CE-7
MULTI-CHANNEL
FM COMMUNICATIONS
MONITOR

CUSHMAN
ELECTRONICS, INC.

APPLICABLE TO INSTRUMENTS WITH
SERIAL NUMBERS HIGHER THAN 261

CE-7
MULTI-CHANNEL
FM COMMUNICATIONS
MONITOR

CUSHMAN ELECTRONICS, INC.
Sunnyvale, Cal. 94086
408-739-6760

Printed in U.S.A.

5601-0015-1

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

CONTENTS

		Page
	WARRANTY	iii
SECTION 1	GENERAL DESCRIPTION	1-1
	1.1 Introduction	1-1
	1.2 Accessories	1-2
	1.2.1 Plug-In Units	1-2
	1.2.2 External Instruments	1-3
	1.2.3 Auxiliary Items	1-3
	1.3 Specifications	1-3
SECTION 2	INSTALLATION	2-1
	2.1 Unpacking and Inspection	2-1
	2.2 Environmental	2-1
	2.2.1 Temperature	2-1
	2.2.2 RF Fields	2-1
	2.3 Power Requirements	2-1
	2.4 Warm-up Requirements	2-1
	2.5 Preparation for Reshipment	2-1
SECTION 3	OPERATING INSTRUCTIONS	3-1
	3.1 Introduction	3-1
	3.2 Controls and Indicators	3-1
	3.3 Starting Procedure	3-1
	3.4 Operating Procedures	3-5
	3.4.1 Frequency and Deviation Measurement	3-5
	3.4.2 CW-Signal Generation	3-6
	3.4.3 FM-Signal Generation	3-6
	3.4.4 IF-Signal Generation	3-7
	3.4.5 Installation and Removal of IF-Oscillators	3-7
	3.4.6 Antenna Installation	3-8
	3.4.7 Installation and Removal of Crystals	3-8
	3.5 Turn-Off Procedure	3-8
SECTION 4	CIRCUIT DESCRIPTION	4-1
	4.1 Introduction	4-1
	4.2 Second IF and Discriminator Board	4-2
	4.3 Power-Supply Board	4-7
	4.4 Frequency Error Meter Board	4-8
	4.5 Harmonic Generator Board	4-8
	4.6 Multi-Oscillator Board	4-10
	4.7 IF Oscillator Board	4-12
	4.8 Signal-Generator Mixer	4-12

Page

SECTION 5 MAINTENANCE 5-1

5.1 Introduction 5-1
5.2 Access 5-1
5.3 Fuses 5-1
5.4 Adjustment Procedures and Check 5-1
5.4.1 Power-Supply Board, Voltage Adjustment 5-2
5.4.2 Crystal-Oscillator Adjustment 5-2
5.4.3 Frequency-Meter Adjustment 5-3
5.4.4 20-dB Fixed-Attenuator Loss Check 5-10
5.4.5 Signal-Generation-Output Level Adjustment 5-11
5.4.6 Signal-Generator-Mixer Input Level Check 5-11
5.5 Troubleshooting Procedures 5-13

SECTION 6 SCHEMATICS, PARTS LISTS, AND PARTS PICTORIALS 6-1

6.1 Introduction 6-1
6.2 Schematics, Parts Lists, Parts Pictorials 6-3
6.2.1 Second IF and Discriminator Board 6-3
6.2.2 Power Supply Board 6-7
6.2.3 Frequency Error Meter Board 6-11
6.2.4 Harmonic Generator Board 6-13
6.2.5 Multi-Oscillator Board 6-17
6.2.6 IF Oscillator Board 6-21
6.2.7 IF Oscillator Board 6-23
6.2.8 Signal Generator Mixer 6-25
6.2.9 Crystal Oven Assembly 6-27
6.2.10 Main Chassis 6-31
6.2.11 Front Panel 6-35
6.2.12 Rear Panel 6-39
6.2.13 Covers and Carrying Cases 6-41

CUSTOMER-COMMENT CARDS

ILLUSTRATIONS

Figure Page

1-1. CE-7 Multi-Channel FM Communications Monitor (Equipped) 1-1
3-1. Installation-Removal, IF-Oscillator Boards 3-7
4-1. CE-7, Block Diagram 4-3
4-2. Second IF and Discriminator Board, Block Diagram 4-5
4-3. Frequency-Meter Bridge, Simplified Schematic Diagram and Waveforms 4-5
4-4. Audio-Output Filter, Simplified Schematic Diagram and Waveforms 4-6

Figure		Page
4-5.	Power-Supply Board, Block Diagram	4-7
4-6.	Harmonic-Generator Board, Block Diagram	4-9
4-7.	Multi-Oscillator Board, Block Diagram	4-11
5-1.	CE-7 Right Interior View Without Plug-In	5-2
5-2.	CE-7 Bottom Interior View	5-4
5-3.	CE-7 Left Interior View Without Plug-In	5-8
6-1.	Second IF and Discriminator Board (0054), Schematic Diagram	6-5
6-2.	Power Supply Board (0100), Schematic Diagram	6-9
6-3.	Frequency-Error-Meter Board (0101), Schematic Diagram	6-11
6-4.	Harmonic-Generator Board (0102), Schematic Diagram	6-15
6-5.	Multi-Oscillator Board (0103), Schematic Diagram	6-19
6-6.	IF Oscillator Board (0104), Schematic Diagram	6-21
6-7.	IF Oscillator Board (0105), Schematic Diagram	6-23
6-8.	Signal Generator Mixer (CH-A3), Schematic Diagram	6-25
6-9.	Crystal Oven Assembly (CH-A4), Schematic Diagram	6-29
6-10.	Main Chassis, Wiring Diagram	6-33
6-11.	Front Panel, Wiring Diagram	6-37
6-12.	Rear Panel, Wiring Diagram	6-39

TABLES

Table		Page
1-1.	Auxiliary Items Furnished with the CE-7	1-3
1-2.	Specifications	1-4
3-1.	Controls and Indicators	3-2
4-1.	Channel Frequency Chart	4-10
5-1.	Power Supply, Resistances to Ground	5-3
5-2.	Power-Supply Board, Voltage Adjustment	5-4
5-3.	Crystal-Oscillator Adjustment	5-5
5-4.	Frequency-Meter Adjustment	5-9
5-5.	20-dB Fixed-Attenuator Loss Check	5-10
5-6.	Signal-Generation-Output Level Adjustment	5-12
5-7.	Signal-Generator-Mixer-Input Level Check	5-13
5-8.	Troubleshooting, Frequency-Deviation-Measure (FDM) Mode	5-14
5-9.	Troubleshooting, Signal-Generator Mode	5-16
5-10.	Troubleshooting, I. F.-Generator Board	5-17
5-11.	Troubleshooting, Crystal-Oven Assembly	5-18
6-1.	Reference Designators and Abbreviations	6-2

SECTION 1
GENERAL DESCRIPTION

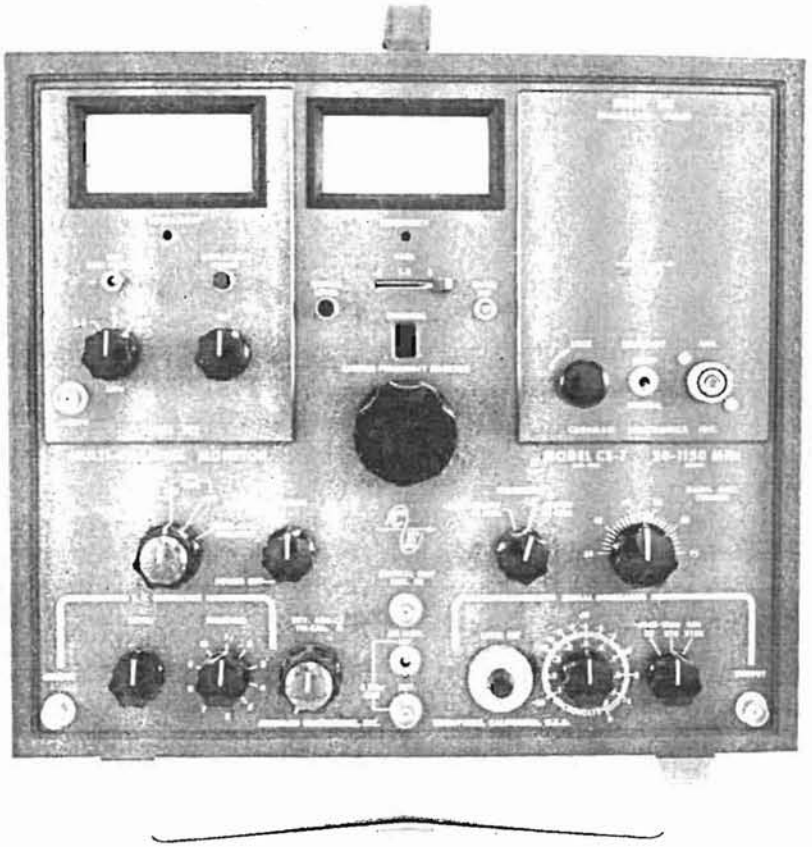


Figure 1-1. CE-7 Multi-Channel FM Communications Monitor (Equipped)

1.1 Introduction

The Model CE-7 Multi-Channel FM Communications Monitor (Figure 1-1) is designed to measure the frequency and frequency-modulation deviation of transmitters and other signal sources. The CE-7 is crystal controlled and can operate on any one of 23 frequencies between 20 MHz and 1150 MHz. Which frequencies are assigned to the 23 positions is specified by the customer. Any number of crystals between one and 23 may be selected and the operation of the instrument is not compromised if only one or two crystals are installed. The Cushman Model MCO-6 Multi-Channel Oscillator (accessory) offers an additional 23 frequencies should the need for other crystal frequencies arise.

The CE-7 can also generate FM and CW signals within the frequency limits stated above. The output level of the generated signal may be adjusted from 0.1 to 100 microvolts and provides the capability of determining the sensitivity of FM communication receivers. Signal generation of up to ten optional crystal-controlled IF

frequencies is available between 250 kHz and 13.5 MHz. The output levels of the IF signals are continuously variable.

The CE-7 must operate with either a Model 301 Oscilloscope or a Model 302 FM Deviation Meter inserted into the left-hand plug-in cavity, and a Model 303 Broadband Mixer or one of the RF plug-ins inserted into the right-hand plug-in cavity. The combination of the plug-ins is at the discretion of the customer.

1.2 Accessories

Three types of accessories are available for use with the CE-7: 1) units that plug into the monitor and obtain operating power from it; 2) external instruments; and 3) auxiliary items supplied with the monitor, but not integral parts of it.

1.2.1 Plug-In Units

A cavity accessible through an opening in the left-hand part of the monitor front panel accepts either the Model 301 Oscilloscope or the Model 302 FM Deviation Meter. One or the other of these must be used to provide FM deviation measurements. A similar cavity in the right-hand part of the front panel accepts a Model 303 Broadband Mixer or a Model 304, 305, or 306B RF Preselector.

The Model 301 Oscilloscope permits visual examination of exact modulation of the transmitter carrier. Unbalanced modulation, power-supply pulses, unusual clipping, and other problems become immediately apparent so that appropriate repairs can be made. The Model 301 has an automatic sync circuit, similar to that found in the most advanced laboratory instruments, to lock on and precisely display waveforms. The scope graticule is calibrated to show devation on any one of three ranges: ±1.5 kHz, ±5 kHz, and ±15 kHz. Switches on the front panel permit use of external vertical inputs while using the internal sweep. External signals may also be connected to the horizontal input. This permits independent use of the Model 301 of the monitoring function for routine testing, troubleshooting, displaying Lissajous patterns, etc. The Oscilloscope can also be used for receiver IF-bandwidth measurement and discriminator alignment.

The Model 302 FM Deviation Meter provides three ranges: 0 to 2.5 kHz, 0 to 6 kHz, and 0 to 25 kHz. An instantaneous-peak-indicator light flashes when the absolute peak deviation of the incoming carrier exceeds an amount preset by the operator. Operation and accuracy of the peak indicator are not affected by modulation frequency, repetition rate, or waveform. A switch permits selection and measurement of either plus or minus deviation peaks. A scope jack is provided for simultaneous meter indications and oscilloscope observations of deviation (a separate oscilloscope, not a Model 301, must be used).

NOTE

Remote display of FM deviation is possible only when the Model 302 FM Deviation Meter is used.

The Model 303 Broadband Mixer operates on all frequencies covered by the CE-7. Sensitivity is less than 10 millivolts, for close-in monitoring and in-shop measurements. A crystal filter in the broadband miser provides sharp selectivity in areas where many strong RF signals are present.

Three different RF Preselector plug-ins are available for use in the CE-7. The Model 304 operates from 25 MHz to 50 MHz, the Model 305 from 145 MHz to 175 MHz, and the Model 306B from 450 MHz to 520 MHz. The sensitivity of these preselectors is less than 20 microvolts and enables it to monitor base stations up to 50 miles away. The preselectors also have a crystal filter that permits sharp selectivity.

A telephone jack on the front panel of the 304 and 305 preselectors permits use of an external meter for reading the AGC voltage, which is indicative of the level of the incoming signal.

1.2.2 External Instruments

Three accessory instruments, the Model MCO-6 Multi-Channel Oscillator, the Model 107 FM Deviation Calibrator, and the Model 309B Remote Meters can be connected to the CE-7. The Model MCO-6 Multi-Channel Oscillator provides up to 23 additional crystal-controlled frequencies. The multi-channel oscillator is connected to the CRYSTAL OUT AUX. IN connector on the CE-7 front panel by the RF cable supplied inside the front cover of the CE-7.

The Model 107 FM Deviation Calibrator provides a means of verifying the accuracy of the FM deviation ranges of the Model 301 Oscilloscope and the Model 302 FM Deviation Meter. The calibrator must be connected to the CE-7 by a cable to the auxiliary equipment connector (CH-J4) on the left side of the CE-7, and must be used in conjunction with an external oscillator with a frequency range of 2080 to 2100 Hz.

The Model 309B Remote Meters consists of an FM DEVIATION meter and a FREQUENCY meter mounted in a cabinet that can be located at a distance of up to several hundred feet from the CE-7. The cable from the Remote Meters plugs into the accessory receptacle on the back of the CE-7. A switch near the receptacle permits selection of internal or external meters.

1.2.3 Auxiliary Items

Auxiliary items (Table 1-1) supplied with the instrument are: a 30-inch telescoping antenna; a 20-dB fixed attenuator with adapter cable, which must be used when the CE-7 is operated as a signal generator; an AC plug adapter (three prong/two prong); an RF cable assembly for interface between the CE-7 and external equipment; and a spare fuse package for replacing a defective fuse contained in the 20-dB fixed attenuator. Installation of the antenna is covered in Paragraph 3.4.6, and operation of the 20-dB fixed attenuator is described in Paragraph 3.4.2, step e.

1.3 Specifications

Table 1-2 lists the specifications for the CE-7 as well as those for the plug-in units that can be used with the CE-7.

Table 1-1. Auxiliary Items Furnished with the CE-7

ITEM	DESCRIPTION	CUSHMAN STOCK NO.	QUANTITY
1	Antenna Assembly	7040-0019	1
2	20-dB Attenuator/Adapter Cable	7040-0016	1
3	RF Cable Assembly	7030-0014	1
4	AC Adapter Plug (three prong/two prong)	2535-0001	1
5	RF Fuse, 1/32 Amp	1955-0005	2
6	Channel Frequency Chart	5500-0006	1
7	Front Cover	2180-0033	1
8	Equipment Manual, CE-7	5601-0015	1

Table 1-2. Specifications

Model CE-7 Multi-Channel FM Communications Monitor	
Frequency Deviation Measure	
Frequency Coverage	20 MHz to 1150 MHz (23 crystal-controlled channels)
Frequency Accuracy	±0.0001% (long term)
Frequency Error Ranges	±500 Hz, ±1.5 kHz, ±5.0 kHz
Frequency Error Resolution	20 Hz
RF Signal Generation - CW and FM	
Frequency Coverage (calibrated in microvolts)	20 MHz to 1150 MHz
Output Level	0-1, 0-10, 10-100 μV; ±2 dB into 50 ohms. Calibrated in μV and dB with external 20-dB fixed attenuator. (100-1000 μV without 20-dB fixed attenuator.)
Frequency Accuracy	±0.0001% (long term)
Internal FM	1.0 kHz modulation frequency. 0 to 25 kHz deviation, less than 2% distortion.
External FM Modulation	60 Hz to 20 kHz modulation frequency. 0 to 25 kHz deviation, 500 μV sensitivity.
IF Signal Generation	
Frequency Coverage	250 kHz to 13.5 MHz (10 crystal controlled channels)
Output Levels	0-1 V, 250 kHz to 900 kHz into 600 ohms; 0-0.5 V, 1.0 MHz to 13.5 MHz into 600 ohms.
Power Requirements	115 or 230 vac ±10%, 50 to 400 Hz, 175W during oven warm up, 75W max. after warm up.
Dimensions	12-1/4 in. high, 13.0 in. wide, 16.0 in. deep
Operating Temperature	+10°F (-12°C) to +130°F (+55°C)
Oven Warm-Up Time	30 minutes
Net Weight	28 pounds less plug-ins, 35 pounds with plug-ins

Table 1-2. Specifications (Continued)

Model 301 Oscilloscope Plug-in			
Deviation Measurement Accuracy	±5% full scale in three ranges: ±1.5 kHz, 5.0 kHz, 15.0 kHz		
External Inputs	Vertical and Horizontal		
External Vertical Sensitivity	300 mv for full scale		
External Frequency Response (3 dB)	30 kHz		
Model 302 Deviation Meter Plug-in			
Accuracy of Measurements	±4% full scale in three ranges: 0-2.5 kHz, 0-6 kHz, 0-25 kHz		
Model 303 Broadband Mixer Plug-in			
Frequency Coverage	20 MHz to 1150 MHz		
Sensitivity	Less than 10 mv below 512 MHz		
Input Impedance (nominal)	50 ohms		
Receiver Bandwidth (3 dB):			
Broad	80 kHz		
Narrow	13.5 kHz		
RF Preselector Plug-ins	Model 304	Model 305	Model 306B
Frequency Coverage	25-50 MHz	145-175 MHz	450-520 MHz
Nominal Input Impedance	50 ohms	50 ohms	50 ohms
Bandwidth (3 dB):			
Broad	80 kHz	80 kHz	80 kHz
Narrow	20 kHz	20 kHz	20 kHz
Sensitivity: Less than	20 microvolts	20 microvolts	20 microvolts

SECTION 2
INSTALLATION

2.1 Unpacking and Inspection

When unpacking the Model CE-7 FM Communications Monitor, inspect the packing box and the instrument for signs of possible shipping damage and see if the auxiliary items listed in Table 1-1 and shown in Figure 1-4 are present. Verify satisfactory performance as outlined in the Operating Instructions (Section 3). If the instrument is damaged, fails to operate properly, or if any of the auxiliary items are missing, file a claim with the transportation agency or, if insured separately, with the insurance company.

2.2 Environmental Requirements

2.2.1 Temperature

The CE-7 is designed to operate between +10° F and +130° F (ambient). Especially in the field, these temperatures can easily be exceeded if normal care is not taken. (For instance, the internal temperature of a closed automobile trunk may exceed 150° F during summer daylight hours.) Avoid using the instrument outside in bright sunlight on a hot day. Do not block the cabinet ventilating louvers. Exceeding the upper or lower temperature limits for extended periods may not result in noticeable damage to the instrument, but may cause poor performance or malfunctioning.

2.2.2 RF Fields

Where extremely high RF radiation fields exist (such as when the CE-7 is used near a transmitter), the telescoping antenna should be pushed down to reduce pickup. Where many high-power transmitters are in use, adjacent-channel interference may be experienced if the transmitters are operating within 90 kHz of each other. In such cases, the SELECTIVITY switch on the Model 303 Broadband Mixer should be placed in the SHARP position.

NOTE

In the SHARP position, the IF bandwidth is narrowed to the extent that absolute accuracy of the deviation display on the Oscilloscope or the meter reading on the FM Deviation meter may be slightly degraded. The SHARP position should, therefore, be used only when absolutely necessary.

2.3 Power Requirements

The CE-7 operates from a 115- or 230-volt (±10%) ac source, 50 to 400 Hz. Power consumption is 75 watts.

2.4 Warm-up Requirements

The accuracy of CE-7 measurements depends on maintaining all oscillator crystals at a constant temperature, so that any one of them may be selected as the "master-oscillator" crystal at any time. A thermostatically controlled oven which requires a 30-minute warm-up period houses up to 23 crystals. Oven operation is independent of the VOLUME POWER OFF control; it is recommended that the instrument be installed such that it can be kept plugged into its power source and be ready to make precise measurements within seconds after power is applied to measuring and generating circuits.

NOTE

If the instrument has been stored at a temperature below +32° F, additional warm-up time may be required.

2.5 Preparation for Reshipment

No special instructions are required for packing the Model CE-7 Multi-Channel FM Communications Monitor, if it becomes necessary to return the instrument to the factory for service or repair, however, it is recommended that the shipping box and foam packaging be kept for this purpose.

SECTION 3
OPERATING INSTRUCTIONS

3.1 Introduction

Section 3 contains instructions for operating the CE-7 Multi-Channel FM Communications Monitor, and includes a functional description of all controls and indicators. Refer to Table 3-1.

The CE-7 can be operated on one of three modes, depending on the position of the black/red concentric control knob located on the left side of the front panel directly below the MULTI-CHANNEL MONITOR.

NOTE

For the purpose of discussion the 5-position, outer black knob will be referred to as the "function switch" throughout this manual.

In the FREQ.-DEV. MEASURE position of the function switch the CE-7 operates as a receiver-monitor. The incoming signal is applied through the ANT. connector on the Broadband Mixer or Preselector, either from an antenna or other signal source. The received signal frequency is measured by selecting the assigned carrier frequency of the transmitter by means of the CARRIER FREQUENCY SELECTOR switch and reading the frequency error on the FREQUENCY meter. Simultaneous with the frequency error, modulation deviation is indicated by the FM DEVIATION meter on the Model 302 FM Deviation Meter or on the screen of the Model 301 Oscilloscope, whichever is used. A built-in speaker makes the modulation on the incoming carrier audible.

In the CAL./CW or FM position of the function switch the CE-7 operates as a signal generator. The desired signal frequency is selected by means of the CARRIER FREQUENCY SELECTOR switch. The generated signal (CW or FM) is available at the SIGNAL GENERATOR OUTPUT connector. The attenuator provides calibrated outputs of 0 to 1, 0 to 10, or 0 to 100 microvolts when the 20-dB fixed attenuator is used. When FM has been selected (instead of CW) the modulation can be varied from zero to 25 kHz deviation. The FM DEVIATION meter or the oscilloscope can also be used to read the modulation of this generated signal. An internally-generated, 1-kHz modulating frequency or an external audio source can be used.

In the I. F. position of the function switch the CE-7 operates as a generator of frequencies that are usually found as IF frequencies in communications receivers. The desired frequency is selected by means of the I. F. GENERATOR SELECTOR switch. The generated IF frequency is available at the I. F. GENERATOR OUTPUT connector and its level is varied by means of the I. F. GENERATOR LEVEL control. When setting the SELECTOR switch, refer to the Channel Frequency Chart located inside the front cover of the CE-7 for the position associated with the desired IF frequency. See Paragraph 3.4.5 for installation and removal of IF Oscillators.

3.2 Controls and Indicators

The Model CE-7 controls and indicators are listed in Table 3-1. For all other equipment or accessories, refer to the applicable equipment manuals.

3.3 Starting Procedure

a. Plug the power cord into an ac-power outlet (115 volts, 50 to 400 Hz) and energize the set by means of the power switch on the VOLUME POWER OFF control.

NOTE

The Crystal Oven Assembly is energized as soon as the CE-7 power cord is plugged in.

b. Ascertain that the channel pilot light is on.

c. Allow the CE-7 to warm up for approximately 30 minutes. The OVEN ON light will begin to cycle on and off. If the CE-7 has been stored at temperatures below 32°F additional warm-up time may be required.

Table 3-1. Controls and Indicators

NAME	REF DESIG.	FUNCTION
I. F. GENERATOR		
OUTPUT	J1	A BNC-type female connector which provides access for the output of IF frequencies in the range of from 250 kHz to 13.5 MHz.
LEVEL	R2	Permits adjustment of the I. F. GENERATOR OUTPUT.
SELECTOR	S4	Permits selection of up to ten different frequencies in the range of from 250 kHz to 13.5 MHz.
Function Switch	S1	Outer black control knob permits selection of I. F. HARM. AMP. TUNING, CAL./CW, FM, or FREQ.-DEV. MEASURE.
		Inner red control knob permits zeroing of the FREQUENCY meter.
I.F.		In this position, the CE-7 is an IF-signal generator and provides the capability of generating up to ten frequencies in the range of from 250 kHz to 13.5 MHz.
HARM. AMP. TUNING		In this position the harmonic amplifier can be tuned for maximum signal output of the selected carrier frequency with the HARM. AMP. TUNING control.
CAL.	R1	In this position the inner red control knob is used to zero the FREQUENCY meter. The FREQUENCY meter range is automatically in ±0.5 kHz regardless of the position of the ±kHz (FREQUENCY lever).
CW		In this position, the CE-7 generates a CW signal.
FM		In this position, the CE-7 generates an FM signal. The frequency of the generated signal is shown on the FREQUENCY meter, and FM deviation is indicated by the Oscilloscope or FM Deviation Meter plug-in.
FREQ.-DEV. MEASURE		In this position, the CE-7 is a receiver-monitor and both carrier frequency and FM deviation of an incoming signal can be measured.
VOLUME POWER OFF	S5, R3	In the POWER OFF position, no AC power is being supplied to any circuits except the Crystal Oven Assembly. In any position other than OFF, AC power is supplied to all circuits of the CE-7. The VOLUME potentiometer provides a means for adjusting the audio-amplifier output.

Table 3-1. Controls and Indicators (Continued)

NAME	REF DESIG.	FUNCTION
DEV. ADJ. FM CAL.	R4 R5	Black/red concentric controls used when the function switch is in the FM position. The outer black control knob, DEV.ADJ., permits adjustment of the amount of deviation of the FM signal generator output and the level of the internally generated 1-kHz output. The inner red control knob, FM CAL., permits adjustment of the generated-FM center frequency. The FREQUENCY meter is automatically in the ±5.0 kHz range when the function switch is in FM.
FM MOD. INT.-EXT. 1 kHz OUT	S6, J2	With the function switch in the FM position, the FM MOD. switch permits selection of the modulation source. In EXT., an external modulation signal can be applied through the BNC connector just below the switch. In INT., an external 1-kHz source is turned on. This same 1-kHz signal is available at the BNC connector for external use.
CRYSTAL OUT AUX. IN	J4	A BNC-type female connector which provides the capability to monitor the crystal frequency of the selected channel. (The output level should be greater than 600 mv unterminated.) It also provides a connection point for 23 additional crystal-controlled frequencies from the Model MCO-6 Multi-Channel Oscillator.
FREQUENCY BELOW 40 MHz - ABOVE 40 MHz	S3	Permits reversing the polarity of the FREQUENCY meter so any carrier-frequency error measured will always be indicated in the correct direction. This is also applicable to the Model 301 Oscilloscope. (When operating BELOW 40 MHz the CE-7 local-oscillator frequency is higher than the frequency to be monitored.)
HARM. AMP. TUNING	C5	Permits tuning of the harmonic amplifiers for the selected RF channel. Tuning is indicated on the FREQUENCY meter. Refer to the Channel Frequency Chart for approximate settings associated with each channel listed.
SIGNAL GENERATOR		
LEVEL SET	R7	When set to the number listed with the desired carrier frequency on the Channel Frequency Chart, the signal-generator output level will be as indicated by the MICROVOLTS (0.1 to 1.0 microvolts) and X1, X10, X100 (Multiplier) settings. The 20-dB fixed attenuator must be used.
MICROVOLTS (Attenuator Vernier)	R8, R9	
X1, X10, X100 (Multiplier)	S7	
OUTPUT	J3	A BNC-type female connector which provides signal generation output for the frequency selected.

Table 3-1. Controls and Indicators (Continued)

NAME	REF DESIG.	FUNCTION
CARRIER FREQUENCY SELECTOR	S1 (CH)	Provides selection of any one of 23 RF channels for frequency error and FM deviation measurement or signal generation. Channel numbers 1 through 23 are associated with specific carrier frequencies as recorded on the Channel Frequency Chart. The AUX. position permits connection of additional crystals to the CRYSTAL OUT AUX. IN connector on the front panel.
SIGNAL LEVEL	DS1	In FREQ.-DEV. MEASURE position, this lamp will light when a received signal is strong enough for reliable frequency measurements. In CAL./CW or FM position, the lamp will always be on.
CHANNEL	DS1 (A1)	Indicates that the CE-7 is on.
OVEN ON	DS2	Indicates that there is power to the Crystal Oven Assembly. The oven will normally be on for approximately 30 seconds and off for approximately 90 seconds after the operating temperature of 76.2°C has been reached.
±kHz (FREQUENCY lever)	S2	Permits selection of the three directly calibrated, full scale FREQUENCY meter ranges of ±0.5 kHz, ±1.5 kHz, or ±5.0 kHz.
FREQUENCY (meter)	M1	Provides indication of received-signal frequency error. This error, and whether it is above or below the selected frequency, is directly indicated in ±kHz. The meter is also used to indicate the center frequency of the signal-generator output. The meter is automatically in the ±5.0 kHz position when the function switch is in FM.
METERS INT.-EXT. (rear panel)	J1 (RP) S1 (RP)	The 8-pin connector permits use of the Model 309B Remote Meters when the associated slide switch is in the EXT. position.
FUSES (rear panel)	F2 (RP) F1 (RP)	Main AC-power to fuse (1.0 amp slo-blo). Provides protection (2/10 amp slo-blo) to the Model 301 Oscilloscope.
Auxiliary Equipment Connector (left side-lower left corner of instrument)	J4 (RP)	A 12-pin connector for the Model 107 FM Deviation Calibrator. NOTE The Model 107 FM Deviation Calibrator must be used in conjunction with an external oscillator with the capabilities of 2080 to 2100 Hz.

3.4 Operating Procedures

3.4.1 Frequency and Deviation Measurement

It is assumed that the CE-7 is equipped with a Model 303 Broadband Mixer and either the Model 301 Oscilloscope or the Model 302 FM Deviation Meter. For measurement of frequency and deviation with one of the RF Preselectors instead of the Model 303, the same procedure is followed except that the preselector frequency dial must be set to the frequency selected with the CARRIER FREQUENCY SELECTOR.

a. Connect the telescoping antenna, an external antenna, or other signal source to the ANT. connector on the Broadband Mixer or Preselector. If the telescoping antenna is used, extend it to its full length for measurements of signals below 30 MHz to approximately 18 inches for VHF measurements; use minimum length for UHF measurements.

b. Select the desired carrier frequency with the CARRIER FREQUENCY SELECTOR.

c. Place the function switch in the HARM. AMP. TUNING position and adjust the HARM. AMP. TUNING control for a maximum reading on the FREQUENCY meter. The HARM. AMP. TUNING control should indicate the appropriate number recorded on the Channel Frequency Chart.

d. Turn the function switch to CAL./CW. The SIGNAL LEVEL lamp should light.

e. Adjust the inner red knob (concentric with the function switch) for a zero (mid-scale) reading on the FREQUENCY meter.

f. If the Model 301 Oscilloscope is being used, set the toggle switches for horizontal and vertical inputs to the INT. positions and adjust the VERT. POS. control so that the trace is on the zero reference line while the deviation range switch is in the ±1.5 position. Adjust the scope INTENSITY, FOCUS, and ASTIGMATISM controls for a sharp trace on the screen.

g. Set the function switch to the FREQ.-DEV. MEASURE position.

CAUTION

The signal level applied to the ANT. connector should not exceed 5 milliwatts or the plug-in may be damaged.

h. Key the transmitter or other signal source to be monitored. The SIGNAL LEVEL lamp should come on. If it does not, increase the signal level at the ANT. connector. Normally, if the telescoping antenna is used, measurements can be made easily when the CE-7 is between 25 to 50 feet from the radiating antenna. When a plug-in preselector is being used, measurements can be made at distances up to 50 miles from the transmitter if an adequate external antenna is used.

i. The difference between the measured signal frequency and the CE-7 carrier frequency is indicated on the FREQUENCY meter according to the position of the ±kHz (FREQUENCY lever).

j. Modulate the transmitter or other signal source to be monitored when FM deviation is to be measured. Select the appropriate full-scale sensitivity with the range switch (kHz) on the deviation plug-in being used. When the oscilloscope is used, positive modulation peaks appear above and negative peaks below the zero reference line; the FM deviation meter will indicate either positive or negative peaks depending on the setting of the FM DEV. PEAKS switch. If the DEVIATION PEAKS indicator on the FM Deviation Meter has been calibrated (see Model 302 FM Deviation Meter equipment manual) all modulation peaks which exceed a preset level will cause this indicator to light. The accuracy of deviation measurement may be affected by the position of the SELECTIVITY switch on the Broadband Mixer or Preselector. (Refer to the applicable plug-in operating instructions.)

3.4.2 CW-Signal Generation

a. Set the CARRIER FREQUENCY SELECTOR to the desired carrier frequency.

b. Place the function switch in the HARM. AMP. TUNING position and adjust the HARM. AMP. TUNING control for a maximum reading on the FREQUENCY meter. The HARM. AMP. TUNING control should indicate approximately the appropriate number recorded on the Channel Frequency Chart.

c. Place the function switch in the CW position and zero (mid-scale) the FREQUENCY meter with the CAL. control (inner red knob).

d. Adjust the LEVEL SET control to the SIG. GEN. SET LEVEL number listed on the Channel Frequency Chart for the desired carrier frequency.

CAUTION

When the CE-7 is directly connected (via the 20-dB fixed attenuator) to a transceiver, its transmitter should NEVER be keyed. Any input in excess of 2 watts will blow the fuse in the 20-dB fixed attenuator and may damage the instrument.

e. A coaxial cable with a 20-dB fixed attenuator is stored inside the instrument's front cover; connect the cable to the front-panel connector marked SIGNAL GENERATOR OUTPUT. The signal-generator attenuator settings are only valid if the 20-dB fixed attenuator is used.

f. The desired frequency is now being generated. The output level can be adjusted by means of the X1, X10, X100 (Multiplier) and MICROVOLTS (Attenuator Vernier) controls.

3.4.3 FM-Signal Generation

a. Perform steps 3.4.2a through f. These steps calibrate the CE-7 in preparation for FM signal generation.

b. Place the function switch in the FM position.

c. Set the DEV. ADJ. control fully counterclockwise.

d. Zero (mid-scale) the FREQUENCY meter with the FM CAL. control (inner red knob).

e. Set the FM MOD. switch to INT. or EXT. as desired. In the INT. position the modulating frequency will be 1 kHz; external modulation frequencies can be applied through the BNC connector when the switch is in the EXT. position. When the FM MOD. switch is in the INT. position, the 1 kHz signal is available at the 1 kHz OUT connector. The level of the 1 kHz OUT is adjusted with the DEV. ADJ. control, which is also used to set the level of external modulation applied to the EXT. connector.

NOTE

The FREQUENCY meter will now show the modulator center frequency and the FM Deviation Meter or Oscilloscope will now indicate the amount of deviation of the generated modulation. The FM CAL. control varies the center frequency of the FM signal and permits testing of receivers for alignment and maximum sensitivity. The FREQUENCY meter is automatically in the ±5.0 kHz range when the function switch is in the FM position, and it cannot be changed by the ±kHz (FREQUENCY lever).

3.4.4 IF-Signal Generation

a. Place the function switch in the I. F. position.

NOTE

On earlier models of the CE-7 the IF position ON switch is part of the I. F. GENERATOR LEVEL control. If the instrument has an I. F. position on the function switch, place the switch in that position rather than in FREQ.-DEV. MEASURE.

b. Set the SELECTOR switch to the desired IF frequency listed on the Channel Frequency Chart.

c. The IF signal output is available at the I. F. GENERATOR OUTPUT connector and the output level may be adjusted by the I. F. GENERATOR LEVEL control.

3.4.5 Installation and Removal of IF-Oscillators

The IF-Oscillator boards 0104 and 0105 are pin mounted on the Multi-Oscillator board 0103 inside the left-hand side of the CE-7. See Figure 3-1. When an IF-crystal frequency is added, deleted, or changed to a different position, the following procedure for removing and installing an IF Oscillator board should be used:

a. Turn the VOLUME POWER OFF control to the OFF position.

b. Remove the left-hand L-shaped cover (six screws).

c. Carefully remove the IF-Oscillator board from the Multi-Oscillator board, When inserting an IF-Oscillator board ensure that the guide pins on the Multi-Oscillator board are aligned with the sleeves on the IF-Oscillator board.

d. Log any additions, deletions, or changes in crystal frequency position on the Channel Frequency Chart.

e. Replace the L-shaped cover and secure with the six screws.

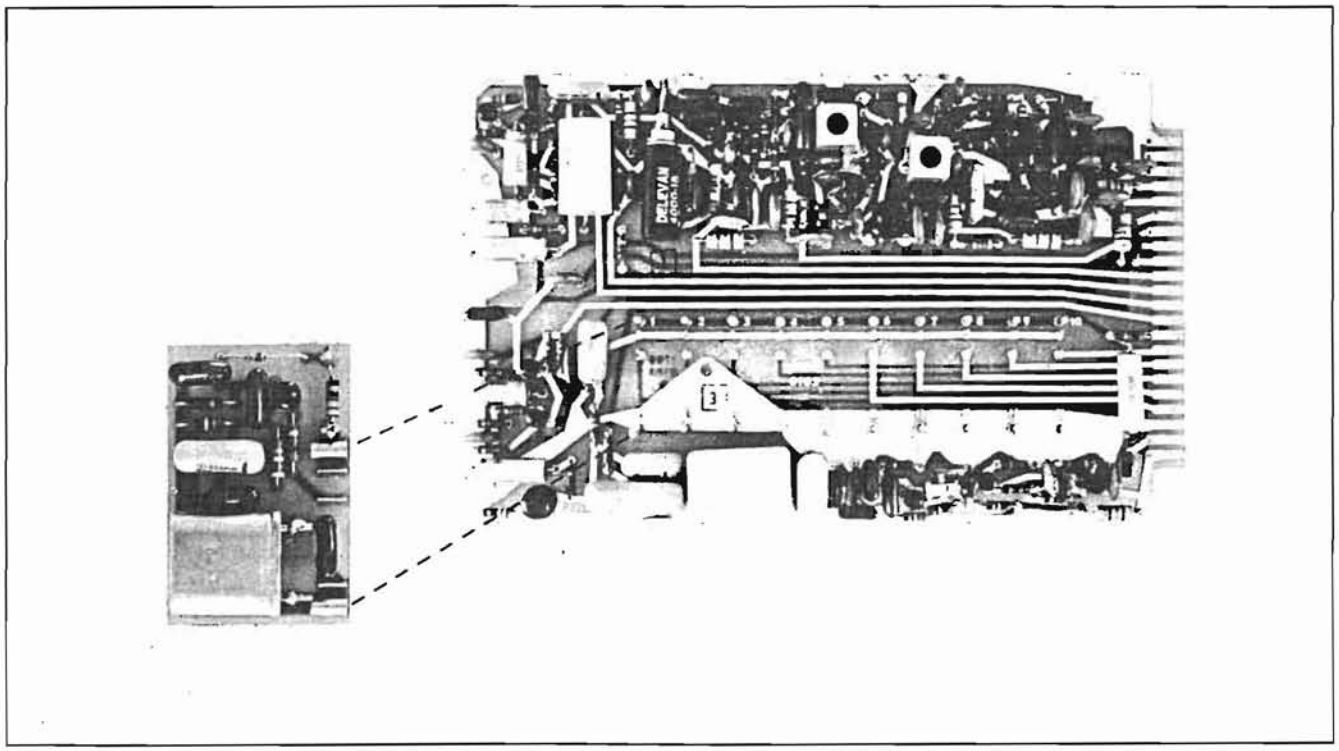


Figure 3-1. Installation-Removal, IF-Oscillator Boards

3.4.6 Antenna Installation

Remove the telescoping antenna from the front cover of the CE-7. Insert the telescoping antenna into the ANT. connector on the RF plug-in used and turn the connector collet until finger-tight.

