CE-21 FREQUENCY SELECTIVE LEVELMETER

CUSHMAN ELECTRONICS, INC.

SERIAL NUMBERS 146 AND UP

CE-21 FREQUENCY SELECTIVE LEVELMETER

CUSHMAN ELECTRONICS, INC.
830 Stewart Dr.• Sunnyvale, CAl. 94086
Telephone Area Code 408—739-6760

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WARRANTY

CUSHMAN ELECTRONICS, INC. WARRANTS EACH OF THE INSTRUMENTS OF THEIR MANUFACTURE TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM THE DATE OF ORIGINAL PURCHASE. THE FOREGOING IS IN LIEU OF ANY OTHER WARRANTY, EXPRESS, IMPLIED OR STATUTORY. THE COMPANY, UNDER THEIR LIBERAL WARRANTY, WILL REPAIR OR REPLACE ANY INSTRUMENT FOUND DEFECTIVE.

THIS WARRANTY MAY NOT APPLY TO INSTRUMENTS WHICH, IN THE OPINION OF THE COMPANY, HAVE BEEN ALTERED OR MISUSED.

This manual is intended to give the user a comprehensive knowledge of the instrument and its operation or repair. In the event of trouble, study the manual carefully. Most instrument malfunctions can be corrected by the user with a minimum of lost usage time.

For assistance or information of any kind, contact the factory. Give full details of the nature of your problem and include the model and serial number of the instrument.

Should it appear that the instrument needs to be returned to the factory for service or recalibration, let us know. Shipping instructions will be promptly given to you. There will be no charge for repair on instruments within the one year warranty other than transportation costs after 90 days of ownership. Estimates of charges for non-warranty or any other service will be supplied by the factory upon request before work is begun and such work will be done on an actual cost basis only.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

* * * * * *

We sincerely pledge our immediate and fullest cooperation
to all users of our precision electronic instruments.

PLEASE ADVISE US IF WE CAN ASSIST YOU IN ANY MANNER

CUSHMAN ELECTRONICS, INC.
830 Stewart Dr. □ Sunnyvale, Cal. 94086 □ 408—739-6760

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INTRODUCTION

This manual presents operating and maintenance information for the CE-21 Frequency Selective Levelmeter, which is a component of Cushman Electronics' 1800-channel, Transmission Test System (TTS). A CE-22 Tracking Signal Generator, or a CE-26 Signal Generator, and a CE-23 Spectrum Display in combination with the CE-21 provides a complete end-to end send/receive and monitor system.

To facilitate reference to specific circuit detail and component descriptions in this manual, the paragraphs describing circuit operation, and pertinent schematics and parts lists are all marked with the same number, which is the circuit reference series number. Thus, those portions of the text, the schematics, and the parts lists relating to board 2500 are also marked "2500".

Related publications are:

CE-22 Tracking Signal Generator
Operation and Maintenance Manual

CE-23 Spectrum Display
Operation and Maintenance Manual

CE-26 Signal Generator
Operation and Maintenance Manual

Transmission Test System (TTS)
Operation and Maintenance Manual

SECTION 1
GENERAL INFORMATION

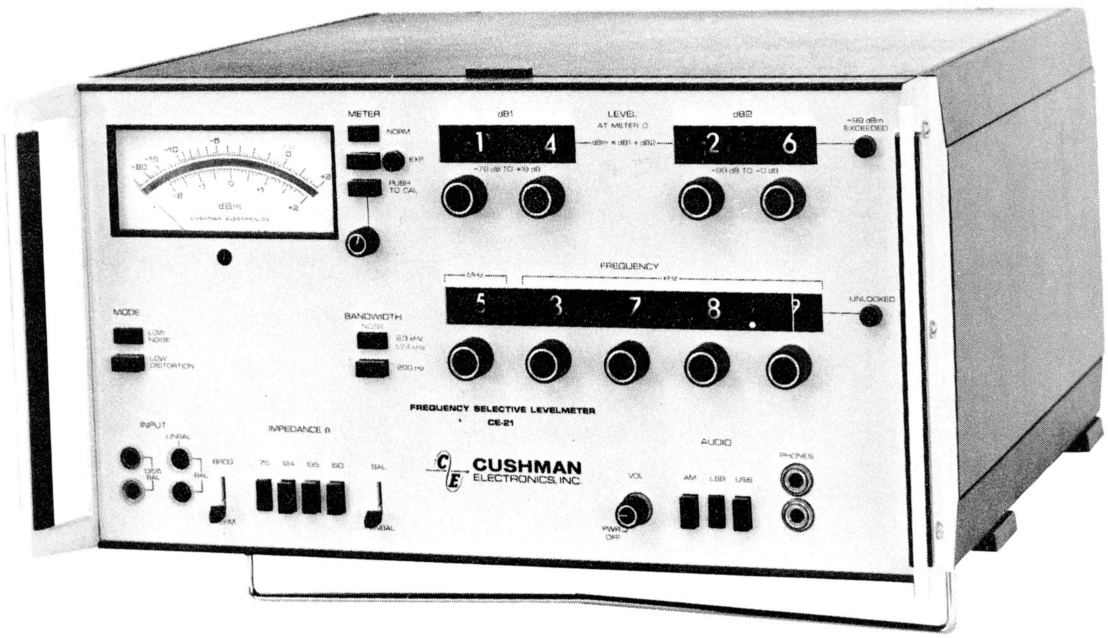


Figure 1-1 CE-21 Frequency Selective Levelmeter

1.1 Description

The CE-21 Frequency Selective Levelmeter is used to measure power levels of signals at up to 1800 voice-channel frequencies in telephone communications systems between 4 kHz and 9.1 MHz. (See figure 1-1.)

To tune the instrument, the frequency of the desired channel is dialed in on a lighted display with five frequency selectors, which have a resolution of 100 Hz.

Depending on whether the instrument is to be connected to a balanced or unbalanced line, the appropriate condition is selected with the BAL/UNBAL switch. The input to the CE-21 can be obtained by bridging the line or by providing termination appropriate to the line impedance. When the TERM/BRDG switch is placed in TERM, the input impedance can be selected with the four-pushbutton INPUT selector (75, 124, 135, or 150Ω). When the TERM/BRDG switch is in BRDG, the input impedance is 20kΩ for balanced lines and 10kΩ for unbalanced lines.

Calibration of the CE-21 is semi-automatic and is performed by pushing a single button which automatically switches the input circuit to 75Ω, provides an accurate-level (0 dBm) internally-generated calibration signal, presets the frequency of the 1st LO, and adjusts the attenuators for a 1 MHz, 0 dBm input. The meter is then manually set to zero which calibrates the instrument for all available input impedances at all signal frequencies within CE-21 range.

After calibration and with an input signal connected to the instrument, two front-panel level selectors are used to attain a zero reading on the meter. There are two displays so that one can be used to set the level of a signal with a certain frequency (for instance to the transmission level point of a pilot tone), while the other is used to establish the level of a second signal. The second level display will thus give a value that is relative to the level indicated on the first display. Either level display can be used to set the reference, and both have two knobs which permit level selection in 10-dB and 1-dB steps. The left display is labeled "dB1" and can be adjusted to read from -79 dB to +19 dB; the one on the right is labeled "dB2" and can be adjusted from -99 dB to -0 dB. As is indicated on the front panel between the two level displays, the measured level in dBm at meter zero (0) is the algebraic sum of the dB1 and dB2 readings. When this sum exceeds -99 dBm, a -99 dBm EXCEEDED light comes on to warn the operator that the range of the instrument is being exceeded.

Since it is inherently impossible to provide both lowest distortion and lowest noise level at the same time in any instrument, provision has been made for selection of either low-distortion or low-noise operation of the CE-21.

Meter readings can be taken from -20 dBm to +2 dBm, or, on an expanded scale, from -2 dBm to +2 dBm. When the expanded scale has been selected, the light adjacent to the meter switch is lit. When the meter -on either scale- indicates a reading other than zero, this reading must be added to the algebraic sum of dB1 and dB2, but the quantity indicated on the meter is not included in the -99 dBm that should not be exceeded. Thus, level measurements are possible from - 119dBm (meter reading = -20 dBm, dB1 + dB2 = -99 dBm) to +21 dBm (meter reading = +2 dBm, dB1 + dB2 = +19 dBm).

The BANDWIDTH (NOISE) selector provides a choice of narrow (200 Hz) bandwidth for separation and level readings of suppressed carriers and pilot tones, or wide (2.3 kHz) bandwidth for noise readings. When the broad bandwidth is selected, audio signals can be monitored over the built-in speaker. The audio selector lets the operator select AM, lower sideband (LSB), or upper sideband (USB). A volume control is also provided.

On the front panel, under BANDWIDTH, the word NOISE appears in blue, and, under "2.3 kHz", "1.74 kHz" is shown, also in blue. The two numbers relate the bandpass of the CE-21 to the concept of Equivalent Noise Bandwidth and the C-message-weighted curve.

As is common knowledge in the telephone industry, the C-message-weighted (Cmw) curve represents the response curve of all telephone handsets used in the United States.

The concept "Equivalent Noise Bandwidth" refers to a perfectly rectangular curve which bounds an area equal to the area bounded by a Cmw curve. It has been shown that when the area bounded by a Cmw curve is found by graphic integration, the result is approximately equal to an area bounded by a curve with a uniform width of 1.74 kHz. It is now almost universally accepted that any bandpass represented by a curve which bounds an area equal to that bound by a 1.74 kHz rectangular curve permits noise measurements that are, for all practical purposes, the same as would be obtained with a bandpass curve identical to the Cmw curve. Thus, when, on the front panel of the CE-21, the broad bandwidth is specified as "2.3kHz, 1.74 kHz", the CE-21 bandpass curve is 2.3 kHz wide at the -3 dB points, and the area bounded by this curve approximately equals the area bounded by a 1.74-kHz-wide rectangular curve.

A commonly used measurement unit for noise is dBrnC (dB referred to noise, C-message weighted), where 0 dBrnC = -90 dBm. When measuring noise levels with the CE-21, a reading in dBrnC measurement units can be obtained by adding 90 to the dBm reading.

By using the CE-22 Tracking Signal Generator in conjunction with the CE-21, frequency tests can be made on transmission lines or circuits of telecommunications systems. The CE-22 provides a stable signal source the frequency of which is controlled by the CE-21. Thus, the CE-22 tracks exactly; it contains an automatic level control, and it provides the capability of presetting its signal level from -70 dBm to +10 dBm, with a resolution of .01 dB.

Another companion unit for the CE-21 is the CE-23 Spectrum Display, which provides simultaneous high-resolution displays of signals that are being measured with the CE-21. In addition, there is also available the CE-26 Signal Generator, which has all the features of the CE-22 Tracking Signal Generator, with the additional capability of generating its own signal. The Frequency Synthesizer used in the CE-26 is virtually identical to the one used in the CE-21. In contrast to the CE-22 and the CE-23, which must be used with the CE-21, the CE-26 can be used independently.

The specifications for the CE-21 are presented in table 1-1.

1.2 Accessories

A BNC to coaxial adapter (Cushman P/N 2532-0001) and a power cord (Cushman P/N 3170-0006) are supplied as accessories with the frequency selective levelmeter.

Table 1-1 Specifications

FREQUENCY	
Range	10 kHz to 9.1 MHz
Digital Resolution	1 kHz
Calibrated Range of Continuous Interpolation	1.1 kHz
Resolution of Interpolation	25 Hz
Stability	≤300 Hz from 0°C to +50°C
Aging	≤150 Hz per year
LEVEL	
Range, referred to 0 dBm on Meter	
10 kHz to 650 kHz	-99 dBm to +19 dBm
650 kHz to 9.1 MHz	-99 dBm to 0 dBm
Accuracy	
1 MHz -0 dBm, 75Ω	
25°C ±10°C	±0.1 dB
25°C ±25°C, additional	±0.1 dB
Frequency response referred to 1 MHz, 75Ω	
60 kHz to 8.5 MHz.	±0.2 dB
10 kHz to 60 kHz, 8.5 MHz to 9.1 MHz, additional	±0.1 dB
Attenuator referred to 0 dBm	±0.25 dB
Control	1 dB and 10 dB steps
Meter Range	
Normal	-20 dBm to +2 dBm
Expanded	-2 dBm to +2 dBm
Resolution	0.05 dBm
INPUT IMPEDANCE	
Unbalanced	75, 124, 135, 150Ω, and 10kΩ shunted by approximately 30 pf
Balanced	75, 124, 135, 150Ω, and 20kΩ shunted by approximately 18 pf
INPUT DC RATING	Each input to ground ±400 volts BRiDginG mode only. Do not apply to TERMinating mode.
INPUT COMMON MODE REJECTION (BALANCED INPUT)	≥30 dB

Table 1-1 Specifications (continued)

BANDWIDTH	
Broad	
3 dB	2.3 kHz ±10%
60 dB	≤ 5.0 kHz
Equivalent Noise	1.74 kHz ±10%
Narrow	
3 dB	200 Hz ±10%
60 dB	≤ 800 Hz
INTERNAL DISTORTION ATTENUATION ("LOW DISTORTION")	
Harmonic	
For 60 dB sensitivity increase, 300 kHz to 9 MHz	≥70 dB
For 50 dB sensitivity increase, 60 kHz to 300 kHz	≥65 dB
Noise Power Ratio (Typical)	
(Equivalent 600 channel system with stop band slot at 2.438 MHz or 70 kHz)	
For 40 dB sensitivity increase	≥55 dB
INTERMEDIATE FREQUENCIES	
I.F. 1	12 MHz
I.F. 2	80 kHz
I.F. REJECTION (I.F. AND/OR I.F. 2)	≥70 dB
IMAGE FREQUENCY REJECTION (24 MHz to 33.1 MHz)	≥65 dB
OUTPUTS, NOMINAL, AT METER ZERO	
Phones (Phone Jack)	
Output Impedance	8Ω
Audio Speaker Power	1 Watt
DC Recorder (BNC)	
Output Impedance	1KΩ
Output Open Circuit Voltage, DC	-790 mV

Table 1-1 Specifications (continued)

Spectrum Display	
80 kHz Out (BNC)	
Output Impedance	600Ω
Voltage	800μV (600Ω)
L. O. In/Out (BNC)	
Impedance	50Ω
Voltage	1.5V, p-p (50Ω)
Tracking Generator	
1st L. O. Out (BNC)	
Output Impedance	50Ω
Voltage	50 mV (50Ω)
2nd L.O. Out (BNC)	
Output Impedance	50Ω
Voltage	10 mV (50Ω)
12 MHz Out (BNC)	
Output Impedance	50Ω
Voltage	1 mV (50Ω)
OPERATING TEMPERATURE RANGE	0°C to 50°C
STORAGE TEMPERATURE RANGE	-40°C to +65°C
POWER REQUIREMENT	117/230V ±10%, 50-400 Hz, 50 Watts
SIZE	9 1/4" h x 17 1/4" w x 18 1/4" d
WEIGHT	28 pounds

SECTION 2
INSTALLATION

2.1 Unpacking and Inspection

When unpacking the CE-21 Frequency Selective Levelmeter, inspect the packing box and the instrument for signs of possible damage. Verify satisfactory performance as outlined in the operating instructions (Section 3) of this manual. If the instrument is damaged, fails to operate properly, or if any of the accessories is missing, file a claim with the transportation agency, or, if insured separately, with the insurance company.

2.2 Installation Procedures

2.2.1 Power Requirements

The CE-21 operates from a 117- or 230-volt (±10%) AC source, 50 to 400 Hz. Power consumption is 49 va. A 3-amp slo-blo fuse in the CE-21 provides protection (1-1/2 amp for 230V operation). When the auxiliary instruments (CE-22, CE-23, CE-26) are used, these units obtain their power through the CE-21.

2.2.2 Grounding Requirements

The CE-21 is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. To preserve this protection when operating the instrument from a two-wire outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2.2.3 Warm-up Requirements

Allow the instrument to warm-up for approximately 30 minutes. This warm-up time is required to stabilize instrument gain. The calibration amplifier, however, does not need this warm-up time, and, the CE-21 can be calibrated immediately.

2.2.4 Conversion to Rack Mount

The CE-21 can be mounted in a standard 19-inch equipment rack. The hardware required for converting the CE-21 from cabinet to rack mount is not supplied with the instrument but is available upon request. If the CE-21 is to be converted for rack mounting, obtain the necessary kit from Cushman Electronics, and proceed as follows:

a. Remove the three screws in each handle.

b. Install the L-shaped brackets with the mounting lip forward; use the previously removed screws and attach to the handles.

c. Carefully slide the instrument into equipment rack and secure with screws provided.

2.3 Preparation for Reshipment

It is recommended that the shipping box and foam packaging be kept in case it becomes necessary to return the instrument to the service point or factory for service or repair.

The following paragraphs contain a general guide for repackaging of the instrument for shipment.

NOTE

If the instrument is to be shipped, attach a tag to the instrument identifying the owner, and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In correspondence, identify the instrument by model number, serial number, and part number.

If the original container is to be used, proceed as follows:

a. Place the instrument in the original

container. (If the original container is not available, one can be purchased from Cushman Electronics.)

b. Ensure that the container is well sealed with strong tape or metal bands.

If the original container is not used, proceed as follows:

a. Wrap the instrument in plastic or heavy paper before placing in an inner container.

b. Place packing material around all sides of the instrument.

c. Place the instrument and inner container in a heavy carton or wood box, and seal with strong tape or metal bands.

d. Mark the shipping container: "DELICATE ELECTRONIC INSTRUMENT," "FRAGILE."

2.4 Service or Repair

In the event service or repair is required, contact:

Cushman Electronics, Inc.
Customer Service Department
830 Stewart Drive
Sunnyvale, California 94086
Area Code: 408
Telephone: 739-6760

The service point for the CE-21 in the southeastern U.S. is:

BCS Associates, Inc.
940 North Fern Avenue
Orlando, Florida 32803
Area Code: 305
Telephone: 843-1510

SECTION 3
OPERATING INSTRUCTIONS

3.1 Controls and Indicators

The locations of front and rear panel controls and indicators are illustrated in figures 3-1 and 3-2. These elements are listed and briefly described in table 3-1.

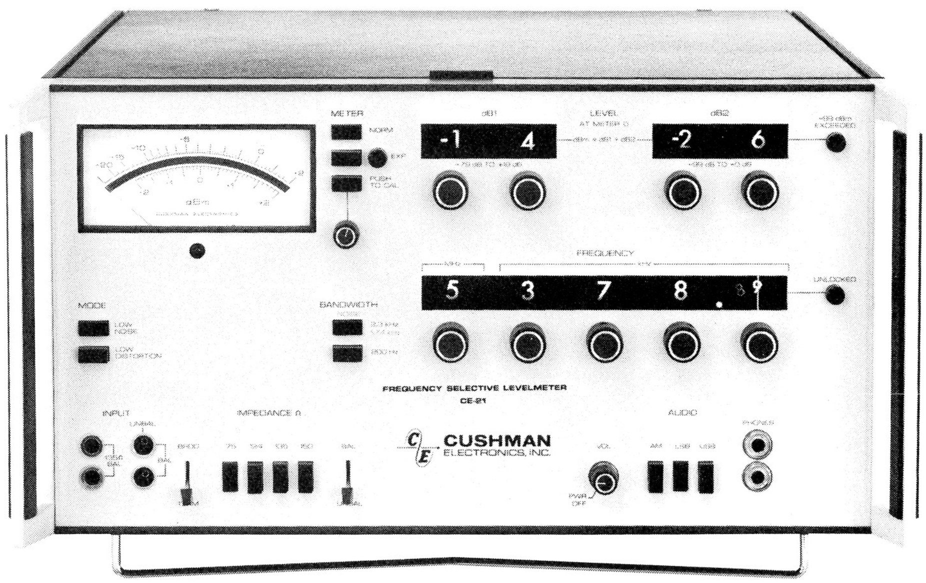


Figure 3-1 Front Panel Controls and Indicators

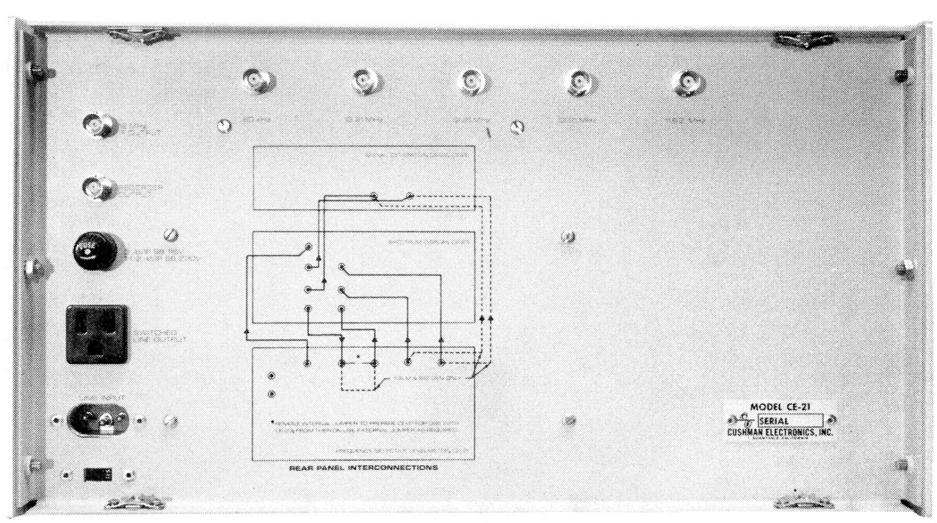


Figure 3-2 Rear Panel Controls and Indicators

Table 3-1 Controls and Indicators

NAME/PANEL DESIGNATION	REF. DESIG	TYPE	PURPOSE
		FRONT PANEL	
METER	M1001	Meter	Indicate signal level with ±0.1-dB resolution. Meter scale is calibrated from -20 dBm to +2 dBm and from -2 dBm to +2 dBm. As indicated by two blue "CAL" markings, meter may be adjusted in either normal or extended range.
Meter range selector NORM/EXP	S1004	Two-pushbutton, mechanically-interlocked switch	Select appropriate meter scale.
EXP	DS1002	Indicator lamp	Lights when expanded meter scale is selected.
PUSH TO CAL	S1005	Pushbutton switch	Calibrate the CE-21. Must be depressed for "on" and depressed again for "off."
Cal adjust	R1005	Potentiometer	Adjust gain of meter circuits so that meter reads 0 dBm (on both scales) when calibrating signal is (automatically) applied to RF stages.
LOW NOISE/LOW DISTORTION	S1001	Two-pushbutton, mechanically-interlocked switch	Provide a logic input to attenuator logic, which switches 10 dB of attenuation from RF stages to 2nd IF stages when low noise is primary signal-to-noise requirement.
BANDWIDTH (NOISE) 2.3 kHz (1.74 kHz)/ 200 Hz	S1006	Two-pushbutton, mechanically-interlocked switch	Select bandwidth for separation and level readings of suppressed carriers and pilot tones (200 Hz) or for noise readings (2.3 kHz). The numbers 2.3 kHz and (1.74 kHz) signify that overall bandwidth of CE-21 (2.3 kHz) provides same noise level measurements as C-message weighting instruments. Figure in blue (1.74 kHz) is called equivalent-noise bandwidth.
INPUT 135 BAL	J1001/ J1002	Dual jack	Accommodate a standard 135Ω balanced-line connector. S1002 must be in TERM position; S1007 must be in BAL position; and 135Ω INPUT selector button must be depressed. This jack is disconnected when any other type input is selected.
INPUT UNBAL/BAL	J1003/ J1004	Jacks	To be used as a dual jack for balanced inputs; J1003 used singly provides for unbalanced inputs. These jacks are used for all types of input except from a 135Ω balanced line.

Table 3-1 Controls and Indicators (continued)

NAME/PANEL DESIGNATION	REF. DESIG.	TYPE	PURPOSE
		FRONT PANEL	
BRDG/TERM	S1002	Lever switch	Permit selection of either a BRiDginG or TERMinating type input. In TERM, 75Ω, 124Ω, 135Ω, or 150Ω INPUT selector button must be depressed.
IMPEDANCE Ω 75, 124, 135, 150	S1003	Four-pushbutton, mechanically-interlocked switch	Provide termination indicated by ohm quantities associated with pushbuttons.
BAL/UNBAL	S1007	Lever switch	Permit selection of either BALanced or UNBALanced type input.
dB1 dB2	S1008/ S1010 S1015/ S1018	Rotary switches	Select desired signal level in 10-dB and 1-dB steps. One level display is used to set a reference and the other is used to set level of a second signal. Value of second level display is relative to level indicated on reference display. Either display can be used to set the reference.
-99 dBm EXCEEDED	DS1010	Indicator lamp	Lights when readings of dB1 and dB2 lighted displays numerically total more than -99 dBm. (-100, -101, etc.).
FREQUENCY MHz/kHz	S1009/ S1011/ S1013/ S1016	Rotary switches	Select first four digits of frequency value to be monitored.
FREQUENCY kHz	R1009	Potentiometer	Select fifth (100-Hz) digit of frequency value to be monitored.
UNLOCKED	DS1011	Indicator lamp	Lights if phase-locked loop of frequency synthesizer becomes unlocked.
AUDIO			
VOL	R1008	Potentiometer	Vary audio level reproduced by speaker or headphones.
PWR OFF	S1014		Apply or remove AC power to CE-21.
AM/LSB/USB	S1017	Three-pushbutton, mechanically-interlocked switch	Permit selection of AM, lower sideband, or upper sideband of signal to be monitored.
PHONES	J1005/ J1006	Phone jacks	Spaced and connected such that standard dual phone plug or single phone plug can be used. Speaker is disconnected when either or both jacks are used.

Table 3-1 Controls and Indicators (continued)

NAME/PANEL DESIGNATION	REF. DESIG.	TYPE	PURPOSE
REAR PANEL			
12 MHz IF OUTPUT	J4001	Jack	Accommodate BNC connector. Used for monitoring 1st IF signal levels.
80 kHz	J4005	Jack	Accommodate BNC connector. Used to make 80-kHz signal available to CE-23 Spectrum Display.
12-21 MHz	J4006	Jack	Accommodate BNC connector. Used to make 12-21-MHz LO available to CE-23 Spectrum Display.
12-21 MHz	J4007	Jack	Accommodate BNC connector. Used to make 12-21-MHz LO available to CE-23 Spectrum Display.
12-21 MHz	J4008	Jack	Accommodate BNC connector. Used to make 12-21-MHz LO available to CE-22 Tracking Signal Generator or to CE-26 Signal Generator.
11.92 MHz	J4009	Jack	Accommodate BNC connector. Used to make 11.92-MHz LO available to CE-22 Tracking Signal Generator or to CE-26 Signal Generator.
RECORDER OUTPUT	J4002	Jack	Accommodate BNC connector. Used for recording of level display.
3 AMP SB 115V 1-1/2 AMP SB 230V	F4001	Fuse	Provide overcurrent protection for 115V or 230V operation.
SWITCHED LINE OUTPUT	J4003	Jack	Provide line power to auxiliary equipment.
LINE INPUT	J4004	Jack	Connector for cord to 115/230V AC power source.
115/230V SWITCH	S4001	Slide switch	Enable selection of either 115V or 230V AC power source.

3.2 Operation

3.2.1 Turn-On

a. At the CE-21 rear panel:

   1. Check the setting of the 115/230V switch, and place in appropriate position.

   2. Connect the power cord to a 115/230V AC, 50-400 Hz power source.

b. At the CE-21 front panel, turn the AUDIO VOL control clockwise out of the PWR OFF position.

c. To stabilize instrument gain, allow 10 to 30 minutes warm-up time, depending on whether the instrument has been stored below normal room temperatures.

3.2.2. Calibration

a. Depress the PUSH TO CAL button. The LEVEL and FREQUENCY readouts are now darkened except that portion of the frequency display associated with the 100-Hz frequency control. Simultaneously, an internally-generated signal is applied to the RF stages, and the attenuators and frequency are preset to permit zeroing the meter.

b. Depress the LOW NOISE button of the MODE switch, the 200 Hz BANDWIDTH button and the METER EXP button.

c. Looking at the meter, rotate the 100-Hz indicator knob until a peak reading is obtained. The 100 Hz indication on the dial should not be greater than ±150 Hz from 0.

d. Zero the meter by adjusting the control below the PUSH TO CAL button for 0 dB ±0.1 dB reading on the EXP meter scale.

e. Depress the METER NORM button; the reading on the upper meter scale should be 0 dB ±0.1 dB. If reading falls outside these limits, make the adjustment described in para. 5.3.7.1.

f. Depress the 2.3 kHz BANDWIDTH button. The meter reading should be 0 dB ±0.1 dB. (If the reading is incorrect make the adjustment as described in para. 5.3.6.

g. Depress the LOW DISTORTION button of the MODE switch. The reading should remain at 0 dB ±0.1 dB.

h. Depress the LOW NOISE button on the MODE switch and the PUSH TO CAL button on the METER switch to release it. Instrument is now in normal condition and calibration is complete.

3.2.3 Operation for Signal Level Measurements

a. Select the proper input conditions by:

   1. Depressing the appropriately marked IMPEDANCE button.

   2. Selecting a TERMinating or a BRiDginG connection.

   3. Selecting a BALanced or an UNBALanced condition.

NOTE

The meter reads dBm in either the TERM or BRDG mode in any of the selectable input impedances, as long as the instrument is properly connected to the circuit.

b. Select the desired BANDWIDTH (2.3 kHz or 200 Hz).

c. Using a patch cord, connect the proper input connector(s) to the line on which tests are to be made.

d. Set the dB1 or dB2 LEVEL controls to indicate the expected level of the signal to be monitored. To compare the levels of two signals or to establish the level of a signal relative to a reference level (transmission level point), use both sets of LEVEL controls as follows:

1. Dial in the dB1 (or dB2) LEVEL to the level of the first signal or of the reference level.

2. Use the dB2 (or dB1) LEVEL to establish the level of the (2nd) signal with respect to the dB1 (or dB2) LEVEL reading.

NOTE

The absolute level of the input signal is the algebraic sum of both readings and should not exceed -99 dBm.

e. Select the LOW NOISE or LOW DISTORTION mode.

NOTE

In the LOW NOISE mode 20 dB of attenuation is switched out of the input circuit and 20 dB attenuation is switched into the IF to give the best signal to noise ratio for use as a Frequency Selective Levelmeter. In the LOW DISTORTION mode the attenuation is switched into the input and a like amount switched out of the IF to reduce the signal to the first mixer, decreasing the possibility of distortion due to overloading from adjacent channels. This applies to attenuator settings above -79 dB. Below this level, since the instrument maximum sensitivity is approached and the 20 dB IF attenuator can no longer be used, the same reading is obtained in either mode. The meter reads correctly in either mode if the first mixer is not overloaded.

f. Dial in the frequency of the signal to be monitored. The fifth frequency selector (100-Hz control) permits tuning over a 1-kHz range and hence peaking on a specific frequency with a resolution of ±25 Hz.

g. The audio signal can be monitored over the speaker or the earphones by depressing the appropriate AUDIO button, AM, LSB or USB. The volume of the audio signal at the speaker or the phone jack is controlled by the VOL control. If it is desired to disconnect the speaker, and phone jack, one of the AUDIO buttons may be depressed slightly until they all come out to the off position.

NOTE

The wider of the two BANDWIDTHS must be used to understand the intelligence of the demodulated signal. The information at the phone jack or the speaker is only that which is contained in the bandwidth selected with the BANDWIDTH control.

3.2.4 Operation for Noise Level Measurements

a. Repeat step 3.2.3-a.

b. Depress the 2.3 kHz (1.74 kHz) BANDWIDTH switch.

c. Repeat steps 3.2.3-c through f.

d. To obtain a noise level reading in dBrnC noise measurement units, add 90 to the dBm reading.

EXAMPLE

Since 0 dBrnC = -90 dBm, a dB1 LEVEL display reading of -25 dBm can be converted to noise level reading of -25 dBm +90 = +65 dBrnC. If the -25 dBm setting is left undisturbed and the level of a second signal is set on the dB2 LEVEL display to -60 dBm at meter zero, the second reading is 60 dB below the first, or -85 dBm. The noise level measurement for the second LEVEL reading would, therefore, be -85 dBm +90 = +5 dBrnC.

OPERATIONAL NOTE

In case it is desirable to disconnect the meter so that it will not be continually pinned, as in using the CE-21 with the CE-23, depress one of the METER switch buttons slightly until all the switches come out into the off position.

SECTION 4
THEORY OF OPERATION

The following functional description is keyed to the overall block diagram illustrated in figure 4-1. The circuit description is keyed to the schematic diagrams of the instrument's 18 printed circuit boards.

4.1 Functional Description

The purpose of the CE-21 is to measure the level of any signal with a frequency between 4 kHz and 9.1 MHz, a range that encompasses 1800 telephone voice channels. The overall block diagram shows the interconnection of the various circuit elements and indicates the signal flow through them.

On the overall block diagram, the circuit path is across the top of the diagram, beginning at the input jacks, where the signal of interest is received, and ending at the meter, which, when registering 0, indicates to the operator that the reading displayed above the dB1 and dB2 level selectors represents the level of the incoming signal. In the figure, a level of -32 dBm is shown (-12 dB + (-20) dB), at a frequency of 3456.5 kHz. The quantities -12 dB and -20 dB are shown under the level selectors S1008, S1010, S1015, and S1018, depicted left of center in the figure. The first four digits and the decimal point (3456.) are shown in the lower left hand corner (black numerals) and the last digit (5), the one after the decimal point, is shown to the right of center.

As has been mentioned, the signal flow from input to meter is shown in the upper part of the figure. A closer look will reveal that the elements in this signal path roughly correspond to those found in any superheterodyned radio receiver. The notable difference is that there are two local oscillators and two mixers and hence two intermediate frequencies.

The first local oscillator is the frequency synthesizer, consisting of the circuits on boards 2100, 2300, and 2400. The second local oscillator is the voltage controlled crystal oscillator (VCXO) circuit on board 3700. The white numerals below the black ones representing the first four digits of the dialed-in frequency, indicate the frequency which the first oscillator (frequency synthesizer) must provide to keep the first IF signal out of the first mixer (3100) at approximately 12 MHz. The second set of white numerals, above the black, indicate the state to which the counter flip-flops (decades) must be preset to produce the first LO frequency.

The second local oscillator provides a signal with a frequency which, when mixed with the approximately 12-MHz first IF, will provide a second IF of 80 kHz. The exact frequency at which the VCXO oscillates is set by means of R1009. This potentiometer is associated with a dial marked from .0 to .9 kHz, with a resolution of .025 kHz. The meter reads zero only when the second IF is exactly 80 kHz. Adjustment of R1009 such that the meter does read zero tunes the instrument to the exact frequency of the incoming signal. As depicted in the block diagram, this frequency is 3456.5 kHz.

4.2 Circuit Description

4.2.1 Input Selection 1000,1100

The IMPEDANCE selector (S1003) on the front panel provides selection of 75Ω, 124Ω, 135Ω, or 150Ω termination impedances when the appropriate button is depressed. These terminations are effective when the BRDG/TERM switch (S1002) is in the TERM position. In BRDG, the input impedance is either 10kΩ or 20kΩ, depending on the position of the BAL/UNBAL switch (S1007). In the UNBAL position, the input is 10kΩ, shunted by approximately 30 pF; in the BAL position, the input is 20kΩ, shunted by approximately 18 pF.

The selector assembly consists of four

ganged pushbutton switches mounted directly on a printed circuit board (1100), with traces that interconnect the various switch segments and the terminating resistors. (See drawing 1100.) In addition to selecting input-termination impedances, the selector assembly also provides an energizing voltage to one of three relays in the 2nd-IF amplifier circuit when a 124Ω, a 135Ω, or a 150Ω input impedance is selected (via P2501-7, -8, and -9), to set the gain for true dBm readings.

The interconnections are such that dual input phone jacks, J1001/J1002, are usable only when the 135Ω pushbutton is depressed. When this condition prevails, R1102 is the terminating resistor. (Drawing 1100). When the 75Ω, the 124Ω, or the 150Ω buttons are depressed, resistors R1104, R1103, R1101, furnish the proper termination. On the referenced drawing, the return line for the terminating resistor is shown as a floating ground. This ground is only floating with respect to the front panel; chassis ground is applied through the shields of the coaxial cables that carry RF inputs 1 and 2 to the RF assembly (J3002 and J3008).

4.2.2 Hi-Z Attenuators No. 1 and No. 2 **3900,3500**

The two Hi-Z attenuators are identical, each consisting of two 40-dB, one 10-dB, and one 20-dB attenuator circuits. All attenuator circuits are alike except for component values, and each is always in the signal path unless the associated relay is energized. Which relays are energized depends on the attenuator logic set by the dB1 attenuator selectors (S1008 and S1010).

Both Hi-Z attenuators are used when a balanced input is chosen (with S1007), but when an unbalanced input has been selected, Hi-Z attenuator no. 2 does not receive any signal and, therefore, has no effect.

4.2.3 Attenuator Control Logic **2700**

The attenuator control logic circuits are actuated by the dB1 and the dB2 LEVEL selectors. When, for a given input signal, these selectors are adjusted for a 0-dBm reading on the meter, the indicated total of the two LEVEL displays represents the level of the input signal at the dialed-in frequency (dB1 + dB2 = dBm, at meter 0).

The logic circuits process control signals from the LEVEL selectors and from the MODE selector switch as well as from the PUSH TO CAL switch.

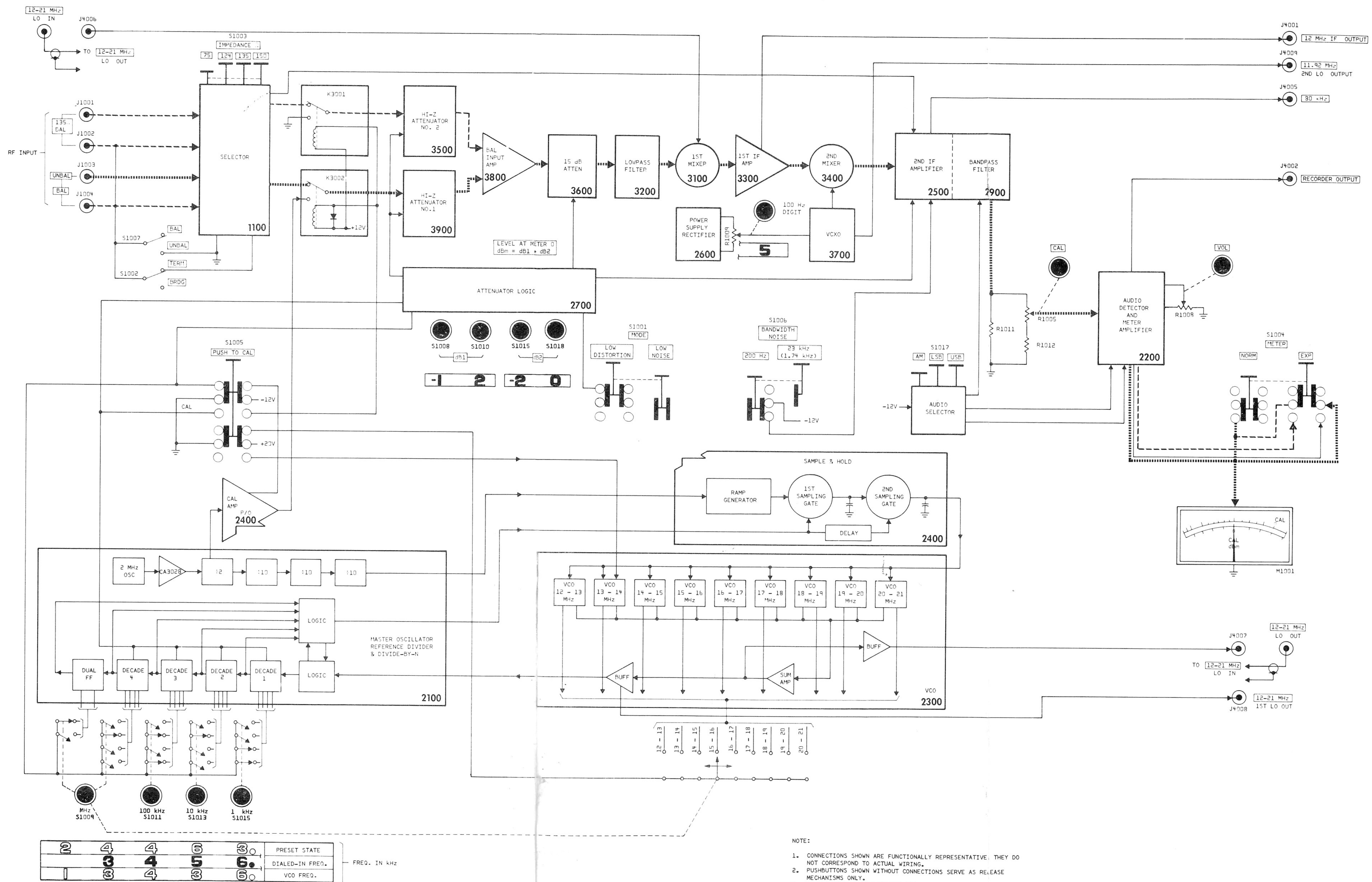
The CE-21 is designed such that with all available attenuation <u>in</u> the signal path, a signal with a level of +19 dBm will cause a 0-dBm meter reading. With all the removable attenuation <u>removed</u> from the signal path, a signal with a level of -99 dBm will cause a zero meter reading.

When CALibrating, the input to the logic circuits has the same effect as when both LEVEL selectors have been adjusted for 0 dBm. When the LOW NOISE mode is selected, the logic circuits cause 10-dB attenuation to be removed out of the RF stages and cause this attenuation to be inserted in the 2nd IF stages. Thus, the correct <u>total</u> amount of attenuation is still in the signal path, but a portion (10 dB) is applied in later stages.

As has been mentioned in paragraph 4.02.02 the Hi-Z attenuators consist of individual circuits that provide 10, 20, 40, and again 40 dB of attenuation. The 15-dB attenuator consists of similar circuits that provide 1, 2, 4, and 8 dB of attenuation. The outputs of the attenuator logic circuits deenergize relays associated with the Hi-Z and the 15-dB attenuators as necessary to remove attenuation from out of the signal path. By deenergizing relays such that correct combinations of attenuator circuits are no longer in the signal path, 118 dB of attenuation can be removed in 1-dB increments.

The lighted displays associated with the dB1 and dB2 level selectors are calibrated as shown in table 4-1 below.

The dB1 level selectors can be adjusted so that the dB1 display reads from +19 to -79 dBm and the dB2 level selectors so



NOTE:

1. CONNECTIONS SHOWN ARE FUNCTIONALLY REPRESENTATIVE. THEY DO NOT CORRESPOND TO ACTUAL WIRING.
2. PUSHBUTTONS SHOWN WITHOUT CONNECTIONS SERVE AS RELEASE MECHANISMS ONLY.
3. ▪▪▪▪▪▪ SIGNIFIES MAIN SIGNAL FLOW.
4. — — SIGNIFIES ALTERNATE OR CONCURRENT SIGNAL FLOW.

Figure 4-1 CE-21, Overall Block Diagram

Table 4-1 Level Selector Displays

REFERENCE		RELATIVE	
Tens	Ones	Tens	Ones
+1	0	-	0
+	1	-1	1
-	2	-2	2
-1	3	-3	3
-2	4	-4	4
-3	5	-5	5
-4	6	-6	6
-5	7	-7	7
-6	8	-8	8
-7	9	-9	9

that the dB2 display reads from -0 to -99 dBm.

Two sets of level selectors have been provided to permit determining how far below the level of a given signal is the level of a second signal.

Thus, when the dB1 display shows the first signal to have a level of -25 dBm (with dB2 at 0), for example, and the instrument is then tuned to the frequency of a second signal without disturing the -25 dBm setting, the level of the second signal can be determined with the dB2 level selector (this presumes, of course, that the second signal has a lower level). If the meter reads zero with -60 dBm shown on the dB2 display, this means that the second-signal level is 60 dB below the first-signal level and that the level of the second signal is therefore -85 dBm.

NOTE

The dB2 level selectors may be used to establish the reference level and the dB1 to measure the relative level.

When all the removable attenuation (118 dB) is out of the signal path, a signal of -99 dBm will cause a zero meter reading. (There is 1 dB left in the signal path that is not removable.) Therefore, when the incoming signal has a level of -25 dBm, the attenuator logic has caused 44 dB of attenuation to be removed out of the signal path, leaving 75 dB still in the circuit. When the second signal now proves to be 60 dB below the first, at a level of -85 dBm, an additional 60 dB of attenuation has been removed from the signal path, leaving 15 dB still in the circuit. A signal with a level of -99 dBm requires that all removable attenuation be removed to cause a zero meter reading.

