



**TECHNICAL MANUAL MS1  
RADIO SET PRC1099A**

 **DATRON**

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 Manual No. TW-PRC1099A-MS1  
Publication #990350  
Printed: August 1995  
Revision L1

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1. 1948

2. 1949

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9. 1956  
10. 1957  
11. 1958  
12. 1959



13. 1960

14. 1961

15. 1962



## One Year Limited Warranty and Remedies

Datron World Communications Inc. (DWC) warrants that its equipment is free from defects in design, materials and workmanship for a period of 12 months from the date of installation of the equipment, but in no event later than 15 months from the date of shipment. If the equipment does not provide satisfactory service due to defects covered by this warranty, DWC will, at its option, replace or repair the equipment free of charge.

Should it be impractical to return the equipment for repair, DWC will provide replacements for defective parts contained in the equipment for a period of 12 months from the date of installation of the equipment, but in no event later than 15 months from the date of shipment.

This warranty is limited to the original purchaser and is not transferable. Repair service performed by DWC is warranted for the balance of the original warranty or 90 days, whichever is longer.

**Exclusive Warranty:** There are no other warranties beyond the warranty as contained herein. No agent, employee, or representative of DWC has any authority to bind DWC to any affirmation, representation, or warranty concerning the equipment or its parts that is not in conformity with the warranties contained herein. EXCEPT AS EXPRESSLY SET FORTH ABOVE, NO OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED, ARE MADE WITH RESPECT TO THE EQUIPMENT OR THE PARTS CONTAINED THEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND DWC EXPRESSLY DISCLAIMS ALL WARRANTIES NOT STATED HEREIN.

**Limitations of Warranty:** This warranty does not cover:

- Physical damage to the equipment or its parts that does not involve defects in design, material or workmanship, including damage by impact, liquids, temperature, or gases.
- Damage to the equipment or its parts caused by lightning, static discharge, voltage transients, or application of incorrect supply voltages.
- Defects or failures caused by unauthorized attempts to repair or modify the equipment.
- Defects or failures caused by Buyer abuse or misuse.

**Return of Equipment - Domestic:** To obtain performance of any obligation under this warranty, the equipment must be returned freight prepaid to the Customer Service Department, Datron World Communications Inc., 304 Enterprise Street, Escondido, California 92029. The equipment must be packed securely. DWC shall not be responsible for any damage incurred in transit. A letter containing the following information must be included with the equipment.

- a. Model, serial number and date of installation;
- b. Name of dealer or supplier of the equipment;
- c. Detailed explanation of problem;
- d. Return shipping instructions; and
- e. Telephone or fax number where buyer may be contacted.

DWC will return the equipment prepaid by United Parcel Service, Parcel Post, or truck. If alternate shipping is specified by Buyer, freight charges will be made collect.

**Return of Equipment - International:** Contact DWC or your local Representative for specific instructions. Do not return equipment without authorization. It is usually not possible to clear equipment through U.S. Customs without the correct documentation. If equipment is returned without authorization, Buyer is responsible for all taxes, customs duties, clearance charges, and other associated costs.

**Parts Replacement:** The following instructions for the supply of replacement parts must be followed:

- a. Return the parts prepaid to "Parts Replacement" Datron World Communications Inc., 304 Enterprise Street, Escondido, California 92029; and
- b. Include a letter with the following information:
  1. part number;
  2. serial number and model of equipment; and
  3. date of installation.

Parts returned without this information will not be replaced. In the event of a dispute over the age of the replacement part, components date-coded over 24 months previously will be considered out of warranty.

**Remedies:** Buyer's sole remedies and the entire liability of DWC are set forth above. In no event will DWC be liable to buyer or any other person for any damages, including any incidental or consequential damages, expenses, lost profits, lost savings, or other damages arising out of use of or inability to use the equipment.

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SERVICE AND TECHNICAL MANUAL - RADIO SET PRC1099A

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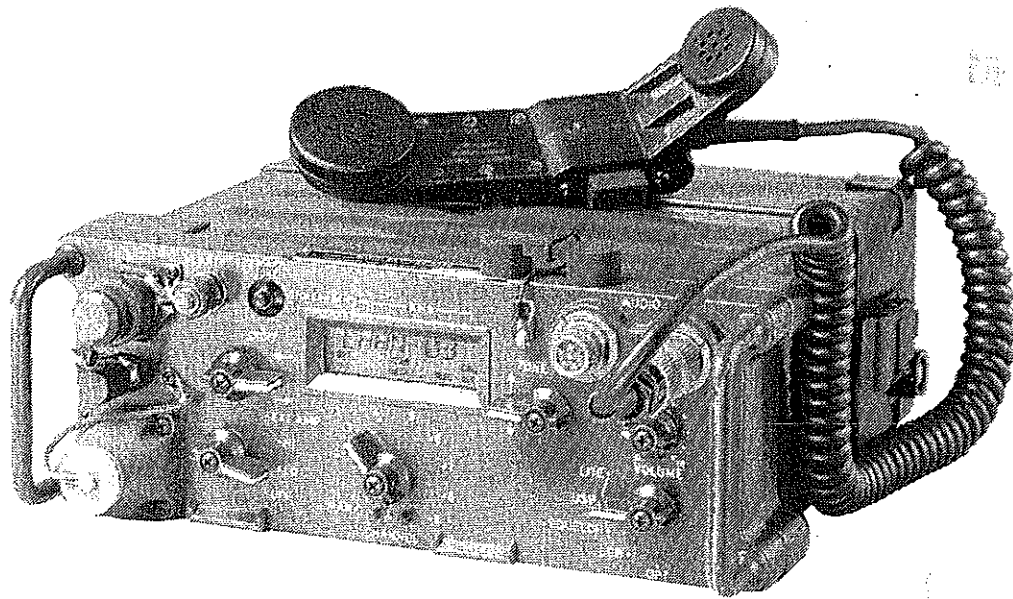
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**FIGURE 1-1. PRC1099A 1.6-30 MHz Manpack Transceiver**

# CHAPTER 1

## INTRODUCTION & TECHNICAL SPECIFICATIONS

### 1-1 GENERAL

This manual provides detailed information on the service and repair of the PRC1099A transceiver. Full technical information is given, including schematic diagrams, theory of operation, and test and alignment procedures. Detailed parts lists are also included.

used in conjunction with this one. It includes full installation, operating and field maintenance instructions.

### 1-2 OPERATOR'S MANUAL

The Operator's Manual TW-PRC1099A-TM1 should be

### 1-3 TECHNICAL SPECIFICATIONS

Chapter 1 contains technical specifications (Table 1-1), semiconductors (Table 1-2), a block diagram (Figure 1-2), and module location diagrams (Figures 1-3 and 1-4).

**TABLE 1-1.**  
**Technical Specifications, PRC1099A.**

<b><u>GENERAL</u></b>	
Frequency Range:	1.6 - 30 MHz (10 Hz resolution).
Preset Memory Channels:	100 (field programmable).
Display:	Backlit multi-function custom LCD.
Power Source:	12 Vdc (10.5-15 V operational).
Battery Pack:	BB-LA6 12-V, 6-Ah sealed lead-calcium. BA5598/U lithium (case holds spare battery). BA4386/U (limited to 5-W operation). PRC-77 nicad battery packs.
Low Battery:	Battery icon illuminated.
Modes:	Voice/Data/CW, USB/LSB, AME optional.
Operating Temperature:	-30° C to +60° C.
Frequency Stability:	± 1 ppm 0° C to +50° C. ± 1 ppm -30° C to +60° C (optional).
Size:	28.2 cm W, 10.4 cm H, 23.5 cm D.
Weight:	Basic radio unit 5.2 kg; Battery case with BA5598/U Battery 0.9 kg.
Design:	To MIL Standard 188C.
Environmental:	Designed to MIL Standard 810D including shock, vibration, humidity, immersion and rough handling.
Interfaces:	Per MIL Standard 188C (audio and RF).
<b><u>TRANSMITTER</u></b>	
Power Output:	High: 20-W PEP/AVG ± 1 dB into 50 Ω. Low: 5-W PEP/AVG.
Output Protection:	Infinite VSWR including short or open circuits.
Duty Cycle:	Continuous—power output automatically reduced to 5 W at heat sink temperatures > 80° C.
Carrier Suppression:	-45 dB.
Unwanted Sideband:	-60 dB at 1 kHz.
Spurious Suppression:	-50 dB
Harmonic Suppression:	-50 dB typical (except below 2 MHz).
Intermodulation Distortion:	-26 dB.

**TABLE 1-1.**  
**Technical Specifications, PRC1099A, Continued.**

Audio Inputs:	150- $\Omega$ automatic gain control and 600 $\Omega$ , 0 dBm.
Audio Bandwidth:	350-2700 Hz.
Audio Compression:	+30 dB above nominal.
ALC:	< + 1-dB change for + 30-dB audio increase.
Sidetone:	Audio sidetone all modes.
Current Drain:	6 A maximum, all modes. 1.5 A typical voice.

**RECEIVER**

SENSITIVITY:	0.5 $\mu$ V for 10-dB SINAD.
SELECTIVITY:	350-2700 Hz at -6 dB, -60 dB at 5 kHz.
IMAGE REJECTION:	80 dB.
IF REJECTION:	80 dB.
AGC CHARACTERISTICS:	<6-dB audio change from 3 $\mu$ V to 300,000 $\mu$ V RF input.
INTERCEPT POINT:	+10 dBm.
INTERMODULATION:	-80 dB.
SQUELCH:	Audio derived, noise immune.
AUDIO OUTPUT:	500 mW @ 16 $\Omega$ , 50 mW @ 150 $\Omega$ , 0 dBm @ 600 $\Omega$ .
CURRENT DRAIN:	Squelched: 190 mA typical @ 20°C. Non-squelched: maximum 220 mA.

**ANTENNA TUNER**

ANTENNAS:	10-ft. (3-m) manpack whip for 2-30 MHz. 16-50 ft. (4.8 m - 15 m) whip or long wire for 1.6-30 MHz. External adapter available for longer antennas.
TUNING TIME:	One second typical.
TUNE MEMORY:	Last tune stored on all 10 channels.
SWITCHING TIME:	20 ms for stored tune information.
TUNE POWER:	500 mW (no output when switching stored tune information).
MAXIMUM OUTPUT VOLTAGE:	1 kV (power automatically reduced if this terminal voltage is exceeded).
ANTENNA SWITCHING:	Antenna tuner disconnects and switches output to 50- $\Omega$ port when whip or long wire terminal is removed.

**OPERATING CONTROLS**

VOLUME:	Sets audio output level.
MODE:	Squelch on, USB, LSB, display backlight and optional mode.
POWER:	Off, Low power (5 W), High power (20 W), external amplifier.
TUNE:	Tunes transceiver frequency up or down.
DIGIT:	Selects digits of displayed frequency and icons on front panel display.
CHANNEL:	Ten switch positions used to display any of the 100 internal channels.
WHIP/TUNE:	Momentary—activates antenna tune cycle. Hold down to store changed frequency or channel.

TABLE 1-2.  
Semiconductors, PRC1099A.

DESIGNATOR	FUNCTION	DESCRIPTION
M1 D1	Clamp	1N4148 Diode
M1 D2	Rectifier	1N4148 Diode
M1 D3	Rectifier	1N4148 Diode
M1 D4	Gate	1N4148 Diode
M1 D5	Gate	1N4148 Diode
M1 D6	Gate	1N4148 Diode
M1 D7	Gate	1N4148 Diode
M1 D8	Gate	1N4148 Diode
M1 D9	Gate	1N34A Diode
M1 D11	Gate	1N34A Diode
M1 D12	Gate	1N4148 Diode
M1 D13	Gate	1N4148 Diode
M1 D14	Gate	1N4148 Diode
M1 D15	Gate	1N34A Diode
M1 D16	Transient Suppressor	1N4181 Diode
M1 D17	Transient Suppressor	1N751A Zener Diode
M1 D18	RX Protection	1N4148 Diode
M1 D19	RF Rectifier	1N4148 Diode
M1 D20	RF Rectifier	1N4148 Diode
M1 D21	Gate	1N4148 Diode
M1 D22	Gate	1N4148 Diode
M1 Q1	Squelch Switch	2N3565 NPN Transistor
M1 Q2	Squelch Switch	2N3565 NPN Transistor
M1 Q5	Mute Switch	2N3565 NPN Transistor
M1 Q6	Squelch Switch	2N2907 PNP Transistor
M1 Q7	RX Switch	2N3565 NPN Transistor
M1 Q8	Relay Switch	2N3567 NPN Transistor
M1 Q9	Relay Switch	2N3567 NPN Transistor
M1 Q10	Relay Switch	2N3567 NPN Transistor
M1 Q11	Relay Switch	2N3567 NPN Transistor
M1 Q12	Relay Switch	2N3567 NPN Transistor
M1 Q13	Relay Switch	2N3567 NPN Transistor
M1 Q14	Relay Switch	2N3567 NPN Transistor
M1 Q15	AME Switch	2N2907 PNP Transistor
M1 Q16	ANT Switch	2N3567 NPN Transistor
M1 Q17	CW Key Switch	MPSD54 DARL Transistor
M1 Q18	ATU Tune Switch	2N3565 NPN Transistor
M1 Q19	CW Oscillator	2N3565 NPN Transistor
M1 Q20	AME Select Switch	2N3565 NPN Transistor
M1 Q21	ALC Amplifier	2N3638 PNP Transistor
M1 Q22	Low Power Switch	2N3565 NPN Transistor
M1 Q23	Amplifier	2N3567 NPN Transistor
M1 Q24	Switch	2N3567 NPN Transistor
M1 Q25	Contrast Gate	PN2222 NPN Transistor
M1 Q26	Signal Inverter	VN2222LL FET Transistor
M1 U1	Squelch Amplifier	LM324 Integrated Circuit
M1 U2	Squelch Hold Timer	CD4001 Integrated Circuit
M1 U3	CW Amplifier	LM324 Integrated Circuit
M1 U4	Product Detector	CA3028 Integrated Circuit
M1 U5	Audio Amplifier	LM386N Integrated Circuit
M1 U6	Balanced Modulator	SL1640 Integrated Circuit
M1 U7	Selector	CD4094 Integrated Circuit
M1 U8	VOGAD	SL6270 Integrated Circuit

**TABLE 1-2.**  
**Semiconductors, PRC1099A, Continued.**

<b>DESIGNATOR</b>	<b>FUNCTION</b>	<b>DESCRIPTION</b>
M1 U9	Selector	CD4094 Integrated Circuit
M1 U10	Audio Amplifier	LM358 Integrated Circuit
M2 D1	Bias	1N4148 Diode
M2 D2	Bias	1N4148 Diode
M2 D3	AGC Rectifier	1N4148 Diode
M2 D4	AGC Rectifier	1N4148 Diode
M2 D5	Bias	1N4148 Diode
M2 D6	Gate	1N4148 Diode
M2 Q1	RX IF Amplifier	3N204 MOSFET
M2 Q2	RX IF Amplifier	2N5770 NPN Transistor
M2 Q3	TX IF Amplifier	2N5770 NPN Transistor
M2 Q4	AGC Amplifier	2N3565 NPN Transistor
M2 Q5	AGC Amplifier	2N3565 NPN Transistor
M3 D1	RF Switch	BA482 PIN Diode
M3 D2	RF Switch	BA482 PIN Diode
M3 D3	Clamp	1N4148 Diode
M3 D4	RF Switch	BA482 PIN Diode
M3 D5	Bias Clamp	1N4148 Diode
M3 D6	Bias Clamp	1N4148 Diode
M3 D7	RF Switch	BA482 PIN Diode
M3 D8	Bias	1N4148 Diode
M3 D9	Bias	1N4148 Diode
M3 D10	Bias	1N4148 Diode
M3 D11	RF Switch	BA482 PIN Diode
M3 D12	Bias	1N4148 Diode
M3 D13	RF Switch	BA482 PIN Diode
M3 D14	RF Switch	BA482 PIN Diode
M3 D15	RF Switch	BA482 PIN Diode
M3 D16	Gate	1N4148 Diode
M3 MX1	RX/TX Mixer	SRA1 Double Balanced Mixer
M3 Q1	Synthesizer Buffer	2N5770 NPN Transistor
M3 Q10	Synthesizer Buffer	2N5770 NPN Transistor
M3 Q11	TX IF Amplifier	3N204 MOSFET
M3 Q12	ALC Amplifier	2N3565 NPN Transistor
M3 Q2	Squelch Switch	2N3565 NPN Transistor
M3 Q3	RX IF Amplifier	2N5109 NPN Transistor
M3 Q4	Squelch Switch	2N3565 NPN Transistor
M3 Q6	Current Regulator	2N3638 PNP Transistor
M3 Q7	TX Switch	2N3565 NPN Transistor
M3 Q7	RX IF Amplifier	3N204 MOSFET
M3 Q8	RX Mixer	3N204 MOSFET
M3 Q9	RX Switch	2N3565 NPN Transistor
M3 U1	TX Amplifier	MAR8 MMIC
M3 U2	TX Mixer	MC1946 Integrated Circuit
M4 D1	Bias	1N4005 Diode
M4 D2	Bias	1N4005 Diode
M4 Q1	Final Pre Driver	MRF476 RF Transistor
M4 Q2	Final Driver	MRF476 RF Transistor
M4 Q3	Final Driver	MRF476 RF Transistor
M4 Q4	Final Power Amplifier	MRF406 RF Transistor
M4 Q5	Final Power Amplifier	MRF406 RF Transistor

**TABLE 1-2.**  
**Semiconductors, PRC1099A, Continued.**

<u>DESIGNATOR</u>	<u>FUNCTION</u>	<u>DESCRIPTION</u>
M4 Q6	Bias Regulator	2N5191 NPN Transistor
M4 Q7	Bias Regulator	2N5191 NPN Transistor
M4 Q8	Overtemp Switch	2N3565 NPN Transistor
<u>M5 Tuner Board</u>		
M5 D1	RF Current Rectifier	1N34 Diode
M5 D2	Clamp	1N4148 Diode
M5 D3	Clamp	1N4148 Diode
M5 U1	Op Amp	LM324 Integrated Circuit
M5 U2	Shift Register	CD4094 Integrated Circuit
M5 U3	Shift Register	CD4094 Integrated Circuit
M5 U4	Shift Register	CD4094 Integrated Circuit
M5 U5	Relay Drivers	MPQ2222 Transistor Array
M5 U6	Relay Drivers	MPQ2222 Transistor Array
M5 U7	Relay Drivers	MPQ2222 Transistor Array
M5 U8	Relay Drivers	MPQ2222 Transistor Array
<u>M5 Tuner Driver Board</u>		
M5 D1	Clamp	IN4148 Diode
M6 D1	Clamp	1N4148 Diode
M6 D2	Varactor Tuning	MV209 Varactor Diode
M6 D3	Clamp	1N4148 Diode
M6 D4	Varactor Tuning	MV209 Varactor Diode
M6 D5	Varactor Tuning	MV209 Varactor Diode
M6 Q1	BFO Oscillator	J310 JFET
M6 Q2	BFO Buffer	J310 JFET
M6 Q3	BFO Amplifier	MFE211 MOSFET
M6 Q4	ENM6A Inverter	VN2222L MOSFET
M6 Q5	Clock Inverter	VN2222L MOSFET
M6 Q6	SYN1 Oscillator	J310 JFET
M6 Q7	SYN1 Buffer	J310 JFET
M6 Q8	SYN1 Amplifier	MFE211 MOSFET
M6 Q9	SYN2 Oscillator	J310 JFET
M6 Q10	SYN2 Buffer	J310 JFET
M6 Q11	Amplifier	MRF904 NPN transistor
M6 Q13	ENM6C Inverter	VN2222L MOSFET
M6 Q16	Reference	BUFFERVN2222L MOSFET
M6 U1	Synthesizer 1	MB87086 Integrated Circuit
M6 U2	Mixer	NE602A Integrated Circuit
M6 U3	SYN2 Amplifier	MAR6 Integrated Circuit
M6 U4	Synthesizer 2	MB87086 Integrated Circuit
M6 U5	Comparator	MC33078 Integrated Circuit
M6 U6	+10 V Reference	MAX680 Integrated Circuit
M6 U7	DDS	STEL-1179 Integrated Circuit
M6 U8	D to A Converter	MB40760 Integrated Circuit
M6 U9	+8V Reference	LM317 Integrated Circuit
M7 D1	Polarity Protection	BAS16 Diode
M7 D2	Gate	BAS16 Diode
M7 D3	Gate	BAS16 Diode
M7 D4	Overvoltage Protection	IN6373 Transorb
M7 Q1	AGC Switch	MMBT2222L Transistor
M7 Q2	Tune Init Switch	MMBT2222L Transistor

**TABLE 1-2.**  
**Semiconductors, PRC1099A, Continued.**

<u>DESIGNATOR</u>	<u>FUNCTION</u>	<u>DESCRIPTION</u>
M7 Q3	Mute Switch	MMBT2222L Transistor
M7 Q4	PTT Switch	MMBT2222L Transistor
M7 Q5	AMP PTT Switch	MMBT2222L Transistor
M7 Q6	Switch	MMBT2222L Transistor
M7 Q7	AMP PTT INverter	MMBT2222L Transistor
M7 U1	Microprocessor	MC68302 Integrated Circuit
M7 U2	EPROM Low	27C512 Integrated Circuit
M7 U3	EPROM High	27C512 Integrated Circuit
M7 U4	RAM Low	MS6264 Integrated Circuit
M7 U5	RAM High	MS6264 Integrated Circuit
M7 U6	A to D Converter	ADC0804 Integrated Circuit
M7 U7	Voltage Selector	74HC02 Integrated Circuit
M7 U8	Interface	MAX242 Integrated Circuit
M7 U9	Watchdog Timer	MAX695 Integrated Circuit
M7 U10	Output Decoder	74HC138 Integrated Circuit
M7 U11	Inverter	74HC14 Integrated Circuit
M7 U12	Parity Tree	MC14531 Integrated Circuit
M7 U13	Multivibrator	MC14528 Integrated Circuit
M7 U14	Input Multiplexer	74HC4067 Integrated Circuit
M7 U15	Output Shift Register	74HC595 Integrated Circuit
M7 U16	Quad or Gate	74HC32 Integrated Circuit
M7 U17	Inverter	74HC04 Integrated Circuit
M7 U18	EPROM	93C46 Integrated Circuit
M7 U19	Audio Amplifier	MC33079 Integrated Circuit
M7 U20	Modem	M6946 Integrated Circuit
M7 U21	MOSFET Load Switch	SI9405 Integrated Circuit
M8 Q1	Backlight Switch	2N6427 NPN Transistor
M8 Q2	Backlight Oscillator	2N3567 NPN Transistor
M8 U1	Display Driver	PCF8576T Integrated Circuit
M8 U3	Backplane Generator	CD4020 Integrated Circuit
M8 U2	Display	Custom LCD
M9 D1	Voltage Clamp	IN5817 Diode
M9 D2	Polarity Protection	IN4005 Diode
M9 D3	Output Protection	IN6373 Transorb
M9 Q1	R8-T8 Switch	IN367 NPN Transistor
M9 Q2	R8-T8 Switch	IN3567 NPN Transistor
M9 U1	+5 V Switcher Regulator	MC34063 Integrated Circuit
M9 U2	+8 V Voltage Regulator	LM317 Integrated Circuit



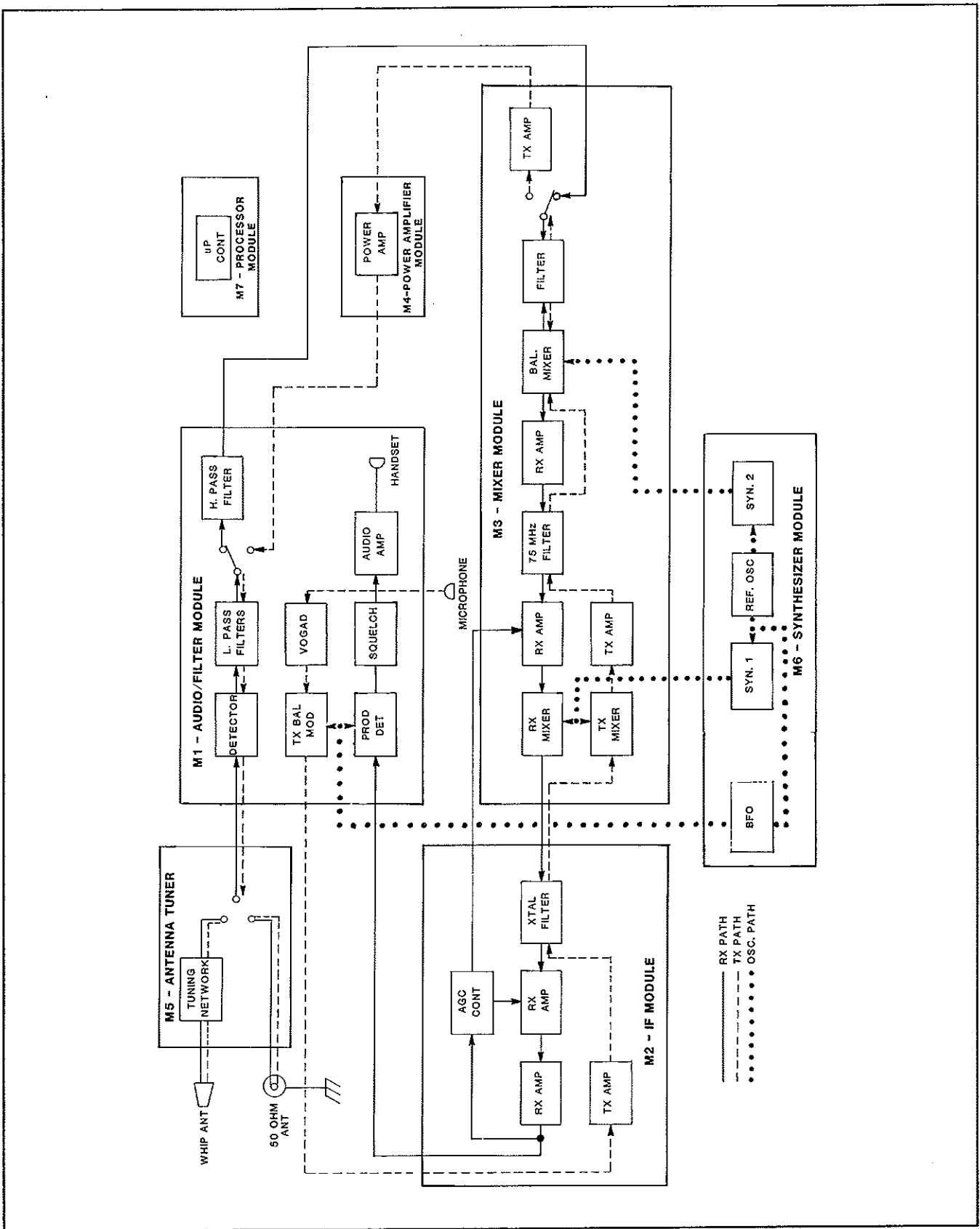
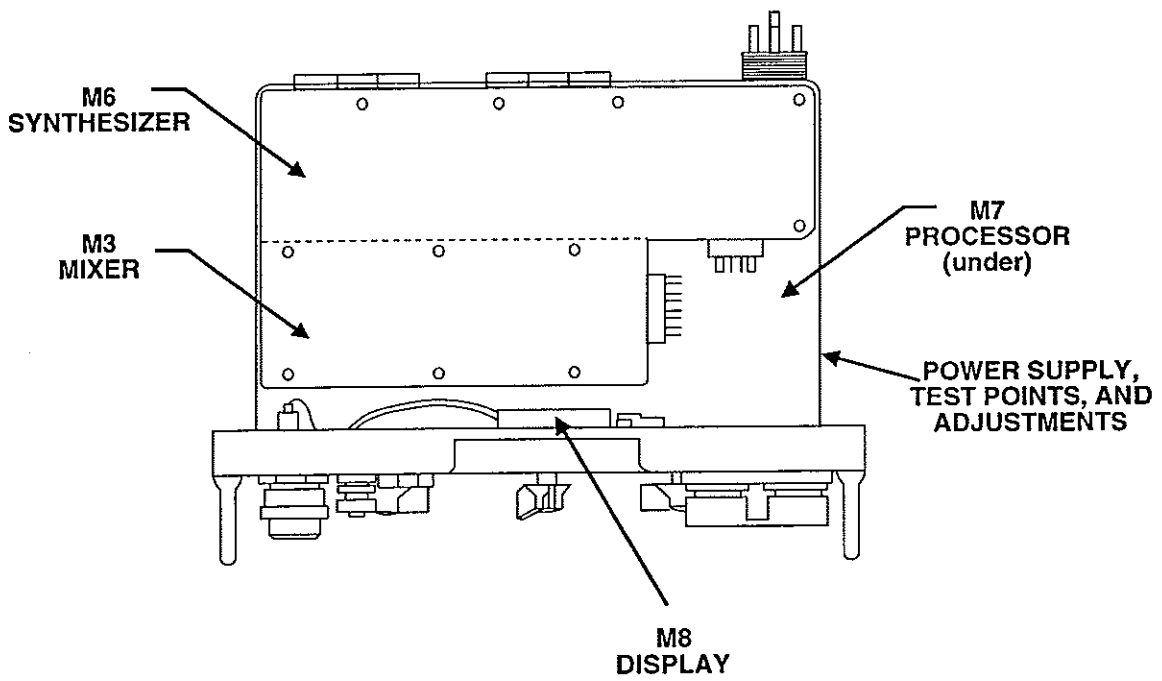
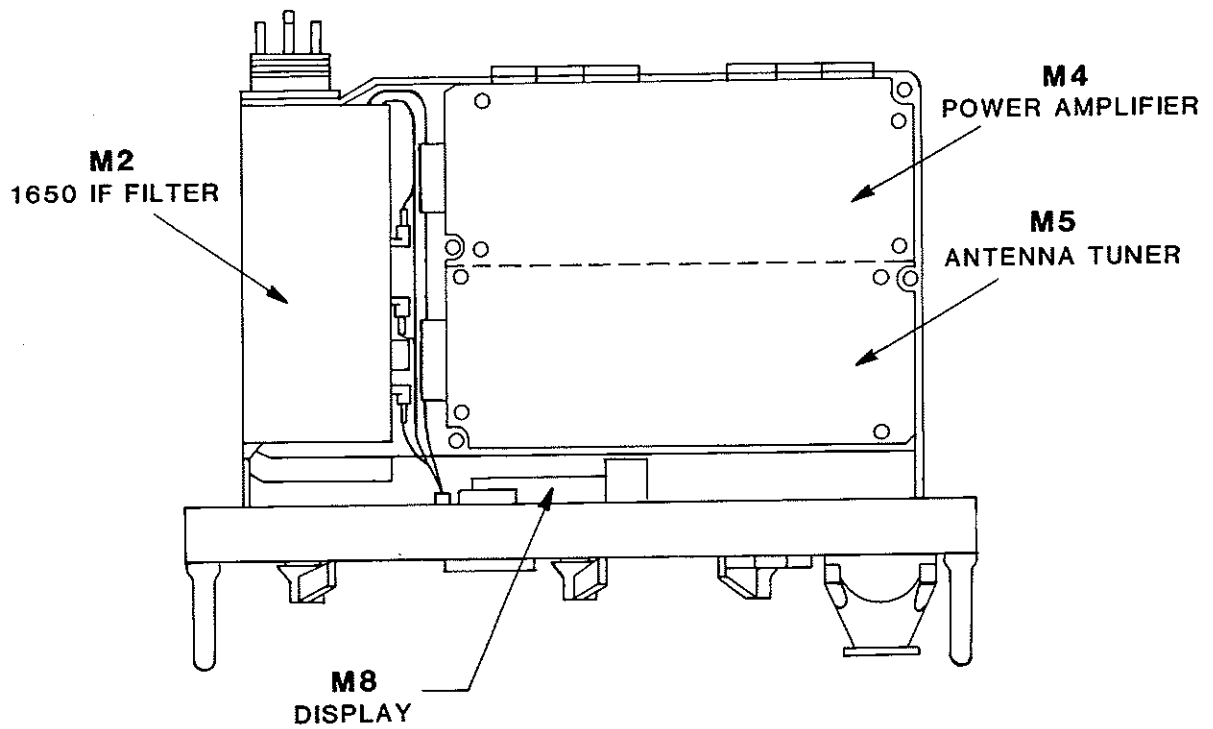


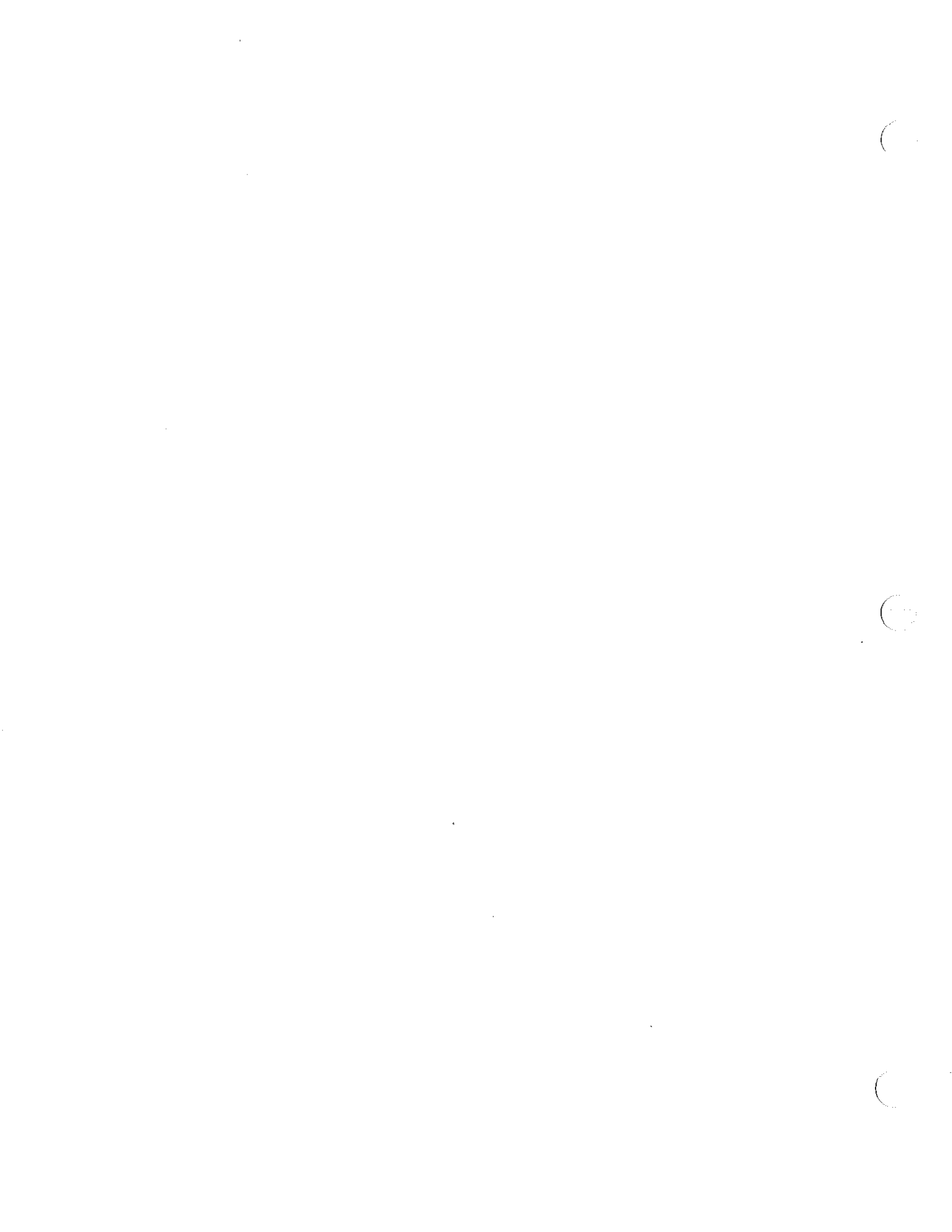
FIGURE 1-2.  
Block Diagram.



**FIGURE 1-3.**  
**Module Locations - Top.**



**FIGURE 1-4.**  
**Module Locations - Bottom.**



## CHAPTER 2

### SERVICE & MAINTENANCE

#### 2-1 SCOPE

This section contains information on the routine maintenance of the transceiver, the method of replacement of modules and components, the methods for locating defective modules, and a description of the recommended test equipment. This section does not cover the maintenance and service of the modules. Refer to the specific chapter for each of the individual modules.

Two separate levels of service are recommended—field service and depot service. The PRC1099A has been constructed so that the complex circuitry is contained in individual modules that may be easily replaced in the field. This section of the manual gives instruction on how to locate the defective module. The modules are designed so that no adjustments will be required after replacement, and the defective module can be returned to the service depot or factory for repair.

#### 2-2 GENERAL

The PRC1099A is a complex transceiver using advanced design techniques to ensure high-performance, trouble-free service. It is essential to recognize that the PRC1099A must be serviced by skilled personnel using the correct test equipment and with a full understanding of the operation of the transceiver.

#### 2-3 TEST EQUIPMENT

Specific models of test equipment have been recommended for servicing the PRC1099A. A description of the key characteristics relevant to the PRC1099A is given for each instrument.

**TABLE 2-1.**  
**Test Equipment.**

<u>ESSENTIAL</u>	
Synthesized Signal Generator:	Frequency Range = 1-105 MHz (minimum) Calibration x Setting Accuracy = 1 kHz (minimum) Output = .1 $\mu$ V to 1 V (with accurate attenuator)
Sinad/Audio Level Meter:	Measures SINAD at 1000 Hz/Audio Level
Electronic Multimeter:	General Purpose Input Impedance 11 M $\Omega$ (minimum)
Digital Voltmeter:	General Purpose Accuracy 1% (10 V Range)
Frequency Counter:	Frequency Range = 1-105 MHz Accuracy = 1 ppm (minimum)
Wattmeter:	Impedance = 50 $\Omega$ Power = 50 W (full scale) Frequency = 2-30 MHz (Thru-line, 50 W Element x Load)
Power Supply:	12 V 8 A Regulated
<u>OPTIONAL</u>	
Oscilloscope:	General Purpose Frequency response 100 MHz
Audio Signal Generator:	300-3000 Hz
RF Millivoltmeter:	Frequency Range = .5-100 MHz Ranges 10 mV to 3 V
Spectrum Analyzer:*	Frequency Range = 1-105 MHz Resolution = 100 Hz

## 2-4 MEASUREMENT TECHNIQUES

The following information will be helpful to technicians and engineers who have not had previous experience in testing modern synthesized equipment.

### 2-4.1 POWER MEASUREMENT

The power output of the PRC1099A is 20 W PEP (peak envelope power) or average. This means that the power output will be 20 W average in the CW mode and will have an instantaneous peak output of 20 W on voice peaks. In the CW mode or on a continuous sinewave tone, an average reading power meter such as the Bird Model 43 will indicate the correct output. On voice or a two-tone test signal, the meter will indicate the average power, which is much lower than the peak power. The meter will typically indicate 5-7 W on a voice waveform. On a two-tone test signal the typical power output will be 8 W as read on the Bird Model 43. Refer to Figures 2-1 and 2-2.

The power output must be read at the 50-ohm BNC connector with no antenna mount in the antenna connector. The 50-ohm connector is disconnected when the antenna mount is placed in the antenna connector.

The supply voltage should be at least 12V under load when making power measurements. The current drain for voice operation is much lower than when operating CW. This means that even when the battery voltage is too low for high-power CW operation, there may be sufficient capacity for satisfactory voice operation.

The power amplifier in the PRC1099A has a substantial reserve capacity and is capable of 25-30 W output. It is not recommended that the power level be set higher than 20 W, as this will simply increase power consumption without any perceptible improvement in signal strength. It is necessary to at least double the output power before there will be any noticeable improvement in performance.

### 2-4.2 SPECTRUM ANALYZER

Although a spectrum analyzer is not an essential test instrument for servicing the transceiver, it is a useful instrument for testing SSB equipment. The spectrum analyzer operates in the frequency domain and permits simultaneous ex-

amination of both frequency and amplitude. This characteristic is very useful for examining the various RF signals for spectral purity and spurious products. For example, the output from the phase-locked loop in the transceiver can be examined to ensure that the loop is locking correctly, the phase noise is satisfactory, and there are no spurious outputs. The spectrum analyzer may be connected, through an attenuator, to the transceiver output and will display harmonics and unwanted spurious outputs. It is very important not to overload the spectrum analyzer when making harmonic measurements. If the input level is too high, the mixer in the spectrum analyzer will generate harmonics internally.

The spectrum analyzer may also be used to measure distortion by using a two-tone test signal. Two equal amplitude audio tones in the transmitter audio passband are used to drive the transmitter to full power output (20 W PEP). The distortion products will appear as signals displaced by the separation of the tone frequencies. It should be noted that the PEP of the transmitter is 6 dB higher than the level of each tone in the two-tone test waveform. This means that if the third order distortion products are 26 dB below each wanted tone, the intermodulation distortion level is -32 dB relative to PEP.

### 2-4.3 SIGNAL GENERATOR

The signal generator is primarily considered an instrument for testing the receiver. It is also a convenient instrument for injecting controlled signals of known frequency and amplitude into different parts of the transceiver. For example, the signal generator may be used as a temporary substitute for one of the synthesizers.

### 2-4.4 FREQUENCY COUNTER

Apart from the important function of frequency calibration, the frequency counter is a useful tool for servicing the synthesizer. By connecting the counter to different points in the circuitry, it is possible to check that the correct divide ratios are occurring in the synthesizer.

## 2-5 ROUTINE MAINTENANCE

Refer to Chapters 4 and 5 of the PRC1099A-TM1 Operator's Manual.

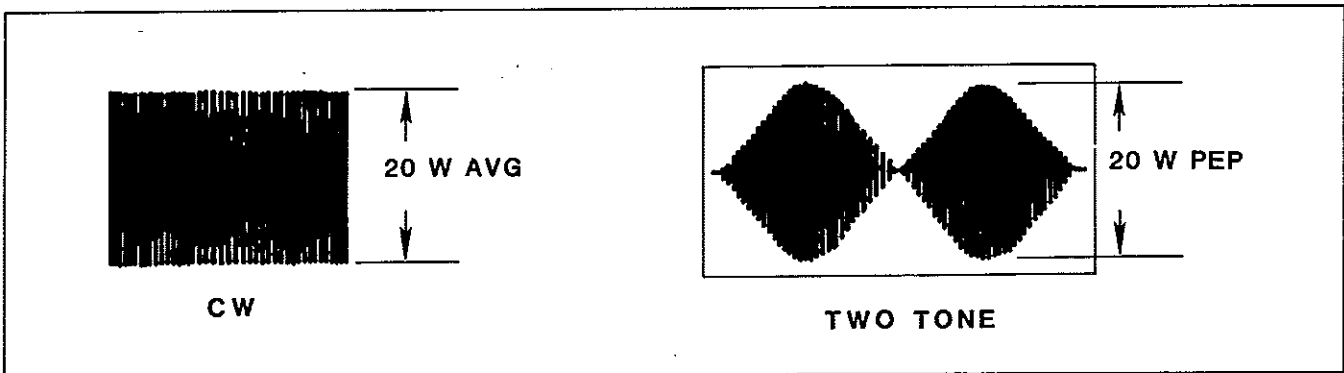
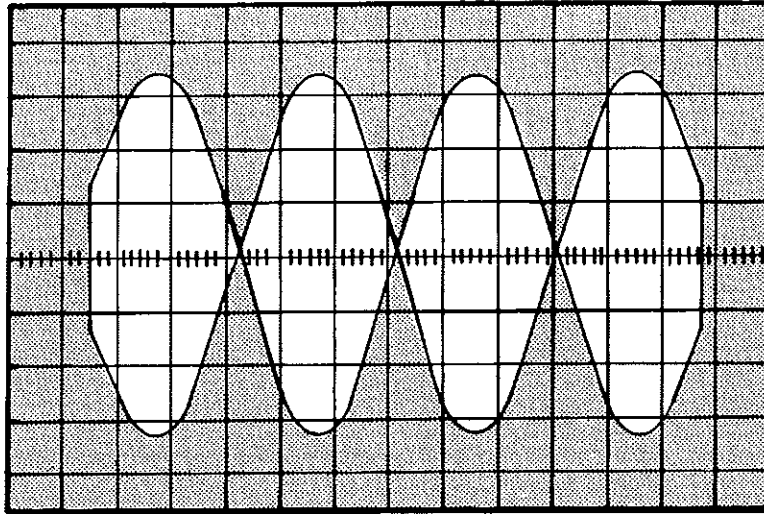


FIGURE 2-1.  
Power Measurement Waveforms.



**FIGURE 2-2.**  
**Two-Tone Test Signal.**

## 2-6 ACCESS & MODULE REMOVAL

### 2-6.1 CASE REMOVAL

Stand the PRC1099A on its front panel (Figure 2-3). Remove the battery case and the battery. Loosen the captive screws and pull the case from the chassis (Figure 2-4). If necessary, insert a flat-blade screwdriver between the front panel and the case to pry off the case.

### 2-6.2 ACCESS

All of the modules, except M1, the Audio Module, are directly accessible when the transceiver is removed from the case. The covers on the modules may be removed, for access to adjustments, while the modules are in place. The Audio Module M1 is mounted in the center of the transceiver between modules M3/M6 and M4/M5 and is accessed by removing the two retaining screws. This permits modules M4/M5 to hinge from the back of the transceiver as shown in Figure 2-5.

## 2-6.3 REMOVAL OF MODULES

### 2-6.3.1 M1 REMOVAL

Access the module as described in Section 2-6.2. Remove the connectors from M4 and M5 and the antenna connection from M5. This permits the M4/M5 mounting bracket to swing full open. Disconnect the two RF connectors from the under side of M4 and M5 and the multipin connectors at the side of the M1 circuit board. Remove the four mounting screws at the corners and a center mounting screw, and carefully lift the module up, disconnecting it from the bottom entry connector pins to the processor.

### 2-6.3.2 M4 REMOVAL

Remove the RF connector from under the module (2-6.3.1). Remove the end connector. Unscrew the two retaining bolts.

### 2-6.3.3 M5 REMOVAL

Remove the RF connector from under the module (2-6.3.1). Remove the end connector. Disconnect the antenna wire. Unscrew the two retaining bolts.

### 2-6.3.4 M3/M6 ASSEMBLY REMOVAL.

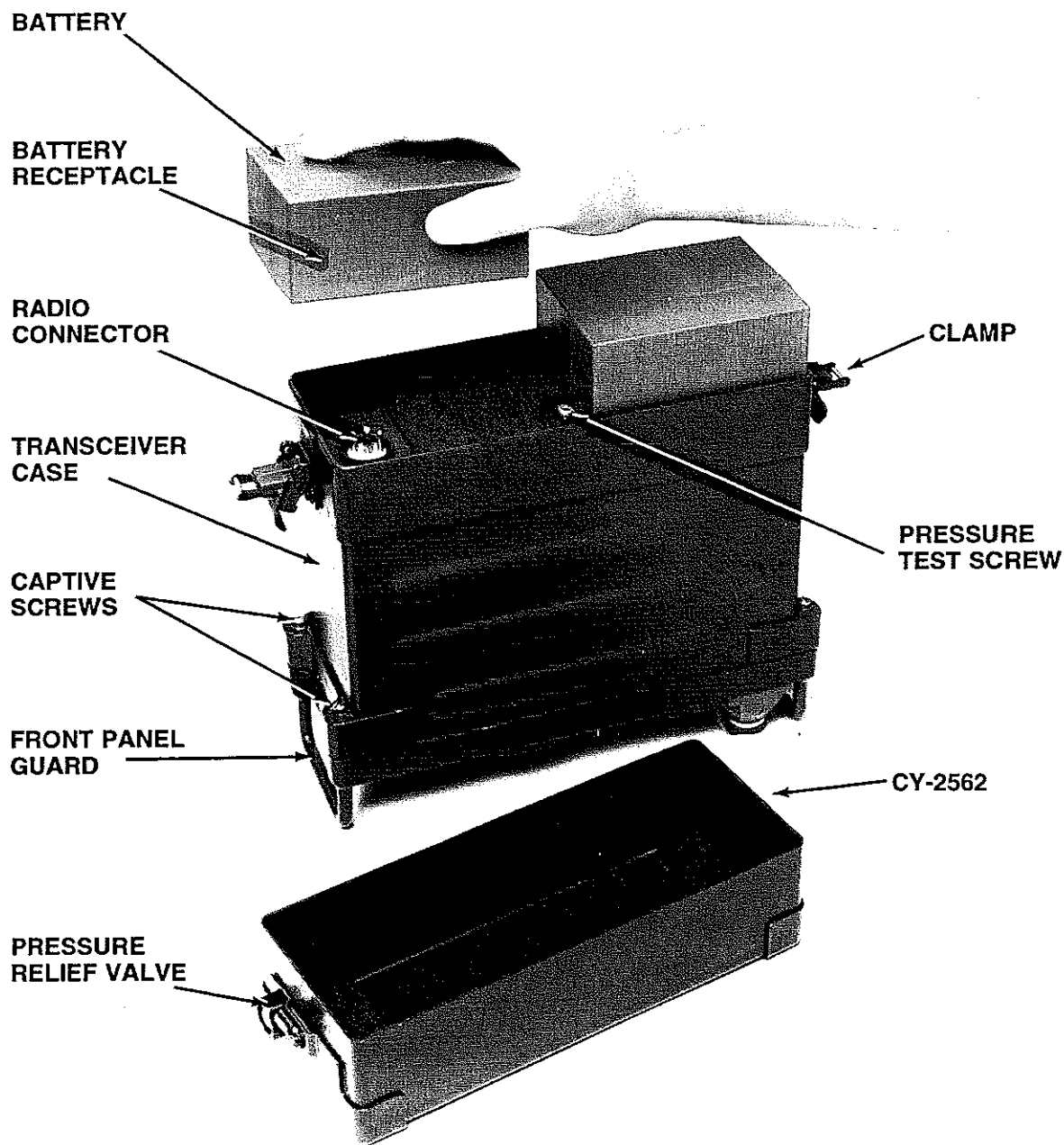
Disconnect the two multi-pin connectors from the M3/M6 assembly. Unscrew the six PAN head screws and remove the assembly.

#### 2-6.3.4.1 M3 REMOVAL

Disconnect the larger multi-pin connector from the M3/M6 assembly. Remove the 11 FLAT head screws holding down the assembly cover, remove cover. Disconnect the two coax connectors connecting to the M6. Remove the six mounting screws and remove the board.

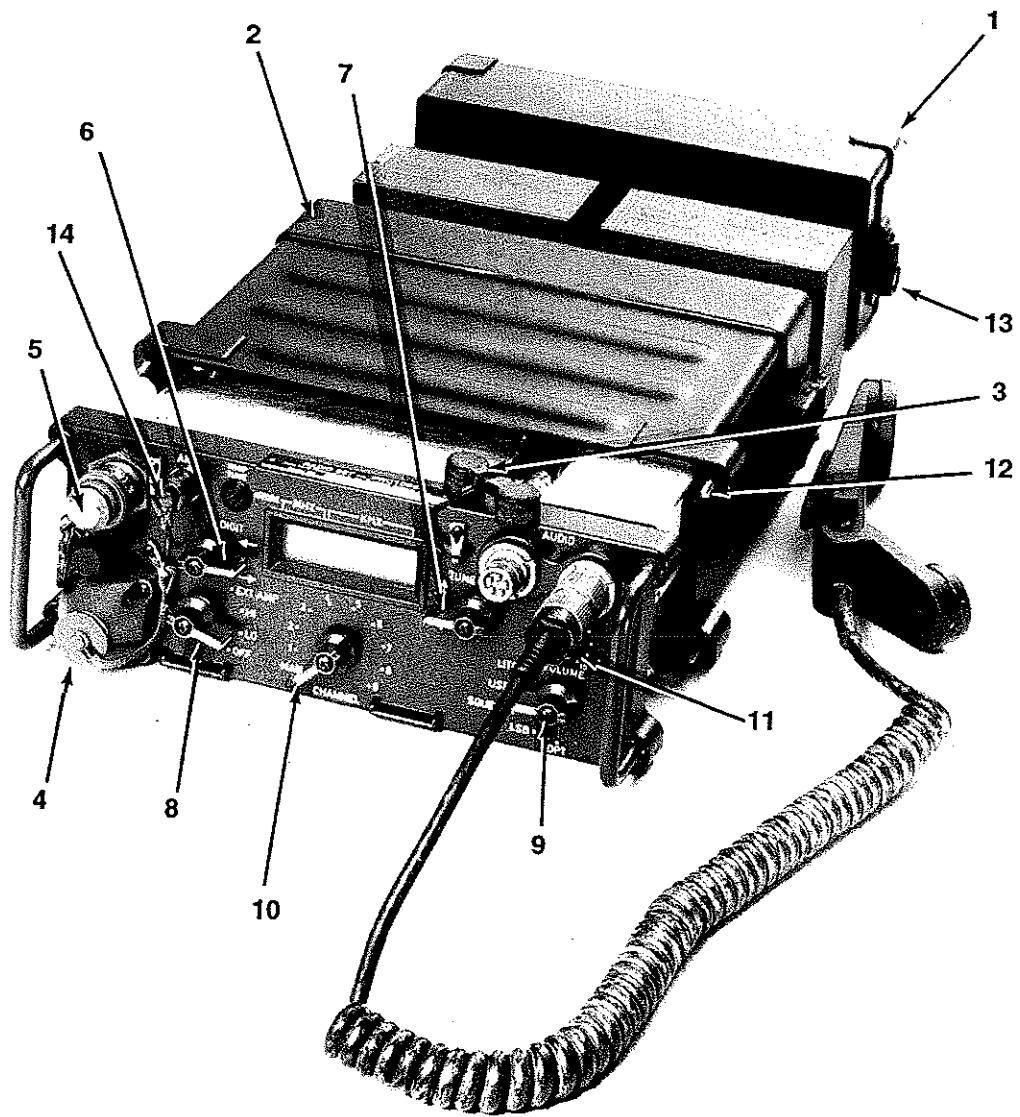
#### 2-6.3.4.2 M6 REMOVAL

Disconnect the smaller multi-pin connector from the M3/M6 assembly. Remove the 11 FLAT head screws holding down the assembly cover, remove cover. Disconnect the two coax connectors coming from the M3. Remove the six mounting screws and remove the board.



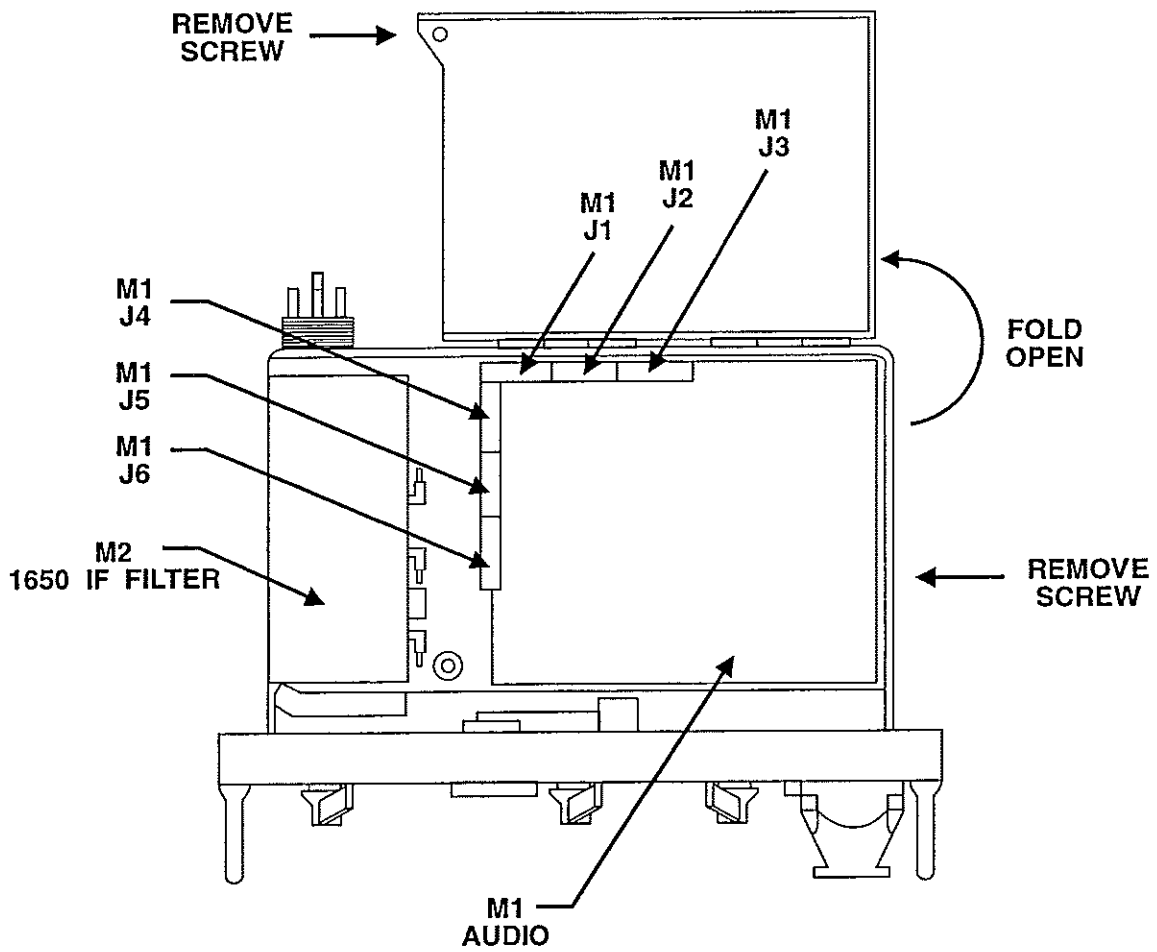
**FIGURE 2-3.**  
**Installation of Battery in Transceiver.**





- |   |   |
|---|---|
| 1. CY-2562                                  | 8. Knob, long-handled (power switch)    |
| 2. Case, transceiver                        | 9. Knob, long-handled (mode switch)     |
| 3. Cover, double rubber connector protector | 10. Knob, long-handled (channel switch) |
| 4. Cover, antenna dust                      | 11. Knob (VOLUME)                       |
| 5. Cover, BNC                               | 12. Screw, captive                      |
| 6. Knob, long-handled (DIGIT Select)        | 13. Hook                                |
| 7. Knob, long-handled (TUNE)                | 14. Dummy connector, plug               |

**FIGURE 2-4.**  
**Receiver/Transmitter, Radio Set PRC1099A—Organizational Repair Parts.**



**FIGURE 2-5.**  
**Module Location Diagram - M1 Access.**

### 2-6.3.5 M2 REMOVAL

Remove the two side retaining screws. Loosen the two retaining screws on the center plate next to M1. Tilt the module sideways to disengage the slots in the cover from these screws. Remove the three RF connectors and the power connector so the module can be lifted out.

### 2-6.3.6 M7 REMOVAL

Remove the M3/M6 assembly (2-6.3.4). Disconnect the 34-pin ribbon cable from the front of the M7. Remove the six mounting screws and carefully lift the board to disengage the rear-entry connectors from the M1 module.

### 2-6.3.7 M8 MODULE

With the PRC1099A laying flat, right side up, remove the top two screws on either side of the front panel. Loosen the bottom two screws, but do not remove them. Tilt the front panel forward to gain access to the M8 module. Tighten the bottom screws again to keep the front panel in place. Disconnect the three connectors and remove the four mounting screws and the board.

### 2-6.3.8 M9 MODULE

Remove the M2 module (2-6.3.5). Disconnect the three connectors and unsolder the two wires from the battery connector. Remove the four mounting screws and remove the board.

### 2-6.3.9 FRONT PANEL

Remove the M3/M6 assembly (2-6.3.4). Disconnect the 34-pin ribbon cable from the front of the M7 module. Disconnect the four-pin cable from the M9 module. Disconnect the ten-pin connector from the M1 module. Remove the four screws connecting the front panel to the chassis. Unsolder the coaxial cable connecting to the 50-ohm port on the front panel.

## 2-7 SEMICONDUCTOR SERVICING

### General

There are two distinct classes of semiconductors used in the transceiver: discrete devices, such as transistors and diodes, and monolithic integrated circuits (see Table 1-2). Considerable information can be found about the operation of the transistors and diodes by measuring the voltage on the various leads. With integrated circuits, there is no external access to much of the circuitry, and it is often necessary to use the "black box" or substitution approach to servicing.

### Signal & Switching Diodes

All diodes may be checked with an ohmmeter. They should show a low forward resistance and a very high back resistance. Check the circuit before making any measurements, as the diode will frequently be shunted by other components—requiring one lead to be lifted before the measurement can be made.

Many of the diodes are used as switches or gates. If the diode is operating correctly, there will be a drop of ap-

proximately 0.7 V across the diode junction in the ON state.

### Varactor Diodes

The varactor diode is designed to change capacitance across the reverse-biased junction as the voltage applied to it is changed. Varactors exhibit the same resistance characteristics as signal diodes and can be checked in the same way.

### Bipolar Transistors

An out-of-circuit method of checking bipolar transistors is to consider the base-emitter and the base-collector junctions as two separate diodes. One lead of the ohmmeter is connected to the base and the other is first connected to the collector and then to the emitter. The ohmmeter leads are then reversed in polarity and the test repeated. This test should indicate high resistance with the leads in one polarization and low resistance in the other. Only in rare instances will a transistor passing this test prove to be faulty in other ways.

A simple in-circuit check of a transistor can be made with a VTVM. The potential across the base-emitter junction should be about 0.7 V. A substantial difference indicates a fault in the transistor or possibly in the surrounding circuitry.

