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# E.F. JOHNSON SERVICE MANUAL

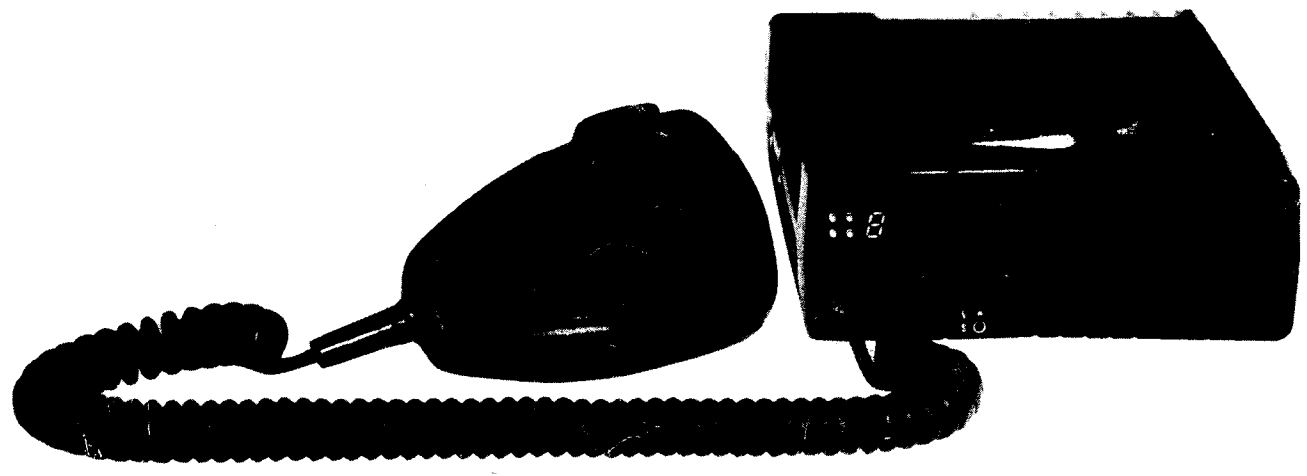
## CHALLENGER™ 7171 FM TWO-WAY RADIO

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CHALLENGER 7171  
13.8 VDC, 15 WATTS, UHF  
PART NO. 242-7171-xxx

NEW \$ 89.95

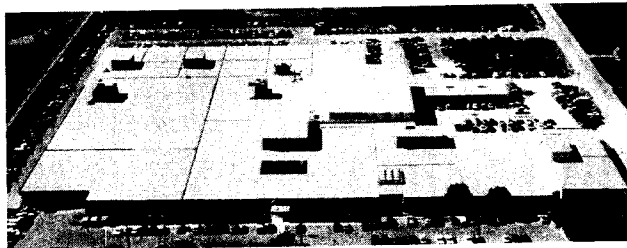


FIRST PRINTING  
FEBRUARY 1986

**COMMUNICATIONS  
ELECTRONICS**

# **JOHNSON CHALLENGER™ 7171 FM TWO-WAY RADIO**

**13.8 VDC, 15 WATTS, UHF  
PART NO. 242-7171-xxx**



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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 mobile telephone 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.

# SECTION 1 GENERAL INFORMATION

**COMMUNICATIONS  
ELECTRONICS**

## 1.1 SCOPE OF MANUAL

This service manual contains installation, programming, service, and alignment information for the Johnson Challenger™ 7171 transceiver, Part No. 242-7171-xxx.

## 1.2 TRANSCEIVER DESCRIPTION

The Johnson Challenger 7171 is a digitally synthesized and microprocessor controlled UHF FM transceiver. Its compact design allows front mounting in almost any vehicle. This transceiver operates on one of the frequency ranges shown in Section 1.3. Power output is 15 watts and bandwidth (without performance degradation) is 8 MHz receive and 12 MHz transmit. Transmit/receive spacing is 15 MHz.

The following features are standard with this transceiver:

- 8-Channel Operation
- Call Guard® (Tone, Digital, or Both)
- Call Indicator
- Busy Indicator
- Time-out Timer
- Transmit Disable When Channel Is Busy

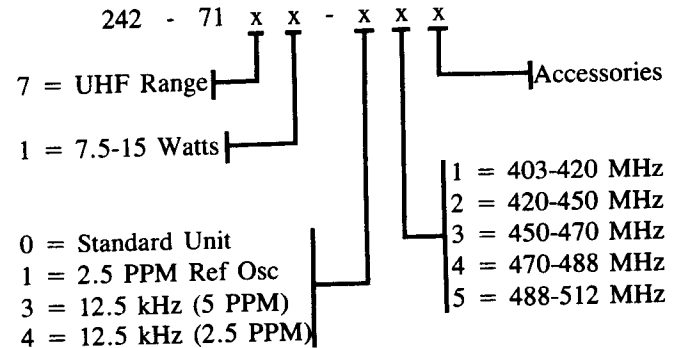
Since each of the following features require one of the two option switches, any two can be programmed:

- Scan
- Call Function On/Off
- Monitor
- Channel Lockout
- Auxiliary

Except for the busy and call indicators which are always enabled, all the preceding features can be enabled or disabled by dealer programming. This transceiver is programmed using a dealer personal computer and a Johnson software package for that computer. The computer interfaces to the transceiver using the RPI (Remote Programming Interface). The RPI plugs into the programming jack on the rear panel of the transceiver. Programming information is stored in the transceiver by an EEPROM on the audio/logic board. Since this type of memory device is nonvolatile and reprogrammable, battery backup and extra PROMs are not required. Refer to Section 3.1 for more programming information.

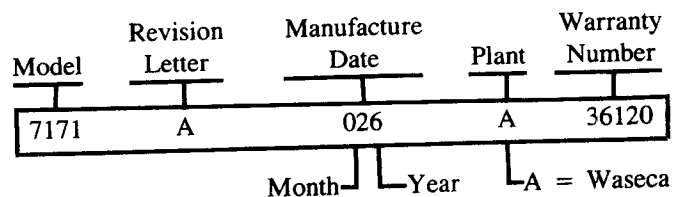
## 1.3 PART NUMBER BREAKDOWN

The following is a breakdown of the part number used to identify a 7171 transceiver:



## 1.4 TRANSCEIVER IDENTIFICATION

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



TM - Trademark of the E.F. Johnson Company.

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## 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 first contact the Product Service Department. They may be able to suggest a solution to the problem so that factory repair would not be required.

When returning equipment for repair, be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired. Clearly describe the difficulty experienced in the space provided and include the form in the shipping container with each unit. This form can be obtained from the Customer Service 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 warranty number of the equipment the part is from (refer to Section 1.4).

