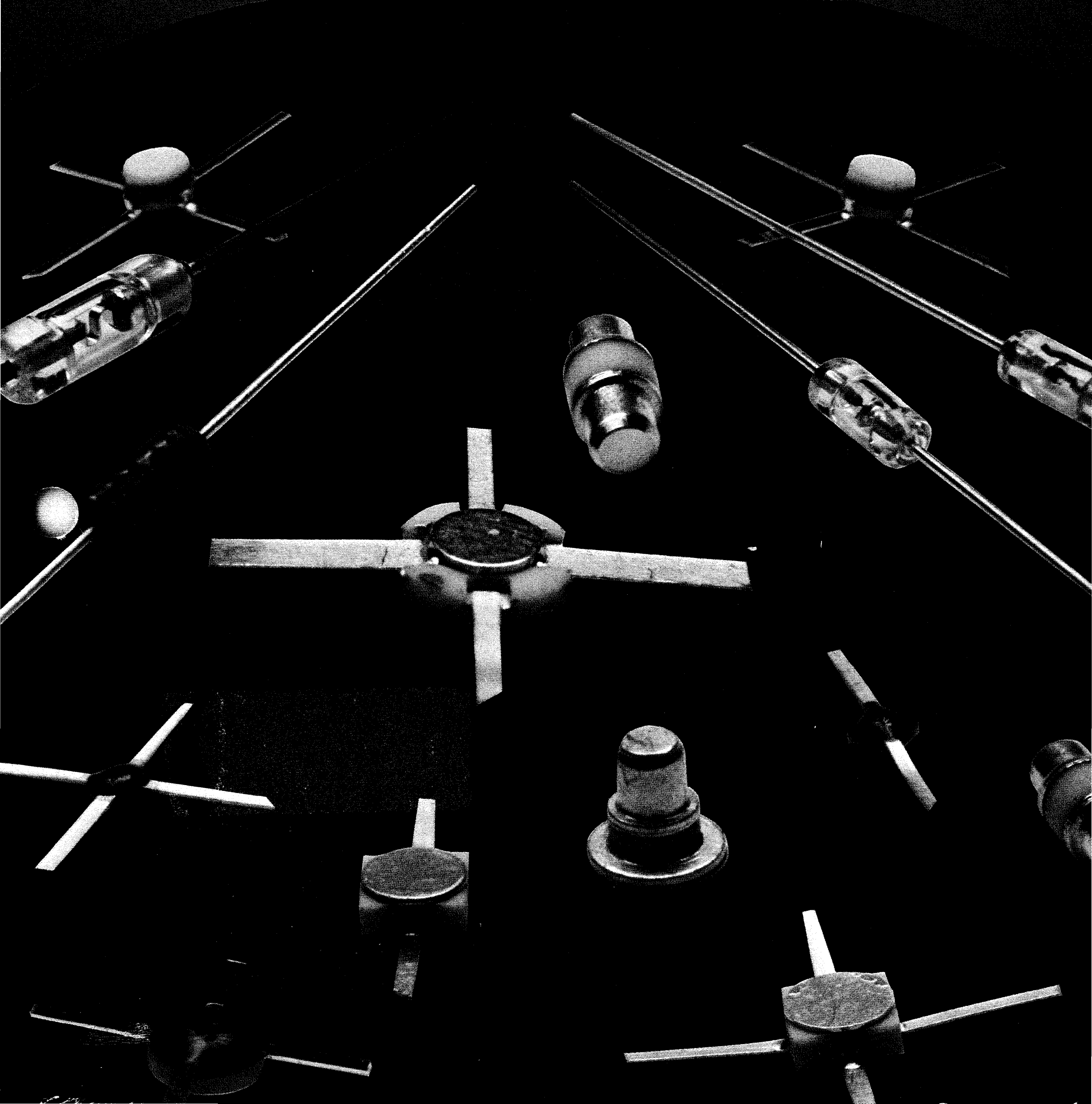
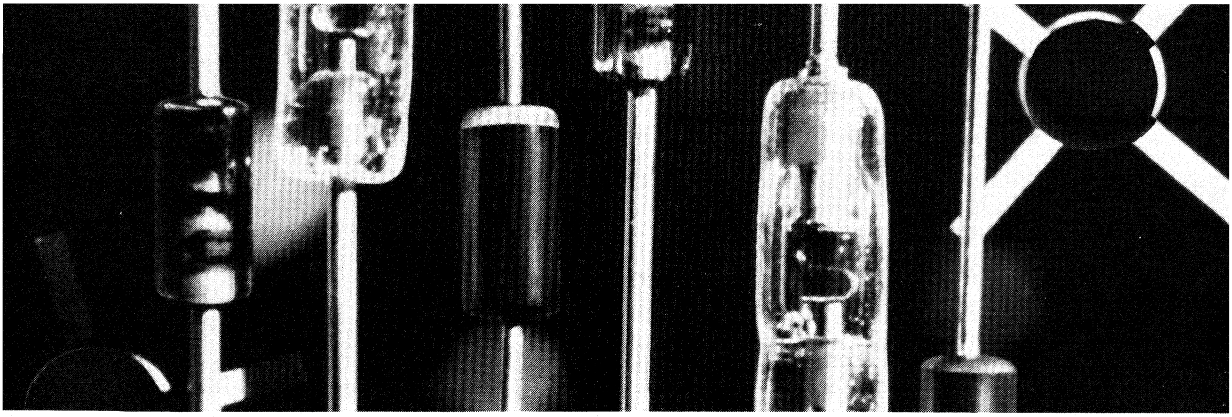
Diode and Transistor Designer's Catalog 1984-85

HEWLETT PACKARD





Microwave Semiconductor Diode and Transistor Designer's Catalog 1984-85

Intensive research and development of advanced manufacturing techniques has enabled Hewlett-Packard to become a high volume supplier of quality, competitively priced RF/Microwave Diodes and Transistors.

In addition to our broad product line, Hewlett-Packard also offers the following services: Applications support, special testing for customer requirements and a one year guarantee on all of our products. Each product accepted for commercial sale has been tested for reliability during the development phase and is subject to quality assurance procedures throughout the manufacturing process.

This package of products and services has enabled Hewlett-Packard to become a recognized leader in the Semiconductor Industry.

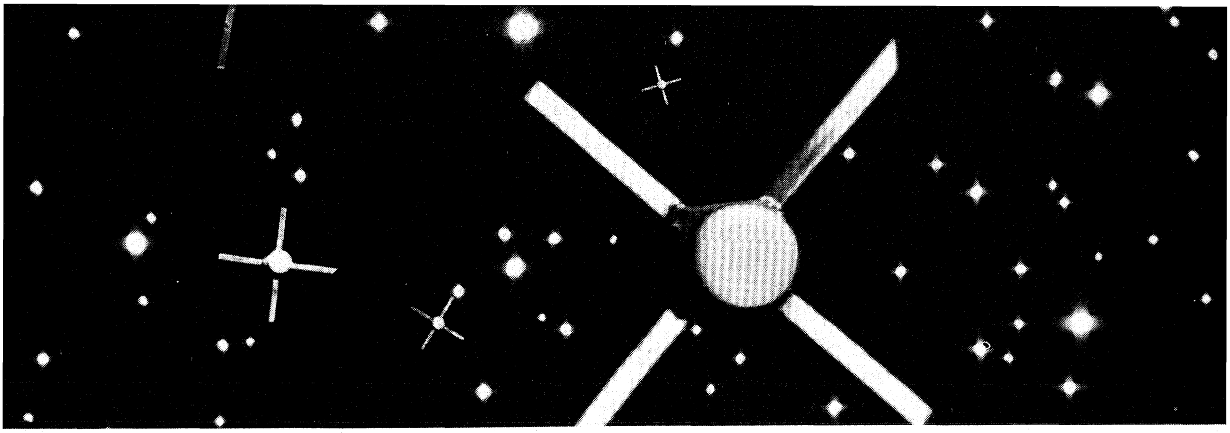
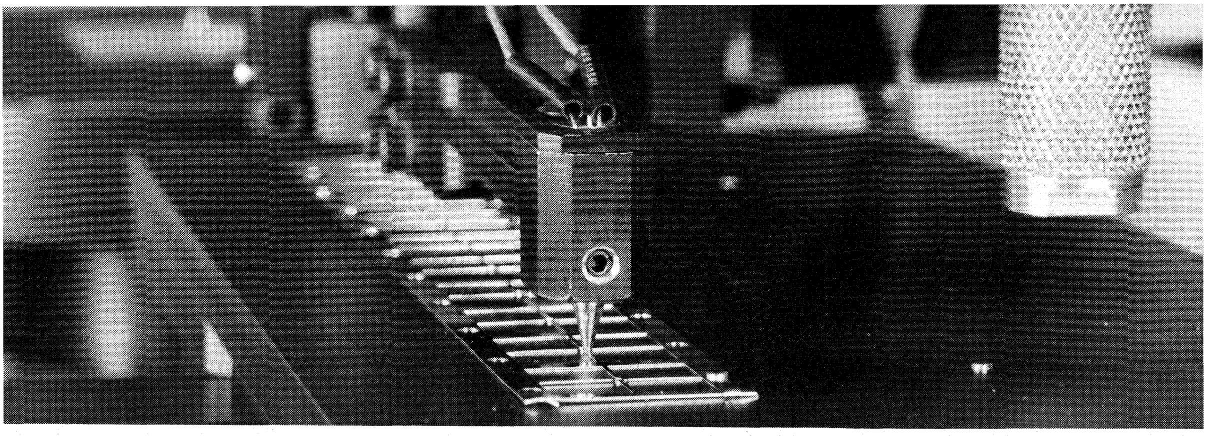


Table of Contents

NEW Identifies newly introduced products or capabilities
New products are also indicated by boldface listings in the Numeric Index.



A Brief Sketch

Hewlett-Packard is one of the world's leading designers and manufacturers of electronic, medical, analytical, and computing instruments and systems, diodes, transistors, integrated products, and optoelectronic products. Since its founding in Palo Alto, California, in 1939, HP has done its best to offer only products that represent significant technological advancements.

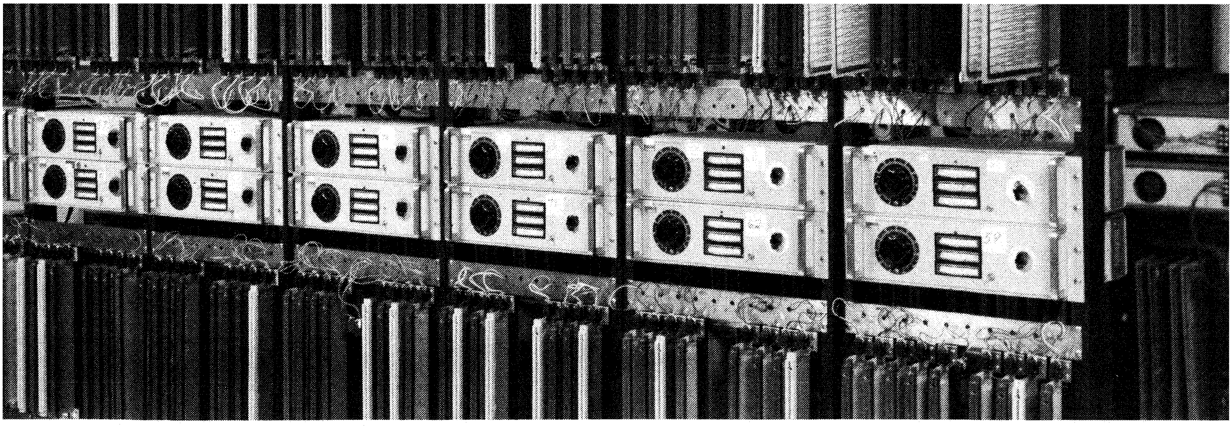
To maintain its leadership in instrument and component technology, Hewlett-Packard invests heavily in new product development. Research and development expenditures traditionally average about 10 percent of sales revenue. This level of commitment enables the company to employ the latest technologies in developing innovative products that can be reliably produced, delivered, and supported on a continuing basis.

HP produces more than 3,500 products at our domestic divisions in California, Colorado, Washington, Oregon, Idaho, Massachusetts, New Jersey and Pennsylvania and at overseas plants located in the German Federal Republic, England, Scotland, France, Japan, Singapore, Malaysia, Brazil, Mexico and Puerto Rico.

However, for the customer, Hewlett-Packard is no further away than the nearest telephone. Hewlett-Packard currently has sales and service offices located around the world. (Pg. 318).

These field offices are staffed by trained engineers, each of whom has the primary responsibility of providing technical assistance and data to customers.

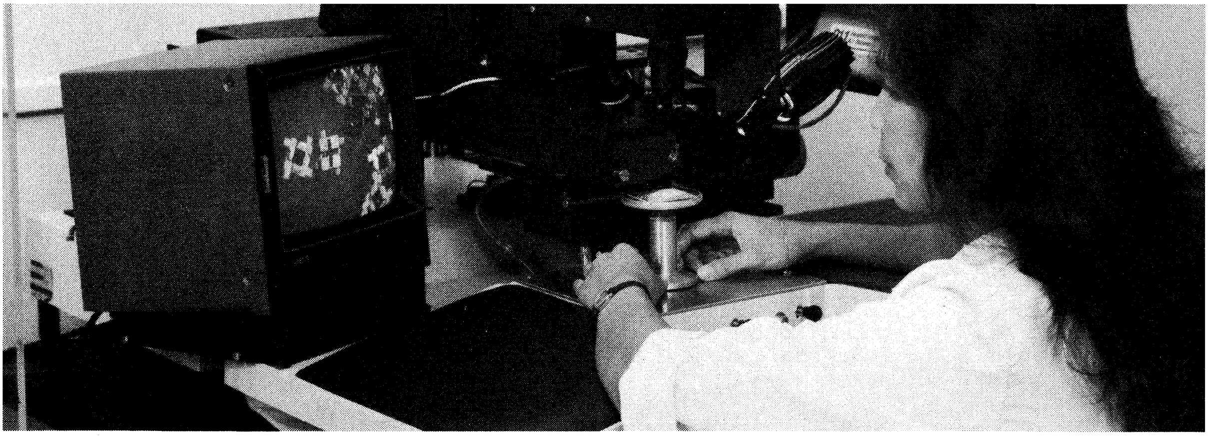
A vast communications network has been established to link each field office with the factories and with corporate offices. No matter what the product or the request, a customer can be accommodated by a single contact with the company.



RF and Microwave Semiconductors

Hewlett-Packard's manufacturing plant located in San Jose, California, houses such modern equipment as projection mask aligning and automation handling systems. Ion implantation, new evaporation and wet processing systems, and scanning electron microscopy provide the basis for quality and dependability for the entire product line.

When quality represents a competitive edge, or when reputation and dependability of your products is on the line, you can count on Hewlett-Packard RF and Microwave Semiconductor Devices for excellent product consistency.



About This Catalog

This Microwave Semiconductor Devices Designer's Catalog contains detailed and up-to-date specifications of our complete line of RF and microwave products. This catalog is divided into 4 product sections: Silicon Bipolar Transistors, Schottky Barrier Diodes, PIN and High Conductance Diodes, and Step Recovery Diodes. At the end of each section, a complete index of application notes and bulletins pertaining to the use of those products is included.

Also included in each section where possible are the equivalent circuits of each product. These will be of use in the computer-aided design circuits.

In the transistor product data sheets, the Absolute Maximum Ratings table indicates the limits of the device. Operation in excess of any of these conditions may result in permanent damage to the device. Information concerning the MTTF design goals for the devices is included in "Reliability Performance of Bipolar Transistors", page 108, as well as on the product data sheets.

How To Use This Catalog

Three methods are incorporated for locating components:

- A table of contents that allows you to locate devices by their general description.
- An alphanumeric index that lists all devices by part number plus generic chip part numbers.
- Selection guides at the beginning of each product section generally grouping products by major specification, frequency, etc.

Although product information and illustrations in this catalog were current at the time it was approved for printing, Hewlett-Packard, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications, designs, and models without notice.

Ordering Information, After Sales Services

How To Order

All Hewlett-Packard components may be ordered through any of the Sales and Service offices listed on page 318. In addition, for immediate off-the-shelf delivery of Hewlett-Packard RF and Microwave Semiconductor devices, contact any of the worldwide stocking distributors and representatives listed on page 315.

Warranty

As an expression of confidence in our products to continue meeting the high standards of reliability and performance that customers have come to expect, Hewlett-Packard Microwave Semiconductor Products carry the following warranty.

HP's Components are warranted against defects in material and workmanship for a period of one year from the date of shipment. HP will repair or, at its option, replace components that prove to be defective in material or workmanship under proper use during the warranty period. This warranty extends only to HP customers.

NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT TORT OR ANY OTHER LEGAL THEORY.

Certification

Some customers are especially interested in the test and quality assurance programs that HP applies to its products. These Hewlett-Packard programs are documented in a Certificate of Conformance which is available upon request at the time of purchase. This certification states:

We certify that the Microwave Semiconductor Division devices were duly tested and inspected prior to shipment and that they met all of the published specifications for these devices.

Hewlett-Packard's calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

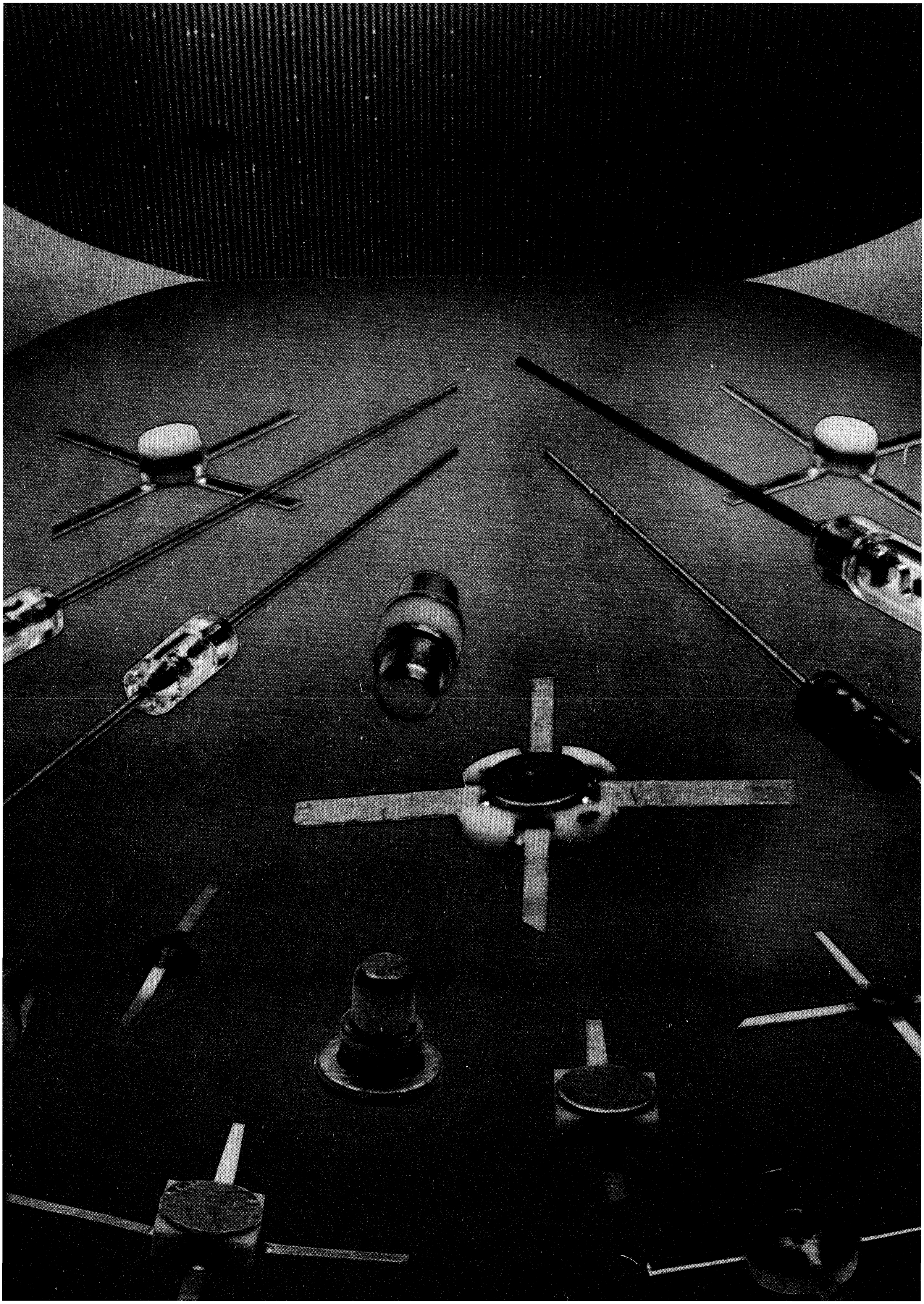
The Hewlett-Packard Quality Program satisfies the requirements of MIL-Q-9858A, MIL-I-45208A, MIL-S-19500, MIL-C-45662A, and NASA 5300.4 (I.C.)

Service

We firmly believe that our obligation to you as a customer goes much beyond just the delivery of your new HP product. This philosophy is implemented by Hewlett-Packard in two basic ways: (1) by designing and building excellent products with good serviceability, and (2) by backing up those products with a customer service program which can respond to your needs with speed and completeness.

The HP customer service program is one of the most important facets of our worldwide operations, providing a local service capability in many of our field offices (listed on page 318). Indeed, this customer service program is one of the major factors in Hewlett-Packard's reputation for integrity and responsibility towards its customers.

ALPHANUMERIC INDEX



High Reliability

HIGH RELIABILITY

Introduction

For over 15 years, MSD has been extensively involved in many military and space oriented High Reliability (Hi-Rel) Test programs. The inherent reliability and proven performance of our products has provided a vehicle with which to build a strong record of performance in the demanding requirements of space programs. By having a large group of Marketing and Product Assurance personnel dedicated to the service of Hi-Rel customers, HP has been frequently called upon to provide the high performance, highly reliable components demanded by many military and commercial space probe and satellite programs. Among the many space programs using HP Microwave Semiconductor Division products are Apollo, Viking, Intelsat, Space Shuttle, Indiasat, G-Star, and Westar.

This section of the catalog describes the use of Hi-Rel testing, to demonstrate the quality and reliability of semiconductor devices.

Reliability Testing

Reliability testing is designed to demonstrate the ability of a device to meet electrical requirements over its specified life to a designated confidence level. To achieve this confidence, Hi-Rel devices are either 100% tested or qualified by testing a random sample of devices from the lot.

The purpose of 100% testing is to verify the stability of the devices in the completed lot, and verify that devices are in the useful life period (see Figure 1). These tests may be environmental tests or functional tests (i.e. electrical) and are normally referred to as preconditioning and screening tests, respectively.

Sample testing is used to statistically demonstrate the capability of the completed lot of devices to operate successfully under the specified test conditions. A sample test plan specifies the acceptance level required before the lot is considered qualified. This test plan depends on the level of reliability required, and is mathematically derived.

If a lot does not successfully pass a particular test during Group A sampling, that lot is 100% retested for that particular parameter. This 100% testing will remove any non-conforming devices thereby ensuring that the remaining lot is reliable.

Sample tests are usually divided into Group A, Group B, and Group C tests.

Group A tests are electrical tests used to demonstrate that the parts meet the functional requirements of the particular specification to which they are purchased.

Group B tests are environmental and life tests. They are used to demonstrate the ability of the lot sample to survive test conditions.

Group C tests are also environmental and life tests. They are used to demonstrate the ability of the generic device to meet the requirements of each test. These tests are run infrequently, hence, they are often referred to as periodic tests.

Group B and C life tests verify the length of the useful life period under specified bias conditions (see Figure 1). Some of the Group B and Group C tests render devices unserviceable. These tests are called destructive tests. MIL-S-19500 defines the following tests as destructive:

Solderability	Terminal Strength
Soldering Heat	Salt Atmosphere
Moisture Resistance	Salt Spray

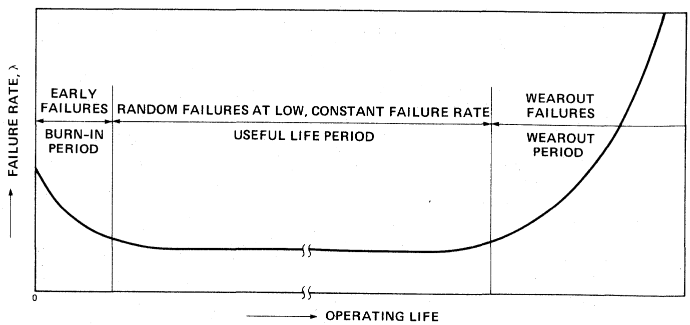


Figure 1.

Role of Military Specifications

There are numerous specifications associated with electronic devices. MIL-S-19500 and MIL-STD-750 are most frequently used to specify test programs, methods and conditions for discrete semiconductors.

MIL-S-19500 is the general specification for discrete semiconductor components. It defines test sequences to achieve different levels of reliability. MIL-STD-750 defines the actual tests and screening methods, conditions and pass/fail criteria as required by MIL-S-19500. These tests are divided into three categories:

a. Environmental Tests (1000 Series)
b. Mechanical Tests (2000 Series)
c. Electrical Tests (3000 and 4000 Series)

Environmental Tests

MIL-STD-750 Method	Test Type	Purpose of Test/Simulated Operation	Frequency of Testing
1001	Barometric Pressure	Simulates non-pressurized portion of aircraft at high altitude. (Required for products with $V_{BR} > 200$ V only.)	Group C (periodic)
1021	Moisture Resistance	Simulates tropical environment of high heat and humidity.	Group C (periodic)
1022	Resistance to Solvents	Simulates cleaning of boards after device installation. Verifies marking permanency.	Group B
1026	Steady State Life (λ)	Simulates accelerated electrical operation. t = 1000 hours.	Group C (periodic)
1027	Steady State Life (LTPD)	Simulates accelerated electrical operation. t = 340 hours.	Group B
1031	Hi-Temp. Non-Op. Life (λ)	Simulates accelerated shelf life. t = 1000 hours.	Group C (periodic)
1032	Hi-Temp. Non-Op. Life (LTPD)	Simulates accelerated shelf life and effect of exposure to temperture. t = 24 hours for screen, t = 340 hours for Group B.	100% screen and Group B.
1038 Diodes	Hi-Temp. Reverse Bias and Burn-in	Simulates time and stress of actual life use on devices. Verifies that devices are in the useful life period.	100% Screen.
1039 Transistors	Hi-Temp. Reverse Bias and Burn-in	Simulates time and stress of actual life use on devices. Verifies that devices are in the useful life period.	100% Screen.
1041	Salt Atmosphere	Simulates accelerated exposure to sea coast environment.	Group C (periodic)
1051	Thermal Shock (Temperature Cycling)	Simulates transfer of parts between extreme environmental conditions.	100% Screen.
1056	Thermal Shock (Glass Strain)	Ensures mechanical integrity by subjecting devices to sudden changes in temperature.	Group C (periodic)
1071	Fine Leak/Gross Leak	Verifies that packaging is hermetically sealed.	100% screen.

Mechanical Tests

MIL-STD-750 Method	Test Type	Purpose of Test/Simulated Operation	Frequency of Testing
2006	Constant Acceleration	Ensures die attach and wire bond integrity.	100% screen.
2016	Mechanical Shock	Verifies devices resistance to mechanical stresses.	Group C (periodic)
2017	Die Shear Test	Verifies integrity of die to package bond.	In process/Group B
2026	Solderability	Confirms that the leads are able to take an even coating of solder with minimum voids.	Group B
2031	Soldering Heat	Determines the devices resistance to the high temperature encountered during soldering.	Guaranteed by design.
2036 A, D, E, F	Terminal Strength	Simulates the leads ability to withstand specified tension, torque, and fatigue.	Group C
2037	Bond Strength	Verifies integrity of chip to package interconnection	In process/Group B
2052	PIND (Partical Impact Noise Detection Test)	Detects loose particles in the package cavity.	100% screen
2056	Vibration Variable Frequency	Simulates mechanical performance of the device when subjected to vibration within the specified frequency range.	Group C (periodic)
2066	Physical Dimensions	Verifies that dimensions meet the design and specification criteria.	Group C (periodic)
2071	Visual and Mechanical	Ensures that marking and packaging meet specified requirements.	Group A
2072	Internal Visual (pre-cap)	Ensures high visual quality of end product.	100% screen
2073	Die Visual	Ensures high quality, defect-free semiconductor die for assembly use.	100% screen
2074	Internal Visual (through glass)	Ensures high visual quality of end product.	100% screen
2075	Decap Design Verification	Verifies that design and construction meet specifications.	Group B
2076	X-Ray	Non-destructive test performed after final seal that verifies seal integrity, bond integrity, and particle-free cavity.	100% screen
2077	Scanning Electron Microscope (SEM)	Verifies quality and acceptability of metallization on semiconductor dice.	Samples from each wafer or lot

Electrical Tests

Class 3000 and 4000 tests define the acceptable testing methods for semiconductor products.

Hi-Rel Screened Products

Hewlett-Packard provides two types of Hi-Rel products: DESC qualified (JAN) and Standard Hi-Rel.

DESC Qualified Products (JAN)

Since a great number of reliability tested devices are used in military programs, the JAN (Joint Army-Navy) system has been established by the U.S. government to provide standardized levels of reliability at minimum cost to all users. There are two major advantages to the JAN type products. First, the specification, and thus the reliability level of the device, is pre-specified for the buyer, eliminating costly creation of special procurement documents. Second, JAN devices can be manufactured in large quantities with subsequent cost reductions.

Three levels of JAN devices are offered by Hewlett-Packard:

1. JAN —
   Shipment lots have had Group B tests performed successfully on a sample basis.
2. JAN TX —
   The shipment lots have been subjected to 100% screening tests. Individual devices have been serialized, and drift data has been recorded. Group B sample data is then done after screening.
3. JAN TXV —
   These are the same level as JAN TX with the additional requirement of a pre-closure visual inspection.

Standard Hi-Rel Programs

Since the advantages of products tested to well established reliability standards can be of significant value to reliabililty oriented customers, HP makes available a number of products that have been tested to the same reliability level as the JAN type devices, but have HP part numbers and meet HP designated electrical specifications. These are our "TX" products. Typical screening programs are set forth in the Hi-Rel data sheets.

Hewlett-Packard provides standard Hi-Rel programs which are patterned after MIL-S-19500. These programs are designed to:

1. Eliminate the costly requirements of generating Hi-Rel specifications.
2. Offer improved delivery for these Hi-Rel devices.
3. Provide assistance in writing Hi-Rel specifications.

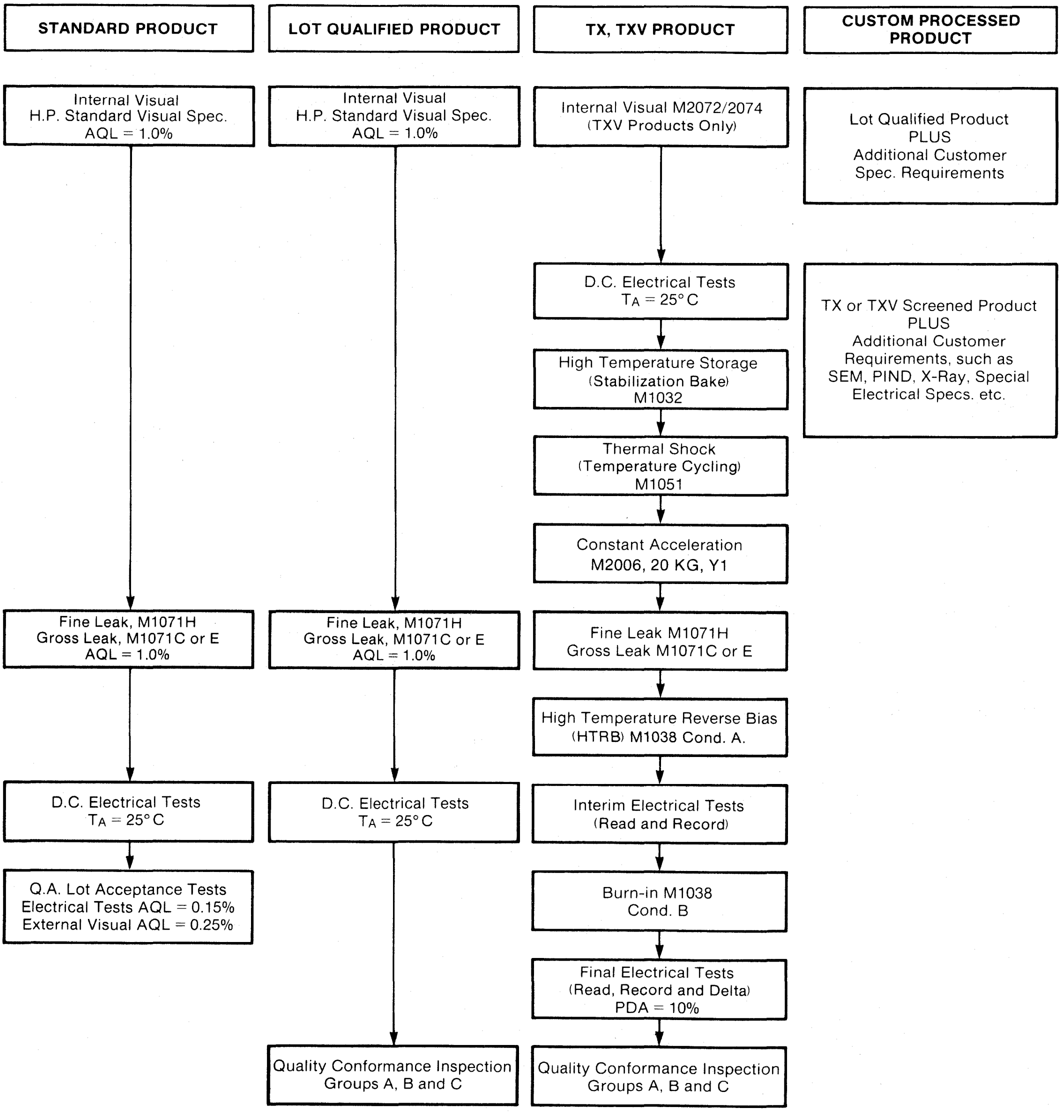
Products available from HP may be classified into four categories:

a. Dice
b. Beam lead devices
c. Glass packaged devices
d. Ceramic packaged devices

Hi-Rel screening requirements vary slightly due to the unique properties of each category. The tables that follow list these screening programs along with the qualification and quality conformance testing performed for each category. Screening programs for each category have been designed to verify the reliability of the end product.

Diode Test and Screening Options (Typical)*

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Diode Test and Screening Options (Typical)* (con't)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)

QUALITY CONFORMANCE INSPECTION

GROUP A

Subgroup 1, LTPD = 5
Visual and Mechanical, M2071

Subgroup 2, LTPD = 5
D.C. Electrical Tests
T_A = 25°C

Subgroup 3, LTPD = 5
D.C. Electrical Tests
High and Low Temp.

Subgroup 4, LTPD = 5
Dynamic Electrical Tests
T_A = 25°C

GROUP B

Subgroup 1, LTPD = 15
Solderability, M2026
Resistance to Solvents, M1022

Subgroup 2, LTPD = 10
Thermal Shock, M1051
(Temperature Cycling)
Fine Leak, M1071H
Gross Leak, M1071C or E
Electrical Tests
(Read and Record)

Subgroup 3, LTPD = 5
Steady State Operating Life, M1027, t = 340 hours
Electrical Tests
(Read, Record and Delta)

Subgroup 4, LTPD = 20
Decap Design Verification
1 Device 0 Failures
Bond Strength, M2037
(LTPD Applied to M2037)

Subgroup 5, LTPD = 10
High Temperature Non-Op Life, M1032, t = 340 hours
Electrical Tests
(Read, Record and Delta)

GROUP C

Subgroup 1, LTPD = 15
Physical Dimensions, M2066

Subgroup 2, LTPD = 10
Thermal Shock Glass Strain, M1056A
Terminal Strength, M2036A
Fine Leak, M1071H
Gross Leak, M1071C or E
Moisture Resistance, M1021
External Visual, M2071
Electrical Tests
(Read and Record)

Subgroup 3, LTPD = 10
Mechanical Shock, M2016
Vibration Variable Frequency, M2056
Constant Acceleration, M2006
20 KG, X1, Y1, Z1
Electrical Tests
(Read and Record)

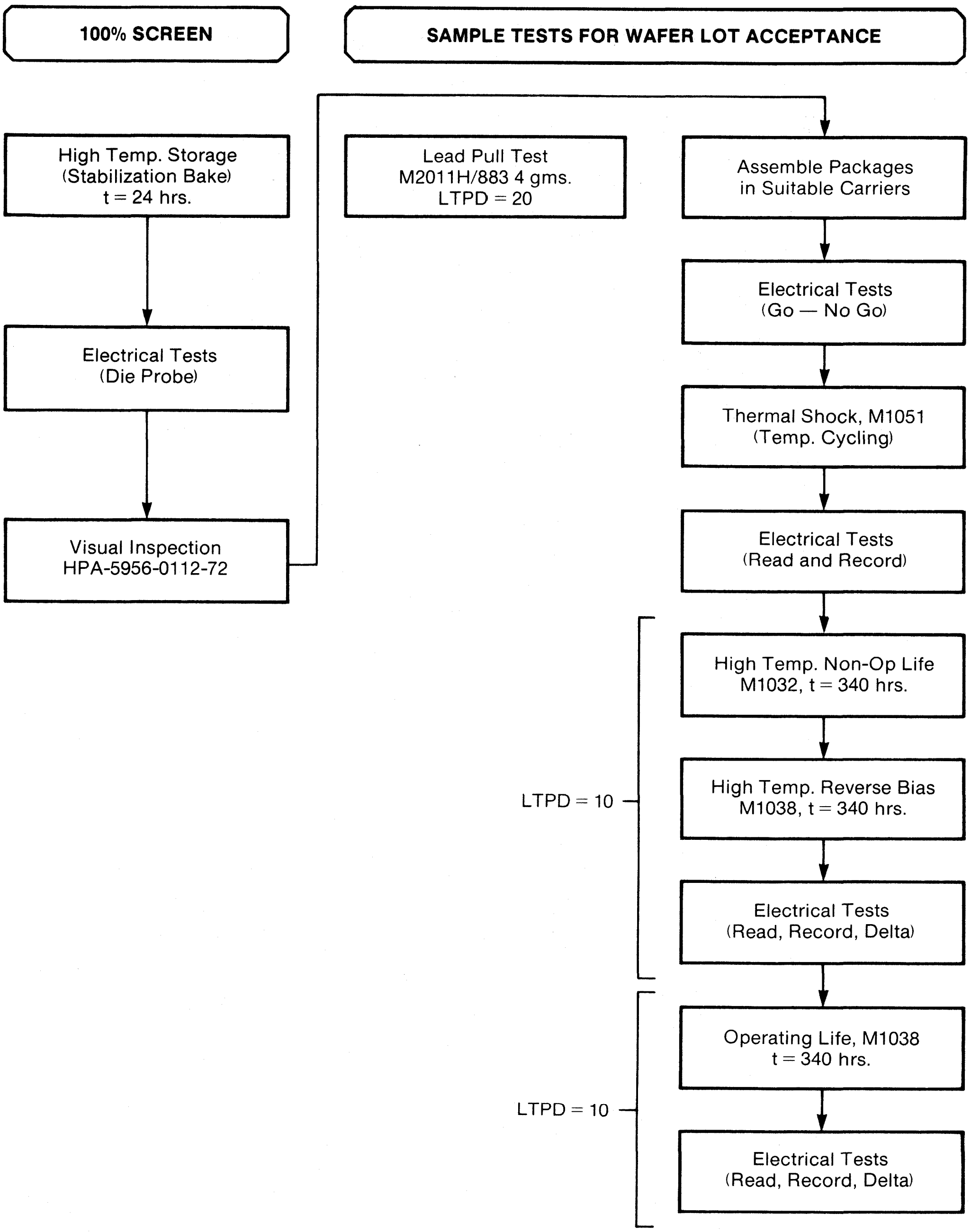
Subgroup 4, LTPD = 15
Salt Atmosphere, M1041

Subgroup 5, λ = 10
Operating Life, M1027
t = 1000 hrs.
Electrical Tests
(Read, Record and Delta)

* This represents a typical screening program for glass or ceramic packaged diodes.

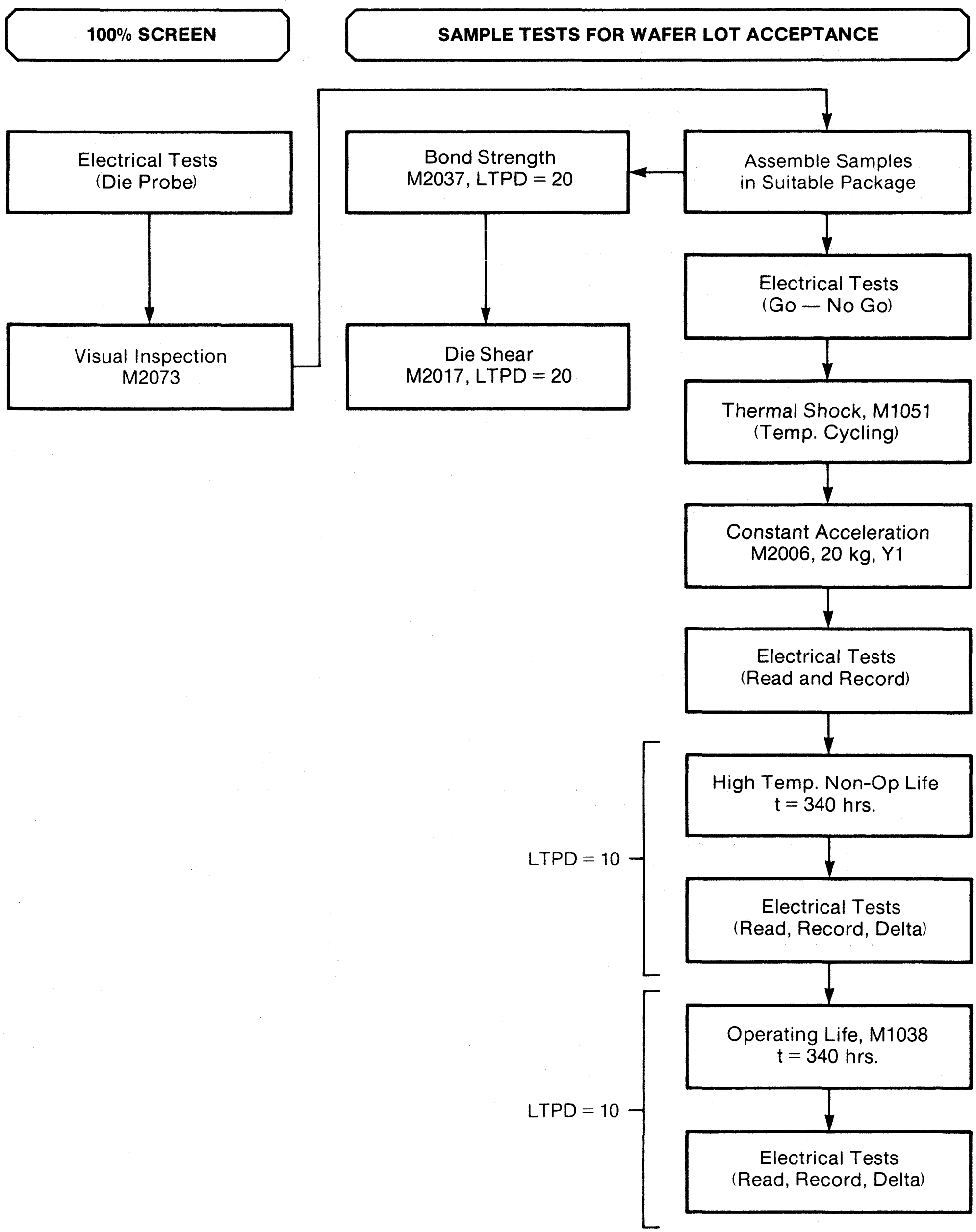
Hi-Rel Beam Lead Diode Test/Screen Program (Typical)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



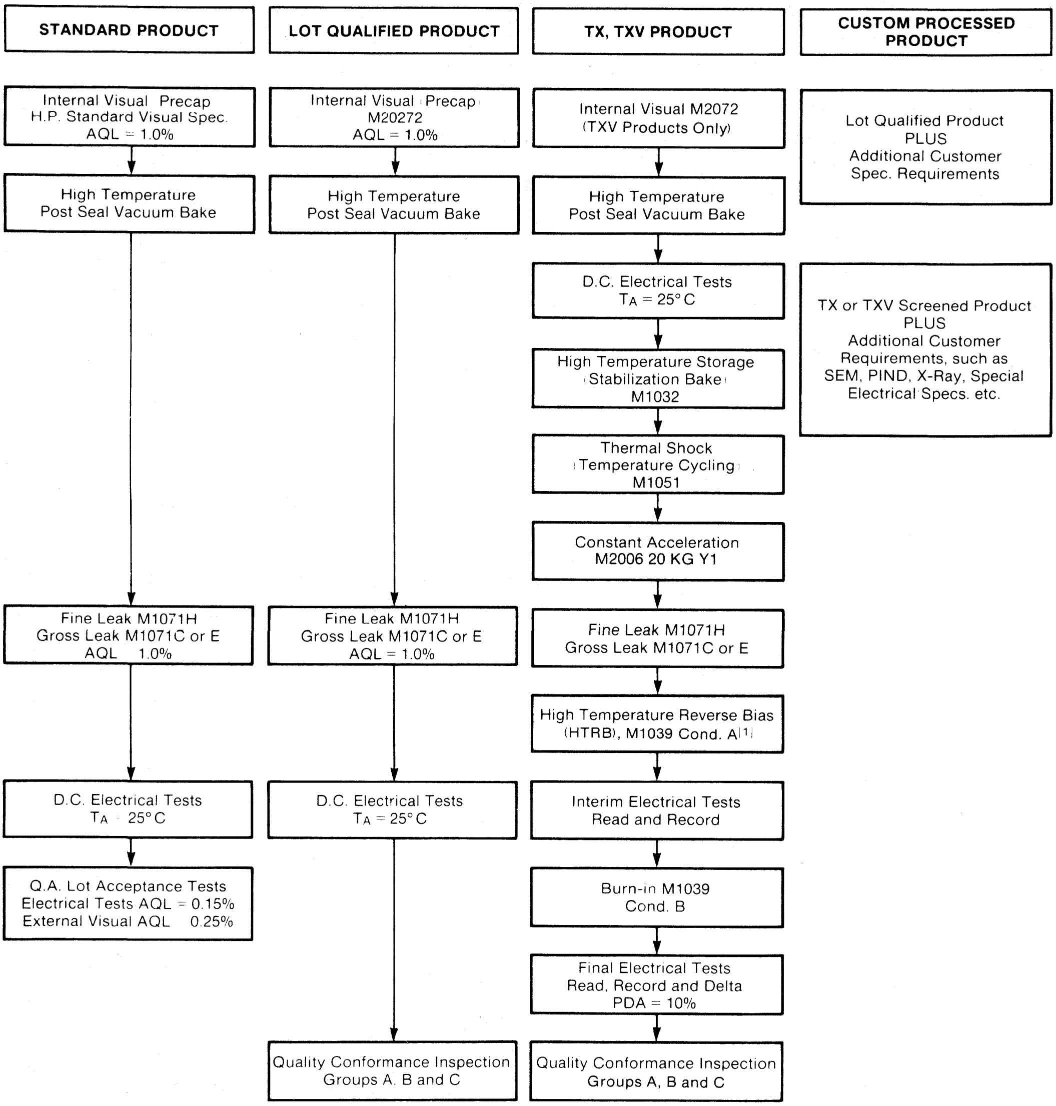
Hi-Rel Chip Diode Test/Screen Program (Typical)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Transistor Test and Screening Options (Typical)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Transistor Test and Screening Options (Typical) (con't)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)

QUALITY CONFORMANCE INSPECTION

GROUP A

Subgroup 1, LTPD = 5
Visual and Mechanical M2071

Subgroup 2, LTPD = 5
D.C. Electrical Tests
$T_A = 25°C$

Subgroup 3, LTPD = 5
D.C. Electrical Tests
$T_A = -55°C$ and $+125°C$

Subgroup 4, LTPD = 5
Dynamic Electrical Tests
$T_A = 25°C$

1. Not applicable to Micro-Plus packaged devices.

GROUP B

Subgroup 1, LTPD = 15
Solderability M2026
Resistance to Solvents M1022

Subgroup 2, LTPD = 10
Thermal Shock M1051
(Temperature Cycling)
Fine Leak M1071H
Gross Leak M1071C or E
Electrical Tests
(Read and Record)

Subgroup 3, LTPD = 5
Steady State Operating Life
M1027, t = 340 hrs.
Electrical Tests
(Read, Record and Delta)

Subgroup 4, LTPD = 20
Decap Design Verification
1 Device 0 Failures
Bond Strength M2037
(LTPD Applies to M2037)

Subgroup 5, LTPD = 15
Thermal Resistance Tests
(Optional)

Subgroup 6, LTPD = 7
High Temp. Non-Op Life,
M1032, t = 340 hrs.
Electrical Tests
(Read, Record and Delta)

GROUP C

Subgroup 1, LTPD = 15
Physical Dimensions M2066

Subgroup 2, LTPD = 10
Thermal Shock (Glass Strain)
M1056A
Terminal Strength, M2036A
Fine Leak, M1071H
Gross Leak, M1071C or E
Moisture Resistance, M1021
External Visual, M2071
Electrical Tests
(Read and Record)

Subgroup 3, LTPD = 10
Mechanical Shock, M2016
Vibration Variable Frequency,
M2056
Constant Acceleration, M2006
20 kg, X1, Y1, Z1
Electrical Tests
(Read and Record)

Subgroup 4, LTPD = 15
Sale Atmosphere M1041

Subgroup 5, $\lambda = 10$
Operating Life M1027
t = 1000 hrs.
Electrical Tests
(Read, Record and Delta)

Marking, Packaging, Shipping and Handling

Device and container marking is dependent on the type of device as shown below:

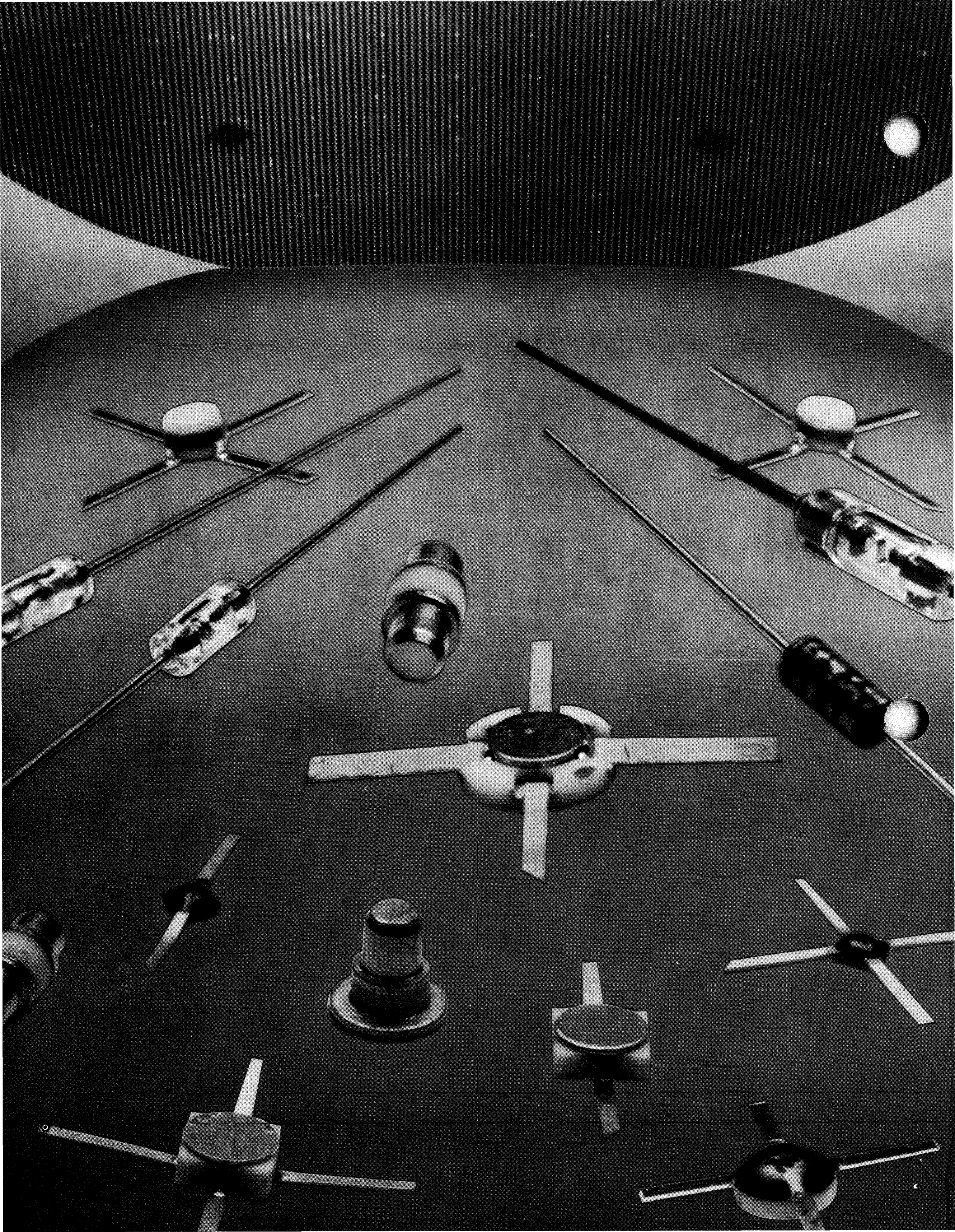
Device	Device Marking				Typical Container/Marking
Dice	None				100 dice per waffle pack. Label on waffle pack.
Beam Lead	None				25 beamleads per gel pack. Label on gel pack.
Glass Package	DESC				Bulk or corregated insert (10 each), packaged in antistatic bag. Label on bag. Tape and Reel
	JAN	JAN TX	JAN TXV	HP, Hi-Rel	
	JIN ABCD[1] AQIM[2]	JXIN ABCD[1] AQIM[2]	JVIN ABCD[1] AQIM[2]	ABC DEF[1] XXX[3]	
Ceramic Package	None on small packages. Marking varies on larger packages.				Individual or multiple packaging. Label on packaging container.

Notes:
1. Part Number.
2. Manufacturers ID.
3. Data Code.

Label Marking:

Hewlett-Packard	Lot Number
Part Number	Country of Origin
Date Code	Quantity

All devices are electrostatic sensitive. Packaging used is antistatic and impregnated with conductive material to provide adequate protection from electrostatic discharge damage. At a receiving station, the parts should be treated as ESD sensitive material and appropriate handling procedures must be used to avoid degradation due to electrostatic discharge.



Quality Assurance

QUALITY ASSURANCE CONCEPTS AND METHODOLOGY

Quality Philosophy

Recognizing the increasing importance of microwave component reliability for the consumer, industrial, and military markets, the Microwave Semiconductor Division (MSD) of Hewlett-Packard has committed itself to achieve error free performance at all levels of manufacturing and to deliver the highest level of product quality and reliability performance. Three basic ingredients are integrated into the manufacture of reliable microwave components:

- The device must be designed with a technical understanding of the user's applications and quality requirements.
- The device must be manufactured with the optimum state-of-the-art technology for the application.
- Controls must be established in the manufacture of the device.

As a major manufacturer of microwave products, MSD produces a broad family of many devices. Since it is not practical, technically necessary, nor cost effective to qualify each of these products via life and environmental testing, the logical approach has been to differentiate assembly/package related failure mechanisms from failure modes associated with the wafer fabrication process. This "die process" and "package product" approach to reliability has been a consideration in the new military standards for microelectronic testing/reliability and is used at MSD with the following definitions:

- **Die Process Family** consists of devices which have identical wafer processing. This premise recognizes that component geometry and layout of a product will have little impact on reliability because established design rules apply to all products fabricated by the same process.
- **Package/Assembly Family** are those of like construction and are assembled with identical materials, manufacturing controls and operations.

Component reliability estimation can therefore be achieved with a high confidence level from environmental and life testing data derived from various product families. Accelerated stress testing techniques are continuously employed to obtain definitive working knowledge of reliability performance, whereby the resulting information is used to predict long-term device reliability for the intended application.

In-process Control and Reliability Testing

The reliability performance of microwave components can be affected by numerous operations associated with device manufacturing; among these being:

- Wafer fabrication process/technology
- Device design and layout
- Packaging design
- The manufacturing processes
  - — Wafer fabrication
  - — Package materials
  - — Assembly materials and procedures
- In-process controls
- Final electrical test procedures
- Quality Assurance inspection procedures
- Post-assembly reliability screening

One of the most important aspects of insuring quality and reliability is through adequate in-process controls of these operations. Wafer fabrication controls provide the assembly operation with a high quality and reliable chip, while the process controls associated with the assembly operation assure the optimum in package integrity. The main areas of Quality Assurance process controls may be summarized according to the fabrication and assembly operations:

Quality Assurance Process Controls

Wafer Fabrication	Assembly
Particle count, room and hood ambient	Die visual
Temperature/Humidity control	Die shear test
Capacitance vs. Voltage plots	Wire bond pull
Furnace tube cleaning	Pre-seal visual
Deionized water checks	Hermeticity
Metal thickness monitor	Electrical test
Metal SEM monitor	
Inspection of starting material	

Life and Environmental Stress Tests

To ensure the highest quality product commensurate with the intended use of the device, numerous life and environmental tests have been designed to assess device performance. The majority of these tests are designed to simulate more extreme operating conditions than would actually be encountered in most practical applications. This ensures the reliability performance of the device relative to its intended application. Typical device testing at MSD generally comprises the following environmental and life tests:

Life Tests

High Temperature Reverse Bias (HTRB)

Operating Life

High Temperature Operating Life (HTOL)

High Temperature Storage Life (HTSL)

Environmental Tests

Moisture Resistance	Hermeticity
Solderability	Mechanical Shock
Thermal Shock	Lead Fatigue
Temperature Cycling	Vibration Variable Frequency
	Vibration Fatigue
Power Cycling	Constant Acceleration
Terminal Strength	Salt Atmosphere

Specific methods and conditions of these tests are in compliance with MIL-STD-202, MIL-STD-750, and MIL-STD-883 test specifications, depending upon the nature of the device being tested and its functional classification. For more information on these testing programs please refer to the High Reliability section of this catalog.

Reliability Assessment and Prediction

Numerous concepts and mathematical models have been proposed to assess the reliability performance of semiconductor components. Of these, essentially three fundamental equations are widely used in the industry for reliability assessment and prediction of failure rate:

- The failure rate equation, λ
- The probability of survival, P_S
- The Arrhenius equation for determining the activation energy of thermal processes, E_a

The **Failure Rate Equation** relates to the population of units failed under life testing and the duration of the test. It is defined by the relationship

$$\lambda = \frac{N_F}{N_O t}$$

where

λ = assessed failure rate

N_F = quantity of failures occuring in a time interval t

N_O = quantity of acceptable devices at zero hours

t = time interval or duration of test

Generally it is more meaningful to discuss failure rates in terms of the Mean Time To Failures or MTTF, which is the reciprocal of the failure rate and expressed as MTTF = $1/\lambda$. It is important to recognize that both λ and MTTF are statistical averages and apply only to the useful life of the product.

The **Probability of Survival** is the likelihood that a particular device will survive for a given period of operating time and may be expressed as:

$$P_S = e^{-\lambda t} = e^{-t/(MTTF)}$$

where

t = operating time of the device

λ = failure rate = 1/MTTF

The third mathematical relationship of importance to reliability is a form of the **Arrhenius Equation,** which relates the rate of a thermally accelerated process to temperature. Expressed in terms of the failure rate λ and the **Activation Energy** (E_a) for the process takes the form:

$$E_a = \frac{kT_2T_1}{(T_2-T_1)} \ln \frac{\lambda_2}{\lambda_1}$$

where

E_a = Activation Energy

k = Boltzmann's Constant (8.63×10^{-5} eV/°K)

T_i = Absolute temperatures at which the failure rates λ_i were measured

λ_i = Failure rate at temperature T_i

From this relationship, the failure rate at some temperature other than the test temperature can be determined provided the activation energy of

Quality and Reliability

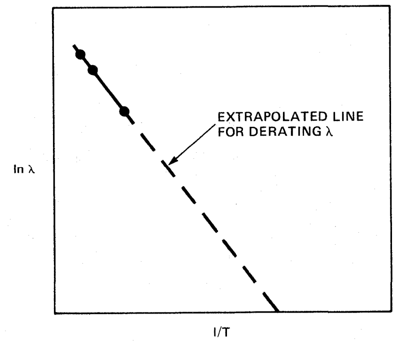
the failure mode is known. More important, the activation energy can be determined for various thermally activated processes. This allows the reliability analysts to fingerprint specific failure mechanisms and hence predict the reliability performance of a product as a function of time and temperature. In practice, the failure mechanism of a device is not clearly understood or the activation energy of the processes are not known. Hence the derating of failure rates from accelerated temperature stress testing is usually accomplished by the use of the non-integrated Arrhenius equation:

$$\ln \lambda = -\frac{E_a}{kT} + \ln A$$

where A is a constant.

A plot of $\ln \lambda$ vs. T^{-1} will yield a straight line as illustrated, with a slope equal to $-E_a k^{-1}$.

ARRHENIUS PLOT



Extrapolation of this line to the junction temperature (T_J) of the device or ambient temperature (T_A) allows the analytical extraction of the failure rate at the temperature of interest. This procedure of derating λ assumes that the failure rate is a linear function of time at a fixed level of stress.

Reliability Product Monitor Program

The accompanying program matrix has been constructed by the Reliability Group to provide an active monitor on the reliability performance of our products; the intent of the program being:

- To provide a periodic on-going evaluation of our product reliability.
- Maintain a pulse on fabrication and assembly operations.
- Identify, via long-term stress testing, the limitations of our products and thereby provide future direction to engineering design, development, and manufacturing improvements.

Fabrication and assembly variables were considered in the construction of the matrix to assure that these products would best represent all product families and their associated processes.

In addition to the following listed products, all new products must pass an extensive reliability test program prior to introduction. This ensures that the tradition of high quality is upheld in all new devices.

Life and Environmental Test Matrix[1]

Life/Environmental Stress	Test Method	Stress Condition	Minimum Stress Duration
Operating Life	MIL-STD-750 Method 1026.3	$T_J/T_{CH} \leq 200°C$	1000 hours
High Temperature Storage	MIL-STD-883 Method 1008	Test Condition D $T_A = 200°C$	2000 hours
HTRB	MIL-STD-750 Method 1038/1039	Test Condition A $T_A = 200°C$	1000 hours
Temperature Cycling	MIL-STD-883 Method 1010	Test Condition D −65° to 200° C	100 cycles
Power Cycling	MIL-STD-750 Method 1036.3	$\Delta T_C = 100°C$	5000 cycles
Thermal Shock	MIL-STD-883 Method 1011	Test Condition D −65° to 200° C	100 cycles
Solderability	MIL-STD-202 Method 208	T_{PbSn} at 230° C	5 second dwell
Hermeticity	MIL-STD-883 Method 1014	Kr-85/dry N_2 Penetrant dye	N/A
Moisture Resistance	MIL-STD-202 Method 106	65° C/98% R.H.	10 day
Vibration Variable Frequency	MIL-STD-750 Method 2056	100 to 2,000 Hz	4 cycles at Sweep Rate $<$ 4 minutes
Mechanical Shock	MIL-STD-883 Method 2002	Acceleration at 1,500 G's	0.5 msec. pulse duration
Terminal Strength	MIL-STD-750 Method 2036.3	TBA (Package Related)	30 second duration

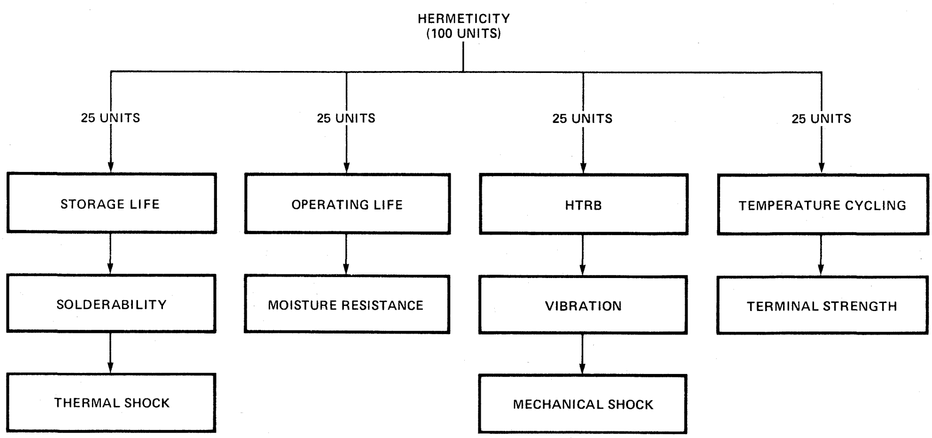
Note:
1. The intent of the monitor program is to maintain a pulse on the reliability performance of products.

Reliability Product Monitor Program

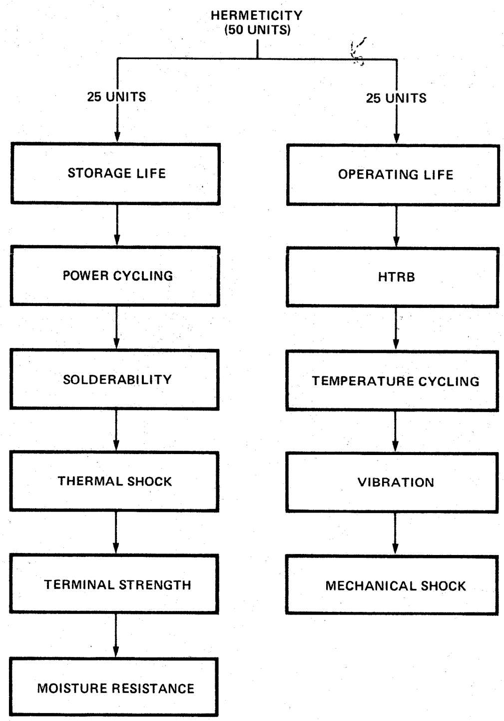
Product Line	Part Number	Quantity	Period of Testing	Life/Environmental Tests
RF Schottky	5082-2800	100	Biannual	Operating Life HTRB[1] High Temperature Storage[1] Temperature Cycling Thermal Shock Hermeticity[1] Solderability[1] Moisture Resistance Vibration Fatigue Mechanical Shock Terminal Strength[1] Power Cycling[1] Moisture Resistance Pressure Pot[1] Lead Fatigue[1] Salt Atmosphere Solvent Resistance
	HSCH-1001	100	Biannual	
	5082-2835	100	Biannual	
	5082-2831	100	Biannual	
Microwave Schottky	5082-2200/2202	100	Biannual	
	5082-2301/2302	100	Biannual	
PIN/SRD	5082-3001	100	Biannual	
	5082-3080	100	Biannual	
	HPND-4001/4050	100	Biannual	
	5082-0180	100	Biannual	
	5082-3188	100	Biannual	
Bipolar Transistors	HXTR-5103	60	Biannual	
		30[2]		
	HXTR-6103/6104	60	Biannual	
		30[2]		
	HXTR-3101/3102	90	Biannual	

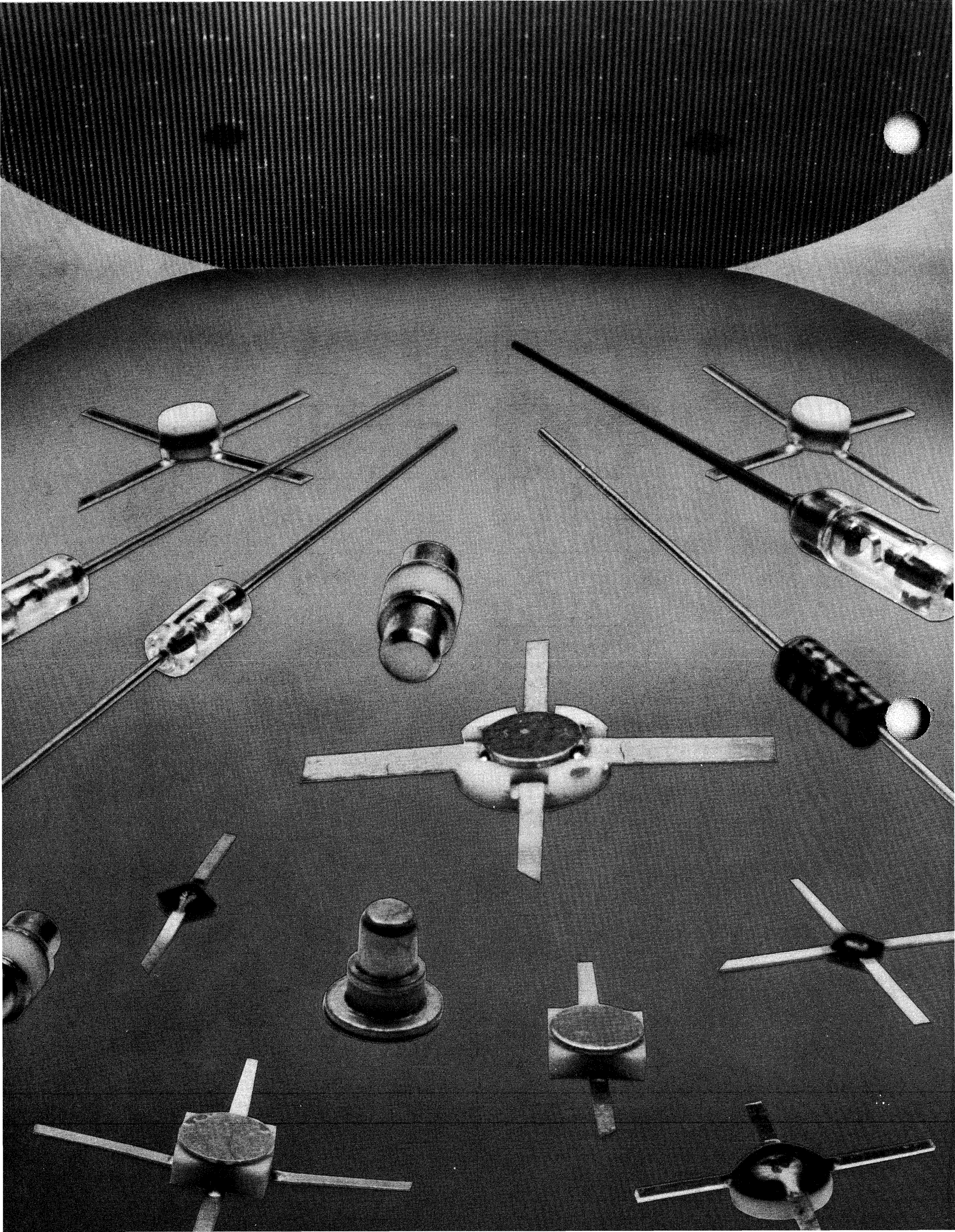
Notes:
1. Where applicable.
2. May be electrical rejects.

DIODES



BIPOLAR TRANSISTORS
(Method of Sequential Testing)





Silicon Bipolar Transistors

SILICON BIPOLAR TRANSISTORS CHARACTERISTICS AND APPLICATIONS

The Silicon Bipolar transistor is a semiconductor device, with amplification due to current gain. The advantages silicon bipolar transistors have over other transistor types are mature technology (both in the understanding of the device physics and the device design), low cost, and proven reliability. Therefore, silicon bipolar transistors offer designers a familiar, reliable, cost effective solution to many of their design needs.

The Hewlett-Packard silicon bipolar transistors are each characterized using standard D.C. and R.F. specifications. The typical D.C. specifications include pertinent junction parameters (such as junction breakdown voltages and leakage currents) and Beta (h_{FE}). The R.F. and D.C. parameters include the following:

F_{MIN} (Minimum Noise Figure) — The lowest possible noise figure of the transistor when properly biased and matched for low noise operation.

f_t (Transition frequency, "Gain Bandwidth Product") — f_t is the theoretical frequency at which the common emitter gain $|h_{fe}|$ is unity (0 dB).

MAG (Maximum Available Gain) — MAG is theoretically the highest transducer power gain that the transistor can deliver at a given frequency. It is important to recognize that MAG can only be defined when the Stability Factor, K, is greater than 1.0.

G_a (Noise Figure Gain) — Noise Figure Gain is the transducer gain measured with the same source impedance as that for obtaining the Minimum Noise Figure, F_{MIN}. G_a is usually lower than MAG since the optimum source impedance for F_{MIN} is usually different than for MAG.

G_T (Tuned Gain) — Tuned Gain is transducer power gain measured with the transistor's input and output impedances matched (tuned).

G_{1dB} (Associated 1 dB Compressed Gain) — Gain associated with P_{1dB}. G_{1dB} is 1 dB less than the transistor small signal gain when it is matched for maximum output power.

$|S_{21E}|^2$ (Transducer Gain) — The forward transmission gain of a transistor with a 50 Ω source and load.

C_{12E} (Reverse Transfer Capacitance) — The collector-base capacitance of a transistor measured with the emitter connected to the guard of a four-terminal pair capacitance meter.

$F_{(50\ \Omega)}$ (50 Ω Noise Figure) — The noise figure of a transistor with a 50 Ω source impedance.

Γ_o (Gamma Optimum) — The source reflection coefficient that yields the lowest possible noise figure of a transistor (F_{MIN}).

IP_3(Third Order Intercept Point) — The intersections of the straight line extensions of the fundamental output and third order intermodulation products of a transistor.

P_{1dB} (Power Output at 1 dB Gain Compression) — When the input power increases until the small signal tuned gain compresses by 1 dB, the resultant output power is called P_{1dB}.

S-Parameters — S-parameters are four measurable normalized vector quantities that relate to reflection coefficients and gains. The four S-parameters are described as follows; S_{11}, the input reflection coefficient; S_{21}, the forward transmission coefficient (gain); S_{12}, the reverse transmission coefficient (isolation), S_{22}, the output reflection coefficient.

BV_{CBO} (Collector Base Breakdown Voltage with Open Emitter) — DC breakdown voltage, collector to base, with the emitter open circuited ($I_E = 0$). This is the highest breakdown voltage of the collector-base junction. BV_{CBO} is the highest voltage at which the transistor can be operated without damage in Common Base circuits.

BV_{CEO} (Collector Emitter Breakdown Voltage with Open Base) — DC breakdown voltage, collector to emitter, with the base open circuited ($I_B = 0$). BV_{CEO} is usually lower (as much as 50%) than BV_{CBO}.

BV_{CES}(Collector Emitter Breakdown Voltage with Base Shorted) — DC breakdown voltage, collector to emitter, with the base short circuited to the emitter ($V_{BE} = 0$).

BV_{EBO} (Emitter Base Breakdown Voltage) —DC breakdown voltage, emitter to base reverse biased, with open circuited collector ($I_C = 0$).

h_{FE} (Common Emitter Current Gain, Beta) — Common emitter DC current gain, the ratio of the total DC collector current to the total DC base current.

I_{EBO} (Emitter Base Leakage Current) — DC leakage current, reverse biased emitter base, with collector open ($I_C = 0$).

I_{CBO} (Collector Base Leakage Current) — DC leakage current, reverse biased collector to base, with emitter open circuited ($I_E = 0$).

I_{CEO} (Common Emitter Leakage Current with Base Open) — DC leakage current, collector to emitter, with base open circuited ($I_B = 0$).

I_{CES} (Collector Emitter Leakage Current with Base Shorted) — DC leakage current, reversed biased collector to emitter, with base shorted to emitter ($V_{EB} = 0$).

$I_{C\,(MAX)}$ (Absolute Maximum Collector Current) — $I_{C\,(MAX)}$ is the maximum collector current that the transistor can safely withstand for an extended period.

$P_{T\,(MAX)}$ (Maximum Power Dissipation) — $P_{T\,(MAX)}$ is the maximum total DC and microwave power dissipation the transistor can safely withstand.

$T_{J\,(MAX)}$ (Maximum Junction Temperature) — The maximum junction temperature at which the reverse biased collector base junction can be maintained without irreversibly damaging the transistor.

Included in the data sheets are the "Absolute Maximum Ratings" which are those conditions that, when exceeded, will cause permanent damage to the device. These are the standard maximum ratings used for derating purposes.

The Hewlett-Packard Silicon Bipolar product line has six basic transistor types; the HXTR-2000 series, the HXTR-3000 series, the HXTR-4101, the HXTR-5000 series, the HXTR-6000 series and the new HXTR-7000 series.

The HXTR-2000 Series

The HXTR-2000 series is designed for general gain amplifier stage requirements. The HXTR-2000 series devices have 2μm emitter widths, and 450 mW of total device dissipation. These transistors have high maximum available gain (typically 17.5 dB at 2 GHz), high linear output power (P_{1dB} typically 20 dBm at 2 GHz) with a small degradation in noise figure (typically 2.2 dB at 2 GHz). The HXTR-2000 series is offered in two rugged hermetic packages, the HPAC-100 and the HPAC-70GT. The HXTR-2101 is packaged in the HPAC-100, and the HXTR-2102 is packaged in the HPAC-70GT. The HXTR-2001, the transistor chip, is also available for hybrid applications. All of the HXTR-2000 series devices are characterized from 100 MHz to 6.5 GHz

The HXTR-3000 Series

The HXTR-3000 series devices are designed for high volume, low cost applications in the UHF range. The HXTR-3000 series consists of two basic chips; the HXTR-3001 and the HXTR-3002. The HXTR-3001 has high gain (typically 16 dB at 2 GHz), and low noise figure (typically 2.2 dB at 2 GHz). The HXTR-3001 is offered in the HPAC-100X (a low cost, rugged metal/ceramic package) as the HXTR-3101 and the HXTR-3103. The HXTR-3002 has high linear output power (typically 21 dBm at 1000 MHz) and high associated 1 dB compressed gain (typically 11.5 dB at 1000 MHz). The HXTR-3002 is also offered in the HPAC-100X, as the HXTR-3102 and the HXTR-3104. Both chip products, the HXTR-3001 and the HXTR-3102 are available for hybrid applications. All of the HXTR-3000 series devices are characterized from 100 MHz to 6 GHz.

The HXTR-4101

The HXTR-4101 is designed and characterized for common-base oscillator transistor applications. The device uses the HXTR-2001 chip packaged in the HPAC-100. The HXTR-4101 has typical output power (oscillator power) of 20 dBm at 4.3 GHz. This device is characterized from 1 GHz to 12 GHz.

The HXTR-5000 Series

The HXTR-5000 series devices are designed for those applications where high linear output is required. The HXTR-5000 series consists of two basic transistor chips, the HXTR-5001 and the HXTR-5002. Both transistor chips have 2 μm emitter widths and Ta_2N ballast resistors. The HXTR-5001 has a total device dissipation of 700 mW, while the HXTR-5002 has a device dissipation of 2.7 W. The HXTR-5001 has higher linear output power than the HXTR-2000 series (P_{1dB} typically 23 dBm at 2 GHz), and high associated 1 dB compressed gain (typically 13.5 dB of 2 GHz). The HXTR-5001 is offered in the HPAC-100 and the HPAC-200. The HXTR-5101 is in the HPAC-100, and the HXTR-5103 is in the HPAC-200. The HXTR-5002 has the highest linear output power of the transistor product line (typically 29 dBm at 2 GHz) and high associated 1 dB compressed gain (typically 12.5

dB gain at 2 GHz). The HXTR-5002 devices are offered in the hermetic packages HPAC-200 GB/GT and the HPAC-200. The HXTR-5102 is packaged in the HPAC-200 GB/GT, and the HXTR-5104 is packaged in the HPAC-200. Both chip transistors, the HXTR-5001 and HXTR-5002, are available for hybrid applications. All the HXTR-5000 series devices are characterized from 100 MHz to 6 GHz.

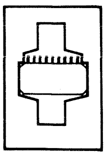
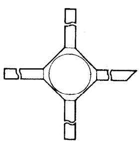
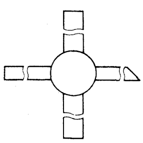
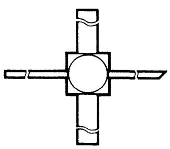
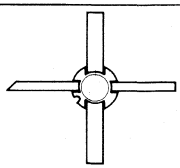
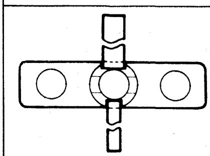
The HXTR-6000 Series

The HXTR-6000 series devices are designed for those applications where low noise performance is a premium. These devices stem from two basic transistor chips, the HXTR-6001 and the HXTR-2001. The transistors using the HXTR-6001 have the lowest noise figure and the highest associated gain. The HXTR-6001 transistor has a 1 μm emitter width, a typical noise figure of 1.7 dB (at 2 GHz) with 13 dB of associated gain, and 150 mW of total device dissipation. The HXTR-6001 transistors are offered in the HPAC-70GT and the HPAC-100. The HXTR-6101 and the HXTR-6102 (low noise selection of the HXTR-6101) are offered in the HPAC-70GT. The HXTR-6103 and the HXTR-6104 (low noise selection of the HXTR-6103) are in the HPAC-100. The chip, the HXTR-6001, is available for hybrid applications. The HXTR-6105 and the HXTR-6106 use the HXTR-2001 chip. The HXTR-6105 is packaged in the HPAC-100, and the HXTR-6106 is packaged in the HPAC-70GT. The HXTR-6105 and the HXTR-6106 are low noise selections of the HXTR-2101 and the HXTR-2102 respectively. These devices are all characterized from 100 MHz to 6 GHz, or higher.

NEW The HXTR-7000 Series

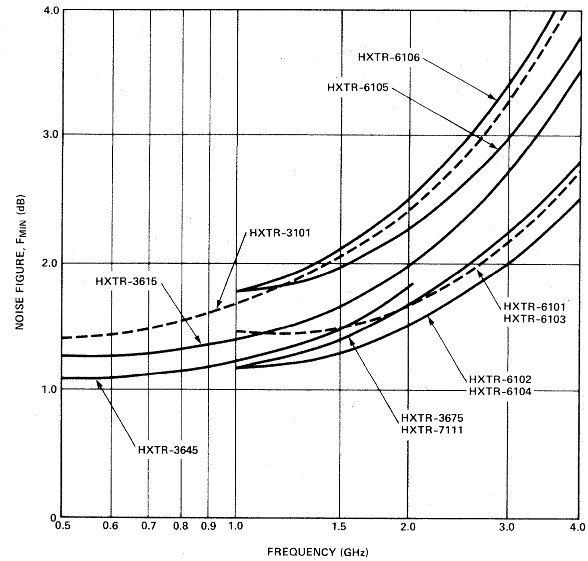
The HXTR-7000 series devices are designed for those applications where low noise and high linear power output performances are required. The chip, the HXTR-7011, has 0.6 μm emitter widths, a typical noise figure of 1.7 dB with an associated gain 13 dB at 2 GHz and 600 mW total device power dissipation. The HXTR-7011 is offered in two rugged hermetic packages: the high volume low cost HPAC-100X (HXTR-3615, HXTR-3645, HXTR-3675) and the HPAC-100 (HXTR-7111). All the HXTR-7000 series devices are characterized from 100 MHz to 6000 MHz.

SILICON BIPOLAR TRANSISTOR PACKAGE SELECTION GUIDE

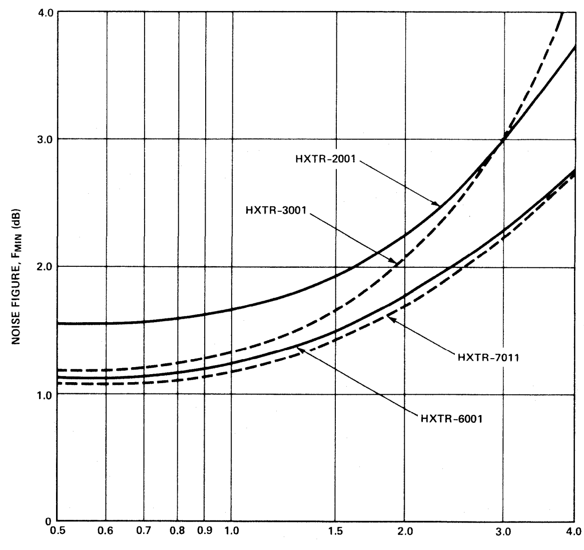
	High Performance						Low Cost		
	Low Noise		General Purpose		Linear Power		Low Noise	General Purpose	Linear Power
	4 GHz (HXTR-)	2 GHz (HXTR-)	4 GHz (HXTR-)	2 GHz (HXTR-)	4 GHz (HXTR-)	2 GHz (HXTR-)	1 GHz (HXTR-)	1 GHz (HXTR-)	1 GHz (HXTR-)
 CHIP	6001 7011	6001 7011	2001	2001 3001	5001 5002	3002 5001 5002	7011	3001 7011	3002 7011
 HPAC-100X	3675	3645	3675	3103 3645		3104	3615 3645	3101 3615	3102 3104 3615
 HPAC-70GT	6101	6102	2102	2102 6106					
 HPAC-100	7111	6103 6104	2101 6105	2101	5101	5101			
 HPAC-200					5103	5103 5104			
 HPAC-200GB/GT					5102	5102			

BIPOLAR TRANSISTOR SELECTION GUIDE

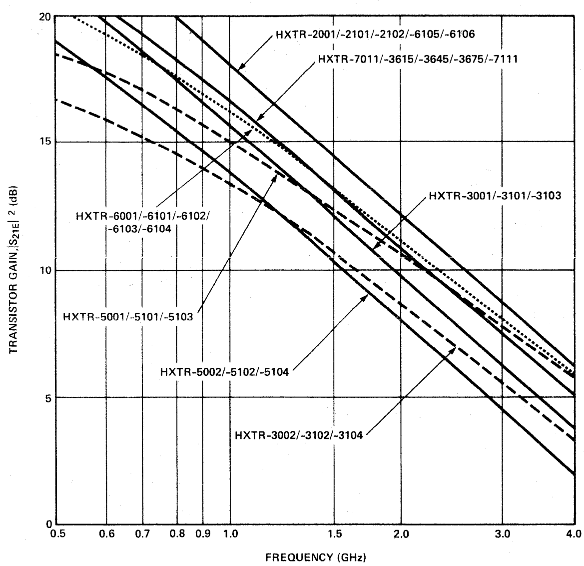
TYPICAL NOISE FIGURE vs. FREQUENCY (PACKAGED TRANSISTOR)



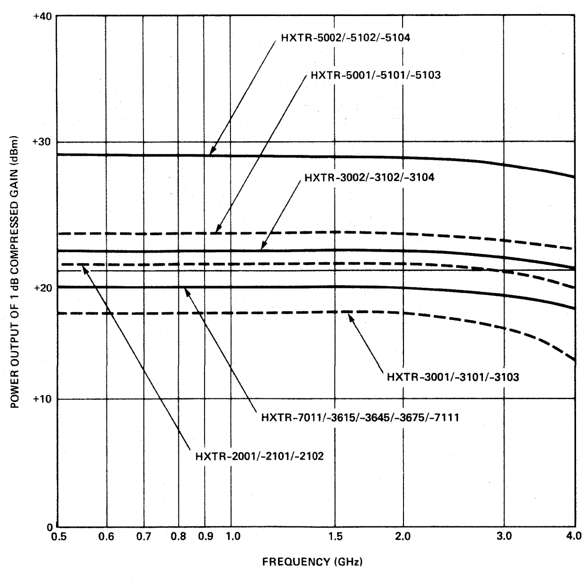
TYPICAL NOISE FIGURE vs. FREQUENCY (CHIP TRANSISTORS)



TYPICAL TRANSISTOR GAIN vs. FREQUENCY



TYPICAL P_{1dB} vs. FREQUENCY



Bipolar Transistors

PART NUMBER SELECTION GUIDE

High Performance

	Part Number HXTR-	Frequency	Typical Noise Figure F_{MIN} (dB)	Typical Associated Gain G_a (dB)	Package HPAC-	Page Number
Low Noise	3675	4 GHz	2.8	8.3	100X	69
	6001	4 GHz	2.7	9.0	Chip	44
	6101 (2N6617)	4 GHz	2.8	9.0	100	86
	7011	4 GHz	2.8	8.2	Chip	46
	7111	4 GHz	2.8	8.7	100	104
	3645	2 GHz	1.7	13.0	100X	66
	6102 (2N6742)	2 GHz	1.6	13.5	100	89
	6103 (2N6618)	2 GHz	1.8	12.0	100	92
	6104 (2N6743)	2 GHz	1.5	12.5	100	95
	7011	2 GHz	1.7	13.0	Chip	46

	Part Number HXTR-	Frequency	Typical $S_{21E}{}^2$ (dB)	Typical Noise Figure F_{MIN} (dB)	Package HPAC-	Page Number
General Purpose	2001	4 GHz	6.0	3.8	Chip	32
	2102	4 GHz	5.3	4.2	70 GT	52
	3675	4 GHz	4.4	2.8	100X	69
	6105	4 GHz	4.6	3.8	100	98
	2001	2 GHz	12.0	3.2	Chip	32
	2101 (2N6679)	2 GHz	11.0	2.7	100	50
	3001	2 GHz	9.8	2.2	Chip	34
	3103 (2N6838)	2 GHz	9.4	2.5	100X	58
	3645	2 GHz	9.8	1.7	100X	66
	6106	2 GHz	10.5	2.5	70 GT	101

	Part Number HXTR-	Frequency	Typical $_{1dB}$ (dBm)	Typical G_{1dB} (dB)	Package HPAC-	Page Number
Linear Power	5001	4 GHz	22.0	8.0	Chip	38
	5002	4 GHz	27.5	7.5	Chip	41
	5101	4 GHz	22.0	7.5	100	74
	5102	4 GHz	27.5	7.0	200 GB/GT	77
	3002	2 GHz	21.0	13.5	Chip	36
	5001	2 GHz	23.0	13.5	Chip	38
	5002	2 GHz	29.0	12.5	Chip	41
	3104 (2N6839)	2 GHz	21.0	13.0	100X	61
	5101	2 GHz	23.0	13.0	100	74
	5103	2 GHz	23.0	11.0	200	80
	5104	2 GHz	29.0	9.0	200	83

Low Cost

	Part Number HXTR-	Frequency	Typical Noise Figure F_{MIN} (dB)	Typical Associated Gain G_a (dB)	Package HPAC-	Page Number
Low Noise	7011	1 GHz	1.2	18.0	Chip	46
	3615	1 GHz	1.4	16.6	100X	63
	3645	1 GHz	1.2	17.5	100X	66

	Part Number HXTR-	Frequency	Typical $S_{21E}{}^2$ (dB)	Typical Noise Figure F_{MIN} (dB)	Package HPAC-	Page Number
General Purpose	3001	1 GHz	15.7	1.5	Chip	34
	3101	1 GHz	15.0	1.8	100X	54
	3103	1 GHz	15.0	1.7	100X	58
	3615	1 GHz	15.8	1.4	100X	63
	7011	1 GHz	16.5	1.2	Chip	46

	Part Number HXTR-	Frequency	Typical P_{1dB} (dBm)	Typical G_{1dB} (dB)	Package HPAC-	Page Number
Linear Power	3002	1 GHz	22.0	18.0	Chip	36
	3102	1 GHz	21.0	15.0	100X	56
	3104	1 GHz	21.0	16.0	100X	61
	3615	1 GHz	19.0	19.0	100X	63
	7011	1 GHz	21.0	19.0	Chip	46

	Part Number HXTR-	Frequency	Typical F_{MIN} (dB)	Typical P_{1dB} (dBm)	Package HPAC-	Page Number
High Performance	3645	2 GHz	1.7	19.0	100X	66
	3675	4 GHz	2.8	17.5	100X	69
	7011	4 GHz	1.7	19.0	Chip	46

Oscillator

Part Number HXTR-	Frequency	Typical P_{OSC} (dBm)	Package HPAC-	Page Number
4101	4.3 GHz	20.5	100	72

BIPOLAR TRANSISTOR ALPHANUMERIC INDEX

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR CHIP

HXTR-2001

Features

HIGH GAIN
17.5 dB Typical at 2 GHz

HIGH OUTPUT POWER
20.0 dBm P_{1dB} Typical at 2 GHz

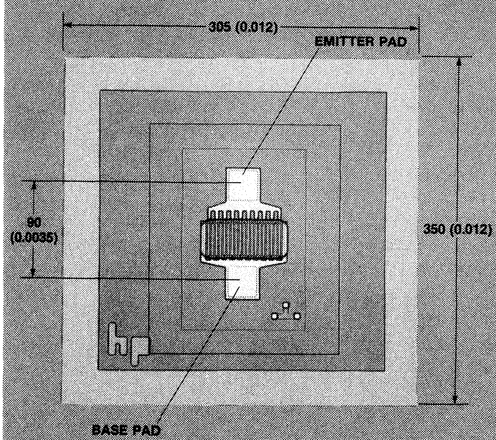
LOW NOISE FIGURE
3.8 dB Typical at 4 GHz

WIDE DYNAMIC RANGE

Description/Applications

The HXTR-2001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-2001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-2001 also is provided with a dielectric scratch protection over its active area.



Chip Outline
Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions:	25 (0.001) x 25 (0.001) Typical
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

(T_A = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 300° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125° C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10° C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10° C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C=100\mu A$		3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE}=15V$		3041.1**	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB}=15V$		3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE}=15V$, $I_C=15mA$		3076.1*	—	50	120	220
MAG	Maximum Available Gain	f=2GHz		dB		17.5	
	$V_{CC} = 15V$, $I_C = 25$ mA	4GHz				11.5	
P_{1dB}	Power Output at 1dB Gain Compression	f=2GHz		dBm		20.0	
	$V_{CE} = 15V$, $I_C = 25$ mA	4GHz				18.5	
F_{MIN}	Minimum Noise Figure	f=2.0GHz	3246.1	dB		2.3	
	$V_{CE} = 15V$, $I_C = 15$ mA	4GHz				3.8	

*300μs wide pulse measurement <2% duty cycle. **Measured under low ambient light conditions.

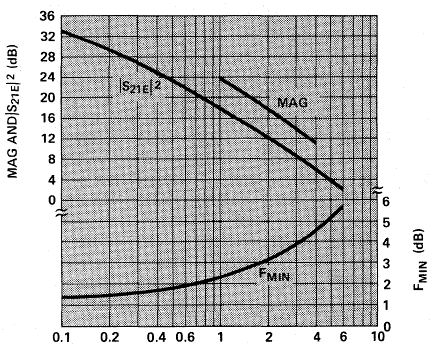


Figure 1. Typical MAG, $|S_{21E}|^2$, and Noise Figure (F_{MIN}) vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

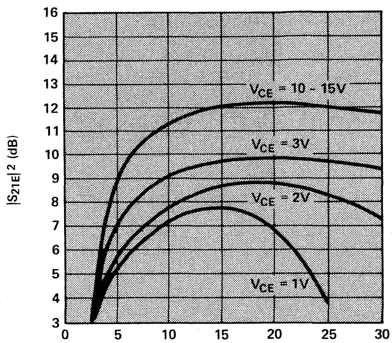


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical S-Parameters* V_{CE} = 15V, I_C = 25mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.57	-88	33.3	46.2	144	-42	0.008	58	0.85	-20
200	0.68	-124	30.2	32.5	123	-39	0.011	43	0.67	-26
300	0.72	-141	27.6	23.9	113	-38	0.013	37	0.56	-26
400	0.74	-150	25.4	18.7	106	-37	0.014	35	0.51	-24
500	0.75	-156	23.7	15.3	102	-37	0.014	35	0.48	-22
600	0.76	-160	22.2	12.9	99	-36	0.015	36	0.46	-21
700	0.76	-163	20.8	11.0	97	-36	0.015	37	0.45	-20
800	0.76	-165	19.9	9.8	95	-36	0.016	38	0.44	-19
900	0.76	-167	18.8	8.7	93	-36	0.016	40	0.44	-18
1000	0.76	-168	18.0	7.9	91	-35	0.017	42	0.44	-18
1500	0.77	-172	14.5	5.3	85	-34	0.021	49	0.43	-18
2000	0.77	-175	12.0	4.0	81	-32	0.025	54	0.43	-20
2500	0.77	-176	10.1	3.2	77	-31	0.029	58	0.43	-23
3000	0.77	-177	8.6	2.7	73	-29	0.034	60	0.43	-26
3500	0.77	-178	7.2	2.3	69	-28	0.038	61	0.44	-29
4000	0.76	-179	6.0	2.0	66	-27	0.043	62	0.44	-32
4500	0.76	-179	5.1	1.8	63	-26	0.048	62	0.45	-35
5000	0.76	-179	4.1	1.6	59	-26	0.052	62	0.45	-38
5500	0.76	-180	3.5	1.5	56	-25	0.057	62	0.46	-41
6000	0.76	-180	2.9	1.4	53	-24	0.062	61	0.47	-44

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 49.

