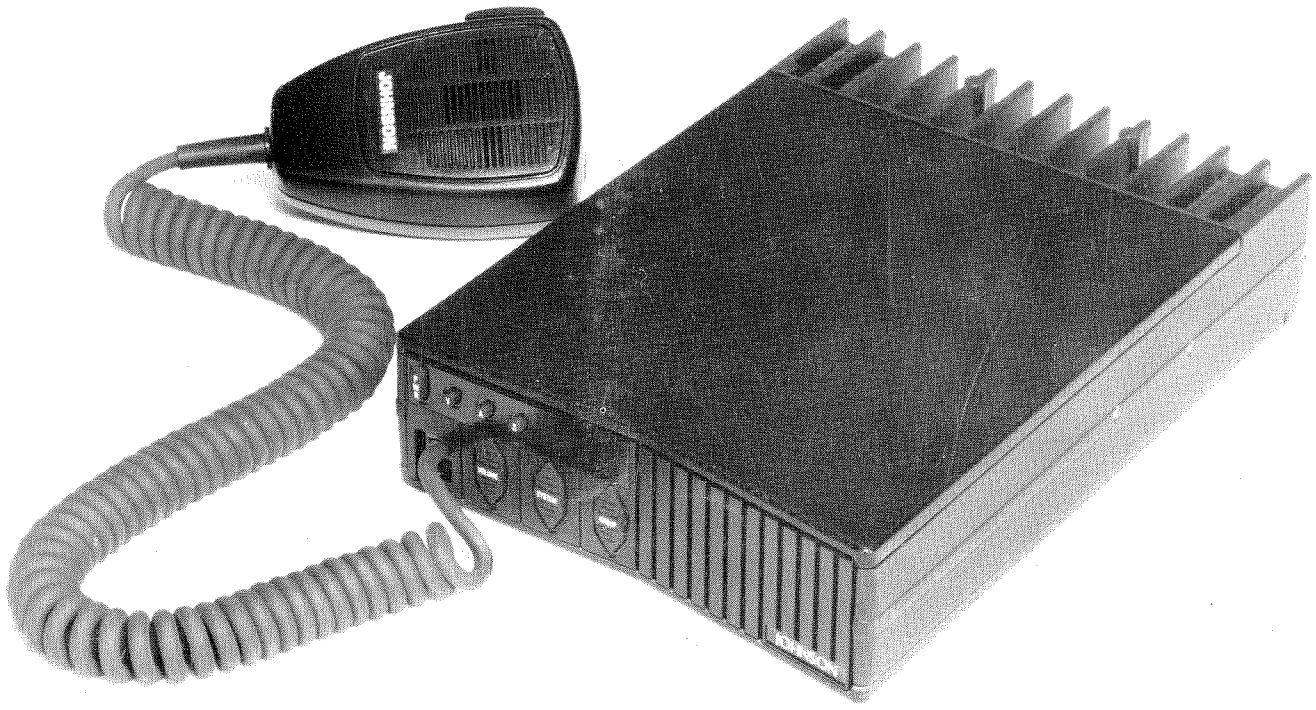
JOHNSON®

LTR® 8655
SERVICE MANUAL

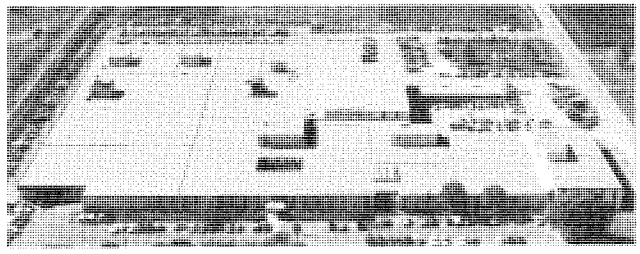


First Printing
December 1987

13.6 VDC, 30 Watts, 900 MHz
Part No. 242-8655-xxx

JOHNSON
LTR® 8655

FM TWO-WAY RADIO
13.6 VDC, 30 Watts
896-902 MHz Tx, 935-941 MHz Rx
Part No. 242-8655-xxx



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 mobiletelephone and land mobile radio services which include business, industrial, government, public safety, aeronautical, and personal users. In addition, Johnson designs and manufactures electronic components used in communications equipment and other electronic devices.

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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® 8655 transceiver.

1.2 TRANSCEIVER DESCRIPTION

The 8655 transceiver operates on 479 narrow-band channels in the 900 MHz frequency range. The transmit frequencies are 896-902 MHz and the receive frequencies are 39 MHz higher or 935-941 MHz. Currently, only the lower 399 channels from 896-901 MHz transmit and 935-940 MHz receive are allocated. Channel spacing is 12.5 kHz, and the maximum deviation is ± 2.5 kHz. Like the 8615, the 8655 operates in both the LTR (trunked) and conventional modes. The following are standard features available with this transceiver. Refer to Section 3 for a complete description of operating features.

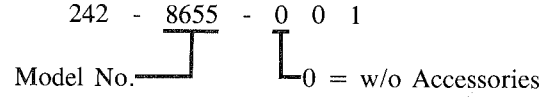
- Up to 10 systems programmable
- Up to 10 groups or channels programmable in each system
- System scan
- Horn alert
- Time-out timer
- Call indicator
- 30 watts power output

Like all Johnson LTR transceivers, the 8655 is digitally synthesized and logic controlled. In LTR trunked systems, all the user has to do to make a call is press the PTT switch. If a busy or out-of-range condition is not indicated by special tones, the path to the other party is complete and speaking can begin. Channel selection, monitoring before transmitting, and squelch control are all performed by the logic.

This transceiver is designed for dash or hump mounting within reach of the operator. Programming is performed using a dealer-supplied personal computer and a Johnson software package for the particular computer (refer to Section 4). No extra PROMs are needed for programming because a reprogrammable memory (EEPROM) is used for data storage.

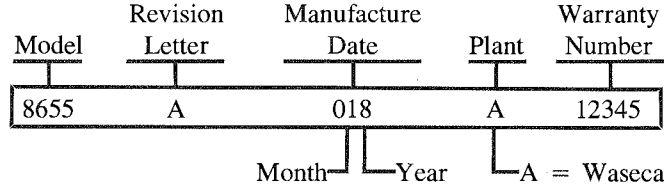
1.3 PART NUMBER BREAKDOWN

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



1.4 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a strip of adhesive-backed tape attached to the transceiver heat sink. The following information is contained in this number:



1.5 ACCESSORIES

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

MOUNTING HARDWARE

The mounting brackets are shown in Figure 2-1 in Section 2. The -918 hardware and cable kit includes the -010 10-foot power cable and also the microphone clip, ground wire, screws, and washers shown in Figure 2-1. The -022, 22-foot power cable is used in vehicles where the transceiver is mounted more than 10 feet from the battery.

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The -916 horn/ignition sense cable kit is used to connect the horn alert and/or ignition sense functions. It is a 4.5 foot, two-wire fused cable with an in-line connector to allow it to be easily unplugged from the transceiver. The desk-mount pedestal kit is used to mount the transceiver on a desk remotely from a power supply. It includes a 10-foot power cable and a pedestal.

MICROPHONES AND SPEAKER

This transceiver uses a low-impedance microphone. The -300 amplified dynamic microphone is the microphone shown on the front cover. The -021 DTMF microphone is used for telephone calls or other uses where DTMF signaling is required. This particular microphone has a lighted keypad, but no memory. The -010 desk microphone is used when this transceiver is used as a control station. It has a monitor button which can be locked down if desired. The -005 speaker has a power rating of 15 watts and a 6-foot cable. The microphone hanger bracket is used when a microphone hanger on the side of the transceiver is desired.

PROGRAMMING HARDWARE AND SOFTWARE

Refer to Section 4.1 for information on transceiver programming.

1.6 PRODUCT WARRANTY

The warranty statement for this transceiver 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

TABLE 1-1
ACCESSORIES

Accessory	Part Number
Standard Mounting Bracket	023-8610-115
Low-Profile Mounting Bracket	023-8610-120
Desk Mount Pedestal Kit	023-8610-914
Hardware and Cable Kit	023-7172-918
DC Power Cable, 10 ft 15 A	023-4143-010
DC Power Cable, 22 ft 15 A	023-4243-022
Horn/Ignition Sense Cable	023-8610-916
Microphone, Amplified Dynamic	250-0740-300
Microphone, DTMF	250-0751-021
Microphone, Desk	250-0742-010
Microphone Hanger Bracket	023-7100-960
Speaker, 5'' Remote (black)	250-0151-005
Front Panel Test Cable	023-8610-925
Remote Programming Interface (RPI)	023-5800-000
RPI Interface Module	023-8610-901
Cable, RPI to Radio Shack Model 100/200	023-5800-016
Cable, RPI to IBM PC	023-5800-017
Programming Software, 8610/8615	
Radio Shack Model 100/200	
Cassette	023-8610-921
Disk	023-8610-922
IBM PC (disk)	023-8610-923

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 8655 SPECIFICATIONS

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

GENERAL

Operating Mode	LTR and/or Conventional, simplex only
Frequency Range	896-902 MHz Tx, 935-941 MHz Rx; 935-941 MHz Tx (Conventional talk-around)
Systems	Up to 10
Groups	Up to 10 per system
Channels	Up to 20 per system (LTR) Up to 10 per system (Conventional)
Mounting Location	Front
Tx/Rx Separation	39 MHz 0 MHz (Conventional talk-around)
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	.35 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 (479 channels)
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	30 watts; 20 watts (Conventional talk-around)
Spurious and Harmonic	−60 dB
FM Hum and Noise	−35 dB (w/ C-message weighting)
Audio Modulation	11K0F1D, 11K0F3D, 11K0F3E
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 standard and talk-around
Frequency Stability	± 1.5 PPM from −22 to +140 degrees F (−30 to +60 degrees C)
Current Drain	12 amperes at 30 watts power output
Duty Cycle	EIA 20%
Circuit Protection	15 ampere fuse in power cable
Load Impedance	50 ohms

SECTION 2
INSTALLATION

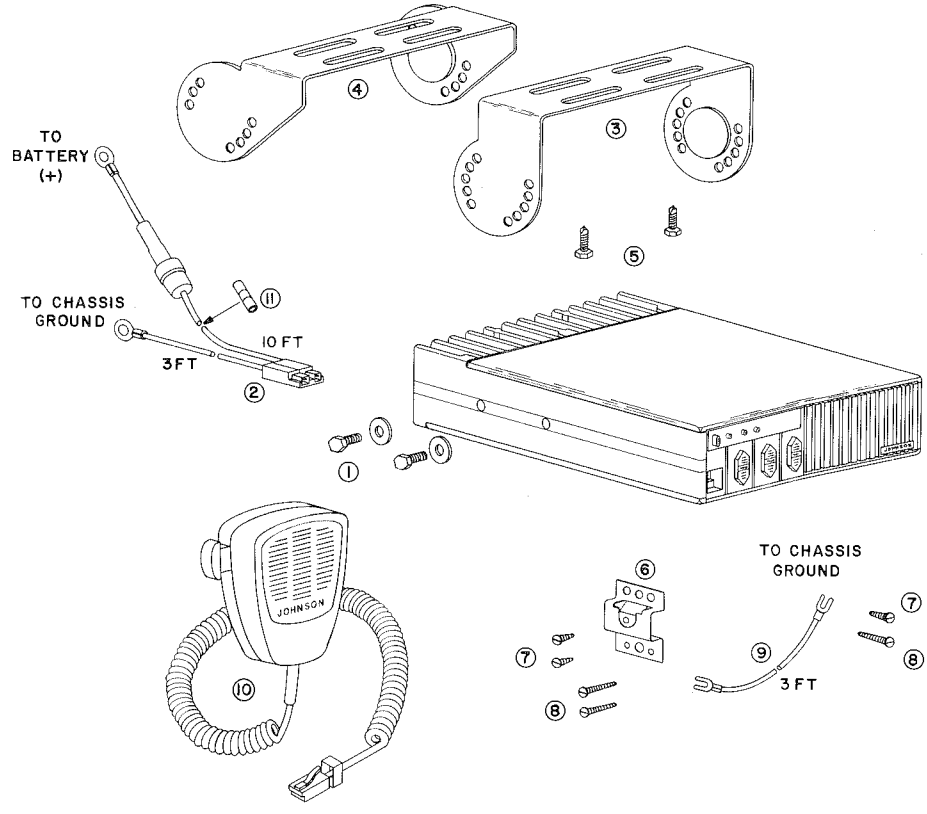
2.1 GENERAL

2.1.1 SCOPE OF INSTRUCTIONS

Since each installation is somewhat unique, the following instructions are intended only as a general familiarization with the components and connections used to install this transceiver.

2.1.2 PERFORMANCE TESTS

Although each transceiver is carefully aligned and tested at the factory, shipment can 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.	023-4143-010	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	023-7171-911
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

MOBILE INSTALLATION COMPONENTS
FIGURE 2-1

2.1.3 TRANSCEIVER PROGRAMMING

This transceiver must be programmed before it can be placed in service. Programming instructions are located in Section 4 and also in the operating manual included with the programming software. The transceiver contains preprogrammed test channels and other factory test parameters when it is shipped.

2.1.4 POWER SOURCE

This transceiver can operate only from a nominal 12 volt power source with the negative side connected to chassis ground. Others require a voltage converter.

2.1.5 SELECTING A MOUNTING LOCATION

This transceiver is designed to be mounted within reach of the operator (usually the dash or hump of the vehicle).

WARNING

The mounting location can affect safe operation of the vehicle. Follow these precautions when mounting the transceiver:

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

2.2 MOBILE INSTALLATION

Hardware and Cable Kit, Part No. 023-7172-918, 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 under the selected mounting location for such things as wiring and brake and gas lines that could be damaged when the transceiver is installed. Then mount the bracket using the included self-drilling screws and install the transceiver in the bracket.

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

c. Disconnect the negative battery cable to prevent damage from accidental short circuits.

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.

d. Route the red power cable to the battery. If there is no hole in the firewall large enough to clear the fuseholder, the red cable can be cut at a convenient location and then spliced again using the included butt splice connector. If a hole is drilled in the firewall, be sure to seal it when installation is complete.

e. Connect the red power cable ring terminal to the positive (+) battery terminal.

f. Connect the blue power cable ring terminal to a good chassis ground point. Make sure there is a good ground return to the negative battery terminal.

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

h. 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 AND IGNITION SENSE INSTALLATION

2.3.1 GENERAL

The optional Horn/Ignition Sense Cable, Part No. 023-8610-916, can be used to connect the external horn alert and/or ignition sense functions. This cable is 4.5 feet long and consists of two fused wires with an in-line connector. These wires plug into pins 13 and 14 of P2 on the audio/logic board (refer to the audio/logic board component layout). This wire harness and a strain relief install through a knockout on the back panel of the transceiver. The horn alert and ignition sense functions operate as described in the next two sections.

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 to enable the horn alert, this output pulses low for 3 seconds (refer to Section 3.5). It then goes back to the disabled mode which is a high-impedance state. Maximum sink current is 800 milliamperes. If this output is connected to a relay coil, a diode should be connected across the relay coil with the cathode to the battery side. This protects Q7 when the relay de-energizes.

2.3.3 IGNITION SENSE OPERATION

The ignition sense input is pin 13 of P2. When 13 volts is applied to this line, the horn alert function is disabled. This line can be connected to the ignition switch or other location to automatically disable the horn alert while the vehicle is being operated. Refer to Section 3.5 for more information.

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 switch. Each system can be programmed with an independent set of operating parameters such as repeater frequencies and selectable groups or channels.

3.1.1 TRANSCEIVER FEATURES

The 8655 is designed to operate on both LTR (trunked) and conventional channels. Each selectable system can be programmed for either type of operation. The following features are standard with both types of channels.

- Any combination of up to ten LTR and conventional systems programmable.
- Up to ten groups programmable in each system
- System scan selectable by front panel "S" switch
- System lockout in scan or horn alert selectable by front panel "A" switch
- Programmable CALL indicator
- Programmable horn alert
- Programmable time-out timer
- Test mode

3.1.2 LTR SYSTEM FEATURES

The following features are available with systems programmed for LTR operation. Refer to Section 3.6 for more information.

- Up to all the following ID codes are programmable in each system:
  - 2 fixed priority decode codes
  - 10 decode and encode codes selectable by GROUP switch (codes can be different)
  - Block of up to 250 decode codes
- Programmable group scan in each system
- Programmable Transmit Inhibit when selected ID is busy
- Free system ringback with RIC (interconnect) calls when system is busy
- Automatic system search when out-of-range of selected system
- Programmable revert system scan time (refer to Section 3.3.2)
- Transpond programmable for each selectable group
- 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 3.7 for more information.

- Up to ten channels programmable per system (channels are selected using GROUP switch)
- Tone, digital, or inverted digital Call Guard® programmable for each transmit and receive channel
- Transmit mode of each channel programmable as normal, talk-around, or disable (receive-only)
- Automatic transmit disable when channel is busy (if microphone is on-hook)

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3.2 FRONT PANEL CONTROLS AND INDICATORS

3.2.1 FRONT PANEL CONTROLS

All front panel switches are the momentary pushbutton type. A short beep sounds when a switch is pressed (except with the Power and Volume Set switches). This provides feedback to the user. The front-panel switches function as follows:

PWR Switch - Switches power to the transceiver. All parameters such as volume level and system and group number return to their previous state when power is turned back on because the status of each is stored in the EEPROM when power is turned off.

VOLUME Up/Down Switch - When the upper part of the VOLUME switch is pressed, the volume level increases by one step. When the lower part of this switch is pressed, the volume level decreases by one step. Holding the switch down causes the function to repeat. The volume is adjustable in sixteen steps of approximately 3 dB each.

SYSTEM Up/Down Switch - When the upper part of the SYSTEM switch is pressed, the selected system number increases by one. When the lower part of this switch is pressed, the system number decreases by one. Holding the switch down causes the function to repeat. After the highest programmed system is displayed, the display rolls over to System 1; likewise, after the lowest system is displayed, the display rolls over to the highest programmed system.

GROUP Up/Down Switch - This switch operates similar to the SYSTEM switch. When the system number is changed, the GROUP display indicates the revert group number (the group displayed when the system was last selected). The programmed groups can be different for each system.

V (Volume Set) Switch - Pressing this switch enables the busy tone for use as a reference when setting the volume level.

A (Auxiliary) Switch - Pressing this switch toggles the auxiliary function which may be programmed as Horn Alert or Scan Lockout. Other functions of this switch are to enable Free System Ringback, System Search, and the clear-to-talk tone (refer to Sections 3.6.5, 3.6.6, and 3.6.9). This switch does not have a repeat function.

S (System Scan) - Pressing this switch toggles the System Scan function (refer to Section 3.3). This switch does not have a repeat function.

3.2.2 FRONT PANEL DISPLAY AND INDICATORS

SYSTEM Display - Displays the selected system number from 0-9. Only programmed systems can be selected. The SYSTEM display is located above the SYSTEM switch.

GROUP Display - Displays the selected group number from 0-9. Only programmed groups can be selected. The GROUP display is located above the GROUP switch.

Scan Indicator - The Scan mode is indicated by the decimal point in the SYSTEM display.

Transmit Indicator - The red Transmit indicator lights when the transmitter is keyed. It is located between the SYSTEM and GROUP displays.

Call Indicator - In LTR systems, the amber Call indicator lights when a particular ID code has been decoded. In conventional systems, each channel can be programmed for a Call indicator (refer to Section 3.4.2 for more information). The CALL indicator is located between the SYSTEM and GROUP displays and is reset by pressing the microphone PTT switch or any front-panel switch.

Auxiliary Indicator - The green Auxiliary indicator lights when the function selected by the Auxiliary switch is enabled. This indicator is located between the SYSTEM and GROUP displays.

3.2.3 MICROPHONE/PROGRAMMING JACK, REAR PANEL JACKS

Microphone/Programming Jack - This is the connection point for the microphone unless programming the transceiver. This jack is then the connection point for the RPI Interface Module (refer to Section 4). This transceiver uses a low-impedance dynamic microphone.

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 selected by the front panel "S" (scan) switch. The scan function is standard on all transceivers without performing any special programming. The scan mode is indicated when the decimal point in the SYSTEM display is lighted. Scanning is sequential through all programmed systems. When scanning, a dash (—) is indicated in both the SYSTEM and GROUP displays. When a call is received, scanning stops and the system and group number of the call are usually indicated by the displays. Exceptions are LTR fixed and block ID's described in Section 3.6.

Scanning occurs only if the microphone is on-hook. When the microphone is taken off-hook or scanning is halted by pressing the Scan switch, the SYSTEM and GROUP displays indicate the revert system/group. The revert system and group is usually the system/group displayed when the Scan mode was entered. However, if a call was received after the Scan mode was entered, it is the system/group of the last call received. Since the display indicates the system/group of the call being received, it is usually not necessary to change the selected system/group to respond to a call.

There is a 3-second delay before scanning resumes after a call is received and after transmitting. This delay prevents scanning while a conversation is in process. The revert system or group can be changed while scanning by simply pressing the GROUP or SYSTEM switch. When either switch is pressed, scanning halts and the system or group number changes as it does when not in the scan mode. Scanning resumes 1 second after the switch is released.

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

3.3.2 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 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 is 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 and block ID's are always decoded when scanning. With selectable ID's, only the selected or revert ID is decoded if group scan is not programmed in a particular system. If group scan is programmed, all selectable ID's are decoded. The priority of the various ID's is the same as when not scanning. Refer to Sections 3.6.2, 3.6.3, and 3.6.4 for more information.

3.3.3 SCANNING CONVENTIONAL SYSTEMS

When System Scan is enabled in transceivers programmed with conventional systems, only the revert channel in each system is scanned. For example, if a particular system is programmed with channels 1, 2, 3, and 4, and channel 3 was the last selected channel in that system, channel 3 is the only channel scanned in that system. Only the revert channel in each system is scanned in the conventional mode because the scanning rate would be very slow if a large number of channels were programmed with Call Guard.

If a channel is programmed for tone or digital Call Guard, Call Guard is detected in the System Scan mode. Scan Lockout (refer to Section 3.3.4) is also available when scanning conventional systems.

3.3.4 SCAN LOCKOUT

If the Auxiliary switch is programmed for the Scan Lockout feature, systems can be locked out of the scan sequence. To lock a system out of the scan sequence, press the Auxiliary switch when the system is displayed. To unlock a system, select the system and press the switch. Any number of systems can be locked out. If the Auxiliary switch is programmed for Horn Alert, the Scan Lockout function is not available.

The Auxiliary indicator lights if the displayed system is locked out. In the scan mode the Auxiliary indicator lights if any system is locked out. To check which systems are locked out, step through the programmed systems while watching the Auxiliary indicator. Since the lockout status is maintained with the power off, channels can be unlocked again only by the Auxiliary switch.

If the selected system is not changed after locking a system out, the revert system is not scanned. If an LTR revert system is to be scanned longer (refer to Revert System Scan Time in Section 3.3.2), you may want to select another system before entering the System Scan mode.

3.4 TIME-OUT TIMER AND CALL INDICATOR

3.4.1 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 prevents possible transmitter damage caused by transmitting for extended periods.

3.4.2 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 indicator is reset by pressing any front-panel switch or the microphone PTT switch. When the Call indicator lights in the System Scan mode, the revert system and group displayed are usually those on which the last call was received. An exception is when another call is received on a group or channel that does not enable the Call indicator.

In LTR systems the Call indicator can be programmed to light for each fixed ID code and also for each of the ten selectable ID codes. Block ID codes cannot be programmed to enable the Call indicator. In conventional systems, the Call indicator can be programmed to light for each channel (group). Since Call Guard is also detected with the Call indicator, it lights whenever a call is received that opens the audio.

3.5 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.

The Auxiliary switch can be programmed to control either the Horn Alert or Scan Lockout functions. When the Horn Alert is enabled by the Auxiliary switch, the Auxiliary indicator lights. If the Auxiliary switch is programmed for Scan Lockout, the Horn Alert function is enabled all the time. If the Horn Alert switch is not used, the ignition sense line or an external switch can be used to disable the Horn Alert when it is not needed. Refer to Section 2.3 for installation information.

3.6 LTR SYSTEM OPERATION

NOTE: Refer to Section 3.7 for information on conventional systems.

3.6.1 GENERAL

Each LTR system can be programmed with the following types of ID codes:

Decode	Encode
2 Fixed	—
10 Selectable	10 Selectable
Block (up to all 250)	—

Any combination of these preceding code types can be programmed and all codes can be different. The fixed decode codes and the code block are always decoded regardless of the group selected. When transmitting, the desired encode group must be selected using the GROUP switch. The ten selectable decode codes may or may not be scanned, depending on whether the system is programmed as standard LTR or group scan (refer to following information).

3.6.2 STANDARD LTR OPERATION

If the system is programmed for standard LTR operation, only the selected ID code and the fixed and block ID codes are decoded. Other selectable ID codes are not decoded. The GROUP display indicates only the selected group in this mode and does not change when a fixed ID is decoded. Therefore, the group may have to be changed to respond to a call.

3.6.3 GROUP SCAN OPERATION

If the system is programmed for group scan and the microphone is on-hook, all the selectable ID codes are scanned and decoded regardless of which group is selected. If the microphone is off-hook, only the selected group ID is decoded. The fixed and block ID's are always decoded, regardless if the microphone is on- or off-hook.

When a system programmed for the group scan mode is selected, the GROUP display still indicates the selected group. (A dash is displayed only when the System Scan function is selected by the front panel switch.) When group scanning and a call is received on one of the selectable group ID's, the display automatically changes to the group ID that the call came in on. That group then becomes the new selected group. If a call is received on one of the fixed ID codes, the selected group changes to Group 1 if the first fixed ID was decoded and to Group 2 if the second fixed ID was decoded. If a block ID is decoded, the display continues to indicate the selected group.

Group scan is inhibited for 3 seconds after an incoming call is finished. This usually prevents another incoming call from interfering with the response. Group scan is also inhibited for 3 seconds after an outgoing call ends.

3.6.4 PRIORITY ID CODES

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 would be 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 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 trunked out mobiles with a priority message, the operator can stay keyed up for several seconds before speaking to allow these mobiles time to return to their home repeater.

The priority of the decode ID codes is as follows:

1. Fixed ID Code 1
2. Fixed ID Code 2
3. Selected ID Code
4. Other Selectable ID Codes
5. Block Decode Codes

For example, if a call is being received on selectable group 4 and fixed ID code 2 is decoded, the call on Group 4 is immediately dropped and the transceiver trunks to another repeater and receives the priority call.

3.6.5 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 Auxiliary 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" tone described in Section 3.6.9 sounds. If another call attempt is then made, the call can usually be completed. This feature is available without any special programming.

3.6.6 SYSTEM SEARCH

This feature is used to automatically access other programmed systems when the selected system cannot be accessed. If a short busy tone followed by an intercept tone is produced when the PTT switch is pressed, the transceiver is unable to complete a data handshake with the selected system. To enter the System Search mode, the Auxiliary switch is momentarily pressed while the intercept tone is sounding with the PTT switch pressed. Then when the PTT switch is released, a short tone sounds and the system search mode is entered.

If the group ID selected when this mode was entered was a RIC (interconnect) ID, the transceiver then attempts to access, in succession, other systems that have

a RIC ID programmed in the revert group location. Likewise, if the group selected is a dispatch ID, the transceiver attempts to access other systems that have the revert group location programmed with a dispatch ID. For example, if System 2, RIC Group 4 is selected when the System Search mode is entered, the revert group in System 3 is checked. If that is a RIC group, the transceiver attempts to access that system. If it is not, it skips that system and goes to System 4 and so on.

As each system is searched, a short beep sounds and the system display indicates the system being accessed. One access attempt is made on each eligible system. If no system can be accessed, the intercept tone sounds for 500 milliseconds and the feature deactivates. If a system is successfully accessed, the feature deactivates and that system becomes the selected system and group.

When a RIC ID is accessed, a dial tone is returned by the RIC; when a dispatch ID is accessed, there is no audible indication except that the intercept tone does not sound. This feature is not functional on conventional systems because there is no data handshake to indicate when the system is accessed.

3.6.7 TRANSPOND

The purpose of the transpond feature is to provide an indication back to the person making a call that the transceiver being called is in service. Any or all the ten selectable decode ID's can be programmed for transpond. If an ID code programmed for transpond is decoded, the transceiver waits until the person transmitting unkeys. It then automatically transmits two data messages with the second message containing the turn-off code. This causes the transceiver originating the call to briefly unsquelch. If that transceiver is equipped with a CALL indicator, it turns on to indicate that a response was received.

If a fixed ID code is decoded, the transceiver checks the revert (displayed) group ID. If that ID is the same as the fixed ID and is programmed for transpond, the transceiver transponds. If the revert group ID is different or if it is not programmed for transpond, the transceiver does not transpond.

3.6.8 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 decrement 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.

3.6.9 LTR SUPERVISORY TONES

There are several supervisory tones that may be heard at various times when operating the transceiver. These tones are as follows:

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. Pressing the Volume Set (V) switch also enables the busy tone for use as a reference to set the volume level.

Intercept Tone

The intercept tone is a siren-like tone consisting of 700 and 900 Hz tones alternating at a 2 Hz rate. This tone indicates that the data handshake with the repeater cannot be completed. The usual cause of this is that the transceiver is out of radio range of the repeater. The intercept tone is preceded by a short busy tone that indicates that repeated access attempts are being made. When the intercept tone sounds, no more access attempts are made until the PTT switch is released and then pressed again. If the transceiver is programmed with transmit inhibit ID codes, the intercept tone may also indicate that the mobile being called is busy. The intercept tone also sounds for 500 milliseconds in the System Search mode to indicate that no system could be accessed.

