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***Operation  
and  
Maintenance Manual***

**HF Transceiver  
MSR 8050A**

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## GLOSSARY

A	Ampere(s)
A/D	Analog-to-Digital (Converter)
AFSK	Audio frequency shift keying; a baseband modulation scheme in which two audio frequencies are used to represent binary coded data; the frequency is shifted to one frequency to represent a 1 (mark) and to the other to represent a 0 (space).
AGC	Automatic gain control
ALC	Automatic level control
ALE	Address latch enable
AM	Amplitude modulation; a modulation scheme in which the carrier is made to vary in amplitude in accordance with the modulating signal.
AMPL	Amplifier
AME	Amplitude modulation equivalent
ANTIVOX	Prevents false VOX operation; see VOX
BNC	Baby "N" connector
BCD	Binary-coded decimal
BFO	Beat Frequency Oscillator, used in SSB detection circuits
BITE	Built-in Test Equipment
BPF	Bandpass filter
BW	Bandwidth
CPU	Central processing unit
CW	Continuous wave; a wave that does not vary in amplitude or frequency and is turned on and off to carry intelligence, e.g., Morse Code
CCW	Counterclockwise
CMOS	Complementary metal oxide semiconductor
D/A	Digital-to-Analog (Converter)
DAGC	Delayed AGC
dB	Decibel(s)
dBm	Decibel(s) relative to one milliwatt
EMI	Electromagnetic interference
EPROM	Erasable programmable read-only memory
FSK	Frequency shift keying
HF	High frequency; a radio frequency band extending from about 3 MHz to 30 MHz; in this manual, HF includes 1.6 to 30 MHz.
HV	High voltage
IF	Intermediate frequency
IP2	Second order intermodulation intercept point
IP3	Third order intermodulation intercept point
ISB	Independent sideband
IMD	Intermodulation (distortion)
I/O	Input/Output
LED	Light emitting diode

## GLOSSARY (Cont.)

LO	Local oscillator
LPA	Linear power amplifier
LPF	Low pass filter
LSB	Lower sideband; a modulation scheme in which the intelligence is carried on the first sideband below the carrier frequency; see SSB
MIC	Microphone
mA	Milliampere(s)
mS	Millisecond(s)
mV	Millivolt(s)
NBFM	Narrow band frequency modulation
OCXO	Oven-controlled crystal oscillator
PEP	Peak envelope power
PCB	Printed circuit board
RAM	Random access memory
RF	Radio frequency
RMS	Root mean square
RX	Receive
RTTY	Radio teletypewriter
SPKR	Speaker
SSB	Single sideband; a modulation scheme in which the intelligence is carried by one of the carrier sidebands, the other sideband and the carrier center frequency being suppressed
TCXO	Temperature-compensated crystal oscillator
TGC	Transmitter gain control
TTL	Transistor/transistor logic
TX	Transmit
uA	Microampere(s)
uP	Microprocessor
uS	Microsecond(s)
USB	Upper sideband; a modulation scheme in which the intelligence is carried on the first sideband above the carrier frequency; see SSB
uV	Microvolt(s)
Vac	Volts, alternating current
VCO	Voltage controlled oscillator
Vdc	Volts, direct current
VSWR	Voltage standing wave ratio; the ratio of the maximum to the minimum voltage of a standing wave on a radio frequency transmission line
W	Watt(s)
XTAL	Crystal element

## SECTION 1

### GENERAL INFORMATION

#### 1.1 SCOPE

This instruction manual contains information necessary for the installation, operation and maintenance of the MSR 8050A transceiver.

#### 1.2 DESCRIPTION

##### 1.2.1 GENERAL

The MSR 8050A is a compact, rugged, fully automatic, solid-state transceiver. It is designed as a continuous-duty, base station unit with a frequency range of 1.6 to 30 MHz in 10 Hz steps with receiver coverage extended down to 100 kHz.

RF power output of the MSR 8050A is 125 watts PEP and Average in the SSB modes; 125 Watts PEP with 35 Watts carrier in AME mode. The transceiver operates on all normal modes including SSB, CW, AM, RTTY, FSK Data and FAX (the latter three require external modems). The unit is designed not only as a stand-alone unit, but as a driver for the MACKAY MSR 1020 1000 Watt Linear Power Amplifier. This configuration is particularly well suited for use as a base station in an HF communications system. With the 1 kW system, four separate power levels from 25 watts to 1 kilowatt may be selected at the transceiver front panel. (Power level 1 (25W) is not available in AME mode).

The receiver section of the transceiver may be used as a 10 Hz step continuous-tuning, channelized, or channel-scanning unit. Up to 10 blocks of channels for scanning may be programmed in the field from its front panel. Each block may contain from 1 to 99 consecutive channels. The number of blocks to be scanned (1 to 10) can also be selected from the front panel keys. Frequency scan with programmable start/stop limits and selectable step size is also provided.

Memory storage space is provided for up to 100 simplex or half-duplex channels, including trans-

mit and receive frequencies, operating mode, AGC decay and transmit power level. Channels are field-programmable using the front panel keyboard.

The MSR 8050A is capable of remote control via either the MSR 6420 remote control unit or by a computer keyboard. The standard unit provides interface with RS-232C, RS-422, RS-423 and MIL-STD-188C at data rates from 300 to 9600 baud. An optional internally-installed FSK modem will provide remote control over telephone or twisted pair lines. "Daisy-chaining" will permit operation of multiple units from one remote control with an optional Audio I/O board. (Simultaneous remote control operation via RS-232, etc., and FSK is not permitted.)

An optional filter board will provide space for up to three additional special IF filters, such as narrow band CW, FSK, etc. An optional Audio I/O board will provide operation over "2-wire or 4-wire" remote lines.

Internal filtering provides excellent rejection of internal spurious signals. The AGC and other important parameters have been tailored to make this unit operable with TADIL-A systems, when special IF filters, designed specifically for TADIL-A usage, are incorporated.

A special "RED" Priority Channel key is provided for emergency use. This priority channel (channel 90) may be preprogrammed to an emergency frequency. Depressing the priority channel key then immediately sets up the transceiver on the emergency channel.

Another special switch exists, which can be reached with a pencil from the front panel, for quick memory dump. All the channel information stored in the memory will be erased if this switch is depressed while the radio is turned on.

## 1.2.2 CHASSIS/MOTHER BOARD

All subassemblies in the transceiver are mechanically and/or electrically connected to the Chassis/Mother board. The chassis houses all plug-in printed circuit boards and provides rf shielding. The Mother board provides all interconnections within the transceiver. The plug-in PC boards connect to the Mother board through board edge connectors. Keys on these connectors discourage the plugging of PC boards into the wrong slot or position.

## 1.2.3 FRONT PANEL ASSEMBLY

The front panel is a rugged aluminum and high impact plastic structure on which the speaker and all front-accessible connectors are mounted. The Light Emitting Diode (LED) displays and indicators, control keys, meter and associated circuitry are all mounted to the Keypad/Display board, which is mounted to the front panel.

## 1.2.4 INTERFACE BOARD

The Interface board provides the interface between the microprocessor and the front panel displays and control keys. It also contains circuitry for the frequency scan and channel scan oscillators. Serial to parallel data conversion is provided on this board.

## 1.2.5 CONTROLLER BOARD

The Controller board is the heart of the MSR 8050A digital control system. It contains a microprocessor, program memory, channel storage memory, address latches, interrupt priority, input buffers, transceiver control decoders and latches, and a bus driver/receiver for external bus interface.

## 1.2.6 SERIAL/SYNTHESIZER LATCH BOARD

This board provides the interface between the microprocessor and the frequency synthesizer. Information from the panel or from memory defining the desired frequency is latched in this board to control the synthesizer output frequency. It also provides a BCD frequency control output to drive an external preselector/postselector (i.e. MSR 6300).

## 1.2.7 COUPLER INTERFACE BOARD

This board provides the interface and control for the MACKAY MSR 4040 150 watt digital coupler and the MSR 4030 1kW coupler.

## 1.2.8 SIGNAL PATH

The MSR 8050A signal path includes seven printed circuit boards: (1) Half Octave Filter board, (2) High Pass Filter board, (3) Mixer board, (4) IF/Filter Board, (5) Transmit Modulator board, (6) Audio/Squelch Board, and (7) Speaker Driver board.

In Transmit mode, the transceiver receives audio inputs from either the front panel microphone or the 600 ohm line, and mixes them with rf signals from the synthesizer, amplifying and filtering until the proper signal to drive the output power amplifier is attained. In the Receive mode, the receiver processes the received signal from the antenna, again mixing with synthesizer signals, and filtering until the detected audio signal is obtained. This is then fed to the Speaker Driver to provide audible output from the speaker. (The audio is also sent to the 600 ohm line driver for use by remote controls, RTTY modems, etc.).

A double conversion scheme is used to provide excellent image rejection. The first Intermediate Frequency (IF) is 59.53 MHz and the second IF is 5.0 MHz. Two sets of crystal filters (one at each IF) determine the radio's bandwidth.

Speech compression on the Transmit Modulator board improves the peak-to-average power ratio of the rf output signal for more effective communications.

A syllabic squelch, designed to open upon reception of a human voice-type signal, reduces random squelch breaks due to static or other environmental noises.

## 1.2.9 SYNTHESIZER

The synthesizer consists of four printed circuit boards: (1) Major Loop board, (2) Translator Loop board, (3) Minor Loop board, and (4) Reference board. The synthesizer is a three loop design, providing the transceiver with the first local oscil-

lator (LO) from the Major Loop board, the second LO from the Translator Loop board, and the third LO from the Reference board. All synthesizer frequencies are derived and locked to a temperature-compensated crystal oscillator (TCXO) frequency standard located on the Reference board. The Reference board also supplies the 1 kHz sidetone used for CW operation. LED indicators on the boards indicate whenever any of the loops has lost its frequency lock. If this occurs, transmission and reception is inhibited through the BITE system.

#### 1.2.10 POWER SUPPLY MODULE

The Power Supply module is a switching type unit that operates from an input voltage of either 115 or 230 VAC, and furnishes regulated +5 VDC and +26 VDC to the transceiver.

#### 1.2.11 REAR PANEL ASSEMBLY

The Rear Panel assembly contains the rf power amplifier assembly and all power and control connectors.

#### 1.2.12 POWER AMPLIFIER ASSEMBLY

The Rf Power Amplifier assembly is a 125 watt PEP and Average solid-state unit. The unit is cooled by a heatsink and a fan.

#### 1.2.13 DUAL REGULATOR ASSEMBLY

This assembly provides regulated +9 VDC for the signal path boards and +14 VDC for the optional high stability oven frequency standard. Input to this module is 26.4 VDC from the power supply module.

### 1.3 SPECIFICATIONS

See Table 1.1.

#### 1.4 EQUIPMENT AND ACCESSORIES SUPPLIED

See Table 1.2.

#### 1.5 OPTIONAL EQUIPMENT - NOT SUPPLIED

See Table 1.3.

**Table 1.1 EQUIPMENT SPECIFICATIONS**

CHARACTERISTIC	SPECIFICATION
Frequency Range	
Transmit	1.60000 to 29.99999 MHz in 10 Hz steps
Receive	100 kHz to 29.99999 MHz in 10 Hz steps
Channel Storage	100 simplex or half-duplex channels, programmable from front panel or remote control
Frequency Stability	± 1 part in 10 <sup>6</sup> Standard (TCXO) ± 1 part in 10 <sup>8</sup> Optional (Oven Oscillator)
Operating Modes	J3E (USB, LSB), H3E (AME), R3E (A3A), J1A (CW), F1B (FSK), J1D (Data), J2B (ARQ/FEC)
RF Input/Output Impedance	50 ohms, nominal
Tx/Rx or Rx/Tx Switching Time	10 msec, maximum in simplex mode (120 msec in duplex mode)
Built-In Test Equipment (BITE)	Synthesizer lock, power supply voltages, $\mu$ P control and others
Remote Control Interfaces	RS-232C/422/423, MIL-STD-188C, FSK Tone Remote Control (Opt.)
Standard Audio Interfaces	Rx/Tx Audio In/Out, Voice and Data separate, 600 ohms, balanced Carbon or Dynamic microphone
Environmental	
Temperature Range, Operating	-10° C to +55° C
Altitude	10,000 Ft.
Humidity	95% at 50° C
Shock (with isolators)	Per MIL-STD-810C, method 516.2, Proc. V
Vibration (with isolators)	Per MIL-STD-810C, method 514.2, Proc. VIII Figure 514.2-6, Curve V
Size	5.2H x 19W x 24D (inches) 13.2H x 48.3W x 61D (cm)

**Table 1.1 EQUIPMENT SPECIFICATIONS (Cont.)**

CHARACTERISTIC	SPECIFICATION
Net Weight	42 lbs (19 kg)
Power Requirements	115/230 VAC $\pm$ 15%, 47 to 63 Hz Transmit: 950 VA, Receive: 150 VA
<b>Receiver</b>	
Sensitivity for 10 dB (S + N)/N	SSB: 0.5 $\mu$ V AME: 3.0 $\mu$ V (30% modulation) <b>NOTE:</b> Degradation of 6 dB/octave permitted below 2 MHz
Selectivity	SSB, CW: 2.7 kHz at -6 dB; 6 kHz max at -60 dB, standard AME: 6 kHz at -6 dB; 18 kHz max at -60 dB, std. (Other bandwidths and filter characteristics available on special order)
Automatic Gain Control	Range: -87 to +13 dBm for <3 dB output change Attack: less than 10 msec Fast Decay: 30 msec nominal Medium Decay: 200 msec nominal Slow Decay: 3.0 sec nominal
Audio Output Levels	Speaker: 3 Watts at 5% maximum distortion 600 ohm Line: -10 to +10 dBm, internally adjustable Handset: 5m watts at 5% distortion
Channel Scan	Up to 99 channels, either singly or in groups with front panel adjustable Scan Rate and Dwell
Squelch	Syllabic
IF and Image Rejection	80 dB minimum (except second IF -65 dB in 4-6 MHz range)
External Spurious Rejection	70 dB minimum
Internal Spurious Rejection	99.5% of all channels have spurious equivalent at least 8 dB below sensitivity level
In-Band Intermodulation Distortion	-35 dB, (-40 dB Typical) at inputs up to -7 dBm
Out-of-Band Intermodulation Distortion	Third Order Intercept is +20 dBm typical

**Table 1.1 EQUIPMENT SPECIFICATIONS (Cont.)**

CHARACTERISTIC	SPECIFICATION
Receiver Gain	10 $\mu$ V input for rated audio output
Antenna Input Protection	To 100 VRMS at 50 ohms, self-resetting
<b>Transmitter</b>	
RF Output Power	SSB/CW: 125 watts $\pm$ 0.5 dB PEP and Average (power level 2) 25W $\pm$ 0.5 dB PEP (power level 1) <b>NOTE:</b> Power level 1 adjustable 20W to 50W  AME: 125 watts PEP, nominal, 35 watts $\pm$ 0.5 dB Carrier (power level 2 only - power level 1 not available)
Intermodulation Distortion	3rd Order: 30 dB below PEP, 33 dB typical 11th Order and greater: 50 dB below PEP
Harmonic Rejection	45 dB below PEP, 50 dB typical
Carrier Suppression	A3J: At least 50 dB below PEP A3A: 16 dB $\pm$ 2 dB below PEP
Undesired Sideband Suppression	50 dB below PEP at 1 kHz
Voice Compression	A 10 dB increase in audio input will cause less than 1 dB increase in output. (Compressor may be internally disabled.)
Hum and Noise	50 dB below PEP, minimum

**Table 1.2 EQUIPMENT AND ACCESSORIES SUPPLIED  
(MSR 8050A P/N 794049-000-002)**

QTY.	ITEM	MACKAY PART NO.
1	Transceiver	794049-001-002
1	Technical Manual	600313-823-001
1	Accessory Kit (Consisting of the following):	794049-017-002
5	Fuse, 8A, Fast-Blo	600004-396-018
5	Fuse, 5A, Slo-Blo	600006-396-030
1	Connector, PL 259	600244-606-001
1	Reducer	600244-606-002
1	Microphone, Hand	600352-713-001
1	Connector, BNC	600268-606-002
1	Power Cord, AC	600078-102-001
2	Connector, DB 25S	600292-606-005
1	Connector, DB 25P	600292-606-006
3	Cable Clamp, DB 25	600225-233-001
1	Connector Assembly, Wired (J38 Key Interlock Disable)	600893-540-001
1	Connector, Shorting (J36 FSK Remote Daisy-Chain Bypass)	700009-608-003
1	Connector, Shorting (J35 RS-232 Remote Daisy-Chain Bypass)	700009-608-001

**Table 1.3 OPTIONAL EQUIPMENT - NOT SUPPLIED**

ITEM	MACKAY PART NO.	DESCRIPTION/USE
Rack Mount Kit, 19"	600078-700-001	Slide racks and mounting hardware for installing the MSR 8050A in a standard 19" rack or cabinet.
Microphone, Desk	600367-713-001	
Handset, type H-250/U	600021-386-001	
Headset, type H-251/U	600036-386-001	
Extender Board Kit	600081-700-001	Plug-in extender boards hold MSR 8050A plug-in PCBs above level of other PCBs to simplify troubleshooting.
Desk Top Cabinet	600257-704-001	Allows the MSR 8050A to be installed as a free-standing desk top unit. Overall dimensions of the MSR 8050A installed in the cabinet: W-19 3/4" x D-19 1/4" x H 6 3/4". Color: Black.
Spares Kit, PC Board	700407-700-002	This kit includes spares of all plug-in modules to allow simple on-site servicing by replacement of defective modules. Included are all plug-in PCBs, switching power supply module, and LPA module.
Spares Kit, Comprehensive (CSK)	700409-700-001	This kit includes all items found in the Spare Boards Kit as well as all other items replaceable by a technician with minimal equipment and requiring minimum down-time. Included items are power transistors, integrated circuits installed in sockets, chassis components, fans, knobs and switches, etc. One comprehensive spares kit should support up to five MSR 8050As for two to four years.
Extension Cable Kit, Power Supply	600289-700-001	This kit allows operation of the power supply in a partially disassembled state for troubleshooting.

**Table 1.3 OPTIONAL EQUIPMENT - NOT SUPPLIED (Cont.)**

ITEM	MACKAY PART NO.	DESCRIPTION/USE
Spares Kit, Depot	700408-700-001	<p>This kit includes all basic components required to repair defective boards and modules. The Depot Spares Kit complements the Comprehensive Spares Kit and together they should support five MSR 8050As for two to four years. This kit is intended for depot level application by trained technicians.</p>
High Stability Reference Option	600288-700-001	<p>Upgrades standard <math>\pm 1</math> in <math>10^6</math> frequency stability to <math>\pm 1</math> in <math>10^8</math>. Factory-installable only.</p>
Preselector Option, MSR 6300	700007-700-003	<p>The Preselector option consists of an external automatically tracking filter which is electrically inserted at the antenna input in receive and in the TX signal path just before the power amplifier in transmit. The preselector attenuates large off-channel signals in receive and reduces broadband PA noise in transmit. Included are the external filter and all RF and control signal routing cables, technical manual and 115/230 VAC power supply. Internal components of this kit are factory-installable only.</p>
Remote Control Option	700412-700-001 700412-700-002	<p>The MSR 8050A Remote Control option comes in three basic configurations. The Remote FSK Modem Option and/or the Addressable Audio I/O option can be added. Table 1.4 shows what features are provided for each configuration. The remote control options are factory-installable. See Section 6 for complete information.</p>

**Table 1.3 OPTIONAL EQUIPMENT - NOT SUPPLIED (Cont.)**

ITEM	MACKAY PART NO.	DESCRIPTION/USE
CSW 1200 Control Software	Consult factory.	The CSW 1200 is computer software which allows an IBM compatible computer to control a system of MSR 8050A transceivers. As many as 99 MSR 8050As may be connected in a system and controlled by this software.
Cable Assemblies		See Table 1.5. Cable assemblies are available for all standard system configurations. Cables available are completely wired with necessary mating connectors at each end, or unterminated cable may be ordered for assembly by customer using connectors furnished in Mackay equipment accessory kits. Please specify length desired.
Antenna Assemblies		See Table 1.6. Various antennas and mounting hardware kits are available.

**Table 1.4 REMOTE CONTROL OPTIONS**

OPTION	REMOTE CONTROL FEATURES
Standard Radio	<p>RS-232C, RS-422, RS-423, MIL-STD-188            Controlled by MSR 6420 remote control unit, a computer, or both. Up to 100 radios can be controlled together in a system.</p>
Remote FSK Modem Option P/N 700412-700-001	<p>Adds: (Tone Key/Modem board P/N 602025-536-002)            300 Baud FSK Remote Control (single remote control unit (RCU), single radio or multi-RCU, single radio)            Tone keying: High speed remote control of exciter keying using keying tone on standard audio line.            Controlled by MSR 6420 or MSR 6420 and a computer.</p>
Addressable Audio I/O Option P/N 700412-700-002	<p>Adds: (Audio I/O board P/N 700025-536-001)            Switched audio: Multiple transceivers can be connected on an audio bus. Remote control audio is sent only to the selected radio.            Controlled by MSR 6420 RCU or MSR 6420 and a computer.</p>
Remote FSK Modem and Addressable Audio I/O P/Ns 700412-700-001 & 700412-700-002	<p>Adds: (Audio I/O board P/N 700025-536-001, Tone Key/Modem board P/N 602025-536-002)            Tone keying            Switched audio            300 Baud FSK control in multi-radio configurations. Can be remote-controlled by a single two-conductor line "daisy-chained" from one radio to the next. Controlled by MSR 6420 RCU or MSR 6420 and a computer.</p>
Data Filter Option P/N 700425-700-001	<p>This option substitutes controlled group delay filters (per TADIL-A specs) for the USB, LSB filters in the standard radio.</p>

**Table 1.5 CABLE ASSEMBLIES**

<u>MSR 8050A to MSR 4020A Antenna Coupler</u>			
Control Cable		Assembled	600686-540-xxx
		Raw Cable	600069-102-009
RF Coaxial Cable	RG-58/U	Assembled	600491-540-xxx
		Raw Cable	600016-102-001
	RG-213/U	Assembled	600492-540-xxx
		Raw Cable	600017-102-001
<u>MSR 8050A to MSR 1020 or MSR 1030 LPA</u>			
Control Cable		Assembled	601034-540-xxx
		Raw Cable	600069-102-010
RF Coaxial Cable	RG-58/U	Assembled	600491-540-xxx
		Raw Cable	600016-102-001
	RG-213/U	Assembled	600492-540-xxx
		Raw Cable	600017-102-001
Please specify desired cable length. Maximum recommended length:			
Control Cable	200 feet		
RG-58/U Coax	50 feet		
RG-213/U Coax	250 feet		
<u>MSR 8050A to MSR 4040 Digital Antenna Coupler</u>			
Control Cable		Assembled	700035-540-xxx
		Raw Cable	700001-102-001
RF Coaxial Cable	RG-58/U	Assembled	600491-540-xxx
		Raw Cable	600016-102-001
	RG-213/U	Assembled	600492-540-xxx
		Raw Cable	600017-102-001
<u>MSR 8050A to MSR 4020A</u>			
Control Cable		Assembled	601035-540-xxx
		Raw Cable	600069-102-009
RF Coaxial Cable	RG-58/U	Assembled	600491-540-xxx
		Raw Cable	600016-102-001
	RG-213/U	Assembled	600492-540-xx
		Raw Cable	600017-102-001
Please specify desired cable length. Maximum recommended length:			
Control Cable	250 feet		
RG-58/U Coax	50 feet		
RG-213/U Coax	250 feet		

**Table 1.6 ANTENNA ASSEMBLIES**

<b>150 Ft. Longwire</b> Includes wire, insulators, eye bolts, rope and instructions.	<b>P/N 600233-817-007</b>
<b>150 Ft. Dipole, MSR 7000</b> Pre-assembled antenna with 40 ft., 450 ohm twin lead feed line, no masts.	<b>P/N 600034-398-001</b>
<b>150 Ft. Dipole, MSR 7001</b> Includes MSR 7000 150 ft. antenna, 40 ft. mast, guys, hardware, instruction manual and carrying case.	<b>P/N 600185-700-001</b>
<b>150 Ft. Dipole, MSR 7002</b> Same as MSR 7001, but with two masts.	<b>P/N 600185-700-002</b>
<b>32 Ft. Whip</b> Rugged, self-supported, eight section tapered fiberglass antenna. Requires flange-mount base, P/N 600018-398-007.	<b>P/N 600018-398-001</b>
<b>Antenna Mounting Base</b> Flange-mounted base for use with 32 foot whip, P/N 600018-398-001.	<b>P/N 600018-398-007</b>

## SECTION 2

### INSTALLATION

#### 2.1 GENERAL

Installation of the MSR 8050A transceiver is fast and simple, as the unit is completely wired, tested and calibrated prior to shipment from the factory. This section provides procedures for unpacking, inspecting and, if necessary, reshipping.

#### 2.2 UNPACKING AND INSPECTION

Unpack the transceiver and make certain all the equipment outlined in Table 1.2 is present. Retain the carton and packing material until the contents have been inspected. If there is evidence of damage, do not attempt to use the equipment. Contact the shipper and file a damage claim.

#### 2.3 RESHIPPING

If return of the equipment becomes necessary, a Returned Material (RM) number must first be obtained from the MACKAY Customer Service Department. This number must be clearly marked on the outside of the carton.

#### 2.4 UNIT INSTALLATION

Thoroughly plan the locations of the transceiver and associated equipment and carefully follow all installation considerations. Satisfactory system performance depends on the care and attention taken prior to and during installation. The protective covers installed on the transceiver connectors should remain over unused connectors. See Figure 2.1 for transceiver outline dimensions.

##### 2.4.1 REAR PANEL

All external connections are made on the transceiver rear panel. Mounted on the rear panel are the following connectors:

a) AC POWER - This is a standard AC power connector.

b) AC Power Line Filter Assy - P/N 700006-537-001

c) GROUND - This is a 1/4-20 chassis ground stud.

d) ANTENNA - This is an SO-239 type coaxial rf connector.

e) ACCESSORY - This is a 55-pin twist-lock connector for connection of the linear power amplifier or the antenna coupler.

**NOTE:** If no accessories are connected, then an interlock bypass connector P/N 702007-608-001 (supplied with the accessory kit) must be connected to J38.

f) SIGNAL IN/OUT - This is a female miniature "D" connector containing signals for external equipment interface.

g) RS 232/PRESELECTOR - This is a male miniature "D" connector containing signals for optional RS 232/422/423/MIL-STD-188 interface or preselector interface.

h) 600 OHM AUDIO IN/OUT - This is also a male miniature "D" connector containing all 600 ohm balanced audio lines for voice and data, and audio for 2-wire or 4-wire remote control when the optional Audio I/O board is included.

i) REF IN/OUT - This is a BNC coaxial rf connector for the 5 MHz reference oscillator. The rear panel switch determines whether this is an input or an output.

j) PA FAN - This is the connector into which the PA fan connector is plugged.

##### 2.4.2 INSTALLATION CONSIDERATIONS

###### 2.4.2.1 Antenna Site Location

For optimum radiation characteristics as well as safety, the antenna should be mounted high enough to clear any surrounding obstructions.

The antenna should also be located as far as possible from nearby objects such as power lines, buildings, etc. Figures 2.2 and 2.3 show typical whip and longwire antenna installations.

#### 2.4.2.2 Grounding

Provide the best possible rf ground for both the transceiver and the antenna coupler. Use a flat copper strap 25 mm wide or copper wire AWG #6 or larger. Connect it to the ground terminal at the rear of the transceiver and on the coupler ground. Leads to the ground system should be as short as possible.

#### 2.4.2.3 Separation of Antenna and Transmitter

Provide maximum separation between the coupler output (antenna) and the transceiver. The MSR 4040 digital coupler may be mounted up to 76 meters (250 feet) from the transceiver when RG-213U or RG-8U coaxial cable is used. For runs under 15 meters (50 feet), RG-58 A/U cable may be used.

#### NOTE

**Transmitters may oscillate if rf power is radiated or conducted into low level stages. Evidence of this condition is erratic or excessive rf output. The cause is the close proximity of the antenna to the transmitter and/or poor rf grounds.**

#### 2.4.2.4 Antenna Lead-in

The lead-in from the coupler to the antenna must be insulated for at least 10 kV potential and should not run parallel to metal objects bonded to ground. The coupler should be as close as possible to the antenna and never more than 1 meter away or antenna efficiency may be degraded.

#### 2.4.3 BASE STATION INSTALLATION

The transceiver may be installed in its own optional cabinet for tabletop mounting or can be installed in a communications rack or console. It is important to provide adequate ventilation for the heatsink. Clearances on the order of 25 mm

minimum on the sides and 50 mm minimum at the top and rear should be provided. If the heatsink gets too hot, the rf power will automatically be reduced.

#### 2.4.3.1 Rack Mount Installation

The transceiver may be conveniently mounted in a standard 19 inch rack using the transceiver rack mount kit (P/N 600078-700-001). This kit includes a pair of rack slides and associated hardware. The transceiver in the rack-mounted configuration requires a standard panel space of 13.21 cm (5.2 inches).

The front panel is not designed to support the transceiver when the unit is installed in an equipment rack. Rack slides should be used to support the transceiver when rack-mounted.

#### CAUTION

***Do not support the transceiver by the chassis bottom in such a way as to restrict the air flow over the heatsink.***

If installation assistance is needed, consult the MACKAY Customer Service Department.

#### 2.4.4 MARINE INSTALLATIONS

The transceiver is NOT weather, splash and corrosion resistant and should not be installed where it is exposed to the elements. It should be installed in a well-ventilated area away from heat sources such as heating vents, etc. The installation location should be as close as possible to the power source and grounding point.

IT IS RECOMMENDED THAT THE TRANSCEIVER BE SECURELY GROUNDED, as poor grounding can degrade performance. With a metal hull, the transceiver may be grounded directly to the vessel's structure. With a wood or fiberglass hull, a ground/counterpoise system must be constructed. The counterpoise should have as much surface area as possible, i.e., about 9.5 square meters (100 square feet) should be provided for 2 MHz operation. A reasonably good ground can be achieved by bonding together several large metal objects. Two or three

wide copper straps, running as far as possible within the hull, should be bonded to this ground together with three or four cross members. Ground plates may be effective on lower frequencies but are subject to fouling, so are not recommended. Figure 2.4 shows a typical ground/counterpoise system.

## 2.5 ANTENNAS AND GROUND SYSTEMS

The transceiver is designed to drive a 50 ohm resistive antenna system with a 2:1 VSWR maximum. When used with a companion coupler like the MSR 4040, the system will drive virtually any HF antenna system from nine foot vehicular whips to 150 foot long wires.

### **CAUTION**

***The antenna radiates dangerous rf voltages which can cause burns and injury. Do not touch the coupler antenna terminal or the antenna while the unit is transmitting.***

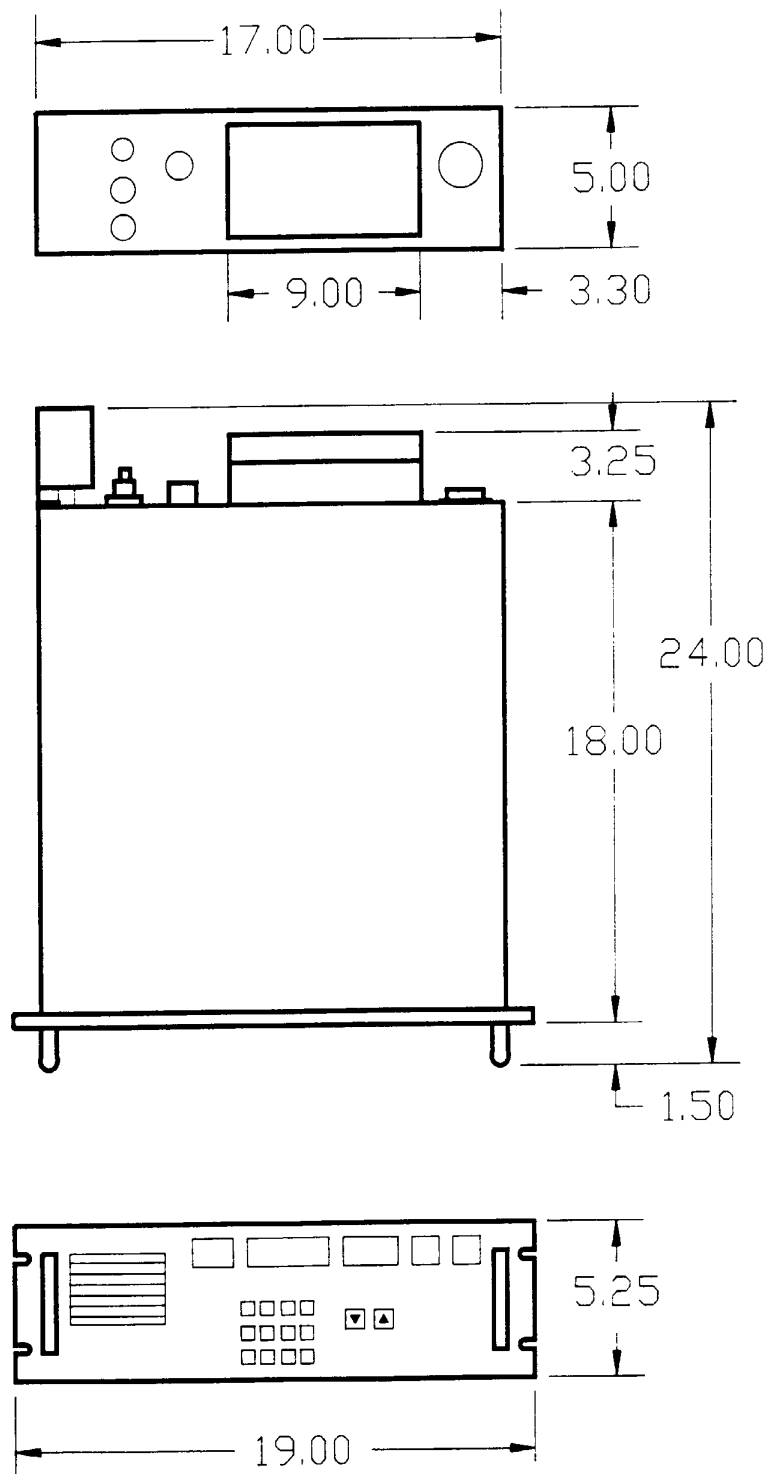
General things to consider when installing an antenna system are:

a) Keep the antenna clear of all large objects such as trees and buildings. Be particularly careful to avoid locating the central radiating part of the antenna near metallic objects.

b) Install the longest antenna length that can be practically realized in your installation. A short whip is a poor choice for a base station antenna because of its poor efficiency at low frequencies, where most station-to-base communications are made. Vehicles are forced to use short whips because of physical size restrictions, however you should be aware of the decreased antenna efficiency.

c) Every antenna requires a GOOD grounding system to operate at its peak efficiency. Otherwise, power is wasted in dissipation in the transmitter, coupler, and transmission line and is not radiated by the antenna. Generally, if poor performance is obtained from a properly-selected antenna, the culprit is an inadequate or poorly-designed ground system.

See the MSR 4040 digital antenna coupler manual for a discussion of narrow-band and non-resonant random length antennas.



**Figure 2.1 TRANSCEIVER OUTLINE DIMENSIONS**

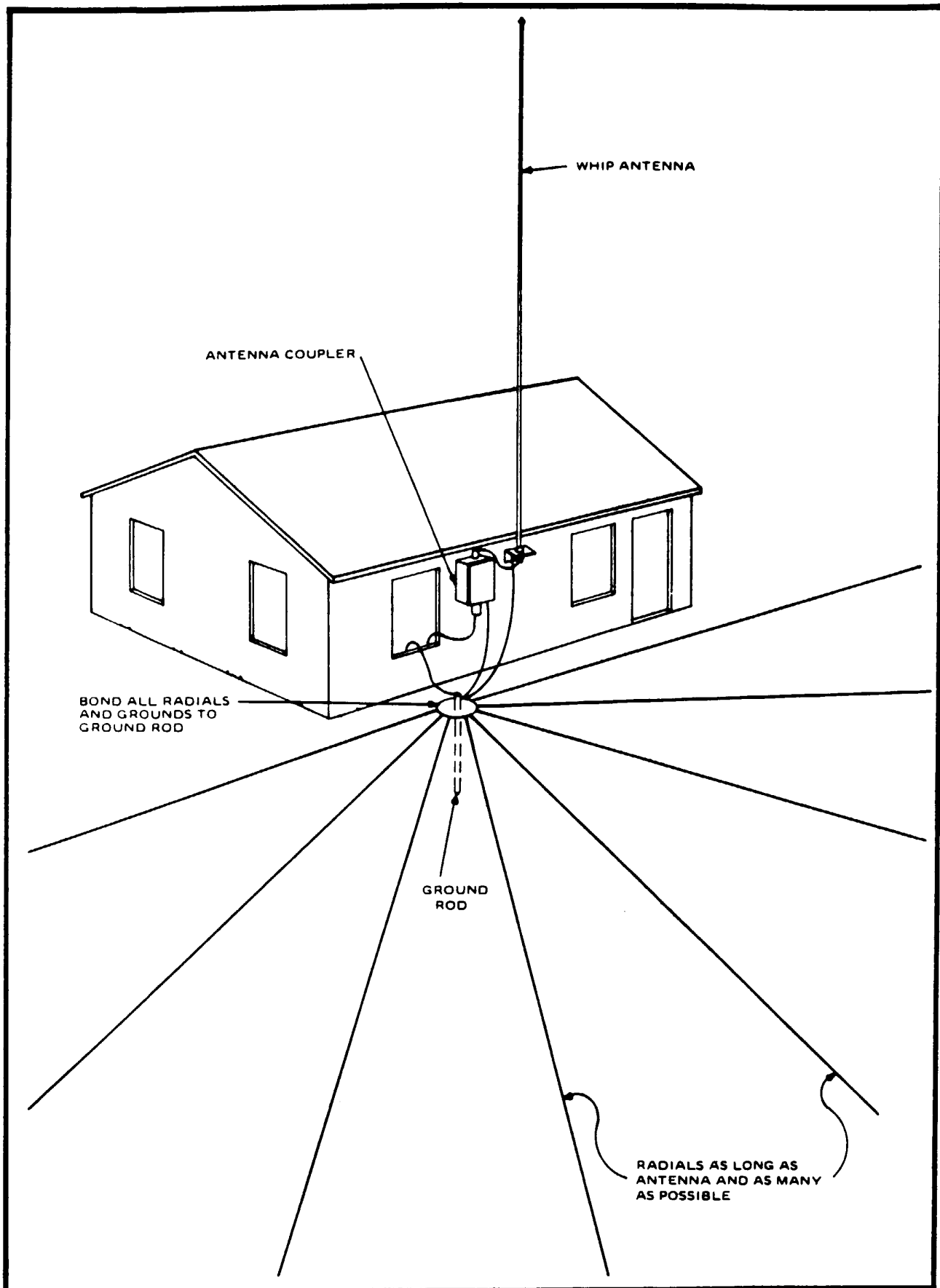


Figure 2.2 TYPICAL WHIP ANTENNA INSTALLATION

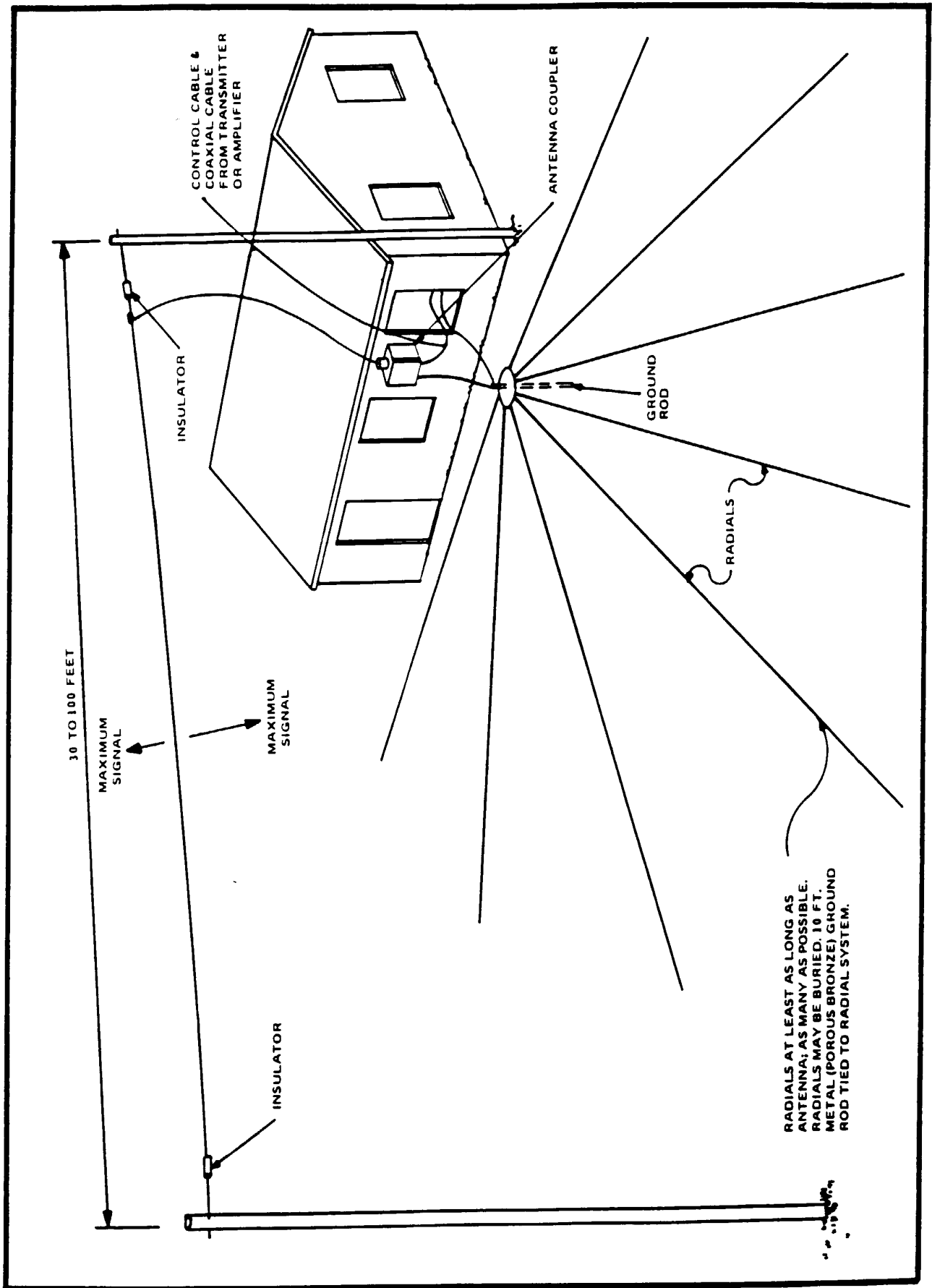
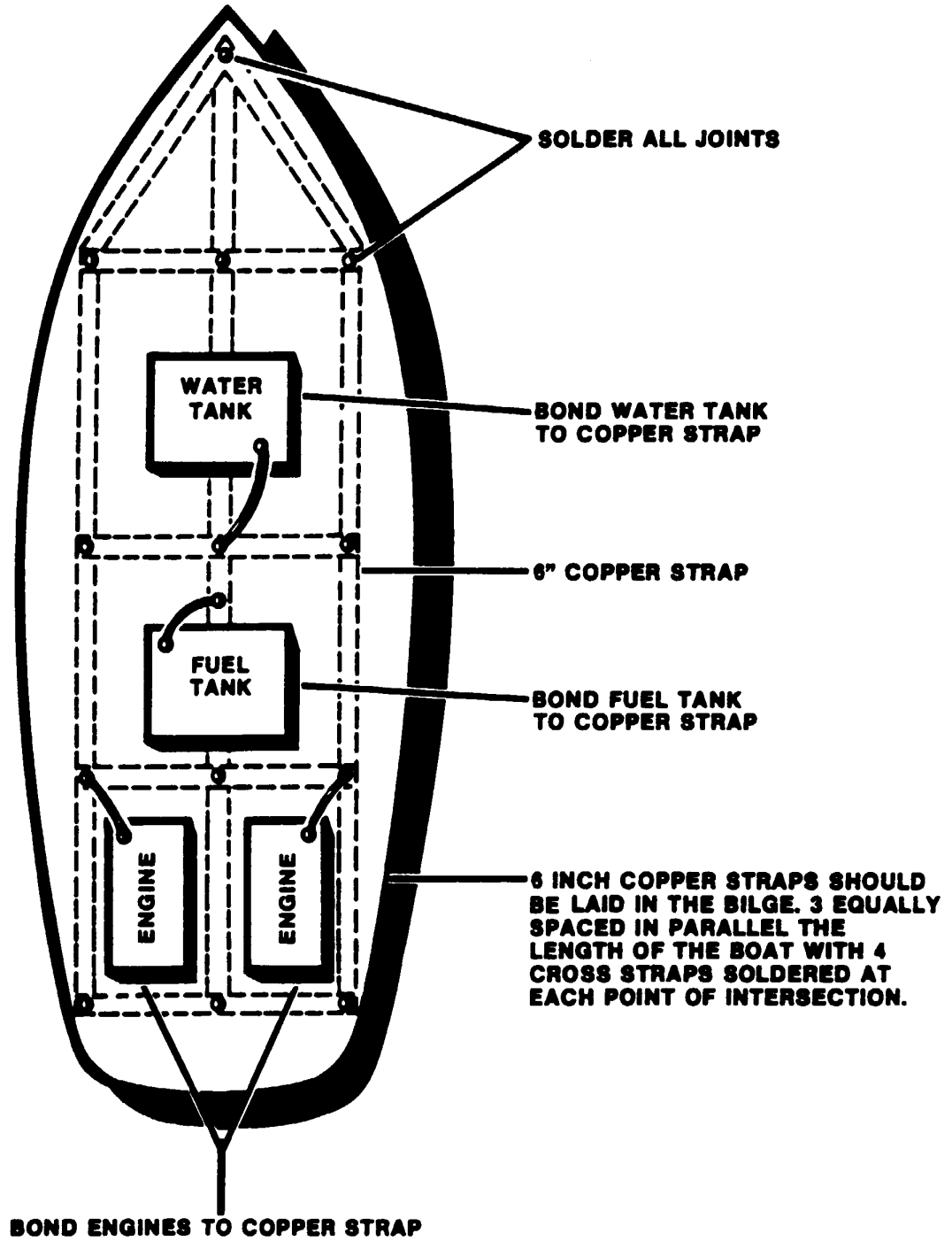


Figure 2.3 TYPICAL LONGWIRE ANTENNA INSTALLATION



**Figure 2.4 TYPICAL GROUND/COUNTERPOISE INSTALLATION**

**Table 2.1****MATING CONNECTORS TO TRANSCEIVER AND ACCESSORIES**

DESCRIPTION	DESIGNATOR	MATING PARTS	
		MIL	MACKAY PART NO.
Microphone/CW	1A1J1	U-229/U	600388-606-002
Antenna	1A2J34	PL-259	600244-606-002
RS-232/ Preselector	1A2J35	DB-25S	600292-606-005
600Ω In/Out	1A2J36	DB-25S	600292-606-005
Signal In/Out	1A2J37	DB-25p	600292-606-006
Accessory	1A2J38	MS3126F-22-55P	600478-606-007
PA Fan	1A2J41	AMP 126-217	600377-606-001

**Table 2.2 ACCESSORY CONNECTOR (J38) PIN ASSIGNMENTS**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
A	Ext. Reflected Pwr	I	This is an analog input to the front panel meter which normally carries reflected power voltage from an antenna coupler or LPA.
B	/Band 2	O	This pin goes low when Band 2 is selected. See pin Y.
C	/Channel "2"	O	This pin goes low when the 2 bit is called for in channel selection.
D	ALC	I	This is an analog input for control of the rf power output of the transceiver in all modes except AME. It is normally used with the LPA for feedback control of system power output.
E	/Medium Power	O	When used with an MSR 1020 LPA, a low on this line will limit output power to 500W (level 3).
F	/TX2	O	This line is low when the exciter is keyed.
G	/Key Interlock	I	This line must be held low to allow the transmitter to be keyed.
H	/Silent Tune	O	This line is used only with the MSR 4030 1 kW coupler. A low on this line puts the coupler in silent tune mode.
J	/Band 8	O	Whenever band 8 is selected, this line goes low. See pin Y.
K	/Coupler Bypass	O	This line is used only with the MSR 4030 coupler. Pressing the Bypass key on the front panel takes this line low, bypassing the coupler in receive mode only.
L	/ALC Ground	I	This is the reference ground for external ALC and ACC.
M	/Band 3	O	Whenever band 3 is selected, this line goes low. See pin Y.

**Table 2.2 ACCESSORY CONNECTOR (J38) PIN ASSIGNMENTS (Cont.)**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
N	/Channel "1"	O	This line goes low whenever the "1" bit is called for in channel select.
P	/Fault	I	When this line is pulled low by the antenna coupler, the front panel FAULT light will come on.
R	/Tuning	I	This line comes from the coupler. A low on this line indicates that the coupler is tuning and will light the front panel TUNING lamp. Pulling this line low causes the MSR 8050A to initiate a TUNE cycle.
S	Ground	O	This is the reference ground for all digital signals and power voltages available at this connector.
T	+26.4 VDC	O	Accessory power source, fused for 5 A.
U	Spare	---	Spare
V	/Tune	O	A low on this line to the antenna coupler will initiate a TUNE cycle.
W	/Band 6	O	This line is low whenever band 6 is selected. See pin Y.
X	LPA On	O	A high on this line will turn on the 1020 LPA in power levels 3 or 4.
Y	/Band 1	O	This line is low whenever band 1 is selected. These band lines select the proper harmonic filter in the MSR 1020 LPA: Band 1 = 1.6-1.9999 MHz Band 2 = 2.0-2.9999 MHz Band 3 = 3.0-3.9999 MHz Band 4 = 4.0-5.9999 MHz Band 5 = 6.0-8.9999 MHz Band 6 = 9.0-12.9999 MHz Band 7 = 13.0-19.9999 MHz Band 8 = 20.0-29.9999 MHz Only one of these lines should be low at any one time.

**Table 2.2 ACCESSORY CONNECTOR (J38) PIN ASSIGNMENTS (Cont.)**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
Z	/Channel "40"	O	This line is low whenever the "40" bit is called for in channel select.
a	/Coupler Enable	I	This line must be held low to allow the transceiver to initialize a coupler tune mode.
b	/Key Enable	I	The antenna coupler takes this line low to key the transmitter during a coupler tune cycle.
c	/Channel "8"	O	This line goes low whenever the "8" bit is active in channel selection.
d	/Surveillance Tune	O	Used only with the MSR 4030 Coupler. A low on this line puts the coupler in surveillance tune mode.
e	/Band 7	O	This line is low whenever band 7 is called for. See pin Y.
f	ACC	I	This is the analog input from the MSR 1020 LPA to control the AM carrier level.
g	/READY	I	This is a signal from the antenna coupler that turns on the front panel READY light when taken low.
h	/Band 4	O	This line is low whenever band 4 is called for. See pin Y.
i	/Band 5	O	This line is low whenever band 5 is called for. See pin Y.
k	Not Used		
m	Ground	O	This is reference ground for all digital and power voltages available at this connector.
n	+26 VDC	O	Accessory power source fused at 5 A.
p	/Channel "20"	O	This line is low whenever the "20" bit is called for in channel select.

**Table 2.2 ACCESSORY CONNECTOR (J38) PIN ASSIGNMENTS (Cont.)**

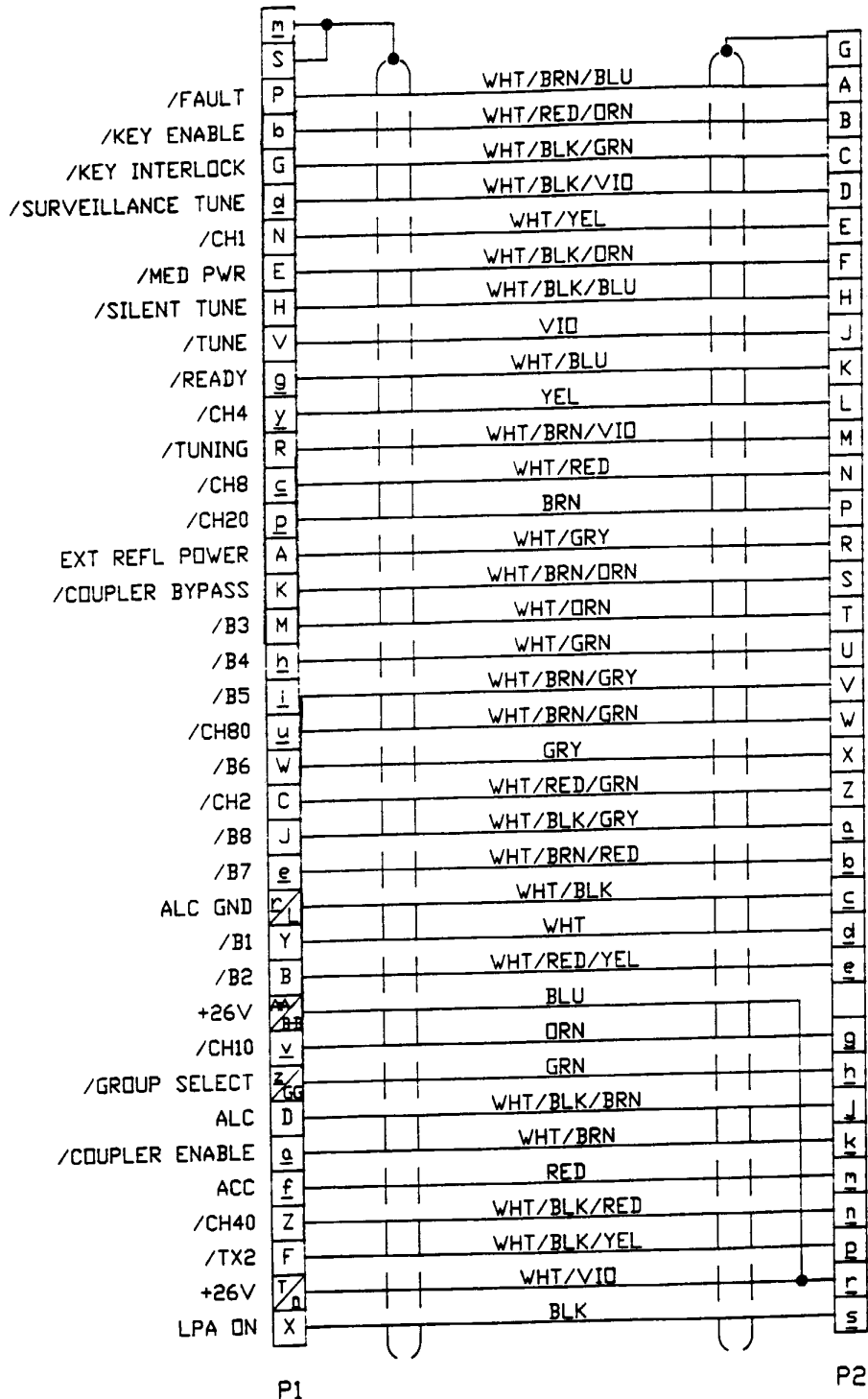
PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
r	ALC Ground	O	This is the reference ground for the external ALC and ACC voltages.
s	Spare	---	Spare
t	Spare	---	Spare
u	/Channel "80"	O	This line is low whenever the "80" bit is called for in channel select.
v	/Channel "10"	O	This line is low whenever the "10" bit is called for in channel select.
w	Not Used		
x	/Low Power	---	This is not presently used.
y	/Channel "4"	O	This line is low whenever the "4" bit is called for in channel select.
z	/Group Select	O	This pin is grounded allowing the MSR 4030 coupler to accept channel information from Ch 1 to 96.
A-A	+26.4 VDC	O	Accessory power source fused at 5 A.
B-B	+26.4 VDC	O	Accessory power source fused at 5 A.
C-C	Spare	---	Spare.
D-D	Spare	---	Spare.
E-E	Spare	---	Spare.
F-F	Spare	---	Spare.
G-G	/Ground	---	

Table 2.3

MSR 8050A TO MSR 1020 INTERCONNECT CABLE  
37 PIN TO 55 PIN CONVERSION

MSR 8050A 1A2J38  
MS 3126F-22-55P

MSR 1020 CONNECTION J1  
MS 3106A-28-21S

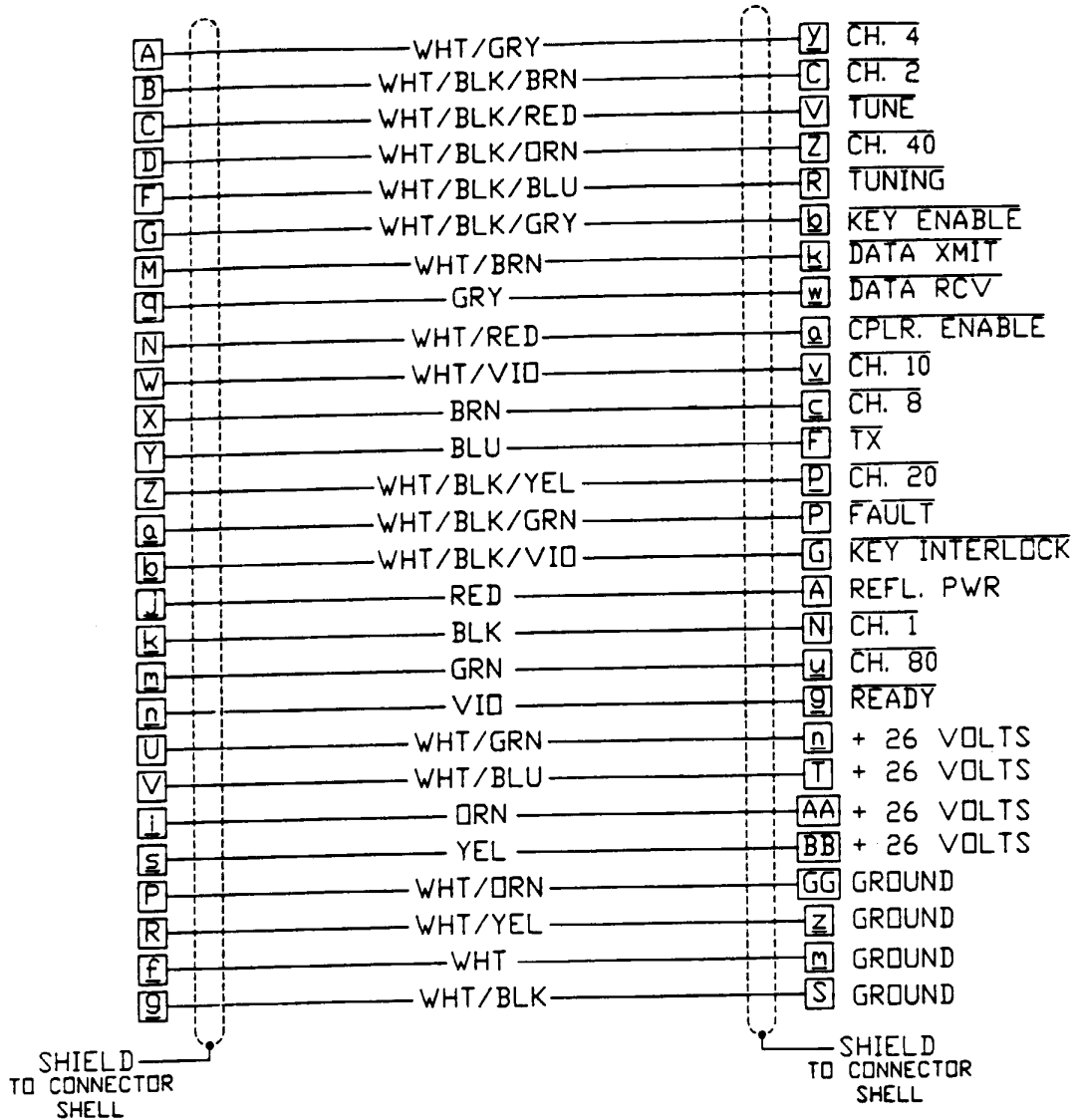


**Table 2.4**

**MSR 4040 to MSR 8050A INTERCONNECT CABLE**

MSR 4040  
MS 3126F-20-41S

MSR 8050A  
MS 3126F-22-55P



**Table 2.5 SIGNAL IN/OUT CONNECTOR (J37) PIN ASSIGNMENTS**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
1	+13 VDC	O	DC Output (50 ma max.)
2	Spare	---	Spare
3	Spare	---	Spare
4	+26 VDC	O	DC Output
5	Spare	---	Spare
6	Spare	---	Spare
7	/Power On	O	Power turn on (logic low)
8	Spare	---	Spare
9	/Mute	I	Mute signal input (logic low)
10	Spare	---	Spare
11	Spare	---	Spare
12	Ground	O	Ground
13	Ground	O	Ground
14	Spare	---	Spare
15	Spare	---	Spare
16	Spare	---	Spare
17	/Tx2	O	Logic low when keyed
18	/Ext Key	I	Logic low keys transmitter
19	AGC	O	AGC voltage monitor
20	(Key Pin)	---	(Connector key pin)
21	+5 VDC	O	DC Output (50 ma max.)
22	/Scan Det (out)	O	Logic low when station detected
23	/Scan Stop (in)	I	Ext logic low stops scan
24	Spare	---	Spare
25	Spare	---	Spare

**Table 2.6 PA FAN CONNECTOR (J41) PIN ASSIGNMENTS**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
A	+26.4 VDC	O	Supply voltage for blower operation
B	Fan on	O	Output from the unit telling fan when to operate
C	Ground	O	Reference ground for the fan supply

**Table 2.7**

**600 OHM AUDIO IN/OUT CONNECTOR (J36) PIN ASSIGNMENTS**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
1	(Key Pin)	---	(Connector key pin)
2	* Cont Stat C	O	Control Status
3	* Cont Stat D	O	Control Status
4	** /Key Int'lock	I	Line must be low to key xmtr
5	/Ext Key	I	Logic low will key xmtr
6	* Sw Std 4W RxA	O	
7	* Sw Std 4W RxB	O	
8	* Sw Std 4W TxA	I	Also Sw Std 2W A
9	* Sw Std 4W TxB	I	Also Sw Std 2W B
10	/Mute	I	Logic low will mute rcvr
11	/FSK	O	Logic low when FSK selected
12	/FSK Key	I	Logic low keys xmtr in FSK Mode
13	Ground	O	Ground
14	/Data	O	Logic low when DATA selected
15	Cont Stat A	I	Control Status
16	Cont Stat B	I	Control Status
17	Tx Data/FSK A	O	600Ω bal. xmit data
18	Tx Data/FSK B	O	600Ω bal. xmit data
19	Rx Data/FSK A	I	600Ω bal. rcv data
20	Rx Data/FSK B	I	600Ω bal. rcv data
21	Rx Voice B	O	600Ω bal. rcv voice
22	Rx Voice A	O	600Ω bal. rcv voice
23	Tx Voice B	I	600Ω bal. xmit voice
24	Tx Voice A	I	600Ω bal. xmit voice
25	/Scan Stop	I	Ext logic low stops scan

**NOTE:** \* available only with optional addressable Audio I/O board  
 \*\* accessible through jumper JP4 on Mother board (Table 4.7)  
 "/" before signal name denotes TTL low to accomplish signal function

**Table 2.8 MICROPHONE/CW CONNECTOR (J1) PIN ASSIGNMENTS**

PIN DESIGNATION	SIGNAL NAME	I/O	DESCRIPTION
A	Ground	O	This is the reference for PTT, microphone audio and receive audio.
B	Receive Audio	O	This line is connected directly to pin 11 of J42 and provides receive audio to the handset.
C	/Push to Talk (PTT) or CW Key	I	This is an active low that keys the transmitter.
D, E	<p>Microphone Audio In</p> <p>High Level Dyn Mic P/N 600352-713-001</p> <p>Low Level Dyn Mic P/N 600002-388-001</p> <p>Carbon Mic P/N 600014-386-001</p>	I	<p>Pins are paralleled. Input characteristics are determined by the CAR/DYN switch on the Mother board and JP1 on the Transmit Modulator board.</p> <p>Mother board switch in DYN pos. 200 mVRMS produces rated power.</p> <p>Mother board switch in CARBON pos. 1 mVRMS will produce rated power with JP1 in 2-3 position.</p> <p>Mother board switch in CARBON pos. 100 mVRMS will produce rated power with JP1 in 1-2 position.</p>

Table 2.9

REMOTE CONTROL/PRESELECTOR CONNECTOR (J35) PIN ASSIGNMENTS

PIN DESIGNATION	SIGNAL NAME		I/O	DESCRIPTION
	Presele	Remote		
1	1M4		O	4 MHz bit
2	Gnd	Gnd	O	Ground
3		RxB Bal	O	Receive line B, balanced
4		TxB	I	Transmit line B (unbal to gnd)
5	1M8			8 MHz bit
6		TxB Bal	I	Transmit line B, balanced
7		RxA Bal	O	Receive line A, balanced
8		TxA Bal	I	Transmit line A, balanced
9		RxA	O	Receive line A (unbal to gnd)
10		TxA	I	Transmit line A (unbal to gnd)
11	100k1			100 kHz bit
12	10k1			10 kHz bit
13	100k2			200 kHz bit
14	1M2			2 MHz bit
15	1M1			1 MHz bit
16	10M2			20 MHz bit
17	10M1			10 MHz bit
18		RxB	O	Receive line B (unbal to gnd)
19		<u>TX2</u>		This output goes low during transmit.
20	<u>Tx.PSL</u> BYPASS			This output goes low during transmit or when preselector is bypassed in receive.
21	10k8			80 kHz bit
22	100k8			800 kHz bit
23	10k4			40 kHz bit
24	100k4			400 kHz bit
25	10k2			20 kHz bit

**NOTE:** This connector contains both remote control signals and preselector control signals. Two ports "A" and "B" are provided for multiradio daisy-chain operation per RS-232,423,MIL-STD-188. Additional balanced lines are used per RS-422. Preselector control signals produce a BCD equivalent to the radio tuned frequency by 5 VOLT CMOS "highs" on the appropriate pins.

A line over the signal name (xxx) denotes TTL low to accomplish signal function.

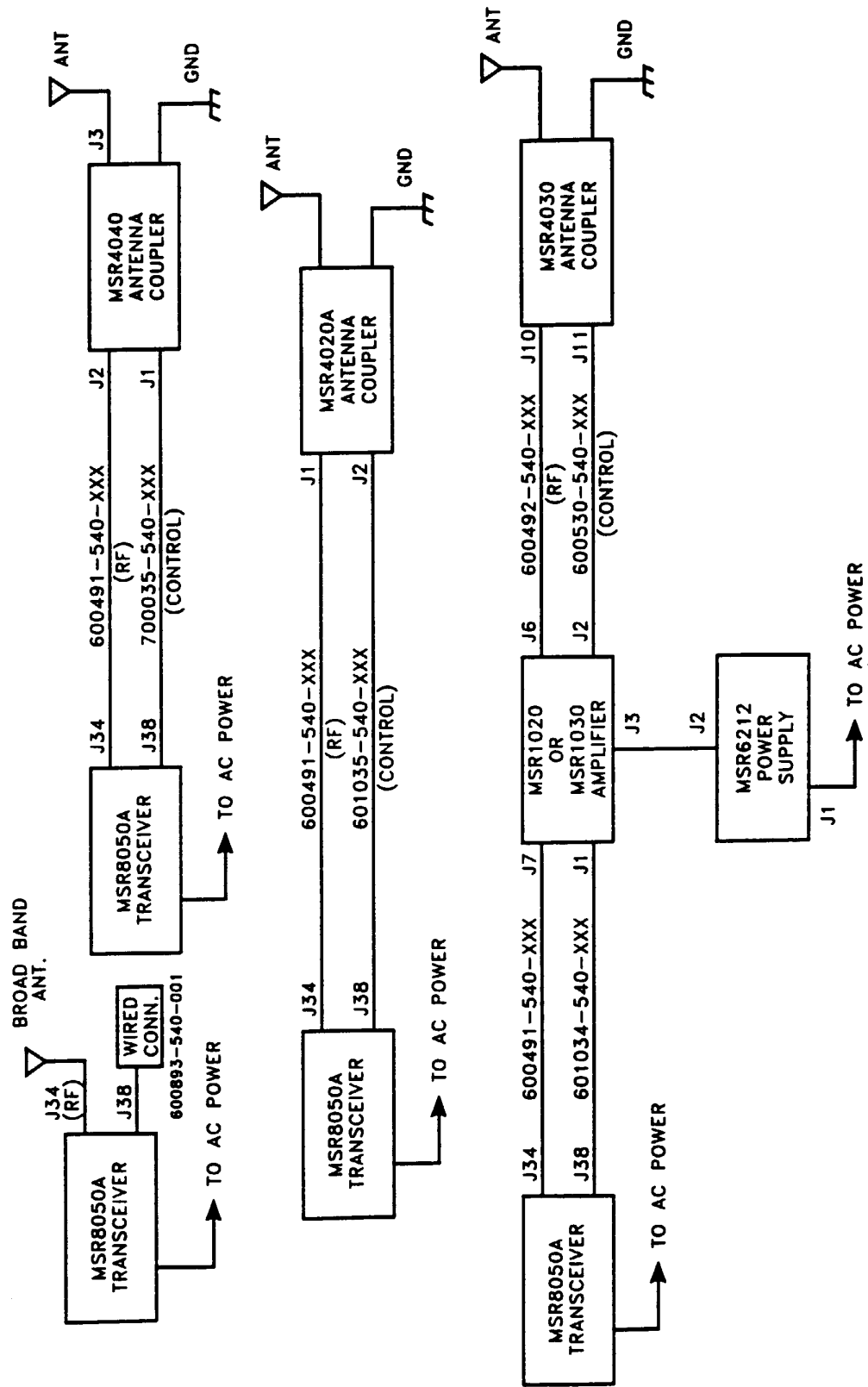


Figure 2.5 SYSTEM INTERCONNECT DIAGRAM

## SECTION 3

### OPERATION

#### 3.1 GENERAL

This section describes the control and connector functions and gives complete operating instructions for the transceiver.

#### 3.2 FRONT PANEL CONTROLS AND SWITCHES

Refer to Figure 3.1 for control locations.

##### NOTE

**Some front panel function switches contain LEDs (Light Emitting Diode) to indicate when that function is active.**

##### 3.2.1 MIC/CW CONNECTOR

This connector provides an input for the palm microphone audio and Push-To-Talk. The connector also provides an input port for the CW Key.

##### 3.2.2 PHONE JACK

This jack provides audio for earphones or a headset, controllable by the front panel VOLUME control.

##### 3.2.3 SPEAKER ON/OFF SWITCH

This switch controls the audio to the MSR 8050A internal speaker.

##### 3.2.4 POWER ON/OFF - VOLUME CONTROL

CCW position interrupts primary power to the transceiver. Rotating the control CW will turn the transceiver power on and will increase the speaker volume of the received signal audio.

##### 3.2.5 RF GAIN/SQUELCH CONTROL

The RF Gain control is effective only when the AGC is set to the OFF position. Here it provides a continuous adjustment of RF/IF gain in the re-

ceiver. The syllabic Squelch is engaged by pulling out the knob on this control.

##### 3.2.6 CHANNEL DISPLAY/PUSHBUTTON

Depressing this pushbutton allows the entry of a new channel number. Until two new numbers are selected, the existing channel number will remain in the display. An LED in the CHAN pushbutton will be illuminated indicating that the CHANNEL mode has been entered. When the desired channel number is shown on the display, depressing the "E" button will cause the radio to shift to that new channel. Data in the channels above and below the selected channel may be "scanned" by depressing the CHANNEL pushbutton, then using the "UP" or "DOWN" arrow buttons to change the channel up or down. The data resident in memory for the channel number displayed will be shown in the various displays.

##### 3.2.7 PRIORITY CHANNEL PUSHBUTTON

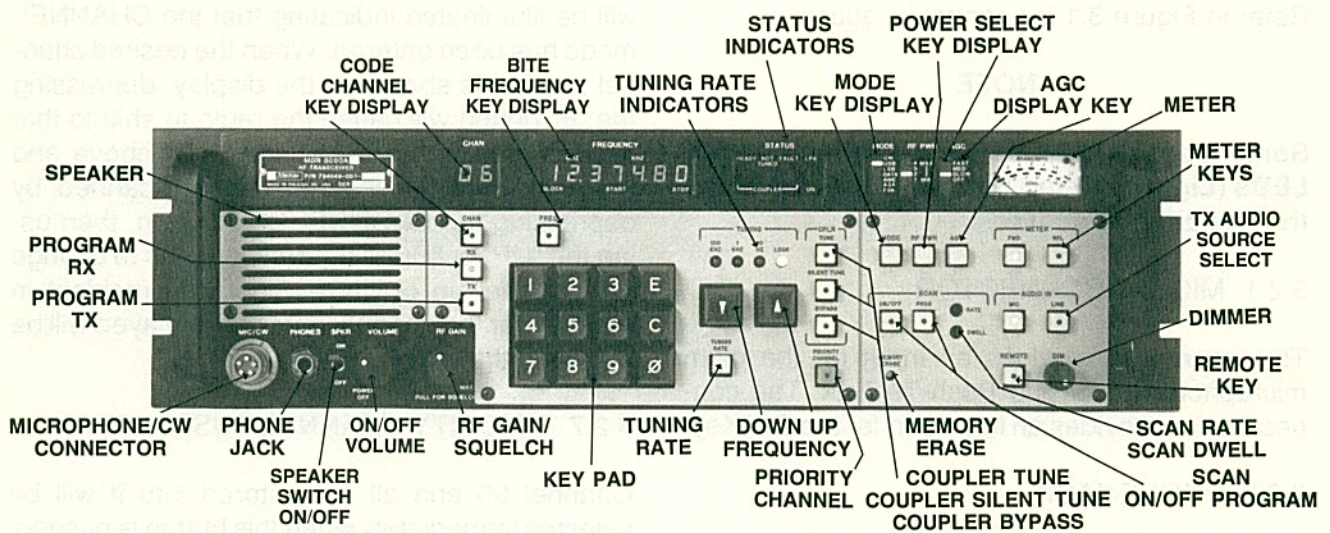
Channel 90 and all data stored into it will be selected immediately when this button is pushed. This is a predetermined special channel to be used in an emergency.

##### 3.2.8 FREQUENCY DISPLAY/PUSHBUTTON

Pressing this button clears the FREQUENCY display and causes the CHAN display to indicate "00", or a "scratch pad" condition for independent frequency entry. After selecting frequency, pressing the "E" key will enter it, while pressing "C" will restore the previously selected channel and frequency. This button is also used during programming sequences to allow selection of frequency.

##### 3.2.9 BUILT-IN TEST EQUIPMENT (BITE)

BITE is exercised each time the equipment power is turned on. This tests for proper operation in the synthesizer, power supply and microprocessor. If a fault is detected, a fault code (see below) is displayed on the front panel ("bite" in the frequency



**Figure 3.1 FRONT PANEL CONTROLS**

display and "E1", "E2", etc. in the channel display) to identify the faulty module. During normal operation, a "background" BITE monitors the power supply voltages and synthesizer. The BITE code is as follows:

E1 = Synthesizer out of lock

E2 = Power Supply failure (other than +5 VDC)

E4 = Memory check sum error ( $\mu$ P fault)

The BITE display will remain even after the fault is cleared until Clear (C), Enter (E), or any key affecting the display is pressed (i.e. **FREQ**, **CHAN**, etc).

### 3.2.10 KEYPAD

The keypad is used to enter the channel and frequency information.

Channel selection is done with two digits. Leading and trailing zeros must be used, that is channel one is entered as 01. The "E" (ENTER) button is pushed to load the new channel into the equipment. The "C" (CLEAR) button will abort the select process and the equipment will revert to the previous selection.

Frequency selection is similar except that only leading zeros need be entered. Again "C" aborts the entry mode.

### 3.2.11 TUNING RATE PUSHBUTTON

Pushing the Tuning Rate button advances the tuning rate of the Up/Down buttons as shown in the TUNING display located immediately above the arrow buttons. The rate will scroll from right to left and back and provides tuning in 10 Hz, 1 kHz and 100 kHz increments, as indicated. When tuning or manual frequency scan is complete, the button should be advanced to LOCK position to prevent receive frequency change caused by inadvertent depression of the Up/Down buttons.

### 3.2.12 UP/DOWN TUNING BUTTONS

These buttons are distinguished by arrows, one pointing up for frequency increase, and the other pointing down for frequency decrease. The re-

ceive frequency of any channel may be varied using these buttons in conjunction with the TUNING RATE pushbutton. The scan rate will increase after about 5 seconds if the button is held in. The frequency will be displayed in the FREQUENCY display window. The original programmed frequency will not change unless reprogrammed, and may be recalled by recalling the channel or depressing the "C" button on the keypad.

### 3.2.13 SCAN ON/OFF PUSHBUTTON

Pushing this button will put the transceiver into CHANNEL SCAN mode. Up to 10 blocks of pre-programmed channels can be scanned automatically in this mode. It can only be activated in Receive mode and when active, its LED will be lit.

### 3.2.14 SCAN PROGRAM PUSHBUTTON

Pressing this button (when the transceiver is in Receive mode) will activate the SCAN PROGRAM mode. Up to 10 blocks of channels with up to 99 channels each can be programmed. The FREQUENCY DISPLAY is used in this mode to define the start and stop channel number of each block to be programmed.

### 3.2.15 SCAN RATE AND DWELL

These two functions are accessible with a small screwdriver through the two front panel holes labelled "Rate" and "Dwell". They allow adjustment of these two parameters. RATE: how often the channel is changed; DWELL: how long a channel is monitored after stopping due to a signal.

### 3.2.16 RX PROG PUSHBUTTON

Depressing this pushbutton shows the receive frequency, AGC and MODE programmed for the selected channel in the FREQUENCY, MODE and AGC displays. This mode is normally automatically selected at the end of a transmission.

### 3.2.17 TX PROG PUSHBUTTON

Depressing this pushbutton shows the transmit frequency, MODE and RF POWER LEVEL programmed for the selected channel in the FRE-

QUENCY, MODE and RF PWR displays. This mode is automatically selected whenever the keyline is grounded and the transmitter energized.

### 3.2.18 MODE PUSHBUTTON AND MODE DISPLAY

The Mode display is an LED bar chart located directly above the Mode pushbutton. Mode may be changed by depressing the Mode pushbutton. The display will increment in an upward direction one Mode position for each momentary push of the button. Mode may be changed at any time using this button, but will not be stored in channel memory unless specifically programmed to do so. In some modes, such as DATA or FSK, two bars will be illuminated. This shows the mode of operation, i.e., DATA, and the sideband being used. The sideband in use may be easily reprogrammed using the "E-1" programming code on the keyboard, selecting the desired sideband using the "C" key and pressing "E" (for Enter). (**NOTE:** "E" and "1" must be depressed within 2 seconds of one another.) If the optional IF Filter board has been installed and a special filter is in place for the selected MODE, i.e., CW, FSK or DATA, it may be selected in the same manner using the "E-1" programming code. In this case, the "C" button will show "SPC" (for Special Filter) in addition to "LSB" and "USB".

### 3.2.19 RF POWER PUSHBUTTON AND RF PWR DISPLAY

The display is located directly above the RF Power pushbutton and indicates the transmit power level being used. When the unit is used without a linear power amplifier (LPA), only positions 1 and 2 are active. Position 1 indicates an output power level of 25 watts and position 2 indicates an output power level of 125 watts. When an LPA is used, position 3 indicates an output power of 500 watts and position 4 indicates the full output of 1 kW. The power level will increment, bottom to top, with depression of the RF Power pushbutton.

### 3.2.20 AGC PUSHBUTTON AND AGC DISPLAY

The AGC display is located directly above the

AGC pushbutton. It will increment, bottom to top, with depression of the AGC pushbutton. Four positions are indicated: Off, Slow, Med and Fast. These indicate AGC decay times; Slow equals 3 Sec nominal, Med equals 200 mSec nominal and Fast equals 30 mSec nominal. The AGC rate is automatically determined when the Mode is selected, but may be changed, if desired, using this button. **NOTE:** Unless the AGC rate change is specifically entered into the information for that channel, it will not be retained the next time that channel is selected.

### 3.2.21 MEMORY ERASE

If this button is pushed the memory of the transceiver will be erased.

### 3.2.22 COUPLER TUNE BUTTON

Momentarily pushing this button initiates an antenna coupler RF TUNE cycle.

### 3.2.23 COUPLER SILENT TUNE PUSHBUTTON

This button is only effective when used with the MSR 4030 1 kW antenna coupler. Momentarily pushing this button will cause the MSR 4030 to position its elements using the position information stored in memory for the selected channel.

### 3.2.24 COUPLER BYPASS PUSHBUTTON

This button also applies to operation with the MSR 4030 antenna coupler when the coupler is fitted with the bypass option. Activating this feature will bypass the reactive elements in the coupler, during receive condition and reconnect those elements during transmit conditions. This may improve receiver signals when a large half duplex split in frequency is employed. Normal coupler operation is restored by depressing the button a second time. When the coupler bypass is active, the LED in the Coupler Bypass pushbutton will be lit.

### 3.2.25 METER PUSHBUTTONS (FWD/RFL)

The meter reading of forward (FWD) or reflected (RFL) transmit power is selected by pushing one of these buttons. The active button will show an

illuminated LED. In receive mode, the meter functions as an "S" meter, indicating relative signal strength of the received signal.

#### 3.2.26 AUDIO IN MIC PUSHBUTTON

Pressing this button selects the audio from the front panel MIC connector (palm microphone) as input for the transmitter and de-selects the 600 ohm rear panel source. When this button has been selected, its LED will be lit.

#### 3.2.27 AUDIO IN LINE PUSHBUTTON

Pressing this button selects the audio from a rear panel accessible 600 ohm source as input for the transmitter and de-selects the front panel mic source. When this button has been selected, its LED will be lit.

#### 3.2.28 DIM CONTROL

This control provides a brightness control for the front panel LED displays. Full CW provides maximum brightness for daytime operation and full CCW gives minimum display intensity for nighttime use.

#### 3.2.29 REMOTE PUSHBUTTON

Pushing this button on the transceiver locks the keyboard (except for PRIORITY CHANNEL) and enables remote control operation. When the radio is in Remote operation, the LED will be lit in the REMOTE pushbutton. A second depression of this button will remove the radio from remote operation and return control to the local keyboard.

### 3.3 REAR PANEL CONTROLS AND CONNECTORS

Refer to Figure 3.2 for locations.

#### 3.3.1 POWER CONNECTOR

This connector accepts a standard AC input of 115 V or 230 V + 15%, 47 to 63 Hz. Operating voltage is selected by a switch in the power supply module. Actual AC input is provided on the AC Filter module which is mounted to the transceiver rear panel.

#### 3.3.2 GROUND STUD

The ground stud is used for making a good rf ground to the transceiver.

#### 3.3.3 PA FAN CONNECTOR (J41)

This connector provides power to the PA fan assembly mounted to the rear panel heatsink.

#### 3.3.4 5 MHZ REFERENCE CONNECTOR (J39)

This BNC connector accepts an input from an external reference source.

#### 3.3.5 5 MHZ INTERNAL/EXTERNAL SWITCH

This switch selects the reference frequency standard to be used with the frequency synthesizer. When in the EXT position, an input from J39 is selected.

#### 3.3.6 ANTENNA CONNECTOR (J34)

This connector provides rf input and output to/from the transceiver. It mates with a standard PL-259 connector.

#### 3.3.7 FUSE

Fuse F1 is a 5 A Slo-Blo type in the 26 VDC supply used by the MSR 4040 digital antenna coupler.

#### 3.3.8 600 OHM INPUT/OUTPUT CONNECTOR (J36)

This connector contains all the 600 ohm balanced audio lines into and out of the transceiver. There are two lines for 600 ohm receive (voice) audio, two lines for 600 ohm transmit (voice) audio, two lines for 600 ohm receive data audio and two lines for 600 ohm transmit data audio. (See Table 2.6 in the previous section for pin assignments). Other functions, such as keyline, scan stop, etc., useful in RTTY or other services, are also provided on this connector. When used with the optional Addressable Audio I/O board, audio for two-wire and four-wire remote operation is provided on this connector.

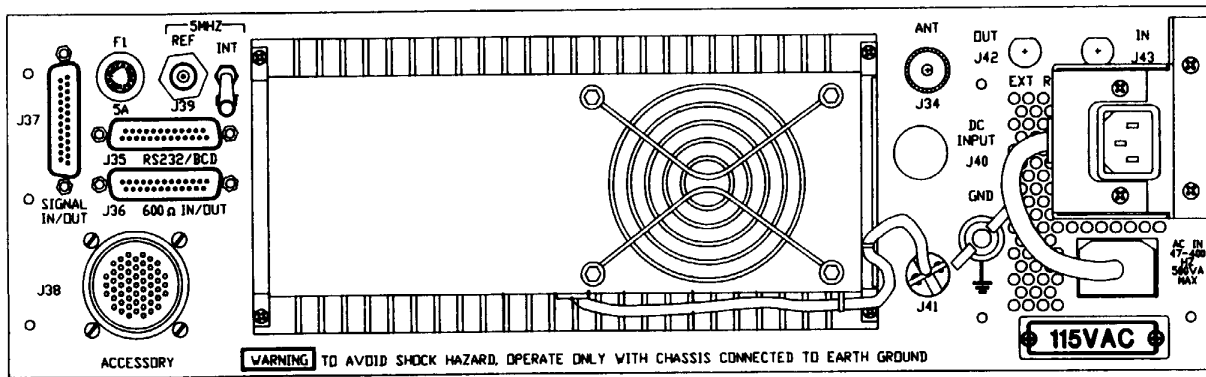


Figure 3.2 REAR PANEL CONTROLS

### 3.3.9 ACCESSORY CONNECTOR (J38)

This connector mates with the MS 3126F-22-55P connector and is used to connect the MSR 1020 linear power amplifier or the MSR 4040 digital antenna coupler to the transceiver. Special interface "pigtail" cables are available to allow use of an existing MSR 6700 accessory cable with the MSR 8050A and to provide direct control of an MSR 4030 1 kW antenna coupler from the transceiver, using an existing MSR 1020 control cable. Consult factory for details.

#### NOTE

**If no equipment is connected, a shorting plug from the accessory kit must be installed to allow transmit operation.**

### 3.3.10 SIGNAL IN/OUT CONNECTOR (J37)

This connector provides signals and voltages for connection of external equipment. See Table 2.4 in the previous section for pin assignments.

### 3.3.11 RS-232 OR BCD REMOTE CONTROL/ PRESELECTOR CONNECTOR (J35)

This connector supplies BCD information from the four most significant digits of the selected frequency for use by the optional preselector. This connector also contains serial transmit and receive ports, balanced and unbalanced, for use with the optional MSR 6420 universal remote control.

### 3.3.12 RF OUT (J42, option)

This is a BNC connector for rf output to the optional preselector.

### 3.3.13 RF IN (J43, option)

This is a BNC connector for rf input from the optional preselector.

### 3.3.14 DC INPUT (J40, option)

This connector is used to connect external +26 VDC and +5 VDC to the transceiver.

## 3.4 OPERATOR INTERNAL CONTROLS

See Figure 3.3 for location of internal controls.

### 3.4.1 LINE VOLTAGE

This control selects a line input of 115 or 230 VAC.

### 3.4.2 FUSES

Internal fuses are for the AC inputs and are 8 A fast-blo types.

### 3.4.3 MICROPHONE

This switch, S1, located on the Mother board, selects carbon or dynamic microphone input from the front panel MIC connector.

### 3.4.4 SCAN DELAY THRESHOLD

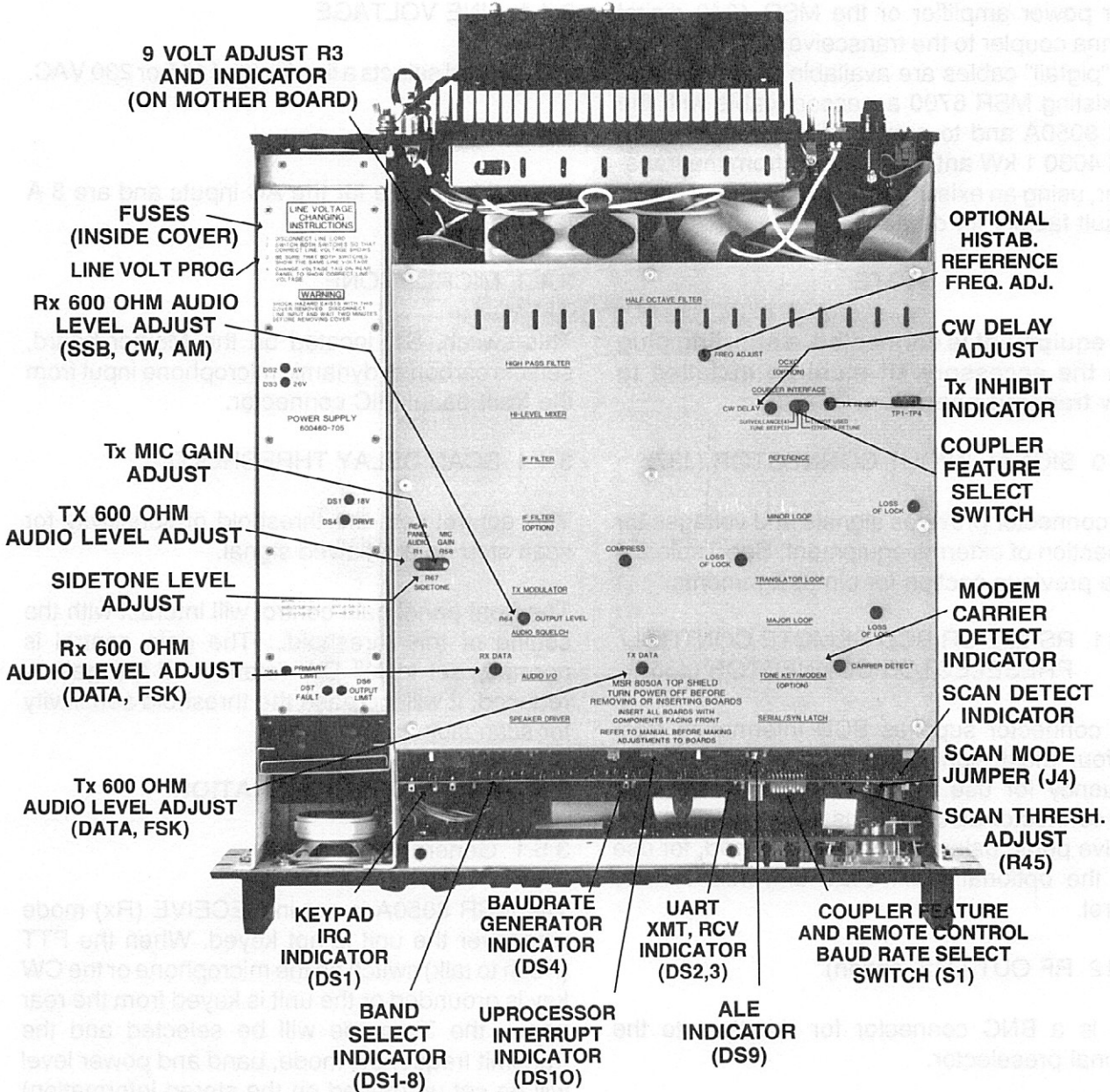
This control sets the threshold of sensitivity for scan stop on a received signal.

The front panel gain control will interact with the setting of this threshold. The gain control is normally set to full CW rotation. If the gain is reduced, it will increase the threshold sensitivity for scan stop.

## 3.5 TRANSCEIVER OPERATION

### 3.5.1 General Procedures

The MSR 8050A is set in RECEIVE (Rx) mode whenever the unit is not keyed. When the PTT (Push to talk) switch on the microphone or the CW key is grounded or the unit is keyed from the rear panel, the Tx mode will be selected and the transmit frequency, mode, band and power level will be set up (based on the stored information) automatically before the transceiver is actually keyed. When the transmission is terminated, i.e., key up, the radio will be switched to Rx mode. The Tx frequency may be read while still in Rx mode by depressing the Tx button. The LED in the Tx button will illuminate indicating that the frequency displayed represents the transmit frequency.



**Figure 3.3 INTERNAL ADJUSTMENTS AND INDICATORS**

## WARNING

***The receive frequency is also changed to the new transmit frequency. Depressing the Rx button will return the Rx frequency to the display or following a transmission, i.e., key down, the Rx frequency will again be displayed.***

Scan tune, channel scan, scan program, and coupler bypass are enabled ONLY in receive mode. Power level, AGC characteristic and MODE may be changed at any time in receive in any channel. When the transmitter is keyed, all front panel key entry, except the "PRIORITY CHANNEL" and meter select key, will not be processed until the radio is unkeyed.

The transceiver can be operated in four different modes. They are as follows:

**CHANNEL MODE** - This is the most common mode of operation where a channel is recalled and the transceiver is operated on the previously stored configuration.

**FREQUENCY MODE** - In this mode the transceiver is set to a new frequency in a "scratch pad" mode and is operated in a simplex frequency mode.

**CHANNELSCAN** - In this mode the receiver is put into the scanning mode.

**PRIORITY CHANNEL** - In this mode the transceiver is forced to the priority channel.

### 3.5.2 FREQUENCY MODE OF OPERATION

#### 3.5.2.1 Manual Operation

Channel "00" is dedicated for this mode of operation. Here the operator can change receiver frequency, mode, AGC speed and power level as he desires. The transceiver is switched to the new frequency setting and the new frequency data is entered into memory for Channel "00" after the "E" button is depressed.

Channel "00" is programmed as follows:

1. Press FREQ button; FREQ button will light and

channel display will show "00"; FREQ display will blank; both Tx and Rx will extinguish. CHAN button will not be lit.

2. Press the appropriate number keys to set the frequency (note that leading zeroes must be used to attain frequencies below 10 MHz). Press the "E" (ENTER) key to enter the frequency into memory and terminate the Frequency Mode. Press MODE or AGC speed keys as desired. Press power level key to select proper power level. **NOTE:** If the "C" (Clear) button is pressed instead of "E", the procedure will be terminated, but the previous frequency data in Channel "00" will be displayed.

### 3.5.3 CHANNEL MODE

The MSR 8050A is in channel mode when any channel between 01 (note leading zero) and 99 is selected. (**NOTE:** When Channel 00 is selected using the CHAN button, it is also in channel mode and all programming procedures apply. It is NOT in channel mode when the FREQ button was used to get to it.) Under this mode of operation, the RECEIVER frequency can be fine tuned by selecting a TUNING RATE, then using the Up/Down buttons, or a different emission mode (both transmit and receive), power output level or AGC speed can be selected. In both Rx and Tx, the stored channel information is not altered. To enter this mode, press the CHAN key followed by a two digit number (if a different channel number is desired), then select MODE, AGC and Power Level and "E".

#### 3.5.3.1 Channel Review Mode

In this mode of operation, stored channel information for any channel can be recalled for checking purposes. This mode of operation is entered as follows:

1. Press CHAN button; CHAN button LED will light, channel, frequency and mode display will not change.
2. Press two number keys (sequentially) to specify the channel to be recalled. As soon as two numbers have been selected, the display will now show channel number, frequency, mode, AGC

speed and power level in memory for that channel. The receiver will change to the new channel frequency allowing the operator to listen on the new channel frequency (the transmitter is locked out until the "E" key has been depressed, entering the new channel). Two more numbers may now be selected and the data for that channel will appear in the display. If it is desired to operate on the selected channel, press the "E" key. This will change the radio to the selected channel and the CHAN button LED will go out.

3. Pressing the "C" instead of the "E" button also terminates this mode of operation, but the radio will remain on its original channel and the display will confirm this.

### 3.5.3.2 Channel Review Scan Mode

In this mode, data in channels above and below the originally selected channel may be displayed. To enter this mode of operation:

1. Depress the CHAN pushbutton. The CHAN pushbutton light will illuminate, but the channel number and all displayed data will remain the same.

2. Use the "UP" or "DOWN" arrows to slowly scan the channels above or below the present channel. Note that the frequency, AGC, power level and mode stored in memory for the new channel are now displayed.

3. To stop on a new channel, release the arrow pushbutton.

4. To change the transceiver to the new channel, depress the "E" pushbutton. The CHAN button LED will extinguish.

5. If, instead, it is desired to return to the original channel, depress the "C" pushbutton. The CHAN button LED will extinguish.

### 3.5.4 CHANNEL SCAN MODE

The operator can select blocks of pre-programmed channels to scan. Scan can then be stopped manually by pressing "C" key and resumed by pressing the "E" key. Pressing the "C" key again after scan has been manually stopped will termi-

nate this mode.

The procedure is as follows:

1. Press SCAN ON key; SCAN ON LED will light and channel display will blank.

2. Press any number between 0 and 9 to select the block of channels to be scanned. The block number and start and stop channel numbers will be shown in the frequency display.

3. Press "E" key to start scanning. If the "C" key is pressed instead of the "E" key, the scan mode will be terminated.

4. After scan starts, pressing SCAN or "C" key will manually stop scanning and the SCAN key LED will flash.

5. Press the "C" key while the SCAN key LED is flashing or press the SCAN ON key to terminate the scan mode and return to the previously selected channel. Pressing the "E" key while the SCAN key LED is flashing will resume the scan.

### 3.5.5 PRIORITY CHANNEL SELECTION

Channel 90 is assigned as priority channel. If the PRIORITY channel button is depressed at any time, even during transmission, the radio will be set up automatically to channel 90. All front panel keys are disabled under this condition except CHAN, FREQ, coupler, meter, audio source and the "C" key. The LED on the PRIORITY key lights to indicate that this channel has been selected. Channel 90 will be shown in the display with the pre-programmed information. Channel or Frequency can be changed by the user, using the CHAN and FREQ pushbuttons. Pressing the "C" button will terminate this mode and return the transceiver to the previously selected channel.

### 3.5.6 MEMORY DUMP

There is a switch behind the front panel of the MSR 8050A for quick memory erase. This switch can be accessed from the front through a 3/16" hole. If this switch is activated with the radio power on, all the channel information stored in memory will be erased.

### 3.5.7 RECEIVER OPERATION

The MSR 8050A is in receive mode whenever the Rx button is pushed or after the keyline has been deenergized following a transmission. The receiver may be operated in manual, frequency, channel or channel scan modes.

#### 3.5.7.1 Manual Mode

This is the normal operational mode of the transceiver when none of the frequency, channel or channel scan modes have been selected. The receiver frequency may be modified by selecting a tuning rate, then depressing the Up or Down pushbuttons. The mode or AGC characteristic may also be changed by pressing the appropriate button. All of the changes made in this mode of operation will not affect the contents of the channel memory.

Following are typical steps for operating the receiver:

- a) Connect an antenna to the ANTENNA connector.
- b) Connect the headphones or turn the SPEAKER switch ON. Turn the POWER switch ON and advance the VOLUME control by approximately 1/3 revolution CW.
- c) If the Tx LED is lit, press the Rx button to select the receive mode.
- d) Turn the RF GAIN control fully CW. Push control "in" (squelch off).
- e) Turn the receiver to the desired frequency by pressing the FREQ button, then selecting a frequency with the number keys (if below 10 MHz, use a leading 0). The radio will be "tuned" to the indicated frequency. Pressing the TUNINGRATE pushbutton to one of the rates as indicated by LED will allow the indicated frequency to be changed with the UP/DOWN keys.
- f) Select the desired operating mode and AGC characteristic by pushing the appropriate buttons and observing the displays.
- g) The radio should now be in receive mode.

Adjust the VOLUME for a comfortable listening level.

h) For voice reception, the SQUELCH control may be pulled out and turned fully CW, muting the speaker until a syllabic (voice) signal is detected. A 2 second hang time will maintain speaker output during short pauses in speech. Pushing the knob back in will disable the SQUELCH.

i) If required, all frequency, mode and AGC data now indicated by the display may be stored in memory for later recall. To program memory:

1. Press "CHAN" button; the CHAN button LED will light.
2. Select the desired channel number (two digits). Press "E" to enter the displayed information into the receiver's memory at this channel location.

#### 3.5.7.2 Frequency Mode

The receiver is in frequency mode when the FREQ button is pressed and the FREQ LED is lit. Any channel, frequency, mode or AGC speed may be selected in this mode. The receiver will be tuned to whatever is displayed on the front panel. The same information will be stored in the selected channel memory when the "E" key is depressed.

#### 3.5.7.3 Channel Mode

This mode is selected when the CHAN button is pressed and its LED is on. The operator may recall any channel by entering a two digit channel number (a leading zero is required for channel numbers below 10). The recalled channel memory may then be modified by changing the frequency, mode or AGC; however, the radio characteristics will not be changed until the "E" button is pressed and the CHAN LED goes out.

When operating in any channel, the Receive Frequency, MODE, POWER LEVEL and AGC characteristic may be changed and will remain as altered as long as the operator remains on that channel. If the memory is not modified per the paragraph above, the alterations selected will not be stored and the radio will retain the old characteristics originally programmed into memory for

that channel.

#### 3.5.7.4 Channel Scan Mode

In this mode, the receiver can scan up to 10 groups of pre-programmed channels.

Scan rate is adjustable through a hole in the front panel. A RF signal will stop scanning for a pre-determined time set by the dwell control on the front panel. Scan may also be stopped manually by pressing the SCAN ON or "C" buttons, and may be resumed by pressing the "E" button. Pressing the "C" button when the SCAN LED is flashing will terminate this mode.

#### 3.5.8 TRANSMITTER OPERATION

The MSR 8050A transceiver will be in transmit mode when the Tx button is lit AND the PTT switch or CW key has been grounded, keying the transmitter. Depressing the Tx button WILL NOT key the radio, but will display and set the radio to the transmit frequency. The transmitter may be in the frequency or channel mode of operation.

The unit is in frequency or manual mode when channel "00" is selected. Both emission mode and power level may be altered, but the channel memory cannot be changed.

The unit is in channel mode if any channel other than "00" is selected.

Typical operation of the transmitter is as described below.

##### 3.5.8.1 Operating the Transmitter

- a) Connect the microphone. Turn the POWER switch to ON.
- b) Press POWER LEVEL 2 (full power). Connect a 150 Watt, 50 ohm dummy load to the transceiver rf output connector.
- c) Set the frequency by pressing the FREQ button. The CHAN display should indicate "00". Select the desired operating frequency and mode to "USB", then press "E".
- d) Verify that the REMOTE radio and coupler

BYPASS functions are OFF.

e) Press the FWD METER button on the MSR 8050A to display forward power.

f) To transmit using the MSR 8050A front panel microphone, press the MIC AUDIO button, then depress the microphone PTT button and speak at a normal level with the microphone held 1/2 to 2 inches from the mouth. The transmitter incorporates an audio speech compressor which adjusts the transmit level automatically. Note the front panel meter on the MSR 8050A deflect upscale as the transmitter is modulated. The meter will indicate a reading of approximately 30 to 50 Watts during voice peaks or other non-steady state modulation. (Note that this is an indication of AVERAGE output power, not PEAK ENVELOPE POWER (PEP), which is typically 4 or more times that read on the meter.)

g) Release the PTT button to unkey the transmitter.

h) If the mode is now changed to AM and the PTT is closed, the meter should indicate about 35 to 45 watts in the FWD position. Unkey the transmitter.

i) In CW mode, when the CW key is closed, a reading of 125 watts will be noted on the MSR 8050A panel meter in FWD position.

##### 3.5.8.2 Operating the Transceiver with the MSR 1020 Linear Power LPA

- a) Connect the microphone. Turn the power switch to ON and note that the MSR 1020 LPA is also turned ON. If not, turn the MSR 1020/MSR 6212 power switch to "REM" or "ON" position.
- b) Press POWER LEVEL 4 (one kilowatt). Connect a 1000 watt dummy load to the LPA rf output.
- c) Set the frequency by pressing the FREQ button. The CHAN display should indicate "00". Select the desired operating frequency and set the mode to "USB", then press "E".
- d) Press the FWD METER button on the MSR 8050A to display forward power. Set the MSR 1020 meter switch to FWD position. **NOTE:** The forward power meter indication on the transceiver

may not be full scale for full output power when used with the LPA. The LPA requires less than full transceiver output for full system output power.

e) To transmit using the MSR 8050A front panel microphone, press the MIC AUDIO button, then depress the microphone PTT button and speak at a normal level with the microphone held 1/2 to 2 inches from the mouth. The transmitter incorporates an audio speech compressor which adjusts the transmit level automatically. Note the front panel meters on both the MSR 8050A and the MSR 1020 deflect upscale as the transmitter is modulated. The MSR 1020 meter will indicate a reading of approximately 200 to 300 watts during voice peaks or other non-steady state modulation. (Note that this is an indication of AVERAGE output power, not PEAK ENVELOPE POWER [PEP], which is typically 4 or more times that read on the meter).

f) Release the PTT button to unkey the transmitter.

g) If the MODE is now changed to AM and the PTT is closed, the MSR 1020 meter should indicate about 250 to 300 watts in the FWD position. Unkey the transmitter.

h) In CW mode, when the CW key is closed, a reading of 1000 watts will be noted on the MSR 1020 panel meter in FWD position.

#### 3.5.8.3 Operating the Transmitter With the MSR 4030 Antenna Coupler

a) Proceed through steps a) through d) above. Note that the FAULT light comes on when AC power is turned ON.

b) Depress the COUPLER TUNE button. The FAULT light should go out, the NOT TUNED light should come on, and some time later the NOT TUNED light should go out and the READY light should come on, indicating that the coupler has successfully completed its tuning cycle. If the coupler cannot tune because of damaged or broken antenna or cable, the FAULT light will come on within 30 seconds.

c) Continue steps f) through h) above.

### WARNING

***All transmissions are now going out ON THE AIR, so proper protocol and regulations must be observed.***

#### 3.5.8.4 Operating the Transceiver with the MSR 4040 Digital Coupler

The extremely high speed operation of the MSR 4040 necessitates a different set of operating instructions. See the technical manual supplied with the MSR 4040 for more complete explanations and instructions.

Upon initial power-on of the MSR 4040 coupler, the status LEDs will indicate READY. This varies from the other couplers because of the MSR 4040 memory pre-tune feature.