### Integrated Circuits

Complex internal IC circuitry makes it impractical to do any analytical fault finding in the device itself. The best approach to servicing them is to isolate the fault to a particular stage. Pin voltages should then be checked against typical values given in the charts. If there are any substantial variations, first check the surrounding circuit components. Finally, the IC may be checked by substitution.

## 2-8 COMPONENT REPLACEMENT

### Circuit Boards

All transceiver printed circuit boards are heavy epoxy fiberglass with 2-oz. tinned copper foil, which meets applicable military specifications. Faults in the board are not likely to occur, unless careless procedures are used when replacing components. If correct procedures are followed, components can be replaced many times without damage to the board. Most integrated circuits are installed in sockets, which makes replacement very simple.

Begin with the correct tools. The soldering iron must have a small instrument-type tip no larger than the circuit board pads. However, do not use a tiny, low-temperature, instrument-type iron. It must have sufficient heat to melt the solder quickly, otherwise component and/or board damage can occur.

Use the iron to melt the solder at the connection. While still molten, remove it with a desoldering tool. (These come in many forms, but even a simple type, consisting of a suction pump with a teflon tip, will be satisfactory.) After all solder

has been removed, the component can be taken out with a gentle tug. To reduce the risk of board damage, do not exert any stress on the foil while removing the component, especially when the connection is hot. The copper foil adhesive forms an extremely strong bond to the board when cold, but can be removed fairly easily at soldering temperature.

Before installing the new component, it is important to clear the holes of any remaining solder. This can be achieved by again applying heat and using the desoldering tool. A frequent cause of foil damage is to push the component through the hole and melt the solder at the same time. If the lead catches, it will frequently lift the foil from the board.

## 2-9 GENERAL FAULT LOCATION - TABLE 2-2

It is possible for non-technical personnel to deduce the reason for numerous faults without opening the transceiver case. Table 2-2 lists those faults that can be identified by operation of the controls and through various indications.

## 2-10 BASIC MODULE FAULT LOCATION - TABLE 2-3

This information is a basic guide to locating faulty modules without the use of test equipment (some fault conditions cannot be recognized in this manner). If this approach is not successful, the modules should be replaced systematically until the faulty one is located. Remember that some of the preliminary tests can indicate which modules are operational. For example, the synthesizer module M6 is used in both the receive and transmit modes. This means that M6 is not faulty if either the transmitter or receiver is operational.

Before replacing any modules, check all cable connections carefully. A broken wire or a loose connector may prevent the module from operating. When modules are replaced, it is not normally necessary to make any adjustments or to realign the transceiver.

All modules may be replaced using a screwdriver. The correct procedure is described in Section 2-6.

## 2-11 MODULE FAULT LOCATION - DETAILED PROCEDURE

### 2-11.1 INTRODUCTION

This section gives more specific information on the methods for measuring the performance of each module. Expert technical knowledge is not required but it is necessary to understand the operation of test equipment. It is recommended that Section 2-10 be followed to locate the fault area and then use Section 2-11 to confirm the nature of the fault.

### 2-11.2 POWER SUPPLY & SWITCHING

The transceiver should be connected to an external 13.8-V, 5-A power supply. Use either the PRC1099A-PS ac power supply or the PRC1099A-CA12V battery cable. It should be noted that the PRC1099A-CA12V contains a protective diode to prevent damage if the polarity of the power sup-

ply is accidentally reversed. There will be a small voltage drop across this diode.

Switch the transceiver on (LO power) and ensure that the supply voltage is 12 volts, the +8 V and R8 are 8 volts, and +5 V is 5 volts. Press the microphone switch and check that the voltage on the T8 line is 8 volts.

The voltage regulators and voltage-adjustment controls are located on the M9 module, along with the R8 and T8 clamps.

It is essential that the correct operating voltages are present before checking the transceiver. Check the power supply, wiring, and module connections before replacing M1 or M7.

### 2-11.3 SYNTHESIZER & MIXER MODULES M3/M6

If the radio works correctly in either the transmit or receive mode, the synthesizer (M6) is operating correctly.

To make the following measurements, remove the ten screws and the cover from the M3/M6 assembly. This gives easy access to the RF input and output connections on the modules.

**Synthesizer 1.** Connect a frequency counter to SYN1 output from M6. The frequency should be the operating frequency + 75 MHz. For example, if the operating frequency is 5.123 MHz, the synthesizer output should be 80.123 MHz.

**Synthesizer 2.** Connect the frequency counter to SYN2 output from M6. The frequency should be approximately 73.35 MHz. It need not be precisely on 73.35 MHz.

**BFO Output** Connect a frequency counter to BFO output on the M6. The frequency should be 1650 kHz in USB, 1647 kHz in LSB

**Transmit Mode.** Connect oscilloscope to "TX OUT" and the signal generator to "1650-kHz I/O." Set the frequency to 1650 kHz and the output level to -10 dBm. The output measured on the oscilloscope should be approximately 0.5 V PEP at the transceiver operating frequency.

**Receive Mode.** Connect the oscilloscope to "1650 kHz I/O" and the signal generator to "RX IN." Set the signal generator to the transceiver operating frequency and the output level to -60 dBm. The output measured on the oscilloscope should be approximately 20 mV PEP at 1650 kHz.

### NOTE

If the receiver is not operating, check the AGC voltage at J1-5 (4 V). The AGC voltage is supplied by M2, and a fault in this module could prevent M3 from operating correctly in the receive mode.

#### 2-11.4 M2 IF MODULE

**Receive Mode.** By using the receive stages in this module, sidetone is generated to listen to the transmitter-exciter low-level output. Normal sidetone confirms this module is operating correctly in the receive mode.

**Transmit Mode.** Connect the signal generator to "TX IN." Adjust the output level to -18 dBm at 1650 kHz. When keyed, the transmitter will have normal output, if M2 is operating correctly.

#### 2-11.5 M1 AUDIO/RF FILTER MODULE

First check for normal operation of M2 and M3/M6.

**Receive Mode.** The transmit audio sidetone indicates this module is operating correctly. Check for low-level hiss with audio gain at maximum.

**Transmit Mode.** Check that the transmitter is operating normally (2-11.4). The presence of the audio sidetone indicates the TX audio stages are operating correctly. If the transmitter operates normally in the CW mode but not on voice, the problem will be in the handset or the audio connections to the module.

**T/R Switching.** The T/R relay can be examined visually for closure when the PTT switch is depressed.

**RF Filters.** The filters switch at 3.1, 5.1, 8.0, 13 and 20 MHz. Incorrect operation in one filter range indicates a problem in the switching relays or the filter.

**Tone Oscillator.** The tone oscillator used for CW and antenna tuning is located on M1.

#### 2-11.6 M4 PA MODULE

Connect the signal generator to "TX IN." Set the frequency to that of the transceiver. Increase the output level until the

power output is 20 W. The drive level should be approximately +3 dBm.

#### 2-11.7 M5 ANTENNA TUNER MODULE

Press the tune button. The tuner should go through the tune cycle. If the pulse tune tone indicates that the tuner did not achieve a correct match, check the antenna connections and try retuning on a different frequency. If the tune cycle does not initiate, ensure that the antenna mount or long-wire adapter is opening the switch at the base of the antenna post.

#### NOTE

The antenna tuner is controlled by the microprocessor. A fault in M7 will normally also cause many other transceiver control malfunctions.

#### 2-11.8 M7 MICROPROCESSOR MODULE

The synthesizer, display, antenna tuner, and many of the control functions are under direct control of the microprocessor. A fault in this module will normally cause multiple malfunctions in the transceiver and the module should be checked by direct replacement.

**Loss of Memory.** The lithium battery for memory backup is located on M7. This battery should be replaced if channel memory is not retained when the transceiver is switched off.

#### 2-11.9 M8 DISPLAY MODULE

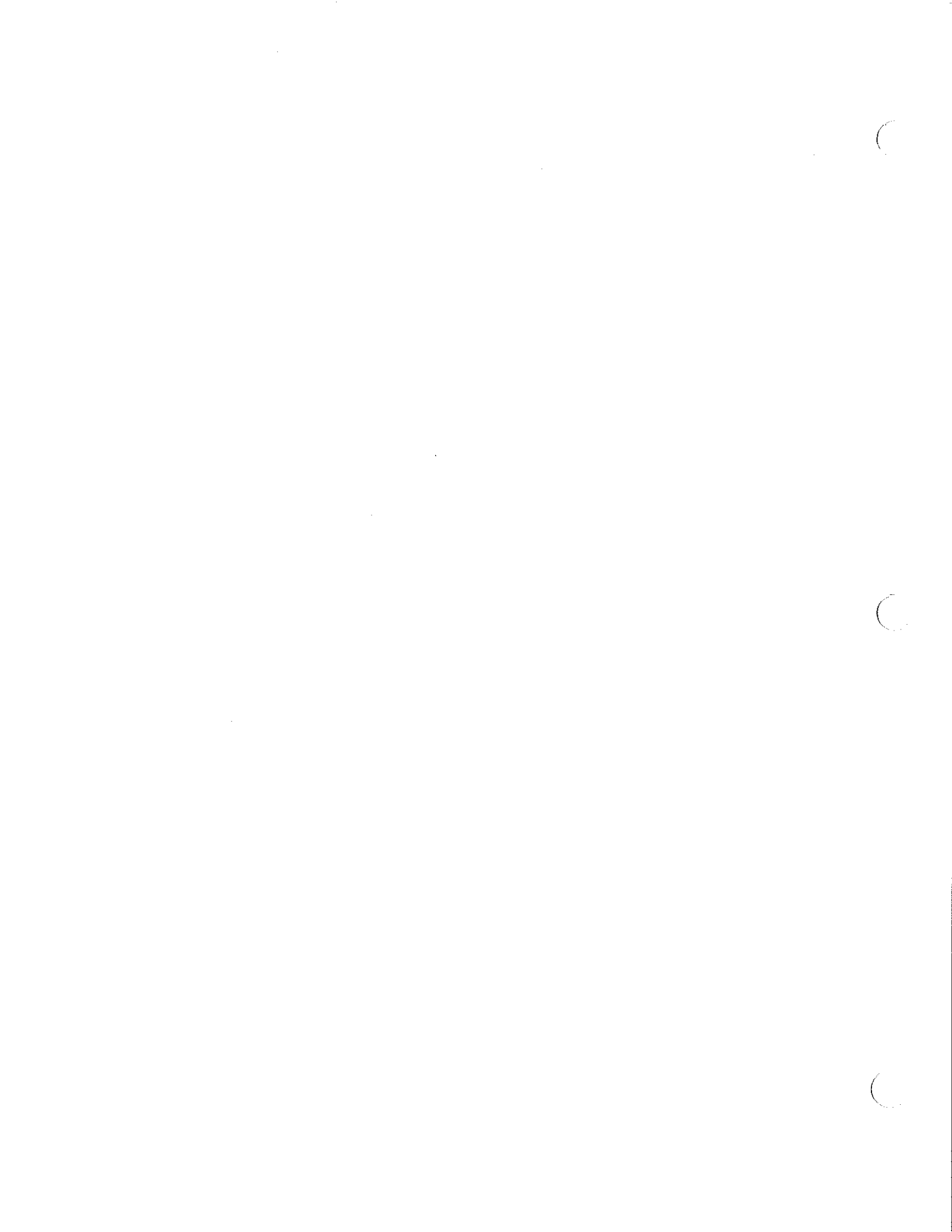
Only if all other transceiver functions are normal should the display module be replaced.

**TABLE 2-2.**  
**General Fault Location Chart.**

<b>SYMPTOM</b>	<b>POSSIBLE FAULT</b>	<b>ACTION</b>
1. No Display	Battery Dead	Turn mode switch to USB and listen for receiver noise. No noise indicates a dead battery. Receiver noise indicates a display fault.
2. No Audio	Handset Fault	Check for sidetone during TX. If sidetone is present, handset is operative and a receiver fault is indicated.
3. No Sidetone (RX Audio Present)	Transmitter Not Operating	Absence of an audible tone in the handset speaker means that the transmitter is not providing the correct output power. Sidetone audio is inhibited by lack of RF output. Retune the antenna, as an incorrect match may restrict output power.
4. Sidetone Distorted	Fault in transmitter exciter or receiver.	The sidetone is generated by listening to the transmitted signal in the receiver. This provides a positive test that the low-level stages are operating correctly.
5. Battery Icon Illuminated	Battery Voltage Low	Replace battery.
6. Receiver Audio Garbled	One of the stations is set to the wrong frequency or out of calibration.	Use tune control to retune receiver.
7. No communication: Receiver & Transmitter appear to operate normally	Incorrect frequency. Incorrect sideband.	Check displayed frequency. Check Mode Switch (USB normal).

**TABLE 2-3.  
Module Fault Location Chart.**

<p><b><u>PRELIMINARY</u></b>            Check supply voltages +12, +8, and +5.            Measure R8. Should read 8 V.            Press PTT switch. Relay K13 on the M1 should close.            Measure T8. Should read 8 V.</p>	
<p><b><u>M1 AUDIO/FILTER MODULE</u></b>            Audio completely dead, not even slight hiss, squelch off, and maximum audio gain.            TX has no output except in CW mode.</p>	<p>Module or handset defective.             Handset defective.</p>
<p><b><u>M2 1650-kHz IF MODULE</u></b>            Receiver operational.             Disconnect "RX Out" coax connector.</p>	<p>Module should also be operating in transmit mode.            If noise level does not decrease, module is defective.</p>
<p><b><u>M3 MIXER MODULE</u></b>            Disconnect 1650-kHz coax connector from M2 IF module.</p>	<p>If receiver noise level does not decrease, module is defective.</p>
<p><b><u>M4 RF POWER AMPLIFIER</u></b>            No simple check without instruments.</p>	<p>Voltages and connections should be carefully checked before replacement.</p>
<p><b><u>M5 TUNER MODULE</u></b>            Tuner does not tune when tune button is pressed.</p>	<p>Check antenna mount or long-wire adapter is screwed into antenna post.</p>
<p><b><u>M6 SYNTHESIZER</u></b>            Transceiver operates in either transmit or receive mode.</p>	<p>Module is operational.</p>
<p><b><u>M7 MICROPROCESSOR MODULE</u></b>            Multiple operating malfunctions.             Memory functions not retained.</p>	<p>The microprocessor controls all of the tuning, mode and switching functions.            Replace lithium battery. (Nominal life is 10 years).</p>
<p><b><u>M8 FREQUENCY DISPLAY MODULE</u></b>            Transceiver appears to be operating correctly but display is not operating.</p>	<p>Check connections.</p>
<p><b><u>M9 JUNCTION MODULE</u></b>            +5, +8, and +12 V supplies missing.</p>	<p>Module defective.</p>
<p><b><u>MICROPHONE</u></b>            Transmitter does not operate.</p>	<p>Check by replacement of handset.            Ground pin C of connector and touch pin B with hand. If transmitter shows RF output, microphone is faulty.</p>





## CHAPTER 3

# GENERAL THEORY OF OPERATION

---

### 3-1 INTRODUCTION

This is a general description of the transceiver. Chapters 4 through 12 give a detailed circuit description of each module as well as technical specifications and servicing data.

### 3-2 FREQUENCY CONVERSION PLAN

The transceiver uses an up conversion plan with the first IF at 75 MHz. This system is used so that the major spurious products fall between 151.6 and 180 MHz, where they can be easily removed by simple low-pass filters. Transmitter spurious responses from a correctly designed double-balanced mixer will be below -70 dBc across the entire operating range. The double-balanced mixers have a level response well into the VHF range and both the receiver and the transmitter exciter have a level response from 1.6 to 30 MHz. This broadband response is achieved without any tuning adjustments.

A special VHF crystal filter provides selectivity at 75 MHz. The 3-dB bandwidth is 30 kHz and the stopband is -70 dB. This filter provides sufficient selectivity at the first IF to prevent overload of the second mixer by powerful out-of-band signals. It is necessary to provide a high degree of selectivity to eliminate interference from adjacent in-band signals, and to generate a clean SSB signal. The transceiver uses a second IF of 1650 kHz. At this frequency, it is easy to provide a stable, high-selectivity crystal filter. The transceiver uses a high-performance, six-pole crystal filter for USB and LSB operation.

To produce the first IF output at 75 MHz, the first loop in the synthesizer must generate an oscillator signal between 76.6 and 105 MHz. The synthesizer generates this frequency range in 10-Hz steps. The second conversion from 75 MHz to 1650 kHz requires an oscillator injection frequency of 73.35 MHz.

Selectable USB/LSB operation is provided by using separate BFO frequencies of 1650 and 1647 kHz, respectively. The synthesizer is automatically offset by 3 kHz when the sidebands are switched and there is no change in the output frequency.

### 3-3 SYNTHESIZER

The synthesizer derives from a single reference oscillator, the first LO, and the BFO. The BFO is set to either 1647 kHz or 1650 kHz, depending upon sideband selection. The first LO is from 75 to 105 MHz, variable in 10-Hz steps. The second LO is a stationary oscillator operating at 73.35 MHz. To provide the stable reference frequency, a Temperature Controlled Crystal Oscillator (TCXO) is used. This TCXO has a standard frequency tolerance of 1 ppm over a temperature range of 0° to +50° C. The complete frequency determination of the entire transceiver is locked

to this reference, giving an output frequency stability equal to the frequency stability of the TCXO.

The first LO uses a phase-locked loop which moves in steps of 1.048576 MHz. These frequency steps are further divided into 10-Hz steps by use of a DDS interpolation generator which operates from 5.951424 to 7 MHz. Since the first LO is capable of 10-Hz resolution, the second LO is a stationary oscillator set to 73.35 MHz.

The second LO, stationary at 73.35 MHz, is derived from a separate crystal oscillator. This frequency is used in the DDS interpolation circuit in the first LO, as well as the second LO. Therefore, any frequency error in the second LO will be completely cancelled out as far as the transceiver tune frequency is concerned.

The BFO frequency is supplied by a separate phase-locked loop, which is required to supply only two frequencies, 1647 and 1650 kHz. These frequencies are also locked to the reference frequency to keep frequency drift at a minimum.

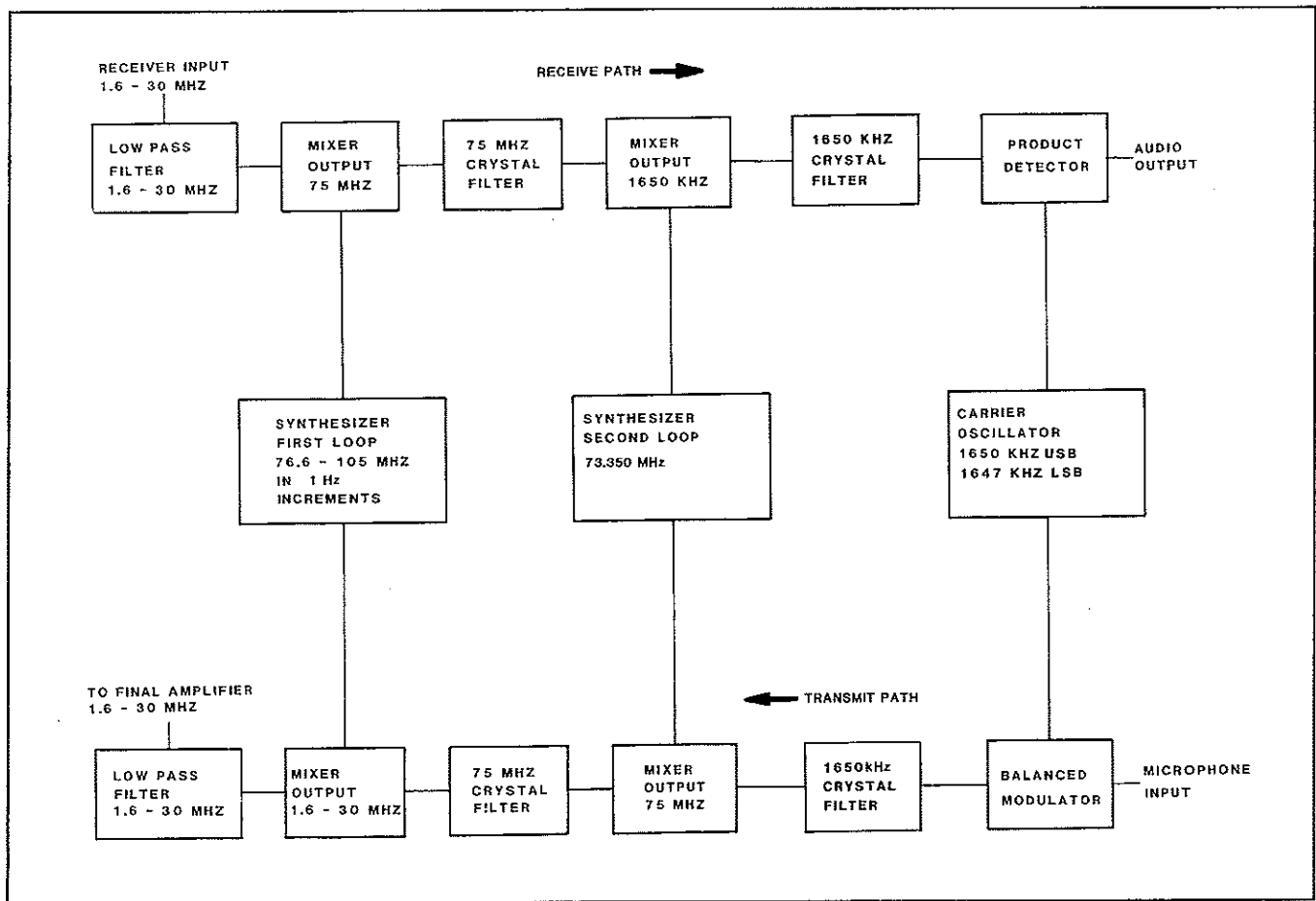
### 3-4 FREQUENCY AND FUNCTION CONTROL

The synthesizers, display, antenna tuner, and many other operating functions are under the control of the microprocessor, with the software program instructions stored in permanent memory (ROM). In addition, programmable functions such as channel frequencies and antenna-tune information are stored in memory (RAM) backed up by a lithium battery with a nominal life of ten years. The transceiver is controlled by a serial bus and the data are decoded in the individual modules. The front panel controls also interface with the microprocessor, and the serial data extends to the accessory connector to control external accessories such as power amplifiers.

### 3-5 RECEIVER

Input signals from the antenna pass through one of six five-pole, elliptic-function filters, then through a 1600-kHz high-pass filter to prevent overload from MF broadcast stations, and finally through a 30-MHz low-pass filter to prevent VHF responses. The signal is applied to a high-level, double-balanced mixer; the 75-MHz output is amplified by a high dynamic range amplifier before passing through the four-pole, monolithic, 75-MHz filter. The +11-dBm intercept point is maintained through to the output of the 75-MHz filter.

Output from the 75-MHz filter is amplified by an AGC-controlled, dual-gate MOSFET amplifier and is then down-converted to 1650 kHz in a dual-gate MOSFET mixer. The signal then passes through the six-pole crystal filter and is amplified by an AGC-controlled dual-gate MOSFET



**FIGURE 3-1.**  
Frequency-Conversion Plan.

amplifier. The final IF amplification is provided by a fixed-gain bipolar amplifier. A two-stage AGC amplifier provides excellent fast-attack, slow-release characteristics. This AGC system is so effective that no separate RF gain control is required. The audio signal passes through the squelch circuit, where it is processed and applied to a pulse counter which detects the low-frequency FM component in human speech. This output controls the squelch which opens in the presence of speech and not on background noise.

### 3-6 TRANSMITTER EXCITER

The microphone amplifier is a VOGAD which automatically adjusts the gain to provide constant audio output. A balanced modulator with a 1650-kHz carrier injection frequency produces 1650-kHz, double-sideband, suppressed carrier output (1647 kHz for LSB operation).

The 1650-kHz DSB signal passes through an amplifier to the crystal filter. The 75-MHz IF amplifier has ALC applied that is derived from the currents and voltages at the transmitter output. The ALC system limits the maximum current

and voltage from the power amplifier so that the transceiver may be safely operated at any VSWR level.

The 1650-kHz SSB signal is applied to a balanced mixer where it is up-converted to 75 MHz. This signal passes through one stage of amplification to the 75-MHz crystal filter. The 75-MHz signal is then down converted to the operating frequency in a double-balanced mixer. A MMIC broadband 1.6 to 30-MHz amplifier increases the exciter output to approximately +3 dBm. A low-pass filter at the output removes the image frequencies.

### 3-7 FINAL AMPLIFIER AND FILTERS

The high-power final amplifier consists of a Class A pre-driver, a push-pull driver stage, and a push-pull final output stage. Special broadband transformers are used for inter-stage and output coupling. The first amplifier operates Class AB and the final stage in Class B using a stabilized bias supply. The final amplifier has low spurious output except for the harmonics. Six separate high-performance, elliptical function filters are used to cover the operating range and provide effective attenuation of the harmonic

spectrum. The selection of the filters is controlled by the microprocessor.

### 3-8 AUTOMATIC ANTENNA TUNER

The automatic antenna tuner uses a series of inductors, in a binary progression and switched by latching relays, to provide variable inductive loading for the antenna. A variable ratio impedance transformer is used to provide the correct impedance match to the final amplifier. Shunt capacitors are switched into circuit for use with inductive antennas. The tuner uses detectors at the tuner input and follows a tuning routine, under control of the microprocessor, to match the antenna for maximum output. When the whip or long-wire antenna is removed, the output is automatically switched to the 50-ohm antenna connector.

### 3-9 TRANSMIT-RECEIVE SWITCHING

The transmit-receive switching is through the T/R relay, which switches the antenna input between the receiver input and the transmitter output. A second pole on this relay

switches the regulated 8-V line to give T8 and R8 voltage outputs. These control lines are used to switch the transceiver circuitry. Transistor and diode gates are used extensively for the switching function. The input to the double-balanced mixer is switched by a relay to minimize high-level intermodulation distortion.

### 3-10 POWER SOURCE

The transceiver operates from a 12 to 15-V supply source. The critical circuitry operates from the regulated 8-V and 5-V supply lines. The higher-power circuitry operates direct from the 12-V supply but will continue to operate down to 10.5 V with only minimal reduction in performance specifications.

### 3-11 SIGNAL FLOW CHARTS

Table 3-2 indicates the signal levels at the various stages of the receive signal path, while Table 3-3 does the same for the squelch circuits. The signal levels for the transmit path are shown in Table 3-4.

**TABLE 3-1.**  
**Module Function Chart.**

<b>M1 AUDIO/RF FILTER MODULE</b>	
<b>FUNCTION</b>	<b>I/O</b>
VOGAD. Amplifies microphone input and automatically controls gain.	Input from front-panel handset. Output to balanced modulator.
Balanced Modulator. Generates DSB 1650-kHz signal, suppresses carrier.	Input from mic. amplifier. Output to J2 1650-kHz IF Filter.
Product Detector. Demodulates 1650-kHz SSB signal.	Input from M2 IF amplifier. Output to squelch and audio PA. BFO input from M6.
Squelch. Detects low-frequency FM voice components to actuate squelch.	Input from product detector. Output to squelch gates.
Audio PA. Amplifies audio for handset or loudspeaker.	Input from product detector through audio gain control. Output to handset.
Audio AMP. Provides 0 dBm 600- $\Omega$ audio output.	Input from product detector. Output to accessory socket.
RF Gate. Detects RF output and opens sidetone gate.	Input from ALC circuitry. Output to squelch gates.
Squelch Gates. Switches on Audio PA. Controls current in RX front end.	Input from squelch control. Output to Audio PA gate and gates M3.
CW Hold. Provides semibreak-in CW and ATU tune signal.	Input from CW key and microprocessor. Output to tone generator M7.
Filter Switching. Decodes serial data & selects correct filter range.	Input from serial data M7 microprocessor. Output to RF filters.
ALC. Measures RF current & RF voltage. Provides 5-W and 20-W level output control.	Input from TX PA output. Output to Sidetone Gate, ALC gain M3.

**TABLE 3-1.  
Module Function Chart, Continued.**

T/R Relay. Switches TX/RX RF and R+ 8-V and T+ 8-V lines.

RF Filters -  
Low-pass filters TX/RX.

Input from filter control selection.  
High-pass filters RX.

Tone Generator.

Input from PTT, microprocessor M7.

Enabled from CW key.

**M2 1650-kHz IF MODULE**

**FUNCTION**

1650-kHz Filter. Generates SSB signal. Provides narrowband RX selectivity.

RX IF Amps. Amplifies 1650-kHz IF signal.

AGC. Amplifies AGC Control IF gain.

TX IF Amp. Amplifies 1650-kHz DSB signal.

**I/O**

Input from mixer module M3 or TX amp.  
Output to M3 mixer module or RX IF amp.

Input from filter.  
Output to M1 audio module.

Input from RX IF output.  
Output to 1650-kHz IF Amp,  
75-MHz IF Amp M3.

Input from balanced modulator M1.  
Output to 1650-kHz sideband filter.

**M3 MIXER & RF MODULE**

**FUNCTION**

Double-Balanced Mixer. Converts received signal to 75-MHz IF.

Converts 75-MHz SSB signal to TX output frequency.

IF Amp 75-MHz Q3 RX.

75-MHz Crystal Filter.

IF Amp 75-MHz Q11 RX.

Mixer. 75-MHz to 1.65-MHz RX.

Mixer. 1.65-MHz to 75-MHz TX.

IF Amp 75-MHz TX.

TX Amp 1.6-30 MHz.

**I/O**

Input from RX antenna through M1.  
Output to RX 75 MHz IF amp.

Input from TX 75-MHz filter.  
Output to TX 2 to 30-MHz amplifier.  
Osc. - 76.6 to 105-MHz Syn. 1 buffer.

Input from double-balanced mixer.  
Output to 75-MHz filter.

Filters 75-MHz IF TX and RX.

Input from 75-MHz filter.  
Input from AGC control.  
Output to mixer Q12.

Input from 75-MHz IF Amp.  
Osc. 73.35-MHz Syn. 2 buffer.  
Output to 1.65-MHz M2.

Input from 1.65-MHz M2.  
Osc. 73.35-MHz Syn. 2 buffer.  
Output to 75-MHz IF Amp TX.

Input from 75-MHz Mixer.  
Input from ALC control M1.  
Output to 75 MHz - Filter 75 MHz.

Input from balanced mixer.  
Output to TX PA M4.

**TABLE 3-1.  
Module Function Chart, Continued.**

SYN 1 BUFFER.	Input from Syn. 1 M6. Output to Mixers.
SYN 2 BUFFER.	Input from Syn. 2 M6. Output to Mixers.
<b><u>M4 TX POWER AMPLIFIER MODULE</u></b>	
<b>FUNCTION</b>	<b>I/O</b>
TX Power Amplifier.	Input from Exciter M3. Output to LP filters M1.
<b><u>M5 AUTOMATIC ANTENNA TUNER MODULE</u></b>	
<b>FUNCTION</b>	<b>I/O</b>
Antenna Tuner.	Input from LP filters M1. Output to Antenna—Whip or 50 ohm.
Serial Decoders & Relay Drivers.	Input from microprocessor M7. Output to latching relays.
<b><u>M6 SYNTHESIZERS - SYN1/SYN2 MODULE</u></b>	
<b>FUNCTION</b>	<b>I/O</b>
Syn. 1: 76.60-104.99 MHz.	Output to Syn. 1 buffer M3.
Syn. 2: 73.35 MHz.	Output to Syn. 2 buffer M3.
BFO 1650 kHz or 1647 kHz	Output to M1.
Serial Decoders.	Input from microprocessor M7.
<b><u>M7 MICROPROCESSOR &amp; CONTROL MODULE</u></b>	
<b>FUNCTION</b>	<b>I/O</b>
Serial Bus.	Input from microprocessor. Output to all serial ports.
Control Switches.	Read by microprocessor.
<b><u>M8 DISPLAY &amp; DRIVER MODULE</u></b>	
<b>FUNCTION</b>	<b>I/O</b>
Backplane Generator.	Output to LCD Display.
Backlight Generator.	Output to LCD Display Backlight.
Serial Decoders & Segment Drivers.	Input from microprocessor M7. Output to LCD Display.
<b><u>M9 Junction Module</u></b>	
+5 V Switcher Regulator.	Output to Various Modules.
+8 V Regulator.	Output to Various Modules.
Dc Clamps T8 - R8.	Output to Various Modules.

**TABLE 3-2.  
Receive Signal Flow.**

**INITIAL CONDITIONS**

Mode:	USB.	Signal Generator Settings:
Frequency:	29.9999 MHz.	Frequency: 30.0009 MHz.
Power Level:	High.	Level: 107 $\mu$ V.
Volume:	Fully CW.	Modulation: 0%.

**LOCATION**

**SIGNAL**

**COMMENTS**

**1. M3 Mixer Module**

M3Q1 Collector	1.2 V <sub>p-p</sub>	104.999999-MHz Synth 1.
M3MX1, Pin 3	0.2 V <sub>p-p</sub>	75-MHz IF Signal.
M3Q3 Collector	1.5 V <sub>p-p</sub>	75-MHz IF Signal.
M3Q7, Pin 1	0.15 V <sub>p-p</sub>	75-MHz IF Signal.
M3Q10 Collector	1.5 V <sub>p-p</sub>	73.35-MHz Synth 2.
M3Q8, Pin 1	0.4 V <sub>p-p</sub>	1650-kHz IF Signal.

**2. M2 1650 IF Module**

M2J3 1650 Input	60 mV <sub>p-p</sub>	1650-kHz IF Signal.
M2Q1, Pin 1	0.4 V <sub>p-p</sub>	1650-kHz IF Signal.
M2Q2 Collector	1.2 V <sub>p-p</sub>	1650-kHz IF Signal.

**3. M1 Audio Module**

M1U4, Pin 1	2.5 V <sub>p-p</sub>	1650-BFO Signal.
M1U4, Pin 8	0.7 V <sub>p-p</sub>	1000-Hz Audio.
M1U5, Pin 2	0.2 V <sub>p-p</sub>	1000-Hz Audio.
M1U5, Pin 5	3.2 V <sub>p-p</sub>	1000-Hz Audio.
M1J6, Pin 3	3.0 V <sub>p-p</sub>	1000-Hz Audio.
M1J6, Pin 9	5.0 V <sub>p-p</sub>	1000-Hz Audio.

**TABLE 3-3.  
Squelch Circuit Signal Flow.**

**INITIAL CONDITIONS**

Same As Receive Signal Flow Initial Conditions.

<u>LOCATION</u>	<u>SIGNAL</u>	<u>COMMENTS</u>
<b>1. M1 Audio Module</b>		
M1U1, Pin 2	0.7 V <sub>p-p</sub>	1000-Hz Audio Sine Wave.
M1U1, Pin 1	6.4 V <sub>p-p</sub>	1000-Hz Square Wave.
M1U1, Pin 7	6.4 V <sub>p-p</sub>	1000-Hz Square Wave.
M1U2, Pin 3	8.0 V <sub>p-p</sub>	1000-Hz Square Wave.
M1U2, Pin 4	8.0 V <sub>p-p</sub>	1000-Hz Square Wave.
M1U1, Pin 8	3.9 Vdc	Squelch Control Signal.
M1U1, Pin 14	6.7 Vdc	Squelch Control Signal.
M1U2, Pin 10	8.0 Vdc	Squelch Control Signal.
M1U2, Pin 11	0.0 Vdc	Squelch Control Signal.
M1Q1 Emitter	0.0 Vdc	Radio Squelched.
M1Q2 Collector	11.5 Vdc	Radio Squelched.
M1Q6 Collector	0.0 Vdc	Radio Squelched.

**TABLE 3-4.  
Transmit Signal Flow.**

**INITIAL CONDITIONS**

Mode: USB.  
 Frequency: 29.999900.  
 Power Level: High.

**NOTE:** A CW Keyer is required for this test. All tests CW keyed.

<b><u>LOCATION</u></b>	<b><u>SIGNAL</u></b>	<b><u>COMMENTS</u></b>
<b>2. M1 Audio Module</b>		
M1U3, Pin 7	5.8 V <sub>p-p</sub>	1000-Hz CW Tone.
M1U3, Pin 8	5.8 V <sub>p-p</sub>	1000-Hz CW Tone.
M1U6, Pin 3	0.6 V <sub>p-p</sub>	1650-kHz BFO Signal.
M1U6, Pin 5	0.25 V <sub>p-p</sub>	1650-kHz IF Signal.
<b>2. M2 1650 IF Module</b>		
M2Q3 Collector	3.0 V <sub>p-p</sub>	1650-kHz IF Signal.
M2J3 1650 Output	0.6 V <sub>p-p</sub>	(Measured with cable removed.)
<b>3. M3 Mixer Module</b>		
M3Q10 Collector	1.5 V <sub>p-p</sub>	73.3499-kHz Synth 2.
M3Q11, Pin 1	0.1 V <sub>p-p</sub>	75-MHz IF Signal.
M3D11 Anode	0.3 V <sub>p-p</sub>	75-MHz IF Signal.
M3D2 Anode	0.15 V <sub>p-p</sub>	75-MHz IF Signal.
M3Q1 Collector	1.2 V <sub>p-p</sub>	104.9999-MHz Synth 1.
M3U1 Output	1.2 V <sub>p-p</sub>	29.9999-MHz RF Signal.
<b>4. M4 Power Amplifier Module</b>		
M4 TX Input	0.9 V <sub>p-p</sub>	29.9999-MHz RF Signal.
M4Q1 Collector	15 V <sub>p-p</sub>	29.9999-MHz RF Signal.
M4Q2(3) Collector	15 V <sub>p-p</sub>	29.9999-MHz RF Signal.
M4Q4(5) Collector	25-35 V <sub>p-p</sub>	29.9999-MHz RF Signal.
M4 TX Output	90-120 V <sub>p-p</sub>	29.9999-MHz RF Signal.



## **3-12 RADIO MENU EXPLANATIONS**

The following is an explanation for each of the standard PRC1099A display menus. The number in parentheses after each menu name refers to the corresponding menu listed on the menu flow chart shown in Figure 3-2.

### **3-12.1 SCAN ICON**

The following menus appear under the SCAN icon.

#### **3-12.1.1 SCAN SELECT (1)**

Use Scan Select to energize the channel scanning feature of the PRC1099A. Once energized, the radio begins to scan the channels whenever the channel select switch is tuned to channel 9. Enter the channels to be scanned using the following two menus.

#### **3-12.1.2 SCAN GROUP NUMBER (2)**

Use Scan Group Number to select the group of channels to scan. A maximum of ten scan groups can be retained in memory.

#### **3-12.1.3 MODIFY SCAN GROUP (3)**

Use Modify Scan Group to enter a scan group or modify a scan group that is already entered. All channels in the radio, 00 through 99, are displayed one at a time. Those channels that are already selected in the scan group will have an asterisk, "\*", next to the channel number. Press the WHIP TUNE button to select or unselect a channel for the scan group.

#### **3-12.1.4 SCAN RATE (4)**

This menu is used to select the length of time the radio will remain at each scanning channel during the scan cycle. The amount of time is selectable from 0.5 seconds to 64.9 seconds.

#### **3-12.1.5 SCAN HOLD (5)**

This menu is used to select the amount of time the radio remains at a particular channel, after a link, during the scan cycle.

#### **3-12.1.6 VOICE DETECT SELECT (6)**

Use Voice Detect to detect voice communication of channels that are scanned and to stop at those channels once voice communications have been detected.

#### **3-12.1.7 VOICE DETECT HOLD (7)**

When voice detect is enabled, the radio will automatically stop scanning on channels where voice communications are detected. This menu is used to set the amount of time the radio will remain at that channel, without hearing more voice communications.

### **3-12.2 DATA ICON**

The following menus appear under the DATA icon.

#### **3-12.2.1 SOURCE SELECT (8)**

Use Source Select to select the source from which the data to the accessory connector is originating. The sources are either the keyfill device or some remote peripheral.

#### **3-12.2.2 BAUD RATE (9)**

Use Baud Rate to select the baud rate of the data to and from the radio accessory connector (75 to 9600 baud).

#### **3-12.2.3 DATA BIT (10)**

Use Data Bit to select the number of data bits used to communicate through the accessory connector. The number of data bits are selectable at either 7 or 8 bits.

#### **3-12.2.4 STOP BIT (11)**

Use Stop Bit to select the number of stop bits which are required to communicate through the accessory connector. The number of stop bits are selectable at either 1 or 2.

#### **3-12.2.5 PARITY (12)**

Use Parity to select the parity of the data. The parity can be E (even), O (odd), or N (none).

#### **3-12.2.6 FLOW CONTROL (13)**

Use Flow Control to control the character flow-control protocol of the input and output data. Flow control refers to XON and XOFF characters that are inserted into the stream of data as flow control markers to mark the beginning and end of data streams.

#### **3-12.2.7 RADIO ADDRESS (14)**

This control is used to select the address number of this unit, when more than one radio are connected on the same data bus.

### **3-12.3 TRANSADAPT ("TA") ICON**

The following menus appear under the TA icon.

#### **3-12.3.1 RX ADDRESS (15)**

The RX Address is the address the receiver station responds to. The receiver address is a number from 001 to 255.

#### **3-12.3.2 BIT ERROR RATE NUMBER (16)**

Use Bit Error Rate Number to select the minimum bit error rate the radio will allow for a valid link.

#### **3-12.3.3 CALL SELECT (17)**

Call Select is used to select which type of call is to be made, either Transadapt or Transcall.

### **3-12.4 MESSAGE ("MSG") ICON**

The following menus appear under the MSG icon.

#### **3-12.4.1 RX MESSAGE (18)**

Use RX Message to read messages received from other stations. Select the message number to be read, then scroll through the message.

#### **3-12.4.2 TX MESSAGE (19)**

Use TX Message to compose messages to send with the ALE message. Select the message number assigned to the message, and compose the message using the TUNE switch and the WHIP TUNE button.

### **3-12.5 OPTION ("OPT") ICON.**

The following menus appear under the OPT icon.

#### **3-12.5.1 TRANSADAPT SELECT (20)**

Use Transadapt Select (T/A SEL) to energize the Transadapt option, when the option is installed. If the option is not installed, this menu will not appear. If both the Transadapt option and the ALE option are installed, energizing one option will automatically de-energize the other

#### **3-12.5.2 AUTOMATIC LINK ESTABLISHMENT SELECT (21)**

Use ALE SELECT to energize the ALE option, when the option is installed. If the option is not installed, this menu will not appear. If both the Transadapt option and the ALE option are installed, energizing one option will automatically de-energize the other.

#### **3-12.5.3 BITE TEST (22)**

Use BITE to activate the BITE function. Once energized, the bite function takes control of the radio and performs all the necessary checks before returning control to the operator. After BITE is completed, the result is displayed on the front panel.

#### **3-12.5.4 FREQUENCY LOCK (23)**

Use FQLOK SEL (frequency lock) to prevent the radio channel frequencies from being changed by accident. Once energized, the radio channel frequencies cannot be changed, until de-energized.

#### **3-12.5.5 BATTERY TEST (24)**

Use this menu to check the voltage of the battery. The battery is checked in increments of 0.25 Vdc. "Batt Bad" indicates the battery is either below 10.5 or above 15 Vdc.

#### **3-12.5.6 PASSWORD (25)**

Use this menu to enter the password to allow access to all menus. If the correct password (five letter maximum) is entered, the following menus will be accessible, if an incorrect password is entered, access will be denied. If no password has been entered using New Password menu 3-12.1.8, the following menus will be accessible and "NONE" will appear on the display.

#### **3-12.5.7 LOCK SELECT (26)**

Use the lock select menu to lock out access to the DATA and ALE option sub-menus (if desired). With the lock ON,

the user cannot access any menu under the DATA and ALE icons. This prevents unauthorized alterations of the settings in those two menus.

#### **3-12.5.8 NEW PASSWORD (27)**

Use this menu to enter a new password or to change an existing password. If no password exists, the menu described in section 3-12.1.6 will indicate "NONE." That menu will only allow access when the same password is entered that was entered here. Enter "⊗" only to remove password.

### **3-12.6 CALL ICON**

The following menus appear under the CALL icon.

#### **3-12.6.1 TRANSADAPT CALL (28)**

When the Transadapt option is installed and energized, the Transadapt Call menu appears. (The menus described in sections 3-12.6.2 through 3-12.6.4 will not appear.) Use Transadapt Call to enter the address of the station to be called. The address is a number from 001 to 255 and is entered using the TUNE switch and WHIP TUNE button. If the address 000 is entered, an "all-call" transmission will result in which every station that hears the transmission will reply.

#### **3-12.6.2 ALE CALL (29)**

When the ALE option is installed and energized the ALE Call Menu appears. (The menu described in section 3-12.6.1 will not appear.) Use ALE Call to enter the address of the station to be called. An alpha-numeric address up to 15 characters in length is allowed.

#### **3-12.6.3 FROM ADDRESS (30)**

Use From Address to include the address of the calling station, which is required in an ALE message. The "From" station address can be an alpha-numeric address up to 15 characters in length.

#### **3-12.6.4 MESSAGE NUMBER (31)**

Use Message Number to indicate which message, if any, is to be sent with an ALE transmission. The messages to be sent are entered or modified using the menu described in section 3-12.4.2. Enter the message number, or if no message is to be sent, select "none".

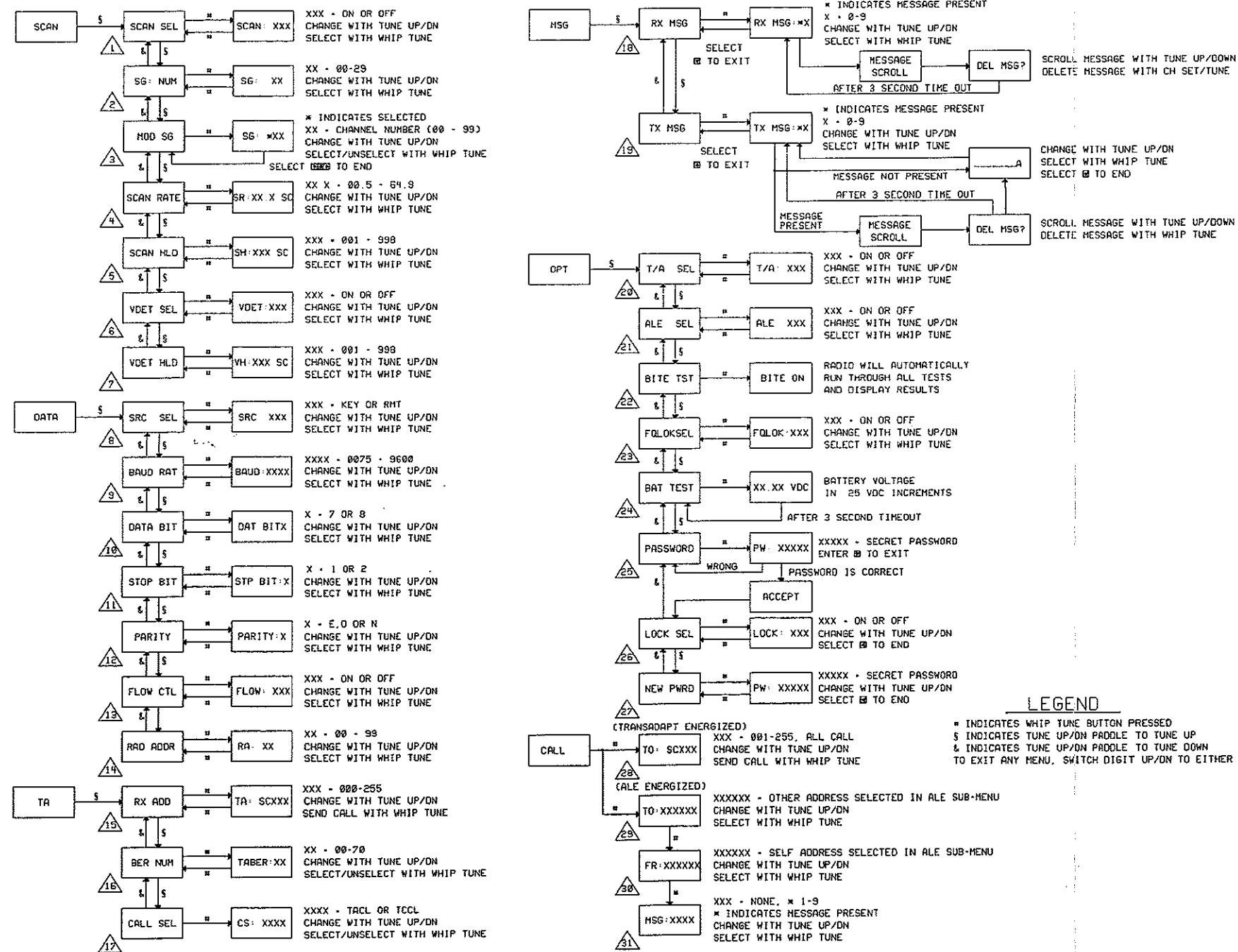


FIGURE 3-2.  
Menu Flow Chart.



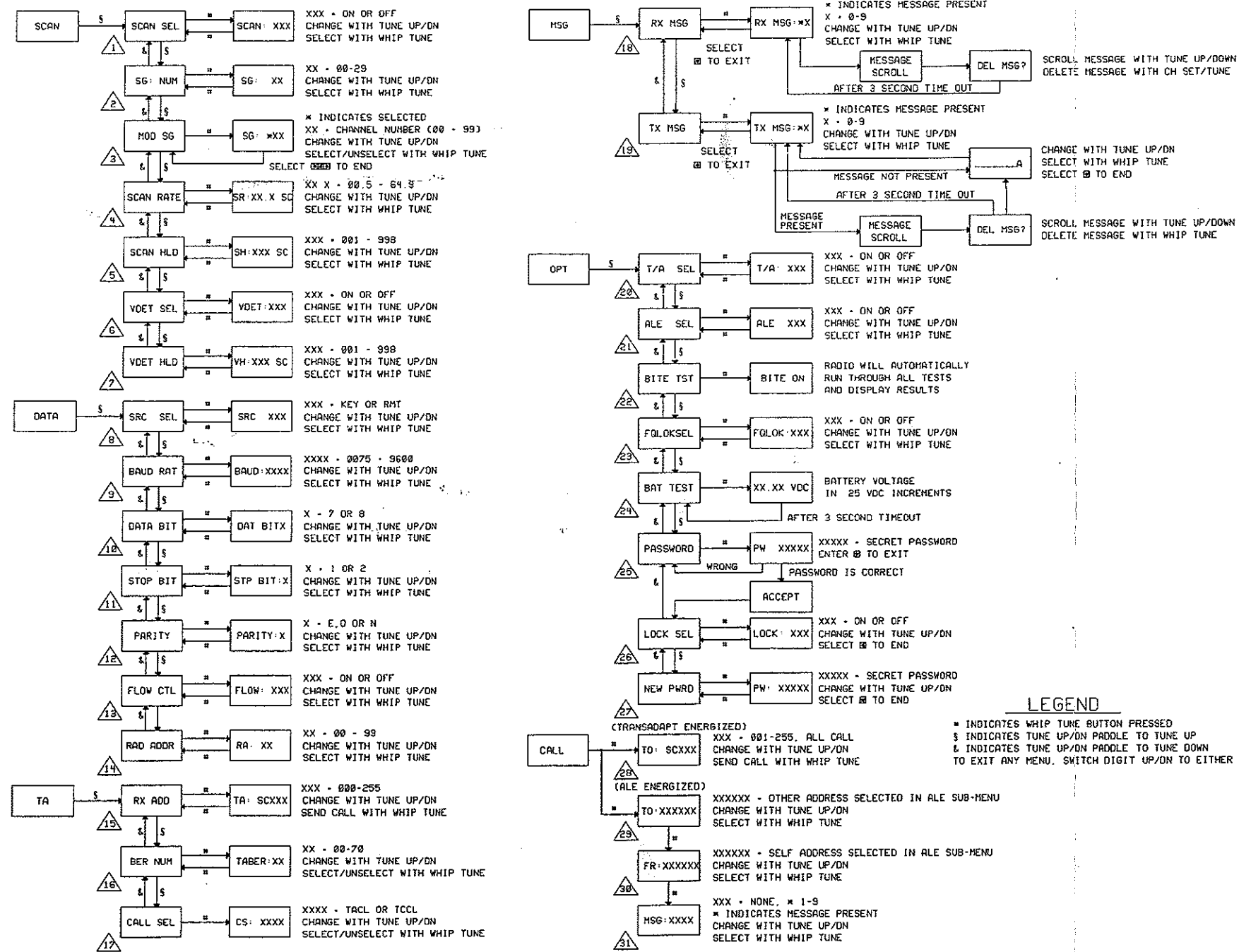


FIGURE 3-2.  
Menu Flow Chart.



# CHAPTER 4

## AUDIO/FILTER MODULE, M1 - TECHNICAL DESCRIPTION

### 4-1 BLOCK DIAGRAM

A block diagram of the module is shown in Figure 4-1. The module is used for the transmitter and receiver audio circuits, the RF filtering of the transmitter and receiver, the transmit/receive switching, and other control functions. The module has the following block components:

1. Receiver Product Detector.
2. Receiver Squelch Circuit.
3. Receiver Audio Amplifier—Handset/Loudspeaker.
4. Receiver Audio Amplifier—600  $\Omega$ .
5. Squelch Gates.
6. Transmitter VOGAD.
7. Transmitter Balanced Modulator.
8. Low-Pass Filters.
9. Relay Drivers and Serial Decoder.
10. Function Decoder.
11. Receiver High-Pass Filter.
12. ALC Detectors and Amplifiers.
13. Low-Power Switch.
14. Sidetone Switch.
15. T/R Switching.
16. CW Hold Timer and Gates.
17. CW Oscillator
18. Contract Control

#### 4-1.1 RECEIVER PRODUCT DETECTOR

The product detector U4 is used to down convert the output from the 1650-kHz IF to the audio base band. U4 is an integrated circuit differential amplifier. The 1650-kHz IF is injected into pin 2, one of the two input ports. The 1650-kHz carrier oscillator (1647-kHz LSB) is injected into pin 1, the other input port. The output at pin 8 is the sum and difference frequencies from the two input signals. The sum frequency at 3.3 MHz is filtered by C17; and the difference frequency, the audio baseband, is left at the output.

#### 4-2 RECEIVE SQUELCH CIRCUIT

The squelch circuit operates by detecting the syllabic rate of change found in the human voice. The squelch is immune to impulse noise, static, carriers, and general background noise. The squelch is preset internally and is activated in the USB mode when the mode switch is turned to the "squelch" position.

The audio output from the product detector is fed into two sections of the quad operational amplifier, U1. The stages operate at high gain and the noise or signal is amplitude limited, which provides square wave output to trigger the one shot U2A and U2B. The output from the one shot is a series of pulses which go through the high-pass filter C2, R5, C3, R6 and the low-pass filter R7, C4, R8, and C5. At this point a dc level proportional to the input frequency of the one shot is present.

The dc level changes as the frequency shifts, which represents the change in frequency of the human voice at a syllabic rate between 0.5 and 2.5 Hz. This signal is ac coupled through C6 to the low-frequency differentiation amplifier U1C. The output is fed into U1D, which will pull down D4 if any signal appears at D2/D3 with a positive or negative amplitude of 0.9 V or greater. This unipolar converter enables the squelch to detect the first syllabic rate change at the output of the product detector.

D4 is connected to U2C and U2D, which form a timer with C9 and R16 to hold the audio on for approximately four seconds after the last syllabic change is detected. The squelch is turned off when the timer output is grounded through R18. The microprocessor can also disable the audio through D23 by setting the output at U9 pin 5 low.

#### 4-3 RECEIVER AUDIO AMPLIFIER - HANDSET/SPEAKER

The output from the product detector is coupled through the front panel audio gain control potentiometer to a monolithic integrated circuit, U5, with a gain of 26 dB. This device has essentially constant voltage output into a wide range of load impedances, provides direct output to the handset or earphones, and is capable of 500-mW output to a separate loudspeaker.

#### 4-4 RECEIVER AUDIO AMPLIFIER - 600 $\Omega$

U10A is half of a fixed-gain operational amplifier providing a separate fixed-level audio output for external devices such as RTTY modems. The amplifier has low impedance output and provides a level of 0 dBm into a 600- $\Omega$  load connected to the accessory socket.

#### 4-5 SQUELCH GATES

The receiver audio is switched by the squelch circuit. The dc supply to U5 is switched by the PNP transistor, Q6, in the +12-V lead. This method of switching is used so that U5 draws no quiescent current when squelched. Q6 is controlled by the input from the RF gate, Q24 or by Q1 and Q2, which are in turn driven by the squelch timer U2C and U2D or the microprocessor mute signal. The output from Q1 also controls the current reduction circuitry in the mixer module, M3. This circuitry is also controlled by the T8 line, which is isolated by the diode gates D5 and D6.

#### 4-6 TRANSMITTER VOGAD

The 50-ohm audio signals are applied to U8, a single integrated circuit VOGAD (Voice Operated Gain Adjusting Device). The VOGAD is a high-gain audio amplifier and automatic-gain control circuit. R48 and C79 control the AGC time constants and are set to provide distortion-free, constant output over a wide range of input signal levels. R47 sets the gain control of the amplifier which is set at a

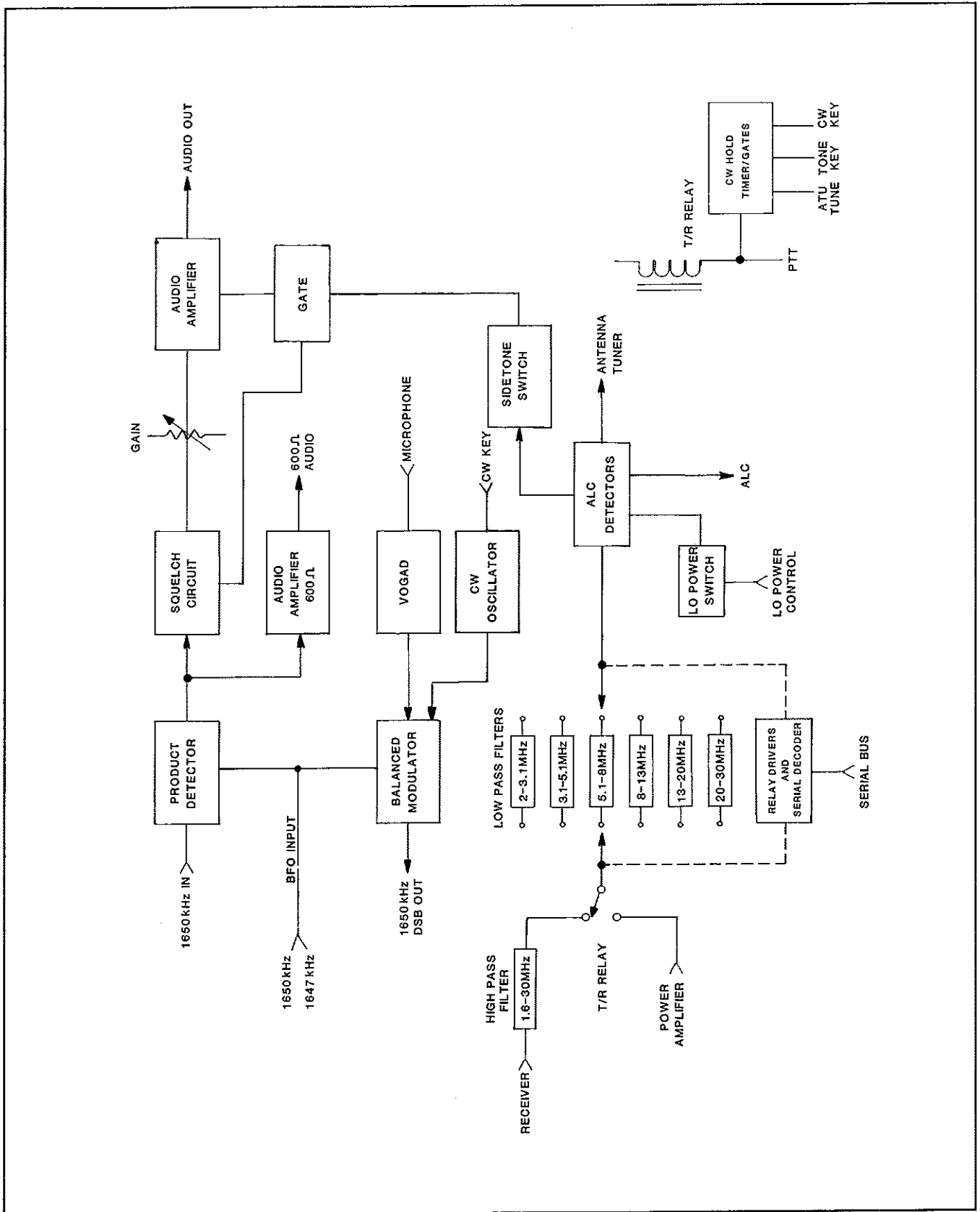


FIGURE 4-1.  
Block Diagram - Audio/Filter Module, M1.



higher than normal level to provide full output for low-level voice inputs (whisper mode). The excellent AGC characteristics maintain level output from a whisper to a shout. L14 and C80 filter RF picked up by the microphone lead.

#### 4-7 TRANSMITTER BALANCED MODULATOR

The attenuator and RF filter C31, L13, C32 and R46 are used for the high-level, 0-dBm audio input. The amplified and leveled audio output is applied to one input (pin 7) of U6. The 1650-kHz (1647-kHz LSB) carrier oscillator from the M6, is applied to the other input (pin 3) of the stage, which is a quad amplifier driven by differential current sources. U6 uses internal bias and load resistors to minimize the number of external components required. The potentiometer R51 applies an adjustable offset current to pin 7. This permits precise balance of the modulator to give maximum carrier suppression. The output from U2 is a low-distortion, 1650-kHz, double-sideband, suppressed-carrier signal. The CW tone oscillator is applied to U6 through R72.