Key Press Tone

This is a 30 millisecond burst of the 700 Hz tone which indicates that a front-panel key has been pressed. This tone provides feedback to the user to indicate when a key closure is detected by the logic.

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).

System Search Mode Confirmation Tone

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

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. To enable or disable this feature, switch transceiver power on with the Auxiliary switch pressed. When this feature is enabled, the clear-to-talk tone sounds when the repeater system has been accessed, and no tone sounds if the system is busy. An exception when the busy tone does sound is when attempting a telephone call on a busy system. This feature is nonfunctional when a conventional system is selected.

3.7 CONVENTIONAL SYSTEM OPERATION

3.7.1 GENERAL

Each conventional system can be programmed with up to ten channels that are selected by the GROUP switch. This permits up to 100 channels to be programmed with this transceiver. Each receive and transmit channel can be programmed with tone, digital, or inverted digital Call Guard or standard carrier squelch. There is also the option to transmit a reverse burst or turn-off code with Call Guard. The reverse burst and digital turn-off code are always decoded by this transceiver when Call Guard is programmed.

Each channel can also be programmed as standard (receive/transmit), receive only, or talk-around. In the talk-around mode, the transceiver transmits on the receive frequency to permit mobile-to-mobile communications when out of range of the repeater system.

When in the conventional mode, a channel programmed with Call Guard is monitored by taking the microphone off-hook. This disables the Call Guard so that the transceiver operates on carrier squelch only.

3.7.2 TRANSMIT INHIBIT

If the PTT switch is pressed with the microphone on-hook and a carrier present, transmitter keying is inhibited and the transceiver remains in the receive mode. As long as the PTT switch remains pressed, squelch is controlled by only the carrier so that channel activity can be monitored. If the PTT switch is released and then pressed again within 1 second, the transmitter keys. When the microphone is off-hook, squelch is always controlled by the carrier and the transmitter keys even if there is a carrier present. No special programming is required for this operation.

There is also a Transmit Disable feature that can be programmed on each group (channel). When a group is programmed with this feature, it is receive-only and the transmitter cannot be keyed. If the PTT switch is pressed, the busy tone sounds.

3.8 TEST MODE

This transceiver has a test mode that can be selected to perform testing. To select the test mode, jumper J5 on the audio/logic board is moved to the TEST position. When the transceiver power is turned on with the jumper in this position, the test mode is selected. To exit the test mode, this jumper is moved back to the OPERATE position and the power turned on. The position of this jumper is detected only when power is initially turned on. The following functions are available in the test mode.

SYSTEM Switch

The SYSTEM switch is used to select up to ten 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

Group Switch

The Group switch selects the following transmit modulation schemes:

Group	Modulation
1	71 Hz Square Wave
2	67 Hz Tone
3	210.7 Hz Tone
4	167 Hz Square Wave
5	No Modulation

Squelch

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

Transmitter

The transmitter is keyed using the microphone PTT switch. The modulation is determined by the GROUP switch setting.

Auxiliary Switch (A)

In the test mode, pressing the Auxiliary switch places the transceiver in the talk-around mode so that it transmits on the receiver frequency. The Auxiliary indicator lights to indicate this mode.

Scan Switch (S)

In the test mode, this switch turns on the Scan indicator (decimal point in SYSTEM display), but is otherwise nonfunctional.

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 Radio Shack and IBM computers (refer to Table 1-1 in Section 1). A typical programming setup using a Radio Shack computer is shown in Figure 4-1.

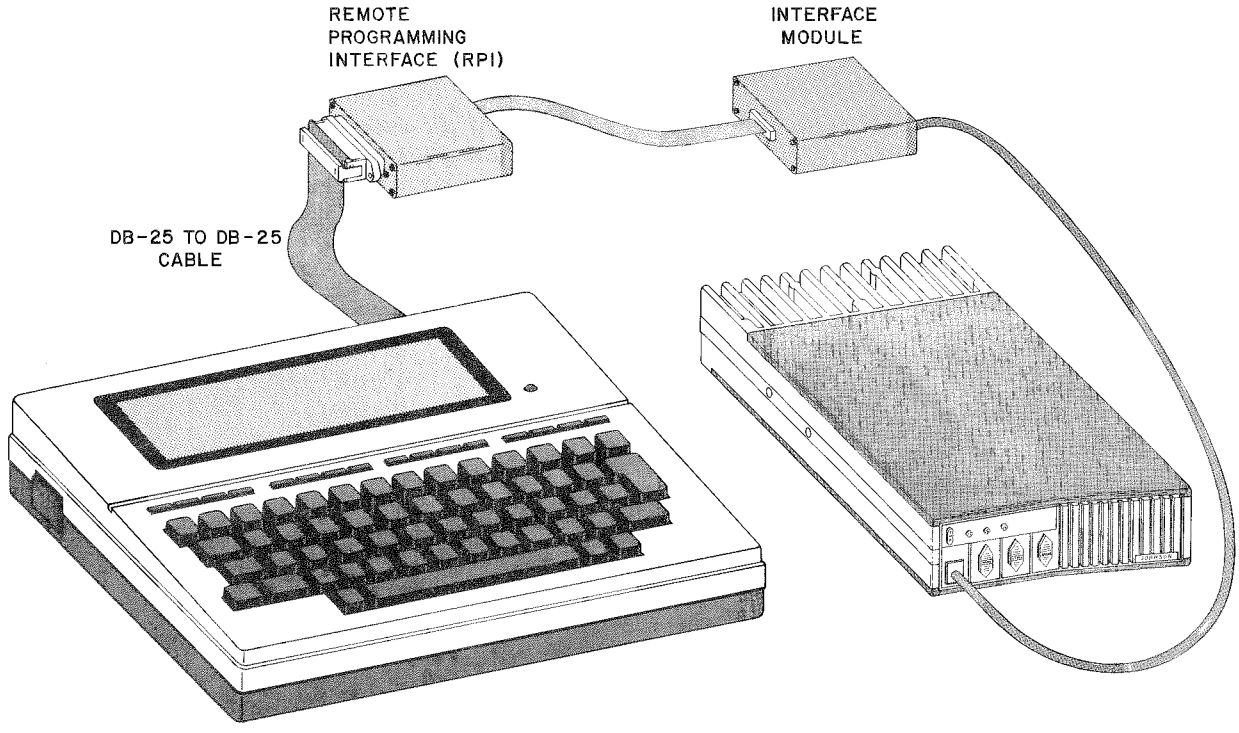
4.1.2 RPI DESCRIPTION

The RPI is required to interface the transceiver to the computer. RPI, Part No. 023-5800-000, 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 the eight-pin programming connector are the input and output pins of a serial data port of the microprocessor.

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 Radio Shack 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.

4.1.3 PROGRAMMING SOFTWARE DESCRIPTION

The Johnson software packages used for programming this transceiver are written in the BASIC programming language. Therefore, the computer must be equipped with a BASIC interpreter (this is usually included with the computer). 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.



TYPICAL PROGRAMMING SETUP
FIGURE 4-1

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/group selected and volume level are 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 be removed from the vehicle without affecting programming. Since an EEPROM is also reprogrammable, 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.

All LTR system types programmable in other Johnson LTR transceivers such as the 8700 and the 8870 are programmable in this transceiver. In addition, new features such as group scan are available which permit expanded capabilities. The information in Table 4-2 is programmed in each LTR system.

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

LTR Application Note (Revision 4)	Part No. 009-0001-020
8810/8870 Service Manual (Section 6)	Part No. 001-8810-001
RIC Operating Manual	Part No. 002-3040-004

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 an ID code programmed for RIC is then selected by the GROUP switch, 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

TABLE 4-1
GENERAL PROGRAMMING PARAMETERS

Parameter	Acceptable Responses	Description
Time-Out Timer	0.5-5 minutes in 0.5 min increments	See Section 3.4.1
No. of Systems	1-10	Number of systems to be programmed
Test System/ Test Frequency	1-10/1-600	FCC Channel numbers for the 10 test channels have been preprogrammed to cover entire 479 channel band, but can be changed if desired. See Section 3.8.
Accessory Mode	Lockout or Horn Honk	Selects the function of the Auxiliary switch. See Sections 3.3.4 and 3.5.

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.

4.5 PROM MAPS

Maps of the EEPROM are shown in Table 4-4 and Table 4-5. Each system requires 128 bytes of memory. Therefore, the 2K x 8 EEPROM can store up to sixteen systems but only ten are used. The addresses for System 1 data are shown in the map and the addresses of the other systems can be determined by adding the following number to that address. For example, the address of the time-out timer setting for System 7 is in location 2 + 768 or 770.

System	Number Added	System	Number Added
1	0	6	640
2	128	7	768
3	256	8	896
4	384	9	1024
5	512	0 (10)	1152

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.
Mode	Standard LTR or Group Scan	Selects if Group Scan is to be enabled (see Sections 3.6.2, 3.6.3). There is also a Select Call Console selection reserved for future use.
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 3.3.2).
Repeater No./ Channel No.	1-20/1-600	Programs the FCC channel number for each active repeater in the system. Programming a negative channel number selects offset channels 12.5 kHz below the normal channel frequency. In addition, 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).
Priority ID	1, 2/1-250	If fixed priority receive ID codes are to be programmed, selects the ID from 1-250 of each of up to two codes (see Sections 3.6.1-3.6.4).
Group ID	1-10/1-250	Programs the selectable receive and transmit ID's. Up to ten selectable groups can be programmed and the transmit and receive ID's for each group can be different. Both the ID's in a group must be programmed (see Sections 3.6.1, 3.6.2).
Call Ind	On, Off	Programs if the Call indicator is to light when the particular ID is decoded. Each of the fixed ID's and the ten selectable ID's can be programmed to enable the Call indicator (see Section 3.4.2).
Horn	On, Off	Programs if the horn alert is to sound when the particular ID is decoded. Each of the fixed ID's and the ten selectable ID's can be programmed to enable the horn alert (see Section 3.5).
Transpond	On, Off	Programs if the transceiver is to transpond when the particular ID is decoded. Only the ten selectable ID's can be programmed for transpond (see Section 3.6.7).
Decode Block	1-250	Programs a block of decode ID codes (up to all 250) that are decoded regardless of the group selected (see Section 3.6.1).
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 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.
Group/Channel No.	1-10/1-600	Programs the FCC channel number for each of up to ten selectable groups. Programming a negative channel number selects offset channels 12.5 kHz below the normal channel frequency.
Transmit Call Guard Mode	None, Tone, Digital, or Inverted Digital	Selects the type of Call Guard for the transmit group (channel) being programmed.
Transmit Call Guard Code	Tone Number or Digital Code	If a tone Call Guard was selected, the number from 1-38 of the tone selected is entered. If a digital Call Guard is programmed, the number of the digital code is entered. These numbers are located in a table in the programming manual.
Receive Call Guard Mode	None, Tone, Digital, or Inverted Digital	Selects the type of Call Guard for the receive group (channel) being programmed.
Receive Call Guard Code	Tone Number or Digital Code	If a tone Call Guard was selected, the number from 1-38 of the tone selected is entered. If a digital Call Guard is programmed, the number of the digital code is entered. These numbers are located in a table in the programming manual.
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 a particular group (channel). Each of the ten selectable groups can be programmed to enable the Call indicator (see Section 3.4.2).
Horn	On, Off	Programs if the horn alert is to sound when a call is received on a particular group (channel). Each of the ten selectable groups can be programmed to enable the horn alert (see Section 3.5).
Talk-Around	On, Off	If programmed, the transceiver transmits on the receive frequency on that group. This permits mobile-to-mobile communication when out of range of the repeater.
Transmit Disable	On, Off	If programmed, the group is receive-only and the transmitter cannot be keyed.
Transmit Turn-off	On, Off	If this feature is enabled and a Call Guard is programmed, a reverse burst or turn-off code is 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).

TABLE 4-4
CONVENTIONAL SYSTEM PROM MAP

PROM Location	Function
0	Mode: Conventional = 3
1	Number of Systems Programmed
2	Transmit Time-Out Timer
3	Auxiliary Switch (Horn or Lockout)
4-5	Reference Counter
6-7	Base N Counter
8	A Counter for Receive
9-10	N & A Counter for Test Channels
11-12	N & A Counter for Group 1
13-14	N & A Counter for Group 2
15-16	N & A Counter for Group 3
17-18	N & A Counter for Group 4
19-20	N & A Counter for Group 5
21-22	N & A Counter for Group 6
23-24	N & A Counter for Group 7
25-26	N & A Counter for Group 8
27-28	N & A Counter for Group 9
29-30	N & A Counter for Group 10
31-32	Receive Call Guard for Group 1
33-34	Receive Call Guard for Group 2
35-36	Receive Call Guard for Group 3
37-38	Receive Call Guard for Group 4
39-40	Receive Call Guard for Group 5
41-42	Receive Call Guard for Group 6
43-44	Receive Call Guard for Group 7
45-46	Receive Call Guard for Group 8
47-48	Receive Call Guard for Group 9
49-50	Receive Call Guard for Group 10
51-52	Transmit Call Guard for Group 1
53-54	Transmit Call Guard for Group 2
55-56	Transmit Call Guard for Group 3
57-58	Transmit Call Guard for Group 4
59-60	Transmit Call Guard for Group 5
61-62	Transmit Call Guard for Group 6
63-64	Transmit Call Guard for Group 7
65-66	Transmit Call Guard for Group 8
67-68	Transmit Call Guard for Group 9
69-70	Transmit Call Guard for Group 10

PROM Location	Function
71	Rx & Tx Call Guard Types for Grp 1
72	Rx & Tx Call Guard Types for Grp 2
73	Rx & Tx Call Guard Types for Grp 3
74	Rx & Tx Call Guard Types for Grp 4
75	Rx & Tx Call Guard Types for Grp 5
76	Rx & Tx Call Guard Types for Grp 6
77	Rx & Tx Call Guard Types for Grp 7
78	Rx & Tx Call Guard Types for Grp 8
79	Rx & Tx Call Guard Types for Grp 9
80	Rx & Tx Call Guard Types for Grp 10
81	Call Ind, Horn, & Talk-Around- Grp 1
82	Call Ind, Horn, & Talk-Around- Grp 2
83	Call Ind, Horn, & Talk-Around- Grp 3
84	Call Ind, Horn, & Talk-Around- Grp 4
85	Call Ind, Horn, & Talk-Around- Grp 5
86	Call Ind, Horn, & Talk-Around- Grp 6
87	Call Ind, Horn, & Talk-Around- Grp 7
88	Call Ind, Horn, & Talk-Around- Grp 8
89	Call Ind, Horn, & Talk-Around- Grp 9
90	Call Ind, Horn, & Talk-Around- Grp 10
91	Not Used
92	Not Used
93	Not Used
94	Not Used
95	Not Used
96	Number of Groups in System
97	Present Group Selected This System
---------- SYSTEM 1 ONLY ----------	
98-127	Power-Up Settings for Volume Level, Scan Enable Status, System Number, Auxiliary Indicator Status, & Lockout Status

TABLE 4-5
LTR SYSTEM PROM MAP

PROM Location	Function
0	Mode: Std=0, Grp Scan=1, Sel Call Con=2
1	Number of Systems Programmed
2	Transmit Time-Out Timer
3	Auxiliary Switch (Horn or Lockout)
4-5	Reference Counter
6-7	Base N Counter
8	A Counter for Receive
9-10	N & A Counter for Test Channels
11-12	N & A Counter for Repeater 1
13-14	N & A Counter for Repeater 2
15-16	N & A Counter for Repeater 3
17-18	N & A Counter for Repeater 4
19-20	N & A Counter for Repeater 5
21-22	N & A Counter for Repeater 6
23-24	N & A Counter for Repeater 7
25-26	N & A Counter for Repeater 8
27-28	N & A Counter for Repeater 9
29-30	N & A Counter for Repeater 10
31-32	N & A Counter for Repeater 11
33-34	N & A Counter for Repeater 12
35-36	N & A Counter for Repeater 13
37-38	N & A Counter for Repeater 14
39-40	N & A Counter for Repeater 15
41-42	N & A Counter for Repeater 16
43-44	N & A Counter for Repeater 17
45-46	N & A Counter for Repeater 18
47-48	N & A Counter for Repeater 19
49-50	N & A Counter for Repeater 20
51	Interconnect Start ID
52	Interconnect Stop ID
53	Transmit Inhibit Start ID
54	Transmit Inhibit Stop ID
55	Block Decode Start ID
56	Block Decode Stop ID
57	1st Fixed Priority ID
58	2nd Fixed Priority ID
59	Group 1 Decode ID
60	Group 2 Decode ID
61	Group 3 Decode ID
62	Group 4 Decode ID
63	Group 5 Decode ID
64	Group 6 Decode ID
65	Group 7 Decode ID
66	Group 8 Decode ID
67	Group 9 Decode ID
68	Group 10 Decode ID
69	Group 1 Encode ID
70	Group 2 Encode ID
71	Group 3 Encode ID
72	Group 4 Encode ID
73	Group 5 Encode ID
74	Group 6 Encode ID
75	Group 7 Encode ID
76	Group 8 Encode ID
77	Group 9 Encode ID
78	Group 10 Encode ID
79	Call Ind & Horn- Fixed Priority 1
80	Call Ind & Horn- Fixed Priority 2
81	Call Ind, Horn, & Transpond- Grp 1
82	Call Ind, Horn, & Transpond- Grp 2
83	Call Ind, Horn, & Transpond- Grp 3
84	Call Ind, Horn, & Transpond- Grp 4
85	Call Ind, Horn, & Transpond- Grp 5
86	Call Ind, Horn, & Transpond- Grp 6
87	Call Ind, Horn, & Transpond- Grp 7
88	Call Ind, Horn, & Transpond- Grp 8
89	Call Ind, Horn, & Transpond- Grp 9
90	Call Ind, Horn, & Transpond- Grp 10
91	Repeaters 1-8 RIC-Equipped
92	Repeaters 9-16 RIC-Equipped
93	Area Bit, Repeaters 17-20 RIC-Equipped
94	Home Repeater Number
95	Revert System Scan Time
96	Number of Groups in System
97	Present Group Selected This System
---------- SYSTEM 1 ONLY ----------	
98-127	Power-Up Settings for Volume Level, Scan Enable Status, System Number, Auxiliary Indicator Status, & Lockout Status

SECTION 5
CIRCUIT DESCRIPTION

5.1 GENERAL TRANSCEIVER DESCRIPTION

5.1.1 INTRODUCTION

This transceiver contains a main board, display board, and an audio/logic board. The main board contains the synthesizer, receiver, and transmitter sections of the transceiver. The display board contains the front panel group and system displays, switches, indicators, and associated encoding and decoding circuits. 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 5.2-5.5. 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, final amplifier Q501, and power module U501. The 5 volt supply is protected by regulator U302 and the 9 volt supply is protected by regulator Q301/U300. 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.

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.

5.1.4 TRANSMITTER

The transmitter doubles the signal from the synthesizer and then amplifies it to produce a power output of 30 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. In addition, a thermal foldback circuit cuts back power if transmitter temperature becomes excessive.

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 these transceivers. 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.

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 (f_R). This frequency is the 17.1500 MHz TCXO frequency divided by the reference counter in U802. The reference frequency is 6.25 kHz for all channels. (Refer to Section 5.2.9 for more information.)

The other input (f_V) 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 (f_R) 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 (Q902)

Q902 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 receive first injection frequency in the receive mode (approximately 450 MHz). The gate is biased negative with respect to the source by constant current source Q903. This stage provides a biasing current that is relatively stable over changes in temperature. The emitter current of Q903 mirrors the current through R906. Diode CR905 provides a PN junction drop and temperature compensation.

L909 is an RF choke, and C907 is a bypass capacitor. An AC voltage divider formed by C922, C923, and C924 starts and maintains oscillation and also matches Q902 to the tank circuit. In addition, C924 compensates for frequency and gain changes in Q902 caused by variations in temperature.

The tank circuit consists of pin diodes CR901-CR902, varactor diodes CR903-CR904, several capacitors, and a section of microstrip. The microstrip behaves as a tapped inductor which resonates with the tank circuit capacitors at the frequency of the oscillator. The VCO frequency is set to the center of the operating band by jumpers on the tank circuit microstrip which can be cut or connected. C921 provides additional temperature compensation of the VCO frequency.

5.2.3 VCO FREQUENCY CONTROL AND MODULATION

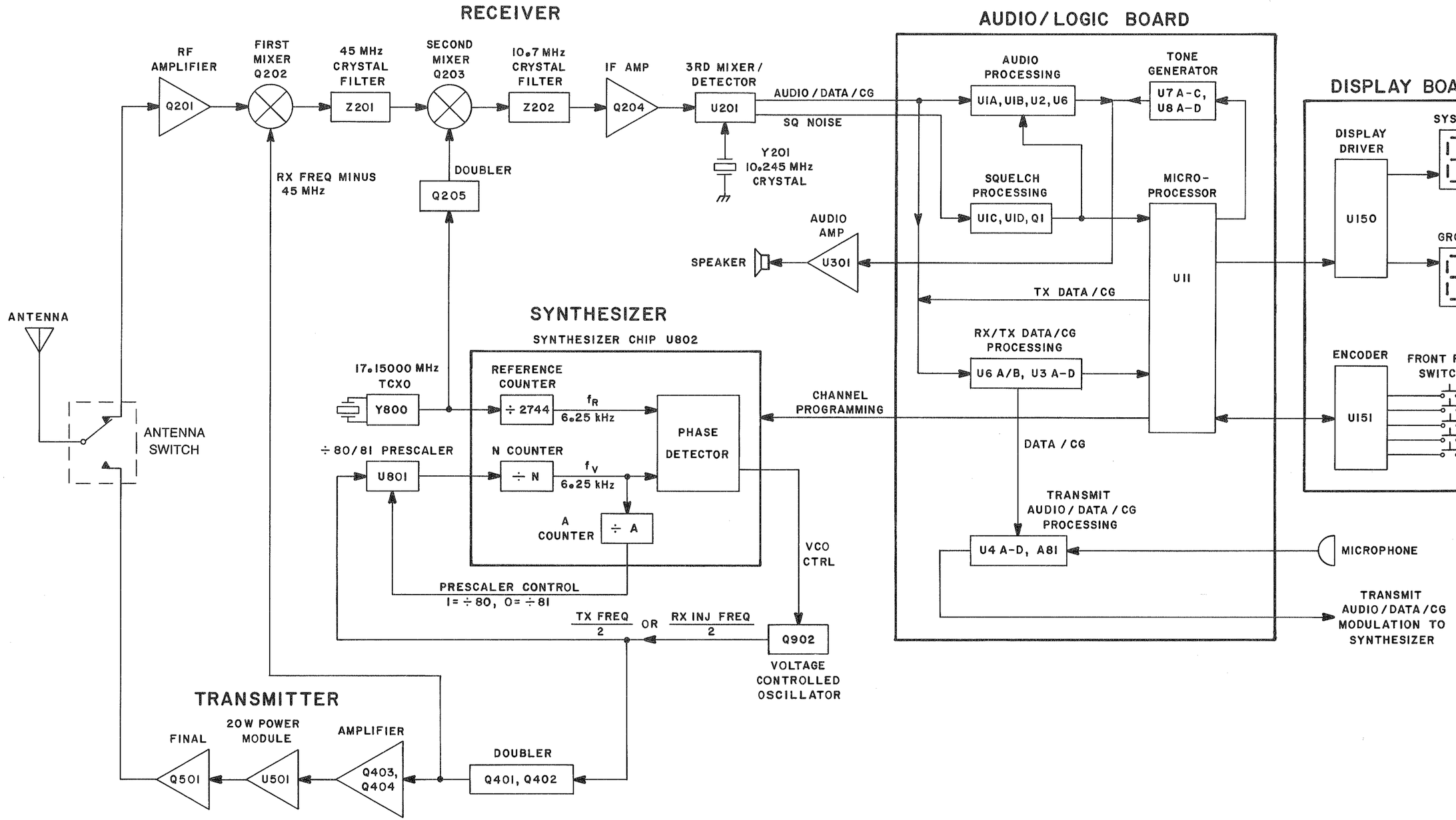
The VCO frequency is controlled by changing the DC voltage applied across varactor diode CR904. As the voltage across a varactor diode increases, its capacitance decreases. This increases the VCO frequency as the control voltage increases and vice versa. C921 in series with CR904 sets the amount of frequency change produced by CR904. The control line is isolated from tank circuit RF by choke L907.

The VCO frequency is modulated by the transmit audio/data signal in a similar manner. The audio/data signal is applied across varactor diode CR903 to vary the VCO frequency at an audio rate. C919 and C918 in series with CR903 determine the amount of modulation produced by the audio signal. L905 provides a DC ground on the anode of CR903, and the modulation line is isolated from tank circuit RF by R920 and C912. Capacitor C920 provides compensation so that modulation remains flat over the entire bandwidth of the VCO. Compensation is required because modulation tends to increase as the capacitance of CR904 decreases (VCO frequency increases).

The 9 volt supply is isolated from the modulation signal and RF by R821 and C813. DC blocking is provided by C801. Resistors R802 and R820 provide summing of the 9 volt bias and the modulation signal. Potentiometer R801 balances the modulation signals applied to the VCO and TCXO (refer to next section for more information).

5.2.4 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



TRANSCEIVER BLOCK DIAGRAM
FIGURE 5-1

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 (f_R and f_V) remain in phase and no phase shift is sensed. This produces a flat audio response. Potentiometer R801 balances the modulating signals.

5.2.5 TALK-AROUND AND TRANSMIT/RECEIVE LATCHES (U805B, U805A)

Talk-Around Mode

In the talk-around mode, transmission is on the receive frequency to permit mobile-to-mobile communication. Therefore, the VCO frequency must increase half the 39 MHz transmit/receive spacing or 19.5 MHz. Since this large of a shift cannot be achieved by increasing the VCO control voltage, additional inductance is switched into the tank circuit by U805B to increase the resonant frequency. This is done as follows:

In the talk-around mode, the Q (not) output of U805B goes high and the Q output goes low. This forward biases pin diode CR901 and it changes from a small capacitance (high impedance) to a very low impedance. A short circuit is then effectively formed by C916, CR901, and C913 at the tank circuit frequency. This connects the microstrip (which is primarily inductive) to the tank circuit, resulting in an increase in the tank circuit frequency of approximately 19.5 MHz. There are jumpers on the microstrip which can be cut or connected to tune the microstrip for the correct frequency shift. C908/L904 and C909/L903 isolate U805B from tank circuit RF, and current limiting is provided by R818.

Receive Mode

In the receive mode, the VCO frequency must decrease half the difference between the transmit and injection frequencies or 3 MHz. (The injection frequency is 45 MHz below the receive frequency and the transmit frequency is 39 MHz below receive frequency.) Since this shift plus the 3 MHz shift necessary to provide the 6 MHz bandwidth cannot be obtained without making the VCO gain undesirably large, the resonant frequency of the tank circuit must be shifted. This is done as follows:

In the receive mode, the Q (not) output of latch U805A goes low and the Q output goes high. CR902 is then forward biased and C917 is effectively connected to C914. This adds capacitance to the tank circuit, resulting in a decrease in the resonant frequency of approximately 3 MHz. In the transmit mode, the Q outputs of U805A are the opposite state which reverse biases CR902.

Latch Programming

D Latches U805B and U805A function like a two-bit shift register. Programming is performed using the same DATA and ENABLE lines that are used to program synthesizer chip U802. After channel selection data has been clocked into U802, two more logic states appear on the DATA line. Each of these states is clocked into the latches by positive-going pulses which appear on the ENABLE line. The first state programs U805A and the second state programs U805B. The pulses on the ENABLE line also latch the data in U802. The programming of U802 is not affected because no clock pulses appear on the CLOCK line.

5.2.6 ACTIVE FILTER (Q901)

Q901 functions as a capacitance multiplier to provide filtering of the 9 volt supply to the oscillator. R904 provides transistor bias and C904 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 C904. Therefore, the base current does not change and the transistor current remains constant. R903 provides isolation and C902, C903, and C905 are RF bypass capacitors.

5.2.7 BUFFER (Q904), BUFFER SWITCH (Q905)

RF energy from the tank circuit is coupled to a section of microstrip connected to gate 1 of buffers Q904 and Q906. These buffers provide amplification and also isolation between the VCO and the circuitry which follows. T901 and C928 on the output of Q904 provide impedance matching with the doubler in the transmitter.

Supply voltage to buffer Q904 is switched by Q905. When the synthesizer is out-of-lock, Q905 is turned off and no supply voltage is applied to buffer Q904. This disables both the transmitter and receiver to prevent the transmission or reception of an improper frequency.

← **FOLDOUT** (FIGURE 5-1, TRANSCEIVER BLOCK DIAGRAM)

5.2.8 PRESCALER BUFFER (Q906), PRESCALER (U801)

Prescaler buffer Q906 is similar in design to Q904. It provides the ECL (emitter-coupled logic) levels required to drive prescaler U801. Impedance matching with U801 is provided by T902, C931, and R803.

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, 80 and 81. This counter divides an input signal in the 450 MHz range down to the 5 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 80 when the control signal from the synthesizer (pin 1) is high and by 81 when the control signal is low. C804 and C807 are coupling capacitors, and R804 and R805 provide a 5 volt logic 1 modulus control input to U801.

5.2.9 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 12). 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 ENABLE input (pin 13) 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 (f_V) is the same frequency as the TCXO-derived input (f_R).

The f_R input is produced by dividing the 17.150 MHz TCXO frequency by 2744. This produces a reference frequency (f_R) 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. C802, L801, and C803 provide low-pass filtering of digital noise fed out of U802 on the OSC input (pin 2). This prevents frequencies near 45 MHz from being fed back to the receiver where they may cause interference.

