Robert Selby

Mackay
COMMUNICATIONS

Operation and Maintenance Manual

HF Transceiver MSR 8000D

WARRANTY

MACKAY COMMUNICATIONS warrants that: (A) for Mackay manufactured equipment sold hereunder for a period of 18 months from Mackay's shipment date or 12 months from Buyer's acceptance, whichever ends first, said equipment shall be free from defects in material and workmanship and conform to Mackay's equipment specifications; (B) all service work shall be performed in a good and workmanlike manner and shall be free from defects in workmanship for 90 days from work completion; and (C) all parts supplied whether in connection with service of the equipment or as a replacement shall be free from defects in material and workmanship for a period of 90 days from Mackay's shipment date, or, if installed by Mackay, from the installation date.

If a defect occurs within the warranty period, Buyer shall notify Mackay immediately and Mackay shall: (A) as to Mackay manufactured equipment sold hereunder, repair or replace defective equipment free of charge, upon its return, shipping charges prepaid to Mackay Communications, Raleigh, NC; (B) as to service work performed hereunder, for 90 days after completion of any service work that was not performed in a good and workmanlike manner, to reperform it, and as to any defective part supplied therewith, to replace or repair and reinstall it, and (C) as to any other defective part, to repair or replace it with a new part (but not reinstall it) provided the defective part is returned, shipping charges prepaid, to Mackay's designated location. Equipment furnished by other vendors and sold by Mackay shall only have the vendor's warranty, which shall be passed on to Buyer to the extent possible.

This warranty does not apply to defects not caused by Mackay (for example, accidents or abuse, work or installation done improperly or contrary to Mackay's standards) or to equipment on which the model or serial numbers, manufacture or shipment dates are changed or removed.

NO OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE, SHALL APPLY.

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SECTION I
INTRODUCTION

1.1 SCOPE

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

1.2 DESCRIPTION

The transceiver is a compact, rugged military-type 120 watt transceiver covering 1.6000 MHz to 29.0000 MHz. The transceiver can operate either simplex or half-duplex in channelized mode or simplex in frequency mode. Ten half-duplex channels, storing frequencies and modes are available and may be programmed from the front panel. Receive and transmit modes are AME (upper sideband with full carrier), CW (1 kHz keyed tone), USB, LSB and FSK (RTTY or FAX with additional modems). The transceiver is mechanically and electrically designed and packaged to meet military specifications for vibration, shock and environment. The transceiver is sealed against dust and spray, making it ideal for for exposed mobile as well as base station installations. The transceiver can operate in temperatures from -30°C to +65°C and in 0 to 95% relative humidity.

The transceiver has been designed and constructed to facilitate quick and easy field service and/or repair. Featuring modular construction, the front panel, rear panel, and power amplifier assemblies are removeable with only a screwdriver and the PC boards simply unplug from the mother board.

The transceiver is composed of eight major subassemblies. A general description and function of these assemblies are provided in Sections 1.2.2 through 1.2.9 and the location of these subassemblies can be found in Figure 1.1.

1.2.2 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.

1.2.3 FRONT PANEL ASSEMBLY

The front panel is a rugged aluminum casting to which all controls are mounted. The control shafts are sealed against water and dust entry and the speaker is waterproof. The LED displays and display driver circuitry are mounted on the front panel board which attaches to the panel. The panel assembly can be removed by removing four screws and two ribbon cable connectors.

1.2.4 LOGIC BOARD

The logic board contains the microprocessor, memory and transceiver control logic and the coupler interface logic. The transceiver channel memory is a CMOS type which is kept alive by a lithium battery with a 10 year typical life. Signals from the logic board provide frequency information to the synthesizer and band and mode information to the receiver/exciter modules.

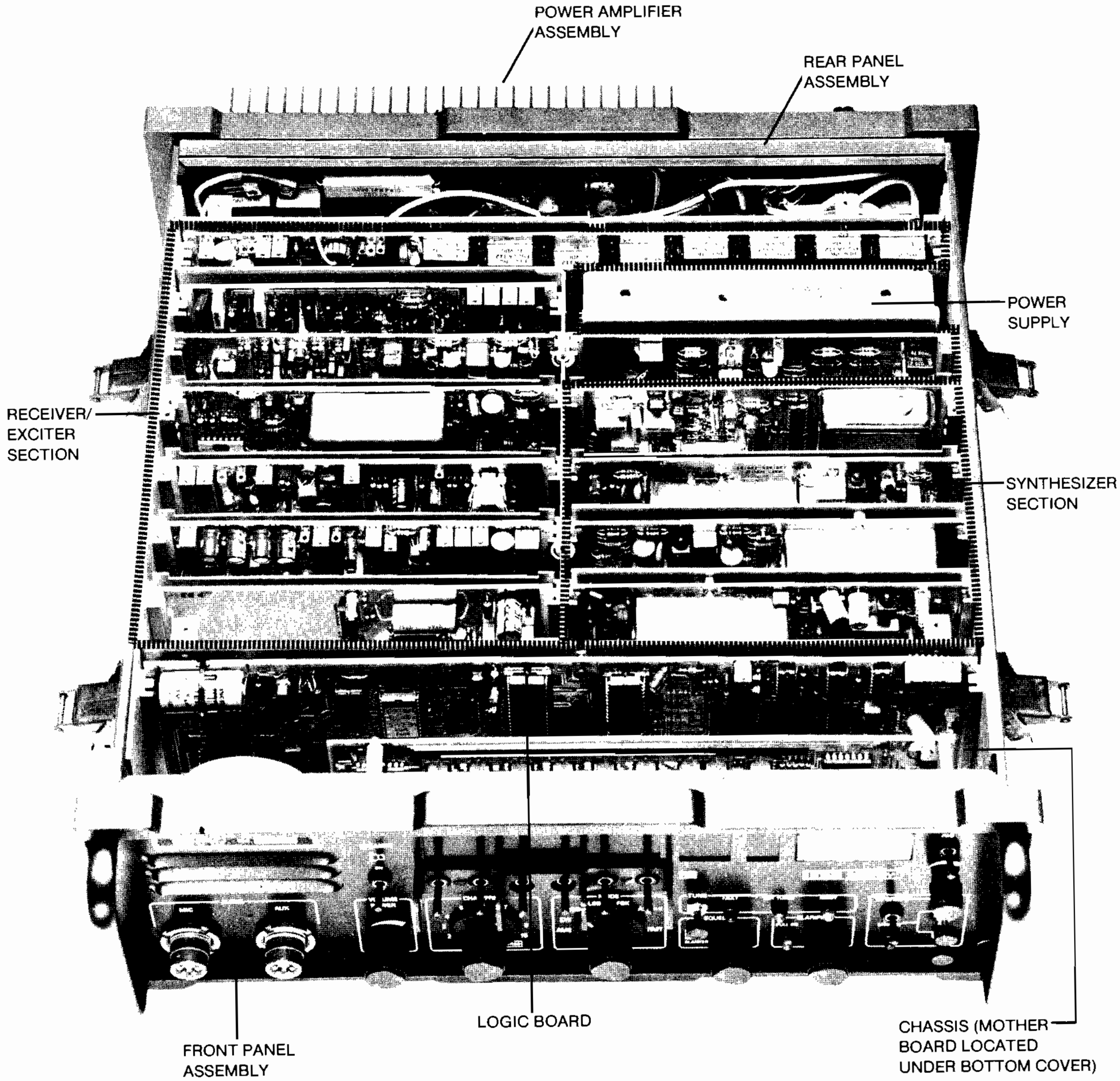


Figure 1.1 Major Subassembly Locations

1.2.5 RECEIVER/EXCITER

The receiver/exciter consists of eight PC boards: (1) speaker driver, (2) transmit modulator, (3) audio/squelch, (4) IF filter, (5) mixer, (6) high pass filter, (7) half-octave filter and (8) noise blanker.

In the transmit mode, the receiver/exciter takes inputs from the microphone or other source and the synthesizer, then generates the proper signal to drive the power amplifier (PA). In the receive mode, the receiver/exciter path processes the received signal from the antenna to the speaker, using inputs from the synthesizer.

A double conversion scheme is used, with the first intermediate frequency (IF) at 59.53 MHz and the second IF at 5.00 MHz. Two sets of crystal filters (one set at each IF) determine the radio bandwidth.

A signal compressor on the transmit modulator board improves the peak-to-average power ratio for more effective communications.

The squelch circuit on the audio/squelch board is voice-frequency activated. This reduces random breaking and is designed so that strong signals (>30 μV) will break the squelch regardless of the control position. The noise blanker helps remove vehicle ignition interference while receiving. It may be activated as needed by pulling out the squelch control.

1.2.6 SYNTHESIZER

The synthesizer consists of four PC boards: (1) major loop, (2) translator loop, (3) minor loop and (4) reference board. The synthesizer is a three loop design which provides the receiver/exciter with the first local oscillator (LO) from the major loop board, the second LO from the translator loop board and the third LO from the reference board to the receiver/exciter. All frequencies are derived from a temperature compensated crystal oscillator (TCXO) on the reference board. The reference board also furnishes the 1 kHz side-tone used for CW. If a fault causes any of the loops to lose lock, the loss-of-lock LED will light on the appropriate board(s) and transmission and reception will be inhibited. Figure 1.1 shows the locations of the loss-of-lock LEDs and other adjustments.

1.2.7 POWER SUPPLY MODULE

The power supply module furnishes regulated +5 and +9 VDC to the transceiver. The power supply is a switching type for good efficiency and operates from either input voltage of 12 or 24 VDC. This module plugs into the mother board.

1.2.8 REAR PANEL ASSEMBLY

The rear panel assembly is an aluminum casting which contains the PA assembly and various connectors. It attaches to the transceiver chassis with four screws and is easily removable as a unit. Figure 1.1 shows the locations of the various rear panel assemblies, connectors and fuse locations.

1.2.9 POWER AMPLIFIER ASSEMBLY

The power amplifier (PA) is a solid state broadband amplifier rated at 125 watts peak envelope power (PEP) and 125 watts average into a 50 ohm load. The unit is cooled by a heatsink on the rear panel and requires an optional blower only when the transceiver is to be used for continuous operation.

The PA is manufactured in two versions, 12 or 24 volts. The operating voltage for the entire transceiver is determined by the PA selection. This means that the transceiver may be easily changed from one operating voltage to the other, even in the field, by simply changing the PA assembly.

1.3 SPECIFICATIONS

1.3.1 FREQUENCY RANGE

1.6000 MHz to 29.9999 MHz in 100 Hz steps.

1.3.2 CHANNEL STORAGE

10 simplex or half-duplex (field programmable)

1.3.3 FREQUENCY STABILITY

±1 ppm from -30°C to +55°C

1.3.4 OPERATING MODES

USB, LSB (A3J upper and lower), USB reduced carrier (A3A), AME (A3H), CW (A1), FSK (F1) (with PA fan option and modem)

1.3.5 POWER INPUT

12V unit: +13.2V ± 10%
Receive: 2A Max.
Transmit: 30A Max.

24V unit: +26.4V ± 10%
Receive: 2A Max.
Transmit: 20A Max.

1.3.6 TEMPERATURE RANGE

-30°C to +55°C (to +65°C with reduced performance)

1.3.7 HUMIDITY

95% RH at +50°C

1.3.8 SHOCK

MIL-STD 810C Method 516.2, Procedure 1, Figure 516.2-2 (with shock mounts)

1.3.9 VIBRATION

MIL-STD 810C Method 514.2, Figure 514.2-6, Curve V (15 to 200 Hz) (with shock mounts)

1.3.10 ENCLOSURE

MIL-STD 108E, splash proof, Table II

1.3.11 SIZE

13.2 x 37.3 x 42.2 cm (HxWxD)
5.2 x 14.7 x 16.6 in (HxWxD)
including handles and heatsink

1.3.12 WEIGHT

15 kg (33 lbs.)

1.3.13 TRANSMITTER

a) Power Output:
125 watts PEP and average ± 0.5 dB

b) AME Carrier Power:
35 watts nominal

c) Harmonic Suppression:
45 dB, 50 dB typical

d) IM Distortion:
30 dB below PEP, 33 dB typical

e) Undesired Sideband Suppression: -50 dB at 1 kHz

f) Hum and Noise: -50 dB

g) Voice Compression:
Average power output increases 1 dB or less for 10 dB increase in audio input (can be disabled by internal strapping if required).

h) Audio Input:
600 ohm balanced, rear panel, -15 to +10 dBm for rated output. Carbon, high or low level dynamic microphone, front panel.

i) Transmitter Audio Response: 6 dB, BW 300- 3 kHz (600Ω input).

1.3.14 RECEIVER

a) Sensitivity:
SSB: 0.5 μV for 10 dB S+N/N
AM: 3 μV for 10 dB S+N/N

b) Selectivity:
6 dB Down 60 dB Down
SSB: 2.7 kHz min 6.0 kHz max
AME: 5 to 7 kHz 20 kHz max

c) Audio Output:
Speaker: 4W at less than 10% distortion.
Phones: 10mW at less than 5% distortion. (10% AM).
Rear Panel: 600 ohm balanced, +10 dBm at less than 5% distortion (10% AM).

d) AGC Characteristics:
< 3 dB output change for an input change from AGC threshold (Type 10 μV) to 1.0 V, USB or LSB.
Decay Time:
AME, USB, LSB, 500 msec.
CW, FSK, 50 msec.

e) IF and Image Rejection: 80 dB

f) External Spurious Response: - 60 dB

g) Internal Spurious Response 99.5% of frequencies below 0.2 μV equivalent noise input

h) Clarifier Range:
±250 Hz minimum (± 200 Hz minimum when MSR 6400 Remote Interface Board is installed).

i) Intermodulation (In Band):
30 dB below two equal 0.1V (-7 dBm) signals in 3 kHz bandwidth

j) Intermodulation (Out of Band):
70 dB below two equal 3 mV (-37 dBm) signals

k) Front End Protection:
Input will withstand 22V RMS (+40 dBm) indefinitely

1.4 EQUIPMENT SUPPLIED

1.4.1 TRANSCEIVER, - Part Number
690022-000-010 - 12V, Grey
690022-000-011 - 12V, O.D.
690022-000-012 - 24V, Grey
690022-000-013 - 24V, O.D.

1.4.2 KIT, ACCESSORY - Part Number 690022-017-001 consisting of:

a) Connector, Audio, MS3106A 20-29P - Part Number 600375-606-006

b) Connector, Accessory, MS3106A 28-21P - Part Number 600375-606-004

c) Fuses, 10 Amp, Slo-Blo (5) - Part Number 600006-396-033

d) Fuses, 30 Amp, (5) - Part Number 600016-396-046

e) Clamp, Cable for Accessory Connector, (1) - Part Number 600376-606-003

f) Clamp, Cable for Audio Connector - Part Number 600376-606-002

g) Connector, RF, PL-259 - Part Number 600244-606-001

h) Reducer, PL-259 - Part Number 600244-606-002

i) Microphone, Hand - Part Number 600352-713-001

j) Cable, Power - Part Number 600452-540-001

k) Manual, Technical - Part Number 600285-823-001

1.5 OPTIONAL EQUIPMENT - NOT SUPPLIED

1.5.1 MSR 4020A COUPLER, AUTOMATIC ANTENNA, - Part Number 600233-800-XXX

1.5.2 SHOCK MOUNT KIT, COUPLER - Part Number 600233-817-006

1.5.3 SHOCK MOUNT KIT, TRANSCEIVER - Part Number 600058-700-001

1.5.4 RACK MOUNT KIT, TRANSCEIVER, 19" -Part Number 600059-700-001 (Grey) PN 600059-700-002 Green (O.D.)

1.5.5 MICROPHONE, DESK - Part Number 600013-386-001

1.5.6 HANDSET, H-250/U - Part Number 600021-386-001

1.5.7 HEADPHONES, H-251/U - Part Number 600036-386-001

1.5.8 KEY, CW - Part Number 600367-616-001

1.5.9 FAN KIT, PA - Part Number 600072-700-001

1.5.10 POWER SUPPLY, MSR 6214, AC to 12/24 VDC, - P/N 697007-000-001

1.5.11 MSR 6400 REMOTE CONTROL, FULL FUNCTION - Part Number 699023-000-00X

1.5.12 KIT, DEPOT, SPARE PARTS - Part Number 600060-700-001

1.5.13 KIT, PC BOARDS, SPARE - Part Number 600061-700

1.5.14 PA MODULE, SPARE, 24V - Part Number 600407-705-001

1.5.15 PA MODULE, SPARE, 12V - Part Number 600407-705-002

1.5.16 CABLE ASSEMBLY RF, WIRED, RG58 A/U WITH UHF MALE (PL259) AND TYPE "N" MALE (UG-536) CONNECTOR - Part Number
600491-540-001 - 10 Ft.
600491-540-002 - 20 Ft.
600491-540-003 - 30 Ft.
600491-540-004 - 40 Ft.
600491-540-005 - 50 Ft.
600491-540-006 - 75 Ft.
600491-540-007 - 100 Ft.

1.5.17 CABLE, RF, RG-58 A/U (SPECIFY LENGTH) - Part Number 600016-102-001

1.5.18 CABLE ASSEMBLY RF, WIRE, RG-213U WITH UHF MALE (PL259) AND TYPE "N" MALE (UG-21D/U) CONNECTORS - Part Number
600492-540-001 - 10 Ft.
600492-540-002 - 20 Ft.
600492-540-003 - 30 Ft.
600492-540-004 - 40 Ft.
600492-540-005 - 50 Ft.
600492-540-006 - 75 Ft.
600492-540-007 - 100 Ft.
600492-540-008 - 150 Ft.
600492-540-009 - 200 Ft.

1.5.19 CABLE, RF, RG-213U (SPECIFY LENGTH) Part Number 600017-102-001 (Recommended for installations of 30 meters (100 feet) or longer)

1.5.20 INTERCONNECT CABLE ASSEMBLY, ANTENNA COUPLER, WIRED, WITH CONNECTORS - Part Number
600686-540-001 - 10 Ft.
600686-540-002 - 20 Ft.
600686-540-003 - 30 Ft.
600686-540-004 - 40 Ft.
600686-540-005 - 50 Ft.
600686-540-006 - 75 Ft.
600686-540-007 - 100 Ft.
600686-540-008 - 150 Ft.
600686-540-009 - 200 Ft.

1.5.21 CABLE, COUPLER CONTROL (SPECIFY LENGTH) - Part Number 600069-102-009

1.5.22 INTERCONNECT CABLE ASSEMBLY, WIRED, FULL FUNCTION REMOTE CONTROL - Part Number
600493-540-001 - 10 Ft.
600493-540-002 - 25 Ft.
600493-540-003 - 50 Ft.
600493-540-004 - 150 Ft.
600493-540-005 - 200 Ft.

1.5.23 CABLE, FULL FUNCTION REMOTE CONTROL (SPECIFY LENGTH) - Part Number 600071-102-002

1.5.24 INTERCONNECT CABLE ASSEMBLY, WIRED, AUDIO REMOTE CONTROL - Part Number
600464-540-001 - 10 Ft.
600464-540-002 - 20 Ft.
600464-540-003 - 30 Ft.
600464-540-004 - 40 Ft.
600464-540-005 - 50 Ft.
600464-540-006 - 75 Ft.
600464-540-007 - 100 Ft.
600464-540-008 - 150 Ft.
600464-540-009 - 200 Ft.

1.5.25 ANTENNA, 9 FOOT WHIP -Part Number 600015-398-002

1.5.26 ANTENNA, 16 FOOT WHIP - Part Number 600015-398-001

1.5.27 BUMPER MOUNT, 9-16 FOOT WHIP - Part Number 600020-398-001

1.5.28 SPRING, HEAVY DUTY BUMPER, 9-16 FOOT WHIP - Part Number 600020-398-002

1.5.29 ANTENNA, LESS MOUNT, 23 FOOT WHIP - Part Number 600019-398-001 (Use with 1.5.35 below)

1.5.30 ANTENNA, 23 FOOT WHIP (with flange mount) - Part Number 600019-398-001

1.5.31 MOUNT, LAYDOWN, 23 FOOT WHIP - Part Number 600019-398-003 (Use with 1.5.34 below)

1.5.32 ANTENNA, SECTIONALIZED WHIP, 32 FOOT - Part Number 600018-398-001 (Use with 1.5.38 or 1.5.39 below)

1.5.33 ANTENNA, SECTIONALIZED WHIP, 16 FOOT - Part Number 600018-398-009 (Use with 1.5.38 or 1.5.39 below)

1.5.34 MOUNT, FLANGE FOR 16 AND 32 FOOT ANTENNA - Part Number 600018-398-007 (Use with 1.5.36 and 1.5.37 above)

1.5.35 MOUNT, FEEDTHRU FOR 16 AND 32 FOOT ANTENNA - Part Number 600018-398-007 (Use with 1.5.36 and 1.5.37 above)

1.5.36 MOUNT, FEEDTHRU FOR 16 FOOT ANTENNA COAX CONNECTIONS WITH HEAVY DUTY SPRING - Part Number 600036-398-001 (Use with 1.5.37 above)

1.5.37 MOUNT, FLANGE FOR 16 FOOT WITH HEAVY DUTY SPRING - Part Number 600035-398-001 (Use with 1.5.37 above)

1.5.38 MOUNT, VEHICULAR FOR 16 FOOT ANTENNA WITH FEEDTHRU MOUNT SIDE BRACKET AND ASSOCIATED MOUNTING HARDWARE - Part Number 600233-817-008 (Use with 1.5.37 above)

1.5.39 RACK MOUNT KIT, MSR 6214 - Part Number 600209-700-001

1.5.40 PC BOARD EXTENDER CARD - Part Number 601198-536-001 (Two required on certain PC boards)

1.5.41 PC BOARD EXTRACTOR - Part Number 600268-618-001

1.5.42 DEPOT SPARE PARTS KIT FOR MSR 6214 POWER SUPPLY (12/24V) - Part Number 600208-700-001

1.5.43 POWER SUPPLY MODULE EXTRACTOR - Part Number 600270-618-001

1.5.44 26 VOLT DC CONVERTER, REQUIRED WITH FULL FUNCTION REMOTE FOR 26 VDC OPERATION - Part Number 600287-537-001

1.5.45 REMOTE OPTION (FACTORY INSTALLED) - Part Number 600219-700-001. Required when MSR 6400 remote is to be used.

1.5.46 POWER CABLE, MSR 6214 - Part Number 600870-540-001

SECTION 2
INSTALLATION

2.1 GENERAL

This section describes the installation procedure for the transceiver. Included within this section are procedures for unpacking, inspection and, if necessary, reshipping.

2.2 UNPACKING AND INSPECTION

Unpack the transceiver and make certain that all equipment outlined in Section 1.4 is present. Retain the carton and packing materials 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 shipment damage claim.

2.3 RESHIPPING

If return of the transceiver should become necessary, a Returned Material (RM) number must first be obtained from the factory. This number must be clearly marked on the outside of the shipping carton.

2.4 INSTALLATION

Thoroughly plan the transceiver/coupler/antenna locations and carefully follow the installation considerations given below. Satisfactory system performance depends upon the care and attention taken prior to and during installation.

The protective connector covers installed on the transceiver for shipping, should remain over unused connectors.

2.4.1 INSTALLATION CONSIDERATIONS

2.4.1.1 Antenna Site Location

For optimum characteristics and 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 2.1 and 2.2 show typical whip and longwire installations.

2.4.1.2 Adequate Ground

Provide the best possible RF ground for the transceiver and the coupler. Use a flat copper strap, 25 mm wide or number 6 gauge or larger wire and connect it to the ground terminal at the rear of the transceiver and on the coupler case. Leads to the ground system should be as short as possible.

2.4.1.3 Separation

Provide maximum separation between the coupler output (antenna) and the transceiver. The coupler may be mounted up to 61 meters (200 feet) from the transceiver when RG-213U cable is used. For runs under 30 meters (100 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

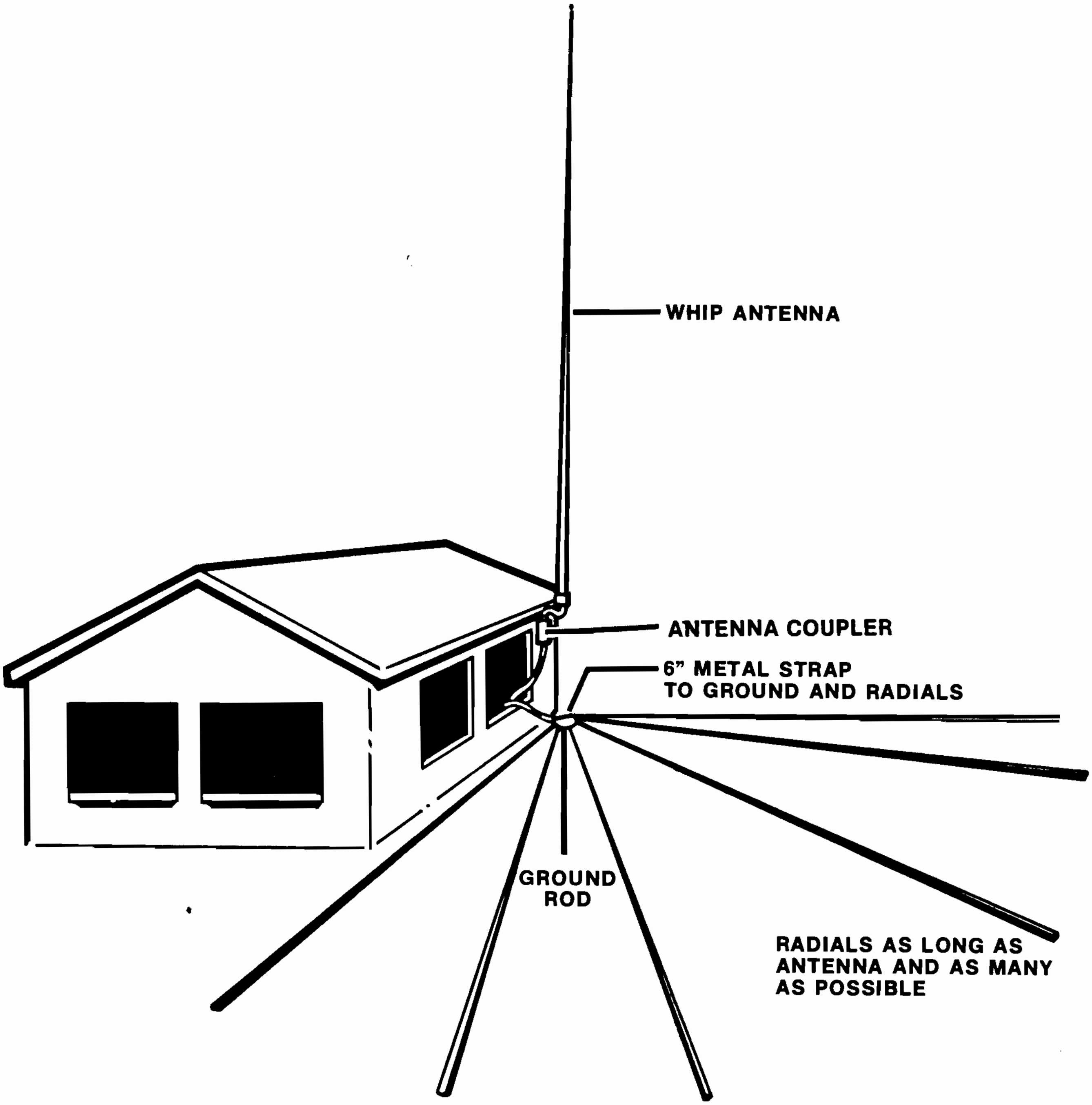


Figure 2.1 Typical Whip Antenna Installation

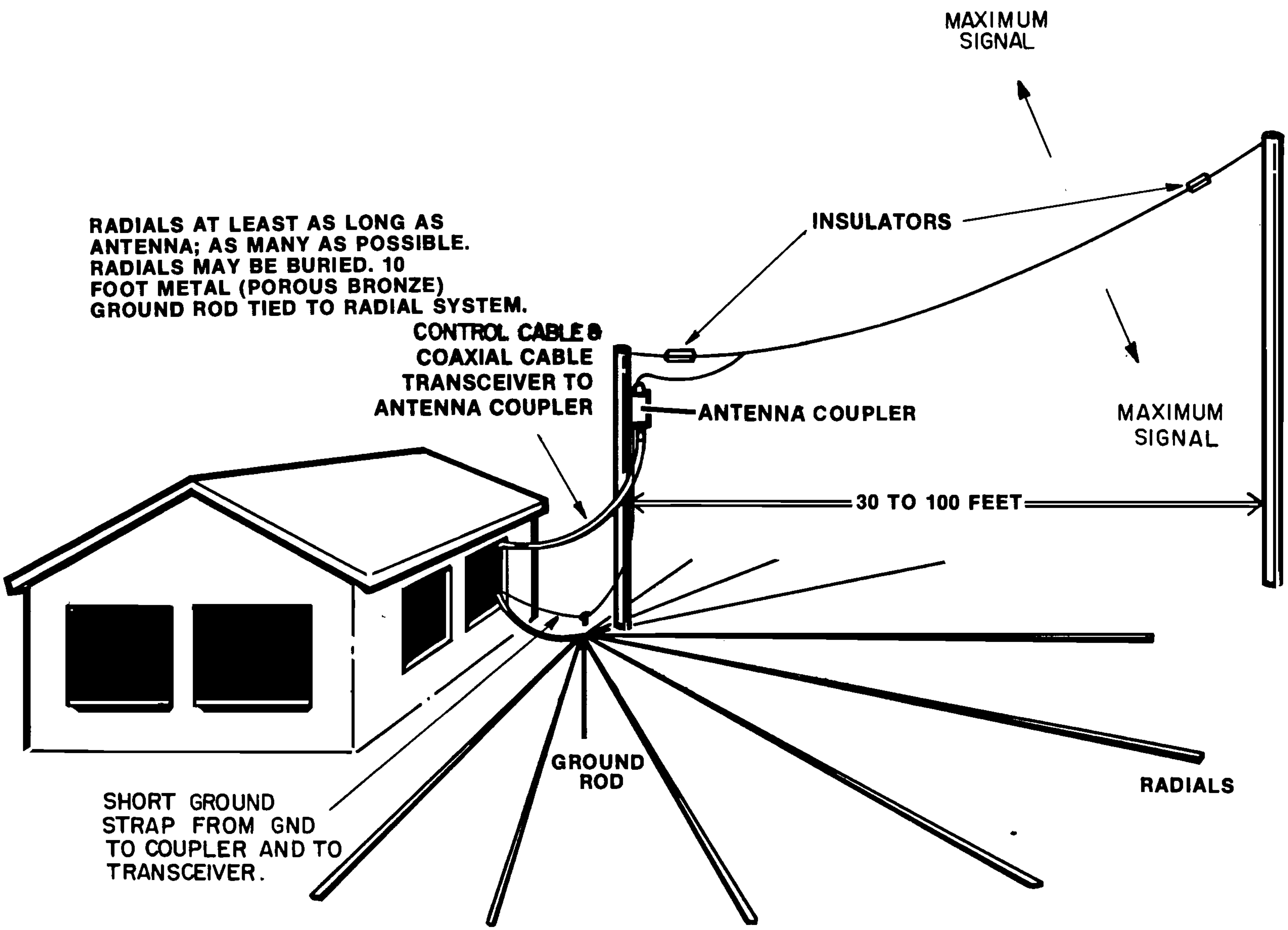


Figure 2.2 Typical Longwire Antenna Installation

cause is the close proximity of the antenna to the transmitter and/or poor RF grounds.

2.4.1.4 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 which are bonded to ground. The coupler should be as close as possible to the antenna and never more than 1 meter away, as this will decrease antenna efficiency.

2.4.2 BASE STATION INSTALLATION

The transceiver has rubber feet so it can be placed on a table or desk. The front feet are longer than the rear ones so the transceiver will tilt at a convenient operating angle. It is important to provide adequate ventilation for the heatsink. Clearances on the order of 25 mm on the sides and 50 mm at the top and rear should be provided. See Figure 2.3 for the transceiver outline dimensions. If the heatsink gets too hot, the RF power will cut back automatically. An optional PA fan (see Section 2.7) is necessary for FSK (RTTY) operation.

2.4.2.1 Rack Mount Installation (Transceiver)

The transceiver may be conveniently mounted in a standard 19 inch rack, by using the transceiver rack mount kit (P/N 600059-700-XXX). This kit includes a pair of rack slides, associated hardware and side adapter brackets. The transceiver in the rack mounted configuration requires a standard panel space of 13.21 cm (5.2 inches). For rack mounting, the four rubber feet and top cover fasteners are removed from the transceiver. See Figure 2.5 for assembly details.

2.4.2.2 Rack Mount Installation (Power Supply)

The power supply may be mounted inside a standard 19 inch rack by using the power supply rack mount kit (P/N 600209-700-001). This kit consists of a mounting plate and the hardware for rack mounting the AC power supply, utilizing if desired, the space immediately behind that of the transceiver. See Figure 2.6 for assembly details.

2.4.3 VEHICULAR INSTALLATION

The transceiver is normally mounted with the optional shock mount kit (600058-700-001) in mobile installations. Figure 2.7 shows a typical system installation in a vehicle.

2.4.3.1 Mounting Shock Rack

The shock rack mounting hole pattern dimensions are shown in Figure 2.8. The screw clearance holes in the isolators are for number 10-32 UNC machine screws. Sixteen (16) machine screws are required for mounting the shock isolators. Refer to Figure 2.8 for the hole locating dimensions for shock isolators.

2.4.3.2 Mounting Radio in Shock Rack

Place the radio on the shock rack with the rubber feet through the cut-out holes. Slide the radio to

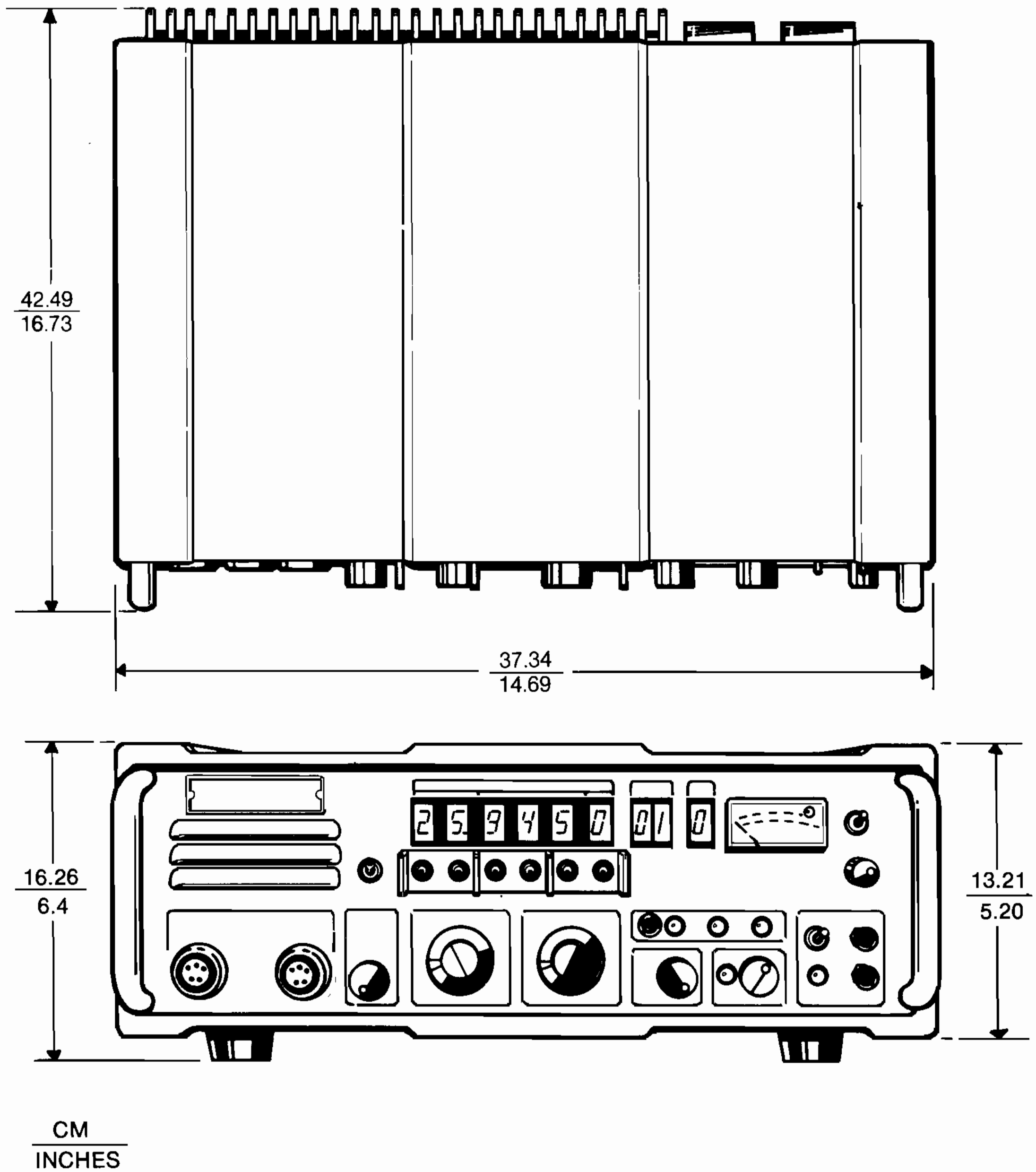


Figure 2.3 Transceiver Outline Dimensions

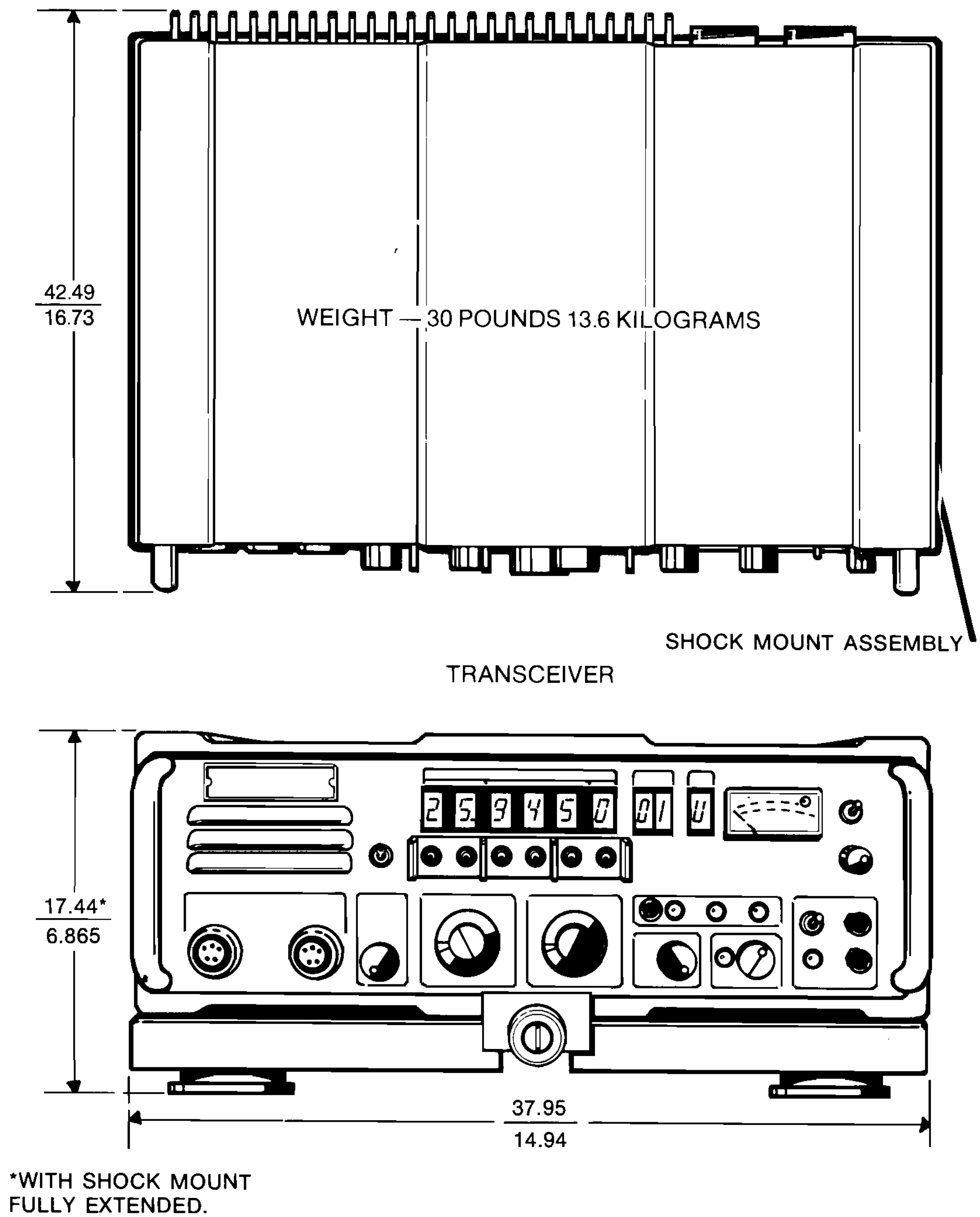


Figure 2.4 Transceiver/Shock Mount Outline Dimensions

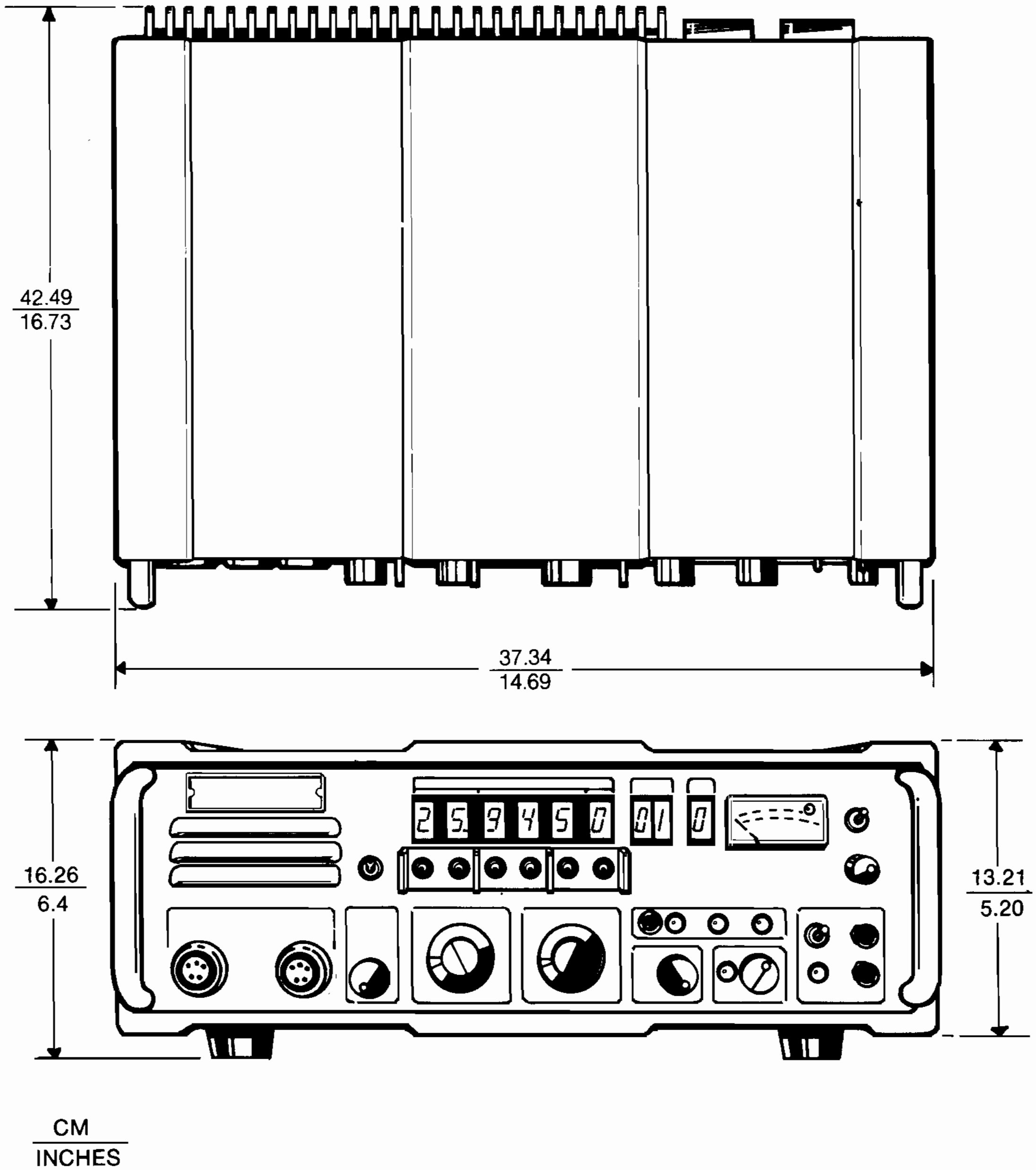


Figure 2.3 Transceiver Outline Dimensions

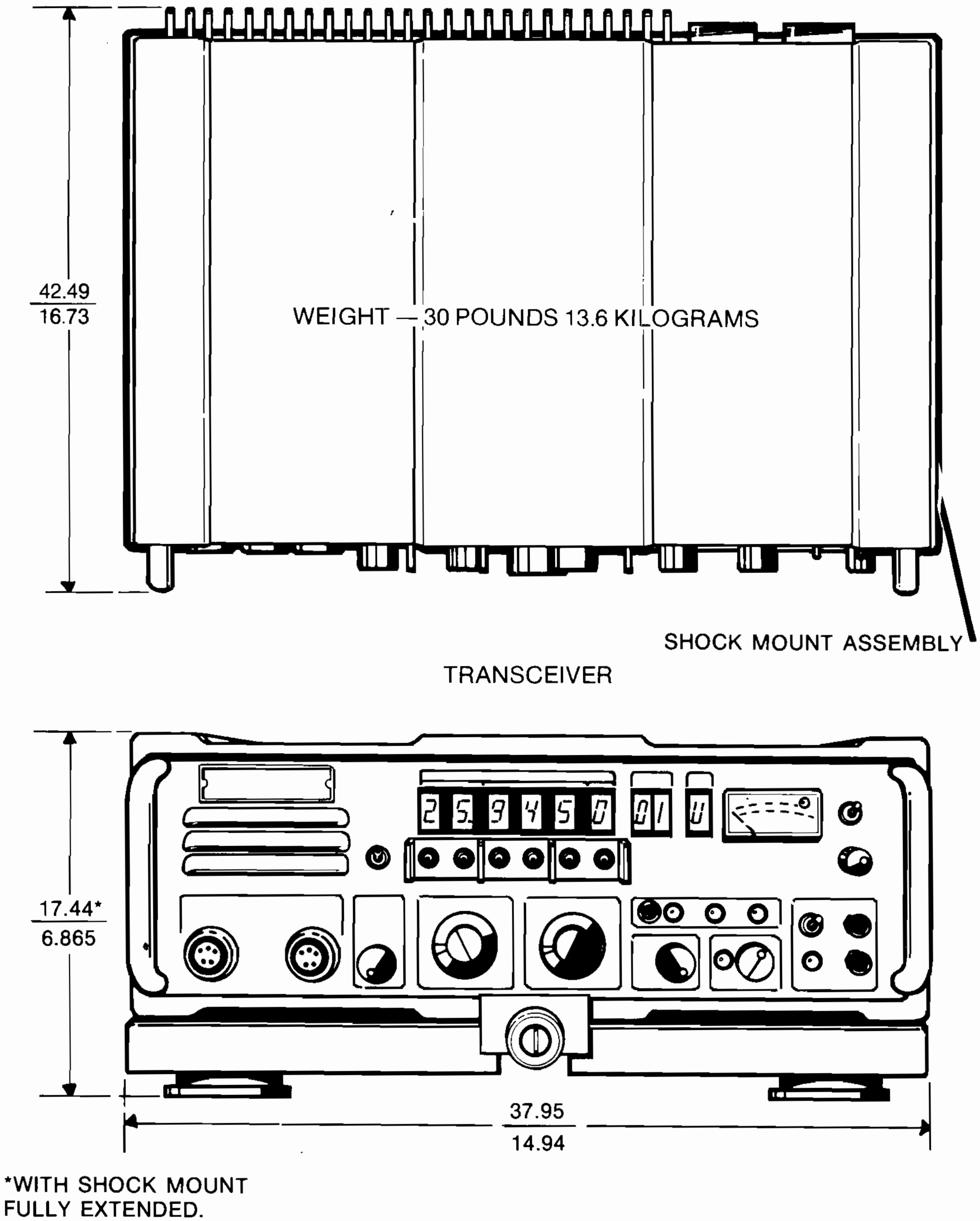


Figure 2.4 Transceiver/Shock Mount Outline Dimensions

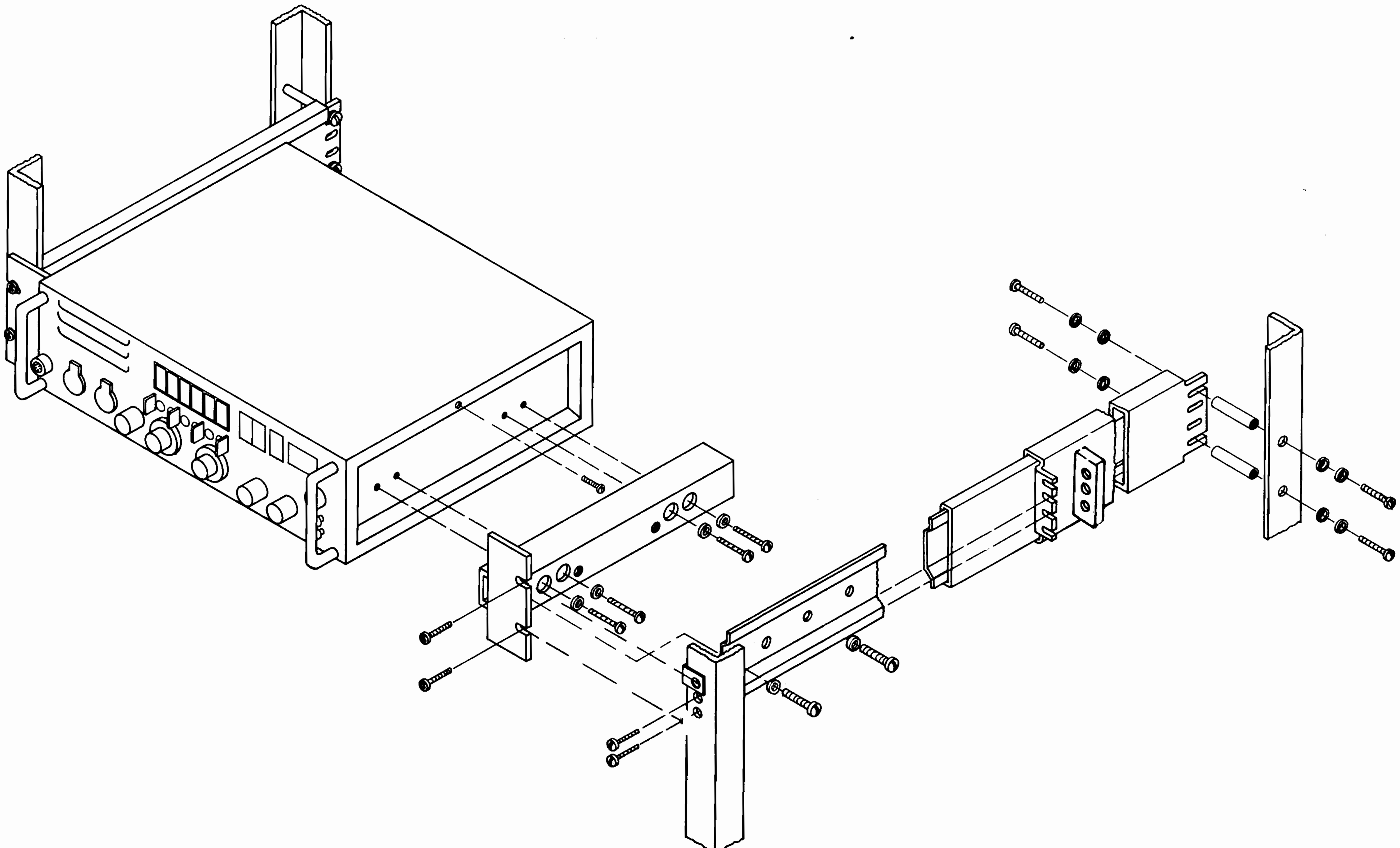


Figure 2.5 Transceiver Rack Mount Installation

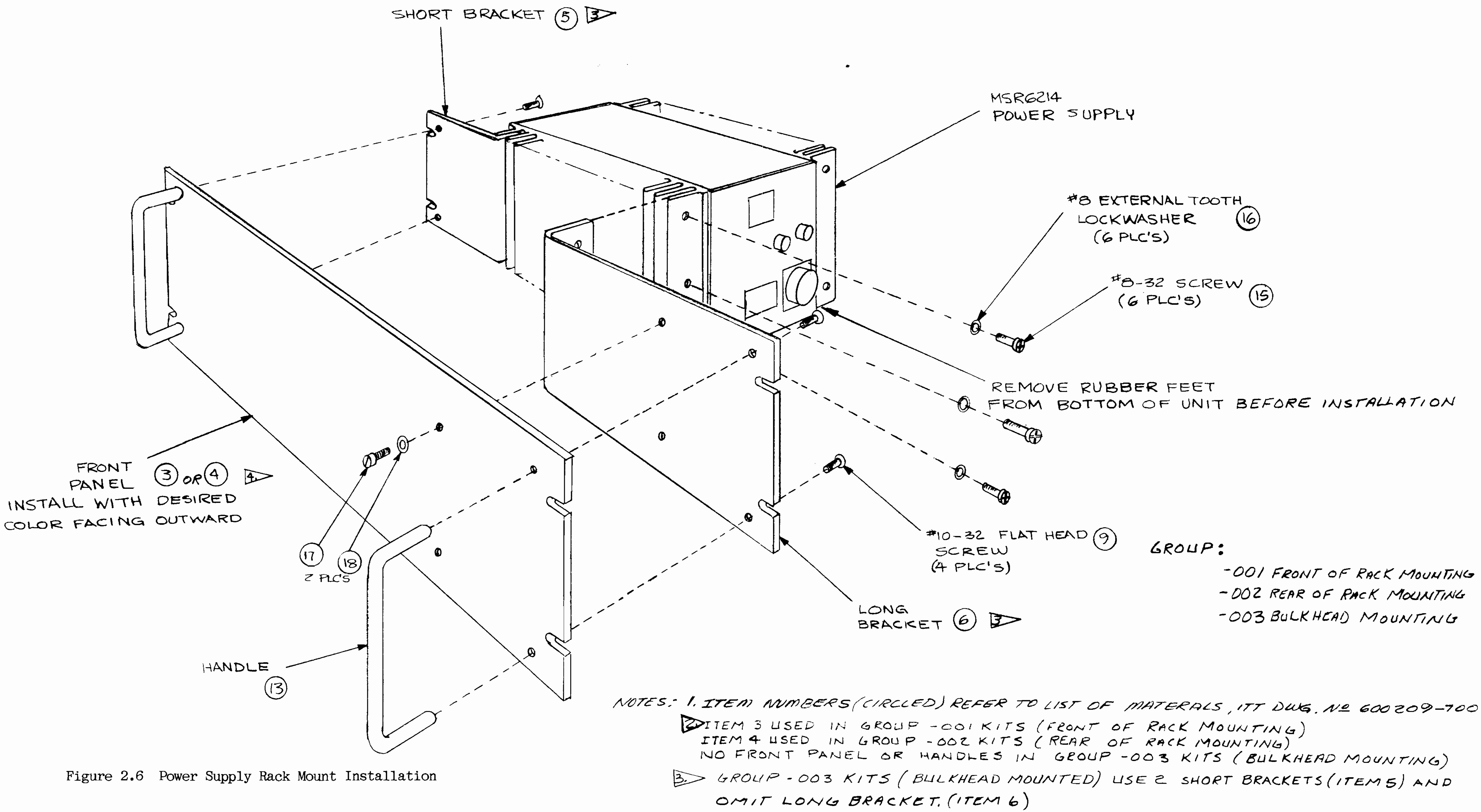


Figure 2.6 Power Supply Rack Mount Installation

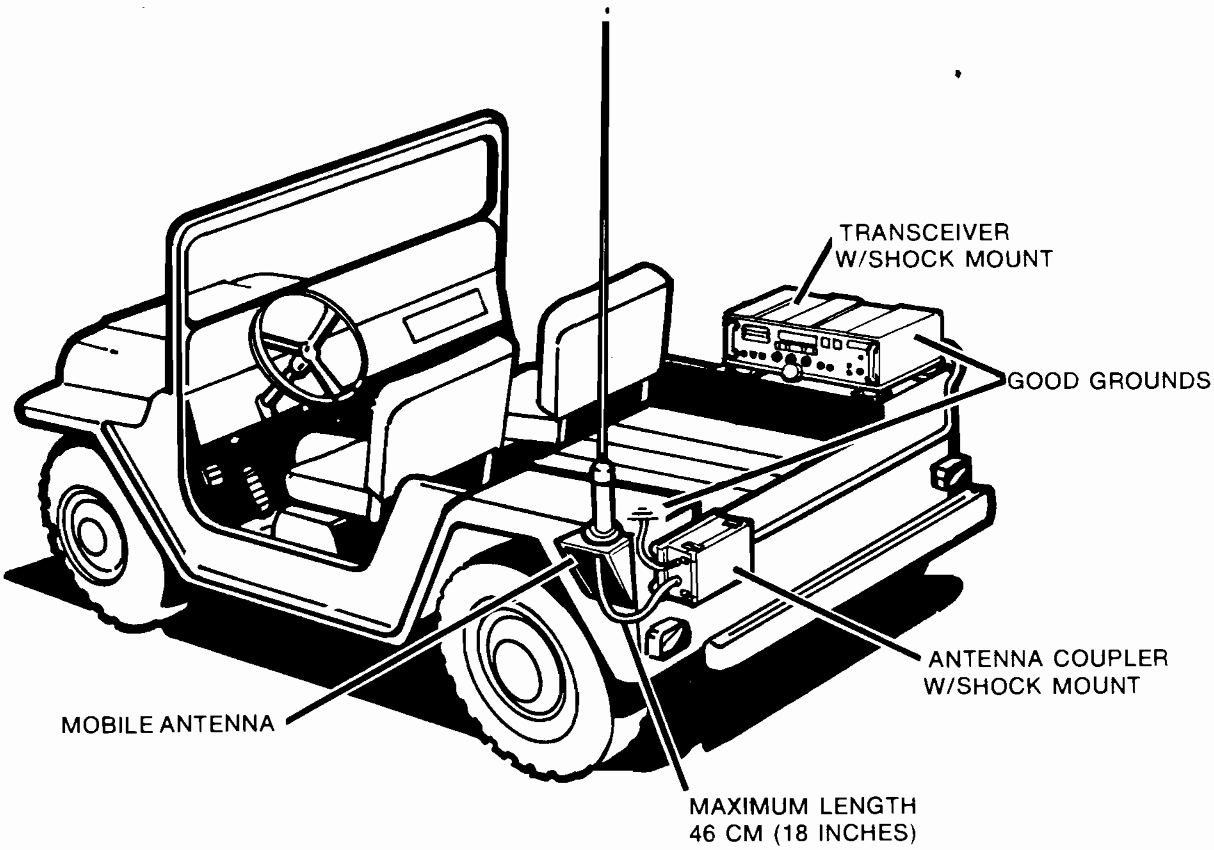


Figure 2.7 Typical Vehicle Installation

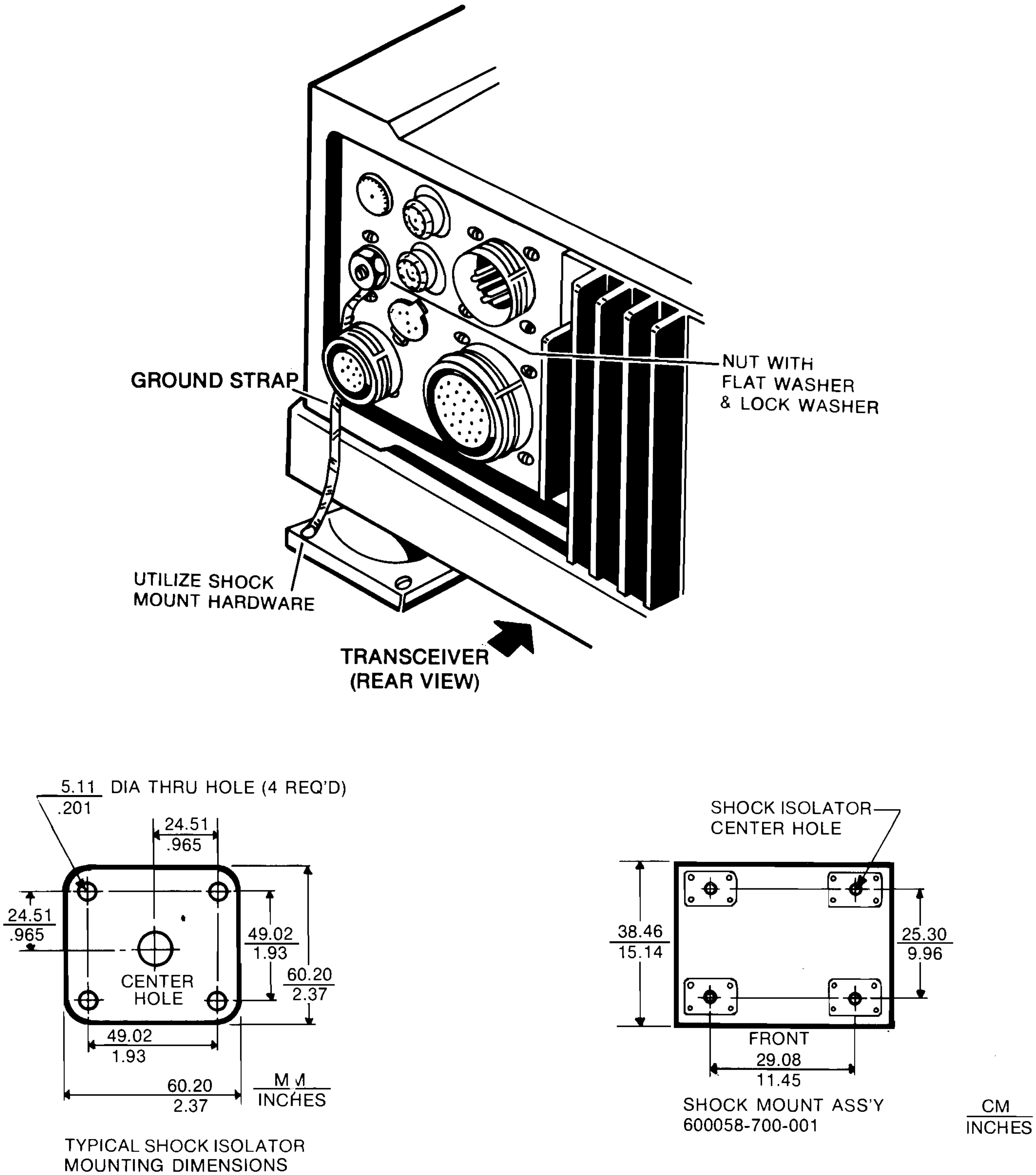


Figure 2.8 Shock Mount Hole Pattern Dimensions

the rear of the shock rack so that the two retainers secure the lower bezel, on the rear of the radio. Position the shock rack clamp so that it clamps the lower bezel on the front of the radio. Hand tighten the knob to lock in place, see Figure 2.9. Overall dimensions of the transceiver and shock rack can be obtained from Figure 2.4.

2.4.3.3 Other Installations

It is recommended that the antenna and transceiver be mounted on opposite sides of the vehicle to minimize stray RF pickup, and the transceiver and coupler MUST be well grounded to the vehicle frame.

Vehicle ignition and charging system noise is frequently a problem in mobile installations. Although the noise blanker in the transceiver minimizes ignition interference, it may be necessary to take some noise suppression measures with the vehicle itself.

The following steps can be taken to reduce ignition and charging system noise.

a) Replace standard spark plugs with high resistance spark plugs (before installing high resistance spark plugs, check with the engine manufacturer or authorized dealer to determine the proper type).

b) Replace the spark plug wiring with radio ignition wire (again, check with the manufacturer or dealer to determine the proper type and length).

c) Install a 0.5 microfarad coaxial capacitor (Cornell-Dublier Type NF-10) in series between the ignition switch and primary of the ignition coil to reduce ignition interference (as close as possible to the coil).

d) Run a length of radio ignition wire from the distributor cap to the coil to reduce distributor interference (caused by the rotor in the distributor cap).

e) The generator (or alternator) causes electrical interference which frequently is blamed on the ignition system. Current passing between the brushes and commutator creates arcing which is heard as a whining sound, that varies with changes in engine speed. Install a 0.5 microfarad coaxial capacitor in series with the armature to reduce whining.

f) The voltage regulator may be a mechanically controlled device having breaker contacts. The breaker points create an arc, causing a popping sound in the receiver. This noise seldom varies with changes in engine speed. Install a 0.5 microfarad coaxial capacitor in series with the terminal connections to reduce voltage regulator noise (the coaxial capacitor is non-inductive and has high attenuation).

CAUTION

Disconnect the battery ground terminal before adding any components to the battery input of the voltage regulator.

2.4.4 MARINE INSTALLATIONS

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

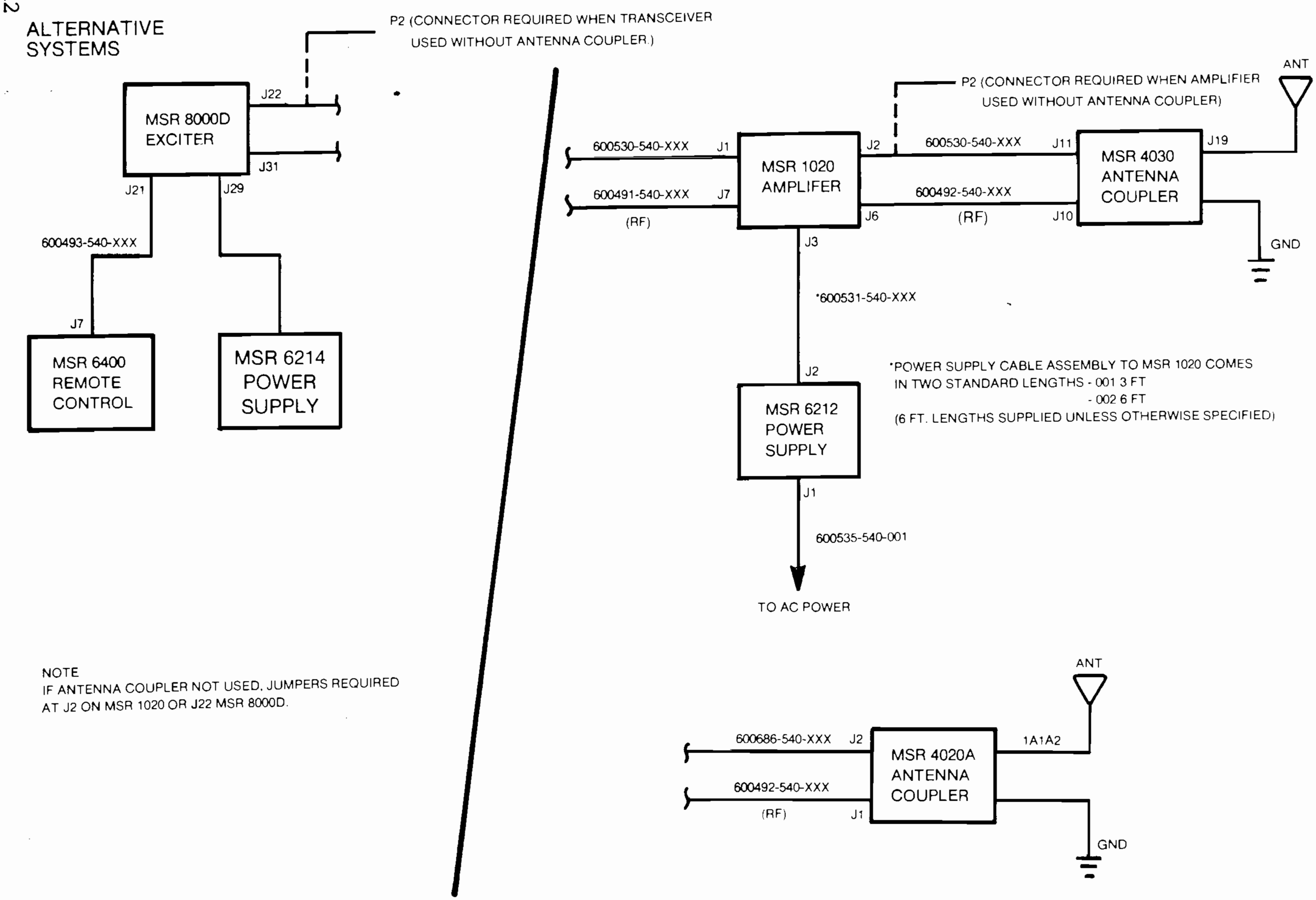


Figure 2.9 Typical System Interconnect Diagram

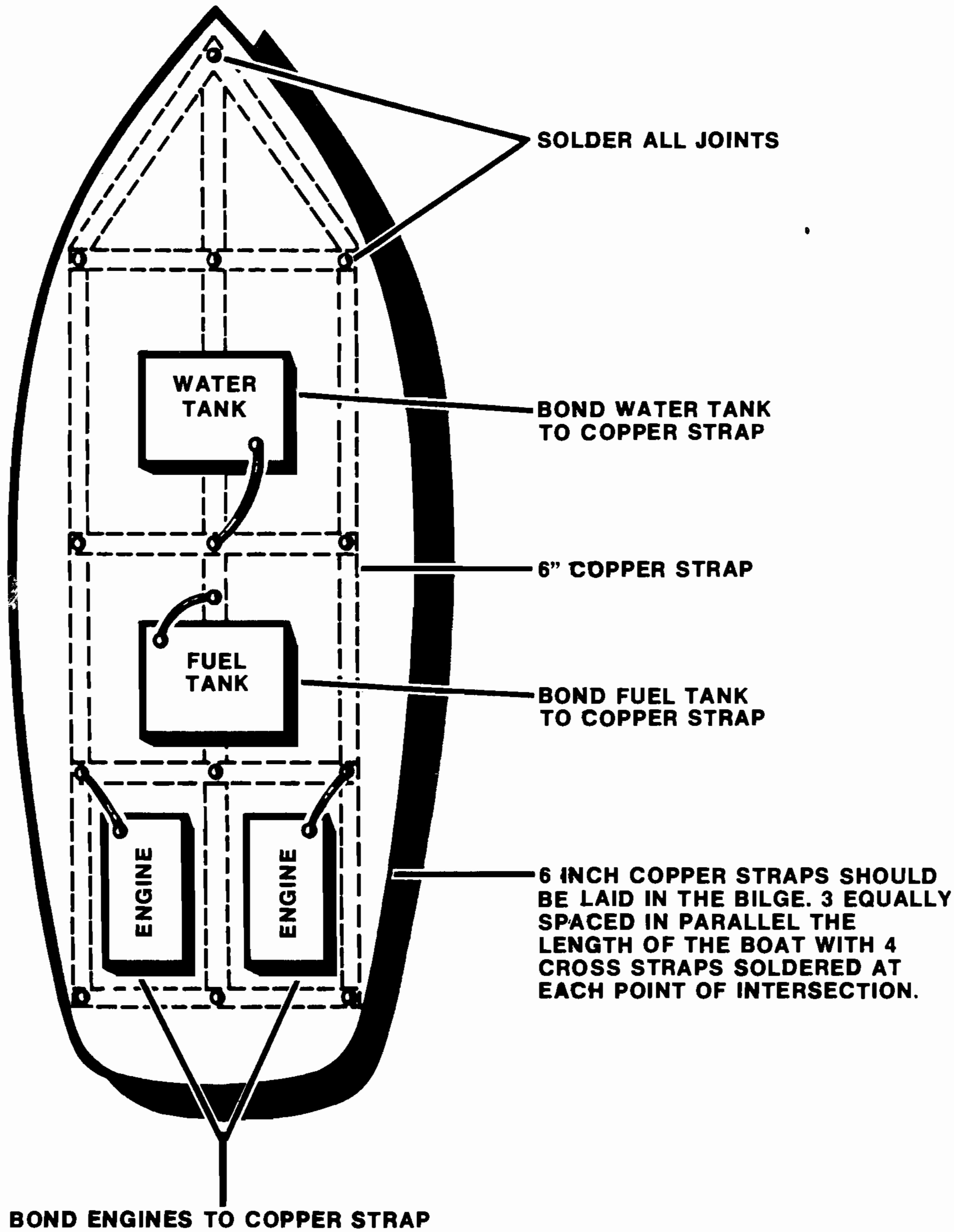


Figure 2.10 Typical Ground/Counterpoise Installation

IT IS RECOMMENDED THAT THE TRANSCEIVER BE SECURELY GROUNDED, as poor grounding can degrade performance. With a metal hull, the transceiver can 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. 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 large metal objects. Bonded to this ground should be two or three wide copper straps running as far as possible fore and aft, together with three or four cross members (ground plates may be effective on lower frequencies but are subject to fouling. Therefore, they are not recommended). Figure 2.10 shows a typical ground/counterpoise system.

