JOHNSON®

LTR® 8640/8644 SERVICE MANUAL

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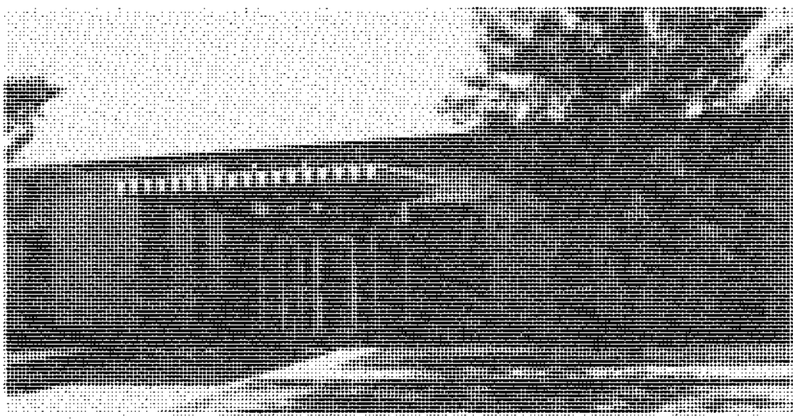
13.6 VDC, 900 MHz, 15W
Part No. 242-864x-001

JOHNSON
LTR® 8640/8644
FM TWO-WAY RADIO

13.6 VDC, 15 Watts
896-902 MHz Tx, 935-941 MHz Rx
Part No. 242-864x-001



The E.F. Johnson Company designs and manufactures two-way radio equipment to serve a wide variety of communications needs. Johnson produces equipment for the land mobile radio and mobiletelephone services which include business, industrial, government, public safety, aeronautical, and personal users. In addition, Johnson designs and manufactures electronic components used in communication equipment and other electronic devices.

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LTR®　　Call Guard®

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SECTION 1
GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains installation, operation, programming, alignment, and service information for the Johnson LTR® 8640/8644 transceiver.

1.2 TRANSCEIVER DESCRIPTION

The 8640 and 8644 are low-cost 900 MHz LTR transceivers. They have fewer operating features and lower power output than the top-of-the-line 8655 transceiver. The main features of 86xx-series transceivers are summarized in Table 1-1.

The only difference between the 8640 and 8644 is the number of systems that can be selected. The 8640 can be programmed with up to ten systems and the 8644 can be programmed with up to four systems. Operation is on the 900 MHz channels from 896-902 MHz (mobile transmit). The receive channels are 39 MHz above these channels (935-941 MHz). Channel spacing is 12.5 kHz and maximum deviation is ± 2.5 kHz. RF power output is 15 watts.

The 8640 and 8644 are designed for front mounting within reach of the operator such as the dash or transmission hump of the vehicle. If remote mounting is desired, the optional Remote Control Unit can be used (refer to Section 1.5 for more information). Like all Johnson LTR transceivers, these are logic controlled and digitally synthesized. All the user has to do to make a call in the LTR mode is press the PTT switch. If a busy or out-of-range condition is not indicated by special tones, the RF path is complete and speaking can begin. Channel selection, monitoring, and squelch control are all performed automatically by the control logic.

Transceiver programming is performed the same as with other 86xx-series transceivers using a dealer-supplied personal computer, the RPI interface, and Johnson software for the particular computer being used. The part numbers of the RPI and programming software are shown in Table 1-2. No PROMs are ever needed because the data is stored by an EEPROM which is a reprogrammable and nonvolatile memory. Refer to Section 4 for more programming information.

The following is a summary of the 8640/8644 transceiver operating features. Refer to Section 3 for more information on transceiver operation.

Systems - 8640 = Up to 10; 8644 = Up to 4

Groups - These transceivers do not have group select capability. However, each system can be programmed to select a specific group (refer to Section 4).

TABLE 1-1
86xx-SERIES TRANSCEIVER FEATURES

Transceiver	Freq	Systems	Groups	Front or Remote Mt	Power Output	LTR, Conv Operation	Conv Talkaround
8600	800 MHz	10	N/A	Front	15W	LTR and Conv	No
8604	800 MHz	4	N/A	Front	15W	LTR and Conv	No
8605	800 MHz	16	10	Front	15W	LTR and Conv	Yes
8610	800 MHz	16	10	Front	35W	LTR only	No
8615	800 MHz	16	10	Front	35W	LTR and Conv	Yes
8620	800 MHz	16	10	Remote	35W	LTR and Conv	Yes
8640	900 MHz	10	N/A	Front	15W	LTR and Conv	No
8644	900 MHz	4	N/A	Front	15W	LTR and Conv	No
8655	900 MHz	16	10	Front	30W	LTR and Conv	Yes

LTR and/or Conventional Operation – Each system can be programmed for LTR (trunked) or Conventional (nontrunked) operation. Each LTR system can be programmed with up to 20 channels, and each conventional system can be programmed with one channel.

System Scan – System scan is available in both the LTR and Conventional modes.

Horn Alert – The vehicle horn or some other type of alert can be used to signal when calls on certain ID codes (LTR) or channels (Conventional) are received.

Call Indicator – Can be programmed similar to the horn alert to signal when calls have been received.

Time-Out Timer – Programmed to automatically disable the transmitter after 0.5-5 minutes.

Remote Control Unit – Compatible with the Remote Control Unit.

1.3 PART NUMBER BREAKDOWN

The following is a breakdown of the part number used to identify this transceiver:

242 – 864X – 001

Model No.
8640 = 10 Systems
8644 = 4 Systems

1.4 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a label that is affixed to the bottom cover. The following information is contained in this number:

Model	Revision Letter	Manufacture Date	Plant	Warranty Number
864X	A	079	A	34089

Manufacture Date: Month, Year
Plant: A = Waseca

1.5 ACCESSORIES

The accessories available for this transceiver are listed in Table 1-2. A brief description of several of these accessories follows.

TABLE 1-2
TRANSCEIVER ACCESSORIES

Accessory	Part No.
Standard Mounting Bracket	023-8610-115
Low-Profile Mounting Bracket	023-8610-120
10-ft Pwr Cable and Hardware Kit	023-4144-410
22-ft Pwr Cable and Hardware Kit	023-4144-422
10-ft DC Power Cable, 15A	023-4143-010
22-ft DC Power Cable, 15A	023-4143-022
Horn Honk/Ignition Sense Cable	023-8610-916
Remote Control Unit	250-8610-501
Dual-Control Adapter	023-8610-540
Control Cables (17 Ft. Standard)	
100 Ft.	597-2002-206
50 Ft.	597-2002-207
Microphones	
Amplified Dynamic	250-0740-300
DTMF	250-0751-021
Desk	250-0742-010
Microphone Hanger Bracket	023-7100-960
Remote Speaker, 5" 15W 3.2 ohm	250-0151-005
Desk Pedestal Kit	023-8610-914
86xx-Series Power Supply, 12A	
117 VAC	239-0226-113
230 VAC	239-0226-213
Modem	
For 8600/04/05/10/15/20	250-3044-200
For 8640/44/55	250-3044-600
Modem Installation Kit (for 86xx Series)	023-4412-558
Remote Programming Interface (RPI)	023-5800-000
RPI Interface Module	023-8610-901
Cable, RPI to Tandy® 100/102	023-5800-016
Cable, RPI to IBM® PC	023-5800-017
Programming Software, Transceiver	
Tandy 100/102 cassette tape	023-8600-921
Tandy 100/102 3-1/2" diskette	023-8600-922
IBM PC 5-1/4" disk	023-8600-923
IBM PC 3-1/2" diskette	023-8600-924
Programming Software, Remote Control Unit	
Tandy 100/102 cassette tape	023-8610-906
Tandy 100/102 3-1/2" diskette	023-8610-907
IBM PC 5-1/4" disk	023-8610-908
IBM PC 3-1/2" diskette	023-8610-909

REMOTE CONTROL UNIT
FIGURE 1-1

Mounting Hardware

The mounting brackets for this transceiver are shown in Figure 2-1 in Section 2. The cable and hardware kits include the DC power cable, microphone hanger, screws, washers, and ground wire shown in Figure 2-1. The -010 and -022 power cables are the cables in the -410 and -422 kits without the hardware. The -916 horn/ignition cable is used to connect the horn alert and ignition sense functions. It is a 4.5 foot, two-wire fused cable with an in-line connector to allow it to be unplugged from the transceiver.

Remote Control Unit

This is the control unit shown in Figure 1-1. Refer to Section 3.10 for more information on features and operation with an 864X transceiver. When used with a front-mount transceiver, dual controls are available when the Dual-Control Adapter is used. This adapter allows both a microphone and the control unit to be plugged into the transceiver microphone jack. The 50- and 100-foot control cables can be used to mount the control unit up to 50 or 100 feet from the transceiver. These cables cannot be connected together because the maximum cable length allowed is 100 feet. Power must still be applied to both the transceiver and the junction box located near the control unit.

Microphones

This transceiver uses a low-impedance (620 ohm) microphone. The -300 amplified dynamic microphone is the microphone shown on the front cover. The -021 DTMF microphone has a keypad and generates DTMF tones for telephone interconnect or other uses. This particular microphone has a lighted keypad but no memory. The -010 desk microphone is used for control station applications. It has a monitor button which can be locked down if desired. The microphone hanger bracket is used when a microphone hanger on the side of the transceiver is desired.

Desk Pedestal Kit and Power Supply

The desk pedestal kit is used to mount the transceiver remotely from the power supply. It includes a wedge-type transceiver mounting pedestal and a 10-foot power cable. This pedestal kit is designed for use with the power supplies shown in Table 1-2 or with other power supplies.

LTR Modem

The LTR modem permits digital data as well as voice to be transmitted and received through an LTR system. A modem is required in the transmitting and receiving transceivers as well as in at least one repeater in the system. The ability to send data through an LTR system allows a data terminal or some other type of data device to be installed in a vehicle or at a control station. The modem has a serial RS-232 compatible port for connecting the data equipment. The installation kit contains a special cable that connects the modem to P2 on the audio/logic board.

Programming Hardware and Software

Programming hardware and software is described in Section 4.1.

1.6 PRODUCT WARRANTY

The warranty statement for these transceivers is available from your product supplier or from the E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093-0514. Phone (507) 835-6222.

1.7 FACTORY CUSTOMER SERVICE

The Product Service Department of E.F. Johnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. If you write to the Product Service Department, please include all information that may be helpful in solving your problem.

Contact: E.F. Johnson Company
Product Service Department
299 Johnson Avenue
Box 1249
Waseca, MN 56093-0514
Phone: (507) 835-6367

1.8 FACTORY RETURNS

Repair service is normally available through local authorized Johnson Land Mobile Radio Service Centers. If local service is not available, the equipment can be returned to the factory for repair. However, it is recommended that you contact the Product Service Department before returning the equipment. A service representative may be able to suggest a solution to the problem and return of the equipment would not be necessary.

When returning equipment for repair, be sure to fill out a Factory Repair Request Form for each unit to be repaired. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Include a form in the shipping container with each unit. This form is No. 271 and it can be obtained from the Service Parts Department.

1.9 REPLACEMENT PARTS

Johnson replacement parts can be ordered directly from the Service Parts Department of the E.F. Johnson Company. For assistance in ordering or identifying parts, call 1-800-533-8991. When ordering, please supply the following information on each part ordered:

a. Part Number
b. Description
c. Quantity

If there is uncertainty about the part number, also include the part designator (C112, etc.) and the model and warranty numbers of the equipment the part is from (refer to Section 1.4).

Send the order to: E.F. Johnson Company
299 Johnson Avenue
Box 1249
Waseca, MN 56093-0514
ATTN: Service Parts Dept.

LTR 8640/8644 SPECIFICATIONS

The following are general specifications intended for use in testing and servicing this transceiver. For current advertised specifications, refer to the Marketing Specification Sheet. Specifications are subject to change without notice.

GENERAL

Operating Mode	LTR (trunked) or conventional (non-trunked) simplex
Frequency Range	896-902 MHz Tx, 935-941 MHz Rx
Systems	Up to 10 (8640) or 4 (8644)
Groups	1 per system (multiple group select not available)
Channels	Up to 20 per system (LTR) 1 per system (Conventional)
Mounting Location	Front
Tx/Rx Separation	39 MHz
Channel Spacing	12.5 kHz
Channel Increment	12.5 kHz
Dimensions	2.0'' high, 6.6'' wide, 9.8'' deep 5.1 cm high, 16.8 cm wide, 24.9 cm deep
Weight	4.0 lb (1.82 kg)
Power Requirement	13.6 V negative ground
Compliance	FCC parts 15 and 90

RECEIVER

Sensitivity	.30 μV (12 dB SINAD) .50 μV (20 dB quieting)
Selectivity	−65 dB
Spurious and Harmonic Rejection	−75 dB
Intermodulation	−65 dB
Audio Output Power	5 watts (3.0 ohm load)
Audio Distortion	Less than 5% at rated output
Audio Response	+2, −8 dB from 6 dB per octave pre-emphasis from 300-3000 Hz
Channel Spread	6 MHz
Frequency Stability	± 1.5 PPM from −22 to +140 degrees F (−30 to +60 degrees C)
Input Impedance	50 ohms
Current Drain	0.5 amp (standby) 1.2 amp (receive at rated audio output)

TRANSMITTER

RF Power Output	15W
Spurious and Harmonic	−65 dB
FM Hum and Noise	−35 dB (w/ C-message weighting)
Audio Modulation	11K0F1D, 11K0F3E, 11K0F3D
Audio Distortion	5% maximum at 1000 Hz
Audio Frequency Response	+1, −3 dB from 6 dB per octave de-emphasis from 300-3000 Hz
Channel Spread	6 MHz
Frequency Stability	± 1.5 PPM from −22 to +140 degrees F (−30 to +60 degrees C)
Current Drain	7 amperes at 15 watts power output
Duty Cycle	EIA 20%
Circuit Protection	12-ampere fuse in power cable
Load Impedance	50 ohms

SECTION 2
INSTALLATION

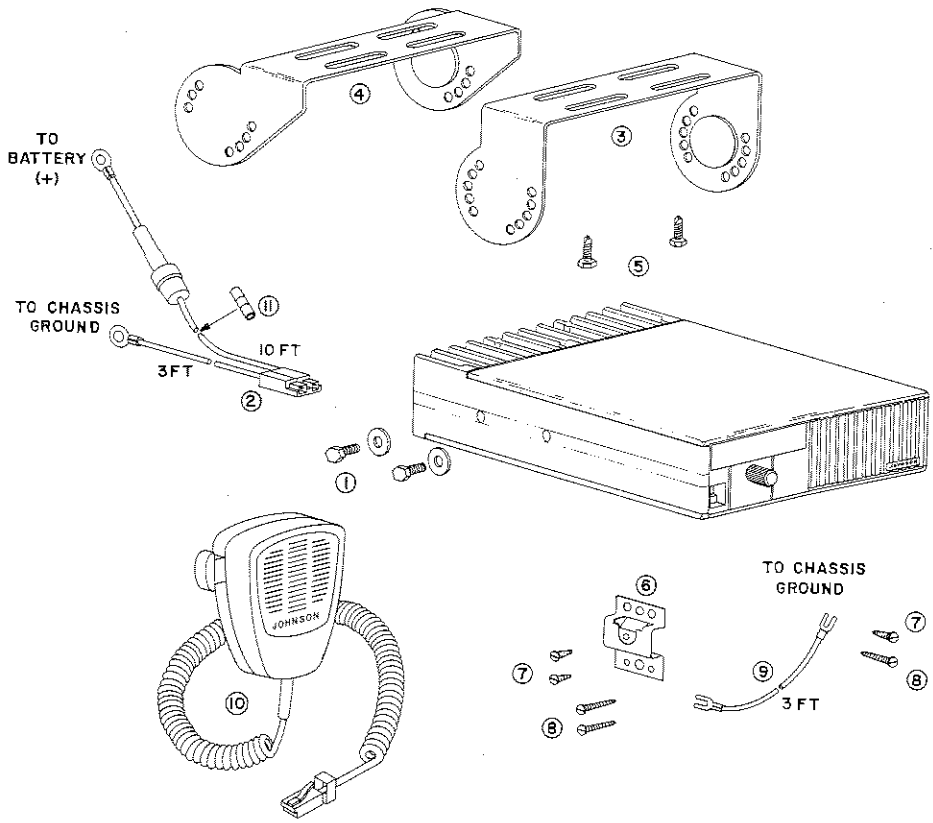
2.1 GENERAL

2.1.1 SCOPE OF INSTRUCTIONS

Since each installation is somewhat unique, the following instructions are general in nature. Shown is the intended use of the mounting hardware and also the electrical connections that should be made. The specific mounting location as well as the electrical connection points are determined by user needs and the type of vehicle in which the equipment is installed.

2.1.2 PERFORMANCE TESTS

Although each transceiver is carefully aligned and tested at the factory, shipment can alter these settings or damage the transceiver. Therefore, it is good practice to check transceiver performance before it is placed in service. Recommended performance tests are located in Sections 7.6 and 7.7.



Item Number	Description	Part Number	Item Number	Description	Part Number
1a	Screw, 10-24 x 7/16 (4)	575-8911-014	6	Microphone hanger	023-3514-001
1b	Flat washer #10 (4)	596-2410-014	7	Screw, 4-24 x 1/4 sht mtl (3)	575-3604-008
2	Power cable, 10 ft.	--	8	Screw, 4-20 x 5/8 thrd frmg (3)	575-5604-020
3	Standard mounting bracket	023-8610-115	9	Microphone hanger gnd wire	--
4	Low-profile mounting bkt	023-8610-120	10	Dynamic microphone	250-0740-300
5	Self-drilling screw (2)	575-9077-565	11	Butt splice connector (1)	586-9008-061

FRONT-MOUNT INSTALLATION COMPONENTS
FIGURE 2-1

2.1.3 TRANSCEIVER PROGRAMMING

The transceiver must be programmed before it is placed in service. When shipped from the factory, transceivers contain test channels and other test parameters. Refer to Section 4 and the operating manual included with the programming software for more information.

In addition, when the transceiver is shipped from the factory, it is configured so that system scanning occurs with the microphone on-hook. If the factory configuration is to be changed so that scanning is continuous or disabled entirely, refer to Section 2.4. This can also affect conventional mode channel monitoring and Call Guard squelch.

2.1.4 POWER SOURCE

These transceivers are designed to operate only from a nominal 12 volt DC power source with the negative side of the battery connected directly to chassis ground. Other power sources require some type of voltage converter.

2.1.5 SELECTING A MOUNTING LOCATION

This transceiver is designed for front mounting within reach of the operator (usually on the dash or transmission hump).

WARNING

The mounting location of the transceiver or remote control unit can affect safe operation of the vehicle. Follow these precautions when installing a transceiver.

- *Mount the transceiver where it does not interfere with operation of vehicle controls.*
- *Mount the transceiver so that the operator can easily see the display and reach the controls.*
- *Mount the transceiver so that it would not likely cause additional injury in case of an accident.*

2.2 TRANSCEIVER INSTALLATON

2.2.1 MOUNTING TRANSCEIVER

Hardware and Cable Kit, Part No. 023-4144-410, includes a 10-foot power cable, microphone hanger, hanger ground wire, butt splice connector, and all the screws normally required for installation. These components and the available mounting brackets are shown in Figure 2-1. Install the transceiver as follows:

a. Check the area underneath the selected mounting location for such things as wiring and brake and gas lines that could be damaged when the mounting bracket is installed. Then install the mounting bracket using the self-drilling screws.

b. Install the transceiver in the bracket using the No. 10 x 7/16" screws and flat washers.

c. Mount the microphone hanger in a convenient location using the screws for either sheet metal or plastic. The hanger must be connected to chassis ground for proper operation of functions such as scan and channel monitoring. If required, connect it to ground using the included ground wire.

2.2.2 POWER CABLE INSTALLATION

a. Disconnect the negative battery cable to prevent damage caused by accidental short circuits when the power cable is installed.

NOTE: It is recommended that the power cable be connected directly to the vehicle battery. Connection to other points such as the ignition switch or fuse block may result in increased interference from the vehicle's electrical system.

b. Route the red power cable to the battery. If it must be routed through the firewall and there is no hole large enough to clear the fuseholder, the red cable can be cut at a convenient location and then spliced again. A butt splice connector is included with the -410 and -422 cable and hardware kits. If a hole is drilled in the firewall, be sure to seal it when installation is complete.

c. Connect the red power cable to the positive (+) terminal of the battery. The fuse should be close to the battery to provide maximum short-circuit protection.

d. Connect the blue cable to a good chassis ground point. If necessary, clean the attachment point to ensure good contact. Make sure that there is a good ground return to the negative battery terminal.

e. With the -410 and -422 power cables, make sure that the correct fuse is installed in the fuseholder. This fuse should be 15A for the 864x (both 7A and 15A are included).

f. Plug the power cable into the transceiver and reconnect the negative battery cable.

g. Install the antenna according to the manufacturer's instructions included with the antenna. Check VSWR. Reflected power should be less than 4% of forward power (VSWR less than 1.5 to 1).

2.3 HORN ALERT/IGNITION SENSE CABLE INSTALLATION

2.3.1 GENERAL

The optional Horn Honk/Ignition Sense Cable, Part No. 023-8610-916, can be used to connect the horn alert and/or ignition sense functions. This cable installs through a knockout on the back panel near the speaker jack. It is 4.5 feet long and consists of two fused wires with an in-line connector. The red wire plugs into pin 13 of P2 on the audio/logic board and the blue wire plugs into pin 14 of P2. The next two sections describe the operation of the horn alert and ignition sense functions.

NOTE: Connector P2 and horn alert driver Q7 are also included in this kit. These components are normally not installed in the transceiver so must be installed on the audio/logic board if the horn alert is used.

2.3.2 HORN ALERT OPERATION

The horn alert output is pin 14 of P2. When a call is received on an ID code or channel that is programmed for horn alert, this output pulses low for 3 seconds (refer to Section 3.7). It then goes back to the disabled mode which is a high-impedance state. Maximum sink current is 800 mA. If this output is connected to the coil of a relay, a diode should be connected across the relay coil with the cathode to the battery side. This protects Q7 on the audio/logic board when the relay de-energizes.

2.3.3 IGNITION SENSE OPERATION

The ignition sense input is pin 13 of P2. When approximately 13 volts is applied to this line, the horn alert function is disabled. This line can be connected to the ignition switch or some other location to disable the horn alert while the vehicle is being operated. Refer to Section 3.7 for more information.

2.4 RECONFIGURING FOR CONTINUOUS OR NO SCAN

The microphone hanger line controls scanning as well as conventional mode channel monitoring. In the standard (factory) configuration, this line is connected to the microphone hanger. Therefore, scanning and Call Guard squelch (if programmed) are enabled when the microphone is on-hook.

Other modes can be selected by reconfiguring jumper JU1 and resistor R314 on the main board so that the hanger line is always high (off-hook sensed) or low (on-hook sensed). The operating mode selected for each configuration of JU1 and R314 is shown below. If required, reconfigure JU1 and R314. Refer to the component layout in the back of this manual for the location of these components. Refer to Section 3.4 for more information on these operating modes.

Operating Mode	JUI	R314
Standard (Factory Configuration)	Out	In
Continuous Scan and Call Guard Squelch	In	In or Out
Scan and Call Guard Squelch Disabled	Out	Out

2.5 CONFIGURING TRANSCEIVER FOR USE WITH REMOTE CONTROL UNIT

When the Remote Control Unit is used with an 864x transceiver, three jumpers and a resistor in the transceiver must be reconfigured. These components are located on the main board in the area of the microphone jack. Refer to the component layout in the back of this manual and reconfigure these components as follows:

a. Install JU1, JU2, and JU3.

b. Remove R314.

NOTE: If scanning is not used with a Remote Control Unit, it can be disabled by not installing JU1 in step a. The conventional mode monitor function of the control unit still operates with JU1 and R314 removed.

SECTION 3
TRANSCEIVER OPERATION

3.1 OPERATING FEATURES

NOTE: "System" as used in the following information usually refers to the systems selected by the front panel System Step switch. Each system can be programmed with an independent set of operating parameters such as repeater frequencies and selectable group or channel.

3.1.1 TRANSCEIVER FEATURES

The 864x transceiver is designed to operate on both LTR and conventional channels. Each selectable system can be programmed for either type of operation. The following features are standard with both types of channels.

- Up to 10 (8640) or 4 (8644) systems programmable.
- Group select is not available, but each system can be programmed to select a specific group.
- System scan selectable by placing microphone on-hook.
- Programmable call indicator
- Programmable horn alert
- Programmable time-out timer
- Test mode
- Microphone off-hook sensing can be disabled by hardware programming.

3.1.2 LTR SYSTEM FEATURES

The following features are available with systems programmed for LTR operation. Refer to Section 3.8 for more information.

- Up to all the following ID codes are programmable in each system:
  - 1 fixed and 2 priority decode codes
  - 1 encode code
    (decode and encode codes can be different)
- Programmable Transmit Inhibit when selected ID is busy.
- Free system ringback with RIC (interconnect) calls when system is busy.
- Programmable revert system scan time (refer to Section 3.3.3).
- Selectable Clear-to-Talk tone

3.1.3 CONVENTIONAL SYSTEM FEATURES

The following features are available with systems programmed for conventional operation. Refer to Section 3.9 for more information.

- One channel programmable per system (channels are selected using System Step switch).
- Tone, digital, or inverted digital Call Guard® squelch programmable for each transmit and receive channel.
- Transmit mode of each channel programmable as normal or disable (receive-only).
- Automatic Transmit Disable When (channel is) Busy if microphone is on-hook.

3.2 FRONT PANEL CONTROLS AND INDICATORS

NOTE: Refer to the transceiver operating manual for more information on the following controls and indicators.

3.2.1 FRONT PANEL CONTROLS

The 864x transceiver has only one front-panel control. It is a rotary On-Off/Volume control and also a pushbutton type System Step Switch. This control functions as follows.

On-Off/Volume – Turning the knob clockwise turns power on and sets the volume level. Turning it counterclockwise to the detent turns power off. Power is on when a number is indicated by the system display.

NOTE: This transceiver does not have a Volume Set switch that enables the busy tone for use as a reference in setting the volume level. However, pressing the System Step switch produces a beep which can be used.

System Step - Pressing the On-Off/Volume knob changes the selected system number. Each time this knob is pressed, the system number increases. Only programmed systems can be selected. Holding this switch down causes the function to repeat. Each time the selected system changes, a beep sounds.

3.2.2 FRONT PANEL DISPLAY AND INDICATORS

System Display - This transceiver has a single-digit system display which indicates the selected system. If system 10 is programmed with an 8640 transceiver, it is displayed as "0".

Scan Indicator - When scanning is enabled, the scan mode is indicated by the decimal point in the system display.

Transmit Indicator - When the transmitter is keyed by pressing the PTT switch, the red Transmit indicator lights.

Call Indicator - The amber Call indicator can be programmed to light when calls are received on particular ID codes (LTR operation) or channels (conventional operation).

3.2.3 FRONT AND REAR PANEL JACKS

Microphone Jack - This is the connection point for the microphone. It is also the connection point for the RPI interface when programming the transceiver (refer to Section 4).

Antenna Jack - Type N connector for connecting a 50-ohm antenna.

Power Connector - Connection point for a nominal 12-volt, negative ground power source.

External Speaker Jack - Miniature phone jack used to connect an external 5-watt, 3-ohm speaker. The internal speaker is disabled when an external speaker is used.

3.3 SYSTEM SCAN

3.3.1 GENERAL

System scan is normally selected when the microphone is on-hook. However, the transceiver can be reconfigured for continuous scan or no scan at all (refer to Section 3.4). The scan mode is indicated when the decimal point in the system display is lighted. The revert system is displayed while scanning is occurring (refer to Section 3.3.2).

Scanning is sequential through all programmed systems. If both LTR and conventional systems are programmed, both are scanned. When an incoming call is detected on any scamed system, scanning stops and the call is received. The display indicates the system on which the call was received so that a response can be made without changing the selected system. However, a response may be required within 3 seconds of when the message ends or the selected system may change (refer to Section 3.3.2).

After transmitting a message, there is also a 3-second delay before scanning resumes. This delay ensures that a response to a message is heard instead of some other message occurring on another system.

3.3.2 FIXED OR FLOATING REVERT SYSTEM

Floating or Fixed Revert System

The transceiver can be programmed so that the revert system is fixed or floating. The revert system is the system that the transceiver transmits on when the PTT switch is pressed while scanning (decimal point lighted). The transceiver returns to the revert channel after the 3-second delay expires when a conversation is finished.

When the transceiver is programmed for floating revert, the system that a call is received on becomes the newly selected system. For example, if System 1 was displayed while scanning and a call is received on System 3, System 3 is displayed and the call is received as described in the preceding section. Then after the conversation is finished and the delay period expires, System 3 continues to be the displayed system. If the transmitter is then keyed, transmission occurs on System 3 instead System 1.

If fixed revert was programmed for the preceding example, the call is received on System 3 as described. However, after the call is finished and the delay period expires, System 1 is redisplayed and any transmissions will occur on that system. Fixed revert should be programmed if most transmissions occur on a "home" system.

Scanning of LTR and conventional systems is somewhat different. The next two sections discuss the differences.

3.3.3 SCANNING LTR SYSTEMS

Revert System Scan Time

When there is no carrier on the home repeater of a programmed LTR system, the system is scanned for only 60 milliseconds. If there is a carrier, three data messages are monitored which takes approximately 500 milliseconds.

The transceiver can be programmed so that scanning time on a revert (displayed) system is longer. It can be increased in multiples of three data messages up to 8. For example, if 2 is programmed, the revert system scan time is 2 x 3 or 6 data messages. This lessens the likelihood that a call will be missed on the revert system. However, if information in the repeater data message indicates that no mobiles on the revert system are being trunked out to other repeaters, only a two-message scanning period occurs, even if additional scan time has been programmed.

The sequence of data messages transmitted by the repeater is as follows: Every third message is the message to the mobile currently using that repeater. Then alternating between those messages are the data messages to the mobiles being trunked to other repeaters. For example, assume that five different mobiles on a five repeater system are making calls. If all have Repeater 1 as their home repeater (not very likely in actual practice), the data message order is as follows: 1 2 3 1 4 5 1 2 3 and so on. Therefore, the maximum number of messages that would occur before repeating is six. A revert scan time of 2 would ensure that no messages are missed in this case.

Scanning of Groups in System Scan

All fixed ID's are decoded when scanning. The priority of the various ID's is the same as when not scanning. Refer to Sections 3.8 for more information.

3.3.4 SCANNING CONVENTIONAL SYSTEMS

When System Scan is enabled in transceivers programmed with conventional systems, the channel programmed in each system is scanned. If a channel is programmed for tone or digital Call Guard squelch, it is detected in the System Scan mode.

3.3.5 SCAN LOCKOUT

Scan lockout is not available with an 864x transceiver unless the Remote Control Unit is used (refer to Section 3.10). The scan lockout feature allows systems to be locked out of the scan sequence so that they are not scanned.

3.4 MICROPHONE HANGER CONTROL OF SCAN AND MONITORING

3.4.1 INTRODUCTION

The microphone hanger line controls scanning and also channel monitoring in the conventional mode. In the standard (factory) configuration, the hanger line is connected to the microphone hanger. Scanning and channel monitoring are then controlled by the on- or off-hook condition of the microphone.

However, the hanger line can be tied high or low by changing the configuration of a jumper and resistor on the main board (refer to Section 2.4). The information which follows describes the operation of scanning and conventional mode channel monitoring with each configuration.

3.4.2 STANDARD ON-HOOK SCAN (HANGER LINE CONNECTED TO HANGER)

Scanning

Scanning is always enabled when the microphone is on-hook and disabled when it is off-hook.

Conventional Mode

The channel is monitored by taking the microphone off-hook. This disables the receive Call Guard (if programmed). The Transmit Disable When Busy feature is functional only when the transmitter is keyed with the microphone on-hook (refer to Section 3.9.3).

3.4.3 CONTINUOUS SCAN AND CALL GUARD SQUELCH (HANGER LINE TIED LOW)

Scanning

Since the microphone hanger line is tied low (on-hook), scanning is always enabled (except while transmitting).

Conventional Mode

Taking the microphone off-hook does not disable Call Guard squelch (if programmed). However, the Transmit Disable When Busy feature is enabled with the microphone off-hook as well as on-hook, so monitoring is performed automatically by that feature (refer to Section 3.9.3).

3.4.4 SCAN AND CALL GUARD SQUELCH DISABLED (HANGER LINE TIED HIGH)

Scanning

Since the microphone hanger line is always pulled high (off-hook) by a pullup resistor in the microprocessor, scanning is always disabled.

Conventional Mode

If Call Guard squelch is programmed, receive mode Call Guard squelch is always disabled; however, transmit mode Call Guard squelch is still functional. The Transmit Disable When Busy feature is not available, so the transmitter always keys when the PTT switch is pressed.

3.5 TIME-OUT TIMER

The time-out timer can be programmed in half minute increments from 0.5 to 5 minutes. If the transmitter is keyed continuously for longer than the programmed time, the transmitter is disabled and the intercept tone begins sounding. The timer and tone are reset by releasing the PTT switch. The time-out timer prevents a repeater from being kept busy for extended periods by an accidentally keyed transmitter and also possible transmitter damage caused by transmitting for extended periods.

3.6 CALL INDICATOR

The purpose of the Call indicator is to indicate that a call was received when the user was away from the vehicle. The call indication is a lighted LED as described in Section 3.2.2. The Call indicator is reset by pressing the front-panel System Step switch or the microphone PTT switch. When the Call indicator lights in the System Scan mode and floating revert is programmed, the revert system displayed is usually the system on which the last call was received. An exception is when another call is received on a system or channel that does not enable the Call indicator.

In LTR systems, the Call indicator can be programmed for each of the three fixed ID codes. In conventional systems, the Call indicator can be programmed for each channel (system). Since Call Guard squelch is also detected with the Call indicator (if an on-hook condition is being detected), the call indication appears whenever a call is received that opens the audio.

3.7 HORN ALERT

The same types of ID codes or channels that can be programmed to turn on the Call indicator can also be programmed to enable the Horn Alert. This function can be used to signal the user of an incoming call when he is away from the vehicle. When the proper ID code or channel is received, the Horn Alert output pulses on for 0.5 second and off for 0.5 second for three cycles. It then goes back to the off state.

This transceiver does not have a horn alert enable/disable switch. Therefore, the horn alert is active whenever transceiver power is on. If the ignition sense cable is installed, the horn alert is automatically disabled when the vehicle ignition switch is on. An external control switch may also be used to disable the horn alert when it is not needed. Installation of the horn alert and ignition sense cables is described in Section 2.3.

3.8 LTR SYSTEM OPERATION

NOTE: Refer to Section 3.9 for information on conventional system operation.

3.8.1 GENERAL

Each selectable LTR system can be programmed with the following ID codes. All codes can be different, and the decode codes have a priority order as described in the next section.

- 1 Fixed and 2 Priority Decode Codes
- 1 Fixed Encode Code

3.8.2 PRIORITY ID CODES

With dispatch (non-telephone) calls, LTR decode ID codes have a priority order which permits a call with a higher priority ID code to interrupt a call with a lower priority ID code. One use of priority ID codes is to allow a dispatcher to interrupt calls in progress with an important "all call" message. If the transceiver detects an ID code with a higher priority than the one it is receiving, it immediately switches to the call with the higher priority. Since priority ID codes are detected with dispatch calls only, telephone (RIC) calls are not interrupted by other calls.

The priority order of the fixed ID codes is as follows:

1. Priority 1 ID Code
2. Priority 2 ID Code
3. Group ID Code

For example, if the transceiver is receiving a dispatch call on the Group ID code and detects a call on the Priority 2 ID Code, the call being received is dropped and the transceiver will trunk to another repeater and receive the call on the Priority 2 ID Code.

Since a transceiver receives incoming call information only on its home repeater, a priority ID code is not detected when the mobile is trunked out to another repeater. To reach these trunked-out mobiles with a priority message, the operator can key the transmitter and then not begin speaking for several seconds to allow these mobiles time to return to the home repeater.

3.8.3 FREE SYSTEM RINGBACK

This feature is available only when a RIC (interconnect) ID code is selected. If a busy tone sounds when the PTT switch is pressed, this mode can be selected to automatically indicate when a repeater is free. System scan is automatically disabled in this mode.

The Free System Ringback mode is entered by momentarily pressing the System Step switch when the busy tone is sounding with the PTT switch pressed. Then when the PTT switch is released, a beep sounds to indicate that this mode has been entered. When a RIC-equipped repeater programmed in the selected system becomes available, (refer to Section 4.3.2), the "ringing" confirmation tone described in Section 3.8.8 sounds. If another call attempt is then made, the call can usually be completed. This feature is available without any special dealer programming.