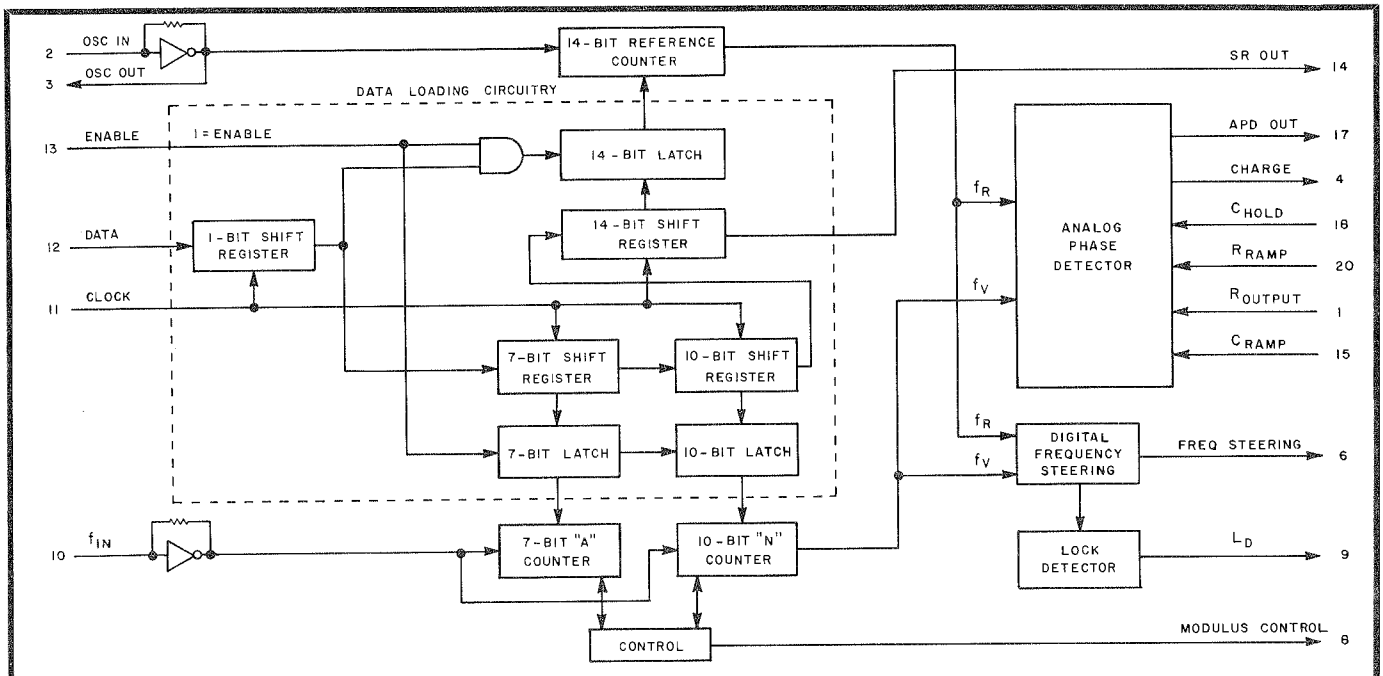
The f_V input is produced by dividing the VCO frequency using prescaler U801 and the N counter in U802. As stated in Section 5.2.4, the prescaler divides by 80 or 81. The divide number of the prescaler is controlled by the N and A counters in U802. These counters function as follows:

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 8) is low and the prescaler divides by 81. Then when the A counter is halted, the modulus control output is high and the prescaler divides by 80.

To illustrate the operation of the prescaler, N, and A counters, the following example will be used. Assume a transmit frequency of 936.2500 MHz (Channel 100) is selected. Since the VCO frequency is half this frequency, it must be 468.1250 MHz for this channel. To produce this frequency, the N and A counters are programmed as follows:

$N = 936 \qquad A = 20$

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 81 for 81×20 or 1620 input pulses. It then divides by 80 for $80 \times (936\text{-}20)$ or 73,280 input pulses. The overall divide number K is therefore 73,280 + 1620 or 74,900.



U802 BLOCK DIAGRAM
FIGURE 5-2

The VCO frequency of 468.1250 MHz divided by 74,900 equals 6.25 kHz which is the f_R input to the phase detector.

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

$$K = 80N + A$$

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

NOTE: Section 6.4.8 describes how the N and A counter divide numbers for other channels can be calculated.

5.2.10 LOCK DETECT (U804A-D)

When the synthesizer is locked, the lock detect output (pin 9) of U802 is high. When the synthesizer is unlocked, narrow negative-going pulses appear on this output. The frequency of these pulses is approximately equal to the difference between the f_R and f_V inputs to the phase detector in U802.

U804D, C814, CR801, R814, and U804C form a one-shot multivibrator which generates a 5 millisecond negative-going pulse whenever it is triggered by a negative-going lock detect pulse. When U804D, pin 12 goes low, the output on pin 11 goes high and C814 charges through R814. While C814 is charging, a logic high is applied to inverter U804C. When C814 is almost fully charged, the voltage across R814 decreases to the threshold of a logic low and the output of U804C goes back high. The output of U804D then goes low and C814 discharges through CR801.

U804B inverts the negative-going pulses and applies them to the adaptive loop filter discussed in the next section. The function of U804A, R815, R816, CR802, and C815 is to detect when the frequency of the lock detect pulses increase to a certain point. When the output of U804C goes high, C815 charges through R815 and R816. Then when a negative-going pulse occurs, C815 discharges through R815 and CR802. If the frequency of the pulses increases enough so that C815 discharges more through CR802 than it charges through R816, the output of U804A goes high and turns off Q905. This disables buffer Q904 (refer to Section 5.2.3).

5.2.11 LOOP FILTER, ADAPTIVE SWITCH (Q801, U803A-D)

The loop filter consists of R809, R810, C811, C812, R811, and C901. It provides low-pass filtering of the phase detector signal to control synthesizer stability and lockup time and suppress the loop reference frequency (f_R).

The phase detector output signal is from a sample and hold circuit in U802. This circuit produces an output voltage proportional to the phase difference of the f_R and f_V inputs. If the phase of f_V lags that of f_R, the phase detector output ramps up between the time the f_V and f_R pulses occur. Conversely, if f_V leads f_R, this output ramps down during this period. The greater the phase difference, the more the ramp voltage increases or decreases before it holds. When the synthesizer is far out-of-lock such as when the channel is changed, the VCO is swept into lock by pulses occuring at a rate equal to the frequency difference between f_R and f_V.

The phase detector output is buffered by Q801 to provide a low output impedance to the loop filter. This minimizes the effect of the high detector output impedance on the rolloff characteristics of the filter. Q801 also increases current drive to permit a faster lockup time.

Analog switches U803C and U803D momentarily bypass the loop filter to shorten the synthesizer lockup time. This bypassing occurs when the synthesizer is far out-of-lock such as when new channel information is programmed into U801 or when the lock detect circuit described in Section 5.2.10 is producing out-of-lock pulses. The analog switches close when the control inputs (pins 6 and 12) are high. The duration of the positive-going ENABLE and lock detect pulses is 5 milliseconds. Analog switches U803A and U803B form an OR gate which helps isolate the VCO control line from noise present on the latch enable line.

5.3 RECEIVER CIRCUIT DESCRIPTION

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

The receive signal from the antenna is fed through an 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 provides a high Q and also permits the filter to be small in size.

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 provides RF bypass. Switching transistor Q200 turns on in the transmit mode and grounds the supply voltage to Q201. This disables Q201 which attenuates high-level RF present when transmitting, especially in the talk-around mode when the transmit frequency is the same as the receive frequency.

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 filter Z201 at 45 MHz by C209 and T200. Capacitor C211 provides DC blocking.

Z201 is a two-pole crystal filter with a center frequency of 45 MHz and a -3 dB passband of $\pm$ 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 the filter 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 34.30 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 34.30 MHz second injection signal. The output is tuned to twice the input frequency by C216, C217, and T202.

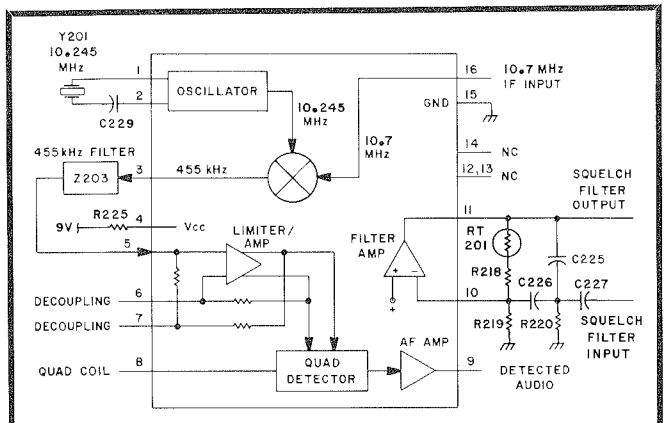
Z202 is a four-pole crystal filter with a center frequency of 10.7 MHz and a −3 dB passband of ± 3.75 kHz. This filter provides additional attenuation of the same frequencies attenuated by Z201. The filter sections are a matched pair and the dot on the case indicates which leads connect together. C220 is a matching capacitor and the value varies with the filter vendor. Occasionally, the value may be different than that shown in the parts list. If this is the case with a replacement filter, the new value is indicated on shipping envelope. 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.

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/detector stage in U201 and also to detector Q206. The purpose of Q206 is to provide a DC indication at TP201 of the 455 kHz signal level for use in tuning the receiver. The limiter in U201 amplifies the 455 kHz signal and then limits it to a specific level. This tends to clip off noise present in the 455 kHz signal.



U201 BLOCK DIAGRAM
FIGURE 5-3

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. The filter output is on pin 11 and is fed to the squelch circuit on the audio/logic board. This transceiver uses receiver noise to control the squelch. 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 (Q401, Q402)

Q401 and Q402 form a push-push frequency doubler. W401 is a quarter-wave line and provides 180 degree out-of-phase input signals. Therefore, one stage is turning on while the other is turning off. Since the outputs of these stages are connected in parallel, two output cycles are produced for every input cycle. This type of multiplier provides a higher output level than a single-stage multiplier and also has good rejection of the fundamental and odd harmonic frequencies.

C402 and C405 are coupling capacitors, L401 provides a DC ground, and C401 and C404 provide matching. R403-R408 provide class C biasing and L402 is an RF choke. C410 is an axial-leaded capacitor which is series resonant at about 450 MHz. Therefore, it provides

a low-impedance path to ground for the fundamental frequency. C411, C412, C413, L403, and L404 form a high-pass filter which also attenuates the fundamental frequency. The output signal from the filter is fed to amplifier Q403 and also to the receiver as the first injection frequency. Capacitors C414 and C415 form an AC voltage divider to provide the correct input level to the mixer.

5.4.2 AMPLIFIER (Q403), DRIVER (Q404)

Amplifier Q403 provides about 10 dB of gain. R412 and C416 across the collector and base provide negative feedback for stabilization. L405, C421, C422, and a section of microstrip* provide matching with driver Q404.

Driver Q404 also provides about 10 dB of gain. L406 and R415 on the input provide self-biasing for class C operation. C423 and C424 provide matching, and R416 and C425 provide negative feedback for stabilization. The output is matched to an attenuator by a section of microstrip, L407, L408, and C429. Supply voltage to this stage is controlled by the power control circuit. R417, R418, C426-C428, and C432 isolate the supply from RF. R417 and R418 also provide current limiting if a short circuit occurs in Q404.

The signal is coupled by C430 to a 2 dB attenuator formed by R419-R424. This circuit reduces the input level to power module U501 to prevent Q501 from being overdriven.

* 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.

5.4.3 POWER MODULE (U501), FINAL (Q501)

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 12 watts. The supply voltage to the last two stages is isolated from RF by L502/L503 and several capacitors. A section of microstrip and C511 and C512 provide matching with Q501.

Final Q501 amplifies the 12 watt output from U501 to provide 35 watts of power at the antenna jack. Class C biasing is provided by L504, and impedance matching with the low-pass filter is provided by C513, C514, C516, C517, and a section of microstrip. The RF signal is coupled by C522 to a low-pass filter consisting of L506, L507, C518, C519, and C520. This filter attenuates harmonic frequencies occurring above the transmit band.

5.4.4 ANTENNA SWITCH (CR501, CR502, CR503)

The antenna switch circuit switches the antenna to the receiver in the receive mode and the transmitter in the transmit mode. Two grounded quarter-wave lines are used to isolate the receiver in the transmit mode. When one end of a quarter-wave line is grounded, the other end presents a high impedance to the quarter-wave frequency. Pin diodes CR501, CR502, and CR503 provide a low impedance when forward biased and a very small capacitance (high impedance) when reverse biased.

One quarter-wave line is formed by discrete components consisting of C533, L510, and C534. In the transmit mode, 9 volts is applied through current limiting resistors R506-R509, and current flows through L508, CR501, L510, L511, and CR502. Since CR501 and CR502 are forward biased, the transmit signal has a low-impedance path to the antenna through coupling capacitor C532, and the discrete quarter-wave line is AC grounded by C535.

The other quarter-wave line is formed by the microstrip between C535 and C540. In the transmit mode, 9 volts is applied through current limiting resistors R509 and R510, and current flows through L513, L514, and CR503. Since CR503 is forward biased, the quarter-wave line is AC grounded by C540. Two grounded quarter-wave lines are required to provide the needed receiver isolation, especially in the talk-around mode when the transmit frequency is the same as the receive frequency.

In the receive mode, the transmit 9 volt supply is removed, so the diodes are reverse biased and the quarter-wave lines are no longer AC grounded. Therefore, the receive signal has a high-impedance path into the transmitter and a low-impedance path into the receiver. The capacitor and inductor across each diode neutralize the small capacitance of the diode when it is reverse biased so that isolation is improved. L508, L511, and L513 function as RF chokes, and R505 dissipates static buildup on the antenna.

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 and to final amplifier Q501. 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 and Q501 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 Q501 caused by too much drive from U501.

The reference voltage on pin 5 of U601B determines the power output of the transceiver. This voltage is controlled by power adjust potentiometer R611 and a thermal foldback circuit. During normal operation, CR601 is reverse biased and the reference voltage is provided by voltage divider R610/R611. Capacitors C604, C605, C607, and C608 provide filtering of the reference voltage.

The thermal foldback circuit consists of RT601, R608, R609, and CR601. The function of this circuit is to decrease the power output as the ambient temperature rises above approximately 176 degrees F (80 degrees C). As the temperature increases, the resistance of RT601 decreases. When the temperature reaches approximately 176 degrees, CR601 becomes forward biased and RT601 and R608 are effectively in parallel with R611. This decreases the reference voltage on U601B, pin 5, which causes the power output to decrease. As the temperature decreases below 176 degrees, power output increases towards normal.

5.5 POWER SWITCHING AND REGULATION, AUDIO AMPLIFIER

5.5.1 POWER SWITCHING (Q307, Q308, U303A-D)

Power to most sections of the transceiver is switched by Q303 and Q304. Exceptions are the power switching circuit described in the next paragraph, and certain sections of the transmitter. Q303 and Q304 are P-channel MOSFETs connected in parallel to provide the required current capability. When switch driver Q305 is turned on, the gate of these transistors is near 0 volts and they conduct. Conversely, when Q305 is turned off, the gates are near 13.6 volts and the transistors are turned off.

Since power off/on switch S159 on the display board is a momentary pushbutton switch, a latch formed by Q308, Q307, and U303A-D is required to control switch driver Q305. Transistors Q308 and Q307 turn on when S159 is pressed and C309 begins charging through R312. This provides a momentary logic 0 input to pins 13 and 1 of NOR gates U303D and U303A. When S159 is released, Q308 and Q307 turn off and C309 discharges through CR303 and R311.

Gates U303C and U303B control switch driver Q305. The outputs of these gates, which are always the opposite states, are fed back to the inputs of gates U303D and U303A. Therefore, pins 12 and 2 are also always the opposite states. When the off/on switch is pressed, a logic 0 is applied to pins 13 and 1. The output of the gate with a logic 0 applied to the other input then goes high and results in the toggling of the outputs of U303C and U303B.

An RC network formed by R308 and C306 causes the output of U303C to always be high after the power cable is plugged into the transceiver. This ensures that power is automatically turned on in this situation. RC networks R309/C307 and R310/C308 have a longer time constant than R312/C309 so that the new logic level applied to pins 12 and 2 is delayed for at least the duration of the low pulse from Q307. This prevents the circuit from oscillating.

5.5.2 NINE VOLT REGULATOR (U300, Q301)

Q301 and U300 form a 9 volt regulator. Q301 is in a series-pass configuration and is controlled by amplifier U300. A 6.2 volt reference voltage is established on the noninverting input of U300 by R319 and zener diode CR304. A voltage divider formed by R320 and R321 provides an input of approximately 6.2 volts on the inverting input of U300 when the regulator output is 9

volts. R305 ensures that the regulator turns on when power is initially applied, and C318 and C303 provide filtering.

5.5.3 AUDIO AMPLIFIER (U301)

Audio amplifier U301 provides up to 5 watts of power to drive the 3 ohm internal or external speaker. The gain of the amplifier is controlled by R314 and R315 which set the amount of feedback coupled by C312 to pin 2. C317, R316, and R318 provide shaping of the audio response, and C313 and C311 provide DC blocking. R313 and C310 on the output 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 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 for a short time after power is applied to the microprocessor. Initialization ensures proper microprocessor operation after it may begin operating improperly such as during low-voltage conditions. The reset circuit operates as follows:

When power is applied to the transceiver, Q5 immediately turns on and turns Q6 off. C33 then charges through R76 which holds the RST input high for a short time. If the 5 volt supply drops below approximately 4.3 volts, Q5 turns off and Q6 turns on. This holds the RST input high and disables the microprocessor until the supply voltage returns to normal. The base of Q5 is biased at approximately 4.0 volts by R70 and R114.

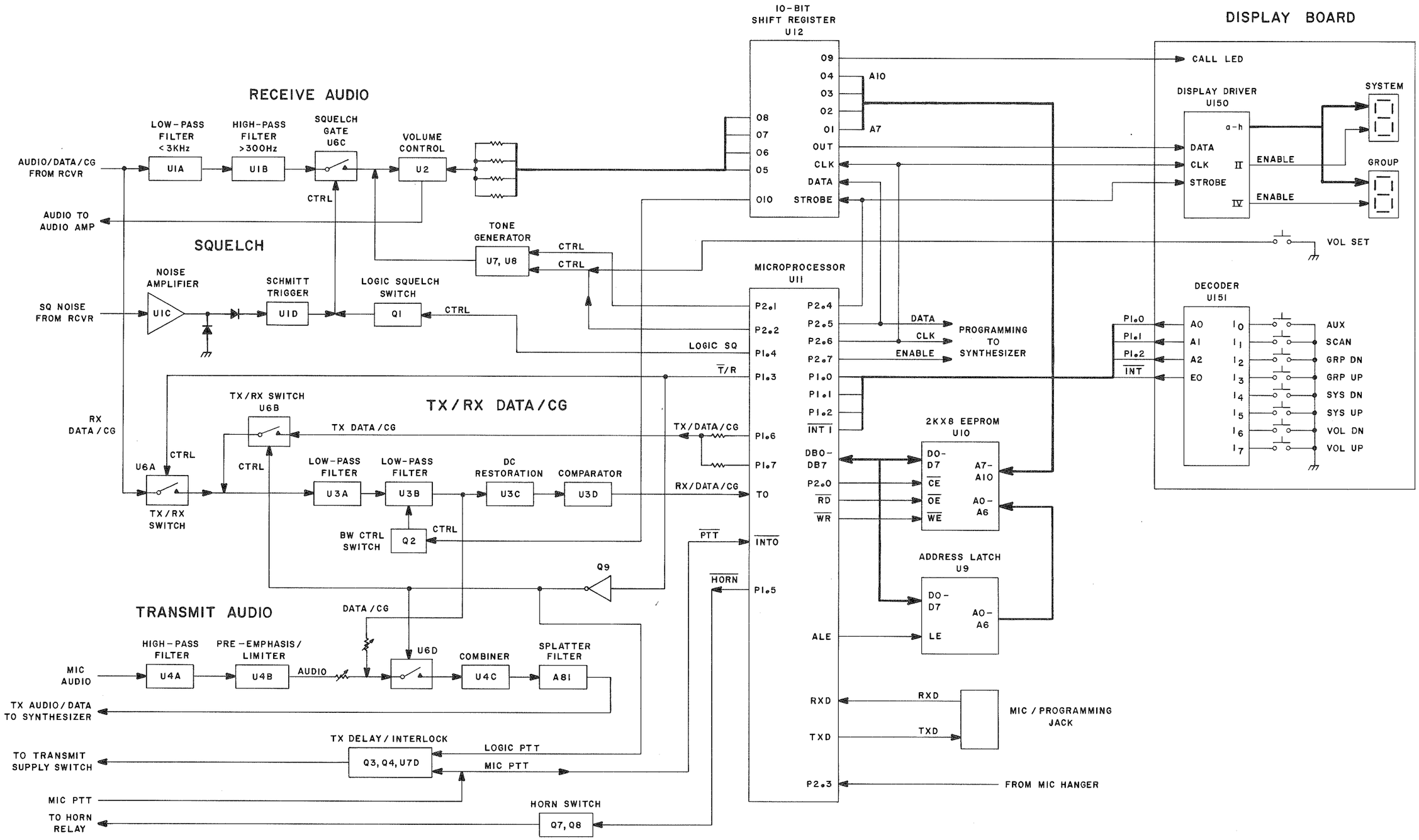
Data Input/Output Ports

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-DB7 (P0.0-P0.7) - These lines are multiplexed data and address lines. They provide the lower seven bits of the EEPROM address and also are used to read and write data to the EEPROM. When a data read or write operation occurs, the lower seven bits of the address first appear on these outputs and are latched by U9 when the ALE output goes low. The data being read or written then appears.

P1.0-P1.2 - Inputs for three-bit code from encoder U151 on the display board. This three-bit code tells the microprocessor which panel switch has been pressed (also see $\overline{\text{INT 1}}$).

P1.3 - Output which provides logic control of transmitter keying. This output is low in the transmit mode and high in the receive mode.



AUDIO/LOGIC BOARD BLOCK DIAGRAM
FIGURE 5-4

P1.4 - Output which 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. The control logic overrides the noise squelch in LTR applications and also in conventional applications when Call Guard is used.

P1.5 - This pin is used as both an input and output. It is used as an input when power is turned on to detect the position of TEST/OPERATE jumper J5. If this input is low, the program enters the test mode (refer to Section 3.8). If it is high or in a high impedance state, it enters the operate mode which is used for normal operation. These states are read only on power up. At other times it provides an output which controls horn switch Q7/Q8. A low output causes the horn or other external alert to sound.

P1.6, P1.7 - Output for the transmit data/Call Guard signal. R89 and R90 along with R24 and R25 are used to provide pulse-shaping to obtain the desired response from the low-pass filter. Four different output levels to the low-pass filter can be produced by the two bits of data provided by these outputs.

P2.0 - Output which provides the logic 0 chip select signal to EEPROM U10. This output goes low during a read or write operation to U10.

P2.1, P2.2 - Outputs used to control the tone oscillator circuit. The four logic combinations select either a busy, intercept, or beep tone or disable the oscillator.

P2.3 - Input used to sense if the microphone is on- or off-hook. This information is used by the microprocessor to control such things as the Call indicator and monitoring before transmitting (when Call Guard is used).

P2.4, P2.5, P2.6, P2.7 - Provide the DATA, CLOCK, ENABLE, and STROBE signals when data is written to shift register U12, synthesizer chip U802, and display driver U150. Refer to the individual descriptions 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.

$\overline{\text{INT 0}}$ (P3.2) - A low on this input indicates that the microphone push-to-talk switch is pressed. The microprocessor then interrupts normal program execution and vectors to a section of the program containing transmit mode instructions.

$\overline{\text{INT 1}}$ (P3.3) - A logic low on this input indicates that a front panel switch has been pressed. The microprocessor then interrupts normal program execution and vectors to a section of the program containing instructions on reading the switch information on the P1.0-P1.2 inputs. If both $\overline{\text{INT 0}}$ and $\overline{\text{INT 1}}$ go low at the same time, $\overline{\text{INT 0}}$ has priority over $\overline{\text{INT 1}}$.

T0 (P3.4) - 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 LTR data or Call Guard signaling is being used, the microprocessor then begins monitoring the receive data input (T0) for valid data or Call Guard. (Information on the T1 input is ignored if no carrier is detected.) The T1 signal has a rapid rise and fall time to immediately tell the microprocessor if a carrier is present.

$\overline{\text{WR}}$ (P3.6) - This output goes low when data is written to EEPROM U10.

$\overline{\text{RD}}$ (P3.7) - This output goes low when data is read from EEPROM U10.

5.6.2 EEPROM (U10)

EEPROM 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 eight-bit data words.

When data is read from this device, the location of the data appears on address inputs A0-A10. Bits A0-A6 of the address are latched by U9 when the ALE (address latch enable) output of the microprocessor goes low. Bits A7-A10 are shifted into shift register U12 and appear on the Q1-Q4 outputs of that device. Data then appears on the D0-D7 outputs of U10 when both the $\overline{\text{CE}}$ (chip enable) and $\overline{\text{OE}}$ (output enable) inputs go low. A data write operation is similar except that data on the D0-D7 inputs is written to the addressed location when $\overline{\text{WE}}$ (write enable) instead of $\overline{\text{OE}}$ goes low.

← **FOLDOUT** (FIGURE 5-4, AUDIO/LOGIC BOARD BLOCK DIAGRAM)

CIRCUIT DESCRIPTION

5.6.3 SHIFT REGISTER (U12)

U12 is a ten-bit shift register used to provide additional microprocessor control outputs. Data on the DATA input is clocked into U12 by a rising edge on the CLOCK input. Data shifted through the register is clocked out on the OUT pin. This data is used to program display/driver U150 on the display board.

Data in the shift register is latched (converted from serial to parallel) when the STROBE input is high. This latched data then controls the ten outputs. The approximate voltage level of a logic 1 output is 9 volts, and maximum drive current of a logic 1 output is 50 milliamperes.

5.6.4 RECEIVE AUDIO PROCESSING (U1A, U1B, U2)

The detected audio/data signal from U201 in the receiver is applied to a bandpass filter formed by C1, C2, 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. This 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 12) 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.

From the squelch gate the signal is fed to attenuator U2. 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, and R10 and R11 set the input level to the attenuator.

Attenuator U2 is used in place of a potentiometer to provide volume control. The output level on pin 7 is determined by the DC control voltage on pin 2. This voltage can be varied in sixteen steps by the logic levels on the Q5-Q8 outputs of shift register U12. The attenuation of U2 increases as the control voltage increases and vice versa. The difference in attenuation between steps is approximately 3 dB. From U2 the audio signal is fed to audio amplifier U301 on the main board.

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, 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 and 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 prevent 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 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)

NOTE: LTR signaling is present when an LTR system is selected, and Call Guard signaling may be present if a conventional system programmed with Call Guard is selected.

Introduction

The data/Call Guard filter formed by U3A and U3B is used to filter both receive and transmit data/Call Guard signals. 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 Q10 output of shift register U12 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), Splatter Filter (A81)

U4C combines the input signals and also provides some low-pass filtering. The output signal from U3B is the sum of the microphone and data/Call Guard signals. The levels of these signals are set by potentiometers R50 and R36. U4D provides additional low-pass filtering to attenuate frequencies over 3 kHz generated by amplitude limiting. The output signal from U4D is fed to accessory jack P2.

Splatter filter A81 is a module which provides additional low-pass filtering to minimize adjacent channel interference. This type of interference must be minimized because of the narrow channel spacing (12.5 kHz) and because adjacent channels are assigned.

5.6.8 PTT DELAY AND INTERLOCK (Q3, U7D, Q4)

Introduction

The circuit consisting of Q3, U7D, Q4, and several other components provides several functions. First, it ensures that the transmitter cannot be keyed for extended periods 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. Secondly, it allows the microprocessor to disable the transmitter when the time-out timer time is exceeded. Thirdly, it provides 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. Lastly, it allows the microprocessor to key the transmitter for a short time when the LTR transpond function is performed.

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 $\overline{\text{INT 0}}$ 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 output of buffer U5B is in a high-impedance state. 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 U11, pin 4, (P1.3) is low. When Q3 turns on, transmit switch Q306 on the main board is turned on and the transmitter keys.

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 (P1.3) as soon as the turn-off code is transmitted.

Logic Transmitter Keying

One-shot multivibrator Q4 permits the logic to key the transmitter for up to the length of the delay described in the preceding paragraph. When the logic keying signal is present, a logic high is applied to the base of Q4 and that transistor turns on. C32 then charges through R63 and a negative-going pulse is applied to buffer U5C. The output on pin 13 then pulses low which charges C31. Capacitor C31 then begins discharging through R61 as when the microphone PTT switch is released (refer to preceding paragraph). This keys the transmitter for the delay period (up to 1 second).

5.6.9 HORN SWITCH (Q7, Q8)

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 from the vehicle 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 3.5 for more information 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 how these tones are generated follows and other tone information is located in Section 3.6.9.

The busy tone may be heard in the LTR mode when a call attempt is made. It indicates 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 that 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 5, 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, and C8 form a pulse shaping network which attenuates harmonics present in the square-wave output of the generator.

5.7 DISPLAY BOARD

5.7.1 DISPLAY DRIVER (U150)

Data is loaded serially into a shift register in display driver U150. Data on the DATA input is clocked into U150 by a high to low transition on the CLOCK input. This data is then latched when the STROBE line connected to the ENABLE input goes high. Data loaded into U150 is first shifted through shift register U12 on the audio/logic board. Since these devices share the same CLOCK and STROBE lines, data is latched by both devices at the same time.