CAUTION

When removing the telescoping antenna from the ANT. connector DO NOT rotate the antenna before loosening the connector, otherwise damage will result.

3.4.7 Installation and Removal of Crystals

The following procedure should be followed when field installation or removal of frequency-determining crystals, inside the Crystal Oven Assembly, becomes necessary.

NOTE

The CE-7 must be disconnected from the AC outlet whenever the insulated Crystal Oven Assembly cover is removed. The oven is energized whenever power is present.

a. Place the CE-7 on its rear panel with the bottom cover toward the operator.

b. Remove the six bottom-cover screws.

c. Remove the four screws securing the insulated Crystal Oven Assembly cover. DO NOT try to remove the center screw.

d. Install the new crystal(s) in the desired position.

NOTE

Be careful to install the proper frequency crystal for the desired operating frequency. The correlation between crystal frequency and operating frequency is shown on the box in which the crystal is packed.

e. RECORD THE POSITION IN WHICH EACH CRYSTAL IS INSTALLED ON THE CHANNEL FREQUENCY CHART.

f. Replace the insulated Crystal Oven Assembly cover with the four screws.

g. After the insulated Crystal Oven Assembly cover has been replaced, allow the oven to stabilize its temperature for approximately 30 minutes.

h. Calibrate the crystal oscillator according to the instructions contained in Paragraph 5.4.2 and Table 5-3.

i. Replace the bottom cover with the six screws.

3.5 Turn-Off Procedure

To turn the CE-7 off, simply place the VOLUME POWER OFF control in the OFF position. If possible leave the AC plug connected so that the Crystal Oven Assembly stays on. Unless the crystals in the oven are kept at a constant temperature, frequencies will vary and precise measurements cannot be made without a minimum warm-up period of 30 minutes.

SECTION 4
CIRCUIT DESCRIPTION

4.1 Introduction

The circuits of the Model CE-7 Multi-Channel FM Communications Monitor are on five printed circuit boards: the Second IF and Discriminator board (0054), the Power Supply board (0100), the Frequency Error Meter board (0101), the Harmonic Generator board (0102), and the Multi-Oscillator board (0103). Figure 4-1 is the functional block diagram of the CE-7. The 115-vac-supply fuse RP-F2, is on the inside of the rear panel.

The CE-7 is basically a multi-channel superheterodyne receiver and a signal generator. In the FREQ.-DEV. MEASURE mode of operation the RF signal, the frequency and frequency deviation of which are to be measured is applied through the ANT. connector of the RF plug-in that is being used (a Broadband Mixer or one of the three Preselectors). The RF signal is mixed in the RF plug-in with the local-oscillator signal from the Harmonic Generator board in the CE-7.

The local oscillator signal has a frequency that results from mixing the output of a selected crystal oscillator (associated with the selected channel) with the output of a 10-MHz crystal oscillator. When an RF signal must be measured for carrier-frequency accuracy, the frequency that has been assigned to the transmitter of the RF signal is the same frequency that is selected on the CE-7. Thus, the CE-7 can only monitor a signal for which it has a crystal of appropriate frequency.

The incoming signal is mixed with the internally generated "standard" or local-oscillator signal. If the transmitter of the incoming signal is on-frequency, the result of this mixing will be an IF of exactly 10-MHz. If the frequency of the incoming signal is not correct, the IF signal will be 10 MHz plus or minus the frequency error.

The 10-MHz signal (± frequency error) is fed to the Second IF and Discriminator board where it is amplified and mixed with a 9.9-MHz signal from the Multi-Oscillator board to form a second IF and 100 kHz (± frequency error). This second-IF signal is amplified and applied to the frequency-error detector.

A squelch detector in the Broadband Mixer or Preselector rectifies the 10-MHz signal. The resulting dc voltage is amplified and fed to the signal-level detector in the CE-7. If the 10-MHz signal exceeds a preset level, the SIGNAL LEVEL lamp lights to indicate that accurate measurements can be made and the frequency-error detector is energized. The frequency-error detector is adjusted to give a zero indication on the FREQUENCY meter when the second IF signal is exactly 100 kHz. If the frequency of the monitored signal is above or below the frequency selected with the CARRIER FREQUENCY SELECTOR, the input to the frequency-error detector will be exactly the same amount above or below 100 kHz. The detector output will cause the FREQUENCY meter to deflect toward the plus (+) or minus (-) side, indicating the direction and amount of frequency error.

If the monitored signal is frequency modulated, the modulation will be present in the output of the frequency-error detector. This output is demodulated and a signal representing the modulation is amplified and fed to either the Model 302 FM Deviation Meter or the Model 301 Oscilloscope. If the Model 302 is used, its FM deviation meter will indicate the peak deviation of the FM signal. On the Model 301 Oscilloscope, the amount of deviation and frequency-error will be shown on the CRT.

The CE-7 can be used as a CW- or FM-signal generator but its range is limited to the frequencies for which crystals are installed (if the Model MCO-6 Oven-Oscillator is used, the range is extended to include the auxiliary crystals).

A signal generated with the CE-7 is derived from the same sources as the LO. signal with which an incoming signal is mixed to form the first IF and to determine frequency error. Because there is always a 10-MHz difference between the selected frequency and the LO. signal, this 10-MHz difference must be removed before the LO. signal can be used as a signal-generator output of the selected frequency. The removal of this difference is accomplished by mixing a 10-MHz signal originating on the Multi-Oscillator board with the LO. signal in the Signal Generator Mixer. For both CW and FM signals, this 10-MHz signal is passed through a step attenuator before being fed through the Signal Generator Mixer. This attenuator permits control of the signal-generator output level, but the calibration is only valid if the 20-dB fixed attenuator provided with the CE-7 is connected to the output connector.

An FM signal can be modulated by an internally generated 1-kHz signal or a modulating signal from an external source can be applied at the FM MOD./1 kHz OUT connector.

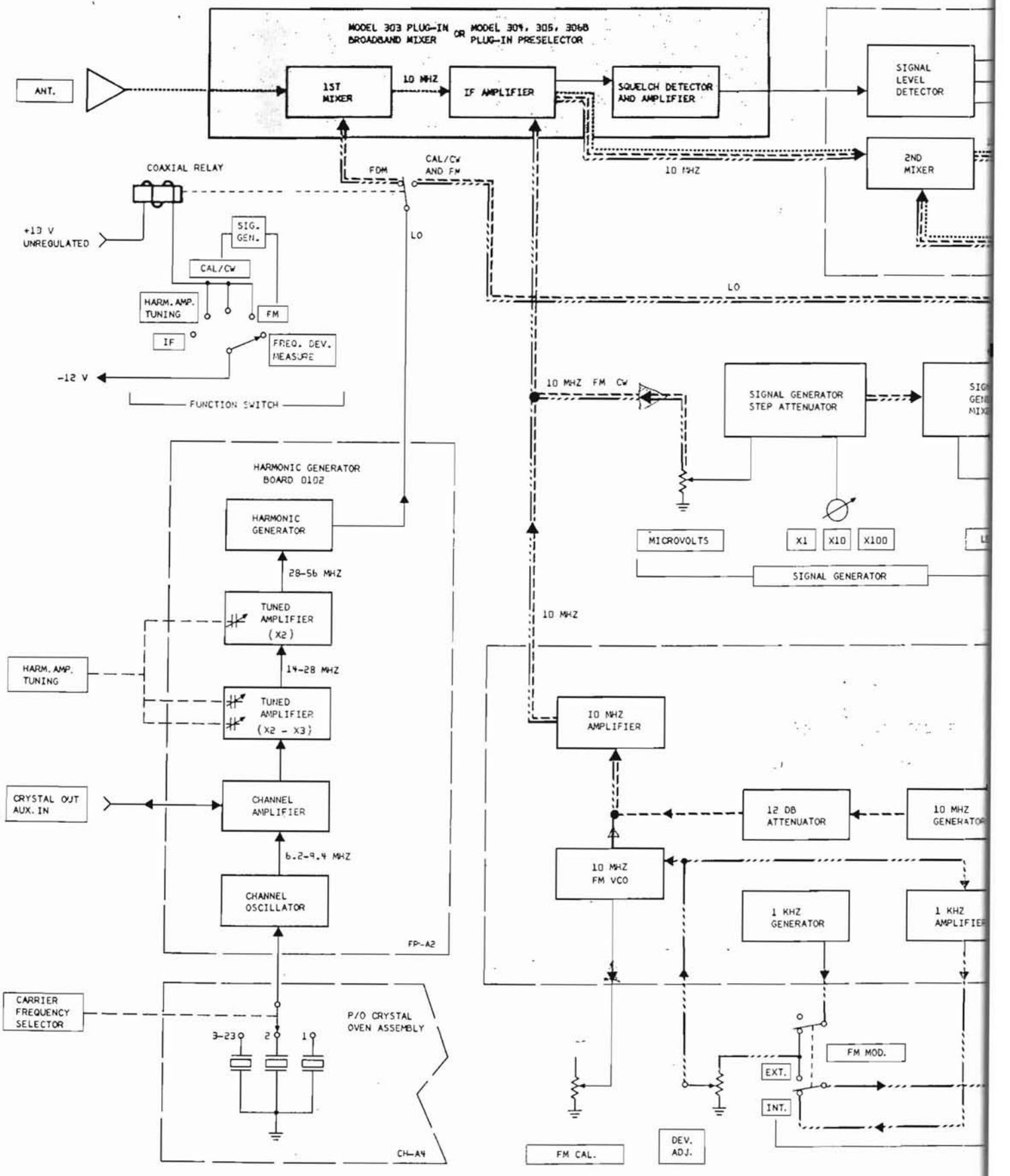
The amount of peak FM deviation is adjustable by the DEV. ADJ. control and is read on the FM Deviation Meter or Oscilloscope in the same manner as when monitoring an incoming RF signal. When the FM MOD. toggle switch is in the INT. position, the 1-kHz signal is available at the FM MOD./1 kHz OUT connector for external use and the output level is adjustable with the DEV. ADJ. control.

The CE-7 can be used as a generator of frequencies that are usually encountered in IF stages of commercial receivers if crystal-controlled IF oscillators are obtained for installation on the Multi-Oscillator board. Up to ten of these plug-in units can be used at one time and crystals with any frequency between 250 kHz and 13.5 MHz can be made available. The desired frequency is selected and the signal level is adjusted with front-panel controls. The output is available at the I. F. GENERATOR OUTPUT cornector.

In the following paragraphs reference will be made to two groups of figures. The first group consists of figures numbered 4-1 through 4-7 which are interspersed with the text; the second group consists of schematics number 6-1 through 6-9 which are part of Section 6. Each schematic in Section 6 is placed adjacent or in close proximity to associated parts lists and parts pictorials.

4.2 Second IF and Discriminator Board

Figure 4-2 is a block diagram and Figure 6-1 is the schematic diagram of the Second IF and Discriminator board. In the FREQ.-DEV. MEASURE mode the first IF of 10 MHz from the Broadband Mixer or Preselector to the Second IF and Discriminator board is amplified by IC1 and mixed in IC2 with a 9.9-MHz second local oscillator signal from the Multi-Oscillator board buffered by Q1. The resulting 100 kHz second-IF signal is filtered and then amplified by Q2 and Q3. The square wave out of Q3 is differentiated by R20 and C22 and sent to pulse shaping network CR1 and CR2. Only the positive alternations are used to trigger Q4, the normally-off side of the one-shot multivibrator; Q4 turns on and Q5 turns off. The multivibrator remains in this state for 5 microseconds before reverting to its normal state. This 5 microsecond period is constant regardless of the frequency with which the multivibrator is triggered and is calibrated by adjusting the CAL. control. If the incoming signal is on frequency, and the second-IF signal is, therefore, exactly 100 kHz and if there is no modulation on the second-IF signal, the time between triggers is 10 microseconds and square waves result at the collectors of Q4 and Q5. Refer to Figure 4-3. When there is an error or the second-IF signal is modulated, then the time between triggers will be longer or shorter than 10 microseconds. When the time between triggers is longer than 10 microseconds, Q5 is turned ON for a longer period than it is turned OFF. When the time is less than 10 microseconds, Q5 will be OFF for a


MODEL 303 PLUG-IN BROADBAND MIXER
OR
MODEL 309, 315, 3068 PLUG-IN PRESELECTOR
ANT.
1ST MIXER
10 MHZ
IF AMPLIFIER
SQUELCH DETECTOR AND AMPLIFIER
SIGNAL LEVEL DETECTOR
2ND MIXER
10 MHZ
COAXIAL RELAY
FDM
CAL/CW AND FM
LO
+13 V UNREGULATED
SIG. GEN.
CAL/CW
HARM. AMP. TUNING
FM
IF
FREQ. DEV. MEASURE
-12 V
FUNCTION SWITCH
LO
10 MHZ FM CW
SIGNAL GENERATOR STEP ATTENUATOR
MICROVOLTS
X1
X10
X100
SIGNAL GENERATOR
HARMONIC GENERATOR BOARD 0102
HARMONIC GENERATOR
28-56 MHZ
TUNED AMPLIFIER (X2)
14-28 MHZ
HARM. AMP. TUNING
TUNED AMPLIFIER (X2 - X3)
CRYSTAL OUT AUX. IN
CHANNEL AMPLIFIER
6.2-9.4 MHZ
CHANNEL OSCILLATOR
FP-A2
10 MHZ
10 MHZ AMPLIFIER
12 DB ATTENUATOR
10 MHZ GENERATOR
10 MHZ FM VCO
1 KHZ GENERATOR
1 KHZ AMPLIFIER
CARRIER FREQUENCY SELECTOR
P/O CRYSTAL OVEN ASSEMBLY
3
2
1
FM MOD.
EXT.
INT.
CH-A4
FM CAL.
DEV. ADJ.

5601**0015**1

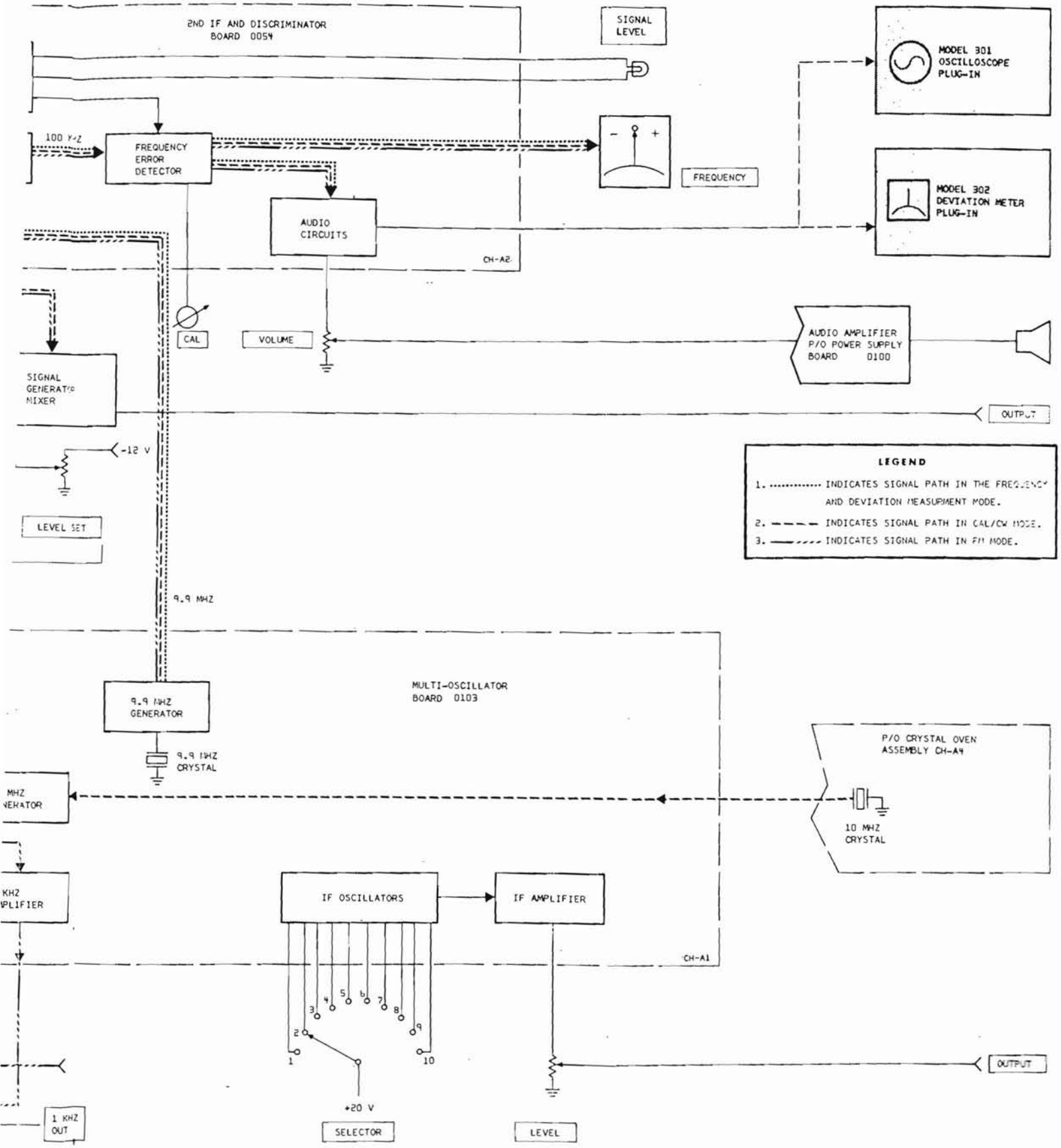


Figure 4-1. CE-7 , Block Diagram

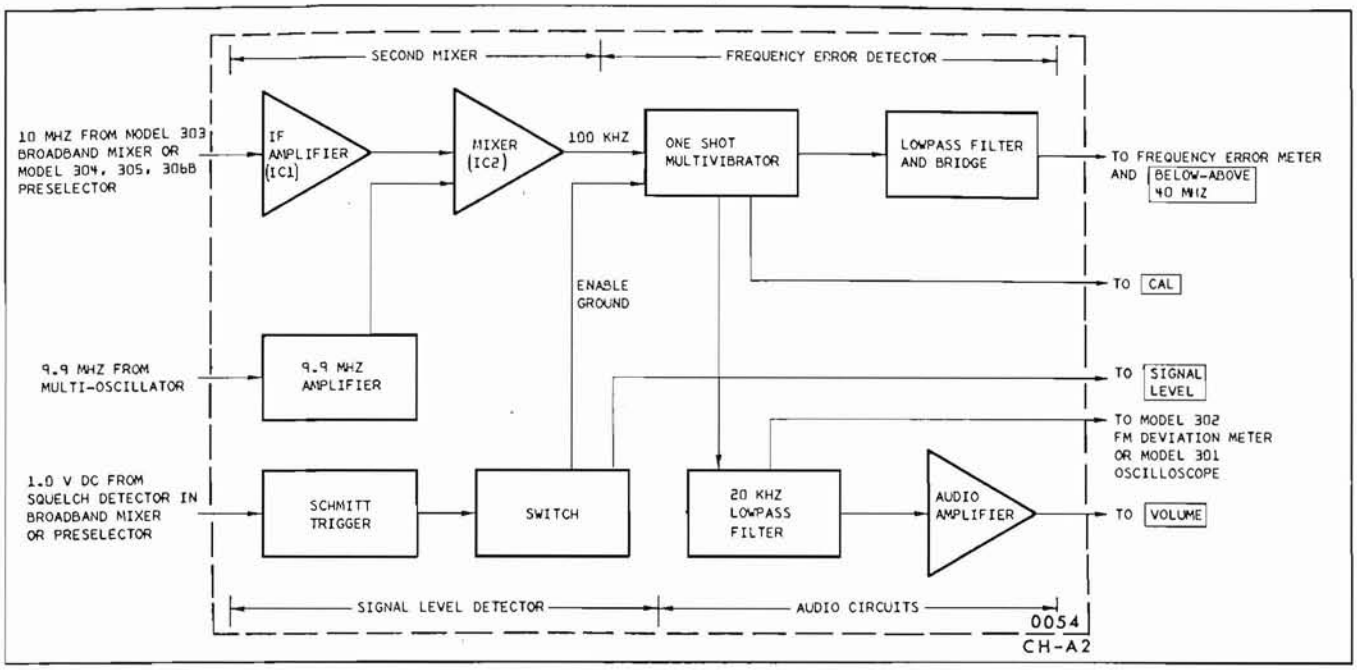


Figure 4-2. Second IF and Discriminator Board, Block Diagram

longer period than it is on. The resulting rectangular waveshape at the collector of Q4 will be high for a time longer or shorter than 10 microseconds and the waveshape at Q5 will be correspondingly low. These push-pull signals are filtered and turned into unbalanced dc signals at the bridge output. The FREQUENCY meter is then driven negative or positive depending on the magnitude and the direction of the error.

The output of the multivibrator is taken from the collector of Q5 and is fed to the base of emitter follower Q9. Q9 drives the 20-kHz lowpass filter which removes the 100 kHz content.

The output of the 20-kHz lowpass filter consists of the average dc value of the square wave at the collector of Q5 with no modulation. This value is 3.2 vdc with the FREQUENCY meter at zero. See Figure 4-4, detail A. During the positive cycle of modulation, the 5-microsecond pulse at the collector of Q5 occurs at shorter intervals. Therefore, the voltage at the output of the 20-kHz lowpass filter

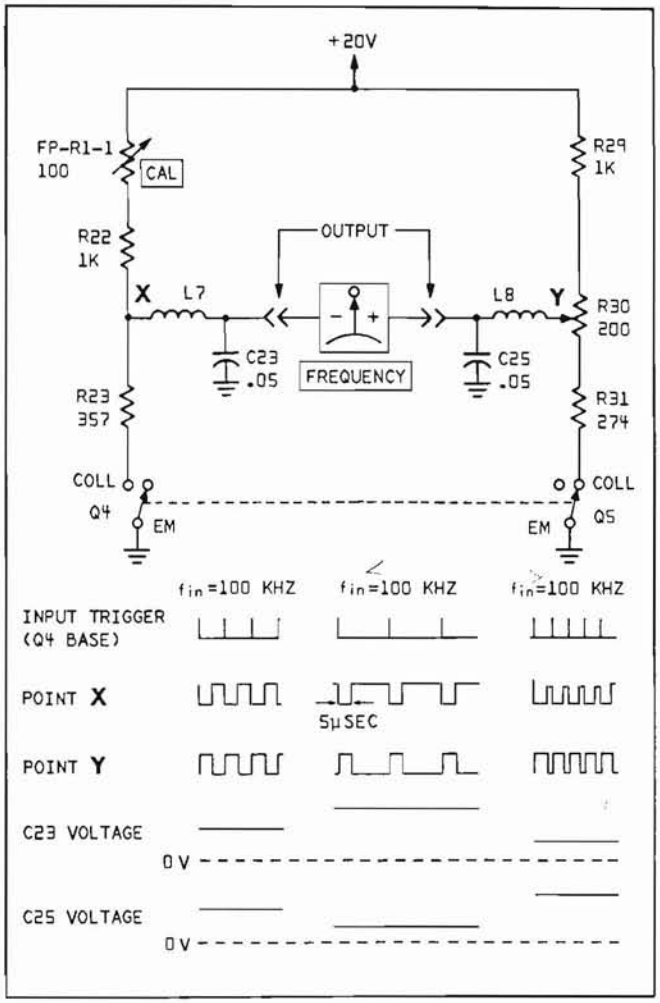


Figure 4-3. Frequency-Meter Bridge, Simplified Schematic Diagram and Waveforms

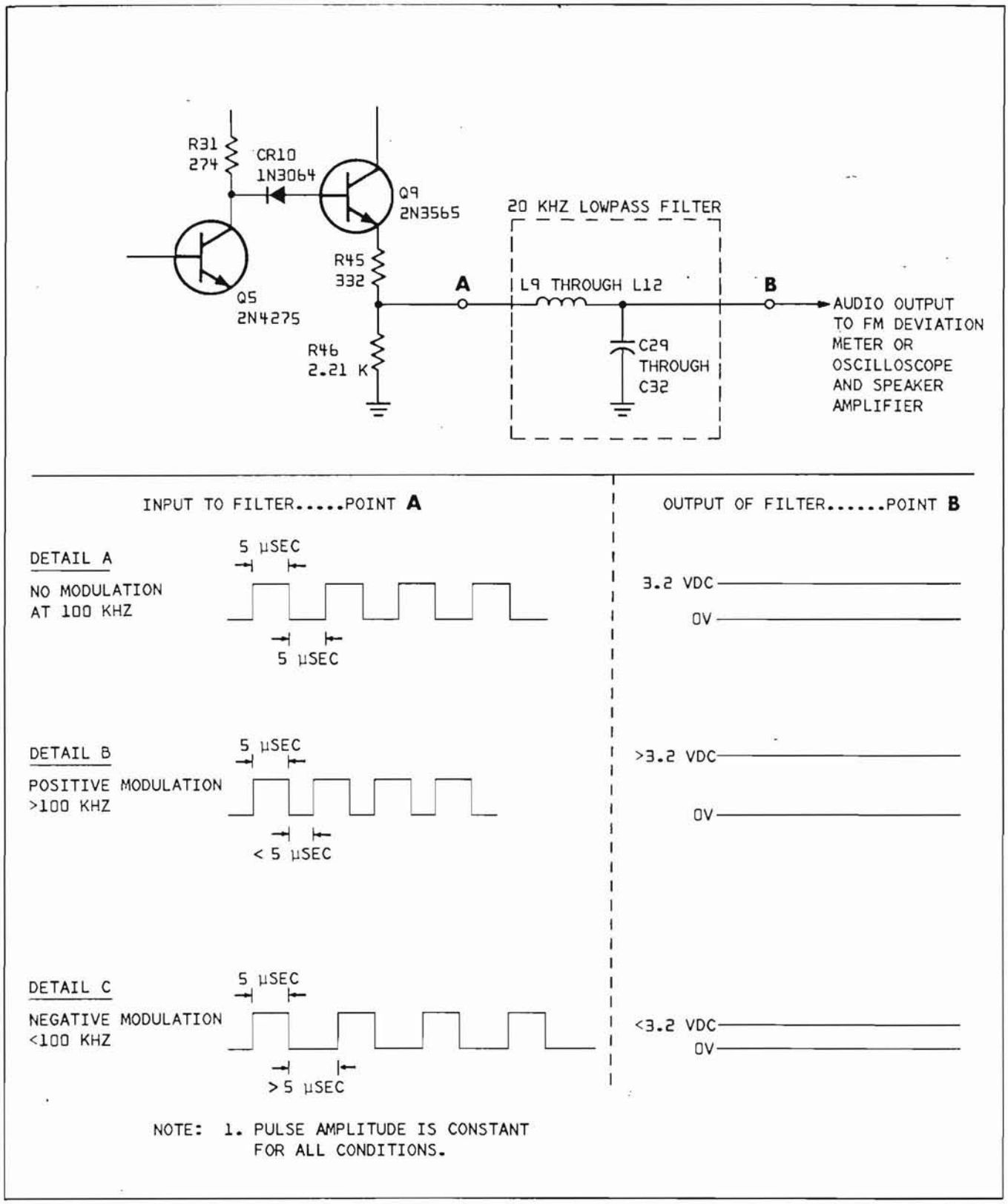


Figure 4-4. Audio-Output Filter, Simplified Schematic Diagram and Waveforms

will be of a higher value. See Figure 4-4, detail B. During the negative cycle of modulation, the pulses occur at longer intervals producing a lower voltage at the output of the filter. See Figure 4-4, detail C. The output of the filter follows the frequency modulation of the IF signal. The resulting audio signal is fed to the VOLUME control and to the Oscilloscope or FM Deviation Meter for an indication of the amount of modulation.

When the monitored signal is of sufficient amplitude, a dc control voltage from the Broadband Mixer or Preselector, turns on Schmitt trigger Q6 and Q7. This results in switch Q8 supplying a ground to the one-shot multivibrator and the SIGNAL LEVEL lamp, turning them on. Thus, reliable measurements can be made providing the signal is of sufficient level.

Two controls are provided to adjust the zero reading of the FREQUENCY meter. Potentiometer R30 is for coarse calibration of the bridge and frequency measuring circuit. The front panel CAL. control (FP-R1-1) is for fine calibration and completes the bridge circuit.

When the CE-7 is used as a CW- or FM-signal generator, the action of the second IF and discriminator circuits is the same as described for the measuring mode. The 10-MHz input to the board, however, originates on the Multi-Oscillator board and the output is amplified in the Broadband Mixer or Preselector (last two stages). After amplification the signal is fed to the second mixer in the Second IF and Discriminator board.

4.3 Power-Supply Board

The CE-7 contains three power supplies providing regulated outputs of +5 volts, +20 volts, and -12 volts. Refer to Figure 4-5 for the block diagram and Figure 6-2 for the schematic diagram of the Power Supply board. AC power is fed through power transformer secondary windings to the +20- and -12-volt rectifiers. The 117-volt AC line power is fed directly to the oven control circuit.

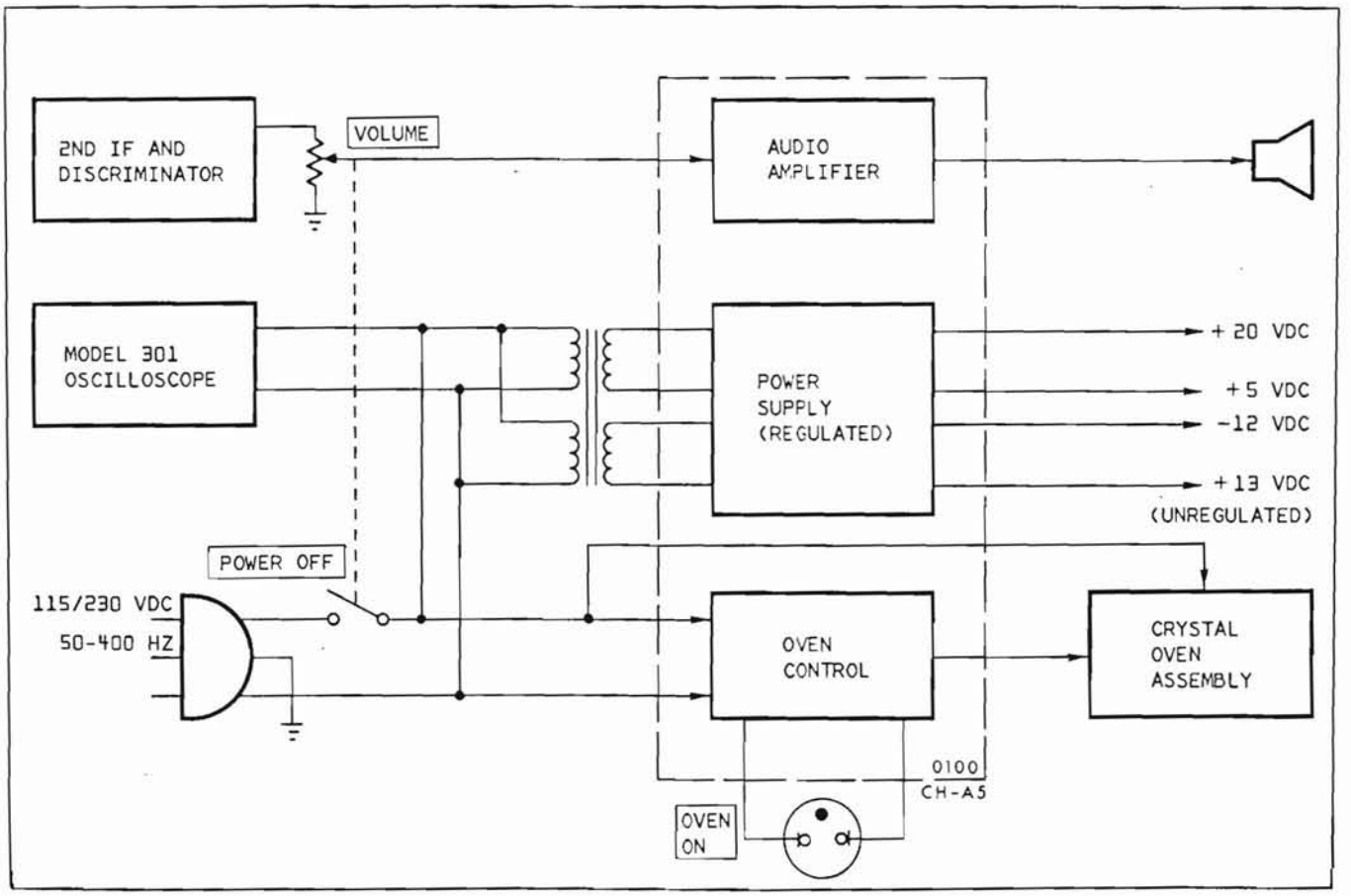


Figure 4-5. Power-Supply Board, Block Diagram

The +20-volt regulator consists of: bridge connected rectifiers CR1, CR2, CR3, CR4; a filter capacitor, C1; a constant current source, Q1; series regulators, Q3 and CH-Q1; a reference element, CR6; differential amplifiers, Q5 and Q6; a dc amplifier, Q4; and an over-current protection circuit, Q2. Potentiometer R9 is the control for adjusting the +20-volt supply to the proper voltage.

The -12-volt supply is similar and the unregulated +13-volt supply is simply the fused output of the bridge rectifiers for the -12-volt supply. Potentiometer R27 is the control for adjusting the -12-volt supply to the proper voltage. The +5-volt supply is derived through means of zener diode CR7 from the +20-volt supply.

The audio input from the VOLUME control is amplified by IC1 and fed to the speaker.

The oven-control circuit controls the AC power supplied to the heat windings of the oven. Fast heat is controlled by the snap-action thermostat which opens at 65°C. Regular heat is controlled by the mercury column thermostat which closes at 76.2°C and shorts out gate Q13, which shuts off the triac and removes the power from the winding. When the temperature drops below 76.2°C, the column opens. This permits the triac to be triggered on the next time the AC voltage goes through zero. The front panel OVEN ON lamp is energized whenever the regular heat is on.

The Crystal Oven Assembly (Figure 6-9) is protected against overheating by thermal fuse TF1. Any time the temperature inside the oven exceeds 81.1°C, thermal fuse TF1 will open and cause the oven to become inoperative.

4.4 Frequency Error Meter Board

Figure 6-3 is the schematic diagram of the Frequency Error Meter board. The push-pull dc outputs from the discriminator and lowpass filter are routed through the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch. The switch reverses the polarity of the signals to the meter as the LO is above or below the desired signal to be monitored or generated. The signals are then routed through the function switch, the EXT. METERS switch located on the rear panel, the ±kHz (FREQUENCY lever) switch, and to the calibration potentiometers.

In the FREQ.-DEV. MEASURE position of the function switch the range of operation of the meter is selectable by the ±kHz (FREQUENCY lever) switch for ±0.5 kHz, ±1.5 kHz or ±5.0 kHz. In the FM or CAL./CW positions of the function switch, the inputs to the meter are through specific resistors to provide fixed ranges of ±0.5 kHz, and ±5.0 kHz, respectively. Diodes CR1 and CR2 provide meter protection in the event of overdrive.

In the HARM. AMP. TUNING position of the function switch, one side of the meter is grounded and the other side is supplied with the dc tuning voltage coming from the Harmonic Generator board.

4.5 Harmonic Generator Board

Figure 4-6 is the block diagram and Figure 6-4 is the schematic diagram of the Harmonic Generator board. Depending on customer requirements, up to 23 crystals in a frequency range of from 6.2 MHz to 9.4 MHz can be installed in the Crystal Oven Assembly. Any one of these can be selected by the CARRIER FREQUENCY SELECTOR switch. The selected crystal is capacitively coupled to the modifed Colpitts oscillator Q8, and amplified by Q7. The output of Q7 is fed to both limiter Q5 and emitter follower Q6; the latter feeds the CRYSTAL OUT AUX. IN connector. This connector is a convenient monitoring point for measuring the frequencies of the crystals and also serves as the input connector for inputs from external crystals (Model MCO-6 Multi-Channel Oscillator). Whether an internal or an external crystal is used as a signal source, the signal is passed through limiter Q5, and capacitively coupled to tuned amplifiers Q1 and Q2. The 6.2 MHz to 9.4 MHz signals are multiplied by Q1 and tuned by Q2 to give a frequency range of

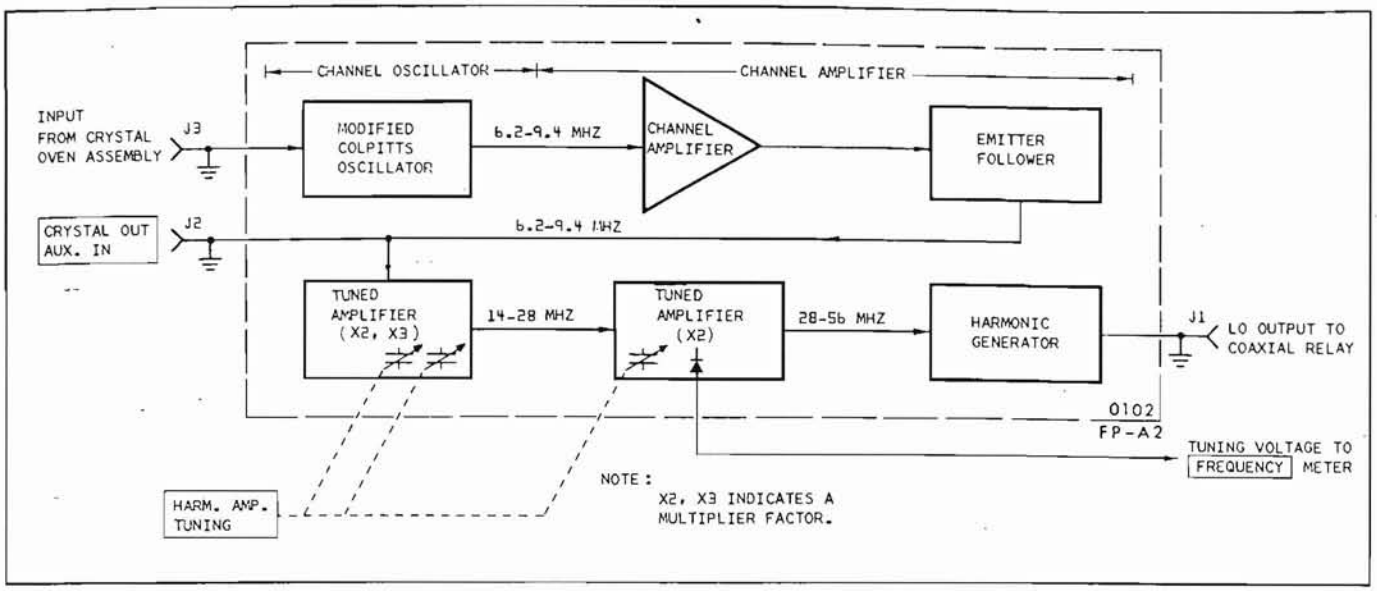


Figure 4-6. Harmonic-Generator Board, Block Diagram

from 14 MHz to 28 MHz. This frequency range is doubled by CR1 and CR2 and amplified by tuned amplifier Q3, to achieve a signal in the range of from 28 MHz to 56 MHz.