##### 3.5.8.4.1 Tuning Procedure

An RF TUNE cycle may be initiated by pressing the TUNE pushbutton on the transceiver front panel. The coupler uses an AM carrier from the transmitter to tune, and the tune cycle will be completed in approximately 1/2 second. During the TUNE cycle, the NOT TUNED LED on the transceiver front panel will come on. As soon as the cycle is complete, it will go out and the READY LED will come back on if a good coupler tune cycle has occurred. The relay positions for this tune are recorded in the coupler memory for the channel number selected.

The next time this channel is selected, the coupler presets the relays per the recorded data for this channel in approximately five (5) milliseconds. The coupler memory can store tuning data for all 100 channels available in the MSR 8050A, including the scratchpad Channel 00.

If the frequency stored in a given channel is changed and a manual RF TUNE is not performed (unless Channel Auto-Retune has been used - see Paragraph 3.6.8), the relay positions stored in memory will no longer be valid. When the transmitter is keyed, a VSWR FAULT will occur. It is recommended that the transmitter be configured for VSWR RETUNE when used with the MSR 4040 digital coupler. This will cause the

transmitter to command an RF TUNE cycle as soon as the fault occurs. The coupler memory is then updated for the selected channel so that subsequent selections of this channel will result in correct relay pretuning. This entire process (called "memory pre-tune") will be completed in approximately 1/2 second after keying the transmitter. It is also recommended that the transceiver be configured for Channel Auto-Retune when used with the MSR 4040.

The MSR 8050A front panel FAULT LED will blink when a fault occurs at the MSR 4040 coupler. The following conditions will cause a coupler fault:

- a) The coupler cannot tune a particular antenna within five (5) seconds.
- b) No rf energy is sent to the coupler from the transmitter within ten (10) seconds after an RF TUNE is initiated.
- c) If the VSWR seen by the coupler exceeds 2:1 (except during a TUNE cycle), and VSWR RETUNE is not selected in the exciter and the coupler.

Whenever the coupler is in a FAULT condition (as indicated by the blinking FAULT LED on the transceiver front panel), the coupler tuning elements are bypassed and the exciter output is connected directly to the antenna.

#### 3.5.8.4.2 Recommended Tuning Modes

If the MSR 8050A is used with the digital coupler, the transceiver should be configured for VSWR RETUNE, CHANNEL AUTO-TUNE and TUNING BEEP. AUTO-RF TUNE and AUTO-SILENT TUNE are unnecessary because of the memory pre-tune feature of the MSR 4040 coupler.

See Table 3.3 for switch settings on the Coupler Interface and Interface boards for these coupler functions.

#### 3.5.9 REMOTE CONTROL OPERATION

There are several remote control configurations possible with the MSR 8050A. The transceiver can be controlled with the MSR 6420 Remote Control Unit (RCU) or by a computer. Allowable

system configurations include multi-radio, single-RCU; single-radio, multi-RCU; and also multi-radio, multi-RCU. Available communications modes are RS-232C, RS-422, RS-423, MIL-STD-188 (all standard) and 300 Baud FSK Modem (optional). Optional "switched audio" circuitry allows the audio lines of exciters, receivers and transceivers in a system to be connected together on a single audio bus. RCU software then controls the audio link between any RCU-radio pair.

Each RCU or radio in a system is identified by its own address code. The address is used by the RCU operator to control or extract status information from one particular radio. The RCU operator selects an address and sends a command signal. The command signal reaches all radios in the system, but is ignored by all except the radio with the selected address.

### 3.6 TRANSCEIVER PROGRAMMING

#### 3.6.1 GENERAL

MSR 8050A channel programming will be in Simplex mode (receive and transmit on the same frequency) if both Tx and Rx LEDs are off when the "E" key is pressed following a FREQUENCY (FREQ pushbutton lit) selection. If either the Tx or Rx LED is lit when the "E" key is pressed following a frequency selection, the display information will be stored in memory for the LED-indicated mode. In the FREQUENCY programming mode, pressing a lit Tx or Rx button will turn it off. Pressing an unlit Tx or Rx button will turn it on. So if SIMPLEX frequency programming is desired (but the Rx or Tx button was inadvertently depressed turning on its LED and setting the unit up for Duplex programming), merely depress the lit pushbutton and the programming will return to Simplex.

#### 3.6.2 CHANNEL PROGRAM MODE

##### 3.6.2.1 Simplex Channel Programming Procedure

The following procedure is used to program a channel in simplex mode, using the "E" key. (When either the "E" or "C" keys are pressed, this mode is terminated and the transceiver is in channel mode.)

1. Press CHAN button; CHAN key LED will light, Tx and Rx LEDs will blank.

2. If it is desired to change the channel number, press two number keys to select the channel to be programmed. Otherwise, proceed to step #3.

3. Press FREQ button, then the number keys to set the frequency. **NOTE:** Be sure that neither the Rx or Tx buttons are lit. If one is lit, press it once to make the LED go out, then proceed.

4. When the correct frequency appears in the display, press the "E" button to record the frequency. Note that the CHAN button LED remains lit.

5. Select MODE, AGC speed and POWER LEVEL desired.

6. Press "E" key to store the above information into channel memory. The CHAN LED should now be out.

7. Pressing the "C" key instead of the "E" key will terminate this mode and ignore all changes.

#### 3.6.2.2 Half-Duplex Channel Programming Procedure

1. Press CHAN button; CHAN key LED will light, Tx and Rx LEDs will blank.

2. If you wish to select a different channel, press two number keys to select the channel to be programmed. Otherwise proceed to step #3.

3. Press Rx button. Rx button LED will light. You are now ready to program the receive frequency into this Half-Duplex channel.

4. Press the FREQ button. The FREQ button LED will light and the FREQUENCY display will show dashed lines.

5. Press number keys to desired RECEIVE frequency, then "E" to store the frequency.

6. Select MODE and AGC speed desired.

7. Press Tx button. Tx button LED will light. You are now ready to program the transmit frequency

into this Half-Duplex channel.

8. Press the FREQ button. The FREQ button LED will light and the FREQUENCY display will show dashed lines.

9. Press number keys to desired TRANSMIT frequency, then "E" to store the transmit frequency. Note that the CHAN LED remains lit.

10. If the transmit MODE is different from the receive MODE, change it to the proper setting. Press "E" to enter the data. Note that the CHAN button LED is now out.

#### **NOTE**

**Rx or Tx frequencies may be stored in any order.**

#### 3.6.3 CHANNEL SCAN PROGRAM MODE

The operator can set up blocks of scan channels in this mode to be used in channel scan. Up to 10 blocks, with 2 to 100 channels each, can be programmed. The start channel **MUST** have a lower number than that for the stop channel for multiple channel block, or the system will recognize it only as a single channel block.

The procedure is as follows:

1. Press SCAN PROG key; SCAN PROG LED will light and frequency display will blank.

2. Enter any number between 0 and 9 to indicate which block is to be programmed. The number will be displayed in the frequency display to the left and dashes will indicate next selection.

3. Enter a two digit number for scan start channel. This number will be displayed in the middle of the frequency display.

4. Enter the stop channel number by pressing two number keys. This number will be displayed in the two right hand locations of the frequency display.

5. Press "E" key to store program in memory and terminate this mode.

6. If an error is made during programming, press

"C" key to clear the display for re-entry of data.

7. If the "C" key is now depressed with the display blanked, the program is terminated with no effect on scan program memory.

#### 3.6.4 AUTO RF-TUNE

When the transceiver is configured for AUTO-RF TUNE, the TUNE button does not need to be pressed to initiate a TUNE cycle. The transmitter will automatically command a TUNE cycle the first time the transmitter is keyed following a channel change. If the user initiates the tune before keying the unit, the AUTO-RF TUNE circuitry will not command a second unnecessary cycle. The coupler only will enter a tune cycle the FIRST time it is keyed and will not retune on subsequent keyings unless the channel is changed.

#### 3.6.5 SILENT TUNE

A SILENT TUNE is initiated just like a normal tune cycle, except the SILENT TUNE pushbutton is depressed. The SILENT TUNE mode can only be used on a channel after an RF TUNE has previously been performed on that channel. The coupler uses memory data stored during that initial tune to determine proper coupler element positions.

The proper SILENT TUNE procedure is as follows:

- a) Perform a successful RF TUNE on all programmed channels (channels 01 through 96 may be used).
- b) All subsequent tune cycles on those channels may be SILENT TUNES.
- c) If the frequency assigned to any channel is changed, or a new channel is programmed and stored in memory, perform an RF TUNE on that channel before using the Silent Tune mode.
- d) If the system antenna is changed or modified in any way, an RF TUNE must again be performed on all channels to adapt coupler memory to the new antenna characteristics.

If the frequency stored in a channel is changed and an RF TUNE is not performed, a SILENT TUNE will send the coupler elements to the previously stored data positions. When the unit is keyed, a VSWR FAULT will occur, requiring the operator to initiate an RF TUNE.

#### 3.6.6 AUTO SILENT-TUNE

When the transceiver is configured for AUTO-SILENT TUNE mode, the coupler will automatically perform a SILENT TUNE cycle every time a different stored channel is selected.

#### 3.6.7 VSWR RETUNE

When the transceiver is configured for VSWR RETUNE, any VSWR fault experienced by the coupler or LPA will command the coupler to enter an RF TUNE cycle.

#### 3.6.8 CHANNEL AUTO-TUNE

When the transceiver is configured for CHANNEL AUTO-TUNE, any change in the frequency on a channel will automatically send a TUNE command to the antenna coupler (if one is connected in the system), providing a complete system READY for that channel.

#### 3.6.9 LOADING TRANSCEIVER MEMORY

- a) Press the CHAN button. The channel and frequency displays will not change, but the CHAN button LED will light.
- b) Select the desired channel number by two digit entry (single digit entry is preceded by a 0). **NOTE:** If the current channel is being reprogrammed, the channel number need not be entered.
- c) Press the FREQ button. The frequency display will show a series of dashed lines, awaiting frequency information. Use the number keys to place the desired frequency in the display, then depress the "E" key to enter the frequency. Now select the desired mode of operation for this channel and the AGC and appropriate power level. Press "E" to enter the displayed SIMPLEX data into the MSR 8050A memory.

d) See Section 3.6.2 for further programming information.

e) Repeat the above procedure to program more channels. There are up to 99 available.

### 3.6.10 REMOTE CONTROL PROGRAMMING

To verify or change the transceiver address:

a) Press "E", then "5" on the transceiver keypad. The present address will appear in the CHAN display. **NOTE:** Both "E" and "5" must be depressed within 2 seconds of one another or the system will revert back to its original condition.

b) If no change is required, press "C" to clear the address and exit the address entry mode.

c) To change address, enter new address desired (single digit address must be preceded by a

leading zero, i.e., 06).

d) Press "E" to enter the new address into the transceiver memory.

To put the transceiver in the Remote Control mode, simply depress the REM pushbutton on the transceiver front panel. When the transceiver is being controlled by an RCU, the front panel controls are not functional and the transceiver cannot be keyed via the front panel (microphone PTT or CW key). If power is lost while the unit is in REM mode, the transceiver will return to remote mode when power is restored. To return the unit to local control, depress the REM pushbutton a second time. The MSR 8050A may also be placed into or removed from remote operation by the RCU.

For further information, refer to the MSR 6420 technical manual and the CSW 1200 technical manual.

**Table 3.1**

**STATUS LAMP INDICATORS  
(When Companion Coupler is used with Transceiver)**

*FAULT, Steady	FAULT lights when power is first applied to MSR 4030 1 kW coupler
**FAULT, Flashing	a) Coupler unable to TUNE within 30 seconds (MSR 4030) or within 5 sec (MSR 4040) b) Operator has changed frequencies, transmitted, & not retuned coupler (MSR 4030)
FAULT, Steady	PA overtemperature indication
FAULT, Steady While Transmitting	PA overvoltage, overcurrent or VSWR fault
NOT TUNED	Coupler is tuning
READY	Coupler is ready to transmit
LEGEND: * = a steady FAULT indicates a condition originating from the transceiver or line to the coupler	
** = a flashing FAULT indicates a condition originating from the antenna coupler or antenna	

**Table 3.2**

**STATUS LAMP INDICATORS  
(When Transceiver is Operated without a Coupler)**

FAULT, Steady	PA overtemperature indication
FAULT, Steady While Transmitting	PA overvoltage, overcurrent, or VSWR fault
NOT TUNED and READY will not indicate	

**Table 3.3**

**S1 SETTINGS ON COUPLER INTERFACE BOARD**

SWITCH POSITION	FUNCTION	MODE OF OPERATION	APPLICATION
S1-2	** VSWR RETUNE	Reflected power causes coupler retune	Both MSR 4030 and MSR 4040
S1-3	TUNING BEEP	Audible beep in panel speaker during TUNE cycle	Both MSR 4030 and MSR 4040
S1-4	* SURVEILLANCE	Enables coupler servos	MSR 4030 only. Recommended for SILENT TUNE or AUTO SILENT TUNE only. *

**S1 COUPLER SETTINGS ON INTERFACE BOARD \*\*\***

SWITCH POSITION	FUNCTION	MODE OF OPERATION	APPLICATION
S1-6	* AUTO SILENT TUNE	When channel is called, coupler does a Silent Tune	MSR 4030 only
S1-5	AUTO RF TUNE	When new channel or frequency is entered, coupler gets TUNE cycle when microphone is keyed	MSR 4030 only (not necessary with MSR 4040)
S1-7	** VSWR RETUNE	Reflected power causes coupler retune	Both MSR 4030 and MSR 4040
S1-8	CHAN AUTO TUNE	When frequency in channel is changed, TUNE sent to coupler	Both MSR 4030 and MSR 4040

\* = Required only for MSR 4030 Analog Coupler. MSR 4040 is high speed 150 watt digital coupler with "instant" tune recall on channel change.

\*\* = Both S1-2 on the Coupler Interface board and S1-3 on the Interface board must be closed for VSWR RETUNE mode. (All units are normally preset to this position by the manufacturer.)

\*\*\* = Switch positions 1, 2, 3 and 4 define Baud rate for remote control.

## SECTION 4

### THEORY OF OPERATION

#### 4.1 GENERAL

The MSR 8050A is a modularized solid state HF communications transceiver. In transmit it produces 125 watt PEP output at 1.6 to 30 MHz from microphone or 600 ohm line inputs. In receive it produces independent speaker and 600 ohm line outputs from antenna inputs (0.5  $\mu$ V SSB sensitivity) from 0.1 to 30 MHz.

It may be operated in multi-radio remote control in various serial data formats from an MSR 6420 remote control unit or from a computer with menu-prompted control.

The MSR 8050A operates with the MSR 1020 1 kW amplifier; the MSR 4020A, MSR 4030, MSR 4040 antenna couplers; and the MSR 6300 pre-selector/postselector.

Figure 4.1 shows the signal flow/block diagram of the transceiver.

##### 4.1.1 SIGNAL PATH

See Figure 4.1.

Low level transmit signals are processed in order through the Audio Interface board, Transmit Modulator board, IF Filter board, High Level Mixer board and High Pass Filter board. The 125 watt PA raises the level to 125 watts and the Half Octave Filter board delivers the final transmit signal to the antenna connector J34. The Tone Key/Modem option modifies the 600 ohm path.

Receive signals are processed from the antenna connector J34 through the Half Octave Filter board, 125 watt PA assembly (through a T/R relay), High Pass Filter board, High Level Mixer board, IF Filter board, Audio Squelch board, and through the Audio Interface board (for 600 ohm rear panel outputs) or through the Speaker Driver board (for front panel speaker output).

##### 4.1.2 600 OHM AUDIO SIGNAL PATH (Rx receive and Tx transmit)

Figure 4.2 shows the 600 ohm audio signal paths and associated signals in both transmit and receive.

The receive 600 ohm audio originates in the Audio Squelch board on J10 pin 14/6 as STD AUDIO. Normal level is 0 dBm - multiple tones are limited to a peak level of this value by the AGC. The audio signal is buffered by U1C in the Audio I/O board and separated into two paths. Analog switch U3 connects either the RX DATA/FSK path (through U1A to rear panel J36-19,20) or the STD Rx path (through U1B to rear panel J36-22,21).

The RX DATA/FSK output is activated when the transceiver is in either DATA or FSK mode. Jumper JP2 on the Audio I/O board allows the  $\overline{\text{FSK/DATA}}$  control signal to automatically reduce the AGC threshold in these modes via Q1 to the Audio Squelch board. The STD Rx output is activated for all other modes (AM, CW and SSB).

The TX 600 ohm audio, either TX DATA/FSK or STD TX is also selected by analog switch U3 with the same relation to mode as the Rx 600 ohm. The STD TX audio input level is set by R1 on the Transmit Modulator for a -10 dBm input for full RF power out. R11 on the Audio I/O board allows the DATA input level to be adjusted independently.

Normally the audio is routed to the Transmit Modulator board through Mother board jumpers JP1, JP2.

When the Tone Key/Modem board option is inserted, the Tx audio goes through a tone key IC, U5 which strips off and detects a 2900 Hz tone which is used to remotely key the radio. U1 is the modem IC which communicates with an external remote control unit.

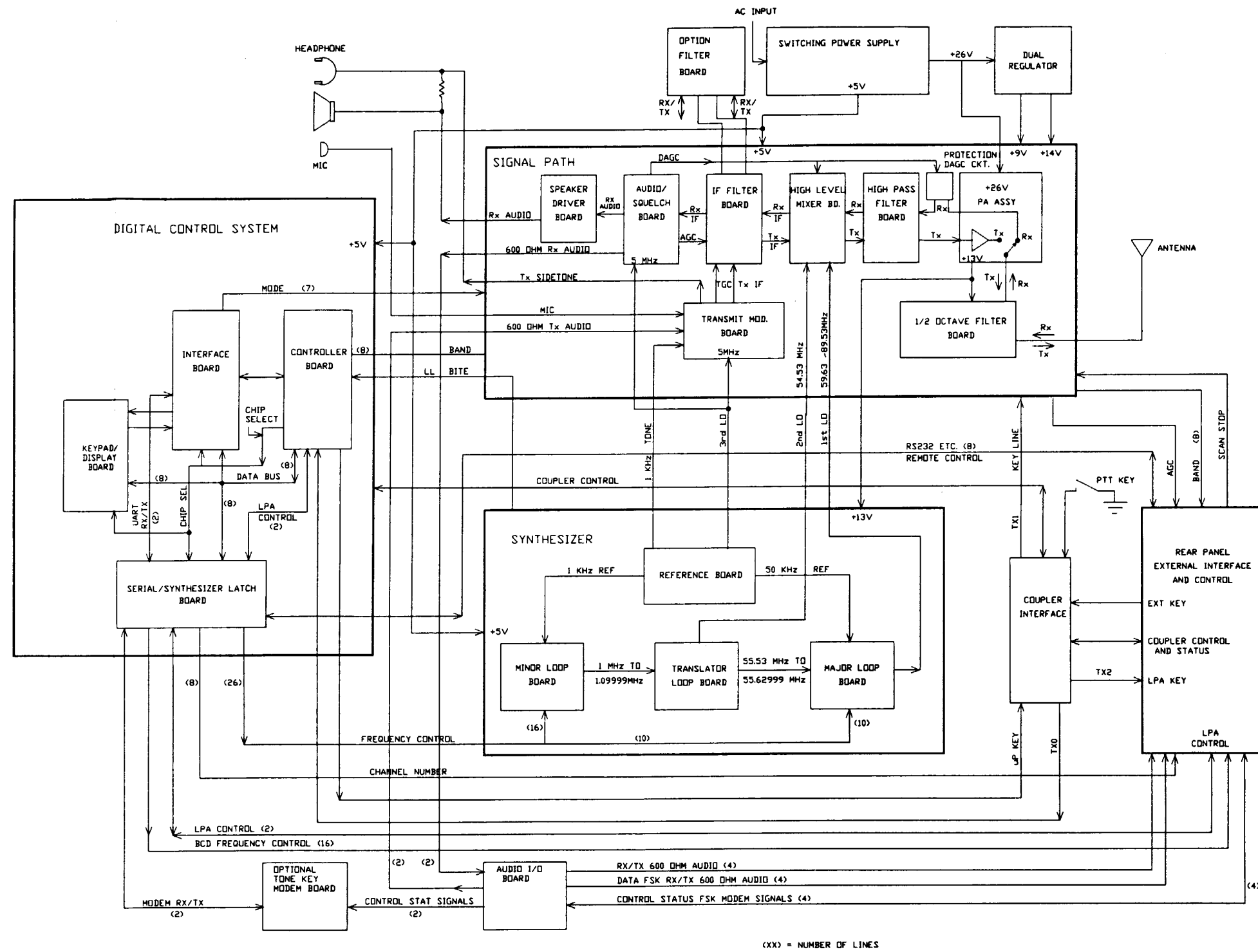


Figure 4.1

MSR 8050A SIGNAL FLOW/BLOCK DIAGRAM

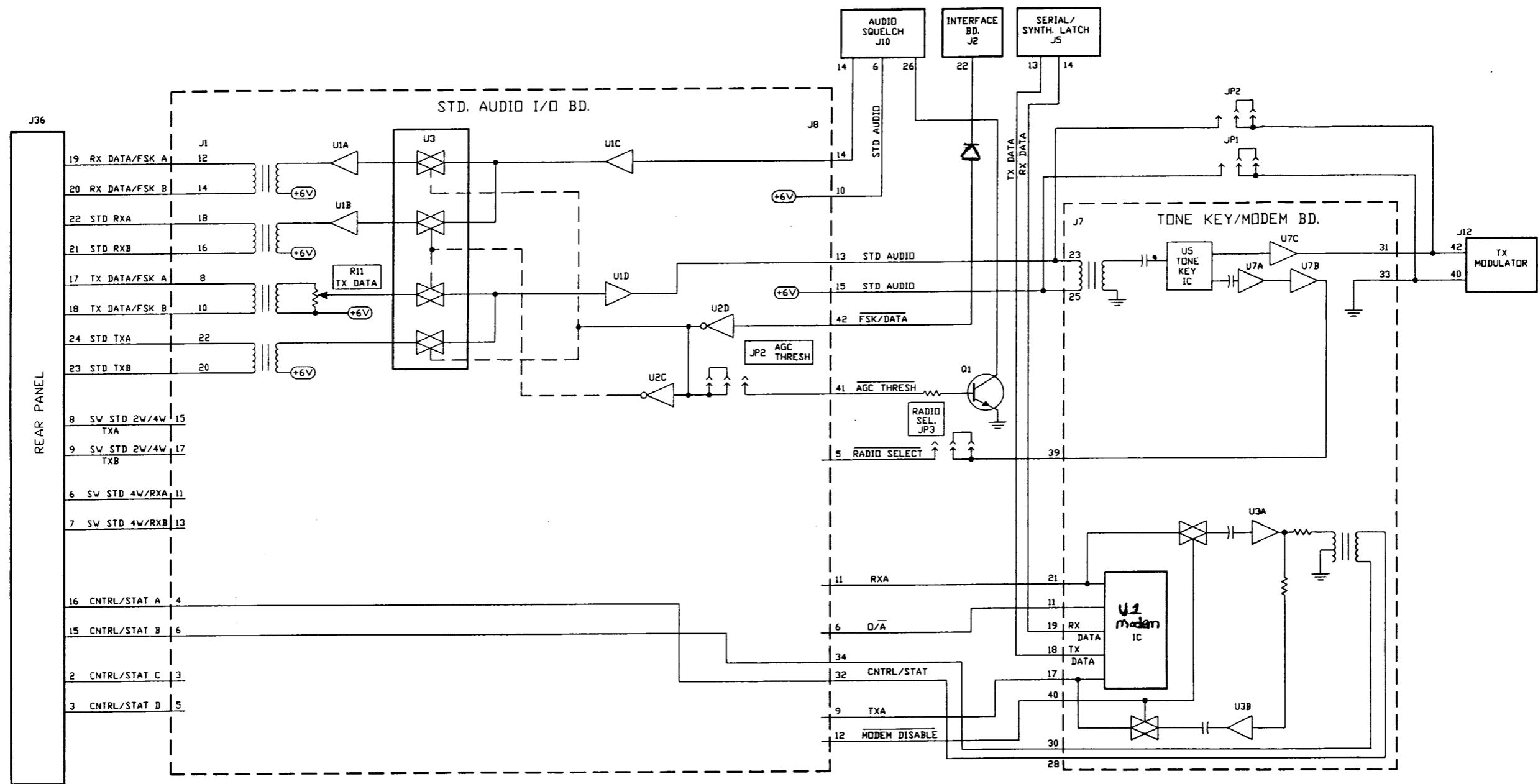


Figure 4.2

MSR 8050A AUDIO SIGNAL PATH

Unused input/output lines are used by an optional Audio I/O board to provide:

- 1) remotely addressable 600 ohm lines
- 2) two-wire 600 ohm lines (RX and TX audio on one pair)
- 3) two-port FSK MODEM connections for daisy-chain remote operation of multiple radios.

See Section 6.4.

#### 4.2 HALF OCTAVE FILTER BOARD

The assembly performs part of the receive mode preselector function, and in the transmit mode, filters the output of the power amplifier. Located on this board are eight elliptical low pass filters with cutoff frequencies of 2, 3, 4, 6, 9, 13, 20 and 30 MHz. Also located on this board are the VSWR detector, ALC detector and amplifier, ACC detector and amplifier and via feedback from the power amplifier assembly, 1A3A1, circuits that will protect the solid state PA from conditions of VSWR, overcurrent, overvoltage and overtemperature.

The desired elliptical filter is selected automatically by relay control ground signals from the Controller board. In the transmit mode, these filters reduce the harmonic output to better than -45 dB. In the receive mode, these same filters attenuate signals that are above that of the desired band of operation.

#### 4.3 125 WATT POWER AMPLIFIER ASSEMBLY

The all solid-state power amplifier accepts the +13 dBm RF drive input from the Mixer assembly, and provides a nominal 38 dB gain to produce 125 watts output to the antenna (through the low pass filters) in the transmit mode. Receive/Transmit signal paths are controlled by relay K1, to route the antenna input directly to the High Pass Filter in the receive mode.

Also contained on this board are circuits that sense PA overvoltage, overcurrent and overtemperature. These voltages are fed to the Half Octave filter board, which via feedback to the Transmit Modulator board, controls overall transmitter gain and power output.

#### 4.4 HIGH PASS FILTER BOARD

This assembly performs part of the receive mode preselection and receive RF amplification. In the transmit mode, the output of the Mixer board is filtered by this board. Contained on this assembly are eight elliptical high pass filters with cutoff frequencies of 1.6, 2, 3, 4, 6, 9, 13 and 20 MHz.

The desired filter is selected automatically by ground signals from the Controller board. This board also contains a broadcast filter which provides attenuation of greater than 70 dB to broadcast signals (signals below 1.6 MHz), and a very low noise receive RF amplifier. A transmit/receive relay is used to bypass the broadcast filter and RF amplifier in the transmit mode and below 1.6 MHz in receive mode.

Additional circuitry located on this board provides analog voltages which are supplied to the Transmit Modulator board to more accurately establish the A3A carrier level on transmit.

#### 4.5 HIGH LEVEL MIXER BOARD

##### 4.5.1 GENERAL

The High Level Mixer board, in RECEIVE mode, converts a 0 to 30 MHz RF input to a 1st IF of 59.53 MHz and subsequently a 2nd IF of 5 MHz. In TRANSMIT mode, it converts a 5 MHz input to 59.53 MHz and then to RF outputs of 1.6 to 30 MHz. All circuit interfaces are at 50 ohm impedance levels.

Figure 5.45 is a functional block diagram of the board. In RECEIVE mode, inputs on the RX input are selected by the RF switch and filtered by the 30 MHz LP filter. The 1st mixer, with an amplified LO input to +21 dBm, 59.63 MHz to 89.53 MHz, converts the RF signals to a 59.53 MHz IF. The mixer is provided a broadband IF termination by a lossless constant resistance network and a non-reflective crystal filter network. A bilateral amplifier provides 18 dB gain which is controllable by a delayed AGC input of 0 to 9 volts. A second crystal filter at 59.53 MHz controls spurious responses due to the second mixer and complements the selectivity of the first filter and the system information filter for a total 120 dB ultimate selectivity. The second mixer, with an

amplified LO of +10 dBm, converts the 59.53 MHz signals to a 5 MHz IF. The second LO amplifier may be gated off by 9 volt pulses to accomplish noise blanking.

In transmit the signal path is reversed with inputs at the 5 MHz IF converted to a 59.53 MHz IF, and amplified by the reversed bilateral amplifier. The RF switch directs the 1.6 to 30 MHz outputs from the 1st mixer to the TX amplifier to produce outputs to +15 dBm.

#### 4.6 IF FILTER BOARD

The IF Filter board contains the three 5 MHz information filters and amplifiers (bilateral) used in both transmit and receive modes. These filters are: FL1 - lower sideband, FL2 - upper sideband, and FL3 - AM. The appropriate filter is selected by diode switching via mode information from the Controller board. During the receive mode, the 5 MHz IF signal from the Mixer board is passed through the appropriate IF filter and further amplified in three stages. The gain of the IF output is adjustable. An AGC voltage is applied from the Audio Squelch board, to two of the IF amplifier stages to reduce the IF gain on very strong received signals.

During the transmit mode, a double sideband signal from the Transmit Modulator board is applied. The appropriate filter will remove the unwanted sideband of the transmitted signal. The signal is then amplified and applied to the Mixer board.

Other circuits on this board include an amplifier combiner, U3A, which applies carrier for AME operation, and DC switches Q1 and Q2 which apply voltages to the appropriate transmit or receive amplifier stage.

#### 4.7 AUDIO SQUELCH BOARD

The Audio Squelch board is used in the receive mode only. This board accepts the 5 MHz IF output from the IF filter board, and performs the final detection function to convert the intermediate frequency signal into usable intelligence in the audio frequency range. This process involves two discrete detector functions. A product detector is used in all modes except the AME mode. In

the AME mode an envelope detector is used.

Two separate audio outputs are provided. A 600 ohm line audio output is applied to the rear panel connector, J36, and a low level output is applied to the Speaker Driver board to provide the front panel speaker and headphones/handset audio.

An input IF amplifier drives the envelope detector which produces AM audio and AGC signals. A fast attack/slow decay peak detector produces the AGC voltage with low distortion. A fast-pulse detector senses the end of a transmission to "dump" the AGC for a fast recovery time. Three AGC decay rates of three seconds, 200 milliseconds and 30 milliseconds are achieved by changing the time constant of the "dump" circuit.

SSB, CW and FSK audio is produced by a double balanced mixer product detector. The mixer is driven by an amplifier which boosts the level of the 5 MHz third LO signal from the Reference board.

An analog switch selects either AM or product detector audio to be further amplified to produce independent speaker and 600 ohm line amplifier signals.

A syllabic squelch circuit which responds only to very low modulations (characteristic of speech) controls an analog switch which is in series with both audio paths. When the squelch is activated from the front panel, the switch is open except for signals characteristic of speech. A jumper controls whether 600 ohm audio may be interrupted by the squelch.

The AGC voltage controls the gain of the IF Filter board and a DAGC voltage (derived from the AGC voltage) controls the gain of the Mixer board and attenuation of the input protection circuit on the Mother board.

#### 4.8 SPEAKER DRIVER BOARD

The Speaker Driver board contains the three watt speaker amplifier and DC volume control circuit. Tuning beep generator and channel number buffers are not used in the MSR 8050A.

Audio from the Audio Squelch board is applied to this board through an optocoupler. The resis-

tance of this optocoupler and thus the output of the speaker driver, U3, is a function of the setting of the volume control located on the front panel.

As the volume control is supplying a variable DC voltage only, hum and noise rejection of the audio amplifier is exceptionally good.

The audio output from this board drives the front panel speaker, the headphone jack and the receive pin of the MIC jack.

#### **4.9 TRANSMIT MODULATOR BOARD**

The Transmit Modulator board contains the speech compressor, balanced modulator, AME carrier insertion circuit, ALC amplifier and control, audio gates and 5 MHz double sideband amplifier.

Audio inputs from the front panel (carbon or dynamic microphone) and the 600 ohm audio input from the rear panel (via the Audio I/O board), are translated into a 5 MHz double sideband signal and then applied to the IF filter board. Transmit ALC and ACC voltages are applied to this board for the establishment of the transmitter gain. ALC controls the output in CW, FSK and SSB, whereas ACC controls the carrier level in AME mode. All transmit audio passes through an audio compressor which maintains a high average level of output. This ultimately results in a higher average level of RF output power from the transceiver. In addition, no microphone level adjust control is required. An adjustment, R1, is provided on the board to reduce the 600 ohm audio input level, if necessary, when audio levels from accessory or optional equipment exceed the recommended 0 dBm audio input level.

Audio inputs to the board (600 ohm, microphone or 1 kHz CW tone) are gated by an analog switch, U6.

In CW mode a 1 kHz tone from the Reference board is processed as normal audio to produce a double sideband 5 MHz board output (4.999 MHz and 5.001 MHz) with no carrier. The IF Filter board uses the "USB" filter to reject the 5.001 MHz sideband and the 4.999 sideband is reversed and translated to the final USB frequency in the Mixer board.

### **4.10 DIGITAL CONTROL AND DISPLAY (See Figure 4.3)**

#### **4.10.1 CONTROLLER BOARD**

The Controller board contains the major components of the control system for the MSR 8050A transceiver. The heart of the system is the microcontroller, U1; program memory storage is provided by EPROMS U3 and U4; data storage is provided by static RAM U5 and non-volatile RAM U6; up to eight levels of program interrupts are handled by U11. Also included on the board are output latches and reset circuitry.

#### **4.10.2 INTERFACE BOARD**

This board serves as an interface between the front panel Keypad/Display board and the Mother board. Its main function is to interface between the microcontroller and the 7-segment displays, LED indicators and the keypad.

It also contains the remote control interface, the remote control baud rate generator, the AGC output buffer, the remote RF gain control, the channel scan circuit, data latches, meter circuit and /RX signal source.

#### **4.10.3 KEYPAD/DISPLAY BOARD**

The Keypad/Display board contains the switches and indicators which interface with the microcontroller to control and display transceiver operating functions.

Pushbutton switches, some with integral LEDs, initiate control functions. Seven-segment LED displays indicate channel, frequency, and miscellaneous functions such as option status, BITE status, etc. Bar graph LEDs indicate mode, AGC speed, and power level. An analog meter indicates signal strength, power level, or reflected power. Discrete LEDs indicate coupler status and frequency tuning rate. A numeric keypad mounted to the front panel enters control data.

#### **4.10.4 FRONT PANEL**

The front panel is removable from the radio with its co-mounted Keypad/Display board. Electrical

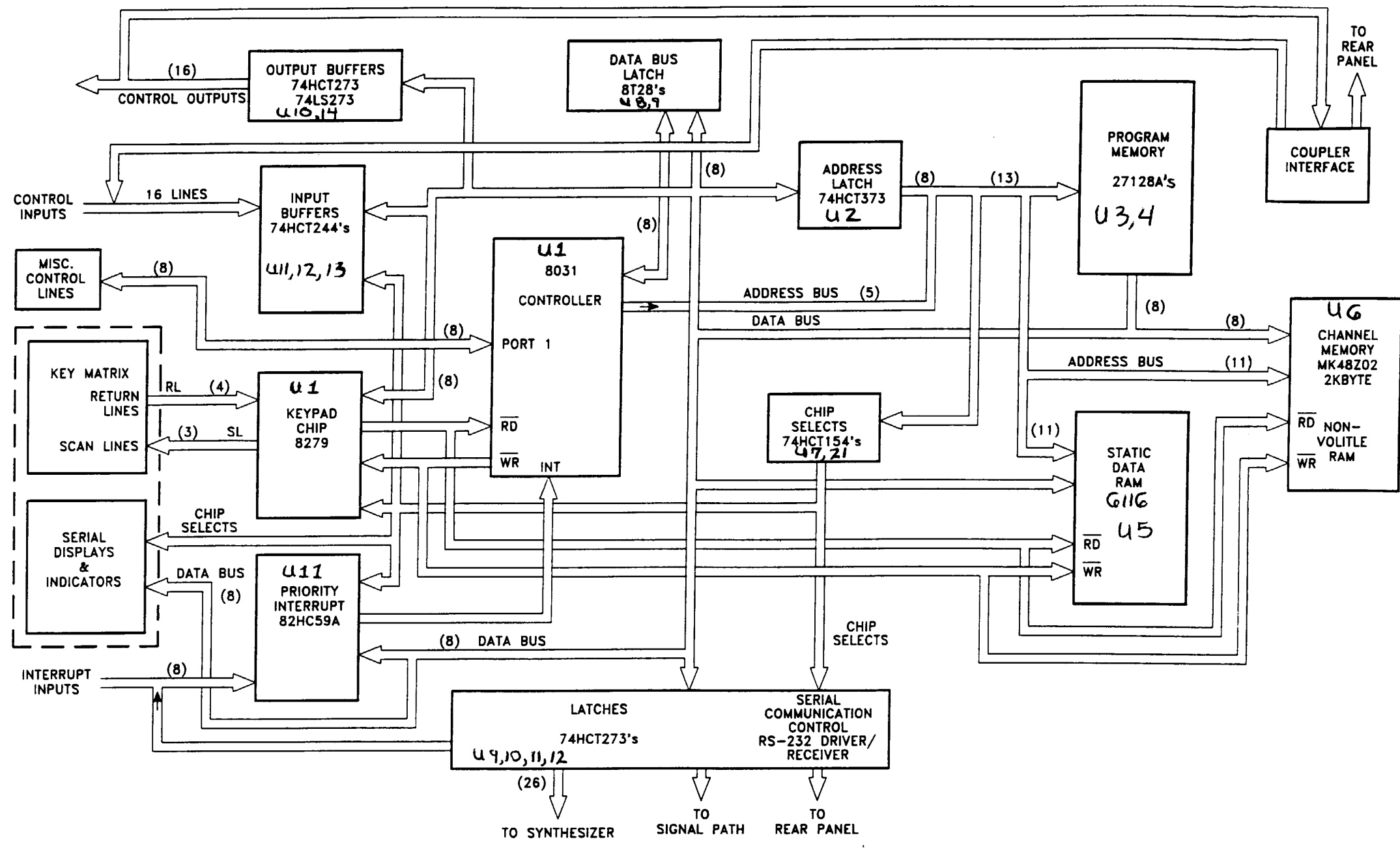


Figure 4.3  
**DIGITAL CONTROL AND DISPLAY  
 SYSTEM BLOCK DIAGRAM**

connection is via several ribbon cable connectors to the Interface board and Mother board. Besides the Keypad/Display controls, the front panel contains local operator directly accessed controls, such as volume, speaker, squelch, etc.

#### 4.10.5 SERIAL SYNTHESIZER LATCH BOARD

This board contains the latches and circuits which transmit the desired information from the micro-processor to:

- a. control the synthesizer frequency
- b. produce a BCD-frequency code to drive an external preselector
- c. control the MSR 1020 linear power amplifier status
- d. interface with remote control circuits for RS-232, RS-422, RS-423, MIL-STD-188 serial data formats (Switch settings on the board determine the compatible operating format.)

#### 4.11 FREQUENCY SYNTHESIZER

(See Figure 4.4 for a block diagram of the synthesizer.)

The frequency synthesizer consists of four subassemblies: Reference board, Minor Loop board, Translator Loop board and Major Loop board. The synthesizer generates the three local oscillator signals that determine the operating frequency of the transceiver. These signals are obtained from the 5 MHz reference oscillator directly, by a combination of direct synthesis and digital phase lock techniques. Frequency accuracy is dependent only upon the 5 MHz TCXO oscillator on the Reference board.

Provisions are made to substitute an optional high stability OCXO for the TCXO. A buffered output of the TCXO or OCXO is provided at the rear panel. Operation from an external 5 MHz reference through the same connector is possible.

##### 4.11.1 REFERENCE BOARD

The Reference board contains the 5 MHz TCXO, which determines the frequency accuracy of the transceiver.

The third LO (5 MHz) is supplied by this board to the Transmit Modulator board, to be used as a carrier generator on transmit, and to the Audio Squelch board to be used as a product detector injection signal on receive. The 1 kHz is also supplied to the Minor Loop board as a phase detector reference. Other circuitry on this board includes a +24 VDC power supply and a 50 kHz reference signal. Both are applied to the Major Loop board.

##### 4.11.2 MINOR LOOP BOARD

This assembly supplies the 1-1.09999 MHz signal to the Translator Loop board that determines the 10 Hz, 100 Hz, 1 kHz and 10 kHz digits of the transceiver frequency. Input to this board is a 1 kHz reference signal from the Reference board, and 100 Hz, 1 kHz and 10 kHz data information from the Logic board.

##### 4.11.3 TRANSLATOR LOOP BOARD

The Translator Loop board provides the 54.53 MHz second LO, which is applied to the Mixer board. This signal originates from a crystal oscillator and is not referenced to the frequency standard, therefore a small frequency error can exist in the second LO. Due to the mixing scheme used in this assembly, the same error appears on the first LO frequency and is therefore cancelled at the output of the first Mixer board. This board supplies to the Major Loop board a 55.53-55.62999 MHz signal. This signal is essentially a mixture of the low digit signal 1-1.09999 MHz, and the second LO (54.53 MHz including frequency error).

##### 4.11.4 MAJOR LOOP BOARD

The Major Loop board supplies the first LO signal (59.63-89.53 MHz) to the Mixer board. The first LO is a phase-locked oscillator covering the frequency range of 59.63 MHz to 89.52999 MHz, in 100 kHz steps. The exact frequency of the first LO is given by:

$$F_1 = 59.53 + F_d + e \text{ (MHz)}$$

where  $F_1$  = first LO frequency  
 $F_d$  = dialed frequency  
 $e$  = second LO error

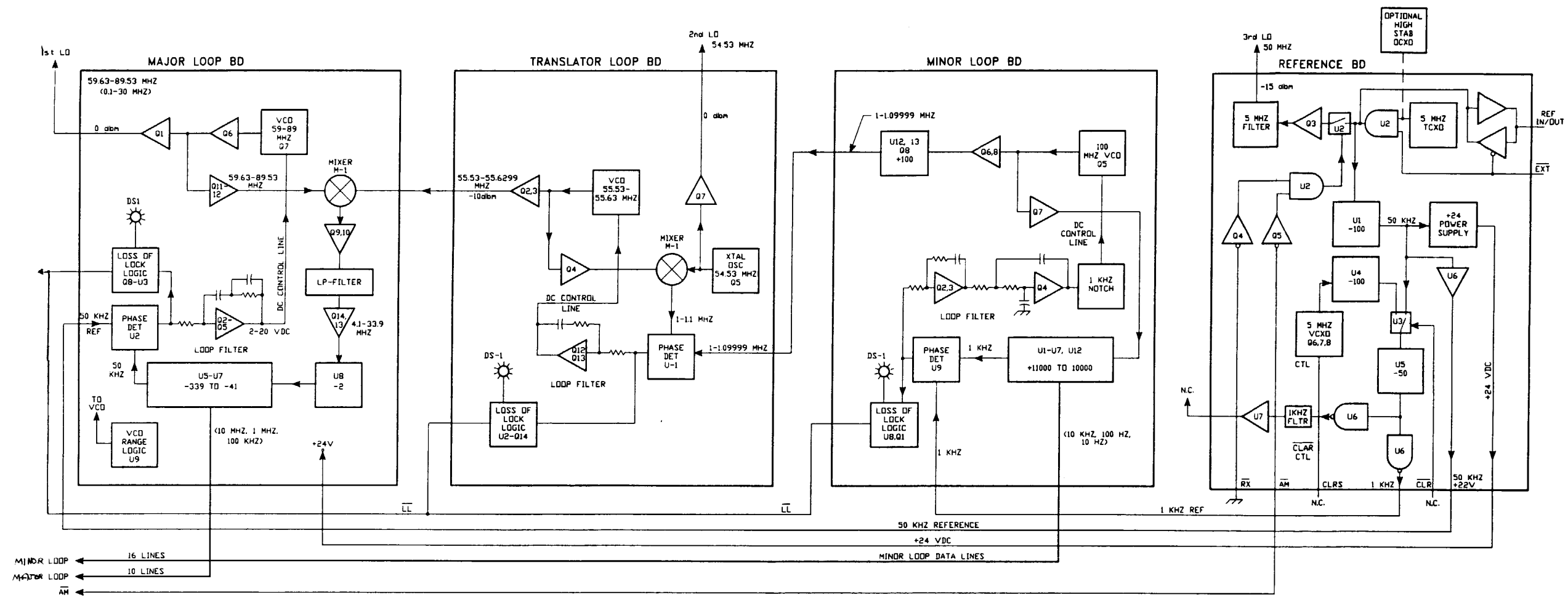


Figure 4.4

MSR 8050A SYNTHESIZER BLOCK DIAGRAM

On receive, the first LO is used to convert the incoming signal up to the first IF frequency (59.53 MHz). On transmit, the first LO is used to convert the transmit signal at the first IF frequency down to its final operating frequency.

This board determines the 10 MHz, 1 MHz and 100 kHz digits of the transceiver frequency. Inputs to this board are the 55.53-55.62999 MHz signal from the Translator Loop board, a 50 kHz signal and +24 VDC from the Reference board, and 10 MHz, 1 MHz and 100 kHz data information from the Controller board.

#### 4.12 CHASSIS/MOTHER BOARD

All subassemblies in the transceiver are electrically or mechanically connected to the Chassis/Mother board. The chassis houses all plug-in PC boards and provides shielding. The Mother board contains all interconnecting wiring in the transceiver. All plug-in PC boards connect to the Mother board through PC edge connectors. Keys on the connectors discourage plugging PC boards in the wrong slots. The only components located on the Mother board are inductors and bypass capacitors, with the exception of the receiver protector described in Paragraph 4.12.1 and miscellaneous interface components.

##### 4.12.1 RECEIVER PROTECTOR

The receiver protector consists of two pairs of back-to-back PIN diodes across the receive signal line. A lightly coupled detector produces dc bias current at about +23 dBm RF inputs, causing the diodes to conduct and attenuate the signal. A transistor interface circuit using the DAGC signal line also adds a dc bias into the diodes to provide an additional gain control element at very high input signal levels. This prevents saturation of the receiver front end for high in-band signal levels.

#### 4.13 TRANSMIT KEYING CIRCUITS

Figure 4.5 shows the interconnection of keying circuits for transmit operation.

The radio may be keyed by:

- 1) Front panel  $\overline{\text{PTT}}$  signal (only if "REM" key not pressed).
- 2) Rear panel  $\overline{\text{EXT}}$  key on J36 as well as J37.
- 3) Rear panel  $\overline{\text{FSK}}$  key on J36 (only if the radio is in FSK mode).
- 4)  $\overline{\mu\text{P}}$  key from the Controller board due to remote control command.
- 5) Key Enable signal from an antenna coupler (i.e. MSR 4040) in conjunction with a  $\overline{\text{TUNE B}}$  signal from the Controller board.
- 6) Tone Key signal from the Tone Key board in response to a 2930 Hz keying tone on the transmit audio line.
- 7) A +6 VDC voltage impressed on the rear panel TX DATA/FSK 600 ohm audio line. This signal brought into the Audio I/O board, is inverted (with JP1 properly positioned) to produce a keying signal on the  $\overline{\text{FSK KEY}}$  line.

The transmit mode line  $\overline{\text{TX1}}$  which enables the transmit circuits on all signal path boards, is produced in the Coupler Interface board.

The  $\overline{\text{TX1}}$  line may be inhibited by any of four inputs to the Coupler Interface board.

- 1) Key Interlock - due to lack of ground on rear panel J38 pin G, which is provided by the MSR 1020 or any compatible antenna coupler. (If neither equipments are installed, a shorting plug is installed on J38.)
- 2)  $\overline{\text{LL}}$  - due to one of the Synthesizer boards being out-of-lock.
- 3)  $\overline{\text{TX INHIBIT}}$  - a control signal from the micro-processor to prevent transmitting during mode changes, frequency changes, etc.
- 4)  $\overline{\text{PS FAULT}}$  - a signal from the power supply due to malfunction.

See Section 5.9.17 (Coupler Interface board) and 5.9.10 (Transmit Modulator board) for more detail.

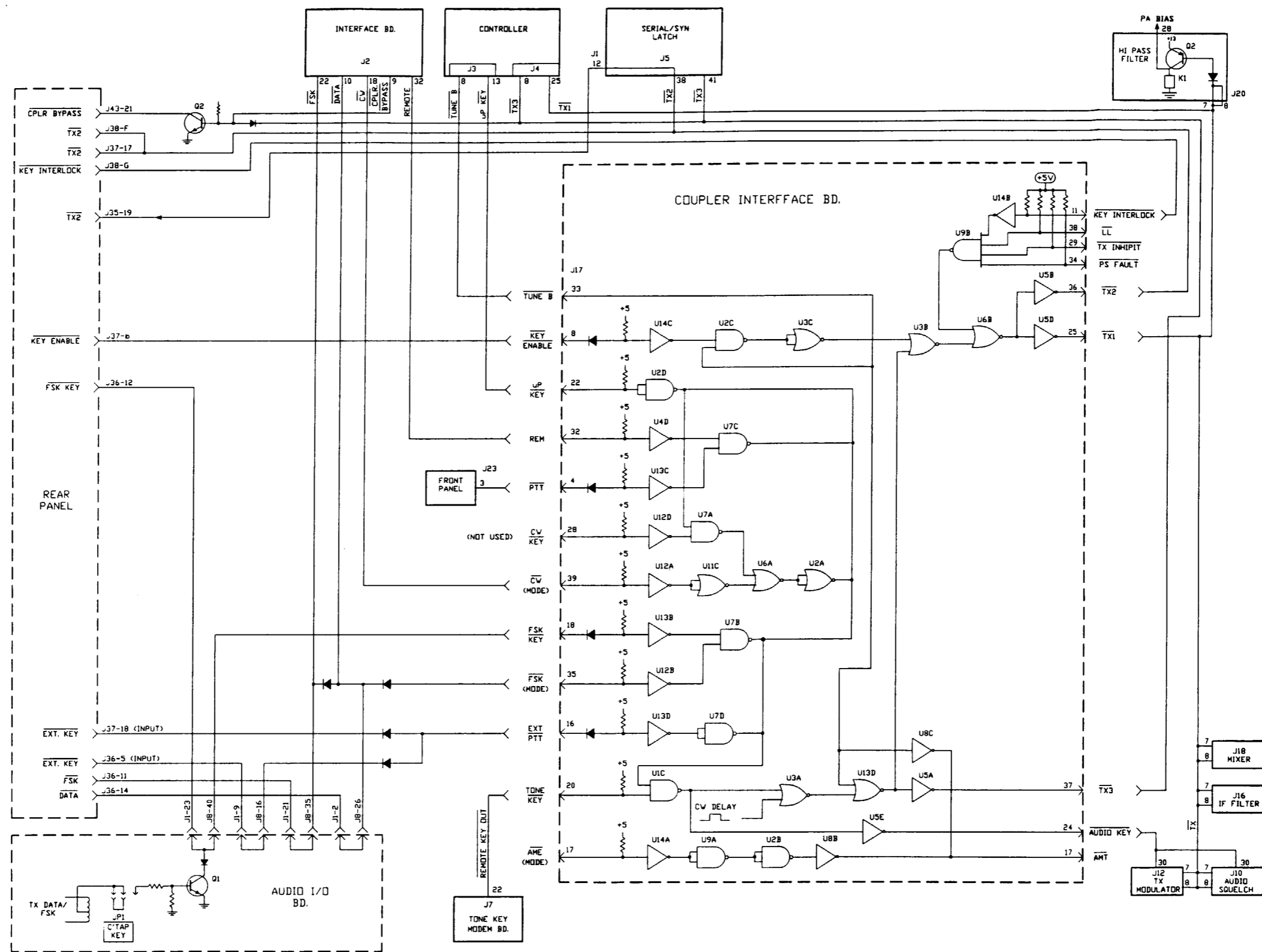


Figure 4.5

MSR 8050A TRANSMIT KEY CIRCUITRY

## SECTION 5

### MAINTENANCE

#### 5.1 GENERAL

This section provides information for routine maintenance, repair and evaluation of overall performance of the transceiver. The modular construction of the transceiver lends itself to a logical and straight-forward troubleshooting procedure. By referring to the overall and individual block diagrams and schematics, and using related level and frequency information, a trouble can be quickly localized to a particular assembly. Voltage and signal levels to all assemblies, except the power amplifier and front panel, may be measured on the Mother board at the appropriate connector or signal point.

#### 5.2 PRINTED CIRCUIT BOARD REPAIRS

##### 5.2.1 REMOVAL AND REINSTALLATION

Care should be used when removing PC boards from the equipment. A card extractor, Mackay P/N 600268-618-001, is available and should be used, if possible. If no card extractor is handy, a temporary substitute can be made from a length of solid heavy gauge wire (#10 - #12). Form a hook at each end of the wire, then insert each hook into holes provided at the top outer edge of each PC board. Apply gentle pressure near each hook to free the board(s) from the edge connectors.

#### NOTE

**Do not use pliers or screwdrivers to remove the boards.**

When replacing boards into the PC sockets, insure that the boards are first in their proper position, then are in the card guides at each board edge. Apply light downward pressure to the top edge of the board until it is fully seated into its edge connector.

##### 5.2.2 SOLDERING

To avoid damaging the PC board during component replacement, extreme care should be used. A low wattage (25 - 50 watts) soldering iron with a narrow tip should be used. A low wattage iron is required to prevent excessive heat from lifting the copper foil from the board, rendering the board unrepairable. Only a high quality electronic grade of rosin core solder should be used in making repairs.

#### CAUTION

***Do Not Use An Acid Core Solder.***

Since the circuit density of most boards is quite high, solder "bridges" or short circuits between adjacent foil runs or socket or connector pins are possible if care is not taken during soldering operations.

Following a soldering repair, the area around the connection(s) should be closely inspected for excess solder or bridges between adjacent runs or connections. Any bridges or excess solder must be removed before reinstalling the board. Because of double-sided construction used on the PC boards, a component lead may be soldered to PC areas on both the top and bottom of the board. Therefore, when a component lead is removed, the replacement component should be resoldered top and bottom, as necessary.

##### 5.2.3 CMOS DEVICE HANDLING PRECAUTIONS

**NOTE:** Most of the Integrated Circuits used in the transceiver are CMOS devices, and will have a "C", "HC" or "HCT" in the middle of their Type Number. Many of the discrete transistors used, such as the devices in the RF Power Amplifier, are also CMOS devices.

CMOS devices may be damaged by static voltages, so the following precautions should be taken:

- a) All MOS devices should be placed on a grounded work bench surface, and the repair operator should be grounded with a wrist strap, or other similar method, prior to handling these devices, since the operator can be statically charged with respect to the work bench surface.
- b) Nylon clothing can generate significant static voltages merely through friction with other parts of clothing, so nylon clothing should not be worn while handling MOS devices.
- c) Do not insert or remove MOS devices from sockets while power is applied.
- d) When soldering MOS devices, make sure the soldering iron is grounded.


### 5.3 LOGIC INTERPRETATION

Several types of digital devices are used in the equipment. The following descriptions are presented to explain their basic operation and symbolic notation. The digital devices used (gates, "flip-flops", inverters, etc.) are binary in nature, i.e., the output voltage of each has only two possible states, high or low. A high (normally greater than 2.0 VDC with a 5 V supply) is called a logic "1", and a low (normally less than 0.8 VDC with a 5 V supply) is called a logic "0".

#### 5.3.1 GATES

A gate is a circuit element whose output depends upon the levels of all its inputs in a particular pattern.

#### AND GATE




INPUTS		OUTPUTS
A	B	
0	0	0
1	0	0
0	1	0
1	1	1

The AND gate can have two or more inputs. The level of its output is dependent on the state of all

input levels. It can be seen from the truth table for the AND gate. If any input is 0, the output is 0. For the output to be 1, all inputs must be 1.


#### NAND GATE



INPUTS		OUTPUTS
A	B	
0	0	1
1	0	1
0	1	1
1	1	0

The outputs of the NAND gate are the opposite of the AND gate. If any output is 0, the output will be 1.


#### OR GATE



INPUTS		OUTPUTS
A	B	
0	0	0
1	0	1
0	1	1
1	1	1

The output of the OR gate is 1 if any input is 1.

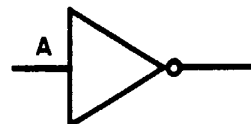
#### NOR GATE



INPUTS		OUTPUTS
A	B	
0	0	1
1	0	0
0	1	0
1	1	0

The output of the NOR gate is the opposite of the OR gate. The output is 0 if any input is 1.

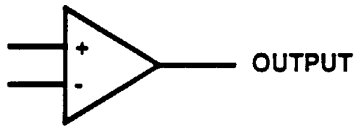
#### 5.3.2 INVERTER



INPUT	OUTPUT
0	1
1	0

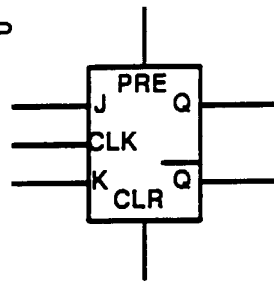
The inverter has a single input. The output level is the opposite of the input level.

### 5.3.3 VOLTAGE COMPARATOR



The voltage comparator has two inputs, inverting (-) and non-inverting (+). The non-inverting input is normally connected to a fixed or reference voltage. The inverting input is usually variable. As the (-) input becomes more positive and exceeds the (+) input level, the output switches low. If the (-) input voltage becomes less positive than the (+) reference input, the output switches to a high level once again.

### 5.3.4 J-K FLIP-FLOP



The flip-flop (FF) is a memory device that stores a logic state. The above symbol is that of a J-K flip-flop, the state of which is referred to by the level of the Q output. If, for example, the Q output is high, the FF contains a 1. The /Q (Q NOT) output is always the opposite of the Q output. The state of the FF can be changed in two ways: by means of the clock (CLK) input, or by the clear (CLR) and preset (PRE) inputs. The effect of an applied clock pulse on the state of a FF depends upon the

J and K inputs. The J input must be high for a clock pulse to cause a 1 output. The K input must be high for a clock pulse to cause a 0 output. If both J and K are high, the FF toggles on each applied clock pulse. The PRE and CLR inputs operate independently of the clock. A high level input to the PRE line drives the FF to a level 1, while a high input to the CLR line drives the FF to a level 0.

### 5.3.5 MICROPROCESSOR

The microprocessor is a small computer con-

tained within an integrated circuit, and has the capability to store, retrieve and process data. The device used in the MSR 8050A contains an 8 bit central processor unit, a 128 byte on-chip RAM, 32 input/output lines, an internal oscillator clock, 64k address space for external data memory, 64k address space for external program memory, two 16 bit timer/counters, a five source interrupt structure with two priority levels, full duplex serial port and a Boolean processor. It is contained in a 40 pin dual in-line package.

### 5.3.6 OUTPUT LATCH

The 8-bit latch is a device used to store output information from the data bus. When triggered, the logic state present on the input pins is transferred to and latched in the output pins. The output pins retain this data and do not change state until the chip is triggered again.

### 5.3.7 RANDOM ACCESS MEMORY

RAMs are logic elements that can be reprogrammed over and over again. The information stored can be retrieved by using the read/write and address inputs. There are two types of RAMs used in this transceiver. One is a volatile RAM that loses all stored information when the power is removed from the chip. The other is non-volatile and retains stored information, even after power has been removed.

### 5.3.8 ERASABLE PROGRAMMABLE READ ONLY MEMORY

The EPROM is a non-volatile memory device that may be erased and reprogrammed, under specific conditions. It contains the codes used to control the microprocessor.

### 5.3.9 PRIORITY INTERRUPT

This device assigns priority to 8 interrupt lines to control the actual interrupt to the microprocessor.

### 5.3.10 TRI-STATE BUFFER

The tri-state buffer is similar to other buffers, in that it has the normal high and low output states, but also has a controllable off (or open circuit) state which allows bi-directional operation.

### 5.3.11 PROGRAMMABLE KEYBOARD/ DISPLAY INTERFACE

This 40-pin integrated circuit operates with the microprocessor to interface the keyboard inputs with the front panel seven-segment displays.

## 5.4 ASSEMBLY AND SUBASSEMBLY IDENTIFICATION

Schematics of each assembly and module, including parts lists, are contained in this section of the manual. Table 5.1 lists the major assemblies and subassemblies for the MSR 8050A Transceiver.

## 5.5 COVER REMOVAL

The top cover of the MSR 8050A transceiver may be removed by rotating the two quick-disconnect quarter-turn fasteners (located along the front edges of the cover) CCW. The cover may then be removed by lifting the front edge of the cover and pulling forward to disengage the rear edge of the cover from its retaining lip. The transceiver bottom cover is held by 10 screws to the chassis, rear panel and front panel.

The transceiver inner card cage cover can be removed by turning nine captive fasteners CCW and lifting the cover. See Figure 5.3.

To reinstall the covers, reverse the above procedure.

### 5.5.1 MODULE REMOVAL

#### 5.5.1.1 Front Panel

The front panel is detachable from the transceiver by seven nuts and four cable connectors. See Figure 5.2.

#### 5.5.1.2 Mother Board

All components except coax wiring are mounted on the top side of the board, including option jumpers and the microphone selector switch. These may be reached by removing the top cover, the card cage top shield and adjacent modules, as necessary. Access to the connector pins of all plug-in modules (at the bottom of the

board) is gained by removing the transceiver bottom cover. (See Figure 5.5.)

Removal of the Mother board is accomplished by first removing the top and bottom covers and the card cage top cover. Then, disconnect the rear panel cable assemblies that connect to the Mother board. Also disconnect the power supply cable (P27). Disconnect the ribbon cable assemblies from the front panel to the Interface board, to the Audio I/O board, and remove all plug-in modules. Then remove all screws holding the Mother board to the chassis and power supply assembly and carefully pull the board from the chassis.

#### 5.5.1.3 Rear Panel Assembly

The rear panel is mounted to the chassis by six screws. It is electrically connected to the transceiver via five 26-pin ribbon cables, five coaxial cables, two quick-disconnect wires and one multi-wire connector. (See Figure 5.4.)

#### 5.5.1.4 Power Amplifier Fan Assembly

The PA Fan assembly is installed using the same four screws which secure the PA module to the rear panel. To remove the unit, disconnect transceiver AC power, remove the four screws noted above and disconnect the fan connector from rear panel connector J41.

#### 5.5.1.5 Power Supply

To remove the power supply from the MSR 8050A:

- 1) Disconnect AC power cord from the rear of the transceiver (at the AC line filter).
- 2) Remove the top and bottom covers of the transceiver and the card cage top cover. Remove the four screws that fasten the power supply to the Mother board. Remove the two screws that hold the power supply to the card cage. Remove the two screws that hold the power supply to the left side panel.
- 3) Disconnect the power supply wiring harness from the MSR 8050A by removing P1 through P4 from their mating connectors.
- 4) Remove the steel top shield from the power

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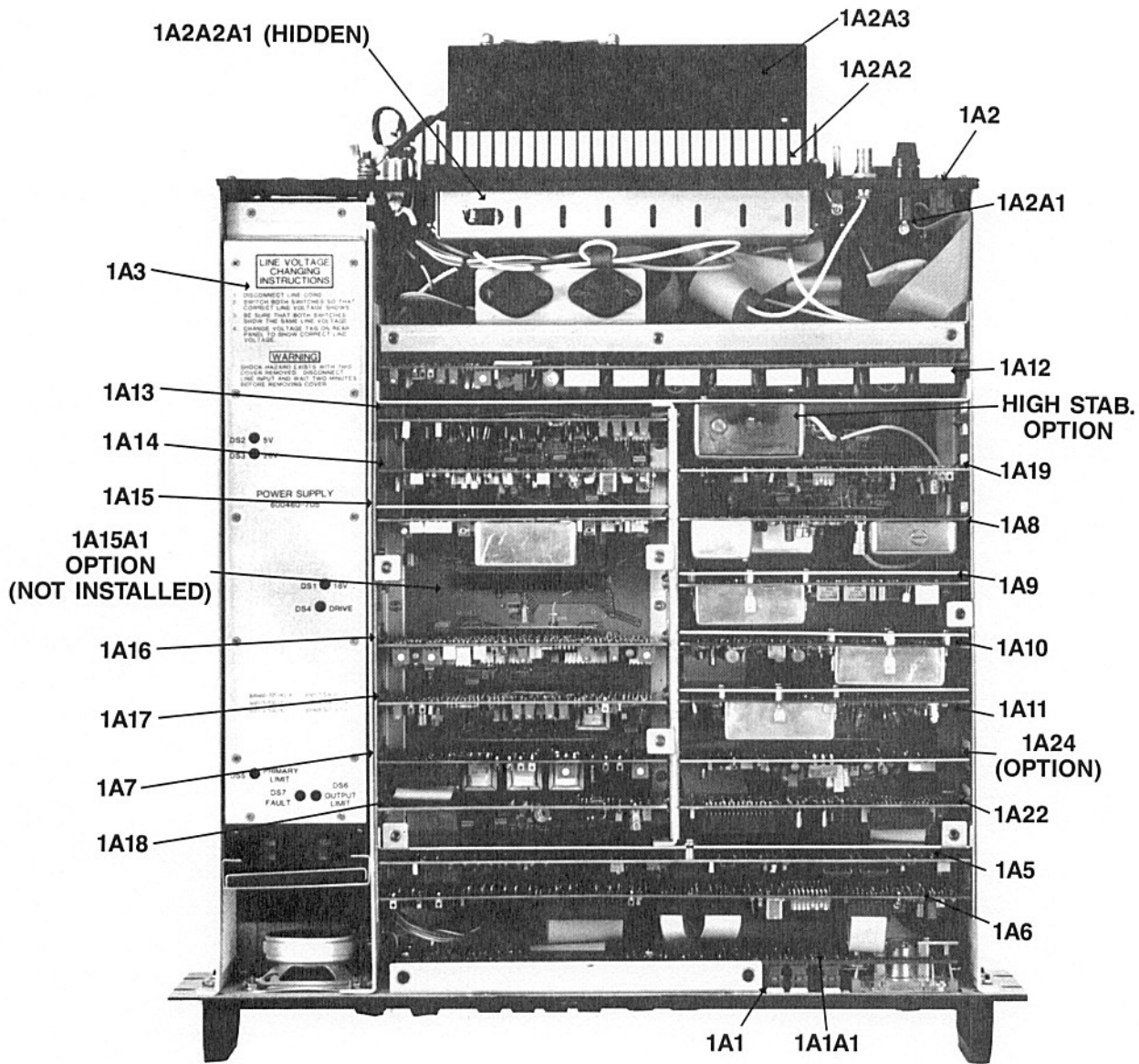


Figure 5.0 TRANSCIVER ASSEMBLIES AND MODULES

**Table 5.1 MAJOR ASSEMBLIES/SUBASSEMBLIES**

DESIGNATOR		DESCRIPTION	PART NUMBER
ASSY	SUBASSY		
1A1	1A1A1	Transceiver Assembly Front Panel Assembly Keypad/Display Board	794049-000-002 700004-539-001 700024-536-001
1A2	1A2A1 1A2A2 1A2A2A1 1A2A3	Rear Panel Assembly Accessory Connector Board Power Amplifier Assembly Power Amplifier Board Assy. Fan Assembly	700200-539-002 602014-536-001 600407-705-001 601192-536-001 700023-700-001
1A3	1A3A1 1A3A2 1A3A3 1A3A3A1 1A3A4 1A3A5	Power Supply Assembly Power Supply Control Board Transformer Board FET Heatsink Assembly FET Driver Board Input Board Power Supply Chassis	600460-705-003 602015-536-001 602016-536-001 600428-537-001 602017-536-001 602018-536-001 600219-651-001
1A4	1A4A1	Card Cage Dual Regulator Assembly	700300-704-001 600429-537-001
1A5		Controller Board	700041-536-951
1A6		Interface Board	700026-536-001
1A7		Audio I/O Board	700046-536-001
1A7		Optional Audio I/O Board	700025-536-001
1A8		Reference Board	601080-536-003
1A9		Minor Loop Board	601214-536-001
1A10		Translator Loop Board	601083-536-001
1A11		Major Loop Board	601081-536-001
1A12		Half Octave Filter Board	601091-536-002
1A13		High Pass Filter Board	601086-536-003
1A14		High Level Mixer Board	601258-536-002
1A15	1A15A1	IF Filter Board Optional IF Filter Board	700047-536-XXX * 700042-536-XXX *

**Table 5.1 MAJOR ASSEMBLIES/SUBASSEMBLIES (Cont.)**

DESIGNATOR		DESCRIPTION	PART NUMBER
ASSY	SUBASSY		
1A16		Transmit Modulator Board	601078-536-003
1A17		Audio/Squelch Board	601077-536-006
1A18		Speaker Driver Board	601120-536-001
1A19		Coupler Interface Board	601197-536-003
1A20		Mother Board	700035-536-001
1A21		Programmed EPROM (1A5U3 Controller Board)	700600-412-001
1A22		Serial/Synthesizer Latch Board	700021-536-001
1A23		AC Filter Assembly	700006-537-001
1A24		Tone Key Modem Board (Option)	602025-536-002

\* The last three digits will vary depending on the combination of filters installed.

**MISCELLANEOUS PARTS**

SYMBOL	DESCRIPTION	PART NUMBER
	Card Cage Cover	700400-604-001
	Shield, Top, Power Supply	700402-604-001
	Bottom Cover	600926-612-001
	Fan Bracket Brace	604383-602-001
	Bracket	604556-602-001
	Cover	600927-612-001
	Shield, Bottom, Power Supply	600341-604-001
	Grommet, Caterpillar, .090 Groove	600112-642-002
	Grommet, Caterpillar, .056 Groove	600112-642-001
J35	Ribbon Cable	600866-540-041
J36	Ribbon Cable	600866-540-040
J37	Ribbon Cable	600866-540-006
(A20J28/A22J2)	Ribbon Cable	600866-540-042
	Insulator, Side, Mother Board	700404-604-001
	Insulator, Front, Mother Board	700405-604-001

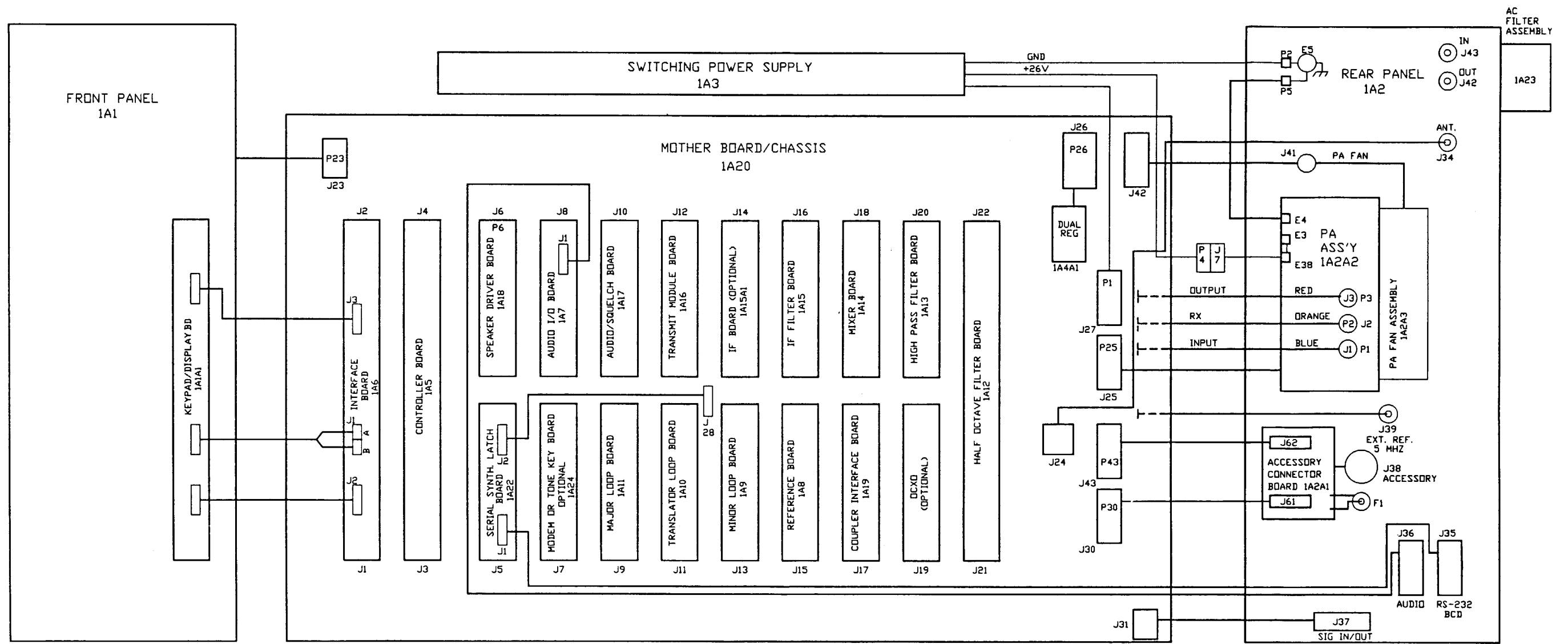


Figure 5.1  
MODULE INTERCONNECT DIAGRAM

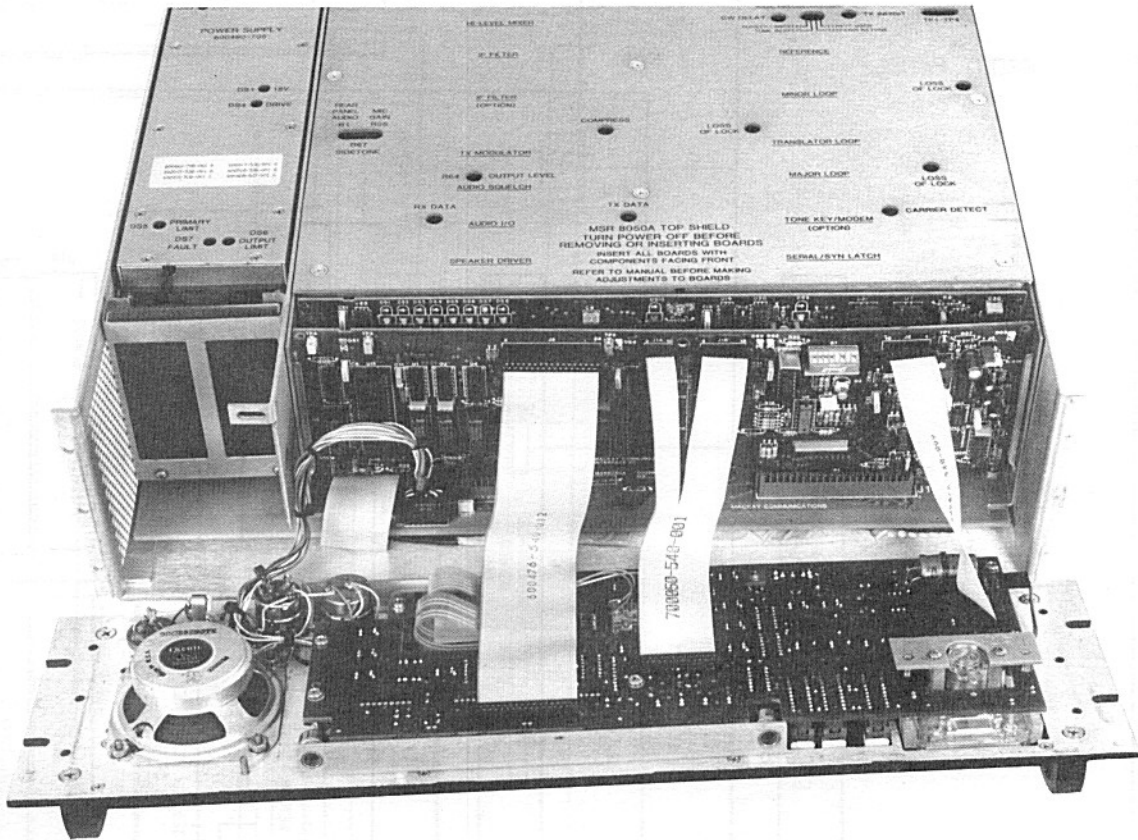
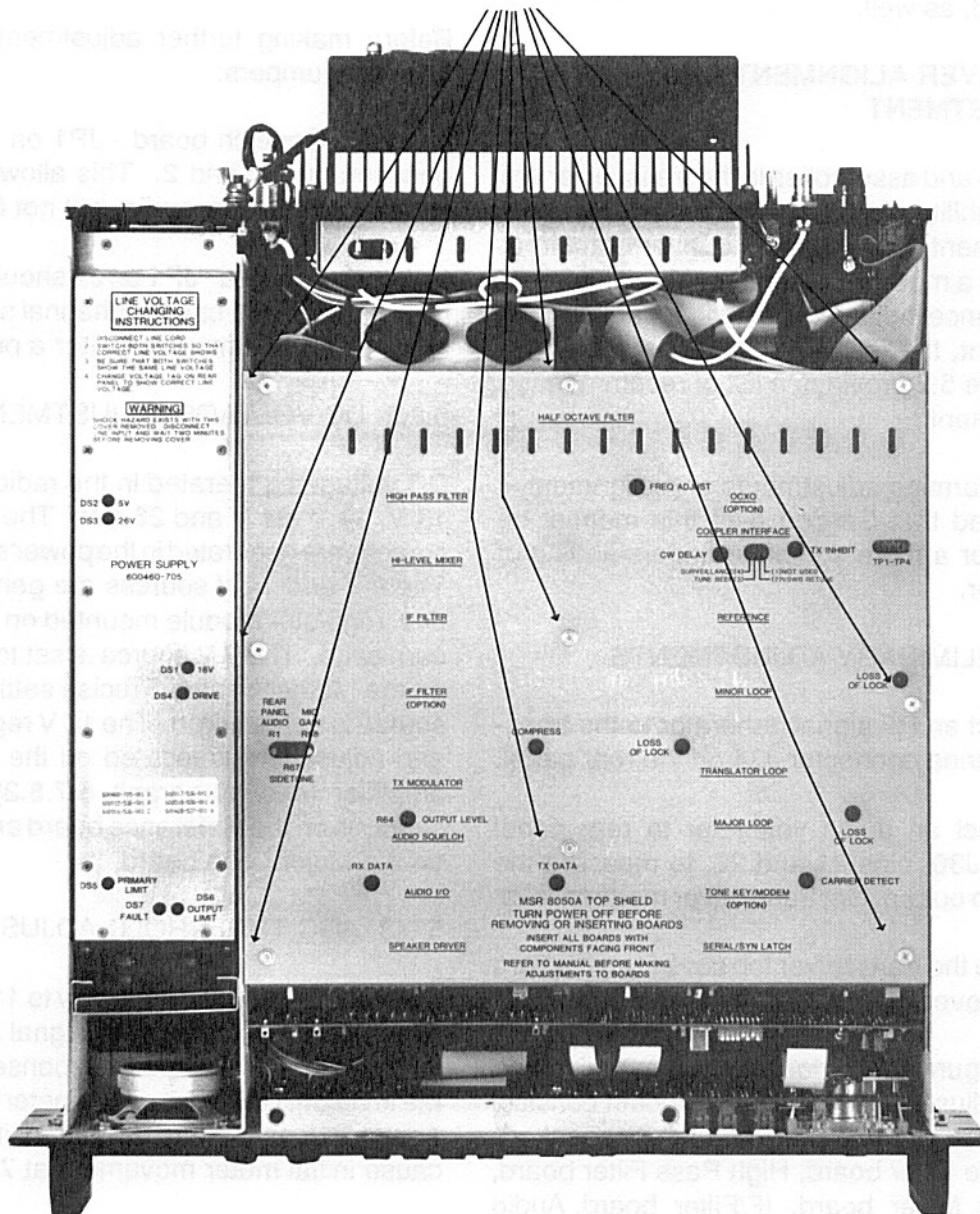


Figure 5.2 FRONT PANEL, DETACHED

### MOUNTING SCREWS



**Figure 5.3 INNER COVER MOUNTING SCREWS**

supply.

5) Remove the power supply unit from the MSR 8050A chassis. The steel bottom shield may now be removed, as well.

## 5.6 RECEIVER ALIGNMENT AND ADJUSTMENT

All modules and assemblies in the transceiver are of high reliability, solid state design. Adjustments and alignment are seldom, if ever, required. However, if a module or component replacement or performance indicates the need for adjustment or alignment, the following procedures are provided. Table 5.2 provides a list of recommended test equipment.

Before performing adjustments or realignment, it is suggested that Section 4 of this manual be reviewed for a more complete understanding of the receiver.

### 5.6.1 PRELIMINARY ADJUSTMENTS

- a) Connect an RF signal generator to the transceiver antenna connector J34 on the rear panel.
- b) Connect an audio voltmeter to rear panel connector J36, pins 21 and 22, to measure the 600 $\Omega$  audio output. Set transceiver mode to USB.
- c) Remove the transceiver top cover and the card cage top cover.

Refer to Figure 5.7 for locations of modules and receiver adjustments. The receive path consists of the following boards (from antenna to speaker): Half Octave Filter board, High Pass Filter board, High Level Mixer board, IF/Filter board, Audio Squelch board, Audio I/O board and Speaker Driver board. Some auxiliary functions exist on the Interface and Keypad/Display boards. No receiver adjustments are contained on the Audio I/O, Half Octave Filter, High Pass Filter or Speaker Driver boards.

The High Level Mixer board has adjustments for internal component tolerances and should not be readjusted. If components are replaced on this board, it may be put back in service by adjusting C33, C35 and L14 for maximum receiver audio

output with 0.5  $\mu$ Vrms rf input to the receiver. Access to adjustments requires that this board be mounted on an extender board (Mackay P/N 601098-536-001).

Before making further adjustments, check the following jumpers:

- 1) Audio/Squelch board - JP1 on E1 should be between pins 1 and 2. This allows muting and squelch of speaker audio, but not 600 $\Omega$  audio.
- 2) Interface board - JP1 on J4 should be between pins 1 and 2. JP1 causes channel scan to stop on signals and resume scan after a preset delay.

### 5.6.2 DC VOLTAGE ADJUSTMENTS

DC voltages generated in the radio are 5 V, 9 V, 13 V, 14 V, 24 V and 26.4 V. The 5 V and 26 V sources are generated in the power supply module. The 9 V and 14 V sources are generated on the dual regulator module mounted on the rear of the card cage. The 9 V source is set to +9.2 V by R3 on the Mother board. Precise setting of the 14 V source is not required. The 13 V regulated supply and adjustment is located on the 125 W power amplifier (see paragraph 5.7.8.2). The 24 V supply is on the Reference board and is only used on the Major Loop board.

### 5.6.3 AGC THRESHOLD ADJUSTMENT

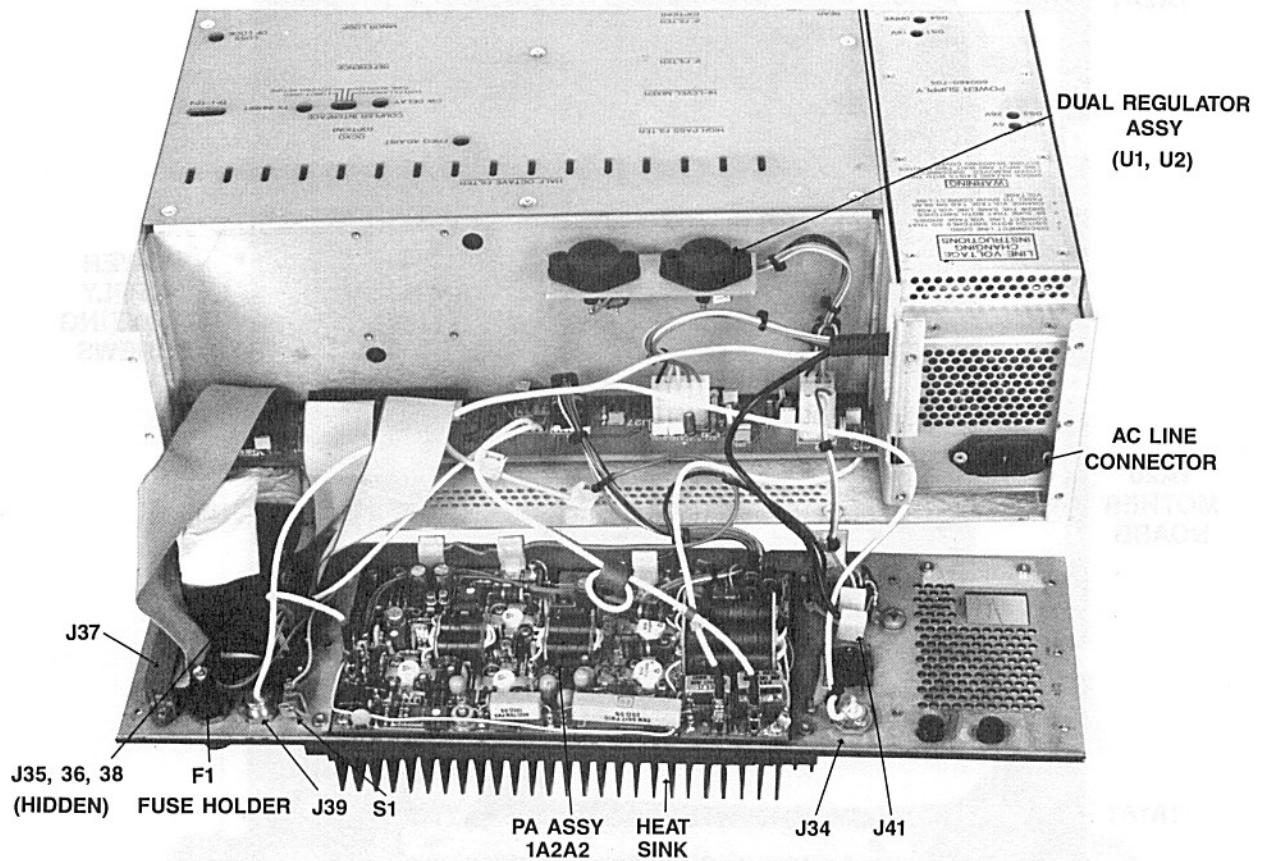
Set the MSR 8050A frequency to 11.6 MHz, USB, FAST AGC. Adjust the rf signal generator frequency to peak the audio response and increase the level until the front panel meter barely moves. Adjust R35 on the IF/Filter board, if necessary, to cause initial meter movement at 7  $\mu$ V rf input.

### 5.6.4 DELAYED AGC, METER AND 600 OHM AUDIO ADJUSTMENT

With power off and ohm meter from ground to E3 on the Audio Squelch board, adjust R80 (squelch) for 2.7k ohms.

With ohm meter from ground to R53 pin 3 (top terminal), adjust R53 (DAGC GAIN) for 100 ohms.

Turn power on. Connect d.c. voltmeter from ground to TP3 on the Audio Squelch board.



**Figure 5.4 REAR PANEL ASSEMBLY, DETACHED  
(WITHOUT FAN ASSEMBLY)**

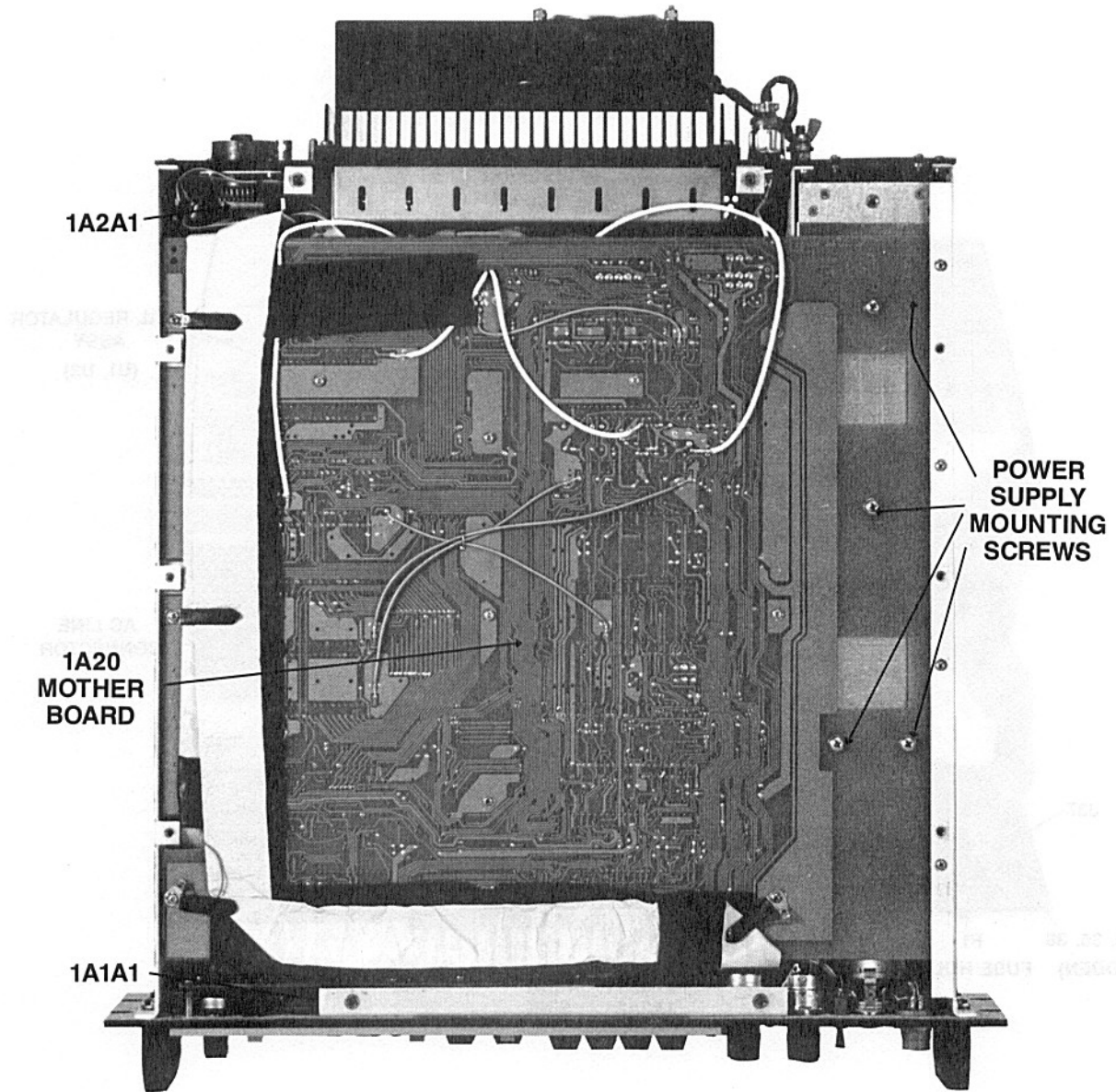


Figure 5.5 BOTTOM VIEW WITH COVERS REMOVED

**Table 5.2 RECOMMENDED TEST EQUIPMENT**

RF Signal Generator	HP 8640 or equal
Audio Meter and Distortion Analyzer	HP 334A or equal
Frequency Counter Accurate to 0.1 PPM at 30 MHz	
Audio Generators	HP 200CD or equal
Digital Multimeter, AC/DC, 3 1/2 digit	Fluke Model 77 or equal
Spectrum Analyzer	HP 8568A or equal
RF Voltmeter	Boonton 92 with 100:1 div and BNC adapter
RF Combiner	Merrimac PD-20-10-M2
Power Meter and Load	GR 1840 or equal
Oscilloscope	Tektronix Model 465
Dummy Load with 30 dB Attenuator	Bird Tenuline 8327
Audio Combiner and Key box (user built)	See Figure 5.6

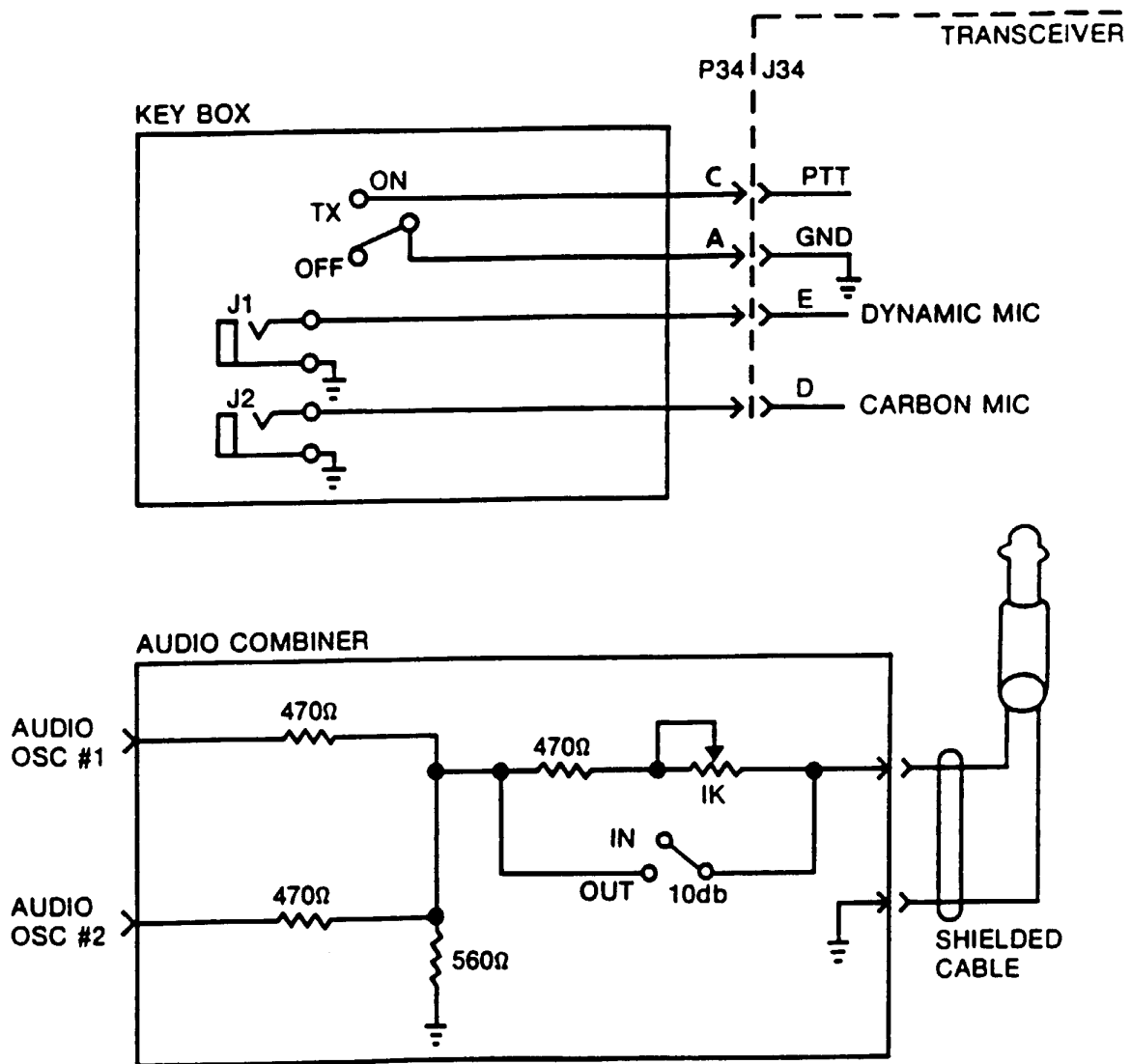
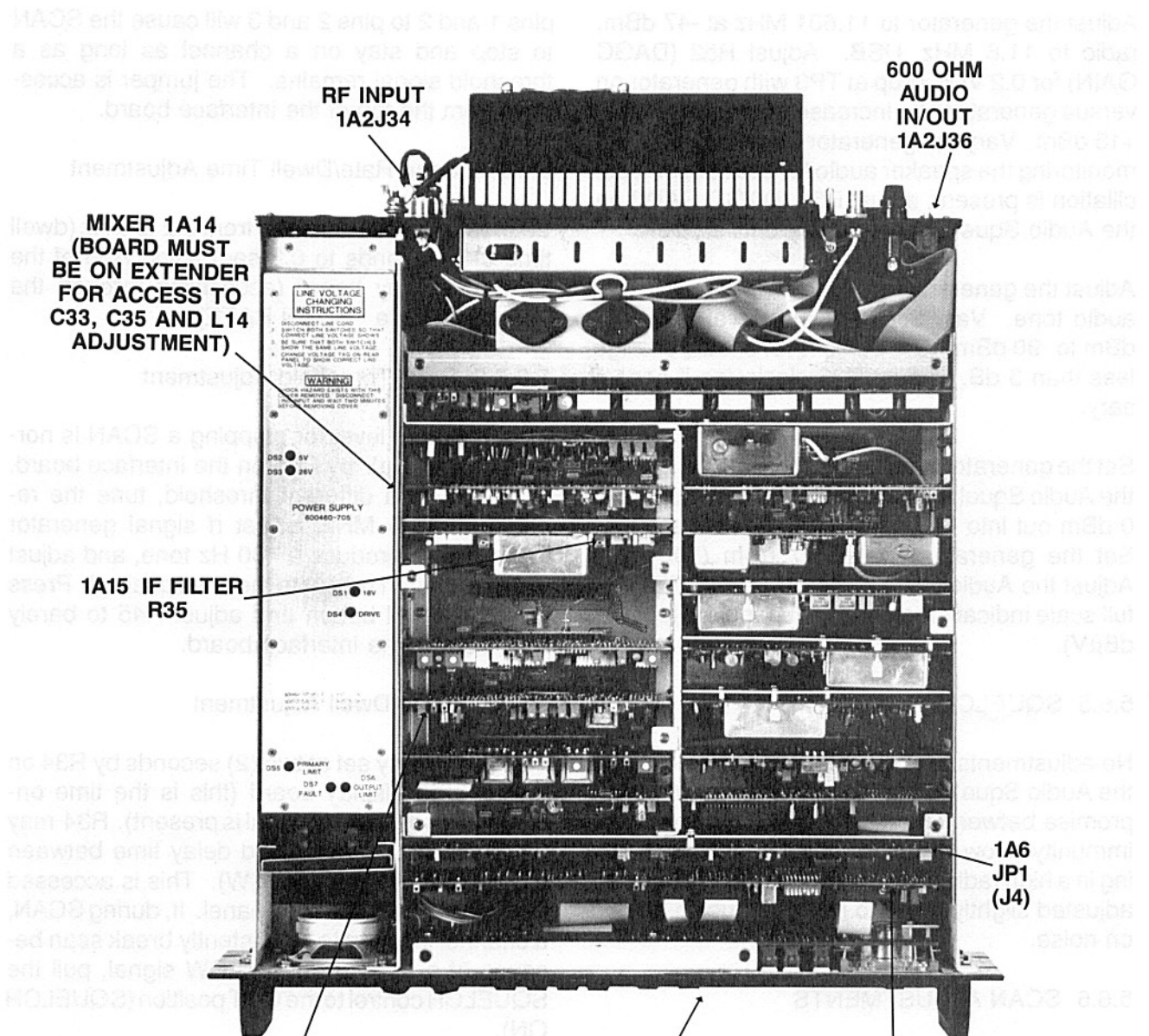


Figure 5.6 AUDIO COMBINER AND KEY BOX



**Figure 5.7 RECEIVER ADJUSTMENTS**

Adjust the generator to 11.601 MHz at -47 dBm, radio to 11.6 MHz, USB. Adjust R52 (DAGC GAIN) for 0.2 VDC drop at TP3 with generator on versus generator off. Increase generator level to +13 dBm. Vary the generator frequency  $\pm 5$  kHz monitoring the speaker audio for oscillation. If oscillation is present, adjust R53 (DAGC GAIN) on the Audio Squelch board CCW until stable.

Adjust the generator frequency to produce 1 kHz audio tone. Vary the generator level from +13 dBm to -90 dBm. The audio level should change less than 3 dB. Adjust R33 clockwise if necessary.

Set the generator level to -73 dBm (50  $\mu$ V). Adjust the Audio Squelch board R64 (600 ohm audio) for 0 dBm out into 600 ohms (J36 pins 21 and 22). Set the generator level to -7 dBm (100 mV). Adjust the Audio Squelch board R44 (SMET) for full scale indication on the front panel meter (100 dB $\mu$ V).

#### 5.6.5 SQUELCH

No adjustments are normally required as R80 on the Audio Squelch board is factory set for a compromise between threshold sensitivity and noise immunity. However, if the receiver will be operating in a high radio noise environment, R80 may be adjusted slightly CCW to reduce squelch breaks on noise.

#### 5.6.6 SCAN ADJUSTMENTS

##### 5.6.6.1 Signal Capture Mode Select

With the front panel RF GAIN/SQUELCH control pushed in (SQUELCH disabled), the SCAN will be stopped by either CW or voice signals above the set threshold. When the RF GAIN/SQUELCH control is pulled out, the SCAN will only be stopped by voice signals above the set threshold. The SCAN may stop momentarily on strong CW signals, but will continue to scan after about two seconds. SCAN will stop and remain on a channel with a voice signal.

In SCAN, the receiver normally operates in a SCAN/DWELL/DETECT/DELAY/CONTINUE mode. Changing JP1 on the Interface board from

pins 1 and 2 to pins 2 and 3 will cause the SCAN to stop and stay on a channel as long as a threshold signal remains. The jumper is accessible from the top of the Interface board.

##### 5.6.6.2 Scan Rate/Dwell Time Adjustment

Scan rate may be adjusted from 0.2 to 3 Hz (dwell time of 5 seconds to 0.3 sec) using R33 of the Keypad/Display board (accessible through the front panel hole - SCAN RATE).

##### 5.6.6.3 Scan Threshold Adjustment

The threshold level for stopping a SCAN is normally set to 2  $\mu$ V by R45 on the Interface board. To adjust to a different threshold, tune the receiver to 11.6 MHz, adjust rf signal generator frequency to produce a 400 Hz tone, and adjust the generator rf output to the level desired. Press the SCAN ON button and adjust R45 to barely light DS1 on the Interface board.

##### 5.6.6.4 Scan Dwell Adjustment

This is normally set at two (2) seconds by R34 on the Keypad/Display board (this is the time on-channel if a threshold signal is present). R34 may be adjusted to any desired delay time between 0.5 sec (CCW) to 5 sec (CW). This is accessed through a hole in the front panel. If, during SCAN, a channel is noted to consistently break scan because of a large unwanted CW signal, pull the SQUELCH control to the OUT position (SQUELCH ON).

#### 5.7 TRANSMITTER ALIGNMENT AND ADJUSTMENT

##### 5.7.1 REQUIRED TEST EQUIPMENT

See Table 5.2 for a list of recommended test equipment.

##### 5.7.2 TEST SETUP

1) Remove the top cover and inside card cage top cover of the MSR 8050A.

2) Connect the Audio Combiner/Key Box (Figure 5.6) to the front panel microphone connector. Be

certain that the CARBON/DYNAMIC switch on the MSR 8050A Mother board is in the DYNAMIC position.

3) Connect the audio oscillator to the audio combiner.

4) Connect the rf voltmeter probe directly to the antenna jack J34 using a "tee" connector. Do not connect the voltmeter to any other part of the transmission line between the transceiver and the load or erroneous readings will result. Do not use a coaxial cable between the "tee" and the rf voltmeter. Connect the dummy load to the "te" using any convenient length of 50 ohm coaxial cable.

### **CAUTION**

***Connect the rf voltmeter probe ground lead to the chassis so that it does not inadvertently cause a short circuit on the Half Octave board.***

#### **5.7.3 BOARD JUMPER SETUP**

Before attempting alignment, check the option jumpers on the Half Octave board and the Transmit Modulator board.

##### **5.7.3.1 Half Octave Board**

JP1 should be in the normal upper (pins 1 and 2) position at E1.

##### **5.7.3.2 Transmit Modulator Board**

Jumpers JP1 (Carbon/Dynamic mic) and JP2 (Center tap key) may be in either position. Jumper JP3 should be in the upper position, pins 2 and 3, for "Compressor In". Jumper JP4 should always be in the left hand position between pins 2 and 3.

#### **5.7.4 OUTPUT POWER ADJUSTMENTS**

Since the oscilloscope is used only for waveform monitoring and absolute value is not important, the scope probe may be placed next to the Half Octave Filter board at any convenient point and capacitive coupling should provide adequate signal for monitoring.

### **NOTE**

**Some adjustments interact. The adjustments should only be made in the order given here.**

#### **5.7.4.1 ALC Threshold Adjustment**

Set the power level to 2. With the transmitter UNKEYED, set R83 on the Transmit Modulator board for 4.00 VDC measured at TP6.

#### **5.7.4.2 ALC Detector Adjustment**

On the Transmit Modulator board, adjust R51 (DSB output) and R17 (carrier) fully CW (max. output). Set radio frequency to 1.6 MHz in CW mode. Key the transmitter and adjust R11 (ALC CAL) on the Half Octave Filter board for 79 VRMS rf output as read on the rf voltmeter. Unkey the transmitter.

Set the radio frequency to 29.9 MHz in CW mode. Key the transmitter and adjust C2 (ALC COMP) on the Half Octave Filter board for 79 VRMS rf output. Recheck results at 1.6 MHz (and 29.9 MHz, if necessary).

#### **5.7.4.3 Low Power Adjust**

Set the radio to 1.6 MHz in CW mode and set power level to 1. Key the transmitter and adjust R84 on the Transmit Modulator board for 35 VRMS rf output.

#### **5.7.4.4 Transmit Modulator Board Output Level Adjust**

Set the frequency to 29.9 MHz in CW mode and set power level to 2. Key the transmitter and adjust R51 CCW until the rf voltage just starts to fall, then turn back CW 1/8 turn.

#### **5.7.5 AMPLITUDE MODULATION EQUIVALENT (AME) ADJUSTMENTS**

Turn R44 (AM MODULATION) on the Half Octave Filter board fully CCW. Set the frequency to 1.6 MHz in AM mode. Key the transmitter with no modulation and adjust R13 (AM CARRIER) on the Half Octave Filter board for 42 VRMS rf output. Unkey the unit.