It is possible to manipulate the four level selectors to obtain a dB1 reading of -79 dBm and a dB2 reading of -99 dBm, simultaneously. This would seem to indicate that a signal with a -178 dBm level can be measured. This is not so; the limit of the instrument's sensitivity is -99 dBm, and all lower dial readings (with zero meter reading) are meaningless. This condition is indicated when the -99 dBm EXCEEDED light is on.

NOTE

> In this context, -99 dBm is considered to be exceeded when, for instance a quantity of -100 dBm is indicated.

It is, however, possible to read a signal level as low as -119 dBm by using the meter calibrations in conjunction with the lighted displays. The normal meter scale is calibrated to -20 dBm so that, when dB1 + dB2 = -99 dBm and the meter indicates -15 dBm, the level of the incoming signal would be -114 dBm. It follows, then, that,using the normal meter scale, measurements are possible down to -119 dBm and,using the expanded meter scale, down to -101 dBm.

The logic circuits shown in drawing 2700 consist of integrated circuits used as adders, inverters, and samplers; two-transistor drivers; a single-transistor lamp driver; a dual-diode gate; and two single-transistor inverters. The inputs from the LEVEL selectors, MODE switch and PUSH-TO-CAL switch are either high (5V) or low (0V), corresponding to binary states 1 or 0.

Integrated circuit IC2701, accepts the inputs of level selector S1008, dB1 tens, and S1015, dB2 tens, and, in the calibrate mode the input from S1005, the PUSH TO CAL switch.

Integrated circuit IC2702 is a full adder that accepts the input of S1010, dB1 ones, and works in conjunction with IC2703, IC2706, and IC2707, which are inverters that permit differentiation between plus values (+ . . . dialed in) and minus values (- . . . dialed in).

Part of IC2704 samples the output of the two Hi-Z attenuators and energizes the relays of both 40-dB attenuators (in each of the attenuators) when 80 dB of attenuation must be removed. The other part of IC2704, in conjunction with IC2705, receives from the MODE switch (S1001) a control signal that determines whether a 10-dB amount of attenuation is to be applied in the RF stages or in the second IF stages. (Placement of this attenuation in the signal path is dependent on whether low noise or low distortion is desired.) Integrated circuit IC2708 subsequently energizes the proper driver circuit to apply the 10-dB attenuation where it is needed.

Integrated circuit IC2709 adds a numerical offset to the logic output. Inverters IC2710, Q2701, Q2702, and Q2722 similarly answer logic-signal requirements that at certain points in the circuit demand an inverted signal.

Diodes CR2715 and CR2716 form a gate that is activated when dB1 + dB2 exceeds -99 dBm. When this condition exists, Q2707 conducts and provides a ground for the -99 dBm EXCEEDED light (DS1010).

Diodes CR2717 and CR2718 are connected as a voltage-dropping device (5V to 3.5V) that compensates for the fact that the outputs of various IC's to the drivers do not quite come up to 5 volts.

4.2.4 Balanced Input Amplifier **3800**

The balanced input amplifier consists of two identical channel amplifiers, Q3801/Q3803 and associated components, and Q3802/Q3804 and associated components. The input signals at Q3801 and Q3802 are amplified and combined. The combiner circuit, (Q3805, Q3806, and associated components) is designed such that when two signals are out of phase, the amplitude of the combined signal is the difference between the amplitudes of the two incoming signals. A characteristic of the balanced input amplifier is the occurrence of common mode rejection which is optimized by use of C3824. Most of the distortion occurring in the CE-21 originates in the balanced input amplifier. To minimize this distortion, potentiometer R3824 can be adjusted to vary the operating point (DC level) of the combiner.

Capacitors C3806 and C3807 are used

to flatten the response of each channel amplifier individually. Potentiometer R3813 makes it possible to adjust the gain of one of the channel amplifiers to conform to the gain of the other, thus ensuring that the effect of the two channel amplifiers is indeed identical.

The single output leaves the board at WT3805 and is directed to the 15-dB attenuator.

4.2.5 15-dB Attenuator **3600**

As indicated in drawing 3600, the 15-dB attenuator consists of four pads that can be switched in and out of the signal path, attenuating the signal by 1 dB, 2 dB, 4 dB, or 8 dB. The Hi-Z attenuators are designed such that attenuation can be removed in 10-dB increments; the 15-dB attenuator used in conjunction with the Hi-Z attenuators makes it possible to remove all removable attenuation in 1-dB steps.

With values of 1, 2, 4, and 8 dB for separate pads, up to 15 dB of attenuation can be placed in the signal path. Since there is only a 119-dB spread between the maximum and minimum acceptable signal levels (+19 dBm and -99 dBm) the 15-dB attenuator needs only to contribute a total of 9 dB to the total of 110 dB of attenuation that the Hi-Z attenuators are able to provide. In addition, the 15-dB attenuator only needs a range of from 0 dB to 9 dB to reduce the 10-dB increments to 1-dB increments.

Because the 15-dB attenuator is used only as a 9-dB attenuator, the logic necessary to apply and remove attenuation can be simplified.

The CE-21 is designed such that 1 dB of attenuation is always left in the circuit path. The 1 dB of attenuation permits "minus" and "plus" dBm readings.

4.2.6 Low-Pass Filter **3200**

The signal from the 15-dB attenuator is accepted at input terminal WT3202, but only the frequency content below 9.3 MHz is passed through to output terminal WT3204.

The low-pass filter is an elliptic-function filter designed to give maximum attenuation at the frequencies indicated in the schematic: 11.9 MHz, 12.9 MHz, 16.2 MHz and 28.3 MHz.

The filter components were chosen such that maximum attenuation occurs at the first IF frequency (12 MHz) and its image frequencies. Thus, rejection of signal components that might cause erroneous meter readings is ensured.

The response of the filter is relatively flat from 4 kHz to 9.3 MHz. At 9.3 MHz the filter begins to roll off sharply to -99 dB, at 11.9 MHz. At 12.9, 16.2 and 28.3 MHz, the attenuation is even greater. Between these low points, the attenuation reaches a minimum of -70 dBm.

4.2.7 First Mixer **3100**

The signal from the low-pass filter is one input to the balanced mixer, the 1st LO signal is the other; the 1st LO enters through WT3101, the RF signal through WT3104.

The mixer is a three-port device which produces the first intermediate-frequency signal (1st IF) at WT3105. The circuit is designed to provide maximum isolation between WT3101 and WT3105 and between ports WT3101 and WT3104. This maximum isolation is achieved by the fact that the balance of the mixer is adjustable. Components R3106 and C3103 are adjusted such that with a 1st LO of 12 MHz and no input through WT3104, the output at WT3105 is minimal.

As shown in the schematic, the circuit is a diode bridge with resistors (R3104 and R3105). Potentiometer R3106 and variable capacitor C3103 are factory adjusted for maximum isolation between WT3101 and WT3105. Thus, for all practical purposes, only the mixing product appears in the secondary of T3102. Transformer T3103 provides an impedance match to the first IF stages.

Components C3101, R3101, R3102, R3103, and L3101 form an equalizer which compensates for roll-off in the low-pass filter but maintains an impedance of 75Ω.

Inductor L3101 is adjustable to maximize the effectiveness of the circuit.

4.2.8 First IF Amplifier **3300**

Two mixing processes take place in the signal path. The first mixer mixes the RF signal with the first local oscillator signal to produce the first IF, which has a frequency of 12 MHz. The second mixer mixes the first IF with a second local oscillator signal to produce a second IF of 80 kHz.

The first IF amplifier circuit, as shown in drawing 3300, consists of two amplifying stages: Q3301, with associated components, and IC3301, with associated components. Between these two stages, a crystal filter is connected that is approximately 1 kHz wide and centered on a frequency of 11.9995 MHz. This filter removes any signal components of frequencies that are image frequencies of the second (80 kHz) IF.

With respect to the overall bandwidth of the CE-21, the bandwidth of the 1st IF amplifier is not critical. When, however, the CE-23 Spectrum Display is used in conjunction with the CE-21, this bandwidth is critical at this point in the signal path, since it affects the selectivity of the CE-23.

Transistors Q3302 and Q3303, together with associated components, are buffer stages that isolate J4001 (the 12 MHz OUT connector on the rear panel) from the signal path.

4.2.9 Second Mixer **3400**

The second mixer is much like the first mixer, except that there are no balance adjustments, and there is no equalizer circuit.

The first IF is accepted through WT3401 and the second local oscillator signal, produced by the VCXO, through WT3406. The mixing product, which is the 80 kHz IF (second IF), is passed through WT3403 to the 2nd-IF amplifier.

4.2.10 Second IF Amplifier **2500, 2900**

The circuits of the second IF amplifier are on two printed circuit boards. (Drawing 2500, and Drawing 2900.) The second intermediate frequency is 80 kHz, and a signal of that frequency is accepted at P2501-2. After passing through a buffer stage (Q2501 and associated components), the signal path is through one or more of four attenuation/impedance-matching pads. In the drawing, these pads are designated 20 dB, 124Ω, 135Ω, and 150Ω. As shown, none of the pads is in the circuit path, representing the condition that exists when a 75Ω input impedance is selected (paragraph 4.02.01). If a 124Ω, 135Ω, or a 150Ω input impedance is selected, the appropriate pad is switched into the circuit by activation of the relay associated with that pad. The pad designated 20 dB is placed in the circuit when LOW NOISE operation is selected (paragraph 4.02.03).

Diodes CR2506 and CR2507 form a limiting circuit that prevents a signal that has not yet been attenuated (by adjustment of the dB1 or dB2 level selectors) from over-driving the meter.

Buffer amplifier IC2501 and associated circuits provide two outputs; one, via P2501-18, to J4005 for connection to a CE-23 spectrum display, and one through the contact of K2505. Relay K2505 is energized or not energized, depending on the choice of bandwidth (position of bandwidth switch).

When a 200-Hz bandwidth is selected, the signal passes through the 200 Hz-bandwidth, 80 kHz-bandpass filter. When a 2.3-kHz bandwidth is selected, the signal passes through a loss pad (R2522, R2523, R2525). In both cases, the signal leaves the board via P2501-21 and is fed to P2901-2. Before amplification by IC2901 and associated components, the signal passes through a self-contained LC network which is designed to permit a bandwidth of 2.3 kHz about a center frequency of 80 kHz.

Thus, when the narrow bandwidth is

selected, the signal passes through both 200-Hz and the 2.3-kHz bandwidth filters. The narrower filter dominates, and the effective bandwidth is 200 Hz. When, on the other hand, the broad bandwidth is selected, the signal goes only through 2.3-kHz bandwidth filter. To present the same level of signal to the input of the 2.3-kHz bandwidth filter, regardless of whether the narrow- or the broad bandwidth is selected, the loss pad is in the signal path when the 200-Hz bandwidth filter is not.

When considering the response of a filter, the bandwidth is customarily measured at the 3-dB point, on the curve. When expressing noise power in a signal, the concept of equivalent noise bandwidth is used. This term is defined as the bandwidth of a rectangular curve that bounds the same areas as the C-message-weighted curve (plotted in terms of normalized power versus frequency). By graphic integration, it has been found that this rectangular curve has a width of 1.74 kHz. The figure 1.74 kHz is shown between parentheses and in blue, adjacent to the bandwidth switch on the front panel. The design of the bandpass filters in the CE-21 was chosen such that the overall bandwidth curve (plotted in terms of normalized power versus frequency) also bounds the same area as the rectangular curve.

It is now an accepted fact that, under these conditions, the bandpass of the CE-21 makes it possible to take noise level measurements that are (for all practical purposes) the same as those taken with standard C-message weighting instruments (e.g. WeCo 7A).

The two numbers which indicate the broad bandwidth position on the CE-21 front panel, 2.3 kHz and 1.74 kHz, signify that the CE-21 bandwidth curve at the 3-dB points is 2.3 kHz and that the area bounded by this curve is the same as an area bounded by a rectangular curve of 1.74-kHz width.

The CE-21 bandpass curve was designed to have a curve with a shape factor of approximately 2:1. Such a bandpass provides the major advantages that tuning is noncritical and that the carriers and pilot tones are "outside the skirts."

4.2.11 Meter Amplifiers **2200**

Drawing 2200 shows both the normal and the expanded meter amplifiers. The audio detector and amplifier circuits are on the same board but are discussed in paragraph 4.2.12.

Irrespective of the position of the NORMAL/EXPANDED meter switch, the 2nd-IF signal is applied to P2201-13. When expanded meter indication is selected, the signal passes (see drawing 1000) through the normal meter amplifier and via P2201-11/M, S1004-B11, and S1004-B10 to P2201-7, the input to the expanded meter amplifier. When normal meter indication is selected, the signal passes through P2201-11/M and via S1004-B11, S1004-B12 to the meter.

Thus, the circuits of the (normal) meter amplifier are in the signal path when both kinds of meter indications are selected.

The design of the (normal) meter amplifier depends on two principles:

a. An operational amplifier (such as IC2201) has, by definition, a very high differential gain, and this gain is adjustable by varying the reactances in the input and in a feedback path. An operational amplifier can also be used as a current source.

b. A level meter is most accurate when driven from a current source.

Because of these principles, a linear variation of voltage (level) applied to the operational amplifier (IC2201) produces a linear current output when the meter bridge circuit is placed in the feedback path. Thus, when the feedback path of IC2201 is considered (between IC2201-6 and IC2201-2), the major elements in this path are the bridge (CR2203, CR2204, C2208, and

C2209), limiters (zener diodes, CR2201, and CR2202), an AC impedance determiner (C2206, R2204), and a component to ensure thermal tracking (R2203). It has already been stated that the output of the bridge is available at P2201-11; an equivalent output is available via P2201-10 at J4002 for driving a strip chart recorder; a third output is connected, via P2201-12, to the audio selector S1017.

When expanded meter indication is selected, the output of the bridge is applied to operational amplifier IC2231. A gain-adjust potentiometer (R2241) in its feedback path is adjusted so that 1 dBm is indeed indicated at 1 dBm on the meter. The meter limiter, consisting of CR2231, CR2232, and CR2233, performs the function implied by the name. And, finally, resistors R2231, R2232, and R2234, together with negative thermal-coefficent resistor R2235 and potentiometer R2233, provide zero adjustment and an offset. The offset is to displace the meter reading so that for a given signal input, a NORMAL zero meter reading will coincide with an EXPANDED zero meter reading. Potentiometer R2233 provides a final adjustment of this offset

4.2.12 Audio Amplifiers **2200**

The audio circuits are on the same printed circuit board as the meter amplifiers and consist of reinsertion oscillators, a product detector/mixer, and an audio amplifier.

Depending on the type of signal (AM, LSB, or USB) that is being measured for amplitude, the appropriate button of the audio selector (S1017) must be depressed so that the signal can be subjected to correct processing to make it audible.

The selection made by means of the audio selector determines at which terminal the input is accepted on the board. Terminal P2201-15 is used when the signal information is contained in the upper sideband (USB); P2201-14 when the lower sideband (LSB) is used; and P2201-17 when the input is a normal (both sidebands and carrier) amplitude-modulated (AM) signal.

The circuit (Q2251, Q2252, Q2253, Y2251, and Y2252, and associated components) is a dual-crystal dual oscillator. Crystals Y2251 and Y2252 have characteristic frequencies of 78 and 82 kHz, respectively, 2 kHz below and above the 80-kHz frequency of the second IF signal.

When -12V is applied to P2201-15, an oscillator circuit, which includes Q2251, Y2251, and Q2253, is activated. When -12V is applied to P2201-14, the oscillator circuit with Q2252, Y2252, and Q2253 operates. Transistor Q2253 is common to both sections, and the signal from its collector is applied to Q2254-2.

When AM is selected, neither oscillator circuit operates, and a signal is applied to P2201-17. This signal is the output of the meter amplifier circuit, leaving the board at P2201-12, passing through contacts C17, C18, B14, B13, A17, and A16 of switch S1017 (see 1000).

When USB is selected, the same signal that is the input to the meter amplifier (P2201-13) is directed from the second IF amplifier and filter (P2901-21) through contacts C14, C15, A13, and A14 of switch S1017. When LSB is selected the path is through B16, B17, A13, and A14 of S1017.

Transistor Q2254 operates an amplifier when AM audio is selected, and only the output signal of the meter bridge is accepted (Q2254-3). This signal consists of the wanted modulation and an unwanted 80-kHz component. The unwanted component is filtered out by an elliptic function (low-pass) filter consisting of L2251, C2263, C2264, and C2267. The output of this filter leaves the board at P2201-16, passes through a portion of volume control R1008, and reenters the board at P2201-21 to be amplified by IC2251 and associated components. The output of IC2251 leaves the board at P2201-19 and is available at audio jacks J1005 and J1006, or, if no plug is inserted in either jack, the audio is audible over the speaker.

When either USB or LSB is selected, Q2254 receives two inputs; one of these (at Q2254-3) consists of a single sideband modulated 80 kHz, the other (at Q2254-2), is the output of either oscillator circuit, with a frequency of 78 kHz or 82 kHz. The inputs are mixed and, when the 78-kHz portion of the dual oscillator is used, the product of this mixing process contains components with frequencies of 78 + 80 = 158 kHz, 80 - 78 = 2 kHz, and 78 kHz. If the 82-kHz portion of the oscillator is used, the components have frequencies of 162, 2, and 82 kHz. In both cases, the modulation of the 80-kHz IF signal accepted at Q2254-3 is now present on the mixing product of Q2254. As has been described before, the output of Q2254 is filtered, amplified, and made available through J1005 and J1006 or the speaker.

4.2.13 Frequency Synthesizer

In normal operation, the frequency synthesizer is a phase-locked-loop that is used to generate the first local oscillator (1st LO) signal. The frequency synthesizer consists of a master oscillator (MO), a voltage controlled oscillator (VCO), a divide-by-N counter (÷N), and various detectors, sampling circuits, dividers, and multipliers. These components are carried on boards 2100, 2300, and 2400. Figure 4-2 provides a block diagram of the frequency synthesizer. A small part of the frequency synthesizer is used when the CE-21 is calibrated.

4.2.13.1 Voltage-Controlled Oscillator **2300**

The voltage-controlled oscillator (VCO) board is used to generate the 1st LO, a signal with a frequency between 12 MHz and 21.1 MHz. Nine oscillator circuits, a driver, and a summing amplifier are carried on the VCO board.

Transistor Q2310 and integrated circuit IC2302 and associated components constitute a driver that is common to all nine oscillator circuits. Also common to all oscillators is the summing amplifier, consisting of IC2301 and associated components.

Eight of the oscillator circuits have a pulling range of 1 MHz, and the ninth circuit has a pulling range of 1.1 MHz. Which of the oscillators is energized depends on the setting of the first (from the left) frequency selector, S1009. Since the first frequency selector has a range of 0 to 9 MHz, and the VCO has a range of 12.000 to 21.100, selection of the number "3" with the first frequency selector will, for example, select the VCO oscillator that operates between 3 + 12 = 15 MHz and 16 MHz. When 3000.00 kHz is dialed in, the selected VCO circuit will resonate at 15,000 kHz, but if the second, third, and fourth frequency selectors are set for values other than 0, the oscillator is fine-tuned by a varicap to the appropriate frequency between 15,000 and 16,000 kHz. The varicap adds to the oscillator circuit the amount of capacitance necessary to adjust the frequency, and this amount of capacitance depends on the control voltage applied to the varicap. The control voltage is a result of a phase-comparison between the output of the ÷N counter and the master oscillator.

The 1st LO is fed from the VCO board via pin P2301-17/U to board 3100 at WT3101. There the 1st LO is mixed with the received signal in the first mixer to produce the first intermediate frequency (1st IF).

A second board output is the VCO frequency, transmitted via pin P2301-15/S to the ÷N counters, which count the oscillations of the VCO output in an early stage of the frequency-synthesizer loop.

4.2.13.2 Divide-by-N **2100**

The divide-by-N (÷N) circuits are used to count the frequency of the VCO output signal and to produce a 1-kHz pulsed output signal. The ÷N circuits consist mainly of counters and gating circuits. The VCO signal enters board 2100 via pin P2101-2/B. The other inputs to the board originate from the binary-coded frequency selectors, S1009, S1011, S1013, and S1016.

In the ÷ N counter are four counting decades, connected in series, each capable of counting to ten, and one dual flip-flop, capable of counting to four. The counter has a maximum counting capability of 39,999. To reach a count other than a full count, each decade must be preset. This is done with the frequency selectors on the front panel. When 3,456.0 kHz is dialed in, for example, the VCO frequency must be 15,456.0 kHz, which means that the ÷ N counters must produce one reset pulse for every 15,456 pulses it counts to produce a 1-kHz output signal. Divide-by-N in this case means divide by 15,456.

The 1-kHz pulsed output signal is used to trigger the first sampling gate in the sample-and-hold circuits. After a 50-μsec delay, this same signal also triggers the second sampling gate.

In a signal that consists of between 12,000,000 pulses per second and 21,100,000 pulses per second (VCO range), each clock or input pulse has a duration of between 48 and 84 nanoseconds. Since it takes the duration of five clock pulses to form a reset pulse, this reset pulse will be between 240 and 420 nanoseconds in duration.

Pulses of this short a duration, even if they occur at the correct frequency, cannot be used to trigger the sampling gates. A pulse-stretching circuit is, therefore, used to lengthen each individual pulse to 200 microseconds. The repetition rate or frequency, however, does not change.

The ÷ N signal leaves the board via pin P2101-D/4, and travels to board 2400.

4.2.13.3 Master Oscillator and Reference Dividers **2100**

The reference oscillator and reference dividers are used to produce a 1-kHz reference pulse that forms a certain phase relationship with the ÷ N 1-kHz signal in the sample-and-hold circuits.

Transistor Q2131 in conjunction with crystal Y2131 and associated components produces a 2-MHz sinewave signal at the emitter that is coupled to amplifier IC2135. The output of IC2135 at pin 8 and test point 1 is roughly a squarewave.

Integrated circuit IC2131 is a combination divider and waveshaper. The frequency of the input signal at pin 12 is divided by 2 to give 1-MHz squarewave outputs at pins 6 and 8. The signal from pin 6 is shaped into a sinewave with the same frequency by the LC combination of L2133, C2143, and C2144. This signal is available at P2101/J2003-W for use in the calibration amplifier.

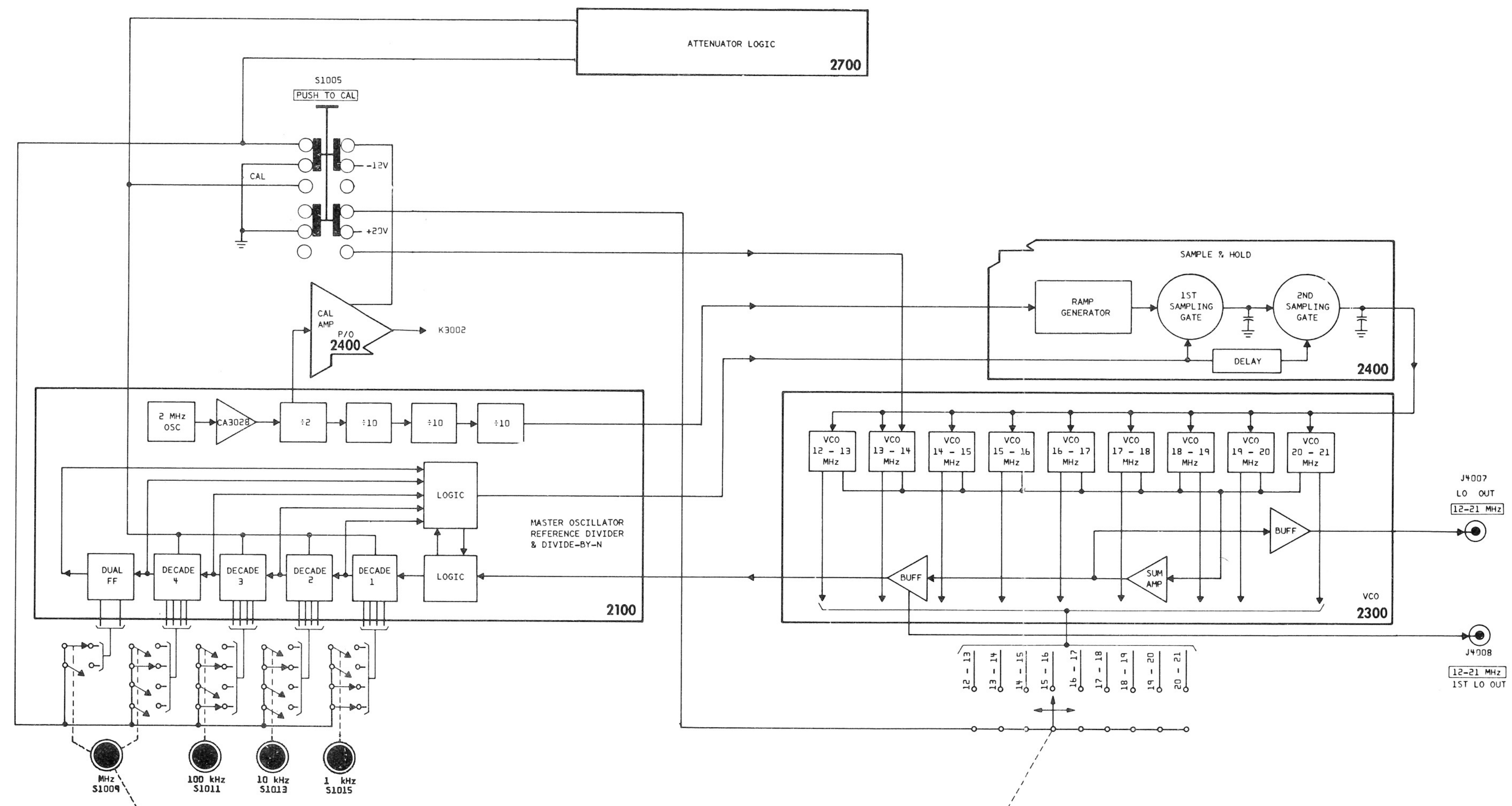
The signal produced in IC2131 emerges at pin 8 and is fed to pin 14 of IC2132, where the frequency is divided by 10. Integrated circuits IC2133 and IC2134 each divide the frequency by 10 also. The resultant signal at test point 2 is a squarewave with the amplitude and pulsewidth shown. This output is directed via P2101-X to the sample and hold circuit, (2400) where it is used to trigger the ramp generator.

4.2.13.4 Sample and Hold **2400**

The sample-and-hold circuits develop a dc voltage to control the varicap of the selected oscillator circuit. The variable capacitance of the varicap serves to tune the selected one of eight VCO circuits to a specific frequency within a 1-MHz range (or, for the ninth VCO circuit, within a 1.1-MHz range).

The sample-and-hold circuits receive two signals: from the ÷ N circuits the 1-kHz pulsed output signal that enters the sample-and-hold board via P2401-10; and, from the master oscillator, the 1-kHz reference pulse that enters the board via P2401-8.

To generate the varicap control voltage in accordance with dialed-in frequency, the trailing edge of the 1-kHz reference divider pulse triggers (and also resets) a ramp generator consisting of Q2401, Q2402, C2405, and associated components. The



2	4	4	6	3	PRESET STATE
	3	4	5	6	DIALED-IN FREQ.
1	3	4	3	6	VCO FREQ.

NOTE:

1. CONNECTIONS SHOWN ARE FUNCTIONALLY REPRESENTATIVE, THEY DO NOT CORRESPOND TO ACTUAL WIRING.

Figure 4-2 Frequency Synthesizer, Block Diagram

resulting ramp has a constant slope with a 1-kHz repetition rate. IC2401 is a voltage follower or buffer that presents a high impedance at its input and provides a low-impedance output, thus preventing C2405 from being loaded by the first sampling gate circuits.

The ramp voltage is applied to the first sampling gate (Q2403, Q2404, and Q2405), which is opened by a pulse of the ÷ N signal. This gate remains open for the duration of the ÷ N pulse (about 20 μsec) and during this time, holding capacitor C2407 charges to the sampled ramp potential.

Integrated circuit IC2402 performs the same function as IC2401 and prevents holding capacitor C2407 from being loaded. The incoming ÷ N signal is also fed through IC2404, IC2405, and IC2406, which delay the ÷ N pulses by about 50 μsec. A delayed pulse is used to trigger and keep open the second sampling gate, consisting of Q2406, Q2407, and Q2408. During this delayed pulse, the second holding capacitor C2409 is charged to the sampled first-holding-capacitor potential. IC2403 prevents C2409 from being loaded in the same manner as described for IC2402 and C2407.

The charge on C2409 is constant as long as the ÷ N signal has a constant phase relationship with the signal from the master oscillator. The potential to which C2409 is charged is used as the control voltage that determines the capacitance of the varicap.

Thus, the capacitance which the varicap adds to the VCO tank is exactly the right amount to cause this tank to resonate at the VCO frequency that is associated with the dialed-in frequency. For the example, this would be a VCO frequency of 15.4560 MHz for a dialed-in frequency of 3.456 MHz.

The output at pin P2401-14 is the control voltage impressed on the varicap of the selected VCO on board 2300.

Integrated circuit IC2404 acts as an inverter and buffer. A part of IC2406 and and transistor Q2409 constitute the UNLOCKED detector. When the phase relation between the two 1-kHz signals varies for more than a few cycles as a result of unwanted circuit perturbations, the output of the lamp-detector portion of IC2406 goes high, causing Q2409 to conduct. This provides the UNLOCKED lamp with a return to ground and the lamp lights. When the loop is unlocked because a different frequency has been dialed in, this unlocked condition prevails only for a few cycles which is too short a time for the lamp to light. Thus, when the UNLOCKED lamp is lit, a malfunction has occurred in the loop.

A small part of the frequency synthesizer is used when the CE-21 is calibrated. When the PUSH TO CAL button is depressed, the input selector is removed from out of the signal path, and the calibration amplifier is energized. A signal from the divide-by-2 circuit in the reference divider is processed (in the calibration amplifier) to give a calibration signal of 1 MHz leveled at 0 dBm. The attenuator logic produces an output which causes the level selectors to have no effect, and the frequency selectors are disabled. The LOW NOISE/LOW DISTORTION mode selector is still operative so that the instrument can be calibrated in either mode.

Because the input selectors are actually cut off from the signal path, it is not necessary to disconnect the CE-21 from any system it may be connected to when calibration becomes necessary.

4.2.14 Voltage-Controlled Crystal Oscillator **3700**

The circuit shown in drawing 3700 produces the second local oscillator signal (2nd LO) which is mixed with the 1st IF signal to produce the 2nd IF signal. The oscillator itself consists of transistor Q3701, crystal Y3701, varicap CR3701 and associated components. As shown in the drawing, the crystal has nominal characteristic frequency of 11.919 MHz, but this frequency can be varied between 11.9188 and 11.9200 MHz by varying the capacitance of varicap CR3701.

The control voltage for the varicap is established by the setting of the 100 Hz, frequency selector R1009, via a resistor network on the power supply rectifier board. Potentiometers R2602 and R2605 (drawing 2600) serve to adjust the endpoints of the voltage range through which the control voltage to the varicap can be adjusted. Potentiometer R1009 is associated with a dial calibrated in 50 Hz steps. The other two transistors (Q3703 and Q3702) and associated components form two buffer amplifier stages; one to isolate the 2nd mixer from the output of the VCXO, the other to isolate any device connected to J4009 (2nd LO out) on the rear panel.

4.2.15 Calibration Amplifier **2400**

The calibration amplifier circuits are on the same printed circuit board as the sample-and-hold circuits (drawing 2400, sheet 2). The calibration amplifier is energized by removing the -12V input to IC2441. The enabling ground source for the counting decades of the ÷ N circuit and for the attenuator logic is disconnected when the PUSH TO CAL switch (S1005) is depressed (no connection between S1005-17 and 18 and S1005-13 and 14; see drawing 1000, sheet 1). Thus the 13 to 14 MHz VCO produces 13.0000 MHz and the attenuator logic is programmed for 0 dBm. Regardless of which voltage-controlled oscillator is selected, depressing the PUSH TO CAL switch removes its +20V supply but applies this supply directly to the 13 to 14 MHz VCO.

The calibration amplifier always receives a 1-MHz input from the ÷ 2 circuit on the 2100 board (drawing 2100, sheet 2) but this signal is not amplified when the calibration amplifier is not energized.

The amplifier circuit is a closed loop consisting of five major elements: an operational amplifier (IC2441) with voltage-controlled gain; a clean-up tank circuit (L2444, C2451, and C2452), resonant at 1 MHz; a detector (CR2441); a leveling amplifier (IC2442); and most importantly, a voltage reference (CR2442).

The main characteristic of the circuit is that the 1-MHz input signal can vary as much as ±10 dB in amplitude and still produce an output of 1 MHz at 0 dBm. The operating principle of the circuit is that the DC input at IC2442-4 accurately tracks the reference DC input at IC2442-3 because of the feedback. The input at IC2442-4 is a DC voltage (produced by CR2441) that is proportional to the amplitude of the 1 MHz signal at that point. Thus, the 1-MHz output is controlled by the reference voltage. The tank circuit ensures that the output is a pure 1-MHz signal.

The 1-MHz signal from the calibration amplifier is applied to a contact of coaxial relay K3002 (drawing 3000). Both coaxial relays, K3001 and K3002, receive an energizing voltage (-12V) via contacts of PUSH TO CAL switch S1005. Energizing the relays disconnects all external signals from the RF stages and applies the 1-MHz calibration signal to HI-Z attenuator number 1 (3900).

The ground source available to the attenuator logic having been removed by depressing the PUSH TO CAL switch voids any setting that may have been dialed in with the four LEVEL controls. In its place, a calibration ground source is applied such that the attenuator logic causes 100 dB of attenuation to be in the signal path. This amount of attenuation corresponds to a dB1 + dB2 setting of -0 dBm.

Since the frequency of the calibration signal is 1 MHz, the VCO should produce a 1st-LO signal of exactly 13 MHz to give a 1st IF of 12 MHz. Depressing the PUSH TO CAL switch energizes the 13 to 14 MHz VCO circuit and deenergizes any other VCO that may have been operating because of a previously dialed-in frequency. It is possible to perform calibration in either the LOW NOISE or LOW DISTORTION mode and also with either a broad or a narrow bandwidth selected. When a narrow bandwidth is selected, however, the last (100 Hz) frequency selector should be set to a peak reading on the meter.

4.2.16 Power Supply **2600 , 2800**

The components of +20, +5, and -12V power supplies are on two printed circuit boards (2600 and 2800) and on the main chassis itself.

The power supply rectifier circuits (drawing 2600) for the three power supplies are identical in configuration with some differences in component values and the types of diodes used in the fullwave bridge rectifiers. Resistors R2607, R2608, and R2609 are charging-current limiters that protect the fuses and the diodes from the surge that occurs when the instrument is turned on.

The power supply regulator circuits are shown in drawing 2800. The regulator transistors are mounted in the main chassis so that no separate heatsinks are required.

The circuits of the +20 and -12V regulators are the same except for the component values. For the +20V regulator, the unregulated voltage, which can swing from 21 to 40 volts without appreciably affecting the +20V regulated output, is applied between terminals P2801-20/X and P2801-21/Y. Integrated circuit IC2801 is connected such that the voltage at IC2801-5 always tracks the voltage at IC2801-4. Zener diode CR2802 is a temperature-compensating reference device across which is a constant voltage drop of 6.2V. A voltage divider consisting of R2806, R2807, and R2808 is adjustable through variation of the potentiometer (R2807) setting to obtain exactly +20V at P2801-18/V.

Transistor Q2803, with diode CR2801 and resistors R2804 and R2809, form a current limiting device that effectively takes regulator transistor Q2001 out of the circuit when too much current is being drawn. Transistor Q2801 drives Q2001.

The circuit of the +5V regulator is the same in principle except that the function of the integrated circuit (i.e. IC2801 or IC2841) is performed by transistor Q2823. This circuit does not provide as good a regulation as the other two circuits. Better regulation is not required since this voltage is only used to energize the integrated circuits in the various printed circuit board requirements. To prevent damage as a result of excessively high voltage, however, zener diode CR2823 is connected across the +5V output. This diode limits any possible voltage "overshoot" to 7.5V.

SECTION 5
MAINTENANCE

5.1 General

Adjustments, performance verification, and troubleshooting procedures for the CE-21 are provided below. If adjustments other than those provided herein are required, the faulty printed circuit board or the entire instrument should be returned to the Cushman Electronics Customer Service Department for repair or shipped to the service point given in paragraph 2.4.

The CE-21 should be warmed up for at least 30 minutes before any adjustment is attempted.

Ten of the printed circuit boards (1100, 2100 through 2900) are plug-ins and are accessible when the top and bottom covers of the CE-21 are removed. The covers can be removed by removing the two fasteners near the edge of each cover.

The remaining nine printed circuit boards (3100 through 3900) are located inside the RF casting and can be reached by removing the top and bottom covers of the casting. Each cover is fastened with 15 screws.

A board extractor and an extender board are furnished with the instrument and are located in the printed circuit board aperture nearest to the front of the instrument (next to the 2nd IF amplifier/2.3-kHz bandpass filter board).

WARNING

Before removing a board, ensure that power to the CE-21 has been disconnected.

Test points marked on various printed circuit boards are indicated in the component assembly drawings accompanying the schematic diagrams in section 6 of this manual.

5.2 Fuses

The 3-amp, slo-blo main fuse is accessible on the outside of the rear panel.

The fuses for the +20V, -12V, and +5V power supplies are inside the CE-21 cabinet on the power supply rectifier board (2600) mounted to the far right, as viewed from the top with the cover removed. The three fuses are in a line, the +5V fuse (F2603) being nearest to the front of the instrument, followed next by the -12V fuse (F2602), and, last, the +20V fuse (F2601). If one of these fuses has blown, the resistance between the appropriate terminal and ground should be measured and compared with the corresponding, correct value given in table 5-1.

Table 5-1 Power Supply Resistances to Ground

+5V	
Measured At	+5V power supply bus (green wire)
Res. (ohms)*	≈8Ω
-12V	
Measured At	-12V power supply bus (orange wire)
Res. (ohms)*	≈30Ω
+20V	
Measured At	+20V power supply bus (red wire)
Res. (ohms)*	≈25Ω

NOTE

All resistance readings taken with a Simpson 270 volt-ohm-milliameter (VOM) using X1 scale.

* Depends on VOM test lead polarity and switch positioning.

5.3 Adjustments

5.3.1 Test Equipment Required

Test equipment required for field maintenance of the CE-21 is listed in table 5-2. If these items are not available, equivalent items may be used.

5.3.2 Power Supply Voltages

CAUTION

The power supplies should be adjusted for error no greater than 0.1V and should not be adjusted unless a DC voltmeter with an accuracy of at least 1% is used.

a. Remove bottom and top covers of the CE-21.

NOTE

Measurements for power supply voltages are performed from the top of the instrument, and adjustments are made from the bottom.

b. Measure +5V supply voltage at +5V bus (green wire). Reading should be exactly +5V. If not, adjust R2825 (as viewed from the bottom, located at the near edge of the power supply regulators board (2800)). 6-65

c. Measure -12V supply voltage at -12V bus (orange wire). Reading should be exactly -12V. If not, adjust R2845 (located at the near edge of board 2800). 6-65

Table 5-2 Test Equipment

Description	Manufacturer	Model/Part No.
Volt-ohm-milliameter	Simpson	270
Frequency Counter	Hewlett-Packard	HP5245L
Signal Generator	Cushman Electronics	CE-26
RF Voltmeter	Boonton	91
Vacuum Tube Voltmeter	Hewlett-Packard	HP400D
Feed-Through Termination, 75-ohm	Hewlett-Packard	HP11094A
Termination Adapter, 50- to 75-ohm	Texscan	n. a.
Termination Adapter, 50- to 600-ohm	Texscan	n. a.
Milliwatt Standard	Western Electric	WE-73B

d. Measure +20V supply voltage at +20V bus (red wire). Reading should be exactly +20V. If not, adjust R2807 (located at the near edge of board 2800).

5.3.3 Master Oscillator Frequency

Method 1

a. Remove the master oscillator/divide-by-N board (2100) and reinstall on the extender board.

b. Connect the frequency counter to TP1.

c. Observe 2-MHz frequency reading on frequency counter. If the 2-MHz reading is not obtained, adjust screw on the piston-type capacitor (C2134) located next to the metal-enclosed crystal.

Method 2

(For a resolution greater than that obtained with method 1)

a. Connect the frequency counter to J4007 at rear panel.

b. Dial in zeroes with the first (from the left) four frequency selectors.

c. Ensure that the UNLOCKED indicator lamp is not lit.

d. Observe a reading of 12 MHz on frequency counter. If the 12-MHz reading is not obtained, adjust screw on the piston-type capacitor (C2134) located next to the metal-enclosed crystal on board 2100.

5.3.4 First Local Oscillator

The first local oscillator (1st LO) is made up of circuits on the master oscillator and divide-by-N board (2100), the voltage-controlled oscillator (VCO) board (2300), and the sample-and-hold/calibration amplifier board (2400). Field maintenance for the 1st LO consists of adjustments to the master oscillator, described above, and to the VCO, described below.

The VCO incorporates eight oscillator circuits each of which is associated with a 1-MHz frequency range from 12 to 20 MHz and a ninth oscillator circuit, associated with the 20 to 21.1-MHz range. Which oscillator circuit, associated with the 20 to 21.1-MHz range. Which oscillator, and, therefore, which frequency range, is selected depends on the setting (0-9) of the first (from the left) frequency selector switch. On the VCO board are nine variable inductors (L2302-L2310), each labelled with a number from 12 through 20. These numbers correspond to the lower limit of the selected frequency range as determined by the setting of the first frequency selector. If the unlocked indicator lamp on the front panel is off, it can be assumed that the selected oscillator is on frequency. However, the inductors have to be properly set to ensure proper locking range of the oscillator. When an oscillator test reading is in error, adjustment is made to the coil associated with that oscillator. Table 5-3 provides a listing of the nine oscillators and associated coils, and the dialed-in frequencies needed to test the upper and lower range limits of the oscillators.

5.3.4.1 VCO Frequency

a. Remove the sample-and-hold/calibration amplifier board (2400) and reinstall on the extender board.

b. Connect DC voltmeter to TP6.

c. With the first (from the left) four frequency selectors, dial in the upper limit of the range associated with the 12-MHz oscillator. (Refer to table 5-3.)

d. Observe voltmeter reading of 13.0 to 13.5 volts. If the reading is in error, align the oscillator by adjusting the appropriate oscillator coil. (Refer to table 5-3.) (Coils are located at the near edge of the board, as viewed from the bottom.)

Table 5-3 VCO Adjustment Chart

Oscillator	Dialed in With the First (from the left) Four Frequency Selectors		Variable Inductor
	Lower Range Limit	Upper Range Limit	
12 MHz	0000	0999	L2302
13 MHz	1000	1999	L2303
14 MHz	2000	2999	L2304
15 MHz	3000	3999	L2305
16 MHz	4000	4999	L2306
17 MHz	5000	5999	L2307
18 MHz	6000	6999	L2308
19 MHz	7000	7999	L2309
20 MHz	8000	9100	L2310

CAUTION

Adjust coil carefully to avoid unlocking phase-locked loop.

e. Repeat steps c and d for remaining oscillators.

f. With the first (from the left) four frequency selectors, dial in the lower limit of the range associated with the 12-MHz oscillator. (Refer to table 5-3.)

g. Observe voltmeter reading of 5.5 to 6.5 volts. If the reading is in error, align the oscillator by adjusting the appropriate oscillator coil. (Refer to table 5-3.) (Coils are located at near edge of board, as viewed from the bottom.)

CAUTION

Adjust coil carefully to avoid unlocking phase-locked loop.

h. If coil has to be adjusted at lower limit, recheck upper limit.

5.3.4.2 First Local Oscillator Level

a. Connect RF voltmeter (50Ω termination) to J4007 at rear panel.

b. Observe voltmeter reading of 300-500 mV rms. If the level reading is in error, repair or replace VCO board. If there is an internal jumper connecting J4006 and J4007, use a high impedance termination. The reading will be 100 mV higher.