2.5 POWER REQUIREMENTS

The transceiver is designed to operate directly from 12 or 24 VDC negative ground vehicle electrical systems. Such systems use nominal 12 or 24 VDC batteries, but because they are normally being charged by an alternator or generator, average system voltage is higher. The actual voltage depends on system current draw and charging rate, but the average is taken to be 13.2 and 26.4 VDC with the transmitter operating.

The operating voltage of the transceiver is determined by the power amplifier (PA) assembly installed in the transceiver. Before connecting power, check the voltage tag on the end of the PA heatsink nearest the connectors.

The transceiver will accept NEGATIVE GROUND ONLY. Positive ground systems will require a inverter/ isolator. The transceiver has reverse polarity protection built in. If the unit does not operate, check the power supply connections.

2.5.1 CONNECTING THE MSR 6214 POWER SUPPLY

Connect the MSR 6214 AC Power Supply as follows: (P/N 697007-000-001, 12 VDC or P/N 697007-000-002, 24 VDC).

a) Check the AC line voltage and DC output voltage tags on the side of the MSR 6214 for correct input and output voltage settings. If voltages marked on tags do not meet application, refer to Sections 2.5.1.1 and 2.5.2.2.

b) Connect the MSR 6214 to the MSR 8000D using the power cable included with the power supply (P/N 600870-540-001). Cable connects between J1 of the power supply and connector J29 on the transceiver rear panel.

2.5.1.1 Line Voltage Setting

a) Disconnect power supply from AC line. Wait at least 3 minutes to allow hazardous DC voltages to bleed down.

b) Remove AC line voltage tag on side of power supply.

c) Set both switches (under tag) to appropriate position.

d) Replace AC line voltage tag with correct line voltage marking to outside.

2.5.1.2 Output Voltage Setting

a) Disconnect power supply from AC line. Wait at least 3 minutes to allow hazardous DC voltages to bleed down.

b) Remove power supply top cover.

c) Disconnect and remove control board.

d) Connect jumpers on TB1 to appropriate locations:
12V - Jumper TB1-1 to TB1-2 and TB1-3 to TB1-4
24V - Stack jumpers together, jumper TB1-2 to TB-3

NOTE

Jumper locations marked on top of TB1.

e) Reinstall control board, ensuring connection of transformer board pins on bottom of control board and ribbon cable on side.

f) Locate jumper JP1 on control board and set jumper to appropriate position (see Figure 2.11 below, also marked on board).

g) Replace top cover.

h) Ensure that output voltage tag shows correct voltage - 12V is on one side of tag, 24 VDC is on other side.

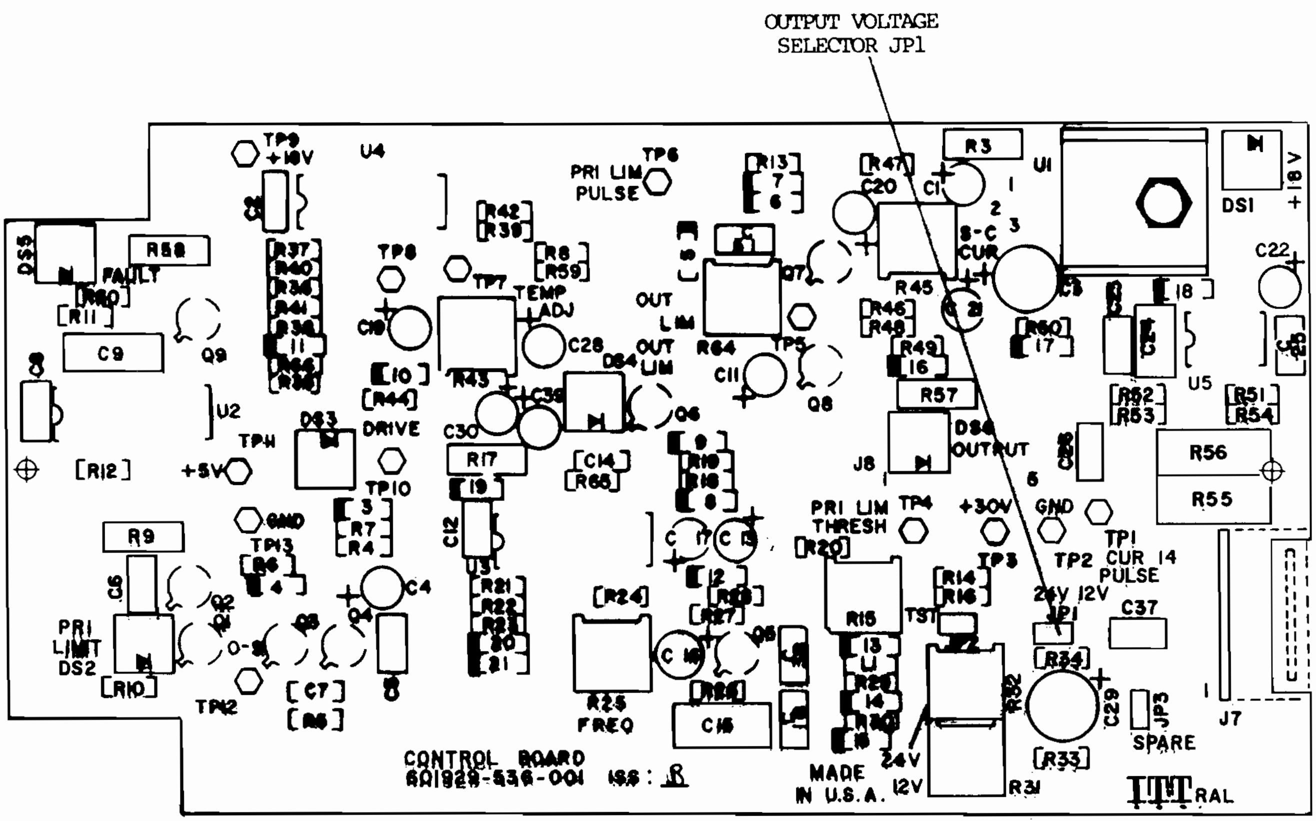


Figure 2.11

MSR 6214 Control Board Detail

2.5.2 CUSTOMER SUPPLIED POWER SUPPLIES

If the transceiver is used with other power supplies, use the DC power cord supplied with the transceiver (P/N 600452-540). This DC cable is supplied with approximately 15 feet of connecting cable. If the installation permits, the cable should be trimmed to a minimum length consistent with a neat installation. This will assure a minimum of voltage drop in the cable, under the high input currents present in transmit, particularly the 13 volt model. Connect the power lead marked "+" to the positive terminal of the power supply, and the lead marked "-" to the negative terminal of the power supply. If the power supply voltage output is adjustable, set the voltage to +13.2 VDC for the 12 VDC model transceiver, or +26.4 VDC for the +24 VDC model. The current capability of the power supply should be 30 amps for the 12 volt model, and 20 amps for the 24 volt model. A schematic of the transceiver power input connector is shown in Figure 2.12.

2.6 ANTENNAS AND GROUND SYSTEMS

CAUTION

The antenna radiates DANGEROUS RF VOLTAGE which can cause BURNS and INJURY. Do not touch the coupler antenna terminal, long wire or whip antenna while transmitting.

The transceiver is designed to drive a 50 ohm resistive antenna system with a 2:1 VSWR maximum. When used with the companion coupler, the system will drive the following antennas:

a) Whip, 3 meter (9 feet) - 1.6 - 30 MHz (vehicular mount)

b) Whip, 5 - 12 meter (16 - 35 feet) 1.6 - 30 MHz

c) Longwire, 15 - 49 meter (50 - 150 feet) - 1.6 - 30 MHz

Some general antenna system guidelines are:

a) Mount the antenna as high as possible.

b) Where possible, use antennas over 1/8 wavelength long at the lowest operating frequency. Short antennas are not efficient radiators.

c) Short antennas are most sensitive to ground loss. When a short antenna is used, the best possible ground system should be obtained (see Figures 2.1 and 2.2).

d) On ships with non-metalic hulls, make the ground/counterpoise system cover as large an area as possible. Make maximum use of large metal objects, copper screen, the propellor shaft and properly bonded copper straps.

e) Use the lowest possible inductance ground connections for the transceiver and coupler.

2.7 ANTENNA COUPLER CONNECTIONS

If the MSR 4020A Antenna Coupler is part of the station system, refer to Publication Number 600262-823-001 for installation details. Figure 2.9 shows typical system interconnections.

NOTE

If the MSR 4020A Antenna Coupler is not connected, accessory plug 1A3-P22 (supplied in the transceiver accessory kit) must be installed on the accessory connector, 1A3-J22. Otherwise, the transceiver will not transmit. This accessory plug contains a jumper between pins C ("transmit-interlock") and pin G ("ground"). The absence of this jumper prevents the exciter from being keyed. The plug also contains a jumper between pins R and G to provide a required termination.

2.8 PA FAN OPTION

The fan option (P/N 600062-700-001), is required for FSK (RTTY) operation of the transceiver. The fan is installed on the rear panel, over the PA heat sink, utilizing the four (4) mounting screws that are used to secure the power amplifier module to the rear panel. Electrical connections to the fan are made via a wiring harness and plug to a mating connector on the rear panel. Once installed, the fan will operate automatically to maintain an acceptable heat sink temperature.

See Section 6 for fan option installation instructions.

2.9 REMOTE CONTROL OPTION

Remote Control of the MSR 8000D Transceiver is possible when used in conjunction with the optional MSR 6400 full function Remote Control P/N 699023-000-XXX. Electrical connections to the remote control ar made via a 17 conductor control cable connected from the MSR 8000D rear panel audio connector 1A3J21, to J7 of the remote control.

NOTE

The transceiver rear panel connector board switch must be in the "REMOTE" position when the remote control unit is used, and in the "LOCAL" position when a remote is not connected. Refer to Fig.5.54 for switch location. Failure to have this switch in the proper position can prevent external keying of the transceiver from the audio connector and prevent ON-OFF power control in remote operation.

The MSR 8000D must be configured for remote operation with a factory-installed Remote Option P/N 600219-700-001. Refer to Section 6 for details.

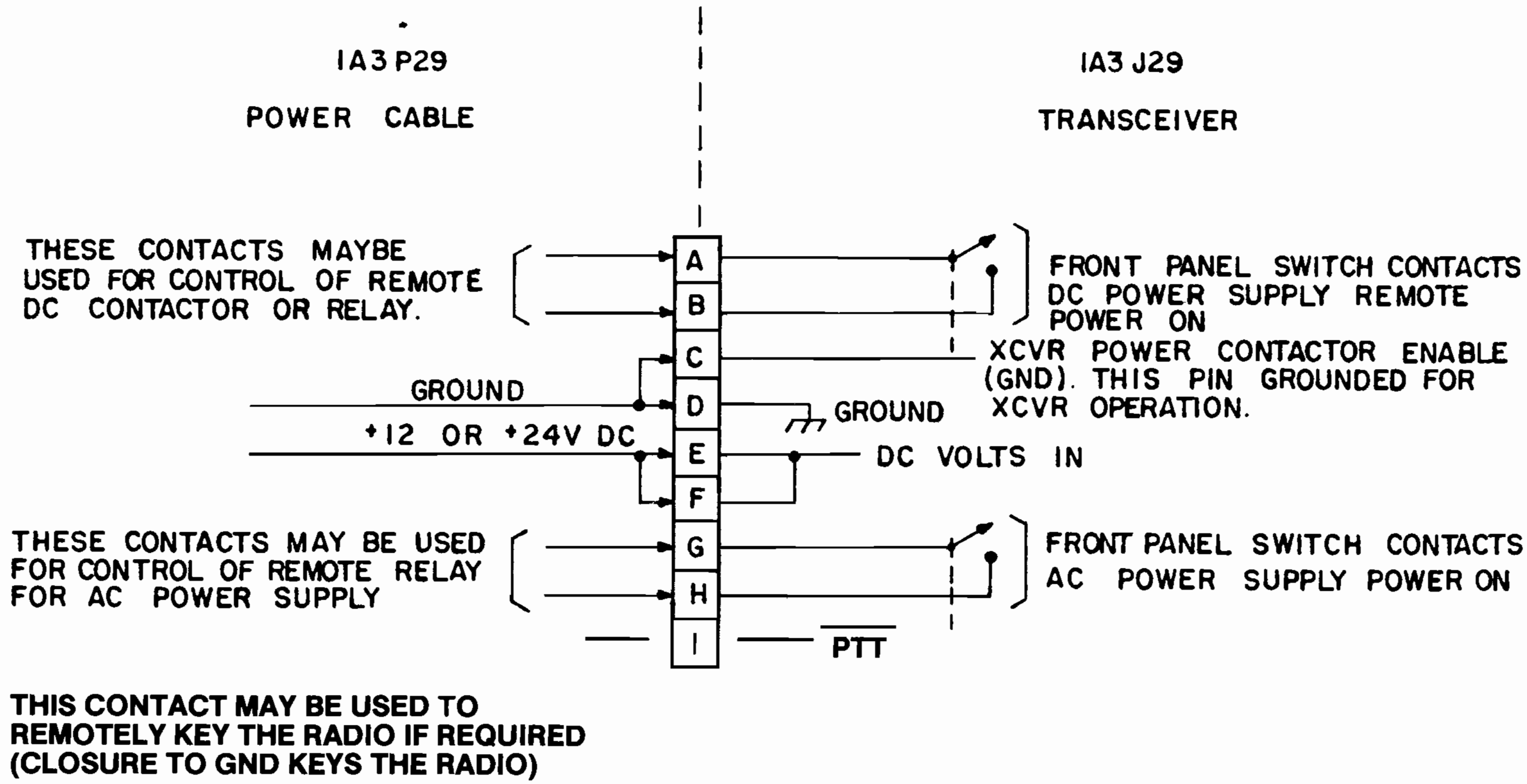


Figure 2.12 Transceiver Power Input Connection Schematic

TABLE 2.1
MATING CONNECTORS TO TRANSCEIVER AND ACCESSORIES

DESCRIPTION	DESIGNATOR	MATING PARTS MIL	ITT PART NUMBER Connector	ITT PART NUMBER Clamp w/Bushing
Microphone	1A2J34	U-229/U	600388-606-002	
Headphone	1A2J32	U-229/U	600388-606-002	
CW Key	1A2J33	U-229/U	600388-606-002	
Rear Panel Audio	1A3J21	MS-3106A-20-29P	600375-606-006	600376-606-002
Power	1A3J29	MS-3106A-24-11S	600375-606-003	600376-606-003
Accessory	1A3J22	MS-3106A-28-21P	600375-606-004	*600274-606-001
Antenna	1A3J31	PL-259	600244-606-002	
PA Fan	1A3J30	AMP 126-217	600377-606-001	

* Bushing not required

TABLE 2.2
TRANSCEIVER REAR PANEL CONNECTIONS

J21 AUDIO CONNECTOR

A	RECEIVE AUDIO OUT (600Ω)
B	PWR ON/OFF/PTT
C	13/26V DC
D	DS1
E	TRANSMIT AUDIO IN (600Ω)
F	TRANSMIT AUDIO IN (600Ω)
G	DS2
H	GND
J	RECEIVE AUDIO OUT (600Ω)
K	DS4
L	DS5
M	DS6
N	DS7
P	FREQ DOWN
R	DS3
S	FREQ UP
T	READY

J22 ACCESSORY CONNECTOR

A	$\overline{\text{FAULT}}$
B	$\overline{\text{KEY ENABLE}}$
C	KEY INTERLOCK
D	$\overline{\text{SURVEILANCE TUNE}}$
E	$\overline{\text{CH1}}$
F	POWER FWD
G	GROUND
H	CB
J	TUNE
K	$\overline{\text{READY}}$
L	$\overline{\text{CH4}}$
M	$\overline{\text{TUNING}}$
N	$\overline{\text{CH8}}$
P	SPARE
R	EXT PFRL
S	SPARE
T	$\overline{\text{B3}}$
U	$\overline{\text{B4}}$
V	$\overline{\text{B5}}$
W	GND
X	$\overline{\text{B6}}$
Z	$\overline{\text{CH2}}$
a	$\overline{\text{B8}}$
b	$\overline{\text{B7}}$
c	$\overline{\text{B2}}$
d	$\overline{\text{B1}}$
e	$\overline{\text{B2}}$
f	GND
g	+13VDC

J29 DC POWER CONNECTOR

A	DCA
B	DCB
C	CONTACTOR ENABLE
D	GND
E	+13/26V DC INPUT
F	+13/26V DC INPUT
G	ACA
H	ACB
I	$\overline{\text{PTT}}$

J30 FAN CONNECTOR

A	13/26 VDC
B	TEMP SENSE
C	NC
D	GND
H	NC

h	SPARE
j	EXT ALC INPUT
k	COUPLER ENABLE
m	EXT ACC INPUT
n	SPARE
r	COUPLER POWER
s	COUPLER POWER

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 CONNECTORS

Refer to Figure 3.1 for control locations.

3.2.1 VOLUME/POWER

Controls the received signal level at the speaker and PHONES jack. Click-off CCW position turns off transceiver primary power. VOLUME setting does not affect 600 ohm receive audio output.

3.2.2 SPEAKER SWITCH

Turns the internal speaker on and off.

3.2.3 CHANNEL/FREQUENCY SWITCH

Selects the active memory channel (one of ten) or selects the variable frequency mode. In switch positions 1 through 10, the transceiver operates at the frequency and mode stored in that memory channel (the MODE and FREQUENCY SELECT switches are disabled). In FREQ position, the transceiver will operate at the frequency and mode selected at the front panel. Simplex operation only is possible in this position.

3.2.4 MODE

Sets the transceiver operating mode. This control is not active during channelized operation (MODE is recalled from memory during channelized operation).

3.2.5 SQUELCH/NOISE BLANKER

Rotary action sets the squelch threshold. The squelch is defeated in fully CCW position (maximum threshold is fully CW). Pulling out the control turns on the noise blanker.

3.2.6 CLARIFIER CONTROL

Pulling out this control activates the clarifier (the amber lamp beside the knob lights to indicate clarifier ON). Rotating the control shifts the receive frequency at least ±250 Hz from the frequency indicated on the display. The clarifier does not affect the transmitted frequency. Frequency may be varied ± 200 Hz when the MSR 6400 Remote Option is installed.

3.2.7 TUNE BUTTON

Pushing this button initiates an antenna coupler tune cycle, if a coupler is connected. The coupler needs to be retuned after changing transmit frequencies.

3.2.8 PA/COUPLER STATUS LAMPS

These three lamps, FAULT, NOT TUNED and READY tell the operator the tune status of the coupler and the status of the PA. When the companion antenna coupler is used with the transceiver as a system, the lamps will indicate one of the conditions listed in Table 3.1.

When the companion coupler is not used and the transceiver is operating into a 50 ohm antenna, the

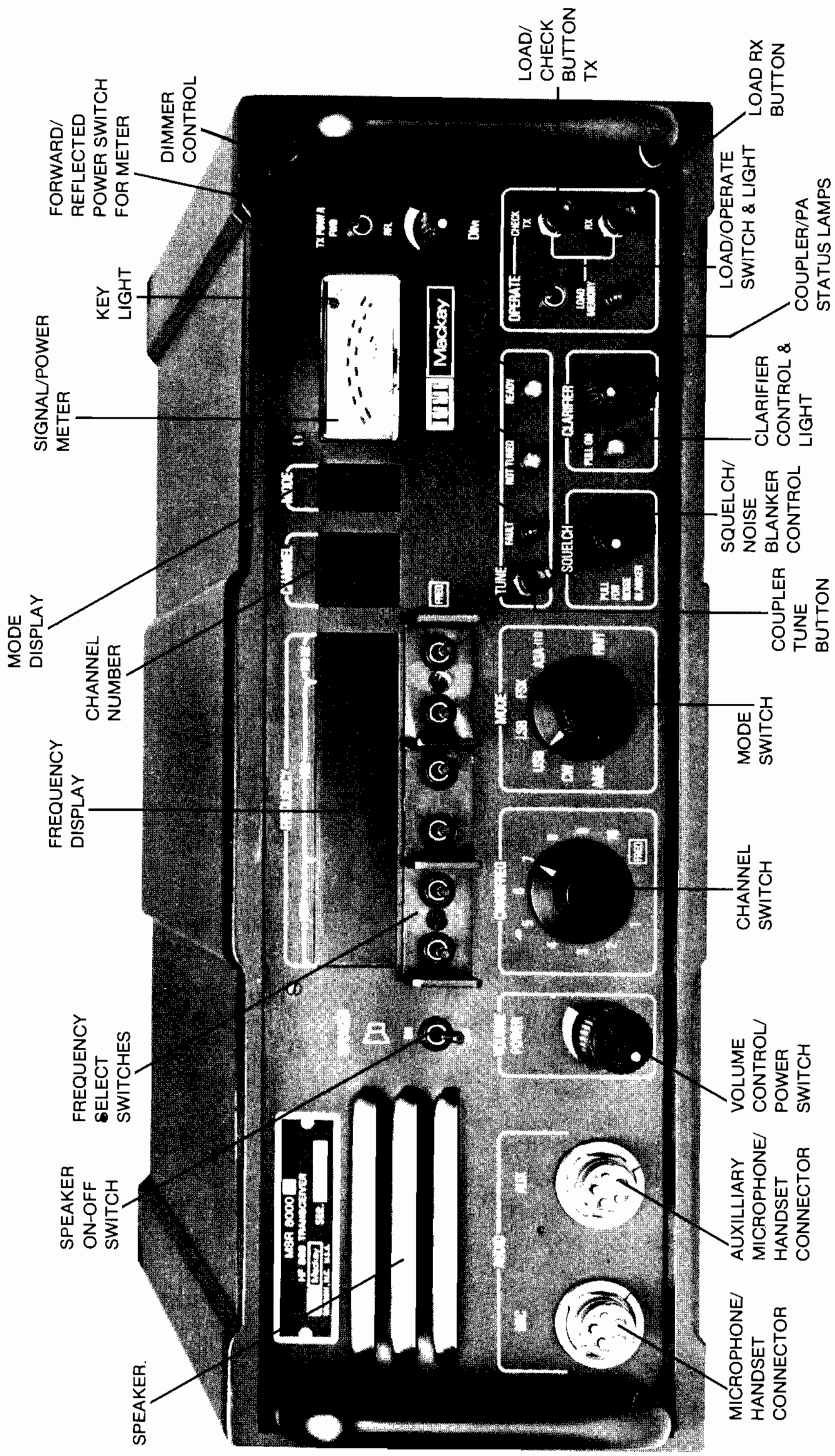


Figure 3.1 Front Panel Controls

TABLE 3.1
STATUS LAMP INDICATORS
(When Companion Coupler Is Used With Transceiver)

FAULT, steady*	FAULT lights when power is first applied to the coupler.
FAULT, flashing**	Coupler unable to reach tuned condition within 30 seconds of TUNE command.
FAULT, flashing	Operator has changed frequencies, transmitted, and not retuned coupler.
FAULT, steady	PA over temperature indication or bad PA fuse.
FAULT, steady while transmitting	PA over voltage, over current or VSWR fault between the transceiver and coupler.
NOT TUNED	Coupler is in the process of tuning.
READY	Coupler has tuned properly and is ready to transmit.

*FAULT, steady indicates a condition originating from the transceiver or line to the antenna coupler.

**FAULT, flashing 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 over temperature indication or bad PA fuse.
FAULT, steady while transmitting	PA over voltage, over current or VSWR fault.
NOT TUNED and READY will not indicate.	

lamps will indicate the conditions listed in Table 3.2.

3.2.9 DIMMER

Adjusts the brightness of the display and indicators for comfortable viewing in high or low ambient light.

3.2.10 SIGNAL/POWER METER

Indicates received signal strength relative to 1 μV, and when transmitting, relative forward or reflected power.

3.2.11 FORWARD/REFLECTED POWER SWITCH

Determines whether the meter displays forward or reflected transmitted power. The reflected power reading should be very small (less than 0.1 on the scale). A high reflected power reading indicates an antenna mismatch.

3.2.12 KEY LIGHT

This red LED in the upper right corner of the meter scale lights when the transmitter is keyed. If the light does not light when the microphone is keyed, the transceiver may have an internal fault which inhibits the transmitter.

3.2.13 MODE DISPLAY

Shows a letter corresponding to the tranceiver mode. A = AME, C = CW, U = USB, L = LSB and F = FSK and 11 = A3A.

3.2.14 CHANNEL NUMBER DISPLAY

Shows the number of the memory channel selected. When the CHAN/FREQ knob is in FREQ position this display is blank.

3.2.15 FREQUENCY DISPLAY

Shows the transceiver operating frequency.

3.2.16 FREQUENCY SELECT SWITCHES

Permit the selection of the transceiver operating frequency. They are active only in FREQ position of the CHAN/FREQ switch or in LOAD MEMORY mode. The switches affect the digit directly above them and the two least significant digits carry into the third. Frequencies above 29.9999 MHz or below 1.6000 MHz cannot be selected.

3.2.17 LOAD/OPERATE

This switch controls memory loading. In the OPERATE position, the transceiver operates normally. In the LOAD MEMORY position, the receiver audio is muted, transmission is inhibited and the memory may be loaded. A warning LED lights when in the LOAD MEMORY position.

3.2.18 LOAD RX BUTTON

Is only active in the LOAD MEMORY switch position. Pushing the button loads the receive frequency and mode into a selected channel.

3.2.19 LOAD/CHECK TX BUTTON

In the OPERATE position, pushing the button displays the transmit frequency stored in a selected memory channel. In LOAD MEMORY position, pushing the button loads the transmit frequency and mode into a selected memory channel.

3.2.20 MIC CONNECTOR

Connector for dynamic microphone, carbon microphone, handset or CW key.

3.2.21 AUX CONNECTOR

Connector is wired in parallel with MIC Connector and may be used with the same accessories.

3.3 REAR PANEL CONTROLS AND CONNECTORS

Refer to Figure 3.2 for locations.

3.3.1 POWER CONNECTOR

Is used to connect DC power to the transceiver. Also contains connections to a remote power relay in the optional AC power supplies. Mates with the standard MS connector MS3106A 24-11S (supplied).

3.3.2 ACCESSORY CONNECTOR

Connects accessory equipment such as the companion antenna coupler. Mates with the standard MS connector MS3106A 28-21P (supplied).

3.3.3 AUDIO CONNECTOR

Connects to/from 600 ohm balanced audio lines or connections to audio remote unit. Mates with the standard MS connector MS3106A 20-29P (supplied).

3.3.4 ANTENNA CONNECTOR

Connects the RF input/output of the transceiver. Mates with the standard PL-259 connector (supplied).

3.3.5 PA FAN CONNECTOR

Supplies DC power to optional PA fan kit.

3.3.6 GROUND STUD

Used for making a good RF ground to the transceiver.

3.3.7 RECEIVER/EXCITER FUSE

Protects the receiver and exciter portions of transceiver.

3.3.8 PA FUSE

Protects the RF power amplifier module.

3.4 OPERATOR INTERNAL CONTROLS

The transceiver is equipped with several internal controls as a convenience which the operator may wish to adjust. They are: function enable/disable switch, CW delay adjust, 600 ohm remote transmit audio input adjust and the 600 ohm receive audio output level adjust. See Figure 3.3 for the location of these controls.

3.4.1 FUNCTION ENABLE/DISABLE SWITCH

This switch (1A1A9-S1) consists of eight (8) co-located switches in one housing. Each section of the switch controls a different function. They are as follows (from right to left):

3.4.1.1 Memory Program Enable SW-1

To be able to program the transceiver memory, this switch must be ON. It may be switched off to prevent inadvertent reprogramming of the memory.

3.4.1.2 Manual Frequency Enable SW-2

NOTE

This switch functions only if wire jumper W1 on the logic board (Figure 5.31) is removed. Units are shipped with this jumper installed, unless specified by customer order.

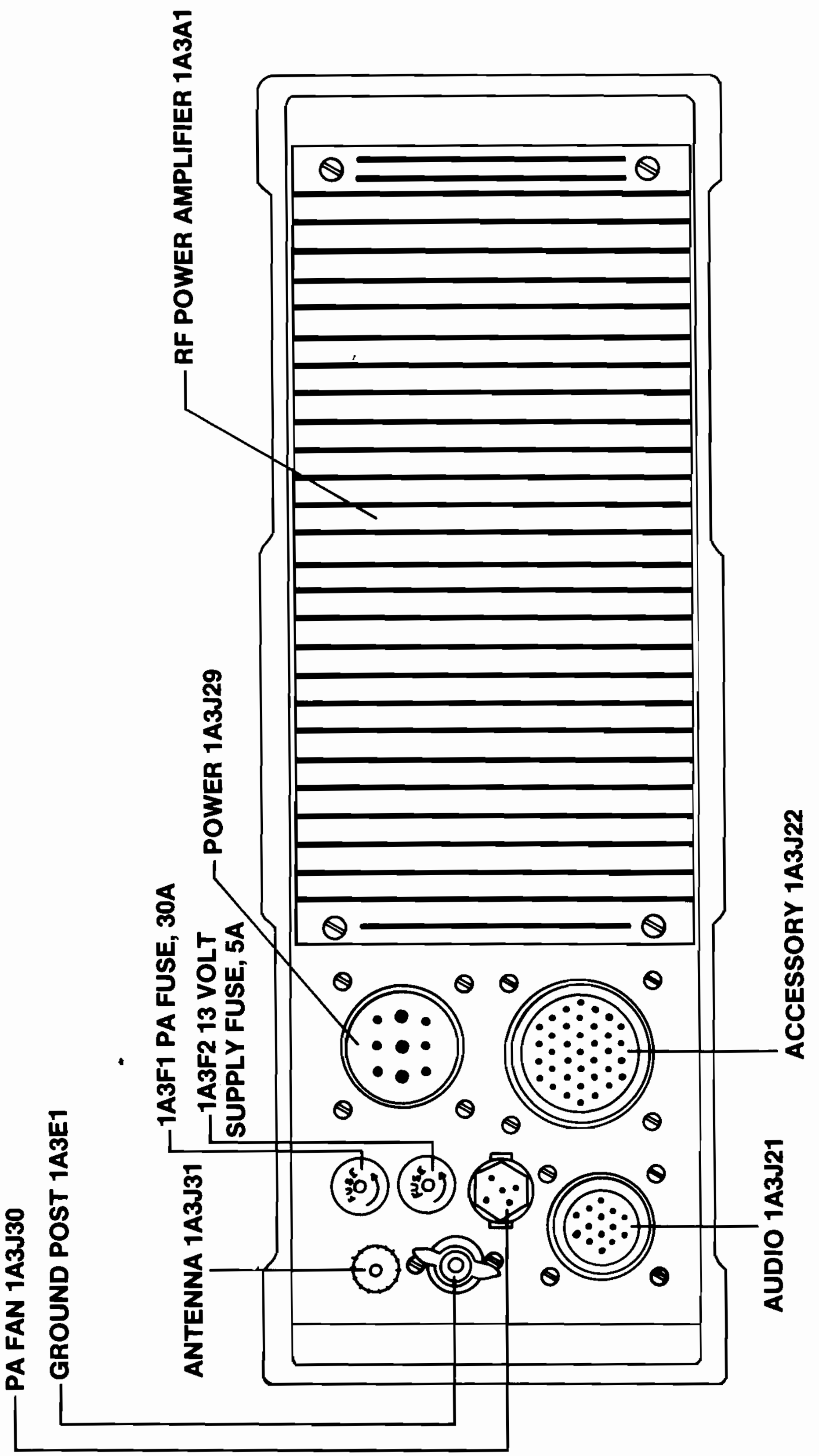


Figure 3.2 Rear Panel Components and Connectors

With the jumper removed, and switch S1-2 set to "OFF", the transceiver frequency and mode cannot be changed when the CHAN/FREQ switch is in the "FREQ" position. Setting the switch to "OFF" will freeze the frequency and mode to those last selected, except that the mode may change to A3A when the switch is thrown.

3.4.1.3 Tuning Beep Tone SW-3

The transceiver generates a beep tone in the speaker when the companion coupler is in the process of tuning. The volume of the tone may be regulated by the VOLUME control. The tone may be disabled by turning its switch OFF.

3.4.1.4 Surveillance Tune SW-4

The companion coupler contains the capability to continuously monitor the state of tune of the antenna over a small range and retune automatically when the VSWR exceeds 2:1. However, RF power must be present for this feature to work, so surveillance tune works best in AME or FSK modes where continuous carrier is present.

If a frequency or antenna VSWR change is made which is out of the surveillance tune range, the FAULT indicator will flash.

Surveillance tune is activated by turning the switch to ON position.

3.4.1.5 Auto-Tune SW-5

When enabled, the companion coupler will tune when a channel change or frequency change greater than 10 kHz is made in the transceiver. Tuning does not commence until the transceiver is keyed.

3.4.1.6 VSWR Retune SW-6

When this switch is closed a coupler tune will be initiated whenever the antenna coupler VSWR is greater than 2:1. When the companion linear amplifier is used, a coupler tune cycle will be initiated if amplifier or antenna coupler VSWR exceeds 2:1. (This feature is not available with the MSR 4020 Antenna Coupler.)

3.4.1.7 Switches 7 and 8

Spare switches not currently used.

3.4.2 CW DELAY ADJUST

This control (1A1A9-R8) adjusts the time delay between transmitting and receiving, when the transceiver is operated in the CW mode.

3.4.3 600 OHM REMOTE TRANSMIT AUDIO INPUT

This control (1A1A3-R1) adjusts the level of 600 ohm transmit audio that is applied to the transceiver from remote sources or optional equipment. Nominal audio input is 0 dBm.

3.4.4 600 OHM RECEIVE OUTPUT LEVEL

This control (1A1A7-R54) adjusts the level of 600 ohm receiver audio that can be supplied from the transceiver to remote sources or optional equipment. Nominal output is 0 dBm, adjustable to +10 dBm.

3.5 TRANSCEIVER OPERATION

3.5.1 OPERATING THE TRANSCEIVER WITH 50 OHM ANTENNA OR 50 OHM LOAD

a) Connect the transceiver to the proper DC power source.

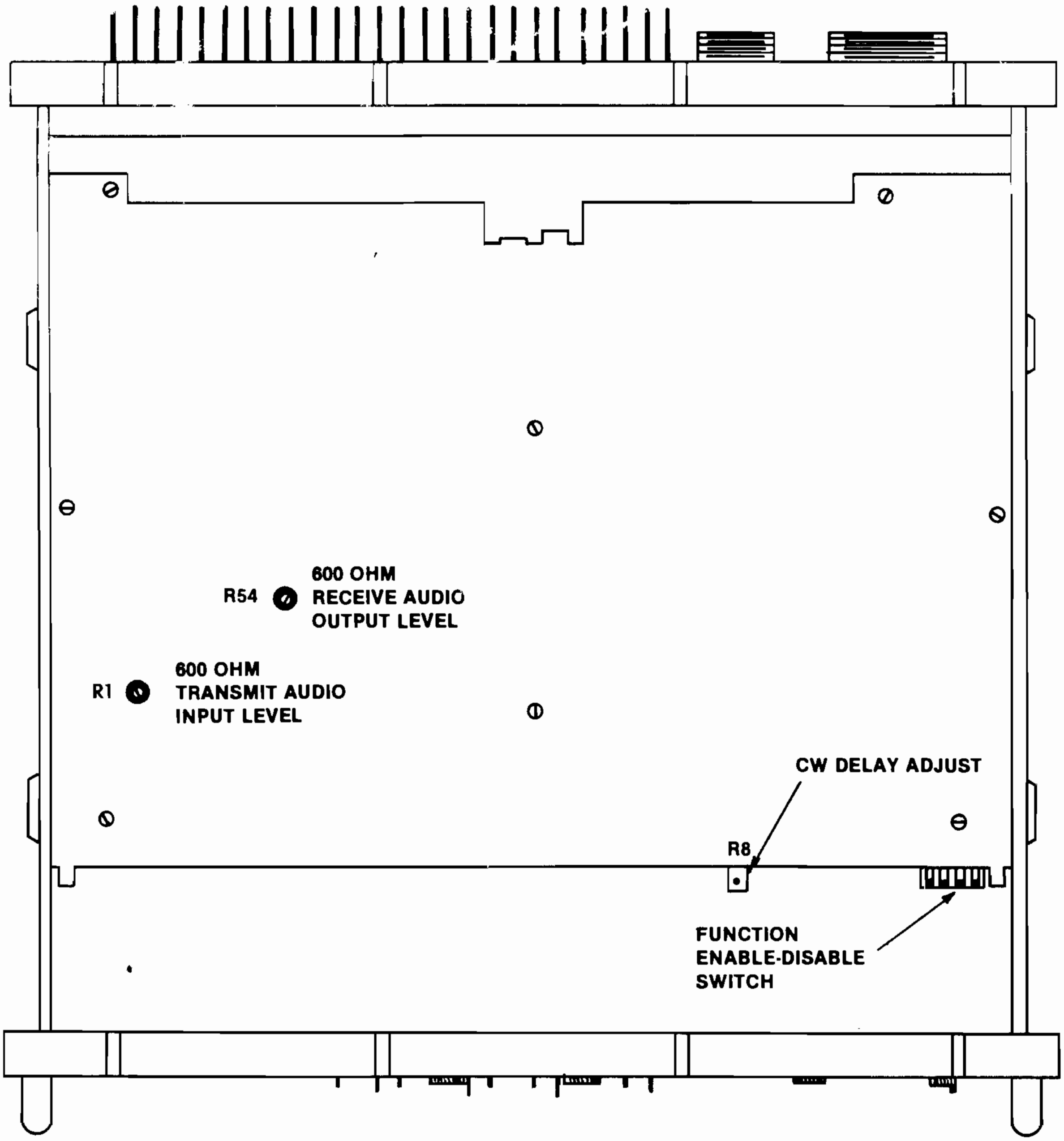


Figure 3.3 Internal Controls Locations

Check the voltage tag on the PA heatsink. Connect a 50 ohm antenna or a 50 ohm, 125W dummy load to the antenna connector.

NOTE

When the automatic antenna coupler is not used, the accessory plug, 1A3P22, which jumpers pin C (key interlock) to pin G (ground), must be installed in 1A3J22. The key interlock line (pin c) must be grounded for the transceiver to transmit.

b) Connect the microphone. Turn power switch to ON and advance VOLUME control to half rotation.

c) Put CHAN/FREQ control in FREQ position.

d) Set MODE switch to desired mode.

e) Turn SQUELCH control fully CCW.

f) Check that CLARIFIER control is pushed in.

g) Adjust DIM control to comfortable viewing level.

h) Use FREQUENCY SELECT switches to select desired operating frequency.

i) Set SPEAKER switch to ON.

j) The unit should now receive. The volume may be adjusted to a comfortable level.

k) The SQUELCH control may now be turned slowly clockwise to a position where background noise is squelched during periods when no signal is present. This is the point of minimum squelch threshold, and further clockwise adjustment beyond this point will require a stronger received signal to cause an audio output.

l) To transmit, press the microphone button and speak at a normal level with the microphone held 12 to 50 mm from the mouth (1/2 - 2 inches). The transceiver has an audio compressor which adjusts the transmit level automatically.

3.5.2 LOADING TRANSCEIVER MEMORY

a) Place the OPERATE/LOAD MEMORY switch in the LOAD MEMORY position. See that the LOAD MEMORY LED lights. If it does not, the PROGRAM ENABLE switch is off. Remove the top cover and switch PROGRAM ENABLE ON (See Figure 3.3).

NOTE

Before the memory is programmed for the first time, or if the battery has been removed from the logic board, the display may indicate 29.9999 MHz USB. This is the "DEFAULT" frequency and mode that is in the operating system prom to prevent invalid frequency or mode data from being displayed or transmitted.

c) Select the desired channel number with the CHAN/FREQ switch. Channels may be loaded in any sequence.

d) Select the desired mode with the MODE switch.

e) Select the desired frequency with the FREQUENCY SELECT switches.

NOTE

If different receive and transmit frequencies are to be loaded for half duplex operation, select the receive frequency first.

f) When loading a simplex frequency (same TX and RX frequency), push the RX button then the CHECK/TX button. (Do not push the buttons at the same time.)

NOTE

If the companion 1 kW amplifier and antenna coupler are connected, the antenna coupler power should be turned off prior to loading transmit frequencies. The CHECK/TX button has dual functions; in addition to loading frequency information, it also activates the silent tune feature of the MSR 4030 coupler. Refer to 3.5.6 for silent tune operation.

g) When loading the receive frequency of a half-duplex pair, push only the RX button.

h) To load the transmit frequency of the half duplex pair, select the transmit frequency, then push the CHECK/TX button.

NOTE

When loading different transmit and receive frequencies, as soon as the CHECK/TX button is released, the display will switch to the receive frequency. DO NOT press the CHECK/TX button again, as this will then load the receive frequency into the transmit memory. To check the transmit frequency, place the OPERATE/LOAD MEMORY switch in the OPERATE position, then push the CHECK/TX button. The transmit frequency will be displayed as long as the button is held.

i) Select a new channel with the CHAN/FREQ switch. Repeat steps c through g.

j) When all channels have been programmed, return OPERATE/LOAD MEMORY switch to OPERATE position. The unit is now ready for operation. Refer to Table 3.3 for a summary of load memory procedure.

3.5.3 OPERATING THE TRANSCEIVER WITH THE COMPANION COUPLER

a) Connect the transceiver to the proper DC power source. Check the voltage tag on the PA heatsink. Connect the control cable from the companion coupler to the transceiver accessory connector. Connect a coaxial cable from the companion coupler RF input to the transceiver's antenna connector.

b) Connect the antenna to the ceramic antenna post on the antenna coupler. See Sections 2.4 and 2.6.

c) Turn the power switch to ON.

d) Select the operating channel or the desired frequency and mode.

e) Note that the FAULT LED shows a steady indication.

f) Push the TUNE button. The FAULT LED will extinguish and the NOT TUNED LED will light. Note that the receive audio is muted during the tune cycle.

g) If the TUNING BEEP TONE switch is on (see Figure 3.3), note that the volume of the beep can be set with the VOLUME control.

h) When the companion coupler completes tuning, the NOT TUNED light will extinguish and the READY LED will light. The system is now ready for operaiton.

i) If the coupler cannot tune the antenna within 30 seconds, (because of a damaged antenna or a broken cable, for example), the FAULT indication will flash. The operator may start another tune cycle by pushing the TUNE button. If successive tune cycles produce a flashing FAULT indicator, the operator should attempt to find the cause of the problem before proceeding.

3.5.4 OPERATING THE TRANSCEIVER WITH THE COMPANION 1KW AMPLIFIER

1. Refer to Paragraph 3.4 "Amplifier Operation" in the Linear Amplifier Operation and Maintenance Manual, Publication No. 600241-823-001.

3.5.5 OPERATING THE TRANSCEIVER WITH THE COMPANION 1KW AMPLIFIER AND 1KW AUTOMATIC ANTENNA COUPLER

1. Refer to Paragraph 3.4.2 in the Linear Amplifier Operation and Maintenance Manual, Publication No. 600241-823-001, and Paragraph 3.2 in the 1KW Antenna Coupler Manual, Publication No. 600236-823-001.

3.5.6 SILENT TUNE MODE

When using with the 1kW Amplifier and Antenna Coupler in the silent tune mode, ten channels can be programmed on the "CHANNEL/FREQ" knob on the front panel of the transceiver. Everytime the antenna coupler is tuned in one of the ten channels, the tuning information is stored in memory within the coupler for that particular channel. To use the silent tune mode, pick a channel that has already been tuned and push the "CHECK TX" pushbutton which is located on the front panel. The coupler will automatically position the tuning elements from memory and the "READY" LED will come on. Because no RF carrier is used, the "TX" LED on the meter will not light and there will be no forward power during the tuning sequence in the silent tune mode. However, there may be a reflected power indication on the meter during tuning due to logic voltages.

3.6 MICROPHONE SELECTION AND AUDIO INPUT LEVELS

The MSR 8000D is configured for use with most microphone types. The handheld microphone (P/N 600352-713-001) is supplied with the radio. The H-250/U Handset (P/N 600002-386-001) is optional.

Carbon microphones such as the H-33 can also be used, but a configuration jumper located on the Transmit Modulator board, 1A1A3, must be moved. If microphones with more or less output than those specified or supplied by ITT are used, R-96 on the Transmit Modulator board can be adjusted for more or less gain (see Section 5.9).

For certain types of digital encoding equipment, audio compressors can create distortion. Jumper plug JP-2 on the Transmit Modulator board can be used to disable the compressor. If JP-2 is connected 1 to 2, the compressor will be disabled and the input audio level will have to be adjusted to produce 0.23-0.27 VPP at 1A1A3-TP1.

TABLE 3.3
LOAD MEMORY SUMMARY

	FOR SIMPLEX OPERATION
1.	Internal PROGRAM ENABLE switch must be ON.
2.	OPERATE/LOAD MEMORY switch to LOAD MEMORY position.
3.	Select channel number.
4.	Select mode.
5.	Select operating frequency.
6.	Push RX button.
7.	Push CHECK/TX button.
8.	Select new channel, etc.
9.	When all channels are programmed, return the OPERATE/LOAD MEMORY switch to the OPERATE position.

	FOR HALF-DUPLEX OPERATION (Different TX and RX Frequencies)
1.	PROGRAM ENABLE switch must be ON.
2.	OPERATE/LOAD MEMORY switch to LOAD MEMORY position.
3.	Select channel number.
4.	Select mode.
5.	Select RECEIVE frequency.
6.	Push RX button only.
7.	Select TRANSMIT frequency. (and mode if different from RECEIVE.
8.	Push CHECK/TX button one time only.
9.	Select new channel, etc.
10.	When all channels are programmed, return the OPERATE/LOAD MEMORY switch to the OPERATE position.

SECTION 4
FUNCTIONAL DESCRIPTIONS

4.1 GENERAL

The transceiver is a modularized state of the art HF communications transceiver. The information contained in this section describes the major functions of the transceiver. The discussions of the functional descriptions of the transceiver will be presented in sixteen parts. Each part will contain a discussion of the major functional elements of that part. For a detailed circuit description of a particular part, refer to Section 5 of this manual.

Figure 4.1 shows an overall block diagram of the transceiver. Refer to this diagram as the function of each section is described.

4.2 HALF OCTAVE FILTER BOARD, 1A1A2

This 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 (8) 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, over current, over voltage and over temperature.

The desired elliptical filter is selected automatically by relay control ground signals from the logic board, 1A1A9. In the transmit mode, these filters reduce the harmonic output to better than -50 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, 1A3A1

The all solid state power amplifier accepts the +13 dBm RF drive input from the mixer assembly, 1A1A5, 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, 1A1A4, in the receive mode.

Also contained on this board are circuits that sense PA over voltage, over current and over temperature. These voltages are fed to the half octave filter board, 1A1A2, which via feedback to the transmit modulator board, 1A1A3, controls overall transmitter gain and power output.

4.4 HIGH PASS FILTER BOARD, 1A1A4

This assembly performs part of the receive mode preselection and receive RF amplification. In the transmit mode, the output of the mixer board, 1A1A5, is filtered by this board. Contained on this assembly are eight (8) 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 logic board, 1A1A9. 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.

Additional circuitry located on this board provides analog voltages which are supplied to the transmit modulator board, 1A1A3, to more accurately establish the A3A carrier level on transmit.

4.5 HIGH LEVEL MIXER BOARD, 1A1A5

4.5.1 GENERAL

The High Level Mixer Board (Figure 5.23) is interchangeable with the Mixer Board, P/N 601075-536, previously used in the MSR 8000, MSR 5050, and MSR 6700. In RECEIVE mode, it 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 4.1 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 of +21 dBm, 50.53 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.

4.5.2 DETAILED DESCRIPTION

4.5.2.1 RX Control

With a TTL low at pins 15 and 16, Q8 saturates putting +9V on all RX functions.

4.5.2.2 RF Switch

CR1 is biased to conduction by the current through R1 with L1 and L2 providing a high impedance to the signal pth for RF signals. The resulting voltage across R1 biases CR2 off, isolating transmit circuits from the signal path. The input signals are thus conducted through C1, CR1, and C3 to the low pass filter.

4.5.2.3 Low Pass Filter

The low pass filter is a 7-element elliptical design (C4 through C8, L3 and L4) with a cut off frequency of 31 MHz. This filter attenuates out-of-band spurious signals in both receive and transmit.

4.5.2.4 First Mixer

Signals from the Low Pass Filter are applied to pin 1 of the first mixer, MX1, a high level double-balanced diode mixer. These signals (0-30 MHz) are modulted with +21 dBm LO signals (59.53 to 89.53 MHz) applied to pin 8 to produce a first IF of 59.53 MHz at pins 3 and 4.

4.5.2.5 Constant Resistance Network

The Constant Resistance Network provides a 50 ohm load to signals from the mixer at frequencies much greater than the IF frequency. R17 provides the 50 ohm load at high frequencies when C30 is short, and at low frequencies when L14 is short. C29 and L1 are series resonant at 59.53 MHz to couple the signal to the 90° hybrid network, maintaining a 50 ohm load at frequencies near the 59.53 MHz IF.

4.5.2.6 90° Hybrid/Filter Network

This circuit maintains a 50 ohm impedance by phasing equal mismatches from the two identical crystal filters FL1 and FL2 so that they cancel at the circuit input and add across R18 at an isolated port. T3 with C31 and C32 form a quadrature hybrid tuned broadly to 59.53 MHz at a 50 ohm impedance. This circuit splits inputs from L13 to equal outputs at L15 and L16 phased 90° apart. L15 and C33 match the 2.3k ohm filter impedance of FL1. L16 and C34 perform the same function for FL2. Matching back down to 50 ohms is accomplished by L19, C35 and L20, and C36. L17 and L18 are used to tune the residual capacitance across the filters to increase the ultimate rejection. A second 90° hybrid (T4, C37 and C38) adds the signals from each filter. The total loss through the whole hybrid/filter network is typically 3.5 dBm.

4.5.2.7 Bilateral Amplifier

The Bilateral Amplifier consists of receive (Q9) and transmit (Q10) amplifiers activated by a 9 volt RX or 9 volt TX control signal. These amplifiers switched into the signal path by CR5, CR9 or CR10, and CR7, allow reverse signal flow in transmit applications since all other circuits are inherently bilateral.

The amplifiers are feedback controlled to maintain a•50 ohm input/output impedance with gain controlled by feedback resistor impedances and the relatively low broadband collector output impedance of ance of 600 ohms.

In Receive, the signal flows through C38, CR5 (biased by R21 and R22 with R21 also serving as a feedback resistor. The gain is set to 18 dB by the ratio of the collector load of 600 ohms and the emitter resistor R23. L25 and C45 match the 600 ohm output to 50 ohms with the output routed through pin diode CR9. The bias through switches CR5 and CR9 produces an 8 volt drop across L21, R20 at the input and L30, R30 at the output which reverse biases transmit path pin diode switches CR7 and CR10. The maximum signal level for strong signals is limited by a delayed AGC (DAGC) signal from pins 39 and 40. The DAGC input (0 to 9 volts) biases shunt pin diodes CR4 and CR8 which attenuate the signal at Q9 input and output for a total of 40 dB at 0 volts DAGC. Bias current is limited by resistors R31 and R29. CR11 delays the output attenuation for optimum linearity. The DAGC circuit is necessary to maintain inband intermodulation rejection of 30 dB at high input signals. The DAGC attenuation varies from 1 dB at 8.3 volts to 40 dB at 0 volts.

in transmit, the circuit of Q10 is connected through CR7, CR10 by the bias produced through L24, L29 by the 9 volt TX signal. The circuit is identical to that of Q9 except for the values of R26 and R28 which produce a 16 dB gain.

4.5.2.8 Crystal Filter

A second crystal filter, F13 at 59.53 MHz is required to reject spurious responses due to the second conversion -especially the second IF image at 49.53 MHz. This filter, identical to FL1 and FL2, is matched to 50 ohms input and output by L31, L33 and C55, C56 with ultimate rejection improved by L32.

4.5.2.9 Second Mixer and 5 MHz Filter

The 59.53 first IF signal is converted to a second IF of 5 MHz by a second double-balanced diode mixer, MX2. The 5 MHz output signal is filtered by a 5 MHz low pass filter C62, C63, L36 to reject the 59.53 MHz IF feed through, the 54.53 MHz second LO, and other undesired mixer outputs.

4.5.2.10 First LO Amplifier

The first LO amplifier produces a +21 dBm signal at MX1 (pin 8), from 0 dBm board inputs from 59.53 to 89.53 MHz at pin 3. Q5 and Q6 are common gate FET's paralleled for a 50 ohm broadband input with a transconductance to produce a 6 dB gain into the 50 ohm load produced by T2. The FET's are self-biased to 10 mA by R16. L8, L9, and C20 form a 40 MHz high pass filter to reduce low frequency LO noise.

Q4 is a grounded emitter amplifier with 15 dB gain which produces the +21 dBm LO signal required by MX1. Q3 is a bias regulator which maintains the voltage drop across R14 (due to the current of Q4) constant by controlling the base current of Q4 through R15. L12 and C28 broadly tune the output for a relatively flat response from 59.53 to 89.53 MHz. Biased at 100 mA, the amplifier can produce a linear output of 250 milliwatts.

4.5.2.11 Second LO Amplifier

Q11 and Q12 are paralleled JFET's which produce a +10 dBm output at MX2, pin 8 from a 0 dBm, 54.53 MHz second LO input at board pin 41. The FET's are self-biased by R32 to 10 milliamperes. L35 and C12 match the 50 ohm level of MX2 to 1.2k ohms at the FET drain to produce a 10 dB gain. With a 9 volt input at board pin 37, Q13 produces an 8 volt bias across R32 which cuts the LO amplifier off, (cutoff voltage of Q11, Q12 is 6.5 volts maximum) which in turn cuts the mixer off and thus breaks the signal path. This is used as a noise blanker gate in the MSR 8000D and may be used as a transmit inhibit gate in transmit applications.

4.5.2.12 Transmit Amplifier

Q1 and Q2 are feedback controlled amplifiers which increase the level of signals from the first mixer, MX1 to +17 dBm outputs, 1.6 to 30 MHz at board pin 6. Signals from the mixer, MX1 are routed through the low pass filter (C4-C8, etc.) C3, CR2, C14, and C15 to the base of Q2. Q2 is biased for 2.9 volts at the base by R9, R10, and R11. R7 and R8 produce 30 milliamperes bias current, with R7 setting the gain and R9 controlling the input/output impedance of 50 ohms. C18 as well as L7 compensate the high frequency roll off. Q1 is the identical circuit with values changed to produce a capability of 160 milliwatts linear output. In addition, the base bias is altered to add CR3

4.6 IF FILTER BOARD, 1A1A6

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 logic board, 1A1A9. During the receive mode, the 5 MHz IF signal from the mixer board, 1A1A5, 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, 1A1A7, 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, 1A1A3, 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, 1A1A5.

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 recieve amplifier stage.

4.7 AUDIO/SQUELCH BOARD, 1A1A7

The audio/squelch board is used in the receive mode only. This board accepts the 5 MHz IF output from the IF filter board, 1A1A6, 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, but not simultaneous, 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, 1A3J24, and a low level output is applied to the speaker/driver board, 1A1A8, to provide the front panel speaker and headphones/handset audio.

Located on this board are an input IF amplifier, AGC detector and amplifier, AM/product detector, squelch amplifiers and gating circuitry. In the AME mode, AGC is carrier derived, in CW, SSB and FSK modes, AGC is derived from the detected audio. Fast attack fast decay is uded for AME and FSK signals, and fast attack slow decay is used for sideband and CW signals. AGC voltage to the IF filter board, 1A1A6, and delayed AGC voltage to the mixer board, 1A1A5, controls the receiver gain.

Other circuitry and functions, through this board, are side tone and mute functions. The rear panel audio (600 ohm) is unaffected by operation of the squelch control.

4.8 SPEAKER/DRIVER BOARD, 1A1A8

The speaker/driver board contains the four watt speaker amplifier, DC volume control circuit, tuning beep generator and channel number buffers.

Audio from the audio squelch board, 1A1A7, is applied to this board through an opto-coupler. The resistance of this opto-coupler and thus the output of the speaker/driver, U3 is a function of the setting of the volume control located on the front panel, 1A2.

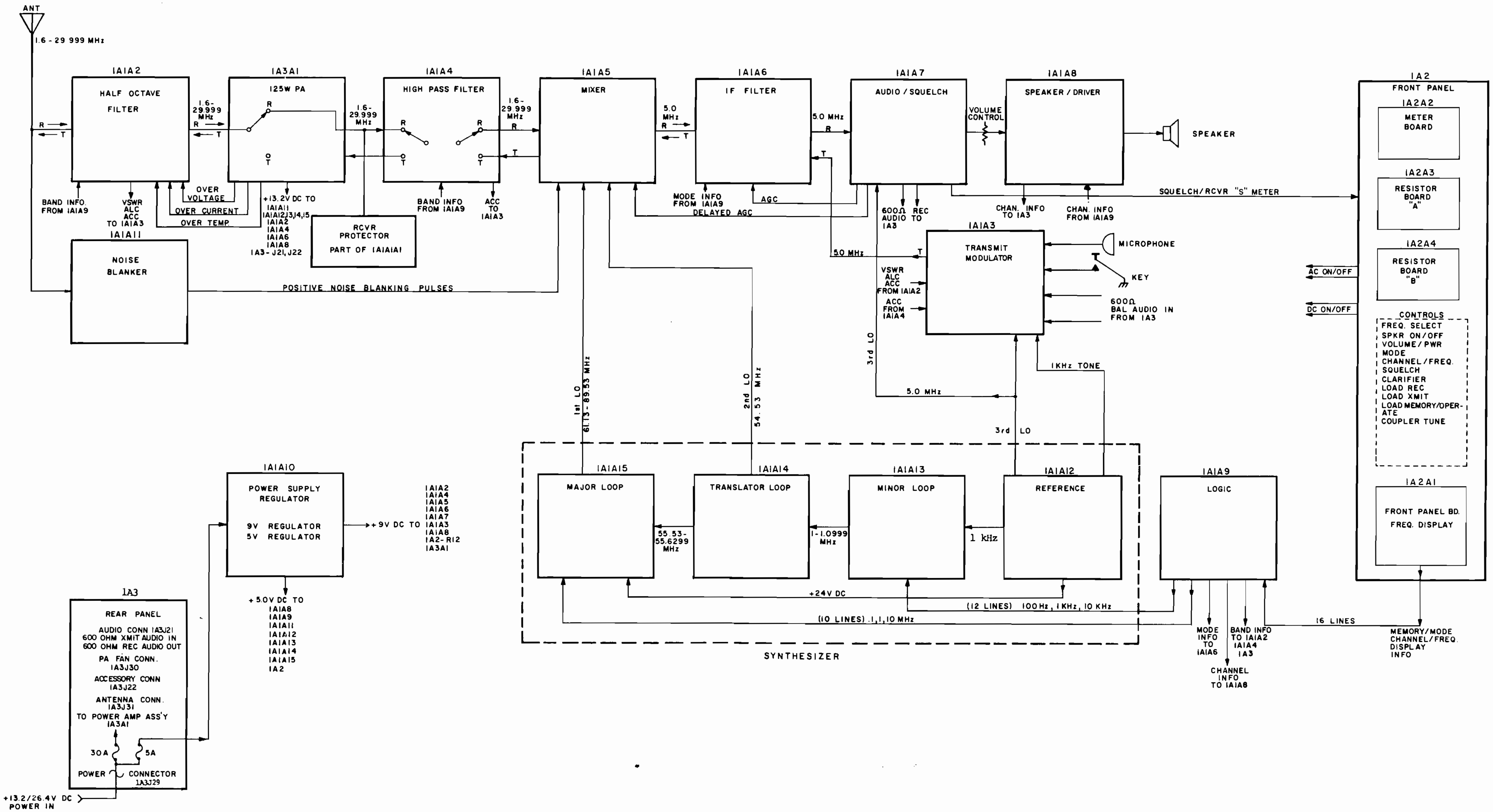


Figure 4.1 Transceiver Block Diagram

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, 1A2-LS1, the headphone jack, 1A2-J32, and the audio output pin of the microphone jack, 1A2-J34.

The beep tone, when enabled by the function ENABLE/DISABLE switch, 1A1A9-S1-3, causes a dual timer, U2, to generate 2 kHz "beeps", as the remote antenna coupler is operated. The amplitude of the beeps can be adjusted by the volume control.

The channel number buffers located on the board buffer the BCD channel number information from the logic board, 1A1A9, before it is routed to the rear panel accessory connector 1A3-J25.

4.9 TRANSMIT MODULATOR BOARD, 1A1A3

The transmit modulator board contains the speech compressor, balanced modulator, AME carrier insertion circuit, ALC amplifier and control, CW tone gate 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, are translated into a 5 MHz double sideband signal and then applied to the IF filter board, 1A1A6. 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, 1A1A3R1, is provided on the board to reduce the 600 ohm audio input level, if necessary, when audio levels from accessory or optional equipment exceeds the recommended 0 dBm audio input level.

The CW tone gate, U3, is an electronic switch which, in the CW mode, supplies a 1 kHz signal (supplied by the reference board, 1A1A12) to the balanced modulator, U2. This signal becomes the CW carrier, and is applied as the CW key is closed. A portion of the 1 kHz tone is applied to the audio/squelch board, 1A1A7, for sidetone.

4.10 LOGIC BOARD, 1A1A9

The logic board contains the microprocessor and supporting circuitry and supplies frequency, band, mode and channel information to other assemblies and/or optional equipment. This board receives input data from the front panel and/or rear panel accessory connector. This data is processed by the microprocessor, and then appropriate commands are applied to other boards in the radio for operation. In addition, ten channels of memory can be stored by U4. A low leakage lithium battery maintains memory power when operating power is not applied or is removed from the transceiver.

Also located on this board is the program ENABLE/DISABLE switch, S1. This eight section switch allows memory, beep tone, manual control mode of the transceiver and surveillance tune mode of the automatic antenna coupler to be enabled or inhibited.

4.11 FREQUENCY SYNTHESIZER, 1A1A12, 1A1A13, 1A1A14, 1A1A15

The frequency synthesizer consists of four subassemblies: reference board, 1A1A12, the minor loop board, 1A1A13, the translator loop board, 1A1A14 and the major loop board, 1A1A15. 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.

4.11.1 REFERENCE BOARD, 1A1A12

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, 1A1A3, to be used as a carrier generator on transmit, and to the audio/squelch board, 1A1A7, to be used as a product detector injection signal on receive. The 1 kHz is also supplied to the minor loop board, 1A1A13, 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, 1A1A15.

4.11.2 MINOR LOOP BOARD, 1A1A13

This assembly supplies the 1-1.0999 MHz signal to the translator loop board, 1A1A14, that determines the 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, 1A1A12, and 100 Hz, 1 kHz and 10 kHz data information from the logic board, 1A1A9.

4.11.3 TRANSLATOR LOOP BOARD, 1A1A14

The translator loop board provides the 54.53 MHz second LO, which is applied to the mixer board, 1A1A5. 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, 1A1A5. This board supplies to the major loop board, 1A1A15, a 55.53-55.6299 MHz signal. This signal is essentially a mixture of the low digit signal 1-1.0999 MHz, and the second LO (54.53 MHz including frequency error).

4.11.4 MAJOR LOOP BOARD, 1A1A15

The major loop board supplies the first LO signal (61.13-89.53 MHz) to the mixer board, 1A1A5. The first LO is a phase locked oscillator covering the frequency range of 61.1300 MHz to 89.5299 MHz, in 100 kHz steps. The exact frequency of the first LO is given by:

$$F1 = 61.1300 + Fd + e \text{ (MHz)}$$

where F1 = first LO frequency
Fd = dialed frequency
e = second LO error

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 55.53-55.6299 MHz signal from translator loop board, 1A1A14, a 50 kHz signal and +24 VDC from the reference board, 1A1A12, and 10 MHz, 1 MHz and 100 kHz data information from the logic board, 1A1A9.

4.12 NOISE BLANKER, 1A1A1

The noise blanker is a high gain noise pulse amplifier and detector which is used to gate off the second LO that is applied to the mixer board, 1A1A5, thus effectively blanking the receiver during periods of interferring noise pulses such as ignition noise, etc. The input of the amplifier is tuned to 35 MHz (above the transceiver operating frequency). Impulse noise occupies a wide bandwidth and can effectively be amplified and detected at this frequency. Using this frequency prevents saturation of the noise blanker by large signals in the 1.4 to 30 MHz band. The noise blanker input is connected to the output (ANT) of the half octave filter board, 1A1A2, and the output of the noise blanker is applied to the mixer board, 1A1A5.

4.13 POWER SUPPLY REGULATOR ASSEMBLY, 1A1A10

The power supply regulator assembly supplies two of the four regulated operating voltages for the transceiver. The two voltages provided by this assembly are +9 volts and +5 volts regulated DC. +12 or +24 VDC from the rear panel power connector, 1A3J30, is applied to the input. U1, and transistors Q1 and Q2 form a +5 volt high efficiency switching regulator. U2, and transistor Q3 form a +9 volt high efficiency regulator. The voltage output of the 5 and 9 volt regulators are adjustable.

The output of the 9 volt regulator is applied to the 1A1A2, 1A1A3, 1A1A4, 1A1A5, 1A1A6, 1A1A7, 1A1A8, 1A2 and 1A3 assemblies.

The output of the +5 volt regulator is applied to the 1A1A8, 1A1A9, 1A1A11, 1A1A12, 1A1A13, 1A1A14, 1A1A15 and 1A2 assemblies.

4.14 CHASSIS/MOTHER BOARD, 1A1A1A1

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 4.14.1.

4.14.1 RECEIVER PROTECTOR (PART OF 1A1A1A1)

The receiver protector consists of two pair of back-to-back connected reverse biased PIN diodes, referenced to +3 VDC and connected in parallel with the receiver input (receiver input to 1A1A4). Any RF voltages in excess of three volts peak will cause conduction of the PIN diodes, thereby protecting the receiver front end.

This type of circuit causes little, if any, received signal attenuation, and does not degrade the excellent receiver low IM distortion characteristics.

4.15 FRONT PANEL ASSEMBLY, 1A2

The front panel contains all switches and controls for transceiver operation. The microphone connector, 1A2J34, auxillary connector, 1A2J35, meter, speaker and antenna coupler tune initiate pushbutton switch are all located on the front panel. Part of the front panel assembly includes the front panel PC board assembly, 1A2A1, which contains the the frequency display and associated circuitry. The front panel is pluggable to the transceiver mother board via connectors 1A2A1-J28 and 1A2P17, and ribbon cable.

4.15.1 FRONT PANEL BOARD, 1A2A1

This board, which is part of the front panel assembly, contains the mode, channel, frequency display, display drives and decoders. This board is connected to the front panel via 1A2J27, and provides the display digit select signals to the front panel UP/DOWN toggle switches to generate the T0 and T1 commands used by the microprocessor on the logic board, 1A1A9, to change the transceiver frequency. Signals from the microprocessor are then applied to this board via 1A1A1A1-J18 for the correct display of channel, mode and frequency. Other circuitry on this board includes the dimmer control circuitry and logic gates, which in conjunction with the front panel switches, supply +5 VDC for operation of the mode switch.

4.16 REAR PANEL ASSEMBLY, 1A3

The rear panel assembly contains the power input, antenna, 600 ohm audio, and accessory connectors. The DC power contactor, power amplifier assembly, 1A3A1, and fuses are also located on the rear panel assembly. The rear panel is pluggable to the transceiver mother board via connectors P20, P24 and P25.

SECTION 5
MAINTENANCE

5.1 GENERAL

This section provides information for routine maintenance, repair and evaluation of the overall performance of the transceiver. Modular construction of the transceiver lends itself to a logical and straight forward troubleshootingting procedure. By referring to the overall and individual block diagrams, 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, 1A3A1, and front panel, 1A2, may be measured on the mother board, 1A1A1A1, at the appropriate connector or signal point.

After establishing the existence of a trouble in a particular assembly, refer to the servicing information for that assembly located elsewhere in this section of the manual.

Figure 5.1 locates the transceiver component assemblies and modules. Figure 5.2 shows the locations of the rear panel assemblies and components.

5.2 PC BOARD REPAIRS

5.2.1 REMOVAL AND REINSTALLATION

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

NOTE

DO NOT USE PLIERS OR SCREWDRIVERS TO REMOVE THE BOARDS.

When replacing boards into the PC sockets, insure that the board is in its proper position 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 boards during the replacement of components, extreme care should be used in soldering and component removal. A low wattage soldering iron (25-50 watts) with a narrow tip should be used.

A low wattage iron is necessary to prevent the application of excessive heat to the copper foil of the PC board. Excessive heat may cause the foil to separate from the board, rendering the board unrepairable. Only a high quality electronic grade rosin solder should be used in making repairs.

CAUTION

DO NOT USE AN ACID CORE SOLDER.

Due to the circuit density on the boards, solder "bridges" or short circuits between adjacent foil runs are possible, if care is not used

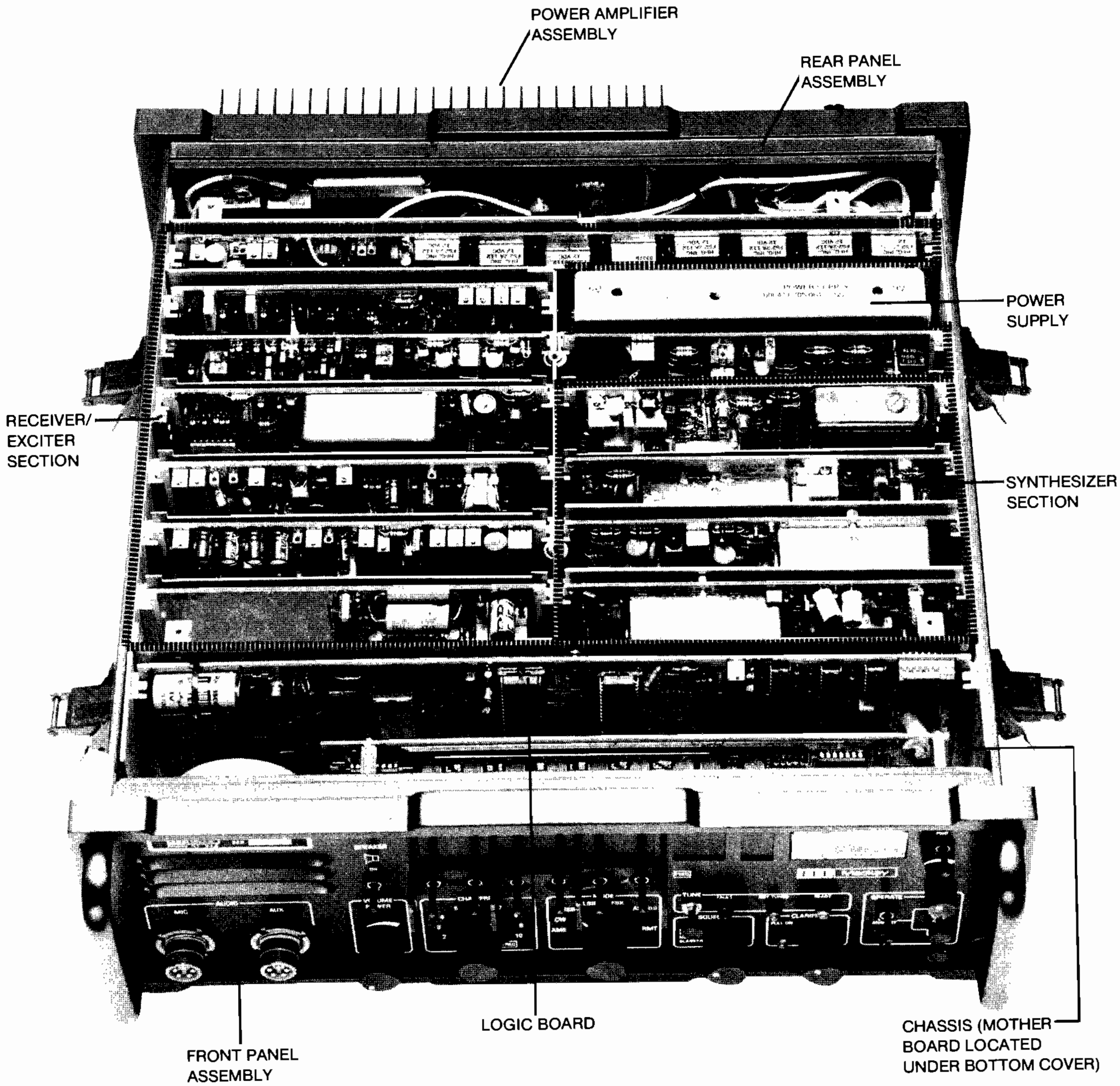


Figure 5.1 Transceiver Assemblies and Modules

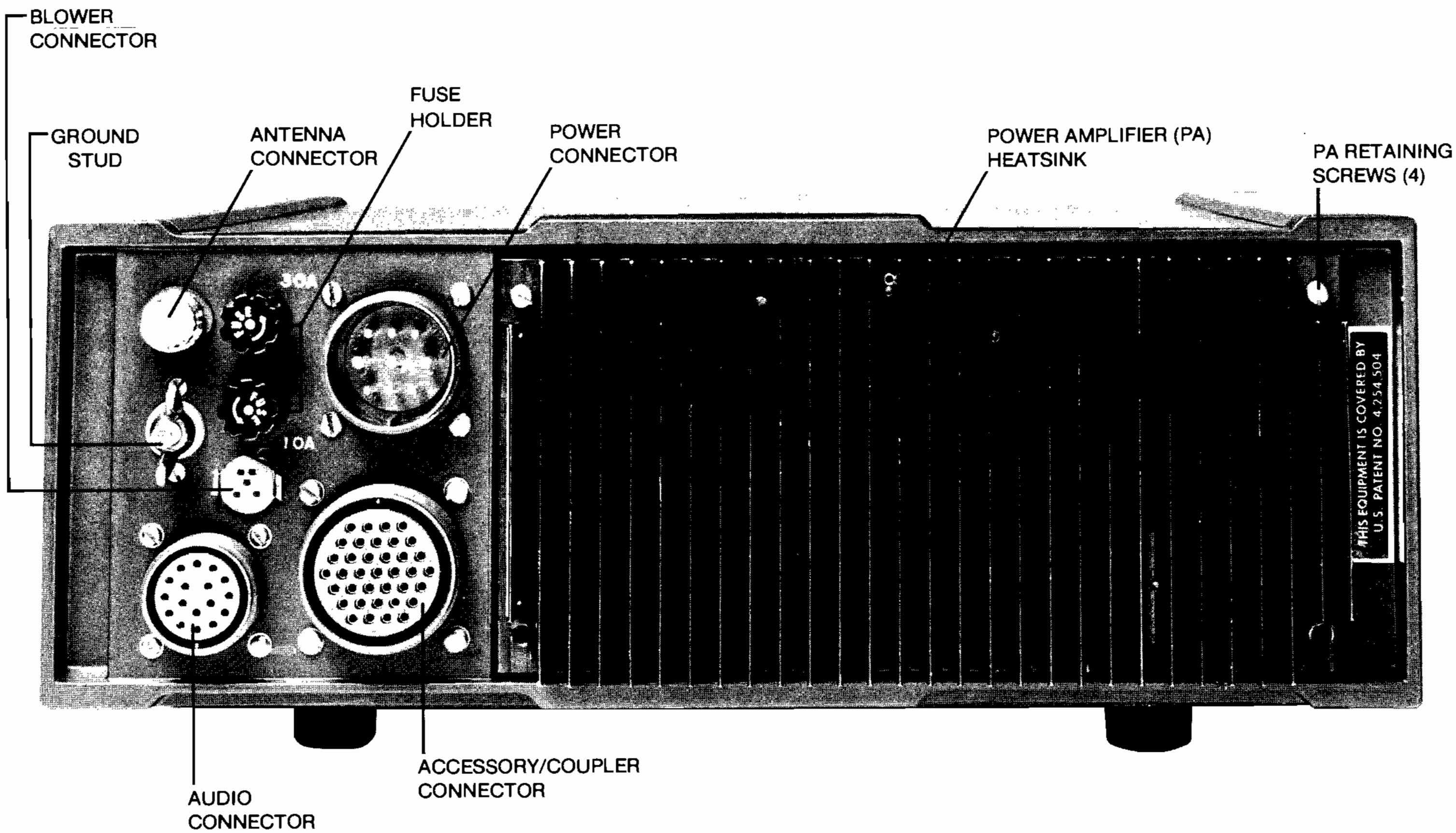


Figure 5.2 Rear Panel Assemblies and Components

during soldering operations. After soldering is completed, the area around the connection should be closely inspected for excess solder or "bridges" between adjacent runs or connections. Any "bridges" or excess solder between connections must be removed before reinstalling the board. Because of the double sided construction used on the PC boards, a component lead may be soldered to printed circuit areas on top and bottom of the board. Consequently, when a component lead is removed, the replacement component should be resoldered top and bottom as applicable.