This signal is matched by emitter follower Q4 to the low impedance of step-recovery diode CR4. The step-recovery diode conducts during the positive half of the input-signal and stores that charge. During the negative half it is quickly driven towards cutoff and snaps back to form an extremely narrow pulse that is rich in harmonics.

The fundamental frequency output is 28 MHz to 56 MHz and the harmonics are usable to 1150 MHz. These pulses and the resulting harmonics form the LO signal. See Table 4-1.
The board output feeds coaxial relay CH-K1. Diode CR3 rectifies a sample of the fundamental frequency range of the harmonic generator that is filtered to form the dc tuning voltage which drives the FREQUENCY meter when the harmonic amplifier is being tuned by the variable capacitors (C5). The capacitors are connected to the HARM. AMP. TUNING control. Transformers T1, T2, and T3, and the trimmer capacitors (C6) are adjusted such that the tuned amplifiers linearly follow (track) the manual tuning.

The Channel Frequency Chart (Table 4-1) provides a means to determine the crystal frequency when the channel frequency is known. Locate the applicable channel frequency range in the CHANNEL FREQUENCY RANGE column. Add or subtract 10 MHz as indicated in the ADD OR SUBTRACT 10 MHz column to determine the first LO frequency required. The resultant frequency should be within the range in the LO FREQUENCY RANGE column. Divide the LO frequency by the number given in the DIVIDE BY column. The resultant frequency is the crystal frequency required and should be within the range in the CRYSTAL FREQUENCY RANGE column.

Example:

153.123 MHz	-	Assigned frequency
10.000 MHz	-	Subtract
143.123 MHz	-	1st LO frequency
143.123 ÷ 18	-	Divide by
7,951.277 kHz	-	Crystal frequency

Table 4-1. Channel-Frequency Chart

CHANNEL FREQUENCY RANGE (MHz)	ADD OR SUBTRACT 10 MHz	L.O. FREQUENCY RANGE (MHz)	DIVIDE BY	CRYSTAL FREQUENCY RANGE (kHz)
18.0 to 27.4	Plus 10 MHz	28.0 to 37.4	4	7,000 to 9,350
27.4 to 40.0	Plus 10 MHz	37.4 to 50.0	6	6,233 to 8,333
40.0 to 47.4	Minus 10 MHz	30.0 to 37.4	4	7,500 to 9,350
47.4 to 66.0	Minus 10 MHz	37.4 to 56.0	6	6,233 to 9,333
66.0 to 84.8	Minus 10 MHz	56.0 to 74.8	8	7,000 to 9,350
84.8 to 122.0	Minus 10 MHz	74.8 to 112.0	12	6,233 to 9,333
122 to 178	Minus 10 MHz	112 to 168	18	6,222 to 9,333
178 to 234	Minus 10 MHz	168 to 224	24	7,000 to 9,333
234 to 290	Minus 10 MHz	224 to 280	30	7,467 to 9,333
290 to 346	Minus 10 MHz	280 to 336	36	7,778 to 9,333
346 to 402	Minus 10 MHz	336 to 392	42	8,000 to 9,333
402 to 514	Minus 10 MHz	392 to 504	54	7,260 to 9,333
514 to 626	Minus 10 MHz	504 to 616	66	7,637 to 9,333
626 to 794	Minus 10 MHz	616 to 784	84	7,333 to 9,333
794 to 1018	Minus 10 MHz	784 to 1008	108	7,260 to 9,333
1018 to 1186	Minus 10 MHz	1008 to 1176	126	8,000 to 9,333

4.6 Multi-Oscillator Board

Figure 4-7 is the block diagram and Figure 6-5 is the schematic diagram of the Multi-Oscillator board. The Multi-Oscillator board consists of: 10-MHz, 9.9-MHz and 1.0-kHz oscillators; an amplifier for up to ten plug-in IF oscillators; and a 10-MHz frequency modulator.

Whenever a frequency is selected (measuring mode as well as signal generating modes) the crystal oscillator associated with that frequency is activated. As has been stated, the output of each crystal oscillator is always mixed with a 10-MHz signal to produce the LO signal. This 10-MHz signal is generated by transistor Q1 in conjunction with a 10-MHz crystal which is located in the Crystal Oven Assembly. The 10-MHz oscillator is energized by +20 volts when the function switch is in the CAL./CW position. Its output is amplified by Q2 and fed to emitter follower Q3 . The signal is then fed through a 12-dB impedance matching circuit and emitter follower Q9 to tuned amplifier Q10. The output of Q10 is fed to the Broadband Mixer or Preselector and is used as a reference signal to zero the FREQUENCY meter. It is also fed to the Signal Generator Step Attenuator.

To modify the LO signal so that it can be used as a signal generator output, another 10-MHz signal must be mixed with the LO signal. This 10-MHz signal is generated by voltage-controlled oscillator Q7, which is energized by +20 volts when the function switch is in the FM position.

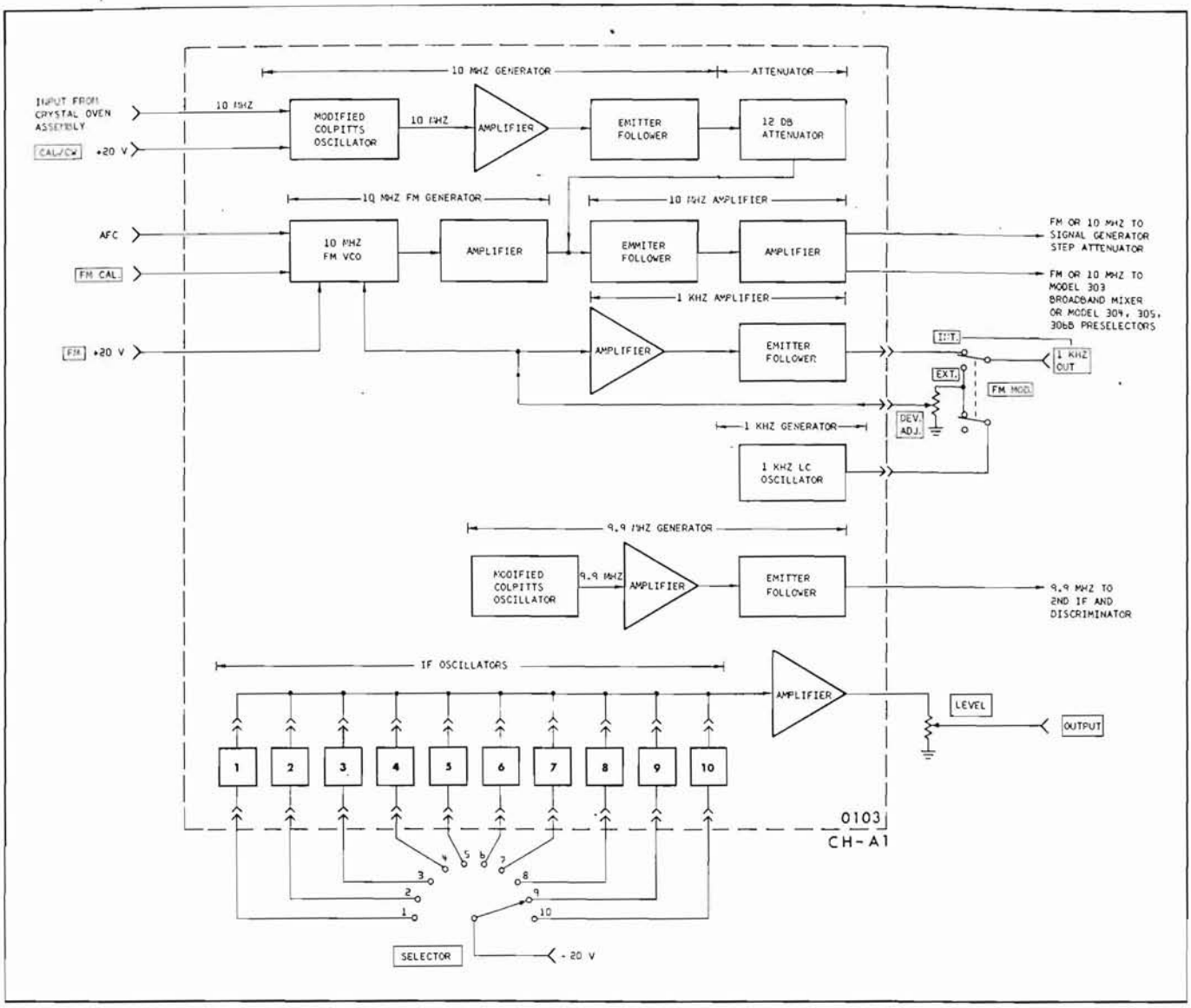


Figure 4-7. Multi-Oscillator Board, Block Diagram

Its frequency is set to 10 MHz with the FM CAL. control FP-R5, which adjusts the voltage to Varicap CR2 in the tuned circuit of the oscillator. When adjusted to exactly 10 MHz, the oscillator frequency is kept constant by the AFC voltage from the frequency-error-detector circuit in the Second IF and Discriminator board which is also applied to Varicap CR2.

The internally-generated modulating signal (for FM signal generation) is produced by the 1-kHz oscillator. Transistor Q4 in this oscillator circuit is energized when +20 volts is applied by turning the FM MOD. switch to the INT. position. The output of the oscillator is fed to the DEV. ADJ. potentiometer, which provides adjustment for the amount of signal being delivered to Varicap CR2 of oscillator Q7 and via amplifier Q5 and emitter follower Q6, to the 1-kHz OUT connector. The Varicap changes capacitance and thus frequency-modulates the 10-MHz output of Q7.

To produce a second-IF signal of 100 kHz, the first IF of 10 MHz is mixed with a 9.9-MHz signal. This signal is produced by crystal-controlled oscillator Q13. The 9.9-MHz crystal is not installed in the Crystal Oven Assembly but operates at ambient temperatures. Transistor Q13 is always energized except when the

function switch is in the I. F. position. Its output is amplified by Q14 and Q15, and fed to the buffer amplifier in the Second IF and Discriminator board where it is mixed with the first IF signal.

4.7 IF Oscillator Board

The Multi-Oscillator board provides 10 receptacles into which IF oscillator boards may be inserted at the option of the customer. Refer to Figure 4-7. The frequencies that may be selected for these crystal-controlled oscillators lie in ranges of from 250 kHz to 900 kHz (see Figure 6-6) and from 1 MHz to 13.5 MHz (see Figure 6-7). When the function switch is in the I. F. position, the I. F. GENERATOR SELECTOR may be turned to one of its numbered positions (1 through 10), thus a +20-volt energizing voltage is applied to the corresponding receptacle. The output of the activated oscillator circuit is amplified by Q11 and Q12, and is available at the I. F. GENERATOR OUTPUT connector. If additional IF frequencies are needed or if it is desirable to change the frequency that is available in a particular position of the SELECTOR, refer to Paragraph 3.4.5 for installation and removal of IF Oscillator boards.

4.8 Signal-Generator Mixer

Figure 6-8 is the schematic diagram of the Signal Generator Mixer. The LO signal which reaches the Signal Generator Mixer from the Harmonic Generator board via the coaxial relay (CH-K1) consists of narrow pulses with a frequency between 28 MHz and 56 MHz. This LO signal is mixed with a second input signal with a 10 MHz frequency from the Signal Generator Step Attenuator. The resultant signals are coupled out to the SIGNAL GENERATOR OUTPUT connector.

If the desired signal output is below 40 MHz then the Harmonic Generator output is higher than the desired signal by 10 MHz and the lower sideband is used, and vice-versa for the above. The FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch should be switched accordingly for proper readout.

The multi-turn LEVEL SET control feeds a dc voltage to mixer-diode CR1 and forward-biases it at different currents for calibrating the signal generation output in the different communications frequency bands.

SECTION 5
MAINTENANCE

5.1 Introduction

This section contains the necessary procedures to perform adjustments and troubleshooting of the CE-7. If adjustments other than those described are required, it is recommended that the instrument or subassembly be returned to Cushman Electronics, Customer Service Department for calibration and alignment.

It is assumed that the operator is familiar with the operating procedures described in Section 3. The instrument should be warmed up for at least 30 minutes before any adjustment or troubleshooting is attempted. For most of the tests and internal adjustments, the side covers and bottom cover must be removed. The test equipment required for each adjustment is given after preliminary instructions (Paragraphs 5.4.1 through 5.4.6). For ease of following the adjustment procedures or checks, the steps are given in tabular form (Tables 5-2 through 5-7). Troubleshooting guides also in tabular form (Tables 5-8 through 5-11) are provided to assist the operator in localizing malfunctions. Interior views of the instrument are included to aid in locating the various test and adjustment points.

5.2 Access

Components in the top part of the instrument can be reached by removing the two L-shaped side covers. Each cover is secured to the chassis by six screws. The speaker leads must be disconnected before the right-hand cover can be removed completely. Components in the bottom part of the instrument can be reached by setting the CE-7 on its rear panel, with the bottom facing forward. The bottom cover is secured to the chassis by six screws.

The Model 302 FM Deviation Meter or the Model 301 Oscilloscope is removed by loosening a small knob on the rear panel of the CE-7 and pushing in on this knob. The Model 303 Broadband Mixer and Models 304, 305, or 306B Preselector are removed by loosening the LOCK knob on the front panel of the plug-ins, and pushing in on the knob to disengage the plug-in connector from the CE-7 receptacle.

5.3 Fuses

There are three regulated power supplies within the CE-7: +5 volts, +20 volts, and -12 volts. The +5-volt supply is derived by means of a zener diode from the +20-volt supply and does, therefore not have a separate adjustment or fuse. Separate fuses and adjustments for the -12- and +20-volt supplies are on Power Supply board 0100 located on the right side of the instrument. See Figure 5-1. The -12- and +20-volt supplies are protected by 1.0 amp slo-blo fuses. The upper-adjusting potentiometer and upper fuse are for the +20-volt supply. The lower-adjusting potentiometer and lower fuse are for the -12-volt supply. If one of these fuses blows, the resistance between the regulator output terminal and ground should be measured to make sure that there is not a short circuit. Table 5-1 gives the approximate resistances to chassis ground for each supply (or, in the case of the plug-ins, for the load across each supply).

There are two separate AC fuses located on the rear panel of the CE-7. A 1.0 amp slo-blo fuse is for the main AC power to the instrument. The other is a 0.2 amp slo-blo fuse that provides protection to the Model 301 Oscilloscope, which has a regulated power supply.

5.4 Adjustment Procedures and Check

The following paragraphs (5.4.1 through 5.4.6) interspersed with their respective tables provide preliminary instructions and test equipment required for performance of the tests given to maintain the CE-7.

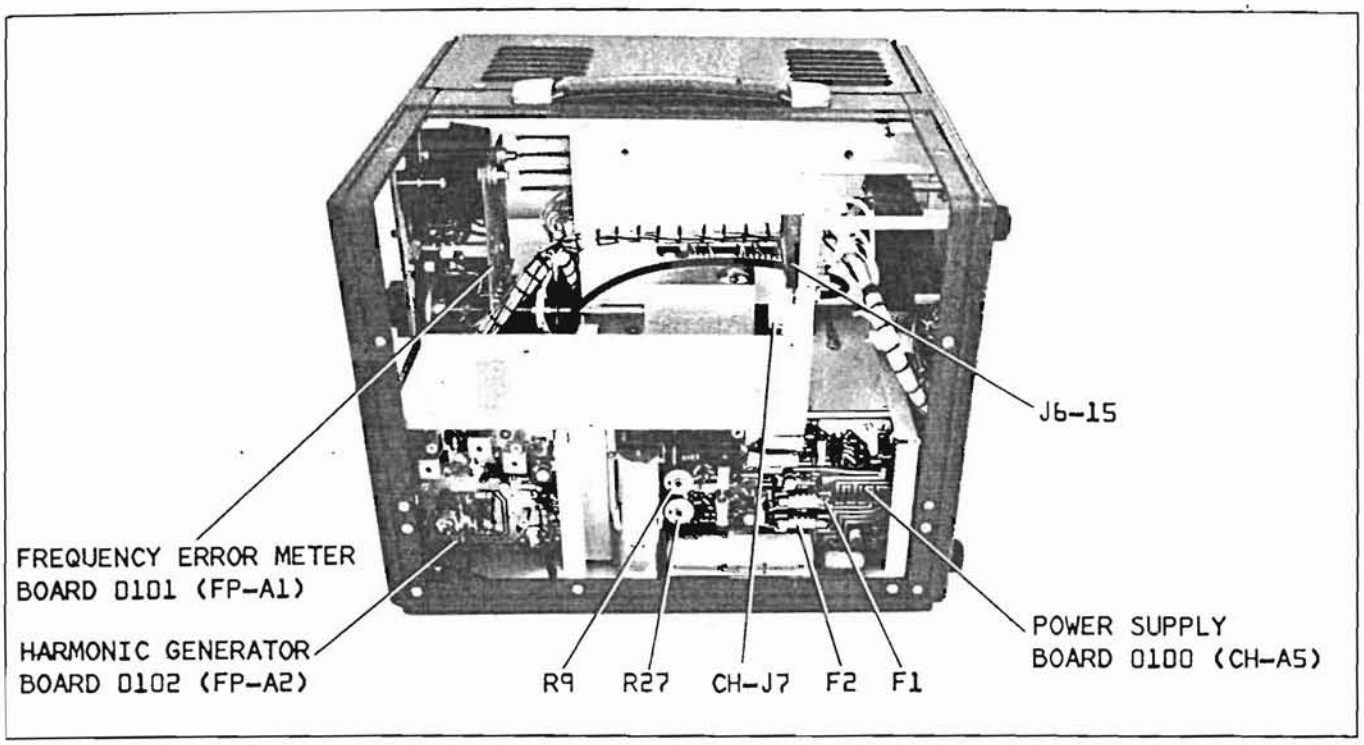


Figure 5-1. CE-7 Right Interior View Without Plug-In

5.4.1 Power-Supply Board, Voltage Adjustment

Preliminary Instructions:

Adjustments for the power supplies (Table 5-2) are on Power Supply Board 0100 (CH-A5) located on the right side of the instrument. See Figure 5-1.

NOTE

The -12-volt and +20-volt regulated power supplies are factory set to within 0.5 percent of rated output voltage and should not be changed unless a voltmeter having an accuracy of at least 1.0 percent is used.

Test Equipment Required:

a. Volt-Ohm-Milliammeter, Simpson Model 270 or equivalent. (20,000 ohms-per-volt or higher sensitivity, 1.0 percent accuracy, +5V and -50V ranges.)

b. VTVM, Hewlett-Packard Model 400H.

5.4.2 Crystal-Oscillator Adjustment

Preliminary Instructions:

a. The crystals and trimmer capacitors for each of the 23 channels are in the Crystal Oven Assembly (CH-A4). Access to the trimmer capacitors is through the bottom of the instrument. See Figure 5-2. The Crystal Oven Assembly cover has a revolving disc with one tuning hole, which can be rotated to line up with the access holes for each of the 23 crystal trimmers. The tuning tool used to adjust the trimmer capacitors must be an insulated female-slotted tuning driver. Refer to Table 5-3 for Crystal Oscillator Adjustment procedures.

b. A separate 10-MHz crystal, also located in the Crystal Oven Assembly (see Figure 5-2), is used when the function switch is in the CAL./CW position. Its trimmer capacitor access hole is located diagonally above crystal position 21 on the Crystal Oven Assembly cover.

c. Place the instrument on its rear panel with the Crystal Oven Assembly facing forward.

Test Equipment Required:

a. Frequency Counter, Hewlett-Packard Model 5245L, or equivalent.

b. Tuning Tool, GC Electronics No. 8279.

c. Signal Generator, Hewlett-Packard Model 608 or 612.

5.4.3 Frequency-Meter Adjustment

Preliminary Instructions:

a. Balancing the Second IF and Discriminator board 0054 (CH-A2) should precede adjustment of the FREQUENCY meter. Perform the following CAL. and FM CAL. centering adjustments.

NOTE

The SIGNAL LEVEL lamp must be on before proper adjustments can be performed.

Table 5-1. Power Supply, Resistances to Ground

	+5V (green wire)		-12V (orange wire)		+20V (red wire)	
	Measured at	Res. (ohms)	Measured at	Res. (ohms)	Measured at	Res. (ohms)
CE-7 Monitor† (less plug-ins)	Pin 15 of RF plug-in receptacle	750-1700*	Pin 14 of RF plug-in receptacle	400-450	Pin 17 of RF plug-in receptacle	500-550
Model 301 Oscilloscope	Not used	--	Pin 14 of connector	4.5K-7.5K††	Pin 13 of connector	1.5K-1.8K*
Model 302 Deviation Meter	Not used	--	Pin 14 of connector	8.2K-8.5K*	Pin 13 of connector	1.7K
Model 303 Broadband Mixer	Pin 15 of connector	3.5K*	Pin 14 of connector	500	Pin 16 of connector Pin 17 of connector	1.8-2.4K*††† 10K*
Model 304 Preselector	Pin 14 of connector	1.25K-50K*	Pin 14 of connector	265	Pin 16 of connector Pin 17 of connector	800 22K-30K*
Model 305 Preselector	Pin 15 of connector	1.25K-50K*	Pin 14 of connector	265	Pin 16 of connector Pin 17 of connector	3.8K 24K
Model 306B Preselector	Pin 15 of connector	5.3K	Pin 14 of connector	500	Pin 16 of connector Pin 17 of connector	3K 12K

NOTE: All resistance readings taken with a Simpson 270 using RX100 scale.
All resistance readings of modules taken with module removed from set.

*Depended on ohmmeter test-lead polarity. The readings may also vary depending upon ohmmeter range.

†Measure resistance to chassis of supply lines.

††Resistance readings taken with "vernier" pot in mid position.

†††Resistance readings taken with selectivity switch in "normal".

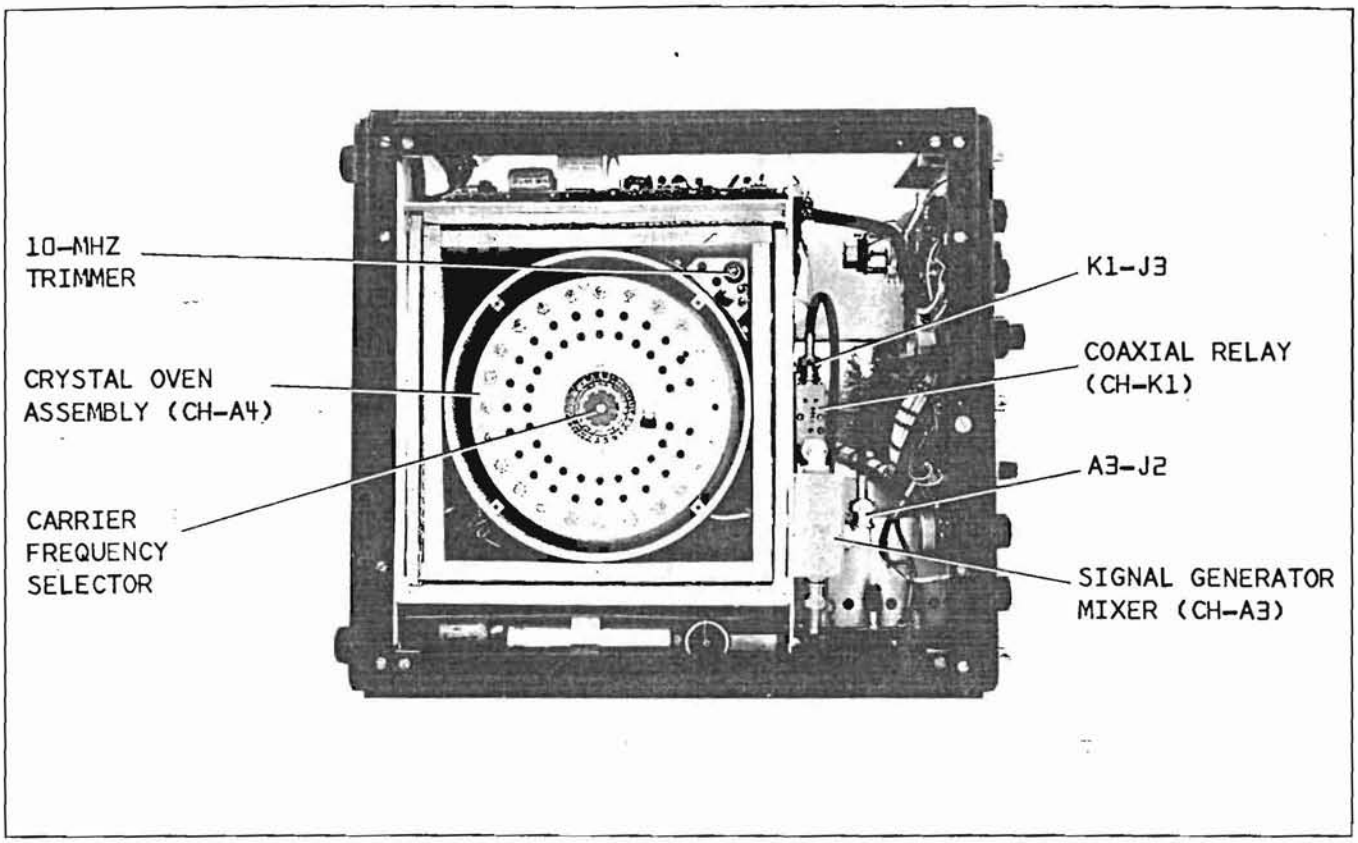


Figure 5-2. CE-7 Bottom Interior View

Table 5-2. Power-Supply Board, Voltage Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Measure -12-volt supply to chassis ground (see Figure 5-3).	TB1-3 (orange wires)	-12 volts
1B	Adjust lower potentiometer (see Figure 5-1).	R27 (CH-A5)	-12 volts
2A	Measure +20-volt supply to chassis ground (see Figure 5-3).	TB1-1 (red wires)	+20 volts
2B	Adjust upper potentiometer (see Figure 5-1).	R9 (CH-A5)	+20 volts
3A	Measure +5-volt supply (see Figure 5-1).	CH-J6-15 (green wires)	Between 4.8 and 5.2 volts.
4A	Measure -12- and +20-volt ripple at test points specified in steps 1A and 2A with vtvm.		Less than 1.0 millivolt.

Table 5-3. Crystal-Oscillator Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Connect input of the counter to the CRYSTAL OUT/AUX. IN connector. **CAUTION** The level at this point is approximately 200 millivolts into 50Ω (0.2 volts). Ensure that the counter can be used at this level.		The crystal frequency selected should be within 3.0 Hz of the specified frequency.
1B	Set CARRIER FREQUENCY SELECTOR to "1".		
1C	Align rotating oven disc to position "1".		
1D	With the tuning tool, adjust trimmer to the crystal frequency listed on the Channel Frequency Chart.	Appropriate Trimmer Capacitor.	Crystal frequency listed for position "1" on Channel Frequency Chart.
1E	Repeat steps 1A through 1D for each of the other 22 crystals. NOTE The following steps are to be performed when installing new, or changing crystals.		
2A	Connect the output of the signal generator to the ANT. connector of the RF plug-in being used.		
2B	Set the signal generator to the approximate frequency of the carrier channel desired.		
2C	Adjust the output level of the signal generator to approximately 20 millivolts.		
2D	Set the function switch to HARM. AMP. TUNING and CHANNEL FREQUENCY SELECTOR to the carrier channel desired.		
2E	Rotate the HARM. AMP. TUNING control fully counterclockwise.		

Table 5-3. Crystal-Oscillator Adjustment (Continued)

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
2F	Rotate the HARM. AMP. TUNING control slowly clockwise to the first peak reading on the FREQUENCY meter.		
2G	Set the function switch to FREQ.-DEV. MEASURE and ensure that the SELECTIVITY switch is in the NORMAL position.		
2H	Set the ±kHz (FREQUENCY lever) to 5 and the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz control to the appropriate position.		
2J	Vary the signal generator around the channel frequency until the SIGNAL LEVEL lamp lights. NOTE False responses may be encountered when varying the signal generator frequency too far above or below the assigned frequency.		
2K	If the SIGNAL LEVEL lamp does not light, the HARM. AMP. TUNING control may be tuned to the wrong peak.		
2L	Set the function switch to HARM. AMP. TUNING and rotate the HARM. AMP. TUNING control slowly clockwise to the next peak. Repeat steps 2G through 2J.		
2M	When the SIGNAL LEVEL lamp lights, center FREQUENCY meter with signal generator frequency control. NOTE Ensure that the FREQUENCY meter deflects towards the plus (+) side when increasing the signal generator frequency.		

Table 5-3. Crystal-Oscillator Adjustment (Continued)

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
2N	Reduce the output level of the signal generator until the SIGNAL LEVEL lamp goes out.		
2P	Slowly increase the signal generator output level until the SIGNAL LEVEL lamp lights.	--	Sensitivity less than 5 millivolts if operating below 500 MHz, less than 10 millivolts if operating above 500 MHz (using a Broadband Mixer). NOTE When using one of the RF Preselectors the sensitivity should be less than 20 microvolts.
2Q	Record the number indicated on the HARM. AMP. TUNING control on the Channel Frequency Chart. NOTE The following steps are to be performed for the 10-MHz adjustment.		
3A	Disconnect coaxial connector atop Signal Generator Mixer, which is above the Crystal Oven Assembly. (See Figure 5-2.)	CH-A3-J2	
3B	Connect the coaxial connector (A3-J2) to the input of the counter with a suitable adapter.		
3C	Set the function switch to CAL./CW.		
3D	Set the SIGNAL GENERATOR attenuator multiplier to X100 and vernier control for maximum output.		
3E	Adjust 10-MHz trimmer with tuning tool.	Trimmer Capacitor.	10.0 MHz ±10.0 Hz as indicated on counter.
3F	Reconnect coaxial connector to Signal Generator Mixer.		

CAL. centering:

1. Set the function switch to CAL./CW.

2. Set the CAL. control (inner red knob) to a twelve o'clock position.

3. Adjust R30 on the Second IF and Discriminator Board 0054 (CH-A2) for a zero reading on the FREQUENCY meter. Refer to Figure 5-3.

FM CAL. centering:

1. Set the function switch to CW.

2. Zero FREQUENCY meter with the CAL. control.

3. Set the function switch to FM.

4. Turn the DEV. ADJ. control fully counterclockwise.

5. Set the FM CAL. control (inner red knob) to a ten o'clock position.

6. Adjust L5 on the Multi-Oscillator Board 0103 (CH-A1) through the access hole in the left frame of the chassis (remove FM Deviation Meter or Oscilloscope) for a zero reading on the FREQUENCY meter. Refer to Figure 5-3.

b. The FREQUENCY meter ranges are adjusted by means of an oscillator which can be offset from 10 MHz by exactly ±0.5 kHz, ±1.5 kHz, and ±5.0 kHz. Refer to Table 5-4. The CE-7 first IF is 10 MHz and its discriminator will detect and display frequency error above or below this frequency.

c. The Model 303 Broadband Mixer must be installed in the CE-7 before any adjustments can be performed.

d. On the Frequency Error Meter board 0101 (FP-A1) mounted on the back of the FREQUENCY meter are three potentiometers. The top one (R2) is for ±0.5 kHz, the middle one (R4) for ±1.5 kHz, and the bottom one (R6) for ±5.0 kHz. See Figure 5-3.

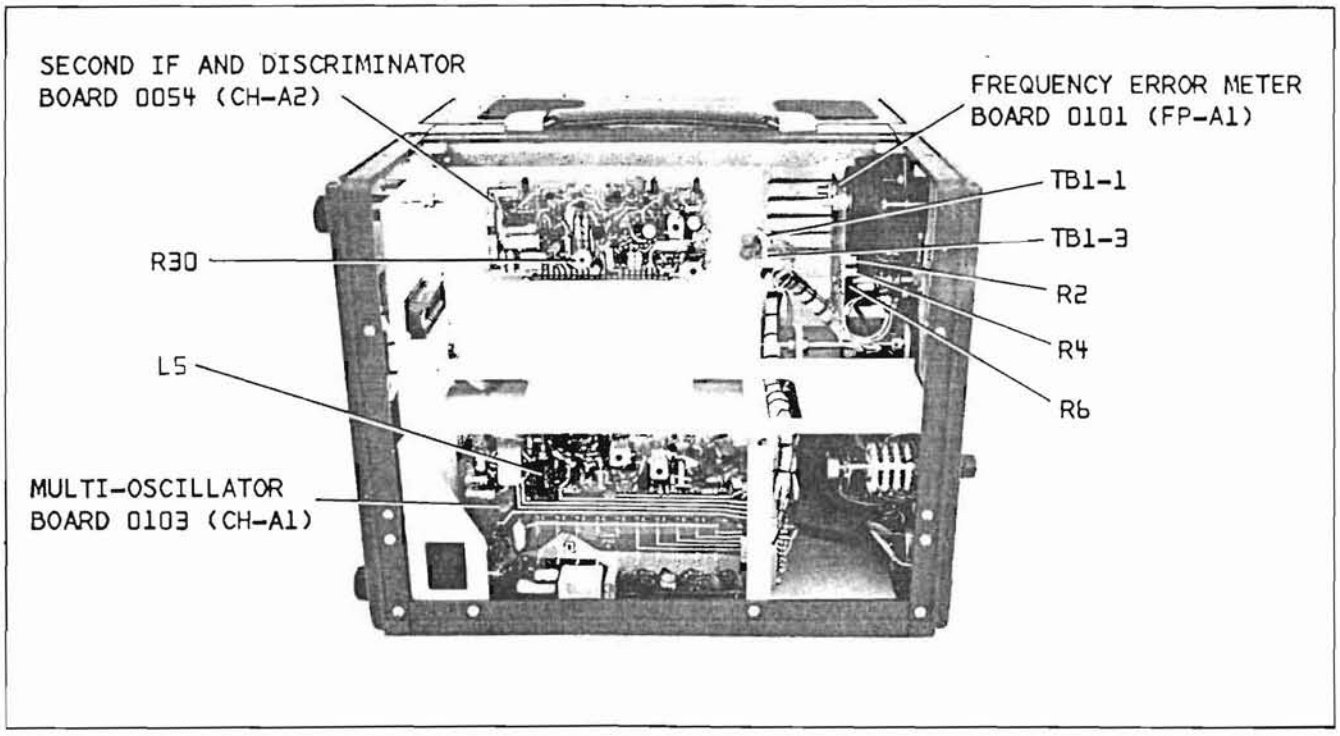


Figure 5-3. CE-7 Left Interior View Without Plug-In

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 606.

b. Frequency Counter, Hewlett-Packard Model 5245L.

c. Tuning Tool, JFD Electronics Co., No. 5284.

Table 5-4. Frequency-Meter Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Set the function switch to CAL./CW and zero the FREQUENCY meter with the inner red control knob.	R1	
1B	Set the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch to ABOVE 40 MHz.	S3	
1C	Set the function switch to FREQ.-DEV. MEASURE and connect the output of the signal generator to both the input of the Model 303 Broadband Mixer and input of the counter (using a "T" adapter). NOTE The SIGNAL LEVEL lamp must be on before proceeding with steps 1D through 1G.		
1D	Set the ±kHz (FREQUENCY lever) to .5.	S2	
1E	Adjust the signal generator to 10,000,500 Hz.		0.5 kHz as indicated on FREQUENCY meter.
1F	Adjust the top (0.5 kHz) potentiometer for full scale.	R2 (FP-A1)	
1G	Repeat steps 1D through 1F but adjust the signal generator to 10,001,500 Hz when the ±kHz (FREQUENCY lever) is set to 1.5, and 10,005,500 Hz when the ±kHz (FREQUENCY lever) is set to 5.	R4 (FP-A1) and R6 (FP-A1)	1.5 kHz and 5.0 kHz as indicated on FREQUENCY meter.

5.4.4 20-dB Fixed-Attenuator Loss Check

Preliminary Instructions:

a. A 20-dB fixed attenuator is supplied with the CE-7 and is stored inside the front cover. The CE-7 attenuators are calibrated in terms of signal voltage at the output of the 20-dB fixed attenuator. Refer to Table 5-5. The fixed attenuator must therefore, always be used if the output levels indicated by the position of attenuator knobs are to mean anything. The purpose of the fixed attenuator is to protect the instrument when the CE-7 is directly connected to a transceiver which is accidentally keyed to transmit. Keying a transmitter will normally burn out the RF fuse. But before the fuse blows, the resistors in the fixed attenuator may have been subjected to a transient overload severe enough to damage them and change their values. Changed ohmic values would cause changed attenuation.