5.3.5 Second Local Oscillator

The second local oscillator (2nd LO) is the voltage-controlled crystal oscillator (VCXO) (board 3700), which is controlled by the fifth (from the left) frequency selector (hereafter referred to as the 100-Hz digit selector). Although the 2nd LO is located within the RF casting, the 2nd LO frequency and level can be checked at the rear panel and adjustments can be made on board 2600.

5.3.5.1 VCXO Frequency

a. Connect frequency counter to J4009 at the rear panel. E

b. Dial zero with the 100-Hz digit selector.

c. Observe frequency counter reading of 11.92 MHz. If the reading is in error, proceed as follows.

1. Dial zero with the 100-Hz digit selector.

2. On the power supply rectifier board (2600), adjust R2605 to obtain a reading of 11.92 MHz on frequency counter. (R2605, labelled 0 Hz, is located at the near edge of the board, as viewed from the bottom.)

d. Dial 9 with the 100-Hz digit selector.

e. Observe a frequency counter reading of 11.919 MHz.

If the reading is in error, proceed as follows:

1. Dial 9 with the 100-Hz digit selector.

2. On board 2600, adjust R2602 to obtain a reading of 11.919 MHz on the frequency counter. (R2602, labelled 900 Hz, is located at the near edge of the board, as viewed from the bottom.)

3. Since the controls interact, repeat until no further adjustment is necessary.

NOTE

The level (25 mV rms unterminated) is quite low and taking this measurement may require the use of an amplifier with the counter.

5.3.5.2 VCXO Level

a. Connect RF voltmeter to J4009 at the rear panel.

b. Observe a level reading of 13 ±3 mV rms on voltmeter, using a 50-ohm termination.

5.3.6 IF Amplifiers

The first IF amplifier is located inside the RF casting. To check the first IF amplifier, refer to paragraph 5.4.5, below.

The second IF amplifier (second IF amplifier/200 Hz bandpass filter board (2500)), located outside of the RF casting, has no tuned circuits. The overall gain of the instrument can be altered by changing the value of resistor R2524. Resistor R2524 is located next to IC2501 and is mounted in reusable receptacles. To increase gain, substitute a resistor with a greater ohmic value. A change of 100 ohms will change the gain of the instrument approximately 1.5 dB.

NOTE

Changing the value of R2524 will not affect calibration of the CE-21.

In the calibration mode, the CE-21 meter reading should be the same for both the 200-Hz and the 2.3-kHz bandwidths. If the readings are not the same, proceed as follows:

a. Depress the PUSH TO CAL button.

b. Depress the 200 Hz BANDWIDTH button.

c. Using the fifth (from the left) frequency selector, obtain a maximum meter reading.

d. Depress the 2.3 kHz BANDWIDTH button.

e. Adjust potentiometer R2523 as necessary to obtain the same meter reading in both bandwidths.

The 2.3-kHz bandpass filter, which is considered a part of the second IF amplifier, is located on a separate board (2900). There are no adjustments to be made on this board.

5.3.7 Meter Amplifiers

The meter amplifiers are located on the meter amplifiers/audio amplifier board (2200).

5.3.7.1 NORM and EXP Scales Readings Balance

To balance the readings on the NORM and EXP scales, proceed as follows:

a. Depress the PUSH TO CAL button.

b. Depress the METER NORM button.

c. Zero the meter by adjusting the calibration potentiometer (R1005) for a zero dBm reading on the meter scale.

d. Depress the METER EXP button. If the meter needle does not align with the CAL mark, correct the meter reading by adjusting potentiometer R2233 (on board 2200) until meter needle is aligned with the CAL mark. (R2233, labelled ZERO ADJUST, is located at the near edge of the board, as viewed from the bottom.)

5.3.7.2 EXP Scale Meter Tracking

To check the meter tracking on the EXP scale, proceed as follows:

a. With either the dB1 or dB2 LEVEL control, increase attenuation 1 dB.

b. Adjust potentiometer R2241 for a meter reading of -1 dB. (R2241, labelled GAIN ADJUST, is located at the edge of the board, as viewed from the bottom.)

NOTE

A +1 dB reading may also be checked, but no adjustment can be made if this reading is in error.

5.3.8 Calibration Amplifier

The internal calibration signal frequency, derived from the master oscillator, is 1 MHz. If the master oscillator accuracy is verified, the internal calibration signal frequency may be assumed to be correct.

To verify the level of the calibration signal, proceed as follows:

a. Using the 50- to 75-ohm adapter, connect the signal generator to the milliwatt standard and establish a 0 dBm signal.

b. Connect the CE-21 to the signal generator.

c. Set the CE-21 to the frequency and level of the signal generator.

d. Depress the 200 Hz BANDWIDTH button.

e. Using the fifth (from the left) frequency selector, carefully peak meter reading.

f. Using front panel CAL potentiometer (R1005), set meter needle to CAL mark.

g. Depress PUSH TO CAL button. If the meter does not indicate the same level as that of the signal generator, adjust potentiometer R2450 (on the sample-and-hold/calibration amplifier board) to obtain correct level reading on meter. (R2450, labelled CAL LEVEL ADJ, is located at the near edge of the board, as viewed from the bottom.)

5.4 Performance Verification

If there is a problem in the CE-21, it is most likely to occur in the plug-in boards or in the RF casting.

5.4.1 Second Mixer to Meter Gain Check

To check the signal gain from the second mixer to the meter, proceed as follows:

a. Tune the signal generator to 80 kHz.

b. Using the 50- to 600-ohm impedance adapter, set the output level of the signal generator to -66 dBm.

c. At the CE-21 front panel, center the CAL potentiometer (R1005) and switch the meter to NORM.

d. Disconnect the coaxial cable from J3011 and connect the signal generator to the coaxial cable.

e. At the CE-21 front panel, observe meter reading of 0 ±4 dB.

If a problem appears in the above check, the problem can be further isolated by proceeding with voltage measurements as follows:

a. Ensure that the CAL potentiometer (R1005) is centered and that the signal generator is adjusted for a meter reading of zero.

b. Observe the following:

   1. A level of, typically, 1000 μV at the input of the 2.3-kHz bandpass filter board (2900), pin 2.

   2. An input signal of, typically, 40 mV at pin 13 of the meter amplifiers/ audio amplifier board (2200).

5.4.2 RF Casting Assembly Gain Check

To check the gain of the RF casting assembly, proceed as follows:

a. Depress METER NORM switch (S1004).

b. Remove all attenuation by dialing -99 dB with the level selectors.

c. Terminate the VTVM with a 600-ohm resistor and connect to J3011.

d. Disconnect cables at J3001 and J3005.

e. Tune the signal generator to 1 MHz, and, using the 50- to 75-ohm adapter, set the level to -50 dBm.

f. Using the 75-ohm feed-through termination, connect the signal generator to J3005 (the unbalanced channel).

g. Observe 10 to 20 mV on VTVM.

h. Using the 75-ohm feed-through termination, connect the signal generator to J3001 (the balanced channel).

i. Observe 10 to 20 mV on VTVM.

The following checks can be made for the boards contained within the RF casting, which are the Hi-Z attenuators (3500 and 3900), the balanced input amplifier (3800), the 15-dB attenuator (3600), the low-pass filter (3200), the first mixer (3100), the first IF amplifier (3300), and the second mixer (3400). Adjustment information for the voltage-controlled crystal oscillator (3700), also housed within the RF casting, is provided in paragraphs 5.3.5.1 and 5.3.5.2, above.

Some of the signal levels in the RF casting are below the range of voltmeters during normal operation and troubleshooting procedures. Proper troubleshooting calls for the use of the gain block diagram (figure 5-1). However, some valid checks can be made by using high level input signals.

5.4.3 First Local Oscillator Check

a. Disconnect the cable from J3008 and connect the RF voltmeter (50-ohm termination) to the cable.

b. Observe a voltmeter reading of 300-500 mV rms.

5.4.4 First IF Check

a. Using a 50-ohm termination, connect the RF voltmeter to rear panel jack J4001.

b. Connect the signal generator to J3001.

c. Set the output level from the signal generator to -40 dBm.

d. Observe RF voltmeter reading of approximately 2 mV.

5.4.5 RF Casting Internal Signal Levels Check

a. Remove casting covers. (Refer to paragraph 5.1.)

b. Tune signal generator to 1 MHz, and, using the 50- to 75-ohm adapter, set the level to 0 dBm.

c. Using the 75-ohm feed-through termination, connect the signal generator to J3005.

d. Remove all attenuation by dialing -99 dB with the level selectors.

e. Using the RF voltmeter with a high impedance probe, measure levels along the signal path and observe the following:

WARNING

The voltage figures given are typical levels. It should be kept in mind that the Boonton voltmeter is a very wide-band instrument.

1. No voltage drop across the Hi-Z attenuators.

2. A near zero gain across the balanced input amplifier.

3. A level of 100 mV at the input to the low-pass filter.

4. A near zero gain across the first mixer.

5. An input level of 45 mV to the first IF amplifier.

f. Lower the drive from the signal generator to -30 dBm to prevent saturation of the first IF amplifier.

g. Observe drive of 115 mV to the second mixer.

5.5 Troubleshooting

If a malfunction should develop in the CE-21, there usually is some external evidence, such as the failure of a meter to indicate or failure to calibrate. The external indications are listed in the first column of table 5-4; the probable cause is described in column 2; and the remedy is indicated in column 3. If the suggested remedy for a given problem does not correct the error, ship the faulty printed circuit board or the entire instrument to the Cushman Electronics Customer Service Department or to the service point given in paragraph 2.4.

NOTE

If more than one CE-21 is available, board substitution is the quickest way to localize the problem.

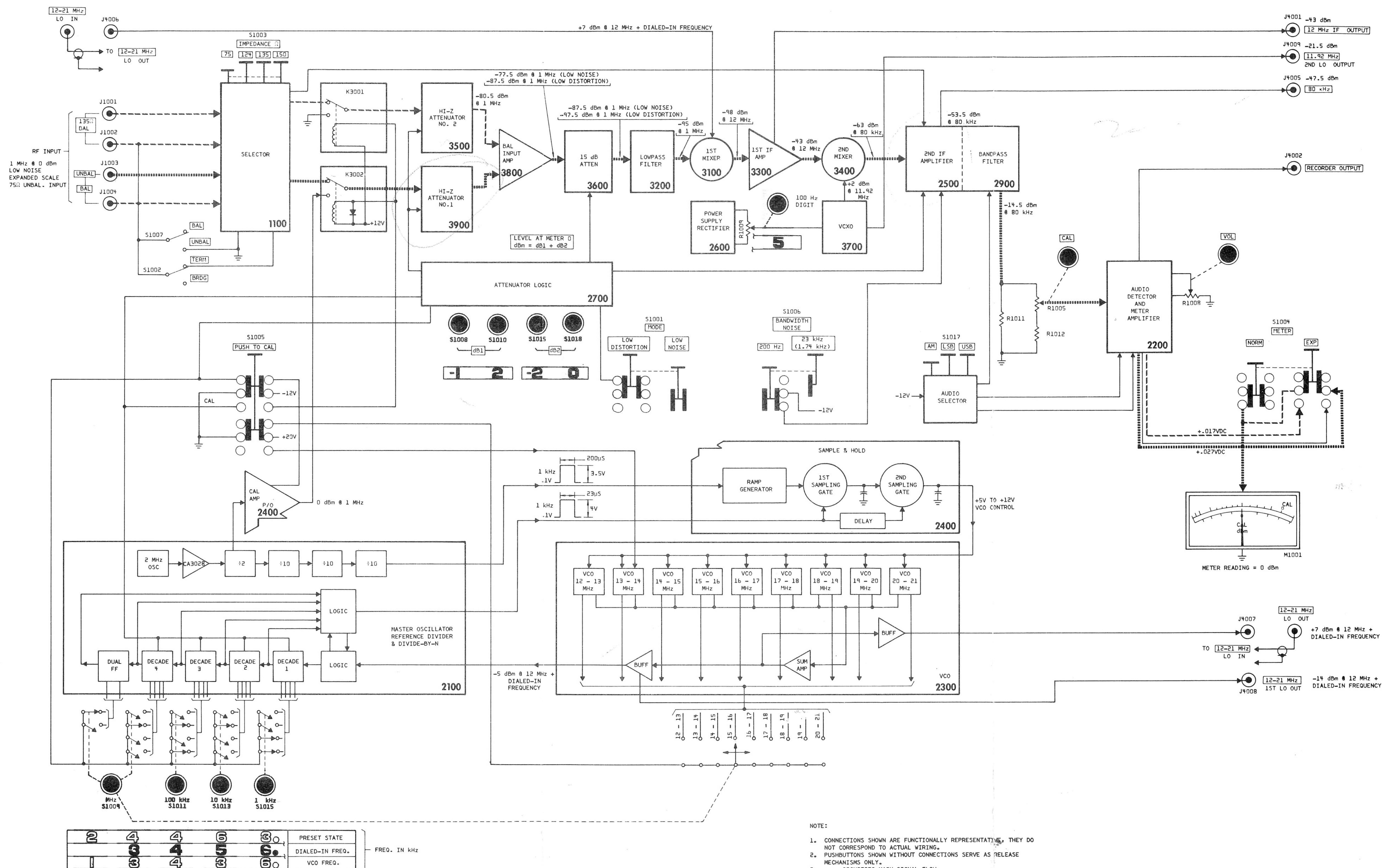


Figure 5-1 RF Casting, Troubleshooting: Gain Block Diagram

5601-0021

Table 5-4 Troubleshooting

Trouble	Probable Cause	Remedy
UNLOCKED indicator lit.	Dialed-in frequency greater than 9.2 MHz.	Check frequency selector switch setting.
UNLOCKED indicator lit at certain MHz dial setting.	Associated MHz oscillator circuit defective.	Check VCO circuit and adjust as necessary. (Refer to paragraph 5.3.4.)
UNLOCKED indicator on at all dialed-in frequencies.	Defective board in frequency synthesizer loop (2100, 2300, 2400).	Check VCO and master oscillator boards. (Refer to paragraphs 5.3.3 and 5.3.4.)
CE-21 will not calibrate; audio and relays operative (relay action is audible when CAL button is depressed).	+5V power supply defective.	Adjust +5V power supply. (Refer to paragraph 5.3.2.)
CE-21 will not calibrate; audio operative, relays inoperative.	-12V power supply defective.	Adjust -12V power supply. (Refer to paragraph 5.3.2.)
CE-21 will not calibrate; audio and relays inoperative.	+20V power supply defective.	Adjust +20V power supply. (Refer to paragraph 5.3.2.)
CE-21 will calibrate, but will not receive; high level of receiver noise in audio.	Input or impedance selector switches not correctly positioned. Input cabling defective.	Check input and impedance selector switches for correct positioning. Check for defective cabling in input section.
CE-21 will calibrate, but will not receive; low level of receiver noise in audio.	Defective receiver board -- 2nd IF amplifier/200 Hz bandpass filter (2500); 2nd IF amplifier/2.3 kHz bandpass filter (2900); or meter amplifiers/audio amplifiers (2200).	Ship board to manufacturer or service point for repair.
No audio in USB, LSB, or AM.	Defective circuit on meter amplifiers/audio amplifiers board (2200).	Check meter, adjust meter amplifiers board as necessary. (Refer to paragraph 5.3.7.)
CE-21 will not calibrate and will not receive.	Internal jumper not connected between J4006 and J4007, or external cable not connected between J4006 and J4007.	Ensure that internal jumper or external cable connected if CE-21 used alone or with CE-22 or CE-26.

SECTION 6
SCHEMATICS, PARTS LISTS, AND COMPONENT LAYOUTS

6.1 Schematics, Parts Lists, and Component Layouts

Parts 6.3.1 through 6.3.23 on the following pages provide schematics, parts lists, and component layouts for the various subassemblies described in Section 4.

6.2 Reference Designators

B	board
C	capacitor
CR	diode
DS	device signaling (lamp)
F	fuse
FL	filter
IC	integrated circuit
J	jack
K	relay
L	inductor, RF, choke
M	meter
FP	front panel
P	plug
Q	transistor
R	resistor
RP	rear panel
S	switch
T	transformer
TB	terminal board
TP	test point
V	vacuum tube
WT	wiring tiepoint
Y	crystal

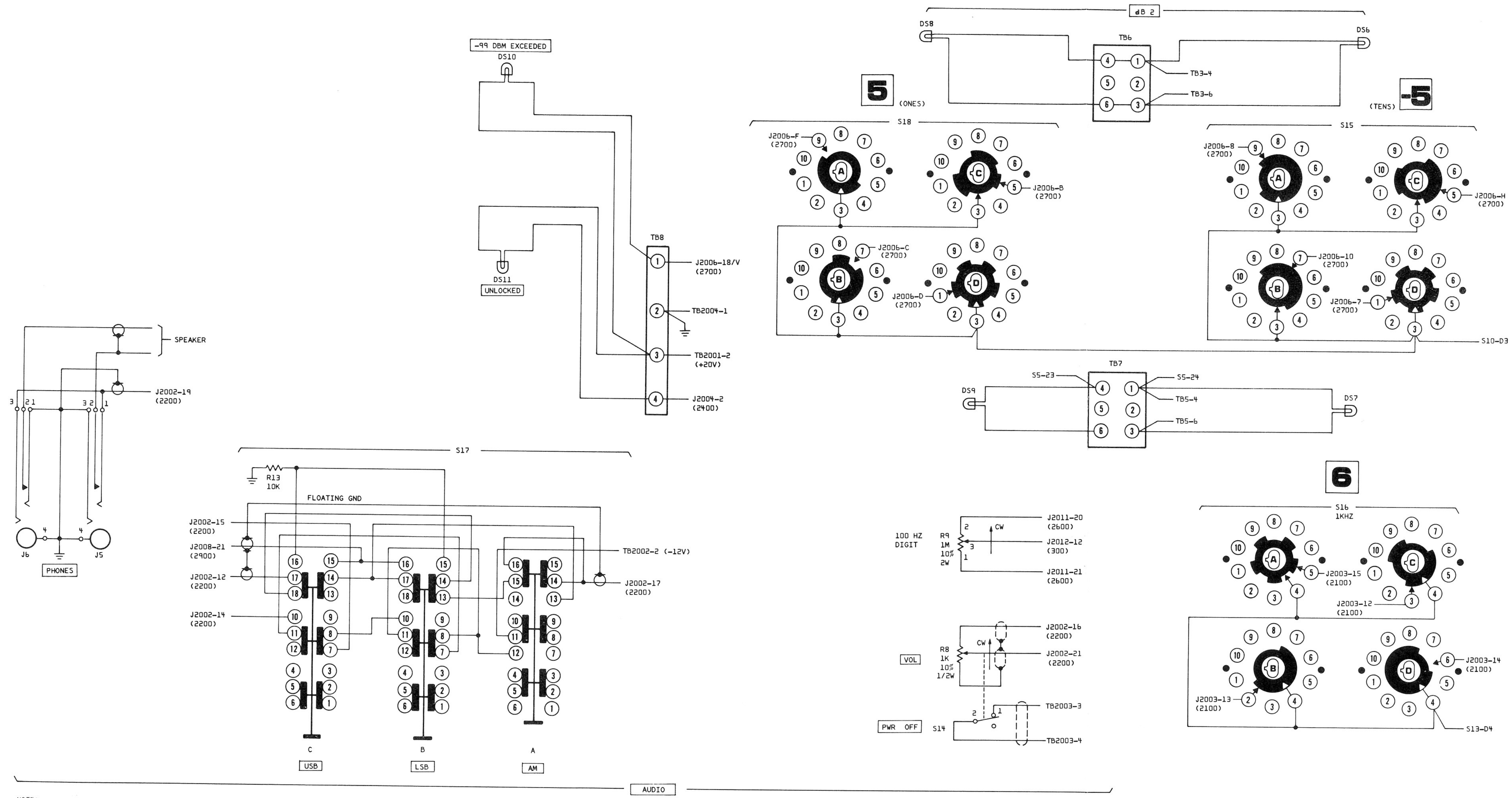
6.3 Abbreviations

AC	alternating current
ADJ	adjust
AFC	automatic frequency control
AM	amplitude modulation
Amp	amperes
Ampl	amplifier
Atten	attenuator
BAL	balanced
BP	bandpass
BRDG	bridging
BUFF	buffer
CAL	calibrate, calibration
CCW	counterclockwise
Cer	ceramic
Comp	composition
CRT	cathode-ray tube
CW	clockwise
dB or DB	decibel
dBm or DBM	dB referred to 0 = 1 milliwatt
DBrnC	dB referred to noise, C-message
DC	direct current
Elect	electrolytic
EXP	expanded
EXT	external
F	farads
FM	frequency modulation
Ge	germanium
GND	ground(ed)
H	Henries
Hz or HZ	hertz
IF	intermediate frequency
INT	internal
k	kilo - 10^3
kHz or KHZ	kilohertz
LO	local oscillator (signal)
Log	logarithmic
LPF	low-pass filter
LSB	lower sideband
m	milli - 10^{-3}
M	mega - 10^6
Met	metal
MFR	manufacturer
MHz or MHZ	megahertz
N	nano - 10^{-9}
N/C	normally closed
N/O	normally open
NORM	normal
P	peak
PC	printed circuit
pF or PF	picofarads - 10^{-12} farads
P/O	part of
Poly	polystyrene or polyester
Pot	potentiometer
p-p	peak-to-peak
PWR	power
Rect	rectifier
RF	radio frequency
SB	slo-blo
Si	silicon
Tant	tantalum
TERM	terminated
TYP	typical
μ	micro - 10^{-6}
UNBAL	unbalanced
UNREG	unregulated
USB	upper sideband
V	volts
Var	variable
VCO	voltage-controlled oscillator
VCXO	voltage-controlled crystal oscillator
VOL	volume
W/	with
W	watts
WW	wirewound
W/O	without

6.3.1 Front Panel

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1000	Assembly, Front Panel	7003-0027	Cushman	
	Front Panel	2800-0038	Cushman	
	DIALS			
	Molded Indicator, for S1008	2750-0022-04	Cushman	
	Molded Indicator, for S1010	2750-0022-05	Cushman	
	Molded Indicator, for S1015	2750-0022-02	Cushman	
	Molded Indicator, for S1018	2750-0022-05	Cushman	
	Molded Indicator, for S1009	2750-0022-05	Cushman	
	Molded Indicator, for S1011	2750-0022-05	Cushman	
	Molded Indicator, for S1013	2750-0022-05	Cushman	
	Molded Indicator, for S1016	2750-0022-05	Cushman	
	Molded Indicator, for R1009	2750-0022-03	Cushman	
	HOLDERS			
	Lamp, for T-1 Bulb for DS10	1965-0007	Display Device	101BWXXXRO
	Lamp, for T-1 Bulb for DS11	1965-0007	Display Device	101BWXXXRO
	Lamp, for T-1 Bulb for DS12	1965-0008	Display Device	101BWXXXTA15
	JACKS			
J1/J2	Twin Phone	2586-0008	Trimm	92N-1009B
J3	Coaxial	2586-0009	Trompeter	J3DW
J4	Coaxial	2586-0009	Trompeter	J3DW
J5	Phone, 3-Conductor Single Closed Circuit, Audio	2586-0011	Switchcraft	113B
J6	Phone, 3-Conductor Single Closed Circuit, Audio	2586-0011	Switchcraft	113B
	KNOBS			
	1/2" Round, w/ind line, Blk, R1005	2780-0023	Cushman	
	Round, Black, S1008, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1010, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1015, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1018, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1009, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1011, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1013, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1016, 0.713 dia.	2780-0024	Cushman	
	Round, Black, R1009, 0.713 dia.	2780-0024	Cushman	
	1/2" round, w/ind line, Black, S1014, R1008	2780-0023	Cushman	
	LAMPS			
DS1	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS2	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS3	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS4	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS5	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS6	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS7	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS8	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS9	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS10	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
DS11	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
DS12	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
	METER			
M1	Level	1402-0023	Cushman	

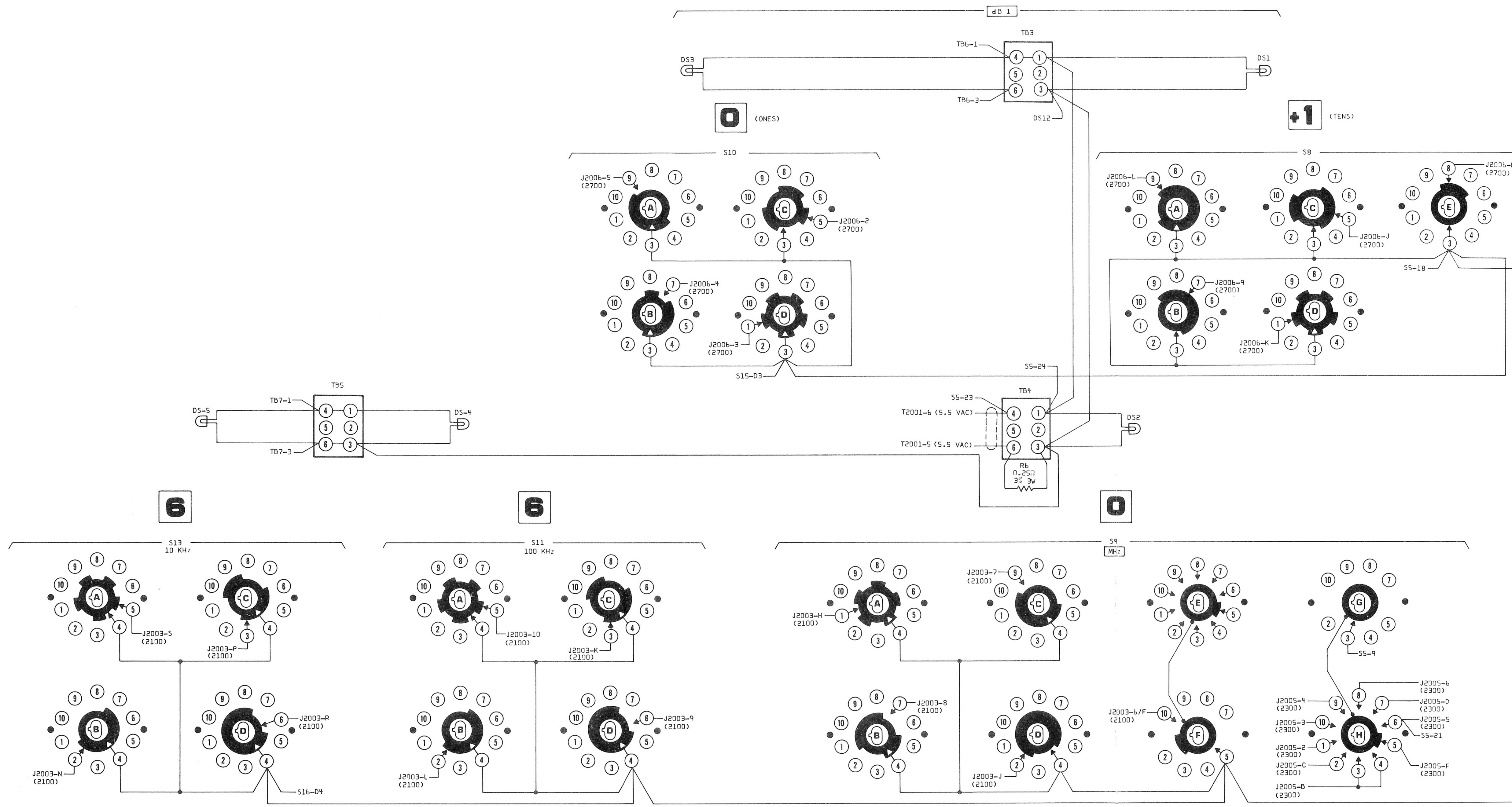
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	RESISTORS			
R1-R4	Not Used			
R5	Pot., 1kΩ ±10%, 1/2W	1203-0035	Allen-Bradley	WA4G032S102UA
R6	WW., 0.25Ω ±3%, 3W	1159-0003	Dale	RS-2B
R7	Not Used			
R8/S14	Pot., 1kΩ	1203-0034	Cushman	
R9	Pot., Cer, Met, 1MΩ ±10%, 2W	1203-0033	Cushman	
R10	Not Used			
R11	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R12	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R14	Comp, 18Ω ±5%, 1/4W	1066-1805	Allen-Bradley	CB1805
	SHIELD			
	Input Switch Assembly	2657-0030	Cushman	
	SWITCHES			
S1	Pushbutton	1852-0002	Cushman	
S2	2-Position Lever	1851-0045	Cushman	
S3	Pushbutton (Assembly)	7011-0006	Cushman	
S4/S5	Pushbutton	1852-0003	Cushman	
S6	Pushbutton	1852-0002	Cushman	
S7	2-Position Lever	1851-0045	Cushman	
S8	Rotary, 5 Pole 10 Position	1851-0042	Cushman	
S9	Rotary, 1-MHz Digit	1851-0057	Cushman	
S10	Rotary, 4 Pole 10 Position	1851-0043	Cushman	
S11	3-4-5 & 6 Digit	1851-0027	Cushman	
S12	Not Used			
S13	3-4-5 & 6 Digit	1851-0027	Cushman	
S14/R8	SPST	1203-0034	Cushman	
S15	Rotary, 4 Pole 10 Position	1851-0041	Cushman	
S16	3-4-5 & 6 Digit	1851-0027	Cushman	
S17	Pushbutton	1852-0004	Cushman	
S18	Rotary, 4 Pole 10 Position	1851-0043	Cushman	
	TERMINAL BOARDS			
TB1	Tiepoint	1760-0001	Cinch Jones	51
TB2	Tiepoint	1760-0002	Cinch Jones	51A
TB3	6 Terminal Type	1760-0014	Cushman	
TB4	6 Terminal Type	1760-0014	Cushman	
TB5	6 Terminal Type	1760-0014	Cushman	
TB6	6 Terminal Type	1760-0014	Cushman	
TB7	6 Terminal Type	1760-0014	Cushman	
TB8	4 Lug Type	1760-0019	Cinch Jones	53F
	DIODES			
CR1	Si, 100V PIV	1281-0023	ITT	IN4002



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

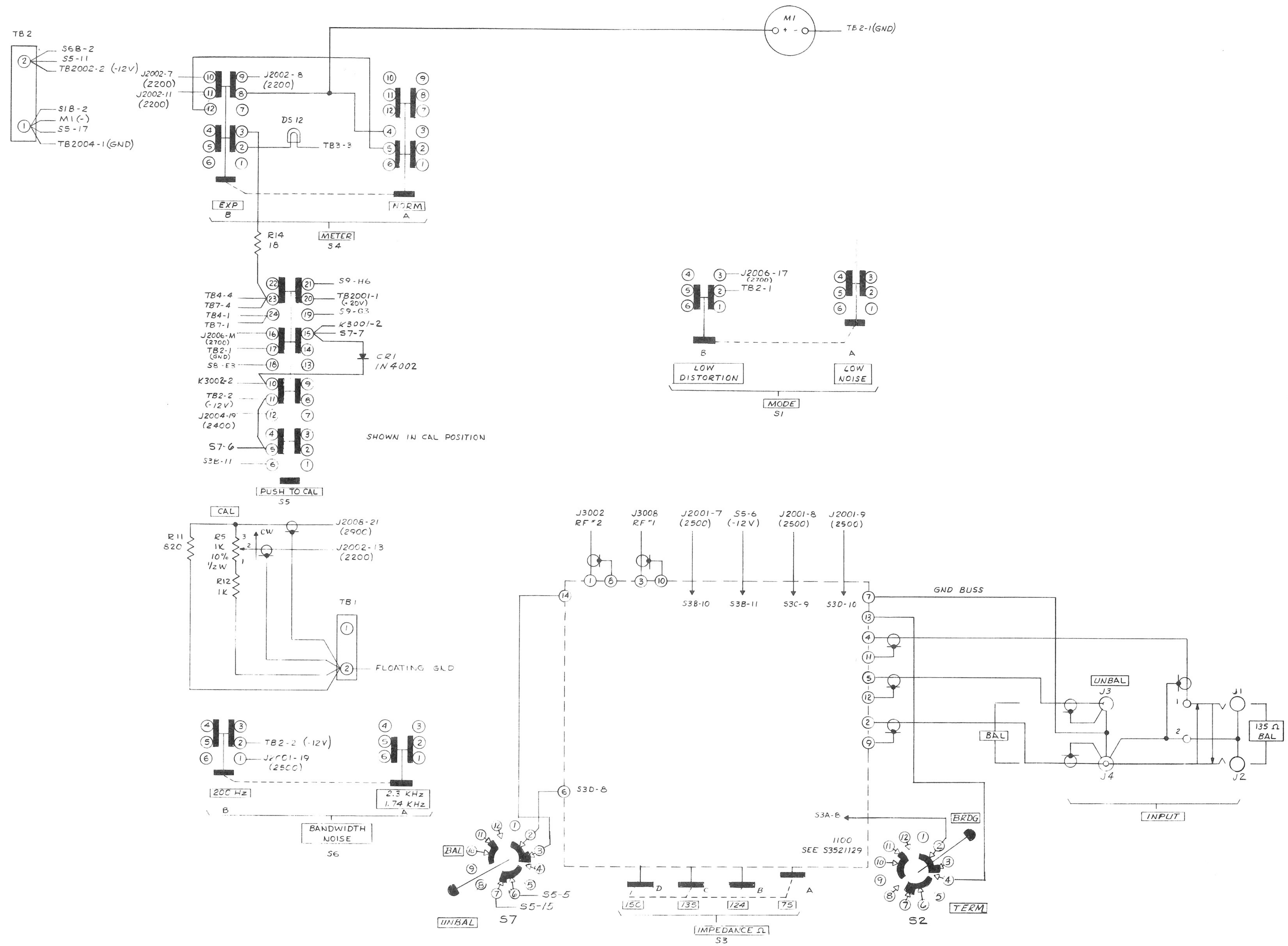
Figure 6-1 Front Panel



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

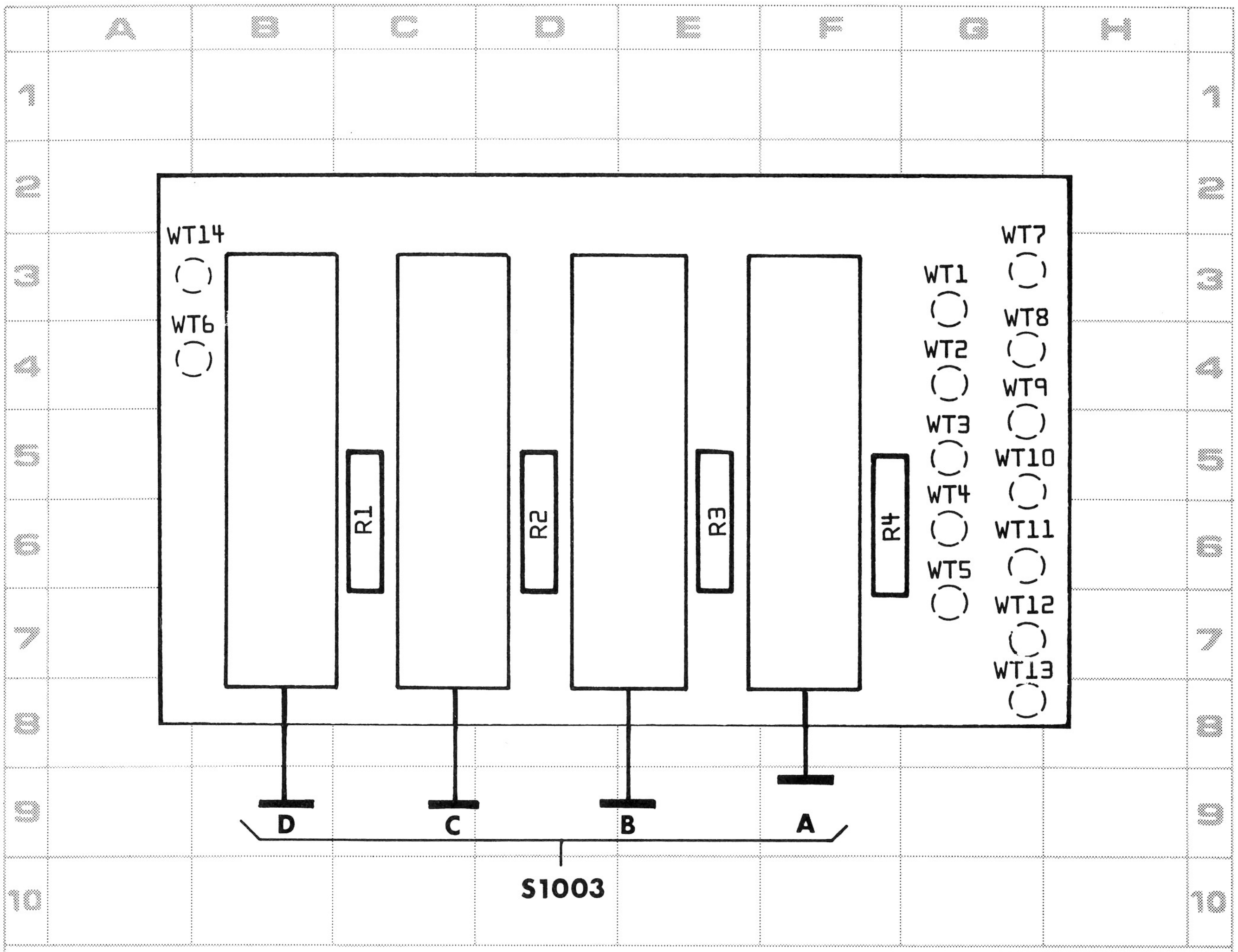
Figure 6-1 Front Panel (continued)



NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

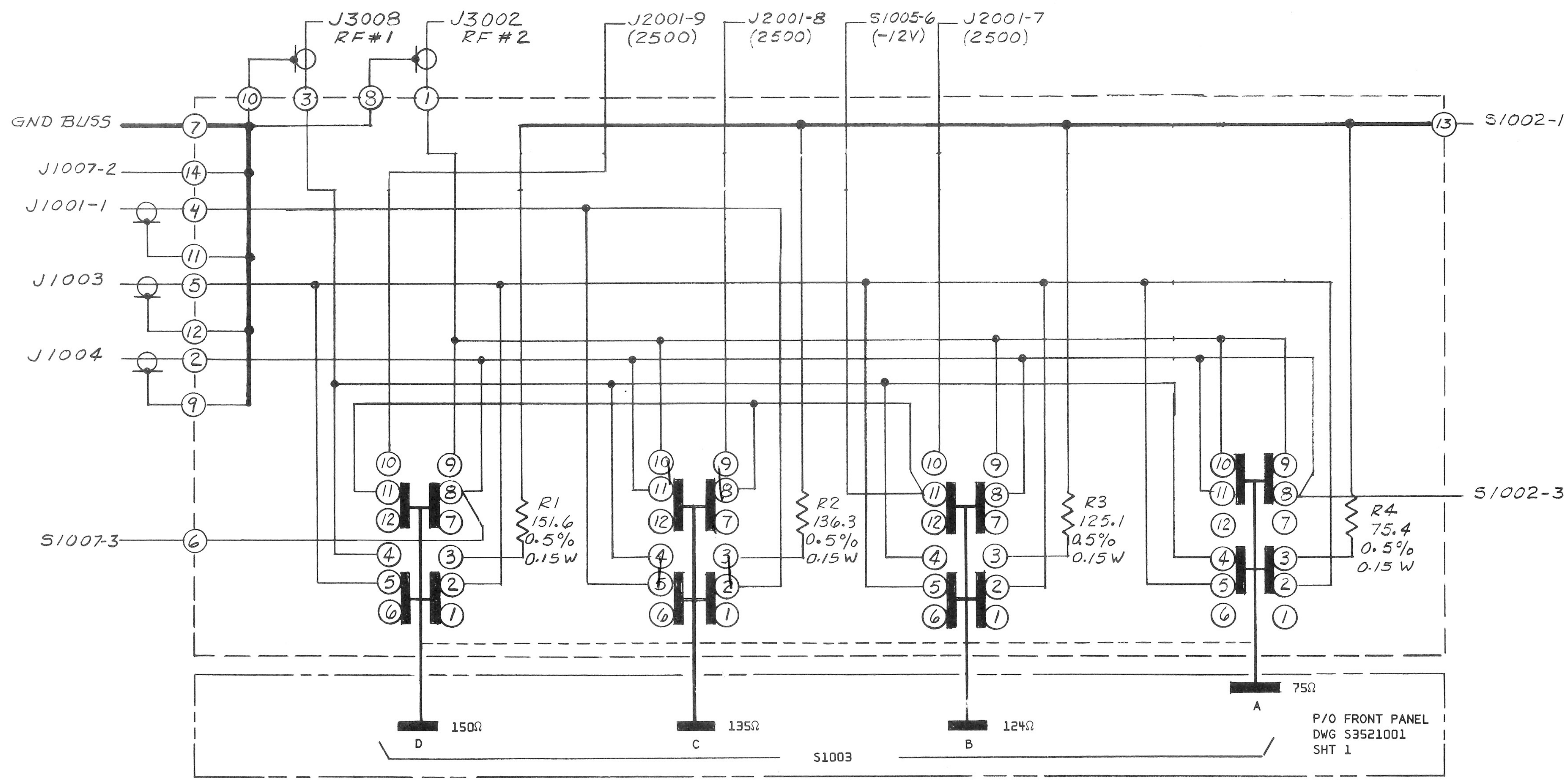
Figure 6-1 Front Panel (continued)



REF DESIG	GRID LOC
RESISTORS	
R1	C-6
R2	D-6
R3	E-6
R4	F-6

6.3.2 Impedance Selector (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1100	Board Assy., Impedance Selector	7001-0080	Cushman	
	Board, Printed Circuit	1780-0129	Cushman	
	RESISTORS			
R1	Met. Film, 151.6Ω ±0.5%, 0.1 W	1074-0017	Dale	MF 1/10-T-9
R2	Met. Film, 136.3Ω ±0.5%, 0.1 W	1074-0016	Dale	MF 1/10-T-9
R3	Met. Film, 125.1Ω ±0.5%, 0.1 W	1074-0015	Dale	MF 1/10-T-9
R4	Met. Film, 75.4Ω ±0.5%, 0.1 W	1074-0009	Dale	MF 1/10-T-9



NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-2 Impedance Selector, Schematic Diagram

6.3.3 Main Chassis

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2000	Assembly, Main Chassis	7007-0003	Cushman	
	Main Chassis	2475-0039	Cushman	
	CAPACITORS			
C1	Cer, 0.01 µF ±20%, 1400V	1005-0051	Sprague	125L-S10
C2	Cer, 0.002 µF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C3	Cer, 0.002 µF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C4	Cer, 0.01 µF ±20%, 1400V	1005-0051	Sprague	125L-S10
	CONNECTORS			
J1	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J2	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J3	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J4	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J5	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J6	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J7	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J8	Female, 22-pin	2535-0018	Viking	2VK22D/1-1
J9-J10	Not Used			
J11	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J12	Panel Mount, 14 contact, Recpt.	2535-0031	Amphenol	57-40140
	INDUCTORS			
L1	Choke, 100 µH ±20%, 2 Amp	1585-0040	Miller	B-6021
L2	Choke, 100 µH ±20%, 2 Amp	1585-0040	Miller	B-6021
	TERMINAL BOARDS			
TB1	Tiepoint	1760-0004	Cinch Jones	52
TB2	Tiepoint	1760-0004	Cinch Jones	52
TB3	Tiepoint, 7-pin	1760-0013	Cinch Jones	55C
TB4	Grounding Wheel, #10 x 0.75 Dia.	3766-0018	Jan Engring.	1001
TB5	Stand-Off Terminal, 9/16"	3001-0012	Lerco	6141
TB6	Lug, #10	3766-0013	Federal	1910
	TRANSFORMER			
T1	Power	1575-0009	Cushman	
	TRANSISTORS			
Q1	Si, NPN	1271-0001	RCA	2N3054
Q2	Si, NPN	1271-0001	RCA	2N3054
Q3	Si, NPN	1271-0001	RCA	2N3054
	TRANSISTOR SOCKETS			
XQ1	TO 66, for Q1	2606-0002	UID	PTS-4
XQ2	TO 66, for Q2	2606-0002	UID	PTS-4
XQ3	TO 66, for Q3	2606-0002	UID	PTS-4