5.2.3 CMOS DEVICE HANDLING PRECAUTIONS

CMOS devices maybe damaged by static voltages, and therefore the following is recommended:

a) All MOS devices should be placed on a grounded work bench surface, and the repair operator should be grounded prior to handling MOS devices, since a person can be statically charged with respect to the work bench surface.

b) Nylon clothing should not be worn while handling MOS circuit or devices.

c) Do not insert or remove MOS devices from sockets while power is applied.

d) When soldering MOS devices, insure the soldering iron used is a grounded type.

5.3 ASSEMBLY AND SUBASSEMBLY IDENTIFICATION

Table 5.5 and Figures 5.6 and 5.7 list and identify the assemblies and modules used in the transceiver. Figures 5.8 and 5.9 are interconnection/wiring diagrams for the transceiver. Schematics for each assembly and module, parts lists, and circuit descriptions are contained in this chapter of the manual.

5.4 COVER REMOVAL

To remove the top from the transceiver, unsnap the two fasteners on each side of the cover, and pull the cover away from the front and rear panel.

The top inner cover can be removed by first removing the eight (8) mounting screws that secure the inner cover to the chassis. See Figure 5.3.

5.5 TRANSCEIVER ALIGNMENT AND ADJUSTMENT

As all modules and assemblies of the transceiver are of high reliability, solid state design, adjustments and alignment is seldom, if ever, required. If a module or component replacement or performance indicates the need for adjustments or alignment, the following tables and procedures are provided.

Before performing adjustments, it is recommended that Section 4, Functional Description, and Figure 4.1, the block diagram be reviewed for a more complete understanding of the transceiver.

5.5.1 PRELIMINARY TO RECEIVE ADJUSTMENTS

(See Table 5.1 for recommended test equipment.)

Before performing adjustments on the transceiver:

a) Remove the transceiver key interlock by removing the accessory connector, plug 1A3-P22, from the rear panel. This removes the jumper between pins "C" and "G" (ground), thereby preventing the transceiver from being unintentionally keyed.

b) Connect an RF signal generator (HP 8640B or equal) to the antenna connector of the transceiver, 1A3-J31.

c) Set the generator frequency and output as listed in Table 5.2.

See Figures 5.1 and 5.4 for the locations of the modules and adjustments.

d) Audio output may be measured by an audio voltmeter (HP 400LR or equal) connected to the 600 ohm receiver output (1A3-J21, pins "A" and "J").

e) To make some of the adjustments on the assemblies, it is necessary to use an extender card (optional equipment, part number 601198-536-001).

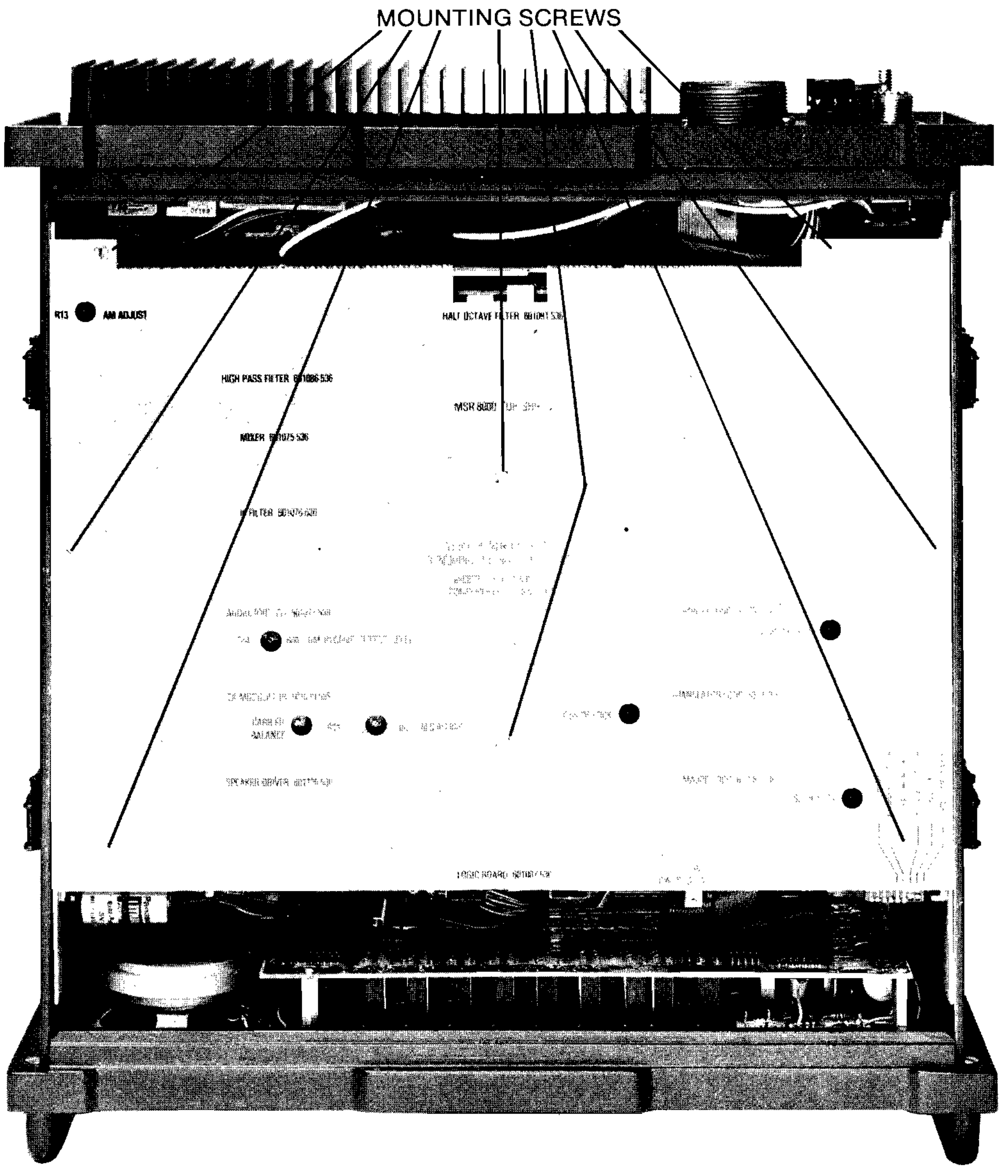


Figure 5.3 Inner Cover Mounting Screws

TABLE 5.1

RECOMMENDED TEST EQUIPMENT

RF Signal Generator:	Hewlett Packard Model 8640B
RF Volt Meter and Adapters:	Boonton Model 91C with 100:1 Divider
Spectrum Analyzer:	Hewlett Packard 141T System with IF Module and 0-110 MHz and 0-1.2 GHz RF Heads
Power Supply:	Hewlett Packard Model 6296
Oscilloscope:	Tektronix Model 465
Audio Oscillator:	Hewlett Packard Model 204D (2 Req'd)
Frequency Counter:	Hewlett Packard Model 5328A with high stability time base
50 Ohm Coaxial Resistor:	Bird Model 8322
RF Wattmeter:	Bird Model 43 with 50H and 250H elements
Volt Ohm Milliameter:	Simpson Model 260
Digital Volt Meter:	Beckman Model Tech 310
Distortion Analyzer:	Hewlett Packard Model 334A
Miscellaneous:	Assorted RF Cables, Adapters, Connectors and Power Cables Power Supply Module Extractor ITT PN 600270-618-001 PC Board Extender Cards (2 Req'd) ITT PN 601198-536-001

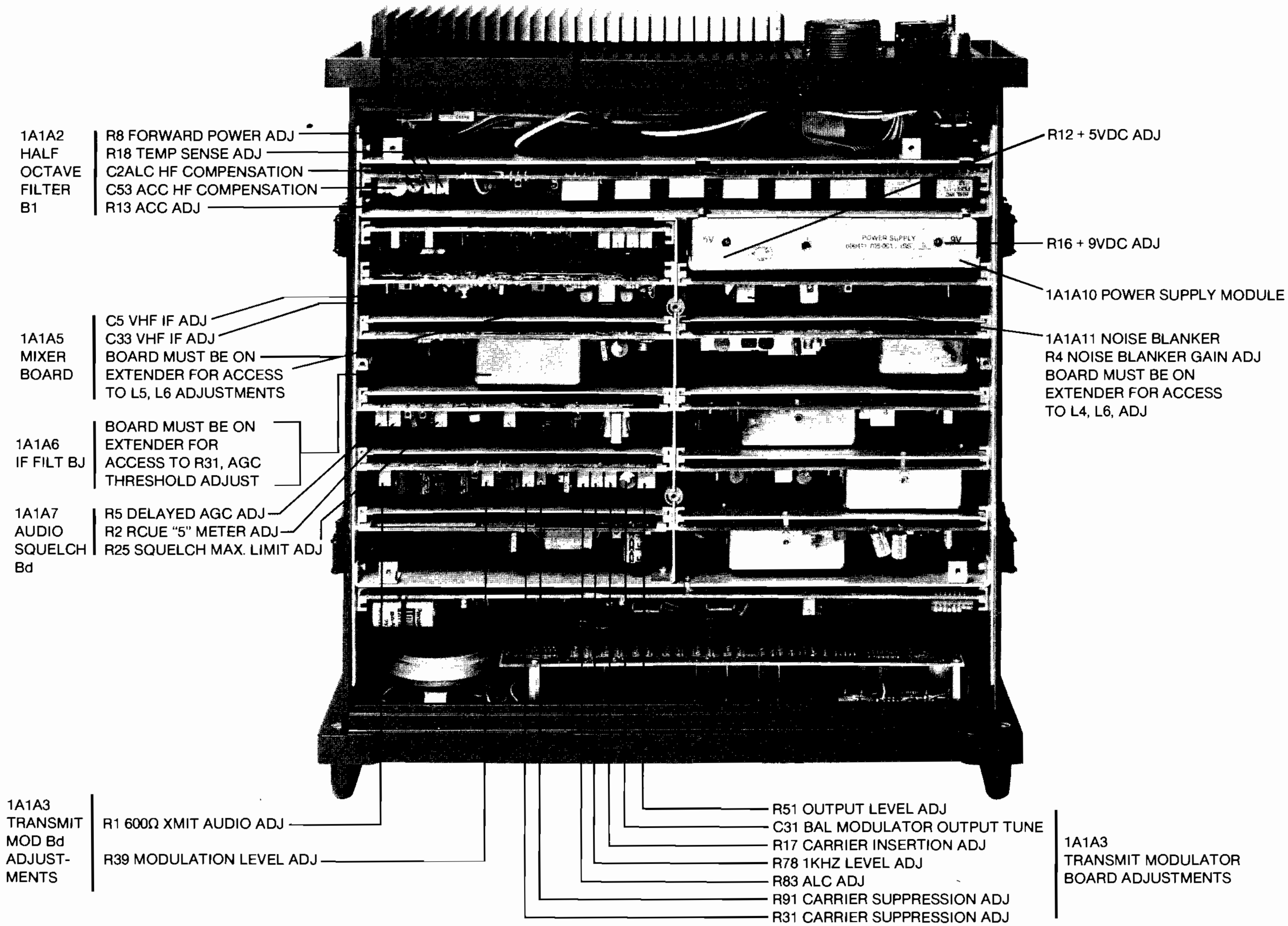


Figure 5.4 Adjustment Locations

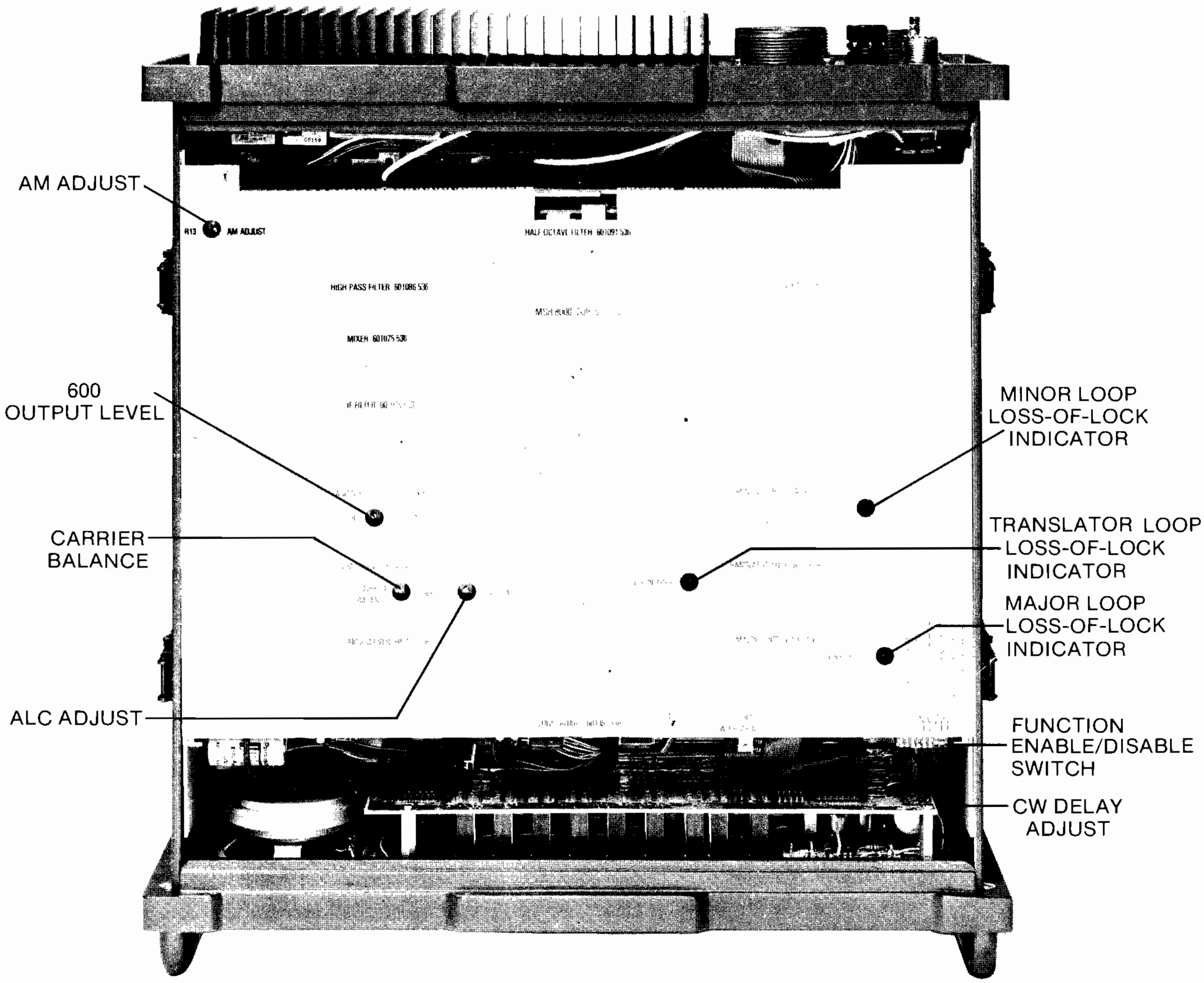


Figure 5.5 Loss-of-Lock LEDs and Other Adjustments

5.5.2 PRELIMINARY TO TRANSMIT ADJUSTMENTS

a) Reinstall accessory plug, 1A3-P22, on the transceiver rear panel.

b) Connect a 50 ohm, 200 watt resistive load to the transceiver antenna jack, 1A3-J31.

c) Connect an oscilloscope (minimum 30 MHz bandwidth) and an RF millivoltmeter/voltmeter across the 50 ohm load. A 100:1 resistive divider is recommended as RF voltages up to 90 VRMS may be present at the 50 ohm load.

TABLE 5.2
RECEIVE ADJUSTMENTS

ASSEMBLY	ADJUSTMENTS AND PERFORMANCE
1A1A10 Power Supply Regulator Board	R12-5 VDC Adj: Measure DC voltage at 1A1A1A1-J13, pin D, adjust for 5.0 VDC
	R16-9 VDC Adj: Measure DC voltage at 1A1A1-J13, pin B, adjust for 9.0 VDC
1A1A5 Mixer Board	L1, C33, C35, IF Out Adj: Frequency to 11.6 MHz mode to USB. Apply 0.5 μV RF, adjust for maximum audio output. Output should be better than 10 dB S+N+D/N+D.
1A1A7 Audio/Squelch Board	R5-Delay AGC Adj: Apply 100,000 μV RF in. Adjust for 1.3 VDC at TP-2.
	R2-Front Panel Meter Adj: With same RF in as above, adjust for meter indication of 80 dB.
	R25-Squelch Maximum Threshold Limit Adj: Front panel squelch control maximum clockwise apply 20 μV RF in. Adjust until squelch just "opens".
1A1A6 IF Filter Board	R31-AGC Threshold Adj: Apply 6.0 μV RF in. Adjust for slight indication of front panel "S" meter. (This adjustment should be made simultaneously with the 1A1A7 board adjustments.)
1A1A11 Noise Blanker	See 5.17.3.

TABLE 5.3
TRANSMIT ADJUSTMENTS AND ALIGNMENT

ASSEMBLY	ADJUSTMENTS AND PERFORMANCE
1A1A2 Half Octave Filter Board	R18-Temperature Sense Adj: Insure that PA heat sink temperature is at ambient (approximately 22°C, 70°F). Measure the DC voltage at TP-3. Adjust for 0.2 volts ±.05 volts. If Fan Option is connected, refer to Section 6.1.3.
1A1A3 Transmit Modulator Board	R39-Modulator Level Adj (USB Mode): Temporarily remove IF Filter board, 1A1A6. Apply 1 kHz audio to J34, pin E (MIC input) and pin A (GND), or via rear panel audio connector J21, pins E & F. Connect an oscilloscope (or an AC voltmeter) from TP1 to GND. Key transmitter. Slowly apply audio until audio compression starts to occur (audio output does not increase as audio input is increased). Adjust R39 for 0.25 vpp (0.088V RMS). **NOTE** Transmitter power adjustments should be made carefully to prevent damage to the RF power amplifier. Preliminary adjustments to set the high power limit (R51) should be made quickly. R51-Output Level Adj: Transmitter frequency to 26.6 MHz. Temporarily adjust R83 max. clockwise and R51 to counterclockwise position. Reinstall IF Filter board. Key transmitter. Adjust R51 clockwise until RF voltmeter (or RF wattmeter) indicates 85V RMS (144 watts) RF output. Adjust R83-ALC adjust counterclockwise until 79V (125 watts) RF is indicated. Unkey the transmitter. R83-ALC Adj: Change frequency to 2.6 MHz. Key transmitter (USB mode and 1 kHz audio input). Adjust R83 for 79V (125 watts) RF output. Unkey the transmitter.

TABLE 5.3
TRANSMIT ADJUSTMENTS AND ALIGNMENT
(continued)

ASSEMBLY	ADJUSTMENTS AND PERFORMANCE
1A1A2 Half Octave Filter Board	C2-ALC Compensation Adj: (This adjustment normally made in conjunction with adjustment of 1A1A3-R83 ALC adjust.) Set frequency to 29.999 MHz. Key transmitter and adjust for 79V (125 watts) RF output. Alternate between the adjustment of R83 on Transmit Modulator board and C2 on Half Octave Filter board until 79V RF (125 watts) output is indicated on 2.6 and 29.999 MHz.
1A1A3 Transmit Modulator Board	R78-1 kHz Level, CW Power Adjust: Frequency to 2.6 MHz, mode to CW. Temporarily remove IF Filter board 1A1A6. Key the transmitter. Measure the 1 kHz signal at TP1. With external 1 kHz audio input to transmitter, switch mode from CW to USB. Compare the voltage at TP1. In CW mode, adjust R78 for the same voltage at TP1 as in USB mode. Unkey transmitter. Reinstall IF board. Key transmitter. Compare CW power out to USB power out (with 1 kHz tone). The RF output should be nearly equal (± 1.2 volt or 2 watts). If CW power and USB power (with 1 kHz tone) differ more than ± 1/2 volt or 2 watts (with equal output @ TP1 in USB and CW mode), the value of R80 (normally 22k) can be increased or decreased in value until both outputs are equal. Increasing R80 increases the CW output, and decreasing the value of R80 decreases the CW power output relative to USB power. R80 values are typically 14k to 22k ohms.
1A1A2 Half Octave Filter Board	R8-Forward Power Adj: Frequency to 2.6 MHz, mode to CW. With front panel Tx power switch in "FWD" position, key the transceiver and adjust for a front panel meter reading of 1.2.

TABLE 5.3
TRANSMIT ADJUSTMENTS AND ALIGNMENT
(continued)

ASSEMBLY	ADJUSTMENTS AND PERFORMANCE
1A1A3 Transmit Modulator Board	R17-Carrier Insertion Adj: (Final) frequency to 11.600 MHz mode to AM. Apply 1.5 kHz modulation. Adjust audio input level from audio oscillator for 0.25 VPP at TP-1. Observe the modulated RF output on the scope. Adjust R17 for a 100% modulation pattern. Increase R17 clockwise until the modulation pattern indicates approximately 80% modulation. R92 & R31-Carrier suppression Adj: Frequency to 11.60 MHz, mode to USB. Key transmitter but do not apply input audio to transceiver. Adjust for minimum output on the RF voltmeter. (R92 once set will not normally require readjustment.
1A1A4 High Pass Filter Board	R46, 47, 48, and 49-A3A Carrier Adj: Select A3A mode and frequency 1.6 MHz. Observe output on the spectrum analyzer with a two tone audio input (0.25 vpp on 1A1A4 TP1). Adjust R49 on High Pass Filter board until the carrier is 16 dB below each tone. (CCW increases the carrier). In a similar manner, adjust R48 at 3.9 MHz, R47 at 13 MHz, and R46 at 20 MHz.
1A3A1 RF Power Amplifier Module	See 5.25.4.

TABLE 5.4
MSR 8000D TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSE
Receiver inoperative, display and and meter not illuminated.	1. DC Power (12 or 24V) from DC source not present. 2. DC Power Cable defective or not connected. 3. 13 Volt Supply Fuse 1A3F2 open. 4. Contactor 1A3K1 on rear panel not functional. 5. Cables 1A3P20 and/or 1A3J45 not plugged into Mother Board 1A1A1A1. 6. Defective Power Supply Regulator Module 1A1A10. 7. Defective Front Panel Volume Control Power Switch 1A2S15.
No audio or background noise at speaker or phones jack. Meter indicates an RF signal present.	1. Speaker Switch at "OFF" or defective. 2. Volume Control at "MIN" position. 3. Squelch Control at "MAX" fully clockwise position. 4. Defective Speaker Driver Board 1A1A8. 5. Defective Audio Squelch Board 1A1A7.
No audio or background noise in all modes, meter and display are illuminated.	1. Synthesizer "Loss of Lock" Light is indicating (see 2 below). 2. Defective Synthesizer Board 1A1A12, 1A1A13, 1A1A14, or 1A1A15. 3. Speaker switch at "OFF" or defective. 4. Volume Control at "MIN" position. 5. Squelch Control at "MAX" fully clockwise position. 6. Defective Speaker Driver Board 1A1A8. 7. Defective Audio Squelch Board 1A1A7. 8. Defective IF Filter Board 1A1A6.

TABLE 5.4
MSR 8000D TROUBLESHOOTING CHART
(continued)

SYMPTOM	PROBABLE CAUSE
AM Mode Normal, other modes inoperative.	1. 3rd L.O. injection absent at 1A1A7 Audio Squelch Board. 2. Synthesizer Reference Board 1A1A12 defective. 3. Defective Logic Board 1A1A9. 4. Defective Mode Switch 1A2S7.
Distorted audio at speaker.	1. Condition may be normal if transmitter of originating signal is defective. 2. Defective Speaker Driver Board 1A1A8. 3. Defective Audio Squelch Board 1A1A7.
Received signals weak in all modes. "S" meter indicates low.	1. Defective High Pass Filter Board 1A1A4. 2. Defective Mixer Board 1A1A5. 3. Defective IF Filter Board 1A1A6. 4. Defective Noise Blanker Board 1A1A11.
Transmitter will not key. Remains in receive.	1. Microphone Connector 1A2P34 improperly attached to Front Panel Microphone Input Connector 1A2J34. 2. Defective microphone or microphone cord.
Transmitter will not key, but transmit indicator is ON and received is muted (except in CW mode), when microphone button is depressed. Front panel "Fault" light is not ON.	1. Key Interlock Jumper from Pin "C" to "G" on accessory connector 1A3J22 is open. 2. Defective High Pass Filter Board 1A1A4. 3. Connector 1A3P20 not connected to 1A1A1A1J20 on the Mother Board. 4. Inoperative Relay 1A3A1K2 on PA Module.
Transmitter will key, but low or no RF output any mode. Fault Light is ON.	1. Defective PA Fuse 1A3F1. 2. Excessive Antenna VSWR. 3. PA over temperature or overcurrent condition.

TABLE 5.4
MSR 8000D TROUBLESHOOTING CHART
(continued)

SYMPTOM	PROBABLE CAUSE
	4. Defective Half Octave Filter Board 1A1A2. 5. Over-Current Adjustment 1A3A1 R16 on PA module improperly adjusted. 6. Defective PA Module 1A3A1.
Transmitter will key, but low or No RF output any mode. Fault Light is OFF.	1. Defective Transmit Modulator Board 1A1A3. 2. Defective IF Filter Board 1A1A6. 3. Defective Mixer Board 1A1A5. 4. Defective High Pass Filter Board 1A1A4. 5. Defective PA Module 1A3A1. 6. Defective Half Octave Filter Board 1A1A2. 7. Defective Synthesizer.
Transmitter keys; output in all modes except CW. Sidetone is heard in speaker.	1. Defective Transmit Modulator Board 1A1A3. 2. Defective Logic Board 1A1A9.
Transmitter keys; output in all modes except CW. No sidetone is heard in speaker.	1. Defective Reference Board 1A1A12. 2. Defective Transmit Modulator Board 1A1A3. 3. Defective Coaxial Cable on Mother Board 1A1A1A1 J6-25 to J9-30.
Transmitter keys; output in CW, carrier in AM, but no modulation in AM, LSB, or USB.	1. Defective microphone or microphone cord. 2. Defect in microphone circuit wiring on Front Panel Assembly 1A2 or harness from front panel P17, to Mother Board J17. 3. Defective Transmit Modulator Board 1A1A3.
Transmitter keys; output OK in CW, USB, LSB, but no carrier in AM.	1. Defective Transmit Modulator Board 1A1A3. 2. Defective Half Octave Filter Board 1A1A2. 3. Defective or improperly adjusted Reference Board 1A1A12.

TABLE 5.4
MSR 8000D TROUBLESHOOTING CHART
(continued)

SYMPTOM	PROBABLE CAUSE
AM carrier too high or too low.	1. 1A1A2 - R13, ACC Adjust on Half Octave Filter Board, and/or 1A1A2 - C53, ACC compensation adjust controls incorrectly adjusted.
AM carrier too high, cannot adjust.	1. Defective Half Octave Filter Board 1A1A2. 2. Defective Transmit Modulator Board 1A1A3.
LSB, USB and CW output too high or too low.	1. 1A1A3 - R83 ALC adjust on transmit Modulator Board 1A1A3, and/or 1A1A2 - C2, ALC compensation on Half Octave Filter Board, 1A1A2, improperly adjusted.
Improper carrier level in A3H Mode.	1. A3A adjust variable resistors 1A1A4 R46, R47, R48 and R49 on High Pass Filter Board 1A1A4 improperly adjusted. 2. Defective High Pass Filter Board 1A1A4.
Frequency display does not change when frequency select switches are operated.	1. Front panel "Channel/Freq" switch is not in "Freq" position. 2. Manual Freq Enable Switch 1A1A9-S1-2 located on Logic Board 1A1A9 is in the "OFF" position. (See Para. 3.4 in manual. 3. Front Panel Mode Switch is in the Remote position. 4. Defective Logic Board 1A1A9.
Unable to program or reprogram memory. Front panel memory light does not indicate.	1. Front Panel Memory/Load Switch not in "load" position. 2. Memory Program Enable Switch 1A1A9-S1-1 located on Logic Board 1A1A9 is in the "OFF" position. (See Para. 3.4 in manual.) 3. Defective Logic Board 1A1A9.

5.6 LOGIC INTERPRETATION

Several types of digital devices are used in the transceiver. 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, that is, the output voltage of each can be only in two permissible states. The two possible states are called logic "1" and logic "0". The assignment of voltage levels to these states is arbitrary. However, in this manual positive logic is standardized, which means we define the logic states as shown below.

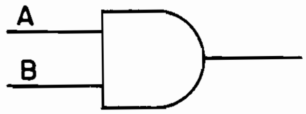
LOGIC STATES

	TTL	CMOS
LOGIC 1: Normally greater than	2.0 Volts	7.0 Volts
LOGIC 0: Normally less than	0.8 Volts	3.0 Volts

5.6.1 GATES

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

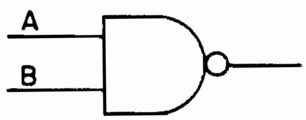
AND GATE



INPUTS		OUTPUT
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 will be 0. For the output to be 1, all inputs must be 1.

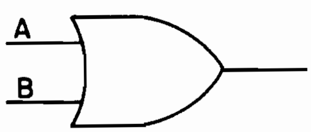
NAND GATE



INPUTS		OUTPUT
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 input is 0, the output will be 1.

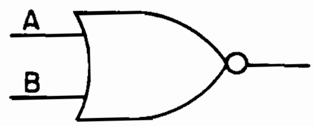
OR GATE



INPUTS		OUTPUT
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.

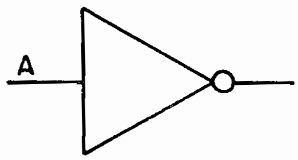
NOR GATE



INPUTS A	INPUTS B	OUTPUT
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.

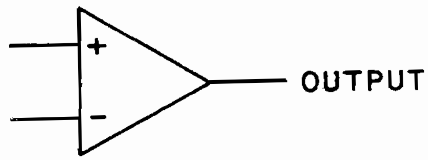
5.6.2 INVERTER



INPUT	OUTPUT
0	1
1	0

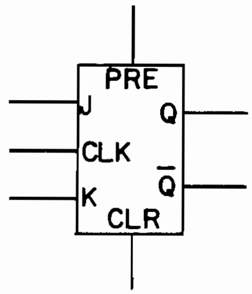
The inverter has a single input. The output level is the opposite of the input level.

5.6.3 VOLTAGE COMPARATOR



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

5.6.4 J-K FLIP-FLOP



The flip-flop 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 (flip-flop) 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. It can be changed by means of the clock input, or by the PRESET and CLEAR 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 inputs are high, the FF toggles (changes state) on each applied clock pulse.

The PRESET and CLEAR inputs operate independently of the clock. A high level input to the PRESET line drives the FF to a level 1, while a high input to the CLEAR line drives the FF to a level 0. Some circuits PRESET or CLEAR with a low level input instead of a high level. This is indicated by a "circle" at the appropriate input terminal.

5.6.5 MICROPROCESSOR

The microprocessor is basically a small computer contained within an integrated circuit. This is a device that can store, retrieve, and process data. They are manufactured in many different configurations. The microprocessor, used in this transceiver, contains an 8 bit central processor unit, a 64 byte on chip RAM, 27 input/output lines, and an internal clock. It is configured in a 40 pin dual in line package.

5.6.6 INPUT/OUTPUT PORT
(8 BIT LATCH)

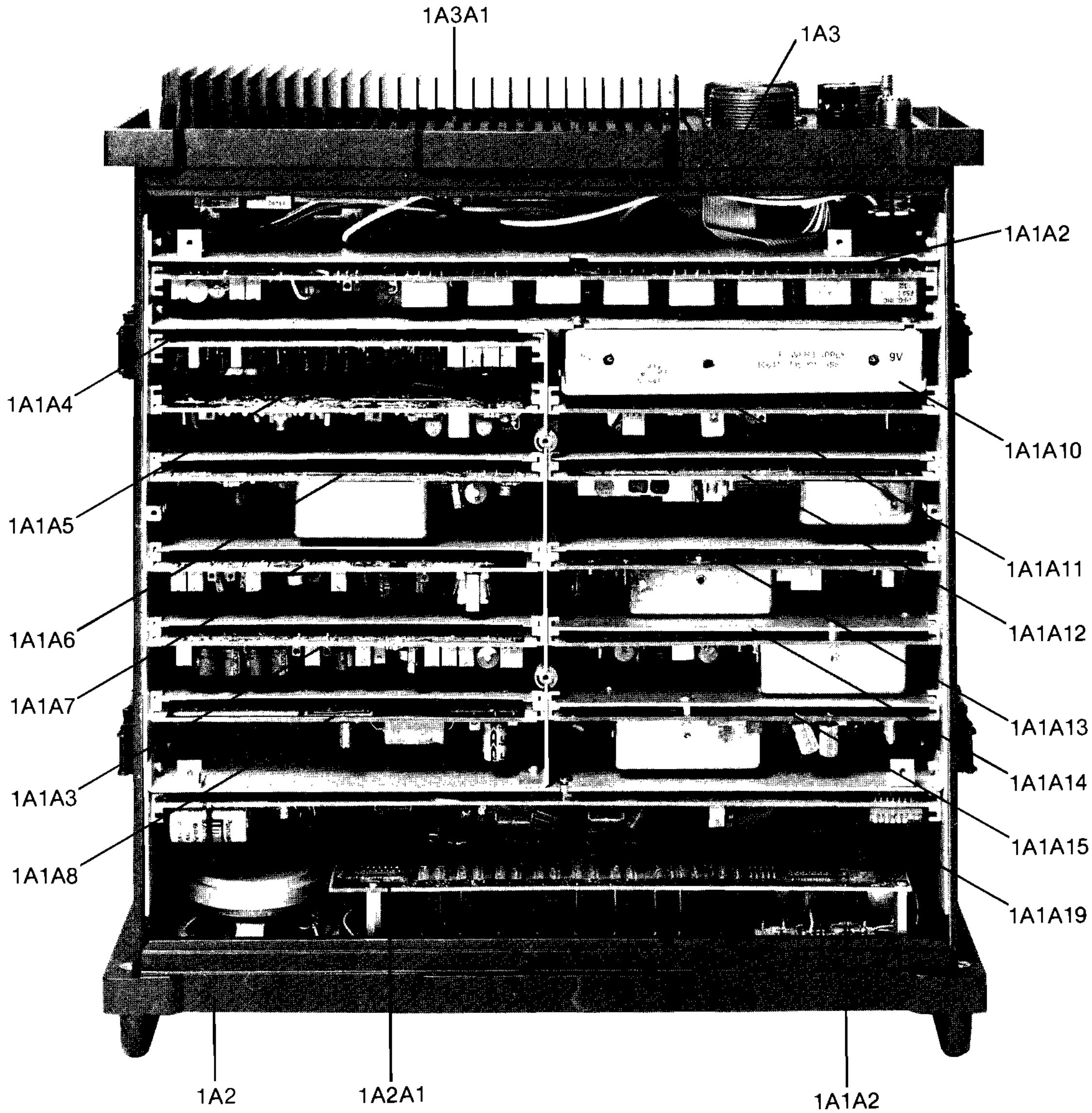
The input/output port is an interface device for use with a microprocessor. It contains, within one package, a large number of gates, buffers, and flip-flops. They are manufactured in many different configurations. The in/out port used in this transceiver is configured in a 24 pin dual in line package.

5.6.7 RAM

Random access memories are logic elements that can be reprogrammed over again many times, and the information stored, can be retrieved by utilizing read/write, and address inputs. A 1024 bit CMOS RAM is used in the transceiver memory system for reliability and low power consumption. It is configured in a 22 pin dual in line package.

5.6.8 INPUT/OUTPUT EXPANDER

The input/output expander is an interface device for use with a microprocessor. The function of which is to increase the permissible number of inputs and outputs to the microprocessor. It contains within one package, a large number of buffers, latches, decoders, and other logic circuitry. Two I/O expanders are used in the transceiver. They are configured in 24 pin dual in line packages.



Fiaure 5.6 Top View and Assemblies

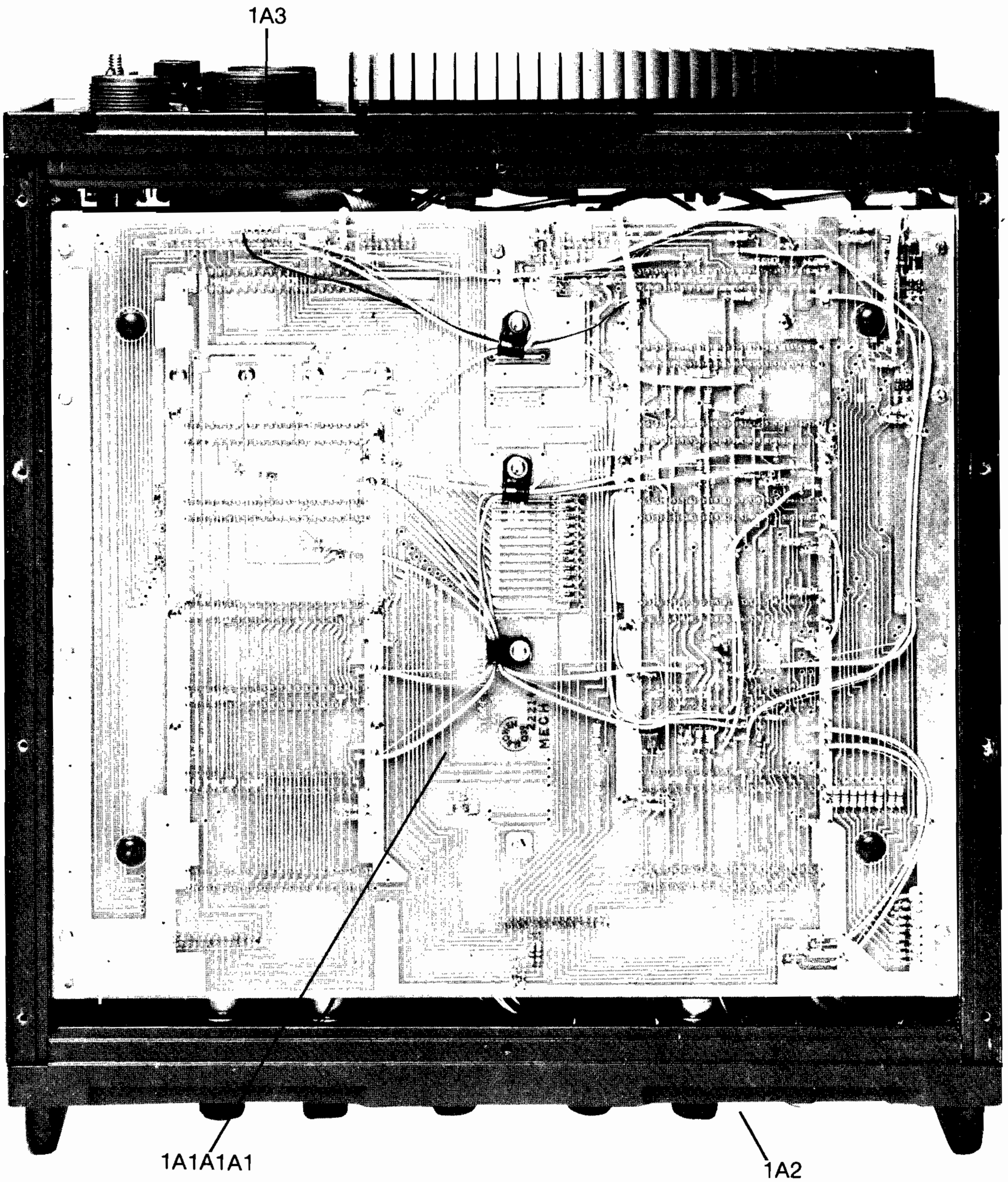


Figure 5.7 Bottom View with Cover and Shield Removed

TABLE 5.5
TRANSCEIVER ASSEMBLIES

DESIGNATOR ASSEMBLY	DESIGNATOR SUBASSEMBLY	DESCRIPTION	PART NUMBER	REV.
1A1		Receiver/Exciter Assembly	690022-001-001	
	1A1A1	Chassis Assembly	600410-705-001	
	1A1A1A1	Mother Board Assembly	601084-536-001	G
	1A1A2	Half Octave Filter PC Board Assembly	601091-536-001	G
	1A1A3	Transmit Modulator PC Board Assembly	601078-536-002	G
	1A1A4	High Pass Filter PC Board Assembly	601086-536-001	F
	1A1A5	High Level Mixer Board Assembly	601258-536-001	C
	1A1A6	IF/Filter PC Board Assembly	601076-536-001	F
	1A1A7	Audio/Squelch PC Board Assembly	601077-536-002	J
	1A1A8	Speaker/Driver PC Board Assembly	601120-536-001	D
	1A1A9	Logic PC Board Assembly	601087-536-002	G
	1A1A10	Power Supply Assembly	600411-705-001	F
	1A1A10A1	Switching Power Supply PC Board Assembly	601085-536-001	F
	1A1A11	Noise Blanker PC Board Assembly	601079-536-001	C
	1A1A12	Reference PC Board Assembly	601080-536-001	E
	1A1A13	Minor Loop PC Board Assembly	601082-536-001	E
	1A1A14	Translator Loop PC Beard Assembly	601083-536-001	F
	1A1A15	Major Loop PC Board Assembly	601081-536-001	E
1A2		Front Panel Assembly	601089-539-001	
	1A2A1	Front Panel PC Board Assembly	601089-536-001	E
	1A2A2	Meter Mounting PC Board Assembly	601121-536-002	C
	1A2A3	Resistor PC Board "A" Assembly	601139-536-002	C
	1A2A4	Resistor PC Board "B" Assembly	601140-536-001	A
1A3		Rear Panel Assembly	600080-539-001	
	1A3A1	Power Amplifier Assembly, 24V	600407-705-001	D
	1A3A1	Power Amplifier Assembly, 12V	600407-705-002	D
	1A3A1A1	Power Amplifier PC Board Assembly, 24V	601192-536-001	D
	1A3A1A1	Power Amplifier PC Board Assembly, 12V	601192-536-002	D
	1A3A2	Rear Panel Connector Board Assembly	602011-536-001	A
1A4		Bottom Cover Assembly, Gray	600667-612-001	
		Bottom Cover Assembly, Olive Drab	600667-612-002	
1A5		Top Cover Assembly, Gray	600062-539-001	
		Top Cover Assembly, Olive Drab	600062-539-002	

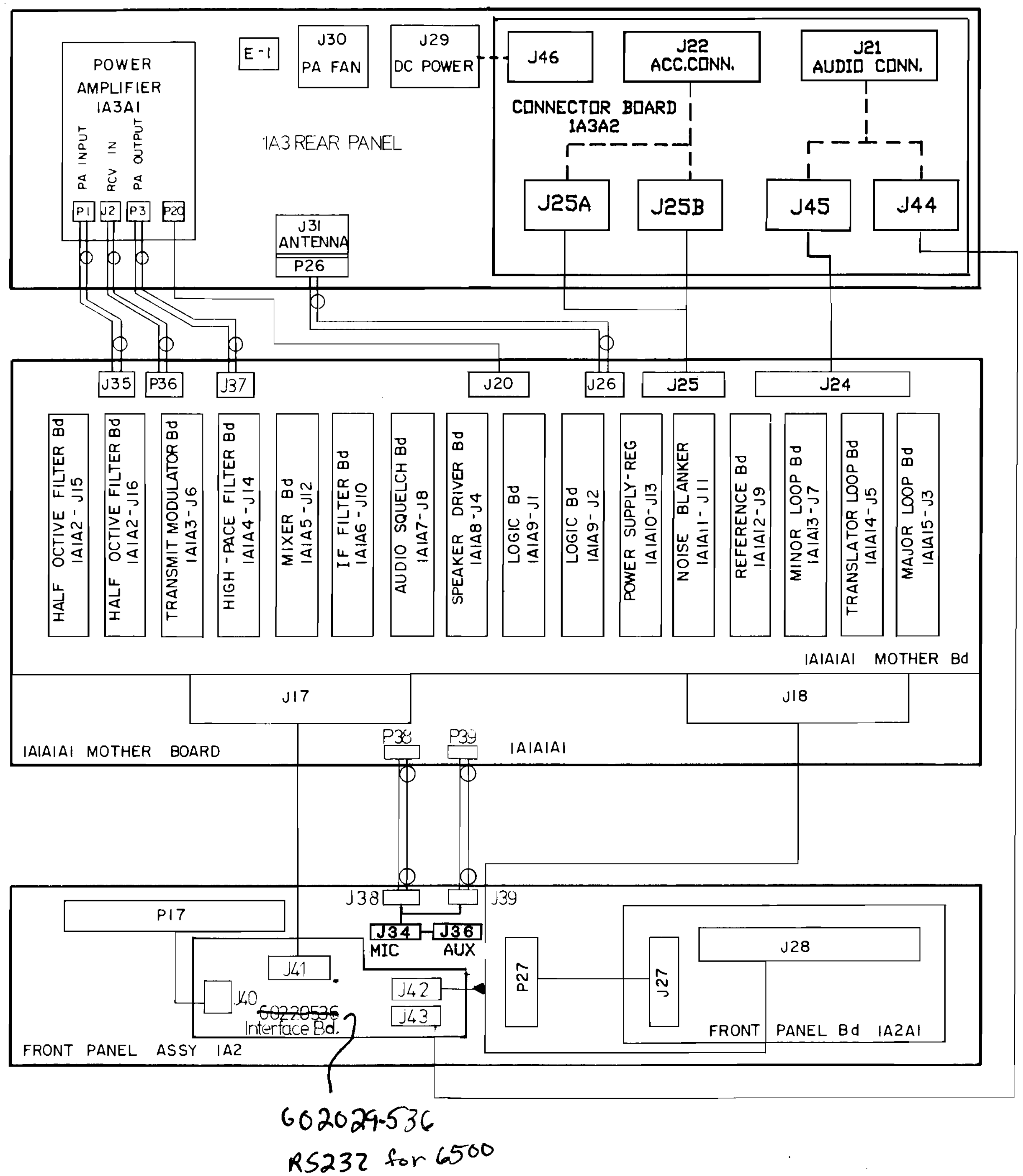


Figure 5.8 Transceiver Simplified Wiring Diagram With Full Function Remote Control

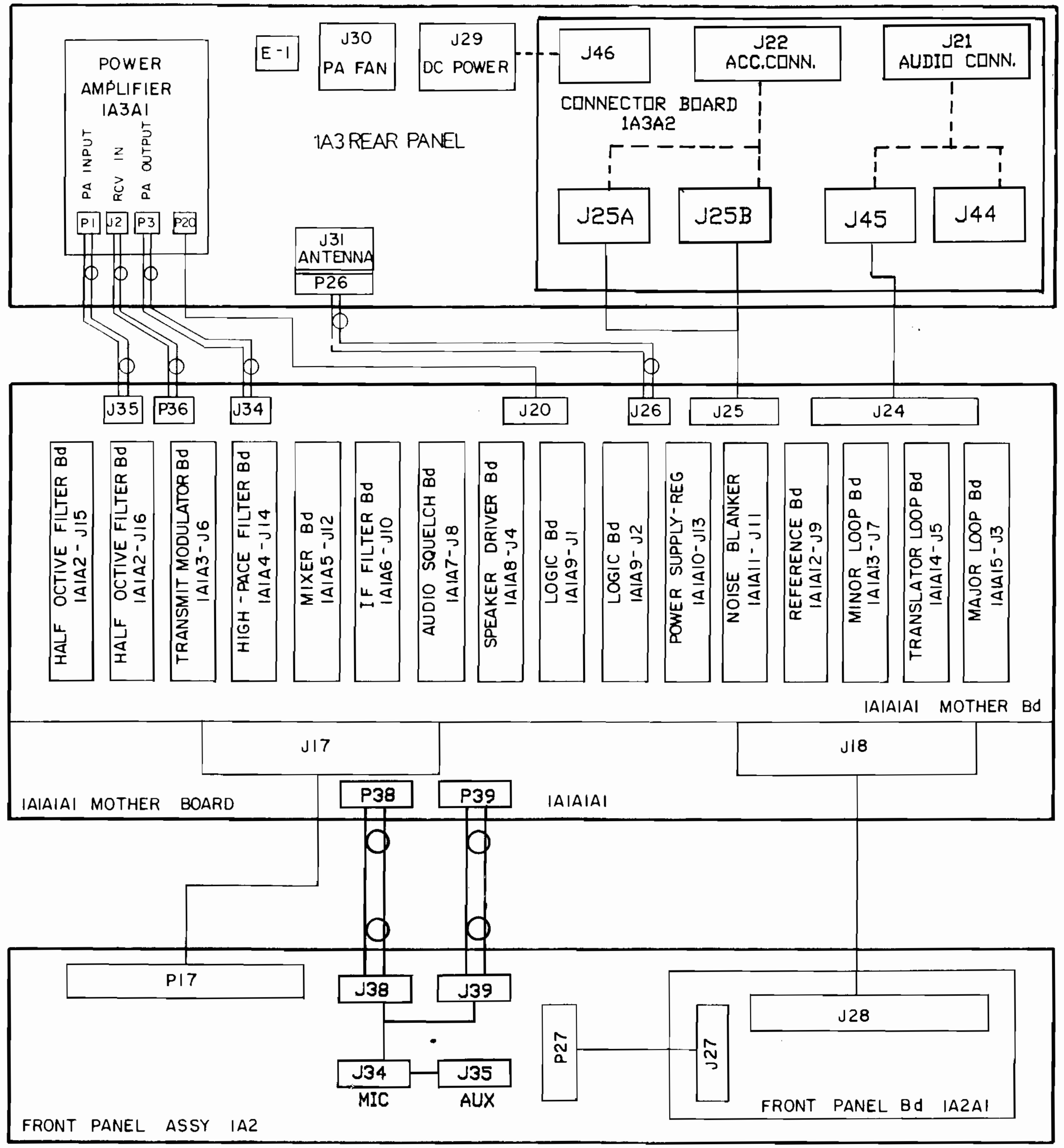


Figure 5.9 Transceiver Simplified Wiring Diagram Without Full Function Remote Control

5.7 MOTHER BOARD, 1A1A1A1

This board, Figures 5.10, 5.11, 5.12, 5.13 and 5.14, is the electrical main frame of the transceiver. All subassemblies in the transceiver, with the exception of the meter board, 1A2A2, and resistor boards A and B, 1A2A3 and 1A2A4, are electrically connected to the mother board. A total of 24 connectors interface the subassemblies to the mother board. All connectors are of the positive locking quick disconnect type, thus assuring fast and efficient module service or replacement. All electrical components (excluding connectors and filter capacitor C52, are located on the bottom side of the board for easy access.

5.7.1 RECEIVER PROTECTOR

This circuitry, Figure 5.10, located on the mother board, serves to protect the receiver input from excessive RF voltages. Refer to the mother board schematic, Figure 5.11. The receiver protector consists of pin diodes CR1, CR2, CR3, and CR4, 6.2V zener diode CR5, resistors R1 thru R4 and inductor L23. Receiver input signals are applied to the high pass filter board, 1A1A4-J14, pin 42. Connected in parallel with this input via R4, are diodes CR1 and CR2, and in parallel reverse are diodes CR3 and CR4. Diodes CR3 and CR4 are in series with zener diode CR5, which establishes the cathodes of CR3 and CR4 at +6.2 VDC. Resistors R2 and R3 form a voltage divider which, via inductor L23, references the anodes of CR3 and CR4, and the cathodes of CR1 and CR2 to +3.1 VDC. Thus all four pin diodes are reverse biased at a potential of +3.1 volts. The RF input voltage amplitude to the high pass filter is therefore limited to 3.1 volts maximum negative or positive. If this amplitude is exceeded, diodes CR1 and CR2 or CR3 and CR4 will conduct, thereby protecting the receiver front end.

5.7.2 MOTHER BOARD ACCESS AND REMOVAL

All components on the mother board, except connectors and filter capacitor C52, are located on the bottom side of the board, thereby providing complete access to these components, by removal of the transceiver bottom cover and mother board bottom shield. Removal of the mother board assembly, 1A1A1A1, should rarely be necessary. If the need for mother board removal should occur, the mother board can easily and quickly be removed as follows:

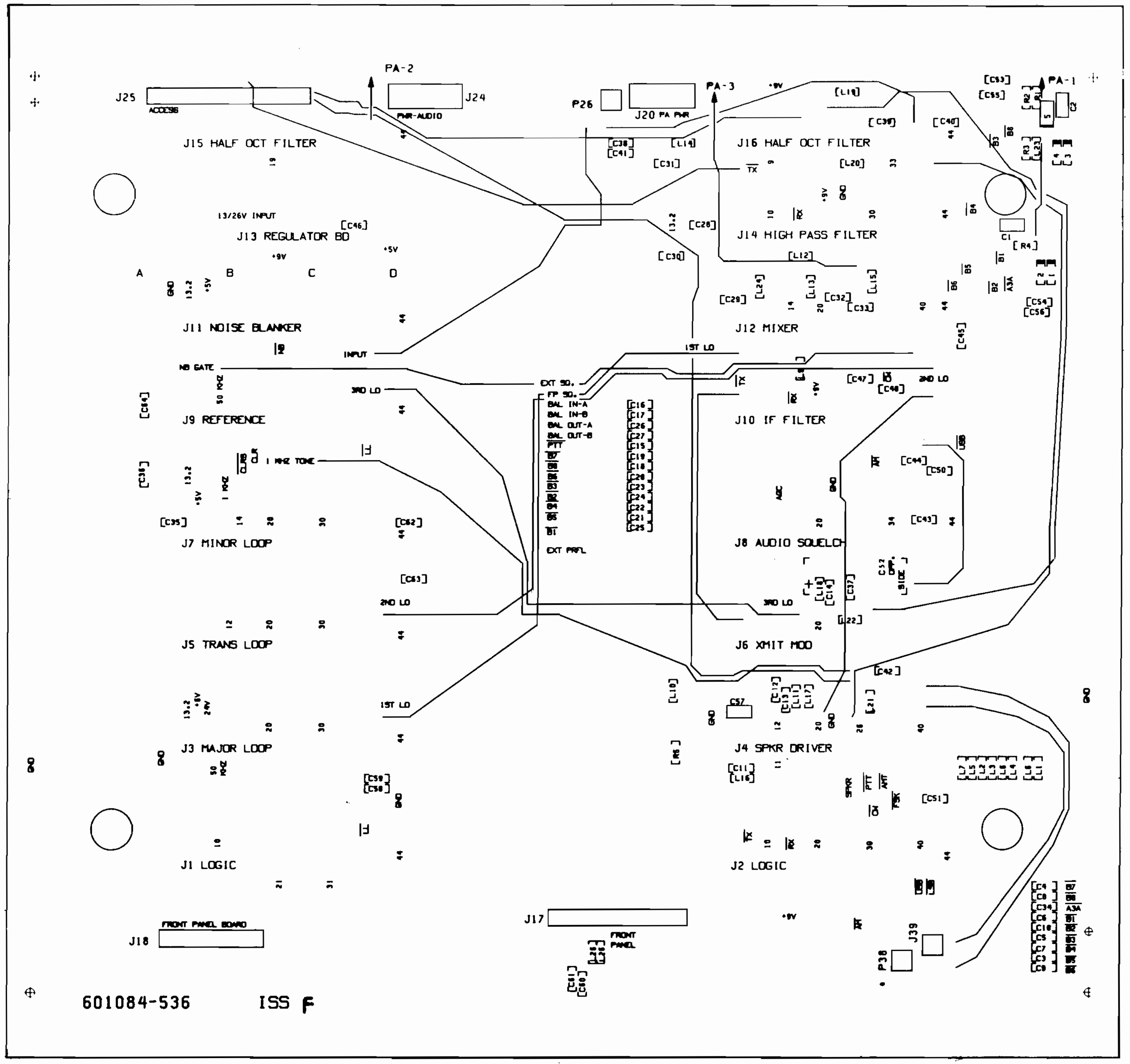
a) Remove the front and rear panel assemblies, 1A2 and 1A3, by removing the mounting screws (two on each side of each panel) that secure the panels to the chassis and unplug each panel assembly from the mother board.

b) Remove each subassembly from the mother board.

   Remove the twelve (12) screws that secure the mother board to the chassis assembly, 1A1A1 (four screws are located on each side of the board and four screws are located in the middle of the board).

c) The mother board should now be completely detached.

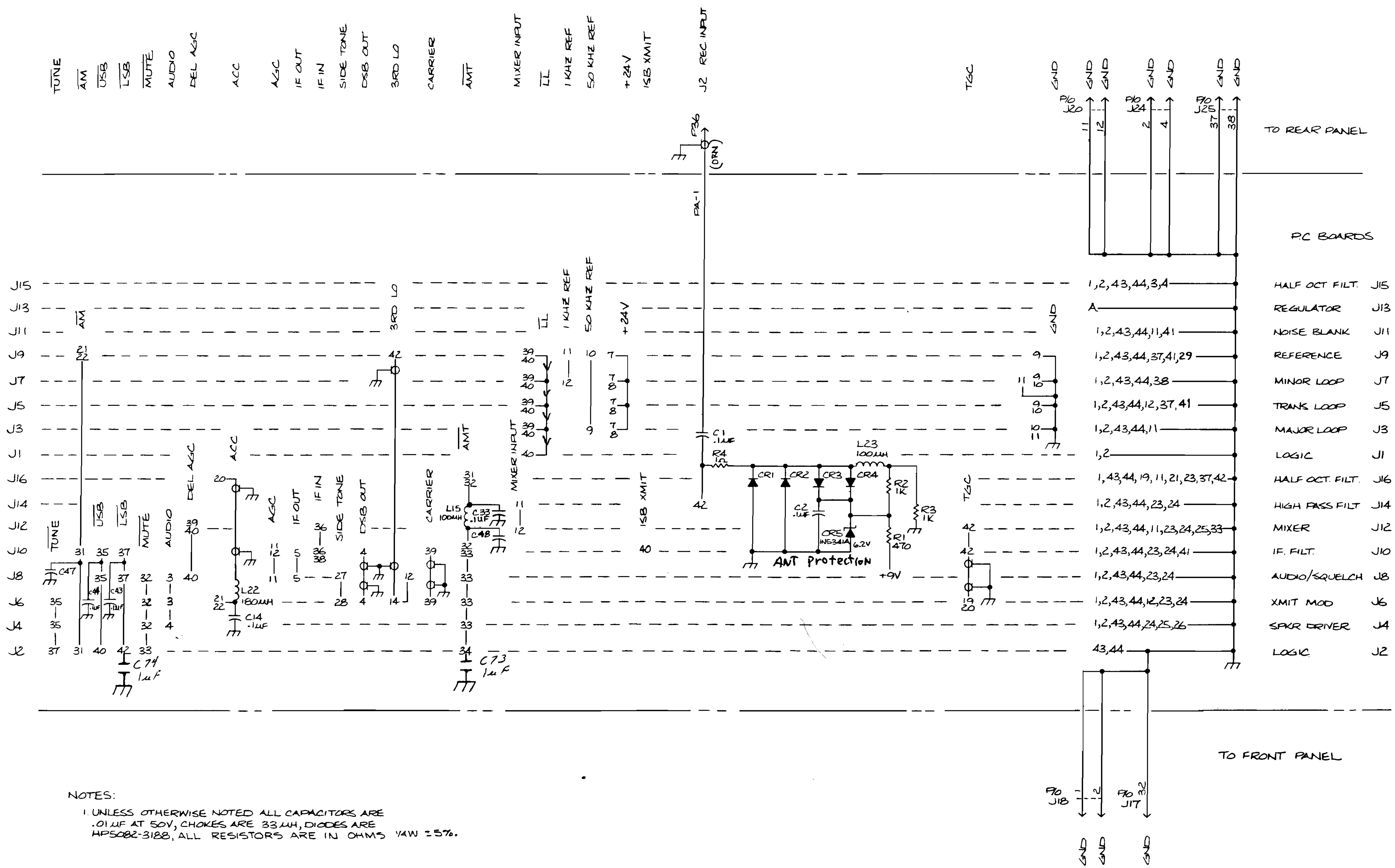
d) To reassemble, reverse the preceding steps.



MOTHER BOARD
(601084-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C2	Capacitor, .1 µf, 50V	600226-314-008
C3-10, C28, C29, C43-45, C33, C35, C36, C14, C17, C60-65, C40, C50, C51, C53-56	Capacitor, .1 µf, 50V	600272-314-001
C11, C12, C59	Capacitor, .001 µf, 50V	600272-314-004
C13, C16, C26, C27, C30-32, C34, C37-39, C58, C46-48, C41, C42	Capacitor, .01 µf, 50V	600272-314-002
C15, C18-25, C66-74	Capacitor, 1 µf	610045-319-350
C52	Capacitor, 1000 µf	600259-314-108
C57, C75-81	Capacitor, 1 µf, 50V	600226-314-008
CR1-4	Diode, HP5082-3188	600144-410-001
CR5	Diode, IN5341A, 6.2V	600026-411-009
J39	Conn., Coax, Female	600385-606-001
J1-12, J14-16	Conn., 22 Pin	600125-605-001
J13-A, J13-B, J13-C, J13-D	Plug, Banana	600092-611-003
J17	Conn., 34 Pin	600174-608-023
J18	Conn., 26 Pin	600174-608-022
J20	Conn., 14 Pin	600174-608-021
J24	Conn., 16 Pin	600174-608-025
J25	Conn., 40 Pin	600174-608-024
L1-14, L16-20	Choke, 33 µH	600125-376-007
L21, L22, L25, L26	Choke, 180 µH	600125-376-022
L23, L24, L15	Choke, 100 µH	600125-376-002
P26, P38	Conn., Coax, Male	600198-606-002
PA-1	Assembly, Coax	600440-540-001
PA-2	Assembly, Coax	600440-540-002
PA-3	Assembly, Coax	600440-540-003
R1, R5	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R2, R3	Resistor, 1k, 1/4W, 5%	610014-341-075
R4	Resistor, 1Ω, 1/4W, 5%	610084-341-075

Figure 5.10 Mother Board Assembly



NOTES:

1. UNLESS OTHERWISE NOTED ALL CAPACITORS ARE .01 UF AT 50V, CHOKES ARE 33 UH, DIODES ARE HP5082-3188, ALL RESISTORS ARE IN OHMS 1/4W ±5%.

Figure 5.11 Mother Board Schematic

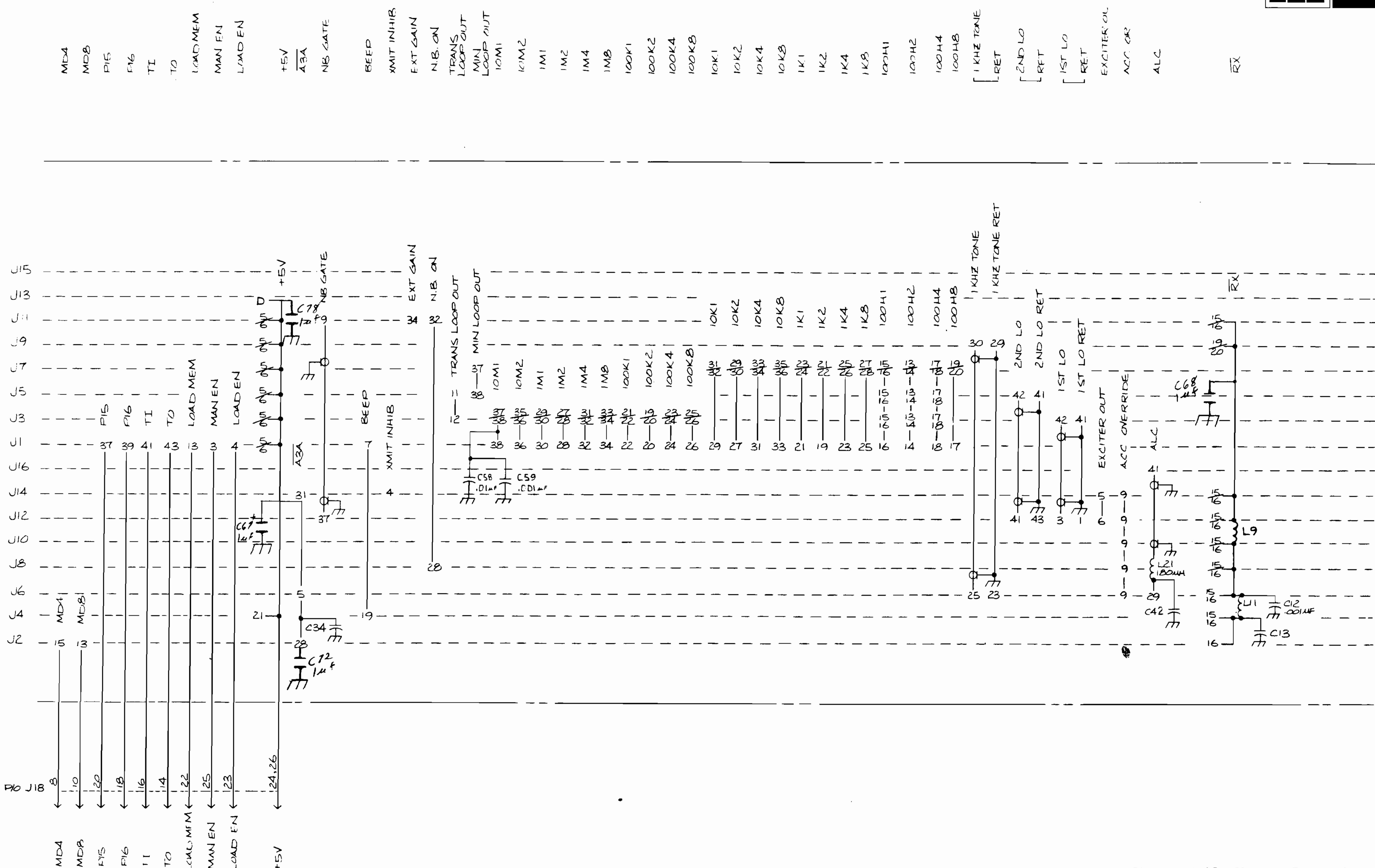


Figure 5.12 Mother Board Schematic

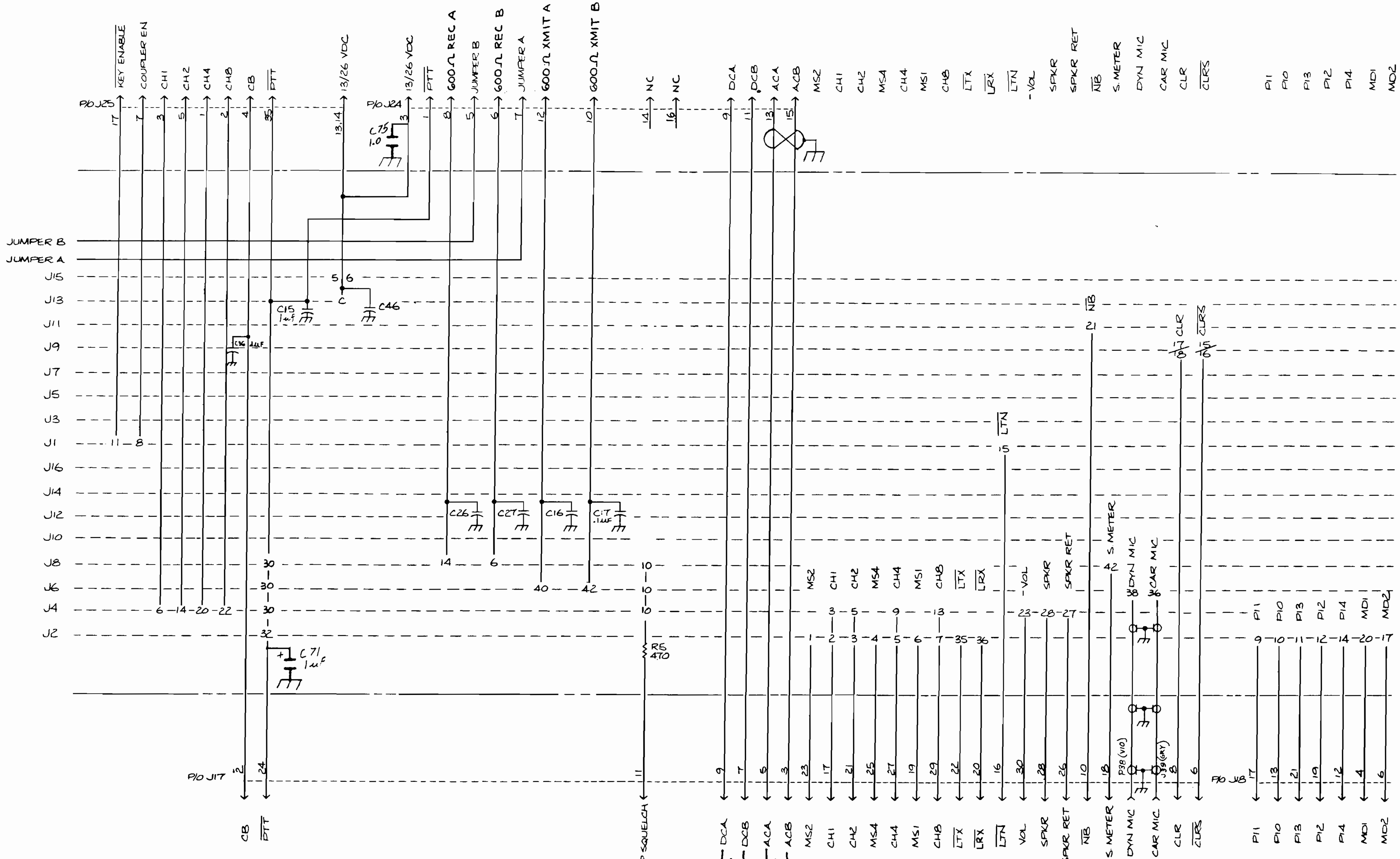


Figure 5.13 Mother Board Schematic

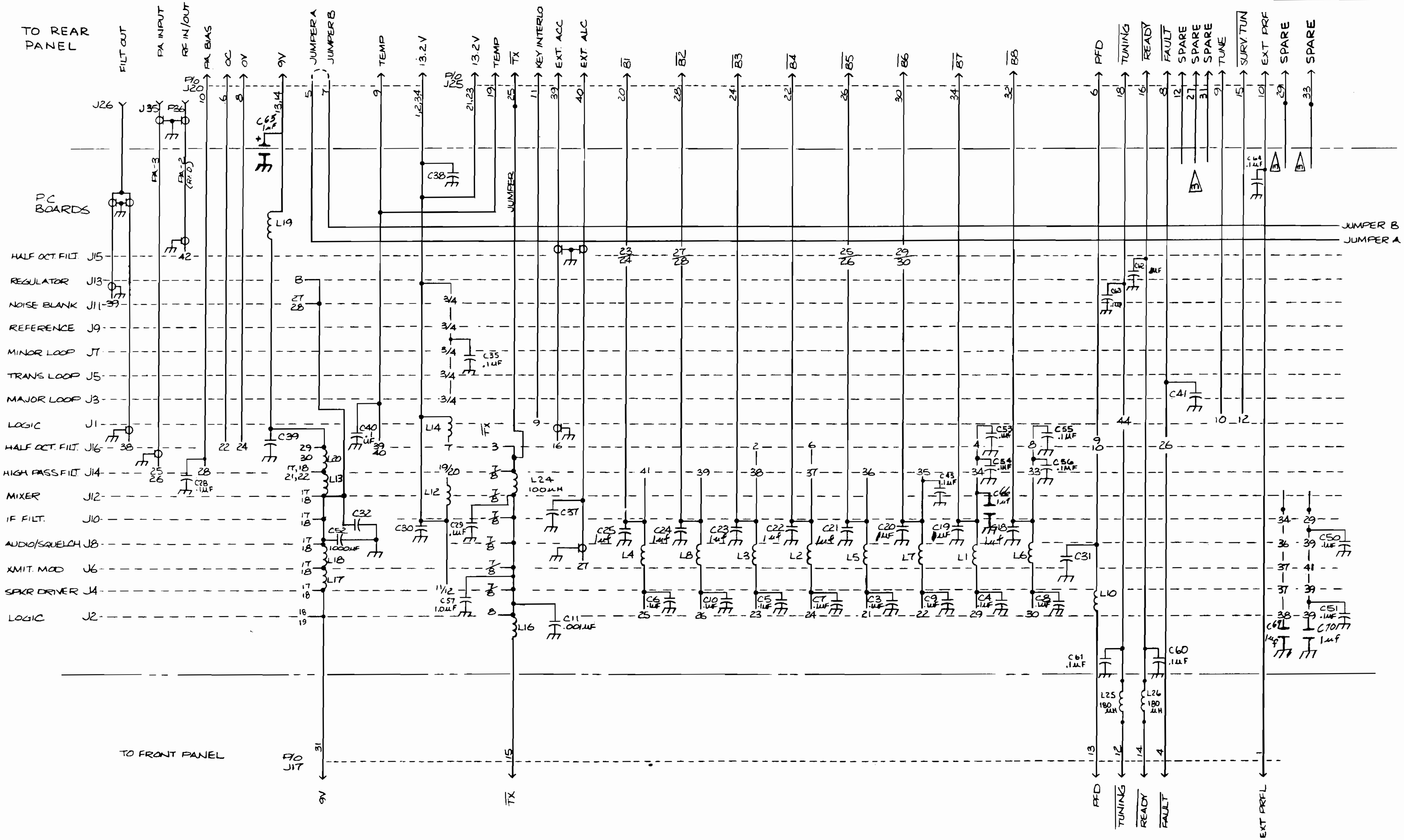


Figure 5.14 Mother Board Schematic

5.8 HALF OCTAVE FILTER BOARD, 1A1A2

5.8.1 GENERAL

This board, Figures 5.15/16 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 (8) elliptical low pass filters with cut off frequencies of 2, 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, over current, over voltage and over temperature.