NOTE  
 certain that the CARBON-DYNAMIC switch on  
 the V52 5000A Motor (located in the DYNAMIC  
 position  
 3) Connect the audio output to the  
 Carbon  
 4) Connect the 10 voltmeter  
 antenna jack (using a 100 ohm  
 connect the voltmeter  
 transmission in  
 a coaxial cable  
 voltmeter  
 using any con  
 5000A  
 Connect the  
 the chassis  
 cause a short  
 5.3.3 BOARD  
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 jumpers on the  
 in the  
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 5.3.3.2 H  
 5.3.3.3 H  
 5.3.3.4 H  
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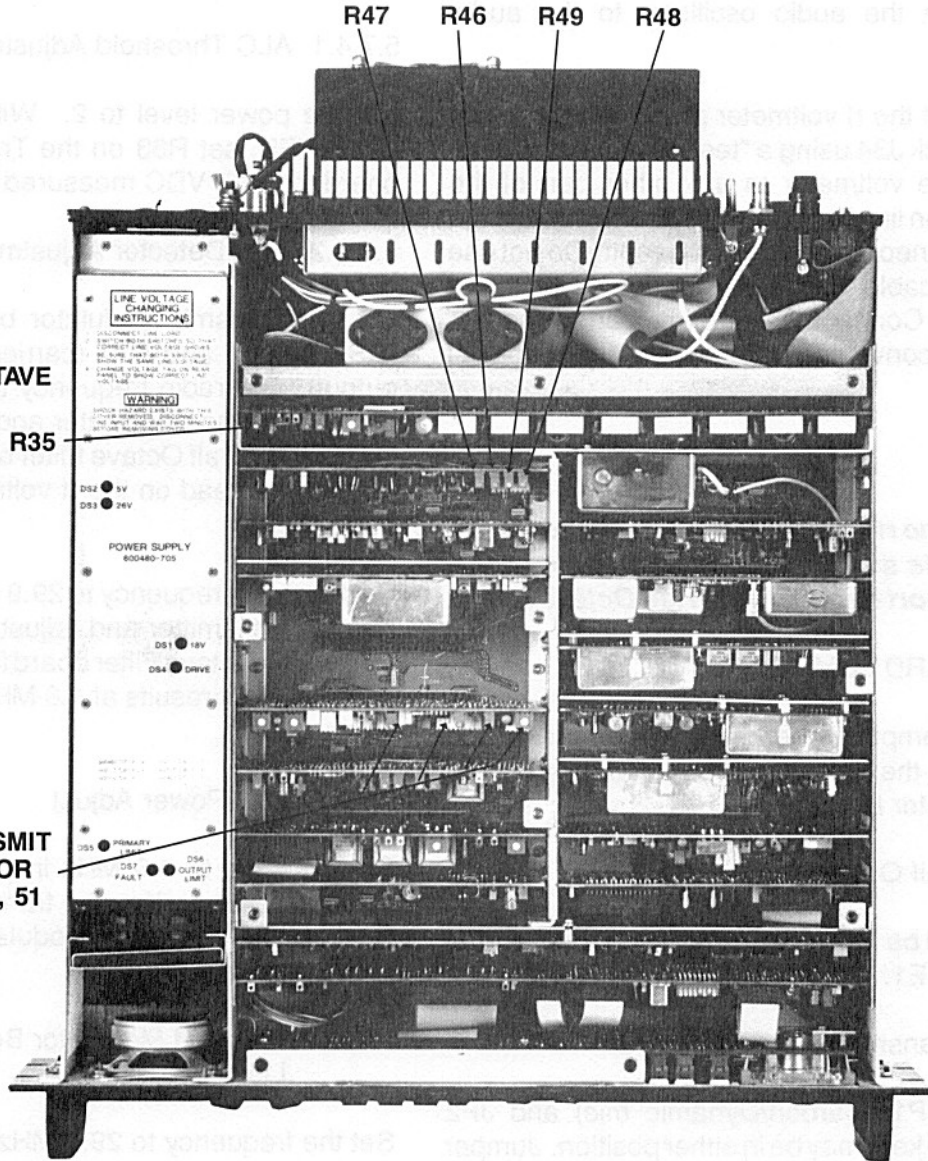
**1A13 HIGH PASS FILTER (A3A CARRIER ADJUST)**

R47 R46 R49 R48

**1A12 HALF OCTAVE FILTER**

R11, R44, R13, R35  
 C30, C2

**1A16 TRANSMIT MODULATOR**  
 R84, 83, 17, 51



**Figure 5.8 TRANSMITTER ADJUSTMENTS**

Connect a load and 30 dB power attenuator to the MSR 8050A rf output connector J34 and, using a convenient length of 50 ohm coaxial cable, connect the Spectrum Analyzer to the attenuator output.

### **CAUTION**

***Do not connect the Spectrum Analyzer directly to the transmitter rf output or severe damage will result. Adjust the Analyzer controls so that the carrier and a tone 1 kHz away can be seen.***

Set the frequency to 29.9 MHz in AM mode. Increase the level of a 1 kHz modulating tone (fed through the mic connector) until the Compressor LED DS1 on the Transmit Modulator board is illuminated. Key the transmitter and adjust R17 (CARRIER) on the Transmit Modulator board until the output monitored on the Spectrum Analyzer shows the sideband 1.5 dB below the carrier. Note that the sideband tone is 1 kHz above the carrier frequency. Unkey the unit.

Set the frequency to 1.6 MHz in AM mode. Key the transmitter. Adjust R44 on the Half Octave Filter board CW until the rf output meter reads 79 VRMS. Unkey the unit.

#### **5.7.6 A3A (REDUCED CARRIER) ADJUSTMENTS**

Connect the load with 30 dB attenuator to the transceiver rf output connector J34 and connect the Spectrum Analyzer to the attenuator output. Set the audio oscillator frequency to 1 kHz and increase its amplitude until the compressor LED DS1 on the Transmit Modulator board is illuminated. Set the radio frequency to 1.9 MHz in A3A mode. Key the transmitter and adjust R49 on the High Pass Filter board so that the carrier is 16 dB below sideband output as observed on the Spectrum Analyzer. Unkey the unit.

Set the radio frequency to 4.0 MHz in A3A mode and key the transmitter. Adjust R48 on the High Pass Filter board so that the carrier is 16 dB below the sideband output. Unkey the unit.

Set the radio frequency to 19 MHz in A3A mode and key the transmitter. Adjust R47 on the High Pass Filter board so that the carrier is 16 dB below the sideband output. Unkey the unit.

Set the radio frequency to 29.0 MHz in A3A mode and key the transmitter. Adjust R46 on the High Pass Filter board so that the carrier is 16 dB below the sideband output. Unkey the unit.

#### **5.7.7 VSWR AND CURRENT LIMIT ADJUSTMENTS**

Set the radio frequency to 29.9 MHz in CW mode. Connect the digital voltmeter (DVM) between TP2 on the Half Octave Filter board and ground. Key the transmitter and adjust C30 on the Half Octave Filter board for a null (minimum voltage). Unkey the unit.

Connect two 50 ohm dummy loads in parallel, using the shortest coaxial lines possible, and connect with a short coax to the transceiver antenna jack J34. Set the radio frequency to 2.0 MHz in CW mode and key the transmitter. Adjust R35 (current limit) on the Half Octave Filter board for an rf output of 45 VRMS as read on the rf voltmeter. Unkey the unit.

#### **5.7.8 PA ADJUSTMENT**

Normally, adjustments to the solid state power amplifier are not required. If a component replacement or operation indicates a need for adjustments, the following adjustments can be made.

##### **5.7.8.1 Test Set-Up**

Terminate the transmit output, 1A2J34 in a 50 ohm, 125 watt load. Install a thru-line wattmeter (Bird or equivalent) in series with the output for these adjustments. Remove the four screws that attach the amplifier module to the Rear Panel assembly.

Carefully position the PA module in a flat position on the test bench. Insure that all wires and harnesses are attached to the exciter and that no electrical short circuit of the exposed PA circuit

board or wiring can occur to the chassis or other metal objects. The exciter power amplifier assembly can be safely operated in this position for short periods.

#### 5.7.8.2 13 VDC Regulator Adjust

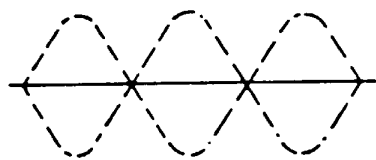
Set the transmit frequency to 5.2 MHz, the mode to USB. Key the radio using the microphone PTT but DO NOT speak into the microphone. Using a DC voltmeter connected between E1 and GND, adjust R2 for +13.2 VDC at E1. Unkey the radio.

#### 5.7.8.3 Output Stage Bias Adjust

Key the radio with no modulation. Adjust R44 (DRIVER BIAS) for .68 VDC measured between the base of Q6 or Q7 and ground. Adjust R47 (FINAL BIAS) for .68 VDC measured between the base of Q8 or Q9 and ground.

#### 5.7.8.4 Drive Stage Bias Adjust

The exciter settings are the same as 5.7.8.3. Connect an oscilloscope across the 50 ohm load and connect the audio combiner key box. Apply two equal audio tones, 700 and 2300 Hz, and key the exciter. The RF output pattern (shown below) on the scope should depict the standard two-tone pattern (similar to an AM modulation pattern with 100% modulation). Adjust R44 until the area between peaks just touches the reference line.



#### 5.7.8.5 Overcurrent Adjustment

Change the transmit frequency to 29.999 MHz, the mode to CW; and key the exciter. 125 watts should be indicated on the wattmeter. Adjust the R16 overcurrent adjust until the output power starts to decrease. Slowly adjust R46 until full power returns. Leave R46 adjusted to this setting. Remove power from the radio. Reinstall the PA module on the Rear Panel assembly.

### 5.7.9 POWER SUPPLY MODULE

See Figures 5.9, 5.10 and 5.11.

#### 5.7.9.1 Troubleshooting

##### 5.7.9.1.1 Troubleshooting Chart

Table 5.5 describes the LED status indicators that are visible through the top cover of the power supply. Table 5.6 outlines symptoms and probable causes of some power supply failure.

##### 5.7.9.2 Use of Extender Cables

The power supply can operate in a partially disassembled mode through the use of optional extension cables. Follow disassembly procedures in Section 5.7.9.3 until the FET Drive board has been removed. Reconnect the FET Drive board to the Control board (P4 to J4 and P5 to J5) outside of the power supply. Use the extension cables to connect P1, P2 and P3 of the FET board to J1, J2 and J3 of the Transformer board. Lay the Control board/ FET board assembly in front of the power supply with the FETs face down. Use the last extension cable to connect J1 of the Control board to P1 of the Input board. In all cases, be careful not to twist the cables or reverse any of the connections. Do not operate the supply at high current output for long intervals because the cooling fan is not connected in this state.

Finally, the power supply can be turned on and off by moving jumper P2 from J2, pins 2 and 3, to J2 pins 1 and 2.

##### 5.7.9.3 Power Supply Removal

To remove the power supply from the radio, follow the steps below.

1. Disconnect AC power cord from rear of radio.
2. Remove top and bottom covers of radio. Top cover is held by two (2) quarter-turn fasteners and bottom cover is secured by ten screws. Remove four (4) pan head screws that fasten power supply to radio Mother board.
3. Disconnect power supply wiring harness from radio by removing P1-4 from their mating connectors.
4. Remove two (2) screws that secure steel top shield to top of power supply. Remove this shield.

5. Remove power supply unit from radio chassis. Steel bottom shield may now be removed also.

#### 5.7.9.4 Disassembly of Power Supply

These instructions assume the power supply has already been removed from its radio. Refer to the Installation section of the radio manual for this procedure.

##### 5.7.9.4.1 Top Cover Removal

Remove the 14 screws that fasten the power supply top cover to its chassis. Note that some units are equipped with a steel shield over the top cover. This shield is held by two of the 14 top cover screws and must be removed first. Lift the top cover from the chassis.

Notice the large cylindrical capacitor C101. It is secured to the side panel by a c-clip that is fastened with a screw. This screw should not be removed.

##### 5.7.9.4.2 Side Panel Removal

1. Remove the three (3) screws that fasten the side panel to the fan bracket.

2. Remove the two (2) screws securing the side panel to the input bracket. Next, lay the power supply on its side and remove the five (5) screws that hold the side panel to the bottom position of the main chassis (A3A5).

3. Return the supply upright and remove the five (5) screws that fasten the side panel to the internal FET heatsink. Do not remove the screw holding the c-clip, but gently pull the side panel outward until the wiring harness can be lifted up and over the top of the input bracket. While pressing the bottom of C101 toward the fan, slide the side panel away from the fan until the c-clip slides off of the end of C101.

##### 5.7.9.4.3 Control Board Removal

The Control board can be removed with disconnecting it from the wiring harness or C101.

Remove two screws on either end of the Control

board. You may have to loosen the black output ground lead at terminal E4 to remove one of the screws. Unplug the fan at connector J3.

Gently work the control upward until the three PC mount connectors (J2, J4, J5) are free. The Control board, C101 and the wiring harness can now be draped over the side wall of the main chassis. If the Control board must be totally removed, disconnect C101 at terminals E1 and E2.

##### 5.7.9.4.4 FET Heatsink Assembly Removal

The FET Heatsink Assembly can be removed by gently pulling it upward until the three connectors (P1, P2, P3) between it and the Transformer board are disengaged.

##### 5.7.9.4.5 Final Disassembly

Further disassembly is usually not required, but careful visual inspection at this state will show the remaining disassembly steps to be self-evident.

#### 5.7.9.5 Power Supply Reassembly

##### 5.7.9.5.1 General

These instructions apply to a power supply whose FET Heatsink Assembly and Control board have been removed, but whose Transformer board and Input board are still installed in the main chassis along with the input and fan brackets.

##### 5.7.9.5.2 FET Heatsink Assembly Installation

The FET Heatsink assembly plugs directly onto the Transformer board by aligning P1, P2 and P3 of the FET board with J1, J2 and J3 of the Transformer board, and carefully pressing downward to engage the connectors.

##### 5.7.9.5.3 Control Board Installation

Carefully work the Control board underneath the lugs of the main chassis side panel and align J4 and J5 of the Control board with P4 and P5 of the FET drive board. Align J1 of the Control board with P1 of the Input board and gently press the Control board into place. Replace the two screws that secure the Control board in place.

#### 5.7.9.5.4 Side Panel Replacement

Place the output wire harness in its place between C101 and the Input board and route it through its normal exit point a notch in the input bracket. Align the edge of the side panel nearest the fan with its corresponding place on the fan bracket and carefully press the side panel into place, guiding C101 into its c-clip. This will require a moderate amount of pressure. Be sure the wiring harness and C101 are in place and reinstall all of the screws into the side panel.

#### 5.7.9.5.5 Top Cover Replacement

Align the holes of the top cover with the corresponding holes in the main chassis and install the screws holding it in place. Tighten all screws securely. If the power supply has a top shield, place it over the top cover of the supply before installing the final two screws that hold it in place.

#### 5.7.9.6 Adjustment Procedures

##### 5.7.9.6.1 General

The power supply is factory preset and should need no further adjustment, but a procedure is presented here for use in the event an adjustment is necessary. It is assumed the technician has a variable load with current indicator. All adjustments are made on the Control board. Adjustment tolerances can be found in Performance Specifications, paragraph 5.9.15.

##### 5.7.9.6.2 Switching Frequency

The Switching Frequency is approximately 40 kHz. It can be measured with an oscilloscope at TP10.

The frequency is set at the factory to optimize current limit circuit performance and should not be readjusted.

##### 5.7.9.6.3 +26V Output Adjustment

The +26V output should be set to 26.4 VDC while loaded to 1.5 amps. Potentiometer R37 is for this adjustment.

##### 5.7.9.6.4 +5V Output Adjustment

While the +26V output is loaded to 1.5 amps, adjust the +5V output for +5.2 VDC. This adjustment is made with potentiometer R9, located on the FET Drive board. An access hole is provided in the Control board near J5.

##### 5.7.9.6.5 Temperature Threshold Adjust

The over-threshold temperature of the FET heatsink should be set to +82°C. This is done by adjusting potentiometer R2 while measuring the DC V at TP4. The adjustment voltage is 355 mV.

##### 5.7.9.6.6 Primary Current Threshold

This adjustment is made with pot R6 by slowly increasing the loading of the +26V out-put until the primary limit indicator (D55) just begins to turn on, and adjusting R6 so that this occurs at a loading of 18 amps. This ensures proper voltage foldback at a load current of about 20 amps.

#### 5.7.9.7 Periodic Maintenance

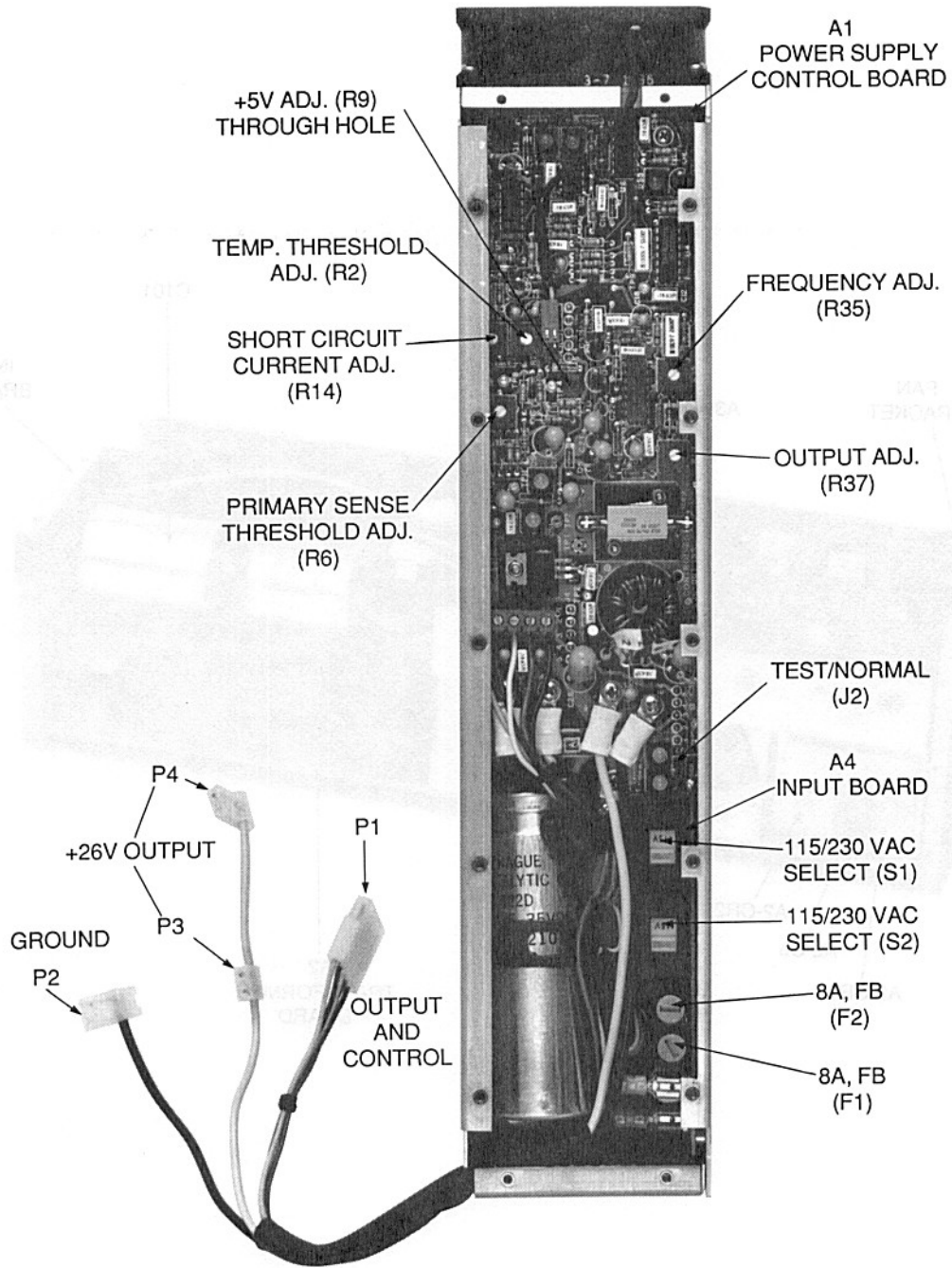
##### 5.7.9.7.1 Intake Air Filter

The intake air filter should be inspected often and cleaned when necessary. A clogged air filter will cause inefficient performance of the power supply, resulting in higher operating temperatures and possible failure. When the overtemperature threshold is reached, the power supply FAULT indicator will come "ON", but the power supply will still be operational. A signal is sent to the host radio which will disable the transmit function if this condition persists.

#### 5.7.9.8 Options and Accessories

##### 5.7.9.8.1 Extension Cable Kit

The optional extension cable kit, P/N 600289-700-001, can be used as a troubleshooting aid, allowing operation of the power supply in a partially disassembled state. This allows access to PC boards and components that otherwise are inaccessible during operation. The kit consists of a set of three cables (P/N 600891-540-001) and a set of one cable (P/N 600891-540-002).



**Figure 5.9 POWER SUPPLY TOP VIEW, COVER REMOVED**

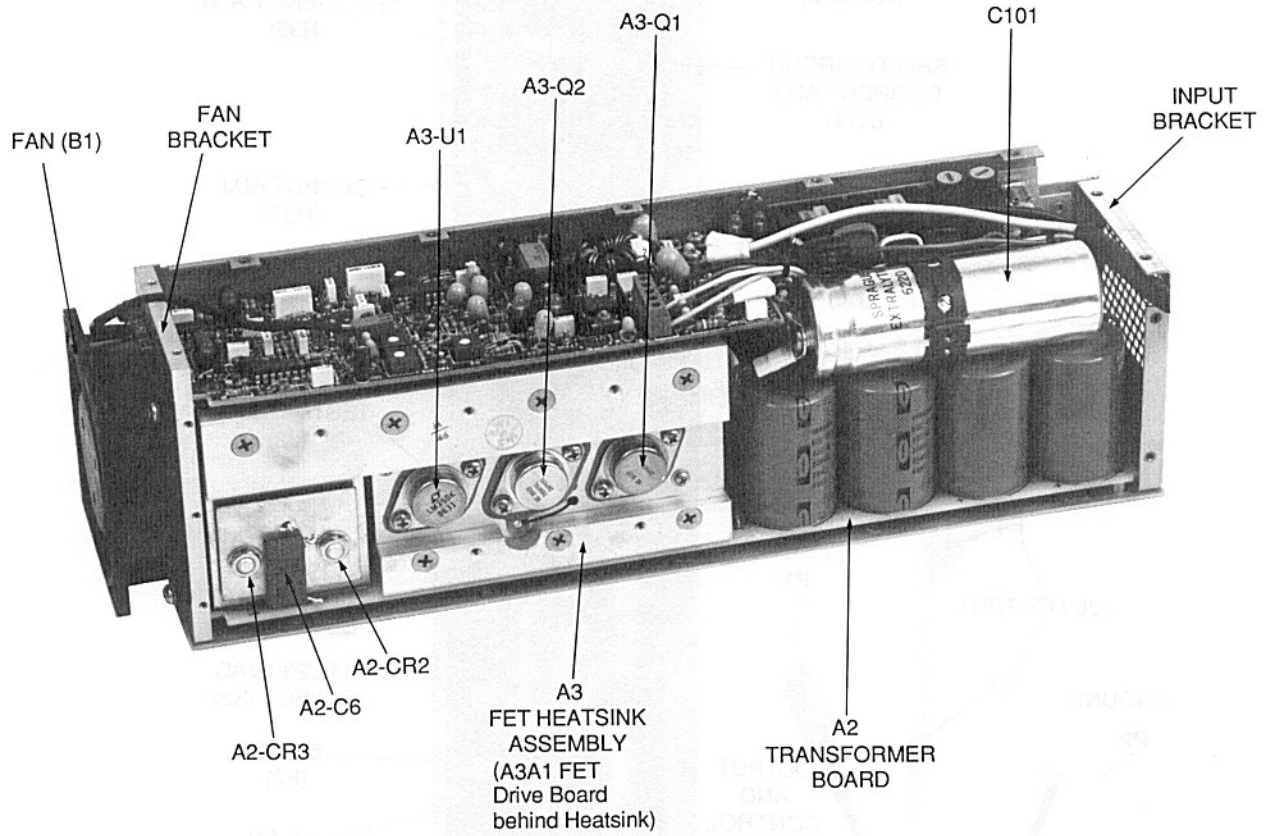


Figure 5.10 POWER SUPPLY MAJOR ASSEMBLIES

LED status and activity indicators and test points may also give clues to malfunction areas.

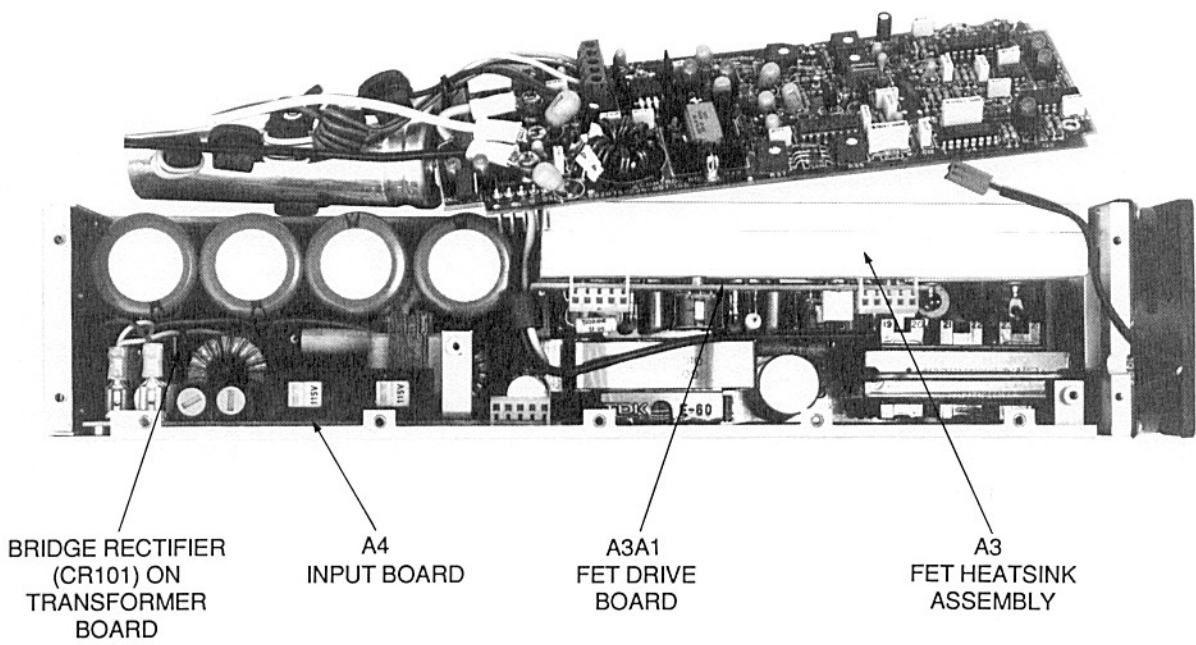
LED status and activity indicators and test points and speaker also aid in locating problems.

Activity indicators from the front panel meter (500 ohm receiver audio level receive signal strength, transmit power, reflected transmit power) localize faults to a module or functional circuit modules and the BITE code (3.2.6) on the panel BITE LED indicators (Figure 5.12, Table 5.3) on

5.2. TROUBLESHOOTING

Troubleshooting the radio is accomplished by associating the symptom with one or more modules. Since the radio consists almost entirely of easily replaced plug-in modules, the trouble may be isolated to a single module by substitution of good modules.

Table 5.3 lists suspected modules with symptoms of malfunctions for the receive mode. Table 5.4 is a similar list for transmit functions and Table 5.5 for power supply functions.



**Figure 5.11 POWER SUPPLY TOP VIEW, CONTROL BOARD REMOVED**

## **5.8 TROUBLESHOOTING**

Troubleshooting the radio is accomplished by associating the symptom with one or more modules. Since the radio consists almost entirely of easily replaced plug-in modules, the trouble may be isolated to a single module by substitution of good modules.

Table 5.3 lists suspected modules with symptoms of malfunctions for the receive mode. Table 5.4 is a similar list for transmit functions and Table 5.6 for power supply functions.

BITE LED indicators (Figure 5.12, Table 5.5) on modules and the BITE code (3.2.9) on the panel localize faults to a module or functional circuit area.

Activity indications from the front panel meter (600 ohm receive audio level, receive signal strength, transmit power, reflected transmit power) and speaker also aid in localizing problems.

LED status and activity indicators and test points may also give clues to malfunction areas.

**Table 5.3 MSR 8050A RECEIVE TROUBLESHOOTING CHART**

SYMPTOM	PROBABLE CAUSES
<p>1. Receiver inoperative, display and key light not lit. Power Supply LEDs not lit.</p>	<p>1. AC line cord defective or not connected. 2. Fuse blown. 3. Power Supply failure.</p>
<p>2. No audio or background noise at speaker or phone jack. Meter indicates RF Signal presence.</p>	<p>1. Speaker switch off or defective. 2. Volume control at "Min" position or defective. 3. Squelch control control pulled out. 4. Defective cable, Front Panel Assy, 1A1, P23. 5. Defective Speaker Driver board, 1A18. 6. Defective Audio Squelch board, 1A17. 7. Defective Interface board, 1A6. 8. Ground on Mother board "LL" trace or Mute line or rear panel connection 1A2J37, pin 9. 9. AGC in "off" position with RF gain control CCW.</p>
<p>3. Same but meter may or may not indicate. One of the Synthesizer "Loss of Lock" lights is indicating.</p>	<p>1. Defective Synthesizer board, 1A8, 1A9, 1A10 or 1A11. (Remove top cover and locate defective board by illuminated Loss-Lock LED.)</p>
<p>4. AM mode normal; other modes inoperative.</p>	<p>1. Third LO injection absent at Audio Squelch board, 1A17. 2. Defective Reference board, 1A8. 3. Defective Controller board, 1A5. 4. Defective Interface board, 1A6.</p>
<p>5. Distorted audio at speaker.</p>	<p>1. Defective Speaker Driver board, 1A18. 2. Defective Audio Squelch board, 1A17. 3. Defective Interface board, 1A6. 4. Defective Display board, 1A1A2. 5. AGC in "off" position, with RF Gain control too far CW.</p>
<p>6. Receiver signals weak in all modes. "S" meter indicates low.</p>	<p>1. Defective High Pass Filter board, 1A13. 2. Defective Half Octave Filter board, 1A12. 3. Defective Mixer board, 1A14. 4. Defective IF Filter board, 1A15. 5. Defective Rear Panel cable to Mother bd, 1A2P24. 6. Defective Audio Squelch board (i.e. DAGC pot adjusted too early). 7. Defective Controller board, 1A5. Band 1-8 signals incorrect. Check board LED indicators on Controller board, 1A5. 8. Defective cables from Mother board to Rear Panel PA, 1A20 P2, 1A20 P3.</p>

**Table 5.3 MSR 8050A RECEIVE TROUBLESHOOTING CHART (Cont.)**

SYMPTOM	PROBABLE CAUSES
7. Received signals weak in some but not all bands.	<ol style="list-style-type: none"> <li>1. Defective Half Octave Filter board, 1A12.</li> <li>2. Defective High Pass Filter board, 1A13.</li> <li>3. Defective Controller board, 1A5.</li> </ol>
8. "E2" appears in RADIO/BITE display; other displays blank.	<ol style="list-style-type: none"> <li>1. Press "C". If display returns to normal, fault was a momentary loss of 9 volts or 13 volts.</li> <li>2. If E2 reappears:               <ol style="list-style-type: none"> <li>a. Defective power supply, 1A3.</li> <li>b. Short circuit or excessive load on 9 or 13 volt bus.</li> <li>c. Short circuit on "PS BITE" line on Mother board to Controller board.</li> </ol> </li> </ol>
9. Front Panel displays and switch LEDs dim or not lit.	<ol style="list-style-type: none"> <li>1. Keypad/Display board, 1A1A1 defective (5 volt DIM circuit).</li> <li>2. Front Panel dimmer control R6 or P5 connection to Interface board defective.</li> </ol>
10. Inoperative meter/switches.	<ol style="list-style-type: none"> <li>1. Keypad/Display board, 1A1A1 defective.</li> </ol>
11. Operation of displays and switches not correct.	<ol style="list-style-type: none"> <li>1. Keypad/Display board, 1A1A1.</li> <li>2. Interface board, 1A6.</li> <li>3. Controller board, 1A5.</li> </ol>
12. No response from Front Panel switches (check that Remote switch is in "OUT" position and not lit).	<ol style="list-style-type: none"> <li>1. Keypad/Display board, 1A1A1.</li> <li>2. Interface board, 1A6.</li> <li>3. Controller board, 1A5.</li> </ol>

**Table 5.4 MSR 8050A TRANSMIT TROUBLESHOOTING CHART**

SYMPTOM	PROBABLE CAUSES
1. Transmitter will not key.	<ol style="list-style-type: none"> <li>1. Microphone connector, 1A1 P1 improperly attached to front panel microphone input.</li> <li>2. Defective microphone or microphone cord.</li> <li>3. Key interlock jumper from pin "G-G" to "G" on accessory connector, A2J38 is open.</li> <li>4. Coupler Interface board defective. Check TX inhibit LED and TP1-4 on Coupler Interface board.</li> </ol>
2. No transmit output, but transmit indicator is ON when microphone button is depressed. Front panel FAULT light is not on.	<ol style="list-style-type: none"> <li>1. Defective High Pass Filter board, 1A13.</li> <li>2. Inoperative relay, 1A2A2K2 on PA module.</li> <li>3. Defective Half Octave Filter board, 1A12.</li> <li>4. Defective PA module 1A2A2.</li> <li>5. Defective PA input cable (CX15) from Mother bd.</li> </ol>
3. Transmitter will key, but low or no RF output in any mode. FAULT light is "ON".	<ol style="list-style-type: none"> <li>1. Excessive antenna VSWR.</li> <li>2. PA over-temperature or over-current condition.</li> <li>3. Defective Half Octave Filter board, 1A12.</li> <li>4. Over-current adjustment, 1A2A2, R16 on PA module improperly adjusted.</li> <li>5. Defective PA module, 1A2A2.</li> </ol>
4. Transmitter will key, but low or no RF output in any mode. FAULT light is "OFF".	<ol style="list-style-type: none"> <li>1. Defective Transmit Modulator board, 1A16.</li> <li>2. Defective IF Filter board, 1A15.</li> <li>3. Defective Mixer board, 1A14.</li> <li>4. Defective High Pass Filter board, 1A13.</li> <li>5. Defective PA module, 1A2A2.</li> <li>6. Defective Half Octave Filter board, 1A12.</li> <li>7. Defective synthesizer.</li> </ol>
5. Transmitter will not key "ON" and TX INHIBIT light is "ON"	<ol style="list-style-type: none"> <li>1. Check TP1,2,3 or 4 to determine which TP is LOW.               <ol style="list-style-type: none"> <li>a. TP1 - Jumper from G to G-G on 1A2J38.</li> <li>b. TP2 - <u>power supply</u> fault.</li> <li>c. TP3 - TX INHIBIT. Check U4 on Mother board.</li> <li>d. TP4 - LL. Check reference switch on rear panel. Check Synthesizer boards.</li> </ol> </li> </ol>
6. Transmitter puts out power but no sidetone heard in handset earpiece.	<ol style="list-style-type: none"> <li>1. Defective Transmit Modulator board, 1A16.</li> <li>2. Front panel cable to Mother board J23 defective.</li> </ol>
7. Transmitter will not key. Synthesizer is out of lock.	<ol style="list-style-type: none"> <li>1. Faulty Serial Synthesizer Latch board, 1A22.</li> <li>2. Faulty Controller board, 1A5.</li> <li>3. Make sure Synthesizer boards 1A8 through 1A11 are seated properly.</li> <li>4. Bad connection between Serial Synthesizer Latch, 1A22, J2 and Mother board, 1A20, J28.</li> <li>5. No +13 VDC from Rear Panel, 1A2A2.</li> </ol>

**Table 5.4 MSR 8050A TRANSMIT TROUBLESHOOTING CHART (Cont.)**

SYMPTOM	PROBABLE CAUSES
8. Transmitter puts out power but front panel meter does not indicate.	<ol style="list-style-type: none"> <li>1. Select FWD power on front panel.</li> <li>2. K1 on the Mother board, 1A20 faulty.</li> <li>3. R8 on Half Octave Filter board, 1A12 misadjusted.</li> <li>4. Faulty circuit on Half Octave Filter board, 1A12.</li> </ol>
9. Transmitter will not operate; no +9 VDC.	<ol style="list-style-type: none"> <li>1. Dual Regulator, 1A4A1 is defective.</li> <li>2. Mother board 1A20, R3 not adjusted properly.</li> </ol>
10. Transmitter will not operate; no +5 VDC.	<ol style="list-style-type: none"> <li>1. +5 VDC circuit in power supply, 1A3 faulty. See Table 5.6.</li> </ol>
11. Transmitter operates satisfactorily on high power but low power function does not operate.	<ol style="list-style-type: none"> <li>1. Bad Interface board, 1A6.</li> <li>2. Transmit Modulator 1A16, R84 misadjusted.</li> </ol>
12. Transmitter operates satisfactorily but cannot turn on the MSR 1020.	<ol style="list-style-type: none"> <li>1. Faulty component on kW "ON" circuit in Serial Synthesizer Latch, 1A7.</li> </ol>
13. Transmitter okay but kW low power function does not operate.	<ol style="list-style-type: none"> <li>1. Q4 or Q5 on Interface, 1A6 faulty.</li> </ol>
14. Transmitter okay but CPLR BY-PASS function does not work.	<ol style="list-style-type: none"> <li>1. Faulty U3 on Interface, 1A6.</li> </ol>
15. Stored silent tune channels do not operate properly when MSR 8050A is connected to MSR 4030.	<ol style="list-style-type: none"> <li>1. Faulty U13, U14 or U15 on Serial Synthesizer Latch, 1A7.</li> <li>2. Faulty Controller board, 1A5.</li> <li>3. Faulty Interface board, 1A6.</li> </ol>
16. Transmitter okay but antenna coupler STATUS lights do not operate properly.	<ol style="list-style-type: none"> <li>1. Faulty LEDs or U7, U10, U11 on Keypad/Display board, 1A1A1.</li> <li>2. Faulty circuits on Coupler Interface board, 1A19.</li> <li>3. Faulty Interface board, 1A6.</li> </ol>
17. Transmitter okay on USB/LSB but no CW power.	<ol style="list-style-type: none"> <li>1. Faulty 1 kHz circuit on Reference board, 1A8.</li> <li>2. Faulty CW circuit on Coupler Interface board, 1A19.</li> <li>3. R67 not adjusted properly on Transmit Modulator, 1A16.</li> </ol>
18. Transmitter okay on USB/LSB/ CW but AM power not correct.	<ol style="list-style-type: none"> <li>1. Transmit Modulator 1A16, R17 not adjusted properly.</li> <li>2. Faulty AMT circuit on Coupler Interface board, 1A19.</li> </ol>
19. Transmitter okay except A3A.	<ol style="list-style-type: none"> <li>1. High Pass Filter 1A13, R46, 47, 48 or 49 not adjusted properly.</li> <li>2. High Pass Filter 1A13, Q3 defective.</li> <li>3. Transmit Modulator 1A16, A3A circuit defective.</li> </ol>

**Table 5.5 POWER SUPPLY LED STATUS INDICATORS**

INDICATOR	NORMAL OPERATION	FUNCTION
DS1	ON	+ 18 VDC present
DS2	ON	+ 5 VDC present
DS3	ON	+ 26 VDC present
DS4	ON	Drive signal present
DS5	OFF	Primary current limit active
DS6	OFF	Output limit active
DS7	OFF	Fault condition present

**Table 5.6 POWER SUPPLY TROUBLESHOOTING CHART**

SYMPTOM	PROBABLE CAUSES
<p>1. Power Supply does not operate. All indicators off or dim.</p>	<ol style="list-style-type: none"> <li>1. Fuse F1 and /or F2 blown.</li> <li>2. Line voltage switches improperly set.</li> <li>3. Bridge rectifier CR101 defective.</li> <li>4. Resistors R2/R3 open.</li> <li>5. Low voltage bridge rectifier defective.</li> <li>6. Voltage regulator does not operate.</li> <li>7. Contactor K1 inoperative.</li> <li>8. On-line circuit open.</li> </ol>
<p>2. +18V indicator DS1 off or dim.</p>	<ol style="list-style-type: none"> <li>1. Low line voltage.</li> <li>2. Line voltage switch S1 improperly set.</li> <li>3. Regulator input voltage at TP2 less than +18 VDC.</li> <li>4. Regulator U1 defective.</li> <li>5. Transformer T2 defective.</li> <li>6. Excessive load on +18 bus.</li> </ol>
<p>3. +5V indicator DS2 off or dim.</p>	<ol style="list-style-type: none"> <li>1. Excessive loading of +5 VDC output (greater than 3A).</li> <li>2. Faulty regulator circuit (FET board).</li> </ol>
<p>4. +26V indicator DS3 off or dim; output limit indicator DS6 and primary limit indicator DS5 on; drive indicator DS4 off.</p>	<ol style="list-style-type: none"> <li>1. Excessive output load.</li> <li>2. Defective power FETs (FET board).</li> <li>3. CR2 and/or CR3 (Transformer board) defective.</li> <li>4. CR1 and CR2 (FET board) defective.</li> <li>5. Defective snubber network C6, C7, C11, R3 (Transformer board).</li> </ol>
<p>5. Drive indicator DS4 off or dim.</p>	<ol style="list-style-type: none"> <li>1. On-line circuit open or not pulled low.</li> <li>2. Output limit or primary limit circuit tripped.</li> </ol>
<p>6. Fault indicator DS5 on.</p>	<ol style="list-style-type: none"> <li>1. Low line voltage.</li> <li>2. Temperature threshold exceeded or misadjusted.</li> <li>3. Temperature sensor CR3 (FET board) defective.</li> </ol>

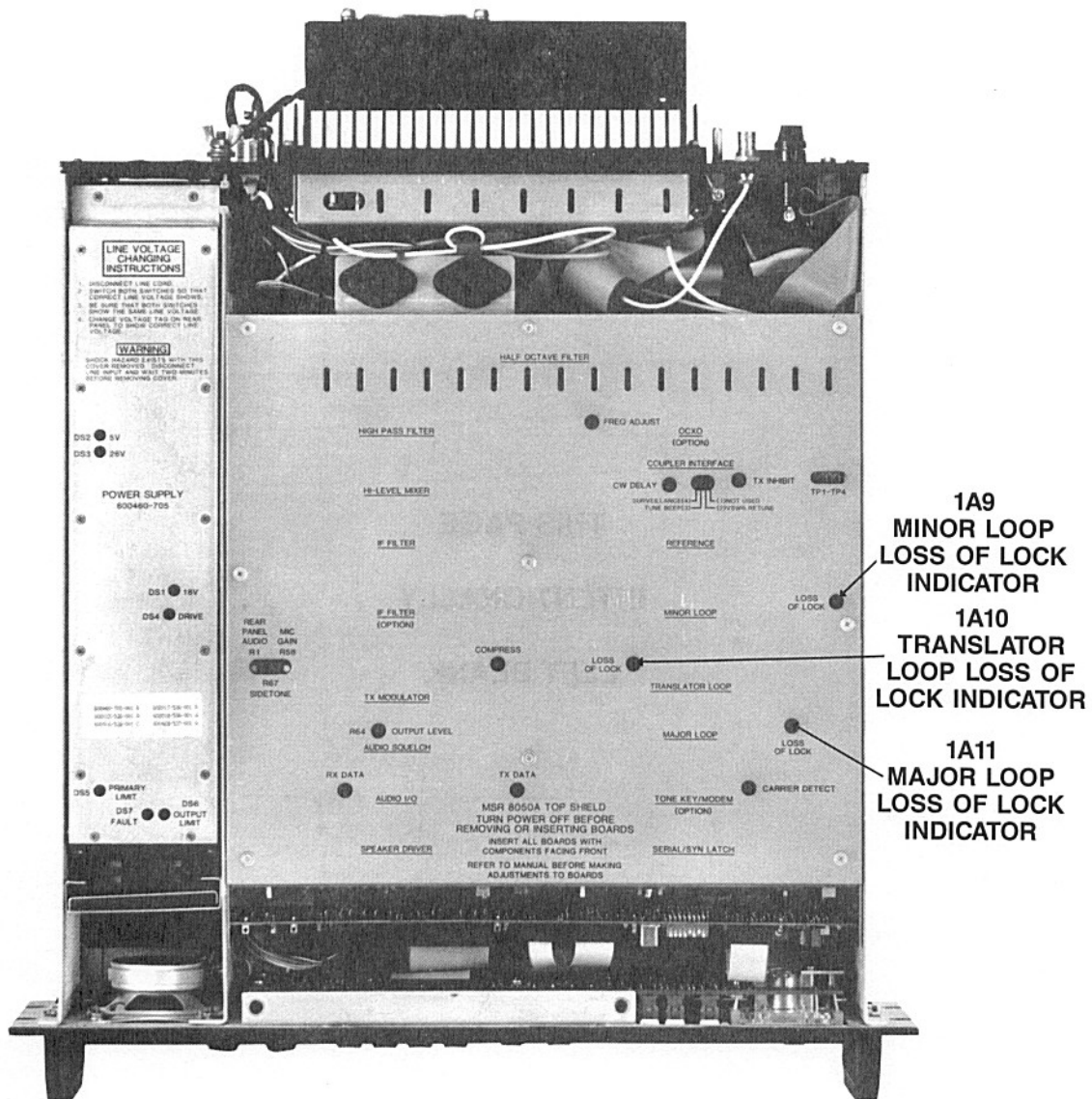


Figure 5.12 LOSS OF LOCK LEDS

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**5.9 MODULE DESCRIPTIONS**

This section describes each module with schematic, parts list, assembly drawing and pinout descriptions.

### 5.9.1 DIGITAL CONTROL AND DISPLAY SYSTEM

This section includes the Front Panel assembly 1A1, which contains the Keypad/Display board 1A1A1 and Front Panel subassembly 1A1A, Controller board 1A5, Interface board 1A6 and the Serial/Synthesizer board 1A22. See Figure 4.3 for a block diagram of the digital control system.

The heart of this system is an eight bit microcontroller with 8k of external memory. It receives key commands from the keypad, converts them into controlling signals for the synthesizer and signal path boards, and returns the transceiver status to the front panel display and indicators. A non-volatile Random Access Memory (RAM) is used for channel information storage. A Universal Asynchronous Receiver/ Transmitter (UART) performs serial to parallel data conversion for remote control use.

### 5.9.1.1 Front Panel Assembly

See Figure 5.14 for Front Panel schematic.

The Front Panel assembly contains all the controls and indicators for operating the transceiver. Mounted to the front panel are the Keypad/Display board, the keypad matrix, the Up/Down Frequency pushbuttons, the loudspeaker, microphone connector J1, phone jack J2, Volume/Power On control, RF Gain/Squelch control and the speaker switch.

(70004-539-001)

PART NUMBER	DESCRIPTION	SYMBOL
700024-536-001	KEYPAD/DISPLAY PCB	
700076-602-001	BRACKET, BOTT COVER	
600023-641-001	BROAD CLOTH	
700005-610-001	PANEL FRONT	
700011-390-001	LENS, DISPLAY, MSR 8050A	
700002-618-001	HANDLE, FRONT PANEL	
600409-230-001	CONNECTOR	(IT.12)
600291-230-001	RECEPTACLE	(P4,5)
600101-618-001	KNOB, 7/8 DIA	(R2/S2, R3/S3)
600101-618-004	SMALL KNOB	(R6)
700500-616-001	KEYCAP, MODIFIED	(S14,15)
600112-642-001	GROMMET	(S4)
600272-314-001	CAP .1UF CERAMIC 50V	C1
600272-314-004	CAP .001UF CERAMIC 50V	C2
600109-410-001	DIODE, 1N4148	CR1
600388-606-001	CONN., MIC, U-183/u	J1
600079-611-002	PHONE JACK	J2
600008-370-001	SPEAKER	LS1
600368-606-033	CONN. HOUSING, 4 POS.	P4,5
700006-608-001	CONNECTOR, CLINCH	P6,7 (S4)
600389-606-002	CONN HOUSING, 16 PIN	P23
600389-606-006	CRIMP CONTACT	(P23)
647004-341-075	RES. 470, 1/4W, 5%	R1
600109-360-001	LINEAR TAPER	R2/S2
600110-360-001	RES. 10K POT	R3/S3
610014-341-075	RES. 1K, 1/4W, 5%	R4
600111-360-001	POT. 500, DIMMER	R6
600213-616-001	TOGGLE SWITCH	S1
700501-616-001	SWITCH, KEYBOARD	S14,15
700001-616-001	KEYPAD	S4

Figure 5.13 FRONT PANEL ASSEMBLY

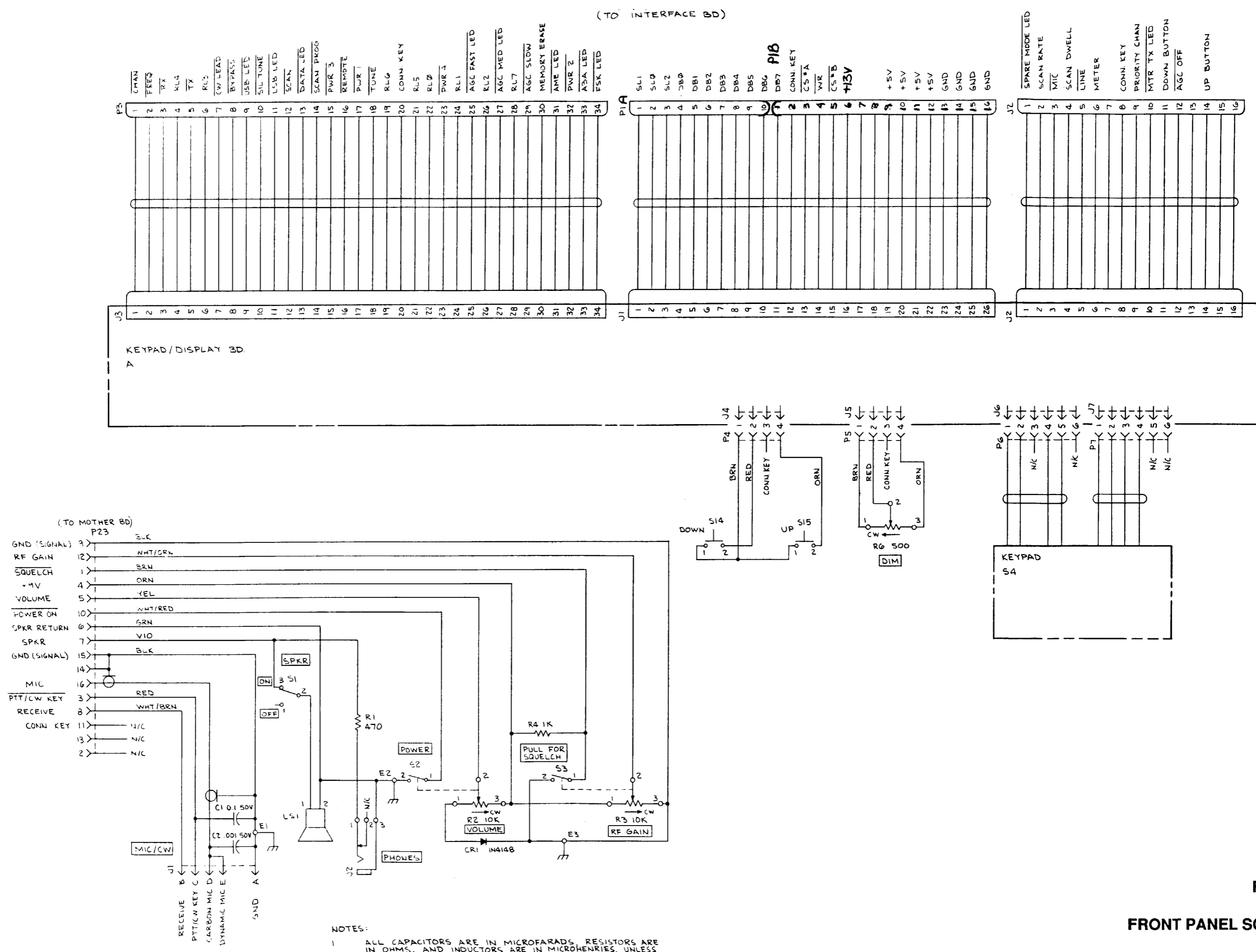


Figure 5.14

FRONT PANEL SCHEMATIC

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### 5.9.1.2 Keypad/Display Board, 1A1A1

See Figure 5.16 for the schematic of the Keypad/Display board.

The Keypad/Display board contains 19 momentary pushbutton switches, of which 15 incorporate LED's to indicate that the function is in operation. An additional pushbutton switch is included for memory erase, but this is accessible only through a small hole in the front panel. When this switch is pressed, +5 VDC is applied to J3-30 which causes the RAM on the Controller board to be written to all "0's", erasing all stored channel and mode memory.

U1 decodes the three least significant scan lines from the keyboard IC on the Interface board to produce eight scan lines for the keyboard switch matrix.

U2 and U10 are hex inverter/drivers used to turn on the "tuning" LEDs, the "status" LEDs, the FWD and REF LEDs, the LPA ON LED and the Priority Channel LED. U10 and part of U2 are driven from latch U11 to turn on their respective LED's. U11 receives its data from the data bus originating on

the Controller board. U7 is also a hex driver used to turn on the Power Level LEDs and the Transmit LED in the meter.

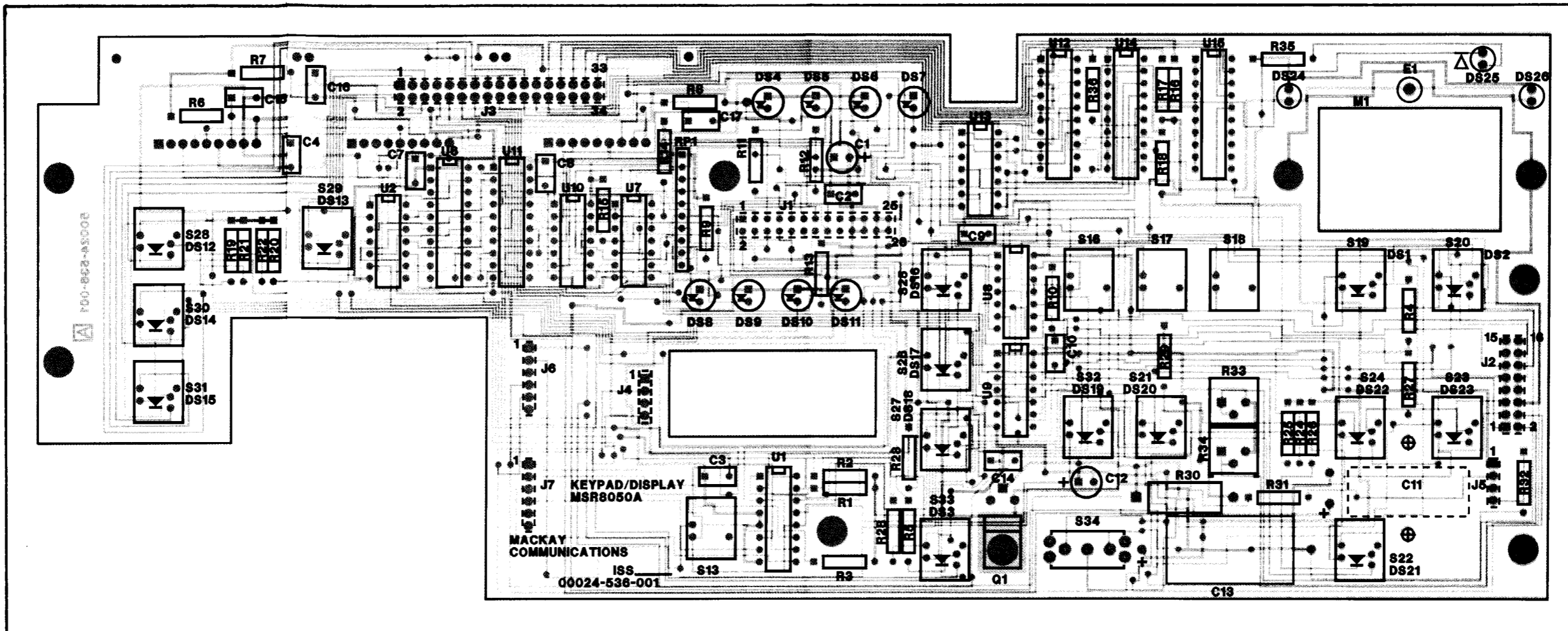
U3, U4 and U5 are display/decoder assemblies containing four 7-segment digits each. U3 displays the Channel number; U4 and U5 display the frequency down to the 10 Hz level. These chips are driven from U6, a latch which receives its data from the data bus. U6 also drives part of U2 to turn on the appropriate LEDs.

U9 is a dual flip-flop which, when energized by the front panel UP/DOWN pushbuttons, provides the scan rate pulses to the Controller board to drive the frequency up and down.

U8 is a hex Schmitt trigger used to provide hysteresis and switch "debouncing" to inputs to the dual flip-flop.

U7 is a quad-OR gate used to "clock" data into latches U6 and U11.

Transistor Q1 is connected as an emitter follower to supply a controllable current to all lights on the front panel for dimming.



(70024-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
700201-390-001	DIFFUSER LAMP	(DS24,26)
700014-602-001	BRKT, METER MOUNTING, 5050A	(M1)
600126-419-001	SOCKET, ELEVATOR, 14 PIN	(U12,14,15)
700002-631-003	SPACER, 9 POS.	(U3-5)
700002-631-002	SPACER, 2 POS	(U3-5)
700002-631-001	SPACER, 1 POS	(U3-5)
600297-314-025	CAP. 47UF, ALUM, 25V	C1,12
600302-314-001	CAP .001UF, MYLAR, 63V	C10,15-17
600297-314-040	CAP. 2200UF, ALUM, 16V	C11
600259-314-108	CAP. 1000UF, ALUM, 16V	C13
600302-314-013	CAP. .1UF, MYLAR, 50V	C14
600302-314-007	CAP. .01UF, MYLAR, 63V	C2-4,7-9
700010-390-001	LED, RED	DS24,26
600074-390-001	LED, RED, SMALL	DS25
700007-390-002	LED, .7 LG	DS4-7
700007-390-001	LED, 1.00 LG	DS8-11
600423-608-104	CONN,RT/AN HEADER, 4 PIN	J4,5
600423-608-106	CONN,RT/AN HEADER, 6 PIN	J6,7
700050-540-001	RIBBON CABLE WITH SPLIT OUTPUT	J1/P1A, P1B
600476-540-009	RIBBON CABLE	J2/P2
600476-540-035	RIBBON CABLE	J3/P3
600034-368-001	METER	M1
600220-413-001	TRANSISTOR MJE520	Q1

PART NUMBER	DESCRIPTION	SYMBOL
647024-341-075	RES. 47K, 1/4W, 5%	R1-3,9,14,15
610024-341-075	RES. 10K, 1/4W, 5%	R10,28
620004-341-075	RES. 200, 1/4W, 5%	R16-18,36
615084-341-325	RES. 1.5, 1W, 5%	R30
612004-341-075	RES. 120, 1/4W, 5%	R31
647004-341-075	RES. 470, 1/4W, 5%	R32
600072-360-014	POT. 100K, 1/2W, CERMET, TOP	R33,34
613004-341-075	RES. 130, 1/4W, 5%	R4,5,11-13,19-27,35
647014-341-075	RES. 4.7K, 1/4W, 5%	R6-8,29
600106-340-016	RES. NETWORK 9x220K	RP1
600366-616-002	SWITCH, PUSH-BUTTON, NON-LIT	S13,16-18
600365-616-002	SWITCH, PUSH-BTN, LIT	S19-32
600365-616-003	SWITCH	S33
600259-616-003	SWITCH	S34
600926-415-001	IC, 74HC138	U1
700001-390-001	BAR GRAPH, HDSP4830	U12,14,15
600076-415-001	IC, 7407, HEX BUFF/DRV	U13
600016-415-001	IC 7406, HEX INV,0/C	U2,10
700116-415-001	DISPLAY, 4 DIGIT, NSM4700A	U3-5
600910-415-001	IC, 74HC374	U6,11
600917-415-001	IC 74HC14	U8
600624-415-001	IC 74HC74N	U9
600873-415-001	IC 74HC32N	U7

Figure 5.15

KEYPAD/DISPLAY BOARD ASSEMBLY

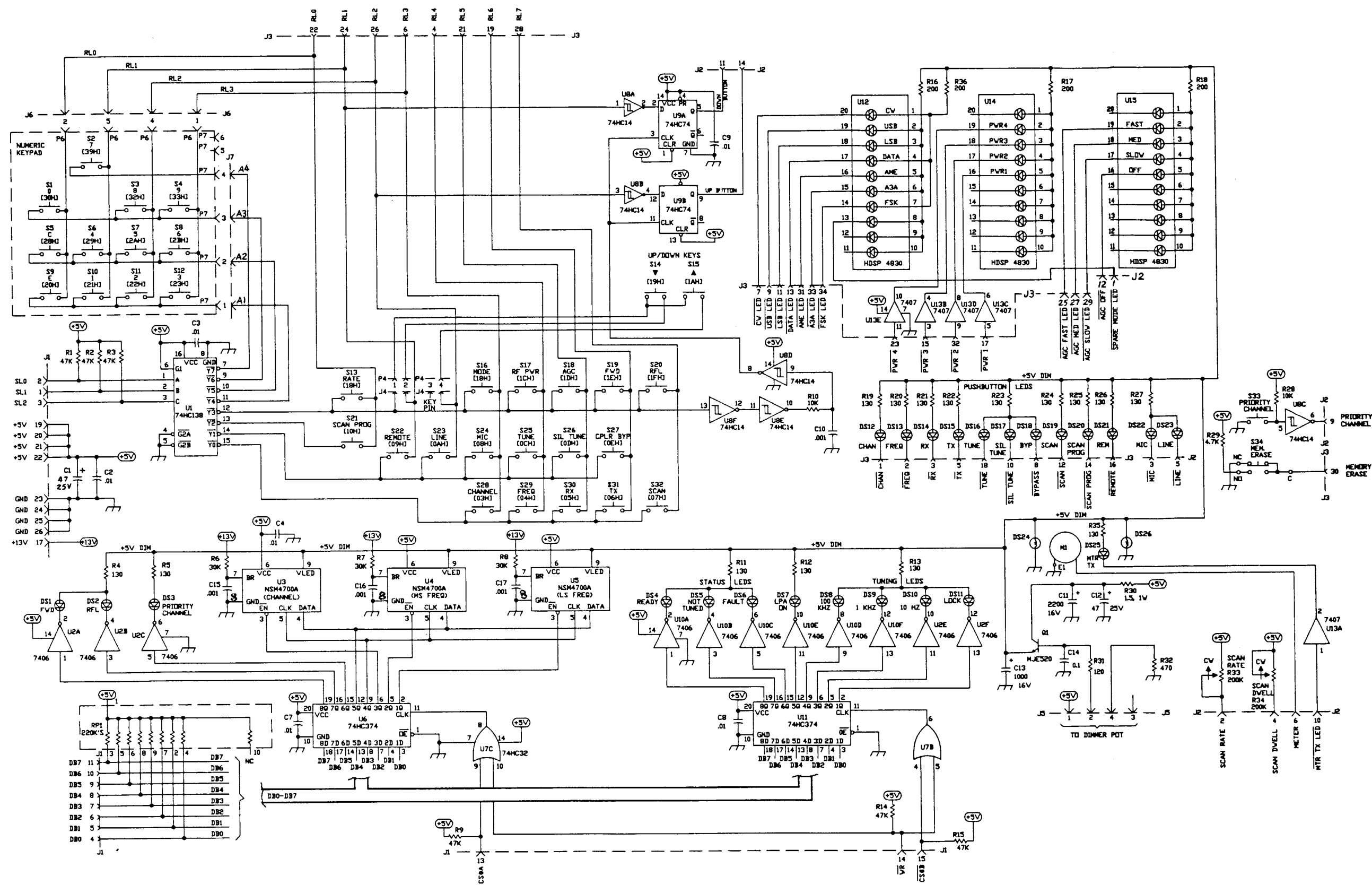


Figure 5.16

KEYPAD/DISPLAY BOARD SCHEMATIC

PIN CONNECTIONS AND VOLTAGE READINGS

1A1A1-J1

SL1	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	SLO
SL2	<input type="checkbox"/>	3	4	<input type="checkbox"/>	DBO
DB1	<input type="checkbox"/>	5	6	<input type="checkbox"/>	DB2
DB3	<input type="checkbox"/>	7	8	<input type="checkbox"/>	DB4
DB5	<input type="checkbox"/>	9	10	<input type="checkbox"/>	DB6
DB7	<input type="checkbox"/>	11	12	<input type="checkbox"/>	
CS#A	<input type="checkbox"/>	13	14	<input type="checkbox"/>	$\overline{WR}$
CS#B	<input type="checkbox"/>	15	16	<input type="checkbox"/>	
+13VDC	<input type="checkbox"/>	17	18	<input type="checkbox"/>	
+5VDC	<input type="checkbox"/>	19	20	<input type="checkbox"/>	+5VDC
+5VDC	<input type="checkbox"/>	21	22	<input type="checkbox"/>	+5VDC
GND	<input type="checkbox"/>	23	24	<input type="checkbox"/>	GND
GND	<input type="checkbox"/>	25	26	<input type="checkbox"/>	GND
	<input type="checkbox"/>	27	28	<input type="checkbox"/>	
	<input type="checkbox"/>	29	30	<input type="checkbox"/>	
	<input type="checkbox"/>	31	32	<input type="checkbox"/>	
	<input type="checkbox"/>	33	34	<input type="checkbox"/>	
	<input type="checkbox"/>	35	36	<input type="checkbox"/>	
	<input type="checkbox"/>	37	38	<input type="checkbox"/>	
	<input type="checkbox"/>	39	40	<input type="checkbox"/>	
	<input type="checkbox"/>	41	42	<input type="checkbox"/>	
	<input type="checkbox"/>	43	44	<input type="checkbox"/>	

KEYPAD/DISPLAY BOARD, 1A1A1

PIN CONNECTIONS AND VOLTAGE READINGS

1A1A1-J4

_____	CLK	<input checked="" type="radio"/>	1	2	<input type="radio"/>	RL1	_____
_____	N.C. - LOC PIN	<input type="radio"/>	3	4	<input type="radio"/>	RL2	_____
_____		<input type="radio"/>	5	6	<input type="radio"/>		_____
_____		<input type="radio"/>	7	8	<input type="radio"/>		_____
_____		<input type="radio"/>	9	10	<input type="radio"/>		_____
_____		<input type="radio"/>	11	12	<input type="radio"/>		_____
_____		<input type="radio"/>	13	14	<input type="radio"/>		_____
_____		<input type="radio"/>	15	16	<input type="radio"/>		_____
_____		<input type="radio"/>	17	18	<input type="radio"/>		_____
_____		<input type="radio"/>	19	20	<input type="radio"/>		_____
_____		<input type="radio"/>	21	22	<input type="radio"/>		_____
_____		<input type="radio"/>	23	24	<input type="radio"/>		_____
_____		<input type="radio"/>	25	26	<input type="radio"/>		_____
_____		<input type="radio"/>	27	28	<input type="radio"/>		_____
_____		<input type="radio"/>	29	30	<input type="radio"/>		_____
_____		<input type="radio"/>	31	32	<input type="radio"/>		_____
_____		<input type="radio"/>	33	34	<input type="radio"/>		_____
_____		<input type="radio"/>	35	36	<input type="radio"/>		_____
_____		<input type="radio"/>	37	38	<input type="radio"/>		_____
_____		<input type="radio"/>	39	40	<input type="radio"/>		_____
_____		<input type="radio"/>	41	42	<input type="radio"/>		_____
_____		<input type="radio"/>	43	44	<input type="radio"/>		_____

KEYPAD/DISPLAY BOARD, 1A1A1

PIN CONNECTIONS AND VOLTAGE READINGS

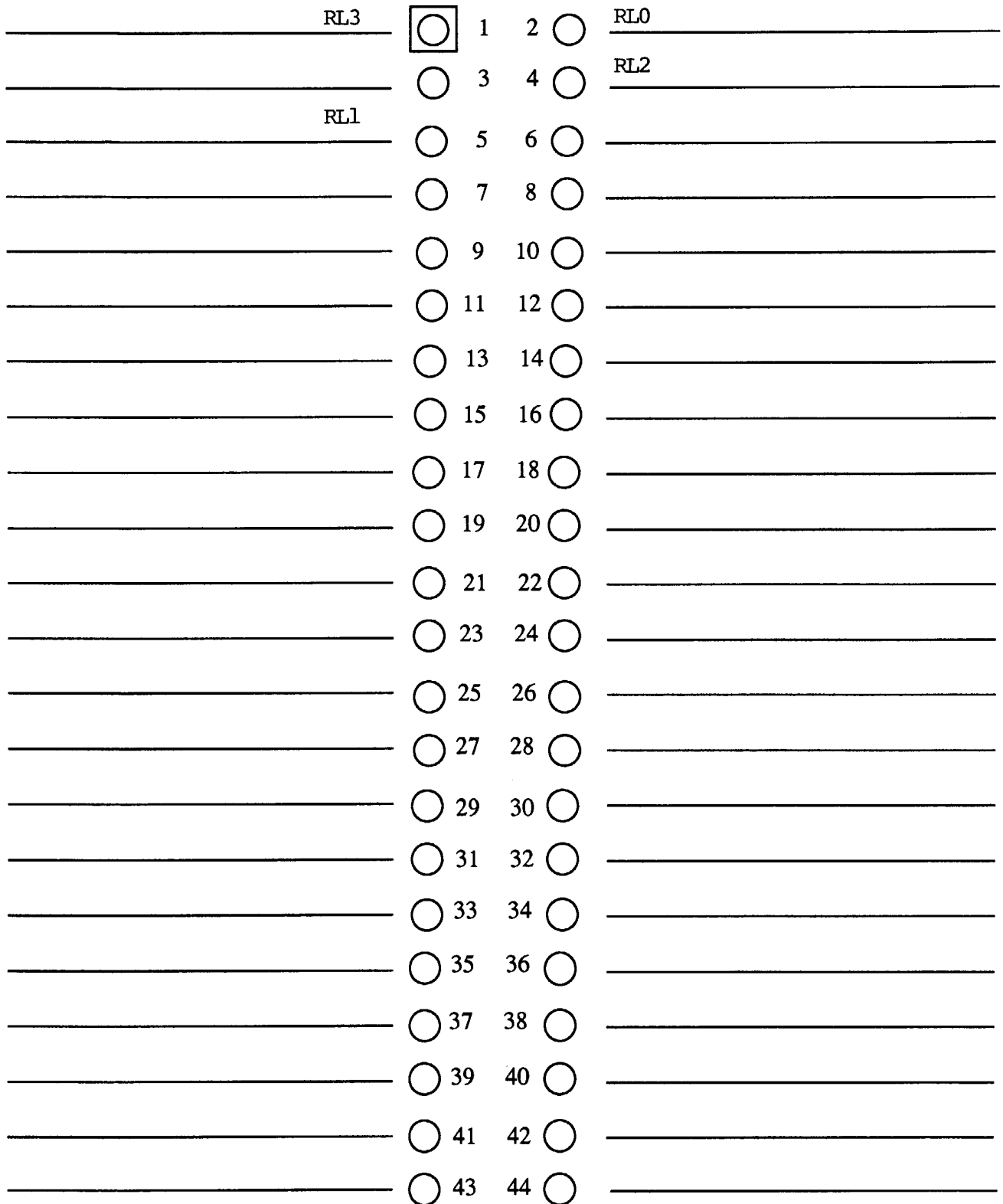
1A1A1-J5

	+5VDC	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	DIMMER
N.C.		<input type="checkbox"/>	3	4	<input type="checkbox"/>	DIMMER RETURN
		<input type="checkbox"/>	5	6	<input type="checkbox"/>	
		<input type="checkbox"/>	7	8	<input type="checkbox"/>	
		<input type="checkbox"/>	9	10	<input type="checkbox"/>	
		<input type="checkbox"/>	11	12	<input type="checkbox"/>	
		<input type="checkbox"/>	13	14	<input type="checkbox"/>	
		<input type="checkbox"/>	15	16	<input type="checkbox"/>	
		<input type="checkbox"/>	17	18	<input type="checkbox"/>	
		<input type="checkbox"/>	19	20	<input type="checkbox"/>	
		<input type="checkbox"/>	21	22	<input type="checkbox"/>	
		<input type="checkbox"/>	23	24	<input type="checkbox"/>	
		<input type="checkbox"/>	25	26	<input type="checkbox"/>	
		<input type="checkbox"/>	27	28	<input type="checkbox"/>	
		<input type="checkbox"/>	29	30	<input type="checkbox"/>	
		<input type="checkbox"/>	31	32	<input type="checkbox"/>	
		<input type="checkbox"/>	33	34	<input type="checkbox"/>	
		<input type="checkbox"/>	35	36	<input type="checkbox"/>	
		<input type="checkbox"/>	37	38	<input type="checkbox"/>	
		<input type="checkbox"/>	39	40	<input type="checkbox"/>	
		<input type="checkbox"/>	41	42	<input type="checkbox"/>	
		<input type="checkbox"/>	43	44	<input type="checkbox"/>	

KEYPAD/DISPLAY BOARD, 1A1A1

PIN CONNECTIONS AND VOLTAGE READINGS

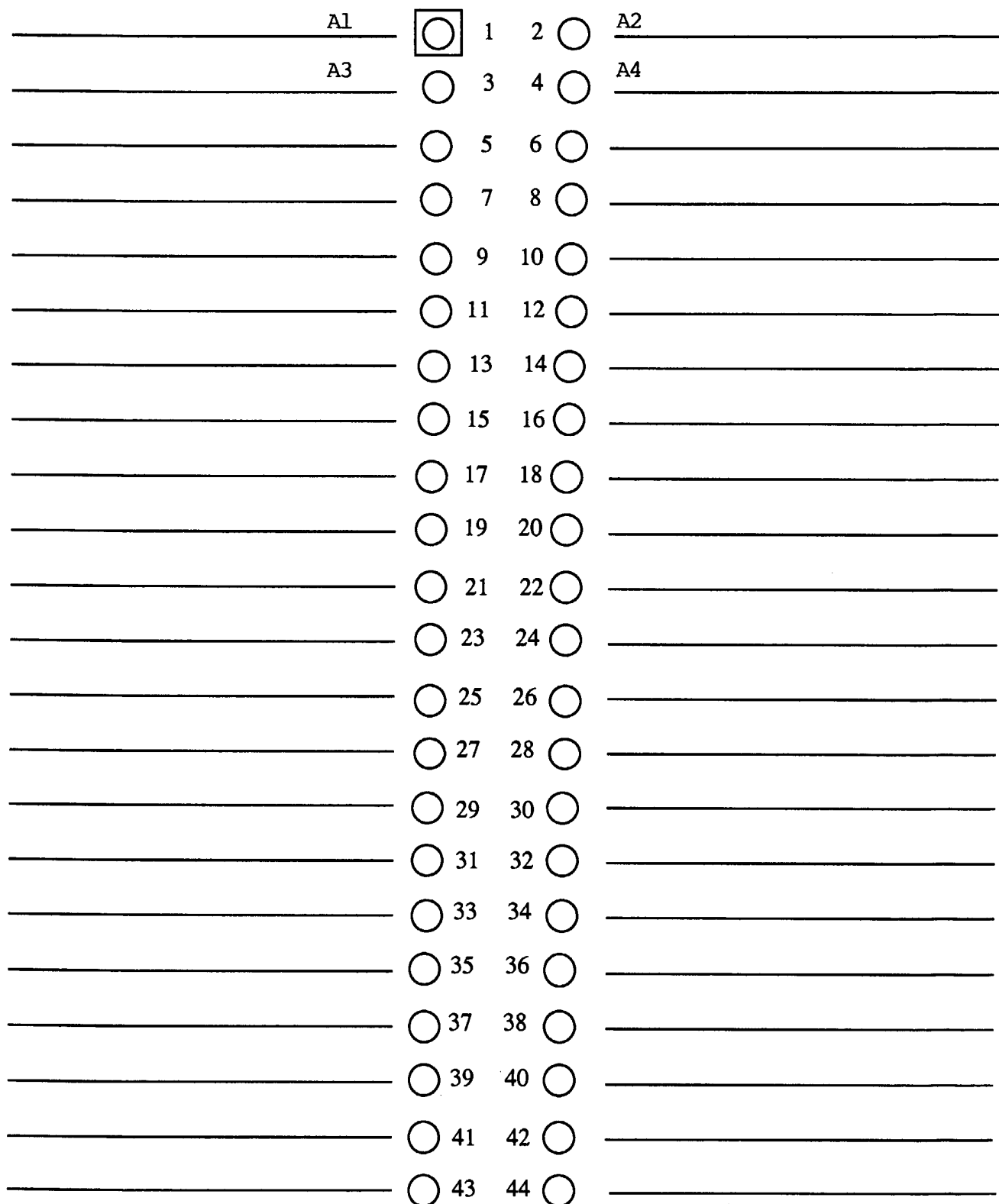
1A1A1-J6



KEYPAD/DISPLAY BOARD, 1A1A1

PIN CONNECTIONS AND VOLTAGE READINGS

1A1A1-J7



### 5.9.1.3 Interface Board, 1A6

See Figure 5.18 for a schematic of the Interface board.

This board provides the interface between the microcontroller and the 7-segment displays, LED indicators, the keypad and other controlling signals. It can be divided into several sections:

- a. Keypad/Display interface
- b. Remote control interface
- c. Remote control Baud rate generator
- d. Receiver AGC Output Driver
- e. Remote rf gain control
- f. Channel scan
- g. Data latches
- h. Meter functions
- i. /RX generator

#### 5.9.1.3.1 Keypad/Display Interface

Keypad entry and 7-segment display are handled by U11, which "talks" to the microprocessor ( $\mu$ P) through the eight bit data bus. The timing of the display code outputs (A0 - A3 and B0 - B3) is synchronized with the scan line outputs so that a 16 digit, eight bit multiplexed display can be performed. Data on the data bus is written into the chip on the write cycle and read by the  $\mu$ P on the read cycle. Address bit 0 determines whether the data bus information is a command (bit high) or data (bit low) during the write cycle. The external clock signal on pin 3 is divided by a programmable prescaler to give a 100 Hz operating frequency. U10F drives the KEYPAD IRQ LED, DS1, showing when U11 has been addressed by the keypad.

#### 5.9.1.3.2 Remote Control Interface

U13 is a UART which provides the interface communications between a remote control unit, such as the MSR 6420 or a computer keyboard, and the transceiver. U12C and U12D provide a signal to the  $\mu$ P whenever an error in data received from the remote unit is detected, so an error message can be displayed on the front panel. U23D and U23E drive the UART XMT and UART RCV LEDs, DS2 and DS3. U12A and U12B tell the UART whether it is in a read or write mode.

#### 5.9.1.3.3 Remote Control Baud Rate Generator

U14 is a Baud rate generator for remote control operation. The desired Baud rate may be selected through the proper combination of closures of switches S1-1 through S1-4 (see Table 5.7). U23F drives DS4, the Baud rate generator LED.

#### 5.9.1.3.4 Receiver AGC Output Driver

U15A provides the internal AGC voltage to the rear panel for external monitoring.

#### 5.9.1.3.5 Remote Rf Gain Control

U17 is a digital gain control for remote control of RF GAIN through U19B. U17 receives its information from the data bus through quad latch U16. U18A is an OR gate providing the correct clock phase to the latch. U19A provides local RF GAIN control through the front panel control. Q2 turns off the local control when the transceiver is in REMOTE control operation. U27B is a buffer/inverter which tells the remote devices when the transceiver is in REMOTE operation. U27E is a buffer/inverter which allows the RF GAIN control amplifiers, U19A and U19B, to operate when the AGC has been turned OFF.

#### 5.9.1.3.6 Channel Scan

A SCAN ON signal allows scan oscillator U20 to start generating a constant repetitive ramp, based on the setting of the SCAN RATE CONTROL, to scan the selected channel group. U21A provides the dwell time, set by a signal present (JP1, 1-2) or by a timer JP1, 2-3), whenever a signal is detected in the passband. U18D provides the dwell signal, SCAN PAUSE, to the  $\mu$ P and drives the SCAN DETECT LED, DS5, through buffer/inverter U27A. Q3 provides the /SCAN DETECT signal to the rest of the system. U21B provides a transient-free channel change during scan. U19D compares the received audio with the scan detect threshold to initiate a scan dwell.

#### 5.9.1.3.7 Data Latches

U3, U5, U7, U25 and U27 are latches which take data from the data bus, maintain its state, and distribute it to various points within the system.

U1, U2, U4, U6, U22, U23 and U24 are buffer/inverters for the latch output lines. U18B and U18C provide the correct clock phase to latches U25 and U26.

#### 5.9.1.3.8 Meter Functions

Transistor Q1 drives the front panel relay controlling the Forward or Reflected Power signal to the front panel meter. U8B provides the "S" meter signal (a voltage proportional to received signal strength) to the meter during receive, and U8C provides the Forward or Reflected Power signal (as selected by the relay) to the meter during transmit. U8A is the meter driver. It also provides the meter data to U9, which is an analog-to-digital converter, taking the analog meter data and trans-

forming it to digital form for transmission on the data bus to the remote control. U10E is a buffer/inverter providing a synchronizing signal from the A to D converter to the  $\mu$ P.

#### 5.9.1.3.9 /RX Generator

U27C is a buffer/inverter which obtains a signal from the /TX1 line, telling it that the transmitter is keyed, and sends a signal to the Audio/Squelch, Transmit Modulator, Reference, IF Filter and High Level Mixer boards to tell them that they are not in receive mode (/RX).

Table 5.7 provides function information for the positions of switch S1. Table 5.8 provides information on the positions of Jumper JP1.

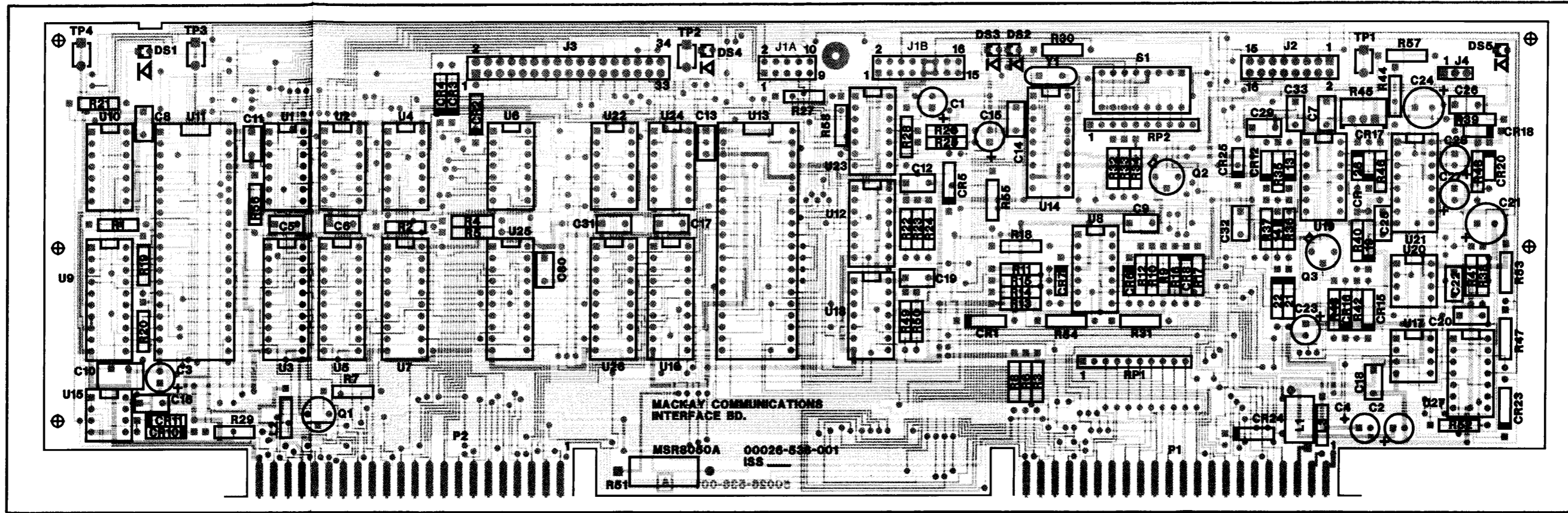
**Table 5.7 1A6 S1 SWITCH POSITIONS**

(X = Closed)

FUNCTION	S1-	1	2	3	4	5	6	7	8
300 Baud			X		X				
600 Baud		X			X				
1200 Baud					X				
2400 Baud		X		X					
4800 Baud		X	X						
9600 Baud		X							
AUTO RF TUNE						X			
AUTO SIL TUNE							X		
VSWR RETUNE								X	
CHANNEL AUTO TUNE									X

**Table 5.8 1A6 JUMPER JP1 POSITIONS (Scan Dwell Adjustment)**

POSITION	FUNCTION
1 - 2	Timer Dwell - (radio will dwell only as long as the time set by the dwell pot on the Keypad/ Display board)
2 - 3	Signal-Present Dwell Time - (during SCAN, unit will dwell as long as received signal is above set threshold)



(700026-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600025-419-001	TRANSISTOR PAD	
600119-419-040	IC SOCKET, 40 POS.	(U11,13)
600119-419-018	IC SOCKET, 18 POS.	(U14)
600119-419-020	IC SOCKET, 20 POS.	(U3,5,7 9,16,25 26)
600297-314-016	CAP. 22UF, ALUM, 25V	C1-4
615003-306-501	CAP. 150PF, 3%, MICA, 500V	C10
600297-314-003	CAP. 1UF, ALUM, 50V	C15,28
600297-314-031	CAP. 100UF, ALUM, 10V	C21
600302-314-013	CAP. .1UF, MYLAR, 50V	C22,25,26 29,32,33 C23,27
600297-314-013	CAP. 10UF, ALUM, 50V	C24
600297-314-037	CAP. 220UF, ALUM, 10V	C5-7,11, 17,20,30 31
600302-314-013	CAP. .1UF, MYLAR, 50V	C8,9, 12-14,16 18,19
600006-411-012	DIODE 1N4739A 9.1V	CR1
600011-416-002	DIODE 1N4004	CR10,11
600052-410-001	DIODE 1N270	CR2-5,15 16,19,21 22,23,24 CR6,7,18 12-14,17 20,25,26
600109-410-001	DIODE 1N4148	CR8
600002-411-001	DIODE, ZENER, 1N746A	CR8
700004-390-001	LED, RED, SUB. MIN.	DS1
700004-390-002	LED, HLMP7019, YELLOW	DS2-5
702006-608-006	CONN	J3
600198-608-005	CONN HEADER, 3 PIN, TIN	J4
702006-608-001	CONN	J1A
702006-608-003	CONN	J1B, J2
600091-376-001	CHOKE 4.7UH	L1
600125-376-001	CHOKE .33UH	L2,3
600190-608-001	CONN, JUMPER, 2 POS.	P4
600221-413-002	TRANSISTOR 2N5308	Q1
600080-413-001	TRANSISTOR 2N2222A	Q2,3
647014-341-075	RES. 4.7K, 1/4W, 5%	R1,2,17, 20,32,43 46,52,53 57

PART NUMBER	DESCRIPTION	SYMBOL
651024-341-075	RES. 51K, 1/4W, 5%	R11
610014-341-075	RES. 1K, 1/4W, 5%	R16,37,38
610024-341-075	RES. 10K, 1/4W, 5%	R19,33,4 34,44,18 5,9,10 12-15 R21,27
668004-341-075	RES. 680, 1/4W, 5%	R25,26,47
612014-341-075	RES. 1.2K, 1/4W, 5%	R29,58
610004-341-075	RES. 100, 1/4W, 5%	R3,6-8, 22-24,28 30,31,49 50
647024-341-075	RES. 47K, 1/4W, 5%	R35,36 R39,55
620034-341-075	RES. 200K, 1/4W, 5%	R40
622014-341-075	RES. 2.2K, 1/4W, 5%	R41
620024-341-075	RES. 20K, 1/4W, 5%	R42
610034-341-075	RES. 100K, 1/4W, 5%	R45
624014-341-075	RES. 2.4K, 1/4W, 5%	R48
600089-360-010	POT. 10K, 1/2W, CERMET, RT/AN	R51
682024-341-075	RES. 82K, 1/4W, 5%	R54
620004-341-075	RES. 200, 1/4W, 5%	R56
682014-341-075	RES. 8.2K, 1/4W, 5%	
627014-341-075	RES. 2.7K, 1/4W, 5%	
600106-340-016	RES. NETWORK 9x220K	RP1
600106-340-009	RE. NETWORK 4.7K	RP2
600264-616-005	DIP 8PST SWITCH	S1
600114-611-001	BROWN TEST POINT	TP1
600114-611-002	RED TEST POINT	TP2
600114-611-003	ORANGE TEST POINT	TP3
600114-611-004	YELLOW TEST POINT	TP4
600016-415-001	IC 7406, HEX INV, 0/C	U1,2,4,6 10,22-24 27
600507-415-101	IC 8279, KEYBD/DISP	U11
600873-415-001	IC SN74HC32N	U12,18
600424-415-101	IC 6402, UART, CMOS	U13
600617-415-001	IC 8116, BAUD RATE GEN	U14
600039-415-003	IC, 1458	U15
700101-415-001	IC, X9MME, E2 POT	U17
600074-415-001	IC NE555, TIMER	U20
600998-415-001	IC 74HC4538	U21
600910-415-001	IC, 74HC374	U3,5,7, 16,25,26 U8,19
600171-415-001	IC LM324, OP AMP, QUAD	U9
700104-415-001	ADC0804LCN NATIONAL IC	
600170-378-001	CRYSTAL, 5.0688 MHZ	Y1

Figure 5.17

INTERFACE BOARD ASSEMBLY

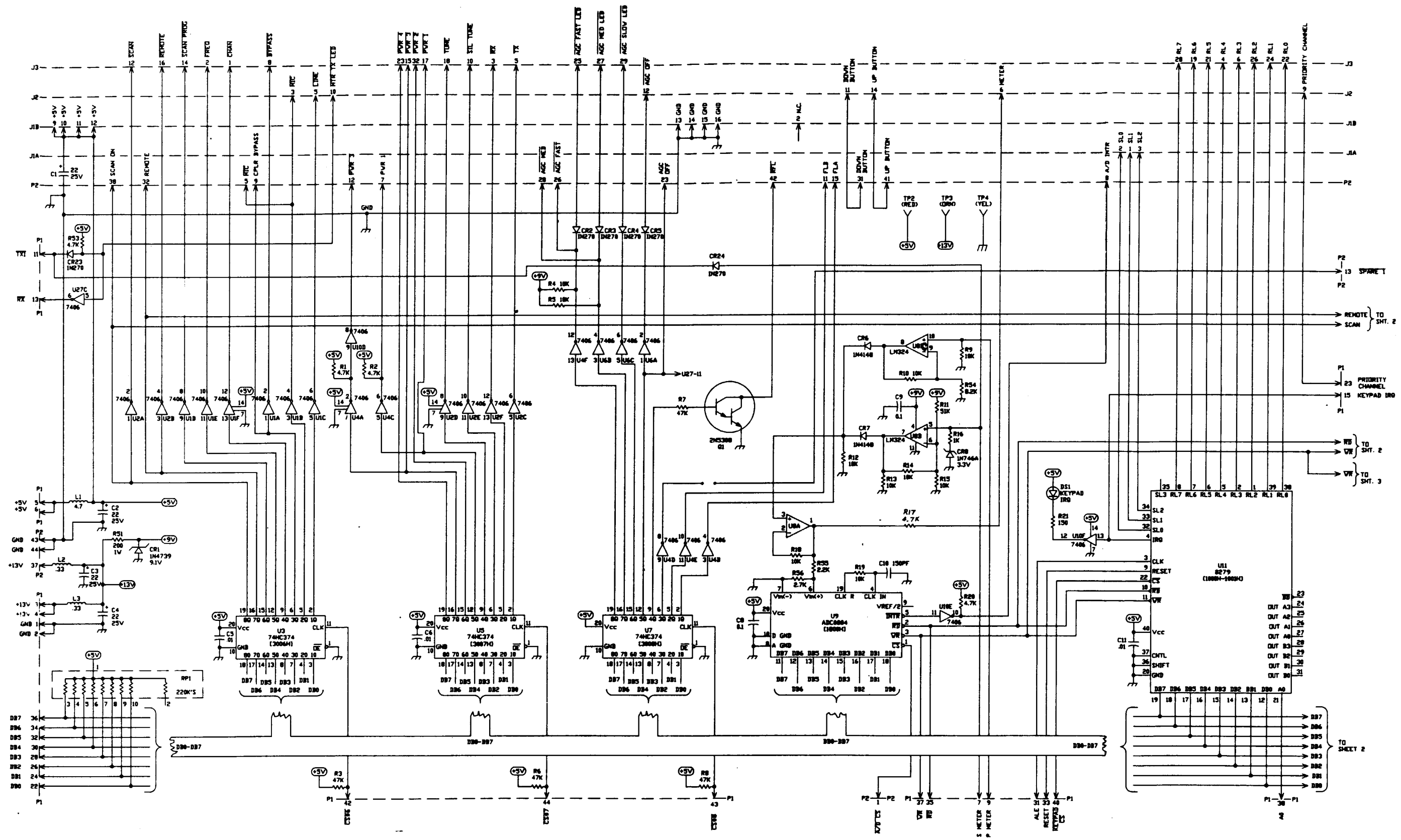


Figure 5.18

INTERFACE BOARD SCHEMATIC  
(SHEET 1 OF 3)

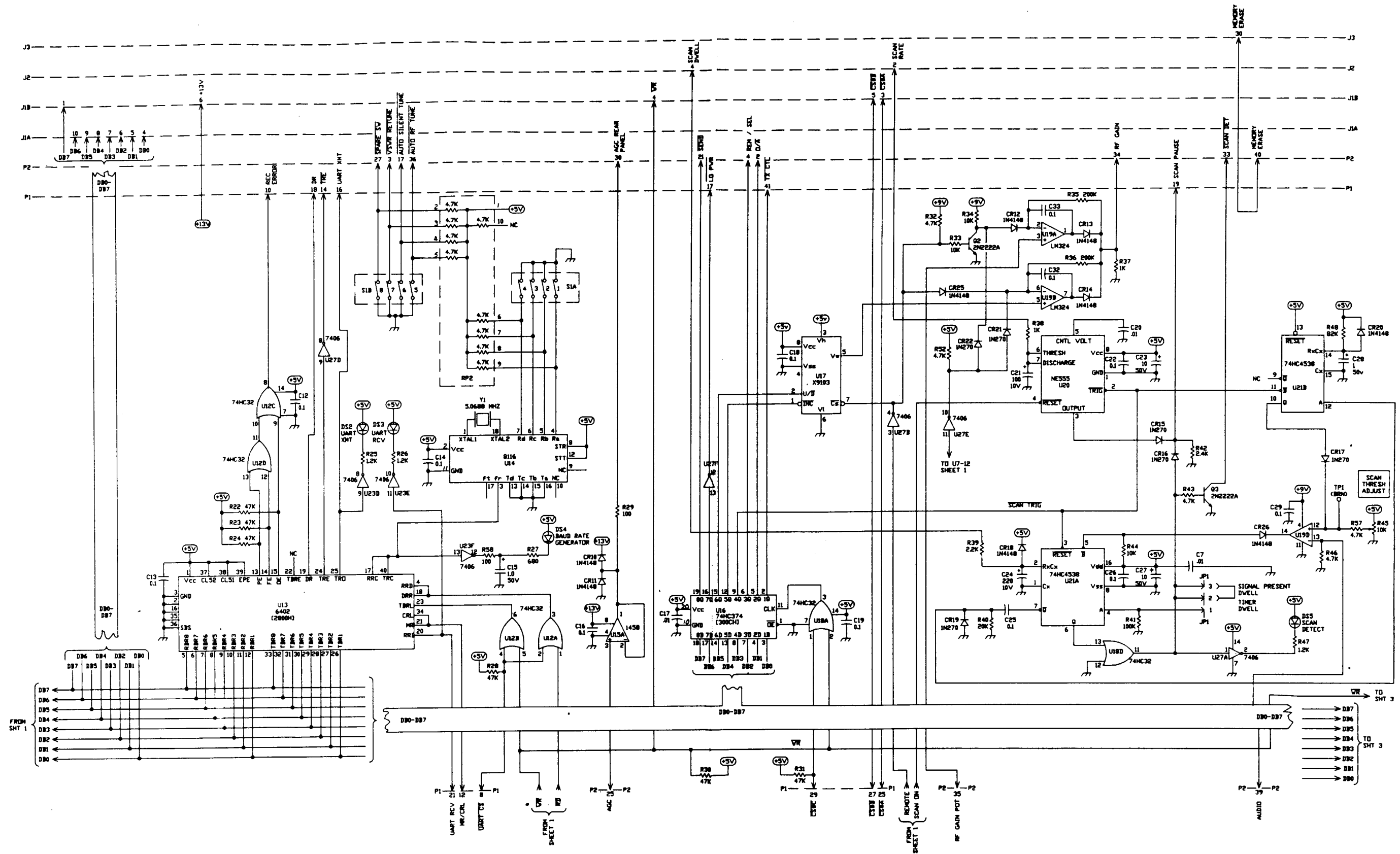
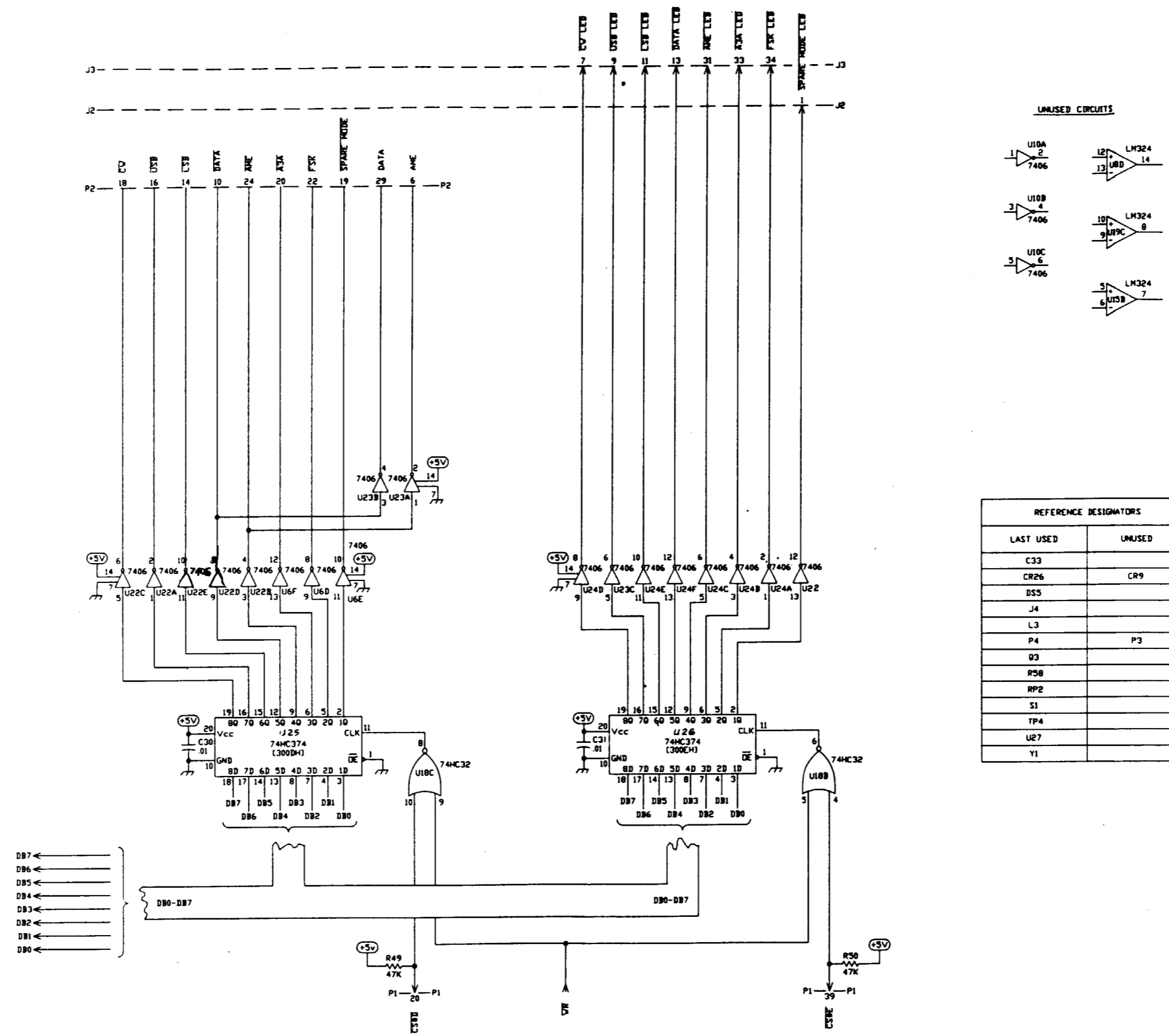
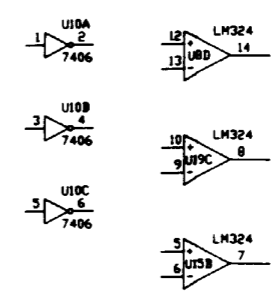


Figure 5.18  
 INTERFACE BOARD SCHEMATIC  
 (SHEET 2 OF 3)



UNUSED CIRCUITS

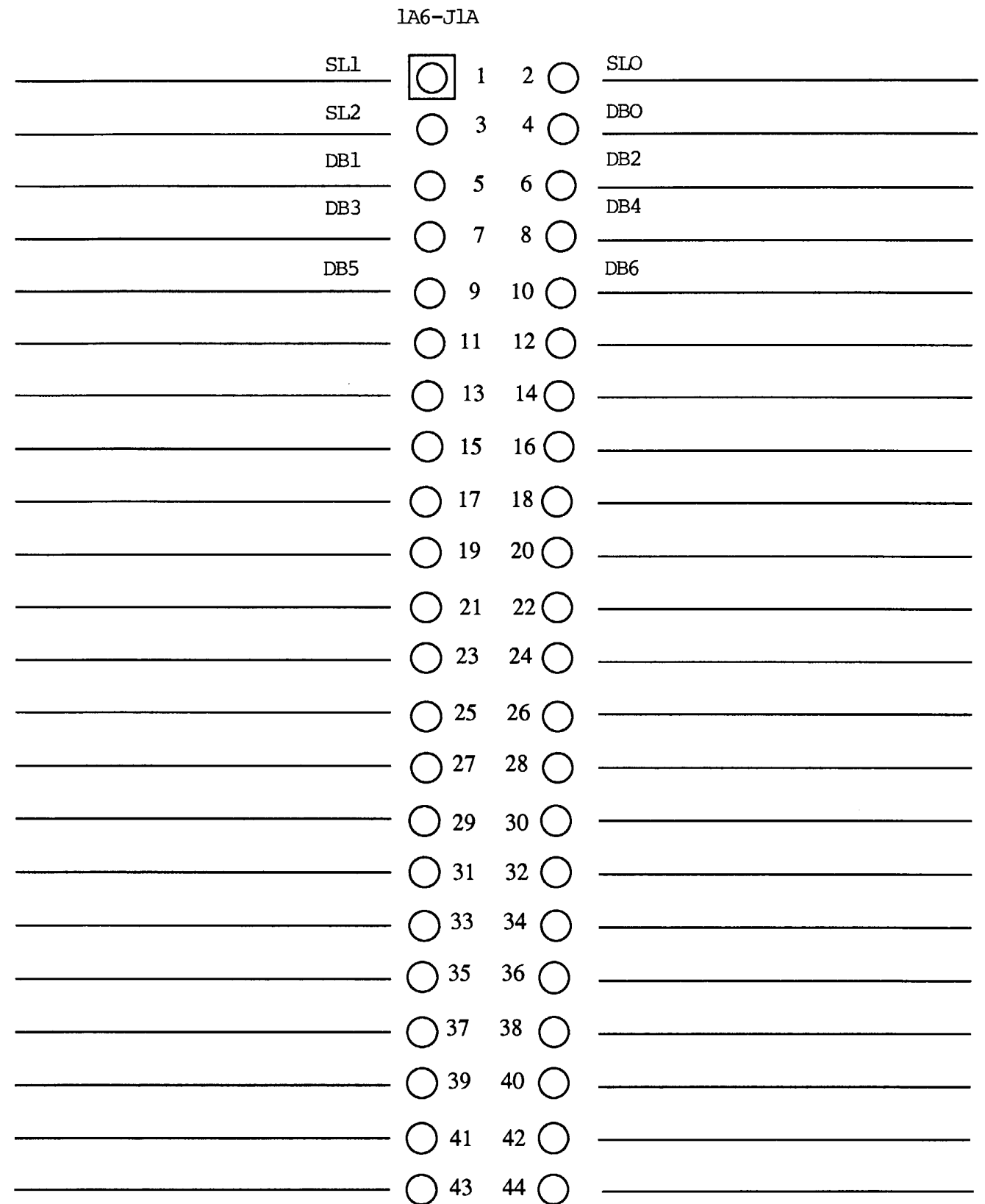


REFERENCE DESIGNATORS	
LAST USED	UNUSED
C33	
CR26	CR9
D55	
J4	
L3	
P4	P3
Q3	
R58	
RP2	
S1	
TP4	
U27	
Y1	

Figure 5.18  
INTERFACE BOARD SCHEMATIC  
(SHEET 3 OF 3)

INTERFACE BOARD, 1A6

PIN CONNECTIONS AND VOLTAGE READINGS



INTERFACE BOARD, 1A6

PIN CONNECTIONS AND VOLTAGE READINGS

1A6-J1B

DB7	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	N.C.
CS#A	<input type="checkbox"/>	3	4	<input type="checkbox"/>	$\overline{WR}$
CS#B	<input type="checkbox"/>	5	6	<input type="checkbox"/>	+13VDC
	<input type="checkbox"/>	7	8	<input type="checkbox"/>	
+5VDC	<input type="checkbox"/>	9	10	<input type="checkbox"/>	+5VDC
+5VDC	<input type="checkbox"/>	11	12	<input type="checkbox"/>	+5VDC
GND	<input type="checkbox"/>	13	14	<input type="checkbox"/>	GND
GND	<input type="checkbox"/>	15	16	<input type="checkbox"/>	GND
	<input type="checkbox"/>	17	18	<input type="checkbox"/>	
	<input type="checkbox"/>	19	20	<input type="checkbox"/>	
	<input type="checkbox"/>	21	22	<input type="checkbox"/>	
	<input type="checkbox"/>	23	24	<input type="checkbox"/>	
	<input type="checkbox"/>	25	26	<input type="checkbox"/>	
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	<input type="checkbox"/>	37	38	<input type="checkbox"/>	
	<input type="checkbox"/>	39	40	<input type="checkbox"/>	
	<input type="checkbox"/>	41	42	<input type="checkbox"/>	
	<input type="checkbox"/>	43	44	<input type="checkbox"/>	

INTERFACE BOARD, 1A6

PIN CONNECTIONS AND VOLTAGE READINGS

1A6-J2

<u>SPARE MODE LED</u>	<input checked="" type="radio"/>	1	2	<input type="radio"/>	<u>SCAN RATE</u>
<u>MIC</u>	<input type="radio"/>	3	4	<input type="radio"/>	<u>SCAN DWELL</u>
<u>LINE</u>	<input type="radio"/>	5	6	<input type="radio"/>	<u>METER</u>
	<input type="radio"/>	7	8	<input type="radio"/>	
	<input type="radio"/>	9	10	<input type="radio"/>	<u>MTR TX LED</u>
	<input type="radio"/>	11	12	<input type="radio"/>	<u>AGC OFF</u>
	<input type="radio"/>	13	14	<input type="radio"/>	
	<input type="radio"/>	15	16	<input type="radio"/>	
	<input type="radio"/>	17	18	<input type="radio"/>	
	<input type="radio"/>	19	20	<input type="radio"/>	
	<input type="radio"/>	21	22	<input type="radio"/>	
	<input type="radio"/>	23	24	<input type="radio"/>	
	<input type="radio"/>	25	26	<input type="radio"/>	
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	<input type="radio"/>	29	30	<input type="radio"/>	
	<input type="radio"/>	31	32	<input type="radio"/>	
	<input type="radio"/>	33	34	<input type="radio"/>	
	<input type="radio"/>	35	36	<input type="radio"/>	
	<input type="radio"/>	37	38	<input type="radio"/>	
	<input type="radio"/>	39	40	<input type="radio"/>	
	<input type="radio"/>	41	42	<input type="radio"/>	
	<input type="radio"/>	43	44	<input type="radio"/>	

INTERFACE BOARD, 1A6

PIN CONNECTIONS AND VOLTAGE READINGS

1A6-J3

$\overline{\text{CHAN}}$	<input checked="" type="radio"/>	1	2	<input type="radio"/>	$\overline{\text{FREQ}}$
$\overline{\text{RX}}$	<input type="radio"/>	3	4	<input type="radio"/>	RL4
$\overline{\text{TX}}$	<input type="radio"/>	5	6	<input type="radio"/>	RL3
$\overline{\text{CW LED}}$	<input type="radio"/>	7	8	<input type="radio"/>	$\overline{\text{BYPASS}}$
$\overline{\text{USB LED}}$	<input type="radio"/>	9	10	<input type="radio"/>	$\overline{\text{SIL TUNE}}$
$\overline{\text{LSB LED}}$	<input type="radio"/>	11	12	<input type="radio"/>	$\overline{\text{SCAN}}$
$\overline{\text{DATA LED}}$	<input type="radio"/>	13	14	<input type="radio"/>	$\overline{\text{SCAN PROG}}$
$\overline{\text{PWR 3}}$	<input type="radio"/>	15	16	<input type="radio"/>	$\overline{\text{REMOTE}}$
$\overline{\text{PWR 1}}$	<input type="radio"/>	17	18	<input type="radio"/>	$\overline{\text{TUNE}}$
RL6	<input type="radio"/>	19	20	<input type="radio"/>	
RL5	<input type="radio"/>	21	22	<input type="radio"/>	RL0
$\overline{\text{PWR 4}}$	<input type="radio"/>	23	24	<input type="radio"/>	RL1
$\overline{\text{AGC FAST LED}}$	<input type="radio"/>	25	26	<input type="radio"/>	RL2
$\overline{\text{AGC MED LED}}$	<input type="radio"/>	27	28	<input type="radio"/>	RL7
$\overline{\text{AGC SLOW LED}}$	<input type="radio"/>	29	30	<input type="radio"/>	MEMORY ERASE
$\overline{\text{AME LED}}$	<input type="radio"/>	31	32	<input type="radio"/>	$\overline{\text{PWR 2}}$
$\overline{\text{A3A LED}}$	<input type="radio"/>	33	34	<input type="radio"/>	$\overline{\text{FSK LED}}$
	<input type="radio"/>	35	36	<input type="radio"/>	
	<input type="radio"/>	37	38	<input type="radio"/>	
	<input type="radio"/>	39	40	<input type="radio"/>	
	<input type="radio"/>	41	42	<input type="radio"/>	
	<input type="radio"/>	43	44	<input type="radio"/>	

INTERFACE BOARD, 1A6

PIN CONNECTIONS AND VOLTAGE READINGS

1A6-P2

<u>A/D CS</u>	<input checked="" type="radio"/>	1	2	<input type="radio"/>	<u>O/A</u>
<u>VSWR RETUNE</u>	<input type="radio"/>	3	4	<input type="radio"/>	<u>REM/SEL</u>
<u>MIC</u>	<input type="radio"/>	5	6	<input type="radio"/>	<u>AME</u>
<u>PWR 1</u>	<input type="radio"/>	7	8	<input type="radio"/>	<u>A/D INTR</u>
<u>CPLR BYPASS</u>	<input type="radio"/>	9	10	<input type="radio"/>	<u>DATA</u>
<u>FLB</u>	<input type="radio"/>	11	12	<input type="radio"/>	<u>PWR 3</u>
<u>NOT USED</u>	<input type="radio"/>	13	14	<input type="radio"/>	<u>LSB</u>
<u>FLA</u>	<input type="radio"/>	15	16	<input type="radio"/>	<u>USB</u>
<u>AUTO SILENT TUNE</u>	<input type="radio"/>	17	18	<input type="radio"/>	<u>CW</u>
<u>NOT USED</u>	<input type="radio"/>	19	20	<input type="radio"/>	<u>A3A</u>
<u>SEND</u>	<input type="radio"/>	21	22	<input type="radio"/>	<u>FSK</u>
<u>AGC OFF</u>	<input type="radio"/>	23	24	<input type="radio"/>	<u>AME</u>
<u>AGC</u>	<input type="radio"/>	25	26	<input type="radio"/>	<u>AGC FAST</u>
<u>SPARE SW</u>	<input type="radio"/>	27	28	<input type="radio"/>	<u>AGC MED</u>
<u>DATA</u>	<input type="radio"/>	29	30	<input type="radio"/>	<u>ACG REAR PANEL</u>
<u>DN BUTTON</u>	<input type="radio"/>	31	32	<input type="radio"/>	<u>REMOTE</u>
<u>SCAN DET</u>	<input type="radio"/>	33	34	<input type="radio"/>	<u>RF GAIN</u>
<u>RF GAIN POT</u>	<input type="radio"/>	35	36	<input type="radio"/>	<u>AUTO RF TUNE</u>
<u>+13VDC</u>	<input type="radio"/>	37	38	<input type="radio"/>	<u>SCAN DN</u>
<u>AUDIO</u>	<input type="radio"/>	39	40	<input type="radio"/>	<u>MEMORY ERASE</u>
<u>UP BUTTON</u>	<input type="radio"/>	41	42	<input type="radio"/>	<u>RFL</u>
<u>GND</u>	<input type="radio"/>	43	44	<input type="radio"/>	<u>GND</u>

#### 5.9.1.4 Controller Board, 1A5

See Figure 5.20 for the schematic of the Controller board.