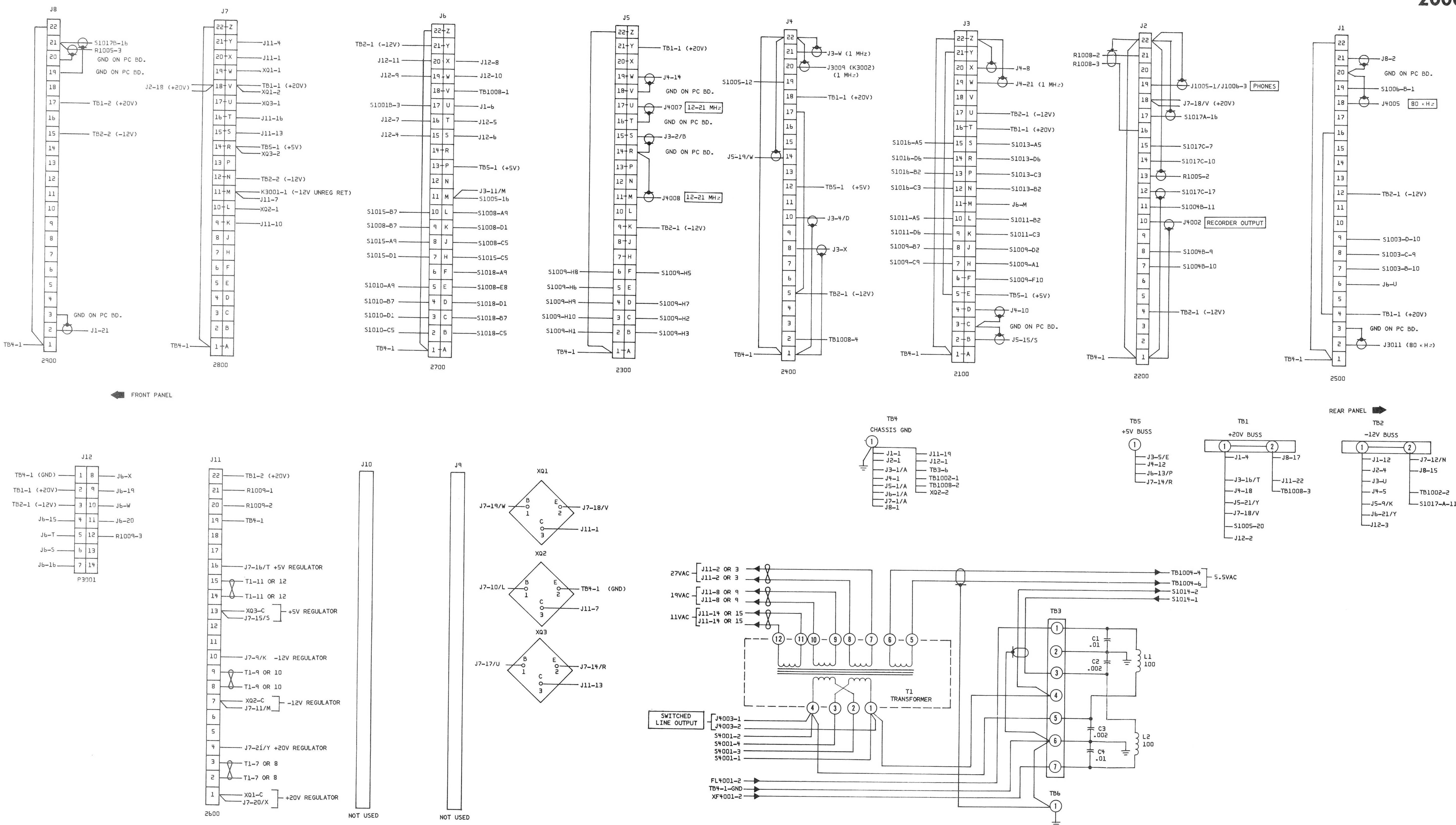
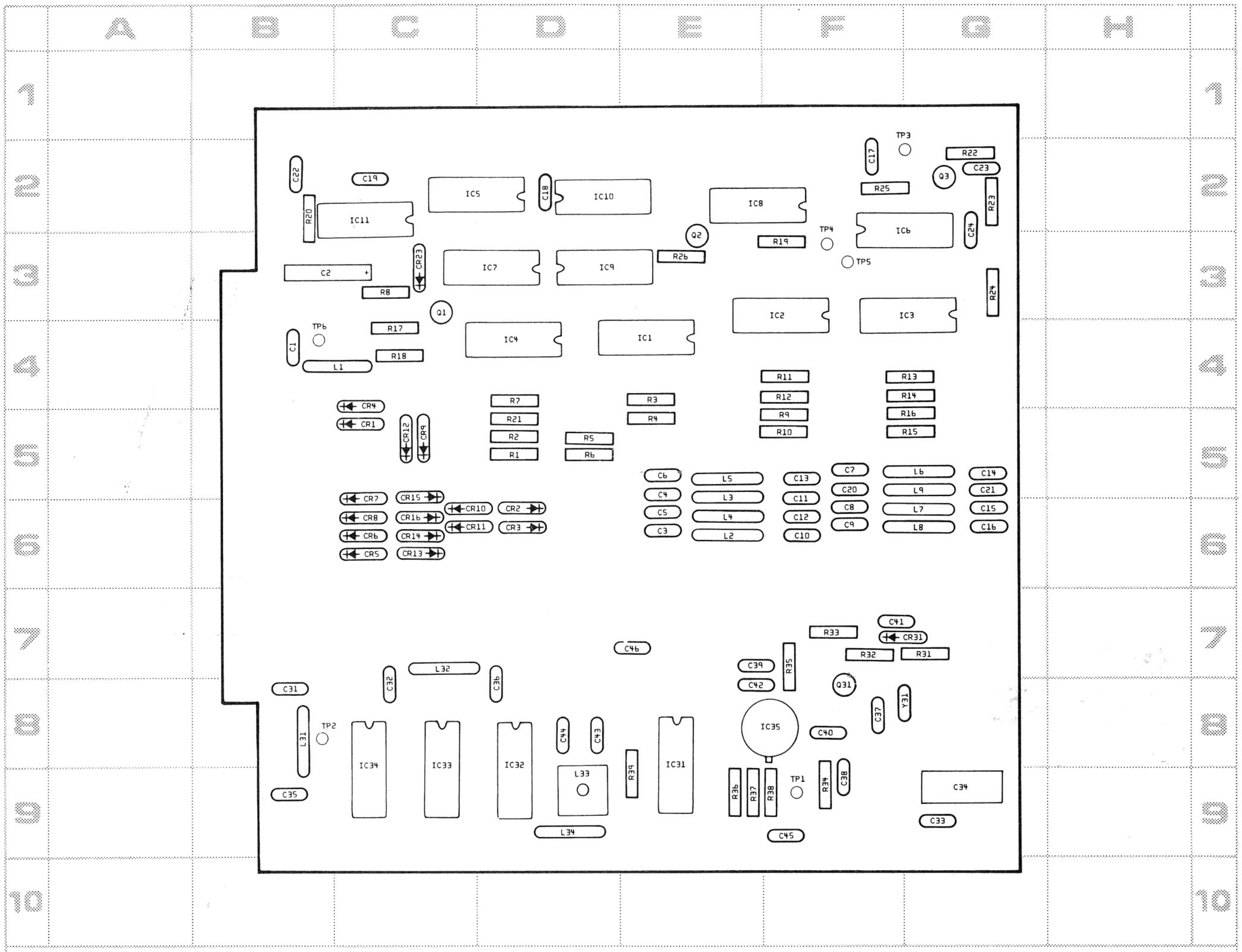


Figure 6-3 Main Chassis, Interconnection Diagram

6.3.4 Master Oscillator/Divide-by-N/Reference Divider



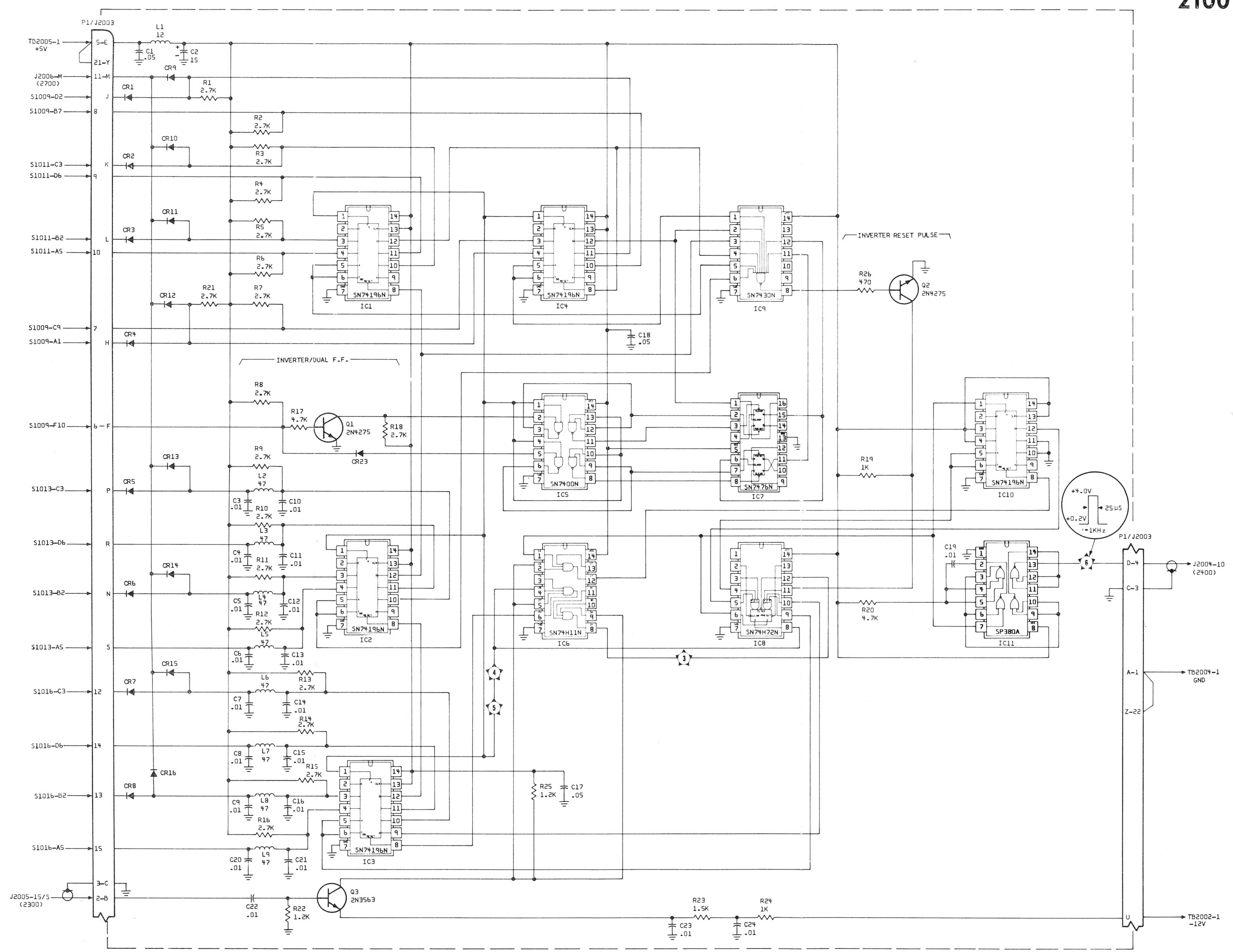
REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C20	F-5	CR14	C-6	IC5	C-2	R12	F-4
C1	B-4	C21	G-5	CR15	C-5	IC6	F-2	R13	G-4
C2	B-3	C22	B-2	CR16	C-6	IC7	D-3	R14	G-4
C3	E-6	C23	G-2	CR23	C-3	IC8	E-2	R15	G-5
C4	E-5	C24	G-3	INDUCTORS		IC9	D-3	R16	G-5
C5	E-6	DIODES		L1	C-4	IC10	D-2	R17	C-4
C6	E-5	CR1	C-5	L2	E-6	IC11	C-2	R18	C-4
C7	F-5	CR2	D-6	L3	E-5	RESISTORS		R19	F-3
C8	F-6	CR3	D-6	L4	E-6	R1	D-5	R20	B-2
C9	F-6	CR4	C-4	L5	E-5	R2	D-5	R21	D-5
C10	F-6	CR5	C-6	L6	G-5	R3	E-4	R22	G-2
C11	F-5	CR6	C-6	L7	G-6	R4	E-5	R23	G-2
C12	F-6	CR7	C-5	L8	G-6	R5	D-5	R24	G-3
C13	F-5	CR8	C-6	L9	G-5	R6	D-5	R25	F-2
C14	G-5	CR9	C-5	INT CKTS		R7	D-4	R26	E-3
C15	G-6	CR10	C-6	IC1	E-4	R8	C-3	TRANSISTORS	
C16	G-6	CR11	C-6	IC2	F-3	R9	F-5	Q1	C-3
C17	F-2	CR12	C-5	IC3	G-3	R10	F-5	Q2	E-3
C18	D-2	CR13	C-6	IC4	D-4	R11	F-4	Q3	G-2
C19	C-2								

REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		L31	B-8
C31	B-8	L32	C-7
C32	C-8	L33	D-9
C33	G-9	L34	D-9
C34	G-9	INT CKTS	
C35	B-9	IC31	E-8
C36	D-8	IC32	D-8
C37	F-8	IC33	C-8
C38	F-9	IC34	C-8
C39	E-7	IC35	F-8
C40	F-8	RESISTORS	
C41	F-7	R31	G-7
C42	E-8	R32	F-7
C43	D-8	R33	F-7
C44	D-8	R34	F-9
C45	F-9	R35	F-7
C46	E-7	R36	E-9
CRYSTAL		R37	E-9
Y31	F-8	R38	F-9
DIODE		R39	E-9
CR31	G-7	TRANSISTOR	
INDUCTORS		Q31	F-8

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2100	Board Assy., Master Oscillator/ Reference Divider/Divide By N	7001-0052	Cushman	
	Board, Printed Circuit	1780-0110	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C2	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C6	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C9	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C12	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C13	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C17	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C19	Poly, 0.01 μF ±10%, 200V	1008-0043	Sprague	225P10392XA3
C20	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C21	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C22	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C23	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C24	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C25-C30	Not Used			
C31	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C32	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C33	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C34	Var, Piston Glass, 0.8 -12 pF,750V	1001-0007	JFD	VC31GWY
C35	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C36	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C37	Polyester, 0.0012 μF ±10%, 100V	1008-0016	Sprague	225P12291WA3
C38	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C39	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C40	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C41	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C42	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C43	Mica, 680 pF ±5%, 500V	1002-0022	Elmenco	DM15-F-681J
C44	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C45	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C46	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
	CRYSTAL			
Y31	2.0 MHz	2035-0008	Cushman	
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4	Ge, Signal	1282-0005	ITT	G633
CR5	Ge, Signal	1282-0005	ITT	G633

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CR6	Ge, Signal	1282-0005	ITT	G633
CR7	Ge, Signal	1282-0005	ITT	G633
CR8	Ge, Signal	1282-0005	ITT	G633
CR9	Ge, Signal	1282-0005	ITT	G633
CR10	Ge, Signal	1282-0005	ITT	G633
CR11	Ge, Signal	1282-0005	ITT	G633
CR12	Ge, Signal	1282-0005	ITT	G633
CR13	Ge, Signal	1282-0005	ITT	G633
CR14	Ge, Signal	1282-0005	ITT	G633
CR15	Ge, Signal	1282-0005	ITT	G633
CR16	Ge, Signal	1282-0005	ITT	G633
CR17-CR22	Not Used			
CR23	Ge, Signal	1282-0005	ITT	G633
CR24-CR30	Not Used			
CR31	Si, Zener	1281-0007	Continental Device	1N957
	INDUCTORS			
L1	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
L2	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L3	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L4	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L5	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L6	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L7	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L8	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L9	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L10	Not Used			
L11-L30	Not Used			
L31	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
L32	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L33	Var, 35 - 60 μH	1596-0006	Cushman	
L34	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
	INTEGRATED CIRCUITS			
IC1	Presettable Decade	2025-0016	TI	SN74196N
IC2	Presettable Decade	2025-0016	TI	SN74196N
IC3	Presettable Decade	2025-0016	TI	SN74196N
IC4	Presettable Decade	2025-0016	TI	SN74196N
IC5	TTL NAND Gate	2025-0003	TI	SN7400
IC6	TTL AND Gate	2025-0017	TI	SN74H11N
IC7	TTL Dual Flip-Flop	2025-0005	TI	SN7476N
IC8	TTL Dual Flip-Flop	2025-0023	TI	SN74H72N
IC9	TTL NAND Gate	2025-0004	TI	SN7430N
IC10	Presettable Decade	2025-0016	TI	SN74196N
IC11	Quad 2-Input NOR Gate	2025-0019	Signetics	SP380A
IC12-IC30	Not Used			
IC31	TTL Dual Flip-Flop	2025-0007	TI	SN7472N
IC32	TTL Decade Counter	2025-0002	TI	SN7490N
IC33	TTL Decade Counter	2025-0002	TI	SN7490N
IC34	TTL Decade Counter	2025-0002	TI	SN7490N
IC35	Ampl, RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R4	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R5	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R6	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R9	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R14	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R15	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R16	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R17	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R19	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R20	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R22	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R23	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R24	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R25	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R26	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R27-R30	Not Used			
R31	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R32	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R33	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R34	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R35	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R36	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R37	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R38	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R39	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
	TRANSISTORS			
Q1	Si, NPN	1272-0016	Fairchild	2N4275
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, NPN	1272-0022	Fairchild	2N3563
Q4-Q30	Not Used			
Q31	Si, NPN	1272-0016	Fairchild	2N4275

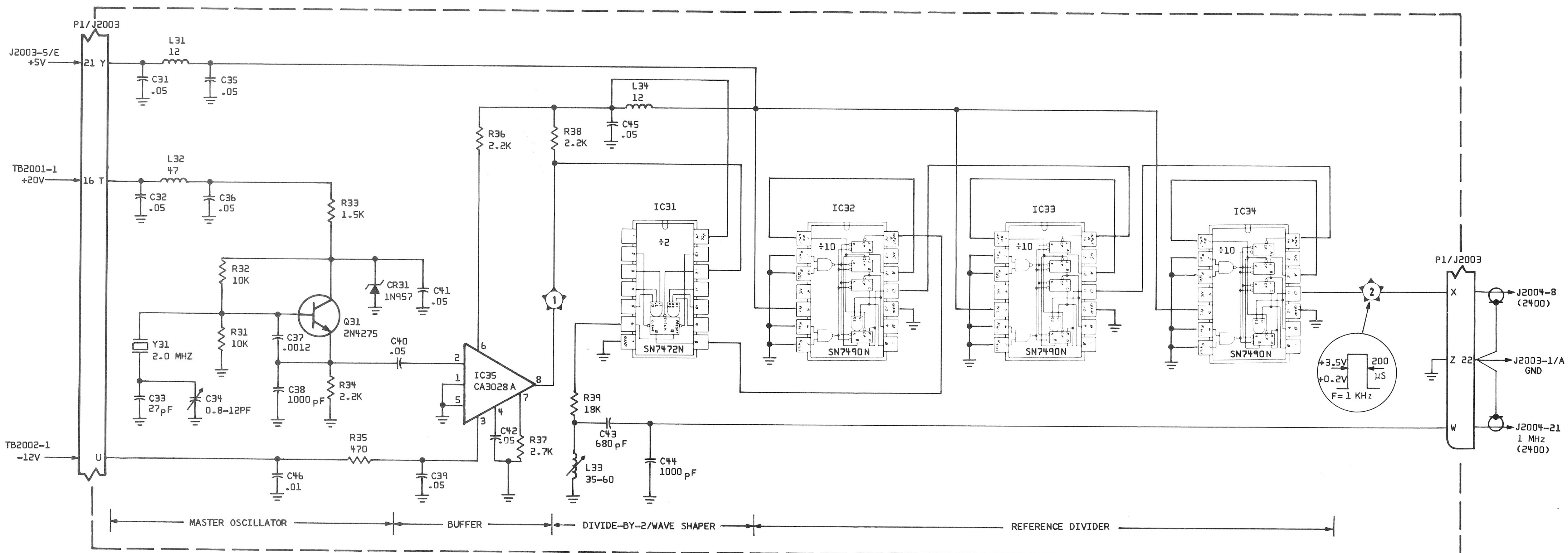


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. ALL DIODES ARE G633 UNLESS OTHERWISE NOTED.

Figure 6-4 Master Oscillator/Divide-by-N, Reference Divider, Schematic Diagram

5601-0021

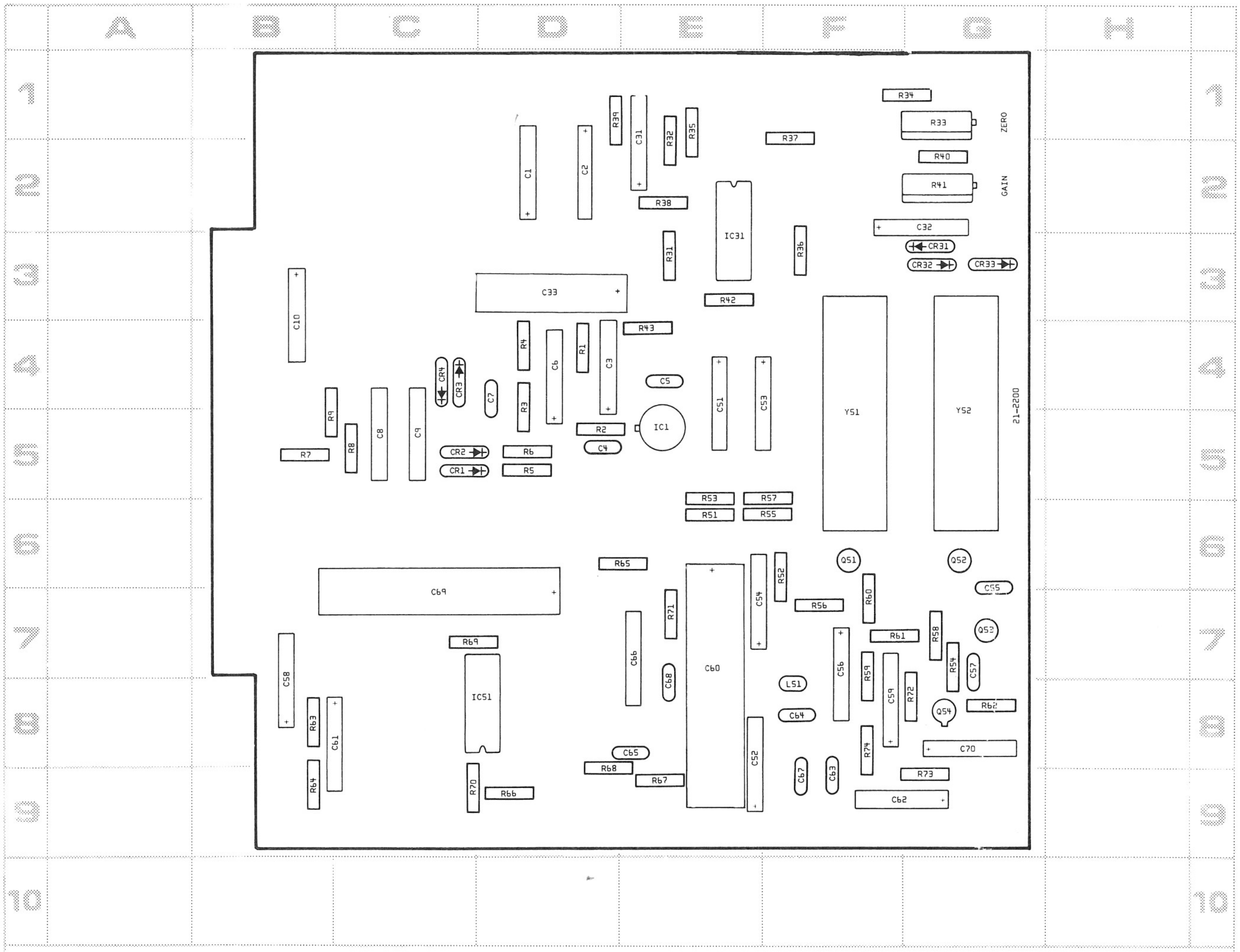


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-4 Master Oscillator/Divide-by-N, Reference Divider, Schematic Diagram (continued)

6.3.5 Meter Amplifiers/Audio Amplifiers



REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		CR3	C-4
C1	D-2	CR4	C-4
C2	D-2	INT CKT	
C3	D-4	IC1	E-5
C4	D-5	RESISTORS	
C5	E-4	R1	D-4
C6	D-4	R2	D-5
C7	D-4	R3	D-5
C8	C-5	R4	D-4
C9	C-5	R5	D-5
C10	B-4	R6	D-5
DIODES		R7	B-5
CR1	C-5	R8	C-5
CR2	C-5	R9	B-5

REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		R32	E-2
C31	E-2	R33	G-1
C32	G-2	R34	G-1
C33	D-3	R35	E-1
DIODES		R36	F-3
CR31	G-3	R37	F-1
CR32	G-3	R38	E-2
CR33	G-3	R39	D-1
INT CKT		R40	G-2
IC31	E-3	R41	G-2
RESISTORS		R42	E-3
R31	E-3	R43	E-4

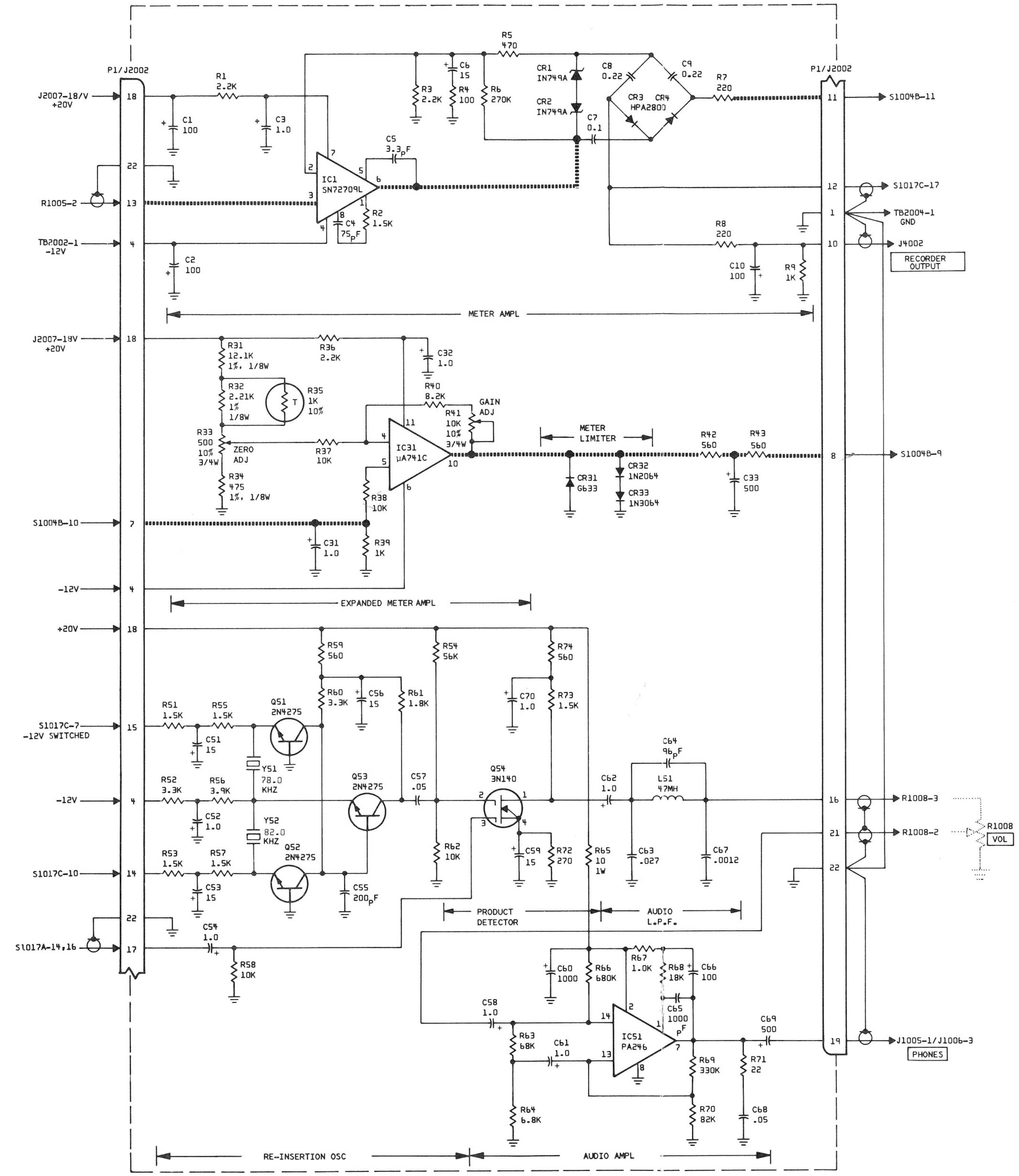
REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C65	E-8	R52	F-6	R66	D-9
C51	E-4	C66	E-7	R53	E-6	R67	E-9
C52	E-8	C67	F-9	R54	G-7	R68	D-9
C53	E-4	C68	E-8	R55	F-6	R69	C-7
C54	E-7	C69	C-7	R56	F-7	R70	C-9
C55	G-6	C70	G-8	R57	F-6	R71	E-7
C56	F-7	CRYSTALS		R58	G-7	R72	G-8
C57	G-7	Y51	F-5	R59	F-7	R73	G-9
C58	B-8	Y52	G-5	R60	F-7	R74	F-8
C59	F-8	INDUCTOR		R61	F-7	TRANSISTORS	
C60	E-7	L51	F-8	R62	G-8	Q51	F-6
C61	C-8	INT CKT		R63	B-8	Q52	G-6
C62	F-9	IC51	D-8	R64	B-9	Q53	G-7
C63	F-9	RESISTORS		R65	E-6	Q54	G-8
C64	F-8	R51	E-6				

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2200	Board Assy., Meter Amplifier/ Audio Amplifier	7001-0053	Cushman	
	Board, Printed Circuit	1780-0111	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C3	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C4	Mica, 75 pF ±5%, 500V	1002-0025	Elmenco	DM15-E-750J
C5	Cer, 3.3 pF ±0.25%, 500V	1005-0011	Erie	301-000-C0J0-339C
C6	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C7	Polyester, 0.1 μF ±10%, 100V	1008-0031	Sprague	225P-10491WA3
C8	Polyester, 0.22 μF ±10%, 75V	1008-0047	Sprague	225P-2249R75Z
C9	Polyester, 0.22 μF ±10%, 75V	1008-0047	Sprague	225P-2249R75Z
C10	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C11-C30	Not Used			
C31	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C32	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C33	Elect., 500 μF +100 -10%, 15V	1013-0014	San Fernando	MAC15.501
C34-C50	Not Used			
C51	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C52	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C53	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C54	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C55	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco	DM15-F-201J
C56	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C57	Cer, 0.05 μF +80 -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C58	Elect., 1.0 μF +75 -10%, 25V	1013-0004	Sprague	30D-105G025BA2
C59	Elect., 15 μF +75 -10%, 12V	1013-0015	Sprague	30D-156G012BA2
C60	Elect., 1000 μF +150 -10%, 25V	1014-0006	Matsushita	ECE-B25V1000N
C61	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C62	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C63	Polyester, 0.027 μF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C64	Mica, 96 pF ±1%, 500V	1002-0049	Elmenco	DM15-F-960F
C65	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C66	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C67	Polyester, 0.0012 μF ±10%, 100V	1008-0016	Sprague	225P12291WA3
C68	Cer, 0.05 μF +80 -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C69	Elect., 500 μF +100 -10%, 25V	1014-0002	Richey	JA-13-500-25-8-P
C70	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
	CRYSTALS			
Y1-Y50	Not Used			
Y51	78.0 kHz	2035-0006	Cushman	
Y52	82.0 kHz	2035-0007	Cushman	
	DIODES			
CR1	Si, Zener	1281-0034	Motorola	1N749A
CR2	Si, Zener	1281-0034	Motorola	1N749A
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR5-CR30	Not Used			
CR31	Ge, Signal	1282-0005	ITT	G633
CR32	Si, High Speed	1281-0013	Transitron	1N3064
CR33	Si, High Speed	1281-0013	Transitron	1N3064

6.3.5 Meter Amplifiers/Audio Amplifiers (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	INDUCTOR			
L1-L50	Not Used			
L51	Choke, RF, 47 mH	1585-0044	Cambion	3635-57
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
IC2	Not Used			
IC3	Not Used			
IC4	Not Used			
IC5	Not Used			
IC6-IC30	Not Used			
IC31	Ampl, Operational	2025-0022	TI	72741N
IC32-IC50	Not Used			
IC51	Ampl, Audio, 5W	2025-0024	GE	PA246
	RESISTORS			
R1	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R2	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R3	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R4	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R5	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R6	Comp, 270kΩ ±5%, 1/4W	1066-2745	Allen-Bradley	CB2745
R7	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R8	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R10-R30	Not Used			
R31	Met. Film, 12.1kΩ ±1%, 1/8W	1075-0011	Electra	MF5C-D-1212-F
R32	Met. Film, 2.21kΩ ±1%, 1/8W	1075-0010	Electra	MF5C-D-2211-F
R33	Trimmer,Cer,Met,500Ω±10%,3/4W	1215-0011	Helitrim	89WR500
R34	Met. Film, 475Ω ±1%, 1/8W	1075-0023	Electra	MF5C-D-4750-F
R35	Thermistor, 1kΩ ±10%	1253-0002	Veco	31E2
R36	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R37	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R38	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R39	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R40	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R41	Trimmer,Cer,Met,10kΩ±10%,3/4W	1215-0014	Helitrim	89WR10K
R42	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R43	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R44-R50	Not Used			
R51	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R52	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R53	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R54	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R55	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R56	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R57	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R58	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R59	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R60	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R61	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R62	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R63	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley	CB6835
R64	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R65	Comp, 10Ω ±5%, 1W	1068-1005	Allen-Bradley	GB1005

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 680kΩ ±5%, 1/4W	1066-6845	Allen-Bradley	CB6845
R67	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R68	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R69	Comp, 330kΩ ±5%, 1/4W	1066-3345	Allen-Bradley	CB3345
R70	Comp, 82kΩ ±5%, 1/4W	1066-8235	Allen-Bradley	CB8235
R71	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R72	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R73	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R74	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
	TRANSISTORS			
Q1-Q50	Not Used			
Q51	Si, NPN	1272-0016	Fairchild	2N4275
Q52	Si, NPN	1272-0016	Fairchild	2N4275
Q53	Si, NPN	1272-0016	Fairchild	2N4275
Q54	Si, MOS FET, Dual Gate	1272-0028	RCA	3N140

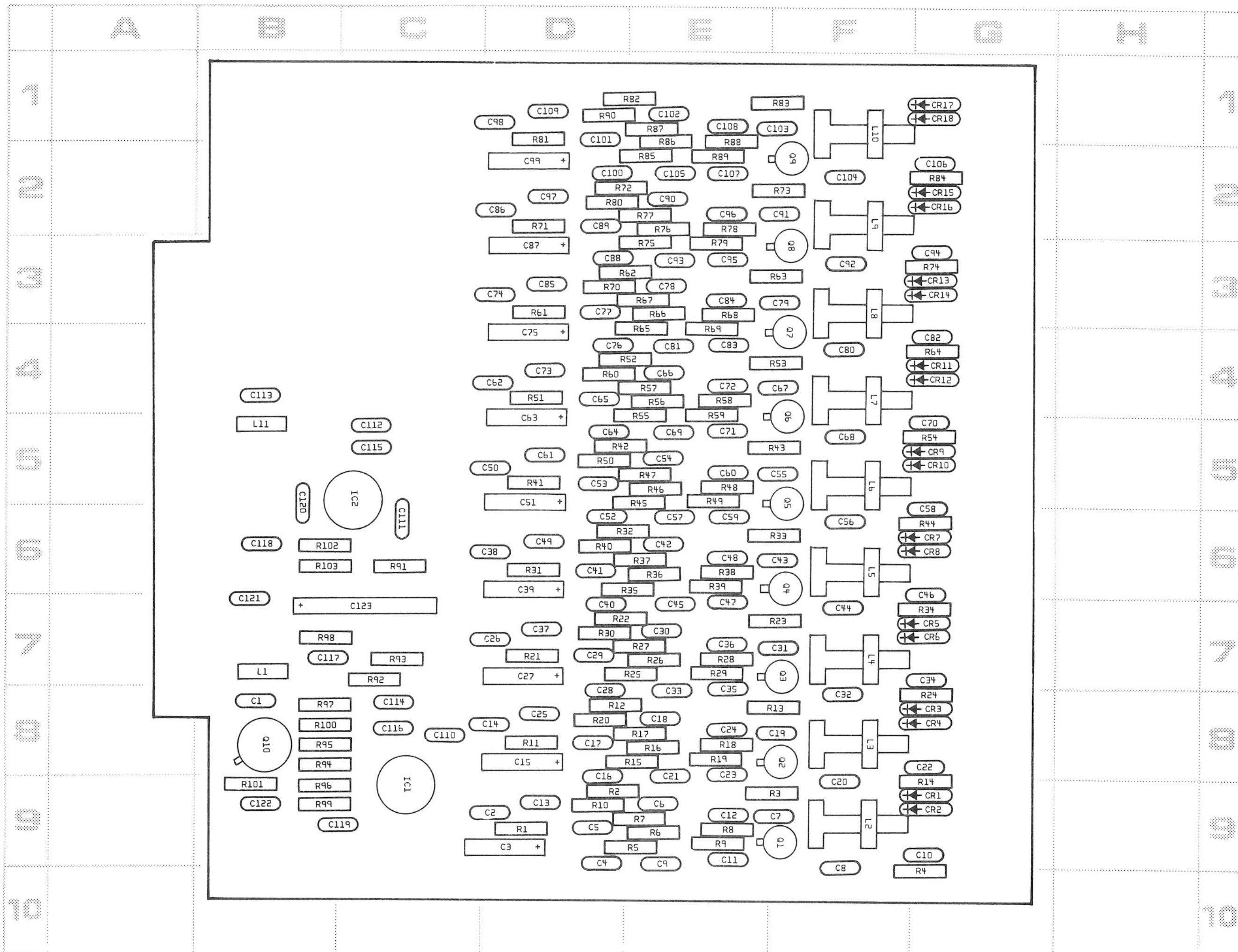


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-5 Meter Amplifiers/Audio Amplifiers, Schematic Diagram

5601-0021-1



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C31	F-7	C62	D-4	C93	E-3	C123	C-7	L10	F-1	R25	E-7	R55	E-5	R85	E-2
C1	B-8	C32	F-8	C63	D-5	C94	G-3	DIODES		L11	B-5	R26	E-7	R56	E-4	R86	E-1
C2	D-9	C33	E-8	C64	D-5	C95	E-3	CR1	G-9	INT CKTS		R27	E-7	R57	E-4	R87	E-1
C3	D-9	C34	G-7	C65	D-4	C96	E-2	CR2	G-9	IC1	C-9	R28	E-7	R58	E-4	R88	E-1
C4	D-9	C35	E-8	C66	E-4	C97	D-2	CR3	G-8	IC2	C-5	R29	E-7	R59	E-5	R89	E-2
C5	D-9	C36	E-7	C67	F-4	C98	D-1	CR4	G-8	RESISTORS		R30	D-7	R60	D-4	R90	D-1
C6	E-9	C37	D-7	C68	F-5	C99	D-2	CR5	G-7	R1	D-9	R31	D-6	R61	D-3	R91	C-6
C7	F-9	C38	D-6	C69	E-5	C100	D-2	CR6	G-7	R2	D-9	R32	D-6	R62	E-3	R92	C-7
C8	F-9	C39	D-6	C70	G-5	C101	D-1	CR7	G-6	R3	F-9	R33	F-6	R63	F-3	R93	C-7
C9	E-9	C40	D-7	C71	E-5	C102	E-1	CR8	G-6	R4	G-10	R34	G-7	R64	G-4	R94	B-8
C10	G-9	C41	D-6	C72	E-4	C103	F-1	CR9	G-5	R5	E-9	R35	E-6	R65	E-4	R95	B-8
C11	E-9	C42	E-6	C73	D-4	C104	F-2	CR10	G-5	R6	E-9	R36	E-6	R66	E-3	R96	B-9
C12	E-9	C43	F-6	C74	D-3	C105	E-2	CR11	G-4	R7	E-9	R37	E-6	R67	E-3	R97	B-8
C13	D-9	C44	F-7	C75	D-4	C106	G-2	CR12	G-4	R8	E-9	R38	E-6	R68	E-3	R98	B-7
C14	D-8	C45	E-7	C76	D-4	C107	E-2	CR13	G-3	R9	E-9	R39	E-6	R69	E-4	R99	B-9
C15	D-8	C46	G-6	C77	D-3	C108	E-1	CR14	G-3	R10	D-9	R40	D-6	R70	D-3	R100	B-8
C16	D-8	C47	E-7	C78	E-3	C109	D-1	CR15	G-2	R11	D-8	R41	D-5	R71	D-2	R101	B-9
C17	D-8	C48	E-6	C79	F-3	C110	C-8	CR16	G-2	R12	D-8	R42	D-5	R72	D-2	R102	B-6
C18	E-8	C49	D-6	C80	F-4	C111	C-6	CR17	G-1	R13	F-8	R43	F-5	R73	F-2	R103	B-6
C19	F-8	C50	D-5	C81	E-4	C112	C-5	CR18	G-1	R14	G-9	R44	G-6	R74	G-3	TRANSISTORS	
C20	F-9	C51	D-5	C82	G-4	C113	B-4	INDUCTORS		R15	E-8	R45	E-5	R75	E-3	Q1	F-9
C21	E-8	C52	D-6	C83	E-4	C114	C-8	L1	B-7	R16	E-8	R46	E-5	R76	E-2	Q2	F-8
C22	G-8	C53	D-5	C84	E-3	C115	C-5	L2	F-9	R17	E-8	R47	E-5	R77	E-2	Q3	F-7
C23	E-8	C54	E-5	C85	D-3	C116	C-8	L3	F-8	R18	E-8	R48	E-5	R78	E-2	Q4	F-6
C24	E-8	C55	F-5	C86	D-2	C117	D-7	L4	F-7	R19	E-8	R49	E-5	R79	E-3	Q5	F-5
C25	D-8	C56	F-6	C87	D-3	C118	B-6	L5	F-6	R20	D-8	R50	D-5	R80	D-2	Q6	F-5
C26	D-7	C57	E-6	C88	D-3	C119	C-9	L6	F-5	R21	D-7	R51	D-4	R81	D-1	Q7	F-4
C27	D-7	C58	G-6	C89	D-2	C120	B-5	L7	F-4	R22	D-7	R52	D-4	R82	E-1	Q8	F-3
C28	D-8	C59	E-6	C90	E-2	C121	B-7	L8	F-3	R23	F-7	R53	F-4	R83	F-1	Q9	F-2
C29	D-7	C60	E-5	C91	F-2	C122	B-9	L9	F-2	R24	G-8	R54	G-5	R84	G-2	Q10	B-8
C30	E-7	C61	D-5	C92	F-3												

6.3.6 Voltage-Controlled Oscillator (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2300	Board Assy., Voltage Controlled Oscillator (VCO)	7001-0091	Cushman	
	Board, Printed Circuit	1780-0133	Cushman	
	CAPACITORS			
C1	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C4	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C5	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C6	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C7	Mica, 5pF ±0.5pF, 500V	1002-0028	Elmenco	DM15-C-050D
C8	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C9	Mica, 220pF±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C10	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C11	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C13	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C16	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C17	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C18	Cer., 0.01μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C19	Mica, 10pF ±5%, 500V	1002-0016	Elmenco	DM15-C-100J
C20	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C21	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C22	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C23	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C24	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C25	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C26	Cer, 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C27	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C28	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C29	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C30	Cer, 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104J
C31	Mica, 15pF ±5%, 500V	1002-0001	Elmenco	DM15-C-150J
C32	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C33	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C34	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C35	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C36	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C37	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C38	Cer, 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C39	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C40	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C41	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C42	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C43	Mica, 18pF ±5%, 500V	1002-0014	Elmenco	DM15-C-180J
C44	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C45	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C46	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C47	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C48	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C49	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C50	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z