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR CHIP

HXTR-3001

Features

HIGH GAIN
16 dB Typical at 2 GHz

HIGH OUTPUT POWER
21.0 dBm P_{1dB} Typical at 1 GHz

LOW NOISE FIGURE
1.5 dB Typical F_{MIN} at 1000 MHz

WIDE DYNAMIC RANGE

LARGE GOLD BONDING PADS

Description/Applications

The HXTR-3001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-3001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-3001 also is provided with a dielectric scratch protection over its active area and large gold bonding pads for ease of use in most hybrid applications.

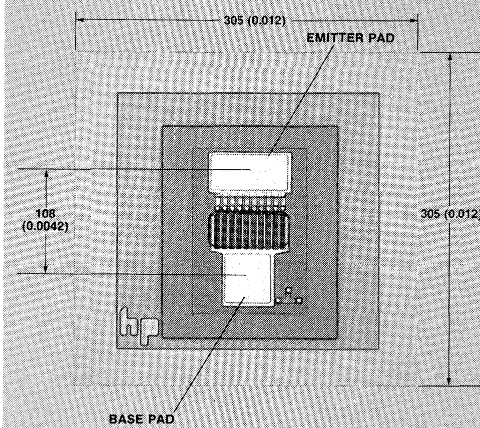
Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 1.0×10^7 hours will be met or exceeded when the junction temperature is maintained under $T_J = 200°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Typical Dimensions	
Base:	50 (0.002) x 50 (0.002)
Emitter:	75 (0.003) x 38 (0.0015)
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C = 100\mu A$	3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15V$	3041.1**	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB} = 15V$	3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 15V$, $I_C = 15mA$	3076.1*	—	50	120	220
MAG	Maximum Available Gain f = 2000 MHz V_{CE}=15V, I_C=15 mA		dB		16.0	
P_{1dB}	Power Output at 1 dB Gain Compression f = 1000 MHz 2000 MHz V_{CE}=15V, I_C=25 mA		dBm		21.0 19.0	
F_{MIN}	Minimum Noise Figure f = 500 MHz 1000 MHz 2000 MHz V_{CE}=10V, I_C=7 mA	3246.1	dB		1.2 1.5 2.2	

*300μs wide pulse measurement <2% duty cycle.
**Measured under low ambient light conditions.

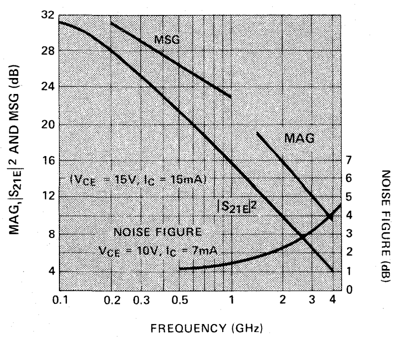


Figure 1. Typical MAG, $|S_{21E}|^2$, Maximum Stable Gain (MSG), and Noise Figure (F_{MIN}) vs. Frequency.

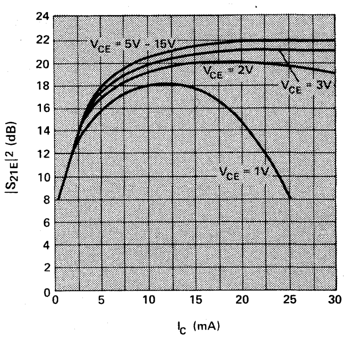


Figure 2. Typical $|S_{21E}|^2$ vs. Current of 500 GHz.

Typical S-Parameters* V_{CE} = 15V, I_C = 15 mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.651	-74	30.6	34.04	146	-37.2	0.014	59	0.851	-23
200	0.714	-113	27.8	24.66	125	-33.9	0.020	43	0.659	-33
300	0.741	-132	25.3	18.41	114	-32.9	0.023	36	0.539	-36
400	0.754	-143	23.2	14.46	107	-32.3	0.024	33	0.471	-36
500	0.761	-151	21.5	11.84	102	-32.0	0.025	31	0.429	-35
600	0.765	-155	20.0	10.00	98	-31.7	0.026	32	0.405	-34
700	0.767	-159	18.7	8.63	95	-31.5	0.027	32	0.389	-34
800	0.768	-162	17.6	7.59	93	-31.2	0.028	33	0.377	-34
900	0.769	-164	16.6	6.77	91	-31.0	0.028	34	0.370	-34
1000	0.770	-166	15.7	6.11	89	-30.7	0.029	35	0.365	-34
1500	0.770	-171	12.2	4.10	81	-29.3	0.034	41	0.358	-38
2000	0.769	-174	9.8	3.06	74	-28.0	0.040	44	0.364	-43
2500	0.766	-176	7.8	2.46	69	-26.8	0.046	47	0.375	-49
3000	0.763	-177	6.2	2.05	63	-25.7	0.052	48	0.389	-55
3500	0.760	-178	4.9	1.75	58	-24.7	0.058	48	0.405	-61
4000	0.756	-179	3.7	1.53	53	-23.8	0.064	48	0.423	-66

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 49.

HEWLETT PACKARD

LINEAR POWER TRANSISTOR CHIP

HXTR-3002

Features

HIGH OUTPUT POWER
22 dBm Typical P_{1dB} at 1 GHz

HIGH P_{1dB} GAIN
18.0 dB Typical G_{1dB} at 1 GHz

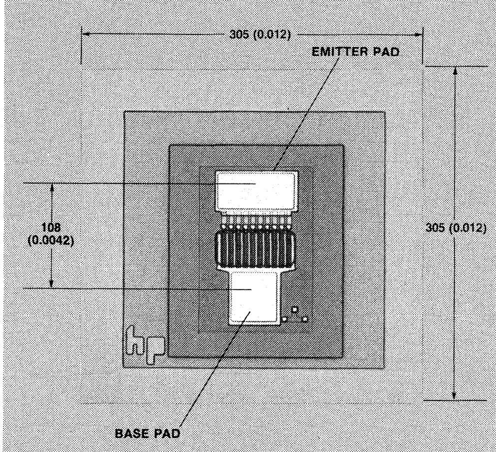
HIGH $|S_{21E}|^2$ GAIN
16.5 dB Typical at 500 MHz

LARGE GOLD BONDING PADS

Description/Applications

The HXTR-3002 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

HXTR-3002 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-3002 also is provided with a dielectric scratch proteciton over its active area and large gold bonding pads for ease of use in most hybrid applications.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Typical Dimensions	
Base:	50 (0.002) x 50 (0.002)
Emitter:	75 (0.003) x 38 (0.0015)
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4W
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 3.5 x 10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 3$ mA	3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at $I_B = 30$ μA	3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at $V_{EB} = 2$ V	3061.1*	μA			2
I_{CES}	Collector-Emitter Leakage Current at $V_{CE} = 32$ V	3041.1**	nA			200
I_{CBO}	Collector-Base Leakage Current at $V_{CB} = 20$ V	3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 18$ V, $I_C = 30$ mA	3076.1*		15	40	75
P_{1dB}	Power Output at 1 dB Gain Compression f = 1000 MHz		dBm		22.0	
G_{1dB}	Associated 1 dB Compressed Gain f = 1000 MHz $V_{CE} = 18$ V, $I_C = 30$ mA		dB		18.0	
$\|S_{21E}\|^2$	Transducer Gain f = 500 MHz 1000 MHz $V_{CE} = 18$ V, $I_C = 30$ mA		dB		16.5 13.6	

*300 μs wide pulse measurement at ≤2% duty cycle.
**Measured under low ambient light conditions.

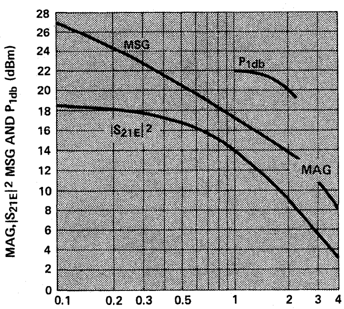


Figure 1. Typical MAG, $|S_{21E}|^2$, Maximum Stable Gain (MSG) and Power Output at 1 dB Gain Compression (P_{1dB}) vs. Frequency, $V_{CE} = 18$ V, $I_C = 30$ mA.

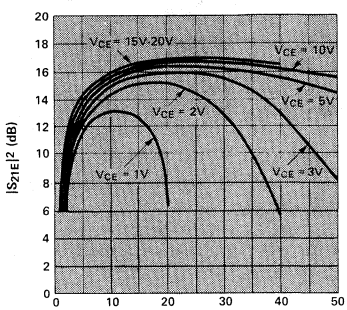


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 500 MHz.

Typical S-Parameters* $V_{CE} = 18V$, $I_C = 30$ mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.658	-17	18.5	8.44	170	-35.9	0.016	82	0.991	-7
200	0.656	-32	18.3	8.18	161	-30.1	0.031	75	0.965	-14
300	0.652	-47	17.8	7.79	153	-27.0	0.045	68	0.926	-20
400	0.648	-60	17.3	7.33	145	-25.0	0.056	62	0.881	-25
500	0.644	-72	16.7	6.85	138	-23.7	0.066	56	0.833	-29
600	0.641	-82	16.1	6.37	132	-22.7	0.073	52	0.787	-33
700	0.637	-91	15.4	5.91	126	-22.0	0.080	48	0.744	-36
800	0.634	-99	14.8	5.49	121	-21.5	0.085	45	0.706	-39
900	0.632	-105	14.2	5.11	117	-21.0	0.089	42	0.671	-41
1000	0.629	-111	13.6	4.76	113	-20.7	0.092	39	0.641	-43
1500	0.623	-131	10.9	3.50	98	-19.7	0.103	32	0.541	-50
2000	0.618	-143	8.8	2.74	88	-19.2	0.110	29	0.492	-54
2500	0.614	-151	7.0	2.24	79	-18.8	0.115	28	0.469	-58
3000	0.611	-156	5.6	1.90	72	-18.4	0.120	27	0.461	-62
3500	0.608	-160	4.3	1.65	65	-18.1	0.125	27	0.460	-66
4000	0.604	-163	3.3	1.46	59	-17.7	0.130	27	0.465	-70

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 49.

HEWLETT PACKARD

LINEAR POWER TRANSISTOR CHIP

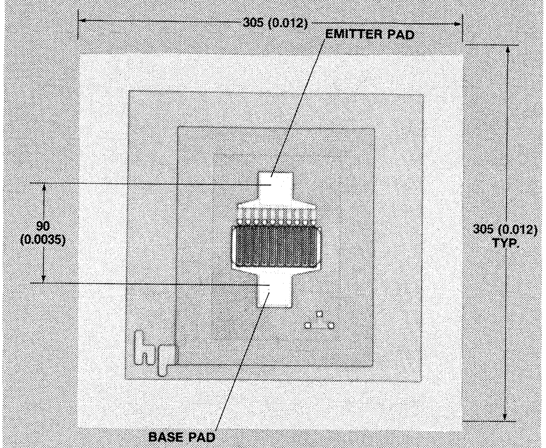
HXTR-5001

Features

HIGH OUTPUT POWER
23 dBm Typical P_{1dB} at 2 GHz
22 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
13.5 dB Typical G_{1dB} at 2 GHz
8.0 dB Typical G_{1dB} at 4 GHz

HIGH POWER-ADDED EFFICIENCY



Chip Outline
Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions:	25 (0.001) x 25 (0.001) Typical
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Description/Applications

The HXTR-5001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-5001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-5001 also is provided with a dielectric scratch protection over its active area.

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4W
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 3.5 x 10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 3$ mA		3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at $I_B = 30$ μA		3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at $V_{EB} = 2$ V		3061.1	μA			2
I_{CES}	Collector-Emitter Leakage Current at $V_{CE} = 32$ V		3041.1**	nA			200
I_{CBO}	Collector-Base Leakage Current at $V_{CB} = 20$ V		3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 18$ V, $I_C = 30$ mA		3076.1*		15	40	75
P_{1dB}	Power Output at 1 dB Gain Compression	f = 2 GHz 4 GHz		dBm		23.0 22.0	
G_{1dB}	Associated 1 dB Compressed Gain	f = 2 GHz 4 GHz		dB		13.5 8.0	
P_{SAT}	Saturated Power Output (8 dB Gain) (3 dB Gain)	f = 2 GHz 4 GHz		dBm		25.5 25.0	
η	Power-Added Efficiency at 1 dB Compression	f = 2 GHz 4 GHz		%		35 25	
IP_3	Third Order Intercept Point $V_{CE} = 18$ V, $I_C = 30$ mA	f = 4 GHz		dBm		32	

*300 μs wide pulse measurement at ≤2% duty cycle.
**Measured under low ambient light conditions.

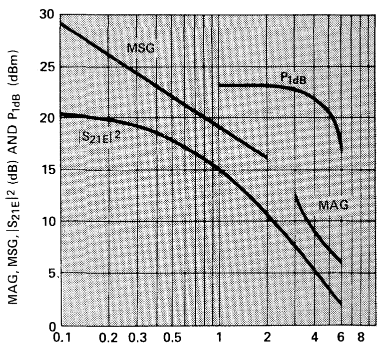


Figure 1. Typical MAG, Maximum Stable Gain (MSG), $|S_{21E}|^2$ and P_{1dB} Linear Power vs. Frequency at $V_{CE} = 18$ V, $I_C = 30$ mA.

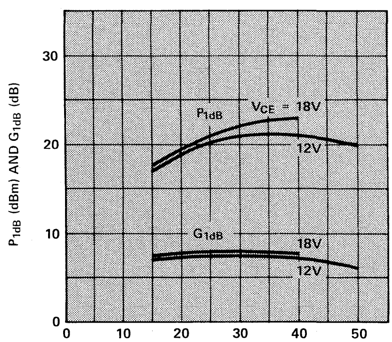


Figure 2. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at $V_{CE} = 12$ V and 18 V at 4 GHz.

Typical S-Parameters* V_{CE} = 18V, I_C = 30 mA

Freq. (GHz)	S11		S21			S12			S22	
	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.	Mag.	Ang.
0.100	0.74	-15	20.2	10.2	171	-38	0.01	83	0.99	-5
0.200	0.73	-30	19.9	9.88	162	-33	0.02	75	0.97	-10
0.300	0.72	-44	19.5	9.42	154	-30	0.03	69	0.93	-15
0.400	0.71	-57	19.0	8.87	146	-28	0.04	63	0.89	-19
0.500	0.70	-68	18.4	8.28	140	-26	0.05	58	0.85	-22
0.600	0.69	-78	17.7	7.71	134	-25	0.06	54	0.80	-24
0.700	0.67	-87	17.1	7.16	129	-25	0.06	50	0.76	-26
0.800	0.67	-94	16.5	6.65	124	-24	0.06	47	0.73	-28
0.900	0.66	-101	15.8	6.19	120	-24	0.07	44	0.70	-29
1.000	0.65	-107	15.2	5.78	117	-23	0.07	42	0.67	-30
1.500	0.63	-128	12.6	4.25	103	-22	0.08	37	0.58	-32
2.000	0.62	-140	10.5	3.33	94	-22	0.08	35	0.53	-32
2.500	0.61	-148	8.7	2.73	87	-21	0.09	35	0.51	-33
3.000	0.61	-154	7.3	2.32	81	-21	0.09	35	0.50	-35
3.500	0.61	-158	6.1	2.02	76	-20	0.10	36	0.49	-36
4.000	0.60	-161	5.8	1.79	71	-20	0.10	37	0.49	-38
4.500	0.60	-164	4.1	1.61	66	-19	0.11	38	0.49	-40
5.000	0.60	-166	3.3	1.47	62	-19	0.11	39	0.49	-43
5.500	0.59	-168	2.6	1.35	58	-19	0.12	40	0.49	-45
6.000	0.59	-169	2.0	1.25	55	-18	0.12	40	0.49	-47

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 49.

LINEAR POWER TRANSISTOR CHIP

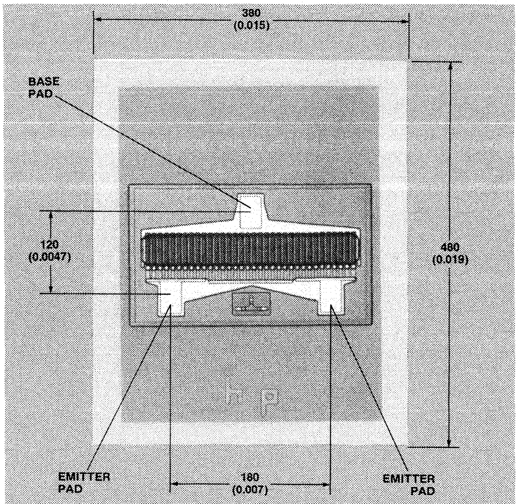
HXTR-5002

Features

HIGH OUTPUT POWER
29 dBm Typical P_{1dB} at 2 GHz
27.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
12.5 dB Typical G_{1dB} at 2 GHz
7.5 dB Typical G_{1dB} at 4 GHz

HIGH POWER-ADDED EFFICIENCY



Chip Outline
Dimensions in micrometers (inches) ±25 (0.001)

Gold Bonding Pad Dimensions: ~38 (0.0015) x 20 (0.008) Typical
Chip Thickness: 90 (0.0035) Typical
Collector Back Contact: Silicon-Gold Eutectic

Description/Applications

The HXTR-5002 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-5002 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-5002 also is provided with a dielectric scratch protection over its active area.

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4W
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 3.5×10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at T_A=25°C

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=10mA		3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=50mA		3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B=100μA		3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V		3061.1	μA			5
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V		3041.1**	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V		3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C=110mA		3076.1*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression	f = 2GHz 4GHz		dBm		29.0 27.5	
G_{1dB}	Associated 1dB Compressed Gain	f = 2GHz 4GHz		dB		12.5 7.5	
P_{SAT}	Saturated Power Output (8dB Gain) (3dB Gain)	f = 2GHz 4GHz		dBm		31.0 29.5	
η	Power-Added Efficiency at 1dB Compression	f = 2GHz 4GHz		%		38 23	
IP_3	Third Order Intercept Point V_{CE}=18V, I_C=110mA	f = 4GHz		dBm		37	

*300 μsec wide pulse measurement at ≤ 2% duty cycle.
**Measured under low ambient light conditions.

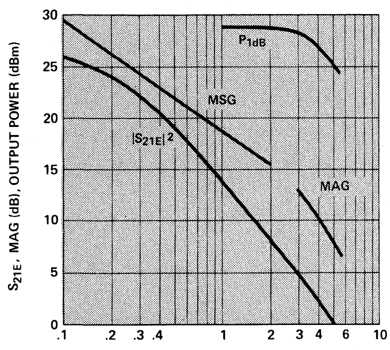


Figure 1. Typical $|S_{21E}|^2$ MAG and P_{1dB} Linear Power vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

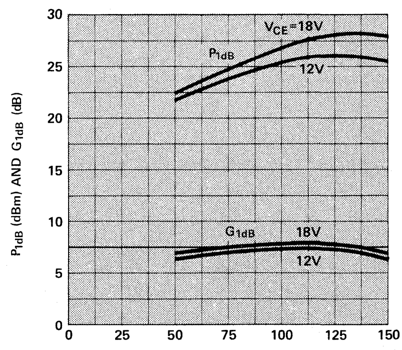


Figure 2. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

Typical S-Parameters* V_{CE} = 18V, I_C = 110mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (GHz)	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**Mag.**	**Ang.**
0.100	0.55	-61	25.4	19.7	156	-31.6	0.03	68	0.93	-26
0.200	0.65	-98	24.2	16.2	133	-27.3	0.04	50	0.76	-46
0.300	0.72	-119	22.3	13.1	125	-25.6	0.05	39	0.63	-60
0.400	0.76	-132	20.6	10.7	117	-24.8	0.06	32	0.53	-71
0.500	0.79	-141	19.1	9.01	111	-24.4	0.06	27	0.45	-78
0.600	0.80	-147	17.8	7.73	106	-24.1	0.06	24	0.40	-84
0.700	0.81	-151	16.6	6.74	102	-24.0	0.06	22	0.36	-89
0.800	0.81	-155	15.5	5.97	99	-23.8	0.06	20	0.33	-93
0.900	0.82	-158	14.6	5.35	97	-23.7	0.06	19	0.31	-96
1.000	0.82	-160	13.7	4.84	94	-23.7	0.06	18	0.30	-99
1.500	0.83	-167	10.3	3.29	86	-23.4	0.07	16	0.25	-109
2.000	0.83	-170	7.9	2.49	80	-23.3	0.07	16	0.24	-114
2.500	0.83	-173	6.0	2.00	74	-23.1	0.07	17	0.24	-117
3.000	0.83	-174	4.5	1.68	69	-22.9	0.07	18	0.25	-118
3.500	0.83	-175	3.2	1.44	64	-22.6	0.07	19	0.27	-119
4.000	0.83	-176	2.1	1.27	60	-22.4	0.08	20	0.28	-120
4.500	0.83	-177	1.1	1.13	55	-22.1	0.08	21	0.30	-121
5.000	0.83	-177	0.3	1.03	51	-21.9	0.08	21	0.32	-121
5.500	0.83	-178	-0.5	0.94	47	-21.6	0.08	22	0.34	-122
6.000	0.83	-178	-1.2	0.87	43	-21.4	0.08	22	0.35	-123

*(Values do not include any parasitic bonding inductances and were generated by use of a computer model.)

RF Equivalent Circuit See page 49.

HEWLETT PACKARD

LOW NOISE TRANSISTOR CHIP

HXTR-6001

Features

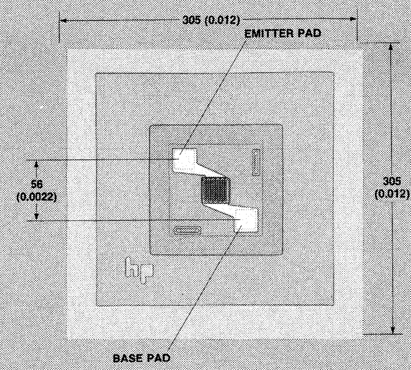
LOW NOISE FIGURE
1.7 dB Typical F_{MIN} at 2 GHz
2.7 dB Typical F_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
13.0 dB Typical G_a at 2 GHz
9.0 dB Typical G_a at 4 GHz

Description/Applications

The HXTR-6001 is an NPN silicon bipolar transistor chip designed for use in hybrid applicattons requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-6001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-6001 also is provided with a dielectric scratch protection over its active area.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions:	25 (0.001) x 25 (0.001) Typical
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 300° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125° C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under $T_J = 200°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10° C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10° C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C=100\mu A$		3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE}=10V$		3041.1**	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB}=10V$		3036.1**	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE}=10V$, $I_C=4mA$		3076.1*	—	50	150	250
F_{MIN}	Minimum Noise Figure	f=2 GHz	3246.1	dB		1.7	
		4 GHz				2.7	
G_a	Associated Gain	f=2 GHz				13.0	
		4 GHz				9.0	
	$V_{CE}=10V$, $I_C=4mA$						

*300μs wide pulse measurement ≤2% duty cycle.
**Measured under low ambient light conditions.

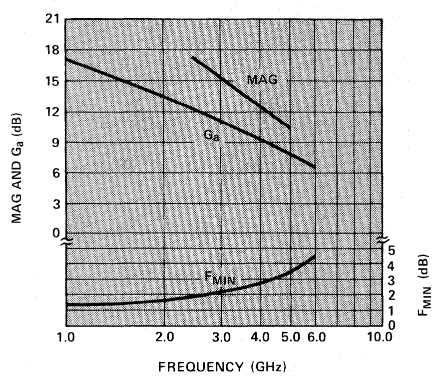


Figure 1. Typical MAG, Noise Figure (F_{MIN}), and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 4 mA.

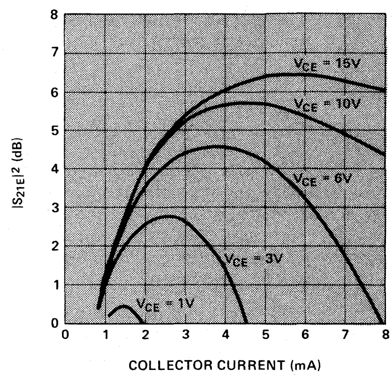


Figure 2. Typical $|S_{21E}|^2$, vs. Current at 4 GHz.

Typical S-Parameters* V_{CE} = 10V, I_C = 4mA

Freq. (MHz)	S11 Mag.	S11 Ang.	S21 (dB)	S21 Mag.	S21 Ang.	S12 (dB)	S12 Mag.	S12 Ang.	S22 Mag.	S22 Ang.
100	0.87	-16	22.0	12.60	170	-46	0.005	82	0.99	-3
200	0.85	-30	21.7	12.10	160	-40	0.010	75	0.98	-5
300	0.82	-44	21.1	11.40	151	-36	0.015	68	0.95	-7
400	0.79	-57	20.5	10.60	144	-35	0.018	63	0.93	-9
500	0.76	-68	19.8	9.77	137	-34	0.021	58	0.91	-10
600	0.73	-78	19.1	9.00	131	-32	0.024	55	0.89	-10
700	0.70	-86	18.5	8.37	126	-32	0.025	52	0.87	-11
800	0.68	-94	17.6	7.62	121	-31	0.027	50	0.85	-11
900	0.66	-100	17.0	7.05	118	-31	0.028	48	0.84	-11
1000	0.65	-106	16.3	6.54	114	-31	0.029	47	0.82	-11
1500	0.60	-126	13.5	4.73	102	-29	0.034	45	0.79	-12
2000	0.58	-139	11.3	3.67	93	-29	0.037	45	0.78	-13
2500	0.57	-146	9.5	2.99	87	-28	0.041	47	0.77	-14
3000	0.56	-152	8.1	2.53	82	-27	0.045	49	0.77	-15
3500	0.56	-156	6.8	2.19	77	-26	0.049	51	0.76	-16
4000	0.55	-159	5.7	1.93	72	-26	0.053	52	0.76	-18
4500	0.55	-162	4.8	1.73	68	-25	0.057	53	0.76	-19
5000	0.55	-164	3.9	1.57	65	-24	0.062	54	0.76	-21
5500	0.55	-165	3.2	1.44	61	-24	0.066	55	0.76	-23
6000	0.54	-167	2.5	1.34	57	-23	0.071	55	0.76	-24
7000	0.54	-169	1.4	1.17	51	-22	0.080	56	0.77	-28

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 49.

HEWLETT PACKARD

LOW NOISE TRANSISTOR CHIP

HXTR-7011

NEW

Features

LOW NOISE FIGURE
2.8 dB Typical F_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
8 dB Typical Ga at 4 GHz

HIGH OUTPUT POWER
18.0 dBm Typical G_{1dB} at 4 GHz

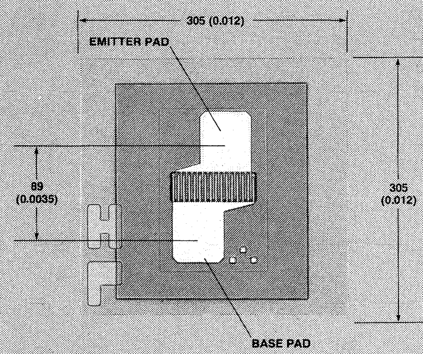
WIDE DYNAMIC RANGE

LARGE GOLD BONDING PADS

Description

The HXTR-7011 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-7011 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-7011 also is provided with a dielectric scratch protection over its active area and large gold bonding pads for ease of use in most hybrid applications.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions (Typical):	40 (0.0016) x 48 (0.0019)
Chip Thickness (Typical):	89 (0.0035)
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 300° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 125° C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.
2. A MTTF of 1 x 10^7 hours will be met or exceeded when the junction temperature is maintained under $T_J = 200°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108, "Reliability Performance of Bipolar Transistors".

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10° C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10° C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CE} = 15$ V		3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage at $V_{CE} = 15$ V		3041.1	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1		55		175
F_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA	f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB		1.2 1.7 2.8	
G_a	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA	f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB		18.0 13.0 8.2	
P_{1dB}	Power Output at 1 dB Gain Compression, $V_{CE} = 15$ V, $I_C = 18$ mA,	f = 4000 MHz		dBm		18.0	
G_{1dB}	Associated 1 dB Compressed Gain, $V_{CE} = 15$ V, $I_C = 18$ mA	f = 4000 MHz		dB		8.5	

*300 μs wide pulse measurement ≤ 2% duty cycle.
**Measured under low ambient light conditions.

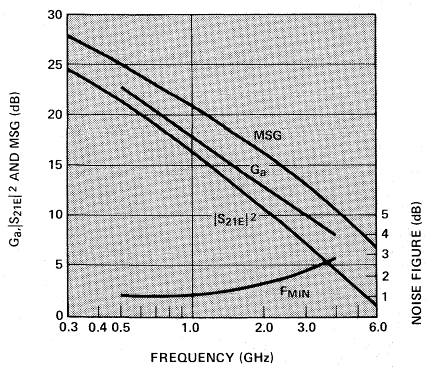


Figure 1. Typical F_{MIN}, G_a, $|S_{21E}|^2$ and MSG vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

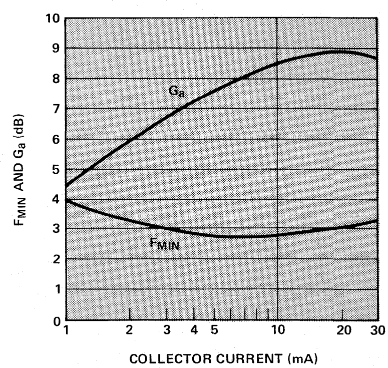


Figure 2. Typical F_{MIN} and Associated Gain vs. I_C at 4 GHz for $V_{CE} = 10$ V.

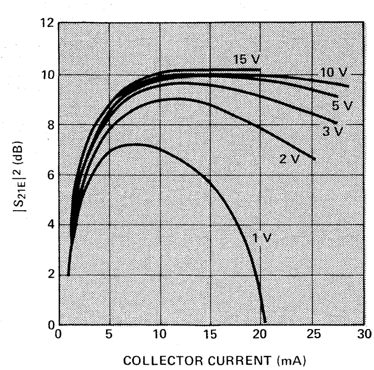


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2000 GHz.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

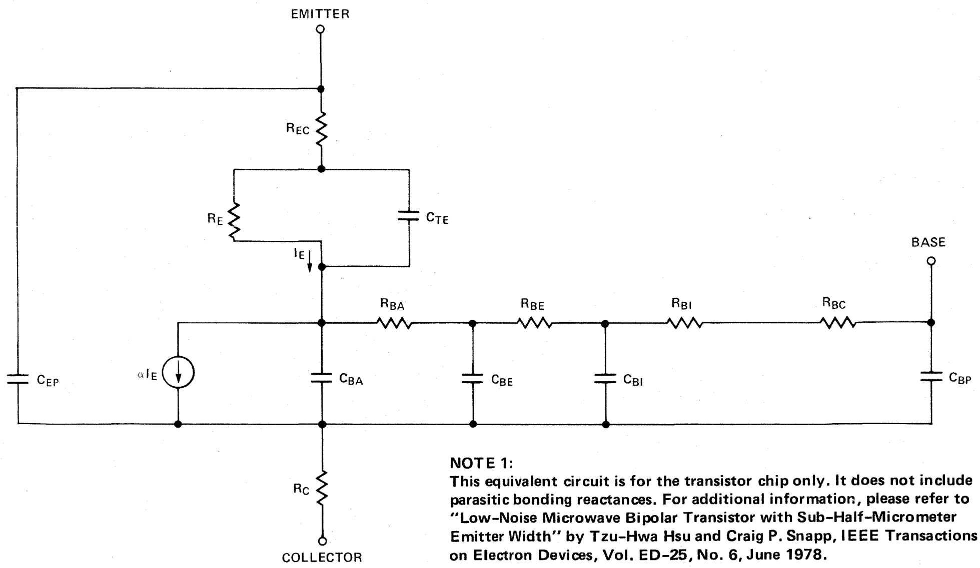
Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.68	-41	27.7	24.27	158	-36.6	0.02	66	0.93	-12
200	0.66	-74	26.1	20.18	140	-33.9	0.02	73	0.83	-19
300	0.63	-99	24.5	16.79	126	-32.1	0.03	55	0.73	-23
400	0.62	-111	23.0	14.13	119	-30.9	0.03	54	0.67	-23
500	0.62	-107	21.5	11.89	112	-29.3	0.03	48	0.62	-24
600	0.61	-135	20.2	10.23	107	-29.2	0.04	51	0.58	-22
700	0.60	-143	19.0	8.91	103	-29.4	0.03	53	0.57	-21
800	0.59	-149	18.0	7.94	99	-29.1	0.04	52	0.55	-20
900	0.59	-154	17.1	7.16	97	-28.6	0.04	55	0.53	-19
1000	0.59	-159	16.2	6.46	95	-27.6	0.04	55	0.52	-18
1500	0.59	-176	12.9	4.42	84	-26.6	0.05	64	0.48	-18
2000	0.57	172	10.5	3.35	77	-24.9	0.06	75	0.50	-15
2500	0.61	163	8.7	2.72	70	-23.3	0.07	83	0.46	-17
3000	0.64	156	7.2	2.29	64	-21.6	0.08	69	0.46	-20
3500	0.70	149	5.9	1.97	58	-20.0	0.10	94	0.43	-21
4000	0.71	144	4.7	1.72	53	-18.7	0.12	95	0.43	-28
4500	0.78	138	3.6	1.51	48	-17.1	0.14	99	0.40	-27
5000	0.83	137	2.8	1.38	42	-16.3	0.15	99	0.35	-41
5500	0.88	133	2.1	1.27	38	-15.0	0.18	98	0.36	-49
6000	0.93	134	1.1	1.14	33	-14.6	0.19	100	0.33	-67

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.63	-53	29.5	29.85	151	-41.1	0.01	71	0.91	-13
200	0.62	-90	27.5	23.71	133	-36.3	0.02	60	0.79	-19
300	0.61	-112	25.5	18.84	121	-34.8	0.02	50	0.70	-21
400	0.61	-127	23.6	15.14	111	-32.6	0.02	56	0.64	-20
500	0.60	-130	22.8	13.80	108	-33.1	0.02	46	0.60	-20
600	0.60	-146	20.6	10.72	103	-31.6	0.03	49	0.59	-18
700	0.59	-152	19.3	9.23	100	-31.2	0.03	53	0.57	-17
800	0.59	-153	18.3	8.22	96	-30.5	0.03	55	0.56	-16
900	0.59	-162	17.3	7.33	94	-30.2	0.03	61	0.55	-14
1000	0.59	-166	16.5	16.68	91	-29.4	0.03	62	0.54	-14
1500	0.59	180	13.1	4.52	82	-27.7	0.04	69	0.52	-14
2000	0.58	163	10.6	3.39	75	-25.6	0.05	81	0.53	-12
2500	0.62	160	8.8	2.75	69	-24.0	0.06	89	0.49	-14
3000	0.64	158	7.8	2.32	63	-21.9	0.08	94	0.50	-17
3500	0.70	147	6.0	2.00	57	-20.5	0.09	97	0.47	-17
4000	0.72	143	4.8	1.74	52	-19.0	0.11	99	0.47	-24
4500	0.79	136	3.7	1.53	46	-17.4	0.14	102	0.44	-24
5000	0.85	136	2.9	1.40	41	-16.6	0.15	101	0.39	-37
5500	0.88	132	2.1	1.27	36	-15.2	0.17	101	0.39	-44
6000	0.94	133	1.2	1.15	31	-14.8	0.18	103	0.35	-61

RF Equivalent Circuit See page 49.

SILICON BIPOLAR TRANSISTOR CHIP EQUIVALENT CIRCUITS[1]



NOTE 1:
This equivalent circuit is for the transistor chip only. It does not include parasitic bonding reactances. For additional information, please refer to "Low-Noise Microwave Bipolar Transistor with Sub-Half-Micrometer Emitter Width" by Tzu-Hwa Hsu and Craig P. Snapp, IEEE Transactions on Electron Devices, Vol. ED-25, No. 6, June 1978.

Current Dependent Current Source

$$\alpha = \frac{\alpha_o}{1 + j\, f/f_b} \exp(-j\, 2\pi f \tau)$$

$$\alpha_o = \frac{h_{FE}}{1 + h_{FE}}$$

$$R_e\, \alpha = \frac{\alpha_o}{1 + (f/f_b)^2} \left[\cos(2\pi f\tau) - \frac{f}{f_b} \sin(2\pi f\tau)\right]$$

$$I_m\, \alpha = \frac{-\alpha_o}{1 + (f/f_b)^2} \left[\sin 2\pi f\tau) + \frac{f}{f_b} \sin(2\pi f\tau)\right]$$

Bipolar Chip Equivalent Circuit Elements

Device	C_{BP} (pF)	C_{EP} (pF)	C_{BI} (pF)	C_{BE} (pF)	C_{BA} (pF)	C_{TE} (pF)	R_{EC} (Ω)	R_{BI} & R_{BC} (Ω)	R_{BE} (Ω)	R_{BA} (Ω)	R_C (Ω)	R_E (Ω)	$\alpha 0$	f_b GHz	τ psec.
HXTR-2001, 15 V, 25 mA	0.066	0.06	0.07	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.0	0.990	22.7	10.8
HXTR-2001, 15 V, 15 mA	0.066	0.06	0.7	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.7	0.990	22.7	10.6
HXTR-3001, 15 V, 15 mA	0.117	0.15	0.07	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.7	0.990	22.7	10.6
HXTR-3002, 18 V, 30 mA	0.117	0.19	0.07	0.053	1.034	5.1	7.2	0.2	5.6	4.7	5	0.86	0.976	22.7	10.8
HXTR-5001, 18 V, 30 mA	0.065	0.06	0.07	0.053	1.034	5.1	7.2	0.2	5.6	4.7	5	0.86	0.976	22.7	10.8
HXTR-5002, 18 V, 110 mA	0.105	0.15	0.22	0.18	0.11	17.3	3.1	0.2	1.7	1.4	3	0.24	0.976	22.7	10.9
HXTR-6001, 10 V, 4 mA	0.053	0.05	0.019	0.016	0.0055	1.03	0.7	0.4	7.8	6.1	7	8.6	0.990	22.7	12.1
HXTR-7011, 10 V, 10 mA	0.113	0.11	0.07	0.034	0.017	3.65	0.22	0.13	0.9	2.0	6	2.6	0.990	16.4	15.6

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

2N6679 (HXTR-2101)

Features

HIGH GAIN

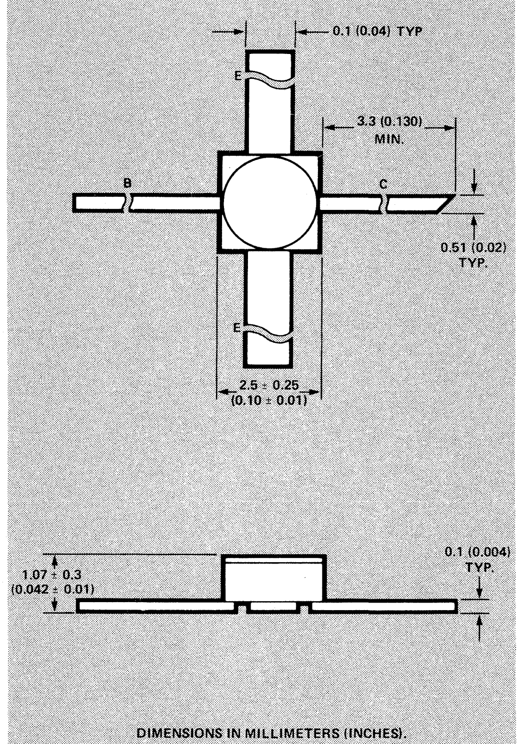
10.5 dB Typical at 4 GHz

HERMETIC PACKAGE

Description

The 2N6679 (HXTR-2101) is an NPN bipolar transistor designed for high gain and output power at 4 GHz. The device is manufactured using ion implantation and self alignment techniques. The chip is provided with a dielectric scratch protection over its active area.

The 2N6679 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 210°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200°C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA	3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V	3041.1	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=15V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio V_{CE}=15V, I_C=15mA	3076.1*	–	50	120	220
G_T	Tuned Gain V_{CE} = 15V, I_C = 25 mA, Frequency = 4 GHz		dB	9.0	10.5	
P_{1dB}	Power Output at 1 dB Compression V_{CE}=15V, I_C=25mA, Frequency = 4 GHz		dBm		18.5	

*300 μs wide pulse measurement ≤2% duty cycle.

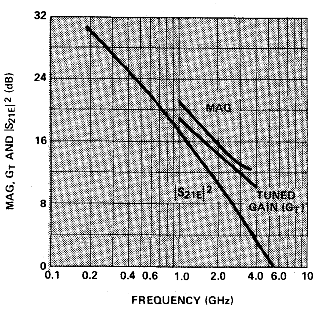


Figure 1. Typical MAG, $|S_{21E}|^2$ and Tuned Gain vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

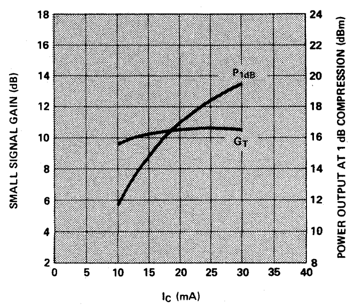


Figure 2. Typical Power Output at 1 dB Compression and Small Signal Gain vs. Collector at 4 GHz for V_{CE} = 15 V.

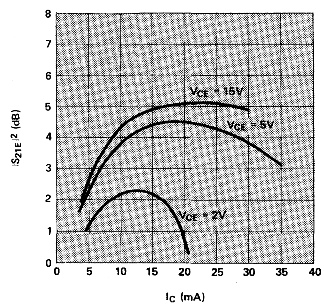


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters V_{CE} = 15V, I_C = 25 mA

	S11		S21			S12			S22	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.59	-66	30.8	34.6	146	-40.0	0.01	69	0.86	-18
500	0.58	-150	22.1	12.7	96	-33.2	0.02	44	0.51	-27
1000	0.59	-175	16.7	6.86	78	-30.5	0.03	51	0.44	-32
1500	0.59	173	13.3	4.61	64	-28.0	0.04	55	0.45	-39
2000	0.60	162	11.0	3.53	53	-25.7	0.05	55	0.44	-49
2500	0.61	156	8.9	2.79	43	-24.2	0.06	55	0.47	-60
3000	0.62	146	7.3	2.32	33	-22.6	0.07	56	0.48	-67
3500	0.63	139	5.9	1.96	22	-21.2	0.09	53	0.52	-79
4000	0.62	131	4.8	1.73	11	-19.7	0.10	50	0.55	-84
4500	0.61	123	3.5	1.50	1	-18.8	0.12	48	0.59	-93
5000	0.60	116	2.6	1.35	-9	-17.0	0.14	44	0.65	-102
5500	0.62	109	1.8	1.23	-19	-15.9	0.16	36	0.66	-113
6000	0.62	103	0.9	1.11	-28	-15.6	0.17	32	0.66	-123
6500	0.62	93	0.0	1.02	-37	-13.7	0.20	28	0.67	-131

HEWLETT PACKARD	GENERAL PURPOSE TRANSISTOR	HXTR-2102

Features

HIGH GAIN

11 dB Typical at 4 GHz

HERMETIC PACKAGE

Description

The HXTR-2102 is an NPN bipolar transistor designed for high gain and wide dynamic range up to 6 GHz. The device is manufactured using ion implantation and self alignment techniques. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-2102 is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

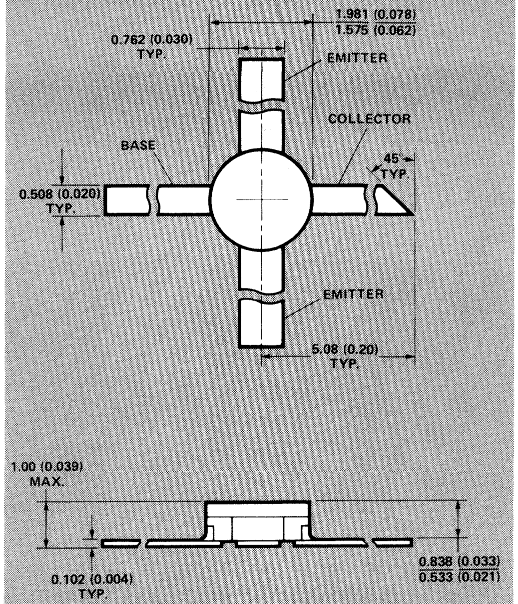
(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 185° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".



DIMENSIONS IN MILLIMETERS AND (INCHES).

Outline HPAC-70 GT

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C = 100\mu A$		3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15V$		3041.1	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB} = 15V$		3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 15V$, $I_C = 15mA$		3076.1*	—	50	120	220
G_T	Tuned Gain $V_{CE} = 15V$, $I_C = 25mA$	f=2 GHz 4 GHz		dB	13.0	15.0 11.0	
P_{1dB}	Power Output at 1 dB Compression $V_{CE} = 15V$, $I_C = 25mA$	f=2 GHz 4 GHz		dBm		20.0 18.5	

*300μs wide pulse measurement ≤2% duty cycle.

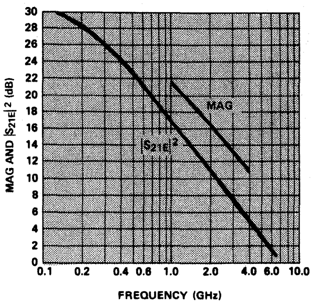


Figure 1. Typical MAG, and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

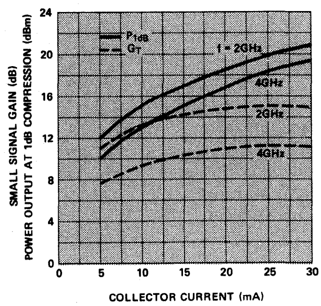


Figure 2. Typical Power Output at 1 dB Compression and Small Signal Gain vs. Current for V_{CE} = 15 V.

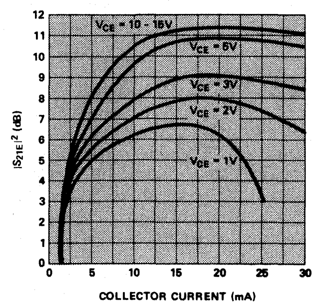


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical S-Parameters V_{CE} = 15V, I_C = 25mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.63	-58	30.5	33.4	149	-39.2	0.011	62	0.88	-16
200	0.63	-99	28.4	26.2	128	-35.9	0.016	49	0.72	-25
300	0.64	-122	26.1	20.3	115	-34.9	0.018	45	0.61	-28
400	0.64	-136	24.2	16.2	107	-33.6	0.021	42	0.54	-29
500	0.64	-146	22.6	13.4	101	-32.8	0.023	42	0.50	-31
600	0.64	-153	21.2	11.5	96	-32.4	0.024	43	0.48	-32
700	0.64	-158	19.9	9.9	92	-32.0	0.025	43	0.47	-33
800	0.64	-162	18.8	8.8	88	-31.7	0.026	45	0.47	-34
900	0.64	-166	17.8	7.8	85	-31.4	0.027	44	0.48	-34
1000	0.64	-170	16.9	7.0	83	-30.8	0.029	46	0.47	-35
1500	0.66	179	13.5	4.7	70	-29.1	0.035	49	0.44	-40
2000	0.65	172	11.1	3.6	60	-27.1	0.044	53	0.46	-50
2500	0.67	165	9.1	2.9	50	-25.7	0.052	55	0.47	-59
3000	0.64	161	7.6	2.4	40	-24.3	0.061	57	0.52	-66
3500	0.72	156	6.4	2.1	32	-23.3	0.068	53	0.51	-79
4000	0.69	149	5.3	1.8	22	-22.6	0.074	48	0.56	-85
4500	0.70	141	4.4	1.7	14	-21.8	0.081	44	0.55	-92
5000	0.72	136	3.3	1.5	6	-21.3	0.086	39	0.58	-101
5500	0.70	128	2.5	1.3	-3	-20.7	0.092	34	0.62	-109
6000	0.75	122	1.7	1.2	-11	-20.1	0.098	30	0.63	-118
6500	0.70	119	0.8	1.1	-20	-19.6	0.105	26	0.70	-127

HEWLETT PACKARD

LOW COST GENERAL PURPOSE TRANSISTOR

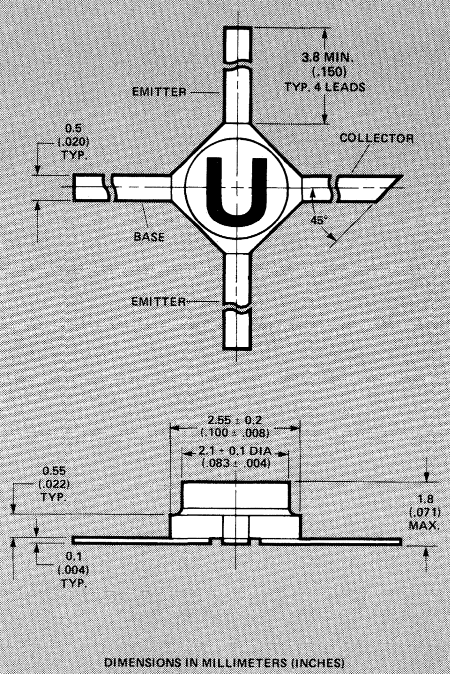
HXTR-3101

Features

HIGH GAIN
19.5 dB Typical at 1 GHz

LOW NOISE FIGURE
1.8 dB Typical F_{MIN} at 1 GHz

LOW COST HERMETIC PACKAGE



Outline HPAC-100X

Description

The HXTR-3101 is a low cost NPN bipolar transistor designed for high gain and wide dynamic range up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-3101 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	18V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	50mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65°C to 150°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 180° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1×10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001.1*	V	30		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036.1**	nA			500
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076.1*		50		180
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 15$ mA		GHz		6	
$\lvert S_{21E}\rvert^2$	Transducer Gain at 1000 MHz at $V_{CE} = 10$ V, $I_C = 15$ mA		dB		15.0	
F_{MIN}	Minimum Noise Figure at 1000 MHz $V_{CE} = 10$ V, $I_C = 10$ mA	3246.1	dB		1.8	
MAG	Maximum Available Gain at 1000 MHz $V_{CE} = 10$ V, $I_C = 15$ mA		dB		19.5	

*300 μs wide pulse measurement ≤ 2% duty cycle.
**Measured under low ambient light conditions.

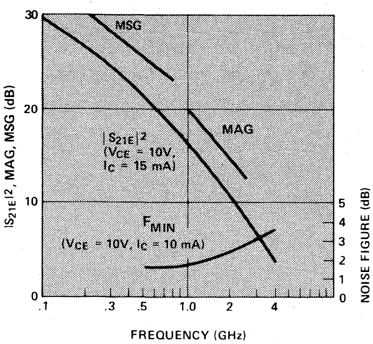


Figure 1. Typical $\lvert S_{21E}\rvert^2$, MAG, Maximum Stable Gain (MSG), and Noise Figure vs. Frequency

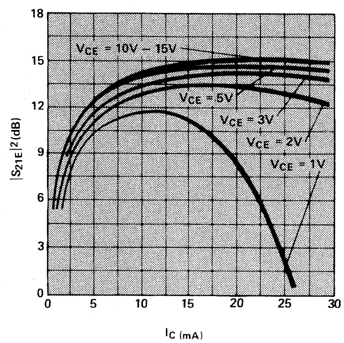


Figure 2. Typical $\lvert S_{21E}\rvert^2$ vs. Current at 1000 MHz

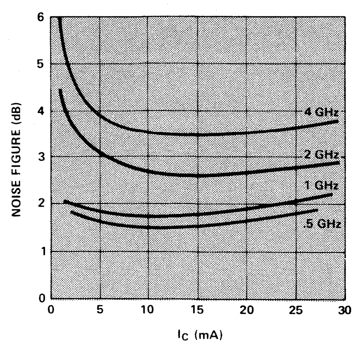


Figure 3. Typical Noise Figure vs. Collector Current ($V_{CE} = 10$V)

Typical S-Parameters ($V_{CE} = 10$ V, $I_C = 10$ mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.705	-50	27.7	24.266	149	-36.7	0.015	60	0.903	-20
300	0.606	-110	23.5	14.962	116	-30.4	0.030	43	0.624	-36
500	0.565	-139	20.1	10.116	101	-28.9	0.036	41	0.499	-40
800	0.559	-162	16.5	6.683	89	-27.4	0.043	43	0.430	-41
1000	0.571	-169	14.5	5.330	78	-25.7	0.052	44	0.408	-43
1500	0.574	174	11.2	3.627	63	-23.6	0.066	48	0.394	-48
2000	0.591	161	8.9	2.774	49	-21.9	0.080	48	0.392	-57
3000	0.619	143	5.7	1.936	25	-18.8	0.115	45	0.427	-81
4000	0.639	125	3.4	1.488	1	-16.2	0.155	39	0.470	-107

($V_{CE} = 10$ V, $I_C = 15$ mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.641	-60	29.5	29.854	144	-37.6	0.013	57	0.863	-23
300	0.565	-122	24.5	16.788	112	-31.8	0.026	44	0.556	-38
500	0.551	-149	20.7	10.839	98	-30.1	0.031	44	0.444	-40
800	0.553	-168	17.1	7.161	87	-28.1	0.039	50	0.387	-41
1000	0.560	-175	15.1	5.709	77	-26.4	0.048	49	0.363	-42
1500	0.564	171	11.8	3.869	62	-23.6	0.066	54	0.356	-47
2000	0.583	159	9.4	2.955	49	-21.6	0.083	52	0.354	-56
3000	0.611	142	6.3	2.058	26	-18.4	0.120	47	0.389	-81
4000	0.633	124	4.0	1.587	2	-15.9	0.160	39	0.431	-106

HEWLETT PACKARD

LOW COST LINEAR POWER TRANSISTOR

HXTR-3102

Features

HIGH OUTPUT POWER
21 dBm Typical P_{1dB} at 1 GHz

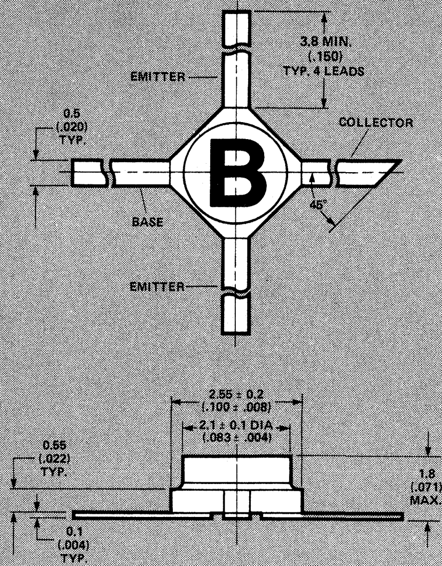
HIGH P_{1dB} GAIN
11.5 dB Typical G_{1dB} at 1 GHz

LOW COST HERMETIC PACKAGE

Description

The HXTR-3102 is a low cost NPN bipolar transistor designed for high linear output power and high gain up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is provided with a dielectric scratch protection over its active area and Ta_2N emitter ballast resistors.

The HXTR-3102 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.



Outline HPAC-100X

Absolute Maximum Ratings*

($T_{CASE} = 25°C$)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	25V
V_{EBO}	Emitter to Base Voltage	3.5V
I_C	DC Collector Current	100mA
P_T	Total Device Dissipation	700mW
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 150°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 165°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5 x 10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	3001.1*	V	35		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 20 V	3036.1**	nA			200
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15 V, I_C = 30 mA	3076.1*		15		75
f_T	Gain Bandwidth Product at V_{CE} = 15 V, I_C = 30 mA		GHz		6	
$\lvert S_{21E}\rvert^2$	Transducer Gain at 1000 MHz at V_{CE} = 15 V, I_C = 30 mA		dB		12.5	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz V_{CE} = 15 V, I_C = 30 mA		dBm		21.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 15 V, I_C = 30 mA		dB		15.0	

*300 μs wide pulse measurement ≤ 2% duty cycle.
**Measured under low ambient light conditions.

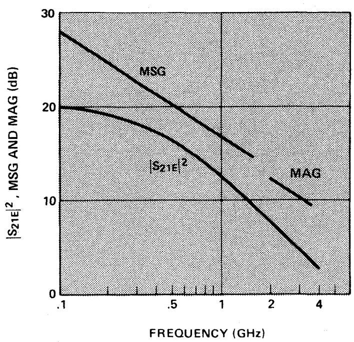


Figure 1. Typical $|S_{21E}|^2$, MAG, and Maximum Stable Gain (MSG) vs. Frequency (V_{CE} = 15 V, I_C = 30 mA)

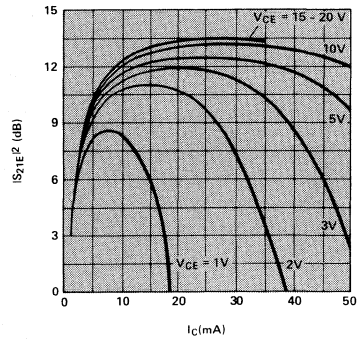


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz

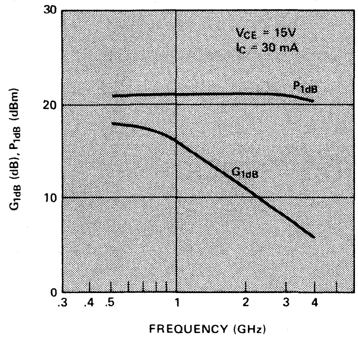


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency.

Typical S-Parameters (V_{CE} = 15 V, I_C = 20 mA)

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.767	-19	18.9	8.810	165	-36.0	0.016	72	0.985	-10
300	0.699	-52	17.7	7.674	143	-27.0	0.045	60	0.892	-25
500	0.620	-79	16.1	6.383	126	-24.0	0.063	50	0.783	-35
800	0.556	-110	13.8	4.898	109	-22.2	0.078	41	0.654	-40
1000	0.548	-126	12.7	4.317	95	-21.0	0.089	34	0.598	-45
1500	0.523	-155	9.9	3.143	74	-20.2	0.098	30	0.525	-55
2000	0.513	-177	7.9	2.475	57	-19.7	0.103	29	0.489	-63
3000	0.534	156	5.1	1.792	30	-17.8	0.129	31	0.495	-85
4000	0.546	132	3.0	1.412	4	-15.6	0.166	29	0.522	-109

(V_{CE} = 15 V, I_C = 30 mA)

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.777	-21	19.7	9.661	164	-35.9	0.016	71	0.985	-10
300	0.694	-57	18.3	8.222	139	-27.1	0.044	58	0.874	-27
500	0.606	-85	16.4	6.607	122	-24.4	0.060	48	0.757	-36
800	0.538	-116	13.9	4.955	105	-22.7	0.073	40	0.630	-40
1000	0.535	-131	12.7	4.296	92	-21.4	0.085	34	0.580	-44
1500	0.513	-159	9.8	3.086	72	-20.4	0.095	32	0.518	-53
2000	0.508	-180	7.7	2.415	55	-19.8	0.102	31	0.488	-62
3000	0.532	153	4.8	1.740	28	-17.8	0.129	33	0.500	-84
4000	0.546	130	2.7	1.362	3	-15.5	0.167	29	0.527	-108

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

2N6838 (HXTR-3103)

Features

GUARANTEED NOISE FIGURE
2.3 dB Maximum F_{MIN} at 1 GHz

HIGH GAIN
13.5 dB Minimum $|S_{21E}|^2$ at 1 GHz

HIGH GAIN BANDWIDTH PRODUCT
7.0 GHz Typical f_T

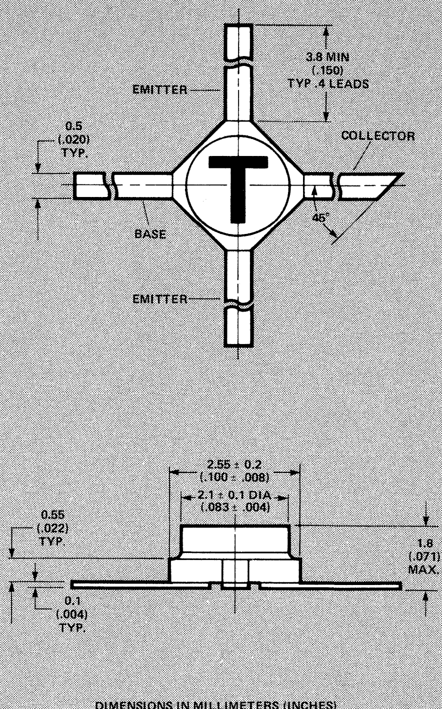
WIDE DYNAMIC RANGE

LOW COST HERMETIC PACKAGE

Description

The HXTR-3103 is an NPN bipolar transistor designed for high gain and wide dynamic range up to 5 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-3103 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	18V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	50mA
P_T	Total Device Dissipation	600mW
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 150°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 180°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200°C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 10$ mA		3011.1*	V	16		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V		3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15V$		3041.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1*		50		180
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 15$ mA			GHz	5.0	7.0	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at $V_{CE} = 10$ V, $I_C = 15$ mA			dB	13.5	15.0	
F_{MIN}	Minimum Noise Figure at 1000 MHz $V_{CE} = 10$ V, $I_C = 10$ mA		3246.1	dB		1.7	2.3
$F_{(50\Omega)}$	Noise Figure with 50 ohm Source $V_{CE} = 10$ V, $I_C = 10$ mA	f = 1000 MHz		dB		2.1	
		f = 500 MHz		dB		1.7	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz $V_{CE} = 10$ V, $I_C = 15$ mA			dBm		16.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz $V_{CE} = 10$ V, $I_C = 15$ mA			dB		16.0	
C_{12E}	Reverse Transfer Capacitance $I_C = 0$ mA; $V_{CE} = 10$ V; f = 1 MHz			pF		0.33	

*300μs wide pulse measurement ≤ 2% duty cycle. **Measured under low ambient light conditions.

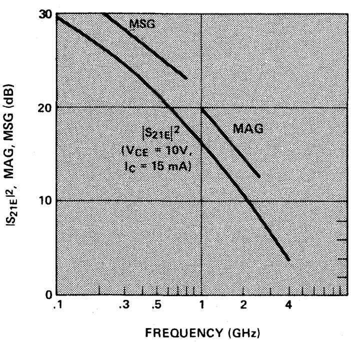


Figure 1. Typical $|S_{21E}|^2$ G_a (max), Maximum Stable Gain (MSG).

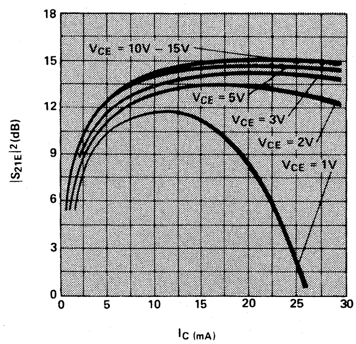


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 GHz.

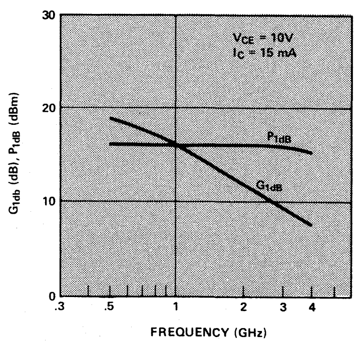


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency.

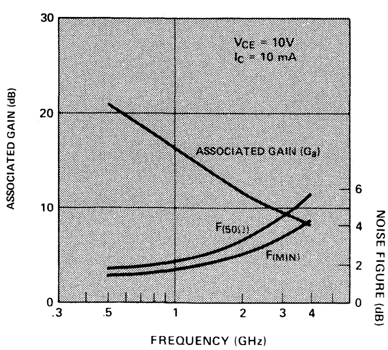


Figure 4. Typical Noise Figure vs. Frequency.

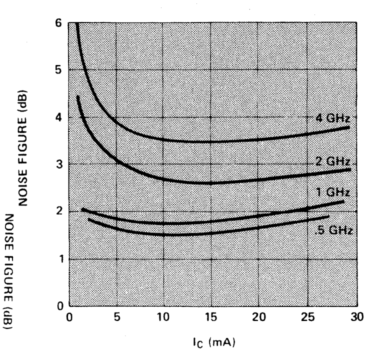


Figure 5. Typical Noise Figure vs. Collector Current.

Typical Noise Parameters

$V_{CC} = 10$ V, $I_C = 10$ mA

Freq. (GHz)	F_{MIN} (dB)	Γ_o Mag.	Γ_o Ang.	R_n (ohms)
.5	1.4	.121	96	114.4
1.0	1.7	.301	121	15.2
2.0	2.5	.461	173	5.2
3.0	3.3	.553	-157	8.4
4.0	4.2	.648	-139	13.4

Typical S-Parameters (VCE = 10 V, IC = 10 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	.70	-50	27.7	24.26	149	-36.7	.015	60	.90	-20
200	.64	-86	25.6	19.05	129	-32.2	.025	49	.74	-31
300	.60	-110	23.5	14.96	116	-30.4	.030	43	.62	-37
400	.57	-127	21.6	12.02	108	-29.6	.033	41	.54	-38
500	.56	-139	20.1	10.11	102	-28.9	.036	41	.49	-40
600	.55	-149	18.7	8.61	97	-28.5	.038	42	.46	-40
700	.56	-157	17.5	7.49	93	-27.9	.040	43	.44	-42
800	.55	-162	16.5	6.68	89	-27.4	.043	44	.43	-42
900	.55	-168	15.5	5.95	85	-26.9	.045	46	.41	-43
1000	.57	-169	14.5	5.33	78	-25.7	.052	42	.40	-40
1500	.57	174	11.2	3.62	63	-23.6	.066	48	.39	-48
2000	.59	162	8.9	2.77	49	-21.9	.080	48	.39	-57
2500	.61	153	7.2	2.28	37	-20.4	.096	48	.39	-71
3000	.61	143	5.7	1.93	25	-18.8	.115	45	.42	-81
3500	.65	134	4.5	1.67	13	-17.5	.134	43	.42	-94
4000	.63	125	3.5	1.48	1	-16.2	.155	39	.47	-107

Typical S-Parameters (VCE =V 10 V, IC = 15 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	.64	-60	29.5	29.85	144	-37.6	.013	57	.86	-24
200	.58	-98	26.9	22.13	124	-33.4	.021	47	.67	-34
300	.56	-122	24.5	16.78	112	-31.8	.026	44	.55	-38
400	.54	-138	22.4	13.18	104	-30.9	.029	43	.48	-39
500	.54	-149	20.7	10.83	98	-30.1	.031	44	.44	-40
600	.53	-157	19.3	9.22	94	-29.5	.033	47	.41	-40
700	.54	-164	18.1	8.03	90	-28.7	.037	49	.39	-41
800	.54	-168	17.1	7.16	87	-28.1	.039	50	.38	-41
900	.54	-173	16.1	6.38	84	-27.4	.043	52	.37	-42
1000	.56	-175	15.1	5.70	77	-26.4	.048	49	.36	-39
1500	.56	171	11.8	3.86	62	-23.6	.066	54	.35	-47
2000	.58	159	9.4	2.95	49	-21.6	.083	52	.35	-56
2500	.61	151	7.7	2.42	38	-20.0	.100	51	.35	-70
3000	.61	142	6.3	2.05	26	-18.4	.120	47	.38	-81
3500	.64	133	5.0	1.78	14	-17.1	.139	44	.38	-94
4000	.63	124	4.0	1.58	2	-15.9	.160	39	.43	-106

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6839 (HXTR-3104)

Features

HIGH OUTPUT POWER
19.0 dBm Minimum P_{1dB} at 1 GHz

HIGH P_{1dB} GAIN
14.0 dB Minimum G_{1dB} at 1 GHz

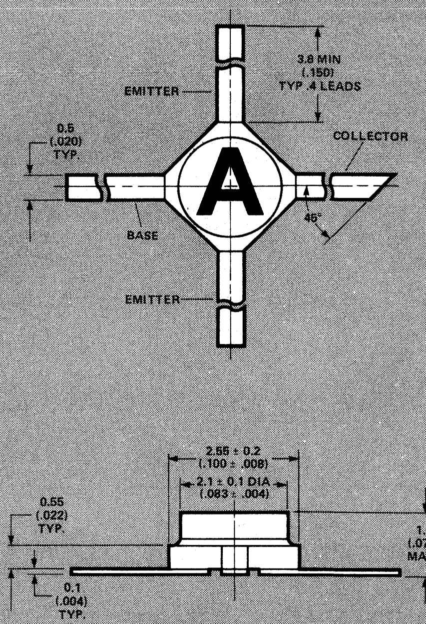
HIGH GAIN BANDWIDTH PRODUCT
5.5 GHz TYPICAL f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3104 is an NPN bipolar transistor designed for high output power and gain up to 4 GHz. Ion implantation and self alignment techniques are used in its manufacture to produce excellent uniformity and reliability. The chip has a dielectric scratch protection over its active area and a Ta_2N ballast resistor for ruggedness.

The HXTR-3104 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and test requirements of MIL-STD-750/883.



Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	25V
V_{EBO}	Emitter to Base Voltage	3.5V
I_C	DC Collector Current	100mA
P_T	Total Device Dissipation	700mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 165° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5 x 10^6 hours will be met or exceeded when the junction temperature is maintained under T_J = 125° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001.1*	V	35		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at $I_B = 30\ \mu A$	3026.1*	V	3.3		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 20$ V	3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V	3041.1	nA			75
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 15$ V, $I_C = 30$ mA	3076.1*		15		75
f_T	Gain Bandwidth Product at $V_{CE} = 15$ V, $I_C = 30$ mA		GHz	4.0	5.5	
$\lvert S_{21E}\rvert^2$	Transducer Gain at 1000 MHz at $V_{CE} = 15$ V, $I_C = 30$ mA		dB	10.5	12.5	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz at $V_{CE} = 15$ V, $I_C = 30$ mA		dBm	19.0	21.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz $V_{CE} = 15$ V, $I_C = 30$ mA		dB	14.0	16.0	
C_{12E}	Reverse Transfer Capacitance $I_C = 0$ mA; $V_{CE} = 10$V; f = 1 MHz		pF		0.36	

*300μs wide pulse measurement ≤ 2% duty cycle. **Measured under low ambient light conditions.

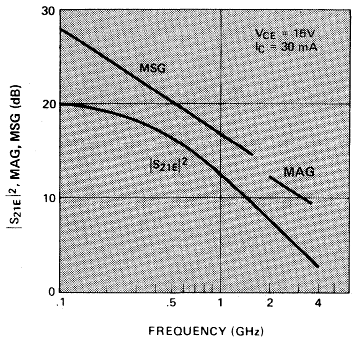


Figure 1. Typical $|S_{21E}|^2$, MAG, and Maximum Stable Gain (MSG) vs. Frequency.

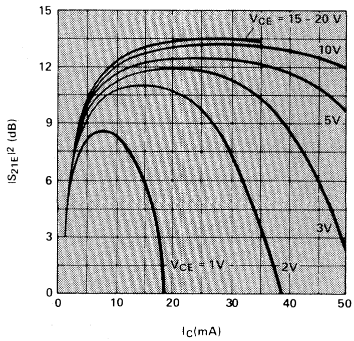


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz.

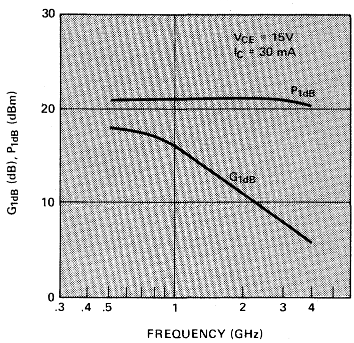


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency.

Typical S-Parameters ($V_{CE} = 15$ V, $I_C = 20$ mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.76	-19	18.9	8.81	165	-36.0	0.016	72	0.98	-10
300	0.69	-52	17.7	7.67	143	-27.0	0.045	60	0.89	-25
500	0.62	-79	16.1	6.38	126	-24.0	0.063	50	0.78	-35
800	0.55	-110	13.8	4.89	109	-22.2	0.078	41	0.65	-40
1000	0.54	-126	12.7	4.31	95	-21.0	0.089	34	0.59	-45
1500	0.52	-155	9.9	3.14	74	-20.2	0.098	30	0.52	-55
2000	0.51	-177	7.9	2.47	57	-19.7	0.103	29	0.48	-63
3000	0.53	156	5.1	1.79	30	-17.8	0.129	31	0.49	-85
4000	0.54	132	3.0	1.41	4	-15.6	0.166	29	0.52	-109

Typical S-Parameters ($V_{CE} = 15$ V, $I_C = 30$ mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.77	-21	19.7	9.66	164	-35.9	0.016	71	0.98	-10
300	0.69	-57	18.3	8.22	139	-27.1	0.044	58	0.87	-27
500	0.60	-85	16.4	6.60	122	-24.4	0.060	48	0.75	-36
800	0.53	-116	13.9	4.95	105	-22.7	0.073	40	0.63	-40
1000	0.53	-131	12.7	4.29	92	-21.4	0.085	34	0.58	-44
1500	0.51	-159	9.8	3.08	72	-20.4	0.095	32	0.51	-53
2000	0.50	-180	7.7	2.41	55	-19.8	0.102	31	0.48	-62
3000	0.53	153	4.8	1.74	28	-17.8	0.129	33	0.50	-84
4000	0.54	130	2.7	1.36	3	-15.5	0.167	29	0.52	-108

![Hewlett Packard logo]

HEWLETT PACKARD

LOW COST, LOW NOISE TRANSISTOR

HXTR-3615

NEW

Features

LOW NOISE FIGURE
1.4 dB Typical F_{MIN} at 1 GHz

HIGH ASSOCIATED GAIN
16.6 dB Typical G_a at 1 GHz

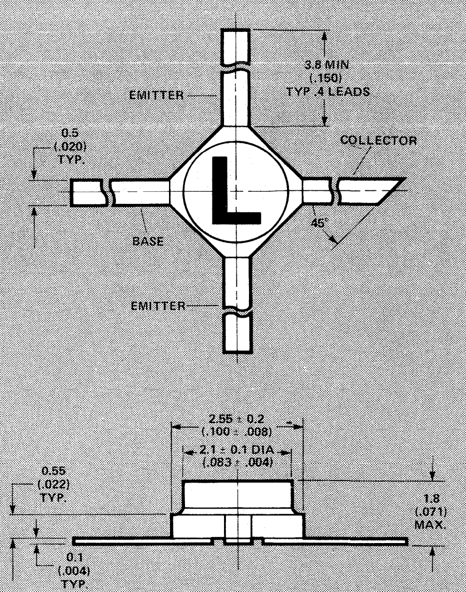
WIDE DYNAMIC RANGE

LOW COST HERMETIC PACKAGE

Description

The HXTR-3615 is a low cost NPN silicon bipolar transistor. Designed to provide low noise, high gain, and wide dynamic range performance for VHF, UHF, and microwave applications. This device is manufactured using ion implantation and self alignment techniques and the transistor chip has a dielectric scratch protection over its active area.

The HXTR-3615 is supplied in the HPAC-100X, a rugged metal/ceramic package, capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.



Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	16 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	55 mA
P_T	Total Device Dissipation	500 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 170° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1 x 7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Bipolar Transistors

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	25		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	16		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V		3036.1**				100
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V		3041.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1*		50		180
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA			GHz		5	
F_{MIN}	Minimum Noise Figure at $V_{CE} = 10$ V, $I_C = 10$ mA	f = 500 MHz f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB		1.3 1.4 2.0 3.5	
G_a	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA	f = 500 MHz f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB		21.5 16.6 12.0 7.0	
P_{1dB}	Power Output at 1 dB Gain Compression at 1000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA			dBm		19.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA			dB		19.0	
C_{12E}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA	f = 1 MHz		pF		0.3	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.
**Measured under low ambient light conditions.

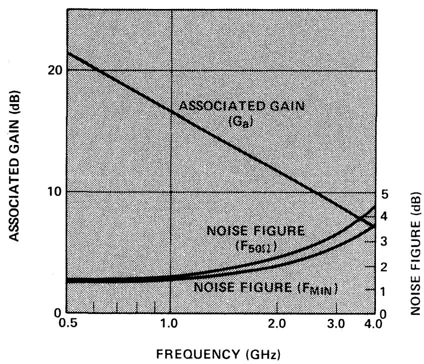


Figure 1. Typical F_{MIN} and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

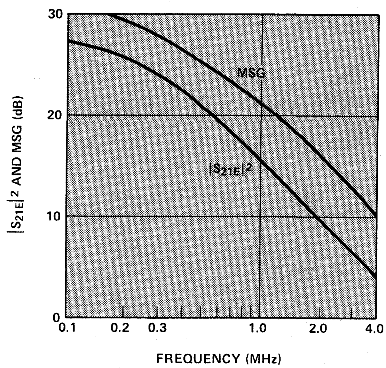


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

Typical Noise Parameters

$V_{CE} = 10$ V, $I_C = 10$ mA

Frequency (MHz)	F_{MIN} (dB)	$F_{50\Omega}$ (dB)	Γ_o Mag.	Ang.	R_n (ohms)
500	1.3	1.3	(50 Ω)	—	0
1000	1.4	1.6	0.20	135	15.4
2000	2.0	2.4	0.39	-177	4.7
4000	3.5	4.4	0.54	-116	18.1

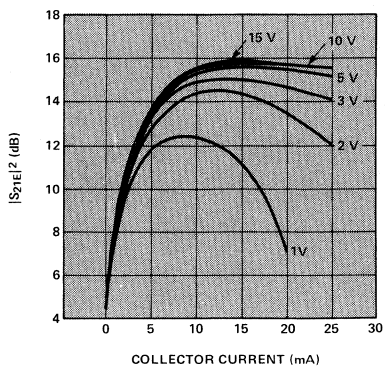


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

Freq. (MHz)	S11		S21			S12			S22	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.92	155	-35.9	0.02	66	0.92	-14
200	0.63	-78	25.9	19.63	136	-33.2	0.02	70	0.81	-23
300	0.59	-103	24.1	15.94	121	-31.4	0.03	53	0.70	-28
400	0.57	-119	22.4	13.22	112	-30.2	0.03	52	0.64	-30
500	0.57	-132	20.9	11.11	105	-28.6	0.04	46	0.59	-32
600	0.55	-141	19.6	9.52	99	-28.4	0.04	49	0.56	-32
700	0.54	-149	18.4	8.30	94	-28.4	0.04	50	0.55	-32
800	0.53	-156	17.4	7.37	89	-28.0	0.04	49	0.53	-32
900	0.53	-162	16.4	6.61	86	-27.3	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.00	83	-26.4	0.05	50	0.50	-34
1500	0.53	172	12.2	4.09	67	-24.7	0.06	55	0.47	-41
2000	0.50	155	9.8	3.11	54	-22.7	0.07	58	0.50	-45
2500	0.54	142	8.1	2.53	43	-20.8	0.09	59	0.47	-55
3000	0.55	130	6.6	2.14	32	-19.0	0.11	58	0.49	-64
3500	0.60	117	5.4	1.87	20	-17.4	0.14	56	0.47	-71
4000	0.61	108	4.3	1.63	10	-16.0	0.16	52	0.49	-83
5000	0.72	90	2.6	1.35	-10	-13.4	0.21	43	0.44	-105
6000	0.81	76	1.2	1.15	-29	-11.2	0.27	32	0.44	-134

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

Freq. (MHz)	S11		S21			S12			S22	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.17	148	-40.0	0.01	69	0.90	-16
200	0.59	-93	27.1	22.60	129	-35.4	0.02	66	0.77	-23
300	0.57	-116	24.9	17.66	115	-34.0	0.02	50	0.67	-26
400	0.55	-131	23.0	14.14	107	-31.7	0.03	55	0.62	-26
500	0.54	-143	21.3	11.65	100	-32.0	0.03	47	0.58	-28
600	0.54	-152	20.0	9.96	95	-30.8	0.03	48	0.56	-27
700	0.53	-158	18.7	8.57	91	-30.0	0.03	51	0.55	-28
800	0.53	-165	17.6	7.57	86	-29.1	0.04	52	0.54	-29
900	0.52	-170	16.6	6.78	83	-28.6	0.04	57	0.53	-28
1000	0.52	-175	15.8	6.16	79	-27.7	0.04	57	0.52	-29
1500	0.52	167	12.4	4.16	65	-25.5	0.05	59	0.50	-37
2000	0.51	152	10.0	3.16	53	-23.2	0.07	63	0.52	-42
2500	0.54	139	8.2	2.57	42	-21.3	0.09	64	0.50	-51
3000	0.56	127	6.7	2.17	30	-19.3	0.11	62	0.52	-61
3500	0.61	115	5.5	1.89	19	-17.8	0.13	59	0.50	-68
4000	0.62	106	4.4	1.66	8	-16.3	0.15	55	0.52	-80
5000	0.74	89	2.7	1.36	-12	-13.6	0.21	45	0.47	-102
6000	0.83	75	1.3	1.16	-31	-11.4	0.27	34	0.46	-130

LOW COST, HIGH PERFORMANCE TRANSISTOR

NEW

HXTR-3645

Features

GUARANTEED NOISE FIGURE
2.2 dB Maximum F_{MIN} at 2 GHz

GUARANTEED ASSOCIATED GAIN
12.2 dB Minimum G_a at 2 GHz

HIGH OUTPUT POWER
19.0 dBm Typical P_{1dB} at 2 GHz

HIGH P_{1dB} GAIN
13.5 dB Typical G_{1dB} at 2 GHz

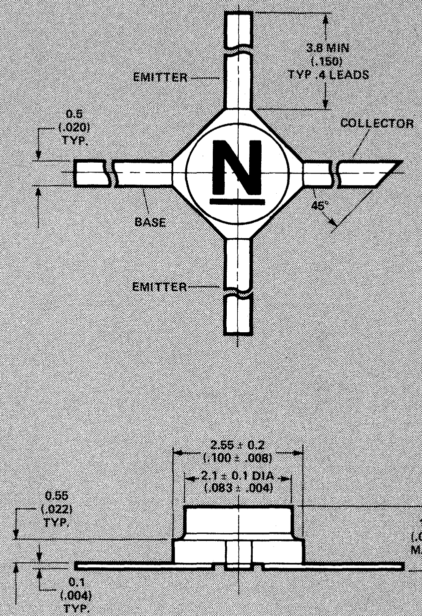
HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3645 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The transistor chip has a dielectric scratch protection over its active area.

The HXTR-3645 is supplied in the HPAC-100X, a rugged hermetic metal-ceramic package, capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 170° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V		3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V		3041.1	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA			GHz		6.0	
F_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA	f = 500 MHz f = 1000 MHz f = 1500 MHz f = 2000 MHz	3246.1	dB		1.2 1.2 1.4 1.7	 1.9
G_a	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA	f = 500 MHz f = 1000 MHz f = 1500 MHz f = 2000 MHz	3246.1	dB	 12.2	22.5 17.5 14.6 13.0	
P_{1dB}	Power Output at 1 dB Gain at 2000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA			dBm		19.0	
G_{1dB}	Associated 1 dB Compressed Gain at 2000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA			dB		13.5	
C_{12E}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA	f = 1 MHz		pF		0.27	

*300 μs wide pulse measurement ≤ 2% duty cycle. **Measured under low ambient light conditions.

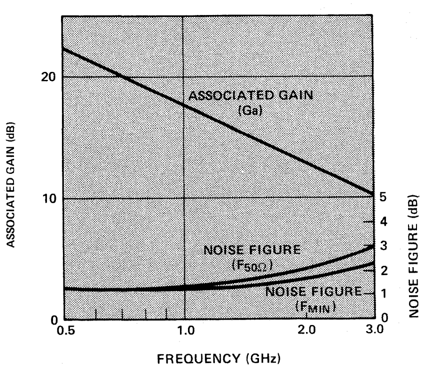


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

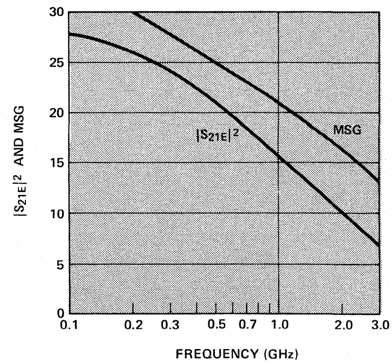


Figure 2. Typical $|S_{21E}|^2$, and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

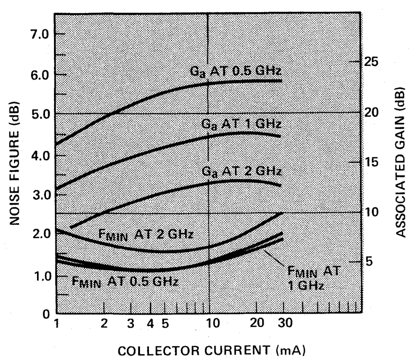


Figure 3. Typical F_{MIN} and Associated Gain (G_a) vs. Collector Current at $V_{CE} = 10$ V.

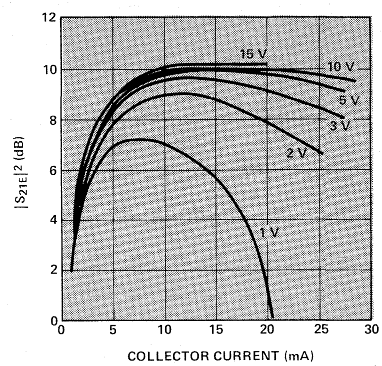


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 2000 MHz.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	F_{MIN} (dB)	$F_{50\Omega}$ (dB)	Γ_o Mag.	Γ_o Ang.	R_n (ohms)
500	1.2	1.2	(50 Ω)	—	0
1000	1.2	1.3	0.20	135	7.3
2000	1.7	2.0	0.39	-177	2.2

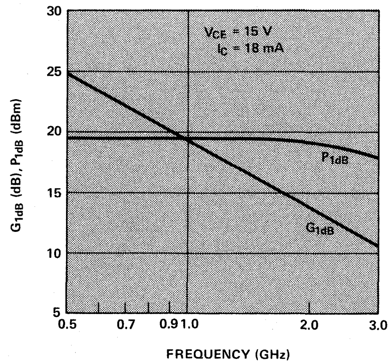


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.92	155	-35.9	0.02	66	0.92	-14
200	0.63	-78	25.9	19.63	136	-33.2	0.02	70	0.81	-23
300	0.59	-103	24.1	15.94	121	-31.4	0.03	53	0.70	-28
400	0.57	-119	22.4	13.22	112	-30.2	0.03	52	0.64	-30
500	0.57	-132	20.9	11.11	105	-28.6	0.04	46	0.59	-32
600	0.55	-141	19.6	9.52	99	-28.4	0.04	49	0.56	-32
700	0.54	-149	18.4	8.30	94	-28.4	0.04	50	0.55	-32
800	0.53	-156	17.4	7.37	89	-28.0	0.04	49	0.53	-32
900	0.53	-162	16.4	6.61	86	-27.3	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.00	83	-26.4	0.05	50	0.50	-34
1500	0.53	172	12.2	4.09	67	-24.7	0.06	55	0.47	-41
2000	0.50	155	9.8	3.11	54	-22.7	0.07	58	0.50	-45
2500	0.54	142	8.1	2.53	43	-20.8	0.09	59	0.47	-55
3000	0.55	130	6.6	2.14	32	-19.0	0.11	58	0.49	-64
3500	0.60	118	5.4	1.87	20	-17.4	0.14	56	0.47	-71
4000	0.61	108	4.3	1.63	10	-16.0	0.16	52	0.49	-83

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.17	148	-40.0	0.01	69	0.90	-16
200	0.59	-93	27.1	22.60	129	-35.4	0.02	66	0.77	-23
300	0.57	-116	24.9	17.66	115	-34.0	0.02	50	0.67	-26
400	0.55	-131	23.0	14.14	107	-31.7	0.03	55	0.62	-26
500	0.54	-143	21.3	11.65	100	-32.0	0.03	47	0.58	-28
600	0.54	-152	20.0	9.96	95	-30.8	0.03	48	0.56	-27
700	0.53	-158	18.7	8.57	91	-30.0	0.03	51	0.55	-28
800	0.53	-165	17.6	7.57	86	-29.1	0.04	52	0.54	-29
900	0.52	-170	16.6	6.78	83	-28.6	0.04	57	0.53	-28
1000	0.52	-175	15.8	6.16	79	-27.7	0.04	57	0.52	-29
1500	0.52	167	12.4	4.16	65	-25.5	0.05	59	0.50	-37
2000	0.51	152	10.0	3.16	53	-23.2	0.07	63	0.52	-42
2500	0.54	139	8.2	2.57	42	-21.3	0.09	64	0.50	-51
3000	0.56	127	6.7	2.17	30	-19.3	0.11	62	0.52	-61
3500	0.61	115	5.5	1.89	19	-17.8	0.13	59	0.50	-68
4000	0.62	106	4.4	1.66	8	-16.3	0.15	55	0.52	-80

HEWLETT PACKARD

LOW COST, HIGH PERFORMANCE TRANSISTOR

NEW

HXTR-3675

Features

GUARANTEED NOISE FIGURE
3.4 dB Maximum F_{MIN} at 4 GHz

GUARANTEED ASSOCIATED GAIN
7.7 dB Minimum G_a at 4 GHz

HIGH OUTPUT POWER
17.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
8.4 dB Typical G_{1dB} at 4 GHz

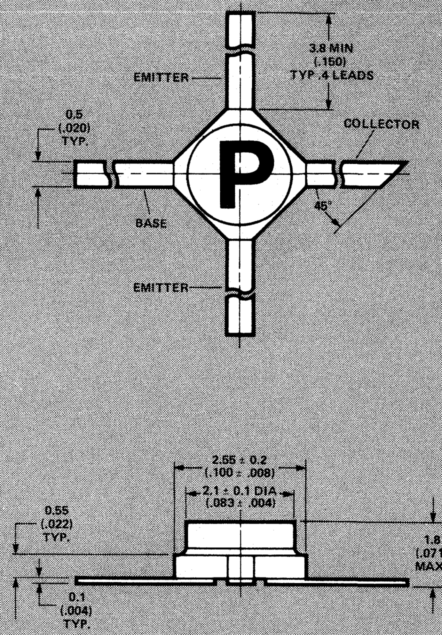
HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3675 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The chip is provided with scratch protection over its active area.

The HXTR-3675 is supplied in the HPAC-100X, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to +150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 170° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V		3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V		3041.1	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA			GHz		6.0	
F_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA	f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB		1.2 1.7 2.8	 3.4
G_a	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA	f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246.1	dB	 7.7	17.7 13.0 8.3	
P_{1dB}	Power Output at 1 dB Compression at 4000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA			dBm		17.5	
G_{1dB}	Associated 1 dB Compressed Gain at 4000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA			dB		8.4	
C_{12E}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA	f = 1 MHz		pF		0.29	

*300 μs wide pulse measurement ≤ 2% duty cycle. **Measured under low ambient light conditions.

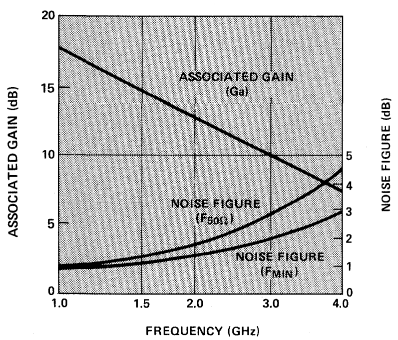


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

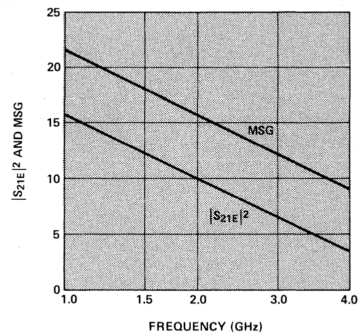


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

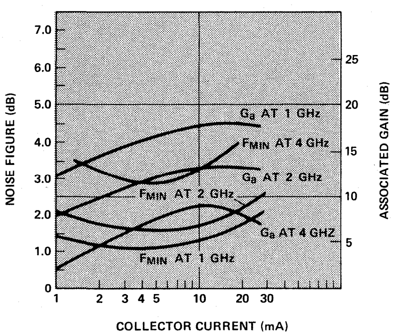


Figure 3. Typical F_{MIN} and Associated Gain (G_a) vs. Collector Current at $V_{CE} = 10$ V.

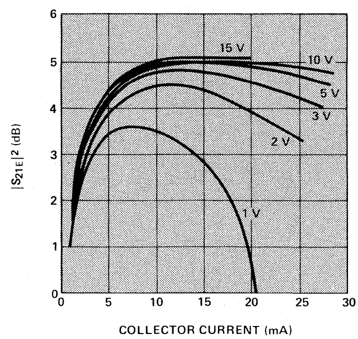


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 4000 MHz.

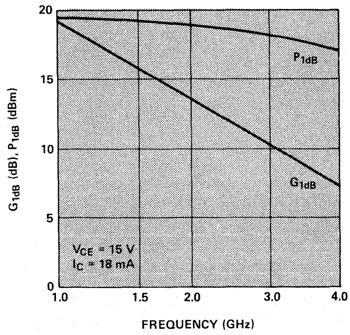


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	F_{MIN} (dB)	$F_{SO\Omega}$ (dB)	G_{MIN} (dB)	Γ_o Mag.	Γ_o Ang.	R_n (ohms)
1000	1.2	1.3	17.7	0.2	135	6.5
2000	1.8	2.0	13.0	0.4	−177	2.9
4000	2.8	4.1	8.3	0.6	−117	21.5

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.9	155	0.02	66	0.92	-14
200	0.63	-78	25.9	19.6	136	0.02	70	0.81	-23
300	0.59	-103	24.0	15.9	121	0.03	53	0.70	-28
400	0.58	-119	22.4	13.2	112	0.03	52	0.64	-30
500	0.57	-132	20.9	11.1	105	0.04	46	0.59	-32
600	0.55	-141	19.6	9.5	99	0.04	49	0.56	-32
700	0.54	-149	18.4	8.3	94	0.04	50	0.55	-32
800	0.53	-156	17.4	7.4	89	0.04	49	0.53	-32
900	0.53	-162	16.4	6.6	86	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.0	83	0.05	50	0.50	-34
1500	0.53	172	12.3	4.1	67	0.06	55	0.47	-41
2000	0.50	155	9.8	3.1	54	0.07	58	0.50	-46
2500	0.54	142	8.0	2.5	43	0.09	59	0.47	-55
3000	0.55	130	6.4	2.1	32	0.11	58	0.49	-64
3500	0.60	118	5.6	1.9	20	0.14	56	0.47	-71
4000	0.61	108	4.1	1.6	10	0.16	52	0.48	-83
4500	0.68	96	3.5	1.5	-1	0.19	48	0.47	-89
5000	0.72	90	2.9	1.4	-10	0.21	43	0.44	-105
5500	0.76	80	2.3	1.3	-20	0.25	36	0.46	-116
6000	0.81	76	0.8	1.1	-29	0.27	32	0.44	-134
6500	0.78	69	0.2	1.0	-37	0.29	26	0.50	-148

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.2	148	0.01	69	0.90	-16
200	0.59	-93	27.1	22.6	129	0.02	66	0.77	-23
300	0.57	-116	25.0	17.7	115	0.02	50	0.67	-26
400	0.55	-131	23.0	14.1	107	0.03	55	0.62	-26
500	0.54	-143	21.3	11.6	100	0.03	47	0.58	-28
600	0.54	-152	20.0	10.0	95	0.03	48	0.56	-27
700	0.53	-158	18.7	8.6	91	0.03	51	0.55	-28
800	0.53	-165	17.6	7.6	86	0.04	52	0.54	-29
900	0.52	-170	16.7	6.8	83	0.04	57	0.53	-28
1000	0.52	-175	15.9	6.2	79	0.04	57	0.52	-29
1500	0.52	167	12.5	4.2	65	0.05	59	0.50	-37
2000	0.51	152	10.1	3.2	53	0.07	63	0.52	-42
2500	0.54	139	8.3	2.6	42	0.09	64	0.50	-51
3000	0.56	127	6.9	2.2	30	0.11	62	0.52	-61
3500	0.61	115	5.6	1.9	19	0.13	59	0.50	-68
4000	0.62	106	4.6	1.7	8	0.15	55	0.52	-80
4500	0.69	94	3.5	1.5	-2	0.18	51	0.50	-87
5000	0.74	89	2.9	1.4	-12	0.21	45	0.47	-102
5500	0.77	78	2.3	1.3	-22	0.24	38	0.49	-113
6000	0.83	75	1.6	1.2	-31	0.27	34	0.46	-130
6500	0.78	67	0.1	1.0	-39	0.28	28	0.52	-146

HEWLETT PACKARD

GENERAL PURPOSE OSCILLATOR TRANSISTOR

HXTR-4101

Features

GUARANTEED OUTPUT POWER
19.0 dBm Minimum at 4.3 GHz

HIGH FREQUENCY PERFORMANCE
12 dBm Typical at 8 GHz

USABLE TO 10 GHz

CHARACTERIZED FOR OSCILLATOR APPLICATIONS UP TO 10 GHz

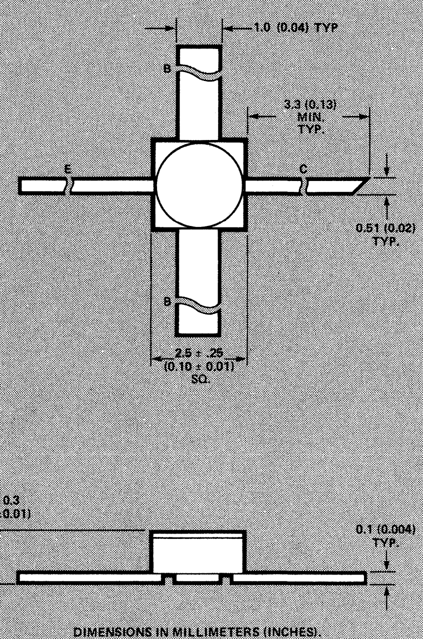
HERMETIC PACKAGE

COMMON BASE CONFIGURATION

Description

The HXTR-4101 is an NPN bipolar transistor designed for consistent high oscillator output. Each device is tested for specified oscillator performance at 4.3 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with dielectric scratch protection over its active area.