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

## SECTION 2 INSTALLATION

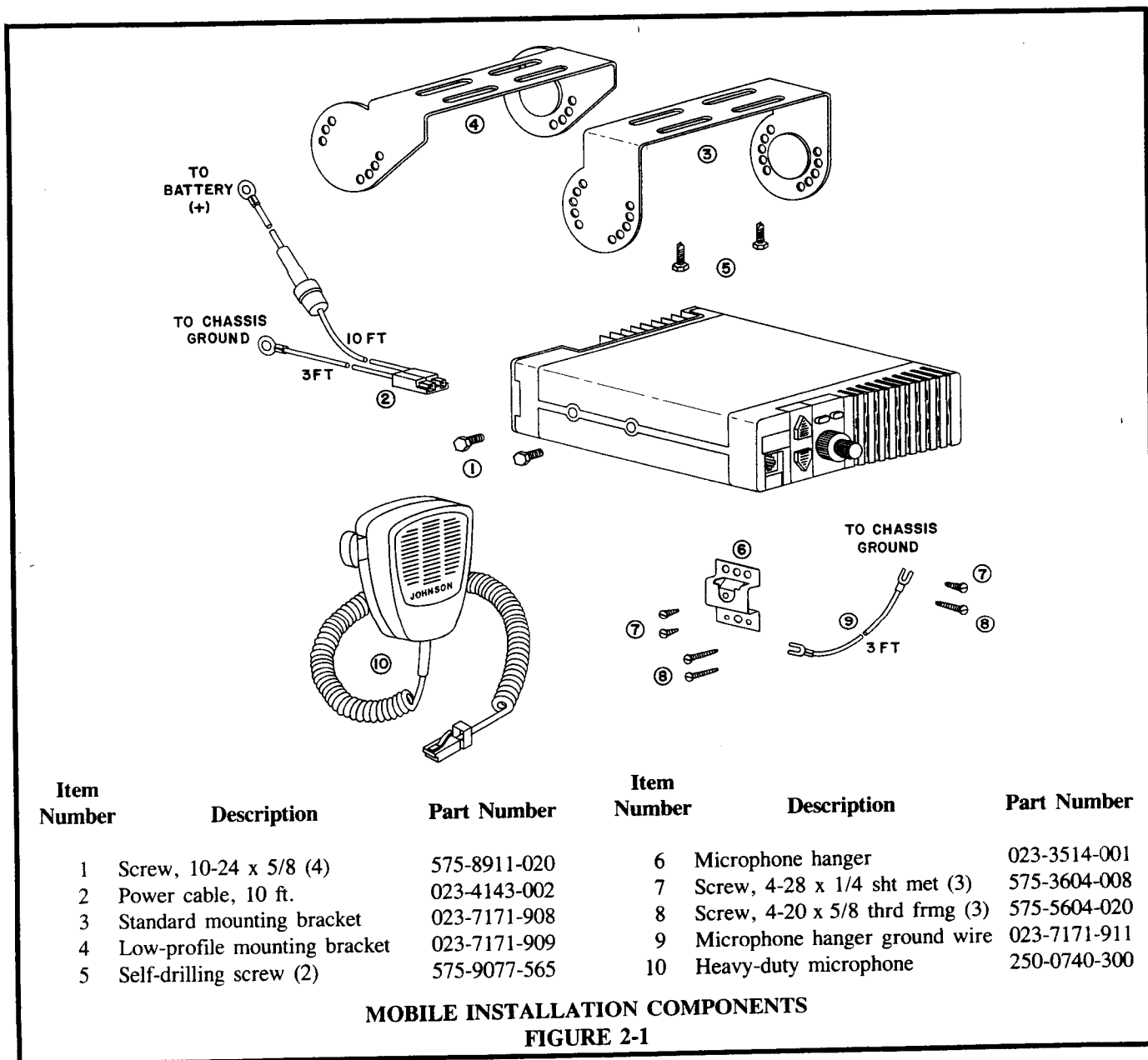
### 2.1 GENERAL

#### 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 PREINSTALLATION PROGRAMMING AND TESTING

If this transceiver was not ordered factory programmed, it must be programmed before it is placed in service (refer to Section 3.1). In addition, performance testing is recommended and realignment may be required.



## SECTION 3 OPERATION AND PROGRAMMING

### 3.1 TRANSCEIVER PROGRAMMING

#### 3.1.1 INTRODUCTION

This transceiver is programmed using a dealer-supplied personal computer, the Johnson RPI (remote-programming interface), and a Johnson programming software package for that particular computer. Software packages are available for several different models of computers such as the IBM® PC and Radio Shack® Model 100 (refer to Table 1-1 in Section 1).

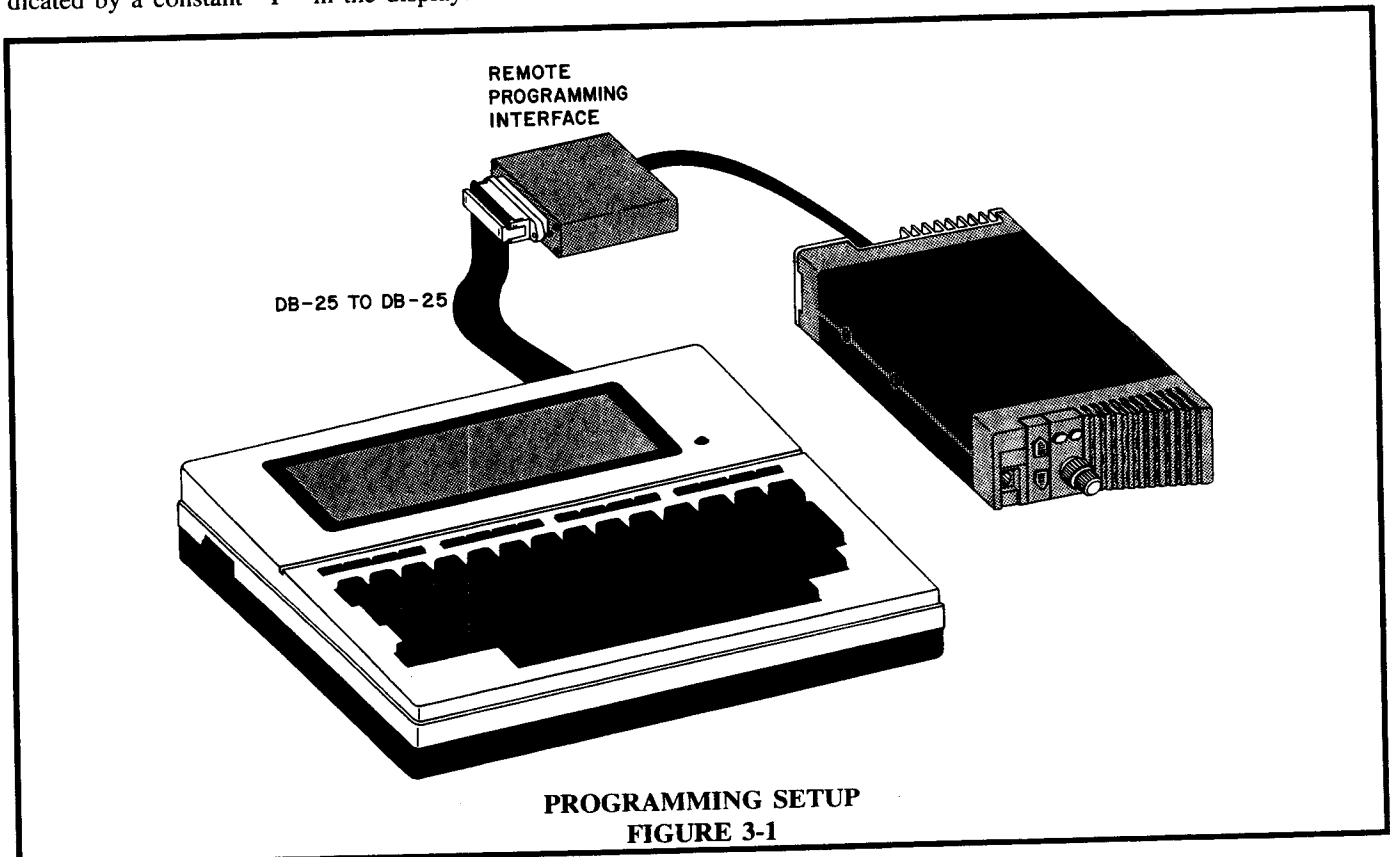
#### 3.1.2 RPI DESCRIPTION

The Remote Programming Interface (RPI) is required to interface a computer to the transceiver. The -000 RPI converts the RS-232 logic levels from the computer to TTL logic levels required by the transceiver and vice versa. The -090 RPI used by the Commodore 64 computer converts parallel data from the computer to serial data and vice versa. When the transceiver power is turned on with the RPI connected, the transceiver goes into the programming mode. The programming mode is indicated by a constant "P" in the display.

The cable between the computer and RPI is included with RPI and the cable between the RPI and computer is not included. The Radio Shack and IBM computers listed in Table 1-1 in Section 1 require either the -016 or -017 cable: If the RS-232 connector on the computer has female pins, the male-to-male cable is required; if it has male pins, the male-to-female cable is required. The Apple computer requires an adapter cable not supplied by Johnson, while the Commodore computer does not require a cable because the RPI plugs directly into the computer. Part numbers for the RPI and cables are listed in Table 1-1. A diagram showing the programming setup with the Radio Shack computer is shown in Figure 3-1.

#### 3.1.3 PROGRAMMING SOFTWARE DESCRIPTION

Since the Johnson software packages are written in the BASIC programming language, a BASIC interpreter is required for the particular computer. (This interpreter is usually included with the computer.) The Johnson software packages utilize menus and ask questions to simplify operation and lessen the chance of programming errors. Routines are included for entering and editing



### 3.2.2 EIGHT-CHANNEL OPERATION

Up to eight channels can be programmed. One frequency can be programmed for transmit and another for receive. Receive-only channels can also be programmed but not transmit-only channels. If transmitting is attempted on a receive-only channel, the display flashes, a warning tone sounds, and the transmitter is disabled. If a transmit-only channel is programmed, it cannot be selected. Restrictions on programmed frequencies are as follows:

- a. The programmed frequency should be exactly divisible by 6.25 kHz or 10 kHz. If not, contact Customer Service (Section 1.7).
- b. All receive channels programmed should be within an 8 MHz band.
- c. All transmit channels programmed should be within a 12 MHz band.
- d. The maximum transmit/receive channel spacing should be 15 MHz.