3.8.4 SYSTEM SEARCH

The system search feature, which automatically accesses other programmed systems when the selected system cannot be accessed, is not available with 8640/8644 transceivers.

3.8.5 TRANSPOND

The transpond feature, which provides an indication back to the person making a call that the transceiver being called is in service, is not available with 8640/8644 transceivers.

3.8.6 TRANSMIT INHIBIT

This transceiver can be programmed with a transmit inhibit block of ID codes. If an ID code within this block is decoded up to 5 seconds before the PTT switch is pressed, the transmitter does not key and the intercept tone sounds. The PTT switch must be released and then pressed again to make another call attempt. The 5 second time period does not decrease while the PTT switch is pressed.

One use of this feature is to prevent your transceiver from interrupting a conversation in progress. This could happen when the other transmitting party unkeys or if an ID code with a higher priority is transmitted by your transceiver. Another use of this feature is to provide an audible indication when the mobile being called is busy.

3.8.7 CLEAR-TO-TALK

The Clear-to-Talk feature sounds a short tone to indicate when speaking can begin when transmitting a message. The clear-to-talk tone sounds after the PTT switch is pressed when the system has been successfully accessed. This feature is enabled or disabled by turning transceiver power on with the System Step switch pressed.

When the Clear-to-Talk feature is enabled, no tone sounds when the system is busy. An exception when the busy tone does sound is when attempting a RIC (telephone) call on a busy system. The intercept tone always remains functional when the Clear-to-Talk feature is enabled. This feature is available only when the selected system is programmed for LTR operation.

3.8.8 LTR SUPERVISORY TONES

The following supervisory tones may be heard at various times when operating this transceiver:

Busy Tone

The busy tone is similar to the standard telephone busy tone and it indicates that all repeaters are busy. It consists of combined 700 and 900 Hz tones switched on and off at a 2 Hz rate. It sounds as long as the PTT switch is pressed or until a repeater becomes available. Repeated access attempts are being made as long as the PTT switch is pressed.

Intercept Tone

This is a siren-like tone consisting of 700 Hz and 900 Hz tones alternating at a 2 Hz rate which indicates an out-of-range condition and other error conditions:

When a brief busy tone precedes this tone, the mobile is not able to complete the data handshake with the repeater. The usual cause of this is that the mobile is out of radio range of the repeater. Repeated access attempts are made as indicated by the busy tone. Once the intercept tone sounds, no more access attempts are made until the PTT switch is released and then pressed again.

If the intercept tone sounds after the transmitter has been keyed for an extended period and the Transmit indicator also goes off, the Time-Out Timer feature has probably timed out. Refer to Section 3.5 for more information.

If the intercept tone sounds as soon as the PTT switch is pressed and is not preceded by a short busy tone, the transmitter may have been disabled by the Transmit Inhibit feature (refer to Section 3.8.6).

If the intercept tones sounds as soon as the PTT switch is pressed with a system programmed for conventional operation selected, the selected channel is probably programmed as receive-only. Refer to Section 3.9 for more information.

Key Press Tone

This is a 30 millisecond burst of the 700 Hz tone that sounds each time the selected system changes when the System Step switch is pressed.

Free System Ringback Mode Tone

This is a 400 millisecond burst of the 700 Hz tone which indicates that the ringback mode has been entered.

Free System Confirmation Tone

When a free repeater is detected in the Free System Ringback Mode, a "ringing" tone sounds. This tone is produced by turning the 700 Hz tone on for 30 milliseconds and off for 20 milliseconds for twenty cycles (1 second).

Clear-To-Talk Tone

When the clear-to-talk feature is enabled, a 10 millisecond burst of the 700 Hz tone sounds after the PTT switch is pressed to indicate when talking can begin. Refer to Section 3.8.7 for more information.

3.9 CONVENTIONAL SYSTEM OPERATION

3.9.1 GENERAL

Each conventional system can be programmed with one channel. This allows up to eight channels (systems) to be selected by the System Step switch. The System Step switch effectively selects a channel when a system programmed for conventional operation is selected.

The transmit and receive mode of each channel can be programmed for tone, digital, or inverted digital Call Guard squelch or standard carrier squelch (none). There is also the option not to transmit a reverse burst with tone-type Call Guard squelch or a turn-off code with digital-type Call Guard squelch. The reverse burst and turn-off code are always decoded by this transceiver when Call Guard squelch is programmed.

Each channel can also be programmed as standard (transmit/receive) or receive-only. When the PTT switch is pressed when a receive-only channel is selected, the transmitter does not key and the intercept tone sounds (refer to Section 3.8.8 for more information on the intercept tone).

3.9.2 MONITORING CHANNELS BEFORE TRANSMITTING

In the conventional mode, when a channel is programmed with Call Guard squelch, only messages intended for that particular user or user group are heard.

In order to hear all messages, Call Guard squelch must be disabled. This is normally done by taking the microphone off-hook so that the transceiver operates on carrier squelch only.

However, the transceiver can be configured so that the microphone hanger line is tied low (on-hook always sensed) or high (off-hook always sensed). Call Guard squelch may then be continuously enabled or disabled. In addition, the operation of the Transmit Disable feature described next is affected. Refer to Section 3.4 for more information on transceiver operation with the various configurations.

3.9.3 TRANSMIT DISABLE WHEN BUSY

If the transmitter is keyed in the conventional mode while an on-hook condition is being detected, the transmitter keying is inhibited if the channel is busy (carrier is present). As long as the PTT switch remains pressed, the transceiver will be in the receive mode with Call Guard squelch disabled so that channel activity can be monitored. If the transmitter is to be keyed in this situation with a carrier present, the PTT switch can be released and then pressed again within 1 second.

When the PTT switch is pressed while an off-hook condition is being detected, the Transmit Disable feature is disabled and the transmitter keys even if a carrier is present.

Refer to Section 3.4 for information on how the configuration of the microphone hanger line affects the operation of this feature.

3.10 OPERATION WITH REMOTE CONTROL UNIT

The 8640/8644 transceivers are compatible with the optional Remote Control Unit (refer to Section 1.5). When this control unit is used, all the standard transceiver functions are available. In addition, there are several enhanced functions that are otherwise not available with this transceiver. These enhanced features are as follows:

Volume Set – The control unit SET switch enables the busy tone for use as a reference in setting the volume level.

Horn Alert – The control unit has a separate horn alert control circuit which can be enabled or disabled by the HORN switch on the control unit. The horn alert can be connected to either the transceiver or control unit horn alert output (refer to Section 2.3). The programmed horn alert ID codes or channels control both horn alert circuits. However, the control unit HORN switch does not control the transceiver horn alert output.

Monitor – The control unit MON switch can be used for monitoring before transmitting on conventional channels. This switch performs the same function as taking the microphone off-hook. This function does not operate if the hanger line is tied high (off-hook) as described in Section 3.4.

Scan – The control unit SCAN switch can be used to enable or disable scanning. This function does not operate if scanning has been disabled by an off-hook condition at the transceiver.

Lockout – The control unit LOCK switch can be used to lock systems out of the scan sequence so that they are not scanned. The lockout status of each system is stored in nonvolatile memory; therefore, systems return to the previous lockout status when power is turned on.

System Step Down – The selected system can be decreased as well as increased because the control unit has both System Up and Down switches.

NOTE: There are a few features described in the control unit operating manual which are not available with this transceiver. The features which are unavailable are as follows:

Group Select – The group select switches and display are nonfunctional. Group scan is also not available.

Selectable Systems – Only up to ten systems are selectable instead of up to sixteen.

System Search – The System Search feature is not available.

3.11 TEST MODE

This transceiver has a test mode that can be selected to perform testing. To select the test mode, a jumper is installed between the TEST pads on the audio/logic board. When the transceiver power is turned on with this jumper installed, the test mode is selected. To exit the test mode, this jumper is removed and power is turned on. The position of this jumper is detected only when power is initially turned on. It is also possible to enter the test mode by turning power on with the outer two pins of the microphone connector shorted (pins A and B). The following functions are available in the test mode.

System Step Switch

The System Step switch is used to select up to eight preprogrammed frequencies. The following test frequencies are automatically programmed unless they are specifically changed (refer to Section 4.2).

System	FCC Channel	System	FCC Channel
1	1	6	279
2	79	7	329
3	129	8	379
4	179	9	429
5	229	0 (10)	479

Squelch

In the test mode, the receiver operates on carrier squelch only.

Transmitter

The transmitter is keyed using the microphone PTT switch. The transmitter modulation consists of a series of ones and zeros. This modulation can be turned on or off by pressing the System Step switch while the transmitter is keyed.

SECTION 4
TRANSCEIVER PROGRAMMING

4.1 GENERAL

4.1.1 INTRODUCTION

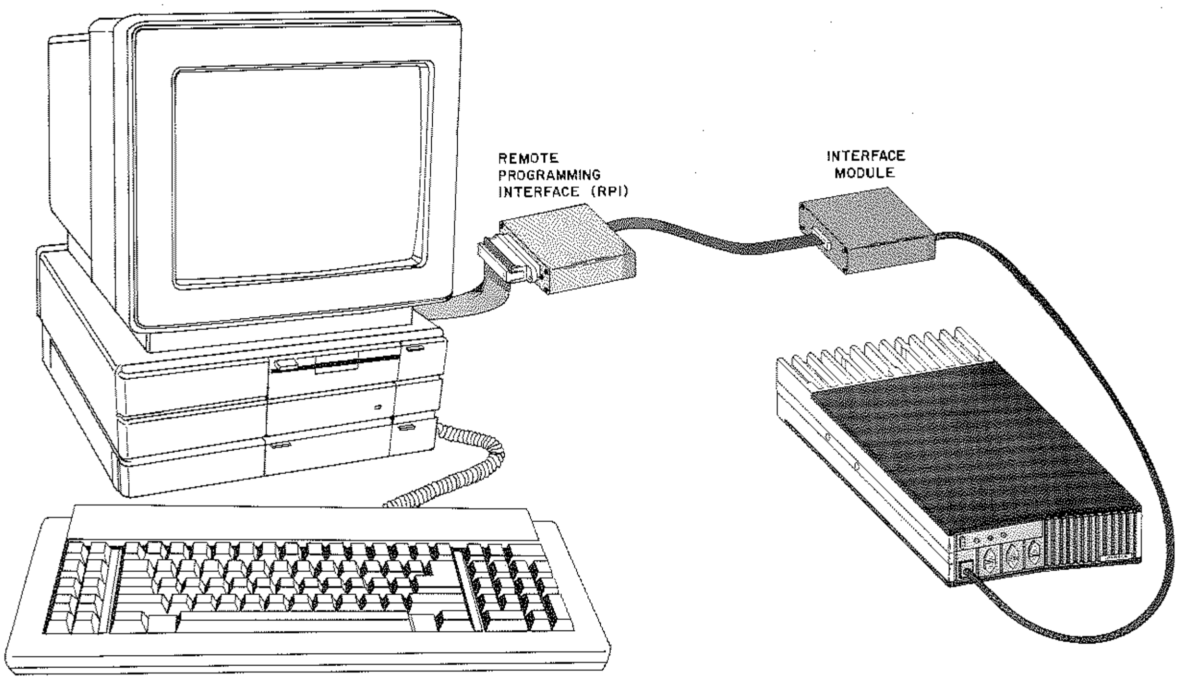
This transceiver is programmed using a dealer-supplied personal computer, the Johnson RPI (Remote Programming Interface), an interface module which adapts the RPI to the transceiver, and a Johnson software package for the particular computer. Software packages are available for selected models of Tandy® and IBM® computers (refer to Table 1-1 in Section 1). A typical programming setup using an IBM compatible PC computer is shown in Figure 4-1.

4.1.2 RPI DESCRIPTION

The RPI is required to interface the transceiver to the computer. RPI, Part No. 023-5800-000, connects to the serial RS-232 port of the computer. An RS-232 port is standard with the Tandy computer, but may be optional with an IBM PC or compatible. This RPI converts the RS-232 logic levels from the computer to TTL levels required by the transceiver and vice versa. Interface module, Part No. 023-8610-901, adapts the RPI to the modular-type microphone/programming connector of the transceiver. The outer two pins of this eight-pin connector are the input and output pins of a serial data port of the microprocessor.

NOTE: If the green indicator on the Interface Module does not light when transceiver power is turned on, check fuse F301 in the transceiver.

The cable between the RPI and the interface module is included with the RPI. However, the cable between the RPI and computer is not included. This cable is Part No. 023-5800-016 for the Tandy computer and Part No. 023-5800-017 for the IBM computer. This is a standard DB-25 to DB-25 cable. The -016 cable has male-to-male connectors and the -017 cable has male-to-female connectors.



PROGRAMMING SETUP USING A PC COMPATIBLE COMPUTER
FIGURE 4-1

Tandy is a registered trademark of the Tandy Corporation.

IBM is a registered trademark of International Business Machines Corporation.

4.1.3 PROGRAMMING SOFTWARE DESCRIPTION

The Johnson software packages used for programming these transceivers are written in the BASIC programming language. An uncompiled version of the program is included which requires a BASIC interpreter program to run (this is usually included with the computer). A compiled version of the program called QB86xx is also included. This version executes faster and does not require a BASIC interpreter.

The programming software displays menus and asks questions to simplify operation and lesson the chance of programming errors. Separate routines are provided for entering and editing data, programming the transceiver, reading data already programmed into the transceiver, and printing and saving data.

4.1.4 EEPROM DATA STORAGE

The data programmed into the transceiver is stored in EEPROM U10 on the audio/logic board. Other information such as the last system selected is also stored in the EEPROM by the microprocessor.

Since an EEPROM (Electrically Eraseable Programmable Memory) is nonvolatile, data is stored by this device indefinitely without the need for a constant power supply. Therefore, battery backup is not required and the transceiver can even be removed from the vehicle without affecting programming. An EEPROM is also reprogrammable, so it can be erased and reprogrammed many times.

4.2 GENERAL PARAMETER PROGRAMMING

The first screen displayed when programming a transceiver is used for programming parameters which are not affected by individual system programming. The parameters in Table 4-1 are programmed from this screen.

4.3 LTR SYSTEM PROGRAMMING

4.3.1 GENERAL

After the general information is programmed, the next screen displayed is used to program individual system information. The first question selects whether an LTR or conventional system is to be programmed and then the appropriate information is displayed. The information in Table 4-2 is programmed in each LTR system, and the information in Table 4-3 is programmed in each conventional system.

For more information on LTR operation, refer to the following literature:

LTR Application Note (Revision 5)	Part No. 009-0001-020
RIC Operating Manual	Part No. 002-3040-004

TABLE 4-1
GENERAL PROGRAMMING PARAMETERS

Parameter	Acceptable Responses	Description
Frequency Band	800 or 900 MHz	8640/8644 = 900 MHz
No. of Systems	1-10	Number of systems to be programmed.
Test System No./ Test Frequency	1-10/1-479	FCC Channel numbers for the 10 test channels have been preprogrammed to cover the entire 479 channel band, but can be changed if desired. See Section 3.11.
Scan Operation	Floating Revert/Fixed Revert	See Section 3.3.2
Time-Out Timer	0.5-5 minutes in 0.5 min increments	See Section 3.5

TABLE 4-2
LTR SYSTEM PROGRAMMING

Parameter	Acceptable Responses	Description
System Type	LTR or Conventional	This question requests the type of system to be programmed. If LTR is selected, the following parameters are displayed; if Conventional is selected, the parameters in Table 4-3 are displayed.
Area	0 or 1	Selects the area of the LTR repeater system.
Home Repeater	1-20	Programs the number of the repeater to which the mobile is assigned.
Weighting	1-8	Selects the revert system scan time when System Scan is enabled (see Section 3.3.3).
Repeater No./ Channel No.	1-20/1-479	Programs the FCC channel number for each active repeater in the system. If a period is entered after the channel number, the repeater is programmed as not RIC-equipped; if a period is not entered, it is programmed as RIC-equipped (see Section 4.3.2). FCC channel numbers are shown in Table 4-4.
Priority ID No.	1, 2/1-250	Up to two priority receive ID codes from 1-250 can be programmed, (see Section 3.8.2).
Tx/Rx Group ID No.	1/1-250	Programs one receive and one transmit fixed ID. These ID's can be different and both must be programmed (see Section 3.8.1).
Call Ind	On, Off	Programs if the Call indicator is to light when the particular ID being programmed is decoded. Any or all three decode ID's can be programmed to enable the Call indicator (see Section 3.6).
Horn	On, Off	Programs if the horn alert is to sound when the particular ID being programmed is decoded. Any or all three decode ID's can be programmed to enable the horn alert (see Section 3.7).
RIC Block	1-250	Programs a block of ID codes (from 1 up to all 250) that are reserved for RIC telephone interconnect operation. If an encode ID code within this block is selected or a decode code within this block is decoded, the transceiver enters the RIC operating mode.
Transmit Inhibit (SCP) Block	1-250	Programs the transmit inhibit block of ID codes (up to all 250). If an ID code within this block is decoded within 5 seconds before the PTT switch is pressed, the transmitter does not key.

TABLE 4-3
CONVENTIONAL SYSTEM PROGRAMMING

Parameter	Acceptable Responses	Description
System Type	LTR or Conventional	This question requests the type of system to be programmed. If Conventional is selected, the following parameters are displayed; if LTR is selected, the parameters in Table 4-2 are displayed.
Channel No.	1-479	Programs the FCC channel number for the particular system. FCC channels are shown in Table 4-4.
Transmit Call Guard Mode	None, Tone, Digital, or Inverted Digital	Selects the type of Call Guard squelch for the transmit mode of the channel being programmed.
Transmit Call Guard Code	Tone Number or Digital Code	If tone Call Guard squelch was selected, the number from 1-38 of the tone selected is entered. If digital Call Guard squelch is programmed, the number of the digital code is entered. These numbers are located on the next page.
Receive Call Guard Mode	None, Tone, Digital, or Inverted Digital	Selects the type of Call Guard squelch for the receive mode of the channel being programmed.
Receive Call Guard Code	Tone Number or Digital Code	If tone Call Guard squelch was selected, the number from 1-38 of the tone selected is entered. If digital Call Guard squelch is programmed, the number of the digital code is entered. These numbers are located on the next page.
NOTE: The transmit and receive Call Guard mode and codes can be different.		
Call	On, Off	Programs if the Call indicator is to light when a call is received on the particular channel being programmed.
Horn	On, Off	Programs if the horn alert is to sound when a call is received on the particular channel being programmed.
Transmit Disable	On, Off	If "ON" is programmed, the channel is receive-only and the transmitter cannot be keyed.
Turn-off Code Disable	On, Off	If "ON" is programmed and Call Guard squelch has been programmed, a reverse burst or turn-off code is not transmitted when the PTT switch is released. The turn-off code eliminates the squelch tail in the receiving mobile (if the receiving mobile can detect it).

4.3.2 SPECIFYING RIC-EQUIPPED REPEATERS

When the transceiver is programmed with the channel number of each repeater, it is possible to specify whether or not that repeater is equipped with Johnson RIC (repeater interconnect). If a period is entered after the channel number, a non-RIC repeater is specified; if a period is not entered, a RIC-equipped repeater is specified. "RIC" or "NO RIC" appears next to the repeater number to indicate the configuration programmed. This feature is available only when programming LTR systems.

If a system with a transmit ID code programmed for RIC is then selected, the transceiver will attempt to access only repeaters specified as equipped with RIC. This allows both RIC and non-RIC repeaters to be programmed in each system. Without this feature, if a RIC call is attempted on a repeater not equipped with RIC, no dial tone or other supervision is returned when the PTT switch is released. Refer to the RIC Operating Manual for more information.

4.4 CONVENTIONAL SYSTEM PROGRAMMING

The information in Table 4-3 is programmed in a conventional system. General parameters are programmed as described in Section 4.2.

CALL GUARD CODES

TONE CALL GUARD CODES

Code	Freq (Hz)	Code	Freq (Hz)	Code	Freq (Hz)	Code	Freq (Hz)
000	00.0	010	94.8	020	131.8	030	186.2
001	67.0	011	97.4	021	136.5	031	192.8
002	71.9	012	100.0	022	141.3	032	203.5
003	74.4	013	103.5	023	146.2	033	210.7
004	77.0	014	107.2	024	151.4	034*	218.1
005	79.7	015	110.9	025	156.7	035*	225.7
006	82.5	016	114.8	026	162.2	036*	233.6
007	85.4	017	118.8	027	167.9	037*	241.8
008	88.5	018	123.0	028	173.8	038*	250.3
009	91.5	019	127.3	029	179.9		

* These tones are normally not used because of their close proximity to voice frequencies.

RECOMMENDED DIGITAL CALL GUARD CODES

023	051	114	143	174	251	315	371	445	532	631	723
025	054	115	152	205	261	331	411	464	546	632	731
026	065	116	155	223	263	343	412	465	565	654	732
031	071	125	156	226	265	346	413	466	606	662	734
032	072	131	162	243	271	351	423	503	612	664	743
043	073	132	165	244	306	364	431	506	624	703	754
047	074	134	172	245	311	365	432	516	627	712	

TABLE 4-4
MOBILE FREQUENCIES

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
001	935.0125	896.0125
002	935.0250	896.0250
003	935.0375	896.0375
004	935.0500	896.0500
005	935.0625	896.0625
006	935.0750	896.0750
007	935.0875	896.0875
008	935.1000	896.1000
009	935.1125	896.1125
010	935.1250	896.1250
011	935.1375	896.1375
012	935.1500	896.1500
013	935.1625	896.1625
014	935.1750	896.1750
015	935.1875	896.1875
016	935.2000	896.2000
017	935.2125	896.2125
018	935.2250	896.2250
019	935.2375	896.2375
020	935.2500	896.2500
021	935.2625	896.2625
022	935.2750	896.2750
023	935.2875	896.2875
024	935.3000	896.3000
025	935.3125	896.3125
026	935.3250	896.3250
027	935.3375	896.3375
028	935.3500	896.3500
029	935.3625	896.3625
030	935.3750	896.3750
031	935.3875	896.3875
032	935.4000	896.4000
033	935.4125	896.4125
034	935.4250	896.4250
035	935.4375	896.4375
036	935.4500	896.4500
037	935.4625	896.4625
038	935.4750	896.4750
039	935.4875	896.4875
040	935.5000	896.5000
041	935.5125	896.5125
042	935.5250	896.5250
043	935.5375	896.5375
044	935.5500	896.5500
045	935.5625	896.5625
046	935.5750	896.5750
047	935.5875	896.5875
048	935.6000	896.6000
049	935.6125	896.6125
050	935.6250	896.6250
051	935.6375	896.6375
052	935.6500	896.6500

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
053	935.6625	896.6625
054	935.6750	896.6750
055	935.6875	896.6875
056	935.7000	896.7000
057	935.7125	896.7125
058	935.7250	896.7250
059	935.7375	896.7375
060	935.7500	896.7500
061	935.7625	896.7625
062	935.7750	896.7750
063	935.7875	896.7875
064	935.8000	896.8000
065	935.8125	896.8125
066	935.8250	896.8250
067	935.8375	896.8375
068	935.8500	896.8500
069	935.8625	896.8625
070	935.8750	896.8750
071	935.8875	896.8875
072	935.9000	896.9000
073	935.9125	896.9125
074	935.9250	896.9250
075	935.9375	896.9375
076	935.9500	896.9500
077	935.9625	896.9625
078	935.9750	896.9750
079	935.9875	896.9875
080	936.0000	897.0000
081	936.0125	897.0125
082	936.0250	897.0250
083	936.0375	897.0375
084	936.0500	897.0500
085	936.0625	897.0625
086	936.0750	897.0750
087	936.0875	897.0875
088	936.1000	897.1000
089	936.1125	897.1125
090	936.1250	897.1250
091	936.1375	897.1375
092	936.1500	897.1500
093	936.1625	897.1625
094	936.1750	897.1750
095	936.1875	897.1875
096	936.2000	897.2000
097	936.2125	897.2125
098	936.2250	897.2250
099	936.2375	897.2375
100	936.2500	897.2500
101	936.2625	897.2625
102	936.2750	897.2750
103	936.2875	897.2875
104	936.3000	897.3000

TABLE 4-4
MOBILE FREQUENCIES (CONT.)

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
105	936.3125	897.3125
106	936.3250	897.3250
107	936.3375	897.3375
108	936.3500	897.3500
109	936.3625	897.3625
110	936.3750	897.3750
111	936.3875	897.3875
112	936.4000	897.4000
113	936.4125	897.4125
114	936.4250	897.4250
115	936.4375	897.4375
116	936.4500	897.4500
117	936.4625	897.4625
118	936.4750	897.4750
119	936.4875	897.4875
120	936.5000	897.5000
121	936.5125	897.5125
122	936.5250	897.5250
123	936.5375	897.5375
124	936.5500	897.5500
125	936.5625	897.5625
126	936.5750	897.5750
127	936.5875	897.5875
128	936.6000	897.6000
129	936.6125	897.6125
130	936.6250	897.6250
131	936.6375	897.6375
132	936.6500	897.6500
133	936.6625	897.6625
134	936.6750	897.6750
135	936.6875	897.6875
136	936.7000	897.7000
137	936.7125	897.7125
138	936.7250	897.7250
139	936.7375	897.7375
140	936.7500	897.7500
141	936.7625	897.7625
142	936.7750	897.7750
143	936.7875	897.7875
144	936.8000	897.8000
145	936.8125	897.8125
146	936.8250	897.8250
147	936.8375	897.8375
148	936.8500	897.8500
149	936.8625	897.8625
150	936.8750	897.8750
151	936.8875	897.8875
152	936.9000	897.9000
153	936.9125	897.9125
154	936.9250	897.9250
155	936.9375	897.9375
156	936.9500	897.9500

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
157	936.9625	897.9625
158	936.9750	897.9750
159	936.9875	897.9875
160	937.0000	898.0000
161	937.0125	898.0125
162	937.0250	898.0250
163	937.0375	898.0375
164	937.0500	898.0500
165	937.0625	898.0625
166	937.0750	898.0750
167	937.0875	898.0875
168	937.1000	898.1000
169	937.1125	898.1125
170	937.1250	898.1250
171	937.1375	898.1375
172	937.1500	898.1500
173	937.1625	898.1625
174	937.1750	898.1750
175	937.1875	898.1875
176	937.2000	898.2000
177	937.2125	898.2125
178	937.2250	898.2250
179	937.2375	898.2375
180	937.2500	898.2500
181	937.2625	898.2625
182	937.2750	898.2750
183	937.2875	898.2875
184	937.3000	898.3000
185	937.3125	898.3125
186	937.3250	898.3250
187	937.3375	898.3375
188	937.3500	898.3500
189	937.3625	898.3625
190	937.3750	898.3750
191	937.3875	898.3875
192	937.4000	898.4000
193	937.4125	898.4125
194	937.4250	898.4250
195	937.4375	898.4375
196	937.4500	898.4500
197	937.4625	898.4625
198	937.4750	898.4750
199	937.4875	898.4875
200	937.5000	898.5000
201	937.5125	898.5125
202	937.5250	898.5250
203	937.5375	898.5375
204	937.5500	898.5500
205	937.5625	898.5625
206	937.5750	898.5750
207	937.5875	898.5875
208	937.6000	898.6000

TABLE 4-4
MOBILE FREQUENCIES (CONT.)

CHANNEL FREQUENCY CHART		
Channel	Receive	Transmit
209	937.6125	898.6125
210	937.6250	898.6250
211	937.6375	898.6375
212	937.6500	898.6500
213	937.6625	898.6625
214	937.6750	898.6750
215	937.6875	898.6875
216	937.7000	898.7000
217	937.7125	898.7125
218	937.7250	898.7250
219	937.7375	898.7375
220	937.7500	898.7500
221	937.7625	898.7625
222	937.7750	898.7750
223	937.7875	898.7875
224	937.8000	898.8000
225	937.8125	898.8125
226	937.8250	898.8250
227	937.8375	898.8375
228	937.8500	898.8500
229	937.8625	898.8625
230	937.8750	898.8750
231	937.8875	898.8875
232	937.9000	898.9000
233	937.9125	898.9125
234	937.9250	898.9250
235	937.9375	898.9375
236	937.9500	898.9500
237	937.9625	898.9625
238	937.9750	898.9750
239	937.9875	898.9875
240	938.0000	899.0000
241	938.0125	899.0125
242	938.0250	899.0250
243	938.0375	899.0375
244	938.0500	899.0500
245	938.0625	899.0625
246	938.0750	899.0750
247	938.0875	899.0875
248	938.1000	899.1000
249	938.1125	899.1125
250	938.1250	899.1250
251	938.1375	899.1375
252	938.1500	899.1500
253	938.1625	899.1625
254	938.1750	899.1750
255	938.1875	899.1875
256	938.2000	899.2000
257	938.2125	899.2125
258	938.2250	899.2250
259	938.2375	899.2375
260	938.2500	899.2500

CHANNEL FREQUENCY CHART		
Channel	Receive	Transmit
261	938.2625	899.2625
262	938.2750	899.2750
263	938.2875	899.2875
264	938.3000	899.3000
265	938.3125	899.3125
266	938.3250	899.3250
267	938.3375	899.3375
268	938.3500	899.3500
269	938.3625	899.3625
270	938.3750	899.3750
271	938.3875	899.3875
272	938.4000	899.4000
273	938.4125	899.4125
274	938.4250	899.4250
275	938.4375	899.4375
276	938.4500	899.4500
277	938.4625	899.4625
278	938.4750	899.4750
279	938.4875	899.4875
280	938.5000	899.5000
281	938.5125	899.5125
282	938.5250	899.5250
283	938.5375	899.5375
284	938.5500	899.5500
285	938.5625	899.5625
286	938.5750	899.5750
287	938.5875	899.5875
288	938.6000	899.6000
289	938.6125	899.6125
290	938.6250	899.6250
291	938.6375	899.6375
292	938.6500	899.6500
293	938.6625	899.6625
294	938.6750	899.6750
295	938.6875	899.6875
296	938.7000	899.7000
297	938.7125	899.7125
298	938.7250	899.7250
299	938.7375	899.7375
300	938.7500	899.7500
301	938.7625	899.7625
302	938.7750	899.7750
303	938.7875	899.7875
304	938.8000	899.8000
305	938.8125	899.8125
306	938.8250	899.8250
307	938.8375	899.8375
308	938.8500	899.8500
309	938.8625	899.8625
310	938.8750	899.8750
311	938.8875	899.8875
312	938.9000	899.9000

TABLE 4-4
MOBILE FREQUENCIES (CONT.)

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
313	938.9125	899.9125
314	938.9250	899.9250
315	938.9375	899.9375
316	938.9500	899.9500
317	938.9625	899.9625
318	938.9750	899.9750
319	938.9875	899.9875
320	939.0000	900.0000
321	939.0125	900.0125
322	939.0250	900.0250
323	939.0375	900.0375
324	939.0500	900.0500
325	939.0625	900.0625
326	939.0750	900.0750
327	939.0875	900.0875
328	939.1000	900.1000
329	939.1125	900.1125
330	939.1250	900.1250
331	939.1375	900.1375
332	939.1500	900.1500
333	939.1625	900.1625
334	939.1750	900.1750
335	939.1875	900.1875
336	939.2000	900.2000
337	939.2125	900.2125
338	939.2250	900.2250
339	939.2375	900.2375
340	939.2500	900.2500
341	939.2625	900.2625
342	939.2750	900.2750
343	939.2875	900.2875
344	939.3000	900.3000
345	939.3125	900.3125
346	939.3250	900.3250
347	939.3375	900.3375
348	939.3500	900.3500
349	939.3625	900.3625
350	939.3750	900.3750
351	939.3875	900.3875
352	939.4000	900.4000
353	939.4125	900.4125
354	939.4250	900.4250
355	939.4375	900.4375
356	939.4500	900.4500
357	939.4625	900.4625
358	939.4750	900.4750
359	939.4875	900.4875
360	939.5000	900.5000
361	939.5125	900.5125
362	939.5250	900.5250
363	939.5375	900.5375
364	939.5500	900.5500

CHANNEL FREQUENCY CHART

Channel	Receive	Transmit
365	939.5625	900.5625
366	939.5750	900.5750
367	939.5875	900.5875
368	939.6000	900.6000
369	939.6125	900.6125
370	939.6250	900.6250
371	939.6375	900.6375
372	939.6500	900.6500
373	939.6625	900.6625
374	939.6750	900.6750
375	939.6875	900.6875
376	939.7000	900.7000
377	939.7125	900.7125
378	939.7250	900.7250
379	939.7375	900.7375
380	939.7500	900.7500
381	939.7625	900.7625
382	939.7750	900.7750
383	939.7875	900.7875
384	939.8000	900.8000
385	939.8125	900.8125
386	939.8250	900.8250
387	939.8375	900.8375
388	939.8500	900.8500
389	939.8625	900.8625
390	939.8750	900.8750
391	939.8875	900.8875
392	939.9000	900.9000
393	939.9125	900.9125
394	939.9250	900.9250
395	939.9375	900.9375
396	939.9500	900.9500
397	939.9625	900.9625
398	939.9750	900.9750
399	939.9875	900.9875
400	940.0000	901.0000
401	940.0125	901.0125
402	940.0250	901.0250
403	940.0375	901.0375
404	940.0500	901.0500
405	940.0625	901.0625
406	940.0750	940.0750
407	940.0875	901.0875
408	940.1000	901.1000
409	940.1125	901.1125
410	940.1250	901.1250
411	940.1375	901.1375
412	940.1500	901.1500
413	940.1625	901.1625
414	940.1750	901.1750
415	940.1875	901.1875
416	940.2000	940.2000

TABLE 4-4
MOBILE FREQUENCIES (CONT.)

CHANNEL FREQUENCY CHART

Chan.	Receive	Transmit
417	940.2125	901.2125
418	940.2250	901.2250
419	940.2375	901.2375
420	940.2500	901.2500
421	940.2625	901.2625
422	940.2750	901.2750
423	940.2875	901.2875
424	940.3000	901.3000
425	940.3125	901.3125
426	940.3250	901.3250
427	940.3375	901.3375
428	940.3500	901.3500
429	940.3625	901.3625
430	940.3750	901.3750
431	940.3875	901.3875
432	940.4000	901.4000
433	940.4125	901.4125
434	940.4250	901.4250
435	940.4375	901.4375
436	940.4500	901.4500
437	940.4625	901.4625
438	940.4750	901.4750
439	940.4875	901.4875
440	940.5000	901.5000
441	940.5125	901.5125
442	940.5250	901.5250
443	940.5375	901.5375
444	940.5500	901.5500
445	940.5625	901.5625
446	940.5750	901.5750
447	940.5875	901.5875
448	940.6000	901.6000
449	940.6125	901.6125
450	940.6250	901.6250
451	940.6375	901.6375
452	940.6500	901.6500
453	940.6625	901.6625
454	940.6750	901.6750
455	940.6875	901.6875
456	940.7000	901.7000
457	940.7125	901.7125
458	940.7250	901.7250
459	940.7375	901.7375
460	940.7500	901.7500
461	940.7625	901.7625
462	940.7750	901.7750
463	940.7875	901.7875
464	940.8000	901.8000
465	940.8125	901.8125
466	940.8250	901.8250
467	940.8375	901.8375
468	940.8500	901.8500

CHANNEL FREQUENCY CHART

Chan.	Receive	Transmit
469	940.8625	901.8625
470	940.8750	901.8750
471	940.8875	901.8875
472	940.9000	901.9000
473	940.9125	901.9125
474	940.9250	901.9250
475	940.9375	901.9375
476	940.9500	901.9500
477	940.9625	901.9625
478	940.9750	901.9750
479	940.9875	901.9875

SECTION 5
CIRCUIT DESCRIPTION

5.1 GENERAL TRANSCEIVER DESCRIPTION

5.1.1 INTRODUCTION

The 8640/8644 transceiver contains a main board and audio/logic board. The main board contains the synthesizer, receiver, and transmitter sections of the transceiver. The audio/logic board contains the audio processing and digital control circuitry. General descriptions of these sections follow and more detailed descriptions are located in Sections 5.2-5.6. A transceiver block diagram is located in Figure 5-1.

Circuit protection is provided by a 15-ampere fuse in the power cable and by regulators which automatically limit current. The power cable fuse protects circuits powered from the 13.6 volt supply such as audio amplifier U301 and power module U501. There is also a fuse on the main board (F301) which protects accessories powered from microphone/programming jack J303 and accessory jack P2 on the audio/logic board. (If the green indicator on the RPI interface module does not light, check this fuse.)

5.1.2 SYNTHESIZER

The synthesizer output signal is half the transmit frequency in the transmit mode and half the receive first injection frequency in the receive mode. This signal is fed to the transmitter, doubled, and then fed to amplifier sections of the transmitter and also to the receiver.