This board contains the major components of the control system for the MSR 8050A transceiver. The heart of the system is the microcontroller, U1; program memory storage is provided by EPROMs U3 and U4; data storage is provided by static RAM U5 and non-volatile RAM U6; up to eight levels of program interrupts are handled by U11. Also included on the board are output latches and circuitry to reset the system to prevent system lock-up.

##### 5.9.1.4.1 Microcontroller

U1 is an 8-bit microprocessor which uses up to 32k of external memory in the system. Data bus information from the  $\mu$ P is latched by U2 and sent to bus transceivers, U8 and U9, before connecting to the rest of the ICs in the system, except for program memory chips U3 and U4. The high four bits of the address bus are tied to U21, a 4 to 16 line decoder, to select other memory chips in the system, such as the DAC chip, keyboard chip, UART chip, etc. U15, a retriggerable one-shot multivibrator, is used (as a watchdog timer) in conjunction with U27 to reset U1 following power dropouts. U27 provides a very positive reset pulse to the  $\mu$ P and latches U10 and U14 whenever the source voltage is momentarily lost and returns. This resets the front panel display and prevents erroneous information from appearing in the display.

##### 5.9.1.4.2 External RAM

U5 is a static RAM used for temporary storage ("scratch pad") by the  $\mu$ P. Information stored on its chip is volatile and will be lost if power is removed from the unit.

##### 5.9.1.4.3 Channel Data RAM

U6 is a 2k static RAM with a built-in lithium battery for memory backup power. Channel information is stored on this chip during channel entry. This

device incorporates a special protection circuit to disable the "write" function if the supply voltage drops below 4.75 VDC. This prevents any change in channel data during power up or power down. When the supply voltage is removed, data is retained in memory by the lithium battery.

##### 5.9.1.4.4 Priority Interrupt

U11 is a priority interrupt chip that can handle up to eight levels of interrupt, with priority established by the  $\mu$ P. Once the level is set, this device rejects interrupts with priority lower than the set level.

##### 5.9.1.4.5 Input Buffer

U12 and U13 are 8-bit tri-state buffers that provide an interface between inputs and the data bus.

##### 5.9.1.4.6 Address Decoder

U7 is a 4 to 16 line decoder used to decode the lower 4 bits of the address bus. It is used to select one of the 8-bit latches during the  $\mu$ P write cycle.

##### 5.9.1.4.7 Band Decoder and Buffer

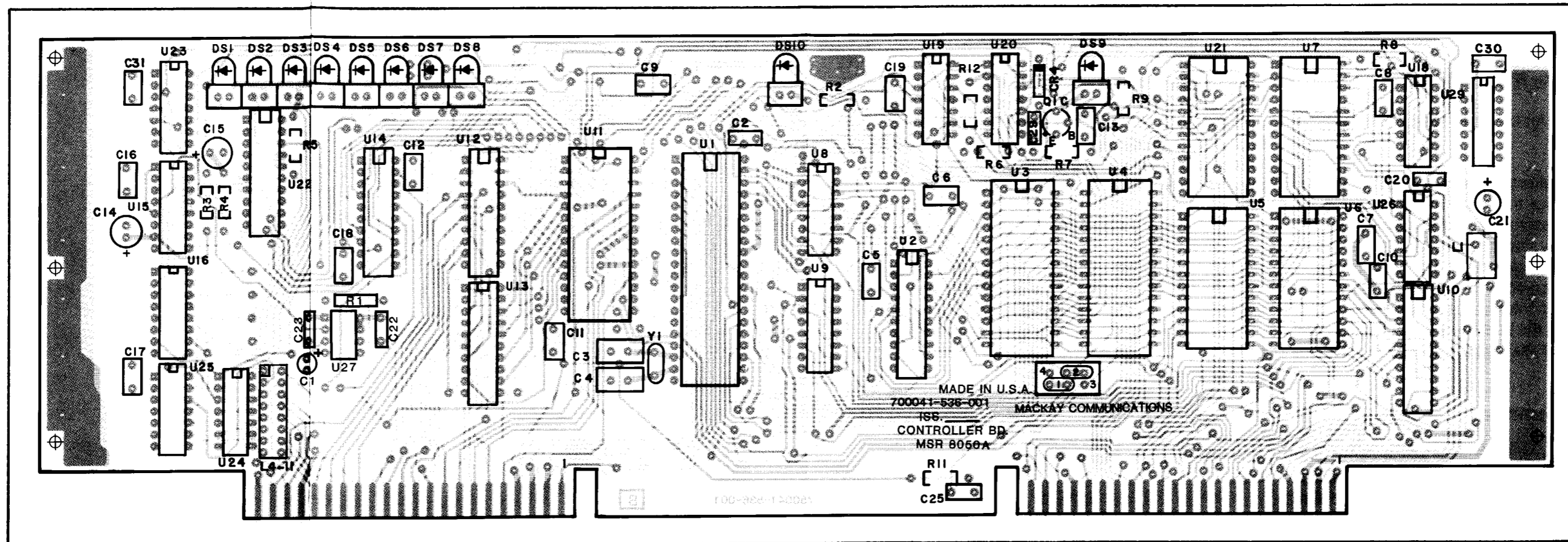
Three-bit band information is latched by U14 and decoded by the 3 to 8-bit decoder, U16. U14 also supplies the high pass filter bypass signal and the /MIC KEY ON signal. U16 provides the eight band outputs to drive the respective Band LED, DS1 through DS8, and band buffers U24 and U25.

##### 5.9.1.4.8 Read/Write Chip Select

U18 and U26 are used to select the proper destination or source chip during internal and external data read and write cycles.

##### 5.9.1.4.9 Miscellaneous Signals

Latch U10 provides the KWA, SIL TUNE, TUNE B, /TX INHIBIT, PRESEL BYPASS and /MUTE signals. It also provides the  $\mu$ P KEY signal through buffer U20.



(700041-536-001)

700600-412-001 MSR8050A, STORED PROGRAM ASSEMBLY (U3)

PART NUMBER	DESCRIPTION	SYMBOL
700122-415-001 700011-430-001	IC, EPROM 27128A OBJECT CODE (SOFTWARE)	U3 (U3)

700041-536-001 -- MSR8050A, CONTROLLER BD. (W/EPROM)

PART NUMBER	DESCRIPTION	SYMBOL
700600-412-001 700041-536-951	STORED PROGRAM ASSY. CONTROLLER BD.	(U3)

PART NUMBER	DESCRIPTION	SYMBOL
600119-419-040	IC SOCKET, 40 POS.	(U1)
600119-419-020	IC SOCKET, 20 POS.	(U2, 10, 12-14, 22)
600119-419-028	IC SOCKET, 28 POS.	(U3, 4, 11)
600119-419-024	IC SOCKET, 24 POS.	(U5-7, 21)
600297-314-013	CAP. 10UF, ALUM, 50V	C1
600297-314-015	CAP., 15UF, 35V	C14
600202-314-007	CAP. 1UF, 35V, TANT.	C15
600302-314-013	CAP. .1UF, MYLAR, 50V	C2, 5-13, 16-20, 22 25, 23 29-31
600297-314-016	CAP. 22UF, ALUM, 25V	C21
630093-306-501	CAP. 30PF, 3%, MICA, 500V	C3, 4
600109-410-001	DIODE 1N4148	CR4
700004-390-002	LED, HLMP7019, YELLOW	DS1-9
700004-390-001	LED, RED, SUB. MIN.	DS10
600064-419-001	4 POS VERTICAL MT.	H1, 2
600091-376-001	CHOKE 4.7UH	L1
600125-376-007	CHOKE 33UH	L4-11
600080-413-001	TRANSISTOR 2N2222A	Q1
610024-341-075	RES. 10K, 1/4W, 5%	R1, 6
615014-341-075	RES. 1.5K, 1/4W, 5%	R2, 5
622034-341-075	RES., 220K, 1/4W, 5%	R3, 4
651004-341-075	RES. 510, 1/4, 5%	R7
610014-341-075	RES. 1K, 1/4W, 5%	R8, 9, 11, 12
700109-415-001	IC, 80C31BH	U1
600277-415-001	IC 74LS273, FF W/CLR	U10
702024-415-001	IC, 82C59A	U11
702020-415-001	IC, 74HCT244	U12, 13
702021-415-001	IC, 74HCT273	U14
702013-415-001	IC, 74HCT123	U15
702014-415-001	IC, 74HCT138	U16
702011-415-001	IC, 74HCT32	U18, 26
702008-415-001	IC, 74HCT04	U19
702022-415-001	IC, 74HCT373	U2
600076-415-001	IC, 7407, HEX BUFF/DRV	U20, 24, 25
702019-415-001	IC, 74HCT241	U22
702009-415-001	IC, 74HCT08	U23
700123-415-001	I.C. TL7705A	U27
702012-415-001	IC, 74HCT93	U29
600627-415-004	IC 6116, 2K X 8 CMOS RAM	U5
600990-415-001	IC MK 48Z02-25, RAM	U6
702015-415-001	IC, 74HCT154	U7, 21
600716-415-001	IC MC8T28P	U8, 9
600212-378-001	MICROPROC XTAL	Y1

Figure 5.19

CONTROLLER BOARD ASSEMBLY

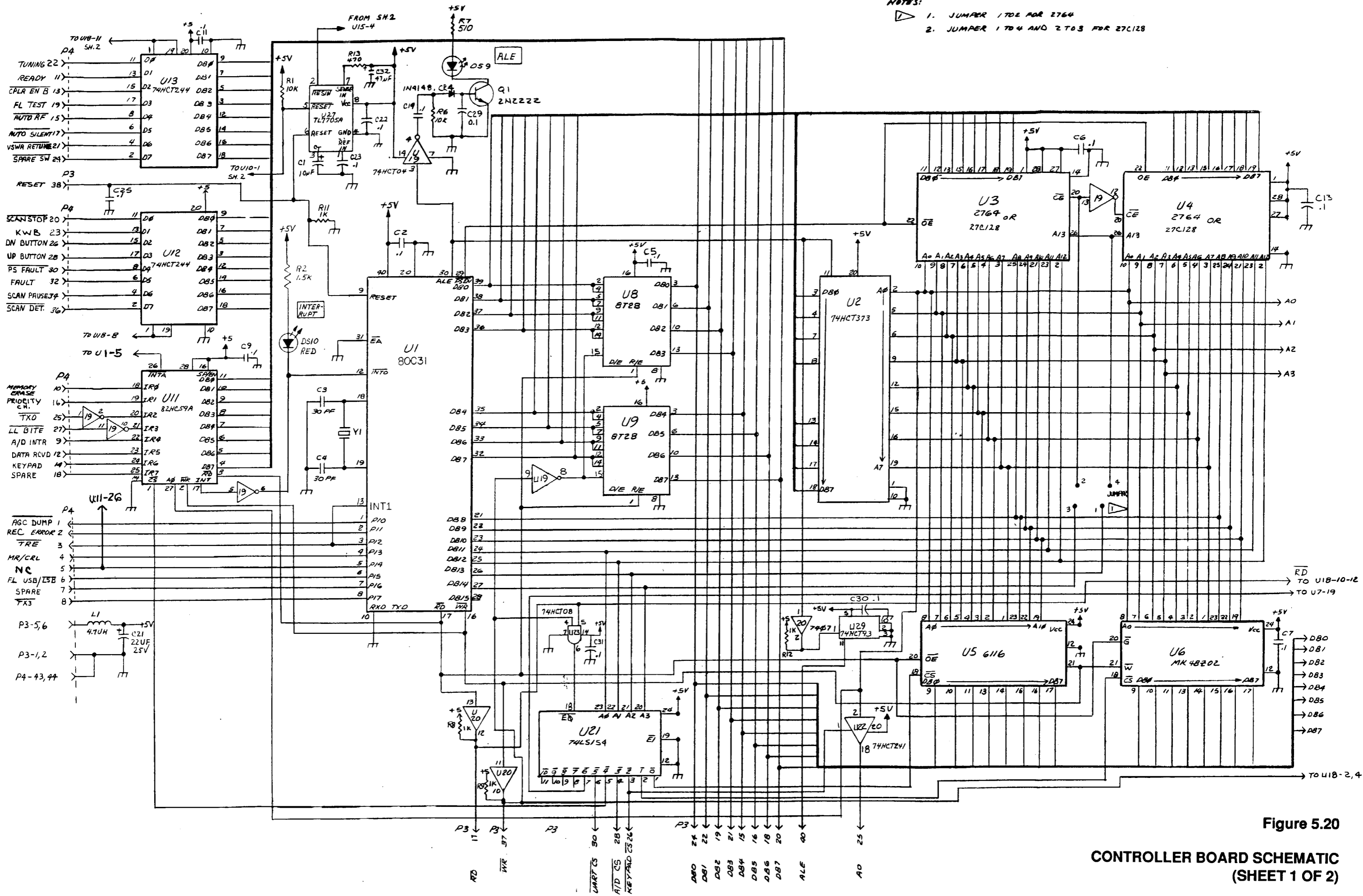
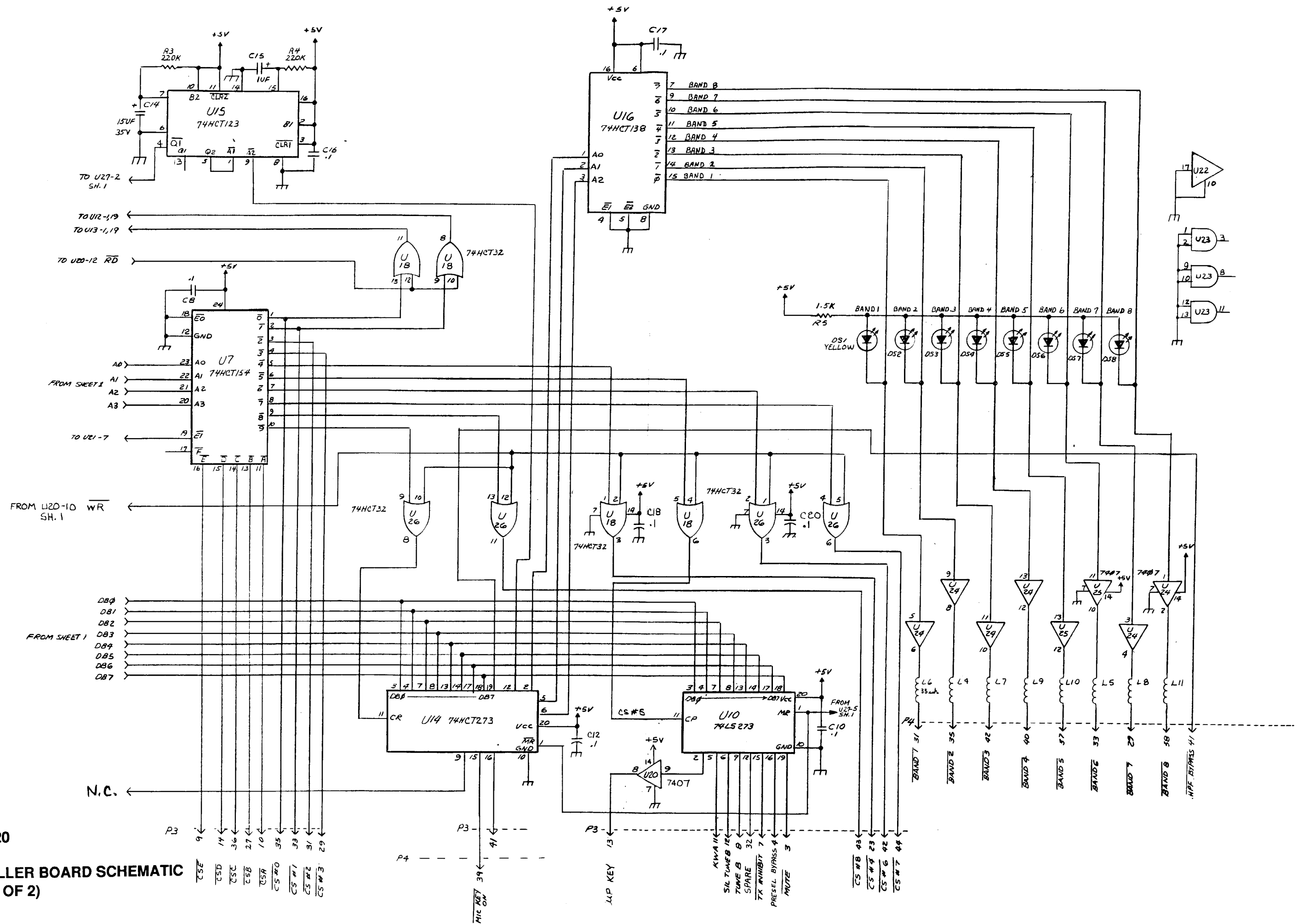


Figure 5.20  
**CONTROLLER BOARD SCHEMATIC**  
 (SHEET 1 OF 2)



**Figure 5.20**  
**CONTROLLER BOARD SCHEMATIC**  
 (SHEET 2 OF 2)

CONTROLLER BOARD, 1A5

PIN CONNECTIONS AND VOLTAGE READINGS

		1A5-P3			
GND	<input checked="" type="radio"/>	1	<input type="radio"/>	GND	
MUTE	<input type="radio"/>	3	<input type="radio"/>	PRESEL BYPASS	
+5VDC	<input type="radio"/>	5	<input type="radio"/>	+5VDC	
TXINHIBIT	<input type="radio"/>	7	<input type="radio"/>	TUNE B	
CSE	<input type="radio"/>	9	<input type="radio"/>	CSA	
KWA	<input type="radio"/>	11	<input type="radio"/>	SIL TUNE B	
UP KEY	<input type="radio"/>	13	<input type="radio"/>	CSD	
DB4	<input type="radio"/>	15	<input type="radio"/>	DB5	
RD	<input type="radio"/>	17	<input type="radio"/>	DB6	
DB2	<input type="radio"/>	19	<input type="radio"/>	DB7	
DB3	<input type="radio"/>	21	<input type="radio"/>	DB1	
CS#4	<input type="radio"/>	23	<input type="radio"/>	DB0	
AO	<input type="radio"/>	25	<input type="radio"/>	KEYPAD CS	
CSB	<input type="radio"/>	27	<input type="radio"/>	A/D CS	
CS#3	<input type="radio"/>	29	<input type="radio"/>	UART CS	
CS#2	<input type="radio"/>	31	<input type="radio"/>	NOT USED	
CS#1	<input type="radio"/>	33	<input type="radio"/>		
CS#0	<input type="radio"/>	35	<input type="radio"/>	CSC	
WR	<input type="radio"/>	37	<input type="radio"/>	RESET	
	<input type="radio"/>	39	<input type="radio"/>	ALE	
NOT USED	<input type="radio"/>	41	<input type="radio"/>	CS#6	
CS#8	<input type="radio"/>	43	<input type="radio"/>	CS#7	

CONTROLLER BOARD, 1A5

PIN CONNECTIONS AND VOLTAGE READINGS

1A5-P4

<u>AGC DUMP</u>	<input checked="" type="radio"/>	1	2	<input type="radio"/>	<u>REC ERROR</u>
<u>TRE</u>	<input type="radio"/>	3	4	<input type="radio"/>	<u>MR/CRL</u>
<u>NOT USED</u>	<input type="radio"/>	5	6	<input type="radio"/>	<u>FL USB/<u>LSB</u></u>
<u>NOT USED</u>	<input type="radio"/>	7	8	<input type="radio"/>	<u>TX3</u>
<u>A/D INTR</u>	<input type="radio"/>	9	10	<input type="radio"/>	<u>MEMORY ERASE</u>
<u>READY</u>	<input type="radio"/>	11	12	<input type="radio"/>	<u>DATA RCVD</u>
<u>CPLR EN B</u>	<input type="radio"/>	13	14	<input type="radio"/>	<u>KEYPAD</u>
<u>AUTO RF</u>	<input type="radio"/>	15	16	<input type="radio"/>	<u>PRIORITY CH</u>
<u>AUTO SILENT</u>	<input type="radio"/>	17	18	<input type="radio"/>	<u>NOT USED</u>
<u>FL TEST</u>	<input type="radio"/>	19	20	<input type="radio"/>	<u>SCAN STOP</u>
<u>VSWR RETUNE</u>	<input type="radio"/>	21	22	<input type="radio"/>	<u>TUNING</u>
<u>KWB</u>	<input type="radio"/>	23	24	<input type="radio"/>	<u>SPARE SW</u>
<u>TX0</u>	<input type="radio"/>	25	26	<input type="radio"/>	<u>DN BUTTON</u>
<u>LL BITE</u>	<input type="radio"/>	27	28	<input type="radio"/>	<u>UP BUTTON</u>
<u>BAND 7</u>	<input type="radio"/>	29	30	<input type="radio"/>	<u>PS FAULT</u>
<u>BAND 1</u>	<input type="radio"/>	31	32	<input type="radio"/>	<u>FAULT</u>
<u>BAND 6</u>	<input type="radio"/>	33	34	<input type="radio"/>	<u>SCAN PAUSE</u>
<u>BAND 2</u>	<input type="radio"/>	35	36	<input type="radio"/>	<u>SCAN DET</u>
<u>BAND 5</u>	<input type="radio"/>	37	38	<input type="radio"/>	<u>BAND 8</u>
<u>MIC KEY ON</u>	<input type="radio"/>	39	40	<input type="radio"/>	<u>BAND 4</u>
<u>HPF BYPASS</u>	<input type="radio"/>	41	42	<input type="radio"/>	<u>BAND 3</u>
<u>GND</u>	<input type="radio"/>	43	44	<input type="radio"/>	<u>GND</u>

### 5.9.1.5 Serial/Synthesizer Latch Board, 1A22

See Figure 5.22 for the schematic of the Serial/Synthesizer Latch board. See Table 5.9 for the remote control switch settings.

The Serial/Synthesizer Latch board contains the latches which transmit the desired frequency information from the microprocessor to control the synthesizer, the MSR 1020 linear power amplifier control interface, the BCD interface circuitry and the remote control interfaces for various serial data formats.

#### 5.9.1.5.1 Frequency Control and Channel Number Latches

Integrated circuits U9, U10, U11 and U12 are used to latch the frequency information from the microprocessor data bus necessary to control the synthesizer output frequency. U8A, U8B, U8C and U8D enable the latches at the proper time based on data bus information. These TTL signals are in BCD format and are latched after the write cycle until new information is written into the latches again. U13 latches the channel information in BCD format and sends it to the rear panel accessory connector via buffer/inverters U14 and U15.

#### 5.9.1.5.2 MSR 1020 Linear Power Amplifier Interface

This circuit (U16A, B and C) is used to energize the MSR 1020 when power levels 3 (500 watts) or 4 (1000 watts) are called for. When the transceiver is in power levels 1 or 2, P5 pin 11 is low, U16A pin 1 is low and Q3 is OFF. So no current is supplied to P5 pin 26 to turn on the LPA. When power level 3 or 4 is selected from the front panel, the  $\mu$ P provides a logic low to P5 pin 11, turning on Q3 to supply current to turn on the LPA (if it is connected). The resulting voltage drop across R20 causes the output of U16C to go high, driving the output of U16B low to signal the  $\mu$ P that an LPA is connected and the selection of power level 3 or 4 is legal. If an LPA is not connected, there is no current flow in Q3, and no voltage drop across R20. So the output of U16B will be high signalling the  $\mu$ P that an LPA is not connected and selection of power levels 3 or 4 is not allowed.

### 5.9.1.5.3 BCD Interface

U17, U18 and U19 modify the BCD synthesizer control signals to BCD outputs corresponding to the input frequency to which the transceiver is set. This is done by subtracting 4 MHz from the BCD synthesizer signals. This data is used by the preselector/postselector option to tune the selective circuits to the transceiver frequency. U18 and U19 are adders which are converted to subtract 4 from the 10 MHz and 1 MHz BCD inputs. U17 is an octal tri-state buffer which provides buffered BCD outputs from the 10 kHz and 100 kHz decades. These outputs are independent of the 10 MHz and 1 MHz signals and are not affected by the 4 MHz subtraction. U4C provides a signal to the preselector to bypass it during transmit or when receiving frequencies below 1.6 MHz.

#### 5.9.1.5.4 Remote Control Serial Data Interface Circuitry

U2D and U2E provide a remote control bus interface for 300 Baud FSK use with the Optional Audio I/O board and the Optional Tone Key/Modem board.

In addition to sending control and status information with FSK signals, the board can use RS-232C, RS-422, RS-423 or MIL-STD-188C interfaces for communication in a remote control network. Rear panel connector J35 provides an input/output port for this purpose. Line driver U5A and U5B provide the unbalanced capability for transmission of RS-232C, RS-423 and MIL-STD-188C, while U6A and U6B provide the balanced output capability for RS-422. In data reception, both the balanced and unbalanced inputs are accepted by line receivers U7A and U7B. The type of interface desired is selected with switches S1, S2 and S3. Refer to Table 5.9 for instructions on proper switch position. When MIL-STD-188C is used, tri-state inverter U3 is switched into the signal path ahead of the line drivers to invert the sense of the signal.

The serial control/status remote control data passes to and from the line drivers and receivers as well as the modem via data Bus A and Bus B. The UART monitors both buses through AND gate U4D. Tri-state buffer U2A and U2B is used by the UART to place control/status data on both

buses.

-10 VDC is required by U5A and U5B for proper data signal level transmission. This is supplied by U1, Q1 and Q2. U1 is a free-running oscillator at a frequency of about 10 kHz. Its output is a square

wave which alternately drives Q1 and Q2 to saturation so that the resulting peak-to-peak swing provides a 0 to +13 VDC square wave. This is detected in a negative voltage doubler, providing -10 VDC.

**Table 5.9 REMOTE CONTROL DATA MODE SWITCHES**

	BAUD RATE SWITCH					
	300	600	1200	2400	4800	9600
1	0	X	0	X	X	X
2	X	0	0	0	X	0
3	0	0	0	X	0	0
4	X	X	X	0	0	0

- 1) Turn off AC power when setting switches.
- 2) All switches must be set to one of the configurations listed.
- 3) S2, S3, Baud Rate Switch:  
X=Closed=On 0=Open=Off

\* FSK-To-Digital Transitional Radio

	RX B, TX B PORTS				RX A, TX A PORTS				C/S PORTS			
	RS-232C RS-423	RS-422	MIL-188C	NO CONN	RS-232C RS-423	RS-422	MIL-188C	NO CONN	C/S USED, NO DIGITAL	NO C/S CONN	*C/S C,C/S D RX A, TX A	*C/S A,C/S B RX B, TX B
S1 - 1	UP	DN	UP	UP	UP	DN	UP	UP	UP	UP	UP	UP
2	UP	DN	UP	UP	DN	UP	DN	DN	UP	UP	UP	UP
3	UP	DN	UP	UP	UP	DN	DN	DN	UP	UP	UP	UP
4	UP	DN	UP	UP	UP	DN	DN	DN	UP	UP	UP	UP
5	UP	DN	UP	UP	UP	DN	DN	DN	UP	UP	UP	UP
S2 - 1	UP	DN	UP	UP	UP	DN	UP	UP	X	0	X	0
2	UP	DN	UP	UP	UP	DN	UP	UP	0	0	0	X
3	UP	DN	UP	UP	UP	DN	UP	UP	UP	UP	UP	UP
4	UP	DN	UP	UP	UP	DN	UP	UP	UP	UP	UP	UP
5	UP	DN	UP	UP	UP	DN	UP	UP	UP	UP	UP	UP
6	UP	DN	UP	UP	UP	DN	UP	UP	UP	UP	UP	UP
7	X	X	0	X	0	0	X	0	UP	UP	UP	UP
8	0	0	X	0	UP	UP	UP	UP	UP	UP	UP	UP
9	X	X	0	X	UP	UP	UP	UP	UP	UP	UP	UP
10	0	0	X	0	UP	UP	UP	UP	UP	UP	UP	UP
S3 - 1	UP	DN	UP	UP	X	X	X	0	UP	UP	UP	UP
2	UP	DN	UP	UP	0	0	0	0	UP	UP	UP	UP
3	UP	DN	UP	UP	X	X	X	0	UP	UP	UP	UP
4	UP	DN	UP	UP	0	0	0	0	UP	UP	UP	UP
5	0	0	0	0	UP	UP	UP	UP	UP	UP	UP	UP
6	X	X	X	0	UP	UP	UP	UP	UP	UP	UP	UP
7	X	X	X	0	UP	UP	UP	UP	UP	UP	UP	UP
8	0	0	0	0	UP	UP	UP	UP	UP	UP	UP	UP
9	UP	DN	UP	UP	UP	UP	UP	UP	X	0	X	0
10	UP	DN	UP	UP	UP	UP	UP	UP	0	0	0	0

H1



CR4  
R14  
CR3

H2

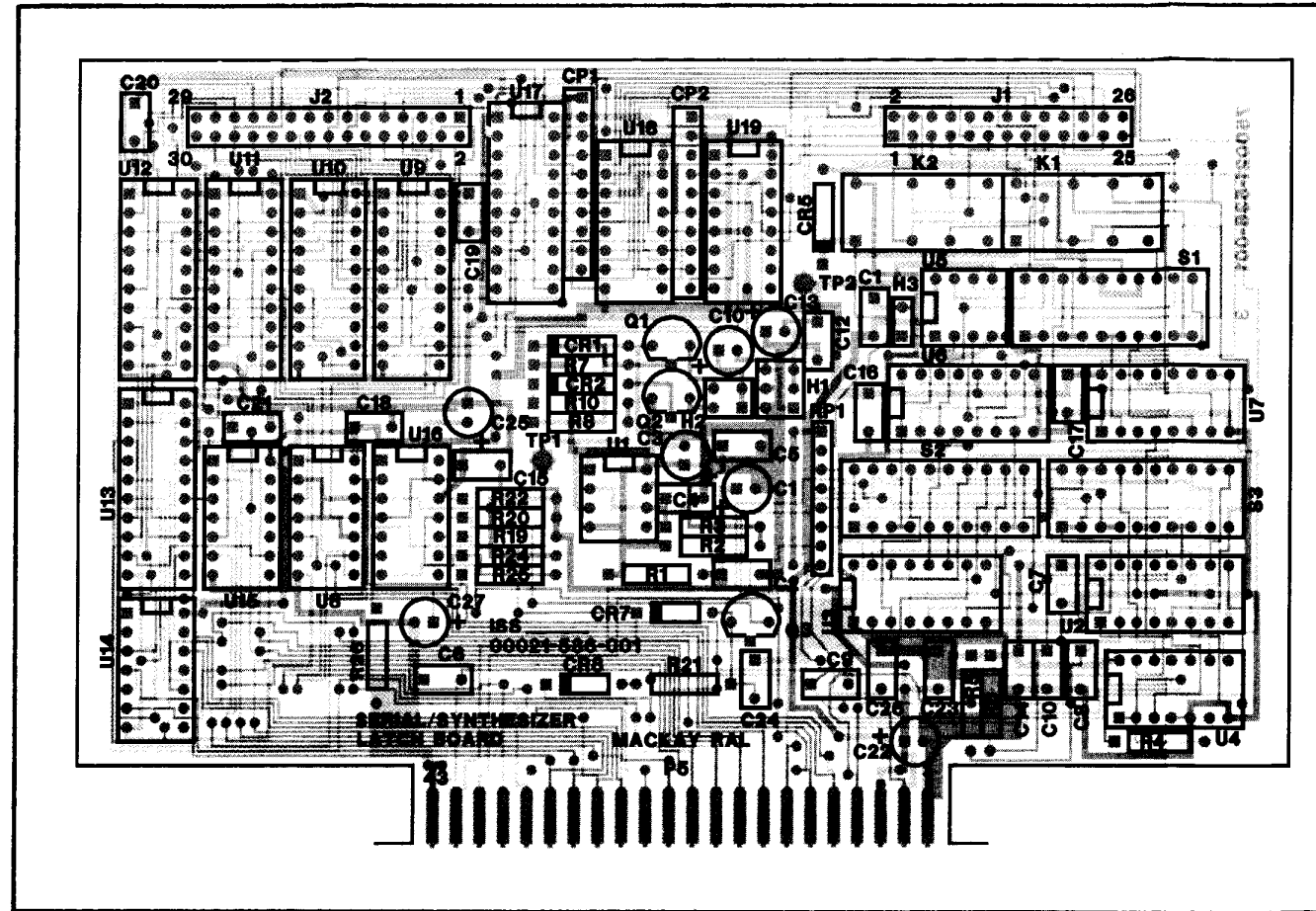


R9  
R11

H3



R15



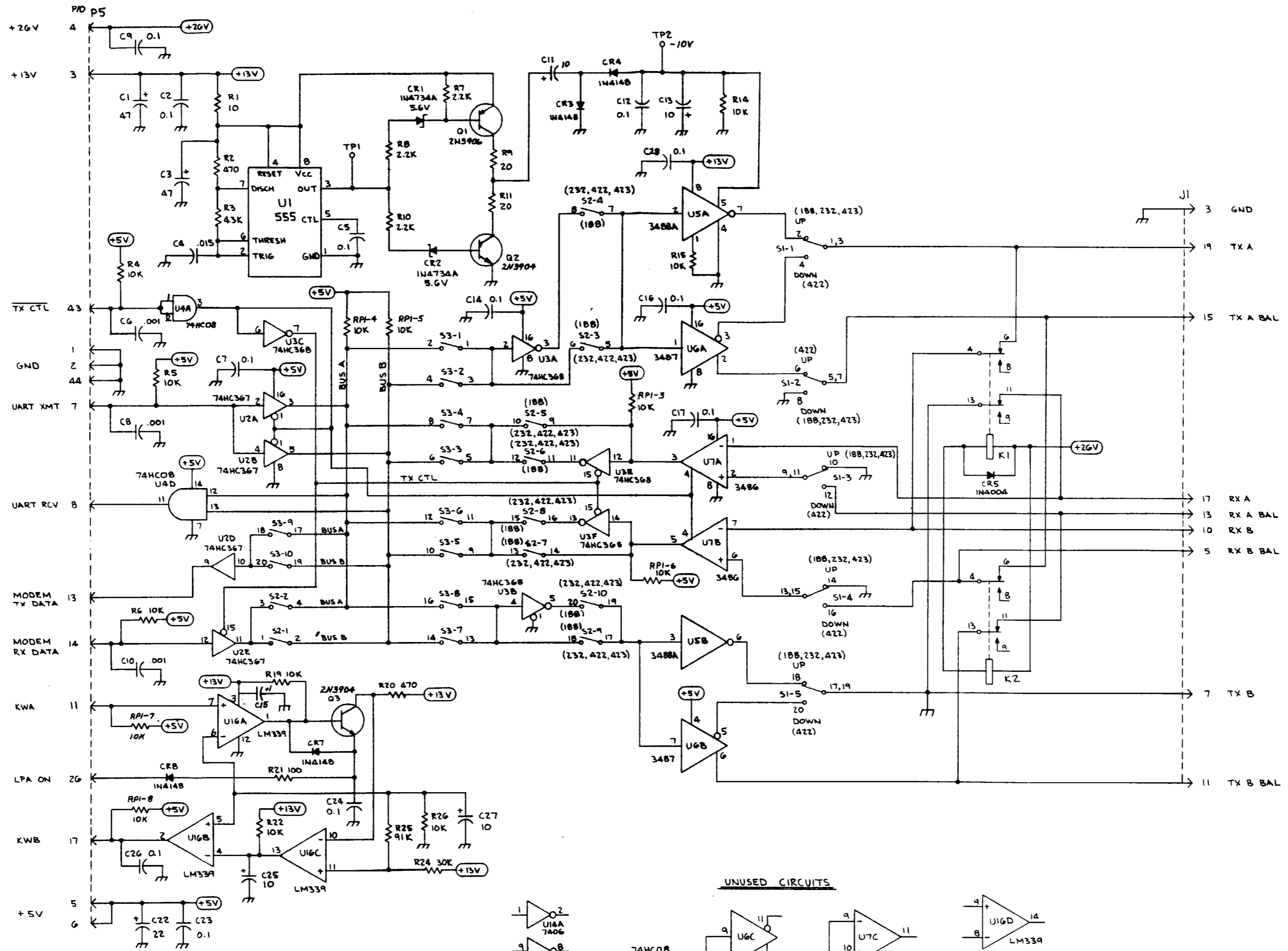
(70021-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600297-314-025	CAP. 47UF, ALUM, 25V	C1,3
600297-314-013	CAP. 10UF, ALUM, 50V	C11,13 25,27
600302-314-013	CAP. .1UF, MYLAR, 50V	C2,5,7,9 12,14-21 23,24,26
600297-314-016	CAP. 22UF, ALUM, 25V	C22
600268-314-011	CAP. .015UF, CER,50V	C4
600302-314-001	CAP. .001UF,MYLAR,63V	C6,8,10
600380-314-002	CAP SIP .1UF X 9	CP1,2
600006-411-007	DIODE IN4734A 5.6V	CR1,2
600109-410-001	DIODE IN4148	CR3,4,7,8
600011-416-002	DIODE IN4004	CR5
600064-419-003	3 POSITION VERTICAL MT	H1
600064-419-004	2 POSITION VERTICAL MT	H2
600064-419-005	1 POSITION VERTICAL MT	H3
702006-608-005		J1
702006-608-023		J2
600094-403-002	RELAY, DPDT, 24V, 3A CONTACTS	K1,2
600116-413-002	TRANS, 2N3906	Q1
600229-413-003	TRANS 2N3904 TO-92	Q2,3
610094-341-075	RES. 10, 1/4W, 5%	R1

PART NUMBER	DESCRIPTION	SYMBOL
647004-341-075	RES. 470, 1/4W, 5%	R2,20
610004-341-075	RES. 100, 1/4W, 5%	R21
630024-341-075	RES. 30K, 1/4W, 5%	R24
691024-341-075	RES. 91K, 1/4W, 5%	R25
643014-341-075	RES. 4.3K, 1/4W, 5%	R3
610024-341-075	RES. 10K, 1/4W, 5%	R4-6,14, 15,19,22 26
622014-341-075	RES. 2.2K, 1/4W, 5%	R7,8,10
620094-341-075	RES. 20, 1/4W, 5%	R9,11
600106-340-011	RES NETWORK 10K X 7	RP1
600244-616-005	DIP SWITCH, SPDT X5	S1
600235-616-010	DIP SWITCH, SPST X10	S2,3
600261-230-001	TERMINAL	TP1,2
600074-415-001	IC NE555, TIMER	U1
600016-415-001	IC 7406, HEX INV.,0/C	U14,15
600324-415-001	IC LM339, COMPARATOR	U16
702020-415-001	IC, 74HCT244	U17
601012-415-001	IC 4560, NBCD ADDER	U18,19
700102-415-001	IC, 74HC367	U2
700103-415-001	IC, 74HC368	U3
600271-415-001	IC 74LS08,AND,2-IN QUAD	U4
700106-415-001	IC, MC3488	U5
700107-415-001	IC, MC3487	U6
700105-415-001	IC, MC3486	U7
600411-415-001	IC 74LS32, OR, 2-IN	U8
600277-415-001	IC 74LS273, FF W/CLR	U9-13

Figure 5.21

SERIAL/SYNTHESIZER  
LATCH BOARD ASSEMBLY



**Figure 5.22**  
**SERIAL/SYNTHESIZER**  
**LATCH BOARD SCHEMATIC**  
**(SHEET 1 OF 2)**

NOTES:  
 1. ALL CAPACITORS ARE MICROFARADS, ALL RESISTORS ARE IN OHMS (1/4W, 5%), AND ALL INDUCTORS ARE IN MICROHENRIES, UNLESS OTHERWISE SPECIFIED.

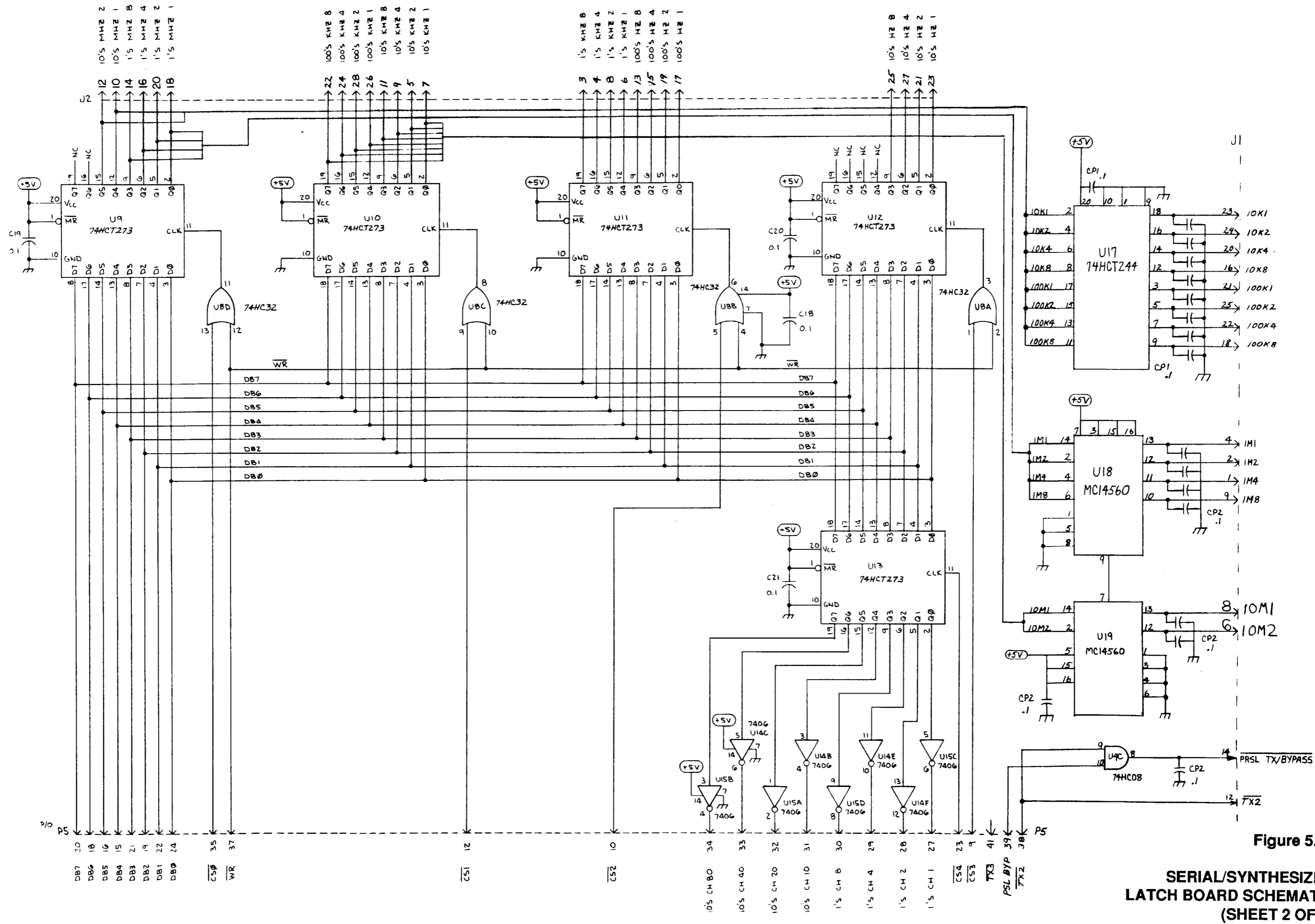


Figure 5.22

SERIAL/SYNTHESIZER  
LATCH BOARD SCHEMATIC  
(SHEET 2 OF 2)

SERIAL/SYNTHESIZER LATCH BOARD, 1A22

PIN CONNECTIONS AND VOLTAGE READINGS

1A22-J1

1M4	<input checked="" type="radio"/>	1	2	<input type="radio"/>	1M2
GND	<input type="radio"/>	3	4	<input type="radio"/>	1M1
RXB BAL	<input type="radio"/>	5	6	<input type="radio"/>	
TXB	<input type="radio"/>	7	8	<input type="radio"/>	
1M8	<input type="radio"/>	9	10	<input type="radio"/>	RXB
TXB BAL	<input type="radio"/>	11	12	<input type="radio"/>	$\overline{\text{TX2}}$
RXA BAL	<input type="radio"/>	13	14	<input type="radio"/>	PRSL TX/BYPASS
TXA BAL	<input type="radio"/>	15	16	<input type="radio"/>	1OK8
RXA	<input type="radio"/>	17	18	<input type="radio"/>	1OOK8
TXA	<input type="radio"/>	19	20	<input type="radio"/>	1OK4
1OOK1	<input type="radio"/>	21	22	<input type="radio"/>	1OOK4
1OK1	<input type="radio"/>	23	24	<input type="radio"/>	1OK2
1OOK2	<input type="radio"/>	25	26	<input type="radio"/>	
	<input type="radio"/>	27	28	<input type="radio"/>	
	<input type="radio"/>	29	30	<input type="radio"/>	
	<input type="radio"/>	31	32	<input type="radio"/>	
	<input type="radio"/>	33	34	<input type="radio"/>	
	<input type="radio"/>	35	36	<input type="radio"/>	
	<input type="radio"/>	37	38	<input type="radio"/>	
	<input type="radio"/>	39	40	<input type="radio"/>	
	<input type="radio"/>	41	42	<input type="radio"/>	
	<input type="radio"/>	43	44	<input type="radio"/>	

SERIAL/SYNTHESIZER LATCH BOARD, 1A22

PIN CONNECTIONS AND VOLTAGE READINGS

1A22-J2

_____	<input checked="" type="radio"/>	1	2	<input type="radio"/>	_____
1'S KHZ 8	<input type="radio"/>	3	4	<input type="radio"/>	1'S KHZ 4
10'S KHZ 2	<input type="radio"/>	5	6	<input type="radio"/>	1'S KHZ 1
10'S KHZ 1	<input type="radio"/>	7	8	<input type="radio"/>	1'S KHZ 2
10'S KHZ 4	<input type="radio"/>	9	10	<input type="radio"/>	10'S MHZ 1
10'S KHZ 8	<input type="radio"/>	11	12	<input type="radio"/>	10'S MHZ 2
100'S HZ 8	<input type="radio"/>	13	14	<input type="radio"/>	1'S MHZ 8
100'S HZ 4	<input type="radio"/>	15	16	<input type="radio"/>	1'S MHZ 4
100'S HZ 1	<input type="radio"/>	17	18	<input type="radio"/>	1'S MHZ 1
100'S HZ 2	<input type="radio"/>	19	20	<input type="radio"/>	1'S MHZ 2
10'S HZ 2	<input type="radio"/>	21	22	<input type="radio"/>	100'S KHZ 8
10'S HZ 1	<input type="radio"/>	23	24	<input type="radio"/>	100'S KHZ 4
10'S HZ 8	<input type="radio"/>	25	26	<input type="radio"/>	100'S KHZ 1
10'S HZ 4	<input type="radio"/>	27	28	<input type="radio"/>	100'S KHZ 2
_____	<input type="radio"/>	29	30	<input type="radio"/>	_____
_____	<input type="radio"/>	31	32	<input type="radio"/>	_____
_____	<input type="radio"/>	33	34	<input type="radio"/>	_____
_____	<input type="radio"/>	35	36	<input type="radio"/>	_____
_____	<input type="radio"/>	37	38	<input type="radio"/>	_____
_____	<input type="radio"/>	39	40	<input type="radio"/>	_____
_____	<input type="radio"/>	41	42	<input type="radio"/>	_____
_____	<input type="radio"/>	43	44	<input type="radio"/>	_____

SERIAL/SYNTHESIZER LATCH BOARD, 1A22

PIN CONNECTIONS AND VOLTAGE READINGS

1A22-P5

GND	<input checked="" type="radio"/>	1	2	<input type="radio"/>	GND
+13VDC	<input type="radio"/>	3	4	<input type="radio"/>	+26VDC
+5VDC	<input type="radio"/>	5	6	<input type="radio"/>	+5VDC
(IN) UART XMT	<input type="radio"/>	7	8	<input type="radio"/>	UART RCV (OUT)
$\overline{\text{CS3}}$	<input type="radio"/>	9	10	<input type="radio"/>	$\overline{\text{CS2}}$
KWA	<input type="radio"/>	11	12	<input type="radio"/>	$\overline{\text{CS1}}$
(OUT) MODEM TX DATA	<input type="radio"/>	13	14	<input type="radio"/>	MODEM RX DATA (IN)
DB4	<input type="radio"/>	15	16	<input type="radio"/>	DB5
KWB	<input type="radio"/>	17	18	<input type="radio"/>	DB6
DB2	<input type="radio"/>	19	20	<input type="radio"/>	DB7
DB3	<input type="radio"/>	21	22	<input type="radio"/>	DB1
$\overline{\text{CS4}}$	<input type="radio"/>	23	24	<input type="radio"/>	DB0
	<input type="radio"/>	25	26	<input type="radio"/>	LPA ON
1'S CH NO. 1	<input type="radio"/>	27	28	<input type="radio"/>	1'S CH NO. 2
1'S CH NO. 4	<input type="radio"/>	29	30	<input type="radio"/>	1'S CH NO. 8
10'S CH NO. 10	<input type="radio"/>	31	32	<input type="radio"/>	10'S CH NO. 20
10'S CH NO. 40	<input type="radio"/>	33	34	<input type="radio"/>	10'S CH NO. 80
$\overline{\text{CS0}}$	<input type="radio"/>	35	36	<input type="radio"/>	
$\overline{\text{WR}}$	<input type="radio"/>	37	38	<input type="radio"/>	$\overline{\text{TX2}}$
PSL BYP	<input type="radio"/>	39	40	<input type="radio"/>	
(N.C.) $\overline{\text{TX3}}$	<input type="radio"/>	41	42	<input type="radio"/>	
$\overline{\text{TX CTL}}$	<input type="radio"/>	43	44	<input type="radio"/>	GND

## 5.9.2 REAR PANEL ASSEMBLY, 1A2

The Rear Panel assembly contains the 125 watt Power Amplifier assembly 1A2A2, Accessory Connector board 1A2A1, three 25-pin "D" connectors (for 600 ohm audio input/output, external equipment interface and remote control interface), 5 MHz Reference In/Out connector and switch, PA fan connector and the Antenna connector.

### 5.9.2.1 Ribbon Cable Connectors

J35, 36 and 37 are 25-pin "D"-type connectors with a 26-wire ribbon cable attached to each one. Each cable is terminated by a 26-pin ribbon connector at the opposite end. J35 goes to J1 on the Serial/Synthesizer board, J36 goes to J1 on the Audio I/O board and J37 goes to J31 on the Mother board. J37 is for external equipment interface, J36 is for 600 ohm audio input and output, and J35 is for an optional remote control or preselector.

### 5.9.2.2 Coaxial Cable Connectors

J34 is the rf input/output connector for the trans-

ceiver. It is normally connected to an antenna or antenna coupler through a length of coaxial cable. J39 is a BNC coaxial connector used as input/output for a 5 MHz frequency reference. If desired, an external 5 MHz source may be used as the standard for the transceiver, or the internal transceiver 5 MHz standard may be used as a reference for other external equipment. Three coaxial cables, P1, P2 and P3, from the Mother board, plug into the Power Amplifier module.

### 5.9.2.3 Quick-Disconnect Wires

Two wires from the switching power supply, orange for +26 VDC and black for ground, attach to the Power Amplifier module and Rear Panel ground lug E5, respectively.

### 5.9.2.4 Multiwire Cable

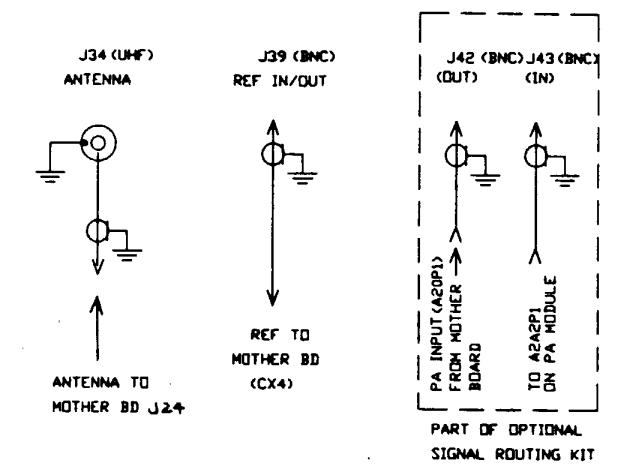
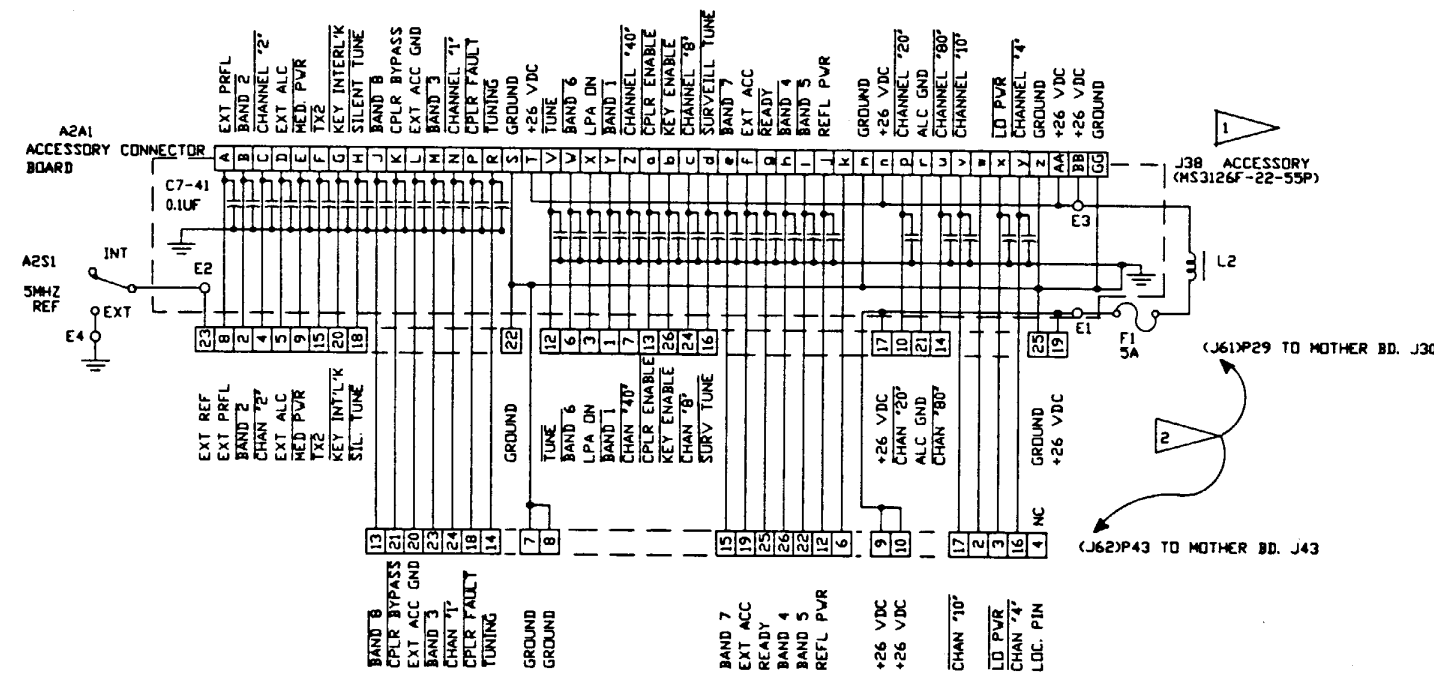
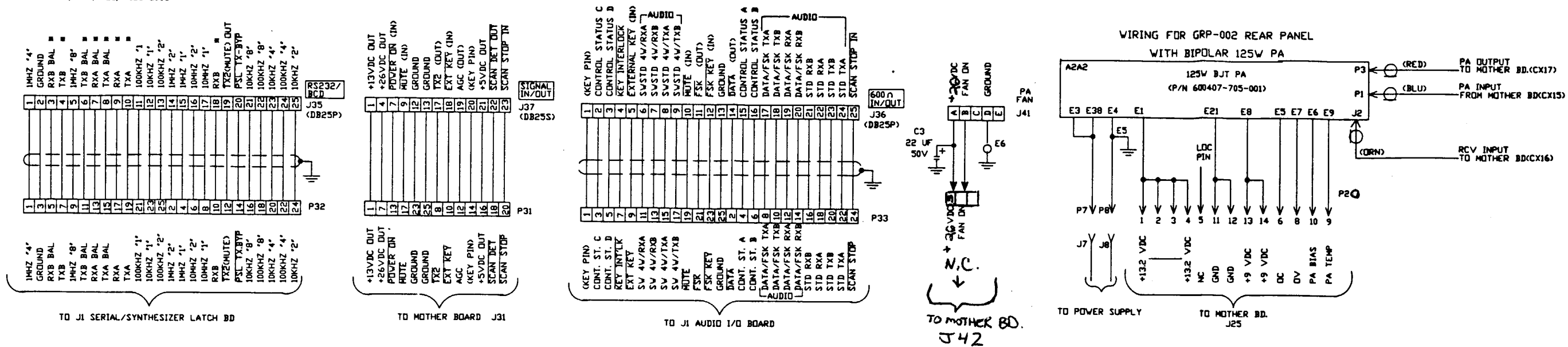
A multiwire cable with 14 pin connectors at each end is used to connect the Power Amplifier module with the Mother board, J25.

(700200-539-001)

PART NUMBER	DESCRIPTION	SYMBOL
600407-705-001	125W PA ASSY	
602014-536-001	ACC CONN PBA	
600338-604-001	SHIELD	
600030-642-017	GROMMET	
700023-700-001	FAN ASSY. 24V LPA	
701501-610-001	PANEL SUB-ASSY	
600297-314-018	CAP. 22UF, ALUM, 50V	C3
600272-314-001	CAP .1UF, CERAMIC, 50V	C4
600006-396-030	FUSE, SLOW BLOW, 5A	F1
600866-540-006	RIBBON CABLE	J37
600866-540-040	RIBBON CABLE	J36
600866-540-041	RIBBON CABLE	J35
600373-606-001	CONN. UHF, PANEL MOUNT	J34
600162-606-001	CONN. BNC INSULATED, PANEL MOUNT	J39
600377-606-001	CONN CIRC 5 PIN(BLOWER)	J41
600267-622-001	TOROID CORE	L2
600270-606-004	RIGHT ANGLE MALE CONN.	P24
600270-606-002	RT ANGLE FEMALE CONN.	P29
600289-616-006	TOGGLE SWITCH	S1
600014-613-002	FUSE HOLDER	XF1

Figure 5.23 REAR PANEL ASSEMBLY

REMOTE CONTROL SIGNALS PER RS232, 422, 423, MILSTD188



NOTES:

1. EXTERNAL JUMPER BETWEEN J38-G AND J38-GG REQUIRED WHEN P38 IS NOT USED.

2. J61, J62 CABLE ENDS ARE SOLDERED TO ACCESSORY BD.

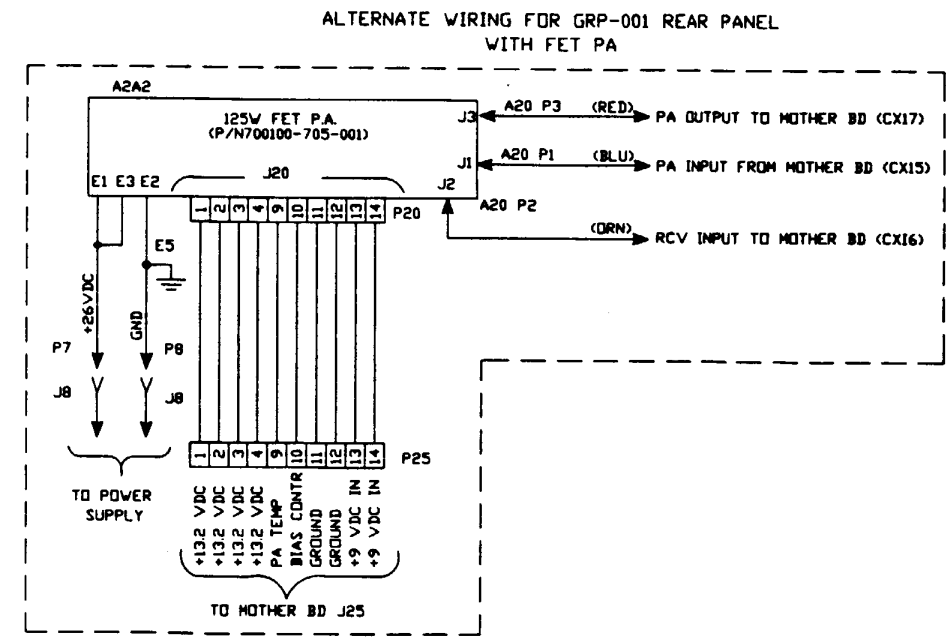
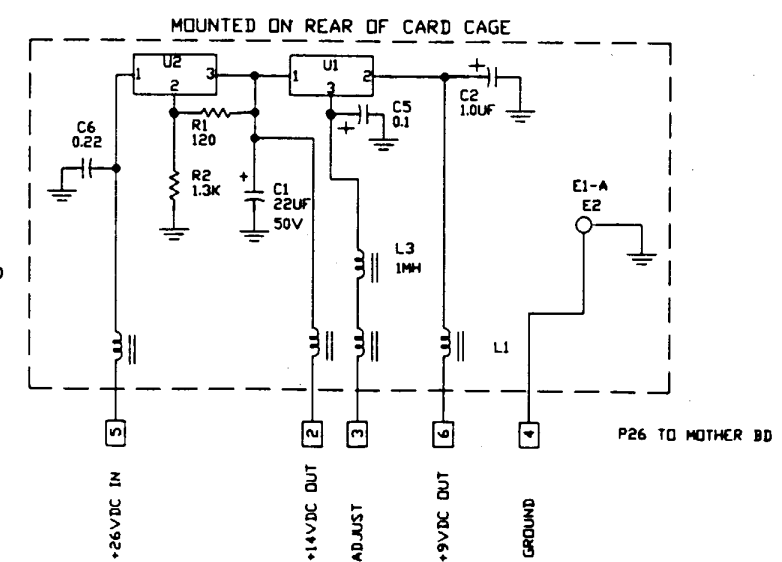


Figure 5.24 REAR PANEL SCHEMATIC

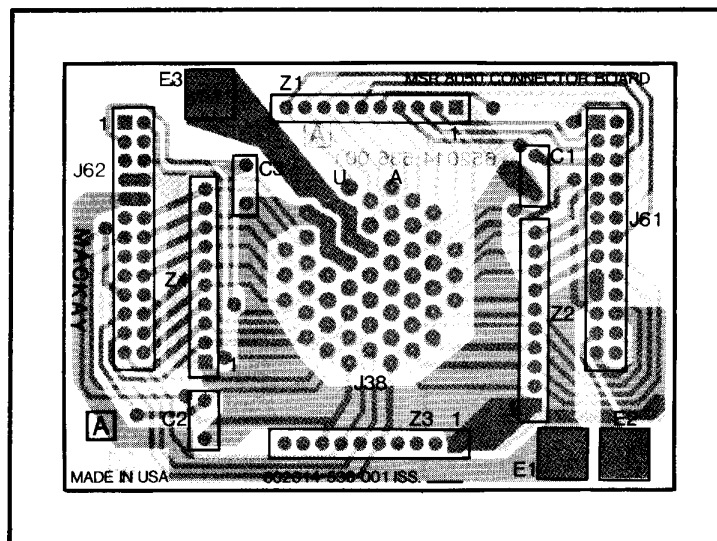
**Table 5.10 TRANSCEIVER REAR PANEL CONNECTORS**

1A2 J35 (DB 25P) RS-232/BCD (See Table 2.8)			1A2 J37 (DB 25S) SIGNAL IN/OUT (See Table 2.4)		1A2 J36 (DB 25P) 600 OHM IN/OUT (See Table 2.6)	
PIN	PRESEL	RS-232,422,423 MIL-STD-188	PIN		PIN	
1	1MHz "4"		1	+13 VDC Out	1	(Key in)
2	Gnd	Gnd	2	-Spare-	2	Cont Stat C
3		RXB Bal	3	-Spare-	3	Cont Stat D
4		TXB	4	+26 VDC Out	4	Key Intlk
5	1MHz "8"		5	-Spare-	5	/Ext Key
6		TXB Bal	6	-Spare-	6	Sw STD 4W/RX A
7		RXA Bal	7	/Pwr On	7	Sw STD 4W/RX B
8		TXA Bal	8	-Spare-	8	Sw STD 4W/TX A (2W A)
9		RXA	9	/Mute	9	Sw STD 4W/TX B (2W B)
10		TXA	10	-Spare-	10	/Mute
11	100kHz "1"		11	-Spare-	11	/FSK
12	10kHz "1"		12	Gnd	12	/FSK Key
13	100kHz "2"		13	Gnd	13	Gnd
14	1MHz "2"		14	-Spare-	14	/Data
15	1MHz "1"		15	-Spare-	15	Cont Stat A
16	10MHz "2"		16	-Spare-	16	Cont Stat B
17	10MHz "1"		17	/TX2	17	Data/FSK 4W TXA
18		RXB	18	/Ext Key	18	Data/FSK 4W TXB
19		/TX2	19	AGC	19	Data/FSK 4W RXA
20	/TX•PRESEL BYP		20	(Key pin)	20	Data/FSK 4W RXB
21	10kHz "8"		21	+5 VDC Out	21	Std 4W RXB
22	100kHz "8"		22	/Scan Det (out)	22	Std 4W RXA
23	10kHz "4"		23	/Scan Stop (in)	23	Std 4W TXB
24	100kHz "4"		24	-Spare-	24	Std 4W TXA
25	10kHz "2"		25	-Spare-	25	/Scan Stop

**Table 5.10 TRANSCEIVER REAR PANEL CONNECTORS (Cont.)**  
**(See Table 2.2)**

**J38 ACCESSORY CONNECTOR**

PIN	FUNCTION
A	External PRfl
B	/Band 2
C	/Channel "2"
D	External ALC
E	/Medium Power
F	/TX2
G	/Key Interlock
H	/Silent Tune
J	/Band 8
K	/Cplr Bypass
L	External ACC Gnd
M	/Band 3
N	/Channel "1"
P	/Cplr FAULT
R	/TUNING
S	Ground
T	+26 VDC
V	/TUNE
W	/Band 6
X	/LPA On
Y	/Band 1
Z	/Channel "40"
G-G	Ground
a	/Cplr Enable
b	/Key Enable
c	/Channel "8"
d	/Surveill Tune
e	/Band 7
f	External ACC
g	/READY
h	/Band 4
i	/Band 5
j	Refl Power
k	
m	Ground
n	+26 VDC
p	/Channel "20"
r	ALC Gnd
u	/Channel "80"
v	/Channel "10"
w	
x	Spare
y	/Channel "4"
z	Ground
A-A	+26 VDC
B-B	+26 VDC



(602014-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600302-314-001	CAP .001UF, MYLAR, 63V	C1,2
600261-230-001	TERMINAL	E1-3
600477-606-005	CONN	J38
600866-540-008	RIBBON CABLE	J61
600866-540-009	RIBBON CABLE	J62
600380-314-002	CAP SIP .1UF X 9	Z1-4

Figure 5.25 ACCESSORY CONNECTOR BOARD ASSEMBLY

### 5.9.2.5 125 Watt Power Amplifier, 1A2A2

The solid-state Power Amplifier assembly (P/N 600407-705-001) consists of a PC board mounted to a heatsink. Heat-dissipating elements are electrically connected to the board yet mechanically mounted to the heatsink for thermal conduction. The assembly may be removed from the rear panel (along with the co-mounted fan assembly) with four screws. Electrical disconnect is via three coax connectors (SMB), a multiwire connector and two quick-disconnect wires.

The solid state power amplifier accepts the +13 dBm RF drive input from the High Pass Filter assembly and provides a nominal 38 dB gain to produce 125 watts output to the antenna (through the low pass filters) in the transmit mode. Also contained on this board are circuits that sense PA overvoltage, overcurrent, and overtemperature. These voltages are fed to the Half Octave Filter board which, via feedback to the Transmit Modulator board, controls overall transmitter gain and power output. Contained also in this module is a +13.2 VDC regulator that supplies regulated +13 VDC to the radio.

#### 5.2.9.5.1 Description

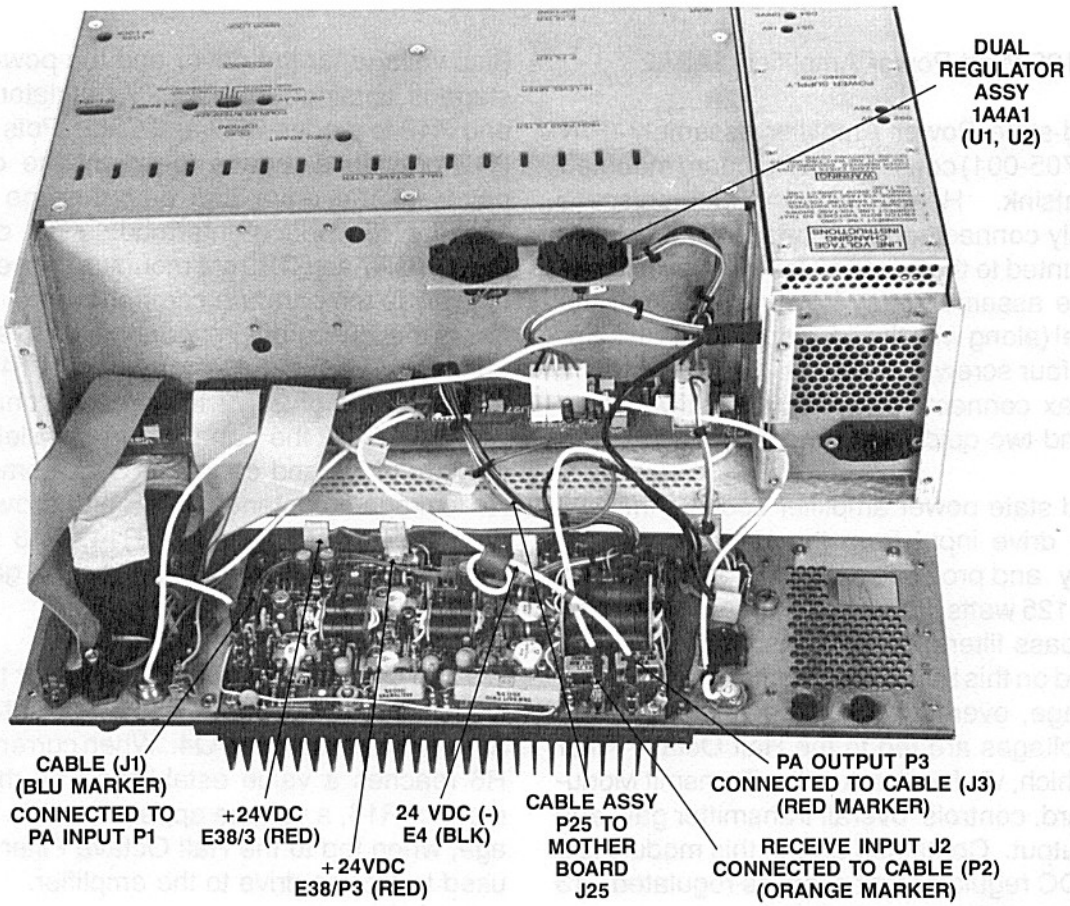
The RF signal is fed into P1. R49, R50 and R51 form a 2 dB 50 ohm attenuator. Therefore, input signals are reduced in amplitude before reaching the first amplifier stage. T1, Q5, and T2 serve as a +15 dB power amplifier. Two signals of equal amplitude and phase are taken from T2 to drive a push-pull power amplifier pair, Q6 and Q7. Bias voltage for Q5 is established by the voltage drop across R37 and diode CR3. Output from Q6 and Q7 (the second stage) is taken from T3 to drive the final push-pull output stage, Q8 and Q9, to the 125 watt output level.

Bias voltage for the driver and the power output stage is obtained from 13.2V regulator via R45 and R46 to diodes CR7 and CR9. Pots R44 and R47 provide a means to adjust the operating points of the drive and output stage for best linearity to reduce intermodulation distortion. Diodes CR7 and CR9 are mounted on the heatsink to provide temperature compensation. T4 transforms the low output impedance of Q8 and Q9 to 50 ohms. The secondary winding of T4 contains two windings of 2 1/2 turns each connected in parallel. C49, the capacitor in parallel with the primary of T4 and capacitor C28, compensates for leakage inductance in T4, and provides high frequency compensation. R14, R13 and C33 provide feedback for Q5 and reduce gain at the low frequency end.

Q3 and Q4 form a differential amplifier to provide DC overcurrent protection. The voltage drop across R6 is applied to Q4. When current through R6 reaches a value established by the adjustment of R16, a voltage appears at E5. This voltage, when fed to the Half Octave Filter board, is used to reduce drive to the amplifier.

Q1 and Q2 comprise a 13.2 volt regulator. The output voltage is set by the adjustment of R2. The output current of the voltage regulator is limited to approximately 2.0 amps. When the voltage across R53 begins to exceed 1.4 volts, diodes CR4, CR5 and CR6 begin to conduct, thereby limiting drive to Q2 and thus limiting the 13.2 volts output current.

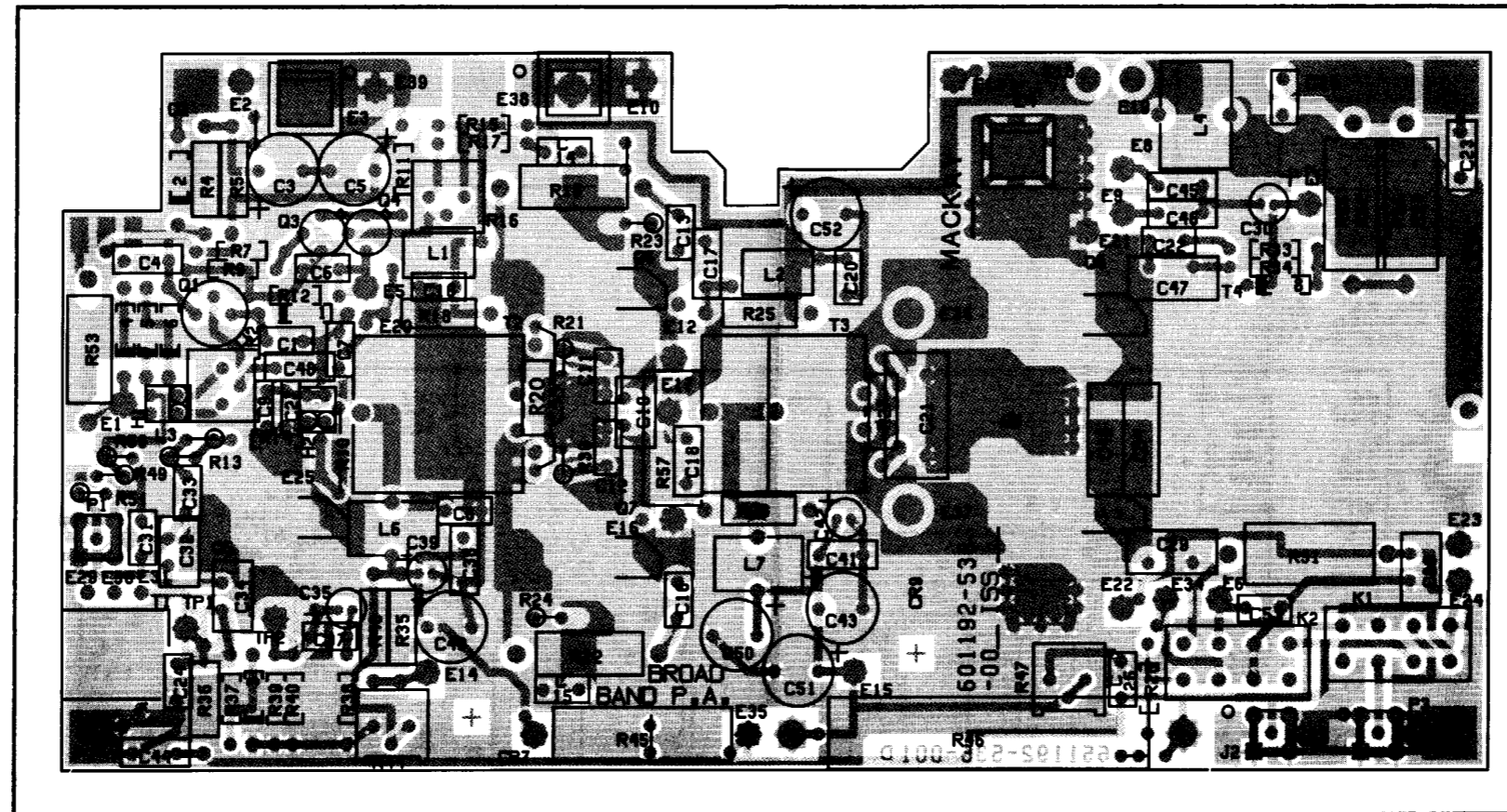
CR8, C30, R33 and R34 are the overvoltage detectors. Any voltage change on the collector of Q9 is fed to the exciter and when excessive, drive to the amplifier is reduced.



(600407-705-001)

PART NUMBER	DESCRIPTION	SYMBOL
600132-233-004	COMPONENT CLIP	
600389-707-001	CABLE ASSY	
601192-536-001	125W LPA PBA	
600170-419-004	THERMAL INSULATOR	
600017-416-001	DIODE MR1121	
600365-713-001	THERMISTER ASSY	
600219-413-001	TRANSISTOR MJE1102	Q2
600273-413-001	TRANSISTOR BLV20	Q5, 6, 7
641320-542-009	TRANSISTOR SD1407-MATCHED	Q8, 9
610004-341-425	RES 100 2W	R58, 59
600009-340-049	RES .05, 10W, 3 $\frac{1}{2}$ , HEATSINK	R6
635107-507-001	TRANSFORMER OUTPUT	T4

Figure 5.26 125 WATT LPA ASSEMBLY



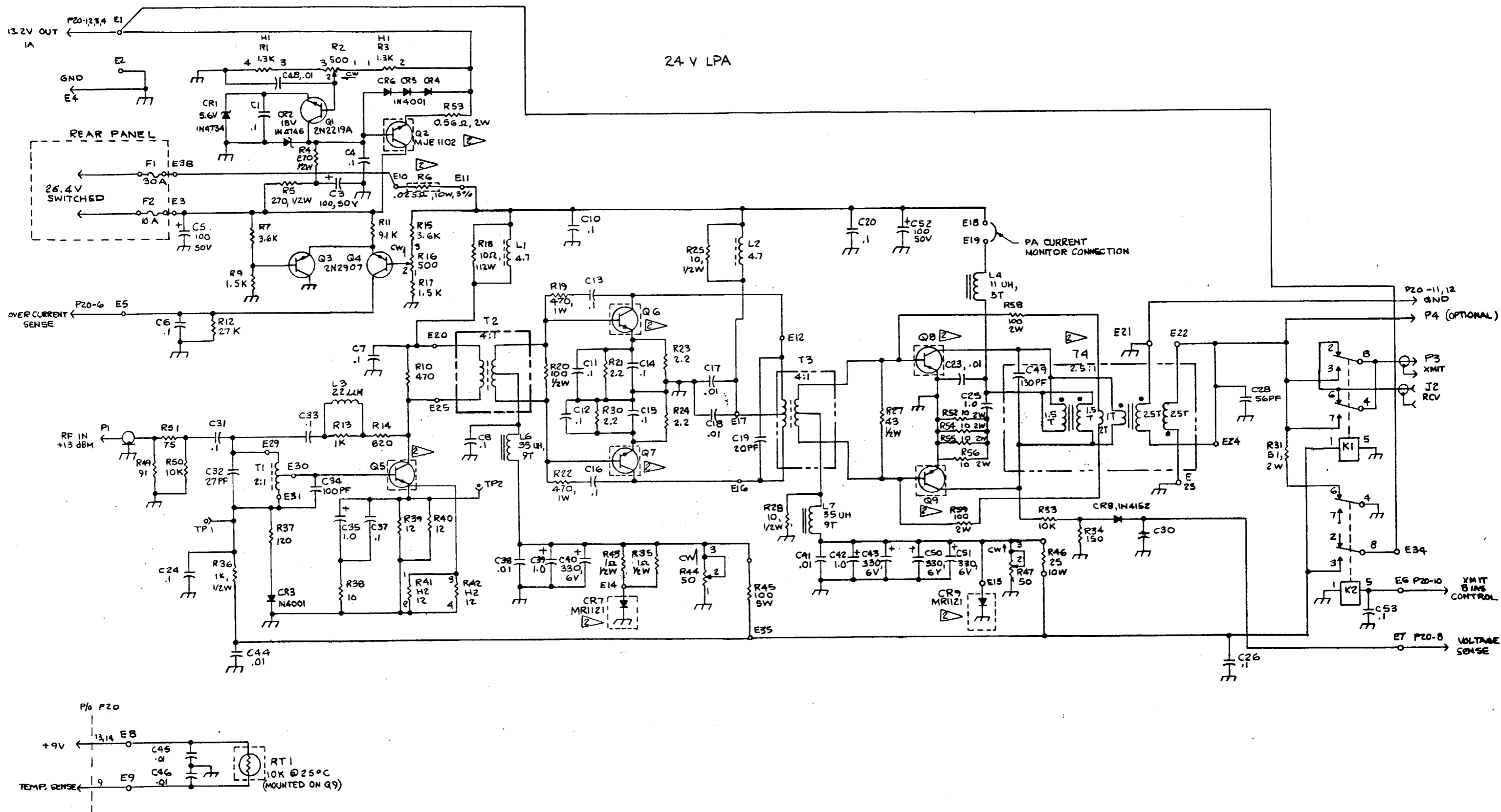
(601192-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600176-608-001	CONN. JUMPER STRAP	
600025-419-001	TRANSISTOR PAD	
600226-314-008	CAP. .1UF, CER, 50V	C1,7,8, 10-16,20 4,24,26, 53,31,33 37,6,30
620093-306-501	CAP. 20PF,3%,MICA,500V	C19
600226-314-014	CAP. 1UF, CER,50V	C25
600269-314-044	CAP. 680PF, CER,100V	C27
656093-306-501	CAP 56PF,3%,MICA,500V	C28
600297-314-033	CAP 100UF 50V	C3,5,52
627093-306-501	CAP 27PF,3%,MICA,500V	C32
610003-306-501	CAP 100PF,3%,MICA,500V	C34
600297-314-003	CAP. 1UF, ALUM, 50V	C39,42,35
600202-314-052	CAP. 330UF, 6V, TANT.	C40,43, 50,51
600189-314-015	CAP. .01UF, CER,100V	C44,45,46
600189-314-015	CAP. .01UF, CER,100V	48,17,18, 23,38,41
600006-411-007	DIODE IN4734A 5.6V	CR1
600006-411-019	DIODE IN4746A 18V	CR2
600011-416-005	DIODE IN4001	CR3,4,5,6
600108-410-001	DIODE IN4152	CR8
600252-230-002	QUICK CONN. TAB	E3,4,38
600064-419-004	2 POS. VERTICAL MT	H1,2
600385-606-001	CONN. FEMALE MIN. RF, PC MOUNT	J2
600028-402-006	12VDC RELAY	K1,2
600091-376-001	CHOKE 4.7UH	L1,2
600125-376-009	CHOKE 22UH	L3
600145-513-001	11UH TOROID COIL	L4
600146-513-001	35UH TOROID COIL	L6,7
600198-606-002	CONN. MALE MIN. RF, PC MOUNT	P3,P1

PART NUMBER	DESCRIPTION	SYMBOL
600082-413-001	TRANSISTOR 2N2219A	Q1
600154-413-001	TRANSISTOR 2N2907A	Q3,4
613014-341-075	RES. 1.3K, 1/4W, 5%	R1,3
647004-341-075	RES. 470, 1/4W, 5%	R10
691014-341-075	RES. 9.1K, 1/4W, 5%	R11
627024-341-075	RES. 27K, 1/4W, 5%	R12
610014-341-075	RES. 1K, 1/4W, 5%	R13
662004-341-075	RES. 620, 1/4W, 5%	R14
610094-341-205	RES 10 1/2W 5%	R18,25,28
647004-341-325	RES. 470, 1W, 5%	R19,22
600072-360-006	POT. 500, 1/2W, CERMET, TOP	R2,16
610004-341-205	RES. 100, 1/2W, 5%	R20
622084-341-075	RES. 2.2, 1/4W, 5%	R21,23, 24,30
643094-341-205	RES. 43, 1/2W, 5%	R27
651094-341-425	RES. 51, 2W, 5%	R31
610024-341-075	RES. 10K, 1/4W, 5%	R33,50
615004-341-075	RES. 150, 1/4W, 5%	R34
610084-341-205	RES. 1, 1/2W, 5%	R35,43
610014-341-205	RES 1K 1/2W 5%	R36
612004-341-075	RES. 120, 1/4W, 5%	R37
610094-341-075	RES. 10, 1/4W, 5%	R38
612094-341-075	RES. 12, 1/4W, 5%	R39-42
627004-341-205	RES 270 1/2W 5%	R4,5
600072-360-003	POT. 50, 1/2W, CERMET, TOP	R44,47
600096-340-101	RES. 100, 5W, 5%	R45
600097-340-250	RES. 25, 10W, 5%	R46
691094-341-075	RES. 91, 1/4W, 5%	R49
675094-341-075	RES. 75, 1/4W, 5%	R51
610094-341-425	RES 10 2W 5%	R52,54, 55,56
600057-340-005	RES .56, 2W, 10%	R53
636014-341-075	RES. 3.6K, 1/4W, 5%	R7,15
615014-341-075	RES. 1.5K, 1/4W, 5%	R9,17
635105-507-001	TRANS,BROADBAND INPUT	T1
635106-507-001	TRANS,DRIVER,125W PA	T2
635106-507-002	TRANS,DRIVER,125W PA	T3
600092-613-001	RELAY SOCKET	XX1,XX2

Figure 5.27

24V PA PC BOARD ASSEMBLY



NOTES:  
 1. UNLESS OTHERWISE SPECIFIED; ALL RESISTORS ARE IN OHMS, AND ARE 1% ± 5%; ALL CAPACITORS ARE IN MICROFARADS; ALL CHOKES ARE IN MICRohenRIES.  
 2. MOUNTED ON HEATSINK.

Figure 5.28  
 24V PA SCHEMATIC

### 5.9.3 POWER AMPLIFIER FAN

See Figure 5.29 for the schematic of the PA Fan.

The PA Fan is installed over the PA heatsink on the Rear Panel assembly and aids in cooling the heatsink during long periods of transmitter operation. The fan is set to operate whenever power is applied to the transceiver.

(700023-700-001)

PART NUMBER	DESCRIPTION	SYMBOL
600079-236-001	SNUB BUSHING	
600027-387-003	FINGER GUARD MOD	
603186-602-001	HOUSING	
700100-387-001	FAN, 24 VDC	B1
600377-606-001	CONN. CIRC, 5 PIN (BLOWER)	P1

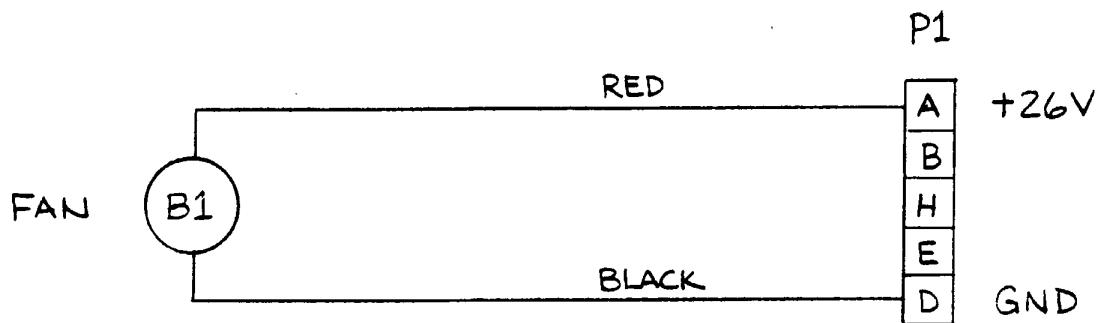


Figure 5.29 PA FAN ASSEMBLY/SCHEMATIC

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#### 5.9.4 FREQUENCY SYNTHESIZER

See Figure 4.4 for the Synthesizer block diagram.

The Frequency Synthesizer consists of four subassemblies: Reference board 1A8, Minor Loop board 1A9, Translator Loop board 1A10, and Major Loop board 1A11. The synthesizer generates the three local oscillator (LO) signals that determine the operating frequency of the transceiver. These signals are obtained from the 5 MHz frequency standard directly and by a combination of direct synthesis and digital phase lock techniques. Frequency accuracy is dependent only upon the accuracy of the frequency standard located on the Reference board.

##### 5.9.4.1 Reference Board, 1A8

See Figure 5.31 for the schematic of the Reference board.

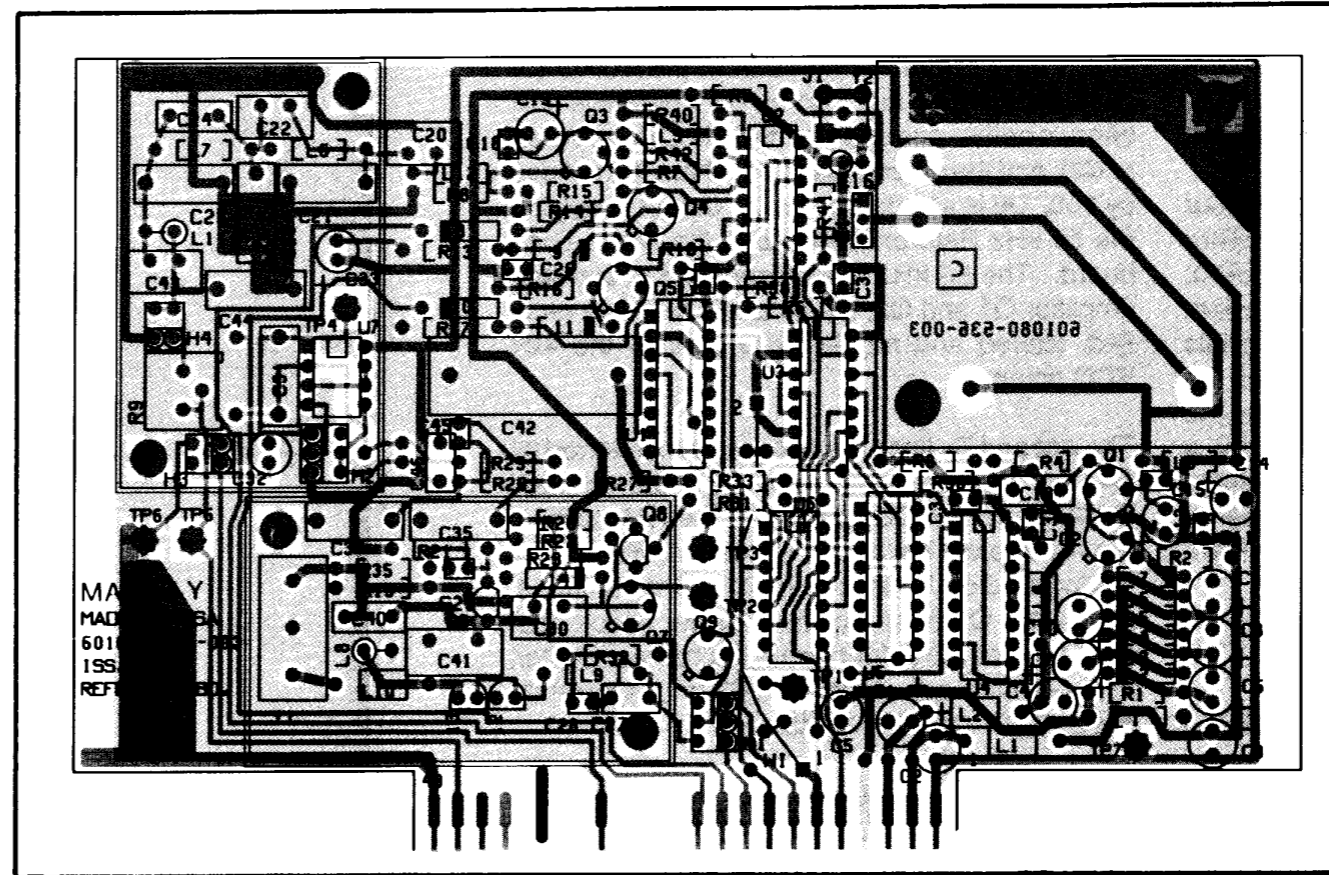
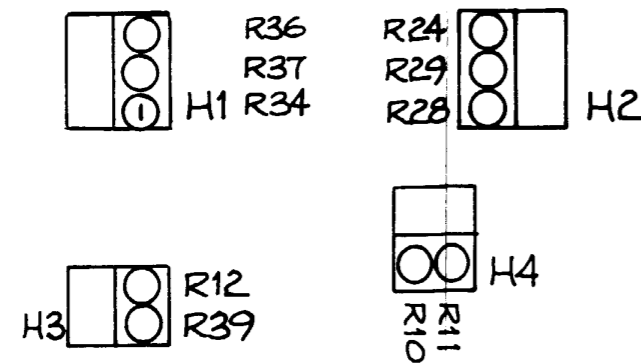
The Reference board contains a 5 MHz TCXO and associated counters/dividers. An input is provided for connecting the optional High Stability Ovenized Frequency Standard instead of the TCXO. The third LO (5 MHz) is supplied by this board to the Transmit Modulator board 1A16 to be used as a carrier generator in Transmit mode. A 1 kHz signal is supplied by this board to the Minor Loop board for a phase detector reference. Also included on the board are a +24 VDC regulated power source and a 50 kHz square wave reference signal, both of which are applied to the Major Loop board.

The 5 MHz reference signal from the TCXO (or oven standard) is buffered by U2 where it is split into two paths: one goes to the 3rd LO switch (part of U2), and the other goes to U1 where it is divided by 100. U6 is a buffer for the U1 output supplying the 50 kHz Reference signal to the Major Loop board. The 50 kHz is also supplied to a power amplifier Q1 and Q2, the output of which is rectified, filtered and regulated to provide the +24 VDC source.

The AM and Rx lines are buffered and inverted by Q4, Q5 and associated circuitry, and are routed by U2. If the MODE switch is in the AM position, the AM line will be low, so U2 output will be high, driving pin 3 of U2 high to inhibit the 3rd LO output. Transistor Q3 is an emitter follower which supplies the 3rd LO output through a harmonic filter. This output is adjustable with R9 and is normally set to 0 dBm (0.224 VRMS).

The 1 kHz reference signal to the Minor Loop board is supplied by U6, which then drives a three section RC filter, converting the square wave into a sinusoid at R25. The upper section of U7 amplifies the 1 kHz sine wave reference, while the lower section is used to bias the upper amplifier at 1/2 the supply voltage.

The 1 kHz reference signal to the Minor Loop board is supplied by U6, which then drives a three section RC filter, converting the square wave into a sinusoid at R25. The upper section of U7 amplifies the 1 kHz sine wave reference, while the lower section is used to bias the upper amplifier at half the supply voltage.



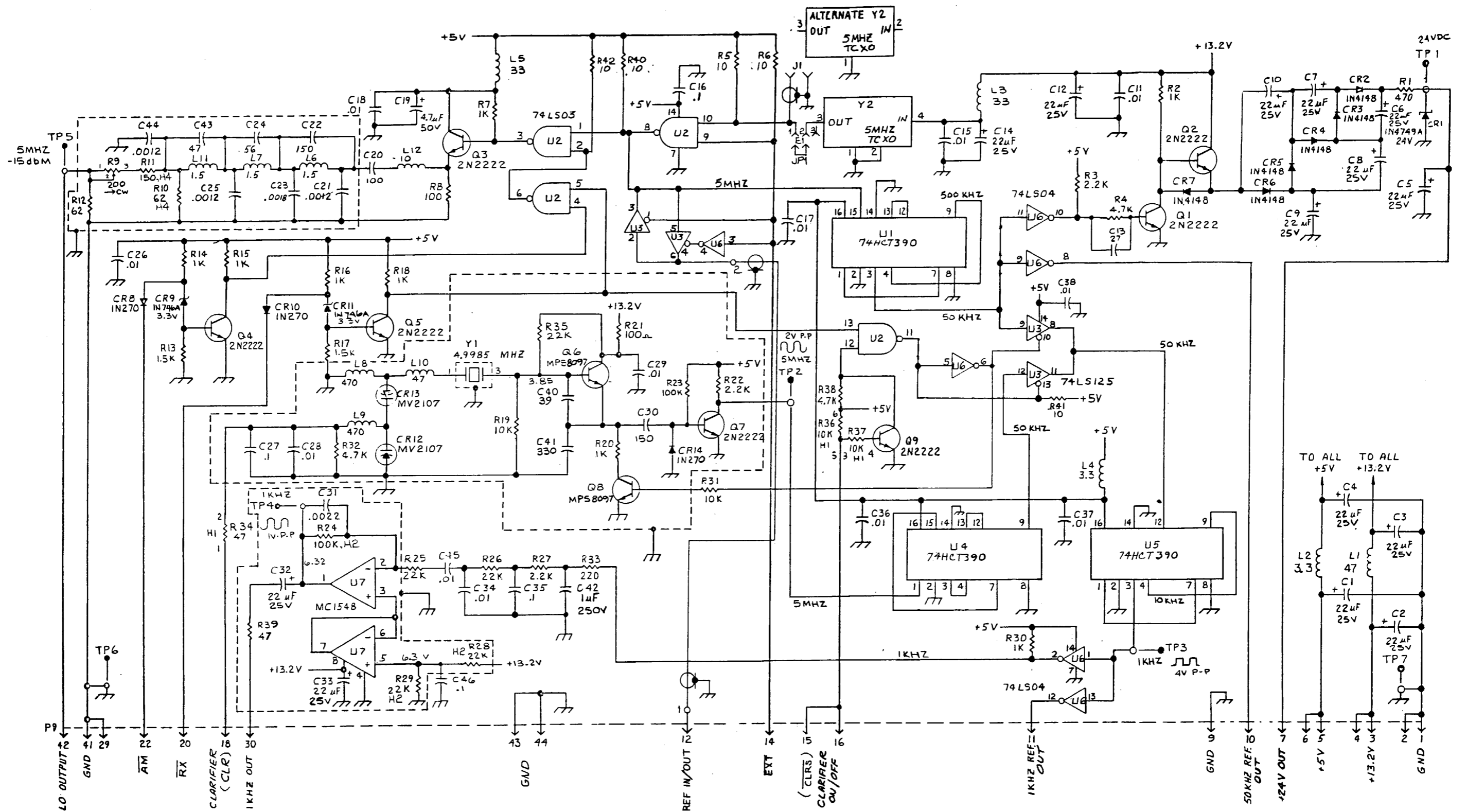
(601080-536-003)

PART NUMBER	DESCRIPTION	SYMBOL
600672-612-002	FILTER CAN	
600004-638-002	INSULATOR WASHER	
600297-314-016	CAP. 22UF, ALUM, 25V	C1-10,12 14,32,33
600268-314-008	CAP. .01UF, CERAMIC, 50V	C11,15-18 26,28
600269-314-016	CAP. 27PF, CERAMIC, 500V	C13
600297-314-010	CAP. 4.7UF, ALUM, 50V	C19
610003-306-501	CAP 100PF, 3%, MICA, 500V	C20
600204-314-039	CAP .0012UF, MYLAR, 630V	C21,25,44
615003-306-501	CAP 150PF, 3%, MICA, 500V	C22,30
600204-314-041	CAP .0018UF, MYLAR, 630V	C23
600269-314-024	CAP. 56PF, CERAMIC, 100V	C24
600226-314-008	CAP. .1UF, CERAMIC, 50V	C27,46
600204-314-029	CAP .0022UF, MYLAR, 1KV	C31
600204-314-001	CAP. .01UF, MYLAR, 400V	C34
600204-314-020	CAP. 0.1UF, MYLAR, 100V	C35
600269-314-020	CAP. 39PF, CERAMIC, 100V	C40
633003-306-501	CAP 330PF, 3%, MICA, 500V	C41
600204-314-008	CAP. 1UF, MYLAR, 250V	C42
647093-306-501	CAP. 47PF, 3%, MICA, 500V	C43
600006-411-052	DIODE IN4749A 24V	CR1
600123-410-004	DIODE, VARACTOR, MV2107	CR12,13
600109-410-001	DIODE IN4148	CR2-7,15
600052-410-001	DIODE IN270	CR8,10,14
600002-411-001	DIODE, ZENER, 1N746A	CR9,11
600198-608-002	CONN. HEADER, 3 PIN, GOLD	E1
600064-419-003	3 POS VERTICAL MT.	H1,2
600064-419-004	2 POS VERTICAL MT.	H3,4
600198-606-002	CONN. MALE MIN. RF, PC MOUNT	J1
600190-608-001	CONN, JUMPER, 2 POS.	JP1
600125-376-008	CHOKE 47UH	L1
600072-376-033	CHOKE 47UH	L10

PART NUMBER	DESCRIPTION	SYMBOL
600125-376-032	CHOKE 10UH	L12
600125-376-007	CHOKE 33UH	L3,5
600125-376-006	CHOKE 3.3UH	L4,2
600125-376-033	CHOKE 1.5 UH	L6,7,11
600125-376-015	CHOKE 470UH	L8,9
600080-413-001	TRANSISTOR 2N2222A	Q1-5,7,9
600025-419-001	TRANSISTOR PAD	(Q1-9)
600278-413-001	TRANSISTOR MPS8097	Q6,8
647004-341-075	RES. 470, 1/4W, 5%	R1
662094-341-075	RES. 62, 1/4W, 5%	R10,12
615004-341-075	RES. 150, 1/4W, 5%	R11
615014-341-075	RES. 1.5K, 1/4W, 5%	R13,17
610014-341-075	RES. 1K, 1/4W, 5%	R2,7,20, 14-16,18 30
610034-341-075	RES. 100K, 1/4W, 5%	R23,24
622024-341-075	RES. 22K, 1/4W, 5%	R25,26,28 29,35
622014-341-075	RES. 2.2K, 1/4W, 5%	R3,22,27
622004-341-075	RES. 220, 1/4W, 5%	R33
647094-341-075	RES. 47, 1/4W, 5%	R34,39
647014-341-075	RES. 4.7K, 1/4W, 5%	R4,32,38
610024-341-075	RES. 10K, 1/4W, 5%	R40-42
610024-341-075	RES. 10K, 1/4W, 5%	R5,6,19, 31,36,37
610004-341-075	RES. 100, 1/4W, 5%	R8,21
600072-360-005	POT 200, 1/2W, CERMET, TOP	R9
600261-230-001	TERMINAL	TP1-7
702023-415-001	IC, 74HCT390	U1,4,5
600239-415-001	IC 74LS03, NAND, O/C, 2-IN	U2
600274-415-001	IC 74LS125, BUFFER 3-ST	U3
600111-415-001	IC 74LS04, HEX INV	U6
600039-415-002	IC SN72558P	U7
600123-378-002	CRYSTAL, 4.99850 MHZ	Y1
600167-378-001	TCXO, 5MHZ	Y2

Figure 5.30

REFERENCE BOARD ASSEMBLY



GRP-003

**NOTES:**  
 1. UNLESS OTHERWISE NOTED.  
 RESISTORS ARE IN OHMS, 1/4W, ±5%; CAPACITOR VALUES ONE OR GREATER ARE IN PICOFARADS (pF), VALUES LESS THAN ONE ARE IN MICROFARADS (μF); INDUCTORS ARE IN MICROHENKYS (μH).