### 3.2.3 CALL GUARD

Tone, digital, and inverted digital Call Guards can be programmed in any combination desired. For example, a channel could be programmed so that a tone Call Guard is transmitted and a digital Call Guard is received.

This transceiver can also be programmed to operate with external encoder or decoder boards. For example, a two tone sequential decoder could be installed and the output connected to the P0.6 input of the microprocessor. The transceiver can then be programmed to unsquelch when this input goes high (EXT +) or low (EXT -). There is no programmable output to enable a tone encoder in the transmit mode. However, wireouts are provided which produce either a high or low signal in the transmit mode.

With digital Call Guards, either normal or inverted (IDCG) can be specified. The only difference is that the signal is inverted. An inverted digital Call Guard may be required if the Call Guard signal is inverted when it is transmitted or received by a repeater or other transceivers in the system. Refer to Section 4.6 for more Call Guard information.

### 3.2.4 MONITOR

The green MONITOR indicator is functional even if a front-panel switch has not been programmed for that function. This indicator lights when the microphone is off-hook or the MONITOR switch is pressed (if programmed). The MONITOR switch produces the same result as taking the microphone off-hook. The MONITOR switch is in the monitor position when the MONITOR indicator lights with the microphone on-hook. When the transceiver power is turned on, the MONITOR switch always reverts to the off mode (not monitoring).

### 3.2.5 CALL

#### Call Indicator Description

The yellow CALL indicator is functional even if a front-panel switch has not been programmed for that function. The CALL indicator lights whenever the transceiver is continuously unsquelched for 2 seconds with the microphone on-hook. If the channel is programmed for Call Guard, then the correct Call Guard must also be detected for the CALL indicator to light. If scanning and there is a priority channel, the Call indicator operates only on the priority channel. If there is no priority channel, the CALL indicator operates on all channels.

#### Turning Call Indicator Off

The CALL indicator remains on until the microphone is taken off-hook or the CALL switch is pressed (if programmed). However, pressing the CALL switch also disables the call function, so this switch should be pressed twice if the CALL indicator is to remain functional. When transceiver power is turned on, the CALL indicator reverts to the off condition.

#### CALL Switch Operation

The CALL switch enables or disables the call function. If the channel display flashes "C" after the switch is pressed, the CALL function is enabled; if "C" is not displayed, the call function is disabled. When transceiver power is turned on and this switch has been programmed, the call function reverts to the disable mode.

### 3.2.6 BUSY INDICATOR

The green BUSY indicator is always functional. This indicator lights whenever a carrier is detected on the selected channel. When Call Guard is being used on the

If there is a dealer programmed fixed priority channel, that channel is indicated by a "P" flashed in the channel display when it is selected while not scanning. If the priority channel is the channel selected by the channel switches, no "P" is displayed. A signal on a priority channel is received regardless of Call Guard. The transceiver can also be programmed so that a beep sounds whenever a message is received on the priority channel. Note that priority channels are available only while scanning.

### Selecting Channels While Scanning

The CHANNEL STEP switches remain active when scanning to permit the selected channel to be changed. Pressing one of these switches once halts scanning and displays the current channel number. If a CHANNEL STEP switch is pressed again within 2 seconds, the selected channel is changed. Scanning resumes if neither CHANNEL STEP switch is pressed for 2 seconds.

### Transmitting When in the Scan Mode

If a message is received on a particular channel while scanning, a response can be made on that channel without exiting the scan mode. However, the transmitter must be keyed within 2 seconds which is the delay period before scanning resumes. After transmitting there is a 5 second delay before scanning resumes to give the other party time to respond.

If the transmitter is keyed while scanning and no message has been received (channel display contains "..."), transmission occurs on the selected channel. (The selected channel is the channel displayed when not in the scan mode.) However, taking the microphone off-hook disables the Call Guard, so any message occurring on any scanned channel may be received and transmission occurs on that channel. In some cases it may be easier to disable scanning before transmitting. The Transmit Disable On Busy feature can be used to prevent transmitting on a busy channel if the user frequently transmits while scanning.

### 3.2.11 CHANNEL LOCKOUT

For the user to lock out channels, one of the option switches must be programmed for the channel lockout function. To lock a channel out of the scan sequence or to unlock a channel, press the CHANNEL LOCKOUT switch when the channel number is displayed. If "L" is flashed in the channel display, the channel is locked out

of scanning. If "L" is not flashed, the channel is unlocked (scanned normally). The following are additional considerations concerning the channel lockout function:

- a. The selected channel is always scanned, even if it is locked out by dealer programming or by the user.
- b. A dealer-programmed priority channel cannot be locked out (refer to "SCAN" description).
- c. While scanning and not receiving a signal, channels cannot be locked out. If a signal is being received, the channel being displayed can be locked out by pressing the CHANNEL LOCKOUT key. Channels cannot be unlocked while scanning.
- d. At least one channel must remain unlocked (the transceiver prevents the lockout of all channels).
- e. Dealer-programmed lockout channels can be unlocked and locked using the CHANNEL LOCKOUT key.
- f. Whenever power is turned off and then on again, all channels revert to the unlocked condition except those locked out by dealer programming.

### 3.2.12 AUXILIARY

The option switches can be programmed to control auxiliary functions such as public address or an external decoder. When an AUXILIARY switch is pressed to enable a function, "A" is flashed in the channel display. If "A" is not flashed when this switch is pressed, the auxiliary function is off. When transceiver power is turned on, this switch always reverts to the off condition.

The AUXILIARY switch controls the P3.5 output of the microprocessor. When auxiliary is enabled, 8 volts is provided at the wire-out on the collector of Q408 on the audio/logic board. When the auxiliary function is disabled, this output goes to a high-impedance state.

## 3.3 CHANNEL DISPLAY

### 3.3.1 INTRODUCTION

The channel display contains channel, option switch position, and error information. The following is a summary of information indicated by the channel display. Additional information on the particular functions may be found in the preceding sections.



## SECTION 4 CIRCUIT DESCRIPTION

### 4.1 GENERAL TRANSCEIVER DESCRIPTION

#### 4.1.1 INTRODUCTION

The Johnson Challenger 7171 FM transceiver comes standard with eight channels, Call Guard, scan, time-out timer, and other features. These features are all selectable when programming the transceiver. The transceiver contains main and audio/logic PC boards. The main board contains the synthesizer, receiver, and transmitter; the audio/logic board contains audio processing and digital control circuitry. Brief descriptions follow in this section and then more detailed descriptions are located in Sections 4.2-4.5. A transceiver block diagram is shown in Figure 4-1.

Circuit protection is provided by a 7-ampere fuse in the power cable and two 4-ampere fuses on the main board. The power cable fuse protects the final amplifier circuitry and also provides overall transceiver protection. The 4-ampere fuses protect the low-current circuits of the transceiver.

#### 4.1.2 SYNTHESIZER

The synthesizer produces the transmit frequency in the transmit mode and the receive first injection frequency in the receive mode. Channels are selected by programming the counters in synthesizer chip U801 to divide by a certain number. This programming data is generated by the microprocessor located on the audio/logic board. Reference oscillator Q809 provides a frequency stability of 5 PPM. An optional TCXO is available which provides a frequency stability of 2.5 PPM for base station applications.

#### 4.1.3 RECEIVER

The receiver is a dual-conversion type with intermediate frequencies of 21.4 MHz and 455 kHz. Receiver selectivity is enhanced by four-pole crystal filter Z202. Two helical bandpass filters formed by T201-T205 reject the image, half IF, injection, and other unwanted frequencies.

Receiver specifications are as follows:

Sensitivity	0.30 $\mu$ V (12 dB SINAD)
Selectivity	-75 dB
Audio Power Output	5 watts (3 ohm ext spkr)
Audio Distortion	Less than 5%
Bandwidth	8 MHz

#### 4.1.4 TRANSMITTER

The transmitter amplifies the input signal from the synthesizer to produce a power output at the antenna jack of 15 watts. Since the input frequency from the synthesizer is the modulated transmit frequency, no frequency multiplication or modulation occurs in the transmitter. A power control circuit maintains a constant power output as changes occur in temperature and supply voltage.

Transmitter specifications are as follows:

Frequency stability	5 PPM (2.5 PPM optional)
RF power output	15 watts
Audio distortion	Less than 3% at 1000 Hz
FM hum and noise	-45 dB
Bandwidth	12 MHz

#### 4.1.5 AUDIO/LOGIC BOARD

A microprocessor-based control system on the audio/logic board provides Call Guard encoding and decoding (tone and/or digital), synthesizer programming, channel scan, and other features. Channels and the various operating features are programmed by a personal computer (refer to Section 3). Programming information is stored by EEPROM U401 on the audio/logic board. Since this type of device is nonvolatile and reprogrammable, no battery backup or extra PROMs are ever needed.