Table 5-5. 20-dB Fixed-Attenuator Loss Check

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Feed a 10-microvolt signal from the signal generator into the receiver.		
1B	Note the receiver meter reading.		
1C	Feed a 100-microvolt signal through the attenuator into the receiver.		
1D	Note the two receiver meter readings.		The two readings should be within 0.5 dB of one another.
	NOTE The 20-dB fixed attenuator loss may be checked using an RF Voltmeter such as the Boonton 91D in place of the receiver. Perform the following steps as required.		
2A	Connect the output of the signal generator into the RF Voltmeter through a 50Ω termination using a 50Ω coaxial cable.		
2B	Set the signal generator output level to approximately 100 millivolts and note the reading on the voltmeter.		
2C	Insert the 20-dB fixed attenuator between the signal generator and voltmeter, and note the difference in readings.		20 dB ±0.5 dB

b. Since it is essential that the fixed attenuation is precisely 20 dB, the checks listed in Table 5-5 must be performed if damage is suspected.

c. When it becomes necessary to repair the fixed attenuator, remove the single screw and slide the cover off. A decal on the side of the fixed attenuator casting shows the component values. The resistors are standard 5 percent values. The fuse is a special RF fuse (Bussman #GFA1/32A).

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 608.

b. Metered receiver with 50Ω input impedances capable of operating at the required frequencies.

c. RF Voltmeter, Boonton Model 91D, or equivalent.

5.4.5 Signal-Generation-Output Level Adjustment

Preliminary Instructions:

a. The output levels are adjusted by signal substitution. Refer to Table 5-6. First, a signal from a calibrated source is fed into a metered receiver and the meter reading noted. The CE-7 is then substituted for the calibrated source and the output LEVEL SET control of the CE-7 is adjusted until the meter reads the same as before. The receiver should be metered at a point where saturation is least likely to occur (for example, the first and second IF stage) and the RF input signal should be preferably 1.0 microvolt.

b. Select a frequency at which the adjustment is to be made. This frequency must be within the capabilities of the external receiver, the external signal generator, and the CE-7.

c. Set the signal generator to this frequency by monitoring it on the CE-7.

NOTE

When using frequencies higher than 100 MHz, the signal generator must be tuned very slowly to accommodate the narrow bandwidth of the CE-7. If a Preselector is being used, ensure that its SELECTIVITY switch is set to NORMAL.

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 608.

b. Metered receiver with 50Ω input impedances capable of operating at the required frequencies.

5.4.6 Signal-Generator-Mixer Input Level Check

Preliminary Instructions:

a. The signal generator mixer may be damaged in the same manner as noted for the 20-dB fixed attenuator (Paragraph 5.4.4). When it becomes necessary to repair the signal generator mixer, it will also be necessary to readjust the signal generator output levels (Table 5-6).

b. The two inputs to the signal generator mixer are: a 10-MHz signal from the Multi-Oscillator via the Signal Generator Step Attenuator, and a signal that may contain frequencies of from 28 MHz to 1150 MHz from the Harmonic Generator via the coaxial relay. Refer to Table 5-7.

Test Equipment Required:

RF Voltmeter, Boonton Model 91D.

Table 5-6. Signal-Generation-Output Level Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Adjust the signal generator output to 1.0 microvolt.		
1B	Feed the signal generator output into the receiver and note the receiver meter reading. (Be cautious of signal generator frequency drift.)		
1C	Set the function switch to CW. Adjust the CE-7 to generate a signal with a 1.0-microvolt level.		
1D	Disconnect the signal generator from the receiver, and connect the output of the CE-7 to the receiver. Use the 20-dB fixed attenuator furnished with the instrument.		
1E	If the receiver meter does not read the same as in step 1B, adjust the 10-turn LEVEL SET attenuator on the CE-7 for the same meter reading. Record the new LEVEL SET number on the Channel Frequency Chart. NOTE The LEVEL SET number for various frequencies in the same band will be the same. For this reason, it is not necessary to make the adjustments for every channel frequency.		Typical calibration frequencies are as follows: FREQUENCY BAND — NOMINAL FREQUENCY for CALIBRATION 20 to 80 MHz — 35 MHz 120 to 180 MHz — 155 MHz 450 to 512 MHz — 460 MHz 900 to 1000 MHz — 960 MHz
1F	Set the function switch to FM and center the FREQUENCY meter with the FM CAL. control. Turn the DEV. ADJ. control fully counterclockwise.		Less than 1.0 dB from CW reference.

Table 5-7. Signal-Generator-Mixer-Input Level Check

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
	10 MHz INPUT LEVEL CHECK		
1A	Set the function switch to CW.		
1B	Disconnect the coaxial cable from the BNC connector atop the signal generator mixer (see Figure 5-2).	CH-A3-J2	--
1C	Terminate RF voltmeter in 50Ω.		
1D	Measure cable output voltage.		200 millivolt ±2.0 dB (attenuator controls must be set at maximum output).
	COAXIAL RELAY LEVEL CHECK		
2A	Set the function switch to CW.		
2B	Disconnect the coaxial cable from left side of the coaxial relay (see Figure 5-2).	CH-K1-J3	
2C	Terminate RF voltmeter in 50Ω.		
2D	Set the function switch to HARM. AMP. TUNING.		
2E	Select any (used) channel with CARRIER FREQUENCY SELECTOR switch.		
2F	Tune HARM. AMP. TUNING control for maximum reading on FREQUENCY meter.		
2G	Measure cable output voltage		At least 700 millivolts.

5.5 Troubleshooting Procedures

The following tables (5-8 through 5-11) detail tests required to localize malfunctions in the CE-7. The malfunctions listed are not necessarily all of the problems that may be encountered. For further information, contact Cushman Electronics, Customer Service Department.

Table 5-8. Troubleshooting, Frequency-Deviation-Measure (FDM) Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
SELECTING PROPER CHANNEL			
Pilot light out	Lamp		Front panel of CE-7.
	Output of -12V regulator	-12V ±0.1V.	Power Supply Board 0100 (Figure 6-2).
	Fuse A5-F2		Power Supply Board 0100 (Figure 6-2).
	AC line fuse CH-F1		Rear panel of CE-7.
HARM. AMP. TUNING			
No meter movement	METERS INT.-EXT. slide switch position.	Set in INT. position.	Rear panel of CE-7.
	Channel crystal. (Select another crystal position and retune).	Greater than 0.3 on FREQUENCY meter.	Crystal Oven Assembly (Figure 6-9).
	Channel oscillator output at CRYSTAL OUT AUX. IN connector.	200 MV at FP-J4.	Harmonic Generator board 0102 (Figure 6-4).
	Harmonic amplifier output at SIGNAL GENERATOR OUTPUT connector.	700 MV at CH-A2-J1.	Harmonic Generator board 0102 (Figure 6-4).
	Wiring or loose contacts on function switch.		Front Panel Wiring diagram (Figure 6-11).
CAL./CW			
No SIGNAL LEVEL light or FREQUENCY meter indication.	RF Plug-in		Applicable instruction manual.
	10-MHz generator. (Try FM position on function switch.)	200 MV at CH-J1-14, R.	Multi-Oscillator board 0103 (Figure 6-5).
	+5V power supply.	-5.0V ±0.2V at CH-J6-15.	Power Supply board 0100 (Figure 6-2).
No SIGNAL LEVEL light indication. FREQUENCY meter OK.	Lamp and connector.	Lamp on in CAL./CW position.	Front Panel Wiring diagram (Figure 6-11).
SIGNAL LEVEL light on, no FREQUENCY meter deflection in CAL./CW.	METERS INT.-EXT. slide switch position.	Set in INT. position.	Rear panel of CE-7.
	Function switch or FREQUENCY meter movement.		Front Panel Wiring diagram (Figure 6-11).
	(Set function switch to FM and adjust DEV. ADJ. control for a reading on FM DEVIATION meter.) If normal, check L7 and L8.		Second IF and Discriminator board 0054 (Figure 6-1).
	Other positions on function switch.		Front Panel Wiring diagram (Figure 6-11).

Table 5-8. Troubleshooting, Frequency-Deviation-Measure (FDM) Mode (Continued)

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
SIGNAL LEVEL light on, FREQUENCY meter reads off scale.	Output of -12V regulator	-12V ±0.1V at CH-J6-14.	Power Supply board 0100 (Figure 6-2).
	9.9 MHz generator.	80-100 MV at CH-J1-2, B.	Multi-Oscillator board 0103 (Figure 6-5).
NOTE The preceding trouble-shooting procedures also apply to the Signal Generator mode of operation.	Q4, Q5		Second IF and Discriminator board 0054 (Figure 6-1).
FREQ.-DEV. MEASURE			
Inoperative in this position only.	RF Plug-in or Broadband Mixer. Pin 7.	Greater than 600 MV.	Applicable instruction manual.
	Local oscillator connector or coaxial relay cable.	700 MV at CH-J7	Figure 5-1.
	Coaxial relay CH-K1 or Harmonic Generator output. (Listen for relay operation while switching function switch to different positions.)	700 MV at FP-A2-J1.	Figure 5-2, and Harmonic Generator board 0102 (Figure 6-4).
No audio, SIGNAL LEVEL light on. (Normal operation of FM Deviation Meter, Model 302.)	Speaker connection.	Audible tone in FM position.	Power Supply board 0100 (Figure 6-2).
	Audio amplifier.	1.0 audio at CH-A5-17 output with 50 MV input.	Power Supply board 0100 (Figure 6-2).
	Speaker.	3.0Ω dc resistance.	Right-hand side cover.
FREQUENCY meter operative but FM DEVIATION meter on Model 302 does not indicate or no trace on Oscilloscope, Model 301.	FM Deviation Meter or Oscilloscope		Applicable instruction manual.
	Q9	3.2 vdc	Second IF and Discriminator board 0054 (Figure 6-1).
CARRIER FREQUENCY SELECTOR			
Erratic FREQUENCY meter action in one or more of the crystal positions. NOTE This is also characteristic of the Signal Generator mode of operation.	Switch contacts on CARRIER FREQUENCY SELECTOR.		Figure 5-2.

Table 5-9. Troubleshooting, Signal-Generator Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
CAL./CW operative as verified in Table 5-4, but no output.	20-dB fixed attenuator.		20-dB fixed attenuator.
	Coaxial relay CH-K1. (Listen for relay operation while switching function switch to different positions.)		Figure 5-2.
	Harmonic amplifier output at SIGNAL GENERATOR OUTPUT connector.	Greater than 700 MV.	Front panel of CE-7.
	Signal Generator Mixer; local oscillator signal from coaxial relay CH-K1.	Greater than 700 MV at CH-A3-J1.	Figure 5-2.
	10-MHz signal from attenuator. (Defective function switch, attenuator, or wiring.)	200 MV at CH-A3-J2.	Front Panel Wiring diagram (Figure 6-11).
	Orange/white wire, (-12V bias diode CR1). LEVEL SET potentiometer or wiring.	-12V with LEVEL SET control set to zero.	Signal Generator Mixer (Figure 6-8).
No modulation. No indication on Model 302 FM Deviation Meter.	FM MOD. INT.-EXT. 1 kHz OUT switch.	Set to INT. position.	Front panel of CE-7.
	1 kHz generator. (1 kHz OUT connector with FM MOD. INT.-EXT. 1 kHz OUT switch in INT. position.)	Greater than 1.0V at FP-J2.	Front panel of CE-7.
	10-MHz FM Generator. Set FM MOD. INT.-EXT. switch to EXT. with external source of 1 kHz at 1.0V fed to EXT. connector.	Control of deviation with DEV. ADJ. control.	Multi-Oscillator board 0103 (Figure 6-5).
	Model 302 FM Deviation Meter.		Applicable instruction manual.

Table 5-10. Troubleshooting, I.F.-Generator Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
No output in all positions of the the SELECTOR switch.	IF Oscillator output.	600 MV at CH-J1-P.	Multi-Oscillator board 0103 (Figure 6-5).
600 MV not present at pin P on Multi-Oscillator board.	+20V to the selected IF Oscillator board position on the Multi-Oscillator board.	+20V ±0.1V.	IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
	Q11 or Q12		Multi-Oscillator board 0103 (Figure 6-5).
	Wiring of SELECTOR switch.		Front Panel Wiring diagram (Figure 6-11).
600 MV present at pin P on Multi-Oscillator board.	Attenuator potentiometer and associated wiring.		Front Panel Wiring diagram (Figure 6-11).
No output in one position of the SELECTOR switch, all other OK.	+20V to selected IF Oscillator board.	+20V ±0.1V.	IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
+20V present from SELECTOR switch.	Crystal or transistors.		IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
+20V not present from SELECTOR switch.	SELECTOR switch wiring associated with that position.		Front Panel Wiring diagram (Figure 6-11).

Table 5-11. Troubleshooting, Crystal-Oven Assembly

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
Excessive frequency error on all channels.			
OVEN ON light on continuously.	Shorted triac 40529, Q13.	Oven light on for approx. 30 seconds and off for approx. 90 seconds after warm-up.	Power Supply board 0100 (Figure 6-2).
	NOTE Thermal fuse TF1 blows if triac shorts.		
	Mercury column thermostat (regular heat).		
OVEN ON light will not energize. (Regular heat failure).	Blown thermal fuse TF1.		Crystal Oven Assembly (Figure 6-9).
	Open triac 40529, Q13.		Power Supply board 0100 (Figure 6-2).
	Snap-action thermostat (fast heat).		Crystal Oven Assembly (Figure 6-9).
	Mercury column thermostat.		Crystal Oven Assembly (Figure 6-9).
	OVEN ON light connector.		Front panel of CE-7.
OVEN ON light stays on for more than twenty minutes. (Slow warm-up noticed, but cycles normally after warm-up.)	Open snap-action thermostat.		Crystal Oven Assembly (Figure 6-9).
OVEN ON light cycles normally.	Mercury column thermostat.		Crystal Oven Assembly (Figure 6-9).
	Temperature with thermometer.	164°F.	

Every effort has been made to ensure the accuracy of this manual. If an error is discovered please notify us on the postpaid cards attached.

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

CUSHMAN ELECTRONICS
PUBLICATIONS DEPARTMENT

There is an error on page _____/figure _____ of the _____ manual; _____

_____

_____

_____

I would like to see these changes incorporated: _____

_____

_____

_____

_____

_____

_____

SIGNATURE _____

COMPANY _____

There is an error on page _____/figure _____ of the _____ manual; _____

_____

_____

_____

I would like to see these changes incorporated: _____

_____

_____

_____

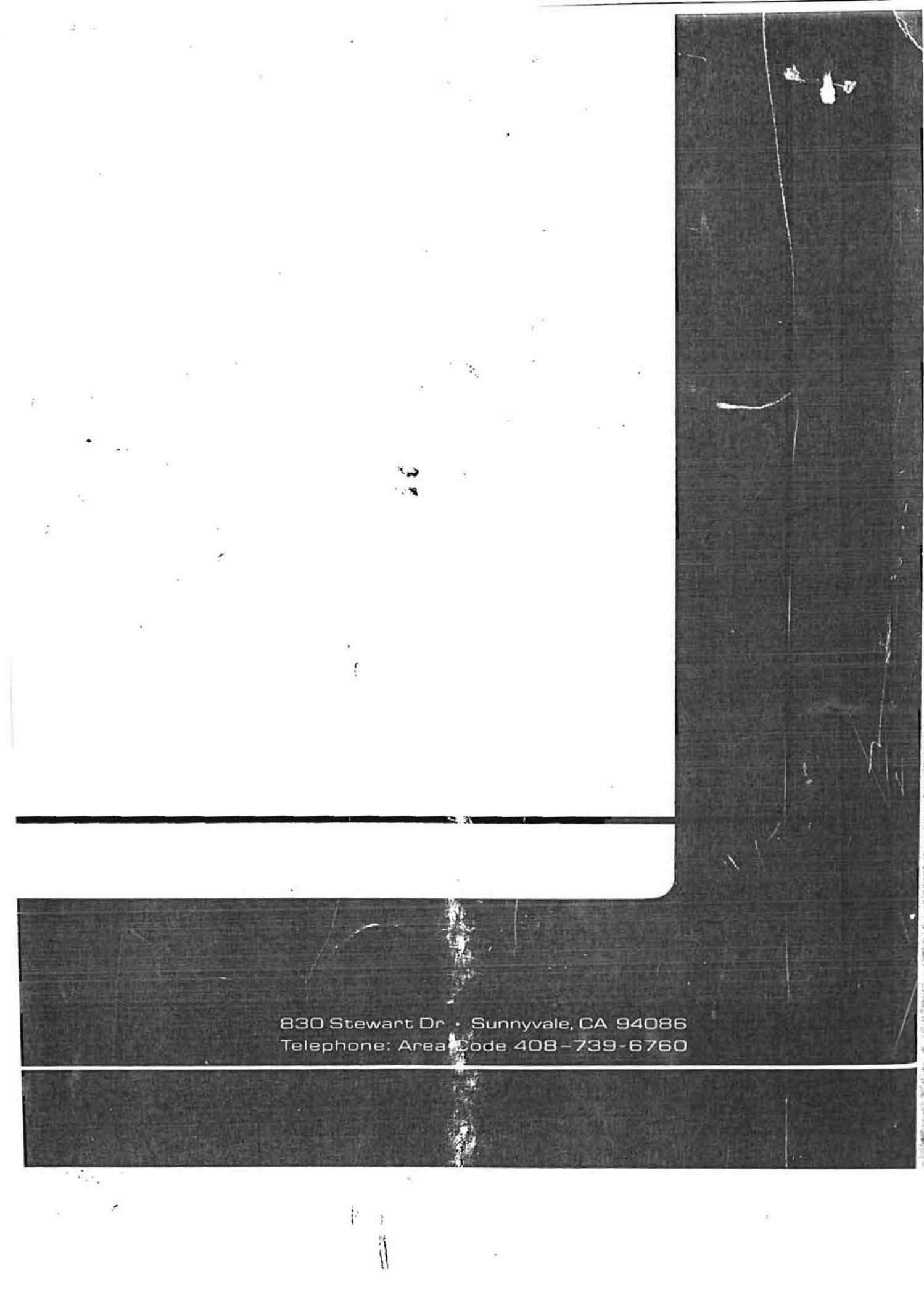
_____

_____

_____

SIGNATURE _____

COMPANY _____



830 Stewart Dr · Sunnyvale, CA 94086
Telephone: Area Code 408-739-6760

SECTION 6

SCHEMATICS, PARTS LISTS, AND PARTS PICTORIALS

6.1 Introduction

Section 6 contains schematic diagrams, wiring diagrams, parts lists, and parts pictorials for the CE-7 Multi-Channel FM Communications Monitor. Table 6-1 lists the reference designations and abbreviations used.

Paragraphs 6.2.1 through 6.2.9 contain: 1) parts pictorials, 2) parts lists, and 3) schematics for the various subassemblies in the order in which they were described in Section 4. Figures 6-10 through 6-12 are the main-chassis, front-panel, and rear-panel wiring diagrams and are accompanied by the associated parts lists and parts pictorials.

Table 6-1. Reference Designators and Abbreviations

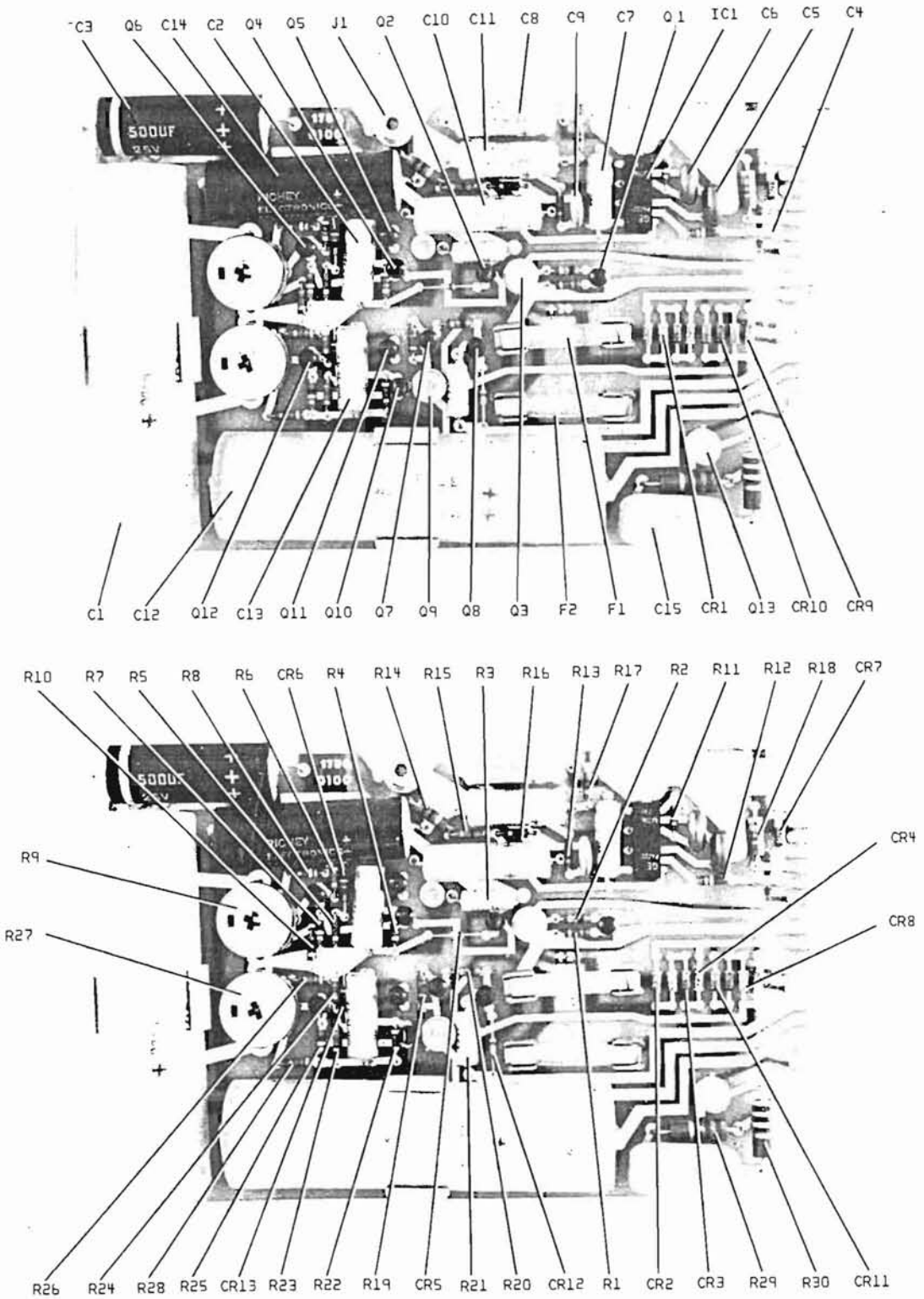
REFERENCE DESIGNATORS

A	assembly
BM	balanced mixer
B	board
C	capacitor
CH	chassis
Y	crystal
DS	device, indicating
CR	diode
V	electron tube
E	electronic part, misc.
FL	filter
FP	front panel
F	fuse
HR	heater
Hz	hertz
L	inductor, RF choke
J	jack
M	meter
P	plug
RP	rear panel
K	relay
R	resistor
SCR	silicon controlled rectifier
LS	speaker
S	switch
TB	terminal board
TP	test point
TF	thermal fuse
RT	thermistor
S	thermostat
T	transformer
Q	transistor
WT	wiring tiepoint

ABBREVIATIONS

AC	alternating current
ADJ	adjust
AFC	automatic frequency control
AMP	amperes
AMPL	amplifier
ANT.	antenna
AUX	auxiliary
BP	bandpass
C.	centigrade
CAL	calibrate
CCW	counterclockwise
CER	ceramic
COAX.	coaxial
COEF	coefficient
COM	common
COMP	composition
CONN	connector
CRT	cathode-ray tube
CW	clockwise
CW	continuous wave
DB	decibel
DC	direct current
Deg	degree
DEV	deviation
ELECT.	electrolytic
ENCAP	encapsulated
EXT	external
F	fahrenheit
F	farad
FM	frequency modulation
FREQ	frequency
Ge	germanium
GRD	ground
H	henry
Harm	harmonic
Hz	hertz
IC	integrated circuit
IF	intermediate frequency
INCD	incandescent
IN.	inch
INT	internal
K	kilo (10^3)
LIN	linear
LO.	local oscillator
LOG.	logarithmic
LP	lowpass
M	milli (10^{-3})
MEG	mega (10^6)
MFR	manufacture
MINAT	miniature
MY	mylar
N	nano (10^{-9})
P	peak
PC	printed circuit
pF	picofarad (10^{-12})
PIV	peak inverse voltage
POS	position(s)
POT.	potentiometer
PP	peak-to-peak
P/O	part of
RECT	rectifier
REPL	replace
RF	radio frequency
SB	slo-blo
SEC	second
Semicond	semiconductor
Si	silicon
Ta	tantalum
TGL	toggle
TOL	tolerance
TRIM	trimmer
TYP	typical
μ	micro (10^6)
UHF	ultra high frequency
V	volt
VAR	variable
VDCW	dc working volts
VERT.	vertical
VHF	very high frequency
W	watt
WW	wire-wound
W/	with
W/O	without

6.2.2 Power-Supply Board



6.2.2 POWER SUPPLY BOARD 0100

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A5	Board Assembly, Power Supply	7001-0005	Cushman
	Board, Printed Circuit	1780-0100	Cushman
	CAPACITORS		
C1	Elect., 2300 μF, 50V	1014-0004	Sprague
C2	Elect., 100 μF, 12V	1013-0011	Sprague
C3	Elect., 500 μF, 25V	1014-0002	Whale
C4	Cer, 0.05 μF +80%, -20%, 25V	1005-0014	Erie
C5	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C6	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C7	Elect., 15 μF, 25V	1013-0005	Sprague
C8	Elect., 100 μF, 25V	1013-0003	Sprague
C9	Cer, 0.05 μF +80%, -20%, 25V	1005-0014	Erie
C10	Elect., 250 μF, 16V	1013-0016	Sprague
C11	Elect., 100 μF, 25V	1013-0003	Sprague
C12	Elect., 2300 μF, 50V	1014-0004	Sprague
C13	Elect., 100 μF, 12V	1013-0011	Sprague
C14	Elect., 500 μF, 25V	1014-0002	Whale
C15	Poly, 0.22 μF, ±10%, 400V	1008-0042	Sprague
	CLIP		
	Fuse	3705-0006	Cluz
	DIODES		
CR1	Si, 1N4002	1281-0023	ITT
CR2	Si, 1N4002	1281-0023	ITT
CR3	Si, 1N4002	1281-0023	ITT
CR4	Si, 1N4002	1281-0023	ITT
CR5	Si, 1N3064	1281-0013	Sylvania
CR6	Si, Zener, 6.8V, 1N957	1281-0007	Continental Devices
CR7	Si, Zener, 5.1V, 1N4733	1281-0031	Motorola
CR8	Si, 1N4002	1281-0023	ITT
CR9	Si, 1N4002	1281-0023	ITT
CR10	Si, 1N4002	1281-0023	ITT
CR11	Si, 1N4002	1281-0023	ITT
CR12	Si, 1N3064	1281-0013	Sylvania
CR13	Si, Zener, 6.8V, 1N957	1281-0007	Continental Devices

6.2.2 POWER SUPPLY BOARD 0100 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	FUSES		
F1	3AG, 1 amp, slo-blo	1955-0006	Littlefuse
F2	3AG, 1 amp, slo-blo	1955-0006	Littlefuse
	INTEGRATED CIRCUIT		
IC1	Ampl, Audio, PA222	2025-0015	G.E.
	JACK		
J1	PC Board, Mounted Phone	2586-0007	Keystone
	RESISTORS		
R1	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley
R2	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R3	Fixed, WW, 1.0Ω, ±3%, 3W	1159-0001	Ohmite
R4	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
R5	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R6	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R7	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R8	Comp, 390Ω, ±5%, 1/4W	1066-3915	Allen-Bradley
R9	Var, WW, 500Ω, 2W	1200-0003	CTS
R10	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
*R11	Comp, 100kΩ, ±5%, 1/4W	1066-1045	Allen-Bradley
R12	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley
R13	Comp, 2.2Ω, ±5%, 1/4W	1066-2205	Allen-Bradley
R14	Comp, 10Ω, ±5%, 1/2W	1067-1005	Allen-Bradley
R15	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R16	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley
R17	Comp, 1Ω, ±5%, 1/4W	1066-1005	Allen-Bradley
R18	Comp, 6.8Ω, ±5%, 1/2W	1067-6815	Allen-Bradley
R19	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley
R20	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R21	Fixed, WW, 1.0Ω, ±3%, 3W	1159-0001	Ohmite
R22	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
R23	Comp, 8200Ω, ±5%, 1/4W	1066-8215	Allen-Bradley
R24	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R25	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R26	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
R27	Var, WW, 500Ω, 2W	1200-0003	CTS
R28	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
R29	Comp, 2.7kΩ, ±5%, 1W	1065-2725	Allen-Bradley
R30	Comp, 33kΩ, ±5%, 1W	1065-3335	Allen-Bradley

*Factory Select. Typical value shown.

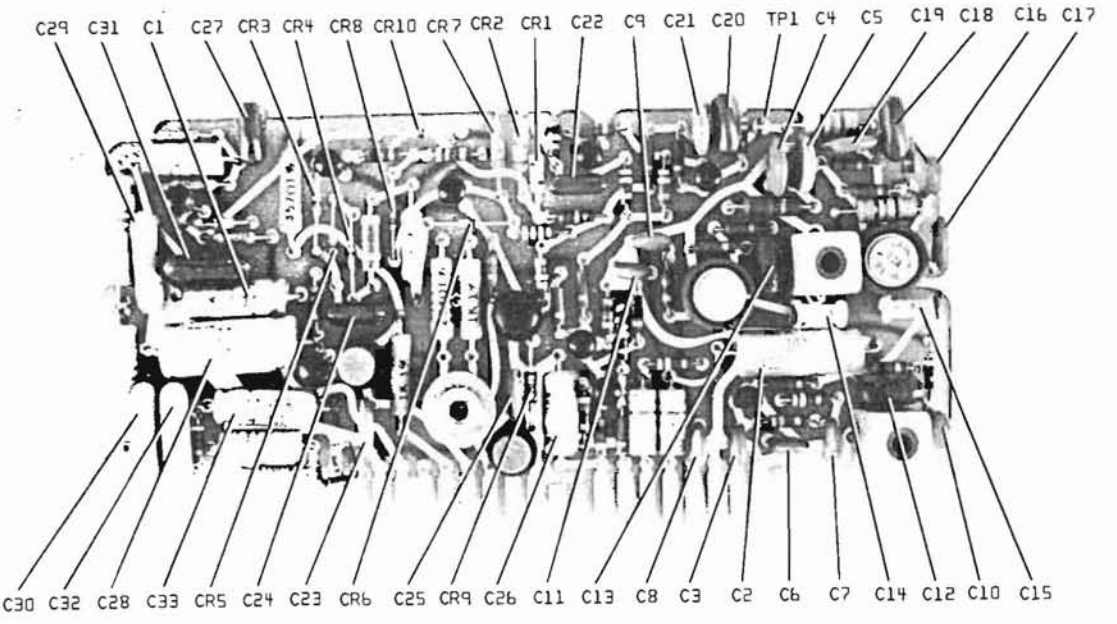
6.2.2 POWER SUPPLY BOARD 0100 (Continued)

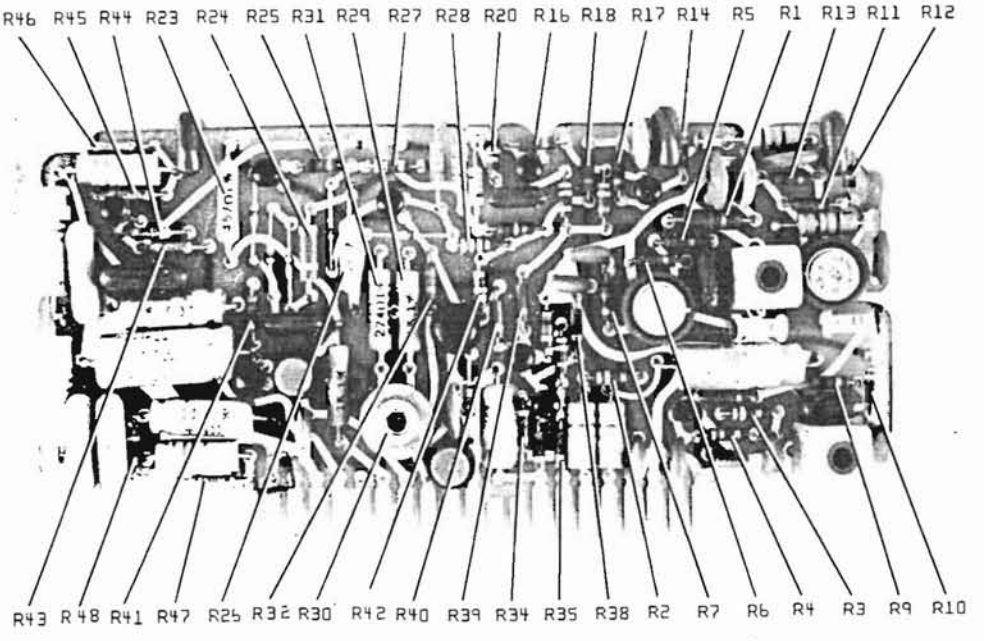
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	TRANSISTORS		
Q1	P Channel FET, 2N4342	1272-0027	Fairchild
Q2	Si, NPN, 2N3416	1271-0006	G.E.
Q3	Si, NPN, 2N3053	1272-0011	RCA
Q4	Si, NPN, 2N3565	1272-0017	Fairchild
Q5	Si, PNP, 2N4249	1272-0024	Fairchild
Q6	Si, PNP, 2N4249	1272-0024	Fairchild
Q7	P Channel FET, 2N4342	1272-0027	Fairchild
Q8	Si, NPN, 2N3416	1271-0006	G.E.
Q9	Si, NPN, 2N3053	1272-0011	RCA
Q10	Si, NPN, 2N3416	1271-0006	G.E.
Q11	Si, PNP, 2N4249	1272-0024	Fairchild
Q12	Si, PNP, 2N4249	1272-0024	Fairchild
Q13	Triac, 40526 or 40529	1272-0029	RCA

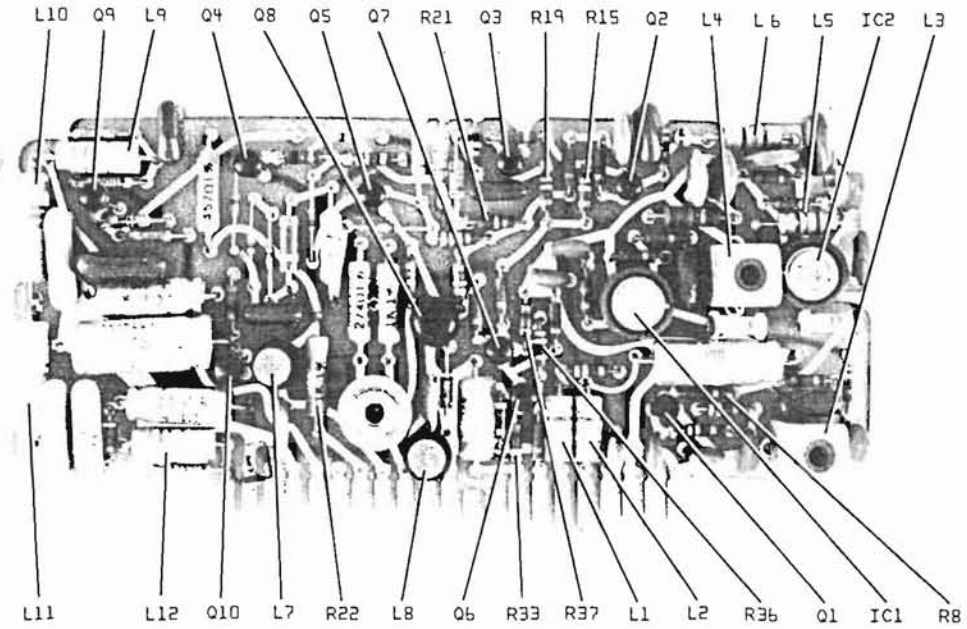
6.2 Schematics, Parts Lists, Parts Pictorials

Paragraphs 6.2.1 through 6.2.9, on the following pages, provide schematics, parts lists, and parts pictorials for the various subassemblies described in Section 4. The parts lists and parts pictorials for the main chassis (CH), front panel (FP), and rear panel (RP) are shown in Paragraphs 6.2.10 through 6.2.12. A parts list for the CE-7 covers and carrying cases is included in Paragraph 6.2.13.