The desired elliptical filter is selected automatically by relays which are controlled by ground signals from the logic board, 1A1A9. In the transmit mode, these filters reduce the harmonic output to better than -50 dB. In the receive mode, these same filters attenuate signals that are above that of the desired band of operation.

5.8.2 DETAILED DESCRIPTIONS

5.8.2.1 Filters

The different filters are selected by grounds being applied to pins on the interface connectors. For example, band 1 (B1) is selected by a ground on pin 24. This causes Q12 to conduct, placing 11 - 13 VDC on the coils of relays K15 and K16, causing them to energize. When energized, the RF power is routed through L15 and L16. Note that all other filters are shorted to ground when not being used.

The components in the filters have been optimized to provide an input impedance of 38-62 ohms with a phase angle of less than ± 30° when the output is terminated with 50 ohms. This is required in order to provide a low VSWR for the solid state PA. The inductors for bands 1 - 4 are wound on low loss toroid cores, while those for bands 5 - 8 are wound on phenolic forms.

5.8.2.2 VSWR Detector

The VSWR detector consists of transformer T1, capacitive voltage divider C7 and C8, CR2, CR3, and associated circuitry. Current transformer T1 (single turn primary) produces a voltage proportional to the current in the line. It is heavily loaded by R5 and R6 to flatten its frequency response from 1.6 to 30 MHz. Capacitive divider C7 and C8 samples the voltage on the line and adds it to the current sample voltage at the junction of R5 and R6. Therefore, the voltage applied to the anodes of CR2 and CR3 is the vector sum of the current sample and the voltage sample. The transformer is phased such that the voltage sample and the current sample add together for CR2 (forward power) and subtract for CR3 (reflected power). When the voltages from the current sample and the voltage sample are in phase and equal in magnitude, the reflected DC output (CR3) is minimum and the forward DC (CR2) is maximum. The component values are selected so the sample voltage phase and magnitudes are equal when terminated with 50 ohms with no phase angle. The P_r DC output is fed to the base of Q3 to reduce the PA drive for VSWR conditions. The Pf DC output is fed through R8 to pin 10 of P16. It is used to drive the front panel meter in the transceiver to indicate transmit power. (The DC voltage for the reflected power indication is supplied by the automatic antenna coupler, if used.)

5.8.2.3 ALC Detector and Amplifier

R1, R2, CR1, Q1 and associated components are used to provide a DC voltage proportional to the peak value of the RF passing through the VSWR detector. The output line (125 watts) (pin 38, P16) is sampled by resistive divider R1 and R2. Capacitors C1 and C2 are used to compensate the AC sample applied to diode CR1. This compensation is necessary to decrease the ALC sample at the higher frequencies and allow more drive to the PA. C2 is normally adjusted to provide 125 watts CW power at 29.9 and 1.6 MHz. The AC sample is rectified by CR1 and fed to the base of Q1. The DC output from Q1 is fed to pin 41 of P16. In the transceiver, the ALC voltage is fed to the transmit modulator and controls the TGC voltage. 125 watts (79 VRMS) generates a DC voltage of 5.5 to 6.5 volts. R4 and C6 provide the ALC time constant. R4 is used to provide a fast rise time for the ALC voltage.

5.8.2.4 ACC Detector and Amplifier

The ACC detector and amplifier consists of R9, R10, CR4, CR21, CR5, R13 and Q2. A sample of the voltage on the line is generated by resistive divider R9 and R10. Frequency compensation of the sample is accomplished by C51 and C53. Voltage doubler C52, CR21 and CR4 rectify the AC sample and drive R12. CR5 is a zener diode that is used to clip modulation peaks when operating AME. This prevents downward modulation of the carrier. The clipped DC sample is applied to R13, which is used to set the level of AM carrier.

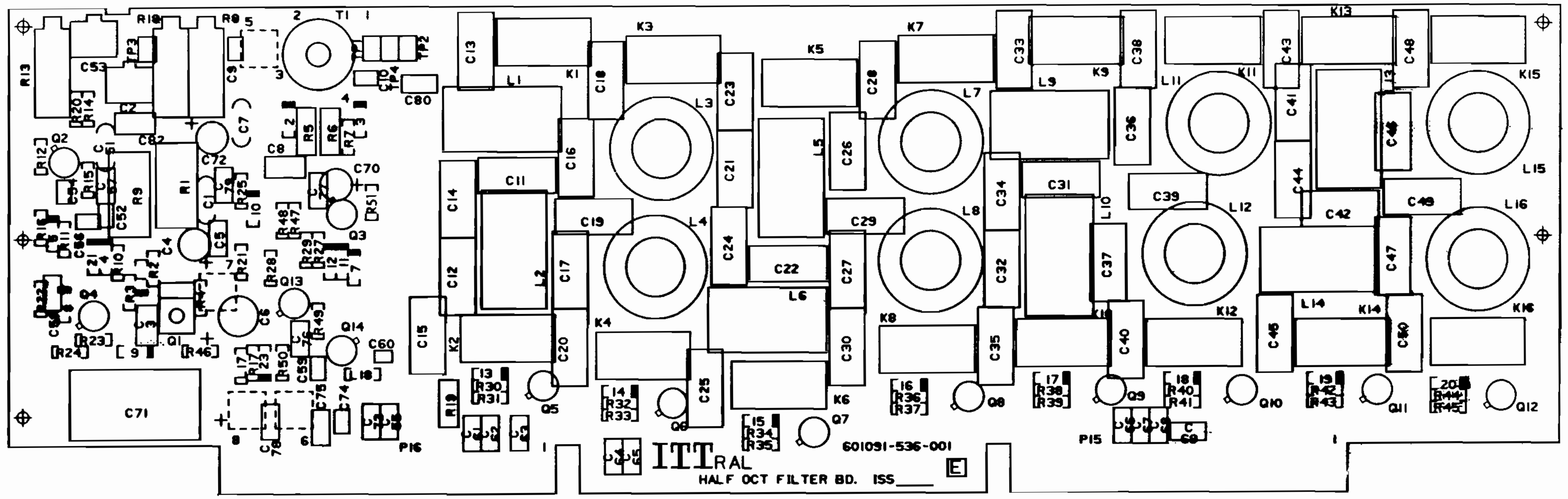
Transistor Q2 is the ACC amplifier and is a FET. It is cut off in the absence of ACC sample by two volts applied to the source by resistive divider R16 and R20. The gate of Q2 is driven from R13 through R14. C56 and C57 are RF bypasses. An external ACC voltage can be fed to Q2 from pin 16 of P16. This is used when the transceiver is driving an external amplifier and the drive from the transceiver must be reduced. The output from the ACC amplifier (Drain) is fed to pin 20 of P16. The ACC line is fed to the transmit modulator board in the transceiver and when the voltage on this line is reduced, the drive to the PA is reduced.

Transistor Q4, along with R22, R23, CR8 and R24 is a switch that disables the ACC amplifier when the transmitter is conditioned to any mode other than AME. The gate voltage of Q2 is shorted to ground any time the AMT line is not at logic 0.

Q3, Q14 and Q13 and associated circuitry are used to protect the solid state PA from conditions of VSWR, OC, OV and temperature. A VSWR fault causes an output from CR3 in the VSWR detector. This DC is applied to the base of Q3. When Q3 conducts, its collector voltage decreases from +8 VDC, causing CR7 to pull down the ACC line, decreasing the drive to the PA. In a similar manner, OC or OV DC inputs to pins 22 and 24, respectively, will cause a decrease in the ACC voltage. The TEMP sense input (pin 39 of P16) must exceed approximately 3 VDC to cause Q3 to conduct. This delay the heat sink temperature to rise to 90°C before the transmitter drive is reduced. R18 is the TEMP sense adjustment and is normally adjusted to 0.2 volts at TP3 at 25°C. Q14 is a switch that when saturated, will cause the fault lamp to be illuminated on the front panel of the transceiver. The fault light will be turned on for severe conditions of VSWR, OC, OV or TEMP when the ACC line is pulled down to less than 3.5 VDC.

5.8.2.5 Miscellaneous Components

The 0.1 microfarad capacitors, such as C66 through C69, are RF bypasses to prevent RF on the band lines from adversely effecting circuitry on the board.



HALF OCTAVE FILTER
(601091-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C51	Capacitor, 2.2 pf, N750	600269-314-049
C2	Capacitor, 9-35 pf, Mica	600018-317-013
C53	Capacitor, 15-60 pf	600018-317-011
C3	Capacitor, 75 pf, mica	675093-306-501
C4, C70, C72	Capacitor, 22 µf, 25V	600297-314-016
C5, C55, C57, C58, C61-69, C73, C75-79	Capacitor, .1 µf, 50V	600226-314-008
C6	Capacitor, 100 µf, 25V	600297-314-032
C7	Capacitor, 10 pf, NPO	600269-314-009
C8	Capacitor, 180 pf, mica	618003-306-501
C9, C10, C52, C54, C56, C59, C60, C74	Capacitor, .01 µf	600268-314-008
C11, C32, C42	Capacitor, 68 pf, mica	600287-314-056
C12	Capacitor, 22 pf, mica	600308-314-011
C13	Capacitor, 1 pf, mica	600227-314-003
C14	Capacitor, 160 pf, mica	600287-314-046
C15	Capacitor, 58 pf, mica	600287-314-040
C16	Capacitor, 270 pf, mica	600287-314-050
C17, C21	Capacitor, 80 pf, mica	600287-314-041
C18	Capacitor, 300 pf, mica	600287-314-054
C19, C46	Capacitor, 820 pf, mica	682002-306-501
C20, C28	Capacitor, 470 pf, mica	600287-314-058
C22	Capacitor, 27 pf, mica	600287-314-036
C23	Capacitor, 47 pf, mica	600287-314-038
C24	Capacitor, 240 pf, mica	600287-314-049
C25	Capacitor, 130 pf, mica	600287-314-044
C26, C34	Capacitor, 390 pf, mica	600287-314-052
C27	Capacitor, 140 pf, mica	600287-314-045
C29	Capacitor, 1200 pf, mica	612011-306-501
C30, C38	Capacitor, 620 pf, mica	662001-306-501
C31, C33	Capacitor, 150 pf, mica	600287-314-055
C35, C37, C41, C47	Capacitor, 180 pf, mica	600287-314-047
C36, C44	Capacitor, 560 pf, mica	656002-306-501
C39	Capacitor, 1600 pf, mica	616012-306-501

SYMBOL	DESCRIPTION	PART NUMBER
C40, C48	Capacitor, 1000 pf, mica	610011-306-501
C43	Capacitor, 220 pf, mica	600287-314-048
C45	Capacitor, 330 pf, mica	600287-314-051
C49	Capacitor, 2400 pf, mica	624011-306-501
C50	Capacitor, 1300 pf, mica	613012-306-501
C71	Capacitor, 1000 µf, 16V	600259-314-108
C82	Capacitor, 20 pf	620093-306-501
CR22	Diode, 1N270	600052-410-001
CR1, CR4, CR7-12, CR21	Diode, 1N4148	600109-410-001
CR5	Diode, 1N754A, 6.8V	600002-411-017
CR2, CR3	Diode, 1N3188	600144-410-001
CR13-20	Diode, 1N4004	600011-416-002
CR23	Diode, 1N746, 3.3V	600002-411-001
K1-16	Relay, 12 VDC	600028-402-006
L1	Inductor, .218 µH	670119-513-001
L2	Inductor, .297 µH	670119-513-002
L3	Inductor, 1.14 µH	670123-513-008
L4	Inductor, 1.55 µH	670123-513-007
L5	Inductor, .330 µH	670119-513-003
L6, L9	Inductor, .452 µH	670119-513-004
L7	Inductor, 1.70 µH	670123-513-006
L8	Inductor, 2.31 µH	670123-513-005
L10	Inductor, .725 µH	670119-513-006
L11	Inductor, 2.25 µH	670123-513-004
L12	Inductor, 3.06 µH	670123-513-003
L13	Inductor, .766 µH	670119-513-007
L14	Inductor, 1.043 µH	670119-513-008
L15	Inductor, 3.32 µH	670123-513-002
L16	Inductor, 4.52 µH	670123-513-001
L17	Inductor, 33 µH	600125-376-007
L18	Inductor, 180 µH	600125-376-022
Q1	Transistor, MJE802	600211-413-001
Q2	Transistor, 2N4338	600274-413-001
Q3, Q4, Q14	Transistor, 2N2222A	600080-413-001
Q5-12, Q13	Transistor, 2N2907A	600154-413-001

SYMBOL	DESCRIPTION	PART NUMBER
R1, R9	Resistor, 6.8k, 2W, 5%	668014-341-425
R2, R10	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R3, R15	Resistor, 100k, 1/4W, 5%	610034-341-075
R4	Resistor, 8.2Ω, 1/4W, 5%	682084-341-075
R5, R6	Resistor, 24Ω, 1/2W, 5%	624094-341-205
R7, R23	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R8	Resistor, 10k, adj.	600063-360-010
R16, R21, R22, R49	Resistor, 1k, 1/4W, 5%	610014-341-075
R11	Resistor, 22k, 1/4W, 5%	622024-341-075
R12	Resistor, 27k, 1/4W, 5%	627024-341-075
R13	Resistor, 100k, adj.	600063-360-014
R14, R25, R46	Resistor, 47k, 1/4W, 5%	647024-341-075
R17	Resistor, 47Ω, 1/4W, 5%	647094-341-075
R18	Resistor, 500Ω, adj.	600063-360-006
R19	Resistor, 10Ω, 1/2W, 5%	610094-341-205
R20	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R26, R24, R47, R48	Resistor, 10k, 1/4W, 5%	610024-341-075
R27, R29	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R28, R50	Resistor, 3.3k, 1/4W, 5%	633014-341-075
R30, R32, R34, R36, R38, R40, R42, R44	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R31, R33, R35, R37, R39, R41, R43, R45	Resistor, 820Ω, 1/4W, 5%	682004-341-075
T1	Transformer	600138-512-001

Figure 5.15 Half Octave Filter Assembly

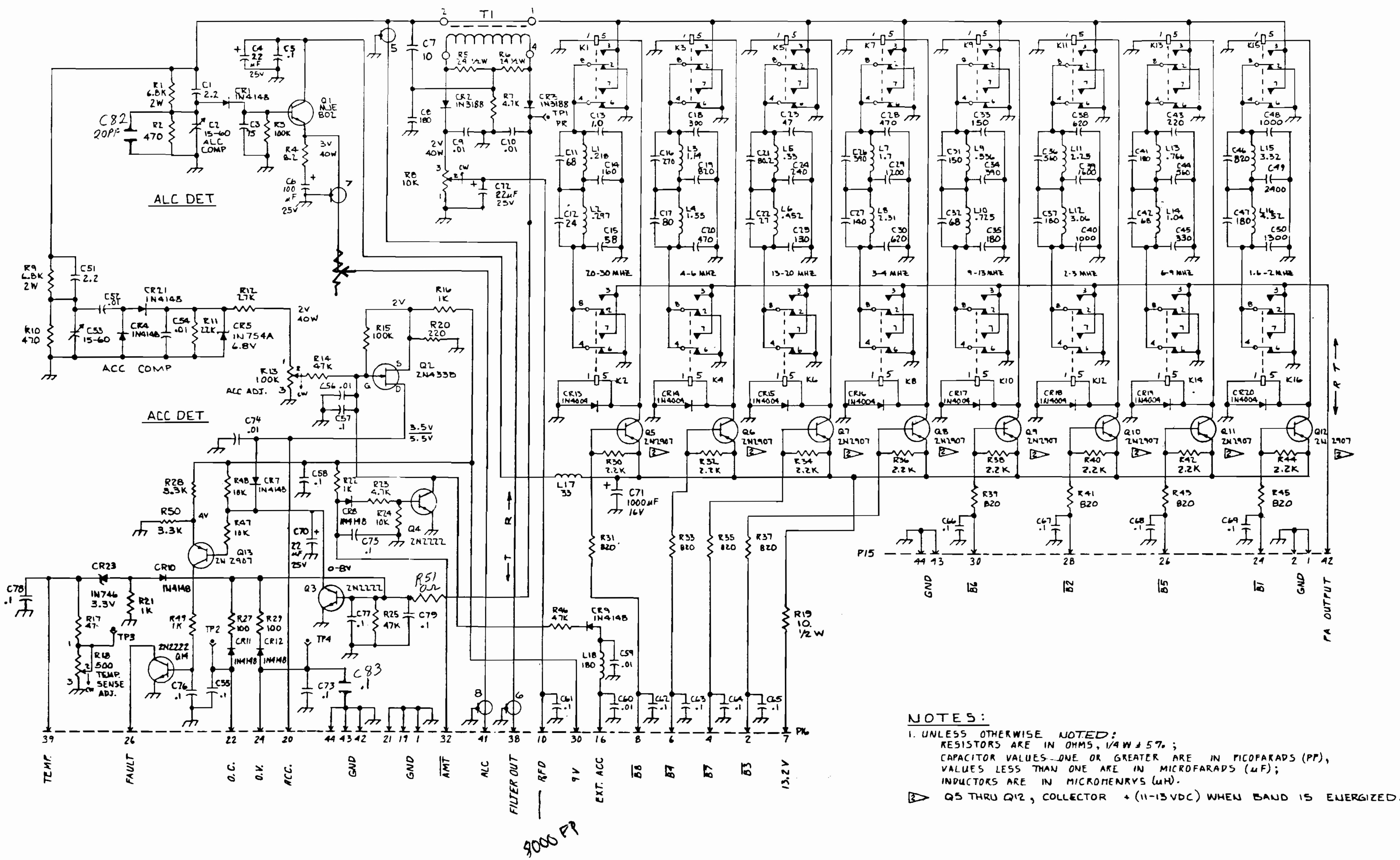


Figure 5.16 Half Octave Filter Schematic

Half Octave Filter Board

1A1A2

Pin Connections and Voltage Readings

1A1A2-J15

GND	1	2	GND
	3	4	
	5	6	
	7	8	
	9	10	
	11	12	
	13	14	
	15	16	
	17	18	
	19	20	
	21	22	
	23	24	B1 Logic "0" or 1
	25	26	B5 Logic "0" or 1
	27	28	B2 Logic "0" or 1
	29	30	B6 Logic "0" or 1
	31	32	
	33	34	
	35	36	
	37	38	
	39	40	
	41	42	Filter In 125W RF(T)
GND	43	44	GND

BOTTOM VIEW

Half Octave Filter Board

1A1A2

Pin Connections and Voltage Readings

1A1A2-J16

GND	1	2	B3 Logic "0" or 1
	3	4	B7 Logic "0" or 1
	5	6	B4 Logic "0" or 1
+12.7 - +13.9 VDC	7	8	B8 Logic "0" or 1
	9	10	PFD 0.5 - 4.0 VDC
	11	12	
	13	14	
	15	16	EXT. ACC (0 - +9 VDC max.)*
	17	18	
GND	19	20	ACC 0 - +6 VDC (AM mode)
GND	21	22	O.C. 0 - +1 VDC
	23	24	O.V. 0 - +1 VDC
	25	26	FAULT Logic "0" or 1
	27	28	
	29	30	+8.9 - 9.1 VDC
	31	32	
	33	34	
	35	36	
	37	38	Filter OUT 125W RF(T)
0 - +6 VDC TEMP.	39	40	
0 - +9 VDC ALC(T)	41	42	GND
GND	43	44	GND

BOTTOM VIEW

*This voltage not present unless external high power amplifier is used.

5.9 TRANSMIT MODULATOR BOARD, 1A1A3

5.9.1 GENERAL

The transmit modulator board, Figures 5.17/18 contains the following: speech compressor, balanced modulator, AME carrier insertion circuit, ALC amplifier and control, CW tone gate 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 are translated into a 5 MHz double sideband signal and then applied to the IF filter board, 1A1A6. 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 normally required. An adjustment is provided to reduce the 600 ohm audio input level, if necessary, when audio levels from accessory or optional equipment exceeds the recommended 0 dBm audio input levels. An audio gain adjustment, R96, is provided for applications when the audio compressor is disabled or additional microphone amplifier gain is required.

5.9.2 DETAILED DESCRIPTIONS

5.9.2.1 Speech Compressor

The speech compressor consists of U1A, U1B, Q2, Q6 and associated components. The compressor accepts a wide range of audio inputs and provides a constant input level to the balanced modulator. The low level microphone is fed from pin 36 through JP1-1 & 2, and R102 to pin 6 of U1A. For carbon microphone operation, JP1 is strapped 2 to 3, and audio is fed from pin 36 through L1, C37, R59, and C40 to the input of U1B. In a similar manner, the dynamic microphone input is fed from pin 38 through L2, R55, U1A, C36, R60 and C40 to the compressor input. The dynamic input is amplified in U1A to provide the same level to the compressor input as the carbon microphone. The 600 ohm audio from the rear panel is fed from pins 40 and 42 through T1, R1, C50, R58 and C40 to the compressor input. All three audio inputs are passed through the compressor.

One of the audio gates in U3 is used to inhibit the 600 ohm input to the compressor when pin 31, ISB INH line is pulled low. This gate allows the front panel microphone to inhibit the 600 ohm audio when it is desired to overide the 600 ohm data input with the microphone. The ISB INH line is controlled by the front panel PTT line.

JP1 is provided to allow connecting of the carbon microphone input to R102 for using dynamic microphones that have much less output than the standard microphone. The input to R102 is amplified approximately 20 dB more than the input to R55. R96 is factory adjusted for normal modulation with average speech. If more modulation is desired, R96 can be adjusted CW to increase the gain of U1A.

Compression is achieved by monitoring (sampling) the output level of U1B and generating a DC control voltage to control the level of input signal applied to pin 3 of U1B. The sample of the output of U1B is fed through R73 and C43 to voltage doubler CR5 and CR6. The resulting

DC is applied between the base and emitter of Q6. This voltage causes Q6 to conduct, generating a collector current that flows through R7 and causes Q2 to conduct. When voltage is applied to the gate of U2, it acts like a variable resistor, decreasing the voltage that appears on pin 3 of U1B. In other words, the gain of U1B is constant and compression is achieved by attenuating its input. R58, R59 and R60 are all series with the IC in put. As the resistance of Q2 decreases, the voltage division ratio increases, causing less voltage on pin 3. CR4, when Q1 is turned on, cuts off U1B to prevent modulation of the signal when the radio is operating in CW or in the antenna coupler tune mode.

5.9.2.2 Balanced Modulator

U2 is the balanced modulator and generates an upper and a lower sideband with the carrier suppressed. The audio signal is applied to pin 1 through C23 and R39. R39 is an adjustment provided to allow the optimum level of audio to be applied to the modulator. Third LO (5 MHz) is applied to pin 8. The modulator (MC1596) is a monolithic balanced modulator circuit. It consists of an upper quad differential amplifier with dual current sources. The output collectors are cross coupled so that full wave cross multiplication of the two input voltages occurs. The output signal is a constant times the product of the two input signals. R31 is used to balance the carrier to a null at the output, pin 6.

5.9.2.3 5 MHz Double Sideband Amplifier

The output from the balanced modulator is fed through C27 to an amplifier. Q7, Q8 and associated components comprise the amplifier. The amplified output of Q7 is fed to the input of Q8 via C32. C51 and Q10 are used to attenuate the base input to Q8 when operating in the AME mode. When in AME, Q10 is saturated and capacitive divider C32 through C51 reduces the voltage applied to the base of Q8. This action is required to prevent over modulation in AME. R51 is a gain adjustment to set the open loop gain of the transmitter path.

5.9.2.4 Carrier Insertion Circuit

When operating AME, a certain level of carrier must be generated and injected into the transmit path after the sideband filters. Q5, Q14 and Q15 are used to control the amount of carrier injected. When in the AME mode, (TX AM), a logic 0 is placed on pin 33 and Q3 conducts. Q3 collector voltage saturates Q10 (reducing the double sideband output) and also causes Q14 to conduct. The voltage supplied by R17 and R18 to the gate of Q14 is adequate to turn on Q14. When Q14 is ON, carrier is fed through C15, Q14, C17 and to the base of Q5. It should be noted that CR19 causes Q15 to be cut off in the AME mode. Q15 is saturated by R85, R86 and CR20 in modes other than AM. When Q15 is saturated, it shorts out to ground any 5 MHz leakage that might pass through Q14. The carrier applied to the base of Q5 is amplified and fed to pin 39 on the connector. R17 is used to adjust the level of carrier applied to the system. Pin 39 is fed to the IF/filter board and applied to the base of the TGC controlled amplifier.

Provision is made for A3A mode of operation. When a logic 0 is applied to pin 5, Q15 is cut off and Q5 is allowed to amplify. An "ACC Override" voltage on pin 9 can turn on Q14 and allow some carrier to be injected. (The ACC override voltage originates on the high pass filter module.)

5.9.2.5 ALC Amplifier

Q13 and associated components comprise the ALC amplifier. The ALC DC sample is detected on the half octave filter board and enters on pin 29. C52, L5 and C16 are used for filtering any RF that might be on the line. R83 is used to set the peak power level. The output of R83 is fed to the gate of Q13. Q13 is cut off in the absence of gate voltage by resistive divider R72 and R90. When the gate voltage of Q13 is more positive than the source voltage, it conducts, reducing the drain voltage. The drain voltage of Q13 is the ACC line. This line goes to the half octave filter and connects to the drain of the ACC amplifier. The ACC voltage is fed through the complimentary output pair Q11 and Q12 to pin 19 and 20. This line is the TGC (transmitter gain control) and connects to the IF board. The gain of the transmitter is controlled by one single stage on the IF board. Provision is made for an external ALC voltage when the transmitter is used to drive another unit, such as a 1 kW amplifier. When this occurs, some means must be provided to reduce the 125 watt PA output to a level suitable to drive the kW. The external ALC is derived from the output of the kW and is brought in on pin 27. It is filtered by C57, L6, C30 and fed through CR18 and R84 to the gate of Q13, where it can be used to override the transceiver ALC.

5.9.2.6 ACC/TGC Voltages and Operating Modes

The ACC line controls the TGC voltage. The gain of the transmitter is proportional to the ACC voltage. That is, with 0 ACC volts, the transmitter has no gain and with +5.5 VDC, it has maximum gain. Q13 reduces the ALC voltage in USB while the ACC amplifier on the half octave filter board reduces the ACC voltage in AME. Note that Q13 gate voltage is shorted out by CR17 in the AME mode. The source voltage for the ACC line (and the TGC line) is provided by resistive dividers for different modes. When in USB or LSB, the ACC voltage is provided by R5, R26 and R74. The voltage is fed to the line by CR9. (Note that in AME, CR12 shorts out this voltage.) When in the AME mode, the ACC source voltage is provided by R76, R81 and CR11. C54 is used to slow the rise of the ACC line to prevent large over shoots when the transmitter is keyed in AM. When operating in CW, the ACC source voltage is provided by R75, R80 and CR10. C53 is used to slow the rise of the ACC line when line when the transmitter is keyed in CW, C53 shapes the leading edge of the CW RF pulse. Note that during the coupler tune mode, CR23 shorts out the ACC voltage supplied through CR10. The three separate source voltages for the ACC lines provide different open loop gains of the exciter for three different modes of operation.

5.9.2.7 CW Operation

To operate CW, a 1 kHz tone is gated into the balanced modulator. This is accomplished as follows: a logic 0 is applied to pin 37. This causes Q1 to conduct. Q1 collector voltage disables U1B through CR4 and also provides emitter voltage for Q9 through CR15. With emitter voltage on Q9, a logic 0 on the PTT line (pin 30) will cause Q9 to conduct. Q9 collector voltage, through R8 turns on the two audio gates. (When pins 13 and 5 rise above 4.5 volts, the gates open.) The 1 kHz tone at pin 25 is gated through pins 1, 2, 3 and 4 of U3 and through C9 to the input of the balanced modulator. CR21 shuts off the 1 kHz tone when the antenna coupler is tuning. The side tone output is taken from pins 2 and 3 of U3 and through R70 to pin 28. R78 is used to adjust the open loop drive level in CW.

5.9.2.8 Miscellaneous Circuitry

Q4 is the transmit switch and when a logic 0 is applied to pins 7 or 8, Q4 collector voltage turns on the 5 5 MHz double sideband amplifier. Capacitors, such as C10, C11, C12, C14, etc. are RF bypasses to prevent RF from getting into the board.

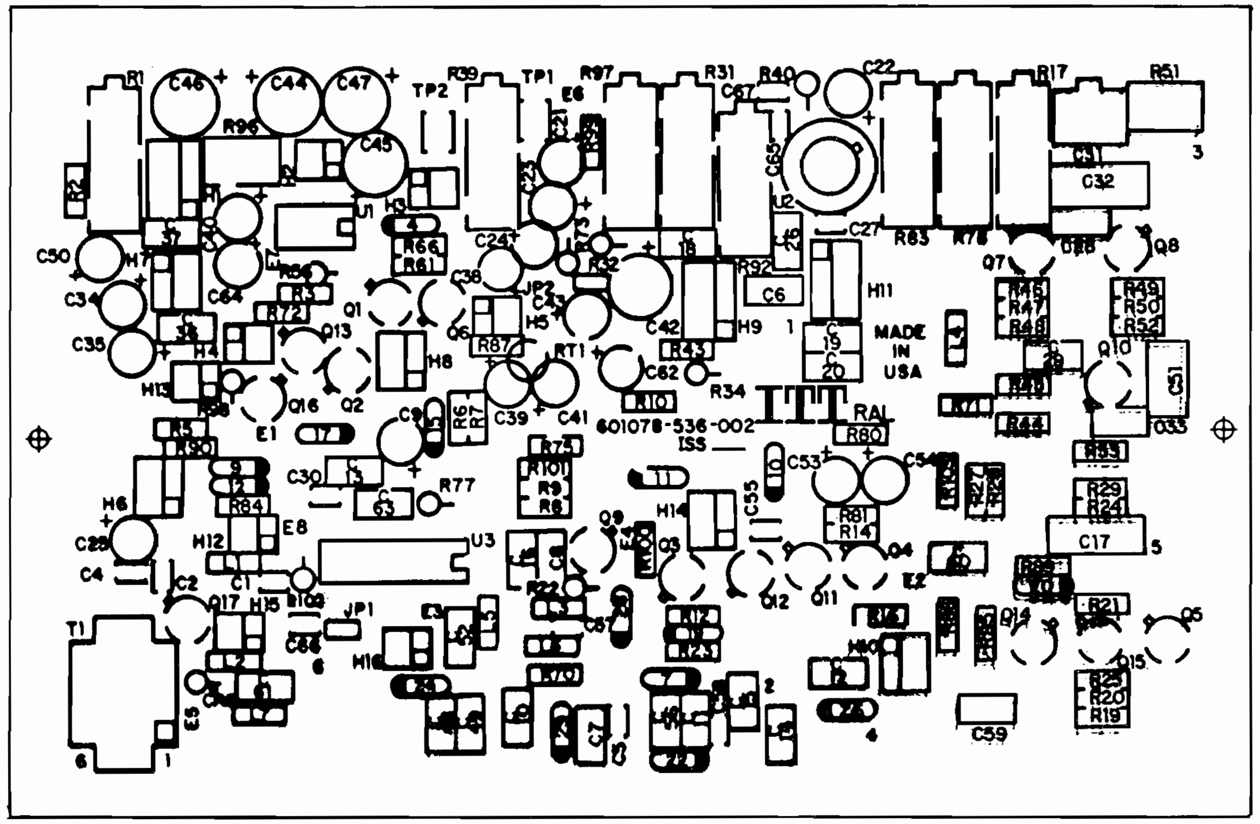
5.9.2.9 Microphone Selection

The chart below lists four different styles of microphones that can be used with the MSR 8000D. Jumper JP-1 is used to condition the unit for different types of microphones. Two options are available: Dynamic or Carbon. Position 1 to 2 of JP1 (See Figure 5.18) is used for dynamic microphones. Units shipped from the factory are in this configuration. Position 2 to 3 configures the input for carbon microphones. JP1, in conjunction with audio gain control R96, allows the radio to be configured for a wide variety of audio input level.

For certain types of digital encoding equipment, audio compressors can create distortion. Jumper plug JP-2 on the transmit modulator board (Figure 5.18) can be used to disable the compressor. If JP-2 is connected 1 to 2, the compressor will be disabled and the input audio level will have to be adjusted using R96 to produce 0.23-0.27 VPP at 1A1A3-TP1.

AUDIO INPUT OPTIONS

AUDIO INPUT	PART NUMBER	CARBON OR DYNAMIC	XMIT MOD JP1	APPROX. AUDIO INPUT LEVEL (V)
Hand Microphone	600352-713-001	DYN	1 to 2	.004 to .010V
Desk Microphone	600367-713-001	DYN	1 to 2	.004 to .010V
H-250/U Handset	600002-386-001	DYN	1 to 2	.0004 to .001V
H-33 Handset	600014-386-001	CAR	2 to 3	.5 to 7.75V
STD, 600 ohm		N/A	N/A	.245 to 7.75V

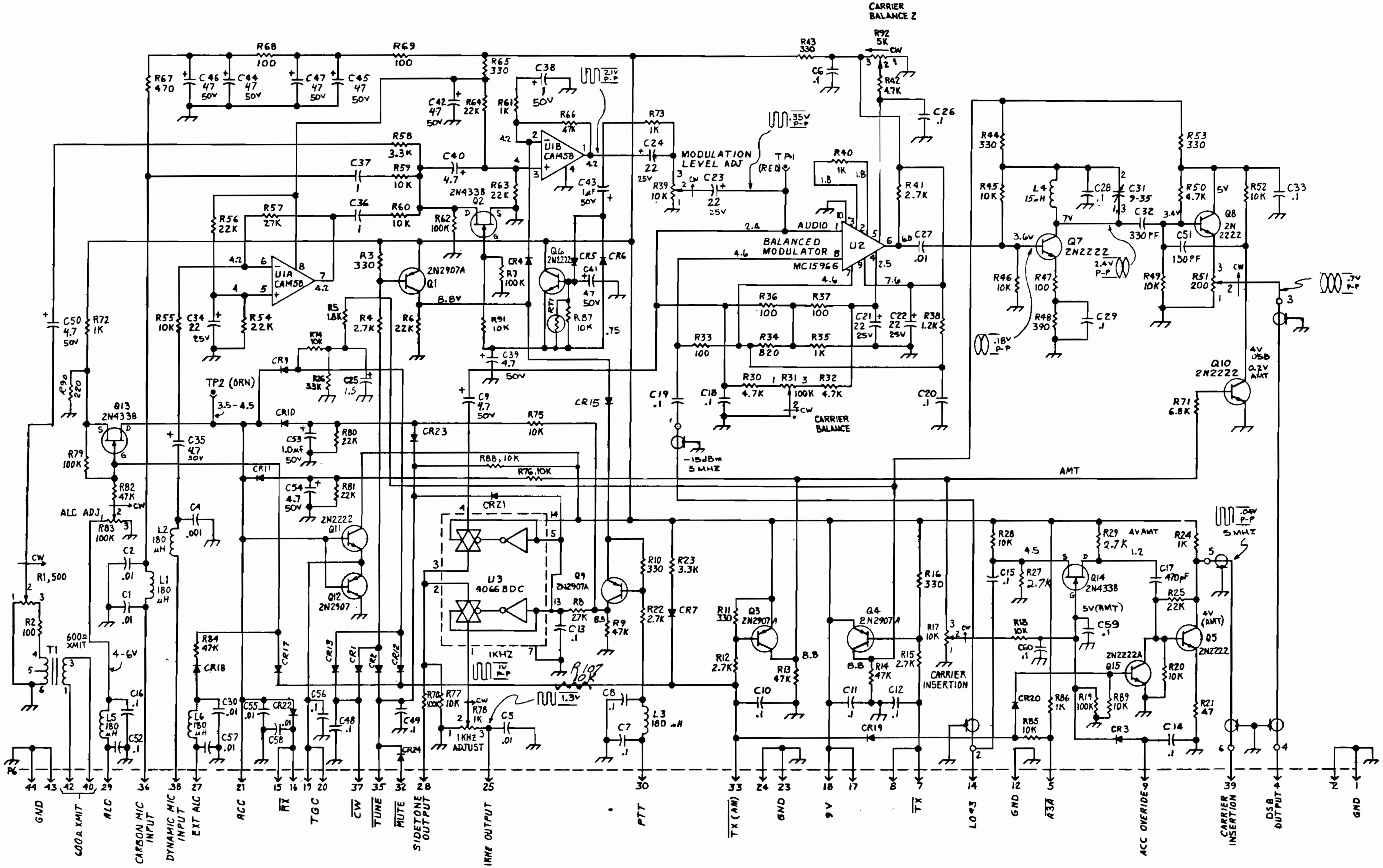


TRANSMIT MODULATOR
(601078-536-002)

SYMBOL	DESCRIPTION	PART NUMBER
Cl, C2, C5, C27 C30, C55, C57, C58, C65, C67	Capacitor, .01 μf, 50V	600268-314-008
C6-C8, C10-16, C18-20, C26, C28, C29, C33, C48, C49, C52, C56, C59, C60, C61, C63	Capacitor, .1 μf, 50V	600226-314-008
C9, C35, C39, C40, C50, C54, C17	Capacitor, 4.7 μf, 50V	600297-314-010
C21-24, C34	Capacitor, 22 μf, 25V	600297-314-016
C25	Capacitor, 1.5 μf, 35V	600202-314-009
C31	Capacitor, 9-35 pf, Var.	600018-317-013
C32	Capacitor, 330 pf	633003-306-501
C36, C37	Capacitor, 1 μf, 50V	600226-314-014
C38, C41, C43, C53	Capacitor, 1 μf, 50V, Alum.	600297-314-003
C42, C44-47, C51	Capacitor, 47 μf, 50V, Alum.	600297-314-026
C4, C66	Capacitor, .0018 μf	600268-314-002
C62	Capacitor, 10 μf, 50V	600297-314-013

SYMBOL	DESCRIPTION	PART NUMBER
CR1. CR2, CR4-13, CR15, CR17, CR19	Diode, 1N4148	600109-410-001
CR19, CR26	Diode, 1N270	600052-410-001
H2-5, H12, H13, H15, H16	Vertical Mount, 2 Pos.	600064-419-004
H6, H7, H8, H14	Vertical Mount, 3 Pos.	600064-419-003
H1, H9, H11	Vertical Mount, 4 Pos.	600198-608-005
JP1, JP2	3 Pin Header	600198-608-005
L1-3, L5-7	Choke, 180 μH	600125-376-022
L4	Choke, 15 μH	600125-376-013
Q1, Q3, Q4, Q9, Q12	Transistor, 2N2907A	600154-413-001
Q2, Q13, Q14, Q16	Transistor, 2N4338	600274-413-001
Q5-8, Q10, Q11, Q15, Q17	Transistor, 2N2222A	600080-413-001
(Q1-17)	Transistor Pad, T018	600025-419-001
R1	Resistor, 500Ω, Var.	600063-360-006
R2, R33, R36, R37, R47, R68, R69, R102	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R3, R101, R11, R16, R43, R44, R53, R65	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R4, R12, R15, R22, R41	Resistor, 2.7k, 1/4W, 5%	627014-341-075
R24, R21, R72, R73, R35, R40,	Resistor, 1k, 1/4W, 5%	610014-341-075
R6, R25, R54, R56, R63, R64, R80, R81	Resistor, 22k, 1/4W, 5%	622024-341-075
R7, R19, R62, R79, R95, R98, R103, R104	Resistor, 100k, 1/4W, 5%	610034-341-075
R8	Resistor, 27K, 1/4W, 5%	627024-341-075
R9, R13, R14, R66, R84, R99, R10	Resistor, 47k, 1/4W, 5%	647024-341-075
R17, R39	Resistor, 10k, Var.	600063-360-010
R20, R28, R45, R46, R49, R52, R55, R57, R60, R70, R74-77, R85, R107, R87-89, R91, R106	Resistor, 10k, 1/4W, 5%	610024-341-075
R23, R58, R59	Resistor, 3.3k, 1/4W, 5%	633014-341-075
R26, R30, R32, R42	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R34	Resistor, 820Ω, 1/4W, 5%	682004-341-075
R38	Resistor, 1.2k, 1/4W, 5%	612014-341-075
R48	Resistor, 390Ω, 1/4W, 5%	639004-341-075
R51	Resistor, 200Ω, variable	600066-360-005
R67	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R71	Resistor, 6.8k, 1/4W, 5%	668014-341-075
R78	Resistor, 1k, Var.	600063-360-007
R31, R83, R97	Resistor, 100k, Var.	600063-360-014
R90	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R92	Resistor, 5k, Var.	600063-360-009
R96	Resistor, 100, Var.	600066-360-014
R5	Resistor, 1.8k, 1/4W, 5%	618014-341-075
R21	Resistor, 47Ω, 1/4W, 5%	647094-341-075
RT1	Thermistor, 10k	600026-367-001
T1	Transformer	635234-501-001
U1	IC, CA1458	600039-415-001
U2	IC, MC1596G	600011-415-001
U3	IC, 4066BDC	600186-415-001

Figure 5.17 Transmit Modulator Assembly



NOTES:
1. UNLESS OTHERWISE NOTED:
RESISTORS ARE IN OHMS, 1/4 W, ±5%;
CAPACITORS ARE IN MFD;
DIODES ARE IN414B.

Figure 5.18 Transmit Modulator Schematic

Transmit Modulator Board

1A1A3

Pin Connections and Voltage Readings

1A1A3-J6

GND	1	2	GND	
	3	4	DBS Output 0 dBm (5 MHz)	
Logic "0" or 1 $\overline{A3A}$	5	6		
Logic "0" or 1 $\overline{TX}$	7	8	$\overline{TX}$ Logic "0" or 1	
0 - +4 VDC ACC Override	9	10		
	11	12	GND	
	13	14	LO 3 - 15 dBm (5 MHz)	
Logic "0" or 1 $\overline{RX}$	15	16	$\overline{RX}$ Logic "0" or 1	
+8.9 - 9.1 VDC	17	18	+8.9 - 9.1 VDC	
+2.9 - +3.9 VDC(T) TGC	19	20	TGC 0 - 5 VDC	
0 - +6 VDC(T) ACC In	21	22		
GND	23	24	GND	
.46 VRMS 1 kHz Out	25	26		
0 - +9 VDC(T) Ext. ALC In	27	28	Sidetone	
0 - +9 VDC(T) ALC In	29	30	PTT Logic "0" or 1	
Logic "0" or "1" ISB INH	31	32	$\overline{MUTE}$ Logic "0" or 1	
Logic "0" or 1 $\overline{TX (AM)}$	33	34		
Logic "0" or 1 $\overline{TUNE}$	35	36	Carbon mic. Input .15-2.0 VRMS	
Logic "0" or 1 $\overline{CW}$	37	38	Dynamic mic. Input .007-.1 VRMS	
-25 - -18 dBm (5 MHz) carrier insert	39	40	600Ω Audio In	-10 dBm +20 dBm
	41	42	600Ω Audio In	
GND	43	44	GND	

BOTTOM VIEW

5.10 HIGH PASS FILTER BOARD, 1A1A4

5.10.1 GENERAL

This board, Figures 5.19/20, performs part of the receive mode preselection and receive RF amplification. In the transmit mode, the output of the mixer board, 1A1A5, is filtered by this board. Contained on this assembly are eight (8) elliptical high pass filters with cut off frequencies of 1.6, 2, 3, 4, 6, 9, 13 and 20 MHz. The desired filter is selected automatically by ground signals from the logic board, 1A1A9. 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. Additional circuitry located on this board provides analog voltages which are supplied to the transmit modulator board, 1A1A3, to more accurately establish the A3A carrier level on transmit.

5.10.2 DETAILED DESCRIPTIONS

5.10.2.1 High Pass Filters

Band 1 (B1) is switched by CR1 and CR2. When a logic 0 (ground) is placed on pin 41, Q6 is saturated, and 9 volts appears on the collector of Q6. This voltage causes current to flow through L19, L20, CR1, L18, R50, CR2, L15 and R20. CR1 and CR2 conduct, and all the other band switching diodes (CR3, CR4, CR5, and CR6, etc.) are back biased. If band 1 is selected in receive, the signal flow is as follows: RF input on pin 42, through K1, C106, CR1, C44, C45, C46, CR2, K1 - pin 8, 2, and through C27 to the broadcast filter. The RF amplifier provides about 4 dB of gain (1.6 - 30 MHz). The output is taken from T1 at pin 11 of P14. Operation of any other band is similar. During the transmit mode, K1 is energized and the signal flow is as follows: RF input to pin 5 of P14, through K1 (pins 3 and 8), through the band selected, through K1 (pins 2 and 7) and out on pin 25.

5.10.2.2 RF Amplifier

The RF amplifier is used in receive only, and consists of Q4 and Q5. Q5 is a high level FET used in the grounded gate configuration for best intermodulation performance. Q4 is used to provide a constant current source for Q5.

5.10.2.3 Transmit Switch

Q2 is a switch used to energize K1 when in the transmit mode. When a ground (logic 0) is placed on pin 7 and 8, Q2 collector voltage pulls in K1. Q2 collector voltage is also connected to the solid state PA to switch on the PA biases during transmit.

5.10.2.4 A3A Control Voltage

When the A3A transmit mode is desired, a band switched analog voltage is required. The A3A control voltage consists of R8, R10, Q3 and R46 thru R49. When A3A is desired, a ground is placed on pin 31. This cuts off Q3, allowing the voltage on R10 to appear on pin 9. Pin 9 is connected to the transmit modulator board and allows some carrier (-16 to -18 dB) to be inserted in the A3A mode. If band 1 or 2 is selected, CR33 or CR34 conducts, causing 9 volts to be applied across R49. R49 is adjusted to provide proper amount of carrier for 1.6 - 30 MHz. In a similar manner, R48 is adjusted for 3 - 13 MHz.

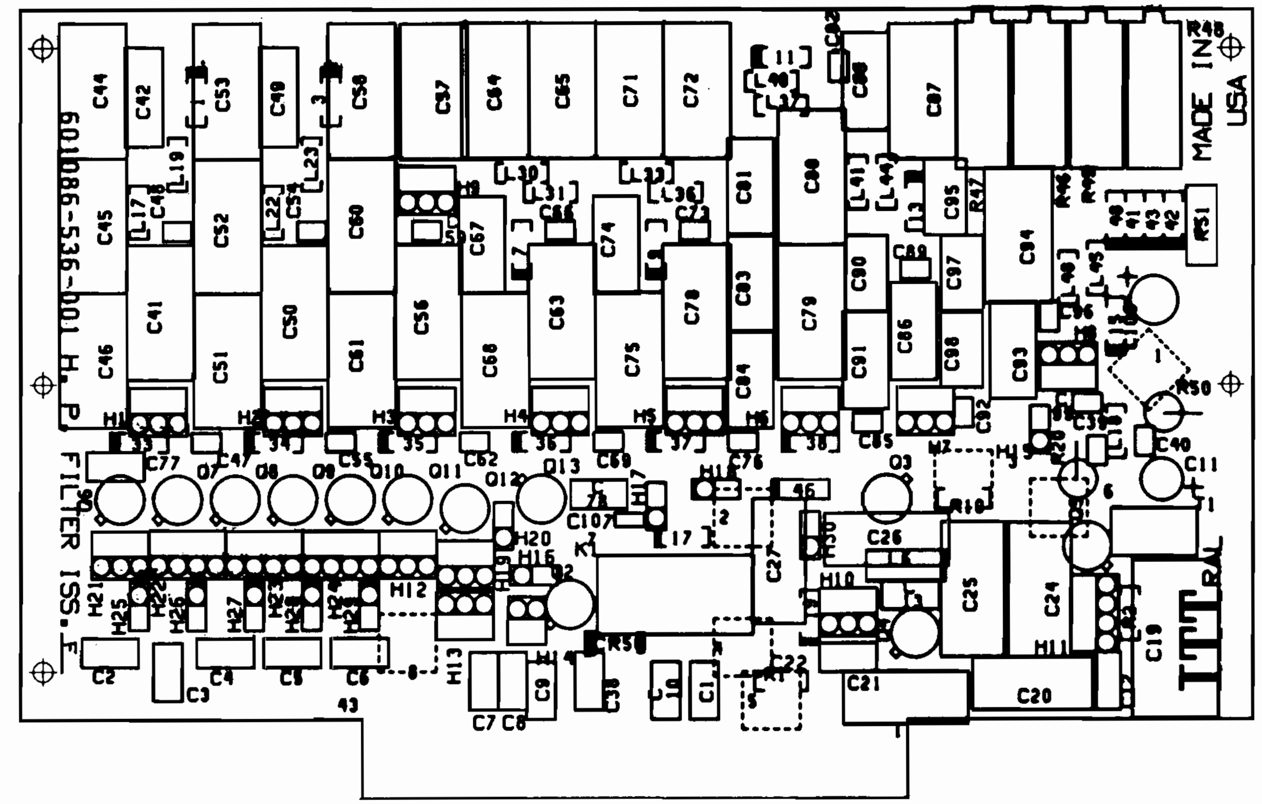
Band 7 (13 - 20 MHz) carrier injection is controlled by R47. R46 controls band 8 (20-30 MHz).

5.10.2.5 Overall Gain or Loss

In the receive mode, the overall gain is +1 dB to +4 dB, depending on the band selected. The loss during transmit is -1 dB to -3 dB.

5.10.2.6 Broadcast Filter

The broadcast filter is used only in receive and provides approximately 35 dB additional attenuation to the broadcast band. The overall rejection of the broadcast band is approximately 70 dB. (6 dB cut off frequency approximately 1.4 kHz.)



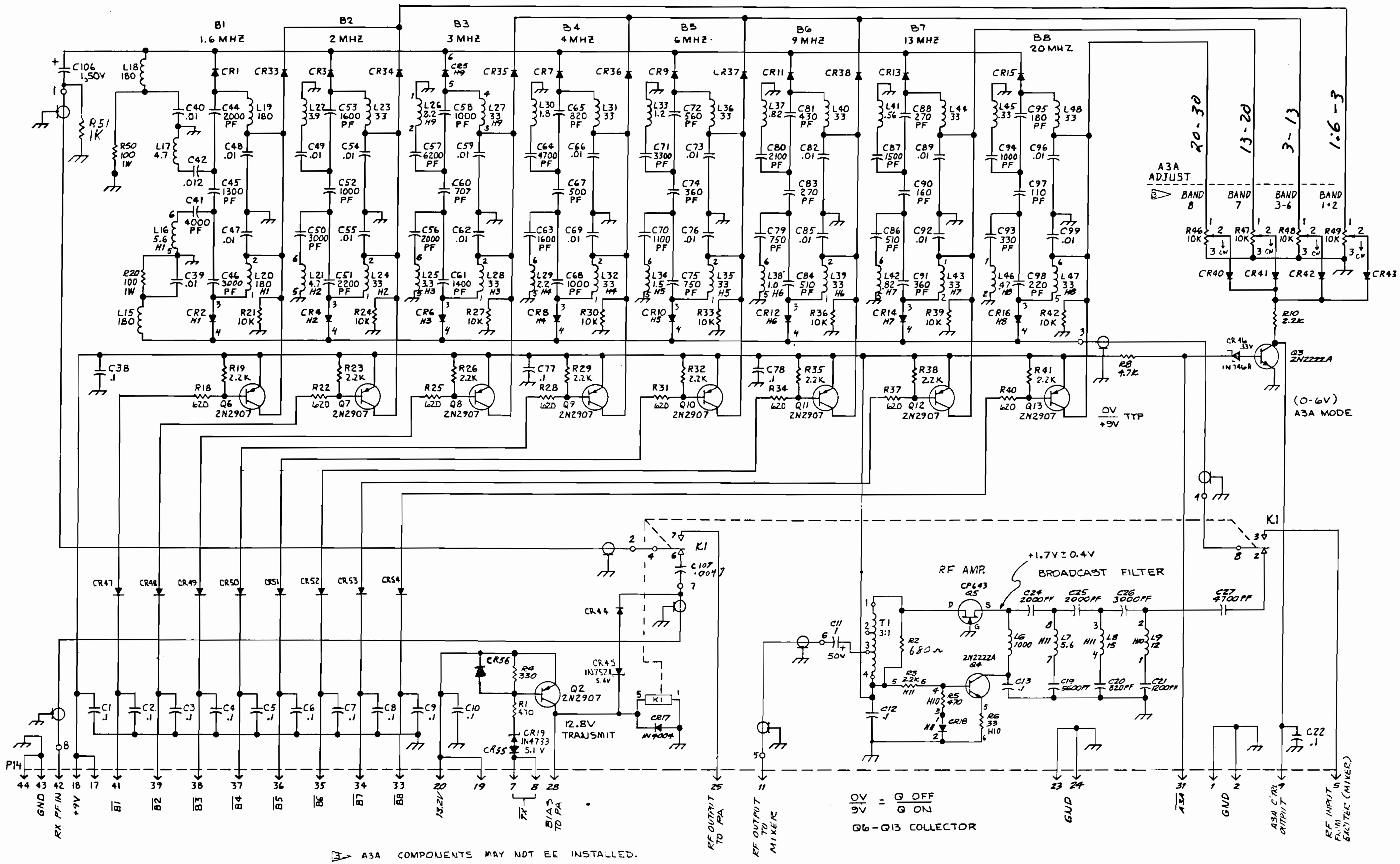
HIGH PASS FILTER
(601086-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-10, C12, C13, C22, C38, C77, C78	Capacitor, .1 μf, 50V	600226-314-008
C11, C106	Capacitor, 1 μf, elec.	600297-314-003
C19	Capacitor, 5600 pf	656013-306-501
C20, C65	Capacitor, 820 pf	682003-306-501
C21	Capacitor, 1200 pf	612013-306-501
C24, C25, C44, C56	Capacitor, 2000 pf	620013-306-501
C26, C46, C50	Capacitor, 3000 pf	630013-306-501
C27, C64	Capacitor, 4700 pf	647014-306-501
C39, C40, C47, C48, C54, C55, C59, C62, C66, C69, C73, C76, C82, C85, C89, C92, C96, C99	Capacitor, .01 μf	600268-314-008
C41	Capacitor, 4000 pf	640011-306-501
C42	Capacitor, .012 μf	600204-314-022
C45	Capacitor, 1300 pf	613014-306-501
C51	Capacitor, 2200 pf	622014-306-501
C52, C58, C68, C94	Capacitor, 1000 pf	610013-306-501
C53, C63	Capacitor, 1600 pf	616014-306-501
C57	Capacitor, 6200 pf	662014-306-501
C60	Capacitor, 707 pf	670703-306-501
C61	Capacitor, 1400 pf	614013-306-501
C67	Capacitor, 500 pf	650001-306-501
C70	Capacitor, 1100 pf	611013-306-501
C71	Capacitor, 3300 pf	633014-306-501
C72	Capacitor, 560 pf	656003-306-501
C74, C91	Capacitor, 360 pf	636003-306-501
C75, C79	Capacitor, 750 pf	675003-306-501
C80	Capacitor, 2100 pf	621011-306-501
C81	Capacitor, 430 pf	643003-306-501
C83, C88	Capacitor, 270 pf	627003-306-501
C84, C86	Capacitor, 510 pf	651004-306-501
C87	Capacitor, 1500 pf	615013-306-501
C90	Capacitor, 160 pf	616003-306-501
C93	Capacitor, 330 pf	633003-306-501
C95	Capacitor, 180 pf	618004-306-501
C97	Capacitor, 110 pf	611004-306-501
C98	Capacitor, 220 pf	622003-306-501
C49	Capacitor, .01 μf	600204-314-001
C107	Capacitor, .0047 μf	600268-314-007

SYMBOL	DESCRIPTION	PART NUMBER
CR1-16	Diode, HP3188	600144-410-001
CR17	Diode, 1N4004	600011-416-002
CR18, CR33-38, CR40-44, CR47-56	Diode, 1N4148	600109-410-001
CR19	Diode, 1N4733, 5.1V	600006-411-006
CR45	Zener, 1N752A, 5.6V	600002-411-007
CR46	Zener, 1N746A, 3.3V	600002-411-001
K1	Relay, 12V	600028-402-006
L6	Choke, 1000 μH	600034-376-001
L7, L16	Choke, 5.6 μH	600125-376-043
L8	Choke, 15 μH	600125-376-013
L9	Choke, 12 μH	600125-376-020
L17, L21	Choke, 4.7 μH	600125-376-030
L15, L18-20	Choke, 180 μH	600125-376-022
L22	Choke, 3.9 μH	600125-376-018
L23, L24, L27, L28, L31, L32, L35, L36, L39, L40, L43, L44, L47, L48	Choke, 33 μH	600125-376-007
L25	Choke, 3.3 μH	600125-376-006
L26, L29	Choke, 2.2 μH	600125-376-016
L30	Choke, 1.8 μH	600125-376-017
L33	Choke, 1.2 μH	600125-376-041
L34	Choke, 1.5 μH	600125-376-033
L37, L42	Choke, .82 μH	600125-376-039
L38	Choke, 1.0 μH	600125-376-040

SYMBOL	DESCRIPTION	PART NUMBER
L41	Choke, .56 μH	600125-376-005
L45	Choke, .33 μH	600125-376-001
L46	Choke, .47 μH	600125-376-027
Q2, Q6-13	Transistor, 2N2907A	600154-413-001
Q3, Q4	Transistor, 2N2222A	600080-413-001
Q5	Transistor, CP643	600340-413-001
R2	Resistor, 2.2k, 1/4W, 5%	622024-341-075
R3, R10	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R4	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R5, R1	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R6	Resistor, 33Ω,, 1/4W, 5%	633094-341-075
R8	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R18, R22, R25, R28, R31, R34, R37, R40,	Resistor, 620Ω, 1/4W, 5%	662004-341-075
R19, R23, R26, R29, R32, R35, R38, R41	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R20, R50	Resistor, 100Ω, 1W, 5%	610004-341-325
R21, R24, R27, R30, R33, R36, R39, R42	Resistor, 10k, 1/4W, 5%	610024-341-325
R46-49	Resistor, 10k, variable	600063-360-010
T1	Transformer, 3:1	600148-512-001

Figure 5.19 High Pass Filter Assembly



NOTES:

1. UNLESS OTHERWISE NOTED:
   RESISTORS ARE IN OHMS, 1/4W, 5%
   CAPACITORS ARE IN MFD
   INDUCTORS ARE IN µHY.
2. DIODE CR17 IS IN4004, CR1-16 ARE HP3188, CR19 IN4728, ALL OTHERS ARE IN4148

Figure 5.20 High Pass Filter Schematic

High Pass Filter Board

1A1A4

Pin Connections and Voltage Readings

1A1A4-J14

GND	1	2	GND
	3	4	
+13 dBm RF(T)	5	6	
$\overline{TX}$	7	8	$\overline{TX}$
0 - 6 VDC (A3A)	9	10	
Rec. RF Output	11	12	
	13	14	
	15	16	
	17	18	
+13.2 VDC	19	20	+13.2 VDC
	21	22	
GND	23	24	GND
+13 dBm RF to PA(T)	25	26	
	27	28	+12.8V
	29	30	
$\overline{A3A}$	31	32	
$\overline{B8}$	33	34	$\overline{B7}$
$\overline{B6}$	35	36	$\overline{B5}$
$\overline{B4}$	37	38	$\overline{B3}$
$\overline{B2}$	39	40	
$\overline{B1}$	41	42	Rec. RF Input
GND	43	44	GND

BOTTOM VIEW

5.11 HIGH LEVEL MIXER BOARD, 1A1A5

5.11.1 GENERAL

The High Level Mixer Board is interchangeable with the Mixer Board, 601075-536, used in the MSR 5050, MSR 8000 and MSR 6700. In receive mode it converts a 0 to 30 MHz RF input to a lst 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 5.21 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 lst mixer, with an amplified LO input of +21 dBm, 50.53 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 lst mixer to the TX amplifier to produce outputs to +15 dBm.

5.11.2 DETAILED DESCRIPTIONS

5.11.2.1 RX Control

With a TTL low at pins 15 and 16, Q8 saturates putting +9V on all RX functions.

5.11.2.2 RF Switch

CR1 is biased to conduction by the current through R1 with L1 and L2 providing a high impedance to the signal path for RF signals. The resulting voltage across R1 biases CR2 off, isolating transmit circuits from the signal path. The input signals are thus conducted through C1, CR1 and C3 to the low pass filter.

5.11.2.3 Low Pass Filter

The Low Pass Filter is a 7-element elliptical design (C4 through C8, L3 and L4) with a cut off frequency of 31 MHz. This filter attenuates out-of-band spurious signals in both receive and transmit.

5.11.2.4 First Mixer

Signals from the Low Pass Filter are applied to pin 1 of the first mixer, MX1, a high level double-balanced diode mixer. These signals (0-30 MHz) are modulated with +21 dBm LO signals)59.53 to 89.53 MHz) applied to pin 8 to produce a first IF of 59.53 MHz at pins 3 and 4.

5.11.2.5 Constant Resistance Network

The Constant Resistance Network provides a 50 ohm load to signals from the mixer at frequencies much greater than the IF frequency. R17 provides the 50 ohm load at high frequencies when C30 is short, and at low frequencies when L14 is short. C29 and L1 are series resonant at 59.53 MHz to couple the

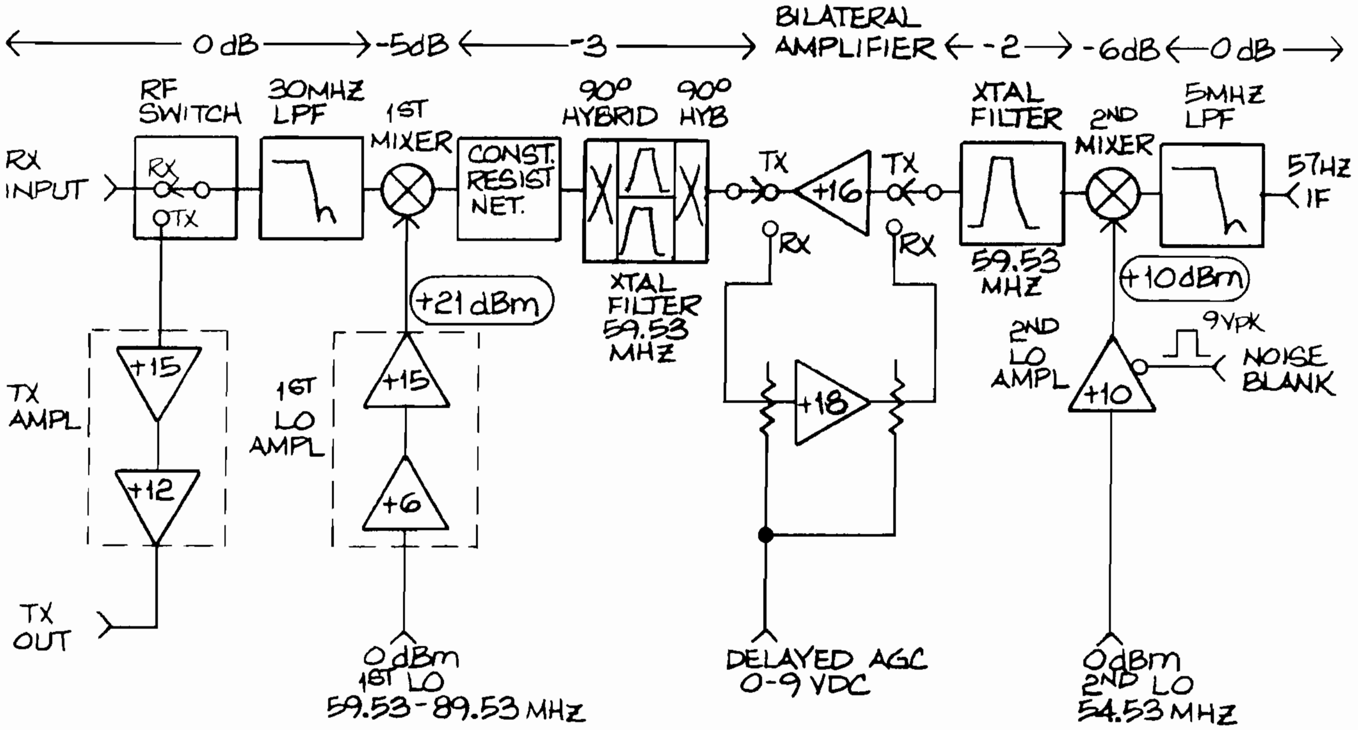


Figure 5.21

Block Diagram
High Level Mixer Board

signal to the 90° hybrid network thus maintaining a 50 ohm load at frequencies near the 59.53 MHz IF.

5.11.2.6 90° Hybrid/Filter Network

This circuit maintains a 50 ohm impedance by phasing equal mismatches from the two identical crystal filters FL1 and FL2 so that they cancel at the circuit input and add across R18 at an isolated port. T3 with C31 and C32 form a quadrature hybrid tuned broadly to 59.53 MHz at a 50 ohm impedance. This circuit splits inputs from L13 to equal outputs at L15 and L16 phased 90° apart. L15 and C33 match the 2.3k ohm filter impedance of FL1. L16 and C34 perform the same function for FL2. Matching back down to 50 ohms is accomplished by L19, C35 and L20, and C36. L17 and L18 are used to tune the residual capacitance across the filters to increase the ultimate rejection. A second 90° hybrid (T4, C37 and C38) adds the signals from each filter. The total loss through the whole hybrid/filter network is typically 3.5 dB.

5.11.2.7 Bilateral Amplifier

The Bilateral Amplifier consists of receive (Q9) and transmit (Q10) amplifiers activated by a 9 volt RX or 9 volt TX control signal. These amplifiers switched into the signal path by CR5, CR9 or CR10, and CR7 allow reverse signal flow in transmit applications since all other circuits are inherently bilateral.

The amplifiers are feedback controlled to maintain a 50 ohm input/output impedance with gain controlled by feedback resistor impedances and the relatively low broad band collector output impedance of 600 ohms.

In receive, the signal flows through C38, CR5 (biased on through L23) and C44 to Q9. Q9 is biased by R21 and R22 with R21 also serving as a feedback resistor. The gain is set to 18 dB by the ratio of the collector load of 600 ohms and the emitter resistor R23. L25 and C45 match the 600 ohm output to 50 ohms with the output routed through pin diode CR9. The bias through switches CR5 and CR9 produces an 8 volt drop across L21, R20 at the input and L30, R30 at the output which reverse biases transmit path pin diode switches CR7 and CR10. The maximum signal level for strong signals is limited by a delayed AGC (DAGC) signal from pins 39 and 40. The DAGC input (0 to 9 volts) biases shunt pin diodes CR4 and CR8 which attenuate the signal at Q9 input and output for a total of 40 dB at 0 volts DAGC. Bias current is limited by resistors R31 and R29. CR11 delays the output attenuation for optimum linearity. The DAGC circuit is necessary to maintain in-band intermodulation rejection of 30 dB at high input signals. The DAGC attenuation varies from 1 dB at 8.3 volts to 40 dB at 0 volts.

In transmit, the circuit of Q10 is connected through CR7, CR10 by the bias produced through L24, L29 by the 9 volt TX signal. The circuit is identical to that of Q9 except for the values of R26 and R28 which produce a 16 dB gain.

5.11.2.8 Crystal Filter

A second crystal filter F13 at 59.53 MHz is required to reject spurious responses due to the second conversion -especially the second IF image at 49.53 MHz. This filter, identical to FL1 and FL2, is matched to 50 ohms input and output by L31, L33 and C55, C56 with ultimate rejection improved by L32.

5.11.2.9 Second Mixer and 5 MHz Filter

The 59.53 first IF signal is converted to a second IF of 5 MHz by a second double-balanced diode mixer, MX2. The 5 MHz output signal is filtered by a 5 MHz low pass filter C62, C63, L36 to reject the 59.53 MHz IF feedthrough, the 54.53 MHz second LO and other undesired mixer outputs.

5.11.2.10 First LO Amplifier

The first LO amplifier produces a +21 dBm signal at MX1 (pin 8) from 0 dBm board inputs from 59.53 to 89.53 MHz at pin 3. Q5 and Q6 are common gate FETS paralleled for a 50 ohm broadband input with a transconductance to produce a 6 dB gain into the 50 ohm load produced by T2. The FETS are self-biased to 10 mA by R16. L8, L9, and C20 form a 40 MHz high pass filter to reduce low frequency LO noise.

Q4 is a grounded emitter amplifier with a 15 dB gain which produces the +21 dBm LO signal required by MX1. Q3 is a bias regulator which maintains the voltage drop across R14 (due to the current of Q4) constant by controlling the base current of Q4 through R15. L12 and C28 broadly tune the output for a relatively flat response from 59.53 to 89.53 MHz. Biased at 100 mA, the amplifier can produce a linear output of 250 milliwatts.