The HXTR-4101 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 250° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 210° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA		3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V		3041.1	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=15V		3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio V_{CE}=15V, I_C=15mA		3076.1*	—	50	120	220
P_{OSC}	Oscillator Output Power V_{CB} =15V, I_C = 30mA	f = 3 GHz		dBm	19.0	21.5	
		4.3 GHz				20.5	
		6 GHz				17.0	
		8 GHz				12.0	
N/C	Phase Noise to Carrier Ratio at 1 KHz from the Carrier (SSB), f = 4.3 GHz			dBc/Hz		-50	

*300μs wide pulse measurement ≤2% duty cycle.

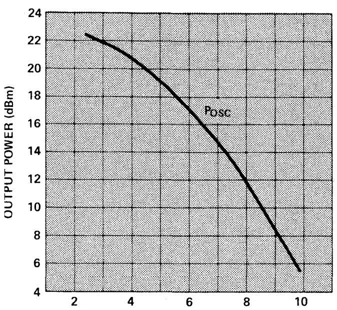


Figure 1. Typical Tuned Power Output vs. Frequency at V_{CB} = 15 V, I_C = 30 mA.

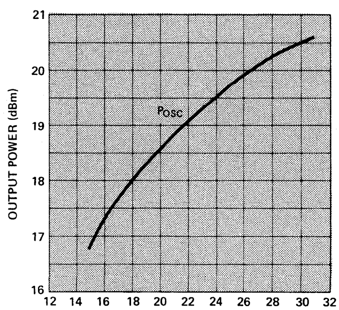


Figure 2. Typical Oscillator Power vs. Current for V_{CB} = 15 V at 4.3 GHz.

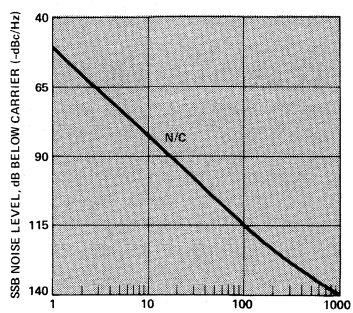


Figure 3. Typical Phase Noise to Carrier Ration (N/C) vs. Frequency from Carrier at 4.3 GHz, V_{CB} = 15 V, I_C = 30 mA.

Typical S-Parameters V_{CB} = 15 V, I_C = 30 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} Mag.	S_{21} Ang.	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
1000	0.93	161	1.93	-29	0.011	127	1.01	-15
1500	0.94	153	1.92	-44	0.023	126	1.04	-31
2000	0.96	144	1.95	-59	0.039	120	1.06	-45
2500	0.98	134	1.97	-76	0.061	113	1.10	-59
3000	0.99	123	1.96	-94	0.086	105	1.12	-74
3500	1.01	115	1.95	-114	0.117	93	1.16	-91
4000	1.02	106	1.87	-133	0.154	84	1.19	-108
4500	1.01	96	1.79	-155	0.186	70	1.20	-127
5000	0.98	88	1.65	-174	0.217	58	1.21	-143
6000	0.91	74	1.32	144	0.245	35	1.10	-176
7000	0.85	61	1.06	109	0.267	17	0.99	157
8000	0.78	49	0.87	74	0.298	1	0.89	135
9000	0.76	44	0.76	60	0.238	-10	0.93	131
10000	0.72	27	0.72	29	0.288	-24	0.89	113
11000	0.70	6	0.68	5	0.302	-38	0.84	102
12000	0.64	-24	0.67	-25	0.320	-58	0.82	92

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6701 (HXTR-5101)

Features

HIGH OUTPUT POWER
- **23 dBm Typical P_{1dB} at 2 GHz**
- **22 dBm Typical P_{1dB} at 4 GHz**

HIGH P_{1dB} GAIN
- **13 dB Typical G_{1dB} at 2 GHz**
- **7.5 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

HERMETIC PACKAGE

Description/Applications

The 2N6701 (HXTR-5101) is an NPN bipolar transistor designed for high output power and gain up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior gain, power, and distortion performance of the 2N6701 commend it for applications in radar, ECM, space, and commercial and military telecommunications. The 2N6701 features both guaranteed power output and associated gain at 1 dB gain compression.

The 2N6701 is supplied in the HPAC-100, a metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

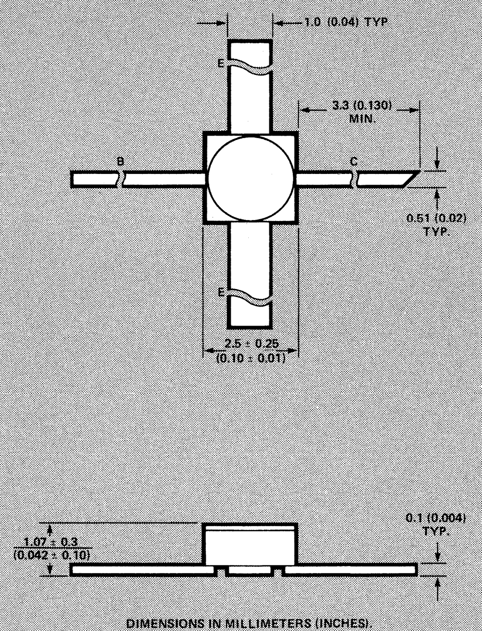
Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.1 W
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 210° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5×10^6 hours will be met or exceeded when the junction temperature is maintained under T_J = 125° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108, "Reliability Performance of Bipolar Transistors".



Outline HPAC-100

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 3mA	3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15mA	3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 30μA	3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V	3061.1	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V	3041.1	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C = 30mA	3076.1*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression f=2GHz		dBm		23.0	
	4GHz			21.0	22.0	
G_{1dB}	Associated 1dB Compressed Gain 2GHz		dB		13	
	4GHz			6.5	7.5	
P_{SAT}	Saturated Power Output (8dB Gain) 2GHz		dBm		25.5	
	(3dB Gain) 4GHz				25.0	
η	Power-Added Efficiency at 1dB Compression 2GHz		%		35	
	4GHz				24	
IP_3	Third Order Intercept Point V_{CE}=18V, I_C=30mA 4GHz		dBm		31	

*300μs wide pulse measurement at ≤2% duty cycle.

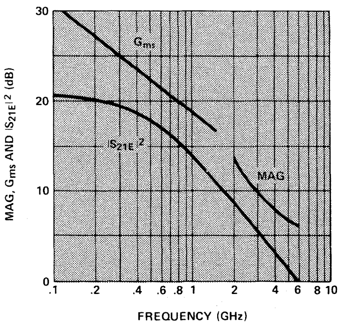


Figure 1. Typical MAG, Maximum Stable Gain (MSG), and $|S_{21E}|^2$, vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

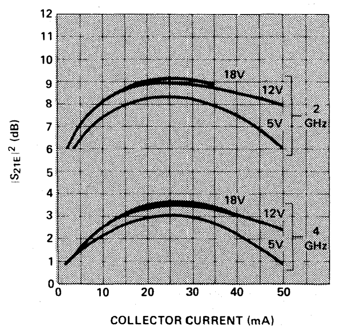


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 and 4 GHz.

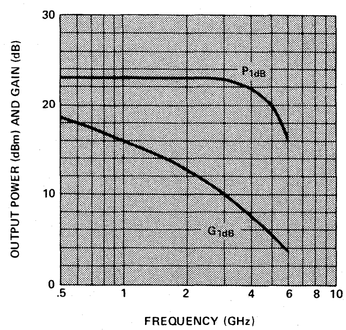


Figure 3. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

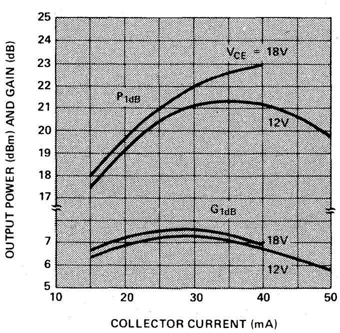


Figure 4. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

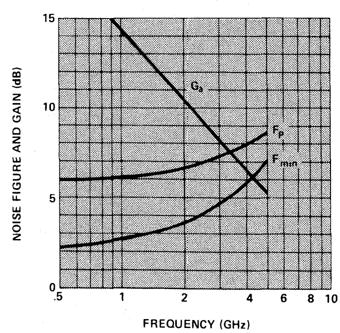


Figure 5. Typical Noise Figure (F_{MIN}) and Associated Gain (G_a) when tuned for Minimum Noise vs. Frequency at V_{CE} = 18 V, I_C = 10 mA. Typical Noise Figure (F_P) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 30 mA.

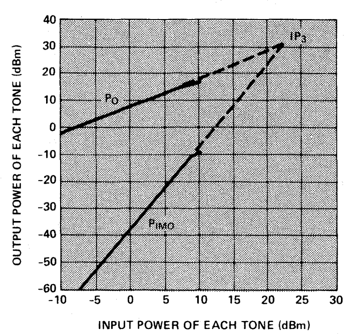


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 30 mA.

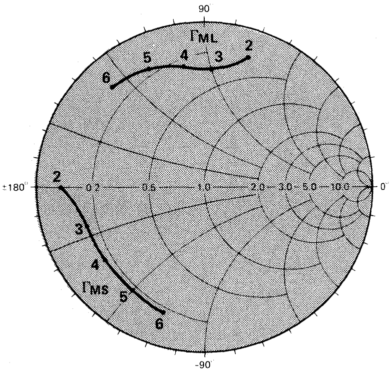


Figure 7. Typical Γ_{MS}, Γ_{ML}, (calculated from the average S-parameters) in the 2 to 6GHz frequency range, at V_{CE} = 18V, I_C = 30mA.

Typical S-Parameters V_{CE} = 18V, I_C = 30mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**Mag.**	**Ang.**
100	0.80	-19	20.6	10.7	165	-37	0.01	77	0.98	-8
200	0.78	-37	20.1	10.2	154	-31	0.03	67	0.94	-15
300	0.75	-53	19.5	9.44	143	-28	0.04	60	0.88	-21
400	0.72	-68	18.7	8.63	133	-27	0.05	53	0.83	-26
500	0.68	-81	17.9	7.87	124	-26	0.05	47	0.78	-30
600	0.66	-92	17.0	7.15	117	-25	0.06	42	0.73	-33
700	0.64	-102	16.2	6.52	110	-24	0.06	39	0.69	-36
800	0.62	-111	15.5	5.96	104	-24	0.07	36	0.66	-38
900	0.61	-119	14.8	5.49	99	-23	0.07	33	0.64	-41
1000	0.60	-126	14.1	5.08	94	-23	0.07	31	0.61	-43
1500	0.56	-151	11.2	3.64	75	-23	0.08	25	0.55	-51
2000	0.55	-169	8.9	2.80	59	-22	0.08	22	0.52	-61
2500	0.56	179	7.2	2.29	45	-21	0.09	21	0.53	-72
3000	0.55	168	5.7	1.93	33	-21	0.09	21	0.52	-79
3500	0.56	158	4.5	1.69	21	-20	0.10	20	0.55	-89
4000	0.54	148	3.5	1.50	10	-19	0.11	19	0.58	-96
4500	0.54	137	2.5	1.33	0	-19	0.11	18	0.58	-106
5000	0.52	128	1.6	1.21	-11	-18	0.13	16	0.62	-113
5500	0.54	115	1.0	1.12	-23	-17	0.14	14	0.60	-122
6000	0.54	108	0.0	1.01	-32	-17	0.15	11	0.64	-132

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**(dB)**	**Mag.**	**Ang.**	**Mag.**	**Ang.**
100	0.80	-18	19.4	9.35	166	-37	0.01	78	0.98	-7
200	0.78	-35	19.1	9.07	155	-31	0.02	69	0.95	-14
300	0.76	-50	18.5	8.44	145	-28	0.03	61	0.91	-20
400	0.73	-64	17.8	7.79	135	-26	0.04	55	0.86	-25
500	0.69	-77	17.1	7.16	127	-25	0.05	49	0.81	-29
600	0.67	-88	16.3	6.56	119	-24	0.06	44	0.76	-32
700	0.64	-97	15.5	6.02	113	-23	0.06	40	0.72	-35
800	0.62	-107	14.8	5.54	107	-23	0.06	37	0.69	-38
900	0.60	-115	14.2	5.13	101	-23	0.07	34	0.66	-40
1000	0.60	-122	13.5	4.76	96	-23	0.07	32	0.63	-43
1500	0.57	-148	10.8	3.47	76	-22	0.08	24	0.57	-53
2000	0.55	-166	8.6	2.69	60	-21	0.08	21	0.54	-63
2500	0.56	-178	6.9	2.21	46	-21	0.09	19	0.55	-75
3000	0.56	171	5.1	1.80	36	-20	0.09	21	0.50	-85
3500	0.56	160	4.3	1.65	21	-20	0.10	18	0.56	-91
4000	0.53	151	3.3	1.47	10	-19	0.11	18	0.59	-99
4500	0.53	141	2.3	1.30	0	-19	0.11	17	0.59	-108
5000	0.50	130	1.5	1.18	-10	-18	0.12	15	0.62	-116
5500	0.52	118	0.8	1.10	-22	-17	0.14	13	0.61	-124
6000	0.53	110	0.0	0.99	-31	-16	0.15	11	0.64	-135

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

HXTR-5102

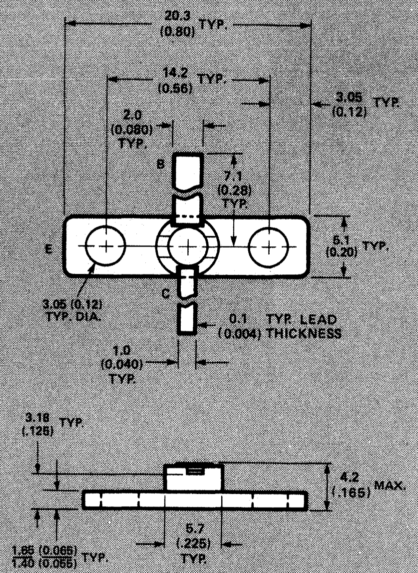
Features

HIGH OUTPUT POWER
29 dBm Typical P_{1dB} at 2 GHz
27.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
11.5 dB Typical G_{1dB} at 2 GHz
7 dB Typical G_{1dB} at 4 GHz

HIGH POWER-ADDED EFFICIENCY

HERMETIC FLANGE PACKAGE



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-200 GB/GT

Description/Applications

The HXTR-5102 is an NPN bipolar transistor designed for high output power and gain up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self-alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness. A silicone conformal coating protects the chip and matching network.

The superior power, gain and distortion performance of the HXTR-5102 commend it for use in broad and narrowband commercial and military telecommunications, radar and ECM applications. Additionally, its partial internal matching makes it ideal for broad bandwidth designs in the 2 to 5 GHz frequency range with minimal sacrifice of output power and gain.

The HXTR-5102 is supplied in the HPAC-200GB/GT, a metal/ceramic hermetic package with a BeO heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

($T_{CASE} = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4W
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 55°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5×10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108, "Reliability Performance of Bipolar Transistors".

Electrical Specifications at T_{CASE} =25°C

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=10 mA	3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=50 mA	3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B=100 μA	3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2 V	3061.1	μA			5
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32 V	3041.1	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20 V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18 V, I_C=110 mA	3076.1*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression f=2 GHz 4 GHz		dBm	 26.5	29.0 27.5	
G_{1dB}	Associated 1dB Compressed Gain 2 GHz 4 GHz		dB	 6.0	11.5 7.0	
P_{SAT}	Saturated Power Output (8 dB Gain) 2 GHz (3 dB Gain) 4 GHz		dBm		31.0 29.5	
η	Power-Added Efficiency at 2 GHz 1 dB Compression 4 GHz		%		37 23	
IP_3	Third Order Intercept Point V_{CE}=18 V, I_C=110 mA		dBm		36	

*300 μs wide pulse measurement at ≤2% duty cycle.

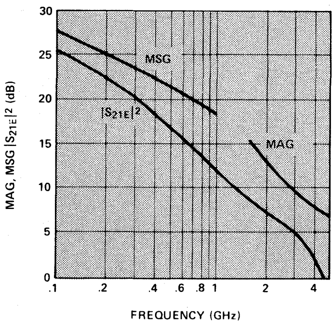


Figure 1. Typical MAG, Maximum Stable Gain (MSG) and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

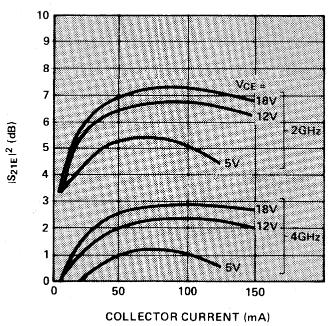


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 and 4 GHz.

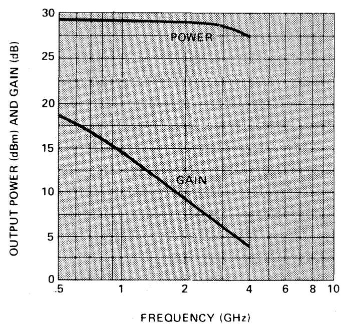


Figure 3. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

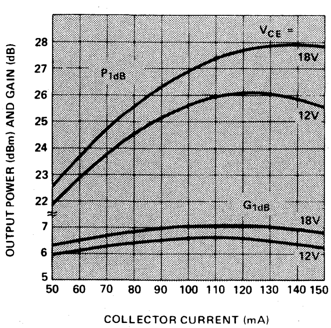


Figure 4. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

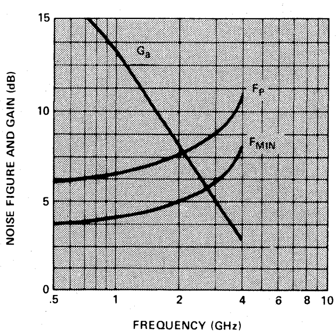


Figure 5. Typical Noise Figure (F_{min}) and Associated Gain (G_a) when tuned for Minimum Noise vs. Frequency at V_{CE} = 18 V, I_C = 25 mA. Typical Noise Figure (F_p) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 110 mA.

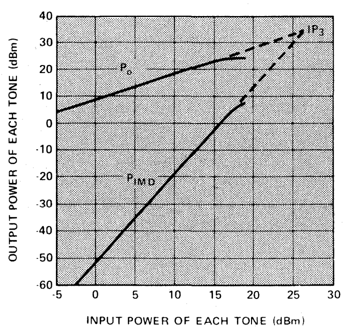


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 4 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 110 mA.

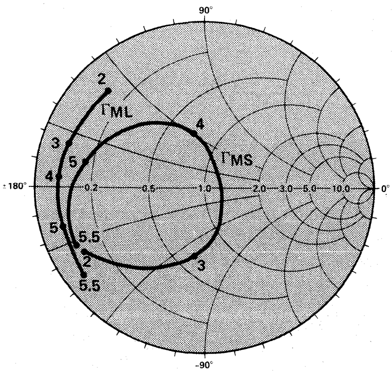


Figure 7. Typical Γ_{MS}, Γ_{ML} (calculated from the average S-parameters) in the 2 to 5.5GHz frequency range, for V_{CE} = 18V, I_C = 110mA.

Bipolar Transistors

Typical S-Parameters V_{CE} = 18 V, I_C = 110 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.55	−74	25.4	18.60	146	−31	0.03	56	0.85	−29
200	0.65	−109	22.7	13.60	123	−28	0.04	39	0.68	−47
300	0.70	−134	20.8	10.90	108	−27	0.05	28	0.55	−59
400	0.72	−144	18.6	8.47	97	−26	0.05	21	0.48	−65
500	0.74	−158	17.2	7.22	88	−26	0.05	17	0.42	−74
600	0.73	−160	15.6	5.99	81	−25	0.05	13	0.41	−75
700	0.74	−167	14.6	5.39	76	−25	0.05	11	0.39	−79
800	0.74	−170	13.4	4.66	69	−25	0.06	8	0.39	−82
900	0.74	−175	12.7	4.32	64	−25	0.06	8	0.38	−86
1000	0.74	−178	11.8	3.91	59	−25	0.06	7	0.37	−92
1500	0.71	166	9.0	2.82	34	−24	0.06	−2	0.43	−107
2000	0.64	153	7.3	2.32	10	−23	0.07	−8	0.51	−119
2500	0.52	140	6.3	2.07	−17	−22	0.08	−22	0.61	−133
3000	0.32	129	5.4	1.86	−49	−21	0.09	−42	0.73	−148
3500	0.15	158	3.8	1.55	−83	−20	0.09	−67	0.77	−165
4000	0.32	−145	2.8	1.38	−113	−22	0.08	−98	0.80	−177
4500	0.52	−158	0.0	1.00	−142	−24	0.06	132	0.82	171
5000	0.70	176	−1.9	0.81	−170	−28	0.04	50	0.87	159
5500	0.78	155	−3.0	0.71	161	−28	0.04	85	0.83	142
6000	0.85	119	−3.9	0.64	121	−19	0.11	16	0.93	121

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6741 (HXTR-5103)

Features

HIGH OUTPUT POWER
23 dBm Typical P_{1dB} at 2 GHz
22 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
11 dB Typical G_{1dB} at 2 GHz
7 dB Typical G_{1dB} at 4 GHz

HIGH POWER-ADDED EFFICIENCY

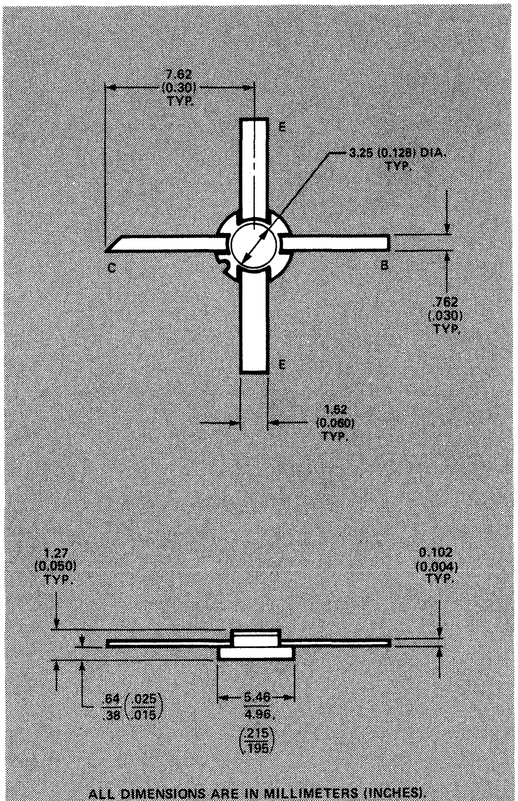
HERMETIC PACKAGE

Description/Applications

The HXTR-5103 is an NPN bipolar transistor designed for high gain and linear output power up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior power, gain and distortion performance of the HXTR-5103 commend it for use in RF and IF applications in radar, ECM, space, and other commercial and military communications.

The HXTR-5103 utilizes the HPAC-200, a metal/ceramic hermetic package with a BeO heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-200

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4 W
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	250° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 125° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5 x 10^6 hours will be met or exceeded when the junction temperature is maintained under T_J = 125° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=3mA	3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=15mA	3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B= 30μA	3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V	3061.1	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V	3041.1	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C=30mA	3076.1*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression f= 2GHz		dBm	22.0	23.0	
G_{1dB}	Associated 1dB Compressed Gain 2GHz		dB	9.5	11.0	
P_{SAT}	Saturated Power Output (Gain=5dB) 2GHz		dBm		25.0	
η	Power-Added Efficiency at 1dB Compression 2GHz		%		34	
IP_3	Third Order Intercept Point V_{CE}=18V, I_C=30mA 2GHz		dBm		32	

*300μs wide pulse measurement at ≤2% duty cycle.

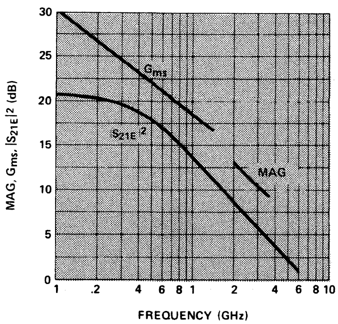


Figure 1. Typical $G_{a(max)}$, Maximum Stable Gain (G_{ms}), and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

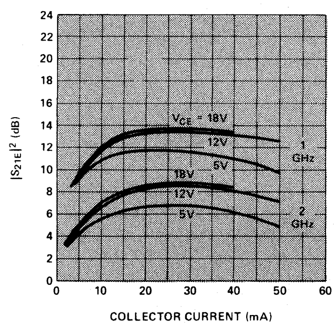


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1 and 2 GHz.

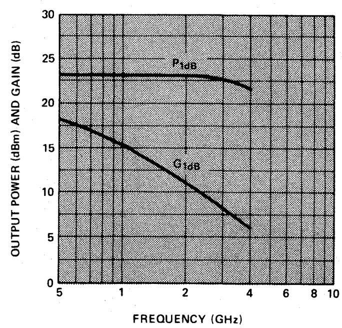


Figure 3. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

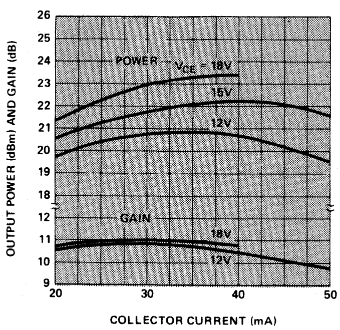


Figure 4. Typical P_{1dB} Linear Output Power and Associated 1 dB Compressed Gain vs. Current at 2 GHz.

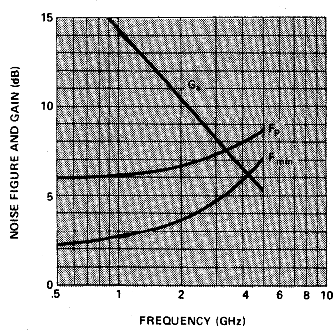


Figure 5. Typical Noise Figure (Fmin) and Associated Gain (G_a) vs. Frequency when tuned for Minimum Noise at V_{CE} = 18 V, I_C = 10 mA. Typical Noise Figure (F_p) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 30 mA.

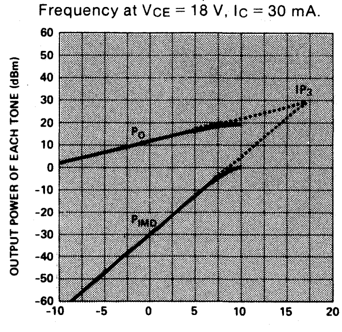


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 30 mA.

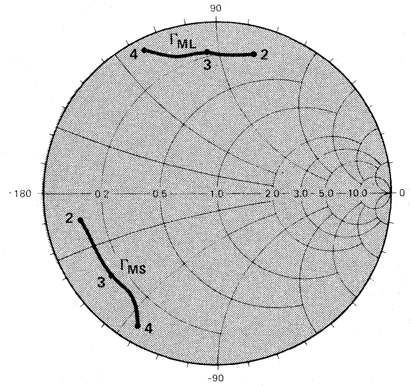


Figure 7. Typical Γ_{MS}, Γ_{ML} (Calculated from the Average S-Parameters) in the 2 to 4GHz Frequency Range for V_{CE} = 18V, I_C = 30mA.

Typical S-Parameters V_{CE} = 18V, I_C = 30mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-20	20.7	10.90	165	-37	0.01	79	0.98	-9
200	0.71	-40	20.3	10.30	152	-32	0.03	68	0.94	-17
300	0.68	-57	19.6	9.49	140	-29	0.04	62	0.89	-23
400	0.65	-72	18.7	8.65	130	-27	0.04	55	0.84	-28
500	0.62	-86	17.8	7.77	121	-26	0.05	49	0.79	-33
600	0.60	-97	16.9	7.01	113	-25	0.06	44	0.75	-37
700	0.58	-108	16.2	6.43	106	-25	0.06	41	0.71	-40
800	0.55	-116	15.4	5.87	100	-24	0.06	38	0.68	-42
900	0.54	-124	14.6	5.38	94	-24	0.07	35	0.65	-44
1000	0.52	-131	13.8	4.91	88	-23	0.07	33	0.63	-46
1500	0.49	-159	11.0	3.53	66	-22	0.08	25	0.58	-59
2000	0.47	-179	8.8	2.77	48	-21	0.09	22	0.56	-67
2500	0.47	165	7.1	2.27	32	-20	0.10	18	0.56	-81
3000	0.45	151	5.8	1.95	17	-19	0.11	15	0.59	-90
3500	0.45	138	4.7	1.71	2	-18	0.12	10	0.59	-103
4000	0.42	123	3.7	1.54	-11	-17	0.14	4	0.64	-111
4500	0.41	110	3.2	1.44	-24	-16	0.16	1	0.65	-121
5000	0.39	89	2.2	1.29	-38	-15	0.17	-6	0.69	-131
5500	0.39	74	1.4	1.18	-53	-14	0.19	-12	0.69	-139
6000	0.37	55	0.7	1.09	-64	-13	0.22	-17	0.69	-148

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-19	19.1	9.05	164	-37	0.01	81	0.98	-8
200	0.70	-37	18.8	8.76	152	-31	0.03	68	0.94	-15
300	0.67	-54	18.2	8.16	141	-28	0.04	60	0.90	-21
400	0.63	-69	17.5	7.52	130	-27	0.05	53	0.85	-26
500	0.60	-83	16.8	6.90	121	-26	0.05	48	0.80	-31
600	0.58	-95	16.0	6.32	113	-25	0.06	43	0.76	-35
700	0.57	-105	15.2	5.78	107	-24	0.06	40	0.73	-38
800	0.55	-113	14.5	5.29	101	-24	0.07	37	0.70	-40
900	0.54	-121	13.8	4.88	95	-23	0.07	34	0.67	-43
1000	0.52	-128	13.0	4.48	89	-23	0.07	31	0.65	-45
1500	0.48	-156	10.2	3.23	66	-22	0.08	25	0.60	-55
2000	0.46	-177	8.0	2.51	48	-21	0.09	21	0.56	-65
2500	0.46	167	6.3	2.00	31	-20	0.10	18	0.57	-77
3000	0.45	153	5.0	1.78	16	-19	0.11	16	0.59	-86
3500	0.44	140	3.8	1.56	0	-18	0.12	12	0.60	-98
4000	0.43	126	2.8	1.38	-13	-17	0.14	8	0.64	-106
4500	0.41	112	1.9	1.24	-26	-16	0.15	4	0.64	-114
5000	0.38	93	1.0	1.12	-40	-15	0.17	-1	0.68	-123
5500	0.39	74	0.8	1.09	-55	-14	0.20	-6	0.70	-130
6000	0.37	56	-0.3	0.96	-67	-13	0.23	-12	0.69	-139

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

HXTR-5104

Features

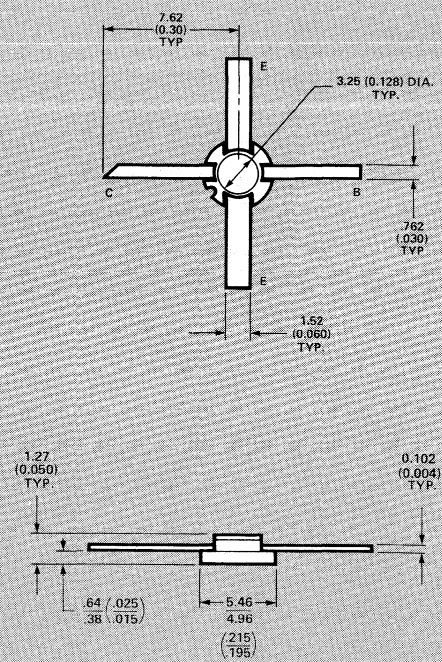
HIGH OUTPUT POWER
29 dBm Typical P_{1dB} at 2 GHz

HIGH P_{1dB} GAIN
9 dB Typical G_{1dB} at 2 GHz

LOW DISTORTION

HIGH POWER-ADDED EFFICIENCY

HERMETIC PACKAGE



ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).

Outline HPAC-200

Description/Applications

The HXTR-5014 is an NPN bipolar transistor designed for high gain and linear output power up to 4 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self-alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior power, gain and distortion performance of the HXTR-5104 commend it for use in RF and IF applications in radar, ECM, space, and other commercial and military communications.

The HXTR-5104 utilizes the HPAC-200, a metal/ceramic hermetic package with a BeO heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

($T_{CASE} = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4 W
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 55°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 3.5×10^6 hours will be met or exceeded when the junction temperature is maintained under $T_J = 125°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=10mA		3001.1*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=50mA		3011.1*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B=100μA		3026.1*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V		3061.1	μA			10
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V		3041.1	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V		3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C=110mA		3076.1*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression	f= 2GHz		dBm	28.0	29.0	
G_{1dB}	Associated 1dB Compressed Gain	2GHz		dB	8.0	9.0	
P_{SAT}	Saturated Power Output (Gain=5dB)	2GHz		dBm		31.0	
η	Power-Added Efficiency at 1dB Compression	2GHz		%		35	
IP_3	Third Order Intercept Point V_{CE}=18V, I_C=110mA	2GHz		dBm		37	

*300μs wide pulse measurement at ≤2% duty cycle.

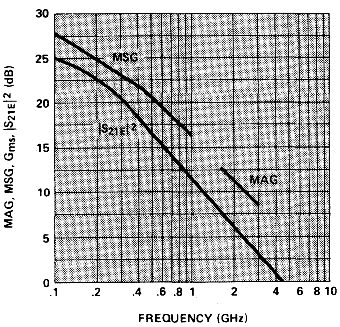


Figure 1. Typical MAG, Maximum Stable Gain (MSG) and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

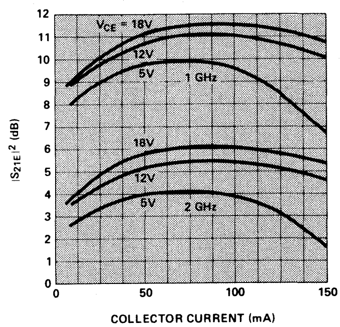


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1 and 2 GHz.

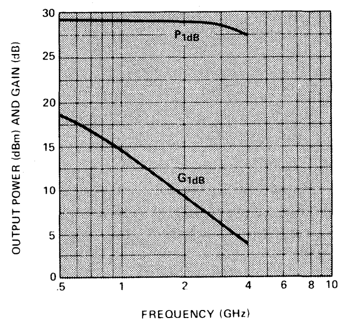


Figure 3. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

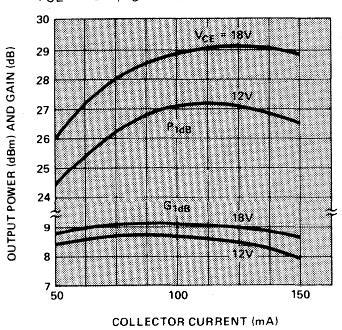


Figure 4. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 2 GHz.

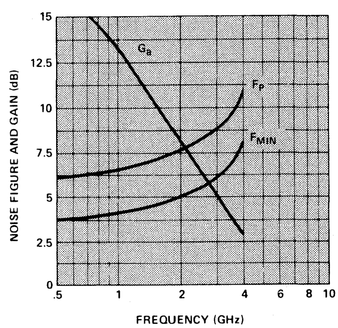


Figure 5. Typical Noise Figure (Fmin) and Associated Gain (G_a) vs. Frequency when tuned for Minimum Noise at V_{CE} = 18 V, I_C = 25 mA. Typical Noise Figure (F_p) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 110 mA.

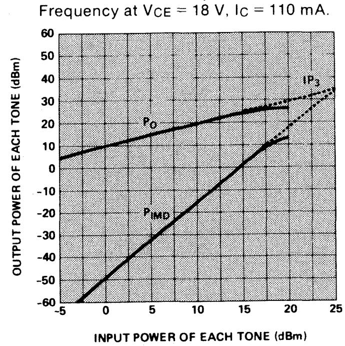


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 110 mA.

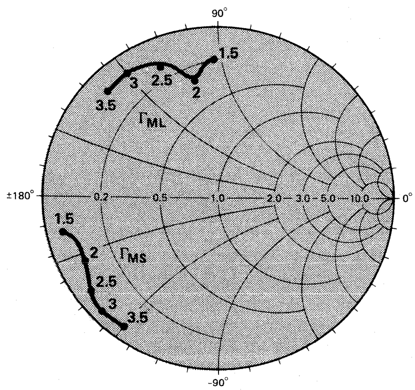


Figure 7. Typical Γ_{MS}, Γ_{ML} (calculated from the average S-parameters) in the 1.5 to 3.5GHz frequency range, at V_{CE} = 18V, I_C = 110mA.

Typical S-Parameters V_{CE} = 18V, I_C = 110mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.48	-68	24.8	17.30	140	-31	0.03	62	0.86	-27
200	0.54	-109	22.6	13.50	127	-27	0.04	48	0.69	-46
300	0.59	-132	20.4	10.50	112	-26	0.05	40	0.55	-58
400	0.61	-146	18.5	8.43	102	-25	0.06	36	0.47	-66
500	0.63	-155	16.9	7.02	94	-24	0.06	34	0.41	-71
600	0.64	-162	15.5	5.98	88	-24	0.06	33	0.38	-76
700	0.65	-168	14.3	5.21	83	-24	0.07	33	0.35	-80
800	0.65	-172	13.3	4.62	78	-23	0.07	33	0.34	-84
900	0.65	-176	12.4	4.15	73	-23	0.07	33	0.32	-87
1000	0.64	179	11.5	3.70	69	-22	0.08	32	0.32	-90
1500	0.65	169	8.2	2.57	50	-20	0.10	31	0.32	-104
2000	0.65	151	6.0	1.99	33	-19	0.11	30	0.33	-118
2500	0.66	139	4.3	1.64	17	-17	0.14	25	0.39	-130
3000	0.65	128	2.9	1.40	2	-16	0.16	20	0.42	-140
3500	0.64	115	1.8	1.23	-13	-15	0.19	14	0.46	-152
4000	0.63	103	0.9	1.11	-27	-13	0.22	5	0.51	-161
4500	0.61	87	0.2	1.03	-41	-12	0.26	-2	0.53	-172
5000	0.59	72	-0.7	0.93	-54	-11	0.29	-12	0.57	179
5500	0.58	53	-1.6	0.84	-67	-10	0.34	-22	0.57	167
6000	0.58	38	-2.3	0.77	-79	-9	0.37	-31	0.60	155

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6617 (HXTR-6101)

Features

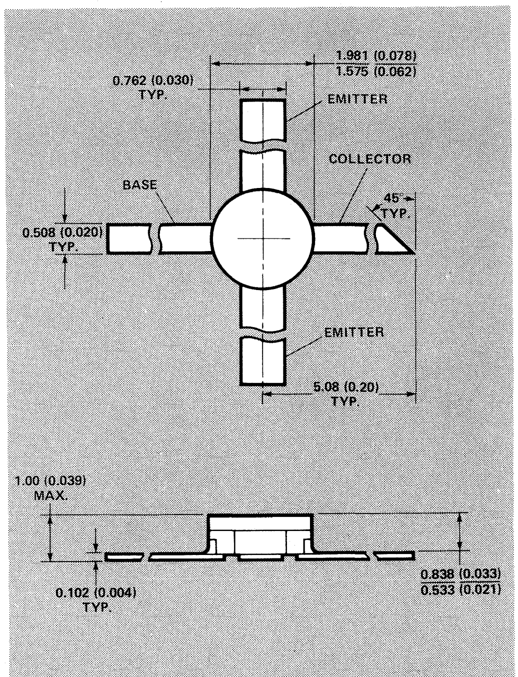
LOW NOISE FIGURE
2.8 dB Typical F_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
9.0 dB Typical G_a at 4 GHz

HERMETIC PACKAGE

Description

The 2N6617 (HXTR-6101) is an NPN bipolar transistor designed for minimum noise figure. The device utlizies ion implantation techniques in its manufacture and the chip is also provided with scratch protection over its active area. The device is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-70GT

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	300° C
$T_{STG(MAX)}$	Storage Temperature	-65° C to
—	Lead Temperature	200° C
	(Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 245° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C=100μA	3001.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=10V	3041.1	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=10V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=10V, I_C=4mA	3076.1*	–	50	150	250
F_{MIN}	Minimum Noise Figure f = 4 GHz 2 GHz	3246.1	dB		1.6 2.8	 3.0
G_a	Associated Gain f = 4 GHz 2 GHz Bias Conditions for Above: V_{CE} = 10V, I_C = 4mA		dB dB	8.0	9.0 13.5	

*300μs wide pulse measurement at ≤2% duty cycle.

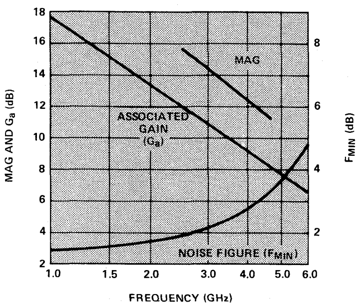


Figure 1. Typical MAG, F_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 4 mA.

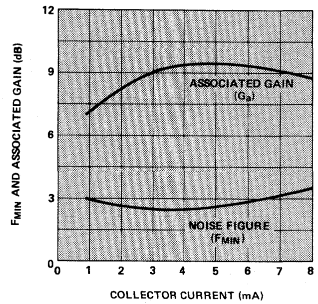


Figure 2. Typical F_{MIN} and Associated Gain vs. I_C at 4 GHz for V_{CE} = 10 V.

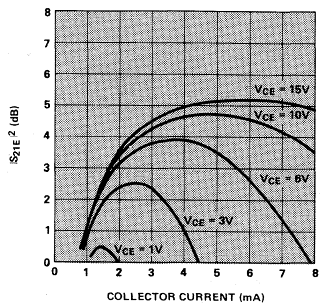


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters V_{CE} = 10V, I_C = 4mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} Mag.	S_{21} Ang.	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.91	-11	7.14	168	0.007	79	0.99	-4
500	0.78	-54	6.27	135	0.026	54	0.90	-18
1000	0.63	-98	5.03	113	0.037	33	0.78	-30
1500	0.59	-127	3.88	87	0.039	28	0.76	-35
2000	0.58	-149	3.14	71	0.042	26	0.75	-43
2500	0.57	-163	2.64	59	0.042	25	0.76	-50
3000	0.57	-173	2.20	48	0.043	25	0.77	-58
3500	0.56	180	1.94	37	0.046	25	0.79	-64
4000	0.54	173	1.66	29	0.049	24	0.81	-71
4500	0.53	167	1.45	20	0.053	24	0.85	-76
5000	0.51	160	1.34	11	0.058	23	0.86	-84
5500	0.50	152	1.21	1	0.060	22	0.88	-92
6000	0.48	146	1.07	-7	0.063	20	0.87	-99
7000	0.49	132	0.89	-23	0.069	15	0.87	-108

Typical Noise Parameters

V_{CE} = 10 V, I_C = 4 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	F_{MIN} (dB)
1000	.480/23°	23.31	1.45
1500	.450/61°	15.57	1.58
2000	.410/88°	15.73	1.72
3000	.425/121°	10.72	2.18
4000	.475/166°	3.50	2.75
5000	.530/-164°	2.81	3.67
6000	.520/-131°	7.23	4.78

Typical S-Parameters V_{CE} = 3V, I_C = 0.25mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang	
500	.988	-22	-6.9	.451	152	-28.2	.039	72	.993	-12	.220
1000	.956	-42	-7.2	.438	127	-23.1	.070	55	.975	-22	.464
1500	.929	-65	-7.5	.423	106	-20.6	.093	38	.956	-33	.586
2000	.910	-81	-7.7	.412	89	-19.7	.104	27	.945	-42	.679
3000	.888	-112	-8.1	.394	56	-19.3	.108	6	.938	-59	.821

V_{CE} = 3V, I_C = 0.50mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.976	-24	-0.8	.991	152	-28.4	.038	70	.986	-13	.220
1000	.929	-47	-1.3	.863	128	-23.6	.066	52	.955	-24	.423
1500	.887	-72	-2.0	.792	107	-21.4	.085	35	.920	-34	.583
2000	.856	-89	-2.5	.747	91	-20.6	.093	24	.906	-43	.682
3000	.818	-121	-3.3	.688	60	-20.1	.099	7	.889	-60	.816

V_{CE} = 3V, I_C = 1.0mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.952	-25	4.4	1.67	149	-28.6	.037	66	.972	-14	.328
1000	.884	-54	3.7	1.54	125	-24.3	.061	47	.919	-25	.492
1500	.821	-82	2.7	1.36	104	-23.1	.070	31	.873	-36	.664
2000	.775	-102	1.9	1.25	88	-22.6	.074	23	.854	-43	.793
3000	.738	-133	.77	1.09	59	-22.1	.079	10	.842	-59	.908

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6742 (HXTR-6102)

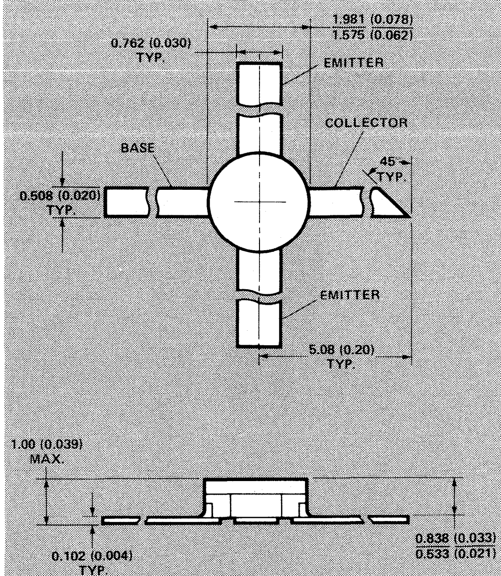
Bipolar Transistors

Features

LOW NOISE FIGURE
2.5 dB Typical F_{MIN} AT 4 GHz

HIGH ASSOCIATED GAIN
9.0 dB Typical G_a

HERMETIC PACKAGE



Outline HPAC-70GT

Description

The 2N6742 (HXTR-6102) is an NPN bipolar transistor designed for minimum noise figure. The device utilizes ion implantation techniques in its manufacture and the chip is also provided with scratch protection over its active area. The device is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

($T_{CASE} = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 245° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0×10^7 hours will be met or exceeded when the junction temperature is maintained under $T_J = 200°C$ (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C = 100\mu A$	3001.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 10V$	3041.1	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB} = 10V$	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10V$, $I_C = 4mA$	3076.1*	–	50	150	250
F_{MIN}	Minimum Noise Figure f = 4 GHz	3246.1	dB		2.8	3.0
	2 GHz		dB		1.6	
G_a	Associated Gain f = 4 GHz		dB	8.0	9.0	
	2 GHz		dB		13.5	
	Bias Conditions for Above: $V_{CE} = 10V$, $I_C = 4mA$					

*300μs wide pulse measurement at ≤2% duty cycle.

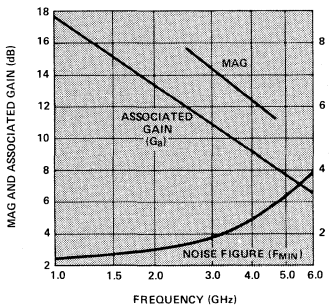


Figure 1. Typical MAG, F_{MIN} and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 4$ mA.

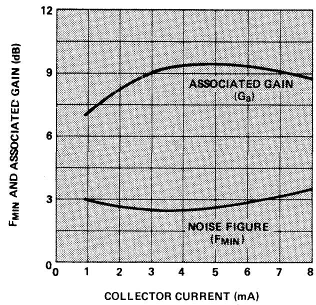


Figure 2. Typical F_{MIN} and Associated Gain vs. I_C at 4 GHz for $V_{CE} = 10$ V (Tuned for F_{MIN}).

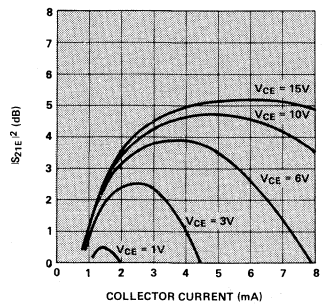


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters $V_{CE} = 10V$, $I_C = 4mA$

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} Mag.	S_{21} Ang.	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.917	-11	7.149	168	0.007	79	0.991	-4
500	0.782	-54	6.277	135	0.026	54	0.901	-18
1000	0.635	-98	5.037	113	0.037	33	0.787	-30
1500	0.598	-127	3.881	87	0.039	28	0.763	-35
2000	0.589	-149	3.148	71	0.042	26	0.754	-43
2500	0.570	-163	2.646	59	0.042	25	0.760	-50
3000	0.575	-173	2.209	48	0.043	25	0.773	-58
3500	0.560	180	1.948	37	0.046	25	0.795	-64
4000	0.548	173	1.665	29	0.049	24	0.816	-71
4500	0.530	167	1.450	20	0.053	24	0.850	-76
5000	0.518	160	1.346	11	0.058	23	0.860	-84
5500	0.500	152	1.210	1	0.060	22	0.880	-92
6000	0.489	146	1.076	-7	0.063	20	0.877	-99
7000	0.491	132	0.897	-23	0.069	15	0.872	-108

Typical Noise Parameters

V_{CE} = 10 V, I_C = 4 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	F_{MIN} (dB)
1000	.480/23°	23.31	1.45
1500	.450/61°	15.57	1.58
2000	.410/88°	15.73	1.72
3000	.425/121°	10.72	2.18
4000	.475/166°	3.50	2.75
5000	.530/-164°	2.81	3.67
6000	.520/-131°	7.23	4.78

Bipolar Transistors

Low Power Bias Performance

Bias		F_{MIN}	G_a	R_N	Γ_o	Γ_L
V_{CE} V	I_C mA	dB	dB	Ohms	Mag./Ang.	Mag./Ang.
3	0.25	2.25	8.5	60.5	.805/31°	.788/25°
3	0.50	1.87	12.7	25.5	.713/38°	.779/29°
3	1.00	1.55	15.7	13.9	.571/39°	.774/29°

Figure 4. Noise Parameters at 1 GHz.

BIAS		Frequency							
		1000 MHz		1500 MHz		2000 MHz		3000MHz	
V_{CE} V	I_C mA	F_{MIN} dB	G_a dB	F_{MIN} dB	G_a dB	F_{MIN} dB	G_a dB	F_{MIN} dB	G_a dB
3	0.25	2.25	8.5	2.67	5.0	2.83	4.7	3.88	4.1
3	0.50	1.87	12.7	2.06	9.9	2.23	7.9	2.93	6.4
3	1.0	1.55	15.7	1.73	11.7	1.79	10.2	2.38	8.1

Figure 5. Noise Performance vs. Frequency and Bias.

Typical S-Parameters V_{CE} = 3V, I_C = 0.25mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang	K
500	.988	-22	-6.9	.451	152	-28.2	.039	72	.993	-12	.220
1000	.956	-42	-7.2	.438	127	-23.1	.070	55	.975	-22	.464
1500	.929	-65	-7.5	.423	106	-20.6	.093	38	.956	-33	.586
2000	.910	-81	-7.7	.412	89	-19.7	.104	27	.945	-42	.679
3000	.888	-112	-8.1	.394	56	-19.3	.108	6	.938	-59	.821

V_{CE} = 3V, I_C = 0.50mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.	K
500	.976	-24	-0.8	.991	152	-28.4	.038	70	.986	-13	.220
1000	.929	-47	-1.3	.863	128	-23.6	.066	52	.955	-24	.423
1500	.887	-72	-2.0	.792	107	-21.4	.085	35	.920	-34	.583
2000	.856	-89	-2.5	.747	91	-20.6	.093	24	.906	-43	.682
3000	.818	-121	-3.3	.688	60	-20.1	.099	7	.889	-60	.816

V_{CE} = 3V, I_C = 1.0mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.	K
500	.952	-25	4.4	1.67	149	-28.6	.037	66	.972	-14	.328
1000	.884	-54	3.7	1.54	125	-24.3	.061	47	.919	-25	.492
1500	.821	-82	2.7	1.36	104	-23.1	.070	31	.873	-36	.664
2000	.775	-102	1.9	1.25	88	-22.6	.074	23	.854	-43	.793
3000	.738	-133	.77	1.09	59	-22.1	.079	10	.842	-59	.908

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6618 (HXTR-6103)

Features

GUARANTEED LOW NOISE FIGURE
2.2 dB Maximum F_{MIN} at 2 GHz

HIGH ASSOCIATED GAIN
12.0 dB Typical G_a at 2 GHz

HERMETIC PACKAGE

Description

The 2N6618 (HXTR-6103) is an NPN bipolar transistor designed for minimum noise figure at 2 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with scratch protection over its active area.

These devices are supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

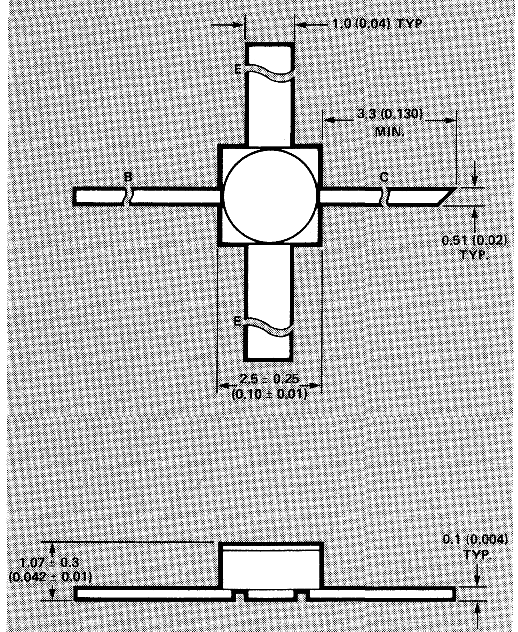
Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 245° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector Emitter Breakdown Voltage at $I_C = 100\mu A$	3011.1*	V	30		
I_{CEO}	Collector Emitter Leakage Current at $V_{CE} = 10V$	3041.1	nA			500
I_{CBO}	Collector Cut Off Current at $V_{CB} = 10V$	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE}=10V, I_C=3mA$	3076.1*	–	50	150	250
F_{MIN}	Minimum Noise Figure at 2 GHz	3246.1	dB		1.8	2.2
G_a	Associated Gain at 2 GHz		dB	11.0	12.0	
	Bias for above: $V_{CE} = 10V$, $I_C = 3$ mA					

*300 μs wide pulse measurement at ≤ 2% duty cycle.

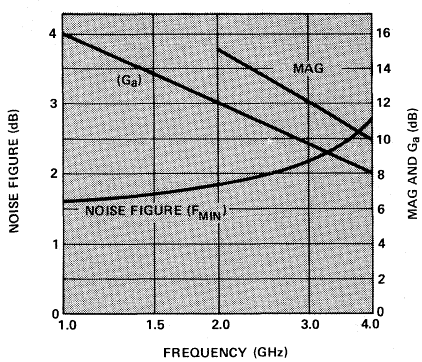


Figure 1. Typical MAG, F_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 3 mA.

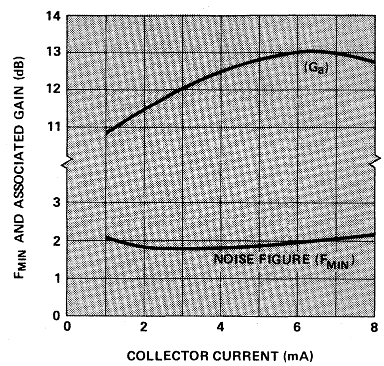


Figure 2. Typical F_{MIN} and Associated Gain vs. Collector Current at 2 GHz for V_{CE} = 10 V (Tuned for F_{MIN}).

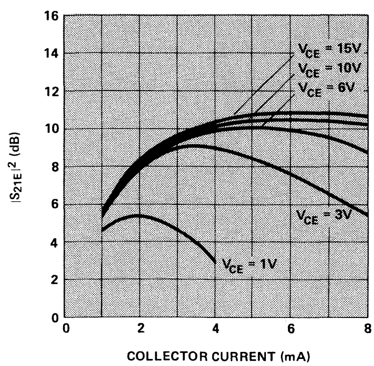


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 2 GHz.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 3 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	F_{MIN} (dB)
1000	.465/36°	25.1	1.55
1500	.369/67°	22.5	1.65
2000	.323/94°	23.3	1.80

Typical S- Parameters V_{CE} = 10V, I_C = 3 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.93	-11.5	16.2	6.46	168.0	-42.0	0.01	77.0	0.99	-4.0
200	0.89	-23.0	17.1	7.13	158.0	-37.0	0.01	77.0	0.97	-8.0
300	0.86	-34.0	16.4	6.58	149.0	-34.0	0.02	66.0	0.94	-12.0
400	0.83	-44.0	15.9	6.26	142.0	-32.0	0.03	60.0	0.92	-16.0
500	0.79	-54.0	15.6	6.02	135.0	-30.0	0.03	55.0	0.89	-19.0
600	0.75	-65.0	15.4	5.91	128.0	-29.0	0.04	51.0	0.87	-21.0
700	0.71	-73.0	15.0	5.62	121.0	-29.0	0.04	48.0	0.85	-24.0
800	0.68	-81.0	14.4	5.25	116.0	-28.0	0.04	45.0	0.84	-25.0
900	0.65	-91.0	14.0	4.99	111.0	-28.0	0.04	43.0	0.83	-27.0
1000	0.62	-97.0	13.5	4.72	106.0	-27.0	0.04	41.0	0.81	-28.0
1500	0.52	-129.0	11.4	3.71	84.0	-27.0	0.05	32.0	0.74	-35.0
2000	0.50	-151.0	9.3	2.93	69.0	-26.0	0.05	31.0	0.72	-43.0
2500	0.50	-169.0	7.8	2.45	55.0	-26.0	0.05	31.0	0.69	-51.0
3000	0.49	175.0	6.5	2.12	42.0	-26.0	0.06	33.0	0.68	-57.0
3500	0.54	165.0	5.4	1.87	29.0	-25.0	0.06	35.0	0.65	-68.0
4000	0.52	156.0	4.5	1.67	19.0	-24.0	0.06	37.0	0.68	-76.0
5000	0.53	140.0	2.6	1.35	-3.0	-23.0	0.08	35.0	0.71	-96.0
6000	0.48	120.0	0.9	1.11	-22.0	-21.0	0.09	34.0	0.73	-112.0

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6743 (HXTR-6104)

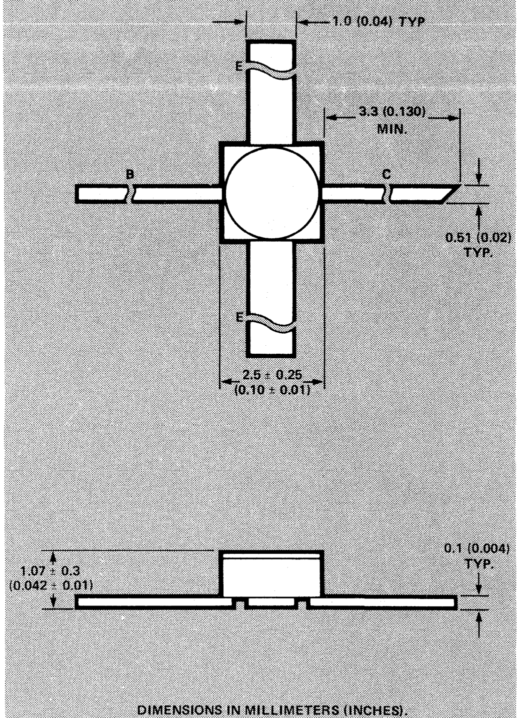
Bipolar Transistors

Features

GUARANTEED LOW NOISE FIGURE
1.6 dB Maximum F_{MIN} at 1.5 GHz

HIGH ASSOCIATED GAIN
14.0 dB Typical G_a at 1.5 GHz

HERMETIC PACKAGE



Outline HPAC-100

Description

The 2N6743 (HXTR-6104) is an NPN bipolar transistor designed for minimum noise figure at 1.5 GHz. The device utilizes ion implantation techniques and self alignment techniques in its manufacture. The chip is provided with scratch protection over its active area.

The 2N6743 (HXTR-6104) is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

Symbol	Parameter	Limit
V_{CBO}[1]	Collector to Base Voltage	35V
V_{CEO}[1]	Collector to Emitter Voltage	20V
V_{EBO}[1]	Emitter to Base Voltage	1.5V
I_C[1]	DC Collector Current	20 mA
P_T[1]	Total Device Dissipation	300 mW
T_J	Junction Temperature	300°C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 245°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200°C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector Emitter Breakdown Voltage at $I_C = 100\mu A$	3011.1*	V	30		
I_{CEO}	Collector Emitter Leakage Current at $V_{CE} = 10V$	3041.1	nA			500
I_{CBO}	Collector Cut Off Current at $V_{CB} = 10V$	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE}=10V, I_C=3mA$	3076.1*	—	50	150	250
F_{MIN}	Minimum Noise Figure f = 1.5 GHz	3246.1	dB		1.4	1.6
G_a	Associated Gain f = 1.5 GHz Bias for above: $V_{CE} = 10V$, $I_C = 3$ mA		dB	13.0	14.0	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

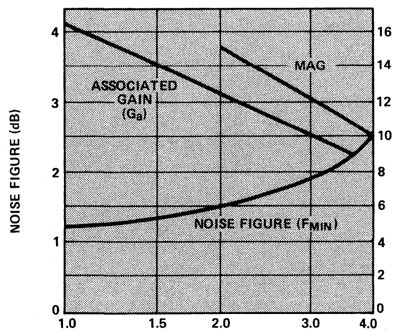


Figure 1. Typical MAG, F_{MIN} and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 3$ mA.

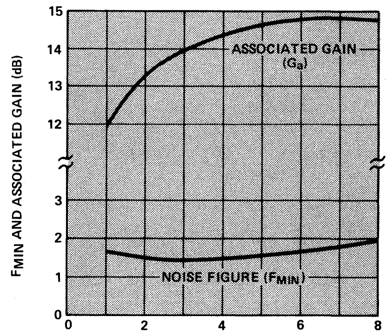


Figure 2. Typical Noise Figure and Associated Gain vs. I_C at 1.5 GHz for $V_{CE} = 10V$ (Tuned for F_{MIN}).

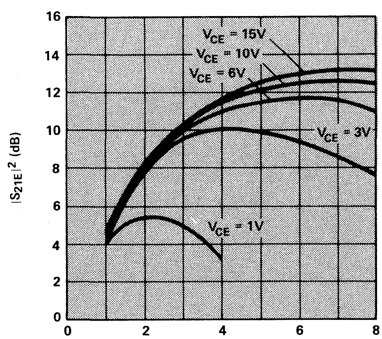


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 1.5 GHz.

Typical Noise Parameters

$V_{CE} = 10$ V, $I_C = 3$ mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	F_{MIN} (dB)
1000	.465/36°	25.09	1.20
1500	.369/67°	22.47	1.40
2000	.323/94°	23.31	1.50

Typical S-Parameters V_{CE} = 10V, I_C = 3 mA

	S11		S21			S12			S22	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.93	-11.5	16.2	6.46	168.0	-42.0	0.01	77.0	0.99	-4.0
200	0.89	-23.0	17.1	7.13	158.0	-37.0	0.01	77.0	0.97	-8.0
300	0.86	-34.0	16.4	6.58	149.0	-34.0	0.02	66.0	0.94	-12.0
400	0.83	-44.0	15.9	6.26	142.0	-32.0	0.03	60.0	0.92	-16.0
500	0.79	-54.0	15.6	6.02	135.0	-30.0	0.03	55.0	0.89	-19.0
600	0.75	-65.0	15.4	5.91	128.0	-29.0	0.04	51.0	0.87	-21.0
700	0.71	-73.0	15.0	5.62	121.0	-29.0	0.04	48.0	0.85	-24.0
800	0.68	-81.0	14.4	5.25	116.0	-28.0	0.04	45.0	0.84	-25.0
900	0.65	-91.0	14.0	4.99	111.0	-28.0	0.04	43.0	0.83	-27.0
1000	0.62	-97.0	13.5	4.72	106.0	-27.0	0.04	41.0	0.81	-28.0
1500	0.52	-129.0	11.4	3.71	84.0	-27.0	0.05	32.0	0.74	-35.0
2000	0.50	-151.0	9.3	2.93	69.0	-26.0	0.05	31.0	0.72	-43.0
2500	0.50	-169.0	7.8	2.45	55.0	-26.0	0.05	31.0	0.69	-51.0
3000	0.49	175.0	6.5	2.12	42.0	-26.0	0.06	33.0	0.68	-57.0
3500	0.54	165.0	5.4	1.87	29.0	-25.0	0.06	35.0	0.65	-68.0
4000	0.52	156.0	4.5	1.67	19.0	-24.0	0.06	37.0	0.68	-76.0
5000	0.53	140.0	2.6	1.35	-3.0	-23.0	0.08	35.0	0.71	-96.0
6000	0.48	120.0	0.9	1.11	-22.0	-21.0	0.09	34.0	0.73	-112.0

Bipolar Transistors

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

HXTR-6105

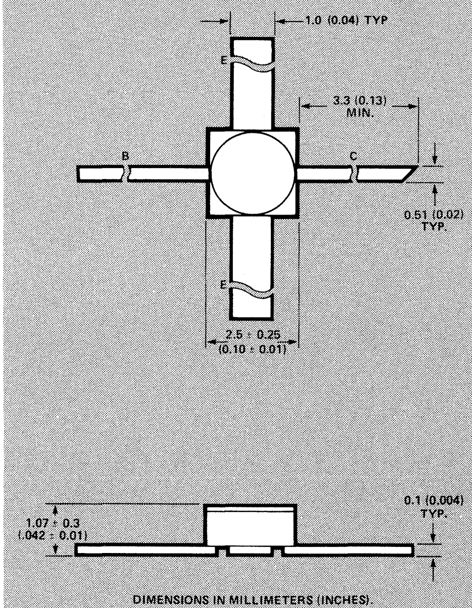
Features

LOW NOISE FIGURE
4.2 dB Maximum F_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
9 dB Typical G_a at 4 GHz

WIDE DYNAMIC RANGE

HERMETIC PACKAGE



Outline HPAC-100

Description

The HXTR-6105 is an NPN bipolar transistor designed for high gain up to 4 GHz with high output dynamic range. This transistor also features high output power and high gain at the NF bias and tuning conditions.

The device utilizes ion implantation techniques and self alignment techniques in its manufacture. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-6105 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 210° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA	3011.1 *	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V	3041.1	nA			500
I_{CBO}	Collector Cut Off Current at V_{CB} = 15V	3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=15V, I_C=15mA	3076.1*	–	50	120	220
F_{MIN}	Minimum Noise Figure f = 1.5 GHz = 4 GHz	3246.1	dB		2.2 3.8	 4.2
G_a	Associated Gain f = 1.5 GHz V_{CE} = 15V, I_C = 15mA = 4 GHz		dB	 8.0	15.0 9.0	
P_{1dB}	Power Output at 1dB Compression at 4 GHz V_{CE} = 15V, I_C = 15mA		dBm		14	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

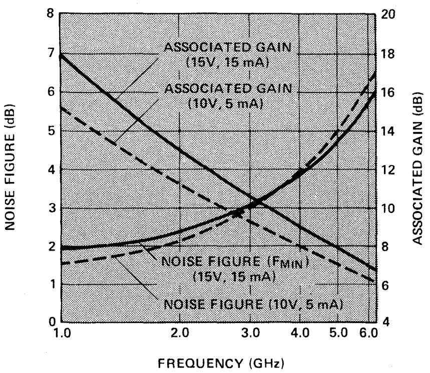


Figure 1. Typical F_{MIN} and Associated Gain vs. Frequency.

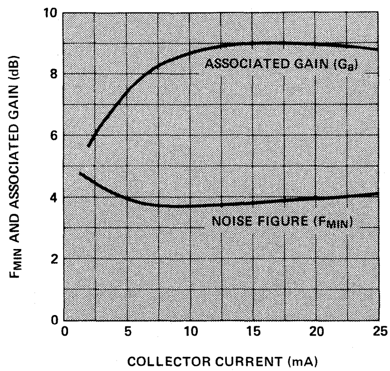


Figure 2. Typical F_{MIN} and Associated Gain vs. I_C at 4 GHz for V_{CE}=15V (Tuned for F_{MIN}).

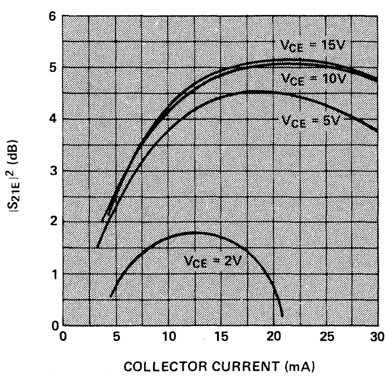


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 4 GHz.

Typical Noise Parameters

V_{CE} = 15 V, I_C = 15 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	F_{MIN} (dB)
1000	.238/123°	6.81	1.80
1500	.385/142°	5.33	2.15
2000	.429/173°	5.04	2.25
3000	.541/-158°	6.54	3.01
4000	.628/-135°	15.54	3.81
5000	.624/-107°	60.14	4.75

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.66	-52	29.0	28.3	152	-39.2	0.01	69	0.90	-16
500	0.59	-139	22.0	12.5	101	-37.7	0.03	41	0.55	-33
1000	0.59	-169	16.5	6.71	80	-29.6	0.03	45	0.47	-37
1500	0.59	177	13.1	4.54	65	-27.5	0.04	49	0.47	-41
2000	0.61	165	10.8	3.48	53	-25.5	0.05	50	0.47	-50
2500	0.60	159	8.8	2.75	43	-24.0	0.06	51	0.49	-61
3000	0.62	148	7.2	2.28	32	-22.7	0.07	52	0.50	-68
3500	0.62	141	5.7	1.93	21	-21.4	0.09	49	0.54	-80
4000	0.62	132	4.6	1.70	10	-20.0	0.10	47	0.57	-85
4500	0.60	126	3.5	1.50	0.0	-19.0	0.11	45	0.60	-94
5000	0.60	118	2.6	1.35	-9	-17.2	0.14	42	0.65	-102
5500	0.61	112	1.8	1.23	-20	-16.8	0.14	35	0.66	-112
6000	0.62	104	0.9	1.11	-29	-16.1	0.16	31	0.67	-122

HEWLETT PACKARD	GENERAL PURPOSE TRANSISTOR	HXTR-6106

Features

GUARANTEED LOW NOISE FIGURE
2.7 dB Maximum F_{MIN} at 2 GHz

HIGH ASSOCIATED GAIN
11.5 dB Typical G_a at 2 GHz

WIDE DYNAMIC RANGE

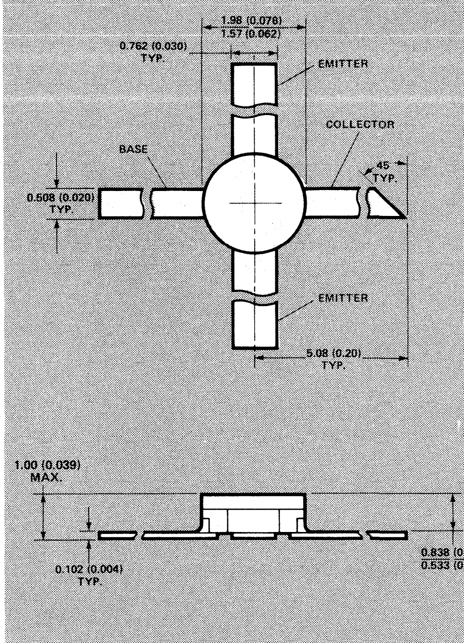
HERMETIC PACKAGE

Description

The HXTR-6106 is an NPN bipolar transistor designed for low noise up to 6 GHz with wide dynamic range. This transistor also features high output power and high gain at the NF bias and tuning conditions.

The device utilizes ion implantation and self alignment techniques in its manufacture and the chip is provided with a dielectric scratch protection over its active area.

The HXTR-6106 is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-70GT

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 185° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at $I_C = 100\mu A$		3011.1*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15V$		3041.1	nA			500
I_{CBO}	Collector Cutoff Current at $V_{CB} = 15V$		3036.1	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 15V$, $I_C = 15mA$		3076.1*	—	50	120	220
F_{MIN}	Minimum Noise Figure	f=2 GHz	3246.1	dB		2.5	2.7
		4 GHz				3.8	
G_a	Associated Gain	f=2 GHz			10.0	11.5	
	$V_{CE} = 15V$, $I_C = 10$ mA	4 GHz				9.0	
P_{1dB}	Associated Output Power at 1dB Gain Compression $V_{CE} = 15V$, $I_C = 10mA$	f=2 GHz		dBm		15	

*300μs wide pulse measurement ≤2% duty cycle.

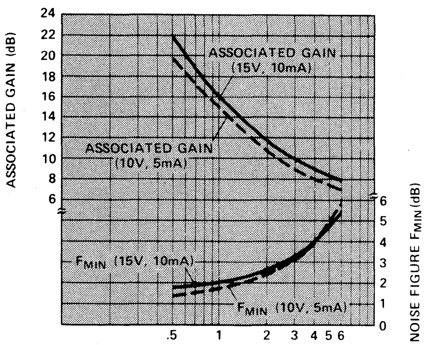


Figure 1. Typical Noise Figure (F_{MIN}) and Associated Gain vs. Frequency.

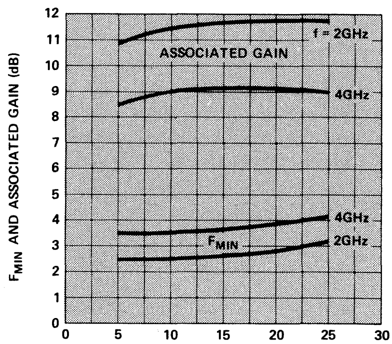


Figure 2. Typical Noise Figure (F_{MIN}) and Associated Gain vs. Current at 2 GHz and 4 GHz at $V_{CE} = 15V$.

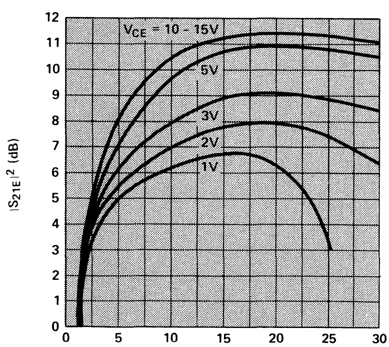


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical Noise Parameters

Freq. (GHz)	F_{min} (dB)	G_a (dB)	Γ_o	R_N (Ω)
1.0	1.8	14.3	.10/60	48.9
1.5	2.1	13.3	.27/132	19.1
2.0	2.4	11.6	.46/156	9.9
3.0	3.4	8.9	.53/167	8.4
4.0	4.3	6.9	.61/174	6.4

Figure 4. Typical Noise Parameters at $V_{CE} = 10V$, $I_C = 5mA$.

Typical S-Parameters V_{CE} = 15V, I_C = 10mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.77	-36	26.4	20.8	157	-38.4	0.012	67	0.93	-12
200	0.72	-70	25.6	19.0	139	-34.0	0.020	55	0.82	-21
300	0.70	-95	24.1	16.0	125	-32.0	0.025	46	0.71	-26
400	0.70	-113	22.7	13.6	115	-31.0	0.028	41	0.64	-29
500	0.69	-126	21.3	11.6	108	-30.5	0.030	37	0.59	-31
600	0.68	-136	20.1	10.1	102	-29.9	0.032	36	0.56	-33
700	0.67	-143	19.0	8.9	97	-29.6	0.033	35	0.54	-34
800	0.66	-149	18.0	7.9	93	-29.4	0.034	35	0.54	-35
900	0.66	-154	17.0	7.0	91	-29.1	0.035	34	0.53	-36
1000	0.66	-159	16.1	6.4	86	-28.9	0.036	35	0.53	-36
1500	0.68	-174	12.8	4.3	72	-27.0	0.040	36	0.48	-41
2000	0.66	177	10.5	3.3	61	-27.1	0.044	40	0.50	-51
2500	0.68	169	8.5	2.6	50	-26.2	0.049	42	0.50	-60
3000	0.67	163	7.0	2.2	39	-25.0	0.056	44	0.54	-67
3500	0.69	156	5.6	1.9	31	-24.1	0.062	46	0.54	-77
4000	0.68	152	4.5	1.7	21	-23.1	0.070	46	0.60	-85
4500	0.69	142	3.6	1.5	12	-22.2	0.078	47	0.60	-92
5000	0.71	138	2.5	1.3	4	-21.2	0.087	46	0.62	-102
5500	0.70	130	1.8	1.2	-5	-20.5	0.094	42	0.66	-111
6000	0.76	124	0.9	1.1	-13	-19.7	0.103	42	0.67	-120
6500	0.71	121	0.0	1.0	-23	-19.1	0.111	38	0.75	-129

HEWLETT PACKARD

LOW NOISE, HIGH PERFORMANCE TRANSISTOR

HXTR-7111

NEW

Features

GUARANTEED NOISE FIGURE
3.4 dB Maximum F_{MIN} at 4 GHz

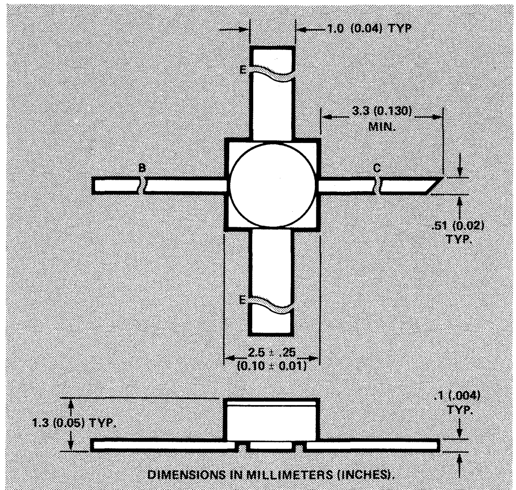
GUARANTEED ASSOCIATED GAIN
8.1 dB Minimum G_a AT 4 GHz

HIGH OUTPUT POWER
18.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
9.1 dB Typical G_{1dB} at 4 GHz

HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

HERMETIC PACKAGE



Outline HPAC-100

Description

The HXTR-7111 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The chip is provided with scratch protection over its active area.

The HXTR-7111 is supplied in the HPAC-100, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	300° C
T_{STG}	Storage Temperature	−65° C to 200° C
	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 170° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 200° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 108. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$		3001.1*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA		3011.1*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V		3036.1**	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V		3041.1	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA		3076.1		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA			GHz		6.0	
F_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA	 f = 1000 MHz f = 2000 MHz f = 4000 MHz	 3246.1	dB		 1.2 1.7 2.8	 3.4
G_a	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA	 f = 1000 MHz f = 2000 MHz f = 4000 MHz	 3246.1	dB	 8.1	 18.5 13.8 8.7	
P_{1dB}	Power Output at 1 dB Gain Compression at 4000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA,			dBm		18.5	
G_{1dB}	Associated 1 dB Compressed Gain at 4000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA			dB		9.1	
C_{12E}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA	f = 1 MHz		pF		0.27	

*300 μs wide pulse measurement ≤ 2% duty cycle. **Measured under low ambient light conditions.

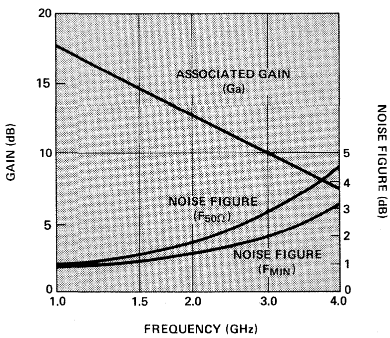


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 10 mA.

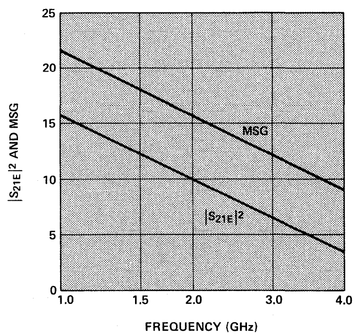


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at V_{CE} = 10 V and I_C = 10 mA.

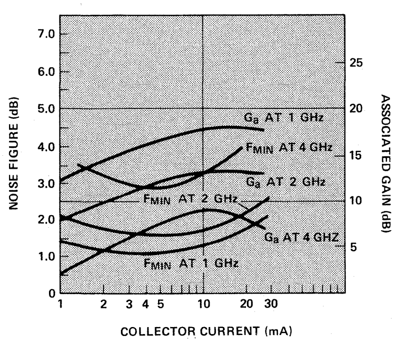


Figure 3. Typical F_{MIN} and Associated Gain (G_a) vs. Collector Current at V_{CE} = 10 V.

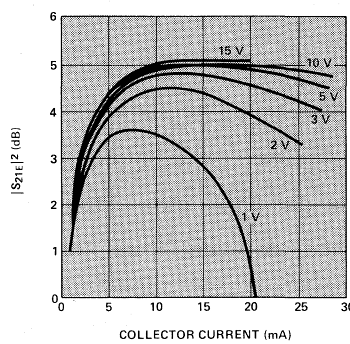


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 4000 MHz.

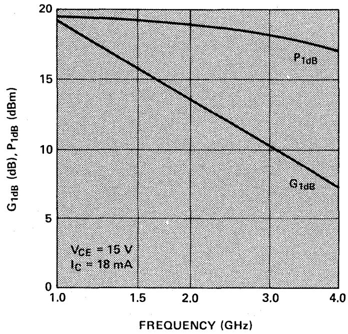


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	F_{MIN} (dB)	G_{MIN} (dB)	Γ_o Mag.	Γ_o Ang.	R_n (ohms)
1000	1.2	18.5	0.22	141	2.6
2000	1.7	13.8	0.43	174	3.3
4000	2.8	8.7	0.57	-138	11.6

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.68	-46	27.8	24.6	154	0.02	63	0.93	-15
200	0.64	-78	26.1	20.2	135	0.02	56	0.80	-26
300	0.65	-105	24.4	16.5	121	0.03	47	0.70	-32
400	0.63	-120	22.7	13.6	113	0.03	43	0.63	-34
500	0.62	-131	21.1	11.4	106	0.03	39	0.58	-35
600	0.61	-140	19.7	9.7	100	0.03	43	0.54	-36
700	0.61	-148	18.6	8.5	95	0.04	43	0.52	-36
800	0.60	-154	17.5	7.5	90	0.04	43	0.50	-37
900	0.61	-160	16.6	6.8	86	0.04	43	0.48	-40
1000	0.61	-164	15.7	6.1	83	0.04	43	0.47	-41
1500	0.61	-178	12.4	4.2	68	0.05	49	0.46	-50
2000	0.61	171	10.1	3.2	57	0.06	56	0.47	-57
2500	0.62	164	8.2	2.6	45	0.07	60	0.49	-68
3000	0.63	156	6.8	2.2	34	0.09	61	0.52	-75
3500	0.63	149	5.5	1.9	24	0.11	61	0.54	-85
4000	0.62	141	4.5	1.7	14	0.13	59	0.57	-93
4500	0.61	132	3.5	1.5	5	0.15	57	0.57	-102
5000	0.60	123	2.7	1.4	-4	0.18	53	0.62	-110
5500	0.61	112	2.0	1.3	-14	0.21	48	0.63	-118
6000	0.62	103	1.2	1.2	-22	0.23	43	0.67	-131
6500	0.62	93	0.5	1.1	-31	0.26	36	0.71	-140

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.63	-59	29.7	30.6	149	0.01	64	0.90	-18
200	0.61	-95	27.4	23.5	129	0.02	46	0.75	-26
300	0.62	-119	25.3	18.3	115	0.02	48	0.65	-30
400	0.62	-133	23.4	14.7	107	0.02	43	0.60	-31
500	0.61	-143	21.7	12.1	101	0.03	48	0.56	-31
600	0.60	-151	20.2	10.2	95	0.03	44	0.53	-32
700	0.60	-157	19.0	8.9	91	0.03	49	0.52	-32
800	0.60	-162	17.8	7.8	87	0.03	49	0.50	-32
900	0.60	-167	16.9	7.0	83	0.03	51	0.49	-35
1000	0.60	-170	16.0	6.3	81	0.03	51	0.48	-35
1500	0.61	177	12.7	4.3	67	0.04	60	0.48	-46
2000	0.61	168	10.4	3.3	55	0.06	65	0.50	-53
2500	0.62	161	8.3	2.6	44	0.07	67	0.52	-64
3000	0.63	153	6.9	2.2	33	0.09	68	0.54	-72
3500	0.63	147	5.6	1.9	23	0.11	66	0.56	-83
4000	0.62	139	4.6	1.7	13	0.13	64	0.60	-89
4500	0.62	130	3.5	1.5	4	0.15	60	0.60	-100
5000	0.60	121	2.9	1.4	-5	0.18	56	0.65	-106
5500	0.62	110	2.3	1.3	-16	0.21	52	0.65	-116
6000	0.63	102	1.6	1.2	-24	0.23	46	0.70	-128
6500	0.63	91	0.8	1.1	-33	0.26	40	0.74	-137

Reliability Data for Silicon Bipolar Transistors

HEWLETT PACKARD

RELIABILITY PERFORMANCE BIPOLAR TRANSISTORS

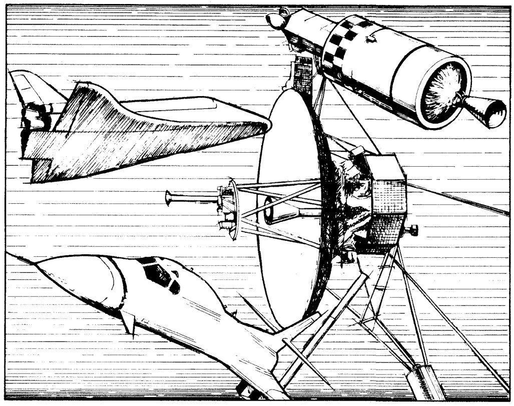
HXTR-2000
HXTR-3000
HXTR-5000
HXTR-6000
HXTR-7000
PRODUCT SERIES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability information for all families of devices.

These bipolar transistor products utilize a common manufacturing process, to include similar metallization systems, ion implantation, and self-alignment techniques, maintaining in this fashion a high degree of uniform quality and reliability.

The reliability performance of this bipolar transistor family is governed primarily by a thermally activated process. Hence, the junction temperature T_j of the device dictates the performance achieved under various applications.

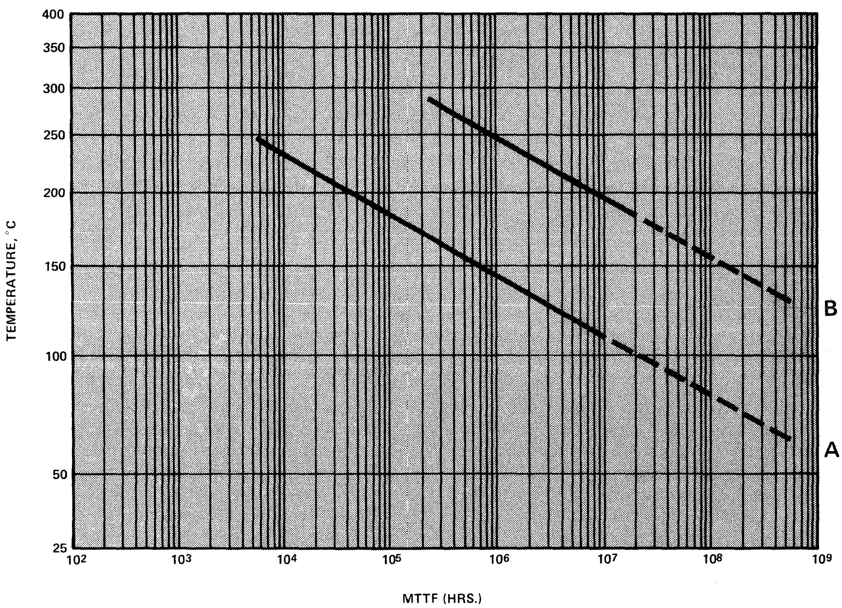


Applications

This information represents the capabilities of the generic device. Performance criteria and Mean Time To Failure (MTTF) values presented here are achieved with MIL-S-19500 level sampling.

Life and Environmental Test Performance

Life/Environment Stress	Test Method	Stress Condition	Minimum Stress Duration	Typical Performance Criteria, LTPD or λ
Operating Life	MIL-STD-750 Method 1026.3	$T_J/T_{CH} = 200°C$	1000 Hours	5
High Temperature Storage	MIL-STD-883 Method 1008	Test Condition D, $T_A = 200°C$	1000 Hours	7
HTRB	MIL-STD-750 Method 1038/1039	Test Condition A, $T_A = 200°C$	1000 Hours	7
Temperature Cycling	MIL-STD-883 Method 1010	Test Condition D, -65°C to 200°C	100 cycles	15
Thermal Shock	MIL-STD-883 Method 1011	Test Condition D, -65°C to 200°C	100 cycles	15
Solderability	MIL-STD-202 Method 208	T_{PbSn} @ 230°C	5 sec. dwell	15
Hermeticity	MIL-STD-883 Method 1014	KR-85/Dry N_2 Penetrant Dye	N/A	15
Moisture Resistance	MIL-STD-202 Method 106	65°C/98% R.H.	10 days	15
Vibration Variable Frequency	MIL-STD-750 Method 2056	100 to 2,000 Hz	4 Cycles @ Sweep Rate < 4 min.	15
Mechanical Shock	MIL-STD-883 Method 2002	Acceleration @ 1500G's	0.5 msec. Pulse Duration	15
Terminal Strength	MIL-STD-750 Method 2036.3	TBA (Package Related)	30 sec. duration	15



Mean Time to Failure (MTTF) vs. Junction Temperature

Curve	MTTF (Hours)	T_J	Activation Energy	Part Number
A	3.5×10^6	125° C	1.1 eV	HXTR-5000 series, HXTR-3002, -3102, and -3104.
B	1.0×10^7	200° C	1.1 eV	HXTR-3001, -3101, -3103, -3615, -3645, 3675, and -4101 HXTR-2000, -6000, and -7000 series

Notes:

1. To determine MTTF, calculate $T_j = P_T \times \Theta_{JC} + T_{CASE}$ and refer to the appropriate curve.
2. To determine the maximum bias conditions ($P_T \approx V_{CE} \times I_C$) to achieve a minimum MTTF, refer to the appropriate curve for $T_{j\ max}$ and calculate $P_{T\ max} = \frac{T_{J\ max} - T_{CASE}}{\Theta_{JC}}$. Do not exceed the absolute maximum P_T ratings specified for the transistor.

Bipolar Transistors

ABSTRACTS OF APPLICATION NOTES AND BULLETINS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins. Many of these publications have been presented in the appropriate catalog sections in condensed form. A complete list with brief abstracts is presented here.

Below is a brief summary of Application Notes and Bulletins for diodes and transistors. All of the Application Notes and Bulletins are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

Bipolar Applications

944-1 Microwave Transistor Bias Considerations

A practical discussion of the temperature dependent variables in a microwave transistor that cause RF performance degradation due to changes in quiescent point. Passive circuit networks that minimize quiescent point drift with temperature are analyzed, and the general equations for dc stability factors are given. Emphasis on practical circuit design is highlighted by typical circuit examples.

967 A Low Noise 4 GHz Amplifier Using the HXTR-6101 Silicon Bipolar Transistor

Describes in detail the design of a single-stage, state-of-the-art, low noise amplifier at 4 GHz using the HXTR-6101 silicon bipolar transistor. Both the input and output matching networks are described.

972 Two Telecommunications Power Amplifiers for 2 and 4 GHz Using the HXTR-5102 Silicon Bipolar Power Transistor

Describes in detail the design of two linear power amplifiers using the HXTR-5102. In each case, small signal S-parameters and power contours are used in the design.

974 Die Attach and Bonding Techniques for Diodes and Transistors

Several package and chip devices are available for use in hybrid circuits. This application note provides detailed instructions for attaching and bonding these devices.

975 A 4.3 GHz Oscillator Using the HXTR-4101 Bipolar Transistor

A general technique for transistor oscillator design is illustrated with the details of a 4.3 GHz bipolar oscillator. Small signal S-parameters are used for a preliminary non-oscillating circuit. Measurements of this circuit yield the information needed to complete the circuit design.

980 A Cost Effective Amplifier Design Approach at 425 MHz Using the HXTR-3101 Silicon Bipolar Transistor

The HXTR-3101, simplified matching networks, and off-the-shelf components are used in an amplifier design which achieves a gain of 13.5 dB at 425 MHz. Construction details include the circuit board layout and component placement.

981 The Design of a 900 MHz Oscillator with the HXTR-3102

This application note describes two useful techniques for determining the optimum load impedance for an oscillator. The device-line technique applies to an initial circuit, with a negative input resistance at the design frequency, that does not oscillate when loaded by a 50 ohm system, and the load-pull technique applies to an initial circuit that is already oscillating. These techniques are used to design a very efficient 900 MHz oscillator.

982 A 900 MHz Driver Amplifier Stage Using the HXTR-3102

A modified version of the "load-pull" technique is used in the design of a power driver amplifier stage at 900 MHz. The final output power is 21.5 dBm at 900 MHz. Design and construction details are provided.

AB 9 Derivation, Definition and Application of Noise Measure

The associated gain at optimum noise figure bias becomes an important parameter at microwave frequencies. The noise measure of a device is a term including both noise figure and associated gain.

AB 10 Transistor Noise Measurements

The increasing acceptance of GaAs field effect and silicon bipolar transistors in low noise pre-amp applications has stressed the importance of the techniques used in measuring noise figure. This application bulletin discusses the various techniques and possible sources of error in making a transistor noise figure measurement.