6.3.6 Voltage-Controlled Oscillator (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C51	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C52	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C53	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C54	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C55	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C56	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C57	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C58	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C59	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C60	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C61	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C62	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C63	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C64	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C65	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C66	Cer., 0.01μF ±10%, 100V	1005-0007	Aerovox	CK06BX104K
C67	Mica, 27pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C68	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C69	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C70	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C71	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C72	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C73	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C74	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C75	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C76	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C77	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C78	Cer., 0.01μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C79	Mica, 27pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C80	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C81	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C82	Mica, 1000pF ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C83	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C84	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C85	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C86	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C87	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C88	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C89	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C90	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C91	Mica, 39pF ±5%, 500V	1002-0018	Elmenco	DM15-E-390J
C92	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C93	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C94	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C95	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C96	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C97	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C98	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C99	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C100	Mica, 100pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J

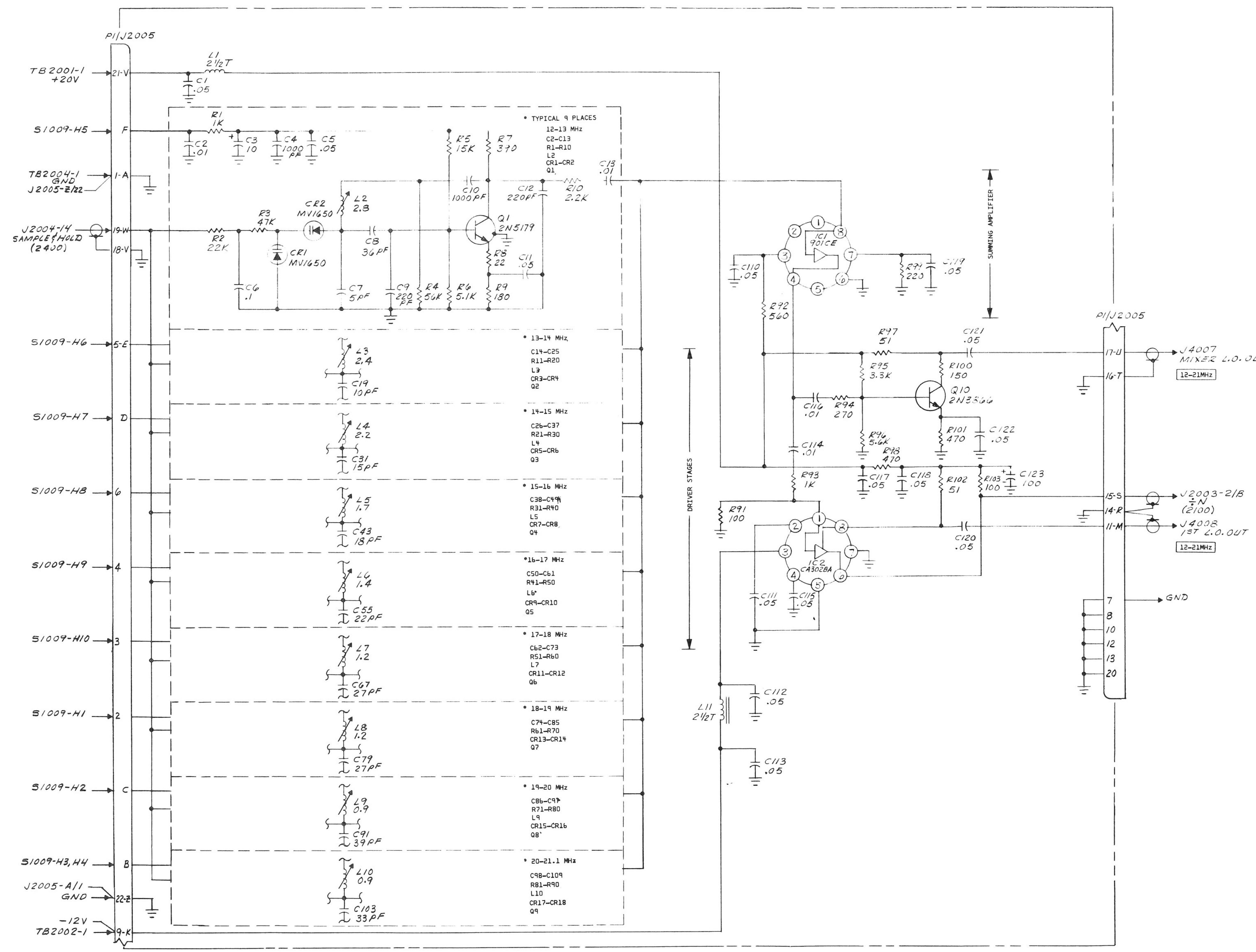
6.3.6 Voltage-Controlled Oscillator (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C101	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C102	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C103	Mica, 33pF ±5%, 500V	1002-0024	Elmenco	DM15-E-330J
C104	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C105	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C106	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C107	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C108	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C109	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C110	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C111	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C112	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C113	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C114	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C115	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C116	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C117	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C118	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C119	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C120	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C121	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C122	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C123	Elect., 100μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
	DIODES			
CR1	Var, 100pF	1281-0037	Motorola	MV1650
CR2	Var, 100pF	1281-0037	Motorola	MV1650
CR3	Var, 100pF	1281-0037	Motorola	MV1650
CR4	Var, 100pF	1281-0037	Motorola	MV1650
CR5	Var, 100pF	1281-0037	Motorola	MV1650
CR6	Var, 100pF	1281-0037	Motorola	MV1650
CR7	Var, 100pF	1281-0037	Motorola	MV1650
CR8	Var, 100pF	1281-0037	Motorola	MV1650
CR9	Var, 100pF	1281-0037	Motorola	MV1650
CR10	Var, 100pF	1281-0037	Motorola	MV1650
CR11	Var, 100pF	1281-0037	Motorola	MV1650
CR12	Var, 100pF	1281-0037	Motorola	MV1650
CR13	Var, 100pF	1281-0037	Motorola	MV1650
CR14	Var, 100pF	1281-0037	Motorola	MV1650
CR15	Var, 100pF	1281-0037	Motorola	MV1650
CR16	Var, 100pF	1281-0037	Motorola	MV1650
CR17	Var, 100pF	1281-0037	Motorola	MV1650
CR18	Var, 100pF	1281-0037	Motorola	MV1650
	INDUCTORS			
L1	Choke, 2-1/2 Turns	1586-0001	Ferroxcube	VK200-10/3B
L2	Var., 2.8μH ±5%	1596-0054	Dale	1DH-1041
L3	Var., 2.4μH ±5%	1596-0056	Dale	1DH-1041
L4	Var., 2.2μH ±5%	1596-0038	Dale	1DH-1041-8
L5	Var., 1.7μH ±5%	1596-0046	Dale	1DH-1041

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
L6	Var., 1.4μH ±5%	1596-0045	Dale	1DH-1041
L7	Var., 1.2μH ±5%	1596-0044	Dale	1DH-1041-26
L8	Var., 1.2μH ±5%	1596-0044	Dale	1DH-1041-26
L9	Var., 0.9μH ±5%	1596-0043	Dale	1DH-1041
L10	Var., 0.9μH ±5%	1596-0043	Dale	1DH-1041
L11	Choke, 2-1/2 turns	1586-0001	Ferroxcube	VK200-10/3B
	INTEGRATED CIRCUITS			
IC1	Ampl., UHF Linear Circuit	2025-0030	Amelco	901CE
IC2	Ampl., RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R2	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R3	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R4	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R5	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R6	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R7	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R8	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R9	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R10	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R12	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R13	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R14	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R15	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R16	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R17	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R18	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R19	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R20	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R21	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R22	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R23	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R24	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R25	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R26	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R27	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R28	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R29	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R30	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R31	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R32	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R33	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R34	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R35	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R36	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R37	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R38	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R39	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R40	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R41	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R42	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R43	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R44	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R45	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R46	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R47	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R48	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R49	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R50	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R51	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R52	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R53	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R54	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R55	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R56	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R57	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R58	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R59	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R60	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R61	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R62	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R63	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R64	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R65	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R66	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R67	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R68	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R69	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R70	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R71	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R72	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R73	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R74	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R75	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R76	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R77	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R78	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R79	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R80	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R81	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R82	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R83	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R84	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R85	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R86	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R87	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R88	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R89	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R90	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R91	Comp., 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R92	Comp., 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R93	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R94	Comp., 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R95	Comp., 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R96	Comp., 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R97	Comp., 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R98	Comp., 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R99	Comp., 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R100	Comp., 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley	CB1515
R101	Comp., 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R102	Comp., 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R103	Comp., 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
	TRANSISTORS			
Q1	Si, NPN	1272-0060	Motorola	2N5179
Q2	Si, NPN	1272-0060	Motorola	2N5179
Q3	Si, NPN	1272-0060	Motorola	2N5179
Q4	Si, NPN	1272-0060	Motorola	2N5179
Q5	Si, NPN	1272-0060	Motorola	2N5179
Q6	Si, NPN	1272-0060	Motorola	2N5179
Q7	Si, NPN	1272-0060	Motorola	2N5179
Q8	Si, NPN	1272-0060	Motorola	2N5179
Q9	Si, NPN	1272-0060	Motorola	2N5179
Q10	Si, NPN	1271-0005	RCA	2N3866

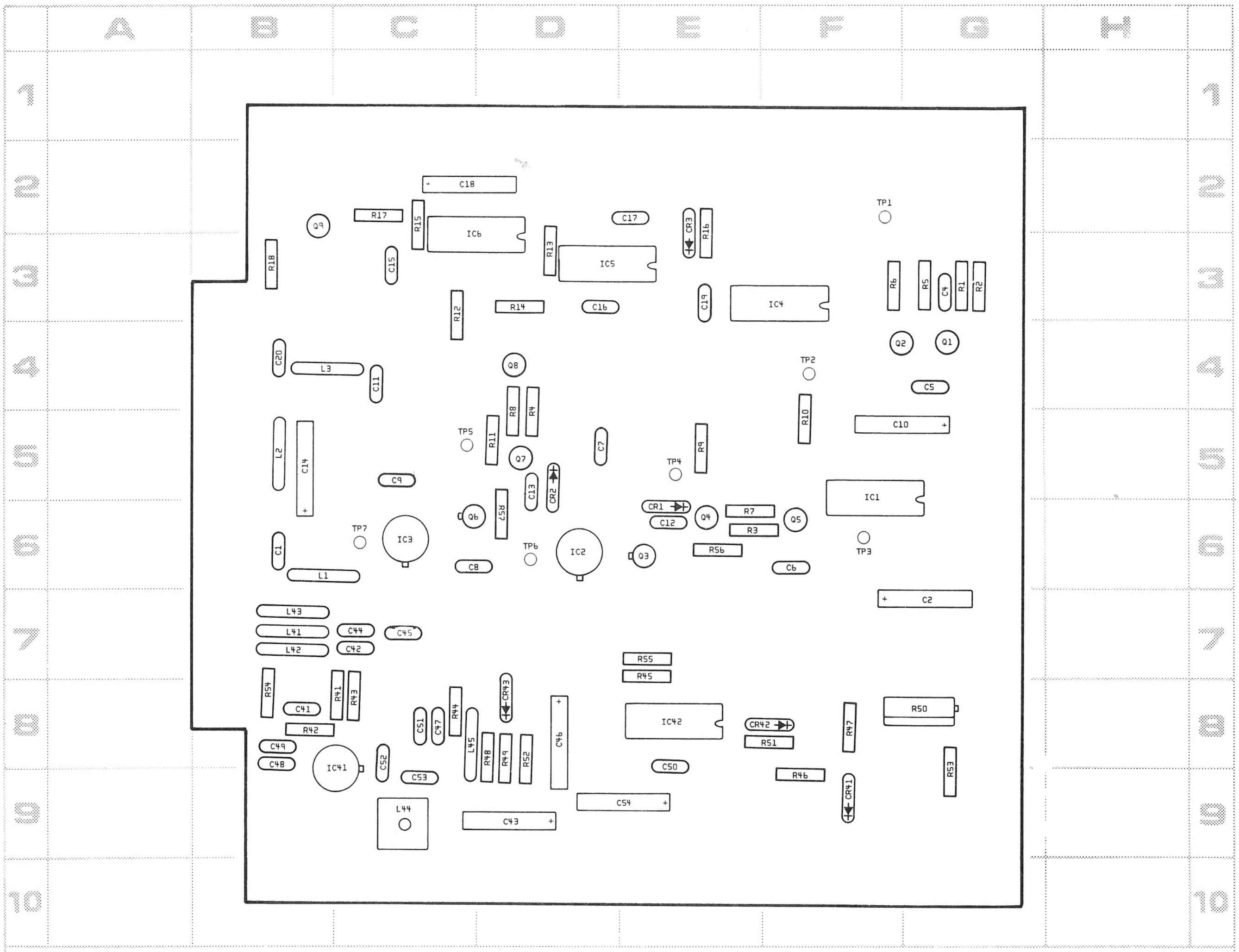


NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN µH UNLESS OTHERWISE NOTED.
4.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-6 Voltage-Controlled Oscillator, Schematic Diagram

6.3.7 Sample-and-Hold/Calibration Amplifier



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		DIODES		R7	E-6	CAPACITORS		L44	C-9
C1	B-6	CR1	E-6	R8	D-5	C41	B-8	L45	C-8
C2	G-7	CR2	D-5	R9	E-5	C42	C-7	INT CKTS	
C3	N/A	CR3	E-2	R10	F-5	C43	D-9	IC41	C-8
C4	G-3	INDUCTORS		R11	D-5	C44	C-7	IC42	E-8
C5	G-4	L1	B-6	R12	C-3	C45	C-7	RESISTORS	
C6	F-6	L2	B-5	R13	D-3	C46	D-8	R41	C-8
C7	D-5	L3	B-4	R14	D-3	C47	C-8	R42	B-8
C8	C-6	INT CKTS		R15	C-2	C48	B-8	R43	C-8
C9	C-5	IC1	F-5	R16	E-3	C49	B-8	R44	C-8
C10	F-5	IC2	D-6	R17	C-2	C50	E-8	R45	E-7
C11	C-4	IC3	C-6	R18	B-3	C51	C-8	R46	F-9
C12	E-6	IC4	F-3	TRANSISTORS		C52	C-8	R47	F-8
C13	D-5	IC5	D-3	Q1	G-4	C53	C-9	R48	D-8
C14	B-5	IC6	C-3	Q2	F-4	C54	E-9	R49	D-8
C15	C-3	RESISTORS		Q3	E-6	DIODES		R50	G-8
C16	D-3	R1	G-3	Q4	E-6	CR41	F-9	R51	F-8
C17	E-2	R2	G-3	Q5	F-6	CR42	F-8	R52	D-8
C18	C-2	R3	E-6	Q6	C-6	CR43	D-8	R53	G-8
C19	E-3	R4	D-5	Q7	D-5	INDUCTORS		R54	B-8
C20	B-4	R5	G-3	Q8	D-4	L41	B-7	R55	E-7
		R6	F-3	Q9	B-2	L42	B-7	R56	E-6
						L43	B-7	R57	D-6

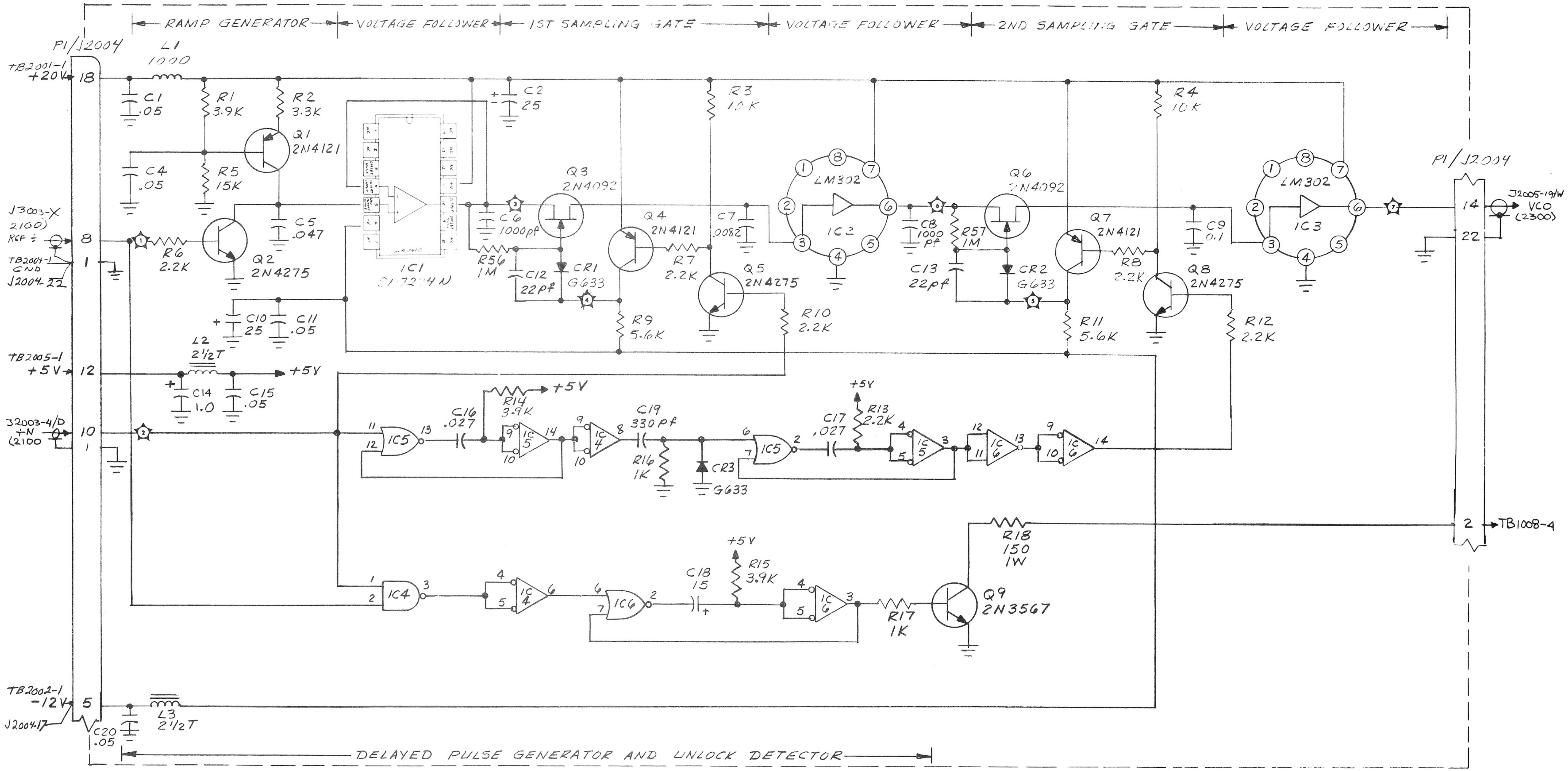
5601-0021-1

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2400	Board Assy., Sample and Hold/ Calibration Amplifier	7001-0090	Cushman	
	Board, Printed Circuit	1780-0132	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C3	Not Used			
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C5	Polyester, 0.047 μF ±10%, 100V	1008-0049	Sprague	225P47391WA3
C6	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C7	Polyester, 0.0082 μF ±10%, 100V	1008-0015	Sprague	225P82291WA3
C8	Mica,1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C9	Polyester, 0.1 μF ±10%, 100V	1008-0031	Sprague	225P10491WA3
C10	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C11	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C13	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C16	Polyester, 0.027 μF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C17	Polyester, 0.027 μF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C18	Elect., 15 μF +75 -10%, 12V	1013-0015	Sprague	30D-156G012BA2
C19	Mica, 330 pF ±5%, 500V	1002-0032	Elmenco	DM15-F-331J
C20	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C21-C40	Not Used			
C41	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C42	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C43	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C44	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C45	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C46	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C47	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C48	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C49	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C50	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C51	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco	DM19-C-272J
C52	Mica, 820 pF ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C53	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco	DM15-E-330J
C54	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4-CR40	Not Used			
CR41	Si, Zener, 6.2V ±5%	1281-0035	Motorola	1N821A
CR42	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR43	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTORS			
L1	Choke, 1 mH ±5%	1585-0020	Delevan	2500-28
L2	Choke, 2-1/2 turns	1586-0001	Ferroxcube	VK200-10/3B
L3	Choke, 2-1/2 turns	1586-0001	Ferroxcube	VK200-10/3B
L4-L40	Not Used			
L41	Choke, 200 μH ±5%	1585-0018	Delevan	1537-92

6.3.7 Sample-and-Hold/Calibration Amplifier (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
L42	Choke, 220 μH ±5%	1585-0018	Delevan	1537-92
L43	Choke, 220 μH ±5%	1585-0018	Delevan	1537-92
L44	Var, 35 - 60 μH	1596-0006	Cushman	
L45	Choke, 2.2 mH ±5%	1585-0004	Miller	70F223A1
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0022	TI	SN72741N
IC2	Voltage Follower	2025-0029	National Semi-conductor	LM302
IC3	Voltage Follower	2025-0029	National Semi-conductor	LM302
IC4	TTL Quad 2-input,POS NAND Gate	2025-0003	TI	SN7400N
IC5	Quad 2-input, NOR Gate	2025-0019	Signetics	SP380A
IC6	Quad 2-input, NOR Gate	2025-0019	Signetics	SP380A
IC7-IC40	Not Used			
IC41	Ampl, RF	2025-0012	RCA	CA3028A
IC42	Ampl, Operational	2025-0022	TI	SN72741N
	RESISTORS			
R1	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R2	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R4	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R5	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R6	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R8	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R9	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R10	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R12	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R13	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R14	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R15	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R16	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R18	Comp, 150Ω ±5%, 1W	1068-1515	Allen-Bradley	GB1515
R19-R40	Not Used			
R41	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R42	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R43	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley	CB2735
R44	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R45	Comp, 1MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R46	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R47	Met. Film, 2.21kΩ ±1%, 1/8W	1075-0010	Electra	MF5C-D-2211-F
R48	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R49	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R50	Trimmer, Cer, Met 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500
R51	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R52	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R53	Met. Film, 619Ω ±1%, 1/8W	1075-0063	Dale	MFF-1/8-T-1
R54	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley	CB7505
R55	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R56	Comp, 1 MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R57	Comp, 1 MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	Si, PNP	1272-0023	Fairchild	2N4121
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, FET, N-Channel	1272-0025	Amelco	2N4092
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, NPN	1272-0016	Fairchild	2N4275
Q6	Si, FET, N-Channel	1272-0025	Amelco	2N4092
Q7	Si, PNP	1272-0023	Fairchild	2N4121
Q8	Si, NPN	1272-0016	Fairchild	2N4275
Q9	Si, NPN	1272-0014	Fairchild	2N3567

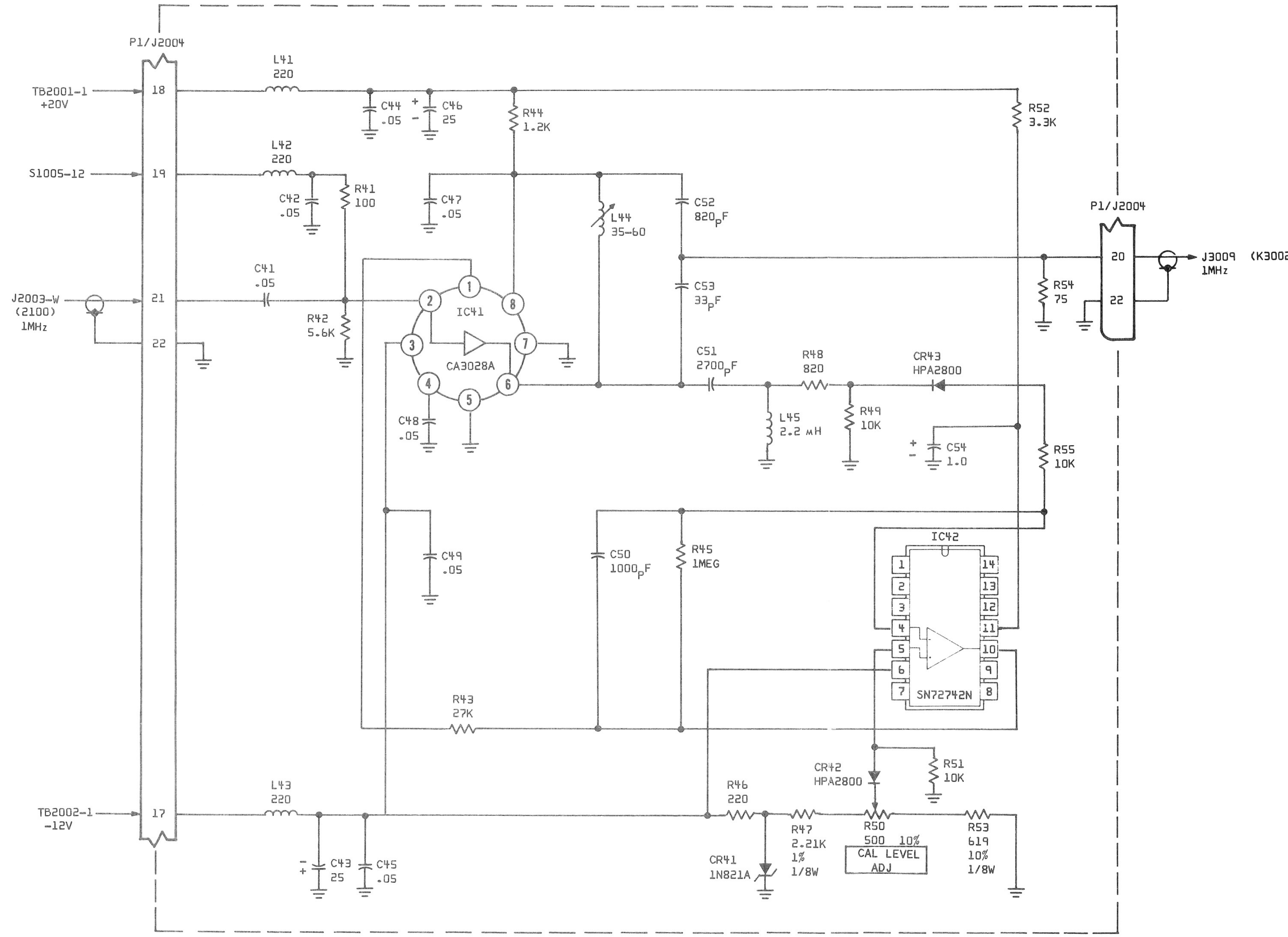


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. REPLACES DWG NO 3521131 (EC-40)

IC,S NO.	TYPE	TERM. NO.	
		VCC	GND
4	SN7400N	14	7
5,6	SP380A	8	1

Figure 6-7 Sample-and-Hold/Calibration Amplifier, Schematic Diagram

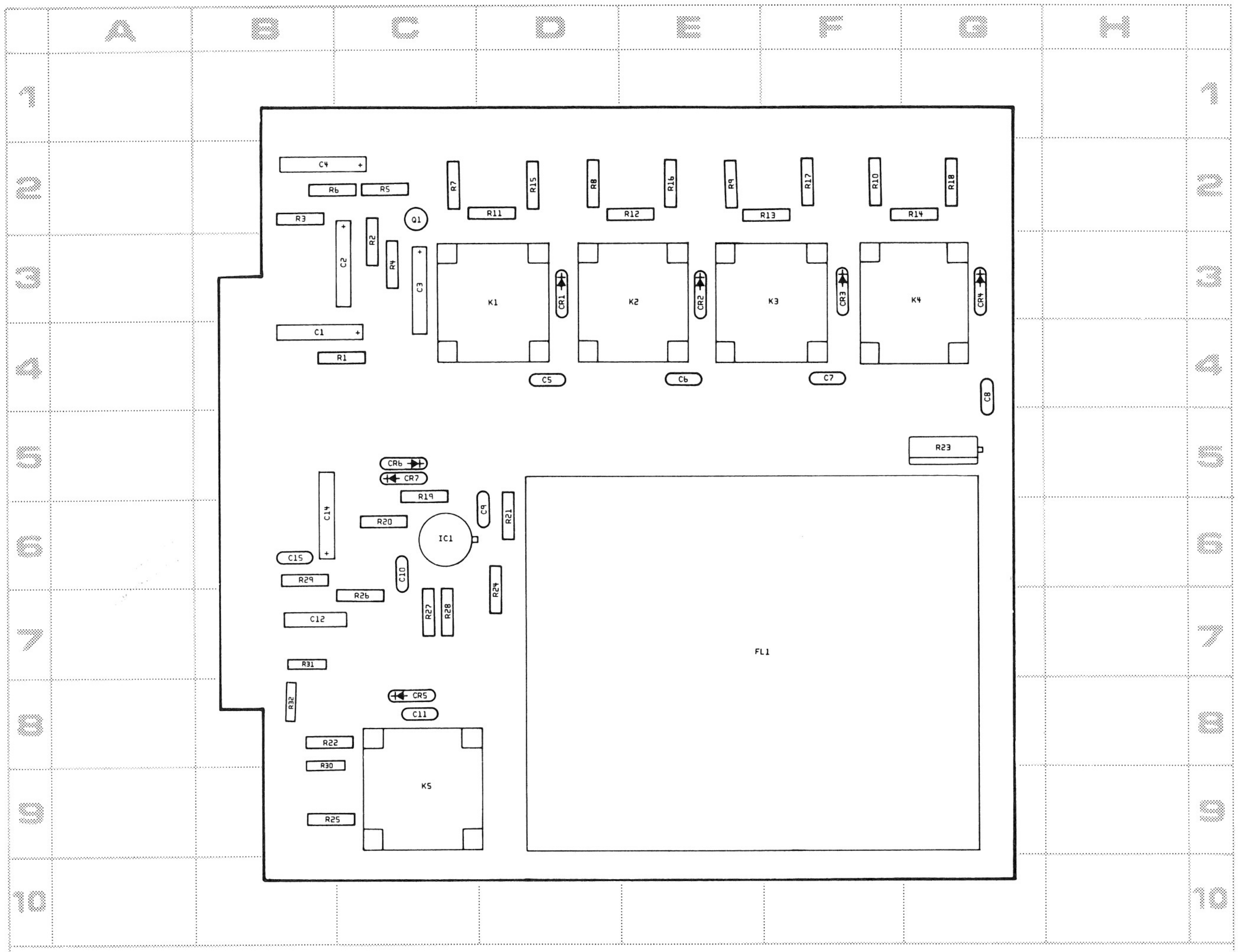


NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-7 Sample-and-Hold/Calibration Amplifier, Schematic Diagram (continued)

6.3.8 Second IF Amplifier/200 Hz Bandpass Filter



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C12	B-7	FILTER		R2	C-3	R14	G-2	R25	B-9
C1	B-4	C13	N/A	FL1	E-7	R3	B-2	R15	D-2	R26	C-7
C2	C-3	C14	B-6	INT CKT		R4	C-3	R16	E-2	R27	C-7
C3	C-3	C15	B-6	IC1	C-6	R5	C-2	R17	F-2	R28	C-7
C4	B-2	DIODES		RELAYS		R6	B-2	R18	G-2	R29	B-6
C5	D-4	CR1	D-3	K1	D-3	R7	C-2	R19	C-5	R30	B-9
C6	E-4	CR2	E-3	K2	E-3	R8	D-2	R20	C-6	R31	B-7
C7	F-4	CR3	F-3	K3	F-3	R9	E-2	R21	D-6	R32	B-8
C8	G-4	CR4	G-3	K4	G-3	R10	F-2	R22	B-8	TRANSISTOR	
C9	D-6	CR5	C-8	K5	C-9	R11	D-2	R23	G-5	Q1	C-2
C10	C-6	CR6	C-5	RESISTORS		R12	E-2	R24	D-7		
C11	C-8	CR7	C-5	R1	C-4	R13	F-2				

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CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2500	Board Assy., Second IF Amplifier/ 200 Hz Bandpass Filter	7001-0056	Cushman	
	Board, Printed Circuit	1780-0123	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C3	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C4	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C6	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C7	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C9	Mica, 510 pF ±5%, 500V	1002-0036	Elmenco	DM15-F-511J
C10	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C11	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague	225P10491WA3
C13	Not Used			
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
CR5	Si, High Speed	1281-0013	Transitron	1N3064
CR6	Si, High Speed	1281-0013	Transitron	1N3064
CR7	Si, High Speed	1281-0013	Transitron	1N3064
	FILTER			
FL1	Crystal, 80 kHz	1040-0014	Cushman	
	INTEGRATED CIRCUIT			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
	RELAYS			
K1	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K2	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K3	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K4	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K5	DPDT, 12VDC	1313-0005	Printact	12BW2-G
	RESISTORS			
R1	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R2	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R3	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R5	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley	CB8205
R6	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R7	Met. Film, 733.2Ω ±0.25%, 0.1 W	1074-0084	Dale	MF-1/10-T-9
R8	Met. Film, 4.799kΩ ±0.25%, 0.1 W	1074-0032	Dale	MF-1/10-T-9
R9	Met. Film, 4.113kΩ ±0.25%, 0.1 W	1074-0030	Dale	MF-1/10-T-9
R10	Met. Film, 3.497kΩ ±0.25%, 0.1 W	1074-0029	Dale	MF-1/10-T-9
R11	Met. Film. 2.970kΩ ±0.25%, 0.1 W	1074-0085	Dale	MF-1/10-T-9
R12	Met. Film, 152.4Ω ±0.25%, 0.1 W	1074-0018	Dale	MF-1/10-T-9
R13	Met. Film, 178.9Ω ±0.25%, 0.1 W	1074-0020	Dale	MF-1/10-T-9

6.3.8 Second IF Amplifier/200 Hz Bandpass Filter (continued)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R14	Met. Film, 212.1Ω ±0.25%, 0.1 W	1074-0021	Dale	MF-1/10-T-9
R15	Met. Film, 733.2Ω ±0.25%, 0.1 W	1074-0084	Dale	MF-1/10-T-9
R16	Met. Film, 4.799kΩ ±0.25%, 0.1 W	1074-0032	Dale	MF-1/10-T-9
R17	Met. Film, 4.113kΩ ±0.25%, 0.1 W	1074-0030	Dale	MF-1/10-T-9
R18	Met. Film, 3.497kΩ ±0.25%, 0.1 W	1074-0029	Dale	MF-1/10-T-9
R19	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R20	Met. Film, 600Ω ±0.5%, 0.1W	1074-0023	Dale	MF-1/10-T-9
R21	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R22	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R23	Trimmer, Cer, Met., 100Ω ±10% 3/4W	1215-0010	Helitrim	89WR100
*R24	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R25	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R26	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R27	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R28	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R29	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R30	Met. Film, 1.82kΩ ±1%, 1/8W	1075-0065	Dale	MFF-1/8-T-1
R31	Met. Film, 453Ω ±1%, 1/8W	1075-0107	Dale	MFF-1/8-T-1
R32	Met. Film, 1.82kΩ ±1%, 1/8W	1075-0065	Dale	MFF-1/8-T-1
	TRANSISTOR			
Q1	Si, NPN	1272-0022	Fairchild	2N3563

* Factory selected. Typical value given.

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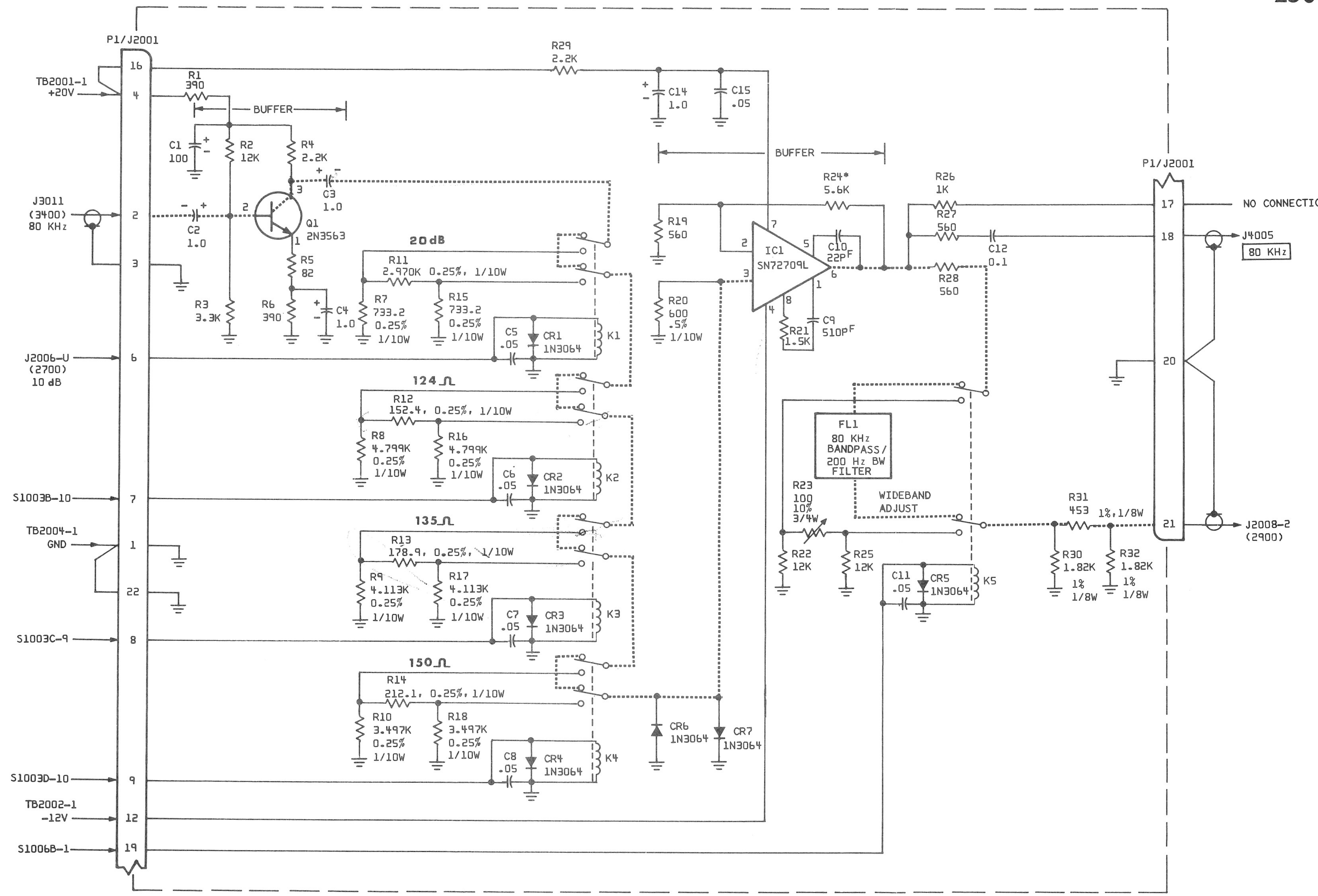


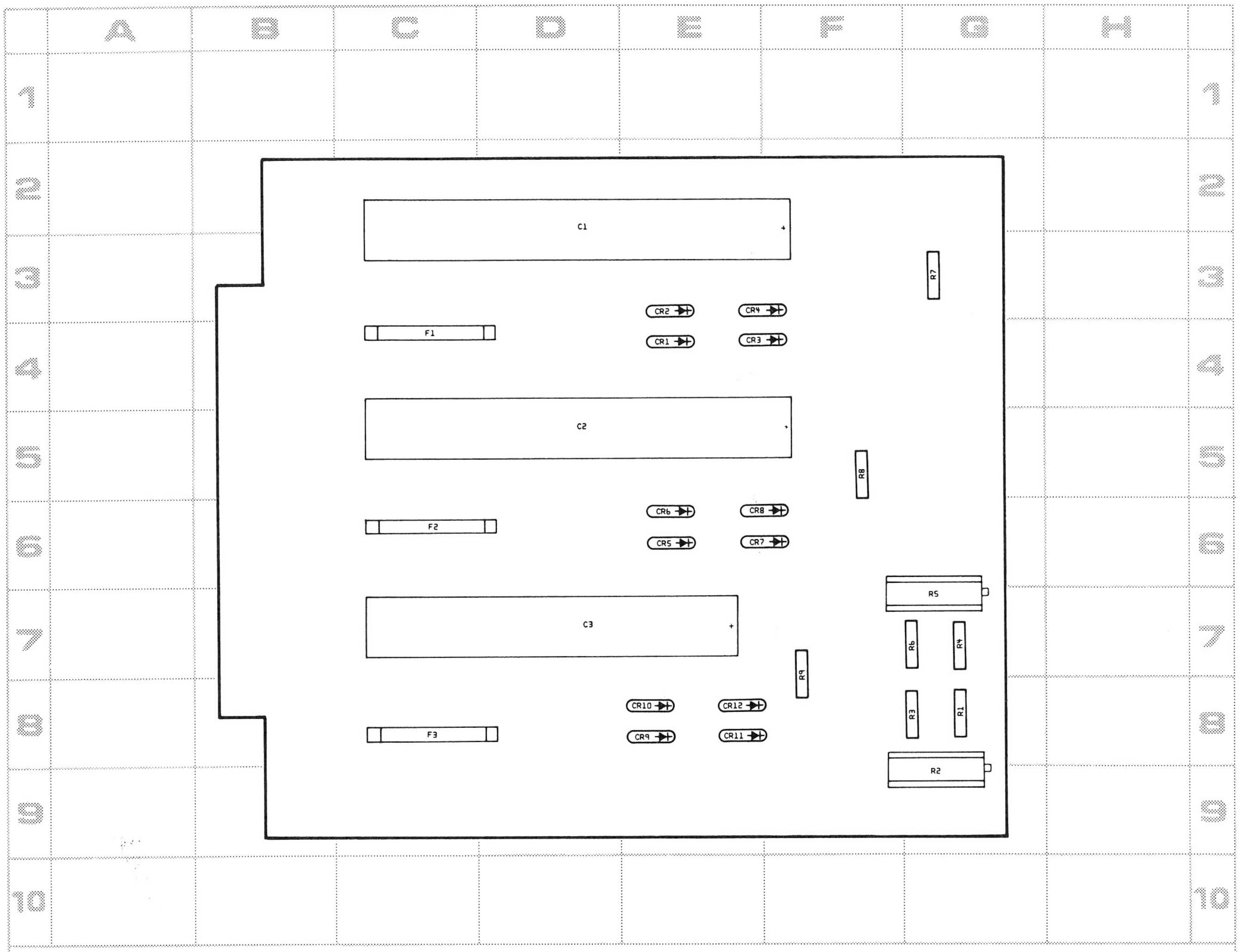
NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. SIGNAL PATH SHOWN FOR 75Ω, LOW DIST, 200 Hz BW.