5.11.2.11 Second LO Amplifier

Q11 and Q12 are paralleled JFET's which produce a +10 dBm output at MX2, pin 8 from a 0 dBm 54.53 MHz second LO input at board pin 41. The FETS are self-biased by R32 to 10 milliamperes. L35 and C12 match the 50 ohm level of MX2 to 1.2k ohms at the FET drain to produce a 10 dB gain. With a 9 volt input at board pin 37, Q13 produces an 8 volt bias across R32 which cuts the LO amplifier off (cutoff voltage of Q11, Q12 is 6.5 volts maximum) which in turn cuts the mixer off and thus breaks the signal path. This is used as a noise blanker gate in the MSR 8000 and may be used as a transmit inhibit gate in transmit applications.

5.11.2.12 Transmit Amplifier

Q1 and Q2 are feedback controlled amplifiers which increase the level of signals from the first mixer, MX1, to +17 dBm outputs, 1.6 to 30 MHz at board pin 6. Signals from the mixer, MX1 are routed through the low pass filter (C4-C8, etc.), C3, CR2, C14, and C15 to the base of Q2. Q2 is biased for 2.9 volts at the base by R9, R10, and R11. R7 and R8 produce 30 milliamperes bias current, with R7 setting the gain and R9 controlling the input/output impedance of 50 ohms. Q1 is the identical circuit with values changed to produce a capability of 160 milliwatts linear output. In addition, the base bias is altered to add CR3 which compensates for bias changes with temperature.

5.11.2.13 DC Control

+13 VDC is supplied through L30 to the first LO amplifier circuit. For installations where 13 volts is not connected to the board, CR6 allows the 9 volts to operate the LO circuit at a slightly reduced level. Grounds on pins 7, 8, or 15, 16 saturate the 9 volt TX or 9 volt RX transistor switches (Q7 or Q8) to supply 9 volts to the appropriate circuits.

High Level Mixer Board

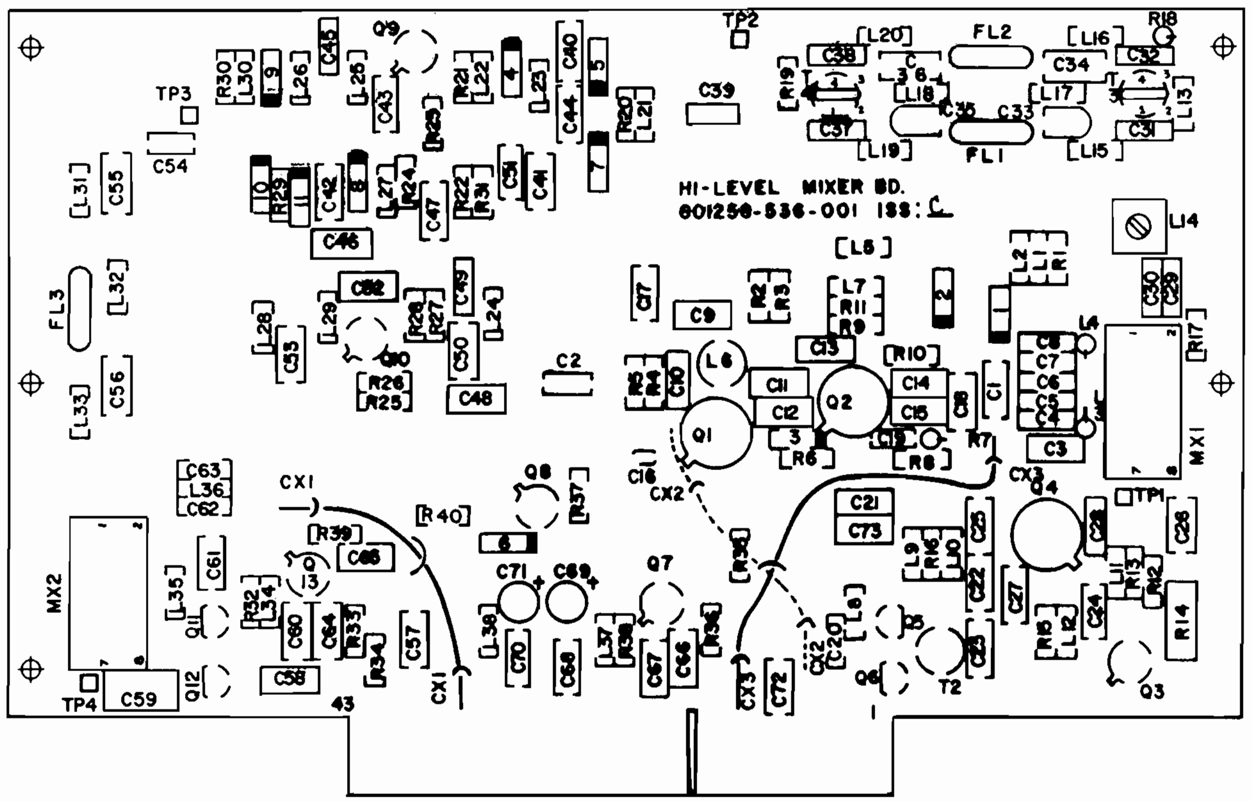
1A1A5

Pin Connections and Voltage Readings

1A1A5-J12

GND	1	2	GND
0 dBm 61.13-89.53 MHz 1st LO	3	4	Logic 1 (Not Used Transceiver)
	5	6	Exciter Out 3 VPP (1.6-30 MHz)T
Logic "0" or 1 $\overline{TX}$	7	8	$\overline{TX}$ Logic "0" or 1
0 - 6 VDC (A3A) ACC Bypass	9	10	
GND	11	12	Mixer Input 1.6-29.999 MHz .2µV-200,000µV(R)
	13	14	
Logic "0" or 1 RX	15	16	$\overline{RX}$ Logic "0" or 1
+9 VDC	17	18	+9 VDC
	19	20	
	21	22	
GND	23	24	GND
GND	25	26	
+13 VDC	27	28	+13 VDC (100 mA)
	29	30	
	31	32	
	33	34	
	35	36	IF In/Out (-120-70 dBm 5 MHz)(R)
(+9Vp) N.B. Gate	37	38	
0 - 9 VDC Delayed AGC	39	40	Delayed AGC 0-9 VDC)
0 dBm 54.53 MHZ 2nd LO	41	42	
GND	43	44	GND

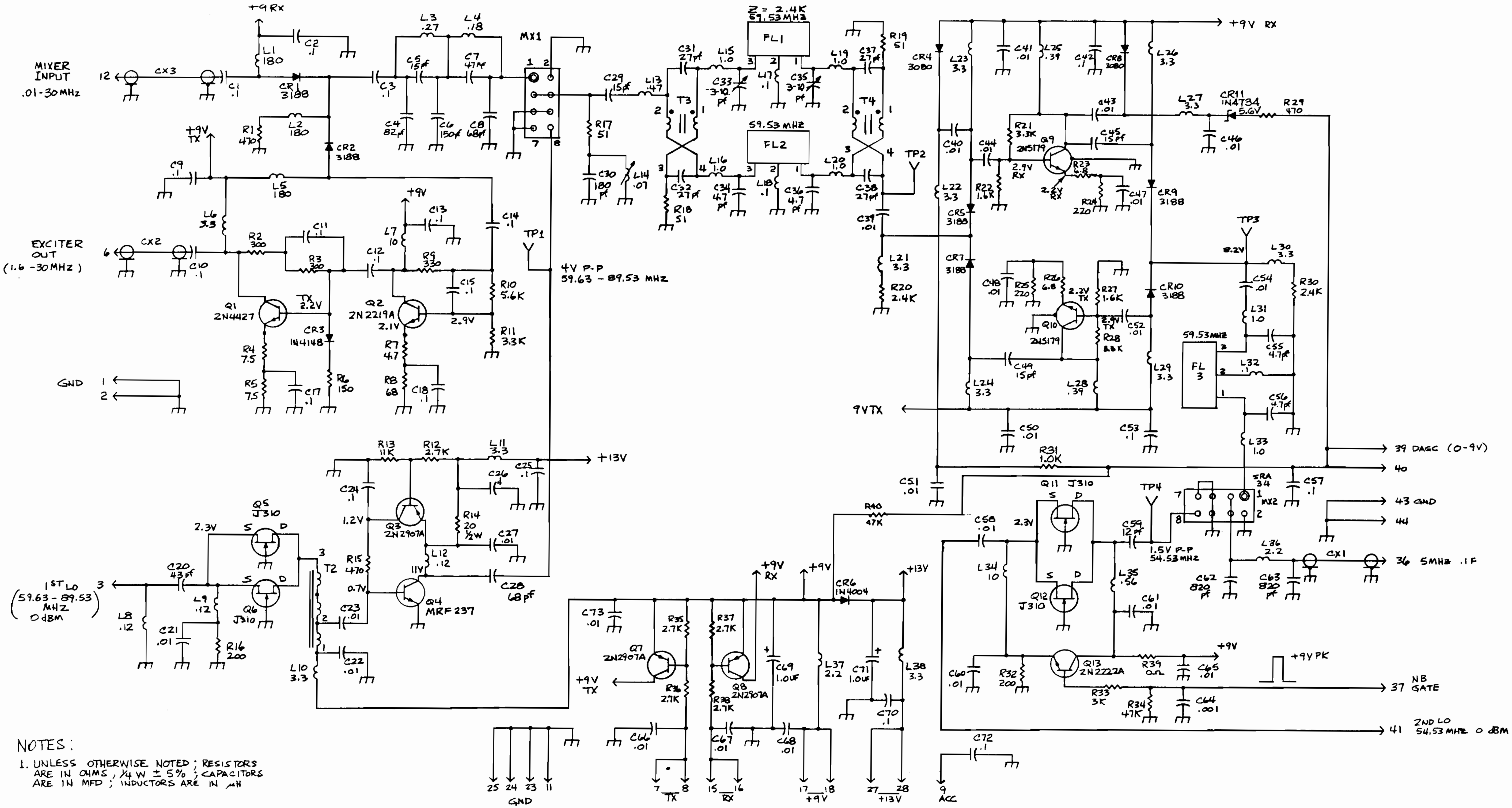
BOTTOM VIEW



HIGH LEVEL MIXER BOARD
(601258-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-3, C9-13, C17, C18, C24-26 C42, C53, C57, C70, C72	Capacitor, .1 μf, 63V	600302-314-013
C4	Capacitor, 82 pf	600369-314-820
C5, C29, C45, C49	Capacitor, 15 pf	600369-314-150
C6	Capacitor, 150 pf	600369-314-151
C7	Capacitor, 47 pf	600369-314-470
C8, C28	Capacitor, 68 pf	600369-314-680
C20	Capacitor, 43 pf	600293-314-430
C21-23, C27, C39-41, C43, C44, C46-48, C50, C52, C54, C58, C60, C61, C65-68, C73	Capacitor, .01 μf, 63V	600302-314-007
C30	Capacitor, 180 pf	600369-314-181
C31, C32, C37, C38	Capacitor, 27 pf	600369-314-270
C34, C36, C55, C56	Capacitor, 4.7 pf	600269-314-005
C59	Capacitor, 12 pf	600369-314-120
C62, C63	Capacitor, 820 pf	600293-314-821
C69, C71	Capacitor, 1 μf, 50V	600297-314-003
C14, C15	Capacitor, .1 μf, 50V	600226-314-008
C33, C35	Capacitor, Variable, 3-10 pf	600052-317-001
CR1, CR2, CR5, CR7, CR9, CR10	Diode, HP3188	600144-410-001
CR3	Diode, 1N4148	600144-410-001
CR4, CR8	Diode, HP3080	600156-410-001
CR6	Diode, 1N4004	600011-416-002
CR11	Diode, 1N4734	600006-411-007
CX1, CX2, CX3	Coax	600100-102-001
FL1-3	Filter, 59.53 MHz	600060-529-004
L1, L2, L5	Choke, 180 μH	600125-376-022
L3	Choke, .27 μH	600125-376-037
L4	Choke, .18 μH	600125-376-031
L6	Choke, 3.3 μH	600072-376-019
L7, L34	Choke, 10 μH	600125-376-032
L8, L9, L12	Choke, .12 μH	600125-376-036
L10, L11, L21-24, L26, L27, L30, L37, L38	Choke, 3.3 μH	600125-376-006
L13	Choke, .47 μH	600125-376-027
L14	Choke, Variable, .07 μH	600243-376-002
L15, L16, L19, L20, L31, L33	Choke, 1.0 μH	600125-376-040
L17, L18, L32	Choke, .1 μH	600125-376-028
L25, L28	Choke, .39 μH	600125-376-004
L35	Choke, .56 μH	600125-376-005
L36, L29	Choke, 2.2 μH	600125-376-016
MX1	Mixer, CHP206	600018-455-001
MX2	Mixer, SRA3H	600007-455-001
Q1	Transformer, 2N4427	600222-413-001
Q2	Transformer, 2N2219A	600082-413-001
Q3, Q7, Q8	Transformer, 2N2907A	600154-413-001
Q4	Transformer, MRF237	600399-413-001
Q5, Q6, Q11, Q12	Transformer, J310	600259-413-001
Q9, Q10	Transformer, 2N5179	600177-413-001
Q13	Transformer, 2N2222	600080-413-001
(Q3, Q7-10, Q13)	Transformer Pad	600025-419-001
(Q2)	Transformer Pad	600017-419-001
R39	Resistor, 0Ω, 1/4W	600000-341-075
R1, R15, R29	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R2, R3	Resistor, 300Ω, 1/4W, 5%	630004-341-075
R4, R5	Resistor, 7.5Ω, 1/4W, 5%	675084-341-075
R6	Resistor, 150Ω, 1/4W, 5%	615004-341-075
R7	Resistor, 4.7Ω, 1/4W, 5%	647084-341-075
R8	Resistor, 68Ω, 1/4W, 5%	668094-341-075
R9	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R10	Resistor, 5.6k, 1/4W, 5%	656014-341-075
R11, R21, R28	Resistor, 3.3k, 1/4W, 5%	633014-341-075
R12, R35-38	Resistor, 2.7k, 1/4W, 5%	627014-341-075
R13	Resistor, 11k, 1/4W, 5%	611024-341-075
R14	Resistor, 20Ω, 1/2W	620094-341-205
R16, R32	Resistor, 200Ω, 1/4W, 5%	620004-341-075
R17-19	Resistor, 51Ω, 1/4W, 5%	651094-341-075
R20, R30	Resistor, 2.4k, 1/4W, 5%	624014-341-075
R24, R25	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R31	Resistor, 1k, 1/4W, 5%	610014-341-075
R33	Resistor, 3k, 1/4W, 5%	630014-341-075
R34, R40	Resistor, 47k, 1/4W, 5%	647024-341-075
R22, R27	Resistor, 1.6k, 1/4W, 5%	616014-341-075
R23, 26	Resistor, 6.8Ω, 1/4W, 5%	668084-341-075
T2	Transformer	600094-512-001
T3, T4	Transformer	600164-513-001

Figure 5.22 High Level Mixer Board Assembly



NOTES:
1. UNLESS OTHERWISE NOTED; RESISTORS ARE IN OHMS, 1/4 W ± 5%; CAPACITORS ARE IN MFD; INDUCTORS ARE IN µH

Figure 5.23 High Level Mixer Board Schematic

5.12 IF FILTER BOARD, 1A1A6

5.12.1 GENERAL

The IF filter board contains the three 5 MHz information filters and amplifiers used in both transmit and receive modes. These filters are: FL1 - upper sideband operation, FL2 - lower sideband operation and FL3 - AM operation. The appropriate filter is selected by diode switching via mode information from the logic board, 1A1A9. During the receive mode, a 5 MHz IF signal from the mixer board, 1A1A5, 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, 1A1A7, 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, 1A1A3, 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, 1A1A5. 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 stages. Figures 5.24 and 5.25 show the assembly and schematic of this board.

5.12.2 DETAILED DESCRIPTION

5.12.2.1 Filter Selection

The filters are selected by placing a ground (logic 0) on certain pins on the connector. FL1 is used to receive USB and also to transmit USB. (The pass band is on the lower side of 5 MHz, but the signal is transferred to the high side in the mixer.) When USB is selected, a ground is placed on pin 35 of P10. This action causes current to flow through R36, CR10, L14 and CR4. Diode CR10 is connected to the common receive input line (CR3, C20) and when it conducts, the signal is applied to the input to FL1. In a similar manner, the ground on pin 35 causes current to flow through R37, CR13, L19, L11 and CR4. When CR13 is conducting, the output of FL1 is connected to the common output line (C35, CR15 and CR17).

It should be noted that CR11 and CR12, used to short out the filter input and output if the filter is not selected, are cut off by R35 and R20. When FL1 is not selected, current through R23, CR11 and CR12 shorts out the filter input and output. Note also, when FL1 is selected, FL2 and FL3 are shorted out. FL2 is selected on pin 37 (LSB). FL3 is selected by a ground on pin 31 (AM). The ground on pin 31 causes Q5 to conduct, selecting the AM filter. During transmit AM (AMT), pin 33 selects the USB operational filter (FL1).

5.12.2.2 Receive Path

The receive input is on pin 36. The input of U3C is matched to 50 ohms by L2 and C3. The signal is amplified by U3C and U3D, the gain of this combination is approximately 20 dB. An ISB output is provided on pin 41 through R1 and C61. The output of U3D is fed through R10, C16 and CR3 to the inputs of the filters. R10 is selected to provide a 50 ohm driving source for the filters. R19 is connected to receive +9 volts through L8 and determines the amount of turn on current through CR3. C4 is used to cancel some inductive reactance and compensate the driving impedance for the filters. The amplified input signal

passes through CR3 and the selected filter. At the output of the filters, the signal passes through C35 and CR19 into the input of U1, the first receive amplifier. R38 determines the turn on current for CR19. C73 is a compensating capacitor to provide a 50 ohm load for the filter termination. (C63 and R39 provide the primary filter terminating impedance.)

The filter output is amplified in U1 and U2, which are AGC controlled. The AGC input is applied to pin 12. As pin 12 voltage is increased above +4 VDC, the gain is decreased. The output from U2 is fed to Q3 and Q4 for further amplification. The overall receive gain is set by adjusting R31. 50 μV input will provide 100,000 μV output at pin 5. In the transceiver, R31 is adjusted to have an AGC threshold of 6 to 8 microvolts input to the receiver. The precise setting of R31 is therefore a function of the transceiver front end gain.

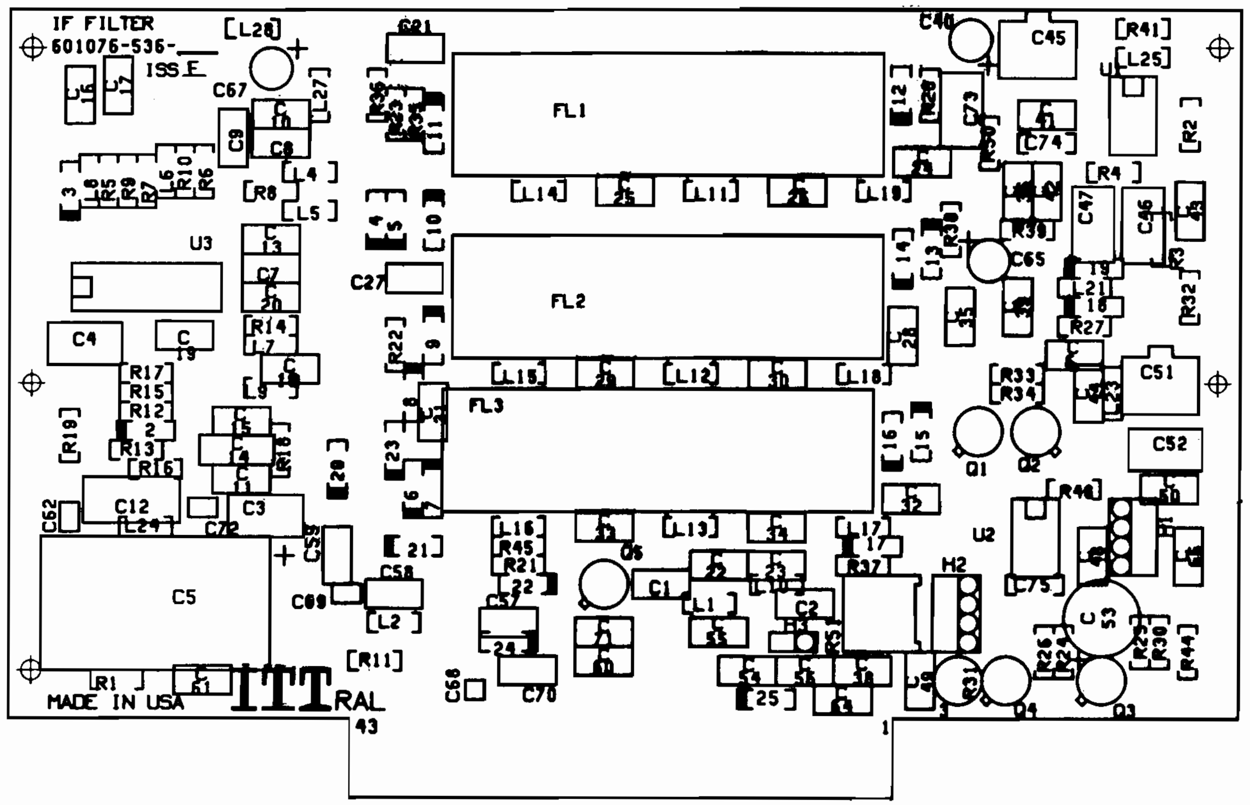
5.12.2.3 Transmit Path

The double sideband input to the IF filter board is applied to pin 4 and passes through C38 and CR18 to the common filter input/output line. CR18 is turned on by the voltage on the T line which is at +9 VDC during the TX mode. The transmit double side input passes through the selected filter and through C20, CR2, C15, C14 and to the base (pin 4) of U3A. U3A is a variable gain amplifier, the gain controlled by the TGC voltage applied to pin 42. The maximum gain of U3A occurs when the TGC voltage is 5.5 volts and decreases as the voltage is lowered. During normal transmit operation, the TGC voltage is between 3.8 and 4.2 volts. The filtered double sideband signal is amplified in U3A and U3B and fed to the output on pin 38. This output is used to drive the mixer.

The overall transmit gain from pin 4 to pin 38 is from 6 to 12 dB, depending on the TGC voltage applied during normal operation. R11 is used to isolate the transmit output when two IF boards are used for ISB operation. AM carrier is inserted through C12 to pin 4 of U3A. It should be noted that the ratio of AM and USB is established on pin 4 of U3A and will remain constant because the TGC voltage controls both components of the signal in AME operation.

5.12.2.4 Miscellaneous Circuitry

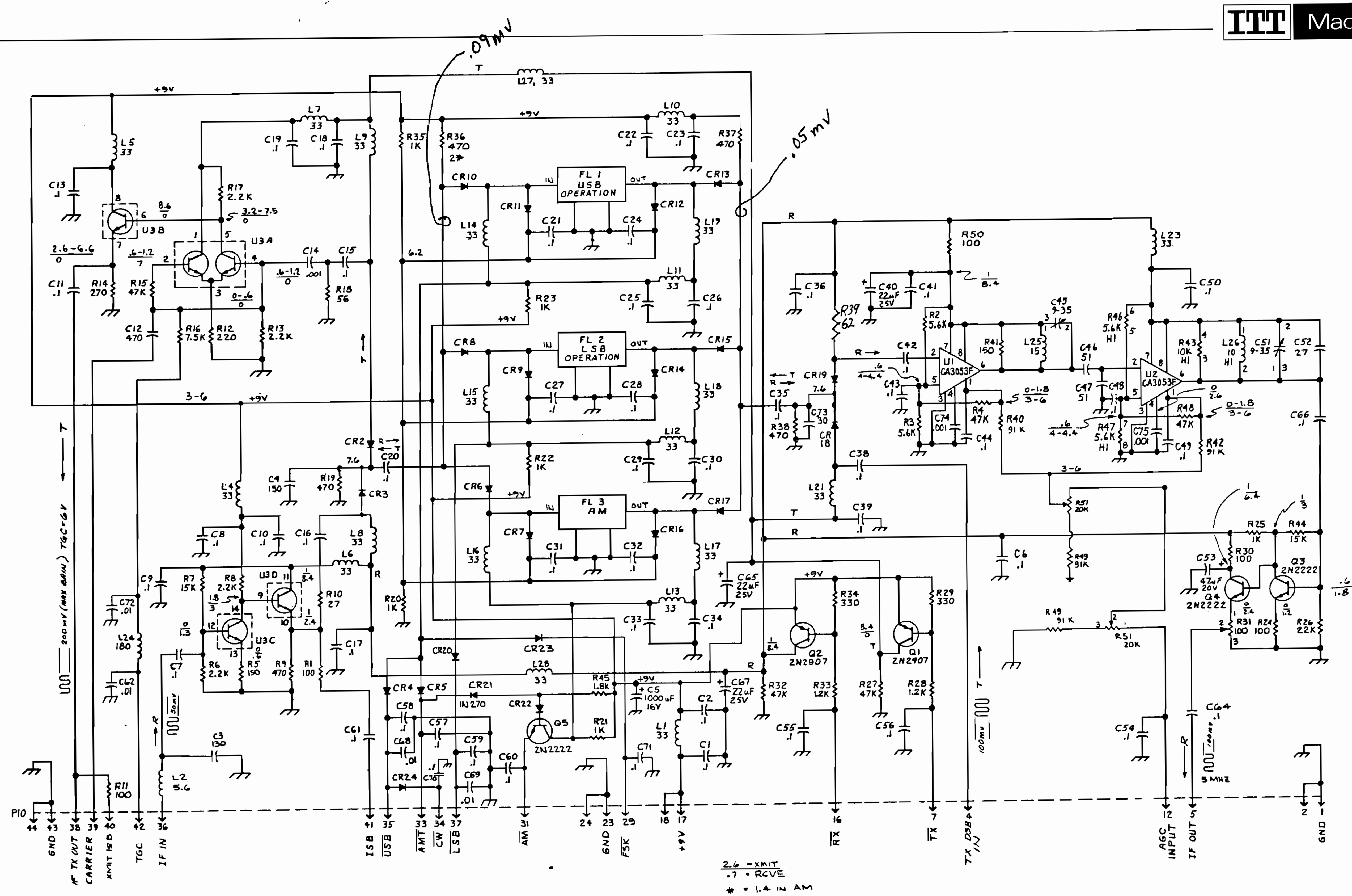
Q1 is the transmit switch and is activated when a logic 0 is placed on pin 7. The collector of Q1 rises to +9 volts and conditions the board for transmit operation. In a similar manner, a logic 0 on pin 16 causes +9 volts on the collector of Q2 and the board is conditioned for receive operation. Capacitors such as C62, C72, C55, C54, etc. are RF bypasses. L24 is used in the TGC line to prevent feedback from the PA causing transmitter loop oscillation.



FILTER/IF AMPLIFIER
(601076-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C2, C6-11, C13, C15-36, C38, C39, C41-44, C48-50, C54-C61, C64, C66, C70, C71	Capacitor, .1 µf, 50V	600226-314-008
C3	Capacitor, 130 pf	613003-306-501
C4	Capacitor, 150 pf	615003-306-501
C5	Capacitor, 1000 µf, 16V	600259-314-007
C12	Capacitor, 470 pf, 5%	647004-306-501
C14	Capacitor, .001 µf	600189-314-014
C40, C65, C67	Capacitor, 22 µf, 25V	600297-314-016
C45, C51	Capacitor, 9-35 pf, Variable	600018-317-013
C46, C47	Capacitor, 51 pf	651093-306-501
C52	Capacitor, 27 pf	627094-306-501
C53	Capacitor, 47 µf, 50V	600297-314-026
C62, C68, C69, C72	Capacitor, .01 µf, 50V	600268-314-008
C73	Capacitor, 30 pf	630094-306-501
C74, C75	Capacitor, .001 µf, 50V	600272-314-004
CR3-7, CR9, CR11, CR12, CR14, CR16-20, CR22-25	Diode, 1N4148	600109-410-001
CR21	Diode, 1N270	600052-410-001
CR2, CR8, CR10, CR13, CR15	Diode, HP3188	600144-410-001
FL2 (LSB)	Crystal Filter	600083-529-001
FL1 (USB)	Crystal Filter	600084-529-001
FL3	Crystal Filter	600082-529-001
H3	Vertical Mounting, 1 Pos.	600064-419-005
L1, L4-19, L21, L27, L28	Choke, 33 µH	600125-376-007
L2	Choke, 5.6 µH	600125-376-043
L24	Choke, 180 µH	600125-376-022
L25	Choke, 15 µH	600125-376-013
L26	Choke, 10 µH	600125-376-032
Q1, Q2	Transistor, 2N2907A	600154-413-001
Q3, Q4, Q5	Transistor, 2N2222A	600080-413-001
R1, R24, R30, R50	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R16	Resistor, 7.5k, 1/4W, 5%	675014-341-075
R49	Resistor, 68k, 1/4W, 5%	668024-341-075
R6, R8, R13, R17	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R7, R44	Resistor, 15k, 1/4W, 5%	615024-341-075
R9, R19, R36-38	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R10	Resistor, 27Ω, 1/4W, 5%	627094-341-075
R12	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R14	Resistor, 270Ω, 1/4W, 5%	627004-341-075
R4, R15, R27, R32, R48	Resistor, 47k, 1/4W, 5%	647024-341-075
R18, R39	Resistor, 62Ω, 1/4W, 5%	662094-341-075
R20-23, R25, R35	Resistor, 1k, 1/4W, 5%	610014-341-075
R26	Resistor, 22k, 1/4W, 5%	622024-341-075
R2, R3, R46, R47	Resistor, 5.6K, 1/4W, 5%	656014-341-075
R28, R33	Resistor, 1.2k, 1/4W, 5%	612014-341-075
R29, R34	Resistor, 330Ω, 1/4W, 5%%	633004-341-075
R31	Resistor, 100Ω, Variable	600061-360-004
R51	Resistor, 20k, Variable	600072-360-011
R40, R42	Resistor, 62k, 1/4W, 5%	662024-341-075
R45	Resistor, 1.8k, 1/4W, 5%	618014-341-075
R5	Resistor, 150Ω, 1/4W, 5%	615004-341-075
R43	Resistor, 10k, 1/4W, 5%	610024-341-075
R41	Resistor, 270Ω, 1/2W, 5%	656094-341-075
U1, U2	IC, CA3053F	600270-415-001
U3	IC, CA3045	600038-415-001

Figure 5.24 Filter/IF Amplifier Assembly



NOTES:
1. UNLESS OTHERWISE NOTED:
RESISTOR ARE IN OHMS, 1/4 W, ±5%;
CAPACITOR VALUES ONE OR GREATER ARE IN PICOFARADS (pF), VALUES LESS THAN ONE ARE MICROFARARADS (μF);
CHOKES ARE IN MICROHENRIES (μH);
U3 IS A CA3045; DIODES ARE IN4148.

Figure 5.25 Filter/IF Amplifier Schematic

IF Filter Board

1A1A6

Pin Connections and Voltage Readings

1A1A6-J10

GND	1	2	GND
	3	4	TX DSB In 100 mVPP
100 mVPP IF Out(R)	5	6	
Logic "0" or 1 $\overline{\text{TX}}$	7	8	
	9	10	
	11	12	AGC Input +3 - +6 VDC(R)
	13	14	
	15	16	$\overline{\text{RX}}$ Logic "0" or 1
+9 VDC	17	18	+9 VDC
	19	20	
	21	22	
GND	23	24	GND
	25	26	
	27	28	
Logic "0" or 1 $\overline{\text{FSK}}$	29	30	
Logic "0" or 1 $\overline{\text{AM}}$	31	32	
Logic "0" or 1 $\overline{\text{AMT}}$	33	34	$\overline{\text{CW}}$ Logic "0" or 1
Logic "0" or 1 $\overline{\text{USB}}$	35	36	Rec. IF In 50 mVPP
Logic "0" or 1 $\overline{\text{LSB}}$	37	38	5 MHz TX IF Out 200 MvPP(T)
(AMT) -18 - 25 dBm 5 MHz	39	40	ISB IF Out 200 mVPP(T)
ISB Out (Not Used)	41	42	TGC +2.9 - +3.9 VDC(T)
GND	43	44	GND

BOTTOM VIEW

5.13 AUDIO/SQUELCH BOARD, 1A1A7

5.13.1 GENERAL

The audio/squelch board, Figures 5.26/27, is used in the receive mode only. This board accepts the 5 MHz IF output from the IF filter board, 1A1A6, and performs the final detector function to convert the intermediate frequency signal into usable audio intelligence. This process involves two discrete, but not simultaneous, detector functions,. A product detector is operative in all modes except the AME mode. In the AME mode, an envelope detector is operative. Two separate audio outputs are provided. A 600 ohm line audio output is applied to the rear panel connector, 1A3J24, and a low level output is applied to the speaker/driver board, 1A1A8, to provide the front panel speaker and headphones/headset audio.

Located on this board are an input IF amplifier, AGC detector and amplifier, AM/product detector, squelch amplifiers and gating circuitry. (In the all modes, AGC voltage is derived from the 5 MHz carrier by CR3 and CR4, and is amplified by Q3. Fast attack, fast decay is used for AM, FSK and CW signals, and fast attack, slow decay is used for sideband signals. AGC voltage to the IF filter board, 1A1A6, and delayed AGC voltage to the mixer board 1A1A5, controls the receiver gain.

Other circuitry and functions through this board are side tone and mute functions. The rear panel audio (600 ohm) is unaffected by operation of the squelch control.

5.13.2 DETAILED DESCRIPTIONS

5.13.2.1 Input IF Amplifier and AGC Amplifier

Q2 is an input amplifier that accepts the IF input on pin 5, amplifies and drives Q10, an emitter follower. The follower is used to provide a low driving impedance for the AGC detector and the product detector. The output of Q10 is rectified in the voltage doubler C4, CR3 and CR4. The rectified DC, applied between the emitter and base of Q3, causes Q3 to conduct, causing current to flow through R1 and R5. The positive going emitter voltage of Q3 is fed through CR17 to pin 11. This AGC voltage is used to reduce the gain of the IF filter board. The AGC voltage drives Q1 through R5, generating a negative going delayed AGC on pin 40. The front panel meter is driven through R2 and CR2. The delayed AGC is used to control the gain of the mixer and is used for large input signals. R5 is adjusted so Q1 collector voltage is +3 VDC when 100,000 μV are applied at the antenna.

5.13.2.2 Product Detector and AM Detector

The product detector consists of U1A, U1B and U1C. The output of Q10 is fed through C17 to pin 2 of U1A. The third LO, from pin 12, is applied via C16, to the base (pin 12) of U1C. Since U1A emitters are connected in series with U1C, the third LO modulates the current through U1A, causing a mixing action. Audio voltage is developed in the collector circuit (pin 5) and the 5 MHz is filtered by C19. The detected audio is fed through U1B and U1D to drive other circuits. It should be noted that in USB or LSB, the collector load for U1A is R23 in parallel with R22. A logic 0 on pin 35 or 37 will cause Q6 to conduct, applying +9 volts through CR7 and R23. During AM operation, Q6 is cut off and the collector load for U1A is R22 only. Also, the third LO input is attenuated 40 dB. For AM detection U1A operates as an envelope detector. When Q6 is cut off, R18 causes current to flow through CR1 and R13. This action further reduces the amount of the third LO present during AM operation.

5.13.2.3 600 Ohm Line Driver

The product detector/AM detector output is fed through emitter follower U1B to C39 and R54. R54 is adjusted to provide the proper output on pin 14 and pin 6. The output of R54 is fed through C40 and R53 to pin 6 of U4A. U4A and Q7 further amplify the signal and the floating 600 ohm output is developed across T1 pin 1 and 3. It should be noted that the DC input to transformer T1 is on pin 5. Q7 current flowing from pin 5 to 4 is balanced by R42 current flowing from pin 5 to 6. This configuration prevents T1 from being saturated by the DC current of T1. The nominal output of the line driver is 0 dBm, but is adjustable to +10 dBm.

5.13.2.4 Squelch Amplifier

The squelch amplifier consists of C20, R25, U4B, Q8, CR9, CR10 and associated components. The audio output from U1B drives through C20 and R25 to pin 3 of U4B. U4B is operated as a variable gain amplifier. The gain variation is achieved by removing negative feedback (reducing negative feedback increases gain) with C23. The front panel squelch (pin 10) applies a positive voltage from +5 to +9 VDC to CR11. This voltage, applied to the gate of Q8, causes Q8 to act as a variable resistor.

As the resistance between the source and the drain of Q8 is lowered, C23 reduces the amount of negative feedback applied to U4B, pin 2, causing U4B gain to increase. Voltage divider R27 and CR16 assures that the source voltage will be greater than the pinch off voltage of Q8. This assures that Q8 will be cut off with no input to its gate. CR14, R35, CR15 and R37 force the anode of CR9 to be more positive when the squelch controls are maximum counterclockwise. This action assures that the audio gate will be open for any signal condition when the squelch control is fully counterclockwise. It should be noted that the feedback network for U4B is frequency selective (R31 and C25) and the amplifier has maximum gain at approximately 300 Hz.

The output of U4B (pin 1) is rectified in voltage doubler C44, CR9 and CR10. This DC is applied to pin 13 of U2. When pin 13 rises about 4.5 volts, the audio gate opens and audio is passed through to Pin 3. The squelch time constant is determined by C28 and R35. R50 and CR18 act as a clamp to limit the excursion of the audio gate voltage, thereby decreases the decay time of the squelch voltage. The N.B. ON input on pin 28 (+9V) forces the squelch gate to be open anytime the noise blanker is on.

5.13.2.5 Audio Squelch Gate and Output Amplifier

U1D accepts the output from the product detector and drives the audio gate, U2. The audio gate can be controlled by the squelch or the audio mute line, pin 32.

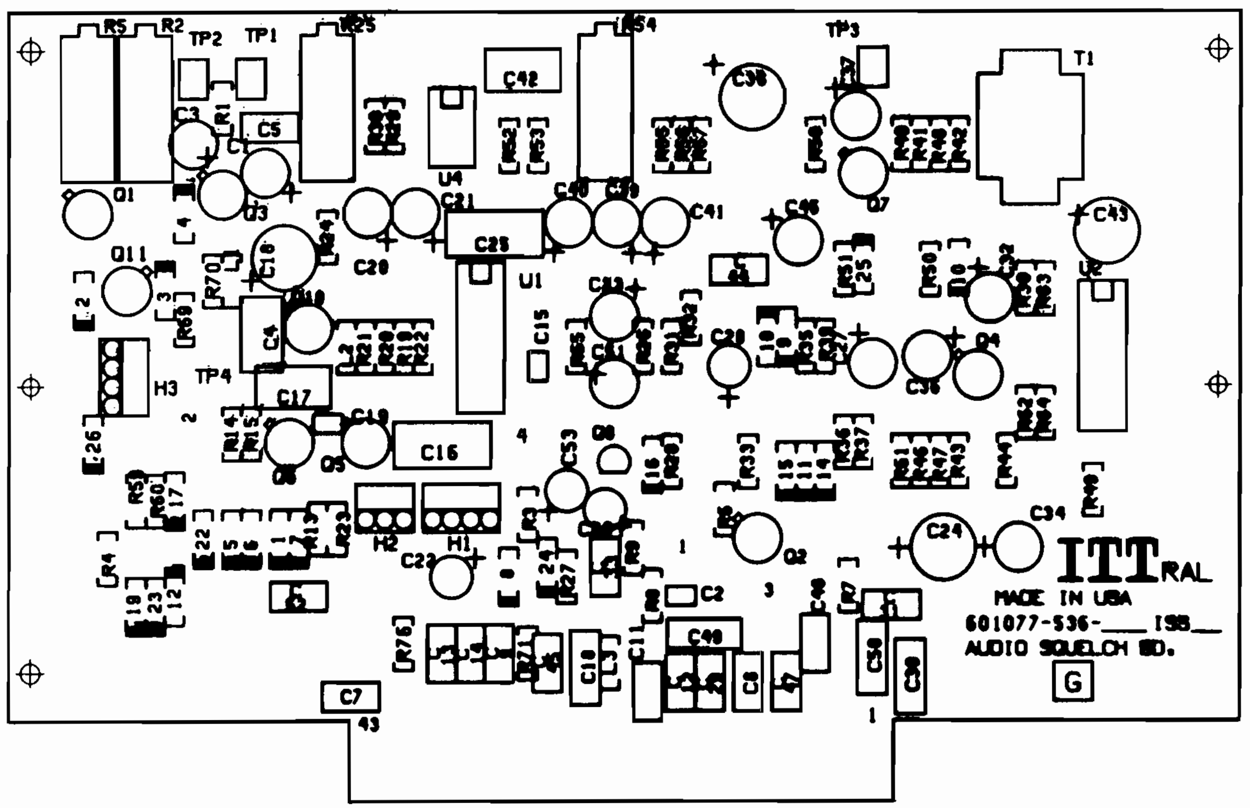
The audio passes through C46, R38, pin 1 of U2, through SWA, out on pin 2 of U2 and into SWB on pin 3. The output of SWB, pin 4, drives the base of Q4 through C32. SWA or SWB of U2 can be closed to kill the speaker audio output. A logic 0 on the mute line will cause pin 5 of U2 U2 to decrease to below +4 VDC and the audio will be killed. The mute line is used to kill the audio during the antenna coupler tuning mode, or any time the synthesizer losses lock (for example, when changing bands). Audio amplifier Q4 can also be driven from the side tone input on pin 27. The side tone input comes from the transmit modulator board and is used during the CW mode to provide aural monitoring of CW keying.

5.13.2.6 Miscellaneous Circuitry

Q5 is the Receive switch and is energized when a logic 0 is placed on pin 15. When Q5 is turned on, +9 volts is applied to most circuitry on the board. Note that Q4 is active in transmit as well as receive because of the side tone requirement. Q6 is a DC Mode switch and is turned on in LSB, USB, or FSK.

5.13.2.7 AGC Time Constants

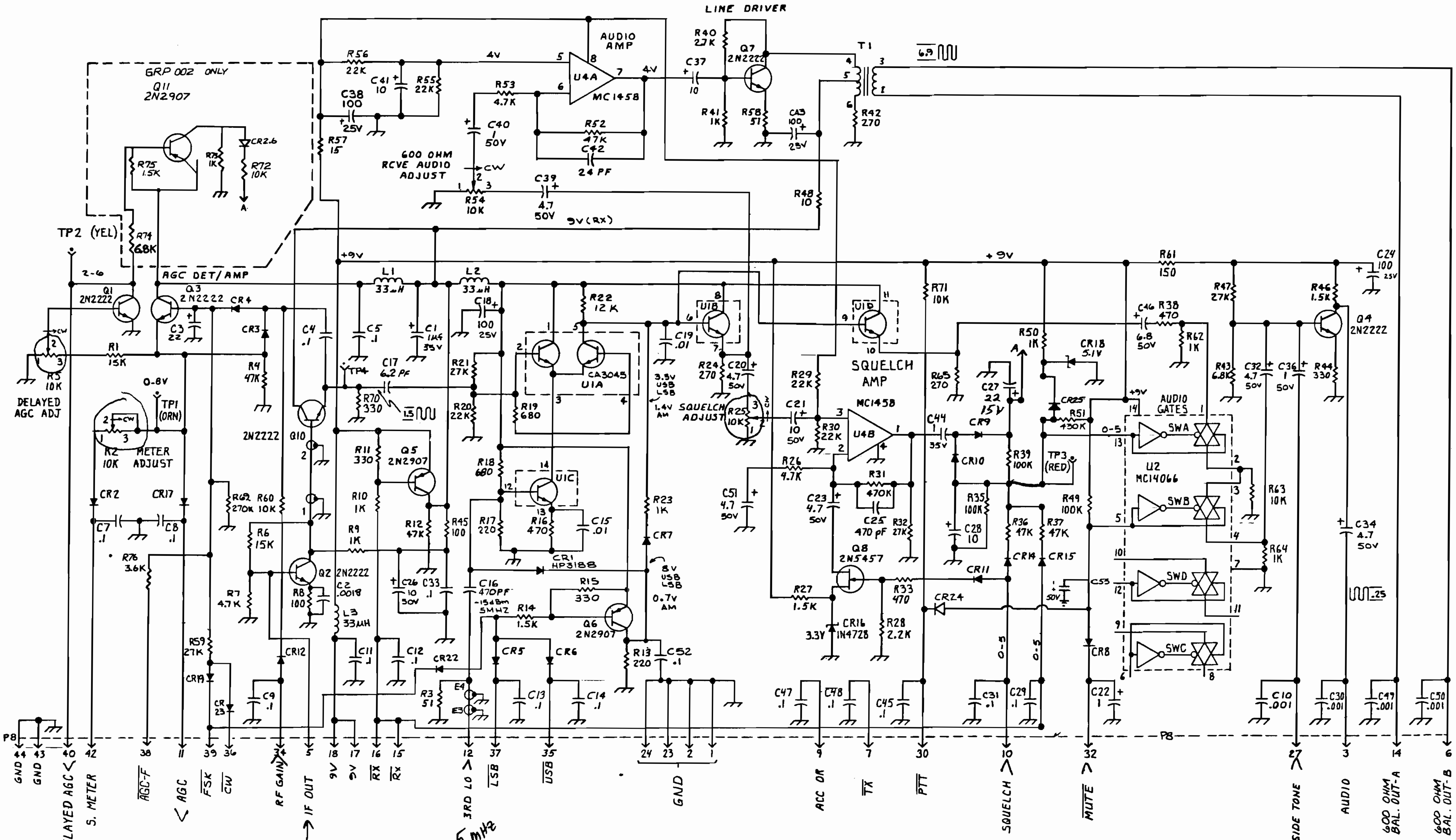
For USB, LSB or AM, the AGC time constant is determined by C3 and R69. When operating in FSK or CW, the time constant is C3 and R59 in parallel with R69. The AGC amplifier has a fast attack and a slow decay. The decay time is decreased in FSK or CW.



AUDIO/SQUELCH BOARD
(601077-536-002)

SYMBOL	DESCRIPTION	PART NUMBER
C1	Capacitor, 1 µf, 35V	600202-314-007
C2	Capacitor, .0018 µf	600268-314-002
C21, C26, C28, C37, C41	Capacitor, 10 µf	600297-314-013
C4, C5, C7-9, C11-14, C29, C31, C33, C45, C47, C48, C52	Capacitor, 0.1 µf, 50V	600226-314-008
C10, C30, C49, C50	Capacitor, .001 µf	600189-314-014
C15, C19	Capacitor, .01 µf	600268-314-008
C17	Capacitor, 6.2 pf	662081-306-501
C18, C24, C38, C43	Capacitor, 100 µf, 25V	600297-314-032
C20, C23, C32, C34, C39, C51	Capacitor, 4.7 µf, 50V	600297-314-010
C16, C25	Capacitor, 470 pf	647003-306-501
C27	Capacitor, 22 µf, Tant	600202-314-022
C22, C36, C40, C53	Capacitor, 1 µf, 50V	600297-314-003
C42	Capacitor, 24 pf	624094-306-501
C46	Capacitor, 6.8 µf, 50V	600297-314-012
C3	Capacitor, 22 µf, 25V	600297-314-016
C27	Capacitor, 4.7 µf, Tant	600202-314-014
C44	Capacitor, 1 µf, Mono	600226-314-014
CR1	Diode, HP3188	600144-410-001
CR2-12, CR14, CR15, CR17, CR19, CR22-25	Diode, 1N4148	600109-410-001
CR16	Diode, 1N4728A	600006-411-001
CR18	Diode, 1N751A	600002-411-006
L1, L2, L3	Choke, 33 µH	600125-376-007
Q1-4, Q7, Q10	Transformer, 2N2222A	600080-413-001
Q5, Q6, Q11	Transformer, 2N2907A	600154-413-001
Q8	Transformer, 2N5457	600182-413-001
(Q1-7, Q10, Q11)	Transformer Pad, T018	600025-419-001
R2, R5, R25, R54	Resistor, 10k, Variable	600063-360-010
R3, R58	Resistor, 51Ω, 1/4W, 5%	651094-341-075
R4, R12, R36, R37, R52	Resistor, 47k, 1/4W, 5%	647024-341-075
R1, R6	Resistor, 15k, 1/4W, 5%	615024-341-075
R7, R26, R53	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R8, R45	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R9, R10, R23, R41, R50, R62, R64, R73	Resistor, 1k, 1/4W, 5%	610014-341-075
R11, R15, R44, R70	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R14, R27, R46	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R24, R42, R65	Resistor, 270Ω, 1/4W, 5%	627004-341-075
R28	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R69	Resistor, 270k, 1/4W, 5%	627034-341-075
R18, R19	Resistor, 680Ω, 1/4W, 5%	668004-341-075
R20, R29, R30, R55, R56	Resistor, 22k, 1/4W, 5%	622024-341-075
R21, R32, R59, R47	Resistor, 27k, 1/4W, 5%	627024-341-075
R40	Resistor, 2.7k, 1/4W, 5%	627014-341-075
R31	Resistor, 470k, 1/4W, 5%	647034-341-075
R33, R38, R16	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R35, R39, R49	Resistor, 100k, 1/4W, 5%	610034-341-075
R60, R63, R71	Resistor, 10k, 1/4W, 5%	610024-341-075
R43, R74	Resistor, 6.8k, 1/4W, 5%	668014-341-075
R48	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R51	Resistor, 430k, 1/4W, 5%	643034-341-075
R57	Resistor, 15Ω, 1/4W, 5%	615094-341-075
R61	Resistor, 150Ω, 1/4W, 5%	615004-341-075
R13, R17	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R22	Resistor, 12k, 1/4W, 5%	612024-341-075
R76	Resistor, 3.6k, 1/4W, 5%	636014-341-075
R75	Resistor, 1.2K, 1/4W, 5%	612014-341-075
R58	Resistor, 51Ω, 1/4W, 5%	651094-341-075
R60, R63, R71, R72	Resistor, 10k, 1/4W, 5%	610024-341-075
T1	Transformer	635234-501-001
U1	I.C., CA3045	600038-415-001
U2	I.C., 4066BDC	600186-415-101
U4	I.C., CA1458	600039-415-001

Figure 5.26 Audio/Squelch Assembly



NOTES:
1. UNLESS OTHERWISE NOTED.
RESISTORS ARE IN OHMS, 1/4 W, ±5%
CAPACITORS ARE IN MFD
DIODES ARE IN4148

Figure 5.27 Audio/Squelch Schematic

ITT Mackay

Audio/Squelch Board

1A1A7

Pin Connections and Voltage Readings

1A1A7-J8

GND	1	2	GND
.3-3 kHz 0-0.15 VRMS Audio	3	4	
5 MHz -29 dBm IF In	5	6	600Ω Rec. Audio Out 0-2.4 VRMS
Logic "0" or 1 $\overline{\text{TX}}$	7	8	
0 - +6 VDC (A3A) ACC "OR"	9	10	F.P. Squelch 0 - +9 VDC
0 - +6 VDC AGC(R)	11	12	3rd LO In -15 dBm 5 MHz
0 - +9 VDC Ext. Squelch*	13	14	600Ω Rec. Audio Out 0-2.4 VRMS
Logic "0" or 1 $\overline{\text{RX}}$	15	16	$\overline{\text{RX}}$ Logic "0" or 1
+9 VDC	17	18	+9 VDC
	19	20	
	21	22	
GND	23	24	GND
	25	26	
1 kHz .05-2.0 VRMS Sidetone	27	28	N.B. On Logic "0" or 1
	29	30	$\overline{\text{PTT}}$ Logic "0" or 1
	31	32	$\overline{\text{MUTE}}$ Logic "0" or 1
	33	34	"RF" Gain 0 - +9 VDC
Logic "0" or 1 $\overline{\text{USB}}$	35	36	$\overline{\text{CW}}$ Logic "0" or 1
Logic "0" or 1 $\overline{\text{LSB}}$	37	38	
Logic "0" or 1 $\overline{\text{FSK}}$	39	40	Delayed AGC +2 - +6 VDC(R)
	41	42	"S" MTR 0 - +6 VDC(R)
GND	43	44	GND

BOTTOM VIEW

*Option Normally Not Used

5.14 SPEAKER/DRIVER BOARD, 1A1A8

5.14.1 GENERAL

The speaker/driver board, Figures 5.27/28, contains the four watt speaker amplifier, DC volume control circuit, tuning beep generator and channel number buffers. Audio from the audio/squelch board, 1A1A7, is applied to this board through an opto-coupler. The resistance of this opto-coupler and thus the output of the speaker/driver IC, U3, is a function of the setting of the volume control located on the front panel, 1A2. As the volume control is supplying a variable DC voltage only, hum and noise rejection of the audio amplifier is exceptionally good. The beep tone, when enabled by the function ENABLE/DISABLE switch, 1A1A9-S1-3, causes a dual timer U2 to generate 2 kHz "beeps", as the remote antenna coupler is operated. The amplitude of the beeps can be adjusted by the volume control. The channel number buffers located on this board buffer the BCD channel number information from the logic board, 1A1A9, before it is routed to the rear panel accessory connector 1A3-J25. The audio output from this board drives the front panel speaker, 1A2-LS1, the headphone jack, 1A2-J32, and the audio output pin of the microphone jack, 1A2-J34.

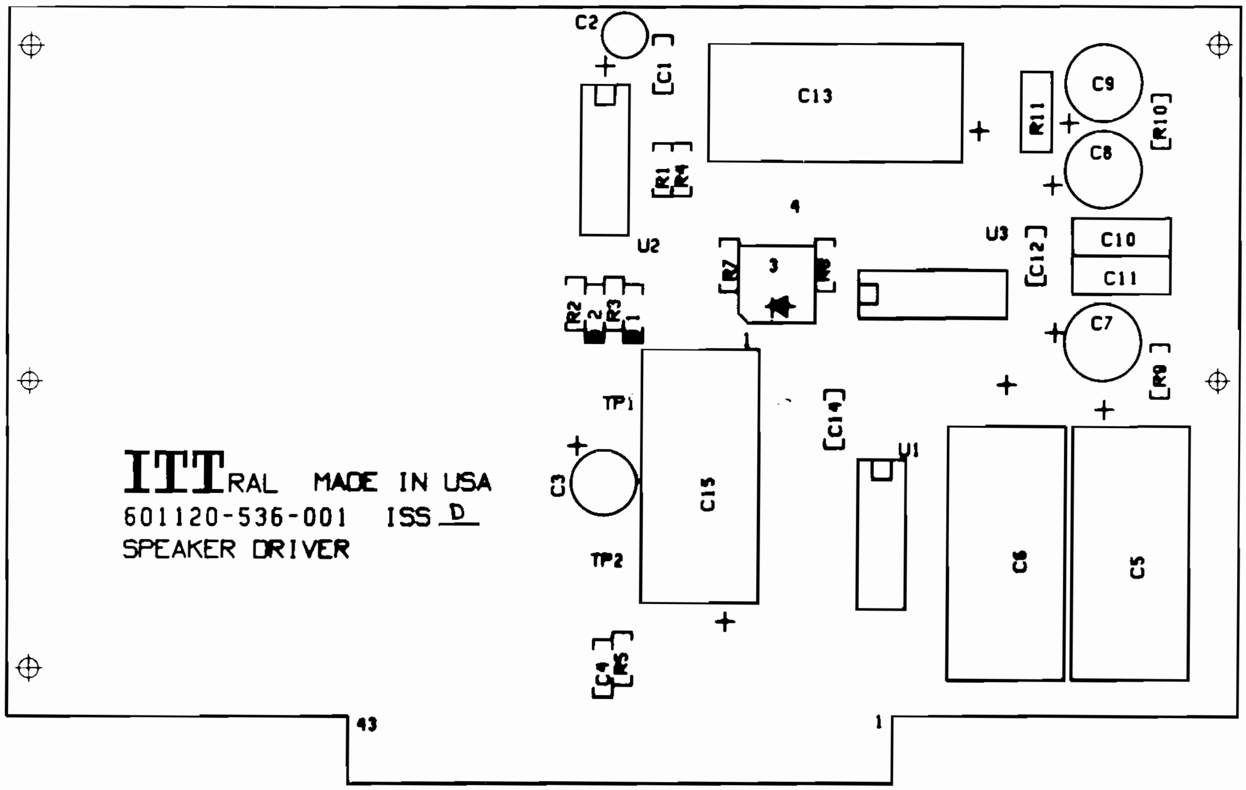
5.14.2 DETAILED DESCRIPTION

The speaker amplifier, U3, is a monolithic audio amplifier in a non-inverting operational configuration. Resistor R10 (56 ohms) sets the nominal voltage gain at 71 (37 dB). Capacitors C10 and C11 are compensation capacitors, and C12 and R11 form an output compensation network. Capacitor C7 is a bootstrap capacitor which enables the amplifier to drive positive nearly to the supply voltage. The output, pin 12, is biased nominally at half the supply voltage. The speaker is coupled through C13.

The audio input is coupled to U3, pin 8, through opto-coupler CR3, which contains a photo resistive cell optically coupled to an LED. As the LED current increases, the resistance of the photocell decreases, applying more input signal to pin 8 (U3). The LED current is limited by R5, and is controlled by the setting of the front panel VOLUME control.

The tuning beep tone burst is coupled to the audio input through R7, which provides attenuation. The tone burst is generated by U2, a dual timer. The timer, whose output is pin 9, generates a 2 kHz tone which is gated off and on by the other timer whose output is pin 5. This timer is set by C3, CR1, CR2, R3 and R2, and is gated on by a high level at pin 4. This signal, called "Beep", comes from the coupler tuning logic.

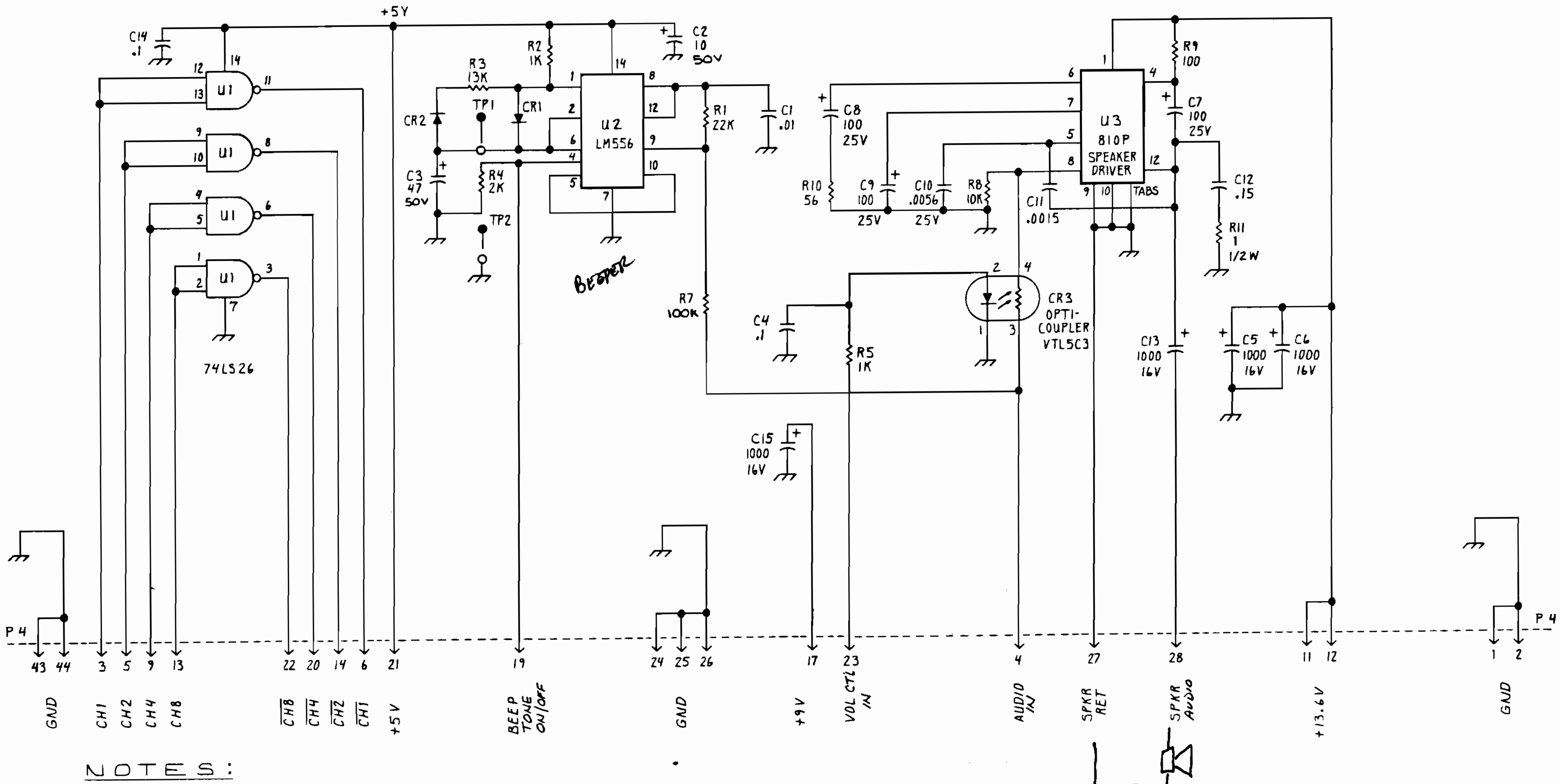
Integrated circuit U1 is simply an inverting open-collector buffer which relays the channel switch information to the rear panel accessory connector.



SPEAKER/DRIVER
(601120-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1	Capacitor, .01 μf, 50V	600272-314-003
C2	Capacitor, 10 μf, 50V	600297-314-013
C3	Capacitor, 47 μf, 50V	600297-314-026
C4, C14	Capacitor, .1 μf, 50V	600272-314-001
C5, C6, C13, C15	Capacitor, 1000 μf, 16V	600259-314-108
C7, C8, C9	Capacitor, 100 μf, 25V	600259-314-006
C10	Capacitor, .0056 μf, 25V	600204-314-045
C11	Capacitor, .0015 μf	600204-314-040
C12	Capacitor, .15 μf, Mylar	600204-314-027
CR1, CR2	Diode, 1N4148	600109-410-001
CR3	Diode, VTL5C3	600006-373-002
R1	Resistor, 22k, 1/4W, 5%	622024-341-075
R2, R5	Resistor, 1k	610014-341-075
R3	Resistor, 13k	613024-341-075
R4	Resistor, 2k	620014-341-075
R7	Resistor, 100k	610034-341-075
R8	Resistor, 10k	610024-341-075
R9	Resistor, 100Ω	610004-341-075
R10	Resistor, 56Ω, 1/4W, 5%	656094-341-075
R11	Resistor, 1Ω, 1/2W, 5%	610084-341-205
U1	IC, 74LS26	600221-415-001
U2	IC, LM556	600237-415-001
U3	IC, 810P	600216-415-001

Figure 5.28 Speaker/Driver Assembly



NOTES:

1. UNLESS OTHERWISE NOTED: RESISTORS ARE IN OHMS 1/4W ± 5%; CAPACITORS ARE IN MFD. INDUCTORS ARE IN µHY. DIODES ARE IN4148.
2. DO NOT REMOVE C15 FROM BOARD AS C15 IS USED TO FILTER THE +9V LINE.

Figure 5.29 Speaker/Driver Schematic

Speaker/Driver Board

1A1A8

Pin Connections and Voltage Readings

1A1A8-J4

GND	1	2	GND
Logic "0" or 1 CH1	3	4	Audio In 0-0.15 VRMS (.3-3 kHz)
Logic "0" or 1 CH2	5	6	$\overline{CH1}$ Logic "0" or 1
	7	8	
Logic "0" or 1 CH4	9	10	
+13.2 VDC	11	12	+13.2 VDC
Logic "0" or 1 CH8	13	14	$\overline{CH2}$ Logic "0" or 1
	15	16	
+9 VDC	17	18	
Logic "0" or 1 Beep ON/OFF	19	20	$\overline{CH4}$ Logic "0" or 1
+5 VDC	21	22	$\overline{CH8}$ Logic "0" or 1
0.6 - +9 VDC Volume Control	23	24	GND
GND	25	26	GND
Spkr. Return (GND)	27	28	Spkr. Audio 0-3.58 VRMS into 3.2Ω
	29	30	
	31	32	
	33	34	
	35	36	
	37	38	
	39	40	
	41	42	
GND	43	44	GND

BOTTOM VIEW

5.15 LOGIC BOARD, 1A1A9

5.15.1 GENERAL

The logic board, Figures 5.29/30, supplies frequency, band, mode and channel information to other assemblies and/or optional equipment. This board receives input data from the front panel and/or rear panel accessory connector. This data is processed, and then appropriate commands are applied to other boards in the radio for operation. This is possible because of the microprocessor U1 and other supporting circuitry. In addition, ten channels of memory can be stored by U4. A low leakage lithium battery maintains memory power when operating power is not applied or is removed from the transceiver. Also located on this board is the program ENABLE/DISABLE switch, S1. This eight section switch allows memory, beep tone, manual control mode of the transceiver and surveillance tune mode of the automatic antenna coupler to be enabled or inhibited.

5.15.2 DETAILED DESCRIPTION

Refer to Figure 5.32 for a block diagram.

U1 is an 8035 microprocessor (μP) with an 82S181 PROM (U3) as program memory and an IM 6551 Static RAM as data memory. U2 (8212) is used as an address latch device to latch address information for external program and data memory chips U3 and U4.

Port 2 of U1 (pins 21 through 24 and 35 through 38) are used as input ports to enter emission mode information (pins 21, 22 and 23). Channel information (pins 24, 35, 36 and 37) and TX/RX information (pin 38). Bits 0 and 1 of port 2 (pins 21 and 22) are also used as ninth and tenth bits of address to address up to 1024 locations on external program memory chip U3. Port 2 is also used as an output port. Under this condition, data in the low four bits (pins 21 through 24) are fed to I/O expander chips U5 and U6. Each expander chip provides four 4 bit output ports. The BCD output of each port is applied to the synthsizer to determine the frequency of the radio. U6-P5 controls the 100 Hz digit, U6-P6 controls the 1 kHz digit, and U5-P5 controls the 10 kHz digit. These outputs are applied to the minor loop board, 1A1A13.

U6-P7 controls the 100 kHz digit, U5-P6 controls the 1 MHz digit, and U5-P7 controls the 10 MHz digit. These outputs are applied to the major loop board, 1A1A15.

U5-P4 is the output of special code for emission mode display. The 3 low bits of this code are detected by U18 to provide emission mode command to the receiver/exciter. The output of U18 is disabled (all high) when U18-12 is high (during the coupler tune period). U18 also provides a coupler home signal when the frequency is changed more than 10 kHz or the channel is changed.

U6-P4 contains band information which is detected by U13 to provide band select commands via decoder, U13.

Port 1 of U1 (pins 27 through 34) is used as the output port. Bits 0 through 3 are channel and frequency information and bits 4, 5 and 6 are the display code for the multiple LED digit display.

T0 and T1 input pins (U1-1 and 39, respectively) are the frequency change command inputs with T0 for frequency increasing and T1 for frequency decreasing. INT pin (U1-6) is the load memory command input. When this pin is pulled low, the program is interrupted and jumps to load memory sub-routine.

NAND gate (U14-11, 12 and 13, R5 and C2) are used to extend the trailing edge of the ALE signal so that port 2 of U1 can be used as an input and output port without affecting each other. U4 is a CMOS static RAM with low voltage data retaining capability. When power is turned off, B1 supplies 3 volts through CR1 to retain the data stored in U4.

U4 is a 256 x 4 bits CMOS static RAM that is used to store data for each channel. There are eight 4 bit words for each channel. Words one through six represent the 6 digit frequency (100 Hz's digits through 10 MHz's digits, respectively). The seventh word is band information and the eighth word is emission mode information. The address lines of this chip are controlled as follows: bits 0, 1 and 2 are controlled by software. For each set channel it will be scanned from 0 to 7 to obtain 8 memory locations required for each channel. Bits 3 through 6 are controlled by the channel switch. The MSB (bit 7) is controlled by the TX/RX switch. In the RX mode, MSB = 0, memory locations 0 through 127 of U4 are selected. For TX, MSB = 1, memory locations 128 through 255 are selected.

Transistor switch Q12 is used to stop the μp immediately when V_{CC} drops below 4 volts to prevent the loss of memory in U4 from occuring.

Whether the transceiver is in the transmit or receive mode is determined by Q5 (TX line) and Q4 (RX line). These are connected so that when U11 pins 11, 3 and 6 are high, Q4 is ON, Q5 is OFF, and the unit is in the receive mode. Q3 drives the AMT line, turning ON when the radio is in the transmit and AM mode. The transmit mode may be caused by only one of pins 11, 3 or 6 going low. For a pin to go low, both of its inputs must be high. Note that input pins 13, 2 and 4 are connected so that if pin 13 is pulled low by U10, pins 1 and 13, the unit cannot go into transmit mode. If the LL (loss-of-lock) line is low, the key interlock line high, or the load memory line high, U10 pin 1 or 13 will be low, inhibiting transmit. Also, U10 pin 10 will mute the audio if either the LL line is low or load memory line is high.

In U11, pin 12 causes transmit during coupler tune, pin 1 causes transmit from the PTT line and pin 5 causes transmit from the CW delay one-shot, U12, pin 13. If the unit is in coupler tune, U15, pin 15 will be high, so U8, pin 10 will be low, pulling U11 pins 2 and 4 low, which will inhibit transmission from pins 1 and 5.

When the PTT line is grounded, pin 2 of U8 goes high which drives U11, pin 3, low (if pin 2 is high), causing transmit. At the same time, U11, pin 8, will go low causing the microprocessor to recall the transmit frequency from memory. During CW operation, it is desirable to keep the transmitter keyed so that the radio does not go from transmit to receive at the end of every dot and dash. If the CW mode is selected, the collector of Q2 will be high, enabling the CW delay one-shot portion of U12. The one-shot is triggered at the end of each character via C25 as pin 2 of U8 rises. U12 is a retriggerable one-shot, which means that pin 13 stays high for 0.5 to 5 seconds (determined by the setting of R8) after any trigger pulse arrives, even if it arrives while the one-shot is already triggered. When the one-shot is triggered, pin 13 is high, driving U11, pin 6 low, which keeps the radio in transmit for 0.5 to 5 seconds after the last CW character is sent.

A normal coupler tune cycle is initiated by a ground on the LTN line from Q8, via R56, C33, S1-6 and Q10, or by the program software, via S1-5 and U16 to supply a logic 0 pulse to U15, pin 1. This flips U15, pin 15, high and pin 14 low, turning ON Q6 (TNG line) and turning OFF Q9. Since the If the TUNING BEEP switch is on, the beep starts. When U15, pin 15, goes high, it sends a TUNE command (low) to the coupler via U8, pin 8. When the coupler responds with a Key Enable command, Q7 turns off and the collectors of Q7 and Q9 will now rise, putting the radio into the transmit mode via U11, pin 11 (logic 0). At the end of the tune cycle, the TUNING line rises, turning on Q10. This triggers the reset one-shot portion of U12, which resets both flip-flops in U15. Note that if the Coupler Enable line is not grounded, Q11 will be on, holding pin 7 at ground. This will hold pin 12 low, which will hold both sections of U15 reset, so a tune cycle cannot be initiated.

When the AUTO-TUNE switch is ON, U16, pin 5, is low, via inverter U8-2. When the PTT line goes low, U8-2 goes high causing U16-5 to be high, and this initiates a TUNE cycle. If the channel is changed, or the frequency is changed more than 10 kHz, a short negative pulse appears on U18, pin 9. This pulse is inverted twice by gates of U16 and resets U15; pin 15, high and pin 14 low. The tune cycle is initiated by pushing the microphone push-to-talk button. This triggers U15, pins 11 and 15 high, and allows the transmit mode. At the end of the cycle, U15 is reset by TUNING going high. A TUNE cycle cannot be initiated unless S1-5 is closed.

5.15.3 SOFTWARE DESCRIPTION (Refer to Program Flow Chart)

When the system is first turned on, or the channel, emission mode and TX/RX switch changed, the microprocessor will read the channel, mode and TX/RX switch settings. The channel number is the first to be detected and displayed (no channel display in the manual mode). Corresponding data for the set channel is moved from U4 to the μp on chip RAM (user's RAM) location 8 through 15. The μp will scan through this data again and again to display frequency and emission mode. Data in user's RAM is used by the μp to display frequency and emission mode, calculate the synthesizer's frequency, output band and emission mode commands. In channelized operation, if the load/operate switch is in the "operate" position, the data in the user's RAM cannot be changed for the set channel. However, if it is in the "load" position or in manual operation (channel switch in position 11), the frequency and emission mode can be changed by the control of the front panel switches. New synthesizer frequency and band information will be up-dated by the μp and the coupler TUNE signal is sent out if the frequency change is more than 10 kHz. The up-dated information in user's RAM will be stored in U4 when the Load TX or Load RX switch is depressed in channelized operation or will be automatically stored in manual operation. If the TX switch is depressed in the channelized and operate mode, the TX frequency will be shown on the display, and the transmitter will not key. The display TX frequency therefore is not being transmitted.

If invalid frequency or mode data is scanned by the μp, a default frequency of 29.9999 MHz and mode of USB will be entered and displayed. This prevents data errors due to a discharged memory backup battery, vehicle electrical system noise, or erroneous memory data entry, causing improper frequency and/or out of band operation.