AB 13 Transistor Speed Up Using Schottky Diodes

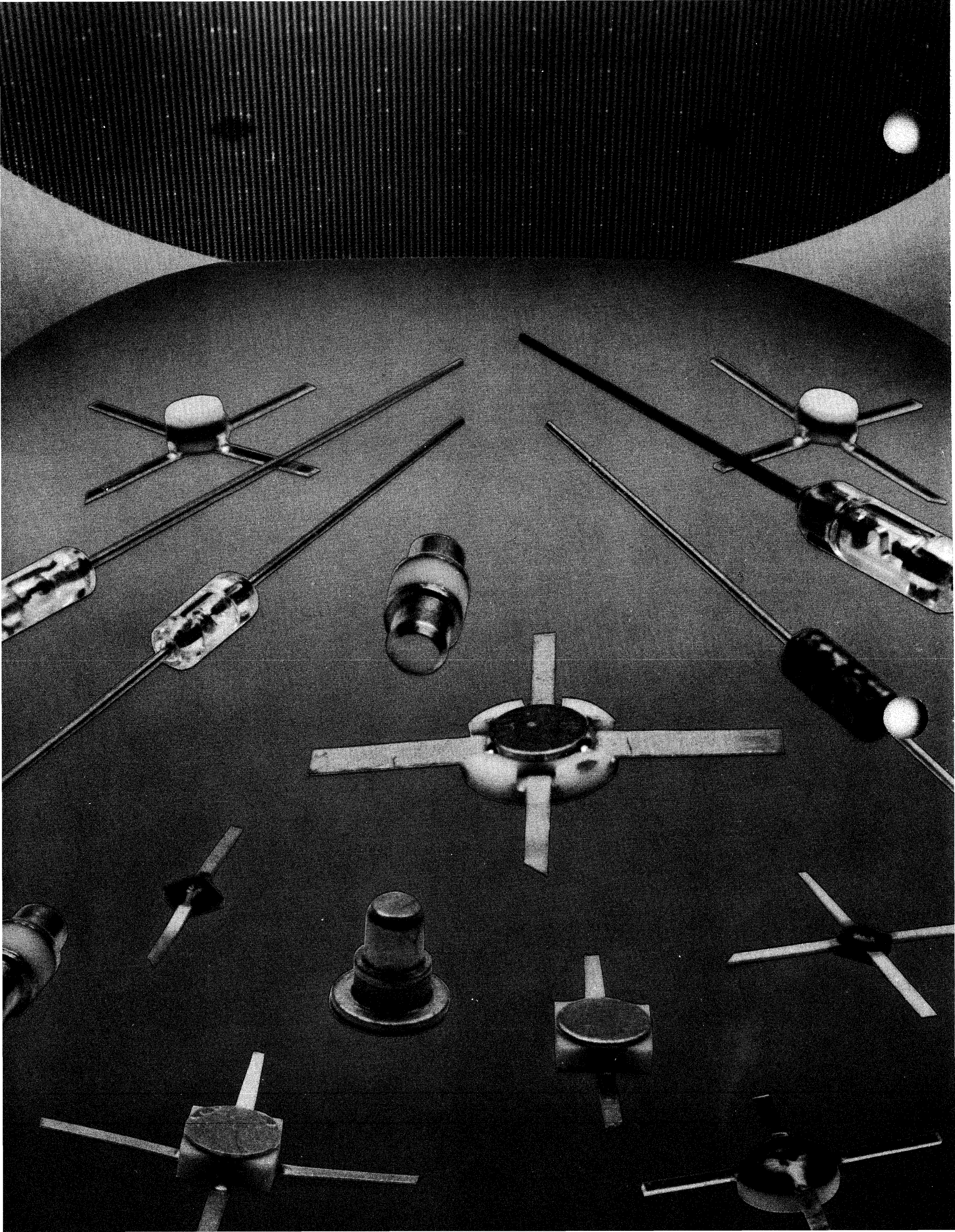
Significant reduction in transistor switching delay time can be activated by adding a Schottky diode and a PIN diode to the transistor switching circuit. This improvement in switching performance also extends the oscillator capability of the transistor to higher frequencies.

AB 17 Noise Parameters and Noise Circles for the HXTR-6101, -6102, -6103, -6104 and -6105 Low Noise Transistors

Noise figures as a function of source reflection coefficient (Γ_s) can be expressed using three parameters, F_{min}, R_n and Γ_o known as noise parameters. These parameters are presented for five microwave transistors. The method of generating noise circles is given in a step-by-step fashion.

AB 18 The Performance of the HXTR-6101 at Submilliampere Bias Levels

Describes the performance of a low noise microwave transistor at bias conditions of $V_{CE} = 3V$ and $I_C = 1.0$ mA, 0.5 mA, 0.25 mA and frequencies 1.0, 1.5, 2.0, and 3.0 GHz.



Schottky Barrier Diodes

CHARACTERISTICS OF SCHOTTKY BARRIER DIODES

A Schottky barrier diode contains a metal-semiconductor barrier formed by deposition of a metal layer on a semiconductor. The resulting non-linear diode is similar to point contact diodes and p-n junction diodes. The Schottky diode is more rugged than the point contact diode because the contact is not subject to change under vibration. The advantage over the p-n junction is the absence of minority carriers which limit the response speed in switching applications and the high frequency performance in mixing and detecting applications.

Types of Diode Construction

There are several assembly geometries used for Schottky barrier diodes. Three types used in this catalog are shown in Figure 1.

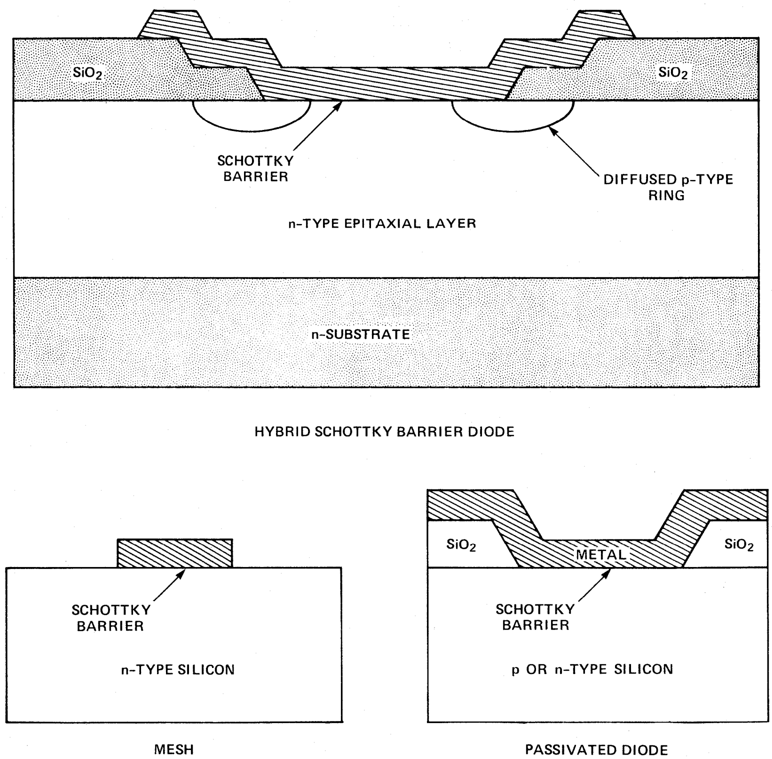


Figure 1. Three Types of Schottky Barrier Diodes

Mesh Diodes

Hewlett-Packard's patented mesh diode is made by depositing metal through a screen to the semiconductor surface. Many closely spaced diodes are created on the chip. The diode contacts are too small for thermocompression bonding. Contact is made by pressing a sharp metal point against one of the metal contacts on the diode. The large number of contacts on the chip provide a good yield to this operation. Although the mesh contacts are too small for thermocompression bonding, they are not small enough for operation at high microwave frequencies. It is not possible to deposit reliable contact areas small enough for operation at frequencies above 7 GHz; in fact, the highest test frequency is 3 GHz. These mesh devices have model numbers in the series 5082-2300, 2400, 2500 and 2900.

Passivated Diodes

The problem of creating small area contacts was solved by the development of the passivated diode process. An oxide layer is formed over the entire silicon area. Then photolithographic techniques are used to open a small hole in the oxide.

The appropriate metal is deposited in the hole to make the small area Schottky barrier. Then gold is deposited to provide a larger surface for the thermocompression bond in ceramic packaged diodes (outlines 44 or 49) or for the pressure contact in glass packaged diodes (outline 15). (Silver is used for the 5082-2835.) Passivated diodes include the 5082-2835, the 5082-2750 series, zero bias detectors, and all diodes in outlines 44 and 49. These devices are used at frequencies up to 40 GHz.

This passivation process is also used in our beam lead diodes. The final gold layer becomes the beam lead itself. Beam lead diodes contain a nitride layer on the oxide to provide immunity from contaminants that could otherwise lead to reverse current drift. There is also a platinum layer between the barrier metal and the gold. This layer permits reliable operation at higher temperatures. Breakdown voltage for passivated type beam lead diodes is 4 volts minimum at 10 microamps.

Beam lead single diodes are included in the HSCH-5300 series, pairs in the HSCH-5500 series, and quads in the 5082-9300 and 5082-9600 series. These beam lead diodes are also available in package outlines C2, C4, E1, H2, and H4.

Hybrid Diodes

The breakdown voltage limitation was solved with the invention of the hybrid process. Hewlett-Packard's patented process combines a Schottky diode with a p-n junction, eliminating the premature breakdown of the passivated diode without sacrificing the picosecond switching response of the Schottky barrier. Breakdown voltage specifications as high as 70 volts are available. Hybrid diodes are numbered from 5082-2800 to 2826 and also 5082-2836. The beam lead version is 5082-2837.

The dual nature of the hybrid diode limits the lowest capacitance to a picofarad. This limits the high frequency guaranteed performance of these diodes to 2 GHz.

Hybrid chips are assembled in an inexpensive glass package (outline 15) with a C-shaped spring contact. The presence of the spring limits the speed of assembly and therefore the cost. The double stud package (outline 12) eliminates the spring by contacting the chip directly between two leads. A new hybrid chip was developed to withstand the higher temperatures used in this automatic assembly process. These low cost diodes are called HSCH-1001 or 1N6263.

The Height of the Schottky Barrier

The current-voltage characteristic of Schottky barrier diodes at room temperature is described by the following equation:

$$I = I_S\left(\exp\left(\frac{V - IR_S}{0.026}\right) - 1\right)$$

For currents below 0.1 mA, the IR_S term may be neglected. On semi-log graph paper, as plotted in this catalog, the current graph will be a straight line with inverse slope 2.3 x 0.026 = 0.060 volts per cycle. All curves have the same slope, but not necessarily the same value of current for a given voltage. This is determined by the saturation current, I_S, and is related to the type of metal deposited on the silicon and to the treatment of the silicon surface layer. The term "barrier height" is related to the voltage required for a given current. Low voltage corresponds to low barrier.

Study of the forward characteristics in this catalog shows that the lowest barrier diode is the HSCH-3486 family of zero bias detectors. Detection at zero bias is possible for a range of barrier heights, but the voltage sensitivity is best for high barrier diodes. The sensitivity degrades for barrier heights less than that of the HSCH-3486. The other extreme is represented by medium barrier mixer diodes such as the 5082-2701. However, this barrier height corresponds to a zero bias junction resistance that requires a load resistance above 10 megohms. Zero bias detection with these diodes is limited to single frequency applications.

APPLICATIONS OF SCHOTTKY BARRIER DIODES

Schottky barrier diodes are useful in a wide variety of applications over a broad frequency range from digital to microwave.

General Purpose Diodes

The HSCH-1001 and similar diodes are useful for clipping, clamping, and speed up of transistor switching. These applications are discussed in Application Note 942, *Schottky Diodes for High Volume Low-Cost Applications,* and in several application bulletins described in the abstracts section of this catalog.

Mixers

The most sensitive receivers using Schottky barrier diodes make use of the nonlinear properties of the diode to produce a difference frequency by mixing the received signal with a local oscillator. Although this can be done with a single diode, it is more common to use multiple diodes in balanced or double balanced mixers. Balanced circuits reduce the effect of a noisy local oscillator and also reduce the level of high order mixing products that are not related to the desired input frequency. For multiple diode mixers, batch matched devices or matched pairs are available.

The most important property of mixer diodes is the noise figure — a measure of how small a signal can be received. The noise level for a perfect receiver is -114 dBm per MHz of bandwidth. A 6 dB noise figure mixer will degrade the noise level to -108 dBm per MHz. If the bandwidth of the receiver is 4 MHz the noise level is raised to -102 dBm. If a 10 dB signal to noise level is required for proper operation of the receiver, the sensitivity is -92 dBm. In this section of the catalog there are several groups of single diodes characterized for mixer applications. For stripline circuits the hermetic H-2, broadband C-2, and beam lead outlines are available. The best diodes are guaranteed to have a noise figure less than 6.0 dB at 9.375 GHz.

The other group of mixer diodes uses outline 15, glass package, for 2 and 3 GHz and outlines 44 and 49, ceramic packages, for 9.375 and 16 GHz. The best units have a 6 dB noise figure with the exception of the 16 GHz devices with a 6.5 dB prime unit.

Applications such as Doppler radar involving intermediate frequencies below 1 MHz will benefit by using the 5082-2400 or -2565 with its lower noise at these output frequencies. The additional noise (flicker noise) varies inversely with difference frequency and may differ as much as 20 dB from one diode type to another. Since the lowest capacitance (passivated) diodes (measured at 9.375 or 16 GHz) have the highest flicker noise, it is sometimes better to choose a Doppler mixer diode for lowest flicker noise rather than for lowest published noise figure.

Another type of mixer diode is the Schottky quad used for double balanced mixers. These quads are available in beam lead versions and in outlines E1, C4 and H4. These units contain a monolithic beam lead quad — four diodes connected in a ring configuration by gold deposited and plated on the wafer. Since the four diodes are made at the same time on the same portion of a wafer, they are nearly identical and ideally suited for double balanced mixers.

In most cases both medium and low barrier models are available. The low barrier units have an impedance closer to 50 ohms. These models give better performance in broad band untuned circuits, particularly in those applications with local oscillator power below normal.

Detector Applications

For system applications with relaxed requirements on sensitivity the video detector receiver is a good alternative to the superheterodyne receiver. The sensitivity is degraded about 50 dB, but the circuitry is simplified and broad bandwidth is easily attained without the problem of tracking the local oscillator frequency.

The important parameters are tangential signal sensitivity (TSS) and voltage sensitivity (γ). Both of these, as well as video resistance (Rv), are guaranteed for these detector diodes. Typical detector performance is shown for mixer diodes, but detector diodes are designed for superior performance for this application.

Tangential signal sensitivity measures the ability of the diode to distinguish a small signal from noise. The name relates to a type of radar display with the bottom of the signal pulse tangent to the top of the noise level. There are subjective aspects to this measurement so that TSS measurement is now made with a voltmeter. The value depends on diode noise as well as detection capability.

In some applications, the detector is used as a monitor and the measurement level is well above the noise. For these applications, voltage sensitivity, voltage output for one microwatt input, is the important parameter.

The third specification, video resistance (R_V), is important for video amplifier and response time considerations. The video amplifier resistance, R_L, should be large compared to R_V because the maximum output voltage is degraded by the factor

$$\frac{R_L}{R_L + R_V}$$

However, response time is proportional to the RC product. If fidelity to pulse shape is important, the presence of pulses with steep edges requires a smaller value of load resistance. Sensitivity must be sacrificed for fidelity.

Zero bias Schottky detector diodes are available in the glass package (outline 15) and ceramic packages (outlines 44 and 49). Two types of metal to semiconductor junctions are used, resulting in two distinct ranges of junction resistance (video resistance). Since voltage sensitivity varies with resistance, the high resistance diodes have better voltage sensitivity. However, high resistance means higher noise so the TSS specifications are better for the low resistance diodes. All tests are done at 10 GHz.

The other type of detector diode (5082-2824 and -2750 series) requires a small forward bias. Production tests are made with 20 microamperes of bias which reduces the video resistance to about 1300 ohms. At zero bias the resistance is higher than for either one of the zero bias detectors. Although the statement has been made that high resistance corresponds to good sensitivity, the resistance is so high for these models (40 megohms for the 2750 series) that the sensitivity is degraded by normal load resistances. These diodes can be used without bias if the load resistance is comparable to the diode resistance. This is discussed in AN988 — All Schottky Diodes are Zero Bias Detectors.

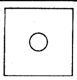
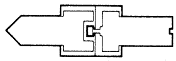
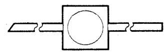
The 5082-2824 diode is tested at 2 GHz. The 2750 series is supplied in outlines 15, 44, and 49 and tested at 10 GHz. The 5082-2787 is similar to the 2755 in outline 15 with the parameters sample tested to reduce cost.

SCHOTTKY DIODE SELECTION GUIDE

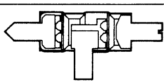
Schottky barrier diodes are useful in a wide variety of applications over a broad frequency range from digital to microwave. To assist you in choosing the appropriate Schottky diode for your application, a selection guide has been prepared. Schottky diodes have been classified as general purpose diodes, mixers, and detectors. Further assistance is provided by selection tables specifying package styles and operating frequency band. All Schottky diode package outlines are shown in the Package Outline Index, beginning on page 310.

TABLE I. GENERAL PURPOSE SCHOTTKY SELECTION GUIDE

TABLE II. LOW BARRIER SCHOTTKY DIODES FOR MIXERS

Frequency	 Chip 01	 Beam Lead 07	 Ceramic/Epoxy C2	 Hermetic H2	 Ceramic Pill 44
to 12 GHz	5082-0013	HSCH-5336 HSCH-5338	5082-2774 5082-2794	5082-2765 5082-2785	5082-2295 5082-2297
12—18 GHz	5082-0013	HSCH-5332 HSCH-5334	5082-2774		5082-2295
to 140 GHz		HSCH-5330			

Beam Lead Pairs for Balanced Mixers

Frequency	 Beam Lead 04
to 140 GHz	HSCH-5530 HSCH-5531

Beam Lead Quads for Double Balanced Mixers

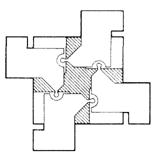
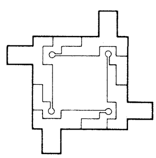
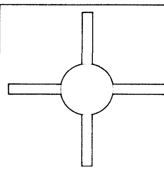
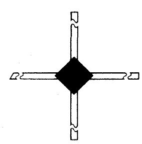
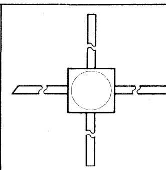
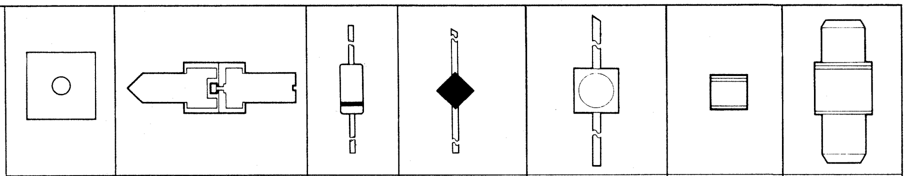
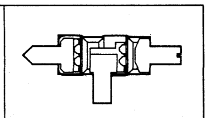
Frequency	 Beam Lead 03	 Beam Lead 08	 Low Cost E-1	 Broadband C4	 Hermetic H-4
to 2 GHz	5082-9697	5082-9697	5082-2831	5082-2271	5082-2231
2-4 GHz	5082-9697	5082-9697		5082-2271	5082-2231
4-8 GHz	5082-9395	5082-9395		5082-2272	5082-2233
8-12 GHz	5082-9397	5082-9397		5082-2279	
12-18 GHz	5082-9399	5082-9399		5082-2280	

TABLE III. MEDIUM BARRIER SCHOTTKY DIODES FOR MIXERS



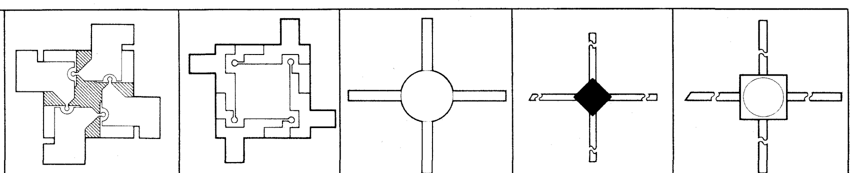
Frequency	Chip 01	Beam Lead 07	Glass Package 15	Ceramic/ Epoxy C2	Hermetic H2	Ceramic Pill 44	Double Stud 49
to 2 GHz	5082-0087	HSCH-5316	5082-2817 5082-2400 5082-2350	5082-2210	5082-2203	5082-2707	5082-2712
2-4 GHz	5082-0023	HSCH-5316	5082-2565 5082-2520	5082-2210	5082-2203	5082-2707	5082-2712
4-12 GHz	5082-0023	HSCH-5316 HSCH-5318		5082-2207 5082-2209	5082-2200 5082-2202	5082-2701 5082-2702	5082-2713 5082-2711
12-18 GHz	5082-0029	HSCH-5312 HSCH-5314		5082-2207		5082-2273	5082-2723
to 140 GHz		HSCH-5310					

Beam Lead Pairs for Balanced Mixers



Frequency	Beam Lead 04
to 140 GHz	HSCH-5510 HSCH-5511

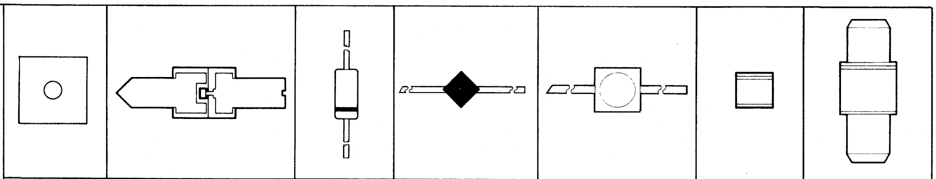
Beam Lead Quads for Double Balanced Mixers



Frequency	Beam Lead 03	Low Cost 08	Broadband E-1	Hermetic C4	H-4
to 2 GHz	5082-9696	5082-9696	5082-2830	5082-2291	5082-2263
2-4 GHz	5082-9696	5082-9696	5082-2277	5082-2291	5082-2263
4-8 GHz	5082-9394	5082-9394	5082-2277	5082-2292	5082-2263
8-12 GHz	5082-9396	5082-9396		5082-2294	
12-18 GHz	5082-9398	5082-9398		5082-2294	

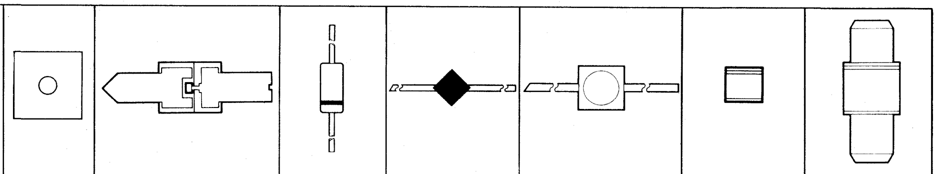
TABLE IV. DETECTOR SELECTION GUIDE

Bias Required



	Chip 01	Beam Lead 07	Glass Package 15	Ceramic/ Epoxy C2	Hermetic H2	Ceramic Pill 44	Double Stud 49
Detector Part Numbers	5082-0009	HSCH-5300 Series	5082-2824 5082-2755 5082-2787	5082-2207/09 5082-2774/94	5082-2200/03 5082-2765/85	5082-2750	5082-2751

Zero Bias



	Chip 01	Beam Lead 07	Glass Package 15	Ceramic/ Epoxy C2	Hermetic H2	Ceramic Pill 44	Double Stud 49
Detector Part Numbers	5082-0013	HSCH-5330 Series	HSCH-3486	5082-2774 5082-2794	5082-2765 5082-2785	HSCH-3207	HSCH-3206

SCHOTTKY BARRIER DIODE ALPHANUMERIC INDEX

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HSCH-0814	Hi Rel Schottky Barrier Diode (5082-2400)		176	203
HSCH-0815	Matched Pair HSCH-0816 (5082-2306)		176	203
HSCH-0816	Hi Rel Schottky Barrier Diode (5082-2301)		176	203
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HSCH-5310	Medium V_F Schottky Beam Lead	127		197, 199
HSCH-5311	Batch Matched HSCH-5310	127		197, 199
HSCH-5312	Medium V_F Schottky Beam Lead	127		197, 199
HSCH-5313	Batch Matched HSCH-5312	127		197, 199
HSCH-5314	Ku Band Medium V_F Schottky Beam Lead	127		197, 199
HSCH-5315	Batch Matched HSCH-5314	127		197, 199
HSCH-5316	Medium V_F Schottky Beam Lead	127		197, 199
HSCH-5317	Batch Matched HSCH-5316	127		197, 199
HSCH-5318	X-Band Medium V_F Schottky Beam Lead	127		197, 199
HSCH-5319	Batch Matched HSCH-5318	127		197, 199
HSCH-5330	Low V_F Schottky Beam Lead	127		197, 199
HSCH-5331	Batch Matched HSCH-5330	127		197, 199
HSCH-5332	Low V_F Schottky Beam Lead	127		197, 199
HSCH-5333	Batch Matched HSCH-5332	127		197, 199
HSCH-5334	Ku Band Low V_F Schottky Beam Lead	127		197, 199
HSCH-5335	Batch Matched HSCH-5334	127		197, 199
HSCH-5336	Low V_F Schottky Beam Lead	127		197, 199
HSCH-5337	Batch Matched HSCH-5336	127		197, 199
HSCH-5338	X-Band Low V_F Schottky Beam Lead	127		197, 199
HSCH-5339	Batch Matched HSCH-5338	127		197, 199
HSCH-5510	Ku Band Med V_F Schottky Beam Lead Pair	133		197, 199
HSCH-5511	Med V_F Schottky Beam Lead Pair	133		197, 199
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JANTXV 1N5711	MIL-S-19500/444 Schottky Diode		178	195
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TXVB-2810	Hi-Rel 5082-2810		186	195
TXVB-2811	Hi-Rel 5082-2811		186	195
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TXVW-5300 Series	Hi-Rel HSCH-5300 Beam Leads		172	197, 199
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5082-0029	Ku-Band Schottky Mixer Chip	125		205
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5082-0041	X-Band Schottky Mixer Chip	125		205
5082-0057	General Purpose Schottky Diode Chip	125		195
5082-0058	General Purpose Schottky Diode Chip	125		195
5082-0087	General Purpose Schottky Chip	125		195
5082-0094	General Purpose Schottky Diode Chip	125		195
5082-0097	General Purpose Schottky Chip	125		195
5082-2080	Batch Matched 5082-2835 Schottky	141		195
5082-2200	Hermetic Stripline Schottky Diode	146		197
5082-2201	Batch Matched 5082-2200	146		197
5082-2202	Hermetic Stripline Schottky Diode	146		197
5082-2203	Batch Matched 5082-2202	146		197
5082-2207	Stripline Schottky Diode	146		197
5082-2208	Batch Matched 5082-2207	146		197
5082-2209	Stripline Schottky Diode	146		197
5082-2210	Batch Matched 5082-2209	146		197
5082-2231	Low V_F Hermetic Stripline Schottky Quad	151		201
5082-2233	Low V_F Hermetic Stripline Schottky Quad	151		201
5082-2263	Hermetic Stripline Schottky Ring Quad	151		201
5082-2271	Low V_F Stripline Schottky Diode Quad	151		201
5082-2272	Low V_F Stripline Schottky Diode Quad	151		201
5082-2273	Ku-Band Schottky Mixer Diode	154		205
5082-2274	Matched pair of 5082-2273	154		205
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5082-2279	Low V_F Broadband Stripline Schottky Quad	151		201
5082-2280	Low V_F Broadband Stripline Schottky Quad	151		201
5082-2291	Stripline Schottky Ring Quad	151		201
5082-2292	Stripline Schottky Ring Quad	151		201
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Part No.	Description	Page Number		
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5082-2712	Matched pair of 5082-2711	154		205
5082-2713	X-Band Schottky Mixer Diode	154		205
5082-2714	Matched pair of 5082-2713	154		205
5082-2723	Ku-Band Schottky Mixer Diode	154		205
5082-2724	Matched pair of 5082-2723	154		205
5082-2750	Schottky Detector Diode	165		207
5082-2751	Schottky Detector Diode	165		207
5082-2755	Schottky Detector Diode	165		203
5082-2765	Low V_F Hermetic Stripline Schottky	146		197
5082-2766	Batch Matched 5082-2765	146		197
5082-2774	Low V_F Stripline Schottky Diode	146		197
5082-2775	Batch Matched 5082-2774	146		197
5082-2785	Low V_F Hermetic Stripline Schottky	146		197
5082-2786	Batch Matched 5082-2785	146		197
5082-2787	Schottky Detector Diode	165		203
5082-2794	Low V_F Stripline Schottky Diode	146		197
5082-2795	Batch Matched 5082-2794	146		197
5082-2800	H V General Purpose Schottky Barrier Diode (1N5711)	141		195
5082-2804	Matched Pair of 5082-2800 Unconnected	141		195
5082-2805	Matched Quad 5082-2800 Unconnected	141		195
5082-2810	General Purpose Schottky Diode (1N5712)	141	186	195
5082-2811	General Purpose Schottky Diode	141	186	195
5082-2813	Matched Bridge Quad 5082-2811 Encapsulated	141		195

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
5082-2814	Matched Ring Quad 5082-2811 Encapsulated	141		195
5082-2815	Matched Quad 5082-2811 Unconnected	141		195
5082-2817	Schottky Barrier Diode	154		195
5082-2818	Matched Pair of 5082-2817	154		195
5082-2824	Schottky Barrier Diode	165		195
5082-2826	Batch Matched Diode 5082-2811	141		195
5082-2830	Monolithic Matched Schottky Diode Ring Quad	151		201
5082-2831	Low V_F Monolithic Matched Schottky Quad 5082-9697	151		201
5082-2835	Low Offset Schottky Diode	141	189	195
5082-2836	Batch Matched Diode 5082-2800	141		195
5082-2837	Schottky Diode Beam Lead	131		197, 199
5082-2900	Schottky Barrier Diode	141		203
5082-2912	Matched pair of 5082-2900 Unconnected	141		203
5082-2970	Matched Quad 5082-2900 Unconnected	141		203
5082-2997	Matched Bridge Quad 5082-2900 Encapsulated	141		203
5082-9394	Beam Lead Quad	137		201
5082-9395	Beam Lead Quad	137		201
5082-9396	Beam Lead Quad	137		201
5082-9397	Beam Lead Quad	137		201
5082-9398	Beam Lead Quad	137		201
5082-9399	Beam Lead Quad	137		201
5082-9696	Beam Lead Quad	137		201
5082-9697	Beam Lead Quad	137		201
5082-9891	X-Band Schottky Detector Chip	125		207

HEWLETT PACKARD

SCHOTTKY BARRIER CHIPS FOR HYBRID INTEGRATED CIRCUITS

5082-0009 5082-0013 5082-0023 5082-0024 5082-0029 5082-0031 5082-0041
5082-0057 5082-0058 5082-0087 5082-0094 5082-0097 5082-9891

Features

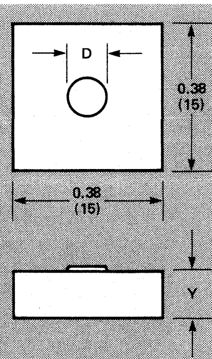
IDEAL FOR HYBRID INTEGRATED CIRCUITS

PLANAR PASSIVATED CONSTRUCTION

UNIFORM ELECTRICAL CHARACTERISTICS

AVAILABLE IN MANY ELECTRICAL SELECTIONS

HIGH REL LOT QUALIFICATION TESTING AVAILABLE



Outline 01
Chip Dimensions

Description

These Schottky chips are designed for hybrid applications at DC through K-band frequencies. The passivated planar construction of these Schottky chips provides a wide temperature range capability combined with broad bandwidth performance.

	HP Part Number 5082-				
Dimension	**0024, 0094**	**0057, 0058 0087, 0097**	**0031**	**0013, 0023, 0029**	**0009**
D	0.10 (4)	0.08 (3)	0.06 (2.5)	0.02 (0.80)	
Y	0.13 (5)			0.10 (4)	
Top Contact	Au, Anode	Au, Anode	Au, Anode	Au, Anode	Au, Cathode
Bottom Contact	Au, Cathode	Au, Cathode	Au, Cathode	Au, Cathode	Au, Anode

Dimensions Tolerance ±0.03 (1)
in Millimeters and (1/1000 inch)

Maximum Ratings

Junction Operating and Storage Temperature
5082-0024, -0057, -0058,
-0087, -0094, -0097 .... –65° C to +200° C
5082-0009, -0013, -0023, -0029,
-0031, -0041, -9891 .... –65° C to +150° C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Applications

A wide variety of chips are provided which are optimized for various applications. Typical applications of Schottky chips are mixing, detecting, switching, gating, sampling and wave shaping.

Electrical Specifications at 25° C

SCHOTTKY BARRIER CHIPS FOR GENERAL PURPOSE APPLICATIONS

Part Number 5082-		Nearest Equivalent Packaged Part No. 5082-	Nearest Equivalent Beam Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Minimum Forward Current I_F (mA)	Maximum Junction Capacitance C_{jo} (pF)
Chip for Epoxy or Solder Die Attach	Chip for Eutectic Die Attach					
0024	0094	2800	2837	70	15	1.7
0087	0057	2810		20	35	1.0
0097	0058	2811		15	20	1.1
0031		2835		8[1]	10[1]	0.8
Test Conditions				I_R = 10 μA [1]I_R = 100 μA	V_F = 1 V [1]V_F = 0.45 V	V_R = 0 V f = 1 MHz

SCHOTTKY BARRIER CHIPS FOR MIXING AND DETECTING

Part Number 5082-		Nearest Equivalent Packaged Part No. 5082-	Nearest Equivalent Beam Lead Part No. HSCH-	Maximum Junction Capacitance C_{jo} (pF)	Typical Parameters	
Chip	9 Contact Chip				Noise Figure NF (dB)[1]	Tangential Sensitivity T_{SS} (dBm)
0023	0041	2713	5316	0.18	6.0	−54
0029		2721	5312	0.13	6.0 7.0**	−54
0013		HSCH-3206* 2295	5332	0.13	6.0	−42† −54
0009	9891	2750		0.10	7.0	−55
Test Conditions		*Zero Bias		V_R = 0 V f = 1 MHz	f = 9.375 GHz **f = 16 GHz	f = 10 GHz BW = 2 MHz I_{BIAS} = 20 μA †Zero Bias

Note 1: NF includes 1.5 dB for the IF amplifier.

Assembly and Handling Procedures for Schottky Chips

1. Cleaning

To remove surface contamination, electronic grade solvents such as freon (T.F. or T.M.C.) trichloroethane, acetone, de-ionized water, and methanol used singularly or in combinations are recommended. Typical cleaning times per solvent are one to three minutes. DI water and methanol should be used (in that order) in the final cleans. Final drying can be accomplished by placing the cleaned dice on clean filter paper and drying with an infrared lamp, for 5-10 minutes. Acids such as hydrofluoric (HF), nitric (HNC) and hydrochloric (HCL) should not be used.

The effects of cleaning methods/solution, should be verified on small samples prior to submitting the entire lot.

Following cleaning, dice should be either used in assembly (typically within a few hours), or stored in clean containers in a reducing (O_2 — N_2) atmosphere or a vacuum chamber.

2. Die Attach

Eutectic — Eutectic die attaching can be accomplished in one of two ways — either by 1.) "scrubbing" the die without a preform and using the gold on the header to combine with the silicon and or the non-alloyed gold-plating on the back of the die to form the eutectic, or 2.) by utilizing a gold-tin eutectic composition preform and "scrubbing" the chip. Typical stage temperatures of 310° C ± 10° C, and heating times of 5-10 seconds are recommended. (Note — times and temperatures utilized may vary depending on the type, composition, and heat capacity of the header or substrate used as well as the metallization systems present.)

Preforms with melting points requiring high stage temperatures (exceeding 325° C) and/or longer times (exceeding 30 seconds) are not recommended.

Epoxy/Solder —

a. For epoxy die-attach, conductive silver or gold-filled epoxies are suggested.

b. For solder die-attach, lead (Pb) — tin (Sn) composition solders are recommended. [Silver (Ag), antimony (Sb), indium (In) and other elements may be present in the base solder]. The preform melting point should be less than 300° C,

The die-attach system (i.e. — furnace, die-attach stage, etc.) should insure that 1.) the preform melting point should not be exceeded by more than 75° C and 2.) a reducing or inert atmosphere is present.

For further reference on die-attach techniques, see Application Note 974 "Die Attach and Bonding Techniques".

3. Wire Bonding

Thermocompression is the recommended bonding method for Hewlett-Packard Schottky chips. Suggested wire is pure gold mesh (333 lines per inch, 1 mil thick) or 0.7 mil wire. Other bonding techniques such as ultrasonic and thermosonic are not recommended. For additional reference material, refer to Application Note 974 "Die Attach and Bonding Techniques".

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODES FOR MIXERS AND DETECTORS (1-18 GHz)

HSCH-5300 SERIES

Features

PLATINUM TRI-METAL SYSTEM
High Temperature Performance

NITRIDE PASSIVATION
Stable, Reliable Performance

LOW NOISE FIGURE
7 dB Typical at 16 GHz

HIGH UNIFORMITY
Tightly Controlled Process Insures Uniform RF Characteristics

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

Description

These beam lead diodes are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

The HP beam lead process allows for large beam anchor pads for rugged construction (typical 6 gram pull strength) without degrading capacitance.

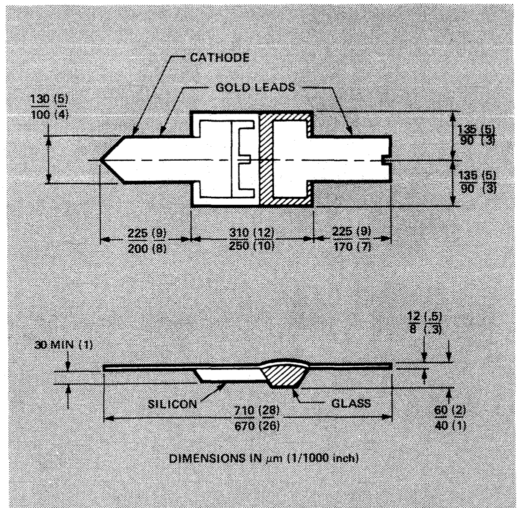
Maximum Ratings

Pulse Power Incident at $T_A = 25°C$ .... 1 W
Pulse Width = 1 μs, Du = 0.001
CW Power Dissipation at $T_A = 25°C$ .... 300 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.

T_{OPR} — Operating Temperature
Range .... −65° C to +175° C
T_{STG} — Storage Temperature
Range .... −65° C to +200° C
Minimum Lead Strength .... 4 grams pull on either lead
Diode Mounting
Temperature .... +350° C for 10 sec. max.

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10⁷ hours.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Outline 07

Applications

The beam lead diode is ideally suited for use in stripline or microstrip circuits. Its small physical size and uniform dimensions give it low parasitics and repeatable RF characteristics through K-band.

The basic medium barrier devices in this family are DC tested HSCH-5310, -5312, and -5316. Batch matched versions are available as the HSCH-5311, -5313, and -5317. Equivalent low barrier devices are HSCH-5330, -5332 and -5336. Batch matched versions are available as HSCH-5331, -5333, and -5337.

For applications requiring guaranteed RF performance, the HSCH-5318 is selected for 6.2 dB maximum noise figure at 9.375 GHz, with RF batch match units available as the HSCH-5319. The HSCH-5314 is rated at 7.2 dB maximum noise figure at 16 GHz with RF batch match units available as the HSCH-5315.

For low-barrier RF performance, the HSCH-5338 and -5334 are selected for noise figure 6.2 dB maximum at 9.375 and 7.2 dB maximum at 16 GHz respectively. Batch matched versions are available as the HSCH-5339 and -5335.

Bonding and Handling Procedures

See page 140.

Electrical Specifications for RF tested Diodes at $T_A = 25°C$

Part Number HSCH-	Batch* Matched HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Forward Voltage V_F (mV)
5318	5319	Medium	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	500
5314	5315		7.2 at 16 GHz					18	0.15	
5338	5339	Low	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	375
5334	5335		7.2 at 16 GHz					18	0.15	
Test Conditions	ΔNF≤0.3dB ΔZ$_{IF}$≤25Ω		DC Load Resistance = 0Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				I_R ≤ 10 μA	I_F = 5 mA	V_R = 0V f = 1 MHz	I_F = 1 mA

*Minimum batch size 20 units.

Electrical Specifications for DC tested Diodes at $T_A = 25°C$

Part Number HSCH-	Batch* Matched HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Forward Voltage V_F (mV)
5316	5317	Medium	4	12	0.25	500
5312	5313			18	0.15	
5310	5311			25	0.10	
5336	5337	Low	4	12	0.25	375
5332	5333			18	0.15	
5330	5331			25	0.10	
Test Conditions	ΔV_F ≤ 15 mV @ 5 mA		I_R = 10 μA	I_F = 5 mA	V_R = 0V f = 1 MHz	I_F = 1 mA

*Minimum batch size 20 units.

Typical Detector Characteristics at $T_A = 25°C$

MEDIUM AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-54	dBm	20μA Bias
Voltage Sensitivity	γ	6.6	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1400	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-44	dBm	Zero Bias
Voltage Sensitivity	γ	10	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1.8	MΩ	f = 10 GHz

Typical Parameters

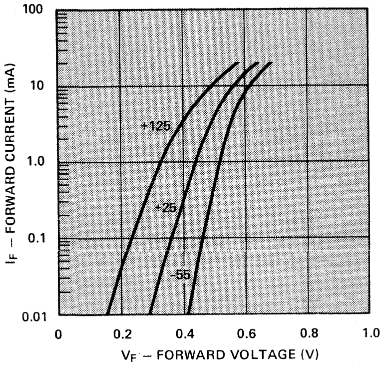


Figure 1. Typical Forward Characteristics, for Medium Barrier Beam Lead Diodes. HSCH-5310 Series.

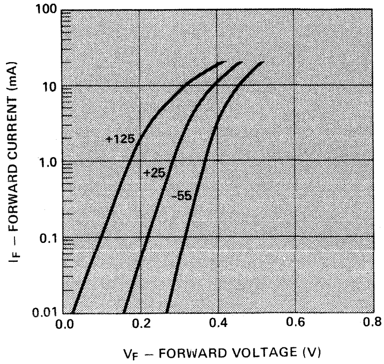


Figure 2. Typical Forward Characteristics, for Low Barrier Beam Lead Diodes. HSCH-5330 Series.

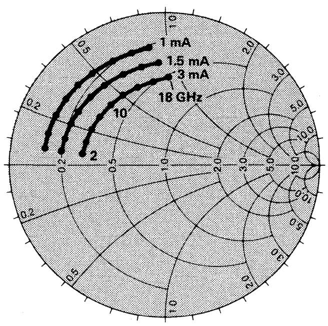


Figure 3. Typical Admittance Characteristics, with Self Bias. HSCH-5314, -5315, -5334, and -5335.

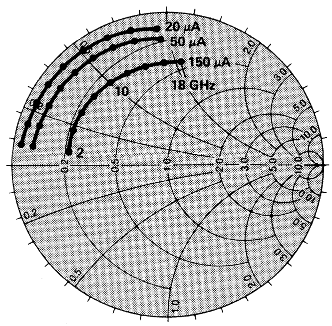


Figure 4. Typical Admittance Characteristics, with External Bias. HSCH-5314, -5315, -5334, and -5335.

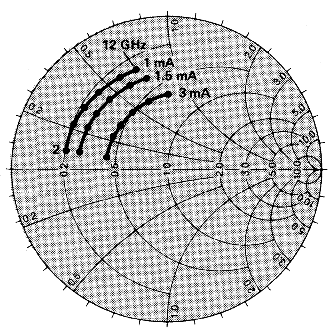


Figure 5. Typical Admittance Characteristics, with Self Bias. HSCH-5318, -5319, -5338 and -5339.

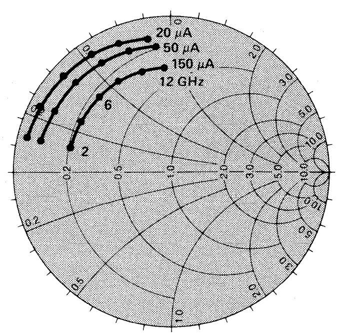


Figure 6. Typical Admittance Characteristics, with External Bias. HSCH-5318, -5319, -5338 and -5339.

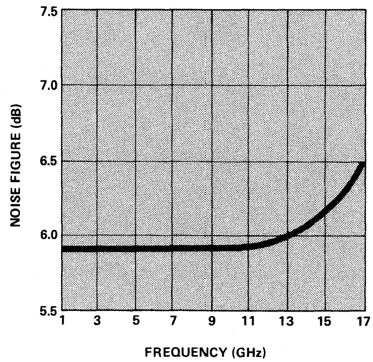
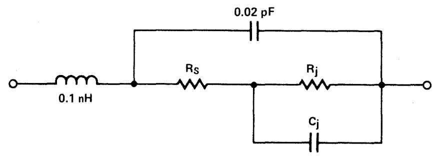


Figure 7. Typical Noise Figure vs. Frequency.

MODELS FOR BEAM LEAD SCHOTTKY DIODES



SELF BIAS

Part Numbers	1.0 mA Self Bias			1.5 mA Self Bias			3.0 mA Self Bias		
	R_S	R_j	C_j	R_S	R_j	C_j	R_S	R_j	C_j
HSCH-5314, -5315, -5334, -5335	5.0	393	0.11	5.2	232	0.11	5.0	150	0.12
HSCH-5318, -5319, -5338, -5339	5.1	244	0.16	5.0	178	0.16	5.0	109	0.19

EXTERNAL BIAS

Part Numbers	20 μADC Bias			50 μADC Bias			150 μADC Bias		
	R_S	R_j	C_j	R_S	R_j	C_j	R_S	R_j	C_j
HSCH-5314, -5315, -5334, -5335	2.8	1240	0.11	4.7	618	0.12	2.7	211	0.13
HSCH-5318, -5319, -5338, -5339	5.1	2050	0.18	3.9	665	0.19	4.7	242	0.20

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE

5082-2837

Features

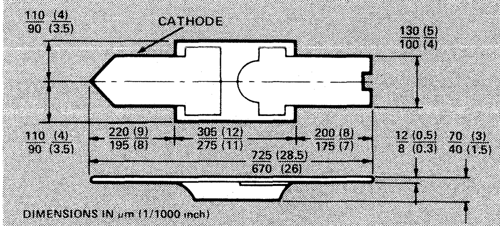
FAST SWITCHING

HIGH BREAKDOWN

BEAM LEAD EQUIVALENT OF 5082-2800

PLATINUM TRI-METAL SYSTEM

WIDE TEMPERATURE RANGE



Outline 10

Description

The HP 5082-2837 is an epitaxial planar passivated Beam Lead Diode whose construction utilizes a unique combination of both a conventional PN junction and a Schottky barrier. This manufacturing process results in a device which has the high breakdown and temperature characteristics of silicon, the turn-on voltage of germanium and the speed of a Schottky diode majority carrier device.

This device is intended for high volume, low cost applications, and is the beam lead equivalent of the HP 5082-2800 glass packaged diode.

Maximum Ratings

Operating Temperature Range .... −65° C to +175° C
Storage Temperature Range .... −65° C to +200° C
Minimum Lead Strength .... 4 grams pull on either lead
Diode Mounting Temperature ... 350° C for 10 sec. max.

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Applications

High level detection, switching, or gating; logarithmic or A-D converting; sampling or wave shaping are jobs the 5082-2837 will do better than conventional PN junction diodes. The low turn-on voltage and subnanosecond switching makes it extremely attractive in digital circuits for DTL gates, pulse shaping circuits or other low level applications. Its high PIV allows wide dynamic range for fast high voltage sampling gates.

The 5082-2837 low turn-on voltage gives low offsets. The extremely low stored charge minimizes output offsets caused by the charge flow in the storage capacitor. At UHF, the diodes exhibit 95% rectification efficiencies. Both their low loss and their high PIV allow the diodes to be used in mixer and modulator applications which require wide dynamic ranges.

The combination of these technical features with the low price make these devices the prime consideration for any hybrid dc or RF circuit requiring nonlinear elements.

Bonding and Handling Procedures

See page 140.

Electrical Specifications at T_A=25°C

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	70	–	Volts	I_R = 10μA
Forward Voltage	V_{F1}	–	410	mV	I_{F1} = 1mA
Forward Voltage	V_{F2}	–	1.0	V	I_{F2} = 15mA
Reverse Leakage Current	I_R	–	200	nA	V_R = 50V
Capacitance	C_o	–	2.0	pF	V_R = 0V and f= 1MHz
Effective Minority Carrier Lifetime	τ	–	100 *	pS	I_F = 5mA Krakauer Method

* Typical

Typical Parameters

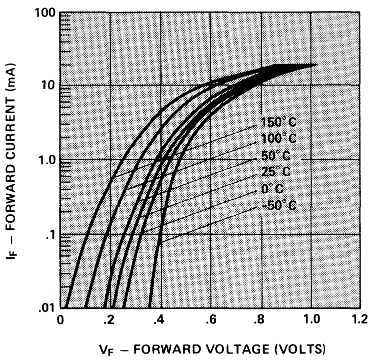


Figure 1. Typical Forward Characteristics

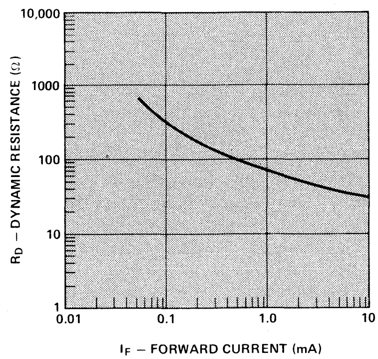


Figure 2. Typical Dynamic Resistance (R_D) vs. Forward Current (I_F)

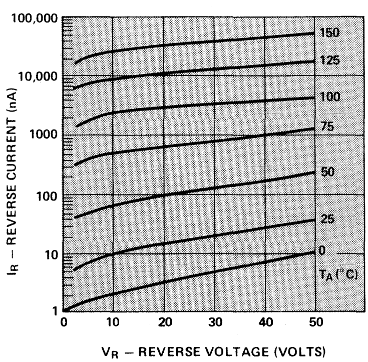


Figure 3. Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures

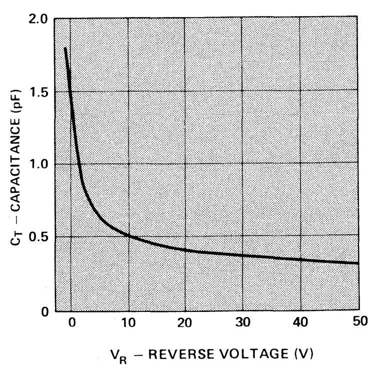


Figure 4. Typical Capacitance (C_T) vs. Reverse Voltage (V_R)

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE PAIRS FOR MIXERS AND DETECTORS

HSCH-5510
HSCH-5511
HSCH-5530
HSCH-5531

Features

MONOLITHIC PAIR
Closely Matched Electrical Parameters

LOW CAPACITANCE
0.10 pF Max. at 0 Volts

LOW NOISE FIGURE
7.0 dB at 16 GHz

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

PLATINUM TRI-METAL SYSTEM
High Temperature

POLYIMIDE SCRATCH PROTECTION

NITRIDE PASSIVATION
Stable, Reliable Performance

Description

These dual beam lead diodes are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

The HP beam lead process allows for large beam anchor pads for rugged construction (typical 6 gram pull strength) without degrading capacitance.

Maximum Ratings (for Each Diode)

Pulse Power Incident at $T_A = 25°C$ .... 1 W
Pulse Width = 1 μs, Du = 0.001

CW Power Dissipation at $T_A = 25°C$ .... 300 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.

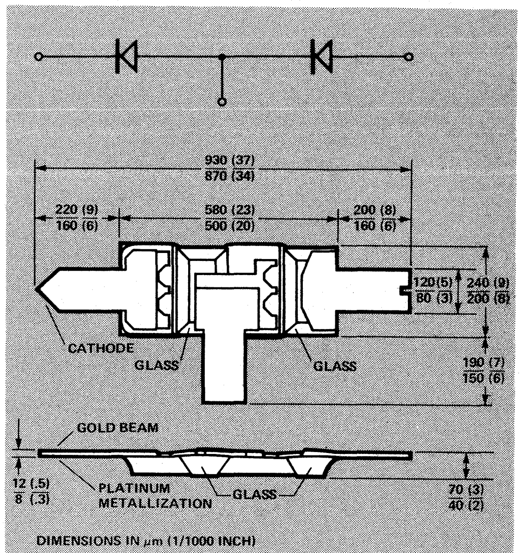
T_{OPR} — Operating Temperature Range .... −65° C to +175° C

T_{STG} = Storage Temperature Range .... −65° C to +200° C

Minimum Lead Strength .... 4 grams pull on either lead

Diode Mounting Temperature .... 350° C for 10 sec. max.
Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Outline 04

Applications

The beam lead diode is ideally suited for use in stripline or microstrip or coplanar waveguide circuits. Its small physical size and uniform dimensions give it low parasitics and repeatable RF characteristics through K-band.

The basic medium barrier device in this family is the DC tested HSCH-5511. The equivalent low barrier device is the HSCH-5531.

For applications requiring guaranteed RF performance, the HSCH-5510 is selected for 7.0 dB maximum noise figure at 16 GHz. For low-barrier RF performance, the HSCH-5530 is selected for 7.0 dB maximum noise figure at 16 GHz.

These dual beam leads are intended for use in balanced mixers and in even harmonic anti-parallel pair mixers. By using several of these devices in the proper configuration it is easy to assemble bridge quads, star quads, and ring quads for Class I, II, or III type double balanced mixers.

Bonding and Handling Procedures

See page 140.

Electrical Specifications for RF tested Diodes at $T_A = 25°C$

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5510	Medium	7.0 @ 16 GHz	200	400	1.5:1	4V	20	3	0.10	0.02	500	10
5530	Low										375	
Test Conditions		DC Load Resistance = 0Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				$I_R \leq 10\ \mu A$	I_F = 5 mA		V_R = 0V f = 1 MHz		I_F = 1 mA	

Electrical Specifications for DC tested Diodes at $T_A = 25°C$

Part Number HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5511	Medium	4V	20	3	0.10	0.02	500	10
5531	Low						375	
Test Conditions		$I_R \leq 10\ \mu A$	I_F = 5 mA		V_R = 0V f = 1 MHz		I_F = 1 mA	

Typical Detector Characteristics at $T_A = 25°C$

MEDIUM BARRIER AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-55	dBm	20μA Bias
Voltage Sensitivity	γ	9.0	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1350	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-46	dBm	Zero Bias
Voltage Sensitivity	γ	17	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1.4	MΩ	f = 10 GHz

Typical Parameters

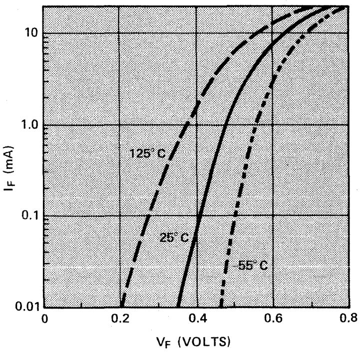


Figure 1. Typical Forward Characteristics, for Medium Barrier Beam Lead Diodes. HSCH-5510 Series.

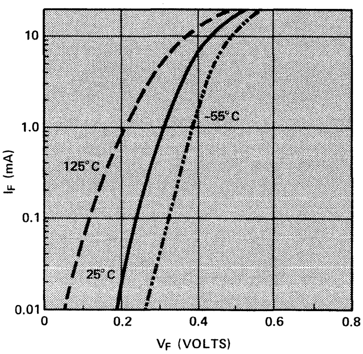


Figure 2. Typical Forward Characteristics, for Low Barrier Beam Lead Diodes. HSCH-5530 Series.

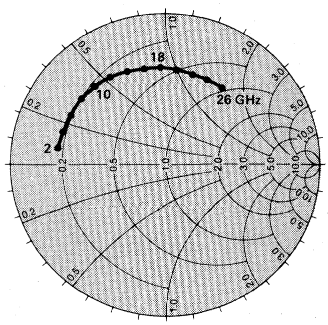


Figure 3. Typical Admittance Characteristics, with 1 mA Self Bias. HSCH-5510, -5530 Series.

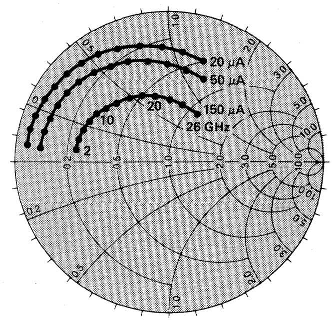


Figure 4. Typical Admittance Characteristics, with External Bias. HSCH-5510, -5530 Series.

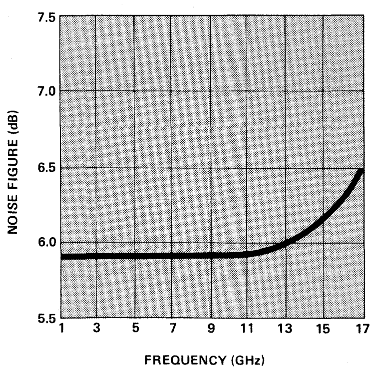
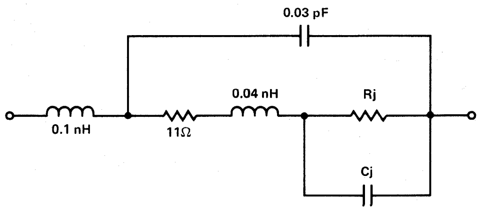


Figure 5. Typical Noise Figure vs. Frequency.

MODEL FOR EACH BEAM LEAD SCHOTTKY DIODE



SELF BIAS

Part Numbers	1.0 mA Self Bias	
	R_j	C_j
HSCH-5510, -5530	267	0.11

EXTERNAL BIAS

Part Numbers	20 μA DC Bias		50 μA DC Bias		150 μA DC Bias	
	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)
HSCH-5510, -5530	1400	0.09	560	0.09	187	0.10

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE QUADS FOR DOUBLE BALANCED MIXERS (1-18 GHz)

5082-9394-9399
5082-9696-9697

Features

PLANAR SURFACE
Easier Bonding, Stronger Leads

NITRIDE PASSIVATED
Stable, Reliable Performance

HIGH UNIFORMITY
Tightly Controlled Process Insures Uniform RF Characteristics

Description

These beam lead diodes are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor.

During manufacturing, gold leads are deposited onto a glass passivation layer before the wafer is separated. This provides exceptional lead strength.

These monolithic arrays of Schottky diodes are interconnected in ring configuration. The relative proximity of the diode junctions on the wafer assures uniform electrical characteristics among the four diodes which constitute a matched quad. They are designed for microstrip or stripline use. The leads provide a good continuity of transmission line impedance to the diode.

Maximum Ratings

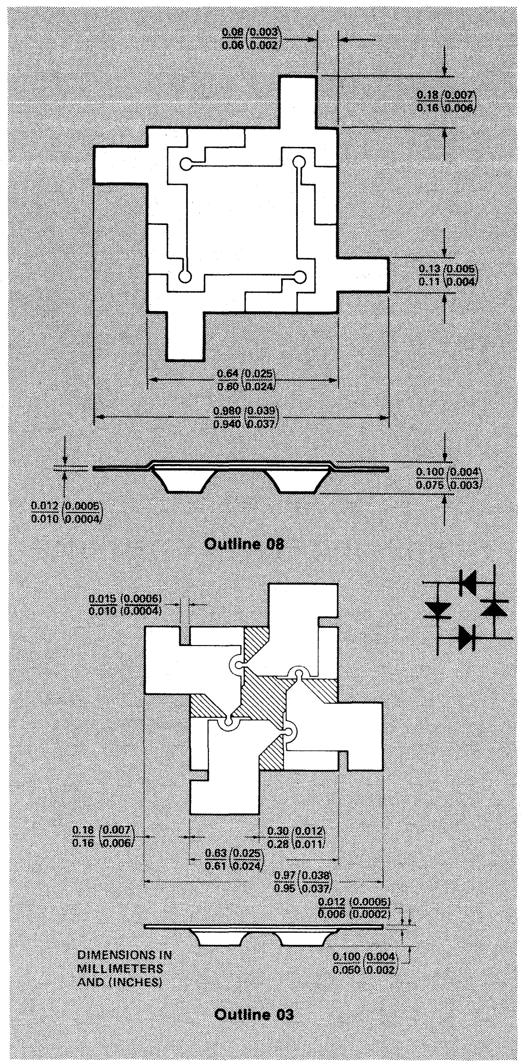
Junction Operating and Storage
Temperature Range .... -65° C to +150° C
DC Power Dissipation at 25° C .... 75 mW/Junction
Derate linearly to zero at $T_{j(op)}$ max.
(Measured in infinite heat sink)
Diode Mounting
Temperature .... 220° C max. for 10 sec.

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Applications

These diodes are designed for use in double balanced mixers, phase detectors, AM modulators, and pulse modulators requiring wideband operation and small size.



Bonding and Handling Procedures

See page 140.

Selection Guide

Package Outline \ Frequency	Barrier	To 2 GHz	2-4 GHz	4-8 GHz	8-12 GHz	12-18 GHz
Beam Lead	Medium	5082-9696	5082-9696	5082-9394	5082-9396	5082-9398
	Low	5082-9697	5082-9697	5082-9395	5082-9397	5082-9399

Electrical Characteristics at $T_A = 25°C$

Typical Parameters

Part Number 5082-	Outline	Barrier	Maximum Capacitance C_T (pF) Diagonal	Maximum Capacitance C_T (pF) Adjacent	Maximum Capacitance Difference ΔC_T (pF)	Maximum V_F Difference ΔV_F (mV)	Maximum Dynamic Resistance R_D (Ω)	Typical Parameters: Forward Voltage V_F (V)
9697	08	Low	0.55	0.74	0.10	20	12	0.25
9395	08		0.35	0.47	0.10		15	0.25
9397	03		0.20	0.27	0.05		16	0.30
9399	03		0.15	0.20	0.05		16	0.30
9696	08	Medium	0.55	0.74	0.10		12	0.35
9394	08		0.35	0.47	0.10		15	0.35
9396	03		0.20	0.27	0.05		16	0.45
9398	03		0.15	0.20	0.05		16	0.45
Test Conditions			$V_R = 0$, f = 1 MHz			$I_F = 5$ mA between Adjacent Leads		$I_F = 1$ mA Measured between Adjacent Leads

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. These two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \text{ where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

Diagonal and Adjacent Capacitance

In a ring quad, diagonal capacitance is the capacitance tested between points A and B as shown in Figure 1. The diagonal capacitance measurement has the same value as the individual diode in the quad.

Example:

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{DIAGONAL} = 1/2 + 1/2 = 1.0$ pF

The capacitance value of the individual diode measured across points A and C in Figure 1 is the adjacent capacitance. The adjacent capacitance measurement of the individual diode contains some capacitive elements of the other diodes in the ring quad.

Example:

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{ADJACENT} = 1 + 1/3 = 1.333$ pF

Therefore, the adjacent capacitance value of the individual diode in the Schottky ring quad is 33% higher than the actual (diagonal) capacitance value, i.e. $C_{ADJACENT} \cong 1.333 \times C_{DIAGONAL}$.

Hewlett-Packard guarantees maximum adjacent capacitance through 100% testing to the limits shown on the data sheet. Maximum diagonal capacitance values have been calculated.

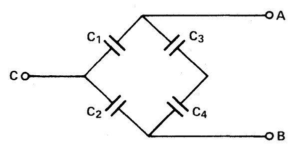


Figure 1.

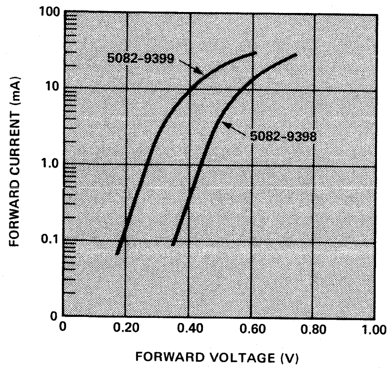


Figure 2. Typical Forward Characteristics at $T_A = 25°C$

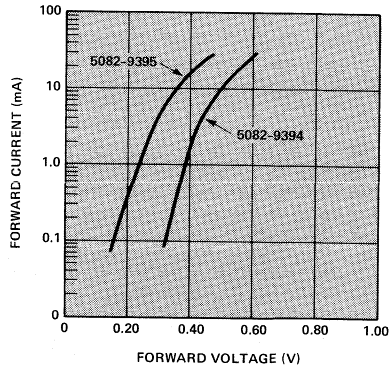


Figure 3. Typical Forward Characteristics at $T_A = 25°C$

BONDING AND HANDLING PROCEDURES FOR BEAM LEAD DIODES

1. Storage

Under normal circumstances, storage of beam lead diodes in HP supplied waffle/gel packs is sufficient. In particularly dusty or chemically hazardous environments, storage in an inert atmosphere desicator is advised.

2. Handling

In order to avoid damage to beam lead devices, particular care must be exercised during inspection, testing, and assembly. Although the beam lead diode is designed to have exceptional lead strength, its small size and delicate nature requires that special handling techniques be observed so that the devices will not be mechanically or electrically damaged. A vacuum pickup is recommended for picking up beam lead devices, particularly larger ones, e.g., quads. Care must be exercised to assure that the vacuum opening of the needle is sufficiently small to avoid passage of the device through the opening. A #27 tip is recommended for picking up single beam lead devices. A 20X magnification is needed for precise positioning of the tip on the device. Where a vacuum pickup is not used, a sharpened wooden Q-tip dipped in isopropyl alcohol is very commonly used to handle beam lead devices.

3. Cleaning

For organic contamination use a warm rinse of trichorethane followed by a cold rinse in acetone and methanol. Dry under unfrared heat lamp for 5-10 mintues on clean filter paper. Freon degreaser may replace trichloroethane for light organic contamination.

- Ultrasonic cleaning is not recommended
- Acid solvents should not be used

4. Bonding

See Application Note 992, "Beam Lead Attachment Methods", for a general description of the various methods for attaching beam lead diodes to both hard and soft substrates.

Thermocompression: See Application Note 979 "The Handling and Bonding of Beam Lead Devices Made Easy". This method is good for hard substrates only.

Wobble: This method picks up the device, places it on the substrate and forms a thermocompression bond all in one operation. This is described in MIL-STD-883B Method 2017 and is intended for hard substrates only. Equipment specifically designed for beam lead wobble bonding is available from KULICKE and SOFFA in Hursham PA.

Ultrasonic: Not recommended.

Resistance Welding or Parallel-GAP Welding: To make welding quads easier, attach one electrode of the welder to the substrate and use the second electrode for welding in lieu of the parallel gap electrode. To make welding on soft substrates easier, a low pressure welding head is recommended. Suitable equipment is available from HUGHES, Industrial Products Division in Carlsbad, CA.

For more information, see Application Note 993, "Beam Lead Diode Bonding to Soft Substrates".

Epoxy: With solvent free, low resistivity epoxies (available from ABLESTIK in Gardenia, CA, MICON in Lexington, MA., and many others) and improvements in dispensing equipment, the quality of epoxy bonds is sufficient for many applications. Equipment is available from ADVANCED SEMICONDUCTOR MATERIALS AMERICA, INC. Assembly Products·Group in Chandler AZ (Automatic), and West Bond in Orange, CA (Manual).

Reflow: By preparing the substrate with tin or solder plating, reflow soldering can be suitably preformed using a modified wire bonder. The probe is used as a soldering tip. WEST BOND or UNITEK bonders make suitable bonds.

SCHOTTKY BARRIER DIODES FOR GENERAL PURPOSE APPLICATIONS

HEWLETT PACKARD

1N5711*
1N5712*
5082-2301
5082-2302
5082-2303
5082-2305
5082-2800/10/11/35*
5082-2900*
HSCH-1001 (1N6263)*

Features

LOW TURN-ON VOLTAGE: AS LOW AS 0.34V AT 1mA
PICO-SECOND SWITCHING SPEED
HIGH BREAKDOWN VOLTAGE: UP TO 70V
MATCHED CHARACTERISTICS AVAILABLE

Description/Applications

The 1N5711, 1N5712, 5082-2800/10/11 are passivated Schottky barrier diodes which use a patented "guard ring" design to achieve a high breakdown voltage. Packaged in a low cost glass package, they are well suited for high level detecting, mixing, switching, gating, log or A-D converting, video detecting, frequency discriminating, sampling and wave shaping.

The 5082-2835 is a passivated Schottky diode in a low cost glass package. It is optimized for low turn-on voltage. The 5082-2835 is particularly well suited for the UHF mixing needs of the CATV marketplace.

The 5082-2300 and 2900 Series devices are unpassivated Schottky diodes in a glass package. These diodes have extremely low 1/f noise and are ideal for low noise mixing, and high sensitivity detecting. They are particularly well suited for use in Doppler or narrow band video receivers.

The HSCH-1001 is a Hybrid Schottky diode sealed in a rugged double stud Outline 12 glass package suitable for automatic insertion. The low turn-on voltage, fast switching speed, and low cost of these diodes make them ideal for general purpose switching.

Application Bulletins 13, 14, 15, and 16 describe applications in which these diodes are used for speed up of a transistor, clipping, clamping, and sampling, respectively. Other digital and RF applications are described in Application Bulletins 26, 27, 28, 30, 31 and 36.

Maximum Ratings

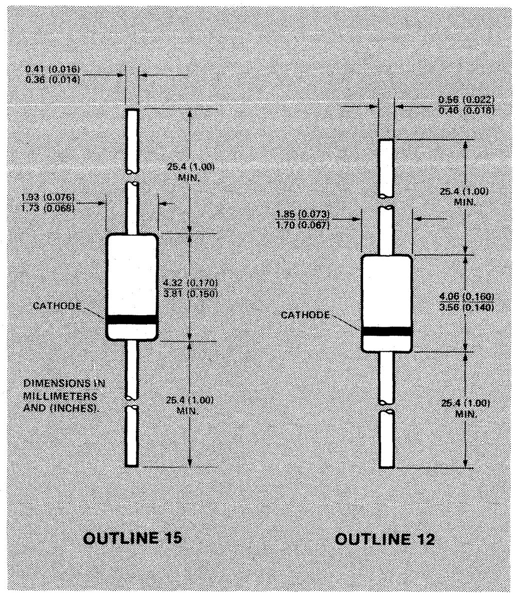
Junction Operating and Storage Temperature Range
- 5082-2305, 2301, 2302, 2303, 2900 .... -60°C to +100°C
- 1N5711, 1N5712, 5082-2800/10/11, HSCH-1001 .... -65°C to +200°C
- 5082-2835 .... -60°C to +150°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10⁷ hours.

DC Power Dissipation (Measured in an infinite heat sink at T_{CASE} = 25°C)

Derate linearly to zero at maximum rated temperature
- 5082-2305, 2301, 2302, 2303, 2900 .... 100 mW
- 1N5711, 1N5712, 5082-2800/10/11 .... 250 mW
- 5082-2835 .... 150 mW
- HSCH-1001 .... 400 mW

Peak Inverse Voltage .... V_{BR}



Package Characteristics

	Outline 15	Outline 12
Lead Material:	Dumet	Dumet
Lead Finish:	1N5711, 1N5712: Tin 2800 Series: Tin 2300, 2900 Series: Gold	Tin
Maximum Soldering Temperature:	230°C for 5 sec.	260°C for 10 sec.
Minimum Lead Strength:	4 lb. Pull	10 lb. Pull
Typical Package Inductance:	1N5711, 1N5712: 2.0 nH 2800 Series: 2.0 nH 2300, 2900 Series: 3.0 nH	1.8 nH
Typical Package Capacitance:	1N5711, 1N5712: 0.2 pF 2800 Series: 0.2 pF 2300, 2900 Series: 0.07 pF	0.25 pF

The leads on the Outline 15 package should be restricted so that the bend starts at least 1/16 inch from the glass body.

*Also available in Tape and Reel. Please contact local HP Sales Office for further information.

Schottky Barrier Diodes

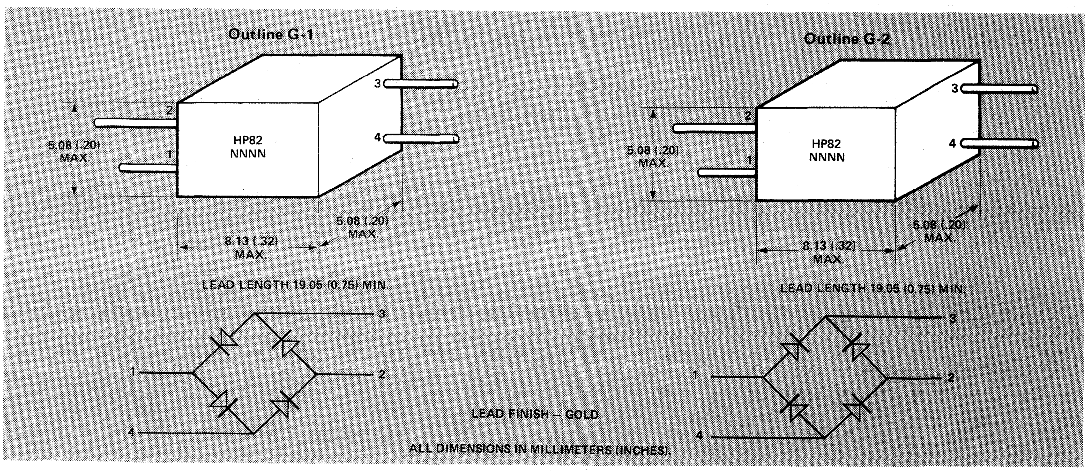
Electrical Specifications at T_A=25°C

Part Number 5082-	Package Outline	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F=1V Max at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA)	at V_R (V)	Maximum Capacitance C_T (pF)
2800	15	70	410	15	200	50	2.0
1N5711	15	70	410	15	200	50	2.0
2305	15	30	400	75	300	15	1.0
2301	15	30	400	50	300	15	1.0
2302	15	30	400	35	300	15	1.0
2303	15	20	400	35	500	15	1.0
2810	15	20	410	35	100	15	1.2
1N5712	15	20	550	35	150	16	1.2
2811	15	15	410	20	100	8	1.2
2900	15	10	400	20	100	5	1.2
2835	15	8*	340	10†	100	1	1.0
HSCH-1001 (1N6263)	12	60	410	15	200	50	2.2
Test Conditions		I_R = 10 μA *I_R = 100 μA	I_F = 1 mA	†V_F = .45V			V_R = 0 V f = 1.0 MHz

Note:
Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 20 mA except for HSCH-1001 (1N6263), 1N5711, and 1N5712 which are measured at 5 mA.

Matched Pairs and Quads

Basic Part Number 5082-	Matched Pair Unconnected	Matched Quad Unconnected	Matched Ring Quad Encapsulated G-1 Outline	Matched Bridge Quad Encapsulated G-2 Outline	Batch Matched	Test Conditions
2301	5082-2306 ΔV_F = 20 mV ΔCo = 0.2 pF					ΔV_F at I_F = 0.75, 20 mA ΔCo at f = 1.0 MHz
2303	5082-2308 ΔV_F = 20 mV ΔCo = 0.2 pF	5082-2370 ΔV_F = 20 mV ΔCo = 0.2 pF	5082-2396 ΔV_F = 20 mV ΔCo = 0.2 pF	5082-2356 ΔV_F = 20 mV ΔCo = 0.2 pF		ΔV_F at I_F = 0.75, 20 mA ΔCo at f = 1.0 MHz
2900	5082-2912 ΔV_F = 30 mV	5082-2970 ΔV_F = 30 mV		5082-2997 ΔV_F = 30 mV		ΔV_F at I_F = 1.0, 10 mA
2800	5082-2804 ΔV_F = 20 mV	5082-2805 ΔV_F = 20 mV			5082-2836* ΔV_F = 20 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 0.5, 5 mA *I_F = 10 mA ΔC_O at f = 1.0 MHz
2811		5082-2815 ΔV_F = 20 mV ΔC_O = 0.20 pF	5082-2814 ΔV_F = 20 mV ΔC_O = 0.20 pF	5082-2813 ΔV_F = 20 mV ΔC_O = 0.20 pF	5082-2826 ΔV_F = 10 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 10 mA ΔC_O at f = 1.0 MHz
2835					5082-2080 ΔV_F = 10 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 10 mA ΔC_O at f = 1.0 MHz



Typical Parameters

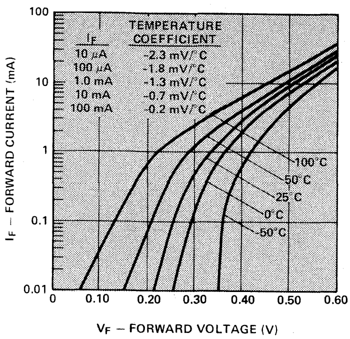


Figure 1. I-V Curve Showing Typical Temperature Variation for 5082-2300 and 5082-2900 Series Schottky Diodes.

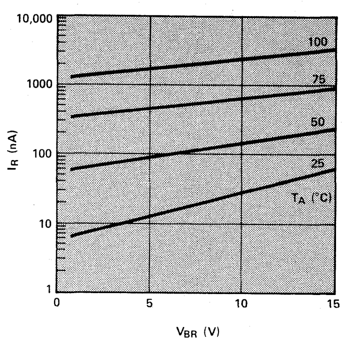


Figure 2. 5082-2300 Series Typical Reverse Current vs. Reverse Voltage at Various Temperatures.

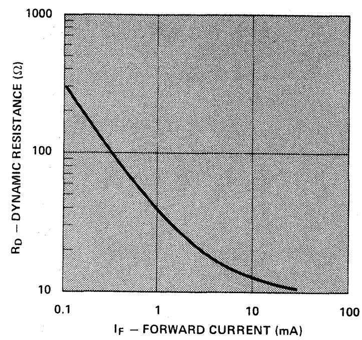


Figure 3. 5082-2300 Series and 5082-2900 Series Typical Dynamic Resistance (R_D) vs. Forward Current (I_F).

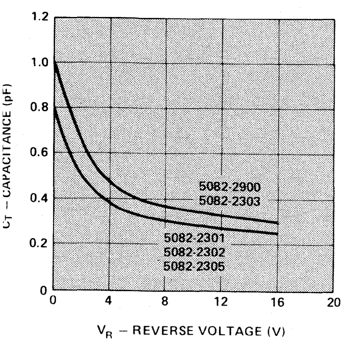


Figure 4. 5082-2300 and 5082-2900 Series Typical Capacitance vs. Reverse Voltage.

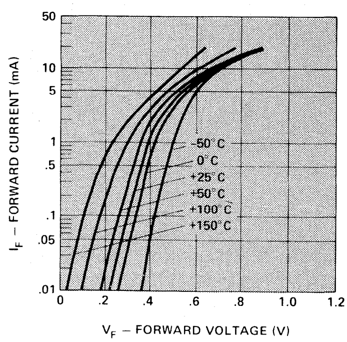


Figure 5. I-V Curve Showing Typical Temperature Variation for 5082-2800 or 1N5711 Schottky Diodes.

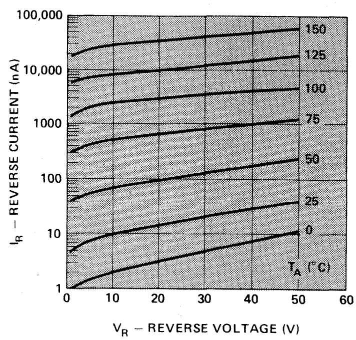


Figure 6. (5082-2800 or 1N5711) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

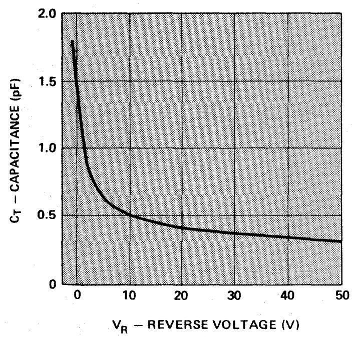


Figure 7. (5082-2800 or 1N5711) Typical Capacitance (C_T) vs. Reverse Voltage (V_R).

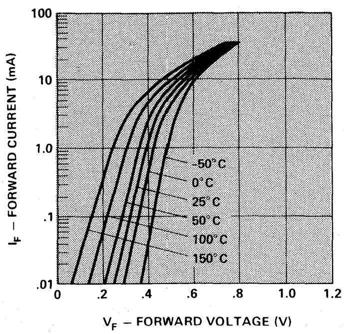


Figure 8. I-V Curve Showing Typical Temperature Variation for the 5082-2810 or 1N5712 Schottky Diode.

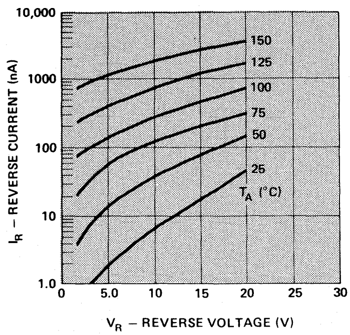


Figure 9. (5082-2810 or 1N5712) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

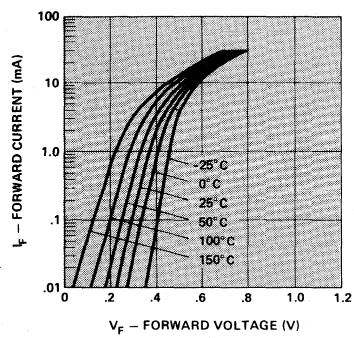


Figure 10. I-V Curve Showing Typical Temperature Variation for the 5082-2811 Schottky Diode.

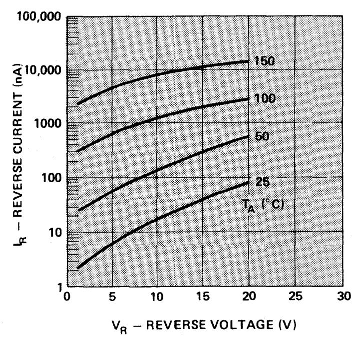


Figure 11. (5082-2811) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

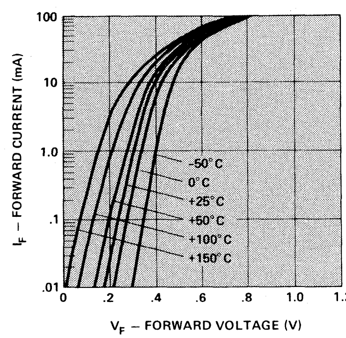


Figure 12. I-V Curve Showing Typical Temperature Variations for 5082-2835 Schottky Diode.

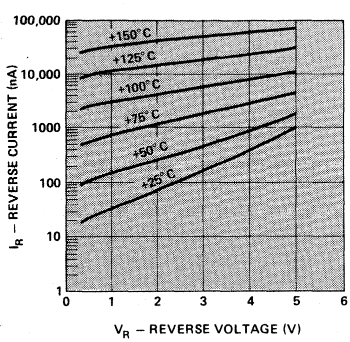


Figure 13. (5082-2835) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

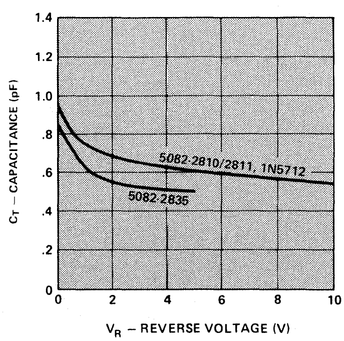


Figure 14. Typical Capacitance (C_T) vs. Reverse Voltage (V_R).

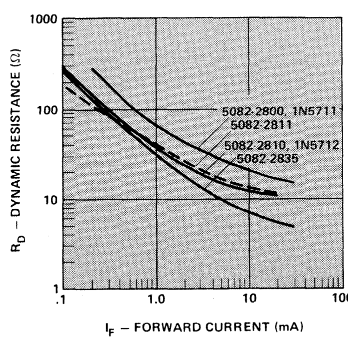


Figure 15. Typical Dynamic Resistance (R_D) vs. Forward Current (I_F).

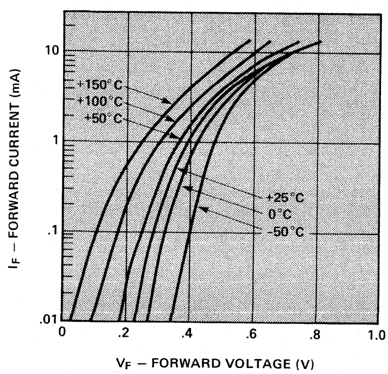


Figure 16. Typical Variation of Forward Current (I_F) vs. Forward Voltage (V_F) at Various Temperatures for the HSCH-1001.

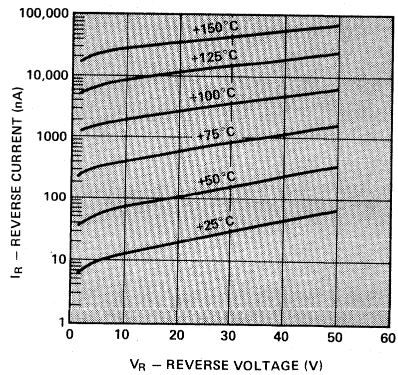


Figure 17. Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures for the HSCH-1001.

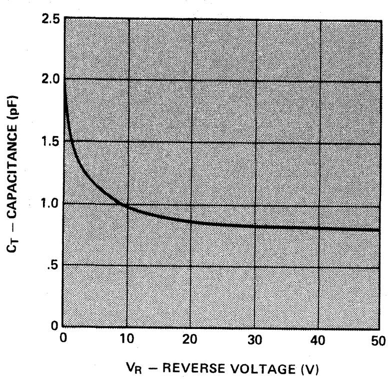


Figure 18. Typical Capacitance (C_T) vs. Reverse Voltage (V_R) for the HSCH-1001.

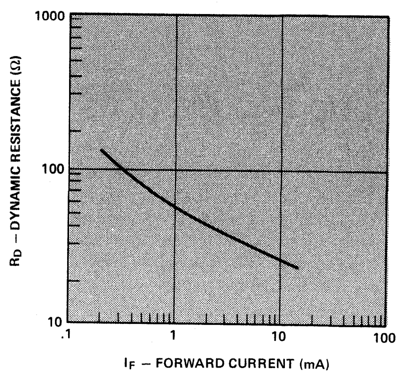


Figure 19. Typical Dynamic Resistance (R_D) vs. Forward Current (I_F) at T_A = 25° C for the HSCH-1001.

Schottky Barrier Diodes

![HP logo] **HEWLETT PACKARD**

SCHOTTKY BARRIER DIODES FOR STRIPLINE, MICROSTRIP MIXERS AND DETECTORS

5082-2200/01/02/03
5082-2207/08/09/10
5082-2765/66
5082-2774/75
5082-2785/86
5082-2794/95

Features

SMALL SIZE

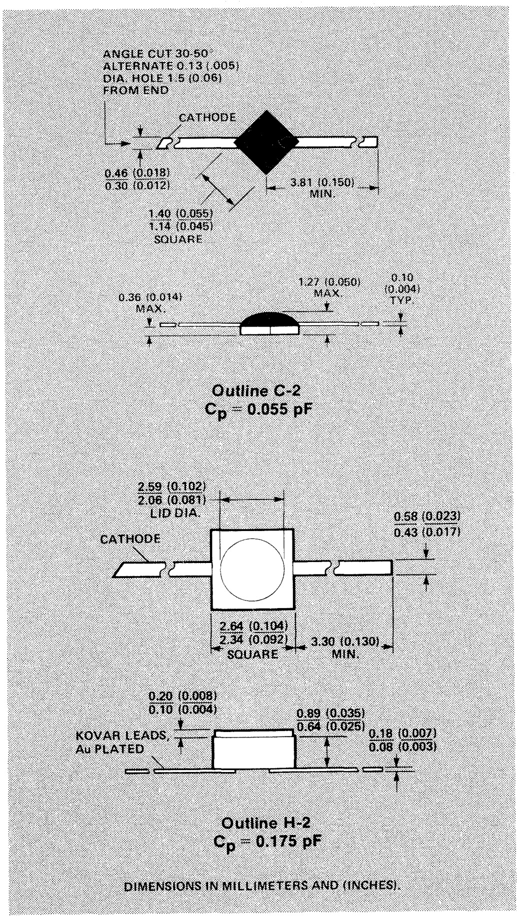
LOW NOISE FIGURE
6 dB Typical at 9 GHz

RUGGED DESIGN

HIGH UNIFORMITY

HIGH BURNOUT RATING
1 W RF Pulse Power Incident

BOTH MEDIUM AND LOW BARRIER AVAILABLE



Outline C-2
$C_p = 0.055$ pF

Outline H-2
$C_p = 0.175$ pF

DIMENSIONS IN MILLIMETERS AND (INCHES).

Description/Applications

This family consists of medium barrier and low barrier beam lead diodes mounted in easily handled carrier packages. Low barrier diodes provide optimum noise figure at low local oscillator drive levels. Medium barrier diodes provide a wider dynamic range for lower distortion mixer designs. Application Note 976 presents impedance matching techniques for an X-Band mixer.

Maximum Ratings

Operating and Storage Temperature Range
C-2 Packaged Diodes .... −65° C to +125° C
H-2 Packaged Diodes .... −65° C to +200° C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Pulse Power Incident at $T_{CASE} = 25°$ C .... 1 W
(1 μs pulse, Du = 0.001)

CW Power Dissipation at $T_{CASE} = 25°$ C
(Mounted in infinite Heat Sink) .... 125 mW
(Derate linearly to Zero at Maximum Operating Temperature)

Diode Mounting Temperature in Packages
C-2 .... 235° C for 10 sec max.
H-2 .... 260° C for 10 sec max.

Peak Inverse Voltage .... 4 V

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

These diodes are designed for microstrip and stripline use. The kovar leads provide good continuity of transmission line impedance to the diode. Outline C2 is a plastic on ceramic package. Outline H2 has a metal ceramic hermetic seal. The ceramic is alumina. Metal parts are gold plated kovar.

The hermetic package, outline H2, is capable of passing many of the environmental tests of MIL-STD-750. The applicable solderability test is reference 2031.1: 260° C, 10 seconds.

RF Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Batch Matched 5082-	Test Freq. (GHz)	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Package	Typical Capacitance C_T (pF)
2200	2201	9.375	Medium	6.0	200	400	1.5:1	Hermetic H-2	0.3
2202	2203		Medium	6.5			2.0:1		
2765	2766		Low	6.0			1.5:1		
2785	2786		Low	6.5			2.0:1		
2207	2208		Medium	6.0	200	400	1.5:1	Broadband C-2	0.22
2209	2210		Medium	6.5			2.0:1		
2774	2775		Low	6.0			1.5:1		
2794	2795		Low	6.5			2.0:1		
Test Conditions	$\Delta NF \leq 0.3$ dB $\Delta Z_{IF} \leq 25\ \Omega$			DC Load Resistance = 0 Ω L.O. Power = 1 mW IF = 30 MHz, 1.5 dB NF					V = 0

Typical Detector Characteristics at $T_A = 25°C$

MEDIUM BARRIER AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-54	dBm	20μA Bias
Voltage Sensitivity	γ	6.6	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1400	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-44	dBm	Zero Bias
Voltage Sensitivity	γ	10	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1.8	MΩ	f = 10 GHz

Typical Parameters

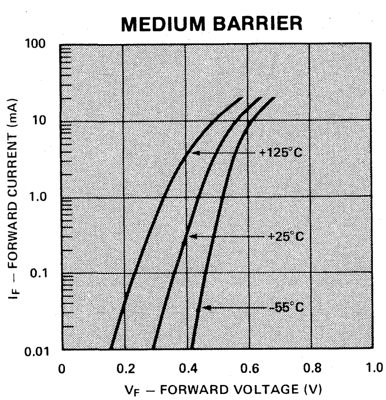


Figure 1. Typical Forward Characteristics

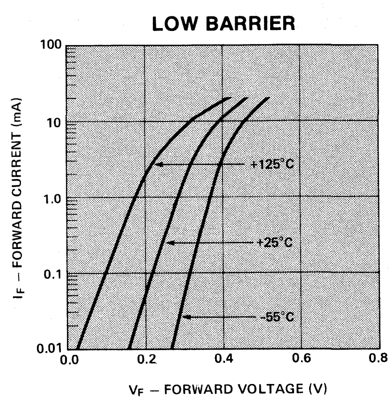


Figure 2. Typical Forward Characteristics

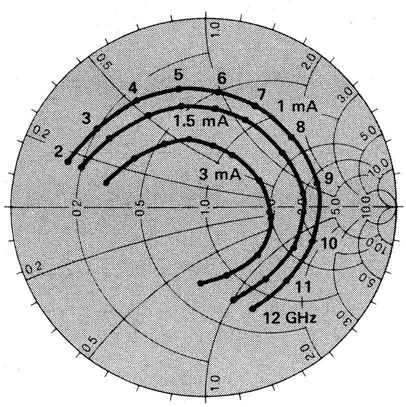


Figure 3. Typical Admittance Characteristics, 5082-2200 and 5082-2765 with self bias.

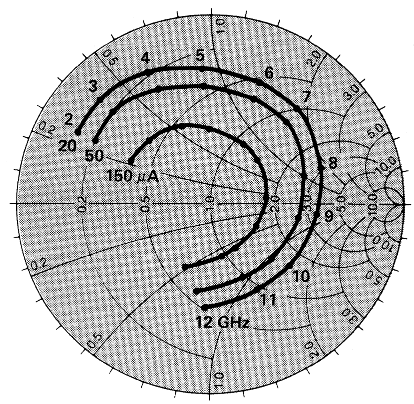


Figure 4. Typical Admittance Characteristics, 5082-2200 and 5082-2765 with external bias.

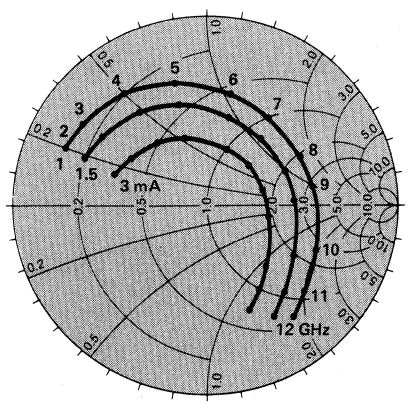


Figure 5. Typical Admittance Characteristics, 5082-2202 and 5082-2785 with self bias.

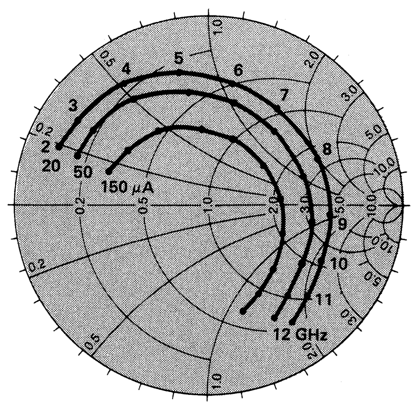


Figure 6. Typical Admittance Characteristics, 5082-2202 and 5082-2785 with external bias.

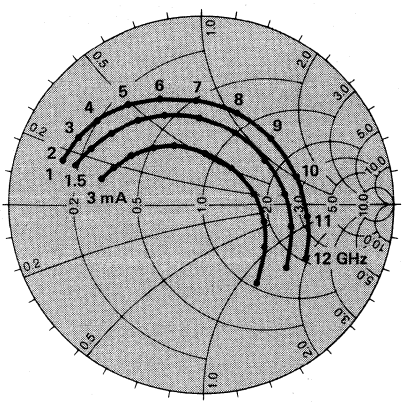


Figure 7. Typical Admittance Characteristics, 5082-2207 and 5082-2774 with self bias.

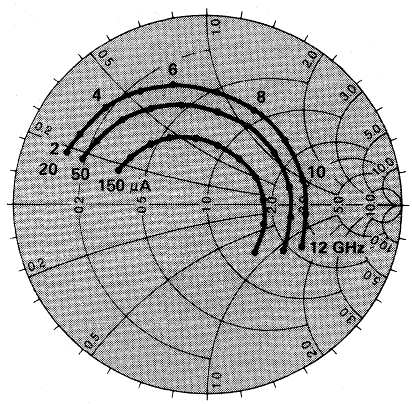


Figure 8. Typical Admittance Characteristics, 5082-2207 and 5082-2774 with external bias.

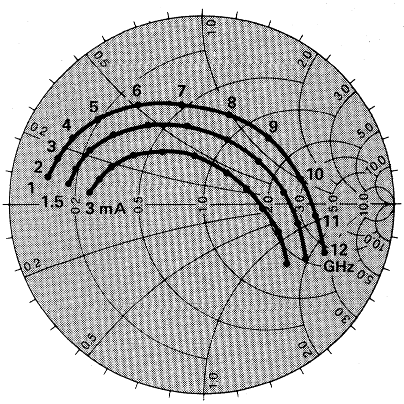


Figure 9. Typical Admittance Characteristics, 5082-2209 and 5082-2794 with self bias.