Figure 6-8 Second IF Amplifier/200 Hz Bandpass Filter, Schematic Diagram

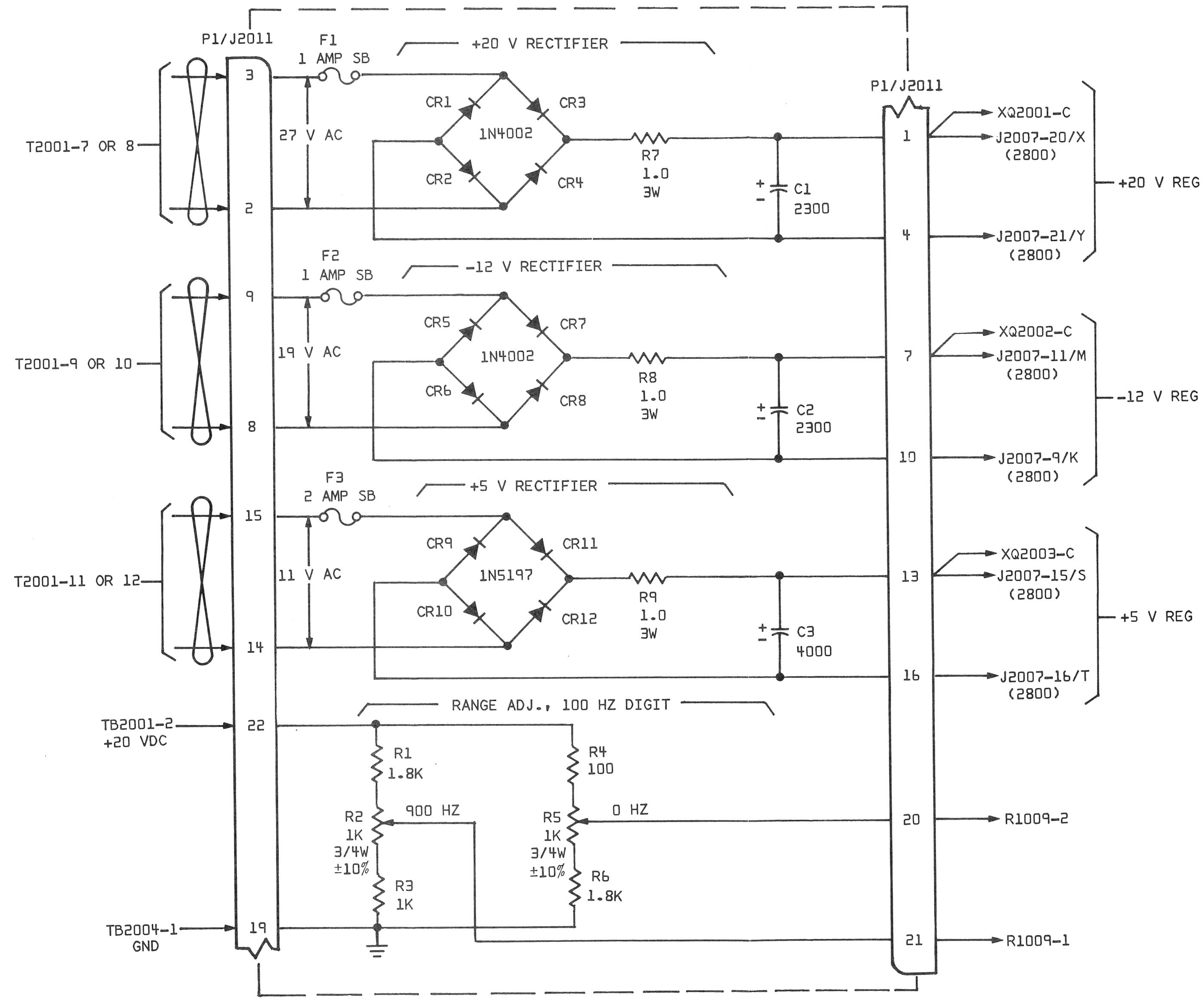
5601-0021-1

6.3.9 Power Supply Rectifiers



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		CR4	E-3	CR12	E-8	R3	G-8
C1	D-2	CR5	E-6	FUSES		R4	G-7
C2	D-5	CR6	E-6	F1	C-4	R5	G-7
C3	D-7	CR7	E-6	F2	C-6	R6	G-7
DIODES		CR8	E-6	F3	C-8	R7	G-3
CR1	E-4	CR9	E-8	RESISTORS		R8	F-5
CR2	E-3	CR10	E-8	R1	G-8	R9	F-7
CR3	E-4	CR11	E-8	R2	G-9		

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2600	Board Assy., Power Supply Rectifier	7001-0057	Cushman	
	Board, Printed Circuit	1780-0124	Cushman	
	CAPACITORS			
C1	Elect., 2300 μF +75 -10%, 50V	1014-0004	Sprague	39D-238G050JT4
C2	Elect., 2300 μF +75 -10%, 50V	1014-0004	Sprague	39D-238G050JT4
C3	Elect., 4000 μF +75 -10%, 25V	1014-0005	Sprague	39D-408G025JS4
	DIODES			
CR1	100V, PIV	1281-0023	ITT	1N4002
CR2	100V, PIV	1281-0023	ITT	1N4002
CR3	100V, PIV	1281-0023	ITT	1N4002
CR4	100V, PIV	1281-0023	ITT	1N4002
CR5	100V, PIV	1281-0023	ITT	1N4002
CR6	100V, PIV	1281-0023	ITT	1N4002
CR7	100V, PIV	1281-0023	ITT	1N4002
CR8	100V, PIV	1281-0023	ITT	1N4002
CR9	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR10	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR11	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR12	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
	FUSES			
F1	Slo-Blo, 1 Amp	1955-0006	Littelfuse	313001
F2	Slo-Blo, 1 Amp	1955-0006	Littelfuse	313001
F3	Slo-Blo, 2 Amp	1955-0001	Littelfuse	313002
	RESISTORS			
R1	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R2	Trimmer, Cer, Met.,1kΩ ±10%, 3/4W	1215-0013	Helitrim	89WR1K
R3	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R4	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R5	Trimmer, Cer, Met., 1kΩ ±10%, 3/4W	1215-0013	Helitrim	89WR1K
R6	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R7	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R8	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R9	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330



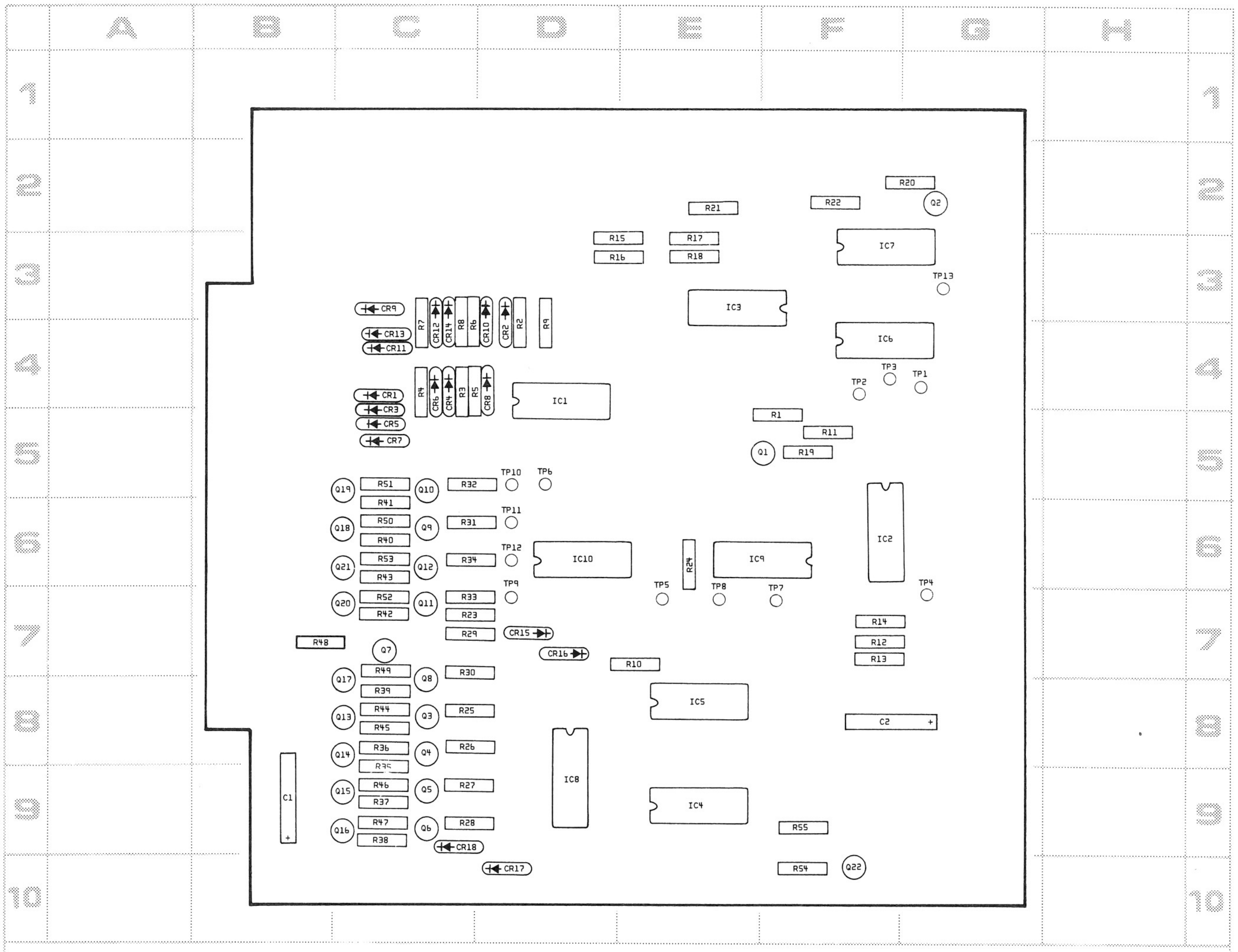
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-9 Power Supply Rectifiers, Schematic Diagram

5601-0021-1

6.3.10 Attenuator Control Logic

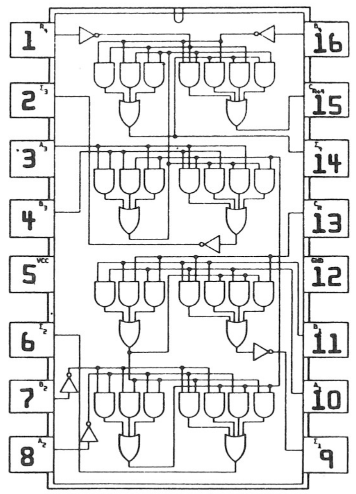


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		CR13	C-4	IC10	D-6	R15	D-3	R31	C-6	R47	C-9	Q7	C-7
C1	B-9	CR14	C-4	RESISTORS		R16	D-3	R32	C-5	R48	B-7	Q8	C-8
C2	F-8	CR15	D-7	R1	F-5	R17	E-3	R33	C-7	R49	C-7	Q9	C-6
DIODES		CR16	D-7	R2	D-4	R18	E-3	R34	C-6	R50	C-6	Q10	C-5
CR1	C-4	CR17	D-10	R3	C-4	R19	F-5	R35	C-8	R51	C-5	Q11	C-7
CR2	D-4	CR18	C-9	R4	C-4	R20	G-2	R36	C-8	R52	C-7	Q12	C-6
CR3	C-5	INT CKTS		R5	C-4	R21	E-2	R37	C-9	R53	C-6	Q13	C-8
CR4	C-4	IC1	D-4	R6	C-4	R22	F-2	R38	C-9	R54	F-10	Q14	C-8
CR5	C-5	IC2	F-6	R7	C-4	R23	C-7	R39	C-8	R55	F-9	Q15	C-9
CR6	C-4	IC3	E-3	R8	C-4	R24	E-6	R40	C-6	TRANSISTORS		Q16	C-9
CR7	C-5	IC4	E-9	R9	D-4	R25	C-8	R41	C-6	Q1	F-5	Q17	C-8
CR8	D-4	IC5	E-8	R10	E-7	R26	C-8	R42	C-7	Q2	G-2	Q18	C-6
CR9	C-3	IC6	F-4	R11	F-5	R27	C-9	R43	C-6	Q3	C-8	Q19	C-5
CR10	D-4	IC7	F-3	R12	F-7	R28	C-9	R44	C-8	Q4	C-8	Q20	C-7
CR11	C-4	IC8	D-9	R13	F-7	R29	C-7	R45	C-8	Q5	C-9	Q21	C-6
CR12	C-4	IC9	E-6	R14	F-7	R30	C-7	R46	C-9	Q6	C-9	Q22	F-10

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2700	Board Assy., Attenuator Control Logic	7001-0058	Cushman	
	Board, Printed Circuit	1780-0126	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4	Ge, Signal	1282-0005	ITT	G633
CR5	Ge, Signal	1282-0005	ITT	G633
CR6	Ge, Signal	1282-0005	ITT	G633
CR7	Ge, Signal	1282-0005	ITT	G633
CR8	Ge, Signal	1282-0005	ITT	G633
CR9	Ge, Signal	1282-0005	ITT	G633
CR10	Ge, Signal	1282-0005	ITT	G633
CR11	Ge, Signal	1282-0005	ITT	G633
CR12	Ge, Signal	1282-0005	ITT	G633
CR13	Ge, Signal	1282-0005	ITT	G633
CR14	Ge, Signal	1282-0005	ITT	G633
CR15	Ge, Signal	1282-0005	ITT	G633
CR16	Ge, Signal	1282-0005	ITT	G633
CR17	Si, High Speed	1281-0013	Transitron	1N3064
CR18	Si, High Speed	1281-0013	Transitron	1N3064
	INTEGRATED CIRCUITS			
IC1	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC2	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC3	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
IC4	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
IC5	TTL Quad2-input, POS NAND Gate	2025-0003	TI	SN7400N
IC6	Dual AND-OR invert. gate	2025-0018	Signetics	N8840A
IC7	Dual AND-OR invert. gate	2025-0018	Signetics	N8840A
IC8	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC9	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC10	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
	RESISTORS			
R1	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R4	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R5	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R6	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R9	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R14	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R15	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R16	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R17	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R19	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R20	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R22	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R23	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R24	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R25	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R26	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R27	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R28	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R29	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R30	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R31	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R32	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R33	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R34	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R35	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R36	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R37	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R38	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R39	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R40	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R41	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R42	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R43	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R44	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R45	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R46	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R47	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R48	Comp, 270Ω ±5%, 1W	1068-2715	Allen-Bradley	GB2715
R49	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R50	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R51	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R52	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R53	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R54	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R55	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
	TRANSISTORS			
Q1	Si, NPN	1272-0016	Fairchild	2N4275
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, PNP	1272-0023	Fairchild	2N4121
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, PNP	1272-0023	Fairchild	2N4121
Q6	Si, PNP	1272-0023	Fairchild	2N4121
Q7	Si, NPN	1272-0014	Fairchild	2N3567
Q8	Si, PNP	1272-0023	Fairchild	2N4121
Q9	Si, PNP	1272-0023	Fairchild	2N4121
Q10	Si, PNP	1272-0023	Fairchild	2N4121
Q11	Si, PNP	1272-0023	Fairchild	2N4121
Q12	Si, PNP	1272-0023	Fairchild	2N4121
Q13	Si, NPN	1272-0016	Fairchild	2N4275
Q14	Si, NPN	1272-0016	Fairchild	2N4275
Q15	Si, NPN	1272-0016	Fairchild	2N4275

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
Q16	Si, NPN	1272-0016	Fairchild	2N4275
Q17	Si, NPN	1272-0016	Fairchild	2N4275
Q18	Si, NPN	1272-0016	Fairchild	2N4275
Q19	Si, NPN	1272-0016	Fairchild	2N4275
Q20	Si, NPN	1272-0016	Fairchild	2N4275
Q21	Si, NPN	1272-0016	Fairchild	2N4275
Q22	Si, NPN	1272-0016	Fairchild	2N4275



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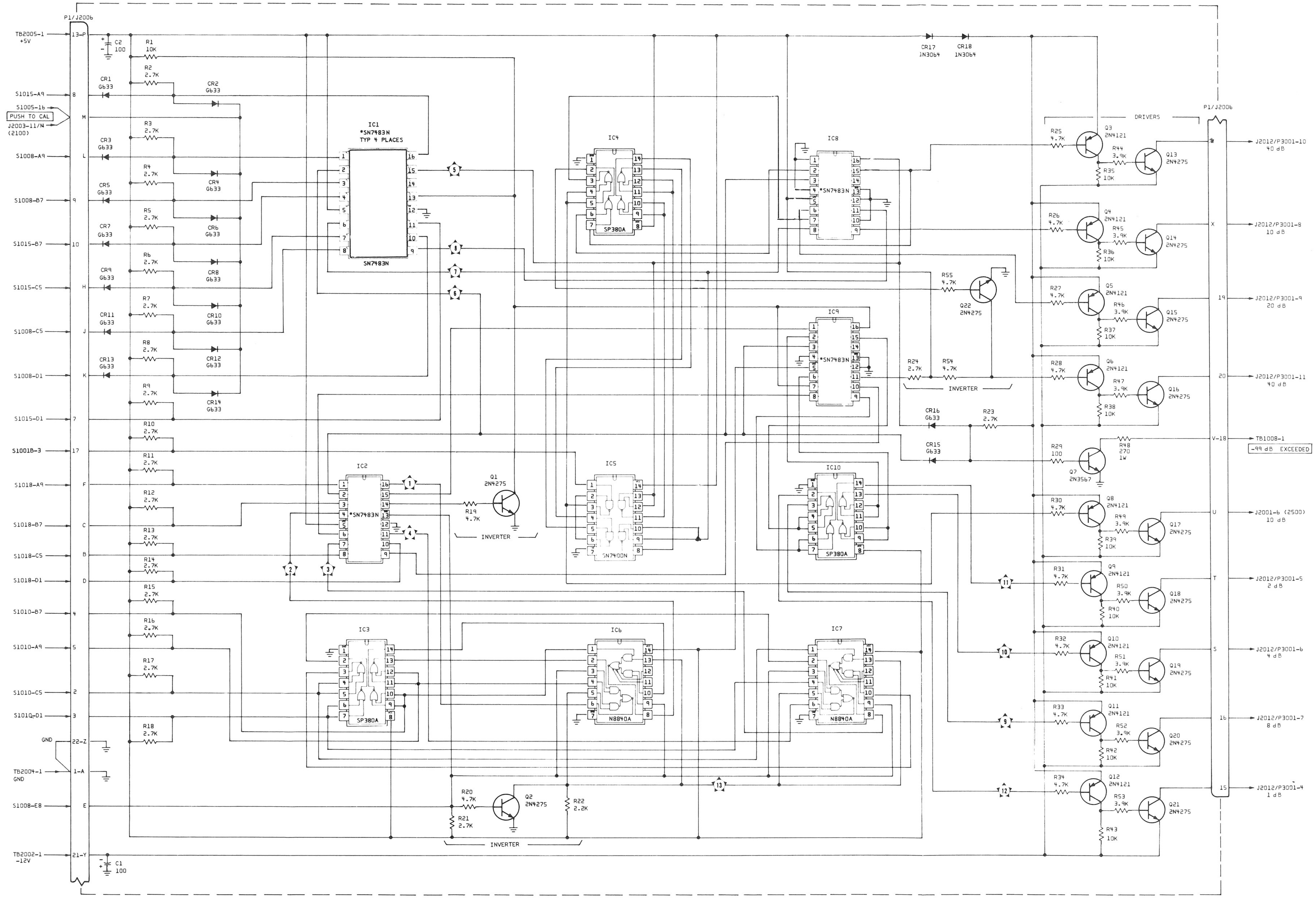


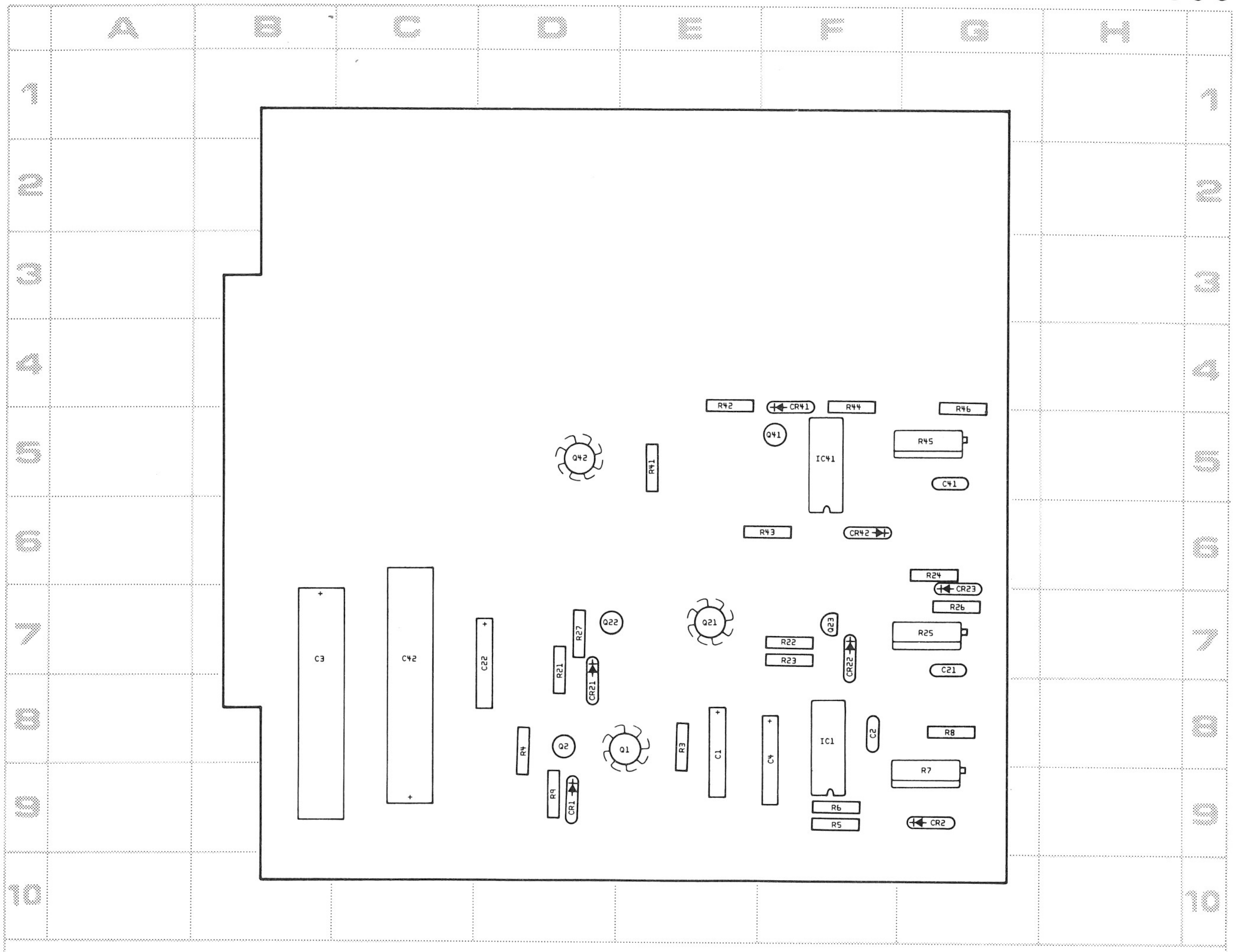
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-10 Attenuator Control Logic, Schematic Diagram

5601-0021-1

6.3.11 Power Supply Regulators



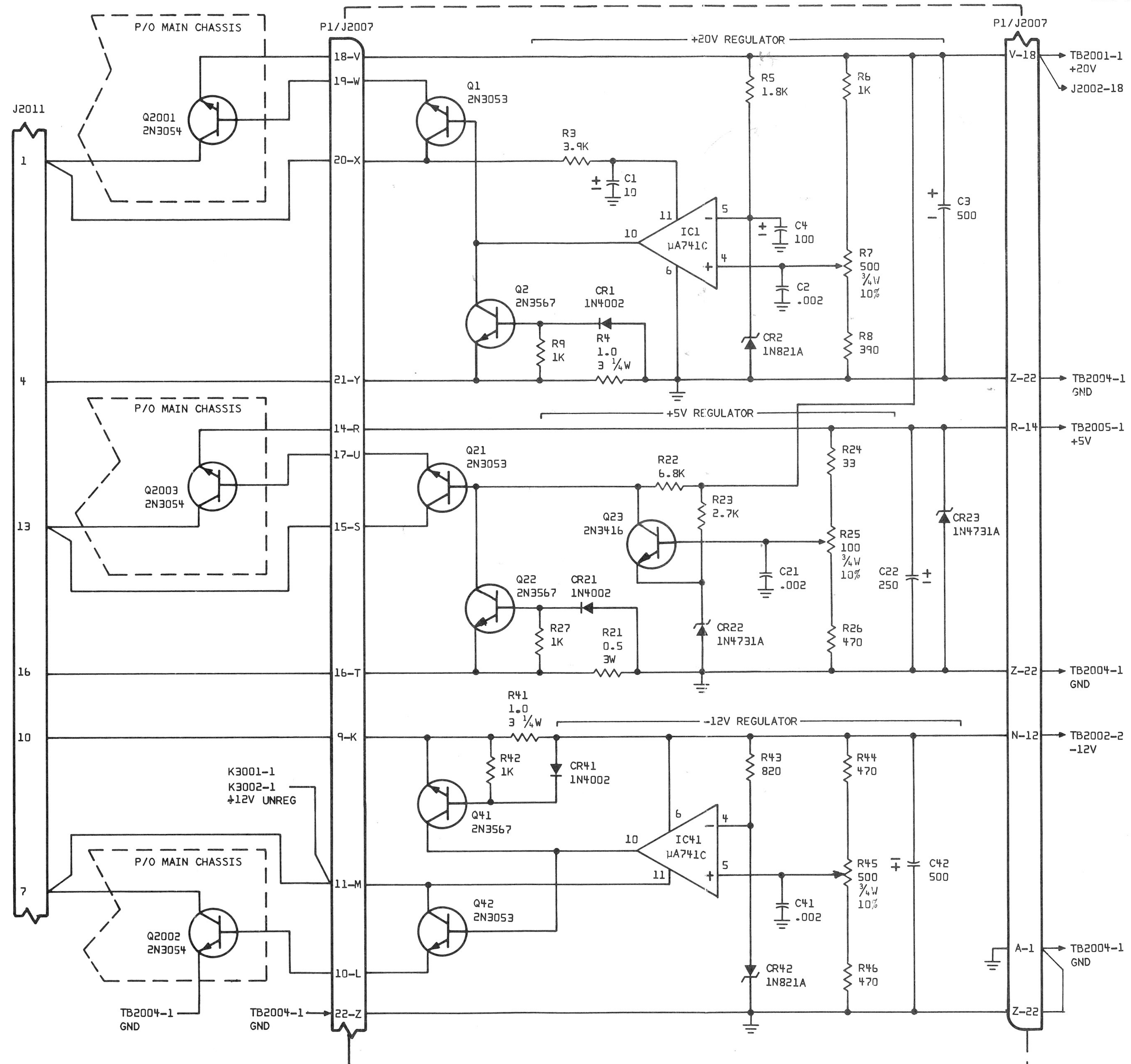
REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		RESISTORS	
C1	E-8	R3	E-8
C2	F-8	R4	D-8
C3	B-7	R5	F-9
C4	F-8	R6	F-9
DIODES		R7	G-9
CR1	D-9	R8	G-8
CR2	G-9	R9	D-9
INT CKT		TRANSISTORS	
IC1	F-8	Q1	E-8
		Q2	D-8

REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		R23	F-7
C21	G-7	R24	G-6
C22	D-7	R25	G-7
DIODES		R26	G-7
CR21	D-8	R27	D-7
CR22	F-7	TRANSISTORS	
CR23	G-7	Q21	E-7
RESISTORS		Q22	D-7
R21	D-7	Q23	F-7
R22	F-7		

REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		R41	E-5
C41	G-5	R42	E-4
C42	C-7	R43	F-6
DIODES		R44	F-4
CR41	F-4	R45	G-5
CR42	F-6	R46	G-4
INT CKT		TRANSISTORS	
IC41	F-5	Q41	F-5
RESISTORS		Q42	D-5

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2800	Board Assy., Power Supply Regs.	7001-0059	Cushman	
	Board, Printed Circuit	1780-0128	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C3	Elect., 500 μF +75% -20%, 25V	1014-0002	Richey	JA-13-500-25-8-P
C4	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C5-C20	Not Used			
C21	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C22	Elect., 250 μF, 16V	1013-0016	Sprague	30D-257G016DF2
C23-C40	Not Used			
C41	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C42	Elect., 500 μF +75% -10%, 25V	1014-0002	Richey	JA-13-500-25-8-P
	DIODES			
CR1	Si, 100V PIV,	1281-0023	ITT	1N4002
CR2	Si, Zener, 6.2V ±5%	1281-0035	Motorola	1N821A
CR3-CR20	Not Used			
CR21	Si, 100V PIV,	1281-0023	ITT	1N4002
CR22	Si, Zener, 4.3V ±5%	1281-0025	Semcor	ZD4.3A
CR23	Si, Zener, 7.5V ±10%	1281-0026	Semcor	ZD7.5A
CR24-CR40	Not Used			
CR41	Si, 100V PIV,	1281-0023	ITT	1N4002
CR42	Si, Zener, 6.2V ±5%	1281-0035	Motorola	1N821A
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0022	TI	72741N
IC2-IC40	Not Used			
IC41	Ampl, Operational	2025-0022	TI	72741N
	RESISTORS			
R1-R2	Not Used			
R3	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R4	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R5	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R7	Trimmer, Cer, Met., 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500
R8	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R10-R20	Not Used			
R21	WW, 0.5Ω ±3%, 3W	1159-0002	Dale	RS-2B
R22	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R23	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R24	Comp, 33Ω ±5%, 1/4W	1066-3305	Allen-Bradley	CB3305
R25	Trimmer, Cer, Met., 100Ω ±10%, 3/4W	1215-0010	Helitrim	89WR100
R26	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R27	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R28-R40	Not Used			
R41	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R42	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R43	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R44	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R45	Trimmer, Cer, Met., 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R46	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
	TRANSISTORS			
Q1	Si, NPN	1272-0011	RCA	2N3053
Q2	Si, NPN	1272-0014	Fairchild	2N3567
Q3-Q20	Not Used			
Q21	Si, NPN	1272-0011	RCA	2N3053
Q22	Si, NPN	1272-0014	Fairchild	2N3567
Q23	Si, NPN	1271-0006	GE	2N3416
Q24-Q40	Not Used			
Q41	Si, NPN	1272-0014	Fairchild	2N3567
Q42	Si, NPN	1272-0011	RCA	2N3053

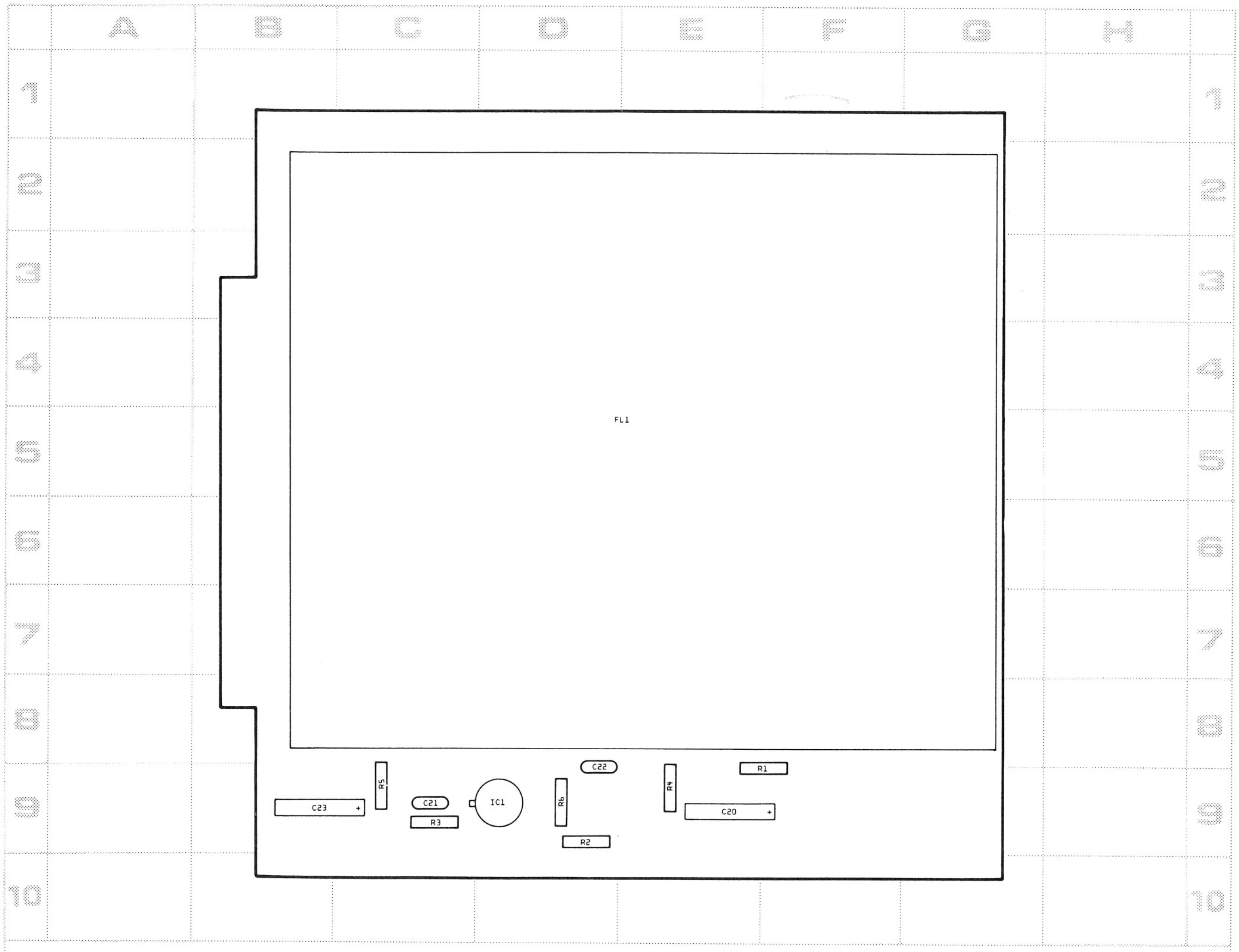


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

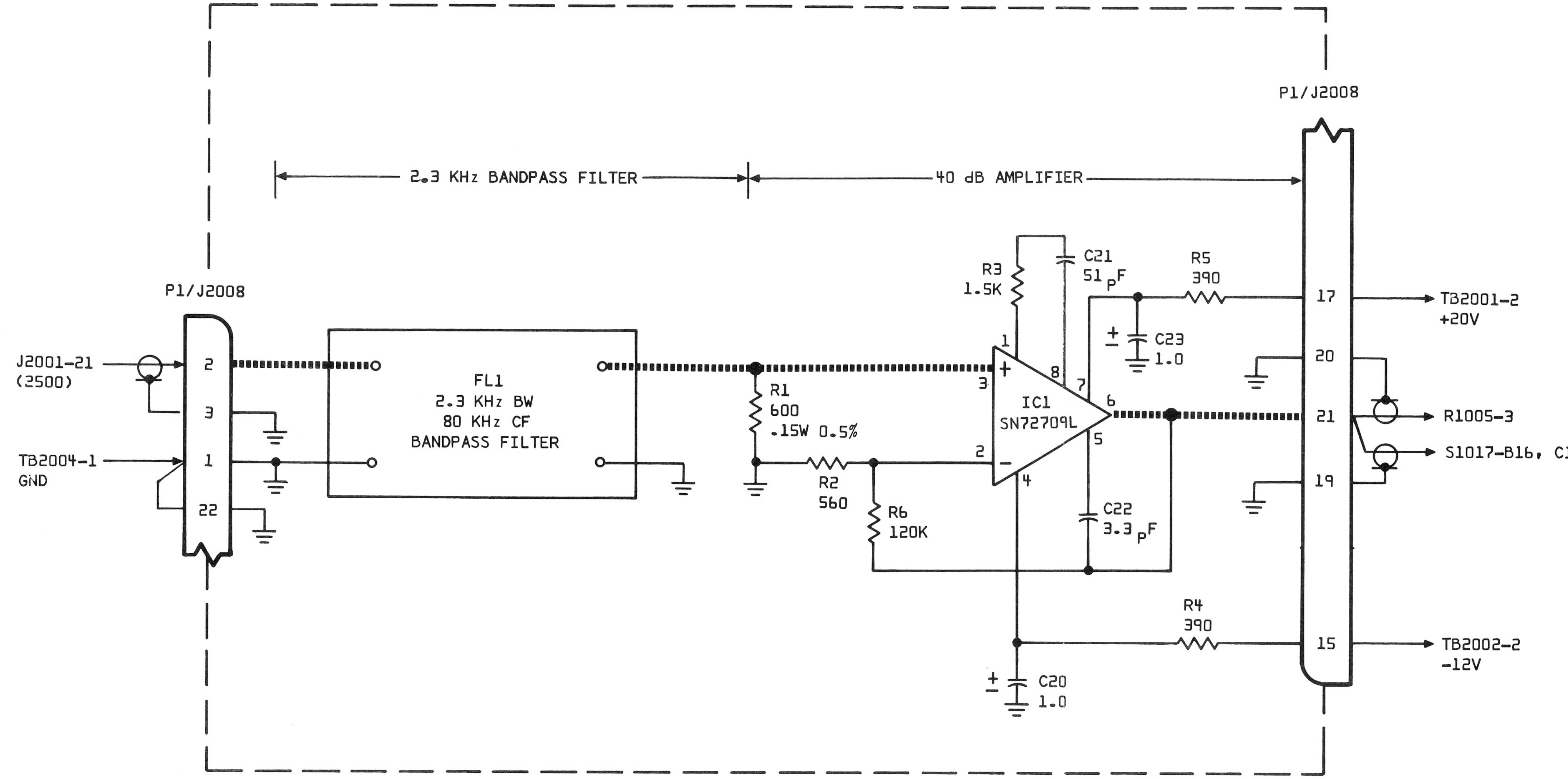
Figure 6-11 Power Supply Regulators, Schematic Diagram

6.3.12 Second IF Amplifier/2.3 kHz Bandpass Filter



REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		IC1	D-9
C20	E-9	RESISTORS	
C21	C-9	R1	F-9
C22	D-9	R2	D-9
C23	B-9	R3	C-9
FILTER		R4	E-9
FL1	E-5	R5	C-9
INT CKT		R6	D-9

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2900	Board Assy., Second IF Amplifier/ 2.3 kHz Bandpass Filter	7001-0060	Cushman	
	Board, Printed Circuit	1780-0130	Cushman	
	CAPACITORS			
C1-C19	Not Used			
C20	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C21	Mica, 51 pF ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
C22	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie	301-000-C0J0-339C
C23	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
	FILTER			
FL1	Crystal, 80 kHz	1040-0020	Cushman	
	INTEGRATED CIRCUIT			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
	RESISTORS			
R1	Met. Film, 600Ω ±0.5%, 0.1 W	1074-0023	Dale	MF-1/10-T-9
R2	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R3	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R4	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R5	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R6	Comp, 120kΩ ±5%, 1/4W	1066-1245	Allen-Bradley	CB1245



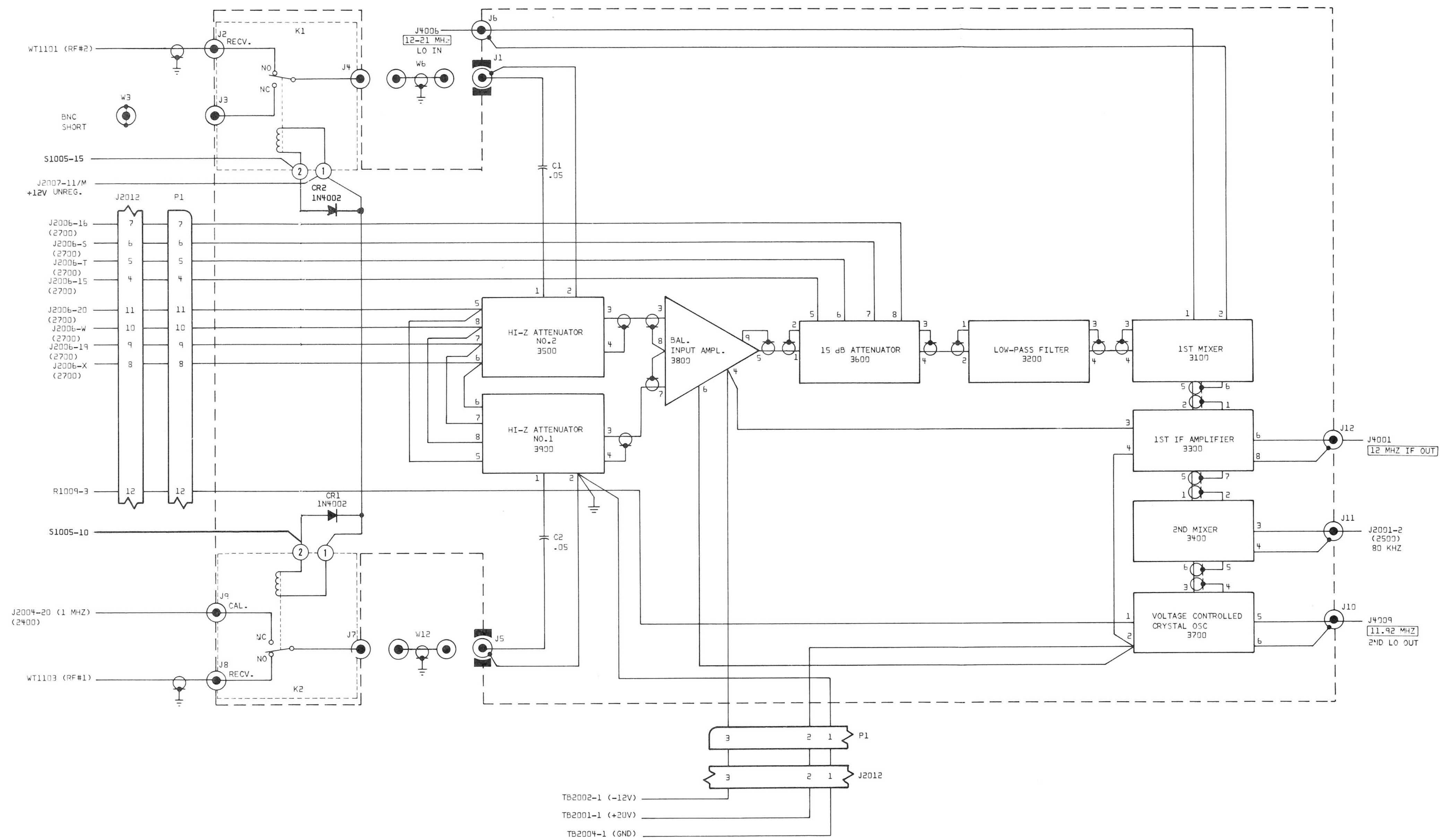
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-12 Second IF Amplifier/2.3 kHz Bandpass Filter, Schematic Diagram

6.3.13 RF Housing

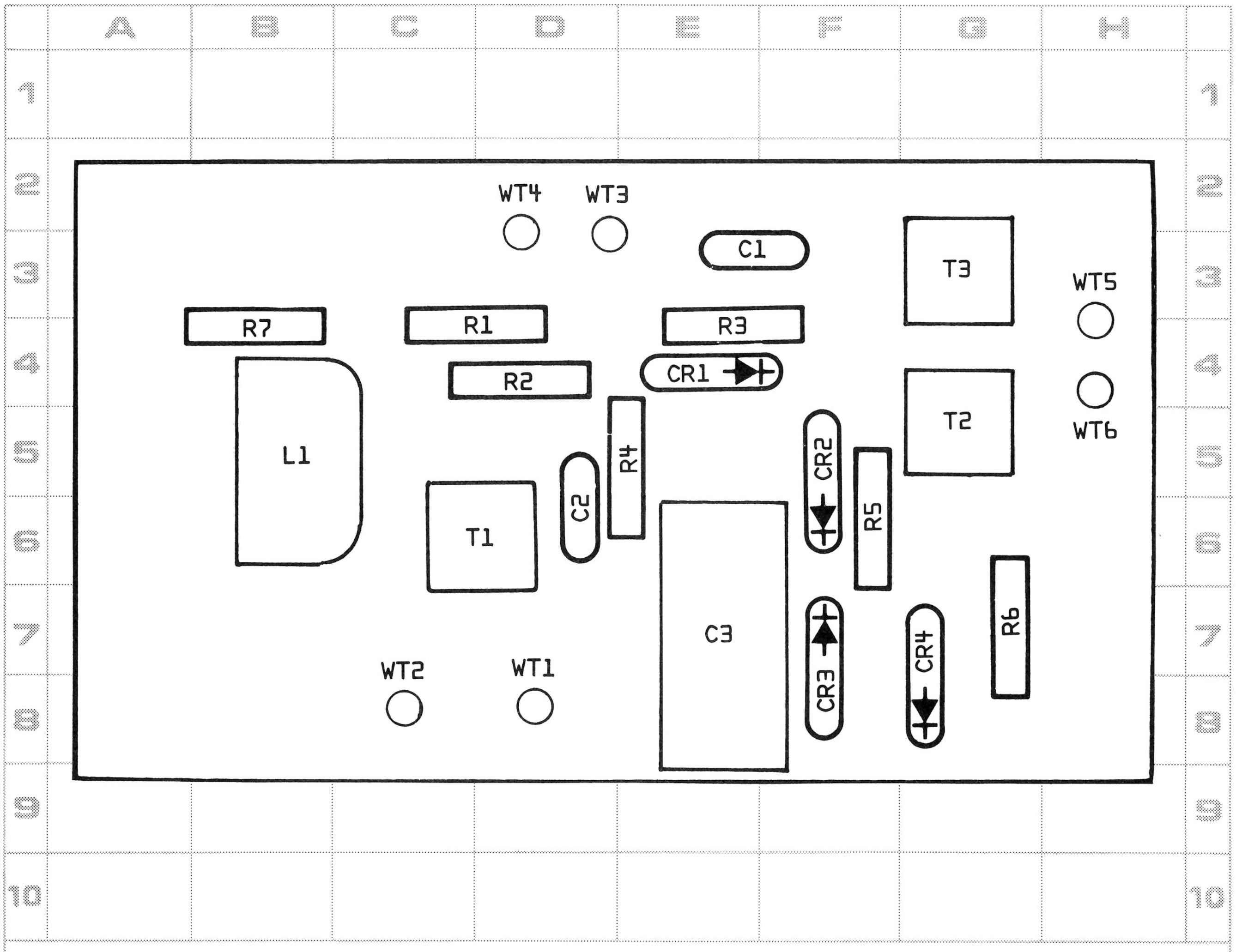
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3000	RF Housing Assembly	7046-0008	Cushman	
	RF Casting	4560-0007	Cushman	
	RF Housing Assembly, Top Cover	2180-0036	Cushman	
	RF Housing Assembly, Bottom Cover	2180-0037	Cushman	
	PRINTED CIRCUIT BOARDS			
3100	First Mixer Board Assy.	7001-0061	Cushman	
3200	Low-Pass Filter Board Assy.	7001-0062	Cushman	
3300	First IF Amplifier Board Assy.	7001-0063	Cushman	
3400	Second IF Amplifier Board Assy.	7001-0064	Cushman	
3500	Hi-Z Attenuator No. 1 Board Assy.	7001-0065	Cushman	
3600	15 dB Attenuator Board Assy.	7001-0067	Cushman	
3700	Voltage Controlled Crystal Osc. Board Assy.	7001-0068	Cushman	
3800	Balanced Input Amplifier Bd Assy.	7001-0069	Cushman	
3900	Hi-Z Attenuator No. 2 Bd Assy.	7001-0065	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 500V	1005-0052	Sprague	5HK-S50
C2	Cer, 0.05 μF +80% -20%, 500V	1005-0052	Sprague	5HK-S50
	DIODE			
CR1	Si, 100V PIV	1281-0023	ITT	IN4002
CR2	Si, 100V PIV	1281-0023	ITT	IN4002
	JACKS			
J1	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J2	P/O Relay K1			
J3	P/O Relay K1			
J4	P/O Relay K1			
J5	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J6	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J7	P/O Relay K2			
J8	P/O Relay K2			
J9	P/O Relay K2			
J10	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J11	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J12	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
	RELAYS			
K1	Coaxial, 50Ω, 250W, 28V	1313-0003	Dow Key	DK77-BNC
K2	Coaxial, 50Ω, 250W, 28V	1313-0003	Dow Key	DK77-BNC