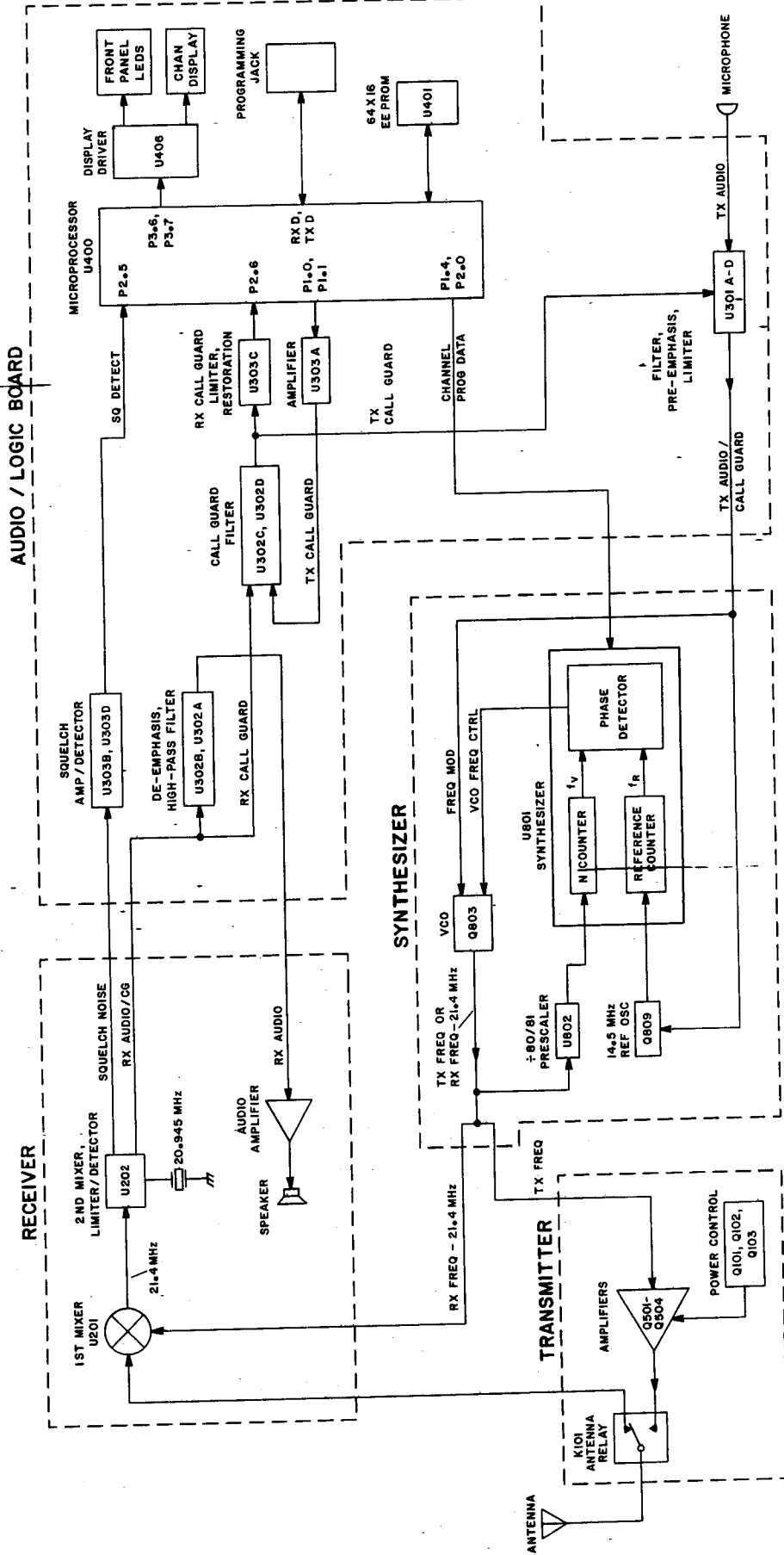
In addition to digital circuitry, the audio/logic board contains analog circuits which provide amplification, filtering, and other processing of the transmit and receive audio, Call Guard, and squelch signals.

**AUDIO / LOGIC BOARD**

**RECEIVER**

**TRANSMITTER**

**SYNTHESIZER**



TRANSCIVER BLOCK DIAGRAM  
FIGURE 4-1

connects C857 and C827 to AC ground through C828. In the transmit mode, Q804 is turned on and CR805 is reverse biased because the cathode is near 8 volts and the anode near 0 volts. L808 is an RF choke and other capacitors in the circuit provide RF bypass. C857 is adjusted to provide a frequency shift of approximately 21.4 MHz.

#### Active Filter (Q802)

Q802 functions as a capacitance multiplier to provide filtering of the 8 volt supply to the oscillator. R814 provides transistor bias and C822 is 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 C822. Therefore, the base/emitter voltage does not change and the transistor current remains relatively constant. C821 and L806 isolate the 8 volt supply from tank circuit RF.

#### 4.2.3 BUFFERS (Q805, Q806), TRANSMIT/RECEIVE SWITCHING (Q807, Q808)

The VCO signal is coupled by C826 to buffer Q805 and then by C831 to buffer Q806. These two transistors provide amplification and also isolation between the VCO and other frequencies present in the transceiver. Impedance matching between stages is provided by L809/C831 and L810/C836. The resistors across L809 and L810 lower the Q of the coil to broaden the response. C830, C833, C834, C837, C838, R839, R822, and R825 provide conditioning of the 8 volt supply to Q805 and Q806.

A circuit consisting of Q807, Q808, CR807, CR808, and several other components switches the buffer output signal to either the transmitter or receiver. This circuit provides isolation between the transmitter and receiver and also attenuates the transmitter signal when in the receive mode.

This circuit operates as follows: In the transmit mode Q807 is turned on and CR808 is reverse biased because the anode is near 0 volts. This blocks the signal path to the receiver. Q808 is turned off and CR807 is forward biased by current flowing through R830 and R829. This allows the signal to be coupled by C840 to the transmitter. In the receive mode Q807 is turned off and Q808 is turned on and the signal is coupled by C841 to the receiver.

#### 4.2.4 PRESCALER (U802)

The input signal to dual-modulus prescaler U802 is the signal developed across R826. A prescaler is a counter

capable of operating at high frequencies and dual modulus refers to the two possible divide numbers (80 and 81). This counter divides the 430-512 MHz VCO signal down to the 5 MHz range. The prescaler utilizes emitter-coupled logic (ECL), so the logic swing is relatively small. U802 divides by 80 when the control input from synthesizer U801 is high and by 81 when the control input is low.

C809 and C805 are coupling capacitors, and zener diode CR806 drops the 8 volt supply by 3 volts to provide a 5 volt input to U804. C807, C808, and C810 bypass various RF frequencies and R806 provides isolation.

### 4.2.5 SYNTHESIZER INTEGRATED CIRCUIT (U801)

#### Introduction

A block diagram of synthesizer U801 is located in Figure 4-3. This integrated circuit contains the reference, A, and N counters; phase and lock detectors; and counter programming circuitry. The basic operation of this device was described in Section 4.2.1.

#### Channel Programming

Channels are selected by programming the three counters in U801 to divide by a certain number. The programming of these counters is performed by the microprocessor on the audio/logic board. The counter programming numbers for each channel are loaded into EEPROM U401 when the transceiver is programmed.

Data is loaded into U801 serially on the DATA input (pin 12). Data is clocked into the shift registers a bit at a time by a low to high transition on the CLOCK input (pin 11). Data is first loaded into the one-bit shift register and then into the seven-, ten-, and fourteen-bit registers. The last bit loaded is present in the one-bit register and it determines if the reference counter will be programmed. If this bit is a logic 1, all three counters are programmed when the ENABLE input (pin 13) goes high. If this bit is a logic 0, only the seven- and ten-bit counters are programmed.

#### U801 Operation

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input ( $f_V$ ) to the phase detector is the same frequency as the reference oscillator-derived input ( $f_R$ ).

frequency difference between  $f_R$  and  $f_V$ . The microprocessor monitors this output to determine if the synthesizer is out-of-lock. If it is, the transmitter is disabled and the channel display begins flashing to alert the operator of this condition.