Channels are selected by programming the counters in synthesizer chip U802 to divide by a certain number. This programming data comes from microprocessor U11 located on the audio/logic board. The frequency stability of the synthesizer is determined by the stability of TCXO (temperature-compensated crystal oscillator) Y800. The stability of Y800 is $\pm$ 1.5 PPM from -22 to $+140$ degrees F (-30 to $+60$ degrees C).

5.1.3 RECEIVER

The receiver is a triple-conversion type with intermediate frequencies of 45 MHz, 10.7 MHz and 455 kHz. Receiver selectivity is enhanced by a two-pole 45 MHz crystal filter and a four-pole 10.7 MHz crystal filter. A six-pole bandpass filter in the front end attenuates the image, half IF, injection, and other frequencies which could degrade receiver performance. Low-side injection is used to produce the intermediate frequencies.

5.1.4 TRANSMITTER

The transmitter doubles the signal from the synthesizer and then amplifies it to produce a power output of 15 watts. The doubler output is also fed to the receiver and is the first injection frequency in the receive mode. All data and audio modulation of the transmit signal occurs in the synthesizer. A power control circuit maintains constant power output by sensing transmitter current.

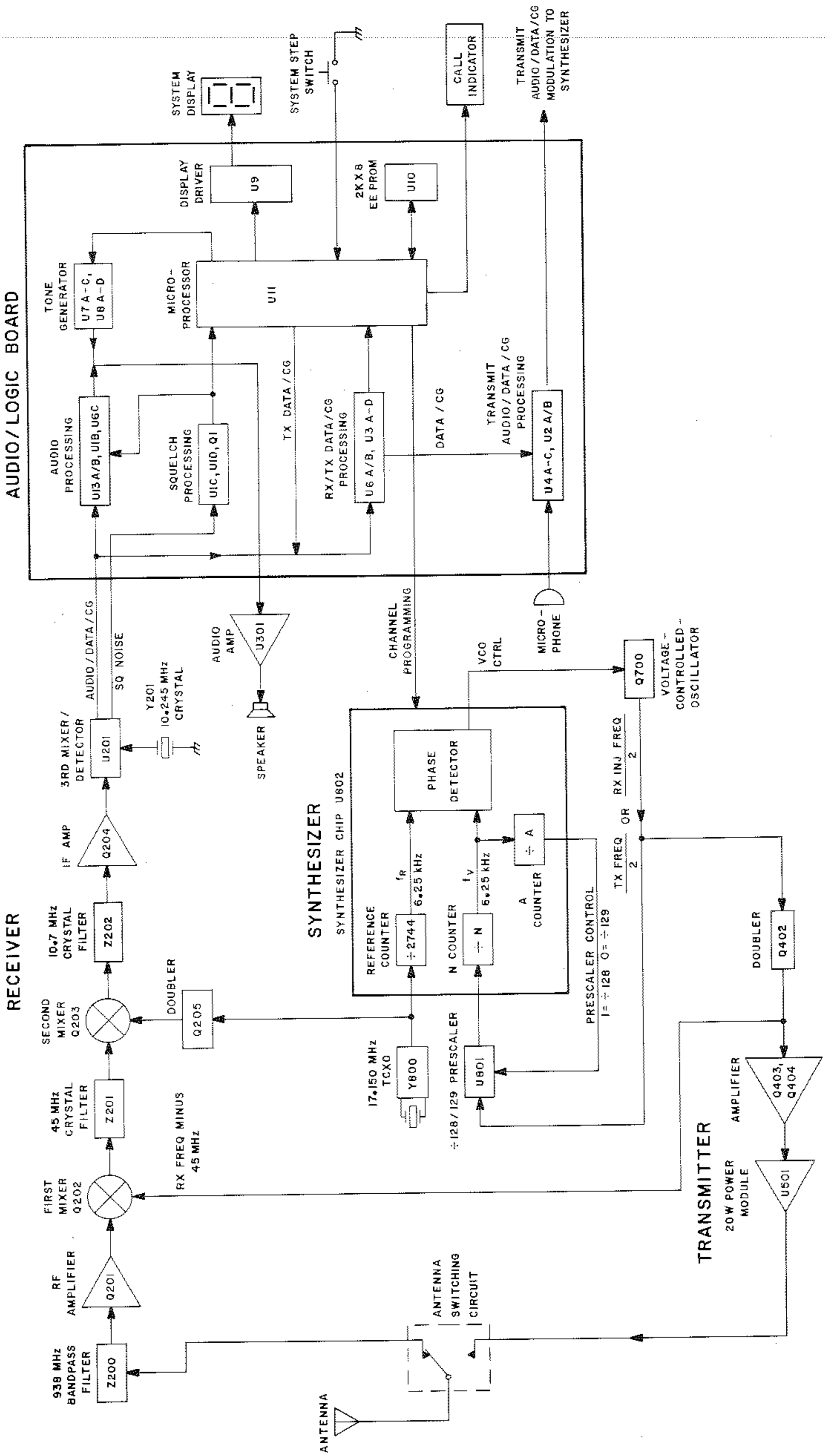
5.1.5 AUDIO/LOGIC BOARD

Microprocessor-based control logic on the audio/logic board provides such functions as synthesizer programming, scan, and data encoding and decoding. Information concerning channels to be selected and various operating parameters is programmed into the transceiver by a personal computer connected to the microphone/ programming jack. This information is stored by the microprocessor in EEPROM U10. Since an EEPROM is a nonvolatile and reprogrammable memory, battery backup and extra PROMs are not needed with this transceiver. In addition to the digital control circuitry, the audio/logic board contains analog circuits which provide amplification, filtering, and other processing of the audio, data, and Call Guard signals.

5.2 SYNTHESIZER CIRCUIT DESCRIPTION

5.2.1 INTRODUCTION

A synthesizer block diagram is shown in Figure 5-1. The synthesizer output signal is produced by a VCO (voltage-controlled oscillator). The VCO frequency is controlled by a DC voltage from the phase detector in U802.



TRANSCEIVER BLOCK DIAGRAM
FIGURE 5-1

The phase detector in U802 senses the phase and frequency of two input signals and then increases or decreases the VCO control voltage if they are not the same. This changes the VCO frequency so that both inputs are synchronized. The VCO is then said to be "locked" on frequency.

One input to the phase detector is the reference frequency (fR). This frequency is the 17.150 MHz TCXO frequency divided by the reference counter in U802. The reference frequency is 6.25 kHz for all channels. Refer to Section 5.2.8 for more information.

The other input (fV) to the phase detector is derived from the VCO signal. To produce this input, the VCO frequency is divided by prescaler U801 and the N counter in synthesizer U802. These counters are programmed for each channel to produce an input to the phase detector which is the same as the reference frequency (fR) when the VCO is oscillating on the correct frequency. The prescaler divide number is controlled by synthesizer U802 which in turn is programmed by the microprocessor.

5.2.2 VOLTAGE-CONTROLLED OSCILLATOR

Oscillator (Q700)

The VCO circuit is located on a ceramic module. Q700 is an N-channel JFET configured as a common-gate oscillator. It oscillates at half the transmit frequency in the transmit mode and half the first injection frequency in the receive mode (approximately 450 MHz). The gate is biased negative with respect to the source by constant current source Q730. This stage provides a biasing current that is relatively stable over changes in temperature. The emitter current of Q730 mirrors the current through R731. Diode CR731 provides a PN junction drop and temperature compensation.

L701 is an RF choke and C704 is a bypass capacitor. An AC voltage divider formed by C701, C702, and C703 starts and maintains oscillation and also matches Q700 to the tank circuit. In addition, C703 compensates for frequency and gain changes in Q700 caused by variations in temperature.

The tank circuit consists of varactor diodes CR710 and CR711, several capacitors, and a section of microstrip. The microstrip is grounded on one end and provides distributed series inductance and shunt capacitance. The tank circuit is tuned at the factory for the correct frequency by laser trimming the end of the microstrip.

Frequency Control and Modulation

The VCO frequency is controlled by changing the DC voltage applied across varactor diode CR710. As the voltage across a reversed-biased varactor diode increases, its capacitance decreases. This increases the VCO frequency as the control voltage increases and vice versa.

The VCO frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode CR711 to vary the VCO frequency at an audio rate. C711 and C713 in series with CR711 determine the amount of modulation produced by the audio signal. R710 provides a DC ground on the anode of CR711, and the modulation line is isolated from tank circuit RF by L711 and C715.

The 9-volt supply is isolated from the modulation signal and RF by R853, and C851. DC blocking is provided by C850. Resistors R851 and R852 provide summing of the 9-volt bias and transmit audio/data signal. Potentiometer R850 balances the modulating signal applied to the VCO and TCXO (refer to Section 5.2.4 for more information).

A circuit formed by PIN diode CR720 and several inductors and capacitors decreases the resonant frequency of the tank circuit by approximately 3 MHz when going from the transmit to the receive mode. If this large of a frequency shift was achieved by lowering the VCO control voltage across CR710, the VCO gain required would be undesirably large. The VCO frequency is shifted 3 MHz because the injection frequency is 45 MHz below the receive frequency and transmit frequency is 39 MHz below the receive frequency which is a difference of 6 MHz. The VCO frequency is changed half this amount because it is later doubled. This 3 MHz shift is achieved as follows:

In the receive mode, the state remaining on the DATA line after synthesizer U802 is programmed is a logic 0 (low). This level is inverted by Q880 which forward biases PIN diode CR702. A PIN diode has a very low impedance when forward biased, and a very high impedance (small capacitance) when reverse biased. Therefore, in the receive mode, C720 and C721 are effectively connected to the tank circuit. This additional capacitance lowers the resonant frequency of the tank by approximately 3 MHz. In the transmit mode, the DATA line is high which reverse biases CR720. Tank circuit RF is decoupled from the control line by L720/C722 and L721/C723.

Buffer (Q740)

A small amount of RF energy is coupled to the base of buffer Q740 by a section of microstrip. Q740 provides amplification and also isolation between the VCO and the resistive splitter formed by R920, R921, and R922. A 50-ohm output impedance is provided by L741, C743, and C741.

5.2.3 VCO AND TCXO FREQUENCY MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U802 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (especially at the lower audio frequencies). If only the TCXO frequency was modulated, the VCO frequency would not change fast enough (especially at the higher audio frequencies). However, by modulating both the VCO and TCXO, the two phase detector inputs (fR and fV) remain in phase and no phase shift is sensed. This produces a flat audio response. Potentiometer R850 balances the modulating signals.

5.2.4 ACTIVE FILTER (Q900)

Q900 functions as a capacitance multiplier to provide filtering of the 9-volt supply to the oscillator. R901 provides transistor bias and C902 provides the capacitance that is multiplied. If a noise pulse or other voltage change appears on the collector, the base voltage does not change significantly because of C902. Therefore, the base current does not change and the transistor current remains constant. R900 provides isolation and C900, C901, and C903 are RF bypass capacitors.

5.2.5 BUFFER (Q930), BUFFER SWITCH (Q842)

A 50-ohm splitter formed by R920, R921, and R922 routes the RF signal to buffer Q930 and buffer Q940. Impedance matching with Q930 is provided by a section of microstrip and C932. Buffer Q930 provides additional amplification and also isolation. Two sections of microstrip and C933 on the output of Q930 provide impedance matching with the doubler in the transmitter. The DC supply is isolated from RF by bypass capacitor C931 and the section of microstrip which also functions as an RF choke.

Bias voltage to buffer Q930 is switched by Q842. When the synthesizer is out-of-lock, Q842 is turned off and no bias voltage is applied to buffer Q930. This disables both the transmitter and receiver to prevent the transmission or reception of an improper frequency. The microstrip between R931 and the base of Q930 provides bias and impedance matching.

5.2.6 PRESCALER BUFFER (Q940), PRESCALER (U801)

Prescaler buffer Q940 is similar in design to Q930. It provides the ECL (emitter-coupled logic) levels required to drive prescaler U801.

U801 is a dual-modulus prescaler. A prescaler is a digital counter capable of operating at high frequencies, and dual-modulus refers to the two divide numbers, 128 and 129. This counter divides an input signal in the 450 MHz range down to the 3 MHz range so that it is within the operating range of the counters in synthesizer U802. Since the prescaler utilizes emitter-coupled logic (ECL), the logic swing is relatively small and the device may feel warm to the touch. U801 divides by 128 when the control signal from the synthesizer (pin 6) is high and by 129 when the control signal is low. The two sections of microstrip, C941, and C943 provide impedance matching and supply voltage isolation similar to components on the output of Q930. Resistors R801, R802, and R803 form an attenuator which provides the required input level to prescaler U801.

5.2.7 SYNTHESIZER INTEGRATED CIRCUIT (U802)

Introduction

A block diagram of synthesizer U801 is located in Figure 5-2. This integrated circuit contains the following circuits: reference (R), N, and A counters; phase and lock detectors; and counter programming circuitry. The basic operation of U802 is described in Section 5.2.1.

Channel Programming

Channels are selected by programming the R, N, and A counters in U802 to divide by a certain number. The programming of these counters is performed by microprocessor U11 on the audio/logic board. The counter programming numbers are loaded into EEPROM U10 when the transceiver is programmed. These counters are programmed as follows:

Data is loaded into U802 serially on the DATA input (pin 10). Data is clocked in a bit at a time by a low to high transition on the CLOCK input (pin 11). Data is first loaded into the 1-bit register (refer to Figure 5-2), and then into the 7-, 10-, and 14-bit registers. The last bit loaded is present in the 1-bit register and it determines which counters will be programmed. If this bit is a 1, the data is latched into all three counters when the latch ENABLE input (pin 11) goes high. If this bit is a 0, data is latched into only the A and N counters.

U802 Operation

As stated in Section 5.2.1, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input to the phase detector (fV) is the same frequency as the TCXO-derived input (fR).

The fR input is produced by dividing the 17.150 MHz TCXO frequency by 2744. This produces a reference frequency (fR) of 6.25 kHz. Since the VCO frequency is later doubled, this frequency allows channels to be incremented in 12.5 kHz steps which is the channel spacing. The reference frequency is 6.25 kHz for all channels selected by this transceiver. C807, L800, and C806 provide low-pass filtering of digital noise fed out of U802 on the OSC input (pin 1). This prevents frequencies near 45 MHz from being fed back to the receiver where they may cause interference.

The fV input is produced by dividing the VCO frequency using prescaler U801 and the N counter in U802. As stated in Section 5.2.4, the prescaler divides by 128 or 129. The divide number of the prescaler is controlled by the N and A counters in U802. The A and N counters function as follows:

Both the A and N counters begin counting down from the number that they were programmed with. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle is repeated. (The A counter is always programmed with a smaller number than the N counter.) While the A counter is counting down, the modulus control output to the prescaler (pin 12) is low and the prescaler divides by 129. Then when the A counter is halted, the modulus control output is high and the prescaler divides by 128.

To illustrate the operation of the prescaler, N, and A counters, the following example will be used. Assume a transmit frequency of 897.2500 MHz (Channel 100) is selected. Since the VCO frequency is half this frequency, it must be 448.625 MHz for this channel. To produce this frequency, the N and A counters are programmed as follows:

$$N = 560 \qquad A = 100$$

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 129 for 129 × 100 or 12,900 input pulses. It then divides by 128 for 128 × (560-100) or 58,880 input pulses. The overall divide number K is therefore 58,880 + 12,900 or 71,780. The VCO frequency of 448.625 MHz divided by 71,780 equals 6.25 kHz which is the fR input to the phase detector.

The overall divide number K can be determined by the following formula:

$$K = 128N + A$$

Where, N= N counter divide number, A= A counter divide number.

NOTE: Section 6.4.7 describes how the N and A counter divide numbers for other channels can be calculated.

5.2.8 LOCK DETECT (Q840)

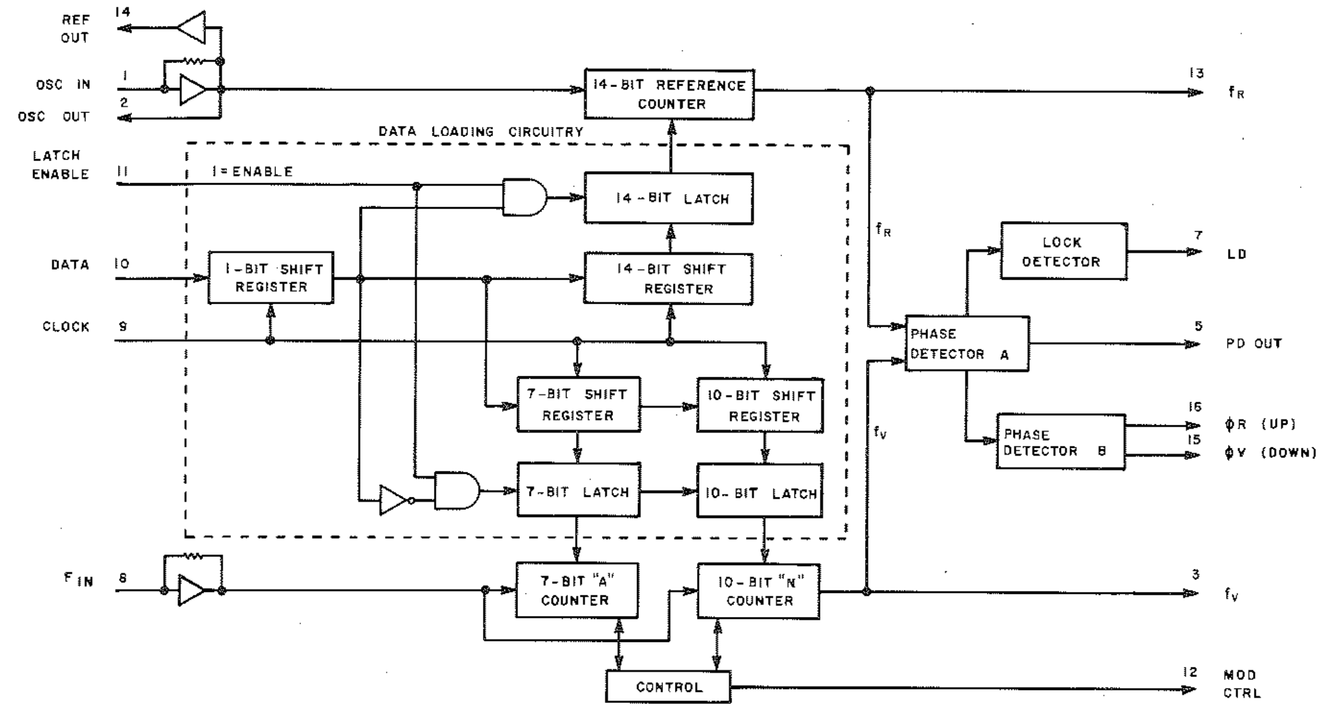
The lock detect circuit disables the VCO output signal to the transmitter and receiver when the synthesizer is not locked on frequency. This disables the transmitter and receiver to prevent the transmission or reception of an improper frequency.

When the synthesizer is locked on frequency, the lock detector output on pin 7 of U802 is basically a high voltage because only very narrow negative-going pulses are present. Then when the sythesizer is unlocked, the negative-going pulses become much wider.

When the synthesizer is locked, C840 and C841 charge more through R840 than they discharge through CR840 and R841 when the negative-going pulses occur. Darlington amplifier Q840 is then turned on which turns on Q842 and applies bias voltage to buffer Q930. When the synthesizer is unlocked, the negative-going pulses widen and the base voltage of Q840 drops below its turn-on point. Both Q840 and Q842 then turn off which interrupts the bias voltage to Q930 and disables the VCO output signal to the transmitter.

5.2.9 VOLTAGE MULTIPLIER (CR810A/B, CR811A/B)

The voltage multiplier circuit provides the 25-volt DC supply to the charge pump circuit. The output signal on pin 14 of U802 is the 17.150 MHz TCXO frequency at



U802 BLOCK DIAGRAM
FIGURE 5-2

a level of approximately 9 volts P-P. This signal is coupled by C810 to the cathode of CR810A. The anode of CR810A is connected to the 9-volt supply, so the signal at the cathode of CR810A is the 9-volt P-P signal riding on top of the 9-volt DC signal (minus the voltage drop across CR810A).

CR810B and C812 rectify this signal, so the voltage on the anode of CR811A is approximately 17 volts DC. C811, CR811A, CR811B, C813, and C814 form another voltage adder circuit similar to C810, CR810A, CR810B, and C812. Therefore, approximately another 8 volts is added which provides approximately 25 volts DC to Q822.

5.2.10 CHARGE PUMP (Q820, Q821, Q822, Q823), LOOP FILTER

The charge pump circuit charges and discharges C830, C831, and C714 in the loop filter to produce the VCO control signal. Pulses which control the charge pump are fed out of U802 on pins 15 and 16. When both inputs to the phase detector in U802 are in phase, the output signals on pins 15 and 16 are high except for a very short period when both pulse low in phase. If the frequency of the fR input to the phase detector is higher than that of the fV input (or if the phase of fR leads fV), the VCO frequency is too low. The negative-going pulses on the UP output (pin 16) then become much wider and the DOWN output (pin 15) stays essentially high. If the frequency of the fV input is greater than that of fR (VCO frequency too high), the opposite occurs.

Q820 and Q823 are level translators which make the 9-volt output levels of U802 compatible with the 25-volt supply to Q821 and Q822. Capacitors C820 and C821 momentarily bypass R820 and R821 when negative-going pulses occur. This speeds up the turn-off time of Q820 and Q821 by minimizing the effect of the base charge on these transistors.

When a negative-going pulse occurs on pin 16, Q820 turns on which turns on Q822. The loop filter capacitors then charge through Q822 and R826 which increases the VCO control voltage. When a negative-going pulse occurs on pin 15, Q821 turns on and the loop filter capacitors discharge through Q821 and R827.

The loop filter formed by C830/C831/C714 and R830/R831 provides low-pass filtering of the signal from the charge pump. This filtering controls synthesizer stability and lockup time and suppresses the reference frequency (6.25 kHz).

5.3 RECEIVER CIRCUIT DESCRIPTION

5.3.1 CERAMIC FILTER (Z200), RF AMPLIFIER (Q201)

The receive signal from the antenna is fed through the antenna switch circuit in the transmitter to bandpass filter Z200. This is a ceramic six-pole filter with a center frequency of 938 MHz. This filter attenuates the image and other unwanted frequencies and also prevents the injection signal from being fed back toward the antenna. The use of a ceramic dielectric allows the filter to be small in size and still provide a high Q.

Impedance matching between the filter and Q201 is provided by C201, C202, and a section of microstrip*. RF amplifier Q201 provides approximately 12 dB of gain to recover filter losses and increase the sensitivity of the receiver. Biasing is provided by R201, R202, R203, and R227. Capacitor C203 bypasses RF.

Switching transistor Q200 turns on in the transmit mode and grounds the supply voltage to Q201. This disables Q201 in the transmit mode so that noise is not amplified and fed back to the transmitter on the first injection line. R822, CR201, and C242 also prevent noise from being fed back to the transmitter. PIN diode CR201 is forward biased in the transmit mode to effectively ground C242 which is a bypass capacitor. Noise fed back to the transmitter is amplified and may cause spurious emissions.

The output of Q201 is matched to mixer Q202 by two sections of microstrip, C205, and C206. Resistor R204 is used to lower the Q of the microstrip to broaden the response of the tuning network. R204 also improves the stability of Q201.

* Microstrip is a form of transmission line with distributed series inductance and shunt capacitance. The characteristic impedance of the line is determined by width of the microstrip and the PC board material and thickness.

5.3.2 FIRST MIXER (Q202), CRYSTAL FILTER (Z201)

Q202 mixes the receive channel frequency with the first injection frequency to produce the 45 MHz first IF. Since low side injection is used, the injection frequency is below the receive frequency. Three sections of microstrip on the input of Q202 provide the proper impedance matching and input levels. R205 and R206 provide biasing, R207 and C208 provide bias isolation, and R208 and C210 provide supply voltage isolation. Q202 is matched to the crystal filter at 45 MHz by C209 and T200.

Z201 is a two-pole crystal filter with a center frequency of 45 MHz and a −3 dB passband of ±7.5 kHz. It attenuates wideband noise, adjacent channels, frequencies resulting from intermodulation, and other undesired frequencies close to the receive channel. Impedance matching between Z201 and second mixer Q203 is provided by C213, C214, and T201.

5.3.3 SECOND MIXER (Q203), DOUBLER (Q205), CRYSTAL FILTER (Z202)

Second mixer Q203 mixes the 45 MHz first IF with a 34.300 MHz signal from doubler Q205 to produce a second IF of 10.7 MHz. The gate of the N-channel JFET is biased negative with respect to the source by R209. The 45 MHz signal is applied to the gate and the injection signal is applied to the source. The output of Q203 is tuned to 10.7 MHz by a resonant circuit formed by the inductor and capacitor in T203. Resistor R210 provides impedance matching, and C219 and R211 isolate the 9-volt supply from RF.

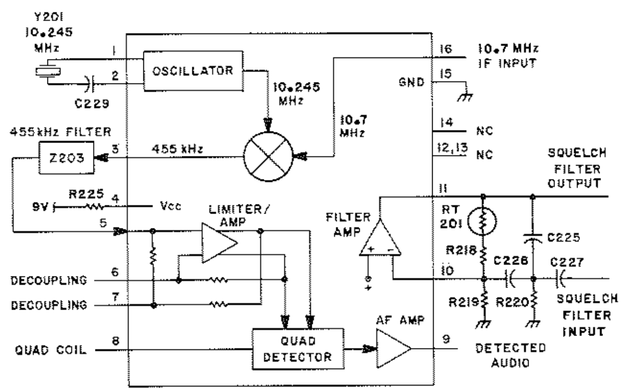
Q205 doubles the 17.150 MHz signal from TCXO Y800 in the synthesizer to produce the 34.300 MHz second injection signal. The output is tuned to twice the input frequency by C216, C217, and T202.

Z202 is a four-pole crystal filter with a center frequency of 10.7 MHz and a −3 dB passband of ± 3.75 kHz. This filter provides additional attenuation of the same frequencies attenuated by Z201. The filter sections are a matched pair and the dot on the case indicates which leads connect together. C240 is a matching capacitor. The filter is matched to IF amplifier Q204 by T204. Capacitor C221 provides DC blocking.

5.3.4 IF AMPLIFIER (Q204), MIXER/DETECTOR (U201)

Q204 amplifies the 10.7 MHz signal to provide the proper input level to the mixer in U201. Biasing is provided by R212-R215; RF bypass is provided by C222 and C223; and C224 provides DC blocking.

U201 contains third mixer and oscillator, limiter, detector, audio amplifier, and squelch filter stages (refer to block diagram in Figure 5-3). The 10.7 MHz second IF signal is mixed with the 10.245 MHz third injection signal produced by Y201 and an internal oscillator circuit.



U201 BLOCK DIAGRAM
FIGURE 5-3

The 455 kHz output of the internal double-balanced mixer is fed out of U201 on pin 3 and filtered by ceramic filter Z203. This filter attenuates wideband noise present in the 455 kHz signal. The 455 kHz signal is then applied to the limiter/amplifier stage in U201. The limiter amplifies the 455 kHz signal and then limits it to a specific level. This clips off noise present in the 455 kHz signal.

From the limiter the signal is fed to the quadrature detector. An external phase shift network connected to pin 8 shifts the phase of one of the detector inputs 90 degrees at 455 kHz (the other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted signal. The detector, which has no output with a 90 degree phase shift, converts this phase shift into an audio signal. T205 is tuned to provide maximum undistorted output from the detector. From the detector the audio signal is applied to an amplifier stage and then fed out of U201 on pin 9.

The audio signal on pin 9 includes audio and data frequencies and also high-frequency noise. This signal is fed to audio processing circuits on the audio/logic board and also to a squelch filter in U201. This is a high-pass filter formed by an operational amplifier in U201 and by the resistors and capacitors connected to pins 10 and 11. The cutoff frequency of this filter is approximately 10 kHz, so only noise frequencies are passed. The filter output is on pin 11 and is fed to the squelch circuit on the audio/logic board. The amount of noise in the detector output tends to increase as the receive signal strength decreases and vice versa.

5.4 TRANSMITTER CIRCUIT DESCRIPTION

5.4.1 DOUBLER (Q402)

Q402 doubles the VCO frequency to produce the first injection and transmit frequencies. Impedance matching on the input of Q402 is provided by R400, C400, C401, L401, and C402. Biasing is provided by R401, R402, R404, and R405. Capacitors C404, C405, C406, and C407 bypass RF from the DC supply, and L402 is an RF choke. R403 and C408 provide negative feedback for stabilization. The output of Q402 is tuned to twice the input frequency by a high-pass filter consisting of C410, C411, L403, C412, L404, C413, and C416. Capacitors C413 and C416 also provide impedance matching with amplifier Q403.

5.4.2 AMPLIFIER (Q403), DRIVER (Q404)

Amplifier Q403 provides about 10 dB of gain. R412 and C422 across the collector and base provide negative feedback for stabilization. L405, C421, a section of microstrip*, C423, and C424 provide matching with driver Q404.

* Microstrip is a form of transmission line with distributed series inductance and shunt capacitance. The characteristic impedance of the line is determined by width of the microstrip and the PC board material and thickness.

Driver Q404 also provides about 10 dB of gain. L406 and R415 on the input provide self-biasing for class C operation. R416 and C425 provide negative feedback for stabilization. The output is matched to power module U501 by L408, C429, C431, and two sections of microstrip. Coupling capacitor C430 provides DC blocking. Supply voltage to Q404 is controlled by the power control circuit. L407, R417, R418, C426, and C432 isolate the supply from RF. R417 and R418 also provide current limiting if a short circuit occurs in Q404.

5.4.3 POWER MODULE (U501)

Power module U501 contains three amplifier stages which together produce approximately 20 dB of gain. Each stage has a separate supply voltage input. Supply voltage to the first stage is from the power control circuit and supply voltage to the other two stages is fed through R601 from the unswitched 13.6 volt supply. By increasing or decreasing the supply voltage to Q404 and the first stage in U501, drive to the following stages is controlled which controls the power output of the transceiver. Typical power input to U501 is 125 milliwatts and typical power output is 17 watts. The supply voltage to the three stages in U501 is isolated from RF by several capacitors.

The output signal on pin 5 of U501 is fed to a low-pass filter consisting of several sections of microstrip and capacitors C507 and C510. This filter attenuates harmonic frequencies occurring above the transmit band.

5.4.4 ANTENNA SWITCH (CR501)

The antenna switching circuit consists of PIN diode CR501 and several other components. A PIN diode has very low impedance when it is forward biased and very high impedance (low capacitance) when it is reverse biased. In the transmit mode, 9 volts is applied to current limiting resistors R501-R504 (several are used to provide the necessary heat dissipation). Current then flows through L501, CR501, and L503. Since CR501 is forward biased, it presents a low impedance to the transmit signal. C518 provides matching and DC blocking, and R505 dissipates static buildup on the antenna.

The signal is blocked from the receiver by a quarter-wave line formed by a section of microstrip. This quarter-wave line is effectively grounded at the receiver end at the transmit frequency by filter Z200. When one end of a quarter-wave line is grounded, the other end presents a high-impedance to the quarter-wave frequency (in this case, the transmit signal).

In the receive mode, the 9-volt supply switches to 0 volts, so CR501 is reverse biased. It then presents a high impedance into the transmitter for the receive frequency. L502 across CR501 tunes out the slight capacitance of CR501 in the receive mode to improve its signal blocking capability. C511 provides DC blocking so that current does not flow through L502 in the transmit mode. The quarter-wave line is also no longer effectively grounded at the receiver end because Z200 presents a high impedance to the receive frequency. Therefore, the quarter-wave line provides a low-impedance path to the receiver for the receive signal. The 9-volt supply is isolated from RF by C512-C516, L501, and R501-R504.

5.4.5 POWER CONTROL (U601A/B, Q601, Q602)

The power control circuit maintains constant power output by monitoring current flow to the last two stages in power module U501. Since power output is generally proportional to transmitter current, constant power output can be maintained by keeping current flow to these stages constant. Current to U501 is sensed by the voltage drop across R601. Amplifier U601A amplifies the difference between the voltage from R601 on pin 2 and the reference voltage on pin 3. The gain is set at approximately 17 by the ratio of R604 to R607.

U601B amplifies the difference between the DC input on pin 6 and the reference voltage on pin 5. The gain is set at about 8 by R612 and R614. AC feedback provided by R613 and C606 prevents oscillation of the power control circuit.

A Darlington amplifier formed by Q601 and Q602 controls the DC voltage applied to driver Q404 and the first two stages in power module U501. As the base voltage of Q601 increases, the collector voltage of Q602 increases and vice versa. The negative feedback provided by R617 limits the collector voltage of Q602 to approximately 10 volts. This prevents possible damage to U501 caused by too much drive.

The reference voltage on pin 5 of U601B determines the power output of the transceiver. This voltage is controlled by R610 and power adjust potentiometer R611. Capacitors C604, C605, and C607 provide filtering of the reference voltage.

5.5 POWER SWITCHING AND REGULATION, AUDIO AMPLIFIER

5.5.1 POWER SWITCHING (Q303, Q304)

Power to most sections of the transceiver is switched by Q303 and Q304. Exceptions are the power control and power amplifying sections of the transmitter. Q303 and Q304 are P-channel MOSFETs connected in parallel to provide the required current capability. When on-off switch S301 is turned on, the gates of these transistors are grounded and they turn on. Conversely, when S301 is off, the transistors are turned off by 13.6 volts applied through R302. Capacitors C300 and C301 provide filtering of the 13.6 volt supply. CR302 suppresses transients and also provides reverse polarity protection by forward biasing and opening the power cable fuse.

5.5.2 Nine Volt Regulator (Q301, U300)

The 9-volt regulator is formed by Q301 and operational amplifier U300. Q301 is in a series-pass configuration and is controlled by U300 which functions as a comparator. When power is turned on, a 5-volt reference is applied to pin 6 of U300 from 5-volt regulator U302. Since the voltage on pin 5 is less than 5 volts, the output on pin 7 goes low and Q301 is turned on. The output voltage on the collector of Q301 then rises to 9 volts and is maintained at that level by U300. Capacitors C307 and C303 provide filtering of the 9-volt supply.

5.5.3 AUDIO AMPLIFIER (U301)

Audio amplifier U301 provides up to 5 watts of power to drive the internal or external speaker. The gain of this amplifier is controlled by R310 and R311 which determine the amount of feedback coupled by C310 to pin 2. Potentiometer R312 sets the volume level and C311 provides DC blocking. R309 and C309 stabilize the amplifier and prevent self-oscillation.

5.6 AUDIO/LOGIC BOARD CIRCUIT DESCRIPTION

NOTE: A block diagram of the audio/logic board is located in Figure 5-4.

5.6.1 MICROPROCESSOR (U11)

Introduction

The digital control logic is based on an 8052 eight-bit microprocessor. The 8052 contains an 8K x 8 ROM, 128 x 8 RAM, 32 input/output lines, and a serial port. The following information describes the functions performed by the various sections of the microprocessor.

Memory

The ROM (read-only memory) in U11 is part of the microprocessor chip and is mask-programmed when the device is manufactured. This memory contains the operating program of the transceiver. Information which changes from transceiver to transceiver, such as channels and operating features, is programmed into EEPROM U10 (refer to Section 5.6.2).

Timing

The operating speed of the microprocessor is established by 11.059 MHz crystal Y1. XTAL 1 is the input of an internal oscillator and XTAL 2 is an output which provides feedback to maintain oscillation. The 11.059 MHz crystal frequency is divided down by internal counters to provide a machine cycle time of 1.08 microseconds. Most instructions are executed in one machine cycle and none require more than four machine cycles.

Reset (RST)

The microprocessor is initialized when transceiver power is turned on and when the 5-volt supply voltage drops below a certain level. Initialization clears several registers in the microprocessor and starts the program over from the beginning. It is performed by holding the RST (reset) input high with power applied to the microprocessor. Initialization ensures proper microprocessor operation after it may begin operating improperly such as during low-voltage conditions.

Reset is controlled by integrated circuit U12 which operates as follows: When power is turned on, the RESET output on pin 6 is initially high while the 5-volt supply stabilizes. Once the 5-volt supply stabilizes, the RESET output is held high for a period equal to several microprocessor machine cycles to ensure that reset occurs. This time delay is set by the capacitor connected to pin 3. If the 5-volt supply drops below a nominal level, the RESET output goes high and interrupts microprocessor operation until the 5-volt supply returns to normal. C10 prevents reset if fast transients should appear in the 5-volt supply.