Four bits of data per digit indicate the number to be displayed and another four digits contain decimal point information. Since U150 can drive up to four digits, up to twenty bits are loaded. The display is multiplexed which means that each digit is enabled individually by a high pulse on the digit enable outputs (II and IV). A internal nonoverlapping clock enables each digit in succession. Therefore, each digit is enabled one-fourth the time. The frequency of this clock is determined by C150 connected to the OSC input. The refresh rate is made high enough to ensure that no flickering is detected. AUXILIARY indicator DS154 is turned on by decimal point information for the GROUP display (digit II).

5.7.2 ENCODER (U151)

Encoder U151 produces a three-bit output which indicates which one of the eight inputs have been forced high by a front panel switch. For example, if input I1 is forced high by pressing scan switch S151, 001 appears on the A0-A2 outputs. The EO output goes low whenever any switch is pressed. That signal tells the microprocessor that there is data waiting to be read.

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

There is a test mode which can be selected to perform transceiver testing. The test mode is described in Section 3.8 and permits the transceiver to be operated like a standard dispatch transceiver. The test mode is especially useful when LTR systems are programmed because the logic 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 544-3x1x-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.

6.3.2 SERVICING TECHIQUES

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, U804A, pin 3 is near 9 volts instead of 0 volts. Buffer switch Q905 then turns off which interrupts supply voltage to buffer Q904. This blocks the synthesizer output signal and disables the transmitter and receiver.

When the VCO is unlocked, the f_R and f_V inputs to the phase detector are not in phase (refer to Figure 6-1). The phase detector in U802 then causes the VCO control voltage to continuously ramp high or low. This causes the VCO frequency to change accordingly.

As shown in Figure 6-1, a loop is formed by VCO Q902, prescaler U801, and the N counter and phase detector in U802. Therefore, improper operation of any of these components causes improper signals throughout the loop. Since the VCO frequency is usually constantly changing when the VCO is unlocked, it may be necessary to break the loop to obtain the stable frequencies needed for troubleshooting. The troubleshooting flowchart in Figure 6-2 and information which follows suggest tests that can be made to help localize a problem to a specific section.

6.4.2 PRELIMINARY CHECKS

VCO Control Voltage

Check the voltage at TP801 with a center channel selected. If it is a steady DC voltage around 5 volts, the VCO is probably locked on frequency. If it is a stepped waveform similar to that shown in Section 6.4.7, it is probably out-of-lock.

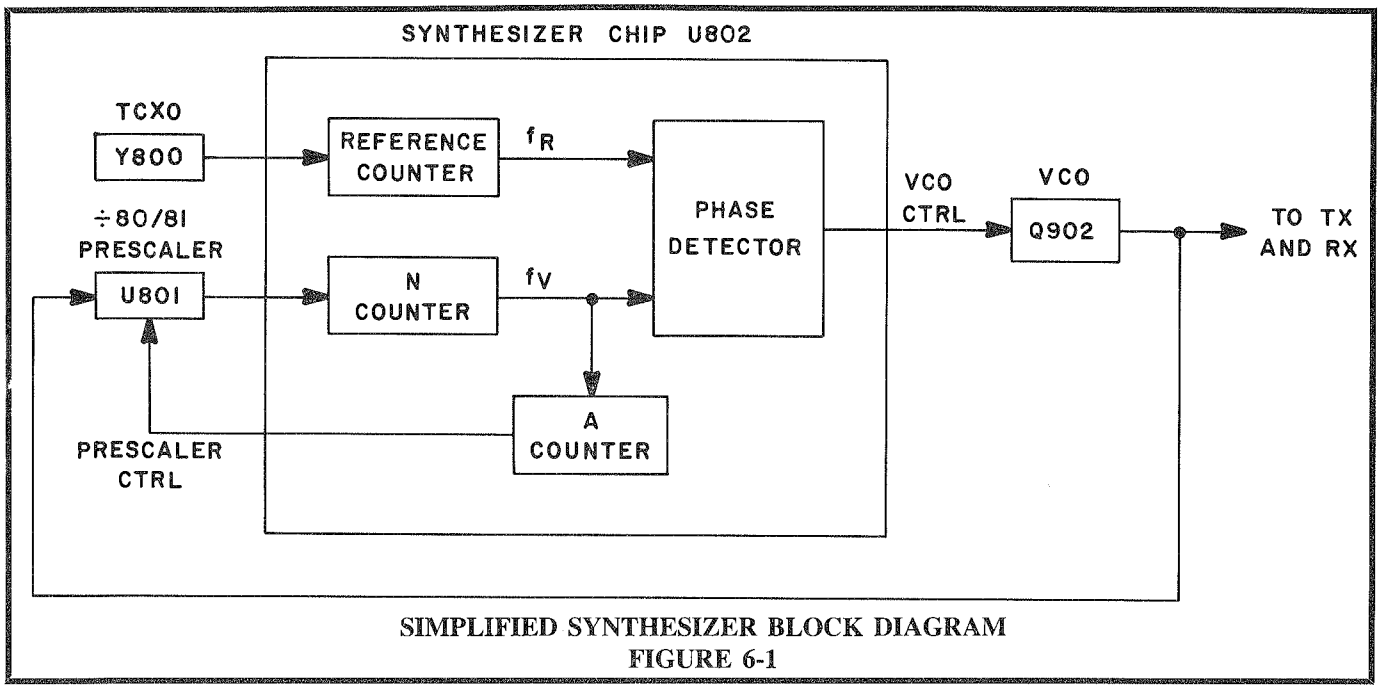
Lock Detect

If the preceding check revealed a locked VCO, buffer Q904 should be enabled and the lock detect output on U802, pin 9, should be high. If it revealed that the VCO is out-of-lock, Q904 should be disabled and the lock detect output should contain negative-going pulses.

If the phase detect and lock detect outputs of U802 are not in agreement in indicating either a locked or unlocked synthesizer, U802 may be defective. An example of this would be if the phase detect output is a DC voltage indicating a locked VCO and the lock detect output is negative-going pulses indicating an unlocked VCO.

TABLE 6-1
APPROXIMATE LOGIC LEVELS

Device	Input Level		Output Level	
	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



SIMPLIFIED SYNTHESIZER BLOCK DIAGRAM
FIGURE 6-1

If the preceding checks do not indicate that U802 or the lock detect circuit is defective, 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 2. This frequency should be 17.1500 MHz and the level should be approximately 1.1 volts rms.

If this signal is not correct, verify that the 9 volt supply is present on pin 3 and that the output is not shorted. If Y800 is defective, it is not serviceable and must be replaced.

6.4.4 ADAPTIVE SWITCH (U803A-D)

The control inputs of U803A and U803B (pins 13 and 5) are normally low except when the channel is changed or the VCO is out-of-lock. When the channel is changed or the transmitter is keyed, two positive-going pulses from the ENABLE line are applied to the control inputs. The first pulse is about 2 microseconds and the second is about 5 milliseconds. When the VCO is out-of-lock, continuous 5 millisecond positive-going pulses from the lock detect circuit are applied to the control inputs. A logic high applied to either pin 13 or 5 should cause pin 6 of U803C and pin 12 of U803D to go high. When pins 13 and 5 are both a logic low, pins 6 and 12 should also be a logic low.

6.4.5 VCO TROUBLESHOOTING

VCO Output Level

The VCO output level can be checked by measuring the RF voltage at the output of buffers Q904 and Q906. The output voltage of Q906 at the junction of C931 and C804 should be approximately 0.35 volts rms. The output voltage of Q904 on the output of C928 should be approximately 0.71 volts rms.

Talk-Around Latch (U805B)

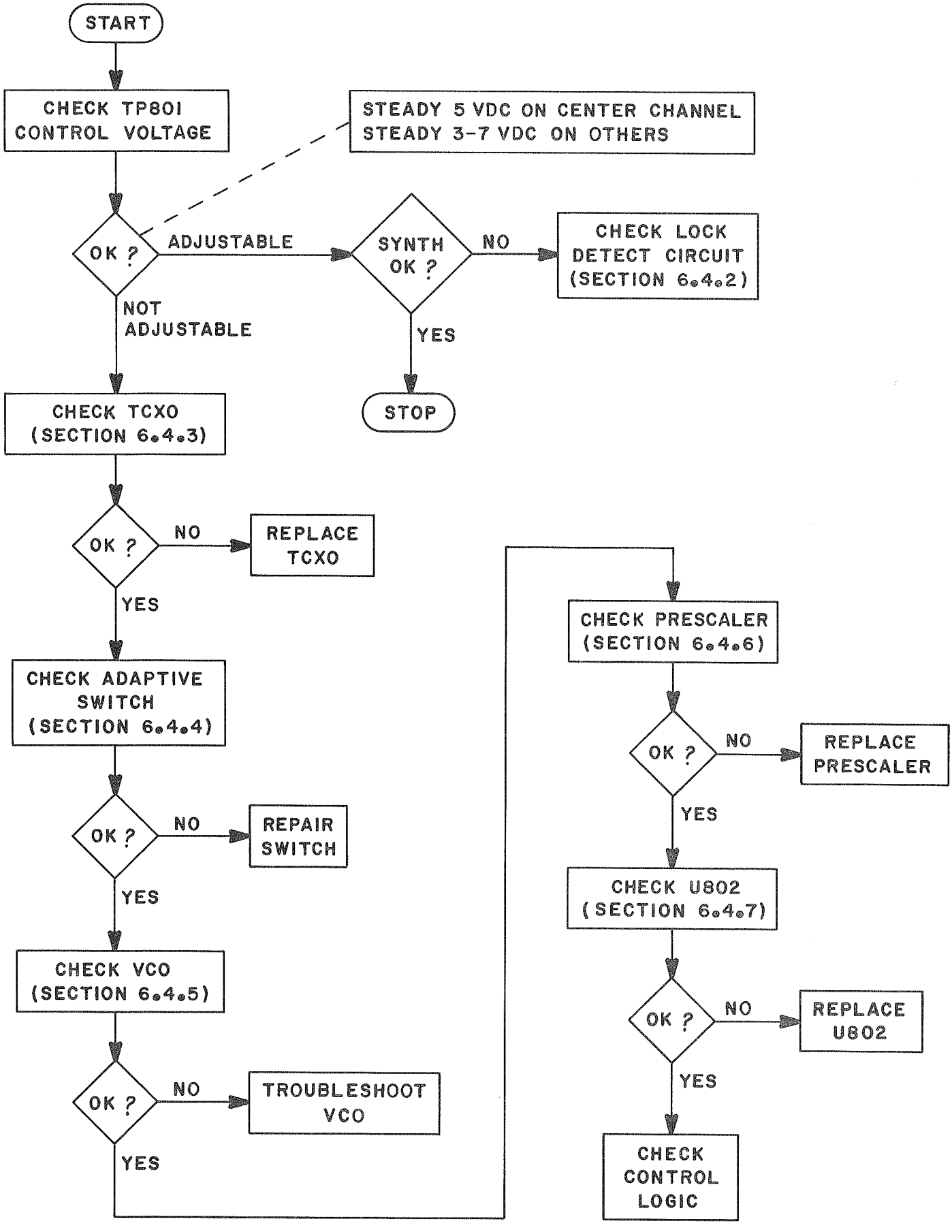
Normally, U805B, pin 12 is low and pin 13 is high. The only time these outputs are the opposite state is in transmit when a channel programmed for talk-around is selected in a conventional system.

Transmit/Receiver Latch (U805A)

In the transmit mode, U805A, pin 2, should be high and pin 1 should be low. In the receive mode, these pins should be the opposite states.

VCO Frequency Check

If the VCO is locked on frequency, the VCO output frequency should be very stable. If the VCO is not locked on frequency, the VCO frequency is usually changing between the low and high ends of its operating range because of the changing control voltage. Check the VCO frequency as follows (bottom shield must be in place).



SYNTHESIZER TROUBLESHOOTING FLOWCHART
FIGURE 6-2

a. Connect a frequency counter to pin 5 of U801. A center channel should be selected and the Talk-Around Mode should not be selected.

b. If the frequency is stable, it should be as follows:

$$\text{Receive Mode} = \frac{\text{Channel Frequency} - 45\ \text{MHz}}{2}$$

$$\text{Transmit Mode} = \frac{\text{Channel Frequency}}{2}$$

If the frequency is correct, the VCO is probably operating properly and the problem may be elsewhere such as with the lock detector.

c. If the VCO frequency is not steady because the control voltage is changing, it can be controlled as follows:

Ground pin 6 of U803. Connect the negative output of a variable DC power supply to chassis ground and connect the positive output to TP801.

d. Set the power supply output for 5.0 volts and the VCO frequency should be approximately 446.25 MHz (receive mode). Vary the output voltage between 3.0 and 7.0 volts and the frequency should vary from approximately 445 MHz to 448 MHz.

e. Key the transmitter (with a suitable antenna load connected). The VCO frequency should increase by approximately 3.0 MHz.

f. Select the talk-around mode and key the transmitter. The frequency should increase by approximately 22.5 MHz from that measured in step d.

If the proper VCO frequencies cannot be obtained using the preceding procedure, the VCO is probably defective. Check Q901, Q902, and Q903. Remove the jumper between pin 6 of U803 and ground unless also checking the prescaler as described in the next section.

6.4.6 PRESCALER U801 TROUBLESHOOTING

If the VCO is out-of-lock, the input frequency to U801 is probably continuously changing. To obtain a stable prescaler input frequency and check the prescaler divide number, proceed as follows:

a. To obtain a steady VCO output frequency, use one of the following methods:

Method 1 (Preferred)

Temporarily cut the PC board trace between C931 and C804 and connect an RF signal generator to the input of C804. The generator output level should be 0 dBm and the frequency should be near 448 MHz.

Method 2

Connect a DC power supply to TP801 as described in step c of the preceding section.

b. If using Method 2, measure the VCO frequency at the junction of C931 and C804 and note the reading.

c. Connect a frequency counter to U802, pin 10.

d. Short U801, pin 1 to pin 2 so that the control input is high. U801 should then divide by 80. For example, 448.0 MHz ÷ 80 = 5.60 MHz.

e. Short U801, pin 1 to ground so that U801 divides by 81. Check the output frequency. For example, 448.0 MHz ÷ 81 = 5.53086 MHz.

f. Remove the short and check the input level on U802, pin 10. It should be approximately 3.6 volts P-P.

If any of the preceding measurements were incorrect, the prescaler is probably not operating properly. The preceding test setup may also be used in the test which follows and in Section 6.4.7.

Checking Prescaler Using Modulus Control Signal

The prescaler can also be checked when it is controlled by the modulus control signal from U802, pin 8. Determine the prescaler divide number for the selected channel using the following formula. (Refer to Section 6.4.8 to determine the A and N counter divide numbers.)

$$\text{Prescaler Divide Number} = 80 + \frac{A}{N}$$

Example: For a transmit frequency of 936.2500 MHz, A= 20, N= 936

$$\text{Prescaler Divide Number} = 80 + \frac{20}{936} = 80.02137$$

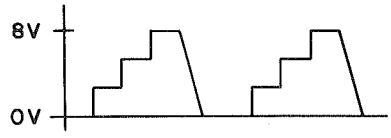
Check the prescaler output frequency using the same procedure used earlier in this section. If the frequency is not correct with this test but was correct when the control input was shorted high and low, U802 may be defective.

6.4.7 SYNTHESIZER U802 TROUBLESHOOTING

The simplest thing to check first is the TCXO frequency as described in Section 6.4.3. If this signal is correct, various U802 outputs can be checked as follows:

VCO Frequency Control Signal (Pin 17)

When the VCO is locked on frequency, U802, pin 17 is a constant DC voltage between 2.4 and 6.4 volts. When it is unlocked and the phase of the f_V input to the phase detector in U802 lags f_R, the signal should be similar to the stepped waveform shown below. If f_V leads f_R, this waveform should step down instead of up. The frequency of this signal is equal to the frequency difference between the f_V and f_R inputs.



To determine if this signal changes to a constant DC level when the VCO is oscillating on the correct frequency, proceed as follows:

a. Control the VCO frequency as described in Section 6.4.6 (Method 1 preferred).

b. Monitor the waveform at U802, pin 17. As the signal generator or VCO frequency is slowly swept toward the correct frequency for the selected channel and mode (transmit or receive), the pulses should decrease in frequency.

c. When the frequency is slowly swept past the correct frequency, a momentary DC voltage between 1 and 6 volts should appear before the out-of-lock pulsing again appears.

If this test indicates proper operation of the VCO control output, then the phase detector and modulus control sections of U802 are probably operating correctly. The problem could then be with another part of the synthesizer such as the VCO or adaptive loop filter. If the correct results were not obtained with this test, U802 may be defective or there may be a problem with the logic which programs U802.

Lock Detect Signal (Pin 9)

This signal should be as follows:

VCO Locked - 8 volts DC (not pulsing)

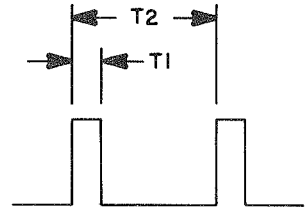
VCO Unlocked - Negative-going pulses at a frequency approximately equal to the difference between the f_R and f_V inputs to the phase detector in U802.

If it is determined that the VCO is locked or unlocked by other testing and the lock detect signal is not correct, U802 may be defective.

Modulus Control Signal (Pin 8)

The frequency of the modulus control signal on pin 8 should be 6.25 kHz. The duty cycle of this signal determines the divide number of the prescaler. The correct duty cycle (T1/T2) for the selected channel should be as follows:

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



Refer to the next section to determine the A and N counter divide numbers. If the frequency or duty cycle is not correct, there may be a problem with channel programming, U802, or the programming logic.

6.4.8 CHANNEL SELECTION

Channels are selected by programming the reference, N, and A counters in synthesizer chip U802 to divide by a certain number. These counters are programmed by serial data from microprocessor U11 on the audio/logic board. The divide numbers of these counters can be determined as follows:

Reference Counter

The reference counter divide number is 2744 for all channels.

N Counter

The N counter divide number is the same as the first three digits of the selected transmit frequency or receive first injection frequency. For example, the N counter divide number for a frequency of 936.2500 MHz is 936. (The receive first injection frequency is 45 MHz below the receive channel frequency.)

A Counter

The A counter divide number is determined from the digits following the decimal point of the selected frequency. The A counter divide number increases by one for each 12.5 kHz that this number is above zero. For example, when 0.2500 MHz is divided by 12.5 kHz, the result is 20 which is the A counter divide number for that frequency. Likewise, the divide number for 936.0000 MHz is 0.

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:

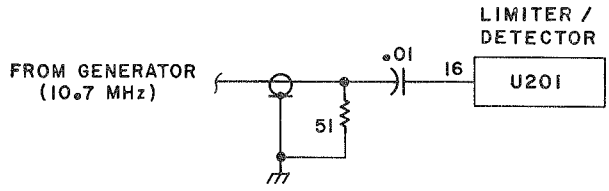
Q306 source – 9 volts
Q306 drain – 9 volts (tx mode)
0 volts (rx mode)

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)

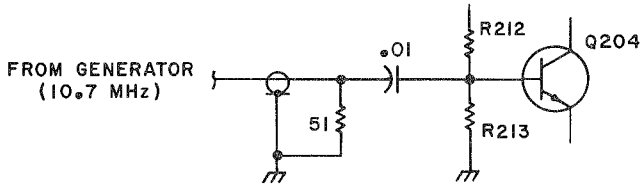
Remove C224 and connect the circuit shown below.



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)

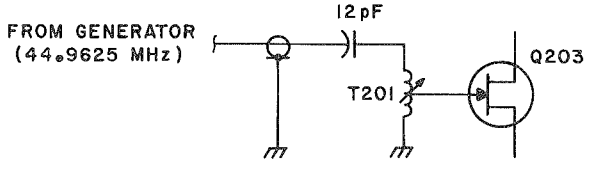
Remove C221 and connect the circuit shown below.



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)

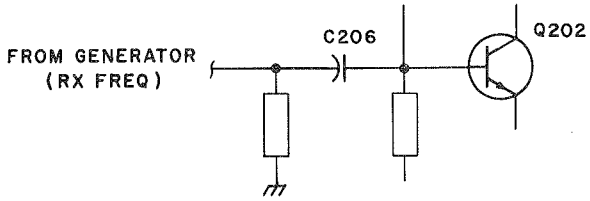
Remove C213 and connect the circuit shown below.



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 collector - 13.6 volts DC
Q306 source - 9 volts
Q306 drain - 9 volts (tx mode)
0 volts (rx mode)

Typical transceiver current in the transmit mode is 12 amperes with 30 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)
Q401 Base	210
Collector	180
Q402 Base	210
Collector	180
Q403 Base	240
Collector	200
Q404 Base	0
Collector	170
U501, Pin 2	240
Pin 3	3.6k
Pin 4	3.6k
Q501 Base	0
Collector	3.5k
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 $\pm$ 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 6.7.2.

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.

SUPPLY VOLTAGES

5 Volts - Pins 31, 40
Ground - Pin 20

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 is programmed on the selected channel and the correct Call Guard 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 is 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. Then when the Test Mode is selected, it provides a low input. This pin should be high at other times.

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 479 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 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 jumper J5 on the audio/logic board in the "TEST" position. When the transceiver power is turned on with this jumper in that position, the test mode is entered. To exit the test mode, transceiver power must be turned on with this jumper in the "OPERATE" position. The following is a summary of some of the test mode functions. Refer to Section 3.8 for more test mode operating information.

SYSTEM Switch – Selects the ten test channels.

GROUP Switch – Selects various transmit tones.

Squelch – Noise squelch only in test mode.

Auxiliary Switch – Selects talk-around mode.

7.2 PRELIMINARY SETUP

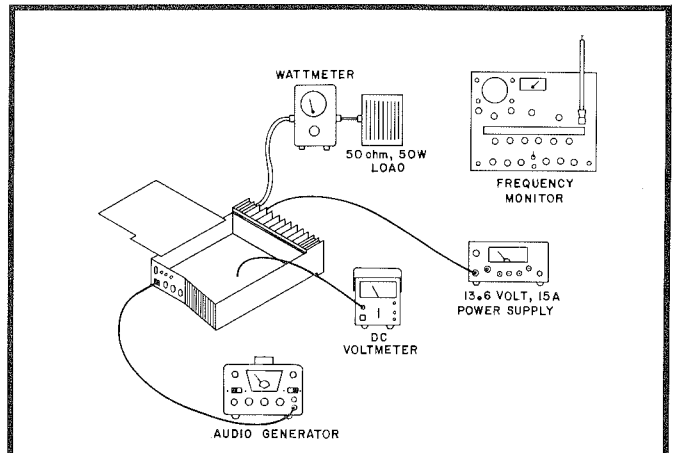
a. Remove the transceiver covers by loosening the five captive screws. Remove the audio/logic board mounting screws and flip the board over. Temporarily support it by reinstalling the two special screws.

b. Connect the test setup shown in Figure 7-1. Connect a 13.6 volt, 15 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. Remove the large shield over the top side of the main PC board. The large shield on the bottom of the PC board must be in place during alignment.

NOTE: A tuning tool with a 0.030" square tip (JMC No. 4193) is required to adjust C516.



TRANSMITTER TEST SETUP
FIGURE 7-1

7.3 SYNTHESIZER ADJUSTMENTS

The voltage readings at TP801 listed in the following procedure are with the top sheet metal shield off. It is normal for these voltages to decrease by approximately 0.5 volt when this shield is replaced. Refer to the alignment point diagram in Figure 7-4 and proceed as follows:

a. Select a channel in the middle of the band (usually System 5). Connect a DC voltmeter to TP801.

NOTE: If the meter reading at TP801 is above approximately 8 volts, the synthesizer is probably unlocked. The cause may be a defective component in the synthesizer or VCO.

b. If the voltage at TP801 is 4.5-8.0 volts, no adjustment is necessary at this time and you can proceed to Section 7.4. If the voltage is low, cut jumpers on the main VCO line until it is above 4.5 volts (start on the open end and alternate from side to side of the line).

c. This provides a coarse adjustment. Further adjustment may be required in step g of the next section.

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 System 5).

b. Preset R611 for maximum power output (fully counterclockwise when viewed from the front of the transceiver).

c. Key the transmitter and tune C516 and C541 for maximum power output.

d. Adjust R611 for desired power output (15 watts minimum, 30 watts maximum).

e. Select Group 1 to generate a 71 Hz square wave. (This produces an average deviation of zero for setting the frequency in the next step.)

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.

f. 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 (± 100 Hz).

NOTE: If soldering is performed in the following step, the heat from the soldering iron may affect the voltage of TP801. Therefore, make sure the voltage is still within the desired range after the board has cooled.

g. Select the center channel and check the DC voltage at TP801 in the transmit mode. It must be in the range of 4.5-5.5 volts. If it is low, cut jumpers as described in step b of the preceding section. If it is high, reconnect jumpers or fill in the small rectangular holes along the main VCO line (start on the closed end and alternate from side to side).

h. Recheck the voltage at TP801 in the receive mode. It must be within the 4.5-5.5 volt range in both the transmit and receive modes.

7.4.2 TALK-AROUND MODE

a. Select a center frequency (usually System 5). Connect a DC voltmeter to TP801.

b. The meter reading should be between 4.5 and 5.5 volts in both the transmit and receive modes. If not, repeat step g in Section 7.4.1.

c. Select the talk-around mode by pressing the Auxiliary switch. The green Auxiliary indicator should light.

d. Key the transmitter and observe the meter reading. The voltage should be 4.60-5.40 VDC. If the voltage is low, cut jumpers on the pin diode shift line; if it is high, reconnect jumpers.

e. Check transmitter power output in the Talk-Around mode. Minimum power output on all channels should be 20 watts (when set for 30 watts in Section 7.4.1).

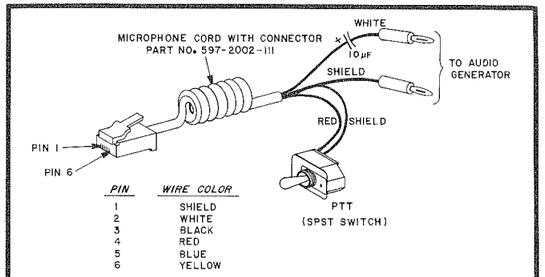
7.4.3 MODULATION BALANCE

a. On the audio/logic board, jumper TP1 to TP2. Make sure that a center channel is selected and the talk-around mode is not selected (Auxiliary indicator off). Select Group 1 to generate a 71 Hz square wave.

b. Connect a 10 μF or larger nonpolarized capacitor from TP3 to TP4. *NOTE: Two 20 μF or larger polarized capacitors can be connected in series with like signs together to form a nonpolarized capacitor.*

c. Key the transmitter and view the demodulated signal on the CRT of a communications monitor. Adjust R801 so that the signal is a square wave with no tilt or overshoot.

d. Unkey the transmitter and remove the jumper and capacitor.



MICROPHONE SUBSTITUTION FIXTURE
FIGURE 7-2

7.4.4 DATA AND AUDIO MODULATION

a. Select Group 1 to generate a 71 Hz square wave.

b. 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).

c. 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.

d. 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 b.

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 System 5).

b. Set the signal generator to the channel frequency (usually 939.8625 MHz) with the modulation off.

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

d. Connect a DC voltmeter to TP201 and adjust the signal generator output to obtain a meter reading of 1-2 volts.

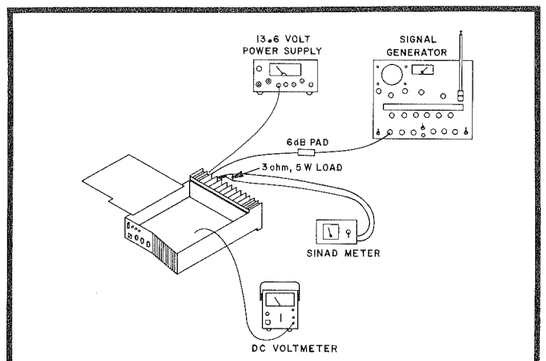
e. Adjust T200, T201, T202, T203, and T204 for a peak meter reading. Readjust the generator output as necessary to maintain a voltage at TP201 of 1-2 volts.