#### 4.2.6 ADAPTIVE LOOP FILTER (Q801, U803A, U803B)

The loop filter consists of C811, C812, C813, R808, R809, and R810. This low-pass filter controls synthesizer stability and lockup time and suppresses the loop reference frequency ( $f_R$ ). Analog switches U803A and U803B are used to bypass resistance in the loop filter to speed up the lockup time. These switches are enabled for about 3 milliseconds whenever a different VCO frequency is selected. A logic high closes the switch and a logic low opens the switch.

The VCO frequency is controlled by a DC voltage filtered by the loop filter. The input signal to the loop filter is the APD (analog phase detector) output of U801. This output is from a sample and hold circuit which produces a voltage proportional to the phase difference between the  $f_V$  and  $f_R$  signals. If the phase of  $f_V$  lags that of  $f_R$ , the APD output ramps up between the time the  $f_V$  and  $f_R$  pulses occur. Conversely, if  $f_V$  leads  $f_R$ , the APD 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 occurring at a rate equal to the frequency difference between  $f_R$  and  $f_V$ .

Buffer Q801 provides a low output impedance to the loop filter. This isolates the high output impedance of the APD output so that it does not affect the rolloff characteristics of the filter. Q801 also improves the current drive capability of the APD output which results in a faster lockup time.

#### 4.2.7 REFERENCE OSCILLATOR (Q809)

Q809 is a modified Colpitts oscillator that is temperature compensated to provide a frequency stability of  $\pm 5$  parts per million from  $-30$  degrees C to  $+60$  degrees C. Capacitors C849 and C850 control the feedback, and C848 sets the adjustment range of C847. Temperature compensation is provided by C846 and thermistor RT801. The capacitance of RT801 changes with temperature to compensate for frequency drifting of the crystal. The value of C846 is specially selected for each crystal and the value is stamped on the crystal. The transmit audio signal applied across varactor diode

CR809 frequency modulates the reference frequency. Refer to the next section for more modulation information. A 2.5 PPM TCXO is also available when this transceiver is used as a base station. Y801, R834, and C851 are removed when the TCXO is used.

#### 4.2.8 VCO AND REFERENCE OSCILLATOR MODULATION

The transmit audio signal modulates both the VCO and the reference oscillator to achieve the required frequency response. If only the VCO was modulated, the phase detector in U801 would sense the frequency change and the VCO control voltage would increase or decrease to counteract the change (especially at the lower frequencies). If only the reference oscillator was modulated, the VCO frequency would not change fast enough (especially at the higher frequencies). However, by modulating both the reference oscillator and the VCO, the two phase detector inputs ( $f_R$ ,  $f_V$ ) remain in phase and no change in the VCO frequency is sensed. Potentiometer R811 balances the reference oscillator and VCO modulation signals.

### 4.3 RECEIVER CIRCUIT DESCRIPTION

*NOTE: A receiver block diagram is located in Figure 4-2.*

#### 4.3.1 HELICAL FILTER (T201/T202/T203), RF AMPLIFIER (Q201)

The receive signal is coupled from the antenna relay to a helical filter formed by T201, T202, and T203. This is a three-section helical filter tuned to pass the 8 MHz receive band of frequencies to RF amplifier Q201. Each helical is tuned by a screw which changes the capacitance between the helix and shield. The signal is inductively coupled between helicals through a small window in the shield.

Impedance matching between the helical filter and RF amplifier Q201 is provided by C208, L204, and C201. The RF signal is amplified by Q201 to recover filter losses and improve receiver sensitivity. R201 and R202 provide biasing; R204 provides isolation of the supply voltage; and C202, C203, and several other capacitors provide RF bypass. CR201 protects the base-emitter junction of Q201 from excessive negative voltages that may occur during high-signal conditions. Impedance matching with helical filter T204/T205 is provided by L205 and C204. This filter provides additional filtering of the receive signal. Resistor R203 lowers the Q of L205.

Class A biasing is provided by R501, R502, and R505. Conditioning of the power supply to this stage is provided by C503, C504, C505, C507, and R504. Negative feedback to prevent self-oscillation is provided by C506 and R503. Inductor L501 is an RF choke.

Predriver Q502 is similar in design to Q501. Impedance matching between Q501 and Q502 is provided by C509, C510, C511, and two sections of microstrip. The supply voltage to this stage is controlled by the power control circuit. This controls the voltage swing which controls the drive to the final. The total power gain of Q501 and Q502 is approximately 22 dB.

\* Microstrip is similar to transmission line with series inductance and shunt capacitance. The characteristic impedance is determined by the width of the PC board pad and the PC board material and thickness.

#### 4.4.2 Driver (Q503), Final (Q504)

Driver Q503 provides a gain of approximately 8 dB. This stage is biased class C by R510 and R512. Impedance matching between Q502 and Q503 is provided by C517, C518, and two sections of microstrip. A section of microstrip between the collector and the power supply functions as an RF choke.

Final amplifier Q504 produces a maximum power output of 18-22 watts. This stage is self biased class C by L504 and R513. Impedance matching between Q503 and Q504 is provided by several capacitors and two sections of microstrip. L505 is an RF choke, and C529-C532 provide filtering of the DC supply.

Impedance matching between Q504 and the harmonic filter is provided by C533-C539 and two sections of microstrip. C537 is a DC blocking capacitor. The harmonic filter consists of L506, L507, L508, and C538-C545. The harmonic filter is a low-pass filter which attenuates harmonics occurring above the transmit band.

Antenna relay K101 switches the antenna from the receiver to the transmitter when the transmitter is keyed. It is controlled by the transmit 8 volt supply. When the 8 volt transmit line goes low, the relay de-energizes and a voltage spike is generated by the relay coil. CR105 clamps this voltage spike to 0.7 volt.

#### 4.4.3 POWER CONTROL (Q101, Q102, Q103)

The power control circuit maintains a constant power output by sensing the final amplifier current and also the ambient temperature and supply voltage of the transmitter.

Current flow to final amplifier Q504 is monitored by sensing the voltage drop across R105. In the transmit mode both Q104 and Q105 are turned on (refer to interconnect schematic) which effectively grounds the junction of R101 and R102. Q104 provides a 6 millisecond delay in transmitter keying to allow the antenna relay time to close before output power is produced.

Current flowing through R101 and CR101 maintains a base voltage on Q101 that is about 0.7 volt less than the voltage at R105. Since the PN junction drop across the base and emitter of Q101 is also about 0.7 volt, a voltage is maintained across R104 that is equal to the voltage across R105.

Assume that the current to the final amplifier attempts to increase. The base voltage of Q101 then decreases which causes the transistor to turn on more to maintain a voltage across R104 that is the same as the voltage across R105. Current through R103, R106, and RT101 then also increases which increases the base voltage of Q102.

Q102 and Q103 form a PNP Darlington amplifier. When the base voltage of Q102 increases, the amplifier conducts less which lowers the supply voltage to pre-driver Q502. The gain of Q502 then decreases and a constant power output is maintained. If the current through R105 attempts to decrease, the opposite occurs.

The setting of potentiometer R103 controls the voltage applied to the base of Q102 and therefore the power output of the transmitter. CR102 and R102 maintain a voltage at RT101/R106 that is 8.2 volts less than the transceiver supply voltage. This provides voltage compensation of the power output. Thermistor RT101 decreases in resistance as the transmitter temperature increases. This provides temperature compensation of the power output. C107 and C110 provide stability to the power control circuit, while C104, C108, and C109 bypass RF.

## 4.5 AUDIO/LOGIC BOARD CIRCUIT DESCRIPTION

### 4.5.1 INTRODUCTION

The audio/logic board contains both analog and digital circuits. The analog circuits provide squelch control and processing of the transmit and receive audio and Call Guard signals. The digital circuits provide such functions as synthesizer programming, Call Guard encoding and decoding, and control of the front panel channel display and indicators. The digital control logic is based on an eight-bit 8051 microcomputer. A block diagram of the audio/logic board is located in Figure 4-5.

**P1.0, P1.1** – Outputs for transmit Call Guard. Refer to Section 4.5.7 for more information.

**P1.2** – This output is high when Call Guard is transmitted and low when Call Guard is received. This output controls whether the transmit or receive Call Guard is routed through the Call Guard filter circuit (U302C, U302D). It also controls gate U402B which opens the path to the transmit audio circuit for the transmit Call Guard signal.

**P1.3** – This output is high for all digital Call Guard codes and for all Call Guard tones less than or equal to 100 Hz. It is low for Call Guard tones above 100 Hz, when the reverse burst is transmitted with tone Call Guards, and when the digital Call Guard turnoff code is transmitted. This signal controls the passband of the Call Guard filter (U302C, U302D).