Data Input/Output Ports

The internal eight-bit data bus of the microprocessor has four input/output ports. These ports have eight lines each, giving a total of 32 input/output lines. These four ports are designated P0, P1, P2, and P3. Port 0 is used as the data and address bus, Ports 1 and 2 are used for general purpose inputs and outputs, and Port 3 is used for specialized functions such as RxD and TxD. The following is a brief description of the functions performed by these inputs and outputs.

DB0-DB3 (P0.0-P0.3) - These lines connect to the display driver and supply the four-digit BCD code of the system number to be displayed. Refer to Section 5.6.3 for more information.

DB4-DB7 (P0.4-P0.7) - Not used.

P1.0-P1.1 - The lines are used to read and program EEPROM U10 (refer to Section 5.6.2).

P1.2 - This output controls the decimal point in the System display. When scanning is occurring, this output goes low and turns on Q6 which lights the decimal point.

P1.3 - This output is low in the transmit mode and high in the receive mode. It controls U6B, U6D, and the PTT circuit.

P1.4 - This output provides logic control of squelch. A high output squelches the receiver regardless of the signal from the noise squelch circuit. A low output permits full squelch control by the noise squelch circuit.

This allows the microprocessor to keep the receiver squelched even though a carrier is present (such as when a call on the channel is intended for someone else).

P1.5 - This pin is used both as an input and output. It is used as an input when power is turned on to detect if a jumper has been installed across the "Test" pads. If this input is low on power up, the microprocessor enters the test mode (refer to Section 3.11). If this input is a high impedance state on power up, it enters the normal operating mode.

At other times, the P1.5 output controls horn switch Q7/Q8. A low output causes the horn or some other external alert connected to P2, pin 14 to sound. When the LTR Data Interface Modem is used, a diode connects this line to P2, pin 6 so that the microprocessor can detect when the modem instead of the PTT switch is keying the transmitter.

P1.6, P1.7 - These are the output pins for the transmitted LTR data or Call Guard signals. R89 and R90 along with R24 and R25 are used to provide pulse shaping to obtain the desired response in the low-pass filter. Four different voltage levels can be produced by the two bits of information provided by these outputs.

When modulation balance is set with the test mode selected (see Section 7.4.2), the "Tune" jumpers are connected. The test signal on P1.7 is then connected to U4C, pin 13 and used to set modulation balance.

P2.0 - This output turns Q2 on and off to control the cutoff frequency of the low-pass filter. Refer to Section 5.6.6 for more information.

P2.1, P2.2 - These outputs control the tone oscillator circuit. The four possible logic combinations select the busy, intercept, beep, or disable modes as shown on the table on the schematic diagram. Refer to Section 5.6.10 for more information.

P2.3 - This input is used to sense if the microphone is on- or off-hook. This information is used by the microprocessor to control such things as scanning and monitoring before transmitting in the conventional mode when Call Guard squelch is programmed.

P2.4 - This output is used to control the Call indicator. The Call indicator is lighted when this output is high.

P2.5, P2.6, P2.7 - These outputs provide the DATA, CLOCK, and ENABLE signals when data is written to synthesizer integrated circuit U802. Refer to Section 5.2 for more information.

RxD, TxD (P3.0, P3.1) - RxD is the serial data input and TxD is the serial data output used when programming the transceiver. An external computer is connected to the microphone/programming jack to program the transceiver. Refer to Section 4 for programming information. These pins also provide serial data communication with the Remote Control Unit when it is used.

INT 0 (P3.2) - A low on this input indicates that the microphone PTT switch is pressed. When this input goes low, the microprocessor interrupts normal program execution and vectors to a section of the program containing transmit mode operating instructions.

INT 1 (P3.3) - This input goes low when the System Step switch is pressed.

T0 (P3.4) - This is the input for the receive data or Call Guard signal.

T1 (P3.5) - A logic 1 on this input indicates that a carrier is present. If an LTR system is selected, the microprocessor then begins looking for LTR data. Likewise, if a conventional system is programmed with Call Guard squelch programmed, it starts looking for Call Guard tones or data. Information on the T0 input is ignored while no carrier is being detected. The T1 input has a rapid rise and fall time to immediately tell the microprocessor when a carrier is present.

WR (P3.6), RD (P3.7) - Not used.

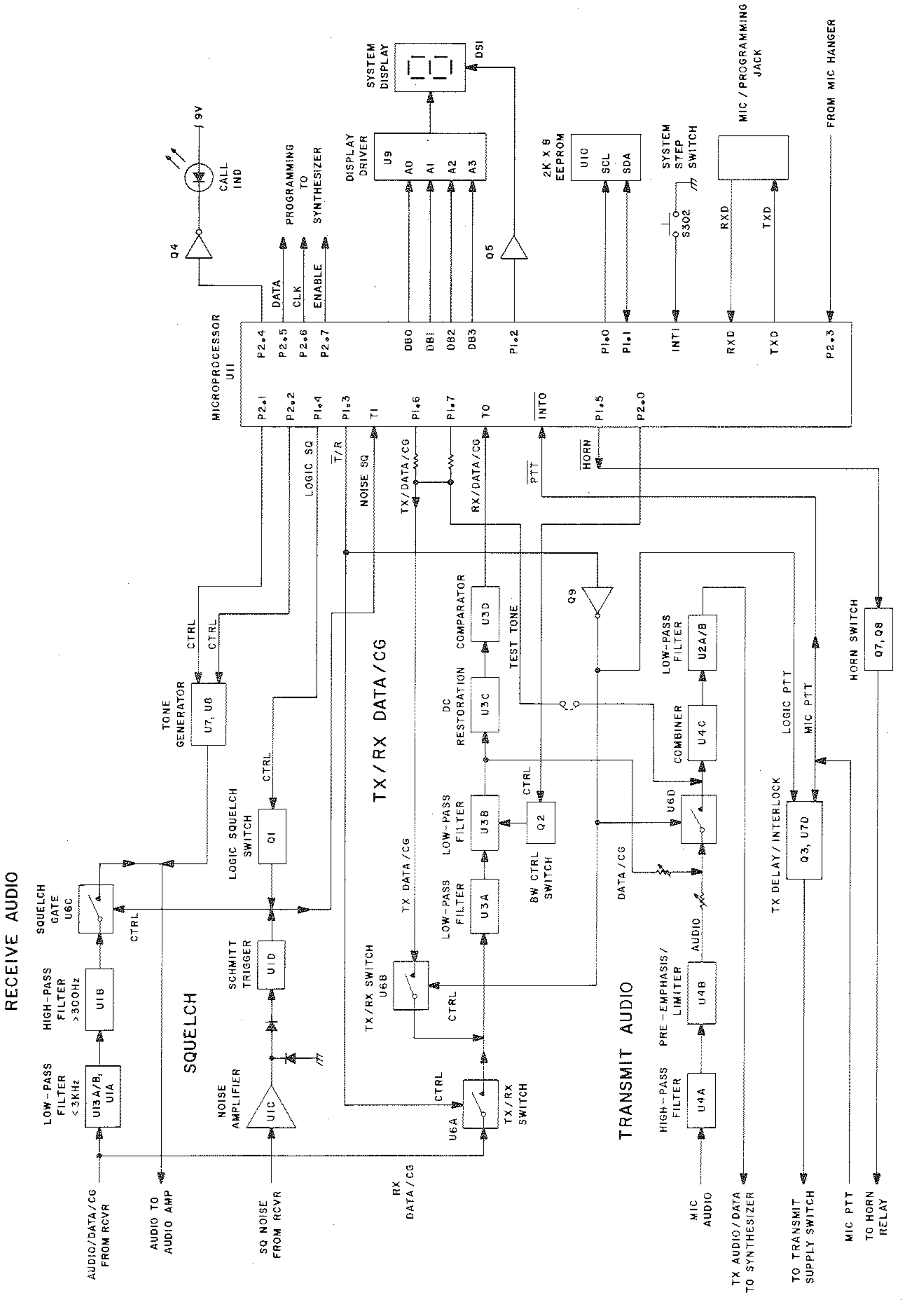
5.6.2 EEPROM (U10)

U10 is an Electrically Eraseable Programmable Memory (EEPROM). This type of device can be reprogrammed over and over again by the microprocessor. Since it is also a nonvolatile memory, battery backup is not required to maintain the data contents when transceiver power is off. This device can store 2048 8-bit words (16,384 bits). This memory is arranged as eight pages, each containing 256 8-bit words.

When a read or write operation is performed, the eight-bit control word shown below is transmitter by the microprocessor.

1 0 1 0 A2 A1 A0 R/W

The four most significant bits of this word are always "1010" and the next three bits are the page address bits. The last bit (R/W) is "1" for a read operation and "0" for a write operation.



AUDIO/LOGIC BOARD BLOCK DIAGRAM
FIGURE 5-4

Following this word is an eight-bit address word which contains the location on the page that data is to be read from or written to. The next eight-bit word is from the microprocessor or the EEPROM and is the actual data being transferred. Data is transferred in and out of U10 on the SDA (serial data) pin when a clock pulse generated by the microprocessor appears on the SCL (serial clock) pin.

In addition to the control, address, and data words, there is a start bit that precedes and a stop bit that follows every read or write operation. Also, after every eight-bit word, the device receiving the data responds with an acknowledge bit.

5.6.3 DISPLAY DRIVER (U9)

U9 is a BCD to seven-segment decoder/driver. It converts the BCD code from the microprocessor into the outputs needed to light the proper segments in System display DS1. Resistors R94-R100 provide current limiting. The common cathode of the display (pin 6) is grounded, and the decimal point input (pin 7) is controlled by the P1.2 output of the microprocessor.

5.6.4 RECEIVE AUDIO PROCESSING (U13A/B, U1A, U1B, U2)

The detected audio/data signal from U201 in the receiver is applied to a signal enhancer stage formed by U13A, U13B, and several other components. This stage attenuates rapidly changing signal above 3 kHz such as noise. R114 and C53 form a low-pass filter, and CR6/CR7 provide feedback of rapidly changing signals. The output of buffer U13B is applied to a bandpass filter formed by C1, R1, R2, U1A, U1B, and several other resistors and capacitors. The filter passes frequencies from about 300-3000 Hz and also provides de-emphasis of the audio signal. It attenuates low frequency data, the Call Guard tone, and high frequency harmonics.

From the filter the signal is fed to squelch gate U6C. When the control input (pin 13) of this gate is high, the gate passes the audio signal. Conversely, when the control input is low, the signal is blocked. This gate is controlled by the noise squelch circuit and by the microprocessor through Q1. The audio signal is passed only if a carrier is detected by the squelch circuit and Q1 is not turned on by the P1.4 output of the microprocessor.

On the output of U6C, capacitor C7 provides DC blocking, and R9 and R23 set the relative levels of the audio and tone generator signals. C8 attenuates high frequency harmonics produced by the tone generator. The audio signal is then fed to the volume adjust potentiometer and audio power amplifier shown on the interconnect schematic (refer to Section 5.5.3).

5.6.5 SQUELCH CIRCUIT (U1C, U1D, Q1)

The squelch circuit is controlled by the amount of noise present in the detector output. When no carrier or a weak carrier is received, there is a large amount of noise present; conversely, when a strong carrier is received, there is very little noise present. This is partially due to the action of the limiter in U201 in the receiver which tends to clip off the noise riding on a strong IF signal.

A high-pass filter formed using an operational amplifier in U201 in the receiver attenuates low-frequency data, Call Guard signaling, and audio frequencies so that only high frequency noise above approximately 10 kHz is passed. This noise is applied to amplifier U1C. The gain of this stage is determined by the ratio of the impedance of C11 and R12 to R13. Capacitor C11 causes noise frequencies to be amplified more than any audio frequencies which may be present. Potentiometer R13 controls the threshold level of the squelch circuit.

The amplified noise is then rectified by CR1 and CR2. Capacitor C13 charges through CR2 and C12 and discharges through R14. Diode CR1 provides a discharge path for C12. When the DC level on pin 9 of Schmitt trigger U1D rises above the reference on pin 10, the output on pin 8 goes low. R16 and R17 provide hysteresis to the triggering level by changing the reference on pin 10 when the output changes. This prevents squelching and unsquelching when receiving a weak or fading signal.

The output signal on pin 8 is applied across a voltage divider and an RC network. The voltage divider formed by R19 and R20 provides a 5-volt logic 1 input level to the microprocessor from a 9-volt output on pin 8. This signal has a fast attack and release time to quickly tell the microprocessor whether or not a carrier is present. The output of U1D also charges and discharges C14 through R18. The time constant of this network provides an attack and release time of about 100 milliseconds to prevent intermittent squelching when receiving a weak signal.

Logic squelch switch Q1 allows the microprocessor to control receiver unsquelching when a carrier is present. This allows the microprocessor to keep the receiver squelched, for example, if an LTR message with the wrong ID code or a dispatch call with the wrong Call Guard tone or code is received. However, the microprocessor cannot unsquelch the receiver if a carrier is not present.

5.6.6 DATA/CALL GUARD SIGNAL PROCESSING (U3A-U3D)

Introduction

The data/Call Guard filter formed by U3A and U3B is used to filter both receive and transmit data/Call Guard signals. LTR signaling is present when an LTR system is selected, and Call Guard signaling is present if a conventional system programmed for Call Guard squelch is selected. Routing of these signals through this filter is controlled by gates U6A and U6B. In the receive mode, the P1.3 output of the microprocessor is high. Gate U6A then passes the receive audio signal to the filter and gate U6B blocks the transmit signal if one is present. In the transmit mode, the P1.3 output of the microprocessor is low, so the opposite occurs.

Low-Pass Filter (U3A, U3B)

The low-pass filter consists of U3A, U3B, and several capacitors and resistors. This filter attenuates high-frequency voice and harmonic frequencies. The passband of the filter is controlled by Q2. When the P2.0 output of the microprocessor is high, Q2 is turned on and additional capacitance is switched into the filter. This additional capacitance lowers the cutoff frequency of the filter to approximately 150 Hz. When Q2 is switched off, the cutoff frequency of the filter is approximately 190 Hz. The 150 Hz cutoff is used for LTR and digital Call Guard signaling, and the 190 Hz cutoff is used for tone Call Guard signaling.

DC Restoration (U3C, U3D)

In the transmit mode the output signal from the filter is applied to the transmit audio circuit through potentiometer R36. In the receive mode it is applied to the DC restoration circuit consisting of U3C and U3D. The purpose of the DC restoration circuit is to convert the AC signal to digital levels that can be applied to the microprocessor.

U3C is a standard noninverting amplifier with a gain of approximately 3.7 determined by R37 and R38 (R38 is AC grounded by C21). Diodes CR3 and CR4 charge and discharge C21 to establish a DC reference on pin 13 of U3C and pin 2 of U3D. This reference is the average of the positive and negative alternations of the data signal.

The amplified data signal is applied to pin 3 of U3D. When this level rises above the reference level on pin 2, the output on pin 1 goes high (9 volts). Conversely, when the data signal decreases below the reference level, the output goes low (near 0 volts). R40 and R41 produce the 5-volt logic 1 input level required by the microprocessor.

5.6.7 TRANSMIT AUDIO PROCESSING (U4A-U4D)

High-Pass Filter (U4A)

The microphone audio signal is applied to a high-pass filter formed by U4A and several resistors and capacitors. This filter has −3 dB cutoff frequency of approximately 300 Hz to attenuate frequencies which could cause interference with data or Call Guard signals. R43 and R44 provide power to the microphone. Those components, along with C22, filter the microphone supply and isolate the 9-volt supply from microphone audio.

Limiter (U4B)

C26 and R47 on the input of limiter U4B provide pre-emphasis of the audio signal. U4B is an amplifier which limits by saturating. The function of this stage is to prevent overmodulation caused by high input levels from the microphone. Potentiometer R50 is used to set the maximum deviation level. Gate U6D blocks the microphone audio signal in the receive mode to prevent modulation of the first injection frequency. C27 and C48 provide DC blocking.

Combiner/Low-Pass Filter (U4C, U4D)

U4C combines the input signals and also provides some low-pass filtering. The output signal from U4C is the sum of the microphone and data/Call Guard signals. The levels of these signals are set by potentiometers R50 and R36.

U2A and U2B form a low-pass splatter filter which attenuates frequencies over 3 kHz generated by amplitude limiting. This prevents adjacent channel interference which is especially important at 900 MHz because of the narrow channel spacing (12.5 kHz), and because adjacent channels are assigned.

5.6.8 PTT DELAY AND INTERLOCK (Q3, U7D)

Introduction

The circuit consisting of Q3, U7D, and several other components provides several functions. It ensures that the transmitter cannot be keyed unless the microphone PTT (push-to-talk) switch is pressed and the logic keying signal is present. This prevents the transmitter from being accidentally keyed by a logic failure. It also allows the microprocessor to disable the transmitter when the LTR data handshake is being made or when the time-out timer time is exceeded. Another function of this circuit is to provide a short delay in the unkeying of the transmitter when the microphone PTT switch is released. This permits LTR and Call Guard turn-off codes to be sent.

PTT Delay/Interlock

When the microphone PTT switch is pressed, the cathode of CR5 is effectively grounded and a logic 0 is applied to the INT 0 input of the microprocessor. This input tells the microprocessor to execute the transmitter keying portion of the program.

When the cathode of CR5 is grounded, C31 is charged and a logic 0 is applied to pin 1 of exclusive OR gate U7D. The output on pin 3 then goes high and Q3 is turned on if the input to buffer U5B is high. U5B is an open collector buffer controlled by the logic keying signal on the P1.3 output of the microprocessor. The P1.3 output is inverted by Q9 and applied to U5B. If the input to U5B is low, the output is near 0 volts; conversely, if the input is high, the output is in a high impedance state. Therefore, Q3 is not turned on unless the microphone PTT switch is pressed and the P1.3 output is low. When Q3 turns on, transmit switch Q302 on the main board is turned on and the transmitter is keyed.

When the microphone PTT switch is released, the cathode of CR5 goes to 5 volts which reverse-biases the diode. C31 then begins discharging through R61, and pin 1 of U7D remains low for approximately 1 second after the PTT switch is released. This delays transmitter turn-off for that length of time. However, the transmitter does not actually remain keyed for that long because it is disabled by the logic keying signal as soon as the turn-off code is transmitted.

5.6.9 HORN SWITCH (Q7, Q8)

NOTE: Driver Q7 is included in the Horn/Ignition Sense Cable Kit (see Section 1.5).

The horn switch formed by Q7 and Q8 controls a dealer-supplied horn relay when the external horn alert feature is used. Normally, the P1.5 output of the microprocessor is high and Q8 is turned on. This places the gate of MOSFET Q7 near 0 volts which turns the transistor off. When the horn alert is enabled, P1.5 is low which turns Q8 off. Nine volts is then applied to the gate of Q7 through R77 and the transistor is turned on. The maximum current which can be sinked by Q7 is 800 milliamperes.

The line from R102 and CR8 can be connected to an ignition sense line that provides a 13.6 volt supply when the vehicle is operating. This automatically disables the horn alert and eliminates the need to manually turn it off when operating the vehicle. Refer to Section 3.7 for more informatiou on the horn alert feature.

5.6.10 TONE GENERATOR (U7A-U7C, U8A-U8D)

General

The tone generator circuit produces the busy, intercept, and beep tones heard at various times during transceiver operation. A description of these tones follows and a more detailed description is located in Section 3.8.8.

The busy tone may be heard in the LTR mode when a call attempt is made. It may indicate that all repeaters are busy. The busy tone consists of combined 700 and 900 Hz tones switched on and off at a 2 Hz rate.

The intercept tone may also be heard in the LTR mode when a call attempt is made. It indicates error conditions such as when the data handshake cannot be completed because the mobile is out of range of the repeater. The intercept tone consists of 700 and 900 Hz tones alternating at a 2 Hz rate.

The low (700 Hz) tone is pulsed at different rates to indicate various functions. "Ringing" is indicated by pulsing this tone on for 30 milliseconds and off for 20 milliseconds each second.

Tone Oscillator Operation

The tone generator circuit consists of three separate oscillators. They are 700 Hz low tone oscillator U7A/U7B, 900 Hz high tone oscillator U8A/U8B, and 2 Hz tone switching oscillator U8C/U8D. The tone generator is controlled by the P2.1 and P2.2 outputs of the microprocessor. The specific tones produced by the four possible logic combinations of these outputs are listed in the table on the schematic diagram. Since all three of these oscillators operate in a similar manner, the following description of the tone switching oscillator also applies to the high and low tone oscillators.

The tone switching oscillator consists of U8C, U8D, C39, R87, and R88. It is enabled whenever the P2.2 output of the microprocessor is low. When U8D, pin 13 goes low, the output on pin 11 goes high. The output of inverter U8C then goes low and C39 begins charging through R87. When the junction of C39 and R87 reaches the threshold of a logic high, pin 12 is high and the output on pin 11 goes low. The output of U8C then goes high and C39 charges in the opposite direction. When pin 12 of U8D reaches the threshold of a logic 0, the output again goes high and the cycle repeats. The values of C39 and R87 are chosen to produce oscillation at a 2 Hz rate.

NOTE: The low tone oscillator is enabled when U7B, pin 9 is high and the high tone oscillator is enabled when U8B, pin 2 is low.

Busy Tone Generation

To produce a busy tone, P2.1 is high and P2.2 is low. The low signal on P2.2 enables the tone switching oscillator. When the output of the tone switching oscillator on pin 10 of U8C goes low, high tone oscillator U8A/U8B is enabled and the output of U7C goes high which enables low tone oscillator U7A/U7B. When the output of U8C goes high, both the high and low tone oscillators are disabled.

Intercept Tone Generation

To produce the intercept tone, both P2.1 and P2.2 are low. The low signal on P2.2 enables the tone switching oscillator. When the output of the tone switching oscillator on pin 10 of U8C goes low, the high tone oscillator is enabled and the output of U7C goes low which disables the low tone oscillator. When the output of U8C goes high, the opposite occurs.

Low Tone Generation

To produce the low (beep) tone, P2.1 is low and P2.2 is high. The high signal on P2.2 disables the low tone oscillator which also disables the high tone oscillator. The output of U7C is high which enables the low tone oscillator.

R81, R82, C36, R23, C49, and C8 form a pulse shaping network which attenuates harmonics present in the square-wave output of the generator.

SECTION 6
SERVICING

6.1 GENERAL

6.1.1 PERIODIC CHECKS

The transceiver should be put on a regular maintenance schedule. Important checks are receiver sensitivity and transmitter frequency, deviation, and power output. Performance tests are described in Sections 7.6 and 7.7. It is recommended that the transceiver be checked annually even though periodic checks are not specifically required by the FCC.

6.1.2 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts for the PC boards used in these transceivers are located in the back of this manual. The main board schematic is divided into synthesizer, receiver, and transmitter sections. An interconnect schematic shows the interconnections between these sections and the audio/logic board. Regulator and power switching circuitry is also located on the interconnect schematic.

Component layouts are located with the schematics in the back of this manual. These layouts permit easy location of components and measurement points. A component locator guide and a grid around the PC board are also provided to aid in component location.

6.1.3 REPLACEMENT PARTS

A replacement parts list containing the Johnson part numbers of all the parts used in these transceivers is located in Section 8. Parts are listed alphanumerically according to designator. For more information on ordering parts, refer to Section 1.9.

6.1.4 TEST MODE

This transceiver has a test mode which can be selected to perform transceiver testing. The test mode is described in Section 3.11 and permits the transceiver to be operated like a standard dispatch transceiver. The test mode is especially useful with an LTR transceiver because the logic normally inhibits operation if a data handshake is not completed.

6.2 SURFACE-MOUNTED COMPONENTS

Surface-mounted components are used extensively on the main and audio/logic boards in this transceiver. Because of their small size, special care should be used when replacing surface-mounted components to prevent damage to either the component or PC board. Surface-mounted components should not be reused because they may be damaged by the unsoldering process. The Surface-Mounted Device Handbook, Part No. 001-0576-001, provides detailed information on the various methods that can be used to replace these components.

6.3 INTEGRATED CIRCUIT SERVICING

6.3.1 CMOS HANDLING TECHNIQUES

Some of the integrated circuits used in this transceiver are CMOS devices. CMOS integrated circuits can be identified by a part number of 544-3xxx-xxx. Since these devices have very high open circuit impedance, they are particularly susceptible to damage from static discharges. Damaging static charges may be present even if static arcs are not observed. When handling these devices, observe the following precautions:

a. Before touching the equipment or a CMOS device, discharge any built-up static charge on your body by touching a good earth ground.

b. Ground all test equipment and make sure the soldering iron tip is grounded. Connect ground leads before connecting test probes.

c. Leave the CMOS device in its conductive shipping container until it is inserted into the PC board.

Once the device is installed in the PC board, it is protected by internal diode protection circuits, so the chance of static damage is reduced. A service bench protection kit, Part No. 299-0026-001, can be ordered from the Service Parts Department. This kit eliminates static build-up on the body and includes a conductive mat, wrist strap, and a grounding strap with a 1 megohm resistor.

TABLE 6-1 APPROXIMATE LOGIC LEVELS				
	Input Level		Output Level	
Device	Logic Low (max)	Logic High (min)	Logic Low (max)	Logic High (min)
CMOS				
5V supply	1.5V	3.5V	0.05V	4.95V
10V supply	3.0V	7.0V	0.05V	9.95V
ECL	3.5V	3.9V	3.4V	4.0V

6.3.2 SERVICING TECHNIQUES

A good starting point when servicing integrated circuits is to measure steady state DC voltages. Operational amplifiers which function as buffers or amplifiers usually have a voltage level on the inputs that is half the supply voltage. Others which function as comparators may have an output voltage which is near the supply voltage or 0 volts, depending on which input is higher.

Troubleshooting operating digital circuits such as the microprocessor usually requires a storage oscilloscope or data analyzer to check the various input and output signals. Even then troubleshooting may be difficult because of the dynamic operation of these devices.

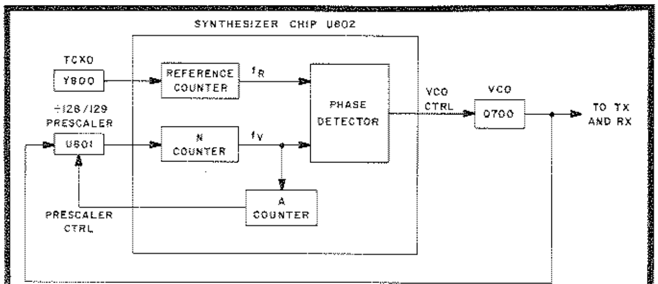
Table 6-1 shows approximate logic levels for CMOS and ECL integrated circuits. ECL devices (U801 in the synthesizer) run warm and have a relatively small logic swing.

6.4 SYNTHESIZER SERVICING

6.4.1 INTRODUCTION

When there is a synthesizer malfunction, the VCO is usually not locked on frequency. When an unlocked VCO is detected by the lock detector circuit, the collector of Q840 switches from approximately 0 volts to approximately 9 volts. Buffer switch Q842 then turns off which interrupts bias voltage to buffer Q930. This blocks the synthesizer output signal and disables the transmitter and receiver.

When the VCO is unlocked, the fR and fV inputs to the phase detector are usually not in phase (refer to Figures 6-1 and 6-2). The phase detector in U802 then causes the VCO control voltage to go to the high or low end of its operating range. This in turn causes the VCO to oscillate at the high or low end of its frequency range.



SIMPLIFIED SYNTHESIZER BLOCK DIAGRAM
FIGURE 6-1

As shown in Figure 6-1, a loop is formed by VCO Q910, prescaler U801, and the N counter and phase detector in U802. Therefore, if any of these components begin operating improperly, improper signals appear throughout the loop. However, correct operation of counters can still be verified by measuring the input and output frequencies to check the divide number.

To localize a synthesizer problem to a specific section, refer to the synthesizer troubleshooting flowchart in Figure 6-3 and also to the information which follows.

6.4.2 PRELIMINARY CHECKS

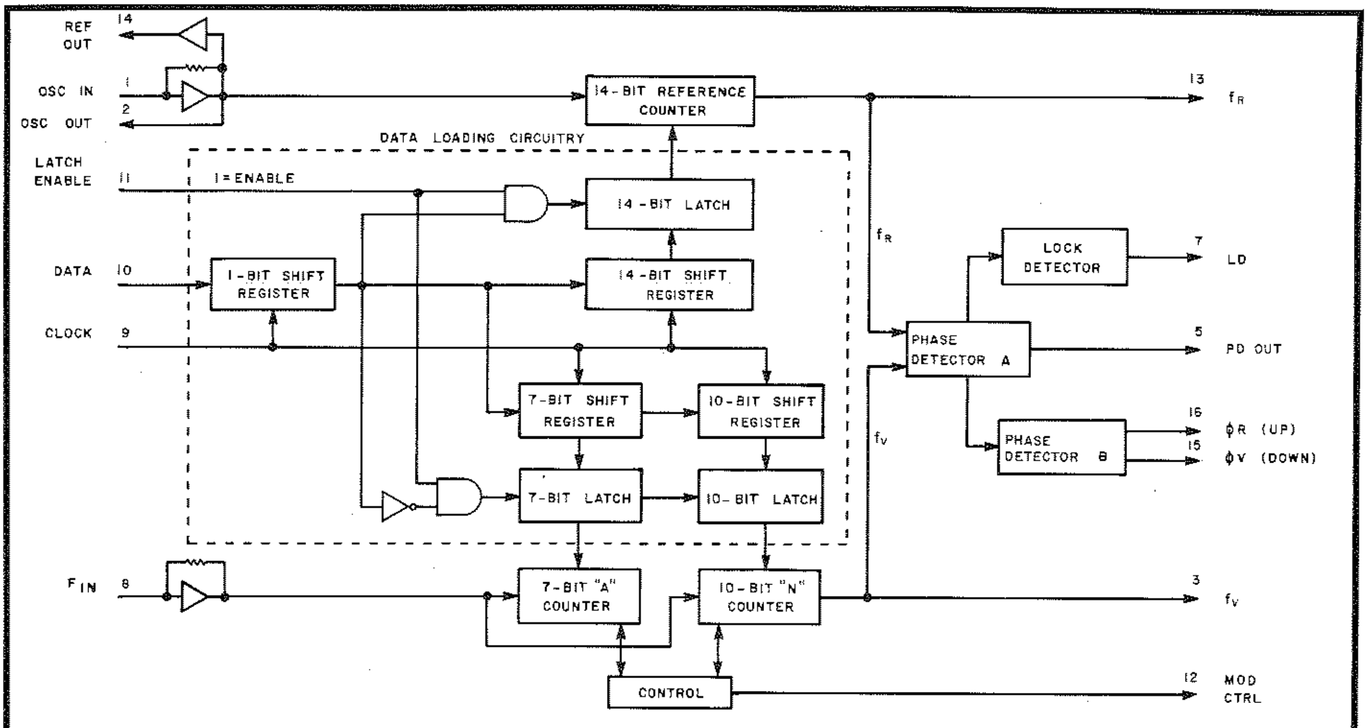
DC Supply Voltages

5-volt supply- U801, pin 2
9-volt supply- U802, pin 4
25-volt supply- C814 (+)

If the 25-volt supply is low, U802, CR810, CR811, or the TCXO may be defective.

VCO Control Voltage

Check the voltage at TP801 with a channel at the low and high end of the band (usually System 1 and 10 in the test mode). If it is a steady DC voltage between 2.8



U802 BLOCK DIAGRAM
FIGURE 6-2

and 18 volts, the VCO is probably locked on frequency. When changing between the transmit and receive modes, the voltage should shift no more than 1.25 volts (the VCO top shield must be in place). If the voltage is not within this range, the VCO or synthesizer may be defective. Proceed to the next check.

NOTE: The VCO control voltage is not adjustable with this transceiver.

Lock Detect

If the preceding check revealed a locked VCO, the lock detect signal on the collector of Q840 should be near 0 volts and buffer Q930 should be enabled. If it revealed that the VCO is out-of-lock, the collector of Q840 should be near 9 volts and Q930 should be disabled.

If both the phase detect and lock detect outputs do not indicate the same condition, U802 may be defective. An example of this would be if the VCO control voltage at TP801 indicated a locked VCO and the collector of Q840 is near 9 volts, indicating an unlocked VCO.

If the preceding check does not reveal a problem with U802, proceed with the following tests to check individual sections of the synthesizer.

6.4.3 TCXO (Y800)

To determine if TCXO Y800 is operating properly, measure the frequency at U802, pin 14. This frequency should be 17.150 MHz at a level of 9 volts P-P.

If this signal is not correct, verify that the 9 volt supply is present on pin 3 of the TCXO. Also measure the RF output level on pin 5. This level should be approximately 1.1 volts rms. If Y800 is defective, it is not serviceable and must be replaced with a new TCXO.

6.4.4 VCO TROUBLESHOOTING

NOTE: The VCO in this transceiver is located on a separate module. This module is coated with a clear lacquer-type material, so it may be difficult to service. Therefore, if the VCO is defective, it may be best to replace it with a new module. In addition, the VCO uses a ceramic substrate which can be easily broken if it is flexed excessively or dropped on a hard surface. Field tuning is not possible.

VCO Output Level

The VCO output level can be checked by measuring the RF voltage at the output of buffers Q940 and Q930. The output voltage of Q940 at the junction of R802 and

R803 should be approximately 0.15 volt rms. The output voltage of Q930 on the output of C933 should be approximately 0.5 volt rms.

VCO Frequency Check

Check the VCO frequency as follows:

a. Connect a frequency counter to the junction of R802 and R803.

b. If the VCO is locked on frequency, the frequency should be stable and as follows for the receive and transmit mode:

$$\text{VCO Freq. (Rx Mode)} = \frac{\text{Channel Frequency} - 45\text{ MHz}}{2}$$

$$\text{VCO Freq (Tx Mode)} = \frac{\text{Channel Frequency}}{2}$$

c. If the VCO is not locked on frequency, the control voltage at TP801 is probably near 0 or 25 volts. The VCO frequency should then be as follows:

TP801 Near 0 Volts - VCO frequency should be less than 444 MHz.

TP801 Near 25 Volts - VCO frequency should be greater than 449 MHz.

If the preceding checks indicate that the VCO output level and frequency are correct, the VCO is probably operating properly and the trouble is elsewhere, such as U801 or U802.

6.4.5 SYNTHESIZER U802 TROUBLESHOOTING

U802 Reference Counter Troubleshooting

If the TCXO checked out okay in Section 6.4.3, the reference counter in U802 can be checked. The reference counter divides by 2744 for all channels. Dividing the TCXO frequency of 17.150 MHz by 2744 produces an output from the reference counter of 6.25 kHz. This frequency is referred to as fR and can be measured at U802, pin 13.

This output should be present even if the VCO is not locked on frequency. If the TCXO frequency is correct and the frequency on pin 13 is not correct, U802 may be defective or the control logic may be programming the reference counter with the wrong divide number.

U802 N Counter Troubleshooting

To check the operation of the N counter, the input and output frequencies can be measured to check the divide number. The divide numbers for the various channels can be derived as shown in Section 6.4.7. The input and output frequencies are measured as follows:

$$\frac{\text{U802, pin 8 Freq.}}{\text{U802, pin 3 Freq.}} = \text{N Counter Divide No.}$$

For example, the divide number for Channel 229 (receive) should be 558. If the VCO is locked on frequency, the following frequencies should be measured. If the VCO is not locked on frequency, the input and output frequencies may be different, but the divide number should be the same.

$$\frac{3.4875\text{ MHz}}{6.25\text{ kHz}} = 558$$

NOTE: If a changing control voltage is causing the VCO frequency to be unstable, the control line can be grounded by shorting across C831.