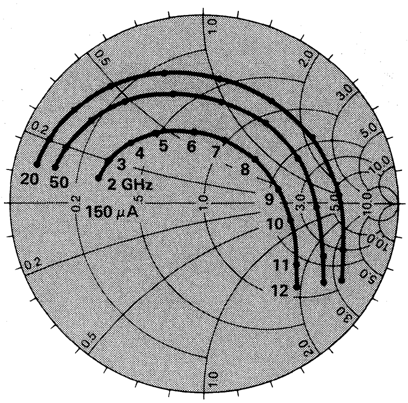


Figure 10. Typical Admittance Characteristics, 5082-2209 and 5082-2794 with external bias.

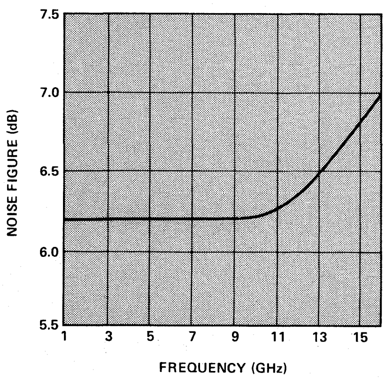


Figure 11. Typical Noise Figure vs. Frequency for 5082-2209, 2794.

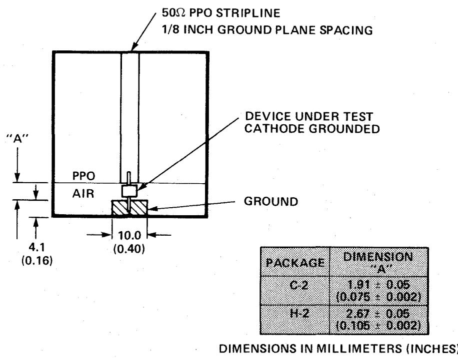
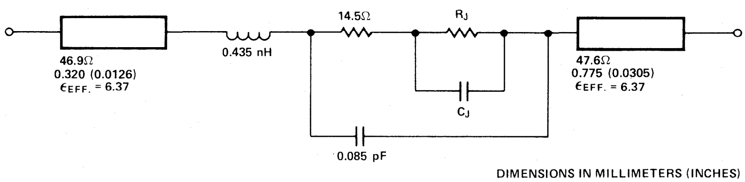


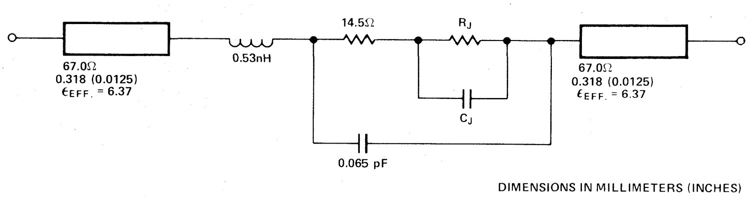
Figure 12. Admittance Test Circuit.

MODEL FOR H2 DIODES



Parameter	Symbol	1 mA Rect. Current 5082-2200, 5082-2765	20 μA Ext. Bias 5082-2200, 5082-2765	Units
Junction Resistance	R_J	258	545	Ohms
Junction Capacitance	C_J	0.255	0.302	pF

MODEL FOR C-2 DIODES



Parameter	Symbol	1 mA Rect. Current 5082-2207, 5082-2774	20 μA Ext. Bias 5082-2207, 5082-2774	Units
Junction Resistance	R_J	338	421	Ohms
Junction Capacitance	C_J	0.189	0.195	pF

SCHOTTKY BARRIER DIODE QUADS FOR DOUBLE BALANCED MIXERS

HEWLETT PACKARD

5082-2231
5082-2233
5082-2263
5082-2271/72
5082-2277
5082-2279/80
5082-2291/92
5082-2294
5082-2830/31

Features

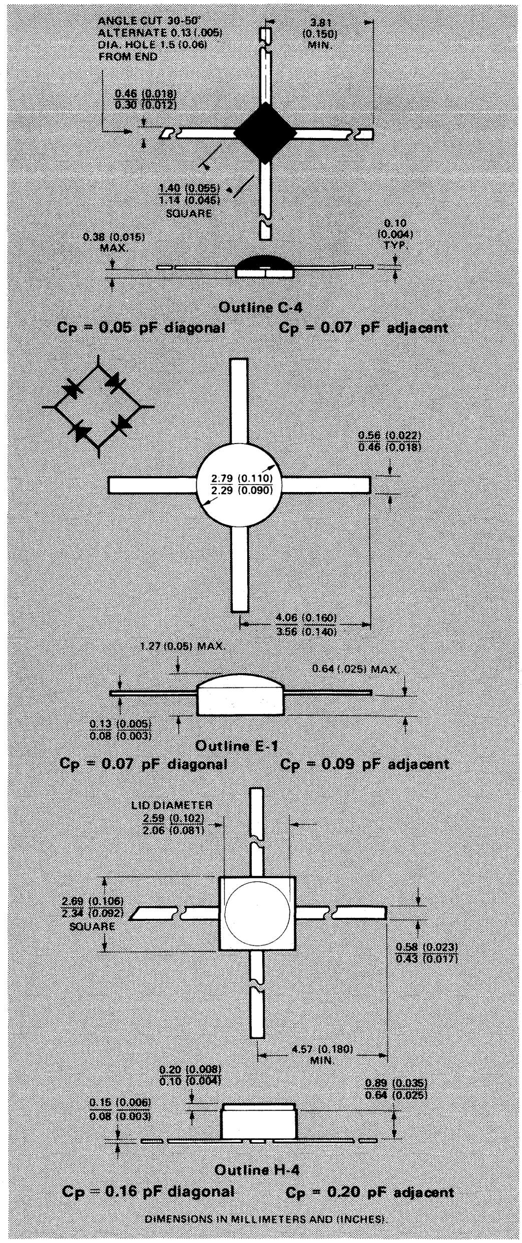
SMALL SIZE
Eases Broad Band Designs

TIGHT MATCH
Improves Mixer Balance

IMPROVED BALANCE OVER TEMPERATURE

RUGGED DESIGN

BOTH MEDIUM AND LOW BARRIER DIODES AVAILABLE



Description / Applications

These matched diode quads use a monolithic array of Schottky diodes interconnected in ring configuration. The relative proximity of the diode junction on the wafer assures uniform electrical characteristics and temperature tracking.

These diodes are designed for use in double balanced mixers, phase detectors, AM modulators, and pulse modulators requiring wideband operation and small size. The low barrier diodes allow for optimum mixer noise figure at lower than conventional local oscillator levels. The wider dynamic range of the medium barrier diodes allows for better distortion performance.

Maximum Ratings

Junction Operating and Storage Temperature Range:

H-4 Packaged Diodes .... -65°C to +150°C
E-1 and C-4 Packaged Diodes .... -65°C to +125°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

DC Power Dissipation .... 75 mW per Junction
Derate linearly to zero at maximum rated temperatures (measured in infinite heat sink at T_{CASE} = 25° C)

Soldering Temperature .... H-4 260° C for 10 sec.
C-4 235° C for 10 sec.
E-1 220° C for 10 sec.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Selection Guide

Package Outline \ Frequency	Barrier	To 2 GHz	2-4 GHz	4-8 GHz	8-12 GHz	12-18 GHz
E-1	Medium	5082-2830	5082-2277	5082-2277		
Low Cost	Low	5082-2831				
H-4	Medium	5082-2263	5082-2263	5082-2263		
Hermetic	Low	5082-2231	5082-2231	5082-2233		
C-4	Medium	5082-2291	5082-2291	5082-2292	5082-2294	5082-2294
Broadband	Low	5082-2271	5082-2271	5082-2272	5082-2279	5082-2280

Electrical Characteristics at $T_A = 25°C$

Typical Parameters

Part Number 5082-	Package	Barrier	Maximum Capacitance C_T (pF) Diagonal	Maximum Capacitance C_T (pF) Adjacent	Maximum Capacitance Difference ΔC_T (pF)	Maximum V_F Difference ΔV_F (mV)	Maximum Dynamic Resistance R_D (Ω)	Forward Voltage V_F (V)
2231	H-4	Low	0.60	0.80	0.10	20	12	0.25
2233			0.40	0.54	0.05		16	0.30
2263		Medium	0.40	0.54	0.05		16	0.45
2830	E-1		0.5 Typ.	0.67 Typ.	0.20		12	0.40
2831		Low	0.5 Typ.	0.67 Typ.	0.20		12	0.25
2277		Medium	0.50	0.67	0.10		15	0.35
2271	C-4	Low	0.60	0.80	0.10		12	0.25
2272			0.40	0.54	0.10		15	0.25
2279			0.25	0.34	0.05		16	0.30
2280			0.20	0.27	0.05		16	0.30
2291		Medium	0.60	0.80	0.10		12	0.35
2292			0.40	0.54	0.10		15	0.35
2294			0.20	0.27	0.05		16	0.45
Test Conditions			$V_R = 0$, f = 1 MHz			$I_F = 5$ mA between Adjacent Leads		$I_F = 1$ mA Measured between Adjacent Leads

Package Characteristics

The HP outline E1 package is designed for MIC, Microstrip, and Stripline use from dc through X-Band. The leads provide a good continuity of transmission line impedance to the monolithic diode array. The leads are tin plated copper.

The C-4 subminiature package is a ceramic carrier whose gold plated kovar leads are brazed to the substrate for maximum package ruggedness. If the leads are to be formed, they should be restricted so the bend starts at least 0.25 mm (0.01 inch) from the package body. The semiconductor is protected from mechanical abrasion by epoxy. The H-4 miniature package is a hermetic metal-ceramic device, which makes it ideal for applications requiring high reliability. The leads are gold plated kovar. Outline H-4 is capable of passing many of the environmental tests of MIL-STD-750. The applicable solderability test is reference 2031.1: 260° C, 10 seconds.

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. The two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \quad \text{where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

Diagonal and Adjacent Capacitance

In a ring quad, DIAGONAL CAPACITANCE is the capacitance tested between points A and B as shown in Figure 1. The diagonal capacitance measurement has the same value as the individual diode in the quad.

Example:

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{DIAGONAL} = 1/2 + 1/2 = 1.0$ pF

The capacitance value of the individual diode measured across points A and C in Figure 1 is the ADJACENT CAPACITANCE. The adjacent capacitance measurement of the individual diode contains some capacitive elements of the other diodes in the ring quad.

Example:

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{ADJACENT} = 1 + 1/3 = 1.333$ pF

Therefore, the adjacent capacitance value of the individual diode in the Schottky ring quad is 33% higher than the actual (diagonal) capacitance value. I.E. $C_{ADJACENT} \cong 1.333 \times C_{DIAGONAL}$.

Hewlett-Packard guarantees maximum capacitance through 100% testing to the limits shown on the data sheet. Maximum adjacent capacitance values have been calculated.

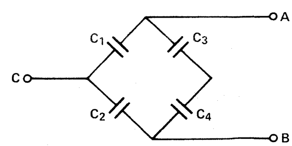


Figure 1.

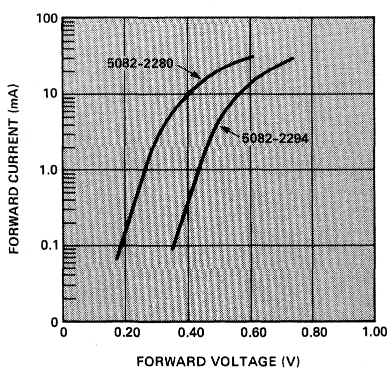


Figure 2. Typical Forward Characteristics at $T_A = 25°$ C

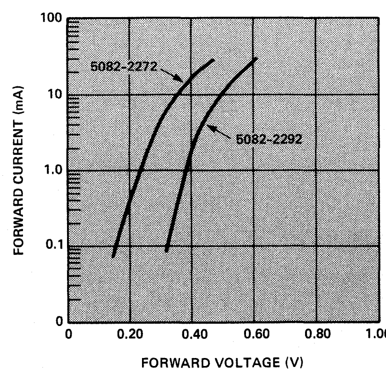


Figure 3. Typical Forward Characteristics at $T_A = 25°$ C

HEWLETT PACKARD

SCHOTTKY BARRIER DIODES FOR MIXERS AND DETECTORS

5082-2273/74
5082-2295-98
5082-2350/51
5082-2400/01
5082-2520/21/65/66
5082-2701/02/06/07
5082-2711-14/23-24
5082-2817/18

Features

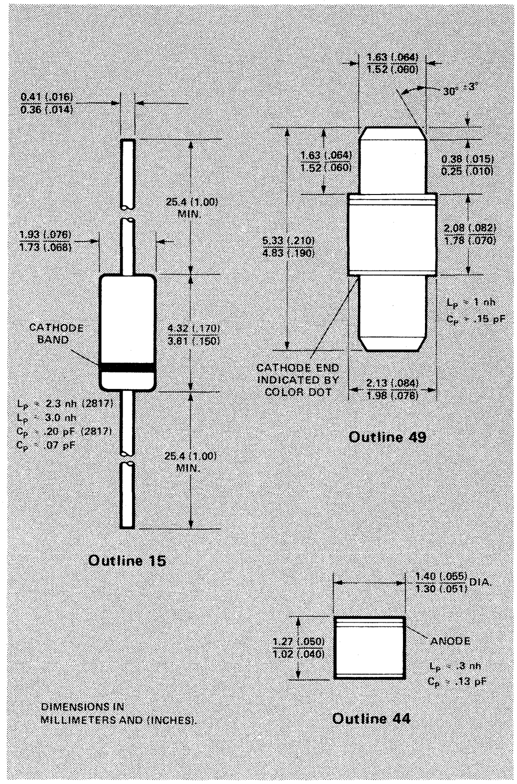
LOW NOISE FIGURE

HIGH BURNOUT RATING
15 W RF Pulse Power Incident

RUGGED DESIGN

HIGH UNIFORMITY

BOTH MEDIUM AND LOW BARRIER DIODES AVAILABLE



Description / Applications

These Schottky diodes are optimized for use in broad band and narrow band microstrip, coaxial, or waveguide mixer assemblies operating to 18 GHz. The low barrier diodes give optimum noise figure performance at low local oscillator drive levels. Medium barrier diodes provide a wider dynamic range for lower distortion mixer designs. The 5082-2350, -2400, -2520 and -2565 have extremely low 1/f noise, making them ideal for use as Doppler mixers.

Maximum Ratings

Junction Operating and Storage Temperature Range
5082-2400, -2401, -2565, -2566, -2350, -2351, -2520, 2521 .... −60° C to +100° C
5082-2817, -2818 .... −60° C to +200° C
All other diodes .... −60° C to +150° C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

CW Power Dissipation (Measured in an infinite heat sink)
Derate linearly to 0 W at max. rated temperature at T_{CASE} = 25° C
5082-2300, -2400, -2500 Series .... 100 mW
5082-2817, -2818 .... 250 mW
Others .... 200 mW
Pulse Power Dissipation
Peak power absorbed by the diode at T_{CASE} = 25° C
1 μs pulse, Du = 0.001 .... 1 W
Soldering Temperature .... 230° C for 5 sec.

Note: The 5082-2200, -2500 and -2700 series are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

The HP Outline 15 package has a glass hermetic seal with plated Dumet leads which should be restricted so that the bend starts at least 1/16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750. Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230° C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Matched Pair 5082-	Barrier	LO Test Frequency (GHz)	Maximum SSB Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Package Outline
2817	2818	Medium	2.0	6.0	250	400	1.5:1	
2400	2401	Medium	2.0	6.0	150	250	1.3:1	
2350	2351	Medium	2.0	7.0	150	250	1.5:1	15
2565	2566	Medium	3.0	6.0	100	250	1.5:1	
2520	2521	Medium	3.0	7.0	100	250	1.5:1	
2713	2714	Medium	9.375	6.0	200	400	1.5:1	49
2711	2712	Medium	9.375	6.5	200	400	2.0:1	
2701	2706	Medium	9.375	6.0	200	400	1.5:1	
2702	2707	Medium	9.375	6.5	200	400	1.5:1	44
2295	2296	Low	9.375	6.0	100	250	1.5:1	
2297	2298	Low	9.375	6.5	100	250	2.0:1	
2723	2724	Medium	16	6.5	200	400	1.5:1	49
2273	2274	Medium	16	6.5	200	400	1.5:1	44
Test Conditions	ΔNF≤0.3dB ΔZ$_{IF}$≤25Ω		LO Power = 1 mW IF=30 MHz, 1.5 dB NF Zero DC Load Resistance (100Ω for 5082-2817)		Same as for NF except IF = 10 KHz		Same as for NF	

Typical Parameters

Junction Capacitance C_{JO} (pF)	Breakdown Voltage V_{BR} (V)
1.0	15
0.7	30
0.9	30
0.7	5
0.7	5
0.10	4
	3
	3
V = 0	I_R = 10 µA

Typical Parameters

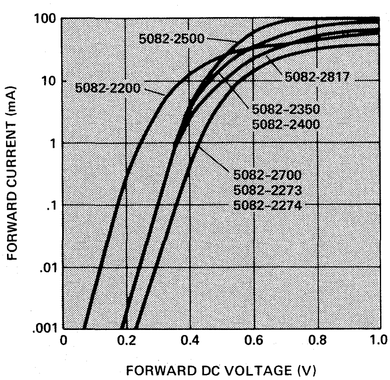


Figure 1. Typical Forward Characteristics at T_A = 25°C.

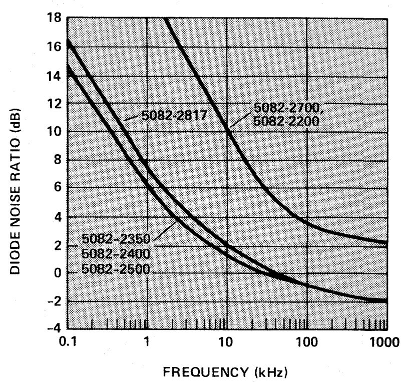


Figure 2. Typical Diode Noise Ratio vs. Frequency at 1 mA Current.

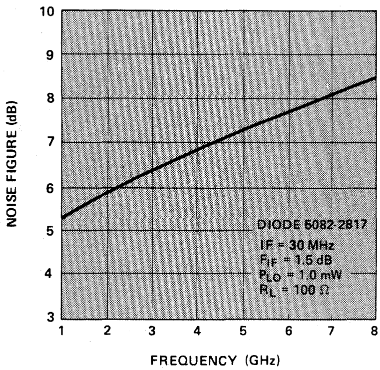


Figure 3. Typical Noise Figure vs. Frequency. The mount is tuned for minimum noise figure at each frequency.

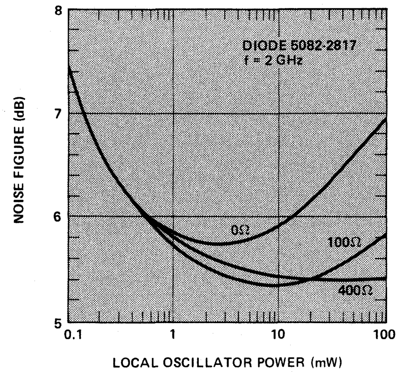


Figure 4. Single Sideband Noise Figure (including an IF-amplifier noise figure of 1.5 dB) vs. Incident LO Power for Various dc-load Resistances R_L. (The mount is tuned for minimum noise figure at each LO power level).

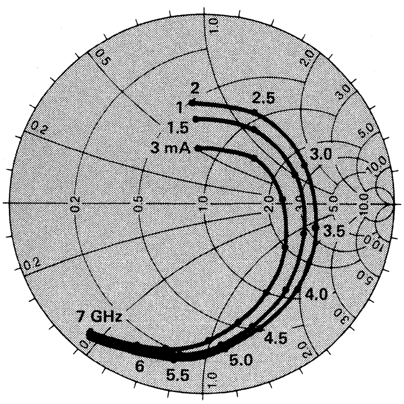


Figure 5. Typical Admittance Characteristics, 5082-2817 with Self Bias.

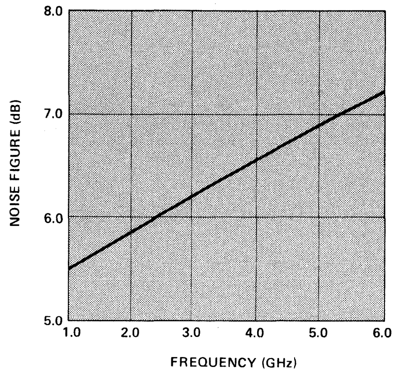


Figure 6. Typical HP 5082-2400 Noise Figure vs. Frequency with P_{LO} = 1.0 mW, IF = 30 MHz, and NF_{IF} = 1.5 dB. Mount Tuned at Each Frequency.

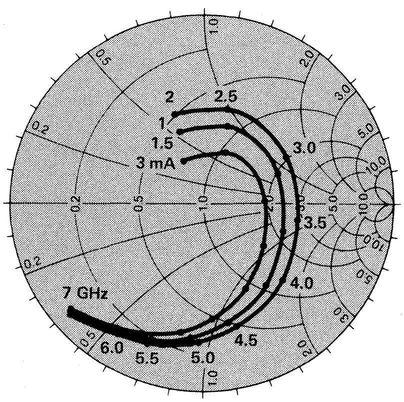


Figure 7. Typical Admittance Characteristics, 5082-2400 with Self Bias.

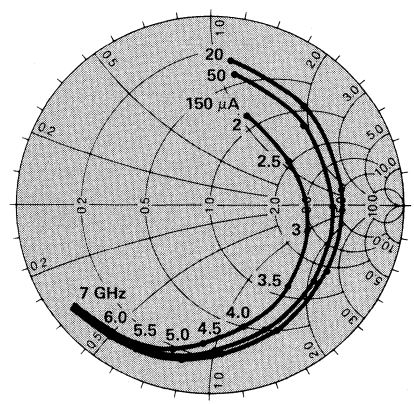


Figure 8. Typical Admittance Characteristics, 5082-2400 with External Bias.

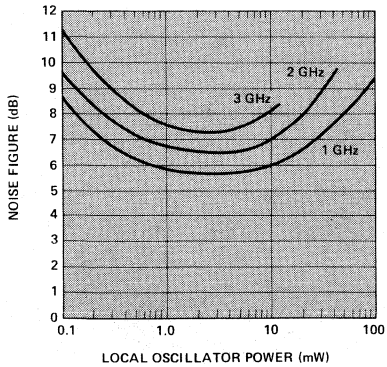


Figure 9. Typical HP 5082-2350 Noise Figure vs. Local Oscillator Power at 1.0, 2.0 and 3.0 GHz with IF = 30 MHz and NF_{IF} = 1.5 dB. (The Mount is tuned for Minimum Noise Figure at each LO Level).

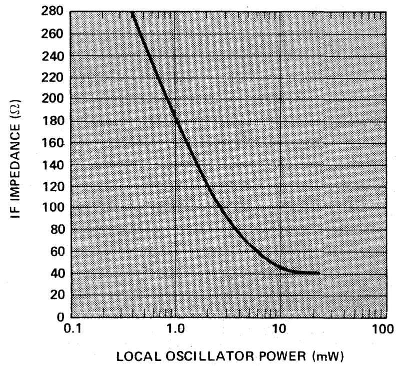


Figure 10. Typical HP 5082-2300 and 2400 Series IF Impedance vs. Local Oscillator Power with f_{LO} = 2.0 GHz and IF = 30 MHz. (The Mount is tuned for Minimum Noise Figure at each LO Level).

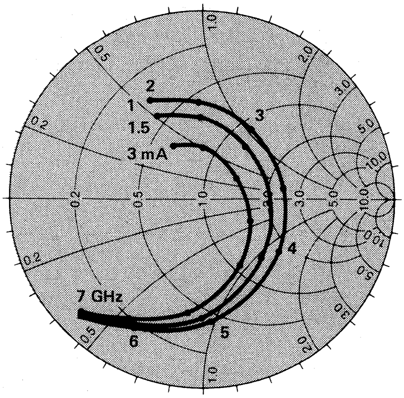


Figure 11. Typical Admittance Characteristics, 5082-2350 with Self Bias.

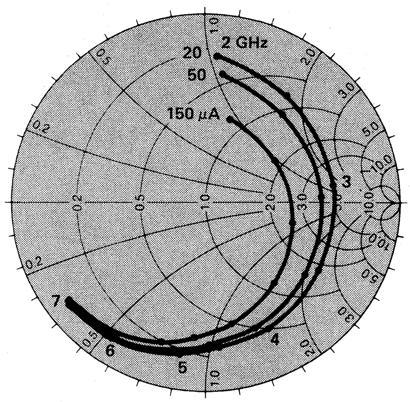


Figure 12. Typical Admittance Characteristics, 5082-2350 with External Bias.

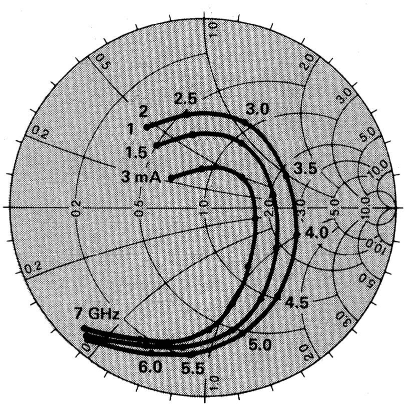


Figure 13. Typical Admittance Characteristics, 5082-2565 with Self Bias.

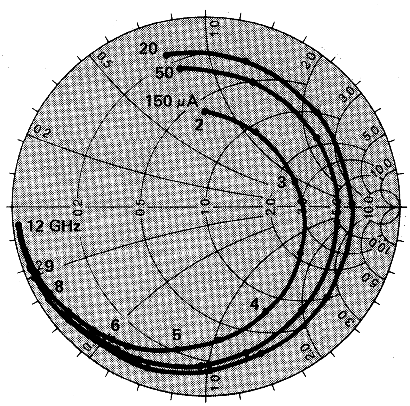


Figure 14. Typical Admittance Characteristics, 5082-2565 with External Bias.

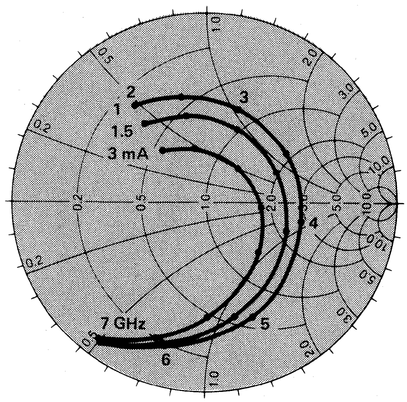


Figure 15. Typical Admittance Characteristics, 5082-2520 with Self Bias.

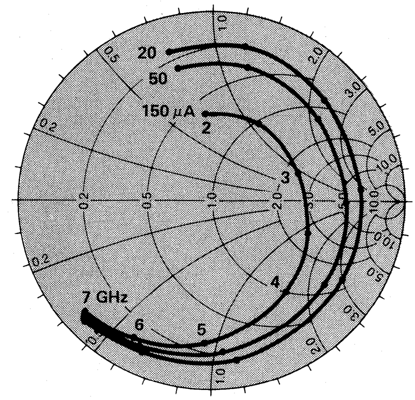


Figure 16. Typical Admittance Characteristics, 5082-2520 with External Bias.

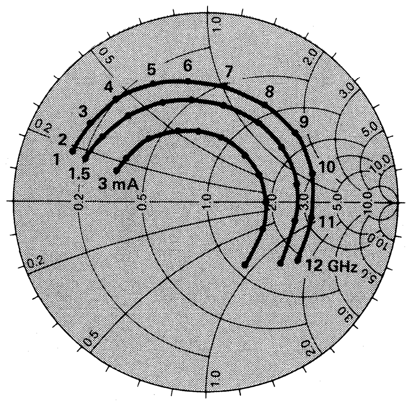


Figure 17. Typical Admittance Characteristics, 5082-2713 with Self Bias.

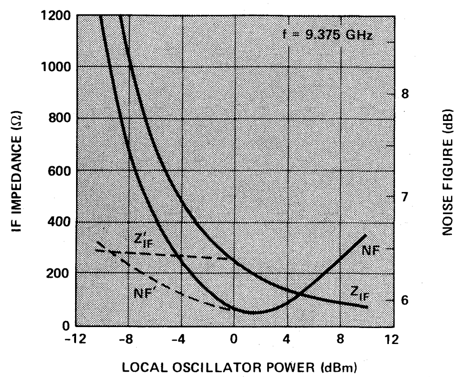


Figure 18. Typical Noise Figure and IF Impedance for 5082-2711 vs. Local Oscillator Power. Note the improved performance at low levels of LO power when dc bias is superimposed (dashed curves). (The Mount is tuned for Minimum Noise Figure at each LO Level).

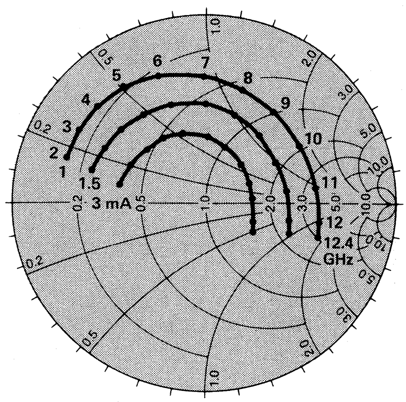


Figure 19. Typical Admittance Characteristics, 5082-2711 with Self Bias.

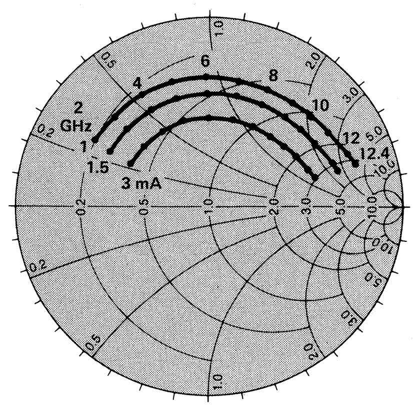


Figure 20. Typical Admittance Characteristics, 5082-2701 with Self Bias.

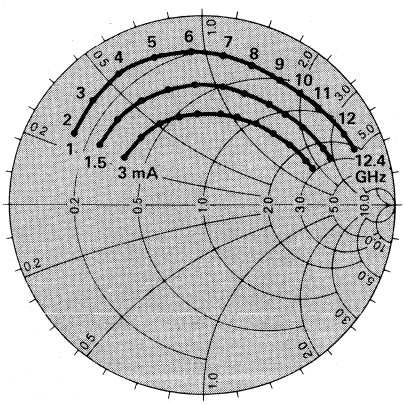


Figure 21. Typical Admittance Characteristics, 5082-2702 with Self Bias.

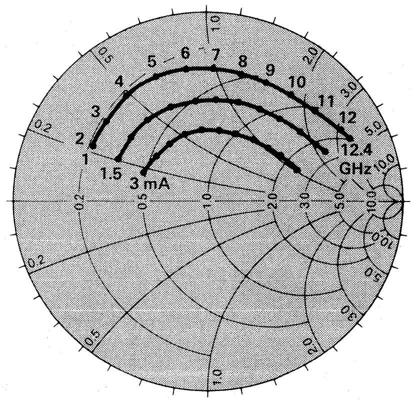


Figure 22. Typical Admittance Characteristics, 5082-2295 with Self Bias.

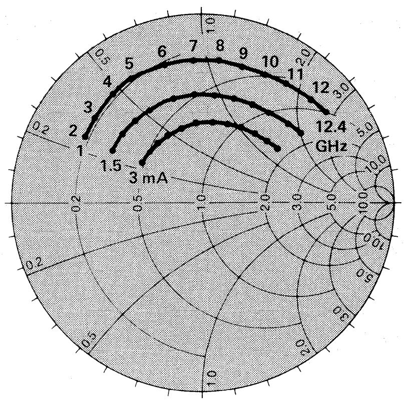


Figure 23. Typical Admittance Characteristics, 5082-2297 with Self Bias.

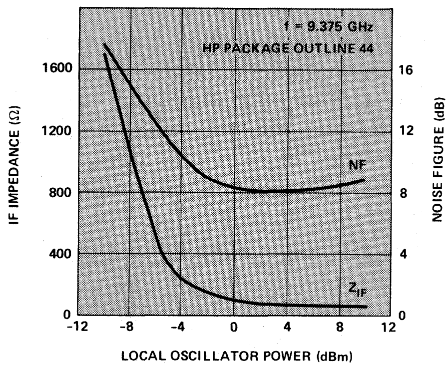


Figure 24. Typical Noise Figure and IF Impedance vs. Local Oscillator Power, 5082-2295 through -2298. Diode unmatched in 50 Ω line..

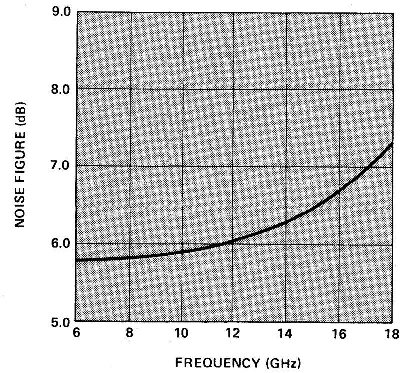


Figure 25. Typical Noise Figure vs. Frequency. IF = 30 MHz, NF_{IF} = 1.5 dB, P_{LO} = 1 mW. Diode tuned at each frequency (5082-2200, -2700 series).

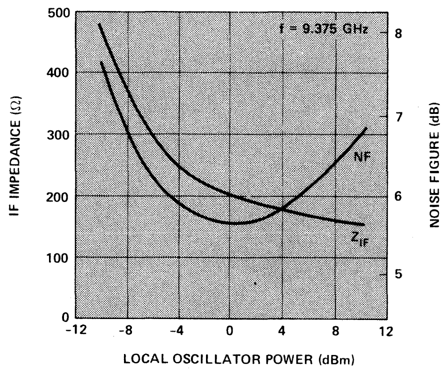


Figure 26. Typical Noise Figure and IF Impedance vs. Local Oscillator Power. Diode tuned at each local oscillator power level (5082-2295).

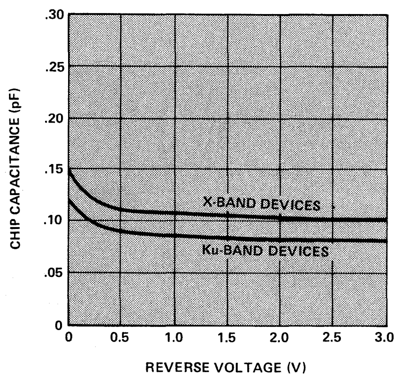


Figure 27. Typical Chip Capacitance vs. Reverse Voltage, -2700 Series.

HEWLETT PACKARD

ZERO BIAS SCHOTTKY DIODES FOR MIXERS AND DETECTORS

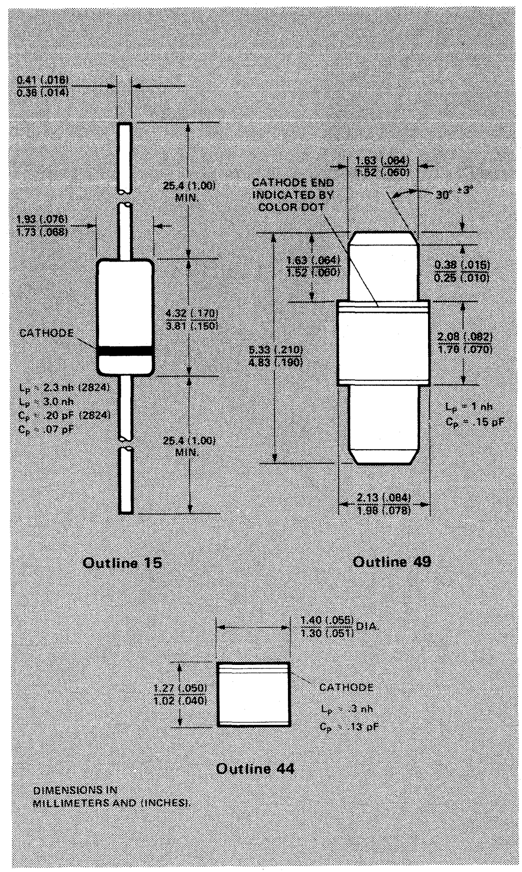
HSCH-3206/07 HSCH-3486

Features

HIGH VOLTAGE SENSITIVITY

NO BIAS REQUIRED

CHOICE OF HIGH OR LOW VIDEO IMPEDANCE



Description/Applications

The high zero bias voltage sensitivity of these Schottky Barrier diodes makes them ideally suitable for narrow bandwidth video detectors, ECM receivers, and measurement equipment. These diodes also make excellent mixers for use with low power LO.

Maximum Ratings

Operating and Storage Temperature Range .... –65° C to +150° C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10⁷ hours.

CW Power Dissipation at T_A = 25° C

HSCH-3206, -3207 .... 200 mW

HSCH-3486 .... 300 mW

Derate Linearly to 0 W at 150° C

Pulse Power Dissipation at T_A = 25° C.

Peak power incident.

1 μs pulse, Du = 0.001 .... 1 W

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

The HP Outline 15 package has a glass hermetic seal with gold plated Dumet leads which should be restricted so that the bend starts at least 1/16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750, Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230° C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds.

Electrical Specifications at $T_A = 25°C$

Part Number	Package Outline	Maximum Tangential Sensitivity TSS (dBm)	Minimum Voltage Sensitivity γ (mV/μW)	Video Resistance R_V (KΩ) Min.	Max.	Typical Total Capacitance C_T (pF)
HSCH-3207	44	-42	8	80	300	0.30
HSCH-3206	49	-42	10	100	300	0.30
HSCH-3486	15	-54	7.5	2	8	0.30
Test Conditions		Video Bandwidth = 2 MHz f_{test} = 10 GHz	Power in = -40 dBm f_{test} = 10 GHz			V_R = 0 V f = 1 MHz

Note:
For HSCH-3207, -3206, I_R = 10 μA (max) at V_R = 3 V at T_A = 25° C. For reverse characteristics of HSCH-3486 see Figure 3.

Typical Characteristics

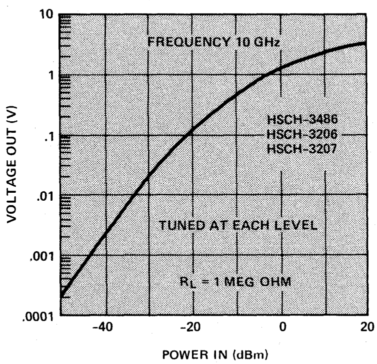


Figure 1. Typical Dynamic Transfer Characteristics.

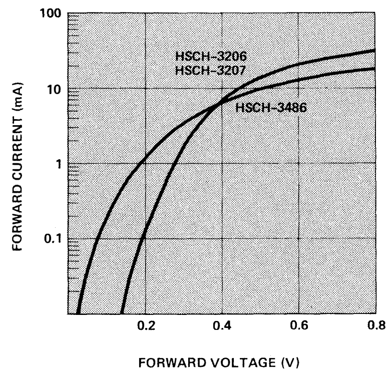


Figure 2. Typical Forward Characteristics at T_A = 25° C.

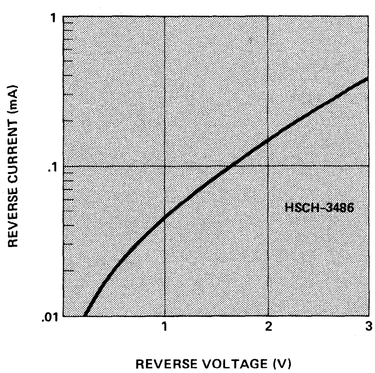


Figure 3. Typical Reverse Characteristics at T_A = 25° C.

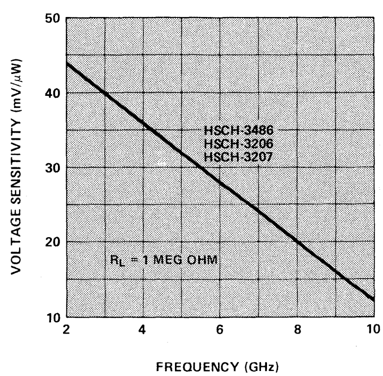


Figure 4. Typical Voltage Sensitivity vs. Frequency.

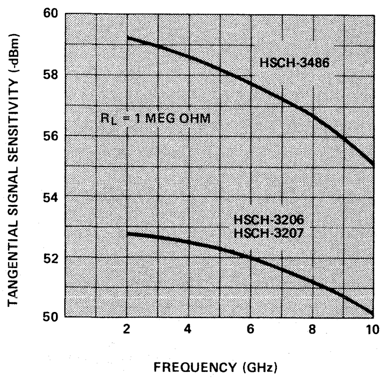


Figure 5. Typical Tangential Sensitivity vs. Frequency.

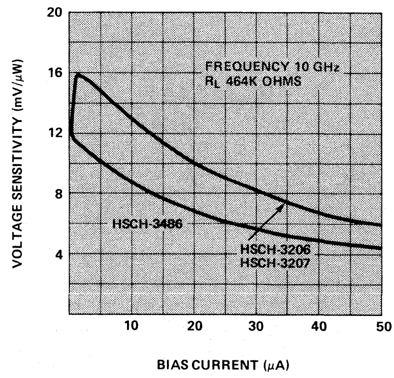


Figure 6. Typical Voltage Sensitivity vs. Bias Current.

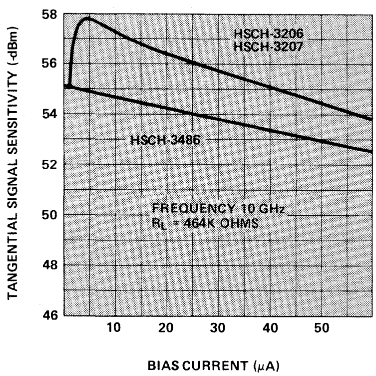


Figure 7. Typical Tangential Sensitivity vs. Bias Current.

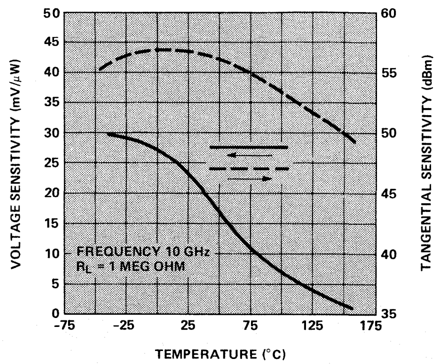


Figure 8. Effect of Temperature on HSCH-3486.

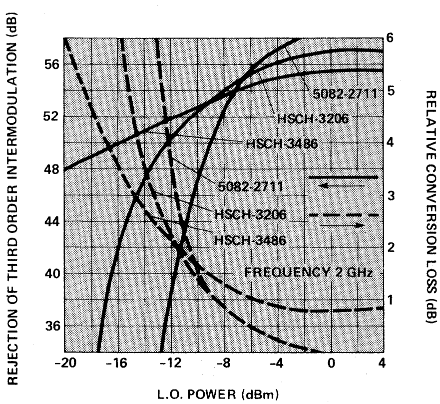


Figure 9. Mixer Performance.

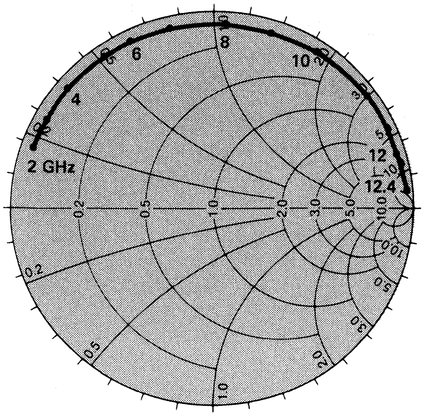


Figure 10. Typical Admittance Characteristics, HSCH-3206.

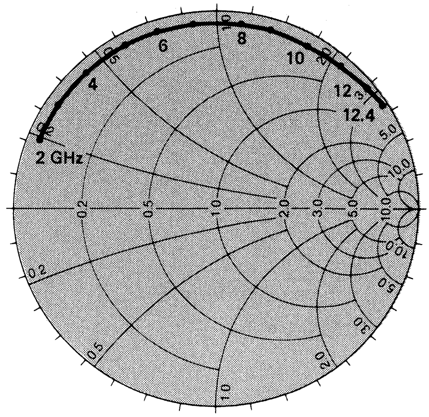


Figure 11. Typical Admittance Characteristics, HSCH-3207.

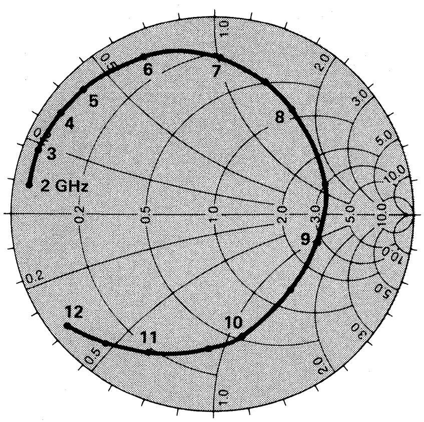


Figure 12. Typical Admittance Characteristics, HSCH-3486.

HEWLETT PACKARD	# SCHOTTKY BARRIER DIODES FOR DETECTORS **5082-2750/51** **5082-2755** **5082-2787** **5082-2824**

Features

IMPROVED DETECTION SENSITIVITY
TSS OF -55 dBm at 10 GHz

LOW 1/f NOISE
Typical Noise-Temperature Ratio = 4 dB at 1 kHz

HIGH PEAK POWER DISSIPATION
4.5 W RF Peak Pulse Power

Description / Applications

The low 1/f noise and high voltage sensitivity make these Schottky barrier diodes ideally suitable for narrow bandwidth video detectors, and Doppler mixers as required in Doppler radar equipment, ECM receivers, and measurement equipment.

Maximum Ratings

Junction Operating and Storage Temperature Range

5082-2824	-65°C to +200°C
All Others	-60°C to +150°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

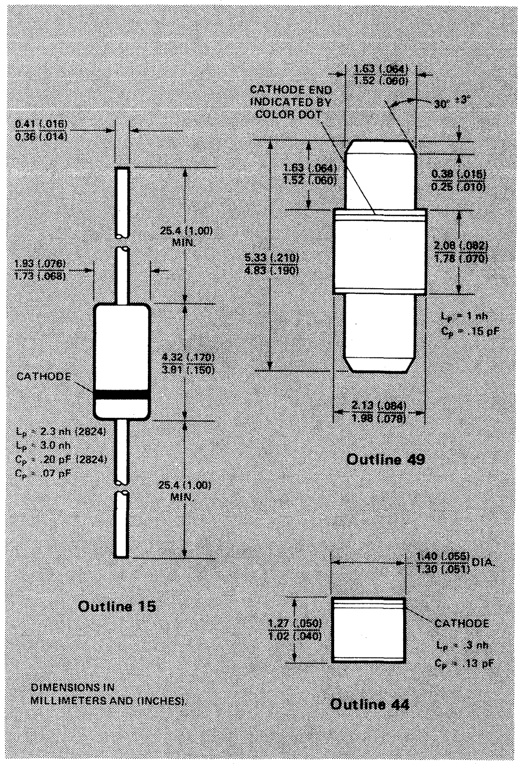
DC Power Dissipation — Power Absorbed by Diode
Derate Linearly to zero at Maximum Temperature

5082-2824	250 mW
All Others	100 mW
Soldering Temperature	230°C for 5 sec.

RF Peak Pulse Power at T_{CASE} = 25°C (Pulse Width = 1 μs, Du = 0.001)

5082-2824 (Power Absorbed by Diode)	4.5 W
All Others (Power Incident)	2.0 W
Maximum Peak Inverse Voltage (PIV)	V_{BR}

Note: The 2700 series diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Package Characteristics

The HP Outline 15 package has a glass hermetic seal with plated Dumet leads which should be restricted so that the bend starts at least 1.16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750, Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230°C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230°C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230°C for 5 seconds.

Electrical Specifications at $T_A = 25°C$ / Typical Parameters

Part Number 5082-	Package Outline	Maximum Tangential Sensitivity TSS (dBm)	Voltage Sensitivity Minimum γ (mV/μW)	Video Resistance R_V (kΩ) Min.	Video Resistance R_V (kΩ) Max.	Minimum Breakdown Voltage V_{BR} (V)	Typical: Noise Temperature Ratio at f (dB)	Typical: Junction Capacitance C_{JO} (pF)
2824		-56	6.0		1.5	15	2 at 20 kHz 8 at 1 kHz	1.0
2787*	15	-52	3.5	1.2	1.8			.12
2755						4	5.0 at 20 kHz 15.0 at 1 kHz	
2751	49	-55	5		1.6			.1
2750	44							
Test Conditions		Video Bandwidth = 2 MHz f_{RF} = 2 GHz for 5082-2824, 10 GHz for all others I_{BIAS} = 20 μA; Video Amp. Eq. Noise, R_A = 500Ω.	Same as for TSS at RF Signal Power Level of -40 dBm. Load Resistance = 100kΩ			I_R = 10 μA	R_V = 50Ω	V = 0

*RF Parameters for the 5082-2787 are sample tested only.

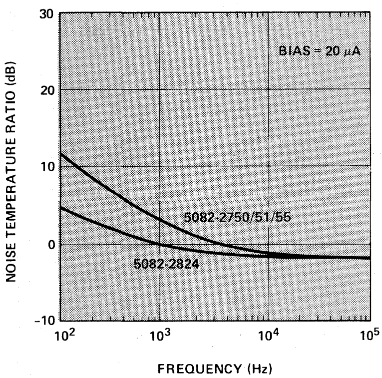


Figure 1. Typical Flicker (1/f) Noise vs. Frequency.

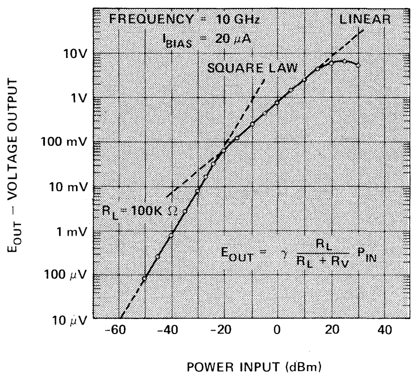


Figure 2. Typical Dynamic Transfer Characteristic. (5082-2750 Series).

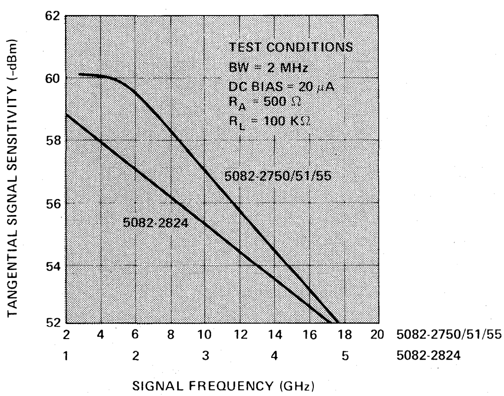


Figure 3. Typical TSS vs. Frequency.

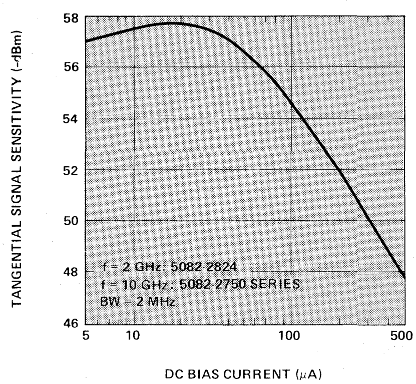


Figure 4. Typical TSS vs. Bias.

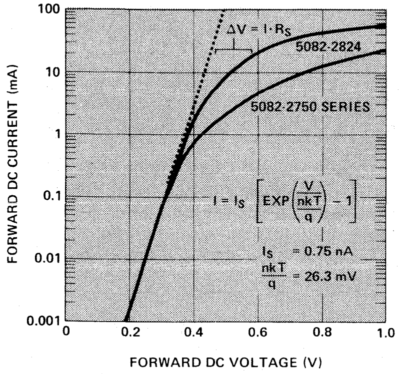


Figure 5. Typical Forward Characteristics at $T_A = 25°C$.

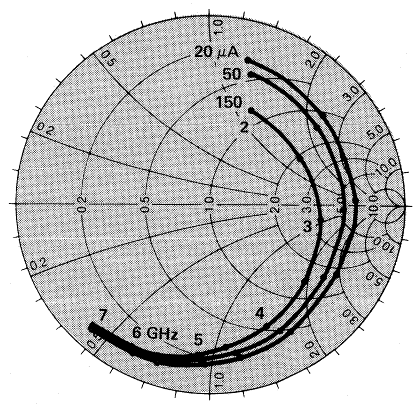


Figure 6. Typical Admittance Characteristics, 5082-2824 with external bias.

Schottky Barrier Diodes

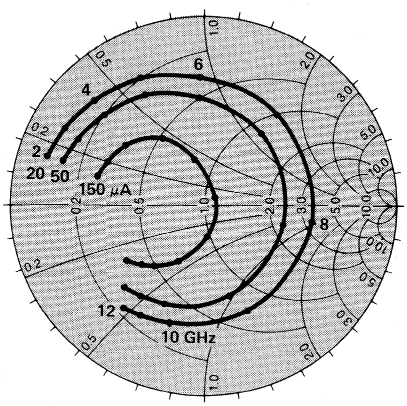


Figure 7. Typical Admittance Characteristics, 5082-2755 with external bias.

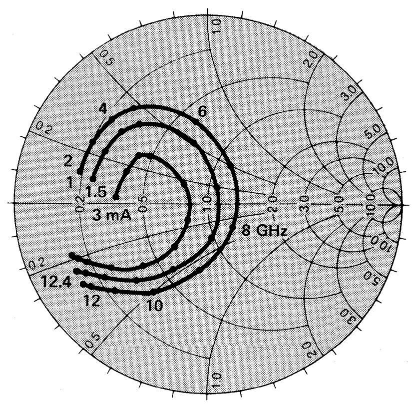


Figure 8. Typical Admittance Characteristics, 5082-2755 with self bias.

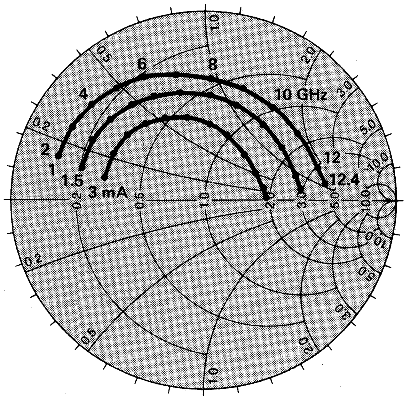


Figure 9. Typical Admittance Characteristics, 5082-2751 with self bias.

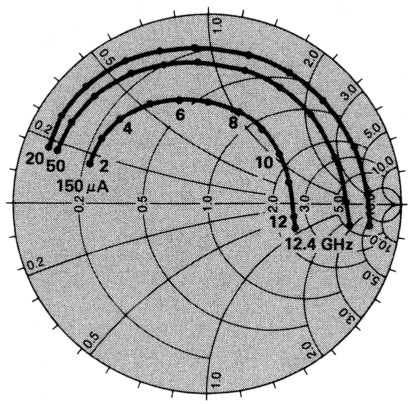


Figure 10. Typical Admittance Characteristics, 5082-2751 with external bias.

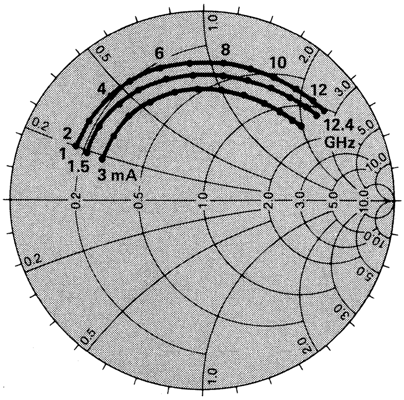


Figure 11. Typical Admittance Characteristics, 5082-2750 with self bias.

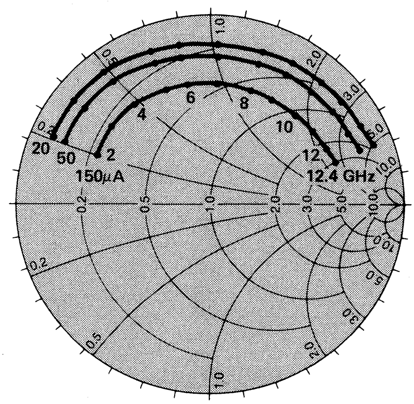


Figure 12. Typical Admittance Characteristics, 5082-2750 with external bias.

High Reliability Data for Schottky Diodes

HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY CHIP FOR MEDICAL APPLICATIONS (Generic 5082-0024)

HSCH-1111

Features

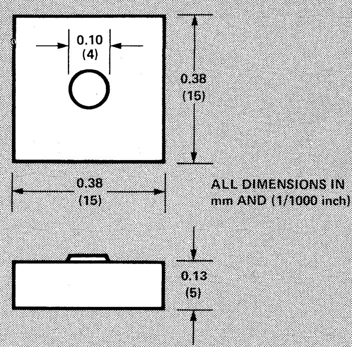
JAN-TXV EQUIVALENT

HIGH BREAKDOWN VOLTAGE

PICO-SECOND SWITCHING SPEED

LOW TURN-ON

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline Drawing

Program Description

Medical life support equipment requires highly reliable components. To meet that requirement, Hewlett-Packard's policy is to supply only components which have been tested in the equivalent of a JAN-TXV program.

The components and documentation supplied conform to the present requirements imposed by the Food and Drug Administration regulations concerning medical devices. It will be standard practice for all orders of life support application components to: (1) be shipped with a statement confirming release to ship by the Product Assurance Department, (2) be provided with traceability of the testing done, and (3) be packaged so they can go into customer stock with minimum handling.

The reliability tests possible for components supplied in chip form are inadequate to condition and screen them thoroughly. The customer must rely on the screening tests he performs on his finished device in order to eliminate chips that are subject to early life failure. To provide the highest confidence that the screening tests on the finished device will be successful, HP will conduct JAN-TXV type qualification tests on packaged samples from the lot of chips and ship only from accepted lots. Qualification data are available upon request.

Maximum Ratings

Operating and Storage Temperature
Range .... -65° C to 200° C
When assembled in hermetic packages, operation of these devices within the recommended temperature limits will assure a device Mean Time to Failure (MTTF) of approximately 1 x 10^7 hours.

Reverse Voltage (Working) .... 50 V (peak)

Power Dissipation at T_{CASE} = 25° C .... 250 mW
(Derate Linearly at 1.43mW/° C to Zero at 200° C)

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C (Similar to 5082-0024)

Specification	Symbol	Min.	Max.	Units	Test Condition
Breakdown Voltage	V_{BR}	70	—	V	I_R = 10 μA
Forward Voltage	V_{F1}	—	.41	V	I_{F1} = 1 mA
Forward Voltage	V_{F2}	—	1.0	V	I_{F2} = 15 mA
Reverse Leakage Current	I_R	—	50	nA	V_R = 50 V
Capacitance	$C_{J(o)}$	—	1.7	pF	V_R = 0 V and f = 1 MHz

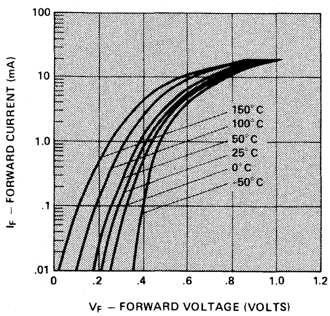
TABLE II. 100% INSPECTION FOR HSCH-1111 SCHOTTKY CHIPS

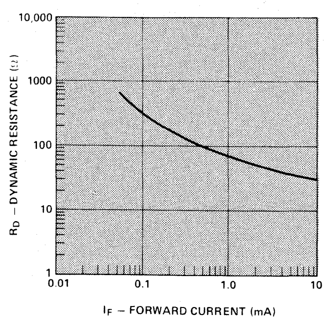
Inspection	MIL-STD-750 Method	Conditions
1. Electrical Test (Die Probe) V_{BR}, V_{F1}, I_R, $C_{j(o)}$	—	Per Table I.
2. Visual Inspection	2073	

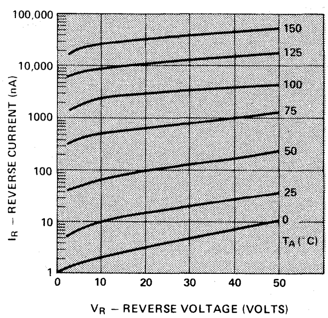
TABLE III. WAFER LOT ACCEPTANCE TEST FOR HSCH-1111

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Bond Strength	MIL-STD-883 Method 2011, Cond. D	Condition A, n = 11, r = 1	20
2. Die Shear Strength (48 hrs. bake at 200° C prior to this test).	MIL-STD-883 Method 2019	n = 11, r = 1	20
3. Assembly in Suitable Carriers	—	—	
4. Electrical Test (Go/No Go)	—	—	
5. Thermal Shock (Temperature Cycling)	1051		
6. Constant Acceleration	2006	20 KG at Y_1	
7. Interim Electrical Test (V_F, V_{BR}, I_R, C_J)		Per Table I	
8. High Temperature Life (Non-Operating)	1032	t = 340 Hours at 200° C	10
9. Interim Electrical Test	—	Per Table I	
10. Operating Life	1038	Condition B, I_O = 33 mA, V_{RM} = 50 V, f = 60 Hz, T_A = 25° C, t = 340 hrs.	10
11. Final Electrical Test	—	Per Table I	
12. Electrical Stability Verification	—	$\Delta V_F \leq 41$ mV at 1 mA $\Delta V_{BR} \leq 5$ V at 10 μA $\Delta I_R \leq 50$ nA at 50 V	

Typical Parameters







HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD SCHOTTKY DIODES FOR MIXERS AND DETECTORS

TXVW-5300 SERIES

Features

PLATINUM TRI-METAL SYSTEM
Higher Temperature

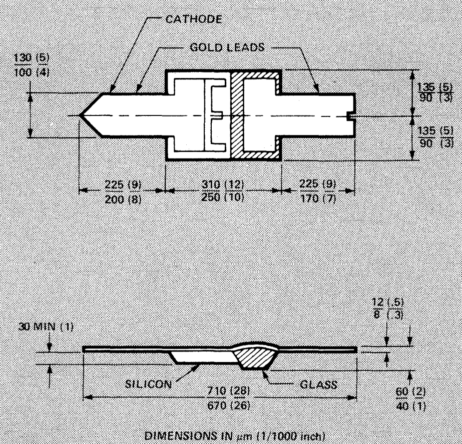
NITRIDE PASSIVATION
Stable, Reliable Performance

LOW NOISE FIGURE
6 dB Typical at 9 GHz

HIGH UNIFORMITY
Tightly Controlled Process Insures Uniform RF Characteristics

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline 07

Description/Applications

This family consists of medium and low barrier microwave Schottky diodes available as hybrid beam leads or mounted in easily handled carrier packages. Hewlett-Packard has developed a cost effective standard test program designed to screen these microwave Schottky diodes for applications requiring high-reliability performance.

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance (C_T (pF)	Maximum Leakage Current I_R (nA)	Typical Forward Voltage V_F (mV)
5318	Medium	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	500	450
5314		7.2 at 16 GHz					18	0.15		
5338	Low	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	500	300
5334		7.2 at 16 GHz					18	0.15		
Test Conditions		DC Load Resistance = 0 Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				I_R = 10 μA	I_F = 5 mA	V_R = 0 V f = 1 MHz	V_R = 1V	I_F = 1 mA

ELECTRICAL SPECIFICATIONS FOR DC TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Typical Forward Voltage V_F (mV)
5316	Medium	4	12	0.25	450
5312			18	0.15	
5310			25	0.10	
5336	Low	4	12	0.25	300
5332			18	0.15	
5330			25	0.10	
Test Conditions		$I_R = 10\ \mu A$	$I_F = 5$ mA	$V_R = 0$ V f = 1 MHz	$I_F = 1$ mA

High Reliability Program

One level of high rel screening is offered for beam lead diodes, which consists of 100% inspection and lot acceptance testing (See Table II). Tables III and IV detail the tests performed. Diodes screened to this program can be ordered as TXVW-53XX.

TABLE II. HIGH RELIABILITY TEST LEVELS

Beam Lead[1]	Inspection Level
HSCH-53XX	Commercial
TXVW-53XX	100% Inspection, visual, and lot acceptance test

Note 1: Beam Leads: Entire HSCH-5300 Series.

Schottky Barrier Diodes

TABLE III. 100% INSPECTION PROGRAM FOR HSCH-5300 SERIES BEAM LEADS (OUTLINE 07)

Screening Test/Inspection	MIL-STD-750 Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 hours at 300° C
2. Electrical Test (Die Probe) V_F, I_R, C_J	—	Per Table I
3. Visual Inspection	HP A5956-0112-72[1]	High Reliability Visual

Notes: 1. Specification available upon request.

TABLE IV. LOT ACCEPTANCE TEST FOR HSCH-5300 SERIES BEAM LEADS (OUTLINE 07)

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Beam Pull Test	MIL-STD-883 Method 2011 Cond. H	Condition H (4 grams min.), n = 11, r = 1	20
2. Assemble Samples in H3 Carrier	—	—	
3. Electrical Test (Go/No Go) V_{BR}, I_R, V_F, C_T	—	Per Table I	
4. Temperature Cycle	1051	F - 10 cycles 15 min. at extremes −65° to 200° C	
5. Interim Electrical Test	—	Read and record	
6. High Temperature Life (Non-Operating)	1032	340 hours at 200° C	10
7. High Temperature Reverse Bias (HTRB)	1038	$V_R = 1.0$ V dC $T_A = 150°C$, t = 240 hours	
8. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
9. Operating Life (LTPD = 10)	1038	$I_O = 10$ mA DC $T_A = 125°C$, t = 340 hours	10
10. Final Electrical Test (I_R, V_F, C_T)	—	Per Table I	
11. Stability Verification	—	$\Delta C_T = 0.05$ pF $\Delta V_F = 10\%$	

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD SCHOTTKY DIODE PAIRS FOR MIXERS AND DETECTORS

TXVW-5500 SERIES

Features

MONOLITHIC PAIR
Closely Matched Electrical Parameters

LOW CAPACITANCE
0.10 pF Max. at 0 Volts

LOW NOISE FIGURE
7.0 dB at 16 GHz

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

PLATINUM TRI-METAL SYSTEM
High Temperature

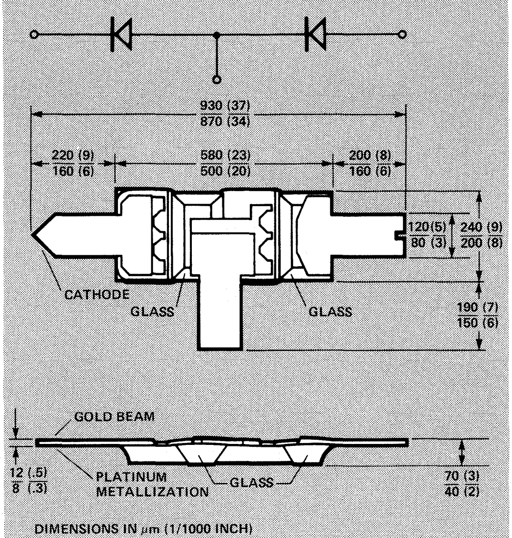
POLYIMIDE SCRATCH PROTECTION

NITRIDE PASSIVATION
Stable, Reliable Performance

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

Description/Applications

This family consists of medium and low barrier microwave Schottky diodes available as hybrid beam leads or mounted in easily handled carrier packages. Hewlett-Packard has developed a cost effective standard test program designed to screen these microwave Schottky diodes for applications requiring high-reliability performance.



Outline 04

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5510	Medium	7.0 @ 16 GHz	200	400	1.5:1	4V	20	3	0.10	0.02	500	10
5530	Low										375	
Test Conditions		DC Load Resistance = 0Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				$I_R < 10$ μA	I_F = 5 mA		V_R = 0V f = 1 MHz		I_F = 1 mA	

ELECTRICAL SPECIFICATIONS FOR DC TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5511	Medium	4V	20	3	0.10	0.02	500	10
5531	Low						375	
Test Conditions		$I_R = 10$ μA	I_F = 5 mA		V_R = 0V f = 1 MHz		I_F = 1 mA	

High Reliability Program

One level of high rel screening is offered for beam lead diodes, which consists of 100% inspection and lot acceptance testing (see Table II). Tables III and IV detail the tests performed. Diodes screened to this program can be ordered as TXVW-55XX.

TABLE II. HIGH RELIABILITY TEST LEVELS

Beam Lead[1]	Inspection Level
HSCH-55XX	Commercial
TXVW-55XX	100% Inspection, visual, and lot acceptance test

Note 1: Beam Leads: Entire HSCH-5500 series.

TABLE III. 100% INSPECTION PROGRAM FOR HSCH-5500 SERIES BEAM LEADS (OUTLINE 04)

Screening Test/Inspection	MIL-STD-750 Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 hours at 300° C
2. Electrical Test (Die Probe)	—	Per Table I
3. Visual Inspection	HP A5956-0112-72[1]	High Reliability Visual

Notes:
1. Specification available upon request.

TABLE IV. LOT ACCEPTANCE TEST FOR HSCH-5500 SERIES BEAM LEADS (OUTLINE 04)

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Beam Pull Test	MIL-STD-883 Method 2011 Cond. H	Condition H (4 grams min.) n = 11, r = 1	20
2. Assemble Samples in H3 Carrier	—	—	
3. Electrical Test (Go/No Go)	—	Per Table I	
4. Temperature Cycle	1051	F - 10 cycles 15 min. at extremes −65° to 200° C	
5. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
6. High Temperature Life (Non-Operating)	1032	340 hours at 200° C	10
7. High Temperature Reverse Bias (HTRB)	1038	V_R = 1.0 V dC T_A = 150° C, t = 240 hours	
8. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
9. Operating Life (LTPD = 10)	1038	I_O = 10 mA DC T_A = 125° C, t = 340 hours	10
10. Final Electrical Test (I_R, V_F, C_T)	—	Per Table I	
11. Stability Verification	—	ΔC_T = 0.05 pF ΔV_F = 10%	

HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY BARRIER DIODES FOR MIXERS AND DETECTORS

(Generic 5082-2301, -2306, -2400, -2401)

HSCH-0813
HSCH-0814
HSCH-0815
HSCH-0816

Features

LOW 1/F NOISE

LOW AND STABLE NOISE FIGURE

HIGH UNIFORMITY

HIGH BREAKDOWN VOLTAGE: 30 VOLTS

MATCHED CHARACTERISTICS AVAILABLE

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

Description

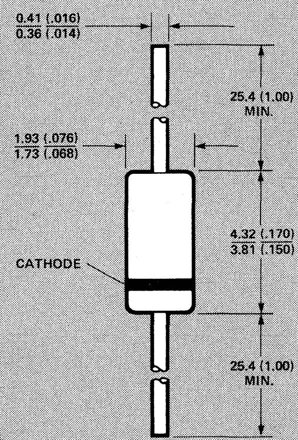
The HSCH-0813, -0814, -0815, -0816 devices are unpassivated Schottky diodes in a glass package. These diodes have extremely low 1/f noise and are ideal for low noise mixing, and high sensitivity detecting. They are particularly well suited for use in Doppler or narrow band video receivers.

Maximum Ratings

Junction Operating and Storage
Temperature Range .... -60° C to +100° C

Operation of these devices within the above temperature ratings will assure a device Mean Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Power Dissipation at T_{CASE} = 25° C .... 100 mW
Derate linearly at 1.33 mW/° C to zero at 100° C



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODE AT T_A = 25° C
(Similar to 5082-2400)

Part Number HSCH-	Matched Pair* HSCH-	Barrier	LO Test Frequency (GHz)	Maximum SSB Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Maximum Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)
0814	0813	Medium	2.0	6.0	150	350	1.3:1	1.0	30
Test Conditions	$\Delta NF \leq 0.3$ dB $\Delta Z_{IF} \leq 25\Omega$		LO Power = 1 mW IF = 30 MHz, 1.5 dB NF Zero DC Load Resistance		Same as for NF except IF = 10 KHz		Same as for NF	V_R = 0V f = 1.0 MHz	I_R = 10 μA

*Match performed after 100% screening.

ELECTRICAL SPECIFICATIONS FOR DC TESTED DIODE AT T_A = 25° C
(Similar to 5082-2301)

Part Number HSCH-	Matched Pair* HSCH-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1V Max. at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at	V_R (V)	Maximum Capacitance C_T (pF)
0816	0815	30	400	50	300	15	1.0
Test Conditions	$\Delta V_F \leq 10$ mV $\Delta C_O \leq 0.2$ pF	I_R = 10 μA	I_F = 1 mA				V_R = 0 V f = 1.0 MHz

*Match performed after 100% screening.

High Reliability Conditioning and Lot Acceptance

(All test methods are per MIL-STD-750 unless otherwise specified)

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual Inspection	—	Per H.P. Method A-5956-0562-72
2. High Temperature Storage (Stabilization Bake)	1032	$t = 48$ hours., $T_A = 100°C$
3. Thermal Shock (Temperature Cycling)	1051	Condition B. −55°C to +100°C
4. Constant Acceleration	2006	200 KG. Y_1 axis.
5. Hermeticity Tests Fine Leak Gross Leak	1071	Condition H. Condition E.
6. Interim Electrical Tests (V_{BR}, I_R, V_F)		Per Table I. $T_A = 25°C$.
7. Burn-in	1038	$P_{FM} = 75$ mW, $V_R = 15$ V (pk) $T_A = 25°C$ $f = 60$ Hz., $t = 168$ hours
8. Final Electrical Tests (V_{BR}, I_R, V_F)		Per Table I. $T_A = 25°C$
9. Drift Evaluation PDA = 10%[1]		$\Delta I_R = 200$ nA or 100% whichever is greater. $\Delta V_F = \pm 50$ mV.
10. Electrical Tests (NF, SWR) HSCH-0813 and HSCH-0814 only		

Note:
1. If rejects are greater than 10% but less than 20%, one more burn-in may be performed with a new 10% PDA.

GROUP A INSPECTION

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 External Visual and Mechanical	2071		5
Subgroup 2 Electrical Test (C_T)		Per Table I.	10
Subgroup 3 D.C. and RF Parameters at 25°C		Satisfied by 100% measurements at post burn-in.	

GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Moisture Resistance End Points (V_{BR}, I_R, V_F)	1021	Omit initial conditioning Per Table I.	10
Subgroup 2 High Temperature Non Operating Life End Points (V_{BR}, I_R, V_F)	1031	$T_A = 100°C$, $t = 1000$ hours Per Table I.	10
Subgroup 3 Operating Life End Points (V_{BR}, I_R, V_F)	1038	$P_{FM} = 75$ mW, $V_R = 15$ V (peak), $f = 60$ Hz, $T_A = 25°C$, $t = 1000$ hours.	10

HEWLETT PACKARD	SCHOTTKY SWITCHING DIODE MILITARY APPROVED MIL-S-19500/444	JAN 1N5711 JANTX 1N5711 JANTXV 1N5711

SCHOTTKY SWITCHING DIODE MILITARY APPROVED MIL-S-19500/444

Features

HIGH BREAKDOWN VOLTAGE
PICO-SECOND SWITCHING SPEED
LOW TURN-ON

Description/Applications

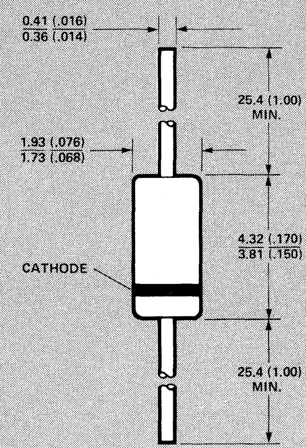
The JAN Series 1N5711 is an epitaxial, planar passivated Schottky Barrier Diode designed to have pico-second switching speed. These devices are well suited for high level detecting, mixing, switching, gating and converting, video detecting, frequency discriminating, sampling, and wave shaping applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings at $T_{CASE} = 25°C$

Operating and Storage Temperature
Range .... -65°C to 200°C

Operation of these devices within the recommended temperature limits will assure a device Mean Time to Failure (MTTF) of approximately 1 x 10^7 hours.

Reverse Voltage (Working) .... 50 V (peak)
Power Dissipation at $T_{CASE} = 25°C$ .... 250 mW
Derate linearly at 1.43 mW/°C to zero at 200°C



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$ (Unless otherwise specified)
(Per Table I, Group A Testing of MIL-S-19500/444)

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	70	–	V	$I_R = 10\mu A$
Forward Voltage	V_{F1}	–	.41	V	$I_{F1} = 1mA$
Forward Voltage	V_{F2}	–	1.0	V	$I_{F2} = 15mA$
Reverse Leakage Current	I_R	–	200	nA	$V_R = 50V$
Reverse Leakage Current	I_R	–	200	μA	$V_R = 50V$, $T_A = +150°C$
Capacitance	$C_{T(o)}$	–	2.0	pF	$V_R = 0V$ and f = 1MHz
Effective Minority Carrier Lifetime	τ	–	100	pS	$I_F = 5mA$ Krakauer Method (Note 1)

Note 1: Per DESC drawing C-68001

JAN 1N5711: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/444.

JANTX 1N5711: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/444***. A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5711 above.

JANTXV 1N5711: Devices are subject to 100% visual inspection in accordance with MIL-S-19500/444 prior to being subjected to TX screening.

***JANTX and JANTXV devices have gold plated leads.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. High Temperature Storage (Stabilization Bake)	1032	$t = 48$ hours, $T_A = 200°C$
2. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
3. Centrifuge (Constant Acceleration)	2006	20 KG, Y_1 axis.
4. Hermeticity Tests Fine Leak Gross Leak	1071	Condition H. Condition E
5. Interim Electrical Tests (I_R, V_F)		See Table I
6. Burn-In	1038	$I_O = 33$ mA, $V_R = 50$ V (peak) $T_A = 25°C$, $f = 60$ Hz, $T = 96$ hours.
7. Final Electrical Tests and Drift Evaluation (I_R, V_{BR}) 10% PDA		$\Delta I_R \leq 50$ nA or 100% whichever is greater $\Delta V_F = \pm 41$ mV dc.

TABLE III. GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 Electrical Tests at 25°C	—	V_{BR}, V_{F1}, V_{F2}, I_{R1}, C_{TO} and τ per Table I.	2
Subgroup 3 High Temperature Operation ($T_A = 150°C$) Reverse Currrent (I_{R2})	—	Per Table I.	5

TABLE IV. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Physical Dimensions	2066		15
Subgroup 2			
Solderability	2026	Immerse to within 0.1 inch of body.	10
Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles	
Thermal Shock (Glass Strain)	1056	Condition A	
Terminal Strength (Tension)	2036	Condition A, 15 secs., 2 lbs.	
Hermetic Seal	1071	Condition E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	

Schottky Barrier Diodes

TABLE IV. GROUP B INSPECTION (Cont.)

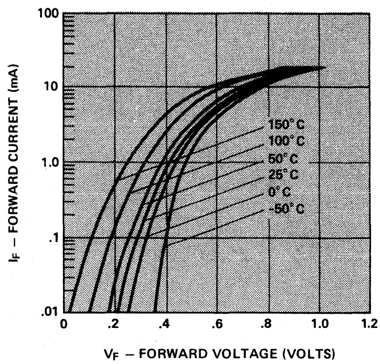
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 3			
Shock	2016	Non-operating; 1500 G; t = 0.5 ms, 5 blows in each orientation X_1, Y_1, Y_2	10
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 KG; X_1, Y_1, Y_2	
End Points: (same as Subgroup 2)			
Subgroup 4			
Terminal Strength; Lead Fatigue	2036	Condition E with lead restriction.	10
Subgroup 5			
High Temperature Life (Non-Operating)	1031	$T_A = 200°C$,[1]	$\lambda = 3$
End Points:			
Breakdown Voltage (V_{BR})	4021	63 V min. at 10 μA	
Forward Voltage (V_F)	4011	1.05 V max. at 15 mA	
Reverse Current (I_R)	4016	300 nA max. at 50 V	
Subgroup 6			
Steady State Operating Life	1026	I_O = 33 mA (avg.); V_R = 50 V (peak) f = 60 Hz, $T_A = 25°C$,[1]	$\lambda = 3$
End Points: (same as Subgroup 5)			

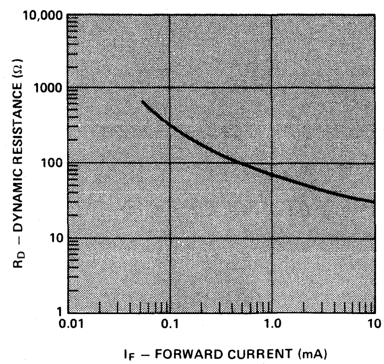
1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

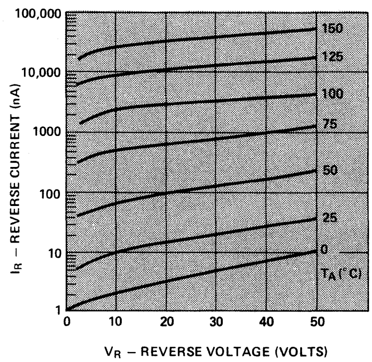
TABLE V. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Salt Atmosphere (Corrosion)	1041		20
Subgroup 2	MIL-STD-202		
Resistance to Solvents	Method 215		10
Subgroup 3			
Thermal Shock (Temperature Cycling)	1051	Condition C. 25 cycles; time at temperature extremes = 15 minutes min. total test time = 72 hours max.	10
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 4			
Low Temperature Operation (−65°C)			20
Forward Voltage (V_{F1})		0.55 V at 1 mA	
Forward Voltage (V_{F2})		1.0 V at 15 mA	
Breakdown Voltage (V_{BR})		70 V at 10 μA	

Typical Parameters







Schottky Barrier Diodes

HEWLETT PACKARD	SCHOTTKY SWITCHING DIODE MILITARY APPROVED MIL-S-19500/445	JAN 1N5712 JANTX 1N5712 JANTXV 1N5712

Features

PICO-SECOND SWITCHING SPEED

LOW TURN-ON VOLTAGE

LOW TEMPERATURE COEFFICIENT

Description/Applications

The JAN Series 1N5712 is an epitaxial, planar passivated Schottky Barrier Diode designed to have pico-second switching speed. These devices are well suited for VHF/UHF mixing and detecting, A/D converting, and switching applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings

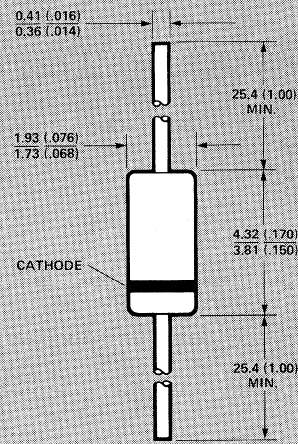
Operating and Storage Temperature
Range .... −65° C to 200° C

Operation of these devices within the recommended temperature limits will assure a device Mean Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Reverse Voltage (Working) .... 16 V (peak)

Power Dissipation at T_{CASE} = 25° C .... 250 mW

Derate linearly at 1.43 mW/° C to zero at 200° C



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C
(Per Table I, Group A Testing of MIL-S-19500/445)

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	20		Vdc	I_R = 10 μA dc
Forward Voltage	V_{F1}		0.55	Vdc	I_{F1} = 1 mA dc
Forward Voltage	V_{F2}		1.0	Vdc	I_{F2} = 35 mA dc
Reverse Leakage Current	I_{R1}		150	nA dc	V_R = 16 V dc
Reverse Leakage Current	I_{R2}		150	μA dc	V_R = 16 V dc, T_A = 150° C
Capacitance	$C_{T(o)}$		1.2	pF	V_R = 0 V and f = 1 MHz
Effective Minority Carrier Lifetime	τ		100	pS	I_F = 5 mA Krakauer Method[1]

Notes:
1. Per DESC drawing C-68001.

JAN 1N5712: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/445.

JANTX 1N5712: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/445* . A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5712 above.

JANTXV 1N5712: Devices are subject to 100% visual inspection in accordance with MIL-S-19500/445 prior to being subjected to TX screening.

*JANTX and JANTXV devices have gold plated leads.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. High Temperature Storage (Stabilization Bake)	1032	$t = 48$ hours, $T_A = 200°C$
2. Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles
3. Centrifuge (Constant Acceleration)	2006	20 KG, Y_1 axis.
4. Hermeticity Tests Fine Leak Gross Leak	1071	Condition G or H. Condition E
5. Interim Electrical Tests (I_R, V_F)		See Table I
6. Burn-In	1038	$I_O = 33$ mA (average), $V_R = 16$ V (peak) $T_A = 25°C$, $f = 60$ Hz, $T = 96$ hours.
7. Final Electrical Tests and Drift Evaluation (I_{R1}, V_{F1}) 10% PDA		$\Delta I_{R1} \leq 30$ nA or 100% whichever is greater $\Delta V_{F1} = \pm 55$ mV

TABLE III. GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	V_{BR}, V_{F1}, V_{F2}, I_{R1}, CT_O, T per Table I.	2
Subgroup 3 High Temperature Operation)$T_A = 150°C$) Reverse Currrent (I_{R2})	4016	per Table I.	2

TABLE IV. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Physical Dimensions	2066		15
Subgroup 2			
Solderability	2026	Immerse to within 0.1 inch of body.	10
Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles	
Thermal Shock (Glass Strain)	1056	Condition A	
Terminal Strength (Tension)	2036	Condition A, 15 secs., 2 lbs.	
Hermetic Seal	1071	Condition E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	

TABLE IV. GROUP B INSPECTION (Cont.)

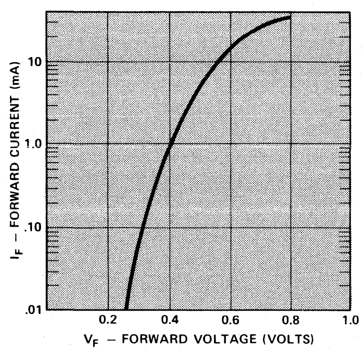
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 3			
Shock	2016	Non-operating; 1500 G; t = 0.5 ms, 5 blows in each orientation X_1, Y_1, Y_2	10
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 KG; X_1, Y_1, Y_2	
End Points: (same as Subgroup 2)			
Subgroup 4			
Terminal Strength; Lead Fatigue	2036	Test Condition E with lead restriction.	10
Subgroup 5			
High Temperature Life (Non-Operating)	1031	$T_A = 200°C$.[1]	λ = 3
End Points:			
Breakdown Voltage (V_{BR})	4021	18 V min. at 10 μA	
Forward Voltage (V_{F2})	4011	1.05 V max. at 35 mA	
Reverse Current (I_{R1})	4016	200 nA max. at 16 V	
Subgroup 6			
Steady State Operating Life	1026	$I_O = 33$ mA; $V_R = 50$ V (peak) f = 60 Hz, $T_A = 25°C$.[1]	λ = 3
End Points: (same as Subgroup 5)			

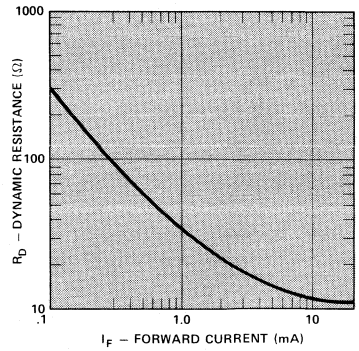
1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

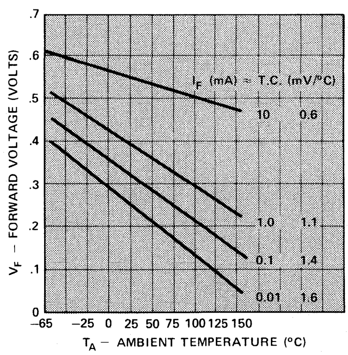
TABLE V. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Salt Atmosphere (Corrosion)	1041		20
Subgroup 2			
Resistance to Solvents	MIL-STD-202 Method 215		10
Subgroup 3			
Thermal Shock (Temperature Cycling)	1051	Condition C. 25 cycles; time at temperature extremes = 15 minutes min., total test time = 72 hours max.	10
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 4			
Low Temperature Operation (−65°C)			20
Forward Voltage (V_{F1})	4011	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Breakdown Voltage (V_{BR})	4021	Per Table I	

Typical Parameters







Schottky Barrier Diodes

HEWLETT PACKARD

HIGH RELIABILITY GENERAL PURPOSE SCHOTTKY BARRIER DIODES

(Generic 5082-2810 and -2811)

TX-2810 TX-2811
TXB-2810 TXB-2811
TXV-2810 TXV-2811
TXVB-2810 TXVB-2811

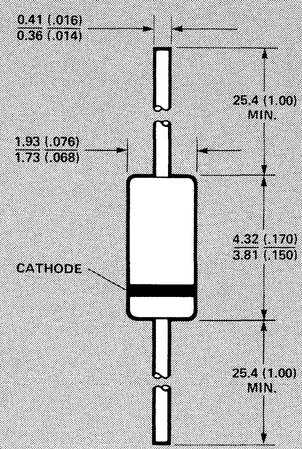
Features

MEDIUM TURN-ON VOLTAGE

PICO-SECOND SWITCHING SPEED

HERMETIC PACKAGE

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

Description/Applications

The 5082-2810 and -2811 are passivated Schottky diodes which use a patented "guard ring" design to achieve a high breakdown voltage. They are packaged in a hermetically sealed glass package. They are well suited for high level detecting, mixing, switching, gating, log or A-D converting, video detecting, frequency discriminating, sampling, and wave shaping.

Maximum Ratings

Operating and Storage Temperature
Range .... –65° C to +200° C
Peak Inverse Voltage .... V_{BR}
Power Dissipation at T_{CASE} = 25° C .... 250 mW
Derate linearly at 1.43 mW/° C to zero at 200° C
Maximum Solder Temperature ..... 230° C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C (UNLESS OTHERWISE SPECIFIED)
Similar to 5082-2810 and 5082-2811

Part Number 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1 V Max. at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at V_R (V)	Maximum Reverse Leakage Current at 125° C I_R (μA) at V_R (V)	Maximum Capacitance C_T (pF)
2810	20	410	35	100 15	150 15	1.2
2811	15		20	100 8	100 8	
Test Conditions	I_R = 10 μA	I_F = 1 mA				V_R = 0 V f = 1.0 MHz

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number	Screening Level
5082-2810 5082-2811	Commercial
TX-2810 TX-2811	100% Screen (per Tables III and IV)
TXB-2810 TXB-2811	100% Screen and Group B (per Tables III, IV and V)
TXV-2810 TXV-2811	100% Screen and Visual (per Tables III and IV)
TXVB-2810 TXVB-2811	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection		MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (TXV only)		2074	
2. High Temperature Storage (Stabilization Bake)		1032	$t = 48$ hours, $T_A = 200°C$
3. Thermal Shock (Temperature Cycling)		1051	Condition C, 10 Cycles
4. Constant Acceleration		2006	20 KG, Y_1 axis
5. Hermeticity Tests	Fine Leak Gross Leak	1071	Condition H Condition C
6. Interim Electrical Tests (V_F, I_{R1})			Per Table I
7. Power Burn-In		1038	Condition B, $t = 96$ hours, $T_A = 25°C$, $V_R = 80\%\ V_{BR}$, $f = 60$ Hz, $I_O = 20$ mA DC (5082-2811), 33 mA DC (5082-2810)
8. Final Electrical Tests (See Table I) and Stability Verification			$\Delta V_F = \pm 55$ mV, $\Delta I_{R1} = \pm 20$ nA or 100% whichever is greater (5082-2811), $\Delta I_{R1} = \pm 30$ nA or 100% whichever is greater (5082-2810)

TABLE IV. GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions (Read and Record)	5
Subgroup 3 Reverse Leakage (I_R) at $T_A = 125°C$	—	See Table I for Tests and Conditions (Read and Record)	5

Schottky Barrier Diodes

TABLE V. GROUP B ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Physical Dimension	2066		15
Subgroup 2			
Solderability	2026		15
Resistance to Solvents	1022		
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Subgroup 3			
Temperature Cycling	1051	Condition C, 10 Cycles	10
Thermal Shock	1056	Condition A	
Terminal Strength	2036	Condition A	
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Moisture Resistance	1021		
Visual and Mechanical	2071		
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Subgroup 4			
Mechanical Shock	2016		10
Vibration, Variable Frequency	2056		
Constant Acceleration	2006		
Electrical Test at 25° C		See Table I	
Subgroup 5			
Terminal Strength	2036	Condition E	15
Subgroup 6			
High Temperature Life (Non-operating)	1032	t = 340 hours, T_A = 200° C	5
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Electrical Stability Verification		$\Delta V_F = \pm 55$ mV, $\Delta I_R = \pm 20$ nA or 100% whichever is greater (5082-2811) $\Delta I_R = \pm 30$ nA or 100% whichever is greater (5082-2810)	
Subgroup 7			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, f = 60 Hz, V_R = 80% V_{BR}, I_O = 20 mA DC (5082-2811) I_O = 33 nA DC (5082-2810)	5
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Electrical Stability Verification		$\Delta V_F = \pm 55$ mV, $\Delta I_R = \pm 20$ nA or 100% whichever is greater (5082-2811) $\Delta I_R = \pm 30$ nA or 100% whichever is greater(5082-2810)	

HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY SWITCHING DIODES
(Generic 5082-2835)

TX-2835
TXV-2835
TXB-2835
TXVB-2835

Features

SUITABLE FOR SPACE APPLICATIONS

LOW TURN-ON VOLTAGE

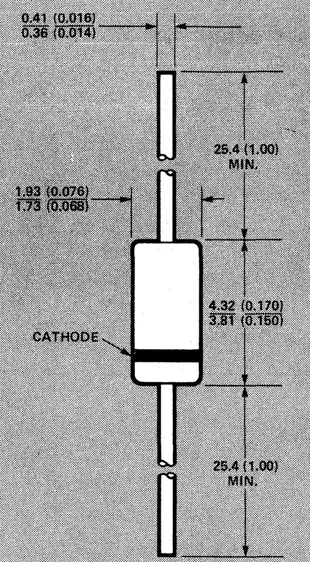
FAST SWITCHING

PLANAR PASSIVATED

LOW TEMPERATURE COEFFICIENT

UNIFORM FORWARD TRACKING

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 15

Description/Applications

The TX-2835 is an epitaxial, planar passivated diode whose construction utilizes a metal-to-silicon junction. This results in extremely low forward voltage drops and ultra high speed switching, for applications that require high reliability screening.

The low forward voltage drop, combined with fast switching and high temperature capability, makes these devices attractive as replacements for germanium and silicon P/N junction diodes in such applications as low level switching, clamping, sampling, reference circuits, and low noise UHF mixers.

The uniformity of forward characteristics with current over the temperature range also makes these units suitable for circuitry requiring tight matching of characteristics.

Maximum Ratings

Power Dissipation at $T_{CASE} = 25°C$ .... 150 mW
Derate linearly at 1.20 mW/°C to zero at 150°C
Operating Temperature Range .... –60°C to +150°C
Storage Temperature Range .... –60°C to +150°C

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Characteristics	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	8		volts	$I_R = 100\ \mu A$
Reverse Current	I_{R1}		100	nA	$V_R = 1$ V
Reverse Current	I_{R2}		100	μA	$V_R = 1$ V, t = 125°C
Forward Voltage	V_{F1}		0.34	volts	$I_F = 1$ mA
Forward Voltage	V_{F2}		0.45	volts	$I_F = 10$ mA
Capacitance	C_{TO}		1.0	pF	$V_R = 0$, f = 1 MHz
Effective Minority Carrier Lifetime	τ		100	psec	$I_F = 20$ mA

PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

TX-2835	Devices undergo 100% screening as specified in Table II and Table III (excluding step 1).
TXV-2835	Devices undergo 100% screening per Table II and Table III.
TXB-2835	Following 100% screen per Table II (delete step 1), samples of lot are subjected to Group A (Table III), and Group B (Table IV).
TXVB-2835	Complete screen and lot qualification per Tables II-IV.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method (Except as Noted)	Conditions
1. Internal Visual	2074	
2. High Temperature Storage	1032	48 Hours minimum at 150°C
3. Temperature Cycling	1051	Condition F — 20 cycles, 10 minutes at extremes (−60°C to ±150°C)
4. Constant Acceleration	2006	20 KG, Y_1 axis
5. Hermetic Seal Fine Leak Gross Leak	1071	Condition H. 5×10^{-8} cc/sec max. Condition E
6. Interim Electrical Test I_{R1}, V_{BR}, C_{TO}, V_{F1}, V_{F2}	—	Read and Record
7. Burn-In	1038	Condition B, P_{FM} = 150 mW pk., V_{RM} = 5 V pk., f = 60 Hz, t = 168 hr. min., T_A = 25°C
8. Final Electrical Test	—	Same as Step 7
9. Electrical Stability Verification		$\Delta I_{R1} \leq$ 50 nA or 100% of initial value, whichever is greater $\Delta V_{F1} \leq$ 10% of initial value
10. Percent Defective Allowable (PDA)		10% of devices submitted to burn-in.