The voltages for the balanced modulator and the VOGAD are normally supplied from the T8 line which prevents any current drain in the receive mode. In the data mode (OPT), these stages are supplied from the +8-V line and are not switched off in the receive mode. This is necessary to eliminate disturbances when using high speed switching in the ARQ mode.

#### 4-8 LOW-PASS FILTERS

The input and output to the antenna or antenna tuners pass through one of six high-performance, 5-pole, elliptic function filters. These filters cover the frequency range as follows:

- 2.0 - 3.1 MHz
- 3.1 - 5.1 MHz
- 5.1 - 8.0 MHz
- 8.0 - 13 MHz
- 13 - 20 MHz
- 20 - 30 MHz

The filters use high Q toroidal inductors and precision silver mica capacitors. The filters are used in both the transmit and receive modes to ensure low harmonic output from the transmitter and minimize out-of-band signals to the receiver input.

#### 4-9 RELAY DRIVERS & DECODER

The correct filters are selected by the microprocessor using the latching relays K1 through K12. The latching relays use dual windings and require separate current pulses to open or close the relay. No holding current is required; this is an important consideration in a battery powered transceiver. The switching transistors Q8 through Q13 control the "on" switching current pulse to each pair of relays while the reset transistor Q14 controls the "off" switching pulse to all relays. The microprocessor serial output data is decoded by the shift register U8 and used to drive the switching transistors. The microprocessor software pro-

gram ensures that all relays are reset before selecting a new filter. The program performs the same function whenever the transceiver is switched on or there is a power interruption. This ensures that the relays are always correctly reset.

#### 4-10 FUNCTION DECODER

The microprocessor serial data is clocked through U7 into U9, where it is decoded and used to control several functions of the M1 module. Pin 4 of U9 allows the microprocessor to control the power setting by saturating Q22. In the same manner, Pin 7 is used to saturate Q20, for AME selection. U9 pin 14 allows the microprocessor to energize the transmitter and the CW oscillator, while Pin 5 is used to disable the 50 ohm audio. Pin 6 is used for the AME option, while pin 13 is used to mute all audio.

#### 4-11 RECEIVER HIGH-PASS FILTER

The antenna input to the receiver passes through a seven-pole Chebyshev filter with a cutoff frequency of 1.6 MHz (C107, C106, C105, C104, L17, L16, and L15). This filter ensures a high level of attenuation to signals below 1.6 MHz in the broadcast band and prevents overload when operating in the vicinity of a powerful broadcast station. The diode D18 shorts the receiver input in the transmit mode and provides transient protection to the user while in the receive mode.

#### 4-12 ALC DETECTORS & AMPLIFIER

The primary control of the transmitter power output is by the ALC system, controlled by the output from a current detector. The current detector uses a transformer, T1/R76, which uses a ferrite toroid with the antenna lead passing through the core to form a one turn primary winding. The RF output is rectified by D19 when the RF voltage exceeds the adjustable back bias applied through the power adjustment control R82. The rectified output is amplified and the polarity reversed by Q21, which in turn drives the ALC amplifier in the mixer module. A separate voltage detector, C111/C110/D20, operates with a fixed bias threshold of 8 V and limits the maximum voltage output to 36 V.

For normal operation the current is set to 630 mA, which corresponds to 20-W output into a 50-ohm load. The current detector controls the output level in loads of 50 ohms or less and limits the maximum output current to 630 mA, even when there is a short circuit on the antenna. If the impedance is higher than 50 ohms (most mismatches present high impedance loads), the voltage detector limits the maximum output voltage to 36 V. This system prevents the rapid fall in output power into mismatched loads yet ensures the transistors will not be operated outside of their ratings.

#### 4-13 LOW-POWER SWITCH

The low-power switch Q22 causes R82, the low-power control, to shunt the bias voltage at the current detector so that the ALC activates at a lower power level. R82 is adjusted for 5-W output after the high-power level is set.

**TABLE 4-1.**  
**Specifications, Audio/RF Filter Module, M1.**

**Transmit**

Current: 8 Vdc @ 31 mA.  
 12 Vdc @ 0 mA. 1  
 Output: 1650 kHz, DSB, 80 mV, PEP.  
 Input: Microphone or 1000 Hz.

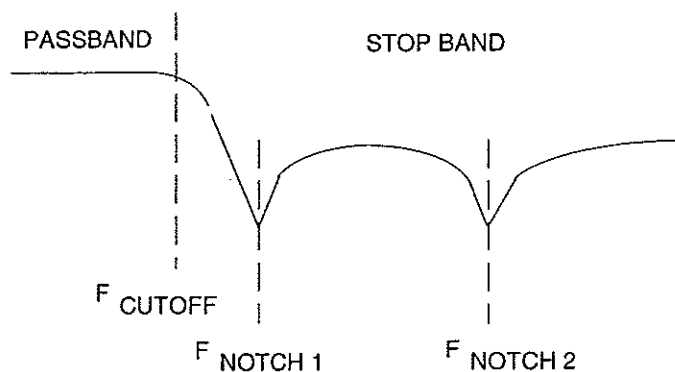
**Receive**

Current: 8 Vdc @ 8 mA.  
 12 Vdc @ 0 mA (squelched).2  
 Output: 1000 Hz.  
 Input: 1651 MHz.  
 System Gain: 48 dB.

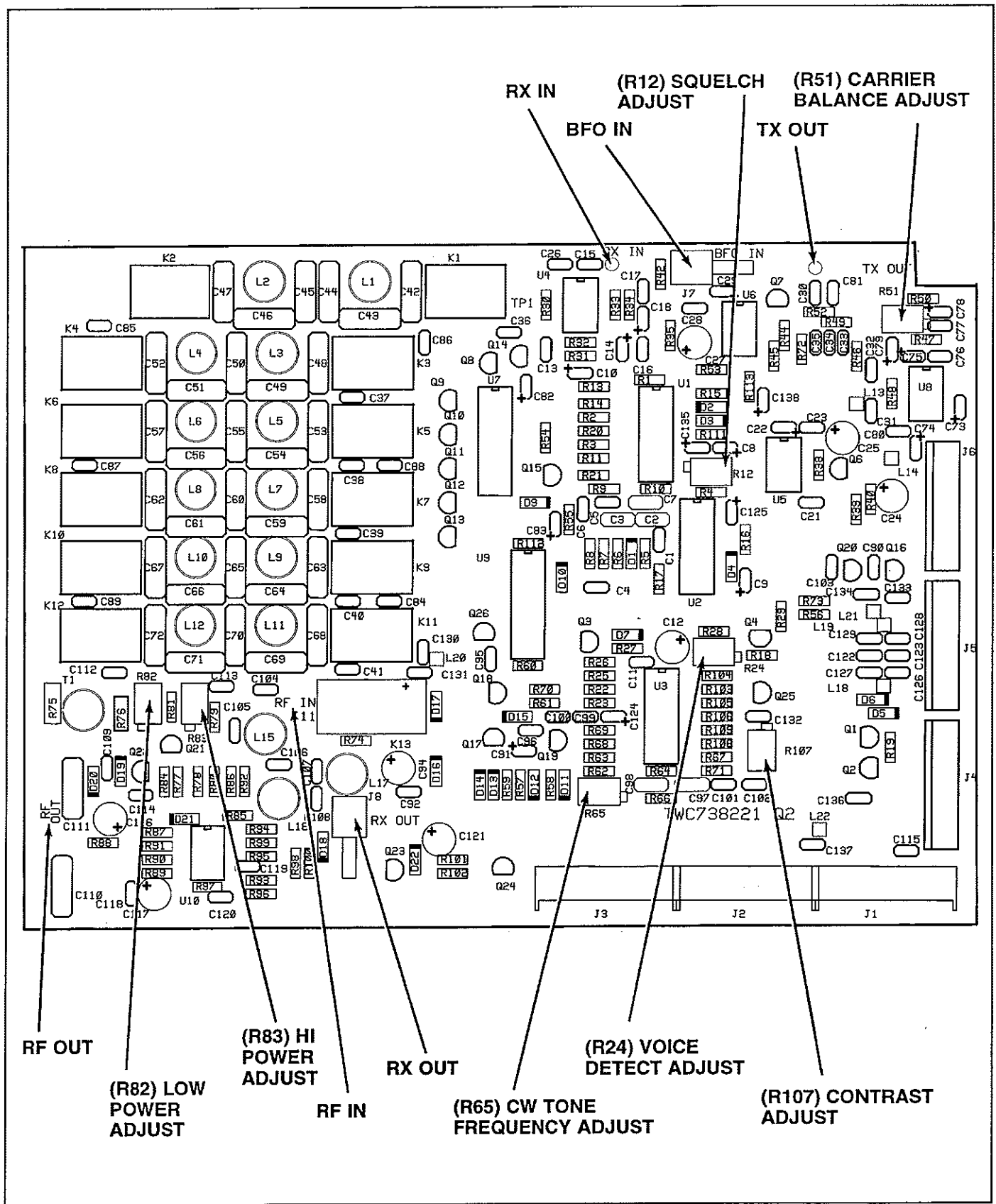
**Low Pass Filters**

Return Loss: 15 dB, minimum.  
 Stopband: Filter adjusted for specified stopband with frequencies.

<u>Range</u>	<u>Notch 1</u>	<u>Notch 2</u>
2-3 MHz	4.2 MHz	6.1 MHz
3-5 MHz	6.6 MHz	9.9 MHz
5-8 MHz	10.8 MHz	16.35 MHz
8-13 MHz	17.2 MHz	27.0 MHz
13-20 MHz	27.6 MHz	43.0 MHz
20-30 MHz	40.5 MHz	60.4 MHz



Notes: 1 Momentary high +12 Vdc current during relay switching.  
 2 Current increases with high audio output into low impedance loads.



**FIGURE 4-2.**  
Signal Connections and Adjustment Points.

#### 4-14 SIDETONE SWITCH

The sidetone will only be present when the transmitter is operating at the correct RF output power. The switch automatically compensates when switched from HI to LO power output. The sidetone switch detects the ALC output voltage. As the detector diodes in the ALC system are biased so that there is no output until the correct current or voltage level is reached, the system automatically checks for correct operation of the final amplifier. U10B is used as a voltage comparator on the ALC line and Q23/Q24 form a hold timer so that the switch will not operate at a syllabic rate on voice signals. Q24 controls Q6, which in turn switches off the audio amplifier when there is no RF output.

#### 4-15 T/R SWITCHING

The T/R switching is controlled by the PTT line. Closing the PTT line activates relay K13, which is a double-pole, high-reliability, fast-acting relay. One pole of this relay switches the antenna from the receive to the transmit function. The other pole switches the regulated +8-V line to give transmit (T8) and receive (R8) control lines. These two control lines are used for transmit/receive functions throughout the receiver.

#### 4-16 CW HOLD TIMER AND GATE

Q17 and the associated components R57/R58/R59/D12 and C91 form a hold timer that holds the transmitter in the transmit mode for a short time after the key is released. The diode gates D13, D14, and D15 isolate the following different functions – ATU tune, tone key, CW key.

#### 4-17 CW OSCILLATOR

Operational amplifiers U3B and U3C form a keyed oscillator for the CW function. The oscillation frequency is determined by R65. The output is inherently stabilized by the limiter stage U3C, which feeds a 20% clipped waveform back into the bandpass filter U3B. The resulting output is very low in distortion, i.e., less than 1%.

The oscillator is keyed by pulling the limiter's inverting input down near ground via Q19. The CW key is attached to the base of Q19 through the tone key input J3-6.

Q19 conducts when the key is open. When the key is closed, correct bias is restored and the oscillator starts smoothly from a zero amplitude to the level where the 20% clipping occurs in the limiter. When the key is opened, the oscillator stops within a few cycles as Q19 saturates. Thus, the keyed envelopes are trapezoidal, as desired. It should be noted that the transmitter will reach full output before the oscillator does when the transmitter gain is enough to reach ALC limits. Therefore, the attack and decay times of the transmitter will be less than those of the oscillator.

#### 4-18 CONTRAST CONTROL

The differential amplifier, U3D, and the associated circuitry, make up a temperature sensing contrast control for the M8 module. R107 is used to set the reference voltage

at the positive input of the differential amplifier. The voltage at the negative input is supplied through Q25, which is essentially connected as a diode. A transistor was chosen instead of a diode for this application, because the characteristic changes in the transistor over temperature more closely approach that of the LCD display. As the temperature and the contrast of the display change, the characteristics of Q25 change. Once inverted through U3D, and applied to the display, this contrast voltage will result in a more constant display contrast.

#### 4-19 SERVICE DATA

Figure 4-2 is a component location diagram with adjustments and signal input/outputs indicated. The following is a summary of the module adjustments:

1. R12. Adjusts the squelch setting; generally factory set for the lowest setting that permits the squelch to open as an incoming signal is swept through the passband.
2. R51. Used to adjust the carrier balance; factory set for minimum RF output in a keyed, unmodulated condition.
3. R83. Sets the transmit output to 20 W in high-power mode.
4. R63. Sets the transmit output to 5 W in low-power mode.
5. R65. Sets CW tone oscillator frequency
6. R24. Sets the voice detect trip point.
7. R107. Sets the contrast level of the M8 display module.

#### 4-20 MODULE INTERCONNECTIONS

The M1 module has the following interconnections with the transceiver.

##### Connector M1J1

- Pin 1 ENM6C. Connects to M1J4 Pin 7 only.
- Pin 2 ENM6B. Connects to M1J4 Pin 8 only.
- Pin 3 ENM6A. Connects to M1J4 Pin 9 only.
- Pin 4 ENM5. Module enable line.
- Pin 5 COMP. Connects to M1J5 Pin 9 only.
- Pin 6 GROUND.
- Pin 7 GROUND.
- Pin 8 LOW POWER. Connects to M1J4 Pin 10 only.
- Pin 9 ALC. Automatic Level Control, used to set the output power level in transmit.
- Pin 10 AGC. Connects to M1J5 Pin 8 only.

##### Connector M1J2

- Pin 1 BITE. Connects to M1J4 Pin 1 only.
- Pin 2 CLOCK. Internal radio clock information.

- Pin 3 DATA. Internal radio data information.
- Pin 4 PTT. Press-To-Talk signal, which keys the radio.
- Pin 5 +8V. 8 volts supplied to the M7 module.
- Pin 6 R8. 8 volts in receive only, supplied to the M7 module.
- Pin 7 T8. 8 volts in transmit only, supplied to the M7 module.
- Pin 8 +12V. 12 volts supplied to the M7 module.
- Pin 9 +5V. 5 volts supplied to the M7 module.
- Pin 10 +5V. 5 volts supplied to the M7 module.
- Pin 5 CLOCK. Microprocessor clock output to the rest of the radio.
- Pin 6 ALC. Automatic Level Control output to the M3 module, used to automatically keep the output power level.
- Pin 7 ENM6C. Output enable pulses from the microprocessor to the M6 module.
- Pin 8 ENM6B. Output enable pulses from the microprocessor to the M6 module.
- Pin 9 ENM6A. Output enable pulses from the microprocessor to the M6 module.
- Pin 10 LOW POWER. Input from the M4 module to automatically switch to low power, when the M4 overheats.

Connector M1J3

- Pin 1 RF DET. RF detect, used to inform the microprocessor of output power.
- Pin 2 VOICE DET. Voice detect, used to inform the microprocessor of received human speech.
- Pin 3 ENM1. Enable pulse which enables U7 and U9.
- Pin 4 MUTE. Low going pulse from the microprocessor to disable the receive audio.
- Pin 5 CONTRAST. Output to the M8 module to set the display contrast.
- Pin 6 CW KEY. A signal from outside the radio used to key the transmitter as well as energize the cw oscillator.
- Pin 7 SPARE2. Not used.
- Pin 8 600-OHM RX AUDIO. Receive audio output to the microprocessor.
- Pin 9 SPARE1. Not used.
- Pin 10 600-OHM TX AUDIO. Transmit audio input from the microprocessor.

Connector M1J4

- Pin 1 BITE. Connects to M1J2 Pin 1 only.
- Pin 2 SQUELCH. Output to the M3 module to disable the receive audio.
- Pin 3 AME SEL. Amplitude Modulation Equivalent output to the M3 module.
- Pin 4 DATA. Microprocessor data output to the rest of the radio.

Connector M1J5

- Pin 1 GROUND.
- Pin 2 ANT SW. Antenna switch output to the M5 module.
- Pin 3 +5V. 5 volts input from the M9 module.
- Pin 4 +12V. 12 volts input from the M9 module.
- Pin 5 T8. 8 volts in transmit output to the rest of the radio.
- Pin 6 R8. 8 volts in receive output to the rest of the radio.
- Pin 7 +8V. 8 volts input from the M9 module.
- Pin 8 AGC. Connects to M1J1 pin 10 only.
- Pin 9 COMP. Connects to M1J1 pin 5 only.
- Pin 10 ENM5. Connects to M1J1 pin 4 only.

Connector M1J6

- Pin 1 SHIELD. Shield for the 50-ohm Tx audio cable, connects to ground.
- Pin 2 50-OHM TX AUDIO. Transmit audio input from the handset connectors.
- Pin 3 SHIELD. Shield for the 50-ohm Rx audio cable, connects to ground.
- Pin 4 50-OHM RX AUDIO. Receive audio output to the handset connectors.
- Pin 5 WIPER. Connects to the wiper of the front-panel volume control.

- Pin 6 VOL HI. Connects to the high side of the front-panel volume control.
- Pin 7 600-OHM TX AUDIO. Transmit audio input from the accessory connector.
- Pin 8 GROUND. Connects to the low side of the front-panel volume control.
- Pin 9 600-OHM RX AUDIO. Receive audio output to the accessory connector.
- Pin 10 ATU TUNE. Input from the accessory connector to key the radio and CW oscillator for tuning of external equipment.

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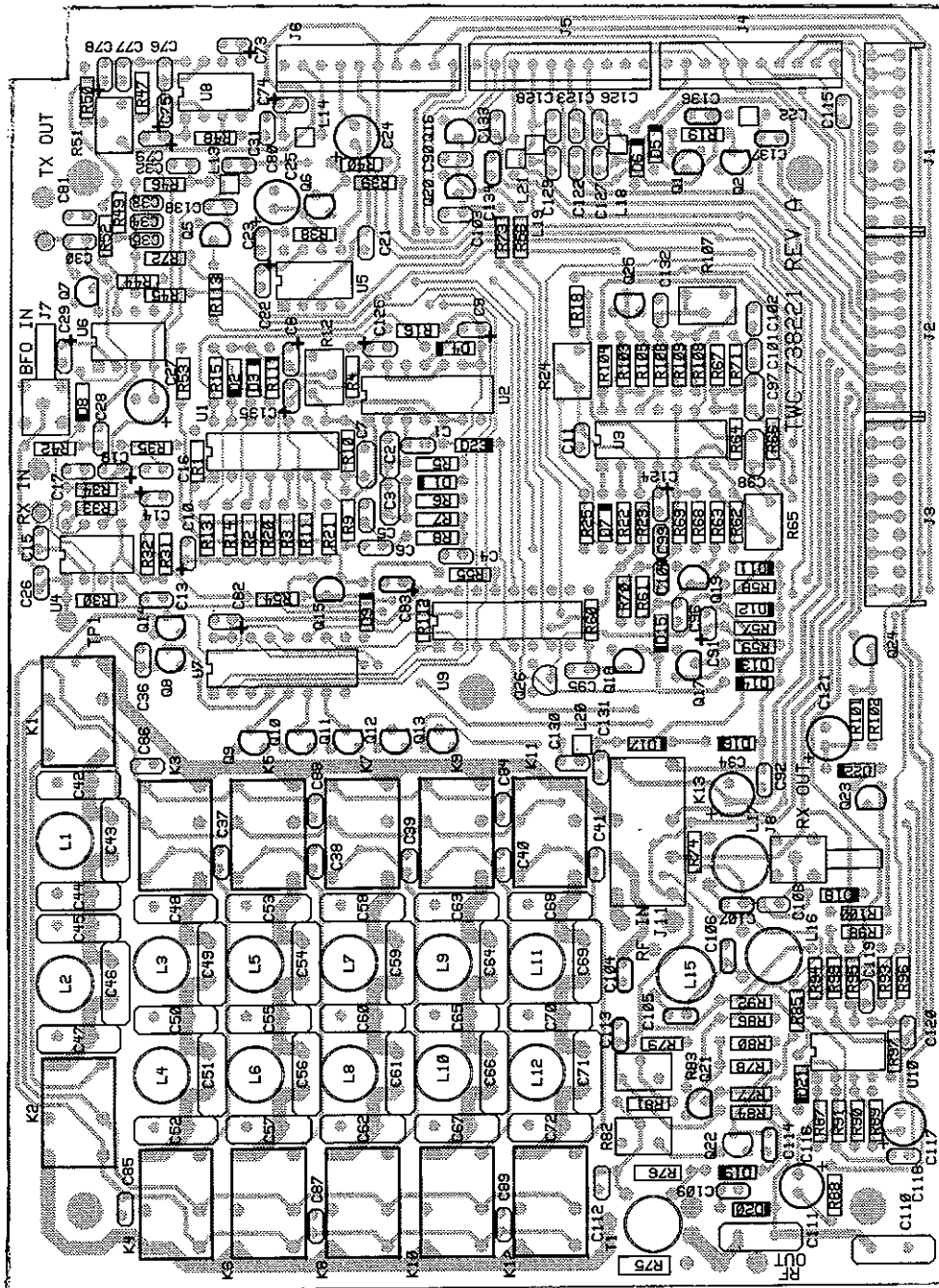


FIGURE 4-3.  
Component Locations, Audio/Filter Module, M1.



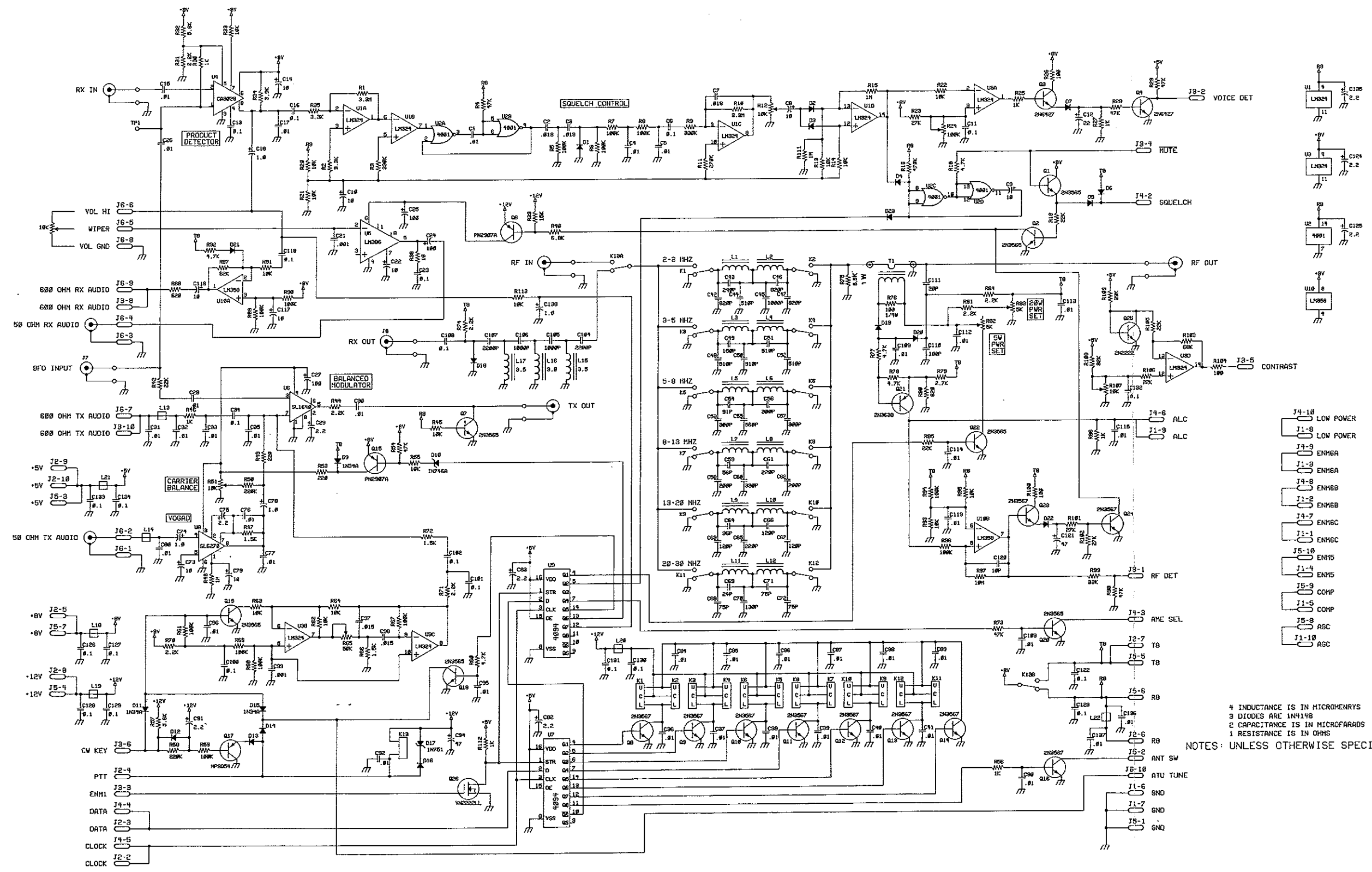


FIGURE 4-4.  
Schematic Diagram, Audio/Filter Module, M1.



TABLE 4-2.  
Parts List, Audio/Filter Module, M1.

C1	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C2,C3	274183	Capacitor, Monolithic 0.018 $\mu$ F
C4,C5	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C6	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C7	274183	Capacitor, Monolithic 0.018 $\mu$ F
C8-C10	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C11	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C12		Not Used.
C13	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C14	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C15	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C16	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C17	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C18	237010	Capacitor, Electrolytic 50 V 1 $\mu$ F
C19,C20		Not Used.
C21	257102	Capacitor, Mylar 0.001 $\mu$ F
C22	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C23	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C24,C25	237101	Capacitor, Electrolytic 16 V 100 $\mu$ F
C26	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C27	237101	Capacitor, Electrolytic 16 V 100 $\mu$ F
C28	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C29	237022	Capacitor, Electrolytic 50 V 2.2 $\mu$ F
C30-C33	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C34	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C35-C41	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C42	220821	Capacitor, Mica DM15 820 pF
C43	220241	Capacitor, Mica 240 pF
C44	220511	Capacitor, Mica 510 pF
C45	220102	Capacitor, Mica DM15 1000 pF
C46,C47	220821	Capacitor, Mica DM15 820 pF
C48	220511	Capacitor, Mica 510 pF
C49	220151	Capacitor, Mica DM15 150 pF
C50	220911	Capacitor, Mica DM15 910 pF
C51,C52	220511	Capacitor, Mica 510 pF
C53	220301	Capacitor, Mica DM15 300 pF
C54	220910	Capacitor, Mica DM15 91 pF
C55	220561	Capacitor, Mica 560 pF
C56,C57	220301	Capacitor, Mica DM15 300 pF
C58	220201	Capacitor, Mica DM15 200 pF
C59	220560	Capacitor, Mica DM15 56 pF
C60	220331	Capacitor, Mica 330 pF
C61	220221	Capacitor, Mica DM15 220 pF
C62	220201	Capacitor, Mica DM15 200 pF
C63	220121	Capacitor, Mica 120 pF
C64	220360	Capacitor, Mica DM15 36 pF
C65	220221	Capacitor, Mica DM15 220 pF
C66,C67	220121	Capacitor, Mica 120 pF
C68	220750	Capacitor, Mica DM15 75 pF
C69	220240	Capacitor, Mica DM15 24 pF
C70	220131	Capacitor, Mica DM15 130 pF
C71,C72	220750	Capacitor, Mica DM15 75 pF
C73	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C74	237010	Capacitor, Electrolytic 50 V 1 $\mu$ F
C75	237022	Capacitor, Electrolytic 50 V 2.2 $\mu$ F
C76,C77	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C78	237010	Capacitor, Electrolytic 50 V 1 $\mu$ F

TABLE 4-2.  
Parts List, Audio/Filter Module, M1, Continued.

C79	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C80	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C81		Not Used.
C82,C83	241020	Capacitor, Tantalum 2.2 $\mu$ F
C84-C90	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C91	237022	Capacitor, Electrolytic 50 V 2.2 $\mu$ F
C92	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C93		Not Used.
C94	237470	Capacitor, Electrolytic 16 V 47 $\mu$ F
C95,C96	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C97,C98	276153	Capacitor, Monolithic 0.2 15000 pF
C99	257102	Capacitor, Mylar 0.001 $\mu$ F
C100-C102	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C103	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C104	276222	Capacitor, Monolithic NPO 100 V 2200 pF
C105,C106	275102	Capacitor, Monolithic NOP 100 V 0.001 $\mu$ F
C107	276222	Capacitor, Monolithic NPO 100 V 2200 pF
C108	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C109	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C110	220101	Capacitor, Mica DM15 100 pF
C111	220200	Capacitor, Mica DM15 20 pF
C112-C115	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C116,C117	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C118	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C119	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C120	210100	Capacitor, Disc NPO 10 pF
C121	237470	Capacitor, Electrolytic 16 V 47 $\mu$ F
C122,C123	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C124,C125	237022	Capacitor, Electrolytic 50 V 2.2 $\mu$ F
C126-C134	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C135	237022	Capacitor, Electrolytic 50 V 2.2 $\mu$ F
C136	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C137	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C138	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
D1-D7	320002	Diode, 1N4148/1N4150
D8		Not Used.
D9	320003	Diode, GE 1N34A
D10		Not Used.
D11	320003	Diode, GE 1N34A
D12-D14	320002	Diode, 1N4148/1N4150
D15	320003	Diode, GE 1N34A
D16	320002	Diode, 1N4148/1N4150
D17	320204	Diode, Zener 1N751A
D18-D23	320002	Diode, 1N4148/1N4150
J1-J3	614027	Connector, Bottom Entry
J4-J6	610144	Connector, 10-pin
K1-K11	540066	Relay, Latchseal
K12		Not Used.
K13	540045	Relay, 12 Vdc 2 A
L1	459013	Inductor, Assembly 17 turns
L2	459014	Inductor, Assembly 20 turns
L3	459143	Inductor, Assembly 19 turns
L4	459139	Inductor, Assembly 11 turns

TABLE 4-2.  
Parts List, Audio/Filter Module, M1, Continued.

L5	459117	Inductor, Assembly 15 turns
L6	459016	Inductor, Assembly 13 turns
L7	459059	Inductor, Assembly 12 turns
L8	459164	Inductor, Assembly 7 turns
L9	459017	Inductor, Assembly 10 turns
L10,L11	459019	Inductor, Assembly 8 turns
L12	459021	Inductor, Assembly 6 turns
L13,L14	459032	Inductor, Assembly 3 turns
L15	459023	Inductor, Assembly 20 turns
L16	459022	Inductor, Assembly 19 turns
L17	459023	Inductor, Assembly 20 turns
L18-L22	459032	Inductor, Assembly 3 turns
Q1,Q2	310006	Transistor, NPN 2N3565
Q3,Q4		Not Used.
Q5	310006	Transistor, NPN 2N3565
Q6	310052	Transistor, PNP PN2907A
Q7	310006	Transistor, NPN 2N3565
Q8-Q14	310003	Transistor, NPN 2N3567
Q15	310052	Transistor, PNP PN2907A
Q16	310003	Transistor, NPN 2N3567
Q17	310060	Transistor, PNP MPSD54
Q18-Q20	310006	Transistor, NPN 2N3565
Q21	310007	Transistor, PNP 2N3538
Q22	310006	Transistor, NPN 2N3565
Q23,Q24	310003	Transistor, NPN 2N3567
Q25	310057	Transistor, NPN PN2222A
Q26	310138	Transistor, FET VN2222LL
R1	113335	Resistor, Carbon Film 1/8 W 5% 3.3 M $\Omega$
R2	113332	Resistor, Carbon Film 1/8 W 5% 3.3 k $\Omega$
R3	113334	Resistor, Carbon Film 1/8 W 5% 330 k $\Omega$
R4	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R5-R8	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R9	113334	Resistor, Carbon Film 1/8 W 5% 330 k $\Omega$
R10	113335	Resistor, Carbon Film 1/8 W 5% 3.3 M $\Omega$
R11	113274	Resistor, Carbon Film 1/8 W 5% 270 k $\Omega$
R12	170221	Resistor, Trimmer 10 k $\Omega$
R13,R14	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R15	113105	Resistor, Carbon Film 1/8 W 5% 1 M $\Omega$
R16	113474	Resistor, Carbon Film 1/8 W 5% 470 k $\Omega$
R17		Not Used.
R18	113472	Resistor, Carbon Film 1/8 W 5% 4.7 k $\Omega$
R19	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R20-R22	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R23	113273	Resistor, Carbon Film 1/8 W 5% 27 k $\Omega$
R24	170225	Resistor, Variable Mini 100 k $\Omega$
R25	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R26-R29		Not Used.
R30	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R31	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R32	113562	Resistor, Carbon Film 1/8 W 5% 5.6 k $\Omega$
R33	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R34	113272	Resistor, Carbon Film 1/8 W 5% 2.7 k $\Omega$
R35	113332	Resistor, Carbon Film 1/8 W 5% 3.3 k $\Omega$
R36,R37		Not Used
R38	113100	Resistor, Film 1/8 W 5% 10 $\Omega$

**TABLE 4-2.**  
**Parts List, Audio/Filter Module, M1, Continued.**

R39	113153	Resistor, Carbon Film 1/8 W 5% 15 k $\Omega$
R40	113682	Resistor, Carbon Film 1/8 W 5% 6.8 k $\Omega$
R41		Not Used.
R42	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R43		Not Used.
R44	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R45	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R46	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R47	113152	Resistor, Carbon Film 1/8 W 5% 1.5 k $\Omega$
R48	113105	Resistor, Carbon Film 1/8 W 5% 1 M $\Omega$
R49	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R50	113224	Resistor, Carbon Film 1/8 W 5% 220 k $\Omega$
R51	170221	Resistor, Trimmer 10 k $\Omega$
R52		Not Used.
R53	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R54	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R55	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R56	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R57	113562	Resistor, Carbon Film 1/8 W 5% 5.6 k $\Omega$
R58	113224	Resistor, Carbon Film 1/8 W 5% 220 k $\Omega$
R59	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R60	113472	Resistor, Carbon Film 1/8 W 5% 4.7 k $\Omega$
R61	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R62-R64	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R65	170232	Resistor, Sealed Trimmer 1/4 Sq. 50 k $\Omega$
R66	113152	Resistor, Carbon Film 1/8 W 5% 1.5 k $\Omega$
R67-R69	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R70,R71	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R72	113152	Resistor, Carbon Film 1/8 W 5% 1.5 k $\Omega$
R73	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R74	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R75	144562	Resistor, Carbon Film 1 W 5% 5.6 k $\Omega$
R76	123101	Resistor, Carbon Film 1/4 W 5% 100 $\Omega$
R77,R78	113472	Resistor, Carbon Film 1/8 W 5% 4.7 k $\Omega$
R79	113272	Resistor, Carbon Film 1/8 W 5% 2.7 k $\Omega$
R80	113821	Resistor, Carbon Film 1/8 W 5% 820 $\Omega$
R81	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R82,R83	170223	Resistor, Trimmer 5 k $\Omega$
R84	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R85	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R86	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R87	113623	Resistor, Carbon Film 1/8 W 5% 62 k $\Omega$
R88	113621	Resistor, Carbon Film 1/8 W 5% 620 $\Omega$
R89,R90	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R91	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R92	113472	Resistor, Carbon Film 1/8 W 5% 4.7 k $\Omega$
R93	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R94	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R95	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R96	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R97	113106	Resistor, Carbon Film 1/8 W 5% 10 M $\Omega$
R98	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R99	113333	Resistor, Carbon Film 1/8 W 5% 33 k $\Omega$
R100	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R101,R102	113273	Resistor, Carbon Film 1/8 W 5% 27 k $\Omega$
R103	113683	Resistor, Carbon Film 1/8 W 5% 68 k $\Omega$
R104	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$

**TABLE 4-2.**  
**Parts List, Audio/Filter Module, M1, Continued.**

R105,R106	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R107	170221	Resistor, Trimmer 10 k $\Omega$
R108	113823	Resistor, Carbon Film 1/8 W 5% 82 $\Omega$
R109	113393	Resistor, Carbon Film 1/8 W 5% 39 k $\Omega$
R110		Not Used.
R111	113105	Resistor, Carbon Film 1/8 W 5% 1 M $\Omega$
R112	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R113	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
T1	459100	Transformer, Assembly 10 turns
U1	330030	IC, LM324N
U2	330134	IC, CD4001BE
U3	330030	IC, LM324N
U4	330274	IC, CA3028AE
U5	330083	IC, LM386N-1
U6	330036	IC, SL164OC
U7	330126	IC, CD4094BD/MC14094BCP
U8	330029	IC, SL6270CDP
U9	330126	IC, CD4094BD/MC14094BCP
U10	330081	IC, LM358N

C

C

C



# CHAPTER 5

## 1650-KHZ IF MODULE, M2 - TECHNICAL DESCRIPTION

### 5-1 BLOCK DIAGRAM

A block diagram of the module is shown in Figure 5-1. The SSB filter is used in both the transmit and receive modes with separate amplifiers for each of these modes. The AGC control system is generated in this module. The module has the following block components and operating functions:

1. 1650-kHz SSB Filter.
2. 1650-kHz RX IF AMP 1.
3. 1650-kHz RX IF AMP 2.
4. AGC RF Amplifier.
5. AGC dc Amplifier.
6. 1650-kHz TX IF AMP.
7. Sidetone Generation.

### 5-2 1650-KHZ SSB FILTER

The 1650-kHz SSB filter is a six-pole Chebyshev design with a -6-dB passband of 2400 Hz and a -60-dB passband

of less than 5000 Hz or a 2:1 shape factor. The filter is computer designed for low group delays within the passband. As the group delays are a function of the percentage bandwidth, the use of the low-frequency IF permits superior performance with much lower group delays than equivalent filters operating at higher frequencies (10.7 MHz for example). For this reason the PRC1099A can be used for data transmission and COMSEC applications usually requiring higher bandwidths (3000 Hz for example). The filter is used in the receive mode to provide rejection of unwanted signals outside the passband. In the transmit mode, the filter removes one of the sidebands from the double-sideband suppressed carrier signal generated by the balanced modulator. The signal path through the filter is reversed between the transmit and receive modes. The filter passband is symmetrical, and this permits the use of one filter for both upper and lower sideband operation. For upper sideband operation the BFO frequency is 1650 kHz

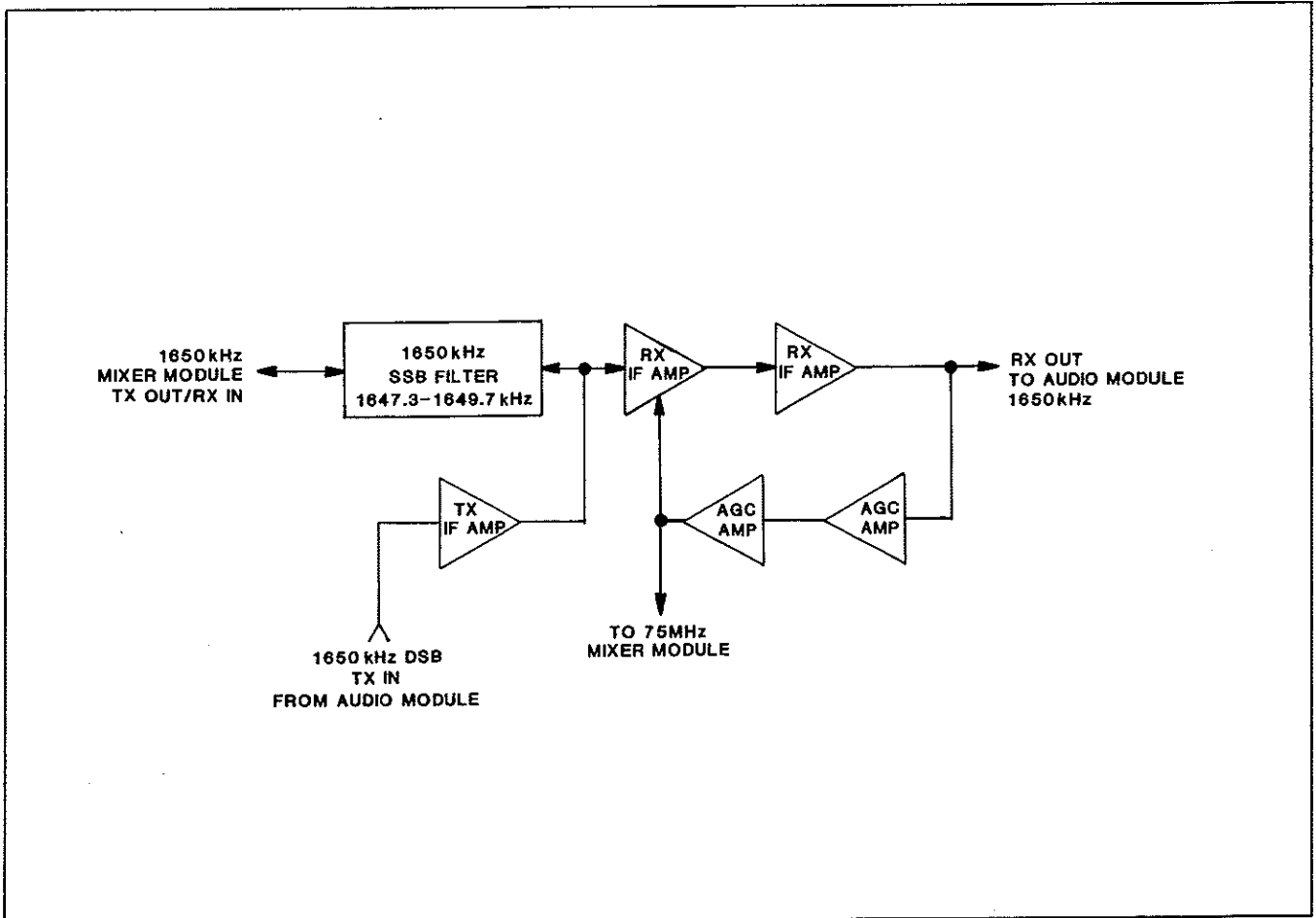


FIGURE 5-1.  
Block Diagram - 1650-kHz IF Module, M2.

passband (the sidebands are reversed in the conversion process and that upper sideband is generated at the 1650-kHz IF frequency as lower sideband). For lower sideband, the BFO frequency is 1647 kHz on the lower side of the filter passband. The synthesizer output is automatically shifted 3 kHz when sidebands are switched, so that the carrier frequency remains unchanged.

**5-3 1650-KHZ RX IF AMPLIFIER 1**

The first 1650-kHz IF amplifier Q1 is a dual gate MOSFET connected directly to the filter output. The stage has a high input impedance which facilitates correct filter matching. The stage gain is controlled by the application of the AGC control voltage applied to gate #2 (Q1, pin 2). A dual gate MOSFET has a low distortion control range of approximately 60 dB by controlling the gate #2 voltage. It is necessary for the gate #2 voltage to go negative with respect to gate #1 in order to achieve the full range of control. The series diodes D1/D2/D5 provide a 1.8 V voltage drop so that gate #1 (Q1, pin 3) is 1.8 V above ground. This means that when gate #2 is at 0 V it is 1.8 V negative with respect to gate #1. The output is transformer coupled through T3 to the next stage.

**5-4 1650-KHZ RX IF AMPLIFIER 2**

The second 1650-kHz IF amplifier Q2 is a fixed-gain common emitter stage with an unbypassed emitter. The output is transformer coupled (T4) to the audio module through the 3-dB attenuator R10/R11.

**5-5 AGC RF AMPLIFIER**

The AGC RF amplifier Q5 is an emitter-follower bipolar transistor. The low impedance output drives the voltage doubler rectifier D3/D4.

**5-6 AGC DC AMPLIFIER**

The AGC dc amplifier Q4 is a common emitter bipolar transistor with R18 as the high impedance collector load. This gives a negative going AGC output of 4 V to 0 V. The AGC output controls the 1650-kHz and 75-MHz IF amplifiers.

**5-7 1650-KHZ TX AMPLIFIER**

The transmit IF amplifier Q3 is a common emitter bipolar transistor with an unbiased emitter resistor. The collector load L1 is isolated from Q3 in the receive mode by the gate D6. This stage provides amplification of the low level DSB signal from the balanced modulator and correct matching to the 1650-kHz filter. It should be noted that the signal path through the filter is reversed in the transmit mode. The output from the filter is a 1650-kHz SSB signal.

**5-8 SIDETONE GENERATOR**

The 1650-kHz IF system also generates the transmit sidetone. The receive IF amplifiers remain switched on in the transmit mode and the receiver "listens" to the low level transmitter exciter output. The diode switch D7 is connected to the drain of Q1 and shorts the drain load of T3. This prevents overload of the receive IF amplifiers. This method of sidetone generation provides a complete check of the entire audio, balanced-modulator, product-detector and 1650-kHz IF system. When coupled with the RF sidetone gate, the sidetone becomes a powerful diagnostic tool in determining the complete system performance (BITE).

**5-9 SERVICE DATA**

Figure 5-2 is a component location diagram with adjustments and signal input/output points indicated.

**TABLE 5-1.**  
**Specifications, 1650-kHz If Module, M2.**

<b>Transmit</b>	
Current:	8 Vdc @ 4 mA.
Output:	1650 kHz, SSB.
Input:	1650 kHz, DSB.
System Gain:	14 dB.
<b>Receive</b>	
Current:	8 Vdc @ 6 mA.
Output:	1650 kHz.
Input:	1650 kHz.
System Gain:	44 dB.
AGC Range:	55 dB.
<b>Filter</b>	
-6 dB:	1647.3-1649.7 kHz.
-60 dB:	1646.0-1651.0 khz.

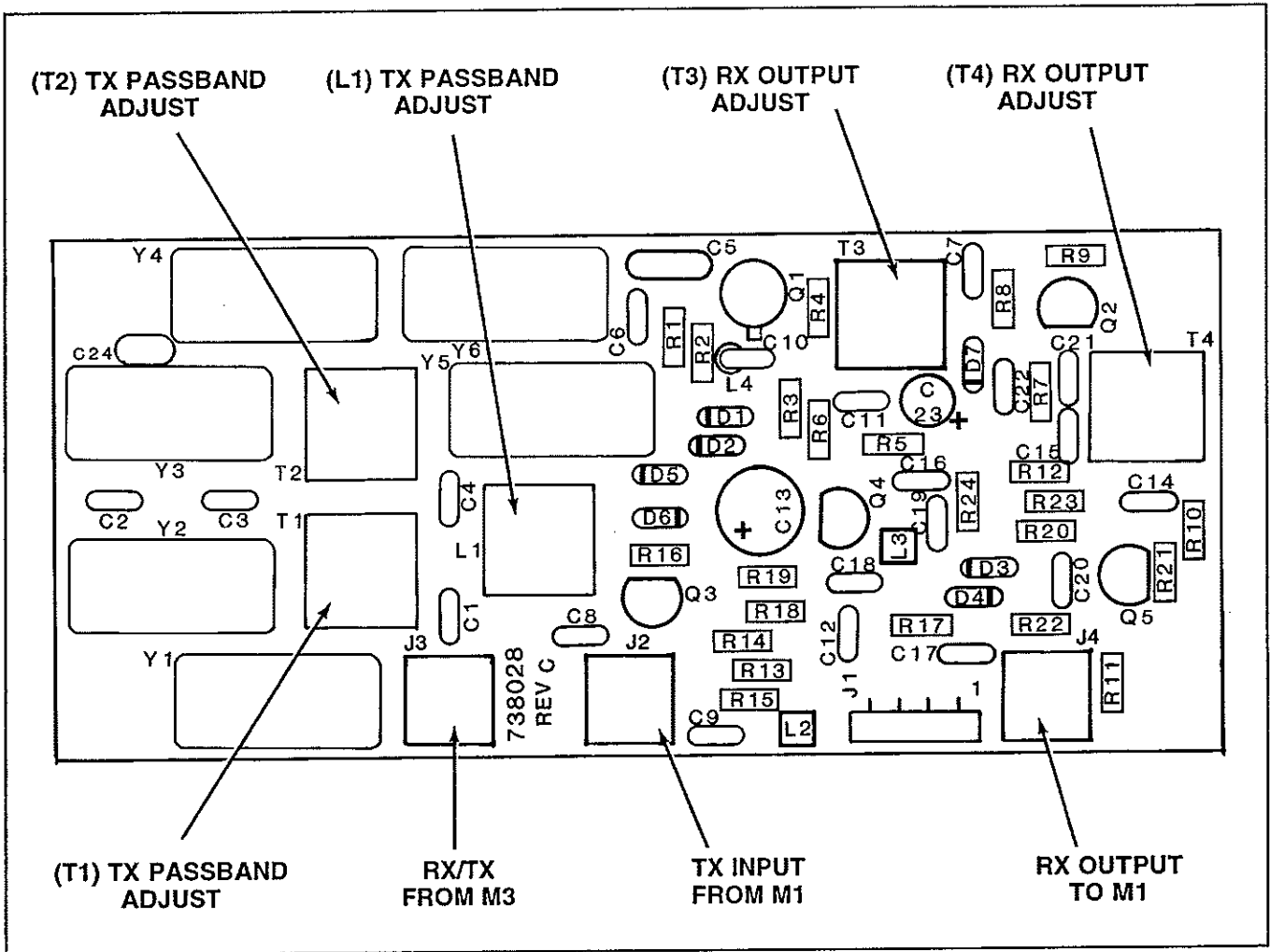


FIGURE 5-2.  
Signal Connections and Adjustment Points.

They are summarized as follows:

1. T1, T2, L1. Used to align the crystal filter for flattest passband response; factory set for  $\pm 0.5$  dB ripple in transmit mode.
2. T3, T4. Factory set for maximum output in receive mode.

#### 5-10 MODULE INTERCONNECTIONS

The M2 module has the following interconnections with the transceiver:

#### Connector M2J1

- |       |   |
|-------|---|
| Pin 1 | AGC. Automatic Gain Control, used to set the audio level in receive. Typically 4 Vdc. |
| Pin 2 | R8. 8 Vdc when radio is in receive, 0 Vdc in transmit.                                |
| Pin 3 | 8 Vdc from power supply.  |
| Pin 4 | T8. 8 Vdc when radio is in transmit, 0 Vdc in receive.                                |

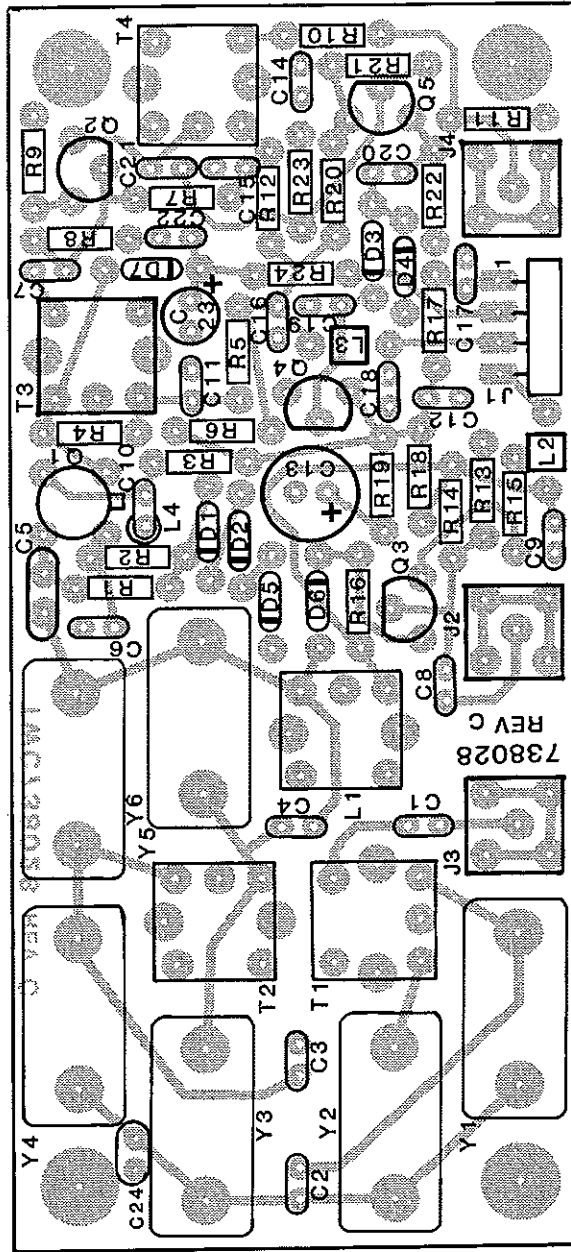
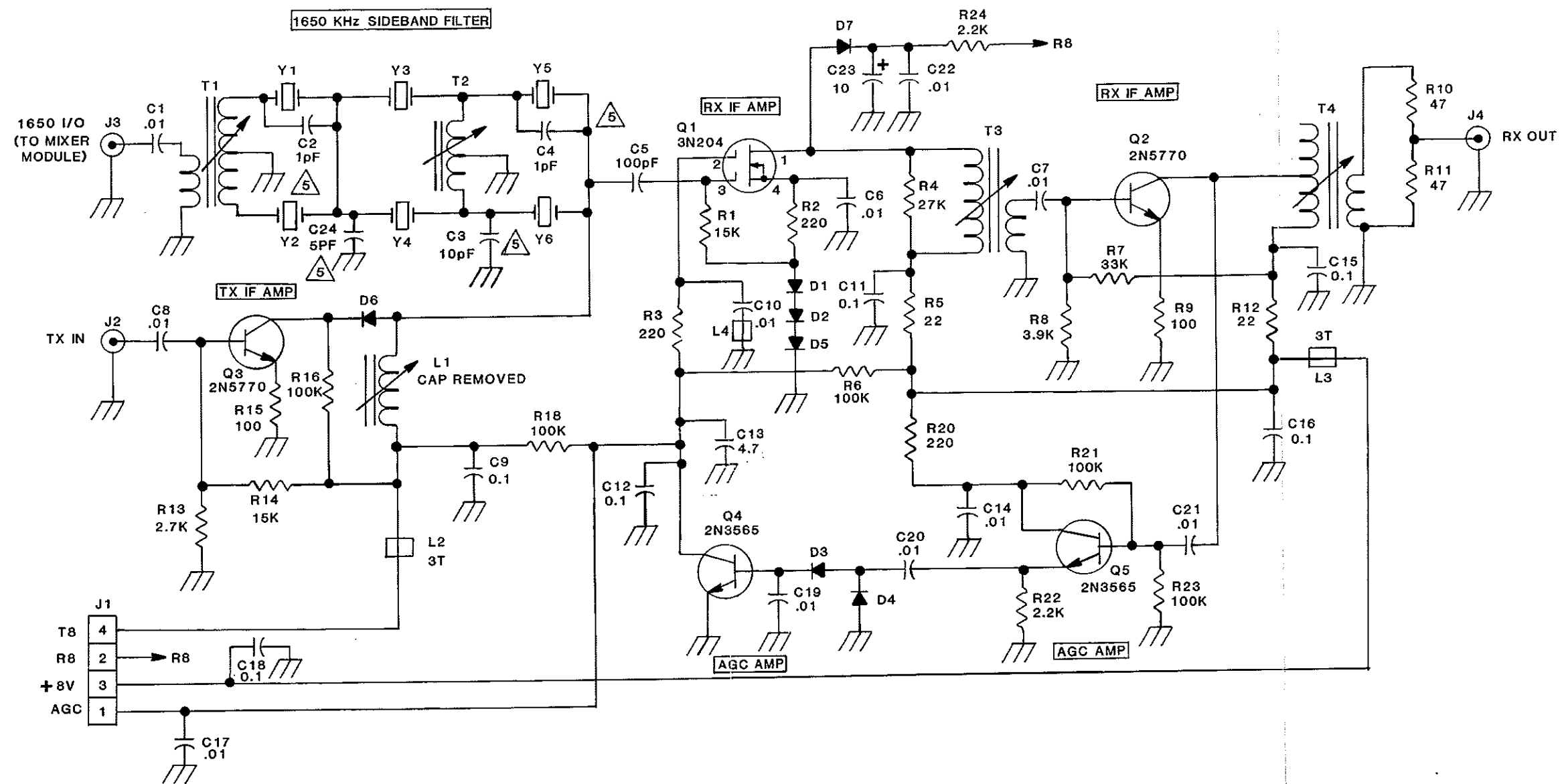


FIGURE 5-3.  
Component Locations, 1650-kHz IF Module, M2.



CONNECTOR WIRING

J1-1	AGC
J1-2	R8
J1-3	+8 VDC
J1-4	T8

- NOTE: UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTORS ARE 1/8W %5%.
  2. RESISTANCE IS IN OHMS
  3. CAPACITANCE IS IN MICROFARADS.
  4. ALL DIODES ARE IN4148/IN4150.
- ⚠ PARTS C2, C3, C4 FITTED OR C24 FITTED.

FIGURE 5-4.  
Schematic Diagram, 1650-kHz IF Module, M2.



TABLE 5-2.  
Parts List, 1650-kHz IF Module, M2.

C1	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C2*	210010	Capacitor, Disc NPO 1.0 pF
C3*	210100	Capacitor, Disc NPO 10 pF
C4*	210010	Capacitor, Disc NPO 1.0 pF
C5	221101	Capacitor, Mica DM5 100 pF
C6-C8	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C9	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C10	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C11,C12	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C13	241040	Capacitor, Tantalum 16 V 4.7 $\mu$ F
C14	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C15,C16	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C17	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C18	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C19-C22	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C23	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C24**	210050	Capacitor, Disc NPO 5 pF
D1-D7	320002	Diode, 1N4148
L1	420051	Inductor, 1650 kHz IF
L2,L3	459032	Inductor, Ferrite 3 turns
Q1	310001	Transistor, MFT 3N204
Q2,Q3	310032	Transistor, NPN 2N5770
Q4,Q5	310006	Transistor, NPN 2N3565
R1	113153	Resistor, Film 1/8 W 5% 15 k $\Omega$
R2,R3	113221	Resistor, Film 1/8 W 5% 220 $\Omega$
R4	113273	Resistor, Film 1/8 W 5% 27 k $\Omega$
R5	113220	Resistor, Film 1/8 W 5% 22 $\Omega$
R6	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R7	113333	Resistor, Film 1/8 W 5% 33 k $\Omega$
R8	113392	Resistor, Film 1/8 W 5% 3.9 k $\Omega$
R9	113101	Resistor, Film 1/8 W 5% 100 $\Omega$
R10,R11	113470	Resistor, Film 1/8 W 5% 47 $\Omega$
R12	113220	Resistor, Film 1/8 W 5% 47 $\Omega$
R13	113272	Resistor, Film 1/8 W 5% 2.7 k $\Omega$
R14	113153	Resistor, Film 1/8 W 5% 15 k $\Omega$
R15	113101	Resistor, Film 1/8 W 5% 100 $\Omega$
R16	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R17		Not Used
R18	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R19		Not Used
R20	113221	Resistor, Film 1/8 W 5% 220 $\Omega$
R21	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R22	113222	Resistor, Film 1/8 W 5% 2.2 k $\Omega$
R23	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R24	113222	Resistor, Film 1/8 W 5% 2.2 k $\Omega$
T1-T4	420018	Transformer, 1650 kHz IF
Y1	361001	Crystal, Filter
Y2	361004	Crystal, Filter
Y3	361003	Crystal, Filter

TABLE 5-2.  
Parts List, 1650-kHz IF Module, M2 (Continued).

Y4	361002	Crystal, Filter
Y5	361001	Crystal, Filter
Y6	361004	Crystal, Filter

\* Parts fitted when C24 not installed.

\*\* Part fitted when C2, C3, C4 not installed



# CHAPTER 6

## MIXER MODULE, M3 - TECHNICAL DESCRIPTION

### 6-1 BLOCK DIAGRAM

A block diagram of the module is shown in Figure 6-1. This module contains the first and second conversion mixers. In the receive mode the signal from the antenna is up converted to 75 MHz, amplified, filtered, amplified again, and then down converted to 1650 kHz. In the transmit mode, the 1650-kHz low-level SSB signal is up converted to 75 MHz, amplified, filtered, down converted to the 1.6 to 30-MHz range, and amplified again to approximately +3 dBm. The module has the following block components:

1. 30-MHz Low-Pass Filter.
2. Double-Balanced Mixer—RX Mode.
3. 75-MHz IF Amplifier 1—RX Mode.
4. 75-MHz Filter—RX Mode.
5. 75-MHz IF Amplifier 2—RX Mode.
6. 75-MHz to 1650-kHz Mixer—RX Mode.
7. 1650-kHz to 75-MHz Mixer—TX Mode.
8. 75-MHz TX Gain-Controlled Amplifier.
9. 75-MHz Filter—TX Mode.
10. Double Balanced Mixer—TX Mode.
11. SYN 1 Buffer.
12. SYN 2 Buffer.
13. Squelch Gates.
14. 1.6 to 30-MHz Amplifier—TX Mode.
15. Current Regulator.

### 6-2 30-MHZ LOW-PASS FILTER

The low-pass filter C9/L3/C10/L4/C11 is located at the mixer port used as the receiver input and the transmitter output. This filter removes the unwanted image and spurious responses above 30 MHz.

### 6-3 DOUBLE-BALANCED MIXER - RX MODE

The balanced mixer MX1 is a high-level, packaged, double-balanced mixer using matched hot-carrier diodes for optimum performance. This mixer is also used in the transmit mode. The receiver input is routed from the antenna tuner or antenna through one of the six low-pass filters and the 1.6-MHz high-pass filter on M1, and is switched to the mixer through the 30-MHz low-pass filter by the relay K1. A relay is used at this point to minimize input cross modulation. The diode switch D4 shorts the input to the receiver in the transmit mode.