NOTE:

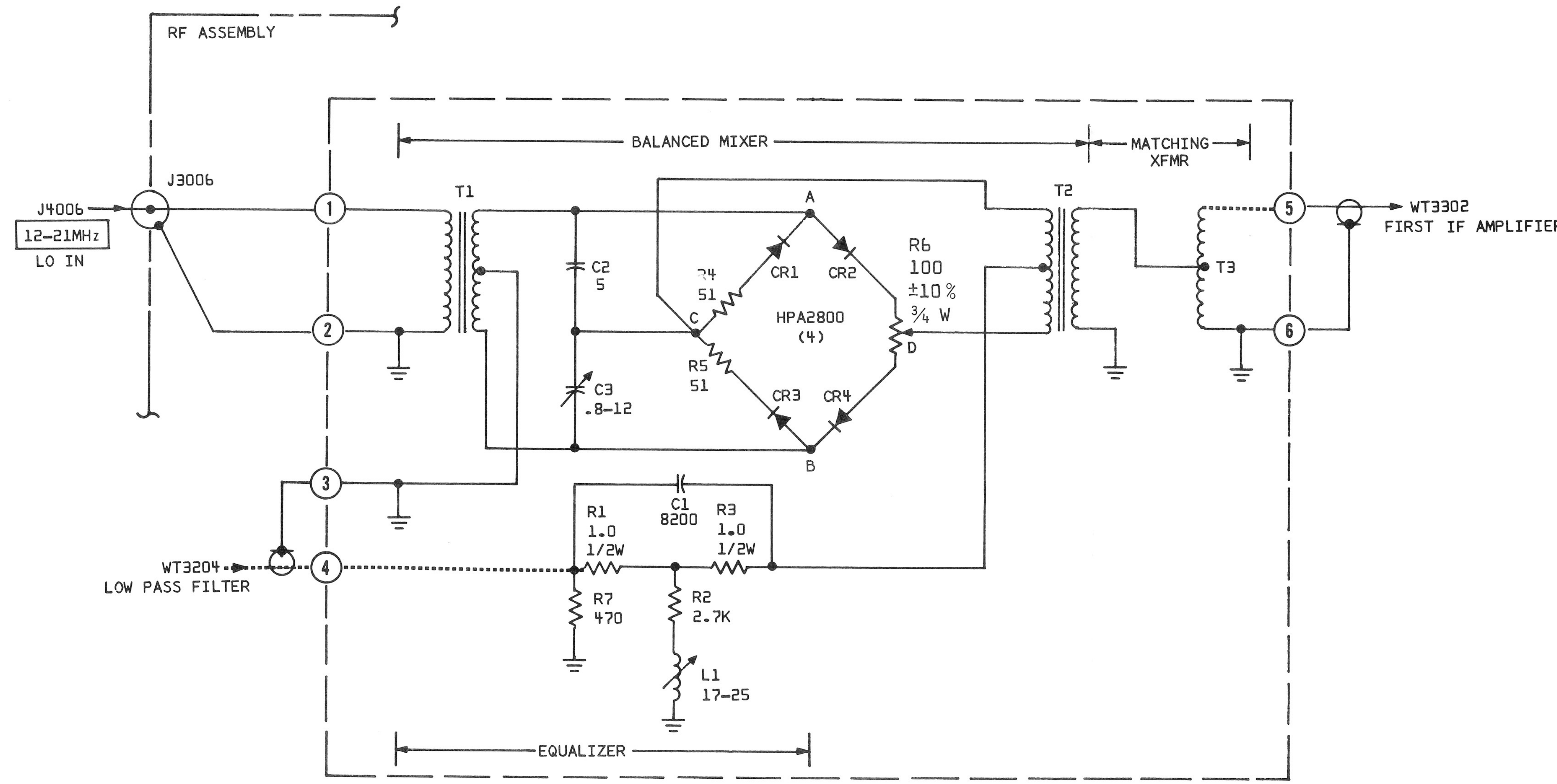
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-13 RF Housing, Interconnection Diagram



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		CR2	F-6	R1	D-4	R7	B-4
C1	E-3	CR3	F-8	R2	D-4	XFMRS	
C2	D-6	CR4	G-7	R3	E-4	T1	D-6
C3	E-7	INDUCTOR		R4	E-5	T2	G-5
DIODES		L1	B-5	R5	F-6	T3	G-3
CR1	E-4	RESISTORS		R6	G-7		

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3100	Board Assy., First Mixer	7001-0061	Cushman	
	Board, Printed Circuit	1780-0115	Cushman	
	CAPACITORS			
C1	Mica, 8200 pF ±5%, 100V	1002-0076	Elmenco	DM19-822J
C2	Mica, 5 pF ±5%, 500V	1002-0028	Elmenco	DM15-C-050D
C3	Var, Glass, 0.8 - 12 pF, 750V	1001-0007	JFD	VC31GWY
	DIODES			
CR1	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR2	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTOR			
L1	Var, 17 - 25 μH	1596-0005	Cushman	
	RESISTORS			
R1	Comp, 1Ω ±5%, 1/2W	1067-0001	Allen-Bradley	EB0001
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 1Ω ±5%, 1/2W	1067-0001	Allen-Bradley	EB0001
R4	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R5	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R6	Trimmer, Cer, Met., 100Ω ±10%, 3/4W	1215-0009	Beckman	89PR100
R7	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
	TRANSFORMERS			
T1	Toroid, Tri-Filar	1579-0017	Cushman	
T2	Toroid, Tri-Filar	1579-0017	Cushman	
T3	Toroid, Tri-Filar	1579-0017	Cushman	

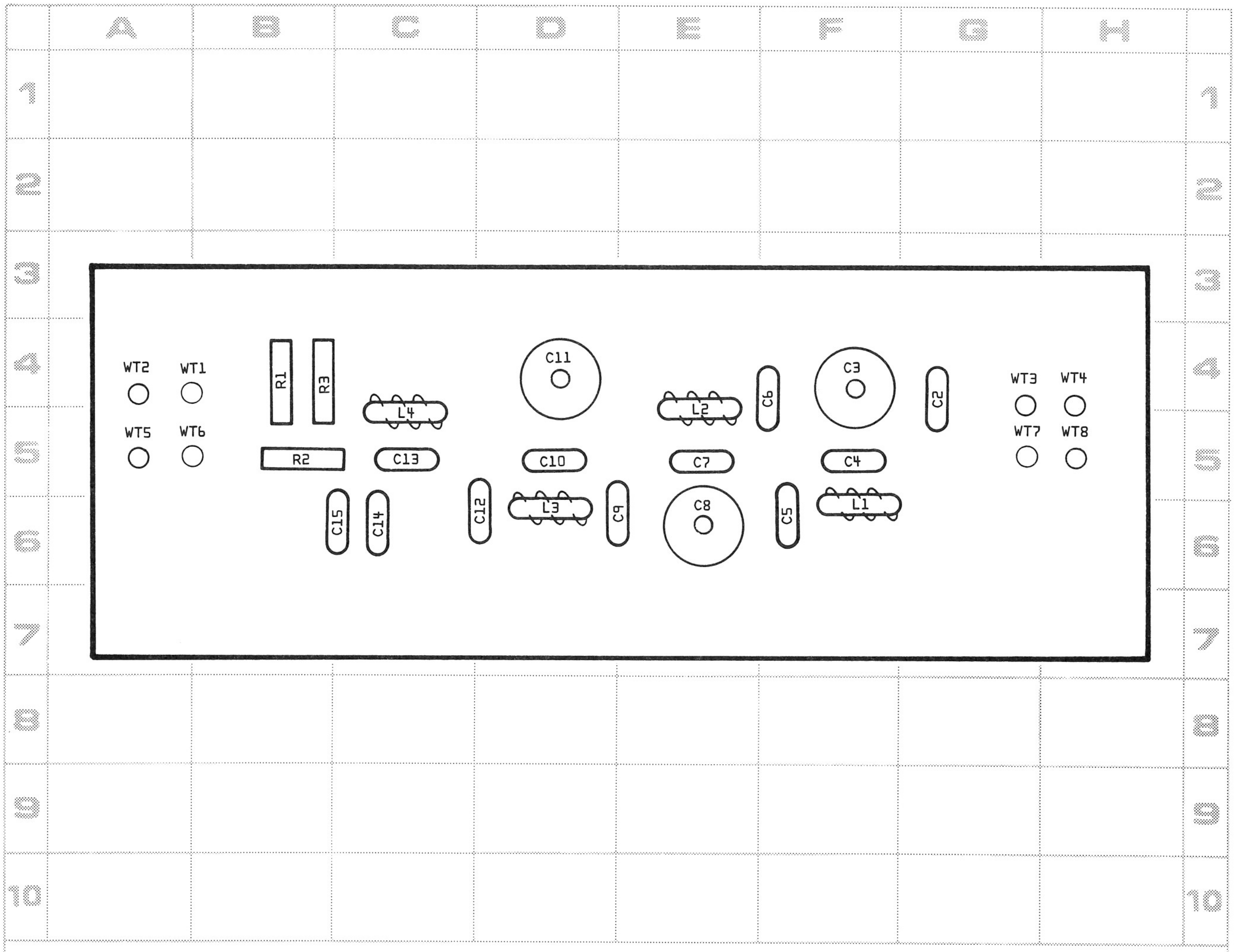


NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN pF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

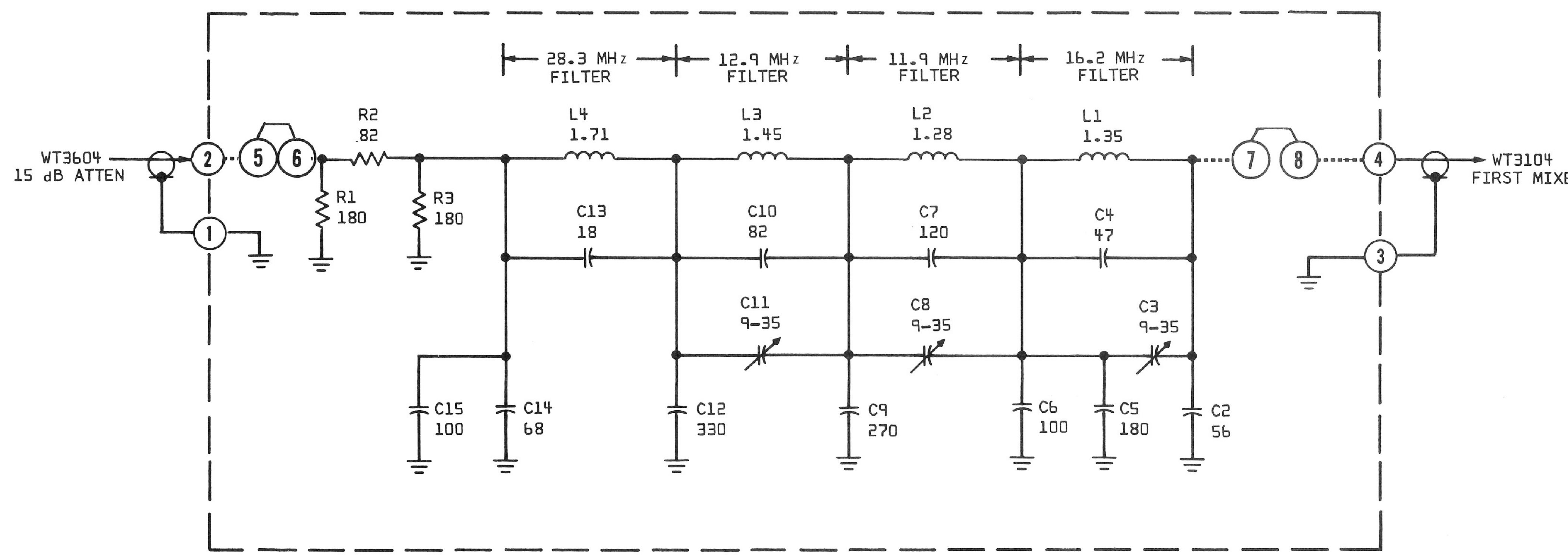
Figure 6-14 First Mixer, Schematic Diagram

6.3.15 Low-Pass Filter



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C8	E-6	INDUCTORS	
C1	N/A	C9	D-6	L1	F-6
C2	G-4	C10	D-5	L2	E-5
C3	F-4	C11	D-4	L3	D-6
C4	F-5	C12	D-6	L4	C-5
C5	F-6	C13	C-5	RESISTORS	
C6	F-4	C14	C-6	R1	B-4
C7	E-5	C15	C-6	R2	B-5
				R3	B-4

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3200	Board Assy., Low Pass Filter	7001-0062	Cushman	
	Board, Printed Circuit	1780-0116	Cushman	
	CAPACITORS			
C1	Not Used			
C2	Mica, 56 pF ±5%, 500V	1002-0019	Elmenco	DM15-E-560J
C3	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C4	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco	DM15-E-470J
C5	Mica, 180 pF ±5%, 500V	1002-0005	Elmenco	DM15-F-181J
C6	Mica, 100 pF ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C7	Mica, 120 pF ±5%, 500V	1002-0010	Elmenco	DM15-F-121J
C8	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C9	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C10	Mica, 82 pF 5%, 500V	1002-0020	Elmenco	DM15-E-820J
C11	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C12	Mica, 330 pF ±5%, 500V	1002-0032	Elmenco	DM15-F-331J
C13	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco	DM15-C-180J
C14	Mica, 68 pF ±5%, 500V	1002-0013	Elmenco	DM15-E-680J
C15	Mica, 100 pF ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
	INDUCTORS			
L1	Toroid, 1.35 μH	1579-0020-02	Cushman	
L2	Toroid, 1.28 μH	1579-0020-01	Cushman	
L3	Toroid, 1.45 μH	1579-0020-03	Cushman	
L4	Toroid, 1.71 μH	1579-0020-04	Cushman	
	RESISTORS			
R1	Comp, 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R2	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley	CB8205
R3	Comp, 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815

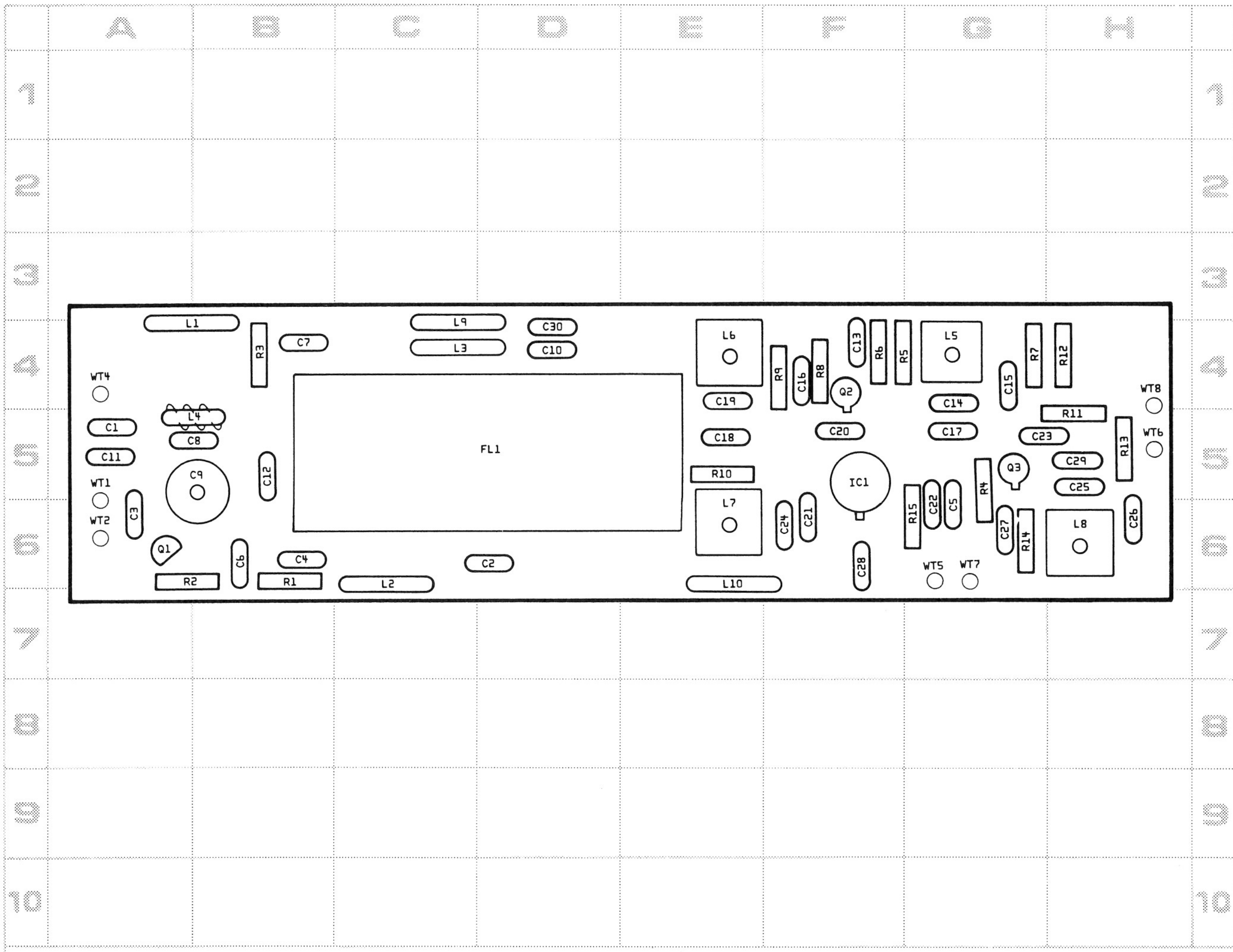


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN pF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-15 Low-Pass Filter, Schematic Diagram

6.3.16 First IF Amplifier

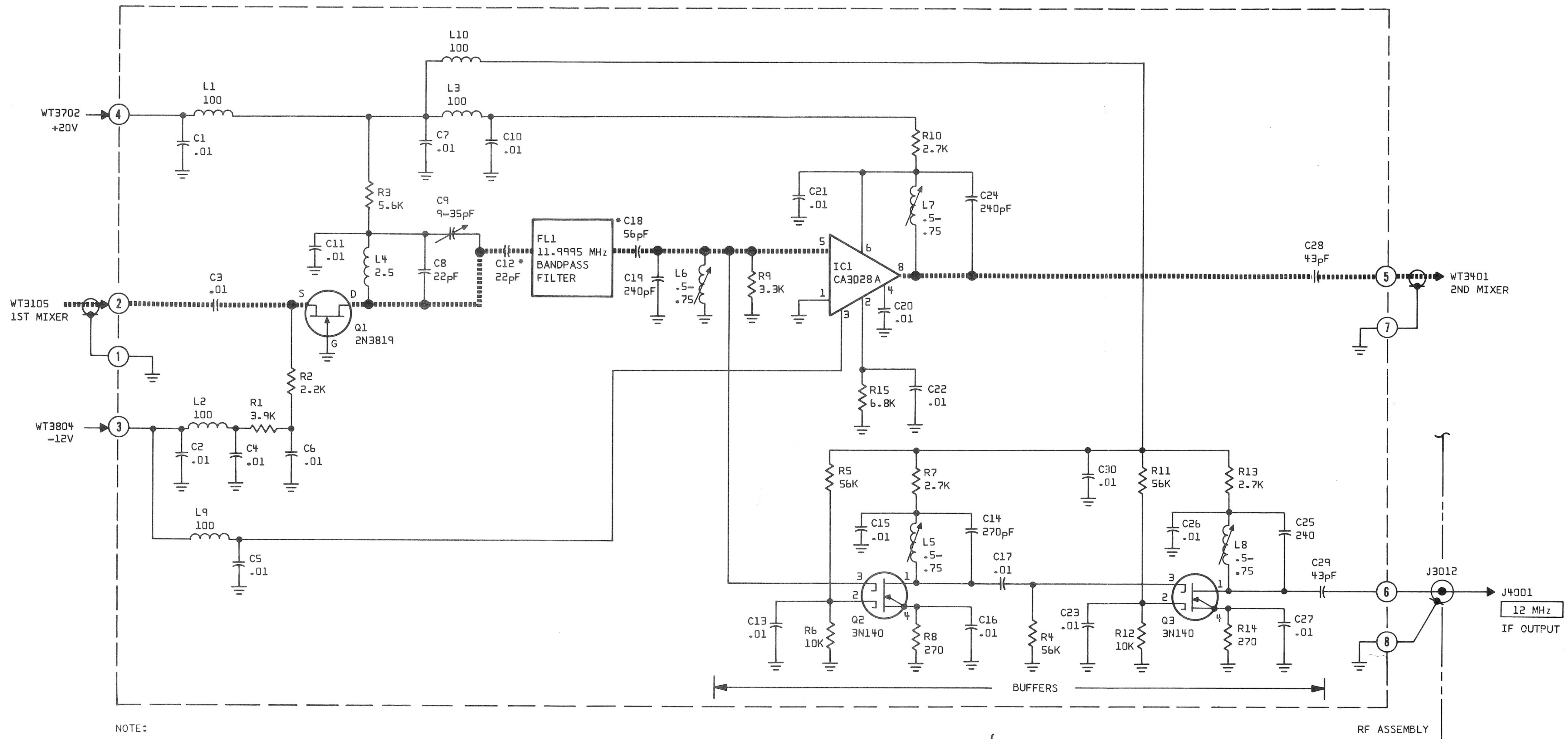


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C11	A-5	C22	G-6	INDUCTORS		INT CKT		R9	F-4
C1	A-5	C12	B-5	C23	G-5	L1	A-4	IC1	F-5	R10	E-5
C2	D-6	C13	F-4	C24	F-6	L2	C-6	RESISTORS		R11	H-5
C3	A-6	C14	G-4	C25	H-5	L3	C-4	R1	B-6	R12	H-4
C4	B-6	C15	G-4	C26	H-6	L4	B-5	R2	A-6	R13	H-5
C5	H-6	C16	F-4	C27	G-6	L5	G-4	R3	B-4	R14	G-6
C6	B-6	C17	G-5	C28	F-6	L6	E-4	R4	G-5	R15	G-6
C7	B-4	C18	E-5	C29	H-5	L7	E-6	R5	F-4	TRANSISTORS	
C8	B-5	C19	E-4	C30	D-4	L8	H-6	R6	F-4	Q1	A-6
C9	B-5	C20	F-5	FILTER		L9	C-4	R7	G-4	Q2	F-4
C10	D-4	C21	F-6	FL1	D-5	L10	E-6	R8	F-4	Q3	G-5

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3300	Board Assy., First IF Amplifier	7001-0063	Cushman	
	Board, Printed Circuit	1780-0117	Cushman	
	CAPACITORS			
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C2	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C6	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C9	Trimmer, Cer, 9-35 pF, 350V, N650	1001-0006	Erie	538-002-94D
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
*C12	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C13	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C17	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
*C18	Mica, 56 pF ±5%, 500V	1002-0019	Elmenco	DM15-E-560J
C19	Mica, 240 pF ±5%, 500V	1002-0030	Elmenco	DM15-F-241J
C20	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C21	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C22	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C23	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C24	Mica, 240 pF ±5%, 500V	1002-0030	Elmenco	DM15-F-241J
C25	Mica, 240 pF ±5%, 500V	1002-0030	Elmenco	DM15-F-241J
C26	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C27	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C28	Mica, 43 pF ±5%, 500V	1002-0046	Elmenco	DM15-E-430J
C29	Mica, 43 pF ±5%, 500V	1002-0046	Elmenco	DM15-E-430J
C30	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
	FILTER			
FL1	Crystal, 11.9995 MHz	1040-0017	Cushman	
	INDUCTORS			
L1	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L2	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L3	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L4	Toroid, 2.5 μH	1579-0019	Cushman	
L5	Var, 0.50 - 0.75 μH	1596-0011	Cushman	
L6	Var, 0.50 - 0.75 μH	1596-0011	Cushman	
L7	Var, 0.50 - 0.75 μH	1596-0011	Cushman	
L8	Var, 0.50 - 0.75 μH	1596-0011	Cushman	
L9	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L10	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
	INTEGRATED CIRCUIT			
IC1	Ampl, RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R2	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R3	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625

* Factory selected. Typical value given.

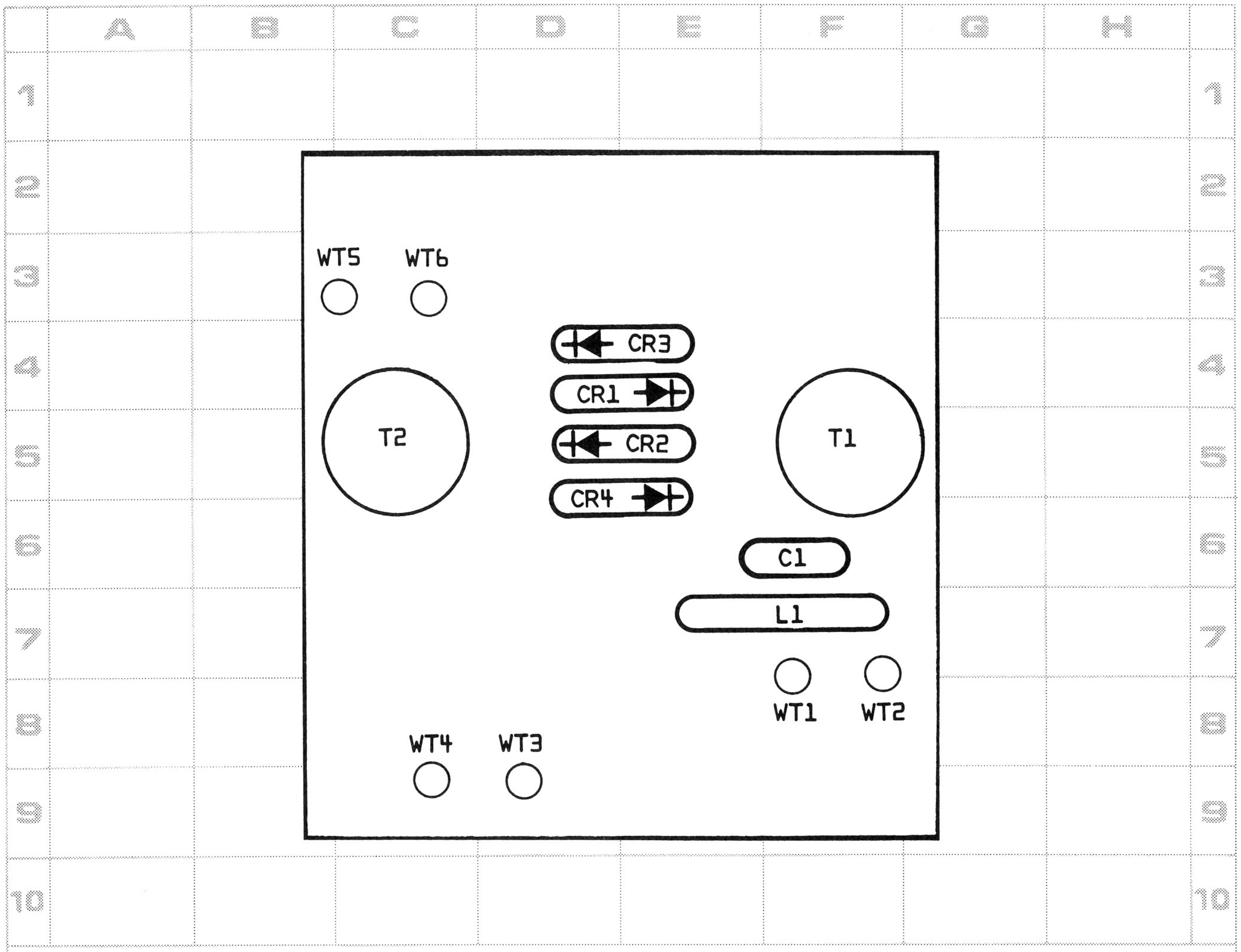
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R4	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R5	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R6	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R9	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R12	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R14	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R15	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
	TRANSISTORS			
Q1	Si, FET, N-Channel	1272-0039	TI	2N3819
Q2	Si, MOS FET, N-Channel	1272-0028	RCA	3N140
Q3	Si, MOS FET, N-Channel	1272-0028	RCA	3N140



NOTE:

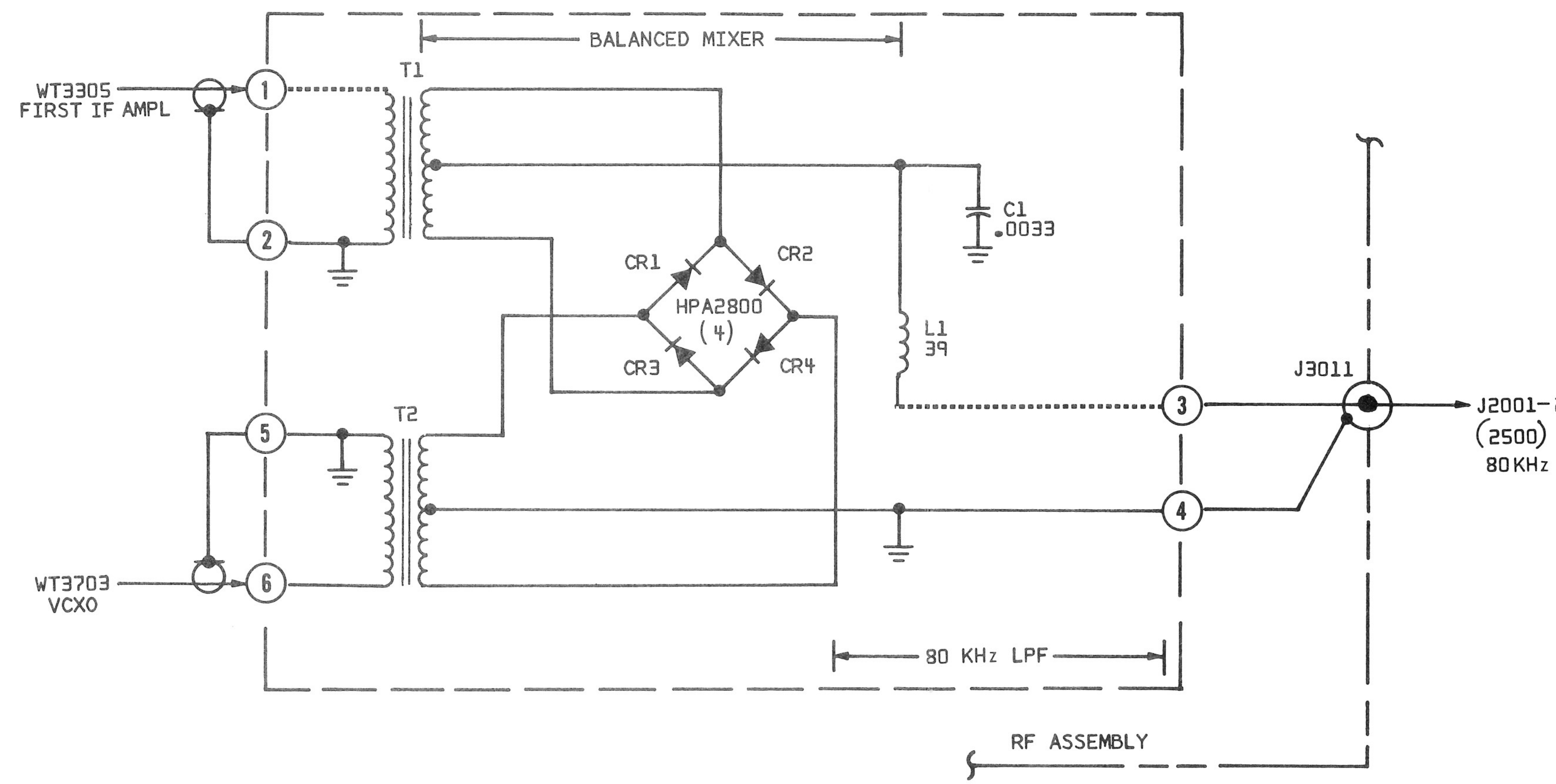
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-16 First IF Amplifier, Schematic Diagram



REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITOR		CR4	D-6
C1	F-6	INDUCTOR	
DIODES		L1	F-7
CR1	D-4	XFMRS	
CR2	E-5	T1	F-5
CR3	E-4	T2	C-5

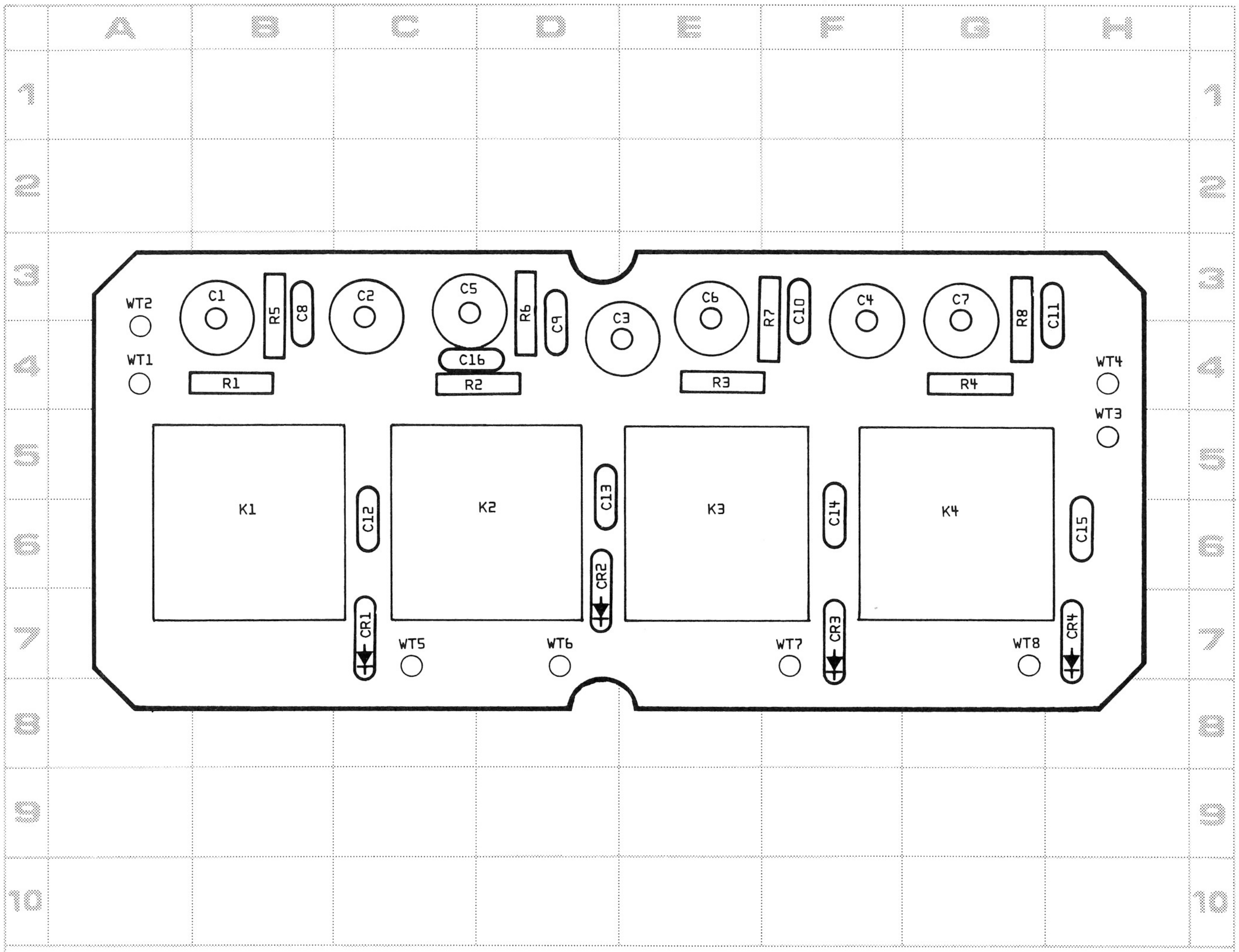
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3400	Board Assembly, Second Mixer	7001-0064	Cushman	
	Board, Printed Circuit	1780-0119	Cushman	
	CAPACITOR			
C1	Poly, 0.0033 μF ±10%, 100V	1008-0041	Sprague	225P33291WA3
	DIODES			
CR1	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR2	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTOR			
L1	Choke, RF, 39 μH ±5%	1585-0043	Delevan	1537-56
	TRANSFORMERS			
T1	Toroid, Tri-filar	1579-0017	Cushman	
T2	Toroid, Tri-filar	1579-0017	Cushman	



NOTE:

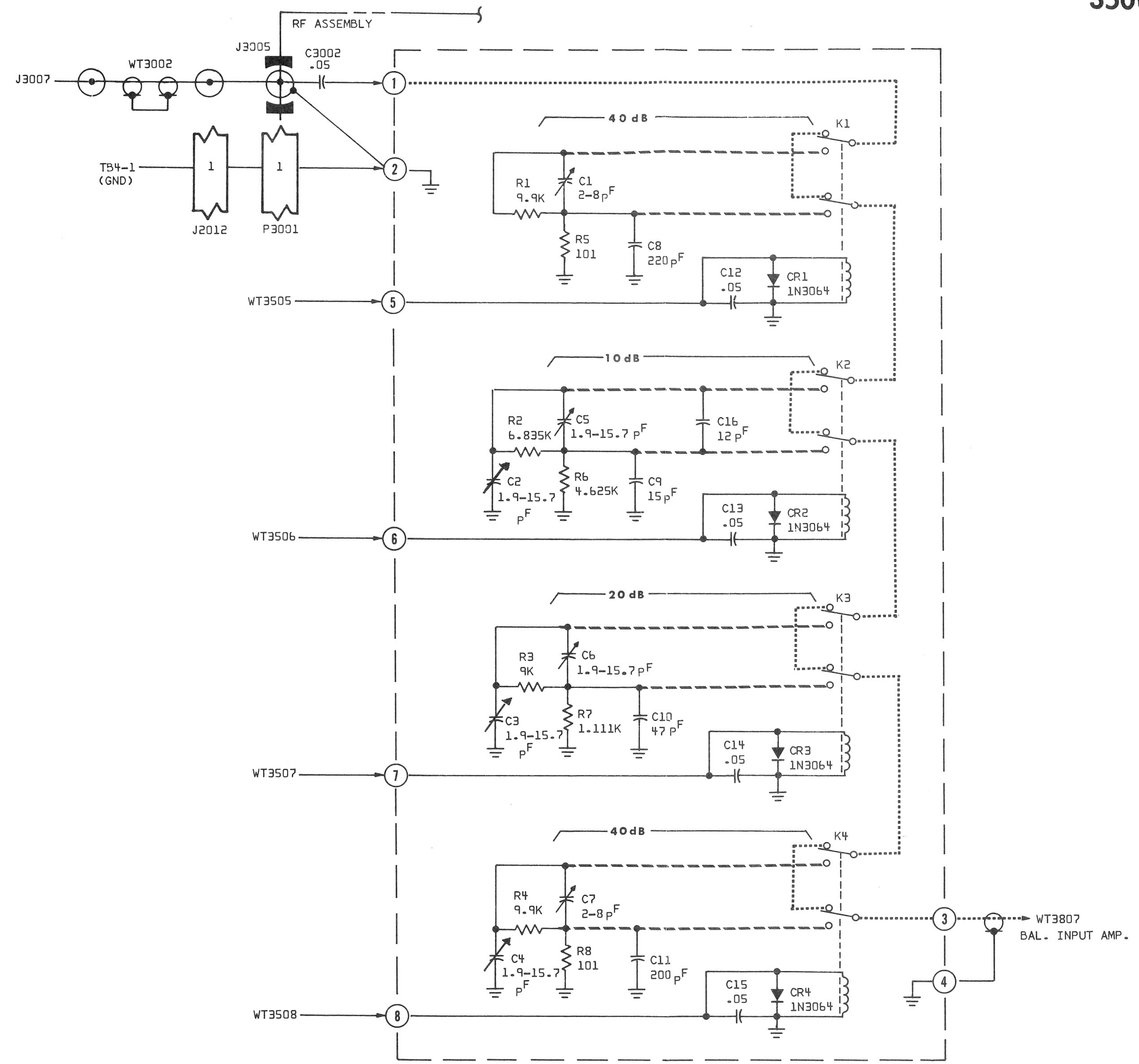
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-17 Second Mixer, Schematic Diagram



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C9	D-3	CR1	C-7	RESISTORS	
C1	B-3	C10	F-3	CR2	D-7	R1	B-4
C2	C-3	C11	H-3	CR3	F-7	R2	D-4
C3	E-4	C12	C-6	CR4	H-7	R3	E-4
C4	F-3	C13	D-5	RELAYS		R4	G-4
C5	C-3	C14	F-6	K1	B-6	R5	B-3
C6	E-3	C15	H-6	K2	D-6	R6	D-3
C7	G-3	C16	C-4	K3	E-6	R7	F-3
C8	B-3	DIODES		K4	G-6	R8	G-3

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3500	Board Assy., Hi-Z Attenuator, No.2	7001-0065	Cushman	
	Board, Printed Circuit	1780-0120	Cushman	
	CAPACITORS			
C1	Trimmer, Cer, 2-8 pF, 350V	1001-0004	Erie	538-002A-2-8-89A
C2	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E.F. Johnson	187-109-5
C3	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E.F. Johnson	187-109-5
C4	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E.F. Johnson	187-109-5
C5	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E.F. Johnson	187-109-5
C6	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E.F. Johnson	187-109-5
C7	Trimmer, Cer, 2-8 pF, 350V	1001-0004	Erie	538-002A-2-8-89A
C8	Mica, 220 pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C9	Mica, 15 pF ±5%, 500V	1002-0001	Elmenco	DM15-C-150J
C10	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco	DM15-E-470J
C11	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco	DM15-F-201J
C12	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C14	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C16	Mica, 12 pF ±5%, 500V	1002-0017	Elmenco	DM15-C-120J
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
	RELAYS			
K1	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K2	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K3	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K4	DPDT, 12VDC	1313-0005	Printact	12BW2-G
	RESISTORS			
R1	Met. Film, 9.9kΩ ±0.25%, 0.1 W	1074-0035	Dale	MF-1/10-T-9
R2	Met. Film, 6.835kΩ ±0.25%, 0.1 W	1074-0033	Dale	MF-1/10-T-9
R3	Met. Film, 9kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF-1/10-T-9
R4	Met. Film, 9.9kΩ ±0.25%, 0.1 W	1074-0035	Dale	MF-1/10-T-9
R5	Met. Film, 101Ω ±0.25%, 0.1 W	1074-0013	Dale	MF-1/10-T-9
R6	Met. Film, 4.625kΩ ±0.25%, 0.1 W	1074-0031	Dale	MF-1/10-T-9
R7	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF-1/10-T-9
R8	Met. Film, 101Ω ±0.25%, 0.1 W	1074-0013	Dale	MF-1/10-T-9