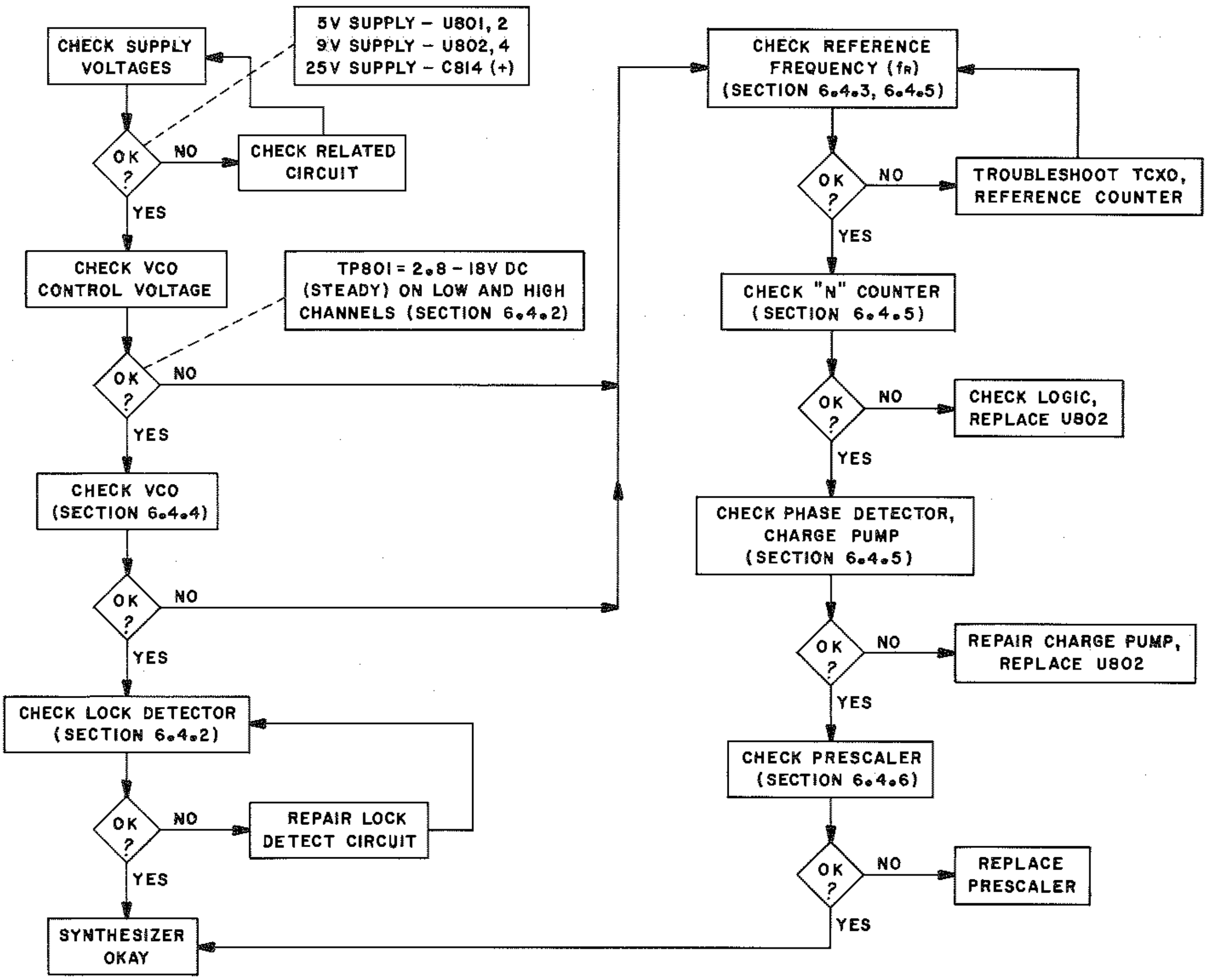
The measured frequencies may not be exactly as calculated due to counter accuracy and resolution limitations. If the divide number is not correct, U802 may be defective or the logic may not be programming the N counter with the correct number. If the divide number is correct, check the phase and lock detectors and prescaler U801.

U802 Phase Detector Troubleshooting

When the VCO is not in lock, the fV and fR inputs to the phase detector in U802 are probably not in phase or the same frequency. Measure the frequency of fV (pin 3) and fR (pin 13) and then check the phase detector outputs (DOWN and UP pins). If the phase detector is operating properly, these outputs should be as follows:

fV Greater Than fR - The negative-going pulses on the DOWN output (pin 15) should be much wider than the negative-going pulses on the UP output (pin 16). The DC voltage on TP801 should be near 0 volts.

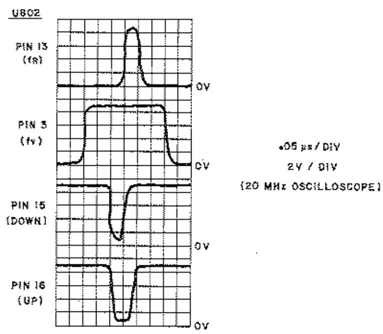
fV Less Than fR - The negative-going pulses on the UP output (pin 16) should be much wider than the negative-going pulses on the DOWN output (pin 15). The DC voltage on TP801 should be near 25 volts.



SYNTHESIZER TROUBLESHOOTING FLOWCHART
FIGURE 6-3

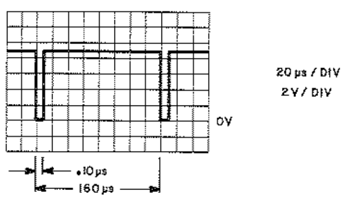
If the preceding conditions are not present when the VCO is out-of-lock, U802 or the charge pump circuit is probably defective. If the phase detector is operating properly, check the lock detector circuit and prescaler U801.

When the VCO is in lock, the following waveforms should be observed at the points indicated (all pulses occur simultaneously).



U802 Lock Detector Troubleshooting

When the VCO is locked on frequency, the waveform at U801, pin 7 should be as follows. When the VCO is unlocked, the negative-going pulses should be much wider than those shown. If these pulses are correct but buffer switch Q842 is not supplying power to Q930, Q842 or the Q840 circuit may be defective. If the lock detect circuit is operating properly, check prescaler U801.

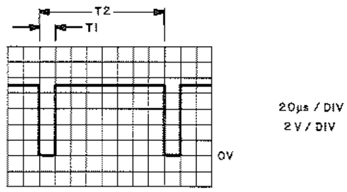


U802 Modulus Control Troublehooting

a. The frequency of the modulus control signal on pin 12 should be equal to the N counter output frequency on pin 3 (either in or out of lock). When the VCO is in lock, this frequency should be 6.25 kHz.

b. The duty cycle of the modulus control signal determines the divide number of the prescaler. The duty cycle (T1/T2) should be as follows:

$$\frac{T1}{T2} = \frac{\text{A Counter Div No.}}{\text{N Counter Div No.}}$$



If the modulus control signal is not correct, U802 may be defective or the logic may not be programming the correct divide number.

6.4.6 PRESCALER U801 TROUBLESHOOTING

Checking Prescaler Divide Number

The prescaler divide number can be checked by measuring the input and output frequencies. The prescaler divide number can be calculated as follows. (A and N counter divide numbers are calculated as described in Section 6.4.7.)

$$\text{Prescaler Divide No.} = 128 + \frac{\text{A Counter Div No.}}{\text{N Counter Div No.}}$$

For example, for Channel 229 (receive)

Prescaler Divide No. = 128 + 5/558 or 128.0089

Measure the prescaler input frequency at the junction of R802 and R801. Then measure the output frequency at pin 4 of U801 and calculate the divide number. If the VCO is not locked on frequency, the divide number should still be correct. The measured frequencies may not be exactly as calculated due to counter accuracy and resolution limitations.

For example, for Channel 229 with the VCO locked on frequency, the following frequencies should be measured:

$$\frac{\text{446.43125 MHz (R802/R803)}}{\text{3.4875 MHz (pin 4)}} = 128.0089$$

If the divide number is not correct, the modulus control signal from U802 may not be correct. To bypass this signal, tie pin 6 of U801 high and low and check the divide number. The divide number should be as follows:

Pin 6	**Divide No.**
High (5V)	128
Low (0V)	129

If the divide number is now correct, U801 is probably okay and the problem may be with the modulus control output of U802 (refer to Section 6.4.5).

6.4.7 CALCULATING "N" AND "A" COUNTER DIVIDE NUMBERS

"N" Counter Divide Number

$$\text{"N" Counter Divide No.} = \text{Integer}\ \frac{\text{VCO Freq. (MHz)}}{0.8}$$

For example, for Channel 229 (receive):

$$\text{VCO Freq.} = \frac{937.8625 - 45\ \text{MHz}}{2} = 446.43125\ \text{MHz}$$

$$\text{N Counter Div No.} = \frac{446.43125}{0.8} = 558.039$$

Integer (whole number) of 558.039 = 558

A Counter Divide Number

"A" Counter Divide No. =

$$\frac{\text{VCO Freq. (MHz)}}{.00625} - (\text{N counter Div. No.} \times 128)$$

For example, for Channel 229 (Receive):

"A" Counter Divide No. =

$$\frac{446.43125\ \text{MHz}}{.00625} - (558 \times 128)$$

$$= 71{,}429 - 71{,}424$$

$$A = 5$$

6.5 RECEIVER SERVICING

6.5.1 PRELIMINARY

To isolate a receiver problem to a defective section, start by checking the DC voltages shown in the next section and on the schematic diagram. If that does not indicate the problem, perform the other tests which follow. A hardline-type coaxial cable is recommended to inject the signal, and surface-mounted components should not be reused if they are removed. If the synthesizer is out-of-lock, the receiver is also nonfunctional because there is no first injection signal.

6.5.2 CHECKING VOLTAGE AND CURRENT

Verify the following receiver supply voltages:

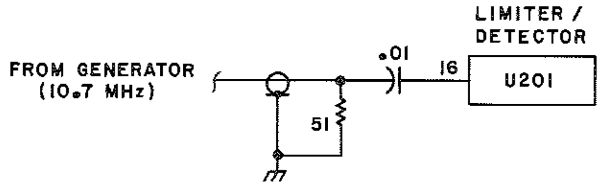
Q301, C - 9 volts
Q302, C - 9 volts (tx mode)
0 volts (rx mode)

Typical transceiver current in the receive mode should be as follows:

0.5 A - Standby (Squelched) Mode
1.2 A - Rated Audio Power Output

6.5.3 THIRD MIXER/DETECTOR (U201)

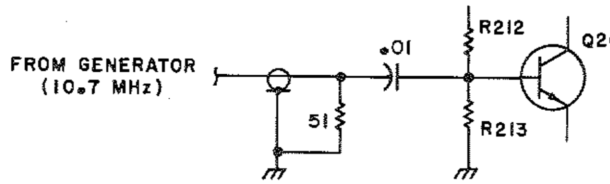
Remove C224 and connect the circuit shown below.



With a 10.7 MHz injection signal, modulated with 1 kHz at ± 3 kHz deviation, 12 dB SINAD at this point should be 2.5-4.0 microvolts.

6.5.4 10.7 MHz IF AMPLIFIER (Q204)

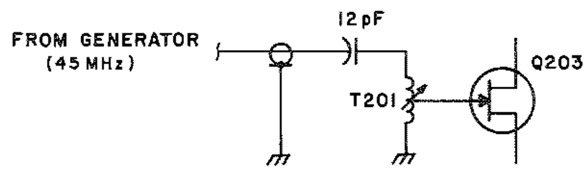
Remove C221 and connect the circuit shown below.



With a 10.7 MHz injection signal, modulated with 1 kHz at ± 3 kHz deviation, 12 dB SINAD sensitivity should be 0.35-0.50 microvolt.

6.5.5 SECOND MIXER (Q203)

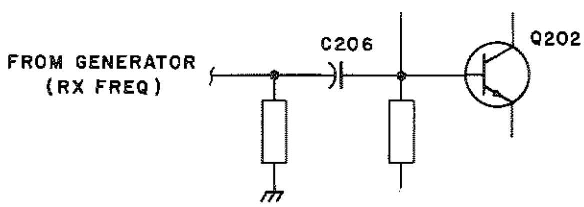
Remove C213 and connect the circuit shown below.



With a 45 MHz injection signal, modulated with 1 kHz at ± 3 kHz deviation, 12 dB SINAD sensitivity should be 0.14-0.20 microvolt.

6.5.6 FIRST MIXER (Q202)

Remove C205 and connect the circuit shown below.



Set the generator to the receive channel frequency, modulated with 1 kHz at ± 3 kHz deviation. 12 dB SINAD sensitivity should be 0.25-0.35 microvolts.

6.6 TRANSMITTER SERVICING

6.6.1 PRELIMINARY

To isolate a transmitter problem to a specific stage, start by checking the DC voltages shown in the next section. Also check the DC and RF voltages shown on the schematic diagram. If this does not indicate the problem, perform other checks which follow.

6.6.2 CHECKING VOLTAGE AND CURRENT

Verify the following transmitter supply voltages:

Q501, pin 3, 4 - 13.6 volts DC
Q301, C - 9 volts
Q302, C - 9 volts (tx mode)
0 volts (rx mode)

Typical transceiver current in the transmit mode is 6 amperes with 15 watts power output.

6.6.3 RESISTANCE MEASUREMENTS

The following resistance measurements can be used to detect shorted components. Unplug the power cable and connect the negative lead of the ohmmeter to chassis ground and the positive lead to the measurement point indicated.

Measurement Point		Meter Reading (Ohms)
Q402	Base	240
	Collector	250
Q403	Base	270
	Collector	200
Q404	Base	0
	Collector	170
U501,	Pin 2	240
	Pin 3	3.6k
	Pin 4	3.6k
Q601	Base	2.6k
	Collector	20k
Q602	Base	20k
	Collector	240

6.6.4 CHECKING DRIVER AND POWER MODULE POWER OUTPUT

CAUTION

In the next two tests, key the transmitter only briefly because power output is maximum and the component being checked could be damaged.

Driver Q404 Power Output

A 50-ohm feedpoint on the output of Q404 can be used for measuring power output. Proceed as follows:

a. Lift U501, pin 1 from the PC board. Connect a coaxial cable to the PC board where pin 1 was attached.

b. Connect a power meter and 50-ohm load to the cable. Power output should be 250-300 milliwatts.

Power Module U501 Power Output

A 50-ohm feedpoint on the output of U501 can be used for measuring power output. Proceed as follows:

a. Lift U501, pin 5 from the PC board. Connect a coaxial cable to pin 5.

b. Connect a power meter and 50-ohm load to the coaxial cable. Set power control R611 for maximum and power output should be 15-20 watts.

6.6.5 OTHER TROUBLESHOOTING HINTS

CAUTION

Do not touch an RF transistor while transmitting because RF burns may result.

a. A transistor that is producing output power should be warm to the touch. After transmitting for a short time, unkey the transmitter and touch the transistor to determine if it is warm.

b. If the power control voltage (Q602, collector) is higher than the normal range of 7.5 volts ± 2 volts, there may be no input power from the synthesizer or there may be a defective transmitter stage. If the power control voltage is near 0 volts, the power control circuit may be defective.

6.7 AUDIO/LOGIC BOARD SERVICING

6.7.1 GENERAL

To isolate a defective analog component on the audio/logic board, measure the DC and AC voltages shown on the schematic diagram. If a problem is suspected with microprocessor U11 or other digital circuits, refer to Section 6.3.2 and the following information.

Before proceeding with troubleshooting, check the following audio/logic board supply voltages.

U1, pin 4 - 9 volts
U11, pin 40 - 5 volts

6.7.2 MICROPROCESSOR TROUBLESHOOTING

If a problem is suspected with microprocessor U11, the measurements which follow can be made. If these measurements do not indicate a problem, the simplest thing to do may be to replace the microprocessor to see if it was the cause of the problem. Because of the dynamic operation of the microprocessor, specialized test equipment and an understanding of the software are required to thoroughly check the microprocessor operation.

The programming of EEPROM U10 can be checked by using the programming computer to read the data currently in the transceiver. The procedure used to read data is described in the operating manual included with the programming software.

CLOCK

ALE (Pin 30) = 1.843 MHz

RESET (PIN 9)

When power is turned on, this input should remain high for at least 100 milliseconds after the 5-volt supply comes up and then it should go low. If the 5-volt supply drops below approximately 4.3 volts, this pin should go high until the 5-volt supply returns to normal.

TONE GENERATOR CONTROL (PINS 22, 23)

Both these pins should be high when no tones are being produced. The table on the schematic diagram shows the logic levels required to produce the various tones.

LOGIC SQUELCH (PIN 5)

A high output squelches the receiver and a low output allows the squelch to be controlled by the noise squelch circuit. This pin is high during LTR operation unless a call with the correct ID code is received. During conventional operation, this pin is high if Call Guard squelch is programmed on the selected channel and the correct Call Guard tone or code has not been detected.

SQUELCH INPUT (PIN 15)

This input is high while a carrier is detected and low while a carrier is not detected.

TRANSMIT DATA/CALL GUARD (PINS 7, 8)

The combined output should be a 5-volt P-P signal when LTR data or conventional mode Call Guard signals are being generated.

PTT ENABLE (PIN 4)

This output should go low when the PTT switch is pressed except if keying is being disabled by the transmit disable feature or the time-out timer. Transmit keying is also disabled at various times in the LTR operating mode.

RECEIVE DATA/CALL GUARD (PIN 14)

A 5-volt P-P square-wave signal should be present on this pin with a receive signal modulated with 100 Hz at $\pm$ 1 kHz deviation.

PTT SENSE (PIN 12)

This input should be low when the PTT switch is pressed and high when it is not pressed.

HORN ALERT (PIN 6)

This output should be low to sound the horn or other external alert. When the test mode is selected, it provides a low input; otherwise, this pin should be high.

SECTION 7
ALIGNMENT PROCEDURE AND PERFORMANCE TESTS

7.1 GENERAL

7.1.1 INTRODUCTION

The following alignment should be performed if repairs are made that could affect the factory alignment. To perform an alignment, the test mode must be selected and test channels in the middle and near the ends of the channel band are required (refer to the following information).

7.1.2 TEST CHANNEL PROGRAMMING

Test channels are programmed into the transceiver when the other operating parameters are programmed (refer to Section 4). The programming software automatically programs the following test channels unless they are specifically changed during programming. The System Step switch selects channels in the test mode.

TEST CHANNEL SELECTION

System Selected	Test Channel (FCC Ch. No.)	System Selected	Test Channel (FCC Ch. No.)
1	1	6	279
2	79	7	329
3	129	8	379
4	179	9	429
5	229	0 (10)	479

7.1.3 TEST MODE OPERATION

The test mode is entered by placing a jumper (solder bridge) between the "Test" pads on the PC board. When the transceiver power is turned on with this jumper in place, the test mode is entered. To exit the test mode, transceiver power must be turned on with this jumper removed. The test mode can also be entered by turning power on with the outer two pins of the microphone connector shorted together (pins A and B). The following is a summary of some of the test mode functions. Refer to Section 3.11 for more test mode operating information.

System Step Switch – Selects the ten test channels.

Squelch – Noise squelch only in test mode.

7.2 PRELIMINARY SETUP

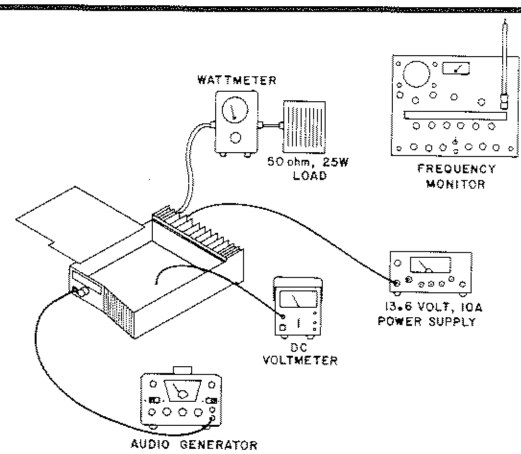
a. Remove the transceiver covers by loosening the five captive screws. Remove the audio/logic board mounting screws and flip the board over. Temporarily support it by reinstalling the two special screws.

b. Connect the test setup shown in Figure 7-1. Connect a 13.6 volt, 10 ampere power supply to the power connector and a wattmeter and dummy load to the antenna jack.

NOTE: Torx® screws are used to secure the PC board and shields. A T-15 driver is required to remove these screws.

c. Select the test mode as described in Section 7.1.3.

NOTE: The large cast shield on the bottom of the PC board must be in place during alignment.



TRANSMITTER TEST SETUP
FIGURE 7-1

7.3 SYNTHESIZER ADJUSTMENTS

NOTE: The VCO control voltage is not adjustable with this transceiver. Leave VCO cover in place for these measurements.

Refer to the alignment point diagram in Figure 7-4 and proceed as follows:

a. Connect a DC voltmeter to TP801.

b. Select a channel on the low end of the band (usually System 1). The meter reading should be greater than 2.8 volts.

c. Select a channel on the high end of the band (usually System [10]). The meter reading should be less than 18 volts.

d. Switch between the transmit and receive modes. The meter reading should change less than 1.2 volts.

e. If any of the preceding voltages were not in the indicated range, there is probably a problem with the synthesizer. Refer to Section 6.4 for troubleshooting information.

7.4 TRANSMITTER TUNEUP

7.4.1 POWER OUTPUT

Refer to the alignment point diagram in Figure 7-4 and proceed as follows:

a. If required, connect the test setup shown if Figure 7-1 and select a center channel (usually Channel 229 selected by System 5).

b. Key the transmitter and turn R611 fully clockwise to produce maximum power output. Then adjust R611 in the other direction for 15 watts power output.

NOTE: The test modulation must be enabled for the next step. If the test modulation is not present, press the System Step switch while transmitting. Do not have the "Tune" jumpers shorted for this step.

c. Monitor the transmit signal with a communications monitor set to the channel frequency (usually 898.8625 MHz). Adjust the capacitor in TCXO Y800 for the correct frequency.

NOTE: Y800 should be adjusted when the ambient temperature is near the calibration reference of 77°F (25°C). This ensures that the frequency will stay within tolerance at the temperature extremes.

7.4.2 MODULATION BALANCE

a. If you have not already done so, short both sets of "Tune" pads on the audio/logic board to generate a 71 Hz square wave.

b. Key the transmitter and view the demodulated signal on the CRT of a communications monitor. Adjust R850 so that the signal is a square wave with no tilt or overshoot.

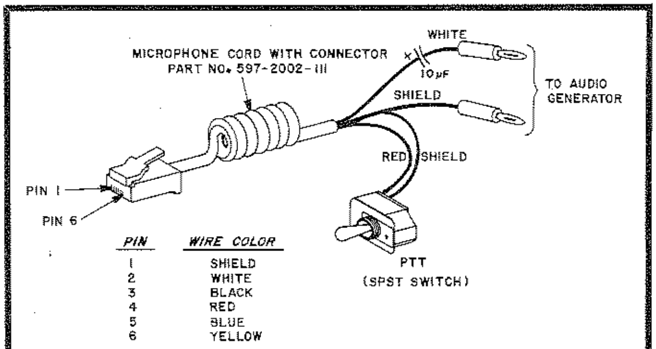
c. Unkey the transmitter and remove the "Tune" pad jumpers to disable the test tone.

7.4.3 DATA AND AUDIO MODULATION

a. With no audio applied to the microphone input, key the transmitter and adjust R36 on the audio/logic board for a data deviation of 800 Hz ± 100 Hz.

b. Connect an audio generator to pin 2 of the microphone connector using a 10 μF or larger coupling capacitor (if the capacitor is polarized, connect the + side to pin 2). A microphone substitution fixture is shown in Figure 7-2.

c. Set the generator output for 1 kHz at a level of 1.0 volt rms. Key the transmitter and adjust R50 on the audio/logic board for a peak deviation of ± 2.3 kHz +0 Hz, −200 Hz. (This includes 800 Hz of data modulation set in step a.)



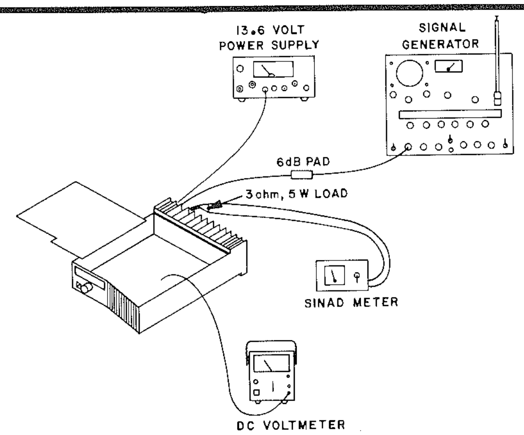
MICROPHONE SUBSTITUTION FIXTURE
FIGURE 7-2

7.5 RECEIVER ALIGNMENT

CAUTION

Do not transmit with the signal generator connected to the antenna jack because severe signal generator damage may result. To disable the transmitter, unsolder one lead of EP301.

a. Connect the test setup shown in Figure 7-3. Select a channel in the middle of the band (usually Channel 229 selected by System 5).



RECEIVER TEST SETUP
FIGURE 7-3

b. Set the signal generator to the channel frequency (usually 937.8625 MHz). Turn the modulation off.

c. Adjust squelch control R13 on the audio/logic board fully counterclockwise to unsquelch the receiver.

d. Connect an RF voltmeter or oscilloscope to TP201 and adjust the signal generator output to obtain a reading at TP201 of 50-100 millivolts rms.

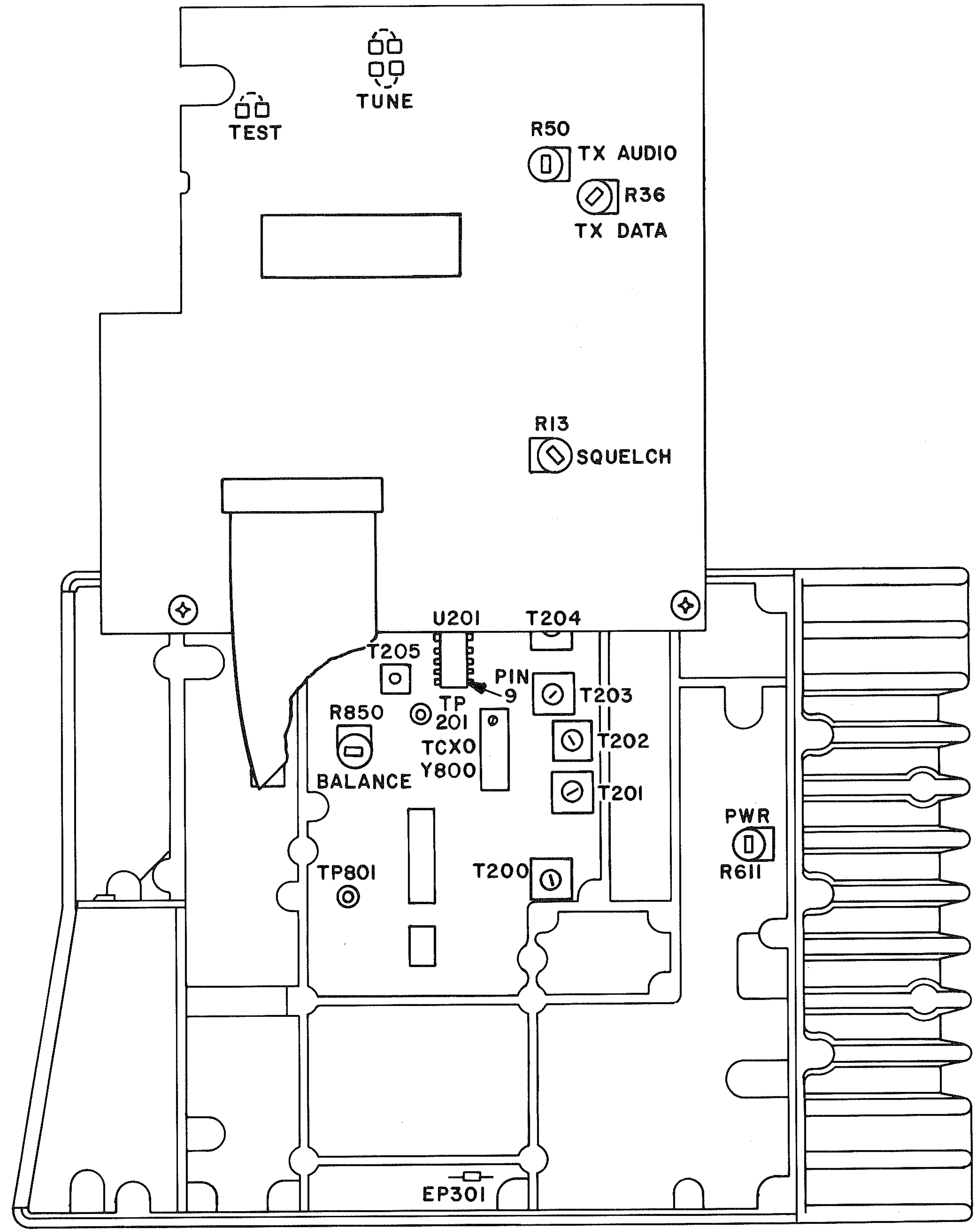
e. Adjust T200, T201, T202, T203, and T204 for a peak meter reading. Readjust the generator output as necessary to maintain a voltage at TP201 of 50-100 millivolts rms.

f. Connect the DC voltmeter to U201, pin 9 and adjust T205 for a meter reading of 3.0 volts ± 0.1 volt.

g. Set the signal generator modulation for 1 kHz at ±3 kHz deviation. Adjust output level to produce 4 dB SINAD.

h. Adjust squelch control R13 on the audio/logic board so that the transceiver just squelches at that level.

i. Switch the power off and remove the jumper across the "Test" pads. Replace the shield over the VCO on the top side of the main PC board.



ALIGNMENT POINT DIAGRAM
FIGURE 7-4

PERFORMANCE TESTS

7.6 RECEIVER PERFORMANCE TESTS

CAUTION

Do not transmit with the signal generator connected to the antenna jack because severe signal generator damage may result. To disable the transmitter, unsolder one lead of EP301.

7.6.1 PRELIMINARY SETUP

a. Connect the test setup shown in Figure 7-3. The 3.0 ohm load should be connected directly to the plug to eliminate a voltage drop in the cable. Connect an AC voltmeter and SINAD meter to the load.

b. Select the test mode as described in Section 7.1. Check the receiver sensitivity using one of the two methods which follow.

7.6.2 EIA SINAD SENSITIVITY

a. Set the generator for the selected channel frequency. Set the output level for 1000 microvolts, modulated with 1 kHz at ± 3 kHz deviation.

b. Adjust the Volume control for an audio output level of 3.9 volts rms across the 3.0 ohm speaker load (5 watts).

c. Decrease the generator output to obtain a 12 dB reading on the SINAD meter. The generator output should be 0.35 microvolt maximum.

d. Check channels at the center and both ends of the 479 channel band.

7.6.3 QUIETING SENSITIVITY

a. With no signal generator output, adjust the VOLUME control for a reference audio output of 0 dB.

b. Set the signal generator to the selected channel frequency and increase the unmodulated output to obtain a 20 dB decrease in the meter reading. The generator output should be 0.50 microvolt maximum.

7.6.4 AUDIO OUTPUT

a. Set the signal generator for the selected channel frequency with an output of 1000 microvolts, modulated with 1 kHz at ± 3 kHz.

b. Audio output power should be 5 watts minimum into a 3.0 ohm load (3.9 volts rms). Distortion at 5 watts should be less than 5%.

7.7 TRANSMITTER PERFORMANCE TESTS

Connect the test setup shown in Figure 7-1.

7.7.1 POWER OUTPUT

a. Key the transmitter and power output should be 15 ±2 watts.

b. Check channels in the center and on both ends of the 479 channel band.

7.7.2 TRANSMIT FREQUENCY

Key the transmitter and monitor the transmit frequency with a communications monitor. The transmit frequency should be within ± 1.5 PPM. Checking the transmit frequency also checks the receive injection frequency.

7.7.3 TRANSMIT MODULATION

a. Key the transmitter and monitor the transmitter deviation with a communications monitor.

b. LTR data and/or Call Guard deviation should be ± 800 Hz (± 100 Hz).

c. Speak into the microphone and deviation should be ± 2.3 kHz maximum (including any data/Call Guard modulation).

←**FOLDOUT** **(Figure 7-4, Alignment Points Diagram)**

MAIN AND AUDIO/LOGIC BOARDS

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 040	Antenna connector assembly	023-8600-040
A 051	Top cover assembly	023-8610-105
A 061	Bottom cover assembly	023-8610-106
A 302	Power connector assembly	023-8610-051
A 700	VCO module	023-8640-060
C 001	.1 μF ±5% 63V polyester	510-1033-103
C 003	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 004	.01 μF ±5% 63V polyester	510-1033-103
C 005	.01 μF ±5% 63V polyester	510-1033-103
C 006	.047 μF ±5% 63V polyester	510-1033-473
C 007	.33 μF ±5% 63V polyester	510-1033-334
C 008	.047 μF ±10% X7R 50V cer	510-3607-473
C 009	10 μF 35V alum electrolytic	510-4235-100
C 010	.1 μF ±10% X7R 50V cer smd	510-3607-104
C 011	680 pF ±5% NPO 50V cer smd	510-3602-681
C 012	.0068 μF ±10% X7R 50V cer	510-3606-682
C 013	.1 μF ±5% 63V polyester	510-1033-104
C 014	2.2 μF 63V alum electrolytic	510-4263-229
C 015	.022 μF ±5% 63V polyester	510-1033-223
C 016	.01 μF ±5% 63V polyester	510-1033-103
C 017	.022 μF ±10% X7R 50V cer	510-3606-223
C 018	.068 μF ±5% 63V polyester	510-1033-683
C 019	.0027 μF±5% 63V polyester	510-1033-272
C 020	2200 pF ±5% NPO 50V cer smd	510-3602-222
C 021	15 μF ±10% 15V tantalum	510-2073-150
C 022	10 μF 35V alum electrolytic	510-4235-100
C 023	.01 μF ±5% 63V polyester	510-1033-103
C 024	.01 μF ±5% 63V polyester	510-1033-103
C 025	.01 μF ±5% 63V polyester	510-1033-103
C 026	.015 μF ±10% X7R 50V cer	510-3606-153
C 027	.22 μF ±5% 63V polyester	510-1033-224
C 028	2200 pF ±5% NPO 50V cer smd	510-3602-222
C 031	10 μF 35V alum electrolytic	510-4235-100
C 032	2200 pF ±5% NPO 50V cer smd	510-3602-222
C 033	2200 pF ±5% NPO 50V cer smd	510-3602-221
C 034	30 pF ±5% NPO 50V cer smd	510-3602-300
C 035	30 pF ±5% NPO 50V cer smd	510-3602-300
C 036	.1μF ±10% X7R 50V cer smd	510-3607-104
C 037	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 038	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 039	.33 μF ±5% 63V polyester	510-1033-334
C 040	47 μF 25V alum electrolytic	510-4225-470
C 041	47 μF 25V alum electrolytic	510-4225-470
C 042	.022 μF ±10% X7R 50V cer	510-3606-223
C 043	47 μF 25V alum electrolytic	510-4225-470
C 044	.022 μF ±10% X7R 50V cer	510-3606-223
C 045	.022 μF ±10% X7R 50V cer	510-3606-223
C 046	.022 μF ±10% X7R 50V cer	510-3606-223
C 047	.022 μF ±10% X7R 50V cer	510-3606-223
C 048	.22 μF ±5% 63V polyester	510-1033-224
C 049	.047 μF ±10% X7R 50V cer	510-3607-473
C 050	.47 μF ±10% 63V polyester	510-1034-474
C 051	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 052	620 ±5% NPO 50V cer smd	510-3602-621
C 053	.047 μ10% X7R 50V cer smd	510-3607-473
C 054	470 ±5% NPO 50V cer smd	510-3602-471
C 201	5.1 pF ±5% NPO 50V cer smd	510-3602-519
C 202	3.9 pF ±5% NPO 50V cer smd	510-3602-399
C 203	270 pF ±5% NPO 50V cer smd	510-3602-271
C 204	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 205	7.5 pF ±5% NPO 50V cer smd	510-3602-759
C 206	15 pF ±5% NPO 50V cer smd	510-3602-150
C 207	.001 μF ±10% X7R 50V cer	510-3606-102
C 208	.001 μF ±10% X7R 50V cer	510-3606-102
C 209	12 pF ±5% NPO 50V cer smd	510-3602-120
C 210	.001 μF ±10% X7R 50V cer	510-3606-102
C 211	.001 μF ±10% X7R 50V cer	510-3606-102
C 212	10 pF ±5% NPO 50V cer smd	510-3602-100
C 213	30 pF ±5% NPO 50V cer smd	510-3602-300
C 214	20 pF ±5% NPO 50V cer smd	510-3602-200
C 215	5.1 pF ±5% NPO 50V cer smd	510-3602-519
C 216	27 pF ±5% NPO 50V cer smd	510-3602-270
C 217	120 pF ±5% NPO 50V cer smd	510-3602-121
C 218	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 219	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 221	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 222	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 223	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 224	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 225	62 pF ±5% NPO 50V cer smd	510-3602-620
C 226	220 pF ±5% NPO 50V cer smd	510-3602-221
C 227	220 pF ±5% NPO 50V cer smd	510-3602-221
C 228	43 pF ±5% NPO 50V cer smd	510-3602-430
C 229	120 pF ±5% NPO 50V cer smd	510-3602-121
C 230	.047 μF ±10% X7R 50V cer	510-3607-473
C 231	.047 μF ±10% X7R 50V cer	510-3607-473
C 232	270 pF ±5% N750 50V cer smd	510-3625-271
C 235	10 μF 25V alum electrolytic	510-4325-100
C 236	.022 μF ±10% X7R 50V cer	510-3606-223
C 237	.001 μF ±10% X7R 50V cer	510-3606-102
C 240	4.7 pF ±5% NPO 50V cer smd	510-3602-479
C 242	7.5 pF ±5% NPO 50V cer smd	510-3602-759
C 300	10 pF ±5% NPO 50V cer smd	510-3602-100
C 301	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 302	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 303	470 μF 16V alum electrolytic	510-4216-471
C 304	220 μF 16V alum electrolytic	510-4216-221
C 305	5.6 μF ±10% 10V tantalum	510-2572-569
C 306	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 307	22 μF ±10% 20V tantalum	510-2574-220
C 308	1000 μF 16V alum electrolytic	510-4216-102
C 309	.047μF ±10% X7R 50V cer smd	510-3607-473
C 310	10 μF 35V alum electrolytic	510-4235-100