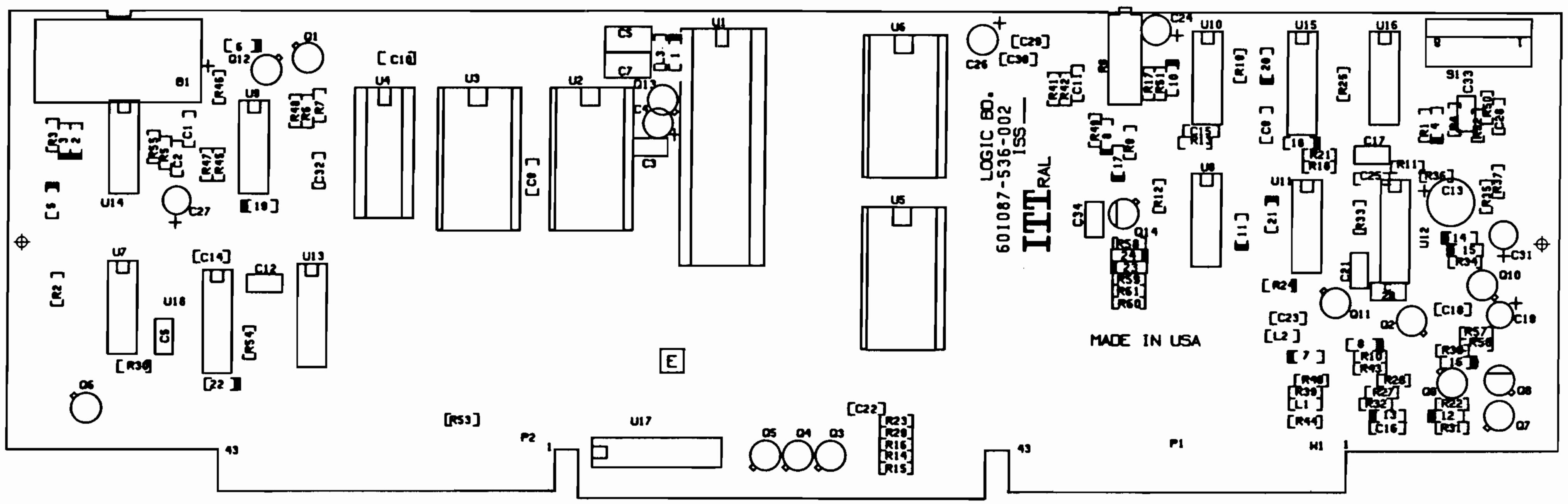
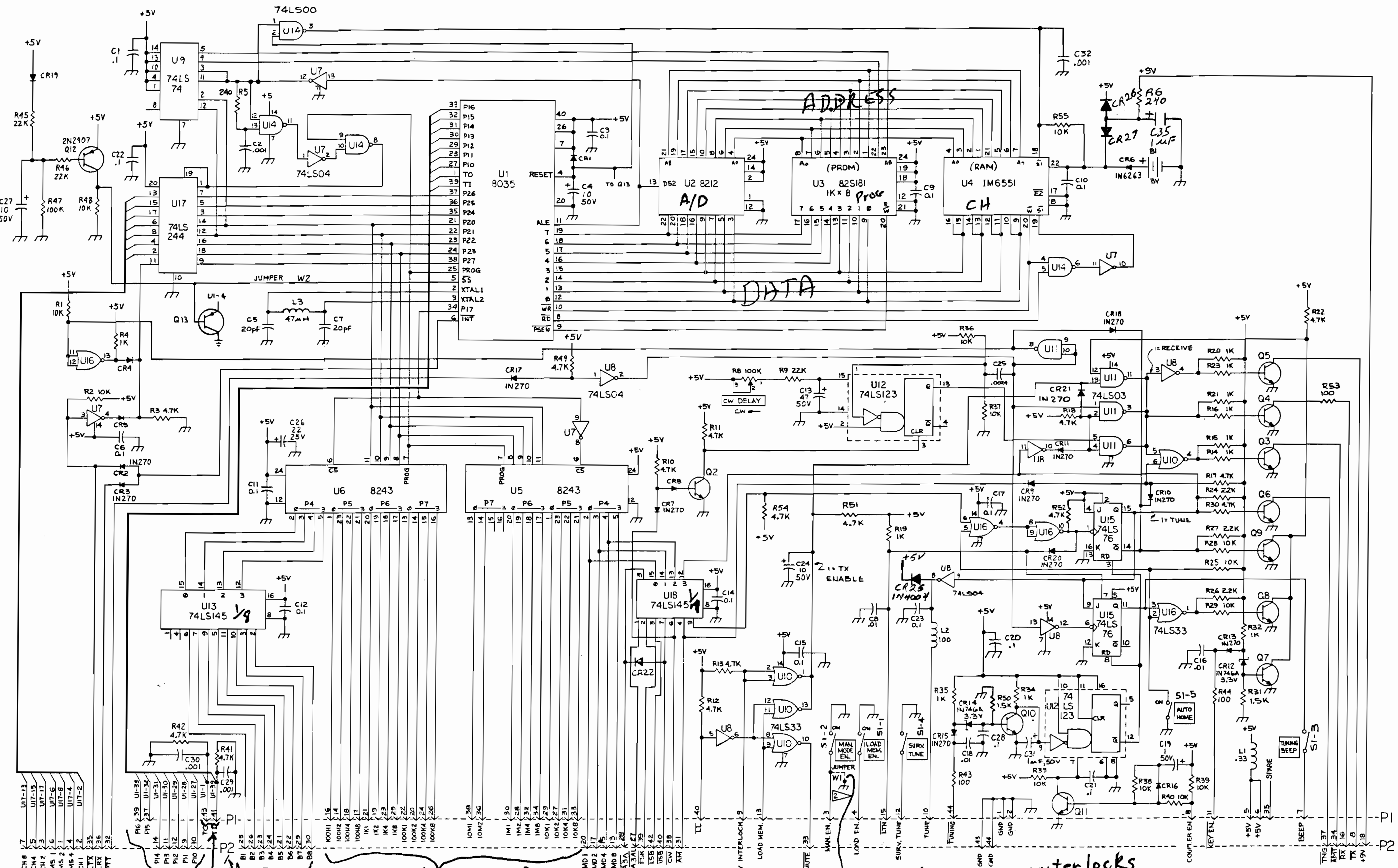


Figure 5.30 Logic Board Assembly

LOGIC BOARD
(601087-536-002)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C9-11, C14, C15, C22, C23, C28	Capacitor, 0.1 μf, 50V	600272-314-001
C3, C6, C12, C17, C21, C20	Capacitor, 0.1 μf, 50V	600226-314-008
C2, C29, C30, C32	Capacitor, .001 μf, 50V	600272-314-008
C25	Capacitor, .01 μf, 50V	600272-314-002
C5, C7	Capacitor, 20 pf	620094-306-501
C8, C16, C18	Capacitor, .01 μf, 50V	600272-314-002
C13	Capacitor, 47 μf, 50V	600297-314-026
C19, C31	Capacitor, 1 μf, 50V	600297-314-003
C24, C27, C4	Capacitor, 10 μf, 50V	600297-314-013
C26	Capacitor, 22 μf, 25V	600297-314-016
C33, C34	Capacitor, .1 μf, 50V	600226-314-008
C35	Capacitor, 1 μf, 35V	610045-319-350
CR25	Diode, 1N4004	600011-416-002
CR1, CR4, CR5, CR8, CR16, CR19, CR22, CR26, CR27	Diode, 1N4148	600109-410-001
CR2, CR3, CR7, CR9, CR10, CR11, CR13, CR15, CR17, CR18, CR20, CR21	Diode, 1N270	600052-410-001
CR6	Diode, 1N6263	600145-410-001
CR12, R14	Diode, 1N746A	600002-411-001
CR23	Diode, 1N270	600052-410-001
CR24	Diode, 1N746A	600002-411-001
L1	Choke, 0.33 μH	600125-376-001
L2	Choke, 100 μH	600125-376-002
L3	Choke, 47 μH	600125-376-008
Q2-11	Transformer, 2N2222A	600080-413-001
Q12, Q13	Transformer, 2N2907A	600154-413-001
Q14	Transformer, 2N2222A	600080-413-001
Q14	Transformer Pad, TO-18	600025-419-001
(Q2-13)	Transformer Pad, TO-18	600025-419-001
R1, R2, R25, R28, R33, R55, R36-40, R48	Resistor, 10k, 1/4W, 5%	610024-341-075
R3, R10-12, R17, R18, R22, R30, R51, R52, R41, R42, R49, R54	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R4, R13-16, R19-21, R23, R32, R34, R35	Resistor, 1k, 1/4W, 5%	610014-341-075
R59, R61	Resistor, 10k, 1/4W, 5%	610024-341-075
R60	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R5, R6	Resistor, 240Ω, 1/4W, 5%	624004-341-075
R8	Resistor, 100k, Variable	600063-360-014
R9, R45, R46	Resistor, 22k, 1/4W, 5%	622024-341-075
R24, R27	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R43, R44	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R47	Resistor, 100k, 1/4W, 5%	610034-341-075
R53	Resistor, 47Ω, 1/4W, 5%	647094-341-075
R56, R57	Resistor, 10k, 1/4W, 5%	610024-341-075
S1	Switch, Dip, 8 Pos.	600264-616-005
U8	I.C., 7406	600016-415-001
U1	I.C., 8035	600218-415-002
U2	I.C., 8212	600530-415-001
U3	I.C., Prom, 82S181	600209-412-001
U4	I.C., IM6551	600531-415-101
U5, U6	I.C., 8243	600217-415-001
U7	I.C., 74LS04	600111-415-001
U9	I.C., 74LS74	600113-415-001
U10, U16	I.C., 74LS33	600219-415-001
U11	I.C., 74LS03	600239-415-001
U12	I.C., 74LS123	600326-415-001
U13, U18	I.C., 74LS145	600528-415-001
U14	I.C., 74LS00	600114-415-001
U15	I.C., 74LS76	600545-415-001
U17	I.C., 74LS244	600282-415-001



NOTE
1. UNLESS OTHERWISE NOTED:
ALL RESISTORS ARE IN OHMS, 1/4 WATT, 5%
ALL CAPACITORS ARE IN MFD.
ALL INDUCTORS ARE IN MICROHENRIES.
ALL TRANSISTORS ARE 2N2222.
ALL DIODES ARE IN4148.
2. JUMPER NORMALY IN BOARD. FOR OPTIONAL MANUAL MODE DISABLE/ENABLE, REMOVE JUMPER.

Figure 5.31 Logic Board Schematic

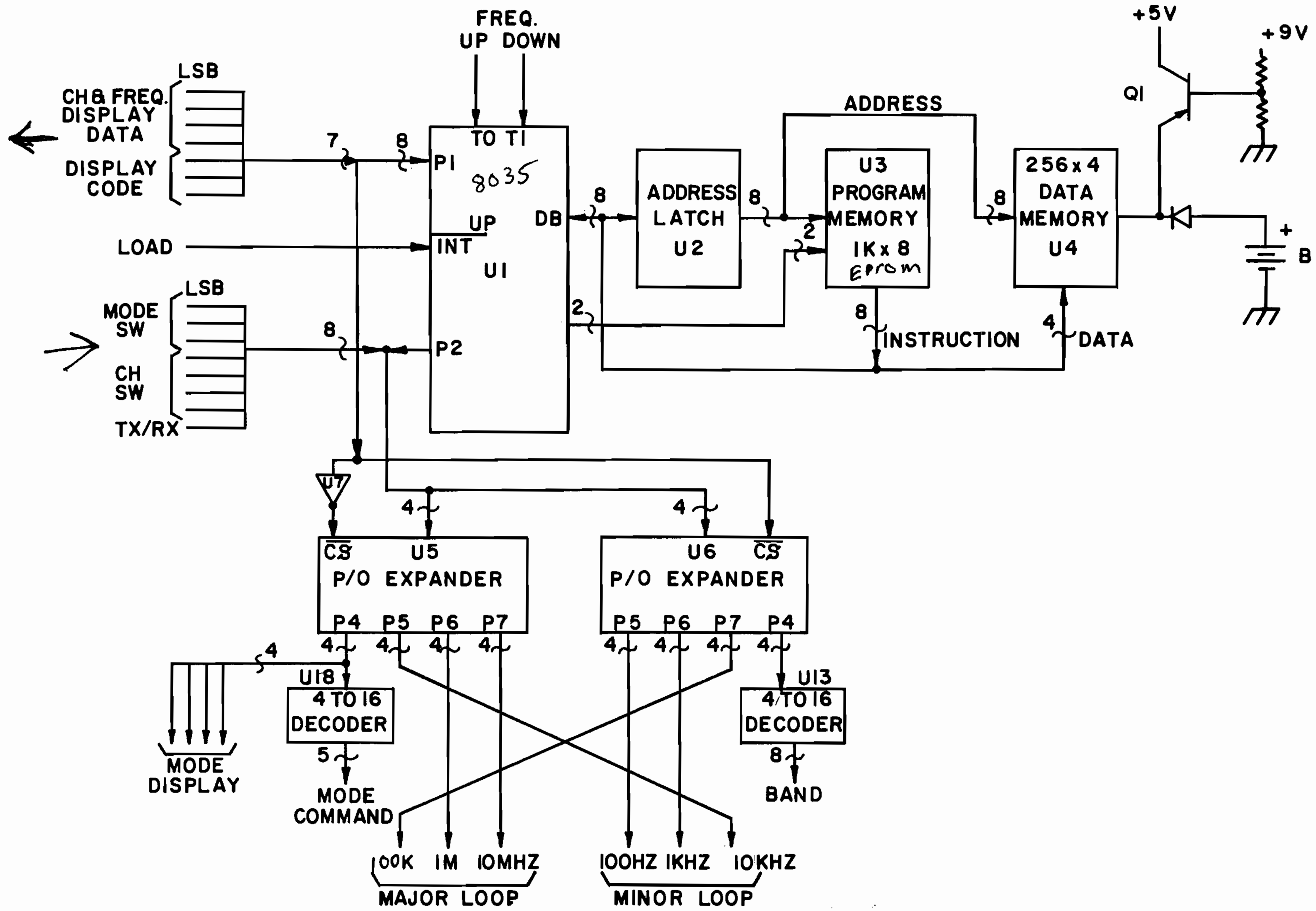


Figure 5.32 Logic Board Block Diagram

Logic Board

1A1A9

Pin Connections and Voltage Readings

1A1A9-J1

GND	1	2	GND
Manual Enable (GND)	3	4	Load Enable TTL
+5 VDC	5	6	+5 VDC
Logic "0" or 1 "BEEP"	7	8	Coupler Enable EXT
R Panel GND Key Interlock	9	10	TUNE Command EXT
EXT Key Enable	11	12	Surveillance Tune EXT
TTL Load Memory	13	14	100 Hz "2" Logic "0" or 1
Logic "0" or 1 LTN	15	16	100 Hz "1" "
Logic "0" or 1 100 Hz "8"	17	18	100 Hz "4" "
" 1 kHz "2"	19	20	100 kHz "2" "
" 1 kHz "1"	21	22	100 kHz "1" "
" 1 kHz "4"	23	24	100 kHz "4" "
" 1 kHz "8"	25	26	100 kHz "8" "
" 10 kHz "2"	27	28	1 MHz "2" "
" 10 kHz "1"	29	30	1 MHz "1" "
" 10 kHz "4"	31	32	1 MHz "4" "
" 10 kHz "8"	33	34	1 MHz "8" "
	35	36	10 MHz "2" "
Data TTL P15	37	38	10 MHz "1" "
" P16	39	40	LL "0" or 1
FREQ Down TTL High TI	41	42	
FREQ Up TTL High TO	43	44	Tuning

BOTTOM VIEW

Logic Board

1A1A9

Pin Connections and Voltage Readings

1A1A9-J2

MS2	1	2	CH1
CH2	3	4	MS4
CH4	5	6	MS1
CH8	7	8	$\overline{TX}$
P11	9	10	P10
P13	11	12	P12
MD8	13	14	P14
MD4	15	16	$\overline{RX}$
MD2	17	18	
	19	20	MD1
B5	21	22	B6
B3	23	24	B4
B1	25	26	B2
	27	28	
B7	29	30	B8
$\overline{AM}$	31	32	$\overline{PTT}$
$\overline{MUTE}$	33	34	$\overline{AMT}$
$\overline{LTX}$	35	36	$\overline{LRX}$
$\overline{THG}$	37	38	$\overline{CW}$
$\overline{FSK}$	39	40	$\overline{USB}$
	41	42	$\overline{LSB}$
GND	43	44	GND

BOTTOM VIEW

All voltages on this connector are logic signals of either a "0" or "1" state.

5.16 POWER SUPPLY REGULATOR ASSEMBLY, 1A1A10

5.16.1 GENERAL

The power supply regulator, Figures 5.33/34, supplies two of the four regulated operating voltages for the transceiver. The two voltages provided by this assembly are +9 volts and +5 volts regulated DC. +12 or +24 VDC from the rear panel power connector, 1A3J30, is applied to the input. U1 and transistors Q1 and Q2 form a +5 volt high efficiency regulator. The voltage output of the 5 and 9 volt regulators are adjustable. The output of the 9 volt regulator is applied to the 1A1A2, 1A1A3, 1A1A4, 1A1A5, 1A1A6, 1A1A7, 1A1A8, 1A2 and 1A3 assemblies.

The output of the +5 volt regulator is applied to the 1A1A8, 1A1A9, 1A1A11, 1A1A12, 1A1A13, 1A1A14, 1A1A15 and 1A2 assemblies.

5.16.2 DETAILED DESCRIPTION

The power supply regulator assembly furnishes regulated +5 volts and +9 volts at high efficiency from any input voltage between 11.2 volts and 30.4 volts. The unit contains two separate supply sections, one for +5 volts output and one for +9 volts output. Since the sections operate identically, only the +9 volt section will be described in detail.

The purpose of U2 is to turn on Q3 with the proper duty cycle to establish the correct output voltage. More about U2 later. The key components in a switching supply are transistor switch Q3, diode CR4 (a fast recovery type), storage inductor L3 and storage capacitors C14, C15 and C16. In operation, Q3 is either on (saturated) or off. When Q3 turns on, the current builds up slowly through L3, while C15-C16 furnish the output current until the current through L3 builds up high enough. When Q3 turns off, the voltage at the junction of L3 and CR4 tries to go negative. When the voltage catches on CR4, L3 continues to suppy output current. The efficiency of the power supply is very high because: 1) Q3 is either saturated or off, wasting little power, 2) little power is wasted in CR4 because its drop is small, and 3) current stored in L3 is used during the off cycle.

Integrated circuit U2 is a switching power supply subsystem which contains: 1) an RC oscillator, 2) a pulse width modulator, 3) output drivers, and 4) an error amplifier, over current sense and a voltage reference. The oscillator runs at a fixed frequency determined (40 kHz) by R19 and C11 (U1 is slaved to U2's oscillator via pins 3 and 7). The output drivers (pins 13 and 12) drive Q3 via R21 with a pulse width determined by the width modulator, which receives instructions from the error amplifier. The error amplifier compares a sample of the output voltage on pin 1 with the reference voltage in pin 2. If the sample is lower than the reference, the pulse width increases. If the sample is higher than the reference, the pulse width decreases. The voltage sample is determined by R18, R17 and adjustable trimpot R16. Network C12 and R20 are feedback stabilization components which determine power supply stability and transient response. Over current is sensed by the drop across R23 and set by R24 and R2.

Chokes L7, L6 and L5, along with capacitors C19, C20 and C21 are filters to reduce RFI outside the can. The +9 volt output has as additional ripple filter L4, C17 and C18, and the input has an additional filter L1, C1 and C2.

Over voltage protection is provided by zeners CR1 and CR2. If pass transistors Q3 or Q5 should short, CR1 or CR2 will hold the output voltage and cause the rear panel radio fuse to blow.

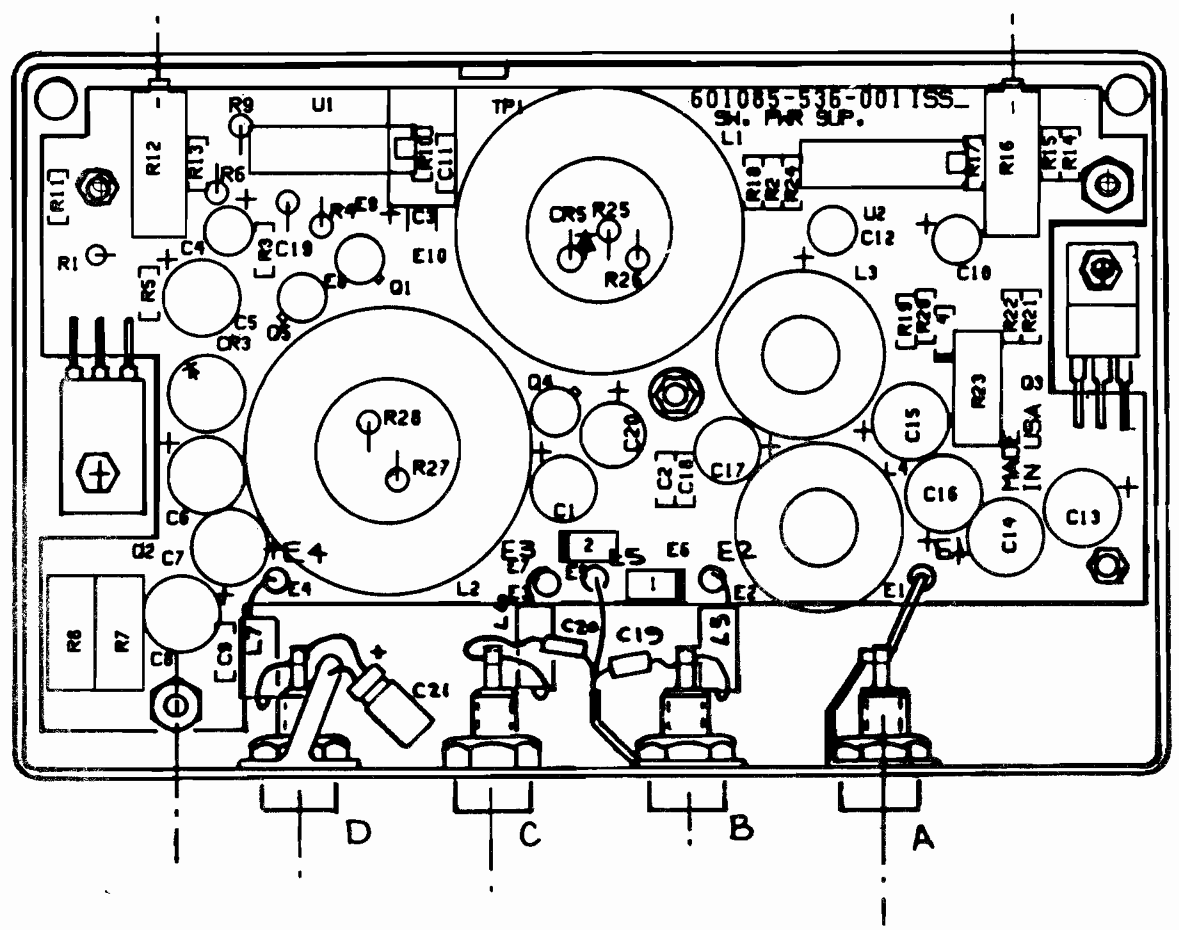
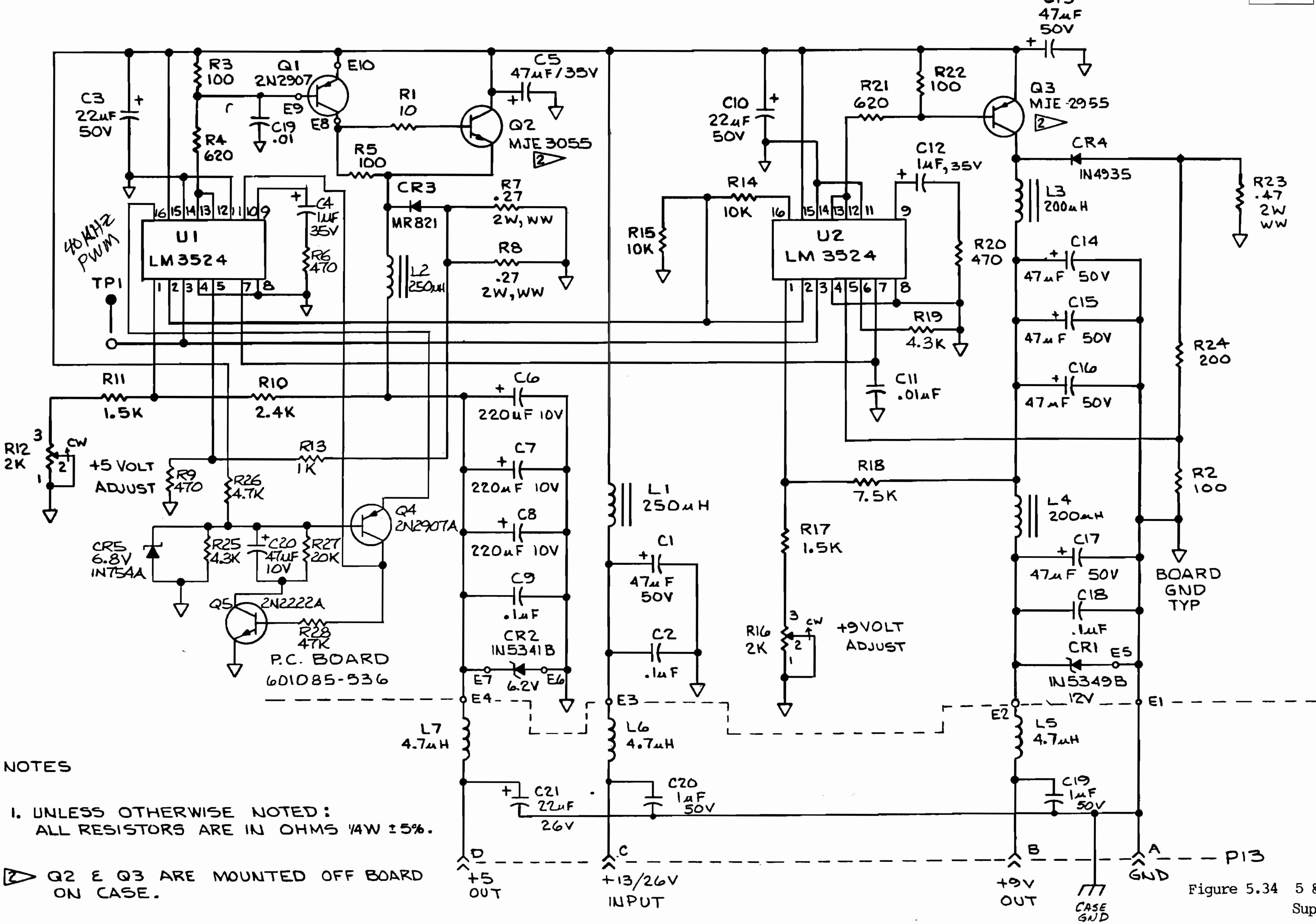


Figure 5.33 Power Supply Regulator Assembly

POWER SUPPLY SWITCHING ASSEMBLY
(600411-705)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C13–C17	Capacitor, 47 µf, 50V	600297-314-026
C2, C9, C18	Capacitor, .1 µf, Axial	600272-314-001
C3, C10	Capacitor, 22 µf, 50V	600297-314-018
C4, C12	Capacitor, 1 µf, 35V, Tant.	600202-314-007
C5	Capacitor, 47 µf, 35V, Tant.	600202-314-045
C6, C7, C8	Capacitor, 220 µf, 10V, Tant.	600202-314-051
C11, C19	Capacitor, .01 µf, 50V	600272-314-003
C20	Capacitor, 47 µf, 10V	600259-314-013
C19, C20	Capacitor, 1 µf, 50V	600226-314-014
C21	Capacitor, 22 µf, 25V	600297-314-016
CR1	Diode, 1N5349B, 12V	600026-411-017
CR2	Diode, 1N5341B, 6.2V	600026-411-009
CR3	Diode, MR821	600062-416-001
CR4	Diode, 1N4935	600033-416-001
CR5	Diode, 1N754A, 6.8V	600002-411-017
L1, L2	Inductor, 250 µH	605039-513-001
L3, L4	Inductor, 200 µH	605038-513-001
L5–7	COIL, 4.7 µH	600091-376-001
Q1, Q4	Transistor, 2N2907A	600154-413-001
Q2	Transistor, MJE3055	600266-413-001
Q3	Transistor, MJE2955	600289-413-001
Q5	Transistor, 2N2222A	600080-413-001
R1	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R2, R3, R5, R22	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R4, R21	Resistor, 620Ω, 1/4W, 5%	662004-341-075
R6, R9, R20	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R7, R8	Resistor, .27Ω, 2W	600057-340-001
R10	Resistor, 2.4k, 1/4W, 5%	624014-341-075
R11, R17	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R12, R16	Resistor, 2k, Pot.	600063-360-008
R13	Resistor, 1k, 1/4W, 5%	610014-341-075
R14, R15	Resistor, 10k, 1/4W, 5%	610024-341-075
R18	Resistor, 7.5k, 1/4W, 5%	675014-341-075
R19, R25	Resistor, 4.3k, 1/4W, 5%	643014-341-075
R23	Resistor, .47Ω, 2W	600057-340-004
R24	Resistor, 200Ω, 1/4W, 5%	620004-341-075
R26	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R27	Resistor, 20k, 1/4W, 5%	620024-341-075
R28	Resistor, 47k, 1/4W, 5%	647024-341-075
U1, U2	IC, LM3524	600466-415-101



NOTES

1. UNLESS OTHERWISE NOTED:
ALL RESISTORS ARE IN OHMS 1/4W ±5%.

2. Q2 & Q3 ARE MOUNTED OFF BOARD ON CASE.

Figure 5.34 5 & 9 Volt Power Supply Schematic

Power Supply Regulator

1A1A10

Pin Connections and Voltage Readings

1A1A10-J13

A GND

B +9 VDC

C +13.2 or +26.4 VDC In

D +5 VDC

BOTTOM VIEW

5.17 NOISE BLANKER, 1A1A11

5.17.1 GENERAL

The noise blanker, Figures 5.35/36, is a high gain noise pulse amplifier and detector which is used to gate off the second LO that is applied to the mixer board, 1A1A5, thus effectively blanking the receiver during periods of interferring noise pulses such as ignition noise, etc. The input of the amplifier is tuned to 35 MHz (above the transceiver operating frequency). Impulse noise occupies a wide bandwidth and can effectively be amplified and detected at this frequency. Using this frequency prevents saturation of the noise blanker by large signals in the 1.4 to 30 MHz band. The noise blanker input is connected to the output (ANT) of the half octave filter board, 1A1A2. The output of the noise blanker is applied to the mixer board, 1A1A5.

5.17.2 DETAILED DESCRIPTION

The noise blanker is a high gain noise pulse amplifier and detector used to gate off the second local oscillator, thus blanking the receiver during interferring noise pulses such as ignition noise. The amplifier is tuned (by C3, L4 and L6) to 35 MHz in a quiet part of the band to prevent saturation by large signals in the 1.4 to 30 MHz band.

The input at pin 39 is taken from the 50 ohm antenna input line of the receiver. C1, C3, C5 and L1 form a single pole bandpass filter with a bandwidth of about 1 MHz. C1 matches a 50 ohm source impedance to 18K ohms across the filter. The small 4.7 pf value of C1 has a negligable effect on the desired signals on the antenna line over the 1.4 to 30 MHz band. It also limits the maximum signal power into the noise blanker during transmit when 125 watts appears on the same antenna line. CR1 and CR2 are pin diodes with low capacitance and high off-resistance to prevent loading the tuned circuit. They protect the following active circuits. The power to each diode from the 125 watt transmit signal is limited to less than 62 milliwatts in the worst case at 30 MHz by the high source impedance provided by C1. C5 matches the filter impedance down to a 1K ohm impedance (the parallel resistance of R1 and the 3K ohm input of U1). L2 tunes the 7 pf parallel input capacitance of U1.

The outputs of U1 and U2 are tuned to a bandwidth of about 1 MHz each by C8, L4, C12 and L6, respectively. R5 and R6 provide damping for stability. The overall bandwidth of the linear circuitry before detection is about 300 kHz. The voltage gain is about 90 dB to the output of U2. The overall gain can be adjusted by R4, which varies the AGC bias to U1. The 80 dB bandwidth is approximately ± 5 MHz. The noise figure from a 50 ohm source is about 19 dB, which gives a 10 dB S/N at -85 dBm input.

The amplifier stages are followed by a peak detector (CR4), which is biased by R7 and CR3 to obtain low level detection with temperature compensation. The detector output (monitored at TP3) will show about 0.2 VDC at maximum gain and no signal. A -90 dBm CW input will produce 0.34 VDC.

The detector is followed by a comparator U3, which is biased within its operating range by R9, R10 and R11. The current through R10 produces a 20 millivolt drop which input pulses must overcome to produce a positive output from U3. The time constant of C16 and R10 produces a differentiator which passes only fast rise time pulses.

The comparator is followed by a dual monostable multivibrator, U4. Input pulses from U3 trigger the first multivibrator through pin 4, which produces a +9 volt peak output pulse, with a pulse width of 340 microseconds as determined by R13 and C19. This pulse is used to gate off an amplifier stage in series with the second local oscillator in the transceiver receiver. The pulse width is wider than necessary to compensate for delays and ringing in the norrowband stages which the noise pulse in the receiver path encounters before it is blanked in the second mixer. A second multivibrator section triggered by the output pulse at pin 12, is used to inhibit the first multivibrator for 1.4 milliseconds (as determined by R15 and C20). This prevents the receiver from being completely blocked by triggering from fast PRF (pulse repetition frequency) signals.

The noise blanker is enabled by a ground on pin 21 (as from a front panel switch) and a ground on pin 16 (which occurs in the receive mode).

The noise blanker requires +9 VDC at 42 milliamperes on pin 27 or 28.

5.17.3 CALIBRATION AND ADJUSTMENT

Normally no calibration or adjustment of the noise blanker is required, as the PC assembly is aligned at the factory. IF component replacement or other reasons indicate the need for alignment or adjustment proceed as follows:

a) Remove the transceiver key interlock, by removing the accessory connector, plug 1A3-P2. This removes the jumper between pins "C" and "G" (ground) thereby preventing the transceiver from being unintentionally keyed.

b) Connect an RF signal generator to the antenna connector 1A3-J31. Set the generator mode to CW, frequency to 35.0 MHz and the output amplitude to -80 dBm (.022 millivolts).

c) Remove the noise blanker card from the transceiver, place on an extender card (optional equipment, part number 601198-536-001) and reinstall in the transceiver.

d) Connect a DC VTVM or VOM (non-digital type) between TP-3 (white) and TP-2 (black) ground. Set the voltmeter to a scale capable of reading 0.5 VDC.

e) Apply power to the transceiver. Turn on the noise blanker from the front panel of the transceiver (pull out on the squelch control).

f) Adjust variable capacitor C3, and variable inductors L4 and L6 for maximum DC voltage indication on the DC voltmeter.

g) Adjust R4 to maximum clockwise position (maximum N.B. gain). The DC voltage at TP-3 should be between 0.29 and 0.41 VDC.

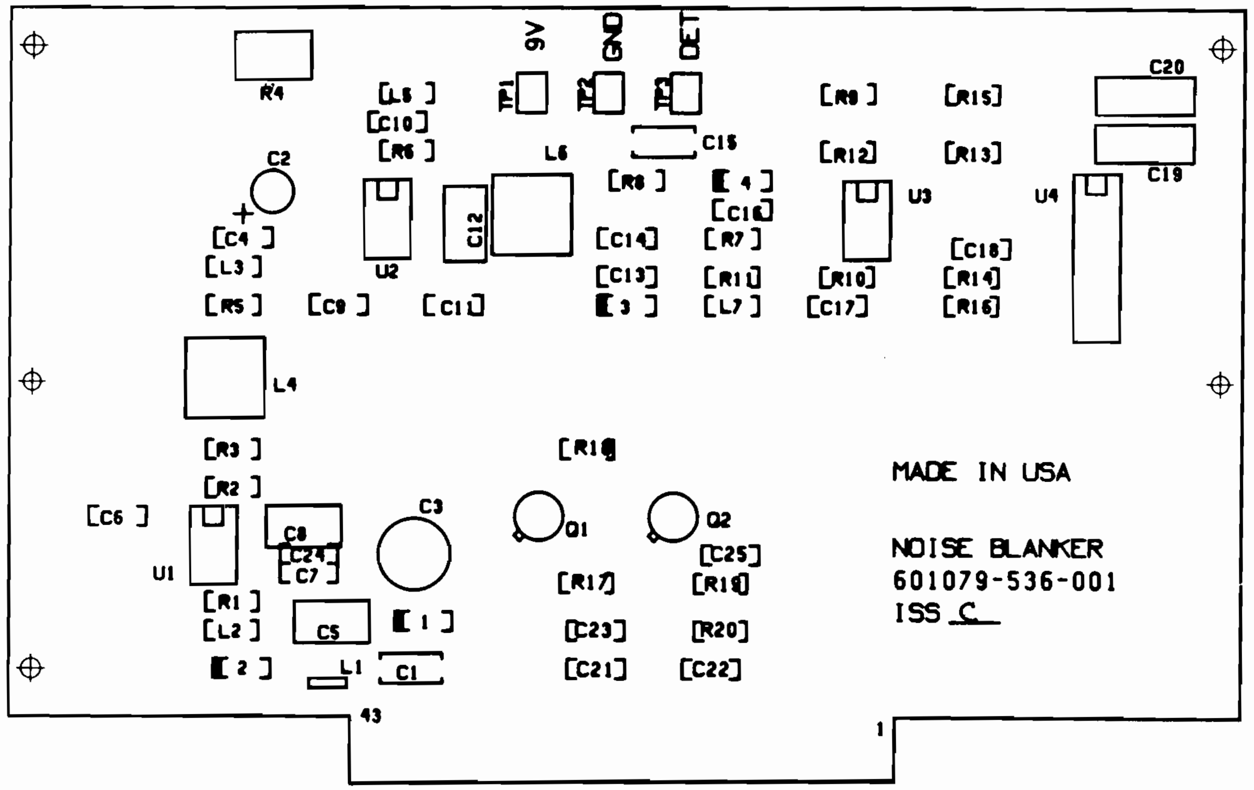
h) Disengage the RF signal generator. Proper N.B. operation may be verified by applying a source or simulated source of impulse type noise to the antenna input of the transceiver. This noise source may be a pulse generator adjusted to the following: pulse width 1 microsecond, pulse amplitude 8 mVPP, pulse rise time 10 nsec. nominal, and pusle repetition frequency (PRF) of 100 pulses per second.

i) Connect an oscilloscope to the output of the noise blanker, pin 9. The output should consist of 240-440 microsecond pulses of approximately 9 volts amplitude.

j) As the pulse generator or impulse noise source is removed, the pulse output of the noise blanker ceases.

k) This completes the checkout and test of the noise blanker, 1A1A11.

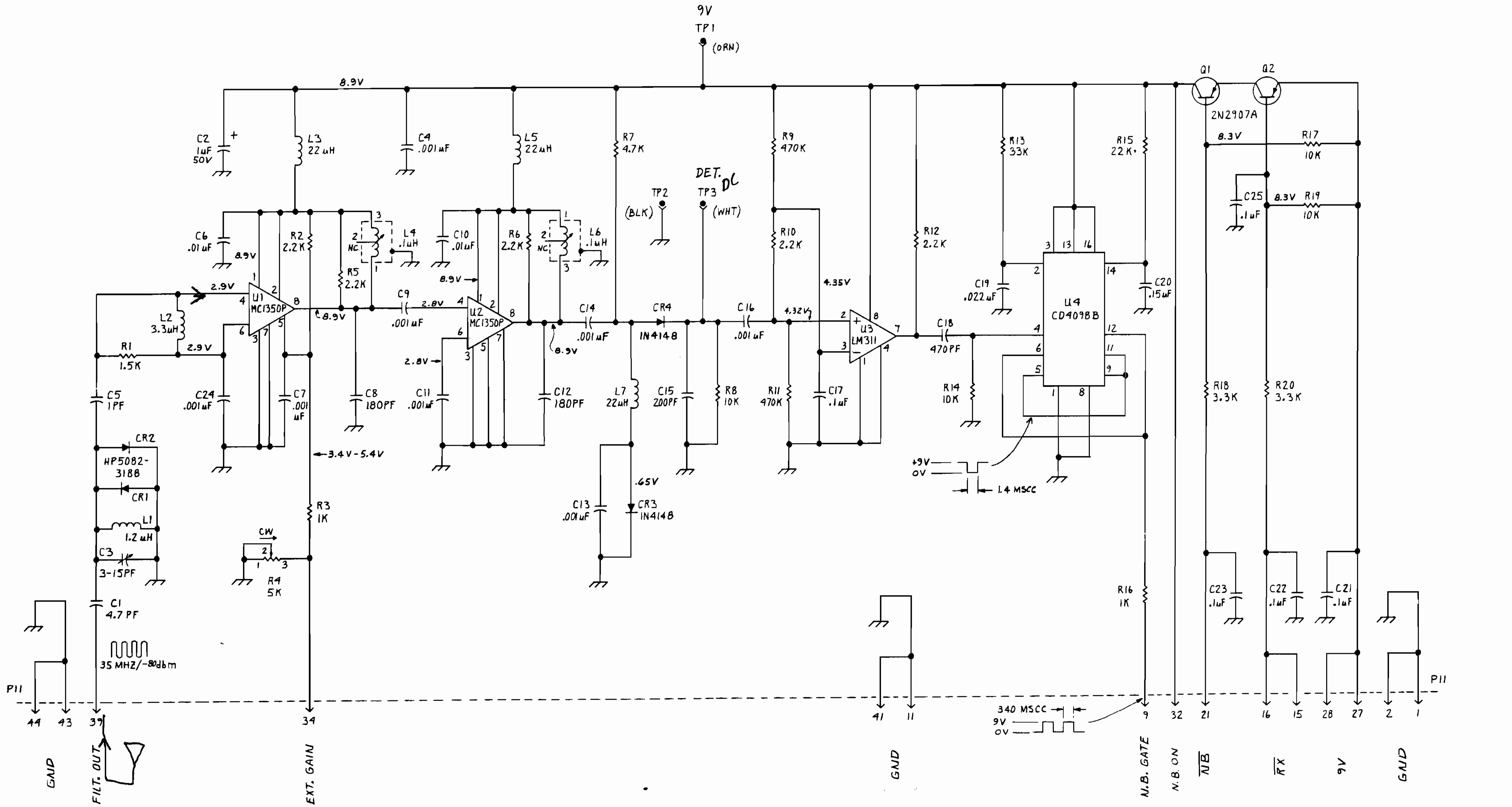
l) In locations of the high ambient impulse noise (such as industrial complexes, etc) if such noise sources cause erratic triggering of the noise blanker, the condition may be improved by decreasing the gain of the noise blanker. This may be done by engaging the noise blanker, and then turning R4 counterclockwise to decrease the noise blanker gain until more satisfactory operation occurs. The noise blanker is still highly effective, even with its gain reduced.



NOISE BLANKER
(601079-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1	Capacitor, 4.7 pf	600269-314-005
C2	Capacitor, 1.0 µf, 50V	600297-314-003
C3	Capacitor, 3-15 pf, Variable	600018-317-006
C4, C7, C9, C11, C13, C14, C16, C24	Capacitor, .001 µf, 50V	600272-314-008
C5	Capacitor, 1 pf	610081-306-501
C6, C10	Capacitor, .01 µf, 400V	600204-314-001
C8, C12	Capacitor, 180 pf	618003-306-501
C15	Capacitor, 220 pf	600269-314-038
C17, C21-C23, C25	Capacitor, .1 µf, 50V	600272-314-001
C18	Capacitor, 470 pf, 50V	600272-314-005
C19	Capacitor, .022 µf	600204-314-009
C20	Capacitor, .15 µf	600204-314-027
CR1, CR2	Diode, HP5082-3188	600144-410-001
CR3, CR4	Diode, 1N4148	600109-410-001
L1	Coil, 1.2 µH	600149-513-001
L2	Choke, 3.3 µH	600125-376-006
L3, L5, L7	Choke, 22 µH	600125-376-009
L4, L6	Coil, .1 µH, Variable	600173-376-001
Q1, Q2	Transistor, 2N2907A	600154-413-001
(Q1, Q2)	Transistor Pad, TO-18	600025-419-001
R1	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R2, R5, R6, R10, R12	Resistor, 2.2k	622014-341-075
R3, R16	Resistor, 1k	610014-341-075
R4	Resistor, 5k, Variable	600066-360-009
R7	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R8, R14, R17, R19	Resistor, 10k, 1/4W, 5%	610024-341-075
R9, R11	Resistor, 470k, 1/4W, 5%	647034-341-075
R13	Resistor, 33k, 1/4W, 5%	633024-341-075
R15	Resistor, 22k, 1/4W, 5%	622024-341-075
R18, R20	Resistor, 3.3k, 1/4W, 5%	633014-341-075
TP1	Test Point, Orange	600114-611-003
TP2	Test Point, Black	600114-611-001
TP3	Test Point, White	600114-611-009
U1, U2	I.C., MC1350P	600214-415-001
U3	I.C., LM311	600298-415-001
U4	I.C., CD4098B	600421-415-101

Figure 5.35 Noise Blanker Assembly



NOTES:

1. UNLESS OTHERWISE NOTED. RESISTORS ARE IN OHMS, 1/4W, ±5%

Figure 5.36 Noise Blanker Schematic

Noise Blanker

1A1A11

Pin Connections and Voltage Readings

1A1A11-J11

GND	1	2	GND
	3	4	
	5	6	
	7	8	
340 MSC +9V Pulses N.B. Gate	9	10	
GND	11	12	
	13	14	
Logic "0" or 1 RX	15	16	RX Logic "0" or 1
	17	18	
	19	20	
	21	22	
	23	24	
	25	26	
+9 VDC	27	28	+9 VDC
	29	30	
	31	32	N.B. "ON" (+9 VDC)
	33	34	EXT. Gain 3.4 - 5.4 VDC
	35	36	
	37	38	
Low Level(R) 125W RF(T) Filter Out	39	40	
GND	41	42	
GND	43	44	GND

BOTTOM VIEW

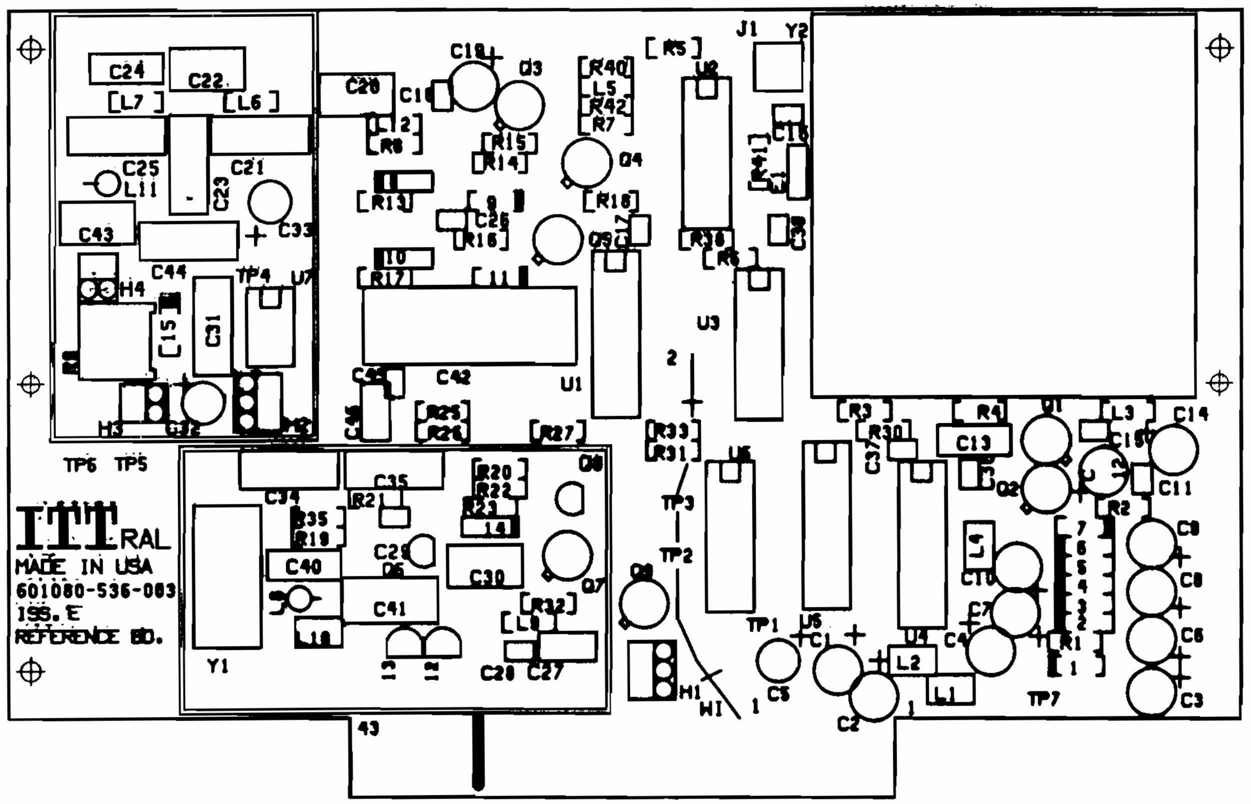
5.18 REFERENCE BOARD, 1A1A12

The reference board, Figures 5.37/38/39, contains the 5 MHz temperature compensated crystal oscillator (TCXO), from which are derived the 50 kHz reference for the major loop, the 1 kHz reference for the minor loop, the 1 kHz CW tone and the 5 MHz third LO signal. This board also contains the clarifier oscillator and a +24 volt bias supply for the major loop.

The TCXO output at 5 MHz is buffered by a NAND gate (U2, pin 8). An external reference input (U2, pin 9) is available for possible future uses of this board where the reference oscillator might be mounted remotely. From U2, pin 8, the 5 MHz splits into two paths. One goes to the third LO switch, pin 1 of U2. The other goes to U1, a dual decade counter, which is connected to divide-by-100. The output of U1 on pin 3 is buffered by U6, pin 8, to become the 50 kHz reference signal to the major loop board. The 50 kHz signal also drives the voltage multiplier from U6, pin 11. Transistors Q1 and Q2 are high current drivers which drive the voltage multiplier with a 50 kHz square wave of approximately 11.5 volts peak-to-peak amplitude. Diodes CR2 through CR6 and associated capacitors form a voltage multiplier. The output is regulated to +24 volts at TP1 by zener CR1, and is designed to supply approximately 2 mA to the major loop board.

The AM and RX lines are buffered and inverted by Q4, Q5 and associated circuitry, and routed to pins 4 and 5 of U2. If the transceiver is in AM receive, the AM and RX lines will both be low, so pins 4 and 5 of U2 will both be high. This drives pin 6 (U2) low which makes pin 3 high, inhibiting the third LO output. Transistor Q3 is an emitter-follower which drives the third LO output through a harmonic filter made up of L12, L6, L7, L11 and associated capacitors. The third LO output level is adjustable with R9. The output level is normally set to 0 dBm (.224 volts RMS).

The clarifier shifts the receive frequency by substituting a variable 1 kHz reference for the fixed 1 kHz, which normally supplies the minor loop. The clarifier oscillator, Q6, is a Colpitts configuration crystal oscillator whose operating frequency is determined principally by Y1, L10 and varicaps CR13 and CR12. The CLARIFIER control on the front panel varies the bias on the varicaps from 0 volts to +9 volts. This causes the frequency of the nominally 5 MHz oscillator to shift at least ±1250 Hz. The output is buffered by Q7, which drives U4, a dual decade counter which is connected to divide by 100 and gives a 50 kHz output at pin 9. The clarifier will be ON only if the RX line is low and the CLRS (clarifier switch) line is low. If this is true, U2 pins 13 and 12 will be high, pin 11 will be low. This disables the pin 11 gate of U3 and enables the pin 6 gate of U3. Since pin 3 is high, Q8 is turned on, which enables the clarifier oscillator. The 50 kHz at U3, pin 8, is now being supplied by the clarifier oscillator rather than the TCXO. U5 is connected to divide by 50 to produce 1 kHz at its output, pin 3. When the clarifier is on, the 1 kHz at TP3 will vary at least ±0.25 kHz with the clarifier control setting. The 1 kHz reference signal to the minor loop is provided by U6, pin 6. U6, pin 3, drives a three section RC filter which converts the square wave at pin 3 into a sine wave at R25. The lower amplifier of U7 is simply a voltage follower used to bias the upper half output at one half of the supply voltage. Pin 1 of U7 provides the 1 kHz tone output. Additional filtering of the signal is provided by C31 and R24. The frequency of the TCXO Y2 can be adjusted by first removing the access screw on the cover. A small screwdriver may then be used to adjust the frequency.



REFERENCE BOARD
(601080-536-003)

SYMBOL	DESCRIPTION	PART NUMBER
C1-C10, C12, C14, C32, C33	Capacitor, 22 µf, 25V	600297-314-016
C13	Capacitor, 27 pf	600269-314-016
C19	Capacitor, 4.7 µf, 50V	600297-314-010
C20	Capacitor, 100 pf	610003-306-501
C21, C25, C44	Capacitor, .0012 µf	600204-314-039
C22, C30	Capacitor, 150 pf	615003-306-501
C23	Capacitor, .0018 µf	600204-314-041
C24	Capacitor, 56 pf	600269-314-024
C27, C46	Capacitor, .1 µf, 50V	600226-314-008
C31	Capacitor, .0022 µf	600204-314-029
C34	Capacitor, .01 µf	600204-314-001
C35	Capacitor, .1 µf	600204-314-020
C40	Capacitor, 39 pf	600269-314-020
C41	Capacitor, 330 pf	633003-306-501
C42	Capacitor, 1 µf, 250V	600204-314-008
C43	Capacitor, 47 pf	647093-306-001
C11, C15-18, C26, C28, C29, C36-38, C45	Capacitor, .01 µf, 50V	600268-314-008

SYMBOL	DESCRIPTION	PART NUMBER
CR1	Diode, 1N4749A, 24V	600006-411-052
CR2-7,CR15	Diode, 1N4148	600109-410-001
CR8, CR10, CR14	Diode, 1N270	600052-410-001
CR9, CR11	Diode, 1N746A, 3.3V	600002-411-001
CR12, CR13	Diode, MV2107	600123-410-004
E1	Terminal	600198-608-006
J1	Connector, Coax	600198-606-002
JP1	Jumper	600190-608-001
L1, L2, L6, L7, L11	Choke, 1.5 µH	600125-376-033
L3, L5	Choke, 33 µH	600125-376-007
L4	Choke, 3.3 µH	600125-376-006
L8, L9	Choke, 470 µH	600125-376-015
L10	Choke, 47 µH	600072-376-033
L12	Choke, 10 µH	600125-376-032
Q1-5, Q7, Q9	Transistor, 2N2222A	600080-413-001
Q6, Q8	Transistor, MPS8097	600278-413-001
R1	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R2, R7, R14-16, R18, R20, R30	Resistor, 1k, 1/4W, 5%	610014-341-075
R3, R5, R6, R22, R27	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R4, R32, R38	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R8, R21	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R9	Resistor, 200Ω, Variable	600072-360-005
R10, R12	Resistor, 62Ω 1/4W, 5%	662094-341-075
R11	Resistor, 150Ω, 1/4W, 5%	615004-341-075
R13, R17	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R19, R31, R36, R37	Resistor, 10k, 1/4W, 5%	610024-341-075
R23, R24	Resistor, 100k, 1/4W, 5%	610034-341-075
R25, R26, R28 R29, R35	Resistor, 22k, 1/4W, 5%	622024-341-075
R33	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R34, R39	Resistor, 47Ω, 1/4W, 5%	647094-341-075
U1, U4, U5	IC, 74L5390	600535-415-001
U2	IC, 74LS03	600239-415-001
U3	IC, 74LS125	600274-415-001
U6	IC, 74LS04	600111-415-001
U7	IC, MC1458	600039-415-002
W1	Coax Cable, RG174/U	600219-608-025
Y1	Crystal, 4.99850 MHz	600123-378-002
Y2	TCXO, 5 MHz	600167-378-001

Figure 5.37 Reference Board Assembly

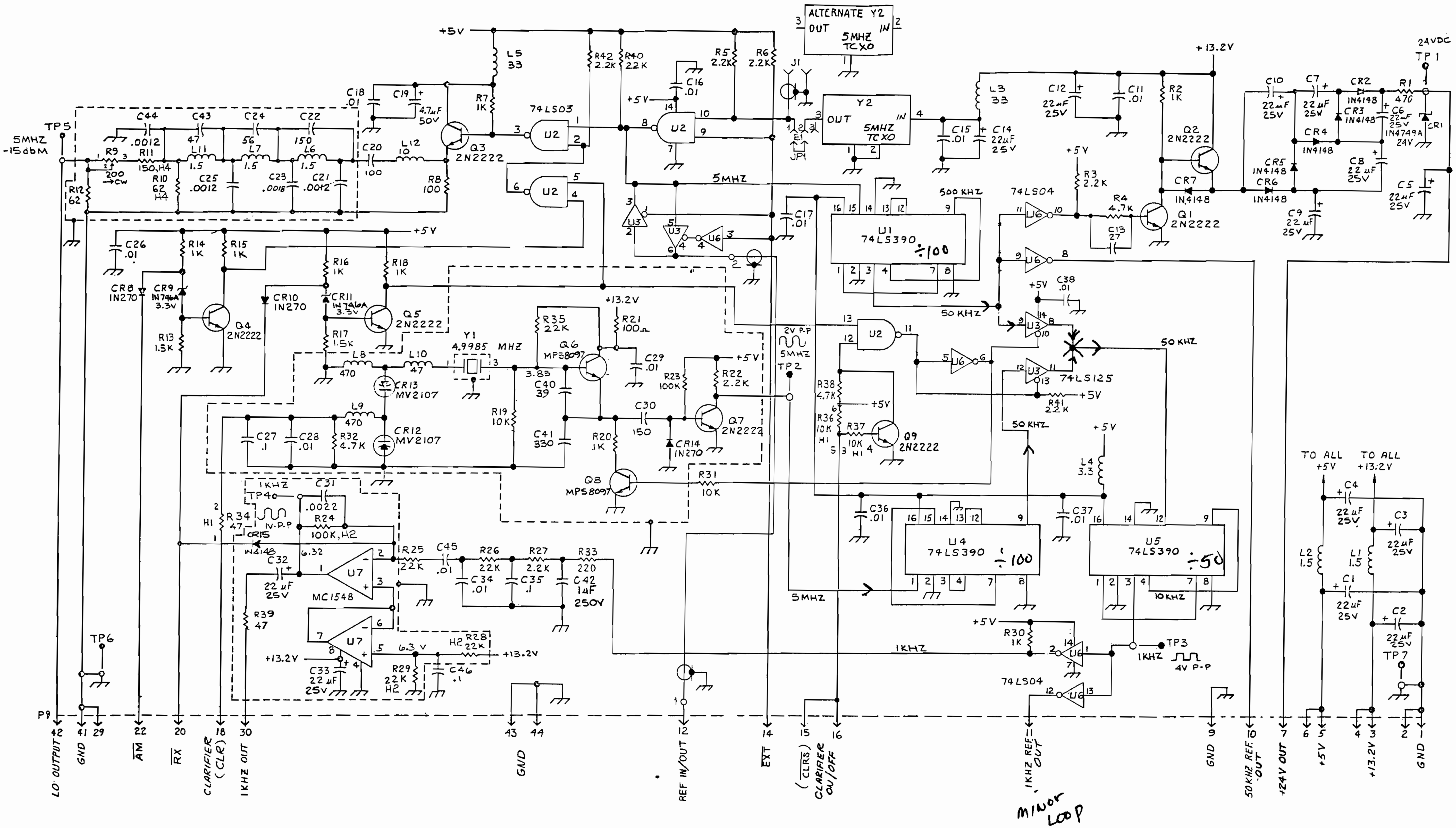


Figure 5.38 Reference Board Schematic

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 MICROHENRYS (μH).

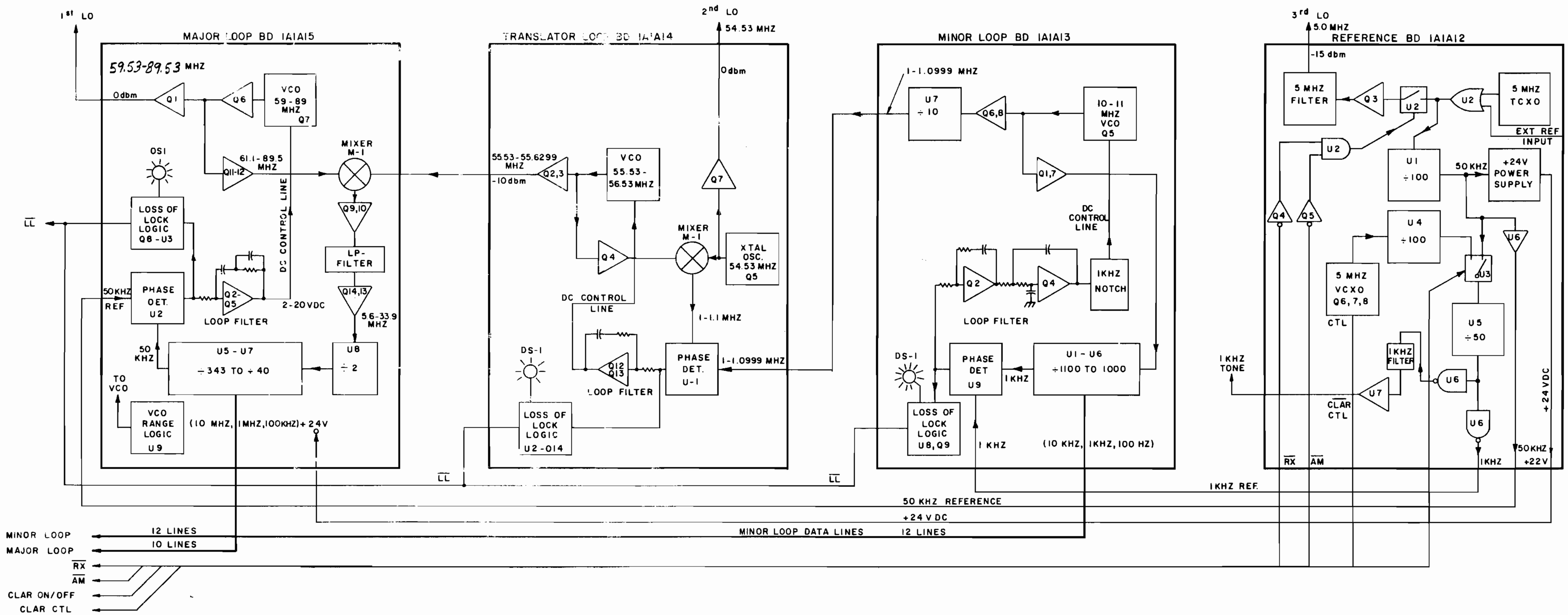


Figure 5.39 Synthesizer Block Diagram

Reference Board

1A1A12

Pin Connections and Voltage Readings

1A1A12-J9

GND	1	2	GND
+13 VDC	3	4	+13.2 VDC
+5 VDC	5	6	+5 VDC
+24V (±2V)	7	8	
GND	9	10	50 kHz Ref.
1 kHz Ref. (w/clari., ±25 kHz)	11	12	
	13	14	5 MHz EXT. Ref. Input (Not Used)
$\overline{CLRS}$	15	16	$\overline{CLRS}$
	17	18	CLR
	19	20	$\overline{RX}$
	21	22	$\overline{AM}$
	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 -15 dBm (3rd LO)
GND	43	44	GND

BOTTOM VIEW

5.19 MINOR LOOP BOARD, 1A1A13

The minor loop, Figures 5.40/41 and block diagram, Figure 5.39, generates the small (100 Hz) steps in the synthesizer. Its output, a 1.0000 to 1.0999 MHz signal, is the reference for the translator loop and comprise the last three digits of the transceiver frequency.

The VCO, Q5, C35, C36, L9 and CR2 through CR6 is a Colpitts oscillator whose frequency (10.000 to 10.999 MHz) is determined by the DC voltage at the junction of CR2 and CR3. The VCO output drives two isolation buffers. The first, Q6 and associated components, drives saturated amplifier Q8, whose output drives U7, a divide-by-10 counter. The minor loop output is pin 11 of U7. Inductor L3, which is in series with the output, slows the waveform transition times to limit harmonic output. The second buffer, Q7 and associated components, feed saturated amplifier Q1, which drives programmable dividers U1 through U6.

The programmable divider functions in the following manner: U3, U4, U5 and U6 are parallel - loadable UP/DOWN counters which are cascaded and permanently connected to count DOWN. Counter U6 is the most significant digit and is permanently connected to load 10 each time its load line goes low, U3 is the least significant. U2 is an array of open collector inverters which have their outputs connected together to form a NOR gate. The output (pins 2, 4, 6, 8, 10 and 12) can only go high if all the inputs (pins 1, 3, 5, 9, 11 and 13) are low. The U2 inputs are connected so that the output goes high when the counter (U6-U3) contains the number 002. To understand the operation, assume that the counter has just been loaded with the number 124. The counters begin counting down. Because the D input, pin 12, is low, pin 9 of U1 (Q) stays low and pin 8 (Q) stays high. After 10,000 pulses, U6 underflows and pin 1 (U2) goes low.

After another 100 pulses, U5 underflows and U2, pin 3, goes low. After another 20 pulses, U4 underflows and U2, pin 5, goes low. After another 2 pulses, pins 9, 11 and 13 of U2 are low, so the "output" of number 002 and the D input, pin 12 of U1 goes high (this is the programmable divider output pulse), and pin goes low, again loading U3, U4, U5 and U6 with the divide number. The next pulse (number 000) toggles pin 8 high and pin 9 low. The cycle can now repeat.

The output of the programmable divider (U1, pin 9) is fed to the phase/frequency detector U9, where it is compared with the 1 kHz reference. If the divider output is too low in frequency or lagging the 1 kHz reference in phase, the phase detector output (pin 5 and 10) goes down. This causes the voltage of the VCO control line to rise, which rises the frequency to correct the error.

The loop amplifier consists of Q2 and Q3, which form a high input impedance inverting stage. The amplifier and feedback components (R4, R5, C27 and C28) form an active loop filter which determines the overall loop stability. Transistor Q4, with componets R7, R8, C29 and C30 forms and active lowpass filter with a sharp corner and steep rolloff to attenuate the reference sidebands.

Components R10, R11 and R12 and C31, C32, C33 and C34 form a twin T-notch filter centered on 1 kHz to further attenuate the first order sidebands.

The loss-of-lock circuitry works as follows: phase detector outputs pin 11 and pin 4 are normally high with nearly 100% duty cycle in a properly locked loop. This means that the base and, therefore, the emitter of Q9 is also high, driving pin 12 of U8 low. This makes pins 2 and 4 of U8 high so the LED is off. When the loop loses lock, the duty cycle will drop at either pin 11 or pin 4 (of U9). This discharges C53 through R31 faster than it can be recharged by R30, so the base voltage of Q9 drops causing pin 12 of U8 to go high. This turns on the LED and drives the LL line low. The pin number (11 or 4) that goes low in loss-of-lock depends on whether the VCO frequency is too high or too low.

An on-card 8 volt regulator, U10, supplies the linear circuits with clean power.

Table 5.5 lists the minor loop VCO output frequency and divider input frequency information.

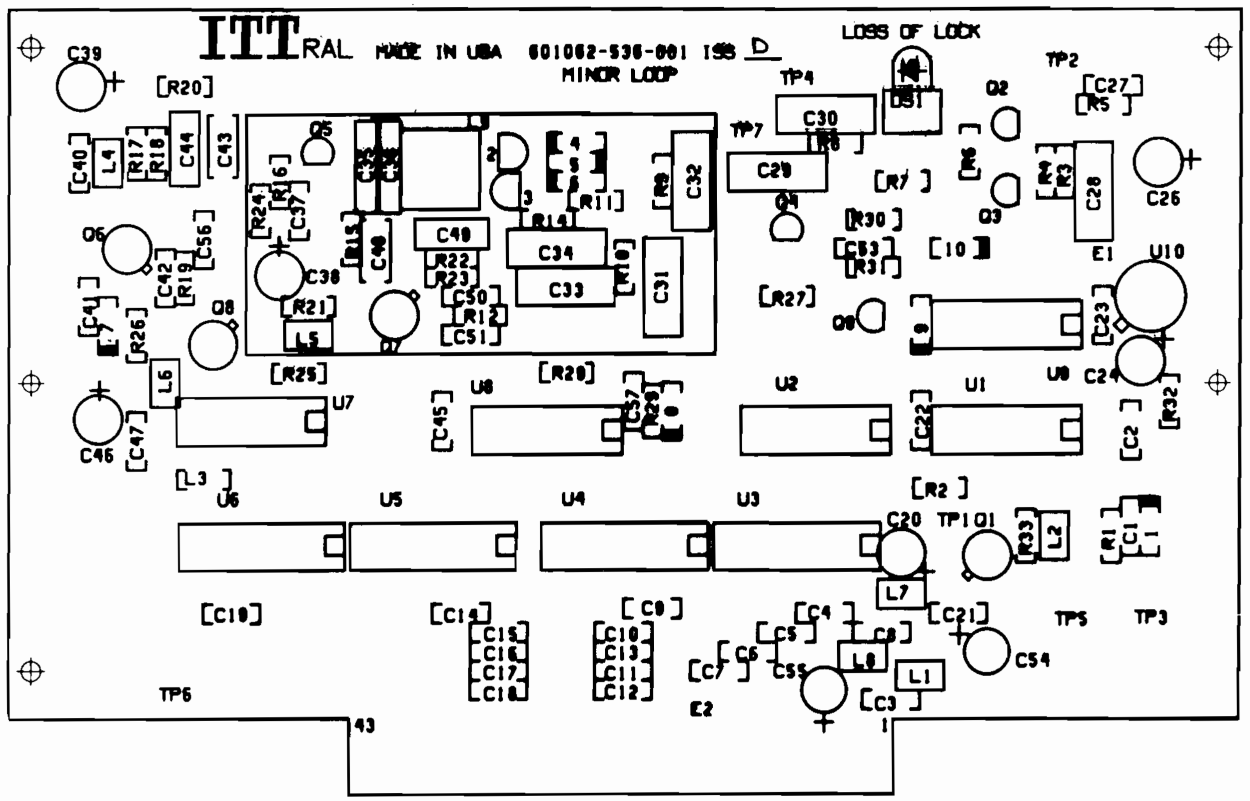
LAST 3 DIGITS OF FREQUENCY	ADJUST	*DC VOLTS AT TP2
000	L9	1.58 TO 1.62
999		3.7 TO 4.9

MINOR LOOP IN LOCK VOLTAGES

* Measurements at TP2 are temperature dependent and should be made at 25°C after radio has operated for 5 minutes with cover and shield removed.