The SYN 1 synthesizer provides the injection to the oscillator port. This synthesizer covers the range 76.6 to 105 MHz in 10-Hz steps; the incoming signal in the 1.6 to 30-MHz range is up converted to the first IF frequency of 75 MHz. The image frequency range is 151.6 to 180 MHz. This means that the image, IF and other lower level spurious responses are easily eliminated by a simple 30-MHz low-pass filter. No tuned circuits are required in the

receiver, which is broadband over the entire frequency range.

The mixer is one of the most important elements in a broadband, high-performance receiver. The SRA1 double-balanced mixer is a high-performance packaged mixer with very low distortion. The oscillator levels and terminations are optimized for best performance, and a third order intercept point in excess of 11 dBm is achieved. This means that the mixer can handle high level signals without the generation of spurious responses.

### 6-4 75-MHZ IF AMP 1 - RX MODE

The 75-MHz IF amplifier Q3 provides a broadband 50-ohm match to the double-balanced mixer. The bipolar transistor used in the amplifier is selected for low noise and high linearity. Emitter degeneration (R11) and collector feedback (R10) ensure low intermodulation distortion. The collector is matched to the filter by the Pi network C17/L5/C18.

### 6-5 75-MHZ FILTER - RX MODE

The 75-MHz filter Y1 is a four-pole, monolithic crystal filter with a bandwidth of 25 kHz. This filter provides the primary selectivity to prevent overload of the IF stages and second mixer before the narrowband SSB filter at 1650 kHz. The filter has a stopband of -70 dB and rejects the IF image and other spurious frequencies. The filter output is matched to 50 ohms by the Pi network C44/L14/C45.

### 6-6 75-MHZ IF AMPLIFIER 2 - RX MODE

The second 75-MHz IF amplifier Q7 is a dual gate MOSFET with AGC applied to gate #2. The AGC voltage has a control range of 0-4 V, and it is necessary to swing gate #2 negative with respect to gate #1 to get the maximum control range of 60 dB. This is achieved by the series diodes D8/D9/D10 in the source circuit of Q7. Gate #1 is connected to the anode of D8 and is biased at +1.8 V. When the AGC control voltage is at 0 V, gate #2 will be 1.8 V negative with respect to gate #1. The 50-ohm output from the filter is selected by D7 and is matched to the input of Q7 by T2, a 50-ohm to 450-ohm broadband transformer. A Pi network, C52/L18/C53, provides the inter-stage coupling to the mixer Q8.

### 6-7 75-MHZ TO 1650-KHZ Mixer - RX MODE

The second conversion mixer Q8 is a dual-gate MOSFET with the signal input to gate #1 and the oscillator input to gate #2. This circuit provides reasonable gain, good linearity, and a low noise figure. The output is coupled through T3 to the IF module (1650 kHz at 50 ohms). Q9 switches the 1650-kHz output in the receive mode. The oscillator output from SYN 2 is at 73.35 MHz.

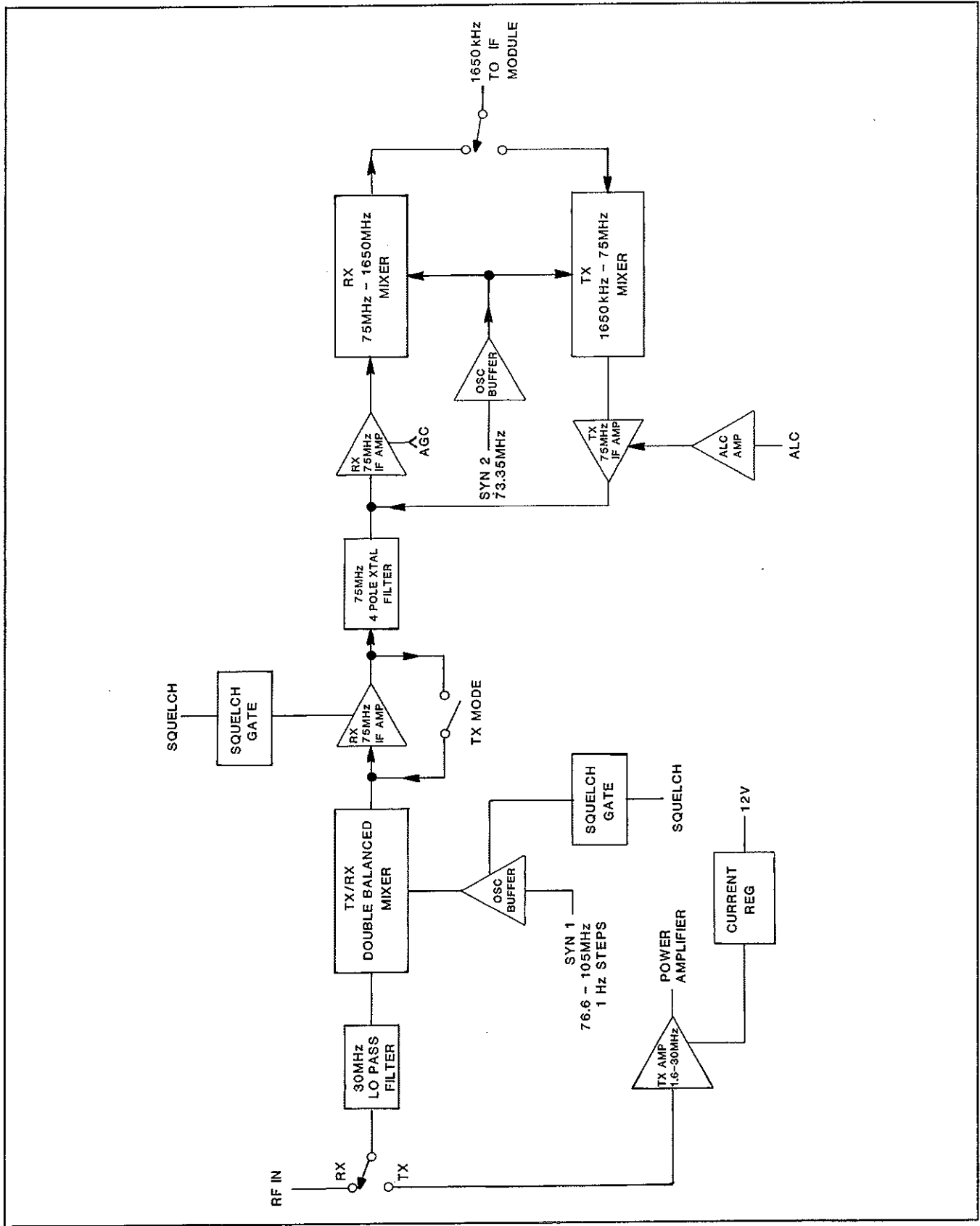
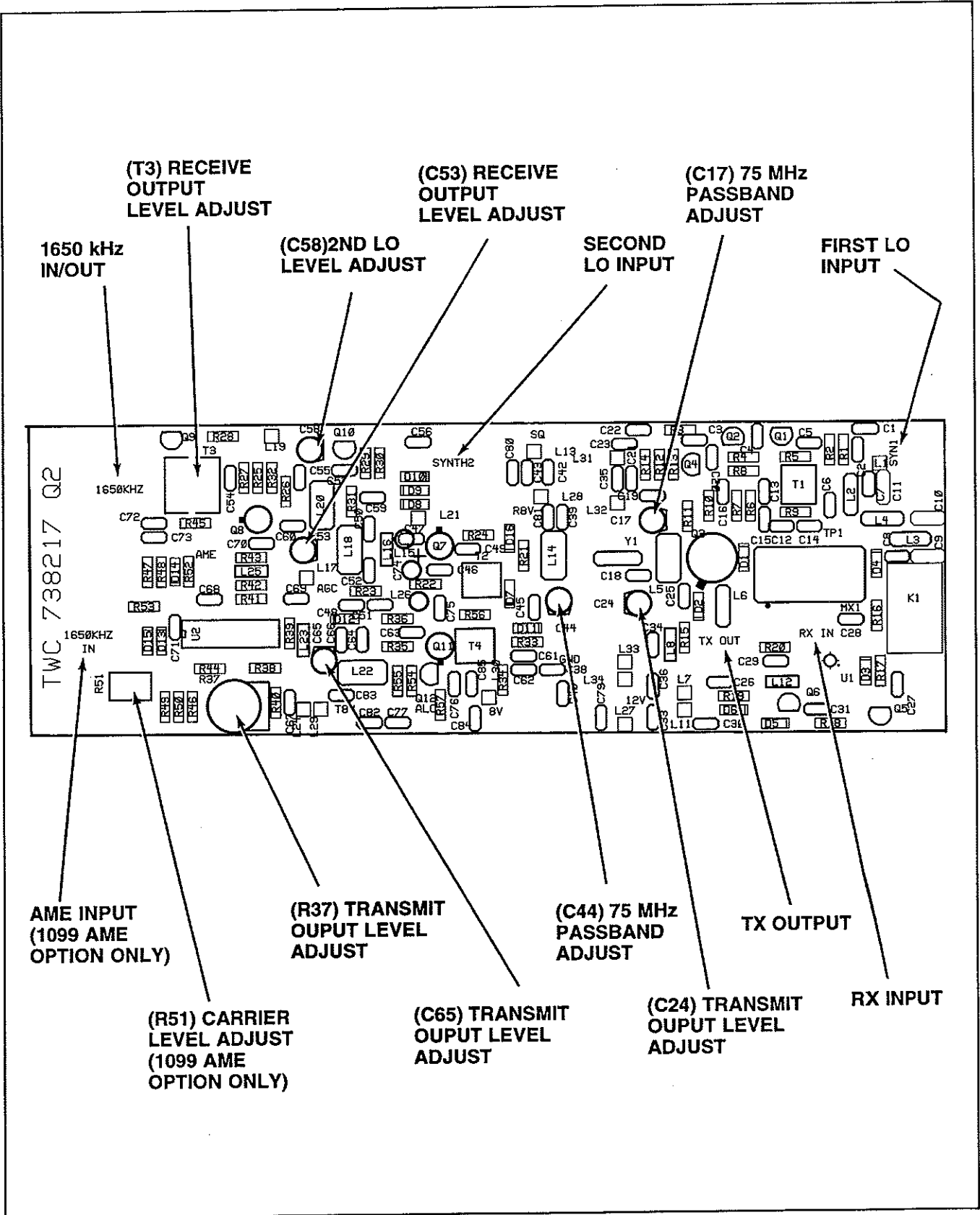


FIGURE 6-1.  
Block Diagram - Mixer Module, M3.



**FIGURE 6-2.**  
Signal Connections and Adjustment Points.

**TABLE 6-1.**  
**Specifications, Mixer Module, M3.**

<b><u>Transmit</u></b>	
Current:	8 Vdc @ 43 mA. 12 Vdc @ 44 mA.
Output:	Channel Frequency (Fs).
Input:	1650 kHz.
Gain:	31 dB.
<b><u>Receive</u></b>	
Current:	8 Vdc @ 20 mA. 8 Vdc @ 12.5 mA (squelched). 12 Vdc @ 17.5 mA. 12 Vdc @ 5.7 mA (squelched).
Output:	1650 kHz.
Input:	Channel Frequency (Fs).
Gain:	32 dB.
<b><u>Oscillators</u></b>	
Level @ TP1:	+7 dBm @ 76.6-105 MHz.
Level @ Q11-G2:	2 V, RMS, @ 73.35 MHz.
Level @ U2-10:	100 mV, RMS, @ 73.35 MHz

#### **6-8 1650-KHZ TO 75-MHZ MIXER - TX MODE**

This stage up converts the 1650-kHz SSB signal for the IF module to 75 MHz. U2 is an integrated circuit, active double-balanced mixer, which gives good oscillator suppression. The gain of the exciter is set by R37. The output is coupled to Q11 through the Pi network C64/L22/C65. The input is switched to the 1650-kHz IF module by D13. The SYN 2 at 73.35 MHz provides the oscillator injection frequency.

#### **6-9 75-MHZ TX GAIN-CONTROLLED AMPLIFIER**

Q11 is a dual gate MOSFET using gate #2 to control the stage gain. The ALC (automatic level control) voltage is supplied from module 1 and is applied to Q12, the ALC amplifier. When there is no ALC voltage present, Q12 does not draw collector current, and the maximum voltage of 4 V is applied through the voltage divider R54/R55 to gate #2 of Q11. In the receive mode the voltage is held at approximately 3 V by R56 and D16 connected to R8 (the receive 8-V line). When ALC voltage is applied, Q12 conducts, which causes the collector and gate #2 voltage to drop. This causes the gain of Q11 to drop and is the same system of control as used for the AGC system (refer Q7). However, a smaller control range is required, and only one diode, D12, is used to provide the fixed reference voltage for gate #1. The collector impedance of Q12 is low in comparison with the collector load R54, and the slow release is provided by C74 discharging through the high impedance load. The ALC system is normally peak reading, and the peak envelope power (PEP) and average power output will be equal. The power amplifier in the PRC1099A has considerable reserve power capability (30-40 W).

The drain of Q11 is connected through the broadband transformer T4 to the 50-ohm input of the 75-MHz filter through the diode switch D11.

#### **6-10 75-MHZ FILTER - TX MODE**

The 75-MHz filter rejects the image output from the mixer U2 and provides additional attenuation of the second conversion oscillator. The output from the filter passes through the Pi network C18/L5/C17 (Q3 is switched off in the TX mode), through the diode switch D2 to the additional section C24/L6 and the diode switch D1 to the double balanced mixer MX1. The signal path through the filter is bilateral, and the TX signal bypasses the RX IF amplifier Q3 in the transmit mode.

#### **6-11 DOUBLE-BALANCED MIXER - TX MODE**

The double-balanced mixer MX1 is used in the reverse direction in the TX mode. The 75-MHz signal is mixed with the SYN 1 output (76.6-105 MHz) to give complete coverage of the 1.6 to 30 MHz range. The image frequency is removed by the 30-MHz low-pass filter, and the mixer is run at very low level to minimize spurious outputs.

#### **6-12 SYN 1 BUFFER**

The SYN 1 buffer Q1 amplifies the low level synthesizer output to a level of approximately +7 dBm for injection into the 50-ohm oscillator port of MX1. The output from Q1 is coupled through T1, a broadband transformer and the 105-MHz, low-pass filter C6/L2/C7. The response is substantially flat over the SYN 1 output range 76.6 to 105 MHz.

### 6-13 SYN 2 BUFFER

The SYN 2 buffer Q10 amplifies the low level 73.35-MHz output from synthesizer 2 to an output level of 2-V RMS. The tuned output circuit, L20/C58 provides good spectral purity. The output is coupled directly into gate #2 of Q8 the receiver mixer, and the level is dropped to 100 mV through R43 for injection into the transmitter mixer U2.

### 6-14 SQUELCH GATES

The squelch gates Q2 and Q4 are used to reduce the receiver current drain in the receive mode. The PRC1099A has a high dynamic range receiver with a performance fully equivalent to most base station receivers. In order to achieve this performance, it is necessary to run high level oscillator injection levels to the double-balanced mixer MX1. The following IF amplifier Q3 must also run at high levels. It is possible to make a substantial decrease in the current drain of the receiver by making a reduction in the dynamic range. The PRC1099A has an intercept point of +11 dBm and a dynamic range exceeding 100 dB. The squelch circuit is used to lower the oscillator injection level and reduce the current drain of the first IF amplifier, which lowers the intercept point to approximately +1 dBm. There is virtually no change in sensitivity or SINAD. Even with the reduced dynamic range, the performance of the receiver meets or exceeds the specification of most HF manpacks.

Q2 is the squelch gate controlling the current drain of the synthesizer buffer Q1. In the squelch mode, Q2 is open circuit, so that the emitter resistor for Q1 is comprised of R5 (47 ohms) and R4 (820 ohms). When the squelch is off, the gate Q2 closes, which shorts R4 to ground and reduces the emitter resistance to 50 ohms. Similarly, Q4 switches in and out the emitter resistor, R13 (150 ohms), for the IF amplifier Q3. In the transmit mode, a diode gate on M1 closes the squelch gates so that the double-balanced mixer is supplied with the high-level oscillator injection.

### 6-15 AMPLIFIER 1.6 TO 30 MHZ - TX MODE

The low-level output from the double-balanced mixer MX1 is amplified by the MMIC (monolithic, microwave, integrated circuit) U1. This is a new class of three terminal devices providing stable 50 ohms to 50 ohms amplification over a very wide frequency range without any external components.

### 6-16 CURRENT REGULATOR

The MMIC (U1) is designed to operate from a 20-V supply using a series bias resistor in the supply load. Since the PRC1099A is designed to operate over a supply range in excess of 10-15 V, a current regulator, Q6, is used to provide a constant current source for U1. The current output is determined by R19. The current to U52 is switched on by the TX gate Q5, which is controlled by the T8 line.

### 6-17 AME OPTION

The purpose of this circuit is to inject a 1650-kHz signal from the carrier oscillator directly into the transmit chain at

the highest possible level. This is necessary as the carrier level should not be controlled by the ALC circuit, and it is not desirable to pass the carrier through the crystal filter. The carrier is applied to the input of the mixer U2 via the PIN diode attenuator D14/D15. In the off position, D14 is forward biased, which shorts the carrier to ground. D15 is reverse biased. This gives approximately 60 dB of attenuation. When the carrier switch is grounded, D15 is forward biased, and D14 is reverse biased, and the carrier is not attenuated. The carrier level is adjusted by the input potentiometer R51.

### 6-18 SERVICE DATA

Figure 6-2 is a component location diagram with adjustment and signal input/output points indicated. Refer to Figure 6-2 for adjustment locations. A summary of adjustments is as follows:

1. C58. Used to set the Syn. 2 level for maximum. The Syn. 2 level can be monitored at R26 and should be approximately 2 V RMS. **NOTE:** The Syn. 1 level is checked at TP1 and should be about +7-10 dBm.
2. C53, T3. Used to set the receiver output level; adjusted at the factory for maximum RX output.
3. C44, C17. With the signal generator set to 7.0 MHz and the level at -50 dBm, adjust C44 and C17 for maximum output. Then alternate the adjustments for C44 and C17 between signal generator settings of 7.0 MHz and 6.999 MHz until the levels are equal. This serves to optimize the 75 MHz filter passband.
4. R37, C65 and C24. With the radio set to 7.0000 MHz, and a wattmeter and dummy load connected to the 50-ohm output, key the radio using a CW keyer and adjust C65 and C24 for maximum output. Now adjust R37 until the power output reads approximately 15 watts, record this value. Set the radio to 6.999 MHz and readjust C65 and C24 for maximum. Alternate between 7.0000 MHz and 6.999 MHz and adjust C65 and C24 for balance between the two frequencies. Once C65 and C24 have been adjusted, increase the output power with R37 until the power stops increasing. Check all test frequencies and insure the output power does not deviate more than 3 watts.

### 6-19 MODULE INTERCONNECTIONS

The M3 module has the following interconnections with the transceiver:

#### Connector M3J1

- |       |   |
|-------|---|
| Pin 1 | GROUND.   |
| Pin 2 | ALC. Automatic Level Control, used to set the output power level in transmit. |
| Pin 3 | +12V. 12 volts from the M9 module.  |

- Pin 4 +8V. 8 volts from the M9 module.
- Pin 5 R8. 8 volts in receive from the M1 module.
- Pin 6 T8. 8 volts in transmit from the M1 module.
- Pin 7 SQUELCH. Squelch signal from the M1 module to disable the receive audio.
- Pin 8 AGC. Automatic Gain Control, used to set the audio level in receive.
- Pin 9 AME. Used to enable the AME option, when installed.
- Pin 10 N/C. No connection.
- Pin A1 1650 KHZ I/O. The 1650 kHz receive output/transmit input.
- Pin A2 TX OUT. The transmit output signal.
- Pin A3 RX IN. The receive input signal.

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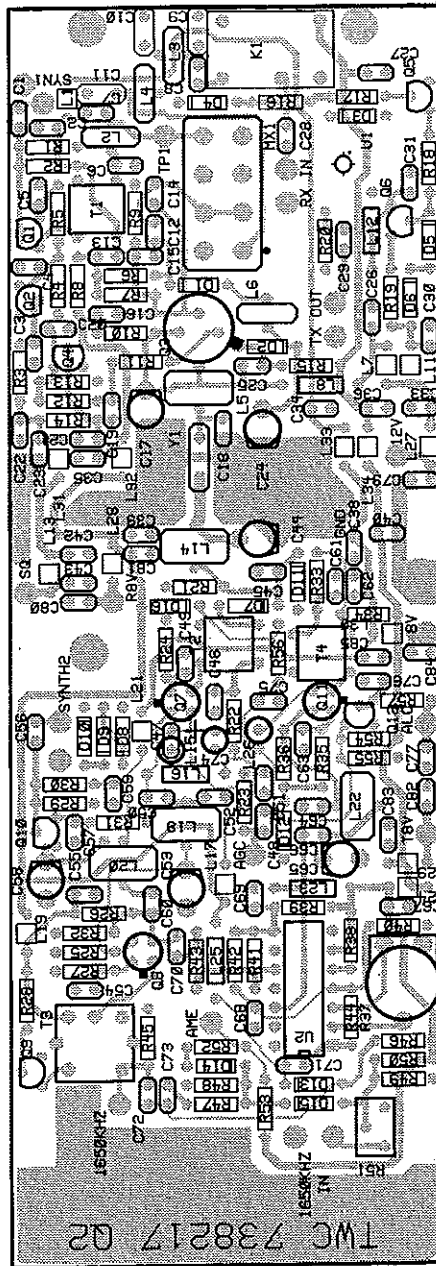


FIGURE 6-3.  
Component Locations, Mixer Module, M3.



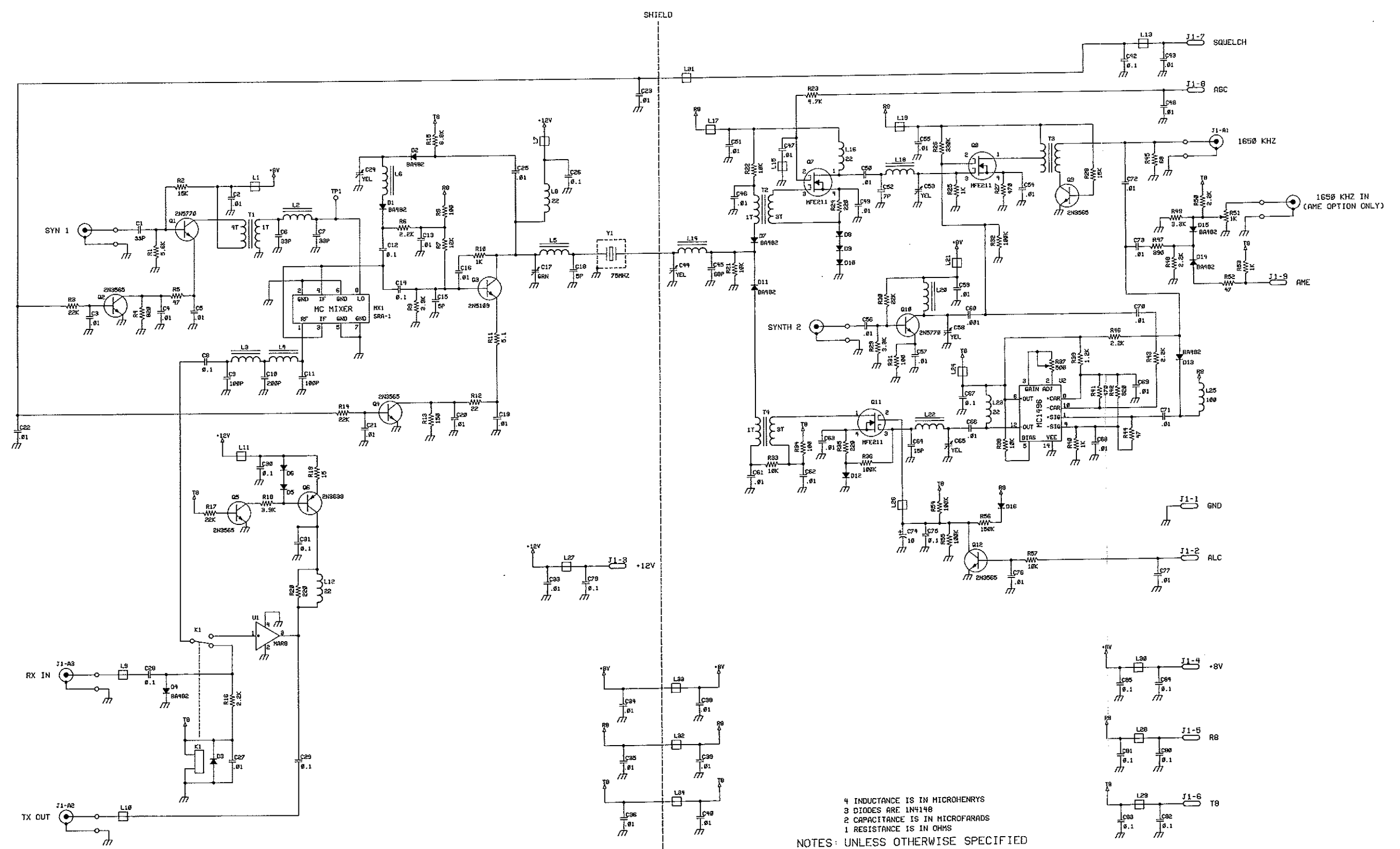
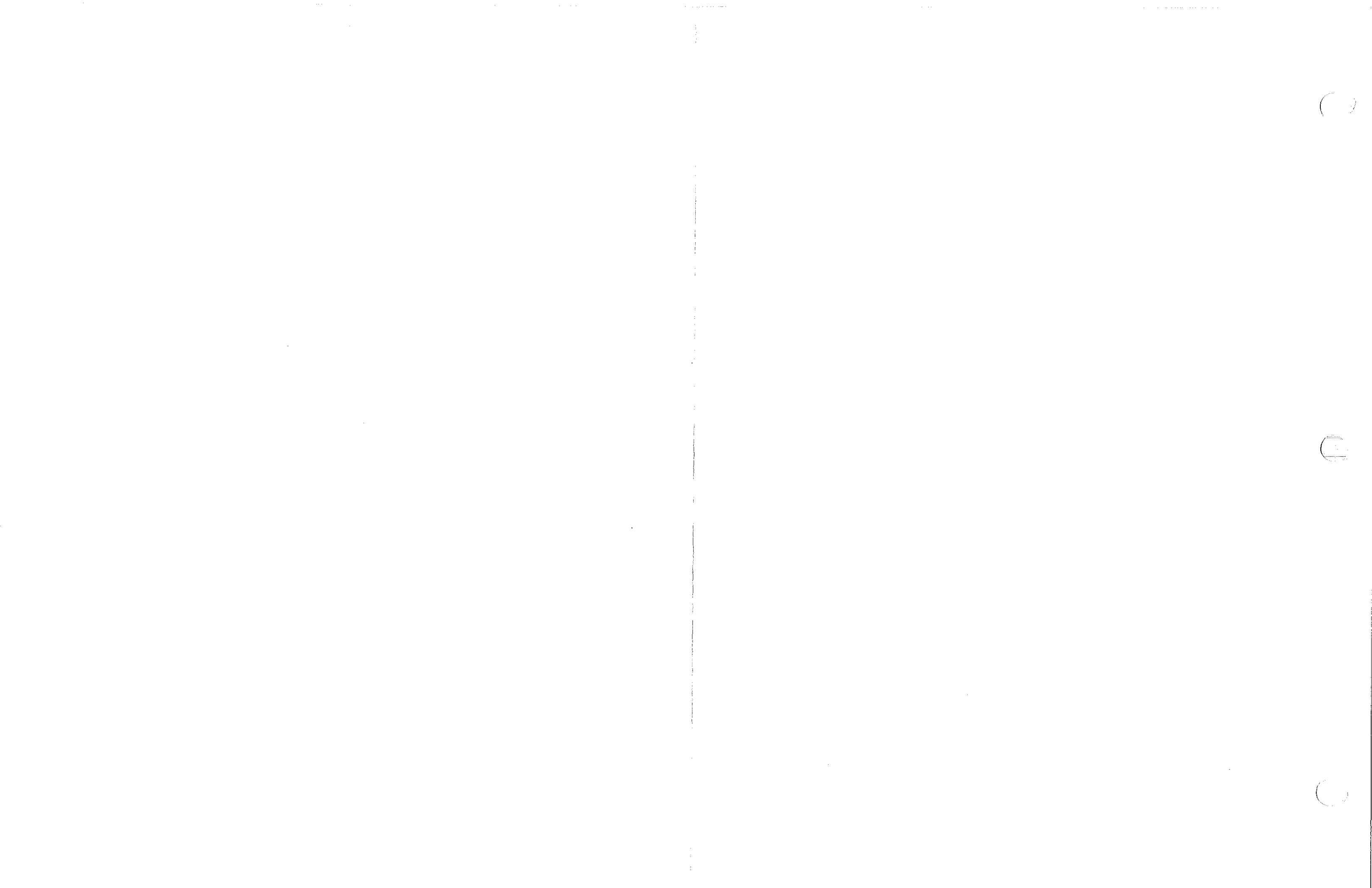


FIGURE 6-4.  
Schematic Diagram, Mixer Module, M3.



**TABLE 6-2.**  
**Parts List, Mixer Module, M3.**

C1	210330	Capacitor, Disc NPO 33 pF
C2-C5	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C6,C7	221330	Capacitor, Mica DM5 33 pF
C8	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C9	221101	Capacitor, Mica DM5 100 pF
C10	221201	Capacitor, Mica DM5 200 pF
C11	221101	Capacitor, Mica DM5 100 pF
C12	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C13	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C14	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C15	210050	Capacitor, Disc NPO 5 pF
C16	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C17	261500	Capacitor, Trimmer 50 pF
C18	210050	Capacitor, Disc NPO 5 pF
C19-C23	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C24	261250	Capacitor, Trimmer 1-25 pF
C25	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C26	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C27	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C28-C31	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C32		Not Used.
C33-C36	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C37		Not Used.
C38-C40	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C41		Not Used.
C42	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C43	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C44	261250	Capacitor, Trimmer 1-25 pF
C45	221680	Capacitor, Mica DM5 68 pF
C46-C51	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C52	210070	Capacitor, Disc NPO 7 pF
C53	261250	Capacitor, Trimmer 1-25 pF
C54-C57	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C58	261250	Capacitor, Trimmer 1-25 pF
C59	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C60	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C61-C63	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C64	210150	Capacitor, Disc NPO 15 pF
C65	261250	Capacitor, Trimmer 1-25 pF
C66	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C67	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C68-C73	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C74	237100	Capacitor, Electrolytic 16 V 10 $\mu$ F
C75	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C76-C77	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C78		Not Used.
C79-C85	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
D1,D2	320005	Diode, Pin BA482
D3	320002	Diode, 1N4148/1N4150
D4	320005	Diode, Pin BA482
D5,D6	320002	Diode, 1N4148/1N4150
D7	320005	Diode, Pin BA482
D8-D10	320002	Diode, 1N4148/1N4150
D11	320005	Diode, Pin BA482
D12	320002	Diode, 1N4148/1N4150
D13-D15	320005	Diode, Pin BA482
D16	320002	Diode, 1N4148/1N4150

TABLE 6-2.  
Parts List, Mixer Module, M3. Continued.

J1	610291	Connector, 10-pin Plus 3 Coax
K1	540060	Relay, SPDT 9 Vdc
L1	459032	Inductor, Assembly 3 turns
L2	459030	Inductor, Assembly 7 turns
L3,L3	459031	Inductor, Assembly 16 turns
L5	459028	Inductor, Assembly 20 turns
L6	459029	Inductor, Assembly 11 turns
L7	459032	Inductor, Assembly 3 turns
L8	430021	Inductor, Fixed 22 $\mu$ H
L9,L10	490203	Bead, Ferrite
L11	459032	Inductor, Assembly 3 turns
L12	430021	Inductor, Fixed 22 $\mu$ H
L13	459032	Inductor, Assembly 3 turns
L14	459025	Inductor, Assembly 17 turns
L15	490201	Bead, Ferrite
L16	430021	Inductor, Fixed 22 $\mu$ H
L17	459032	Inductor, Assembly 3 turns
L18	459025	Inductor, Assembly 17 turns
L19	459032	Inductor, Assembly 3 turns
L20	459027	Inductor, Assembly 9 turns
L21	459032	Inductor, Assembly 3 turns
L22	459026	Inductor, Assembly 16 turns
L23	430021	Inductor, Fixed 22 $\mu$ H
L24	459032	Inductor, Assembly 3 turns
L25	430014	Inductor, Molded 100 $\mu$ H
L26	490201	Bead, Ferrite
L27-L34	459032	Inductor, Assembly 3 turns
MX1	380006	Mixer, Mini Double-Balanced
Q1	310032	Transistor, NPN 2N5770
Q2	310006	Transistor, NPN 2N3565
Q3	310059	Transistor, NPN 2N5109
Q4,Q5	310006	Transistor, NPN 2N3565
Q6	310007	Transistor, PNP 2N3638
Q7,Q8	310126	Transistor, MFE211
Q9	310006	Transistor, NPN 2N3565
Q10	310032	Transistor, NPN 2N5770
Q11	310126	Transistor, MFE211
Q12	310006	Transistor, NPN 2N3565
R1	113562	Resistor, Carbon Film 1/8 W 5% 5.6 $k\Omega$
R2	113153	Resistor, Carbon Film 1/8 W 5% 15 $k\Omega$
R3	113223	Resistor, Carbon Film 1/8 W 5% 22 $k\Omega$
R4	113821	Resistor, Carbon Film 1/8 W 5% 820 $\Omega$
R5	113470	Resistor, Carbon Film 1/8 W 5% 47 $\Omega$
R6	113222	Resistor, Carbon Film 1/8 W 5% 2.2 $k\Omega$
R7	113123	Resistor, Carbon Film 1/8 W 5% 12 $k\Omega$
R8	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R9	113392	Resistor, Carbon Film 1/8 W 5% 3.9 $k\Omega$
R10	113102	Resistor, Carbon Film 1/8 W 5% 1 $k\Omega$
R11	113050	Resistor, Carbon Film 1/8 W 5% 5 $\Omega$
R12	113220	Resistor, Carbon Film 1/8 W 5% 22 $\Omega$
R13	113151	Resistor, Carbon Film 1/8 W 5% 150 $\Omega$

**TABLE 6-2.**  
**Parts List, Mixer Module, M3. Continued.**

R14	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R15	113682	Resistor, Carbon Film 1/8 W 5% 6.8 k $\Omega$
R16	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R17	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R18	113392	Resistor, Carbon Film 1/8 W 5% 3.9 k $\Omega$
R19	113150	Resistor, Carbon Film 1/8 W 5% 15 $\Omega$
R20	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R21,R22	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R23	113472	Resistor, Carbon Film 1/8 W 5% 4.7 k $\Omega$
R24	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R25	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R26	113334	Resistor, Carbon Film 1/8 W 5% 330 k $\Omega$
R27	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R28	113153	Resistor, Carbon Film 1/8 W 5% 15 k $\Omega$
R29	113332	Resistor, Carbon Film 1/8 W 5% 3.3 k $\Omega$
R30	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R31	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R32	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R33	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R34	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R35	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R36	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R37	170110	Resistor, Trimmer 500 $\Omega$
R38	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R39	113122	Resistor, Carbon Film 1/8 W 5% 1.2 k $\Omega$
R40	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R41	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R42	113821	Resistor, Carbon Film 1/8 W 5% 820 $\Omega$
R43	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R44	113470	Resistor, Carbon Film 1/8 W 5% 47 $\Omega$
R45	113680	Resistor, Carbon Film 1/8 W 5% 68 $\Omega$
R46	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R47	113391	Resistor, Carbon Film 1/8 W 5% 390 $\Omega$
R48	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R49	113332	Resistor, Carbon Film 1/8 W 5% 3.3 k $\Omega$
R50	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R51	170224	Resistor, Variable Mini 1 k $\Omega$
R52	113470	Resistor, Carbon Film 1/8 W 5% 47 $\Omega$
R53	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R54,R55	113104	Resistor, Carbon Film 1/8 W 5% 100 k $\Omega$
R56	113154	Resistor, Carbon Film 1/8 W 5% 150 k $\Omega$
R57	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
T1	459033	Transformer, Assembly 4 turns / 1 turn
T2	459034	Transformer, Assembly 1 turn / 3 turns
T3	420018	Transformer, IF 1650 kHz
T4	459034	Transformer, Assembly 1 turn / 3 turns
U1	380010	IC, MAR-8
U2	330006	IC, MC1496P
Y1	370007	Crystal, Filter 75 MHz

C.

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# CHAPTER 7

## POWER-AMPLIFIER MODULE, M4 - TECHNICAL DESCRIPTION

### 7-1 BLOCK DIAGRAM

A block diagram of the module is shown in Figure 7-1. The power-amplifier module is used to amplify the low-level (+3 dBm) transmitter signal from the mixer module, M3, to a power level of 20 W with a low level of distortion. Apart from the predriver, the module operates in class AB to minimize current drain. The module has the following block components:

1. Predriver Amplifier.
2. Driver Amplifier.
3. Final Amplifier.
4. Bias Regulator.
5. Overtemperature Switch.

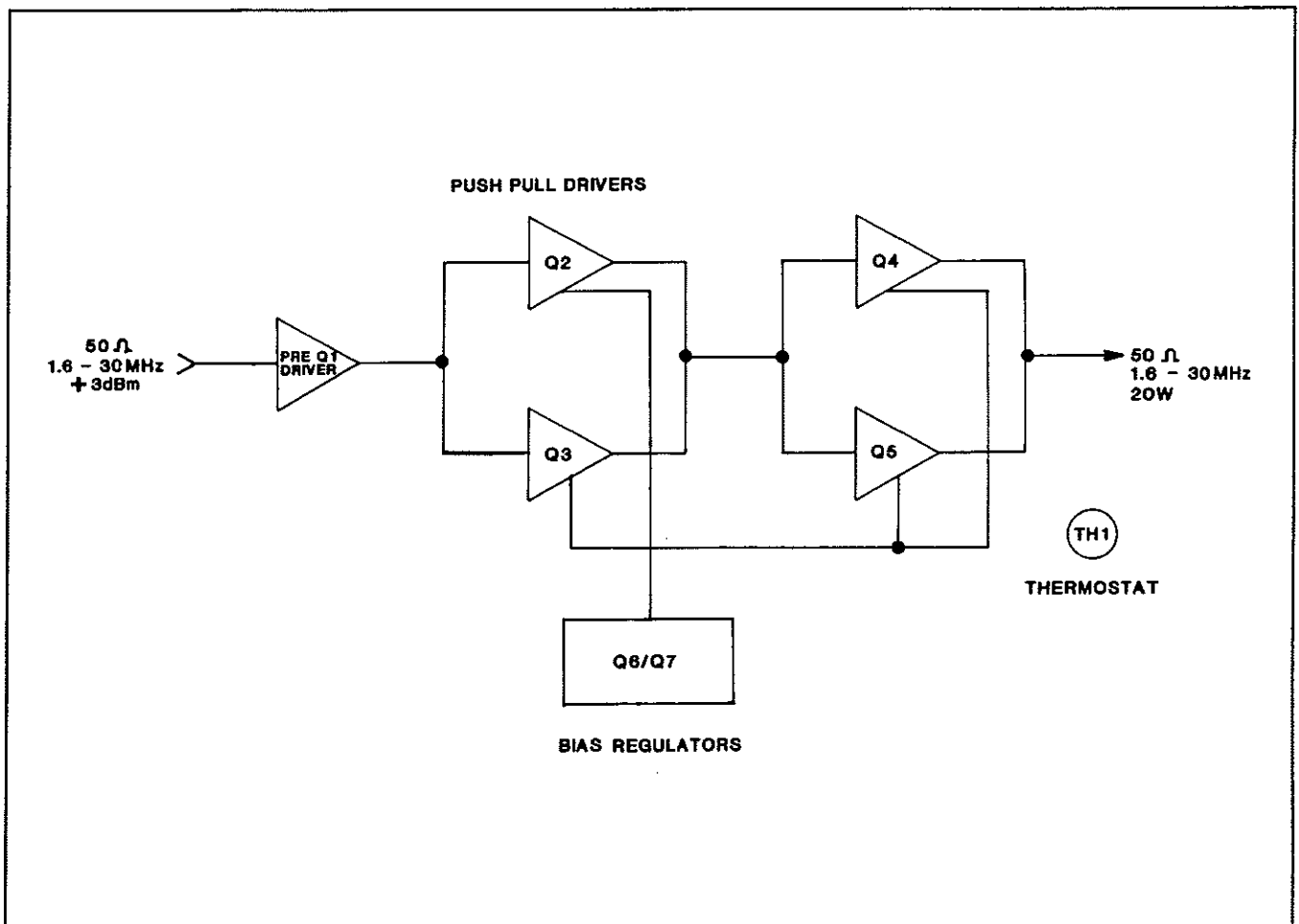
### 7-2 PREDRIVER AMPLIFIER

The predriver amplifier Q1 is a class A amplifier with fixed bias—R22/R2 and emitter resistor—R4. Collector-

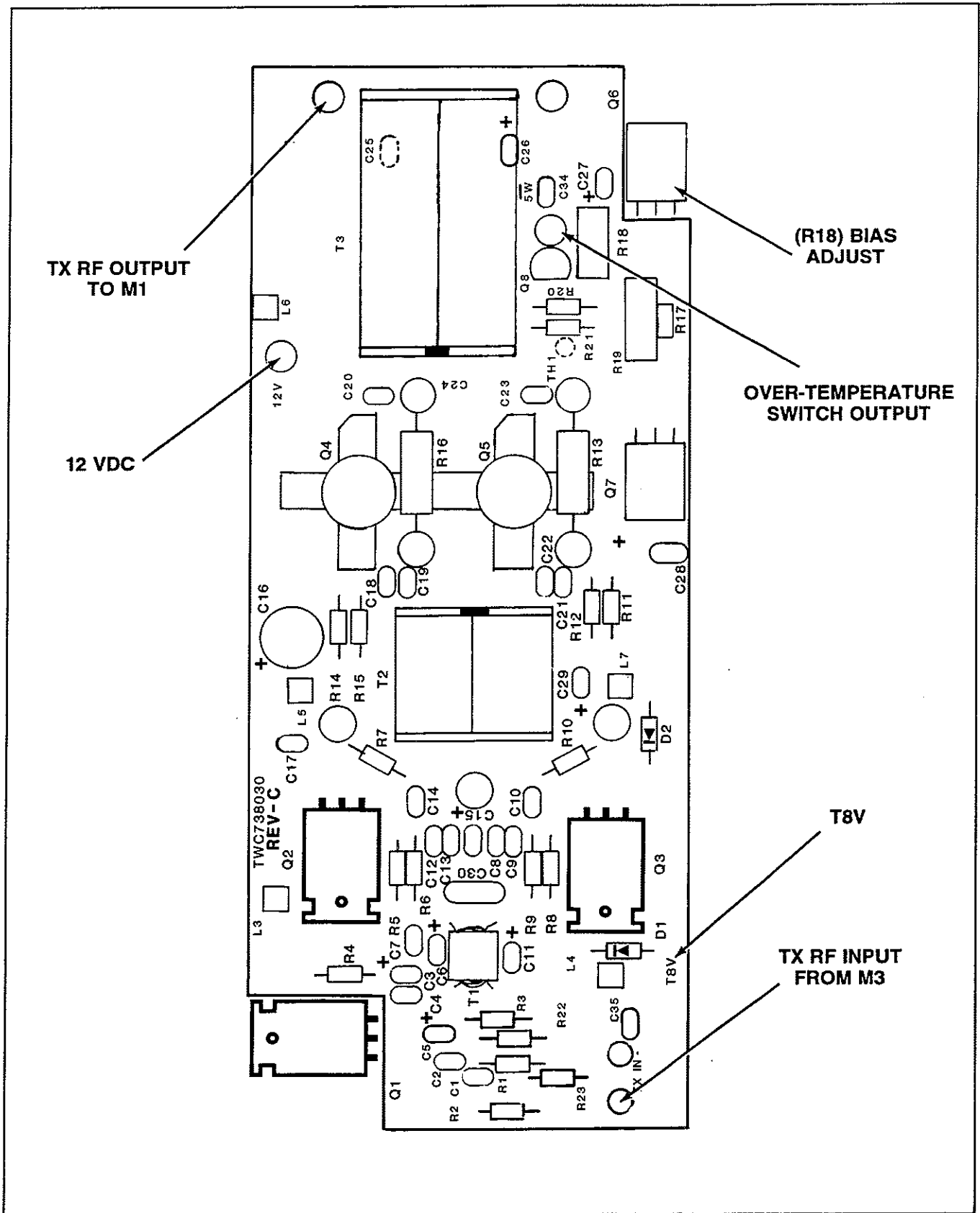
base feedback is provided by R3/C5. The network C1/R1 provides gain leveling. The output is coupled from the collector through the broadband transformer T1. The stage operates from the regulated transmit 8-V line (T8 line) and is switched off in the receive mode.

### 7-3 DRIVER AMPLIFIER

The driver amplifier Q2/Q3 is a push-pull amplifier using two RF power-amplifier transistors designed for linear broadband RF service. The driver amplifier operates in class AB with a regulated bias supply and grounded emitters. Collector base feedback is provided by C14/R7 and C10/R10. The input is coupled from the push-pull secondary on T1. The output is coupled to the final amplifier through T2, a broadband tubular-type, ferrite-loaded transformer with a push-pull primary and secondary. The driver



**FIGURE 7-1.**  
Block Diagram - PA Module, M4.



**FIGURE 7-2.**  
Signal Connections and Adjustment Points.



**TABLE 7-1.**  
**Specifications, Power-Amplifier Module, M4.**

<b>Transmit</b>	
Current:	+8 Vdc @ 65 mA. +12 Vdc @ 200 mA (quiescent). +12 Vdc @ 3.6 A (20 W, CW, output).
Frequency:	1.6-30 MHz (Fs).
Output:	20 W, CW, into 50 $\Omega$ .
Input:	0 dBm, $\pm$ 2 dB.
Gain:	43 dB.

amplifier operates directly from the 12-V supply and is switched off by the bias supply.

#### 7-4 FINAL AMPLIFIER

The final amplifier Q4/Q5 is two push-pull, RF power-amplifier transistors designed for SSB service in the HF range. The transistors operate in class AB with the bias derived from the bias regulator circuit. The emitters are grounded. The input is coupled from the push-pull secondary on T2, and the output transformer T3 is a tubular-type, ferrite-loaded transformer with a push-pull primary and a single ended 50-ohm secondary. The final amplifier operates directly from the 12-V supply and is switched on and off by controlling the bias supply. The output transistors have been chosen for their rugged construction and are operated at much reduced ratings. The final amplifier is actually capable of power outputs of 30 to 40 W and provides excellent reliability and very good linearity, even at reduced battery voltages. The amplifier uses collector-base feedback R16/C20 and R13/C23.

#### 7-5 BIAS REGULATORS

The bias regulator Q6/Q7 operates directly from the regulated T8-V line and is switched off in the receiver mode. The final amplifier and driven amplifier are connected permanently to the battery supply but cannot draw current until the bias is applied in the transmit mode. The bias regulator uses the dc coupled regulators Q6 and Q7 to provide a very stable, fixed bias source for the two stages. The quiescent current is set by adjusting R18.

#### 7-6 OVERTEMPERATURE SWITCH

TH1 is a temperature-sensitive resistor with a positive temperature coefficient. This means as the resistor gets hotter, its resistance goes up. By forming a voltage divider

with this thermistor, Q8 is made to conduct when the heat sink temperature exceeds 80° C. This forces the power output to 5 W or less until the unit cools. TH1 is mounted in a hole in the heat sink and normally measures about 150 ohms at room temperature.

#### 7-7 SERVICE DATA

Figure 7-2 is a component location diagram with signal input/output points and adjustments indicated. The following is the only M4 adjustment.

1. R18. Used to set the bias current; factory set for 200 mA on the 12-volt line.

#### 7-8 MODULE INTERCONNECTIONS

The M4 module has the following interconnections with the transceiver:

##### Connector M4J1

- Pin 1 12 Vdc from the power supply.
- Pin 2 12 Vdc from the power supply.
- Pin 3 LOW POWER. Switches the amplifier to the low-power position when the amplifier overheats, or when the front-panel switch is in LOW POWER.
- Pin 4 T8. 8 Vdc when radio is in transmit, 0 Vdc in receive.
- Pin 5 Ground.
- Pin 6 Ground.

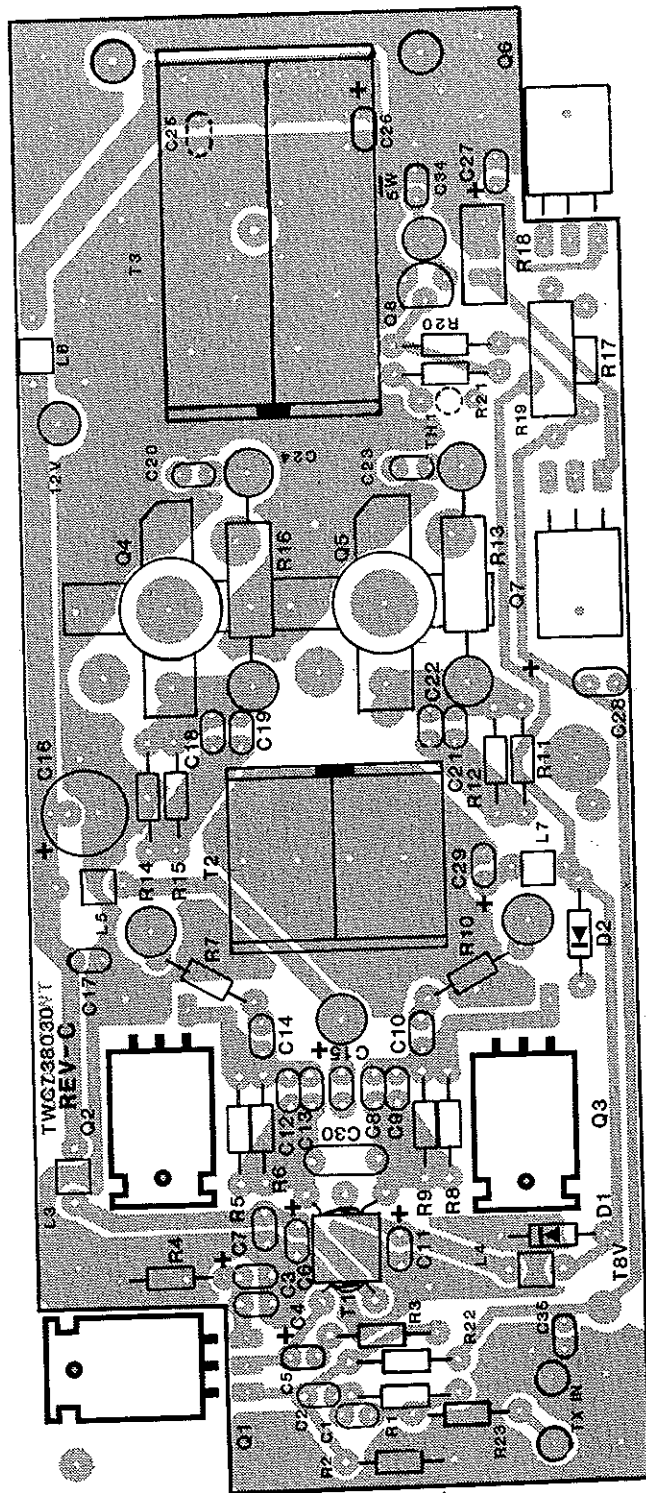
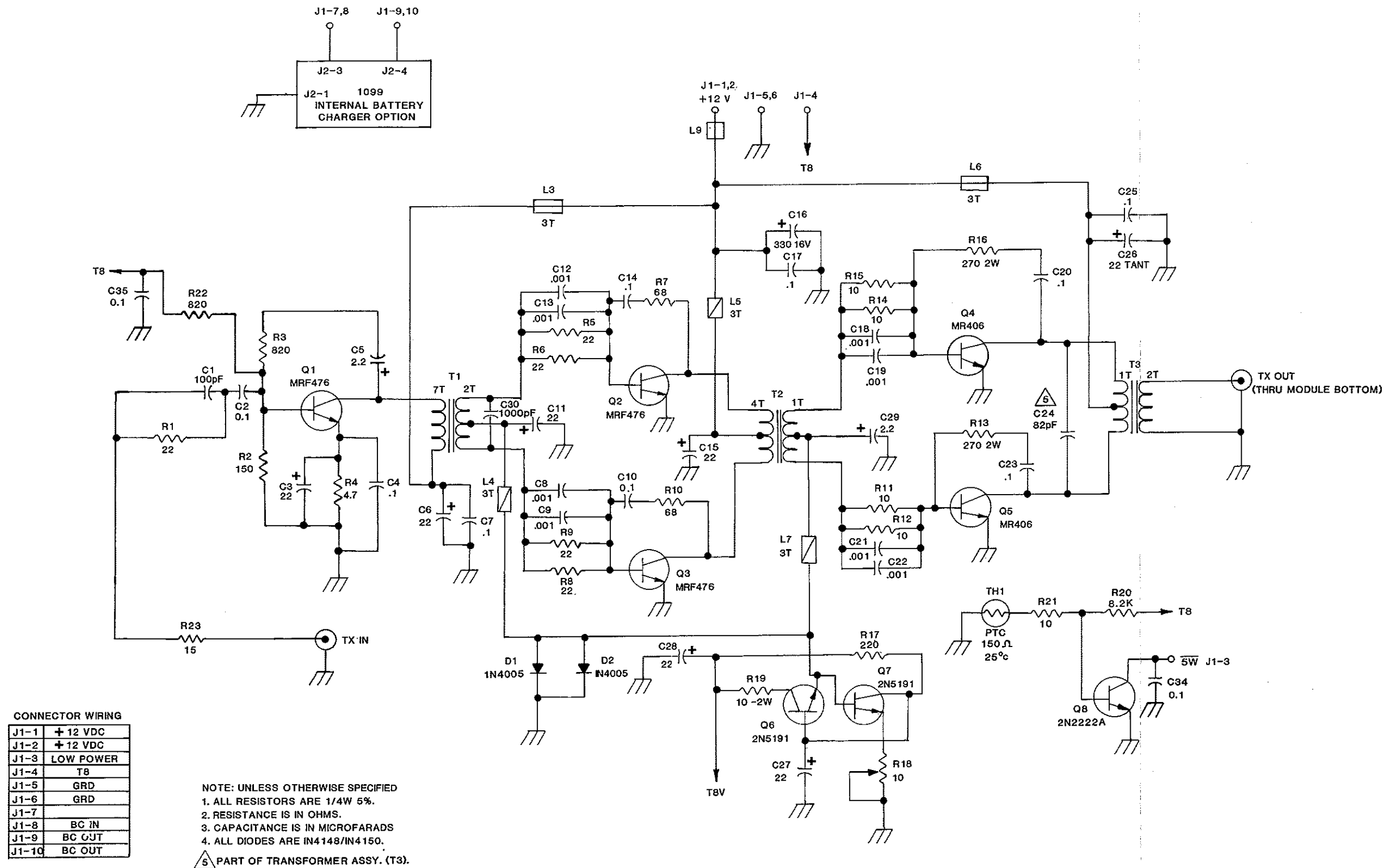


FIGURE 7-3.  
Component Locations, Power-Amplifier Module, M4.



**CONNECTOR WIRING**

J1-1	+ 12 VDC
J1-2	+ 12 VDC
J1-3	LOW POWER
J1-4	T8
J1-5	GRD
J1-6	GRD
J1-7	
J1-8	BC IN
J1-9	BC OUT
J1-10	BC OUT

NOTE: UNLESS OTHERWISE SPECIFIED  
 1. ALL RESISTORS ARE 1/4W 5%.  
 2. RESISTANCE IS IN OHMS.  
 3. CAPACITANCE IS IN MICROFARADS  
 4. ALL DIODES ARE IN4148/IN4150.  
 ⚠ PART OF TRANSFORMER ASSY. (T3).

FIGURE 7-4.  
 Schematic Diagram, Power-Amplifier Module, M4.



**TABLE 7-2.**  
**Parts List, Power-Amplifier Module, M4.**

C1	221101	Capacitor, Mica DM5 100 pF
C2	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C3	241226	Capacitor, Tantalum 22 $\mu$ F
C4	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C5	241020	Capacitor, Tantalum 2.2 $\mu$ F
C6	241226	Capacitor, Tantalum 22 $\mu$ F
C7	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C8,C9	210102	Capacitor, Disc .001 $\mu$ F
C10	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C11	241226	Capacitor, Tantalum 22 $\mu$ F
C12,C13	210102	Capacitor, Disc .001 $\mu$ F
C14	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C15	241226	Capacitor, Tantalum 22 $\mu$ F
C16	231331	Capacitor, Electrolytic 16 V 330 $\mu$ F
C17	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C18,C19	210102	Capacitor, Disc .001 $\mu$ F
C20	275104	Capacitor, Monolithic 50 V $\mu$ F
C21,C22	210102	Capacitor, Disc .001 $\mu$ F
C23	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C24	220820	Capacitor, Mica DM15 82 pF
C25	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C26-C28	241226	Capacitor, Tantalum 22 $\mu$ F
C29	241020	Capacitor, Tantalum 2.2 $\mu$ F
C30	220102	Capacitor, Mica DM15 1000 pF
C31		Not Used.
C32,C33		Not Used
C34-C35	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
D1,D2	320101	Diode 1N4005
L1,L2		Not Used
L3-L7	459032	Inductor, Ferrite 3 turns
L8		Not Used
L9	490203	Bead, Ferrite
Q1-Q3	310097	Transistor, MRF476
Q4,Q5	310096	Transistor, MRF406
Q6,Q7	310055	Transistor, NPN 2N5191
Q8	310057	Transistor, NPN PN2222A
R1	124220	Resistor, Film 1/4 W 5% 22 $\Omega$
R2	124151	Resistor, Film 1/4 W 5% 150 $\Omega$
R3	124821	Resistor, Film 1/4 W 5% 820 $\Omega$
R4	124047	Resistor, Film 1/4 W 5% 4.7 $\Omega$
R5,R6	124220	Resistor, Film 1/4 W 5% 22 $\Omega$
R7	124680	Resistor, Film 1/4 W 5% 68 $\Omega$
R8,R9	124220	Resistor, Film 1/4 W 5% 22 $\Omega$
R10	124680	Resistor, Film 1/4 W 5% 68 $\Omega$
R11,R12	124100	Resistor, Film 1/4 W 5% 10 $\Omega$
R13	154271	Resistor, Film 2 W 270 $\Omega$
R14,R15	124100	Resistor, Film 1/4 W 5% 10 $\Omega$
R16	154271	Resistor, Film 2 W 270 $\Omega$
R17	124221	Resistor, Film 1/4 W 5% 220 $\Omega$
R18	170212	Resistor, Trimmer 15 Turns 10 $\Omega$
R19	154100	Resistor, Film 2 W 10 $\Omega$
R20	124822	Resistor, Film 1/4 W 5% 8.2 k $\Omega$

**TABLE 7-2.**  
**Parts List, Power-Amplifier Module, M4. Continued.**

R21	124100	Resistor, Film 1/4 W 5% 10 $\Omega$
R22	124821	Resistor, Film 1/4 W 5% 820 $\Omega$
R23	124150	Resistor, Film 1/4 W 5% 15 $\Omega$
T1	459252	Transformer, 7 turns: 2 turns
T2	459253	Transformer, 4 turns: 1 turn
T3	459254	Transformer, 1 turn: 2 turns
TH1	350115	Thermistor, 150 $\Omega$ @ 25oC

## CHAPTER 8

# ANTENNA-TUNER MODULE, M5 - TECHNICAL DESCRIPTION

### 8-1 DESIGN CONSIDERATIONS

The antenna tuner must match the standard AT271A/U whip antenna and a variety of long wire antennas over the range 2 to 30 MHz. This poses special design problems in a packset, as the antenna will be very short in relationship to a resonant antenna over most of the frequency range. Additionally, the ground system is extremely poor in the man-pack configuration. It is very difficult to maintain an exact match to the antenna, since very small movements by the operator will detune the antenna. The tuner should be fast in operation, have low current drain in the tune mode, and no standby current drain. It is also desirable to keep the tune power as low as possible and to retain in memory the tune data for the fixed channel frequencies.

### 8-2 MATCHING NETWORK

The resonant frequency of the whip antenna is approximately 24 MHz. This means that over most of the frequency range the antenna will have a capacitive reactance which can be cancelled by an equivalent series inductance. The tuner uses a binary-sequenced series of inductors to cancel out the reactive component of the antenna. If the antenna has inductive reactance, capacitance is added so that the antenna appears capacitive and the small residual reactance is cancelled by adding series inductance. The internal capacitors will match the whip antenna and most long wire antennas, but on some frequencies the inductive reactance may be very high. The long wire adapter contains a series capacitor to bring the reactance within the tuning range of the network. After the reactance is cancelled, the tuner will present a resistive load between 6 and 400 ohms to the transceiver. A broadband impedance transformer is used to select the closest available matching impedance—12.5, 50, or 200 ohms.

### 8-3 TUNING SYSTEM

A very simple and reliable tuning system is used. Instead of using a VSWR detector, a current detector measures the current flowing to the antenna. The transceiver operates in the low-power (5 W) mode, and a 10-dB attenuator reduces the power to 500 mW. Because the output impedance of the transmitter is 50 ohms (determined by the resistive pad), maximum current will flow when there is a conjugate match or a resistive load of 50 ohms. The system is simple, reliable, and accurately determines minimum VSWR.