TABLE III. GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
Subgroup 1 External Visual Inspection	2071		5
Subgroup 2 Electrical Test I_{R1}, V_{BR}, C_{TO}, V_{F1}, V_{F2} at T_A = 25°C		See Table I (Read and Record)	3
Subgroup 3 Electrical Test at T_A = 25°C Carrier Lifetime (τ)		See Table I (Read and Record)	3
Subgroup 4 Electrical Test Reverse Leakage (I_R) at T_A = 125°C		See Table I (Read and Record)	7

TABLE IV. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	$t = 340$ hours, $T_A = 25°C$, $P_{FM} = 200$ mW, $f = 60$ Hz, $V_{RM} = 56$ V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Bond Strength	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	$t = 340$ hours, $T_A = 150°C$	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY ZERO BIAS SCHOTTKY DETECTOR DIODE (Generic HSCH-3486)

HSCH-0812

Features

HIGH TANGENTIAL SENSITIVITY

NO BIAS REQUIRED

HERMETIC GLASS PACKAGE

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

Description/Applications

The high tangential sensitivity of these Schottky Barrier diodes makes them ideally suitable for narrow bandwidth video detectors, ECM receivers, and measurement equipment. These diodes also make excellent mixers for use with low power LO.

Maximum Ratings

Operating and Storage Temperature Range .... –65° C to +150° C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

CW Power Dissipation at T_{CASE} = 25° C .... 300 mW

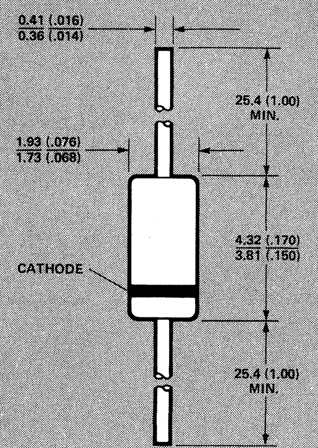
Derate linearly at 2.40 mW/° C to zero at 150° C

Pulse Power Dissipation

Peak Power absorbed by the diode at T_A = 25° C

1 µs pulse, Du = 0.001 .... 1 W

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Maximum Tangential Sensitivity TSS (dBm)	Minimum Voltage Sensitivity γ (mV/µW)	Video Resistance R_V (KΩ) Min.	Video Resistance R_V (KΩ) Max.	Maximum Forward Viktage V_F (mV)	Typical Total Capacitance C_T (pF)
HSCH-0812 (Screened HSCH-3486)	–54	7.5	2	8	400	0.30
Test Conditions	Video Bandwidth = 2 MHz f_{test} = 10 GHz	Power in = –40 dBm f_{test} = 10 GHz			I_F = 1 mA	V_R = 0 V f = 1 MHz

High Reliability Conditioning and Acceptance Testing

(All methods are per MIL-STD-750 unless otherwise specified)

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual Inspection	—	Per H.P. Method A-5956-0562-72
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours., T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	−65° C to +150° C, 10 cycles, 30 minutes per cycle
4. Constant Acceleration	2006	200 KG. Y_1 axis.
5. Hermeticity Tests Fine Leak Gross Leak	1071	Condition G or H. Condition A or C. Step 1 only.
6. Interim Electrical Tests (V_F)		Per Table I. T_A = 25° C.
7. Burn-in	1038	P = 10 mW, T_A = 25° C, t = 168 hours
8. Final Electrical Tests (V_F)		Per Table I. T_A = 25° C
9. Drift Evaluation PDA = 15[1]		$\Delta V_F = \pm 5$ mV
10. Electrical Tests. RF Parameters		

Note:
1. If rejects are greater than 15% but less than 30%, one more burn-in may be performed with a new 10% PDA.

GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		15
Subgroup 2 DC Electrical Tests at 25° C		Per Table I	5

Reliability Data for Schottky Diodes

HEWLETT PACKARD

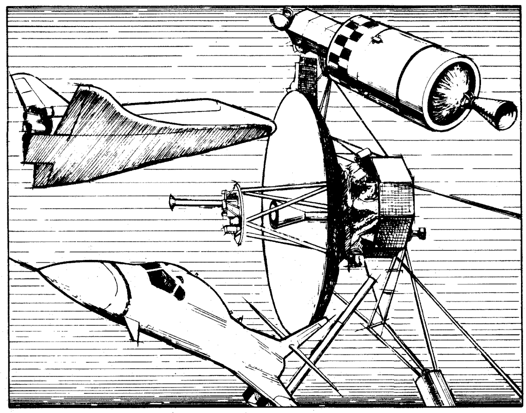
RELIABILITY DATA PASSIVATED GENERAL PURPOSE SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for passivated Schottky diodes mounted in hermetically sealed glass packages.

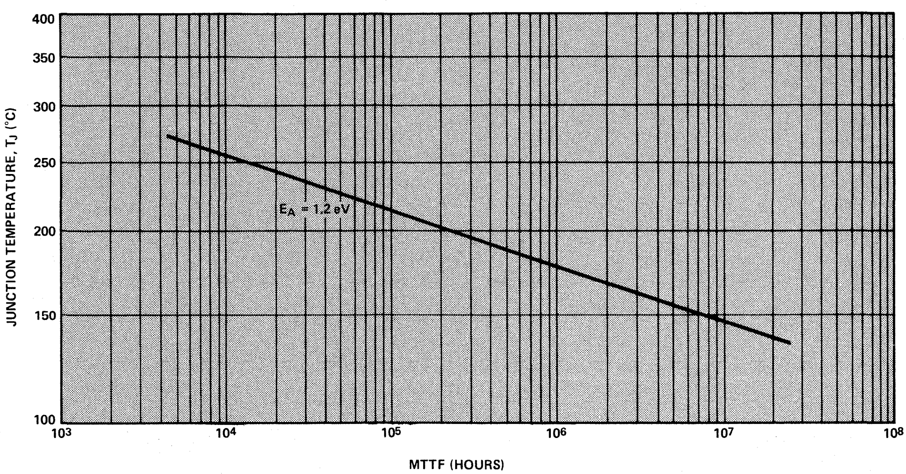
Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

1N5711	5082-0097	5082-2815
1N5712	5082-2080	5082-2817
1N6263	5082-2800	5082-2818
5082-0024	5082-2804	5082-2824
5082-0031	5082-2805	5082-2826
5082-0057	5082-2810	5082-2835
5082-0058	5082-2811	5082-2836
5082-0087	5082-2813	HSCH-1001
5082-0094	5082-2814	



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at: 200° C	2.0
Steady State Operating Life	P_{FM} = 250 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 200° C	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 200° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046.1	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Constant Acceleration	2006	20KG, 1 minute per axis	5
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041.1	35° C fog for 24 hours	5
Solderability	2026	Sn 60, Pb 40, 230° C	10

RELIABILITY DATA
TRI METAL BEAM LEAD SCHOTTKY DIODES

HEWLETT PACKARD

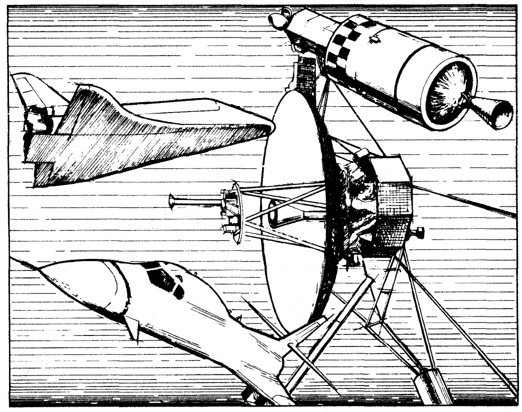
Schottky Barrier Diodes

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for tri metal beam lead Schottky diodes mounted in hermetically sealed H packages.

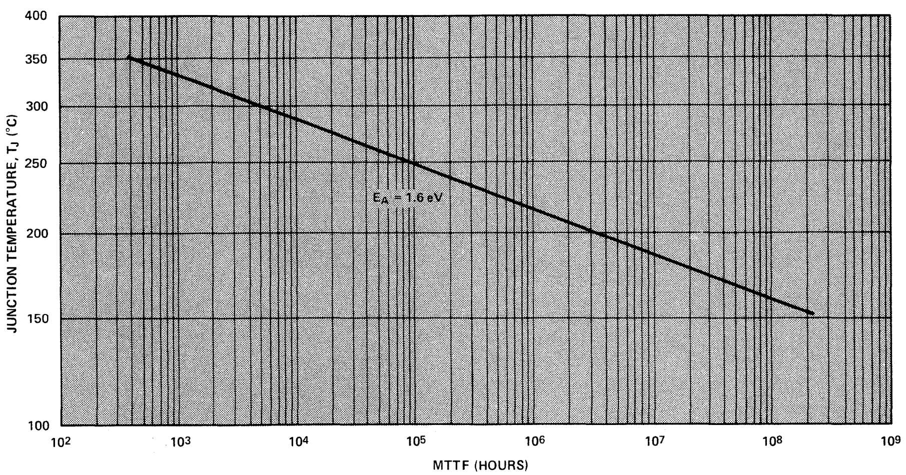
Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

HSCH-5300 Series	5082-2208	5082-2775
HSCH-5500 Series	5082-2209	5082-2785
5082-2200	5082-2210	5082-2786
5082-2201	5082-2765	5082-2794
5082-2202	5082-2766	5082-2795
5082-2203	5082-2774	5082-2837
5082-2207		



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at: 200° C	2.0
Steady State Operating Life	I_F = 10 mA DC T_A = 175° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 175° C	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 200° C, 5 hrs. at extremes, 5 min. transfer	6
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	6
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	6
Vibration Fatigue	2046.1	20G min., 60 Hz	6
Constant Acceleration	2006	20KG, 1 minute per axis	6
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	6
Salt Atmosphere	1041	35° C fog, 24 hours	10

RELIABILITY BULLETIN TRI METAL BEAM LEAD SCHOTTKY DIODES

HEWLETT PACKARD

Conclusion

Hewlett-Packard's beam lead diodes have successfully passed stringent environmental testing. Hewlett-Packard beam lead diodes may be used in military and space applications without the necessity of hermetically sealed packaging.

General

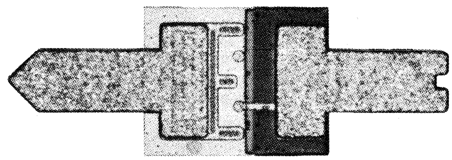
For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the specified design criteria. All Schottky beam lead families have fulfilled the standard requirements of reliability qualification, and the results of these tests are available upon request from Hewlett-Packard.

Program Description

The purpose of this program is to qualify all beam lead diodes for operation in extreme environmental conditions which may be encountered during military and space operations.

The following test sequence has been designed to assess the endurance of beam lead diodes through relevent environmental stresses such as heat and humidity. To qualify a device as hermetic, the conventional procedure is to perform dye-penetrant and Radiflo tests. However, because of the absence of an enclosed cavity in the unique design of the beam lead diode, these tests are not directly applicable. Therefore, this program utilizes reliability tests such as moisture resistance, salt atmosphere, and immersion to verify that the passivation layer on the beam lead acts as a seal to protect the active area of the diode.

To perform these tests, various Schottky diodes were mounted in non-hermetic, open packages and tested as exposed beam lead devices.



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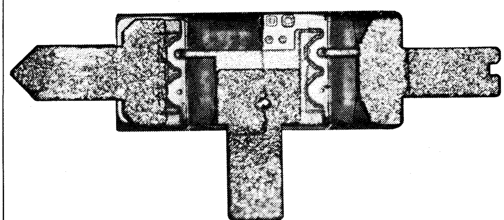


PAIR

Typical Beam Lead Outlines

Applicable Part Numbers

Schottky Beam Leads

5082-2837
HSCH-5300 Series
HSCH-5500 Series

Test Sequence

Test	MIL-STD-750	Test Condition	Units Tested	Failed	LTPD
Moisture Resistance[1, 2]	1021	98% R.H. −10° C to 65° C, 10 days			
Temperature Cycling	1051	−65° C to 200° C, 100 cyc.	80	0	<7
Constant Acceleration	2006	20 KG, 1 min. each axis	(40 per lot)		
Salt Atmosphere[2]	1041	35° fog, 24 hours	25	0	<10
Salt Water Immersion[2]	(MIL-STD-883B, M1002B)	65° C saturated NaCl solution, 2 cycles	25	0	<10

Notes:
1. The sequence of moisture resistance and temperature cycling followed by constant acceleration assures a thorough evaluation of the effect of exposure to high humidity and heat conditions. End points were taken after each test.
2. End points were: Visual at 100X magnification and D.C. testing to MIL-STD-19500.

Results

As demonstrated by these tests, Hewlett-Packard's beam lead diodes exhibit superior performance when subjected to severe environmental conditions. This proven reliability is achieveable because of Hewlett-Packard's unique beam lead design. These beam lead diodes are made of tri-metal (Ti-Pt-Au or NiCr-Pt-Au), which extends both the operating and storage temperature range. In addition, a nitride passivation layer acts as a sealant and provides immunity from contaminants which could lead to I_R drift. Conductive particle protection is provided by a layer of polyimide, which also functions as scratch protection. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

HEWLETT PACKARD

RELIABILITY DATA BI METAL BEAM LEAD SCHOTTKY DIODES

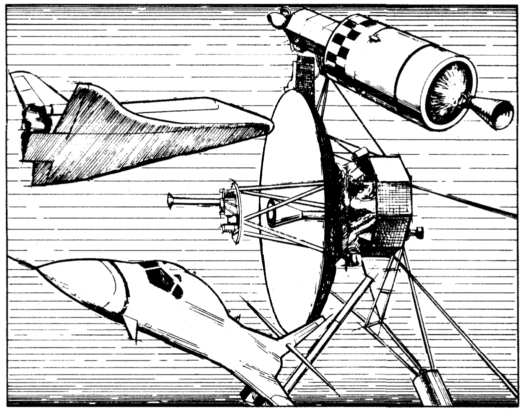
Schottky Barrier Diodes

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for bi metal beam lead Schottky diodes mounted in non-hermetically sealed E-1 packages.

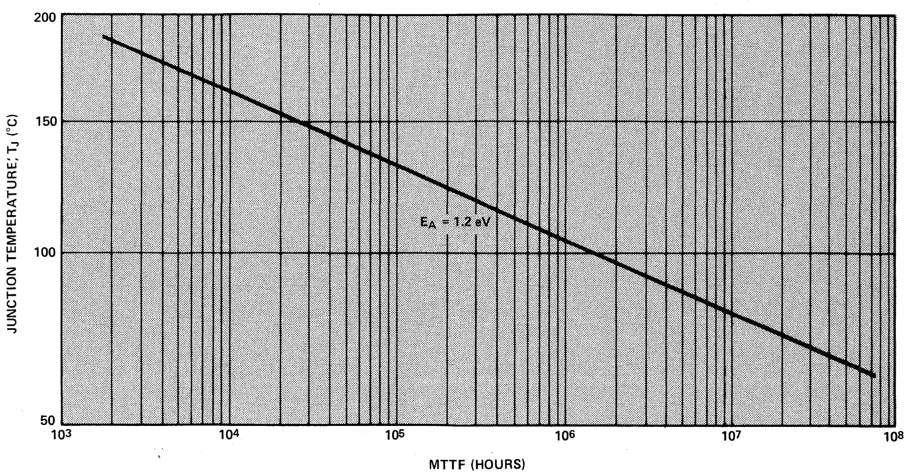
Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

5082-2231	5082-2277	5082-2294
5082-2233	5082-2279	5082-2830
5082-2263	5082-2280	5082-2831
5082-2271	5082-2291	5082-9300 Series
5082-2272	5082-2292	5082-9600 Series



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125° C	2.0
Steady State Operating Life	P_{FM} = 50 mW T_A = 25° C f = 60 Hz	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 125° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041.1	35° C fog for 24 hours	10
Solderability	2026	Sn 60, Pb 40, 230° C	10

HEWLETT PACKARD

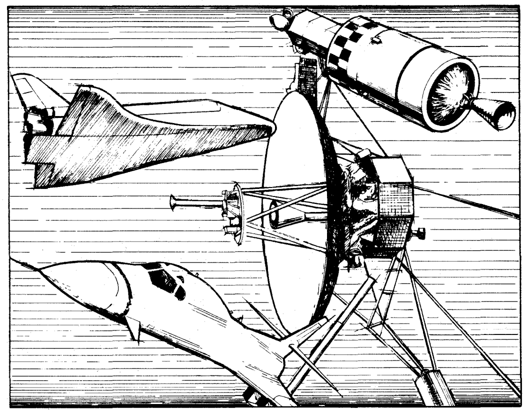
RELIABILITY DATA MESH SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for mesh Schottky diodes mounted in hermetically sealed glass packages.

Applications

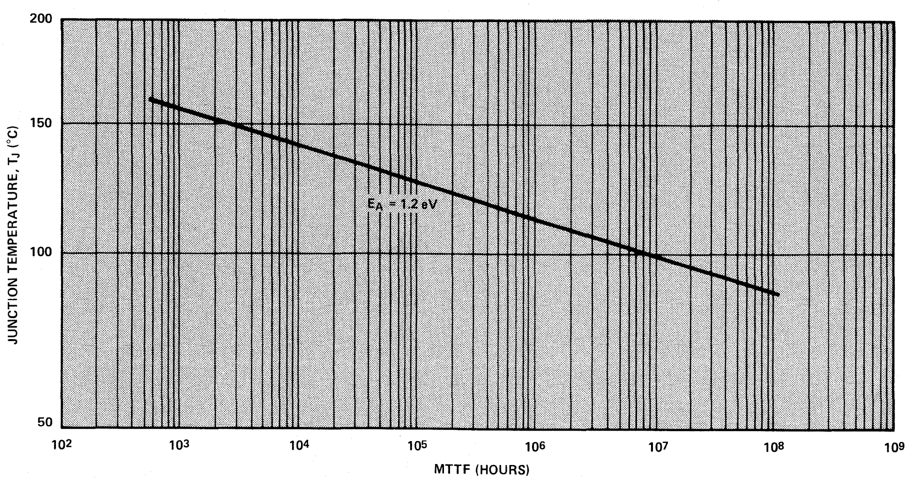
This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

5082-2301	5082-2356	5082-2566
5082-2302	5082-2370	5082-2755
5082-2303	5082-2396	5082-2787
5082-2305	5082-2400	5082-2900
5082-2306	5082-2401	5082-2912
5082-2308	5082-2520	5082-2970
5082-2350	5082-2521	5082-2997
5082-2351	5082-2565	HSCH-3486

Schottky Barrier Diodes



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 100° C	2.0
Steady State Operating Life	P_{FM} = 125 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 100° C	3.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 100° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	10
Terminal Strength	2036.1	Condition A	10
Solderability	2026	Sn 60, Pb 40, 230° C	10

RELIABILITY DATA PASSIVATED N-TYPE MICROWAVE SCHOTTKY DIODES

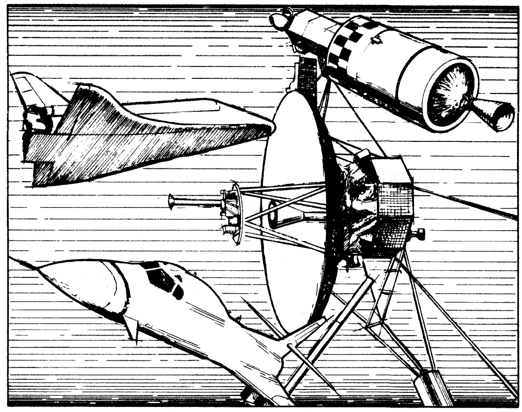
HEWLETT PACKARD

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for N-type passivated microwave Schottky diodes mounted in non-hermetic unsealed 44 packages.

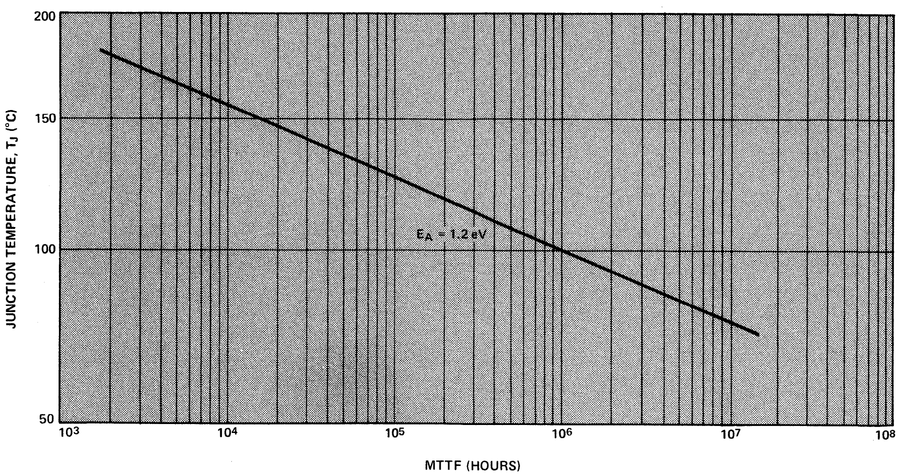
Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

5082-0013	5082-2297	5082-2712
5082-0023	5082-2298	5082-2713
5082-0029	5082-2701	5082-2714
5082-0041	5082-2702	5082-2723
5082-2273	5082-2706	5082-2724
5082-2274	5082-2707	HSCH-3206
5082-2295	5082-2711	HSCH-3207
5082-2296		



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125°C	3.0
Steady State Operating Life	P_{FM} = 75 mW V_{RM} = 80% of V_{BR} T_A = 25°C f = 60 Hz	4.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65°C to 125°C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0°C to 100°C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046.1	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Constant Acceleration	2006	20KG, 1 minute per axis	10
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041.1	35°C fog for 24 hours	12

HEWLETT PACKARD

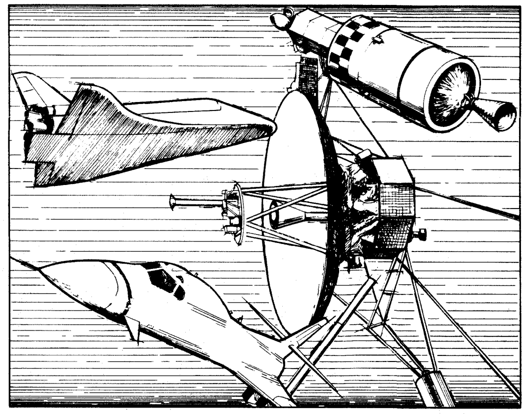
RELIABILITY DATA PASSIVATED P-TYPE MICROWAVE SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for P-type passivated microwave Schottky diodes mounted in non-hermetic unsealed 44 packages.

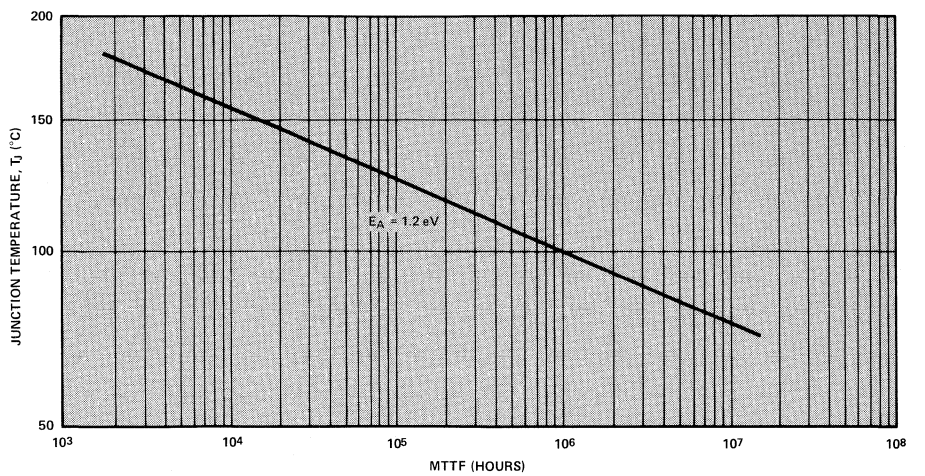
Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.



Applicable Part Numbers

5082-0009
5082-2750
5082-2751
5082-9891



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125°C	4.0
Steady State Operating Life	P_{FM} = 100 mW V_{RM} = 80% of V_{BR} T_A = 25°C f = 60 Hz	3.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65°C to 200°C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0°C to 100°C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046.1	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021.1	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041.1	35°C fog for 24 hours	12

ABSTRACTS OF APPLICATION NOTES AND BULLETINS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or brief application bulletins. A complete list with brief abstracts is presented here.

Below is a brief summary of Application Notes for diodes and transistors. All of the Application Notes are available from your local HP Sales Office or nearest Components Authorized Distributor or Representative.

Schottky Diode Applications

923 Hot Carrier Diode Video Detectors

Describes the characteristics of HP Schottky barrier diodes intended for use in video detector or video receiver circuits, and discusses some design features of such circuits.

Though less sensitive then the heterodyne receiver, the many advantages of the video receiver make it extremely useful. The Schottky diode can be used to advantage in applications such as beacon, missile-guidance, fuse-activating, and counter-measure receivers, and as power-leveling and signal-monitoring detectors.

Among the subjects discussed are the performance characteristics of video detector diodes — tangential sensitivity, video resistance, voltage sensitivity and figure of merit; how these characteristics affect the bandwidth of a video detector, video detector design considerations; considerations that affect dynamic range; and considerations that vary the level at which burnout can occur.

942 Schottky Diodes for High Volume Low-Cost Applications

Discusses switching, sampling, mixing, and other applications where the substitution of Schottky diodes will provide significant improvement over PN junction devices.

956-1 The Criterion for the Tangential Sensitivity Measurement

Discusses the meaning of Tangential Sensitivity and a recommended measurement technique.

956-3 Flicker Noise in Schottky Diodes

Treats the subject of flicker (1/f) noise in Schottky diodes, comparing 4 different types.

956-4 Schottky Diode Voltage Doubler

Explains how Schottky detectors can be combined to achieve higher output voltages than would be produced by a single diode.

956-5 Dynamic Range Extension of Schottky Detectors

Discusses operation of two types of detectors: the small signal type, also known as square-law detectors; and the large signal type, also known as linear or peak detectors. Techniques for raising the compression level are presented. An example is given illustrating the effect of bias current level on an HP 5082-2751 detector.

956-6 Temperature Dependence of Schottky Detector Voltage Sensitivity

A discussion of the effects that temperature changes have on Schottky barrier diodes. Performance improves at lower temperatures in a predictable manner. Data presented were obtained using HP 5082-2750 detector diodes.

963 Impedance Matching Techniques for Mixers and Detectors

Presents a methodical technique for matching complex loads, such as Schottky diodes, to a transmission line. Direct application to broadband mixers and detectors is illustrated.

969 An Optimum Zero Bias Schottky Detector Diode

Describes the use of HSCH-3486 zero bias detector diodes. Their forward voltage characteristics are detailed, as well as discussion of voltage sensitivity including effects of junction capacitance, load resistance and reflection loss on sensitivity. Temperature characteristic curves for both devices are also included.

976 Broadband Microstrip Mixer Design, The Butterfly Mixer

A microstrip mixer on RT/duroid substrate is designed for the frequency range 8 GHz to 12 GHz. Hewlett-Packard Schottky barrier diode model 5082-2207 is used. Low impedance shunt transmission lines are difficult to realize and present a problem in this type of circuit. Radial line stubs are used to avoid this problem.

986 Square Law and Linear Detection

Frequency, diode capacitance, breakdown voltage, and load resistance all have an effect on the slope of a microwave detector. At high input levels the linearity may be controlled by proper tuning.

NEW 987 Is Bias Current Necessary?

Bias current is often necessary to reduce the impedance of detector diodes to a reasonable level. However, when the signal level is high, rectified current may reduce the impedance without the need for bias current. Measurements with the 5082-2755 diode are used to illustrate this effect.

988 All Schottky Diodes are Zero Bias Detectors

Diodes which are normally biased make excellent detectors when the bias is eliminated. It is necessary to use a load with an impedance comparable to the diode impedance. This is shown with a 5082-2755 diode used with a 3469B multimeter as the load.

Hybrid Integrated Circuits Applications

974 Die Attach and Bonding Techniques for Diodes and Transistors

Several package styles are available for use with hybrid integrated circuits. This application note gives detailed instructions for attaching and bonding these devices. A brief description of an impedance matching technique for mixer diodes is also included.

979 The Handling and Bonding of Beam Lead Devices Made Easy

Beam Lead devices are particularly attractive for hybrid circuits because of their low parasitics and small size. The availability of equipment and techniques specifically designed for their small size has facilitated the handling and bonding of these devices. This application note describes some of this equipment and techniques, and outlines suggestions for the proper handling and bonding of Beam Lead devices.

991 Harmonic Mixing with the HSCH-5530 Series Dual Diode

The dual diode on coplanar waveguide forms an antiparallel pair. This arrangement is excellent for mixers with subharmonic local oscillators. A mixer for 34 GHz was designed and built. Conversion loss was measured as a function of frequency and local oscillator power level.

NEW 992 Beam Lead Attachment Methods

This application bulletin gives a general description of various methods of attaching beam lead components to both hard and soft substrates. A table summarizes the most common attachment methods with advantages, disadvantages, and equipment costs.

NEW 993 Beam Lead Diode Bonding to Soft Substrate

The hard gold surface on standard pc boards with soft substrate material makes it almost impossible to successfully bond beam lead diodes onto the boards with normally recommended thermocompression bonding. Described in this application note is a new method of resistive spot welding or modified gap welding, which uses a single electrode to weld the beam while the conductor is contacted separately. This method allows tight pressure to be used on the weld probe, resulting in an effective bond without damaging the beam lead device.

Schottky Diodes

AB 5 Current Source for Diode Testing

This application bulletin describes a constant current source designed primarily for the ease of use in laboratory measurements. Easily programmable by thumb wheel switching in 10 μA steps from 10 μA to 700 mA, its accuracy exceeds most commercially available current sources.

AB 7 Mixer Distortion Measurements

Describes the measurement of distortion in a balanced mixer by the two tone method.

AB 13 Transistor Speed Up Using Schottky Diodes

Significant reduction in transistor switching delay time can be achieved by adding a Schottky diode and a PIN diode to the transistor switching circuit. This improvement in switching performance also extends the oscillator capability of the transistor to higher frequencies.

AB 14 Waveform Clipping with Schottky Diodes

Consideration is given in this application bulletin to the design requirements of clipping circuits which are used to limit the transmission of signals above or below specified levels. The characteristics of Schottky diodes needed to achieve the required performance in these circuits are discussed and recommendations made.

AB 15 Waveform Clamping with Schottky Diodes

Discussed in this application bulletin are the circuit design and diode performance requirements for a clamping circuit, which is used as a DC restorer or level shifter. Schottky diodes having the required characteristics for this type of circuit are recommended.

AB 16 Waveform Sampling with Schottky Diodes

This application bulletin discusses the design considerations for a sampling circuit used to sample high frequency repetitive signals and reproduce them at lower frequencies for ease of monitoring. Schottky diode performance requirements important in the realization of a sampling circuit are considered.

AB 26 Using the HSCH-1001 Schottky Diode for Interfacing in Microprocessor Controlled A/D Conversion Circuits

The use of custom codec (coder/decoder) IC chips simplifies the analog to digital circuitry in microprocessor controlled digital switching circuits. This application bulletin describes the use of the HSCH-1001 Schottky diode to achieve the required compatible interface between the codec chip and the rest of the circuit in order to realize optimum circuit performance.

AB 27 Using the HSCH-1001 Schottky Diode in an AGC Detector Circuit

A detector circuit such as one used for AGC or video detection simply realized with the use of the HSCH-1001 Schottky diode is described in this application bulletin.

AB 28 Optocoupler Speedup using the HSCH-1001 Schottky Diode

An optocoupler typically contains a transistor in the output circuit. When the optocoupler is turned on, the transistor is usually in the saturated state, which means the turn-off time will be unnecessarily long. This application bulletin describes how the HSCH-1001 Schottky diode can be used to alleviate the saturation effects on the transistor and thus improve switching time.

AB 30 Using the 5082-2835 Schottky Diode for Protecting and Improving the Performance of an Operational Amplifier

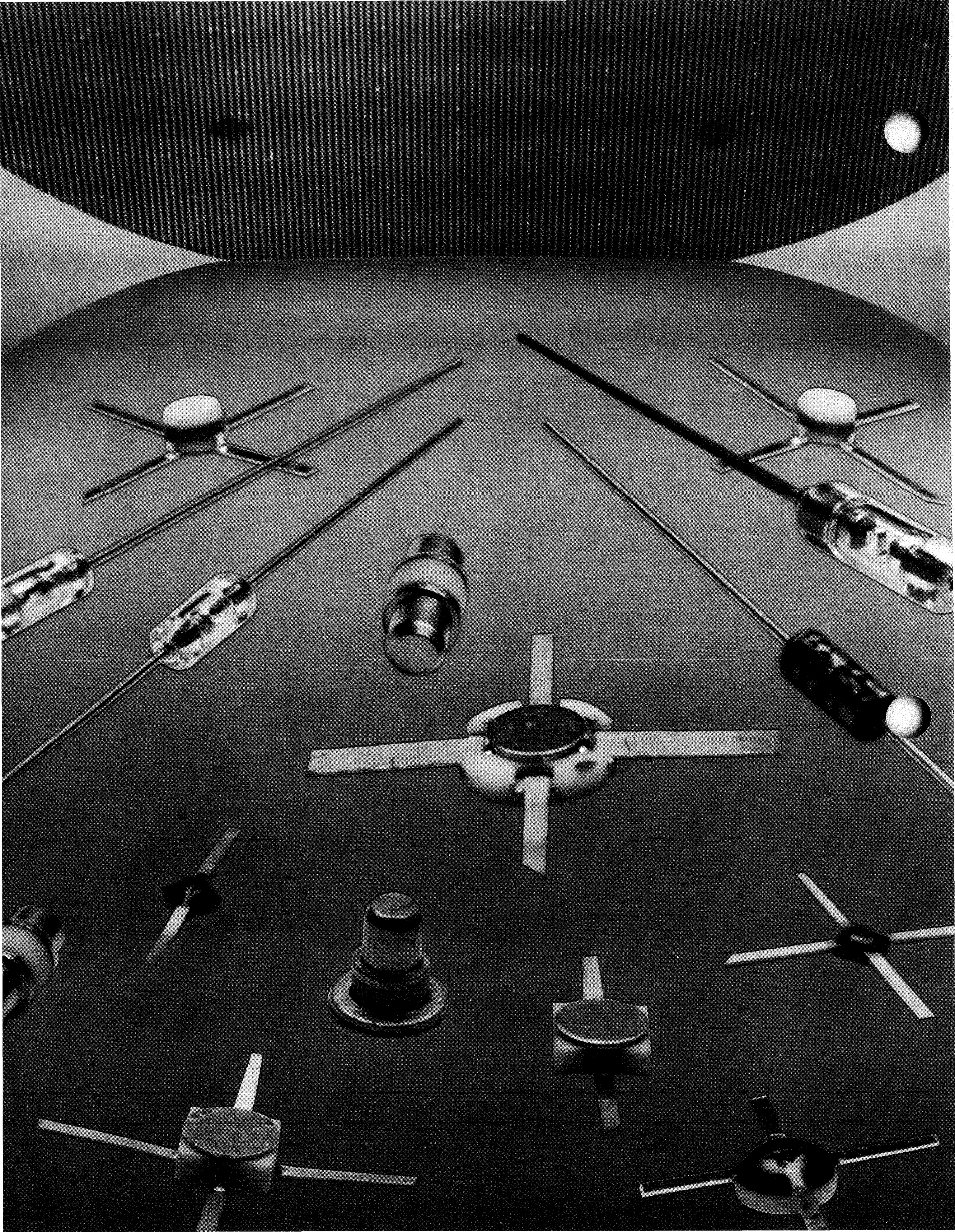
High level voltage spikes degrade the performance of an operational amplifier, and, in extreme cases, destroy the amplifier permanently. This application bulletin describes how the 5082-2835 Schottky diode can be used to protect an operational amplifier against high level voltage overload, and also to improve output response.

AB 31 Using the HSCH-1001 Schottky Diode in a Data Terminal Memory

The simplicity in a read only memory (ROM) circuit allows the circuit to be large in terms of storage capacity. A large capacity requires a large matrix of active devices. The use of HSCH-1001 Schottky diodes in a ROM circuit can ease the power drain because of their low forward voltage. The use of discrete circuit elements offers ease of repair and modification. These and other important considerations are discussed in this application bulletin.

AB 36 Using the HSCH-1001 Schottky Diode in a Digital Logic Gate

Simple "and" and "or" gates consisting of diodes and resistors can be combined into circuits which will perform increasingly complex functions. The achievement of low loss when the diode is biased on and of high isolation when the diode is biased off are the principal characteristics of these types of logic gates. This application bulletin describes how the HSCH-1001 Schottky diode is particularly suited for this type of application because of its low forward voltage and other inherent characteristics.



PIN and High Conductance Diodes

CHARACTERISTICS OF PIN DIODES

The most important feature of the PIN diode is its basic property of being an almost pure resistor at RF frequencies, whose resistance value can be varied from approximately 10,000 ohms to less than 1 ohm by the control current flowing through it. Most diodes exhibit this characteristic to some degree, but the PIN diode is optimized in design to achieve a relatively wide resistance range, good linearity, low distortion, and low current drive. The characteristics of the PIN diode make it suitable for use in switches, attenuators, modulators, limiters, phase shifters, and other signal control circuits.

Device Characteristics

The principal parameters of a PIN diode which play major roles in determining the performance of a circuit include the following:

RF Resistance

The PIN diode structure consists of an I (Intrinsic) layer of very high resistivity material sandwiched between regions of highly doped P (positively charged) material and N (negatively charged) material. With reverse or zero bias, the I-layer is depleted of charges and the PIN diode exhibits very high resistance. When forward bias is applied across the PIN diode, positive charge from the P region and negative charge from the N region are injected into the I-layer, therefore increasing its conductivity and lowering its resistance. The high off resistance and low on resistance make the PIN diode attractive for switching applications.

At RF frequencies, the PIN diode with forward bias behaves essentially as a pure resistor. The resistance of the PIN diode is related to the bias current, the geometry of the I-layer and the properties of the carriers. For a given type of PIN diode with uniform characteristics, resistance is inversely proportional to the forward bias current. Whereas, only high off resistance and low on resistance are important in switching applications, the resistance characteristics in the entire dynamic range are of concern in attenuator applications. Linearity of resistance with bias makes the PIN diode useful for attenuator applications.

Carrier Lifetime

An important parameter of the PIN diode is the carrier lifetime, τ, which is useful for defining the low frequency limit, $f_O = \frac{1}{2\pi\tau}$, for linear performance of the diode. For RF signal frequencies below f_O, the PIN diode rectifies the signal much like an ordinary PN junction diode, and considerable output distortion results. (See Application Note 957-3 for additional discussion on rectification causes and effects). At frequencies above f_O, less rectification occurs with increasing frequency, allowing the PIN diode to appear more linear, approaching a pure resistor.

For applications requiring good linearity and low distortion the minimum signal frequency should be ten times f_O, i.e., $f_{min} = \frac{10}{2\pi\tau}, = \frac{1.6}{\tau}$. This restriction is not important in switching applications, where the diode is normally biased either completely off or on. In those states, since most of the power is either reflected or transmitted, the effect of RF current on the total charge is small and distortion is not a problem.

Capacitance

Diode capacitance limits switch and attenuator performance at high frequencies in the form of isolation rolloff and increased insertion loss. Optimum performance can be achieved by one of several alternatives available. Using a low capacitance diode would be one solution. Since the junction capacitance of a PIN diode is related to the geometry and electrical properties of the I-layer similar to the case of RF resistance, an R-C trade-off may be feasible. Special techniques can be employed to minimize capacitive (and other parasitic) effects, and in some cases even to take advantage of them. (Some of the techniques for improving high frequency performance are discussed in Application Notes 922 and 957-2.)

Reverse Recovery Time

Reverse recovery time is a measure of switching time, and is dependent on the forward and reverse bias applied. With forward bias current, charge is stored in the I-layer. When a reverse pulse is applied, reverse current will flow for a short period of time, known as delay time, t_d. When a sufficient number of carriers have been removed, the current begins to decrease. The time required for the reverse current to decrease from 90% to 10% is called the transition time, t_t. The sum, $t_d + t_t$, is the reverse recovery time, which is a measure of the time it takes to switch the diode from on to off.

Reverse Breakdown Voltage

The reverse breakdown voltage defines the recommended maximum signal level for safe operation of the diode. Operation at signal levels above the reverse breakdown voltage may result in degradation of diode characteristics or in permanent damage to the diode.

APPLICATIONS OF PIN DIODES

PIN diodes are used principally for the control of RF and microwave signals. Applications include switching, attenuating, modulating, limiting and phase shifting. Certain diode requirements are common to all these control functions, while others are more important in a particular type of usage.

Switching Applications

The performance of a PIN diode circuit is directly related to the basic characteristics of the diode. As an illustrative example, the performance of a PIN diode switch can be simply approximated by treating the PIN diode essentially as a resistor in the forward biased state and a capacitor in the reverse biased state. Switch performance can then be analyzed as follows:

Insertion Loss

The loss of signal attributed to the diode when the switch is on (transmission state) is insertion loss. For low insertion loss, low resistance is needed in a series switch (Figure 1). Low capacitance (particularly at high frequencies) is needed in a shunt switch (Figure 2).

Isolation

Isolation is the measure of RF leakage between the input and output when the switch is off. For high isolation (low transmission) low capacitance is required in a series switch especially at high frequencies (Figure 3). Low resistance is required in a shunt switch (Figure 4).

Switching Speed

In many applications, switching time is very important. Reverse recovery time is a measure of the switching time of a PIN diode, the time required to switch the diode from ON to OFF. The time needed to switch the diode from OFF to ON is shorter. (See Application Note 929 for details).

Power Handling Capability

The RF power (CW or pulse) that can be handled safely by a diode switch is limited by two factors — the breakdown voltage of the diode, and thermal considerations, which involve the maximum junction temperature and the thermal resistance of the diode and packaging. Other factors affecting power handling capability are ambient temperatures, frequency, attenuation level (which is related to diode resistance), pulse width and duty cycle. (See Application Note 922 for details).

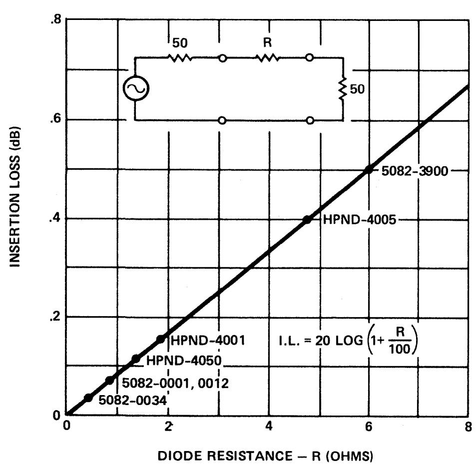


Figure 1. Typical Insertion Loss of Series Diode Switch.

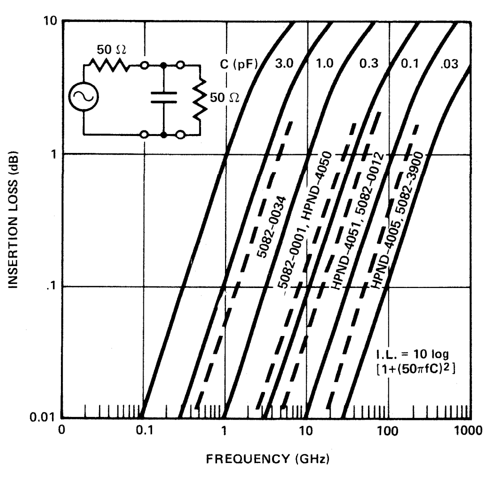


Figure 2. Typical Insertion Loss of Shunt Diode Switch.

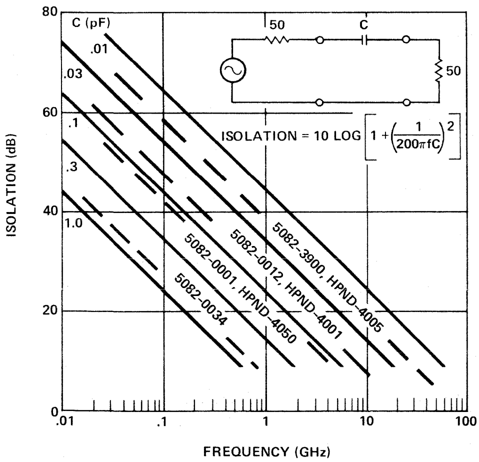


Figure 3. Typical Isolation of Series Diode Switch.

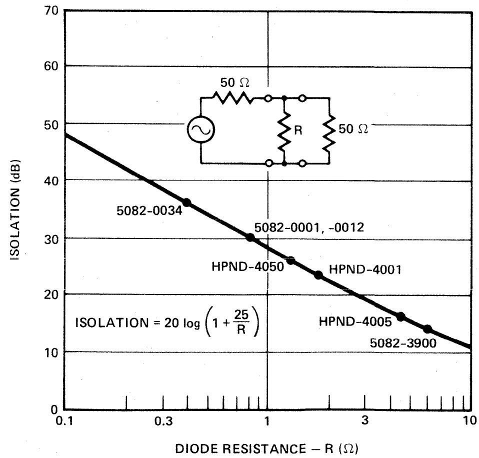


Figure 4. Typical Isolation of Shunt Diode Switch.

Attenuators

Whereas a switch is used only in its maxium ON or OFF state, an attenuator is operated throughout its dynamic range (or resistance range in the case of a diode attenuator). Although a single diode series or shunt switch can be used as an attenuator, it cannot offer in its entire dynamic range constant input and output impedance, which is required for optimum source and load matching in most attenuator applications. By using a multiple diode circuit such as a π, T, or bridged-T attenuator, constant input and output impedance can be achieved throughout the attenuation range.

An additional requirement in most attenuator applications is low distortion. Distortion can be kept at a minimum, if the carrier lifetime of the PIN diode used is greater than the inverse of the signal frequency, preferrably $\tau > \frac{1.6}{f}$, where τ is the carrier lifetime and f is the signal frequency.

Limiters

Sensitive amplifiers, mixers, and detectors in microwave systems can be protected against damage by high level signals with the use of a PIN diode limiter shunting the transmission line.

A PIN diode limiter is essentially an attenuator that uses self bias rather than externally applied bias. As the RF input increases, the rectified current generated by the PIN diode (in some limiter circuits by an auxiliary Schottky diode) biases the diode to a low resistance state. Most of the input power is then attenuated, allowing very little to be transmitted. The sensitive equipment that follows is thus protected.

For a limiter circuit to be efficient, it is essential that the PIN diode has fast switching time. Without an auxiliary diode, a PIN diode with good rectification efficiency is needed to achieve low resistance. Another diode requirement is good heat transfer characteristics (low thermal resistance).

Phase Shifters

The high speed switching capabilities and low ON and high OFF resistance states of the PIN diode make it also very useful for many types of high speed, current controlled phase shifter applications. Another important requirement for these applications is the uniformity of diode characteristics such as capacitance and resistance particularly in systems where a large number of elements are involved.

PIN DIODE SELECTION GUIDE

Hewlett-Packard PIN diodes are available in chip form and several types of packages, which lend themselves more suitable for particular applications. Packaged devices containing the generic chips are listed in the Selection Guide in the order of increasing junction capacitance.

For switching, attenuating, and other general purpose applications particularly in the VHF/UHF range, the low cost glass package (Outline 15) is suitable. Due to their low parasitics, ceramic packages (Outlines 31 and 38) are suited for broadband circuits up to 1 GHz and for resonated narrowband circuits up to 8 GHz. In addition, they have medium power handling capability.

Stripline packages (Outlines 60 and 61), containing built-in low pass matching circuits, can be used in broadband designs up to 18 GHz. Because of good heat sinking, they can handle high power in switching, attenuating and limiting applications. The beam lead packages with low parasitics are designed for use in stripline or microstrip circuits using welding or thermo-compression bonding techniques.

(Devices listed in the order of increasing junction capacitance)
All part numbers, 5082- (except HPND- as noted)

Maximum Junction Capacitance C_{JVR} (pF) (Note 1)	Typical RF Resistance R_s (Ω) (Note 3)	Chip	Packaged Devices Containing Similar Chips (Package Outline)					
			Beam Lead	Glass (15)	Ceramic (31)	Ceramic (38)	Stripline (60)	Stripline (61)
0.02***	4.7††		HPND-4005					
0.025****	6.0†		3900					
0.08*	1.8†††		HPND-4001					
0.12	0.8	0012		3001 3002 3039 3077 1N5719 HPND-4165 HPND-4166	3201 3202	3101 3102	3140	3040
0.12	0.8	0030			3303 3304		3170	3340
0.15	0.6	0047						
0.15**	1.3†††		HPND-4050					
0.16**	0.8††	0001		3042 3043	3306	3305	3141	3041 3071
0.20	1.5	0025		3080 3379 1N5767				
0.20	2.0	0039		3081				
0.20	0.6	0049						3046
1.2**	0.4†††	0034		3168 3188				
Package Capacitance (pF)			(Note 2)	.13	.2	.2	.03	.03
Pages								

Notes:

1. All capacitance measured with V_R = 50 volts, except:
   *V_R = 30 volts ***V_R = 10 volts
   V_R = 20 volts **V_R = 0 volt
2. Capacitance of beam lead devices includes package capacitance.
3. RF resistance measured with I_F = 100 mA, except:
   †I_F = 50 mA
   ††I_F = 20 mA
   †††I_F = 10 mA

PIN DIODE ALPHANUMERIC INDEX

HEWLETT PACKARD

PIN DIODE CHIPS FOR HYBRID MIC SWITCHES/ATTENUATORS

5082-0001
5082-0012
5082-0025
5082-0030
5082-0034
5082-0039
5082-0047
5082-0049

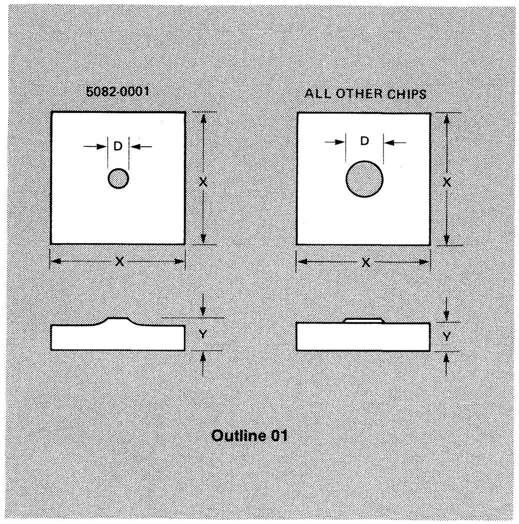
Features

WIDE RANGE OF CAPACITANCE
0.12 pF to 1.2 pF Maximum

LOW SERIES RESISTANCE
0.4 Ω Typical

OXIDE PASSIVATED

WIDE RANGE OF BREAKDOWN VOLTAGE
35 V to 300 V Minimum



Outline 01

Description

These PIN diode chips are silicon dioxide passivated of mesa (5082-0001), pitted planar (5082-0012, -0030), and planar (5082-0047, -0034, -0025, -0039, -0049) construction. The fabrication processes are optimized for long term reliability and tightly controlled for uniformity in electrical performance.

Dimension	HP Part Number 5082-						
	0012 0047	0030	0034	0025	0039	0049	0001
D	0.13 (5)			0.23 (9)	0.24 (9.5)		0.06 (2.5)
X	0.38 (15)			0.51 (20)			0.38 (15)
Y	0.09 (3.5)		0.13 (5)	0.15 (6)	0.23 (9)	0.08 (3.2)	0.11 (4.5)
Top Contact	Au, Cathode	Au, Anode	Ag, Anode	Ag, Cathode			Au, Anode
Bottom Contact	Au, Anode	Au, Cathode		Au, Anode			Au, Cathode

Dimensions in millimeters (1/1000 inch)

Maximum Ratings

Junction Operating and Storage
Temperature Range .... −65° C to +150° C
Soldering Temperature
5082-0012, -0025, -0030, -0034, -0039,
-0047, -0049 .... +425° C for one minute maximum
5092-0001 .... +300° C for one minute maximum

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Applications

These general purpose PIN diodes are intended for low power switching applications such as duplexers, antenna switching matrices, digital phase shifters, time multiplex filters, TR switches, pulse and amplitude modulators, limiters, leveling circuits, and attenuators.

The 5082-0034 is ideally suited for hybrid VHF/UHF bandswitching.

The 5082-0001 is optimized for applications requiring fast switching.

Electrical Specifications at $T_A = 25°C$

Typical Parameters

Chip Part Number 5082-	Nearest Equivalent Packaged Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Junction Capacitance C_j (pF)	Typical Series Resistance R_S (Ω)	Typical Lifetime τ (ns)	Typical Reverse Recovery Time, t_{rr} (ns)
0012	3001	150	0.12	0.8	400	100
0030	3301	150	0.12	0.8	400	100
0047	3001	150	0.15	0.6	400	100
0001*	3041	70	0.16*	0.8*	15	5
0025	3080	100	0.20	1.5	1300	1000
0039	3081	100	0.20	2.0	2000	1000
0049	3046	300	0.20	0.6	1000	200
0034	3168	35	1.2*	0.4**	40	12
[1*, 2]		$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	$V_R = 50V$ $*V_R = 20V$ $f = 1$ MHz [3]	$I_F = 100$ mA $*I_F = 20$ mA $**I_F = 10$ mA $f = 100$ MHz	$I_F = 50$ mA $I_R = 250$ mA	$I_F = 20$ mA $V_R = 10V$

Notes:

1. Use standard thermocompression bonding techniques. Ultrasonic bonding is not recommended.
2. Either ultrasonic or thermocompression bonding techniques can be employed.
3. Total capacitance $C_T = C_j + C_p$, where C_j is the junction capacitance under reverse bias and C_p is the package parasitic capacitance.

HEWLETT PACKARD

LOW LOSS BEAM LEAD PIN DIODES

HPND-4001 HPND-4050

Features

LOW SERIES RESISTANCE
1.3Ω Typical

LOW CAPACITANCE
0.07 pF Typical

FAST SWITCHING
2 ns Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

Description

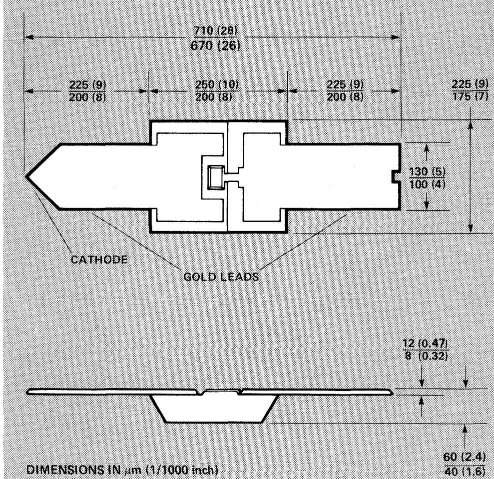
The HPND-4001 and -4050 are beam lead PIN diodes designed specifically for low capacitance, low series resistance and rugged construction. The new HP mesa process allows the fabrication of beam lead PINs with a very low RC product. A nitride passivation layer provides immunity from contaminants which would otherwise lead to I_R drift. A deposited glass layer (glassivated) provides scratch protection.

Maximum Ratings

Operating Temperature .... -65°C to +175°C
Storage Temperature .... -65°C to +200°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Power Dissipation at T_{CASE} = 25°C .... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength .... 4 grams pull on either lead



Outline 07

Applications

The HPND-4001 and -4050 beam lead PIN diodes are designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting and modulating at microwave frequencies. The low capacitance and low series resistance at low current make these devices ideal for applications in the shunt configuration.

Bonding and Handling Procedures

See page 228.

Electrical Specifications at $T_A = 25°C$

Part Number	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)		Capacitance C_T (pF)		Minority Carrier Lifetime τ (ns)	Reverse Recovery Time t_{rr} (ns)
	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Typ.
HPND-4001	50	80	1.8	2.2	0.07*	0.08*	30	3
HPND-4050	30	40	1.3	1.7	0.12	0.15	25	2
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$		$I_F = 10$ mA f = 100 MHz		$V_R = 10$ V *$V_R = 30$V f = 1 MHz		$I_F = 10$ mA $I_R = 6$ mA	$I_F = 10$ mA $V_R = 10$V

Typical Parameters

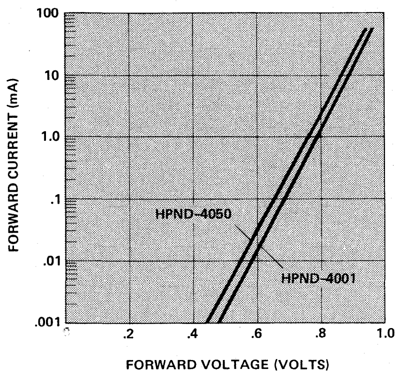


Figure 1. Typical Forward Characteristics.

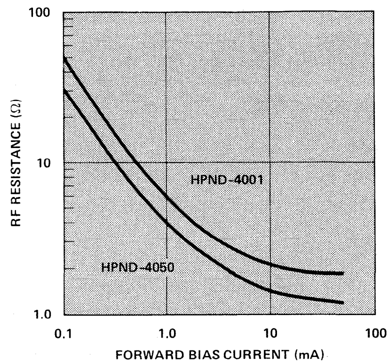


Figure 2. Typical RF Resistance vs. Forward Bias Current.

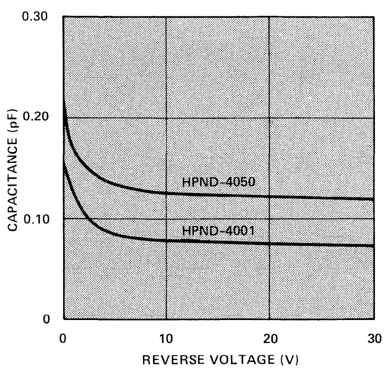


Figure 3. Typical Capacitance vs. Reverse Voltage.

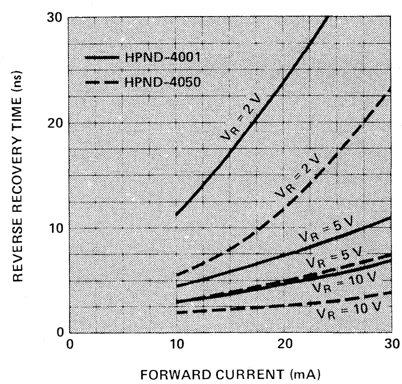


Figure 4. Typical Reverse Recovery Time vs. Forward Current (Shunt Configuration)

![HP logo] HEWLETT PACKARD

BEAM LEAD PIN DIODE

HPND-4005

Features

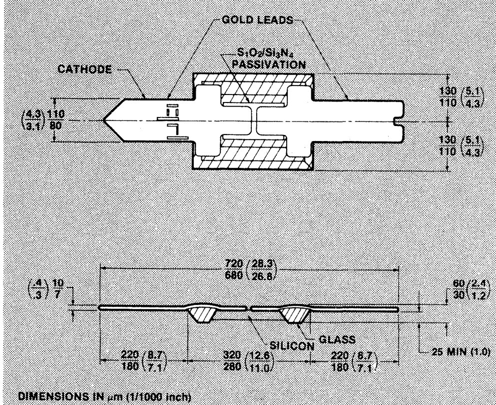
HIGH BREAKDOWN VOLTAGE
120V Typical

LOW CAPACITANCE
0.017 pF Typical

LOW RESISTANCE
4.7Ω Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

NITRIDE PASSIVATED



Outline 21

Description

The HPND-4005 planar beam lead PIN diode is constructed to offer exceptional lead strength while achieving excellent electrical performance at high frequencies. High beam strength offers users superior assembly yield, while extremely low capacitance allows high isolation to be realized.

Nitride passivation and polyimide glassivation provide reliable device protection.

Maximum Ratings

Operating Temperature .... −65°C to +175°C

Storage Temperature .... −65°C to +200°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Power Dissipation at T_{CASE} = 25°C .... 250 mW
(Derate linearly to zero at 175°C)

Minimum Lead Strength .... 4 grams pull on either lead

Diode Mounting Temperature .... 220°C for 10 seconds maximum

Applications

The HPND-4005 beam lead PIN diode is designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies. The extremely low capacitance of the HPND-4005 makes it ideal for circuits requiring high isolation in a series diode configuration.

Bonding and Handling Procedures

See page 228.

Electrical Specifications at $T_A = 25°C$

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Breakdown Voltage	V_{BR}	100	120	—	V	$I_R = 10\ \mu A$
Series Resistance	R_S	—	4.7	6.5	Ohm	$I_F = 20$ mA, f = 100 MHz
Capacitance	C_T	—	.017	.02	pF	$V_R = 10V$, f = 10 GHz
Minority Carrier Lifetime	τ	—	100	150	ns	$I_F = 10$ mA $I_R = 6$ mA
Reverse Recovery Time	t_{rr}	—	20	35	ns	$I_F = 20$ mA $V_R = 10$ V 90% Recovery

*Total capacitance calculated from measured isolation value in a series configuration.

Typical Parameters

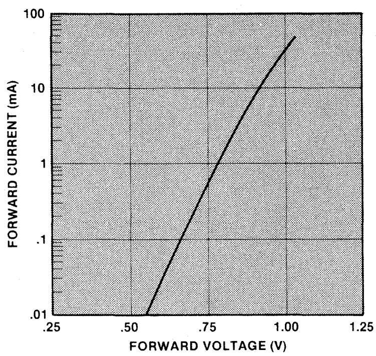


Figure 1. Typical Forward Conduction Characteristics.

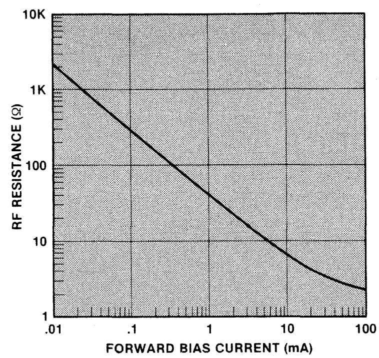


Figure 2. Typical RF Resistance vs. Forward Bias Current.

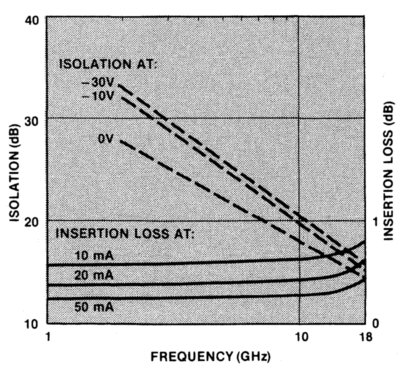


Figure 3. Typical Isolation and Insertion Loss in the Series Configuration ($Z_O = 50\Omega$).

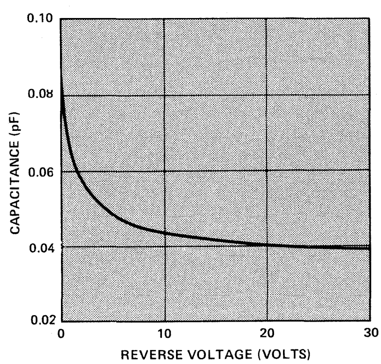


Figure 4. Typical Capacitance at 1 MHz vs. Reverse Bias.

PIN Diodes

HEWLETT PACKARD

BEAM LEAD PIN DIODE

5082-3900

Features

HIGH BREAKDOWN VOLTAGE
200 V Minimum

LOW CAPACITANCE
0.02 pF Typical

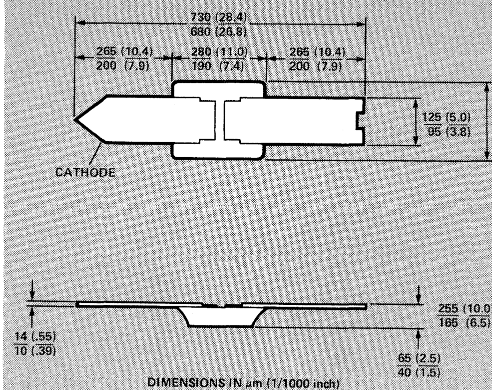
RUGGED CONSTRUCTION
2 grams Minimum Lead Pull

NITRIDE PASSIVATED

Description

The 5082-3900 planar beam lead PIN diode offers low capacitance to allow high isolation at RF and Microwave frequencies. Nitride passivation and rugged construction insures reliable performance and assembly yields.

Outline Drawing



Outline 06

Maximum Ratings

Operating Temperature .... −60° C to + 150° C
Storage Temperature .... −60° C to +150° C
Power Dissipation at T_{CASE} = 25° C .... 250 mW
(Derate linearly to zero at 150° C)
Minimum Lead Strength .... 2 grams pull on either lead
Diode Mounting Temperature ..... 220° C for 10 sec. max.

Operation of these devices within the above temperature ratings will assure a device Median Time to Failure (MTTF) of approximately 1 x 10^7 hours.

Applications

The HP 5082-3900 Beam Lead PIN diode is designed for use in stripline or microstrip circuits using welding, thermocompression or ultrasonic bonding techniques. PIN applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies.

Bonding and Handling Procedures

See page 228.

Electrical Specifications at $T_A = 25°C$

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Breakdown Voltage	V_{BR}	150	200	—	V	$I_r = 10\ \mu A$
Series Resistance	R_S	—	6	8	ohm	$I_f = 50$ mA, f = 100 MHz
Capacitance	C_O	—	0.02	0.025	pF	V = 0 V, f = 3 GHz
Minority Carrier Lifetime	τ	—	150	—	ns	$I_f = 50$ mA, $I_r = 250$ MHz

Typical Parameters

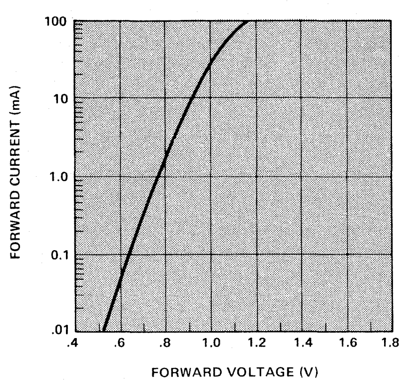


Figure 1. Typical Forward Conduction Characteristics.

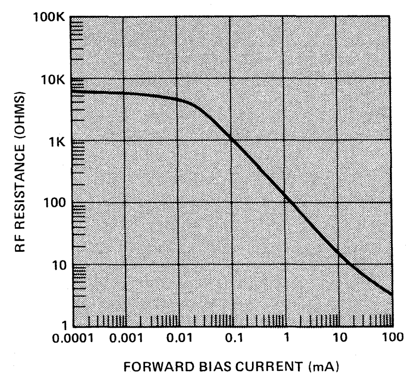


Figure 2. Typical RF Resistance vs. DC Bias Current.

BONDING AND HANDLING PROCEDURES FOR BEAM LEAD DIODES

1. Storage

Under normal circumstances, storage of beam leads in HP supplied waffle/gel packs is sufficient. In particularly dusty or chemically hazardous environments, storage in an inert atmosphere desicator is advised.

2. Handling

In order to avoid damage to beam lead devices, particular care must be exercised during inspection, testing, and assembly. Although the beam lead diode is designed to have exceptional lead strength, its small size and delicate nature requires special handling techniques be observed so that the device will not be mechanically or electrically damaged. A vacuum pickup is recommended for picking up beam lead devices, particularly larger ones e.g., quads. Care must be exercised to assure that the vacuum opening of the needle is sufficiently small to avoid passage of the device through the opening. A #27 tip is recommended for picking up single beam lead devices. A 20X magnification is needed for precise positioning of the tip on the device. Where a vacuum pickup is not used, a sharpened wooden Q-tip dipped in isopropyl alcohol is very commonly used to handle beam lead devices.

3. Cleaning

For organic contamination use a warm (<75° C) rinse of trichloroethane followed by a cold rinse in acetone and methanol. Dry under infrared heat lamp for 5-10 minutes on clean filter paper. Freon degreaser may replace trichloroethane for light organic contamination.

- Ultrasonic cleaning is not recommended
- Acid solvents should not be used

4. Bonding

Thermocompression: See Application Note 979 "The Handling and Bonding of Beam Lead Devices Made Easy". This method is good for hard substrates only.

Wobble: This method picks up the device, places it on the substrate and forms a thermocompression bond all in one operation. This is described in MIL-STD-883B Method 2017 and is intended for hard substrates only. Equipment specifically designed for beam lead wobble bonding is available from KULICKE and SOFFA in Hursham, PA.

Ultrasonic: Not recommended.

Resistance Welding or Parallel Gap Welding: To make welding quads easier, attach one electrode of the welder to the substrate and use the second electrode for welding in lieu of the parallel gap electrode. To make welding on soft substrates easier a low pressure welding head is recommended. Suitable equipment is available from HUGHES, Industrial Products Division in Carlsbad, CA.

Epoxy: With solvent free, low resistivity epoxies (available from ABLESTIK in Gardena, CA, MICON in Lexington, MA, and many others) and improvements in dispensing equipment, the quality of epoxy bonds is sufficient for many applications. Equipment is available from ADVANCED SEMICONDUCTOR MATERIALS AMERICA, INC. Assembly Products Group in Chandler, AZ (Automatic), and West Bond in Orange, CA (Manual).

Reflow: By preparing the substrate with tin or solder plating, reflow soldering can be suitably preformed using a modified wire bonder. The probe is used as a soldering tip. WEST BOND or UNITEK bonders make suitable bonds.

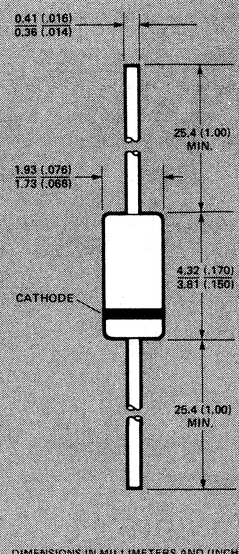
HEWLETT PACKARD

PIN DIODES FOR RF SWITCHING AND ATTENUATING

1N5719 *
1N5767 *
5082-3001/02
5082-3039 *
5082-3042/43
5082-3077 *
5082-3080 *
5082-3081
5082-3168/88 *
5082-3379
HPND-4165/66

Features

- **LOW HARMONIC DISTORTION**
- **LARGE DYNAMIC RANGE**
- **LOW SERIES RESISTANCE**
- **LOW CAPACITANCE**
- **LOW TEMPERATURE COEFFICIENT**
  Typically Less Than 20% Resistance Change from 25°C to 100°C



Outline 15

Description / Applications

These general purpose switching diodes are intended for low power switching applications such as RF duplexers, antenna switching matrices, digital phase shifters, and time multiplex filters. The 5082-3168/3188 are optimized for VHF/UHF bandswitching.

The RF resistance of a PIN diode is a function of the current flowing in the diode. These current controlled resistors are specified for use in control applications such as variable RF attenuators, automatic gain control circuits, RF modulators, electrically tuned filters, analog phase shifters, and RF limiters.

Maximum Ratings

Junction Operating and Storage
Temperature Range .... -65°C to +150°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Power Dissipation at 25°C .... 250 mW
(Derate linearly to zero at 150°C)
Peak Inverse Voltage (PIV) .... V_{BR}

Mechanical Specifications

The HP Outline 15 package has a glass hermetic seal with dumet leads. The lead finish is tin for all PIN diode products except the 5082-3042 and -3043, which have gold plated leads. The leads on the Outline 15 package should be restricted so that the bend starts at least 1/16 inch (1.6mm) from the glass body. With this restriction, Outline 15 package will meet MIL-STD-750, Method 2036, Conditions A (4 lbs., [1.8 kg.], tension for 30 minutes) and E. The maximum soldering temperature is 230° C for five seconds. Typical package inductance and capacitance are 2.5 nH and 0.13pF, respectively. Marking is by digital coding with a cathode band.

*Also available in Tape and Reel. Please contact your local HP sales office for further information.

General Purpose Diodes
Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Maximum Total Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Residual Series Resistance R_S (Ω)	Minimum Effective Carrier Lifetime τ (ns)	Maximum Reverse Recovery Time t_{rr} (ns)
GENERAL PURPOSE SWITCHING AND ATTENUATING					
-3002	0.25	300	1.0	100	100 (typ)
-3001	0.25	200	1.0	100	100 (typ)
-3039	0.25	150	1.25	100	100 (typ)
IN5719	0.3**	150	1.25	100	100 (typ)
-3077	0.3	200	1.5	100	100 (typ)
FAST SWITCHING					
-3042	0.4*	70	1.0*	15 (typ)	5
-3043	0.4*	50	1.5*	15 (typ)	10
BAND SWITCHING					
-3188	1.0*	35	0.6**	40 (typ)	12 (typ)
-3168	2.0*	35	0.5**	40 (typ)	12 (typ)
Test Conditions	V_R = 50V *V_R = 20V **V_R = 100V f = 1 MHz	$V_R = V_{BR}$ Measure $I_R \leqslant 10\mu A$	I_F = 100mA *I_F = 20mA **I_F = 10mA f = 100 MHz	I_F = 50mA I_R = 250mA	I_F = 20mA V_R = 10V 90% Recovery

Note: Typical CW power switching capability for a shunt switch in a 50Ω system is 2.5W.

RF Current Controlled Resistor Diodes
Electrical Specifications at $T_A = 25°C$

Part Number	Minimum Effective Carrier Lifetime τ (ns)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Residual Series Resistance R_S (Ω)	Maximum Total Capacitance C_T (pF)	High Resistance Limit, R_H (Ω)		Low Resistance Limit, R_L (Ω)		Maximum Difference in Resistance vs. Bias Slope, Δχ
					Min.	Max.	Min.	Max.	
HPND-4165	100	100	1.5	0.3	1100	1660	16	24	.04
HPND-4166	100	100	1.5	0.3	830	1250	12	18	.04
5082-3080*	1300(typ)	100	2.5	0.4	1000			8**	
5082-3379	1300(typ)	50		0.4				8**	–
5082-3081	2000(typ)	100	3.5	0.4	1500			8**	
Test Conditions	I_F=50mA I_R=250mA	$V_R=V_{BR}$, Measure $I_R \leqslant 10\mu A$	I_F=100mA f=100mHz	V_R=50V f=1mHz	I_F=0.01mA f=100mHz		I_F=1.0mA **I_F=20mA f=100mHz		Batch Matched at I_F=0.01mA and 1.0mA f=100mHz

*The 1N5767 has the additional specifications:
τ = 1.0 μsec minimum
I_R = 1 μA maximum at V_R = 50V
V_F = 1V maximum at I_F = 100mA.

Typical Parameters

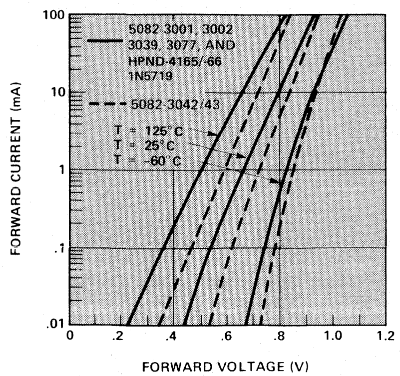


Figure 1. Typical Forward Current vs. Forward Voltage.

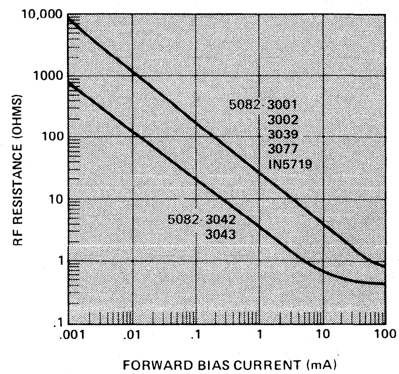


Figure 2. Typical RF Resistance vs. Forward Bias Current.

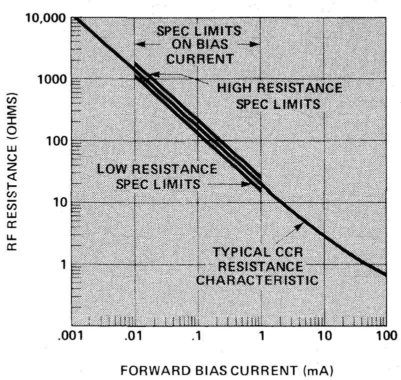


Figure 3. Typical RF Resistance vs. Bias for HPND-4165.

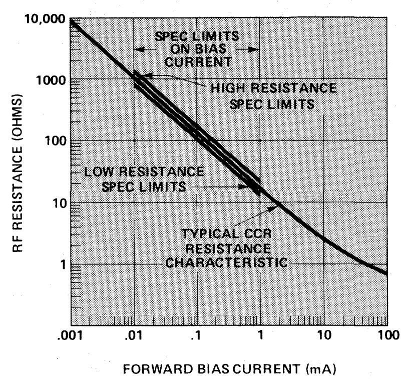


Figure 4. Typical RF Resistance vs. Bias for HPND-4166.

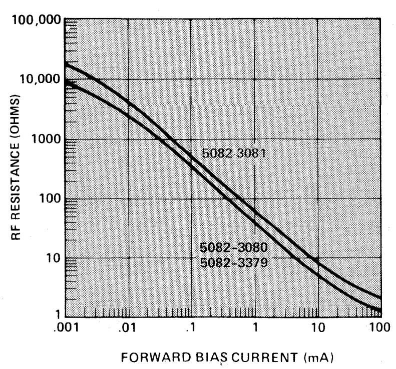


Figure 5. Typical RF Resistance vs. Forward Bias Current.

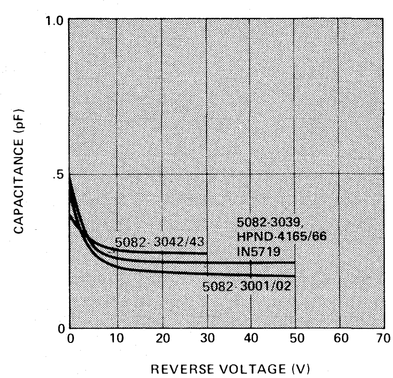


Figure 6. Typical Capacitance vs. Reverse Voltage.

Typical Parameters (Continued)

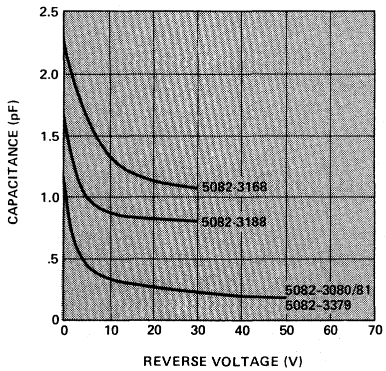


Figure 7. Typical Capacitance vs. Reverse Voltage.

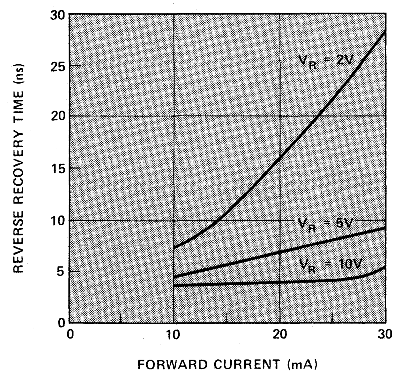


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3042, 3043.

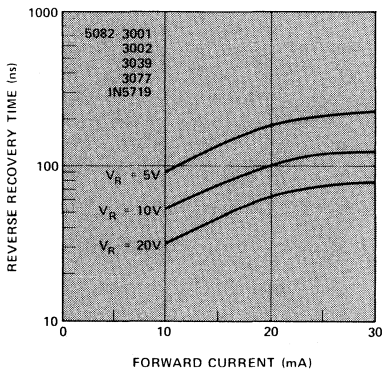


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

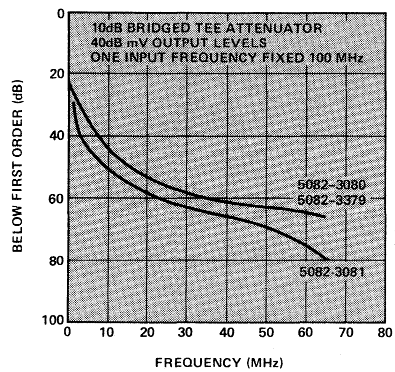


Figure 10. Typical Second Order Intermodulation Distortion.

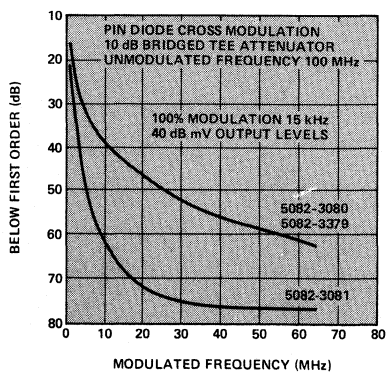


Figure 11. Typical Cross Modulation Distortion.

HEWLETT PACKARD

PIN DIODE LIMITER

5082-3071

Features

HIGH POWER HANDLING CAPABILITY
50 W Peak Pulse Power

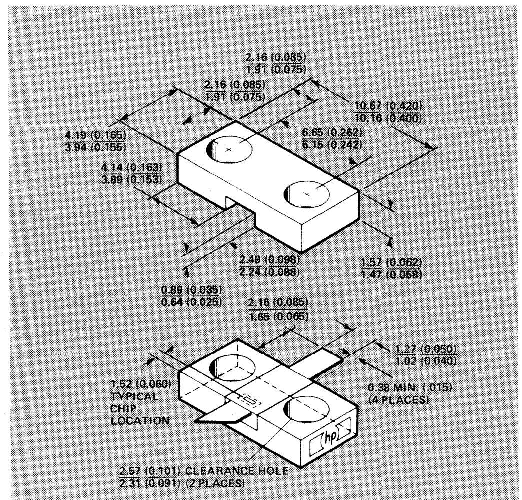
LOW INTERMODULATION PRODUCTS
Typical 0.2 W Threshold Assures Wide Dynamic Linear Range

BROAD BANDWIDTH
500 MHz to 10 GHz

LOW INSERTION LOSS
Less than 1 dB in X-band

EASY TO USE
Package Compatible with Stripline and Microstrip

NEGLIGIBLE SPIKE LEAKAGE



Outline 61

Description/Applications

The HP 5082-3071 passive limiter chip is functionally integrated into a 50 ohm transmission line to provide a broadband, linear, low insertion loss transfer characteristic for small signal levels. At higher signal levels self-rectification reduces the diode resistance to provide limiting as shown in Figure 2. Limiter performance is practically independent of temperature over the rated temperature range.

The 5082-3071 limiter module is designed for applications in telecommunication equipment, ECM receivers, distance measuring equipment, radar receivers, telemetry equipment, and transponders operating anywhere in the frequency range from 500 MHz through 10 GHz. An external dc return is required for self bias operation. This dc return is often present in the existing circuit, i.e. inductively coupled antennas, or it can be provided by a $\lambda/4$ resonant shunt transmission line. Selection of a high characteristic impedance for the shunt transmission line affords broadband operation. Another easy to realize dc return consists of a small diameter wire connected at a right angle to the electric field in a microstrip or stripline circuit. A 10 mA forward current will actuate the PIN diode as a shunt switch providing approximately 20 dB of isolation.

Maximum Ratings

Junction Operating and Storage Temperature Range	−65° C to +125° C
Power Dissipation[1]	1.0 W
Peak Incident Pulse Power[2]	50 W
Peak Inverse Voltage	50 V
Soldering Temperature	230° C for 5 sec

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10⁷ hours.

Notes:
1. Device properly mounted in sufficient heak sink at $T_A = 25°C$, derate linearly to zero at maximum operating temperature.
2. $t_p = 1\ \mu s$, f = 10 GHz, Du = 0.001, $Z_0 = 50\ \Omega$, $T_A = 25°C$.

Mechanical Specifications

The cover channel supplied with each diode should be used in balanced stripline circuits in order to provide good electrical continuity from the upper to the lower ground plane through the package base metal. Higher order modes will be excited if this cover is left off or if poor electrical contact is made to the ground plane.

The package transmission channel is filled with epoxy resin which combines a low expansion coefficient with high chemical stability.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Maximum Insertion Loss (dB)	Maximum SWR	Maximum RF Leakage Power (W)	Typical Recovery Time (ns)
3071	61	Cathode	1.2	2.0	1.0	100
Test Conditions	—	—	P_{in} = 0 dBm f = 9.4GHz	P_{in} = 0 dBm f = 9.4GHz	P_{in} = 50 W	P_{in} = 50 W

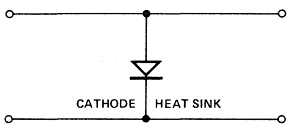


Figure 1. Heat Sink Polarity

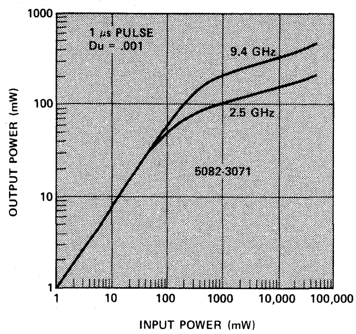


Figure 2. Typical Pulse Limiting Characteristics

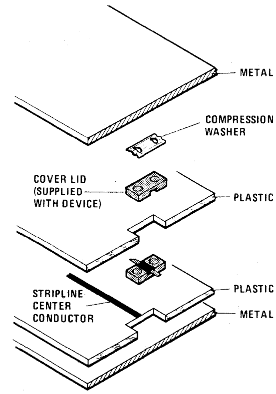


Figure 3. Suggested Stripline Assembly

HEWLETT PACKARD

STRIPLINE PIN DIODE SWITCHES/ ATTENUATORS

5082-3040
5082-3041
5082-3046
5082-3340

Features

LOW COST TO USE
Designed for Easy Mounting

BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 0.5 dB to 10 GHz (5082-3040, -3340)

HIGH ISOLATION
Greater than 20 dB to 10 GHz

FAST SWITCHING/MODULATING
5 ns Typical (5082-3041)

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation (5082-3041)

Description/Applications

These diodes are designed for applications in microwave and HF-UHF systems using stripline or microstrip transmission line techniques.

Typical circuit functions performed consist of switching, duplexing, multiplexing, leveling, modulating, limiting, or gain control functions as required in TR switches, pulse modulators, phase shifters, and amplitude modulators operating in the frequency range from HF through Ku-Band.

These diodes provide nearly ideal transmission characteristics from HF through Ku-Band.

The 5082-3340 is a reverse polarity device with characteristics similar to the 5082-3040. The 5082-3041 is recommended for applications requiring fast switching or high frequency modulation of microwave signals, or where the lowest bias current for the maximum attenuation is required.

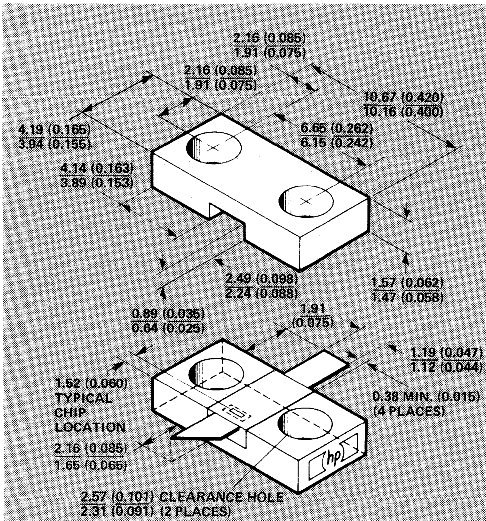
The 5082-3046 has been developed for high peak pulse power handling as required in TR switches for distance measurement and TACAN equipment. The long effective minority carrier lifetime provides for low intermodulation products down to 10 MHz.

More information is available in HP AN 922 (Applications of PIN Diodes) and 929 (Fast Switching PIN Diodes).

Mechanical Specifications

The cover channel supplied with each diode should be used in balanced stripline circuits in order to provide good electrical continuity from the upper to the lower ground plane through the package base metal. Higher order modes will be excited if this cover is left off or if poor electrical contact is made to the ground plane.

The package transmission channel is filled with epoxy resin which combines a low expansion coefficient with high chemical stability.



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 61

Maximum Ratings

Part No. 5082-	-3040 -3340	-3041	-3046
Junction Operating and Storage Temperature Range	-65°C to 125°C	-65°C to 125°C	
Power Dissipation[1]	2.5 W	1.0 W	4.0 W
Peak Incident Pulse Power[2]	225 W	50 W	2000 W
Peak Inverse Voltage	150 V	70 V	300 V
Soldering Temperature	230°C for 5 sec.		

Notes:
1. Device properly mounted in sufficient heat sink at 25°C, derate linearly to zero at maximum operating temperature.
2. $t_p = 1\ \mu s$, f = 10 GHz, Du = 0.001, $Z_O = 50\ \Omega$, $T_A = 25°C$.

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time t_{rr} (ns)	Typical Carrier Lifetime τ (ns)	Typical CW Power Switching Capability P_A (W)
3040	61	Anode	20	0.5	1.5	—	400	30
3041	61	Cathode	20	1.0	1.5	10	15	13
3046	61	Anode	20	1.0	1.5	—	1000	50
3340	61	Cathode	20	0.5	1.5	—	400	30
Test Conditions (Note 3)	—	—	I_F=100mA (Except 3041; I_F=20mA)	I_F = 0 P_{in} = 1mW	I_F = 0 P_{in} = 1mW	I_F = 20mA V_R = 10V Recovery to 90%	I_F = 50mA I_R = 250mA	—

Note 3:Test Frequencies: 8 GHz 5082-3041, -3046; 10 GHz 5082-3040, and -3340.

Typical Parameters

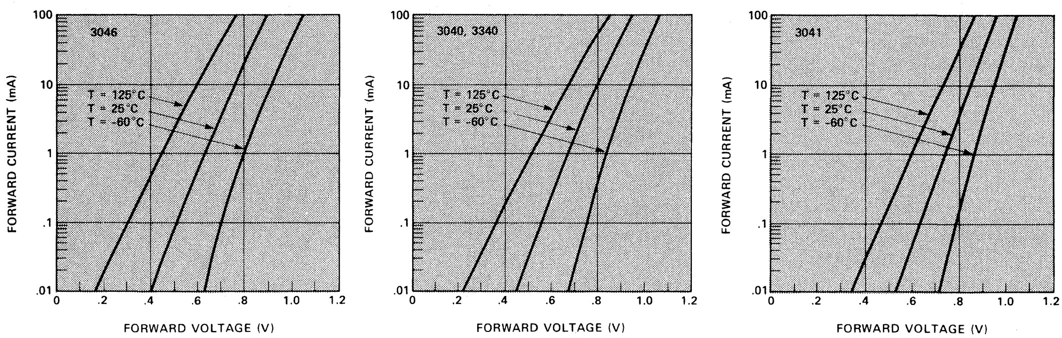


Figure 1. Typical Forward Characteristics.

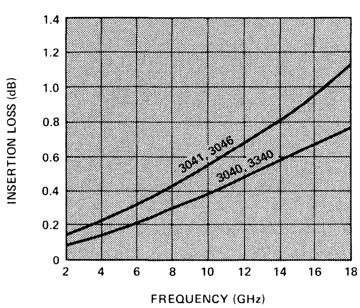


Figure 2. Typical Insertion Loss vs. Frequency.

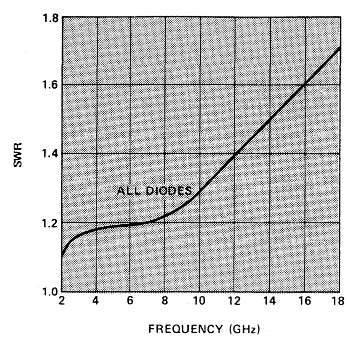


Figure 3. Typical SWR vs. Frequency.

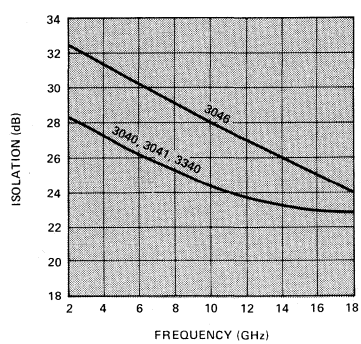


Figure 4. Typical Isolation vs. Frequency.

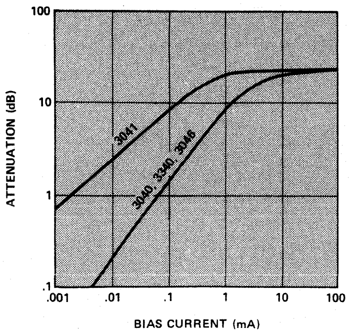
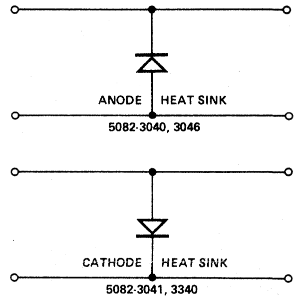


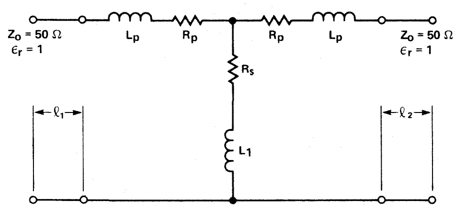
Figure 5. Typical Attenuation Above Zero Bias Insertion Loss vs. Bias Current at f = 8 GHz.



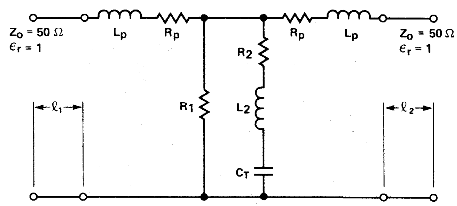
HEAT SINK POLARITY

Equivalent Circuits

Forward Bias (Isolation State)



Zero Bias (Insertion Loss State)



Typical Equivalent Circuit Parameters - Forward Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	Rs (Ω)	L_1 (pH)	ℓ_1 (mm)	ℓ_2 (mm)
3040, 3340	200	0.25	1.0	20	2.4	5.0
3041	220	0.25	1.0	20	2.4	5.0
3046	220	0.25	0.6	17	2.4	5.0

Typical Equivalent Circuit Parameters - Zero Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	R_1 (KΩ)	L_2 (pH)	R_2 (KΩ)	C_T (pF)	ℓ_1 (mm)	ℓ_2 (mm)
3040, 3340	200	0.25	∞	0	5.0	0.10	2.4	5.0
3041	220	0.25	∞	0	1.5	0.15	2.4	5.0
3046	220	0.25	∞	0	1.5	0.15	2.4	5.0

Typical Switching Parameters

RF SWITCHING SPEED
HP 5082-3041

The RF switching speed of the HP 5082-3041 may be considered in terms of the change in RF isolation at 2 GHz. This switching speed is dependent upon the forward bias current, reverse bias drive pulse, and characteristics of the pulse source. The RF switching speed for the shunt-mounted stripline diode in a 50 Ω system is considered for two cases: one driving the diode from the forward bias state to the reverse bias state (isolation to insertion loss), second, driving the diode from the reverse bias state to the forward bias state (insertion loss to isolation).

The total time it takes to switch the shunt diode from the isolation state (forward bias) to the insertion loss state (reverse bias) is shown in Figure 6. These curves are for three forward bias conditions with the diode driven in each case with three different reverse voltage pulses (V_{PR}). The total switching time for each case includes the delay time (pulse initiation to 20 dB isolation) and transition time (20 dB isolation to 0.9 dB isolation). Slightly faster switching times may be realized by spiking the leading edge of the pulse or using a lower impedance pulse driver.

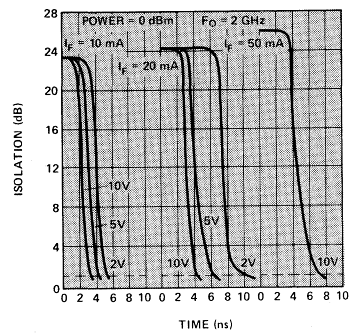


Figure 6. Isolation vs. Time (Turn-on) for HP 5082-3041. Frequency, 2 GHz.