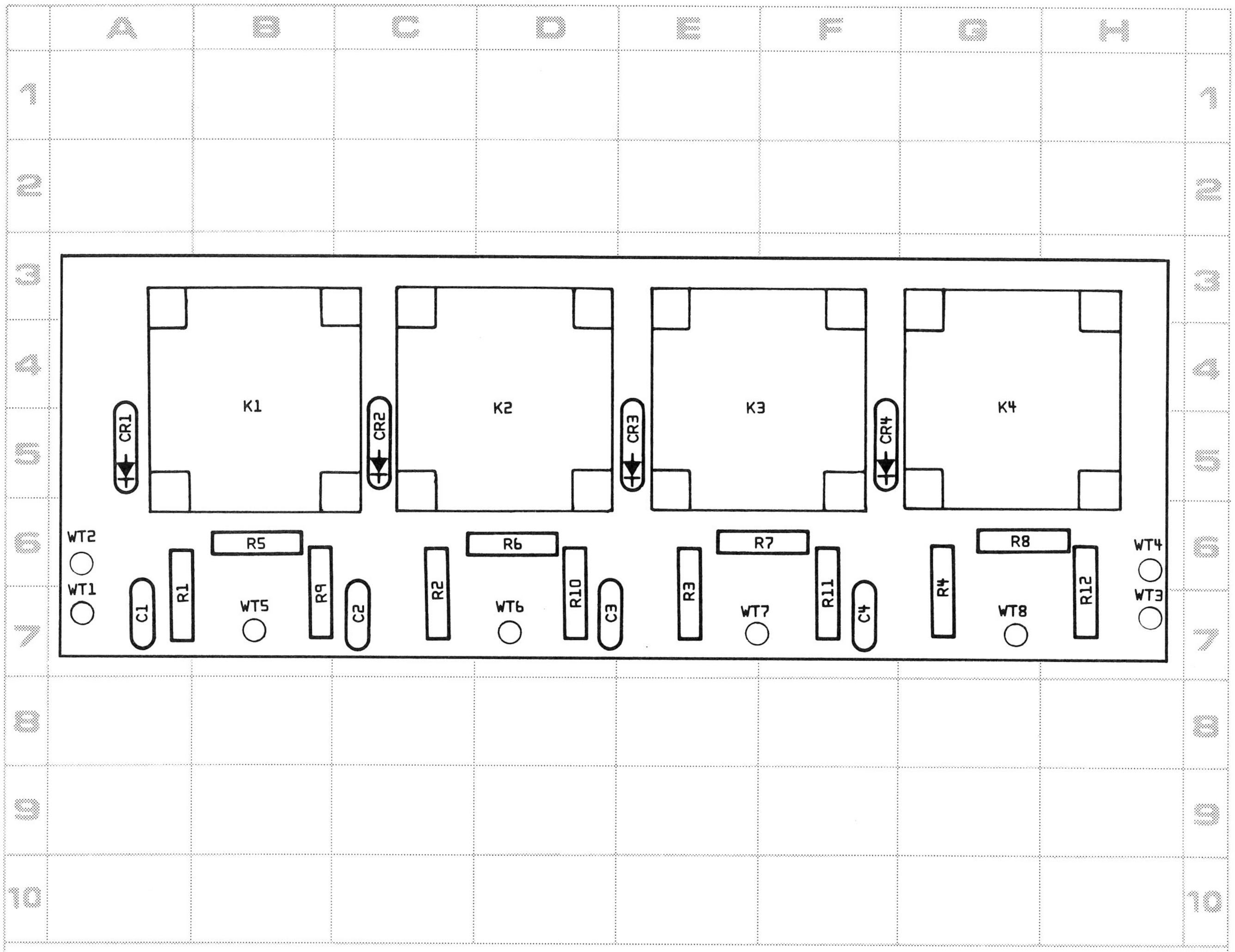


NOTE:

1. RESISTORS-.15W,0.25% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. RELAYS SHOWN IN THE -99 dBm CASE.

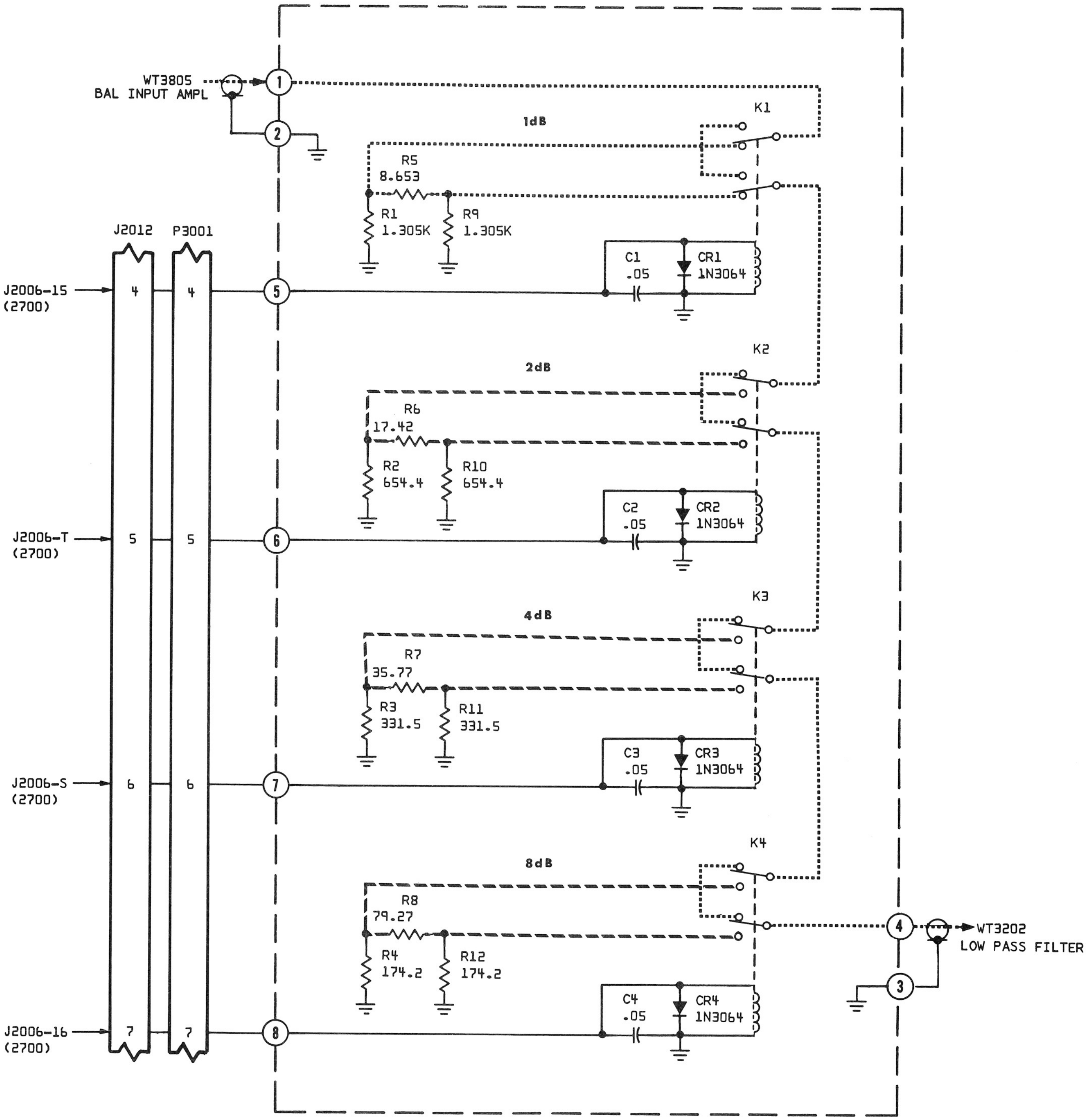
Figure 6-18 Hi-Z Attenuator No. 2, Schematic Diagram

6.3.19 15-dB Attenuator



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		CR2	C-5	K4	G-4	R6	D-6
C1	A-7	CR3	E-5	RESISTORS		R7	F-6
C2	C-7	CR4	F-5	R1	A-7	R8	G-6
C3	D-7	RELAYS		R2	C-7	R9	B-7
C4	F-7	K1	B-4	R3	E-7	R10	D-7
DIODES		K2	D-4	R4	G-7	R11	F-7
CR1	A-5	K3	E-4	R5	B-6	R12	H-7

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3600	Board Assembly, 15 dB Attenuator	7001-0067	Cushman	
	Board, Printed Circuit	1780-0121	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
	RELAYS			
K1	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K2	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K3	DPDT, 12VDC	1313-0005	Printact	12BW2-G
K4	DPDT, 12VDC	1313-0005	Printact	12BW2-G
	RESISTORS			
R1	Met. Film, 1.305kΩ ±0.25%, 0.1 W	1074-0028	Dale	MF 1/10-T-9
R2	Met. Film, 654.4Ω ±0.25%, 0.1 W	1074-0024	Dale	MF 1/10-T-9
R3	Met. Film, 331.5Ω ±0.25%, 0.1 W	1074-0022	Dale	MF 1/10-T-9
R4	Met. Film, 174.2Ω ±0.25%, 0.1 W	1074-0019	Dale	MF 1/10-T-9
R5	Met. Film, 8.653Ω ±0.25%, 0.15W	1074-0001	IRC	T-1
R6	Met. Film, 17.42Ω ±0.25%, 0.15W	1074-0002	IRC	T-1
R7	Met. Film, 35.77Ω ±0.25%, 0.1 W	1074-0003	Dale	MF 1/10-T-9
R8	Met. Film, 79.27Ω ±0.25%, 0.1 W	1074-0010	Dale	MF 1/10-T-9
R9	Met. Film, 1.305kΩ ±0.25%, 0.1 W	1074-0028	Dale	MF 1/10-T-9
R10	Met. Film, 654.4Ω ±0.25%, 0.1 W	1074-0024	Dale	MF 1/10-T-9
R11	Met. Film, 331.5Ω ±0.25%, 0.1 W	1074-0022	Dale	MF 1/10-T-9
R12	Met. Film, 174.2Ω ±0.25%, 0.1 W	1074-0019	Dale	MF 1/10-T-9

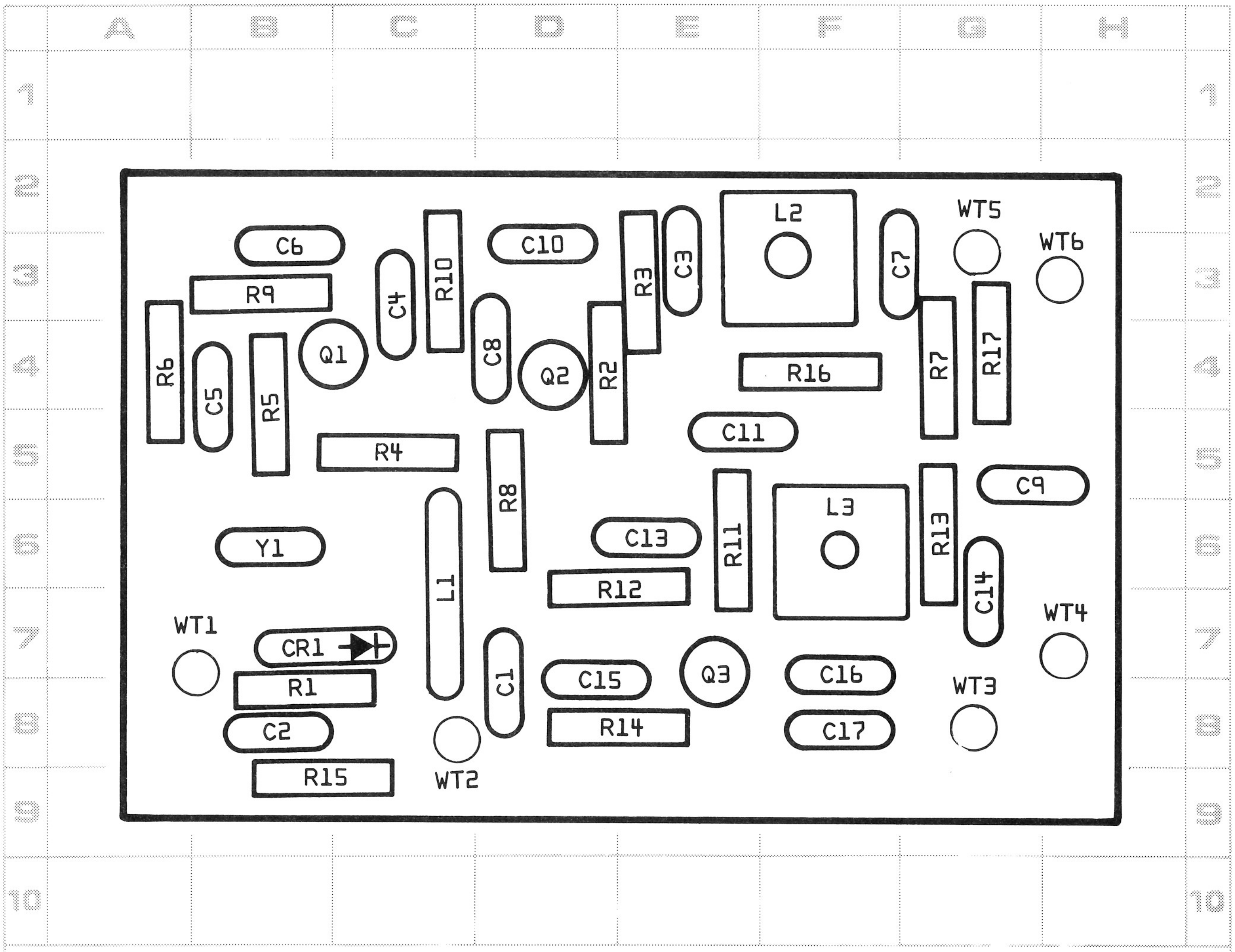


NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. RELAYS SHOWN IN THE -99 dBm CASE.

Figure 6-19 15-dB Attenuator, Schematic Diagram

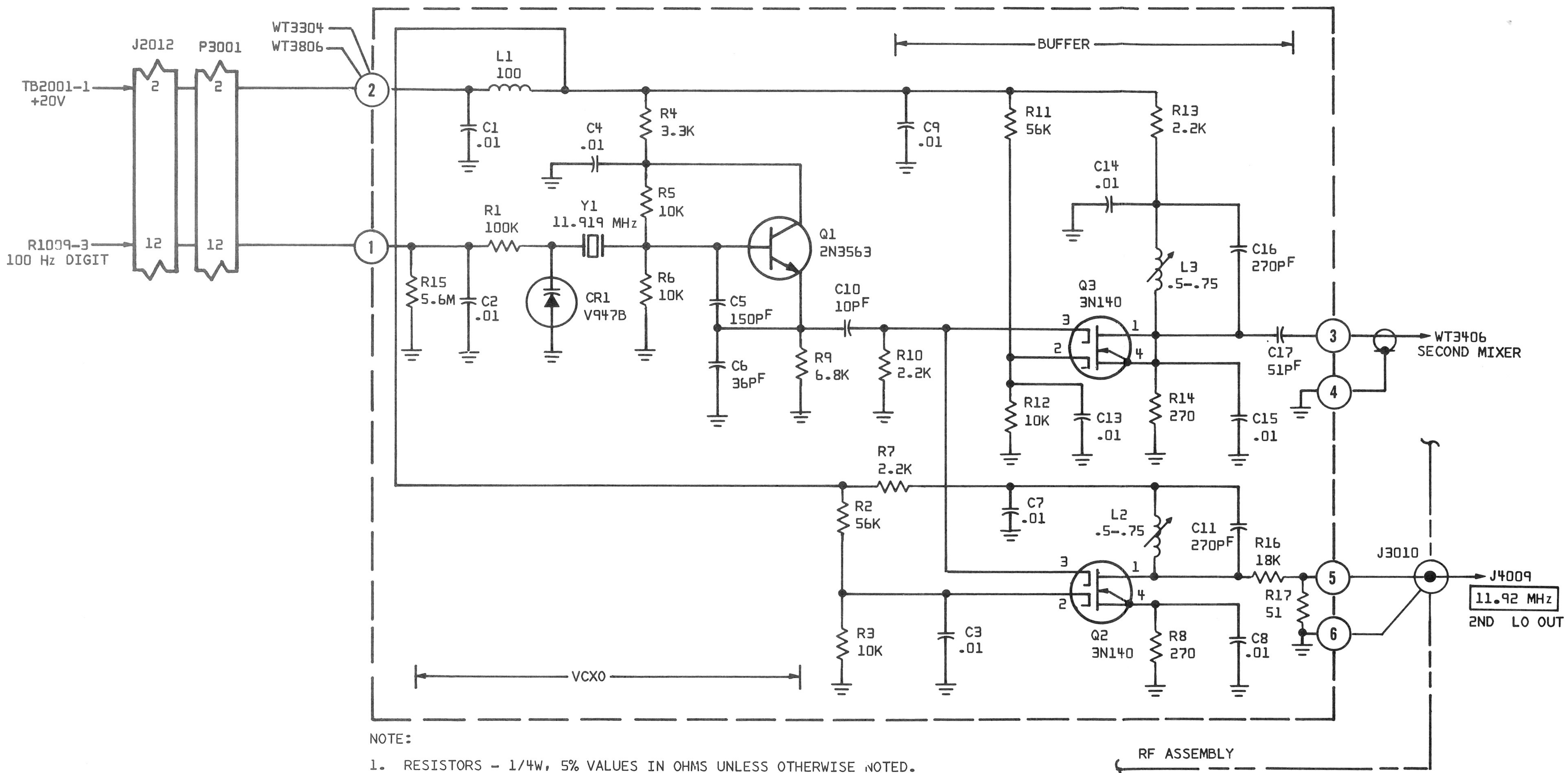
5601··0021



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C8	D-4	C16	F-7	L2	F-3	R6	A-4	R14	D-8
C1	D-8	C9	G-5	C17	F-8	L3	F-6	R7	G-4	R15	B-9
C2	B-8	C10	D-3	CRYSTAL		RESISTORS		R8	D-5	R16	F-4
C3	E-3	C11	E-5	Y1	B-6	R1	B-8	R9	B-3	R17	G-4
C4	C-3	C12	N/A	DIODE		R2	D-4	R10	C-3	TRANSISTORS	
C5	B-4	C13	E-6	CR1	B-7	R3	E-3	R11	E-6	Q1	B-4
C6	B-3	C14	G-7	INDUCTORS		R4	C-5	R12	D-6	Q2	D-4
C7	F-3	C15	D-8	L1	C-6	R5	B-4	R13	G-6	Q3	E-7

5601-0021-1

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3700	Board Assy., Voltage Controlled Crystal Oscillator (VCXO)	7001-0068	Cushman	
	Board, Printed Circuit	1780-0122	Cushman	
	CAPACITORS			
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C2	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco	DM15-F-151J
C6	Mica, 36 pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C9	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C10	Mica, 10 pF ±5%, 500V	1002-0016	Elmenco	DM15-C-100J
C11	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C12	Not Used			
C13	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C16	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C17	Mica, 51 pF ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
	CRYSTAL			
Y1	11.919 MHz	2035-0017	Cushman	
	DIODE			
CR1	Varicap	1281-0019	TRW	V947B
	INDUCTORS			
L1	Choke, RF, 100 μH ±5%	1585-0017	Delevan	1537-76
L2	Var, 0.5 - 0.75 μH	1596-0011	Cushman	
L3	Var, 0.5 - 0.75 μH	1596-0011	Cushman	
	RESISTORS			
R1	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R2	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R4	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R5	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R6	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R8	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R9	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R10	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R12	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R13	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R14	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R15	Comp, 5.6 MΩ ±5%, 1/4W	1066-5655	Allen-Bradley	CB5655
R16	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R17	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
	TRANSISTORS			
Q1	Si, NPN	1272-0022	Fairchild	2N3563
Q2	Si, MOS/FET	1272-0028	RCA	3N140
Q3	Si, MOS/FET	1272-0028	RCA	3N140



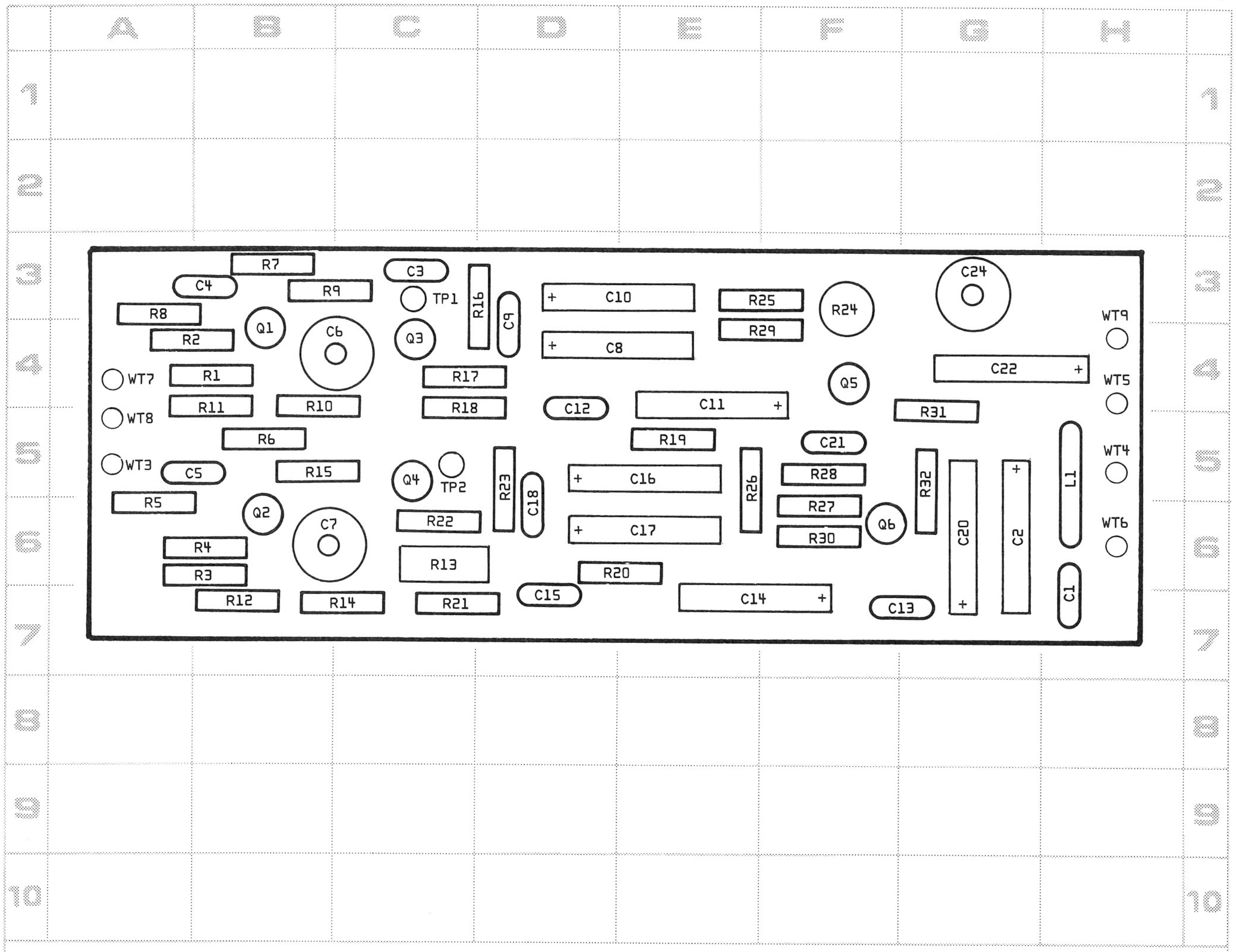
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-20 Voltage-Controlled Crystal Oscillator, Schematic Diagram

5601-0021-1

6.3.21 Balanced Input Amplifier

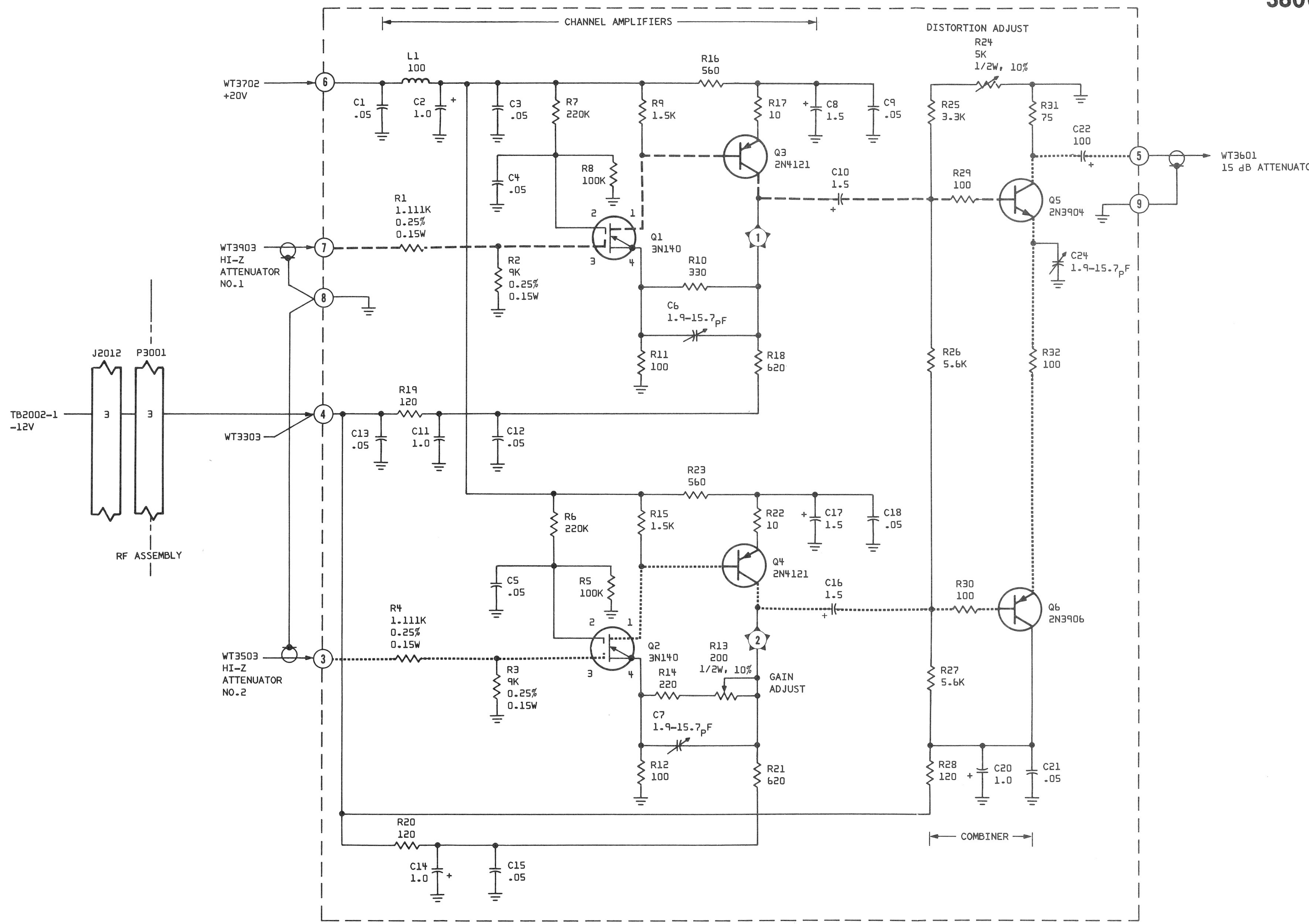


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C14	F-7	R1	B-4	R14	C-7	R27	F-6
C1	H-7	C15	D-7	R2	A-4	R15	B-5	R28	F-5
C2	G-6	C16	E-5	R3	B-6	R16	D-3	R29	F-4
C3	C-3	C17	E-6	R4	B-6	R17	C-4	R30	F-6
C4	B-3	C18	D-6	R5	A-6	R18	C-4	R31	G-5
C5	B-5	C19	N/A	R6	B-5	R19	E-5	R32	G-5
C6	C-4	C20	G-6	R7	B-3	R20	E-6	TRANSISTORS	
C7	B-6	C21	F-5	R8	A-3	R21	C-7	Q1	B-4
C8	D-4	C22	G-4	R9	B-3	R22	C-6	Q2	B-6
C9	D-4	C23	N/A	R10	B-4	R23	D-5	Q3	C-4
C10	D-3	C24	G-3	R11	B-4	R24	F-3	Q4	C-5
C11	E-4	INDUCTOR		R12	B-7	R25	F-3	Q5	F-4
C12	D-5	L1	H-5	R13	C-6	R26	E-5	Q6	F-6
C13	G-7	RESISTORS							

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3800	Board Assy., Balanced Input Amplifier	7001-0069	Cushman	
	Board, Printed Circuit	1780-0127	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C2	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C6	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
C7	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
C8	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C9	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C10	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C11	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C12	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C16	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C17	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C19	Not Used			
C20	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C21	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C22	Elect., 100 μF +75% -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C23	Not Used			
C24	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
	INDUCTOR			
L1	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
	RESISTORS			
R1	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF 1/10-T-9
R2	Met. Film, 9.0kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF 1/10-T-9
R3	Met. Film, 9.0kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF 1/10-T-9
R4	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF 1/10-T-9
R5	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R6	Comp, 220kΩ ±5%, 1/4W	1066-2245	Allen-Bradley	CB2245
R7	Comp, 220kΩ ±5%, 1/4W	1066-2245	Allen-Bradley	CB2245
R8	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R9	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R10	Comp, 330Ω ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R11	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R12	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R13	Pot., 200Ω, ±10%, 1/2W	1215-0016	Helitrim	66WR200
R14	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R15	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R16	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R17	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R18	Comp, 620Ω ±5%, 1/4W	1066-6215	Allen-Bradley	CB6215
R19	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R20	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R21	Comp, 620Ω ±5%, 1/4W	1066-6215	Allen-Bradley	CB6215
R22	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R23	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R24	Pot., Cer, Met. 5kΩ ±10%, 1/2W	1200-0021	Helitrim	62P-R5K
R25	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R26	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R27	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R28	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R29	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R30	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R31	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley	CB7505
R32	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
	TRANSISTORS			
Q1	Si, MOS/FET, N-Channel	1272-0028	RCA	3N140
Q2	Si, MOS/FET, N-Channel	1272-0028	RCA	3N140
Q3	Si, PNP	1272-0023	Fairchild	2N4121
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, NPN	1272-0032	Motorola	2N3904
Q6	Si, PNP	1272-0037	Motorola	2N3906

5601-0021

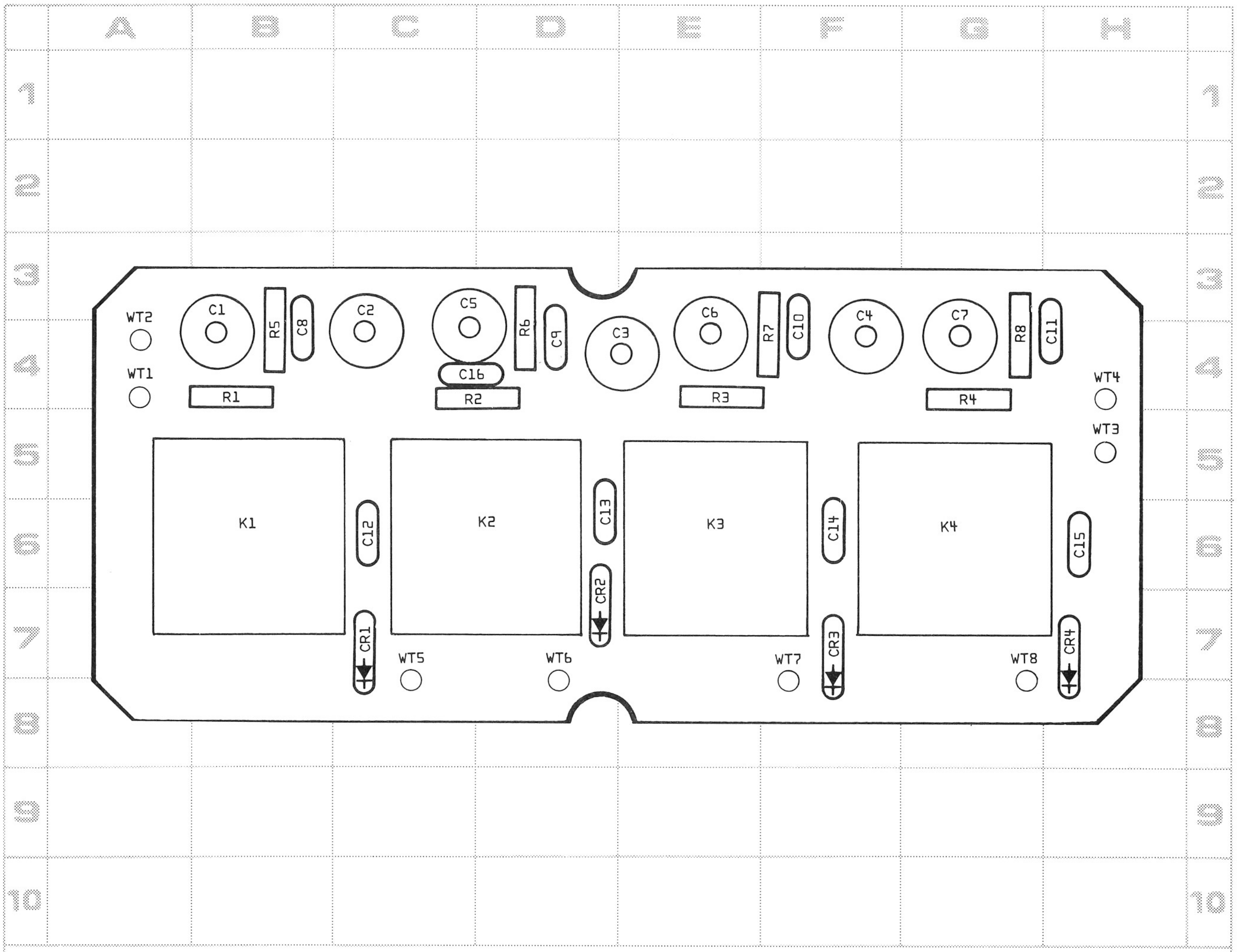


NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. SIGNAL PATH SHOWN FOR UNBAL. MODE

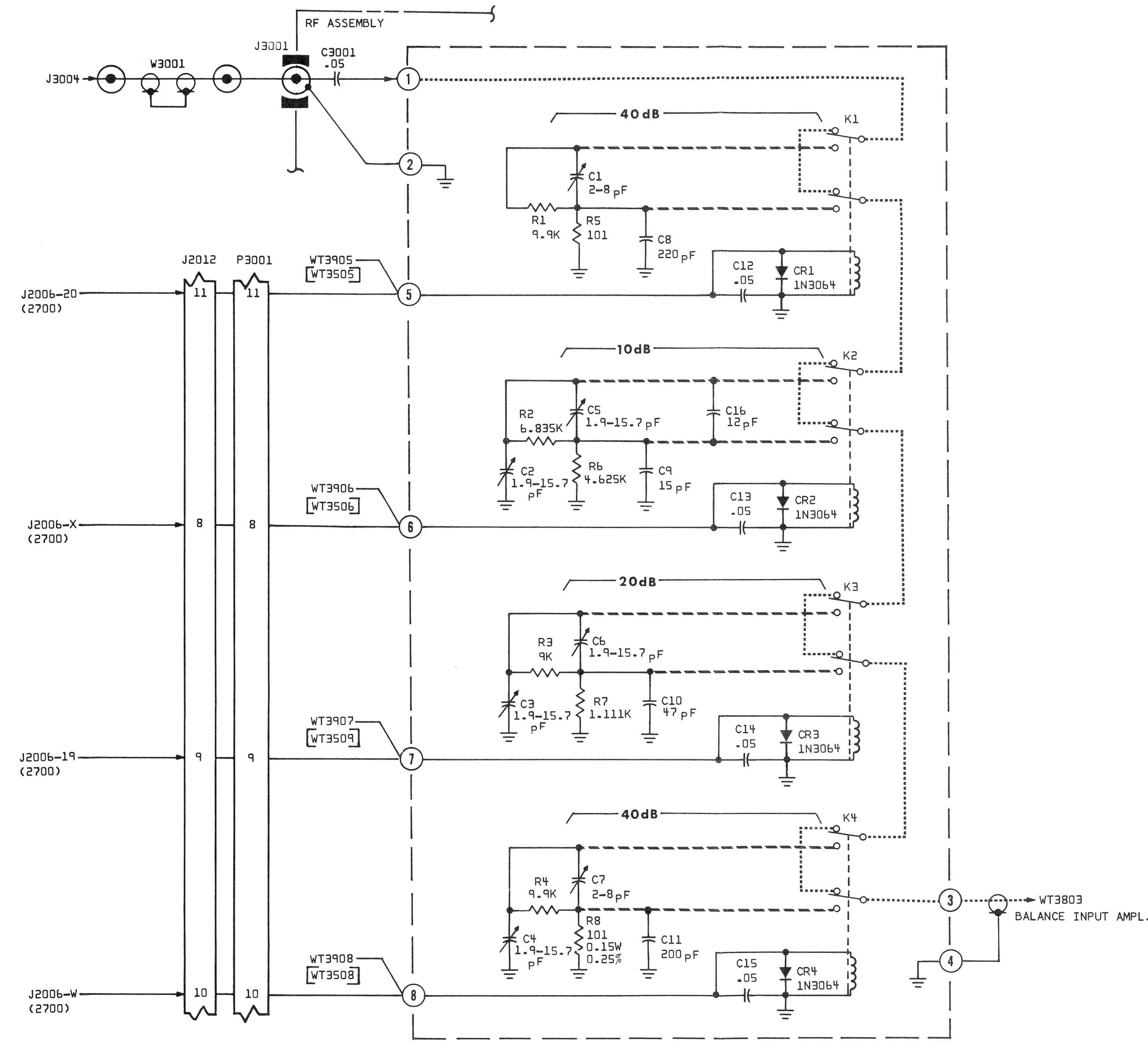
Figure 6-21 Balanced Input Amplifier, Schematic Diagram

6.3.22 Hi-Z Attenuator No. 1



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
CAPACITORS		C9	D-4	CR1	C-7	RESISTORS	
C1	B-4	C10	F-4	CR2	D-7	R1	B-4
C2	C-4	C11	H-4	CR3	F-7	R2	D-4
C3	E-4	C12	C-6	CR4	H-7	R3	E-4
C4	F-4	C13	D-6	RELAYS		R4	G-4
C5	C-4	C14	F-6	K1	B-6	R5	B-4
C6	E-4	C15	H-6	K2	D-6	R6	D-4
C7	G-4	C16	C-4	K3	E-6	R7	F-4
C8	B-4	DIODES		K4	G-6	R8	G-4

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3900	Board Assy., Hi-Z Attenuator No. 1	7001-0065	Cushman	
	Board, Printed Circuit	1780-0134	Cushman	
	Same as Hi-Z Attenuator No. 2 (3500)			



NOTE:

1. RESISTORS-.15W,0.25%VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. RELAYS SHOWN IN THE -99 dBm CASE.

Figure 6-22 Hi-Z Attenuator No. 1, Schematic Diagram

6.3.23 Rear Panel

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
4000	Assembly, Rear Panel	7003-0028	Cushman	
	Rear Panel	2800-0039	Cushman	
	FUSE			
F1	Slo-Blo, 3 Amp, 3 AG	1955-0012	Littelfuse	313003
	FUSEHOLDER			
	3 AG, Bayonet Knob	1965-0001	Littelfuse	342012
	JACKS			
J1	BNC	2536-0010	Kings	KC79-35
J2	BNC	2536-0010	Kings	KC79-35
J3	Outlet, 3-wire	2535-0025	Waber Electronics	3017
J4/FL1	3-contact, Flush Mt., Recpt & Filter, RF-1 Line	p/o2535-0024	Components Corp.	5A-2
J5	BNC	2536-0010	Kings	KC79-35
J6	BNC	2536-0010	Kings	KC79-35
J7	BNC	2536-0010	Kings	KC79-35
J8	BNC	2536-0010	Kings	KC79-35
J9	BNC	2536-0010	Kings	KC79-35

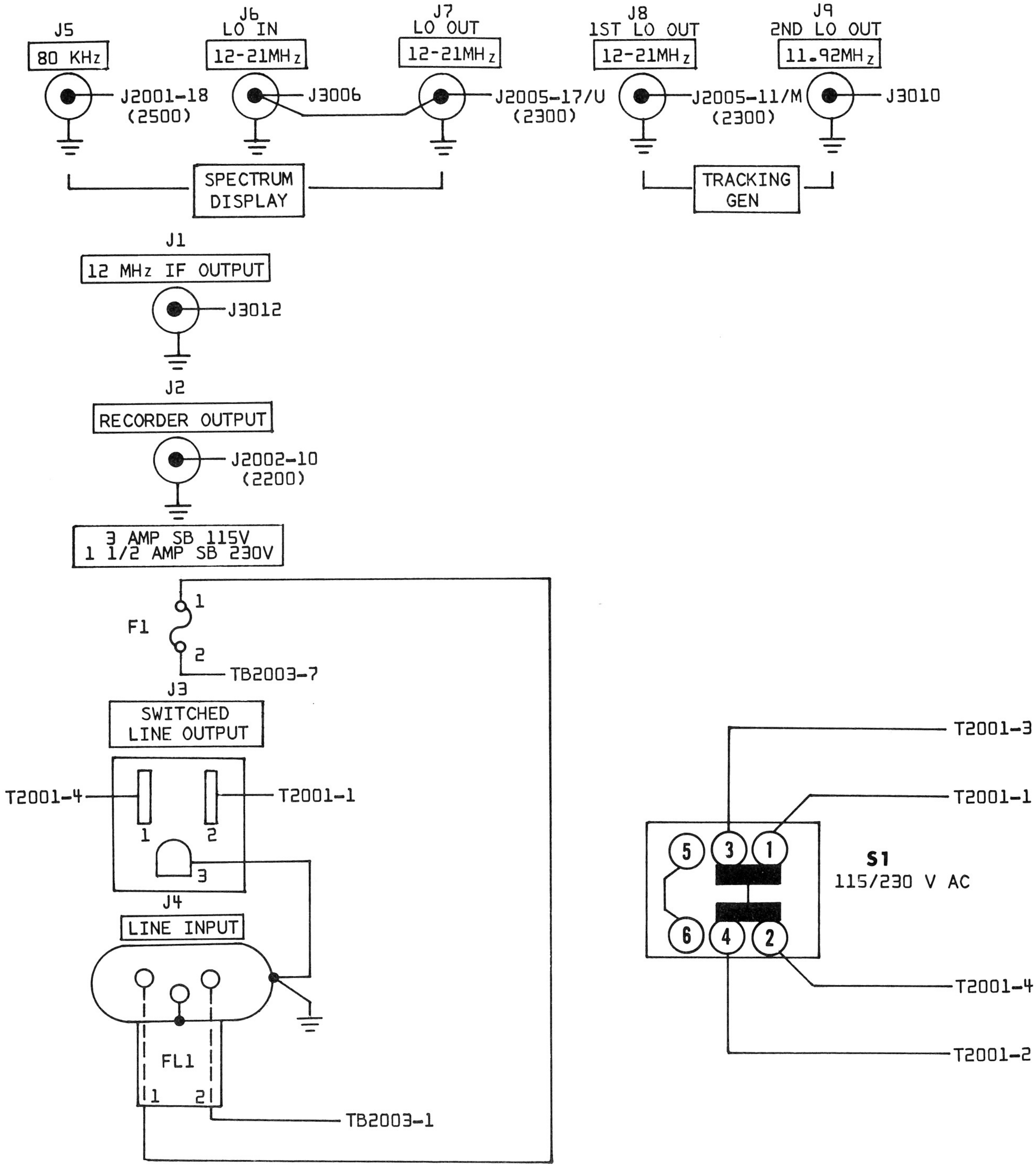


Figure 6-23 Rear Panel Interconnection Diagram

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Please indicate where the error has been made. To improve future manuals your comments are requested.

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