6.2.1 Second IF and Discriminator Board





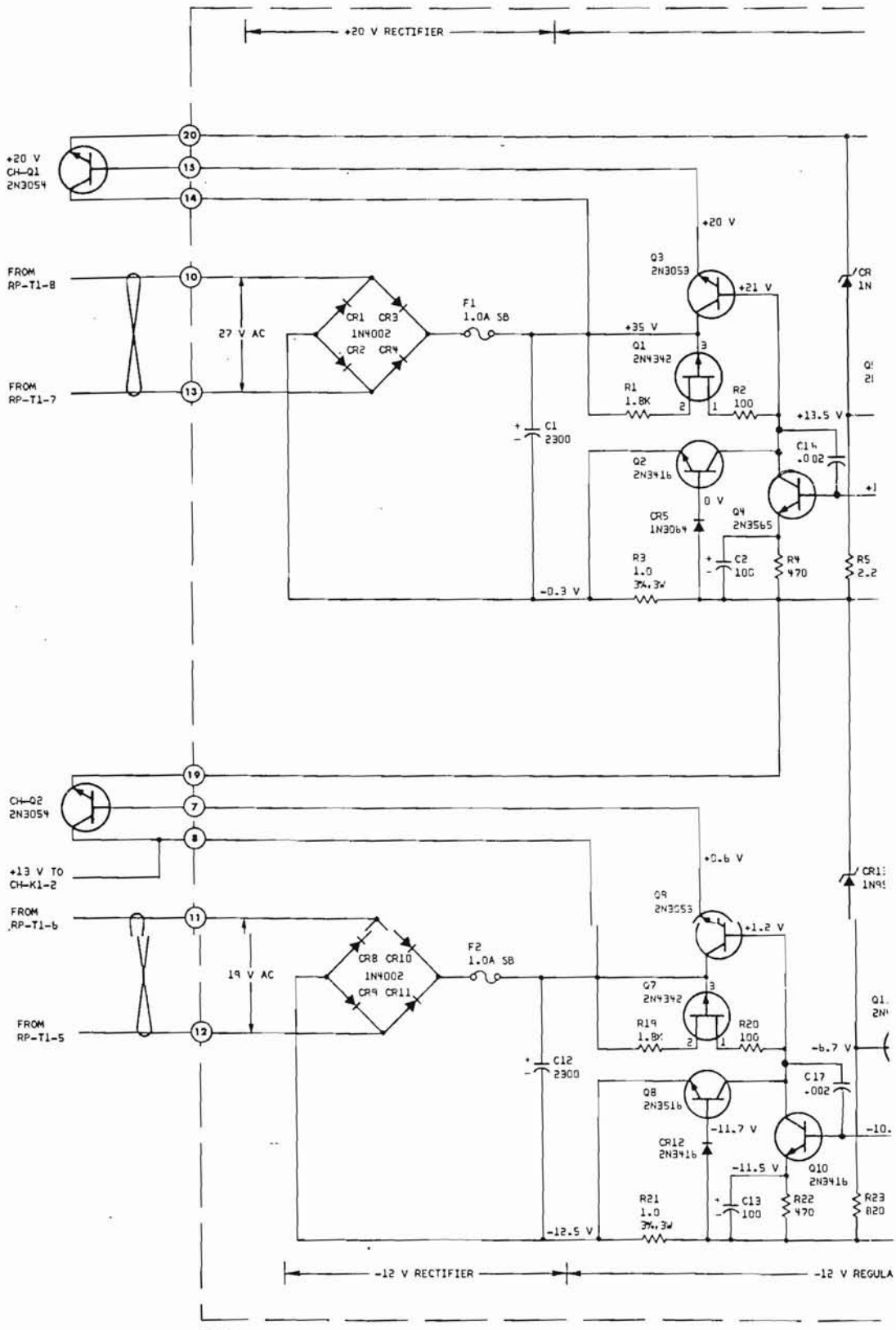


6.2.1 SECOND IF AND DISCRIMINATOR BOARD 0054

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A2	Board Assembly, Second IF and Discriminator	7001-0004	Cushman
	Board, Printed Circuit	1730-0054	Cushman
	CAPACITORS		
C1	Elect., 15 μF, 25V	1013-0005	Sprague
C2	Elect., 100 μF, 12V	1013-0011	Sprague
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C6	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C9	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C12	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C13	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C14	Cer, 3.3 pF ±0.25 pF, 600V	1005-0011	Erie
C15	Cer, 2.2 pF ±0.25 pF, 500V	1005-0017	Erie
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C17	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C18	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C19	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C20	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C21	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C22	Mica, 100 pF ±5%, 100V	1002-0011	Elmenco
C23	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C24	Mica, 470 pF ±1%, 100V	1002-0044	Elmenco
C25	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C26	Elect., 15 μF, 12V	1013-0015	Sprague
C27	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C28	Elect., 100 μF, 25V	1013-0003	Sprague
C29	Poly, 0.027 μF ±10%, 100V	1003-0032	Sprague
C30	Poly, 0.027 μF ±10%, 100V	1005-0032	Sprague
C31	Mica, 2000 pF ±5%, 100V	1002-0077	Elmenco
C32	Poly, 0.027 μF ±10%, 100V	1005-0032	Sprague
C33	Elect., 15 μF, 25V	1013-0005	Sprague

6.2.1 SECOND IF AND DISCRIMINATOR BOARD 0054 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	COILS		
L1	Choke, RF, 470 μH ±5%	1585-0019	Delevan
L2	Choke, RF, 470 μH ±5%	1585-0019	Delevan
L3	Inductor, Var, 0.5-0.75 μH	1596-0011	TRW
L4	Inductor, Var, 0.5-0.75 μH	1596-0011	TRW
L5	Choke, RF, 82 μH ±5%	1585-0032	Delevan
L6	Choke, RF, 82 μH ±5%	1585-0032	Delevan
L7	Choke, RF, 22 μH ±5%	1585-0029	Delevan
L8	Choke, RF, 22 μH ±5%	1585-0029	Delevan
L9	Choke, RF, 2.2 μH ±5%	1585-0030	Delevan
L10	Choke, RF, 4.7 mH ±5%	1585-0006	Delevan
L11	Choke, RF, 4.7 mH ±5%	1585-0006	Delevan
L12	Choke, RF, 2.2 μH ±5%	1585-0030	Delevan
	DIODES		
CR1	Ge, G633	1282-0005	ITT
CR2	Ge, G633	1282-0005	ITT
CR3	Si, 1N3064	1281-0013	Sylvania
CR4	Si, 1N3064	1281-0013	Sylvania
CR5	Si, 1N3064	1281-0013	Sylvania
CR6	Si, 1N3064	1281-0013	Sylvania
CR7	Ge, G633	1282-0005	ITT
CR8	Si, 1N3064	1281-0013	Sylvania
CR9	Ge, G633	1282-0005	ITT
CR10	Si, 1N3064	1281-0013	Sylvania
	INTEGRATED CIRCUITS		
IC1	Ampl, RF, CA3023A	2025-0012	RCA
IC2	Ampl, RF, CA3023A	2025-0012	RCA
	RESISTORS		
R1	Comp, 820Ω, ±5%, 1/2W	1067-8215	Allen-Bradley
R2	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley
R3	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley
R4	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
R5	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley
R6	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R7	Comp, 510Ω, ±5%, 1/4W	1066-5105	Allen-Bradley
R8	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley
R9	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R10	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley



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.

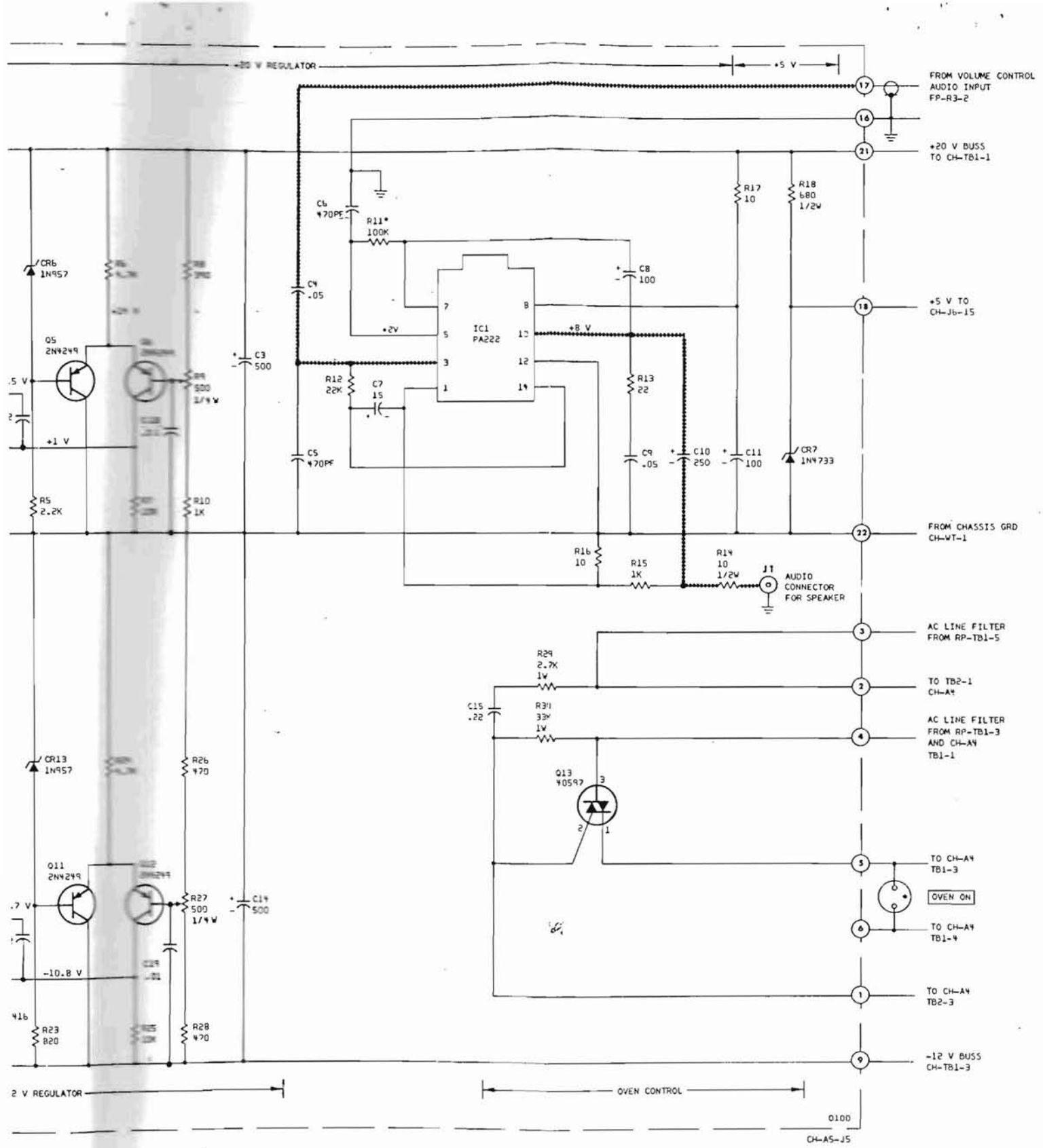
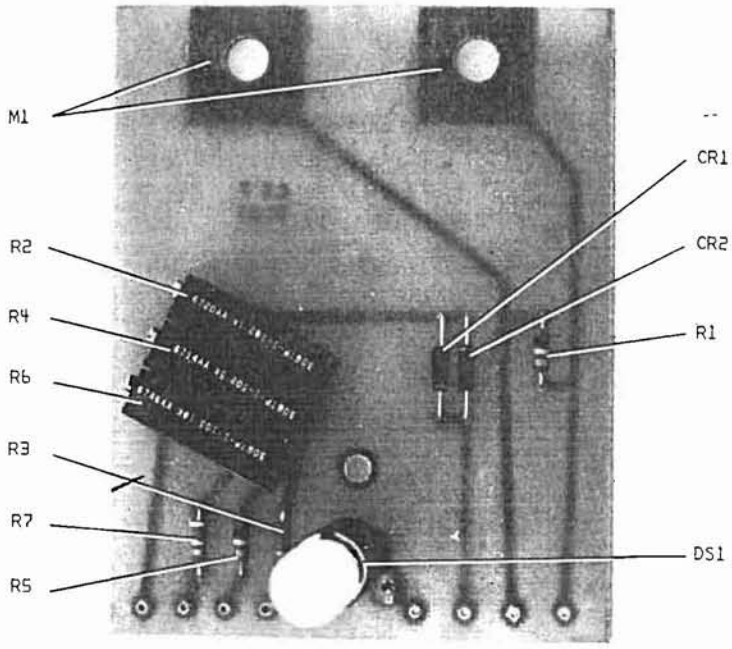


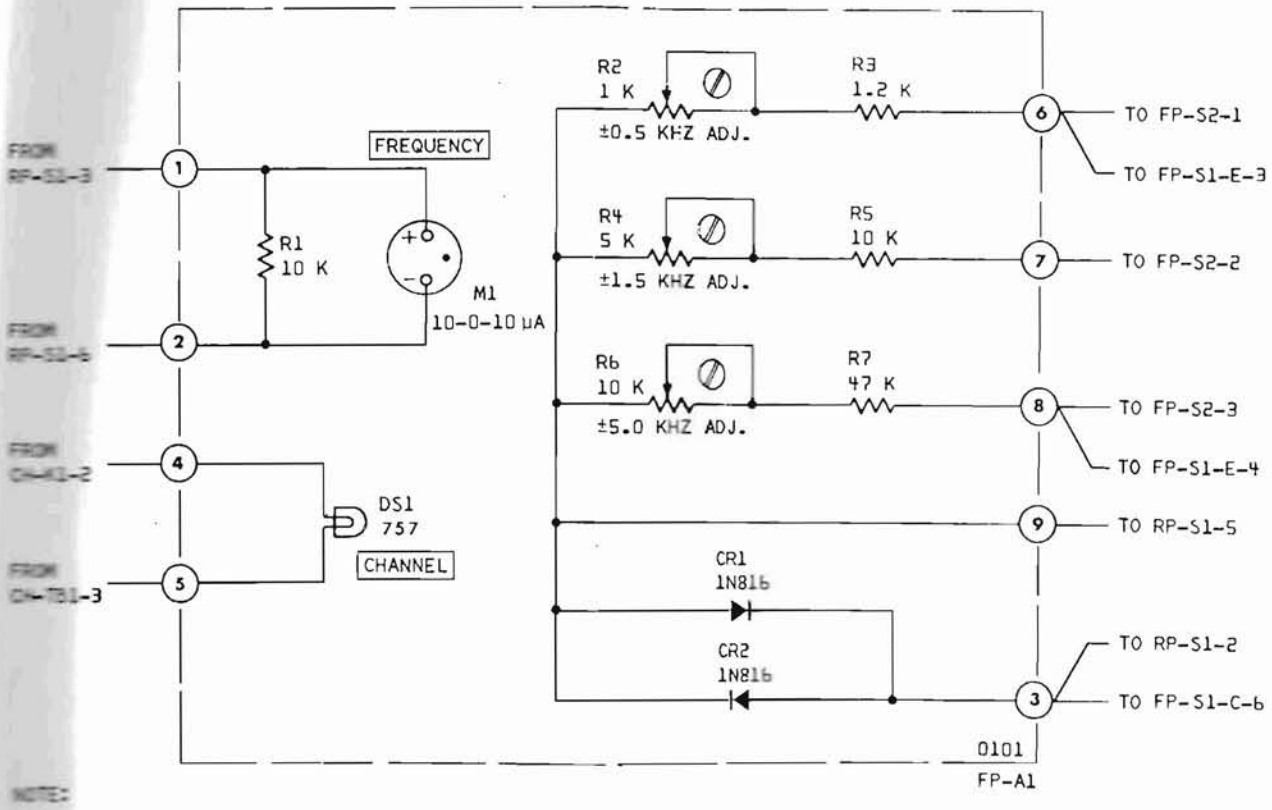
Figure 6-2. Power-Supply Board (0100)

6.2.3 Frequency-Error-Meter Board



6.2.3 FREQUENCY ERROR METER BOARD 0101

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
FP-A1	Board Assembly, Frequency Error Meter	7001-0006	Cushman
	Board, Printed Circuit	1780-0101	Cushman
	DIODES		
CR1	Si, 1N816	1281-0019	Sylvania
CR2	Si, 1N816	1281-0019	Sylvania
	LAMP		
DS1	Incandescent, #1820	2820-0012	G.E.
	METER		
M1	Frequency Error	1402-0015	Cushman
	RESISTORS		
R1	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R2	Pot., WW, 1kΩ, 1/2W	1215-0004	Helitrim
R3	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley
R4	Pot., WW, 5kΩ, 1/2W	1215-0013	Helitrim
R5	Comp, 10kΩ, ±5%, 1/4W	1066-1027	Allen-Bradley
R6	Pot., WW, 10kΩ, 1/2W	1215-0005	Helitrim
R7	Comp, 47kΩ, ±5%, 1/4W	1066-4735	Allen-Bradley

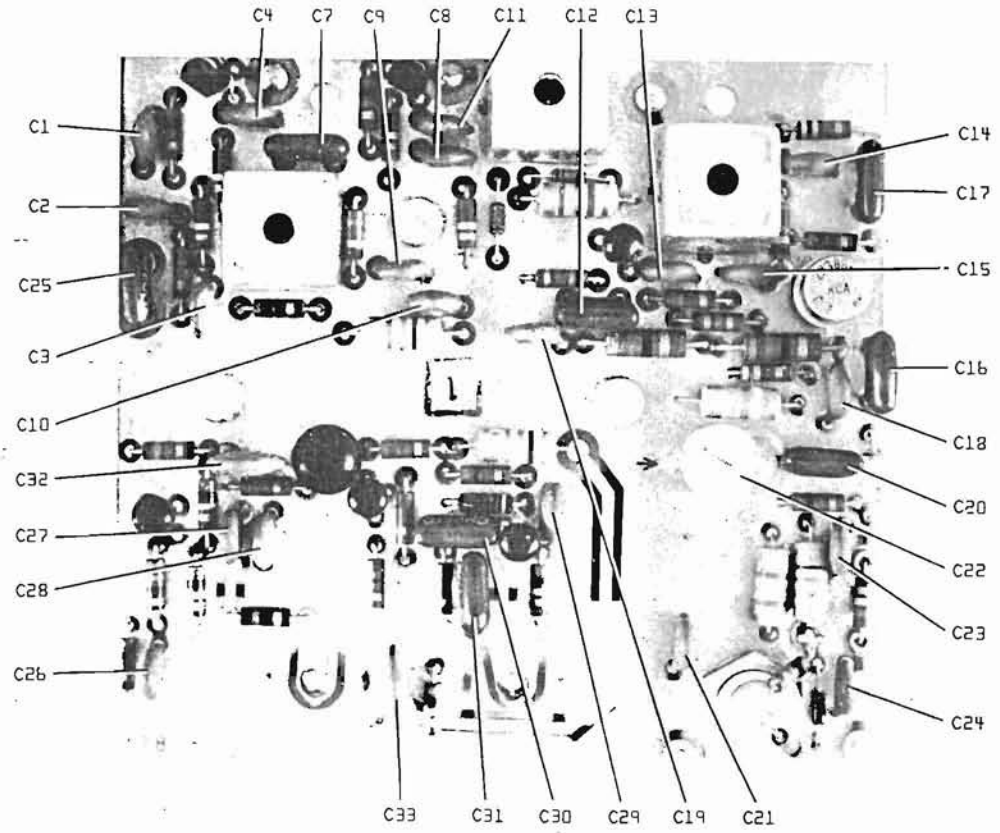


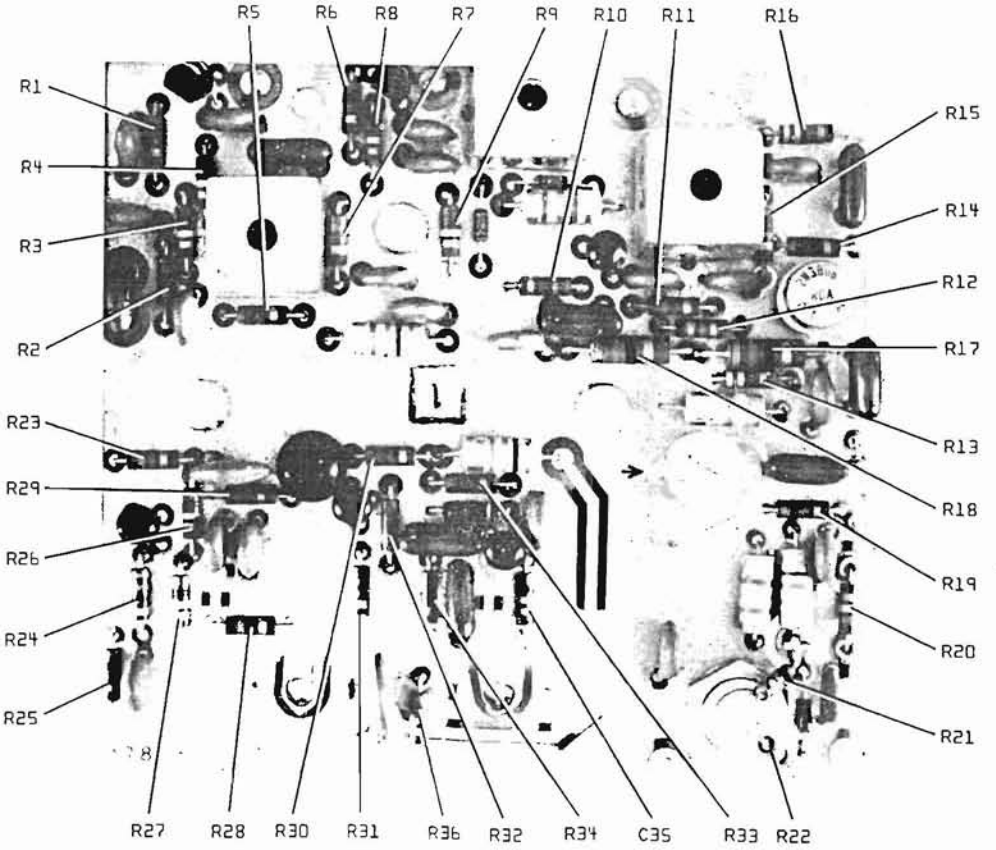
NOTE:

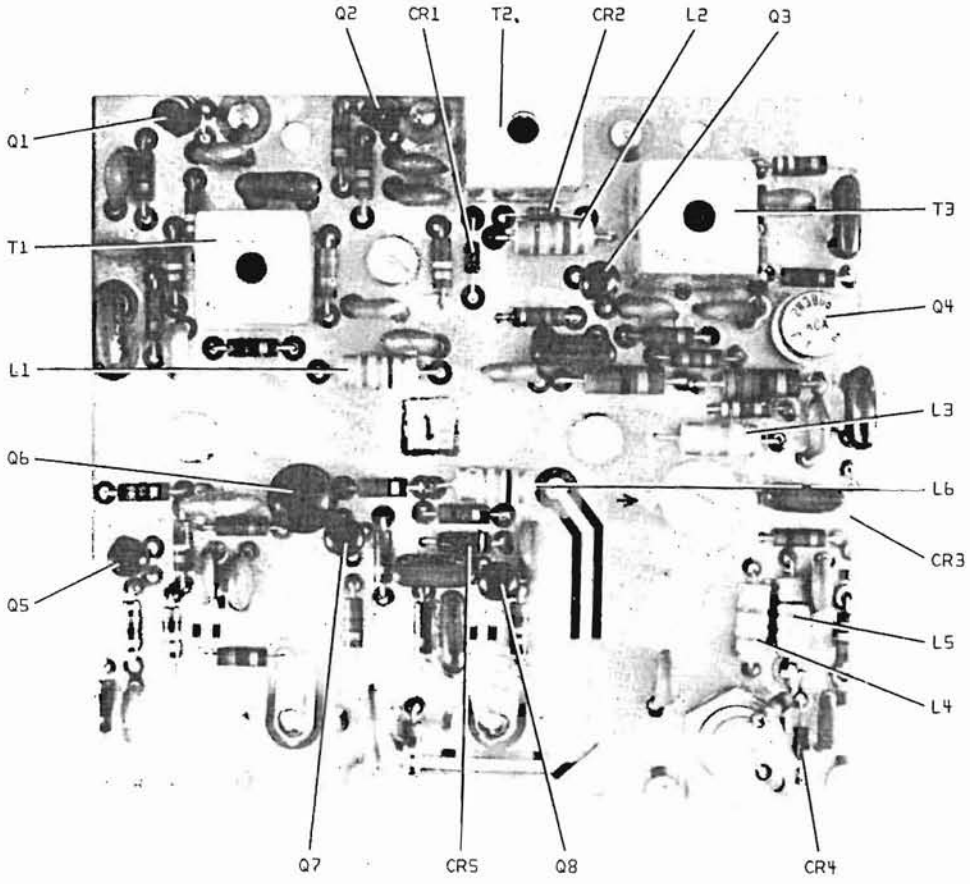
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.

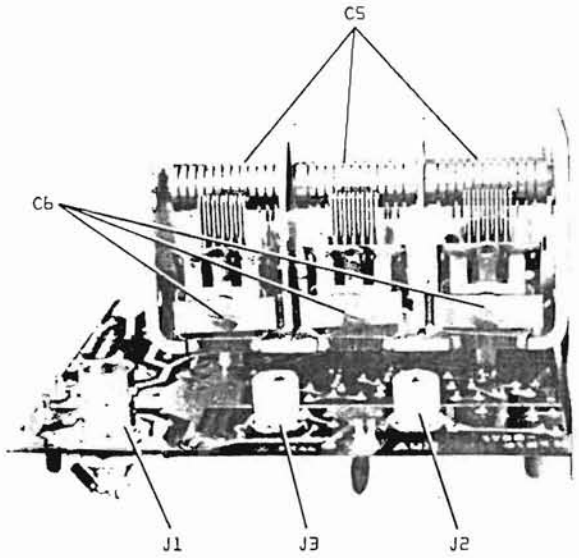
Figure 6-3. Frequency-Error-Meter Board (0101)

6.2.4 Harmonic-Generator Board









6.2.4 HARMONIC GENERATOR BOARD 0102

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
FP-A2	Board Assembly, Harmonic Generator	7001-0007	Cushman
	Board, Printed Circuit	1780-0102	Cushman
	CAPACITORS		
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C2	Cer, 0.002 μF ±20%, 600V	1005-0003	Erie
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C5	Capacitor, Var, 8.1-117.5 pF, 3 section, Type B1000-0006 with 180° stop	1000-0006	TRW
C6	Cap, Var, P/O C5		
C7	Mica, 100 pF, ±5%, 100V	1002-0011	Elmenco
C8	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C9	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C11	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C12	Mica, 180 pF, ±5%, 500V	1002-0005	Elmenco
C13	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C14	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C15	Cer, 0.002 μF, ±20%, 600V	1006-0003	Erie
C16	Mica, 270 pF, ±5%, 100V	1002-0031	Elmenco
*C17	Mica, 39 pF, ±5%, 100V	1002-0018	Elmenco
C18	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C19	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C20	Mica, 82 pF, ±5%, 100V	1002-0020	Elmenco
C21	Cer, 0.002 pF, ±20%, 600V	1005-0003	Erie
C22	Cer, Var, 9-35 pF	1001-0006	Erie
C23	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C24	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
*C25	Mica, 100 pF, ±5%, 100V	1002-0011	Elmenco
C26	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C27	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C28	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C29	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C30	Mica, 180 pF, ±5%, 500V	1002-0005	Elmenco
C31	Mica, 180 pF, ±5%, 500V	1002-0005	Elmenco
C32	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C33	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie

*Factory select. Typical value shown.

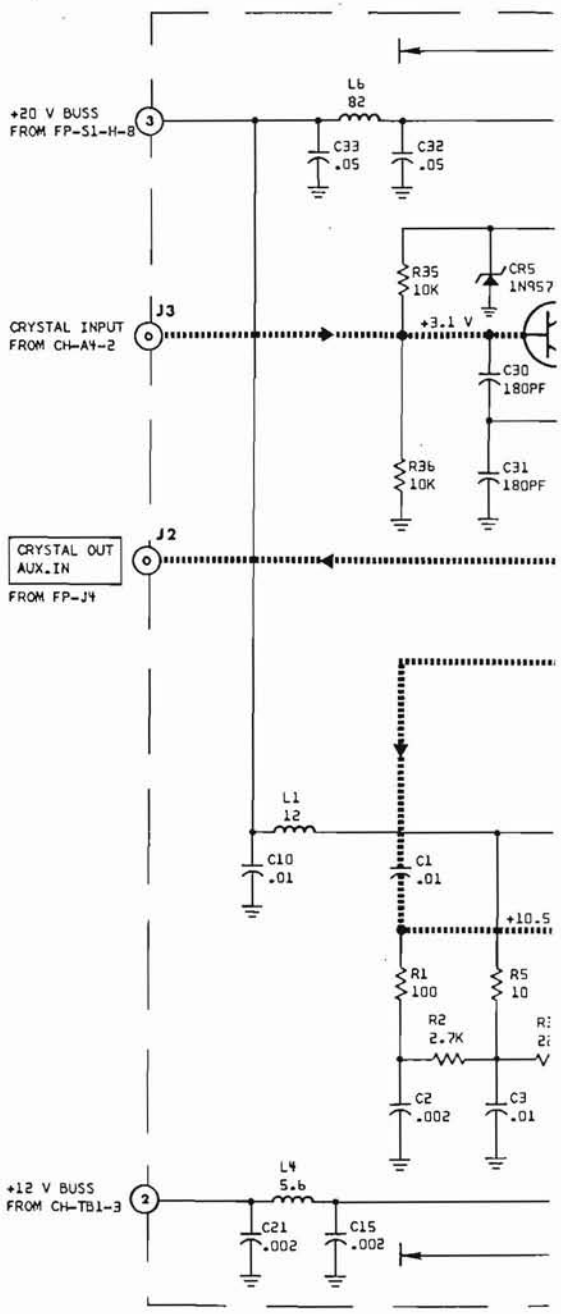
6.2.4 HARMONIC GENERATOR BOARD 0102 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	CONNECTOR		
J1	Female, KC 79-35	2536-0010	King
	DIODES		
CR1	Si, 2800	1283-0001	HPA
CR2	Si, 2800	1283-0001	HPA
CR3	Ge, G633	1282-0005	ITT
CR4	Si, 0138	1282-0006	HPA
CR5	Si, Zener, 6.8V, 1N957	1281-0007	Continental Devices
	INDUCTORS		
L1	Choke, RF, 12 μH, ±10%	1585-0011	Delevan
L2	Choke, RF, 5.6 μH, ±10%	1585-0028	Delevan
L3	Choke, RF, 3.9 μH, ±5%	1585-0014	Delevan
L4	Choke, RF, 5.6 μH, ±10%	1585-0028	Delevan
L5	Choke, RF, 0.1 μH, ±5%	1585-0041	Delevan
L6	Choke, RF, 82 μH, ±5%	1585-0032	Delevan
	JACKS		
J2	PC Board, mounted, phone	2586-0007	Keystone
J3	PC Board, mounted, phone	2586-0007	Keystone
	RESISTORS		
R1	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R2	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley
R3	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley
R4	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley
R5	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley
R6	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R7	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley
R8	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley
R9	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley
R10	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley

6.2.4 HARMONIC GENERATOR BOARD 0102 (Continued)

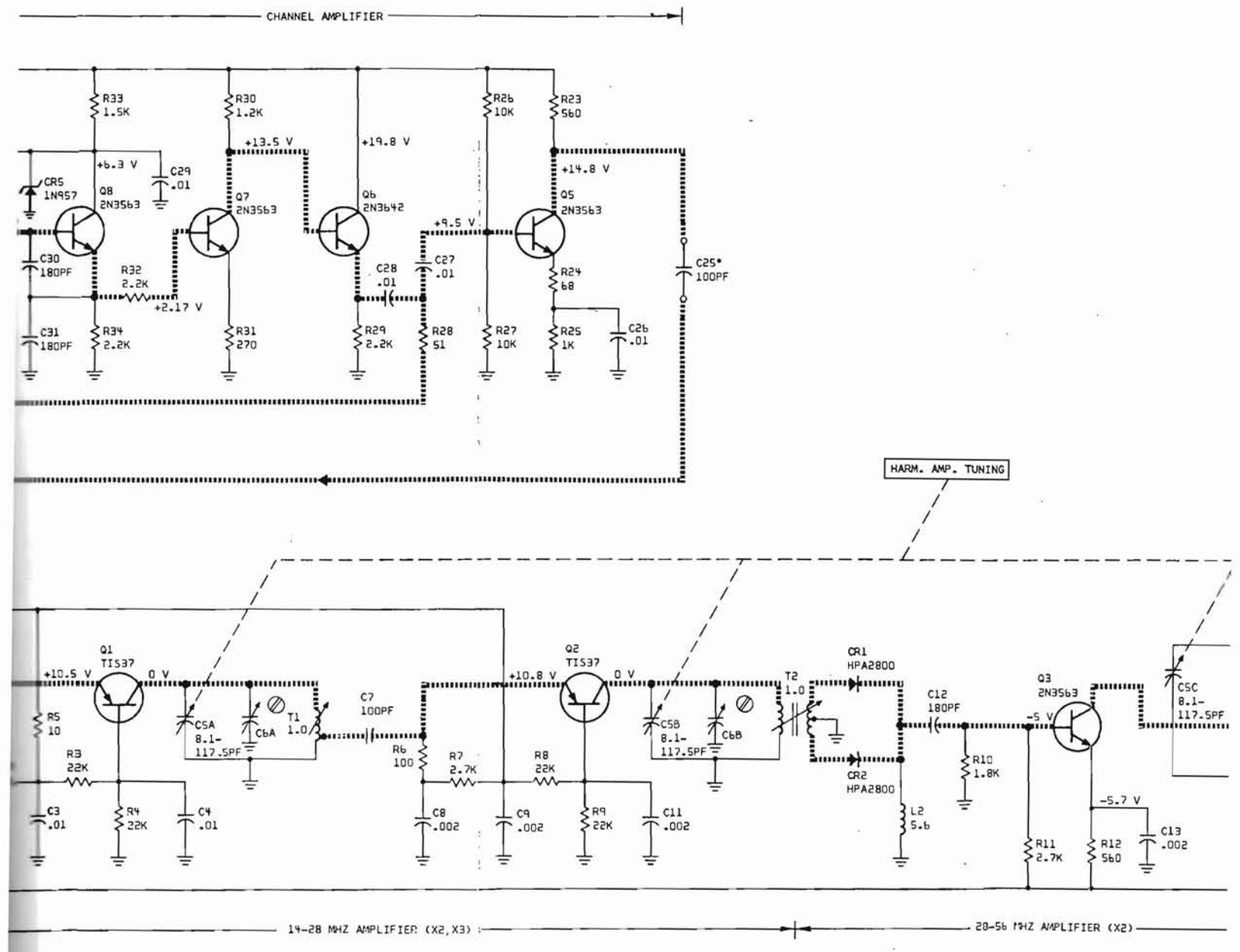
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R11	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley
R12	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
R13	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
R14	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley
R15	Comp, 820Ω, ±5%, 1/4W	1066-8215	Allen-Bradley
R16	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley
R17	Comp, 68Ω, ±5%, 1/2W	1067-6805	Allen-Bradley
R18	Comp, 82Ω, ±5%, 1/2W	1067-8205	Allen-Bradley
R19	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
*R20	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley
R21	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R22	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R23	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
R24	Comp, 680, ±5%, 1/4W	1066-6805	Allen-Bradley
R25	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R26	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R27	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 51Ω, ±5%, 1/4W	1066-5105	Allen-Bradley
R29	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R30	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley
R31	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley
R32	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R33	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley
R34	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R35	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R36	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	TRANSFORMERS		
T1	RF, Tunable, 1.0 μH	7050-0025	Cushman
T2	RF, Tunable, 1.0 μH	7050-0026	Cushman
T3	RF, Tunable, 0.25 μH	7050-0027	Cushman
	TRANSISTORS		
Q1	Si, PNP, T1S37	1271-0003	T.I.
Q2	Si, PNP, T1S37	1271-0003	T.I.
Q3	Si, NPN, 2N3563	1272-0022	Fairchild
Q4	Si, NPN, 2N3866	1271-0005	RCA
Q5	Si, NPN, 2N3563	1272-0022	Fairchild
Q6	Si, NPN, 2N3642	1272-0018	Fairchild
Q7	Si, NPN, 2N3563	1272-0022	Fairchild
Q8	Si, NPN, 2N3563	1272-0022	Fairchild

*Factory Select. Typical value shown.



NOTE:

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



UNLESS OTHERWISE NOTED.
OTHERWISE NOTED.
OTHERWISE NOTED.
SHOWN.
NOTED.