### 8-4 TUNING RESOLUTION

The tuner typically tunes for a VSWR of less than 1.5:1 but can reach 2:1, if the resistive component falls midway between the impedance taps. In a manpack, the impedance match changes every time the operator moves. Therefore, it is very important to design the final amplifier so that it is very tolerant of mismatched loads. The PRC1099A final amplifier is capable of a power output of 30 to 40 W and is

able to deliver 20 W into substantial mismatches. At VSWR's of 2:1 there is typically less than 0.5-dB output degradation and, even at 3:1 VSWR there is only about 1-dB performance change.

### 8-5 TUNING PROGRAM

The tuning program is resident in the ROM and is under the control of the microprocessor in M7. The tuning program uses proprietary algorithms developed specifically for the PRC1099A. When the tune button is pressed, the microprocessor checks the frequency and determines which elements should be used. The transmitter is keyed in the low-power mode and the inductors are stepped in a special sequence until a current peak is reached. If no current peak is detected, the antenna is inductive and the capacitors are sequenced in combination with the inductors until a tuning peak is reached. At this point the antenna current is checked. If the current is low, the alternate tap positions are checked, and the tap with the optimum current is selected. The current is then checked, and if the current is low, an incorrect tune will be signaled. It may be possible to operate the transceiver even if an incorrect tune is signaled. The tuner will remain at the setting that achieved the best match. The last tune combination is retained in memory and will be automatically selected each time the channel is changed. The tune information in memory is updated each time the tune button is pressed. The antenna tuner is selected automatically when the whip or long wire adapter is used. A rod on the end of the antenna mount (AB591/U) or long wire adapter activates a microswitch which disconnects the 50-ohm connector.

### 8-6 BLOCK DIAGRAM

A block diagram of the antenna tuner is shown in Figure 8-1. This diagram shows the block functions of the antenna tuner and control circuitry. The module has the following block functions:

1. Binary Sequence Inductors—0.25 to 168  $\mu$ H.
2. Shunt Capacitors—50/100 pF.
3. Series Capacitor—22 pF.
4. Current Detector.
5. Impedance Transformer.
6. Attenuator.
7. Comparator.
8. D/A Decoder.
9. Serial Decoders.
10. Relay Drivers.

### 8-7 BINARY SEQUENCED INDUCTORS

In order to resonate the whip antenna at 2 MHz, an inductance of approximately 168  $\mu$ H is required. It must be possible to vary the inductance from zero to 168  $\mu$ H. The best solution is a series of inductors, switched in and out of

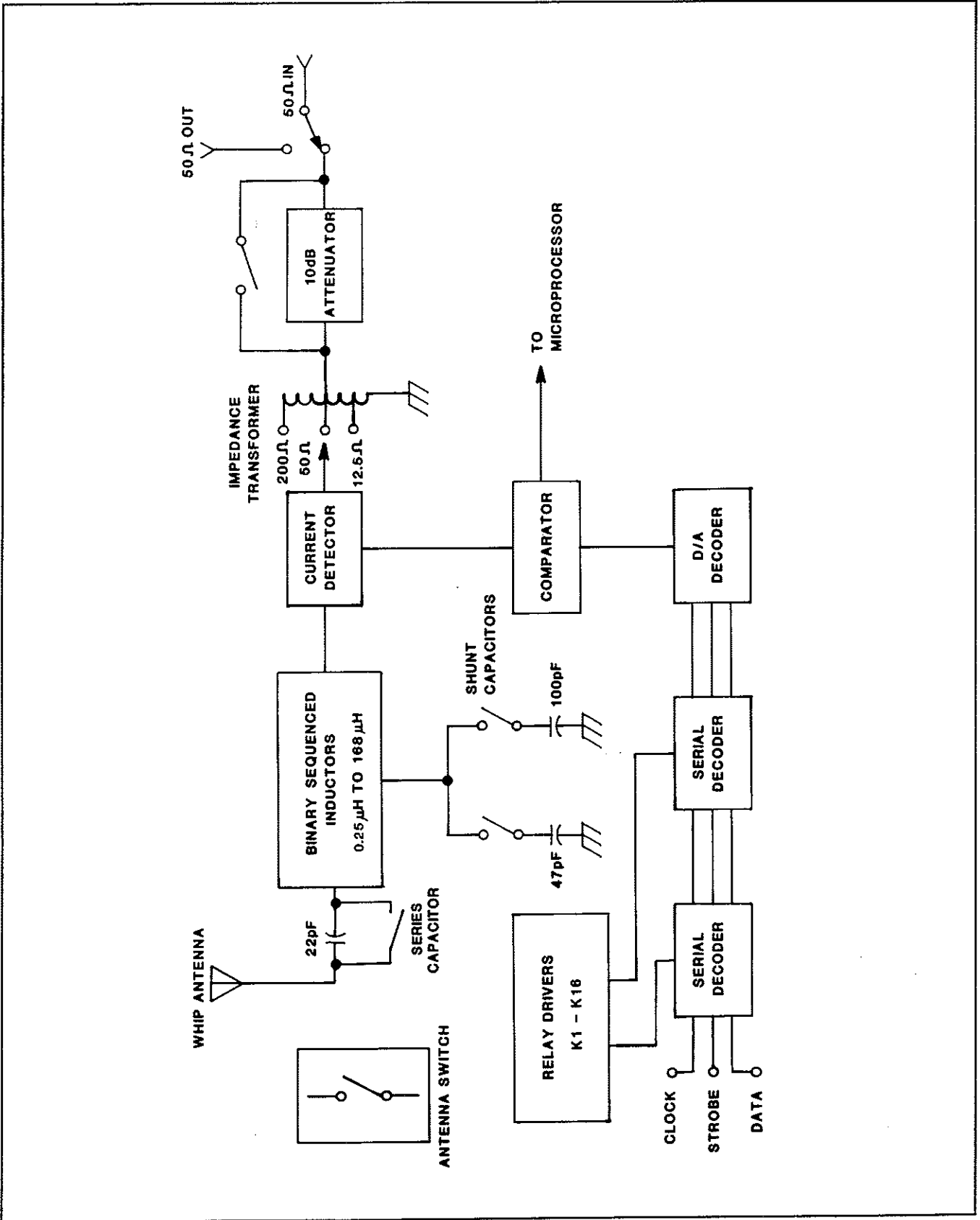
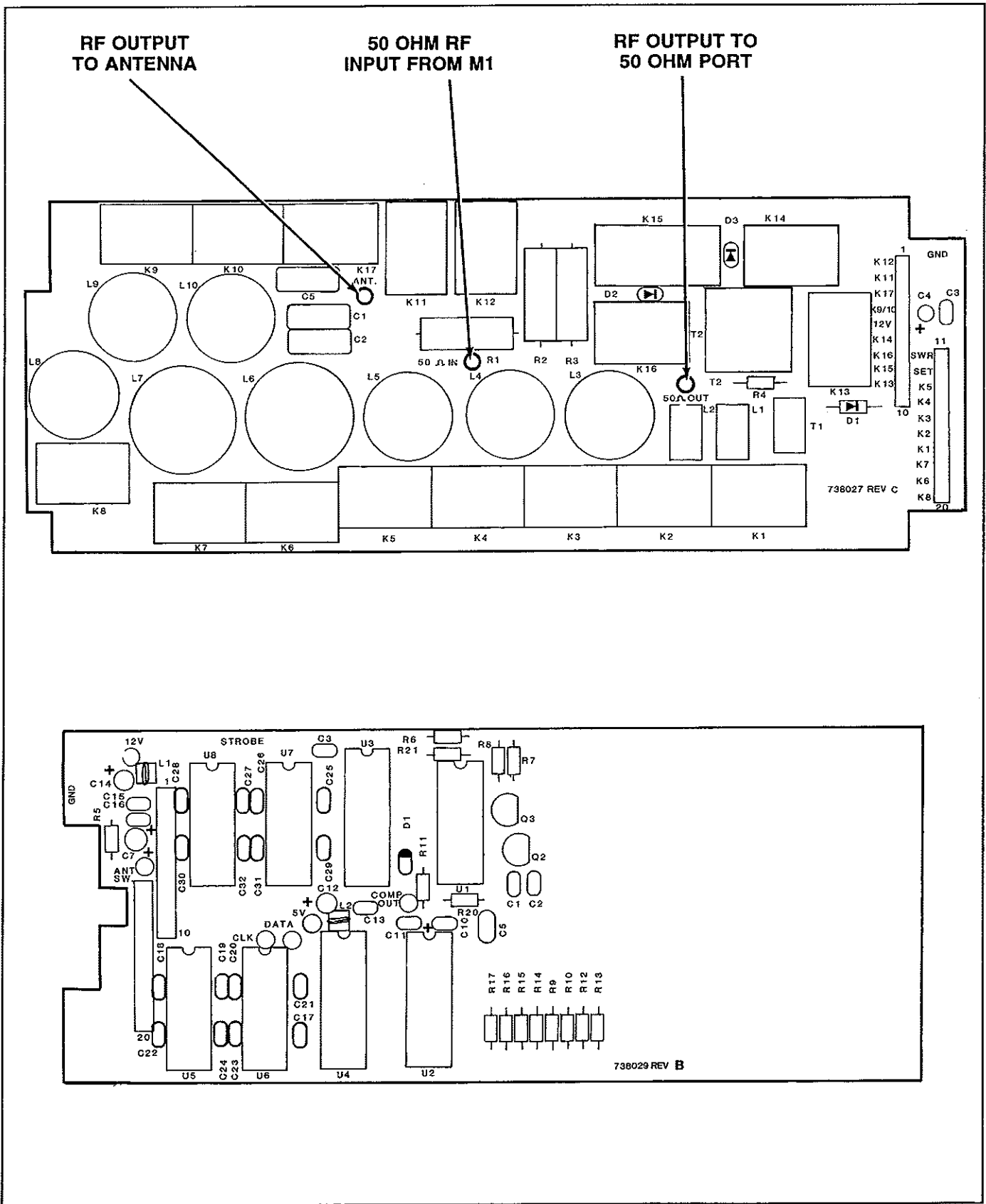


FIGURE 8-1.  
Block Diagram - Antenna Tuner, M5.





**FIGURE 8-2.**  
**Signal Connections.**

**TABLE 8-1.**  
**Specifications, Antenna Tuner, M5.**

<u>Current Drain:</u>													
a. Static:	1.2 mA typical @ 12 V. 5 $\mu$ A typical @ 5 V.												
b. Tuning:	400 mA average @ 12 V. 2000 mA maximum instantaneous @ 12 V. 16 mA average @ 5 V.												
<u>Rated Input Power:</u>													
a. Output $\leq$ 1 kV:	20 W PEP.												
b. Output would exceed 1 kV:	5 W PEP (Power level automatically switched by M7).												
Maximum Output Voltage:	1000 V RF.												
Useable Antennas:													
	<table border="0"> <thead> <tr> <th align="center"><u>Range</u></th> <th align="center"><u>Antenna</u></th> </tr> </thead> <tbody> <tr> <td align="center">2.0-30 MHz</td> <td align="center">3 m whip</td> </tr> <tr> <td align="center">1.6-30 MHz</td> <td align="center">7 m whip</td> </tr> <tr> <td align="center">5.0-30 MHz</td> <td align="center">1.5 m whip (for very short-range operation)</td> </tr> <tr> <td align="center">1.6-30 MHz</td> <td align="center">7-16 m long wire</td> </tr> <tr> <td align="center">1.6-30 MHz</td> <td align="center">Longer antennas with LWA adaptor</td> </tr> </tbody> </table>	<u>Range</u>	<u>Antenna</u>	2.0-30 MHz	3 m whip	1.6-30 MHz	7 m whip	5.0-30 MHz	1.5 m whip (for very short-range operation)	1.6-30 MHz	7-16 m long wire	1.6-30 MHz	Longer antennas with LWA adaptor
<u>Range</u>	<u>Antenna</u>												
2.0-30 MHz	3 m whip												
1.6-30 MHz	7 m whip												
5.0-30 MHz	1.5 m whip (for very short-range operation)												
1.6-30 MHz	7-16 m long wire												
1.6-30 MHz	Longer antennas with LWA adaptor												
Manual tune time:	1 s typical. 12 s maximum before fault.												
Memory tune time:	20 ms typical.												
Tune indicator:	900 Hz sidetone.												
Fault indicator:	Pulsating tone.												

solution is a series of inductors, switched in and out of circuit in a binary progression. By starting with L1, a 0.33- $\mu$ H inductor, and doubling the size of each inductor up to 84  $\mu$ H, it is possible to change the inductance in 0.33- $\mu$ H steps from zero up to 168  $\mu$ H and use only nine inductors. The tuner uses ten inductors, as it is necessary to use two separate 44  $\mu$ H inductors, L9 and L10, for the final inductance step. This prevents voltage flashover and keeps the size of the inductors compatible with the available space in the module. Each inductor is a toroid using wire and core sizes carefully optimized for maximum Q. Very high voltages are generated at maximum inductance when using the whip antenna. In order to prevent flashover and possible RF burns to the operator, the power is automatically reduced when inductors L8, L9, and L10 are in circuit. This keeps the maximum output voltage from exceeding approximately 1000 V.

#### 8-8 SHUNT CAPACITORS

The two shunt capacitors C1 and C2 are used when the antenna exhibits inductive reactance. The capacitors give 50 to 150 pF in 50-pF steps. The minimum step size that will cause the antenna to appear capacitive is used, and the remaining reactance is cancelled with series inductance. The capacitors are connected between L6 and L7. This

minimizes the effects of stray capacitance and reduces the required voltage rating.

#### 8-9 SERIES CAPACITOR

A series capacitor, C5, is connected between the antenna terminal and the largest binary inductor, L10. It is switched in and out of the network by relay K17. This element is needed in some instances where the antenna impedance is near resonance; it rotates the impedance to a value that can be matched by the rest of the network.

#### 8-10 CURRENT DETECTOR

The current detector uses a saturated transformer directly in line to the series inductors. The transformer is a ferrite toroid, T1, with a single-turn primary and a multi-turn secondary virtually shorted by the 47-ohm resistor, R4. The detector output is a voltage proportional to the current flowing in the primary. The RF voltage is rectified by D1.

#### 8-11 IMPEDANCE TRANSFORMER

The impedance transformer is a 2:1 ferrite balun switched by relays K13 and K14. The transformer may be switched out of circuit to provide a 50-ohm match, act as a step-up transformer for a 200-ohm match and act as a step-down transformer for a 12.5-ohm match. With the three impedances available, the transformer will provide a match

of 2:1 or better over the impedance range of 6 ohms to 400 ohms.

### 8-12 10-DB ATTENUATOR

The attenuator pad R1/R2/R3 is switched into circuit during the tune mode by the relay K15. The exact attenuation of 9.5 dB has been chosen so that standard-value resistors may be used. The transmitter operates in the low-power mode (5 W) during the tune cycle, and the attenuator reduces the output power to 500 mW. The resistive pad ensures that the transmitter has a true output impedance of 50 ohms, so that maximum output is with a 50-ohm load (a conjugate match). This means that maximum output current to the antenna corresponds with minimum VSWR.

### 8-13 COMPARATOR

The comparator U1C is used to compare the output from the current detector and the reference level from the digital to the analog convertor U2. The output from the current detector is amplified by one section of the quad amplifier U1B. The switches Q2 and Q3 switch R7 and R8 to ground. This gives three different gain levels set by the ratio of R21 to R6, R7, or R8.

### 8-14 D/A DECODER

The microprocessor can only recognize a high or low output, and it is necessary to provide a reference level to the comparator in order to measure the analog output from the current detector. The output from the decoder is under serial control by the microprocessor and is quantized into 64 steps by output from the decoder. The binary steps are selected by the switching of R12 through R17. Switching R7 and R8 controls the gain of U1A.

### 8-15 SERIAL DECODER

The serial decoders U3 and U4 translate the serial data from the microprocessor to 16 different outputs controlling the relay drivers.

### 8-16 RELAY DRIVERS

The relay drivers U5, U6, U7, and U8 are 16 NPN transistors contained in four separate 16-pin DIP packages. There are 14 latching relays in the tuner. These relays have

separate coils for latching and unlatching the relay. The relays require short current pulses for latching or unlatching and draw no current in the static condition. Separate drivers are provided to latch each relay, and one transistor, Q1 (driven by one section of U8), is used to unlatch all relays. The microprocessor always unlatches all relays before each switching operation and resets those latched relays that require no change of state, as well as those relays requiring switching. This system means that separate drivers are not required to unlatch each relay.

### 8-17 SERVICE DATA

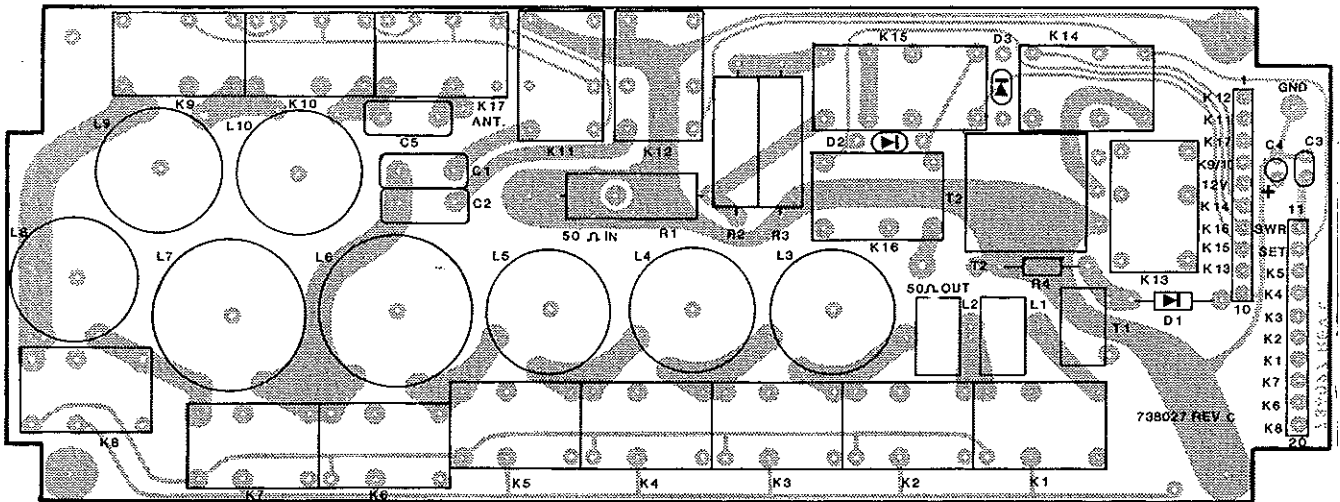
Figure 8-2 is a component location diagram with signal input/output points indicated.

### 8-18 MODULE INTERCONNECTS

The M5 module has the following interconnections with the transceiver:

#### Connector M5J1

- Pin 1 Ground.
- Pin 2 12 Vdc from power supply.
- Pin 3 DATA. Internal radio data.
- Pin 4 CLOCK. Internal radio clock information.
- Pin 5 5 Vdc from power supply.
- Pin 6 Select. Internal radio select data.
- Pin 7 COMP OUT. This is the comparator output to the processor, used for tuning cycles.
- Pin 8 ANT SWITCH. Used to determine if a whip antenna is installed. 0Vdc with no antenna, 4.8 Vdc with antenna installed.
- Pin 9 No connection.
- Pin 10 No connection.



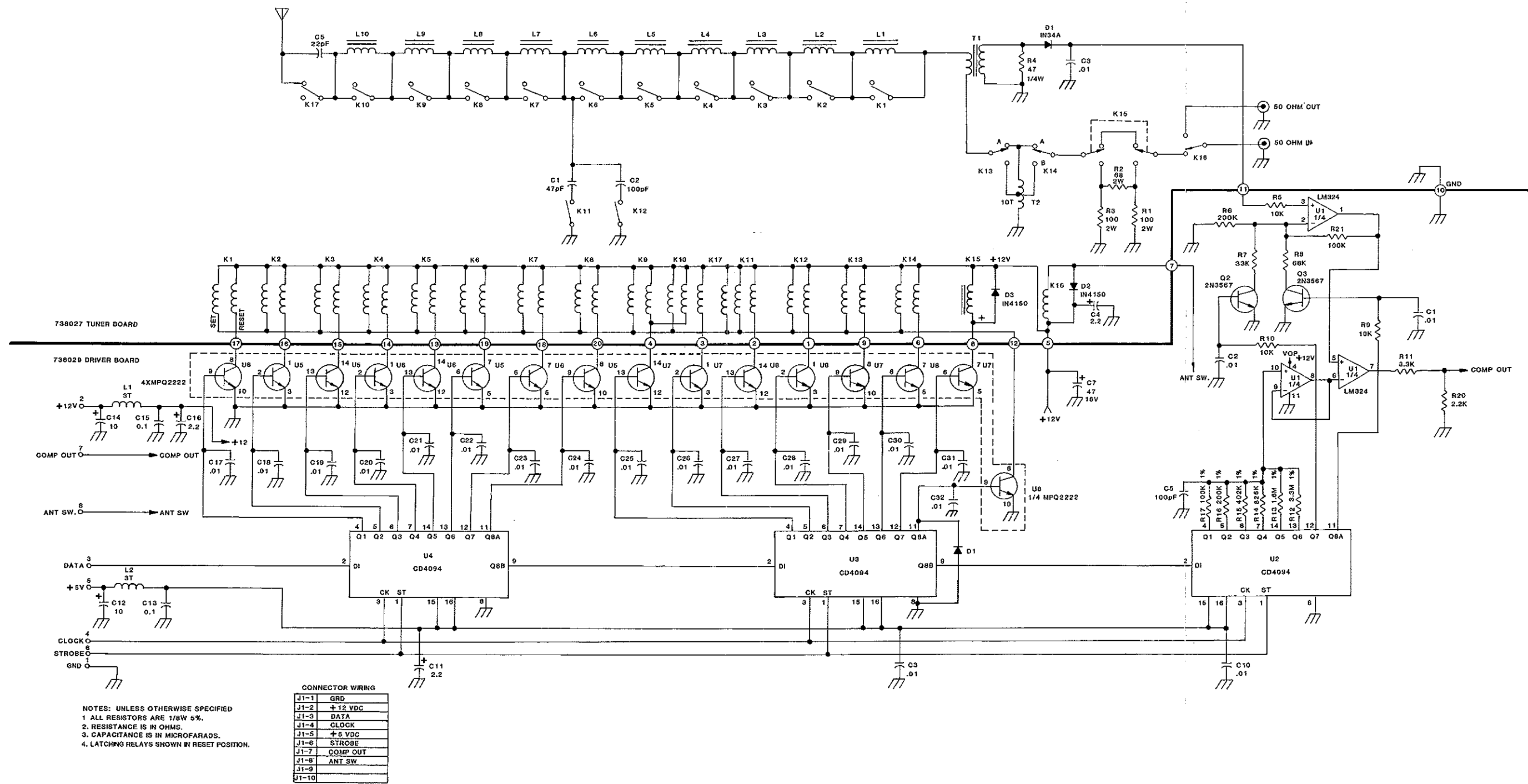
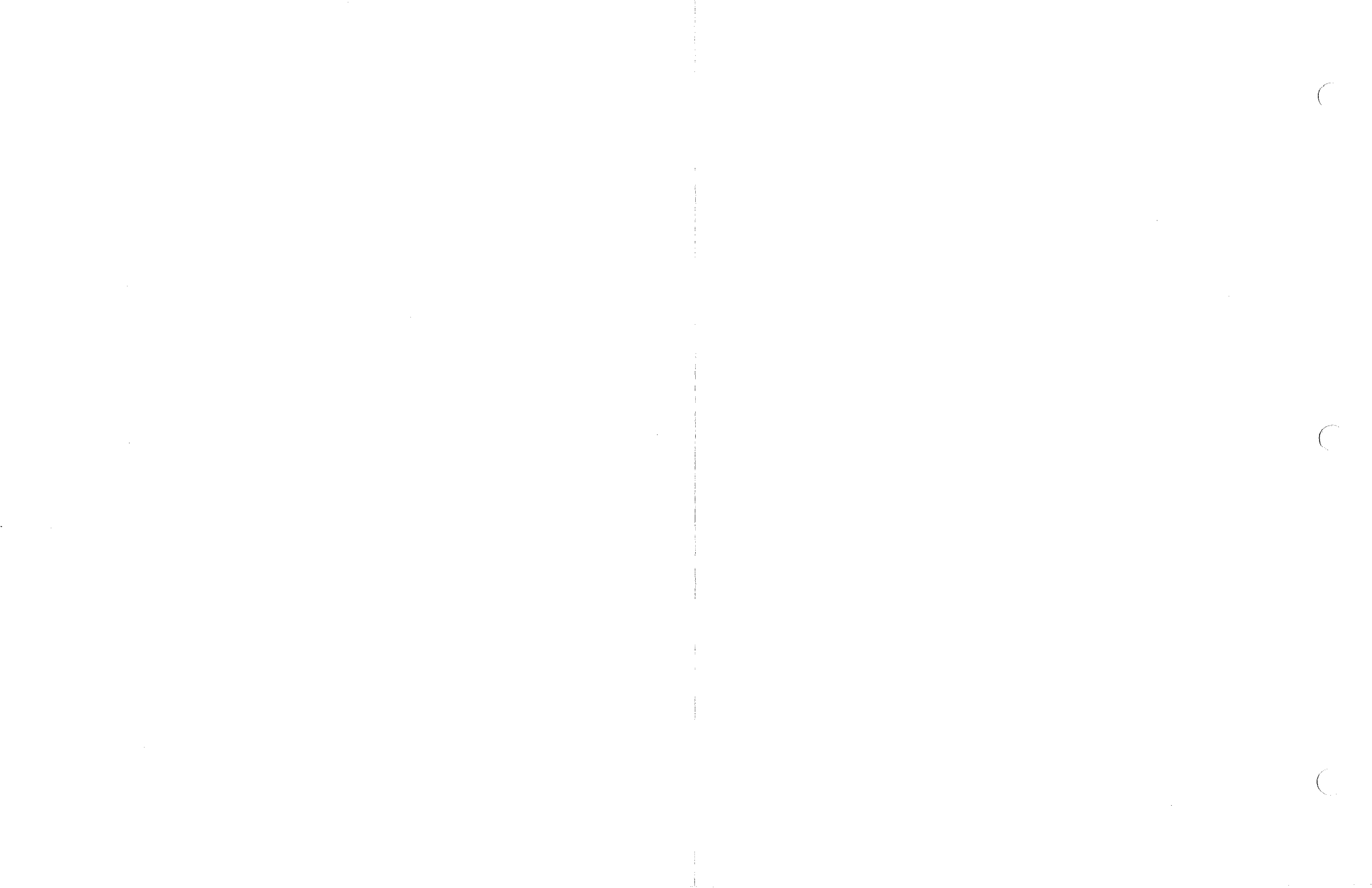


FIGURE 8-4.  
Schematic Diagram, Tuner Module, M5.



**TABLE 8-2.**  
**Parts List, Tuner Module, M5. Tuner Board.**

C1	220470	Capacitor, Mica DM15 47 pF
C2	220101	Capacitor, Mica DM15 100 pF
C3	214103	Capacitor, Monolithic 0.01 $\mu$ F
C4	241020	Capacitor, Tantalum 2.2 $\mu$ F
C5	220220	Capacitor, Mica DM15 22 pF
D1	320003	Diode, 1N34A
D2,D3	320002	Diode, 1N4148
K1-K14	540019	Relay, SPDT 12 Vdc
K15	540045	Relay, DPDT 12 Vdc
K16	540056	Relay, SPDT 12 Vdc
K17	540019	Relay, SPDT 12 Vdc
L1	459005	Inductor, Toroid 0.33 $\mu$ H 8 turns
L2	459004	Inductor, Toroid 0.66 $\mu$ H 12 turns
L3	459003	Inductor, Toroid 1.3 $\mu$ H 15 turns
L4	459002	Inductor, Toroid 2.5 $\mu$ H 23 turns
L5	459006	Inductor, Toroid 5.23 $\mu$ H 23 turns
L6	459007	Inductor, Toroid 10.5 $\mu$ H 32 turns
L7	459010	Inductor, Toroid 21 $\mu$ H 42 turns
L8	459008	Inductor, Toroid 70 turns
L9,L10	459118	Inductor, Toroid 74 turns
R1	154101	Resistor, Film 2 W 5% 100 $\Omega$
R2	154680	Resistor, Film 2 W 5% 68 $\Omega$
R3	154101	Resistor, Film 2 W 5% 100 $\Omega$
R4	124470	Resistor, Film 1/4 W 5% 47 $\Omega$
T1	459009	Transformer, 6 turns
T2	459011	Transformer, 10 turns

**TABLE 8-3.**  
**Parts List, Tuner Module, M5. Tuner Driver Board.**

C1-C3	214103	Capacitor, Monolithic 0.01 $\mu$ F
C5	210101	Capacitor, Disc 100 pF
C7	237470	Capacitor, Tantalum 16 V 47 $\mu$ F
C10	214103	Capacitor, Monolithic 0.01 $\mu$ F
C11	241020	Capacitor, Tantalum 2.2 $\mu$ F
C12	241100	Capacitor, Tanatalum 10 $\mu$ F
C13,C15	275104	Capacitor, Monolithic 0.1 $\mu$ F
C14	241100	Capacitor, Tantalum 10 $\mu$ F
C16	241020	Capacitor, Tantalum 2.2 $\mu$ F
C17-C32	214103	Capacitor, Monolithic 0.01 $\mu$ F
D1	320002	Diode, IN4148
L1,L2	459032	Inductor, Ferrite 3 turns
Q2,Q3	310003	Transistor, NPN 2N3567
R5	113103	Resistor, Film 1/8 W 5% 10 $k\Omega$
R6	1112003	Resistor, Film 1/8 W 1% 200 $k\Omega$
R7	113333	Resistor, Film 1/8 W 5% 33 $k\Omega$
R8	113683	Resistor, Film 1/8 W 5% 68 $k\Omega$
R9	113103	Resistor, Film 1/8 W 5% 10 $k\Omega$
R10	113103	Resistor, Film 1/8 W 5% 10 $k\Omega$
R11	113332	Resistor, Film 1/8 W 5% 3.3 $k\Omega$
R12	1113304	Resistor, Film 1/8 W 1% 3.3 $M\Omega$
R13	1111604	Resistor, Film 1/8 W 1% 1.6 $M\Omega$
R14	1118253	Resistor, Film 1/8 W 1% 825 $k\Omega$
R15	1114023	Resistor, Film 1/8 W 1% 402 $k\Omega$
R16	1112003	Resistor, Film 1/8 W 1% 200 $k\Omega$
R17	1111003	Resistor, Film 1/8 W 1% 100 $k\Omega$
R20	113222	Resistor, Film 1/8 W 5% 2.2 $k\Omega$
R21	113104	Resistor, Film 1/8 W 5% 100 $k\Omega$
U1	330030	IC, LM324N
U2-U4	330126	IC, CD4094BE/MC14094BCP
U5-U8	310101	IC, MPQ2222



# CHAPTER 9

## SYNTHESIZER MODULE, M6 - TECHNICAL DESCRIPTION

### 9-1 BLOCK DIAGRAM

A block diagram of the module is shown in Figure 9-1. The synthesizer module derives, from a single reference oscillator, the first LO (75 to 107 MHz in 1-Hz steps), the second LO at 73.35 MHz, and the BFO which is at 1650 kHz or at 1647 kHz, depending on sideband selection. Although the synthesizer is capable of 1-Hz resolution, the output frequencies are limited to 10-Hz resolution. It has the following major components:

1. The reference oscillator at 16.777216 MHz.
2. The major increment phase-locked loop, which moves in steps of 1.048576 MHz.
3. The DDS interpolation generator which operates in 1-Hz steps from 5.951424 to 7 MHz.
4. The interpolation active mixer, which generates a frequency range of 1.048576 MHz centered on 66.8 MHz.
5. A five-pole resonator band pass filter on the above frequency.
6. A separate phase-locked loop to supply the BFO frequencies.

### 9-2 16.777216-MHz REFERENCE OSCILLATOR

The 16.777216-MHz oscillator is a TCXO which determines the frequency of the entire transceiver. This TCXO has a frequency stability of 1 ppm over a temperature range of 0° to +50° C. There are no other oscillators which affect the frequency of operation. The frequency is chosen to give the DDS section of the synthesizer an exact 1-Hz increment capability. The DDS section has a 24-bit accumulator which requires a 2 to the 24th power clock frequency. There is an optional version of the TCXO which has a frequency stability of 1 ppm over a temperature range of -30° to +60° C. See 1099HS in Chapter 14.

### 9-3 MAJOR PHASE-LOCKED LOOP

U4 is a serial-programmed CMOS-synthesizer chip which has a 16-bit reference counter and a 10-bit divide-by-N counter. The routing of the serial bit stream is determined by an additional trailing control bit added to each bit string. A trailing "1" routes the data stream to the 16-bit register. The reference divider of this device is programmed to give a division of 16, which gives a reference frequency of 1.0448576 MHz. The "N" divider is set from 8 at zero tune frequency, to 36 at a tune frequency of 30 MHz. Therefore, this loop operates from 8.388608 to 37.748736 MHz in 1.048576-MHz increments. Since this synthesizer chip has a divide-by-N maximum frequency of around 100 MHz without prescaling, it is well within its maximum counting frequency.

The input to U4 is derived by heterodyning the VCO with a frequency variable in 1-Hz steps from 66.350000 to

67.398576 MHz. This frequency is supplied by the DDS interpolation circuit.

The actual heterodyne process is carried out in the passive double-balanced mixer MX1. The lower sideband of this mixer output is filtered by two identical low-pass filters. A broad band amplifier, U3, fitted between the low-pass filters, raises the level of the signal enough to drive the synthesizer chip.

### 9-4 LOOP FILTER

The loop filter is composed of U5A, and R37 thru R42, together with C72 thru C77. This filter has an approximate loop bandwidth of 50 kHz and the lock-up time is in the order of 40 to 50 microseconds. The output of U5A controls the frequency of the single VCO.

### 9-5 VCO

The VCO, Q8, is a modified Hartley oscillator covering the entire first LO range of 77 to 105 MHz. Diode D3 in the gate of Q6 performs a level control function, by controlling the dc value of the gate voltage. Varactor D4 is the frequency-controlling element. The oscillator is buffered by source follower Q7, and dual-gate isolation amplifier Q8. The high-impedance output of Q8 is transformed to 50 ohms by T2 and fed both to the transceiver first mixer and, via isolation stage Q11, to the synthesizer high level mixer.

### 9-6 SECOND LO

The second LO is a third overtone crystal oscillator, Q9, and buffer, Q10, and serves a dual purpose. First it is used to heterodyne the first IF filter output, which is at a nominal 75 MHz, down to the final IF frequency of 1650 kHz. It is also a component part of the DDS interpolation circuit described below. Any drift in this oscillator is completely cancelled out as far as the transceiver tune frequency is concerned. The only effect that frequency deviation will have is to shift the effective first conversion passband in the 75 MHz first IF filter. Since this filter has a relatively wide passband, no degradation of performance will occur.

### 9-7 DDS INTERPOLATION

The direct-digital synthesis unit operates from 5.951424 to 7.000000 MHz and consists of U7, which is programmed with a 24-bit serial bit string. The most significant ten of the twelve available numerical output bits of this device, give a binary representation of the instantaneous value of a sinewave and are routed to U8, a high speed digital-to-analog converter. The output of U8 is passed through a low-pass filter to remove the alias output, and fed to active mixer U2.

The local oscillator for this device is from the 73.35 MHz second LO described above. The lower sideband of the

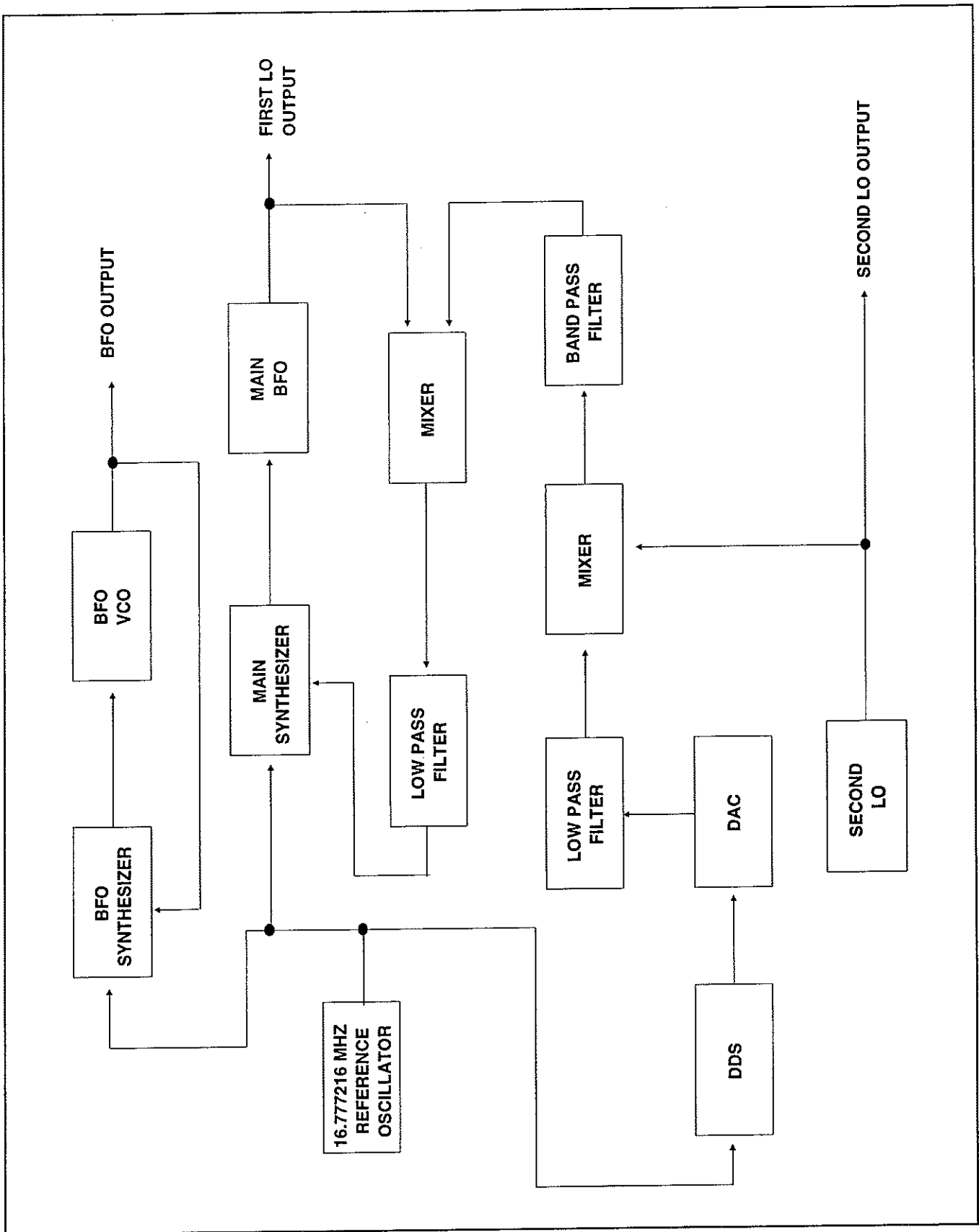


FIGURE 9-1.  
Block Diagram - Synthesizer Module, M6.

result of this mix is heavily filtered in a five-resonator band-pass filter which eliminates both the 73.35 MHz LO and the output of the DDS unit.

The output of the band-pass filter is fed to the passive high-level mixer which generates the input for the phase-locked loop.

### 9-8 BFO PHASE-LOCKED LOOP

The BFO phase-locked loop is required to provide only two frequencies. When upper sideband is in use, the BFO is required to be on 1650 KHz. (Since sideband inversion takes place at the final mix, this actually generates lower sideband at 1650 kHz.) When lower sideband is in use, the BFO is on 1647 kHz.

The BFO phase-locked loop utilizes the same synthesizer chip as the main synthesizer. (Refer to that section for a description of the device and its programming routine.)

Normally, a 1-kHz increment loop would be required to obtain the above frequencies. However in this implementation, only two frequencies need to be generated. Therefore, it is possible to achieve a much faster loop by changing BOTH the reference AND the divide-by-N counters simultaneously. This makes it possible to achieve reference frequencies of around 13 kHz, with less than a 10-Hz error. It is then possible to correct this error in software by offsetting the main synthesizer so that the BFO error is cancelled.

The actual numbers programmed are as follows:-

For 1650 KHz. "R" = 1271 "N" = 125  
For 1647 KHz. "R" = 1365 "N" = 134

### 9-9 BFO VCO

The BFO VCO is identical to the main VCO, except for the frequency determining components and the fact that it has two varactors in parallel. The BFO VCO also has the same source follower and isolation stages as the main VCO. Q1, Q2, and Q3 are the active devices.

### 9-10 BFO LOOP FILTER

The BFO loop has a passive filter only, which is composed of R12 thru R14, and C13, C14, and C107. The output of

this filter is fed to the frequency determining input of the BFO VCO.

### 9-11 SERVICE DATA

Figure 9-2 is a component location diagram which indicates the signal input/output points and adjustments. The following adjustment points are used:

1. R50. Used to adjust the frequency of the TCXO. (USED WITH THE 1099HS HIGH STABILITY OPTION ONLY.)
2. L1. Used to adjust the frequency of the BFO oscillator.
3. L7. Used to adjust the frequency of the second LO.
4. L13-L17. Band-pass filter adjustments.

### 9-12 MODULE INTERCONNECTIONS.

#### Connector M6J1

Pin 1 Ground.

Pin 2 Ground.

Pin 3 ENM6C/. Used to enable main synthesizer IC.

Pin 4 DATA. Microprocessor data input.

Pin 5 CLOCK. Microprocessor clock input.

Pin 6 N/C.

Pin 7 +12V. 12 VDC from the power supply.

Pin 8 +5V. 5 VDC from the power supply

Pin 9 ENM6B/. Used to enable the DDS IC.

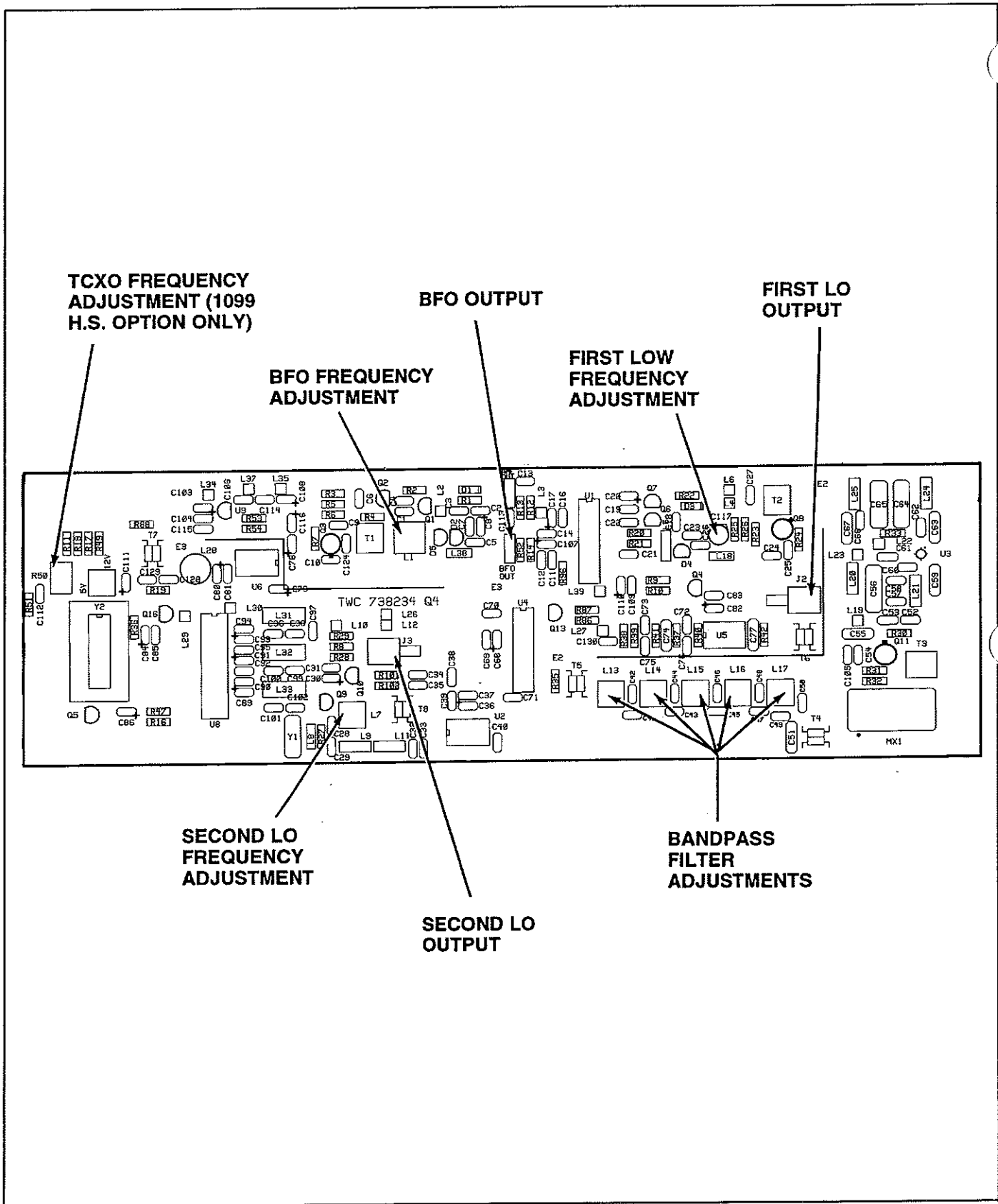
Pin 10 ENM6A/. Used to enable BFO synthesizer IC.

#### Connector J2

First LO output to the mixer.

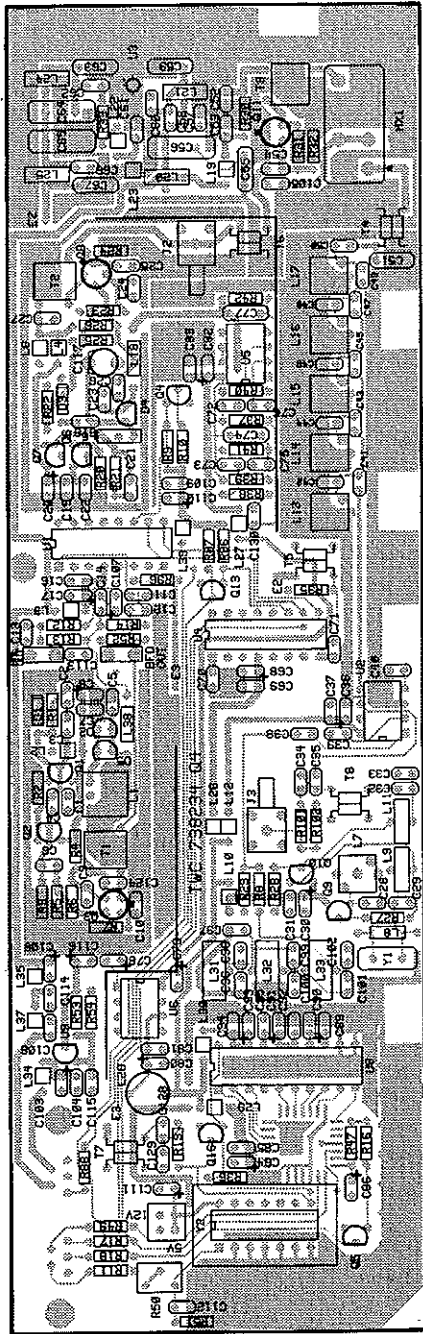
#### Connector J3

Second LO output to the mixer.



**FIGURE 9-2.**  
Signal Connections and Adjustment Points.

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**FIGURE 9-3.**  
**Component Locations, Synthesizer Module, M6.**







**TABLE 9-1.**  
**Parts List, Synthesizer Module, M6.**

C1	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C2	221101	Capacitor, Mica DM5 100 pF
C3	275391	Capacitor, Monolithic Disk 390 pF
C4	275122	Capacitor, Monolithic 100 V 1200 pF
C5-C7	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C8	241100	Capacitor, Tantalum 10 $\mu$ F
C9	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C10	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C11	214103	Capacitor, Monolithic 50V 0.01 $\mu$ F
C12	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C13	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C14	214103	Capacitor, Monolithic 50V 0.01 $\mu$ F
C15,C16	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C17	241100	Capacitor, Tantalum 10 $\mu$ F
C18	210100	Capacitor, Disc NPO 10 pF
C19	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C20	241100	Capacitor, Tantalum 10 $\mu$ F
C21	210330	Capacitor, Disc NPO 33 pF
C22	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C23	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C24	214103	Capacitor, Monolithic 50V 0.01 $\mu$ F
C25	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C26,C27	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C28	210100	Capacitor, Disc NPO 10 pF
C28	210150	Capacitor, Disc NPO 15 pF
C29	210200	Capacitor, Disc NPO 20 pF
C30	241100	Capacitor, Tantalum 10 $\mu$ F
C31,C32	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C33	221101	Capacitor, Mica DM5 100 pF
C34,C35	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C36	241100	Capacitor, Tantalum 10 $\mu$ F
C37	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C38	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C39,C40	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C41	210070	Capacitor, Disc NPO 7 pF
C42	210390	Capacitor, NPO 39 pF
C43	210018	Capacitor, Disc NPO 1.8 pF
C44	210390	Capacitor, NPO 39 pF
C45	210010	Capacitor, Disc NPO 1 pF
C46	210390	Capacitor, NPO 39 pF
C47	210010	Capacitor, Disc NPO 1 pF
C48	210390	Capacitor, NPO 39 pF
C49	210018	Capacitor, Disc NPO 1.8 pF
C50	221560	Capacitor, Mica DM5 56 pF
C51	221221	Capacitor, Mica DM15 220 pF
C52,C53	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C54	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C55	221101	Capacitor, Mica DM5 100 pF
C56	221560	Capacitor, Mica DM5 56 pF
C57	221151	Capacitor, Mica DM5 150 pF
C58	210200	Capacitor, Disc NPO 20 pF
C59	221121	Capacitor, Mica DM5 120 pF
C60	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C61	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C62	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C63	221101	Capacitor, Mica DM5 100 pF
C64	221560	Capacitor, Mica DM5 56 pF

**TABLE 9-1.**  
**Parts List, Synthesizer Module, M6. Continued.**

C65	221151	Capacitor, Mica DM5 150 pF
C66	210200	Capacitor, Disc NPO 20 pF
C67	221121	Capacitor, Mica DM5 120 pF
C68	241100	Capacitor, Tantalum 10 $\mu$ F
C69-C73	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C74	221101	Capacitor, Mica DM5 100 pF
C75,C76	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C77	221101	Capacitor, Mica DM5 100 pF
C78-C80	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C81	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C82	241100	Capacitor, Tantalum 10 $\mu$ F
C83	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C84	241100	Capacitor, Tantalum 10 $\mu$ F
C85	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C86	241020	Capacitor, Tantalum 2.2 $\mu$ F
C87,C88		Not Used.
C89	241010	Capacitor, Tantalum 1.0 $\mu$ F
C90	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C91	241100	Capacitor, Tantalum 10 $\mu$ F
C92	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C93	241100	Capacitor, Tantalum 10 $\mu$ F
C94	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C95	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C96	221271	Capacitor, Mica DM5 270 pF
C97	210200	Capacitor, Disc NPO 20 pF
C98	221301	Capacitor, Mica DM5 300 pF
C99	221101	Capacitor, Mica DM5 100 pF
C100	221271	Capacitor, Mica DM5 270 pF
C101	221680	Capacitor, Mica DM5 68 pF
C102	221221	Capacitor, Mica DM15 220 pF
C103	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C104	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C105	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C106	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C107	241010	Capacitor, Tantalum 1.0 $\mu$ F
C108	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C109	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C110	241100	Capacitor, Tantalum 10 $\mu$ F
C111	241020	Capacitor, Tantalum 2.2 $\mu$ F
C112	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C113	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C114,C115	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C116	237101	Capacitor, Electrolytic 16 V 100 $\mu$ F
C117	261006	Capacitor, Trimmer 1.8-6 pF
C118-C123		Not Used.
C124	275181	Capacitor, Monolithic 100 V 180 pF
C125-C127		Not Used.
C128	210102	Capacitor, Disc 25 V 0.001 $\mu$ F
C129	221680	Capacitor, Mica DM5 68 pF
C130		Not Used.
C131	275821	Capacitor, Monolithic 820 pF
D1	320002	Diode, 1N4148/1N4150
D2	320305	Diode, MV209
D3	320002	Diode, 1N4148/1N4150
D4,D5	320305	Diode, MV209

**TABLE 9-1.**  
**Parts List, Synthesizer Module, M6. Continued.**

D6,D7	320002	Diode, 1N4148/1N4150
J1	610425	Connector, 10-pin Plus Coax
J2,J3	610510	Connector, SMB Right Angle
L1	490149	Inductor, Variable 22 $\mu$ H
L2-L4	459032	Inductor, Assembly 3 turns
L5	459236	Inductor, 11 turns / TAP / 4 turns
L6	459032	Inductor, Assembly 3 turns
L7	490109	Inductor, Variable 12.5 turns
L8	430005	Inductor, Fixed 0.68 $\mu$ H
L9	459235	Inductor, Assembly 16 turns
L10	459032	Inductor, Assembly 3 turns
L11	459234	Inductor, Assembly 8 turns
L12	459032	Inductor, Assembly 3 turns
L13-L17	490114	Inductor, Variable 6.5 turns
L18	430013	Inductor, Fixed 27 $\mu$ H
L19	459032	Inductor, Assembly 3 turns
L20	459233	Inductor, Assembly 9 turns
L21	459234	Inductor, Assembly 8 turns
L22,L23	459032	Inductor, Assembly 3 turns
L24	459233	Inductor, Assembly 9 turns
L25	459234	Inductor, Assembly 8 turns
L26,L27	459032	Inductor, Assembly 3 turns
L28	430051	Inductor, Molded 1 $\mu$ H
L29,L30	459263	Inductor, Assembly 8 turns
L31	459232	Inductor, Assembly 21 turns
L32	459230	Inductor, Assembly 17 turns
L33	459231	Inductor, Assembly 18 turns
L34,L35	459032	Inductor, Assembly 3 turns
L36		Not Used.
L37	459032	Inductor, Assembly 3 turns
L38	430014	Inductor, Molded 100 $\mu$ H
L39	459032	Inductor, Assembly 3 turns
MX1	380006	Mixer, Mini Double-Balanced
Q1,Q2	310033	Transistor, FET J310
Q3	310126	Transistor, MFE211
Q4,Q5	310138	Transistor, FET VN2222LL
Q6,Q7	310033	Transistor, FET J310
Q8	310126	Transistor, MFE211
Q9,Q10	310033	Transistor, FET J310
Q11	310040	Transistor, NPN MRF904
Q12		Not Used.
Q13	310138	Transistor, FET VN2222LL
Q14,Q15		Not Used.
Q16	310033	Transistor, FET J310
R1	113334	Resistor, Carbon Film 1/8 W 5% 330 $\text{k}\Omega$
R2	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R3	113681	Resistor, Carbon Film 1/8 W 5% 680 $\Omega$
R4	113223	Resistor, Carbon Film 1/8 W 5% 22 $\text{k}\Omega$
R5	113104	Resistor, Carbon Film 1/8 W 5% 100 $\text{k}\Omega$
R6	113223	Resistor, Carbon Film 1/8 W 5% 22 $\text{k}\Omega$
R7	113271	Resistor, Carbon Film 1/8 W 5% 270 $\Omega$

**TABLE 9-1.**  
**Parts List, Synthesizer Module, M6. Continued.**

R8	113181	Resistor, Carbon Film 1/8 W 5% 180 $\Omega$
R9	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R10	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R11	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R12,R13	113682	Resistor, Carbon Film 1/8 W 5% 6.8 k $\Omega$
R14	113272	Resistor, Carbon Film 1/8 W 5% 2.7 k $\Omega$
R15	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R16	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R17,R18	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R19	113271	Resistor, Carbon Film 1/8 W 5% 270 $\Omega$
R20	113334	Resistor, Carbon Film 1/8 W 5% 330 k $\Omega$
R21	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R22	113681	Resistor, Carbon Film 1/8 W 5% 680 $\Omega$
R23	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R24	113271	Resistor, Carbon Film 1/8 W 5% 270 $\Omega$
R25,R26	113223	Resistor, Carbon Film 1/8 W 5% 22 k $\Omega$
R27	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R28	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R29	113820	Resistor, Carbon Film 1/8 W 5% 82 $\Omega$
R30	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R31	113122	Resistor, Carbon Film 1/8 w 5% 1.2 k $\Omega$
R32	113561	Resistor, Carbon Film 1/8 W 5% 560 $\Omega$
R33	113680	Resistor, Carbon Film 1/8 W 5% 68 $\Omega$
R34		Not Used.
R35	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R36	113221	Resistor, Carbon Film 1/8 W 5% 220 $\Omega$
R37-R40	113222	Resistor, Carbon Film 1/8 W 5% 2.2 k $\Omega$
R41,R42	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R43-R46		Not Used.
R47	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R48		Not Used.
R49	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R50	170225	Resistor, Variable Mini 100 k $\Omega$
R51	113623	Resistor, Carbon Film 1/8 W 5% 62 k $\Omega$
R52	113392	Resistor, Carbon Film 1/8 W 5% 3.9 k $\Omega$
R53	113152	Resistor, Carbon Film 1/8 W 5% 1.5 k $\Omega$
R54	113822	Resistor, Carbon Film 1/8 W 5% 8.2 k $\Omega$
R55-R85		Not Used.
R86	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R87	113473	Resistor, Carbon Film 1/8 W 5% 47 k $\Omega$
R88	113101	Resistor, Carbon Film 1/8 W 5% 100 $\Omega$
R89-R95		Not Used.
R96	113470	Resistor, Carbon Film 1/8 W 5% 47 $\Omega$
R97-R100		Not Used.
R101	113220	Resistor, Carbon Film 1/8 W 5% 22 $\Omega$
R102	113470	Resistor, Carbon Film 1/8 W 5% 47 $\Omega$
R103		Not Used.
R104	113105	Resistor, Carbon Film 1/8 W 5% 1 M $\Omega$
T1	459240	Transformer, Assembly 4 turns / 1 turn
T2	459033	Transformer, Assembly 4 turns / 1 turn
T3	459239	Transformer, Assembly 5 turns / 2 turns
T4	459237	Transformer, Assembly 2 turns / 2 turns
T5	459238	Transformer, Assembly 2 turns / 8 turns
T6	459237	Transformer, Assembly 2 turns / 2 turns
T7	459246	Transformer, Assembly 3 turns / 3 turns

**TABLE 9-1.**  
**Parts List, Synthesizer Module, M6. Continued.**

T8	459237	Transformer, Assembly 2 turns / 2 turns
U1	330472	IC, MB87086A
U2	330417	IC, NE602AN
U3	380011	IC, MAR6
U4	330472	IC, MB87086A
U5	330368	IC, MC33078
U6	330471	IC, MAX680CPA
U7	330418	IC, STEL-1179/CM
U8	330470	IC, MB40760
U9	330343	IC, LM317LZ
Y1	361094	Crystal, 73.35 MHz
Y2	361095	16.77726 MHz TCXO

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# CHAPTER 10

## PROCESSOR MODULE, M7 - TECHNICAL DESCRIPTION

### 10-1 GENERAL DESCRIPTION

The processor module contains a microprocessor and the associated components to perform the control functions in the transceiver. These include the tuning of the synthesizer, harmonic filter selection, antenna-tuner control, and driving of the LCD frequency display.

Communication with the external modules is conducted through a serial data bus. Within a piece of digital equipment, it is normal to transfer data in parallel—all bits in a group (byte or word) are sent at the same time. The synthesizer itself requires 80 bits of information; if the data were sent in parallel 80 lines would be required, which would be too expensive and complex for this application. The solution to this problem is serial data transmission, in which each of the bits is sent in turn, in agreed sequence, over a single channel or wire.

The microprocessor operates only during the period required to perform its specific control functions. This gives two important operational advantages. The first is that the processor only draws current during the brief period required to perform the control functions, typically only a few milliseconds. The second advantage is that there is no need to provide extensive shielding to stop noise in the receiver. The processor operates only when controls are changed.

CMOS devices are used throughout the module. Therefore, power drain is very low, especially in standby mode.

### 10-2 M7 BLOCK DIAGRAM

The M7 module contains the main microprocessor module. It also has interface capabilities to an optional TransAdapt modem and optional ALE card. The M7 contains a Motorola 68302 microprocessor, which performs all radio control functions.

A block diagram of the M7 is shown in Figure 10-1. The module has the following block components:

#### M7

1. Microprocessor
2. EPROM Program Storage
3. RAM Memory Storage.
4. Clock Oscillator Circuit
5. Microprocessor Controller
6. Memory Backup Circuit
7. RS-232 I/O Circuit
8. Control Bus Outputs
9. Control Outputs
10. EEPROM Memory
11. Input Demultiplexer
12. Wake-up Control

13. Analog Converter System
14. Audio Buffers
15. ALE switch
16. Transadapt Modem

### 10-3 MICROPROCESSOR

The microprocessor U1, is combined with the input/output circuits to form a special purpose microcomputer. The theory of operation of the microprocessor is beyond the scope of this manual. Simply stated, the microprocessor controls the operation of the transceiver in response to the control inputs, in accordance with the program stored in memory.

The M7 microprocessor is a Motorola MC68302, which uses a 68000 microprocessor core. This microprocessor has the capability of addressing up to 2 Mbytes of EPROM memory and 64 Kbytes of static RAM for future program expansion. It also has three UARTS, two timers, 18 bidirectional input/output lines, and four external interrupt sources.