The time it takes to switch the diode from zero or reverse bias to a given isolation is less than the time from isolation to the insertion loss case. For all cases of forward bias generated by the pulse generator (positive pulse), the RF switching time from the insertion loss state to the isolation state was less than 2 nanoseconds. A more detailed treatise on switching speed is published in AN929; Fast Switching PIN Diodes.

REVERSE RECOVERY TIME

Shown below is reverse recovery time, (t_{rr}) vs. forward current, (I_F) for various reverse pulse voltages V_R. The circuit used to measure t_{rr} is shown in Figure 7.

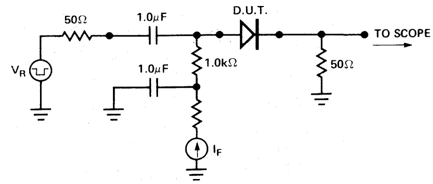


Figure 7. Basic t_{rr} Test Setup.

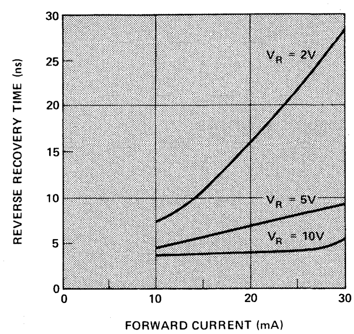


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3041.

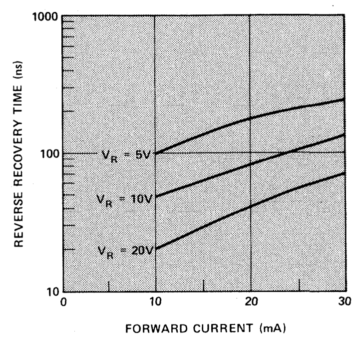


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3340.

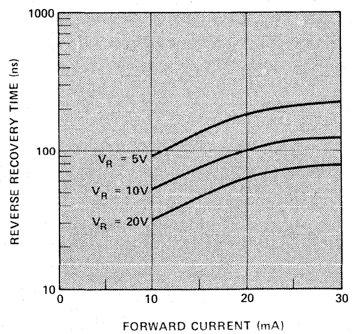


Figure 10. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3040.

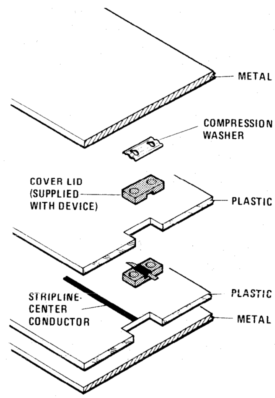


Figure 11. Suggested Stripline Assembly.

PIN Diodes

HEWLETT PACKARD

HERMETIC PIN DIODES FOR STRIPLINE/MICROSTRIP SWITCHES/ATTENUATORS

5082-3140
5082-3141
5082-3170

Features

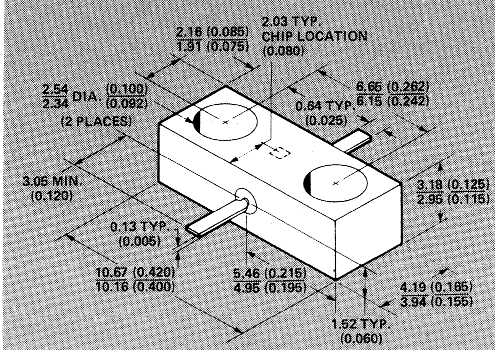
BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 0.5 dB to 10 GHz (5082-3140, -3170)

HIGH ISOLATION
Greater than 20 dB to 10 GHz (5082-3140, -3170)

FAST SWITCHING/MODULATING
5 ns Typical (5082-3141)

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation (5082-3141)



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 60

Description/Applications

The HP 5082-3140 and -3170 are passivated planar devices and the 5082-3141 is a passivated mesa device. All are in a shunt configuration in hermetic stripline packages which are suitable for Hi-Rel applications. These diodes are optimized for good continuity of characteristic impedance which allows a continuous transition when used in 50 ohm microstrip or stripline circuits.

These diodes are designed for applications in microwave and HF-UHF systems using stripline or microstrip transmission line techniques.

Typical circuit functions performed consist of switching, duplexing, multiplexing, leveling, modulating, limiting, or gain control functions as required in TR switches, pulse modulators, phase shifters, and amplitude modulators operating in the frequency range from HF through Ku-Band. These diodes provide nearly ideal transmission characteristics from HF through Ku-Band.

The 5082-3170 is a reverse polarity device with characteristics similar to the 5082-3140.

The 5082-3141 is recommended for applications requiring fast switching or high frequency modulation of microwave signals, or where the lowest bias current for maximum attenuation is required.

More information is available in HP Application Note 922 (Applications of PIN Diodes) and 929 (Fast Switching PIN Diodes).

Maximum Ratings

Part No. 5082-	-3140 -3170	-3141
Junction Operating and Storage Temperature Range	-65° C to 150° C	-65° C to 150° C
Power Dissipation[1]	1.75 W	0.75 W
Peak Incident Pulse Power[2]	225 W	50 W
Peak Inverse Voltage	150 V	70 V
Soldering Temperature	230° C for 5 sec.	

Notes:
1. Device properly mounted in sufficient heat sink at 25° C, derate linearly to zero at maximum operating temperature.
2. $t_p = 1\ \mu s$, f = 10 GHz, Du = 0.001, $Z_o = 50\ \Omega$, $T_A = 25°C$.

Mechanical Specifications

Package Outline 60 is hermetically sealed and capable of meeting the stringent requirements of space level high reliability testing. Both the package and lead materials are gold plated Kovar.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time t_{rr} (ns)	Typical Carrier Lifetime τ (ns)	Typical CW Power Switching Capability P_A (W)
3140	60	Anode	20	0.5	1.5	–	400	30
3141	60	Cathode	20	1.0	1.5	10	15	13
3170	60	Cathode	20	0.5	1.5	–	400	30
Test Conditions (Note 3)	–	–	I_F=100mA (Except 3141; I_F=20mA)	$I_F = 0$ P_{in} = 1mW	$I_F = 0$ P_{in} = 1mW	I_F = 20mA V_R = 10V Recovery to 90%	I_F = 50mA I_R = 250mA	–

Note 3: Test Frequencies: 8 GHz 5082-3141. 10 GHz 5082-3140, -3170.

Typical Parameters

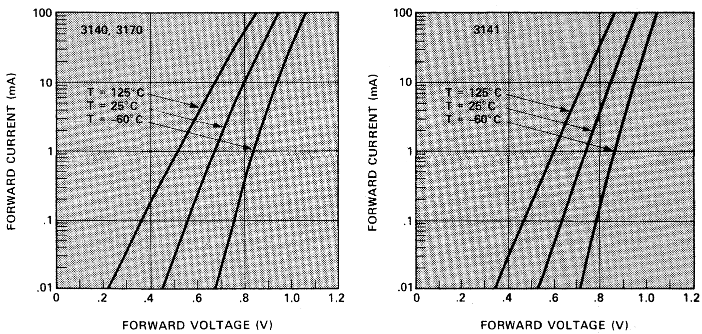


Figure 1. Typical Forward Characteristics.

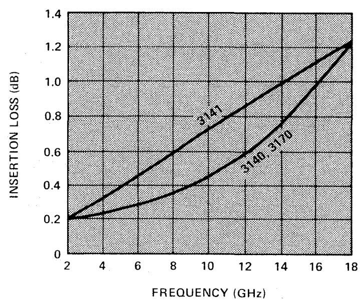


Figure 2. Typical Insertion Loss vs. Frequency.

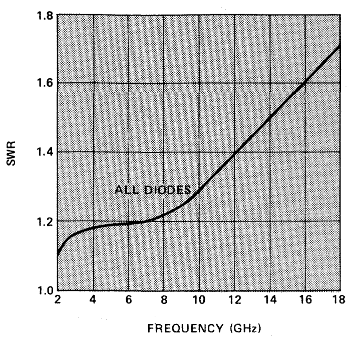


Figure 3. Typical SWR vs. Frequency.

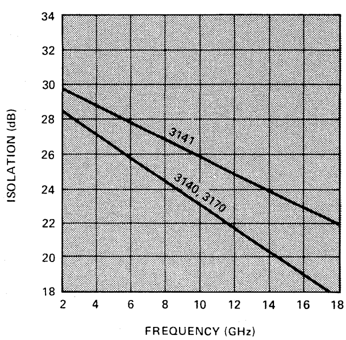


Figure 4. Typical Isolation vs. Frequency.

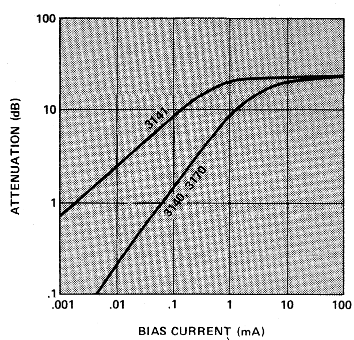
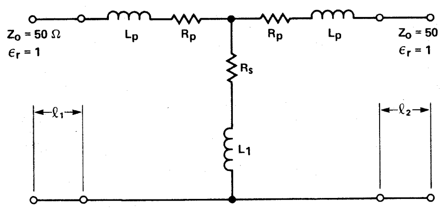


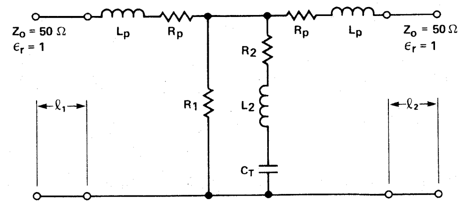
Figure 5. Typical Attenuation Above Zero Bias Insertion Loss vs. Bias Current at f = 8 GHz.

Equivalent Circuits

Forward Bias (Isolation State)



Zero Bias (Insertion Loss State)



Typical Equivalent Circuit Parameters - Forward Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	Rs (Ω)	L_1 (pH)	ℓ_1 (mm)	ℓ_2 (mm)
3140, 3170	150	0.0	0.95	30	3.8	3.8
3141	150	0.0	0.8	20	3.8	3.8

Typical Equivalent Circuit Parameters - Zero Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	R_1 (KΩ)	L_2 (pH)	R_2 (KΩ)	C_T (pF)	ℓ_1 (mm)	ℓ_2 (mm)
3140, 3170	30	0.0	1.2	16	0.0	0.20	5.3	5.3
3141	200	0.0	∞	0	0.4	0.14	4.4	4.4

Typical Switching Parameters

RF SWITCHING SPEED

HP 5082-3141

The RF switching speed of the HP 5082-3141 may be considered in terms of the change in RF isolation at 2 GHz. This switching speed is dependent upon the forward bias current, reverse bias drive pulse, and characteristics of the pulse source. The RF switching speed for the shunt-mounted stripline diode in a 50 Ω system is considered for two cases, one driving the diode from the forward bias state to the reverse bias state (isolation to insertion loss), second driving the diode from the reverse bias state to the forward bias state (insertion loss to isolation).

The total time it takes to switch the shunt diode from the isolation state (forward bias) to the insertion loss state (reverse bias) is shown in Figure 6. These curves are for three forward bias conditions with the diode driven in each case with three different reverse voltage pulses (V_{PR}). The total switching time for each case includes the delay time (pulse initiation to 20 dB isolation) and transition time (20 dB isolation to 0.9 dB isolation). Slightly faster switching times may be realized by spiking the leading edge of the pulse or using a lower impedance pulse driver.

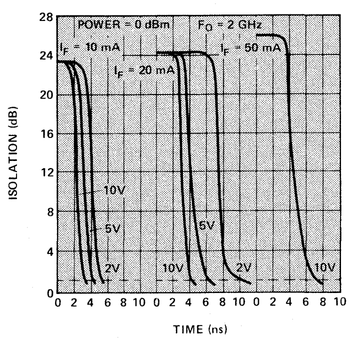


Figure 6. Isolation vs. Time (Turn-on) for HP 5082-3141 Frequency, 2 GHz.

The time it takes to switch the diode from zero or reverse bias to a given isolation is less than the time from isolation to the insertion loss case. For all cases of forward bias generated by the pulse generator (positive pulse), the RF switching time from the insertion loss state to the isolation state was less than 2 nanoseconds. A more detailed treatise on switching speed is published in AN929; Fast Switching PIN Diodes.

REVERSE RECOVERY TIME

Shown below is reverse recovery time, (t_{rr}) vs. forward current, (I_F) for various reverse pulse voltages V_R. The circuit used to measure t_{rr} is shown in Figure 7.

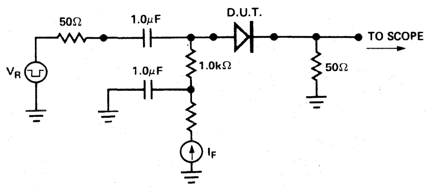


Figure 7. Basic t_{rr} Test Setup.

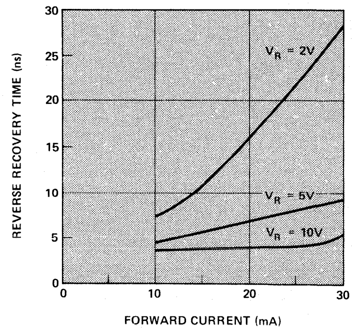


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3141.

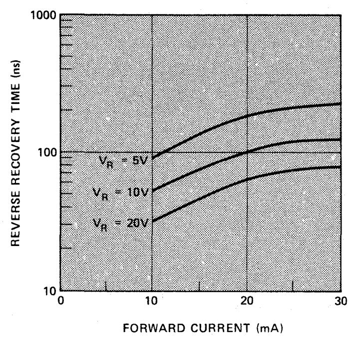


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3140.

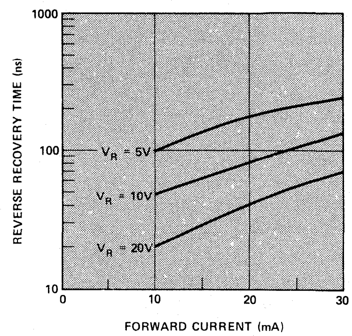


Figure 10. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3170.

HEWLETT PACKARD

PIN DIODES FOR FAST SWITCHING AND ATTENUATING

5082-3305
5082-3306

Features

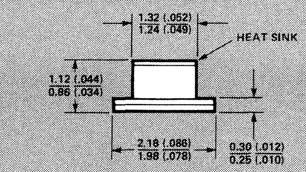
NANOSECOND SWITCHING TIME
Typically Less than 5 ns

LOW RESIDUAL SERIES RESISTANCE
Less than 1 Ω

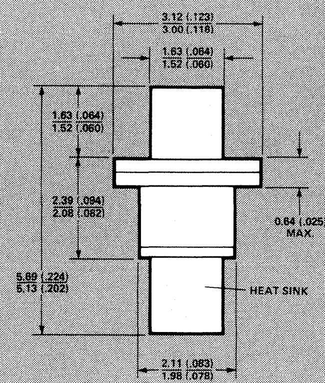
LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 1 Ω R_S

HIGH POWER LIMITING CAPABILITY
50 W Peak Pulse Power

CATHODE HEAT SINK



Outline 38 (5082-3305)



Outline 31 (5082-3306)

DIMENSIONS IN MILLIMETERS AND (INCHES).

Description/Applications

The HP 5082-3305 and 5082-3306 are passivated silicon PIN diodes of mesa construction. Precisely controlled processing provides an exceptional combination of fast RF switching and low residual series resistance.

These HP PIN diodes provide unique benefits in the high isolation to insertion loss ratio afforded by the low residual resistance at low bias currents and the ultra-fast recovery realized through lower stored charge. Where low drive power is desired these diodes provide excellent performance at very low bias currents.

The HP 5082-3305 and 5082-3306 ceramic package PIN diodes are intended for controlling and processing microwave signals up to Ku band. Typical applications include single and multi-throw switches, pulse modulators, amplitude modulators, phase shifters, duplexers, diplexers and TR switches.

Maximum Ratings

Junction Operating and Storage Temperature Range
.... -65°C to +150°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

DC Power Dissipation at T_{CASE} = 25°C
(Derate linearly to zero at 150°C)

HP 5082-3305 .... 0.7 W
HP 5082-3306 .... 1.25W

Mechanical Specifications

The HP Package Outline 31 has a metal ceramic hermetic seal. The heat sink stud is gold-plated copper. The opposite stud is gold-plated kovar. Typical package inductance is 1.0 nH and typical package capacitance is 0.2 pF.

The HP Package Outline 38 also has a metal ceramic hermetic seal. The heat sink contact is gold plated copper. The opposite contact is gold-plated kovar. Typical package inductance is 0.4 nH and typical package capacitance is 0.2 pF.

The maximum soldering temperature for diodes in either package is 230°C for 5 seconds.

FAST SWITCHING/ATTENUATING
Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Series Resistance R_S (Ω)	Maximum Reverse Recovery Time t_{rr} (ns)
3305	38	Cathode	70	0.4	1.0	10.0
3306	31		70	0.45	1.0	10.0
Test Conditions			$V_R = V_{BR}$, meas. $I_R \leq 10\,\mu A$	f = 1 MHz V_R = 20V	f = 100 MHz I_F = 20mA	I_F = 20mA V_R = 10V 90% Recovery

Typical Parameters

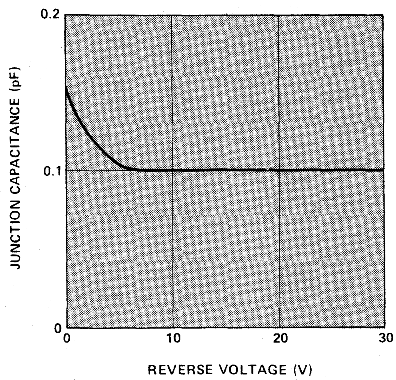


Figure 1. Typical Junction Capacitance vs. Reverse Voltage.

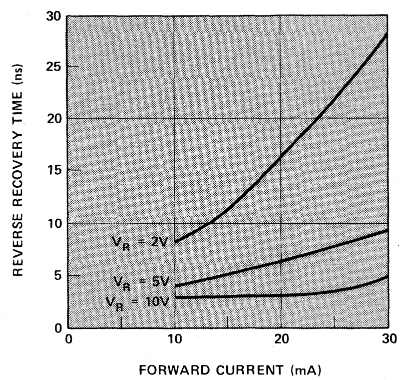


Figure 2. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

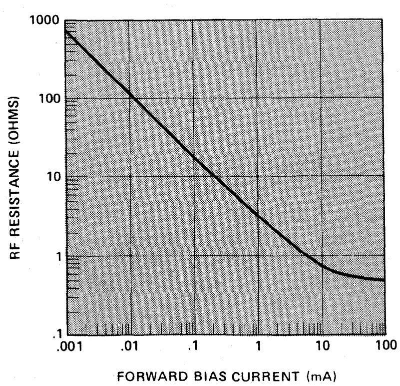


Figure 3. Typical RF Resistance vs. Forward Bias Current.

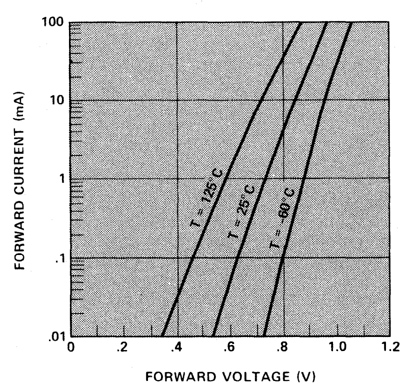


Figure 4. Typical Forward Current vs. Forward Voltage.

PIN Diodes

HEWLETT PACKARD

PIN DIODES FOR RF POWER SWITCHING/ ATTENUATION

5082-3101
5082-3102
5082-3201
5082-3202
5082-3303
5082-3304

Features

HIGH ISOLATION
Greater Than 25 dB

LOW INSERTION LOSS

HIGH CONTROL SIGNAL DYNAMIC RANGE
10,000: 1 RF Resistance Change

LOW HARMONIC DISTORTION LIFETIME
Greater Than 100 ns

BOTH ANODE AND CATHODE HEAT SINK MODELS AVAILABLE

Description/Applications

HP 5082-3101/02, 5082-3201/02, 5082-3303/04 PIN diodes are silicon devices manufactured using modern processing techniques to provide optimum characteristics for RF switching, signal conditioning and control. These devices are of planar passivated design. Both anode and cathode heat sink models are available.

PIN diodes provide a variable RF resistance with DC bias current. The main advantages of a PIN diode over PN switching diodes are the low forward resistance and the low device capacitance.

These HP PIN Diodes are intended for use in RF switching, multiplexing, modulating, phase shifting, and attenuating applications from approximately 10 MHz to frequencies well into the microwave region. Due to their low parasitic capacitance and inductance, both HP Package Outline 31 and 38 are well suited for broadband circuits up to 1 GHz and for resonated circuits up to 8 GHz.

These devices are especially useful where the lowest residual series resistance and junction capacitance are required for high on-to-off switching ratios. At constant bias the RF resistance is relatively insensitive to temperature, increasing only 20% for a temperature change from +25°C to +100°C.

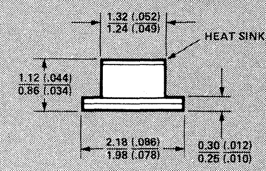
Maximum Ratings

Junction Operating and Storage
Temperature Range .... -65°C to +150°C

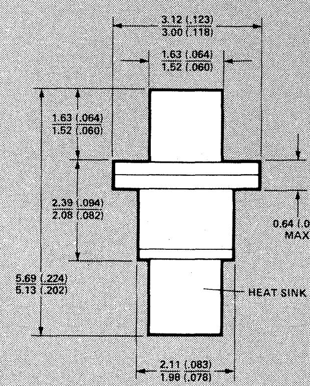
Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

DC Power Dissipation at 25° C. (Derate linearly to zero at 150° C)

HP 5082-3101, 3102 .... 1.0 W
HP 5082-3201, 3202, 3303, 3304 .... 3.0 W



Outline 38



Outline 31

DIMENSIONS IN MILLIMETERS AND (INCHES)

Mechanical Specifications

The HP Package Outline 31 has a metal ceramic hermetic seal. The heat sink stud is gold-plated copper. The opposite stud is gold-plated kovar. Typical package inductance is 1.0 nH and typical package capacitance is 0.2 pF.

The HP Package Outline 38 also has a metal ceramic hermetic seal. The heat sink contact is gold plated copper. The opposite contact is gold-plated kovar. Typical package inductance is 0.4 nH and typical package capacitance is 0.2 pF.

The maximum soldering temperature for diodes in either package is 230°C for 5 seconds.

RF POWER SWITCHING/ATTENUATING
Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Residual Series Resistance R_S (Ω)	Minimum Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Typical CW Power Handling Capability P_A (W)
3101	38	Anode	200	0.32	1.2	100	100	40
3102	38	Anode	300	0.30	0.8	100	100	60
3201	31	Anode	200	0.35	1.2	100	100	120
3202	31	Anode	300	0.32	0.8	100	100	180
3303	31	Cathode	200	0.40	1.2	100	100	120
3304	31	Cathode	300	0.32	0.8	100	100	180
Test Conditions			$V_R = V_{BR}$, meas. $I_R \leq 10\mu A$	$V_R = 50V, f = 1MHz$	$I_F = 100mA$ $f = 100MHz$	$I_F = 50mA$ $I_R = 250mA$	$I_F = 20mA$, $V_R = 10V$ 90% Recovery	Series* Switch in 50Ω System

*Divide by four for a shunt switch.

Typical Parameters

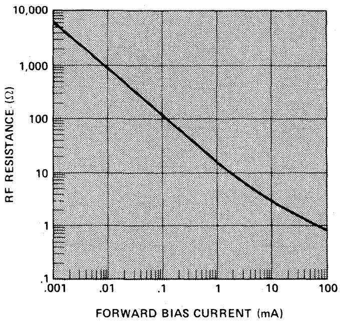


Figure 1. Typical RF Resistance vs. Forward Bias Current

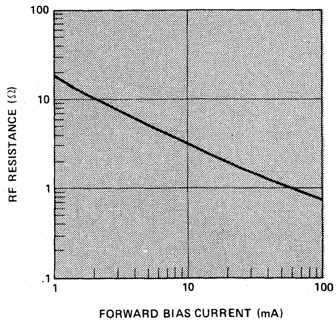


Figure 2. Typical RF Resistance vs. Forward Bias Current.

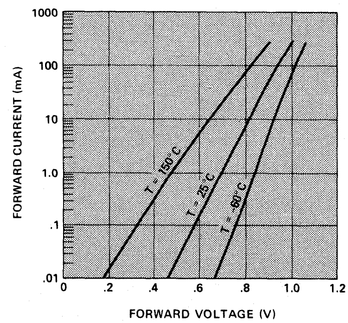


Figure 3. Typical Forward Characteristics.

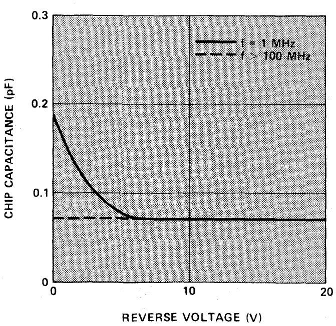
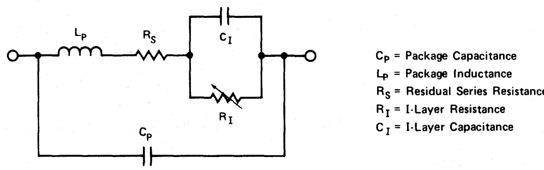


Figure 4. Typical Chip Capacitance vs. Reverse Voltage



TYPICAL VALUES FOR C_P AND L_P ARE GIVEN UNDER "MECHANICAL SPECIFICATIONS". WITH REVERSE BIAS, $R_I > 10k\ \Omega$. TOTAL CAPACITANCE IS C_T AND IS GIVEN IN "ELECTRICAL SPECIFICATIONS". WITH FORWARD BIAS C_I IS NO LONGER PRESENT. R_I DECREASES WITH INCREASING FORWARD BIAS TO APPROXIMATELY ZERO AT 100 mA.

Figure 5. Device Equivalent Circuit.

PIN Diodes

HEWLETT PACKARD

HIGH CONDUCTANCE DIODES

5082-1001
5082-1002
5082-1006

Features

FAST SWITCHING
LOW CAPACITANCE
HIGH CURRENT CAPABILITY

Description/Applications

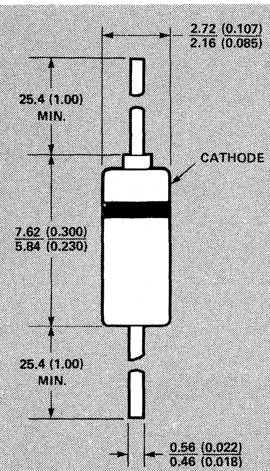
The 5082-1000 series of diodes feature planar silicon epitaxial construction to provide high conductance, low capacitance, and nanosecond turn-on and turn-off. Turn-on time and voltage overshoot are minimized in these diodes of low conductivity modulation.

These diodes are ideally suited for applications such as core drivers, pulse generators, input gates or wherever high conductance without loss of speed is required.

Maximum Ratings

WIV — Working Inverse Voltage
1006 .... 40 Volts
1001/1002 .... 30 Volts
I_F (Surge) — Forward Current Surge,
1.0 Second Duration .... 0.75 Amp
I_F (Surge) — Forward Current Surge,
1.0 Microsecond Duration .... 7.50 Amp
Power Dissipation[1] @ T_{CASE} = 25°C .... 500 mW
Operating Temperature Range .... −65°C to +175°C
Storage Temperature Range .... −65°C to +200°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.



DIMENSIONS IN MILLIMETERS AND (INCHES)
Outline 11

Mechanical Specifications

The HP Outline 11 package has a glass hermetic seal with dumet leads. The package will meet MIL-STD-750, Method 2036, Condition A (2 lbs. tension for 15 sec.) and E. The maximum soldering temperature is 230°C for 5 seconds. Outline 11 package capacitance and inductance are typically 0.15 pF and 4 nH respectively.

Electrical Specifications at T_A = 25°C

Part Number 5082-	Minimum Breakdown Voltage V_{BR} (V)	Minimum Forward Current I_F (mA)	Minimum Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA)	Maximum Reverse Leakage Current I_R (μA)	Maximum Total Capacitance C_O (pF)	Maximum Reverse Recovery Time t_{rr} (ns)	Maximum Turn-On Time t_{on} (ns)
1001	35	150	500	200	200	1.5	1.5	2.5
1002	35	300	800	200	200	3.0	2.0	2.5
1006	50	150	500	200	200	1.1	1.5	—
Test Conditions	I_R=10μA	V_F=1.0V [2]	V_F=1.4V [2]	[3]	150°C[3]	V_R=0V, f=1.0 MHz	(Figure 9)	(Figure 10)

NOTES: 1. Mounted on a printed circuit board in still air.
2. Measured at a repetition rate not to exceed the power dissipation.
3. V_R=35V for 1006; V_R=30V for 1001, 1002.
4. Inductance measured at the edge of the glass package seal is typically 4.0 nH for all devices.
5. Rectification Efficiency is typically 65% for all devices (Figure 8).

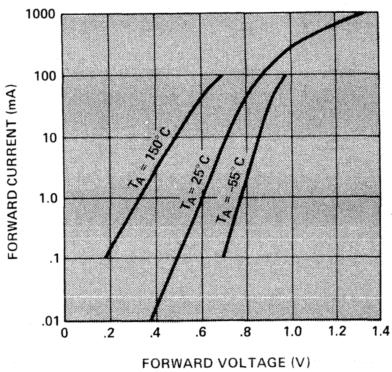


Figure 1. Typical Forward Conduction Characteristics. 5082-1001 and 1006.

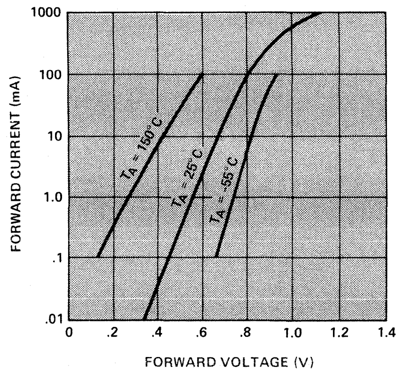


Figure 2. Typical Forward Conduction Characteristics. 5082-1002.

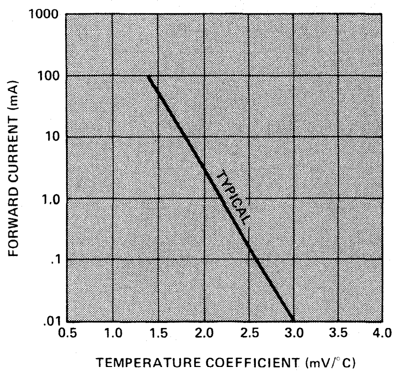


Figure 3. Typical Forward Current Temperature Coefficient.

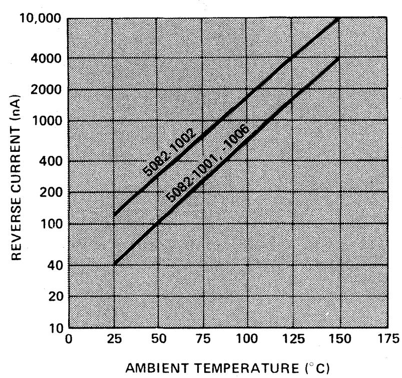


Figure 4. Typical Reverse Current at Specified V_R vs. Increasing Temperature.

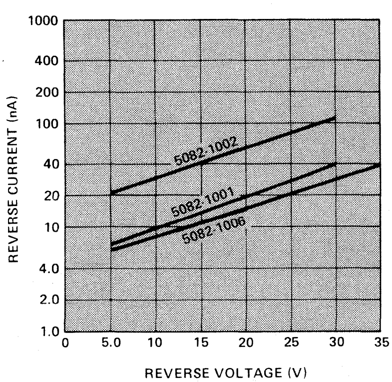


Figure 5. Typical Reverse Current vs. Reverse Voltage.

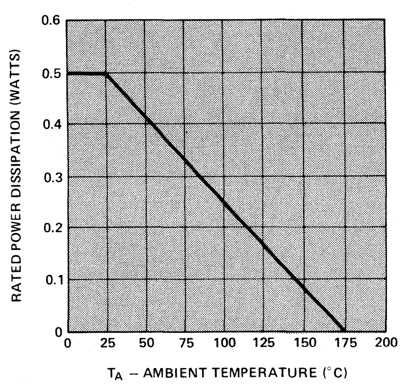


Figure 6. Power Dissipation Derating Characteristics.

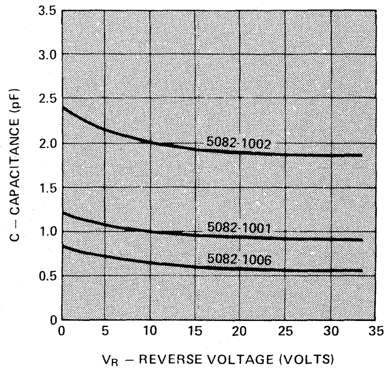


Figure 7. Typical Capacitance vs. Reverse Voltage Characteristics.

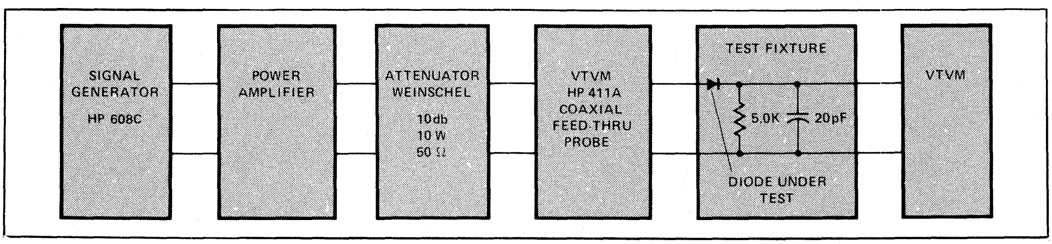


Figure 8. Test Circuit for Measuring the Rectification Efficiency. Signal source is adjusted to 100 MHz and 2V RMS as read on the 411A. The rectification efficiency calculated from the DC output voltage by RE = $V_{DC}/2.83$ is typically 65% for all devices.

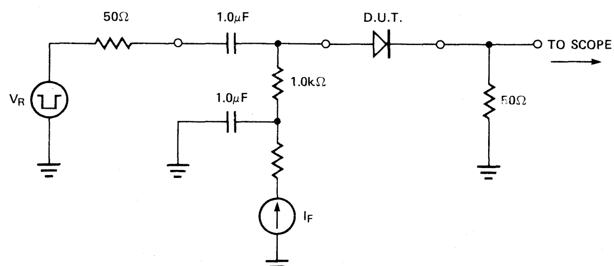


Figure 9. Test Circuit for Measuring Reverse Recovery Time. I_F is set at 20 mA and V_R at 2V.

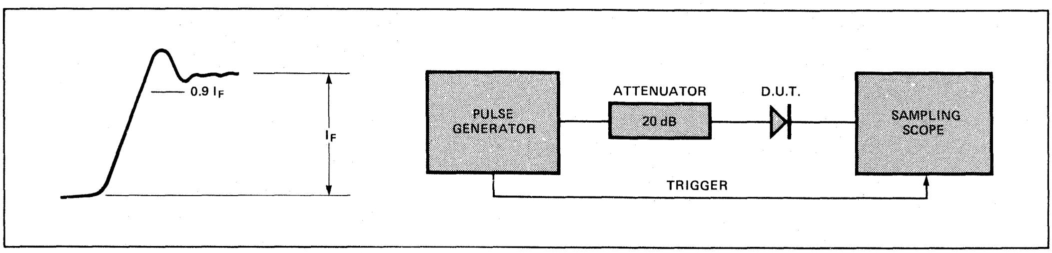


Figure 10. Test Circuit for Measuring Turn-On Time. I_F is adjusted for 10 mA after applying the step voltage. t_{ON} is measured as the time required to reach 0.9 I_F from initial application of the step voltage. For high excitation levels the t_{ON} value is significantly lower than the value specified, i.e., at 100 mA t_{ON} is typically less than 1.0 ns.

High Reliability Data for PIN Diodes

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD PIN DIODES

(Generic HPND-4001/-4050)

TXVP-4001
TXVP-4050

Features

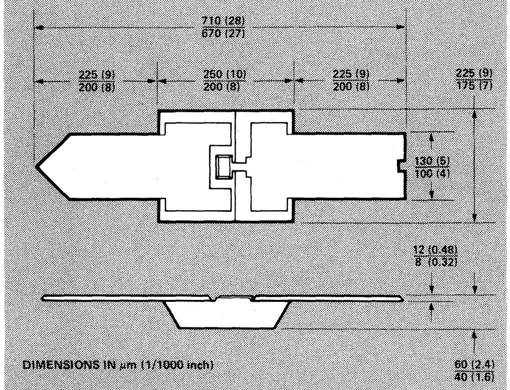
QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

LOW SERIES RESISTANCE
1.3 Ω Typical

LOW CAPACITANCE
0.07 pF Typical

FAST SWITCHING
2 ns Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull



Outline 21

Description/Applications

The TXVP-4001 and -4050 are beam lead PIN diodes designed specifically for low capacitance, low series resistance and rugged construction. The new HP mesa process allows the fabrication of beam lead PINs with a very low RC product. A nitride passivation layer provides immunity from contaminants which would otherwise lead to I_R drift. A deposited layer provides scratch protection.

The TXVP-4001 and -4050 beam lead PIN diodes are designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting and modulating at microwave frequencies. The low capacitance and low series resistance at low current make these devices ideal for applications in the shunt configuration.

After completion of the 100% inspection program per Table II, lot samples are subjected to the tests of Table III.

Maximum Ratings

Operating Temperature .... -65°C to +175°C
Storage Temperature .... -65°C to +200°C
Power Dissipation at 25°C .... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength ...... 4 grams pull on either lead

Bonding Techniques

Thermocompression bonding is recommended but welding, thermosonic bonding or conductive epoxy can also be used. For additional information, see Application Note 974, "Die Attach and Bonding Techniques for Diodes and Transistors," or Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy".

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Part Number	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)		Capacitance C_T (pF)		Minority Carrier Lifetime τ (ns)	Reverse Recovery Time t_{rr} (ns)	Reverse Current I_R (nA)	Forward Voltage V_F (V)
	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Typ.	Max.	Max.
TXVP-4001	50	80	1.8	2.2	0.07*	0.08*	30	3	100**	0.97
TXVP-4050	30	40	1.3	1.7	0.12	0.15	25	2	100	0.98
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$		$I_F = 10$ mA f = 100 MHz		$V_R = 20$ V *$V_R = 30$ V f = 1 MHz		$I_F = 10$ mA $I_R = 6$ mA	$I_F = 10$ mA $V_R = 10$ V	$V_R = 10$ V **H2 samples only	$I_F = 50$ mA

*Total capacitance calculated from measured isolation value in a series configuration.

TABLE II. 100% INSPECTION PROGRAM

Test/Inspection	Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 Hours at 300°C
2. Electrical Test (die probe) V_{BR}, I_A, V_F	—	See Table I
3. Visual Inspection	HP A-5956-0112-72 [1]	—

Note 1. Specification available upon request.

TABLE III. LOT QUALIFICATION

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
1. Beam Pull Test	2011H [1]	4 gram min., n = 11, r = 1	20
2. Assemble Samples in H2 Carrier	—	—	—
3. Electrical Test (Go/No Go)	—	See Table I	—
4. Thermal Shock (Temperature Cycling)	1051	10 cycles from −65°C to +200°C, 15 minutes at extremes	—
5. First Interim Electrical Test (Read and Record)	—	—	—
6. Non-Operating Life	1032	340 hours at 200°C, n = 65	10
7. High Temperature Reverse Bias	1038	240 hours V_R = 80% of rated V_{BR}, T_C = 150°C	
8. Second Interim Electrical Test (Read, Record and Delta)	—	$\Delta I_R < \pm 50$ nA or 100% whichever is greater, $\Delta V_F < 10\%$	
9. Operating Life	1038	340 hours, f = 60 Hz, T_C = 125°C V_R = 80% of rated V_{BR}, PFM = 50 mW, n = 65	10
10. Final Electrical Test (Read, Record and Delta)	—	$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$	

Note 1: Per MIL-STD-883.

Typical Parameters

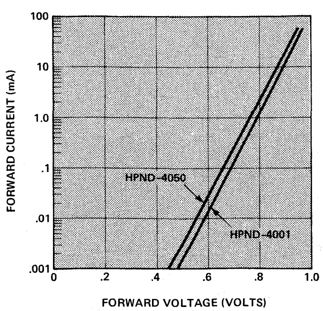


Figure 1. Typical Forward Characteristics.

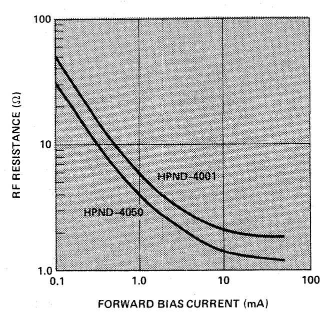


Figure 2. Typical RF Resistance vs. Forward Bias Current.

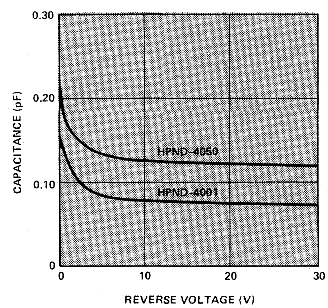


Figure 3. Typical Capacitance vs. Reverse Voltage.

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD PIN DIODE

(Generic HPND-4005)

TXVP-4005

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

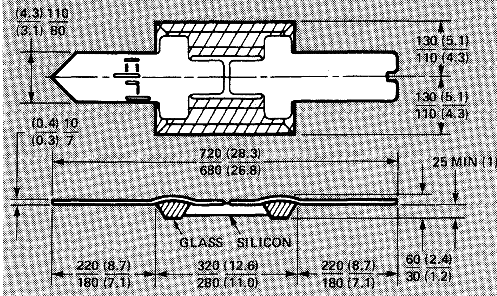
HIGH BREAKDOWN VOLTAGE
120V Typical

LOW CAPACITANCE
0.017 pF Typical

LOW RESISTANCE
4.7Ω Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

NITRIDE PASSIVATED



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 21

Description/Applications

The TXVP-4005 planar beam lead PIN diodes are constructed to offer exceptional lead strength while achieving excellent electrical performance at microwave frequencies.

The TXVP-4005 beam lead PIN diode is designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies. The extremely low capacitance of the TXVP-4005 makes it ideal for circuits requiring high isolation in a series diode configuration.

After completion of the 100% inspection program per Table I, lot samples are subjected to the tests of Table III.

Maximum Ratings

Operating Temperature .... -65°C to +175°C
Storage Temperature .... -65°C to +200°C
Power Dissipation at 25°C .... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength ...... 4 grams pull on either lead

Bonding Techniques

Thermocompression bonding is recommended but welding, thermosonic bonding or conductive epoxy can also be used. For additional information, see Application Note 974, "Die Attach and Bonding Techniques for Diodes and Transistors", or Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy".

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Part Number	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)		Capacitance C_T (pF)		Minority Carrier Lifetime τ (ns)		Reverse Recovery Time t_{rr} (ns)		Forward Voltage V_F (V)	Reverse Current I_R (nA)
TXVP-4005	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Max.	Max.
	100	100	4.7	6.5	0.017	0.02	100	150	20	35	1.0	100
Test Conditions	$I_R = 10\ \mu A$		$I_F = 20$ mA, f = 100 MHz		$V_R = 10V$, f = 10 GHz		$I_F = 10$ mA, $I_R = 6$ mA		$I_F = 20$ mA, $V_R = 10V$, 90% Recovery		$I_F = 10$ mA, H2 Samples Only	$V_R = 30V$

TABLE II. 100% INSPECTION PROGRAM

Test/Inspection	Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 Hours at 300°C
2. Electrical Test (die probe) V_{BR}, I_R, V_F	—	Per Table I
3. Visual Inspection	HP A-5956-0112-72 [1]	—

Note 1. Specification available upon request.

TABLE III. LOT QUALIFICATION

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
1. Beam Pull Test	2011H [1]	4 gram min., n = 11, r = 1	20
2. Assemble Samples in H2 Carrier	—	—	—
3. Electrical Test (Go/No Go)	—	See Table I	—
4. Temperature Cycle (Thermal Shock)	1051	10 cycles from −65° C to +200° C, 15 minutes at extremes	—
5. First Interim Electrical Test (Read and Record)	—	—	—
6. Non-Operating Life	1032	340 hours at 200° C, n = 65	—
7. High Temperature Reverse Bias	1038	240 hours V_R = 80% of rated V_{BR}, T_C = 150° C	10
8. Second Interim Electrical Test (Read and Record)	—	$\Delta I_R < \pm 50$ nA or 100% whichever is greater, $\Delta V_F < 10\%$	
9. Operating Life	1038	340 hours, f = 60 Hz, T_C = 125° C V_R = 80% of rated V_{BR}, PFM = 50 mW, n = 65	10
10. Final Electrical Test (Read, Record)	—	$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$	

Note 1: Per MIL-STD-883.

Typical Parameters

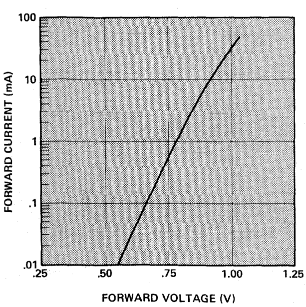


Figure 1. Typical Forward Conduction Characteristics.

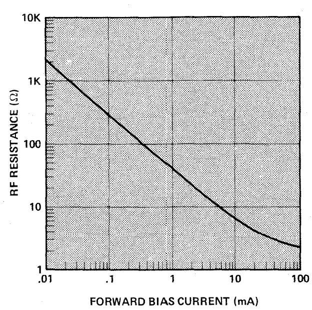


Figure 2. Typical RF Resistance vs. Forward Bias Current.

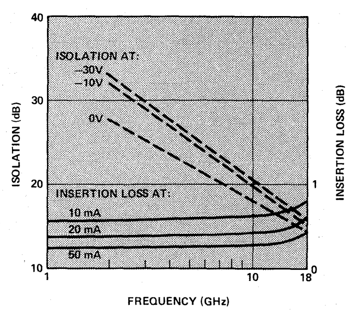


Figure 3. Typical Isolation and Insertion Loss in the Series Configuration (Z_0 = 50 Ω).

HEWLETT PACKARD

PIN SWITCHING DIODE MILITARY APPROVED MIL-S-19500/443

JAN 1N5719
JANTX 1N5719

Features

QUALITY PERFORMANCE TESTED
Proven Reliability

LARGE DYNAMIC RANGE

LOW HARMONIC DISTORTION

HIGH SERIES ISOLATION

Description/Applications

The JAN Series 1N5719 is a planar passivated silicon PIN diode designed for use in RF switching circuits. These devices are well suited for variable attenuator, AGC, modulator, limiter, and phase shifter applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings at $T_{CASE} = 25°C$

Operating and Storage Temperature Range .... -65°C to +150°C

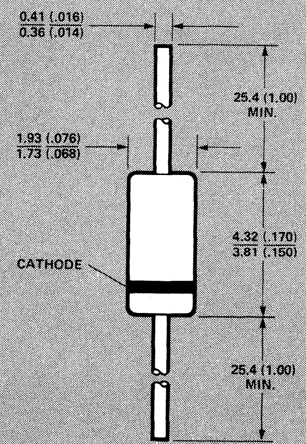
Operation of these devices within the recommended temperature limits will assure a device Mean Time to Failure (MTTF) of approximately 1 x 10^7 hours.

Reverse Voltage (Working) at 25°C .... 100 V dc

Reverse Voltage (non-rep) .... 150 V pk

Power Dissipation [At 25°C] .... 250 mW

Derate at 2.0 mW/°C above T_{CASE} = 25°C; assumes an infinite heat sink.



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C
(Per Table I, Group A Testing of MIL-S-19500/443)

Part Number	Minimum Breakdown Voltage[1] V_{BR} (V)	Maximum Forward Voltage V_F (V)	Maximum Reverse Current I_{R1} (nA)	Maximum Reverse Current I_{R2} (μA)	Maximum Capacitance C_{VR} (pF)	Maximum Series Resistance R_S (Ω)	Minimum Effective Carrier Lifetime τ (ns)
1N5719	150	1.0	250	15	0.30	1.25	100
Test Conditions	I_R = 10 μA	I_F = 100 mA	V_R = 100V	V_R = 100V T_A = 150° C	V_R = 100V f = 1 MHz	I_F = 100 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA

Note 1:
Tested per MIL-STD-750, Method 4021.

JAN 1N5719: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/443.

JANTX 1N5719: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/443*. A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5719 above.

*JANTX devices have gold plated leads.

Table II 100% SCREENING PROGRAM (TX)

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles, Condition F
3. Centrifuge (Constant Acceleration)	2006	20 Kg., Y_1 axis
4. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C or E
5. Interim Electrical Tests (I_R, V_F)		See Table I
6. Burn-in	1038	I_O = 70 mA (Average), V_R = 120V (Peak) T_A = 25° C, f = 60 Hz, t = 96 hrs
7. Final Electrical Tests and Drift Evaluation (I_R, V_F) 10% P DA		ΔI_R = ±250 nA or 100% whichever is greater ΔV_F = ±100 mV

Table III GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	V_{BR}, V_F, I_{R1}, C_{VR} and R_S per Table I	2
Subgroup 3 Dynamic Electrical Tests at 25° C	—	τ per Table I	10
Subgroup 4 High Temperature Operation (T_A = 150° C) Reverse Current (I_{R2})	4016	Per Table I	10

Table IV GROUP B INSPECTION

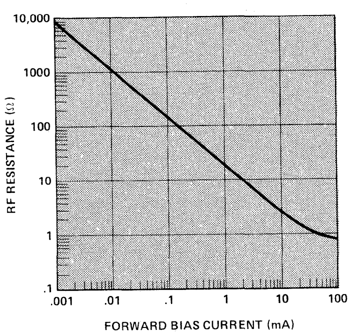
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			15
Physical Dimensions	2066		
Subgroup 2			10
Solderability	2026	Immerse to within 0.1 inch of body	
Thermal Shock (Temperature Cycling)	1051	Test Condition F	
Thermal Shock (Glass Strain)	1056	Test Condition A	
Terminal Strength (Tension)	2036	Test Condition A, 15 secs., 4 lbs.	
Hermetic Seal	1071	Test Condition E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	
Subgroup 3			10
Shock	2016	Non-operating, 1500G; t = 0.5 ms 5 blows in each orientation X_1, Y_1, Y_2	
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 kg; X_1, Y_1, Y_2	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	
Subgroup 4			10
Terminal Strength; Lead Fatigue	2036	Test Condition E with lead restriction	
Subgroup 5			$\lambda = 3$
High Temperature Life (Non-Operating)	1031	$T_A = 150°C$,[1]	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Drift (ΔI_{R1})	—	$\Delta I_R = +25\%$ of initial value or +50 nA whichever is greater	
Subgroup 6			$\lambda = 3$
Steady State Operating Life	1026	$I_O = 70$ mA, $V_R = 120$ V (Peak); f = 60 Hz,[1]	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Drift (ΔI_{R1})	—	$\Delta I_R = +25\%$ of initial value or +50 nA whichever is greater	

1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

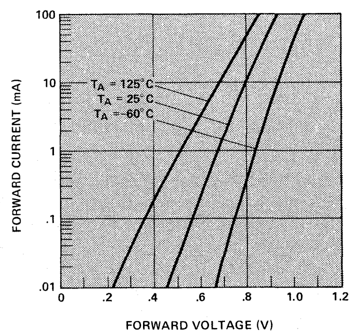
Table V GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Barometric Pressure, Reduced	1001	Pressure = 15 mm Hg; t = 1 min.	20
Measurements During Test:			
Reverse Current	4016	D.C. Method. V_R = 100 V dc	
Subgroup 2			20
Salt Atmosphere (Corrosion)	1041		
Subgroup 3			20
Resistance to Solvents	—	Method 215 of MIL-STD-202	
Subgroup 4			20
Thermal Shock (Temperature Cycling)	1051	Test Condition F-1; Time at temperature extremes = 15 minutes minimum total test time = 72 hours maximum.	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 5			20
Low Temperature Operation (−65° C)			
Forward Voltage (V_F)	4011	< 1.15 V at I_F = 100 mA	
Breakdown Voltage (V_{BR})	4021	Per Table I	

Typical Parameters



Typical RF Resistance vs. Forward Bias Current.



Typical Forward Current vs. Forward Voltage.

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES FOR RF SWITCHING AND ATTENUATING

(Generic 5082-3001, -3002, -3039 and -3077)

TX-3001/2
TXB-3001/2
TXV-3001/2
TXVB-3001/2
TX-3039
TXB-3039
TXV-3039
TXVB-3039
TX-3077
TXB-3077
TXV-3077
TXVB-3077

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

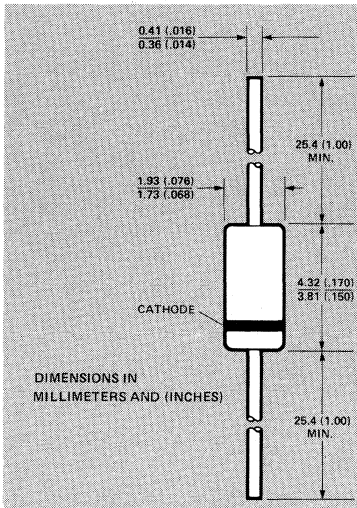
LOW HARMONIC DISTORTION

LARGE DYNAMIC RANGE

LOW SERIES RESISTANCE

LOW CAPACITANCE

LOW TEMPERATURE COEFFICIENT
Typically Less Than 20% Resistance Change from 25°C to 100°C



Outline 15

Description / Applications

These general purpose switching diodes are intended for low power switching applications such as RF duplexers, antenna switching matrices, digital phase shifters, and time multiplex filters.

The RF resistance of a PIN diode is a function of the current flowing in the diode. These current controlled resistors are specified for use in control applications such as variable RF attenuators, automatic gain control circuits, RF modulators, electrically tuned filters, analog phase shifters, and RF limiters.

Maximum Ratings

Junction Operating and Storage
Temperature Range .... -65°C to +150°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Power Dissipation at T_{CASE} = 25°C 250mW
(Derate linearly to zero at 150°C)

Peak Inverse Voltage (PIV) .... V_{BR}

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25°C

Part Number	Maximum Total Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Residual Series Resistance R_S (Ω)	Minimum Effective Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (nA)
5082-3002	0.20	300	1.0	100	100	1.0	100
5082-3001	0.25	200	1.0	100	100	1.0	100
5082-3039	0.25	150	1.25	100	100	1.0	100
5082-3077	0.30	200	1.5	100	100	1.0	100
Test Conditions	V_R = 50 V f = 1 MHz	$V_R = V_{BR}$ Measure I_R = 10 μA	I_F = 100 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% Recovery	I_F = 100 mA	V_R = 100 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number Prefix	Screening Level
5082-	Commercial
TX-	100% Screen (per Tables III and IV)
TXB-	100% Screen and Group B (per Tables III, IV and V)
TXV-	100% Screen and Visual (per Tables III, and IV)
TXVB-	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Strorage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C or E
6. High Temperature Reverse Bias (HTRB)	1038	t = 96 hours, T_A = 150° C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-in	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}.
9. Final Electrical Tests (I_R, V_F) (PDA = 10%)		$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$

TABLE IV. GROUP A PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for Tests and Conditions	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
D.C. Electrical Tests (I_R and V_F)		See Table I	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25°C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}	5
D.C. Electrical Tests (I_R and V_F)			
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Die Shear	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150°C	
D.C. Electrical Tests (I_R and V_F)		See Table I	

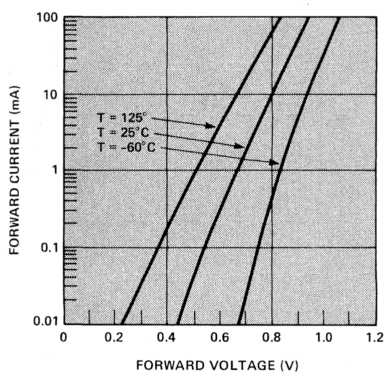


Figure 1. Typical Forward Current vs. Forward Voltage.

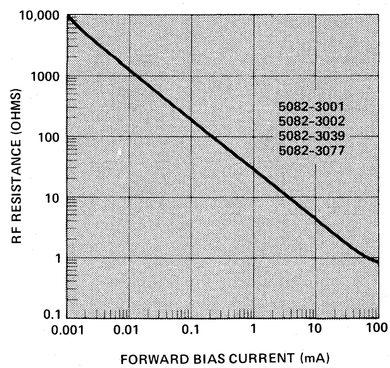


Figure 2. Typical RF Resistance vs. Forward Bias Current.

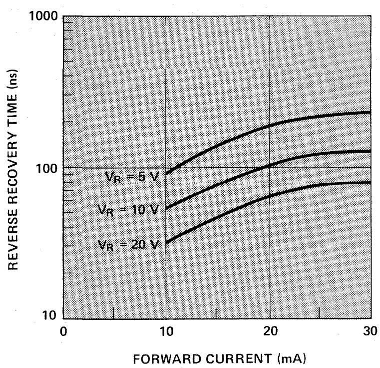


Figure 3. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES

(Generic 5082-3042 and -3043)

TX-3042	TX-3043
TXB-3042	TXB-3043
TXV-3042	TXV-3043
TXVB-3042	TXVB-3043

Features

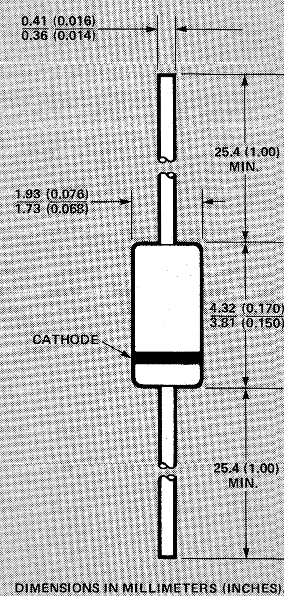
QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

FAST SWITCHING
10 ns Maximum

LOW SERIES RESISTANCE
1.5 Ω Maximum

LOW CAPACITANCE
0.4 pF Maximum

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 1Ω R_S



Outline 15

Description/Applications

The TX-3042 and -3043 are oxide passivated silicon PIN diodes of mesa construction. Precisely controlled processing provides an exceptional combination of fast RF switching and low residual series resistance.

These hermetically sealed, glass packaged PIN diodes are intended for controlling and processing microwave signals through Ku band. Typical applications include single and multi-throw switches, pulse modulators, amplitude modulators, phase shifters, TR switches and duplexers.

Maximum Ratings

Operating and Storage Temperature Range .... -65°C to +150°C
Reverse Voltage (Working) .... Rated V_{BR}
Power Dissipation at T_{CASE} = 25°C .... 250 mW
(Derate linearly to zero at 150°C)
Package 15 Maximum Solder Temperature ...... 230°C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25°C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance CT-20 (pF)	Maximum Residual Series Resistance R_S (Ω)	Typical Effective Carrier Lifetime τ (ns)	Maximum Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (ns)
5082-3042	70	0.4	1.0	15	5	1	100
5082-3043	50	0.4	1.5	15	10	1	100
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	V_R = 20 V f = 1 MHz	I_F = 20 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% Recovery	I_F = 100 mA	V_R = 80% Rated V_{BR}

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3042 5082-3043	Commercial
TX-3042 TX-3043	100% Screen (per Tables III and IV)
TXB-3042 TXB-3043	100% Screen and Group B (per Tables III, IV and V)
TXV-3042 TXV-3043	100% Screen and Visual (per Tables III and IV)
TXVB-3042 TXVB-3043	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Storage (Stab. Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity (Seal Tests) Fine Leak Gross Leak	1071	 Condition H Condition C or E
6. HTRB	1038	t = 48 hours, T_A = 150° C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and condititons.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25°C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Die Shear	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150°C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY PIN ATTENUATOR DIODES

(Generic 5082-3080)

TX-3080
TXB-3080
TXV-3080
TXVB-3080

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

LOW DISTORTION

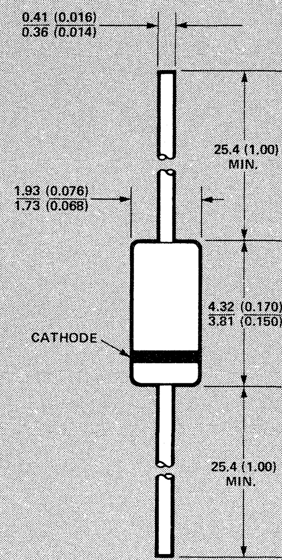
HERMETICALLY SEALED GLASS PACKAGE

USEFUL DOWN TO 1 MHz

TIGHT RESISTANCE TRACKING BETWEEN UNITS

SPECIFIED RF RESISTANCE WITH BIAS

LOW TEMPERATURE COEFFICIENT



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 15

Description/Applications

The TX-3080 passivated silicon planar diffused PIN diode is specially tested as an RF current controlled resistor. The long minority carrier lifetime assures usefulness at operating frequencies down to 1 MHz, with very low distortion. Tightly controlled fabrication process for RF resistance variation with bias makes these diodes ideally suited for constant impedance AGC-circuits, leveling circuits, electronically controlled RC and RL circuits, pi-, T-, or bridged T- attenuators operating between 1 MHz to 1 GHz with very low distortion.

Maximum Ratings

Operating and Storage Temperature Range .... -65° C to +150° C
Reverse Voltage (Working) .... 100 V(peak)
Power Dissipation at T_{CASE} = 25° C .... 250 mW
(Derate linearly to zero at 150° C)
Package 15 Maximum Solder Temperature ...... 230° C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Typical Effective Minority Carrier Lifetime τ (ns)	Maximum Residual Series Resistance R_S (Ω)	Minimum High Resistance Limit R_H (Ω)	Maximum Low Resistance Limit R_L (Ω)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (nA)
-3080	100	0.4	1300	2.5	1000	8	1	100
Test Condition	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	V_R = 50 V f = 1 MHz	I_F = 50 mA I_R = 250 mA	I_F = 100 mA f = 100 MHz	I_F = 0.01 mA f = 100 MHz	I_F = 20 mA f = 100 MHz	I_F = 30 mA	V_R = 50 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Tables III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3080	Commercial
TX-3080	100% Screen (per Tables III and IV)
TXB-3080	100% Screen and Group B (per Tables III, IV and V)
TXV-3080	100% Screen and Visual (per Tables III and IV)
TXVB-3080	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As Required by Table II)	2074	
2. High Temperature Storage (Stabilization Bake)	1032	$t = 48$ hours, $T_A = 150°C$
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C or E
6. High Temperature Reverse Bias (HTRB)	1038	$t = 48$ hours, $T_A = 150°C$ $V_R = 80$ V
7. Interim Electrical Tests (I_R, V_R)		See Table I
8. Burn-In	1038	$t = 168$ hours, $T_A = 25°C$, PFM = 200 mW, f = 60 Hz, $V_{RM} = 80$ V
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25°C	—	See Table I for tests and conditons.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	$t = 340$ hours, $T_A = 25°C$, PFM = 200 mW, f = 60 Hz, $V_{RM} = 80$ V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Die Shear	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	$t = 340$ hours, $T_A = 150°C$	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY UHF/VHF SWITCHING PIN DIODES
(Generic 5082-3168 and -3188)

TX-3168 TX-3188
TXB-3168 TXB-3188
TXV-3168 TXV-3188
TXVB-3168 TXVB-3188

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

LOW SERIES RESISTANCE

LOW CAPACITANCE

HERMETIC PACKAGE

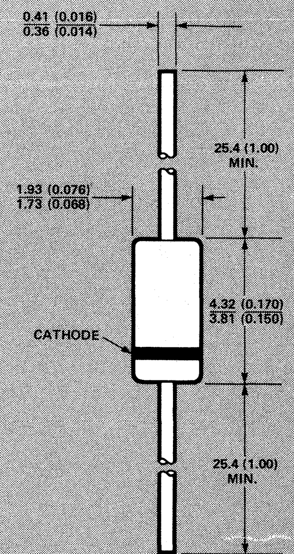
Description/Applications

The TX-3168 and -3188 are passivated silicon PIN diodes designed for optimal VHF/UHF switching characteristics. These devices switch rapidly between high and low values of RF impedance as a function of DC bias current.

These PIN diodes are designed for use in VHF/UHF band switching and general purpose RF switching that require high performance, and mechanical and environmental reliability.

Maximum Ratings

Operating and Storage Temperature Range .... -65°C to +150°C
Reverse Voltage (Working) .... 35 V
Power Dissipation at T_{CASE} = 25°C .... 250 mW
(Derate linearly to zero at 150°C)
Package 15 Maximum Solder Temperature ...... 230°C for 5 seconds



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 15

PIN Diodes

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25°C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Residual Series Resistance R_S (Ω)	Typical Effective Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Current I_R (nA)
5082-3168	35	2.0	0.5	40	12	1	100
5082-3188	35	1.0	0.6	40	12	1	100
Test Conditions	I_R = 10 μA	V_R = 20 V f = 1 MHz	I_F = 10 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% recovery	I_F = 100 mA	V_R = 20 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Tables III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3168 5082-3188	Commercial
TX-3168 TX-3188	100% Screen (per Tables III and IV)
TXB-3168 TXB-3188	100% Screen and Group B (per Tables III, IV and V)
TXV-3168 TXV-3188	100% Screen and Visual (per Tables III and IV)
TXVB-3168 TXVB-3188	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As Required by Table II)	2074	
2. High Temperature Storage (Stab. Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis.
5. Hermeticity Fine Leak Gross Leak	1071	 Condition H Condition C or E
6. High Temperature Reverse Bias (HTRB)	1038	t = 48 hours, T_A = 150° C, V_R = 28 Volts Max.
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 28 Volts
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and conditions.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 28 V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Die Shear	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES FOR STRIPLINE AND MICROSTRIP SWITCHES, ATTENUATORS, AND LIMITERS

(Generic 5082-3141)

TX-3141
TXB-3141
TXV-3141
TXVB-3141

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

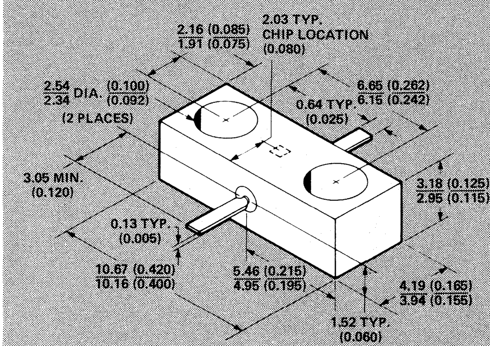
BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 1.0 dB to 8 GHz

HIGH ISOLATION
Greater than 20 dB to 8 GHz

FAST SWITCHING/MODULATING
5 ns Typical

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 60

Description/Applications

The 5082-3141 is a specially processed oxide passivated mesa PIN diode in shunt configuration within a 50 Ω hermetic package (Outline 60), optimized for good continuity of characteristic impedance, which allows a continuous transition when used in 50 Ω stripline or microstrip circuits. The stripline package overcomes the limitations in insertion loss, isolation, and bandwidth that are imposed by package parasitics of the other packages. The TX-3141 is recommended for applications requiring fast switching or high frequency signal modulation or where low bias current for maximum attenuation is required.

Maximum Ratings

Operating and Storage Temperature
Range .... –65° C to 150° C

Operation of these devices within the recommended temperature limits will assure a device Mean Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Reverse Voltage (Working) .... 70 V
Power Dissipation at T_{CASE} = 25° C .... 250 mW
(Derate linearly to zero at 150° C)
Peak Incident Pulse Power .... 50 W
(t_p = 1 μs, f = 10 GHz, Du - 0.001, Z_O = 50 Ω)

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time (t_{rr}) (ns)	Typical Carrier Lifetime (ns)	Forward Voltage V_F (V)	Reverse Current I_R (nA)
5082-3141	Cathode	20	1.0	1.5:1	10	15	1.0	100
Test Conditions		I_F = 20 mA f = 8 GHz	I_F = 0 P_{IN} = 1 mW f = 8 GHz	I_F = 0 P_{IN} = 1 mW f = 8 GHz	I_F = 20 mA V_R = 10 V Recovery to 90%	I_F = 50 mA I_R = 250 mA	I_F = 50 mA	V_R = 50 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number	Screening Level
5082-3141	Commercial
TX-3141	100% Screen (per Table III and IV)
TXB-3141	100% Screen and Group B (per Table III, IV, and V)
TXV-3141	100% Screen and Visual (per Table III, and IV)
TXVB-3141	100% Screen and Group B (per Table III, IV, and V) with Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C or E
6. High Temperature Reverse Bias (HTRB)	1038	t = 48 hours, T_A = 150° C, V_R = 56 V
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, V_{RM} = 56 V
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and conditons.	5

TABLE V. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C or E	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, $T_A = 25°C$, PFM = 200 mW, $V_{RM} = 56$ V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075		
Die Shear	2037		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, $T_A = 150°C$	7
DC Electrical Tests (I_R and V_F)		See Table I.	

Reliability Data for PIN Diodes

HEWLETT PACKARD

RELIABILITY BULLETIN BEAM LEAD DIODES

Conclusion

Hewlett-Packard's beam lead diodes have successfully passed stringent environmental testing. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

General

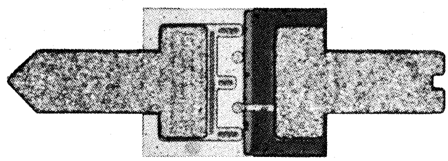
For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the specified design criteria. All Schottky and PIN beam lead families have fulfilled the standard requirements of reliabililty qualification, and the results of these tests are available upon request from Hewlett-Packard.

Program Description

The purpose of this program is to qualify all beam lead diodes for operation in extreme environmental conditions which may be encountered during military and space operations.

The following test sequence has been designed to assess the endurance of beam lead diodes through relevant environmental stresses such as heat and humidity. To qualify a device as hermetic, the conventional procedure is to perform dye-penetrant and Radiflo tests. However, because of the absence of an enclosed cavity in the unique design of the beam lead diode, these tests are not directly applicable. Therefore, this program utilizes reliability tests such as moisture resistance, salt atmosphere, and immersion to verify that the passivation layer on the beam lead acts as a seal to protect the active area of the diode.

To perform these tests, various Schottky and PIN diodes were mounted in non-hermetic, open packages and tested as exposed beam lead devices.



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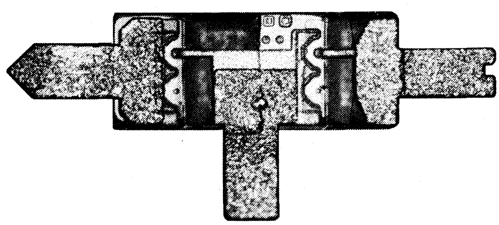


PAIR

Typical Beam Lead Outlines

Applicable Part Numbers

PIN Beam Leads

HPND-4001
HPND-4005
HPND-4050

Test Sequence

Test	MIL-STD-750	Test Conditions	LTPD
Moisture Resistance[1, 2]	1021	98% R.H. −10°C to 65°C, 10 days	
Temperature Cycling	1051	−65°C to 200°C, 100 cyc.	7
Constant Acceleration	2006	20 KG, 1 min. each axis	
Salt Atmosphere[2]	1041	35° fog, 24 hours	10
Salt Water Immersion[2]	(MIL-STD-883B, M1002B)	65°C saturated NaCl solution, 2 cycles	10

Notes:
1. The sequence of moisture resistance and temperature cycling followed by constant acceleration assures a thorough evaluation of the effect of exposure to high humidity and heat conditions. End points were taken after each test.
2. End points were: Visual at 100X magnification and D.C. testing to MIL-STD-19500.

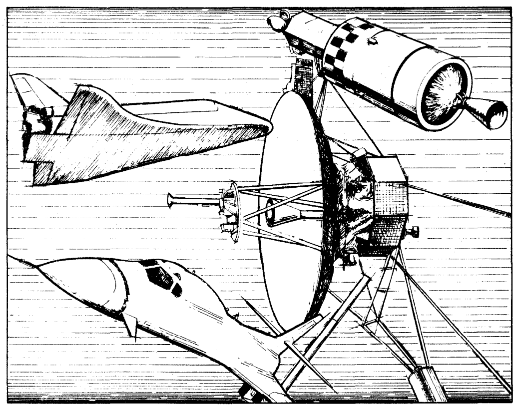
Results

As demonstrated by these tests, Hewlett-Packard's beam lead diodes exhibit superior performance when subjected to severe environmental conditions. This proven reliability is achieveable because of Hewlett-Packard's unique beam lead design. These beam lead diodes are made of tri-metal (Ti-Pt-Au or NiCr-Pt-Au), which extends both the operating and storage temperature range. In addition, a nitride passivation layer acts as a sealant and provides immunity from contaminants which could lead to I_R drift. Conductive particle protection is provided by a layer of polyimide, which also functions as scratch protection. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

HEWLETT PACKARD	RELIABILITY DATA BEAM LEAD PIN DIODES	HPND-4005

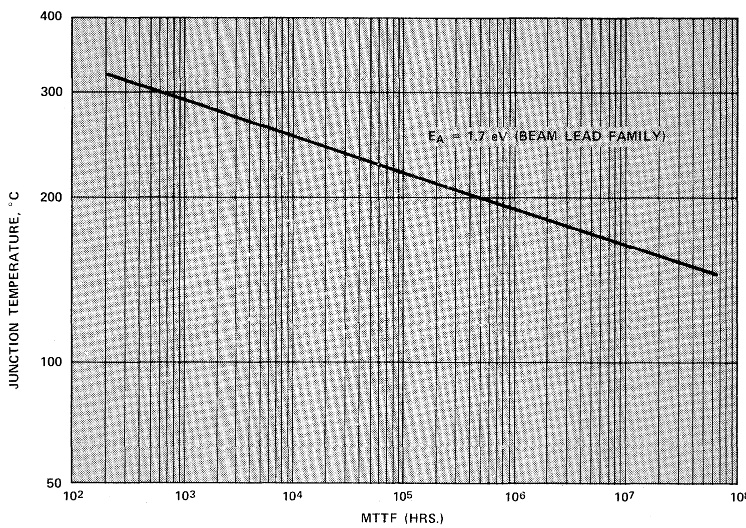
Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.



Applications

This information represents the capabilities of the generic device. Failure rates and MTTF values presented here are achievable with normal MIL-S-19500 TX level screening. Reliability can only be guaranteed by testing specified lots of devices, under specified conditions, with specified LTPD levels.



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 200° C	2.0
Steady State Operating Life	1,000 hrs. min. operating time @ I_F = 30 mA, T_A = 150° C	2.0

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Temperature Cycling	1051.1 Cond. B	10 cycles from −65° C to +200° C, 30 min. at extremes, 5 min. transfer	4
Thermal Shock	1056.1	10 cycles from 0° C to +100° C, 3 sec. transfer	6
Soldering Heat	2031	10 seconds at 260° C	15
Shock	2016.1	5 blows each at X_1, Y_1, Y_2, 1500 G, 0.5 msec pulse	5
Vibration Fatigue	2046	32 ± 8 hrs. each at X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	5

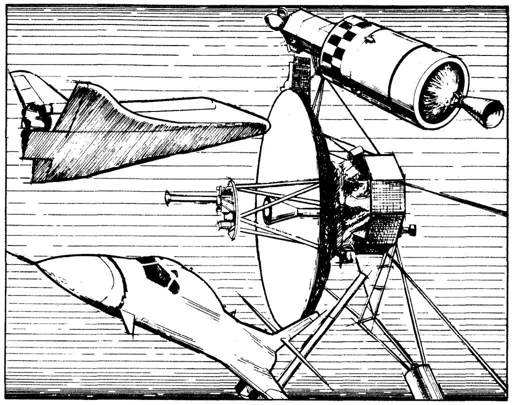
HEWLETT PACKARD

RELIABILITY DATA PIN DIODES

1N5767
5082-3080
5082-3168
5082-3188

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.



Applications

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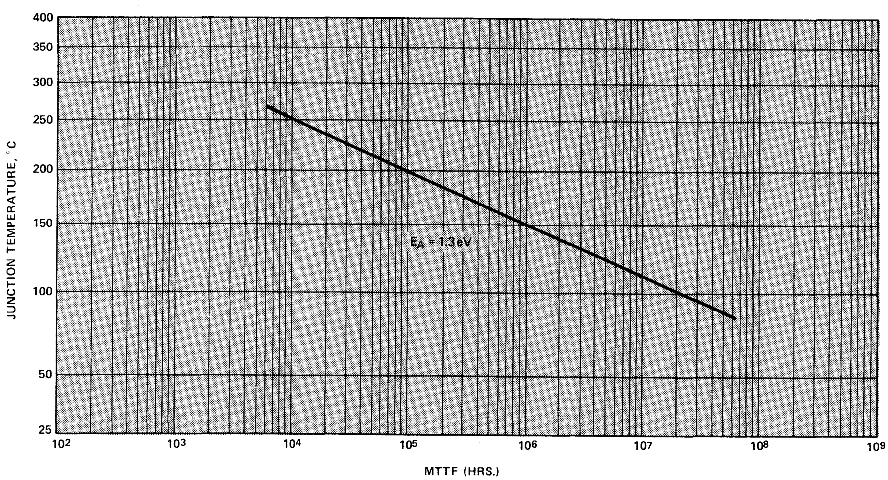


Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 150° C	2
Steady State Operating Life	1,000 hrs. min. operating time @ P_{FM} = 250 mW, V_{RM} ≈ 20 V, f = 60 Hz, T_A = 25° C	2

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Solderability	2026	Sn 60, Pb 40, solder at 230° C	6
Temperature Cycling	1051.1 Cond. B	10 cycles from −65° C to +150° C, 0.5 hrs. at extremes, 5 min. transfer	7
Thermal Shock	1056.1	5 cycles from 0° C to +100° C, 3 sec. transfer	6
Moisture Resistance	1021.1	10 days, 90-98% RH, −10 to +65° C, non operating	5
Shock	2016.1	5 blows each X_1, Y_1, Y_2, 1500 G. 0.5 msec pulse	6
Vibration Fatigue	2046	32 ± 8 hrs. each X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	5
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	5
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	5
Terminal Strength	2037.1 Cond. E	Miniature glass package, −3, 90° arcs, 2 leads, 8 oz., lead restriction	6
Salt Atmosphere	1041.1	35° fog for 24 hours	7

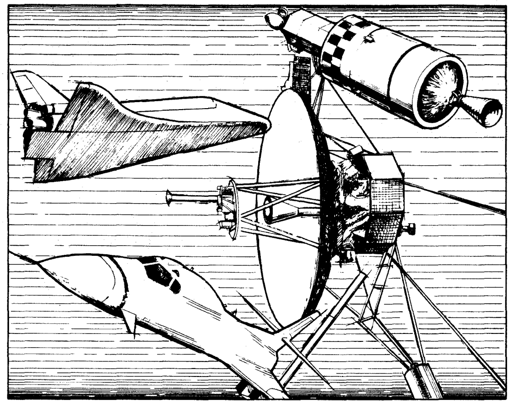
HEWLETT PACKARD

RELIABILITY DATA PIN DIODES

1N5719
5082-3001
5082-3002
5082-3039
5082-3077
HPND-4165
HPND-4166

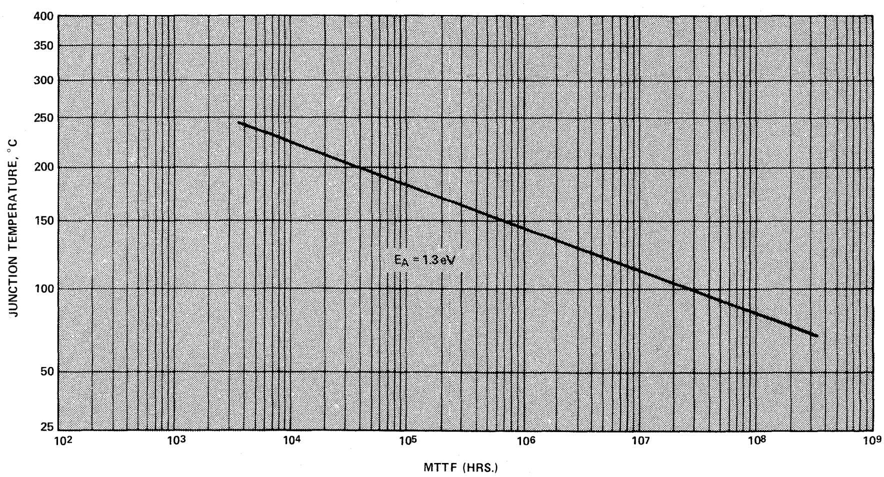
Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.



Applications

This information represents the capabilities of the generic device. Failure rates and MTTF values presented here are achievable with normal MIL-S-19500 TX level screening. Reliability can only be guaranteed by testing specified lots of devices, under specified conditions, with specified LTPD levels.



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 150°C	2
Steady State Operating Life	1,000 hrs. min. operating time @ P_{FM} = 250 mW, V_{RM} ≈ 150 V, f = 60 Hz, T_A = 25°C	2

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Solderability	2026	Sn 60, Pb 40, solder at 230° C	5
Temperature Cycling	1051.1 Cond. B	5 cycles from −65° C to +150° C, 0.5 hrs. at extremes, 5 min. transfer	5
Thermal Shock	1056.1	5 cycles from 0° C to +100° C, 3 sec. transfer	8
Moisture Resistance	1021.1	10 days, 90-98% RH, −10 to +65° C, non-operating	5
Shock	2016.1	5 blows each X_1, Y_1, Y_2, 1500 G. 0.5 msec pulse	5
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	5
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	5
Terminal Strength	2037.1 Cond. E	Miniature glass package -3, 90° arcs, 2 leads, 8 oz., lead restriction	5
Hermeticity	1014	Kr-85/dry N_2 penetrant dye	2

PIN Diodes

ABSTRACTS OF APPLICATION NOTES AND BULLETINS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins.

A complete list with brief abstracts is presented here. Below is a brief summary of Application Notes for PIN diodes. All of the Application Notes are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

918 Pulse and Waveform Generation with Step Recovery Diodes

This note describes how the Step Recovery Diode can be used in a variety of pulse shaping and waveform generating circuits. The pulse shaping circuits involve reduction of rise and/or fall time of an input pulse. Other applications include a square wave generator, pulse delay generator, and FM discriminator.

922 Application of PIN Diodes

Discusses how the PIN diode can be applied to a variety of RF control circuits. Such applications as attenuating, leveling, amplitude and pulse modulating, switching, and phase shifting are discussed in detail. Also examines some of the important properties of the PIN diode and how they affect its application.

929 Fast-Switching PIN Diodes

Discusses the switching speed of the PIN diodes and the considerations which affect switching capability. For HP's 5082-3041/3042 fast-switching PIN diodes, AN 929 outlines basic drive requirements and comments on a few practical switching circuits. Considerations involved in the design of the filters required for use with the diodes are also discussed. For the 5082-3041, AN 929 provides two curves: 1) typical isolation vs. forward bias and 2) switching time vs. forward bias for peak reverse current as a parameter.

932 Selection and Use of Microwave Diode Switches and Limiters

Helps the systems designer select the proper switching or limiting component and assists him in integrating this component into the overall design of the system. This note is a practical, user-oriented approach to problems encountered with switching and limiting microwave signals.

936 High Performance PIN Attenuator for Low-Cost AGC Applications

PIN diodes offer an economical way of achieving excellent performance in AGC circuits. Significant improvements in crossmodulation and intermodulation distortion performance are obtained, compared to transistors. This note discusses other advantages of PIN diodes, such as low frequency operation, constant impedance levels, and low power consumption.

957-1 Broadbanding the Shunt PIN Diode SPDT Switch

Covers an impedance matching technique which improves the bandwidth of shunt PIN diode switches.

957-2 Reducing the Insertion Loss of a Shunt PIN Diode

Examines a simple filter design which includes the shunt PIN diode capacitance into a low pass filter, thereby extending the upper frequency limit.

957-3 Rectifcation Effects in PIN Attenuators

Attenuation levels of PIN diodes are changed by high incident power. Variation in attenuation may be minimized by proper choice of bias resistance. Performance of a PIN diode is limited by both carrier level and frequency because of rectification effects. This note presents the effects of frequency, power level, and bias supply for three types of HP diodes: 5082-3170, 3140 and 3141.

971 The Beam Lead Mesa PIN in Shunt Applications

The low RC product, fast switching time, and other unique features of the HPND-4050 beam lead PIN diode make it well-suited for switching applications in the shunt configuration. Switching performance, practical circuits, handling, and bonding instructions are included in this application note.

974 Die Attach and Bonding Techniques for Diodes and Transistors

Several package styles are available for use with hybrid integrated circuits. This application note gives detailed instructions for attaching and bonding these devices. A brief description of an impedance matching technique for mixer diodes is also included.

985 Achieve High Isolation in Series Applications with the Low Capacitance HPND-4005 Beam Lead PIN

Low capacitance is required for a diode to achieve high isolation in the series configuration. On the other hand, low resistance is needed for low insertion loss. This combination of characteristics in the HPND-4005 Beam Lead PIN diode makes it well suited for series switching applications. The performance of this diode in a SPST switch and a SPDT switch is described in this application note. The equivalent circuits derived in this note would be useful in the design of circuits for switching and other signal control applications.

992 Beam Lead Attachment Methods

This application bulletin gives a general discription of various methods of attaching beam lead components to both hard and soft substrates. A table summarizes most common attachment methods with advantages, disadvantages, and equipment costs.

993 Beam Lead Diode Bonding to Soft Substrate (Restart)

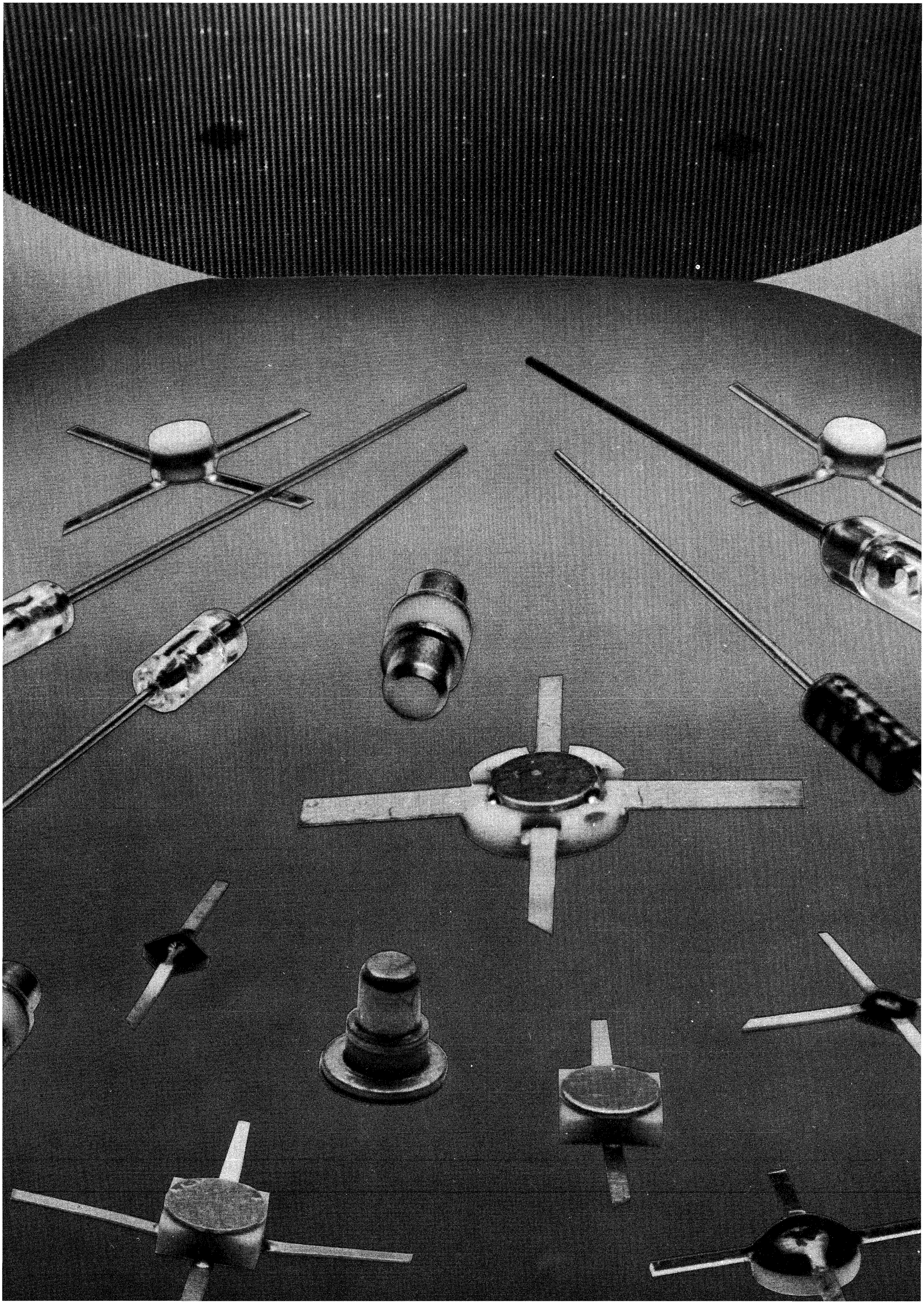
The hard gold surface on standard PC boards with soft substrate material makes it almost impossible to successfully bond beam lead diodes on to the boards with normally recommended thermocompression bonding. Described in this application note is a new method of resistive spot welding or modified gap welding, which uses a single electrode to weld the beam while the conductor is contracted separately. This method allows light pressure to be used on the weld probe, resulting in an effective bond without damaging the beam lead device.

AB 5 Current Source for Diode Testing

This application bulletin describes a constant current source designed primarily for the ease of use in laboratory measurements. Easily programmable by thumb wheel switches in 10 μA steps from 10 μA to 700 mA, its accuracy exceeds most commercially available current sources.

AB 6 PIN Diode RF Resistance Measurement

The use of the HP 4815 Vector Impedance Meter in conjunction with a tunable test fixture provides an efficient and reliable means for measuring the RF resistance of a PIN diode.



Step Recovery Diodes

CHARACTERISTICS OF STEP RECOVERY DIODES

The Step Recovery diode is most graphically described as a charge-controlled switch. That is, a forward bias stores charge, a reverse bias depletes this stored charge, and when fully depleted the SRD ceases to conduct current. The action of turning off, or ceasing current conduction, takes place so fast that the diode can be used to produce an impulse. If this is done cyclically, a train of impulses is produced. A periodic series of impulses in the time domain converts to a series of frequencies (all multiples of the basic exciting frequency) in the frequency domain. If these impulses are used to excite a resonant circuit, much of the total power in the spectrum can be concentrated into a single frequency. Thus input power at one frequency can be converted to output power at a higher frequency.

Two specifications that limit the total power output in any given multiplier mode are maximum junction temperature and thermal resistance. Within this limit, the output for a given input is determined by the efficiency of conversion. Efficiency depends heavily on the design of the multiplier, so Hewlett-Packard does not specify it.

The above specifications are related as follows:

1. Maximum Power Dissipation, P_D (power dissipated by the diode)

$$P_D = \frac{200^\circ C - T_A}{\Theta_{JC}}$$

where T_A = ambient temperature, °C
Θ_{JC} = thermal resistance, °C/W

2. Efficiency, $\eta = \frac{P_O}{P_O + P_D} \cdot 100\%$

where P_O = output power
P_D = power dissipation

The reverse voltage breakdown limit, V_{BR}, limits the pulse height and can limit the input power before the thermal limit is reached.

The low frequency limit of the exciting signal is set by minority carrier lifetime, τ, and the ability to form an effective impulse at the higher frequencies is determined by the transition time, t_t. Under forward current flow, I_F, charge is built up in the SRD. Once reverse biased, reverse current will flow for a short period of time. This is called the delay time, t_d, as in the PIN diode. When all of the carriers have been removed, the current drops abruptly to zero. The time required for the reverse current to go from 0.8 I_R to 0.2 I_R is called transition time. Typical transition times range from 360 psec. down to 60 psec. for Step Recovery diodes.

The delay time t_d is related to minority carrier life time τ by

$$\frac{t_d}{\tau} = \ln\left(1 + \frac{I_F}{I_R}\right).$$

Lifetime is measured by setting $I_F = 1.7\ I_R$ so that $t_D = \tau$.

Minority carrier lifetime sets the lower input frequency limit because as the frequency gets lower and lower, more and more of the charge is dissipated by recombination during a cycle which reduces the energy in the impulse. The input frequency should be larger than the inverse of τ to minimize this loss of energy.

The highest output frequency for reasonable efficiency as a multiplier is limited by the width of the impulse spike which is determined by the transition time. Efficiency declines when the output frequency exceeds the inverse of the transition time.

APPLICATIONS OF STEP RECOVERY DIODES

As brought out in the previous section, the Step Recovery diode can be made to produce very sharp and narrow pulses. These contain harmonics of the exciting frequency.

A circuit which exploits the Step Recovery diode's production of a multitude of frequency components is called a Comb Generator. Comb generators are used in measurement equipment such as Spectrum Analyzers to produce locking signals.

Another type of circuit picks out a single harmonic and optimizes the power output around that harmonic. This circuit is called a Multiplier. The end result of a multiplier is output power at some multiple ($2f_i$, $3f_i$, etc.) of the input frequency. The efficiency of the conversion is high enough to make this a very practical scheme for multiplying up from a readily available low frequency oscillator to get a higher frequency signal. Multipliers are used as local oscillators, low power transmitters, or transmitter drivers in radar, telemetry, telecommunications, and instrumentation.

The Microwave Semiconductor Division Field Sales Representative is supported by an applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The result of these investigations are reported in application notes. Below is a brief summary of Application Notes for Step Recovery Diodes. All of these are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

928 Ku-Band Step Recovery Multipliers

Discusses the use of step-recovery diodes in a times-eight single-stage frequency multiplier which, at 16 GHz, has a typical maximum output of 75 mW. The note also provides design modifications, together with references, for meeting other performance requirements.

948 How to Get More Output Power from a Comb Generator with the Right Bias Resistance

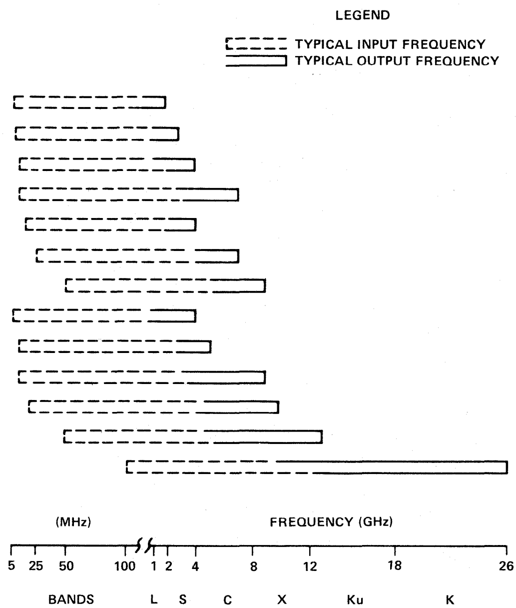
Power output in a comb generator can be doubled by using an appropriate bias resistor. With a half watt input level near 1 GHz, the optimum resistance is about 200 ohms. Higher values of resistance would be needed for higher input frequencies or lower input power.

989 Step Recovery Diode Multiplier

A straightforward technique for multiplier design is presented. The input circuit is a low pass filter which allows all of the input power to be absorbed by the diode and reflects harmonic power back to the diode. The output circuit is a bandpass filter which offers a low loss path to the desired frequency while reflecting all other harmonics back to the diode. The technique is illustrated by a doubler to 4 GHz using Hewlett-Packard 5082-0805 step recovery diode.