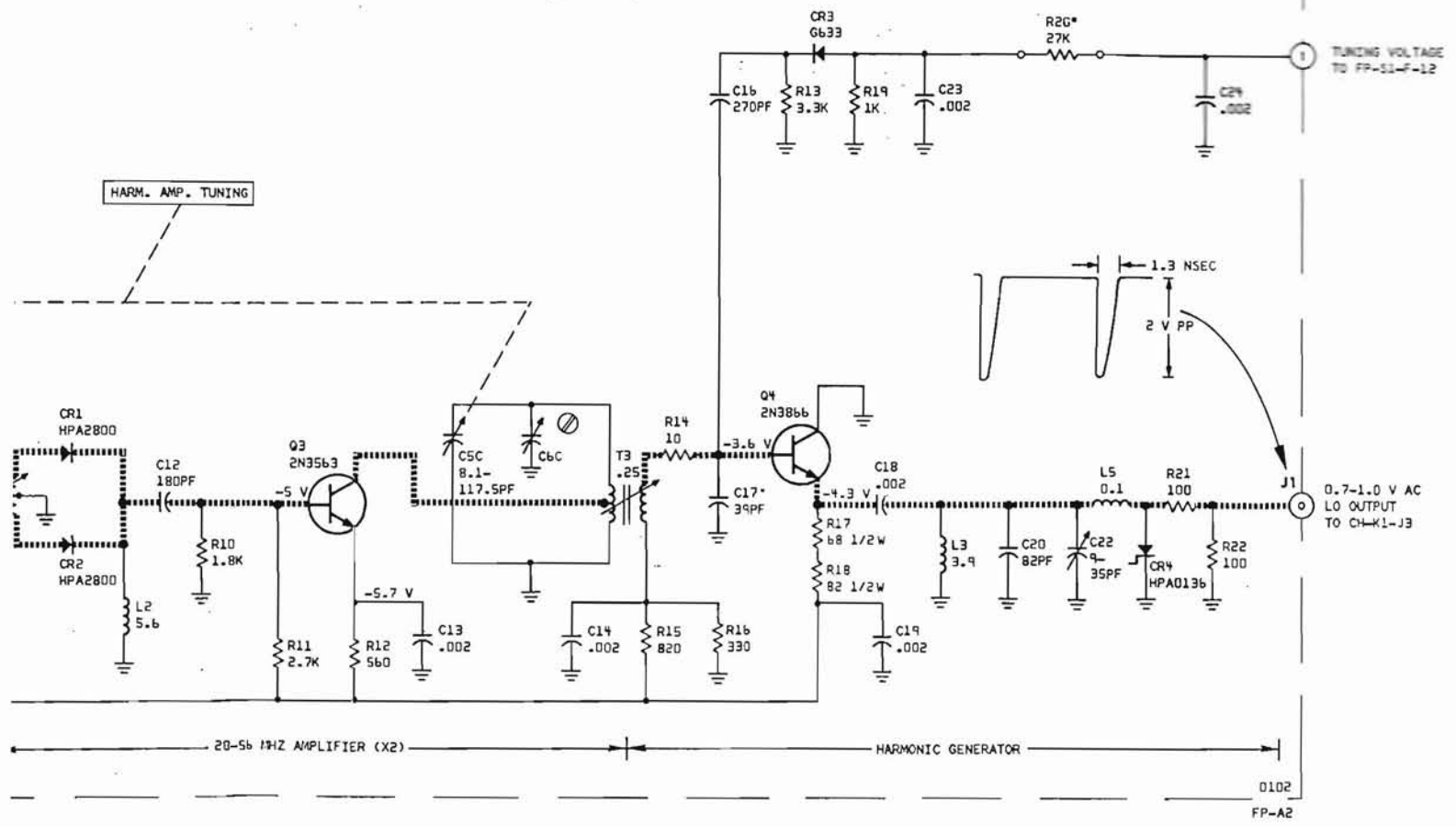
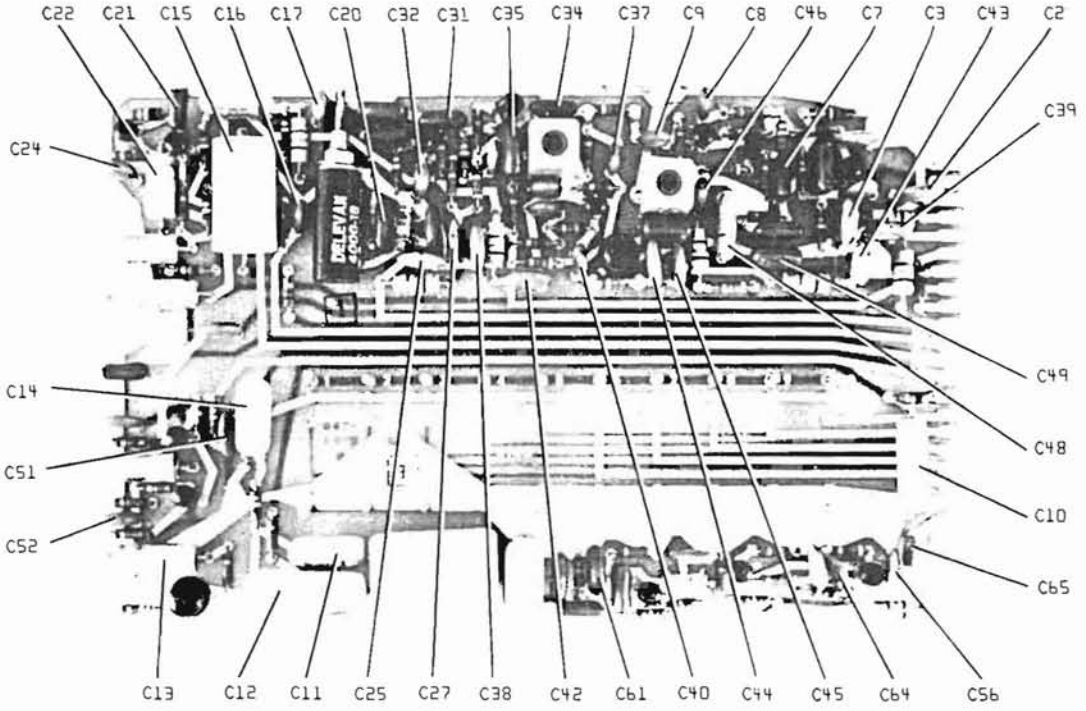
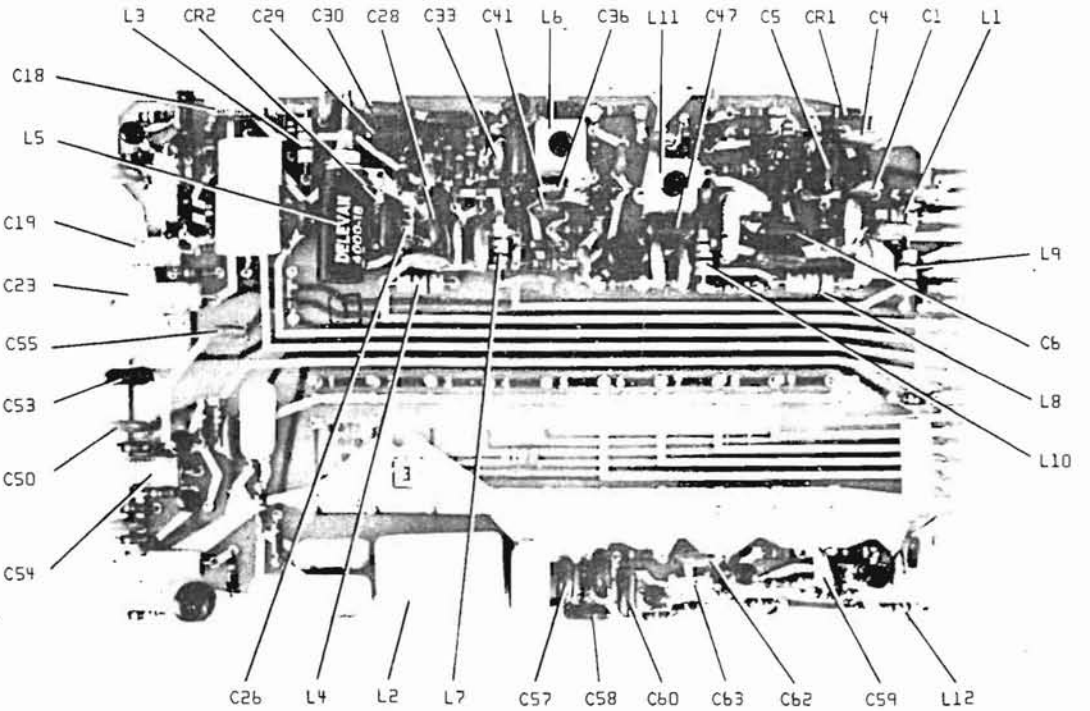
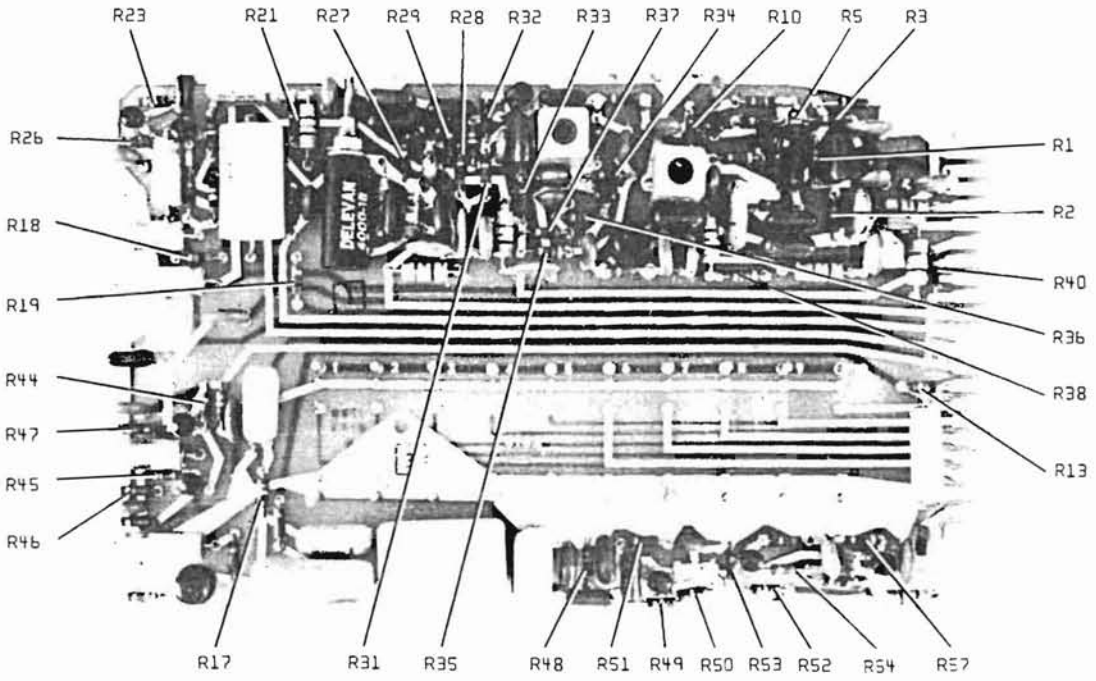


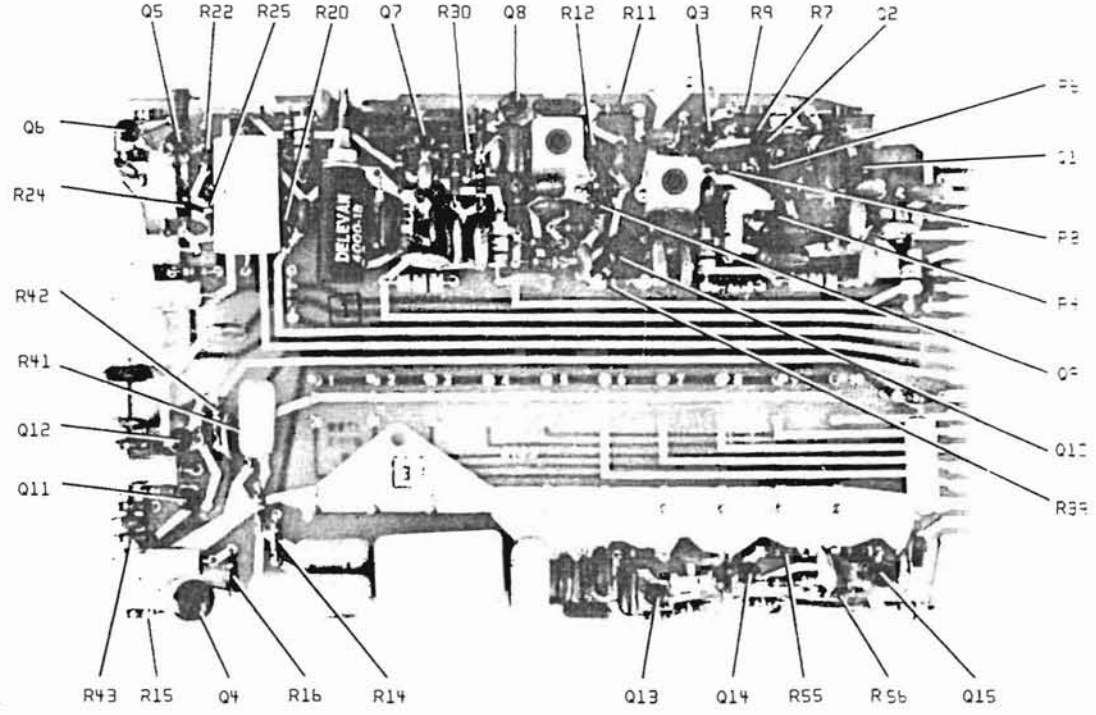
Figure 6-4. Harmonic-Generator Board (0102)

6.2.5 Multi-Oscillator Board






R23
R21
R27
R29
R28
R32
R33
R37
R34
R10
R5
R3
R26
R1
R18
R2
R19
R40
R36
R44
R38
R47
R13
R45
R46
R17
R31
R35
R48
R51
R49
R50
R53
R52
R54
R57


Q5
R22
R25
R20
Q7
R30
Q8
R12
R11
Q3
R9
R7
Q2
Q6
R24
R42
R41
Q12
Q11
R43
R15
Q4
R16
R14
Q13
Q14
R55
R56
Q15

6.2.5 MULTI-OSCILLATOR BOARD 0103

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A1	Board Assembly, Multi-Oscillator	7001-0008	Cushman
	Board, Printed Circuit	1780-0103	Cushman
	CAPACITORS		
C1	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C2	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C3	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C4	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C5	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C6	Mica, 220 pF, ±5%, 100V	1002-0029	Elmenco
C7	Mica, 39 pF, ±5%, 100V	1002-0018	Elmenco
C8	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C9	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C10	Elect., 15 µF, 25V	1013-0005	Sprague
C11	Poly, 0.082 µF, ±10%, 100V	1008-0023	Sprague
C12	Poly, 0.27 µF, ±10%, 100V	1008-0028	Sprague
C13	Elect., 15 µF, 25V	1013-0005	Sprague
C14	Poly, 0.1 µF, ±10%, 100V	1008-0031	Sprague
C15	Elect., 1.0 µF, 25V	1013-0004	Sprague
C16	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C17	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C18	Poly, 0.027 µF, ±10%, 100V	1008-0032	Sprague
C19	Elect., 1.0 µF, 25V	1013-0004	Sprague
C20	Mica, 180 pF, ±5%, 100V	1002-0005	Elmenco
C21	Mica, 180 pF, ±5%, 100V	1002-0005	Elmenco
C22	Elect., 1.0 µF, 25V	1013-0004	Sprague
C23	Elect., 15 µF, 25V	1013-0005	Sprague
C24	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C25	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C26	Cer, 22 pF, ±2%, 600V, NPO	1005-0007	Centralab
C27	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C28	Mica, 22 pF, ±5%, 100V	1002-0023	Elmenco
C29	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C30	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C31	Mica, 10 pF, ±5%, 100V	1002-0016	Elmenco
C32	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C33	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C34	Mica, 27 pF, ±5%, 100V	1002-0006	Elmenco
C35	Mica, 390 pF, ±5%, 100V	1002-0033	Elmenco

6.2.5 MULTI-OSCILLATOR BOARD 0103 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
* C36	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C37	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C38	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C39	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C40	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C41	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C42	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C43	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C44	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C45	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C46	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C47	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C48	Poly, 0.0022 µF, 100V	1008-0020	Sprague
C49	Mica, 1000 pF, ±5%, 100V	1002-0015	Elmenco
C50	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C51	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C52	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C53	Mica, 47 pF, ±5%, 100V	1002-0012	Elmenco
C54	Elect., 1.0 µF, 25V	1013-0004	Sprague
C55	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C56	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C57	Mica, 10 pF, ±5%, 100V	1002-0016	Elmenco
C58	Mica, 27 pF, ±5%, 100V	1002-0006	Elmenco
C59	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C60	Mica, 470 pF, ±5%, 100V	1002-0035	Elmenco
C61	Mica, 220 pF, ±5%, 100V	1002-0027	Elmenco
C62	Cer, 0.05 µF +80% -20%, 25V	1005-0003	Erie
C63	Cer, 4.7 pF, ±5%, 600V	1005-0015	Erie
C64	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
C65	Cer, 0.01 µF +80% -20%, 25V	1005-0013	Erie
	CLIPS		
	Terminal P.C.	3769-0004	Elco
	Guide Pin	3768-0005	Elco
	DIODES		
CR1	Si, Zener, 6.8V, 1N957	1281-0007	Continental Devices
CR2	Voltage Variable C, V33	1281-0010	PSI

6.2.6 MUL

CKT. REF.
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
*R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25

*Factory Sel

6.2.5 MULTI-OSCILLATOR BOARD 0103 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R26	Comp, 1.5kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley
R27	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley
R29	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley
R30	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R31	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R32	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley
R33	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R34	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley
R35	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R36	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
R37	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
R38	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
*R39	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley
R40	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley
R41	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R42	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley
R43	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R44	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R45	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley
R46	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley
R47	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R48	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R49	Comp, 56kΩ, ±5%, 1/4W	1066-5635	Allen-Bradley
R50	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley
R51	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R52	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley
R53	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R54	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley
R55	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
R56	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R57	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3563	1272-0022	Fairchild
Q4	Si, NPN, 2N3567	1272-0014	Fairchild
Q5	Si, NPN, 2N3565	1272-0017	Fairchild

*Factory Select. Typical value shown.

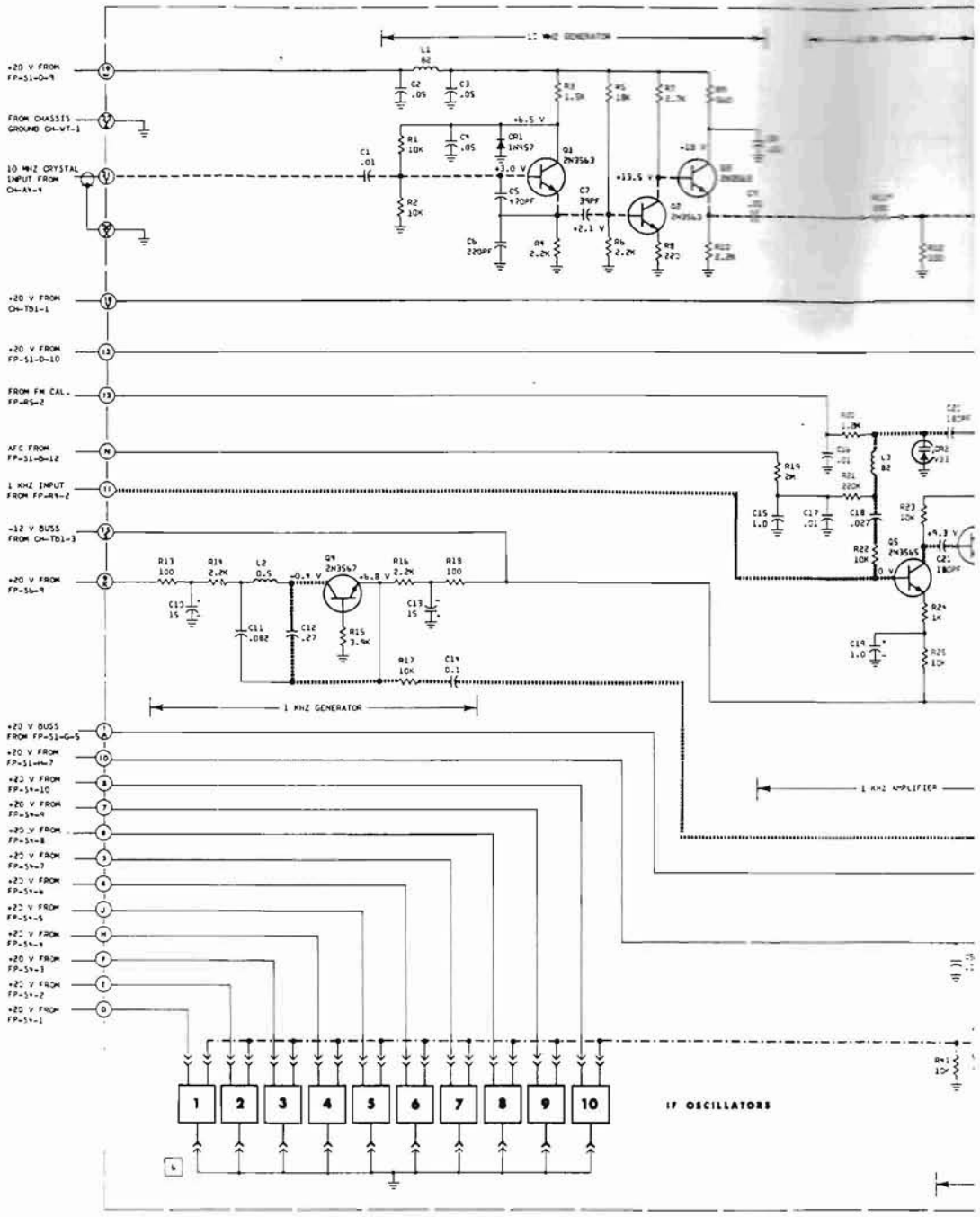
6.2.5 MULTI-OSCILLATOR BOARD 0103 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
Q6	Si, NPN, 2N3565	1272-0017	Fairchild
Q7	Si, NPN, 2N3563	1272-0022	Fairchild
Q8	Si, PNP, TIS37	1271-0003	T.I.
Q9	Si, NPN, 2N3563	1272-0022	Fairchild
Q10	Si, NPN, 2N3642	1272-0018	Fairchild
Q11	Si, NPN, 2N3563	1272-0022	Fairchild
Q12	Si, NPN, 2N3563	1272-0022	Fairchild
Q13	Si, NPN, 2N3563	1272-0022	Fairchild
Q14	Si, NPN, 2N3563	1272-0022	Fairchild
Q15	Si, NPN, 2N3563	1272-0022	Fairchild

MULTI-OSCILLATOR BOARD 0103 (Continued)

REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	INDUCTORS		
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Toroid, 0.5 µH	1579-0008	Pulse Engr.
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Inductor, Var, 3.8-7.3 µH	1596-0025	Delevan
	Inductor, Var, 0.50-0.75 µH	1598-0011	TRW
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	Inductor, Var, 0.50-0.75 µH	1598-0011	TRW
	Choke, RF, 82 µH, ±5%	1583-0032	Delevan
	RESISTORS		
	Comp, 10MΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	Comp, 1.5kΩ, ±5%, 1/4W	1066-1325	Allen-Bradley
	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley
	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley
	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley
	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley
	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley
	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley
	Comp, 2MΩ, ±5%, 1/4W	1066-2055	Allen-Bradley
	Comp, 1.2MΩ, ±5%, 1/4W	1066-1255	Allen-Bradley
	Comp, 220kΩ, ±5%, 1/4W	1066-2245	Allen-Bradley
	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley

*Select. Typical value shown.



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. OPTIONAL IF OSCILLATOR (1.0-13.5 MHZ) OR IF OSCILLATOR (250 KHZ, 290 KHZ, 455 KHZ).

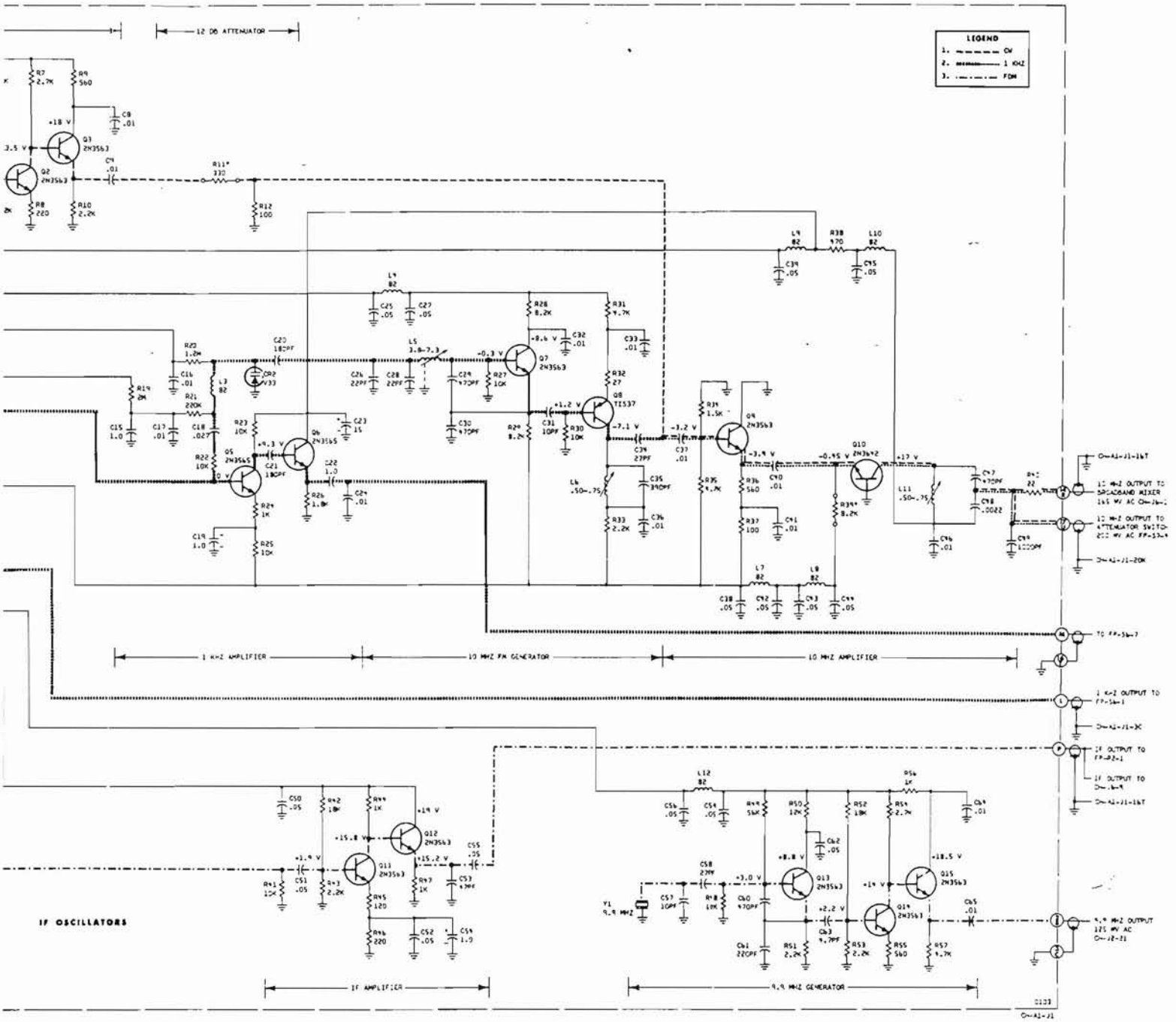
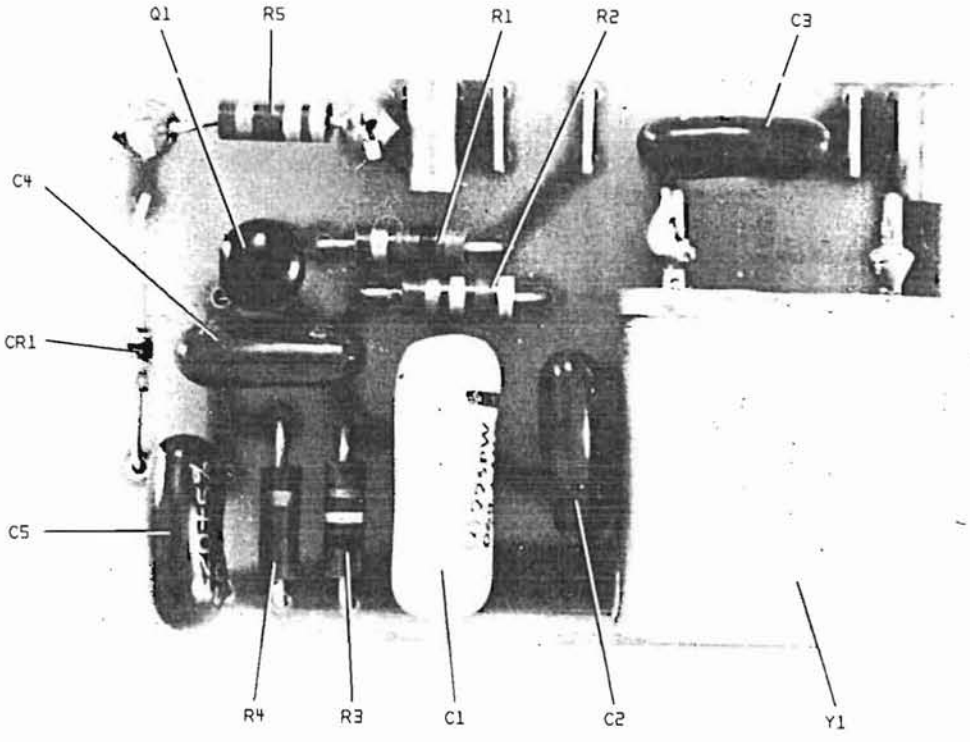


Figure 6-5. Multi-Oscillator Board (0103)

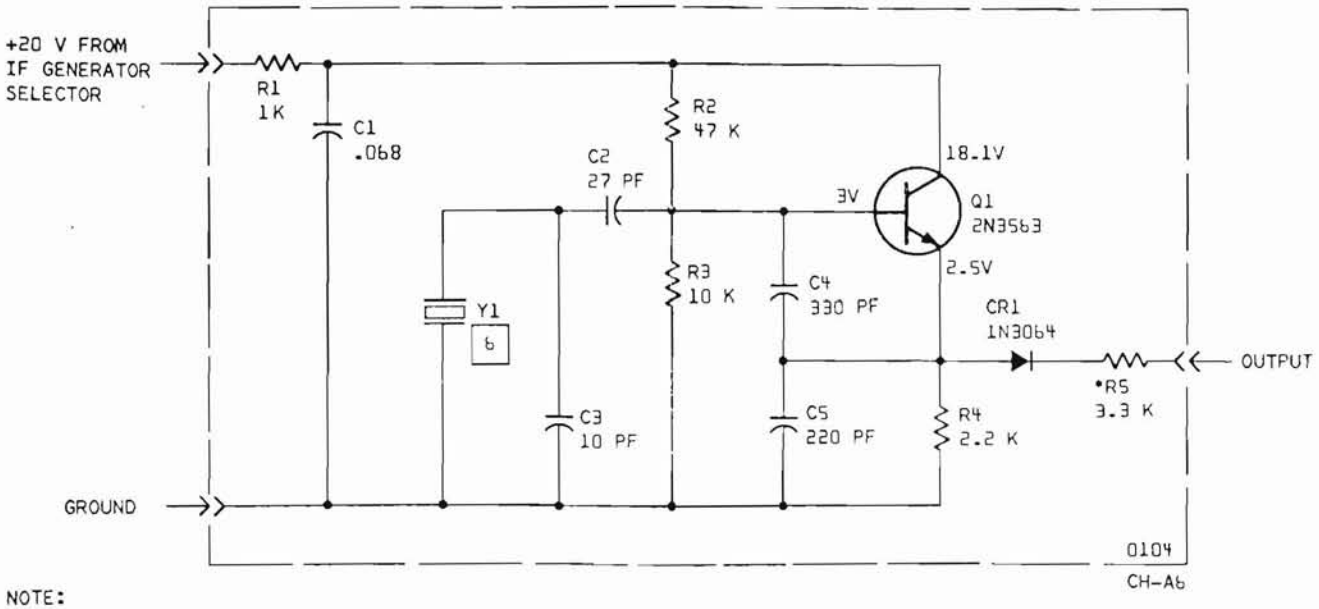
6.2.6 IF Oscillator Board



6.2.7 IF OSCILLATOR BOARD 0104

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A6	Board Assembly, IF Oscillator	7001-0002	Cushman
	Board, Printed Circuit	1780-0164	Cushman
	CAPACITORS		
C1	Poly, 0.068 μF, ±10%, 100V	1008-0036	Sprague
C2	Mica, 27 pF, ±5%, 100V	1002-0005	Elmenco
C3	Mica, 10 pF, ±5%, 100V	1002-0015	Elmenco
C4	Mica, 330 pF, ±5%, 100V	1002-0032	Elmenco
C5	Mica, 220 pF, ±5%, 100V	1002-0029	Elmenco
	CLIPS		
	Sleeve, Guide	3768-0005	Elco
	Terminal, Printed Circuit	3768-0007	Elco
	CRYSTAL		
Y1	Crystal (Customer Request)		Cushman
	DIODE		
CR1	Si, 1N3064	1281-0013	Sylvania
	RESISTORS		
R1	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R2	Comp, 47kΩ, ±5%, 1/4W	1066-4735	Allen-Bradley
R3	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R4	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
*R5	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
	TRANSISTOR		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild

*Factory Select, Typical value shown.

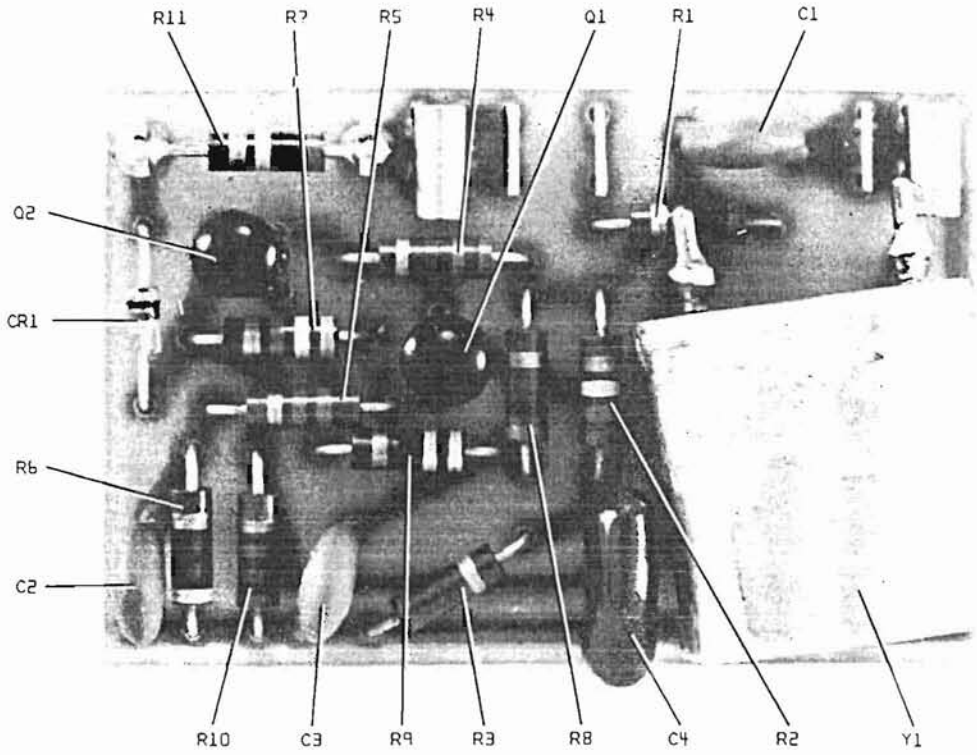


NOTE:

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. CUSTOMER REQUEST. (1.0 MHZ TO 13.5 MHZ).

Figure 6-6. IF-Oscillator Board

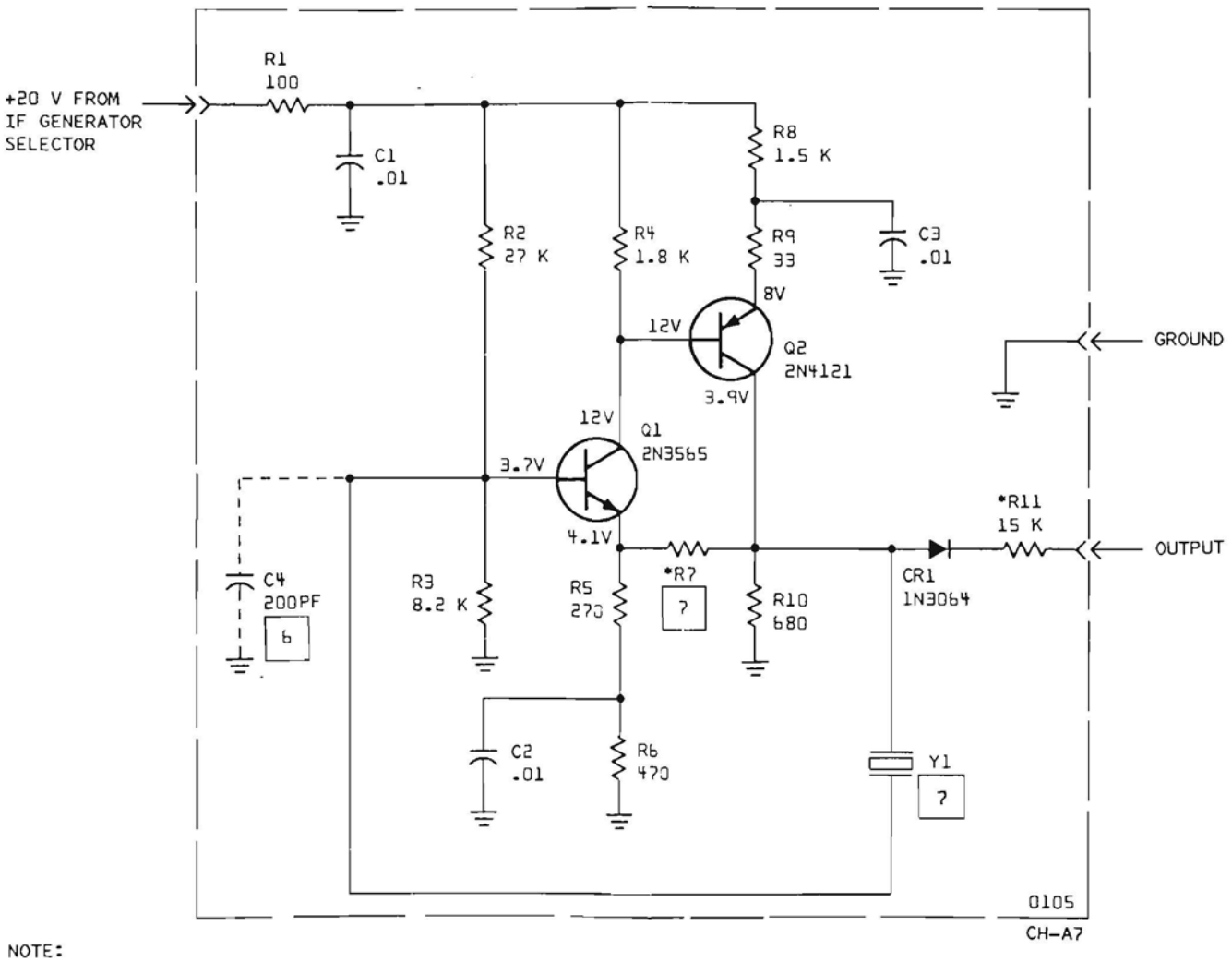
6.2.7 IF-Oscillator Board



6.2.7 IF OSCILLATOR BOARD 0105

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A7	Board Assembly, IF Oscillator	7003-0003	Cushman
	Board, Printed Circuit	1750-0105	Cushman
	CAPACITORS		
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C2	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C4	Mica, 200 pF, ±5%, 100V	1002-0042	Elmenco
	CLIPS		
	Sleeve, Guide	3755-0006	Elco
	Terminal, Printed Circuit	3753-0007	Elco
	CRYSTAL		
Y1	Crystal (Customer Request)		Cushman
	DIODE		
CR1	Si, 1N3064	1251-0013	Transitron
	RESISTORS		
R1	Comp, 100Ω, ±5%, 1/4W	1066-1015*	Allen-Bradley
R2	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley
R3	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley
R4	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley
R5	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley
R6	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley
R7	Factory Select (Customer Request)		
R8	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley
R9	Comp, 33Ω, ±5%, 1/4W	1066-3305	Allen-Bradley
R10	Comp, 680Ω, ±5%, 1/4W	1066-6815	Allen-Bradley
*R11	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3565	1272-0017	Fairchild
Q2	Si, PNP, 2N4121	1272-0023	Fairchild

*Factory Select. Typical value shown.

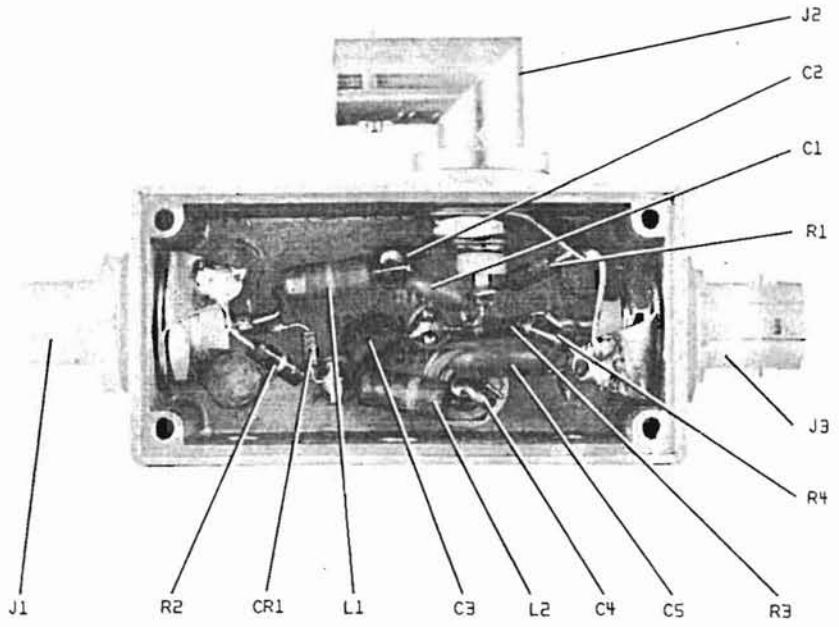


NOTE:

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. C4, 200pF IS ADDED WHEN 250 KHZ OR 290 KHZ CRYSTAL IS USED.
7. CUSTOMER REQUEST.(250 KHZ TO 900 KHZ).