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 311	.047 μF ±10% X7R 50V cer	510-3607-473
C 312	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 313	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 314	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 315	.001 μF ±10% X7R 50V cer	510-3606-102
C 316	56 pF ±5% NPO 50V cer smd	510-3602-560
C 400	56 pF ±5% NPO 50V cer smd	510-3602-560
C 401	2.4 pF ±5% NPO 50V cer smd	510-3602-249
C 402	2.4 pF ±5% NPO 50V cer smd	510-3602-249
C 404	56 pF ±5% NPO 50V cer smd	510-3602-560
C 405	.001 μF ±10% X7R 50V cer	510-3606-102
C 406	56 pF ±5% NPO 50V cer smd	510-3602-560
C 407	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 408	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 409	56 pF ±5% NPO 50V cer smd	510-3602-560
C 410	1.5 pF ±5% NPO 50V cer smd	510-3602-159
C 411	3.3 pF ±5% NPO 50V cer smd	510-3602-339
C 412	1.0 pF ±5% NPO 50V cer smd	510-3602-109
C 413	3.3 pF ±5% NPO 50V cer smd	510-3602-339
C 414	1.0 pF ±5% NPO 50V cer smd	510-3602-109
C 415	1.0 pF ±5% NPO 50V cer smd	510-3602-109
C 416	3.3 pF ±5% NPO 50V cer smd	510-3602-339
C 417	56 pF ±5% NPO 50V cer smd	510-3602-560
C 418	56 pF ±5% NPO 50V cer smd	510-3602-560
C 419	56 pF ±5% NPO 50V cer smd	510-3602-560
C 420	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 421	1.5 pF ±5% NPO 50V cer smd	510-3602-159
C 422	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 423	56 pF ±5% NPO 50V cer smd	510-3602-560
C 424	7.5 pF ±5% NPO 50V cer smd	510-3602-759
C 425	.01 μF ±30% Y5R 25V ax cer	510-3528-103
C 426	56 pF ±5% NPO 50V cer smd	510-3602-560
C 429	5.1 pF ±5% NPO 50V cer smd	510-3602-519
C 430	56 pF ±5% NPO 50V cer smd	510-3602-560
C 431	1.0 pF ±5% NPO 50V cer smd	510-3602-109
C 432	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 501	5.6 μF ±10% 10V tantalum	510-2572-569
C 502	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 503	56 pF ±5% NPO 50V cer smd	510-3602-560
C 504	5.6 μF ±10% 35V tantalum	510-2575-569
C 505	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 506	56 pF ±5% NPO 50V cer smd	510-3602-560
C 507	1.5 pF hi Q 50V cer smd	510-3663-159
C 508	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 509	56 pF ±5% NPO 50V cer smd	510-3602-560
C 510	5.6 pF hi Q 50V cer smd	510-3663-569
C 511	56 pF 500V ±5% mica smd	510-0620-560
C 512	56 pF ±5% NPO 50V cer smd	510-3602-560
C 513	.047 μF ±10% X7R 50V cer	510-3607-473
C 514	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 515	56 pF ±5% NPO 50V cer smd	510-3602-560
C 516	.001 μF ±10% X7R 50V cer	510-3606-102
C 518	5.6 pF hi Q 50V cer smd	510-3663-569
C 601	56 pF ±5% NPO 50V cer smd	510-3602-560

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 602	56 pF ±5% NPO 50V cer smd	510-3602-560
C 604	56 pF ±5% NPO 50V cer smd	510-3602-560
C 605	56 pF ±5% NPO 50V cer smd	510-3602-560
C 606	.022 μF ±10% X7R 50V cer	510-3606-223
C 607	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 701	47 pF ±5% NPO 50V cer smd	510-3602-470
C 702	9.1 pF ±5% NPO 50V cer smd	510-3602-919
C 703	18 pF ±5% N750 50V cer smd	510-3625-180
C 704	220 pF ±5% NPO 50V cer smd	510-3602-221
C 705	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 706	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 707	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 710	3.6 pF ±5% N750 50V cer smd	510-3625-369
C 711	1.8 pF ±5% NPO 50V cer smd	510-3602-189
C 713	47 pF ±5% NPO 50V cer smd	510-3602-470
C 714	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 715	220 pF ±5% NPO 50V cer smd	510-3602-221
C 720	9.1 pF ±5% NPO 50V cer smd	510-3602-919
C 721	11 pF ±5% NPO 50V cer smd	510-3602-110
C 722	220 pF ±5% NPO 50V cer smd	510-3602-221
C 723	220 pF ±5% NPO 50V cer smd	510-3602-221
C 740	220 pF ±5% NPO 50V cer smd	510-3602-221
C 741	220 pF ±5% NPO 50V cer smd	510-3602-221
C 742	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 743	1.8 pF ±5% NPO 50V cer smd	510-3602-189
C 744	1.8 pF ±5% NPO 50V cer smd	510-3602-189
C 745	10 pF ±5% NPO 50V cer smd	510-3602-100
C 801	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 802	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 803	.001 μF ±5% NPO 50V cer smd	510-3602-102
C 804	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 805	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 806	27 pF ±5% NPO 50V cer smd	510-3602-270
C 807	27 pF ±5% NPO 50V cer smd	510-3602-270
C 810	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 811	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 812	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 813	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 814	1.0 μF ±10% 35V tantalum	510-2575-109
C 820	4.7 pF ±5% NPO 50V cer smd	510-3602-479
C 821	5.1 pF ±5% NPO 50V cer smd	510-3602-519
C 830	.056 μF ±5% 63V polyester	510-1033-563
C 831	.0047 μF ±5% 63V polyester	510-1033-472
C 840	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 841	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 850	10 μF 25V alum electrolytic	510-4325-100
C 851	10 μF 25V alum electrolytic	510-4325-100
C 871	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 872	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 900	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 901	33 pF ±5% NPO 50V cer smd	510-3602-330
C 902	22 μF ±10% 20V tantalum	510-2574-220
C 903	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 931	.01 μF ±10% X7R 50V cer smd	510-3606-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 932	220 pF ±5% NPO 50V cer smd	510-3602-221
C 933	56 pF ±5% NPO 50V cer smd	510-3602-560
C 934	220 pF ±5% NPO 50V cer smd	510-3602-221
C 935	220 pF ±5% NPO 50V cer smd	510-3602-221
C 936	.01 μF 10% X7R 50V cer smd	510-3606-103
C 937	3.3 pF ±5% NPO cer smd	510-3602-339
C 941	.01 μF ±10% X7R 50V cer smd	510-3606-103
C 942	220 pF ±5% NPO 50V cer smd	510-3602-221
C 943	56 pF ±5% NPO 50V cer smd	510-3602-560
C 944	220 pF ±5% NPO 50V cer smd	510-3602-221
C 945	220 pF ±5% NPO 50V cer smd	510-3602-221
C 950	.01 μF ±10% X7R 50V cer smd	510-3606-103
CH001	Chassis assembly	015-0920-110
CR001	UHF/VHF band sw diode sot	523-1504-012
CR002	UHF/VHF band sw diode sot	523-1504-012
CR003	UHF/VHF band sw diode sot	523-1504-012
CR004	UHF/VHF band sw diode sot	523-1504-012
CR005	UHF/VHF band sw diode sot	523-1504-012
CR006	1N67A germanium diode	523-1500-067
CR007	1N67A germanium diode	523-1500-067
CR008	UHF/VHF band sw diode sot	523-1504-012
CR011	UHF/VHF band sw diode sot	523-1504-012
CR201	PIN diode sot	523-1500-010
CR302	Transient suppressor, 1500W	523-2591-002
CR501	8.5W PIN diode VHF/UHF	523-1500-010
CR710	Varicap diode	523-1504-014
CR711	Varicap diode	523-1504-014
CR720	PIN switching diode	523-1504-001
CR731	Switching diode	523-1504-002
CR810	Switching diode, dual sot	523-1504-023
CR811	Switching diode, dual sot	523-1504-023
CR840	Switching diode sot	523-1504-002
DS001	Display, 7-segment .3" grn	549-4002-020
DS002	LED yellow	549-4001-202
DS003	LED red	549-4001-201
EP001	Crystal pin insulator (Y1)	018-1080-001
EP201	Crystal pin insulator (Z202)	018-1080-002
EP203	Crystal pin insulator (Y201)	018-1080-002
EP204	Crystal pin insulator (Z201)	018-1080-006
EP300	.29" x .29" ferrite bead	517-2002-006
EP301	Ferrite bead	517-2502-007
EP302	Insulating pad (under U301)	574-5005-111
EP601	Ferrite bead	517-2502-007
EP602	Insulating pad (under Q602)	574-5005-110
EP700	VCO module pin	515-9034-008
F 301	Fuse 2A subminiature	534-0009-020
HW001	Hold down screw (center of A/L bd)	013-1705-021
HW003	Nut, 5/8-24 (ant jk)	560-9079-028
HW004	Lockwasher, int 5/8 (ant jk)	596-9119-028
HW005	Screw, 6-32 x 5/16" Torx	575-0006-010
HW006	Screw, 6-32 x 7/16" Torx	575-0006-014
HW010	Grounding strip, serrated	537-5001-005
HW011	Screw, No. 6 captive (covers)	575-9606-148
HW012	Gasket, chassis (spkr wires)	018-1134-135
HW013	Washer, No. 4 shldr (for Q602)	596-4504-008
HW014	Grounding strip, serrated	537-5001-005
HW015	Washer, insulated 3/8" (under J301)	596-9047-012
HW018	Screw, 6-32 x 7/16" Torx	575-1006-014
HW104	Bottom shield rubber bumper	018-1134-135
HW105	Bot shld sq thin rubber pad	018-1134-136
HW151	Screw, No.4 hi-lo (spkr mtg)	575-5644-008
J 300	Antenna connector assembly	023-8600-040
J 301	Speaker jack, 3.6 mm	515-2001-011
J 302	Power connector assembly includes:	023-8610-051
	Connector terminal	515-9033-006
	Connector body, dual	515-9033-012
J 303	Modular 8-pin mic jack	515-2006-040
J 304	Connector, 18-pin ribbon	515-5012-018
J 306	Connector, 2-pin female	515-9031-281
L 301	1-1/2T ferrite choke	517-2005-003
L 401	6.5T coil 22 AWG	542-0010-065
L 402	1.0 μH ±20% choke	542-3513-109
L 403	2.5T coil 22 AWG	542-0010-025
L 404	2.5T coil 22 AWG	542-0010-025
L 405	1.5T coil 22 AWG	542-0010-015
L 406	1.0 μH ±20% choke	542-3513-109
L 407	1.0 μH ±20% choke	542-3513-109
L 408	1-1/2T coil 22 AWG	542-0010-015
L 501	5.5T coil 26 AWG	542-0001-055
L 502	6.5T coil 22 AWG	542-0010-065
L 503	5.5T coil 26 AWG	542-0001-055
L 700	.27 μH ±5% inductor smd	542-9000-278
L 701	.27 μH ±5% inductor smd	542-9000-278
L 710	.27 μH ±5% inductor smd	542-9000-278
L 711	.27 μH ±5% inductor smd	542-9000-278
L 720	.27 μH ±5% inductor smd	542-9000-278
L 721	.27 μH ±5% inductor smd	542-9000-278
L 740	.27 μH ±5% inductor smd	542-9000-278
L 741	.030 μH ±5% inductor smd	542-9000-307
L 800	6.8 μH ±20% choke	542-3513-689
L 870	2.2 μH ±20% choke	542-3513-229

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
LS301	Speaker, 3" x 2" 5W 4 ohm	589-1015-004
MP001	Stand off	013-1188-007
MP002	Shield, top (over VCO cavity)	017-2224-107
MP002	LED holder (DS2, DS3)	032-0791-210
MP004	Regulator clip (U301, etc.)	017-2224-110
MP005	Knob (on-off/vol)	032-0791-095
MP010	Bottom shield (cast)	015-0920-118
MP102	Speaker cavity gasket	018-1134-121
MP103	Bottom cover damper	018-1134-133
MP112	Speaker cavity gasket	018-1134-120
MP113	Top cover damper	018-1134-132
MP150	Front panel (plastic)	032-0791-090
MP151	Lens, front panel	032-0791-122
MP153	Bracket, speaker w/bend	017-2224-125
MP154	Gasket, speaker cavity	018-1134-130
MP155	Bracket, speaker w/o bend	017-2224-126
MP156	Gasket (between spkr/frt pnl)	018-1134-155
NP150	Nameplate, Johnson	559-0039-026
P 002	Connector, 14-pin male	515-9031-437
P 306	Connector, 2-pin male	515-9031-201
PC001	PC board, main	035-8640-010
PC020	PC board, audio/logic	035-8600-020
PC700	Ceramic substrat (VCO)	023-8640-065
Q 001	NPN amplifier SOT-23	576-0003-658
Q 002	NPN amplifier SOT-23	576-0003-658
Q 003	NPN amplifier SOT-23	576-0003-658
Q 004	NPN amplifier SOT-23	576-0003-658
Q 005	PNP low-noise amp SOT-23	576-0003-657
Q 007	N-channel MOSFET	576-0006-107
Q 008	NPN amplifier SOT-23	576-0003-658
Q 009	NPN amplifier SOT-23	576-0003-658
Q 200	NPN amplifier SOT-23	576-0003-658
Q 201	NPN low-noise RF amp	576-0003-610
Q 202	NPN high freq amp SOT-23	576-0003-628
Q 203	N-channel JFET SOT-23	576-0006-019
Q 204	NPN amplifier SOT-23	576-0003-658
Q 205	NPN VHF/UHF amp SOT-23	576-0003-634
Q 301	PNP 80V 7A amp T0-220	576-0002-021
Q 302	PNP 80V 7A amp T0-220	576-0002-021
Q 303	P-channel 50V 1.1A MOSFET	576-0006-111
Q 304	P-channel 50V 1.1A MOSFET	576-0006-111
Q 402	NPN high freq amp SOT-23	576-0003-628
Q 403	NPN VHF amplifier	576-0003-660
Q 404	NPN 750 mW 800 MHz amp	576-0004-098
Q 601	NPN amplifier SOT-23	576-0003-658
Q 602	PNP 80V 7A amp T0-220	576-0002-021
Q 700	Silicon N-chan JFET	576-0006-019
Q 730	NPN amplifier	576-0003-658
Q 740	RF amp/switch	576-0003-659
Q 820	NPN low-noise amp SOT-23	576-0001-300
Q 821	NPN low-noise amp SOT-23	576-0001-300
Q 822	PNP low-noise amp SOT-23	576-0003-650
Q 823	PNP low-noise amp SOT-23	576-0003-650
Q 840	NPN Darlington amp SOT-23	576-0007-011
Q 842	PNP low-noise amp SOT-23	576-0003-657
Q 880	PNP low-noise amp	576-0003-657
Q 900	NPN amplifier SOT-23	576-0003-658
Q 930	NPN low-noise amp	576-0003-628
Q 940	NPN low-noise amp	576-0003-628
R 001	20k ohm ±5% 1/8W smd	569-0115-203
R 002	20k ohm ±5% 1/8W smd	569-0115-203
R 003	560k ohm ±5% 1/8W smd	569-0115-564
R 004	10k ohm ±5% 1/8W smd	569-0115-103
R 005	750k ohm ±5% 1/8W smd	569-0115-754
R 006	20k ohm ±5% 1/8W smd	569-0115-203
R 007	180k ohm ±5% 1/8W smd	569-0115-184
R 008	100k ohm ±5% 1/8W smd	569-0115-104
R 009	330 ohm ±5% 1/8W smd	569-0115-331
R 011	10k ohm ±5% 1/8W smd	569-0115-103
R 012	6.8k ohm ±5% 1/8W smd	569-0115-682
R 013	300k ohm trimmer	562-0122-304
R 014	68k ohm ±5% 1/8W smd	569-0115-683
R 015	330k ohm ±5% 1/8W smd	569-0115-334
R 016	330k ohm ±5% 1/8W smd	569-0115-334
R 017	100k ohm ±5% 1/8W smd	569-0115-104
R 018	47k ohm ±5% 1/8W smd	569-0115-473
R 019	680 ohm ±5% 1/8W smd	569-0115-681
R 020	1k ohm ±5% 1/8W smd	569-0115-102
R 021	150k ohm ±5% 1/8W smd	569-0115-154
R 022	100k ohm ±5% 1/8W smd	569-0115-104
R 023	4.7k ohm ±5% 1/8W smd	569-0115-472
R 024	430k ohm ±5% 1/8W smd	569-0115-434
R 025	82k ohm ±5% 1/8W smd	569-0115-823
R 026	100k ohm ±5% 1/8W smd	569-0115-104
R 027	100k ohm ±5% 1/8W smd	569-0115-104
R 028	47k ohm ±5% 1/8W smd	569-0115-473
R 029	16k ohm ±5% 1/8W smd	569-0115-163
R 030	10k ohm ±5% 1/8W smd	569-0115-103
R 031	56k ohm ±5% 1/8W smd	569-0115-563
R 032	56k ohm ±5% 1/8W smd	569-0115-563
R 033	150k ohm ±5% 1/8W smd	569-0115-154
R 034	47k ohm ±5% 1/8W smd	569-0115-473
R 035	22k ohm ±5% 1/8W smd	569-0115-223
R 036	300k ohm trimmer	562-0121-304
R 037	270k ohm ±5% 1/8W smd	569-0115-274
R 038	68k ohm ±5% 1/8W smd	569-0115-683
R 039	100k ohm ±5% 1/8W smd	569-0115-104
R 040	680 ohm ±5% 1/8W smd	569-0115-681

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 041	1k ohm ±5% 1/8W smd	569-0115-102
R 042	100k ohm ±5% 1/8W smd	569-0115-104
R 043	620 ohm ±5% 1/8W smd	569-0115-621
R 044	620 ohm ±5% 1/8W smd	569-0115-621
R 045	20k ohm ±5% 1/8W smd	569-0115-203
R 046	130k ohm ±5% 1/8W smd	569-0115-134
R 047	5.6k ohm ±5% 1/8W smd	569-0115-562
R 048	470k ohm ±5% 1/8W smd	569-0115-474
R 049	16k ohm ±5% 1/8W smd	569-0115-163
R 050	300k ohm trimmer	562-0121-304
R 051	68k ohm ±5% 1/8W smd	569-0115-683
R 052	100k ohm ±5% 1/8W smd	569-0115-104
R 053	27k ohm ±5% 1/8W smd	569-0115-273
R 056	1k ohm ±5% 1/8W smd	569-0115-102
R 057	10k ohm ±5% 1/8W smd	569-0115-103
R 058	100k ohm ±5% 1/8W smd	569-0115-104
R 059	1k ohm ±5% 1/8W smd	569-0115-102
R 060	10k ohm ±5% 1/8W smd	569-0115-103
R 061	100k ohm ±5% 1/8W smd	569-0115-104
R 062	100k ohm ±5% 1/8W smd	569-0115-104
R 063	10k ohm ±5% 1/8W smd	569-0115-103
R 065	1k ohm ±5% 1/8W smd	569-0115-102
R 066	82k ohm ±5% 1/8W smd	569-0115-823
R 067	82k ohm ±5% 1/8W smd	569-0115-823
R 068	68k ohm ±5% 1/8W smd	569-0115-683
R 069	68k ohm ±5% 1/8W smd	569-0115-683
R 070	1.5k ohm ±5% 1/8W smd	569-0115-152
R 071	47k ohm ±5% 1/8W smd	569-0115-473
R 072	1k ohm ±5% 1/8W smd	569-0115-102
R 073	10k ohm ±5% 1/8W smd	569-0115-103
R 074	10k ohm ±5% 1/8W smd	569-0115-103
R 075	10k ohm ±5% 1/8W smd	569-0115-103
R 076	10k ohm ±5% 1/8W smd	569-0115-103
R 077	4.7k ohm ±5% 1/8W smd	569-0115-472
R 078	47k ohm ±5% 1/8W smd	569-0115-473
R 079	2.2k ohm ±5% 1/8W smd	569-0115-222
R 080	47k ohm ±5% 1/8W smd	569-0115-473
R 081	4.7k ohm ±5% 1/8W smd	569-0115-472
R 082	4.7k ohm ±5% 1/8W smd	569-0115-472
R 083	47k ohm ±5% 1/8W smd	569-0115-473
R 084	1.0M ohm ±5% 1/8W smd	569-0115-105
R 085	39k ohm ±5% 1/8W smd	569-0115-393
R 086	1.0M ohm ±5% 1/8W smd	569-0115-105
R 087	470k ohm ±5% 1/8W smd	569-0115-474
R 088	1.0M ohm ±5% 1/8W smd	569-0115-105
R 089	1.0M ohm ±5% 1/8W smd	569-0115-105
R 090	220k ohm ±5% 1/8W smd	569-0115-224
R 091	470 ohm ±5% 1/8W smd	569-0115-471
R 092	470 ohm ±5% 1/8W smd	569-0115-471
R 093	470 ohm ±5% 1/8W smd	569-0115-471
R 094	220 ohm ±5% 1/8W smd	569-0115-221
R 095	220 ohm ±5% 1/8W smd	569-0115-221
R 096	220 ohm ±5% 1/8W smd	569-0115-221
R 097	220 ohm ±5% 1/8W smd	569-0115-221

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 098	220 ohm ±5% 1/8W smd	569-0115-221
R 099	220 ohm ±5% 1/8W smd	569-0115-221
R 100	220 ohm ±5% 1/8W smd	569-0115-221
R 101	22k ohm ±5% 1/8W smd	569-0115-223
R 102	47k ohm ±5% 1/8W smd	569-0115-473
R 103	220 ohm ±5% 1/8W smd	569-0115-221
R 104	1.2k ohm ±5% 1/8W smd	569-0115-122
R 105	1k ohm ±5% 1/8W smd	569-0115-102
R 106	220 ohm ±5% 1/8W smd	569-0115-221
R 107	4.7k ohm ±5% 1/8W smd	569-0115-472
R 108	4.7k ohm ±5% 1/8W smd	569-0115-472
R 109	4.7k ohm ±5% 1/8W smd	569-0115-472
R 110	10k ohm ±5% 1/8W smd	569-0115-103
R 112	10k ohm ±5% 1/8W smd	569-0115-103
R 113	10k ohm ±5% 1/8W smd	569-0115-103
R 114	1.3k ohm ±5% 1/8W smd	569-0115-132
R 115	100k ohm ±5% 1/8W smd	569-0115-104
R 116	100k ohm ±5% 1/8W smd	569-0115-104
R 200	10k ohm ±5% 1/8W smd	569-0115-103
R 201	12k ohm ±5% 1/8W smd	569-0115-123
R 202	2k ohm ±5% 1/8W smd	569-0115-202
R 203	200 ohm ±5% 1/8W smd	569-0115-201
R 204	220 ohm ±5% 1/8W smd	569-0115-221
R 205	12k ohm ±5% 1/8W smd	569-0115-123
R 206	2.2k ohm ±5% 1/8W smd	569-0115-222
R 207	10k ohm ±5% 1/8W smd	569-0115-103
R 208	1k ohm ±5% 1/8W smd	569-0115-102
R 209	1.5k ohm ±5% 1/8W smd	569-0115-152
R 210	5.1k ohm ±5% 1/8W smd	569-0115-512
R 211	10 ohm ±5% 1/8W smd	569-0115-100
R 212	15k ohm ±5% 1/8W smd	569-0115-153
R 213	4.7k ohm ±5% 1/8W smd	569-0115-472
R 214	1k ohm ±5% 1/8W smd	569-0115-102
R 215	1k ohm ±5% 1/8W smd	569-0115-102
R 216	4.7k ohm ±5% 1/8W smd	569-0115-472
R 217	1.5k ohm ±5% 1/8W smd	569-0115-152
R 218	470k ohm ±5% 1/8W smd	569-0115-474
R 219	100k ohm ±5% 1/8W smd	569-0115-104
R 220	18k ohm ±5% 1/8W smd	569-0115-183
R 221	47k ohm ±5% 1/8W smd	569-0115-473
R 222	820 ohm ±5% 1/8W smd	569-0115-821
R 225	270 ohm ±5% 1/8W smd	569-0115-271
R 226	150k ohm ±5% 1/8W smd	569-0115-154
R 227	200 ohm ±5% 1/8W smd	569-0115-201
R 301	5.6k ohm ±5% 1/8W smd	569-0115-562
R 302	10k ohm ±5% 1/8W smd	569-0115-103
R 304	1k ohm ±5% 1/8W smd	569-0115-102
R 305	1k ohm ±5% 1/8W smd	569-0115-102
R 307	1.8k ohm ±5% 1/8W smd	569-0115-182
R 308	2.2k ohm ±5% 1/8W smd	569-0115-222
R 309	2.7 ohm ±5% 1/8W smd	569-0115-279
R 310	300 ohm ±5% 1/8W smd	569-0115-301
R 311	10 ohm ±5% 1/8W smd	569-0115-100
R 312	10k ohm pot/dual sw	562-0018-071

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 313	1.5k ohm ±5% 1/8W smd	569-0115-152
R 314	10 ohm ±5% 1/8W smd	569-0115-100
R 315	1.5k ohm ±5% 1/8W smd	569-0115-152
R 400	680 ohm ±5% 1/8W smd	569-0115-681
R 401	240 ohm ±5% 1/8W smd	569-0115-241
R 402	1k ohm ±5% 1/8W smd	569-0115-102
R 403	1k ohm ±5% 1/8W smd	569-0115-102
R 404	10 ohm ±5% 1/8W smd	569-0115-100
R 405	68 ohm ±5% 1/8W smd	569-0115-680
R 410	270 ohm ±5% 1/8W smd	569-0115-271
R 411	1.5k ohm ±5% 1/8W smd	569-0115-152
R 412	680 ohm ±5% 1/8W smd	569-0115-681
R 413	10 ohm ±5% 1/8W smd	569-0115-100
R 414	10 ohm ±5% 1/8W smd	569-0115-100
R 415	68 ohm ±5% 1/8W smd	569-0115-680
R 416	1k ohm ±5% 1/8W smd	569-0513-102
R 417	20 ohm ±5% 1/8W smd	569-0115-200
R 418	20 ohm ±5% 1/8W smd	569-0115-200
R 501	51 ohm ±5% 1/8W smd	569-0115-510
R 502	51 ohm ±5% 1/8W smd	569-0115-510
R 503	51 ohm ±5% 1/8W smd	569-0115-510
R 504	51 ohm ±5% 1/8W smd	569-0115-510
R 505	10k ohm ±5% 1/8W smd	569-0115-103
R 601	.1 ohm 2W wirewound	569-2004-108
R 602	5.76k ohm ±1% 1/8W smd	569-0111-374
R 603	4.99k ohm ±1% 1/8W smd	569-0111-368
R 604	2.7k ohm ±5% 1/8W smd	569-0115-272
R 605	6.81k ohm ±1% 1/8W smd	569-0111-381
R 606	4.99k ohm ±1% 1/8W smd	569-0111-368
R 607	47k ohm ±5% 1/8W smd	569-0115-473
R 610	10k ohm ±5% 1/8W smd	569-0115-103
R 611	10k ohm trimmer	562-0121-103
R 612	20k ohm ±5% 1/8W smd	569-0115-203
R 613	1.8k ohm ±5% 1/8W smd	569-0115-182
R 614	180k ohm ±5% 1/8W smd	569-0115-184
R 615	1k ohm ±5% 1/8W smd	569-0115-102
R 616	180 ohm ±10% 1/2W carb comp	569-1504-181
R 617	100 ohm ±10% 1/2W carb comp	569-1504-101
R 710	100k ohm ±5% 1/8W smd	569-0115-104
R 730	750 ohm ±5% 1/8W smd	569-0115-751
R 731	75 ohm ±5% 1/8W smd	569-0115-750
R 732	51 ohm ±5% 1/8W smd	569-0115-510
R 740	180 ohm ±5% 1/8W smd	569-0115-181
R 741	390 ohm ±5% 1/8W smd	569-0115-391
R 742	1k ohm ±5% 1/8W smd	569-0115-102
R 801	100 ohm ±5% 1/8W smd	569-0115-101
R 802	68 ohm ±5% 1/8W smd	569-0115-680
R 803	100 ohm ±5% 1/8W smd	569-0115-101
R 804	2.2k ohm ±5% 1/8W smd	569-0115-222
R 805	15k ohm ±5% 1/8W smd	569-0115-153
R 806	12k ohm ±5% 1/8W smd	569-0115-123
R 820	100k ohm ±5% 1/8W smd	569-0115-104
R 821	100k ohm ±5% 1/8W smd	569-0115-104
R 822	47k ohm ±5% 1/8W smd	569-0115-473

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 823	15k ohm ±5% 1/8W smd	569-0115-153
R 824	3k ohm ±5% 1/8W smd	569-0115-302
R 825	3k ohm ±5% 1/8W smd	569-0115-302
R 826	150 ohm ±5% 1/8W smd	569-0115-151
R 827	150 ohm ±5% 1/8W smd	569-0115-151
R 830	56k ohm ±5% 1/8W smd	569-0115-563
R 831	100k ohm ±5% 1/8W smd	569-0115-104
R 840	1.0M ohm ±5% 1/8W smd	569-0115-105
R 841	100 ohm ±5% 1/8W smd	569-0115-101
R 842	27k ohm ±5% 1/8W smd	569-0115-273
R 843	2k ohm ±5% 1/8W smd	569-0115-202
R 844	1k ohm ±5% 1/8W smd	569-0115-102
R 850	10k ohm trimmer	562-0121-103
R 851	100k ohm ±5% 1/8W smd	569-0115-104
R 852	10k ohm ±5% 1/8W smd	569-0115-103
R 853	47k ohm ±5% 1/8W smd	569-0115-473
R 880	4.7k ohm ±5% 1/8W smd	569-0115-472
R 881	4.7k ohm ±5% 1/8W smd	569-0115-472
R 882	10k ohm ±5% 1/8W smd	569-0115-103
R 883	1k ohm ±5% 1/8W smd	569-0115-102
R 900	10 ohm ±5% 1/8W smd	569-0115-100
R 901	2k ohm ±5% 1/8W smd	569-0115-202
R 920	16 ohm ±5% 1/8W smd	569-0115-160
R 921	16 ohm ±5% 1/8W smd	569-0115-160
R 922	16 ohm ±5% 1/8W smd	569-0115-160
R 931	4.7k ohm ±5% 1/8W smd	569-0115-472
R 932	10 ohm ±5% 1/8W smd	569-0115-100
R 933	1.5k ohm ±5% 1/8W smd	569-0115-152
R 934	75 ohm ±5% 1/8W smd	569-0115-750
R 935	470 ohm ±5% 1/8W smd	510-0115-471
R 941	4.7k ohm ±5% 1/8W smd	569-0115-472
R 942	10 ohm ±5% 1/8W smd	569-0115-100
R 943	1.5k ohm ±5% 1/8W smd	569-0115-152
R 944	75 ohm ±5% 1/8W smd	569-0115-750
R 945	470 ohm ±5% 1/8W smd	510-0115-471
R 950	10 ohm ±5% 1/8W smd	569-0115-100
RT201	Thermistor	569-3001-001
S 301	See R312	
S 302	See R312	
T 200	10mm 45 IF MHz transformer	592-5015-026
T 201	10mm 45 IF MHz transformer	592-5015-026
T 202	10mm 27 MHz autotransformer	592-5015-005
T 203	10mm 10.7 MHz IF transformer	592-5013-012
T 204	10mm 10.7 MHz IF transformer	592-5013-012
T 205	7mm 455 kHz ceramic disc coil	592-5022-005
U 001	Op amp (quad) 224	544-2020-014
U 002	Op amp (dual) 532	544-2019-004
U 003	Op amp (quad) 224	544-2020-014
U 004	Op amp (quad) 224	544-2020-014
U 005	Buffer (hex) 74C906	544-3716-906

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 006	Analog switch (quad) 4066	544-3016-066
U 007	Exclusive OR (quad) 4070	544-3016-070
U 008	NOR, 2-input (quad) 4001	544-3016-001
U 009	Driver, LED BCD/7-seg 4511	544-2027-011
U 010	EEPROM 2048 x 8 serial 24C16	544-5001-408
U 011	Microprocessor, w/software 8052 (for 8640)	023-9998-168
	Microcomputer, w/software 8052 (for 8644)	023-9998-169
U 012	Reset controller 7705	544-2012-001
U 013	Op amp (dual) 532	544-2019-004
U 201	FM IF system 3361	544-2026-007
U 300	Op amp (dual) 2904	544-2019-003
U 301	Amp, audio 10W TDA2003	544-2006-015
U 302	Regulator, 5V T0-220 7805	544-2003-016
U 501	18W 870-950 MHz power module	544-4001-029
U 601	Op amp (dual) 3358	544-2019-001
U 801	Prescaler,div by 128/129 MB501	544-3954-017
U 802	Synthesizer, ser input 45158	544-3014-158
W 007	Flex cable, 18-conductor 5"	597-0016-014
X 001	IC socket, 10-pin	515-5008-250
X 011	IC socket, 40-pin	515-5008-019
Y 001	Crystal, 11.0590 MHz	521-0011-059
Y 201	Crystal, 10.245 MHz	519-0009-002
Y 800	TCXO, 17.150 MHz 1.5 PPM	518-7017-153
Z 200	Ceramic 938 MHz 6-pole filter	532-2006-010
Z 201	45 MHz 2-pole crystal filter	532-0020-001
Z 202	Crystal filter, 10.7 MHz 4-pole	532-0006-004
Z 203	Ceramic filter, 455 kHz	532-2004-006

DC POWER CABLE AND HARDWARE KIT PART NO. 023-4144-410/-422

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP001	Spade terminal, #6 crimp	586-0003-034
EP101	Power connector contact (2)	515-9033-006
EP104	Ring term, #10 12-10 AWG	586-0007-010
EP105	Ring term, 3/8" 8-12 AWG	586-0007-022
F 201	Fuse kit, 15A and 7A	534-0003-100
FH101	Fuseholder assembly includes:	
	Body	534-1004-031
	Knob w/washer	534-1004-032
	Contact, 14-16 AWG	534-1004-037
	Spring	534-1004-035
HW201	Screw, 4-24 x 1/4" (3)	575-3604-008
HW202	Screw, 4-20 x 5/8" (3)	575-5604-020
HW203	Screw, 10-24 x 7/16 (4)	575-8911-014
HW204	Self-drilling screw (2)	575-9077-565
HW205	Splice, butt insulated (1)	586-9008-061
HW206	Washer, flat #10 (4)	596-2410-014
HW207	Screw, 1/4-20 x 9/16" dogpt (2)	575-9005-018
HW208	Screw, 1/4-20 x 3/8" (2)	575-1914-012
HW209	Washer (2)	018-0822-001
HW210	Screw, 4-40 x 3/8" (1)	575-0604-012
MP201	HD mic clip	023-3514-001
P 101	Pow connector housing, dual	515-9033-012
W 101	Wire, 12 AWG stranded red	597-7021-202
W 103	Wire, 12 AWG stranded blue	597-7021-206

DC POWER CABLE ASSEMBLY PART NO. 023-4143-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP003	Contact 14-16 AWG	534-1004-037
EP101	Ring terminal 12-10 AWG	586-0007-010
EP103	Power connector contact	515-9033-006
F 101	Fuse 15A 32V FB AGC	534-0003-038
MP001	Fuseholder body	534-1004-031
MP002	Fuseholder knob	534-1004-032
MP003	Fuseholder spring	534-1004-035
P 101	Power connector, dual	515-9033-012
W 101	Wire 12 AWG blue	597-7021-206
W 102	Wire 12 AWG red	597-7021-202