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

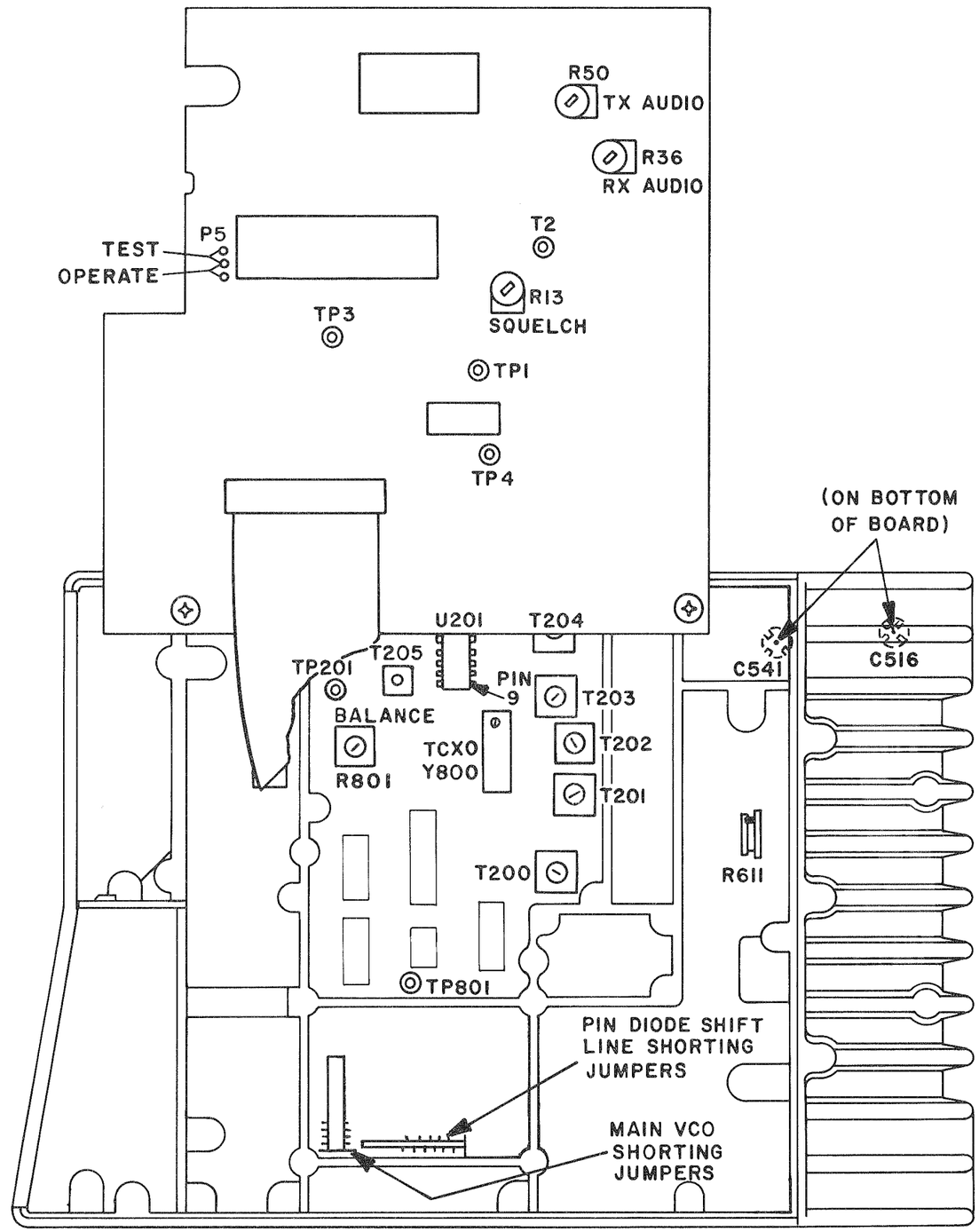
g. Set the signal generator modulation for 1 kHz at ±3 kHz deviation. The 12 dB SINAD sensitivity on all channels should be less than 0.35 microvolts. If not, repeat step e.

h. Adjust the signal generator output level for 4 dB SINAD. Adjust squelch control R13 on the audio/logic board so that the transceiver just squelches at that level.

i. Switch the power off and move the Test/Operate jumper back to the "OPERATE" position. Replace the shield over the top side of the main PC board.



RECEIVER TEST SETUP
FIGURE 7-3



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 operating 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 volt 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 30 watts maximum at 13.6 volts DC. Output power is settable down to 15 watts.

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

c. Check power output in the talk-around mode. Minimum power output should be 20 watts if set for 30 watts as in step a.

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. Data 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 POINT DIAGRAM)

SECTION 8
PARTS LIST

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 001	Main board assembly	023-8650-001
A 011	Audio/logic board assembly	023-8650-011
A 031	Front panel assembly	023-8610-031
A 051	Top cover assembly includes:	023-8610-100
	Cover	032-0791-105
	Speaker cavity gasket	018-1134-120
A 061	Bottom cover assembly includes:	023-8610-101
	Cover	032-0791-110
	Speaker cavity gasket	018-1134-121
A 081	Splatter filter module	023-8650-081
C 001	.0068 μF ±5% 63V polyester	510-1033-682
C 002	.0068 μF ±5% 63V polyester	510-1033-682
C 003	.001 μF ±5% 63V polyester	510-1033-102
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 chip	510-3607-473
C 009	.1 μF ±5% 63V polyester	510-1033-104
C 010	.001 μF ±10% X7R 50V chip	510-3606-102
C 011	680 pF ±5% NPO 50V cer chip	510-3602-681
C 012	.0068 μF ±10% X7R 50V chip	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 chip	510-3606-223
C 018	.068 μF ±5% 63V polyester	510-1033-683
C 019	.0027 ±5% 63V polyester	510-1033-272
C 020	.0022 μF ±5% 63V polyester	510-1033-222
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	.0068 μF ±5% 63V polyester	510-1033-682
C 027	.22 μF ±5% 63V polyester	510-1033-224
C 028	.0022 μF ±5% 63V polyester	510-1033-222
C 029	.0018 μF ±5% 63V polyester	510-1033-182
C 030	470 pF ±5% NPO 50V cer chip	510-3602-471
C 031	10 μF 35V alum electrolytic	510-4235-100
C 032	.047 μF ±10% X7R 50V chip	510-3607-473
C 033	10 μF 35V alum electrolytic	510-4235-100
C 034	30 pF ±5% NPO 50V cer chip	510-3602-300
C 035	30 pF ±5% NPO 50V cer chip	510-3602-300
C 036	.1 μF ±10% X7R 50V cer chip	510-3607-104
C 037	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 038	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 039	.33 μF ±5% 63V polyester	510-1033-334
C 041	100 μF 16V alum electrolytic	510-4216-101
C 042	.022 μF ±10% X7R 50V chip	510-3606-223
C 043	47 μF 25V alum electrolytic	510-4225-470
C 044	.022 μF ±10% X7R 50V cerm chip	510-3606-223
C 045	.022 μF ±10% X7R 50V cerm chip	510-3606-223
C 046	.022 μF ±10% X7R 50V cerm chip	510-3606-223
C 047	.022 μF ±10% X7R 50V cerm chip	510-3606-223
C 048	.22 μF ±5% 63V polyester	510-1033-224
C 049	100 μF 16V alum electrolytic	510-4216-101
C 050	100 μF 16V alum electrolytic	510-4216-101
C 150	.01 μF ±10% X7R 50V chip	510-3606-103
C 151	.01 μF ±10% X7R 50V chip	510-3606-103
C 152	.01 μF ±10% X7R 50V chip	510-3606-103
C 201	5.1 pF ±5% NPO 50V cer chip	510-3602-519
C 202	3.9 pF ±5% NPO 50V cer chip	510-3602-399
C 203	270 pF ±5% NPO 50V cer chip	510-3602-271
C 204	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 205	7.5 pF ±5% NPO 50V cer chip	510-3602-759
C 206	4.7 pF ±5% NPO 50V cer chip	510-3602-479
C 207	.001 μF ±10% X7R 50V chip	510-3606-102
C 208	.001 μF ±10% X7R 50V chip	510-3606-102
C 209	12 pF ±5% NPO 50V cer chip	510-3602-120
C 210	.001 μF ±10% X7R 50V chip	510-3606-102
C 211	.001 μF ±10% X7R 50V chip	510-3606-102
C 212	.001 μF ±10% X7R 50V chip	510-3606-102
C 213	30 pF ±5% NPO 50V cer chip	510-3602-300
C 214	20 pF ±5% NPO 50V cer chip	510-3602-200
C 215	5.1 pF ±5% NPO 50V cer chip	510-3602-519
C 216	27 pF ±5% NPO 50V cer chip	510-3602-270
C 217	120 pF ±5% NPO 50V cer chip	510-3602-121
C 218	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 219	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 220	7.5 pF ±5% 50V NPO cer disc	510-3213-759
C 221	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 222	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 223	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 224	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 225	62 pF ±5% NPO 50V cer chip	510-3602-620
C 226	220 pF ±5% NPO 50V cer chip	510-3602-221
C 227	220 pF ±5% NPO 50V cer chip	510-3602-221
C 228	43 pF ±5% NPO 50V cer chip	510-3602-430
C 229	120 pF ±5% NPO 50V cer chip	510-3602-121
C 230	.047 μF ±10% X7R 50V chip	510-3607-473
C 231	.047 μF ±10% X7R 50V chip	510-3607-473
C 232	270 pF ±5% N750 50V ceramic	510-3120-271
C 233	.001 μF ±10% X7R 50V chip	510-3606-102
C 234	.01 μF ±10% X7R 50V chip	510-3606-103
C 235	10 μF 35V alum electrolytic	510-4235-100
C 236	.022 μF ±10% X7R 50V chip	510-3606-223

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 237	.001 μF ±10% X7R 50V chip	510-3606-102
C 300	10 pF ±5% NPO 50V cer chip	510-3602-100
C 301	.01 μF ±10% X7R 50V chip	510-3606-103
C 302	.01 μF ±10% X7R 50V chip	510-3606-103
C 303	470 μF 16V alum electrolytic	510-4216-471
C 304	470 μF 25V alum electrolytic	510-4225-471
C 305	6.8 μF ±20% 35V tantalum	510-2245-689
C 306	.047 μF ±10% X7R 50V chip	510-3607-473
C 307	.047 μF ±10% X7R 50V chip	510-3607-473
C 308	.047 μF ±10% X7R 50V chip	510-3607-473
C 309	.047 μF ±10% X7R 50V chip	510-3607-473
C 310	.047 μF ±10% X7R 50V chip	510-3607-473
C 311	1000 μF 16V alum electrolytic	510-4216-102
C 312	10 μF 35V alum electrolytic	510-4235-100
C 313	.047 μF ±10% X7R 50V chip	510-3607-473
C 314	.01 μF ±10% X7R 50V chip	510-3606-103
C 315	.01 μF ±10% X7R 50V chip	510-3606-103
C 316	.01 μF ±10% X7R 50V chip	510-3606-103
C 317	.022 μF ±10% X7R 50V chip	510-3606-223
C 318	47 μF ±20% 15V tantalum	510-2243-470
C 319	.022 μF ±10% X7R 50V chip	510-3606-223
C 320	.022 μF ±10% X7R 50V chip	510-3606-223
C 401	2.2 pF ±5% NPO 50V cer chip	510-3602-229
C 402	56 pF ±5% NPO 50V cer chip	510-3602-560
C 403	56 pF ±5% NPO 50V cer chip	510-3602-560
C 404	1.0 pF ±5% NPO 50V cer chip	510-3602-109
C 405	56 pF ±5% NPO 50V cer chip	510-3602-560
C 406	56 pF ±5% NPO 50V cer chip	510-3602-560
C 407	56 pF ±5% NPO 50V cer chip	510-3602-560
C 408	.01 μF ±10% X7R 50V chip	510-3606-103
C 409	.047 μF ±10% X7R 50V chip	510-3607-473
C 410	47 pF ±5% N750 ax ceramic	510-3521-470
C 411	2.2 pF ±5% NPO 50V cer chip	510-3602-229
C 412	1.8 pF ±5% NPO 50V cer chip	510-3602-189
C 413	2.2 pF ±5% NPO 50V cer chip	510-3602-229
C 414	1.0 pF ±5% NPO 50V cer chip	510-3602-109
C 415	1.0 pF ±5% NPO 50V cer chip	510-3602-109
C 416	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 417	56 pF ±5% NPO 50V cer chip	510-3602-560
C 418	56 pF ±5% NPO 50V cer chip	510-3602-560
C 419	56 pF ±5% NPO 50V cer chip	510-3602-560
C 420	.01 μF ±10% X7R 50V chip	510-3606-103
C 421	3.3 pF ±5% NPO 50V cer chip	510-3602-339
C 422	1.0 pF ±5% NPO 50V cer chip	510-3602-109
C 423	3.3 pF ±5% NPO 50V cer chip	510-3602-339
C 424	3.3 pF ±5% NPO 50V cer chip	510-3602-339
C 425	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 426	56 pF ±5% NPO 50V cer chip	510-3602-560
C 427	.01 μF ±10% X7R 50V cer chip	510-3606-103
C 428	6.8 μF ±20% 35V tantalum	510-2245-689
C 429	3.3 pF ±5% NPO 50V cer chip	510-3602-339
C 430	56 pF ±5% NPO 50V cer chip	510-3602-560
C 431	3.3 pF ±5% NPO 50V cer chip	510-3602-339
C 432	.01 μF ±10% X7R 50V chip	510-3606-103
C 501	6.8 μF ±20% 35V tantalum	510-2245-689
C 502	.01 μF ±10% X7R 50V chip	510-3606-103
C 503	56 pF ±5% NPO 50V cer chip	510-3602-560
C 504	6.8 μF ±20% 35V tantalum	510-2245-689
C 505	.01 μF ±10% X7R 50V chip	510-3606-103
C 506	56 pF ±5% NPO 50V cer chip	510-3602-560
C 507	6.8 μF ±20% 35V tantalum	510-2245-689
C 508	.01 μF ±10% X7R 50V chip	510-3606-103
C 509	56 pF ±5% NPO 50V cer chip	510-3602-560
C 511	11 pF ±5% 250V mini mica	510-0020-110
C 512	15 pF ±5% 250V mini mica	510-0020-150
C 513	11 pF ±5% 250V mini mica	510-0020-110
C 514	15 pF ±5% 250V mini mica	510-0020-150
C 515	56 pF ±5% NPO 50V cer chip	510-3602-560
C 516	1-4.5 pF variable smd	512-1008-001
C 517	4.0 pF ±5% 250V mini mica	510-0020-409
C 518	3.9 pF ±5% 250V mini mica	510-0028-399
C 519	6.8 pF ±5% 250V mini mica	510-0028-689
C 520	3.9 pF ±5% 250V mini mica	510-0028-399
C 522	56 pF ±10% 50V mica chip	510-0620-560
C 524	56 pF ±5% NPO 50V cer chip	510-3602-560
C 525	.047 μF ±10% X7R 50V chip	510-3607-473
C 527	.01 μF ±10% X7R 50V chip	510-3606-103
C 528	56 pF ±5% NPO 50V cer chip	510-3602-560
C 529	56 pF ±5% NPO 50V cer chip	510-3602-560
C 530	.001 μF ±10% X7R 50V chip	510-3606-102
C 531	56 pF ±10% 50V mica chip	510-0620-560
C 532	56 pF ±10% 50V mica chip	510-0620-560
C 533	3.9 pF ±10% 50V mica chip	510-0620-399
C 534	1.5 pF ±10% 50V mica chip	510-0620-159
C 535	3.9 pF ±10% 50V mica chip	510-0620-399
C 536	56 pF ±10% 50V mica chip	510-0620-560
C 537	56 pF ±5% NPO 50V cer chip	510-3602-560
C 538	.001 μF ±10% X7R 50V chip	510-3606-102
C 539	56 pF ±5% NPO 50V cer chip	510-3602-560
C 540	7.5 pF ±5% NPO 50V cer chip	510-3602-759
C 541	1-4.5 pF variable smd	512-1008-001
C 542	.001 μF ±10% X7R 50V chip	510-3606-102
C 601	56 pF ±5% NPO 50V cer chip	510-3602-560
C 602	56 pF ±5% NPO 50V cer chip	510-3602-560
C 603	56 pF ±5% NPO 50V cer chip	510-3602-560
C 604	56 pF ±5% NPO 50V cer chip	510-3602-560
C 605	56 pF ±5% NPO 50V cer chip	510-3602-560
C 606	.022 μF ±10% X7R 50V chip	510-3606-223
C 607	.01 μF ±10% X7R 50V chip	510-3606-103
C 608	2.2 μF ±20% 35V tantalum	510-2245-229
C 801	10 μF 35V alum electrolytic	510-4235-100
C 802	27 pF ±5% NPO 50V cer chip	510-3602-270
C 803	27 pF ±5% NPO 50V cer chip	510-3602-270
C 804	.001 μF ±10% X7R 50V chip	510-3606-102

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 805	.001 µF ±10% X7R 50V chip	510-3606-102
C 806	.01 µF ±10% X7R 50V chip	510-3606-103
C 807	.001 µF ±10% X7R 50V chip	510-3606-102
C 808	470 pF ±5% NPO 50V cer chip	510-3602-471
C 809	47 pF ±5% NPO 50V cer chip	510-3602-470
C 810	.047 µF ±10% X7R 50V chip	510-3606-473
C 811	.47 µF ±5% 63V polyester	510-1033-474
C 812	.047 µF ±5% 63V polyester	510-1033-473
C 813	10 µF 35V alum electrolytic	510-4235-100
C 814	.047 µF ±10% X7R 50V chip	510-3607-473
C 815	1.0 µF ±20% 35V tantalum	510-2245-109
C 816	.01 µF ±10% X7R 50V chip	510-3606-103
C 820	.047 µF ±10% X7R 50V chip	510-3606-473
C 821	220 pF ±5% NPO 50V cer chip	510-3602-221
C 822	220 pF ±5% NPO 50V cer chip	510-3602-221
C 901	.0022 µF ±10% X7R 50V chip	510-3606-222
C 902	.01 µF ±10% X7R 50V chip	510-3606-103
C 903	33 pF ±5% NPO 50V cer chip	510-3602-330
C 904	22 µF ±10% 20V tantalum	510-2574-220
C 905	.01 µF ±10% X7R 50V chip	510-3606-103
C 906	.001 µF ±10% X7R 50V chip	510-3606-102
C 907	220 pF ±5% NPO 50V cer chip	510-3602-221
C 908	220 pF ±5% NPO 50V cer chip	510-3602-221
C 909	220 pF ±5% NPO 50V cer chip	510-3602-221
C 910	220 pF ±5% NPO 50V cer chip	510-3602-221
C 911	220 pF ±5% NPO 50V cer chip	510-3602-221
C 912	220 pF ±5% NPO 50V cer chip	510-3602-221
C 913	220 pF ±5% NPO 50V cer chip	510-3602-221
C 914	3.6 pF ±5% NPO 50V cer chip	510-3602-369
C 916	56 pF ±5% NPO 50V cer chip	510-3602-560
C 917	3.3 pF ±5% 50V NPO cer chip	510-3602-339
C 918	4.3 pF ±5% 50V NPO cer chip	510-3602-439
C 919	1.0 pF ±5% 50V NPO cer chip	510-3602-109
C 920	1.0 pF ±5% 50V NPO cer chip	510-3602-109
C 921	4.3 pF ±5% 50V N750 cer chip	510-3625-439
C 922	27 pF ±5% NPO 50V cer chip	510-3602-270
C 923	9.1 pF ±10% 50V cer chip	510-3353-919
C 924	18 pF ±5% N750 50V cer chip	510-3625-180
C 926	.001 µF ±10% X7R 50V chip	510-3606-102
C 927	.001 µF ±10% X7R 50V chip	510-3606-102
C 928	220 pF ±5% NPO 50V cer chip	510-3602-221
C 929	.001 µF ±10% X7R 50V chip	510-3606-102
C 930	.001 µF ±10% X7R 50V chip	510-3606-102
C 931	4.7 pF ±5% NPO 50V cer chip	510-3602-479
CH001	Chassis	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	UHF/VHF band sw diode SOT	523-1504-012
CR007	4.3V ±5% 600 mW zener	523-2008-439
CR008	UHF/VHF band sw diode SOT	523-1504-012
CR009	UHF/VHF band sw diode SOT	523-1504-012
CR010	UHF/VHF band sw diode SOT	523-1504-012
CR011	UHF/VHF band sw diode SOT	523-1504-012
CR201	UHF/VHF band sw diode SOT	523-1504-012
CR202	Pin switching diode SOT	523-1504-001
CR301	18V ±5% 1W zener	523-2503-180
CR302	1500W transient suppressor	523-2901-002
CR303	UHF/VHF band sw diode SOT	523-1504-012
CR304	4.3V ±5% zener SOT	523-2016-439
CR501	8.5W pin diode VHF/UHF	523-1000-010
CR502	8.5W pin diode VHF/UHF	523-1000-010
CR503	Pin switching diode SOT	523-1504-001
CR601	UHF/VHF band sw diode SOT	523-1504-012
CR801	UHF/VHF band sw diode SOT	523-1504-012
CR802	UHF/VHF band sw diode SOT	523-1504-012
CR901	Pin switching diode SOT	523-1504-001
CR902	Pin switching diode SOT	523-1504-001
CR903	Varicap SOT-23	523-1504-018
CR904	Varicap SOT-23	523-1504-018
CR905	UHF/VHF band sw diode SOT	523-1504-012
DS150	7-segment LED display	549-4002-020
DS151	7-segment LED display	549-4002-020
DS152	Yellow LED	549-4001-202
DS153	Red LED	549-4001-201
DS154	Green LED	549-4001-203
EP001	Foam tape, dbl side 1/16''	574-3002-015
EP015	Extruded neoprene cord	574-3002-001
EP201	Crystal pin insulator	018-1080-002
EP204	Crystal pin insulator (Z201)	018-1080-006
EP300	.375 x .375 ferrite bead	517-2002-003
EP301	Ferrite bead	517-2502-007
EP302	Insulating pad (under U301 etc)	574-5005-111
EP602	Insulating pad (under Q602)	574-5005-110
F 301	Fuse, 2A subminiature	534-0009-020
HW001	Screw, A/L bd hold-down	013-1705-020
HW002	Urethane foam (on A/L bd)	042-0361-320
HW003	Nut, hex 5/8-24 (ant jk)	560-9079-028
HW005	Screw, 6-32 x 5/16 torx	575-0006-010
HW006	Screw, 6-32 x 7/16 torx	575-0006-014
HW008	Screw, 6-32 (for MP3)	575-9066-008
HW011	Screw, 6-32 captive (for covers)	575-9606-148
HW151	Screw #4 x¼ hi-lo	575-5644-008

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
J 005	3-pin male header	515-7100-003
J 007	Connector, 30-pin male	515-7117-080
J 306	Connector, 2-pin female	515-9031-281
J 300	Antenna connector assembly	023-8610-021
J 301	3.6 mm speaker jack	515-2001-011
J 302	Power connector	023-8610-051
	includes:	
	Connector terminal	515-9033-006
	Connector body, dual	515-9033-012
J 303	Modular jack, 8-pin	515-2006-040
J 305	Connector, 14-pin male	515-7103-127
L 201	2.2 μH ±20% axial	542-3513-229
L 301	2-1/2T ferrite choke	517-2005-005
L 401	1-1/2T coil 22 AWG	542-0010-015
L 402	5.5T coil 26 AWG	542-0001-055
L 403	2.5T coil 22 AWG	542-0010-025
L 404	2.5T coil 22 AWG	542-0010-025
L 405	4.5T coil 22 AWG	542-0010-045
L 406	5.5T coil 26 AWG	542-0001-055
L 407	5.5T coil 26 AWG	542-0001-055
L 408	1-1/2T coil 22 AWG	542-0010-015
L 501	5.5T coil 22 AWG	542-0010-055
L 502	5.5T coil 22 AWG	542-0010-055
L 503	5.5T coil 22 AWG	542-0010-055
L 504	6T coil 22 AWG	542-0015-006
L 505	6T coil 22 AWG	542-0015-006
L 506	3T 22 AWG SMD	542-0015-003
L 507	3T 22 AWG SMD	542-0015-003
L 508	5.5T coil 26 AWG	542-0001-055
L 509	1.5T coil 26 AWG	542-0001-015
L 510	1-1/2T coil 22 AWG	542-0010-015
L 511	5.5T coil 26 AWG	542-0001-055
L 512	1.5T coil 26 AWG	542-0001-015
L 513	5.5T coil 26 AWG	542-0001-055
L 514	1.5T coil 26 AWG	542-0001-015
L 601	1-1/2T ferrite choke	517-2005-003
L 801	6.8 μH ±20% axial	542-3513-689
L 901	1.0 μH ±20% axial	542-3513-109
L 902	1.0 μH ±20% axial	542-3513-109
L 903	1.0 μH ±20% axial	542-3513-109
L 904	1.0 μH ±20% axial	542-3513-109
L 905	1.0 μH ±20% axial	542-3513-109
L 907	1.0 μH ±20% axial	542-3513-109
L 908	1.0 μH ±20% axial	542-3513-109
L 909	1.0 μH ±20% axial	542-3513-109
LS301	Speaker, 2 x 3 6W 3.2 ohm	589-1015-002

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
MP001	Stand off	013-1188-007
MP002	Shield plate (top)	017-2224-105
MP003	Exciter shield	017-2224-130
MP004	Regulator clip	017-2224-110
MP005	Speaker cavity damper	018-1134-145
MP010	Bottom shield (cast)	015-0920-121
MP150	Front panel	032-0791-100
MP151	Lens	032-0791-120
MP152	Keypad	032-0791-115
MP153	Bracket, speaker	017-2224-125
MP154	Speaker cavity gasket	018-1134-130
MP155	Bracket, speaker w/o bend	017-2224-126
NP150	Nameplate, Johnson	559-0039-026
P 002	Connector, 14-pin male	515-9031-437
P 005	Shorting socket	515-5010-001
P 155	Connector, 14-pin female	515-7111-007
P 304	Connector, 30-pin female	515-7117-029
P 306	2-pin male header	515-9031-201
PC001	PC board, main	035-8650-001
PC011	PC board, audio/logic	035-8610-011
PC041	PC board, display	035-8610-041
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 006	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 150	NPN amplifier SOT-23	576-0003-658
Q 151	NPN amplifier SOT-23	576-0003-658
Q 200	NPN amplifier SOT-23	576-0003-658
Q 201	NPN low noise 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	PNP VHF/UHF amp SOT-23	576-0003-634
Q 206	PNP low-noise amp SOT-23	576-0003-657
Q 301	Si PNP 80V 7A amp T0-220	576-0002-021
Q 303	P-channel MOSFET	576-0006-106
Q 304	P-channel MOSFET	576-0006-106
Q 305	NPN amplifier SOT-23	576-0003-658
Q 306	P-channel MOSFET	576-0006-106
Q 307	NPN amplifier SOT-23	576-0003-658
Q 308	PNP low-noise amp SOT-23	576-0003-657
Q 401	NPN high freq amp SOT-23	576-0003-628

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 402	NPN high freq amp SOT-23	576-0003-628
Q 403	NPN VHF amplifier	576-0003-660
Q 404	NPN 750mW UHF/800 MHz amp	576-0004-098
Q 501	NPN 870 MHz 45W amplifier	576-0004-818
Q 601	NPN amplifier SOT-23	576-0003-658
Q 602	PNP 80V 7A amp T0-220	576-0002-021
Q 801	PNP low-noise amp SOT-23	576-0003-657
Q 901	NPN amplifier SOT-23	576-0003-658
Q 902	N-channel JFET	576-0006-019
Q 903	NPN amplifier SOT-23	576-0003-658
Q 904	N-channel dual gate MOSFET	576-0006-233
Q 905	PNP low-noise amplifier	576-0003-657
Q 906	N-channel dual gate MOSFET	576-0006-233
R 001	39k ohm ±5% 1/8W chip	569-0115-393
R 002	39k ohm ±5% 1/8W chip	569-0115-393
R 003	560k ohm ±5% 1/8W chip	569-0115-564
R 004	10k ohm ±5% 1/8W chip	569-0115-103
R 005	750k ohm ±5% 1/8W chip	569-0115-754
R 006	20k ohm ±5% 1/8W chip	569-0115-203
R 007	180k ohm ±5% 1/8W chip	569-0115-184
R 008	100k ohm ±5% 1/8W chip	569-0115-104
R 009	330 ohm ±5% 1/8W chip	569-0115-331
R 010	10 ohm ±5% 1/8W chip	569-0115-100
R 011	1k ohm ±5% 1/8W chip	569-0115-102
R 012	6.8k ohm ±5% 1/8W chip	569-0115-682
R 013	300k ohm trimmer	562-0121-304
R 014	68k ohm ±5% 1/8W chip	569-0115-683
R 015	330k ohm ±5% 1/8W chip	569-0115-334
R 016	330k ohm ±5% 1/8W chip	569-0115-334
R 017	100k ohm ±5% 1/8W chip	569-0115-104
R 018	47k ohm ±5% 1/8W chip	569-0115-473
R 019	680 ohm ±5% 1/8W chip	569-0115-681
R 020	1k ohm ±5% 1/8W chip	569-0115-102
R 021	150k ohm ±5% 1/8W chip	569-0115-154
R 022	100k ohm ±5% 1/8W chip	569-0115-104
R 023	16k ohm ±5% 1/8W chip	569-0115-163
R 024	430k ohm ±5% 1/8W chip	569-0115-434
R 025	82k ohm ±5% 1/8W chip	569-0115-823
R 026	100k ohm ±5% 1/8W chip	569-0115-104
R 027	100k ohm ±5% 1/8W chip	569-0115-104
R 028	47k ohm ±5% 1/8W chip	569-0115-473
R 029	16k ohm ±5% 1/8W chip	569-0115-163
R 030	10k ohm ±5% 1/8W chip	569-0115-103
R 031	56k ohm ±5% 1/8W chip	569-0115-563
R 032	56k ohm ±5% 1/8W chip	569-0115-563
R 033	270k ohm ±5% 1/8W chip	569-0115-274
R 034	10k ohm ±5% 1/8W chip	569-0115-103
R 035	22k ohm ±5% 1/8W chip	569-0115-223
R 036	300k ohm trimmer	562-0121-304
R 037	270k ohm ±5% 1/8W chip	569-0115-274
R 038	100k ohm ±5% 1/8W chip	569-0115-104
R 039	100k ohm ±5% 1/8W chip	569-0115-104
R 040	680 ohm ±5% 1/8W chip	569-0115-681
R 041	1k ohm ±5% 1/8W chip	569-0115-102
R 042	100k ohm ±5% 1/8W chip	569-0115-104
R 043	620 ohm ±5% 1/8W chip	569-0115-621
R 044	620 ohm ±5% 1/8W chip	569-0115-621
R 045	20k ohm ±5% 1/8W chip	569-0115-203
R 046	130k ohm ±5% 1/8W chip	569-0115-134
R 047	3.3k ohm ±5% 1/8W chip	569-0115-332
R 048	470k ohm ±5% 1/8W chip	569-0115-474
R 049	16k ohm ±5% 1/8W chip	569-0115-163
R 050	300k ohm trimmer	562-0121-304
R 051	180k ohm ±5% 1/8W chip	569-0115-184
R 052	47k ohm ±5% 1/8W chip	569-0115-473
R 053	27k ohm ±5% 1/8W chip	569-0115-273
R 054	62k ohm ±5% 1/8W chip	569-0115-623
R 055	62k ohm ±5% 1/8W chip	569-0115-623
R 056	1k ohm ±5% 1/8W chip	569-0115-102
R 057	10k ohm ±5% 1/8W chip	569-0115-103
R 058	100k ohm ±5% 1/8W chip	569-0115-104
R 059	4.7k ohm ±5% 1/8W chip	569-0115-472
R 060	10k ohm ±5% 1/8W chip	569-0115-103
R 061	100k ohm ±5% 1/8W chip	569-0115-104
R 062	100k ohm ±5% 1/8W chip	569-0115-104
R 063	150k ohm ±5% 1/8W chip	569-0115-154
R 064	10k ohm ±5% 1/8W chip	569-0115-103
R 065	470 ohm ±5% 1/8W chip	569-0115-471
R 066	22k ohm ±5% 1/8W chip	569-0115-223
R 067	1k ohm ±5% 1/8W chip	569-0115-102
R 068	1.5k ohm ±5% 1/8W chip	569-0115-152
R 069	100 ohm ±5% 1/8W chip	569-0115-101
R 070	1k ohm ±5% 1/8W chip	569-0115-102
R 071	4.3k ohm ±5% 1/8W chip	569-0115-432
R 072	9.1k ohm ±5% 1/8W chip	569-0115-912
R 073	20k ohm ±5% 1/8W chip	569-0115-203
R 074	39k ohm ±5% 1/8W chip	569-0115-393
R 075	10k ohm ±5% 1/8W chip	569-0115-103
R 076	10k ohm ±5% 1/8W chip	569-0115-103
R 077	4.7k ohm ±5% 1/8W chip	569-0115-472
R 078	47k ohm ±5% 1/8W chip	569-0115-473
R 079	2.2k ohm ±5% 1/8W chip	569-0115-222
R 080	47k ohm ±5% 1/8W chip	569-0115-473
R 081	3.3k ohm ±5% 1/8W chip	569-0115-332
R 082	3.3k ohm ±5% 1/8W chip	569-0115-332
R 083	47k ohm ±5% 1/8W chip	569-0115-473
R 084	1M ohm ±5% 1/8W chip	569-0115-105
R 085	39k ohm ±5% 1/8W chip	569-0115-393
R 086	1M ohm ±5% 1/8W chip	569-0115-105
R 087	470k ohm ±5% 1/8W chip	569-0115-474
R 088	1M ohm ±5% 1/8W chip	569-0115-105
R 089	1M ohm ±5% 1/8W chip	569-0115-105