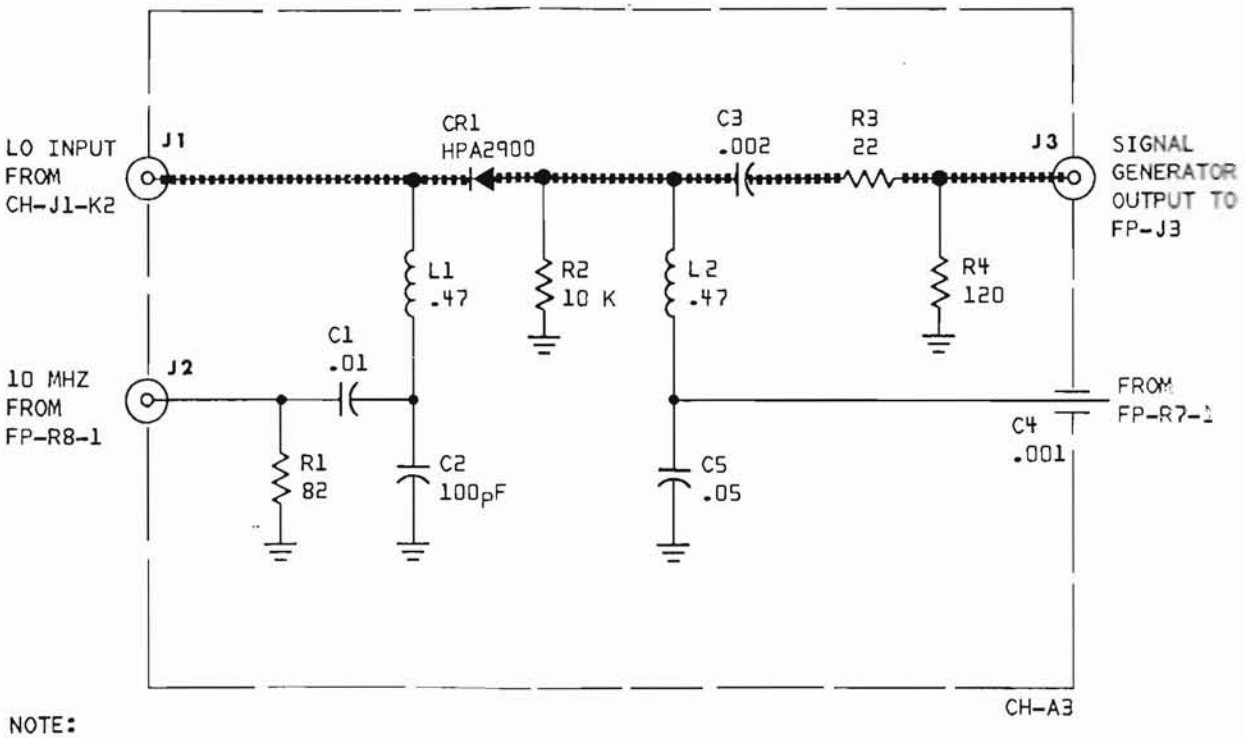
Figure 6-7. IF-Oscillator Board (0105)

6.2.8 Signal-Generator Mixer



6.2.8 SIGNAL GENERATOR MIXER

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A3	Assembly, Signal Generator Mixer	7001-0009	Cushman
	CAPACITORS		
C1	Cer, 0.01 μF +80% -20%, 75V	1005-0013	Erie
C2	Cer, Stand Off, 100 pF, GMV, 500V	1005-0049	Erie
C3	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C4	Cer, Feedthru, 0.001 μF, ±20%, 500V	1005-0008	Erie
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	Choke, RF, 0.47 μH, ±20%	1585-0031	Delevan
L2	Choke, RF, 0.47 μH, ±20%	1585-0031	Delevan
	CONNECTORS		
J1	Connector, BNC	2536-0006	Startronics
J2	Connector, BNC	2536-0006	Startronics
J3	Connector, BNC	2536-0010	King
	DIODE		
CR1	Si, HPA2900	1283-0003	HPA
	RESISTORS		
R1	Comp, 82Ω, ±5%, 1/4W	1066-8205	Allen-Bradley
R2	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R3	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley
R4	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley

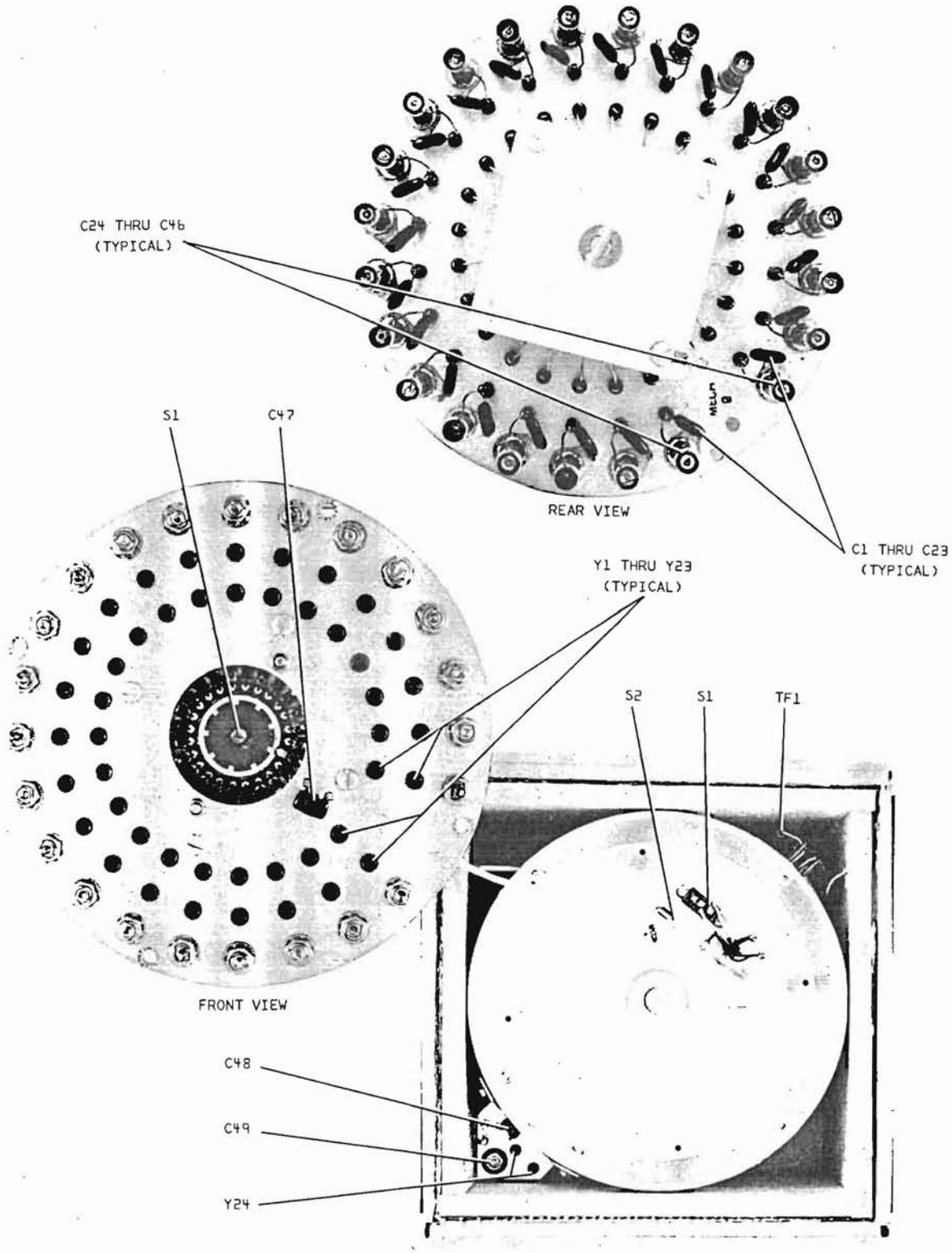


NOTE:

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.

Figure 6-8. Signal-Generator Mixer (CH-A3

6.2.9 Crystal-Oven Assembly



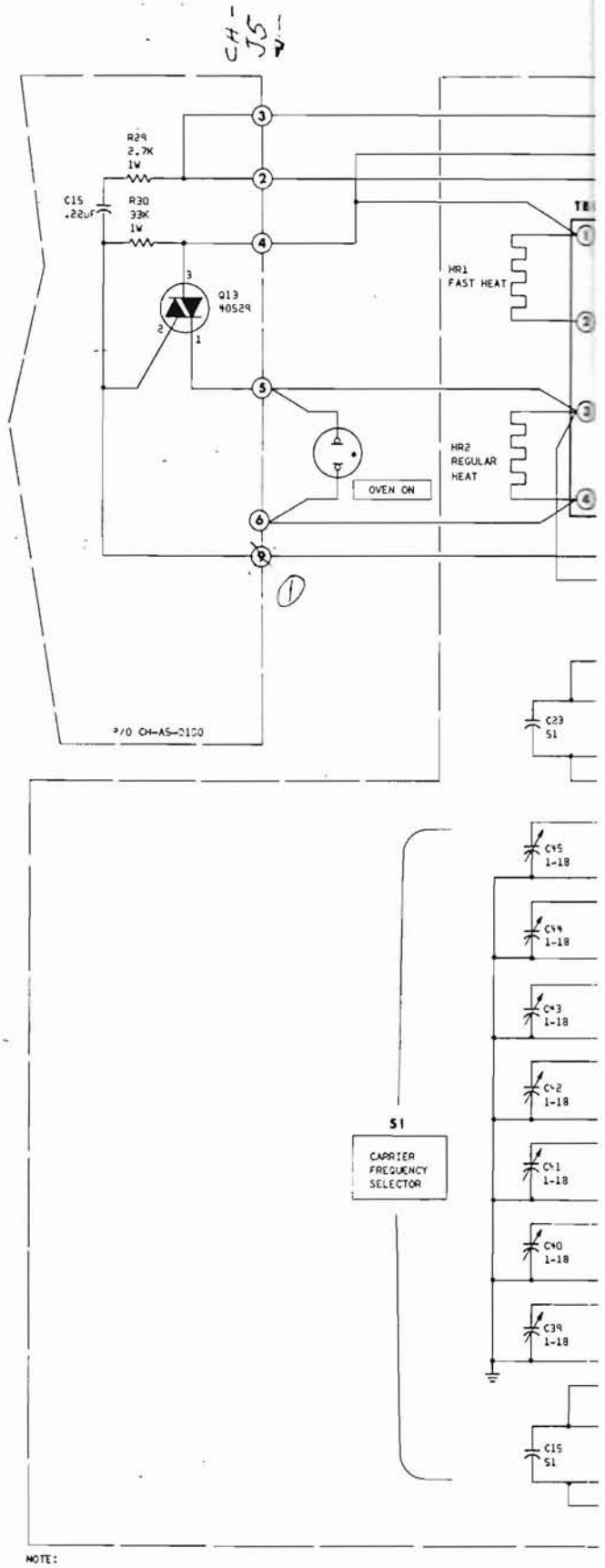
6.2.9 CRYSTAL OVEN ASSEMBLY

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CR-A4	Assembly, Crystal Oven	7001-0017	Cushman
	Assembly, Oven Body	7001-0018	Cushman
	Assembly, Crystal Base	7001-0019	Cushman
	Assembly, 10-MHz Crystal Bracket	7001-0020	Cushman
	Assembly, Oven Cover	7001-0021	Cushman
	CAPACITORS		
C1	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C2	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C3	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C4	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C5	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C6	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C7	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C8	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C9	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C10	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C11	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C12	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C13	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C14	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C15	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C16	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C17	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C18	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C19	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C20	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C21	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C22	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C23	Mica, 51 pF, ±1%, 100V	1002-0056	Elmenco
C24	Var, glass, 1-18 pF	1001-0001	J. F. D.
C25	Var, glass, 1-18 pF	1001-0001	J. F. D.
C26	Var, glass, 1-18 pF	1001-0001	J. F. D.
C27	Var, glass, 1-18 pF	1001-0001	J. F. D.
C28	Var, glass, 1-18 pF	1001-0001	J. F. D.
C29	Var, glass, 1-18 pF	1001-0001	J. F. D.
C30	Var, glass, 1-18 pF	1001-0001	J. F. D.

6.2.9 CRYSTAL OVEN ASSEMBLY (Continued

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C31	Var, glass, 1-18 pF	1001-0001	J. F. D.
C32	Var, glass, 1-18 pF	1001-0001	J. F. D.
C33	Var, glass, 1-18 pF	1001-0001	J. F. D.
C34	Var, glass, 1-18 pF	1001-0001	J. F. D.
C35	Var, glass, 1-18 pF	1001-0001	J. F. D.
C36	Var, glass, 1-18 pF	1001-0001	J. F. D.
C37	Var, glass, 1-18 pF	1001-0001	J. F. D.
C38	Var, glass, 1-18 pF	1001-0001	J. F. D.
C39	Var, glass, 1-18 pF	1001-0001	J. F. D.
C40	Var, glass, 1-18 pF	1001-0001	J. F. D.
C41	Var, glass, 1-18 pF	1001-0001	J. F. D.
C42	Var, glass, 1-18 pF	1001-0001	J. F. D.
C43	Var, glass, 1-18 pF	1001-0001	J. F. D.
C44	Var, glass, 1-18 pF	1001-0001	J. F. D.
C45	Var, glass, 1-18 pF	1001-0001	J. F. D.
C46	Var, glass, 1-18 pF	1001-0001	J. F. D.
*C47	Mica, 82 pF, ±2%, 500V	1002-0003	Elmenco
*C48	Mica, 27 pF, ±5%, 100V	1002-0008	Elmenco
C49	Var, glass, 1-18 pF	1001-0001	J. F. D.
	CRYSTALS		
Y1 through Y23	Crystal, (Customer Request)		Cushman
Y24	Crystal, 10-MHz	2035-0005	Cushman
	FUSE		
TF1	Thermal	1955-0010	Micro Devices
	INSULATION		
	Oven Body	4971-0010	Durvon
	SWITCH		
S1	Rotary, 24 pos	1851-0028	Oak
	THERMOSTATS		
S1	Switch, #32410-0	1345-0002	Fenwal
S2	Mercury Col, #A011102	1345-0001	Princo

*Factory select. Typical value shown.



NOTE:

1. CAPACITORS - VALUES IN PF UNLESS OTHERWISE NOTED.
2. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. Y1 THROUGH Y23 PLUG-IN CRYSTALS. (CUSTOMER REQUEST)
4. ALL POSITIONS S1A INTERCONNECT S1B EXCEPT PIN 24 AS SHOWN.

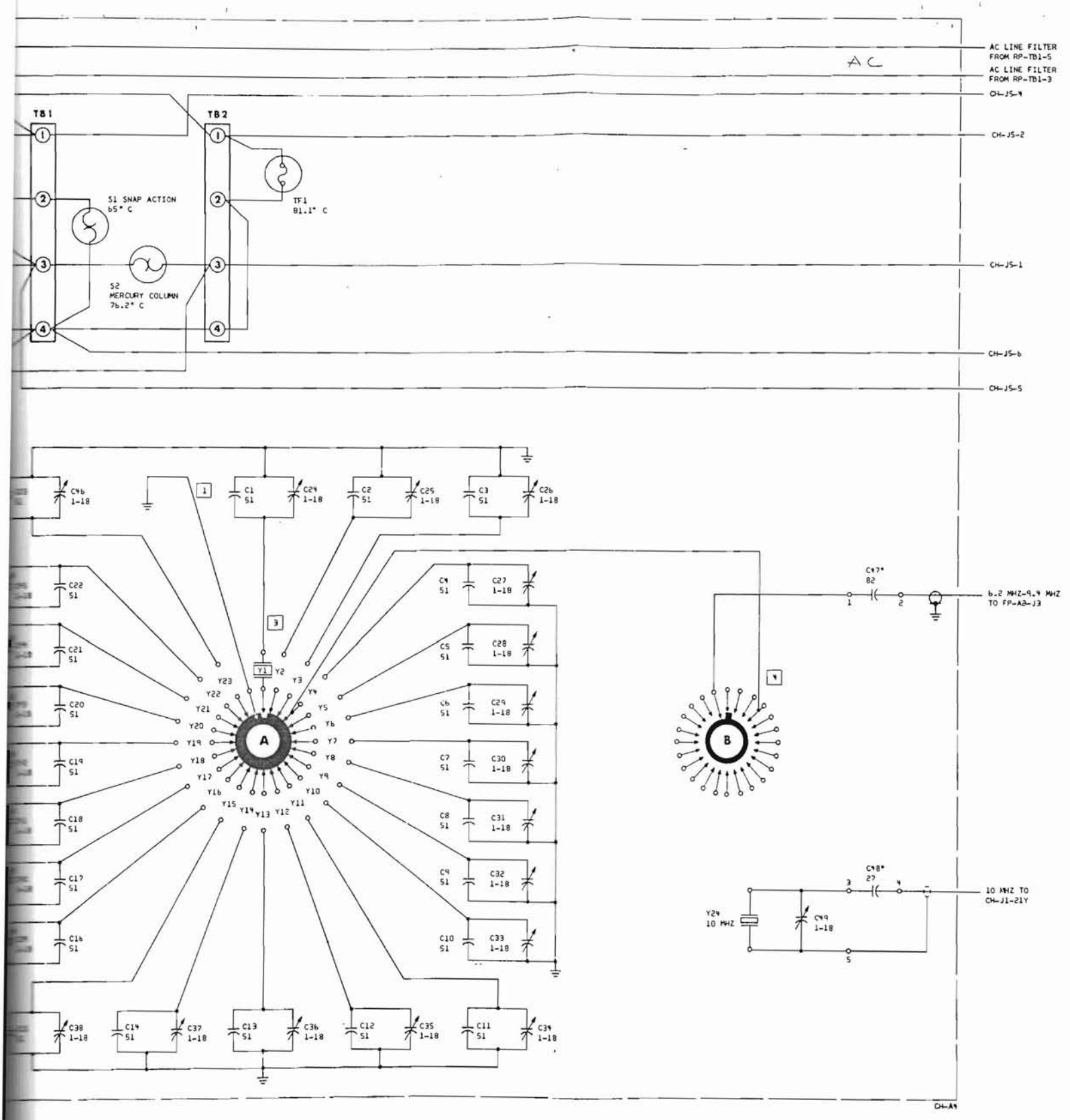
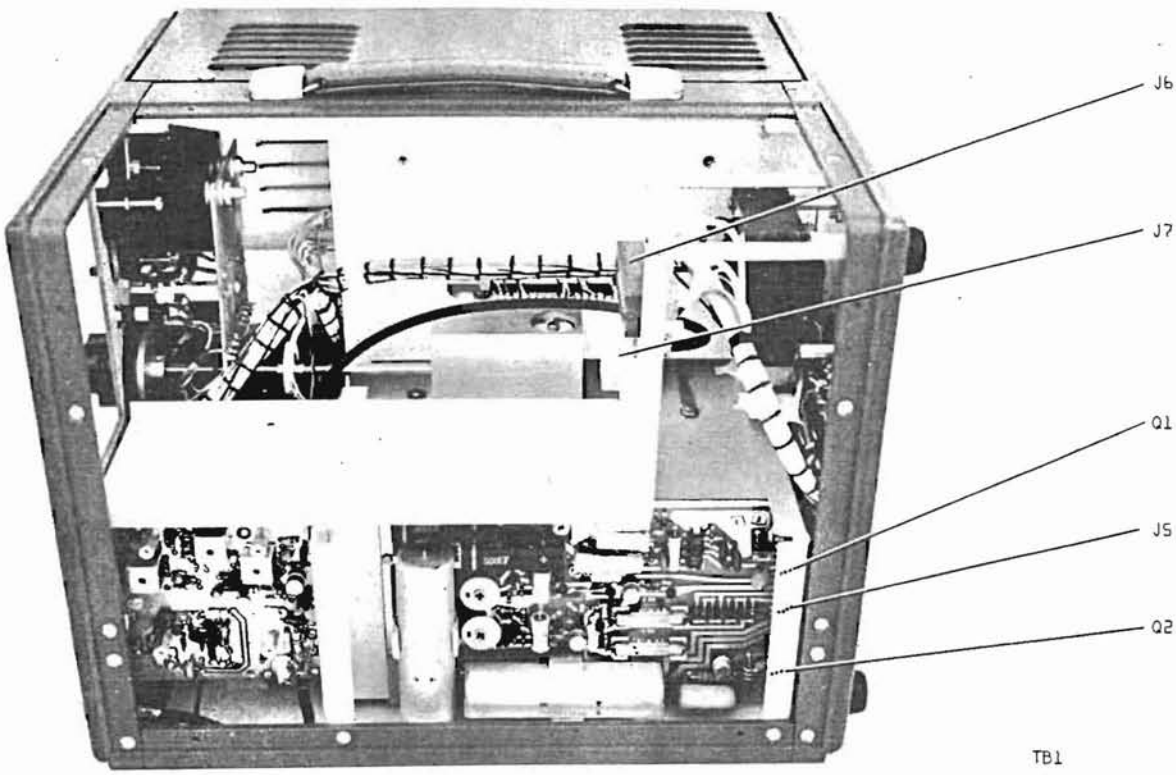
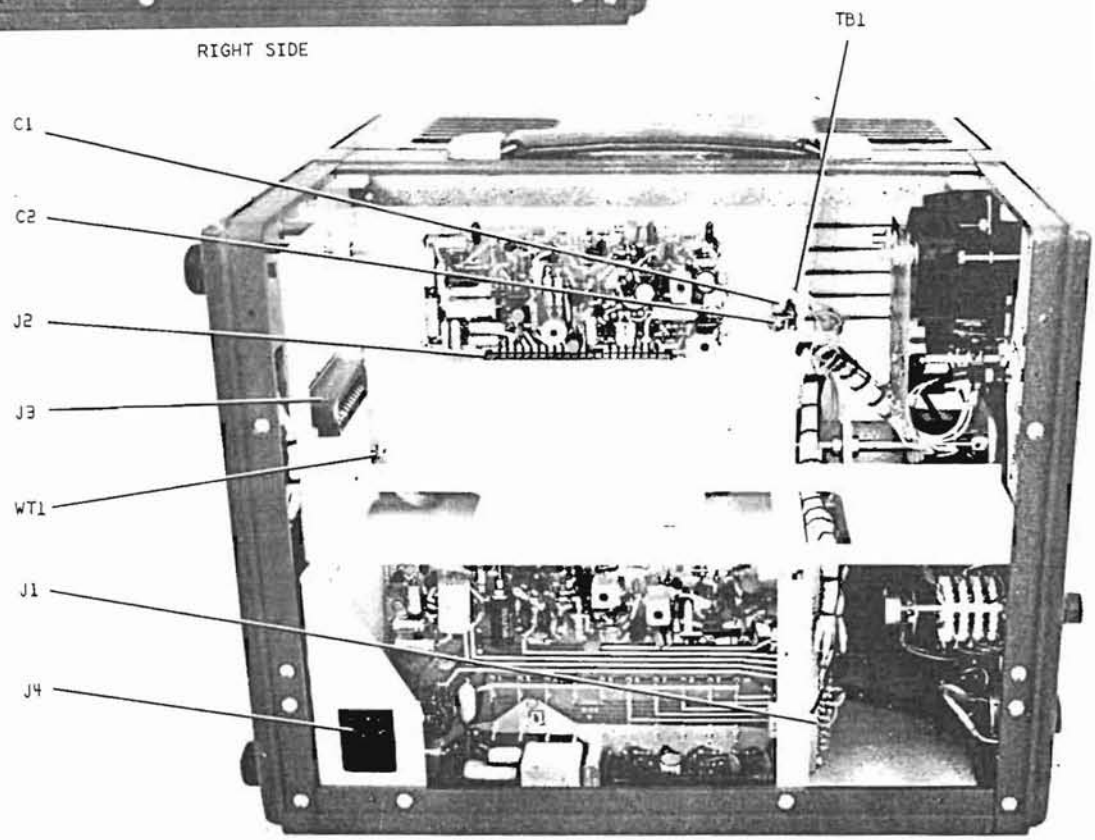


Figure 6-9. Crystal-Oven Assembly (CH-A4)

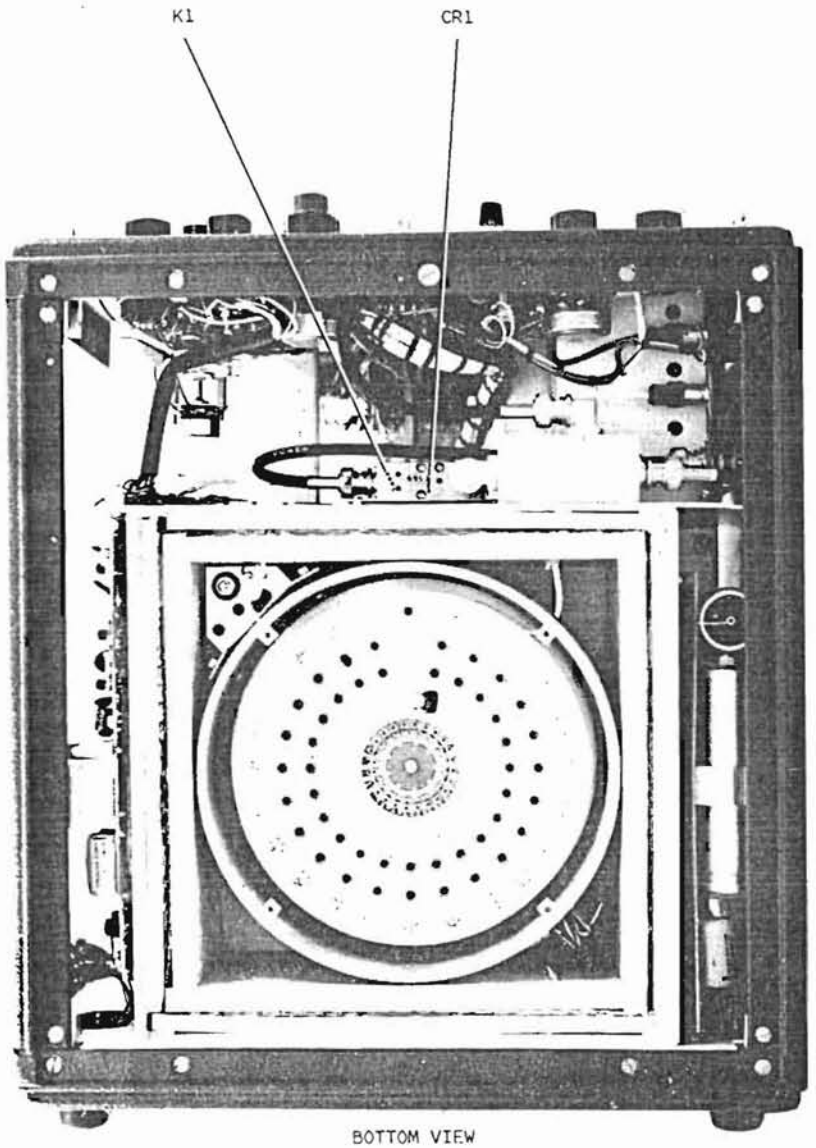
6.2.10 Main Chassis, Wiring Diagram



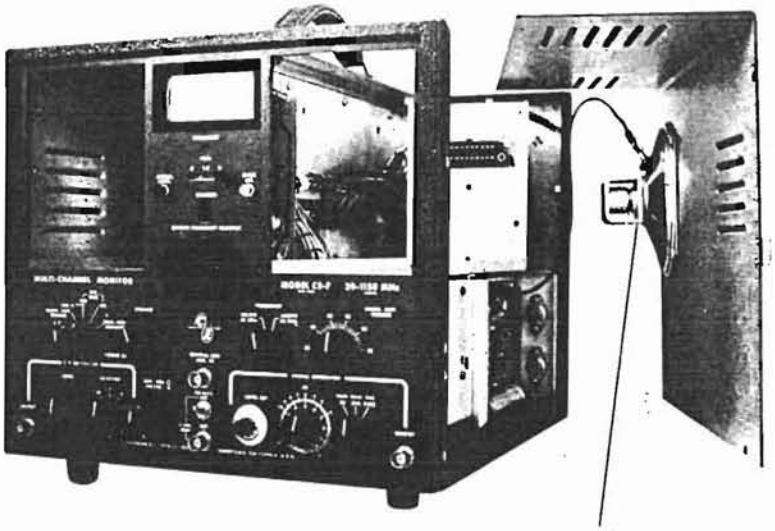
RIGHT SIDE

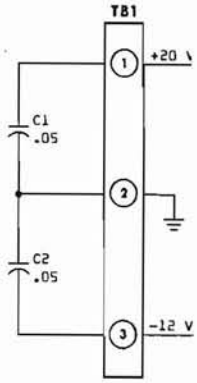


LEFT SIDE



BOTTOM VIEW



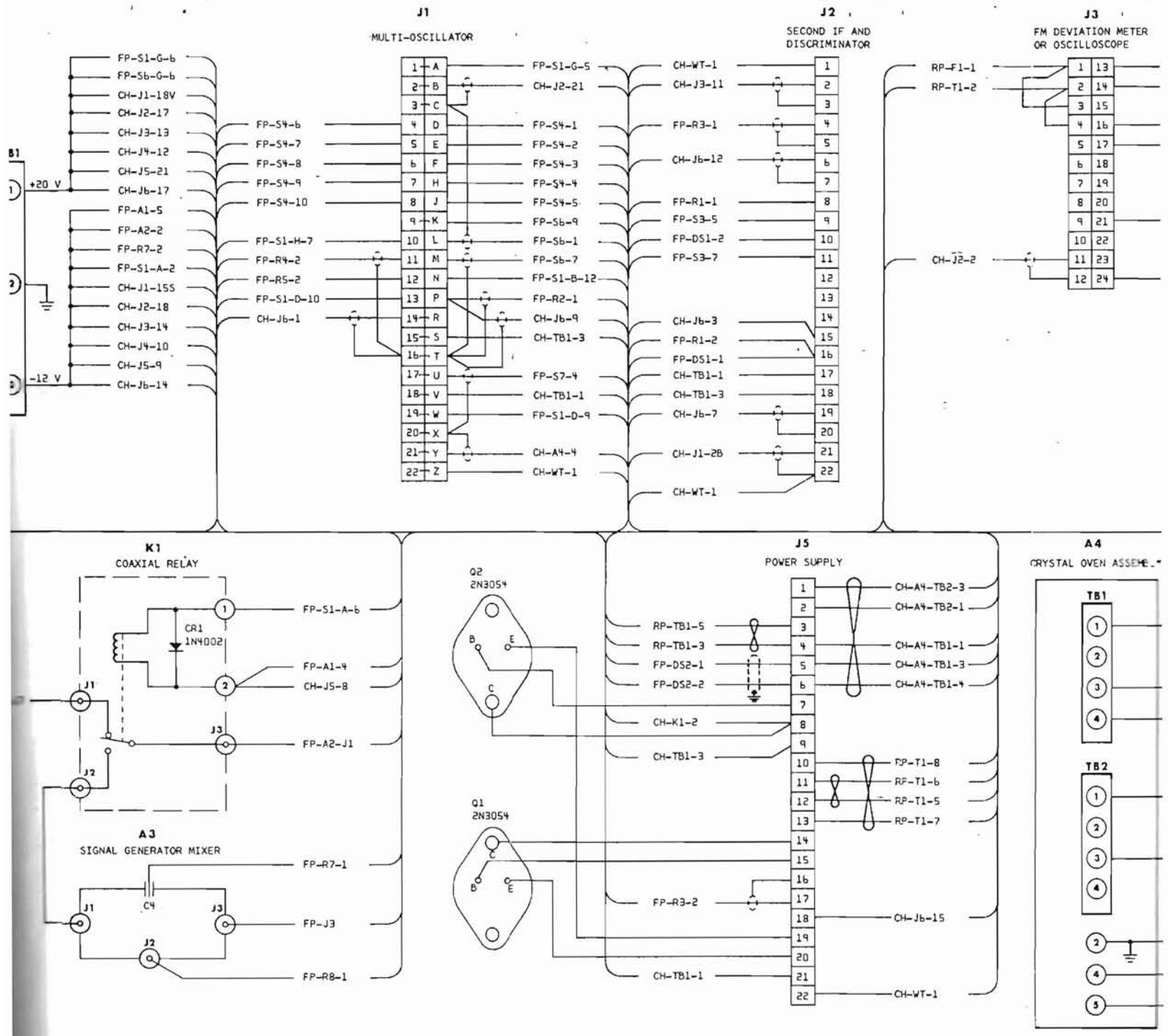


TO FRONT PANEL (FP) WIRING

CH-J7

6.2.10 MAIN CHASSIS

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH	Assembly, Main Chassis	7001-0011	Cushman
	Assembly, Right Angle Drive	7040-0027	Cushman
	Assembly, Handle	4230-0004	Phila Handle Co.
	CAPACITORS		
C1	Cer, 0.05 μH +80% -20%, 25V	1005-0014	Erie
C2	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
	CONNECTORS		
J1	Female, 44 pin	2535-0023	Viking
J2	Female, 22 pin	2535-0018	Viking
J3	Female, 24 pin	2535-0020	Amphenol
J4	Female, 12 pin	2535-0013	Cinch-Jones
J5	Female, 22 pin	2535-0018	Viking
J6	Female, 24 pin	2535-0020	Amphenol
J7	Connector, BNC, KC 79-43	2536-0003	King
	DIODE		
CR1	Si, 1N4002	1281-0023	Sylvania
	RELAY		
K1	Coaxial, 50Ω, 250W, 28V	1313-0003	Dow-Key
	SPEAKER		
LS1	3 in. x 5 in. Speaker	1715-0003	Quam
	TERMINAL		
TB1	Terminal Strip, +20V,-12V	1780-0004	Cinch-Jones
	TRANSISTORS		
Q1	Si, NPN, 2N3054	1271-0001	RCA
Q2	Si, NPN, 2N3054	1271-0001	RCA


J1
MULTI-OSCILLATOR
J2
SECOND IF AND DISCRIMINATOR
J3
FM DEVIATION METER OR OSCILLOSCOPE
B1
+20 V
-12 V
FP-S1-G-6
FP-S6-G-6
CH-J1-18V
CH-J2-17
CH-J3-13
CH-J4-12
CH-J5-21
CH-J6-17
FP-A1-5
FP-A2-2
FP-R7-2
FP-S1-A-2
CH-J1-15S
CH-J2-18
CH-J3-14
CH-J4-10
CH-J5-9
CH-J6-14
FP-S4-6
FP-S4-7
FP-S4-8
FP-S4-9
FP-S4-10
FP-S1-H-7
FP-R4-2
FP-R5-2
FP-S1-D-10
CH-J6-1
FP-S1-G-5
CH-J2-21
FP-S4-1
FP-S4-2
FP-S4-3
FP-S4-4
FP-S4-5
FP-S6-9
FP-S6-1
FP-S6-7
FP-S1-B-12
FP-R2-1
CH-J6-9
CH-TB1-3
FP-S7-4
CH-TB1-1
FP-S1-D-9
CH-A4-4
CH-WT-1
CH-WT-1
CH-J3-11
FP-R3-1
CH-J6-12
FP-R1-1
FP-S3-5
FP-DS1-2
FP-S3-7
CH-J6-3
FP-R1-2
FP-DS1-1
CH-TB1-1
CH-TB1-3
CH-J6-7
CH-J1-28
CH-WT-1
RP-F1-1
RP-T1-2
CH-J2-2
K1
COAXIAL RELAY
CR1
1N4002
FP-S1-A-6
FP-A1-4
CH-J5-8
FP-A2-J1
A3
SIGNAL GENERATOR MIXER
C4
FP-R7-1
FP-J3
FP-R8-1
Q2
2N3054
Q1
2N3054
J5
POWER SUPPLY
RP-TB1-5
RP-TB1-3
FP-DS2-1
FP-DS2-2
CH-K1-2
CH-TB1-3
FP-R3-2
CH-TB1-1
CH-A4-TB2-3
CH-A4-TB2-1
CH-A4-TB1-1
CH-A4-TB1-3
CH-A4-TB1-4
RP-T1-8
RP-T1-6
RP-T1-5
RP-T1-7
CH-J6-15
CH-WT-1
A4
CRYSTAL OVEN ASSEMBLY
TB1
TB2