HORN CABLE KIT PART NO. 023-8610-916

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP001	Contact, fuse 20-16 AWG	586-9004-001
EP002	Connector, tap 18-22 AWG	515-9005-007
F 001	Fuse 1A 250V FB AGC	534-0003-020
F 002	Fuse 1A 250V FB AGC	534-0003-020
HW001	Strain relief	574-0003-010
J 001	Connector (mates w/P2 on A/L board)	515-9031-231
MP001	Fuseholder body	534-1004-031
MP002	Fuseholder knob	534-1004-032
MP003	Fuseholder spring	534-1004-035
P 000	Connector, 14-pin	515-9031-437
P 001	Connector, 2-pos in-line	515-9032-302
P 002	Connector, 2-pos in-line	515-9032-302
Q 007	N-channel MOSFET	576-0006-107

AMPLIFIED DYNAMIC MICROPHONE PART NO. 250-0740-300

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 001	3.3 μF 20V tantalum chip	510-2606-339
C 002	220 pF ±5% NPO 50V cer chip	510-3602-221
EP001	Contact .038'' diameter	586-9008-100
EP002	Mic cord w/mod connector	597-2002-111
EP004	Terminal (on hanger)	022-0069-011
HW001	Screw 4-20 x 3/8	575-5604-012
HW002	Screw 4-20 x 5/16	575-5604-010
HW004	Screw 2-56 x 3/8	575-1602-012
MK001	Dynamic mic cartridge	589-1011-003
MP001	Case front black	032-0426-100
MP002	Case back black	032-0427-100
MP003	Actuator black	032-0428-050
MP004	Cartridge gasket	032-0429-075
MP005	Blast filter	018-1033-001
MP006	Switch bracket	017-1885-030
MP007	Hanger button	013-1216-005
MP008	Crimp retainer	017-2222-005
MP009	Rubber bumper	018-0798-009
MP010	Backing plate	015-0876-026
MP011	Strain relief, mic cord	032-0429-085
MP012	Shim support, rubber bumper	017-2222-007
NP001	Nameplate	559-0039-025
PC001	PC board, amplifier	035-0441-020
Q 001	NPN amplifier SOT-23	576-0003-631
R 001	51k ohm ±5% 1/8W chip	569-0115-513
R 002	18 ohm ±5% 1/8W chip	569-0115-180
S 001	Leaf switch SPST	583-1004-031

15 WATT SPEAKER (BLACK) PART NO. 250-0151-005

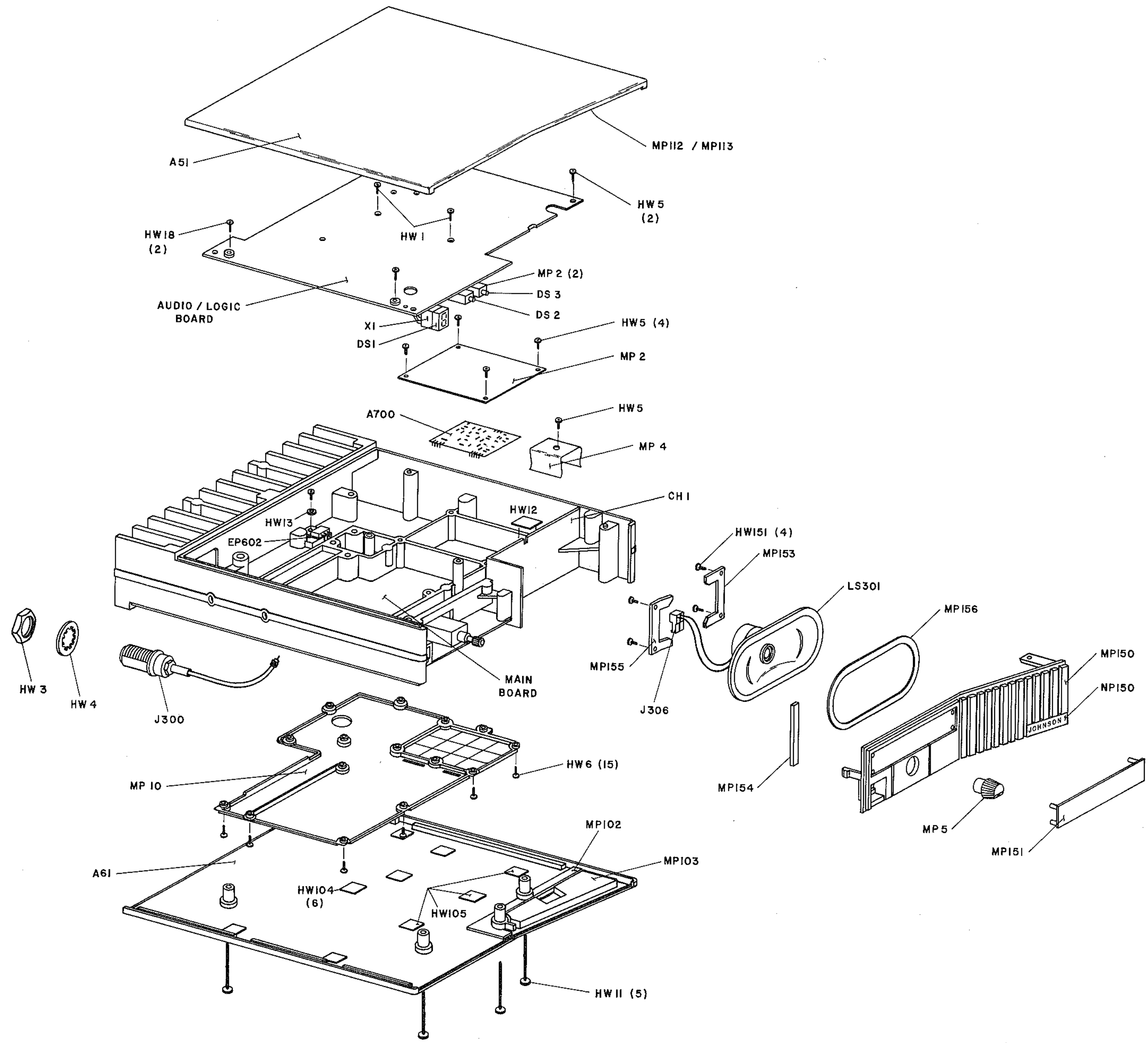
SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 001	Strain relief (near spkr plug)	023-3784-010
HW000	Screw, self-drilling	575-9077-543
HW001	Strain relief (in case back)	574-0003-008
HW003	Screw, 4-20 x ½ pan head	575-5604-016
HW005	Foam gasket	018-1126-001
HW006	Retaining washer	596-9210-012
LS001	Speaker, 5'' 15W 3.2 ohm	589-1016-001
MP000	Mounting bracket (black)	032-0760-004
MP000	Tri knob 10-32	547-0016-004
MP001	Case front (black)	032-0758-004
MP002	Case back (black)	032-0759-004
NP001	Overlay, speaker front	559-0072-010
P 001	Miniature phone plug	515-0020-003
W 001	Cable, 2-cond 18 AWG	597-2006-100

REMOTE PROGRAMMING INTERFACE (RPI) PART NO. 023-5800-000

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 001	Interface cable (RPI-adapter)	023-5800-011
C 001	10 μF 25V electrolytic	510-4325-100
C 002	10 μF 25V electrolytic	510-4325-100
C 003	.1 μF ±20% 25V Z5U ax cer	510-3546-104
C 004	10 μF 25V electrolytic	510-4325-100
C 005	.1 μF ±20% 25V Z5U ax cer	510-3546-104
C 006	10 μF 25V electrolytic	510-4325-100
C 007	.1 μF ±20% 25V Z5U ax cer	510-3546-104
C 008	470 μF 16V electrolytic	510-4316-471
CR001	1N4448 silicon diode	523-1500-883
HW101	Extruded chassis	014-0777-020
HW112	Polarizing key	515-7109-010
J 101	Connector, female 25-pin	515-0506-010
J 102	Connector, 10-pin	515-7104-005
J 103	2-pin header	515-7100-002
J 104	2-pin header	515-7100-002
MP102	End plate (J102)	017-2206-010
MP103	End plate (J101)	017-2206-015
MP107	Spacer, 4-40 hex male/fem	013-1160-103
NP100	Nameplate	559-3370-001
P 103	Shorting socket	515-5010-001
P 104	Shorting socket	515-5010-001
PC100	RPI PC board	035-5800-001
U 001	Line receiver (quad) 1489	544-2023-006
U 002	Line driver (quad) 1488	544-2023-007
U 003	Voltage converter 7660	544-2019-060
U 004	Regulator 5V 100 mA 78L05	544-2003-039
U 005	Regulator 9V 100 mA 78L09	544-2003-014

RPI INTERFACE MODULE
PART NO. 023-8610-901

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CR001	LED, green	549-4001-037
HW001	Extruded chassis	014-0777-020
HW002	Polarizing key	515-7109-010
J 001	Connector, 10-pin	515-7104-005
J 002	Connector, modular 8-pin	515-2006-040
MP001	End plate (J001)	017-2206-010
MP002	End plate, switch side	017-2206-020
PC001	PC board, interface	035-8610-901
R 001	1.0k ohm ±5% 1/4W CF	569-0513-102
S 001	Slide switch SPDT	583-3012-001
W 001	Cable, modular 8-cond	597-2002-200



864x EXPLODED VIEW

CHIP COMPONENT IDENTIFICATION

CHIP RESISTORS

The value of chip resistors is indicated by a number printed on the resistor. A three-digit number is used to identify ±5% and ±10% resistors, and a four-digit number is used to identify ±1% resistors. Refer to the following information.

±5% and ±10% Resistors (PN 510-0115-xxx)

The three digit number used to identify ±5% and ±10% resistors corresponds to the last three digits of the Johnson part number. This number is derived as shown below. For example, "273" indicates a 27,000 (27k) ohm resistor and "339" indicates a 3.3 ohm resistor.

X X X

Value in ohms — Multiplier

0 = 0
1 = 10
2 = 100
3 = 1000
4 = 10,000
5 = 100,000
6 = 1,000,000
7 = 10,000,000
8 = .01
9 = .1

±1% Resistors (PN 510-0111-xxx)

Some resistors with a ±1% tolerance are identified by a four-digit number and others may not have a marking. When identified with a four-digit number, the first three digits are the value and the fourth digit is the multiplier. For example, "5761" indicates a 5.76k ohm resistor.

CHIP CAPACITORS (CERAMIC AND TANTALUM)

Ceramic Chip Capacitors (PN 510-36xx-xxx)

Ceramic chip capacitors are identified using either an American or Japanese EIA standard. The American standard uses a single letter or number to indicate the value and the color of this letter or number to indicate the multiplier. The Japanese standard uses a letter to indicate the value followed by a number to indicate the multiplier. The values for both standards are shown in Table 1. For example, if there is a single black "E" on a capacitor, it uses the American standard and its value is 15 pF. This same value is identified with the Japanese standard by "E1".

The Japanese standard may also utilize a bar code to indicate the temperature coefficient. The following coefficients are indicated by this bar code. For example, "$\overline{A2}$" indicates a 100 pF NPO capacitor.

$\overline{X\ X}$ = NPO $\overline{X}$ X = N150   X $\overline{X}$ = N220
$\underline{X\ X}$ = N330 $\underline{X}$ X = N470   X $\underline{X}$ = N750
|X X = X7R

Tantalum Chip Capacitors (PN 510-26xx-xxx)

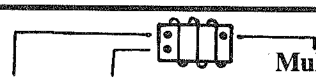
Tantalum chip capacitor identification varies with vendor and the physical size of the capacitor. The positive (+) end is usually indicated by a colored band or beveled edge. The value and voltage may be indicated by printing it on the capacitor or by using a special code.

TABLE 1 CERAMIC CHIP CAPACITOR IDENTIFICATION			
American EIA Standard		**Japanese EIA Standard**	
First Letter/Number	**Value (pF)**	**First Letter/Number**	**Value (pF)**
A	10	A	1.0
B	11	B	1.1
C	12	C	1.2
D	13	D	1.3
E	15	E	1.5
H	16	F	1.6
I	18	G	1.8
J	20	H	2.0
K	22	J	2.2
L	24	K	2.4
N	27	L	2.7
O	30	M	3.0
R	33	N	3.3
S	36	P	3.6
T	39	Q	3.9
V	43	R	4.3
W	47	S	4.7
X	51	T	5.1
Y	56	U	5.6
Z	62	V	6.2
3	68	W	6.8
4	75	X	7.5
7	82	Y	8.2
9	91	Z	9.1
Letter/Number Color	**Multiplier**	**Second Number**	**Multiplier**
Orange	0.1	0	1
Black	1	1	10
Green	10	2	100
Blue	100	3	1000
Violet	1000	4	10,000
Red	10,000	5	100,000

CHIP INDUCTORS (PN 542-9000-xxx)

Three colored dots are used to indicate the value of chip inductors. The two dots on the left side indicate the first and second digits of the value in nanohenries, and the single dot on the right side indicates the multiplier (refer to Table 2). For example, brown, black, and red dots indicate a value of 10 nH x 100 which is 1000 nH (1.0 μH). The last three digits of the part number are also the value and multiplier. The multiplier digits are shown in Table 2.

TABLE 2
CHIP INDUCTOR IDENTIFICATION



Color	1st Digit	2nd Digit	Multiplier (Last PN Digit)
Black	0	0	1 (7)
Brown	1	1	10 (8)
Red	2	2	100 (9)
Orange	3	3	1000 (0)
Yellow	4	4	10,000 (1)
Green	5	5	100,000 (2)
Blue	6	6	- - - -
Violet	7	7	- - - -
Gray	8	8	- - - -
White	9	9	0.1 (6)

CHIP TRANSISTORS AND DIODES

Surface mounted transistors and diodes are identified by a special number that is shown in the table on the first page of the schematic diagram and component layout section.

SECTION 9
SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

TRANSISTOR AND DIODE REFERENCE TABLE

TRANSISTORS

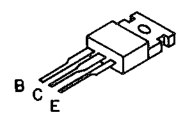
Part Number	Basing Diagram	Identification
576-0001-300	3	1R
576-0002-021	1	—
576-0003-610	2	02
576-0003-611	3	7X
576-0003-628	3	R22
576-0003-631	3	1A
576-0003-634	3	3B
576-0003-650	3	—
576-0003-657	3	2A
576-0003-658	3	1A
576-0003-659	3	7C
576-0003-660	4	3660
576-0004-098	5	—
576-0006-019	6	6T
576-0006-107	7	6107
576-0007-011	3	1N-FF

Number on schematic

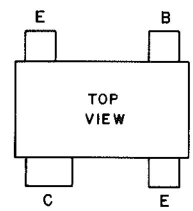
DIODES

523-1504-001	—	4D
523-1504-002	—	5A
523-1504-012	—	A2
523-1504-018	—	S1
523-1504-023	—	A7

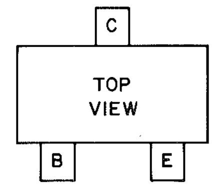
TRANSISTORS
(Bottom View Unless Otherwise Specified)



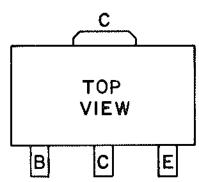
1



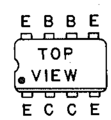
2



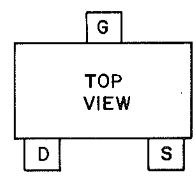
3



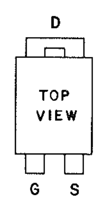
4



5

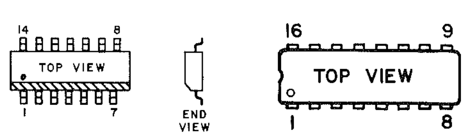


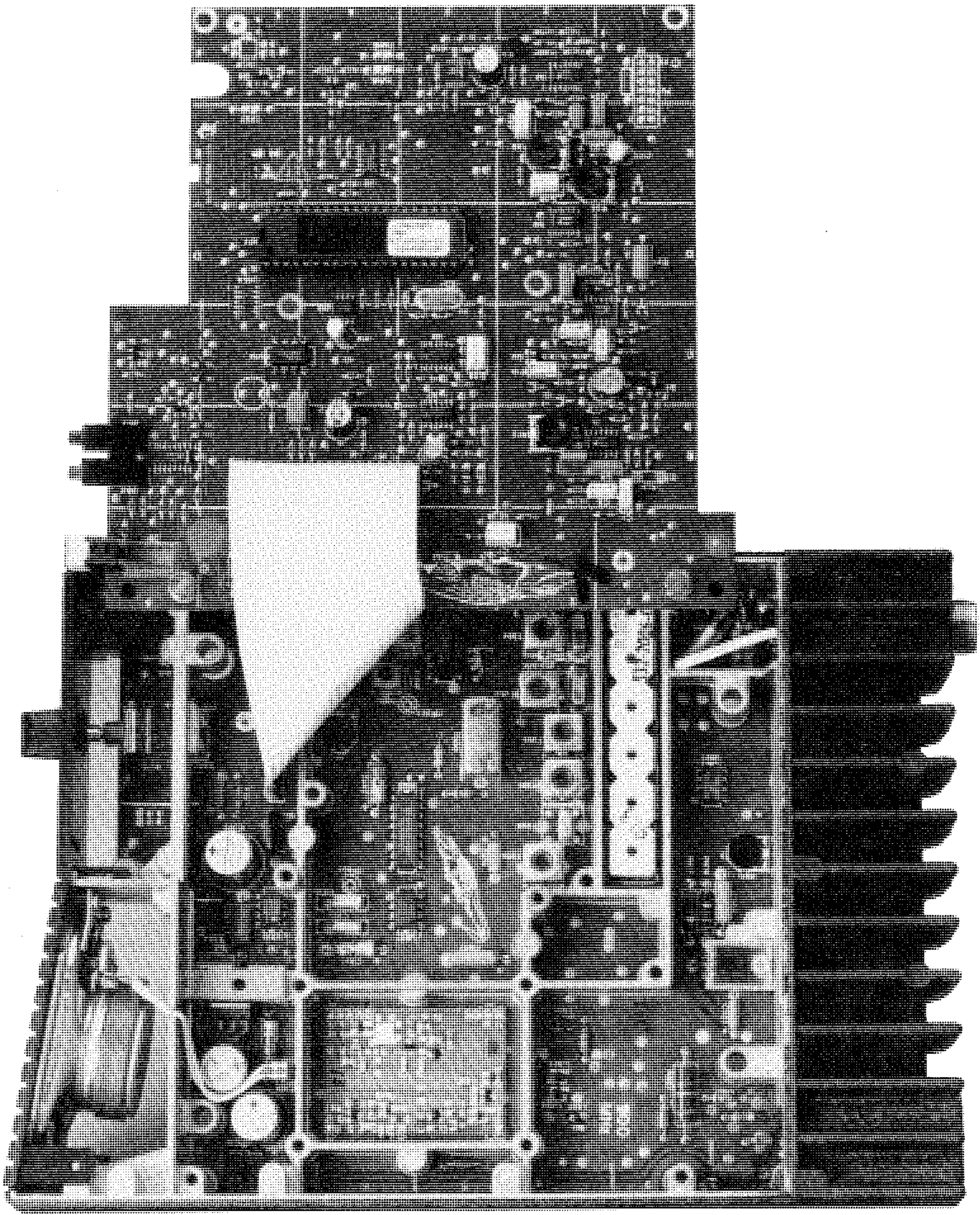
6



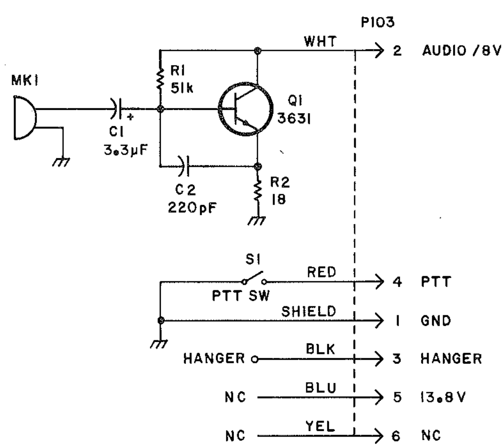
7

INTEGRATED CIRCUITS
TYPICAL PIN NUMBERING

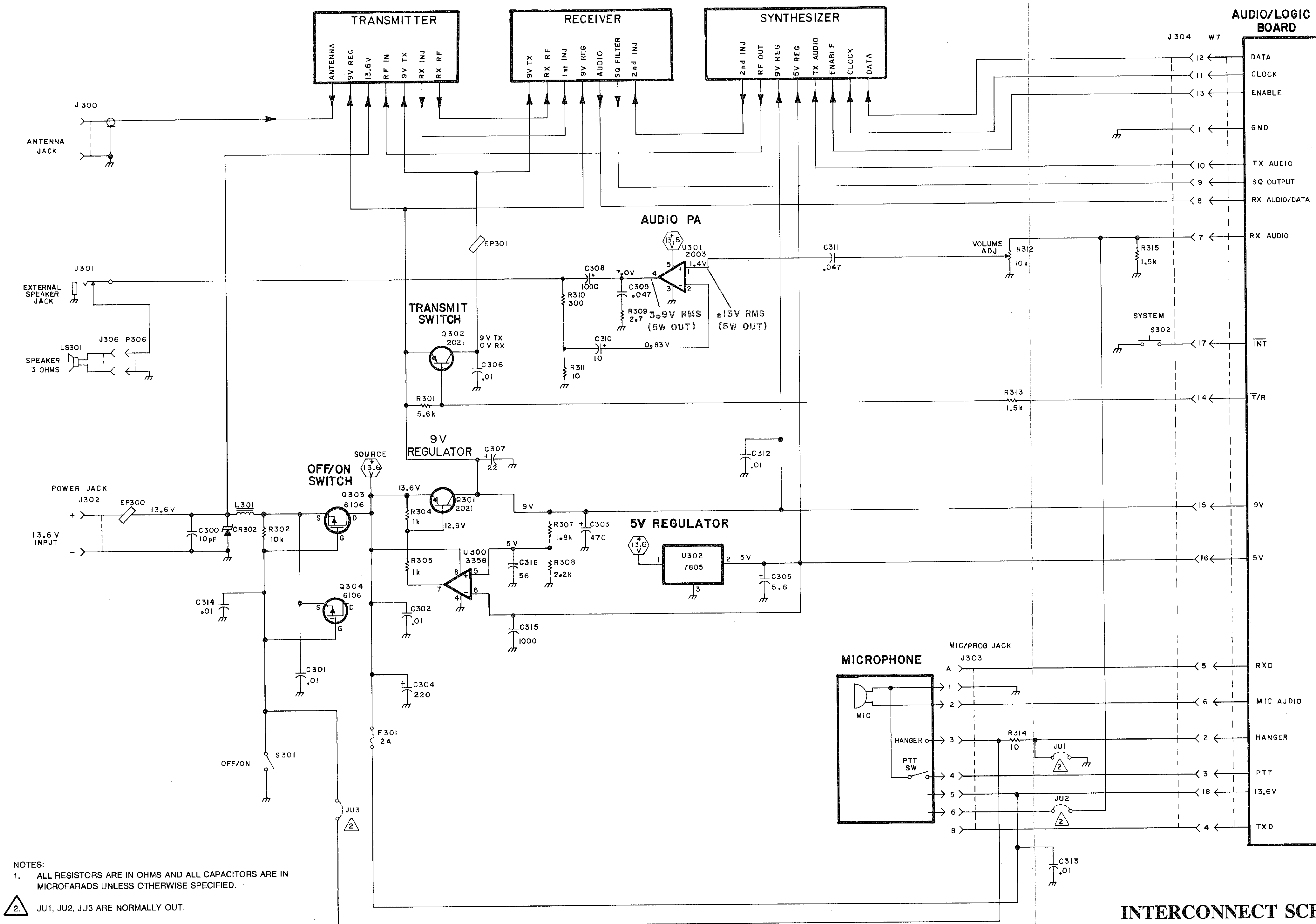




TRANSCEIVER TOP VIEW



DYNAMIC MICROPHONE SCHEMATIC
(Part No. 250-0740-300)

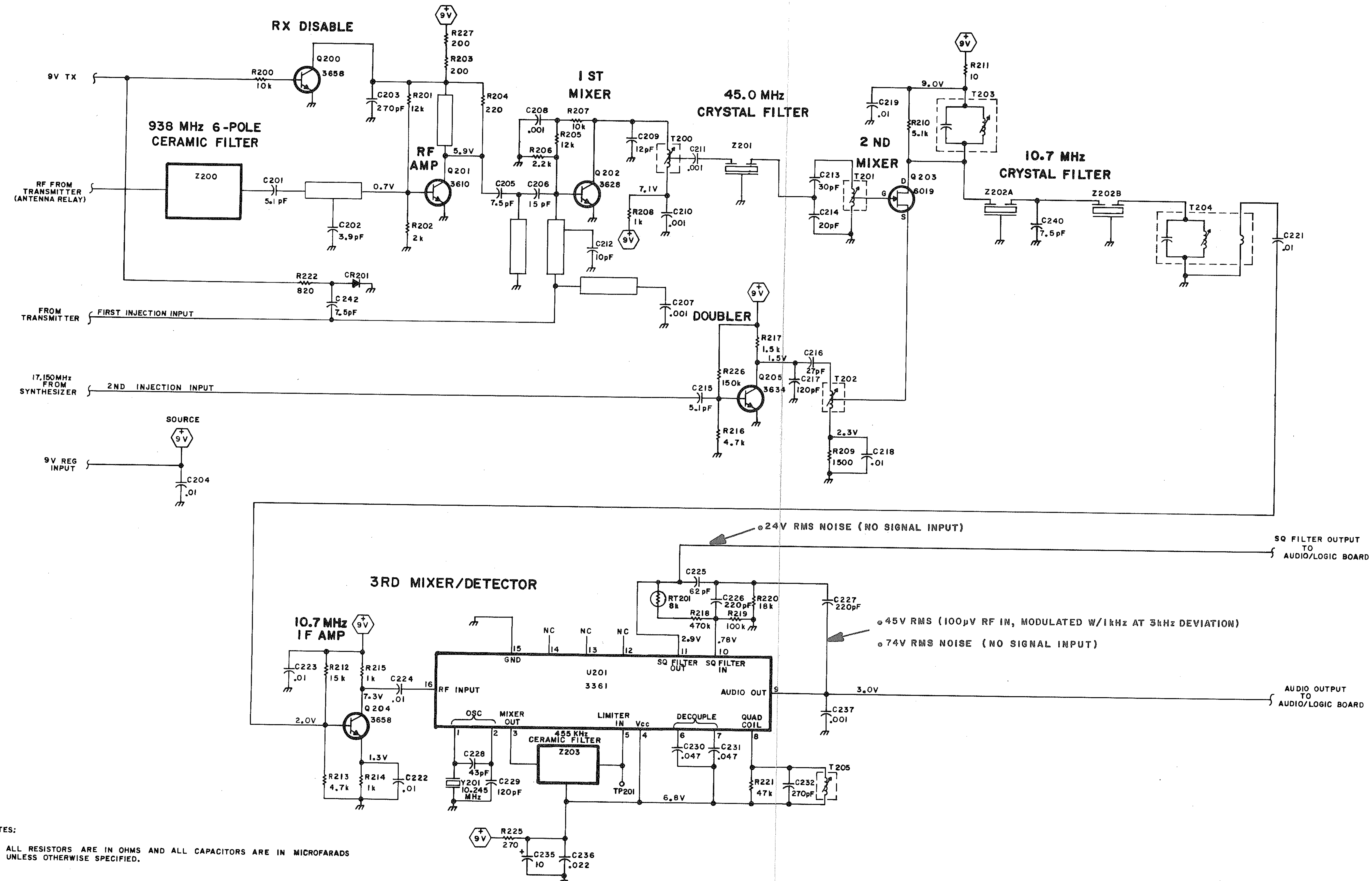


NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

△2. JU1, JU2, JU3 ARE NORMALLY OUT.

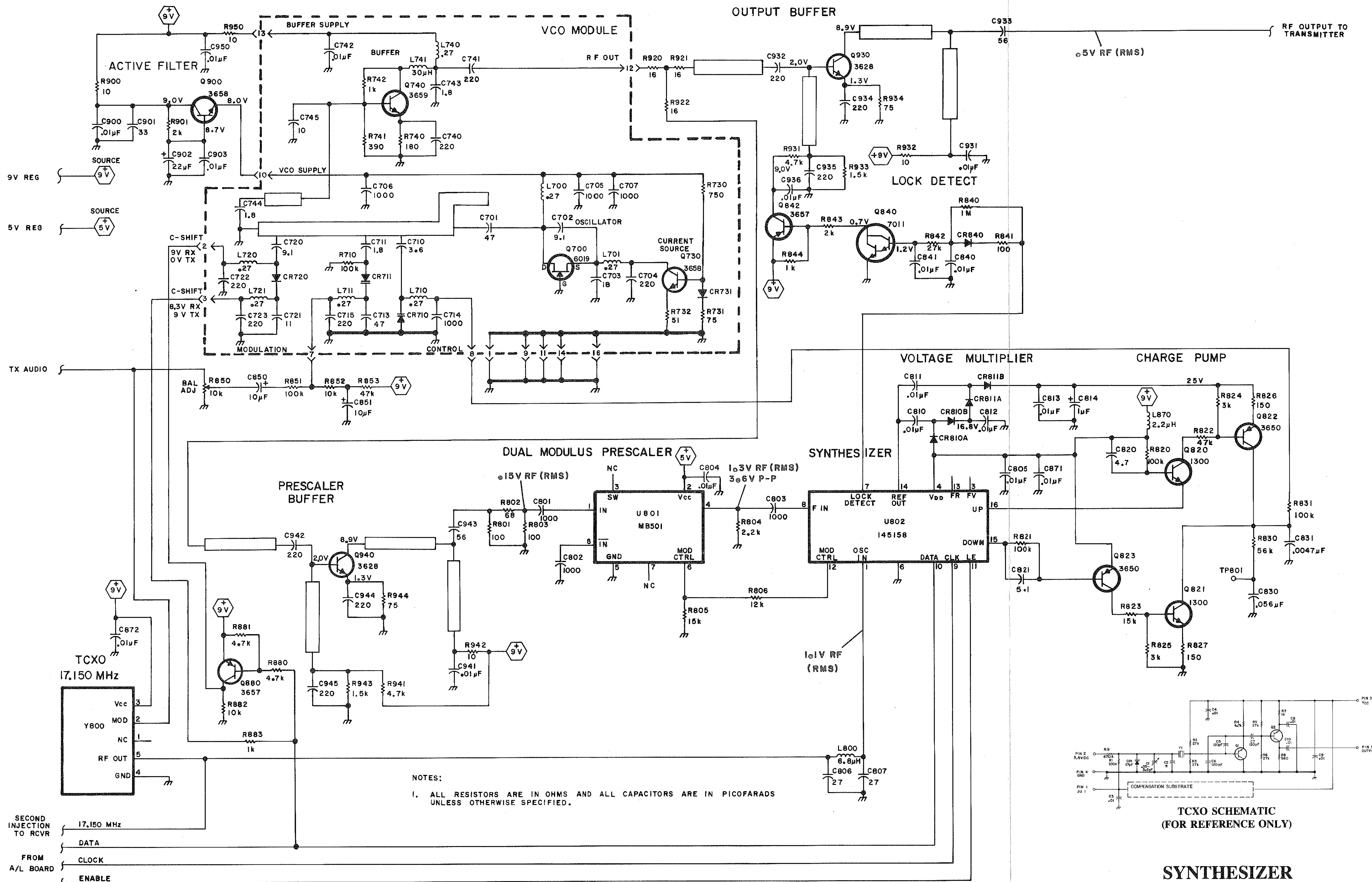
INTERCONNECT SCHEMATIC
(Receiver on Next Page)



NOTES:

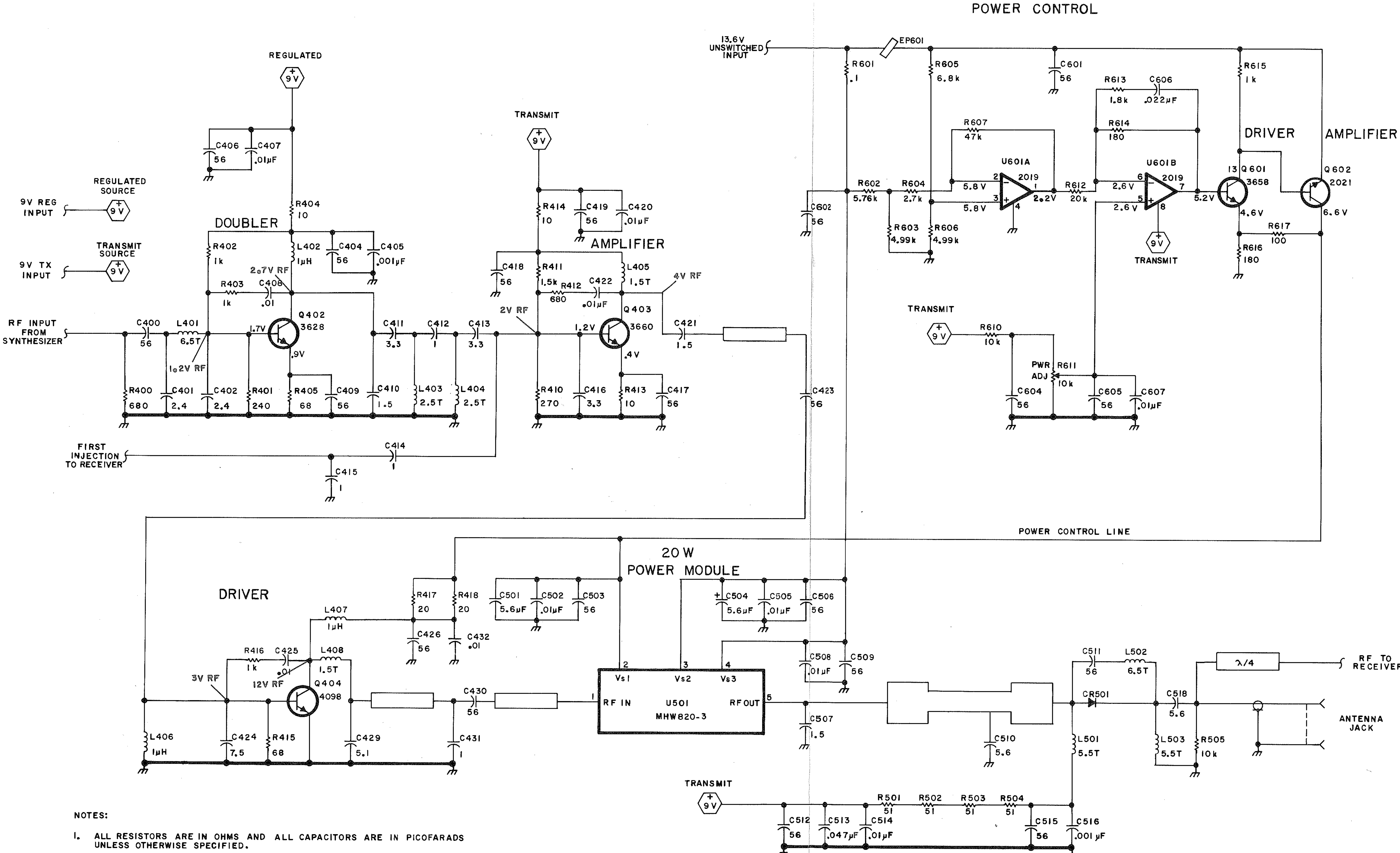
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

RECEIVER SCHEMATIC



SYNTHESIZER
(Transmitter on Next Page)

NOTE: The VCO Module is not serviceable because it is laser tuned at the factory and then coated with a plastic-type material.