The microprocessor operates at a clock frequency of 4.00 MHz and uses an internal oscillator controlled by Y1. UART1 is used for RS-232 communications through the front-panel communications port. UART2 is used for communications with the optional ALE card. UART3 is used for communications with the optional TransAdapt modem. PA2 through PA7 are used to drive the control bus, while PA10 through PA14 are used for the d-mux bus. PA15 and PB0 through PB4 are used for miscellaneous control functions. GPI1 through GPI3 are used for external interrupt sources. Address lines A1 through A20 and Data Lines D0 through D15 are used for communications with the external EPROM, RAM, and analog converter system.

### 10-4 EPROM PROGRAM STORAGE

The EPROM chips U2 and U3 are where the main software operating program for the radio is stored. EPROM storage was chosen for its speed, ease of reprogrammability, high reliability factor and low current consumption.

### 10-5 RAM PROGRAM STORAGE

The RAM chips U4 and U5 are where all the channel frequency data, display data, and memory tuner information is stored. RAM storage was chosen for its speed, high reliability factor, and low current consumption.

### 10-6 CLOCK OSCILLATOR CIRCUIT

The clock oscillator is internal within the microprocessor, except for the external crystal Y1, and capacitors C48 and C49.

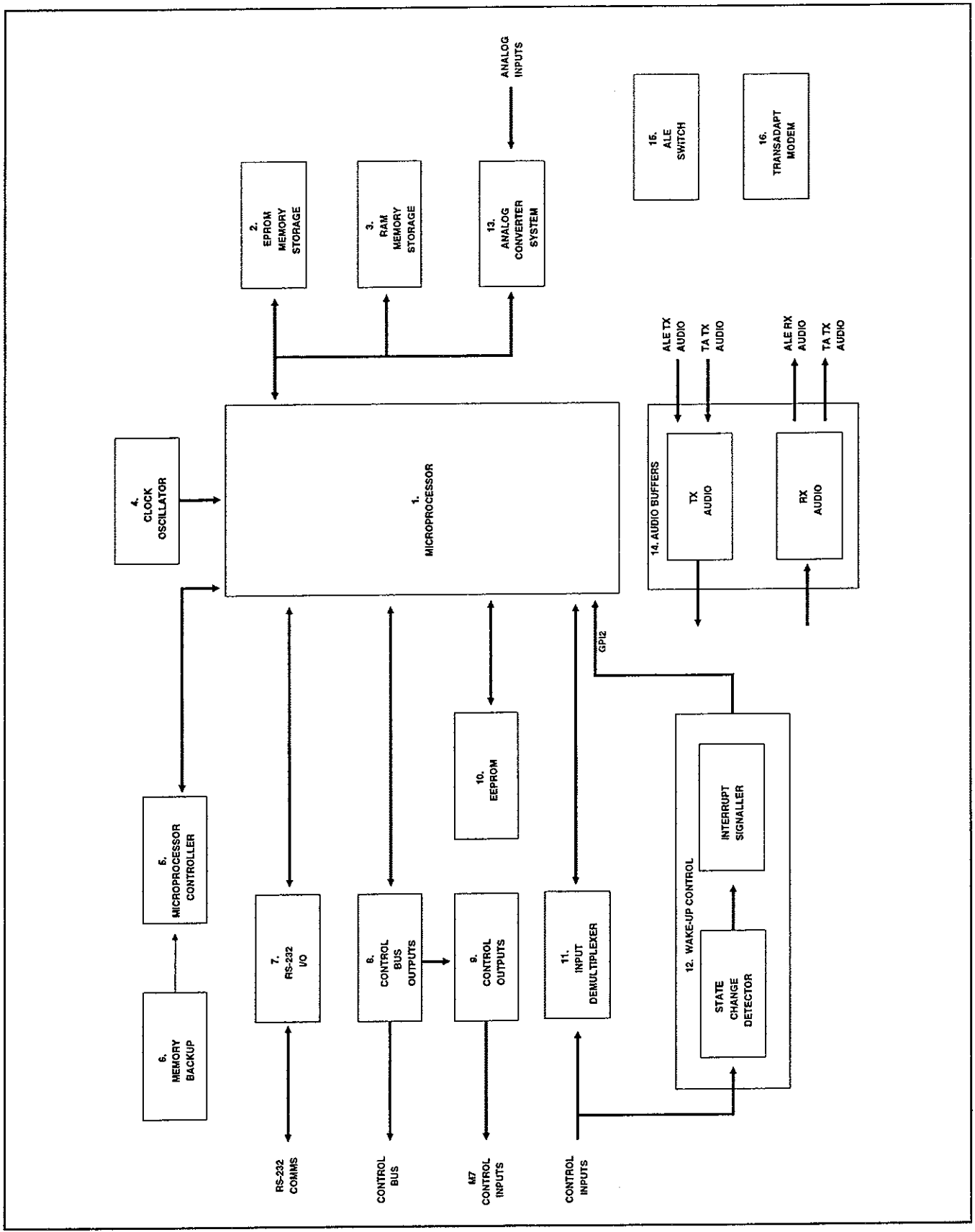


FIGURE 10-1.  
Block Diagram - Processor Module, M7.



**TABLE 10-1.**  
**Specifications, Processor Module, M7.**

<b>Current Drain:</b>	
a. Static:	20 mA typical @ 5 V.
b. Operating:	40 mA typical @ 5 V.
c. Lithium Cell:	2 $\mu$ A typical @ 2.5 V.
<b>Lithium Cell Life:</b>	5 years minimum, 10 years typical.

### 10-7 MICROPROCESSOR CONTROLLER

The controller U9, provides three functions. The first function is a reset controller which has a voltage detector that monitors the +5-volt line. It will generate a reset output to hold the microprocessor's reset line low whenever the +5-volt line is below 4.65 Vdc. An internal monostable multivibrator holds the reset line low for 200 milliseconds after the +5-volt line rises above 4.65 Vdc. This prevents repeated toggling of the reset line.

The second function is a power-failure detector that issues a non-maskable interrupt to the microprocessor whenever a power-failure occurs. This lets the microprocessor power down in the correct state before data is lost.

The third function is a memory backup function that preserves the contents of the RAM memory storage. This is where the frequency program information is stored and this must be preserved at all times. When a power-failure is detected, the lithium battery is automatically switched in to preserve the RAM memory data.

### 10-8 MEMORY BACKUP CIRCUIT

This circuit contains the memory backup battery BT1, current limiting resistor R22, and reverse protection diode D3. This battery is for backing up the RAM memory storage data.

### 10-9 RS-232 I/O CIRCUIT

The RS-232 chip U8, is used for communications with the front panel communications port. U8 has an on-board capacitor charge pump for generating the -10 Vdc and +10 Vdc that are necessary for RS-232 communications. This circuit can easily handle baud rates up to 9600 baud. It also can be put into a low power idle mode for low power consumption.

### 10-10 CONTROL BUS OUTPUTS

The control bus outputs PA2 through PA7 are used to provide the serial programming information to the other radio modules. This bus includes synthesizer select signals, data and clock signals, along with filter and tuner signals. The control bus also outputs the display information to the M8 display module.

### 10-11 CONTROL OUTPUTS

The control outputs are from the serial shift register U15 and are used to control the following devices:

- a. Tune initiate to the front panel.
- b. Enable and shutdown signals to the RS-232 chip.
- c. AGC time constant switching.
- d. Light on/off control.
- e. External amplifier PTT enable.
- f. Transadapt modem control.
- g. ALE board switch.

### 10-12 EEPROM MEMORY

The serial EEPROM memory chip U18, is used to store certain critical operating parameters that are necessary for proper radio operation. It was chosen for its long term storage capabilities.

### 10-13 INPUT DEMULTIPLEXER

The input demultiplexer U14 is used to interface the 16 input lines to the microprocessor. U14 is an HC14067 analog multiplexer/demultiplexer which has 16 channels and four address lines. The processor communicates with the input demultiplexer through the d-mux bus. The five-line d-mux bus consists of four address lines which are connected to PA10 through PA13 of the microprocessor and an input line connected to PA14. The microprocessor outputs the desired input channel address through the address lines, and data is read in through the input line.

### 10-14 WAKE-UP CONTROL

The state-change detector U12, which represents half of the wake-up control block, monitors the input lines for any change in the state of the inputs, which then triggers the interrupt signaller to create an interrupt within the microprocessor. U12 is an MC14531 12-bit parity tree which has 12 inputs, odd/even parity-select input and a parity valid output. The interrupt signaller U13 is an MC14528B dual-monostable multivibrator. One section of the multivibrator is configured to trigger on the rising edge of the parity tree input and the other on the falling edge. The outputs of the multivibrators drive the interrupt line of the microprocessor, which then bring the processor out of the standby state.

### 10-15 ANALOG CONVERTER SYSTEM

The analog converter system consists of the analog-to-digital converter (ADC) chip U6 and the analog multiplexer chip U7.

The analog multiplexer is used to select the proper input into the ADC chip. The ADC chip has a 256-position

precision resistor array inside that lets it determine the input voltage down to a resolution of 20 mV. The analog converter system allows precise monitoring of the battery voltage, ALC line, AGC line, handset voltage, 8 Vdc, receive 8 Vdc, and transmit 8 Vdc.

#### 10-16 AUDIO BUFFERS

The op-amp U19 is used as a buffer for the transmit and receive audio path to and from the optional ALE card and optional Transadapt modem.

#### 10-17 ALE SWITCH

The FET switch U21 is used to switch the power on and off to the optional ALE card.

#### 10-18 TRANSADAPT MODEM

The optional Transadapt modem is installed for Transadapt operation. This modem generates the Transadapt tones that are transmitted and decodes the incoming Transadapt tones. The Transadapt transmit audio level is adjusted by R39, while the receive audio level is adjusted by R40. Refer to Figure 10-2 for location of adjustments.

#### 10-19 PROGRAM OPERATION

Most of the time, the microprocessor is in standby mode waiting for a command from any of the inputs. When a control input is changed, the state-change detector signals the processor to switch to active mode. The processor then polls all the inputs through the input demultiplexer to find out which input triggered the interrupt. Upon determining the correct input, the processor executes the proper instructions to perform the command determined by the specific input. For example, a change in the channel switch line would wake up the processor, which then retrieves the new channel frequency data stored in RAM. The new channel data is then sent to the synthesizer, antenna tuner, and harmonic filter through the control bus, and the display module data is sent through the display bus.

The input to any of the UART's and the rest of the interrupt sources is very similar, except all the interrupt circuitry is internal to the 68302 chip.

#### 10-20 CONTROL BUS

The control bus basically consists of three signals. The signals are clock, data, and select. The microprocessor places the first data bit on the data line at the SPTXD pin. Then it toggles the clock line (SPCLK) twice, so that the data is shifted into the selected shift register. This is repeated until all the data in the data stream is shifted out. The desired select line is chosen by the 3-to-8 demultiplexer U10 by putting the proper address on PA2 through PA4. The select line is toggled twice to latch the shifted data into the desired register. The display has its own interface bus lines, PA6 and PA7, which are display data and display clock, respectively. Display bus operation is similar to the control bus, except that no select line is needed since the display is the only device.

#### 10-21 MEMORY DUMP FEATURE

The PRC1099A is equipped with a Memory Dump Feature, which allows the operator to erase all frequencies and channel information stored in memory (channels 00 through 99) in one quick maneuver. This ability to quickly erase the memory can be very useful to avoid compromising unit frequencies in the event of an enemy capture. To erase the frequencies stored in memory, simply hold the DIGIT switch down, hold the TUNE switch up, and turn the radio from OFF to ON. This will cause the radio to reset all programmed frequencies to 2.000 MHz.

#### 10-22 BUILT-IN-TEST-EQUIPMENT PROGRAM (BITE) - GENERAL DESCRIPTION

##### 10-22.1 INTRODUCTION

BITE is a series of built-in tests to enable the radio operator to test various sections of the PRC1099A. The BITE software is capable of performing tests on the following sections of the PRC1099A:

1. Battery
2. Antenna
3. LCD display
4. Processor RAM
5. Receiver
6. Transmitter
7. Antenna tuner

Section 10-22.2 describes the operation of the PRC1099A BITE program. Sections 10-23.1 through 10-23.12 give an overview of the BITE program, describe each test step in detail, and include pass or fail indications and areas of required operator interaction.

##### 10-22.2 BITE OPERATION

Before starting BITE, the radio should be configured as follows:

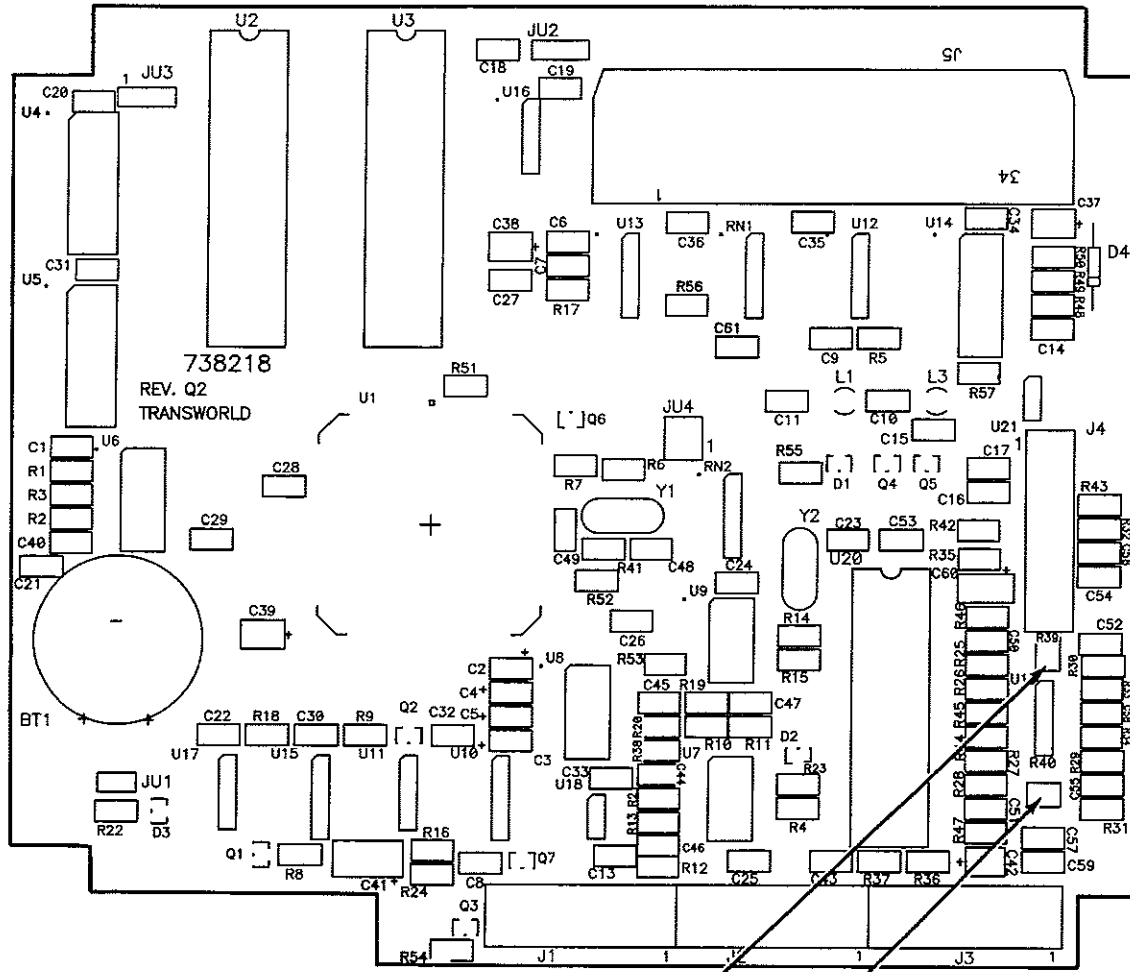
- Whip antenna installed (or adapter, when using a long wire antenna).
- Handset connected to one of the audio connectors.
- Mode switch set to "USB".
- Volume control set to the "5" position.

The BITE tests are invoked by selecting the BITE TST menu under the OPT icon. Depress the WHIP/TUNE button to start the BITE test sequence. The display will show 'BITE ON.' The BITE program will begin stepping through each test routine, and will halt if a failure occurs (except with tests requiring operator interaction) and display an error message. DO NOT depress the PTT switch on the handset when using BITE, as it may interfere with the BITE tests.

#### 10-23 BITE TEST DESCRIPTIONS

##### 10-23.1 BATTERY TEST

The battery test tests the battery pack. The battery voltage is read by the analog converter system and if it is below



(R39) TRANSADAPT  
TRANSMIT LEVEL ADJUST

(R40) TRANSADAPT  
RECEIVE LEVEL ADJUST

**FIGURE 10-2**  
**Signal Connections and Adjustment Points**

the minimum level of 11 volts, then the display will show 'BAT LOW' and BITE will halt. If the battery voltage is above 15 volts, then the display will show 'BAT HIGH' and BITE will halt. Otherwise, the display will show 'BAT PASS' and BITE will proceed to the next test.

### 10-23.2 WHIP ANTENNA TEST

The whip antenna test tests the antenna whip switch and verifies that a whip antenna or antenna adapter is installed (which is required for the transmitter tests). If an antenna is not installed, BITE will fail, halt, and display the error message 'ANT FAIL'. Otherwise, the display will show 'ANT PASS' and BITE will proceed to the next test.

### 10-23.3 LCD DISPLAY TEST

The display test tests the front-panel LCD display and verifies that each digit, segment, and icon of the display functions properly. BITE tests each digit/segment by performing a "walking digit" test in which the entire 14-segment digit is first displayed on the left of the display and then is "shifted" over one digit to the right until it has been through all eight digit positions. The second portion of the test exercises the colons of the display by "shifting" a colon in the same manner. The third portion of the test "shifts" the icons to exercise the icons of the display. This test requires the presence of the radio operator to determine if this portion of the test passes or fails. When the test is completed, the display will show 'DIS PASS' and BITE will proceed to the next test.

### 10-23.4 PROCESSOR RAM TEST

The RAM test tests the RAM within the static RAM chips U4 and U5. BITE does a non-destructive memory test which writes and reads selected test bit patterns to insure the integrity of the battery-backed-up RAM. BITE will fail this portion of the test upon any read/write cycle failure. Upon failure, BITE will display 'RAM FAIL' and halt. If no memory test error is detected, the display will show 'RAM PASS' and BITE will proceed to the next test.

### 10-23.5 USB RECEIVER TEST

The USB test tests the receiver circuitry of the PRC1099A in upper sideband mode. During this test, the operator can hear an audible tone for at least 2 seconds in the handset. If BITE does not detect the tone, it will display 'USB FAIL' and halt. Otherwise, it will display 'USB PASS' and will proceed to the next test.

### 10-23.6 LSB RECEIVER TEST

The LSB test tests the receiver circuitry of the PRC1099A in lower sideband mode. During this test, the operator can hear an audible tone for at least two seconds in the handset. If BITE does not detect the tone, then it will display 'LSB FAIL' and halt. Otherwise, it will display 'LSB PASS' and will proceed to the next test.

### 10-23.7 TRANSMITTER TESTS

The transmitter tests exercise the transmitter functions of the PRC1099A radio. This section of the BITE program begins by tuning the synthesizer to one of the six test frequencies (USB) in Table 10-2 below.

The transmitter test then sets the radio to low-power mode and attempts to tune the antenna to the current test frequency. The BITE program generates an audible test tone through the handset for two seconds, (which the operator should verify). If the radio passes, the BITE program switches the transmitter to high power for two seconds. (If the resulting antenna tune setting includes L8, L9, or L10, the transmitter will stay in low power.) The operator should verify that the test tone is audible for this portion of the test as well. If the antenna-tuning section fails to tune during the transmitter test sequence, the BITE program will display 'xxx FAIL' (where xxx is the current test frequency)—and fail that portion of the BITE program. If the test tone is not present or fades during the low/high power sections of any of the transmitter tests, the current test should be failed by the operator.

### 10-24 MODULE INTERCONNECTIONS

The M7 module has the following interconnects with the transceiver:

#### Connector M7-J1

- Pin 1 AGC line from M3 and M2. Varies from 0 to 4.5 Vdc with signal strength in receive.
- Pin 2 ALC line from M4. Varies from 0 to 1.0 Vdc with transmit power.
- Pin 3 LOW POWER. From the M4 module, 0 Vdc in LO or EXT AMP, 5 Vdc in HIGH.

**TABLE 10-2.**  
**Transmitter Test Frequencies.**

29.9 Test	29.9000 MHz
19.9 Test	19.9000 MHz
12.9 Test	12.9000 MHz
7.9 Test	7.9000 MHz
4.9 Test	4.9000 MHz

Pin 4,5 Ground.  
 Pin 6 COMP. Comparator output from M5.  
 Pin 7 ENM5. Enable line for the antenna tuner.  
 Pin 8,9,10 ENM6A,B,C. Enable lines for the synthesizer.

Connector M7-J2

Pin 1,2 5 Vdc from the power supply.  
 Pin 3 12 Vdc from the power supply.  
 Pin 4 T8. Transmit 8 Vdc from power supply.  
 Pin 5 R8. Receive 8 Vdc from power supply.  
 Pin 6 8 Vdc from power supply.  
 Pin 7 PTT. 13.6 Vdc in receive, 0 Vdc in transmit.  
 Pin 8 DATA. Internal radio data.  
 Pin 9 CLOCK. Internal radio clock information.  
 Pin 10 BITE. Currently not used.

Connector M7-J3

Pin 1 TX AUDIO. Transmit audio to M1.  
 Pin 2 No connection.  
 Pin 3 RX AUDIO. Receive audio from M1.  
 Pin 4 No connection.  
 Pin 5 CW KEY. 13.6 Vdc in receive, 0 Vdc in CW transmit.  
 Pin 6 CONTRAST. Control of the front LCD display contrast.  
 Pin 7 MUTE. Used to mute the receive audio in transmit. 8 Vdc in receive, 0 Vdc in transmit.  
 Pin 8 ENM1. Enable line for audio/rf filter.  
 Pin 9 VOICE DET. Voice detect line from M1.  
 Pin 10 RF DET. Currently not used.

Connector M7-J4

Pin 1,2 5 Vdc from power supply.  
 Pin 3,4 Digital grounds.  
 Pin 5,6 Analog grounds.

Pin 7-14 No connections.  
 Pin 15 KEYLINE. ALE PTT input.  
 Pin 16 ALEPTT. ALE PTT output.  
 Pin 17 SC RXD. ALE serial data receive.  
 Pin 18 SC TXD. ALE serial data transmit.

Pin 19 ALERXA. ALE receive audio.  
 Pin 20 ALETXA. ALE transmit audio.

Connector M7-J5

Pin 1 OPTSW. Option switch position.  
 Pin 2 LITE. Controls LCD backlight operation.  
 Pin 3 LSBSW. LSB switch position.  
 Pin 4 5 Vdc to display module.  
 Pin 5 SLEWDN. Slew down switch, normally 5 Vdc, 0 Vdc with TUNE switch down.  
 Pin 6 SLEWUP. Slew up switch, normally 5 Vdc, 0 Vdc with TUNE switch up.  
 Pin 7 SQUELCH. Squelch switch position.  
 Pin 8 DISDATA. Data information sent to the display.  
 Pin 9 DISCLK. Clock information sent to the display.  
 Pin 10 12 Vdc to the front panel mic connector.  
 Pin 11-13 No connections.  
 Pin 14 Ground.  
 Pin 15 CWKEY. Connects to front panel mic connector.  
 Pin 16 PTT. Connects to front panel mic connector.  
 Pin 17 CONTRAST. Control of the front panel LCD display.  
 Pin 18 EXT SEL. Control of an external device.  
 Pin 19 DIGDN. Digit down switch, normally 5 Vdc, 0 Vdc with DIGIT switch down.  
 Pin 20 TUNE INIT. initiates external tune cycle.  
 Pin 21 ANT SW. Antenna switch position, 0 Vdc with no antenna, 4.8 Vdc with antenna.

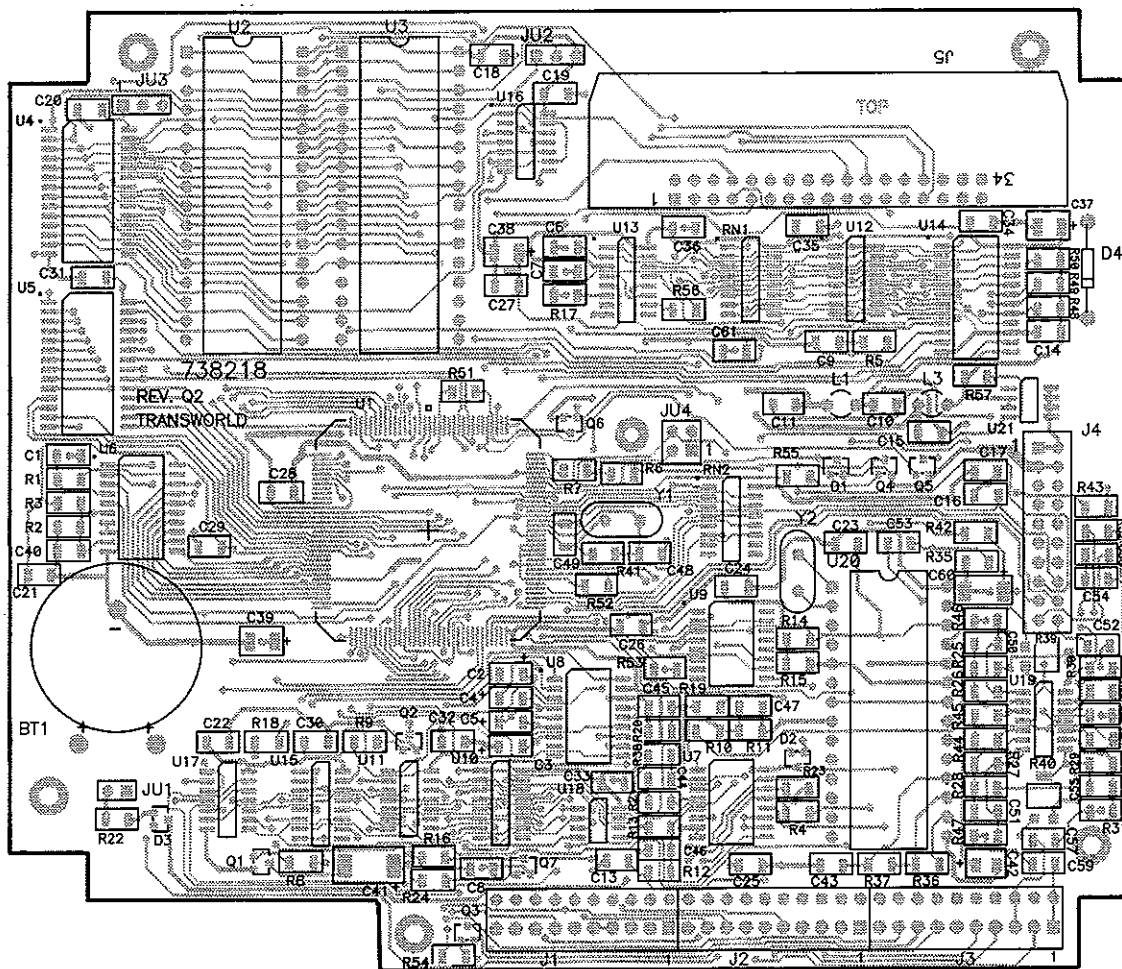
- Pin 22 CH SET/TUNE. Channel set/Tune switch, normally 5 Vdc, 0 Vdc with WHIP TUNE pressed.
- Pin 23 HANDSET. External handset voltage.
- Pin 24 ALC line to external connector.
- Pin 25 DIGUP. Digit up switch, normally 5 Vdc, 0 Vdc with DIGIT switch up.
- Pin 26 AMP PTT. If in EXT AMP, then this will toggle with PTT.
- Pin 27 RS232TXD. RS-232 front panel serial communications.
- Pin 28 RS232RXD. RS-232 front panel serial communications.
- Pin 29 EXT AMP. 0 Vdc in EXT AMP, 5 Vdc in HIGH or LOW.

Pin 30 LOW POWER. from the front panel switch, 0 Vdc in LO or EXT AMP, 5 Vdc in HIGH.

Pin 31-34 See chart below:

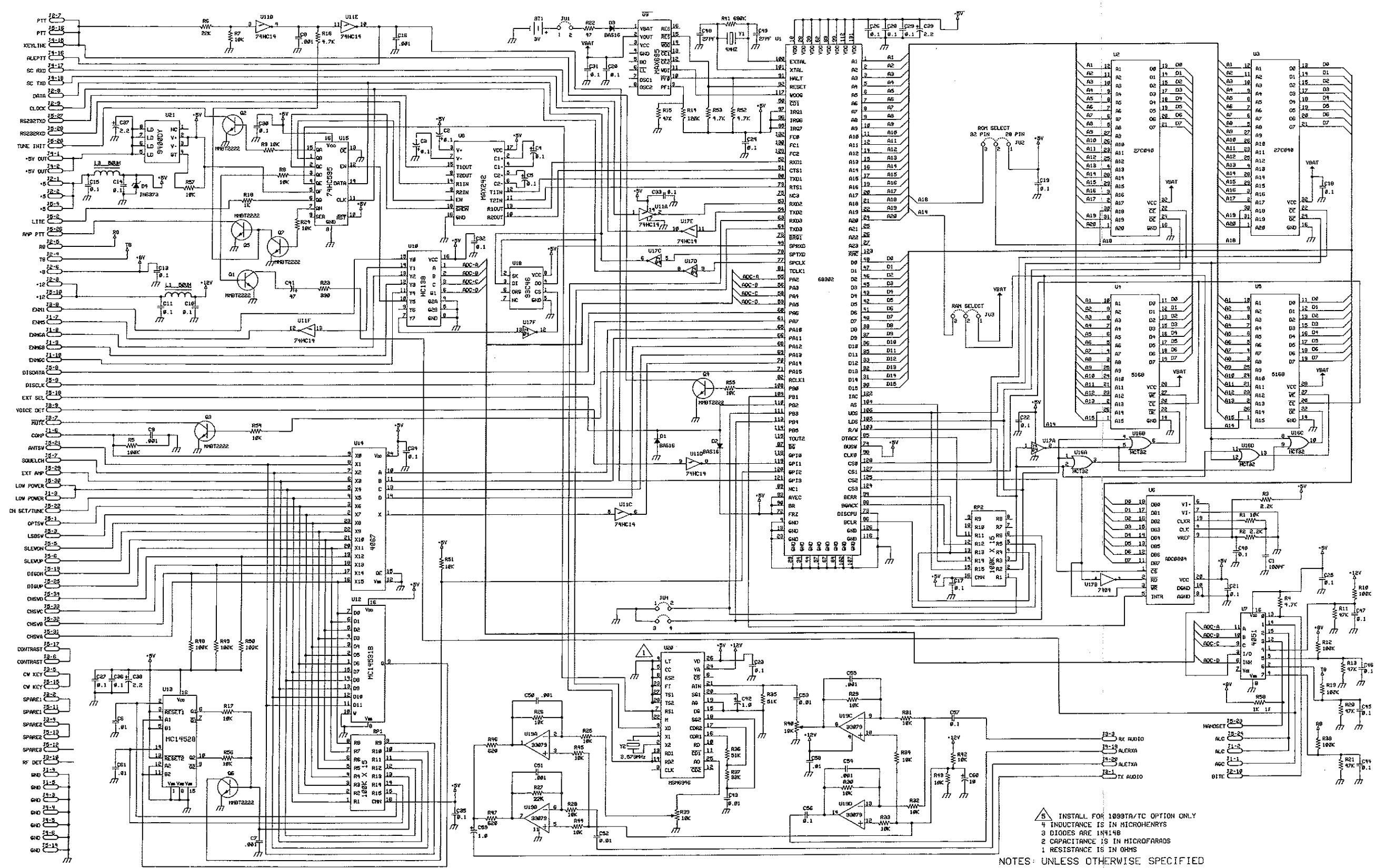
<b>Channel Switch</b>	<b>Pin 31</b>	<b>Pin 32</b>	<b>Pin 33</b>	<b>Pin 34</b>
Manual	5 Vdc	5 Vdc	5 Vdc	5 Vdc
1	0 Vdc	5 Vdc	5 Vdc	5 Vdc
2	5 Vdc	5 Vdc	5 Vdc	0 Vdc
3	0 Vdc	5 Vdc	5 Vdc	0 Vdc
4	5 Vdc	5 Vdc	0 Vdc	5 Vdc
5	0 Vdc	5 Vdc	0 Vdc	5 Vdc
6	5 Vdc	5 Vdc	0 Vdc	0 Vdc
7	0 Vdc	5 Vdc	0 Vdc	0 Vdc
8	5 Vdc	0 Vdc	5 Vdc	5 Vdc
9	0 Vdc	0 Vdc	5 Vdc	5 Vdc

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**FIGURE 10-3.**  
**Component Locations, Processor Module, M7.**

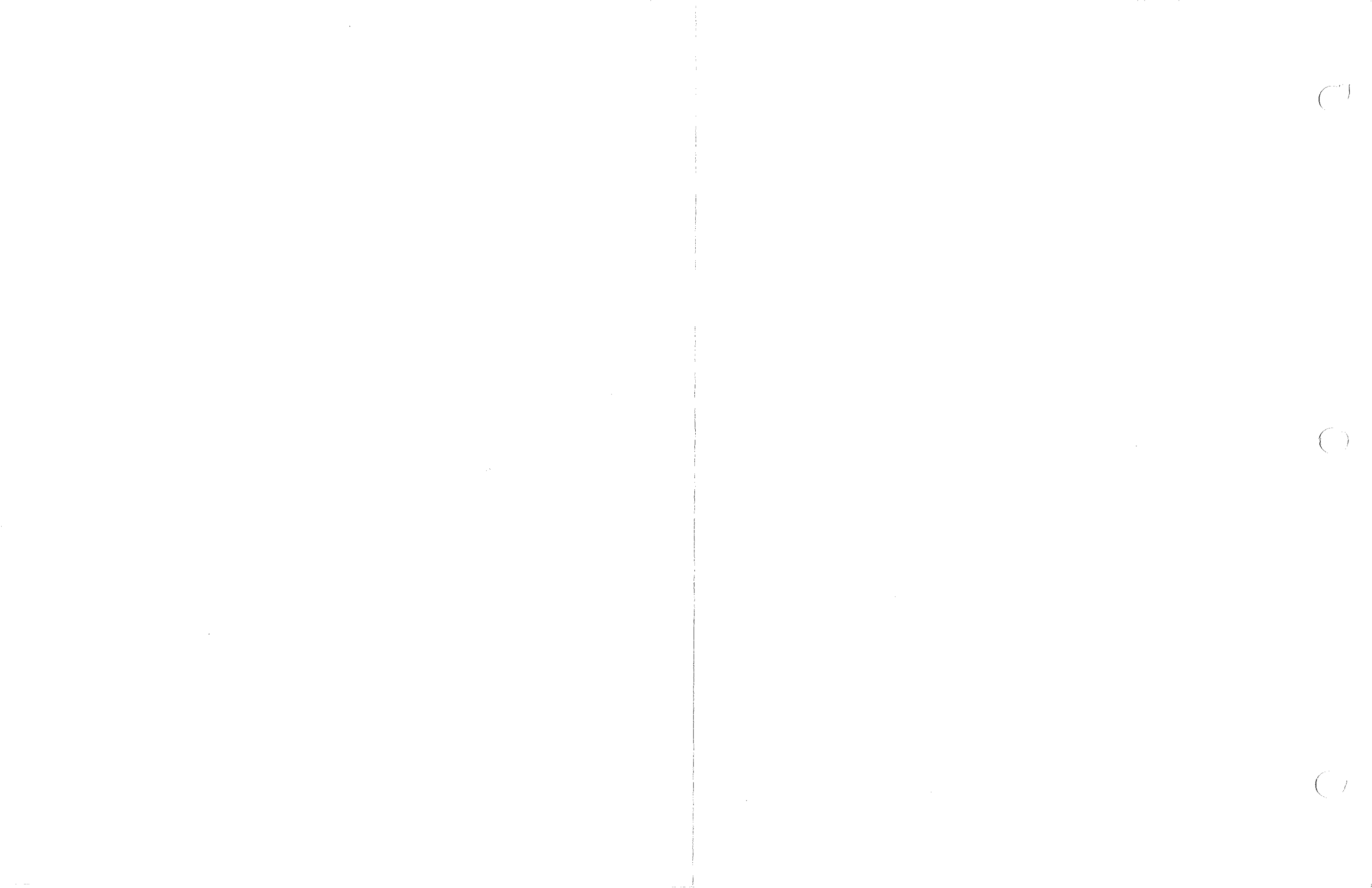




INSTALL FOR 1099TA/TC OPTION ONLY  
 † INDUCTANCE IS IN MICROHENRYS  
 ‡ DIODES ARE 1N4148  
 § CAPACITANCE IS IN MICROFARADS  
 ¶ RESISTANCE IS IN OHMS

NOTES: UNLESS OTHERWISE SPECIFIED

FIGURE 10-4.  
 Schematic Diagram, Processor Module, M7.



**TABLE 10-3.**  
**Parts List, Processor Module, M7.**

BT1	750057	Battery, 3 V Lithium
C1	020101	Capacitor, 50 V 100 pF SMT
C2C-5	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C6	021103	Capacitor, 50 V 0.01 $\mu$ F SMT
C7-C9	021102	Capacitor, 50 V 0.001 $\mu$ F SMT
C10,C11	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C12		Not Used.
C13-C15	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C16	021102	Capacitor, 50 V 0.001 $\mu$ F SMT
C17-C36	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C37-C39	022020	Capacitor, Tantalum 16 V 2.2 $\mu$ F SMT
C40	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C41	023470	Capacitor, Tantalum 10 V 47 $\mu$ F SMT
C42	021010	Capacitor, 16 V 1 $\mu$ F SMT
C43	021103	Capacitor, 50 V 0.01 $\mu$ F SMT
C44-C47	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C48,C49	020270	Capacitor, 27 pF SMT
C50,C51	020101	Capacitor, 50 V 100 pF SMT
C52,C53	021103	Capacitor, 50 V 0.01 $\mu$ F SMT
C54,C55	021102	Capacitor, 50 V 0.001 $\mu$ F SMT
C56,C57	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C58	021103	Capacitor, 50 V 0.01 $\mu$ F SMT
C59	021010	Capacitor, 16 V 1 $\mu$ F SMT
C60	021100	Capacitor, Tantalum 16 V 10 $\mu$ F SMT
C61	021103	Capacitor, 50 V 0.01 $\mu$ F SMT
D1-D3	031002	Diode, BAS16 SMT
D4	320433	Diode, Transorb 1N6373 6 Vdc
J1-J3	614027	Connector, 10-pin Bottom Entry
J4	620028	Header, 20-pin 0.025 Sq Female
J5	620027	Header, 34-pin 0.025 Sq Post
JU1-JU3		Not Used.
JU4	620025	Header, 4-pin Dual Male
L1	459032	Inductor, Assembly 3 turns
L2		Not Used.
L3	459032	Inductor, Assembly 3 turns
Q1-Q5	032004	Transistor, MMBT2222AL SMT
Q6		Not Used.
Q7	032004	Transistor, MMBT2222AL SMT
R1	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R2,R3	013222	Resistor, 1/8 W 5% 2.2 k $\Omega$ SMT
R4	013472	Resistor, 1/8 W 5% 4.7 k $\Omega$ SMT
R5	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R6	013223	Resistor, 1/8 W 5% 22 k $\Omega$ SMT
R7-R9	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R10	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R11	013473	Resistor, 1/8 W 5% 47 k $\Omega$ SMT
R12	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R13	013473	Resistor, 1/8 W 5% 47 k $\Omega$ SMT
R14	013124	Resistor, 1/8 W 5% 120 k $\Omega$ SMT
R15	013473	Resistor, 1/8 W 5% 47 k $\Omega$ SMT

TABLE 10-3.  
Parts List, Processor Module, M7, Continued.

R16	013472	Resistor, 1/8 W 5% 4.7 k $\Omega$ SMT
R17	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R18	013102	Resistor, 1/8 W 5% 1 k $\Omega$ SMT
R19	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R20,R21	013473	Resistor, 1/8 W 5% 47 k $\Omega$ SMT
R22	013470	Resistor, 1/8 W 5% 47 $\Omega$ SMT
R23	013391	Resistor, 1/8 W 5% 390 $\Omega$ SMT
R24-26	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R27	013223	Resistor, 1/8 W 5% 22 k $\Omega$ SMT
R28-31	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R32		Not Used.
R33,R34	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R35,R36	013513	Resistor, 1/8 W 5% 51 k $\Omega$ SMT
R37	013333	Resistor, 1/8 W 5% 33 k $\Omega$ SMT
R38	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R39,R40	017003	Resistor, Variable 10 k $\Omega$ SMT
R41	013684	Resistor, 1/8 W 5% 680 k $\Omega$ SMT
R42-R45	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R46,R47	013621	Resistor, 5% 620 $\Omega$ SMT
R48-R50	013104	Resistor, 1/8 W 5% 100 k $\Omega$ SMT
R51	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
R52,R53	013472	Resistor, 1/8 W 5% 4.7 k $\Omega$ SMT
R54-R57	013103	Resistor, 1/8 W 5% 10 k $\Omega$ SMT
RN1	018003	Resistor, Network 100 k $\Omega$ SMT
RN2	018002	Resistor, Network 10 k $\Omega$ SMT
U1	033080	IC, MC68302 SMT
U2-U3	330401	IC, M27C512
U4,U5	033078	IC, MS6264 SMT
U6	033032	IC, ADC0804FN SMT
U7	033046	IC, 74HC4051 Analog SMT
U8	033079	IC, MAX242 SMT
U9	033019	IC, MAX695CWE SMT
U10	033043	IC, 74HC5138 SMT
U11	033035	IC, 74HCT14 SMT
U12	033014	IC, MC14531BD SMT
U13	033013	IC, MC14528BD SMT
U14	033020	IC, 74HC4067D SMT
U15	033007	IC, 74HC595
U16	033077	IC, 74HCT32 SMT
U17	033076	IC, 74HCT04 SMT
U18	033030	IC, 93C46 SMT
U19	033024	IC, MC33079D SMT
U20		Not Used.
U21	033084	IC, 519405D4 SMT
Y1	361093	Crystal, 4.00 MHz MS49/HC495 Case
Y2	361081	Crystal, 3.579545 MHz

# CHAPTER 11

## DISPLAY MODULE, M8 - TECHNICAL DESCRIPTION

### 11-1 GENERAL DESCRIPTION

The display module contains the LCD (Liquid Crystal Display), the display driver, and the backlight generator. The display module also acts as a connection point to connect the processor module to the front-panel switches.

### 11-2 DISPLAY

The custom LCD display has eight, 14-segment alphanumeric characters as well as 12 custom ICONS. The display also has UP-DOWN and LEFT-RIGHT indicators for use with text messages. The display is driven by a PCF8576, a CMOS LCD Driver, which is capable of driving up to 40 segments with four backplanes. The display driver has an internal clock, with frequency determined by R1 and is set to approximately 189 kHz. The display driver is serially controlled by the microprocessor through the DISDATA and DISCLOCK lines, with the display contrast controlled through the CONTRAST line from the M1 module.

### 11-3 BACKLIGHT GENERATOR

The LCD is backlit by an electroluminescent display on the backplane. The signal to drive the backplane is generated from the internal clock signal of the display driver. This clock signal has a frequency of approximately 189 kHz, which is divided by 256 by U3, to give approximately 738 Hz, which is used to drive the backplane. The backplane is energized when the emitter of Q2 is grounded, which saturates the transistor. This is accomplished by the LITE signal from the microprocessor going high, which turns on Q1, which effectively grounds the emitter of Q2, or the FPLITE line from the front panel being grounded. Once Q2 is turned on, the square wave signal from U3 is applied to the step-up auto transformer T1. The output of T1 is approximately 150 V p-p, and is used to power the backlight. For safety reasons, do not switch on the back light when working on the display.

### 11-4 JUMPER SELECTION

The display module has three jumpers which are used to enable various options. The jumper LK1 is normally installed but must be removed when any other jumper is installed. When the radio is to be used with the Remote Tune Option (1099RT), LK1 must be removed and LK3 must be installed. When the radio is to be used with the Internal Battery Charger option (1099IBC), LK1 must be removed and LK2 must be installed. Refer to Chapter 13 for information on the various options.

### 11-5 MODULE INTERCONNECTIONS

The M8 module has the following interconnections with the transceiver.

#### Connector M8J1

- Pin 1 OPTSW. Connects to J4 Pin 1 only.
- Pin 2 LITE. Used to energize Q1, which turns on Q2, to enable the backlight.
- Pin 3 LSBSW. Connects to J4 Pin 2 only.
- Pin 4 +5V. 5 Vdc from the power supply.
- Pin 5 SLEW DN. Connects to J4 Pin 3 only.
- Pin 6 SLEW UP. Connects to J4 Pin 4 only.
- Pin 7 SQUELCH. Connects to J4 Pin 5 only.
- Pin 8 DIS DATA. Microprocessor data to the display driver.
- Pin 9 DIS CLOCK. Microprocessor clock to the display driver.
- Pin 10 +12V. 12 Vdc from the power supply.
- Pin 11 SPARE1. Connects to J4 Pin 6 only.
- Pin 12 SPARE3. No connection.
- Pin 13 SPARE2. Connects to J4 Pin 7 only.
- Pin 14 GROUND.
- Pin 15 CW KEY. Connects to J4 Pin 8 only.
- Pin 16 PTT. Connects to J4 Pin 9 only.
- Pin 17 CONTRAST. Input from the M1, sets the contrast of the LCD display.
- Pin 18 EXTSEL. Connects to J3 Pin 4 only.
- Pin 19 DIG DN. Connects to J3 Pin 5 only.
- Pin 20 TUNE INIT. Connects to J3 Pin 6 only.
- Pin 21 ANT SW. Connects to J3 Pin 7 only.
- Pin 22 CHSET/TUNE. Connects to J3 Pin 8, also used for the Remote Tune Option (1099RT).
- Pin 23 HANDSET. Connects to J3 Pin 9 only.
- Pin 24 ALC. Connects to J3 Pin 10 only.

Pin 25 DIG UP. Connects to J2 Pin 1 only.  
Pin 26 AMP PTT. Connects to J2 Pin 2 only.  
Pin 27 RS232TXD. Connects to J2 Pin 3 only.  
Pin 28 RS232RXD. Connects to J2 Pin 4 only.  
Pin 29 EXT AMP. Connects to J2 Pin 5 only.  
Pin 30 LOW POWER. Connects to J2 Pin 6 only.  
Pin 31 CHSWA. Connects to J2 Pin 7 only.  
Pin 32 CHSWB. Connects to J2 Pin 8 only.  
Pin 33 CHSWC. Connects to J2 Pin 9 only.  
Pin 34 CHSWD. Connects to J2 Pin 10 only.

Connector M8J2

Pin 1 DIG UP. Connects to J1 Pin 25 only.  
Pin 2 AMP PTT. Connects to J1 Pin 26 only.  
Pin 3 RS232TXD. Connects to J1 Pin 27 only.  
Pin 4 RS232RXD. Connects to J1 Pin 28 only.  
Pin 5 EXT AMP. Connects to J2 Pin 29 only.  
Pin 6 LOW POWER. Connects to J1 Pin 30 only.  
Pin 7 CHSWA. Connects to J1 Pin 31 only.  
Pin 8 CHSWB. Connects to J1 Pin 32 only.  
Pin 9 CHSWC. Connects to J1 pin 33 only.  
Pin 10 CHSWD. Connects to J1 Pin 34 only.

Connector M8J3

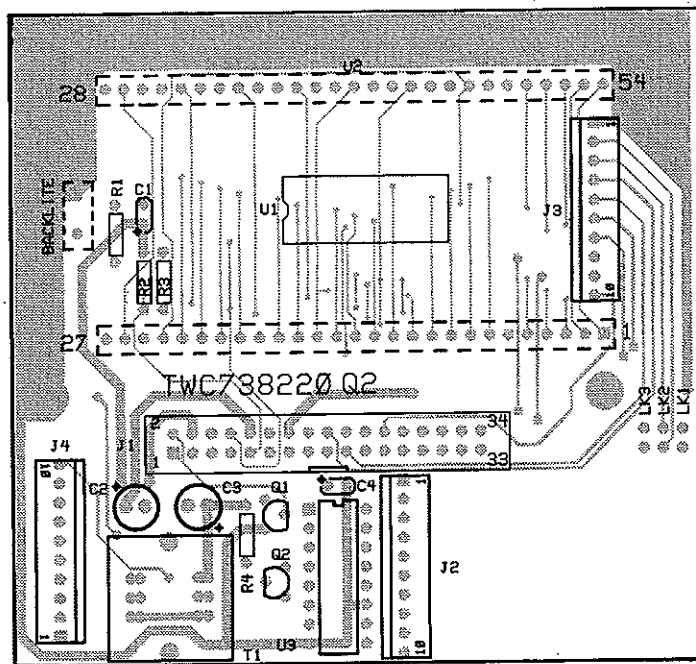
Pin 1 GROUND.

Pin 2 BC IN. Batter charger input, used to drive the internal battery charger option, when equipped.  
Pin 3 OPTION PIN. Output to the accessory connector, used for various options.  
Pin 4 EXT SEL. Connects to J1 Pin 18 only.  
Pin 5 DIG DN. Connects to J1 Pin 19 only.  
Pin 6 TUNE INIT. Connects to J1 Pin 20 only.  
Pin 7 ANT SW. Connects to J1 Pin 21 only.  
Pin 8 CHSET/TUNE. Connects to J1 pin 22, also used for the Remote tune option (1099RT).  
Pin 9 HANDSET. Connects to the outer-most audio connector, used for a remote handset.  
Pin 10 ALC. Connects to J1 pin 24 only.

Connector M8J4

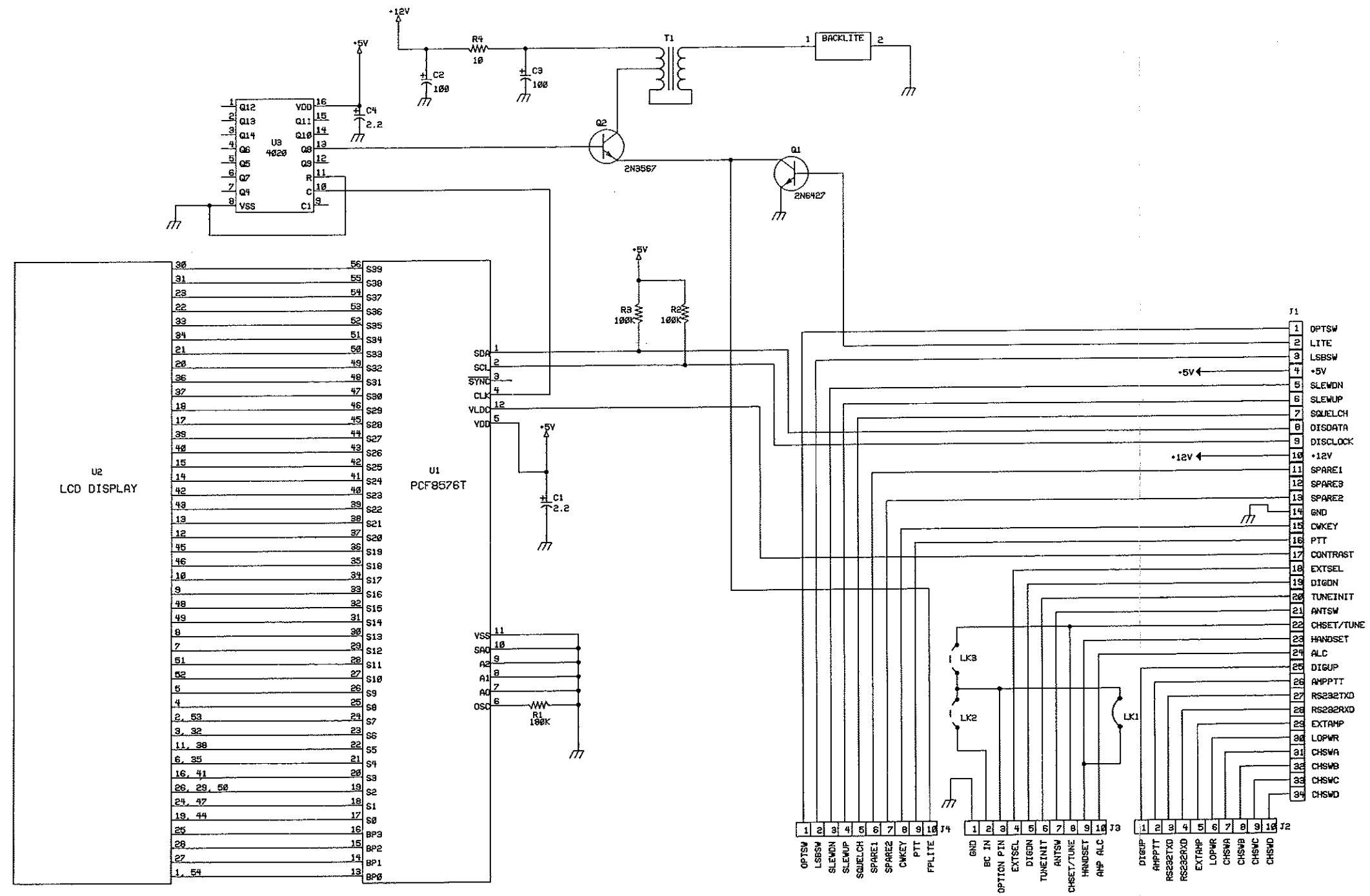
Pin 1 OPTSW. Connects to J1 Pin 1 only.  
Pin 2 LSBSW. Connects to J1 Pin 3 only.  
Pin 3 SLEW DN. Connects to J1 Pin 5 only.  
Pin 4 SLEW UP. Connects to J1 Pin 6 only.  
Pin 5 SQUELCH. Connects to J1 Pin 7 only.  
Pin 6 SPARE1. Connects to J1 Pin 11 only.  
Pin 7 SPARE2. Connects to J1 Pin 13 only.  
Pin 8 CW KEY. Connects to J1 Pin 15 only.  
Pin 9 PTT. Connects to J1 Pin 16 only.  
Pin 10 FPLITE. Input from the MODE switch, used to energize the backlight.

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**FIGURE 11-1.**  
**Component Locations, Display Module, M8.**





7 FOR REMOTE TUNE OPTION. REMOVE LK1 AND INSTALL LK3  
 6 FOR BC OPTION, REMOVE LK1 AND INSTALL LK2  
 5 LK1 NORMALLY INSTALLED  
 4 INDUCTANCE IS IN MICROHENRYS  
 3 DIODES ARE 1N4148  
 2 CAPACITANCE IS IN MICROFARADS  
 1 RESISTANCE IS IN OHMS

NOTES: UNLESS OTHERWISE SPECIFIED

FIGURE 11-2. Schematic Diagram, Display Module, M8.



**TABLE 11-1.  
Parts List, Display Module, M8.**

C1	241020	Capacitor, Tantalum, 2.2 $\mu$ F
C2,C3	237101	Capacitor, Electrolytic 16 V 100 $\mu$ F
C4	241020	Capacitor, Tantalum, 2.2 $\mu$ F
DS1	392001	Panel, Electro-luminescent
J1		Not Used.
J2-J4	610208	Connector, 10-pin Right Angle
Q1	310064	Transistor, Darlington 2N6427
Q2	310003	Transistor, NPN 2N3567
R1	113184	Resistor, 1/8 W 5% 180 $k\Omega$
R2,R3	113104	Resistor, Carbon Film 1/8 5% 100 $k\Omega$
R4	113100	Resistor, Carbon Film 1/8 W 5% 10 $\Omega$
T1	410019	Transformer, Mini 600CT-600CT
U1	033083	IC, PCF8576T
U2	320806	LCD, Custom PRC1099A
U3	330209	IC, MC14020BCP

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# CHAPTER 12

## JUNCTION BOARD, M9 - TECHNICAL DESCRIPTION

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### 12-1 GENERAL DESCRIPTION

The junction board is used to supply power to the radio and also acts as a junction point for module interconnects. The junction board has the 5-volt and 8-volt regulators as well as the clamps for the R8 and T8 lines.

### 12-2 5-VOLT SUPPLY

The +5-volt supply for the entire transceiver is located on the junction board. U1, a dc-to-dc switching voltage converter, is used to convert the +12-volt input voltage to the +5 volts that is required. A switching converter is used to minimize current drain, since this type of dc converter is much more efficient than a typical linear regulator. The +5V-volt supply is current limited by R1, with the maximum current limited to approximately 700 mA. The output of the converter is heavily filtered by L1, L4, C2 - C4, and C17 to reduce the voltage ripple of the converter to less than 20 mVp-p. The output of the converter is adjusted by R4 and measured at TP3. The remainder of the transceiver is protected against a catastrophic failure of U1 by PF1 and D3. Refer to Figure 12-1 for location of adjustments.

### 12-3 8-VOLT SUPPLY

A linear voltage regulator was selected because the transceiver draws very little current from the +8-volt supply. This regulator, U2, has internal thermal overload protection which allows the output to be short circuited without damaging the device. The output voltage is filtered by C6, C10, C13, and L5 to remove any residual ripple, while the +8 volts is adjusted by R5 and is measured at TP2.

### 12-4 DC CLAMPS

The R8 and T8 dc clamps are also located on the junction board. These clamps, Q1 and Q2, are alternately energized, by either R8 or T8, clamping the other to ground. In this manner, switching between T8 and R8 is accomplished immediately.

### 12-5 MODULE INTERCONNECTIONS

The M9 module has the following interconnections with the transceiver.

#### Connector M9J1

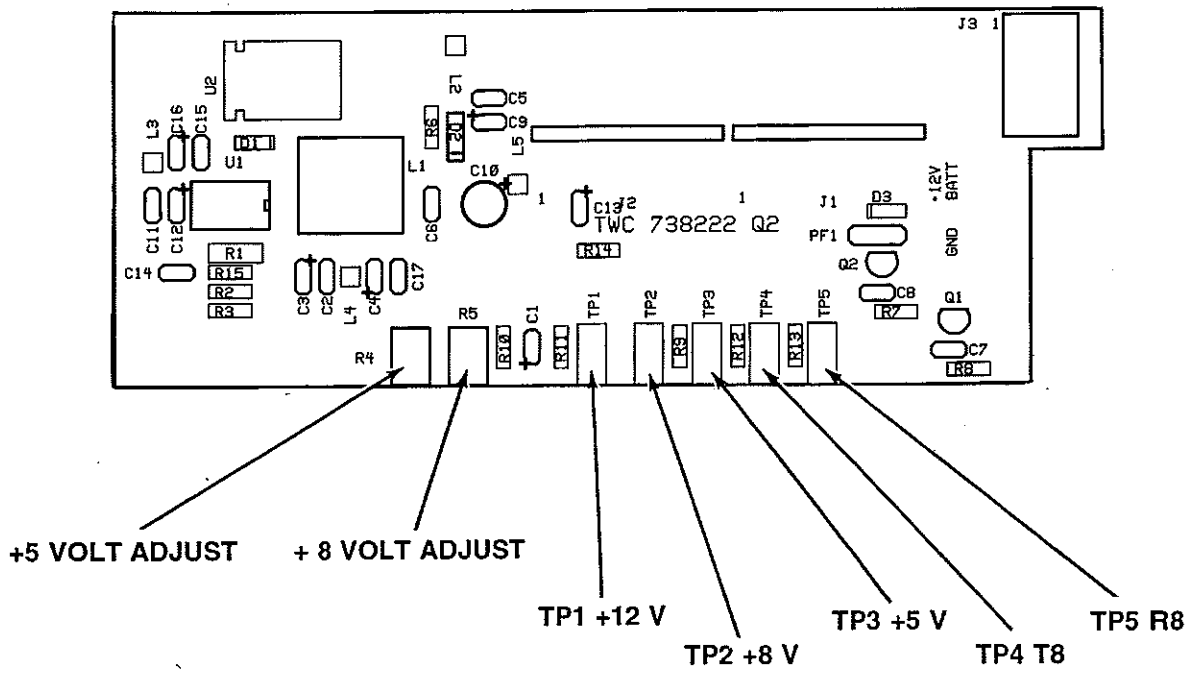
- Pins 1-2 BAT CHG OUT. Battery charger output, used to drive the internal battery charger option (1099IBC).
- Pins 3-4 BAT CHG IN. Input from the battery charger used to charge the battery (1099IBC only).
- Pins 5-7 AGC. Interconnections for the AGC line.
- Pins 8-12 T8. Interconnections for the T8 line.
- Pins 13-16 R8. Interconnections for the R8 line.
- Pin 17 +5V. 5 volt supply output.
- Pin 20 +5V. 5 volt supply output to synthesizer only.

#### Connector M9J2

- Pins 1-5 +8V. 8 volt supply output.
- Pins 6-12 +12V. 12 volt supply output.
- Pins 13-20 GROUND. Interconnections for ground.

#### Connector M9J3

- Pin 1 GROUND. Ground to the front panel.
- Pin 2 +12V SWITCHED. 12 volts from the power switch.
- Pin 3 +12V BATTERY. 12 volts to the power switch.
- Pin 4 BATTERY CHARGER. External signal, used to power the internal battery charger option (1099IBC).