Figure 5.31  
 REFERENCE BOARD SCHEMATIC

REFERENCE BOARD, 1A8

PIN CONNECTIONS AND VOLTAGE READINGS

1A8-P15

GND	1	2	GND
+1.3VDC	3	4	+1.3VDC
+5VDC	5	6	+5VDC
+24V (+2V)	7	8	
GND	9	10	50 KHZ REF
(NC) 1KHZ REF	11	12	REF IN/OUT
	13	14	EXT
(NC) $\overline{\text{CLRS}}$	15	16	$\overline{\text{CLRS}}$ (NC)
	17	18	CLR (NC)
	19	20	$\overline{\text{RX}}$
	21	22	$\overline{\text{AM}}$ LOGIC "1" OR "0"
	23	24	
	25	26	
	27	28	
GND	29	30	1 KHZ OUT
	31	32	
	33	34	
	35	36	
	37	38	
	39	40	
GND	41	42	5 MHZ - 15DBM (3RD LO)
GND	43	44	GND

#### 5.9.4.2 Minor Loop Board, 1A9

See Figure 5.33 for the schematic of the Minor Loop board.

The Minor Loop board generates the small (10 Hz) steps in the synthesizer. Its output, a 1.00000 to 1.09999 MHz signal, is the reference for the Translator loop.

The Voltage Controlled Oscillator (VCO), Q5, is a Colpitts design whose frequency (100.000 to 100.999 MHz) is determined by the DC voltage at varactor CR1. The VCO drives two isolated buffers, Q6 and Q7. Q6 drives a divide-by-10 prescaler U12 which drives a divide-by-10 counter U13. This is then filtered and amplified by Q8 before being sent to the Translator Loop board. Q7 drives prescaler U11 which drives the programmable divider string, U1 through U6.

In the programmable divider string, U3 through U6 are cascaded parallel-loaded Up/Down counters which are permanently connected to count down. Counter U6 is the most significant digit while U1 is the least significant.

U7 is an array of open-collector inverters which have their outputs connected together to form a NOR gate. The inputs of this device are connected so that the output goes high when the counter (U6-U3) contains the number 002. Let's assume the counter has been loaded with the number 1240. The counters begin counting down and because on U2 the D input (pin 2) is low, pin 5 (Q) stays low and pin 6 (/Q) stays high. After 10,000 counts, U6 underflows and U1 pin 7 goes low.

After another 100 pulses, U5 underflows and U7 pin 3 goes low. After another 20 pulses, U4 underflows and U7 pin 5 goes low. After another

two pulses, pins 9, 11 and 13 of U7 are low, so the "output" of number 0020 and the D input of U2 go high again reloading U1, U3, U5 and U6 with the divide number. The next pulse (000) toggles pin 6 high and pin 5 low so the cycle can repeat. U1 controls the least significant number, and when it overflows, sets U2 pin 9 which resets preselector U2 to divide by 10 or 11.

The programmable divider output is fed to the phase/frequency detector U9, where it is compared to the 1 kHz reference frequency. If the divider output is too low in frequency, the phase detector output dc level decreases, causing the VCO control line voltage to rise, raising the VCO frequency to correct the error.

The Loop amplifier, Q2 and Q3, forms an active loop filter with its feedback components, which determines the overall loop stability. Q4 forms an active low pass filter with a sharp cut-off frequency and steep roll-off to attenuate the reference sidebands. An RC Twin-T notch filter further attenuates the first-order sidebands.

The loss-of-lock circuitry operates in the following manner: phase detector output pins 11 and 4 are normally a logic high with nearly 100% duty cycle in a properly locked loop. This drives the base and emitter of Q1 high, driving U8 pin 2 low. Pins 12 and 4 of U8 are high so the Loss-of-lock LED is off. When the loop loses lock, the duty cycle drops at either pin 11 or 4 of U9. This discharges C35 faster than it can be recharged, so the base of Q1 drops, causing U8 pin 2 to go high. This turns on the LED and drives the "LL" line low.

An on-card 8 VDC regulator, U10, supplies the linear circuits with a clean source voltage.

Table 5.11 lists the Minor Loop output frequency and divider input frequency information.

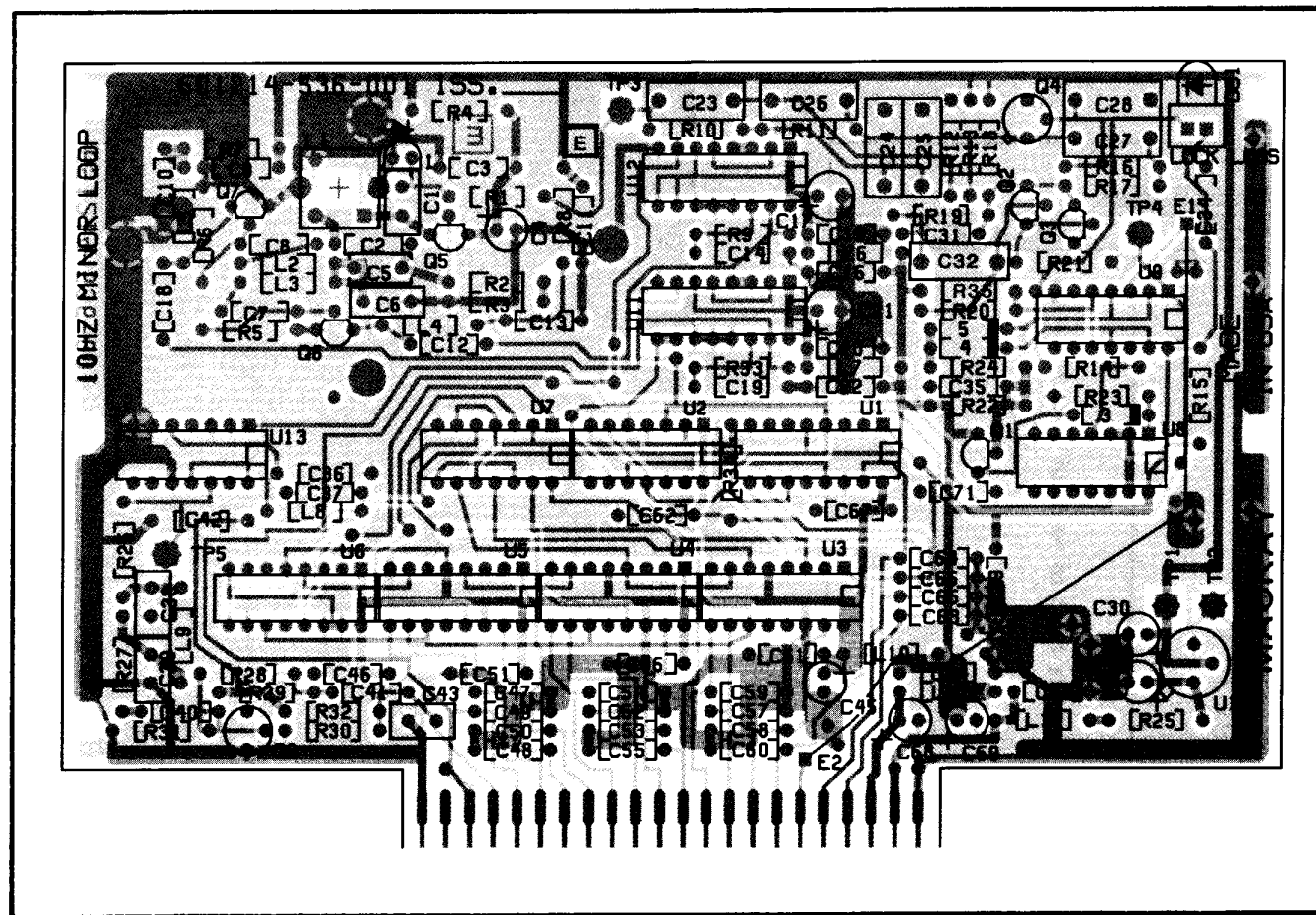
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**Table 5.11 MINOR LOOP FREQUENCY INFORMATION**

LAST 4 DIGITS OF RX OR TX FREQ - MHZ	VCO FREQ MHZ	PROGRAM NUMBER		
		10 KHZ	1 KHZ	100 KHZ
0000	1.0000	0	0	0
0001	1.0001	0	0	1
0002	1.0002	0	0	2
0003	1.0003	0	0	3
0004	1.0004	0	0	4
0005	1.0005	0	0	5
0006	1.0006	0	0	6
0007	1.0007	0	0	7
0008	1.0008	0	0	8
0009	1.0009	0	0	9
0010	1.0010	0	1	0
0020	1.0020	0	2	0
0030	1.0030	0	3	0
0040	1.0040	0	4	0
0050	1.0050	0	5	0
0060	1.0060	0	6	0
0070	1.0070	0	7	0
0080	1.0080	0	8	0
0090	1.0090	0	9	0
0100	1.0100	1	0	0
0200	1.0200	2	0	0
0300	1.0300	3	0	0
0400	1.0400	4	0	0
0500	1.0500	5	0	0
0600	1.0600	6	0	0
0700	1.0700	7	0	0
0800	1.0800	8	0	0
0900	1.0900	9	0	0

**MINOR LOOP LOCK-IN VOLTAGES**

LAST 4 DIGITS OF FREQUENCY	ADJUST	DC VOLTS AT TP3
0000	L1	2.2 ± 0.02 VDC
9999		5.5 - 6.5 VDC



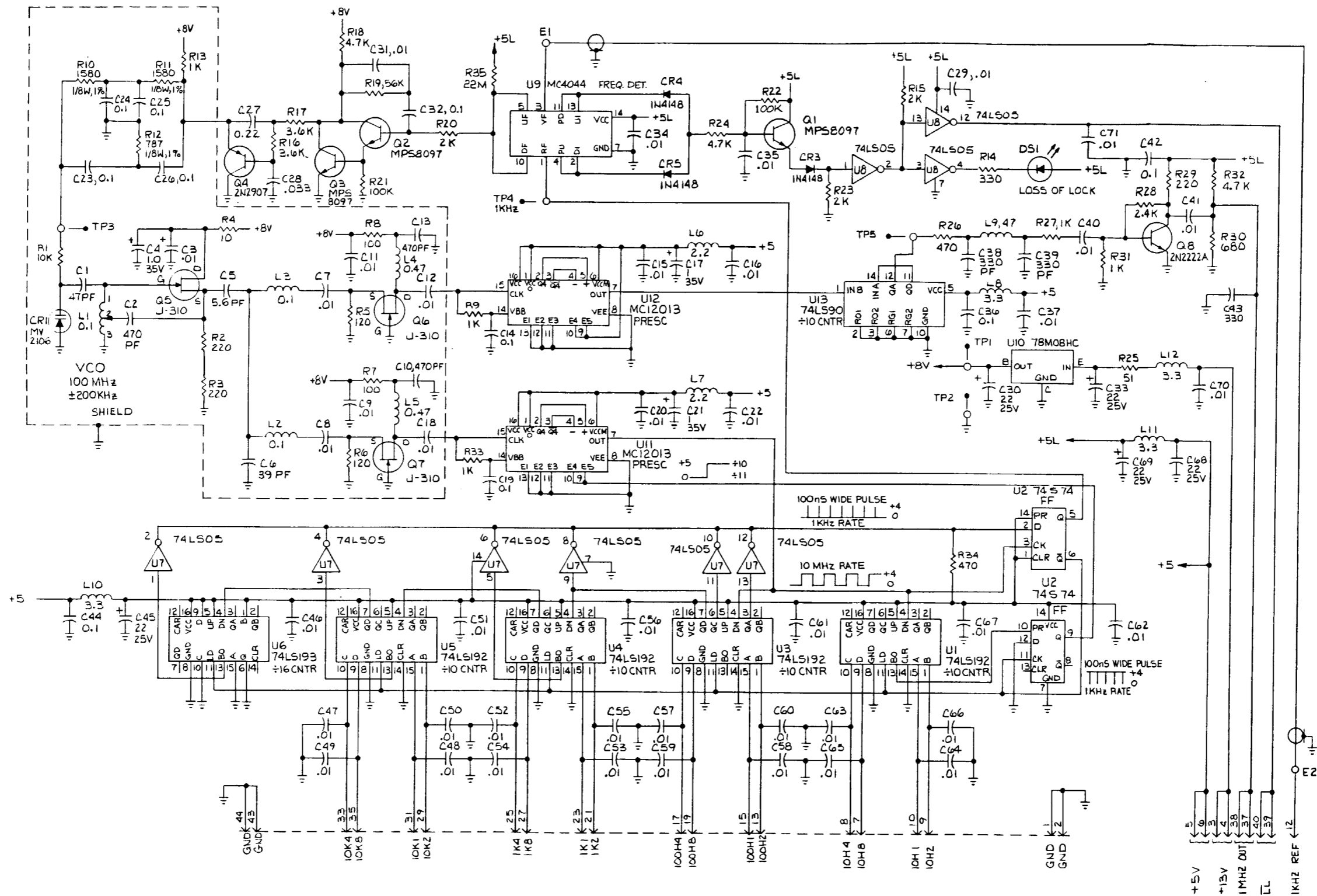
(601214-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600037-643-001	RUBBER BUMPER	(USED ON SHIELD)
600184-708-001	CAN SHIELD	
600291-604-901	LED MOUNT	(DS1)
600005-635-001	TRANSISTOR PAD	(Q4, 8)
600025-419-001	TRANSISTOR PAD	(U10)
647093-306-501	CAP 47PF, 3%, MICA, 500V	C1
600272-314-001	CAP. .1UF, CERAMIC, 50V	C14, 19, 36, 42
600306-314-007	CAP. 1UF, 35V, TANT	C17, 21, 4
600272-314-003	CAP .01UF, CERAMIC, 50V	C18, 20, 22, 29, 31, 34, 3, 7-9, 11, 12, 15, 16, 35, 37, 40, 71, 41-44, 46-67, 70
600272-314-005	CAP. 470PF, CERAMIC, 50V	C2, 10, 13
600204-314-020	CAP. 0.1UF, MYLAR, 100V	C23-26, 32
600204-314-019	CAP. .22UF, MYLAR, 100V	C27
600204-314-012	CAP. .033UF, MYLAR, 250V	C28
600297-314-016	CAP. 22UF, ALUM, 25V	C30, 33, 68, 69, 45
633004-306-501	CAP. 330PF, 5%, MICA, 500V	C38, 39, 43
600269-314-006	CAP 5.6PF, CERAMIC, 500V	C5
600269-314-020	CAP 39PF, CERAMIC, 100V	C6
600123-410-003	DIODE, VARACTOR, MV2106	CR1
600109-410-001	DIODE IN4148	CR3, 4, 5
600036-390-001	LED, RED	DS1
600173-376-001	COIL, VAR, .1UH	L1
600125-376-028	CHOKE .1UH	L2, 3
600125-376-027	CHOKE .47UH	L4, 5
600125-376-016	CHOKE 2.2UH	L6, 7
600125-376-008	CHOKE 47UH	L9

PART NUMBER	DESCRIPTION	SYMBOL
600125-376-006	CHOKE 3.3UH	L8, 10-12
600278-413-001	TRANSISTOR MPS8097	Q1, 2, 3
600154-413-001	TRANSISTOR 2N2907A	Q4
600259-413-001	TRANSISTOR J310	Q5, 6, 7
600080-413-001	TRANSISTOR 2N2222A	Q8
610024-341-075	RES. 10K, 1/4W, 5%	R1
615811-342-059	RES. 1580, 1/8W, 1%	R10, 11
678701-342-059	RES. 787, 1/8W, 1%	R12
610014-341-075	RES. 1K, 1/4W, 5%	R13, 27, 31, 9, 33
633004-341-075	RES. 330, 1/4W, 5%	R14
620014-341-075	RES. 2K, 1/4W, 5%	R15, 20, 23
636014-341-075	RES. 3.6K, 1/4W, 5%	R16, 17
647014-341-075	RES. 4.7K, 1/4W, 5%	R18, 24, 32
656024-341-075	RES. 56K, 1/4W, 5%	R19
622004-341-075	RES. 220, 1/4W, 5%	R2, 3, 29
610034-341-075	RES. 100K, 1/4W, 5%	R22, 21
651094-341-075	RES. 51, 1/4W, 5%	R25
647004-341-075	RES. 470, 1/4W, 5%	R26, 34
624014-341-075	RES. 2.4K, 1/4W, 5%	R28
668004-341-075	RES. 680, 1/4W, 5%	R30
622054-341-075	RES. 22M, 1/4W, 5%	R35
610094-341-075	RES. 10, 1/4W, 5%	R4
612004-341-075	RES. 120, 1/4W, 5%	R5, 6
610004-341-075	RES. 100, 1/4W, 5%	R7, 8
600261-230-001	TERMINAL	TP1-5
600225-415-001	IC 74LS192, UP/DN CNTR, SYNC	U1, 3, 4, 5
600526-415-001	IC 78M08, 8V REG	U10
600241-415-001	IC 2013, 2-MOD	U11, 12
600175-415-001	IC 74LS90, DEC CNTR	U13
600157-415-001	IC 74S74, D FLIP-F, DUAL	U2
600122-415-001	IC 74LS193, UP/DN CNTR 4 BIT	U6
600240-415-001	IC 74LS05, HEX INV, O/C	U7, 8
600092-415-001	IC MC4044, PHASE DET.	U9

Figure 5.32

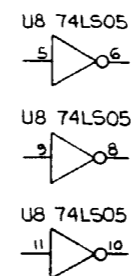
MINOR LOOP BOARD ASSEMBLY



**NOTES**

- UNLESS OTHERWISE SPECIFIED; ALL RESISTORS ARE RATED IN OHMS, 1/4W, 5%; ALL CAPACITORS RATED IN MICROFARADS; ALL INDUCTORS RATED IN MICROHENRIES.

**SPARE GATES**



**Figure 5.33**

**MINOR LOOP BOARD SCHEMATIC**

PIN CONNECTIONS AND VOLTAGE READINGS

		1A9-P13			
GND	○	1	2	○	GND
+13VDC	○	3	4	○	+13VDC
+5VDC	○	5	6	○	+5VDC
10 HZ "8"	○	7	8	○	10 HZ "4"
10 HZ "2"	○	9	10	○	10 HZ "1"
GND	○	11	12	○	1 KHZ REF
100 HZ "2"	○	13	14	○	
100 HZ "1"	○	15	16	○	
100 HZ "4"	○	17	18	○	
100 HZ "8"	○	19	20	○	
1 KHZ "2"	○	21	22	○	
1 KHZ "1"	○	23	24	○	
1 KHZ "4"	○	25	26	○	
1 KHZ "8"	○	27	28	○	
10 KHZ "2"	○	29	30	○	
10 KHZ "1"	○	31	32	○	
10 KHZ "4"	○	33	34	○	
10 KHZ "8"	○	35	36	○	
1-1.1 MHZ RF	○	37	38	○	1-1.1 MHZ REF
LOGIC "0" OR "1" $\overline{1L}$	○	39	40	○	$\overline{1L}$ LOGIC "0" OR "1"
	○	41	42	○	
GND	○	43	44	○	GND

#### 5.9.4.3 Translator Loop Board, 1A10

See Figure 5.35 for the schematic of the Translator Loop board.

The Translator Loop board provides the 54.53 MHz second LO to the Mixer board. The board supplies a 55.53 to 55.62999 MHz signal to the Major Loop board, this being a mixture of the low digit signal (1 to 1.09999 MHz) and the second LO.

The second LO signal is generated by a Colpitts crystal oscillator, Q6 and associated components. The crystal is a parallel resonant type with frequency adjustable via trimmer C61. The crystal is not temperature compensated because both first and second LOs are derived from it, so any crystal frequency drift is cancelled in the frequency generation scheme, leaving the overall frequency stability of the transceiver dependent only upon the stability of the TCXO (or optional ovenized frequency standard). The output amplitude of the crystal oscillator may be adjusted with C64.

The VCO, Q1, is a Colpitts oscillator whose frequency is varied by changing the varactor CR4 control line voltage at TP6. The VCO output is split into two paths: one through cascode amplifier Q2 and Q3, and the other to buffer Q4, which drives mixer M1. The mixer output is amplified by Q8 and Q9, filtered to remove harmonics, and amplified to the 4 VP-P level for the loop input to the phase/frequency detector U1. The phase detector output is connected to a lead-lag active loop filter Q12 and Q13.

Since the outputs of the phase detector are normally high with a nearly 100% duty cycle, the base and emitter of Q14 are also high, driving U2 pin 6 low, keeping the LED off. When the loop loses lock, the duty cycle decreases dropping the base voltage of Q14, causing U2 pin 6 to go high, turning on the LED and driving the LL line low.

U3 is an on-card 8 VDC regulator used to supply the linear circuits.

(601083-536-001)

PART NUMBER	DESCRIPTION	SYMBOL	PART NUMBER	DESCRIPTION	SYMBOL
600145-419-001	HEATSINK		600154-413-001	TRANSISTOR 2N2907A	Q11
600236-604-001	SHIELD		600025-419-001	TRANSISTOR PAD	(Q2-14)
600184-708-001	CAN		600085-413-001	TRANSISTOR 2N918	Q2-7
			600080-413-001	TRANSISTOR 2N2222A	Q8-10, 12-14
600297-314-018	CAP. 22UF, ALUM, 50V	C1-5,49	610094-341-075	RES. 10, 1/4W, 5%	R1,3,21, 25,32,62
600269-314-016	CAP. 27PF,CERAMIC,500V	C10,20, 21,24,25 37-39,41	600000-341-075	RES. 0, 1/4W, 5%	R11,64
			656014-341-075	RES. 5.6K, 1/4W, 5%	R12,24,29
600272-314-003	CAP. .01UF,CERAMIC,50V	C11-13, 18,19,23 26,29,30 35,36,45 48,65	630004-341-075	RES. 300, 1/4W, 5%	R14,16, 33,60
			618094-341-075	RES. 18, 1/4W, 5%	R15,34
600269-314-026	CAP. 68PF,CERAMIC,100V	C14	610024-341-075	RES. 10K, 1/4W, 5%	R17,38,52
600052-317-001	CAP. VAR, 3-10PF	C15,64	675094-341-075	RES. 75, 1/4W, 5%	R18,19
600269-314-022	CAP. 47PF,CERAMIC,100V	C17,27, 34,60,63	647004-341-075	RES. 470, 1/4W, 5%	R2,36
			612004-341-075	RES. 120, 1/4W, 5%	R20
600272-314-005	CAP. 470PF,CERAMIC,50V	C22	622024-341-075	RES. 22K, 1/4W, 5%	R26,27
600269-314-009	CAP. 10PF,CERAMIC,500V	C28,46,62	622004-341-075	RES. 220, 1/4W, 5%	R28
600269-314-027	CAP. 75PF,CERAMIC,100V	C31,32,33	633004-341-075	RES. 330, 1/4W, 5%	R35,47
600272-314-008	CAP. .001UF,CERAMIC,50V	C42	643014-341-075	RES. 4.3K, 1/4W, 5%	R4
600202-314-007	CAP. 1UF, 35V, TANT.	C43	610004-341-075	RES. 100, 1/4W, 5%	R44,46
600272-314-001	CAP. .1UF,CERAMIC, 50V	C44,50-53	656034-341-075	RES. 560K, 1/4W, 5%	R45
600204-314-020	CAP. 0.1UF,MYLAR, 100V	C47	636014-341-075	RES. 3.6K, 1/4W, 5%	R48
600269-314-033	CAP. 130PF,CERAMIC,100V	C54,56	610014-341-075	RES. 1K, 1/4W, 5%	R49
600269-314-035	CAP. 160PF,CERAMIC,100V	C55	615014-341-075	RES. 1.5K, 1/4W, 5%	R5,41, 42,51
600269-314-017	CAP. 30PF,CERAMIC,500V	C6			R53
600018-317-004	CAP. VAR, 9-35PF	C61	620024-341-075	RES. 20K, 1/4W, 5%	R54
600269-314-028	CAP. 82PF,CERAMIC,100V	C7,9	647094-341-075	RES. 47, 1/4W, 5%	R55,56
600269-314-002	CAP. 2.2PF,CERAMIC,500V	C8,16	620004-341-075	RES. 200, 1/4W, 5%	R57,58
			668004-341-075	RES. 680, 1/4W, 5%	R6,23,30 39,43,50 59,63
600123-410-008	DIODE,VARACTOR, MV2109	CR4	620014-341-075	RES. 2K, 1/4W, 5%	R61
600109-410-001	DIODE IN4148	CR6-8			R7,13 22,31
			651094-341-075	RES. 51, 1/4W, 5%	R8,10
600036-390-001	LED, RED	DS1	613004-341-075	RES. 130, 1/4W, 5%	R9
600064-419-003	3 POS VERTICAL MT.	H1	615004-341-075	RES. 150, 1/4W, 5%	
600064-419-004	2 POS VERTICAL MT.	H2	639094-341-075	RES. 39, 1/4W, 5%	
			600261-230-001	TERMINAL	TP1-6
600125-376-006	CHOKE 3.3UH	L1			
600125-376-003	CHOKE .22UH	L13	600092-415-001	IC MC4044, PHASE DET.	U1
600125-376-022	CHOKE 180UH	L15	600240-415-001	IC 74LS05,HEX INV,O/C	U2
600125-376-028	CHOKE .1UH	L2,3	600017-419-001	TRANSISTOR PAD	(U3)
600125-376-027	CHOKE .47UH	L4,5,7,11	600526-415-001	IC 78M08, 8V REG	U3
600173-376-001	COIL, VAR, .1UH	L6			
600125-376-005	CHOKE .56UH	L9,14,16	600005-635-001	LED MOUNT	XDS1
			600163-378-001	CRYSTAL, 54.53 MHZ	Y1
600008-455-001	MIXER SLB-1	M1			
600259-413-001	TRANSISTOR J310	Q1			

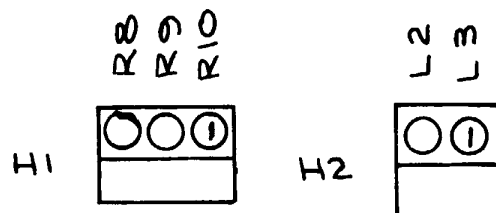
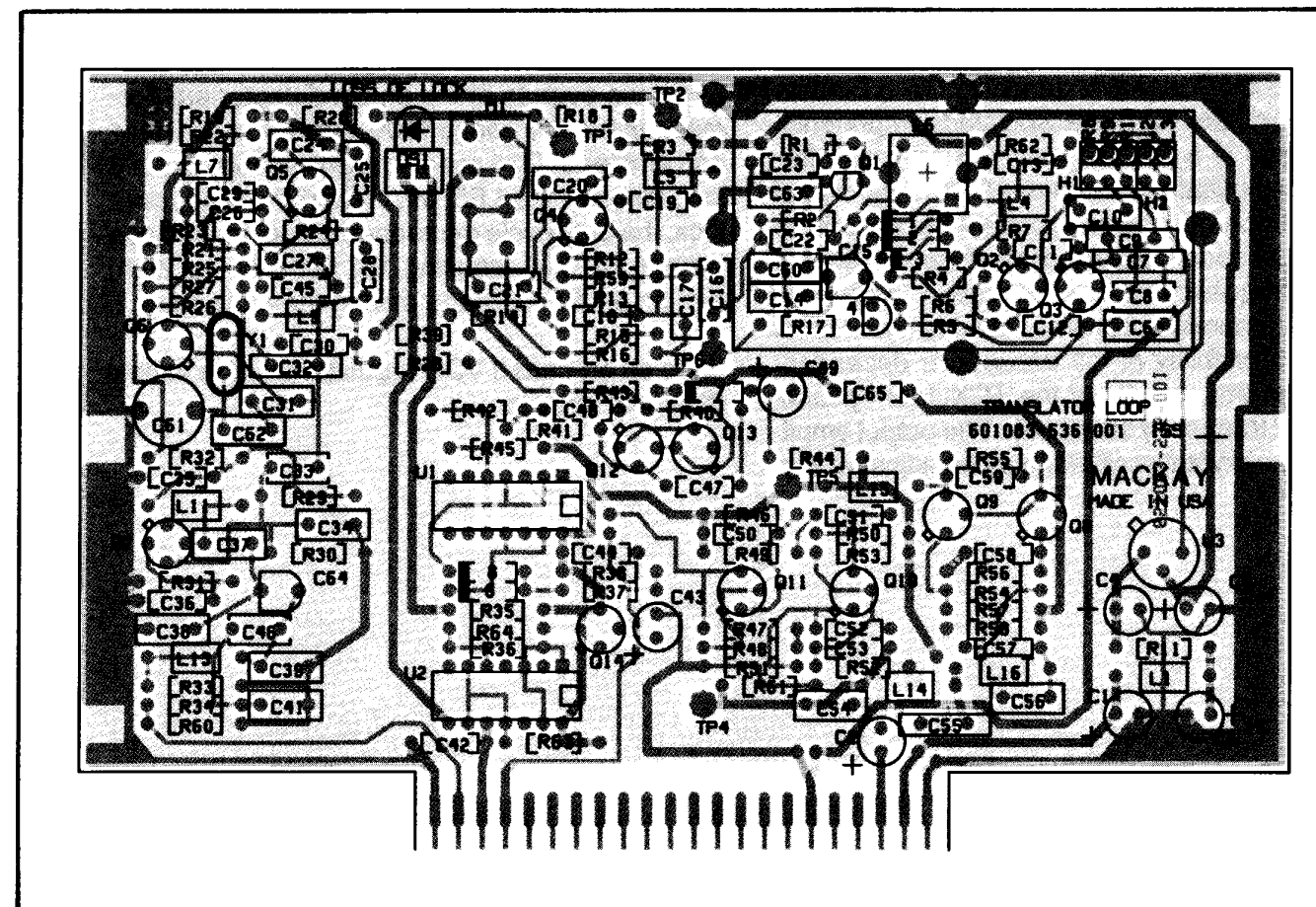
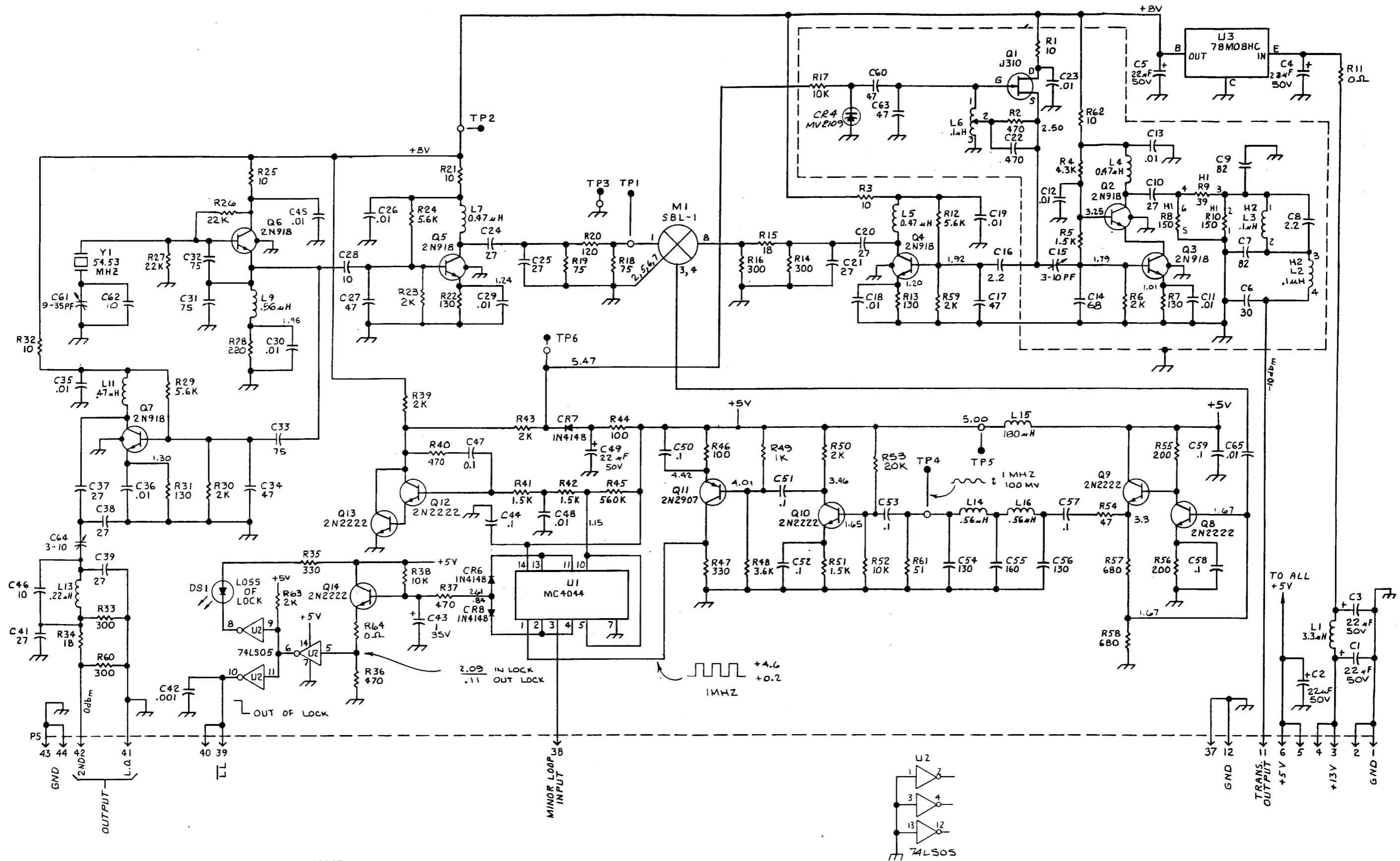


Figure 5.34

TRANSLATOR LOOP BOARD ASSEMBLY



NOTES:  
 1. UNLESS OTHERWISE NOTED:  
 RESISTORS ARE IN OHMS, 1/4W, ±5%  
 CAPACITOR VALUES ONE OR GREATER ARE IN  
 PICO FARADS (pF), VALUES LESS THAN ONE  
 ARE MICROFARADS (μF).

Figure 5.35

TRANSLATOR LOOP BOARD SCHEMATIC

TRANSLATOR LOOP BOARD, 1A10

PIN CONNECTIONS AND VOLTAGE READINGS

1A10-P11

GND	1	2	GND
+13VDC	3	4	+13VDC
+5VDC	5	6	+5VDC
	7	8	
	9	10	
(-10DBM) 55.53 - 55.6299 MHZ	11	12	GND
	13	14	
	15	16	
	17	18	
	19	20	
	21	22	
	23	24	
	25	26	
	27	28	
	29	30	
	31	32	
	33	34	
	35	36	
GND	37	38	MINOR LOOP INPUT 1-1.1 MHZ
LOGIC "0" OR "1"	39	40	$\overline{1L}$ LOGIC "0" OR "1"
(2ND LO)	41	42	54.53 MHZ - 10DBM (2ND LO)
GND	43	44	GND

#### 5.9.4.4 Major Loop Board, 1A11

See Figure 5.37 for the schematic of the Major Loop board.

The Major Loop board provides the first LO signal (59.53 to 89.53 MHz) for the First Mixer in the signal path. The loop itself uses a 50 kHz reference frequency and generates the 10 MHz, 1 MHz and 100 kHz steps. Smaller step sizes are generated by the Minor Loop through the Translator Loop.

The VCO, Q7, is a Colpitts design with three switched ranges covering 59.53 to 89.53 MHz. Range switching is accomplished by pin diodes CR2 and CR13. The highest range has only varicaps CR7 and CR8 in combination with L3 to determine the VCO frequency; in the middle range, CR2 is turned on, putting capacitors C71 and C73 in parallel with the tuned circuit; in the lowest range, CR2 remains on and CR13 is turned on, adding parallel capacitors C72 and C74 to the tuned circuit. Diodes CR4, CR5 and CR6 limit the oscillation amplitude. The output of Q6 is then supplied to two buffers: cascode amplifier Q11 and Q12, and output amplifier Q1. Q11 and Q12 provide exceptional reverse isolation and feed mixer M1.

In addition to the first LO signal, Mixer M1 also receives the Translator Loop frequency. The resulting output, 4 to 33.9 MHz, is amplified by Q9 and Q10, then filtered and further amplified by Q13 and Q14. This output is fed to the clock input of U8, where it divides the signal by 2 and provides a reliable square wave for the programmable divider. The divide by two factor is compensated for by using a 50 kHz reference frequency instead of a 100 kHz signal.

In the programmable divider, U5, U6 and U7 are parallel-loadable Up/Down counters cascaded and connected to permanently count down. U5 is the most significant digit and U7 is the least significant. U4 is an array of open collector inverters which have their outputs connected to-

gether to form a NOR gate. The output can only go high if all the inputs are low. The gate is connected so that the output goes high when the counter, U5 through U7, contains the number 002. To understand the operation, we'll assume that the counter has been loaded with the number "124". The counters begin counting down. (Because of the "D" input on U8, pin 12 (U8) is low, pin 9 (Q) is low and pin 8 (/Q) stays high.) After 100 counts, U5 underflows and U4 pin 3 goes low. After another 2 pulses, U6 underflows and U4 pin 5 goes low. After another 2 pulses, pins 9, 11 and 13 go low so the "output" of U4 can go high. The counter now contains the number 002 so the "D" input of U8 (programmable divider output pulse goes high, sending the (/Q) line, pin 8, low and loading U5, U6 and U7 with the divide number. The next pulse toggles the flip-flop again allowing the cycle to repeat.

The programmable divider is fed to the phase/frequency detector U2, where it is compared to the 50 kHz reference. If the divider output frequency is too low, the phase detector output decreases, causing the voltage on the VCO control line to rise, raising the frequency to correct the error.

The loop amplifier, Q3, Q4 and Q5, form an active loop filter which determines overall loop stability. Transistor Q2 provides an active low pass filter with a sharp corner and steep roll-off to attenuate the reference sidebands. The loss-of-lock circuitry, Q8 and U2, works in the same manner as described previously for the Minor Loop board.

U1 is an on-card 8 VDC regulator to supply power for the linear circuits.

The loop response and settling time depends upon the time constants of the loop filter components and the loop "gain" equation  $K_v \times K_p / N$ , where  $K_v$  is the VCO transfer constant in Rad/sec/Volt,  $K_p$  is the phase detector constant in Volts/Rad, and  $N$  is the programmable divider number. The following tables provide Major Loop frequency data and lock-in voltage figures.

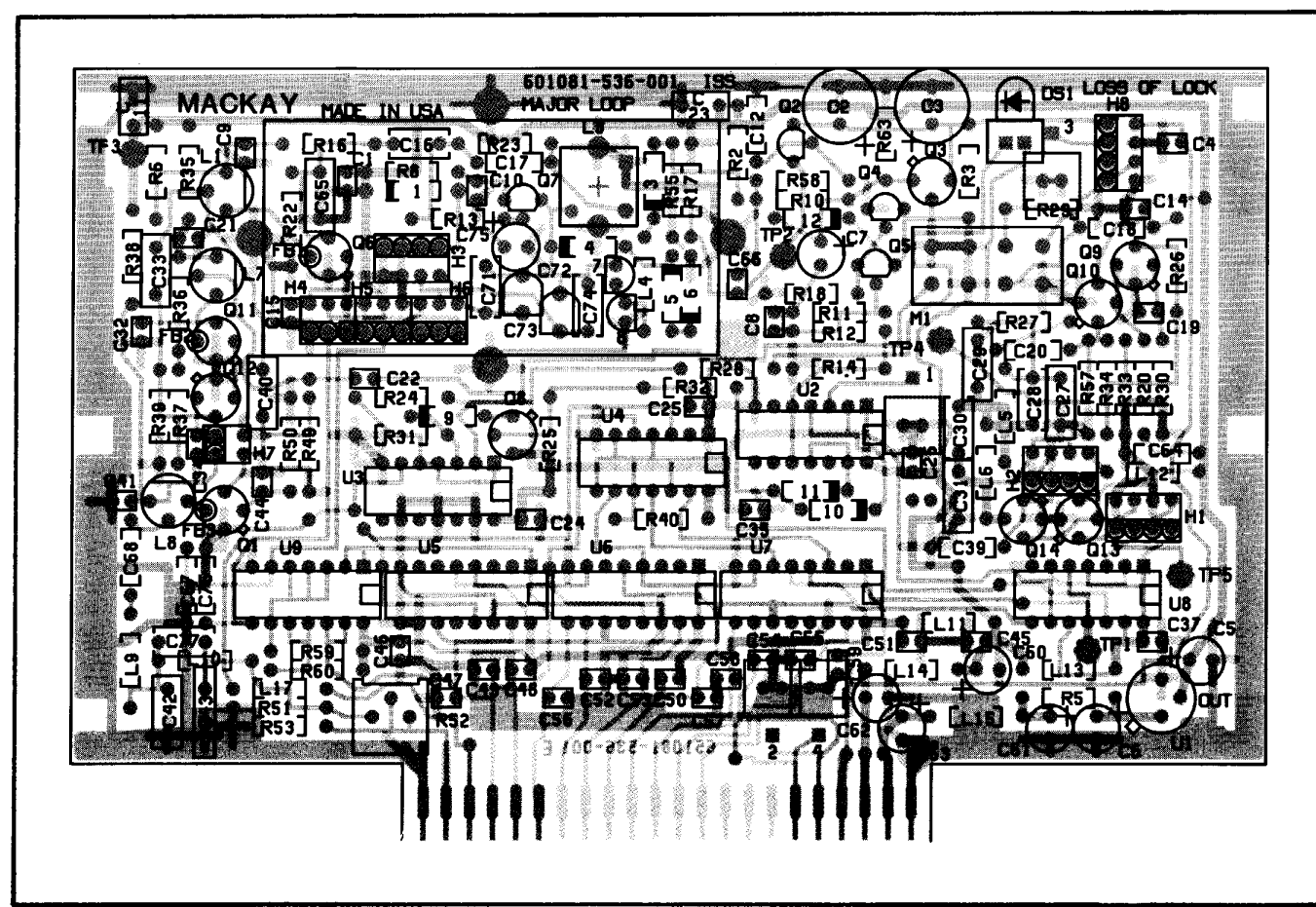
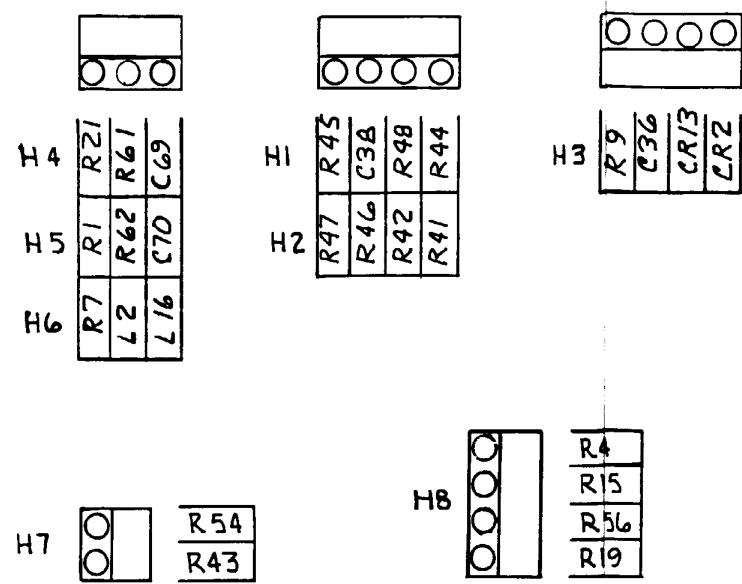
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**Table 5.12 MAJOR LOOP FREQUENCY INFORMATION**

FIRST 3 DIGITS OF RX OR TX FREQ MHZ	VCO FREQ MHZ	PROGRAM NUMBER	U9 PIN 8	U9 PIN 6	CR13	CR2
1.60	61.13	056 to 099	Low	Low	On	On
5.90	65.43	100 to 199	High	Low	On	Off
6.00	65.53	200 to 399	High	High	Off	Off
15.90	75.43					
16.00	75.53					
29.90	89.43					

**MAJOR LOOP LOCK-IN VOLTAGE**

FIRST 3 DIGITS OF	ADJUST	DC VOLTS AT TP2
29.9	L3	18.4 to 18.6
16.0		3.6 to 5.00
15.9	C72	18.2 to 18.7
06.0		2.9 to 4.5
05.9	C73	18.2 to 18.7
01.6		5.50 to 5.70



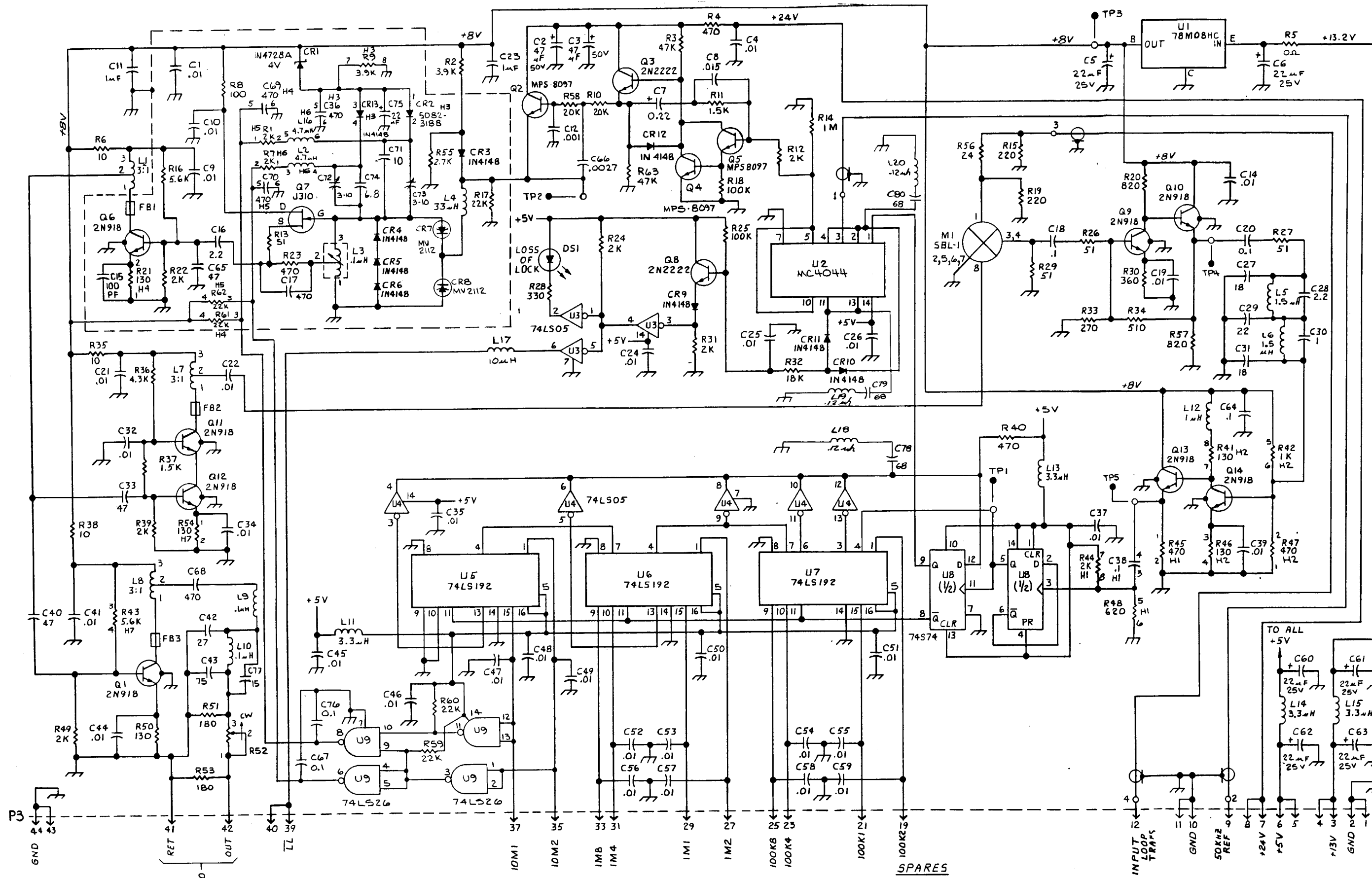
(601081-536-001)

Figure 5.36  
MAJOR LOOP  
BOARD ASSEMBLY

PART NUMBER	DESCRIPTION	SYMBOL
600184-708-001	CAN SHIELD	
600235-604-001	TRANSISTOR PAD	FOR U1, L7
600025-419-001	TRANSISTOR PAD	
600017-419-001	HEATSINK	
600145-419-001	CAP .01UF, CER, 50V	C22, 24-26
600268-314-008		32, 34, 35
		37, 41, 1
		44-59, 4
		9, 10, 14
		19, 21
600226-314-014	CAP. 1UF, CER, 50V	C11, 23
600272-314-008	CAP. .001UF, CER, 50V	C12
600267-314-002	CAP. 100PF, CER, 100V	C15
600269-314-002	CAP. 2.2PF, CER, 500V	C16, 28
600272-314-005	CAP. 470PF, CER, 50V	C17, 36,
		68, 69, 70
600272-314-001	CAP. .1UF, CER, 50V	C18, 20,
		38, 64, 67
		76
600297-314-026	CAP. 47UF, ALUM, 50V	C2, 3
600269-314-012	CAP. 18PF, CER, 500V	C27, 31
600269-314-014	CAP. 22PF, CER, 500V	C29
600269-314-001	CAP. 10PF, CER, 500V	C30
600269-314-022	CAP. 47PF, CER, 100V	C33, 40, 65
600272-314-007	CAP. .01UF, CER, 100V	C39
600269-314-016	CAP. 27PF, CER, 500V	C42
600269-314-027	CAP. 75PF, CER, 100V	C43
600297-314-016	CAP. 22UF, ALUM, 25V	C5, 6, 60,
		61, 62, 63
		75
600268-314-004	CAP. .0027UF, CER, 50V	C66
600202-314-003	CAP. .22UF, 35V, TANT.	C7
600269-314-009	CAP. 10PF, CER, 500V	C71
600052-317-001	CAP. VAR, 3-10PF	C72, 73
600269-314-007	CAP. 6.8PF, CER, 500V	C74
600269-314-011	CAP. 15PF, CER, 500V	C77
600268-314-011	CAP. .015UF, CER, 50V	C8

PART NUMBER	DESCRIPTION	SYMBOL
600006-411-001	DIODE, ZENER, 1N4728A 4V	CR1
600144-410-001	DIODE HP3188	CR2, 13
600109-410-001	DIODE 1N4148	CR3-6,
		9-12
600123-410-009	DIODE, VARACTOR, MV2112	CR7, 8
600036-390-001	LED, RED	DS1
600246-622-001	FERRITE BEAD	FB1-3
600064-419-001	4 POS VERTICAL MT.	H1-3, 8
600064-419-003	3 POS VERTICAL MT.	H4-6
600064-419-004	2 POS VERTICAL MT.	H7
600094-512-001	TRANS, 3:1, BALUN	L1, 7, 8
600125-376-006	CHOKE 3.3UH	L11, 13-15
600125-376-040	CHOKE 1.0UH	L12
600125-376-032	CHOKE 10UH	L17
600125-376-030	CHOKE 4.7UH	L2, 16
600173-376-001	COIL, VAR, .1UH	L3
600125-376-007	CHOKE 33UH	L4
600125-376-033	CHOKE 1.5 UH	L5, 6
600125-376-028	CHOKE .1UH	L9, 10
600008-455-001	MIXER SLB-1	M1
600085-413-001	TRANSISTOR 2N918	Q1, 6, 9-14
600278-413-001	TRANSISTOR MPS8097	Q2, 4, 5
600080-413-001	TRANSISTOR 2N2222A	Q3, 8
600259-413-001	TRANSISTOR J310	Q7
620014-341-075	RES. 2K, 1/4W, 5%	R1, 7, 12,
		22, 24, 31
		39, 44, 49
620024-341-075	RES. 20K, 1/4W, 5%	R10, 58
615014-341-075	RES. 1.5K, 1/4W, 5%	R11, 37
651094-341-075	RES. 51, 1/4W, 5%	R13, 26
		27, 29

PART NUMBER	DESCRIPTION	SYMBOL
610044-341-075	RES. 1M, 1/4W, 5%	R14
622004-341-075	RES. 220, 1/4W, 5%	R15, 19
656014-341-075	RES. 5.6K, 1/4W, 5%	R16, 43
622024-341-075	RES. 22K, 1/4W, 5%	R17, 59-62
610034-341-075	RES. 100K, 1/4W, 5%	R18, 25
639014-341-075	RES. 3.9K, 1/4W, 5%	R2, 9
682004-341-075	RES. 820, 1/4W, 5%	R20, 57
613004-341-075	RES. 130, 1/4W, 5%	R21, 41,
		46, 50, 54
633004-341-075	RES. 330, 1/4W, 5%	R28
647024-341-075	RES. 47K, 1/4W, 5%	R3, 63
636004-341-075	RES. 360, 1/4W, 5%	R30
618024-341-075	RES. 18K, 1/4W, 5%	R32
627004-341-075	RES. 270, 1/4W, 5%	R33
651004-341-075	RES. 510, 1/4, 5%	R34
643014-341-075	RES. 4.3K, 1/4W, 5%	R36
647004-341-075	RES. 470, 1/4W, 5%	R4, 23,
		40, 45, 47
610014-341-075	RES. 1K, 1/4W, 5%	R42
662004-341-075	RES. 620, 1/4W, 5%	R48
600000-341-075	RES. 0, 1/4W, 5%	R5
618004-341-075	RES. 180, 1/4W, 5%	R51, 53
600072-360-004	POT. 100, 1/2W, CERMET, TOP	R52
627014-341-075	RES. 2.7K, 1/4W, 5%	R55
624094-341-075	RES. 24, 1/4W, 5%	R56
610094-341-075	RES. 10, 1/4W, 5%	R6, 35, 38
610004-341-075	RES. 100, 1/4W, 5%	R8
600261-230-001	TERMINAL	TP1-5
600526-415-001	IC 78M08, 8V REG	U1
600092-415-001	IC MC4044, PHASE DET	U2
600240-415-001	IC 74LS05, HEX INV, O/C	U3, 4
600225-415-001	IC 74LS192, UP/DN CNTR, SYNC	U5, 6, 7
600157-415-001	IC 74S74, D FLIP-F, DUAL	U8
600221-415-001	IC 74LS26, NAND, HV, QUAD	U9
600005-635-001	LED MOUNT	XDS1



NOTES:  
 1. UNLESS OTHERWISE NOTED, RESISTORS ARE IN OHMS, 1/4W, ±5% CAPACITOR VALUES ONE OR GREATER ARE IN PICO FARADS (pF), VALUES LESS THAN ONE ARE MICROFARADS (μF).

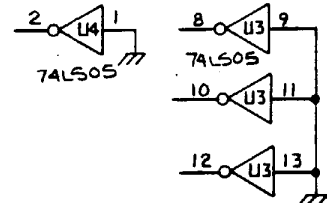


Figure 5.37  
 MAJOR LOOP BOARD SCHEMATIC

MAJOR LOOP BOARD, 1A11

PIN CONNECTIONS AND VOLTAGE READINGS

1A11-P9

GND	1	2	GND
+13VDC	3	4	+13VDC
+5VDC	5	6	+5VDC
+24VDC	7	8	+24VDC
50 KHZ REF	9	10	GND
GND	11	12	55.53 - 55.6299 MHZ (-10DBM)
	13	14	
	15	16	
	17	18	
100 KHZ "2"	19	20	
100 KHZ "1"	21	22	
100 KHZ "4"	23	24	
100 KHZ "8"	25	26	
1 MHZ "2"	27	28	
1 MHZ "1"	29	30	
1 MHZ "4"	31	32	
1 MHZ "8"	33	34	
10 MHZ "2"	35	36	
10 MHZ "1"	37	38	
LOGIC "0" OR "1" $\bar{L}$	39	40	$\bar{L}$ LOGIC "0" OR "1"
(1ST LO) GND	41	42	59.63 - 89.53 MHZ ODBM (1ST LO)
GND	43	44	GND

### 5.9.5 STANDARD AUDIO INPUT/OUTPUT BOARD, 1A7

See Figure 5.39 for the schematic of the Standard Audio I/O board.

The standard Audio I/O board provides gain and frequency response control for the 600 ohm voice and data signals provided at the rear of the transceiver. Separate output ports are provided for FSK or DATA signals when the transceiver is in either of those two modes. In all, four separate 600 ohm ports are provided on connector J36: receive Data/FSK, standard receive, transmit data/FSK and standard transmit.

U3 is an analog switch which is controlled by U2C and U2D to channel the audio to the appropriate output port. The receive signal is amplified and shaped by U1C, then is switched to either amplifier U1A (with gain controlled by R4) for DATA/FSK output, or to amplifier U1B for voice output. The transmit DATA/FSK audio (gain controlled by R13) and the standard audio both enter switch sections of U3 where they are routed to amplifier U1D before being sent to the transceiver transmitter.

Operational amplifier U2A provides an audio "ground" reference at roughly 1/2 the supply voltage to allow the amplifiers on this board to "swing" both positively and negatively around the audio "ground".

Transistor Q1 provides a keying signal to the transmitter for centertap keying, a feature used with a TADIL A high speed data modem. Center-

tap keying is enabled by placing jumper JP1 in position 2-3. With this circuit enabled, a +6 VDC voltage on the DATA/FSK TX lines will key the transmitter if it is in Data or FSK mode. Centertap keying is disabled if JP1 is set to position 1-2.

Jumper JP2 is used to provide an AGC threshold reduction for Data or FSK modes. When the receiver is being used for voice communications, it is desirable, from an operator fatigue standpoint, to reduce the normal received noise level as much as possible. This can be done easily by having the AGC threshold at a level slightly above the normal received noise level, letting the signal "rise out of the noise". In data or FSK communications, however, it is generally much more desirable to have the receiver output remain essentially constant over the wide range of received input signal levels. This can be done easily by having the AGC threshold as close to the sensitivity level of the receiver as possible. Doing this for voice communications is very undesirable because it makes the receiver extremely noisy and tedious to listen to. Here, when the signal goes away, it is displaced by the noise at equal audio level. Hence it is desirable to have two AGC thresholds: one for best voice communications operation, and one for best data/FSK operation.

When jumper JP2 is placed in the 1-2 position, the AGC threshold is reduced from about 7  $\mu$ VRMS to about 2  $\mu$ VRMS when the receiver is in the Data or FSK mode. The standard position for JP2 is position 1-2. If the jumper is changed to position 2-3, R4 should be used to reduce the audio level to coincide with that through the standard (voice) channel.

(700046-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600190-608-001	CONN, JUMPER, 2 POS.	(JP1,2)
600204-314-001	CAP .01UF,MYLAR,400V	C1-5
600302-314-013	CAP.1UF, MYLAR, 50V	C10,13, 15,17-25
600297-314-003	CAP. 1UF, ALUM, 50V	C12
600297-314-032	CAP 100UF,ALUM, 25V	C14,16,31
600268-314-017	CAP. 1200pf,50V	C29,30
600268-314-015	CAP. 470pf,50V	C6
600268-314-016	CAP. .001UF,50V	C7-9
600028-411-001	DIODE, VOLT SUPPRESSOR P6KE6, 8A	CR1-8
600109-410-001	DIODE 1N4148	CR11
600174-608-005	CONN HEADER,26 PIN,ST	J1
600198-608-005	CONN HEADER,3 PIN,TIN	JP1,2
600125-376-007	CHOKE 33UH	L1
600229-413-001	TRANS 2N3904-TD018	Q1
615004-341-075	RES. 150, 1/4W, 5%	R1,5
662004-341-075	RES. 620, 1/4W, 5%	R11,12
612034-341-075	RES. 120K 1/4W 5%	R18,20
622024-341-075	RES. 22K, 1/4W, 5%	R19
639014-341-075	RES. 3.9K, 1/4W, 5%	R2
611024-341-075	RES. 11K, 1/4W, 5%	R22
620014-341-075	RES. 2K, 1/4W, 5%	R24
651014-341-075	RES 5.1K 1/4W 5%	R3
600066-360-011	POT 20K	R4,13
612024-341-075	RES. 12K, 1/4W, 5%	R6,8,21
610024-341-075	RES. 10K, 1/4W, 5%	R7,14-17
630014-341-075	RES. 3K, 1/4W, 5%	R9,10
635234-501-001	TRANS,600 OHM,AUDIO	T1-4
600114-611-001	BROWN TEST POINT	TP1
600114-611-002	RED TEST POINT	TP2
600114-611-003	ORANGE TEST POINT	TP3
600114-611-004	YELLOW TEST POINT	TP4
600114-611-005	JACK	TP5
600114-611-006	TEST JACK	TP6
700121-415-001	IC,QUAD OP AMP,MC33074	U1
600171-415-001	IC LM324,OP AMP,QUAD	U2
600186-415-101	IC 4066BDC, CHOS BIL SW, QUAD	U3

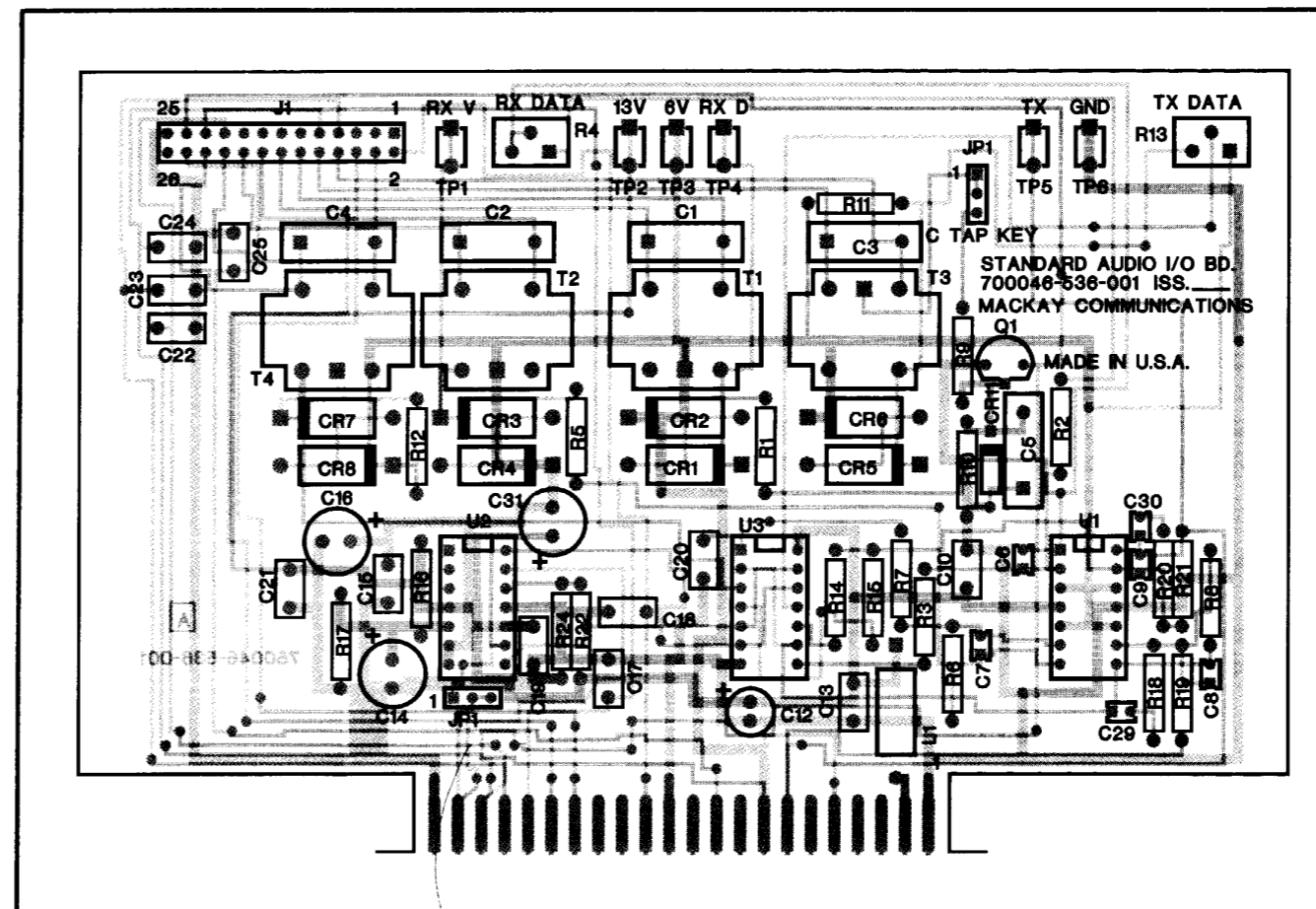


Figure 5.38

STANDARD AUDIO I/O BOARD ASSEMBLY

ECO

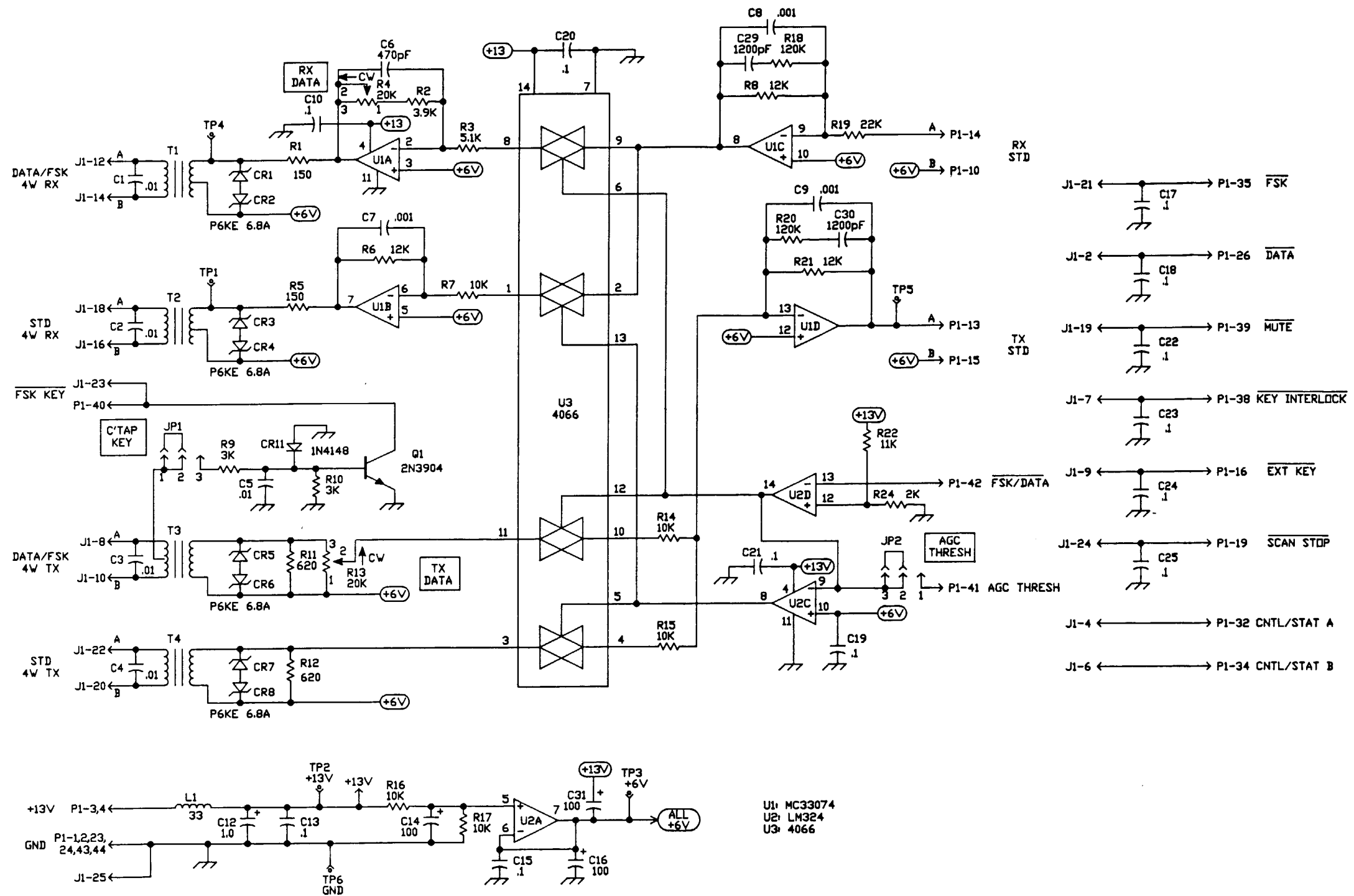


Figure 5.39

STANDARD AUDIO I/O BOARD SCHEMATIC

STANDARD AUDIO I/O BOARD, 1A7

PIN CONNECTIONS AND VOLTAGE READINGS

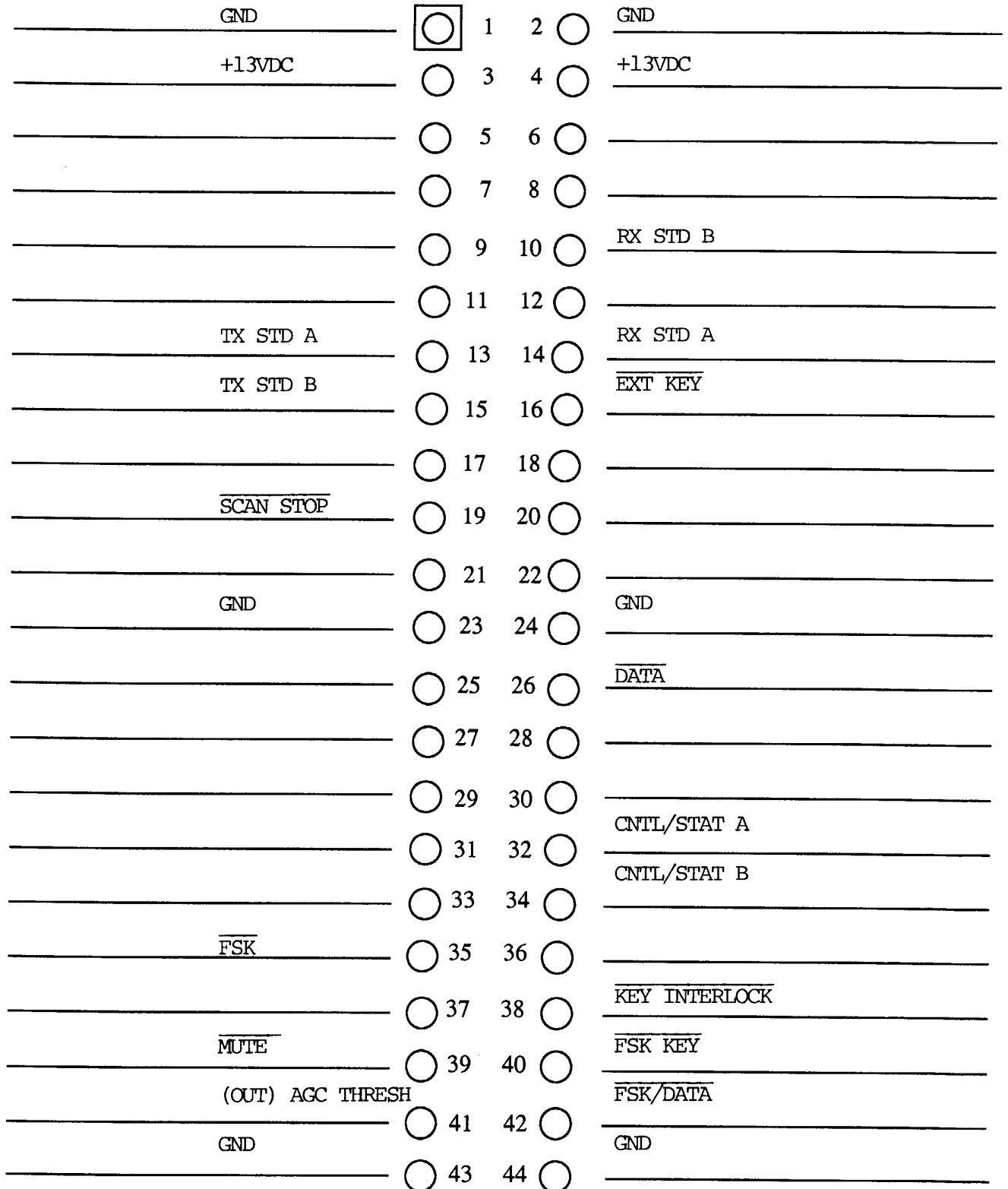
1A7-J1

	<input checked="" type="radio"/>	1	2	<input type="radio"/>	$\overline{\text{DATA}}$
	<input type="radio"/>	3	4	<input type="radio"/>	CN1L/STAT A
	<input type="radio"/>	5	6	<input type="radio"/>	CN1L/STAT B
$\overline{\text{KEY INTERLOCK}}$	<input type="radio"/>	7	8	<input type="radio"/>	DATA/FSK 4W TX A
$\overline{\text{EXT KEY}}$	<input type="radio"/>	9	10	<input type="radio"/>	DATA/FSK 4W TX B
	<input type="radio"/>	11	12	<input type="radio"/>	DATA/FSK 4W RX A
	<input type="radio"/>	13	14	<input type="radio"/>	DATA/FSK 4W RX B
	<input type="radio"/>	15	16	<input type="radio"/>	STD 4W RX B
	<input type="radio"/>	17	18	<input type="radio"/>	STD 4W RX A
$\overline{\text{MUTE}}$	<input type="radio"/>	19	20	<input type="radio"/>	STD 4W TX B
$\overline{\text{FSK}}$	<input type="radio"/>	21	22	<input type="radio"/>	STD 4W TX A
$\overline{\text{FSK KEY}}$	<input type="radio"/>	23	24	<input type="radio"/>	$\overline{\text{SCAN STOP}}$
GND	<input type="radio"/>	25	26	<input type="radio"/>	
	<input type="radio"/>	27	28	<input type="radio"/>	
	<input type="radio"/>	29	30	<input type="radio"/>	
	<input type="radio"/>	31	32	<input type="radio"/>	
	<input type="radio"/>	33	34	<input type="radio"/>	
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	<input type="radio"/>	37	38	<input type="radio"/>	
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	<input type="radio"/>	41	42	<input type="radio"/>	
	<input type="radio"/>	43	44	<input type="radio"/>	

STANDARD AUDIO I/O BOARD, 1A7

PIN CONNECTIONS AND VOLTAGE READINGS

1A7-P8



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## 5.9.6 TRANSMIT MODULATOR BOARD, 1A16

See Figure 5.41 for the schematic of the Transmit Modulator board.

The Transmit Modulator board processes audio inputs and generates the double sideband suppressed carrier (DSSC) rf signal at the transmitter's IF. This DSSC signal is then filtered to remove the unwanted sideband, shifted to the desired transmit frequency and amplified.

The following circuits are located on this board: audio input, audio limiter, modulator, control and ALC.

### 5.9.6.1 Modulator Section

The Modulator M1 is a double-balanced ring mixer. The 5 MHz third LO signal is applied to the LO port of the mixer and audio is applied to the IF port. The resulting DSSC signal is obtained from the rf port, pin 1. Because of the inherent balance of the mixer, the carrier is suppressed 50 dB with no adjustments required.

### 5.9.6.2 Double Sideband Amplifier

The DSSC signal is amplified by Q4. The gain of the amplifier may be varied by R51 which, by controlling the current through PIN diode CR29, varies the amount of negative feedback in the amplifier.

### 5.9.6.3 Third LO Amplifier

The 5 MHz third LO is amplified by transistor Q5 and injected into the modulator M1.

### 5.9.6.4 Carrier Injection

#### 5.9.6.4.1 AME Mode

In either AME (full carrier) and A3A (partial carrier) operation, some carrier must be replaced in the SSB signal following unwanted sideband removal. Since the unwanted sideband is removed in the IF filters, and the IF filters are narrow enough to remove at least 15 dB or so of carrier frequency, the carrier must be reinjected following this operation. The carrier is then routed to the IF Filter board where it is mixed with the SSB

signal after the filters. Transistor Q12 on the Transmit Modulator board is a switch used to turn off the carrier output when it is not wanted in CW and SSB modes. In the AM Transmit mode, the /AMT line will be low, making U4 pin 1 low, turning off Q6 (removing the short to ground on the third LO line) and turning on Q12. This allows the third LO signal to be sent to the IF Filter board for carrier injection. Carrier level is determined by the current through PIN diode CR8, which is set by control R17.

#### 5.9.6.4.2 A3A Mode

In the A3A mode, the /A3A line is low, making U4 pin 14 high, which turns on Q12. This allows the third LO to be sent to the IF Filter board for carrier reinsertion. Q6 will be on so no third LO signal can flow through CR8, and the carrier level is entirely controlled by the current through PIN diode CR9. The control voltage for CR9 is located on the High Pass Filter board.

### 5.9.6.5 Audio Compressor

The audio compressor provides two benefits: it limits the maximum audio level applied to the modulator, preventing distortion; and it increases the average transmit power by compressing the voice amplitude range. The compressor consists of U1, Q1 and Q2. U1A is the audio amplifier stage with its gain controlled by the resistance of FET Q1. The amplifier receives input from two sources: the front panel microphone and the rear panel 600 ohm inputs. When Q1 is off, the overall gain of U1A is roughly unity. When Q1 is turned on completely, the gain is reduced about 26 dB. The gain is controlled by a feedback loop through U1C to keep the output level of U1A constant. The attack time for the compressor is about 4.7 msec and the release time is about 1 second. U1D drives an LED to indicate when there is sufficient audio to activate the compressor. The output of the compressor is a buffer amplifier U1B and Q2, which supplies audio to the modulator.

The gain of the buffer amplifier can be altered to reduce the DSSC level during AME and low power modes of operation. When the radio is in any mode except low power or AM, the output of U4A and U4B is high, keeping CR6 and CR7 turned off. When the /AMT line goes low, U4B

output will go low, turning on CR6, which reduces the output level by about 7.5 dB. When the low power signal is high, U4A output goes low, turning on CR7, which reduces the output level about 6 dB. Both the low power and AM transmit conditions are not permitted together and are prohibited by the transceiver's software.

#### 5.9.6.6 Audio Input Circuits

The purpose of the audio input circuits is to condition and amplify the microphone and 600 ohm line inputs.

##### 5.9.6.6.1 600 Ohm Line Input

The 600 ohm balanced line audio is applied to transformer T1, the output of which is terminated with 600 ohms (R3 and R4 in parallel), and protected from high voltage spikes by back-to-back zener diodes. The audio is fed into U2A for amplification. The amplifier's gain is adjustable via R1 to accommodate input levels from -26 dBm to 0 dBm. The amplifier output is then fed to audio gate U6A, which is on, allowing audio to pass unless /TUNE or /CW is low. This latter condition prevents modulation from the 600 ohm line during either TUNE or CW operation.

##### 5.9.6.6.2 High Level Dynamic Microphone Input

The dynamic microphone input is first filtered to remove any rf present on the line, then is amplified by U2B. This amplifier has three different gain ranges, depending upon which microphone input is used. Microphone gain is adjustable via R58. The amplifier output goes to gate U6B, which is on, allowing audio to pass unless /TUNE or /CW is low.

##### 5.9.6.6.3 Low Level Dynamic Microphone Input

The other microphone input (for carbon or dynamic microphones) can be set via jumper JP1 to accommodate either a carbon or a low-level dynamic microphone.

##### 5.9.6.6.4 Carbon Microphone Input

When jumper JP1 is in the 1-2 position, the input

is set for a carbon microphone. DC for the carbon element is provided by Q9, a well-filtered emitter follower source.

##### 5.9.6.6.5 Sidetone Output

Amplifier U2C provides a sidetone output designed to drive the earpiece of a handset. The amplifier picks up the microphone amplifier output and applies it to the earpiece. The sidetone level is adjustable via R67.

##### 5.9.6.6.6 Center Tap Key

An arrangement allowing radio keying by application of a DC voltage on either side of the 600 ohm audio line is provided by Q10. This feature is furnished to comply with the TADIL-A high speed data specification. If a DC voltage is detected at the center tap of the 600 ohm input transformer, Q10 will turn on, pulling the keyline to ground, and keying the transceiver. This feature may be disabled by placing jumper JP2 in the 2-3 position.

##### 5.9.6.6.7 1 kHz Input Circuit

The 1 kHz tone used to modulate the transmitter during CW operation is fed to audio gate U6D. Gates U6D and U6C are toggled together and are turned on only when /CW is low, /PTT is low, and /TUNE is high. These conditions occur only when the transmitter is keyed in CW mode. The output of audio gate U6E is fed to the compressor input. Use of the compressor eliminates the need for a tone level adjustment control. The CW sidetone audio is taken from gate U6D and fed to the Audio/Squelch board to provide CW sidetone during transmit.

#### 5.9.6.7 Control Circuits

This section describes the various control circuits used on the Transmit Modulator board.

##### 5.9.6.7.1 Internal Power Supplies

Transistor Q3 provides a switched +9 VDC source available only during transmit. It supplies power to the third LO amplifier Q5 and DSSC amplifier Q4. U5 provides a regulated +5 VDC for use on the board. The regulated +5 VDC is applied to

voltage follower U2D, which is the signal "ground" (at +4.5 VDC) reference for the operational amplifiers.

#### 5.9.6.7.2 Compressor Control

The audio compressor may be disabled by either an external circuit (TTL low pin 34) or a jumper (JP3 pin 1 to 2) on the board. The disable arrangement, however, prevents disabling when /CW is low, so that the CW tone level remains controlled. U4D is used for the disable function.

#### 5.9.6.7.3 /PTT, /TUNE and /CW Control

The /PTT command comes from the front panel, is filtered to remove rf, and is fed to the /PTT comparator, U3C. This works in conjunction with the /CW comparator, U3D, during CW operation to shape the keying of the 1 kHz tone to control the rate-of-rise of the CW envelope and limit its overshoot.

The /CW command is applied to the /CW comparator, U3D, which controls transistor Q11. In CW operation, Q11 cuts off audio gates U6A and U6B, inhibiting other audio inputs to the compressor. When Q11 is turned on, diode CR22 is turned off allowing the /PTT command to key the transmitter 1 kHz CW tone.

The purpose of the /TUNE command is to set the Tx Modulator board for coupler tuning - AM carrier with no modulation as a coupler rf source. When /TUNE goes low, it also pulls the /MUTE line low, muting the receive audio, disables the 1 kHz tone, and inhibits the microphone and 600 ohm audio.

#### 5.9.6.8 Automatic Level Control (ALC) Circuitry

The purpose of the ALC circuit is to keep the transmitted output power (PEP) constant in SSB, CW, FSK, DATA and A3A modes without regard to changes in signal path gain, temperature or load impedance. In addition to the internal ALC circuitry, an external ALC port is provided for output level control when the transmitter is driving the MSR 1020 1 kW linear power amplifier. The ALC is a voltage type, which holds the rf output voltage constant, regardless of load impedance.

If the load is 50 ohms, 125 watts of power will be produced. If the output impedance is different from 50 ohms, a different amount of output power will be produced as the output voltage is held constant at 79 VRMS. A VSWR sensing circuit on the Half Octave Filter board decreases the output to protect the power amplifier if the load impedance is too high or too low.

#### 5.9.6.8.1 Internal ALC

The internal ALC circuit is enabled whenever the /AMT line is high, indicating that the transmitter is not in AM mode, sending U4B output high, cutting off diode CR15. Conversely, when the /AMT line is low, diodes CR14 and CR15 are both turned on, disabling both the internal and external ALC circuits.

The internal ALC gets its input from the ALC Detector located on the Half Octave Filter board. This input is a voltage proportional to the rf output voltage of the transmitter, and is adjusted so that it is +6.0 VDC when the rf output voltage is 79 VRMS. A reference voltage for the ALC amplifier U3A establishes the ALC threshold.

During operation at power level 2, diode CR16 is off so that the threshold level is determined by ALC control R83. During low power (power level 1) operation, diode CR16 is turned on by U4A, putting low power adjust control R84 in parallel with R83, letting R84 now control the threshold level. Note that since the adjustments interact, R83 must be adjusted first.

The output of the ALC amplifier U3A is applied to complementary amplifiers Q7 and Q8 whose output is the Transmit Gain Control (TGC) line. This line is set up so that a TGC voltage of +6 VDC produces no gain decrease in the transmitter, while a voltage of +1 VDC produces the maximum gain decrease. The gain control circuit is located on the IF Filter board.

When the ALC voltage from the ALC detector exceeds the reference voltage, the output of U3A decreases, causing the TGC voltage to drop, reducing the transmit gain and the rf output. Loop feedback causes the TGC voltage to settle somewhere between +1 and +6 VDC, wherever 79 VRMS output is produced. Because the open

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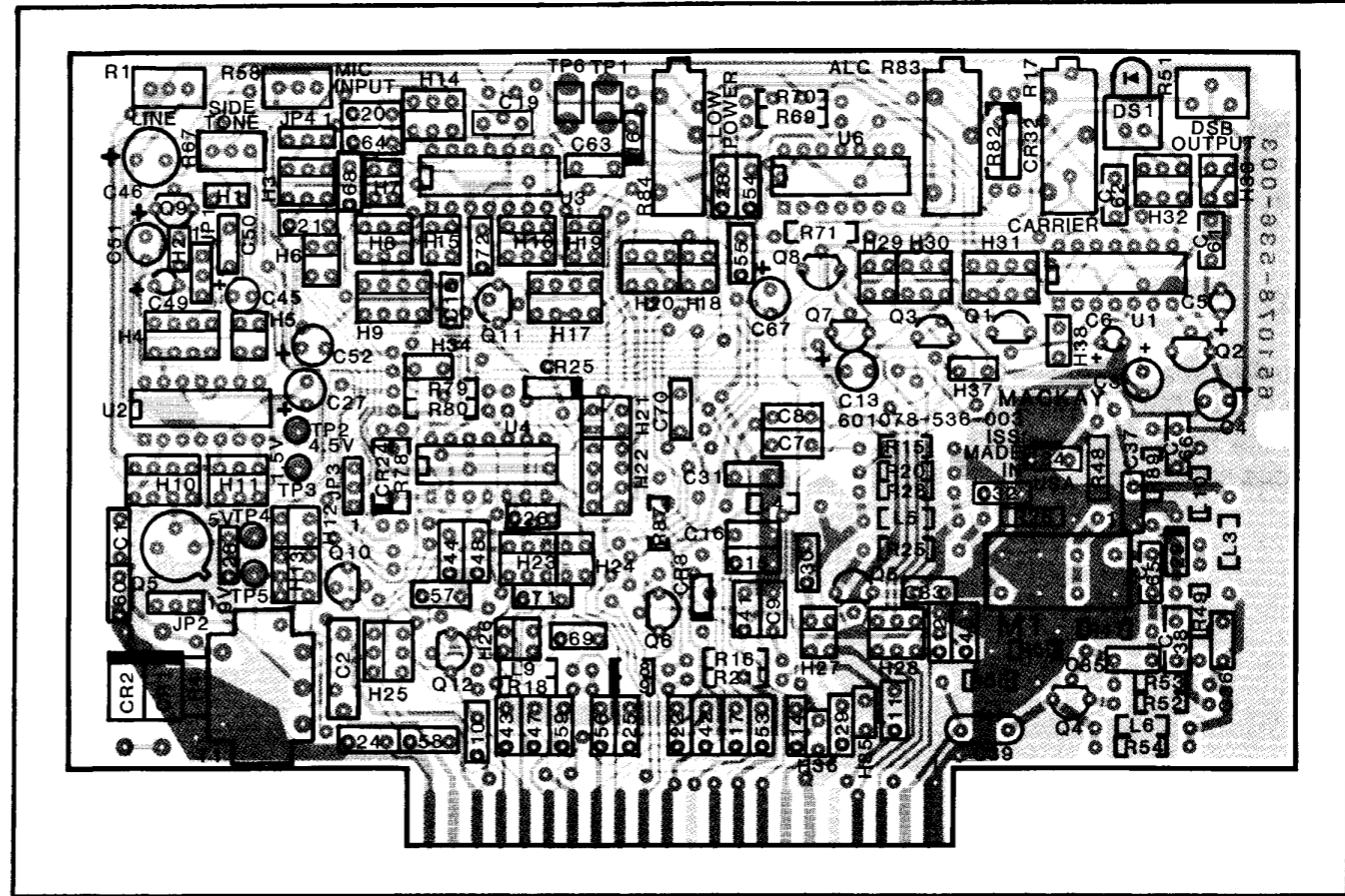
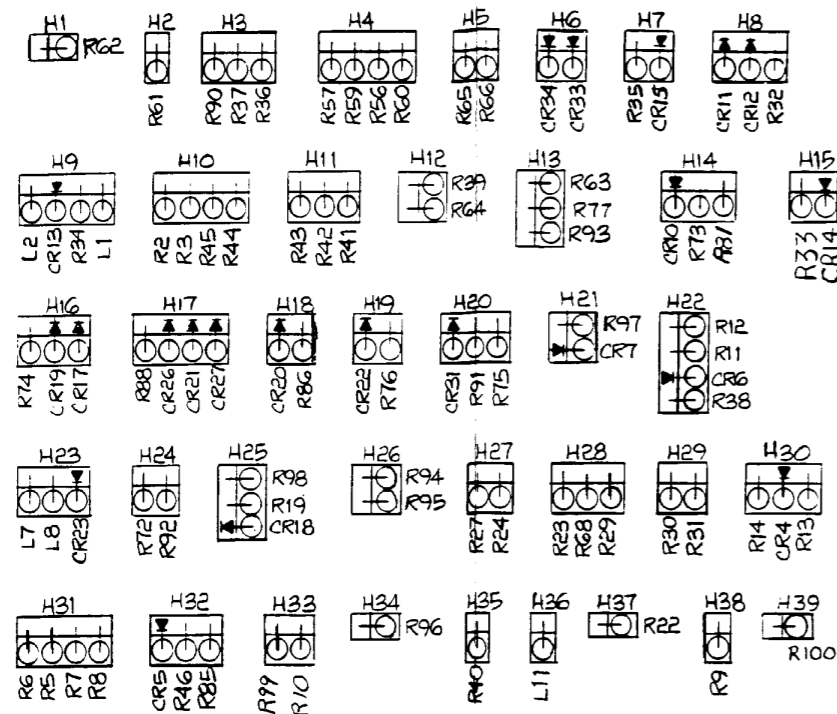
loop gain of the ALC control loop is very high, the final rf output voltage depends only on the ALC detector characteristics, not on the transmit signal path gain.

#### 5.9.6.8.2 External ALC

The external ALC is applied to amplifier U3B. Its output is also applied to the TGC amplifier, Q7 and Q8, for control of the transmitter output as described in the previous paragraph.

#### 5.9.6.8.3 Automatic Carrier Control (ACC)

The ACC circuit is responsible for controlling the transmitter output average power in AME mode. The circuit itself is located on the Half Octave Filter board, but uses Q7 and Q8 to control the TGC line voltage. While the ALC circuitry controls the Peak Envelope Power of the transmitter, the ACC controls the average output power to maintain good AM linearity and keep the carrier level constant.



(601078-536-003)

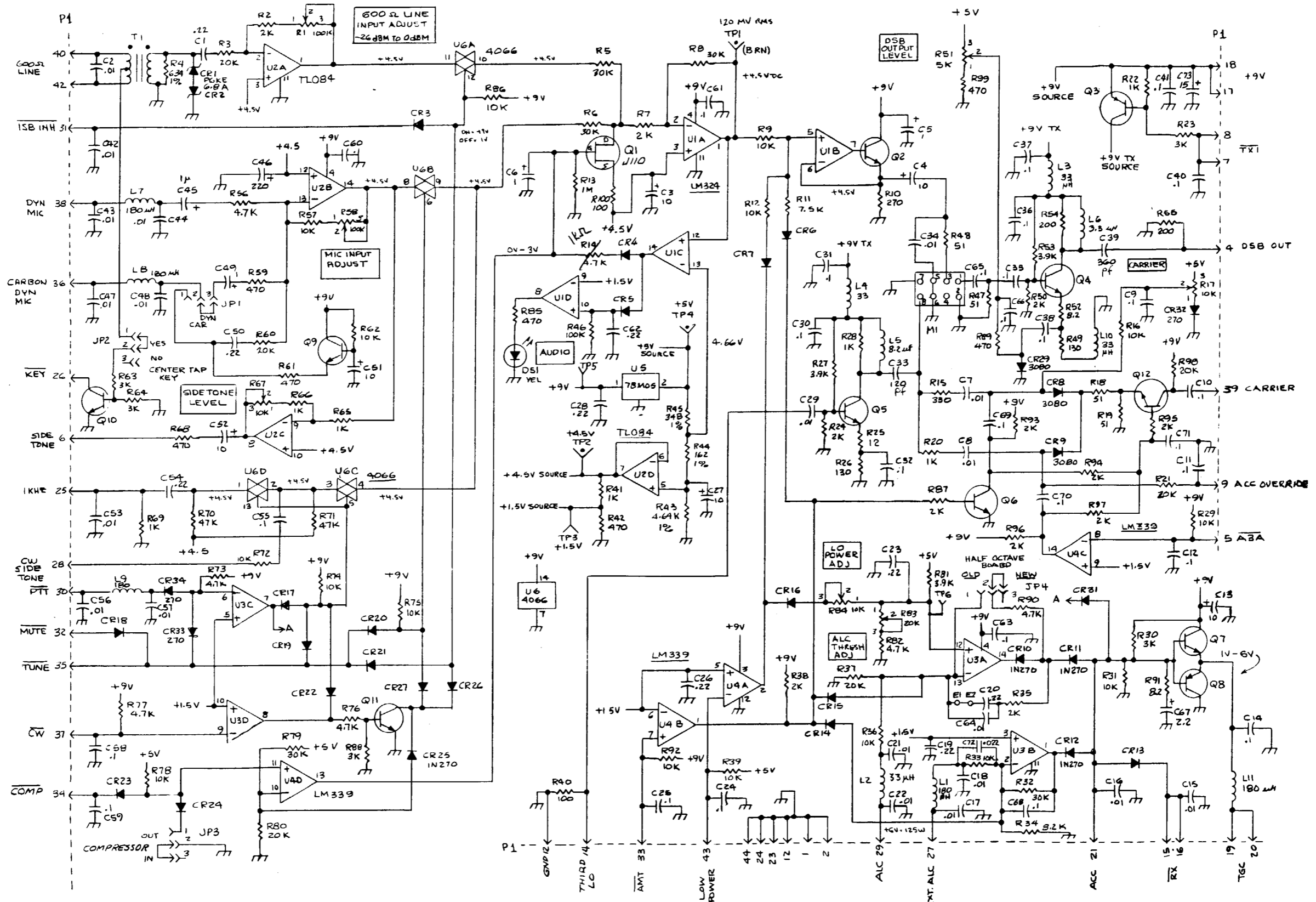
PART NUMBER	DESCRIPTION	SYMBOL
600005-635-001	LED MOUNT	(DS1)
600190-608-001	CONN, JUMPER, 2 POS.	(JP1-4)
600017-419-001	TRANSISTOR PAD	(U5)
600302-314-015	CAP .22UF,MYLAR,50V	C1,19,20 23,26,28 50,54,62
600204-314-001	CAP .01UF,MYLAR,400V	C2
600202-314-018	CAP. 10UF, 25V, TANT.	C3,4,13, 27,51,52
612003-306-501	CAP. 120PF, 3%, MICA, 500V	C33
600302-314-007	CAP. .01UF,MYLAR,63V	C34,47 48,53 56,57,64 7,8,21 15-18,22 29,42-44
600302-314-013	CAP. .1UF, MYLAR,50V	C35-38, 40,41,55 68-71,14 9-12,24 25,30-32 58-61,63 65,66
636003-306-501	CAP. 360PF, 3%, MICA, 500V	C39
600297-314-037	CAP. 220UF, ALUM, 10V	C46
600202-314-007	CAP. 1UF, 35V, TANT.	C5,6, 45,49
600202-314-011	CAP. 2.2UF,35V,TANT	C67
600302-314-009	CAP .022UF,MYLAR,63V	C72
600202-314-020	CAP. 15UF,20V,TANT	C73
600028-411-001	DIODE, VOLT SUPPRESSOR P6KE6, 8A	CR1,2
600052-410-001	DIODE IN270	CR10-12, 25,32-34
600109-410-001	DIODE IN4148	CR3-7, 13-24,26 27,31
600156-410-001	DIODE HP3080	CR8,9,29
600043-390-002	LED, YEL	DS1
600064-419-001	4 POS VERTICAL MT.	H4,9,10 17,22,31

PART NUMBER	DESCRIPTION	SYMBOL
600064-419-003	3 POS VERTICAL MT.	H3,8,11 13,14,16 20,23,25 28,30,32
600064-419-004	2 POS VERTICAL MT.	H24,26,27 29,33,12 5-7,15,18 19,21
600064-419-005	1 POS VERTICAL MT.	H1,2, 34-39
600198-608-005	CONN HEADER,3 PIN,TIN	JP1-4
600125-376-022	CHOKE 180UH	L1,7,8
600125-376-007	CHOKE 33UH	L2-4,10
600125-376-034	CHOKE 8.2UH	L5
600125-376-006	CHOKE 3.3UH	L6
600008-455-001	MIXER SLB-1	M1
600349-413-001	TRANS J 110, JFET	Q1
600229-413-003	TRANS 2N3904 TO-92	Q2,4-7 9-12
600116-413-002	TRANS, 2N3906	Q3,8
600089-360-014	POT. 100K, 1/2W, CERMET, RT/AN	R1,58
627004-341-075	RES. 270, 1/4W, 5%	R10
675014-341-075	RES. 7.5K, 1/4W, 5%	R11
610044-341-075	RES. 1M, 1/4W, 5%	R13
647014-341-075	RES. 4.7K, 1/4W, 5%	R14,56, 76,77,82 90,73
633004-341-075	RES. 330, 1/4W, 5%	R15
600063-360-010	POT. 10K, 15 TURN	R17,84
651094-341-075	RES. 51, 1/4W, 5%	R18,19 47,48
620014-341-075	RES. 2K, 1/4W, 5%	R2,24,35 38,50,87 7,93-97
610014-341-075	RES. 1K, 1/4W, 5%	R20,22, 28,41,65 66,69
630014-341-075	RES. 3K, 1/4W, 5%	R23,30, 63,64,88

PART NUMBER	DESCRIPTION	SYMBOL
612094-341-075	RES. 12, 1/4W, 5%	R25
613004-341-075	RES. 130, 1/4W, 5%	R26,49
639014-341-075	RES. 3.9K, 1/4W, 5%	R27,53,81
620024-341-075	RES. 20K, 1/4W, 5%	R3,21,37 60,80,98
682014-341-075	RES. 8.2K, 1/4W, 5%	R34
610024-341-075	RES. 10K, 1/4W, 5%	R39,57, 72,74,75 78,86,92 9,12,16 29,31,33 36,62
663401-342-059	RES. 634, 1/8W, 1%	R4
610004-341-075	RES. 100, 1/4W, 5%	R40,100
647004-341-075	RES. 470, 1/4W, 5%	R42,59, 61,68,85 89,99
646411-342-059	RES. 4.64K, 1/8W, 1%	R43
616201-342-059	RES. 162, 1/8W, 1%	R44
634801-342-059	RES. 348, 1/8W, 1%	R45
610034-341-075	RES. 100K, 1/4W, 5%	R46
630024-341-075	RES. 30K, 1/4W, 5%	R5,6,8, 32,79 R51
600066-360-009	POT. 5K, 1/2W, CERMET, RT/AN	
682084-341-075	RES. 8.2, 1/4W, 5%	R52,91
620004-341-075	RES. 200, 1/4W, 5%	R54,55
600089-360-010	POT. 10K, 1/2W, CERMET, RT/AN	R67
647024-341-075	RES. 47K, 1/4W, 5%	R70,71
600063-360-011	POT. 20K, 15 TURN	R83
635234-501-001	TRANSFORMER,600 OHM, AUDIO	T1
600114-611-001	BROWN TEST POINT	TP1
600261-230-001	TERMINAL	TP2-5
600114-611-006	TEST JACK	TP6
600171-415-001	IC LM324,OP AMP,QUAD	U1,3
600485-415-002	IC TL082, OP AMP,QUAD	U2
600324-415-001	IC LM339, COMPARATOR	U4
600331-415-001	IC 78MOS, 5V REG	U5
600186-415-101	IC 4066BDC, CMOS BIL SW, QUAD	U6

Figure 5.40

TRANSMIT MODULATOR  
BOARD ASSEMBLY



NOTES:  
 1. RESISTORS ARE 1/4W 5% UNLESS OTHERWISE NOTED.  
 UNMARKED DIODES ARE 1N4148  
 NPN TRANSISTORS ARE 2N3904  
 PNP TRANSISTORS ARE 2N3906  
 CAPACITORS IN MICROFARADS

Figure 5.41

TRANSMIT MODULATOR BOARD SCHEMATIC

TRANSMIT MODULATOR BOARD, 1A16

PIN CONNECTIONS AND VOLTAGE READINGS

1A16-P12

GND	1	2	GND
	3	4	DSB OUTPUT -15DBM (5MHZ)
LOGIC "0" OR "1" $\overline{A3A}$	5	6	SIDETONE (AUDIO - 20 DBM)
LOGIC "0" OR "1" $\overline{TX}$	7	8	$\overline{TX}$ LOGIC "0" OR "1"
0 - + 6VDC ACC OVERRIDE	9	10	
	11	12	GND
	13	14	3RD LO -15DBM (5MHZ)
LOGIC "0" OR "1" $\overline{RX}$	15	16	$\overline{RX}$ LOGIC "0" OR "1"
+8.9 - + 9.1 VDC	17	18	+ 8.9 - +9.1VDC
+1 to +6VDC TGC	19	20	TGC +1 to +6 VDC
0 - + 6VDC ACC IN	21	22	
GND	23	24	GND
.4 VRMS 1 KHZ IN	25	26	$\overline{KEY}$
0-+9VDC EXT ALC IN	27	28	CW SIDETONE (25MV)
0-+9VDC (T) ALC IN	29	30	PIT LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{ISB INH}$	31	32	MUTE LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{AMT}$	33	34	$\overline{COMP}$
LOGIC "0" OR "1" TUNE	35	36	* LOW LEVEL DYN MIC IN (.005 - .07 VRMS) CARBON MIC INPUT (.15 - 2.0 VRMS)
LOGIC "0" OR "1" $\overline{CW}$	37	38	DYNAMIC MIC INPUT (.03 - .35 VRMS)
-30 to -50 DBM (5MHZ) CARRIER OUT	39	40	600 OHM AUDIO IN (-10 - + 10 DBM)
	41	42	BAL XFMR RETURN FOR PIN 40
LOGIC "0" OR "1" LOW PWR	43	44	GND

\* JP1 MUST BE IN CORRECT POSITION

### 5.9.7 IF FILTER BOARD, 1A15

See Figure 5.43 for the schematic of the IF Filter board.