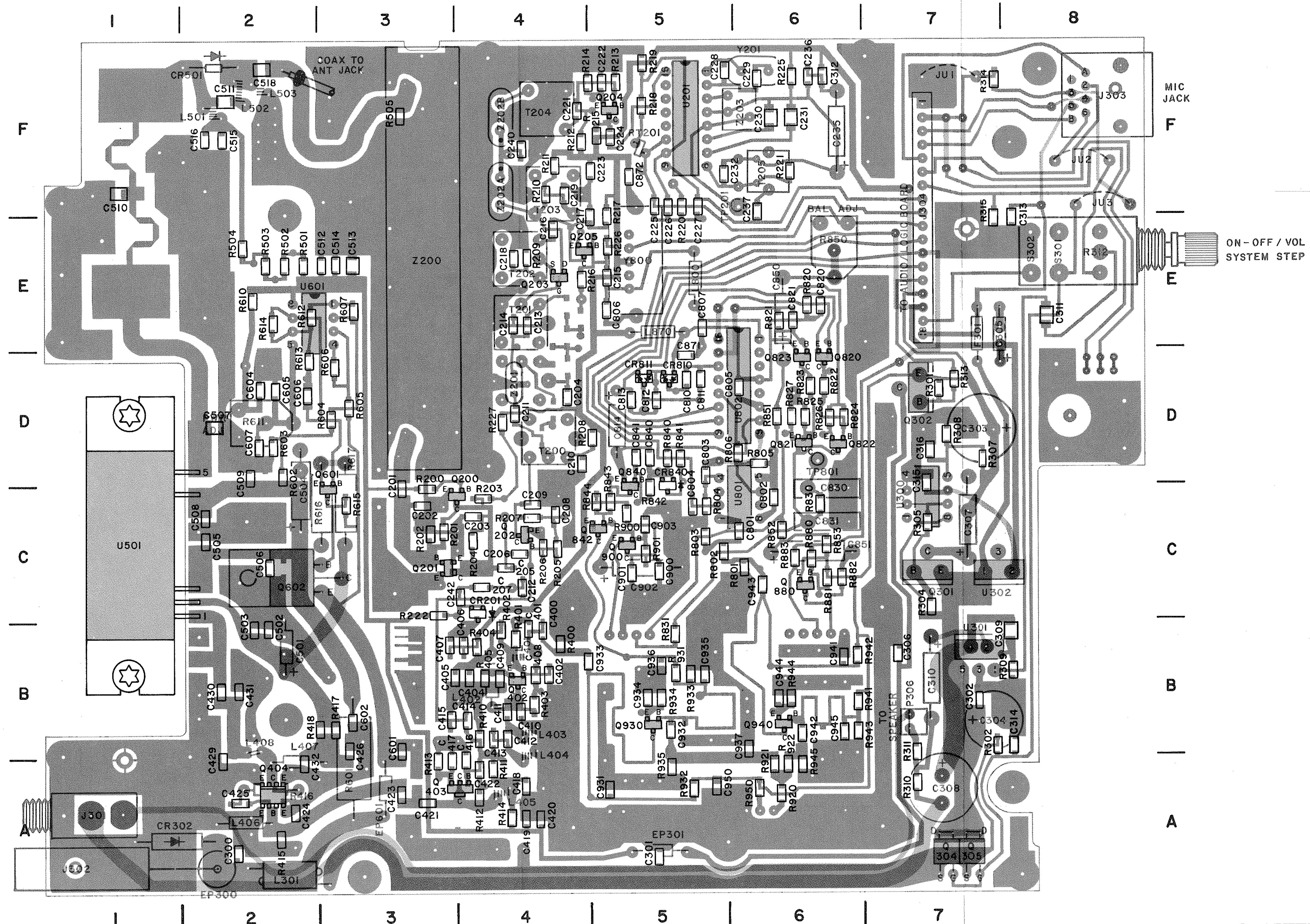


NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN PICOFARADS UNLESS OTHERWISE SPECIFIED.

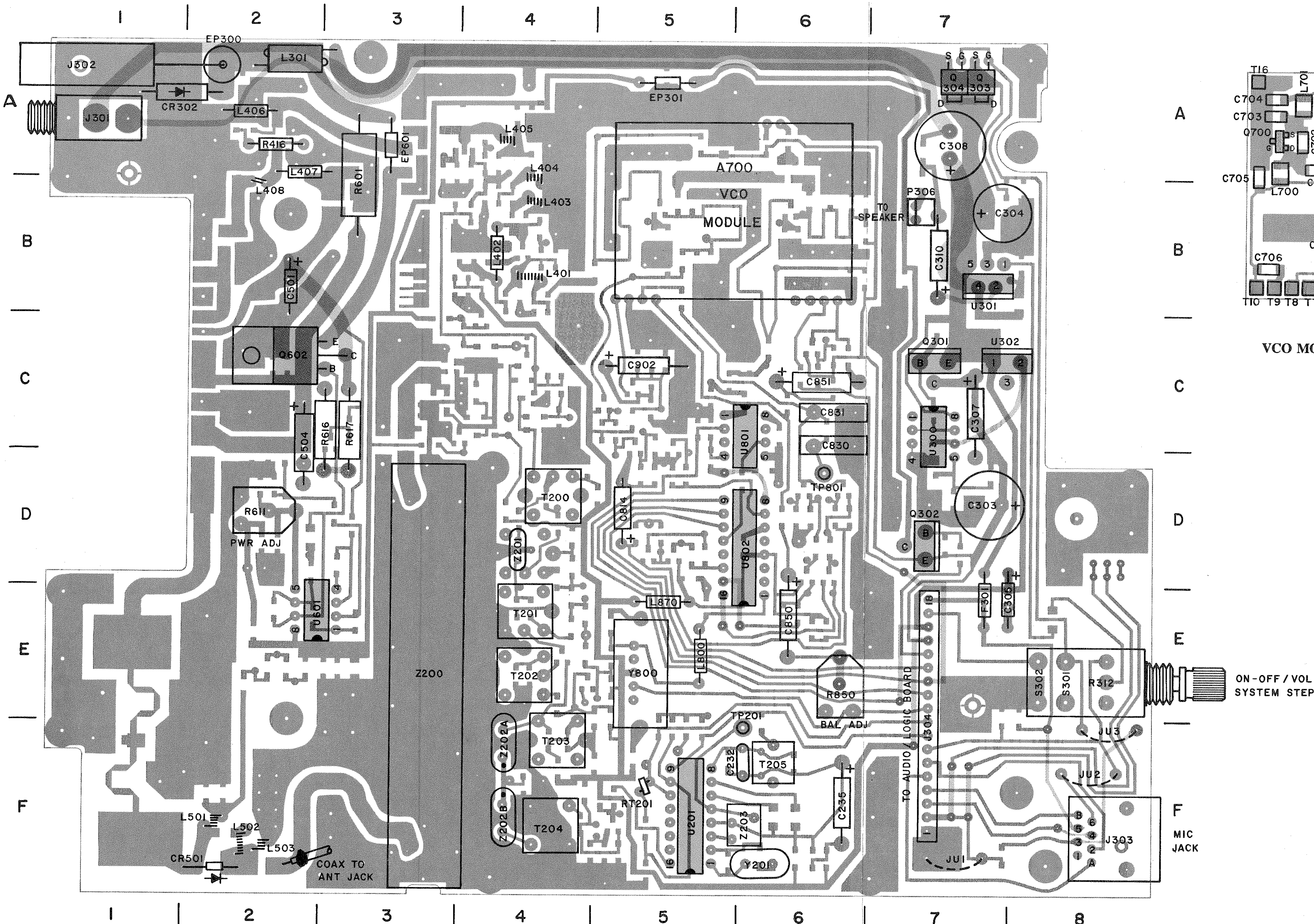
2. POWER CONTROL DC VOLTAGES MEASURED AT RATED POWER OUTPUT. OTHERS MEASURED WITH NO RF PRESENT.

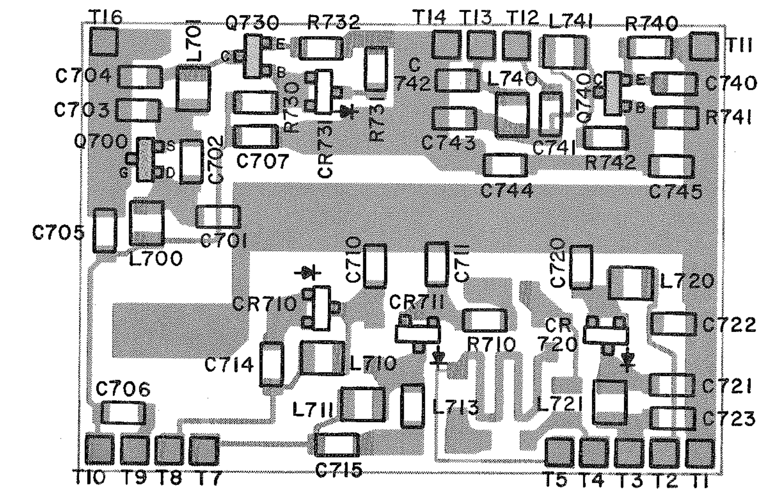
TRANSMITTER SCHEMATIC



MAIN BOARD BOTTOM VIEW
(Top View on Next Page)

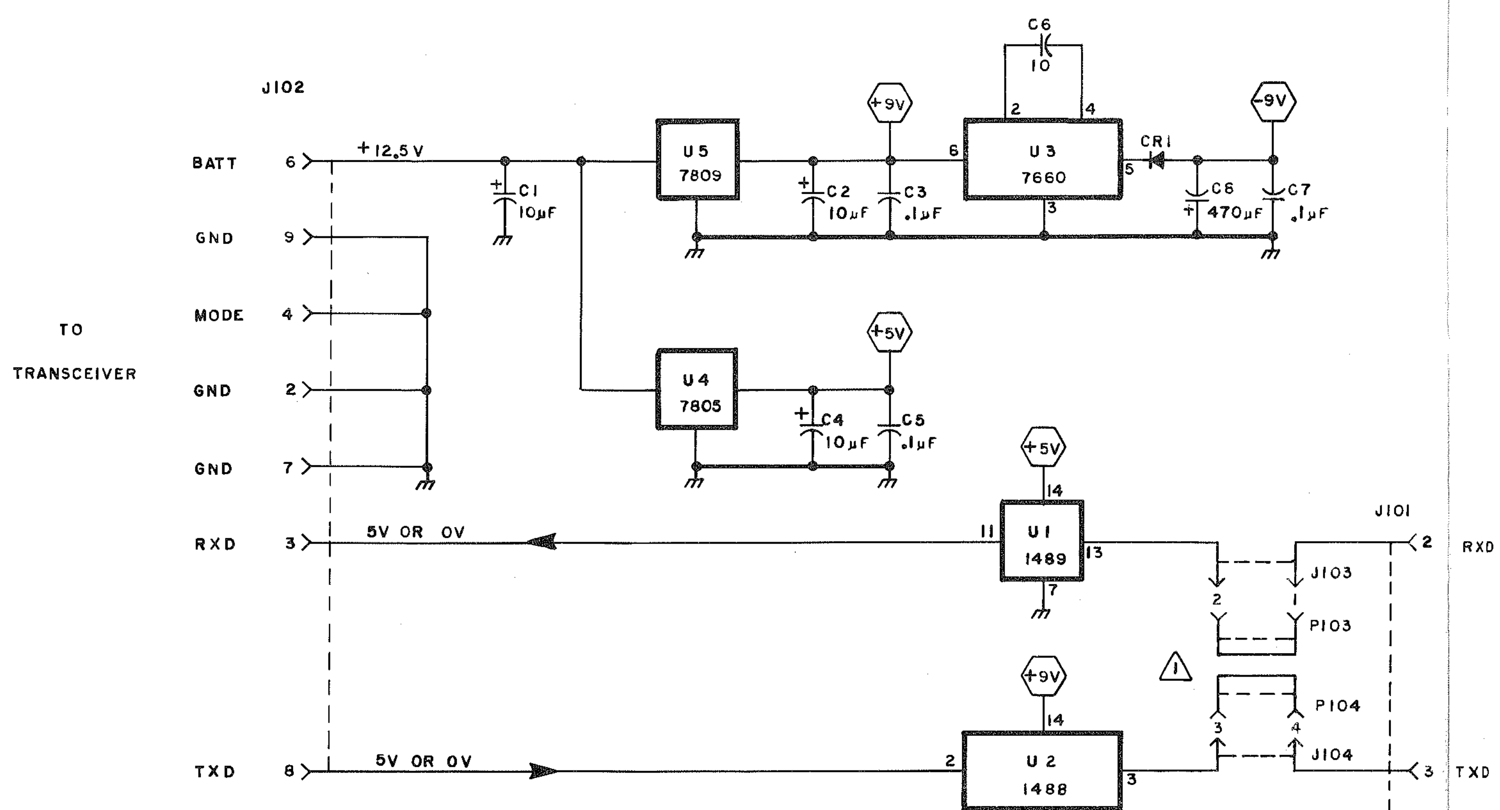
Note: Components in blue are located on the top side of the board.





VCO MODULE COMPONENT SIDE VIEW
(For Reference Only)

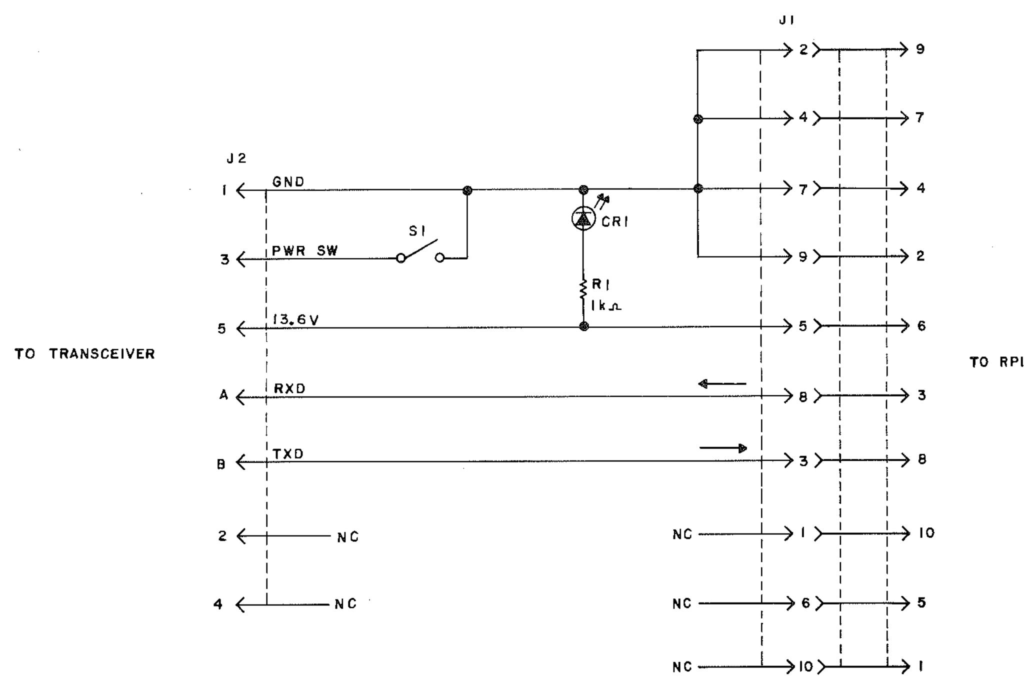
MAIN BOARD TOP VIEW



NOTES:

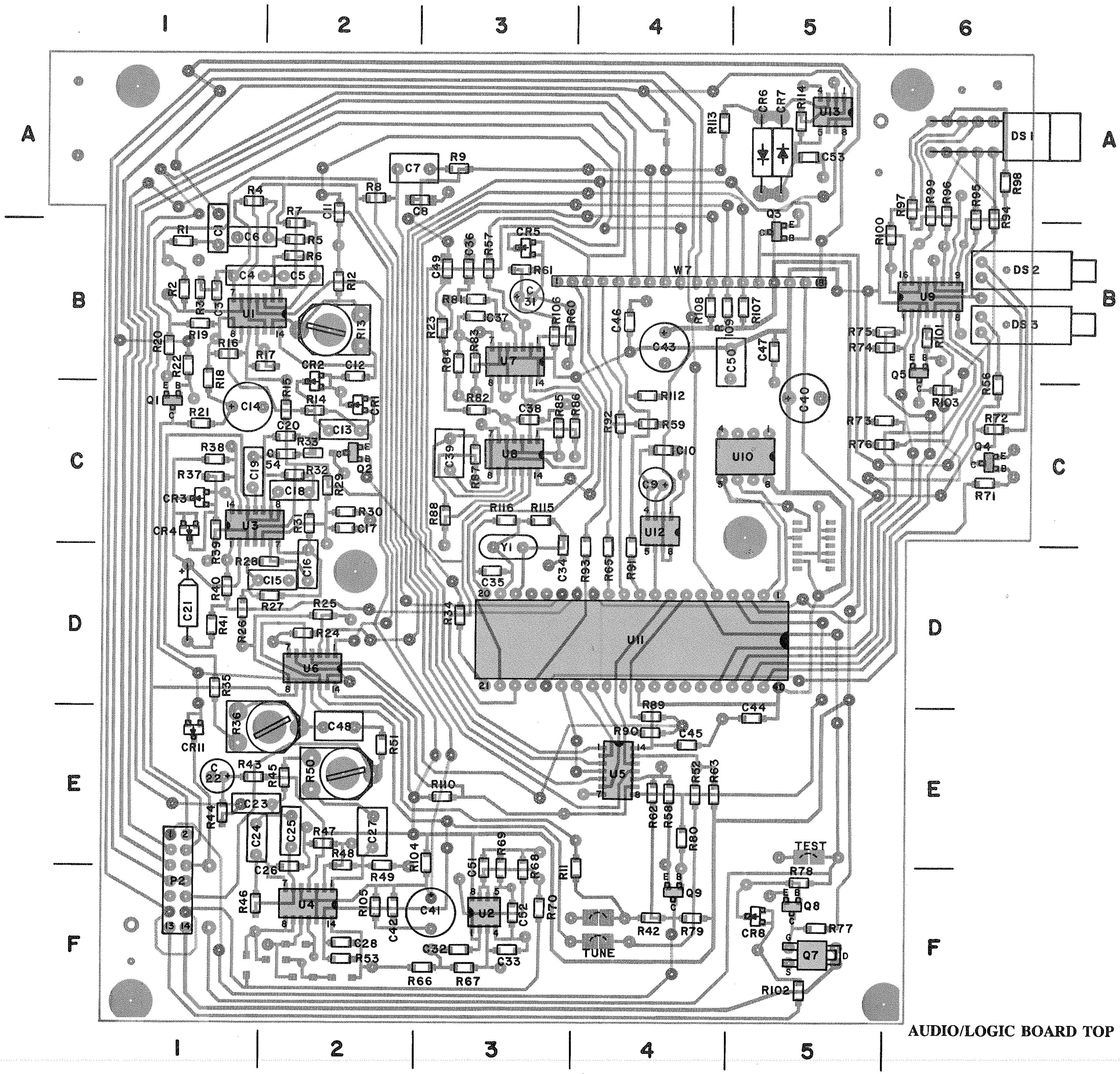
1. TO REVERSE RXD AND TXD, JUMPER J103 PIN 2 TO J104 PIN 4 AND J103 PIN 1 TO J104 PIN 3 BY ROTATING JUMPERS 90°.

REMOTE PROGRAMMING INTERFACE (RPI)
Part No. 023-5800-000

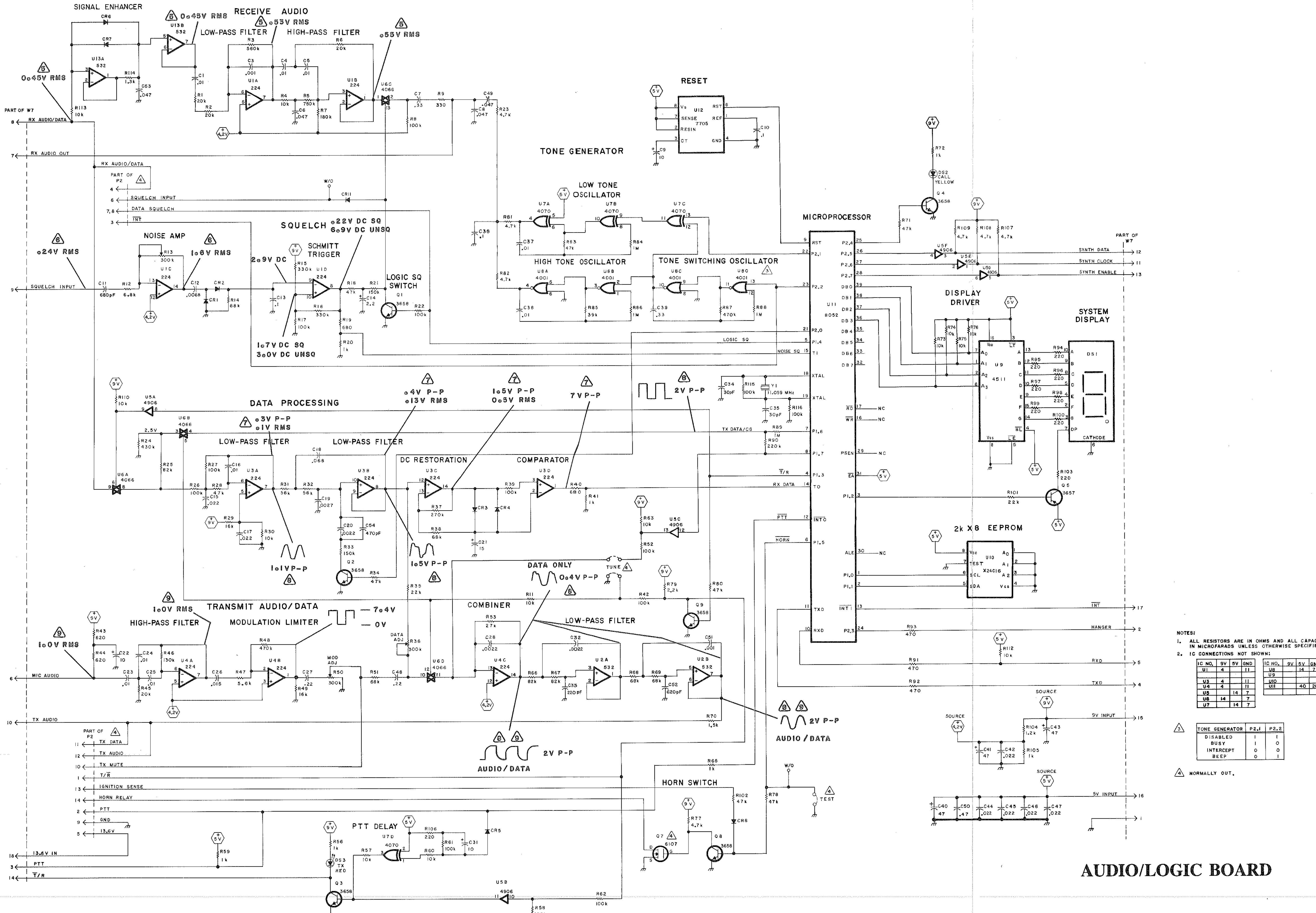


RPI INTERFACE MODULE SCHEMATIC DIAGRAM
Part No. 023-8610-901

(Audio/Logic Board Component Layout) FOLDOUT→



AUDIO/LOGIC BOARD TOP VIEW



AUDIO/LOGIC BOARD

The following information can be used to locate components on both sides of the PC board. Refer to the grid around the component layout to determine the location of the component.

MAIN BOARD COMPONENT LOCATOR GUIDE

COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM
A 302	See J302		C 309	B8	B	C 510	F1	B	C 813	D5	B
A 700	B6	T	C 310	B7	T	C 511	F2	B	C 814	D5	T
C 201	C3	B	C 311	E8	B	C 512	E3	B	C 820	E6	B
C 202	C3	B	C 312	F6	B	C 513	E3	B	C 821	E6	B
C 203	C4	B	C 313	E8	B	C 514	E3	B	C 830	C6	T
C 204	D4	B	C 314	B8	B	C 515	F2	B	C 831	C6	T
C 205	C4	B	C 315	D7	B	C 516	F2	B	C 840	D5	B
C 206	C4	B	C 316	D7	B	C 518	F2	B	C 841	D5	B
C 207	C4	B	C 400	B4	B	C 519	F1	B	C 850	E6	T
C 208	C4	B	C 401	B4	B	C 601	B3	B	C 851	C6	T
C 209	C4	B	C 402	B4	B	C 602	B3	B	C 871	D5	B
C 210	D4	B	C 404	B4	B	C 604	D2	B	C 872	F5	B
C 211	D4	B	C 405	B3	B	C 605	D2	B	C 900	C5	B
C 212	C4	B	C 406	B4	B	C 606	D2	B	C 901	C5	B
C 213	E4	B	C 407	B3	B	C 607	D2	B	C 902	C5	T
C 214	E4	B	C 408	B4	B	C 701	VCO Module		C 903	C5	B
C 215	E5	B	C 409	B4	B	C 702	VCO Module		C 931	A5	B
C 216	E4	B	C 410	B4	B	C 703	VCO Module		C 932	B5	B
C 217	E4	B	C 411	B4	B	C 704	VCO Module		C 933	B4	B
C 218	E4	B	C 412	B4	B	C 705	VCO Module		C 934	B5	B
C 219	F4	B	C 413	B4	B	C 706	VCO Module		C 935	B5	B
C 221	F4	B	C 414	B4	B	C 707	VCO Module		C 936	B5	B
C 222	F5	B	C 415	B3	B	C 710	VCO Module		C 937	B6	B
C 223	F5	B	C 416	A4	B	C 711	VCO Module		C 941	B6	B
C 224	F5	B	C 417	A3	B	C 713	VCO Module		C 942	B6	B
C 225	F5	B	C 418	A4	B	C 714	VCO Module		C 943	C6	B
C 226	F5	B	C 419	A4	B	C 715	VCO Module		C 944	B6	B
C 227	F5	B	C 420	A4	B	C 720	VCO Module		C 945	B6	B
C 228	F5	B	C 421	A3	B	C 721	VCO Module		C 950	A5	B
C 229	F6	B	C 422	A4	B	C 722	VCO Module		CR201	C4	B
C 230	F6	B	C 423	A3	B	C 723	VCO Module		CR302	A1	T
C 231	F6	B	C 424	A2	B	C 740	VCOModule		CR501	F2	T
C 232	F6	T	C 425	A2	B	C 741	VCO Module		CR710	VCO Module	
C 235	F6	T	C 426	B3	B	C 742	VCO Module		CR711	VCO Module	
C 236	F6	B	C 429	B2	B	C 743	VCO Module		CR720	VCO Module	
C 237	F6	B	C 430	B2	B	C 744	VCO Module		CR731	VCO Module	
C 240	F4	B	C 431	B2	B	C 745	VCO Module		CR810	D5	B
C 242	C4	B	C 432	A2	B	C 801	C6	B	CR811	D5	B
C 300	A2	B	C 501	B2	T	C 802	C6	B	CR840	C5	B
C 301	A5	B	C 502	B2	B	C 803	D5	B	EP300	A2	T
C 302	B7	B	C 503	B2	B	C 804	C5	B	EP301	A5	T
C 303	D7	T	C 504	C2	T	C 805	D6	B	EP601	A3	T
C 304	B7	T	C 505	C2	B	C 806	E5	B	F 301	E7	T
C 305	E7	T	C 506	C2	B	C 807	E5	B	J 301	A1	T
C 306	B7	B	C 507	D2	B	C 810	D5	B	J 302	A1	T
C 307	C7	T	C 508	D2	B	C 811	D5	B	J 303	F8	T
C 308	A7	T	C 509	D2	B	C 812	D5	B	J 304	E7	T

MAIN BOARD COMPONENT LOCATOR GUIDE (Cont.)

COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM
L 301	A2	T	Q 940	B6	B	R 415	A2	B	R 843	C5	B
L 401	B4	T	R 200	C3	B	R 416	A2	T	R 844	C5	B
L 402	B4	T	R 201	C3	B	R 417	A3	B	R 850	F6	T
L 403	B4	T	R 202	C3	B	R 418	B3	B	R 851	D6	B
L 404	A4	T	R 203	C4	B	R 501	E2	B	R 852	C6	B
L 405	A4	T	R 204	C4	B	R 502	E2	B	R 853	C6	B
L 406	A2	T	R 205	C4	B	R 503	E2	B	R 880	C6	B
L 407	A2	T	R 206	C4	B	R 504	E2	B	R 881	C6	B
L 408	B2	T	R 207	C4	B	R 505	F3	B	R 882	C6	B
L 501	F2	T	R 208	D5	B	R 601	B3	T	R 883	C6	B
L 502	F2	T	R 209	E4	B	R 602	D2	B	R 900	C5	B
L 503	F2	T	R 210	F4	B	R 603	D2	B	R 901	C5	B
L 700	VCO Module		R 211	F4	B	R 604	D3	B	R 920	A6	B
L 701	VCO Module		R 212	F4	B	R 605	D3	B	R 921	A6	B
L 710	VCO Module		R 213	F5	B	R 606	D3	B	R 922	A6	B
L 711	VCO Module		R 214	F5	B	R 607	E3	B	R 931	B5	B
L 720	VCO Module		R 215	F5	B	R 610	E2	B	R 932	A5	B
L 721	VCO Module		R 216	E4	B	R 611	D2	T	R 933	B5	B
L 740	VCO Module		R 217	F5	B	R 612	E2	B	R 934	B5	B
L 741	VCO Module		R 218	F5	B	R 613	D2	B	R 935	A5	B
L 800	E5	T	R 219	F5	B	R 614	E2	B	R 941	B6	B
L 870	E5	T	R 220	F5	B	R 615	C3	B	R 942	B6	B
P 306	B7	T	R 221	F6	B	R 616	C3	T	R 943	B6	B
Q 200	C3	B	R 222	C3	B	R 617	C3	T	R 944	B6	B
Q 201	C3	B	R 225	F6	B	R 710	VCO Module		R 945	A6	B
Q 202	C4	B	R 226	E5	B	R 730	VCO Module		R 950	A6	B
Q 203	E4	B	R 227	D4	B	R 731	VCO Module		RT201	F5	T
Q 204	F5	B	R 301	D7	B	R 732	VCO Module		T 200	D4	T
Q 205	E4	B	R 302	B7	B	R 740	VCO Module		T 201	E4	T
Q 301	C7	T	R 304	C7	B	R 741	VCO Module		T 202	E4	T
Q 302	D7	T	R 305	C7	B	R 742	VCO Module		T 203	F4	T
Q 303	A7	T	R 307	D7	B	R 801	C6	B	T 204	F4	T
Q 304	A7	T	R 308	D7	B	R 802	C5	B	T 205	F6	T
Q 402	B4	B	R 309	B8	B	R 803	C5	B	TP201	E6	T
Q 403	A4	B	R 310	A7	B	R 804	C5	B	TP801	D6	T
Q 404	A2	B	R 311	B7	B	R 805	D6	B	U 201	F5	T
Q 601	C3	B	R 312	E8	T	R 806	D6	B	U 300	C7	T
Q 602	C2	T	R 313	D7	B	R 820	E6	B	U 301	B7	T
Q 700	VCO Module		R 314	F7	B	R 821	E6	B	U 302	B7	T
Q 730	VCO Module		R 315	E7	B	R 822	D6	B	U 501	C1	B
Q 740	VCO Module		R 400	B4	B	R 823	D6	B	U 601	E2	T
Q 820	D6	B	R 401	B4	B	R 824	D6	B	U 801	C6	T
Q 821	D6	B	R 402	B4	B	R 825	D6	B	U 802	D6	T
Q 822	D6	B	R 403	B4	B	R 826	D6	B	Y 201	F6	T
Q 823	D6	B	R 404	B4	B	R 827	D6	B	Y 800	E5	T
Q 840	C5	B	R 405	B4	B	R 830	C6	B	Z 200	E3	T
Q 842	C5	B	R 410	B4	B	R 831	B5	B	Z 201	D4	T
Q 880	C6	B	R 412	A4	B	R 840	B5	B	Z 202	F4	T
Q 930	C5	B	R 413	A3	B	R 841	D5	B	Z 203	F6	T
Q 930	B5	B	R 414	A4	B	R 842	C5	B			

The following guide can be used to locate components on the audio/logic board. Refer to the grid around the audio/logic board component layout to determine the location of the component.

AUDIO/LOGIC BOARD COMPONENT LOCATOR GUIDE

COMP	LOC	COMP	LOC	COMP	LOC	COMP	LOC
C 001	B1	C 053	A5	R 029	C2	R 081	B3
C 003	B1	C 054	C2	R 030	C2	R 082	C3
C 004	B1	CR001	C2	R 031	C2	R 083	B3
C 005	B2	CR002	C2	R 032	C2	R 084	B3
C 006	B1	CR003	C1	R 033	C2	R 085	C3
C 007	A2	CR004	C1	R 034	D3	R 086	C4
C 008	A2	CR005	B3	R 035	D1	R 087	C3
C 009	C4	CR006	A5	R 036	E2	R 088	C3
C 010	C4	CR007	A5	R 037	C1	R 089	E4
C 011	A2	CR008	F5	R 038	C1	R 090	E4
C 012	B2	DS001	A6	R 039	C1	R 091	D4
C 013	C2	DS002	B6	R 040	D1	R 092	C4
C 014	C1	DS003	B6	R 041	D1	R 093	D4
C 015	D2	P 002	F1	R 042	F4	R 094	A6
C 016	D2	Q 001	C1	R 043	E1	R 095	A6
C 017	C2	Q 002	C2	R 044	E1	R 096	A6
C 018	C2	Q 003	B5	R 045	E2	R 097	A6
C 019	C1	Q 004	C6	R 046	F1	R 098	A6
C 020	C2	Q 005	B6	R 047	E2	R 099	A6
C 021	D1	Q 007	F5	R 048	E2	R 100	B6
C 022	E1	Q 008	F5	R 049	E2	R 101	B6
C 023	E1	Q 009	F4	R 050	E2	R 102	F5
C 024	E1	R 001	B1	R 051	E2	R 103	C6
C 025	E2	R 002	B1	R 052	E4	R 104	E3
C 026	F2	R 003	B1	R 053	F2	R 105	F2
C 027	E2	R 004	A1	R 056	C6	R 106	B3
C 028	F2	R 005	B2	R 057	B3	R 107	B5
C 031	B3	R 006	B2	R 058	E4	R 108	B4
C 032	F3	R 007	B2	R 059	C4	R 109	B4
C 033	F3	R 008	A2	R 060	B3	R 110	E3
C 034	C3	R 009	A3	R 061	B3	R 112	C4
C 035	D3	R 011	F4	R 062	E4	R 113	A4
C 036	B3	R 012	B2	R 063	E4	R 114	A5
C 037	B3	R 013	B2	R 065	D4	R 115	C3
C 038	C3	R 014	C2	R 066	F3	R 116	C3
C 039	C3	R 015	C2	R 067	F3	U 001	B1
C 040	C5	R 016	B1	R 068	F3	U 002	F3
C 041	F3	R 017	B1	R 069	F3	U 003	C1
C 042	F2	R 018	B1	R 070	F3	U 004	F2
C 043	B4	R 019	B1	R 071	C6	U 005	E4
C 044	E5	R 020	B1	R 072	C6	U 006	D2
C 045	E4	R 021	C1	R 073	C5	U 007	B3
C 046	B4	R 022	B1	R 074	B5	U 008	C3
C 047	B5	R 023	B3	R 075	B5	U 009	B6
C 048	E2	R 024	D2	R 076	C5	U 010	C5
C 049	B3	R 025	D2	R 077	F5	U 011	D4
C 050	B5	R 026	D1	R 078	F5	U 012	C4
C 051	F3	R 027	D2	R 079	F4	U 013	A5
C 052	F3	R 028	D2	R 080	E4	Y 001	D3

SERVICE MANUAL QUESTIONNAIRE

Your name ______________________

Company Name ______________________

Company Address ______________________

______________________ Zip ________

Today's Date ____________

Service Manual Title

Printing Date (3 or 4 digit number on back cover)

The purpose of this questionnaire is to improve our service manuals by including the most useful information. We feel that you, the user of this manual, know what kind of information you need to service our equipment. Therefore we need to hear from you and we are willing to use your ideas if we can get them.

1. Does the Installation Section help you install the transceiver? ________ If not, why? ________

2. Do you use the Circuit Description Section? ________ How? ________

3. What information in the Troubleshooting Section is most useful? ________

What type of troubleshooting information would be most useful to you? ________

4. Do you use the suggested test setups? ________ Can you suggest any test setups or test procedures that you feel are quicker or easier? ________

5. Do you use the suggested alignment procedure? ________ If not, what procedure do you follow? ________

6. Can you find the replacement part numbers in the Parts List quickly and easily? ________ If not, how would you like to see the Parts List arranged? ________

7. General Comments ________

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22	422	92Y	927.2750
23	423	92N	927.2875
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28	428	95Y	927.3500
29	429	95N	927.3625
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32	432	97Y	927.4000
33	433	97N	927.4125
34	434	98Y	927.4250
35	435	98N	927.4375
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45	445	103N	927.5625
46	446	104Y	927.5750
47	447	104N	927.5875
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49	449	105N	927.6125
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54	454	108Y	927.6750
55	455	108N	927.6875
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57	457	109N	927.7125
58	458	110Y	927.7250
59	459	110N	927.7375
60	460	111Y	927.7500
61	461	111N	927.7625
62	462	112Y	927.7750
63	463	112N	927.7875
64	464	113Y	927.8000
65	465	113N	927.8125
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67	467	114N	927.8375
68	468	115Y	927.8500
69	469	115N	927.8625
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71	471	116N	927.8875
72	472	117Y	927.9000
73	473	117N	927.9125
74	474	118Y	927.9250
75	475	118N	927.9375
76	476	119Y	927.9500
77	477	119N	927.9625
78	478	120Y	927.9750
79	479	120N	927.9875

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