**FIGURE 12-1.**  
**Signal Connections and Adjustment Points.**

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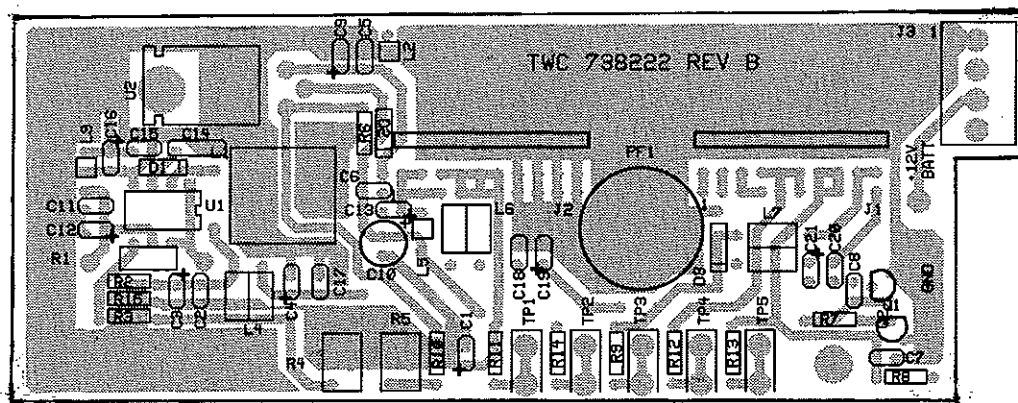
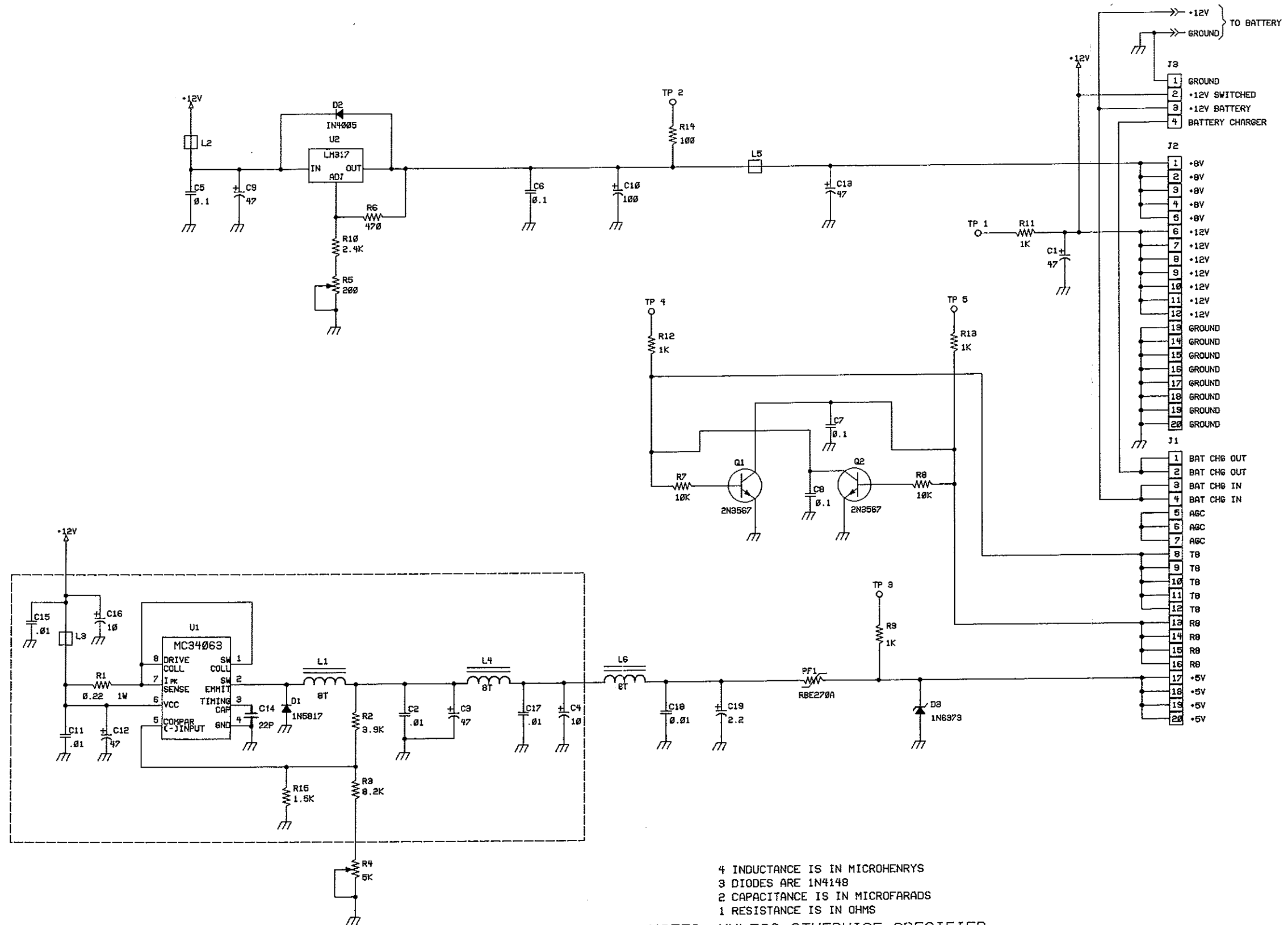


FIGURE 12-2.  
Component Locations, Junction Board, M9.





4 INDUCTANCE IS IN MICROHENRYS  
 3 DIODES ARE 1N4148  
 2 CAPACITANCE IS IN MICROFARADS  
 1 RESISTANCE IS IN OHMS  
 NOTES: UNLESS OTHERWISE SPECIFIED

FIGURE 12-3.  
 Schematic Diagram, Junction Board, M9.



**TABLE 12-1.**  
**Parts List, Junction Board, M9.**

C1	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C2	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C3	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C4	241100	Capacitor, Tantalum 10 $\mu$ F
C5-C8	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C9	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C10	237101	Capacitor, Electrolytic 16 V 100 $\mu$ F
C11	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C12,C13	241476	Capacitor, Tantalum 16 V 47 $\mu$ F
C14	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C15	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C16	241100	Capacitor, Tantalum 10 $\mu$ F
C17,C18	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C19	241020	Capacitor, Tantalum 2.2 $\mu$ F
C20	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C21	241020	Capacitor, Tantalum 2.2 $\mu$ F
D1	320429	Diode, 1N5817
D2	320101	Diode, 1N4005
D3	320433	Diode, Transorb 6 Vdc 1N6373
J1,J2	610280	Connector, 20-pin Right Angle
J3	610211	Connector, 4-pin Polarize
L1	459241	Inductor, Assembly 8 turns
L2,L3	459032	Inductor, Assembly 3 turns
L4	459263	Inductor, Assembly 8 turns
L5	459032	Inductor, Assembly 3 turns
L6,L7	459263	Inductor, Assembly 8 turns
PF1	550042	Fuse, Poly 1.4 Amps
Q1,Q2	310003	Transistor, NPN 2N3567
R1	144002	Resistor, Metal Film 1 W 0.22 $\Omega$
R2	113392	Resistor, Carbon Film 1/8 W 5% 3.9 k $\Omega$
R3	113562	Resistor, Carbon Film 1/8 W 5% 5.6 k $\Omega$
R4	170223	Resistor, Trimmer 5 k $\Omega$
R5	170327	Resistor, Trimmer Side Adjust 200 $\Omega$
R6	113471	Resistor, Carbon Film 1/8 W 5% 470 $\Omega$
R7,R8	113103	Resistor, Carbon Film 1/8 W 5% 10 k $\Omega$
R9	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R10	113242	Resistor, Carbon Film 1/8 W 5% 2.4 k $\Omega$
R11-R14	113102	Resistor, Carbon Film 1/8 W 5% 1 k $\Omega$
R15	113152	Resistor, Carbon Film 1/8 W 5% 1.5 k $\Omega$
U1	330191	IC, MC34063PI
U2	330340	IC, LM317T



# CHAPTER 13 CHASSIS/MAINFRAME

## 13-1 GENERAL

This chapter contains information on the mainframe components not covered elsewhere, as well as an overall wiring diagram of the transceiver. Figure 13-1 shows a top

view of the module locations; Figure 13-2 shows the bottom view. The mainframe schematic is depicted in Figure 13-3 and the parts are specified in Table 13-1.

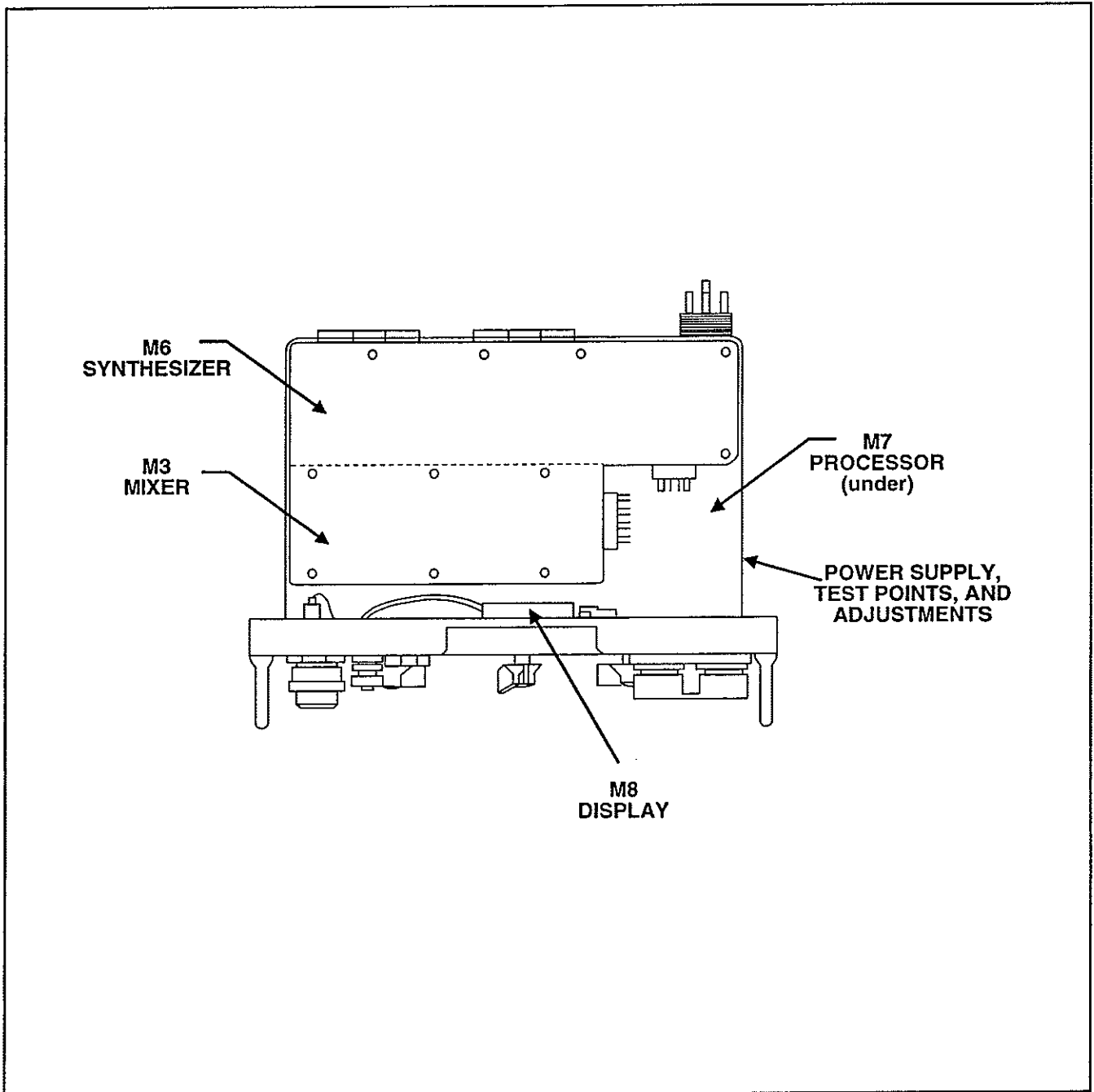
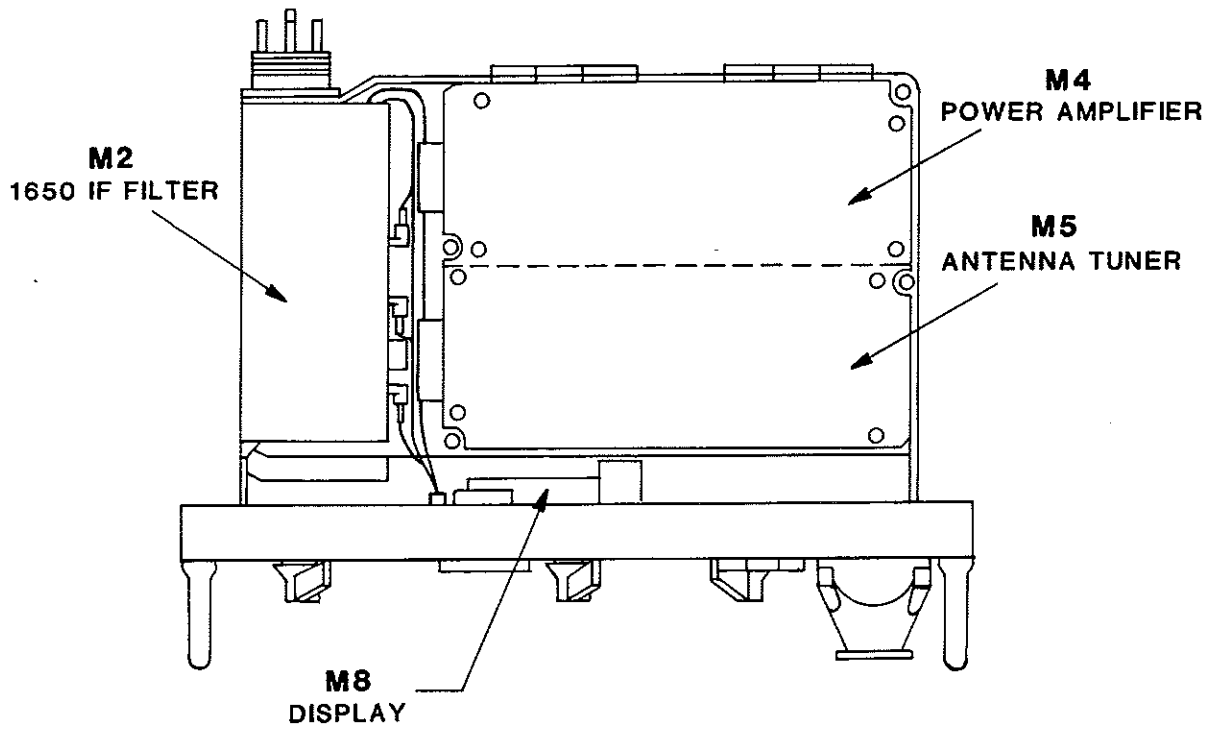


FIGURE 13-1  
Module Locations, Top View.



**FIGURE 13-2.**  
**Module Locations, Bottom View.**

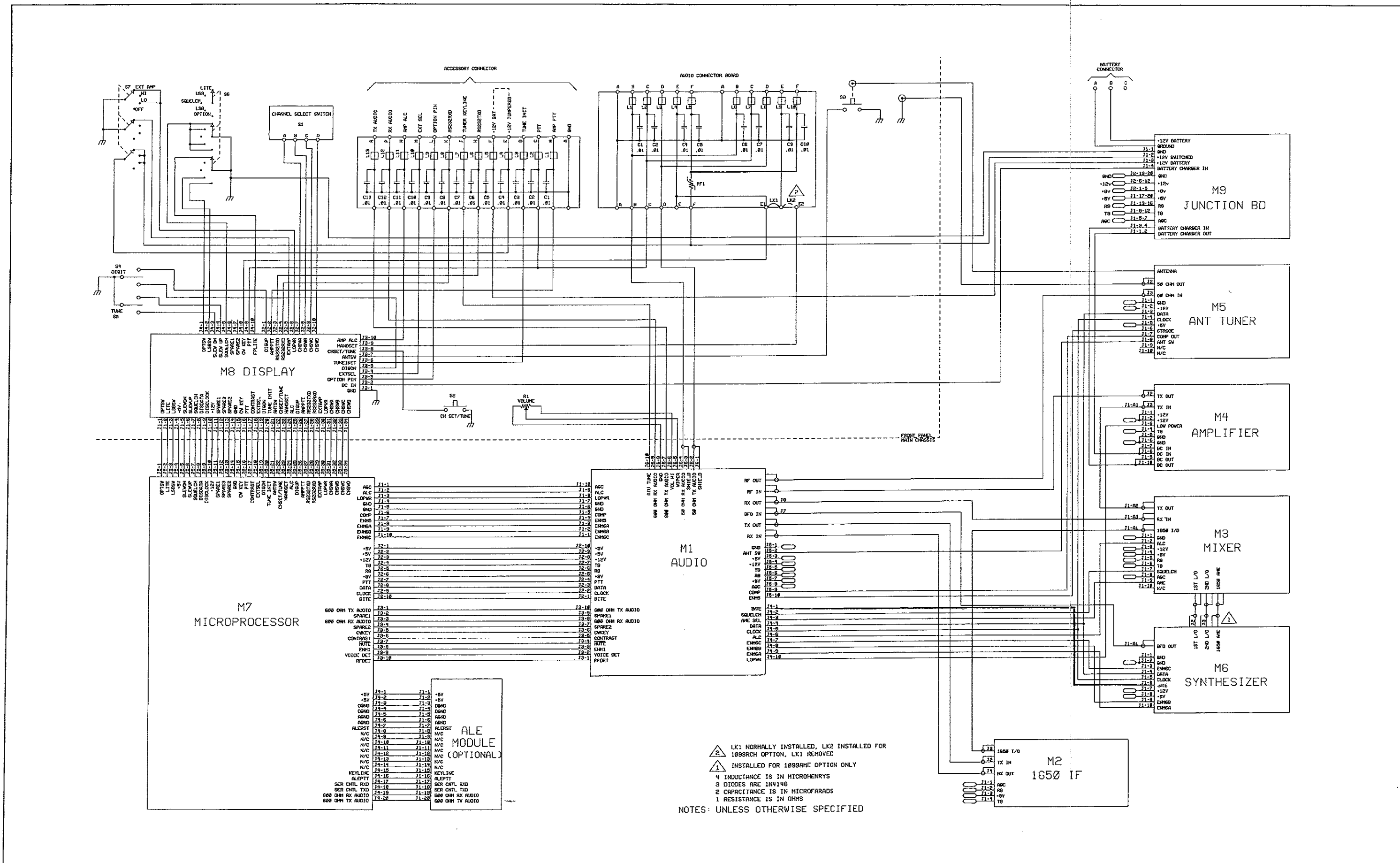


FIGURE 13-3. Schematic Diagram, Mainframe.



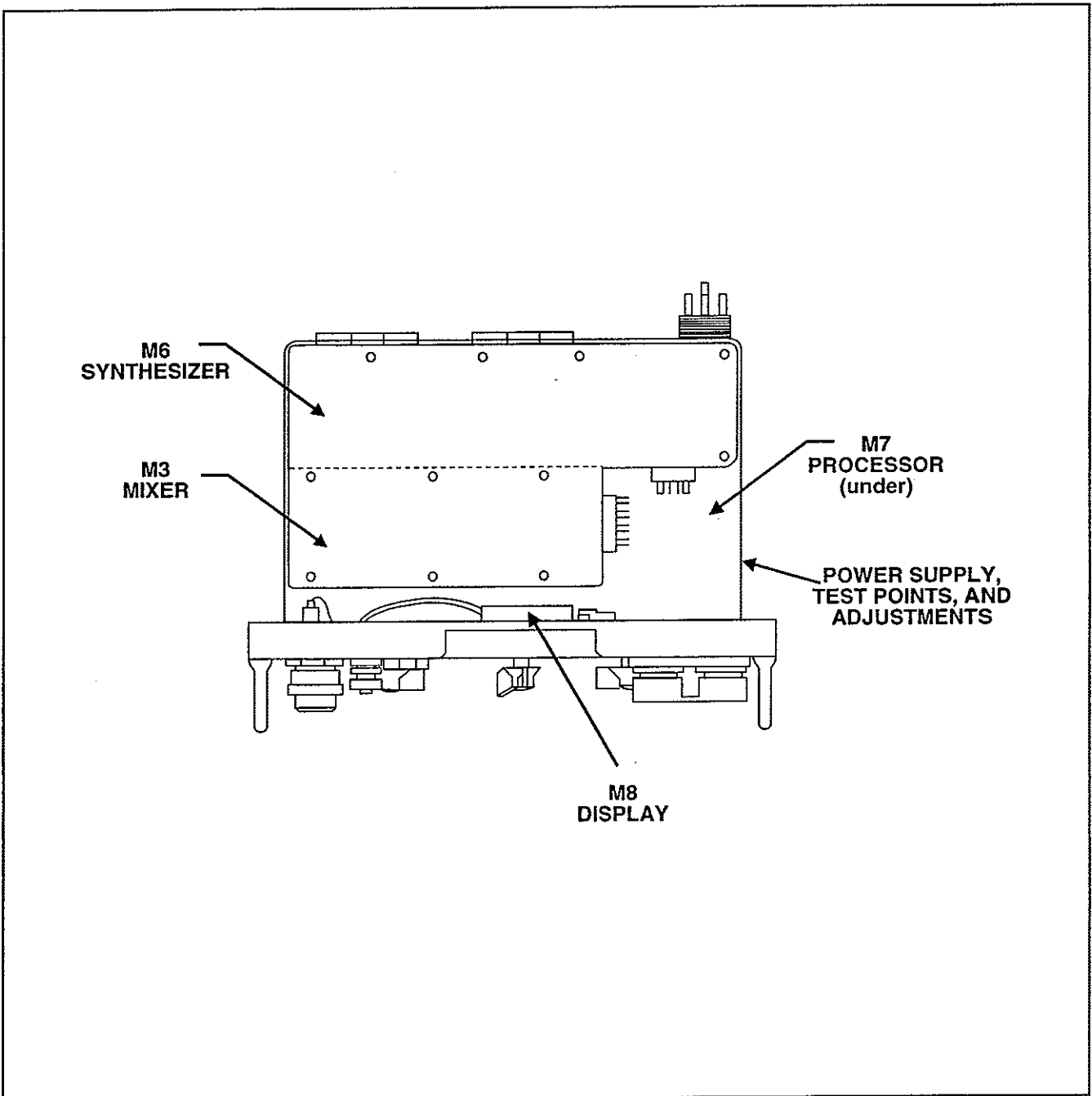


# CHAPTER 13 CHASSIS/MAINFRAME

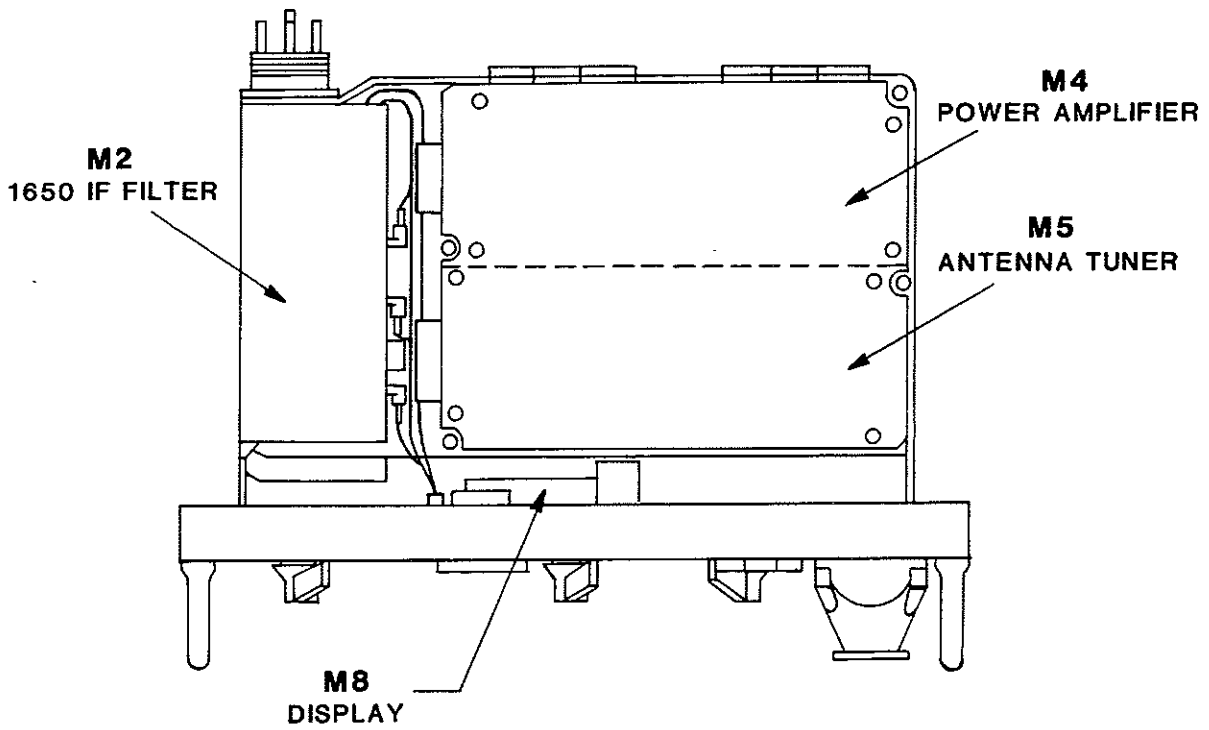
## 13-1 GENERAL

This chapter contains information on the mainframe components not covered elsewhere, as well as an overall wiring diagram of the transceiver. Figure 13-1 shows a top

view of the module locations; Figure 13-2 shows the bottom view. The mainframe schematic is depicted in Figure 13-3 and the parts are specified in Table 13-1.



**FIGURE 13-1**  
**Module Locations, Top View.**



**FIGURE 13-2.**  
**Module Locations, Bottom View.**

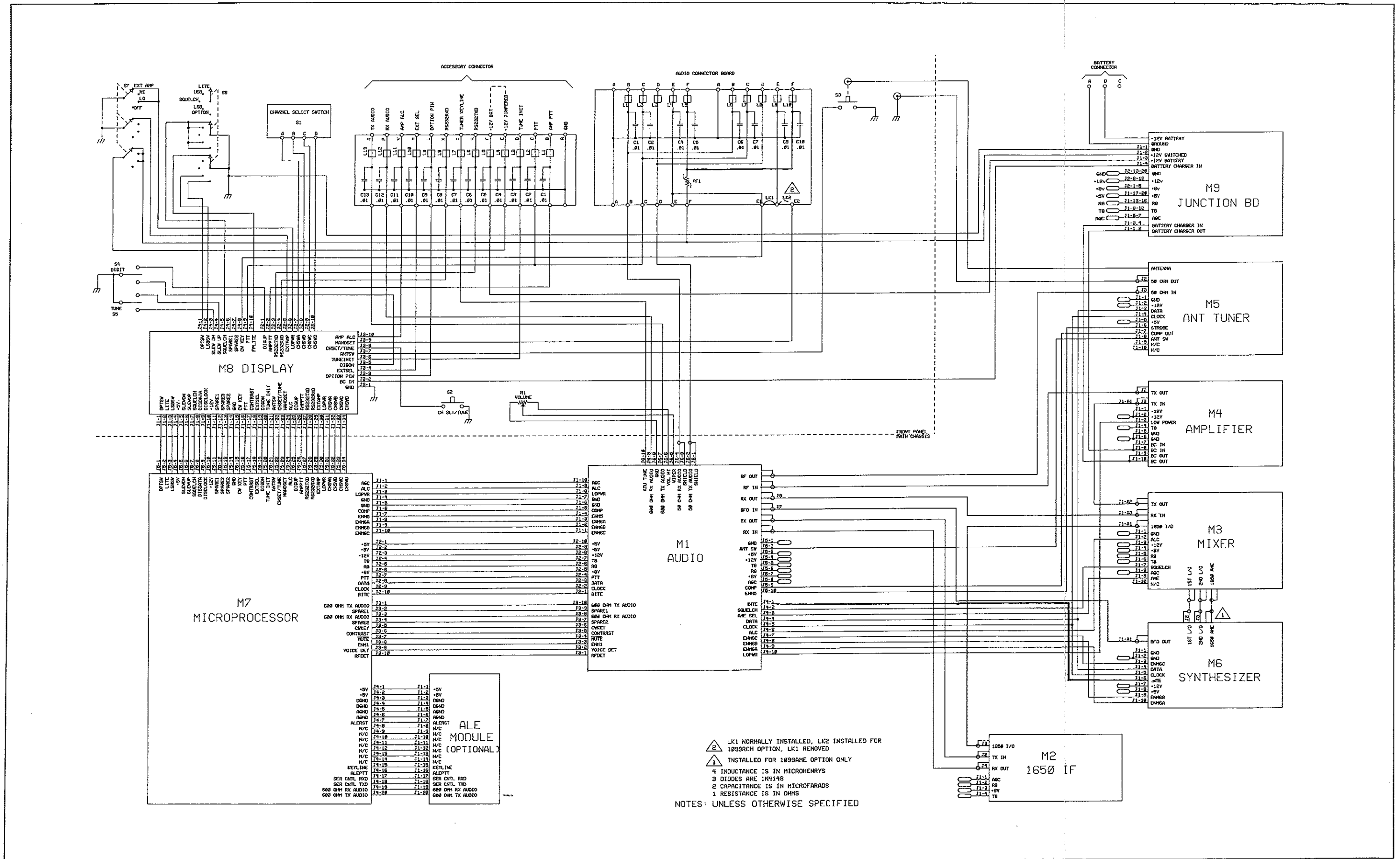
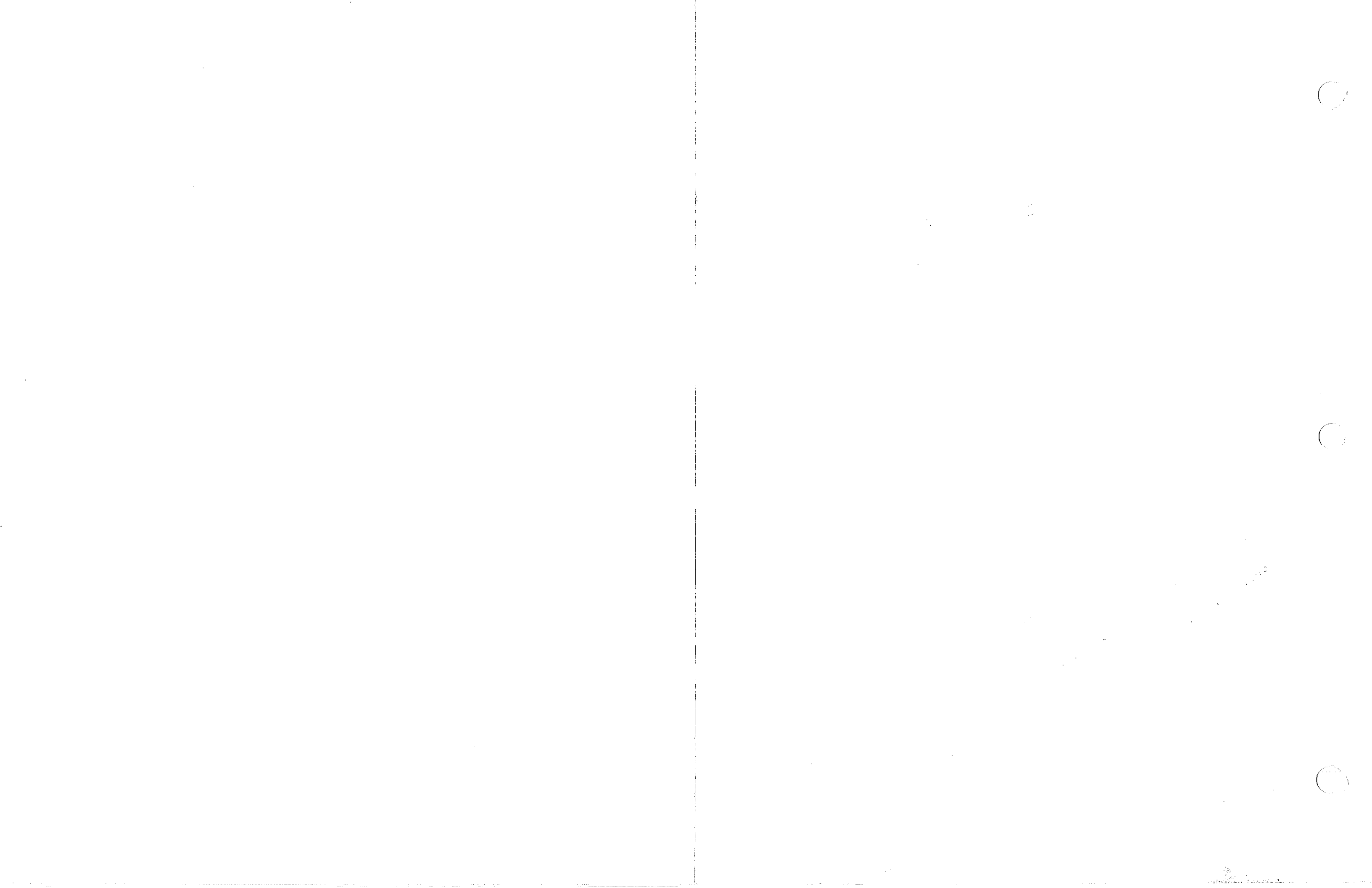


FIGURE 13-3. Schematic Diagram, Mainframe.



**TABLE 13-1.**  
**Parts List, Mainframe.**

**Filter Board**

C1-C13	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
L1-L13	490201	Bead, Ferrite

**Audio Connector Board**

C1,C2	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C3		Not Used.
C4-C7	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
C8		Not Used.
C9,C10	214103	Capacitor, Monolithic 50 V 0.01 $\mu$ F
L1-L10	459032	Inductor, Ferrite 3 turns
PF1	550042	Poly Fuse 1.4 Amps

**Front Panel**

R1	170015	Resistor, Potentiometer 10 $k\Omega$
SW1	510028	Switch, Channel Select
SW2	530025	Switch, Channel Set/Tune
SW3	532005	Switch, Whip Antenna
SW4	510029	Switch, Digit
SW5	510029	Switch, Tune
SW6	510061	Switch, Mode
SW7	510060	Switch, Power

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## CHAPTER 14 TRANSCEIVER INTERNAL OPTIONS

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### 14-0 INTRODUCTION

This section covers optional internal features that can be added to the transceiver at the customer's request. These optional features are listed below.

<u>SECTION</u>	<u>INTERNAL OPTION</u>	<u>DESIGNATION</u>
14-1	Amplitude Modulation Equivalent Option	1099AME
14-2	Remote Control Handset Option	1099RCH
14-3	Remote Tuning Option	1099RT
14-4	High Stability Option	1099HS
14-5	Internal Battery Charger	1099IBC
14-6	TransAdapt/Transcall Option	1099TA/TC
14-7	Automatic Link Establishment Option	1099ALE

## 14-1 AMPLITUDE MODULATION EQUIVALENT OPTION (1099AME)

### 14-1.1 GENERAL DESCRIPTION

The PRC1099A is a single-sideband transmitter and uses special circuitry to suppress the carrier and one sideband of a normal AM signal. Being a single-sideband transmitter, the standard PRC1099A is unable to communicate with normal AM radios. The 1099AME option (Amplitude Modulation Equivalent) allows the PRC1099A to communicate with both single-sideband as well as AM radios. For operation in AME mode, simply select OPT (option) with the mode selector switch.

### 14-1.2 CIRCUIT DESCRIPTION

Refer to Chapter 6 for information on the M3 mixer module. All the circuitry for carrier reinsertion for the 1099AME option is located on the M3 mixer module. The purpose of this circuitry is to inject a 1650-kHz signal from the BFO oscillator on the M6 synthesizer module directly into the transmit chain at the highest possible level. This is necessary as the carrier level should not be controlled by the ALC circuit, and it is not desirable to pass the carrier through the crystal filter. The carrier is applied to the input of the mixer U2 via the PIN diode attenuator D15/D14. When disabled through the AME line, D14 is forward biased, which shorts the carrier to ground, while D15 is reversed biased. When enabled, D15 is forward biased and D14 is reversed biased, so the carrier is not attenuated. The carrier level is adjusted by the input potentiometer R51.

## 14-2 REMOTE-CONTROL HANDSET OPTION (1099RCH)

### 14-2.1 GENERAL DESCRIPTION

The PRC1099A remote-control handset option, along with the special RCH handset, allows the operator to adjust the handset volume, PTT, RX, and TX audio, and change channels from the handset. When a transceiver is equipped with the 1099RCH option, the outer-most audio connector is configured to operate with the RCH handset. In addition, when a transceiver is equipped with the 1099RCH option, the transceiver channel can be controlled remotely through the accessory connector.

### 14-2.2 OPERATION

For proper operation of the remote-control handset, the transceiver's channel selector must be in the MAN position, and the remote control handset must be connected to the outer-most audio connector. This allows the remote-control handset to control the channel selection. To control the transceiver from the front panel, the channel selector on the remote-control handset must be placed in the "C" or the "I/C" position.

## 14-2.3 CIRCUIT DESCRIPTION

When the transceiver is equipped with the 1099RCH option, Pin L of the accessory connector, and Pin E of the outer-most audio connector are connected to an analog-to-digital converter on the M7, microprocessor module (refer to Chapter 10 for information on the microprocessor module). This analog-to-digital converter, M7U7, senses the voltage on the handset line and digitally feeds this information to the microprocessor chip M7U1, where the microprocessor determines what channel is selected. The voltage on the handset line is determined by the resistor ladder network inside the remote control handset in series with a 1-kilohm resistor connected to +8V. This resistor network will cause the voltage on the handset line to vary from 2.25 Vdc for Channel 1 to 6.25 Vdc for Channel 9, in .5-Vdc steps. In the intercom position, the handset line is at 8 Vdc.

## 14-3 REMOTE TUNE OPTION (1099RT)

### 14-3.1 GENERAL DESCRIPTION

The PRC1099A has the capability to be tuned to an antenna from a remote position. This option allows a user to initiate an antenna tuning sequence from the the internal antenna tuner, from a ancillary piece of equipment connected to the accessory connector.

### 14-3.2 OPERATION

To initiate the antenna tuning sequence with the option installed, apply a ground to Pin L of the accessory connector. This action simulates an operator pushing the WHIP/TUNE button on the front panel of the receiver.

## 14-4 HIGH-STABILITY OPTION (1099HS)

### 14-4.1 GENERAL DESCRIPTION

The standard frequency tolerance over temperature is  $\pm 1$  ppm from 0° to +50° C. The 1099HS option extends this temperature range to -30° to +60° C.

### 14-4.2 CIRCUIT DESCRIPTION

Refer to Chapter 9 for information on the synthesizer module, M6. Because the synthesizer module of the transceiver was specifically designed with frequency stability in mind, the local oscillator, as well as the BFO, are frequency locked to a single reference oscillator. This reference oscillator, located in the synthesizer module, is a TCXO (Temperature Controlled Crystal Oscillator), whose output frequency is guaranteed not to exceed 1 ppm over a temperature range of 0° to +50° C. For the 1099HS option, this reference oscillator TCXO is replaced with a reference oscillator TCXO, whose output frequency is guaranteed not to exceed 1 ppm over a temperature range of -30° to +60° C. Since all frequency determining elements are frequency locked to a single oscillator, the transceiver operating frequency can only vary as much as the reference oscillator frequency. With the 1099HS option installed, this variation is 1 ppm over a temperature range of -30° to +60° C.



## 14-5 INTERNAL BATTERY CHARGER OPTION (1099IBC)

### 14-5.1 GENERAL DESCRIPTION

The PRC1099A has an internal battery charger option (1099IBC) which can be used to charge the attached battery from an external power source. The battery charger is designed to take a 12- to 30-Vdc input and provides a constant current 400 mA output to charge the battery.

### 14-5.2 OPERATION

A wiring diagram showing the charger connections to the radio is given in Figure 14-1. The following steps must be followed to charge a battery.

1. The battery must be in the PRC1099A battery box and the box must be attached to the transceiver.
2. A 12- to 30-Vdc power source must be attached to the transceiver accessory connector.
3. The moment the external power source is connected, the timer circuit in the charger automatically resets and the charger is programmed to run for approximately 14 hours.
4. Removal of the external power source deactivates the charger.

### 14-5.3 CIRCUIT DESCRIPTION

Refer to the schematic in Figure 14-3. The charger is physically located inside the M4 module in the PRC1099A. To access the charger, the M4 top cover must be removed and turned over to expose the charger circuitry which is contained on a PC board mounted to the underside of the cover.

#### 14-5.3.1 CHARGER/TIMER

The charging time for the battery charger is controlled by U1, a long-range timer. This timer is reset whenever the 10-Vdc output of U2 is applied, which happens whenever an external power source is applied. Once reset, Pin 3 of U1 goes high, which enables the relay K1 and causes U1 to begin generating timing pulses with a period corresponding to the charge time of C4/C5 through R4. After 1024 of these timing pulses have been counted by U1, the output at U1 Pin 3 goes low, deenergizing K1. The timing pulse, multiplied by 1024, equals the charging time of the charger (approximately 14 hours).

#### 14-5.3.2 BUCK/BOOST REGULATOR

The buck/boost regulator, U3 is configured as a step-down dc-to-dc converter. In this configuration, U3 acts as a voltage sensor, whose output controls the resistance of the series-pass element, Q4. The voltage on the gate of Q4 is used to vary the transistor between saturation and cutoff, which keeps the output voltage at the desired level. Q5 and Q3 are used to clamp the output parallelly in much the same manner as Q4 did serially.

#### 14-5.3.3 CURRENT LIMITER

The current limiter consists of U4 and R16-18 and is a very simple circuit. As the current through the parallel resistors,

R16-18, increases, the voltage dropped by the resistors increases, which causes the adjustment voltage of U4 to decrease and reduces the output voltage of U4. If the current continues to increase, U4 will continue to decrease the output voltage until the voltage reaches 0.

## 14-6 TRANSADAPT/TRANSCALL OPTION (1099TA/TC)

### 14-6.1 GENERAL DESCRIPTION

#### 14-6.1.1 TRANSADAPT/TRANSCALL

Transadapt/Transcall are adaptive HF communications systems which provide automatic selective calling, automatic scanning, and selective calling. These systems are useful for automatically establishing communications and as an anti-jamming feature.

### 14-6.2 OPERATION

#### 14-6.2.1 ENABLING TRANSADAPT

To enable the PRC1099A TRANSADAPT option, select the OPTION icon using the DIGIT switch. Hold the TUNE switch up momentarily and the display will change to: "T/A SEL." Press the WHIP TUNE button and "T/A XXX" will be displayed. XXX will be either ON or OFF. Select ON with the TUNE switch, and the transadapt option is now energized. If the radio is also equipped with the 1099ALE (Automatic Link Establishment) option, only one of these options may be energized at a time. If one of the options is already energized, energizing the other option will automatically de-energize the first.

#### 14.6.2.2 RECEIVE STATION

When the transadapt option is installed and energized, the radio automatically responds to any correct acquisition calls that are received. To enable SCAN, select the SCAN icon and press the WHIP TUNE button. The display will indicate "SCAN SEL." Press the WHIP TUNE button again and the display will indicate "OFF" or "SCAN XXX," where XXX is 0-9. Select the number of channels to scan using the TUNE switch and SCAN is now energized. Once scan has been energized, enable it by switching the CHANNEL selector to position 9.

With the CHANNEL selector in channel 9, the radio automatically goes into a fast channel scan, called receive scan. In receive scan, the radio jumps from channel to channel listening for an acquisition call from a transmitting station that contains that receiver's Selcall code, or 000 for "Allcall." If no acquisition call containing the correct Selcall code or 000 is received after one second, the radio automatically jumps to the next channel.

The receiver Selcall code is entered through a sub-directory of the TA icon. To enter the Selcall code, select the TA icon with the DIGIT switch. Hold the TUNE switch up momentarily causing "RX ADD" to be displayed on the front panel. Push the WHIP TUNE button and the display will change to: "RXA: XXX", where XXX indicates the Selcall

code previously entered. To change this code, hold the TUNE switch up or down until the desired code is displayed. Push the WHIP TUNE button to select and return to previous sub-menu. Hold the DIGIT switch up or down momentarily to escape.

The radio has the ability to scan up to nine different groups of channels. To enter or alter these scan groups, select the TA icon with the DIGIT switch and hold the tune switch up momentarily to enter the sub menu. "RX ADD" will be displayed. Hold the TUNE switch down momentarily and the display will change to: "SG X," where X equals the scan group selected (1-9). To change the selected scan group, press the WHIP TUNE button. The group number can be changed with the TUNE switch. Select with the WHIP TUNE button. To modify the individual Scan groups, select the desired group. Turn the TUNE switch down and the display will indicate: "MOD TASG." Press the WHIP TUNE button and the display will indicate: "TASG#:\*XX," where # indicates which scan group (1-9), "\*" indicates that the channel number displayed has been selected to be part of that scan group, and XX indicates the channel number. Each scan group can have a maximum of nine channels in each.

#### 14-6.2.3 TRANSMITTER STATION

**Transmit Selcall Code Entry** To call a particular station, the transmitting station must know the Selcall code of the receiving station. This code must be entered so that it can be transmitted with the acquisition call. Therefore, the first step to initiate a call, is entering the Selcall code to be transmitted. To initiate a call and enter the Selcall code to be transmitted, select the CALL icon with the DIGIT switch and hold the TUNE switch UP momentarily. The Display will now indicate: "TO: XXX," where XXX indicates the code to be transmitted. This code can be changed with the TUNE switch and is selected with the WHIP TUNE button. When the code is selected with the WHIP TUNE button, the radio automatically begins to initiate a CALL.

**MODE 1** In mode 1 of TRANSADAPT (Selcall compatible), the transmitting station is stationary on any channel (other than 9, if scan is enabled), while the receive station is either stationary on the same channel as the transmit station, or in receive scan (channel 9, scan enabled). When a call is initiated from the transmitting station, the transmit call is timed to allow enough time for the receiver to scan through all nine channels, to ensure that the receiver and transmitter are on the same channel. If no reply is received, a slow error alarm will be heard in the handset, and the radio will automatically return to normal operation. If a reply from the transmitting station is received, a fast call alarm will be heard in the handset, and BOTH transceivers will display "CALL" on the front panel.

**MODE 2** In mode 2 of TRANSADAPT (Transcall Compatible), the transmitting station is in receive scan (Channel

9, scan enabled). When a call is initiated, the radio enters into an acquisition scan. In acquisition scan, the radio scans each channel selected in the scan group in order. The scan on each channel is timed to give time for the receiver to scan all nine channels while the transmitter is calling on one. If there is no acknowledgement after one complete acquisition scan cycle, a slow error alarm is heard in the handset and the radio automatically returns to receive scan. When the receive station responds, a fast call alarm is heard in the handset and both radios discontinue scanning and display "CALL" on the front panel. Both radios will resume scanning two minutes after the last transmission has been sent.

#### 14-6.3 CIRCUIT DESCRIPTION

The standard PRC1099A radio can easily be upgraded with the Transadapt/Transcall option, since nearly all the circuitry is already included. The only component that must be installed is the modem I.C. itself. The circuitry used for the Transadapt/Transcall option is described in the micro-processor section, Chapter 10.

### 14-7 AUTOMATIC LINK ESTABLISHMENT OPTION (1099ALE)

#### 14-7.1 GENERAL DESCRIPTION

The Automatic Link Establishment (ALE) module contains two microprocessors which work together to perform the handling of all the ALE functions. The first processor is the main processor and it is a standard 8-bit microprocessor that is used to process the ALE data into meaningful messages and call signs for the operator. The second processor is a high-speed Digital Signal Processor (DSP). It generates the transmit ALE tones and detects the incoming ALE tones for processing by the main processor. The two processors communicate through the dual-port ram module, which effectively lets them leave messages for each other to process.

#### 14.7.2 OPERATION

The ALE functions are all operator accessible through the front panel menu system. This system is accessed by sequencing the DIGIT UP/DOWN paddle until the ALE icon blinks and then using the TUNE UP/DOWN to sequence through the menus. To see what selections are available under a menu, push the WHIP TUNE button once. For example, to see the scan rates available under the "SCAN RAT" menu, just press the WHIP TUNE button once. The selection "SCAN 2" is on the display. Scroll through the available selections until the desired one is displayed. Press the WHIP TUNE button once and the "SAVED" message appears briefly. This indicates the selection was saved and the "SCAN RAT" menu appears. All menus used for the 1099ALE option are described below. Refer to Figure 14-5 for a menu flow chart. The numbers in parentheses after each section correspond to the numbers in the triangles on the menu flow chart.

#### **14.7.2.1 ALE SCAN RATE (1)**

This control sets the rate at which the radio will scan the selected channels. This can be set at two channels per second, five channels per second, and OFF, where the radio does not scan at all. This scan control is independent of the normal radio scan control located under the SCAN icon.

#### **14.7.2.2 ALE SCAN GROUP NUMBER (2)**

The ALE scan group number refers to a number given to a group of channels to be scanned. The radio has a capability of scanning up to ten different groups of channels. Use this control to select the desired scan group. Refer to section 14.7.2.9 to enter or modify the separate scan groups.

#### **14.7.2.3 ALE TUNE SELECT (3)**

To properly receive or transmit on a channel, the radio must be matched to the antenna at that channel. Use this control to instruct the radio to automatically tune every channel in a scan group. Do this prior to using each channel to ensure maximum performance. To activate the automatic tune, select the scan group to be used and press the WHIP TUNE button. The radio automatically does the rest.

#### **14.7.2.4 RECEIVE SELECT (4)**

Use the Receive Select control to disable the automatic transmission of a reply to a properly received ALE signal. This is useful for times when transmissions are not allowed. Select "RX ONLY" to prevent replies from being transmitted.

#### **14.7.2.5 SELF ADDRESS (5)**

The ALE self address for each radio can be up to 15 characters in length. Each radio can have a maximum of 20 different self addresses. Use this control to enter and modify all 20 different self addresses for the radio.

#### **14.7.2.6 OTHER ADDRESS (6)**

When a station initiates a call, the identity of the station to be called must be included within the ALE message that is sent. Use this control to enter all the addresses of other radios that messages will be sent to using up to 15 characters per address. The radio has a maximum capacity of 100 other addresses that can be retained in memory. Enter the the other address that is called most often first to minimize time searching through all 100 memory locations.

#### **14.7.2.7 NET ADDRESS (7)**

When a station initiates a call to a net, the identity of the net to be called must be included in the ALE message. The radio has a capacity of 20 net addresses that can be retained in memory, using a maximum of 15 characters in length per address.

#### **14.7.2.8 NET SELF (8)**

Use this control to enter the self address of this radio to be used in a net.

#### **14.7.2.9 NET OTHER (9)**

The Net Other control is used to enter the addresses of other stations to be used in the net.

#### **14.7.2.10 NET SIZE (10)**

Use this control to select the size of the net to be formed. The maximum size of a net is 65.534 seconds and refers to the length of time stations will remain at a channel to wait for replies.

#### **14.7.2.11 MODIFY ALE SCAN GROUP (11)**

Use this control to modify or create scan groups. Select the scan group to be modified or created with the "ALSG NUM" control explained in section 14.7.2.2. After the scan group has been selected, use this control to select/unselect the channels in the scan group. The maximum number of channels for each scan group is 100.

#### **14.7.2.12 SOUNDING SELECTION (12)**

Use this control to activate the ALE Sounding function. Sounding is used to periodically communicate over the air with another station and update the Link Quality Analysis information to ensure the stations are communicating on the best possible channel. Use this control to enable and disable Sounding.

#### **14.7.2.13 SOUNDING ADDRESS (13)**

Use this control to select the self address to be used when periodically communicating with other stations to maintain Link Quality Analysis information.

#### **14.7.2.14 SOUND LENGTH (14)**

When the sounding function is activated, the radio automatically transmits sounding bursts to be evaluated by the receiving station. Once evaluated, the receiving station responds with its own sounding burst. Use this control to set the length of the sounding burst to be transmitted.

#### **14.7.2.15 SOUND INTERVAL (15)**

Use this control to select the time interval between sounding transmissions. The interval is selectable in one minute increments between 1 minute and 24 hours. This interval is only valid for the channel selected. Each channel will have to be individually configured.

#### **14.7.2.16 CALL RETRY LIMIT (16)**

Use this control to enter the number of attempts to establish communications on each channel. The number of attempts selectable is 1 to 5.

#### **14.7.2.17 SELF TIMEOUT (17)**

When one station makes a call to another station, and the other station replies, both stations will remain linked for a predetermined length of time. Use this control to set the length of time this station will remain linked after INITIATING the call. Each increment is equal to 15 seconds of time.

#### **14.7.2.18 OTHER TIMEOUT (18)**

When another radio calls and is answered, both radios remain in a linked state for a predetermined length of time. Use this control to set the length of time the radios remain linked after they RECEIVE a call. Each increment is equal to 15 seconds.

#### 14.7.2.19 AUTOFILL (19)

Use the Autofill function to allow the radio to automatically enter and retain addresses of other radios it hears over the air but with which it has never made contact. This autofill function occurs automatically unless de-energized using this command.

#### 14.7.2.20 LQA EXCHANGE (20)

LQA refers to Link Quality Analysis, a numerical evaluation grade given to each channel after it has been used. Use this control to exchange LQA information with other stations.

#### 14.7.2.21 LQA DECAY RATE (21)

Radio frequency propagation through the atmosphere is changing constantly, therefore the Link Quality Analysis evaluation score for each channel changes. Use this control to select the time that each LQA score remains valid, unless it is updated. The time is selectable at either 1, 2, 4, or 8 hours. Selecting "NO" means the score remains valid indefinitely.

#### 14.7.2.22 BIT ERROR RATE THRESHOLD (22)

The Bit Error Rate Threshold is the amount of bit error that is allowed before a 8-bit word is rejected. Use this control to select the threshold (between 00 and 48).

#### 14.7.2.23 GOLAY THRESHOLD (23)

The Golay threshold is the amount of word encoding error that is allowed before a word is rejected. Use this control to select the threshold (between 0 and 4, with the default at 3).

#### 14.7.2.24 ERROR THRESHOLD (24)

Use this control to select the number of errors that are allowed before a word is rejected (between 0 and 4, with the default at 3).

#### 14.7.2.25 ALE MEMORY DUMP (25)

Use the ALE Memory Dump function to erase the memory of the ALE data. A partial memory dump is used to erase the LQA data and a full memory dump is used to erase all ALE data in the radio.

### 14-7.3 CIRCUIT DESCRIPTION

The ALE module contains the main processor and the DSP processor. A block diagram of the ALE module is shown in Figure 14-4. The module has the following block components:

#### ALE

1. Microprocessor
2. Reset Controller
3. Clock Oscillator
4. Buffers
5. EPROM Program Storage
6. RAM Memory Storage
7. Memory Backup Circuit
8. EEPROM Memory Storage
9. Dual-Port RAM
10. Control Logic

11. Digital Signal Processor (DSP)
12. Audio Interface
13. -5 Volt Generator
14. Audio Buffers

### 14-7.3.1 MICROPROCESSOR

The microprocessor U3 is combined with the input/output circuits to form a special purpose microcomputer. The theory of operation of the microprocessor is beyond the scope of this manual. Simply stated, the microprocessor controls the processing of the ALE data as it comes into it from the DSP. It also prepares the ALE data before it is sent to the DSP for transmission.

This microprocessor has the capability of addressing up to 64 kilobytes of EPROM memory and 64 kilobytes of static RAM for future program expansion. It also has one UART, two timers, 32 bi-directional input/output lines, and six external interrupt sources.

The microprocessor operates at a clock frequency of 11.0592 MHz and uses the external oscillator U2. The UART is used for communications with the main radio processor through the serial buffers.

The PORT 1 functions are used for miscellaneous control functions. P1.0 is used to select the communications mode for the external serial-control interface. This interface can be used for strictly processor control or control through an external dumb terminal. P1.1 is used to set the serial control interface baud rate of 9600 or 19200 baud. P1.2 is a keyline output drive for keying the PTT line of an external device. P1.3 is an input used to read the current status of the PTT line. P1.4 is used to provide the microprocessor watchdog output to the reset controller chip U1. P1.5 provides a control input into the DSP processor. P1.6 monitors the dual port RAM interrupt going to the DSP processor. P1.7 provides the DSP processor reset pulse for a controlled power-up of the DSP processor.

The PORT 3 functions are used for interrupt functions that have a high priority. P3.1 is the transmit driver pin for the serial-control interface. P3.2 is the receive pin for the serial-control interface. P3.3 is the interrupt from the dual port RAM which indicates the DSP has left data for it to process there and it must fetch it. P3.4 and P3.5 are external timing inputs from the DSP processor.

The ALE, PSEN, RD, WR, Address/Data lines AD0-AD7 and Data Lines A8-A15 are used for communications with the external EPROM, RAM, EEPROM, and DSP processor.

### 14-7.3.2 RESET CONTROLLER

The controller, U1, provides three functions. The first function is as a reset pulse generator that monitors the +5-volt line. It will generate a reset output to hold the microprocessor's reset line low whenever the +5-volt line is below 4.5 Vdc. On power-up, an internal monostable multivibrator holds the reset line low for 250 ms, which allows

the power supply to stabilize before generating the reset pulse. This also prevents repeated toggling of the reset line.

The second function is a debounced reset-input line that is used as an external pushbutton to reset the microprocessor. It is available on J1 pin 7.

The third function of U1 is as a microprocessor watchdog that requires the microprocessor to toggle STB input at least once every 500 ms. If the microprocessor fails to do so, then the reset controller will assume that it has had a lockup and will provide a reset pulse to start it again. This is a very rare occurrence but the ALE card is able to recover from it without any external help.

#### **14-7.3.3 CLOCK OSCILLATOR**

The clock oscillator, U2, provides the internal clock for the main microprocessor, U1. The clock oscillator, U12, is a high-stability oscillator used to provide the internal clock and timing for the DSP processor.

#### **14-7.3.4 BUFFERS**

The inverter/buffer chip, U22, provides protection for the main processor from the outside world. The outputs U22D and U22C buffer the serial control interface. The outputs U22E and U22F buffer the PTT input and output.

#### **14-7.3.5 EPROM PROGRAM STORAGE**

The EPROM chip U4 stores the main software operating program for the ALE card. The DSP EPROM chips U18 and U19 store the high speed DSP software. EPROM storage was chosen for its speed, ease of reprogrammability, high reliability factor, and low current consumption.

#### **14-7.3.6 RAM PROGRAM STORAGE**

The RAM chip, U5, stores all the current operating data. The DSP RAM chips U14 and U15 execute the high speed DSP software. RAM storage was chosen for its speed, high reliability factor, and low current consumption.

#### **14-7.3.7 MEMORY BACKUP**

Capacitor C10 provides memory backup to the RAM chip, U5. This capacitor is designed to provide only a limited retention period (a few days) on the RAM memory.

#### **14-7.3.8 EEPROM PROGRAM STORAGE**

The EEPROM chips, U6 and U7, provide storage to long term operating data and parameters. EEPROM storage was chosen for its non-volatile memory characteristics.

#### **14-7.3.9 DUAL-PORT RAM**

The dual-port RAM (DPRAM) chip, U9, provides an easy interface between the main microprocessor and the DSP processor. Each time the DSP processor receives some ALE data, it stores it in the DPRAM. The DPRAM then sends an interrupt to the main microprocessor to tell it there is data waiting for it. The main processor then retrieves and processes the received data. Conversely, when the

microprocessor wants to transmit, it stores the data in the DPRAM. The DPRAM then sends an interrupt to the DSP processor. The DSP processor then retrieves the data and transmits it.

#### **14-7.3.10 CONTROL LOGIC**

The PAL chip, U20, is a programmable logic-array chip which contains all the interface logic between the main microprocessor and its memories, and the DSP processor and its memories. It also provides the control interface between the main and DSP processors.

The bus multiplex, chip U21, multiplexes the address and data lines coming from the main microprocessor. The address is first presented to the lower address bus and then is latched with the ALE signal from the main microprocessor. The bus is then able to read or write data on AD0-AD8.

#### **14-7.3.11 DIGITAL SIGNAL PROCESSOR (DSP)**

The Digital Signal Processor (DSP), U13, is a very special purpose microprocessor that is optimized for very fast math functions. The theory of operation of the DSP processor is beyond the scope of this manual. The digital processing enables the DSP processor to distinguish ALE tones from normal background noise in very noisy environments. It also generates transmit tone with superb quality so that the likelihood of detecting it at the receiving end is enhanced.

The DSP processor operates at a clock frequency of 20.736 MHz. It is a very high-stability oscillator that is necessary for precise ALE tone generation and decoding.

The DSP processor interfaces to U11, the analog interface chip, which processes all the incoming received audio and digitizes it for the DSP processor. It also generates the ALE transmit tones from the digital data that the DSP processor sends. The DS, PS, IS, STAB, and RW are used in conjunction with U20 to provide the switching logic for the external EPROM, RAM, and DPRAM chips. The address lines A0-A15 and D0-D15 are used for communications with the external EPROM, RAM, and DPRAM chips.

#### **14-7.3.12 AUDIO INTERFACE**

The audio interface chip, U11, is responsible for the decoding and generation of the ALE tones. The chip is divided into two parts, the receive and the transmit circuitry. The receive circuits consist of a 14-bit analog-to-digital converter (ADC) that breaks down the incoming signal into a digital sequence which is then sent to the DSP processor. The transmitting circuits use a 14-bit digital-to-analog converter (DAC) to convert the incoming digital sequence from the DSP processor into a precise transmit audio tone.

#### **14-7.3.13 -5 VOLT GENERATOR**

The -5-volt generator, U10, generates the -5 Vdc needed by the audio interface chip, U11. It uses a monolithic charge-pump inverter that converts the +5-Vdc input to -5 Vdc. This uses the capacitors C3 and C4 at 45 kHz to generate the necessary voltage and current.