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 090	220k ohm ±5% 1/8W chip	569-0115-224
R 091	470 ohm ±5% 1/8W chip	569-0115-471
R 092	470 ohm ±5% 1/8W chip	569-0115-471
R 093	470 ohm ±5% 1/8W chip	569-0115-471
R 094	6.2k ohm ±5% 1/8W chip	569-0115-622
R 095	6.2k ohm ±5% 1/8W chip	569-0115-622
R 096	6.2k ohm ±5% 1/8W chip	569-0115-622
R 097	6.2k ohm ±5% 1/8W chip	569-0115-622
R 098	10k ohm ±5% 1/8W chip	569-0115-103
R 099	10k ohm ±5% 1/8W chip	569-0115-103
R 100	10k ohm ±5% 1/8W chip	569-0115-103
R 101	10k ohm ±5% 1/8W chip	569-0115-103
R 102	47k ohm ±5% 1/8W chip	569-0115-473
R 103	1k ohm ±5% 1/8W chip	569-0115-102
R 104	1.2k ohm ±5% 1/8W chip	569-0115-122
R 105	1k ohm ±5% 1/8W chip	569-0115-102
R 106	1k ohm ±5% 1/8W chip	569-0115-102
R 107	4.7k ohm ±5% 1/8W chip	569-0115-472
R 108	4.7k ohm ±5% 1/8W chip	569-0115-472
R 109	4.7k ohm ±5% 1/8W chip	569-0115-472
R 110	10k ohm ±5% 1/8W chip	569-0115-103
R 112	10k ohm ±5% 1/8W chip	569-0115-103
R 113	47 ohm ±5% 1/8W chip	569-0115-470
R 114	20k ohm ±5% 1/8W chip	569-0115-203
R 150	220 ohm ±5% 1/8W chip	569-0115-221
R 151	220 ohm ±5% 1/8W chip	569-0115-221
R 152	220 ohm ±5% 1/8W chip	569-0115-221
R 153	220 ohm ±5% 1/8W chip	569-0115-221
R 154	220 ohm ±5% 1/8W chip	569-0115-221
R 155	220 ohm ±5% 1/8W chip	569-0115-221
R 156	220 ohm ±5% 1/8W chip	569-0115-221
R 157	220 ohm ±5% 1/8W chip	569-0115-221
R 158	10k ohm ±5% 1/8W chip	569-0115-103
R 159	10k ohm ±5% 1/8W chip	569-0115-103
R 160	10k ohm ±5% 1/8W chip	569-0115-103
R 161	10k ohm ±5% 1/8W chip	569-0115-103
R 162	10k ohm ±5% 1/8W chip	569-0115-103
R 163	10k ohm ±5% 1/8W chip	569-0115-103
R 164	10k ohm ±5% 1/8W chip	569-0115-103
R 165	10k ohm ±5% 1/8W chip	569-0115-103
R 166	470 ohm ±5% 1/8W chip	569-0115-471
R 200	10k ohm ±5% 1/8W chip	569-0115-103
R 201	12k ohm ±5% 1/8W chip	569-0115-123
R 202	2k ohm ±5% 1/8W chip	569-0115-202
R 203	200 ohm ±5% 1/8W chip	569-0115-201
R 204	220 ohm ±5% 1/8W chip	569-0115-221
R 205	12k ohm ±5% 1/8W chip	569-0115-123
R 206	2.2k ohm ±5% 1/8W chip	569-0115-222
R 207	10k ohm ±5% 1/8W chip	569-0115-103
R 208	1k ohm ±5% 1/8W chip	569-0115-102
R 209	1.5k ohm ±5% 1/8W chip	569-0115-152
R 210	5.1k ohm ±5% 1/8W chip	569-0115-512
R 211	10 ohm ±5% 1/8W chip	569-0115-100
R 212	15k ohm ±5% 1/8W chip	569-0115-153
R 213	4.7k ohm ±5% 1/8W chip	569-0115-472
R 214	1k ohm ±5% 1/8W chip	569-0115-102
R 215	1k ohm ±5% 1/8W chip	569-0115-102
R 216	4.7k ohm ±5% 1/8W chip	569-0115-472
R 217	1.5k ohm ±5% 1/8W chip	569-0115-152
R 218	470k ohm ±5% 1/8W chip	569-0115-474
R 219	100k ohm ±5% 1/8W chip	569-0115-104
R 220	18k ohm ±5% 1/8W chip	569-0115-183
R 221	47k ohm ±5% 1/8W chip	569-0115-473
R 222	5.1k ohm ±5% 1/8W chip	569-0115-512
R 223	47k ohm ±5% 1/8W chip	569-0115-473
R 224	2k ohm ±5% 1/8W chip	569-0115-202
R 225	270 ohm ±5% 1/8W chip	569-0115-271
R 226	150k ohm ±5% 1/8W chip	569-0115-154
R 227	200 ohm ±5% 1/8W chip	569-0115-201
R 228	820 ohm ±5% 1/8W chip	569-0115-821
R 301	5.6k ohm ±5% 1/8W chip	569-0115-562
R 302	1k ohm ±5% 1/8W chip	569-0115-102
R 303	10k ohm ±5% 1/8W chip	569-0115-103
R 304	47k ohm ±5% 1/8W chip	569-0115-473
R 305	10k ohm ±5% 1/8W chip	569-0115-103
R 306	1k ohm ±5% 1/8W chip	569-0115-102
R 307	1k ohm ±5% 1/8W chip	569-0115-102
R 308	1k ohm ±5% 1/8W chip	569-0115-102
R 309	20k ohm ±5% 1/8W chip	569-0115-203
R 310	20k ohm ±5% 1/8W chip	569-0115-203
R 311	10k ohm ±5% 1/8W chip	569-0115-103
R 312	5.6k ohm ±5% 1/8W chip	569-0115-562
R 313	2.7 ohm ±5% 1/8W chip	569-0115-279
R 314	300 ohm ±5% 1/8W chip	569-0115-301
R 315	10 ohm ±5% 1/8W chip	569-0115-100
R 316	10k ohm ±5% 1/8W chip	569-0115-103
R 317	10 ohm ±5% 1/8W chip	569-0115-100
R 318	22k ohm ±5% 1/8W chip	569-0115-223
R 319	1k ohm ±5% 1/8W chip	569-0115-102
R 320	2k ohm ±5% 1/8W chip	569-0115-202
R 321	1.8k ohm ±5% 1/8W chip	569-0115-182
R 322	10k ohm ±5% 1/8W chip	569-0115-103
R 323	47k ohm ±5% 1/8W chip	569-0115-473
R 324	3.3k ohm ±5% 1/8W chip	569-0115-332
R 325	10k ohm ±5% 1/8W chip	569-0115-103
R 401	150 ohm ±5% 1/8W chip	569-0115-151
R 403	1.5k ohm ±5% 1/8W chip	569-0115-152
R 404	240 ohm ±5% 1/8W chip	569-0115-241
R 405	47 ohm ±5% 1/8W chip	569-0115-470
R 406	1.5k ohm ±5% 1/8W chip	569-0115-152
R 407	240 ohm ±5% 1/8W chip	569-0115-241
R 408	47 ohm ±5% 1/8W chip	569-0115-470
R 409	10 ohm ±5% 1/8W chip	569-0115-100
R 410	270 ohm ±5% 1/8W chip	569-0115-271

PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 411	1.5k ohm ±5% 1/8W chip	569-0115-152
R 412	680 ohm ±5% 1/8W chip	569-0115-681
R 413	10 ohm ±5% 1/8W chip	569-0115-100
R 414	10 ohm ±5% 1/8W chip	569-0115-100
R 415	68 ohm ±5% 1/8W chip	569-0115-680
R 416	680 ohm ±5% 1/8W chip	569-0115-681
R 417	20 ohm ±5% 1/8W chip	569-0115-200
R 418	20 ohm ±5% 1/8W chip	569-0115-200
R 419	910 ohm ±5% 1/8W chip	569-0115-911
R 420	910 ohm ±5% 1/8W chip	569-0115-911
R 421	22 ohm ±5% 1/8W chip	569-0115-220
R 422	22 ohm ±5% 1/8W chip	569-0115-220
R 423	910 ohm ±5% 1/8W chip	569-0115-911
R 424	910 ohm ±5% 1/8W chip	569-0115-911
R 505	10k ohm ±5% 1/8W chip	569-0115-103
R 506	51 ohm ±5% 1/8W chip	569-0115-510
R 507	51 ohm ±5% 1/8W chip	569-0115-510
R 508	51 ohm ±5% 1/8W chip	569-0115-510
R 509	51 ohm ±5% 1/8W chip	569-0115-510
R 510	620 ohm ±5% 1/8W chip	569-0115-621
R 601	.03 ohm ±5% 3W MF	569-4150-307
R 602	5.76k ohm 1% 1/8W chip	569-0111-374
R 603	4.99k ohm 1% 1/8W chip	569-0111-368
R 604	2.7k ohm ±5% 1/8W chip	569-0115-272
R 605	6.81k ohm ±1% 1/8W chip	569-0111-381
R 606	4.99k ohm ±1% 1/8W chip	569-0111-368
R 607	47k ohm ±5% 1/8W chip	569-0115-473
R 608	10 ohm ±5% 1/8W chip	569-0115-100
R 609	27k ohm ±5% 1/8W chip	569-0115-273
R 610	6.8k ohm ±5% 1/8W chip	569-0115-682
R 611	5k ohm 1/8W PC trim pot	562-0004-502
R 612	20k ohm ±5% 1/8W chip	569-0115-203
R 613	1.8k ohm ±5% 1/8W chip	569-0115-182
R 614	180k ohm ±5% 1/8W chip	569-0115-184
R 615	1k ohm ±5% 1/8W chip	569-0115-102
R 616	180 ohm ±10% 1/2W CC	569-1504-181
R 617	100 ohm ±10% 1/2W CC	569-1504-101
R 801	10k ohm trimmer	562-0112-103
R 802	120k ohm ±5% 1/8W chip	569-0115-124
R 803	150 ohm ±5% 1/8W chip	569-0115-151
R 804	15k ohm ±5% 1/8W chip	569-0115-153
R 805	12k ohm ±5% 1/8W chip	569-0115-123
R 806	10k ohm ±5% 1/8W chip	569-0115-103
R 807	100k ohm ±5% 1/8W chip	569-0115-104
R 808	1k ohm ±5% 1/8W chip	569-0115-102
R 809	82k ohm ±5% 1/8W chip	569-0115-823
R 810	8.2k ohm ±5% 1/8W chip	569-0115-822
R 811	82k ohm ±5% 1/8W chip	569-0115-823
R 812	2k ohm ±5% 1/8W chip	569-0115-202
R 813	100k ohm ±5% 1/8W chip	569-0115-104
R 814	150k ohm ±5% 1/8W chip	569-0115-154
R 815	10k ohm ±5% 1/8W chip	569-0115-103
R 816	39k ohm ±5% 1/8W chip	569-0115-393
R 817	2k ohm ±5% 1/8W chip	569-0115-202
R 818	1k ohm ±5% 1/8W chip	569-0115-102
R 819	1k ohm ±5% 1/8W chip	569-0115-102
R 820	20k ohm ±5% 1/8W chip	569-0115-203
R 821	47k ohm ±5% 1/8W chip	569-0115-473
R 903	10 ohm ±5% 1/8W chip	569-0115-100
R 904	2k ohm ±5% 1/8W chip	569-0115-202
R 905	750 ohm ±5% 1/8W chip	569-0115-751
R 906	51 ohm ±5% 1/8W chip	569-0115-510
R 907	51 ohm ±5% 1/8W chip	569-0115-510
R 910	10k ohm ±5% 1/8W chip	569-0115-103
R 911	10k ohm ±5% 1/8W chip	569-0115-103
R 912	10 ohm ±5% 1/8W chip	569-0115-100
R 913	470 ohm ±5% 1/8W chip	569-0115-471
R 914	10k ohm ±5% 1/8W chip	569-0115-103
R 915	10k ohm ±5% 1/8W chip	569-0115-103
R 916	10 ohm ±5% 1/8W chip	569-0115-100
R 920	10k ohm ±5% 1/8W chip	569-0115-103
RT201	8k ohm thermistor	569-3001-001
RT601	100k ohm ±5% thermistor	569-3601-104
T 200	45 MHz IF transformer	592-5015-026
T 201	45 MHz IF transformer	592-5015-026
T 202	27 MHz autotransformer	592-5015-005
T 203	10.7 MHz IF transformer	592-5013-012
T 204	10.7 MHz IF transformer	592-5013-012
T 205	455 kHz ceramic disc coil	592-5022-005
T 901	RF transformer	592-5022-114
T 902	RF transformer	592-5022-114
TP001	Test jack, brown	105-2208-211
TP002	Test jack, red	105-2202-211
TP003	Test jack, orange	105-2206-211
TP004	Test jack, yellow	105-2207-211
TP201	Test jack, brown	105-2208-211
TP801	Test jack, red	105-2202-211
U 001	Op amp (quad) hi rel 3303	545-2020-003
U 002	Electronic attenuator 3340	544-2036-001
U 003	Op amp (quad) hi rel 3303	545-2020-003
U 004	Op amp (quad) hi rel 3303	545-2020-003
U 005	Buffer (hex) 74C906	544-3714-906
U 006	Analog switch (quad) 4066	544-3014-066
U 007	Exclusive OR (quad)4070	544-3014-070
U 008	NOR, 2-input (quad) 4001	544-3014-001
U 009	D latch (octal) 54LS373	544-3532-373
U 010	EEPROM 16k x 8 2816	544-5001-401
U 011	Microprocessor w/software	023-9998-124
U 012	Shift register, 10-bit 5810	544-2027-007
U 150	Display driver 14499	544-2027-008
U 151	Encoder, 8-input 4532	544-3016-532

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 201	FM IF system 3361	544-2026-007
U 300	Op amp (dual) 532	544-2019-004
U 301	10W audio amp TDA2003	544-2006-015
U 302	Regulator 5V 1.5A 7805	544-2003-016
U 303	NOR, 2-input (quad) 4001	544-3014-001
U 501	18W 870-950 MHz pwr module	544-4001-029
U 601	Op amp (dual) 3358	544-2019-001
U 801	Div by 80/81 prescaler 8719	544-3954-012
U 802	Freq synthesizer 145159	544-3014-159
U 803	Analog switch (quad) 3067	544-3014-067
U 804	NAND, 2-input (quad) 4011	544-3014-011
U 805	D flip-flop (dual) 4013	544-3014-013
W 007	Flexible cable, 4'' 30 cond	597-0016-201
W 401	Phasing line	016-2228-021
X 001	40-pin IC socket	515-5008-019
X 002	24-pin IC socket	515-5008-017
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	938 MHz 6-pole ceramic filter	532-2006-010
Z 201	45 MHz 2-pole crystal filter	532-0020-001
Z 202	10.7 MHz 4-pole crystal filter	532-0006-004
Z 203	455 kHz ceramic filter	532-2004-006

HARDWARE AND CABLE KIT
PART NO. 023-7172-918

A 002	DC power cable assembly	023-4143-010
A 003	Mic clip ground wire	023-7171-911
HW001	Screw, 4-24 Phil sheet met (3)	575-3604-008
HW002	Screw, 4-20 Phil (3)	575-5604-020
HW003	Screw, 10-24 x 7/16 hex hd (4)	575-8911-014
HW004	Self-drilling screw (2)	575-9077-565
HW005	Washer, flat #10 (4)	596-2410-014
HW105	Butt splice connector (1)	586-9008-061
MP001	HD mic clip	023-3514-001

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

EP003	Contact 14-16 AWG	534-1004-037
EP101	Ring terminal 12-8 AWG	586-0007-022
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

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, flat	574-0003-010
J 001	Connector (mates w/ P2)	515-9031-231
MP001	Fuseholder body	534-1004-031
MP002	Fuseholder knob	534-1004-032
MP003	Fuseholder spring	534-1004-035
P 001	Connector, 2-pos in-line	515-9032-302
P 002	Connector, 2-pos in-line	515-9032-302

AMPLIFIED DYNAMIC MICROPHONE
PART NO. 250-0740-300

C 001	3.3 μF 20V tantalum chip	510-2606-339
C 002	220 pF $\pm$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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW001	Screw 4-20 x 3/8	575-5604-012
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	018-1033-002
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
NP001	Nameplate	559-0039-026
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

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	597-2006-001

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

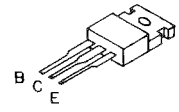
A 001	Interface cable (RPI-adapter)	023-5800-011
C 001	10 µF 25V electrolytic	510-4325-100
C 002	10 µF 25V electrolytic	510-4325-100
C 003	.1 µF ±20% 25V Z5U ax cer	510-3546-104
C 004	10 µF 25V electrolytic	510-4325-100
C 005	.1 µF ±20% 25V Z5U ax cer	510-3546-104
C 006	10 µF 25V electrolytic	510-4325-100
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	RPI INTERFACE MODULE PART NO. 023-8610-901	
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER

SECTION 9
SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

TRANSISTOR BASING DIAGRAM REFERENCE TABLE	
Transistor Part No.	**Basing Diagram**
576-0002-021	1
576-0003-610	2
576-0003-628	3
576-0003-631	3
576-0003-634	3
576-0003-657	3
576-0003-658	3
576-0003-660	4
576-0004-098	5
576-0004-818	6
576-0006-019	7
576-0006-106	8
576-0006-107	8
576-0006-233	9



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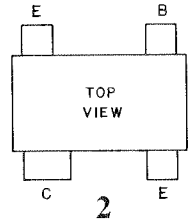

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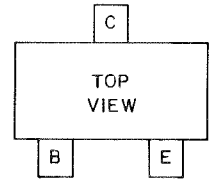

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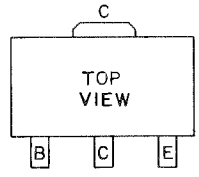

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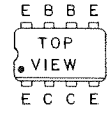

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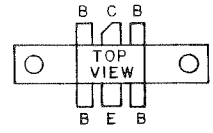

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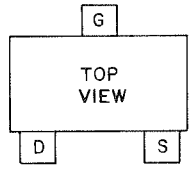

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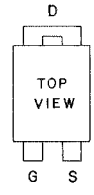

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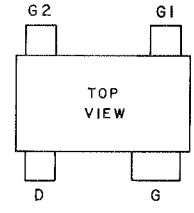
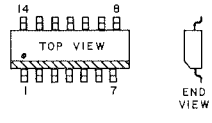
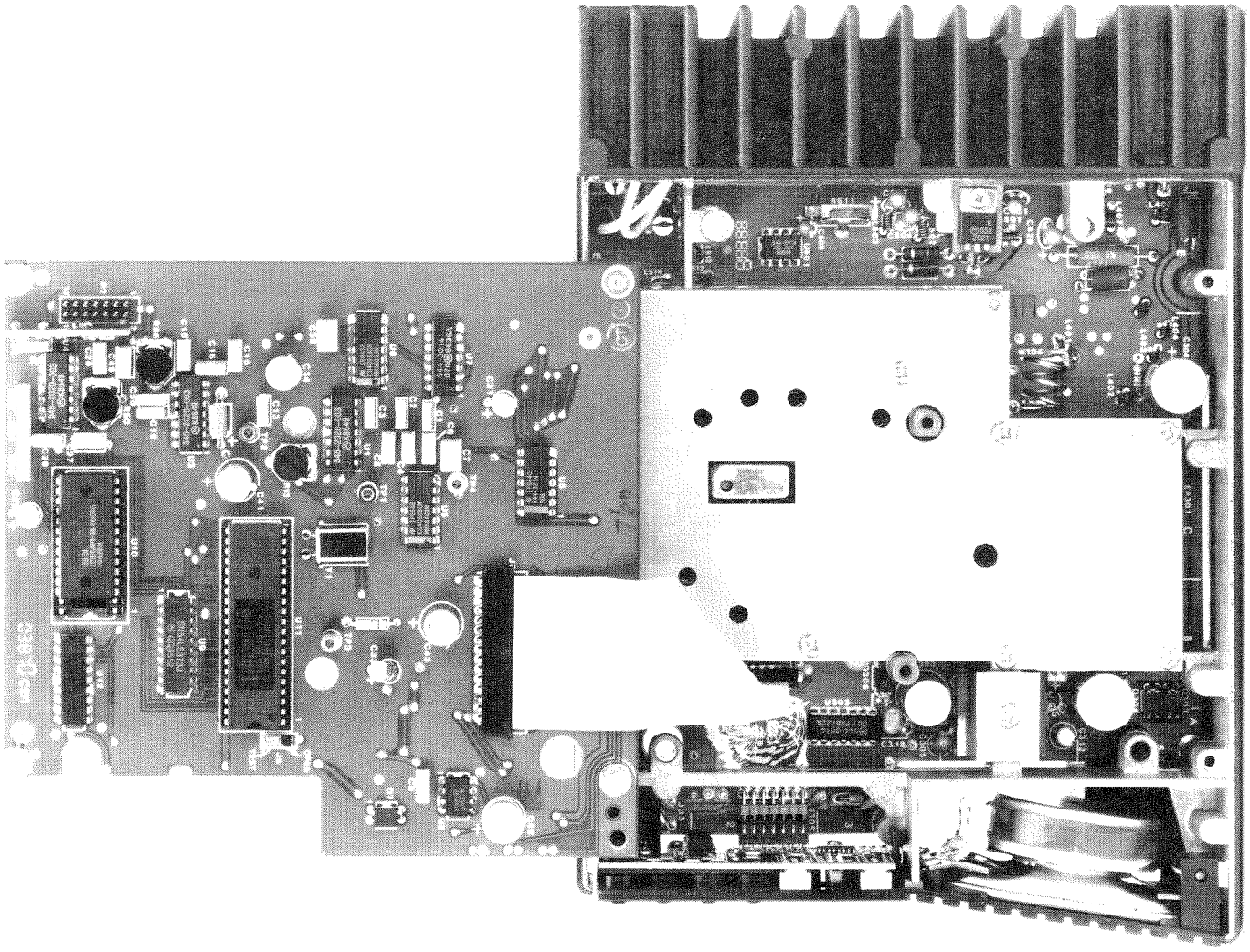


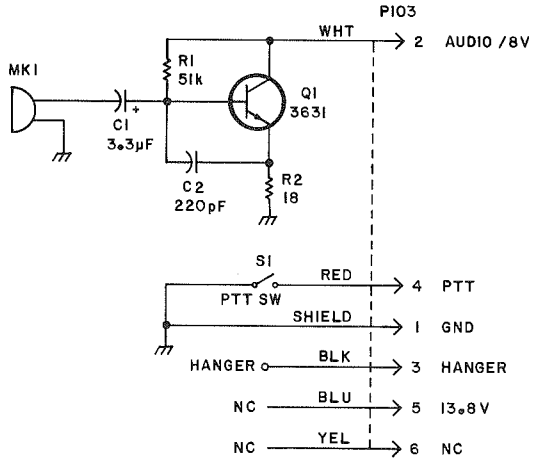
9

TRANSISTORS
(Bottom View Unless Otherwise Specified)

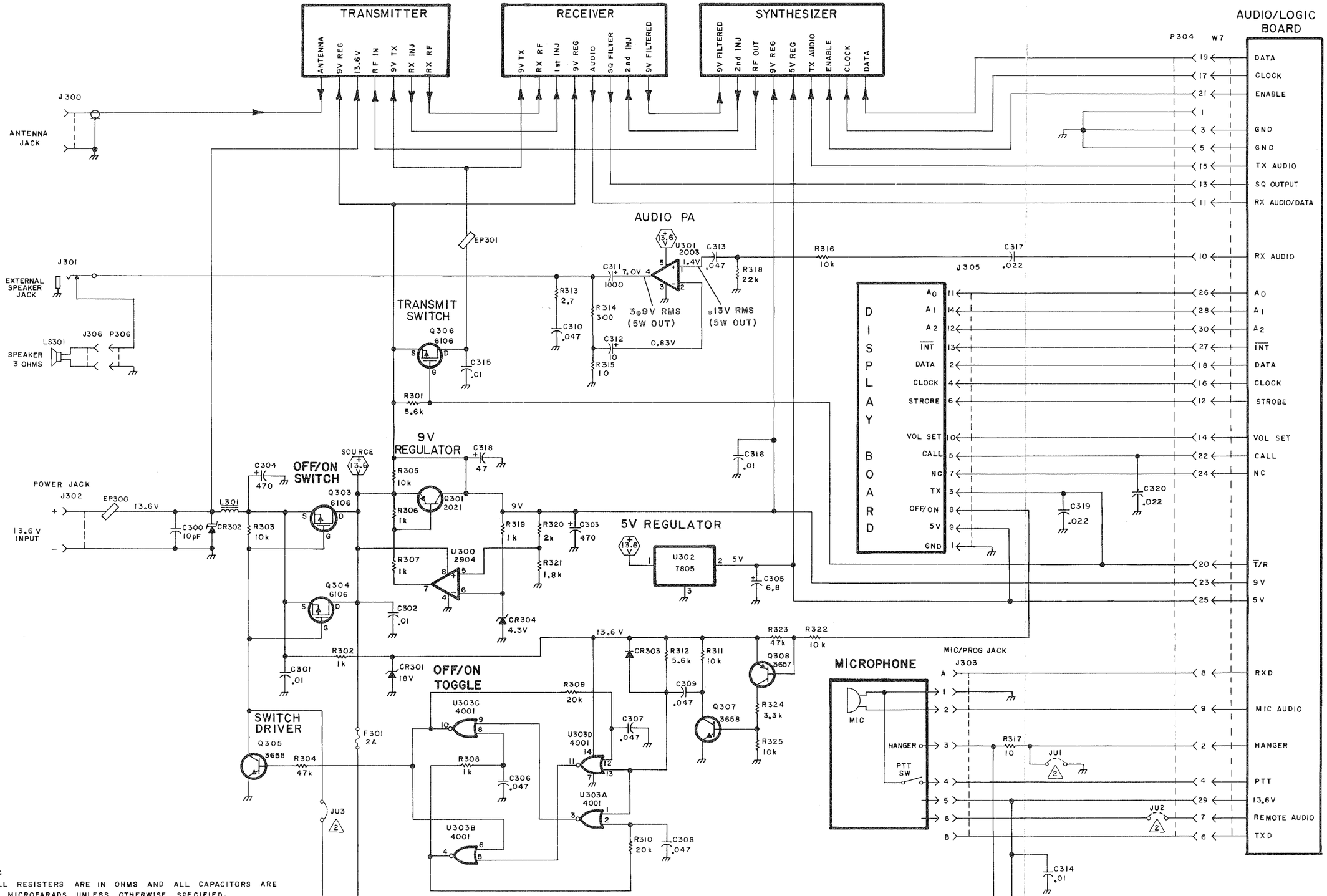




TRANSCEIVER TOP VIEW



DYNAMIC MICROPHONE SCHEMATIC
Part No. 250-0740-300



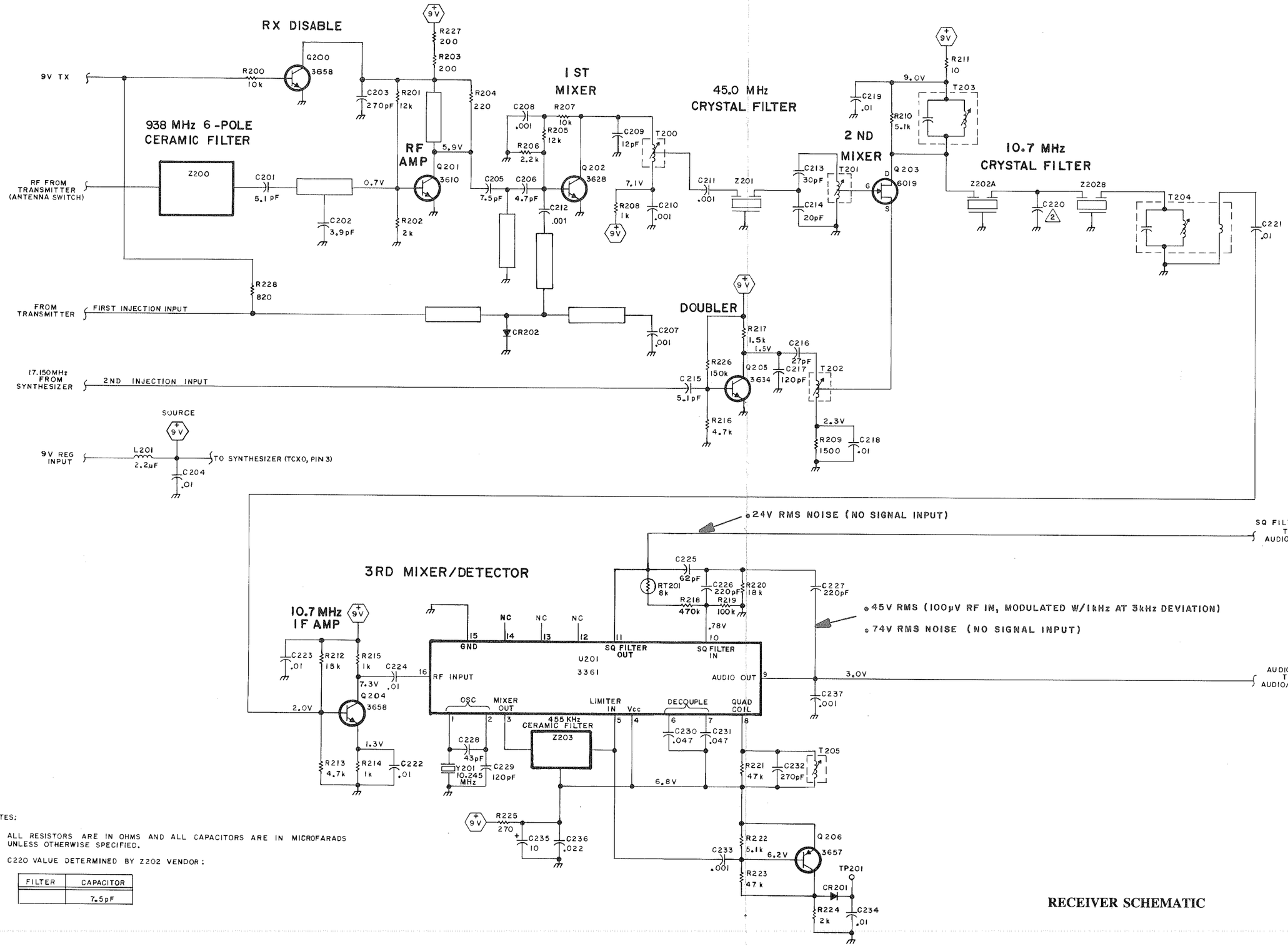
NOTES:

1. ALL RESISTERS 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)



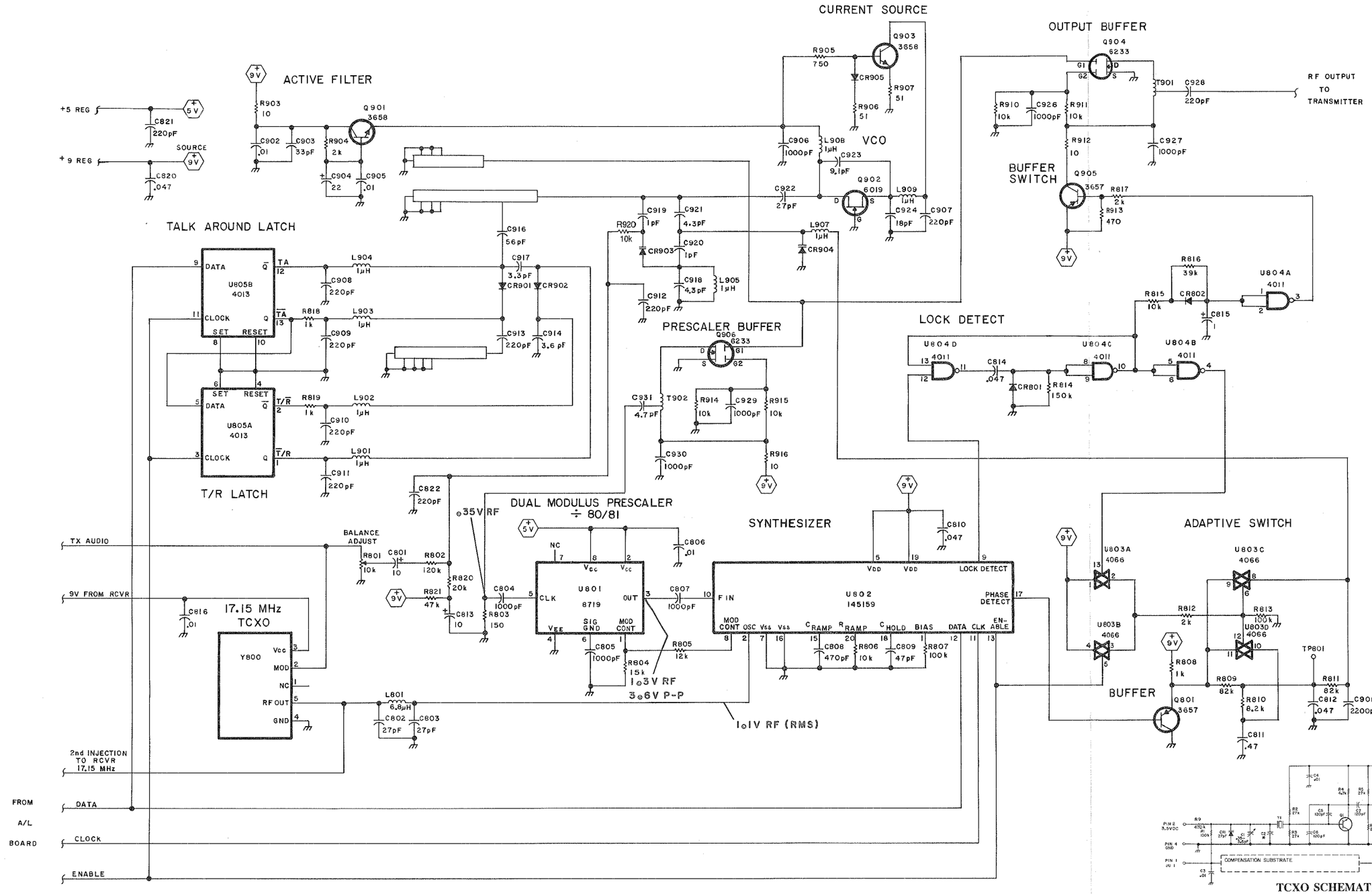
NOTES:

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

(2) C220 VALUE DETERMINED BY Z202 VENDOR:

FILTER	CAPACITOR
	7.5pF

RECEIVER SCHEMATIC



NOTES:

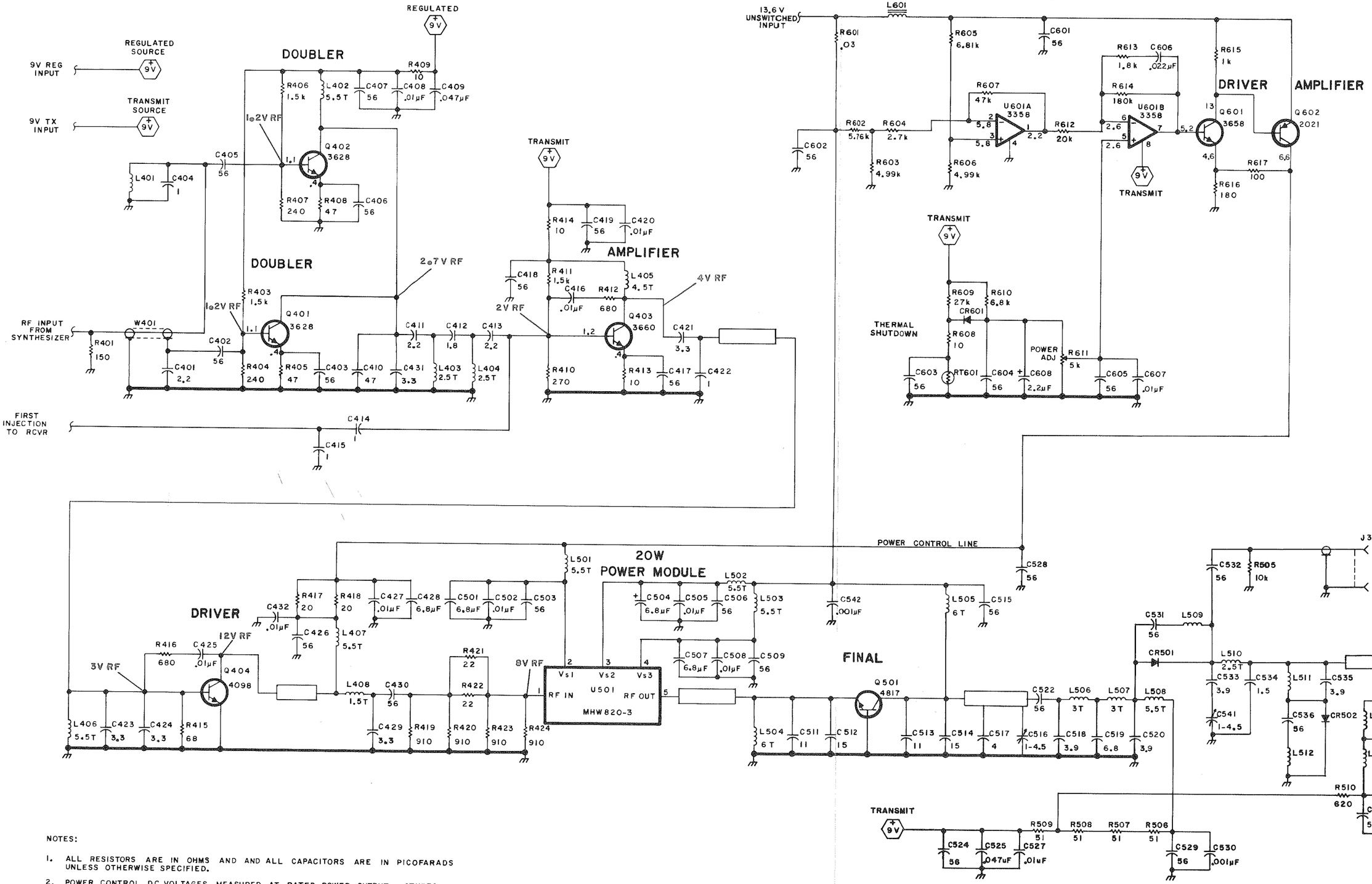
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

2. IC CONNECTIONS NOT SHOWN:

IC	9V	GND
U803	14	7
U804	14	7
U805	14	7

TCXO SCHEMATIC
(FOR REFERENCE ONLY)

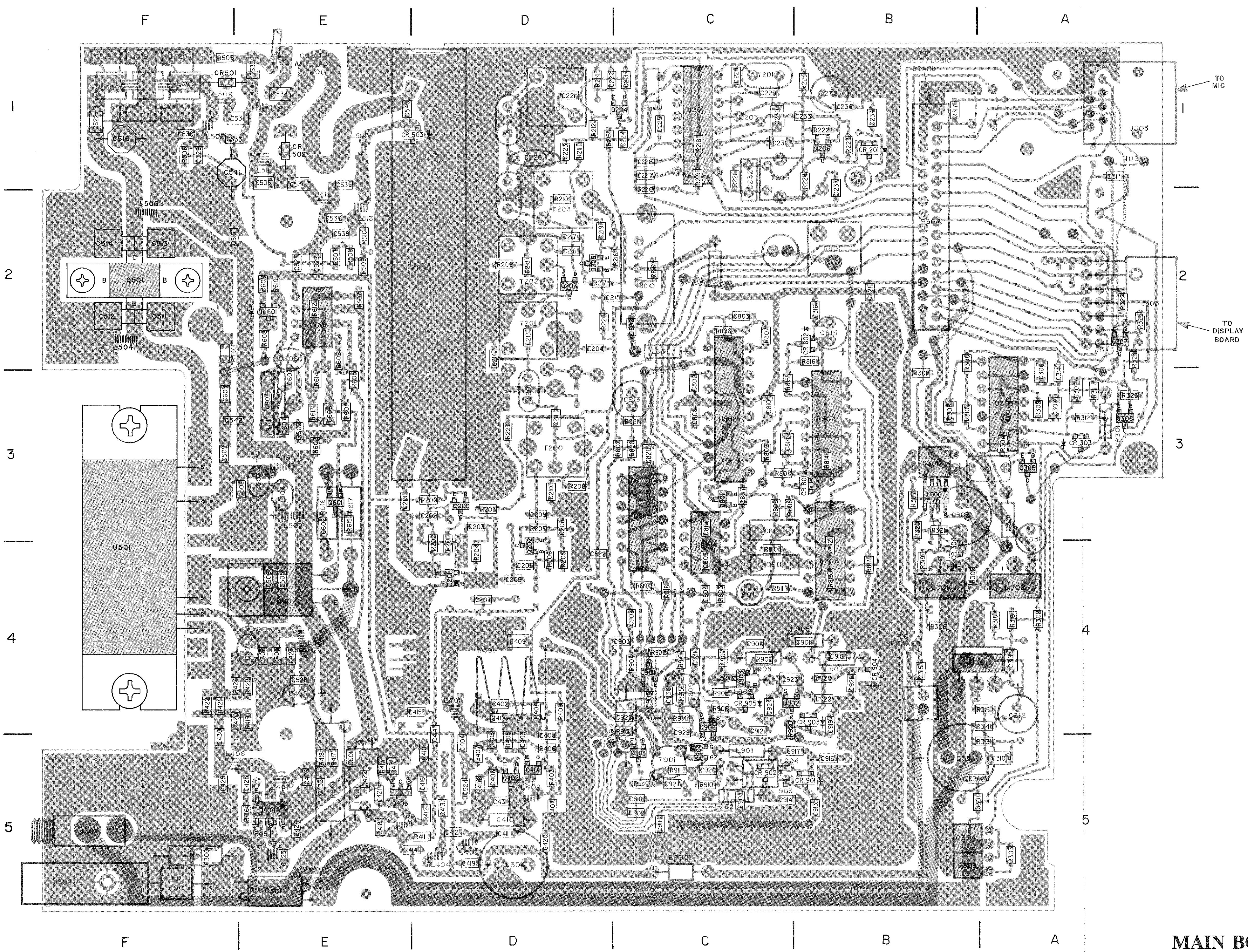
SYNTHESIZER SCHEMATIC
(Transmitter on Next Page)



NOTES:

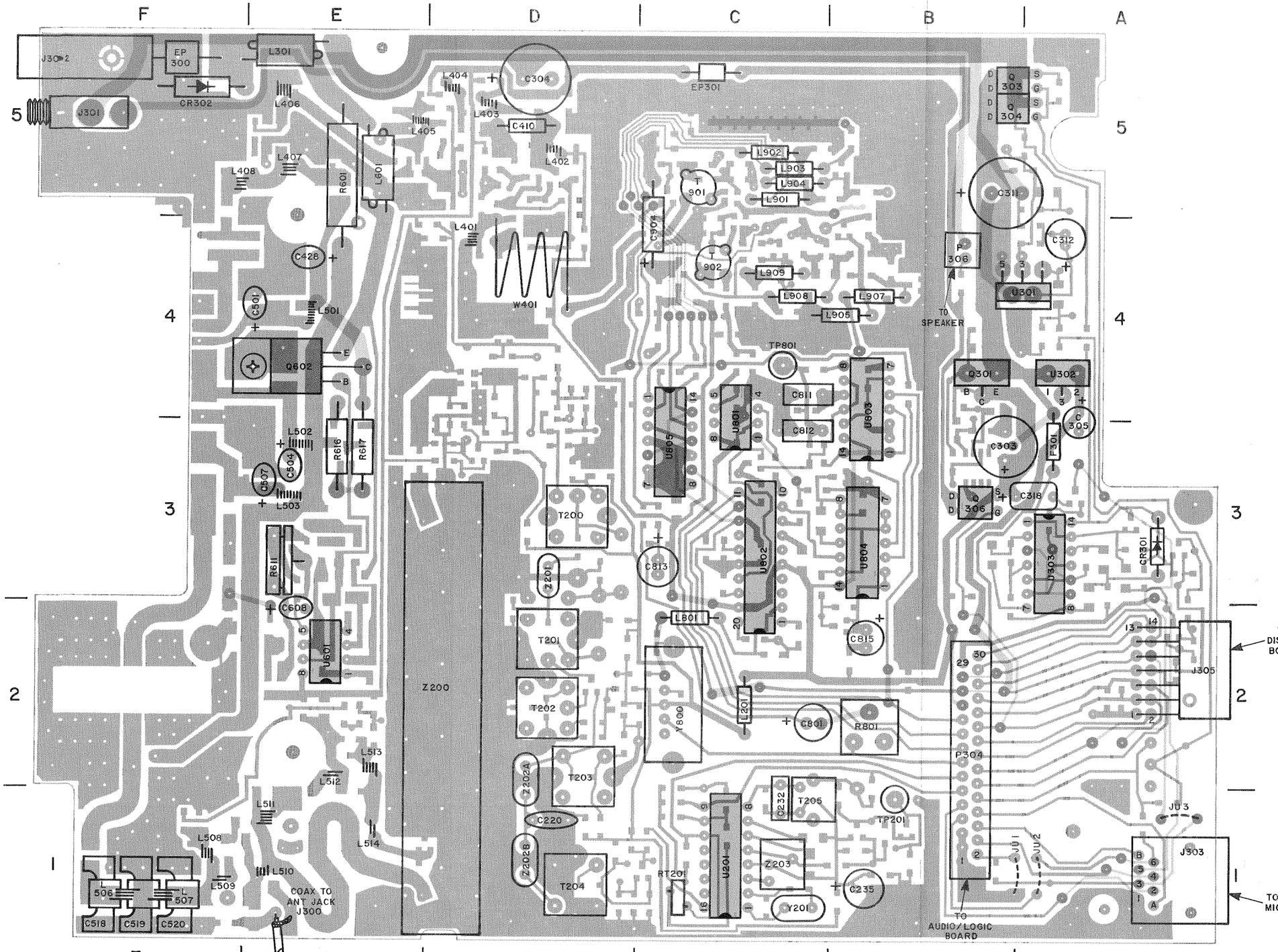
1. ALL RESISTORS ARE IN OHMS AND AND ALL CAPACITORS ARE IN PICOFARADS UNLESS OTHERWISE SPECIFIED.
2. POWER CONTROL DC VOLTAGES MEASURED AT RATED POWER OUTPUT. OTHERS MEASURED WITH NO RF PRESENT.

TRANSMITTER SCHEMATIC

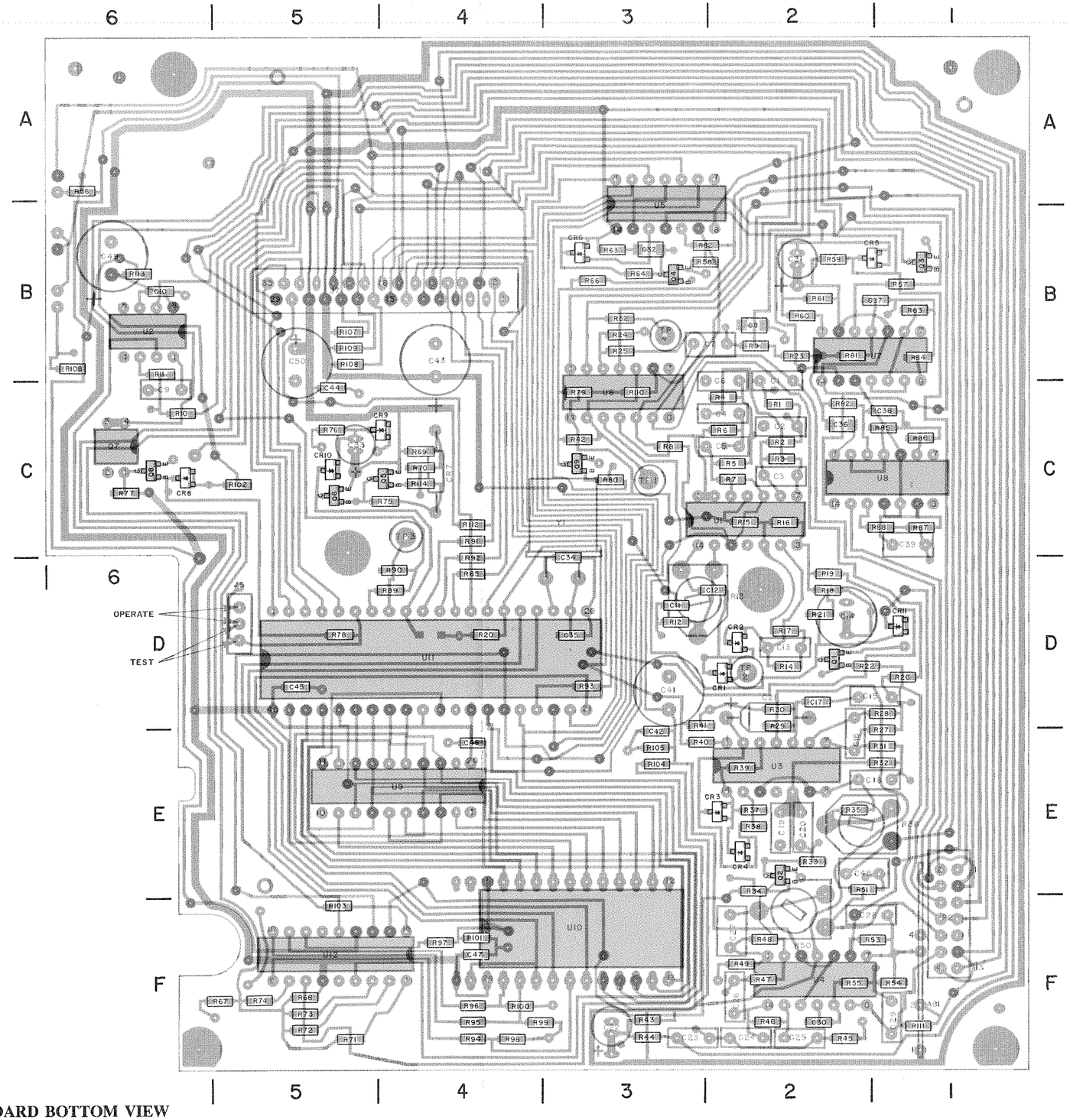


MAIN BOARD BOTTOM VIEW
(Top View on Next Page)

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



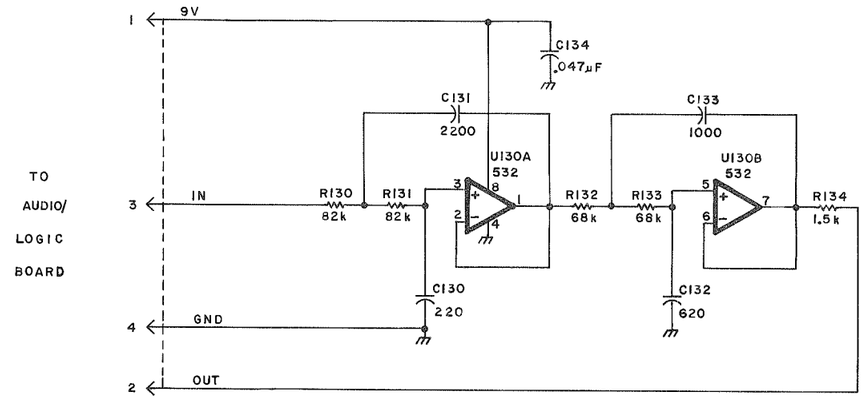
MAIN BOARD TOP VIEW



AUDIO/LOGIC BOARD BOTTOM VIEW

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

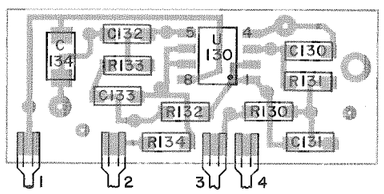
(AUDIO/LOGIC BOARD TOP VIEW) **FOLDOUT →**



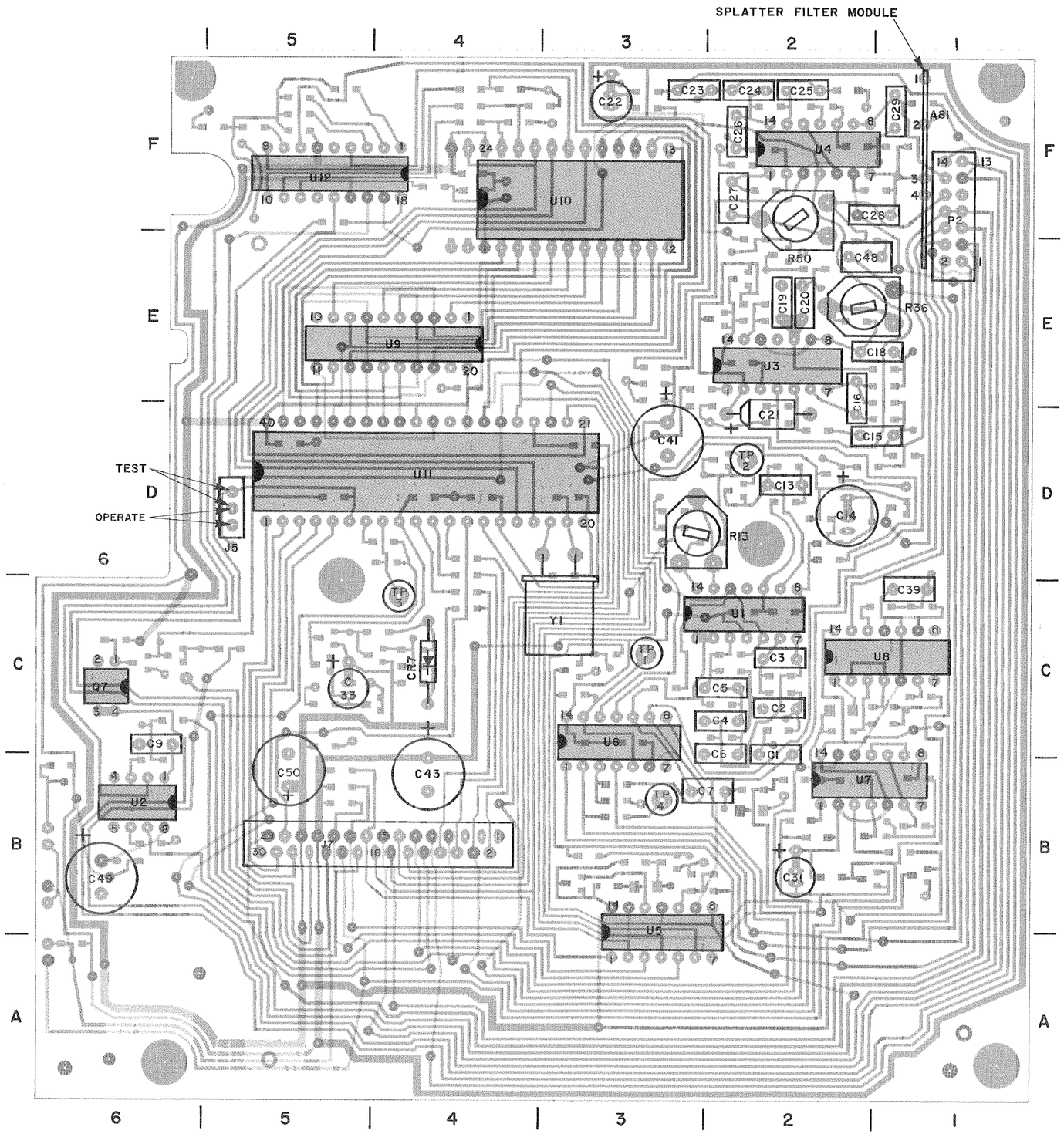
NOTES:

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

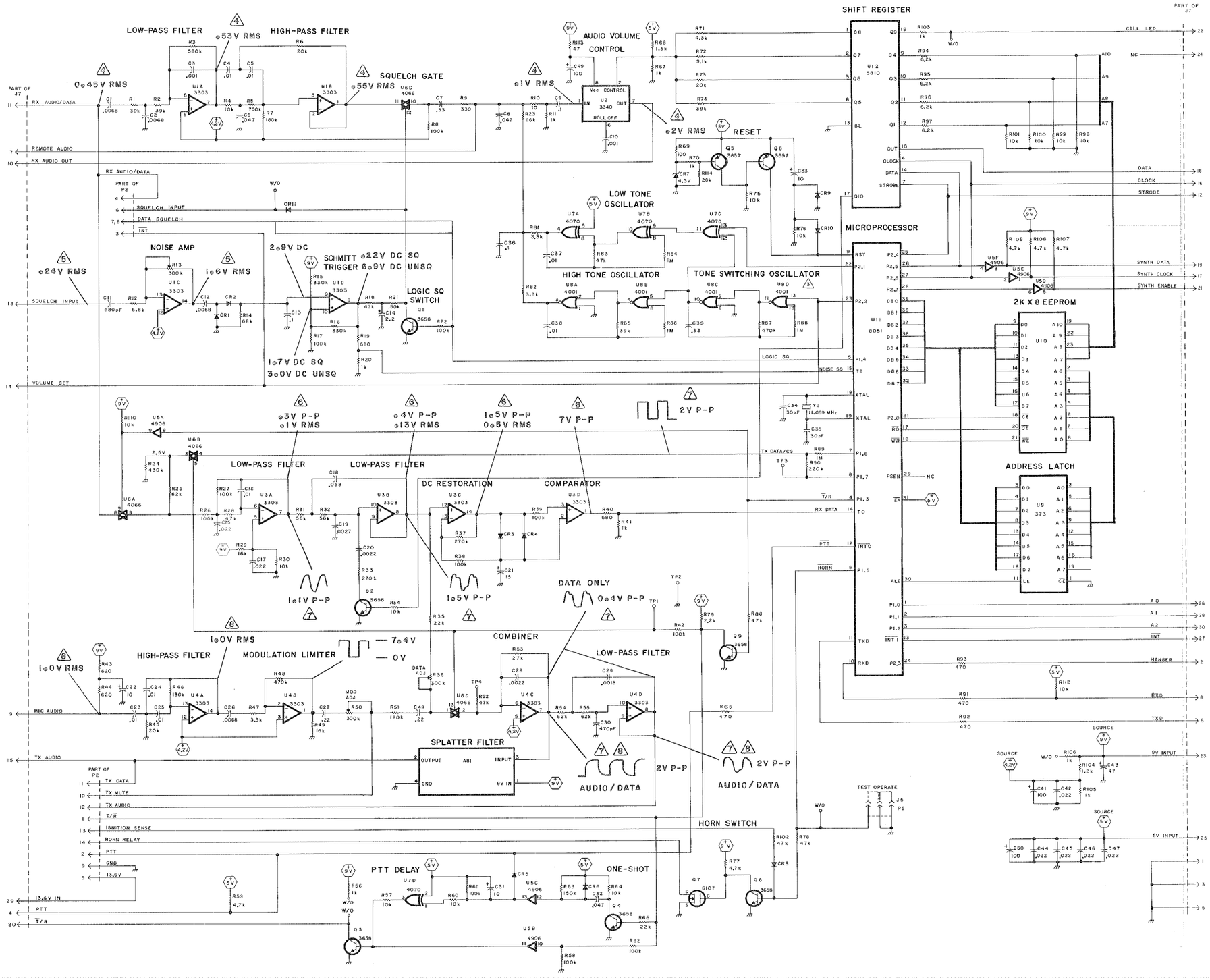
SPLATTER FILTER SCHEMATIC



SPLATTER FILTER BOARD



AUDIO/LOGIC BOARD TOP VIEW



NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. IC CONNECTIONS NOT SHOWN:

IC NO.	9V	5V	GND
U1	4		11
U2			5
U3	4		11
U4	4		11
U5		14	7
U6	14		7
U7	14		7

IC NO.	9V	5V	GND
U8		14	7
U9		20	10
U10		24	12
U11		40	20
U12	15	6	5

(1)

TONE GENERATOR	P2.1	P2.2
DISABLED	1	1
BUSY	1	0
INTERCEPT	0	0
BEEP	0	1

(4) AUDIO VOLTAGES MEASURED WITH 1000 μV INPUT AT ANTENNA JACK, MODULATED WITH 1 kHz AT ±3 kHz DEVIATION. AUDIO OUTPUT IS 5 WATTS ACROSS A 3.0 OHM LOAD.