TABLE 5.6
MINOR LOOP FREQUENCY INFORMATION

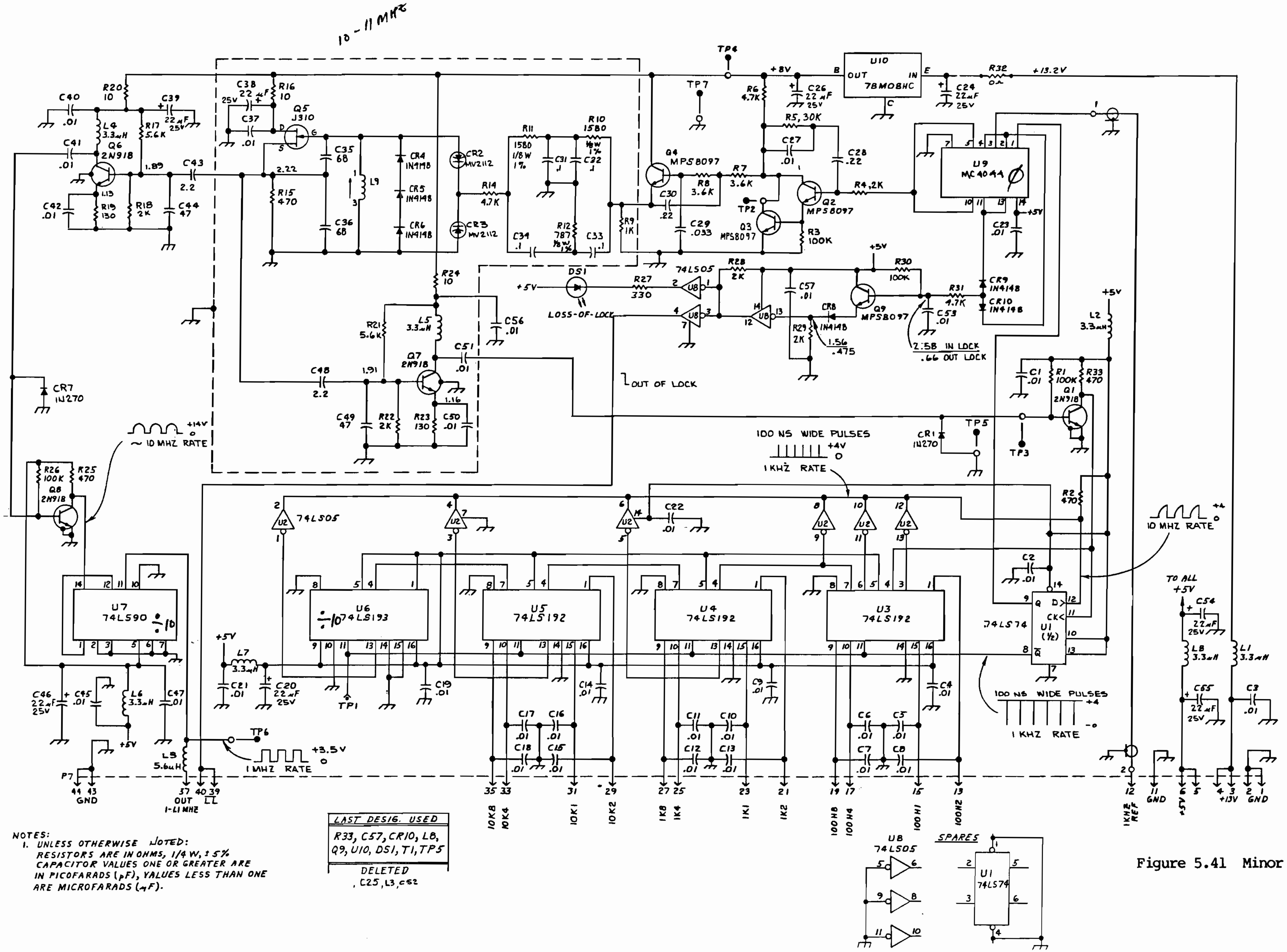
LAST 3 DIGITS OF RX or TX FREQUENCY MHz	VCO FREQUENCY MHz	PROGRAM NUMBER 10 kHz	1 kHz	100 Hz
000	1.0000	0	0	0
001	1.0001	0	0	1
002	1.0002	0	0	2
003	1.0003	0	0	3
004	1.0004	0	0	4
005	1.0005	0	0	5
006	1.0006	0	0	6
007	1.0007	0	0	7
008	1.0008	0	0	8
009	1.0009	0	0	9
010	1.0010	0	1	0
020	1.0020	0	2	0
030	1.0030	0	3	0
040	1.0040	0	4	0
050	1.0050	0	5	0
060	1.0060	0	6	0
070	1.0070	0	7	0
080	1.0080	0	8	0
090	1.0090	0	9	0
100	1.0100	1	0	0
200	1.0200	2	0	0
300	1.0300	3	0	0
400	1.0400	4	0	0
500	1.0500	5	0	0
600	1.0600	6	0	0
700	1.0700	7	0	0
800	1.0800	8	0	0
900	1.0900	9	0	0



MINOR LOOP
(601082-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-C19, C21-23, C27, C37, C40-42, C45, C47, C50, C51, C53, C56, C57	Capacitor, .01 µf, X7R	600272-314-003
C20, C24, C26, C38, C39, C46, C54, C55	Capacitor, 22 µf, 25V	600297-314-016
C28, C30	Capacitor, .22 µf	600204-314-019
C29	Capacitor, .033 µf	600204-314-012
C31-34	Capacitor, .1 µf	600204-314-020
C35, C36	Capacitor, 68 pf	600269-314-026
C43, C48	Capacitor, 2.2 pf	600269-314-002
C44, C49	Capacitor, 47 pf	600269-314-022
CR1, CR7	Diode, 1N270	600052-410-001
CR2, CR3	Diode, MV2112	600123-410-009
CR4-6, CR8-10	Diode, 1N4148	600109-410-001
DS1	LED	600036-390-001
L1, L2, L4-8	Choke, 3.3 µH	600125-376-006
L3	Choke, 5.6 µH	600125-376-043
L9	Choke, Variable	600093-512-001
Q1, Q6-8	Transistor, 2N918	600085-413-001
Q2-4, Q9	Transistor, MPS8097	600278-413-001
Q5	Transistor, J310	600259-413-001
(Q1-4, Q6-9)	Transistor Pad, TO-18	600025-419-001
R3	Resistor, 10k, 1/4W, 5%	610024-341-075
R1, R26, R30	Resistor, 100k, 1/4W, 5%	610034-341-075
R2, R15, R25, R33	Resistor, 470Ω, 1/5W, 5%	647004-341-075
R5	Resistor, 30k, 1/4W, 5%	630024-341-075
R6,R14, R31	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R7, R8	Resistor, 3.6k, 1/4W, 5%	636014-341-075
R9	Resistor, 1k, 1/4W, 5%	610014-341-075
R4,R18, R22, R28, R29	Resistor, 2k, 1/4W, 5%	620014-341-075
R16, R20, R24	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R17, R21	Resistor, 5.6k, 1/4W, 5%	656014-341-075
R19, R23	Resistor, 130Ω, 1/4W, 5%	613004-341-075
R27	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R32	Resistor, 0Ω, 1/4W, 5%	600000-341-075
R10, R11	Resistor, 1580Ω, 1/8W, 1%	615811-342-059
R12	Resistor, 787Ω, 1/8W, 1%	678701-342-059
TP1-7	Terminal	600261-230-001
U1	I.C., 74LS74	600113-415-001
U2, U8	I.C., 74LS05	600240-415-001
U3, U4, U5	I.C., 74LS192	600225-415-001
U6	I.C., 74LS193	600122-415-001
U7	I.C., 74LS90	600175-415-001
U9	I.C., MC4044	600092-415-001
U10	I.C., 78M08HC	600526-415-001
XDS1	Mount, LED	600005-635-001

Figure 5.40 Minor Loop Assembly



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

Figure 5.41 Minor Loop Schematic

Minor Loop Board

1A1A13

Pin Connections and Voltage Readings

1A1A13-J7

Signal	Pin	Pin	Signal
GND	1	2	GND
+13 VDC	3	4	+13 VDC
+5 VDC	5	6	+5 VDC
	7	8	
	9	10	
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	
Logic "0" or 1 $\overline{LL}$	39	40	$\overline{LL}$ Logic "0" or 1
	41	42	
GND	43	44	GND

BOTTOM VIEW

5.20 TRANSLATOR LOOP BOARD, 1A1A14

The translator loop board, Figures 5.42/43, provides the 55.530 to 55.6299 MHz signal for use by the major loop and provides the 54.53 MHz second LO for the receiver/exciter. Also, refer to the block diagram, Figure 5.39.

The second LO signal is generated by a Colpitts configuration crystal oscillator, Q6 and associated components. The crystal is a parallel resonant type and is adjusted on frequency by trimmer C61. An uncompensated crystal can be used because both the first and second LO signals are derived from it, so any 54.53 MHz frequency drift cancels in the transmit and receive frequency, leaving the overall frequency stability dependent only on the TCXO reference oscillator.

The output of the 54.53 MHz oscillator is split into two paths. One path goes to buffer Q5, which drives mixer M1. The other path goes to buffer Q7, which provides the 0 dBm second LO output. The output amplitude can be adjusted to 0 dBm by C64. Components L13, C39, C46 and C41 form a harmonic filter.

The translator output is the sum of the second LO (54.53 MHz) and the minor loop output (1.0000 to 1.0999 MHz). The VCO, consisting of Q1, L6, C63, C60 and associated components is a Colpitts oscillator whose frequency is varied by changing the control line voltage at TP6. A change in the DC voltage here will change the bias on varicap CR4, changing the VCO tank capacitance and thus, the VCO frequency. The output signal is split into two paths. One path goes through output level adjust C15, then to cascode amplifier Q2 and Q3. The cascode amplifier provides excellent reverse isolation and a -10 dBm output level through harmonic filter L3, L2 and associated capacitors. The other path from the VCO goes to buffer Q4, which drives pin 8 of mixer M1. The output of the mixer (pins 3 and 4) is a 1.0000 to 1.0999 MHz signal. This signal is amplified by a 15 dB amplifier (Q8, Q9 and associated components) and then coupled through R54 and C57 to lowpass filter L14, L16, C54, C55 and C56 to provide a 100 millivolt p-p signal at TP4. From here, the signal is amplified by high gain common emitter amplifiers Q10 and Q11 to generate a 4 volt p-p waveform for the loop input to the phase/frequency detector (pin 1). The reference frequency is the 1.0000 to 1.0999 MHz signal from from the minor loop and is fed to pin 3 of U1. Thus, the loop translator causes the VCO to generate a frequency which, when 54.53 MHz is subtracted by M2, is the same as the minor loop input frequency.

The output of phase detector U1, is at pins 5 and 10 and is a high impedance when the loop is locked. This output is connected to a lead-lag type active loop filter consisting of Q12, Q13, R42, R41, C48, C47 and R40. The filter output goes through R43 to TP6. Diode CR7 prevents the voltage at TP6 from dropping below 4.3 volts and the VCO frequency from falling below 54.53 MHz, which would cause a false lock.

The loss-of-lock circuitry works as follows: phase detector outputs pin 11 and pin 4 are normally high with nearly 100% duty cycle in a properly locked loop. This means that the base and, therefore, the emitter of Q14 is also high, driving pin 6 of U2 low. This makes pins 8 and 10 of U2 high so the LED is off. When the loop loses lock, the duty cycle will drop at either pin 11 or pin 4 (of U1). This discharges C43 through R37 faster than it can be recharged by R38, so the base voltage of Q14 drops causing pin 6 of U2 to go high. This turns on the LED and drives LL line low. The pin number (11 or 4) that goes low in loss-of-lock depends on whether the VCO frequency is too high or too low.

An on-card 8 volt regulator, U3, supplies the linear circuits with clean power.

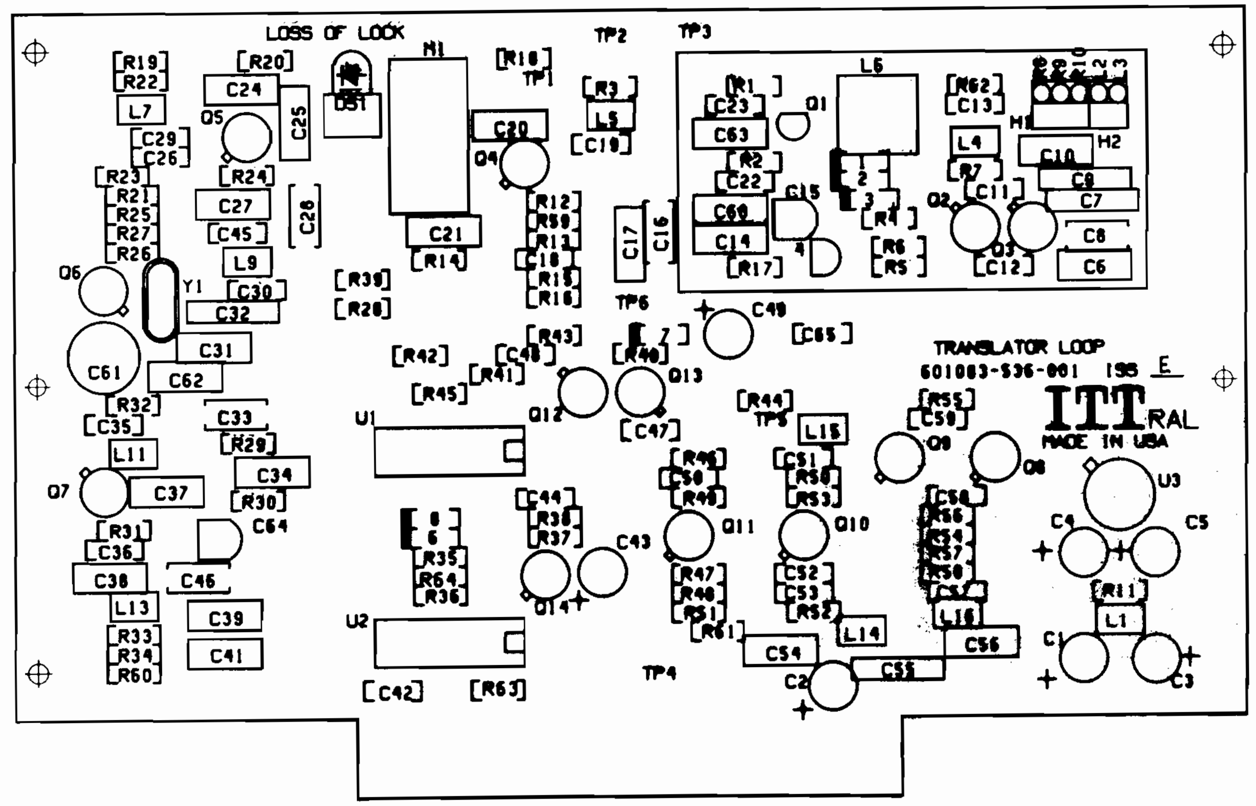
LAST 3 DIGITS OF FREQUENCY	ADJUST	*DC VOLTS AT TP 6
000	L6	5.6 to 5.8
999	L6	5.9 to 6.2

TRANSLATOR IN LOCK LOOP VOLTAGES

* Measurements at TP6 are temperature dependent and should be made at 25°C after radio has operated for 5 minutes with cover and shield removed.

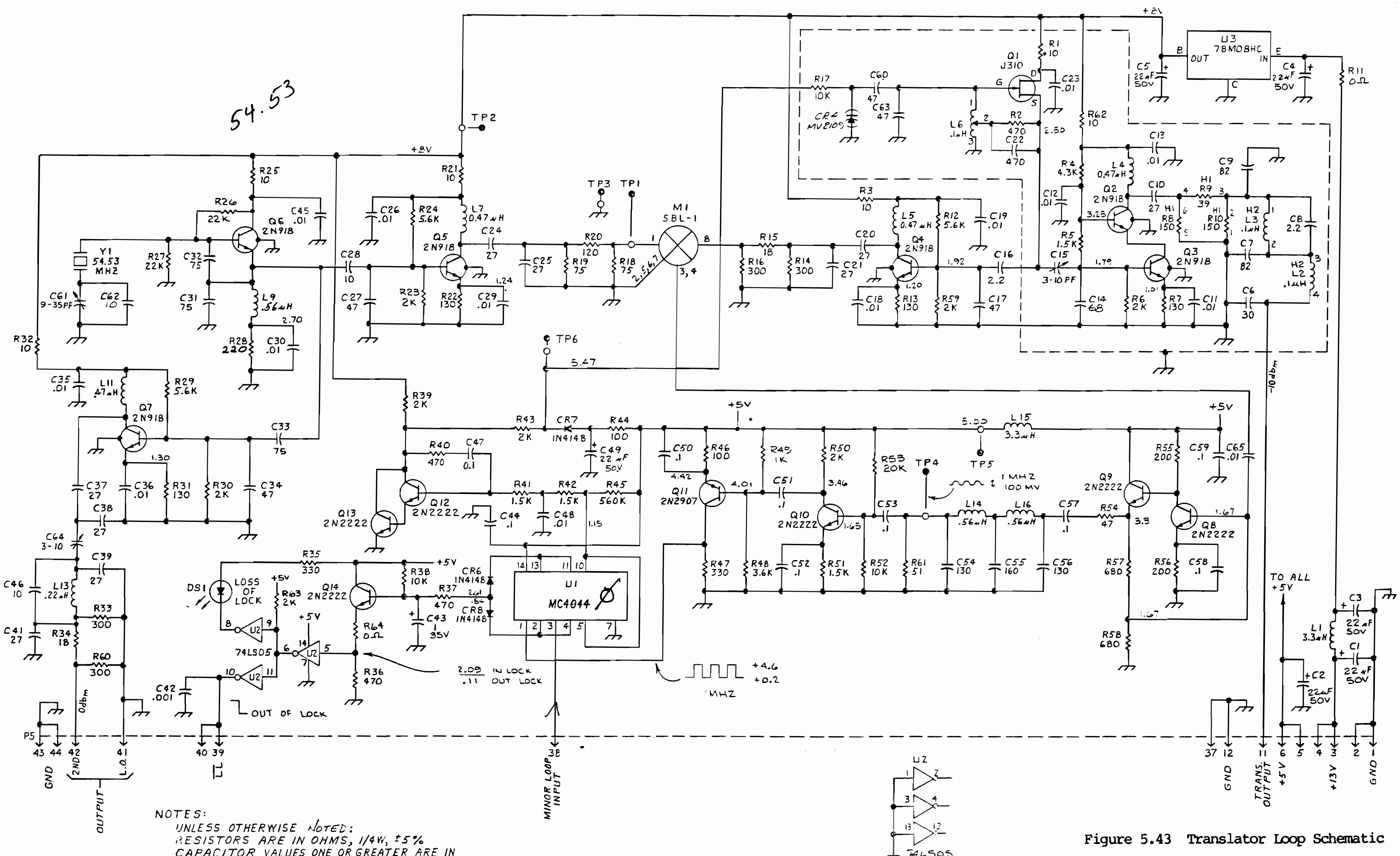
TRANSLATOR LOOP
(601083-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-5, C49	Capacitor, 22 µf, 50V	600297-314-018
C6	Capacitor, 30 pf	600269-314-017
C7, C9	Capacitor, 82 pf	600269-314-028
C8, C16	Capacitor, 2.2 pf	600269-314-002
C10, C20, C21, C24, C25, C37-39, C41	Capacitor, 27 pf	600269-314-016
C11-13, C18, C19, C23, C26, C29, C30, C35, C36, C45, C48, C65	Capacitor, .01 µf, X7R	600272-314-003
C17, C27, C34, C60, C63	Capacitor, 47 pf	600269-314-022
C15, C64	Capacitor, 3-10 pf, Trim	600052-317-001
C22	Capacitor, 470 pf, NPO	600272-314-005
C28, C46, C62	Capacitor, 10 pf	600269-314-009
C31, C32, C33	Capacitor, 75 pf	600269-314-027
C14	Capacitor, 68 pf	600269-314-026
C42	Capacitor, .001 µf, X7R	600272-314-008
C43	Capacitor, 1 µf, Tant., 35V	600202-314-007
C44, C50-53, C57-59	Capacitor, .1 µf, 50V	600272-314-001
C54, C56	Capacitor, 130 pf	600269-314-033
C55	Capacitor, 160 pf	600269-314-035
C61	CAPACITOR, 9-35 pf, Trim	600018-317-004
C47	Capacitor, .1 µf, Mylar	600204-314-020
CR6-8	Diode, 1N4148	600109-410-001
CR4	Diode, MV2109	600123-410-008
DS1	LED	600036-390-001
L1, L15	Choke, 3.3 µH	600125-376-006
L2, L3	Choke, .1 µH	600125-376-028
L4, L5, L7, L11	Choke, .47 µH	600125-376-027
L6	Choke, .1 µH, Variable	600173-376-001
L13	Choke, .22 µH	600125-376-003
L14, L16	Choke, .56 µH	600125-376-005
M1	Mixer	600008-455-001
Q1	Transistor, J310	600259-413-001
Q2-7	Transistor, 2N918	600085-413-001
Q8-10, Q12-14	Transistor, 2N2222A	600080-413-001
Q11	Transistor, 2N2907A	600154-413-001
R1, R3, R21, R25, R32, R62	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R2, R36, R37, R40	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R4	Resistor, 4.3k, 1/4W, 5%	643014-341-075
R5, R41, R42 R51	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R6, R23, R30, R39, R43, R50, R59, R63	Resistor, 2k, 1/4W, 5%	620014-341-075
R7, R13, R22 R31	Resistor, 130Ω, 1/4W, 5%	613004-341-075
R8, R10	Resistor, 150Ω, 1/4W, 5%	615004-341-075



SYMBOL	DESCRIPTION	PART NUMBER
R9	Resistor, 39Ω, 1/4W, 5%	639094-341-075
R28	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R12, R24, R29	Resistor, 5.6k, 1/4W, 5%	656014-341-075
R14, R16, R33 R60	Resistor, 300Ω, 1/4W, 5%	630004-341-075
R15, R34	Resistor, 18Ω, 1/4W, 5%	618094-341-075
R17, R38, R52	Resistor, 10k, 1/4W, 5%	610024-341-075
R18, R19	Resistor, 75Ω, 1/4W, 5%	675094-341-075
R20	Resistor, 120Ω, 1/4W, 5%	612004-341-075
R26, R27	Resistor, 22k, 1/4W, 5%	622024-341-075
R35, R47	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R44, R46	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R45	Resistor, 560k, 1/4W, 5%	656034-341-075
R48	Resistor, 3.6k, 1/4W, 5%	636014-341-075
R49	Resistor, 1k, 1/4W, 5%	610014-341-075
R53	Resistor, 20k, 1/4W, 5%	620024-341-075
R54	Resistor, 47Ω, 1/4W, 5%	647094-341-075
R55, R56	Resistor, 200Ω, 1/4W, 5%	620004-341-075
R57, R58	Resistor, 680Ω, 1/4W, 5%	668004-341-075
R61	Resistor, 51Ω, 1/4W, 5%	651094-341-075
R11, R64	Resistor, 0Ω, 1/4W, 5%	600000-341-075
U1	I.C., MC4044	600092-415-001
U2	I.C., 74LS05	600240-415-001
U3	I.C., 78M08HC	600526-415-001
Y1	Crystal, 54.53 MHz	600163-378-001

Figure 5.42 Translator Loop Assembly



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

Figure 5.43 Translator Loop Schematic

Translator Loop Board

1A1A14

Pin Connections and Voltage Readings

1A1A14-J5

GND	1	2	GND
+13 VDC	3	4	+13 VDC
	5	6	+5 VDC
	7	8	
	9	10	
(-10 dBm) 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 $\overline{LL}$	39	40	$\overline{LL}$ Logic "0" or 1
(2nd LO) 54.53 MHz -10 dBm	41	42	54.53 MHz -10 dBm (2nd LO)
GND	43	44	GND

BOTTOM VIEW

5.21 MAJOR LOOP BOARD, 1A1A15

The major loop, Figures 5.44/45, provides the first local oscillator (LO) signal (59.53 MHz to 89.53 MHz) for the first mixer in the signal path. The loop itself uses a 50 kHz reference frequency and generates 10 10 MHz, 1 MHz, and 100 kHz steps. Smaller step sizes are possible by stepping the translator RF input to the major loop from 55.53 MHz to 55.6299 MHz. The translator loop takes 100 Hz steps over this range, which also gives the major loop output 100 Hz steps. The smaller step sizes are actually generated by the minor loop, so different step sizes are possible by changing minor Refer to the block diagram, Figure 5.39.

The VCO, Q7, is a Colpitts oscillator with three switched ranges. The VCO control line is the junction of varicaps CR7 and CR8 driven through decoupling choke, L4. The oscillator covers 59.53 MHz to 89.53 MHz in three course ranges (see Table 5.6). This keeps the loop gain expression $\frac{Kvkp}{N}$ * nearly constant which insures that loop dynamics (stability, settling time) are constant throughout the range. Range switching is accomplished by PIN diodes CR13 and CR2. The top range has only varicaps CR7 and CR8 in combination with L3 determining the VCO frequency. In the middle range, CR2 is turned on, which puts C71 and C73 in parallel with the varicaps. In the low range, CR2 remains on and CR13 turned on, which adds parallel capacitors C72 and C74 to the tank circuit. Diodes CR4, CR5 and CR6 limit the oscillation amplitude. Resistor R23 sets the static FET operating point an unbypassed resistor R13 degenerates the gain slightly to limit high order harmonic production.

The output of Q6 is taken from 3:1 broadband transformer L1 (L7 and L8 are similar transformers) and fed to two additional buffers. Cascode amplifiers Q12 and Q11 provide extremely good reverse isolation (70 to 80 dB) and feeds mixer M1.

The first LO output is from buffer Q1. Components L9, L10, C42, C43 and C77 provide harmonic filtering. R52 is used to adjust the output level.

The translator loop frequency is fed to pin 1 of mixer M1 and the VCO is fed to pin 8. The output, on pins 3 and 4, is amplified by Q9 and Q10 and fed to a bandpass filter consisting of L5, L6 and associated capacitors. The filter passes the difference frequency of 4 to 33.9 MHz to be further amplified by Q13 and Q14. Both the Sum $F_{VCO} + F_{TRANS}$ and difference $F_{VCO} - F_{TRANS}$ are present in the mixer output. We want only the difference frequency. The output is fed to the clock input of U8, which is a D flip-flop connected to toggle (-2). Resistors R44 and R48 bias U8's clock input at threshold for reliable triggering. The presence of the -2 is compensated for by using a 50 kHz (not 100 kHz) reference signal for the loop.

The programmable divider determines the VCO frequency in the following manner: the <u>output</u> of the programmable divider (U8, pin 9) is <u>always</u> 50 kHz if the loop is locked. The <u>input</u> frequency (U8, pin 11), then, is N x 50 kHz, when N is the programmed divide number. Working back up to the VCO: (N x 50 kHz x 2) + $F_{TRANS} = F_{VCO}$.

The programmable divider functions in the following manner: U5, U6 and U7 are parallel - loadable UP/DOWN counters which are cascaded and permanently connected to count DOWN. Counter U5 is the most significant digit, U7 the least significant. U4 is an array of open collector inverters which have their outputs connected together to form a NOR gate. The output (pins 4, 6, 8, 10 and 12) can only go high if all the inputs (pins 3, 5, 9, 11 and 13) are low. The U4 inputs are connected so that the output goes high when the counter (U5-U7) contains the number 002. To understand the operation, assume that the counter has just been loaded with the number 124. The counters begin counting down. Because of the D input, pin 12, is low, pin 9 of U8 (Q) stays low and pin 8 (Q) stays high. After 100 pulses, U5 underflows and U4, pin 3, goes low. After another 20 pulses, U6 underflows and U4, pin 5, goes low. After another 2 pulses, pins 9, 11 and 13 of U8 are low, so the "output" of U4, pins 4, 6, 8, 10 and 12 can go high. The counter now contains the number 002 and the D input, pin 12 of U8 goes high (this is the programmable divider output pulse), and pin goes low, again loading U5, U6 and U7 with the divide number. The next pulse (number 000) toggles pin 8 high and pin 9 low. The cycle can now repeat.

The output of the programmable divider (U8, pin 9) is fed to the phase/frequency detector U2, where it is compared with the 50 kHz reference. If the divider output is too low in frequency or lagging the 50 kHz reference in phase, the phase detector output (pins 5 and 10) goes down. This causes the voltage of the VCO control line to rise, which raises the frequency to correct the error.

The loop amplifier consists of Q5, Q4 and Q3, which form a high input impedance inverting stage. The amplifier and feedback components (C7, R12, R11 and C8 form an active loop filter, which determines the overall loop stability. Transistor Q2, with components R10, R58, C12 and C66 forms an active lowpass filter with a sharp corner and steep rolloff to attenuate the reference sidebands. The amplifier and active lowpass are fed +24 volts from the reference board. The +24 volts is needed to increase the varicap range.

The loss-of-lock circuitry works as follows: phase detector outputs pin 11 and pin 4 are normally high with nearly 100% duty cycle in a properly locked loop. This means that the base and, therefore, the emitter of Q8 is also high, driving pin 4 of U3 low. This makes pins 2 and 6 of U3 high so the LED is off. When the loop loses lock, the duty cycle will drop at either pin 11 or 4 (of U2). This discharges C25 through R32 faster than it can be recharged by R25, so the base voltage of Q8 drops causing pin 4 of U3 to go high. This turns on the LED and drives the LL line low. The pin number (11 or 4) that goes low in loss-of-lock depends on whether the VCO frequency is too high or too low.

An on-card 8 volt regulator, U1, supplies the linear circuits with clean power.

*While a complete discussion of loop theory is beyond the scope of this technical description, the following is an extremely simplified explanation: the loop response time and setting time depends on the time constants of the loop filter components and the loop "gain" $\frac{K_vK_p}{N}$, where K_v is the VCO transfer constant in Radians/Sec/Volt, K_p is the phase detector constant in Volts/Radian, and N is the programmable divide number. Typical numbers for the major loop might be:

$Kv = 3.14 \times 10^6$

$Kp = .44$ so $\frac{KvKp}{N} = 11.1 \times 10^3$

$N = 124$

Table 5.6 lists the major loop VCO output frequency and divider program information.

TABLE 5.7
MAJOR LOOP FREQUENCY INFORMATION

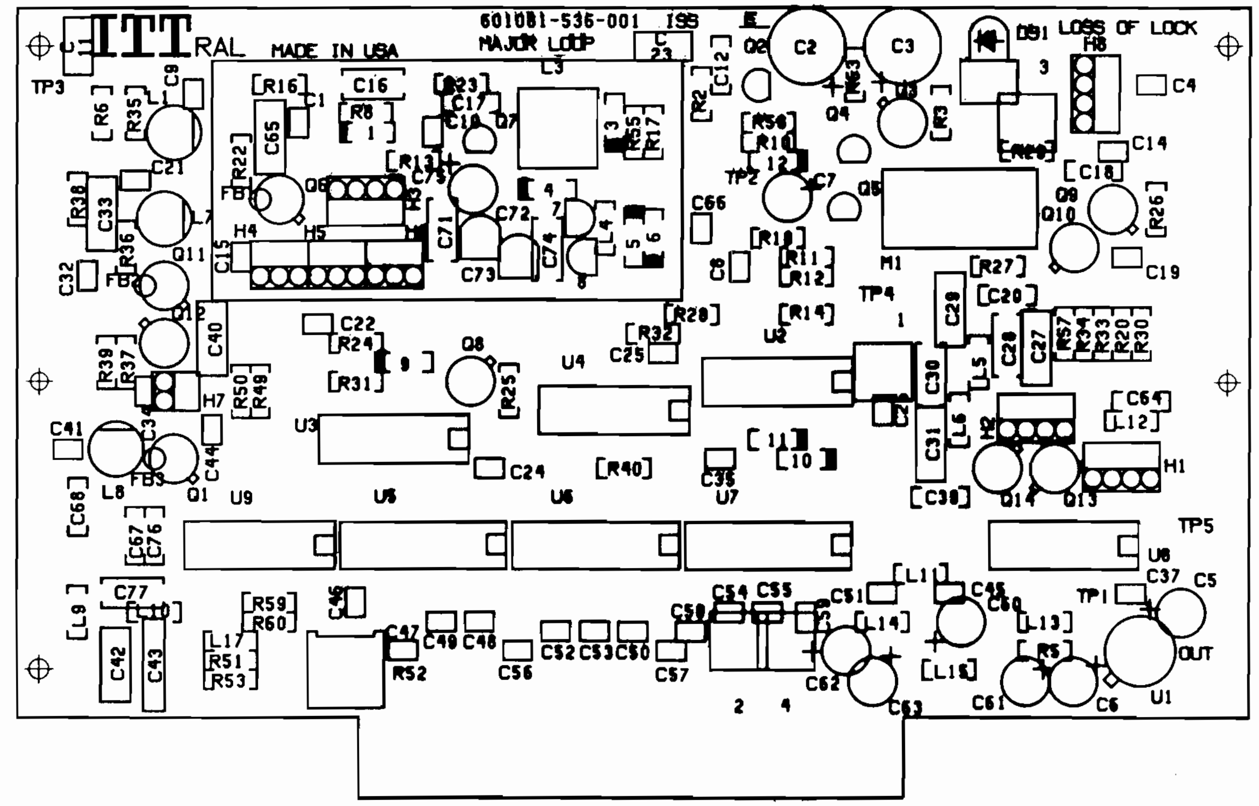
FIRST 3 DIGITS OF RX or TX FREQUENCY MHz	VCO FREQUENCY MHz	PROGRAM NUMBER	U9 PIN 8	U9 PIN 6	CR13	CR2
1.60 5.90	61.13 65.43	056 to 099	LOW	LOW	ON	ON
6.00 15.90	65.53 75.43	100 to 199	HIGH	LOW	ON	OFF
16.00 29.90	75.53 89.43	200 to 399	HIGH	HIGH	OFF	OFF

FIRST 3 DIGITS OF FREQUENCY MHZ	ADJUST	DC VOLTS 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

Major Loop In-Lock Loop Voltage

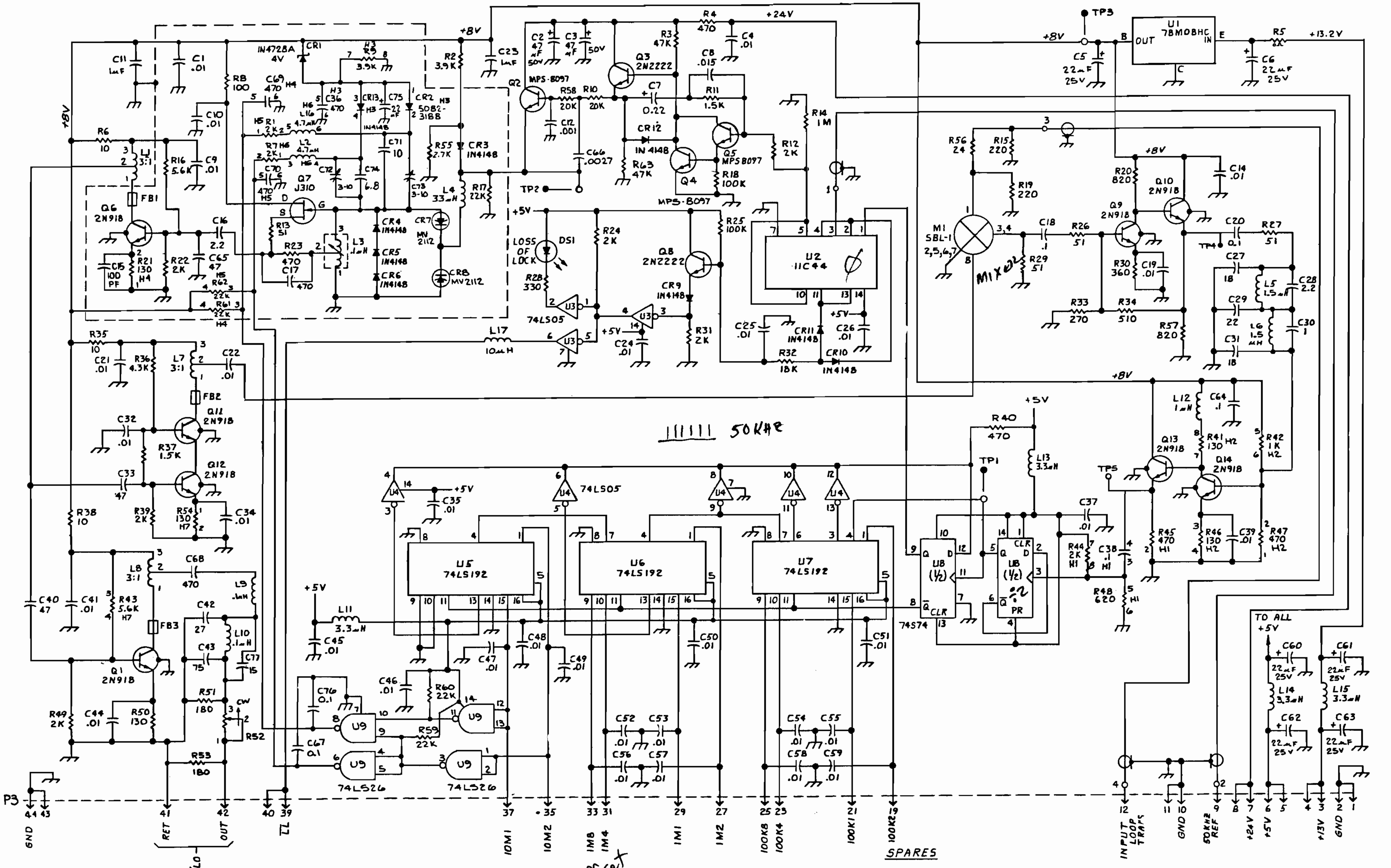
MAJOR LOOP ASSEMBLY
(601081-536)

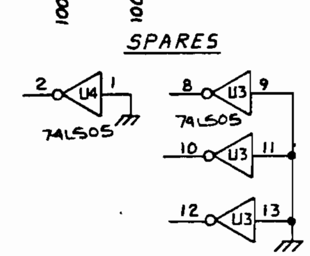
SYMBOL	DESCRIPTION	PART NUMBER
C1, C4, C9, C10, C14, C19, C21, C22, C24-26, C32, C34, C35, C37, C41, C44-59	Capacitor, .01 µf, 50V	600268-314-008
C2, C3	Capacitor, 47 µf, 50V	600297-314-026
C5, C6, C60, C61, C62, C63, C75	Capacitor, 22 µf, 25V	600297-314-016
C7	Capacitor, .22 µf	600202-314-003
C8	Capacitor, .015 µf	600268-314-011
C11, C23	Capacitor, 1 µf	600226-314-014
C12	Capacitor, .001 µf, X7R	600272-314-008
C15	Capacitor, 100 pf	600267-314-002
C16, C28	Capacitor, 2.2 pf, NPO	600269-314-002
C17, C36, C68, C69, C70	Capacitor, 470 pf, NPO	600272-314-005
C18, C20, C38, C64, C67, C76	Capacitor, .1 µf, 50V	600272-314-001
C27, C31	Capacitor, 18 pf, NPO	600269-314-012
C29	Capacitor, 22 pf	600269-314-014
C30	Capacitor, 1 pf	600269-314-001
C33, C40, C65	Capacitor, 47 pf	600269-314-022
C42	Capacitor, 27 pf	600269-314-016
C43	Capacitor, 75 pf	600269-314-027
C66	Capacitor, .0027 µf	600268-314-004
C71	Capacitor, 10 pf	600269-314-009
C72, C73	Capacitor, 3-10 pf, Variable	600052-317-001
C74	Capacitor, 6.8 pf	600269-314-007
C77	Capacitor, 15 pf	600269-314-011
C39	Capacitor, .01 µf, X7R	600272-314-007
CR1	Diode, 1N4728A, 4V	600006-411-001
CR2, CR13	Diode, 5022-3188	600144-410-001
CR3-6,CR9-12	Diode, 1N4148	600109-410-001
CR7, CR8	Diode, MV2112	600123-410-009
DS1	LED	600036-390-001
FB1-3	Ferrite Bead	600141-622-001
L1, L7, L8	Transformer, 3:1	600094-512-001
L2, L16	Choke, 4.7 µH	600125-376-030
L3	Coil, Var., .1 µH	600173-376-001
L4	Choke, 33 µH	600125-376-007
L5, L6	Choke, 1.5 µH	600125-376-033
L9, L10	Choke, .1 µH	600125-376-028
L11, L13-15	Choke, 3.3 µH	600125-376-006
L12	Choke, 1 µH	600125-376-040
L17	Choke, 10 µH	600125-376-032
M1	Mixer, SLB-1	600008-455-001
Q1, Q6, Q9-14	Transistor, 2N918	600085-413-001
Q2, Q4, Q5	Transistor, MPS8097	600278-413-001
Q3, Q8	Transistor, 2N2222A	600080-413-001
Q7	Transistor, J310	600259-413-001
R55	Resistor, 2.7k, 1/4W, 5%	627014-341-075
R1, R7, R12, R22, R24, R31, R39, R44, R49	Resistor, 2k, 1/4W, 5%	620014-341-075
R2, R9	Resistor, 3.9k, 1/4W, 5%	639014-341-075
R3, R63	Resistor, 47k, 1/4W, 5%	647024-341-075
R42	Resistor, 1k, 1/4W, 5%	610014-341-075
R5	Resistor, 0Ω, 1/4W, 5%	600000-341-075
R6, R35, R38	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R8	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R10, R58	Resistor, 20k, 1/4W, 5%	620024-341-075
R4, R23, R40, R45, R47	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R13, R26, R27, R29	Resistor, 51Ω, 1/4W, 5%	651094-341-075
R14	Resistor, 1M, 1/4W, 5%	610044-341-075
R15, R19	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R16, R43	Resistor, 5.6k, 1/4W, 5%	656014-341-075
R17, R59-62	Resistor, 22k, 1/4W, 5%	622024-341-075
R18, R25	Resistor, 100k, 1/4W, 5%	610034-341-075



SYMBOL	DESCRIPTION	PART NUMBER
R20, R57	Resistor, 820Ω, 1/4W, 5%	682004-341-075
R21, R41, R46, R50, R54	Resistor, 130Ω, 1/4W, 5%	613004-341-075
R28	Resistor, 330Ω, 1/4W, 5%	633004-341-075
R30	Resistor, 360Ω, 1/4W, 5%	636004-341-075
R32	Resistor, 18k, 1/4W, 5%	618024-341-075
R33	Resistor, 270Ω, 1/4W, 5%	627004-341-075
R36	Resistor, 4.3k, 1/4W, 5%	643014-341-075
R11, R37	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R48	Resistor, 620Ω, 1/4W, 5%	662004-341-075
R51,R53	Resistor, 180Ω, 1/4W, 5%	618004-341-075
R34	Resistor, 510Ω, 1/4W, 5%	651004-341-075
R56	Resistor, 24Ω, 1/4W, 5%	624094-341-075
R52	Resistor, 100Ω, Variable	600072-360-004
U1	I.C., 78M08HC	600526-415-001
U2	I.C., MC4044	600092-415-001
U3, U4	I.C., 74LS05	600240-415-001
U5, U6, U7	I.C., 74LS192	600225-415-001
U8	I.C., 74S74	600157-415-001
U9	I.C., 74LS26	600221-415-001
	Heatsink	600145-419-001

Figure 5.44 Major Loop Assembly





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 MICROFARADS (μF).

Figure 5.45 Major Loop Schematic

Major Loop Board

1A1A15

Pin Connections and Voltage Readings

1A1A15-J3

Signal	Pin	Pin	Signal
GND	1	2	GND
+13 VDC	3	4	+13 VDC
	5	6	
+24 VDC	7	8	+24 VDC
50 kHz Ref.	9	10	GND
GND	11	12	55.53 - 55.6299 MHz -10 dBm
	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 $\overline{LL}$	39	40	$\overline{LL}$ Logic "0" or 1
	41	42	61.13 - 89.53 MHz 0 dBm (1st LO)
GND	43	44	GND

BOTTOM VIEW

5.22 FRONT PANEL, 1A2

5.22.1 GENERAL

The front panel, Figures 5.47/48, contains all switches and controls for transceiver operation. The microphone connector, 1A2J34, auxillary connector, 1A2J35, meter, and speaker switch are all located on the front panel. Part of the front panel assembly includes the front panel PC board assembly, 1A2A1, which contains the frequency display and associated circuitry. The front panel is pluggable to the transceiver mother board via connectors 1A2J28 and 1A2P17 and ribbon cable. Refer to Figure 5.49 for Resistor Board A, Resistor Board B and the Meter Mount Board.

5.22.2 DETAILED DESCRIPTION

The front panel contains all switches needed for the transceiver. It also provides LED indicators to show status of the transceiver, a meter to indicate transmit power or receive signal level, a phonejack and speaker for receiver audio monitoring, a key and microphone connector for transmitter keying and an audio input.

S7 is the emission mode switch. It provides mode information in BCD form. For AME operation, S7 generates the number 1. A complete table of numbers (BCD codes) generated by S7, appears on the schematic diagram, Figure 5.44. It is not active in the channelized operate mode of operation.

S8 is a channel switch. It provides BCD output for channels 1 through 10. The transceiver is in the channelized mode when S8 is in positions 1 through 10. Position 11 of S8 is used to generate a special code (1011), BCD, number 11, for manual mode identification. Switches S9 through S14 are connected to the display digit select output on the front panel board, so that the digit being displayed can be changed directly through UP/DOWN switches during the frequency change routine controlled by the software. The three digits on the right (10 kHz's, 1 kHz's and 100 Hz's) can also be changed indirectly by the digit next to it as a result of carry or borrow during a frequency change. Switches S9 through S14 are active only in the manual mode of operation and are active in the channelized load mode of operation only under software control.

S3 and/or S4 which are located behind the front panel, generates an interrupt signal for the microprocessor to guide the program to the load memory subroutine, and to load the TX or RX frequency and mode information from the channel selected by the CHAN/FREQ switch S8 into the static RAM.

S17 generates a command for the coupler to perform the tuning procedure.

S6 turns the noise blanker on and off.

S1 selects the meter to indicate transmit forward power, or transmit reflected power. Transmit reflected power will be indicated only if the automatic antenna coupler is used, as the voltage for this indication is supplied by the antenna coupler.

R1 controls the base voltage of dimmer transistor Q17, on the front panel board to control the brightness of the display and indicators.

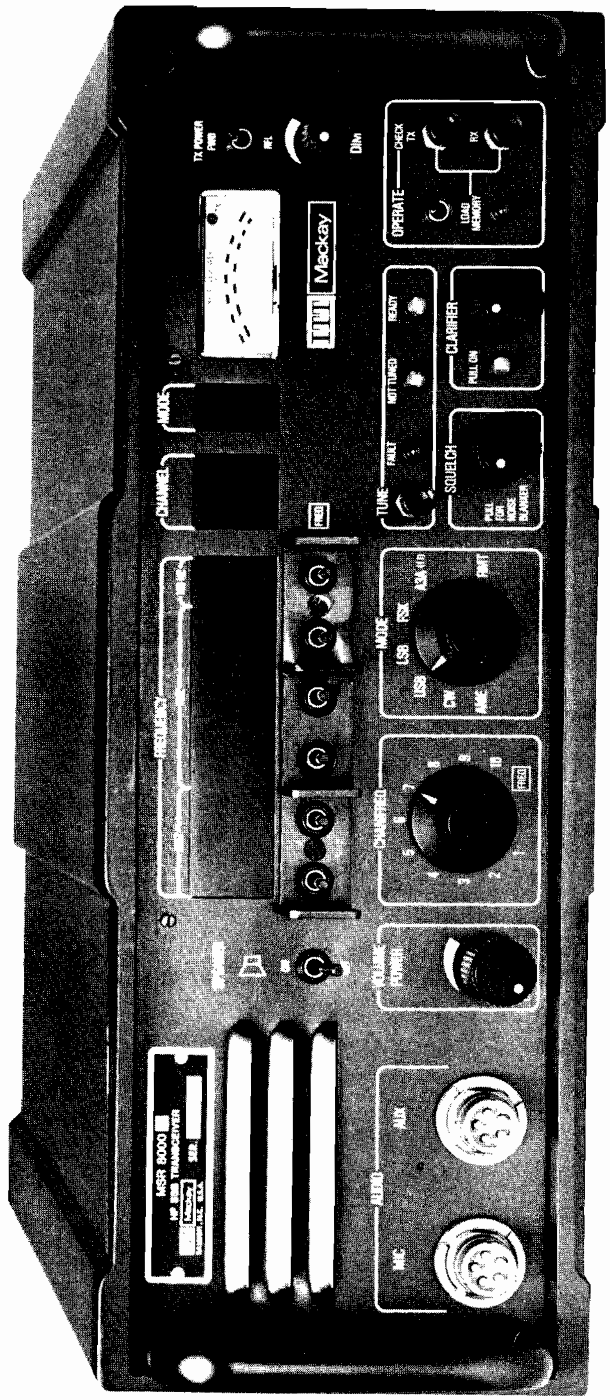
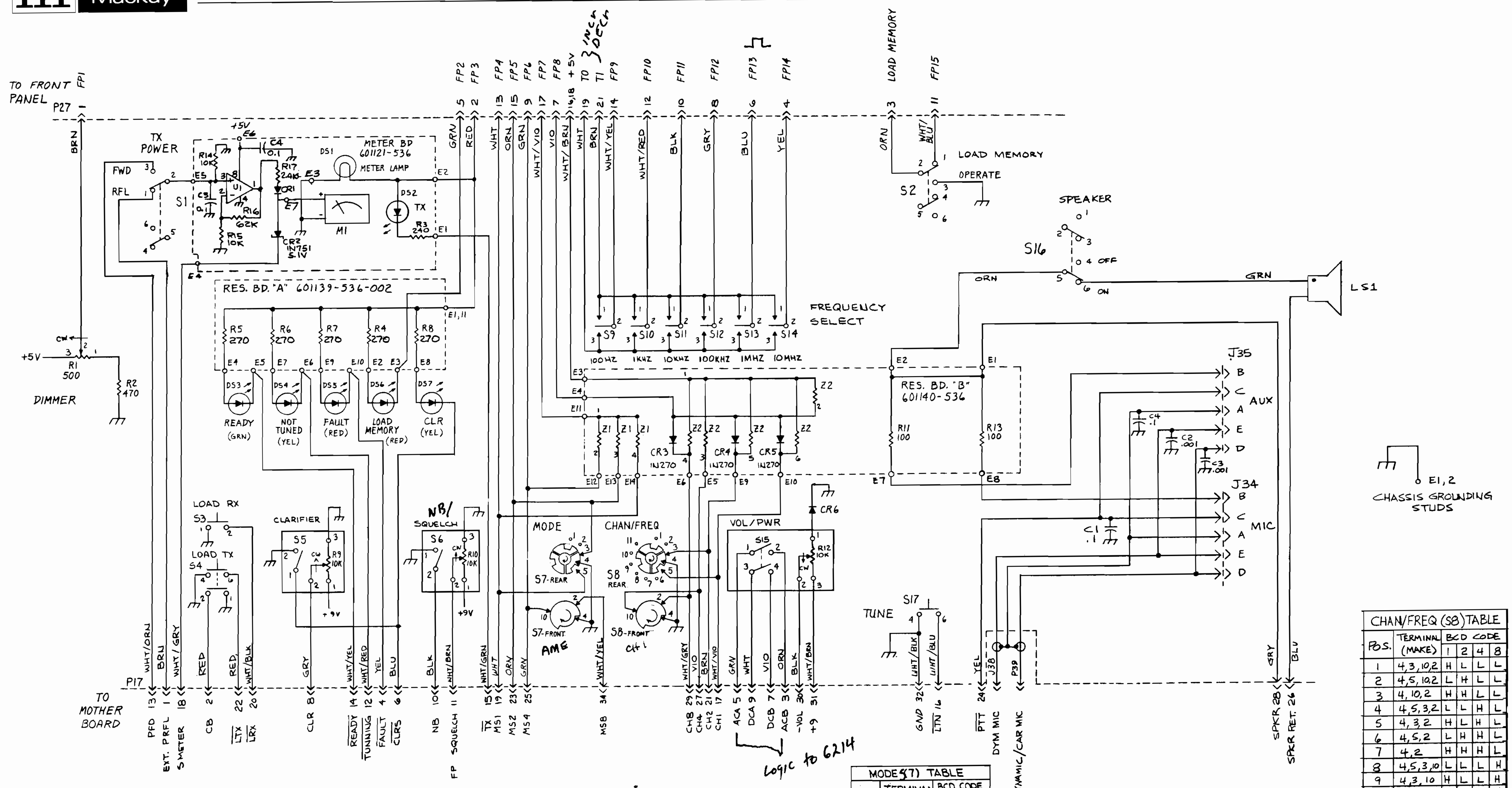


Figure 5.46 Transceiver Front Panel

FRONT PANEL ASSEMBLY
(600089-539)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C4	Capacitor, .1 µf	600226-314-008
C2, C3	Capacitor, .001 µf	600189-314-014
CR6	Diode, 1N4148	600109-410-001
DS3	LED, Green	600116-390-002
DS4, DS7	LED, Yellow	600116-390-003
DS5, DS6	LED, Red	600116-390-001
J34, J35	Connector, Microphone	600388-606-001
J38	Coax Cable Assembly	600440-540-016
LS1	Speaker	600008-370-001
M1	Meter	600034-368-001
P17	Connector, 34 Pin	600389-606-004
P27	Connector, 26 Pin	600389-606-003
P39	Coax Cable Assembly	600440-540-017
R1	Pot, 500Ω, Dimmer	600111-360-001
R2	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R9/S5, R10/S6	Pot w/Switch, 10k, DPST	600110-360-001
R12/S15	Pot w/Switch, 10k, DPST	600109-360-001
S1, S2, S16	Switch, DPDT	600287-616-002
S3, S4, S17	Switch, Push-Button	600170-616-001
S7, S8	Switch, BCD	600283-616-001
S9-14	Switch, SPDT	600287-616-002

Figure 5.47 Front Panel Assembly



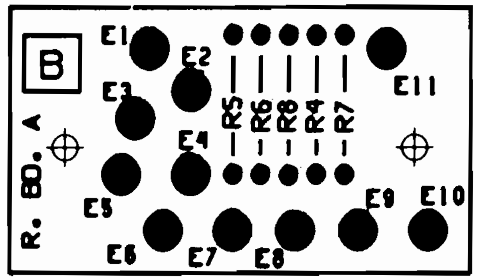
MODE S(7) TABLE					
POS	TERMINAL (MAKE)	BCD CODE			
		1	2	4	8
AME	4.3.10.2	H	L	L	L
CW	4.5.10.2	L	H	L	L
USB	4.10.2	H	H	L	L
LSB	4.5.8.2	L	L	H	L
FSK	4.3.2	H	L	H	L
A3A	4.5.2	L	H	H	L
—	4.2	H	H	H	L
RMT	4.5.3.10	L	L	L	H

CHAN/FREQ (S8) TABLE					
POS.	TERMINAL (MAKE)	BCD CODE			
		1	2	4	8
1	4,3,10,2	H	L	L	L
2	4,5,10,2	L	H	L	L
3	4,10,2	H	H	L	L
4	4,5,3,2	L	L	H	L
5	4,3,2	H	L	H	L
6	4,5,2	L	H	H	L
7	4,2	H	H	H	L
8	4,5,3,10	L	L	L	H
9	4,3,10	H	L	L	H
10	4,5,10	L	H	L	H
FREQ	4,10	H	H	L	H

NOTES:

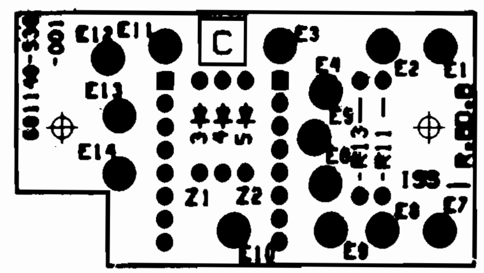
1. UNLESS OTHERWISE NOTED: RESISTORS ARE IN OHMS, 1/4 W, ±5%; CAPS ARE IN MICROFARADS (uF); DIODES ARE IN4148;
2. RESISTOR PACKS Z1 + 2 ARE 4.7K.

Figure 5.48 Front Panel Schematic



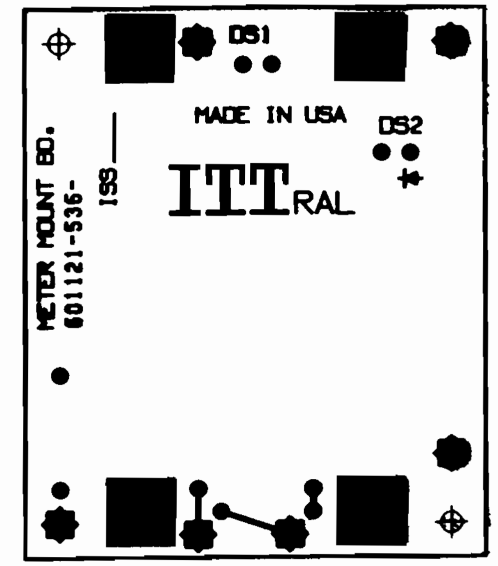
RESISTOR BOARD A
(601139-536-002)

SYMBOL	DESCRIPTION	PART NUMBER
E1-11	Terminals	600261-230-001
R4-R8	Resistor, 270Ω, 1/4W, 5%	627004-341-075



RESISTOR BOARD B
(601140-536)

SYMBOL	DESCRIPTION	PART NUMBER
CR3, CR4, CR5	Diode, 1N270	600052-410-001
E1-14	Terminal	600261-230-001
R11, R13	Resistor, 100Ω, 1/4W, 5%	610004-341-075
Z1, Z2	Resistor, pack, 4.7K	600201-537-001



METER MOUNTING BOARD
(601121-536-002)

SYMBOL	DESCRIPTION	PART NUMBER
C3, C4	Capacitor, .01 µf	600272-314-001
DS1 DS2	Lamp, Meter LED, Red	600075-390-001 600074-390-001
CR1 CR2	Diode, 1N4148 Diode, 1N751	600109-410-001 600002-411-006
DS1 DS2	Meter Lamp TX LED, Red	600075-390-001 600074-390-001
E1-7	Terminal	600261-230-001
R3 R14, R15 R16 R17	Resistor, 240Ω, 1/4W, 5% Resistor, 10k, 1/4W, 5% Resistor, 62k, 1/4W, 5% Resistor, 2.4k, 1/4W, 5%	624004-341-075 610024-341-075 662024-341-075 624014-341-075
U1	I.C., LM358	600150-415-001

Figure 5.49 Front Panel Assembly PC Boards

5.23 FRONT PANEL BOARD, 1A2A1

5.23.1 GENERAL

This board, Figures 5.46 and 5.47, receives signals from the logic board to display channel, frequency and emission modes. A dimmer circuit is provided to control the brightness of display through a dimmer pot on the front panel. Logic gates on this board will generate +5 volts to BCD mode switch through the control of LOAD/OPERATE switch. LOAD/ENABLE switch, MANUAL/ENABLE switch and CHANNEL switch. It also provides display digit select signal to UP/DOWN switches on the front panel to generate TO and TI command during frequency change routine.

5.23.2 DETAILED DESCRIPTION

U4 receives BCD frequency and channel data from the microprocessor and converts it into a seven segment display signal to drive segment drivers Q18 through Q24.

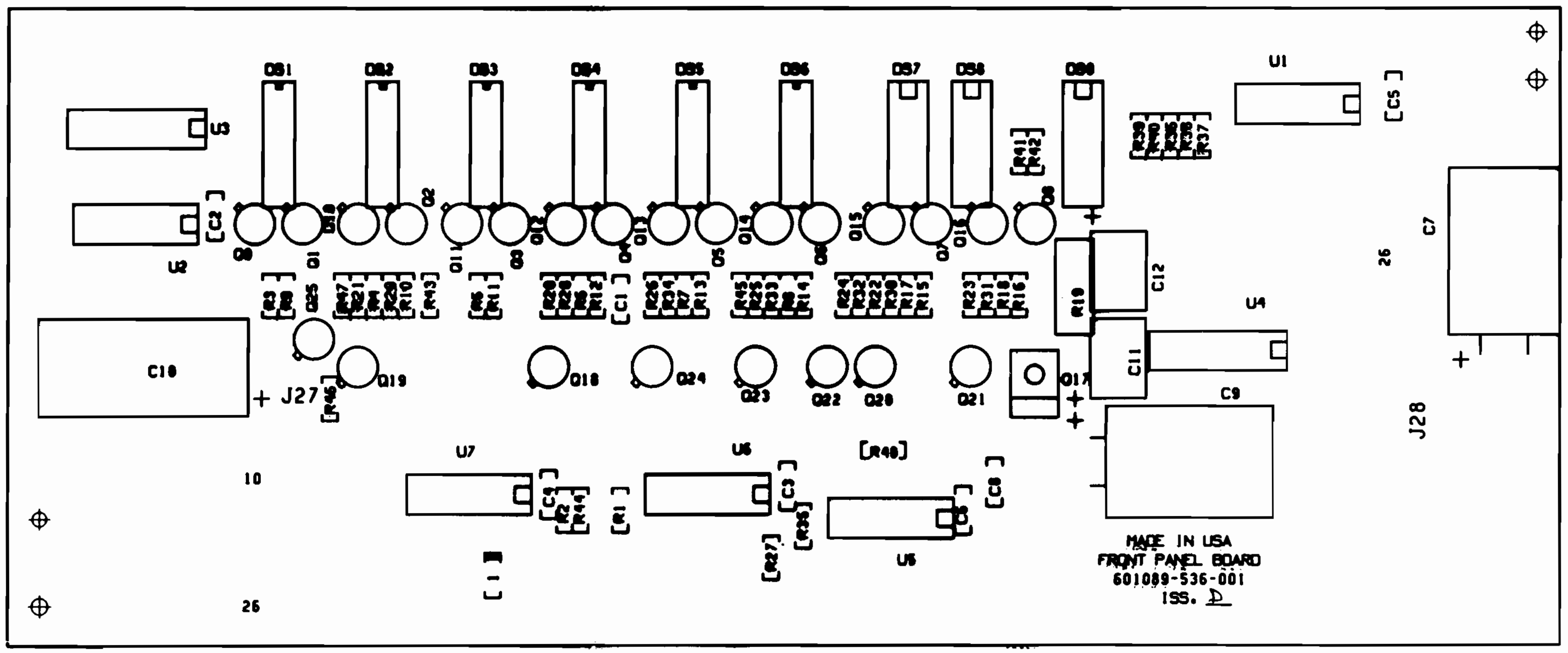
A display code signal from the microprocessor is applied to U3, pins 1, 2, and 3. U3 decodes this signal and drives one of eight digit drivers to turn on one display digit at a time. The repetition rate of the display signal is approximately 300 Hz. U2 is an inverter driver which provides enough current to drive digit driver pairs Q1, Q9, Q2, Q10, etc., to be able to sink 700 mA peak current. Output of U2 is also sent to the front panel UP/DOWN switch ON.

Q17 and associated circuitry is used to vary the anode voltage to the displays to change their brightness.

U6 and U7 serve as logic gates to switch on and off the +5 volts to the BCD mode switch on the front panel.

The dimmer output voltage is also fed to the front panel through P27-2 for the LED indicators.

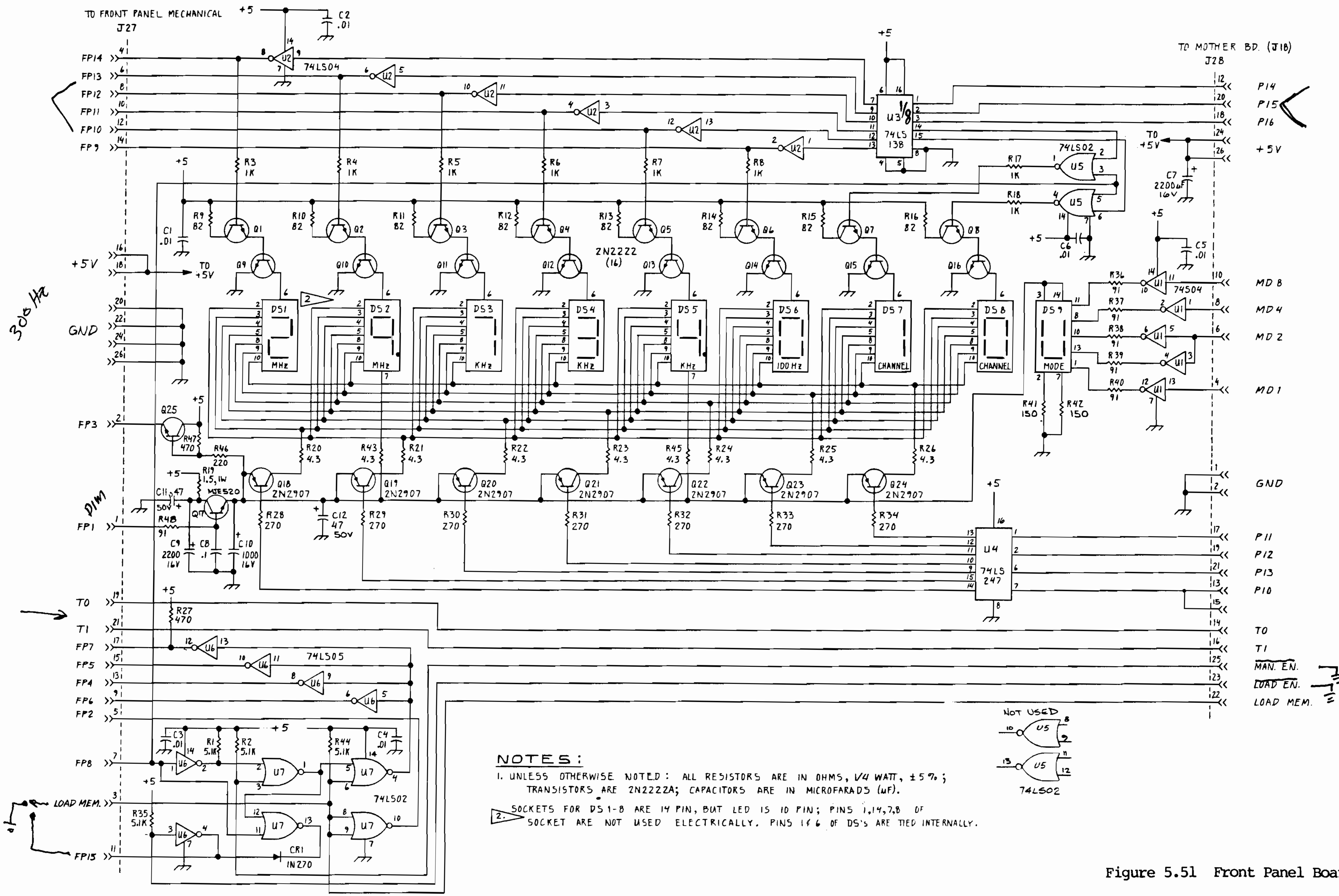
U5 is used as a switch to turn off the channel display during the manual mode of operation.



FRONT PANEL BOARD
(601089-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-6	Capacitor, .01 µf	600272-314-002
C7, C9	Capacitor, 2200 µf, 16V	600297-314-040
C8	Capacitor, .1 µf, 50V	600272-314-001
C10	Capacitor, 1000 µf, 16V	600259-314-108
C11, C12	Capacitor, 47 µf, 50V	600297-314-026
CR1	Diode, 1N270	600052-410-001
DS1-8	LED, HDSP-3533	600550-415-002
DS9	LED, HDSP-3530	600550-415-001
J27	Header, 90°	600174-608-015
J28	Header	600174-608-005
Q1-16, Q25	Transistor, 2N2222A	600080-413-001
Q17	Transistor, MJE520	600220-413-001
Q18-24	Transistor, 2N2907A	600154-413-001
R1, R2, R35, R44	Resistor, 5.1k, 1/4W, 5%	651014-341-075
R3-8, R17, R18	Resistor, 1k	610014-341-075
R9-16	Resistor, 82Ω	682094-341-075
R19	Resistor, 1.5Ω, 1W	615084-341-325
R20-26, R43, R45	Resistor, 4.3Ω	643084-341-075
R27, R47	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R28-34	Resistor, 270Ω	627004-341-075
R36-40, R48,	Resistor, 91Ω	691094-341-075
R46	Resistor, 220Ω	622004-341-075
R41, R42	Resistor, 150Ω, 1/4W, 5%	615004-341-075
U1	IC, 74S04	600316-415-001
U2	IC, 74LS04	600111-415-001
U3	IC, 74LS138	600309-415-001
U4	IC, 74LS247	600524-415-001
U5, U7	IC, 74LS02	600118-415-001
U6	IC, 74LS05	600240-415-001

Figure 5.50 Front Panel Board Assembly



NOTES:

1. UNLESS OTHERWISE NOTED: ALL RESISTORS ARE IN OHMS, 1/4 WATT, ±5%; TRANSISTORS ARE 2N2222A; CAPACITORS ARE IN MICROFARADS (uF).

2. SOCKETS FOR DS 1-8 ARE 14 PIN, BUT LED IS 10 PIN; PINS 1,14,7,8 OF SOCKET ARE NOT USED ELECTRICALLY. PINS 1 & 6 OF DS'S ARE TIED INTERNALLY.

Figure 5.51 Front Panel Board Schematic

Front Panel Board

1A2A1

Pin Connections and Voltage Readings

1A2A1-J27/1A2-P27

Dim. Control Out 2.3-5 VDC	1	2	Dimmer 2-3.5 VDC
TTL High Load Memory TTL	3	4	Freq. Up/Down Input TTL
Load Memory Indicator TTL FP2	5	6	Freq. Up/Down Input TTL
TTL High FP8	7	8	Freq. Up/Down Input TTL
Mode SW Volts In TTL FP6	9	10	Freq. Up/Down Input TTL
TTL High Load Memory In FP15	11	12	Freq. Up/Down Input TTL
Mode SW Volts In TTL FP4	13	14	Freq. Up/Down Input TTL
Mode SW Volts In TTL FP5	15	16	+5 VDC
Mode SW Volts In TTL FP7	17	18	+5 VDC
TTL High (Freq. Up) TO	19	20	GND
TTL High (Freq. Down) TI	21	22	GND
	23	24	GND
	25	26	GND

BOTTOM VIEW

TTL High: 2.0 Volts Minimum
TTL Low: 0.8 Volts Maximum

Front Panel Board

1A2A1

Pin Connections and Voltage Readings

1A2A1-J28/1A1A1-J18

GND	1	2	GND
	3	4	Mode 1 TTL High
	5	6	Mode 2 TTL High
	7	8	Mode 4 TTL High
	9	10	Mode 8 TTL High
	11	12	P14 Data TTL(Display)
Display Data TTL P10	13	14	TO Freq. Up Command TTL High
Display Data TTL P10	15	16	TI Freq. Down Command TTL High
Display Data TTL P11	17	18	P16 Data TTL(Display)
Display Data TTL P12	19	20	P15 Data TTL(Display)
Display Data TTL P13	21	22	Load Memory
TTL Load Enable	23	24	+5 VDC
TTL Manual Enable	25	26	+5 VDC

BOTTOM VIEW

TTL High: 2.0 Volts Minimum
TTL Low: 0.8 Volts Maximum

5.24 REAR PANEL ASSEMBLY, 1A3

The rear panel, Figure 5.55, contains the power input, antenna, 600 ohm audio, and accessory connector. The DC power contactor, power amplifier assembly, 1A3A1, connector board, 1A3A2, and fuses are also located on the rear panel assembly. The rear panel is pluggable to the transceiver mother board via connectors P20, P24 and P25.

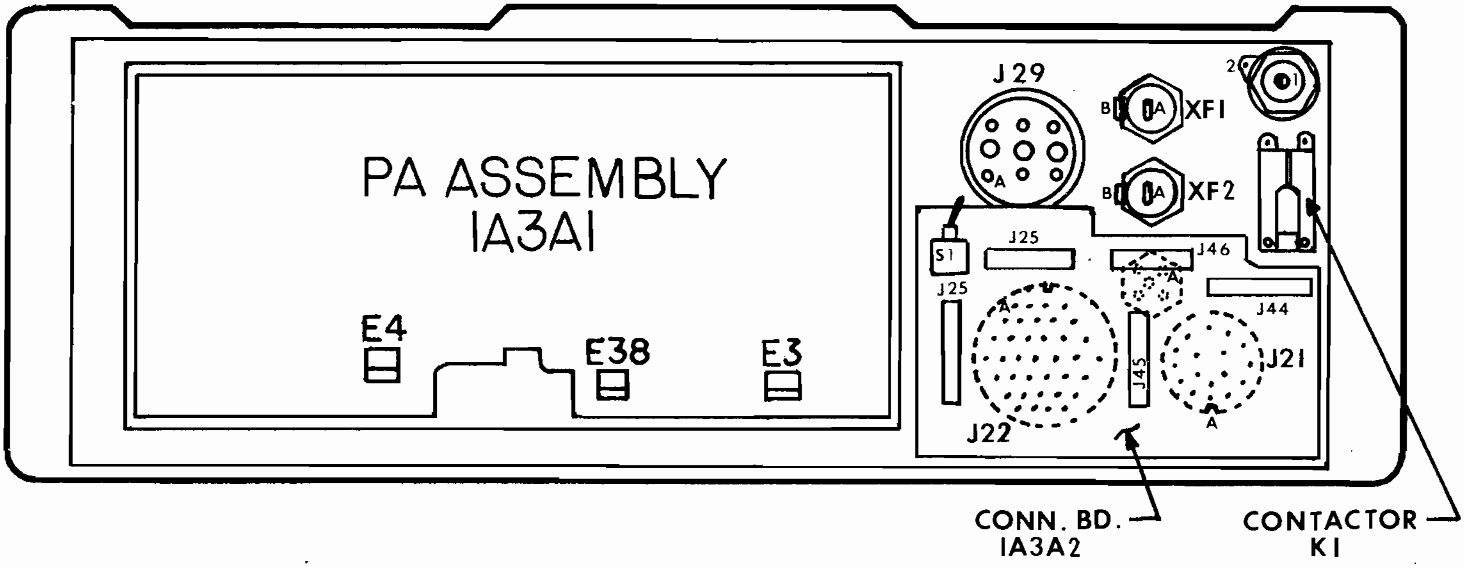
As the rear panel assembly serves to provide an interconnection function between the rear panel connectors and the chassis/mother board assembly, 1A1, maintenance on this assembly is normally not required.

Should removal from the transceiver be required, the four mounting screws (two on each side) should be removed (also remove the one screw from the bottom cover), and the rear panel is easily detachable as a unit.

CAUTION

Remove all power from the transceiver before attempting to remove the rear panel assembly.

A connector board, Figures 5.51 and 5.52, serves to provide an interconnection function between the audio connector, 1A3-J21, the accessory connector, 1A3-J22, and the mother board, 1A1A1A1. Most of the rear panel RF bypass capacitors are mounted on this PC assembly.