#### 14-7.3.14 AUDIO BUFFERS

The audio buffer chip, U17, is used to provide buffering of the receive audio input and transmit audio output. It also allows adjustment of the input and output levels by adjusting R10 and R11. Refer to Figure 14-1 for location of adjustment points.

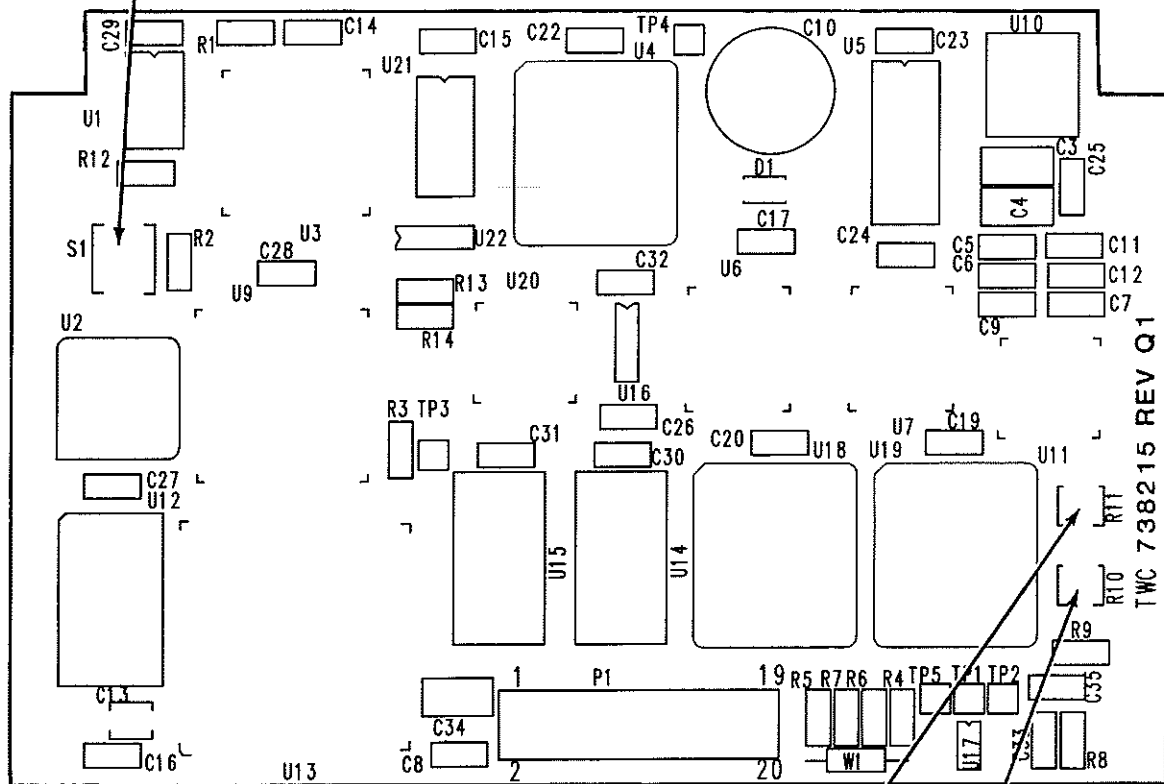
#### 14-7.3.15 MODULE INTERCONNECTIONS

The ALE module has the following interconnects with the transceiver:

#### Connector J1

Pin 1,2 5 Vdc from power supply.  
Pin 3,4 Digital grounds.  
Pin 5,6 Analog grounds.  
Pin 7-14 No connections.  
Pin 15 KEYLINE - ALE ptt input.  
Pin 16 ALEPTT - ALE ptt output.  
Pin 17 SC RXD - ALE serial data receive.  
Pin 18 SC TXD - ALE serial data transmit.  
Pin 19 ALERXA - ALE receive audio.  
Pin 20 ALETXA - ALE transmit audio.

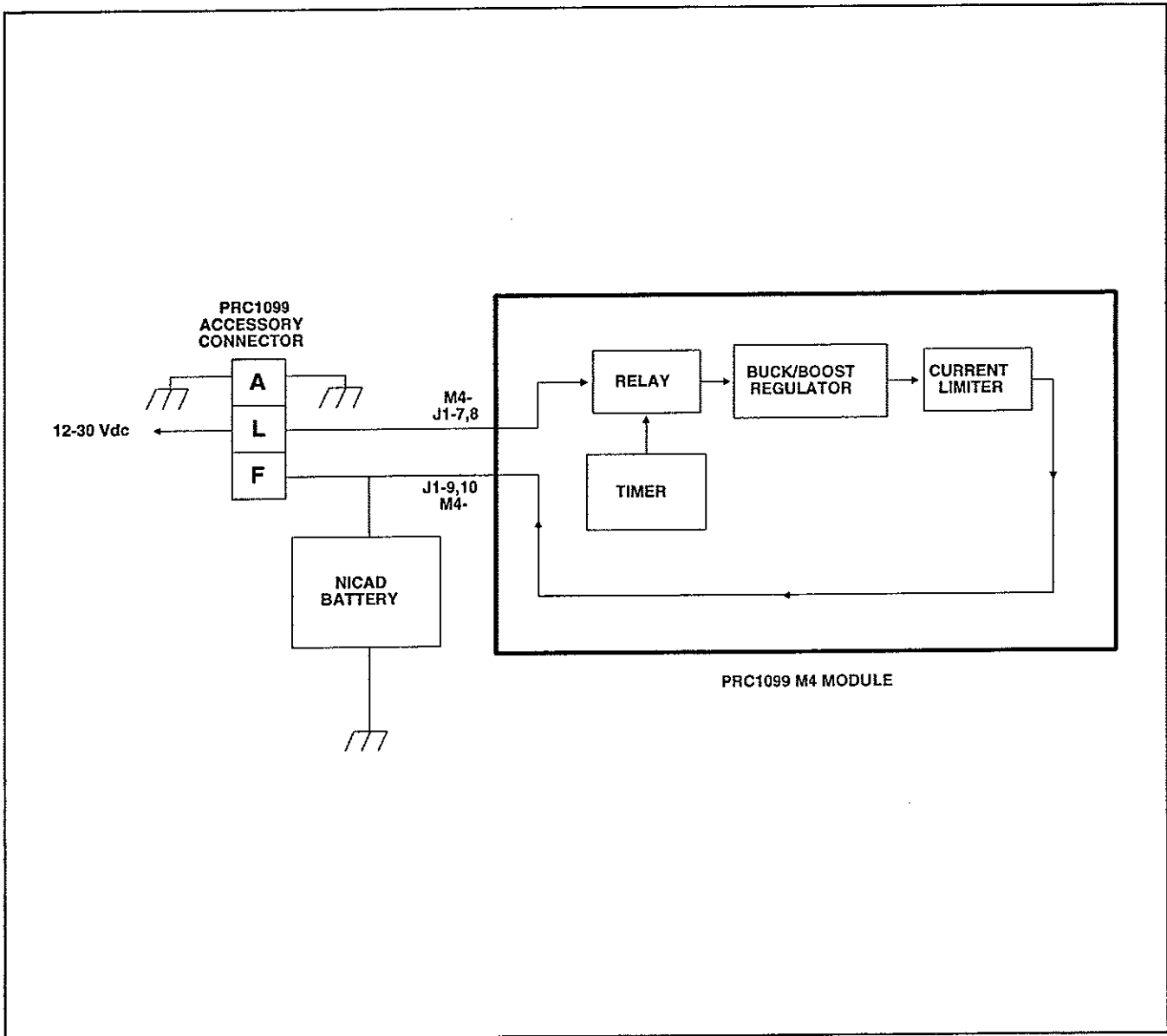
**S1-1 SELECTS NORMAL MODE (ON)  
FOR USE WITH TERMINAL (OFF)**  
**S1-2 SELECTS 9600 BAUD (ON)  
19200 BAUD (OFF)**



**(R10) TRANSMIT  
LEVEL ADJUST**

**(R11) RECEIVE  
LEVEL ADJUST**

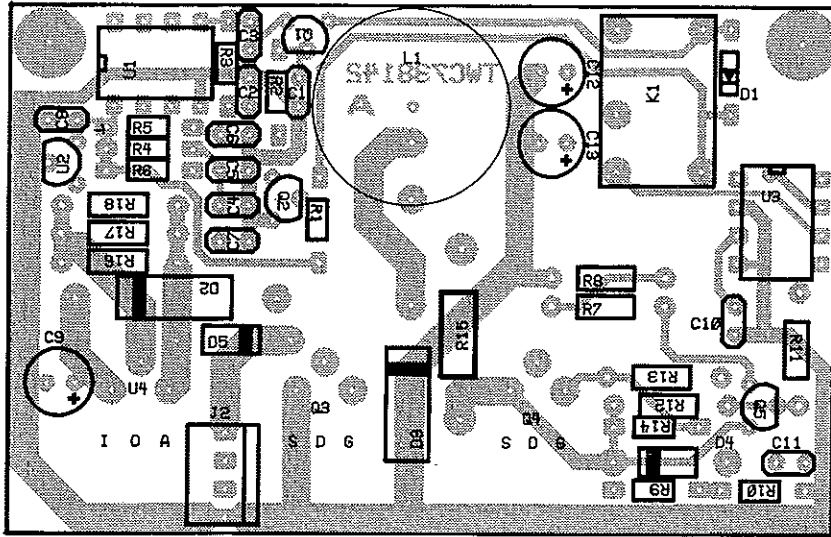
**FIGURE 14-1**  
**Signal Connections and Adjustment Points, ALE Option.**



**FIGURE 14-2**  
Wiring Diagram, Internal Battery Charger Option.



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**FIGURE 14-3**  
**Component Locations, Internal Battery Charger Option.**

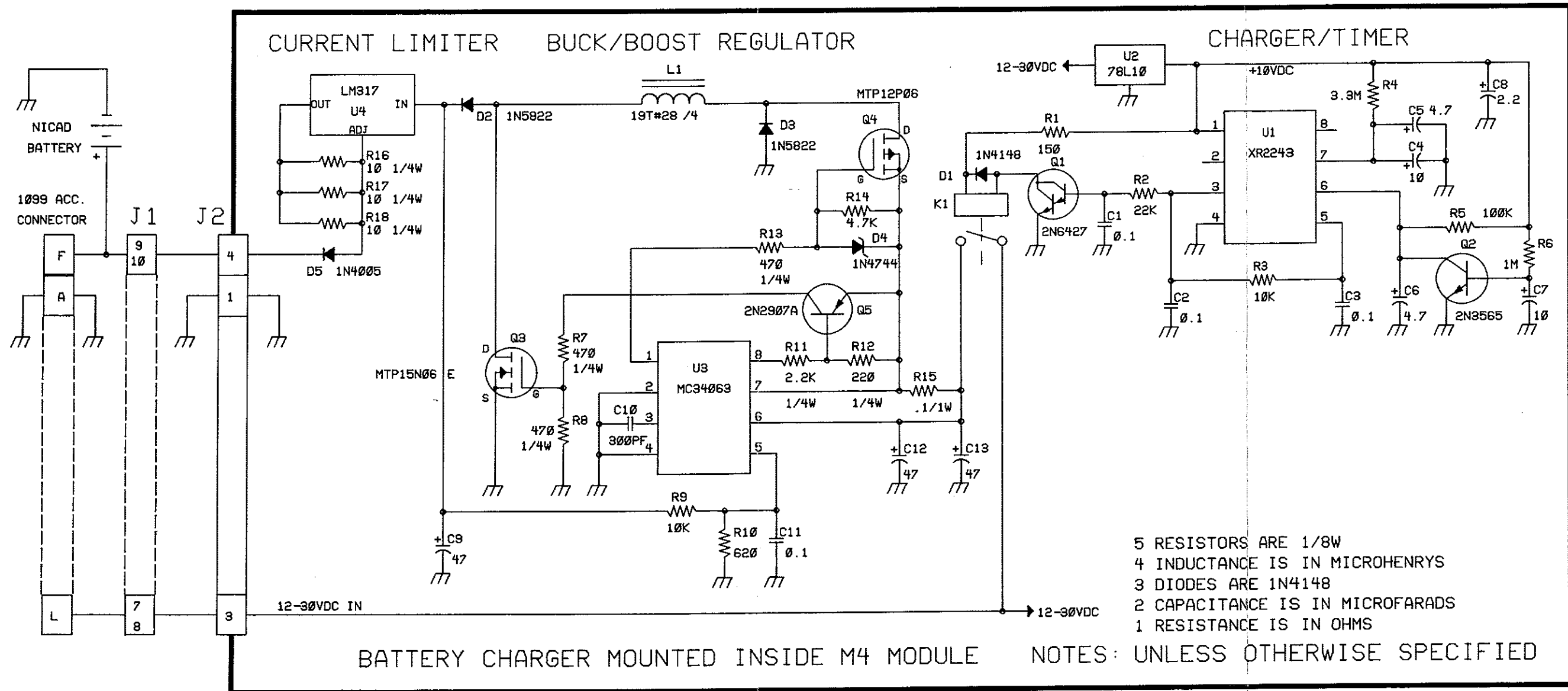
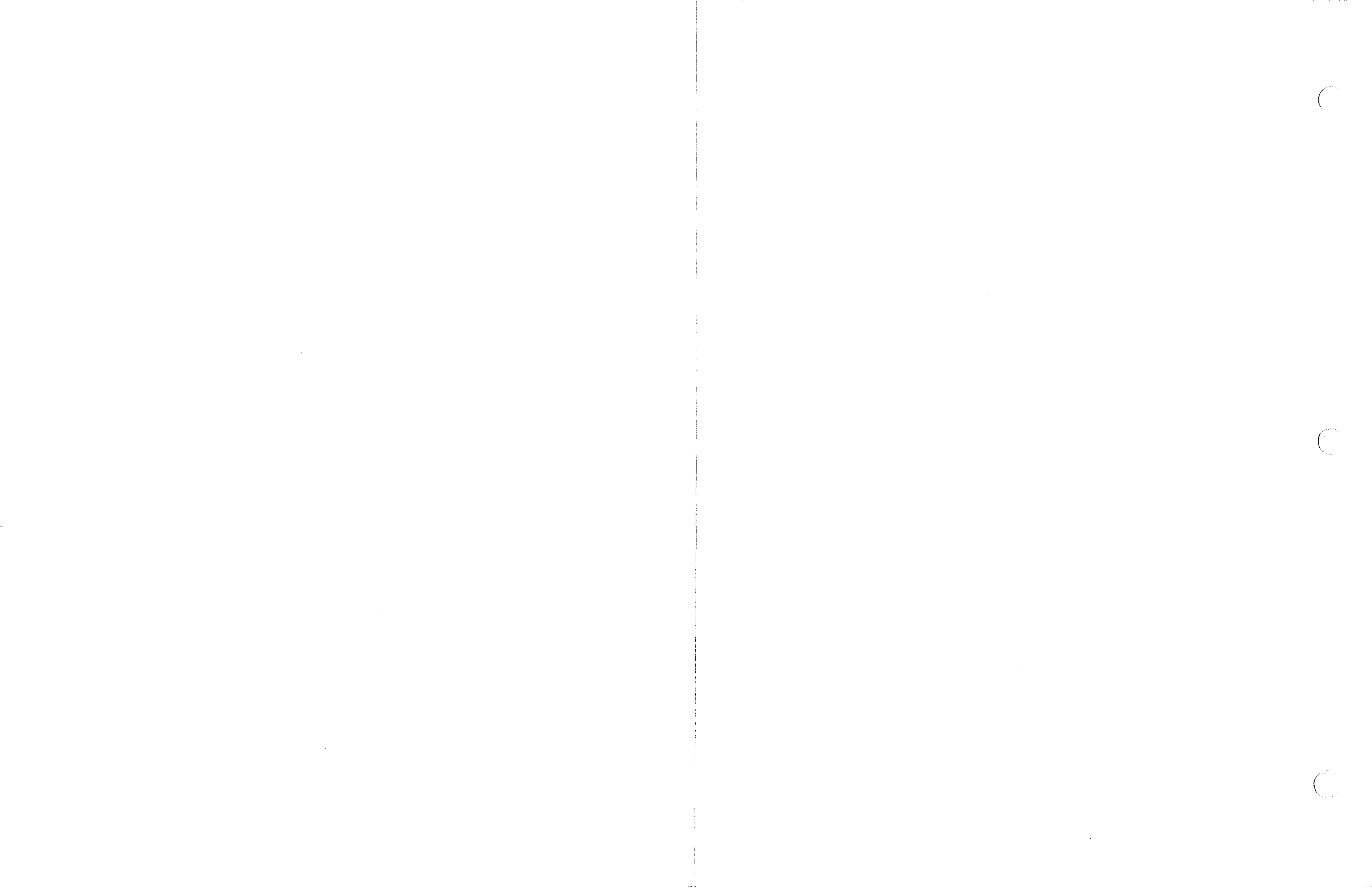
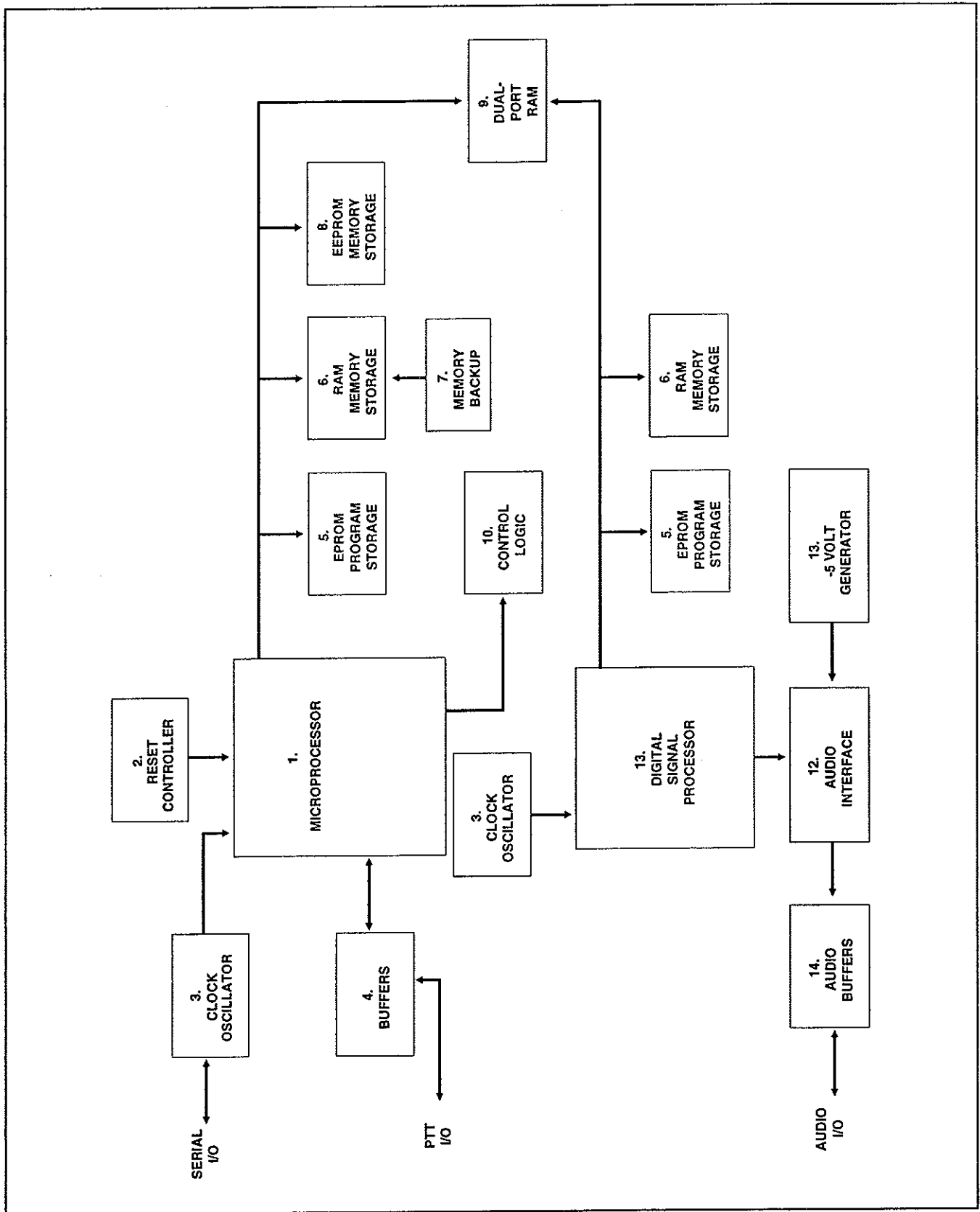


FIGURE 14-4  
Schematic Diagram, Internal Battery Charger Option.



**TABLE 14-1**  
**Parts List, Internal Battery Charger Option.**

C1-C3	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C4	241100	Capacitor, Tantalum 10 $\mu$ F
C5,C6	241040	Capacitor, Tantalum 35 V 4.7 $\mu$ F
C7	241100	Capacitor, Tantalum 10 $\mu$ F
C8	241020	Capacitor, Tantalum 2.2 $\mu$ F
C9	234470	Capacitor, Electrolytic 35 V 47 $\mu$ F
C10	221301	Capacitor, Mica 300 pF
C11	275104	Capacitor, Monolithic 50 V 0.1 $\mu$ F
C12,C13	234470	Capacitor, Electrolytic 35 V 47 $\mu$ F
D1	320002	Diode, 1N4148
D2,D3	320420	Diode, Schottky 1N5822
D4	320205	Diode, Zener 1N4744
D5	320101	Diode, 1N4005
K1	540060	Relay, SPDT 9 Vdc
L1	459158	Inductor, Toroid 19 turns
Q1	310064	Transistor, NPN Darlington 2N6427
Q2	310006	Transistor, NPN 2N3565
Q3	310127	Transistor, NCH MTP15N06E
Q4	310128	Transistor, PCH MTP12P06
Q5	310052	Transistor, PNP PN2907A
R1	113151	Resistor, Film 1/8 W 5% 150 $\Omega$
R2	113223	Resistor, Film 1/8 W 5% 22 k $\Omega$
R3	113103	Resistor, Film 1/8 W 5% 10 k $\Omega$
R4	113335	Resistor, Film 1/8 W 5% 3.3 M $\Omega$
R5	113104	Resistor, Film 1/8 W 5% 100 k $\Omega$
R6	113105	Resistor, Film 1/8 W 5% 1 M $\Omega$
R7,R8	124471	Resistor, Film 1/4 W 5% 470 $\Omega$
R9	113103	Resistor, Film 1/8 W 5% 10 k $\Omega$
R10	113621	Resistor, Film 1/8 W 5% 620 $\Omega$
R11	124222	Resistor, Film 1/4 W 5% 2.2 k $\Omega$
R12	113221	Resistor, Film 1/8 W 5% 220 $\Omega$
R14	113472	Resistor, Film 1/8 W 5% 4.7 k $\Omega$
R15	144001	Resistor, Film 1 W 5% 0.1 $\Omega$
R16-R18	124100	Resistor, Film 1/4 W 5% 10 $\Omega$
U1	330347	IC, XR2243
U2	330300	IC, UA78L10CLP
U3	330191	IC, MC34063PI
U4	330340	IC, LM317T



**FIGURE 14-5**  
**Block Diagram, ALE Module.**

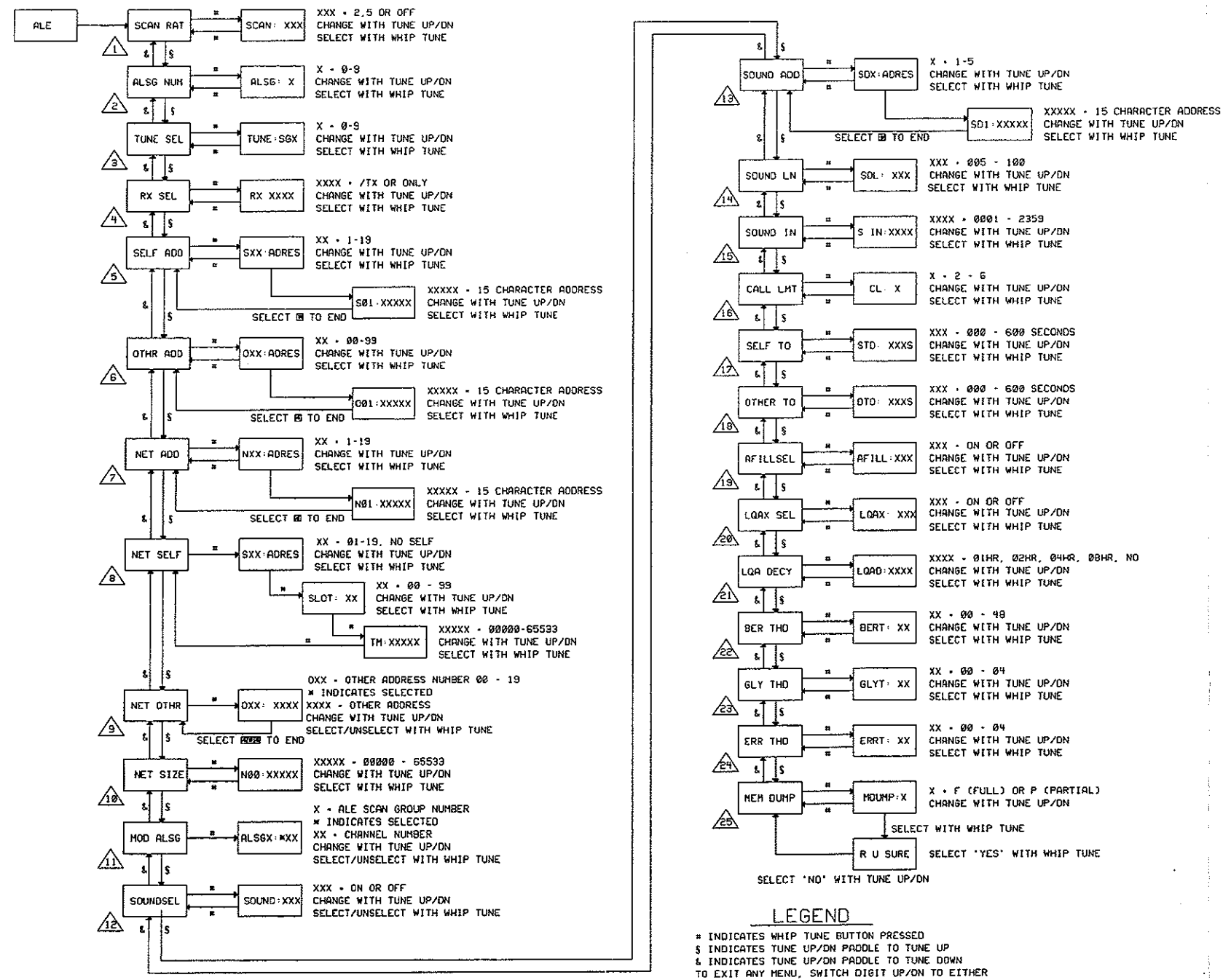
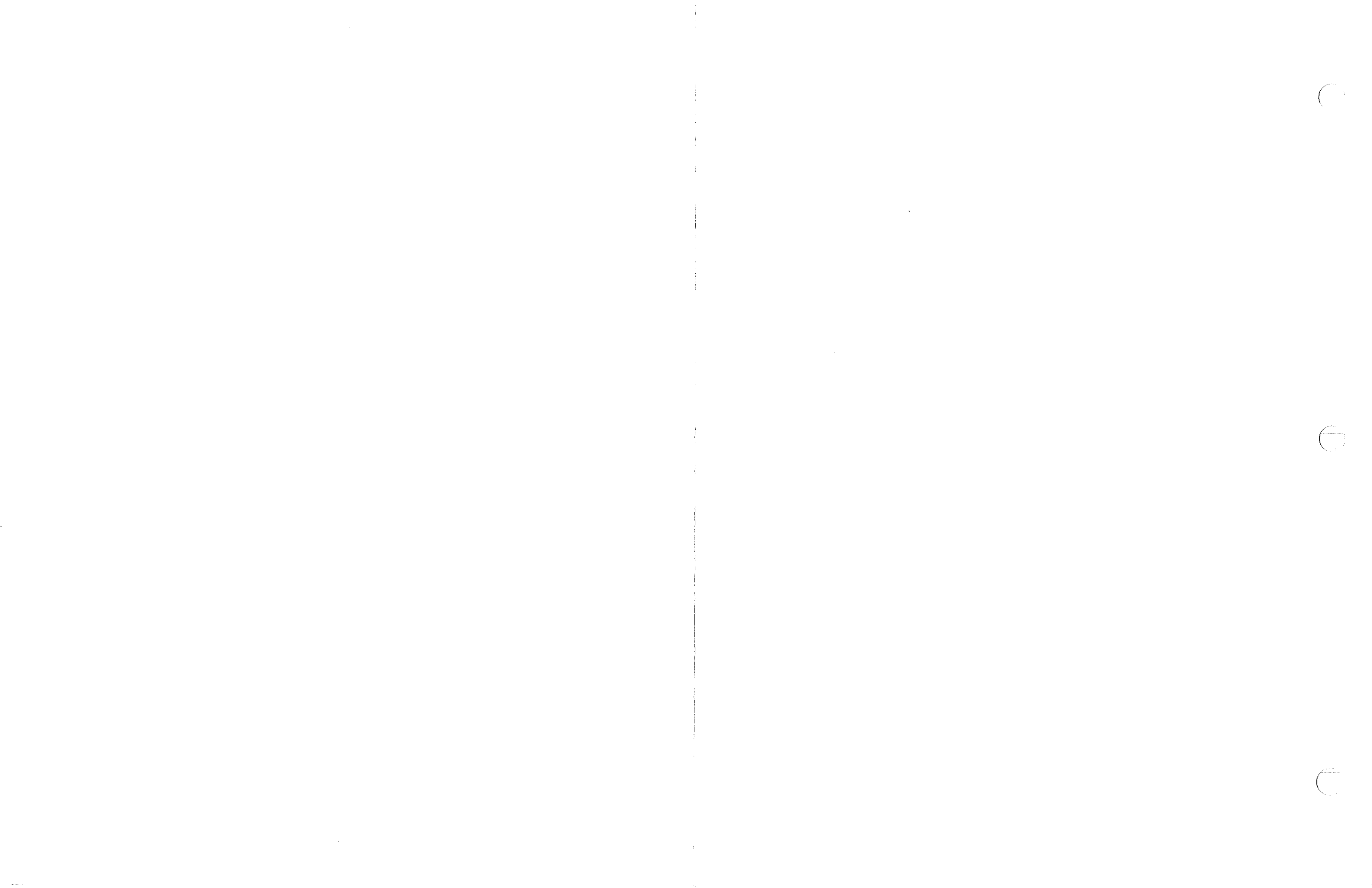


FIGURE 14-6  
Flowchart, ALE Module.





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**TABLE 14-2**  
**Parts List, ALE Module.**

C1,C2		Not Used.
C3,C4	023470	Capacitor, Tantalum 10 V 47 $\mu$ F SMT
C5-C9	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C10	238224	Capacitor, Electrolytic 5.5 V 0.22 $\mu$ F
C11,C12	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C13	025003	Capacitor, Trimmer 4.5-20 pF SMT
C14-C17	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C18		Not Used.
C19,C20	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C21		Not Used.
C22-C33	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
C34	023470	Capacitor, Tantalum 10 V 47 $\mu$ F SMT
C35	021104	Capacitor, 50 V 0.1 $\mu$ F SMT
D1	031004	Diode, Schottkey 1 Amp SMT
R1-R4	001002	Resistor, 1/8 W 1% 10 k $\Omega$ SMT
R5	006040	Resistor, 1/8 W 1% 604 $\Omega$ SMT
R6-R9	001002	Resistor, 1/8 W 1% 10 k $\Omega$ SMT
R10,R11	017003	Resistor, Variable 10 k $\Omega$ SMT
R12-R14	001002	Resistor, 1/8 W 1% 10 k $\Omega$ SMT
S1	053001	Switch, 2 Position SMT
U1	033056	IC, DS1232/S SMT
U2	361090	Crystal, Oscillator 11.0592 MHz 5 Vdc
U3	033051	IC, 80C31BHN SMT
U4		Not Used.
U5	033048	IC, CXK58257AM-12LL SMT
U6,U7	033050	IC, CAT28C64ANC-120 SMT
U8		Not Used.
U9	033053	IC, IDT7130LA55J SMT
U10	033060	IC, MAX660CPA SMT
U11	033054	IC, TLC32044CFN SMT
U12	361091	Crystal, Oscillator 20.736 MHz
U13	330407	IC, TMS320C25FNL
U14,U15	033049	IC, TC55328J-35 SMT
U16	033057	IC, MM74HC00M SMT
U17	033061	IC, MC1458D SMT
U18-U20		Not Used.
U21	033058	IC, 74HC573ADW SMT
U22	033059	IC, 74ACT14M SMT

C

E

C

# APPENDIX A

## A-1 GENERAL

A basic knowledge of the techniques used in the synthesizer design is necessary for both understanding and troubleshooting these circuits. The transceiver has two completely independent synthesizers, one providing the 76.6 to 104.99-MHz signal for the First Local oscillator and the other providing the 73.3401 to 73.350-MHz signal for the Second Local oscillator. The heart of both synthesizers is a phase-locked loop; a brief analysis of phase-locked loops is given in this section. Another important concept used in the design of the synthesizer is dual-modulus prescaling. The knowledge of this concept is important not only in the understanding of the synthesizer design, but also in the programming of the transceiver radio frequencies.

This section includes a block diagram of the overall synthesizer. The description of the block diagram is shown in relation to the techniques of the phase-locked loop and dual-modulus prescaling in order to give a better understanding of the operation of the synthesizer. An example illustrating the frequency programming of each synthesizer loop demonstrates the mathematical algorithms used and their relationship to the overall frequency conversion scheme.

Also shown in this section is a description of the frequency scheme used in the transceiver. Numerical examples are provided to clearly illustrate this approach. The overall frequency stability of the transceiver is also discussed, and an equation is developed which shows how the stability criterion is established.

## A-2 BLOCK DIAGRAM DESCRIPTION

A block diagram of the synthesizer is shown in Figure A-1. It is composed of two completely independent single-loop digital synthesizers. The 10-kHz Loop uses a VCO phase-locked to a 10-kHz reference frequency. This choice of reference frequency enables using a loop bandwidth high enough for good stability and switching speed, and also low enough for good reference spurious suppression. The 10-kHz Loop is a single-loop synthesizer using no mixing or multiplication, and as such has excellent spectral purity. The 100-Hz Loop uses a VCXO phase-locked to a 100-Hz reference frequency. The very stable crystal oscillator is "pulled" over a 10-kHz range using the 100-Hz PLL. Because of the inherent stability and purity of crystal oscillators, the 100-Hz Loop provides an exceptionally good I.O. signal for the Second Mixers.

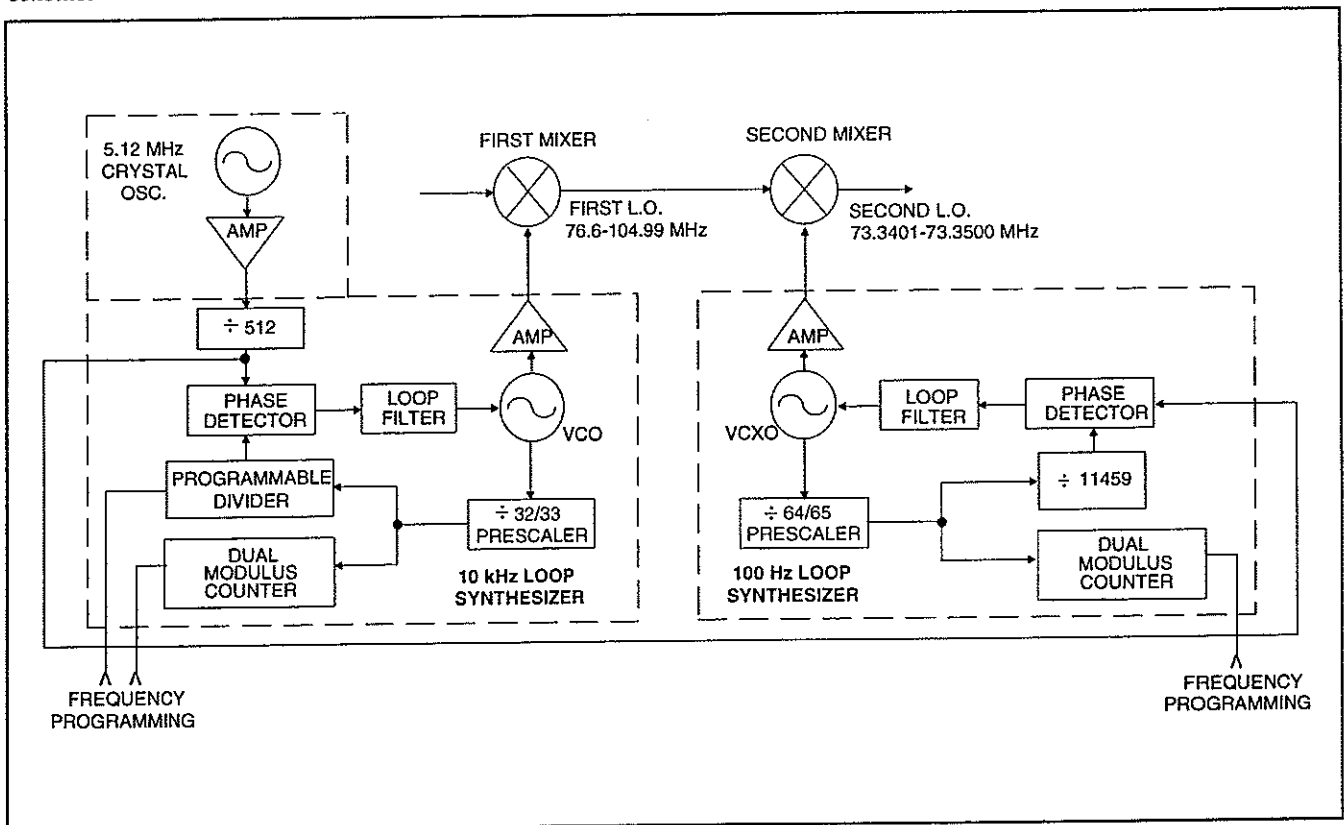


FIGURE A-1.  
Synthesizer Block Diagram.

### A-3 PHASE-LOCKED LOOPS

The heart of each synthesizer is the phase-locked loop (PLL), a simplified diagram of which is depicted in Figure A-2. Referring to this diagram, it is seen that a PLL consists of the following basic elements:

1. A Voltage Controlled Oscillator (VCO).
2. A Phase Detector.
3. A Divider; either fixed ( $\div M$ ) or Variable ( $\div N$ ).
4. A Loop Filter.

The purpose of a PLL is to provide a VCO, which operating alone might be unstable, with the stability and accuracy of a single, highly stable reference frequency. The inputs to the phase detector are a reference frequency (generally a very stable temperature-controlled crystal oscillator), and the VCO output frequency divided by the integers  $N \times M$ . The phase detector dc output controls the VCO frequency, and under proper PLL conditions, will change the VCO frequency (divided by  $M \times N$ ) to equal the reference frequency. The  $\div M$  is generally a fixed divider called a prescaler, whose purpose is to reduce a high VCO frequency to a lower level that can be handled by standard programmable logic system.

The  $\div N$  can be either a fixed or a variable divider. When  $N$  is variable, it can be programmed externally to change the VCO frequency in discrete steps. The phase detector will electronically tune the VCO each time  $N$  is changed

to bring the output of the divider to the same frequency and phase as that of the reference. The loop is locked when  $F_{out} = NMF_{ref}$ .

Once the loop is locked, operation proceeds as follows: If the output frequency increases, the frequency out of the divider will exceed  $F_{ref}$  and the phase detector will react by trying to drive the VCO frequency lower. The tuning voltage to the VCO will decrease as a result and the output frequency will decrease, which counters the initial frequency increase. The loop filter is present to suppress undesired components produced in the phase detector so they don't cause unacceptable FM on the VCO. The loop filter also has an important effect on other types of noise, on acquisition of lock, loop response time, and stability.

In a PLL synthesizer, the error signal driving the VCO changes value only once each reference period; the loop bandwidth, which determines response speed, is set to be approximately one-tenth the reference frequency. This is necessary for stability and for suppression of the reference frequency sidebands. The higher the reference frequency, the faster the loop response time; but the reference frequency also determines the minimum synthesizer channel spacing. For example, if the reference frequency is 10 kHz, the MINIMUM channel spacing is 10 kHz. If the fixed divider  $M$  in Figure A-2 is greater than one, the  $F_{out}$  can only be changed in steps of  $MF_{ref}$ . If  $M$  is made equal to one, then the channel spacing depends only on  $F_{ref}$ .

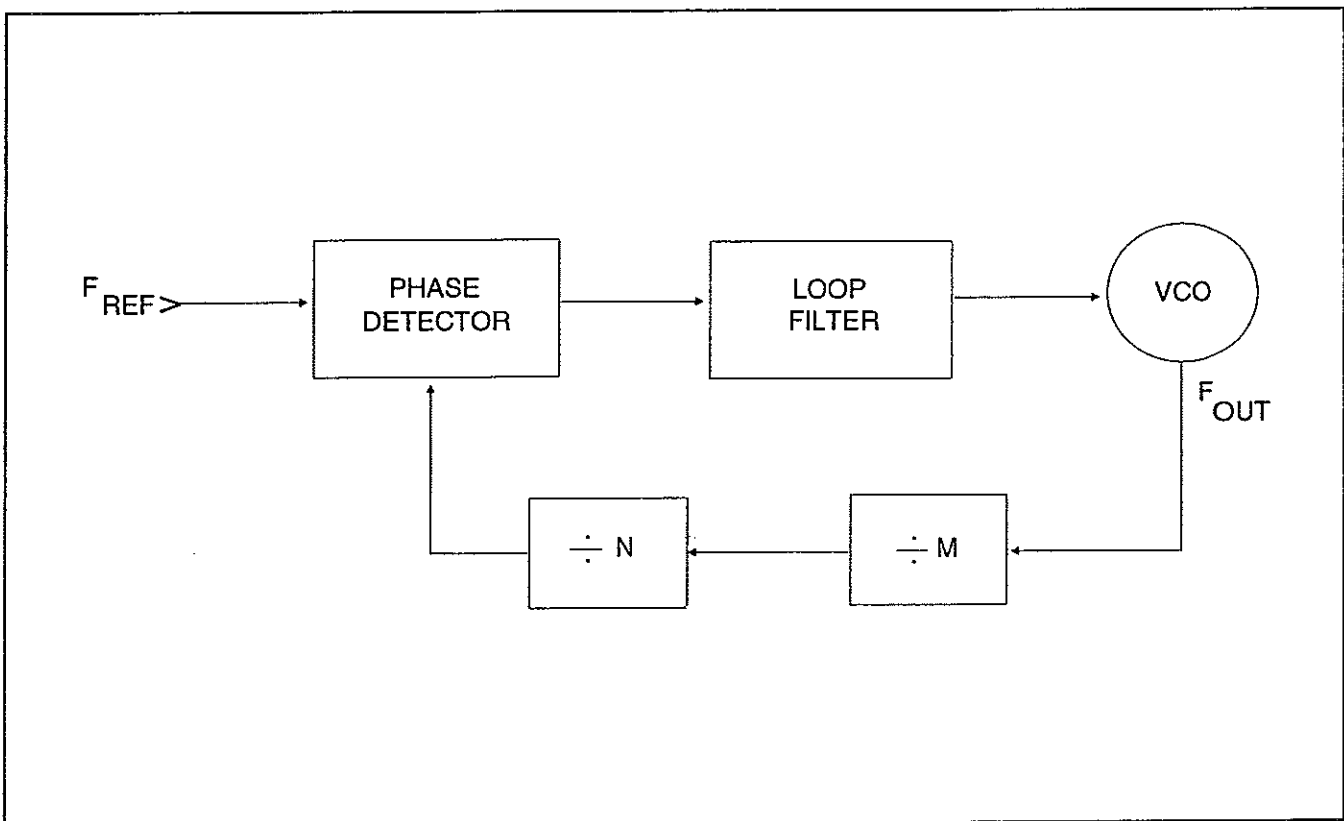


FIGURE A-2.  
Phase-Locked Loop.



In our case, the ultimate channel spacing is 100 Hz. But to make a single-loop synthesizer with a 100-Hz reference covering a 28-MHz range would place severe restrictions on loop response time as well as VCO stability. Thus, the transceiver uses two synthesizers: the 10-kHz Loop covering 76.6-104.99 MHz with 10-kHz channel spacing which provides a loop BW high enough for good response time and stability, and a 100-Hz Loop covering 10 kHz in 100-Hz steps using a high-stability crystal oscillator.

#### A-4 DUAL-MODULUS PRESCALING

CMOS dividers provide not only the lowest power approach, but also the best approach for spectral purity because of their switching response. However, CMOS dividers are restricted in operating speed to below 10 MHz for reliable operation.

With the 10-kHz Loop operating at 76.6-104.99 MHz, and the 100-Hz Loop at 73 MHz, it is clear that some form of prescaling (or  $\div M$ ) is required to reduce the VCO frequency to a level that can be handled by standard CMOS programmable dividers, and still the channel spacing needed for 10-MHz and 100-Hz loops.

The synthesizers solve this problem by using a technique known as dual-modulus prescaling. This approach allows low-frequency CMOS programmable counters to be used as high-frequency programmable counters with speeds of several hundred MHz. This is possible without the sacrifice in channel spacing and performance that would otherwise result if a fixed divider was used for the prescaler ( $\div M$ ). Prescalers are used whose division ratio can be switched between two values to allow effective division at the high prescaler input frequency (VCO output), with the actual programmable dividers operating at the lower output frequency of the prescaler.

Figure A-3 illustrates how a dual-modulus divider system operates. The VCO drives the dual-modulus prescaler (which can divide by P and P+1), which in turn drives two programmable counters in parallel. These two counters are programmed to "A" and "N". The prescaler and the A-counter are connected in such a way that in a complete count cycle, the prescaler divides by P+1 until the A-counter reaches zero and then reverts to a division ratio of P. Both the A-counter and the N-counter start counting at the same time. Therefore, the prescaler divides by P+1 for "A" counts and by P for "N-A" counts. For example, the programmed divide ratio NT is:

Figure A-3 illustrates how a dual-modulus divider system operates. The VCO drives the dual-modulus prescaler (which can divide by P and P+1), which in turn drives two programmable counters in parallel. These two counters are programmed to "A" and "N". The prescaler and the A-counter are connected in such a way that in a complete count cycle, the prescaler divides by P+1 until the A-counter reaches zero and then reverts to a division ratio of P. Both the A-counter and the N-counter start counting at the same time. Therefore, the prescaler divides by P+1 for "A" counts and by P for "N-A" counts. For example, the programmed divide ratio NT is:

$$NT = (N-A) P + A(P+1)$$

or

$$NT = NP + A$$

Therefore, the overall divider system divides by P+1 for as long a count as the A-counter is programmed (A counts), and then divides by P for the remainder of the cycle (N-A counts). The only restriction on the scheme is that the total count cycle (N) be greater than A.

For example, the 10-kHz Loop Synthesizer (as shown in Figure A-1) uses a  $\div 32/33$  prescaler (an MC12015 rated at

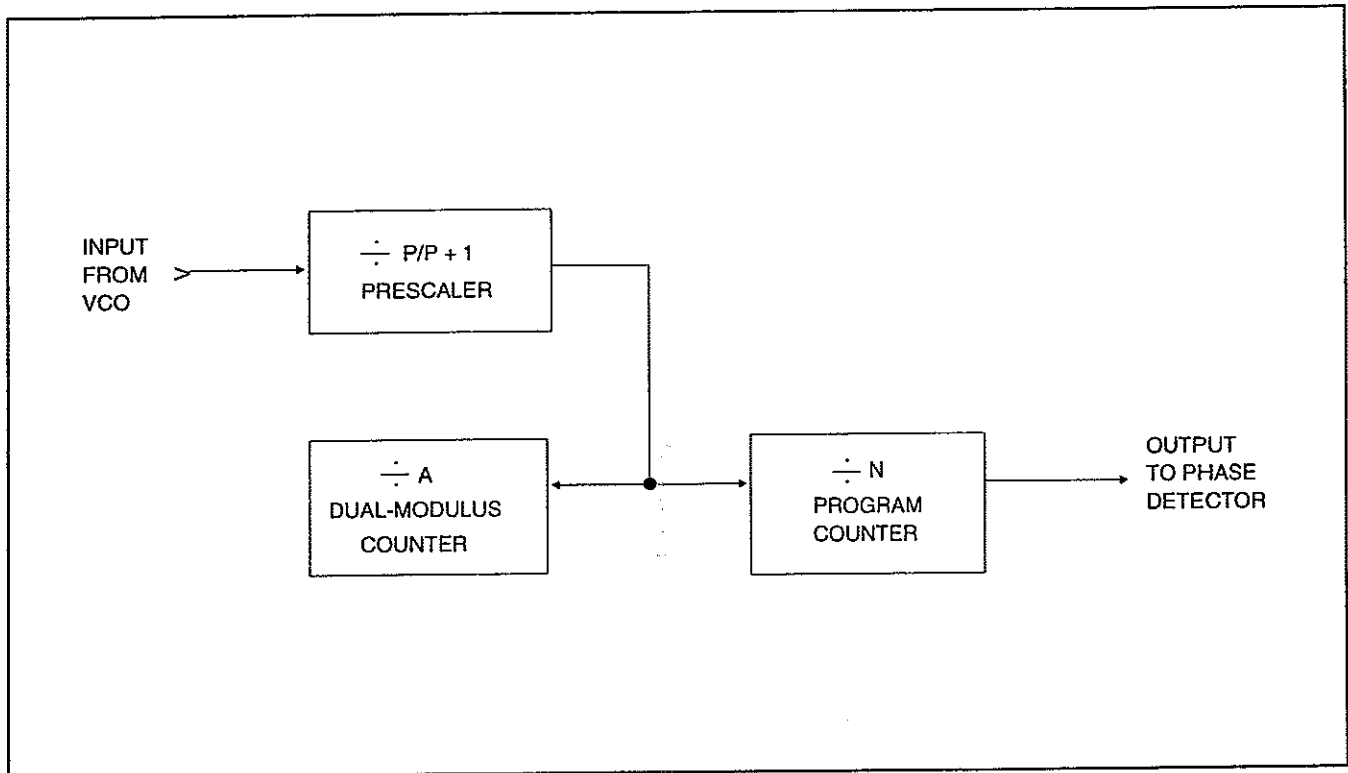


FIGURE A-3.  
Dual-Modulus Prescaler.

200 MHz). The highest VCO frequency is 105 MHz, which when divided by 32 equals 5—well below the 30-MHz MC145152 CMOS counting speed. If the selected channel frequency is 25 MHz, then the VCO frequency is  $25 + 75 = 100$  MHz. The total divide ratio is:  $N_T = F_{out} / F_{ref} = NP + A$ ; or  $N_T = 100 \times 106/104 = NP + A$ . Therefore, the total division ratio is 10,000 and with  $P = 32$ , the equation division ratio is 10,000 and with  $P = 32$ , the equation is:

$$10,000 = 32N + A,$$

or

$$N = 312, \text{ and } A = 16$$

Then 312 is the number programmed into the N-counter and 16 is the number programmed into the A-counter. The +32/33 prescaler then divides by 33 for 10 counts and 32 for 296 counts to account for the overall division ratio of 10,000.

$$33 \times 16 = 528$$

$$32 \times 296 = 9472$$

$$\therefore 528 + 9472 = 10,000$$

The 100-Hz Loop Synthesizer (Figure A-1) uses a +64/65 prescaler with a frequency limit of 200 MHz. The VCXO frequency is 73.3401-73.3500 MHz. Therefore, the output of the prescaler into the programmable divider is approximately 1 MHz. Since this loop has only 100 discrete frequencies (73.3401-73.350 MHz in 100-Hz steps) all the programming can be done in the dual-modulus counter (set for count from 1-100), while the +N programmable counter has a fixed division ratio of 11459. The total 100-Hz Loop divide ratio is:

$$N_T = 64N + A, \text{ or } N_T = 64 \times 11459 + A$$

which is:

$$N_T = 733376 + A$$

This means that the loop will divide by 65 for "A" counts, and then divide by 64 for (11459-A) counts.

#### A-5 FREQUENCY PROGRAMMING EXAMPLE

To illustrate the concept of dual-modulus prescaling used in the synthesizer, the following example is presented:

##### EXAMPLE:

Let the selected channel frequency be 9,124,200 Hz. The 10-kHz Loop programming then goes as follows:

1. The first L.O. output frequency is:  
 $09.12 + 75.00 = 84.12$  MHz

2. Using the formula developed earlier for the 10-kHz Loop:

$$N_T = F_{out} / F_{ref} = 84,120,000 / 10,000 = 8412$$

3. Therefore, the total division ratio for the 10-kHz Loop is  $N_T = 8412$ .

4. Since  $N_T = 32N + A$ , where "N" is the number programmed into the variable programmable counter, and "A" is the number programmed into the dual modulus counter then,

$$8142 = 32N + A$$

$$\therefore N = 8142/32 = 254$$

$$\text{Then, } A = 8142 - 254 \times 32 = 14$$

5. The total 10-kHz Loop counter cycle is then 254, with the loop dividing by 33 for 14 counts and by 32 for  $254 - 14 = 240$  counts. Thus,  $N_T = (33 \times 14 = 462) + (240 \times 32 = 7680) = 8142$ .

6. With the 10-kHz Loop at 84.12 MHz and the channel frequency at 9.1242 MHz, the First IF is 74.9958 MHz (or 4.2 kHz below the center of the 75-MHz IF filter passband). The Second L.O. is then:

$$\text{Second L.O.} = 74.9958 - 1.65 = 73.3458 \text{ MHz}$$

7. 100-Hz Loop programming is done by first looking at the 1-kHz and 100-Hz digits of the channel frequency (in this case, 9.1242 MHz).

- a. Let these two digits equal EF. Then  $A = 124 - EF$ .
- b. In this case, the two digits are 42.  
 Therefore,  $A = 124 - 42 = 82$ .

8. The dual-modulus frequency formula for the 100-Hz Loop is then applied:

$$N_T = 11459 \times 64 + A$$

$$N_T = 733376 + 82 = 733458$$

9. The output frequency is then  $F_{LO} = F_{ref} \times N$ , or  $F_{LO} = 733,458 \times 100 \text{ Hz} = 73.3458 \text{ MHz}$ , which corresponds with the frequency determined in part 6.

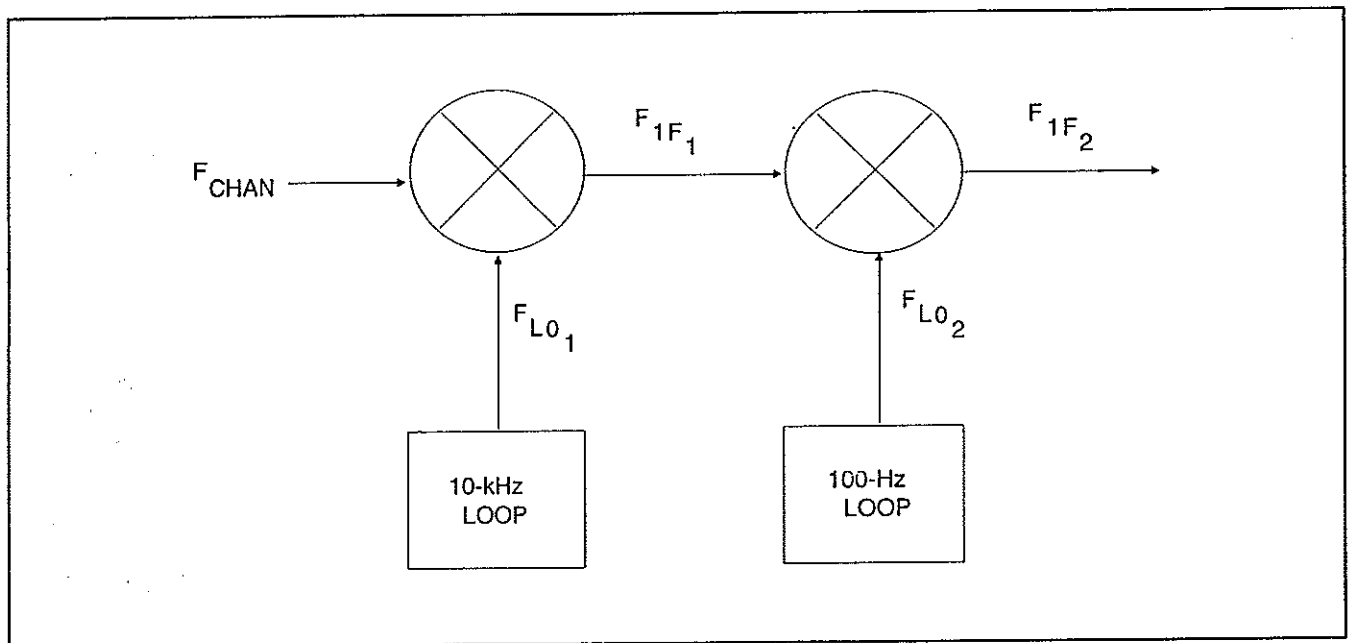
#### A-6 FREQUENCY CONVERSION SCHEME

This simplified diagram in Figure A-4 illustrates the overall frequency scheme.

Frequencies shown are as follows:

$F_{chan}$  = RF channel frequency of the radio; 1,600-29,999 MHz, selectable in 100-Hz increments resulting in 284,000 available channels.

$F_{LO1}$  = Output of the 10-kHz Loop, a phase-locked loop (PLL) synthesizer generating a 76.60 to 104.99-MHz output in 10-kHz increments.



**FIGURE A-4.**  
**Frequency Scheme.**

$F_{1F1}$  = First IF; varies between 75.000 and 74.9901 MHz depending on the chosen channel frequency.

$F_{LO2}$  = Output of the 100-Hz Loop, a PLL synthesizer operating from 73.3401-73.350 MHz in the 100-Hz increments.

$F_{1F2}$  = Second IF; fixed at 1.65 MHz.

#### A-7 EXAMPLES OF OSCILLATOR FREQUENCIES

Table A-1 shows the oscillator injection frequencies for a few sample channel RF frequencies. Note that the first IF frequency is not fixed at 75.00 MHz but varies over a 10-kHz range depending on the selected channel frequency. This is accomplished as follows:

$$f_{LO1} = f_{chan} + 75.00 \text{ MHz}^*$$

1. The first IF is always:

$$F_{1F1} = F_{LO1} - f_{chan}$$

2. The second IF is always fixed at 1.65 MHz. Therefore, the second L.O. is:

$$F_{LO2} = F_{1F2} - 1.650 \text{ MHz}$$

#### \*NOTE

Only the first four digits of the channel frequency are used in determining  $F_{LO1}$ .

#### EXAMPLE:

$f_{chan} = 2,000,000 \text{ Hz}$ , and  
 $f_{chan} = 2,005,900 \text{ Hz}$

Both result in  $F_{LO1} = 2.00 + 75.00 = 77.00 \text{ MHz}$  (remember that the first digit is always the 10-MHz digit; therefore, the first four digits of 2,000,000 Hz are 02.00).

#### A-8 FREQUENCY STABILITY

Since both local oscillators are locked to a single reference frequency, the frequency errors in the two oscillators due to a change in reference frequency will tend to cancel each other. Therefore, the overall radio frequency error due to a shift in the reference is proportional to the difference in the two L.O. frequencies. The following is the equation for overall system frequency shift due to a shift in the reference frequency:

$$f_{system} = \frac{F_{LO1} - F_{LO2}}{F_{ref}} (f_{ref})$$

where:

$f_{system}$  = System Frequency Shift

$F_{LO1}$  = first L.O.

$F_{LO2}$  = second L.O.

$f_{ref} = 5.120 \text{ MHz}$

$f_{ref}$  = drift in  $F_{ref}$  from 5.120 MHz

The transceiver's reference oscillator uses a 5.120-MHz crystal oscillator. Stabilities in the order of  $\pm 5 \text{ ppm}$  can be achieved in this fashion. This translates into a 25.6-Hz drift in reference frequency over the specified  $-30^\circ\text{C}$  to  $+55^\circ\text{C}$  temperature range. The total frequency drift of the radio is then:

At 2 MHz:

$$f_{system} = \frac{77 - 73.35}{5.12} \times 25.6 = 18.25 \text{ Hz}$$

At 30 MHz:

$$f_{system} = \frac{105 - 73.35}{5.12} \times 25.6 = 158.25 \text{ Hz}$$

**TABLE A-1.**  
**Example Frequencies.**

<b>Fchan</b>	<b>FLO1</b>	<b>FIF1</b>	<b>FLO2</b>	<b>FIF2</b>
2.0000	77.0000	75.0000	73.3500	1.6500
2.0001	77.0000	74.9999	73.3499	1.6500
2.0099	77.0000	75.9901	73.3401	1.6500
2.0100	77.0100	75.0000	73.3500	1.6500
3.0000	78.0000	75.0000	73.3500	1.6500
29.9999	104.9900	74.9901	73.3401	1.6500

**NOTE**

As Fchan goes through 10-kHz (e.g. from 2.000-2.0099), FLO1 remains the same frequency (77.0000 MHz), and FLO2 makes one hundred 100-Hz steps (from 73.3500 to 73.3401).

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<b>NOTES</b>
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1. 10/1/80  
2. 10/1/80  
3. 10/1/80  
4. 10/1/80  
5. 10/1/80

1. 10/1/80  
2. 10/1/80  
3. 10/1/80  
4. 10/1/80  
5. 10/1/80

10/1/80

10/1/80

10/1/80