**P1.4** – This output controls EEPROM and synthesizer programming. Refer to Sections 4.5.3 and 4.2.5 respectively, for additional information.

**P1.5** – This is the data output for programming LED driver U406, EEPROM U401, and the synthesizer. Refer to Sections 4.5.4, 4.5.3, and 4.2.5 respectively, for additional information.

**P1.6** – Selects EEPROM U401 when it is read or programmed. Refer to Section 4.5.3 for additional information.

**P1.7** – Serial data input when reading EEPROM U401. Refer to Section 4.5.3 for additional information.

**P2.0** – Latch enable output used for synthesizer programming. Refer to Section 4.2.5 for additional information.

**P2.1** – This output controls the adaptive loop filter in the synthesizer. Whenever the synthesizer frequency is changed, this line goes high for approximately 3 milliseconds to speed up the lockup time. This pulse also charges C308 in the squelch circuit (refer to Section 4.5.6).

**P2.2** – Not used.

**P2.3** – This output controls the transmit/receive switching circuit in the synthesizer. It is high in the transmit mode and low in the receive mode. Refer to Section 4.2.2 for more information.

**P2.4** – This output allows the logic to control the squelch when Call Guard is used. A high squelches the receiver regardless of the signal output from Schmitt trigger U303D; a low permits the squelch to be entirely controlled by the squelch circuit.

**P2.5** – This input from the squelch circuit is low when a carrier is detected and high when no carrier is detected. If the selected channel is programmed for Call Guard, a low signal on this input tells the microcomputer to begin looking for valid Call Guard on the P2.6 input.

**P2.6** – Input for Call Guard tone or data. The microcomputer determines the tone or code by decoding this signal which is at 0 and 5 volt logic levels.

**P2.7** – This output is used by the microcomputer to disable transmitter keying. This output must be low and the microphone push-to-talk switch depressed for the transmitter to key. This allows the microcomputer to disable the transmitter with the time-out timer and Transmit Disable When Channel Is Busy features are used or when the synthesizer is out-of-lock.

**RxD (P3.0)** – This is the input for serial programming data when programming the transceiver. This data comes from a personal computer.

**TxD (P3.1)** – This is the output for serial data when the transceiver is being programmed. Refer to Section 3 for more programming information.

**P3.2** – This input is grounded (TP402 connected to TP401) when setting the synthesizer modulation balance. When this input is grounded, the microcomputer generates a square-wave signal on the P1.0 output when the push-to-talk switch is depressed. A signal is produced even if Call Guard is not programmed on the selected channel.

**INT1 (P3.3)** – This input is low when the synthesizer is out-of-lock. A low on this input vectors the microcomputer to a section of the program which immediately disables the transmitter to prevent the transmission of an improper frequency. The transmitter is disabled by changing P2.7 to a high output. The display also begins flashing to indicate the out-of-lock condition to the user.

**P3.4** – This is the output for the time-out timer tone heard when the transmitter is disabled. It is also the output for the beep tone. This signal is applied to the input of the audio amplifier in the receiver. An RC network formed by R401 and C400 attenuates high-frequency harmonics present in the square-wave output.

**P3.5** – This output controls Q407 and Q408 which provide an 8 volt output to the optional decoder board. The specific operation of this output is determined by transceiver programming.

**P3.6, P3.79** – Outputs used to program LED driver U406. Refer to Section 4.5.4 for additional information.

detected and the selected channel is programmed for Call Guard, the microcomputer begins looking for a valid Call Guard signal on the P2.6 input.

The output signal of Schmitt trigger U303D is also applied to an RC network consisting of R313, R314, and C309. This network produces an additional delay which results in a 140 millisecond threshold attack time and an 80 millisecond release time for the signal applied to squelch gate U402A. This time is somewhat longer to prevent intermittent squelching when receiving a weak, fading signal. Squelch gate U402A is enabled when C309 charges to approximately 4.5 volts and is disabled when C309 discharges to the same level. Q400 allows the microcomputer to control the squelch when Call Guard is used.

#### 4.5.7 TRANSMIT/RECEIVE CALL GUARD PROCESSING (U302C, U302D, U303C)

##### Introduction

The Call Guard filter formed by U302C and U302D provides filtering of both the receive and transmit Call Guard signals. Routing of each of these signals through the filter is controlled by gates U402B, U402C, and U402D.

##### Receive Call Guard Processing

In the receive mode the P1.2 output of the microcomputer is low. This turns off Q401 which enables analog gate U402D and disables analog gates U402B and U402C. This opens the receive audio path to the Call Guard filter and blocks the transmit audio signal path to the Call Guard filter and transmit audio circuit.

The Call Guard filter consists of U302C, U302D, and several capacitors and resistors. This is a low-pass filter which attenuates low-frequency voice and also certain harmonic frequencies. The passband of this filter is controlled by Q402.

With all digital Call Guard codes and also tone Call Guard tones less than or equal to 100 Hz, the P1.3 output of the microcomputer is high. This turns on Q402 which switches additional capacitance into the filter. This additional capacitance lowers the passband of the filter to approximately 140 Hz. For tone Call Guard signals above 100 Hz, the reverse burst transmitted with tone Call Guards, and the turnoff code transmitted with digital Call Guards, the P1.3 output is low which turns Q402 off. This increases the passband of the filter to approximately 210 Hz. Restricting the passband for all digital codes and for the lower tone frequencies attenuates harmonics which could cause improper Call Guard operation.

The output signal of the Call Guard filter is applied to amplifier Q301. This stage has an AC gain of approximately three to provide the correct input level to U303C. Comparator U303C converts the Call Guard signal from AC floating near 3.6 volts to digital levels that can be decoded by the microcomputer. The DC reference voltage on pin 9 of U303C is the average of the positive- and negative-going alternations of the Call Guard signal. This voltage is produced by C316 charging and discharging through R328, CR302, and CR303.

When the average voltage changes, CR302 and CR303 temporarily bypass R328 to shorten the time required for the voltage across C316 to stabilize. When the input voltage on pin 10 of U303C rises above the reference on pin 9, the output on pin 8 goes to near 7 volts. Conversely, when the input voltage decreases below the reference on pin 9, the output goes to near 0 volts. These 0 and 7 volt levels are inverted and changed to 0 and 5 volt levels by U404B.

##### Transmit Call Guard Processing

In the transmit mode the P1.2 output of the microcomputer is high. This signal enables gates U402C and U402B which routes the transmit Call Guard signal through the Call Guard filter. It also turns on Q401 which disables analog gate U402D and blocks the receive audio path to the Call Guard filter.

The Call Guard data or tone is generated by the microcomputer on outputs P1.0 and P1.1. The resistor network connected to these outputs (R316-R319) produces four different voltage levels from the four possible logic combinations on P1.0 and P1.1. These voltages are 1.60, 1.75, 2.00, and 2.15 volts. By changing these voltages at a rate six times the Call Guard tone, an approximation of a sine wave is produced. Since a sine wave contains fewer harmonics than a square wave, a much simpler circuit can be used to filter this signal. With a digital Call Guard, only the 1.60 and 2.00 levels are used.

U303A is a noninverting amplifier with a gain of approximately two. This amplifier provides the proper input level to the Call Guard filter. The Call Guard filter functions the same in the transmit mode as in the receive mode discussed near the beginning of this section. The filtering provided when the narrower passband is selected attenuates harmonics which could cause improper Call Guard operation in the transceiver receiving the signal.

because of their close proximity to the voice frequencies which begin at 300 Hz. This transceiver can be programmed to transmit one tone and receive another on the same channel if desired. It can also be programmed with both tone and digital Call Guards.

This transceiver also transmits and receives a reverse burst when a tone Call Guard is programmed on the selected channel. The reverse burst is transmitted when the push-to-talk switch is released. When it is detected by the transceiver receiving the message, the receiver immediately squelches and no squelch tail (noise burst) is produced. Both the transmitting and receiving transceivers must be equipped with the reverse-burst feature for it to be utilized.

#### 4.6.3 DIGITAL CALL GUARD

A digital Call Guard is controlled by digital data instead of subaudible tones. This data consists of continuous repetitions of 23-bit words. No bit or word sync information is contained in the transmitted data. When

the push-to-talk switch is released, a turn off code is transmitted that eliminates the squelch tail (noise burst) in the transceiver receiving the message.

Although there are thousands of possible code combinations with 23 bits, only 83 are unique with the data scheme used. The number specified when the code is programmed is not the binary number transmitted. Instead, it is a seed in a special algorithm used by the microcomputer to generate the 23-bit code.