The IF Filter board contains the three standard selectable 5 MHz information filters and amplifiers used in both receive and transmit operation. These filters are: FL1, for USB, CW, FSK and AME (transmit) operation; FL2, for LSB operation; and FL3, for AM receive operation. An optional board is available allowing selection of up to three additional filters, two for receive functions only and a third for both transmit and receive use. Two rf connectors on the IF Filter board provide access to the Option IF Filter board.

The appropriate filter is selected via diode switching based on mode information from the Interface board. During receive, a 5 MHz IF signal is passed through the selected IF filter and further amplified in three stages. An Automatic Gain Control (AGC) voltage from the Audio/Squelch board controls the gain of these amplifiers to maintain a constant IF output over a large range of input levels.

In transmit, a 5 MHz Double Sideband Suppressed Carrier (DSSC) signal from the Transmit Modulator board is applied to the board and the selected filter removes the unwanted sideband. In AME or A3A modes, a hybrid combiner adds a controlled amount of 5 MHz carrier. The signal is then routed through an amplifier whose gain is controlled by the TGC voltage.

#### 5.9.7.1 Filter Selection

The filters are selected by placing a ground (logic low) on the appropriate filter select line. FL1 is used to receive and transmit USB, CW, FSK and DATA and to transmit AME and A3A. Since a frequency inversion occurs in the mixer, the USB passband is actually on the lower side of 5 MHz. In other words, FL1 is in reality an LSB filter at the IF.

When USB is selected, a ground placed on the /USB line will turn on diode CR11 which turns on PIN diodes CR2 and CR3, allowing the signal to flow through FL1. The other diodes are back-biased and are therefore turned off, preventing

the signal from entering any other filter.

Filter FL2 is selected in a similar manner.

Filter FL3 is selected for AM receive operation by a ground on the /AM line, which turns Q5 on, turning on CR6 and CR7, allowing the signal to pass through FL3. During AM transmit, a ground on the /AMT line disables Q5 and the AM filter, and selects FL1, the USB filter.

#### 5.9.7.2 Receive Path

Q3 is the receive path 5 MHz amplifier and provides 22 dB gain with a 50 ohm input and output impedance. The output of this amplifier is passed through diode CR9, turned on by the application of the +9R voltage bus, to the selected filter. CR8 is back-biased, preventing loading by the transmit circuitry.

The filter output is routed through CR19, turned on by application of the +9R voltage bus (back-biasing CR20), and applied to IF Amplifier Q6. Rx gain control, R35, allows variation in the receive path gain to overcome tolerances in the receive signal path, and to provide a fixed end-to-end board gain. This adjustment directly affects the AGC threshold for the receiver. The gain of Q6 may be reduced by 30 dB in response to an AGC signal through PIN diode CR16.

The signal is further amplified by Q7 in a similar circuit with AGC control through PIN diode CR17.

Q8 is an emitter follower which provides the IF output, with a low source impedance for the Audio Squelch board.

U1 is an AGC amplifier driving current amplifier Q11 which supplies current to the PIN diodes CR16 and CR17 for AGC control of the IF amplifier. The AGC will reduce the IF gain by about 60 dB with an AGC voltage input of 8 VDC.

#### 5.9.7.3 Transmit Path

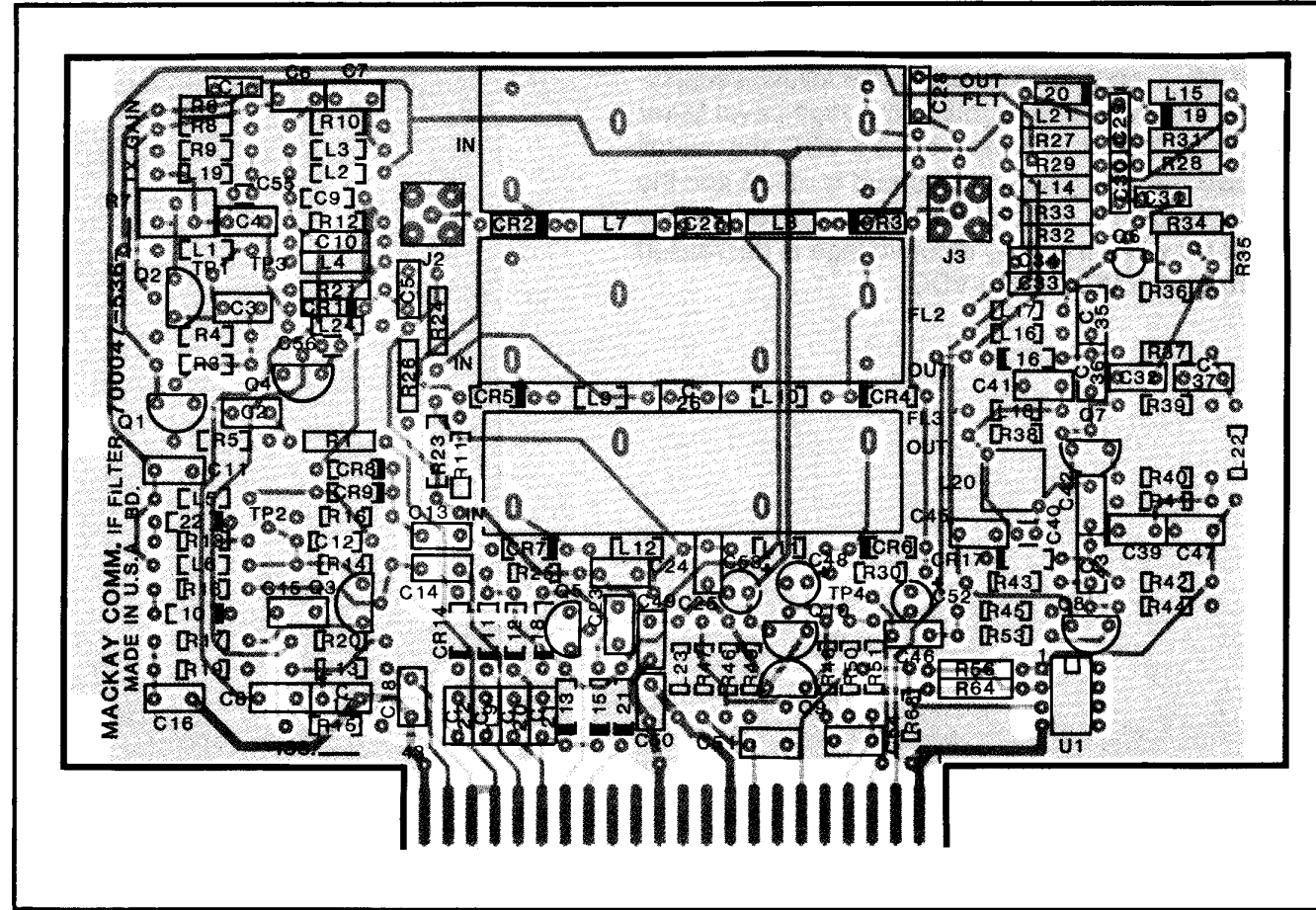
The double sideband input to the IF Filter board is attenuated by 3 dB, then applied to the proper filter through CR20. CR20 is turned on by the +9T voltage bus activated in transmit mode. The USB or LSB emerging from the filter is passed through

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CR8 (turned on by the +9T bus) to a 3 dB combiner circuit tuned to 5 MHz. The combiner adds carrier to the SSB signal in AME or A3A modes.

The combiner output is amplified by Q2. Overall fixed maximum transmit gain is established with control R7, while dynamic gain is established through the TGC system into Q4, which supplies

current through PIN diode CR1 to adjust the gain of Q2. Transistor Q1 is an emitter follower supplying the transmit IF signal to the High Level Mixer board. With a TGC input of +5.5 VDC, the overall SSB transmit gain on this board is +6 dB and the carrier gain is +32 dB. Both gains are reduced by 32 dB when the TGC input voltage is decreased from +5.5 VDC to 2.0 VDC.



(700047-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002	INSULATOR WASHER	(FL1-3)
600084-529-001	FILTER, USB	FL1
600083-529-001	FILTER, LSB	FL2
600082-529-001	FILTER, AM, 6KHZ BANDWIDTH	FL3
700047-536-951	IF FILTER BD W/O FILTERS	W/O FILTERS

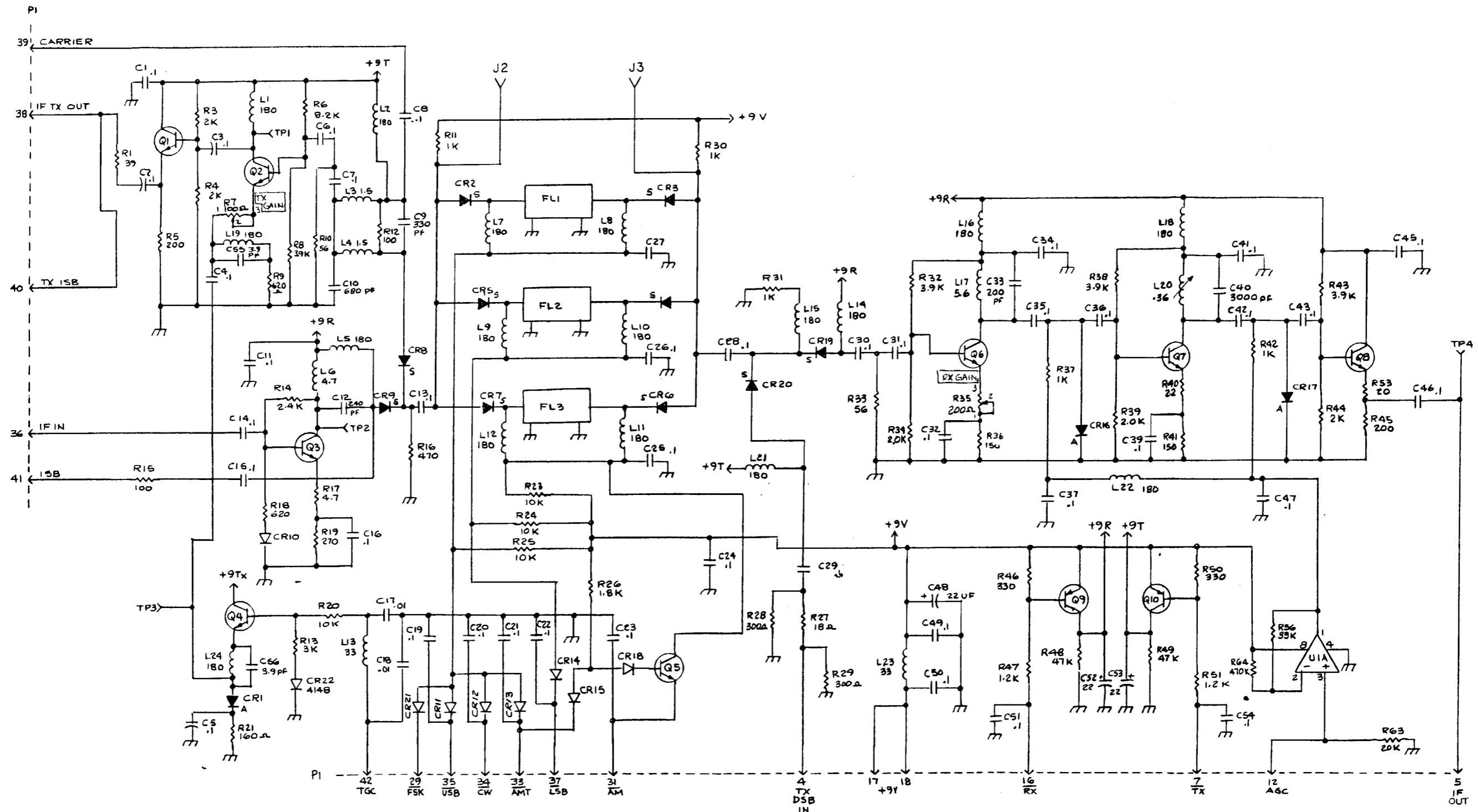
(700047-536-951) WITHOUT FILTERS

PART NUMBER	DESCRIPTION	SYMBOL
600302-314-013	CAP. .1UF, MYLAR, 50V	C1-8,11 13-16,39 19-32, 34-37, 41-43 45-47,54 49-51
600293-314-681	CAP. 680PF, CER, 50V	C10
600293-314-241	CAP. 240PF, CER, 50V	C12
600302-314-007	CAP. .01UF, MYLAR, 63V	C17,18
600293-314-201	CAP. 200PF, CER, 50V	C33
600265-314-026	CAP. 3000PF, CER, 100V	C40
600297-314-016	CAP. 22UF, ALUM, 25V	C48,52,53
600265-314-008	CAP. 3.9PF, CER, 100V	C55,56
600293-314-331	CAP. 330PF, CER, 50V	C9
600156-410-001	DIODE HP3080	CR1,16,17
600109-410-001	DIODE IN4148	CR10-14 18,21,22
600052-410-001	DIODE IN270	CR15
600144-410-001	DIODE HP3188	CR2-9, 19,20
702002-608-001	CONN. COAX, RT ANGLE	J2,J3
600125-376-022	CHOKE 180UH	L1,2,5, 7-12,18 14-16,19 21,22,24
600125-376-007	CHOKE 33UH	L13,23
600125-376-043	CHOKE 5.6UH	L17
600247-376-001	COIL,VAR, .283-.405UH	L20
600125-376-033	CHOKE 1.5 UH	L3,4
600125-376-030	CHOKE 4.7UH	L6
600229-413-003	TRANS 2N3904 TO-92	Q1-8
600116-413-002	TRANS, 2N3906	Q9,10
639094-341-075	RES. 39, 1/4W, 5%	R1

PART NUMBER	DESCRIPTION	SYMBOL
656094-341-075	RES. 56, 1/4W, 5%	R10,33
610014-341-075	RES. 1K, 1/4W, 5%	R11,30, 31,37,42
610004-341-075	RES. 100, 1/4W, 5%	R12,15
630014-341-075	RES. 3K, 1/4W, 5%	R13
624014-341-075	RES. 2.4K, 1/4W, 5%	R14
647004-341-075	RES. 470, 1/4W, 5%	R16
647084-341-075	RES. 4.7, 1/4W, 5%	R17
627004-341-075	RES. 270, 1/4W, 5%	R19
610024-341-075	RES. 10K, 1/4W, 5%	R20,23-25
616004-341-075	RES. 160, 1/4W, 5%	R21
618014-341-075	RES. 1.8K, 1/4W, 5%	R26
618094-341-075	RES. 18, 1/4W, 5%	R27
630004-341-075	RES. 300, 1/4W, 5%	R28,29
620014-341-075	RES. 2K, 1/4W, 5%	R3,4,34 39,44 R35
600066-360-005	POT. 200, 1/2W, CERMET, RT/AN	R36,41
615004-341-075	RES. 150, 1/4W, 5%	R40
622094-341-075	RES. 22, 1/4W, 5%	R46,50
633004-341-075	RES. 330, 1/4W, 5%	R47,51
612014-341-075	RES. 1.2K, 1/4W, 5%	R48,49
647024-341-075	RES. 47K, 1/4W, 5%	R5,45
620004-341-075	RES. 200, 1/4W, 5%	R53
620094-341-075	RES. 20, 1/4W, 5%	R56
633024-341-075	RES. 33K, 1/4W, 5%	R6
682014-341-075	RES. 8.2K, 1/4W, 5%	R63
620024-341-075	RES. 20K, 1/4W, 5%	R64
647034-341-075	RES. 470K, 1/4W, 5%	R7
600066-360-004	POT. 100, 1/2W, CERMET, RT/AN	R8,32, 38,43 R9,18
639014-341-075	RES. 3.9K, 1/4W, 5%	U1
662004-341-075	RES. 620, 1/4W, 5%	
600150-415-001	IC LM358, OP AMP, LP DUAL	

Figure 5.42

IF FILTER BOARD ASSEMBLY



CAPACITORS IN UF  
 RESISTORS 1/4 W 5%  
 IC = LM358  
 CHOKES IN μH 1/4 W  
 TRANSISTORS 2N3904 NPN 2N3906 PNP  
 DIODES  $\nabla$  = IN4148  
 $\nabla_S$  = HPS0B2-3188  
 $\nabla_A$  = HPS0BE-3080

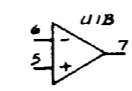


Figure 5.43  
 IF FILTER BOARD SCHEMATIC

IF FILTER BOARD, 1A15

PIN CONNECTIONS AND VOLTAGE READINGS

1A15-P16

GND	1	2	GND
	3	4	TX DSB IN -15DBM (5MHZ)
(5MHZ) -30DBM IF OUT (R)	5	6	
LOGIC "0" OR "1" TX	7	8	
	9	10	
	11	12	AGC INPUT (R) +1-+8VDC
	13	14	
	15	16	RX LOGIC "0" OR "1"
+9VDC	17	18	+9VDC
	19	20	
	21	22	
GND	23	24	GND
	25	26	
	27	28	
LOGIC "0" OR "1" FSK	29	30	
LOGIC "0" OR "1" AM	31	32	
LOGIC "0" OR "1" AMT	33	34	CW LOGIC "0" OR "1"
LOGIC "0" OR "1" USB	35	36	IF IN (R) -120 -15DBM (5MHZ)
	37	38	IF TX OUT -8DBM MAX (5MHZ)
(5MHZ) -30-50DBM CARRIER	39	40	TX ISB (NOT USED)
(NOT USED) RX ISB	41	42	TGC (T) +1-+6VDC
	43	44	GND

## 5.9.8 HIGH LEVEL MIXER BOARD, 1A14

See Figure 5.46 for the schematic of the High Level Mixer board and Figure 5.44 for the block diagram.

The High Level Mixer board is a bidirectional board, that is, it has signal gain in both transmit and receive directions. In receive mode, it converts a 0 to 30 MHz rf input signal to a first IF of 59.53 MHz and subsequently a second IF of 5 MHz. In transmit mode, it converts a 5 MHz input to 59.53 MHz and then to rf outputs of 1.6 to 30 MHz. All interfaces are at 50 ohms impedance.

In receive, inputs on the Rx input are selected by the rf switch and filtered by the 30 MHz low pass filter. The first mixer, with amplified LO input of +21 dBm at 59.53 to 89.53 MHz, converts the rf signals to a 59.53 MHz IF. A lossless constant-resistance network and a non-reflective crystal filter network provide the mixer with a broadband IF termination. A bilateral amplifier provides gain controllable by a delayed AGC. A second crystal filter at 59.53 MHz controls spurious responses due to the second mixer and complements the selectivity of the first filter and the system information filter, giving a total of 120 dB ultimate selectivity. The second mixer, with an amplified LO level of +10 dBm, converts the 59.53 MHz signals to a 5 MHz IF. The second LO amplifier may be gated off by 9 VDC pulses for noise blanking.

In transmit, the signal path is reversed with inputs at the 5 MHz IF, converted to a 59.53 MHz IF and amplified by the bilateral amplifier (in the transmit direction this time). The rf switch directs the 1.6 to 30 MHz outputs from the first mixer to the Tx amplifier for output to the power amplifier.

### 5.9.8.1 Rx Control

A TTL low level at the base of Q8 causes the transistor to saturate, putting +9 VDC on all RX functions.

### 5.9.8.2 Rf Switch

CR1 is turned on by the +9 RX line, allowing received signals to be conducted to the input low pass filter. CR2, the transmit switch, is back-biased off.

### 5.9.8.3 First Mixer

Signals from the low pass filter are applied to the first mixer, MX1, a high level double-balanced mixer. These input rf signals are mixed with the First LO signal to produce a first IF of 59.53 MHz. A 90 degree hybrid tuned broadly to 59.53 MHz splits the input into each filter and recombines the signals at the filter outputs. These networks maintain a 50 ohm impedance over a very broad range of frequencies, minimizing nonlinearity due to mismatch.

### 5.9.8.4 Bilateral Amplifier

The bilateral amplifier, Q9 and Q10, is activated in the appropriate direction by the +9 Rx or +9 Tx voltage sources. They are switched into the signal path by diodes CR5, CR9 or CR10, CR7 to allow signal amplification in either direction through the board.

In receive, the signal flows through CR5 to Q9, where it is amplified by 18 dB, then output through CR9 to filter FL3. When CR5 and CR9 are turned on, transmit path diodes CR7 and CR10 are back-biased off. The delayed AGC (DAGC) forward biases PIN diodes CR4 and CR8 to reduce the gain of Q9, attenuating both input and output levels to maintain linearity.

In transmit, amplifier Q10 is connected to the signal path in the transmit direction by CR7 and CR10. The circuit is essentially identical to that of Q9.

### 5.9.8.5 Second Mixer

The 59.53 MHz first IF signal is converted to a second IF of 5 MHz by a second double-balanced mixer, MX2, then filtered to remove the 59.53 MHz IF feedthrough, the second LO and other undesired mixing products.

### 5.9.8.6 First LO Amplifier

The first LO amplifier, consisting of FETS Q5 and Q6 in parallel and grounded emitter stage Q4, produces a +21 dBm signal at the Mixer from a 0 dBm input. An input filter to the FET amplifier reduces low frequency LO noise. Q3 is a bias regulator that maintains a constant collector cur-

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rent through Q4 by regulating the base current.

#### 5.9.8.7 Second LO Amplifier

JFETs Q11 and Q12 are paralleled to produce a +10 dBm output at the second mixer, from a 0 dBm, 54.53 MHz second LO input. Q13 is a gate which cuts off the LO amplifier when Q13 receives a +9 VDC signal at its base circuit. This could be used as a noise blanker gate and may be used as a transmit inhibit gate in transmit applications.

#### 5.9.8.8 Transmit Amplifier

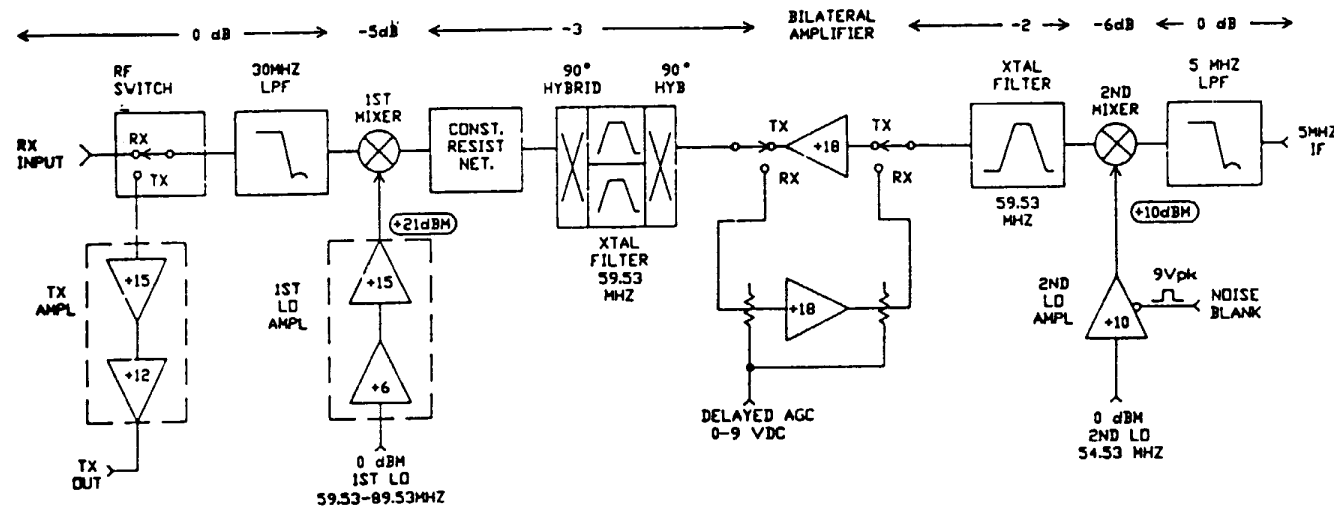
Q1 and Q2 are feedback-controlled amplifiers which increase the first mixer output level to +17 dBm at 1.6 to 30 MHz. The mixer output is routed

first through a low pass filter to remove unwanted mixer products, then is sent to the base of Q2. The amplified signal at the collector of Q2 is passed on to Q1, where it is further amplified for use by the power amplifier. Diode CR3 provides temperature compensation to the bias network of Q1.

#### 5.9.8.9 DC Voltage Control

Q7 and Q8 provide the sources for the +9 Rx and +9 Tx buses. A ground on the /Tx or /Rx lines will energize the appropriate switch, allowing the receive or transmit circuits to be energized. The signals controlling the /Rx and /Tx lines are generated from mutually-exclusive logic, so both Rx and Tx cannot be on at the same time.

Figure 5.44 HIGH LEVEL MIXER BOARD BLOCK DIAGRAM



(601258-536-002)

PART NUMBER	DESCRIPTION	SYMBOL
600083-242-001	COMPONENT HOLDER	(L6)
600170-419-008	THERMAL WASHER	(Q1)
600017-419-001	TRANSISTOR PAD	(Q2)
600025-419-001	TRANSISTOR PAD	(Q3, 7-10 13, 11-3)
600226-314-014	CAP. 1UF, CER, 50V	C1, 3
600226-314-008	CAP. .1UF, CER, 50V	C14, 15
600210-314-040	CAP. 470PF, CER, 100V	C16
600210-314-037	CAP. 1500PF, CER, 100V	C19
600302-314-013	CAP. .1UF, MYLAR, 50V	C2, 9-13, 17, 18, 42 24-26, 53 57, 70, 72
600293-314-430	CAP. 43PF, CER, 50V	C20
600369-314-181	CAP. 180PF, CER, 100V	C30
600369-314-270	CAP. 27PF, CER, 100V	C31, 32, 37, 38
600052-317-001	CAP. VAR, 3-10PF	C33, 35
600269-314-005	CAP. 4.7PF, CER, 500V	C34, 36, 55, 56
600369-314-820	CAP. 82PF, CER, 100V	C4
600369-314-150	CAP. 15PF, CER, 100V	C5, 29, 45, 49
600302-314-007	CAP. .01UF, MYLAR, 63V	C58, 60, 61 65-68, 73 44, 46-48 50-52, 54 21-23, 27 39-41, 43
600369-314-120	CAP. 12PF, CER, 100V	C59
600369-314-151	CAP. 150PF, CER, 100V	C6
600293-314-821	CAP. 820PF, CER, 50V	C62, 63
600302-314-001	CAP. .001UF, MYLAR, 63V	C64
600297-314-003	CAP. 1UF, ALUM, 50V	C69, 71
600369-314-470	CAP. 47PF, CER, 100V	C7
600297-314-025	CAP. 47UF, ALUM, 25V	C74, 75
600369-314-680	CAP. 68PF, CER, 100V	C8, 28
600144-410-001	DIODE HP3188	CR1, 2, 5 7, 9, 10
600006-411-007	DIODE IN4734A 5.6V	CR11
600109-410-001	DIODE IN4148	CR3
600156-410-001	DIODE HP3080	CR4, 8
600011-416-002	DIODE IN4004	CR6
600100-102-001	CABLE	CX1, 2, 3
600060-529-004	FILTER, 59.53 MHZ	FL1-3
600125-376-015	CHOKE 470UH	L1
600125-376-027	CHOKE .47UH	L13
600243-376-008	COIL, VAR, .06uH	L14
600125-376-040	CHOKE 1.0UH	L15, 16, 19, 20, 33, 31

PART NUMBER	DESCRIPTION	SYMBOL
600125-376-028	CHOKE .1UH	L17, 18, 32
600125-376-022	CHOKE 180UH	L2, 5
600125-376-004	CHOKE .39UH	L25, 28
600125-376-037	CHOKE .27UH	L3
600125-376-006	CHOKE 3.3UH	L30, 37 38, 29, 10 11, 21-24 26, 27
600125-376-005	CHOKE .56UH	L35
600125-376-016	CHOKE 2.2UH	L36
600125-376-031	CHOKE .18UH	L4
600072-376-032	CHOKE 39UH	L6
600125-376-032	CHOKE 10UH	L7, 34
600125-376-036	CHOKE .12UH	L8, 9, 12
600018-455-001	MIXER CNP206	MX1
600007-455-001	MIXER SRA 3H	MX2
600222-413-001	TRANSISTOR 2N4427	Q1
600080-413-001	TRANSISTOR 2N2222A	Q13
600082-413-001	TRANSISTOR 2N2219A	Q2
600154-413-001	TRANSISTOR 2N2907A	Q3, 7, 8
600399-413-001	TRANSISTOR MRF237	Q4
600259-413-001	TRANSISTOR J310	Q5, 6, 11, 12 Q9, 10
600177-413-001	TRANSISTOR 2N5179	
647004-341-075	RES. 470, 1/4W, 5%	R1, 15, 29
656014-341-075	RES. 5.6K, 1/4W, 5%	R10
633014-341-075	RES. 3.3K, 1/4W, 5%	R11, 21, 28
627014-341-075	RES. 2.7K, 1/4W, 5%	R12, 35-38
611024-341-075	RES. 11K, 1/4W, 5%	R13, 41
620094-341-205	RES. 20, 1/2W, 5%	R14
620004-341-075	RES. 200, 1/4W, 5%	R16, 32
651094-341-075	RES. 51, 1/4W, 5%	R17-19
630004-341-075	RES. 300, 1/4W, 5%	R2, 3
624014-341-075	RES. 2.4K, 1/4W, 5%	R20, 30
616014-341-075	RES. 1.6K, 1/4W, 5%	R22, 27
668084-341-075	RES. 6.8, 1/4W, 5%	R23, 26
622004-341-075	RES. 220, 1/4W, 5%	R24, 25
610014-341-075	RES. 1K, 1/4W, 5%	R31
630014-341-075	RES. 3K, 1/4W, 5%	R33
647024-341-075	RES. 47K, 1/4W, 5%	R34, 40
600000-341-075	RES. 0, 1/4W, 5%	R39
675084-341-075	RES. 7.5, 1/4W, 5%	R4, 5
615004-341-075	RES. 150, 1/4W, 5%	R6
647084-341-075	RES. 4.7, 1/4W, 5%	R7
668094-341-075	RES. 68, 1/4W, 5%	R8
633004-341-075	RES. 330, 1/4W, 5%	R9
600094-512-001	TRANS, 3:1, BALUN	T2
600164-513-001	TRANSFORMER	T3, 4

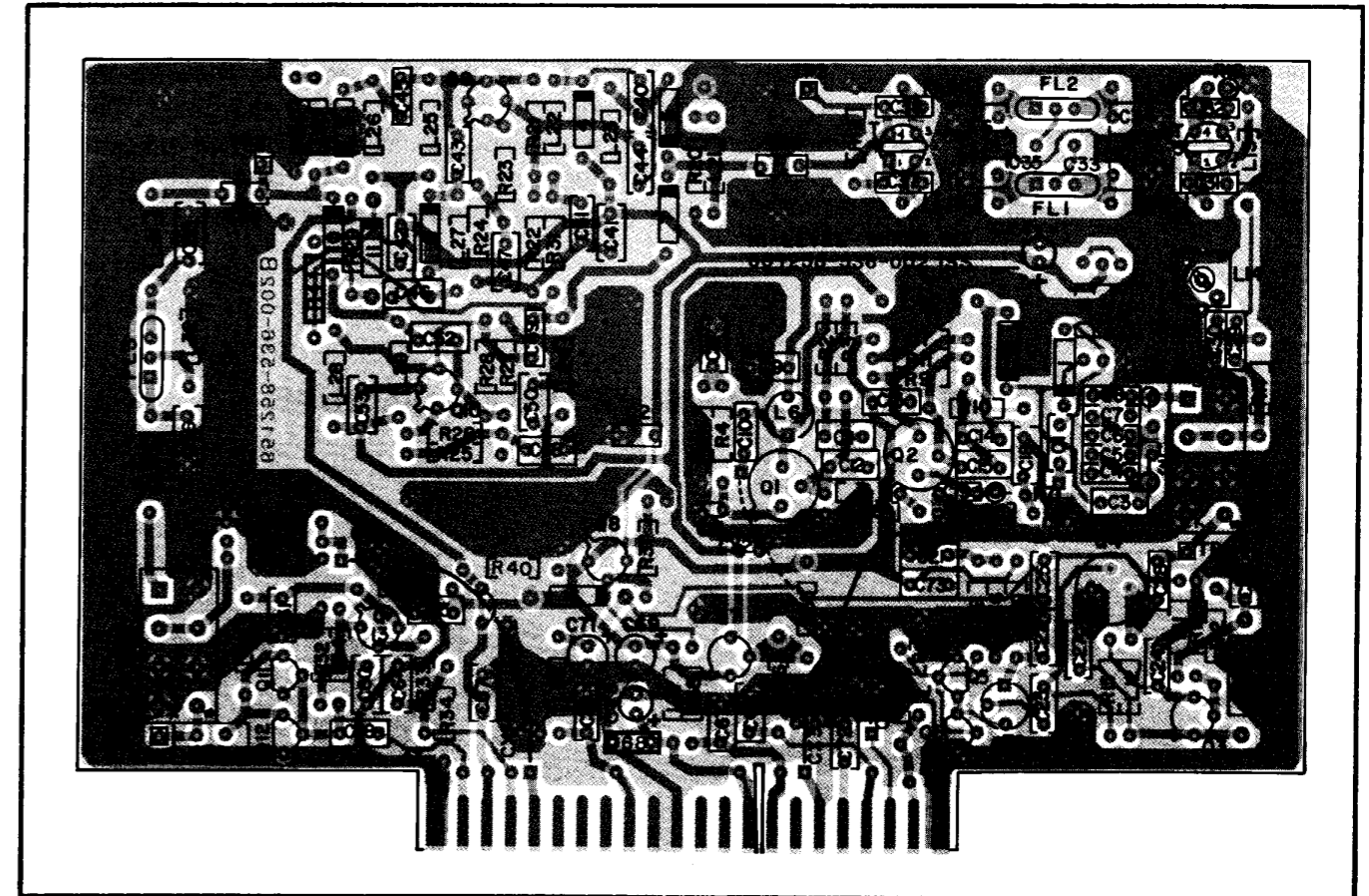
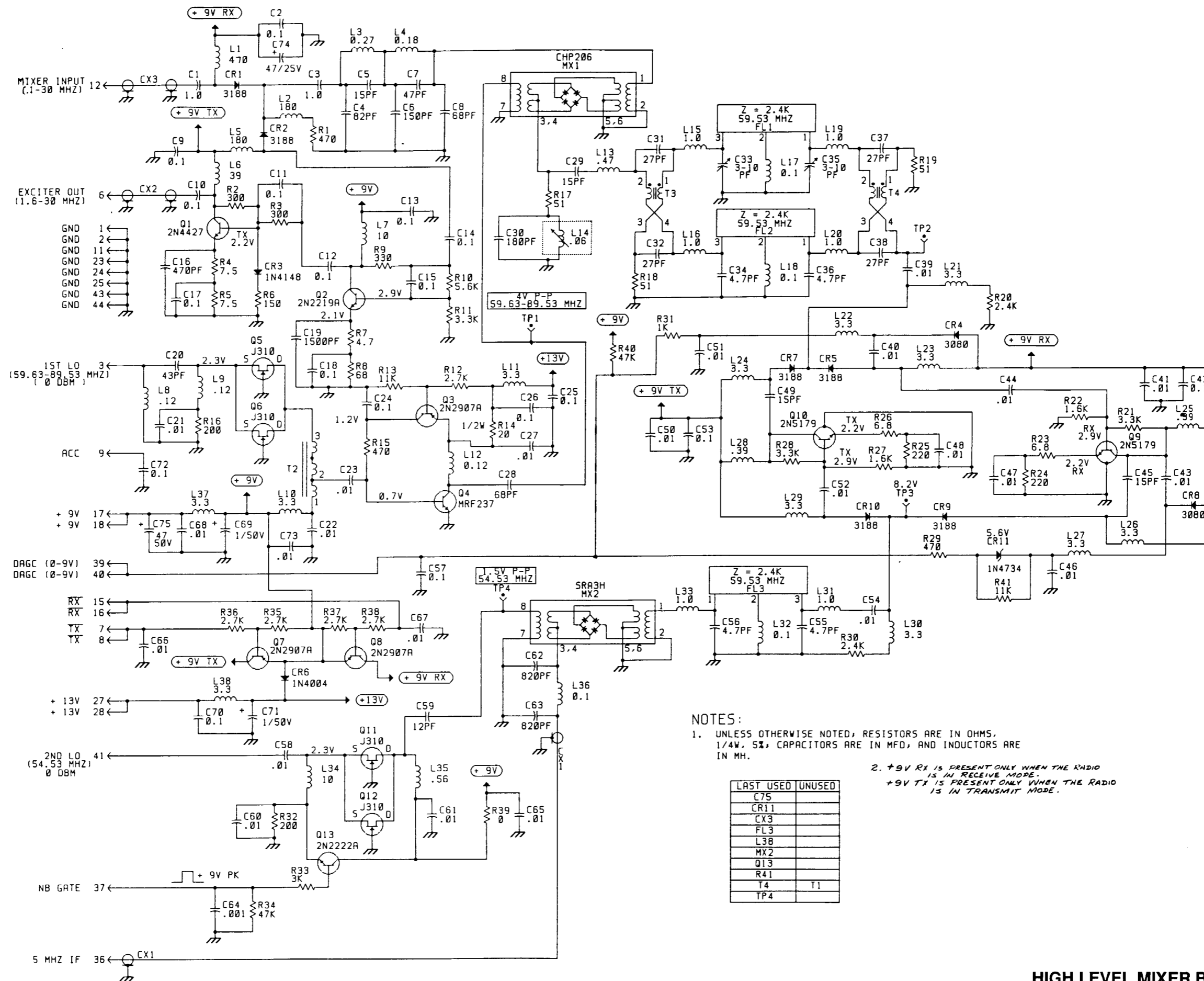


Figure 5.45

HIGH LEVEL MIXER BOARD ASSEMBLY



NOTES:  
 1. UNLESS OTHERWISE NOTED, RESISTORS ARE IN OHMS, 1/4W, 5%, CAPACITORS ARE IN MFD, AND INDUCTORS ARE IN MH.  
 2. +9V RX IS PRESENT ONLY WHEN THE RADIO IS IN RECEIVE MODE.  
 +9V TX IS PRESENT ONLY WHEN THE RADIO IS IN TRANSMIT MODE.

LAST USED	UNUSED
C75	
CR11	
CX3	
FL3	
L38	
MX2	
Q13	
R41	
T4	T1
TP4	

Figure 5.46

HIGH LEVEL MIXER BOARD SCHEMATIC

HIGH LEVEL MIXER BOARD, 1A14

PIN CONNECTIONS AND VOLTAGE READINGS

		1A14-P18			
GND	○	1	2	○	GND
ODBM 59.63 - 89.53 MHZ 1ST LO	○	3	4	○	
	○	5	6	○	EXCITER OUT 3VP-P (1.6 - 30.0 MHZ)
LOGIC "0" OR "1" TX	○	7	8	○	TX LOGIC "0" OR "1"
(N.C.) ACC	○	9	10	○	
GND	○	11	12	○	MIXER INPUT (.1-30.0 MHZ) .2 μV - 1.0V(R)
	○	13	14	○	
LOGIC "0" OR "1" RX	○	15	16	○	RX LOGIC "0" OR "1"
+9VDC	○	17	18	○	+9VDC
	○	19	20	○	
	○	21	22	○	
GND	○	23	24	○	GND
GND	○	25	26	○	+13.2VDC
+13.2VDC	○	27	28	○	
	○	29	30	○	
	○	31	32	○	
	○	33	34	○	
	○	35	36	○	IF IN/OUT (-120-15DBM 5.0 MHZ)
(NOT USED) N.B. GATE	○	37	38	○	
(0-+6VDC) DELAYED AGC	○	39	40	○	DELAYED AGC (0-+6VDC)
0 DBM 54.53 MHZ 2ND LO	○	41	42	○	
GND	○	43	44	○	GND

### 5.9.9 HIGH PASS FILTER BOARD, 1A13

See Figure 5.48 for the schematic of the High Pass Filter board.

The High Pass Filter board contains eight half-octave high pass filters with cut-off frequencies of 1.6, 2, 3, 4, 6, 9, 13 and 20 MHz. These filters are switched with diodes and transistors. The board also contains a broadcast band filter and an rf amplifier, used in the receive mode. The adjustment controls for the A3A carrier level are located on this board. A transmit/receive relay is used to bypass the broadcast filter and the rf amplifier in the transmit mode. And a filter bypass relay is used to bypass the filter board in receive modes at frequencies below 2.0 MHz.

#### 5.9.9.1 High Pass Filters

Band 1 is switched by diodes CR1 and CR2, which are energized by transistor Q6. Q6 is turned on by a ground at the /B1 input. All other band switching diodes are back-biased. A ground at any of the band lines, /B1 through /B8, will energize that band in a similar manner, turning off all other bands. Output of the filter network is sent to the broadcast filter.

#### 5.9.9.2 Rf Amplifier

The receive rf amplifier consists of two paralleled

high level FETs, Q4 and Q5, in grounded gate configuration for best intermodulation performance. With this amplifier, the overall receive gain on this board is +4 to +8 dB.

#### 5.9.9.3 Transmit Switch

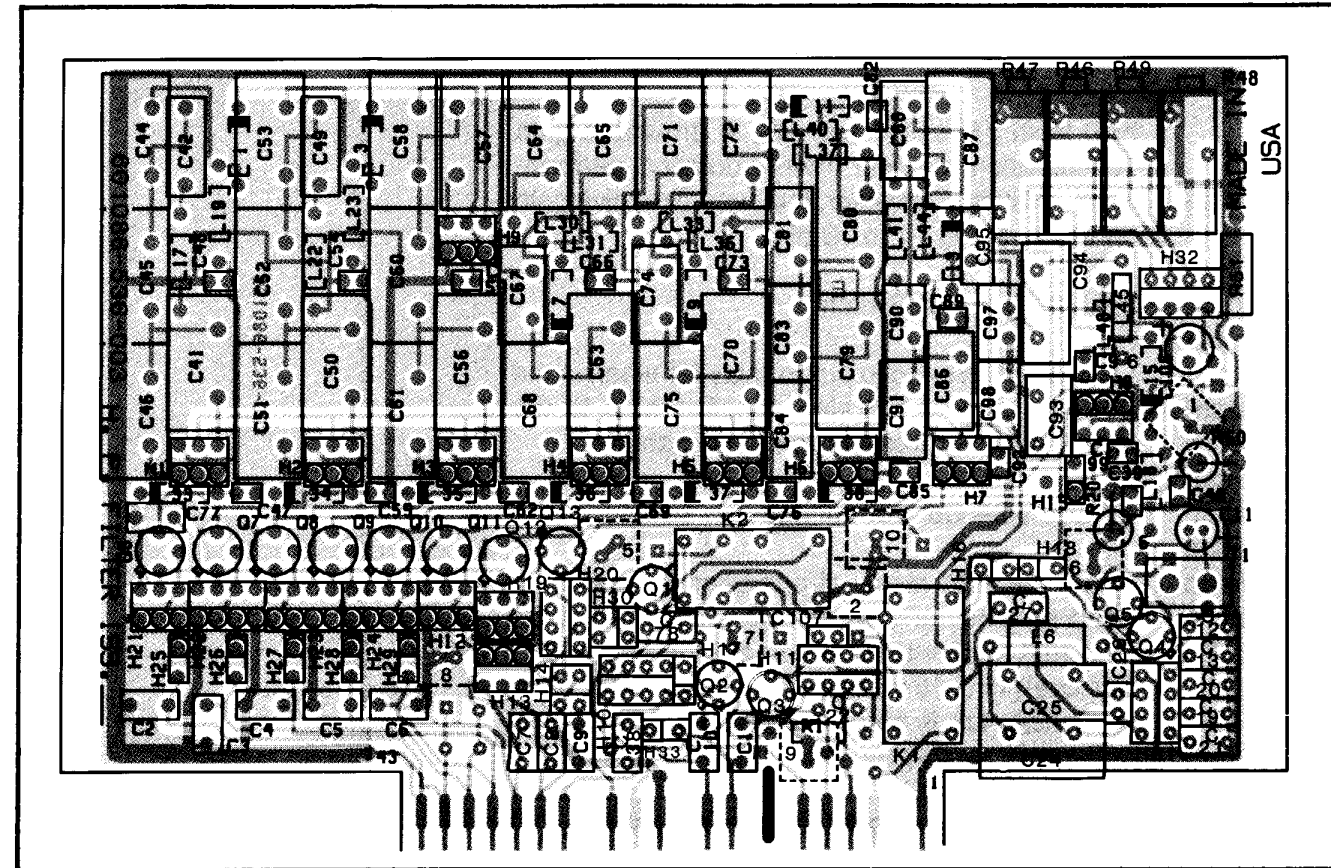
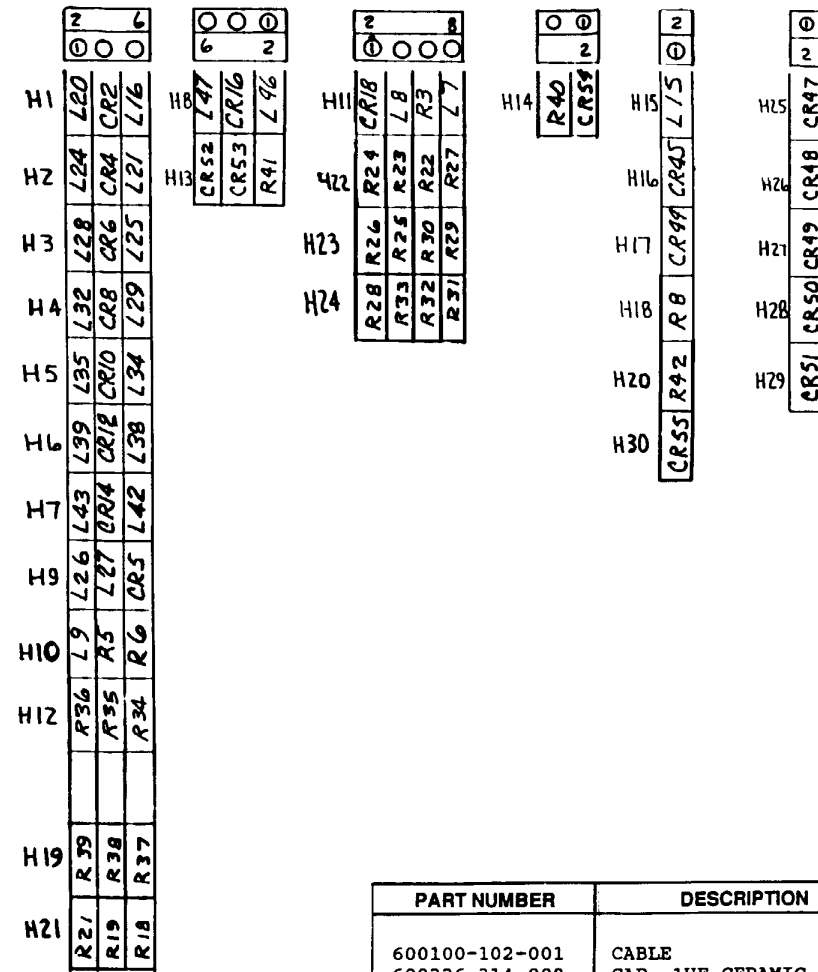
Q2 is a switch used to pull in relay K1 when in the transmit mode. Q2 also supplies bias to the power amplifier transistors during transmit.

#### 5.9.9.4 A3A Control Voltage

When the A3A mode of operation is desired, a band-switched analog voltage is required at the Transmit Modulator board to set the proper carrier level (16 to 18 dB below PEP). In modes other than A3A, Q3 is saturated and no A3A control voltage is available. When A3A is selected, a ground appears on the /A3A line and transistor Q3 is cut off, allowing the appropriate control, R46 through R49, to supply A3A carrier control voltage to the Transmit Modulator board.

#### 5.9.9.5 High Pass Filter Bypass

Transistor Q1 is used to energize relay K2, bypassing the entire High Pass Filter board when a receive frequency below 2.0 MHz is selected. A ground on the /HPF Bypass line saturates Q1, pulling in relay K2.



(601086-536-003)

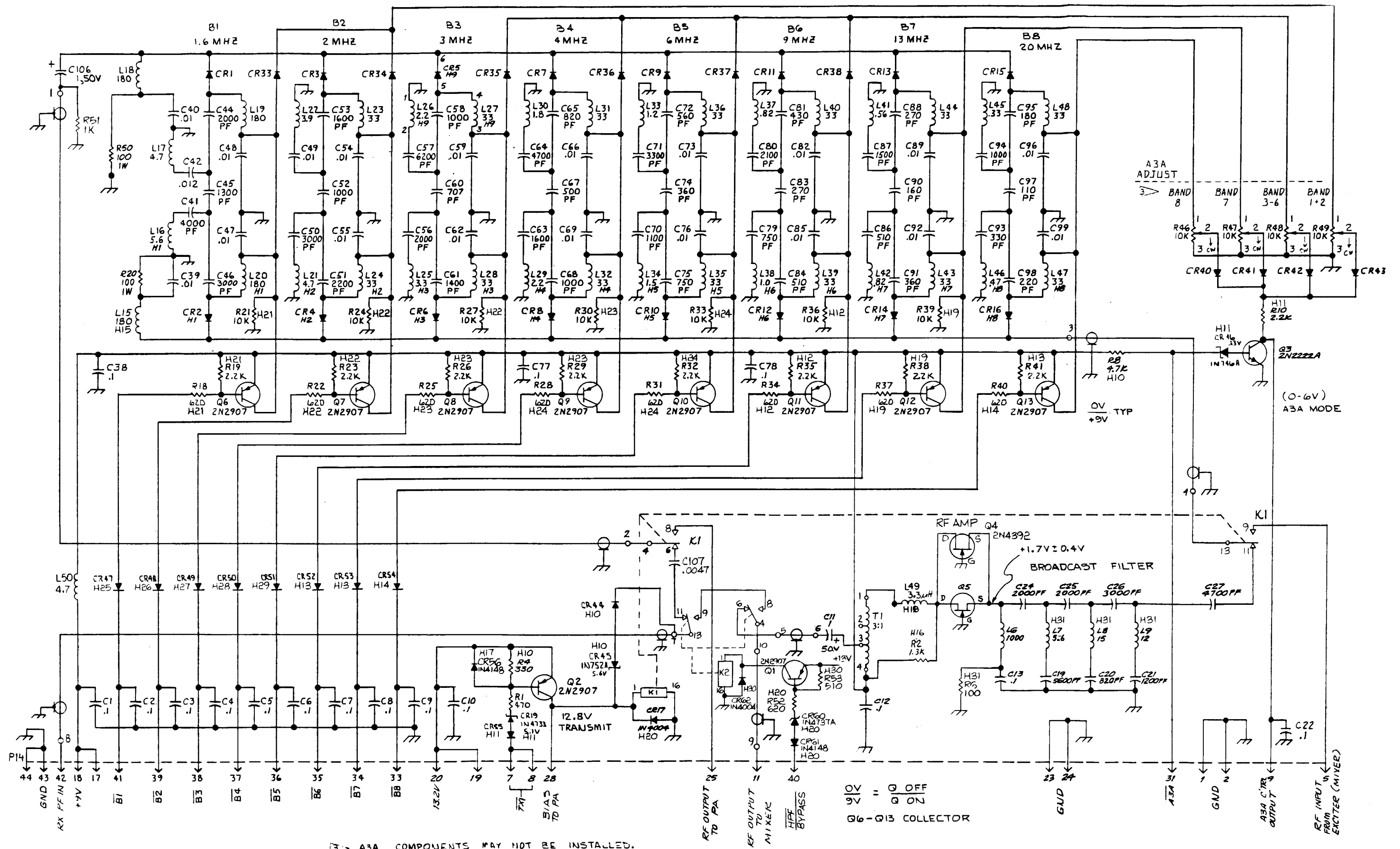
Figure 5.47

HIGH PASS FILTER BOARD ASSEMBLY

PART NUMBER	DESCRIPTION	SYMBOL
600100-102-001	CABLE	C1-10, 12
600226-314-008	CAP .1UF, CERAMIC, 50V	13, 22, 38 77, 78
600268-314-007	CAP .0047UF, CERAMIC, 50V	C107
600297-314-003	CAP. 1UF, ALUM, 50V	C11, 106
600369-314-562	CAP 5600PF, CERAMIC, 100V	C19
600369-314-821	CAP 820PF, CERAMIC, 100V	C20
600369-314-122	CAP 1200PF, CERAMIC, 100V	C21
620013-306-501	CAP. 2000PF, 3%, MICA, 500V	C24, 25, 44, 56
600265-314-026	CAP. 3000PF, CER, 100V	C26
600369-314-472	CAP. 4700PF, CER, 100V	C27
600268-314-008	CAP. .01UF, CER, 50V	C39, 40, 47, 48, 54 55, 59, 62 66, 69, 73 76, 82, 85 89, 92, 96 99
640011-306-501	CAP. 4000PF, 1%, MICA, 500V	C41
600204-314-022	CAP .012UF, MYLAR, 400V	C42
613014-306-501	CAP. 1300PF, 5%, MICA, 500V	C45
630014-306-501	CAP. 3000PF, 5%, MICA, 500V	C46, 50
600204-314-001	CAP. .01UF, MYLAR, 400V	C49
622014-306-501	CAP. 2200PF, 5%, MICA, 500V	C51, 57
610013-306-501	CAP. 1000PF, 3%, MICA, 500V	C52, 58 68, 94
616013-306-501	CAP. 1600PF, 3%, MICA, 500V	C53, 63
670703-306-501	CAP. 707PF, 3%, MICA, 500V	C60
614013-306-501	CAP. 1400PF, 3%, MICA, 500V	C61
647014-306-501	CAP. 4700PF, 5%, MICA, 500V	C64
682003-306-501	CAP. 820PF, 3%, MICA, 500V	C65
650001-306-501	CAP. 500PF, 1%, MICA, 500V	C67
611013-306-501	CAP. 1100PF, 3%, MICA, 500V	C70
633014-306-501	CAP. 3300PF, 5%, MICA, 500V	C71
656003-306-501	CAP. 560PF, 3%, MICA 500V	C72

PART NUMBER	DESCRIPTION	SYMBOL
636003-306-501	CAP. 360PF, 3%, MICA, 500V	C74, 91
675003-306-501	CAP. 750PF, 3%, MICA, 500V	C75, 79
621011-306-501	CAP. 2100PF, 1%, MICA, 500V	C80
643003-306-501	CAP. 430PF, 3%, MICA, 500V	C81
627003-306-501	CAP. 270PF, 3%, MICA, 500V	C83, 88
651003-306-501	CAP. 510PF, 3%, MICA, 500V	C84, 86
615013-306-501	CAP. 1500PF, 3%, MICA, 500V	C87
616003-306-501	CAP. 160PF, 3%, MICA, 500V	C90
633003-306-501	CAP. 330PF, 3%, MICA, 500V	C93
618004-306-501	CAP. 180PF, 5%, MICA, 500V	C95
611004-306-501	CAP. 110PF, 5%, MICA, 500V	C97
622003-306-501	CAP. 220PF, 3%, MICA, 500V	C98
600144-410-001	DIODE HP3188	CR1-16
600011-416-002	DIODE IN4004	CR17, 62
600006-411-006	DIODE, ZENER, 1N4733A	CR19
600109-410-001	DIODE IN4148	CR33-38, 40-44, 61 47-56 CR45
600002-411-007	DIODE, ZENER, 1N752A 5.6V	CR46
600002-411-001	DIODE, ZENER, 1N746A	CR60
600006-411-010	DIODE, ZENER, 1N4737A, 7.5V	
600064-419-001	4 POS VERTICAL MT.	H10, 11, 20 22-24, 31
600064-419-003	3 POS VERTICAL MT.	H1-9, 12 13, 19, 21
600064-419-004	2 POS VERTICAL MT.	H14, 30
600064-419-005	1 POS VERTICAL MT.	H15-18, 25-29
600094-403-003	RELAY, DPDT, 12V, 3A CONTACTS	K1, 2
600125-376-022	CHOKE 180UH	L15, 18-20
600125-376-030	CHOKE 4.7UH	L17, 21, 50

PART NUMBER	DESCRIPTION	SYMBOL
600125-376-018	CHOKE 3.9UH	L22
600125-376-007	CHOKE 33UH	L23, 24, 28, 31, 32 35, 39, 40 43, 44, 47 48, 27, 36 L25, L49
600125-376-006	CHOKE 3.3UH	L26, 29
600125-376-016	CHOKE 2.2UH	L30
600125-376-017	CHOKE 1.8UH	L33
600125-376-041	CHOKE 1.2UH	L34
600125-376-033	CHOKE 1.5 UH	L37, 42
600125-376-039	CHOKE .82UH	L38
600125-376-040	CHOKE 1.0UH	L41
600125-376-005	CHOKE .56UH	L45
600125-376-001	CHOKE .33UH	L46
600125-376-027	CHOKE .47UH	L6
600034-376-001	CHOKE 1000UH	L7, 16
600125-376-043	CHOKE 5.6UH	L8
600125-376-013	CHOKE 15UH	L9
600125-376-020	CHOKE 12UH	
600154-413-001	TRANSISTOR 2N2907A	Q1, 2, 6-13
600080-413-001	TRANSISTOR 2N2222A	Q3
600396-413-001	TRANSISTOR 2N4392	Q4, 5
647004-341-075	RES. 470, 1/4W, 5%	R1
622014-341-075	RES. 2.2K, 1/4W, 5%	R10, 19, 23 26, 29, 32 35, 38, 41 R18, 22, 25 28, 31, 34 37, 40, 52
662004-341-075	RES. 620, 1/4W, 5%	R2
613014-341-075	RES. 1.3K, 1/4W, 5%	R20, 50
610004-341-325	RES. 100, 1W, 5%	R21, 24, 30, 33, 36 39, 42, 27
610024-341-075	RES. 10K, 1/4W, 5%	R37, 40, 52 18, 22, 25 28, 31, 34 R39, 42, 21 24, 27, 30 33, 36
662004-341-075	RES. 620, 1/4W, 5%	R4
633004-341-075	RES. 330, 1/4W, 5%	R46, 49
600063-360-010	POT. 10K, 15 TURN	R51
610014-341-075	RES. 1K, 1/4W, 5%	R53
651004-341-075	RES. 510, 1/4, 5%	R6
610004-341-075	RES. 100, 1/4W, 5%	R8
647014-341-075	RES. 4.7K, 1/4W, 5%	
600148-512-001	TRANS, 3:1, TOROID	T1



⚠ A3A COMPONENTS MAY NOT BE INSTALLED.

- NOTES:
- UNLESS OTHERWISE NOTED :  
RESISTORS ARE IN OHMS, 1/4W, 5%  
CAPACITORS ARE IN MFD  
INDUCTORS ARE IN MHY.
  - DIODE CR17 IS IN4004, CR1-16 ARE HP3108, CR19 IN4728,  
ALL OTHERS ARE IN4148

Figure 5.48  
HIGH PASS FILTER BOARD SCHEMATIC

HIGH PASS FILTER BOARD, 1A13

PIN CONNECTIONS AND VOLTAGE READINGS

1A13-P20

GND	1	2	GND
	3	4	
+13 DBM RF (T)	5	6	$\overline{\text{TX}}$ LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{TX}}$	7	8	
0 - +6 VDC A3A	9	10	
REC. RF OUTPUT	11	12	
	13	14	
+9VDC	15	16	+9VDC
	17	18	
+13.2VDC	19	20	+13.2 VDC
	21	22	
GND	23	24	GND
+13DBM RF TO PA (T)	25	26	
	27	28	PA BIAS +12.8VDC
	29	30	
LOGIC "0" OR "1" $\overline{\text{A3A}}$	31	32	$\overline{\text{B7}}$ LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{B8}}$	33	34	$\overline{\text{B5}}$ LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{B6}}$	35	36	
LOGIC "0" OR "1" $\overline{\text{B4}}$	37	38	$\overline{\text{B3}}$ LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{B2}}$	39	40	HPF BYPASS
LOGIC "0" OR "1" $\overline{\text{B1}}$	41	42	REC. RF INPUT
GND	43	44	GND

### 5.9.10 HALF OCTAVE FILTER BOARD, 1A12

See Figure 5.50 for the schematic of the Half Octave Filter board.

This board contains the harmonic filters for the transmitter output, the ALC detector, the ACC circuitry, a reflected power detector for protection of the power amplifier module under excessive VSWR conditions, and circuits to protect the PA from over-temperature, over-current and over-voltage conditions.

#### 5.9.10.1 Harmonic Filters

The harmonic filters are divided into eight bands with cut-off frequencies of 2, 3, 4, 6, 9, 13, 20 and 30 MHz. The filters are designed for 40 dB attenuation of PA harmonics and are optimized for rejection of the second harmonic, and for flatness of in-band impedance. The proper filter is selected by a ground on one of the band lines, /B1 through /B8. This saturates the appropriate control transistor, Q2 through Q9, energizing the appropriate relays at the input and output of the chosen filter. Unused filters are shorted out by their relays when deenergized. Diodes are used as transient snubbers to prevent damage to the switching transistors. In band 8, CR25 protects against the relay turn-off spike, and CR33 protects against damage from plugging or unplugging the board with power applied.

#### 5.9.10.2 ALC Detector

The ALC detector provides the ALC circuit with a DC voltage proportional to the peak rf output voltage of the transmitter. A resistive divider on the rf output line generates a sample of the rf voltage and applies it to rectifier CR1. Frequency compensation of this divider is provided by C2, which is adjusted to give the same detector output at 29.9 MHz as was obtained at 2 MHz. The detected rf signal (now a DC voltage) is rf filtered and passed to DC amplifiers U1A and U1C. U1A is a peak-detecting voltage follower designed to store the peak ALC voltage in C3. This peak ALC voltage is applied to U1B, a variable-gain amplifier adjusted via R11 to give 6.0 VDC output on the

ALC line for 79 VRMS rf output.

#### 5.9.10.3 ACC Circuitry

The ACC circuitry is responsible for keeping the average rf power output constant in AME mode. A sample of the ALC detector voltage is amplified by U1C, giving an output waveform which follows the modulation envelope. This is applied to the ACC threshold amplifier U1D and compared with the carrier threshold voltage set by R13. The output of U1D is connected to the ACC line through diodes CR6 and CR8. The ACC line is routed to the Transmit Modulator board, where a reduction in voltage causes a decrease in the transmit signal path gain. With no ACC, this line is at about +6.5 VDC. When the ACC circuit is controlling the output, the line voltage will stabilize at some value between +6 VDC and +1 VDC.

When the transceiver is keyed in AME mode, the /AMT command line will be low, causing U3A to go high. This cuts off CR5 and CR7, allowing the ACC amplifier U1D and the external ACC amplifier U2A to operate.

#### 5.9.10.4 External ACC

External ACC is applied to the input of the external ACC amplifier, U2A. When no external ACC voltage exists, the input to U2A is biased so that diode CR9 is cut off and the external ACC amplifier is out of the circuit. When an external ACC voltage is present, the output voltage on U2A decreases to turn on CR9 and allow the external ACC amplifier to control the ACC output.

#### 5.9.10.5 Power Amplifier Protection Circuits

U2B monitors PA overcurrent, U2C monitors reflected power, and U2D monitors the PA temperature. These devices act to protect the power amplifier and turn on the front panel FAULT light, indicating a problem. Comparators' outputs are OR'd together with CR10, CR11, CR12 and CR13, so that a fault in overcurrent or temperature will pull the ACC line low, reducing drive to the power amplifier. If VSWR or temperature circuits are activated, U3B and Q1 turn on the FAULT indicator.

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#### 5.9.10.5.1 Reflected Power

The reflected power detector provides an output voltage proportional to the reflected power seen by the PA. When this voltage exceeds a preset threshold, the output of U2C drops, causing a Fault indication through U3B, Q1, etc.

#### 5.9.10.5.2 Overtemperature

The PA contains a thermistor which provides a varying resistance proportional to the temperature of the mounting flange of one of the output power transistors. The thermistor is connected to +9 VDC and so supplies a varying voltage to the comparator U2D, which is compared with a preset threshold. When this threshold is exceeded, the comparator cuts back the drive power to the PA, reducing the dissipation and temperature to safe levels. Since the temperature time constant is very long, an uncorrected over-temperature condition will cause the rf output voltage ampli-

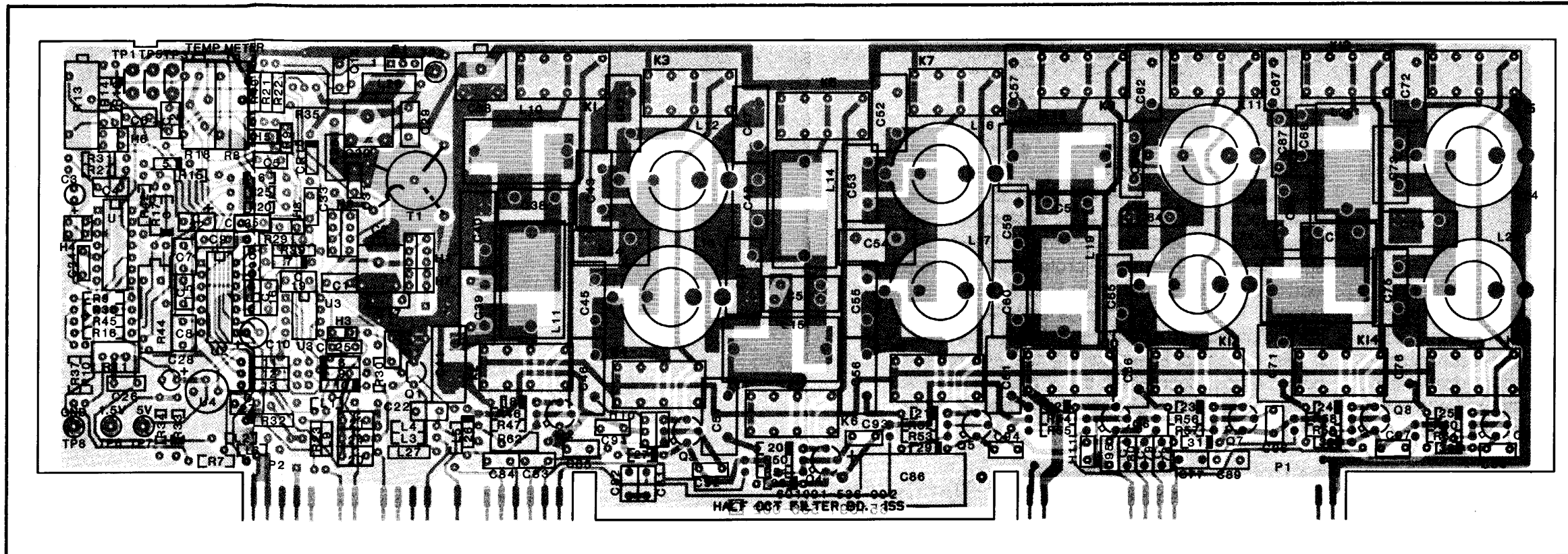
tude to vary at a very slow rate.

#### 5.9.10.5.3 Overcurrent

Detector diode CR16 provides a DC voltage proportional to the current in the transmission line, which in turn is proportional to the load impedance. The ALC already protects the PA from loads greater than 50 ohms by limiting the output voltage. This circuit protects the PA from loads less than 50 ohms by limiting the output current. The detector output is fed to U2B where it is compared with a preset threshold (+1.5 VDC). If this threshold is exceeded, the comparator output drops, decreasing the rf drive to the PA until the current level detected is equal to the preset threshold.

#### 5.9.10.6 Internal Voltage Regulator

U4 provides a regulated +5 VDC for stable threshold voltages.



(601091-536-002)

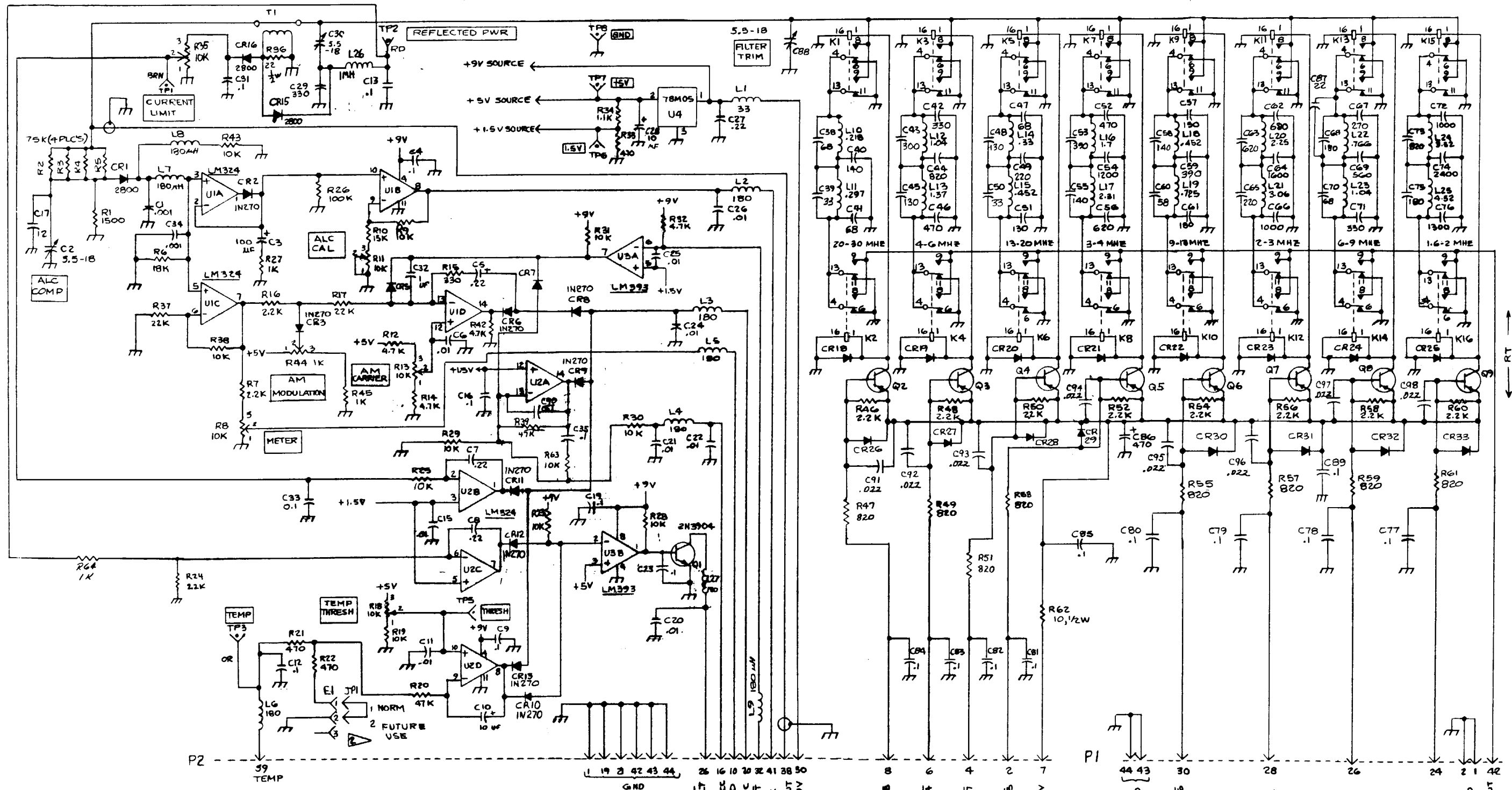
PART NUMBER	DESCRIPTION	SYMBOL
600037-643-001	RUBBER BUMPER	
600342-604-001	SHIELD	
600302-314-001	CAP. .001UF,MYLAR,63V	C1,34
600202-314-018	CAP. 10UF, 25V, TANT.	C10,28
600269-314-010	CAP. 12PF,CERAMIC,500V	C17
600018-317-014	TRIMMER CAP, 5.5-18PF, 175VDC	C2,30,88
633003-306-501	CAP. 330PF,3%,MICA,500V	C29
600297-314-031	CAP. 100UF, ALUM, 10V	C3
600302-314-013	CAP. .1UF, MYLAR, 50V	C31,33, 35,77-85 89
600226-314-014	CAP. 1UF, CERAMIC, 50V	C32
600287-314-056	CAP 68PF,DM19,MICA,500V	C38,41, 47,70
600308-314-013	CAP 33PF,CERAMIC,2.5KV	C39,50
600302-314-013	CAP. .1UF, MYLAR, 50V	C4,9, 12-13,16 19,23
600287-314-045	CAP 140PF,DM19,MICA, 500V	C40,55, 58
600287-314-051	CAP 330PF,DM19,MICA, 500V	C42,71
600287-314-054	CAP 300PF,DM19,MICA, 500V	C43
682002-306-501	CAP. 820PF, 2%,MICA, 500V	C44,73
600287-314-044	CAP 130PF,DM19,MICA, 500V	C45,48, 51
600287-314-058	CAP 470PF,DM19,MICA, 500V	C46,52
600287-314-048	CAP 220PF,DM19,MICA, 500V	C49,65
600302-314-015	CAP. .22UF, MYLAR, 50V	C5,7,8,27
600287-314-052	CAP 390PF,DM19,MICA, 500V	C53,59
612011-306-501	CAP 1200PF,1%,MICA,500V	C54
662001-306-501	CAP. 620PF, 1%,MICA, 500V	C56,63
600287-314-055	CAP 150PF,DM19,MICA, 500V	C57
600302-314-007	CAP. .01UF, MYLAR, 63V	C6,11,15 20,21,22 24-26
600287-314-040	CAP 58PF,DM19,MICA, 500V	C60
600302-314-009	CAP .022UF,MYLAR,63V	C91-98
600287-314-047	CAP 180PF,DM19,MICA 500V	C61,68, 75

PART NUMBER	DESCRIPTION	SYMBOL
668002-306-501	CAP 680PF,2%,MICA,500V	C62
616012-306-501	CAP 1600PF,2%,MICA,500V	C64
610011-306-501	CAP. 1000PF,1%,MICA, 500V	C66,72
600287-314-050	CAP 270PF,DM19,MICA, 500V	C67
656002-306-501	CAP 560PF,2%,MICA,500V	C69
624011-306-501	CAP 2400PF,1%,MICA,500V	C74
613012-306-501	CAP. 1300PF,2%,MICA, 500V	C76
600259-314-103	CAP 470UF,ALUM,25V, AXIAL	C86
600308-314-011	CAP 22PF,CERAMIC,2.5KV	C87
600302-314-013	CAP. .1UF, MYLAR, 50V	C90
600118-410-002	DIODE,HOT CARRIER, HP2800	CR1,15, 16
600052-410-001	DIODE IN270	CR2,3,6 8-13
600109-410-001	DIODE IN4148	CR5,7, 18-33
600198-608-005	CONN. HEADER,3 PIN,TIN	E1
600064-419-001	4 POS VERTICAL MT.	H2
600064-419-003	3 POS VERTICAL MT.	H1,10
600064-419-004	2 POS VERTICAL MT.	H4,6,7
600064-419-005	1 POS VERTICAL MT.	H3,5,8,9
600190-608-001	CONN, JUMPER, 2 POS.	JP1
600094-403-003	RELAY, DPDT, 12V, 3A CONTACTS	K1-16
600125-376-007	CHOKE 33UH	L1
670119-513-001	INDUCTOR .218UH	L10
670119-513-002	INDUCTOR .297UH	L11
670123-513-010	COIL, TOROID, 1.04 UH	L12
670123-513-009	COIL, TOROID 1.37UH	L13
670119-513-003	INDUCTOR .330UH	L14
670119-513-004	INDUCTOR .452UH	L15,18
670123-513-006	INDUCTOR 1.70UH	L16
670123-513-005	INDUCTOR 2.31UH	L17
670119-513-006	INDUCTOR .725UH	L19
600125-376-022	CHOKE 180UH	L2-9,27
670123-513-004	INDUCTOR 2.25UH	L20
670123-513-003	INDUCTOR 3.06UH	L21
670119-513-007	INDUCTOR .766UH	L22
670119-513-008	INDUCTOR 1.043UH	L23
670123-513-002	INDUCTOR 3.32UH	L24

PART NUMBER	DESCRIPTION	SYMBOL
670123-513-001	INDUCTOR 4.52UH	L25
600034-376-001	CHOKE 1000UH	L26
600229-413-003	TRANSISTOR 2N3904 TO-92	Q1
600154-413-001	TRANSISTOR 2N2907A	Q2-9
615014-341-075	RES. 1.5K, 1/4W, 5%	R1
615024-341-075	RES. 15K, 1/4W, 5%	R10
600089-360-010	POT. 10K, 1/2W, CERMET RT/AN	R11,35
647014-341-075	RES. 4.7K, 1/4W, 5%	R12,14, 32,42
633004-341-075	RES. 330, 1/4W, 5%	R15
622024-341-075	RES. 22K, 1/4W, 5%	R17,37
675024-341-075	RES. 75K, 1/4W, 5%	R2-5
647024-341-075	RES. 47K, 1/4W, 5%	R20,39
647004-341-075	RES. 470, 1/4W, 5%	R22,21,33
610034-341-075	RES. 100K, 1/4W, 5%	R26
610014-341-075	RES. 1K, 1/4W, 5%	R27,45,64
611014-341-075	RES. 1.1K, 1/4W, 5%	R34
622094-341-205	RES. 22, 1/2W, 5%	R36
610024-341-075	RES. 10K, 1/4W, 5%	R38,43,63
600063-360-007	POT. 1K, 15 TURN	R44
682004-341-075	RES. 820, 1/4W, 5%	R47,49, 53,55,57 59,61,51
618024-341-075	RES. 18K, 1/4W, 5%	R6
610094-341-205	RES 10 1/2W 5%	R62
622014-341-075	RES. 2.2K, 1/4W, 5%	R7,16,24 46,48,50 52,54,56 58,60
600063-360-010	POT. 10K, 15 TURN	R8,13,18
610024-341-075	RES. 10K, 1/4W, 5%	R9,19,23 25,28-30 31
600138-512-001	DETECTOR TOROID	T1
600114-611-001	BROWN TEST POINT	TP1
600114-611-003	ORANGE TEST POINT	TP3
600114-611-005	JACK	TP5
600261-230-001	TERMINAL	TP6-8,2
600171-415-001	IC LM324,OP AMP,QUAD	U1,2
600486-415-001	IC LM393,DUAL VOL COMP	U3
600017-419-001	TRANSISTOR PAD	(U4)
600331-415-001	IC 78MOS, 5V REG	U4

Figure 5.49

HALF OCTAVE FILTER BOARD ASSEMBLY



NOTES:  
 1. UNLESS OTHERWISE NOTED:  
 RESISTORS ARE IN OHMS, 1/4W ±5%;  
 CAPACITOR VALUES OF ONE OR GREATER ARE IN PICOFARADS (PF),  
 VALUES LESS THAN ONE ARE IN MICROFARADS (UF);  
 INDUCTORS ARE IN MICRONEHRS (MH).  
 Q2 THRU Q9 COLLECTOR + (11-13VDC) WHEN BAND IS ENERGIZED.  
 POSITION 1 IS THE NORMAL POSITION FOR JPI. POSITION 2  
 IS FOR FUTURE USE WITH LATER VERSION PA ASSEMBLIES.

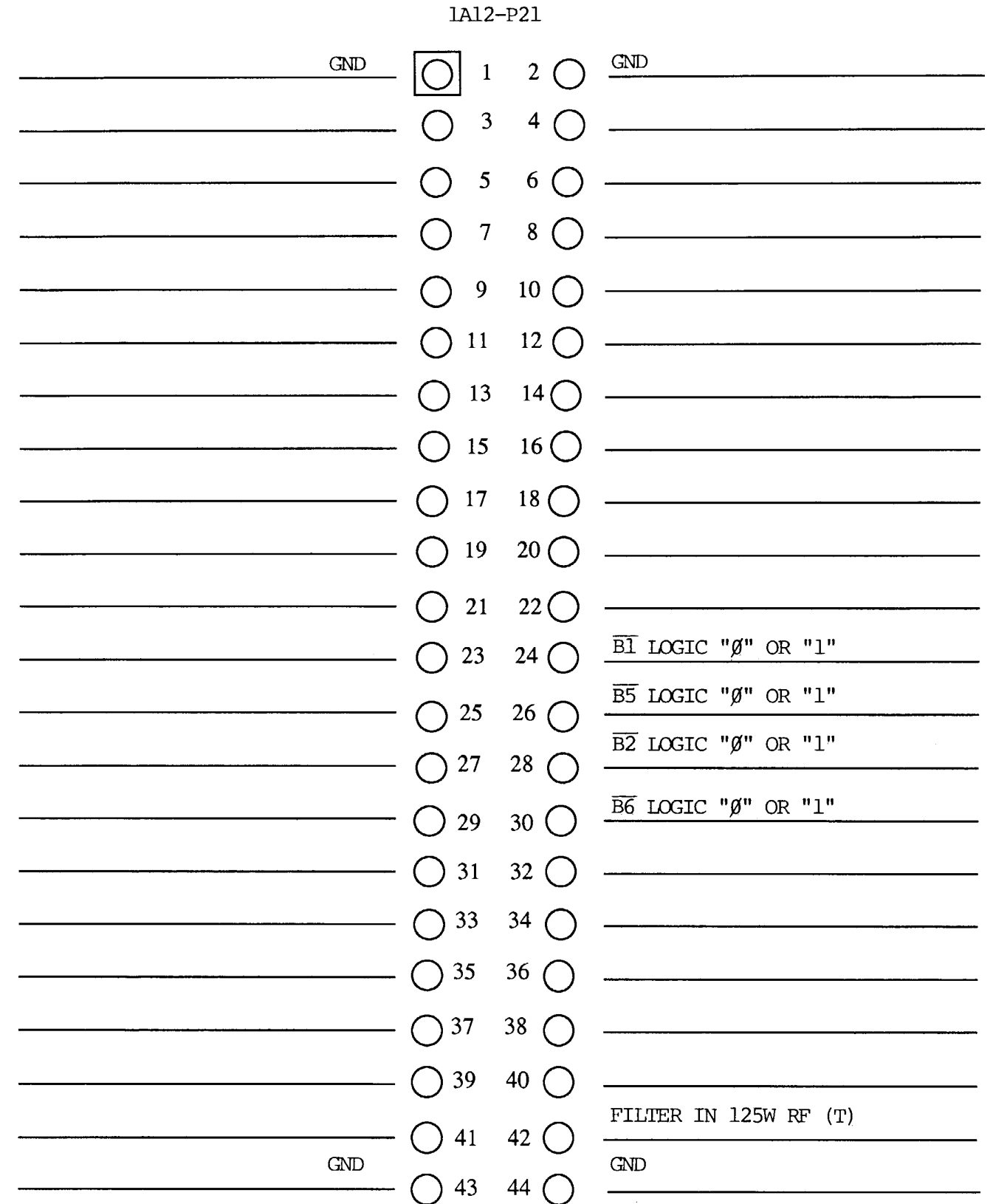
ALL UNMARKED DIODES ARE 1N4148  
 Q2 - Q9 = 2N2907A  
 Q1 = 2N3904

Figure 5.50

HALF OCTAVE FILTER BOARD SCHEMATIC

HALF OCTAVE FILTER BOARD, 1A12

PIN CONNECTIONS AND VOLTAGE READINGS



HALF OCTAVE FILTER BOARD, 1A12

PIN CONNECTIONS AND VOLTAGE READINGS

1A12-P22

GND	<input checked="" type="radio"/>	1	<input type="radio"/>	2	$\overline{B3}$ LOGIC "0" OR "1"
	<input type="radio"/>	3	<input type="radio"/>	4	$\overline{B7}$ LOGIC "0" OR "1"
	<input type="radio"/>	5	<input type="radio"/>	6	$\overline{B4}$ LOGIC "0" OR "1"
+12.7--13.9VDC	<input type="radio"/>	7	<input type="radio"/>	8	$\overline{B8}$ LOGIC "0" OR "1"
GND	<input type="radio"/>	9	<input type="radio"/>	10	PFD
GND	<input type="radio"/>	11	<input type="radio"/>	12	
	<input type="radio"/>	13	<input type="radio"/>	14	
	<input type="radio"/>	15	<input type="radio"/>	16	EXT ACC (0--9VDC MAX) *
	<input type="radio"/>	17	<input type="radio"/>	18	
GND	<input type="radio"/>	19	<input type="radio"/>	20	ACC 0--6VDC (AM MODE)
GND	<input type="radio"/>	21	<input type="radio"/>	22	
	<input type="radio"/>	23	<input type="radio"/>	24	
	<input type="radio"/>	25	<input type="radio"/>	26	$\overline{FAULT}$ LOGIC "0" OR "1"
	<input type="radio"/>	27	<input type="radio"/>	28	
	<input type="radio"/>	29	<input type="radio"/>	30	+8.9 - + 9.1 VDC
	<input type="radio"/>	31	<input type="radio"/>	32	$\overline{AMT}$
	<input type="radio"/>	33	<input type="radio"/>	34	
	<input type="radio"/>	35	<input type="radio"/>	36	
	<input type="radio"/>	37	<input type="radio"/>	38	FILTER OUT
0 - +6VDC TEMP.	<input type="radio"/>	39	<input type="radio"/>	40	
0 - +9VDC ALC (T)	<input type="radio"/>	41	<input type="radio"/>	42	GND
GND	<input type="radio"/>	43	<input type="radio"/>	44	GND

\* THIS VOLTAGE NOT PRESENT UNLESS EXTERNAL HIGH POWER AMPLIFIER IS USED.

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### 5.9.11 AUDIO/SQUELCH BOARD, 1A17

See Figure 5.52 for the schematic of the Audio Squelch board.

The Audio Squelch board is used to process receive functions only. It accepts the 5 MHz output from the IF Filter board and performs the final detector function of converting the intermediate frequency signal into usable audio intelligence. A product detector is used in SSB, CW, FSK and DATA modes, while an envelope detector is used in the AM mode. Two separate audio outputs are provided: one ultimately ends up at the rear panel as a balanced 600 ohm output and the other is amplified by a speaker driver and appears at the transceiver front panel speaker and phone output.

Located on the board are an input IF amplifier, envelope detector, AGC circuitry, a delayed AGC circuit, product detector, third LO amplifier, 600 ohm audio amplifier, speaker/sidetone circuits and squelch circuits. The AGC has fast attack and front panel selectable fast, medium and slow decay times. The squelch circuit is syllabic, responding to the syllabic characteristic of human speech, with a front panel enabling control.

#### 5.9.11.1 Input IF Amplifier and Envelope Detector

Q1 is a common emitter amplifier with 36 dB gain connected through an impedance-stabilizing pad to the product detector, M1, and to the gate of FET Q2. This latter stage is a source follower buffer amplifier which drives envelope detector Q3. The detected envelope is routed to U2, which selects either the product detector output in SSB, CW, FSK or DATA, or the envelope detector signal in AM. The envelope signal is also applied to the AGC circuit at U1A and U1C.

#### 5.9.11.2 Product Detector and Third LO Amplifier

The 5 MHz third LO signal for the product detector is supplied at -15 dBm. Transistor Q4 amplifies this to about +7 dBm for the product detector. The 5 MHz IF signal input to the product detector is about -10 dBm. The detected audio is applied to the analog switch U2.

#### 5.9.11.3 Speaker Audio and 600 Ohm Audio

The selected envelope or product detector audio signal from switch U2 is amplified by U4A. The audio levels from the two detectors are matched so that they are the same for an SSB (100% modulated) signal as they are for a 100% modulated AM signal. The AC ground reference for most of the analog circuitry is established at 1/2 the supply voltage by U5A. This eliminates transient outputs in the audio during switching. The 600 ohm audio signal is routed through the MUTE/SQUELCH switch U2 unless bypassed by jumper JP1 from E1, pins 1 to 2. R64 provides a level control for the 600 ohm line audio provided by the line amplifier, U4B and Q10. The line amplifier is capable of supplying +10 dBm when loaded with 600 ohms.

The speaker audio goes through analog switch U2 and is buffered by amplifier U4C before being sent to the front panel Speaker Driver board. A CW sidetone signal from the Transmit Modulator board is injected into the buffer amplifier.

#### 5.9.11.4 Squelch Circuits

The syllabic squelch circuit is basically a pulse count discriminator and integrator, which produces a gating output for the slowly changing, i.e., syllabic, frequency content of the audio signal. The gating output has a fast attack and slow decay characteristic.

The audio signal is first amplified by U6B, then squared in U6C to produce a square wave input to U7A for signals as weak as the receiver noise level. U7A and U7B form a monostable multivibrator with an output pulse width of 0.5 msec. A differentiator and integrator produce a DC voltage output proportional to the average frequency of the audio signal. U6A is an integrator with a time constant of 73 msec, which reduces output due to fast (greater than 5 Hz) frequency changes. U5D is an absolute value amplifier which produces a negative output when the peak voltage changes from R80 exceed the forward voltage drop of either CR17 or CR18. The one-shot multivibrator, formed by U7C and U7D, is triggered through CR16 and resets in about 2 seconds, unless retriggered. The positive output from U7C through CR15 forces comparator U5B high, which in turn

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enables the 600 ohm audio gate U2B and the speaker audio gate U2C.

The squelch gates may also be enabled through comparator U5B by comparator U5C, which is driven by the front panel SQUELCH control and provides a degree of squelch threshold control. (In the MSR 8050A only an OFF/ON signal is obtained from the front panel control.)

#### 5.9.11.5 AGC Circuits

U1A is an amplifier/peak detector which amplifies (gain of 50) signals from Q3 and applies them to U1B. The attack time is established by R95 and R22 with C23 to less than 10 msec. The decay time is determined by the discharge time constant of C23 through R23 for 3.0 seconds in slow AGC, through R39 for 200 msec in medium AGC, and through R38 for 30 msec in fast AGC.

U1C is identical to U1A, but with a gain of 200 and a fast charge and discharge time. The outputs of both amplifiers are compared in U1D. The output of U1C is normally higher than that of U1A, so U1D output is low. If the signal level suddenly falls, the output of U1C follows, but the output of U1A remains high due to the slow decay of C23.

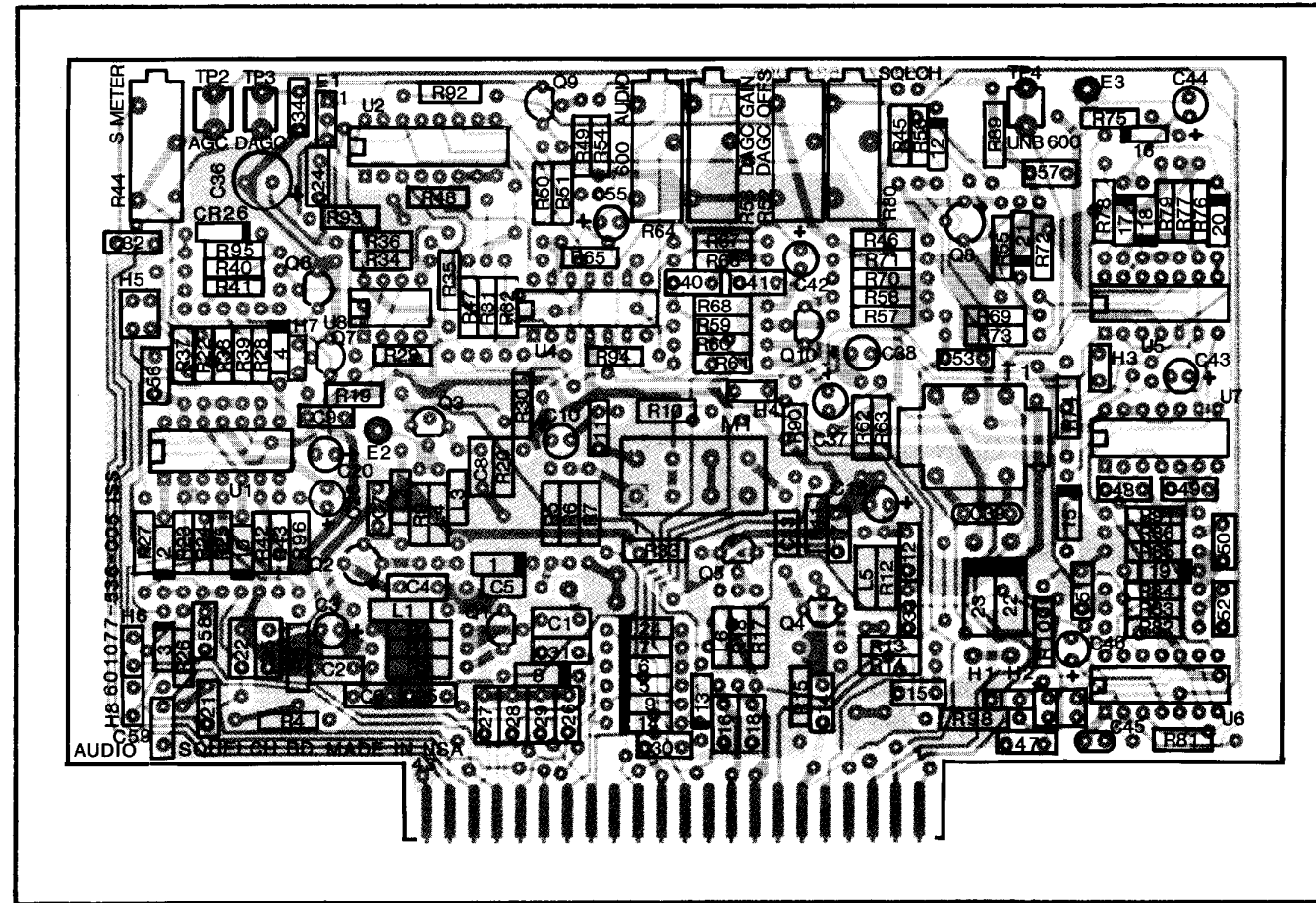
The output of U1D then goes high, switching on Q6 or Q7 (whichever has been selected by open collector comparators U3A and U3B). U3A or U3B is selected by voltage level presented to the board at pin 38. If the input voltage exceeds +7.7

VDC, both comparator outputs are low, both Q6 and Q7 are turned off and the AGC decay is slow. If the input voltage is between +3 VDC and +7.7 VDC, U3A output is high and U3B output is low, turning on Q6, and the AGC decay is medium. If the input voltage is below +3 VDC, both comparator outputs are high, turning on both Q6 and Q7, and the AGC decay is fast. An external ground on U1B through CR10 will dump the AGC voltage, putting the receiver in maximum gain. A DC voltage through CR3 allows the AGC to be overridden by the RF GAIN control. U1B is the AGC output amplifier. A logic high on pin 29 disconnects the signal driven AGC allowing the receive gain to be determined only by the RF GAIN d.c. input at pin 34.

The AGC controls the gain of the IF Filter board amplifiers, maintaining a constant audio output level over a wide rf input level range. A short on pin 26 ( $\overline{\text{DATA}}$ ) reduces the AGC threshold (lower input level for constant output) from about -90 dBm to -100 dBm. The S-meter output is adjustable by R44. A delayed AGC signal to control High Level Mixer board gain is produced by current amplifier U4D and Q9. Delayed AGC offset is adjusted with R52. Delayed AGC current gain is set with R53.

#### 5.9.11.6 Receive Voltage Gate

Transistor Q5 applies +9 VDC to the third LO amplifier Q3 and to IF amplifier and detector Q1, Q2 and Q3 in receive when the /Rx line goes low.



(601077-536-006)

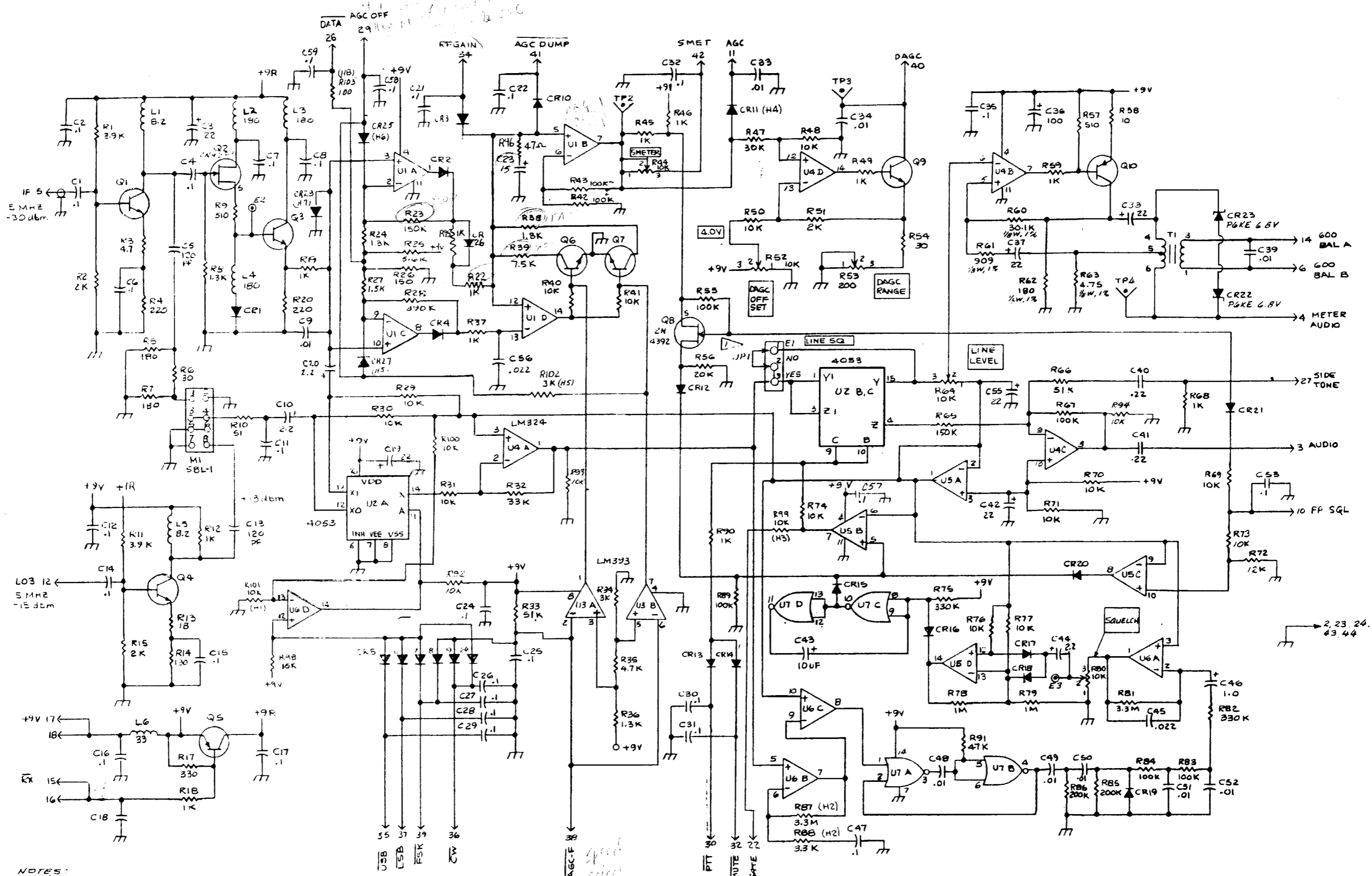
PART NUMBER	DESCRIPTION	SYMBOL
600302-314-013	CAP. .1UF, MYLAR, 50V	C1,2,4, 6-8,11 12,21,22 14-18,35 24-32,47 53,58,59
600297-314-006	CAP. 2.2UF, ALUM, 50V	C10,20,44
600202-314-020	CAP. 15UF, 20V, TANT.	C23
600297-314-016	CAP. 22UF, ALUM, 25V	C3,19,37 38,42,55
600297-314-032	CAP. 100UF, ALUM, 25V	C36
600189-314-018	CAP. .01UF, 500V	C39
600302-314-015	CAP. .22UF, MYLAR, 50V	C40,41
600202-314-018	CAP. 10UF, 25V, TANT.	C43
600268-314-012	CAP. .022UF, CER, 50V	C45
600202-314-007	CAP. 1UF, 35V, TANT.	C46
600293-314-121	CAP., 120PF, 50V	C5,13
600302-314-009	CAP. .022UF, MYLAR, 63V	C56
600302-314-007	CAP. .01UF, MYLAR, 63V	C9,33,34 48-52,57
600109-410-001	DIODE IN4148	CR1-21 24-27
600028-411-001	DIODE, VOLT.SUPPRESSOR P6KE6, 8A	CR22,23
600198-608-005	CONN HEADER, 3 PIN, TIN	E1
600261-230-001	TERMINAL	E2,3
600190-608-001	CONN, JUMPER, 2 POS.	JP1
600125-376-034	CHOKE 8.2UH	L1,5
600125-376-022	CHOKE 180UH	L2,3,4
600125-376-011	CHOKE 33UH	L6
600008-455-001	MIXER SLB-1	M1

PART NUMBER	DESCRIPTION	SYMBOL
600229-413-003	TRANS 2N3904 TO-92	Q1,3,4 6,7,9
600396-413-001	TRANSISTOR 2N4392	Q2,8
600116-413-002	TRANS, 2N3906	Q5,10
600025-419-001	TRANSISTOR PAD	(Q8)
639014-341-075	RES. 3.9K, 1/4W, 5%	R1,11
651094-341-075	RES. 51, 1/4W, 5%	R10
610004-341-075	RES. 100, 1/4W, 5%	R103
610014-341-075	RES. 1K, 1/4W, 5%	R12,18, 19,22,37 45,46,59 68,90,49 95-99
618094-341-075	RES. 18, 1/4W, 5%	R13
613004-341-075	RES. 130, 1/4W, 5%	R14
633004-341-075	RES. 330, 1/4W, 5%	R17
620014-341-075	RES. 2K, 1/4W, 5%	R2,15,51
618014-341-075	RES. 1.8K, 1/4W, 5%	R24,38
656014-341-075	RES. 5.6K, 1/4W, 5%	R25
615004-341-075	RES. 150, 1/4W, 5%	R26
615014-341-075	RES. 1.5K, 1/4W, 5%	R27
639034-341-075	RES. 390K, 1/4W, 5%	R28
610024-341-075	RES. 10K, 1/4W, 5%	R29-31, 40,41,48 50,69-71 73,74,76 77,92-94 98,100 101
647084-341-075	RES. 4.7, 1/4W, 5%	R3
633024-341-075	RES. 33K, 1/4W, 5%	R32
651024-341-075	RES. 51K, 1/4W, 5%	R33,66
630014-341-075	RES. 3K, 1/4W, 5%	R34,102
647014-341-075	RES. 4.7K, 1/4W, 5%	R35
675014-341-075	RES. 7.5K, 1/4W, 5%	R39
622004-341-075	RES. 220, 1/4W, 5%	R4,20

PART NUMBER	DESCRIPTION	SYMBOL
610034-341-075	RES. 100K, 1/4W, 5%	R42,43, 55,67,83 84,89
600063-360-010	POT. 10K, 15 TURN	R44,52 64,80
630024-341-075	RES. 30K, 1/4W, 5%	R47
618004-341-075	RES. 180, 1/4W, 5%	R5,7,62
600063-360-005	POT. 200, 15 TURN	R53
620024-341-075	RES. 20K, 1/4W, 5%	R56
610094-341-075	RES. 10, 1/4W, 5%	R58
630094-341-075	RES. 30, 1/4W, 5%	R6,54
630121-342-059	RES. 30.1K, 1/8W, 1%	R60
690901-342-059	RES. 909, 1/8W, 1%	R61
647581-342-059	RES. 4.75, 1/8W, 1%	R63
615034-341-075	RES. 150K, 1/4W, 5%	R65,23
612024-341-075	RES. 12K, 1/4W, 5%	R72
633034-341-075	RES. 330K, 1/4W, 5%	R75,82
610044-341-075	RES. 1M, 1/4W, 5%	R78,79
613014-341-075	RES. 1.3K, 1/4W, 5%	R8,36
633044-341-075	RES. 3.3M, 1/4W, 5%	R81,87
620034-341-075	RES. 200K, 1/4W, 5%	R85,86
633014-341-075	RES. 3.3K, 1/4W, 5%	R88
651004-341-075	RES. 510, 1/4, 5%	R9,57
647024-341-075	RES. 47K, 1/4W, 5%	R91
647094-341-075	RES. 47, 1/4W, 5%	R96
635234-501-001	TRANS, 600 OHM, AUDIO	T1
600114-611-002	RED TEST POINT	TP2
600114-611-003	ORANGE TEST POINT	TP3
600114-611-004	YELLOW TEST POINT	TP4
600171-415-001	IC LM324, OP AMP, QUAD	U1,4-6
600908-415-001	IC 4053, MUX/DEMUX	U2
600486-415-001	IC LM393, DUAL VOL COMP	U3
600078-415-101	IC MC14001B, NOR QUAD 2-IN	U7

Figure 5.51

**AUDIO SQUELCH  
BOARD ASSEMBLY**



NOTES:  
 ▽ PLACE JPI BETWEEN E1-1 AND E1-2 TO DISABLE LINE AUDIO SQUELCH

UNLESS OTHERWISE SPECIFIED:  
 RESISTORS ARE 1/4W, 5%  
 CAPACITORS IN μF  
 INDUCTORS IN μH  
 TRANSISTERS  
 NPN 2N3904  
 PNP 2N3906  
 DIODES ARE 1N4148

Figure 5.52

AUDIO SQUELCH BOARD SCHEMATIC

AUDIO SQUELCH BOARD, 1A17

PIN CONNECTIONS AND VOLTAGE READINGS

		1A17-P10			
		1	2	GND	
0-		3	4	METER AUDIO 0-1.2 VRMS	
.3-3KHZ (.15VRM) AUDIO		5	6	600 OHM REC. AUDIO OUT (2.4 VRMS)	
5 MHZ (-30DBM) IF IN		7	8		
		9	10	F.P. SQUELCH 0 +9VDC	
+1+8VDC (R) AGC		11	12	3RD LO -15DBM (5MHZ)	
		13	14	600 OHM REC. AUDIO OUT (0- 2.4 VRM)	
LOGIC "0" OR "1" $\overline{RX}$		15	16	$\overline{RX}$ LOGIC "0" OR "1"	
+9VDC		17	18	+9VDC	
		19	20	(NOT USED)	
		21	22	SQUELCH GATE 0 OR +8VDC	
GND		23	24	GND	
		25	26	DATA HI - Z OR .1VDC	
1 KHZ (25MV) SIDE TONE		27	28		
.8VDC OR 5VDC AGC OFF		29	30	$\overline{PTT}$ LOGIC "0" OR "1"	
		31	32	$\overline{MUTE}$ LOGIC "0" OR "1"	
		33	34	RF GAIN 0+4.5 VDC	
LOGIC "0" OR "1" $\overline{USB}$		35	36	$\overline{CW}$ LOGIC "0" OR "1"	
LOGIC "0" OR "1" $\overline{LSB}$		37	38	$\overline{AGC-F}$ +1.5 to + 7VDC	
		39	40	DELAYED AGC 0+6VDC	
0 OR +9VDC $\overline{AGC DUMP}$		41	42	"S" MET 0+6VDC	
GND		43	44	GND	

### 5.9.12 SPEAKER DRIVER BOARD, 1A18

See Figure 5.54 for the schematic of the Speaker Driver board.