REAR PANEL ASSEMBLY
(600080-539-002)

SYMBOL	DESCRIPTION	PART NUMBER
CR1, CR2	Diode, 1N4004	600011-416-002
F1	Fuse, 30 Amp	600016-396-046
F2	Fuse, 10 Amp, Slo/Blo	600006-396-033
J29	Connector, Power	600374-606-003
J30	Connector, Blower	600377-606-002
J31	Connector, UHF	600373-606-001
(J31)	Cable Assembly, Coax	600440-540-011
K1	Relay, Power	600063-403-001
P26	Connector	600389-606-021
(P26)	Pin, Connector	600389-606-006
XF1, XF2	Fuse Holder	600014-613-002
1A3A1	PA Assembly, 24V	600407-705-001
1A3A1	PA Assembly, 12V	600407-705-002
1A3A2	Connector Board	602011-536-001
(K1)	Bracket, Relay	604381-602-001
(J25A/B)	Cable Assembly, Ribbon	600879-540-001
(J44)	Cable Assembly, Ribbon	600882-540-001

Figure 5.52 Rear Panel Interior View

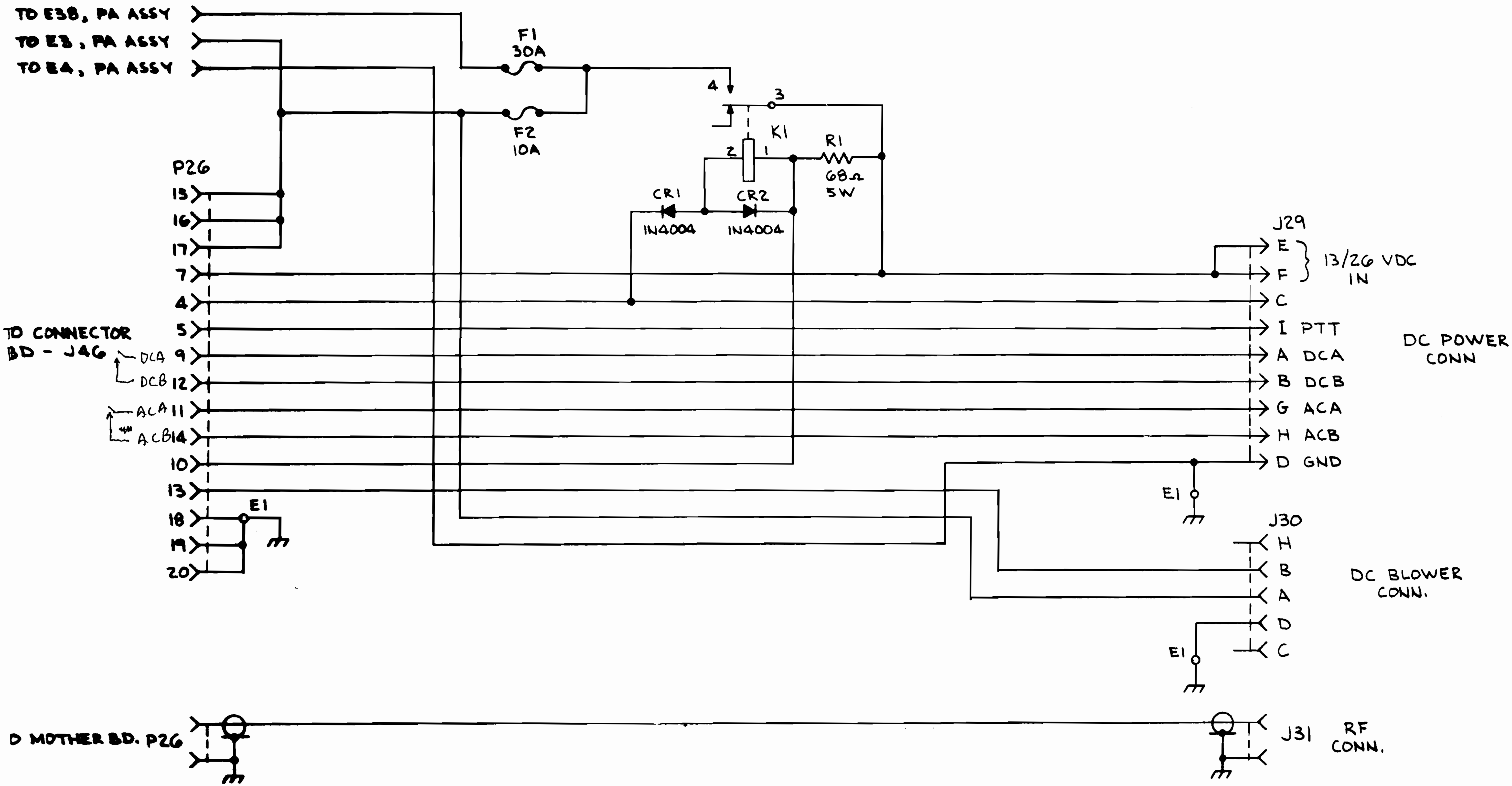
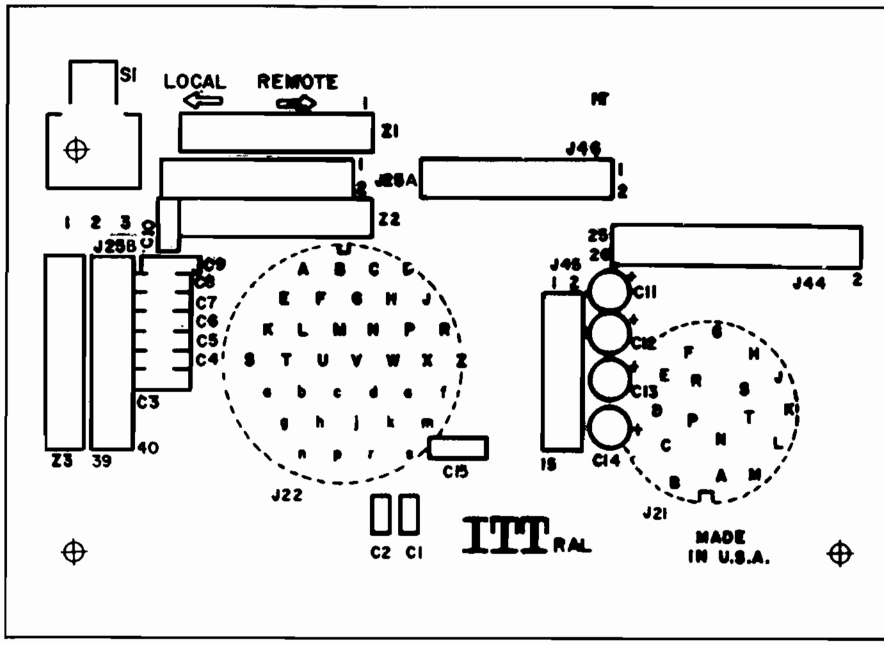


Figure 5.53 Rear Panel Schematic



REAR PANEL CONNECTOR BOARD
(602011-536-001)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C2	Capacitor, .0018 µf	600268-314-002
C3-10	Capacitor, .47 µf	600226-314-012
C11-14	Capacitor, 10 µf, 25V	600202-314-018
C15	Capacitor, .1 µf, 63V	600302-314-013
J21	Connector, M.S.	600472-606-003
J22	Connector, M.S.	600472-606-001
J25A, J25B	Header, 20 Pin	600174-608-004
J46	Header, 20 Pin	600165-608-001
J45	Header, 16 Pin	600174-608-003
J44	Header, 26 Pin	600174-608-005
S1	Switch, P.C.	600205-616-001
Z1-3	Capacitor, SlP, .1 µf	600380-314-002

Figure 5.54 Rear Panel Connector Board Assembly

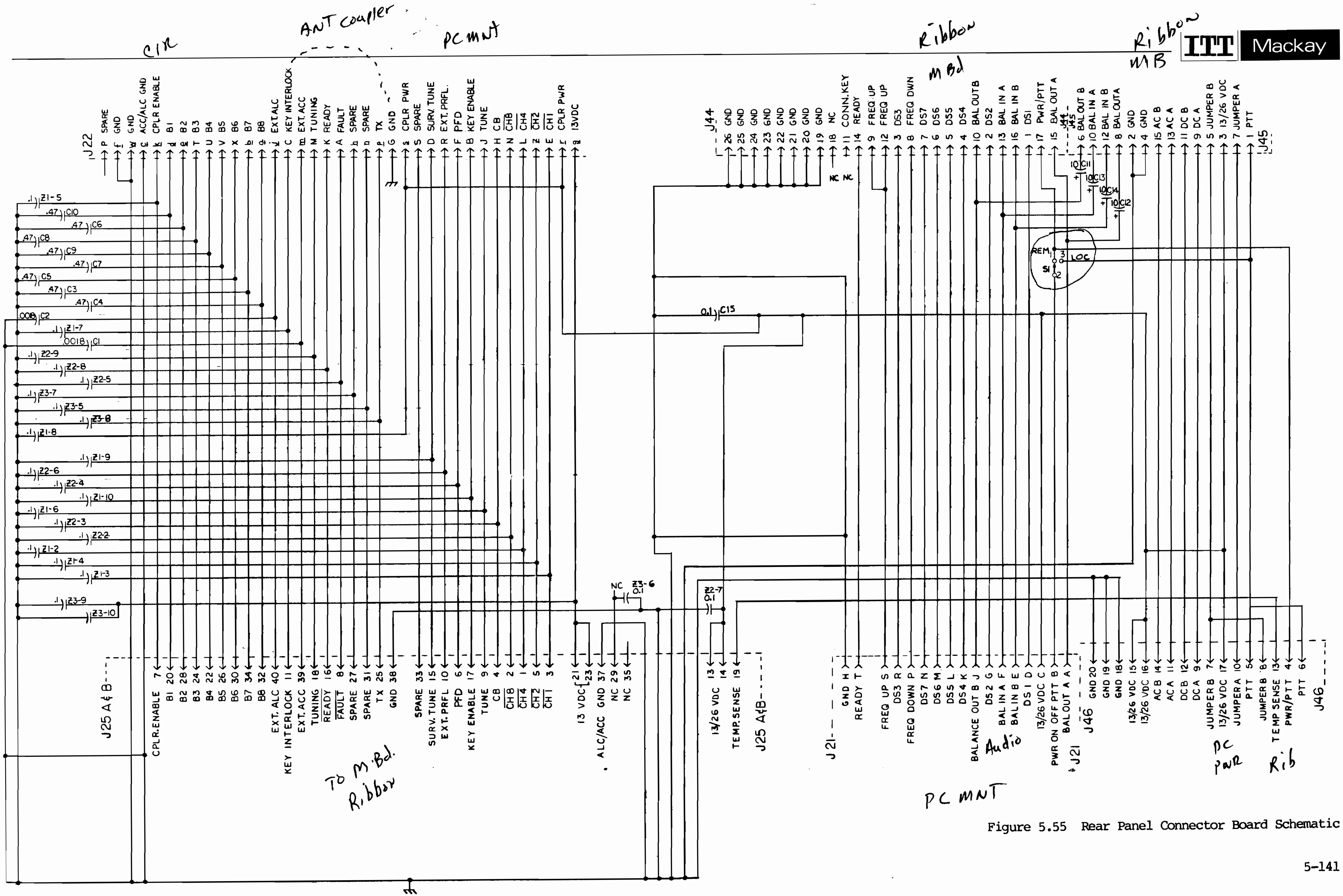


Figure 5.55 Rear Panel Connector Board Schematic

5.25 125 WATT POWER AMPLIFIER ASSEMBLY, 1A3A1

5.25.1 GENERAL

The all solid state power amplifier, Figures 5.57/58 (24 volts), and Figures 5.59/60 (12 volts), accepts the +13 dBm RF drive input from the mixer assembly, 1A1A5, 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, 1A1A4, in the reecive mode. Also contained on this board are circuits that sense PA over voltage, over current and over temperature. These voltages are fed to the half octave filter board, 1A1A2, which, via feedback to the transmit modulator board, 1A1A3, controls overall transmitter gain, and power output. Contained also in this module is a +13.2 VDC regulator (+24 volt module only) that supplies regulated +13 VDC to the following boards: 1A1A2, 1A1A4, 1A1A6, 1A1A8, 1A1A11, 1A1A12, 1A1A14, 1A1A15 and to the rear panel 1A3-J21 and 1A3-J22.

5.25.2 DETAILED 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 13.2 volt regualtor via R45 and R46 to diodes CR7 and CR9. Pots R44 and R47 provide a means to adjust the operating points of the driver, 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 in the group 001 amplifier and a single secondary winding of four turns in the group 002 amplifier. C49, the capacitor in parallel with the primary of T4, and capacitor C28 compensate for leakage inductance in T4 and provide high frequency compensation. R14, R13 and C33 provide feedback for Q5, and reduce gain at the low frequency end. R58 and R59 provide negative feedback from a 2 turn winding on T4 to the bases of Q8 and Q9 (24V model only).

Q3 and Q4 form a differential amplifier to provide DC over current 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, 1A1A2, is used to reduce drive to the amplifier.

Q1 and Q2 comprise a 13.2 volt regulator (24 VDC model only). 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 limiting the 13.2 volts output current.

Diode CR8, capacitors C22 and C30, resistors R33 and R34 are the over voltage detector. Any voltage change on the collector of Q9 is fed to the transceiver or exciter, and when excessive, drive to the amplifier is reduced.

5.25.4 PA ADJUSTMENTS

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.

5.25.4.1 Test Set-Up

Terminate the transceiver output, 1A3-J31, 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 transceiver (Refer to RF pattern diagram) and that no electrical short circuit of the exposed PA module circuit board or wiring can to the chassis or other metal objects. The transceiver power amplifier assembly can be safely operated in this position for short periods.

5.25.4.2 13.2 VDC Regulator Adjust (24 Volt Model Only)

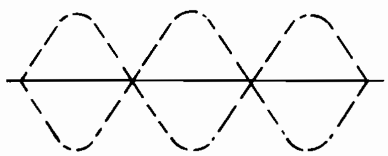
Set the transceiver frequency to 5.2 MHz, the mode to USB. Key the transceiver using the microphone PTT, but DO NOT speak into the microphone. Using a DC voltmeter connected between E1 and GND, adjust R2 for +13.2 VDC at E1. Unkey the transceiver.

5.25.4.3 Output Stage Bias Adjust

Remove the jumper strap between E18 and E19. Connect a DC ammeter + to E18 - to E19. Using the same transceiver setting as above, key the transceiver (no modulation) adjust R47 for the 24 volt PA to 0.15A and for the 12 volt PA to 0.5A. Unkey the transceiver and turn off the power. Replace the strap between E18 and E19.

5.25.4.4 Driver Stage Bias Adjust

The transceiver settings are the same as 5.25.4.2, above. Connect an oscilloscope across the 50 ohm load. Connect the audio combiner key box described in the diagram below, apply two equal audio tones, 700 and 2300 Hz, and key the transmitter. The RF output pattern 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.



RF PATTERN SHOWING PROPERLY ADJUSTED PA BIAS

5.25.5 Over Current Adjustment

Change the transceiver frequency to 29.999 MHz, the mode to CW and key the transceiver. 125 watts should be indicated on the wattmeter. Adjust R16, the over current 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 transceiver. Reinstall the PA module on the rear panel assembly.

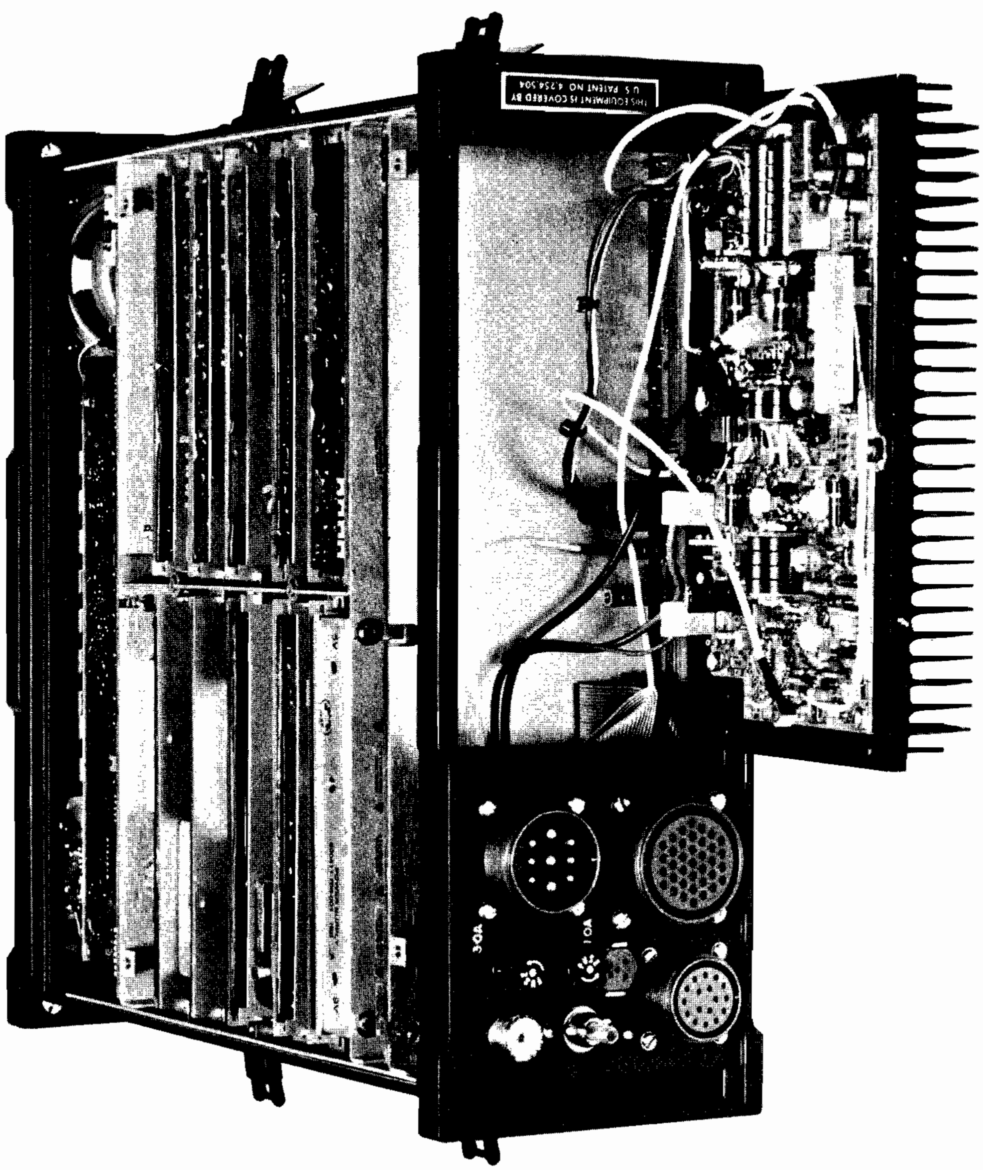
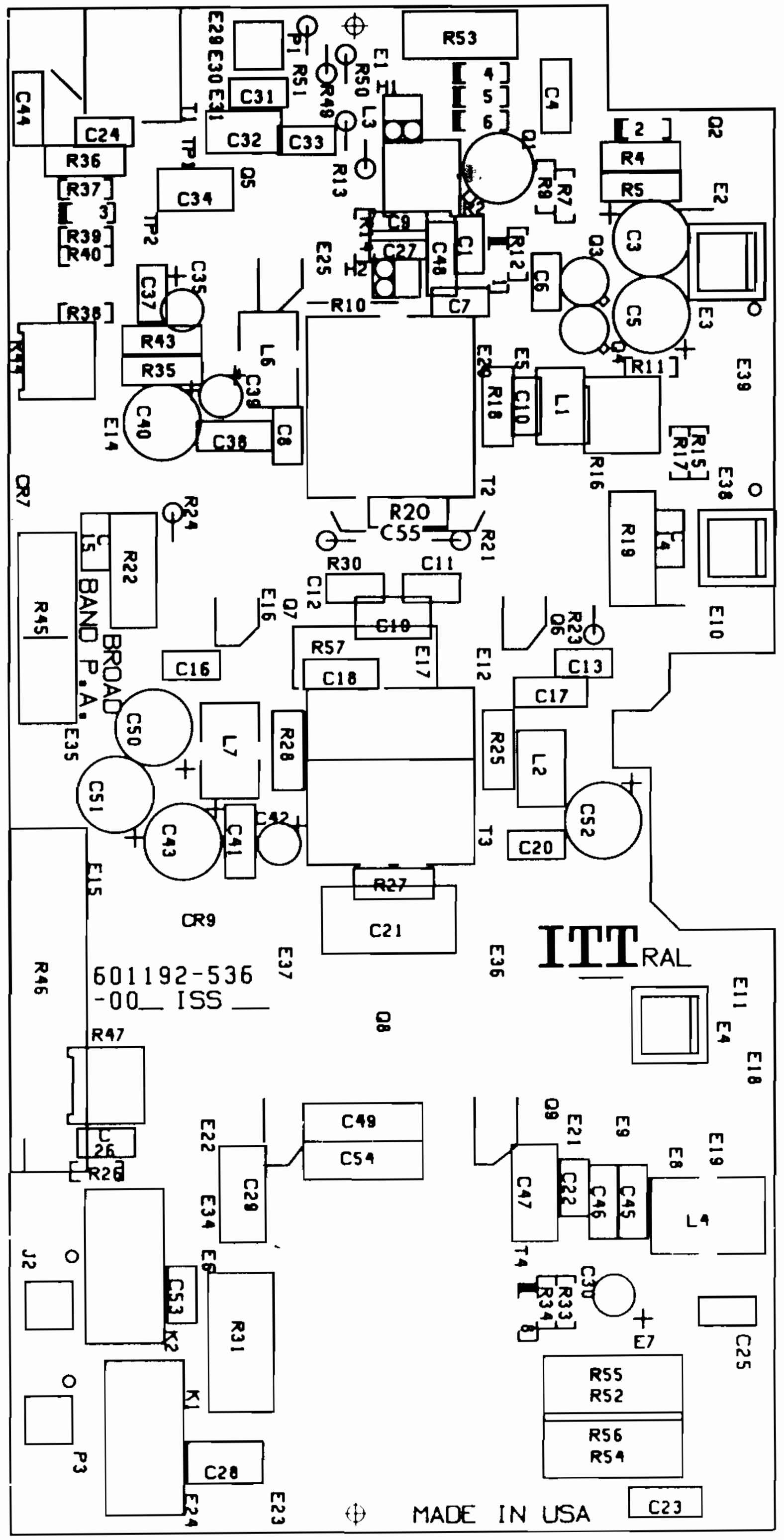


Figure 5.56 Power Amplifier Assembly

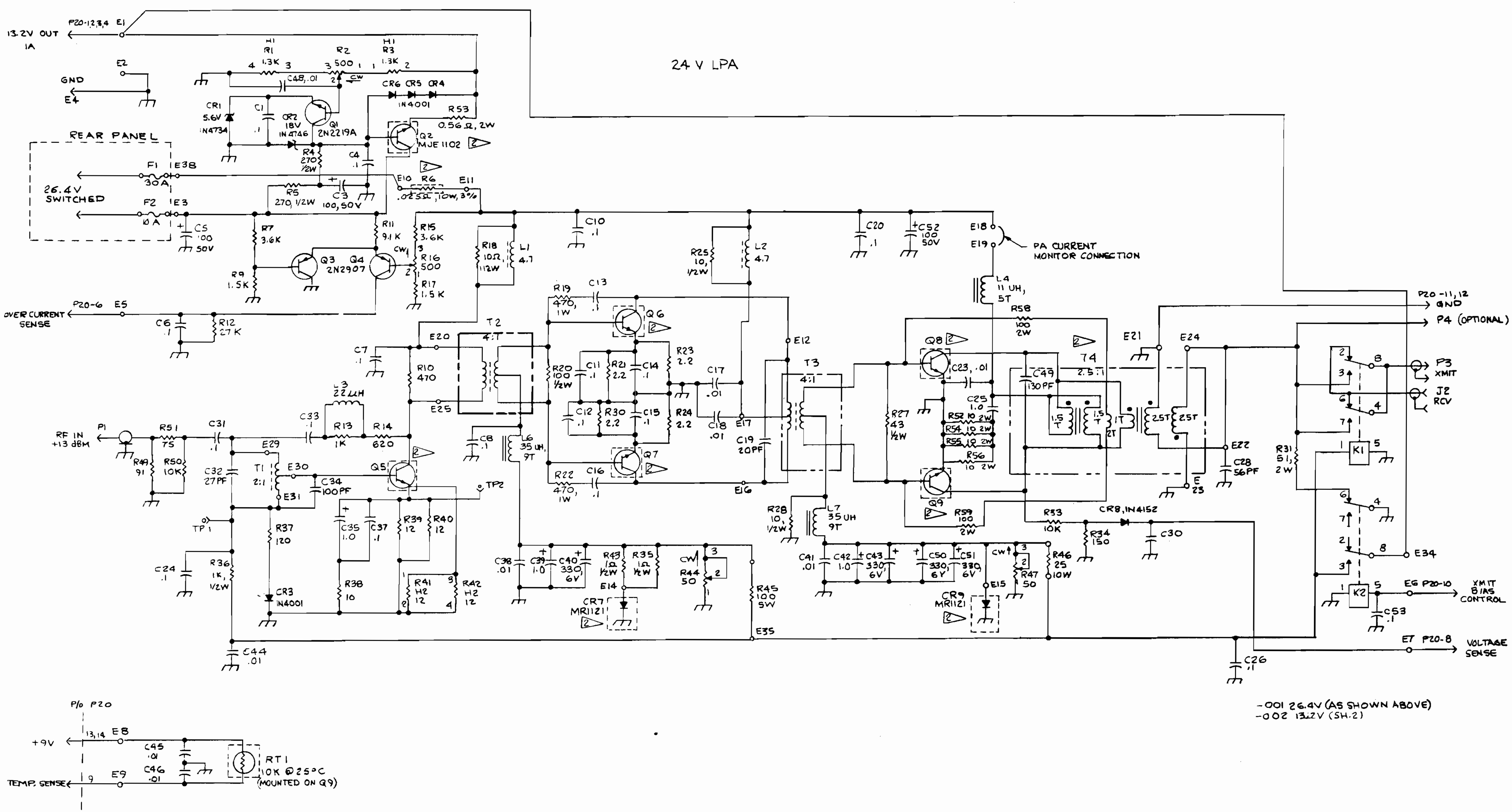


24V BROADBAND POWER AMPLIFIER
(600407-705-001)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C4, C7-10, C13, C16, C20, C26, C31, C32, C41, C53, C59, C60, C62, C63, C64, C66-69, C72, C74	Capacitor, .1 µf, 50V	600226-314-008
C3, C5, C52	Capacitor, 100 µf, 50V	600297-314-033
C6, C17, C18, C23, C30, C33-35, C38, C42, C45, C48	Capacitor, .01 µf	600268-314-008
C11, C12, C14, C15	Capacitor, .0047 pf	600268-314-007
C19	Capacitor, 51 pf	651093-306-501
C25, C39, C44	Capacitor, 1.0 µf	600226-314-014
C28	Capacitor, 36 pf	636093-306-501
C37, C61	Capacitor, 470 pf	600210-314-040
C40, C43	Capacitor, 330 µf, 6V	600202-314-052
C70	Capacitor, 1-9 pf, Trimmer	600052-317-001
C71	Capacitor, 220 pf	622003-306-501
C73	Capacitor, 22 µf, 25V	600297-314-016
CR1	Diode, 1N4734A, 5.6V	600006-411-007
CR2	Diode, 1N4746A, 18V	600006-411-019
CR3	Diode, KS1001	600179-410-001
CR4, CR5, CR6, CR7	Diode, 1N4001	600011-416-005
CR8	Diode, 1N4751A, 30V	600006-411-054
CR9	Diode, 1N4733A, 5.1V	600006-411-006
CR11, CR12	Diode, 1N4148	600109-410-001
J2	Connector, PCB Coax	600385-606-001
K1, K2	Relay, DPDT, 12V	600073-403-003
L2	Choke, RF, 4.7 µH	600091-376-001
L4	Toriod, 11 µH, 5T	600145-513-001
L6, L8	Choke, 15 µH	600072-376-027
L7	Choke, 35 µH, 9T	600146-513-001
L9	Coil, 1 MH	600034-376-001
L10	Coil, VSWR Det.	600138-512-001
L3	Choke, RF, 5.6 µH	600125-376-043
Q1	Transistor, 2N2219A	600082-413-001
(Q1)	Transistor Pad, T05	600017-419-001
Q3	Transistor, 2N2907	600154-413-001
(Q3)	Transistor Pad, T018	600025-419-001
Q2	Transistor, MJE1102	600219-413-001
Q5, Q6, Q7	Transistor, BLV20	600273-413-001
Q8, Q9	Transistor, SD1407	641320-542-009
P1, P3	Connector, PCB Coax	600198-606-002

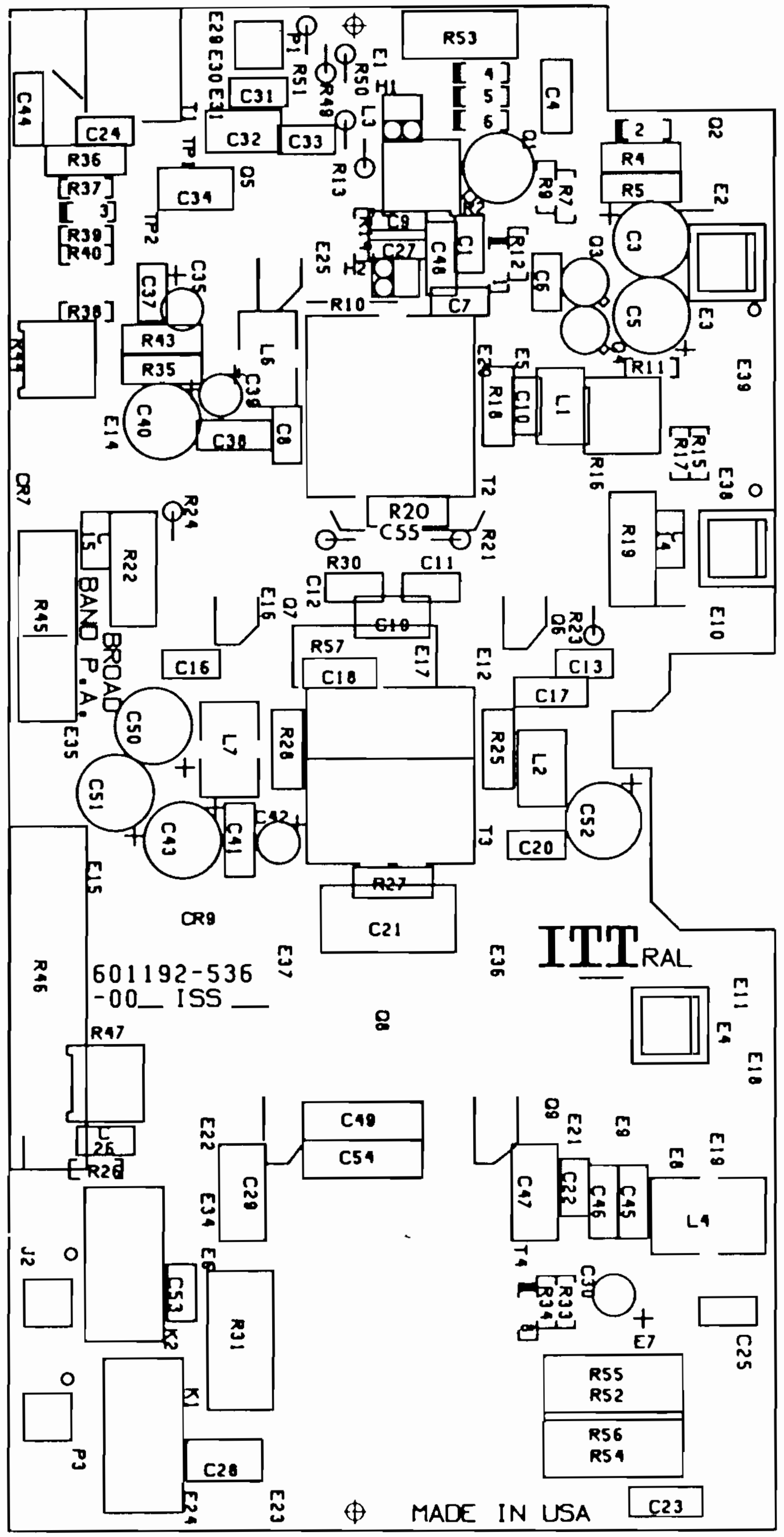
SYMBOL	DESCRIPTION	PART NUMBER
R1, R3	Resistor, 1.3k, 1/4W, 5%	613014-341-075
R44	Pot, 500Ω	600072-360-006
R4, R5	Resistor, 270Ω, 1/2W, 5%	627004-341-205
R6, R10, R33, R34, R38, R71	Resistor, 1k, 1/4W, 5%	610014-341-075
R2, R16	Pot, 500Ω	600051-360-006
R7, R11	Resistor, 2k, 1/4W, 5%	620014-341-075
R8	Resistor, 200Ω, 1/4W, 5%	620004-341-075
R9, R13, R14, R17	Resistor, 1.5k, 1/4W, 5%	
R37	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R12, R15	Resistor, 3.6k, 1/4W, 5%	636014-341-075
R18, R28	Resistor, 10Ω, 1/2W, 5%	610094-341-205
R19, R22	Resistor, 470Ω, 1W	647004-341-325
R21, R23, R24, R30	Resistor, 2.2Ω, 1/4W, 5%	622084-341-075
R25	Resistor, 4.7Ω, 1/2W	647084-341-205
R26	Resistor, 360Ω, 1/2W, 5%	636004-341-205
R27	Resistor, 15Ω, 1W	615094-341-325
R29, R43, R54, R56	Resistor, 10k, 1/4W, 5%	610024-341-075
R31	Resistor, 51Ω, 1W, 5%	651094-341-325
R35	Resistor, 220Ω, 1/2W, 5%	622004-341-205
R36	Resistor, 1k, 1/2W, 5%	610014-341-205
R39, R42	Resistor, 22Ω, 1/4W, 5%	622094-341-075
R40	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R45	Resistor, 22Ω, 1W, 5%	622094-341-325
R46	Resistor, 25Ω, 10W, 5%	600097-340-250
R47	Pot, 50Ω	600072-360-003
R49	Resistor, 33Ω, 1/2W, 5%	633094-341-205
R50	Resistor, 30Ω, 1/4W, 5%	630094-341-075
R52	Resistor, 10Ω, 2W, 5%	610094-341-425
R51	Resistor, 33Ω, 1/4W, 5%	633094-341-075
R53	Resistor, 0.56Ω, 2W, 1%	600057-340-005
R55	Resistor, 51k, 1/4W, 5%	651024-341-075
R57	Resistor, 100k, 1/4W, 5%	610034-341-075
R58, R59, R62, R63	Resistor, 1Ω, 1/4W, 5%	610084-341-075
R60, R61	Pot, 1k	600051-341-075
R64	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R70	Resistor, 300Ω, 1/4W, 5%	630004-341-075
R6	Resistor, .05Ω, 10W	600009-340-017
R58, R59	Resistor, 100Ω, 2W	610004-341-425
RT1	Thermistor Assembly	600365-713-001
T2	Transformer, Core	600266-622-002
T3	Transformer, Core	600266-622-002
T4	Output Transformer	635107-507-001
U1	I.C., LM393	600486-415-001
U2	I.C., LM324	600171-415-001
XK1, XK2	Relay, Socket	600108-419-003

Figure 5.57 24 Volt Broadband Power Amplifier Assembly



NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, AND ARE 1/4 W, ±5%. ALL CAPACITORS ARE IN MICROFARADS. ALL CHOKES ARE IN MICROHENRIES.
2. MOUNTED ON HEATSINK.

Figure 5.58 24 Volt Broadband Power Amplifier Schematic

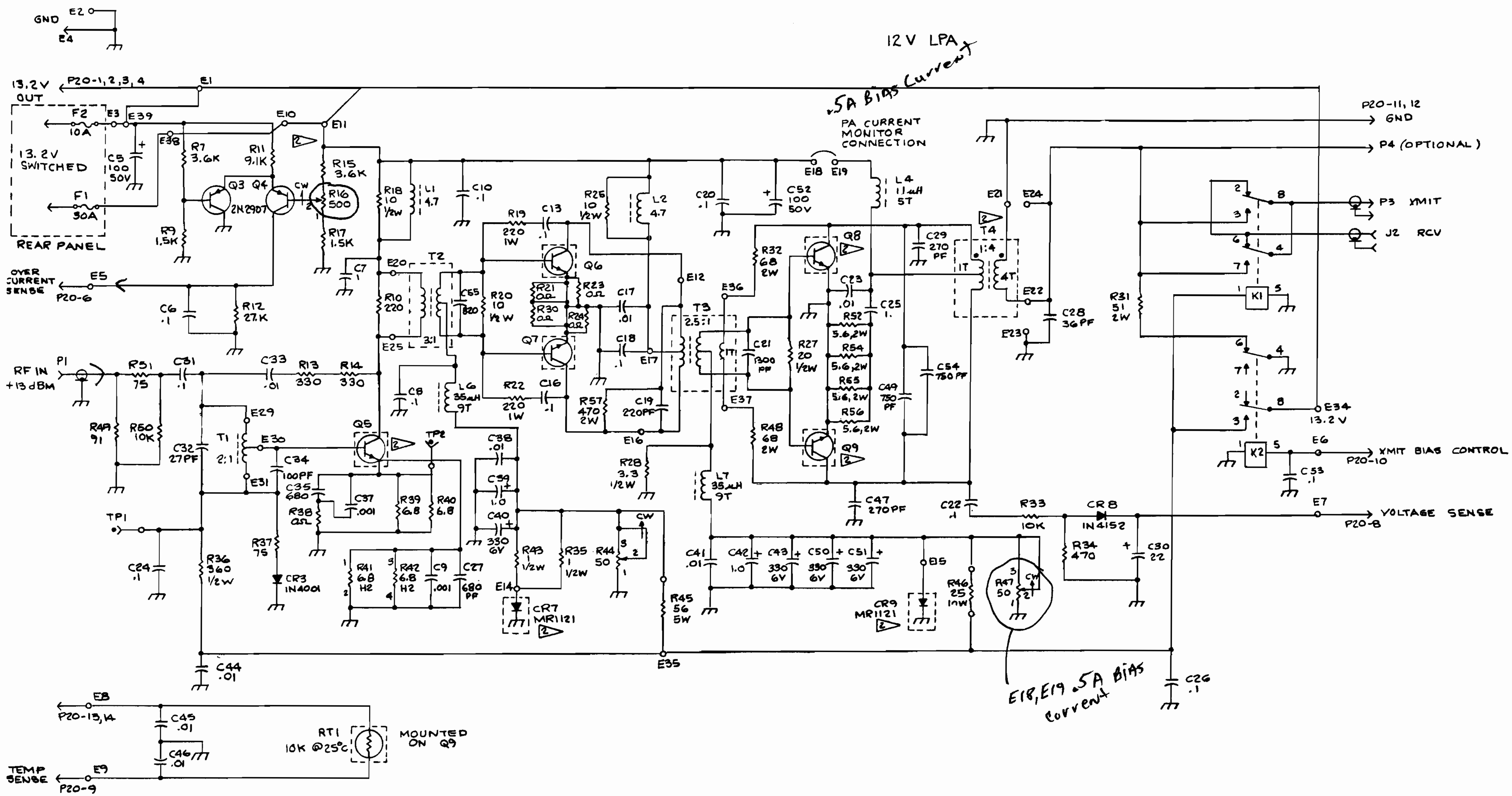


12V BROADBAND POWER AMPLIFIER
(600407-705-002)

SYMBOL	DESCRIPTION	PART NUMBER
C5, C52	Capacitor, 100 µf, 50V	600297-314-033
C6, C11, C12,	Capacitor, .01 µf	600268-314-008
C14, C15, C33-35, C45, C68 C7, C9, C10, C13, C16, C18, C20, C26, C31, C32, C53, C59, C60, C62, C63, C64, C67, C69, C72, C74	Capacitor, .1 µf, 50V	600226-314-008
C19	Capacitor, 150 pf	615003-306-501
C21	Capacitor, 1500 pf	615013-306-501
C23	Capacitor, .001 µf	600189-314-018
C25, C30, C44	Capacitor, 1.0 µf	600226-314-014
C28	Capacitor, 36 pf	636093-306-501
C37, C61	Capacitor, 470 pf	600210-314-040
C40, C43	Capacitor, 330 µf, 6V	600202-314-052
C49, C54	Capacitor, 820 pf, Mica	682003-306-501
C58	Capacitor, 20 pf	600269-314-013
C70	Capacitor, 1-9 pf, Trimmer	600052-317-001
C71	Capacitor, 220 pf	622003-306-501
C73	Capacitor, 22 µf, 25V	600297-314-016
CR3	Diode, KS1001	600179-410-001
CR7	Diode, 1N4004	600011-416-005
CR8	Diode, 1N4745	600006-411-018
CR9	Diode, 1N4733A, 5.1V	600006-411-006
CR11, CR12	Diode, 1N4148	600109-410-001
J2	Connector, PCB Coax	600385-606-001
K1, K2	Relay, DPDT, 12V	600073-403-003
L1, L2	Choke, RF, 4.7 µH	600091-376-001
L3	Coil, 1 µH	600125-376-040
L4	Toriod, 11 µH, 5T	600145-513-001
L6, L8	Choke, 15 µH	600072-376-027
L7	Choke, 35 µH, 9T	600146-513-001
L9	Coil, 1 MH	600034-376-001
L10	Coil, VSWR, Det.	600138-512-001
P1, P3	Connector, PCB Coax	600198-606-002

SYMBOL	DESCRIPTION	PART NUMBER
Q3	Transistor, 2N2907	600154-413-001
(Q3)	Transistor Pad, T018	600025-419-001
Q5	Transistor, BLV20	600273-413-001
Q6, Q7	Transistor, MRF433	600342-413-101
Q8, Q9	Transistor, SD1487	641320-542-010
R6	Resistor, .025Ω, 10W	600009-340-049
R44	Pot, 500Ω	600072-360-006
R7, R11	Resistor, 2k, 1/4W, 5%	620014-341-075
R8	Resistor, 200Ω, 1/4W, 5%	620004-341-075
R9, R13, R14, R17	Resistor, 1.5k, 1/4W, 5%	615014-341-075
R10, R37	Resistor, 220Ω, 1/4W, 5%	622004-341-075
R12, R15	Resistor, 3.6k, 1/4W, 5%	636014-341-075
R16	Pot, 500Ω	600051-360-006
R18, R25	Resistor, 10Ω, 1/2W, 5%	610094-341-205
R19, R22	Resistor, 220Ω, 1W	622004-341-325
R21, R23, R24, R30	Resistor, 1Ω, 1/4W, 5%	610084-341-075
R26	Resistor, 360Ω, 1/2W, 5%	636004-341-205
R29, R43, R54, R56	Resistor, 10k, 1/4W, 5%	610024-341-075
R31	Resistor, 51Ω, 1W, 5%	651094-341-325
R6, R33, R34, R38, R71	Resistor, 1k, 1/4W, 5%	610014-341-075
R35	Resistor, 220Ω, 1/2W, 5%	622004-341-205
R36	Resistor, 1k, 1/2W, 5%	610014-341-205
R39, R42	Resistor, 10Ω, 1/4W, 5%	610094-341-075
R40	Resistor, 100Ω, 1/4W, 5%	610004-341-075
R45	Resistor, 22Ω, 1W, 5%	622094-341-325
R46	Resistor, 25Ω, 10W, 5%	600097-340-250
R47	Pot, 50Ω	600072-360-003
R49	Resistor, 33Ω, 1/2W, 5%	633094-341-205
R50	Resistor, 30Ω, 1/4W, 5%	630094-341-075
R51	Resistor, 33Ω, 1/4W, 5%	633094-341-075
R52	Resistor, 4.7k, 1/2W, 5%	647084-341-205
R55	Resistor, 51k, 1/4W, 5%	651024-341-075
R57	Resistor, 100k, 1/4W, 5%	610034-341-075
R60, R61	Pot, 1k	600051-360-007
R64	Resistor, 4.7k, 1/4W, 5%	647014-341-075
R70	Resistor, 51Ω, 1/4W, 5%	651094-341-075
RT1	Thermistor Assembly	600365-713-001
T2	Transformer, Core	600266-622-002
T3	Transformer, Core	600266-622-001
T4	Output Transformer	635113-507-001
U1	I.C., LM393	600486-415-001
U2	I.C., LM324	600171-415-001
XK1, XK2	Relay, Socket	600108-419-003

Figure 5.59 12 Volt Broadband Power Amplifier Assembly



NOTES:

1. UNLESS OTHERWISE NOTED: ALL RESISTORS ARE IN OHMS, AND ARE 1/4 W, ± 5%; ALL CAPACITORS ARE IN MICROFARADS; ALL CHOKES ARE IN MICROHENRIES.

2. MOUNTED ON HEATSINK.

3. FOR FURTURE DESIGN, NOT ON EXISTING BOARD.

Figure 5.60 12 Volt Broadband Power Amplifier Schematic

SECTION 6
OPTIONS AND ACCESSORIES

6.1 POWER AMPLIFIER FAN OPTION

The Power Amplifier (PA) option is required whenever FSK (RTTY) data is transmitted for an extended period of time. The fan is installed on the rear panel, 1A3, over the PA heaksink, 1A3A1, utilizing the four (4) mounting screws that are used to secure the power amplifier module to the rear panel. Electrical connections to the fan are made via a wiring harness and plug to mating connector 1A3-J30, in the rear panel.

6.1.1 TECHNICAL CHARACTERISTICS

6.1.1.1 Operating Voltage

+11.2 to +14 VDC, and +22.4 to +29 VDC

6.1.1.2 Fan Type

Brushless DC, 12 VDC, 4W nominal, 41 CFM air flow

6.1.1.3 Fan Control

ON/OFF

6.1.1.4 Temperature Sense Element

Remote sense thermistor (part of PA assembly)

6.1.1.5 Temperature Sense Adjust Range

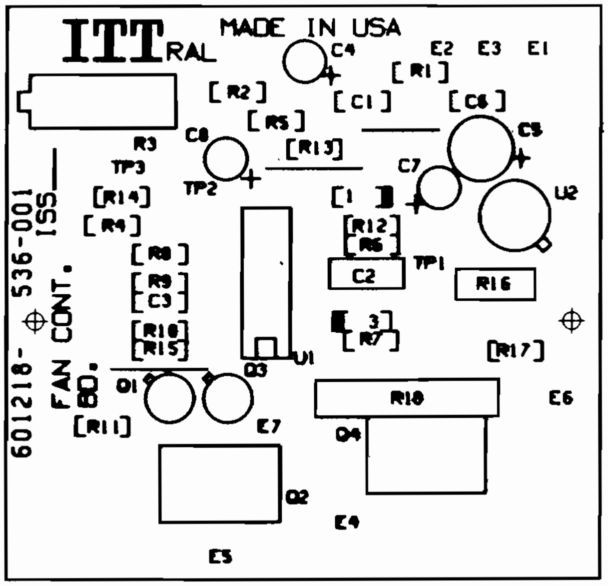
1 to 4 VDC, ±15%

6.1.2 TECHNICAL DESCRIPTION

The PA fan option is designed to provide additional cooling to the PA information supplied by a thermistor mounted on the PA heatsink (part of PA assembly). The circuit automatically supplies the proper operating voltage for the fan (12 VDC) on the 12 or 24 VDC transceiver. Refer to Figures 6.1 and 6.2.

The fan operates automatically when the PA heatsink temperature rises to approximately 60°C (140°F). The heart of the circuit is U1, an LM339 quad comparator, which is powered by U2, a monolithic 8 volt regulator. U2 always produces an 8 volt output with input voltages from 10 to 30 volts. Comparator U1A determines the switching temperature by comparing the voltage from the remote thermistor which is applied via R1 to U1, pin 4, to the "temperature threshold set" voltage applied to U1, pin 5. When the voltage on U1, pin 4, becomes greater than the voltage on U1, pin 5, U1A switches and the output voltage on U1, pin 2, becomes low, which reduces via CR3, R5 and R6, the "temperature threshold set" voltage applied to U1, pin 5. This provides a hysteresis, which prevents the circuit from reverting to its original condition until the PA heatsink temperature decreases (voltage applied to E3 increases).

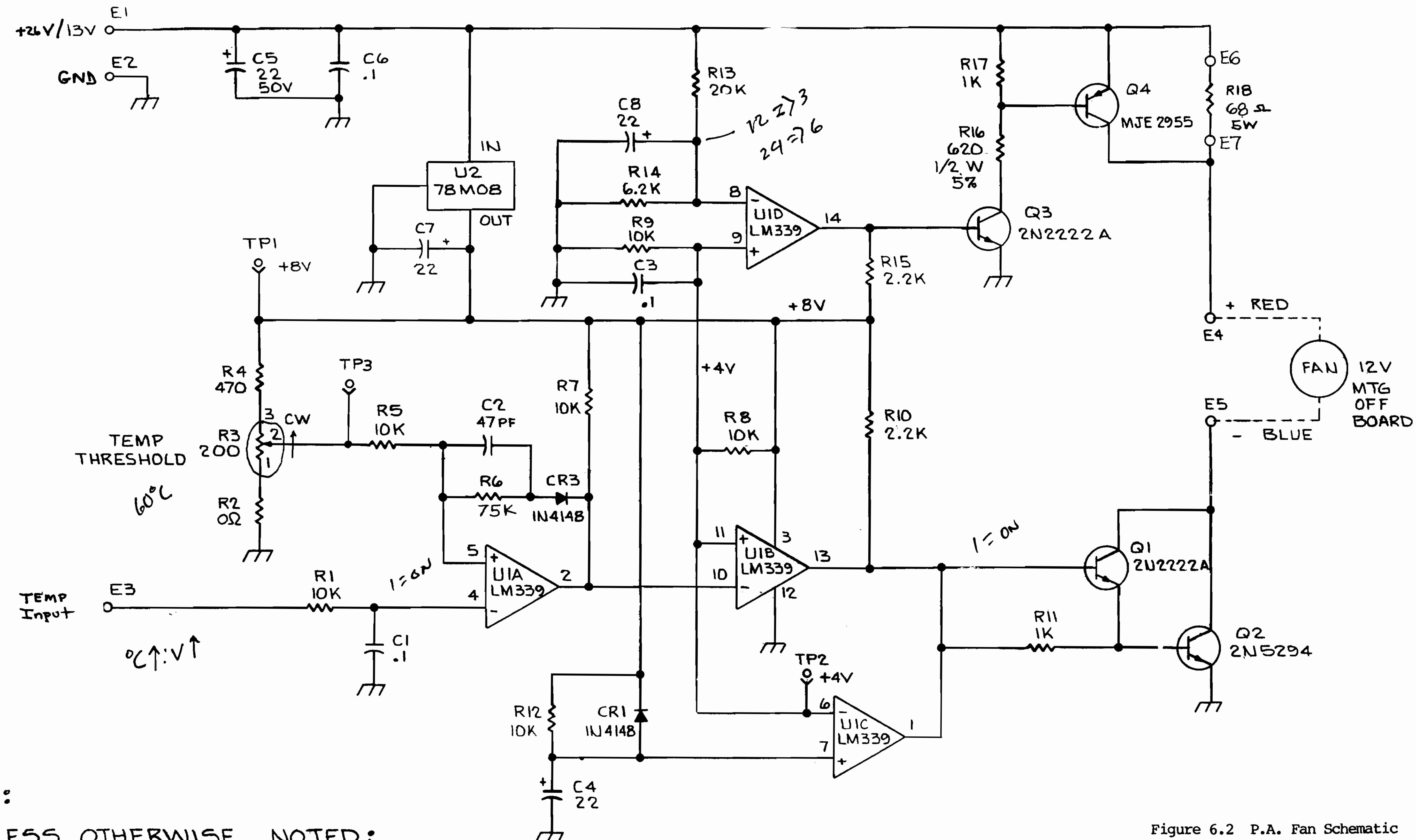
U1B is connected as an inverter for the output of U1A, and drives transistors Q1 and Q2, which is used as a switch connected in series with the fan motor. Resistors R8 and R9 form a voltage divider to supply +4 volts to U1B, U1C, and U1D. U1C provides a 1 second delay following transceiver power on, inhibiting fan operation during this time.



PA FAN CONTROL BOARD
(601218-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1, C3, C6	Capacitor, .1 µf	600272-314-008
C2	Capacitor, 47 pf, NPO	600269-314-022
C4, C7, C8	Capacitor, 22 µf, 25V	600297-314-016
C5	Capacitor, 22 µf, 50V	600297-314-018
CR1, CR3	Diode, 1N4148	600109-410-001
E1-5, TP1, TP2, TP3	Terminal, Small	600261-230-001
E6, E7	Terminal, Large	600260-230-001
Q1, Q3	Transistor, 2N2222	600080-413-001
Q2	Transistor, 2N5294	600178-413-001
Q4	Transistor, MJE-2955	600289-413-001
R1, R5, R7-9, R12	Resistor, 10k, 1/4W, 5%	610024-341-075
R2	Resistor, 0Ω, 1/4W, 5%	600000-341-075
R3	Resistor, 200Ω, Pot.	600063-360-005
R4	Resistor, 470Ω, 1/4W, 5%	647004-341-075
R6	Resistor, 75k, 1/4W, 5%	675024-341-075
R10, R15	Resistor, 2.2k, 1/4W, 5%	622014-341-075
R11, R17	Resistor, 1k, 1/4W, 5%	610014-341-075
R13	Resistor, 20k, 1/4W, 5%	620024-341-075
R14	Resistor, 6.2k, 1/4W, 5%	662014-341-075
R16	Resistor, 620Ω, 1/2W, 5%	662004-341-025
R18	Resistor, 68Ω, 5W	600062-340-047
U1	IC, LM339	600324-415-001
U2	IC, 78M08	600526-415-001

Figure 6.1 P.A. Fan Assembly



NOTES:

1. UNLESS OTHERWISE NOTED;
ALL CAPACITORS ARE IN MFD., AND
ALL RESISTORS ARE IN OHMS., 1/4 W, ± 5%.

Figure 6.2 P.A. Fan Schematic

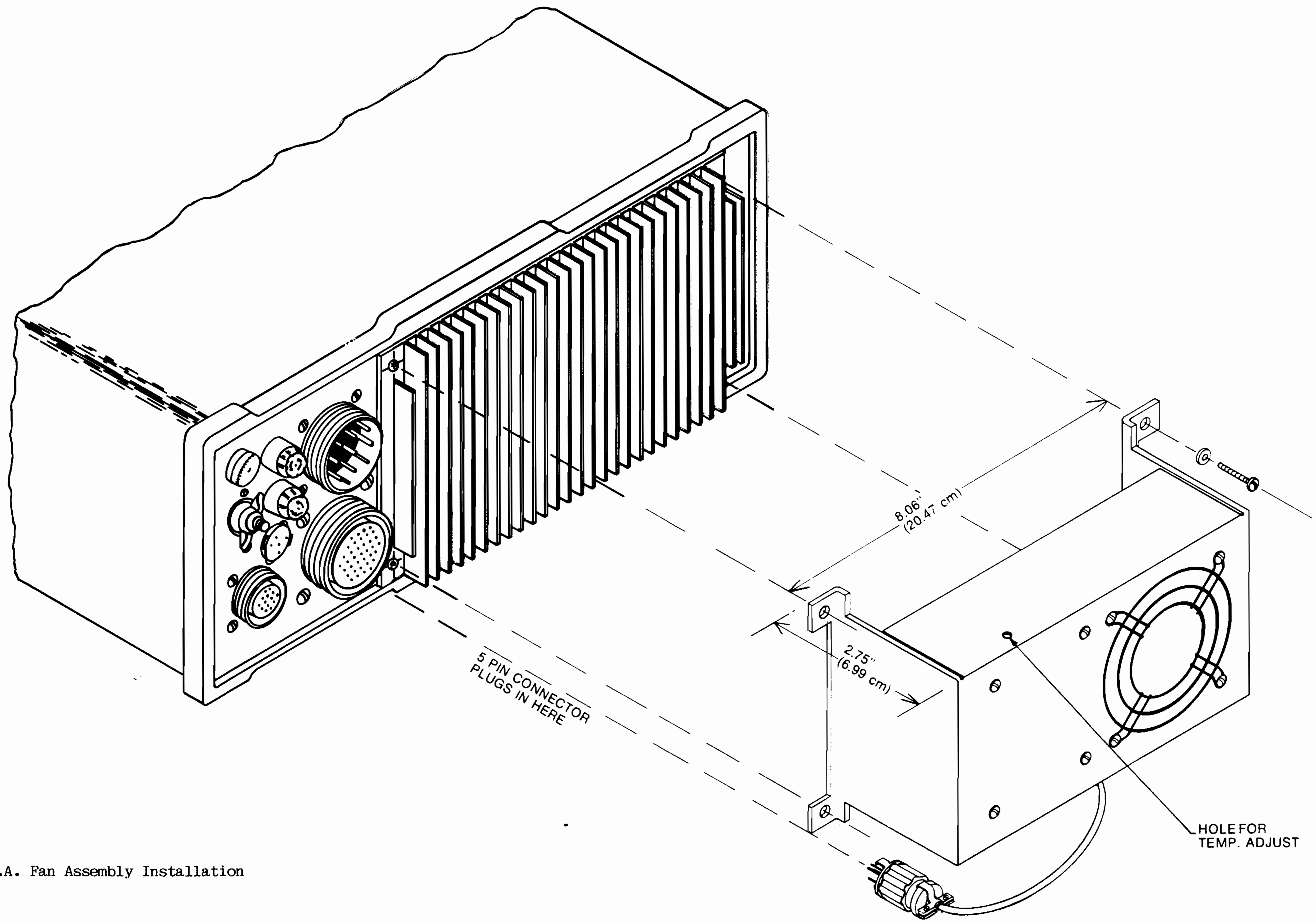


Figure 6.3 P.A. Fan Assembly Installation

This delay allows voltage transients to dissipate so that the correct DC input voltage range switching decision can be made before power is applied to the fan.

This decision is made by U1D, by comparing a sample of the DC input voltage applied to pin 8 via R13, to the +4 volt reference applied to pin 9. The input voltage must be greater than +17 volts before the output of U1D, pin 14, will go low. With less than +17 volts DC input at E1, the output of U1D is high. This causes Q3 to conduct, thereby causing Q4 to conduct, which applies the full input voltage at E1 to be applied to the fan.

If the DC voltage at E1 is greater than approximately +17 volts, the output of U1D goes low, turning off Q3 and Q4. This, in turn, places R18 in series with the fan, effectively supplying the correct operating voltage to the fan.

6.1.3 INSTALLATION, OPERATION, AND ADJUSTMENT

Installation of the PA fan assembly consists of mounting the assembly on the PA heatsink utilizing the four (4) mounting screws that secure the PA module to the rear panel assembly, 1A3. Remove all power to the transceiver before attempting to mount the fan assembly. Remove the four screws that secure the PA heatsink to the rear panel. Mount the fan assembly per Figure 6.3, using the same hardware. Engage the connector plug from the fan assembly into accessory connector 1A3-J30. Lock into place by twisting the outer locking ring.

An adjustment is required on the Half Octave Filter board, 1A1A2. Remove the top cover and shield from the transceiver.

Adjust R18 on the Half octave Filter Board, 1A1A2, fully clockwise. Replace cover and shield. Adjust R3 fully counterclockwise. (Accessible through a hole in housing-reference, Figure 6.3.)

To verify proper fan operation, the transmitter must be keyed into a 50 ohm load (CW mode) at 26 MHz. After transmitting for 30 seconds, adjust R3 on the Fan Assembly clockwise until the fan operates. Use caution, as the heatsink can cause burns.

If it is desired to change the temperature threshold of fan operation due to abnormal circumstances, R3 may be adjusted clockwise to increase the threshold and counterclockwise to decrease it.

Once installed, fan operation is automatic. When the PA heatsink temperature rises to approximately 60°C, the fan will operate, increasing air circulation around the PA heatsink, thereby lowering the heatsink temperature. When the heatsink temperature has been lowered to a point below that originally required for fan activation, fan operation ceases.

6.2 REMOTE OPTION

6.2.1 GENERAL

The transceiver may be supplied with a factory installed Remote Option P/N 600219-700. For more detailed information, refer to the MSR 6400 Manual, Publication No. 600250-823-001.

6.2.1 REMOTE CONTROL INTERFACE BOARD, 2A1A3

This PC Board Assembly is installed within the remote controlled transceiver, and is mounted on the front panel assembly, 1A2, between the front panel board, 1A2A1, and the logic board, 1A1A9. (Refer to Figure 6.6.) Contained on this board are circuits which allow signals to and from the logic board, 1A1A9, to be routed to the transceiver front panel, or to the remote control unit. This allows frequency, channel, and mode data to the transceiver to be from the local or remote source. The assembly drawing and schematic diagram are shown in Figures 6.4 and 6.5. Circuit operation is as follows.

U1 is a tri-state buffer that is enabled in local mode operation of the transceiver, so that channel and mode data can be sent from the transceiver front panel, 1A2, through U1, to the logic board, 1A1A9. When in remote operation, (transceiver mode switch is in position 8) U1 is inhibited, and its output impedance is high.

U2 and U12 are tri-state output four bit receivers, which receive channel and mode data from the remote control unit. When U1 is inhibited, and at the end of a display period, U2 and U12 will be enabled and will transfer channel and mode data from the remote unit, 2A1, to the logic board, 1A1A9.

U4 is a dual four bit tri-state buffer, with opposite enable polarity. It is used to combine the four bit mode and frequency display information. During the frequency display cycle, pin 14 of line decoder U5 is high. Output pins 3, 5, 7, and 9 of buffer U4 are enabled, connecting frequency display data FD1, FD2, FD4, and FD8 to the inputs of U3, pins 2, 4, 6, and 8. At the end of the frequency display cycle, U5, pins 14 will go low, enabling U4 outputs, pins 18, 16, 14, and 12, which then transfers mode display data MD1, MD2, MD4, and MD8 to U3, pins 2, 4, 6, and 8.

U3 is an eight bit tri-state buffer used to combine display data and the display code, for the remote display of frequency and mode. Input pins 2, 4, 6, and 8 are for frequency display data, and pins 17, 15, and 13 are inputs for the three bit display code. U3 is enabled in the remote control mode of the transceiver, and during a display cycle. At the end of a display cycle, all display data bits (FD1, FD2, FD4, and FD8) are high, thereby back biasing diodes CR1, CR2, CR3, and CR4. This causes NAND gates U6A, U6B, and U6C to inhibit U3, (logic "1" on pins 1 and 19) and to enable U2 and U12 (logic "1" on pin 12).

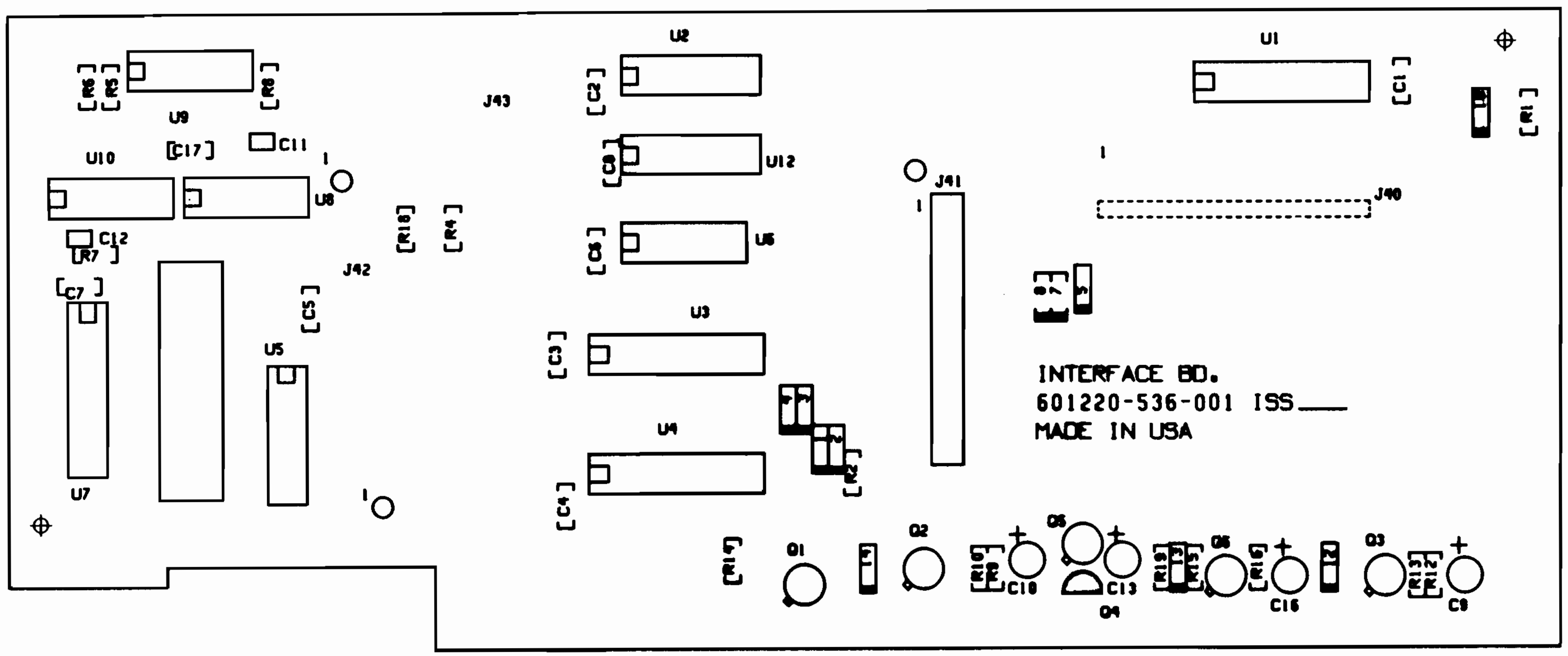
The seven bit data channel of the remote control system is therefore bi-directional. During the display cycle, the data direction is from the logic board, 1A1A9, to the remote control. At the end of the display cycle, for approximately 1.5 milliseconds. The data direction is from the remote control to the logic board, 1A1A9. This is controlled by diodes CR1, CR2, CR3, and CR4, and NAND gates U6A, U6B, and U6C. During a display, at least one of the diodes (cathode) will be low, causing U6A, U6B, and U6C to enable U3, and inhibit U2 and U12.

Data direction is now from the transceiver to the remote control unit. This cycle repeats approximately 300 times per second.

U9 is a DC amplifier to amplify the "FORWARD POWER" indication signal from the transceiver to 3.5 volts maximum.

The output of U9 is applied to U10, an analog switch, that is turned on by U8A during transmit. The "FORWARD POWER" signal, "PFD" is then sent to the remote unit for application to the TX LED circuit. When U10 is enabled, U7 is inhibited, the "PFD" signal therefore cannot be applied to the logic board, 1A1A9, in conjunction with the frequency down signal TI, which shares the same interface line with the "PFD" signal.

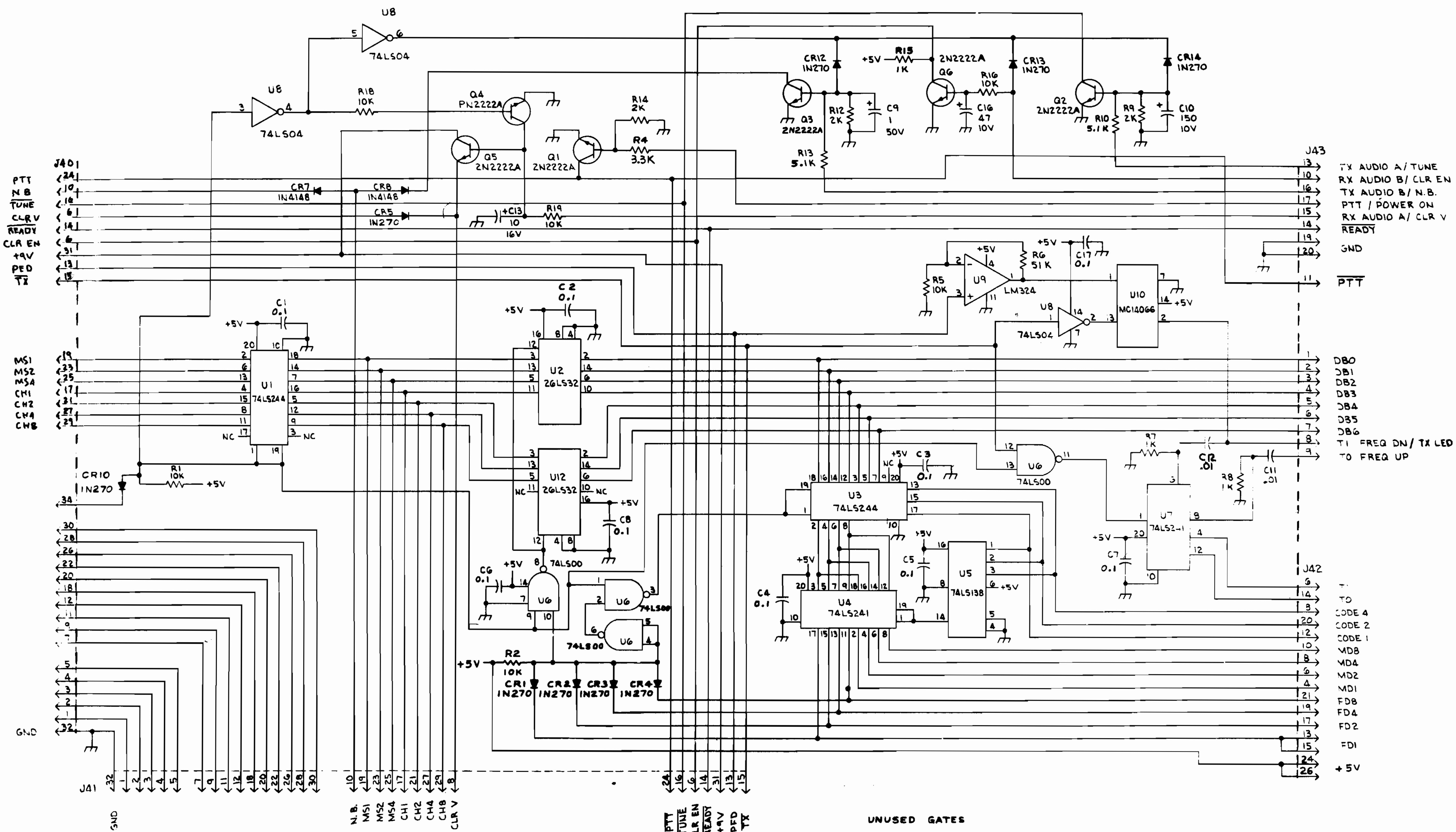
Q1, Q2, and Q3 are used to detect and convert REMOTE, PTT, TUNE, and NOISE BLANKER commands to compatible transceiver commands.



INTERFACE BOARD
(601220-536)

SYMBOL	DESCRIPTION	PART NUMBER
C1-8, C17	Capacitor, .1 µf	600272-314-001
C9	Capacitor, 1 µf, 50V	600259-314-001
C10	Capacitor, 150 µf, 10V	600297-314-035
C11, C12	Capacitor, .01 µf, 50V	600268-314-008
C13	Capacitor, 10 µf, 16V	600259-314-008
C16	Capacitor, 47 µf, 10V	600297-314-024
CR1-5, CR10, CR12-14	Diode, 1N270	600052-410-001
CR7, CR8	Diode, 1N4148	600109-410-001
J40	Connector, 34 Pin	600174-608-016
J41	Connector, 34 Pin	600174-608-006
J42	Connector, 26 Pin	600174-608-005
J43	Connector, 20 Pin	600174-608-004
Q1-3, Q5-6	Transistor, 2N2222A	600080-413-001
Q1-3, Q5-6)	Transistor Pad	600025-419-001
Q4	Transistor, PN2222A	600080-413-003
R1, R2, R5, R16, R18, R19	Resistor, 10k, 1/4W, 5%	610024-341-075
R4	Resistor, 3.3k, 1/4W, 5%	633014-341-075
R7, R8, R15	Resistor, 1k	610014-341-075
R6	Resistor, 51k	651024-341-075
R10, R13	Resistor, 5.1k, 1/4W, 5%	651014-341-075
R9, R12, R14	Resistor, 2k, 1/4W, 5%	620014-341-075
U1, U3	IC, 74LS244	600282-415-001
U2, U12	IC, 26LS32	600426-415-001
U4, U7	IC, 74LS241	600311-415-001
U5	IC, 74LS138	600309-415-001
U6	IC, 74LS00	600114-415-001
U8	IC, 74LS04	600111-415-001
U9	IC, LM324	600171-415-001
U10	IC, MC14066	600186-415-101

Figure 6.4 Remote Control Interface Board Assembly



UNUSED GATES

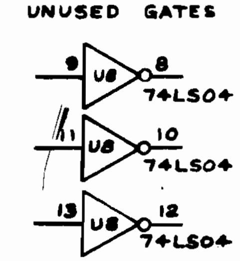


Figure 6.5 Remote Control Interface Board Schematic

Notes:

UNLESS OTHERWISE SPECIFIED: RESISTORS ARE IN OHMS, 1/4W, 5%; CAPACITORS ARE IN MICROFARADS.