The data is transmitted at a rate of 134.4 bits per second. Therefore, approximately six 23-bit words are transmitted each second. When the data is decoded, 23-bit samples are taken and compared to the receive Call Guard programmed in memory. Since word and bit sync information is not used, there is no way to detect when one 23-bit word ends and the next begins. Therefore, a sample usually contains bits from two different words. In order to recreate the programmed code, the bits are rotated. If the programmed Call Guard is detected, the receiver is unsquelched. The receiver is squelched again when the turn-off code is decoded, digital Call Guard is lost, or the noise squelch circuit detects loss of carrier.



## SECTION 5 SERVICING

### 5.1 GENERAL

#### 5.1.1 PERIODIC CHECKS

This transceiver should be put on a regular maintenance schedule and an accurate performance record should be kept. The procedure for performing various performance checks is located in Sections 6.7 and 6.8. These checks include receiver sensitivity and transmitter frequency, deviation, and power output. It is recommended that annual checks be made even though they are no longer required by the FCC.

#### 5.1.2 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts for the two boards in this transceiver are located in the back of this manual. The main board 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 included 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 on the PC board are also provided to aid in component location.

#### 5.1.3 REPLACEMENT PARTS

A replacement parts list containing the Johnson part numbers of all the parts used in this transceiver is located in Section 7. Parts are listed alphanumerically according to designator. For more information on ordering parts, refer to Section 1.9.

#### 5.1.4 TRANSCEIVER PROGRAMMING

This transceiver must be programmed to make it operational. Refer to Section 3.1.

### 5.2 SURFACE-MOUNTED COMPONENTS

Surface-mounted components are used extensively on both boards of this transceiver. Because of their small size, special procedures must be used when replacing these components to prevent damage to either the component or the PC board pads. Surface-mount components should not be reused because they are usually damaged by the unsoldering process. The Surface-Mounted Device Handbook, Part No. 001-0576-001, provides detailed information on how to replace these components.

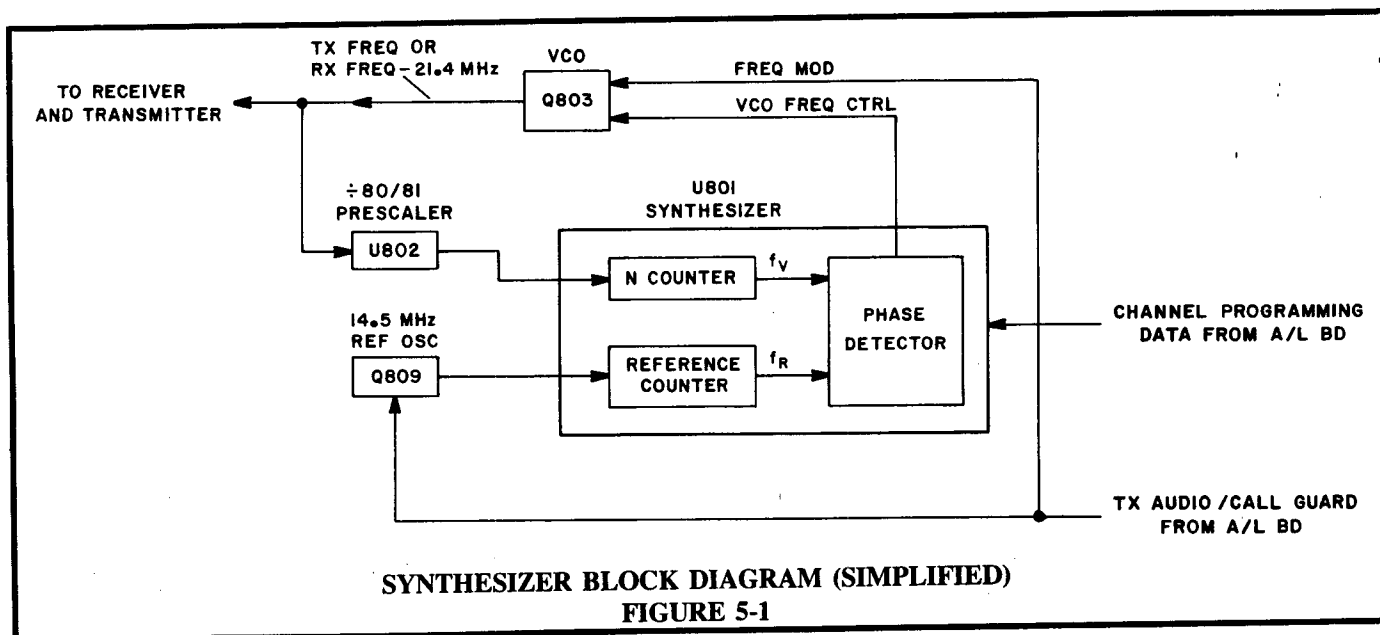
### 5.3 INTEGRATED CIRCUITS

#### 5.3.1 CMOS HANDLING TECHNIQUES

CMOS integrated circuits have very high open circuit impedance, so are particularly susceptible to damage from static discharges. CMOS integrated circuits used in this transceiver include U402-U405, U801, and U803. Static charges can cause damage to these components that is not immediately apparent. Damaging static charges may be present even if no discharges are observed. When handling these devices, observe the following precautions:

- a. Before touching any equipment or a CMOS device, discharge any built-up 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 CMOS device is inserted in the PC board, it is somewhat protected by internal diode protection circuits. A service bench CMOS protection kit, Part No. 299-0026-001, can be ordered from the Service Parts Department (refer to Section 1.9). This kit eliminates static buildup on your body and includes a conductive mat, wrist strap, and a grounding strap with a 1 megohm resistor.



SYNTHESIZER BLOCK DIAGRAM (SIMPLIFIED)  
FIGURE 5-1

by serial data from microcomputer U400 on the audio/ logic board. Possible causes of incorrect programming are improperly programmed transceiver, defective microcomputer, or defective U801.

The divide numbers for the R, N, and A counters are determined by the channel frequency and spacing specified when programming the transceiver. The divide numbers of these counters are derived as follows:

Reference Counter (R)

$$R = \frac{\text{Ref Osc Freq}}{\text{Channel Spacing}}$$

Example:

$$\frac{14.5 \text{ MHz}}{6.25 \text{ kHz}} = 2320$$

N Counter

$$N = \text{INT} \left( \frac{\text{Channel Freq}}{\text{Channel Spacing} \times 80} \right)$$

Example:

$$\text{INT} \left( \frac{455.200 \text{ MHz}}{6.25 \text{ kHz} \times 80} \right) = \text{INT} 910.4 = 910$$

NOTE: To produce an integer (INT), drop any numbers to the right of the decimal point.

A Counter

$$A = \frac{\text{Channel Frequency} - (N \times \text{Channel Spacing} \times 80)}{\text{Channel Spacing}}$$

Example:

$$A = \frac{455.200 \text{ MHz} - (910 \times 6.25 \text{ kHz} \times 80)}{6.25 \text{ kHz}} = 32$$