STEP RECOVERY DIODE SELECTION GUIDE

Part Number (5082-)			
Chip	Glass Package	Ceramic Package	V_{BR} (V)
0017	—	0300	75
0032	0180	0241	50
—	0113, 0114	—	35
0021	—	0310	40
0015	0112	0132	35
—	—	0243	35
0018	0151, 0153	0253	25
—	0803	0800	75
—	0815	0805	60
—	—	0810	60
0090	0825	0820, 0821	45
0020	0833	0830, 0320	30
0008	0840	0335, 0830, 0885	25
page 292	page 294	page 297	



STEP RECOVERY DIODE ALPHANUMERIC INDEX

Part No.	Description	Page Number Chip	Page Number Commercial Data Sheet	Page Number Reliability Data Sheet
5082-0008	Step Recovery Diode Chip		292	301
5082-0015	Step Recovery Diode Chip		292	301
5082-0017	Step Recovery Diode Chip		292	301
5082-0018	Step Recovery Diode Chip		292	301
5082-0020	Step Recovery Diode Chip		292	301
5082-0021	Step Recovery Diode Chip		292	301
5082-0032	Step Recovery Diode Chip		292	301
5082-0090	Step Recovery Diode Chip		292	301
5082-0112	Step Recovery Diode	5082-0015	294	301
5082-0113	Step Recovery Diode		294	301
5082-0114	Step Recovery Diode		294	301
5082-0132	Step Recovery Diode	5082-0015	297	301
5082-0151	Step Recovery Diode	5082-0018	294	301
5082-0153	Step Recovery Diode	5082-0018	294	301
5082-0180	Step Recovery Diode	5082-0032	294	301
5082-0241	Step Recovery Diode	5082-0032	297	301
5082-0243	Step Recovery Diode		297	301
5082-0253	Step Recovery Diode	5082-0018	297	301
5082-0300	Step Recovery Diode	5082-0017	297	301
5082-0310	Step Recovery Diode	5082-0021	297	301
5082-0320	Step Recovery Diode	5082-0020	297	301
5082-0335	Step Recovery Diode	5082-0008	297	301
5082-0800	Step Recovery Diode		297	301
5082-0803	Step Recovery Diode		294	301
5082-0805	Step Recovery Diode		297	301
5082-0810	Step Recovery Diode		297	301
5082-0815	Step Recovery Diode		297	301
5082-0820	Step Recovery Diode	5082-0090	297	301
5082-0821	Step Recovery Diode	5082-0090	297	301
5082-0825	Step Recovery Diode	5082-0090	294	301
5082-0830	Step Recovery Diode	5082-0020	297	301
5082-0833	Step Recovery Diode	5082-0020	294	301
5082-0835	Step Recovery Diode	5082-0008	297	301
5082-0840	Step Recovery Diode	5082-0008	294	301
5082-0885	Step Recovery Diode	5082-0008	297	301

HEWLETT PACKARD

STEP RECOVERY DIODE CHIPS

5082-0008
5082-0015
5082-0017
5082-0018
5082-0020
5082-0021
5082-0032
5082-0090

Features

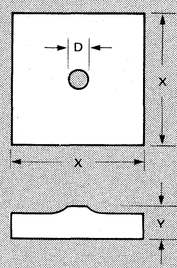
OPTIMIZED FOR BOTH LOW AND HIGH ORDER MULTIPLIER DESIGNS FROM UHF THROUGH Ku BAND

PASSIVATED CHIP FOR MAXIMUM STABILITY AND RELIABILITY

GOLD TOP CONTACT FOR LONG SHELF LIFE AND BONDABILITY

Description

These diodes are manufactured using modern epitaxial growth techniques. The diodes are passivated with a thermal oxide for maximum stability. The result is a family of devices offering highly repeatable, efficient and reliable performance. Both the anode and cathode contact metalizations are gold allowing long shelf life and repeatable bondability. These diodes are designed to meet the general requirements of MIL-S-19500.



Outline 01

Dimension	5082-							
	0020	0008	0015	0017	0018	0021	0032	0090
D	0.13 (5)	0.06 (2.5)	0.15 (6)	0.39 (15.5)	0.05 (2)	0.22 (8.5)	0.32 (12.5)	0.15 (6)
X	0.38 (15)	0.38 (15)	0.38 (15)	0.64 (25)	0.38 (15)	0.51 (20)	0.51 (20)	0.38 (15)
Y	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)

DIMENSIONS IN MILLIMETERS (1/1000 inch)

Maximum Ratings

Junction Operating and
Storage Temperature Range .... −60° C to +200° C
Maximum Die Attach
Temperature .... +310° C for 1 minute

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

Applications

These Step Recovery Diodes are intended for medium and low power multipliers. Typical applications are in hybrid local oscillators, especially where low phase noise is required, in terrestrial communications, satellite communications, TVRO, mobile communications and test equipment Input frequencies extend down to 10 MHz with output frequencies through 40 GHz.

Electrical Specifications at $T_A = 25°C$

Part Number	Minimum Breakdown Voltage, V_{BR} (V)[1]	Typical Chip Capacitance C_J (pF)[2]	Typical Lifetime τ (ns)[3]	Typical Transition Time: Transition Time t_t (ps)	Typical Transition Time: Charge Level (pc)	Nearest Equivalent Packaged Part No. 5082-
5082-0020	25	0.4-1.0	20	60	300	0830
5082-0008	15	0.15-0.5	10	50	100	0835
5082-0032	65	4.0	150	250	1500	0241
5082-0090	45	1.0	50	80	300	0820
5082-0021	40	2.0	100	150	1000	0310
5082-0015	35	1.2	60	150	1000	0132
5082-0017	75	4.0	300	300	2400	0300
5082-0018	25	0.5	20	70	200	0253

Notes:
1. Minimum Breakdown Voltage test condition is $I_R = 10\ \mu A$.
2. Capacitance sample test condition is $V_R = 10$ V and f = 1 MHz.
3. Lifetime sample test condition is $I_F = 10$ mA and $I_R = 6$ mA.

GLASS PACKAGED STEP RECOVERY DIODES

HEWLETT PACKARD

5082-0112 5082-0803
5082-0113 5082-0815
5082-0114 5082-0825
5082-0151 5082-0833
5082-0153 5082-0840
5082-0180

Features

OPTIMIZED FOR BOTH LOW AND HIGH ORDER

MULTIPLIER DESIGNS FROM UHF THROUGH Ku BAND

PASSIVATED CHIP FOR MAXIMUM STABILITY AND RELIABILITY

AVAILABLE IN A VARIETY OF PACKAGES

Description/Applications

These diodes are manufactured using modern epitaxial growth techniques. The diodes are passivated with a thermal oxide for maximum stability. The result is a family of devices offering highly repeatable, efficient and reliable performance which are designed to meet the general requirements of MIL-S-19500.

These diodes are intended for medium and low power multipliers. Typical applications are in local oscillators, especially where low phase noise is required, in terrestrial communications, satellite communications, TVRO, mobile communications and test equipment. Input frequencies extend down to 10 MHz with output frequencies reaching 26 GHz.

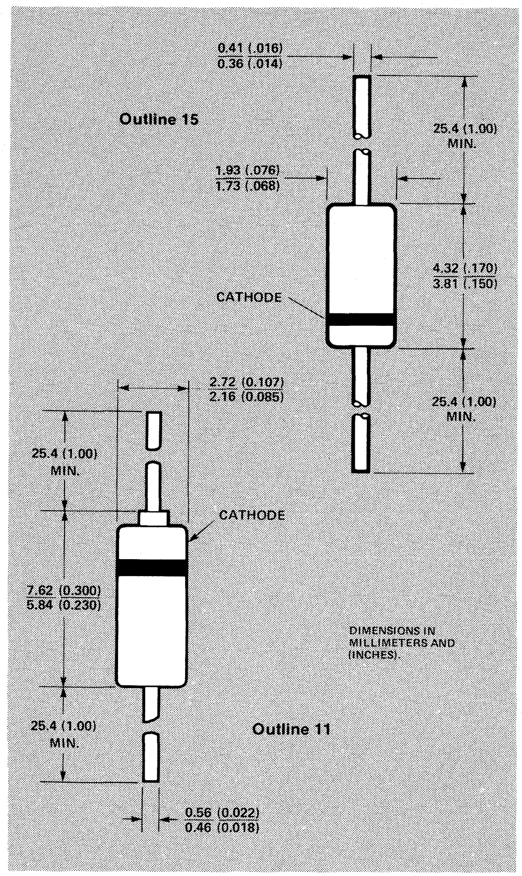
Maximum Ratings

Junction Operating and Storage Temperature . . . . -65°C to 200°C

Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

DC Power Dissipation at $T_{CASE} = 25°C$ . . . . $\frac{200°C - T_{case}}{\theta_{jc}}$

Soldering Temperature . . . . 230°C for 5 sec.



Mechanical Specifications

The HP outline 15 and 11 packages have glass hermetic seals with dumet leads. The maximum soldering temperature is 230°C for 5 seconds. The leads on outline 15 should be restricted so that any bend starts at least 1.6 mm (.063 in.) from the glass body.

Electrical Specifications at $T_A = 25°C$

Part Number	Maximum Junction Capacitance C_J (pF)	Minimum Breakdown Voltage V_{BR} (V)	Minimum Cutoff Frequency f_C (GHz)	Transition Time[1]		Minimum Lifetime τ (nsec)	Package Outline
				Maximum t_t (psec)	Charge Level (pc)		
5082-0803	6.0*	70	100	400	1500	200	15
5082-0113	4.85	35	—	250	1500	80	11
5082-0180	4.45	50	—	225	1500	100	11
5082-0815	4.0*	50	140	320	1500	100	15
5082-0114	3.85	35	—	225	1500	80	11
5082-0825	2.0*	45	160	160	300	30	15
5082-0833	1.6*	25	175	90	300	10	15
5082-0112	1.55	35	—	175	1000	50	11
5082-0151	0.65	15	—	100	200	10	15
5082-0840	0.60*	15	300	75	100	10	15
5082-0153	0.40	25	—	95	200	10	15
Test Conditions	f = 1 MHz V_R = 10 V *V_R = 6 V	$I_R = 10\ \mu A$	$f_C = \frac{1}{2\pi R_S C_j}$			I_F = 10 mA I_R = 6 mA	

Notes:
1. The transition times shown for the package 15 devices are limited by the package inductance to a minimum of 100 ps. The lower transition times shown for the -0833, -0840, -0151, and -0153 are based on the performance of the chip.
2. Typical Θ_{JC} for Outline 15 is 600° C/W and for Outline 11 is 300° C/W.

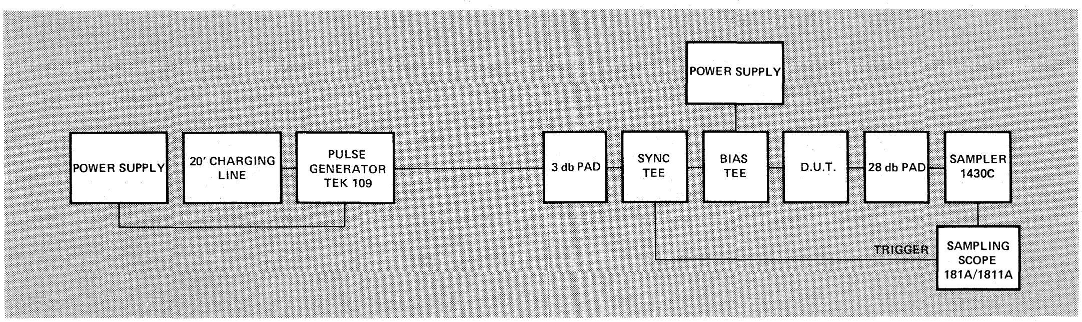


Figure 1. Test circuit for transition time. The pulse generator circuit is adjusted for a 0.5 A pulse when testing 5082-0151 and -0840. A pulse of 1.0A is used for all other diodes. The bias current is adjusted for the specified stored charge level. The transition time is read between the 20% and the 80% points on the oscilloscope.

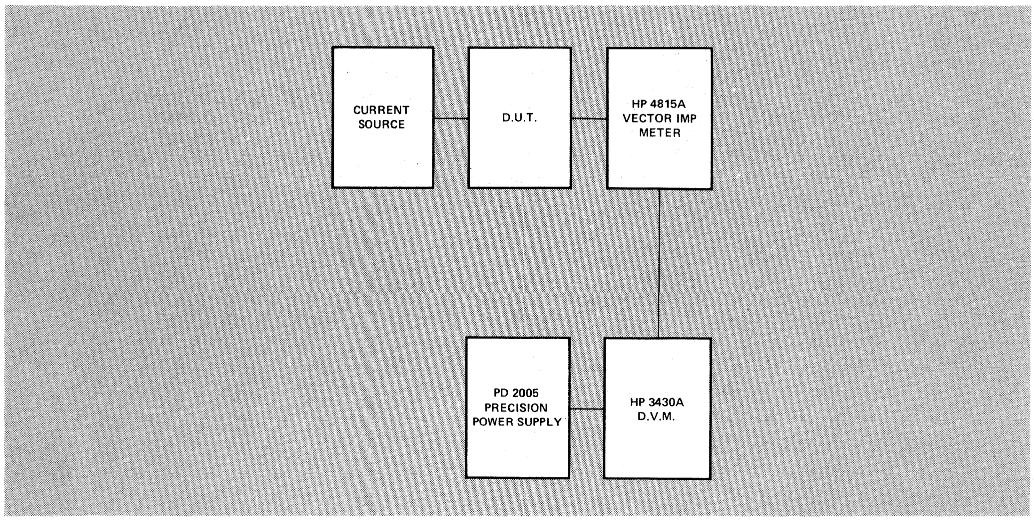


Figure 2. Test set-up for measurement of series resistance. The D.U.T. is forward biased (I_F) and the real part of the diode impedance is measured at 100 MHz. The D.V.M. is set up to read the real part on the Vector voltmeter. The precision power supply is used to offset the test circuit resistance. R_S is measured at I_F = 100 mA except 5082-0803 where I_F = 500 mA.

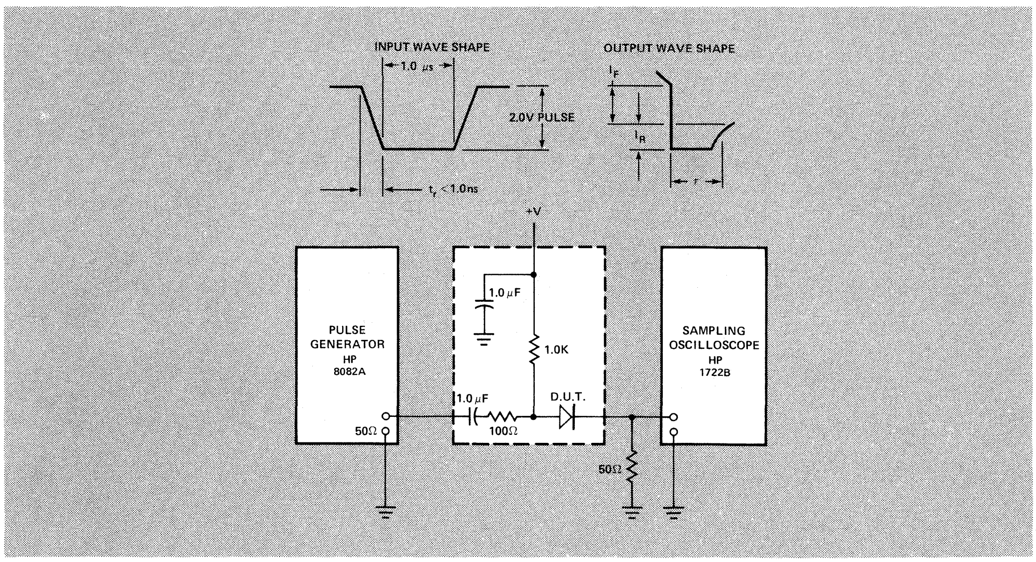


Figure 3. The circuit for measurement of the effective minority carrier lifetime. The value of the reverse current (I_R) is approximately 6 mA and the forward current (I_F) is 10 mA. The lifetime (τ) is measured across the 50% points of the observed wave shape. The input pulse is provided by a pulse generator having a rise time of less than one nanosecond. The output pulse is amplified and observed on a sampling oscilloscope.

HEWLETT PACKARD

CERAMIC PACKAGED STEP RECOVERY DIODES

5082-0132	5082-0800
5082-0241	5082-0805
5082-0243	5082-0810
5082-0253	5082-0820
5082-0300	5082-0821
5082-0310	5082-0830
5082-0320	5082-0835
5082-0335	5082-0885

Features

UHF THROUGH Ku BAND DIODES
For Low Order and High Order Multipliers

RF TESTED
For Guaranteed Performance (5082-0300 Series)

HERMETIC PACKAGE
For Industrial/Military Environments

Description/Applications

HP Step Recovery Diodes are constructed using modern epitaxial techniques. Oxide passivation insures maximum stability and reliability. Devices are available in many package styles.

These devices are intended for use as low and high order harmonic generators requiring the ultimate in performance and reliability. They excel as doublers as well as high order multipliers, because the fast transition time design allows full usage of the forward stored charge effect in improving nonlinearity and efficiency for frequency multiplication. These step recovery diodes have the basic design capability to meet the general reliability requirements of MIL-S-19500, in addition to the special reliability requirements of man-rated space systems.

Maximum Ratings

Junction Operating and Storage Temperature .... −65° C to 200° C

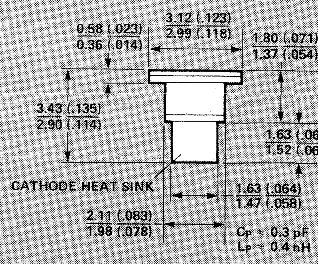
Operation of these devices within the above temperature ratings will assure a device Median Time To Failure (MTTF) of approximately 1 x 10^7 hours.

DC Power Dissipation at $T_{CASE} = 25°C$ .... $\frac{200°C - T_{CASE}}{\theta_{jc}}$

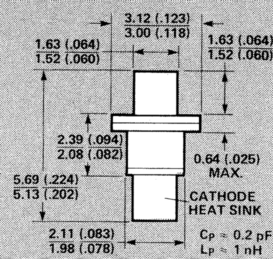
Soldering Temperature .... 230° C for 5 sec.

Mechanical Specifications

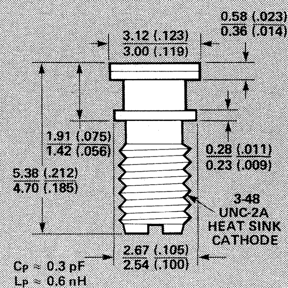
Hewlett-Packard's Step Recovery Diodes are available in a variety of packages. The metal ceramic packages are hermetically sealed. The anode studs and flanges are gold-plated Kovar. The cathode studs are gold-plated copper. The maximum soldering temperature for metal-ceramic packages is 230° C for 5 seconds.



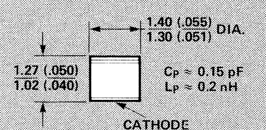
Outline 41



Outline 31



Outline 40



Outline 56

DIMENSIONS IN MILLIMETERS AND (INCHES)

Electrical Specifications at $T_A = 25°C$

Part Number	Junction Capacitance C_J (pF) Min.	Junction Capacitance C_J (pF) Max.	Minimum Breakdown Voltage V_{BR} (V)	Minimum Cutoff Frequency f_C (GHz)	Package Outline	Transition Time: Maximum t_t (psec)	Transition Time: Charge Level (pC)	Minimum Lifetime τ (nsec)	Typical Thermal Resistance θ_{jc} (°C/W)	Typical Output Power P_O (W)
5082-0800	3.5	5.0	75	100	40	400	1500	200	15	10
5082-0241	—	4.6*	65	—	31	200	1500	100	20	—
5082-0805	2.5	3.5	60	140	31	320	1500	100	20	6
5082-0810	1.5	2.5	60	140	31	260	1000	80	25	4
5082-0820	0.7	1.5	45	160	31	160	300	30	30	2.5
5082-0821	0.7	1.5	45	160	41	160	300	30	30	2.5
5082-0132	—	1.5*	35	—	31	175	1000	50	40	—
5082-0243	—	1.2*	35	—	31	200	600	40	50	—
5082-0830	0.35	1.2	25	200	31	100	300	10	45	1.0
5082-0253	—	0.6*	25	—	31	100	200	10	75	—
5082-0835	0.1	0.5	15	350	31	75	100	10	60	0.3
5082-0885	0.1	0.5	15	350	56	75	100	10	60	0.3
Test Conditions	f = 1 MHz, V_R = 6 V, *V_R = 10 V		I_R = 10 μA	$f_C = \frac{1}{2\pi R_S C_j}$				I_F = 10 mA, I_R = 6 mA		As a doubler at midband.

RF Tested Diodes at $T_A = 25°C$

ELECTRICAL SPECIFICATIONS

Part Number 5082-	Output Frequency, f_O (GHz)	N Order	Minimum Output Power, P_O[1] (W)	Junction Capacitance at -10 V, C_j (pF) Min.	Junction Capacitance Max.	Breakdown Voltage at I_R = 10 μA V_{BR} (V) Min.	Breakdown Voltage Max.	Maximum Thermal Resistance, θ_{jc} (°C/W)	Package Outline	Typical Transition Time t_t (ps)	Typical Transition Time Charge Level (pc)	Typical Lifetime τ (ns)
0300	2	X 10	2.0	3.2	4.7	75	100	14	40	300	2400	200
0310	6	X 10	0.4	1.6	2.7	40	80	30	41	160	1000	75
0320	10	X 5	0.23	0.35	1.0	25	40	60	41	75	300	25
0335	16	X 8	0.03	0.25	0.5	20	30	75	31	80	100	15

Note:
1. Guaranteed multiplier tested results. Input power is:
5082-0300 15 W 5082-0320 2 W
5082-0310 4 W 5082-0335 0.65 W

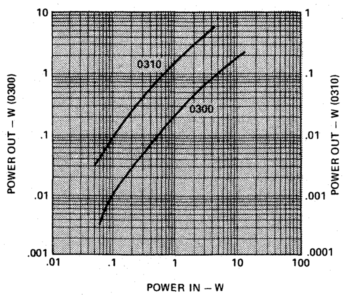


Figure 1. Typical Output Powers vs. Input Power at $T_A = 25°$ C. The 5082-0300 is measured in a x 10 multiplier with P_{IN} at 0.2 GHz and P_O at 2.0 GHz. The 5082-0310 is measured in a x 10 multiplier with P_{IN} at 0.6 GHz and P_O at 6.0 GHz.

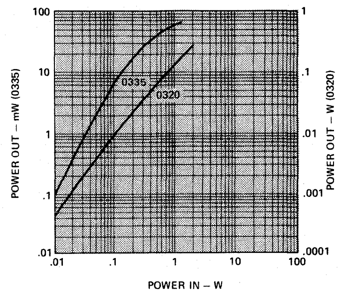


Figure 2. Typical Output Power vs. Input Power at $T_A = 25°$ C. The 5082-0335 is measured in a x 8 multiplier with P_{IN} at 2 GHz and P_O at 16 GHz. The 5082-0320 is measured in a x 5 multiplier with P_{IN} at 2.0 GHz and P_O at 10 GHz.

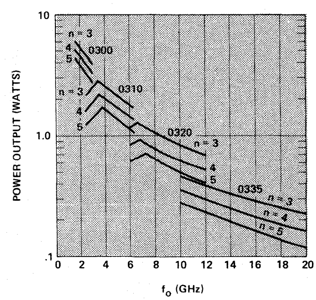


Figure 3. Predicted power output curves for 03XX step recovery diodes in X3, X4, and X5 multiplier applications. These results were obtained using computer optimization programs.

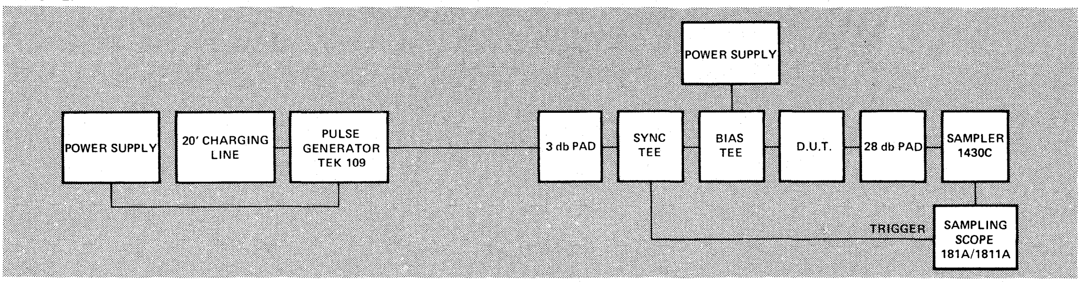


Figure 4. Test circuit for transition time. The pulse generator circuit is adjusted for a 0.5 A pulse when testing 5082-0253, -0335, -0835, and -0885. A pulse of 1.0 A is used for all other diodes. The bias current is adjusted for the specified stored charge level. The transition time is read between the 20% and the 80% points on the oscilloscope.

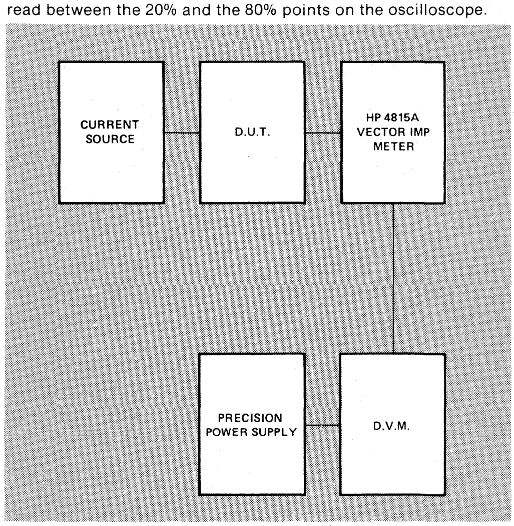


Figure 5. Test set-up for measurement of series resistance. The D.U.T. is forward biased (I_F) and the real part of the diode impedance is measured at 100 MHz. The D.V.M. is set up to read the real part on the Vector Voltmeter. The precision power supply is used to offset the test circuit resistance. R_S is measured at $I_F = 100$ mA except -0800 where $I_F = 500$ mA.

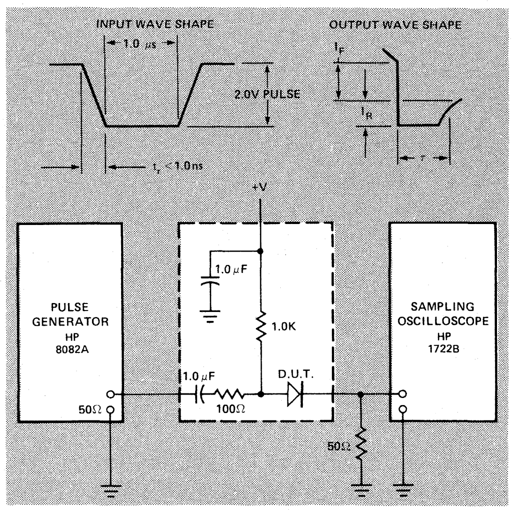


Figure 6. The circuit for measurement of the effective minority carrier lifetime. The value of the reverse current (I_R) is approximately 6 mA and the forward current (I_F) is 10 mA. The lifetime (τ) is measured across the 50% points of the observed wave shape. The input pulse is provided by a pulse generator having a rise time of less than one nanosecond. The output pulse is amplified and observed on a sampling oscilloscope.

Reliability Data for Step Recovery Diodes

HEWLETT PACKARD

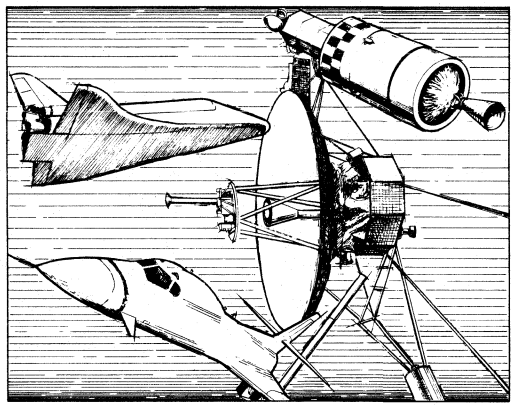
RELIABILITY DATA
STEP RECOVERY DIODES

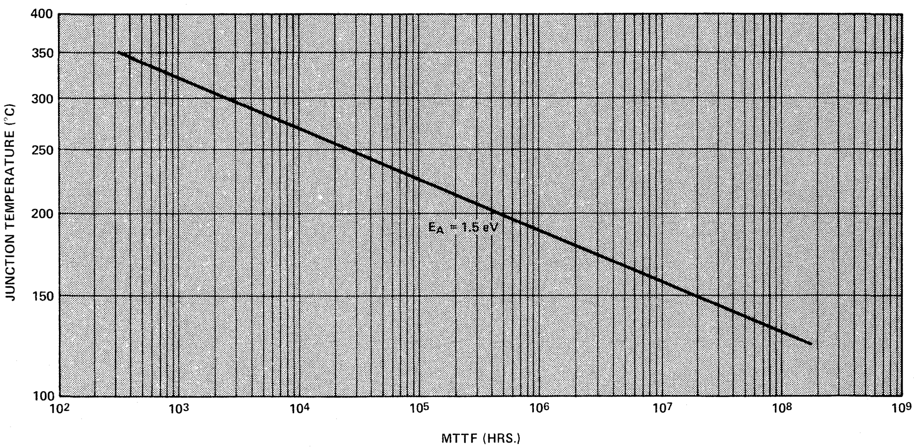
Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.

Applications

This information represents the capabilities of the generic device. Failure rates and MTTF values presented here are achievable with normal MIL-S-19500 TX level screening. Reliability can only be guaranteed by testing specified lots of devices, under specified conditions, with specified LTPD levels.





Mean Time To Failure vs. Junction Temperature

Burn-In and Storage

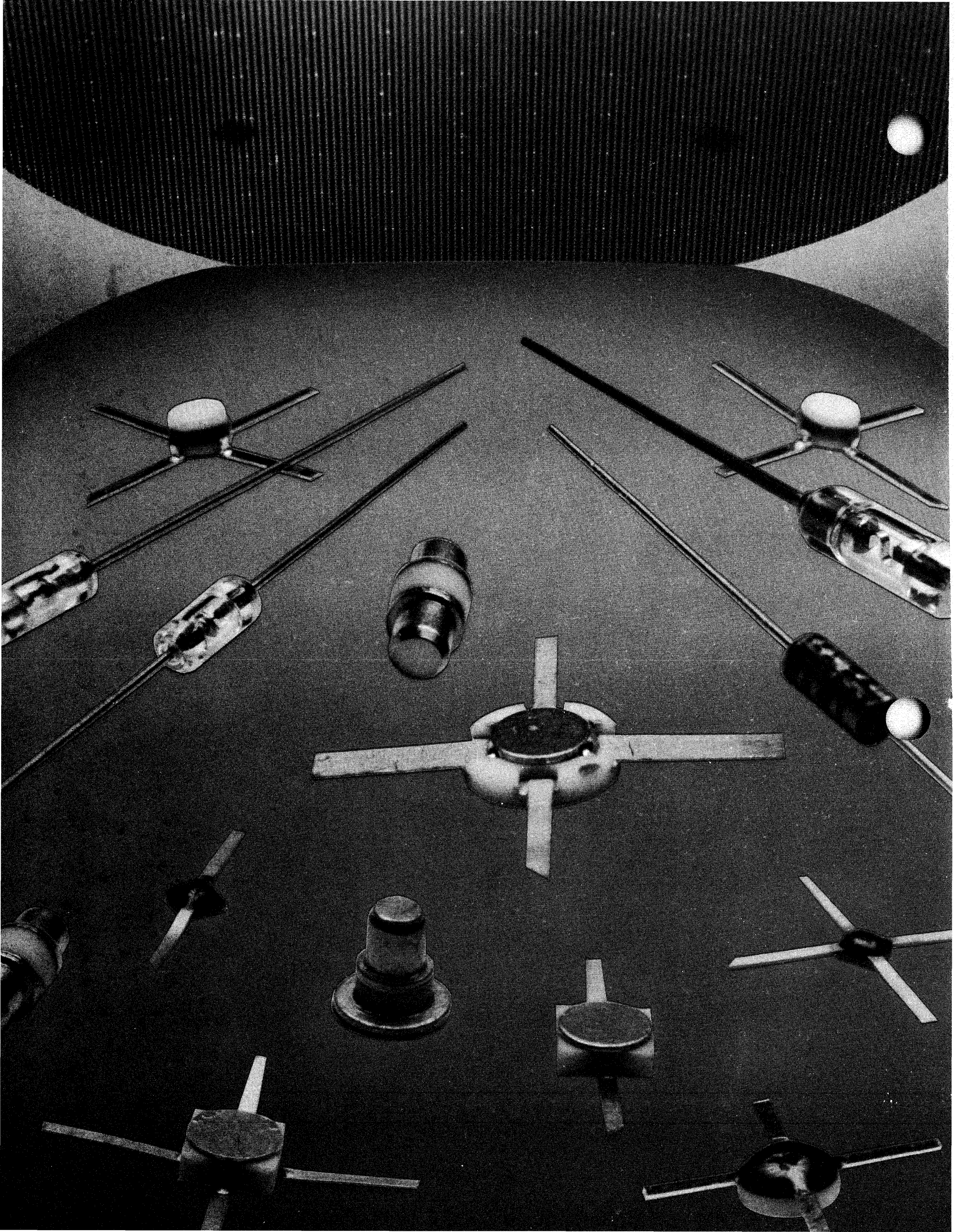
Preconditioning and screening tests are recommended for devices terminating in high reliability equipments. The following results were obtained with preconditioning and screening.

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time at 150°C	2
Steady State Operating Life	1,000 hrs. min. operating time at T_A = 150°C, P_{FM} = 175 mW, V_{RM} = 12 V, f = 60 Hz, T_A = 25°C	3

Environmental

The following cumulative test results have been obtained from reliability testing performed at HP Components Division, in accordance with the latest revisions of Military Semiconductor Specifications MIL-STD-19500, MIL-STD-202 and MIL-STD-750.

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Temperature Cycling	1051.1 Cond. B	5 cycles from −65° C to +150° C, .5 hours at extremes, 5 min. transfer	5
Thermal Shock	1056.1	5 cycles from 0° C to +100° C, 3 sec. transfer	5
Moisture Resistance	1021.1	10 days, 90-98% RH, −10 to +65° C, non-operating	8
Shock	2016.1	5 blows each X_1, Y_1, Y_2, 1500 G, 0.5 msec pulse	10
Vibration Fatigue	2046	32 ± 8 hrs. each X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	10
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	10
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	10
Terminal Strength	2037.1 Cond. F	Pkg. 32 — 2 lbs. for 3 sec, 120° apart	20
Salt Atmosphere	1041.1	35° fog for 24 hours	20



Integrated Products

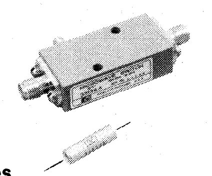
HEWLETT PACKARD

INTEGRATED PRODUCTS

SWITCHES
MODULATORS
LIMITERS
MIXERS
COMB GENERATORS

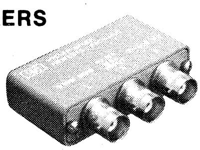
PIN DIODE SWITCHES

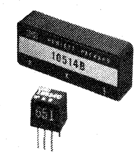
- Broadband, .1-18 GHz
- 33130 Series Optimized for Low Insertion Loss
- 33140 Series Optimized for Fast Swtiching, 5 ns
- Medium and High Isolation Units Available in Each Series
- Hermetic PIN Diode Modules
- Add-On Driver Available for 33140 Series



DOUBLE BALANCED MIXERS

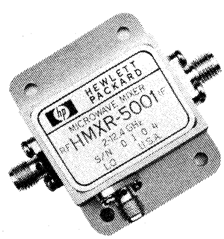
- Broadband
  10534 Series: .05-150 MHz
  10514 Series: .2-500 MHz
- Low Conversion Loss
- Low 1/f Noise, Typically Less than 100 nV per Root Hz
- High Isolation Between Ports
- Wide Range of Package Styles
  "A" Versions: BNC Jacks (Options Available)
  "B" Versions: Pins for PC Mounting
  "C" Versions: Miniature, Pins for PC Mounting
- Hermetically Sealed Schottky Diodes





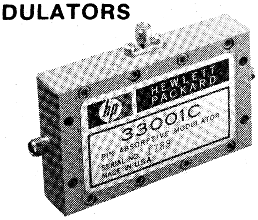
HMXR-5001 WIDEBAND DOUBLE BALANCED MIXER

- Wideband — 2 to 12.4 GHz Usable to 18 GHz
- Wide IF Bandwidth 0.01 to 1.0 GHz
- Good Conversion Loss
  7.5 dB Typical to 8 GHz
  8.5 dB Typical to 12.4 GHz
- Excellent Isolation LO-RF: 30 dB Typical
- Rugged Construction
- Hermetically Packaged Diodes



PIN ABSORPTIVE MODULATORS

- 50Ω Match at all Attenuation Levels
- Greater than Octave Band Coverage
- 50ns Switching (10ns Available on Special Request)
- Hermetic PIN Diode Modules

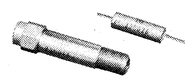


PIN DIODE LIMITERS

- Broadband, .4-12 GHz
- Low Limiting Threshold, 5mW Typical, 8-12 GHz
- Low Insertion Loss, 1.5dB Typical, 8-12 GHz
- Low Leakage, 20mW Typical, 8-12 GHz
- Hermetic PIN Diode Module
  33701A — Module
  33711A — Module with SMA Connectors

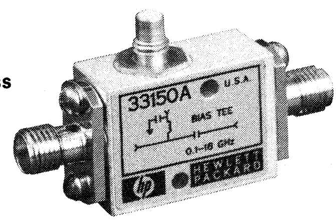
COMB GENERATORS

- 100, 250, 500 and 1000 MHz Drive Frequencies (Drive Frequencies in 50-1500 MHz Range Available on Special Request)
- Input Matched to 50Ω
- Self-biased, no External Bias Required
- Narrow Output Pulses: 130ps Pulse Width with 10V Amplitude
- Broadband Output Comb Up to 40 GHz Available
- Hermetic Step Recovery Diode Modules

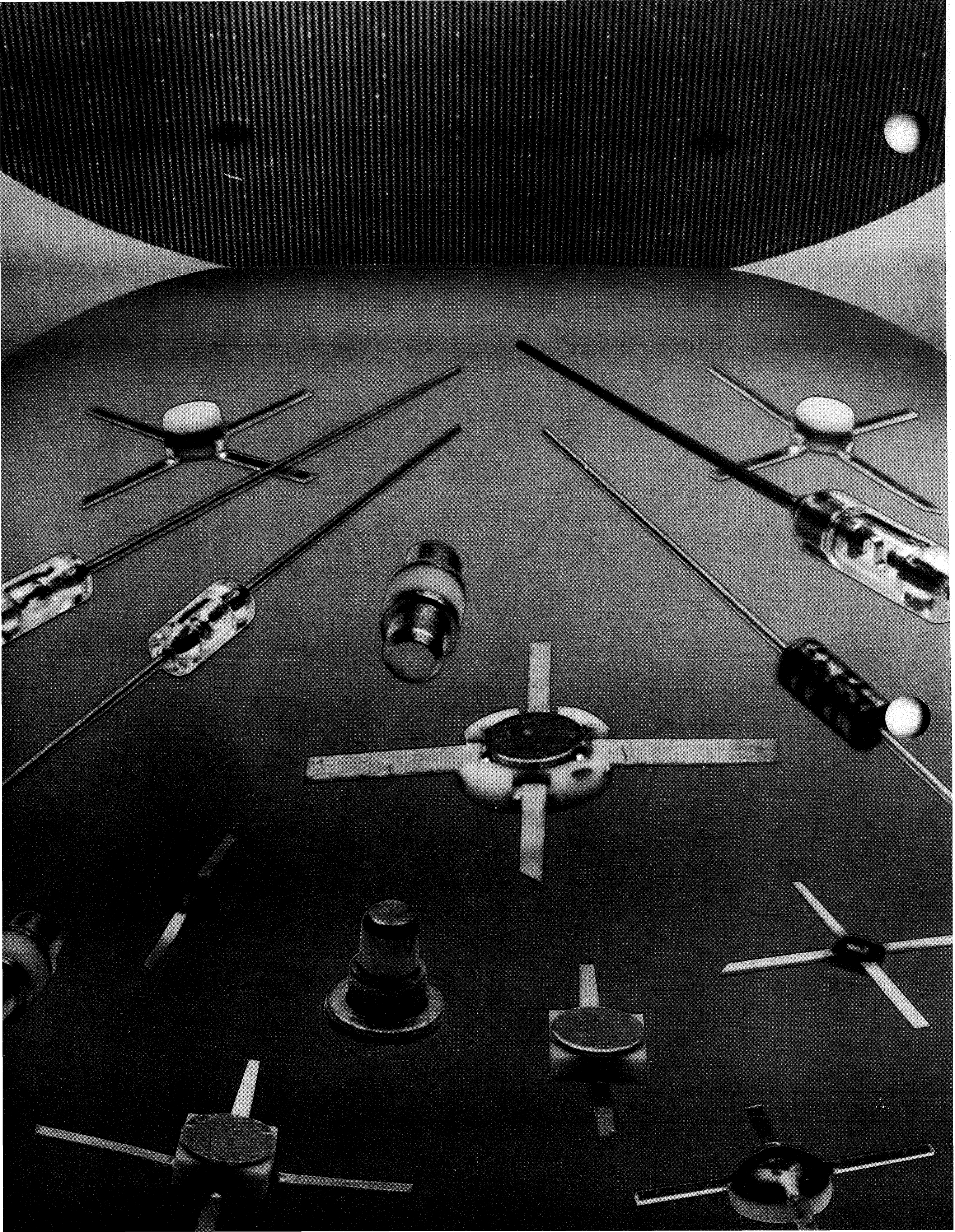


33150A MICROWAVE BIAS NETWORK 0.1-18 GHz

- Wideband
- Low Insertion Loss
- High RF to DC Isolation



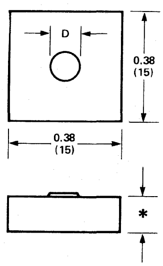
For a copy of the Microwave Integrated Products Catalog (5952-9871D) write: Inquiries Mgr., Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304.



Appendix

PACKAGE OUTLINES

All dimensions in millimeters (inches), except where noted.
For complete package specifications refer to individual product specification sheets.
Drawings are not to scale.



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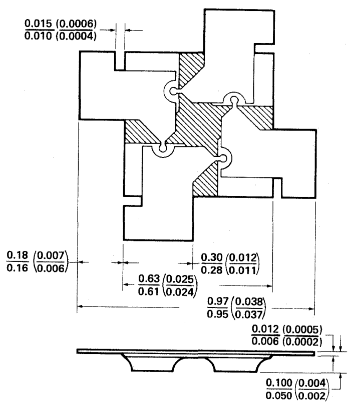

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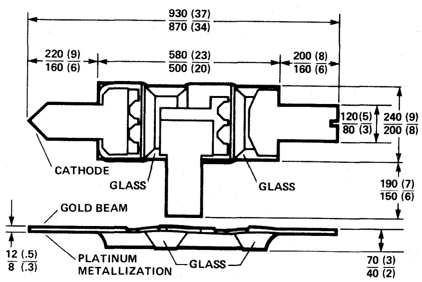
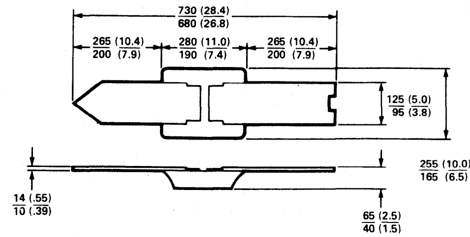


DIMENSIONS IN μm (1/1000 INCH)

04



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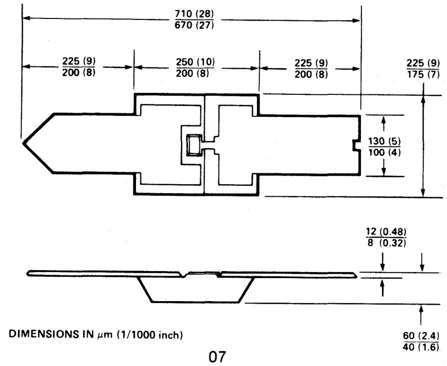

DIMENSIONS IN μm (1/1000 inch)

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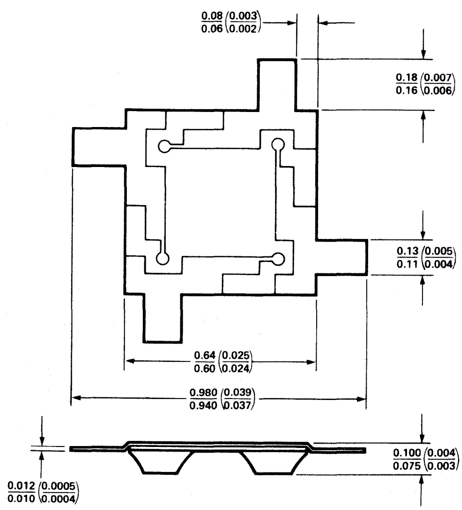

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All dimensions in millimeters (inches), except where noted.
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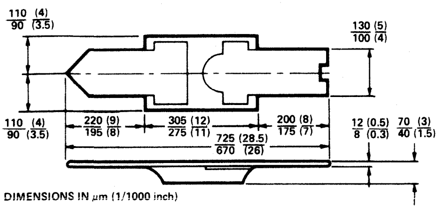

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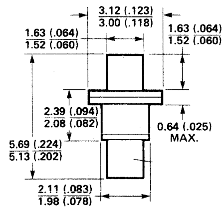

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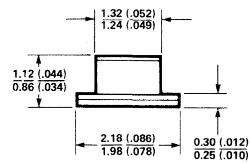

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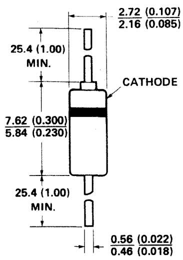

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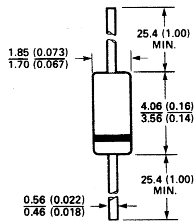

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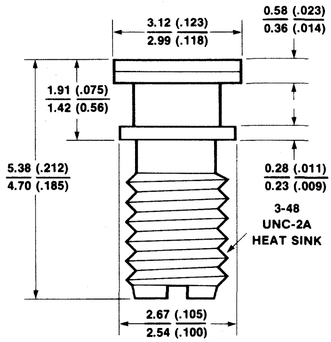

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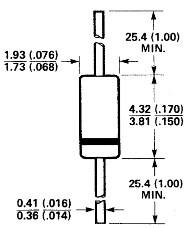

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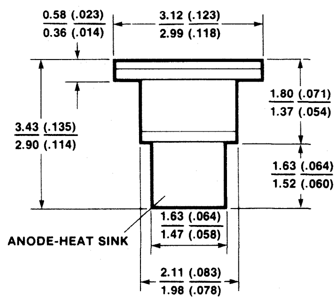

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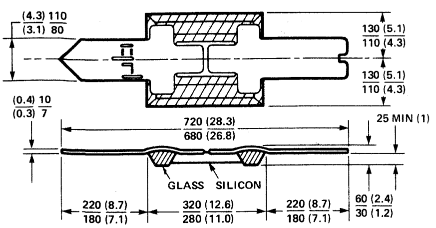

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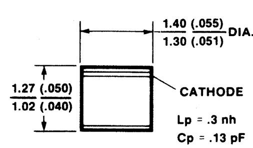

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All dimensions in millimeters (inches), except where noted.
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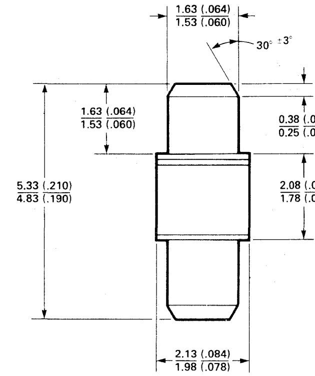

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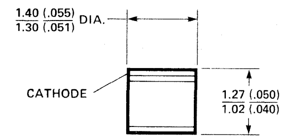

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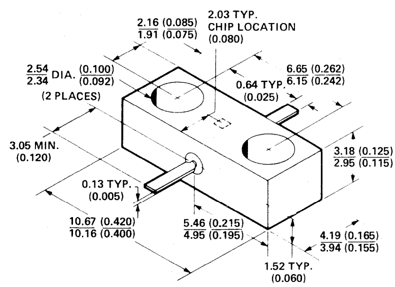

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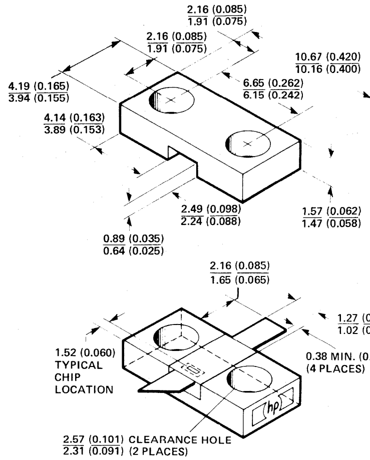

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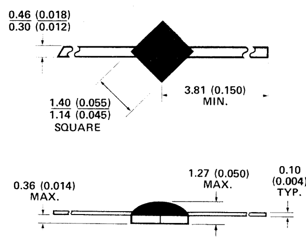

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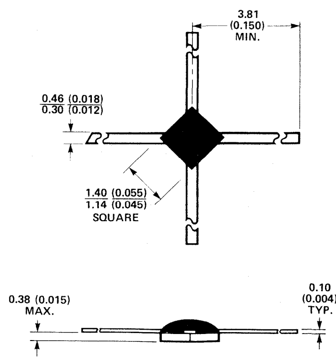

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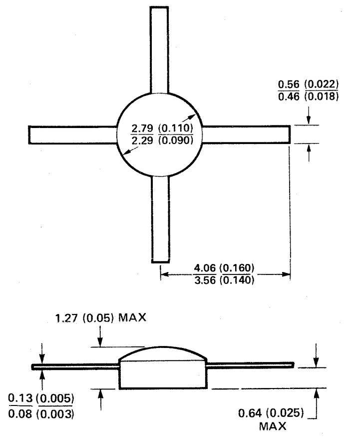
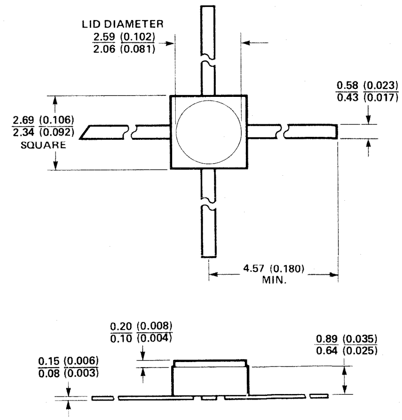


E1



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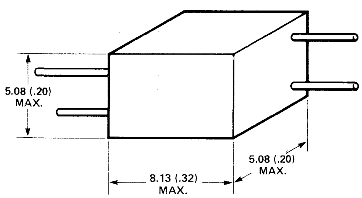
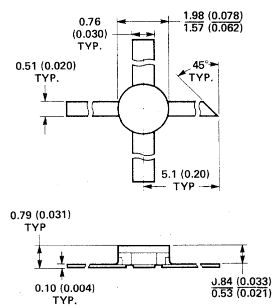
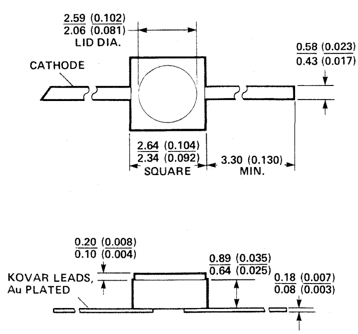


LEAD LENGTH 19.05 (0.75) MIN.

G1/G2



HPAC-70GT



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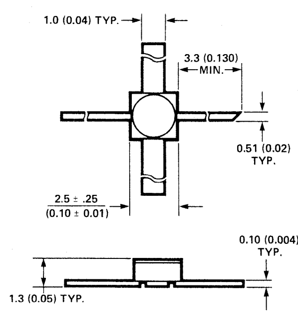

HPAC-100

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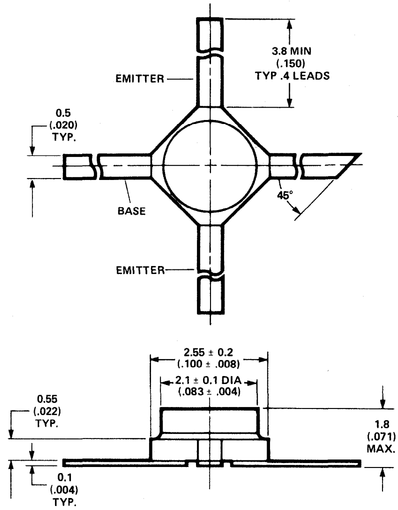

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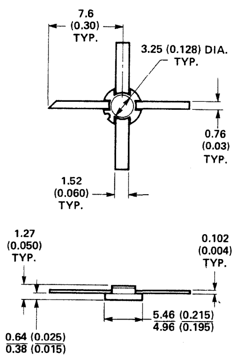
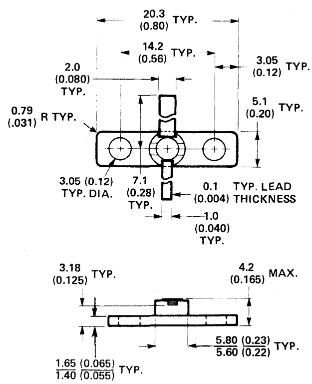


HPAC-200



HPAC-200 GB/GT

HP Components Authorized Distributor and Representative Directory

May 1984

United States

Alabama

Hall-Mark Electronics
4900 Bradford Drive
Huntsville 35805
(205) 837-8700

Hamilton/Avnet
4812 Commercial Drive
Huntsville 35805
(205) 837-7210

Schweber Electronics
2227 Drake Avenue, S.W.
Suite 14
Huntsville 35805
(205) 882-2200

Arizona

Hamilton/Avnet
505 South Madison
Tempe 85281
(602) 231-5100

Wyle Laboratories
Electronics Marketing Group
8155 North 24th Avenue
Phoenix 85021
(602) 249-2232
in Tucson (602) 884-7082

California

Hall-Mark Electronics
1110 Ringwood Court
San Jose 95131
(408) 946-0900

Hamilton/Avnet
4103 Northgate Blvd.
Sacramento 95834
(916) 925-2216

Hamilton/Avnet
4545 Viewridge Avenue
San Diego 92123
(619) 571-7510

Hamilton/Avnet
1175 Bordeaux Drive
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(408) 743-3355

Hamilton Electro Sales
3170 Pullman Street
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Hamilton Electro Sales
10950 W. Washington Blvd.
Culver City 90230
(213) 558-2121

Schweber Electronics
21139 Victory Boulevard
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(213) 999-4702

Schweber Electronics
17822 Gillette Avenue
Irvine 92714
(714) 863-0200

Schweber Electronics
1771 Tribute Road
Suite B
Sacramento 95815
(916) 929-9732

California (cont.)

Schweber Electronics
3110 Patrick Henry Drive
Santa Clara 95050
(408) 748-4700

Wyle Laboratories
Electronics-Marketing Group
124 Maryland Street
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(213) 322-8100

Wyle Laboratories
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Wyle Laboratories
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(916) 638-5282

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(619) 565-9171

Wyle Laboratories
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Colorado

Hamilton/Avnet
8765 East Orchard
Suite 708
Englewood 80111
(303) 740-1000

Wyle Laboratories
Electronics Marketing Group
451 E. 124th Avenue
Thornton 80241
(303) 457-9953

Connecticut

Hamilton/Avnet
Commerce Drive
Commerce Industrial Park
Danbury 06810
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Schweber Electronics
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Florida

Hall-Mark Electronics
1671 W. McNab Road
Ft. Lauderdale 33309
(305) 971-9280

Hall-Mark Electronics
7648 Southland Blvd.
Suite 100
Orlando 32809
(305) 855-4020

Florida (cont.)

Hall-Mark Electronics
15301 Roosevelt Blvd.
Suite 303
Clearwater 33520
(813) 530-4543

Hamilton/Avnet Electronics
6801 N.W. 15th Way
Ft. Lauderdale 33309
(305) 971-2900

Hamilton/Avnet
3197 Tech Drive North
St. Petersburg 33702
(813) 576-3930

Hamilton/Avnet
6947 University Blvd.
Winter Park 32792
(305) 628-3888

Schweber Electronics
181 Whooping Loop
AltaMonte Springs 32701
(305) 331-7555

Schweber Electronics
2830 N. 28th Terrace
Hollywood 33020
(305) 927-0511

Georgia

Hall-Mark Electronics
6410 Atlantic Boulevard
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Norcross 30071
(404) 447-8000

Hamilton/Avnet
5825 D. Peachtree Corners East
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Schweber Electronics
303 Research Drive
Suite 210
Norcross 30092
(404) 449-9170

Illinois

Hall-Mark Electronics
1177 Industrial Drive
Bensenville 60106
(312) 860-3800

Hamilton/Avnet
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Bensenville 60106
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Indiana

Hamilton/Avnet
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Iowa

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Schweber Electronics
25 Wiggins Avenue
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Michigan

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Hamilton/Avnet
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Livonia 48150
(313) 522-4700

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Livonia 48150
(313) 525-1800

Schweber Electronics
12060 Hubbard Drive
Livonia 48150
(313) 525-8100

Minnesota

Hall-Mark Electronics
7838 12th Avenue, So.
Bloomington 55420
(612) 854-3223

Hamilton/Avnet
10300 Bren Road E.
Minneapolis 55343
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7424 W. 78th Street
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(612) 941-5280

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Maryland Heights 63043
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Bedford Farms, Bldg. 2
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Cherry Hill 08003
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Hamilton/Avnet
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Schweber Electronics
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Fairfield 07006
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Albuquerque 87106
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New York

Hall-Mark Electronics
1 Comac Loop
Ronkonkoma 11779
(516) 737-0600

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East Syracuse 13057
(315) 437-2641

Hamilton/Avnet
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Melville 11746
(516) 454-6060

Hamilton/Avnet
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Rochester 14623
(716) 475-9130

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Rochester 14623
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Schweber Electronics
Jericho Turnpike
Westbury 11590
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North Carolina

Hall-Mark Electronics
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Raleigh 27604
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Hamilton/Avnet
3510 Spring Forest Road
Raleigh 27604
(919) 878-0810

Schweber Electronics
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Raleigh 27604
(919) 876-0000

Ohio

Hall-Mark Electronics
5821 Harper Road
Solon 44139
(216) 349-4632

Hall-Mark Electronics
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Westerville 43081
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Hamilton/Avnet
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Hamilton/Avnet
945 Senate Drive
Dayton, Ohio 45459
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Pioneer-Standard
4800 East 131st Street
Cleveland 44105
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Pioneer-Standard
4433 Interpoint Boulevard
Dayton 45404
(513) 236-9900

Schweber Electronics
23880 Commerce Park Road
Beachwood 44122
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Ohio (cont.)

Schweber Electronics
7865 Paragon Road
Suite 210
Dayton, 45459
(513) 439-1800

Oklahoma

Hall-Mark Electronics
5460 South 103rd E. Avenue
Tulsa 74145
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Schweber Electronics
4815 S. Sheridan
Suite 109
Tulsa 74145
(918) 622-8000

Oregon

Hamilton/Avnet
6024 S.W. Jean Road
Bldg. C, Suite 10
Lake Oswego 97034
(503) 635-8831

Wyle Laboratories
Electronics Marketing Group
5289 N.E. Elam Young Parkway
Suite E-100
Hillsboro 97123
(503) 640-6000

Pennsylvania

Pioneer-Standard
259 Kappa Drive
Pittsburg 15238
(412) 782-2300

Schweber Electronics
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Horsham 19044
(215) 441-0600

Schweber Electronics
1000 RIDC Place
Suite 203
Pittsburg 15238
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Texas

Hall-Mark Electronics
12211 Technology
Austin 78759
(512) 258-8848

Hall-Mark Electronics
11333 Pagemill Drive
Dallas 75231
(214) 341-1147

Hall-Mark Electronics
8000 Westglen
P.O. Box 42190
Houston 77042
(713) 781-6100

Hamilton/Avnet
2401 Rutland
Austin 78758
(512) 837-8911

Texas (cont.)

Hamilton/Avnet
3939 Ann Arbor
Houston 77063
(713) 780-1771

Hamilton/Avnet
2111 W. Walnut Hill Lane
Irving 75062
(214) 659-4111

Schweber Electronics
6300 La Calma Drive
Suite 240
Austin 78752
(512) 458-8253

Schweber Electronics
4202 Beltway Drive
Dallas 75234
(214) 661-5010

Schweber Electronics
10625 Richmond Avenue
Suite 100
Houston 77042
(713) 784-3600

Utah

Hamilton/Avnet
1585 West 21st S.
Salt Lake City 84119
(801) 972-2800

Wyle Laboratories
Electronics Marketing Group
1959 S. 4130 West
Unit B
Salt Lake City 84104
(801) 974-9953

Washington

Hamilton/Avnet
14212 N.E. 21st Street
Bellevue 98006
(206) 453-5844

Wyle Laboratories
Electronics Marketing Group
1750 132nd Avenue, N.E.
Bellevue 98005
(206) 453-8300

Wisconsin

Hall-Mark Electronics
9625 South 20th Street
Oakcreek 53154
(414) 761-3000

Hamilton/Avnet
2975 Moorland Road
New Berlin 53151
(414) 784-4510

Schweber Electronics
150 S. Sunnyslope
Suite 120
Brookfield 53005
(414) 784-9020

International

Australia

STC-Cannon Components Pty. Ltd.
Gabba Towers
411 Vulture Street
Woolloongabba, Qld. 4102
(61) 07 393-0377
(61) 07 393-0595

STC-Cannon Components Pty. Ltd.
Unit 2
66 Humphries Terrace
Kilkenny
South Australia 5009
(61) 08 268 7088

Australia (cont.)

STC-Cannon Components Pty. Ltd.
605 Gardeners Road
Mascot, New South Wales 2020
(61) 02 693 1666

STC-Cannon Components Pty. Ltd.
248 Wickham Road
Moorabbin
Victoria 3189
(61) 03 555 9566

Australia (cont.)

STC-Cannon Components Pty. Ltd.
396 Scarborough Beach Road
Osborne Park
Western Australia 6017
(61) 09 444 0211

VSI Electronics Pty. Ltd.
Office 8
116 Melbourne Street
North Adelaide
South Australia 5006
(61) 08 267 4848

Australia (cont.)

VSI Electronics Pty. Ltd.
11th Floor
United Dominion Building
127 Creek Street
Brisbane, Queensland 4000
(61) 07 229 8827

VSI Electronics Pty. Ltd.
Suite 3
118 Church Street
Hawthorn, Victoria 3122
(61) 03 819 5044

Australia (cont.)

VSI Electronics Pty. Ltd.
Unit 1
25 Brisbane Street
East Perth, W.A. 6000
(61) 09 328 8499

VSI Electronics Pty. Ltd.
16 Dickson Avenue
Artarmon, N.S.W. 20
(61) 02 439 8622

Austria

Transistor V.m.b.H
Auhofstr. 41a
A-1130 Wien
(43) 222 829451
(43) 222 829404

Belgium

Diode Belgium
Luchtschipstraat/Rue De
L'Aeronef 2
1140 Brusselss
(32) 2 216 2100

Brazil

Datatronix Electronica LTDA
Av. Pacaembu, 746-C11
Sao Paulo
(55) 11 8260111

Canada

Hamilton/Avnet
Electronics Ltd.
6845 Rexwood Drive
Units 3, 4 & 5
Mississauga, Ontario L4V 1R2
(416) 677-7432

Hamilton/Avnet
Electronics Ltd.
2670 Sabourin Street
St. Laurent
Montreal, Quebec H4S 1M2
(514) 331-6443

Hamilton/Avnet
Electronics Ltd.
210 Colonnade Road
Nepean, Ontario K7E 7J5
(613) 226-1700

Zentronics, Ltd.
8 Tilbury Court
Brampton, Ontario L6T 3T4
(416) 451-9600

Zentronics, Ltd.
Bay #1
3300 14th Avenue, N.E.
Calgary, Alberta T2A 6J4
(403) 272-1021

Zentronics, Ltd.
155 Colonnade Road
Units 17 & 18
Nepean, Ontario K2E 7K1
(613) 226-8840

Zentronics, Ltd.
505 Locke Street
St. Laurent
Montreal, Quebec H4T 1X7
(514) 735-5361

Zentronics, Ltd.
Unit 108
11400 Bridgeport Road
Richmond, B.C. V6X 1T2
(604) 273-5575

Zentronics, Ltd.
546 Weber Street North
Unit 10
Waterloo, Ontario N2L 5C6
(519) 884-5700

Zentronics, Ltd.
590 Berry Street
Winnipeg, Manitoba R3H 0S1
(204) 775-8661

Denmark

Interelko A.P.S.
SILOVEJ
2690 Karlslunde
(45) 3 140700

Finland

Field-OY
Veneentekijantie 18
00210 Helsinki 21
(358) 0 6922 577

France

Almex
Zone Industrielle d'Antony
48, rue de l'Aubepine
92160 Antony
(33) 1 6662112

F. Feutrier
8, Benoit Malon
92150 Surensnes
(33) 1 7724646

F. Feutrier
Rue de Trois Glorievses
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(33) 77 7746733

S.C.A.I.B.
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Zone Silic
94150 Rungis
(33) 1 6872313

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Distron GmbH
Behaimstr. 3
D-1000 Berlin 10
(49) 30 3421041

EBV Elektronik
Oberweg 6
D-8025 Unterhaching
(49) 89 611051

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(49) 4621 23121

Jermyn GmbH
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D-6277 Camberg
(49) 6434 230

SASCO GmbH
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Hermann-Oberth-StraBe 16
Munich
(49) 89 46111

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1402 Tung Wah Mansion
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Wanchai
(852) 5 729376

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Blue Star Ltd. (REP)
Sabri Complex II Floor
24 Residency Road
Bangalore 560 025
Tel: 55660

Blue Star Ltd. (REP)
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
Bombay 400 025
Tel: 422-6155

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Bhandari House,
7th/8th Floors
91 Nehru Place
New Delhi 110 024
Tel: 682547

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Motorola Israel Ltd.
Electronics and Engineering
16 Kremenetski Street
P.O. Box 25016
Tel Aviv 67899
(972) 3 338973

Italy

Celdis Italiana S.p.A.
Via F. LL Gracchi, 36
20092 Cinisello Balsamo
Milano
(39) 2 6120041

Eledra S.p.A.
Viale Elvezia 18
20154 Milano
(39) 2 349751

Japan

Ryoyo Electric Corporation
Meishin Building
1-20-19 Nishiki
Naka-Ku, Nagoya, 460
(81) 52 2030277

Ryoyo Electric Corporation
Taiyo Shoji Building
4-6 Nakanoshima
Kita-Ku, Osaka, 530
(81) 6 4481631

Ryoyo Electric Corporation
Konwa Building
12-22 Tsukiji, 1-Chome
Chuo-Ku, Tokyo
(81) 3 543771

Tokyo Electron Company, Ltd.
Sinjuku-Nomura Building
Tokyo 160
(81) 3 3434411

Korea

Samsung Electronics Co., Ltd.
Industrial Products Division
76-561 Yeoksam-Dong Kangnam-Ku
Seoul
(82) 2 555 7555

Netherlands

Koning en Hartman
Elektrotechniek BV
Koperwerf 30
2544 EN Den Haag
(31) 70 210101

New Zealand

VSI Electronics Pty. Ltd.
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Epsom, Auckland
(64) 97686042

VSI Electronics Pty. Ltd.
P.O. Box 11145
Wellington
(64) 4848922

VSI Electronics Pty. Ltd.
295 Cashel Street
Christchurch
(64) 60928

Norway

HEFRO Teknisk A/S
P.O. Box 6596, Rodeloekka
Oslo 5
(47) 2 380286

Singapore

Dynamar International Ltd.
Suite 05-11
12, Lorong Bakar Batu
Kolam Ayer Industrial Estate
Singapore 1334
(65) 747-6188

So. Africa

Advanced Semiconductor
Devices (Pty) Ltd.
P.O. Box 2944
Johannesburgh 2000, S.A.
(27) 11 802-58204

Spain

Diode Espana
Avda. Brasil 5, 1st Planta
Madrid 20
(34) 1 455 3686

Sweden

TRACO AB
Box 103
123 22 Farsta
(46) 8132160

Switzerland

Baerlocher AG
Foerrlibuckstrasse 110
CH-8037 Zuerich
(41) 1 429900

Fabrimex Ag
Kirchenweg 5
CH-8032 Zuerich
(41) 1 251-2929

United Kingdom

Celdis Ltd.
37-39 Loverock Road
Reading, Berkshire
RG3 1ED
(44) 734 585171

Jermyn-Mogul Distribution
Vestry Estate
Otford Road
Sevenoaks, Kent
TN14 5EU
(44) 732 450144

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Slough, Berkshire
SL1 6LN
(44) 628 64422

Farnell Electronic
Components Ltd.
Canal Road
Leeds LS12 2TU
(44) 532-636311

Yugoslavia

Elektrotehna N. Sol. O.
Tozd Elzas N. Sol. O.
Titova 81
61001 Ljubljana
(38) 61 347749
(38) 61 347841

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Product Line Sales/Support Key

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CH Computer Systems Hardware Sales and Services
CS Computer Systems Software Sales and Services
E Electronic Instruments & Measurement Systems
M Medical Products
MP Medical Products Primary SRO
MS Medical Products Secondary SRO
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CH-1217 **MEYRIN** 2, Switzerland
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Telex: 27835 hpse
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ASIA
Hewlett-Packard Asia Ltd.
6th Floor, Sun Hung Kai Centre
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G.P.O. Box 795
HONG KONG
Tel: 5-832 3211
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47th Floor, China Resources Bldg.
26 Harbour Rd., Wanchai
HONG KONG
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Cable: HEWPACK HONG KONG

CANADA
Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 610-492-4246

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Lieblgasse 1
P.O.Box 72
A-1222 **VIENNA**, Austria
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Uilenstede 475
P.O.Box 999
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The Netherlands
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Hewlett-Packard S.A.
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OTHER EUROPE
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Tel: (022) 83 8111
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Hewlett-Packard Co.
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P.O. Box 3919
LOS ANGELES, CA 91604
Tel: (213) 506-3700

OTHER INTERNATIONAL AREAS
Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
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Telectra
Empresa Técnica de Equipamentos
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Tel: 35515,35516
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AUSTRALIA

Adelaide, South Australia Office
Hewlett-Packard Australia Ltd.
153 Greenhill Road
PARKSIDE, S.A. 5063
Tel: 272-5911
Telex: 82536
Cable: HEWPARD Adelaide
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Brisbane, Queensland Office
Hewlett-Packard Australia Ltd.
10 Payne Road
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Tel: 30-4133
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121 Wollongong Street
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Sydney, New South Wales Office
Hewlett-Packard Australia Ltd.
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Tel: 887-1611
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Telex: 32375
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Rua Bage, 103
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Tel: (011) 570-5726
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SALES & SUPPORT OFFICES
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CANADA

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Hewlett-Packard (Canada) Ltd.
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Tel: (403) 235-3100
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2670 Queensview Dr.
OTTAWA, Ontario K2B 8K1
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WILLOWDALE, Ontario M2J 1R5
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CAIRO
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Telex: IEA UN 93830
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EGYPOR
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42 El Zahraa Street
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Telex: 93 337
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Hewlett-Packard Oy
(Olarinluoma 7)
PL 24
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CH

FRANCE
Hewlett-Packard France
Z.I. Mercure B
Rue Berthelot
F-13763 Les Milles Cedex
AIX-EN-PROVENCE
Tel: 16 (42) 59-41-02
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A,CH,E,MS,P*

Hewlett-Packard France
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F-61000 **ALENCON**
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Hewlett-Packard France
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Tel: 16 (98) 03-38-35

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Chemin des Mouilles
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Tel: 16 (78) 833-81-25
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Hewlett-Packard France
Tour Lorraine
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F-91035 **EVRY** Cedex
Tel: 16 6 077-96-60
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Parc d'Activite du Bois Briard
Ave. du Lac
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Tel: 16 6 077-8383
Telex: 692315F
E

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Tel: 16 (76) 25-81-41
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Hewlett-Packard France
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Nouveau Chemin de la Garde
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Hewlett-Packard France
125, rue du Faubourg Bannier
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Avenue des Tropiques
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F-75782 **PARIS** CEDEX 16
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CH**,CS

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Telex: 890141F
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Le Péripole
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F-31083 **TOULOUSE** Cedex
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A,CH,CS,E,P*

Hewlett-Packard France
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F-26000 **VALENCE**
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CH

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F-59658 **VILLENEUVE D'ASCQ** Cedex
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Telex: 160124F
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GERMAN FEDERAL REPUBLIC
Hewlett-Packard GmbH
Geschäftsstelle
Keithstrasse 2-4
D-1000 **BERLIN** 30
Tel: (030) 24-90-86
Telex: 018 3405 hpbln d
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Telex:
A,CH,CM,CS,E,MP,P

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A,CH,CS,E,MS,P

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Geschäftsstelle
Schleefstr. 28a
D-4600 **DORTMUND**-Aplerbeck
Tel: (0231) 45001

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Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 **FRANKFURT** 56
Tel: (0611) 50-04-1
Telex: 04 13249 hpffm d
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Geschäftsstelle
Aussenstelle Bad Homburg
Louisenstrasse 115
D-6380 **BAD HOMBURG**
Tel: (06172) 109-0

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Geschäftsstelle
Kapstadtring 5
D-2000 **HAMBURG** 60
Tel: (040) 63804-1
Telex: 021 63 032 hphh d
A,CH,CS,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Heidering 37-39
D-3000 **HANNOVER** 61
Tel: (0511) 5706-0
Telex: 092 3259
A,CH,CM,E,MS,P

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Geschäftsstelle
Rosslauer Weg 2-4
D-6800 **MANNHEIM**
Tel: (0621) 70050
Telex: 0462105
A,C,E

Hewlett-Packard GmbH
Geschäftsstelle
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D-7910 **NEU ULM**
Tel: 0731-70241
Telex: 0712816 HP ULM-D
A,C,E*

Hewlett-Packard GmbH
Geschäftsstelle
Ehhericherstr. 13
D-8500 **NÜRNBERG** 10
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Telex: 0623 860
CH,CM,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Eschenstrasse 5
D-8028 **TAUFKIRCHEN**
Tel: (089) 6117-1
Telex: 0524985
A,CH,CM,E,MS,P

GREAT BRITAIN
See United Kingdom

GREECE
Kostas Karaynnis S.A.
8 Omirou Street
***ATHENS** 133*
Tel: 32 30 303, 32 37 371
Telex: 215962 RKAR GR
A,CH,CM,CS,E,M,P

PLAISIO S.A.
G. Gerardos
24 Stournara Street
ATHENS
Tel: 36-11-160
Telex: 221871
P

GUATEMALA
IPESA
Avenida Reforma 3-48, Zona 9
GUATEMALA CITY
Tel: 316627, 314786
Telex: 4192 TELTRO GU
A,CH,CM,CS,E,M,P

HONG KONG
Hewlett-Packard Hong Kong, Ltd.
G.P.O. Box 795
5th Floor, Sun Hung Kai Centre
30 Harbour Road
HONG KONG
Tel: 5-8323211
Telex: 66678 HEWPA HX
Cable: HEWPACK HONG KONG
E,CH,CS,P

CET Ltd.
1402 Tung Wah Mansion
199-203 Hennessy Rd.
*Wanchia, **HONG KONG***
Tel: 5-729376
Telex: 85148 CET HX
CM

Schmidt & Co. (Hong Kong) Ltd.
Wing On Centre, 28th Floor
Connaught Road, C.
HONG KONG
Tel: 5-455644
Telex: 74766 SCHMX HX
A,M

ICELAND
Elding Trading Company Inc.
Hafnarnvoli-Tryggvagotu
P.O. Box 895
IS-REYKJAVIK
Tel: 1-58-20, 1-63-03
M

INDIA
Computer products are sold through Blue Star Ltd. All computer repairs and maintenance service is done through Computer Maintenance Corp.

Blue Star Ltd.
Sabri Complex II Floor
24 Residency Rd.
***BANGALORE** 560 025*
Tel: 55660
Telex: 0845-430
Cable: BLUESTAR
A,CH,CM,CS*,E*

Blue Star Ltd.
Band Box House
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-3101
Telex: 011-3751
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-6155
Telex: 011-4093
Cable: FROSTBLUE
A,CH,CM,CS*,E,M*

Blue Star Ltd.
Kalyan, 19 Vishwas Colony
*Alkapuri, **BORODA,** 390 005*
Tel: 65235
Cable: BLUE STAR
A

Blue Star Ltd.
7 Hare Street
***CALCUTTA** 700 001*
Tel: 12-01-31
Telex: 021-7655
Cable: BLUESTAR
A,M

Blue Star Ltd.
133 Kodambakkam High Road
***MADRAS** 600 034*
Tel: 82057
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
Bhandari House, 7th/8th Floors
91 Nehru Place
***NEW DELHI** 110 024*
Tel: 682547
Telex: 031-2463
Cable: BLUESTAR
A,CH,CM,CS*,E,M*

Blue Star Ltd.
15/16:C Wellesley Rd.
***PUNE** 411 011*
Tel: 22775
Cable: BLUE STAR
A

Blue Star Ltd.
2-2-47/1108 Bolarum Rd.
***SECUNDERABAD** 500 003*
Tel: 72057
Telex: 0155-459
Cable: BLUEFROST
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
***TRIVANDRUM** 695 013*
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E

Computer Maintenance Corporation Ltd.
115, Sarojini Devi Road
***SECUNDERABAD** 500 003*
Tel: 310-184, 345-774
Telex: 031-2960
*CH***

SALES & SUPPORT OFFICES
Arranged alphabetically by country

INDONESIA
BERCA Indonesia P.T.
P.O.Box 496/Jkt.
Jl. Abdul Muis 62
JAKARTA
Tel: 21-373009
Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA
P

BERCA Indonesia P.T.
P.O.Box 2497/Jkt
Antara Bldg., 17th Floor
Jl. Medan Merdeka Selatan 17
JAKARTA-PUSAT
Tel: 21-344-181
Telex: BERSAL IA
A,CS,E,M

BERCA Indonesia P.T.
P.O. Box 174/SBY.
Jl. Kutei No. 11
SURABAYA
Tel: 68172
Telex: 31146 BERSAL SB
Cable: BERSAL-SURABAYA
A,E,M,P*

IRAQ
Hewlett-Packard Trading S.A.
Service Operation
Al Mansoor City 9B/3/7
BAGHDAD
Tel: 551-49-73
Telex: 212-455 HEPAIRAQ IK
CH,CS

IRELAND
Hewlett-Packard Ireland Ltd.
82/83 Lower Leeson Street
DUBLIN 2
Tel: 0001 608800
Telex: 30439
A,CH,CM,CS,E,M,P

Cardiac Services Ltd.
Kilmore Road
Artane
***DUBLIN** 5*
Tel: (01) 351820
Telex: 30439
M

ISRAEL
Eldan Electronic Instrument Ltd.
P.O.Box 1270
***JERUSALEM** 91000*
16, Ohaliav St.
***JERUSALEM** 94467*
Tel: 533 221, 553 242
Telex: 25231 AB/PAKRD IL
A

Electronics Engineering Division
Motorola Israel Ltd.
16 Kremenetski Street
P.O. Box 25016
TEL-AVIV 67899
Tel: 3 88 388
Telex: 33569 Motil IL
Cable: BASTEL Tel-Aviv
CH,CM,CS,E,M,P

ITALY
Hewlett-Packard Italiana S.p.A
Traversa 99C
Via Giulio Petroni, 19
I-70124 **BARI**
Tel: (080) 41-07-44
M

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/III
I-40132 **BOLOGNA**
Tel: (051) 402394
Telex: 511630
CH,E,MS

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291
C,P

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVIGLIO**
(Milano)
Tel: (02) 923691
Telex: 334632
A,CH,CM,CS,E,MP,P

Hewlett-Packard Italiana S.p.A.
Via C. Colombo 49
I-20090 **TREZZANO SUL NAVIGLIO**
(Milano)
Tel: (02) 4459041
Telex: 322116
C,M

Hewlett-Packard Italiana S.p.A.
Via Nuova San Rocco a
Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
Telex: 710698
A,CH,E

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07
Telex: 215238
E,C

Hewlett-Packard Italiana S.p.A.
Via Pelizzo 15
I-35128 **PADOVA**
Tel: (049) 664888
Telex: 430315
A,CH,E,MS

Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA EUR**
Tel: (06) 54831
Telex: 610514
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Hewlett-Packard Italiana S.p.A.
Via di Casellina 57/C
I-50018 **SCANDICCI-FIRENZE**
Tel: (055) 753863

Hewlett-Packard Italiana S.p.A.
Corso Svizzera, 185
I-10144 **TORINO**
Tel: (011) 74 4044
Telex: 221079
CH,E

JAPAN
Yokogawa-Hewlett-Packard Ltd.
152-1, Onna
ATSUGI, Kanagawa, 243
Tel: (0462) 28-0451
CM,C*,E

Yokogawa-Helwett-Packard Ltd.
Meiji-Seimei Bldg. 6F
3-1 Hon Chiba-Cho
CHIBA, 280
Tel: 472 25 7701
E,CH,CS

Yokogawa-Hewlett-Packard Ltd.
Yasuda-Seimei Hiroshima Bldg.
6-11, Hon-dori, Naka-ku
HIROSHIMA, 730
Tel: 82-241-0611

Yokogawa-Hewlett-Packard Ltd.
Towa Building
2-3, Kaigan-dori, 2 Chome Chuo-ku
KOBE, 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi 82 Bldg
3-4 Tsukuba
KUMAGAYA, Saitama 360
Tel: (0485) 24-6563
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Asahi Shinbun Daiichi Seimei Bldg.
4-7, Hanabata-cho
KUMAMOTO,860
Tel: (0963) 54-7311
CH,E

Yokogawa-Hewlett-Packard Ltd.
Shin-Kyoto Center Bldg.
614, Higashi-Shiokoji-cho
Karasuma-Nishiiru
Shiokoji-dori, Shimogyo-ku
KYOTO, 600
Tel: 075-343-0921
CH,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg
4-73, Sanno-maru, 1 Chome
MITO, Ibaraki 310
Tel: (0292) 25-7470
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Sumitomo Seimei 14-9 Bldg.
Meieki-Minami, 2 Chome
Nakamura-ku
NAGOYA, 450
Tel: (052) 571-5171
CH,CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg.,
4-20 Nishinakajima, 5 Chome
Yodogawa-ku
OSAKA, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
27-15, Yabe, 1 Chome
SAGAMIHARA Kanagawa, 229
Tel: 0427 59-1311

Yokogawa-Hewlett-Packard Ltd.
Daiichi Seimei Bldg.
7-1, Nishi Shinjuku, 2 Chome
Shinjuku-ku,**TOKYO** 160
Tel: 03-348-4611
CH,E

Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3 Chome
Suginami-ku **TOKYO** 168
Tel: (03) 331-611
Telex: 232-2024 YHPTOK
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
Daiichi Asano Building
2-8, Odori, 5 Chome
UTSUNOMIYA, Tochigi 320
Tel: (0286) 25-7155
CH,CS,E

Yokogawa-Hewlett-Packard Ltd.
Yasuda Seimei Nishiguchi Bldg.
30-4 Tsuruya-cho, 3 Chome
YOKOHAMA 221
Tel: (045) 312-1252
CH,CM,E

JORDAN
Mouasher Cousins Company
P.O. Box 1387
AMMAN
Tel: 24907, 39907
Telex: 21456 SABCO JO
CH,E,M,P

KENYA
ADCOM Ltd., Inc., Kenya
P.O.Box 30070
NAIROBI
Tel: 331955
Telex: 22639
E,M

KOREA
Samsung Electronics HP Division
12 Fl. Kinam Bldg.
San 75-31, Yeoksam-Dong
Kangnam-Ku
Yeongdong P.O. Box 72
SEOUL
Tel: 555-7555, 555-5447
Telex: K27364 SAMSAN
A,CH,CM,CS,E,M,P

KUWAIT
Al-Khaldiya Trading & Contracting
P.O. Box 830 Safat
KUWAIT
Tel: 42-4910, 41-1726
Telex: 22481 Areeg kt
CH,E,M

Photo & Cine Equipment
P.O. Box 270 Safat
KUWAIT
Tel: 42-2846, 42-3801
Telex: 22247 Matin kt
P

LEBANON
G.M. Dolmadjian
Achrafieh
P.O. Box 165.167
BEIRUT
Tel: 290293
*MP***

Computer Information Systems
P.O. Box 11-6274
BEIRUT
Tel: 89 40 73
Telex: 22259
C

LUXEMBOURG
Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 **BRUSSELS**
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
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MALAYSIA
Hewlett-Packard Sales (Malaysia)
Sdn. Bhd.
1st Floor, Bangunan British
American
Jalan Semantan, Damansara Heights
KUALA LUMPUR 23-03
Tel: 943022
Telex: MA31011
A,CH,E,M,P*

MAYLAYSIA (Cont'd)
Protel Engineering
P.O.Box 1917
Lot 6624, Section 64
23/4 Pending Road
*Kuching, **SARAWAK***
Tel: 36299
Telex: MA 70904 PROMAL
Cable: PROTELENG
A,E,M

MALTA
Philip Toledo Ltd.
Notabile Rd.
MRIEHEL
Tel: 447 47, 455 66
Telex: Media MW 649
E,P

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Av. Periferico Sur No. 6501
Tepepan, Xochimilco
16020 **MEXICO D.F.**
Tel: 6-76-46-00
Telex: 17-74-507 HEWPACK MEX
A,CH,CS,E,MS,P

Hewlett-Packard Mexicana, S.A. de C.V.
Ave. Colonia del Valle 409
Col. del Valle
Municipio de Garza Garcia
MONTERREY, Nuevo Leon
Tel: 78 42 41
Telex: 038 410
CH

ECISA
José Vasconcelos No. 218
Col. Condesa Deleg. Cuauhtémoc
***MEXICO** D.F. 06140*
Tel: 553-1206
Telex: 17-72755 ECE ME
M

MOROCCO
Dolbeau
81 rue Karatchi
CASABLANCA
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E

Gerep
2 rue d'Agadir
Boite Postale 156
CASABLANCA
Tel: 272093, 272095
Telex: 23 739
P

NETHERLANDS
Hewlett-Packard Nederland B.V.
Van Heuven Goedhartlaan 121
NL 1181KK **AMSTELVEEN**
P.O. Box 667
NL1180 AR **AMSTELVEEN**
Tel: (020) 47-20-21
Telex: 13 216 HEPA NL
A,CH,CM,CS,E,MP,P

Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPELLE A/D IJSSEL**
P.O. Box 41
NL 2900AA **CAPELLE A/D IJSSEL**
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
A,CH,CS,E

Hewlett-Packard Nederland B.V.
Pastoor Petersstraat 134-136
NL 5612 LV **EINDHOVEN**
P.O. Box 2342
NL 5600 CH **EINDHOVEN**
Tel: (040) 326911
Telex: 51484 hepae nl
A,CH**,E,M

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
5 Owens Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPACK Auckland
CH,CM,E,P*

Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, **WELLINGTON 3**
Tel: 877-199
Cable: HEWPACK Wellington
CH,CM,E,P

Northrop Instruments & Systems Ltd.
369 Khyber Pass Road
P.O. Box 8602
AUCKLAND
Tel: 794-091
Telex: 60605
A,M

Northrop Instruments & Systems Ltd.
110 Mandeville St.
P.O. Box 8388
CHRISTCHURCH
Tel: 486-928
Telex: 4203
A,M

Northrop Instruments & Systems Ltd.
Sturdee House
85-87 Ghuznee Street
P.O. Box 2406
WELLINGTON
Tel: 850-091
Telex: NZ 3380
A,M

NORTHERN IRELAND

See United Kingdom

NORWAY
Hewlett-Packard Norge A/S
Folke Bernadottes vei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (Bergen)
Tel: 0047/5/16 55 40
Telex: 16621 hpnas n
CH,CS,E,MS

Hewlett-Packard Norge A/S
Österndalen 16-18
P.O. Box 34
N-1345 **ÖSTERÅS**
Tel: 0047/2/17 11 80
Telex: 16621 hpnas n
A,CH,CM,CS,E,M,P

OMAN
Khimjil Ramdas
P.O. Box 19
MUSCAT
Tel: 722225, 745601
Telex: 3289 BROKER MB MUSCAT
P

Suhail & Saud Bahwan
P.O.Box 169
MUSCAT
Tel: 734 201-3
Telex: 3274 BAHWAN MB

PAKISTAN
Mushko & Company Ltd.
1-B, Street 43
Sector F-8/1
ISLAMABAD
Tel: 51071
Cable: FEMUS Rawalpindi
A,E,M

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
***KARACHI** 0302*
Tel: 524131, 524132
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
*A,E,M,P**

PANAMA
Electrónico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929
PANAMA 5
Tel: 63-6613, 63-6748
Telex: 3483 ELECTRON PG
A,CM,E,M,P

PERU
Cía Electro Médica S.A.
Los Flamencos 145, San Isidro
Casilla 1030
***LIMA** 1*
Tel: 41-4325, 41-3703
Telex: Pub. Booth 25306
CM,E,M,P

PHILIPPINES
The Online Advanced Systems Corporation
Rico House, Amorsolo Cor. Herrera Street
Legaspi Village, Makati
P.O. Box 1510
*Metro **MANILA***
Tel: 85-35-81, 85-34-91, 85-32-21
Telex: 3274 ONLINE
A,CH,CS,E,M

Electronic Specialists and Proponents Inc.
690-B Epifanio de los Santos Avenue
*Cubao, **QUEZON CITY***
P.O. Box 2649 Manila
Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 40018, 42000 ITT GLOBE MACKAY BOOTH
P

PORTUGAL
Mundinter
Intercambio Mundial de Comércio S.A.R.L.
P.O. Box 2761
Av. Antonio Augusto de Aguiar 138
P-LISBON
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

Soquimica
Av. da Liberdade, 220-2
*1298 **LISBOA** Codex*
Tel: 56 21 81/2/3
Telex: 13316 SABASA
P

Telectra-Empresa Técnica de Equipmentos Eléctricos S.A.R.L.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
P-LISBON 1
Tel: (19) 68-60-72
Telex: 12598
CH,CS,E,P

PUERTO RICO
Hewlett-Packard Puerto Rico
Ave. Muñoz Rivera #101
Esq. Calle Ochoa
HATO REY, Puerto Rico 00918
Tel: (809) 754-7800

Hewlett-Packard Puerto Rico
Calle 272 Edificio 203
Urb. Country Club
RIO PIEDRAS, Puerto Rico
P.O. Box 4407
CAROLINA, Puerto Rico 00628
Tel: (809) 762-7255
A,CH,CS

QATAR
Computearbia
P.O. Box 2750
DOHA
Tel: 883555
Telex: 4806 CHPARB
P

Eastern Technical Services
P.O.Box 4747
DOHA
Tel: 329 993
Telex: 4156 EASTEC DH

Nasser Trading & Contracting
P.O.Box 1563
DOHA
Tel: 22170, 23539
Telex: 4439 NASSER DH
M

SAUDI ARABIA
Modern Electronic Establishment
Hewlett-Packard Division
P.O. Box 22015
Thuobah
AL-KHOBAR
Tel: 895-1760, 895-1764
Telex: 671 106 HPMEEK SJ
Cable: ELECTA AL-KHOBAR
CH,CS,E,M

Modern Electronic Establishment
Hewlett-Packard Division
P.O. Box 1228
Redec Plaza, 6th Floor
JEDDAH
Tel: 644 38 48
Telex: 4027 12 FARNAS SJ
Cable: ELECTA JEDDAH
CH,CS,E,M

Modern Electronic Establishment
Hewlett-Packard Division
P.O.Box 22015
RIYADH
Tel: 491-97 15, 491-63 87
Telex: 202049 MEERYD SJ
CH,CS,E,M

Abdul Ghani El Ajou
P.O. Box 78
RIYADH
Tel: 40 41 717
Telex: 200 932 EL AJOU
P

SCOTLAND

See United Kingdom

SINGAPORE
Hewlett-Packard Singapore (Sales) Pte. Ltd.
#08-00 Inchcape House
450-2 Alexandra Road
P.O. Box 58 Alexandra Rd. Post Office
SINGAPORE, 9115
Tel: 631788
Telex: HPSGSO RS 34209
Cable: HEWPACK, Singapore
A,CH,CS,E,MS,P

SALES & SUPPORT OFFICES
Arranged alphabetically by country

SINGAPORE (Cont'd)
Dynamar International Ltd.
Unit 05-11 Block 6
Kolam Ayer Industrial Estate
***SINGAPORE** 1334*
Tel: 747-6188
Telex: RS 26283
CM

SOUTH AFRICA
Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 120
Howard Place **CAPE PROVINCE** 7450
Pine Park Center, Forest Drive,
Pinelands
CAPE PROVINCE 7405
Tel: 53-7954
Telex: 57-20006
A,CH,CM,E,MS,P

Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 37099
92 Overport Drive
DURBAN 4067
Tel: 28-4178, 28-4179, 28-4110
Telex: 6-22954
CH,CM

Hewlett-Packard So Africa (Pty.) Ltd.
6 Linton Arcade
511 Cape Road
Linton Grange
PORT ELIZABETH 6000
Tel: 041-302148
CH

Hewlett-Packard So Africa (Pty.) Ltd.
P.O.Box 33345
Glenstantia 0010 **TRANSVAAL**
1st Floor East
Constantia Park Ridge Shopping Centre
Constantia Park
PRETORIA
Tel: 982043
Telex: 32163
CH,E

Hewlett-Packard So Africa (Pty.) Ltd.
Private Bag Wendywood
SANDTON 2144
Tel: 802-5111, 802-5125
Telex: 4-20877
Cable: HEWPACK Johannesburg
A,CH,CM,CS,E,MS,P

SPAIN
Hewlett-Packard Española S.A.
Calle Entenza, 321
E-BARCELONA 29
Tel: 322.24.51, 321.73.54
Telex: 52603 hpbee
A,CH,CS,E,MS,P

Hewlett-Packard Española S.A.
Calle San Vicente S/No
Edificio Albia II
E-BILBAO 1
Tel: 423.83.06
A,CH,E,MS

Hewlett-Packard Española S.A.
Crta. de la Coruña, Km. 16, 400
Las Rozas
E-MADRID
Tel: (1) 637.00.11
CH,CS,M

Hewlett-Packard Española S.A.
Avda. S. Francisco Javier, S/no
Planta 10. Edificio Sevilla 2,
E-SEVILLA 5
Tel: 64.44.54
Telex: 72933
A,CS,MS,P

Hewlett-Packard Española S.A.
Calle Ramon Gordillo, 1 (Entlo.3)
E-**VALENCIA** 10
Tel: 361-1354
CH,P

SWEDEN
Hewlett-Packard Sverige AB
Sunnanvagen 14K
S-22226 **LUND**
Tel: (046) 13-69-79
Telex: (854) 17886 (via Spånga office)
CH

Hewlett-Packard Sverige AB
Östra Tullgatan 3
S-21128 **MALMÖ**
Tel: (040) 70270
Telex: (854) 17886 (via Spånga office)

Hewlett-Packard Sverige AB
Våstra Vintergatan 9
S-70344 **ÖREBRO**
Tel: (19) 10-48-80
Telex: (854) 17886 (via Spånga office)
CH

Hewlett-Packard Sverige AB
Skalholtsgatan 9, Kista
Box 19
S-16393 **SPÅNGA**
Tel: (08) 750-2000
Telex: (854) 17886
Telefax: (08) 7527781
A,CH,CM,CS,E,MS,P

Hewlett-Packard Sverige AB
Frötallisgatan 30
S-42132 **VÄSTRA-FRÖLUNDA**
Tel: (031) 49-09-50
Telex: (854) 17886 (via Spånga office)
CH,E,P

SWITZERLAND
Hewlett-Packard (Schweiz) AG
Clarastrasse 12
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Navigation Road
ALTRINCHAM
Cheshire WA14 1NU
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LONDON EC4V 6BS
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LONDON COLNEY
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Eskdale Rd.
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Telex: 848884
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Hewlett-Packard Co.
Suite A
708 North Argonne Road
SPOKANE, WA 99212
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West Virginia
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Tel: (414) 784-8800
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URUGUAY
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ZIMBABWE
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SALISBURY
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