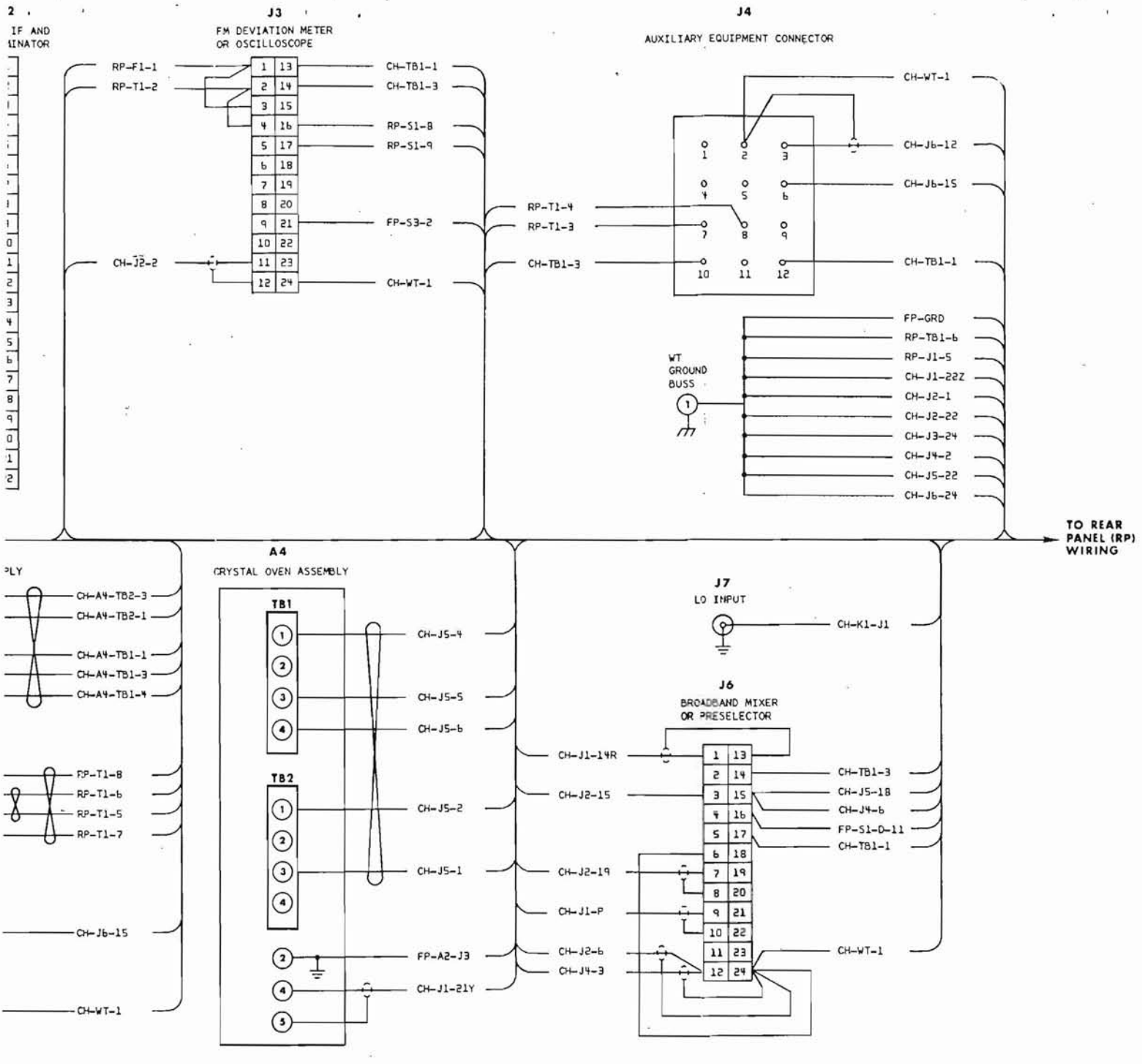
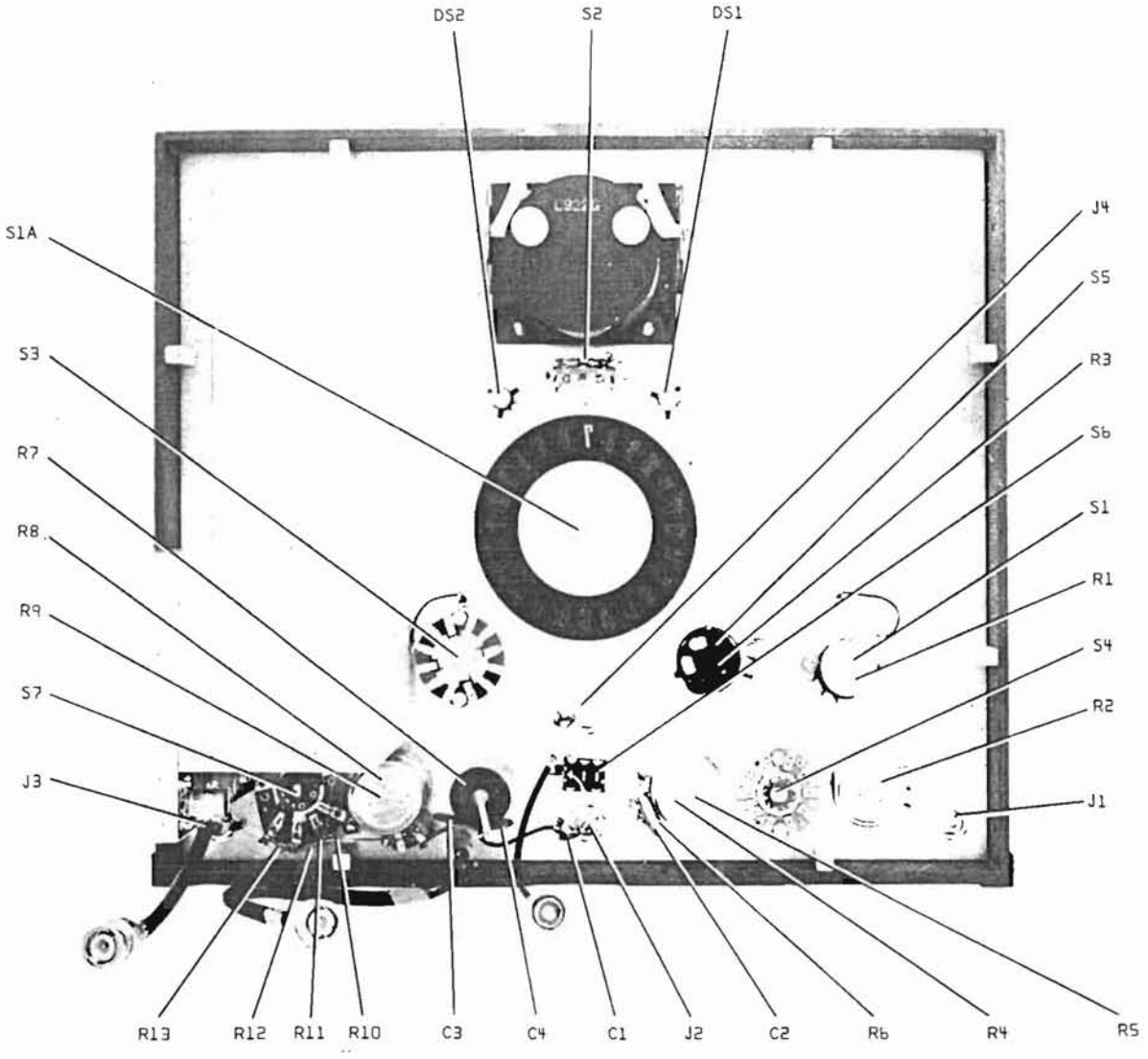


Figure 6-10. Main Chassis, Wiring Diagram

6.2.11 Front Panel, Wiring Diagram

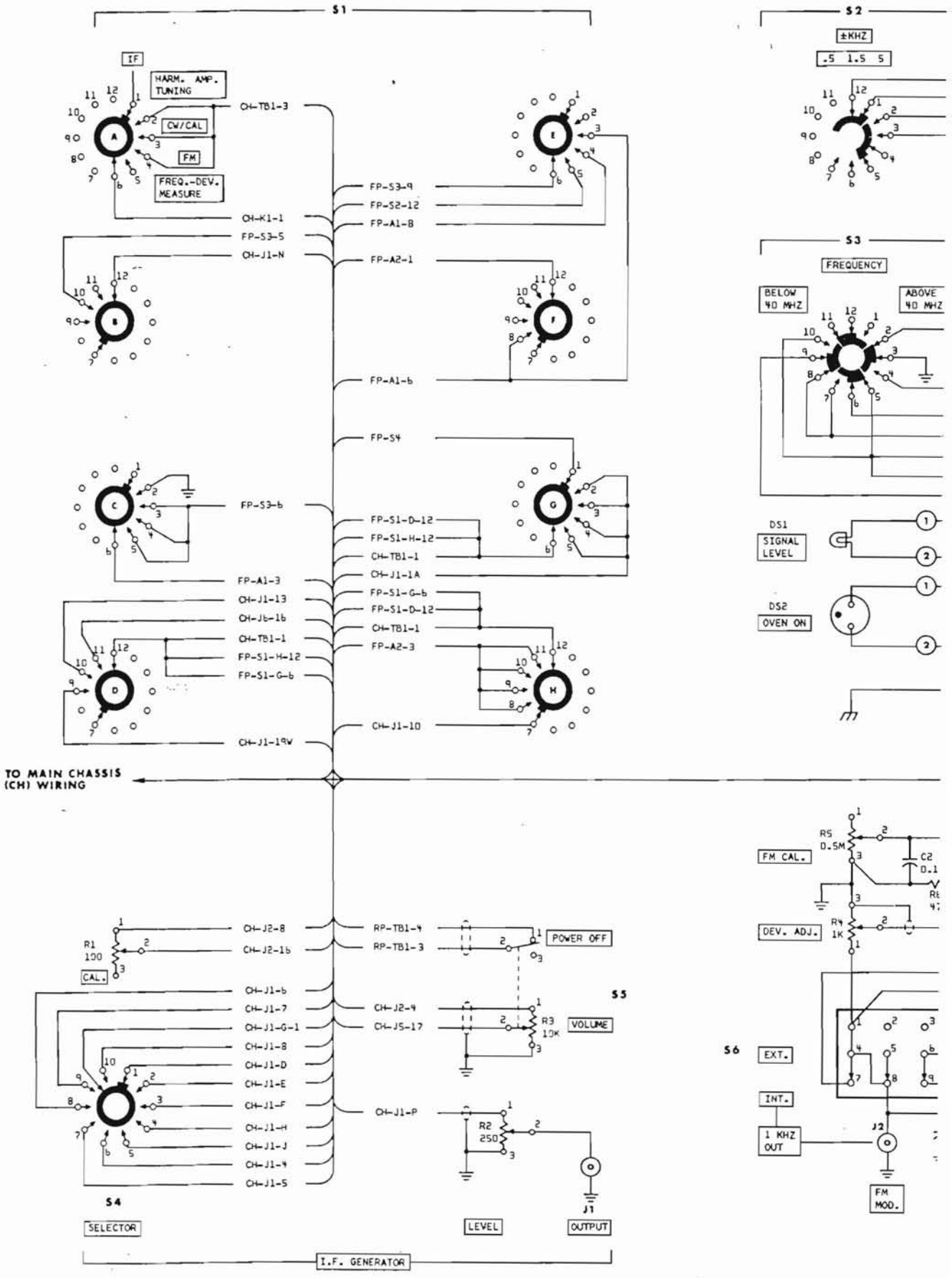


6.2.11 FRONT PANEL

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
FP	Assembly, Front Panel	7001-0010	Cushman
	BEZEL		
	Front	4560-0005	Cushman
	CAPACITORS		
C1	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C2	Cer, 0.1 μF +80% -30%, 75V	1005-0019	Centralab
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
	CONNECTORS		
J1	BNC, Female, U6-1094/U	2536-0010	King
J2	BNC, Female, U6-1094/U	2536-0010	King
J3	BNC, Female, U6-1094/U	2536-0010	King
J4	BNC, Female, U6-1094/U	2536-0010	King
	DIAL		
	Readout	2750-0012	Cushman
	KNOBS		
C5	Control	2780-0008	Kurz-Kasch
R1	Control	2780-0009	Kurz-Kasch
R2	Control	2780-0015	Kurz-Kasch
R4	Control	2780-0007	Kurz-Kasch
R5	Control	2780-0009	Kurz-Kasch
R7	Control	2750-0010	Amphenol
R8	Control	2750-0015	Kurz-Kasch
S1	Control, Chassis	2780-0022	Kurz-Kasch
S1	Control	2750-0007	Kurz-Kasch
S2	Control	2780-0021	Oak
S3	Control	2750-0015	Kurz-Kasch
S4	Control	2780-0015	Kurz-Kasch
S5	Control	2780-0015	Kurz-Kasch
S7	Control	2750-0015	Kurz-Kasch

6.2.11 FRONT PANEL (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	LAMPS		
DS1	Incandescent, cartridge, 10V, 14MA	2870-0010	Dialco
DS2	Neon, cartridge	2900-0007	Dialco
	PANEL		
	Front	2800-0031	Cushman
	RESISTORS		
R1	Pot., comp, lin, 100Ω, 2W	p/o1851-0040	CTS
R2	Pot., comp, lin, 250Ω, 2W	1203-0019	Allen-Bradley
R3	Pot., comp, lin, 10kΩ, 2W	p/o1203-0018	Allen-Bradley
R4	Pot., comp, log, 1kΩ, 2W	p/o1204-0003	Allen-Bradley
R5	Pot., comp, lin, 0.5MΩ, 2W	p/o1204-0003	Allen-Bradley
R6	Comp, 470kΩ, ±5%, 1/4W	1666-4745	Allen-Bradley
R7	Pot., 10 turn, 10kΩ	1203-0029	Amphenol
R8	Pot., comp, lin, 3kΩ, 2W	p/o1204-0004	Allen-Bradley
R9	Pot., comp, lin, 50Ω, 2W	p/o1204-0004	Allen-Bradley
R10	M Film, 54.9Ω, ±1%, 1/10W	1075-0005	Electra
R11	M Film, 61.9Ω, ±1%, 1/10W	1075-0007	Electra
R12	M Film, 499Ω, ±1%, 1/10W	1075-0008	Electra
R13	M Film, 499Ω, ±1%, 1/10W	1075-0008	Electra
	SWITCHES		
S1	Rotary, special	1551-0040	CTS
S2	Lever, 2P3 pos. range	1551-0016	Centralab
S3	Rotary, 4P2 pos.	1551-0022	Centralab
S4	Rotary, 1P10 pos.	1551-0030	Oak
S5	2P2 pos. with pot., power off, vol. control	p/o1203-0018	Allen-Bradley
S6	Toggle, 3P2 pos.	1550-0007	Alco
S7	Rotary, 1P3 pos.	1551-0001	CRL


S1
S2
S3
S4
S5
S6
IF
HARM. AMP. TUNING
CW/CAL
FM
FREQ.-DEV. MEASURE
A
B
C
D
E
F
G
H
CH-TB1-3
CH-K1-1
FP-S3-5
CH-J1-N
FP-S3-9
FP-S2-12
FP-A1-8
FP-A2-1
FP-A1-6
FP-S4
FP-S3-6
FP-S1-D-12
FP-S1-H-12
CH-TB1-1
CH-J1-1A
FP-A1-3
CH-J1-13
CH-J6-16
CH-TB1-1
FP-S1-H-12
FP-S1-G-6
FP-S1-G-6
FP-S1-D-12
CH-TB1-1
FP-A2-3
CH-J1-19W
CH-J1-10
TO MAIN CHASSIS (CH) WIRING
±KHZ
.5 1.5 5
FREQUENCY
BELOW 40 MHZ
ABOVE 40 MHZ
DS1
SIGNAL LEVEL
DS2
OVEN ON
R1 100
CAL.
CH-J2-8
CH-J2-16
CH-J1-6
CH-J1-7
CH-J1-G-1
CH-J1-8
CH-J1-D
CH-J1-E
CH-J1-F
CH-J1-H
CH-J1-J
CH-J1-4
CH-J1-5
RP-TB1-4
RP-TB1-3
POWER OFF
CH-J2-4
CH-J5-17
R3 10K
VOLUME
CH-J1-P
R2 250
J1
SELECTOR
LEVEL
OUTPUT
I.F. GENERATOR
R5 0.5M
FM CAL.
C2 0.1
DEV. ADJ.
R4 1K
EXT.
INT.
1 KHZ OUT
J2
FM MOD.

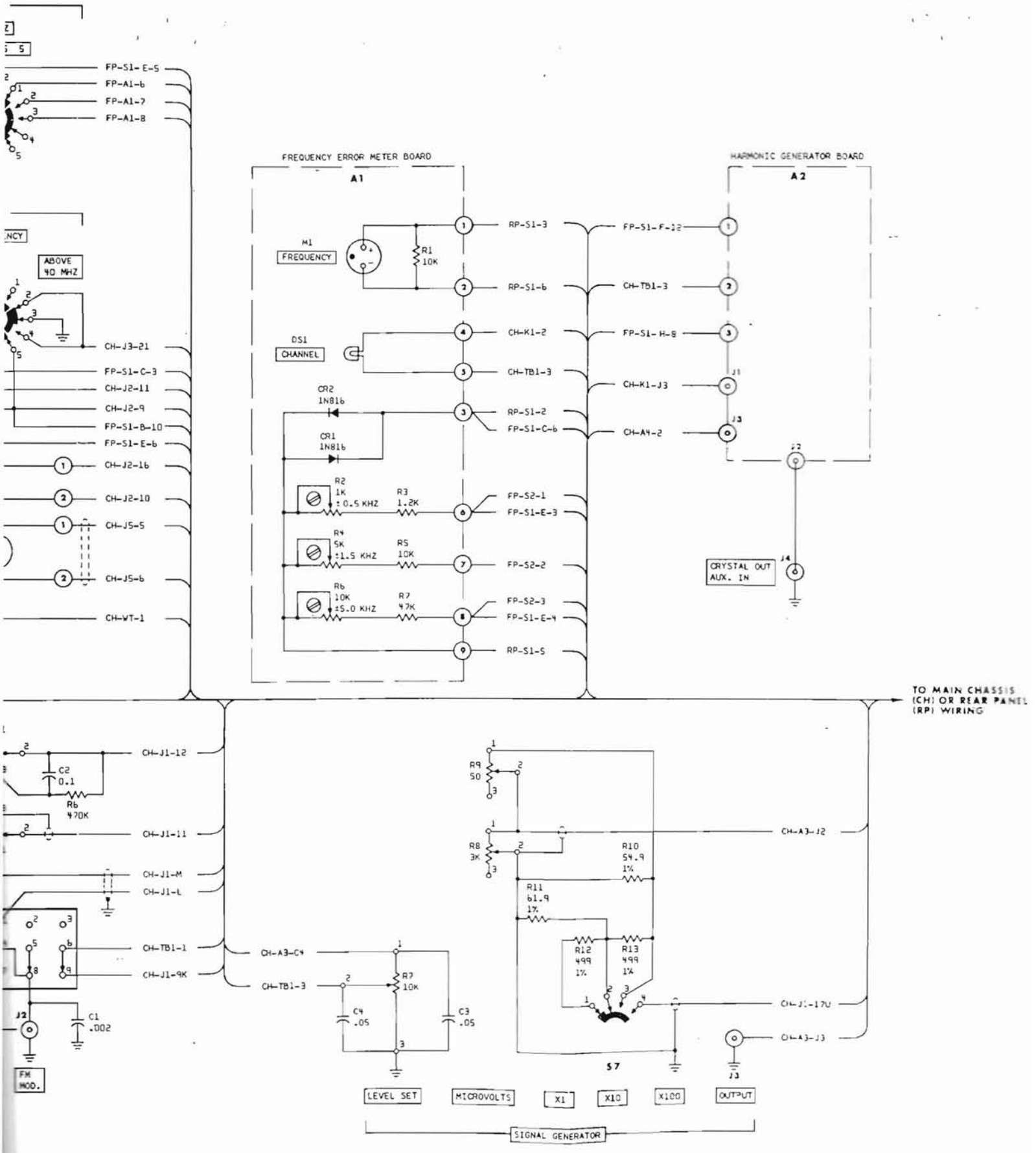
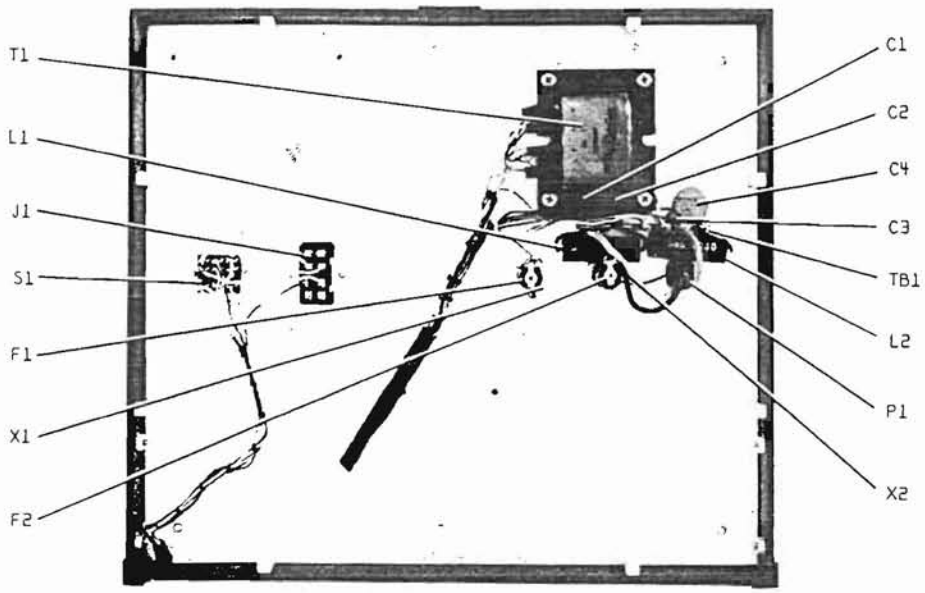


Figure 6-11. Front Panel, Wiring Diagram

6.2.12 Rear Panel



6.2.12 REAR PANEL

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
RP	Assembly, Rear Panel	7001-0012	Cushman
	BEZEL		
	Rear	4560-0005	Cushman
	CAPACITORS		
C1	Cer, 0.01 μF, ±20%, 1.4KV	1005-0051	Sprague
C2	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C3	Cer, 0.002 μF, ±20%, 600V	1005-0003	Erie
C4	Cer, 0.01 μF, ±20%, 1.4KV	1005-0051	Sprague
	COILS		
L1	Choke, RF, 100 μH, ±10%, 600V	1585-0040	Miller
L2	Choke, RF, 100 μH, ±10%, 600V	1585-0040	Miller
	FUSES		
F1	3AG MDL, 2/10 amp,slo-blo	1955-0009	Bussman
F2	3AG, 1 amp, slo-blo	1955-0006	Littlefuse
	FUSEHOLDERS		
X1	Fuseholder	1965-0004	Littlefuse
X2	Fuseholder	1965-0004	Littlefuse
	JACK		
J1	Female, 8 pin	2535-0003	Cinch-Jones
	PANEL		
	Rear	2800-0032	Cushman
	PLUG		
P1	Moulded, 3 wire, 18 gauge	3170-0001	Belden
	SWITCH		
S1	Side, 3 P.D.T.	1850-0011	Switchcraft
	TERMINAL		
TB1	Strip, AC Filter	1760-0013	Cinch-Jones
	TRANSFORMER		
T1	Transformer, Power	1575-0008	Cushman

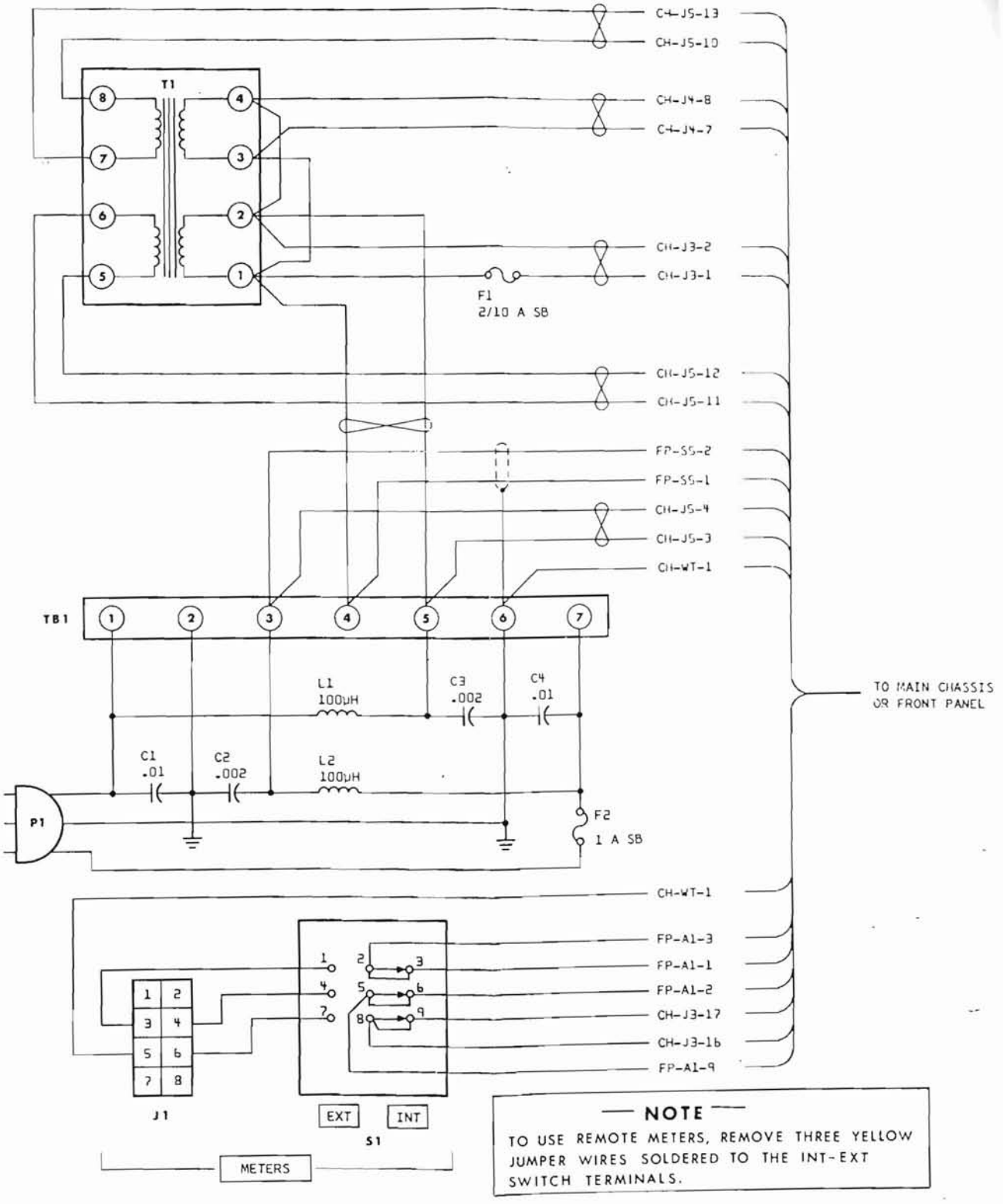
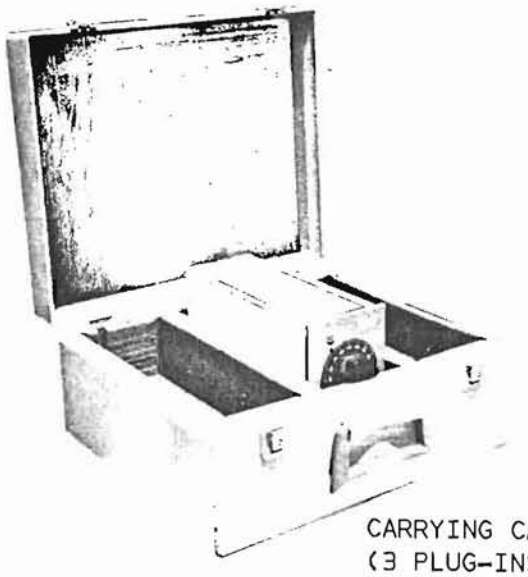


Figure 6-12. Rear Panel, Wiring Diagram

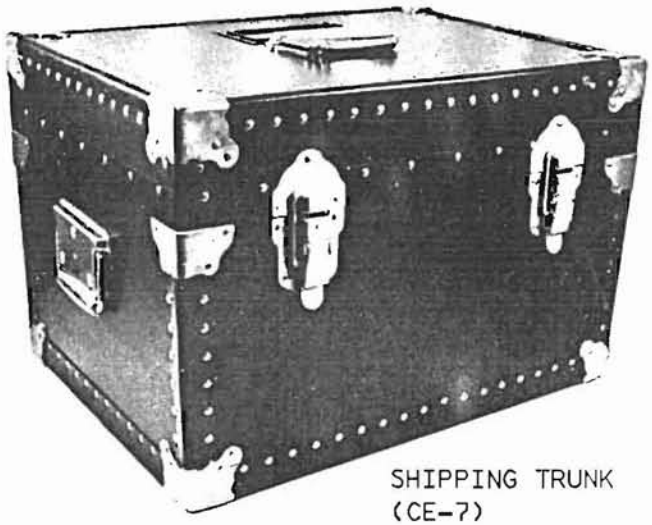
6.2.13 CE-7 Covers and Carrying Cases



CARRYING CASE
(3 PLUG-INS)

PROTECTIVE
ZIPPER COVER

SHIPPING TRUNK
(4 PLUG-INS)



SHIPPING TRUNK
(CE-7)

§ 2.13 COVERS AND CARRYING CASES

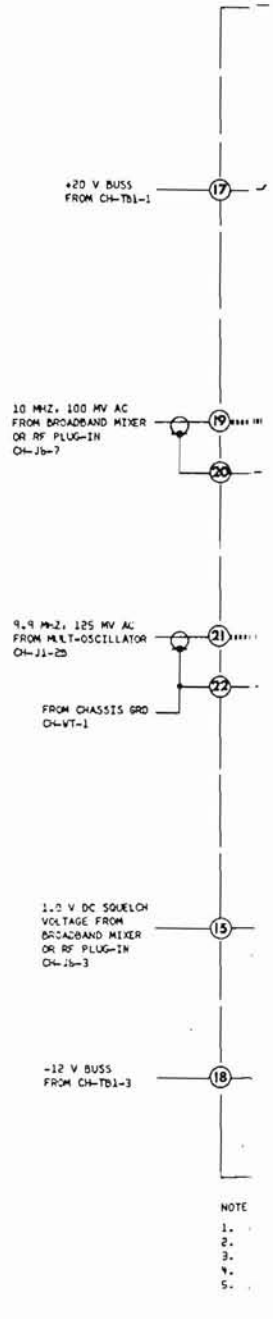
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	Cover Assembly, Front	7001-0015	Cushman
	Cover Assembly, Bottom	7001-0016	Cushman
	Cover, Left-Side	7001-0013	Cushman
	Cover, Right-Side	7001-0014	Cushman
	OPTIONAL ITEMS		
	Cover, Protective Zipper	5287-0013	Cushman
	Trunk, Shipping	5287-0014	Cushman
	Carrying Case, Plug-Ins (holds 3 RF Plug-ins)	5287-0009	Cushman
	Shipping Trunk, Plug-Ins (holds 3 RF Plug-ins plus one deviation or Oscilloscope plug-in)	5287-0015	Cushman

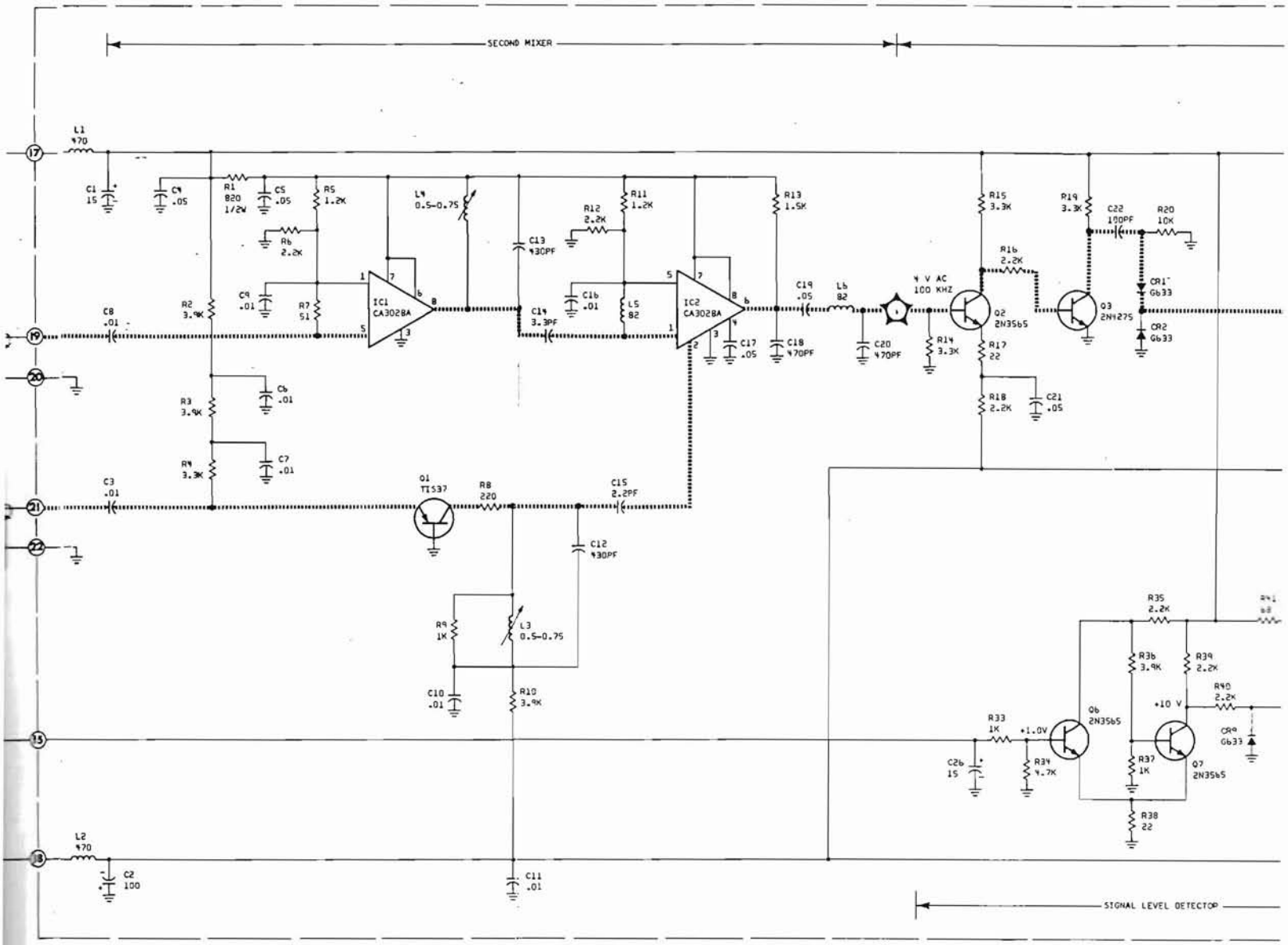
6.2.1 SECOND IF AND DISCRIMINATOR BOARD 0054 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R11	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley
R12	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R13	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley
R14	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
R15	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
R16	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R17	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley
R18	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R19	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley
R20	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley
R22	M Film, 1kΩ, ±1%, 1W	1076-0007	Electra
R23	M Film, 357Ω, ±1%, 3/4W	1076-0012	Electra
R24	Comp, 1.2kΩ, ±5%, 1/2W	1067-1225	Allen-Bradley
R25	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R26	M Film, 14.7kΩ, ±1%, 1/2W	1076-0011	Electra
R27	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R28	Comp, 33kΩ, ±5%, 1/4W	1066-3335	Allen-Bradley
R29	M Film, 1kΩ, ±1%, 1W	1076-0007	Electra
R30	Pot., comp, 200Ω, 1/4W	1200-0016	Allen-Bradley
R31	M Film, 274Ω, ±1%, 3/4W	1076-0013	Electra
R32	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley
R33	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R34	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley
R35	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R36	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley
R37	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley
R38	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley
R39	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R40	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley
R41	Comp, 68Ω, ±5%, 1/4W	1066-6805	Allen-Bradley
R42	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley
R43	M Film, 2.21kΩ, ±1%, 1/4W	1075-0010	Electra
R44	M Film, 10kΩ, ±1%, 1/4W	1075-0009	Electra
R45	M Film, 332Ω, ±1%, 1/4W	1075-0024	Electra
R46	M Film, 2.21kΩ, ±1%, 1/4W	1075-0010	Electra
R47	M Film, 475Ω, ±1%, 1/4W	1075-0023	Electra
R48	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley

6.2.1 SECOND IF AND DISCRIMINATOR BOARD 0054 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	TRANSISTORS		
Q1	Si, PNP, TIS37	1271-0003	T.I.
Q2	Si, NPN, 2N3565	1272-0017	Fairchild
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N4275	1272-0016	Fairchild
Q5	Si, NPN, 2N4275	1272-0016	Fairchild
Q6	Si, NPN, 2N3565	1272-0017	Fairchild
Q7	Si, NPN, 2N3565	1272-0017	Fairchild
Q8	Si, NPN, 2N3567	1272-0014	Fairchild
Q9	Si, NPN, 2N3565	1272-0017	Fairchild
Q10	Si, NPN, 2N3565	1272-0017	Fairchild





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.

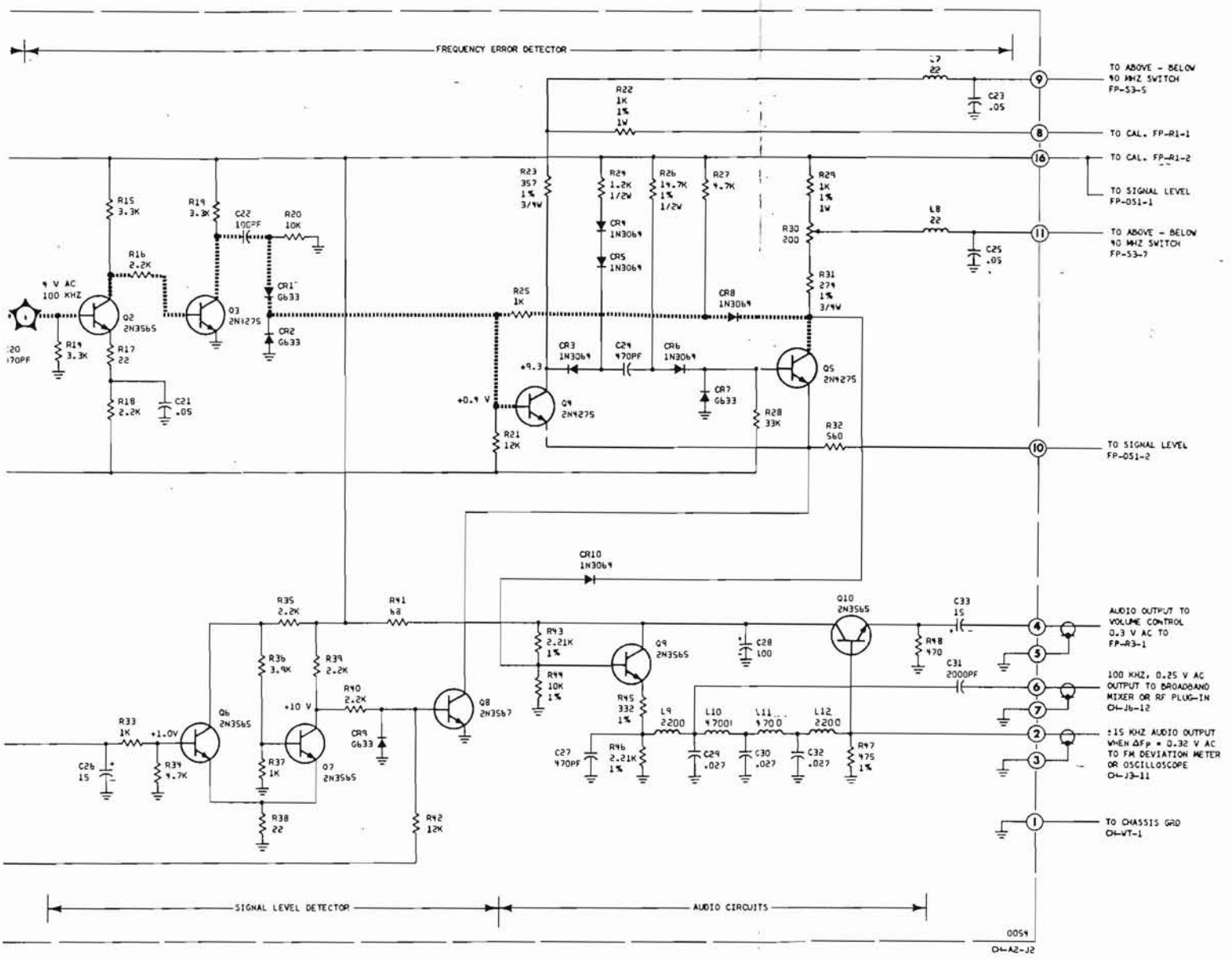


Figure 6-1. Second IF and Discriminator Board (0054)