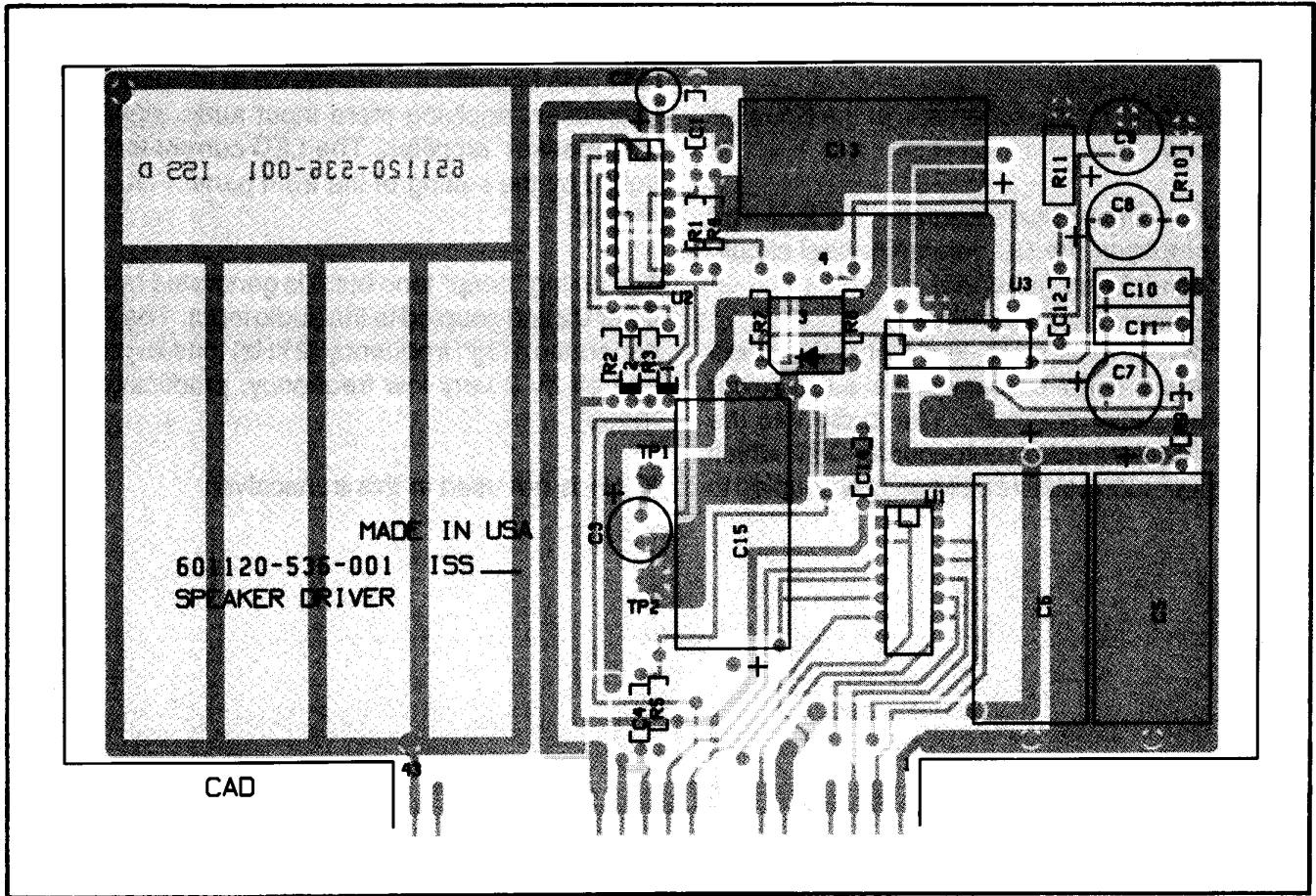
The Speaker Driver board contains the four watt speaker amplifier, the DC volume control circuit, and the tuning beep generator.

The speaker amplifier, U3, is a monolithic audio amplifier which supplies four watts of audio power to the front panel speaker. The audio into the board is coupled through optocoupler CR3, which contains a photo-resistive cell optically coupled to

an LED. As the LED current increases and the LED gets brighter, the resistance of the photocell decreases, applying more input audio signal to the speaker amplifier. The LED current is controlled by the setting of the front panel VOLUME control.

The tuning "beep" tone burst is generated by dual timer U2 and coupled to the audio input. The timer generates a high frequency (2 kHz) tone keyed on and off by a very low frequency, producing the "beep".

IC U1 is not used in this transceiver.

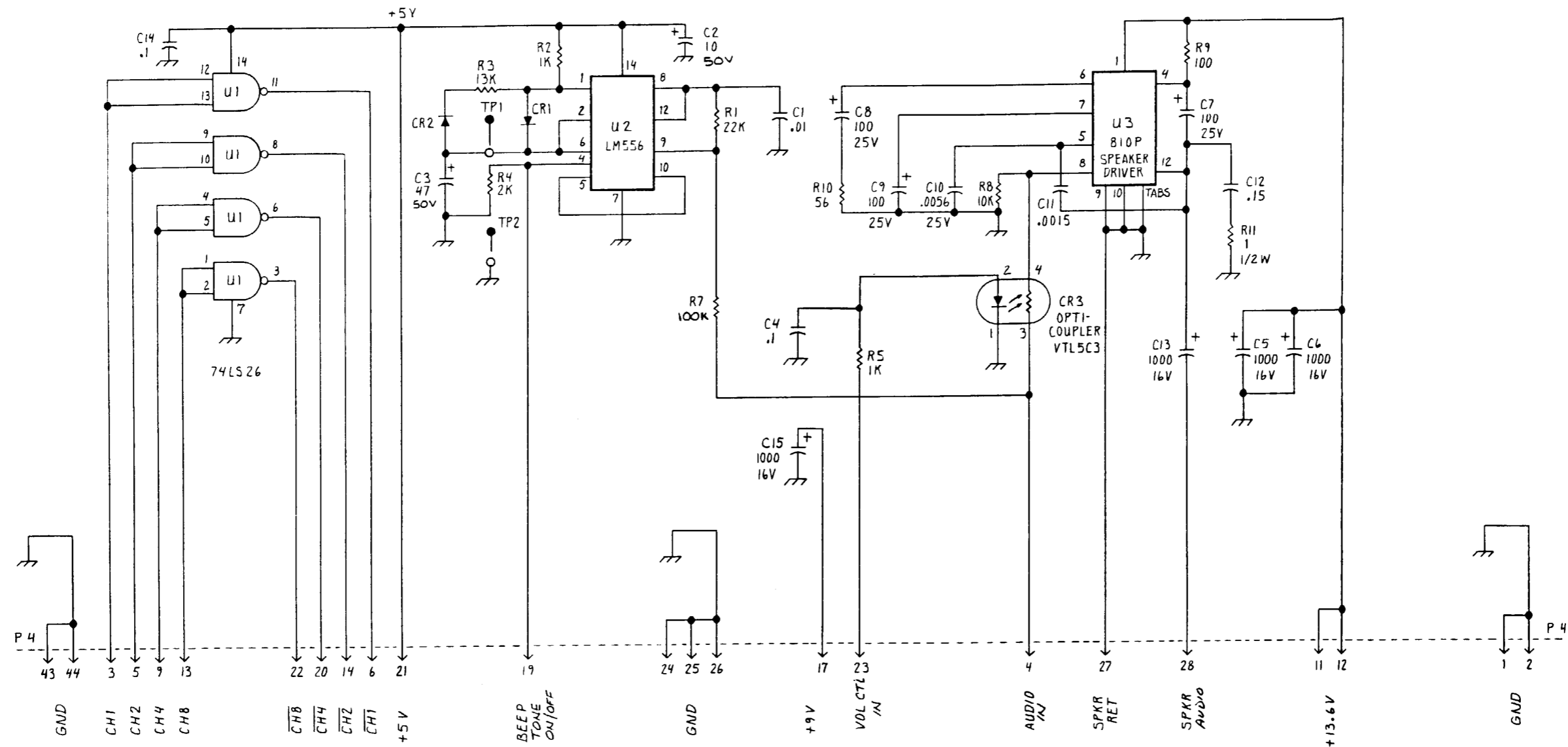


(601120-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600272-314-003	CAP. .01UF, CER, 50V	C1
600204-314-045	CAP .0056UF,MYLAR,630V	C10
600204-314-040	CAP .0015UF,MYLAR,630V	C11
600204-314-027	CAP. .15UF,100V,MYLAR	C12
600297-314-013	CAP. 10UF, ALUM, 50V	C2
600297-314-026	CAP. 47UF, ALUM, 50V	C3
600272-314-001	CAP. .1UF, CER,50V	C4, 14
600259-314-108	CAP 1000UF,ALUM,16V	C5, 6, 13, 15 C7, 8, 9
600259-314-006	CAP. 100UF 25V	
600109-410-001	DIODE IN4148	CR1, 2
600006-373-002	LED CELL	CR3
622024-341-075	RES. 22K, 1/4W, 5%	R1
656094-341-075	RES. 56, 1/4W, 5%	R10
610084-341-205	RES. 1, 1/2W, 5%	R11
610014-341-075	RES. 1K, 1/4W, 5%	R2, 5
613024-341-075	RES. 13K, 1/4W, 5%	R3
620014-341-075	RES. 2K, 1/4W, 5%	R4
610034-341-075	RES. 100K, 1/4W, 5%	R7
610024-341-075	RES. 10K, 1/4W, 5%	R8
610004-341-075	RES. 100, 1/4W, 5%	R9
600261-230-001	TERMINAL	TP1, 2
600221-415-001	IC 74LS26,NAND,HV,QUAD	U1
600237-415-001	IC LM556, DUAL TIMER	U2
600216-415-001	IC 810P, AUDIO AMP	U3

Figure 5.53

**SPEAKER DRIVER BOARD ASSEMBLY**



**NOTES:**

1. UNLESS OTHERWISE NOTED: RESISTORS ARE IN OHMS 1/4W ± 5%; CAPACITORS ARE IN MFD. INDUCTORS ARE IN MHY. DIODES ARE 1N4148.
2. DO NOT REMOVE C15 FROM BOARD AS C15 IS USED TO FILTER THE +9V LINE.

Figure 5.54

SPEAKER DRIVER BOARD SCHEMATIC

SPEAKER DRIVER BOARD, 1A18

PIN CONNECTIONS AND VOLTAGE READINGS

		1A18-P6				
	GND	<input checked="" type="radio"/>	1	<input type="radio"/>	2	GND
(NOT USED)						(0.3 - 3 KHZ)
LOGIC "0" OR "1"	CH1	<input type="radio"/>	3	<input type="radio"/>	4	AUDIO IN 0 - 0.15 VRMS
(NOT USED)						(NOT USED)
LOGIC "0" OR "1"	CH2	<input type="radio"/>	5	<input type="radio"/>	6	CH1 LOGIC "0" OR "1"
		<input type="radio"/>	7	<input type="radio"/>	8	
(NOT USED)						
LOGIC "0" OR "1"	CH4	<input type="radio"/>	9	<input type="radio"/>	10	
	+13.2VDC					+13.2VDC
(NOT USED)						(NOT USED)
LOGIC "0" OR "1"	CH8	<input type="radio"/>	11	<input type="radio"/>	12	CH2 LOGIC "0" OR "1"
		<input type="radio"/>	13	<input type="radio"/>	14	
		<input type="radio"/>	15	<input type="radio"/>	16	
	+9VDC					
		<input type="radio"/>	17	<input type="radio"/>	18	
LOGIC "0" OR "1"	BEEP ON/OFF	<input type="radio"/>	19	<input type="radio"/>	20	(NOT USED) CH4 LOGIC "0" OR "1"
	+5VDC					(NOT USED) CH8 LOGIC "0" OR "1"
		<input type="radio"/>	21	<input type="radio"/>	22	
0.6 - + 9VDC VOL. CONTROL		<input type="radio"/>	23	<input type="radio"/>	24	GND
	GND	<input type="radio"/>	25	<input type="radio"/>	26	GND
SPEAKER RETURN (GND)		<input type="radio"/>	27	<input type="radio"/>	28	SPEAKER AUDIO (0 - 3.1 VRMS INTO 3.2 OHM)
		<input type="radio"/>	29	<input type="radio"/>	30	
		<input type="radio"/>	31	<input type="radio"/>	32	
		<input type="radio"/>	33	<input type="radio"/>	34	
		<input type="radio"/>	35	<input type="radio"/>	36	
		<input type="radio"/>	37	<input type="radio"/>	38	
		<input type="radio"/>	39	<input type="radio"/>	40	
		<input type="radio"/>	41	<input type="radio"/>	42	
	GND	<input type="radio"/>	43	<input type="radio"/>	44	GND

### 5.9.13 COUPLER INTERFACE BOARD, 1A19

See Figure 5.56 for the schematic of the Coupler Interface board.

This board acts as an interface for inputs and outputs between the Controller board, Interface board, Auxiliary connector, Accessory connector, and the signal path boards. The two basic functions performed by this board are: control of transmitter keying and control of a system antenna coupler. See Figure 4.5 for a simplified diagram of the keying circuits.

#### 5.9.13.1 Keying Inputs and Outputs

Following is a listing of the various keying inputs and use restrictions.

1. Pin 20 - /TONE KEY. A logic low at this input will key the transmitter under all conditions. This pin is connected to the TONE KEY output of the optional Tone Key Modem board.
2. Pin 16 - /EXT KEY. This input from the rear panel will also key the transmitter whenever it is pulled low.
3. Pin 18 - /FSK KEY. This input from the rear panel will key the transmitter when pulled low only if the radio is in the FSK mode.
4. Pin 14 - /PTT. This is another front panel input which keys the transmitter in any mode unless Pin 32, REM, is a logic high.
5. Pin 32 - REM. This input is high whenever the radio is being remotely controlled. In this state, the /CW KEY and /PTT are both disabled.
6. Pin 22 -  $\mu$ P KEY. This signal comes directly from the microprocessor and keys the transmitter whenever it is a logic high.
7. Pin 8 - /KEY ENABLE. This comes from the system antenna coupler and keys the transmitter during a coupler TUNE cycle. A logic low at this input will key the transmitter only when a TUNE cycle is commanded by a logic high at Pin 33, TUNE B.

The following pins are transmitter keying outputs:

1. Pin 25 - /TX1. This is the primary keying output which sets all signal path boards in the transmit mode. This output also controls the front panel TX LED. This output goes low when the transmitter is keyed.

2. Pin 36 - /TX2. This output is similar to /TX1 except that it is used to key external equipment by going low when the transmitter is keyed.
3. Pin 37 - /TX3. This output is similar to /TX1 and /TX2 except it is not disabled by the TX INHIBIT circuitry. /TX3 is used to control the MSR 4030 coupler bypass circuitry, disabling the bypass relay whenever the transmitter is keyed. /TX3 also informs the  $\mu$ P when there is any attempt to key the transmitter.
4. Pin 24 - /AUDIO KEY. This output differs from TX1 in that it is not affected by the CW delay. It controls the transmitter modulation in CW mode.
5. Pin 17 - /AMT. This output is logic low when the transmitter is keyed in AME mode.

The following inputs all inhibit the transmitter keying. When active, the TX INHIBIT LED will light and the test point (TP1 through TP4) responsible for the inhibit will be a logic low.

1. Pin 11 - KEY INTERLOCK. This input is used by the antenna coupler to ensure that the transmitter will not be keyed at a time when the coupler is vulnerable to damage. This line must be pulled low or the transmitter cannot be keyed. If an antenna coupler is NOT in the system, a shorting plug connecting this pin to ground must be connected to the radio's accessory connector (pin 11 to ground in the accessory connector). This function may also be controlled on J36 pin 4 if Mother board jumper JP4 is in position 2-3.
2. Pin 38 - /LL. This input goes to a logic low whenever any of the loops in the synthesizer loses lock. This prevents transmitter keying unless the frequency is valid.
3. Pin 29 - /TX INHIBIT. This is used by the microprocessor to prevent keying at any time that the software program has determined that keying is inappropriate, such as during a mode change or during Silent Tune.
4. Pin 34 - /PS FAULT. This input comes from the power supply and prevents keying whenever the power supply is disabled.

#### 5.9.13.2 Keying Control Circuits

When any of the keying inputs (except for the coupler /KEY ENABLE) commands the transmitter to key and no inhibiting signals exist, U1 pin 8 will be high. This brings the /AUDIO KEY line to a logic low. U10A provides a variable CW "hang"

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delay when the radio is in CW mode. A high at U3 pin 2 lengthens the keydown time in CW mode.

Keying can be prevented by a high at U3 pin 11 or U6 pin 6. U3 pin 11 is high during a coupler TUNE cycle and U6 pin 6 is high if any of the inhibit inputs is active. If neither of these points is high, a keying input will cause /TX1, /TX2 and /TX3 to go to a logic low. Note that /TX3 is not affected by the transmit inhibit signals. /TX3 does not key the transmitter; it is used to turn off the MSR 4030 coupler bypass relay during transmit mode.

#### 5.9.13.3 Coupler Control Circuit

Inverter/drivers U13A, U12C, U14D, U14C and U14B interpret coupler control inputs.

The /TUNING line is taken to a logic low by the coupler whenever the antenna coupler is tuning. If switch S1-3 is closed, the tuning "BEEP" is energized. This commands the radio to create a pulsing audio tone audible in the speaker during the TUNE cycle.

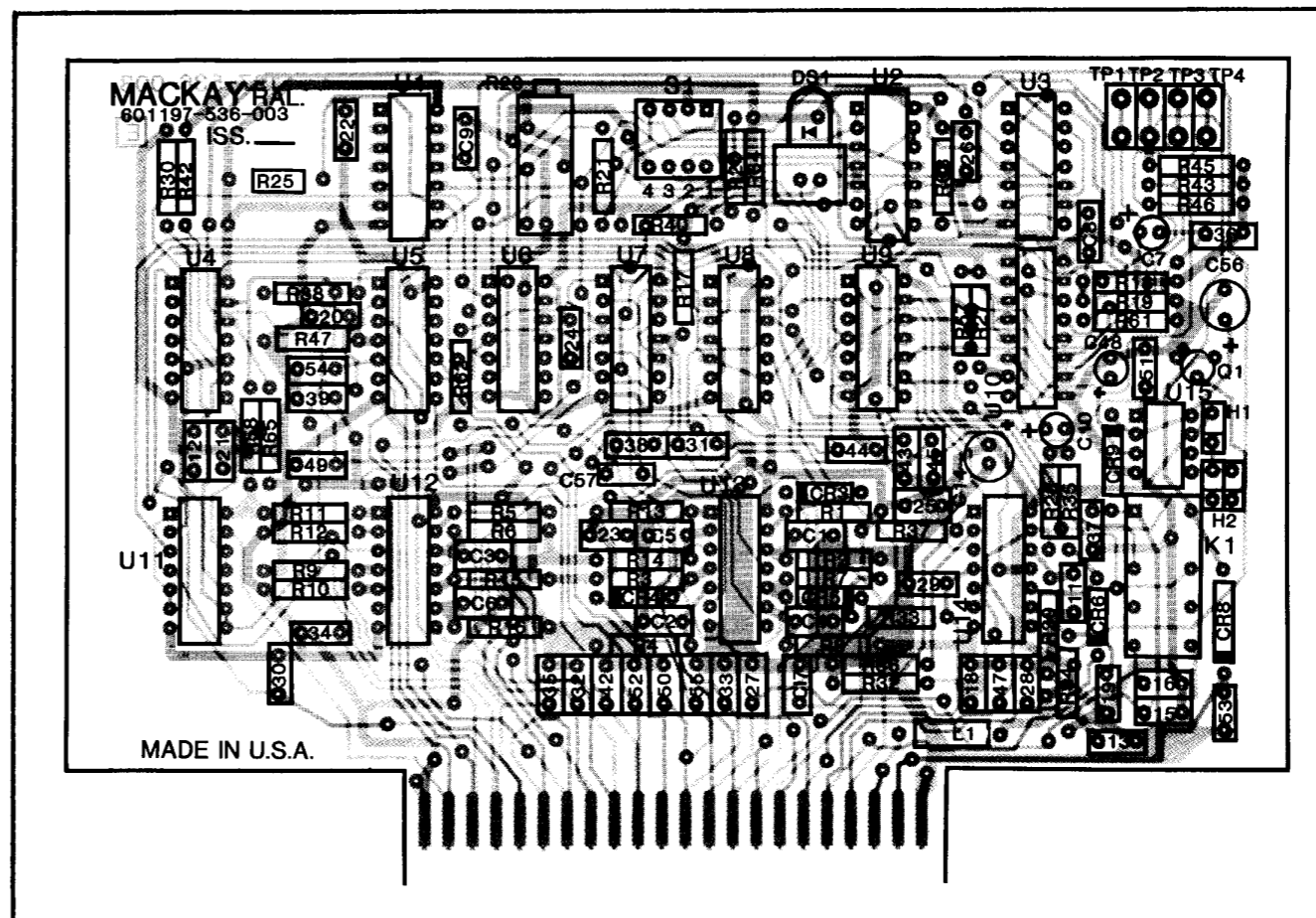
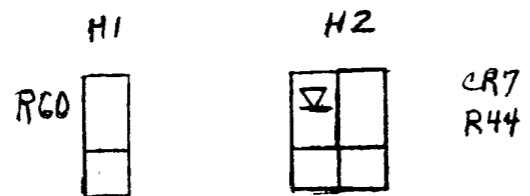
VSWR RETUNE is an optional coupler feature which provides for an automatic coupler TUNE whenever a VSWR FAULT is detected by the antenna coupler or the linear power amplifier (if

used). A TUNE cycle is requested by the coupler or LPA by pulling the /TUNING input low (when not already in a TUNE cycle). U10B prolongs the duration of this momentary low-going pulse, so that it will be detected by the microprocessor. If the VSWR RETUNE is not desired, S1-2 is left open, deactivating U10B. **NOTE:** Selection of the VSWR RETUNE feature also requires the closure of the VSWR RETUNE coupler option switch located elsewhere in the radio.

Coupler TUNE commands from the microprocessor are onTUNE B (pin 33) for normal tune and SILENT B (pin 26) for a silent tune (MSR 4030 only). These commands are inverted by U8D and U8E and are denoted as /TUNE and /SIL TUNE.

U15 and K1 prevent the coupler tune commands from being sent to the coupler before the radio has been turned on long enough to clear any transient.

When a coupler TUNE is commanded (pin 33 high), U3 pin 11 will be high, disabling all keying inputs except the coupler keying input /KEY ENABLE. The coupler pulls this line low when it needs an rf signal to operate during the TUNE cycle.



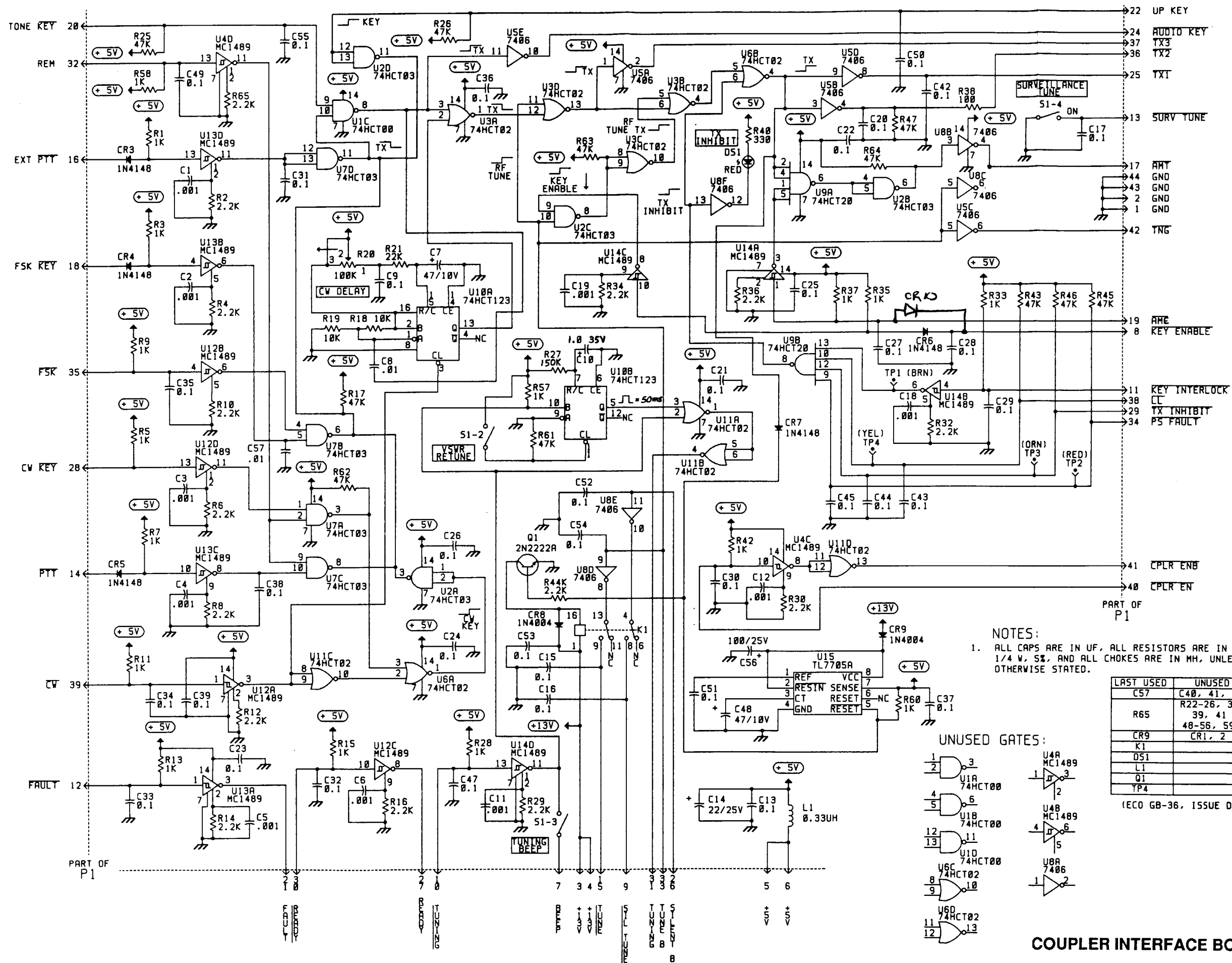
(601197-536-003)

PART NUMBER	DESCRIPTION	SYMBOL
600005-635-001	LED MOUNT	(DS1)
600025-419-001	TRANSISTOR PAD	(Q1)
600302-314-001	CAP .001UF,MYLAR,63V	C1-6,11, 12,18,19
600202-314-007	CAP. 1.0UF,ALUM, 35V	C10
600297-314-016	CAP. 22UF, ALUM, 25V	C14
600302-314-013	CAP .1UF, MYLAR, 50V	C42-45, 47,49-55 9,13, 15-17 20-39
600297-314-032	CAP 100UF, ALUM, 25V	C56
600297-314-024	CAP. 47UF, ALUM, 10V	C7,48
600302-314-007	CAP .01UF,MYLAR, 63V	C8,57
600109-410-001	DIODE IN4148	CR3-7
600011-416-002	DIODE IN4004	CR8,9
600036-390-001	LED, RED	DS1
600094-403-003	RELAY, DPDT, 12V, 3A CONTACTS	K1
600125-376-001	CHOKE .33UH	L1
600080-413-001	TRANSISTOR 2N2222A	Q1
610014-341-075	RES. 1K, 1/4W, 5%	R1,3,5,7 9,11,13 15,28,33 35,37,42 57,58,60

PART NUMBER	DESCRIPTION	SYMBOL
622014-341-075	RES. 2.2K, 1/4W, 5%	R16,29, 30,32,34 36,2,4, 6,8,10 12,14,65 44
647024-341-075	RES. 47K, 1/4W, 5%	R17,25, 26,43, 45-47, 61-64
610024-341-075	RES. 10K, 1/4W, 5%	R18,19
600063-360-014	POT. 100K, 15 TURN	R20
622024-341-075	RES. 22K, 1/4W, 5%	R21
615034-341-075	RES. 150K,1/4W, 5%	R27
610004-341-075	RES. 100, 1/4W, 5%	R38
633004-341-075	RES. 330, 1/4W, 5%	R40
600264-616-001	SWITCH, DIP, 4 POS.	S1
600114-611-001	BROWN TEST POINT	TP1
600114-611-002	RED TEST POINT	TP2
600114-611-003	ORANGE TEST POINT	TP3
600114-611-004	YELLOW TEST POINT	TP4
702005-415-001	IC, 74HCT00	U1
702013-415-001	IC, 74HCT123	U10
700123-415-001	I.C. TL7705A	U15(+5v Super- visor)
702007-415-001	IC, 74HCT03	U2,7
702006-415-001	IC, 74HCT02	U3,6,11
600415-415-001	IC 1489,LNRCVR,QUAD	U4,12, 13,14
600016-415-001	IC 7406,HEX INV,0/C	U5,8
702010-415-001	IC 74HCT20	U9

Figure 5.55

COUPLER INTERFACE BOARD ASSEMBLY



NOTES:  
 1. ALL CAPS ARE IN UF, ALL RESISTORS ARE IN OHMS, 1/4 W, 5%, AND ALL CHOKES ARE IN MH, UNLESS OTHERWISE STATED.

LAST USED	UNUSED
C57	C40, 41, 46
R65	R22-26, 31, 39, 41, 48-56, 59
CR9	CR1, 2
K1	
DS1	
L1	
Q1	
TP4	

(ECO GB-36, ISSUE D)

UNUSED GATES:

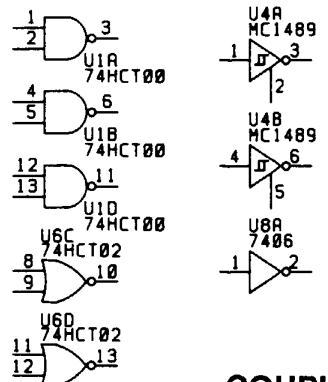


Figure 5.56

COUPLER INTERFACE BOARD SCHEMATIC

COUPLER INTERFACE BOARD, 1A19

PIN CONNECTIONS AND VOLTAGE READINGS

		1A19-P17			
GND	○	1	2	○	GND
+13VDC	○	3	4	○	+13VDC
+5VDC	○	5	6	○	+5VDC
LOGIC "0" OR "1" BEEP	○	7	8	○	KEY ENABLE LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{SIL TUNE}}$	○	9	10	○	TUNING LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{KEY INTERLOCK}}$	○	11	12	○	FAULT LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{SURV TUNE}}$	○	13	14	○	PIT LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{TUNE}}$	○	15	16	○	EXT PIT LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{AMT}}$	○	17	18	○	FSK KEY LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{AME}}$	○	19	20	○	tone KEY LOGIC "0" OR "1"
LOGIC "0" OR "1" FAULT	○	21	22	○	UP KEY LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{TX1}}$	○	23	24	○	AUDIO KEY LOGIC "0" OR "1"
LOGIC "0" OR "1" READY	○	25	26	○	SILENT B LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{TX INHIBIT}}$	○	27	28	○	CW KEY (NOT USED)
LOGIC "0" OR "1" TUNING	○	29	30	○	READY LOGIC "0" OR "1"
LOGIC "0" OR "1" TUNE B	○	31	32	○	REM LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{FSK}}$	○	33	34	○	PS FAULT LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{TX3}}$	○	35	36	○	TX2 LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{CW}}$	○	37	38	○	LL LOGIC "0" OR "1"
LOGIC "0" OR "1" $\overline{\text{CPLR ENB}}$	○	39	40	○	CPLR EN LOGIC "0" OR "1"
GND	○	41	42	○	TNG LOGIC "0" OR "1"
GND	○	43	44	○	GND

#### 5.9.14 MOTHER BOARD, 1A20

See Figure 5.59 for the schematic of the Mother board.

This board is the electrical main frame of the MSR 8050A transceiver. All subassemblies in the transceiver are electrically connected to the Mother board. A total of 32 connectors interface the subassemblies with the Mother board. Twenty-one (21) connectors are 44 pin dual-readout p.c. card edge connectors, one reserved for the Tone Key modem option and one reserved for the IF/Filter option. Eight connectors interface the rear panel assembly with the Mother board; one connector is used for the main power supply; and one connector is used for the +9 VDC supply. One connector interfaces with the front panel. All p.c. board connectors are keyed to discourage plugging the wrong board into the wrong connector.

##### 5.9.14.1 Jumper Connections

Jumpers JP1 and JP2 are used when an optional

Modem board is not plugged into J7. This routes the audio from the rear panel to the Transmit Modulator board. Jumper JP3 provides a selection to the Tone Key modem board to allow tone keying only when transceiver is under direct control of an MSR 6420 Remote Control Unit or under computer control. Jumper JP4 transfers Key Interlock control from J37 to J36 (for future use). Jumper JP5 allows defeat of the audio compressor when the transceiver is in the FSK or DATA mode. Table 5.13 and Figure 5.57 show jumper positions. Normal position for all jumpers is 1 to 2.

##### 5.9.14.2 Microphone Switch

Microphone switch S1 is used to select the proper gain and impedance characteristic for the chosen microphone. For a dynamic microphone, S1 should be to the left, in position 1. If a carbon microphone is to be used, S1 should be switched to the right, in position 3.

**Table 5.13 MOTHER BOARD JUMPER POSITIONS**

JUMPER	POSITION	CONDITION
JP1, JP2	1 and 2 2 and 3	Modem board not installed. Modem board installed.
JP3	1 and 2 2 and 3	Tone Key enabled in remote control only. Tone Key always enabled.
JP4	1 and 2 2 and 3	Key Interlock control by Coupler. Key Interlock through Audio Connector.
JP5	1 and 2 2 and 3	Defeat compressor in FSK and DATA. No defeat.

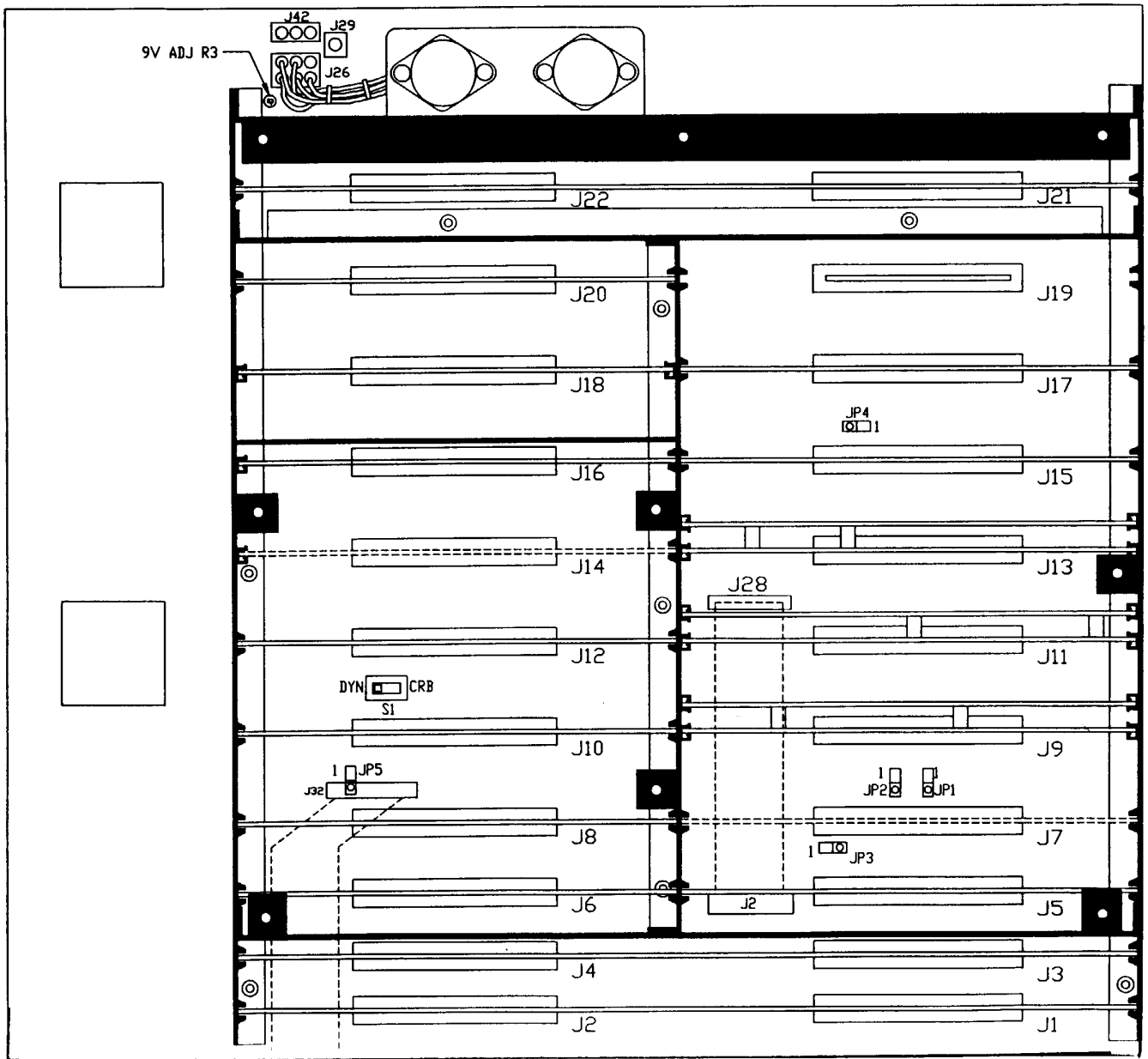


Figure 5.57

**MOTHER BOARD JUMPER AND ADJUSTMENT LOCATIONS**

(700035-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600060-102-001 600100-102-001 600005-635-001 600190-608-001 600206-419-016	COAX CABLE CABLE LED MOUNT CONN, JUMPER, 2 POS. IC SOCKET, 16 PIN	(DS1) (JP1-5) (K1)
600302-314-013	CAP .1UF,MYLAR,50V	C1,3-32 36-42, 45-52, 55-57, 62-67,149 71-76, 78-86,88 92-96, 99-103 105,110, 112,120, 116-118, 121,131, 132,134, 138,147, 126-129
600302-314-015	CAP .22UF,MYLAR,50V	C113,124 125,130, 140,35, 44,53,89 97,98,90 104,111 106-109 91
600269-314-005 600269-314-022 639093-306-501	CAP. 4.7PF,CER,500V CAP. 47PF,CER,100V CAP. 39PF, 3%, MICA, 500V	C114 C115 C135,136
600272-314-001	CAP. .1UF,CER,50V	C137,141 143-145, 148 C2
600297-314-016	CAP. 22UF,ALUM,25V	

PART NUMBER	DESCRIPTION	SYMBOL
600226-314-008	CAP. .1UF,CER,50V	C33,34,56 60,61,87
600226-314-014 600302-314-007 600297-314-012	CAP. 1UF,CER,50V CAP .01UF,MYLAR,63V CAP 6.8UF 50V	C43,122 C54 C77,133
600109-410-001 600173-410-002 600173-410-001 600052-410-001	DIODE 1N4148 DIODE,PIN,UM4001CR DIODE, UM4001C DIODE 1N270	CR1,2,11 CR12 CR13 CR3,5-10 19-23,31 CR4
600011-416-002	DIODE 1N4004	
600043-390-002	LED, YEL	DS1
600147-605-001 600174-608-025 600385-606-001	CONN CARD EDGE,44 PIN CONN HEADER,16 PIN,ST CONN. FEMALE MIN. RF, PC MOUNT	J1-20,22 J23 J24
600174-608-021 600237-608-004	CONN HEADER,14 PIN,ST CONN. MOLEX, 6 PIN, PC MOUNT	J25 J26
600237-608-003	CONN. MOLEX, 5 PIN, PC MOUNT	J27
600174-608-033 600174-608-022 600221-606-001 600237-608-002	CONN HEADER CONN HEADER,26 PIN,ST CONN CONN. MOLEX, 3 PIN, PC MOUNT	J28 J30,31,43 J39(CX4) J42
600279-608-002	CONN. HEADER, 4 PIN, PC MOUNT	JP1-5
600094-403-002	RELAY, DPDT, 24V, 3A CONTACTS	K1

PART NUMBER	DESCRIPTION	SYMBOL
600072-376-025 600125-376-015 600125-376-007	CHOKE 10UH CHOKE 470UH CHOKE 33UH	L1,3 L12,13 L2,5-11, 14-19,25 26,30,31 L24,27, 28,32 L29
600091-376-001	CHOKE 4.7UH	L33,34 L4,35-37
600125-376-002 600125-376-036 600125-376-022	CHOKE 100UH CHOKE .12UH CHOKE 180UH	
600270-606-001 600270-606-003	RF CONN STRAIGHT FEMALE CONN	P1,3 P2
600229-413-003 600116-413-002	TRANS 2N3904 TO-92 TRANS, 2N3906	Q1,2,4 Q3
647004-341-075	RES. 470, 1/4W, 5%	R1,5, 14,15
600000-341-075 647014-341-075	RES. 0, 1/4W, 5% RES. 4.7K, 1/4W, 5%	R11 R12,23,24 26-28,30
662024-341-075 651024-341-075 610004-341-075 622014-341-075 600051-360-007 691004-341-075 610014-341-075	RES. 62K, 1/4W, 5% RES. 51K, 1/4W, 5% RES. 100, 1/4W, 5% RES. 2.2K, 1/4W, 5% POT. 1K, 1/2W, CERMET RES. 910, 1/4W, 5% RES. 1K, 1/4W, 5%	R13 R18,7 R19 R2,6 R3 R4 R16, 17,20,31 R8,21, 22,25,29
610024-341-075	RES. 10K, 1/4W, 5%	
600130-616-001	SWITCH, SLIDE, DPDT, PC MOUNT	S1
600380-314-002	CAP SIP .1UF X 9	Z1

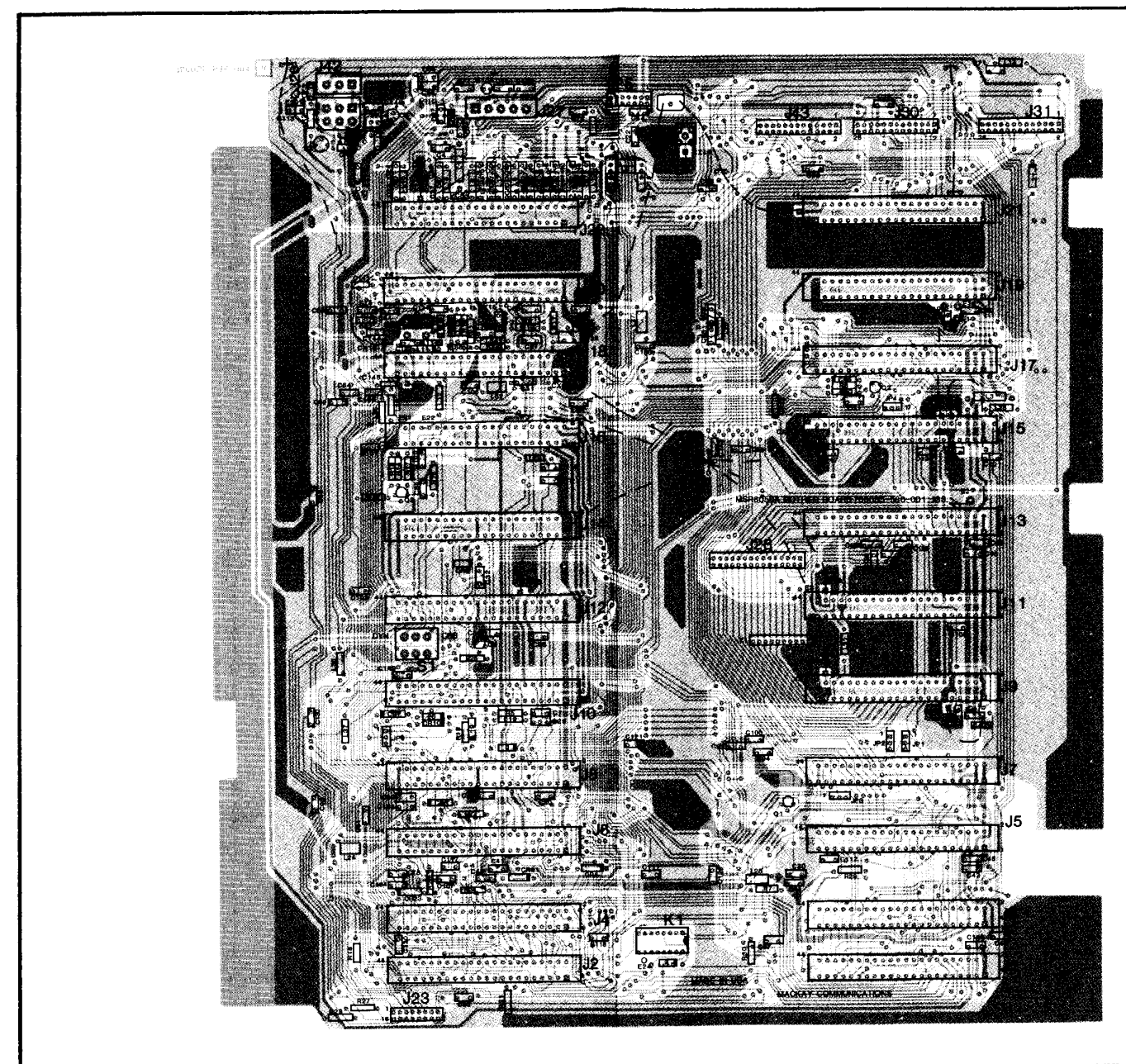


Figure 5.58

MOTHER BOARD ASSEMBLY

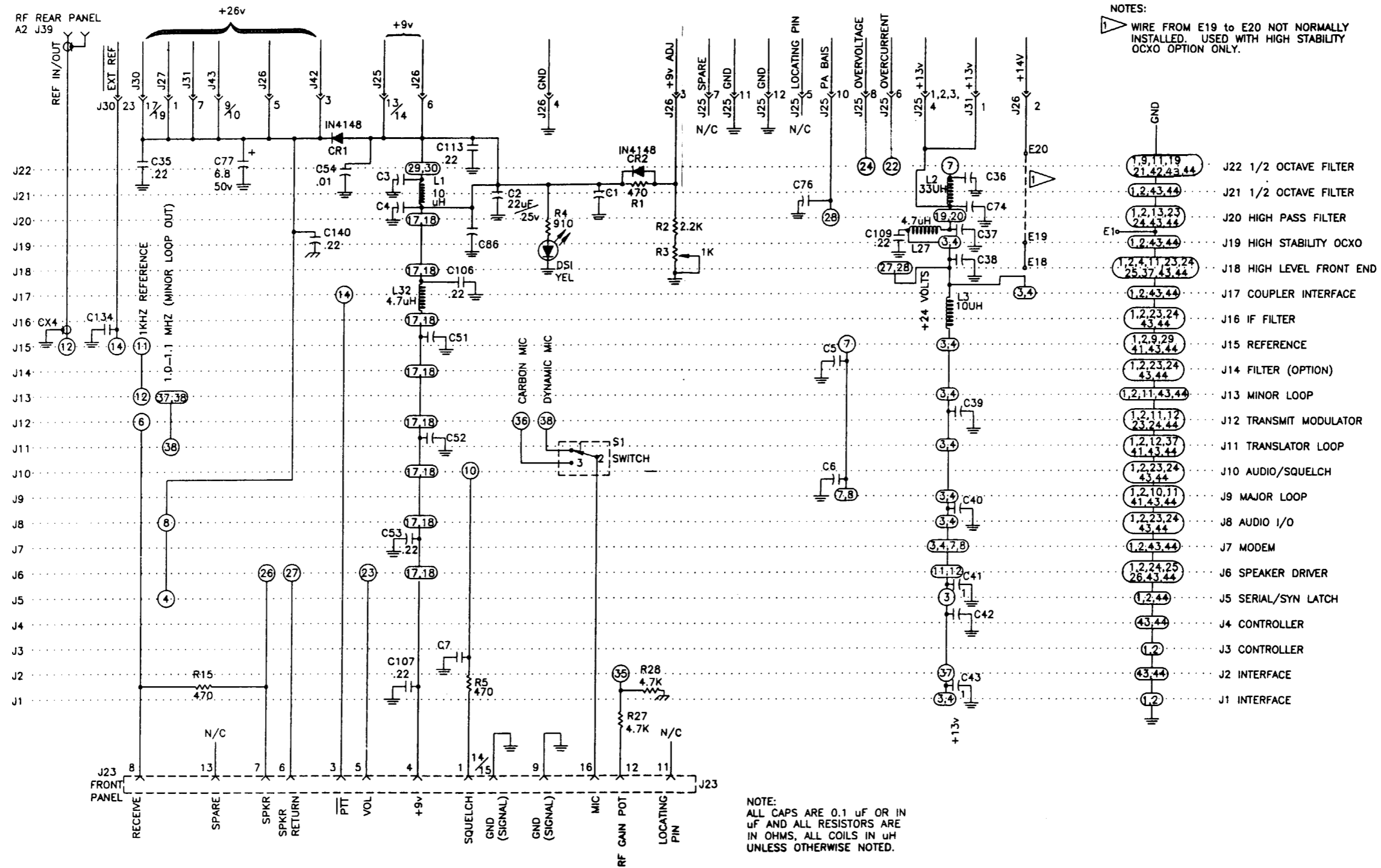


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 1 OF 10)

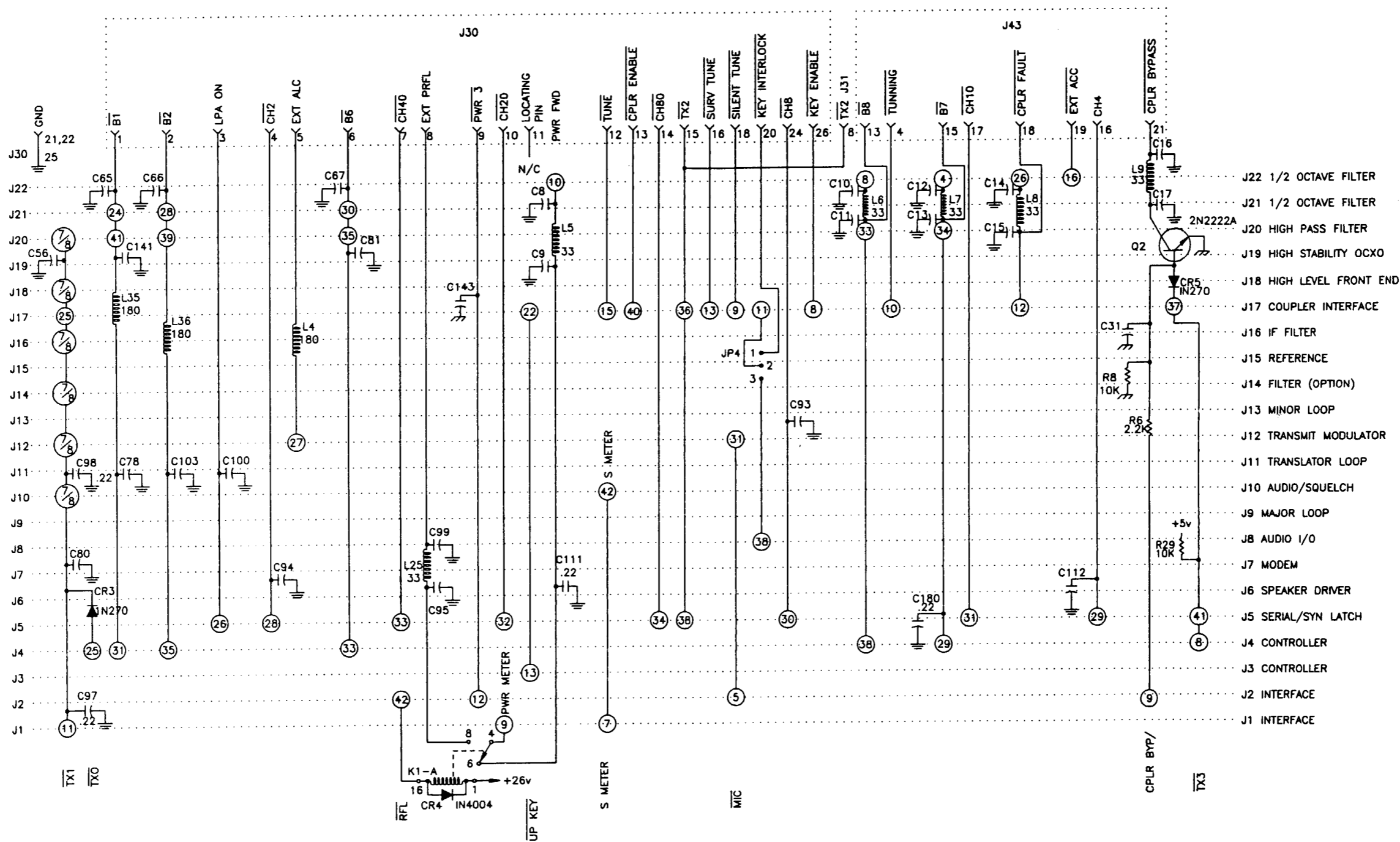


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 2 OF 10)

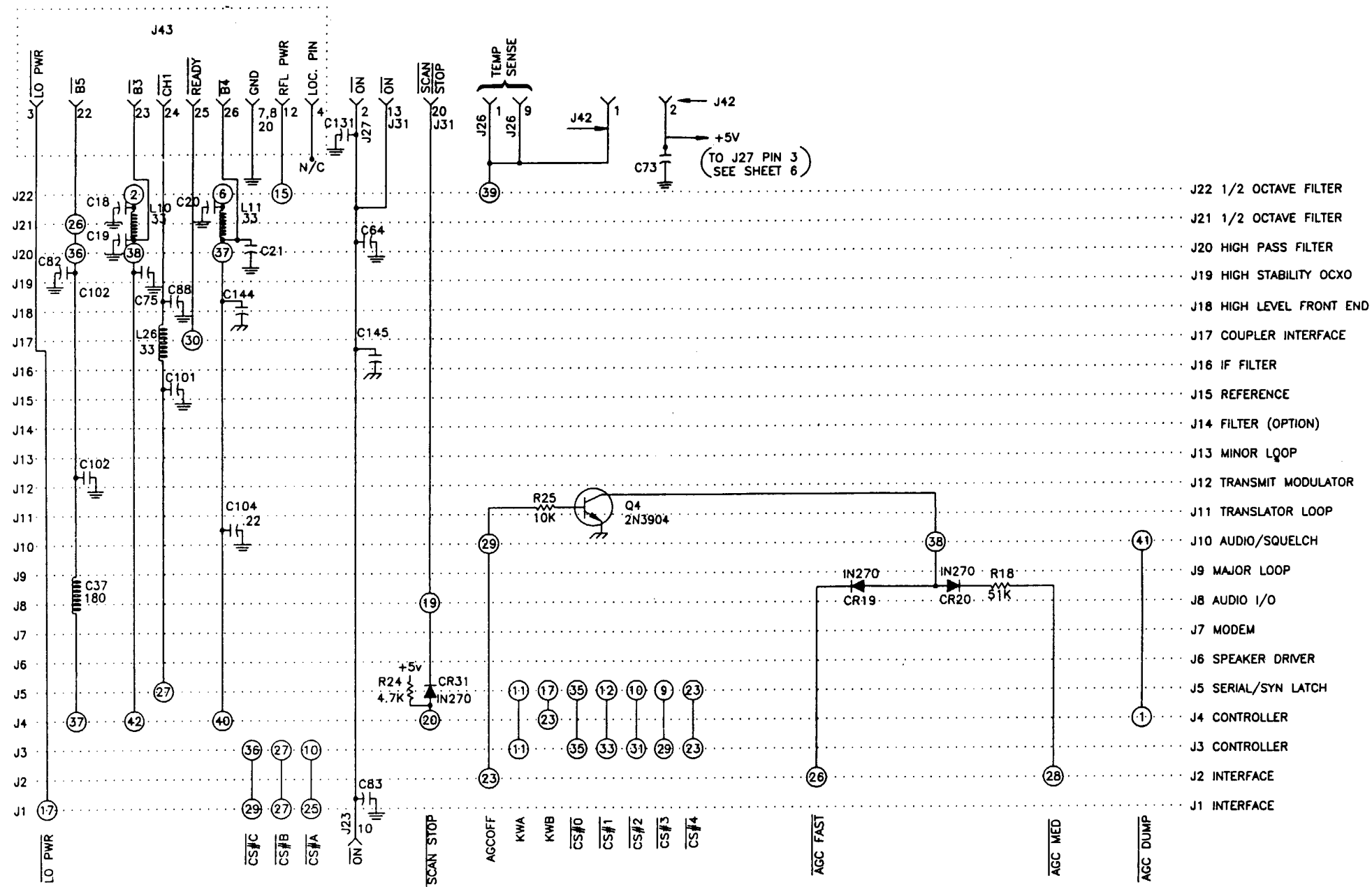


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 3 OF 10)

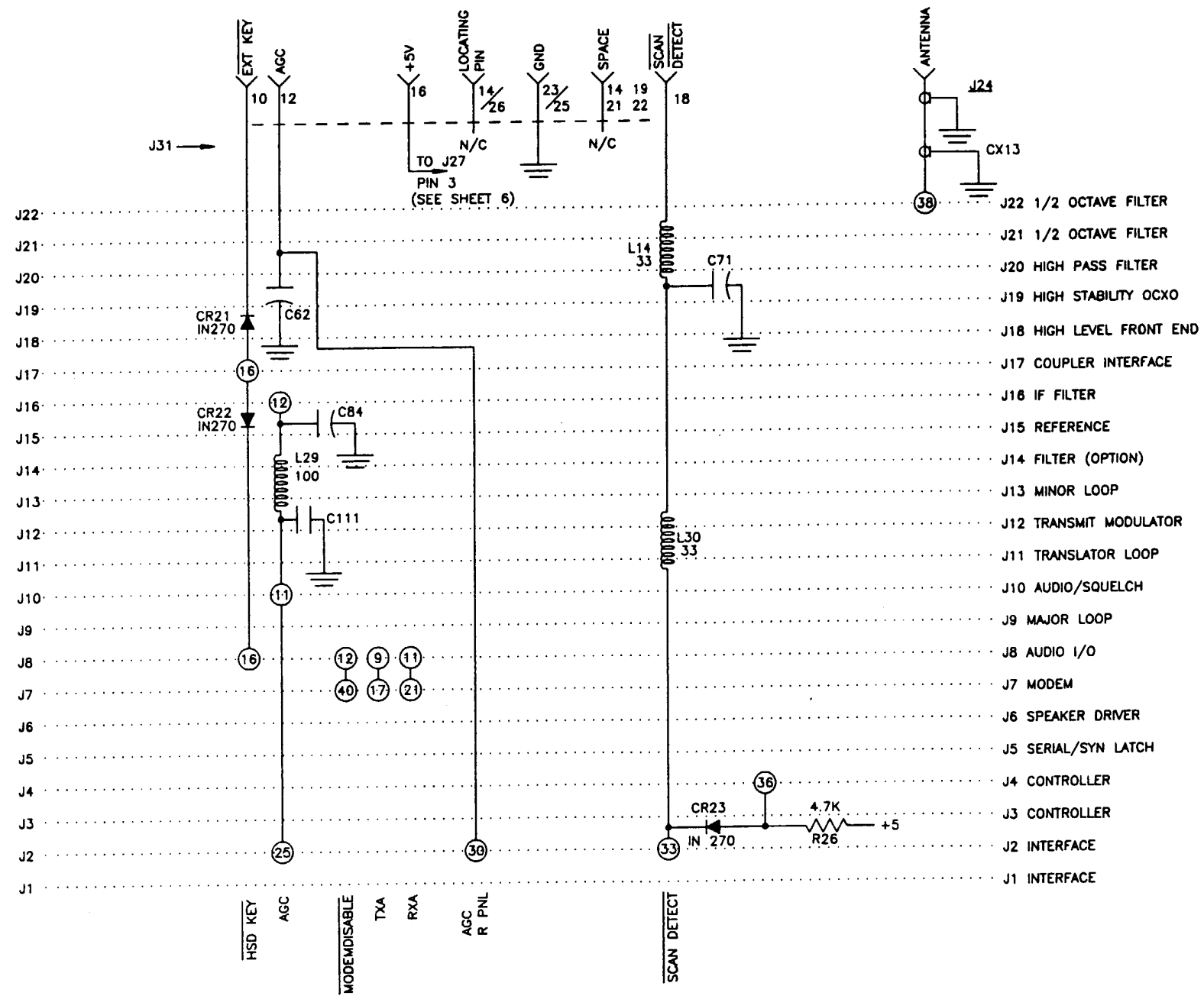


Figure 5.59  
MOTHER BOARD SCHEMATIC  
(SHEET 4 OF 10)

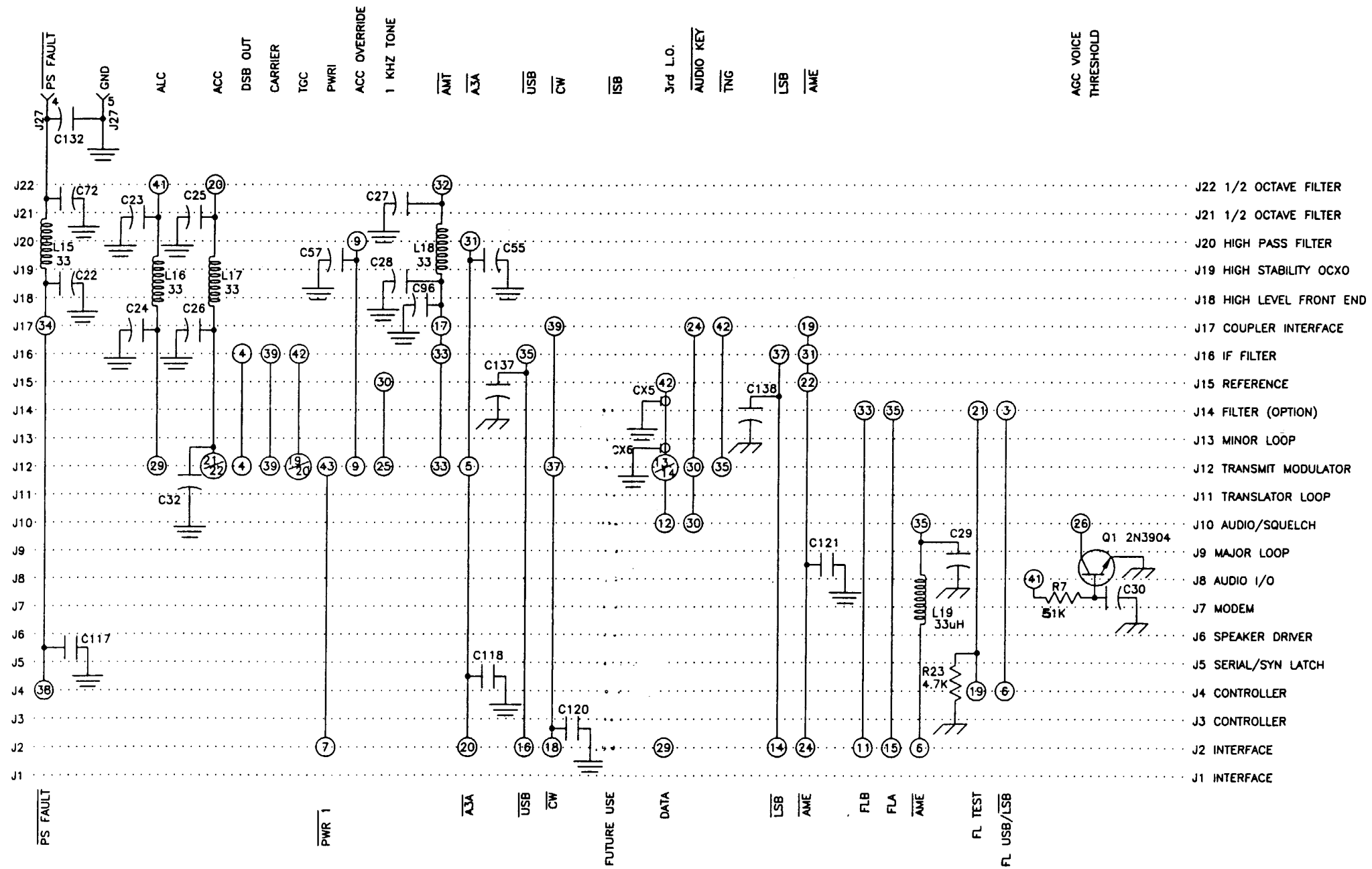


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 5 OF 10)

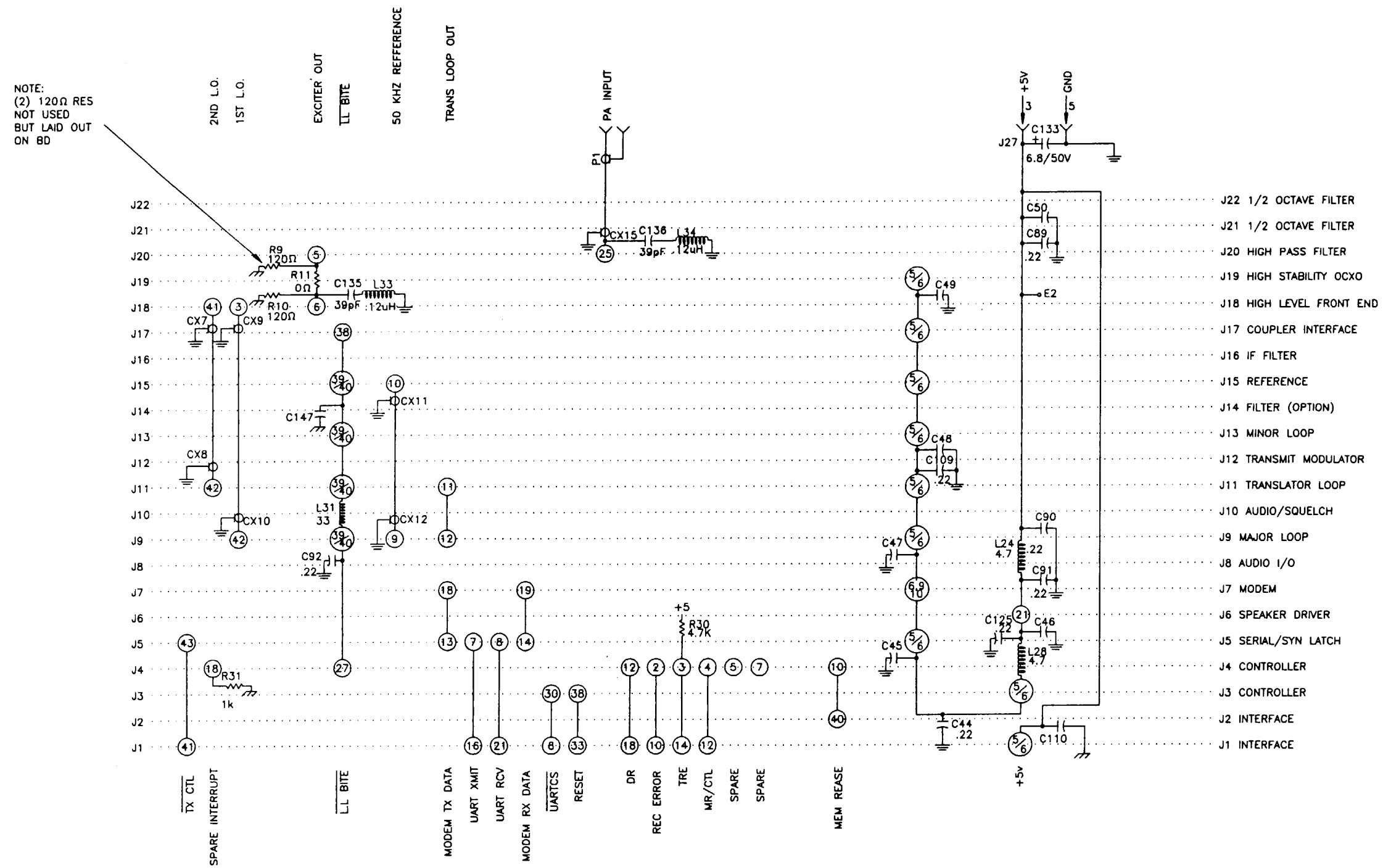


Figure 5.59  
MOTHER BOARD SCHEMATIC  
(SHEET 6 OF 10)

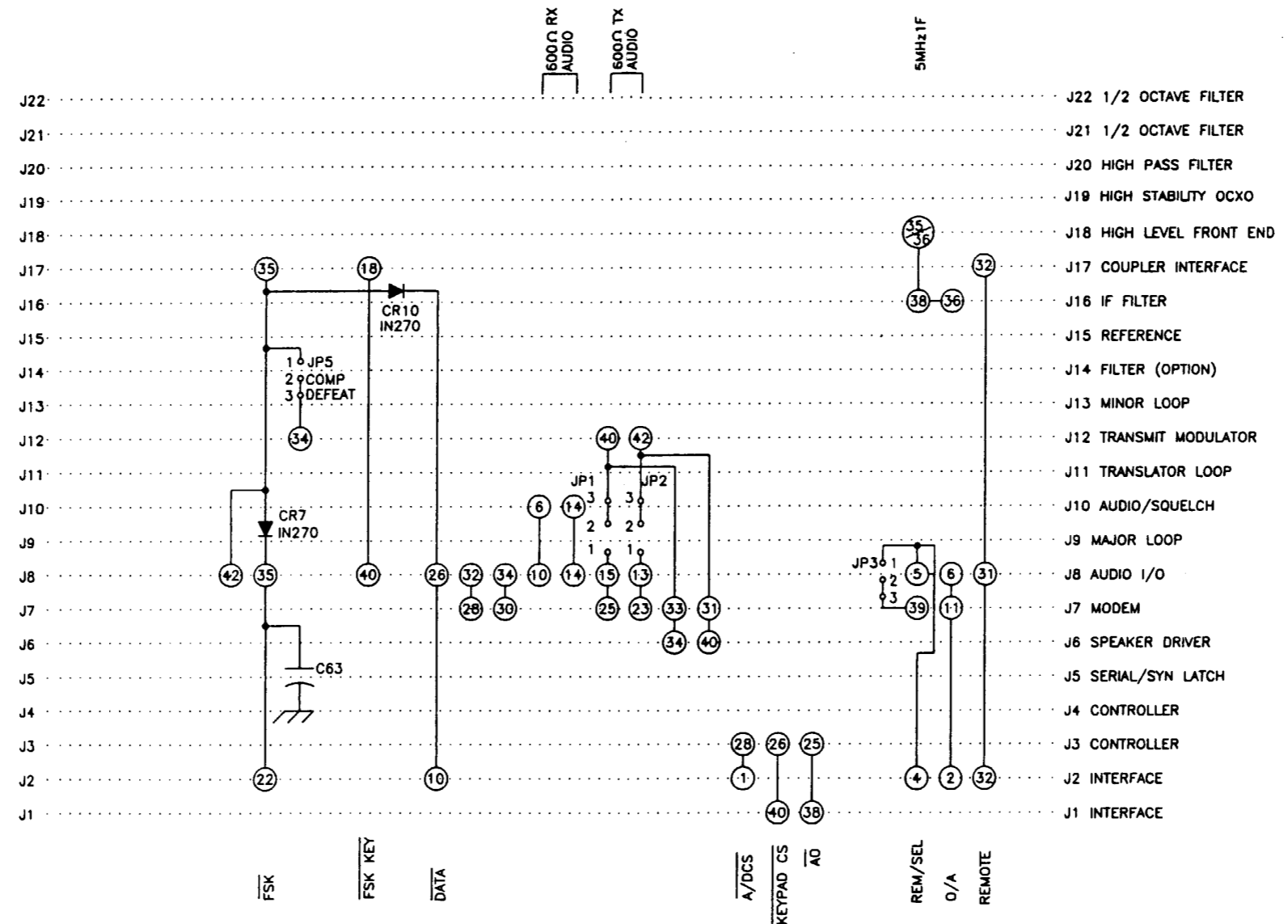


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 7 OF 10)

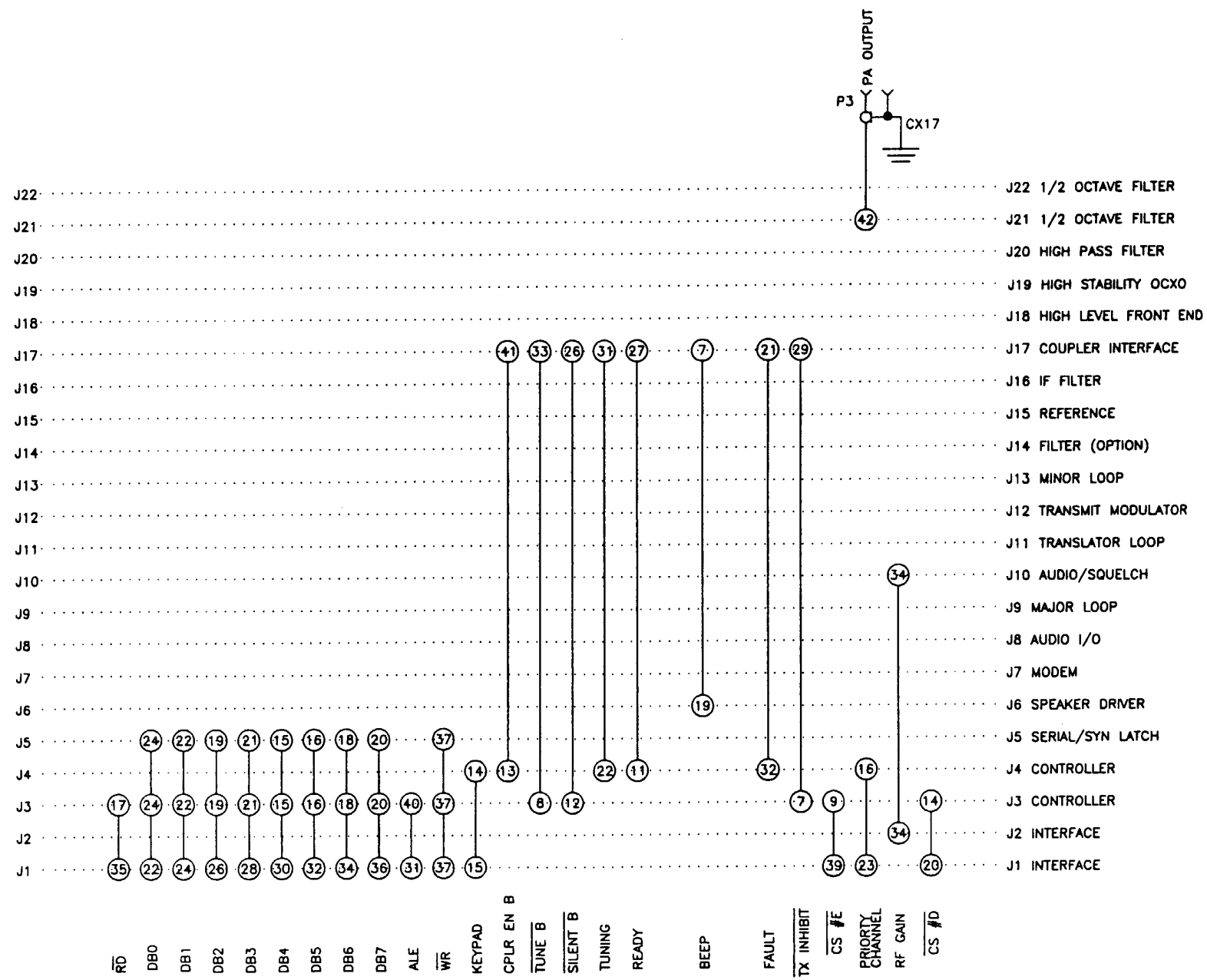


Figure 5.59  
MOTHER BOARD SCHEMATIC  
(SHEET 8 OF 10)

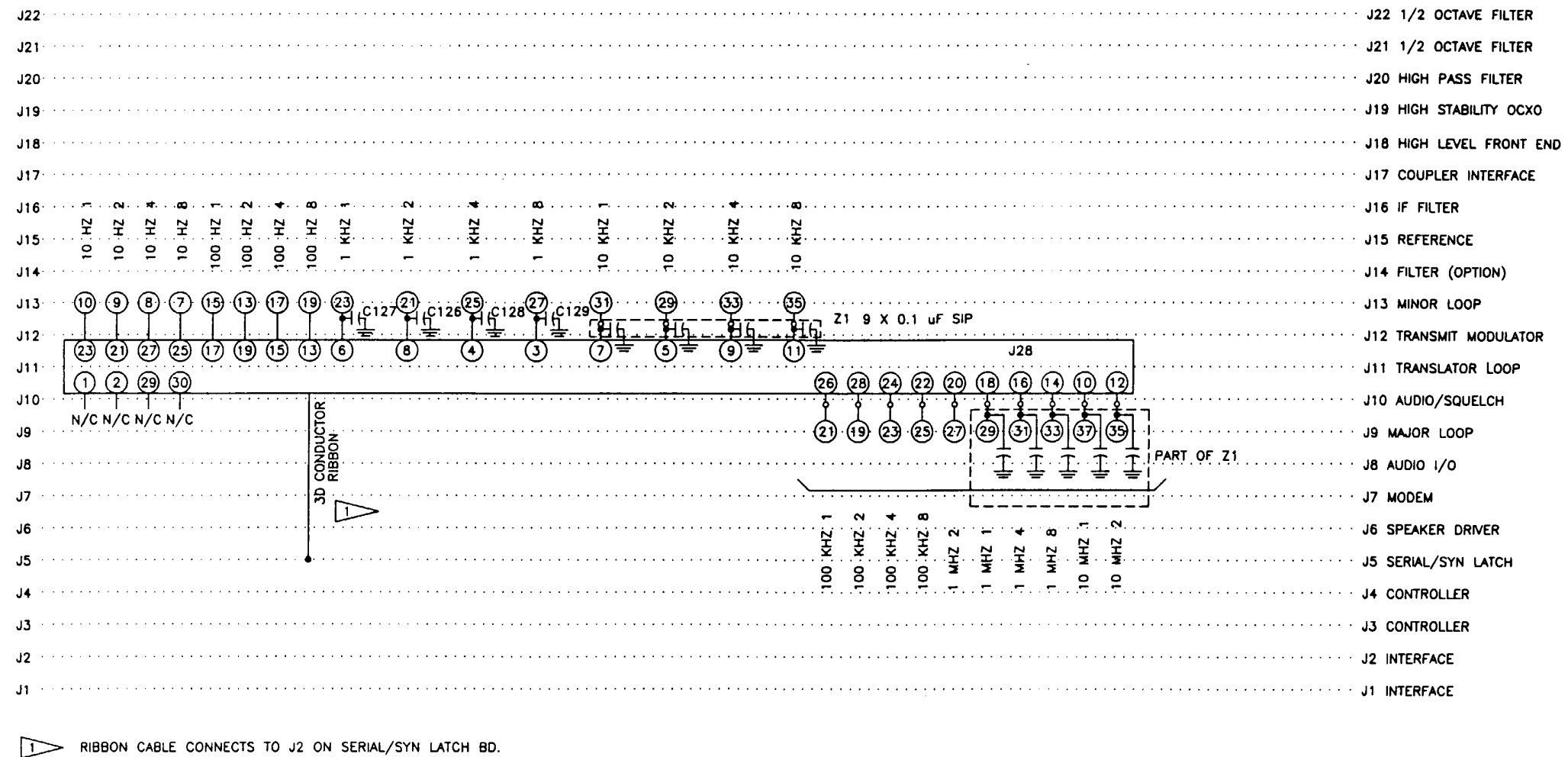


Figure 5.59

MOTHER BOARD SCHEMATIC  
(SHEET 9 OF 10)

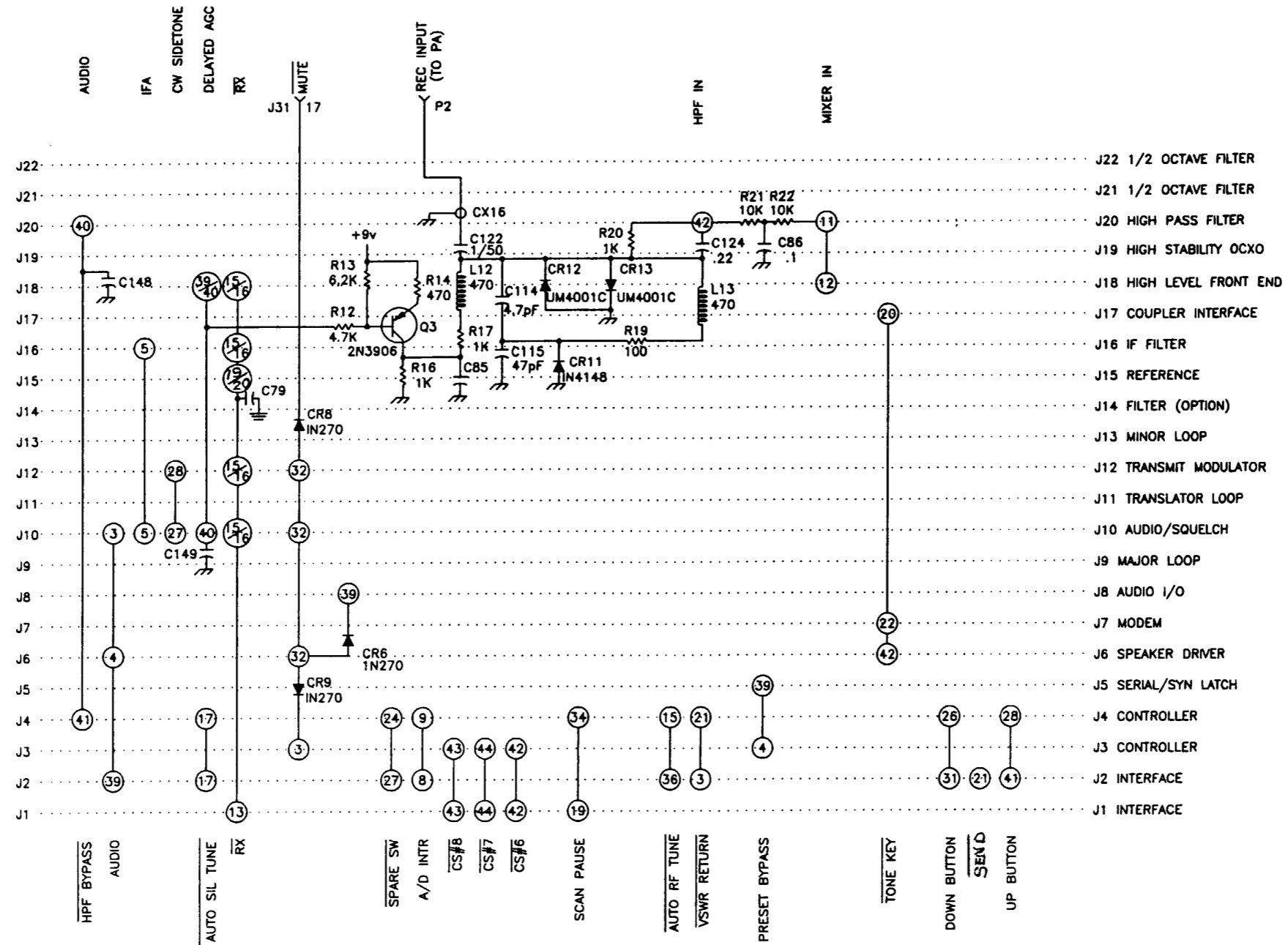


Figure 5.59  
 MOTHER BOARD SCHEMATIC  
 (SHEET 10 OF 10)

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### 5.9.15 SWITCHING POWER SUPPLY, 1A3

The Power Supply assembly used in the MSR 8050A is a switching-type design which utilizes a switching regulator integrated circuit. This chip provides a reference voltage, an error amplifier and a pulse-width modulator. The drive from this device is transformer-coupled to two power FETs, and regulated output voltages of +26 VDC and +5 VDC are generated. Over-current and over-temperature protection is also provided. Extensive decoupling, filtering and shielding are used to eliminate the spurious generated by the switching waveform, so that the receiver is free of received "birdies" radiated or conducted from the power supply.

The power supply will provide up to 400 watts output on a continuous basis; 15 Amps at +26 VDC and 2 Amps at +5 VDC. Line voltage connection is made through an externally-mounted filter assembly which further reduces the conducted spurious from the power supply.

The Power Supply Input Assembly board contains two fuse holders and two line voltage switches for manual selection of 115 VAC or 230 VAC input.

#### 5.9.15.1 Input Voltage for Full Performance

115 VAC Range = 103 to 132 VAC, 47 Hz to 63 Hz  
230 VAC Range = 185 to 264 VAC, 47 Hz to 63 Hz

#### 5.9.15.2 Input Voltage for Minimum Operation

115 VAC Range = Down to 88 - 100 VAC  
230 VAC Range = Down to 172 - 185 VAC

#### 5.9.15.3 Input Current

4.0 Amp RMS maximum at 230 VAC input and 400 watts output

8.0 Amp RMS maximum at 115 VAC input and 400 watts output

#### 5.9.15.4 Apparent Power Input

805W nominal at 230 VAC input and 400 watts output

615W nominal at 115 VAC input and 400 watts output

#### 5.9.15.5 Real Power Input and Efficiency

520W nominal at 115/230 VAC input and 400 watts output

77% efficiency

#### 5.9.15.6 /ON Control Line

The DRIVE indicator shall extinguish when the voltage of the /ON line is taken from +6 VDC to open circuit (this may rise to as such as +35 VDC). It will glow when the voltage on the /ON line is taken to a value between 0 and +4 VDC.

#### 5.9.15.7 Output Under FAULT Conditions

If either a low-voltage fault or over-temperature fault is detected, the +5 VDC output voltage shall decrease to a value less than +1.2 VDC (with 1k load).

#### 5.9.15.8 Low Line Trip Point

The power supply shall turn off and the FAULT indicator shall light if the +18 VDC bus drops to a value of  $+16 \pm 1$  VDC.

#### 5.9.15.9 Drive Characteristics

The drive pulse waveform at TP10 will have the following characteristics:

Pulse period: 24  $\mu$ sec to 26  $\mu$ sec  
Amplitude: 14 V P-P  
ON duty cycle: 46% to 50%

The DRIVE indicator DS4 will glow with a brightness proportional to the drive duty cycle.

#### 5.9.15.10 Circuit Protection

##### 5.9.15.10.1 Primary Current Limit

R6 sets the primary current limit threshold to 20 A (at nominal line voltage).

#### 5.9.15.10.2 Output Current Limit

R14 sets the maximum short circuit output current limit to 6 A.

#### 5.9.15.10.3 Temperature Threshold

R2 sets the heatsink overtemperature threshold to +82 degrees C.

#### 5.9.15.10.4 Indicators

INDICATOR	COLOR	FUNCTION
DS1	Yellow	+18 VDC is present
DS2	Yellow	+5 VDC is present
DS3	Yellow	+26 VDC is present
DS4	Yellow	Drive is present
DS5	Red	Primary current limit is active
DS6	Red	Output current limit is active
DS7	Red	Fault: over-temp or low line

#### 5.9.15.11 +26 VDC Output Specifications

The +26 VDC output is measured across connectors P3/P4 and P2 with a 15  $\mu$ F/35 V tantalum capacitor from +26 VDC to ground, and the +5 VDC supply loaded for 2 Amp current.

Output Voltage (25°C and 1.5 A load): +26.4 VDC  $\pm$  0.2 V

Design Output Current: 15 Amp

Peak Output Current (at nominal line volts): 18 Amp, min 5 % duty cycle

Short Circuit Current: 5 to 7 Amp

Ripple (PAR): 300 mv p-p, 30 mvrms, 20 to 50 Hz

Load Effect: 2% maximum change in output voltage for currents of 1.5 A to 15 A

Source Effect: 2% maximum change in output voltage for input voltages specified in 5.9.15.1

Temperature Effect: 0.02% of output per degree C after 30 minute warmup

Load Transient Recovery: Output recovers to within 100 mv in less than 1 msec following a load current change from 5 to 10 Amp or from 10 to 5 Amp

#### 5.9.15.12 +5 VDC Output Specifications

The +5 VDC output shall be measured across output connector P1 pin 3 and P1 pin 5 with a 15  $\mu$ F/30 V tantalum capacitor from +5 VDC to ground, and the +26 VDC output loaded for 1.5 Amp current.

Output Voltage: +5.12 VDC to +5.28 VDC

Design Output Current (Continuous): 2.0 Amp

Short Circuit Current: 3.4 to 4.5 Amp

Ripple: 75 mv p-p and 26 mvrms

Temperature Effect: Output voltage change is a maximum of  $\pm$  1% over the specified temperature range

#### 5.9.15.13 Circuit Description

##### 5.9.15.13.1 General

See Figure 5.61 for the schematic/block diagram of the power supply.

##### 5.9.15.13.2 Input Board, 1A3A4

See Figure 5.63 for the schematic of the Input board.

S1 and S2 select the input voltage for 115 VAC or 230 VAC operation. The AC input is filtered to remove the switching frequency transients and harmonics from the power cable. Transformer T2 supplies power to the Control board to provide initial turn on signals to the power supply.

##### 5.9.15.13.3 Control Board, 1A3A1

See Figure 5.65 for the schematic of the Control board.

The Control board receives the DC voltage from the Input board and regulates it in U1, which supplies +18 VDC to the control circuitry. Indicator DS1 glows to show the presence of the +18 VDC which remains on as long as AC power is supplied to the unit.

The heart of the control circuit is a switching regulator IC, U3. A +5 VDC reference output is provided for control and protection circuitry. Negative-going pulses are applied to the base of Q4, where they are inverted and applied to Q5. The output of this transistor is then coupled through connector J4 to the FET driver transformers located on the FET Drive board. Q5 also turns on DS4, indicating the presence of drive pulses. The drive frequency may be adjusted with R35. When U3 pin 9 is taken low through CR9, the switching regulator is disabled. CR9 is controlled by the /ON line and the protection circuitry. When the /ON line is taken low, U2A output goes high, allowing the switching regulator to come on.

The Control board protection circuitry provides primary current, output current and over-temperature sensing for the power supply. A low-line sensing circuit is also provided to disable the regulator in the event of low AC line voltage.

The input current is monitored pulse by pulse on the FET Drive board and sent to the Control board. This signal is filtered then fed to U5 for comparison with an adjustable voltage. If the average input current exceeds the threshold voltage, U5 triggers one-shot multivibrator U4, which turns on Q6, disabling the remainder of the drive pulse. The circuit then recovers to monitor the next pulse, and so forth. U5 also drives Q3 to turn on the primary limit indicator DS5. The primary limit threshold is normally set by R8 to begin current limiting at 18 A output current.

Under current limiting conditions, when the output voltage drops below about +4.4 VDC, transistor Q2 is turned on, making the inverting input of U5C go high. This makes U5C output go low, the non-inverting input to U2B (and its output) go low, turning U3, the switching regulator, off through CR9. At the same time, Q1 is turned on the DS6, the output limit LED, is illuminated. R14 is used to adjust the short circuit current to 6 Amps.

Overtemperature sensing takes a signal from a temperature sensor on the FET Drive assembly and applies it to comparator U5D, where it is compared to a fixed level established by R2. When the temperature sensor voltage exceeds the threshold, the output of U5D goes low, making U6D output go high and U6E output go low, turning on the FAULT LED, DS7. The output of U6F also goes low, pulling the /FAULT line low.

Low line voltage conditions are detected by U5A by comparing a sample of the +18 VDC bus with the +5 VDC bus. When the regulated 18 VDC bus drops about 10% (indicating that the primary 30 VDC input has dropped to about 18 VDC), U5A output goes low, U6A output goes high, and both U6B and U6C outputs go low. U6B disables the switching regulator and U6C turns on the FAULT LED through U6D and U6E.

#### 5.9.15.13.4 FET Heatsink Assembly, 1A3A3

See Figure 5.67 for the schematic of the FET Heatsink assembly/FET Drive board.

The FET Heatsink assembly consists of the FET Drive board, the heatsink and the FET transistors, connected together as an integral unit.

#### 5.9.15.13.4.1 FET Drive Board, 1A3A3A1

The FET Drive board consists of two FET switches, Q1 and Q2, driver transformers, snubber networks, and voltage regulator U1 and associated circuitry. A current sense transformer and temperature sensor, CR3, are also included.

The gates of the two switching devices, Q1 and Q2, are fed out of phase so that when one transistor is on, the other is off, and vice versa.

The Control board regulates the output voltage by adjusting the pulse width of the drive signal to the switches, varying the "on" time to correspond with the average power output required. Snubber networks between each drain and source prevent switching-generated voltage "spikes" from exceeding the FET's voltage ratings.

Voltage regulator U1 provides the power supply's +5 VDC output. The output voltage is adjustable via R9.

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#### 5.9.15.13.5 Transformer Board, 1A3A2

See Figure 5.69 for the schematic of the Transformer board.

The Transformer board contains the main power output transformer, rectifiers and filters for the power supply. It also includes the high voltage bus circuit filter capacitors. There are no active elements on this board.

(600460-705-003)

PART NUMBER	DESCRIPTION	SYMBOL
601067-609-001	PS COVER MARKED	
600219-651-001	CHASSIS	
604382-602-001	FAN BRACKET	
604384-602-001	FAN BRACKET SUPPORT	
604386-602-001	INPUT BRACKET	
600267-622-001	TOROID CORE	
604539-602-002	CHASSIS SIDE	
600131-233-007	CAPACITOR CLAMP	(C101)
600471-608-001	CONN TERMINAL	(P5)
602015-536-001	PS CONTROL PBA	1A1
602016-536-001	PS TRANSFORMER PBA	1A2
600428-537-001	FET HEATSINK ASSY	1A3
602018-536-001	PS INPUT PBA	1A4
600031-387-001	FAN, 24 VDC	B1
600183-314-036	CAP. 12000UF,ALUM,35V	C101
600070-416-105	RECT. BRIDGE,MDA 2500	CR101
600116-611-001	RECEPTACLE	J1
600267-622-001	TOROID CORE	L101
600352-606-001	5 PIN CONNECTOR	P1
600471-608-002	CONN. HOUSING,MOLEX, 2 POS.	P5
600223-230-002	FEMALE CONN. PIN	(P1)
600237-230-002	MALE CONN. PIN	(P1)

Figure 5.60 POWER SUPPLY ASSEMBLY

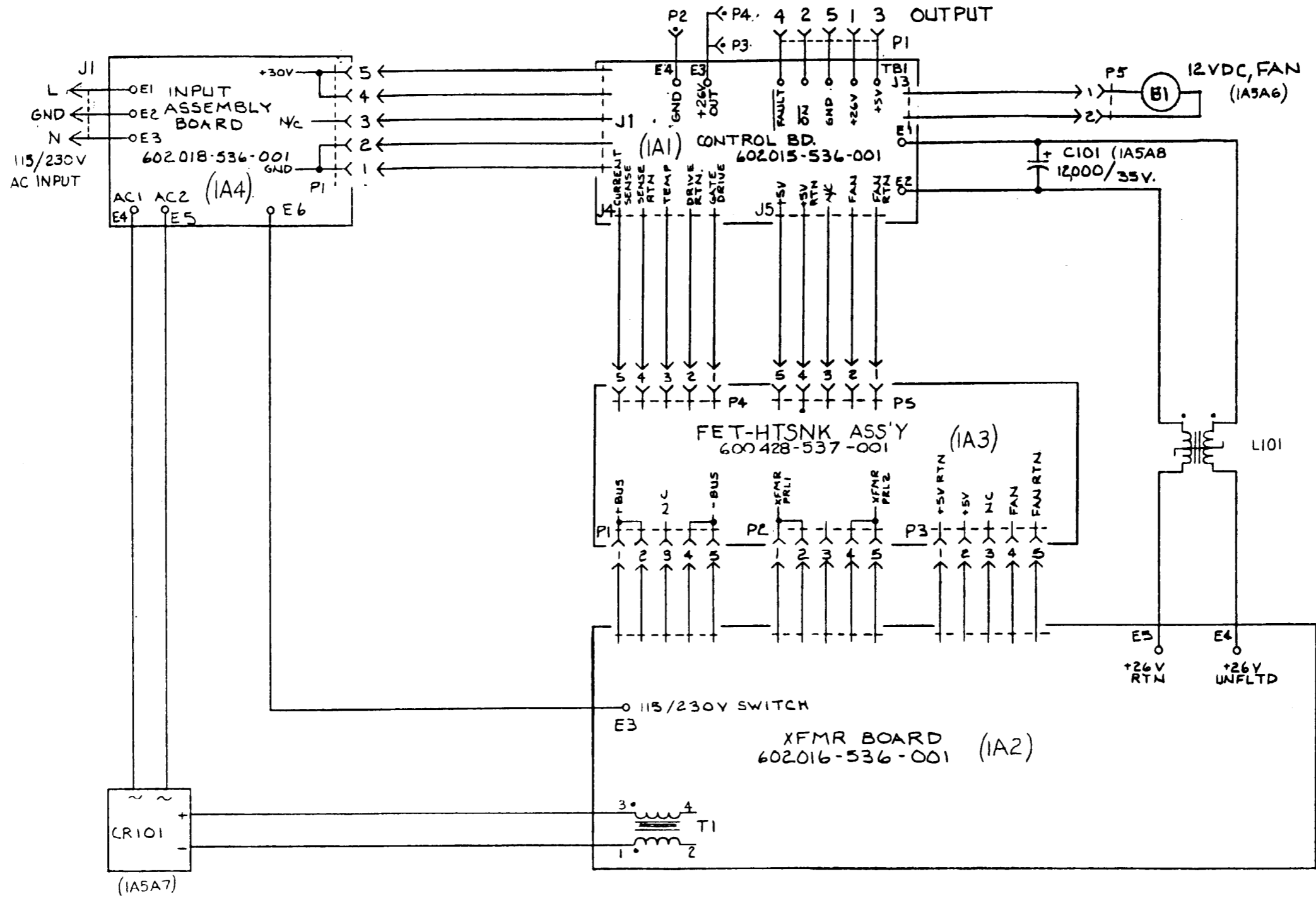


Figure 5.61  
POWER SUPPLY SCHEMATIC

(602018-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600472-314-013	CAP 1UF, POLYPROP, 400V	C1,2
600472-314-007	CAP. 0.1UF, POLYPROP, 630V	C3,4
600297-314-042	CAP. 1000UF, ALUM, 50V	C5
600302-314-013	CAP. .1UF, MYLAR, 50V	C6
600297-314-036	CAP., 150UF, 50V	C7
600014-416-001	RECT BRIDGE, MDA 920A-6	CR1
600011-416-002	DIODE IN4004	CR2
600006-411-055	DIODE, ZENER, 1N4752 33V	CR3
600004-396-018	8A F.B. FUSE	F1,2
600078-403-001	RELAY, 24V, PC MOUNT	K1
600121-608-016	CONN SOC. MOLEX, 5 PIN RT/AN	P1
610044-341-205	RES. 1M, 1/2W, 5%	R1,2
600062-340-049	RES. 180, 5W, 5%	R3,4
610094-341-205	RES. 10, 1/2W, 5%	R5
610024-341-205	RES., 10K, 1/2W, 5%	R6
615004-341-205	RES., 150, 1/2W, 5%	R7
600381-616-001	SWITCH, SLIDE, DPDT, RT/AN	S1,2
600166-513-003	CHOKE COIL, TOROID, BIFILAR	T1
600198-512-001	TRANS, DUAL, 24V SEC.	T2
600144-613-001	FUSE HOLDER	XF1,2

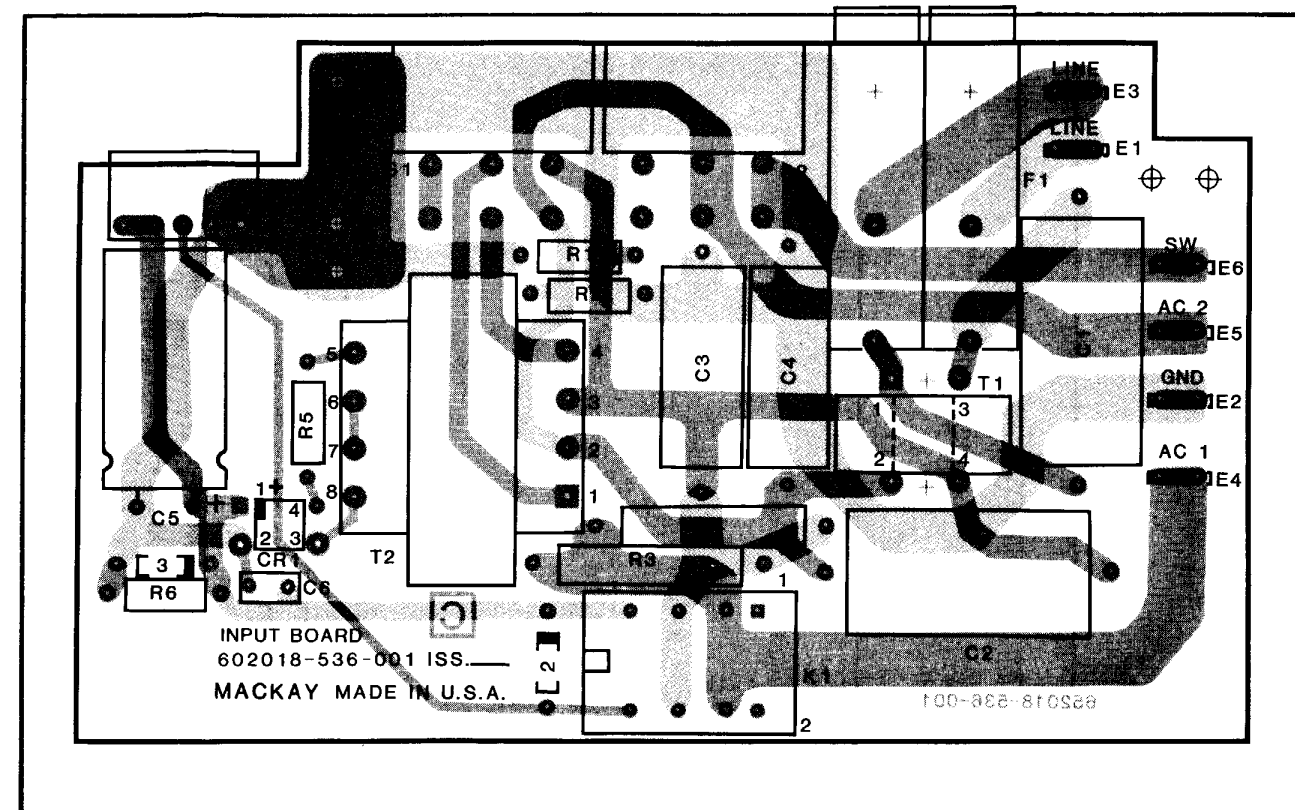
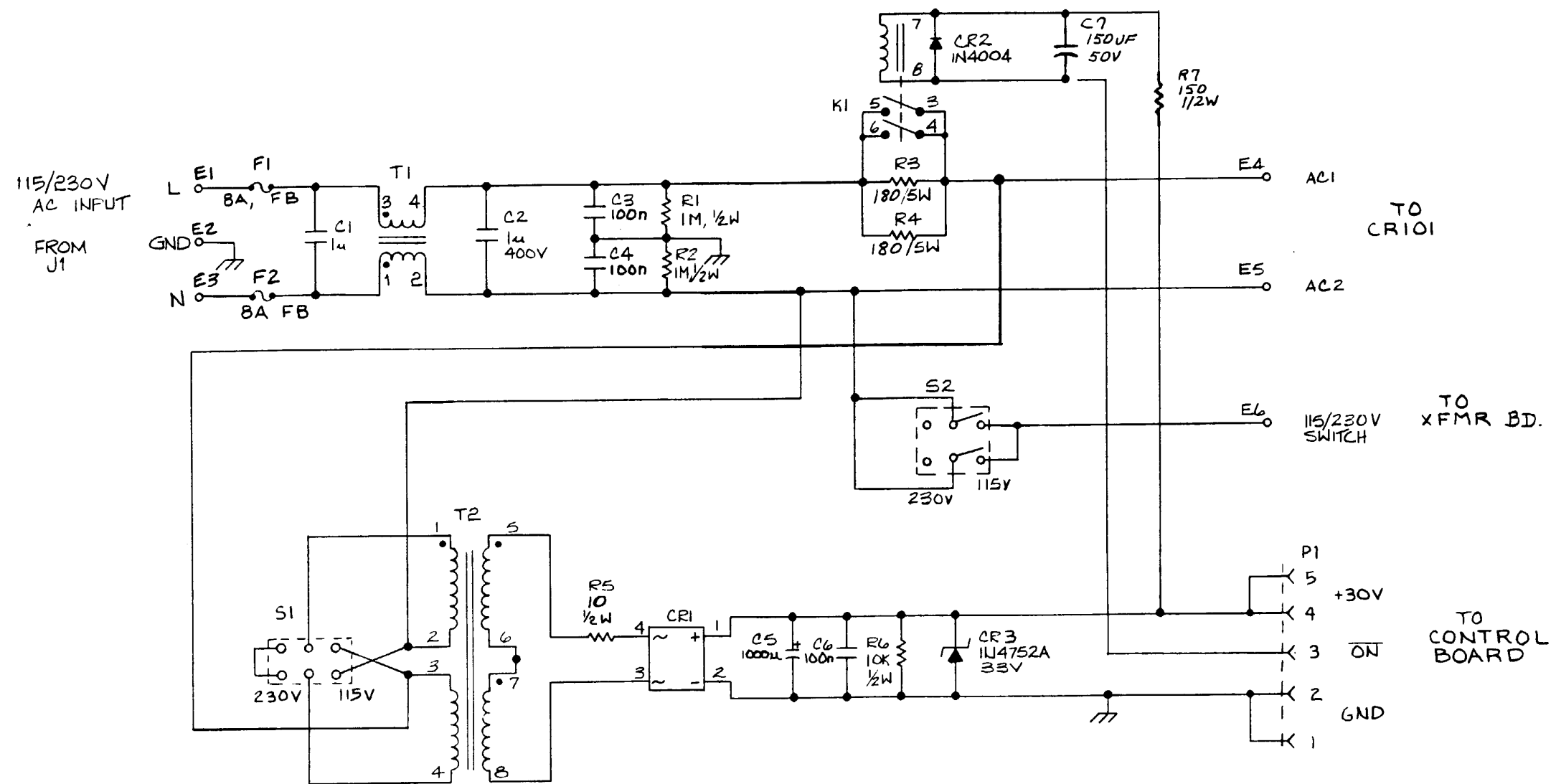


Figure 5.62

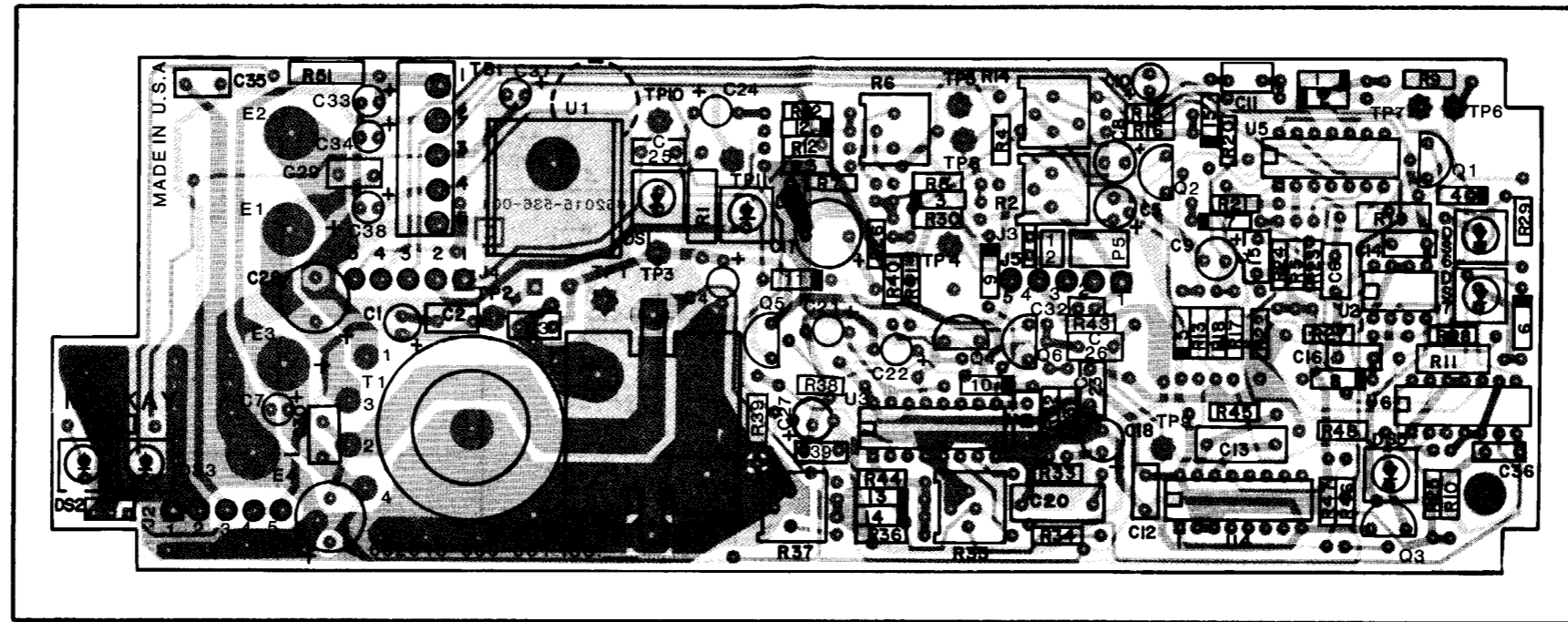
INPUT BOARD ASSEMBLY



NOTES:

1. RESISTOR VALUES ARE IN OHMS, UNLESS FOLLOWED BY MULTIPLIER K OR M, AND ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE IN FARADS, UNLESS FOLLOWED BY MULTIPLIER  $\mu$ , n OR P.