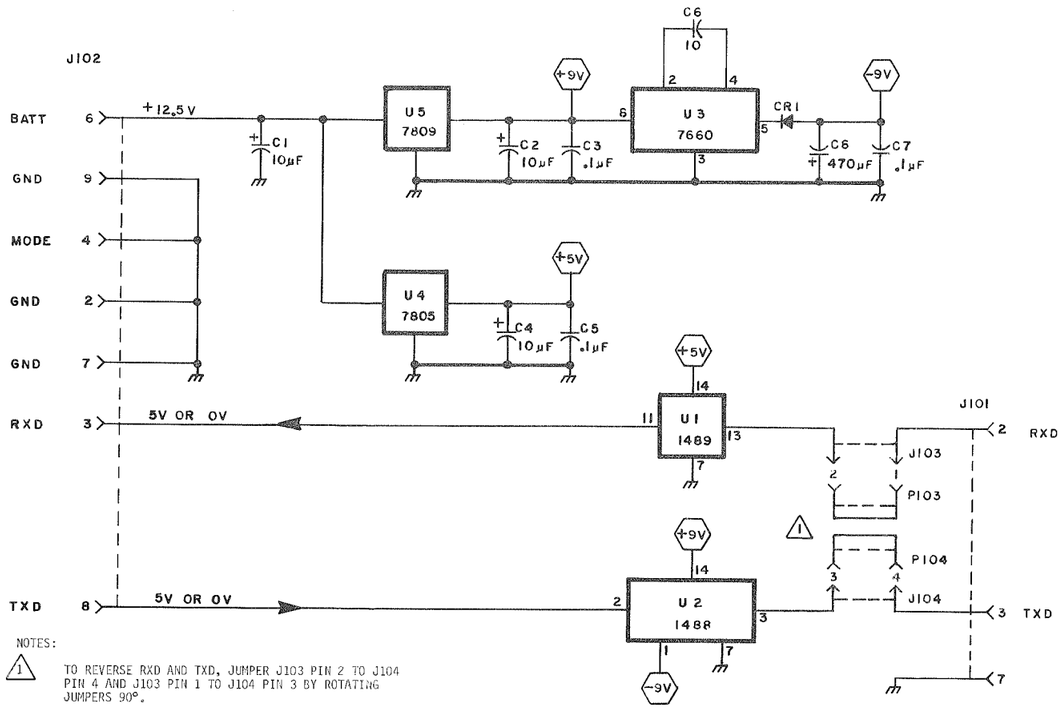
(5) SQUELCH VOLTAGES MEASURED WITH NO SIGNAL INPUT.

(6) VOLTAGES MEASURED WITH 1000 μV RF INPUT, MODULATED WITH 100 Hz AT ±1 kHz DEVIATION.

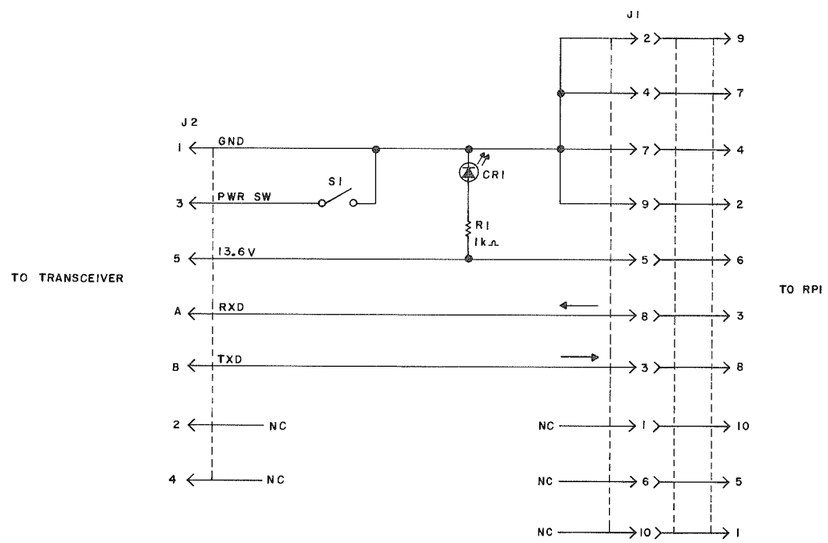
(7) VOLTAGES MEASURED IN TRANSMIT MODE WITH 71 Hz SQUARE WAVE.

(8) VOLTAGES MEASURED WITH 1 kHz, 1.0 VRMS SIGNAL INJECTED AT MICROPHONE INPUT.

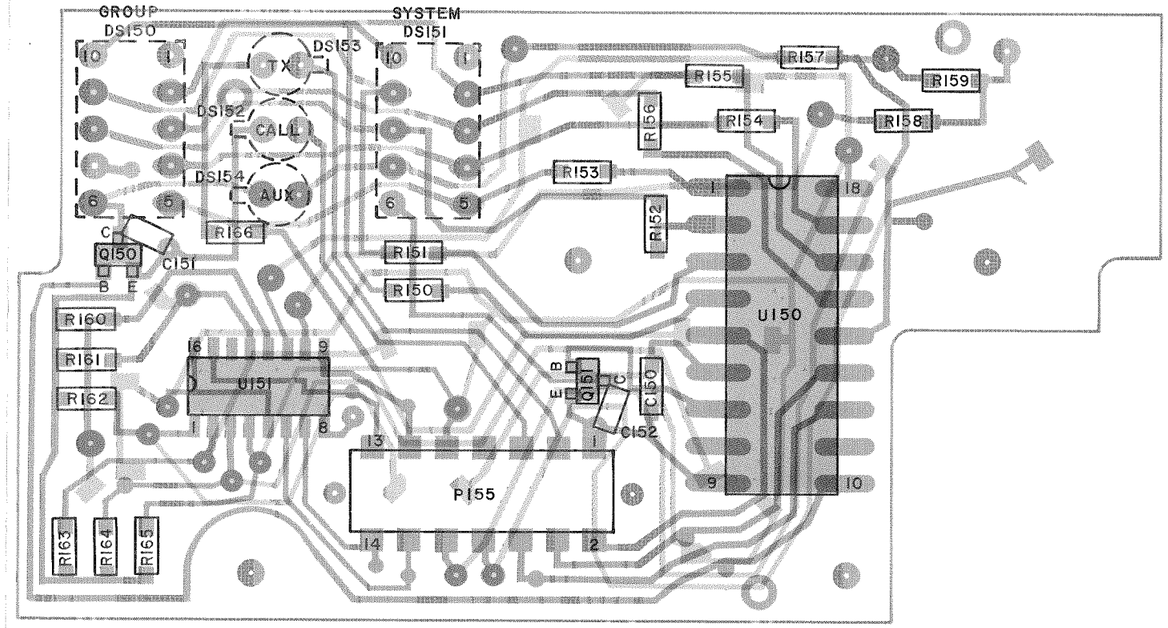
AUDIO/LOGIC BOARD SCHEMATIC



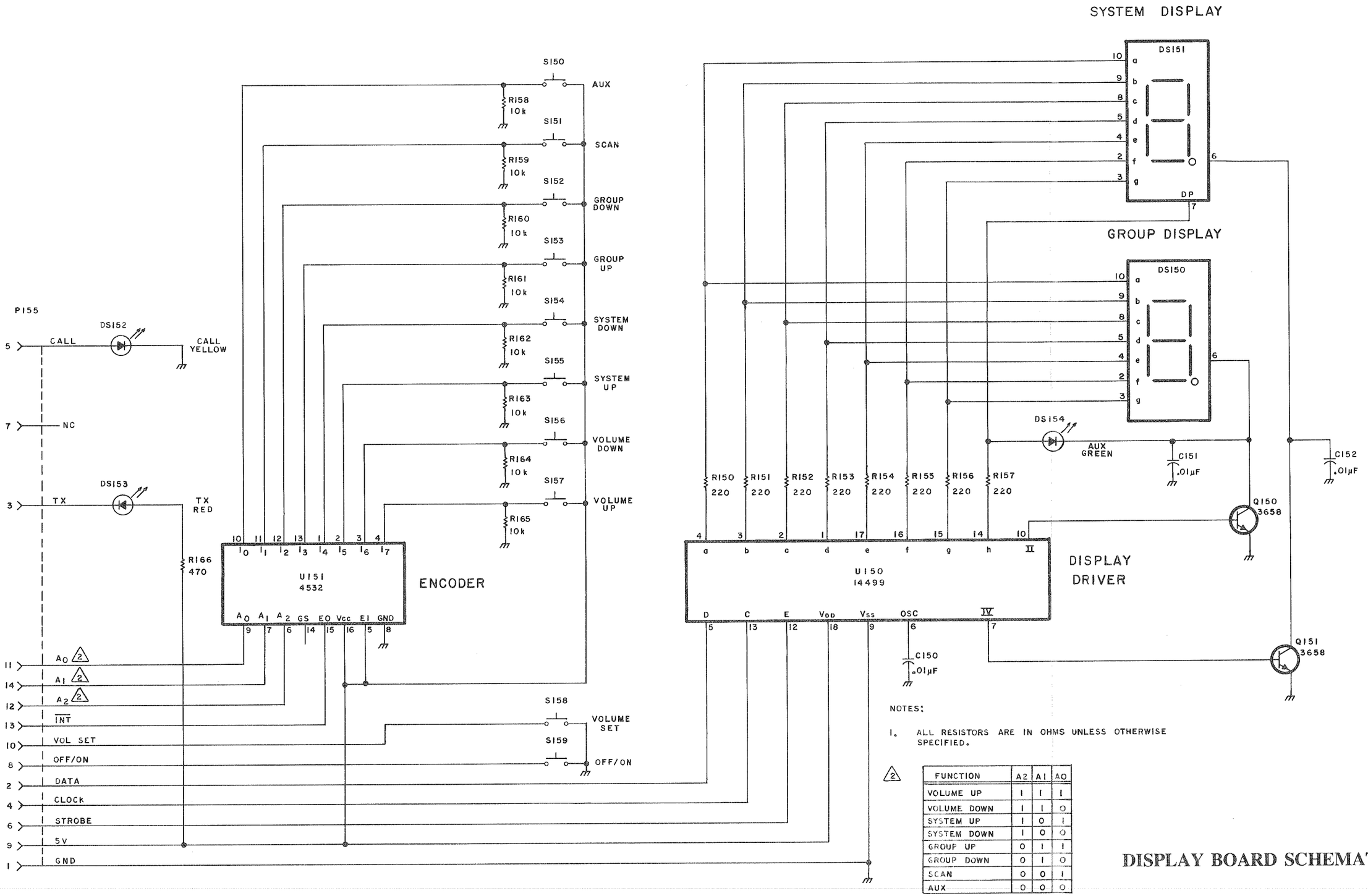
REMOTE PROGRAMMING INTERFACE (RPI)
Part No. 023-5800-000



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



DISPLAY BOARD COMPONENT LAYOUT
(BACK VIEW)



NOTES:

1. ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.

△2

FUNCTION	A2	A1	A0
VOLUME UP	1	1	1
VOLUME DOWN	1	1	0
SYSTEM UP	1	0	1
SYSTEM DOWN	1	0	0
GROUP UP	0	1	1
GROUP DOWN	0	1	0
SCAN	0	0	1
AUX	0	0	0

DISPLAY BOARD SCHEMATIC

The following guide can be used to locate components on the main board. Refer to the grid around the main board 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
C 150	Display Bd		C 309	A3	B	C 506	E4	B	C 809	C3	B
C 151	Display Bd		C 310	A5	B	C 507	E3	T	C 810	C3	B
C 152	Display Bd		C 311	B5	T	C 508	E3	B	C 811	C4	T
C 201	E3	B	C 312	A4	T	C 509	F3	B	C 812	C3	T
C 202	D3	B	C 313	A4	B	C 511	F2	B	C 813	C3	T
C 203	D3	B	C 314	A3	B	C 512	F2	B	C 814	C3	B
C 204	D2	B	C 315	B4	B	C 513	F2	B	C 815	B2	T
C 205	D4	B	C 316	B2	B	C 514	F2	B	C 816	C2	B
C 206	D4	B	C 317	A1	B	C 515	F3	B	C 820	C3	B
C 207	D4	B	C 318	A3	T	C 516	F1	B	C 821	B2	B
C 208	D3	B	C 319	A2	B	C 517	F2	B	C 822	D4	B
C 209	D3	B	C 320	A2	B	C 518	F1	T	C 901	B4	B
C 210	D3	B	C 401	D4	B	C 519	F1	T	C 902	C4	B
C 211	D3	B	C 402	D4	B	C 520	F1	T	C 903	C4	B
C 212	D4	B	C 403	D5	B	C 522	F1	B	C 904	C4	T
C 213	D2	B	C 404	D5	B	C 524	D5	B	C 905	C4	B
C 214	D2	B	C 405	D5	B	C 525	E2	B	C 906	C4	B
C 215	C2	B	C 406	D5	B	C 527	E2	B	C 907	C4	B
C 216	D2	B	C 407	D5	B	C 528	E4	B	C 908	C5	B
C 217	D2	B	C 408	D5	B	C 529	F1	B	C 909	C5	B
C 218	D2	B	C 409	D4	B	C 530	F1	B	C 910	C5	B
C 219	D2	B	C 410	D5	T	C 531	E1	B	C 911	C5	B
C 220	D1	T	C 411	D5	B	C 532	E1	B	C 912	C4	B
C 221	D1	B	C 412	D5	B	C 533	F1	B	C 913	B5	B
C 222	C1	B	C 413	D5	B	C 534	E1	B	C 914	C5	B
C 223	D1	B	C 414	D4	B	C 535	E1	B			
C 224	C1	B	C 415	D4	B	C 536	E1	B	C 916	B5	B
C 225	C1	B	C 416	D5	B	C 537	E2	B	C 917	B5	B
C 226	C1	B	C 417	E5	B	C 538	E2	B	C 918	B4	B
C 227	C1	B	C 418	E5	B	C 539	E1	B	C 919	B4	B
C 228	C1	B	C 419	D5	B	C 540	E1	B	C 920	B4	B
C 229	C1	B	C 420	D5	B	C 541	F1	B	C 921	B4	B
C 230	C1	B	C 421	E5	B	C 542	F3	B	C 922	B4	B
C 231	C1	B	C 422	E5	B	C 601	E5	B	C 923	C4	B
C 232	C1	T	C 423	E5	B	C 602	E3	B	C 924	C4	B
C 233	B1	B	C 424	E5	B	C 603	F3	B	C 926	C5	B
C 234	B1	B	C 425	E5	B	C 604	E3	B	C 927	C5	B
C 235	B1	T	C 426	E5	B	C 605	E3	B	C 928	C4	B
C 236	B1	B	C 427	E4	B	C 606	E3	B	C 929	C4	B
C 237	B1	B	C 428	E4	T	C 607	E3	B	C 930	C4	B
C 300	F5	B	C 429	F5	B	C 608	E2	T	C 931	C4	B
C 301	A5	B	C 430	F5	B	C 801	C2	T	CR201	B1	B
C 302	A5	B	C 431	D5	B	C 802	C2	B	CR202	D4	B
C 303	B3	T	C 432	E5	B	C 803	C2	B	CR301	A3	T
C 304	D5	T	C 501	E4	T	C 804	C4	B	CR302	F5	T
C 305	A3	T	C 502	E4	B	C 805	C4	B	CR303	A3	B
C 306	A3	B	C 503	E4	B	C 806	C3	B	CR304	B4	B
C 307	A3	B	C 504	E3	T	C 807	C3	B	CR501	F1	B
C 308	B3	B	C 505	E4	B	C 808	C3	B	CR502	E1	B

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
CR503	E1	B	L 901	C5	T	R 157	Display Bd		R 311	A3	B
CR601	B2	B	L 902	C5	T	R 158	Display Bd		R 312	A3	B
CR801	B3	B	L 903	C5	T	R 159	Display Bd		R 313	A5	B
CR802	B2	B	L 904	C5	T	R 160	Display Bd		R 314	A4	B
CR901	B5	B	L 905	B4	T	R 161	Display Bd		R 315	A4	B
CR902	C5	B				R 162	Display Bd		R 316	A4	B
CR903	B4	B	L 907	B4	T	R 163	Display Bd		R 317	B1	B
CR904	B4	B	L 908	C4	T	R 164	Display Bd		R 318	A4	B
CR905	C4	B	L 909	C4	T	R 165	Display Bd		R 319	B4	B
DS150	Display Bd		P 155	Display Bd		R 166	Display Bd		R 320	B3	B
DS151	Display Bd		P 304	B2	T	R 200	D3	B	R 321	B3	B
DS152	Display Bd		P 306	B4	T	R 201	D4	B	R 322	A2	B
DS153	Display Bd		Q 150	Display Bd		R 202	D4	B	R 323	A3	B
DS154	Display Bd		Q 151	Display Bd		R 203	D3	B	R 324	A2	B
EP300	F5	T	Q 200	D3	B	R 204	D4	B	R 325	A2	B
EP301	C5	T	Q 201	D4	B	R 205	D4	B	R 401	D4	B
F 301	A3	T	Q 202	D4	B	R 206	D4	B	R 403	D5	B
J 300	Chassis		Q 203	D2	B	R 207	D3	B	R 404	D4	B
J 301	F5	T	Q 204	C1	B	R 208	D3	B	R 405	D5	B
J 302	F5	T	Q 205	D2	B	R 209	D2	B	R 406	D5	B
J 303	A1	T	Q 206	B1	B	R 210	D2	B	R 407	D5	B
J 305	A2	T	Q 301	B4	T	R 211	D1	B	R 408	D5	B
J 306	See P306		Q 303	B5	T	R 212	D1	B	R 409	D4	B
L 201	C2	T	Q 304	B5	T	R 213	C1	B	R 410	D5	B
L 301	E5	T	Q 305	A3	B	R 214	D1	B	R 411	D5	B
L 401	D4	T	Q 306	B3	T	R 215	D1	B	R 412	D5	B
L 402	D5	T	Q 307	A2	B	R 216	C2	B	R 413	E5	B
L 403	D5	T	Q 308	A3	B	R 217	D2	B	R 414	D5	B
L 404	D5	T	Q 401	D5	B	R 218	C1	B	R 415	E5	B
L 405	E5	T	Q 402	D5	B	R 219	C1	B	R 416	E5	B
L 406	E5	T	Q 403	E5	B	R 220	C1	B	R 417	E5	B
L 407	E5	T	Q 404	E5	B	R 221	C1	B	R 418	E5	B
L 408	F5	T	Q 501	F2	B	R 222	B1	B	R 419	E4	B
L 501	E4	T	Q 601	E3	B	R 223	B1	B	R 420	B4	B
L 502	E3	T	Q 602	E4	T	R 224	B1	B	R 421	F4	B
L 503	E3	T	Q 801	C3	B	R 225	B1	B	R 422	F4	B
L 504	F2	B	Q 901	C4	B	R 226	D2	B	R 423	E4	B
L 505	F2	B	Q 902	C4	B	R 227	D3	B	R 424	E4	B
L 506	F1	T	Q 903	C4	B	R 228	D4	B	R 505	F1	B
L 507	F1	T	Q 904	C5	B	R 301	B3	B	R 506	F1	B
L 508	F1	T	Q 905	C5	B	R 302	A4	B	R 507	B3	B
L 509	F1	T	Q 906	C4	B	R 303	A5	B	R 508	B3	B
L 510	E1	T	R 150	Display Bd		R 304	A3	B	R 509	B3	B
L 511	E1	T	R 151	Display Bd		R 305	B4	B	R 510	E2	B
L 512	E2	T	R 152	Display Bd		R 306	B4	B	R 601	E5	T
L 513	E2	T	R 153	Display Bd		R 307	B3	B	R 602	E3	B
L 514	E1	T	R 154	Display Bd		R 308	B2	B	R 603	E3	B
L 601	E5	T	R 155	Display Bd		R 309	A3	B	R 604	E3	B
L 801	C2	T	R 156	Display Bd		R 310	B3	B	R 605	E3	B

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
R 606	E2	B	R 809	C3	B	R 912	C5	B	U 201	C1	T
R 607	B2	B	R 810	C4	B	R 913	C4	B	U 300	B3	B
R 608	E3	B	R 811	C4	B	R 914	C4	B	U 301	A4	T
R 609	E3	B	R 812	B4	B	R 915	C4	B	U 302	A4	T
R 610	E3	B	R 813	B4	B	R 916	C4	B	U 303	A3	T
R 611	E3	T	R 814	B3	B	R 920	C5	B	U 501	Chassis	
R 612	E2	B	R 815	C3	B	RT201	C1	T	U 601	E2	T
R 613	E3	B	R 816	B2	B	RT601	F2	B	U 801	C3	T
R 614	E3	B	R 817	B4	B	T 200	D3	T	U 802	C3	T
R 615	E3	B	R 818	C4	B	T 201	D2	T	U 803	B3	T
R 616	E3	T	R 819	C4	B	T 202	D2	T	U 804	B3	T
R 617	E3	T	R 820	C3	B	T 203	D2	T	U 805	C3	T
R 801	B2	T	R 821	C3	B	T 204	D1	T	W 401	D4	T
R 802	C3	B	R 903	C4	B	T 205	C1	T	Y 201	C1	T
R 803	C4	B	R 904	C4	B	T 901	C5	T	Y 800	C2	T
R 804	C3	B	R 905	C4	B	T 902	C4	T	Z 200	D2	T
R 805	C3	B	R 906	C4	B	TP201	B1	T	Z 201	D2	T
R 806	C2	B	R 907	C4	B	TP801	C4	T	Z 202	D1	T
R 807	C2	B	R 910	C5	B	U 150	Display Bd		Z 203	C1	T
R 808	C3	B	R 911	C5	B	U 151	Display Bd				

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	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM	COMP	LOC	TOP OR BOTTOM
A 081	F1	T	CR002	D2	B	R 029	D2	B	R 080	C3	B
C 001	C2	T	CR003	E2	B	R 030	D2	B	R 081	B2	B
C 002	C2	T	CR004	E2	B	R 031	E1	B	R 082	C2	B
C 003	C2	T	CR005	B2	B	R 032	E1	B	R 083	B1	B
C 004	C2	T	CR006	B3	B	R 033	E2	B	R 084	B1	B
C 005	C2	T	CR007	C4	T	R 034	E2	B	R 085	C1	B
C 006	C2	T	CR008	C6	B	R 035	E2	B	R 086	C1	B
C 007	C2	T	CR009	C4	B	R 036	E2	T	R 087	C1	B
C 008	B2	B	CR010	C5	B	R 037	E2	B	R 088	C1	B
C 009	C6	T	CR011	D1	B	R 038	E2	B	R 089	D4	B
C 010	D6	B	J 005	D5	T	R 039	E2	B	R 090	D4	B
C 011	D3	B	J 007	B5	T	R 040	E3	B	R 091	C4	B
C 012	D2	B	P 002	F1	T	R 041	D3	B	R 092	D4	B
C 013	D2	T	P 005	See J5		R 042	C3	B	R 093	D3	B
C 014	D2	T	Q 001	D2	B	R 043	F3	B	R 094	F4	B
C 015	D1	T	Q 002	E2	B	R 044	F3	B	R 095	F4	B
C 016	E2	T	Q 003	B1	B	R 045	F2	B	R 096	F4	B
C 017	D2	B	Q 004	B3	B	R 046	F2	B	R 097	F4	B
C 018	E1	T	Q 005	C4	B	R 047	F2	B	R 098	F4	B
C 019	E2	T	Q 006	C5	B	R 048	F2	B	R 099	F3	B
C 020	E2	T	Q 007	C6	T	R 049	F2	B	R 100	F4	B
C 021	D2	T	Q 008	C6	B	R 050	F2	T	R 101	F4	B
C 022	F3	T	Q 009	C3	B	R 051	E2	B	R 102	C5	B
C 023	F3	T	R 001	C2	B	R 052	B3	B	R 103	F5	B
C 024	F2	T	R 002	C2	B	R 053	F1	B	R 104	E3	B
C 025	F2	T	R 003	C2	B	R 054	F1	B	R 105	E3	B
C 026	F2	T	R 004	C2	B	R 055	F2	B	R 106	B6	B
C 027	F2	T	R 005	C2	B	R 056	A6	B	R 107	B5	B
C 028	F2	T	R 006	C2	B	R 057	B1	B	R 108	B5	B
C 029	F1	T	R 007	C2	B	R 058	B3	B	R 109	B5	B
C 030	F2	B	R 008	C3	B	R 059	B2	B	R 110	C3	B
C 031	B2	T	R 009	B2	B	R 060	B2	B	R 112	C4	B
C 032	B3	B	R 010	C6	B	R 061	B2	B	R 113	B6	B
C 033	C5	T	R 011	B6	B	R 062	B3	B	R 114	C4	B
C 034	D3	B	R 012	D3	B	R 063	B3	B	TP001	C3	T
C 035	D3	B	R 013	D3	T	R 064	B3	B	TP002	D2	T
C 036	C2	B	R 014	D2	B	R 065	D4	B	TP003	C4	T
C 037	B1	B	R 015	C2	B	R 066	B3	B	TP004	B3	T
C 038	C1	B	R 016	C2	B	R 067	F5	B	U 001	C2	T
C 039	C1	T	R 017	D2	B	R 068	F5	B	U 002	B6	T
C 041	D3	T	R 018	D2	B	R 069	C4	B	U 003	E2	T
C 042	E3	B	R 019	D2	B	R 070	C4	B	U 004	F2	T
C 043	B4	T	R 020	D4	B	R 071	F5	B	U 005	B3	T
C 044	C5	B	R 021	D2	B	R 072	F5	B	U 006	C3	T
C 045	D5	B	R 022	D2	B	R 073	F5	B	U 007	B2	T
C 046	E4	B	R 023	B2	B	R 074	F5	B	U 008	C1	T
C 047	F4	B	R 024	B3	B	R 075	C4	B	U 009	E4	T
C 048	E2	T	R 025	B3	B	R 076	C5	B	U 010	F3	T
C 049	B6	T	R 026	D1	B	R 077	C6	B	U 011	D4	T
C 050	B5	T	R 027	E1	B	R 078	D5	B	U 012	F5	T
CR001	D2	B	R 028	D1	B	R 079	C3	B	Y 001	C3	T

E.F. JOHNSON COMPANY, WASECA, MN 56093-0514

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