Figure 5.63  
INPUT BOARD SCHEMATIC

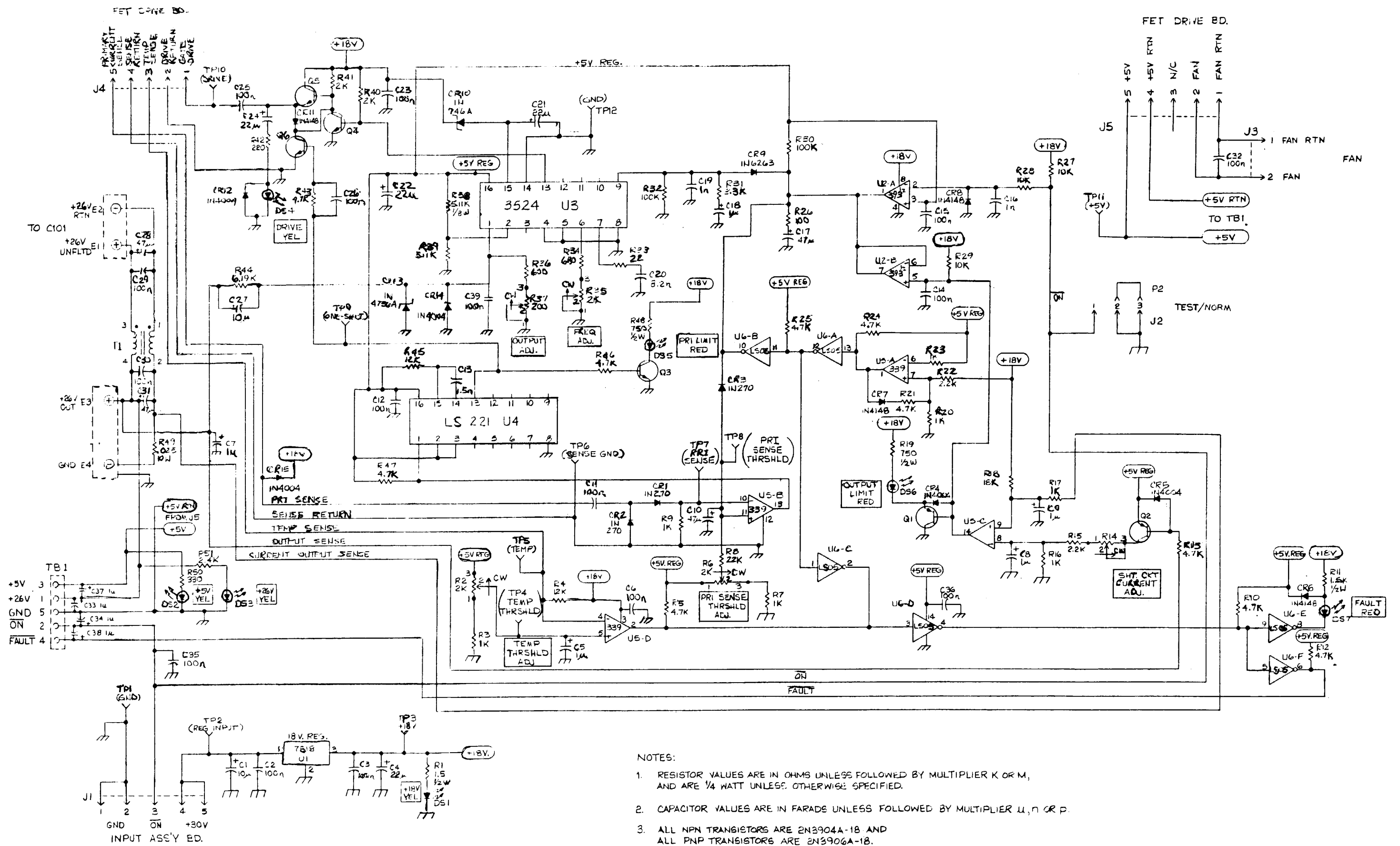


(602015-536-001)

PART NUMBER	DESCRIPTION	SYMBOL	PART NUMBER	DESCRIPTION	SYMBOL
600182-419-001	HEATSINK		600072-360-009	POT 5K, 1/2W, CERMET, TOP	R14
600037-643-002	RUBBER SPACER		622014-341-075	RES. 2.2K, 1/4W, 5%	R15, 22
600297-314-013	CAP. 10UF, ALUM, 50V	C1	618024-341-075	RES. 18K, 1/4W, 5%	R18
600297-314-024	CAP. 47UF, ALUM, 10V	C10	675004-341-205	RES. 750, 1/2W, 5%	R19, 48
600204-314-040	CAP. .0015UF, MYLAR, 630V	C13	600072-360-008	POT 2K, 1/2W, CERMET, TOP	R2, 6, 35
600302-314-001	CAP. .001UF, MYLAR, 63V	C16, 19, 26	610004-341-075	RES. 100, 1/4W, 5%	R26
600202-314-044	CAP. 47UF, 20V, TANT.	C17	610024-341-075	RES. 10K, 1/4W, 5%	R27-29
600302-314-013	CAP. .1UF, MYLAR, 50V	C2, 3, 6, 12, 14, 15, 23, 25, 29, 30, 35, 36, 39, 11	610014-341-075	RES. 1K, 1/4W, 5%	R3, 7, 9, 16, 17, 20, 23
600204-314-031	CAP. 0082UF, MYLAR, +630V	C20	610034-341-075	RES. 100K, 1/4W, 5%	R30, 32
600202-314-038	CAP. 10UF, 35V, TANT.	C27	633014-341-075	RES. 3.3K, 1/4W, 5%	R31
600202-314-045	CAP. 47UF, 35V, TANT.	C28, 31	622094-341-075	RES. 22, 1/4W, 5%	R33
600226-314-008	CAP. .1UF, CERAMIC, 50V	C32	668004-341-075	RES. 680, 1/4W, 5%	R34
600202-314-041	CAP. 22UF, 35V, TANT.	C4, 21, 22, 24	660001-342-059	RES. 600, 1/8W, 1%	R36
600202-314-007	CAP. 1UF, 35V, TANT.	C5, 7-9, 33, 34, 37, 38, 18	600072-360-005	POT. 200, 1/2W, CERMET, TOP	R37
600052-410-001	DIODE IN270	CR1-3	651111-342-059	RES. 5.11K, 1/8W, 1%	R38, 39
600002-411-001	DIODE, ZENER, 1N746A	CR10	612024-341-075	RES. 12K, 1/4W, 5%	R4, 45
600006-411-009	DIODE IN4736A 6.8V	CR13	620014-341-075	RES. 2K, 1/4W, 5%	R40, 41
600011-416-002	DIODE IN4004	CR4, 5, 12, 14, 15	622004-341-075	RES. 220, 1/4W, 5%	R42
600109-410-001	DIODE IN4148	CR6-8, 11	661911-342-059	RES. 6.19K, 1/8W, 1%	R44
600145-410-001	DIODE IN6263	CR9	604540-602-001	HEATSINK, RES	(R49)
600043-390-002	LED, YEL	DS1-4	600009-340-049	RES .05, 10W, 3%, HEATSINK	R49
600036-390-001	LED, RED	DS5-7	647014-341-075	RES. 4.7K, 1/4W, 5%	R5, 10, 12, 13, 21, 24, 25, 43, 46, 47
600121-608-013	CONN. HEADER, MOLEX, 5 PIN	J1, 4, 5	633004-341-075	RES. 330, 1/4W, 5%	R50
600198-608-005	CONN. HEADER, 3 PIN, TIN	J2	624014-341-205	RES. 2.4K, 1/2W, 5%	R51
600471-608-003	CONN. HEADER, MOLEX, 2 PIN	J3	622024-341-075	RES. 22K, 1/4W, 5%	R8
600190-608-001	CONN, JUMPER, 2 POS.	P2	650128-513-001	TRANSFORMER	T1
600116-413-002	TRANS, 2N3906	Q1, 2	600231-631-001	CONN	TB1
600229-413-003	TRANS, 2N3904 TO-92	Q3-6	600261-230-001	TERMINAL	TP1-11
615014-341-205	RES. 1.5K, 1/2W, 5%	R1, 11	600335-415-001	IC 7818 REG. 18V	U1
			600486-415-001	IC LM393, DUAL VOL COMP	U2
			600466-415-001	IC LM3524, P-W MOD	U3
			600392-415-001	IC 74LS221, MONO MLTVB, DUAL	U4
			600324-415-001	IC LM339, COMPARATOR	U5
			600240-415-001	IC 74LS05, HEX INV, O/C	U6
			600005-635-001	LED MOUNT	XDS1-7

Figure 5.64

CONTROL BOARD ASSEMBLY



NOTES:

1. RESISTOR VALUES ARE IN OHMS UNLESS FOLLOWED BY MULTIPLIER K OR M, AND ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE IN FARADS UNLESS FOLLOWED BY MULTIPLIER U, N OR P.
3. ALL NPN TRANSISTORS ARE 2N3904A-18 AND ALL PNP TRANSISTORS ARE 2N3906A-18.

Figure 5.65

CONTROL BOARD SCHEMATIC

(600428-537-001) FET HEATSINK ASSY.

PART NUMBER	DESCRIPTION	SYMBOL
604554-602-001	HEATSINK	
604555-602-001	HEATSINK	
604388-602-001	HEATSINK	
602017-536-001	PS FET DRIVE PBA	1A3
600598-415-001	DIODE LM335Z, PREC TEMP SENSOR	CR3
600408-413-001	POWER MOSFET IRF451	Q1,2
600170-419-001	TRANS INSULATOR	(Q1,U1)
600255-419-001	SIL PAD SHIELD	(Q2)
600817-415-001	IC LM350K,ADJ VOL REG	U1
600152-419-003	TO-5 HEATSINK	XCR3
600250-419-001	TO-3 SOCKET	XQ1,2;XU1

(602017-536-001) FET BOARD ASSY.

PART NUMBER	DESCRIPTION	SYMBOL
600357-314-005	CAP .0047UF, POLYPROP, 1500V	C1
600302-314-015	CAP. .22UF, MYLAR, 50V	C11
600204-314-001	CAP .01UF, MYLAR, 400V	C2,3
600357-314-002	CAP .0015UF, POLYPROP, 1500V	C4,5
600297-314-026	CAP. 47UF, ALUM, 50V	C6
600302-314-013	CAP. .1UF, MYLAR, 50V	C7,8,10, 12
600202-314-044	CAP. 47UF, 20V, TANT.	C9
600042-416-002	DIODE MR856, FAST RECOVERY	CR1,2
600011-416-002	DIODE IN4004	CR4
600121-608-016	CONN. SOC. MOLEX, 5 PIN RT/AN	P1-5
656094-341-075	RES. 56, 1/4W, 5%	R1
647004-341-075	RES. 470, 1/4W, 5%	R10
610004-341-075	RES. 100, 1/4W, 5%	R2,4
610044-341-075	RES. 1M, 1/4W, 5%	R3,5
600062-340-056	RES. 56, 3W, 5%	R6,7
610014-341-075	RES. 1K, 1/4W, 5%	R8
600066-360-007	POT. 1K, 1/2 W,CERMET, RT/AN	R9
635323-501-001	TRANSFORMER, CURRENT SENSE	T1
635312-501-001	TRANSFORMER, FET DRIVER	T2,3

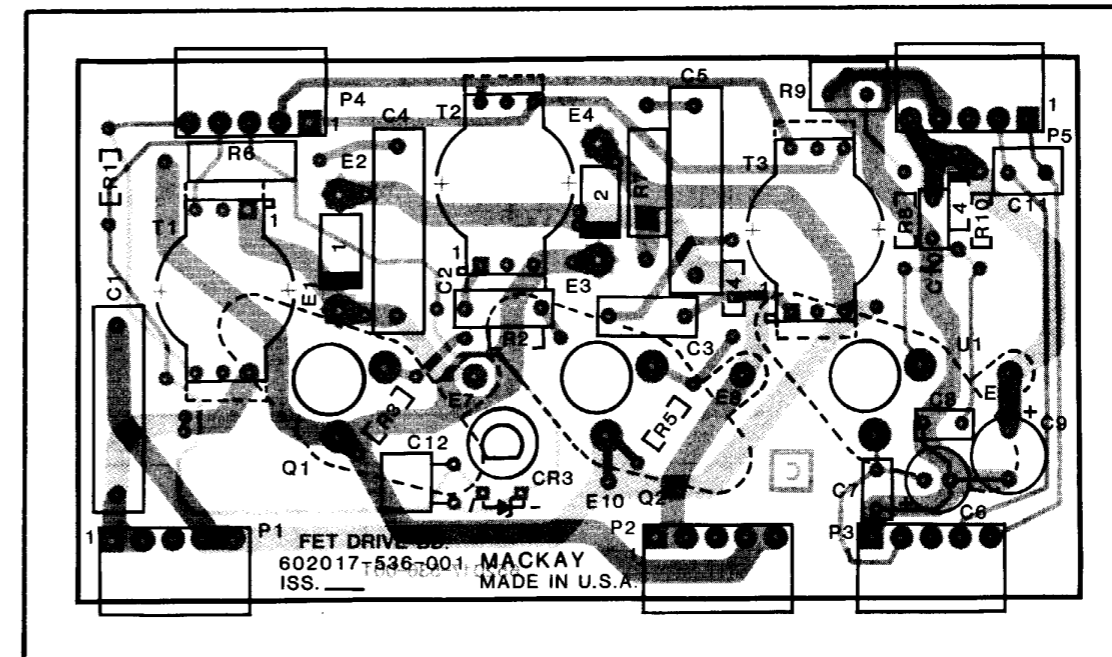
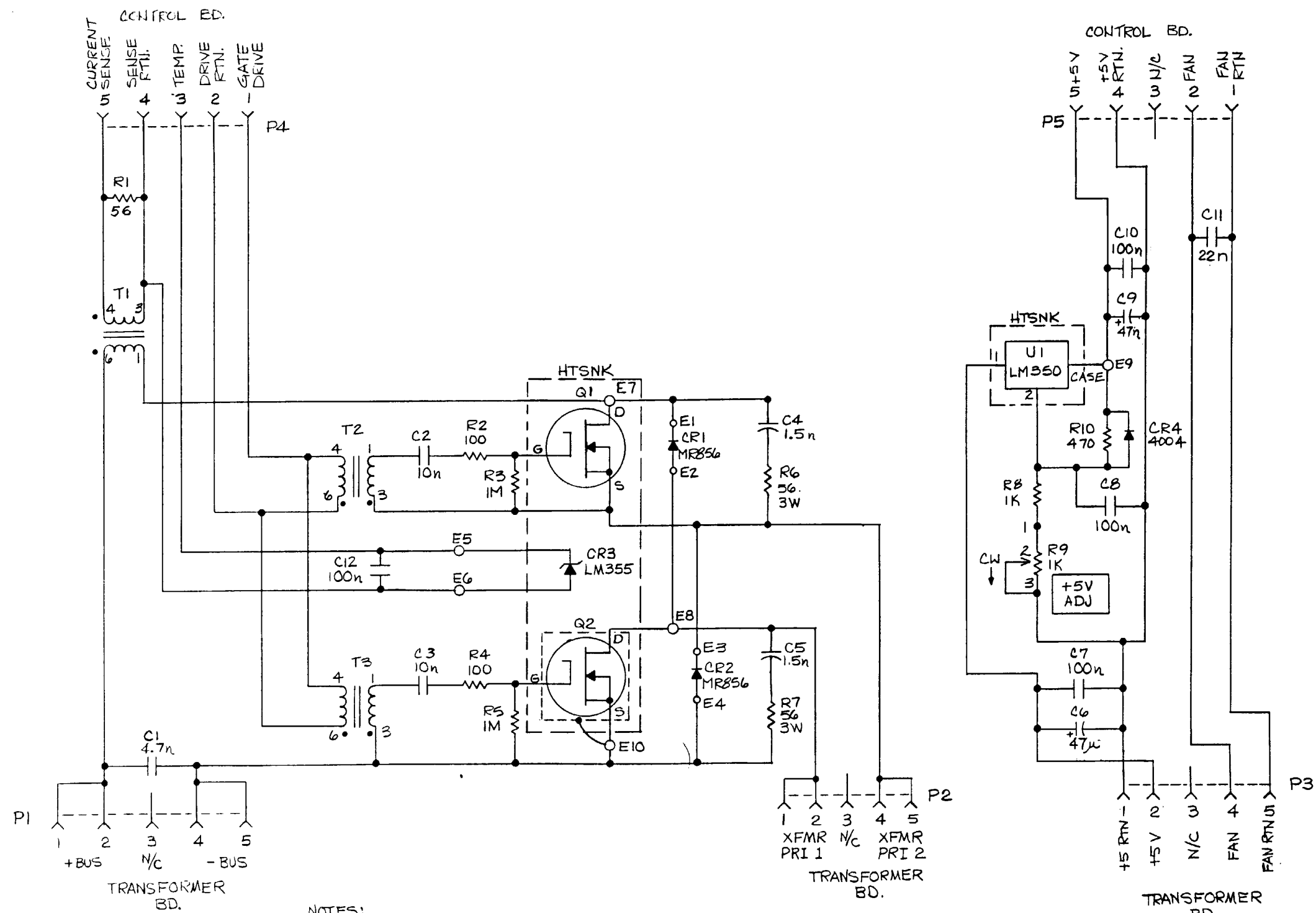


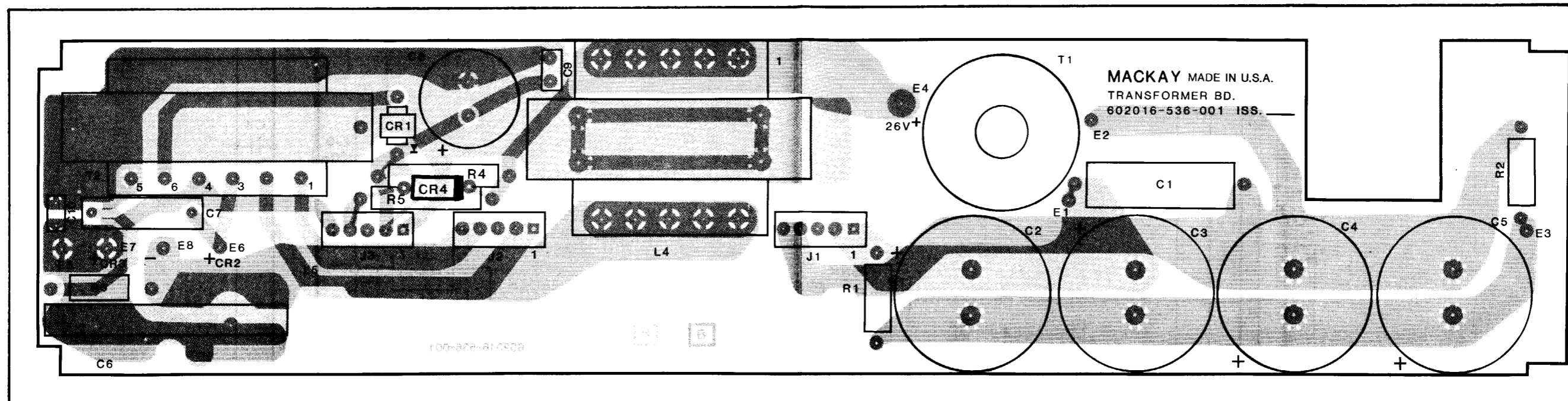
Figure 5.66

FET BOARD ASSEMBLY



- NOTES:
1. RESISTOR VALUES IN OHM UNLESS FOLLOWED BY MULTIPLIER K OR M, AND ARE 1/4W UNLESS OTHERWISE SPECIFIED.
  2. CAPACITOR VALUES IN FARADS UNLESS FOLLOWED BY MULTIPLIER  $\mu$ , n OR p.

Figure 5.67  
FET SCHEMATIC

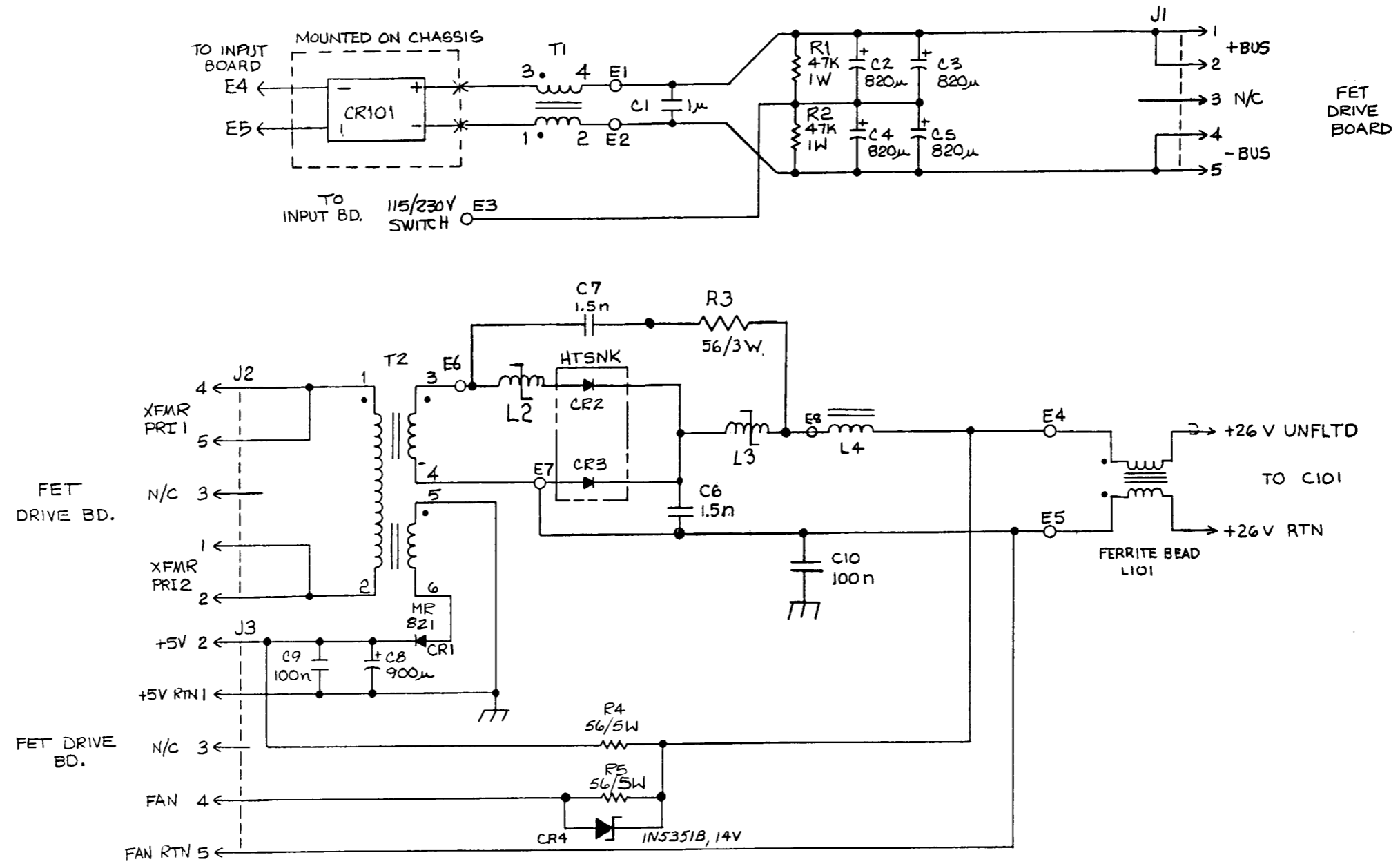


(602016-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600270-314-005	CAP. 1.0 UF, 400V	C1
600366-314-002	CAP. 820UF, ALUM, 200V	C2-5
600357-314-002	CAP. .0015UF, POLYPROP 1500V	C6,7
600257-314-006	CAP. 900UF, ALUM, 25V	C8
600302-314-013	CAP. .1UF, MYLAR, 50V	C9,10
600062-416-001	DIODE MR821, FAST RECOVERY	CR1
604387-602-001	HEATSINK, RECT	(CR2,3)
600170-419-005	DIODE INSULATOR	(CR2,3)
600470-608-001	RECT CONN	(CR2,3)
600018-638-005	SHOULDER WASHER	(CR2,3)
700001-416-001	DIODE MUR-5020, ULTRA FAST REC	CR2,3
600026-411-019	DIODE IN5351B	CR4
600121-608-013	CONN. HEADER, MOLEX, 5 PIN	J1,2,3
600267-622-001	TOROID CORE	L2,3
635048-510-001	TRANSFORMER	L4
647024-341-325	RES. 47K 1W 5%	R1,2
600062-340-056	RES. 56, 3W, 5%	R3
600062-340-001	RES. 56, 5W, 5%	R4,5
600166-513-002	COIL, TOROID, BIFILAR	T1
635340-501-002	TRANSFORMER, POWER	T2

Figure 5.68

TRANSFORMER BOARD ASSEMBLY



NOTES:

1. RESISTOR VALUES ARE IN OHMS UNLESS FOLLOWED BY MULTIPLIER K OR M AND ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE IN FARADS UNLESS FOLLOWED BY MULTIPLIER μ, n OR p.

Figure 5.69  
TRANSFORMER BOARD SCHEMATIC

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#### 5.9.16 DUAL REGULATOR MODULE, 1A4A1

See Figure 5.70 for the schematic of the Dual Regulator module.

This module is mounted on the rear of the card cage for heatsinking and it provides a source of regulated +14 VDC and +9 VDC for the radio.

The dual regulator connects to the Mother board.

U2 is an adjustable 3 Amp regulator set to produce +14 VDC from the +26.4 VDC power supply. This regulator provides power for the optional ovenized high stability frequency standard, and also acts as a source for the +9 VDC regulator, U1. Precise adjustment to +9.2 VDC is made by potentiometer R3 located on the Mother board. LED DS1 lights to show the presence of voltage on the +9 Volt line.

(600429-537-001)

PART NUMBER	DESCRIPTION	SYMBOL
600302-314-015	CAP. .22UF, MYLAR, 50V	C6
600170-419-001	TRANS INSULATOR	
604588-602-001	MTG BRACKET	
600297-314-016	CAP. 22UF, ALUM, 25V	C1
600226-314-014	CAP. 1UF, CERAMIC, 50V	C2
600272-314-001	CAP. .1UF, CERAMIC, 50V	C5
600160-631-005	TERM STRIP	E1
600267-622-001	TOROID CORE	L1
600034-376-001	CHOKE 1000UH	L3
600353-606-001	CONN. MOLEX, 6 POS.	P26
600223-230-002	FEMALE CONN. PIN	(P26)
600237-230-002	MALE CONN. PIN	(P26)
612004-341-075	RES. 120, 1/4W, 5%	R1
613014-341-075	RES. 1.3K, 1/4W, 5%	R2
600817-415-001	IC LM350K, ADJ VOL REG	U1, U2
600288-419-001	INSULATING COVER	(U1, U2)
600250-419-001	TO-3 SOCKET	XU1

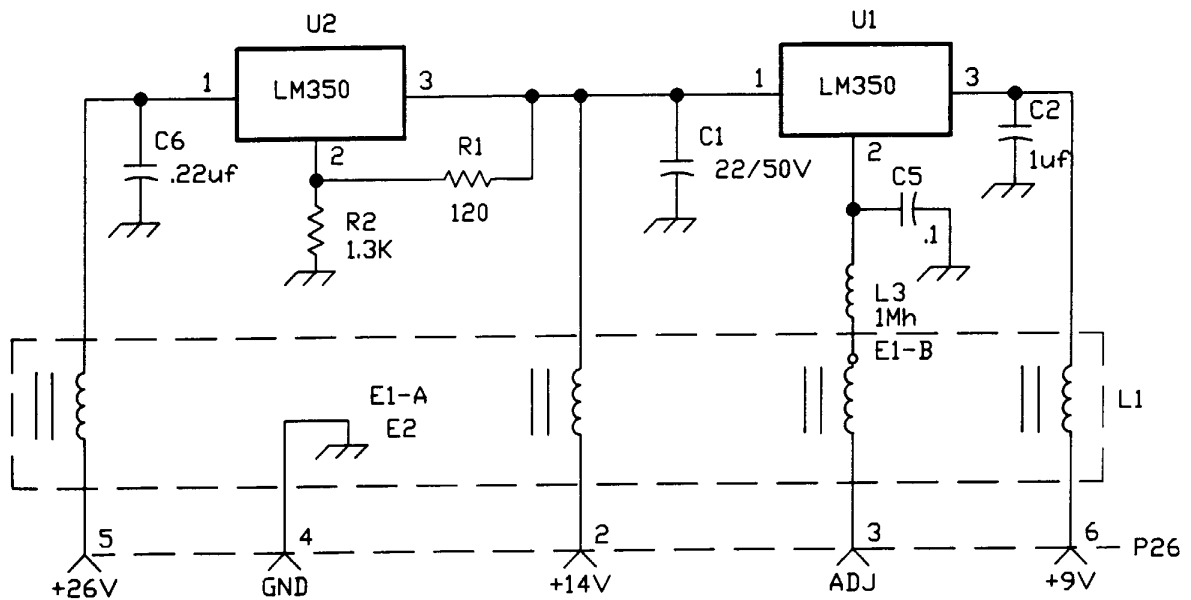


Figure 5.70 DUAL REGULATOR ASSEMBLY/SCHEMATIC

### 5.9.17 AC LINE FILTER, 1A23

The AC line filter complements the transceiver internal filters to reduce line noise in applications where a nearby receive antenna is not well shielded or isolated from the transceiver. In less sensitive areas the filter could be removed, allowing operation on line frequencies to 400 Hz. The filter mounts on the left rear of the radio, sharing three mounting screws from the rear panel.

(700006-537-001)

PART NUMBER	DESCRIPTION	SYMBOL
700002-102-001	CORD LINE AC	
600246-230-001	TERMINAL	
600246-230-002	TERMINAL	
700001-529-001	FILTER LINE AC	
700061-602-001	BRACKET AC LINE FILTER	
700095-602-001	COVER AC LINE FILTER	
600030-642-031	LARGE GROMMET	

**Figure 5.71 AC LINE FILTER ASSEMBLY**

## SECTION 6

### OPTIONS AND ACCESSORIES

#### 6.1 PRESELECTOR OPTION

The Preselector Kit (Mackay P/N 700007-700-003) provides front end selectivity to the receiver to prevent interference from strong off-channel stations. It may also be added near the output of the transceiver to reduce broadband noise introduced into the linear power amplifier input.

The Preselector Option consists of the following:

- a) MSR 6300 Preselector, P/N 699038-000-001 (separate manual supplied)
- b) Preselector Interface Cable, P/N 600878-540-002
- c) +12 VDC/1.6 A Power Supply, P/N 600055-391-001 (separate manual provided)

If it is desired to use the preselector also as a post-selector, order the Signal Routing Kit, (Mackay P/N 600279-700-001).

##### 6.1.1 DESCRIPTION

See Figure 6.1 for the installation diagram.

The Preselector is a digitally-tuned bandpass filter with 38 dB rejection at the center frequency  $\pm 10\%$ . It is tuned to the radio operating frequency by 14 BCD input lines provided from the transceiver. The preselector tunes from 1.6 to 10 MHz in 20 kHz steps, and from 10 to 29.9 MHz in 100 kHz steps, with a 3 dB bandpass of  $\pm 1\%$  around the center frequency and a gain of  $-1 \pm 3$  dB. The noise figure (and sensitivity) of the receiver is degraded by 6 dB maximum at the preselector input. The preselector and receiver are protected from large steady-state antenna signals by relays which open the antenna circuit when a power level of 2 Watts or more is detected. An indicator light is provided to show the operator when this condition exists. Fast-acting gas discharge tubes protect the preselector and receiver from transients on the antenna line. The preselector is

automatically bypassed (noted by panel light) at frequencies below 1.6 MHz, allowing the receiver to operate down to 100 kHz. A front panel switch can be operated to bypass the internal amplifier, decreasing the front end gain by 10 dB for operation under extreme signal interference where receiver sensitivity is not critical.

The Preselector gets its power from the external power supply which is furnished with the kit. With this supply, the preselector must be internally strapped in the "LO V" regulator bypass position. The power supply may be operated from 115 VAC, 47 to 400 Hz. To operate the power supply from 230 VAC, consult the power supply manual.

The Preselector Interface connector interconnects the transceiver and preselector with 14 BCD lines, a TRANSMIT status line and a signal common (ground) line. Two wires branch out from the preselector mating connector to connect to the power supply for +12 VDC. The black wire goes to the power supply negative terminal and the white wire goes to the power supply positive terminal. A standard cable length of 4.5 feet provides ample strain relief for servicing.

To operate the unit as a transmitter post-selector, a signal routing kit (P/N 600279-700-001) must be added to the transceiver. This kit consists of a jumper cable and rear panel connectors which allow the preselector to be electrically inserted into the transmitter signal path at the LPA input.

The preselector can be used with the MSR 8050A to add filtering in both the receive path and in the transmit path to the antenna. Relays in the preselector operate from the /TX signal from the transceiver to transfer the filter circuits between the two paths.

##### 6.1.2 CHECKOUT PROCEDURES

###### 6.1.2.1 Test

Check the preselector to be sure the internal

jumper is in the "LO V" position. Connect the preselector to the transceiver at rear panel connector J35. Turn the transceiver power switch ON. Turn the Preselector Amplifier switch ON. Check receive and transmit operation on the following frequencies to ensure that all 6 preselector bands are functioning properly: 1.6, 2.6, 4.3, 6.9, 11.3, 18.4 and 29.9 MHz. Note the transmit power. If it falls below specification limits (because of loss in the post-selector), readjust the Transmit Modulator gain (see Section 5.7.4.4) at the frequency with the lowest output.

To change the preselector status from In-circuit to Out-of-circuit or vice versa, depress keyboard "E", then "4". The frequency display will show PSL IN or PSL OUT. Change status by depressing "C". The display will toggle between IN and OUT. Select the desired preselector status and depress "E" to enter it into the system. **NOTE:** The "E" and the "4" must be depressed within 2 seconds of one another or the microprocessor will return the system to its original condition.

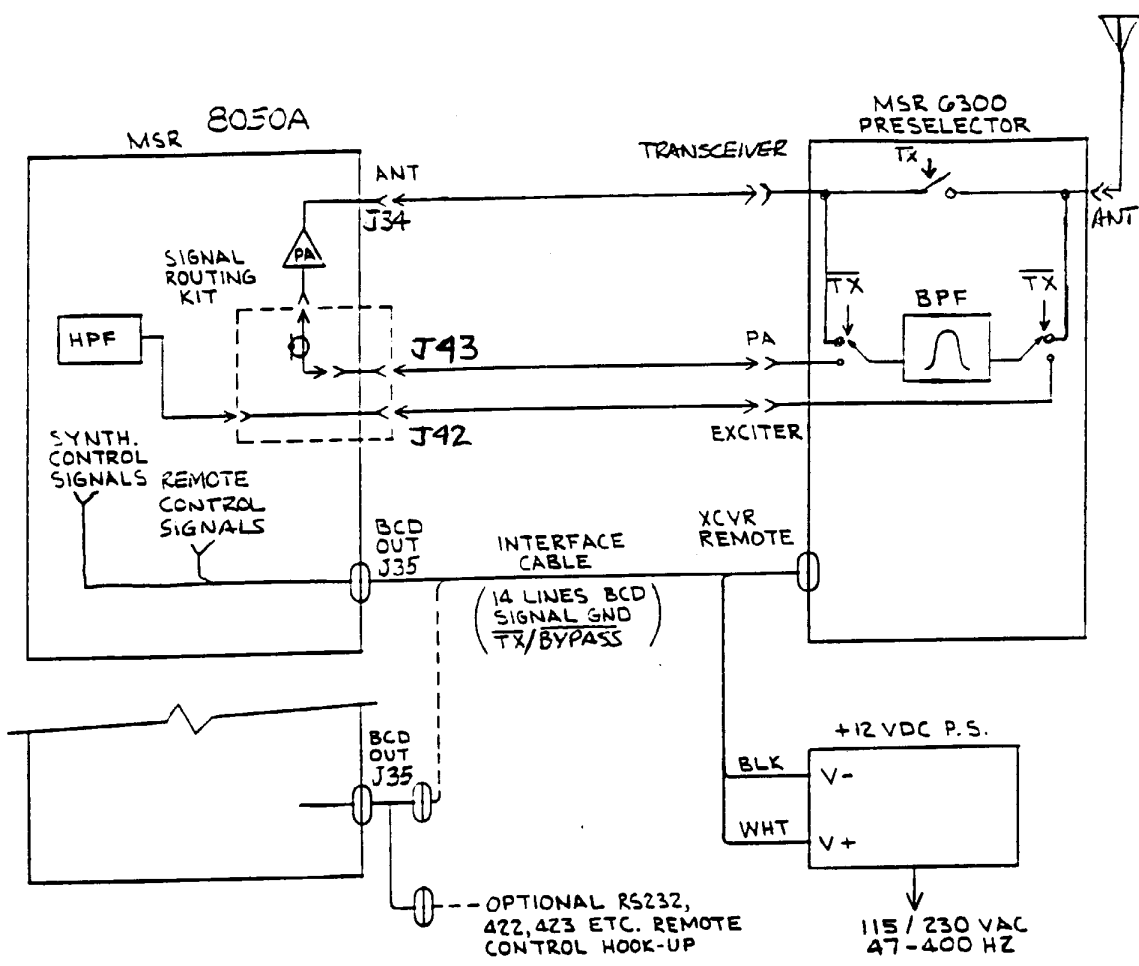
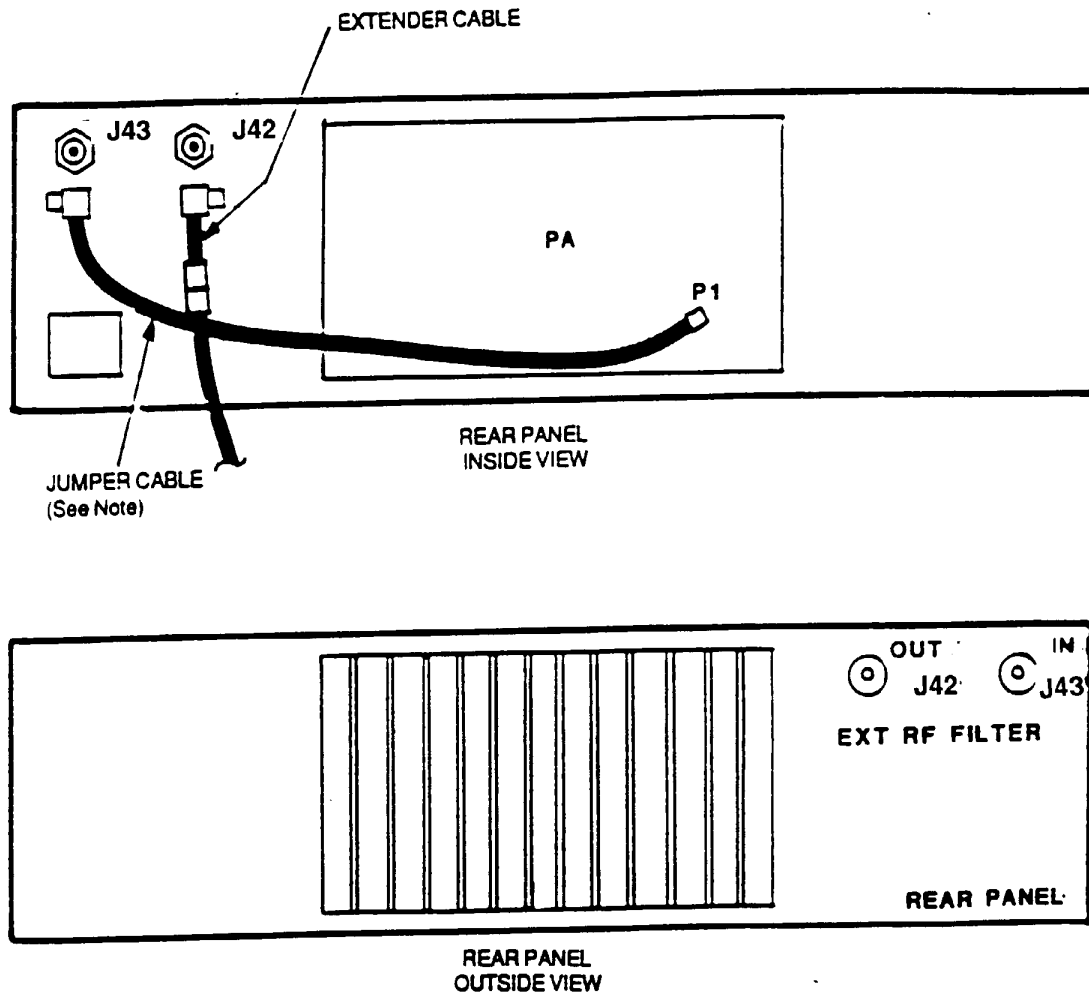


Figure 6.1 TYPICAL PRESELECTOR INSTALLATION DIAGRAM

## 6.2 SIGNAL ROUTING KIT

The Signal Routing Kit (600279-700) provides two rear panel BNC connectors which break the transmit signal at the MSR 8050A LPA input. This allows reduction of broadband transmit noise by an external filter. The kit is normally installed as

part of the Preselector Option (P/N 700007-700-003). Figure 6.1 shows a typical installation. Figure 6.2 shows installation details of the Signal Routing Kit which adds a coax jumper cable, extender cable, and two rear panel BNC/SMB connectors.



**NOTE:** Remove the cable from P1 on the PA as shown and connect it to J42 on the MSR 8050A rear panel with extender cable. Jumper cable is connected to P1 on PA with right-angle connector being connected to rear panel J43.

**Figure 6.2 DETAILED INSTALLATION, SIGNAL ROUTING KIT**

### 6.3 HIGH STABILITY REFERENCE OPTION

Aging:  $\pm 1 \times 10^{-6}$  per year

This option (600288-700-001) is factory-installed and provides a high stability oven frequency standard for the transceiver. With this option, the MSR 8050A frequency accuracy can be held within  $\pm 0.3$  Hz at 30 MHz.

Warm-up Time Required: 30 min. from +25° C

Power Required (furnished by Xcvr): Oscillator and Oven: +13 VDC  $\pm 15\%$ , 670 mA during warm-up  
 Oscillator (steady state): 200 mA typical at 25° C ambient

#### 6.3.1 TECHNICAL SPECIFICATIONS

Output Frequency: 5,000,000.00 Hz

The High Stability Frequency Standard is connected to J1 of the Reference board to replace the 5 MHz reference frequency from the standard on-board TCXO (Temperature Compensated Crystal Oscillator). Jumper JP1 on the Reference board is set to position 2-3 to disable the TCXO.

Output Waveform: TTL Levels

Frequency Stability: Ambient:  $\pm 1 \times 10^{-8}$  from 0° C to + 65° C

(600288-700-001)

SYMBOL	DESCRIPTION	PART NUMBER
C1	Cap., .1 $\mu$ F, 50V	600272-314-001
E19,E20 (E18) (E10)	22 AWG Wire, Red	600007-100-002
	Wire, 22 Gauge	600007-100-090
	22 AWG Wire, Black	600007-100-000
OCXO	Crystal	600173-378-001
	Coax Cable	600440-540-010

#### WIRING LIST

Symbol	From	Pin	To	Pin	Item No.
C1	OCXO	1	OCXO	2	8
	OCXO	1	Mother Bd.	E18	10 & 14
	OCXO	2	Mother Bd.	E1	11 GND
	OCXO	2	Shield	12	
	OCXO	3	Center Lead	12	Ref. Out
	Mother Bd.	E19	Mother Bd.	E20	9

Figure 6.3 HIGH STABILITY REFERENCE ASSEMBLY

**6.4 ADDRESSABLE AUDIO I/O OPTION  
(700412-700-002)  
(Audio I/O Board 700025-536-001)**

In addition to the standard functions supplied by the Standard Audio I/O board, the Optional Audio I/O board provides 2-wire and 4-wire operation as well as FSK remote control with "daisy-chain" features. It replaces the existing board in the Audio I/O slot on the Mother board. All additional features are automatically connected.

The extra features provided by the optional Audio I/O board include:

1. Switched Audio - this allows the MSR 8050A, along with any number of other MSR 8050A transceivers, MSR 6700A transmitters or MSR 5050A receivers, to be connected to an MSR 6420 remote control unit using a single audio bus. The switched audio feature connects the remote control audio ONLY to the single radio that is under its direct control.

2. Two Wire Switched Audio - with this feature, the audio circuits of any number of MSR 8050As (or other "A series" equipment) may be connected to an MSR 6420 RCU's two wire circuits using a single twisted pair. Both transmit and receive audio travel over the single pair.

3. Daisy-Chain FSK Control - this allows multiple MSR 8050As, MSR 6700As and/or MSR 5050As to be connected together in a remote control system using 300 Baud FSK. To use this feature, the radios must also incorporate the optional Tone Key/Modem board.

Figure 6.5 is a schematic of the Optional Audio I/O board. Figures 4.2 and 6.6 shows the transceiver audio paths with the standard and optional Audio I/O board.

**6.4.1 INSTALLATION**

To install the optional Audio I/O board, simply remove the standard Audio I/O board and replace it with the option board. There are switches and jumpers on the option board that should be set prior to installation to configure the board to the desired mode of operation.

**SWITCH S1 -  
2-WIRE/4-WIRE SWITCHED AUDIO**

<u>Switch</u>	<u>Left Position</u>	<u>Right Position</u>
S1-1	4W	2W
S1-2	4W	2W
S1-3	4W	2W
S1-4	No Tone Notch	Tone Notch Enabled

**JUMPER POSITIONS**

<u>Jumper</u>	<u>Position 1-2</u>	<u>Position 2-3</u>
JP1	Centertap Key OFF	Centertap Key ON
JP2	AGC Threshold decreases (in Data Mode)	No AGC Threshold Change
JP3	Local Audio Normal	Local Audio Disabled

These switches and jumpers are explained in Section 6.4.2.

For additional information on operating an MSR 8050A with an MSR 6420 RCU and other MACKAY equipment, see the MSR 6420 manual.

**6.4.2 TECHNICAL DESCRIPTION**

**6.4.2.1 Audio Reference**

Operational amplifier U3A creates a DC reference for the audio circuitry of about 6.5 VDC, roughly 1/2 of the +13 VDC supply voltage. All audio signals use this reference on this board, including the 300 Baud FSK tones. By establishing the audio ground at 1/2 the supply voltage, the operational amplifiers used on this board can "swing" both positively and negatively with reference to the audio "ground".

**6.4.2.2 Standard (Unswitched) Audio**

U5 is a bilateral analog switch which routes the transmit and receive audio through the DATA/FSK TX and DATA/FSK RX ports when the transceiver is in either the DATA or FSK modes. In any other mode, it routes the audio through the STD TX or STD TX ports. This switching is controlled by comparators U1A and U1B. Amplifiers U3B, U3C and U3D (with gain control R4) control the gain and frequency response of the receive audio

output. U2A (and gain control R13 in DATA or FSK modes) controls the transmit audio input.

#### 6.4.2.3 Centertap Keying

Transistor Q7 allows the transmitter to be keyed by a DC level change detected on the external DATA/FSK TX audio lines. This feature is meant for use with a TADIL A high speed data modem. With JP1 set to positions 2 and 3, +6 VDC on the DATA/FSK TX lines will key the transmitter if the transceiver is in the DATA or FSK mode. Centertap keying is disabled if JP1 is set to positions 1 and 2.

#### 6.4.2.4 AGC Threshold Reduction

When the transceiver is in either DATA or FSK mode, the AGC threshold level may be reduced (from about 7  $\mu$ VRMS to about 2  $\mu$ VRMS) to provide a more constant receive audio level over the full input signal level range. Jumper JP2 enables (position 1-2) or disables (position 2-3) this feature. Position 1-2 is the standard position for this jumper, enabling the threshold change.

When the AGC threshold drops (in DATA or FSK mode) with JP2 enabled, the receive audio level also decreases. The audio level may be brought back up to normal levels with R4. If JP2 position is changed to position 2-3, R4 should be used to decrease the received output to its original level, matching the level in the standard channels.

#### 6.4.2.5 Switched Audio

The switched audio ports may be configured for either four wire or two wire operation by switch S1: all switches set to the left for four wire operation, and all switches set to the right for two wire operation. Darlington transistor Q6 closes relay K1 when the transceiver is in the REMOTE mode and is THE radio under control (in a remote network) by the MSR 6420 RCU. Closing K1 connects both of the switched audio ports to the audio bus lines running between the RCU and all of the units in the remote control network.

Amplifier U2B buffers the incoming switched audio, while U2C buffers and amplifies the outgoing switched receive audio signal.

Tone IC U6 is used to put a notch in the receive audio signal when the radio is configured for two wire operation. This notch is required to prevent the possibility of inadvertently keying the transceiver, when it is configured for tone keying (see Section 6.5 Tone Key Modem board). In two wire operation, the receive audio is present on the transmit audio lines. If the transceiver is configured for tone keying, any receive audio at the keying tone frequency will key the transmitter. U6 prevents this by "notching out" the keying tone frequency from the receive audio. When S1-4 is set to the four wire position (left), the receive audio signal passes through U6 unnotched.

Comparator U1C may be used to disable all local audio while the transceiver is connected to the audio bus. When jumper JP3 is set to positions 2 and 3, no transceiver audio will enter or exit through the local (unswitched) audio ports when the transceiver is selected by the RCU. With JP3 in positions 1 and 2, local transmit audio is added to any incoming switched audio, and receive audio is available at both the local and switched audio ports.

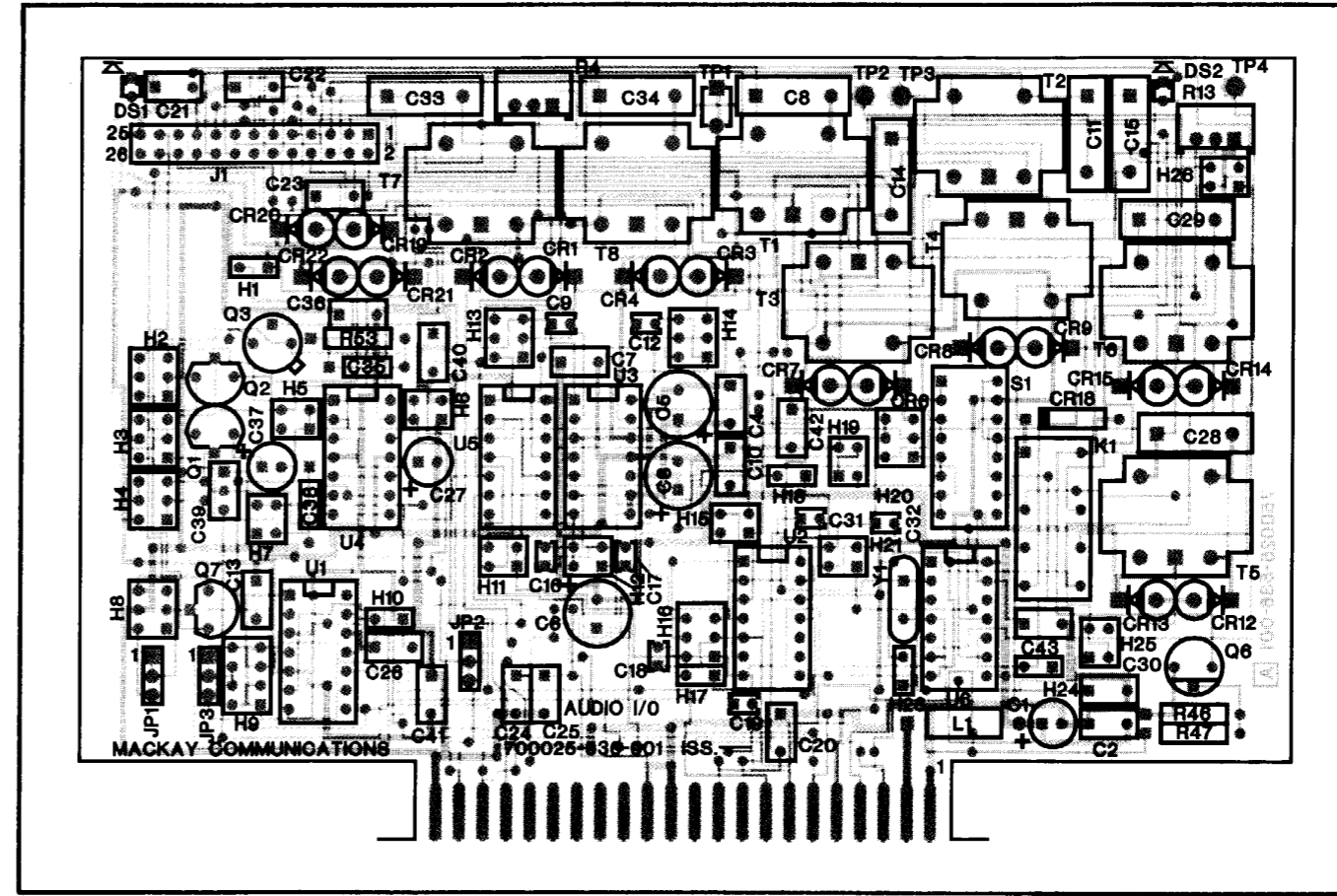
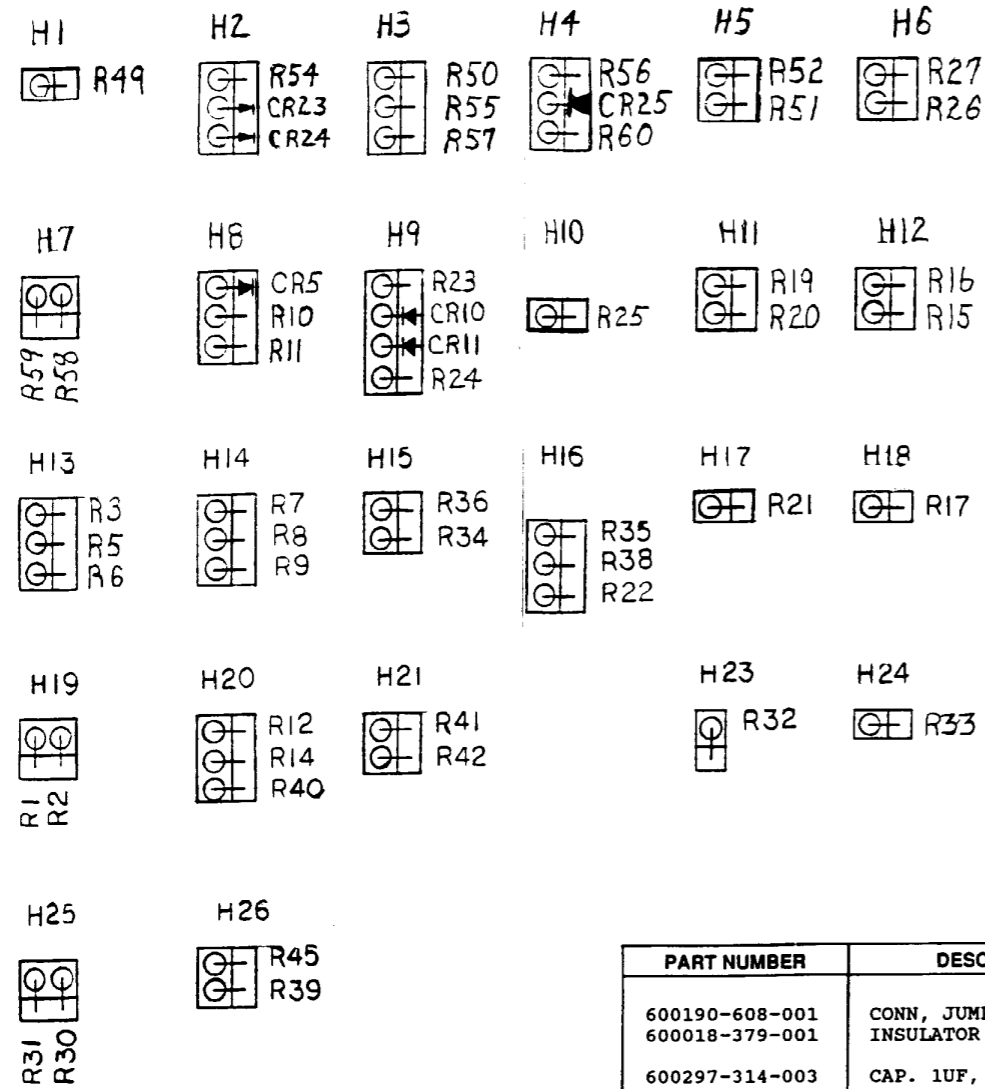
#### 6.4.2.6 Daisy-Chain FSK Remote Control

This circuitry allows the transceiver to be connected with other MACKAY transmitters and receivers in a remote control system using 300 Baud FSK control. The radios and remote control units in the system are "daisy-chained" together in a string. FSK signals enter the radios or RCUs via one of the Control/Status (CNTL/STAT) ports and leave through the other with 2 dB loss. This limits the number of radios to 10. When the transceiver is sending out status information, the FSK tones are transmitted into both legs of the remote control string.

The Originate/Answer (O/A) control line configures the daisy chain circuitry to either receive a control command from the RCU (originate) or return a status signal (answer). U4B transforms the TTL level O/A command into a +13 VDC signal and U4C inverts it. These 13 VDC signals control FETs Q1, Q2 and Q3. When in receive mode, Q2 and Q3 conduct, allowing the FSK tones to flow freely between the two CNTL/STAT ports and to be sent through buffer U4A to the

RX A port on the Tone Key/Modem board. Q1 is non-conducting, preventing transmit FSK tones from reaching the CNTL/STAT ports.

When the O/A line goes low and the transceiver sends out status information on the CNTL/STAT lines, Q1 conducts, while Q2 and Q3 are turned off. The status signals from the TX A port on the Tone Key/Modem board are buffered by U4D, pass through Q1, and exit both CNTL/STAT ports.



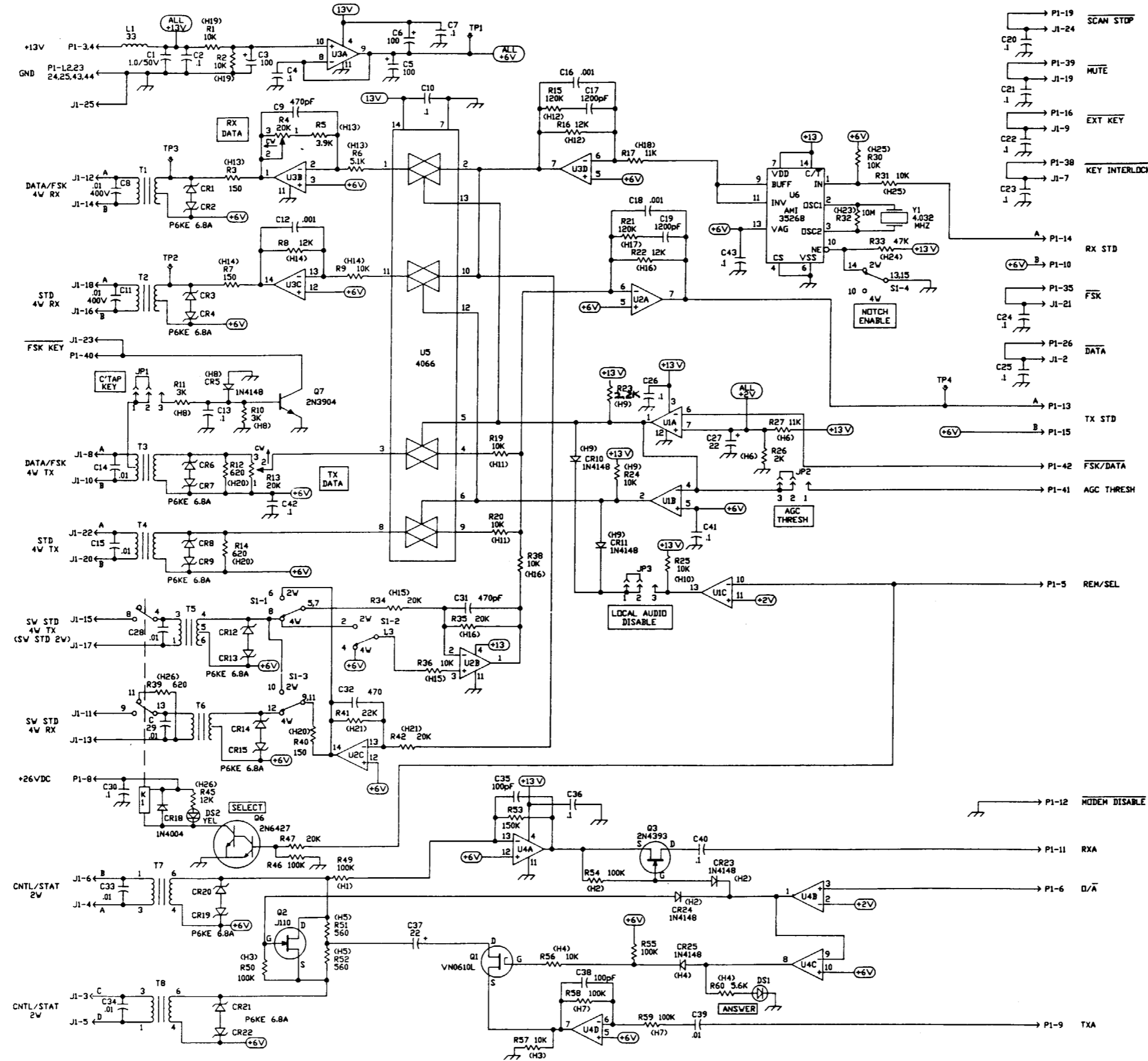
(700025-536-001)

PART NUMBER	DESCRIPTION	SYMBOL
600190-608-001	CONN, JUMPER, 2 POS.	(JP1-3)
600018-379-001	INSULATOR	(Y1)
600297-314-003	CAP. 1UF, ALUM, 50V	C1
600268-314-016	CAP. .001UF, 50V	C12, 16, 18
600268-314-017	CAP. 1200pf, 50V	C17, 19
600302-314-013	CAP. .1UF, MYLAR, 50V	C2, 4, 7, 10, 13, 30, 20-26, 36, 39, 40-43
600297-314-016	CAP. 22UF, ALUM, 25V	C27, 37
600297-314-032	CAP. 100UF, ALUM, 25V	C3, 5, 6
600204-314-001	CAP. .01UF, MYLAR, 400V	C33, 34
600293-314-101	CAP. 100PF 50V 5%	C35, 38
600204-314-001	CAP. .01UF, MYLAR, 400V	C8, 11, 14, 15, 28, 29
600268-314-015	CAP. 470pf, 50V	C9, 31, 32
600028-411-001	DIODE, VOLT.SUPPRESSOR P6KE6, 8A	CR1-4, 6-9, 12-15, 19-22
600011-416-002	DIODE, 1N4004	CR18
600109-410-001	DIODE 1N4148	CR5, 10, 11, 23, 24, 25
700004-390-002	LED, HLMP7019, YELLOW	DS1, 2
600064-419-001	4 POS VERTICAL MT.	H9
600064-419-003	3 POS VERTICAL MT.	H2, 3, 4, 8, 13, 14, 16, 20
600064-419-004	2 POS VERTICAL MT.	H5, 6, 7, 11, 12, 15, 19, 21, 25, 26
600064-419-005	1 POS VERTICAL MT.	H1, 10, 17, 18, 23, 24
600174-608-005	CONN. HEADER, 26 PIN, ST	J1
600198-608-005	CONN. HEADER, 3 PIN, TIN	JP1-3
600094-403-002	RELAY, DPDT, 24V, 3A CONTACTS	K1
600125-376-007	CHOKE 33UH	L1

PART NUMBER	DESCRIPTION	SYMBOL
600390-413-001	POWER MOSFET, VN0610L	Q1
600349-413-001	TRANSISTOR J 110, JFET	Q2
700001-413-001	TRANSISTOR 2N4393	Q3
700002-413-001	TRANSISTOR 2N6427	Q6
600229-413-001	TRANS. 2N3904-TD018	Q7
610024-341-075	RES. 10K, 1/4W, 5%	R1, 2, 9, 19, 20, 23-35, 30, 31, 36, 38, 56, 57
630014-341-075	RES. 3K, 1/4W, 5%	R10, 11
662004-341-075	RES. 620, 1/4W, 5%	R12, 14, 39
612034-341-075	RES. 120K 1/4W 5%	R15, 21
611024-341-075	RES. 11K, 1/4W, 5%	R17, 27
620014-341-075	RES. 2K, 1/4W, 5%	R26
615004-341-075	RES. 150, 1/4W, 5%	R3, 7, 40
610044-341-075	RES. 1M, 1/4W, 5%	R32
647024-341-075	RES. 47K, 1/4W, 5%	R33
620024-341-075	RES. 20K, 1/4W, 5%	R34, 35, 42, 47
600066-360-011	POT 20K	R4, 13
622024-341-075	RES. 22K, 1/4W, 5%	R41
610034-341-075	RES. 100K, 1/4W, 5%	R46, 50, 54, 55, 58, 59, 49
639014-341-075	RES. 3.9K, 1/4W, 5%	R5
656004-341-075	RES., 560, 1/4W, 5%	R51, 52
615034-341-075	RES. 150K, 1/4W, 5%	R53
651014-341-075	RES 5.1K 1/4W 5%	R6
656014-341-075	RES. 5.6K, 1/4W, 5%	R60
612024-341-075	RES. 12K, 1/4W, 5%	R8, 16, 22, 45
600244-616-004	SWITCH, 4 X SPDT, DIP	S1
635234-501-001	TRANSFORMER, 600 OHM, AUDIO	T1-8
600114-611-001	BROWN TEST POINT	TP1
600261-230-001	TERMINAL	TP2-4
600324-415-001	IC LM339, COMPARATOR	U1
700121-415-001	IC, QUAD OP AMP, MC33074	U2-4
600186-415-101	IC 4066BDC, CMOS BIL SW, QUAD	U5
601003-415-001	IC S3526B, 2600 HZ BAND PASS	U6
600206-378-001	CRYSTAL	Y1

Figure 6.4

OPTIONAL AUDIO I/O BOARD ASSEMBLY



IC'S  
 U1 LM339  
 U2-U4 MC33074  
 U5 4066  
 U6 3526B

Figure 6.5

OPTIONAL AUDIO I/O BOARD SCHEMATIC

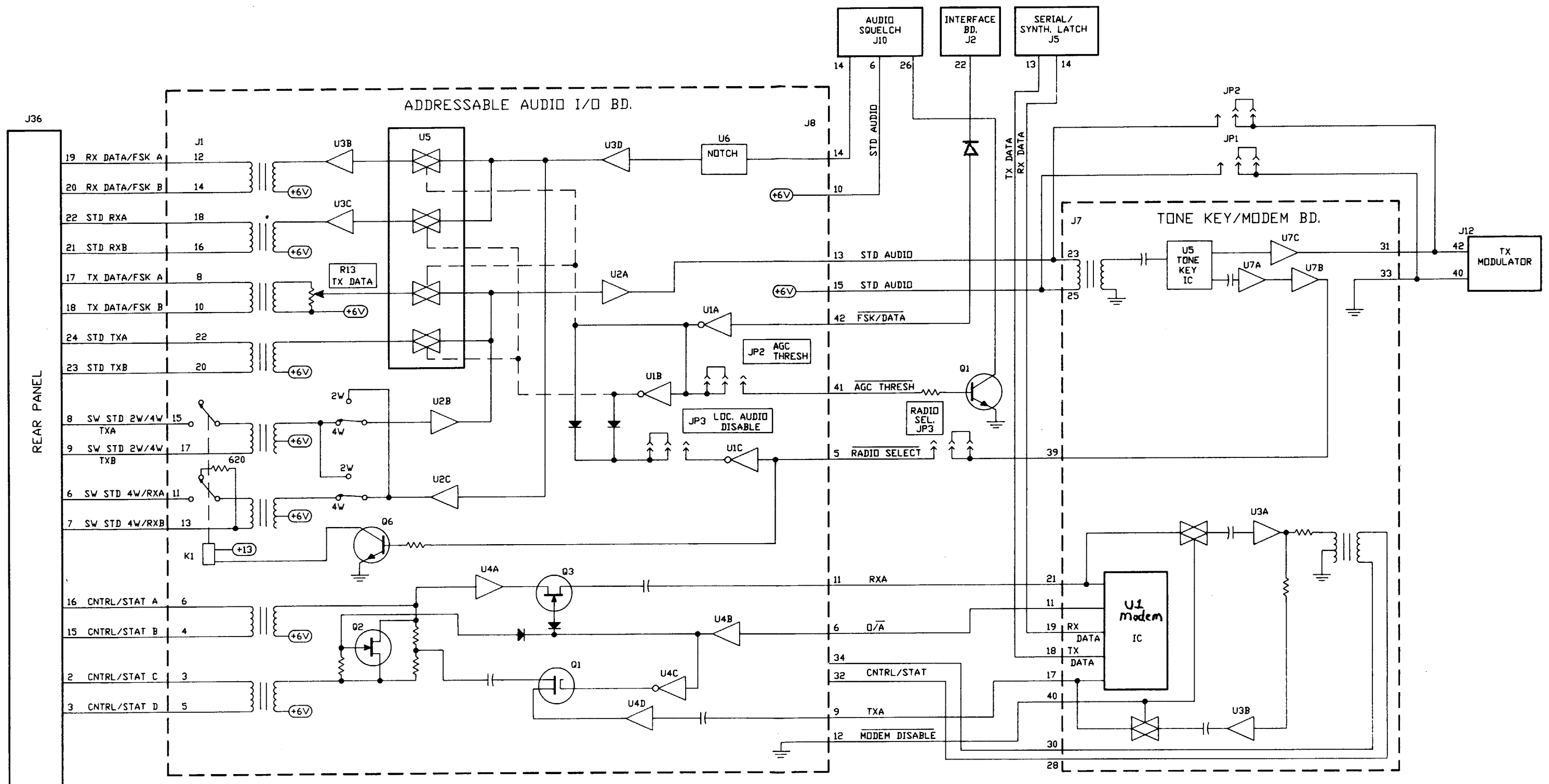


Figure 6.6

AUDIO SIGNAL PATH WITH  
OPTIONAL AUDIO I/O BOARD

OPTIONAL AUDIO I/O BOARD, 1A7

PIN CONNECTIONS AND VOLTAGE READINGS

1A7-J1

	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	DATA
CNTL/STAT2W C	<input type="checkbox"/>	3	4	<input type="checkbox"/>	CNTL/STAT2W A
CNTL/STAT2W D	<input type="checkbox"/>	5	6	<input type="checkbox"/>	CNTL/STAT2W B
KEY INTERLOCK	<input type="checkbox"/>	7	8	<input type="checkbox"/>	DATA/FSK4W TX A
EXT KEY	<input type="checkbox"/>	9	10	<input type="checkbox"/>	DATA/FSK4W TX B
SW STD 4W RX	<input type="checkbox"/>	11	12	<input type="checkbox"/>	DATA/FSK 4W RX A
SW STD 4W RX	<input type="checkbox"/>	13	14	<input type="checkbox"/>	DATA/FSK 4W RX B
(SW STD 2W) SW STD 4W TX	<input type="checkbox"/>	15	16	<input type="checkbox"/>	STD 4W RX B
(SW STD 2W) SW STD 4W TX	<input type="checkbox"/>	17	18	<input type="checkbox"/>	STD 4W RX A
MUTE	<input type="checkbox"/>	19	20	<input type="checkbox"/>	STD 4W TX B
FSK	<input type="checkbox"/>	21	22	<input type="checkbox"/>	STD 4W TX A
FSK KEY	<input type="checkbox"/>	23	24	<input type="checkbox"/>	SCAN STOP
GND	<input type="checkbox"/>	25	26	<input type="checkbox"/>	
	<input type="checkbox"/>	27	28	<input type="checkbox"/>	
	<input type="checkbox"/>	29	30	<input type="checkbox"/>	
	<input type="checkbox"/>	31	32	<input type="checkbox"/>	
	<input type="checkbox"/>	33	34	<input type="checkbox"/>	
	<input type="checkbox"/>	35	36	<input type="checkbox"/>	
	<input type="checkbox"/>	37	38	<input type="checkbox"/>	
	<input type="checkbox"/>	39	40	<input type="checkbox"/>	
	<input type="checkbox"/>	41	42	<input type="checkbox"/>	
	<input type="checkbox"/>	43	44	<input type="checkbox"/>	

OPTIONAL AUDIO I/O BOARD, 1A7

PIN CONNECTIONS AND VOLTAGE READINGS

1A7-P8

GND	<input checked="" type="radio"/>	1	2	<input type="radio"/>	GND
+13VDC	<input type="radio"/>	3	4	<input type="radio"/>	+13VDC
REM/SEL	<input type="radio"/>	5	6	<input type="radio"/>	O/ $\bar{A}$
	<input type="radio"/>	7	8	<input type="radio"/>	+26 VDC
TXA	<input type="radio"/>	9	10	<input type="radio"/>	RX STD B
RXA	<input type="radio"/>	11	12	<input type="radio"/>	$\overline{\text{MODEM DISABLE}}$ (GND)
TX STD A	<input type="radio"/>	13	14	<input type="radio"/>	RX STD A
TX STD B	<input type="radio"/>	15	16	<input type="radio"/>	$\overline{\text{EXT KEY}}$
	<input type="radio"/>	17	18	<input type="radio"/>	
$\overline{\text{SCAN STOP}}$	<input type="radio"/>	19	20	<input type="radio"/>	
	<input type="radio"/>	21	22	<input type="radio"/>	
GND	<input type="radio"/>	23	24	<input type="radio"/>	GND
	<input type="radio"/>	25	26	<input type="radio"/>	$\overline{\text{DATA}}$
	<input type="radio"/>	27	28	<input type="radio"/>	
	<input type="radio"/>	29	30	<input type="radio"/>	
	<input type="radio"/>	31	32	<input type="radio"/>	
	<input type="radio"/>	33	34	<input type="radio"/>	
$\overline{\text{FSK}}$	<input type="radio"/>	35	36	<input type="radio"/>	
	<input type="radio"/>	37	38	<input type="radio"/>	$\overline{\text{KEY INTERLOCK}}$
$\overline{\text{MUTE}}$	<input type="radio"/>	39	40	<input type="radio"/>	$\overline{\text{FSK KEY}}$
(OUT) AGC THRESH	<input type="radio"/>	41	42	<input type="radio"/>	$\overline{\text{FSK/DATA}}$
	<input type="radio"/>	43	44	<input type="radio"/>	
GND	<input type="radio"/>			<input type="radio"/>	GND

## 6.5 TONE KEYING MODEM OPTION (700412-700-001)

(Tone Key/Modem Board 602025-536-002)

Figure 6.8 is a schematic of the optional Tone Keying Modem board.

This factory-installed option, consisting of printed circuit board 602025-536-001, provides two separate remote control features: tone keying to provide a high speed keying rate and FSK communication between the transceiver and the MSR 6420 remote control unit over a telephone line or a pair of wires.

When this board is used, the transceiver must be correctly configured to accept it.

If tone keying is desired and the transceiver's standard audio or switched standard audio lines are connected to an MSR 6420 which is configured for Tone Key operation, set S1 on the Tone Key Modem board to TONE KEY. Otherwise, make sure that S1 is set to SERIAL KEY. Audio level input is normally -6 dBm. Tone level must be at least 10 dB below audio level.

When this board is installed, even if Tone Keying is not used, the radio's standard audio lines must be routed through the board. See Table 5.13 and Figure 5.57 for correct Mother board jumper positions.

If the modem circuitry is being used, set switches S1-2 and S1-4 on the Interface board (see Table 5.7) to the ON position. This configures the unit to the modem's 300 Baud rate. Serial/Synthesizer Latch board switches S1, S2 and S3 must also be set for FSK remote control operation. See Table 5.9. Receive signals should be -15 to -36 dBm on the 600 ohm line. Transmit signals are -16 dBm.

### 6.5.1 FSK MODEM

This circuit provides frequency shift keying (FSK) communications between the radio and the RCU at 300 Baud. Transmission and reception of binary data is performed over a standard telephone line or a pair of wires. If the optional Audio I/O board is installed, multiple radios may be controlled by daisy-chaining on the 600 ohm line.

#### 6.5.1.1 FSK Modem Operation

A brief description of FSK modem operation is provided to allow the user to understand the system.

Two modems are required for two-way communications, command and acknowledge, so each modem must be capable of transmission as well as reception. The tones are passed between the RCU and the transceiver over balanced 600 ohm audio lines called the CNTL/STAT (control/status) lines. The RCU sends CONTROL commands to the radio, and the radio replies with STATUS information. At the transmit end of the signal path, a modem converts a digital signal into two separate audio tones, one at a low frequency (2025 Hz) representing the logic low (0), and the other at a higher frequency (2225 Hz) representing the logic high (1). The tones are transmitted over a pair of wires to the second modem at the receive end of the signal path. At the receive end, the tones are again converted back into a serial logic data stream.

The heart of the FSK modem circuitry is U1. This chip operates at 300 Baud and provides modulation, demodulation and filtering. The audio tones are developed from an internal crystal oscillator whose frequency can be measured at TP4. Digital transmission data comes into the board on pin 18 and goes directly to U1 pin 10. This data is converted to audio tones, which can be monitored at TP6, and exits the chip on pin 16. Received tones come to pin 15 of U1 from either the TX A line (when the Optional Audio I/O board is used) or from the output of U3B. The received tones may be monitored at TP5. They are converted to a serial bit stream by U1 and exit the chip on pin 4. The bit stream may be monitored at TP1.

A carrier-detect indicator, DS1, is provided to show when the modem has acquired a carrier signal from another modem and communication between the two is possible. U1 drives the LED through U2A and U2B.

The frequencies of transmitted and received tones depend on whether the modem is in the ORIGINATE or ANSWER (O/A) mode - based on the state of U1 pin 12. If pin 12 is high, the modem is in the ORIGINATE mode, and if low, the modem

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is in the ANSWER mode. This O/A line is controlled by the transceiver microprocessor.

The transceiver normally waits to receive a CONTROL command from the RCU with the O/A line high. After a command has been received and performed, the O/A line goes low, and the transceiver replies with transmission of its STATUS to the RCU.

The active hybrid, U3, allows the modem to receive input tones from, and transmit output tones over, a single 600 ohm balanced audio line. The transmit tones are buffered by U3A and the receive tones are buffered by U3B.

If the Optional Audio I/O board is installed in the radio, the external FSK lines go to the Audio I/O board instead of the Tone Key Modem board. Analog gates U6C and U6D are opened by a ground on pin 40 from the Audio I/O board. This disconnects active hybrid U3 from the U1 modem chip. The RCVA and TX A signals go to the Audio I/O board instead.

#### 6.5.1.2 Tone Key Circuit

When the transceiver is in the TONE KEY mode, the RCU adds a 2930 Hz tone to the standard audio to signal the radio to transmit. This allows very fast CW keying rates, not limited by digital command communication delays. A notch filter removes the 2930 Hz keying tone before the audio signal is sent to modulate the rf carrier in the transmitter. If normal keying is desired, the board can be switched to the SERIAL KEY mode, disabling the Tone Key circuitry.

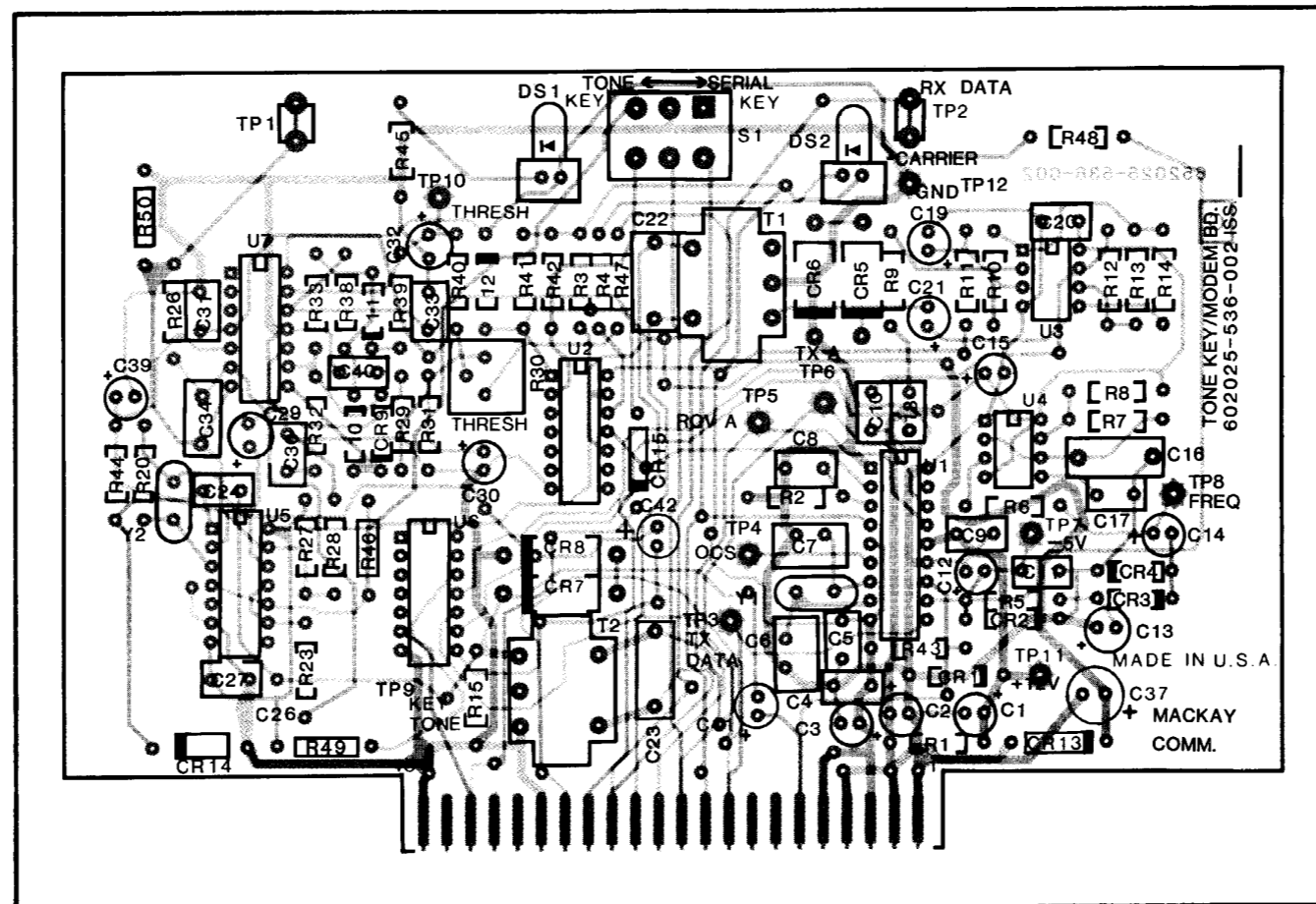
U5 is a single frequency bandpass filter, band reject filter and tone generator with selectable-input buffer amplifier. The tone is generated from an external crystal (other crystals may be used to provide tones from 1500 Hz to 3400 Hz); the band

reject filter is used to "notch out" all audio at the tone frequency; the bandpass filter extracts the tone from the input audio signal to allow detection of the keying tone; and the selectable-input buffer amplifier can amplify either the unfiltered audio input or the filtered audio output with the keying tone removed. The logic state of the notch-enable line, pin 10, determines which signal the buffer will amplify: a low switch in the filtered (notched) audio input and a high causes the unfiltered audio output to be amplified.

When S1 is set to the TONE KEY position (to the right), audio comes into the board on P1 pins 23 and 25; the notch enable line is low, so the keying tone is notched from the audio signal. This signal is next amplified by U7C and exits the board at P1 pin 31. When the RCU is keyed, a 2930 Hz tone is present on the incoming audio. This tone passes through the chip bandpass filter, is amplified and rectified by U7A, and is passed on to variable threshold detector U7B. The purpose of the variable detector is to keep the exciter key pulse duration the same as that of the key pulse sent by the RCU. When the keying tone is detected, DS1 lights to indicate the keyed condition. The logic high that turns on DS1 is inverted by U2D to key the transmitter via the REMOTE KEY line. A jumper on the Mother board allows TONE KEYING under all conditions or just under remote control via the RADIO select line, P1 pin 39.

When S1 is in the SERIAL KEY position (to the left), the REMOTE KEY IN and OUT are jumpered together, removing control of the REMOTE KEY line from the TONE KEY board. The notch-enable is no longer low so the audio into the board does not pass through the notch filter before it leaves the board.

Integrated circuit U4 is a free-running oscillator whose output is rectified and zener regulated to -5 VDC, which is used by the modem chip, U1.



(602025-536-002)

PART NUMBER	DESCRIPTION	SYMBOL
600005-635-001	LED MOUNT	(DS1,2)
600202-314-018	CAP. 10UF, 25V, TANT.	C1-3,42 12-15,19 28,30,41
600204-314-003	CAP. .015UF, 400V	C16
600297-314-016	CAP. 22UF, ALUM, 25V	C21
600204-314-001	CAP. .01UF,MYLAR,400V	C22,23
600302-314-013	CAP. .1UF,MYLAR,50V	C27,31, 33,40,4, 5,9,10, 18,20,24
600202-314-007	CAP. 1UF, 35V, TANT	C29,32
647003-306-501	CAP. 470PF, 3%, MICA, 500V	C34
600302-314-015	CAP. .22UF,MYLAR,50V	C36
600297-314-032	CAP 100UF,ALUM, 25V	C37
600202-314-022	CAP. 22UF, 15V, TANT	C39
615091-306-501	CAP. 15PF, 1%, MICA, 500V	C6,7
600302-314-007	CAP. .01UF,MYLAR,63V	C8,11,17
600033-411-022	DIODE, ZENER, 1N4242B	CR1
600052-410-001	DIODE 1N270	CR12,14 15
600011-416-002	DIODE 1N4004	CR13
600006-411-006	DIODE, ZE	CR2
600109-410-001	DIODE 1N4148	CR3,4, 9-11
600028-411-001	DIODE, VOLT.SUPPRESSOR P6KE6, 8A	CR5-8
600043-390-002	LED, YEL	DS1,2
636094-341-075	RES. 36,1/4W, 5%	R1
682014-341-075	RES. 8.2K, 1/4W, 5%	R10
615004-341-075	RES. 150, 1/4W, 5%	R14
662004-341-075	RES. 620, 1/4W, 5%	R15
610014-341-075	RES. 1K, 1/4W, 5%	R18,31, 32,39,47

PART NUMBER	DESCRIPTION	SYMBOL
610044-341-075	RES. 1M, 1/4W, 5%	R2,20
620024-341-075	RES. 20K, 1/4W, 5%	R23
610024-341-075	RES. 10K, 1/4W, 5%	R27-29, 33,38,49 3,11-13, 40-43 R30
600072-360-007	RES. 1K POT	R4,5,8,45
647004-341-075	RES. 470, 1/4W, 5%	R44,46
647024-341-075	RES. 47K, 1/4W, 5%	R48
636014-341-075	RES. 3.6K, 1/4W, 5%	R50
620014-341-075	RES. 2K, 1/4W, 5%	R6
610004-341-075	RES. 100, 1/4W, 5%	R7
647014-341-075	RES. 4.7K, 1/4W, 5%	R9,26
622024-341-075	RES. 22K, 1/4W, 5%	
600130-616-001	SWITCH, SLIDE, DPDT, PC MOUNT	S1
635234-501-001	TRANSFORMER, 600 OHM, AUDIO	T1,2
600114-611-001	BROWN TEST POINT	TP1
600114-611-002	RED TEST POINT	TP2
600261-230-001	TERMINAL	TP3-8, 10-12
600871-415-001	TMS 99532	U1
600016-415-001	IC 7406,HEX INV.,0/C	U2
600039-415-002	IC SN72558P	U3
600074-415-001	IC NE555, TIMER	U4
601003-415-001	IC S3526B, 2600 HZ BANDPASS	U5
600186-415-001	IC MCL14066B, QUAD BIL SWITCH	U6
600171-415-001	IC LM324, OP AMP, QUAD	U7
600206-378-001	CRYSTAL	Y1,2

Figure 6.7

TONE KEY/MODEM BOARD ASSEMBLY



TONE KEY/MODEM BOARD, 1A24  
OPTIONAL

PIN CONNECTIONS AND VOLTAGE READINGS

1A24-P7

GND	1	2	GND
+13VDC	3	4	+13VDC
NC	5	6	+5VDC
+13VDC	7	8	+13VDC
+5VDC	9	10	+5VDC
LOGIC "0" OR "1" ORIGINATE/ANSWER	11	12	AUDIO IN (NOT USED)
	13	14	
	15	16	
AUDIO TONES -10DBM TXA	17	18	TX DATA IN
RX DATA OUT	19	20	
AUDIO TONES (-15 to -36 DBM) RCVA	21	22	REM KEY OUT LOGIC "0" OR "1"
AUDIO (.3-3.4 KHZ) -6-0DBM STDINA	23	24	NC
AUDIO (.3-3.4KHZ) -6-0DBM STD INB	25	26	
REM KEY IN	27	28	FSK 600 OHM A } AUDIO TONES
NC-RESERVED	29	30	FSK 600 OHM B } TX -16DBM RX -15to-36DBM
(.3-3.4 KHZ) 0DBM AUDIO OUT	31	32	
GND	33	34	
	35	36	
	37	38	
LOGIC "0" OR "1" RADIO SELECT	39	40	MODEM DIS LOGIC "0" OR "1"
	41	42	
GND	43	44	GND

## 6.6 OPTIONAL IF FILTER BOARD

This board provides access to up to three additional filters to the standard USB (voice), LSB (voice) and AM filters normally supplied with the MSR 8050A transceiver. The board plugs into the Mother board slot directly in front of the existing IF Filter board. The two short coaxial cables plug into two mating coaxial connectors on the Standard IF Filter board. The special filters installed on the option board are addressed by the microprocessor when programmed into particular modes. I.e., a special narrow band CW filter can be programmed into CW receive mode; a special FSK filter can be programmed into the FSK receive mode; and a special DATA filter can be programmed into receive and transmit modes. Logic on the option board tells the microprocessor when a special filter is in place, so it may be selected in the menu.

Selection of a special filter is accomplished in CW, FSK and DATA modes as follows:

1. Select the MODE desired.
2. Depress the "E" key and the "1" key in order. **NOTE:** The "E" and "1" keys must be depressed within 2 seconds of one another or the system will return to its original condition. The frequency display will show USB, LSB or SPC (if a special filter has been installed in this slot).
3. Toggle through the selections by depressing the "C" button until the desired filter is shown.
4. Depress the "E" key to enter the selected filter into this MODE.
5. The frequency display will again show the operating frequency.

When the above MODE is selected, this newly selected filter will be called up. It may later be changed by again using the "E1" selection code.

Figure 6.10 is a schematic of the optional IF Filter board.

### 6.6.1 TECHNICAL DESCRIPTION

Integrated circuit U1 is a double pole 4-throw analog switch. One pole is used to provide a turn-on signal to one of three transistor switches, Q1, Q2 and Q3, which energizes one of three optional filters on this board. The other pole of U1's switch is used to determine whether or not the selected filter is installed on the option board. When a filter is installed in its proper position on the board (FL1 is the DATA filter, FL2 is the CW filter, and FL3 is the FSK filter), the FL TEST line will be high, indicating that the filter may be selected. If a filter is not installed, a 0 ohm resistor is connected where the filter would have been installed, taking the FL TEST line low, indicating that a filter does not exist in the selected position. (When the filter is installed, the 0 ohm resistor is removed from the circuit.)

If a filter has been installed, the FL TEST line signal allows the  $\mu$ P to include it in the menu for FSK, CW and DATA filters accessed through the "E-1" keyboard code. The special filter will show up in the menu as "SPC". If a filter has not been installed, it will not appear as a choice in the menu.

Filter FL1, the DATA filter, is used on both transmit and receive. Filters FL2, the CW filter, and FL3, the FSK filter, are used only in receive. The transmit path is through the USB or LSB filter located on the standard IF Filter board. Jumper JP1 is used to tell the  $\mu$ P which sideband is desired for CW and FSK transmission: in position 1-2, USB is selected, and in position 2-3, LSB is selected.

Specifications for standard available filters are:

#### FL1 (DATA-SPC):

Bandwidth, 2 dB	450 to 3050 Hz
Bandwidth, 3 dB	300 to >3050 Hz
Bandwidth, 60 dB	-400 to 440 Hz
Ripple, <2 dB	450 to 3050 Hz
Differential Group Delay, <500 $\mu$ sec	850 to 3050 Hz
Rx Sensitivity, -113 dBm	2 to 30 MHz (10 dB S+N/N)

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FL2 (CW-SPC):

Bandwidth, 1 dB     $F_o \pm 85$  Hz min.  
Bandwidth, 3 dB     $F_o \pm 250$  Hz max.  
Bandwidth, 60 dB    4 kHz max.  
Ripple, 1 dB  
Fo Offset  
+1 kHz Ref Radio Tuned Frequency  
Rx Sensitivity, -120 dBm  
2 to 30 MHz (10 dB S+N/N)

FL3 (FSK-SPC)

Bandwidth, 1 dB     $F_o \pm 85$  Hz min.  
Bandwidth, 3 dB     $F_o \pm 250$  Hz max.  
Bandwidth, 60 dB    4 kHz max.  
Ripple, 1 dB  
Fo Offset  
+1.7 kHz Ref Radio Tuned Frequency  
Rx Sensitivity, -120 dBm  
2 to 30 MHz (10 dB S+N/N)

The combination of filters installed determines  
the Option Filter board part number:

FL1 only:    700042-536-001  
FL2:        700042-536-002  
FL3:        700042-536-003  
FL1, FL2:    700042-536-004  
FL1, FL3:    700042-536-005  
FL2, FL3:    700042-536-006  
FL1, FL2, FL3: 700042-536-007  
No Filters:    700042-536-951

(700042-536-951)

PART NUMBER	DESCRIPTION	SYMBOL
600100-102-001	CABLE	(P2,P3)
600302-314-013	CAP. .1UF, MYLAR, 50V	C1-5
600144-410-001	DIODE HP3188	CR1-6
600198-608-005 600198-608-001	CONN. HEADER, 3 PIN, TIN CONN.	JP1 (JP1)
600125-376-022	CHOKE 180UH	L1-7
702003-608-001	PLUG, COAX RT ANGLE	P2,P3
600229-413-003	TRANS 2N3904 TO-92	Q1-3
600000-341-075 647014-341-075	RES. 0, 1/4W, 5% RES. 4.7K, 1/4W, 5%	R1-3 R4-8
600106-340-008	RES. NETWORK 8 PIN, 4.7K	RP1
600855-415-401	IC 4052	U1

(700042-536-001)

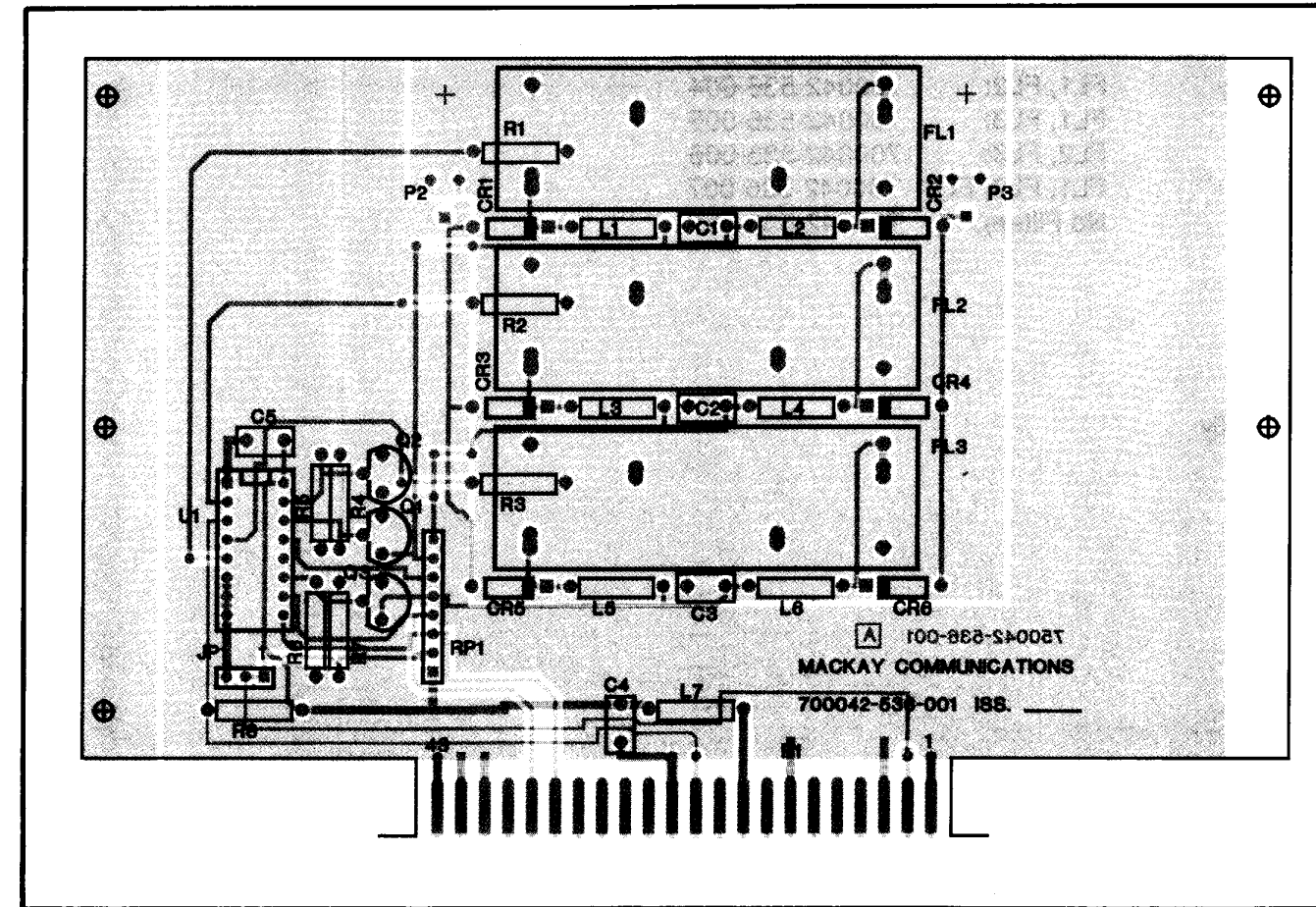
PART NUMBER	DESCRIPTION	SYMBOL
600127-529-001	FILTER, USB	FL1 (FL1)
600004-638-002 700042-536-951	INSULATOR WASHER IF FILTER BOARD	W/O FILTERS

(700042-536-002)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 700006-529-001 700042-536-951	INSULATOR WASHER FILTER, 5MHZ OFFSET CW OPTIONAL FILTER BD. W/O FILTER	(FL2) FL2 W/O FILTERS

(700042-536-003)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 600068-529-001 700042-536-951	INSULATOR WASHER FILTER, RTTY OPTIONAL FILTER BD. W/O FILTER	(FL3) FL3 W/O FILTERS



(700042-536-004)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 600127-529-001 700006-529-001 700042-536-951	INSULATOR WASHER FILTER, USB FILTER, 5MHZ OFFSET CW OPTIONAL FILTER BD. W/O FILTER	(FL1, FL2) FL1 FL2 W/O FILTERS

(700042-536-006)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 700006-529-001 600068-529-001 700042-536-951	INSULATOR WASHER FILTER, 5MHZ OFFSET CW FILTER, RTTY OPTIONAL FILTER BD. W/O FILTER	(FL2, 3) FL2 FL3 W/O FILTERS

(700042-536-005)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 600127-529-001 600068-529-001 700042-536-951	INSULATOR WASHER FILTER, USB FILTER, RTTY OPTIONAL FILTER BD. W/O FILTER	(FL1, FL3) FL1 FL3 W/O FILTERS

(700042-536-007)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002 600127-529-001 700006-529-001 600068-529-001 700042-536-951	INSULATOR WASHER FILTER, USB FILTER, 5MHZ OFFSET CW FILTER, RTTY OPTIONAL FILTER BD. W/O FILTER	(FL1, 2, 3) FL1 FL2 FL3 W/O FILTERS

Figure 6.9

OPTIONAL IF FILTER BOARD ASSEMBLY



### 6.7 DATA FILTER OPTION

The Data Filter option (P/N 700425-700-001) substitutes controlled group delay filters for the LSB and USB filters in the IF Filter boards. The filter characteristics conform to those specified in MIL-STD-188-203-1 for TADIL A data modems. They will be compatible with most high-speed multitone RF data modems where tight control of amplitude and group delay (timing) in the passband is required. The specifications for the USB filter (P/N 600127-529-001) are as follows: (LSB filter (P/N 600128-529-001) has identical specs with mirrored frequencies):

BW, 2 dB           +450 to +3050 Hz  
 BW, 3 dB           +300 to >+3050 Hz  
 BW, 60 dB          -400 to +4400 Hz  
 Ripple 2 dB maximum  
 Diff. Time Delay 815 to 3050 Hz, 500 μS max.  
 (Frequencies are referenced to the carrier and amplitudes are referenced to peak passband response.)

Option 700425-700-001 (for the standard radio) replaces IF Filter board #1 (1A15) P/N 700047-536-001 with P/N 700047-536-002. The new board is identical except for FL1 and FL2 (see Section 5.9.7).

FL1 = P/N 600127-529-001  
 (vs. 600084-529-001) (USB)

FL2 = P/N 600128-529-001  
 (vs. 600083-529-001) (LSB)

FL3 = Same as old board (600082-529-001)  
 (AM)

(700047-536-002)

PART NUMBER	DESCRIPTION	SYMBOL
600004-638-002	INSULATOR WASHER	(FL1-3)
600127-529-001	FILTER, USB	FL1
600128-529-001	FILTER, LSB	FL2
600082-529-001	FILTER, AM, 6KHZ BANDWIDTH	FL3
700047-536-951	IF FILTER BD W/O FILTERS	W/O FILTERS

Figure 6.11 DATA FILTER ASSEMBLY

OPTIONAL IF FILTER BOARD, 1A15A1

PIN CONNECTIONS AND VOLTAGE READINGS

1A15A1 - P14