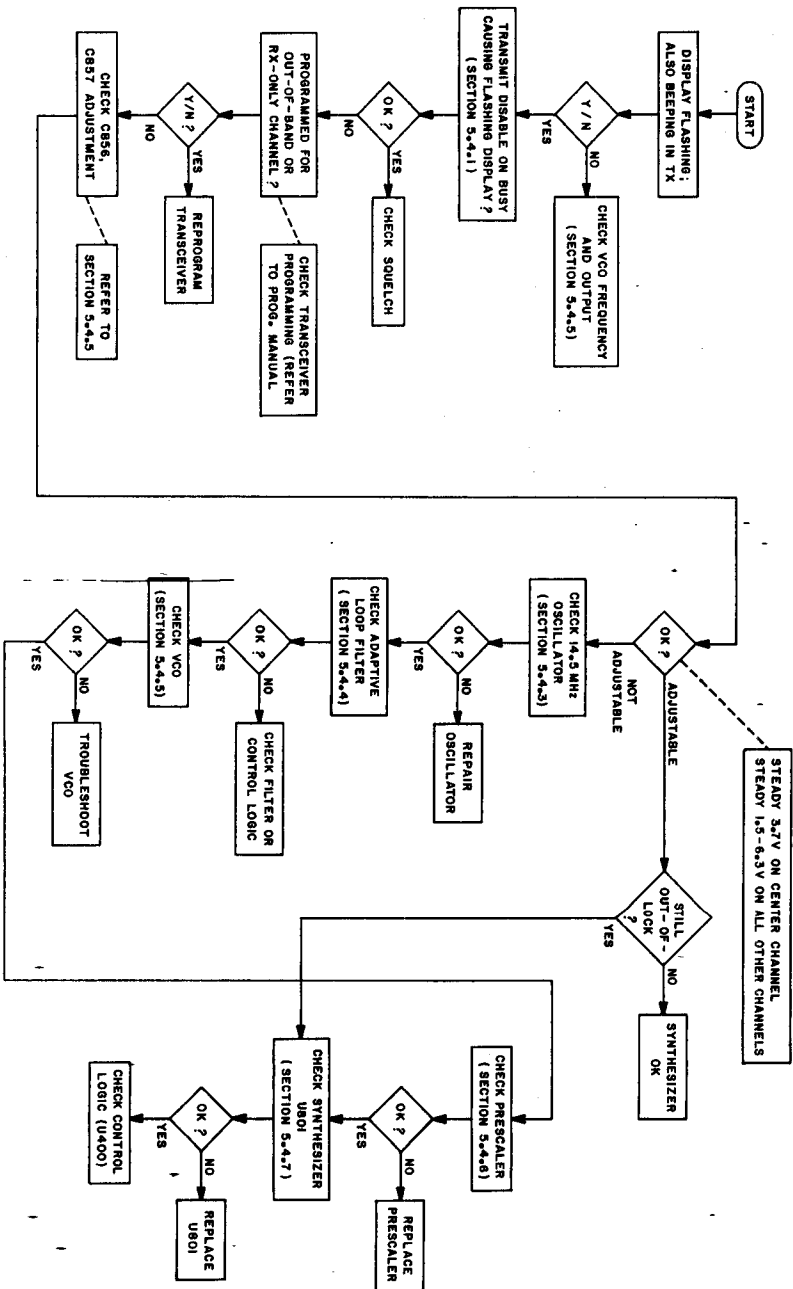
5.4.3 REFERENCE OSCILLATOR (Q809)

To determine if Q809 is operating properly, check the frequency at U801, pin 3. It should be 14.500 MHz and approximately 2 volts peak-to-peak.

If that signal is incorrect, verify operation of Q809 by checking the RF and DC voltages shown on the schematic. The DC voltages are measured with the oscillator disabled by shorting the C848 side of crystal Y801 to ground. If the 2.5 PPM TCXO is used, check the DC supply voltage and the RF voltage. The TCXO is not field serviceable.

5.4.4 ADAPTIVE LOOP FILTER

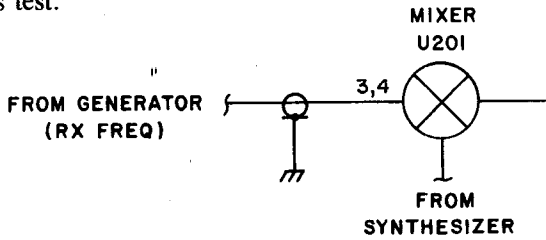
The adaptive filter control signal on U803, pins 6 and 12, should be low except when the VCO frequency changes. It should then go high (+8V) for approximately 3 milliseconds and then go back low. The purpose of this signal is to broaden the frequency response of the loop filter to speed up the lock time. If this pulse does not occur, the VCO probably will not lock on frequency.



SYNTHESIZER TROUBLESHOOTING FLOWCHART  
FIGURE 5-2

5.5.4 MIXER (U201)

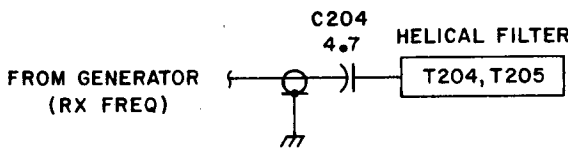
Connect the circuit shown below. C209 must be removed or the trace between pin 4 and C209 cut to do this test.



With the selected receive frequency (modulated with 1 kHz at  $\pm 3$  kHz deviation) injected at this point, 12 dB SINAD sensitivity should be .40-.60 microvolt.

5.5.5 FILTER (T204/T205)

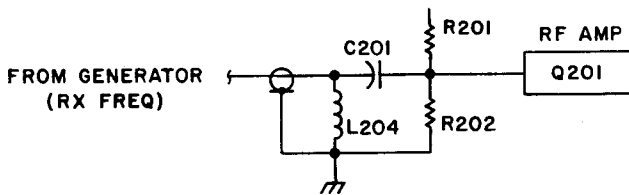
Connect the circuit shown below. C204 must be removed or the trace between C204 and L205 cut to do this test. If C204 is removed, a 4.7 pF coupling capacitor is required.



With the selected receive frequency (modulated with 1 kHz at  $\pm 3$  kHz deviation) injected at this point, 12 dB SINAD sensitivity should be .50-.80 microvolt.

5.5.6 RF AMPLIFIER (Q201), FILTER (T201-T203)

Connect the circuit shown below. C208 must be removed or the trace between C208 and L204 cut to do this test.

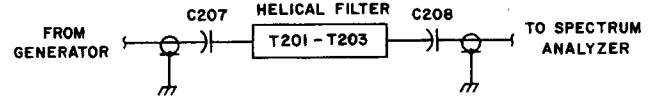


With the selected receive frequency (modulated with 1 kHz at  $\pm 3$  kHz deviation) injected at this point, 12 dB SINAD sensitivity should be .15-.20 microvolt.

5.5.7 T201-T203 FILTER RESPONSE

Connect the circuit shown below. C207 and C208 must be removed or the traces near C207 and between

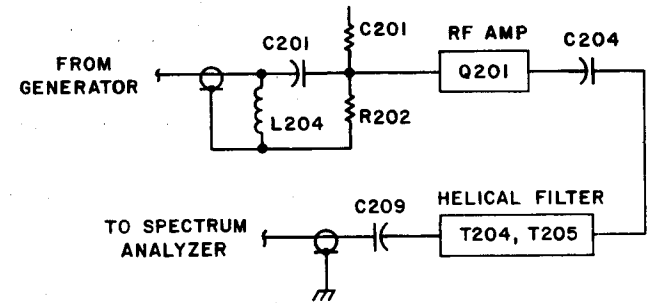
C208 and L204 cut to perform this test. If C207 and C208 are removed, coupling capacitors of the same value are required between the generator and analyzer.



With a frequency in the receive band injected at this point, insertion loss should be approximately 2.5 dB. Bandwidth (-3 dB) should be 12-13 MHz.

5.5.8 T204, T205 FILTER RESPONSE

Connect the circuit shown below. C208 and C209 must be removed or the traces cut between C208 and L204 and between C209 and pin 4 of U201. If C209 is removed, a coupling capacitor of the same value is required.



With a frequency in the receive band injected at this point, gain should be 13-14 dB. Bandwidth (-3 dB) should be 14 MHz.

5.6 TRANSMITTER SERVICING

5.6.1 GENERAL

To isolate a transmitter problem to a specific stage, check the DC and RF voltages shown on the schematic diagram. Also refer to the checks which follow in this section.

Typical supply voltages and transceiver current should be as follows in the transmit mode:

- Q106 C - 8 volts
- Q104 C - 0.3 volts
- Q103 E - 13.4 volts

Transceiver Current (15 W Power Out) - 3.5 A

**PTT SENSE (PIN 35)**

This input should be high when the push-to-talk switch is pressed and low when it is not pressed.

**PTT ENABLE (PIN 28)**

This output should be low when the transmitter is keyed except when the transmitter is disabled by the time-out timer or the Transmit Disable When Channel Is Busy feature.

**BALANCE SET INPUT (PIN 12)**

This pin should be grounded (TP402 connected to TP401) only when setting the modulation balance as described in Section 6.5.2.

**MICROPHONE HANGER INPUT (PIN 34)**

This input should be low when the microphone is on-hook and high when it is off-hook.

**FRONT PANEL OPTION SWITCHES (PINS 36-39)**

The appropriate input should be low when the switch is pressed and high when it is not pressed.

**WARNING TONE OUTPUT (PIN 14)**

A continuous 1 kHz tone should be produced on this pin when the time-out timer expires and a pulsing tone should be produced at times when a beep is sounded.

**LOCK DETECT INPUT (PIN 13)**

This input should be high except when the VCO is out-of-lock. It should then be a square-wave signal.

**TRANSMIT/RECEIVE CONTROL (PIN 24)**

This output should be high in the transmit mode and low in the receive mode.

**ADAPTIVE FILTER CONTROL (PIN 22)**

This output should go high for approximately 3 milliseconds whenever an out-of-lock pulse is detected on pin 13 such as when changing channels or changing between the transmit and receive modes.

**MODE CONTROL INPUT (PIN 32)**

This input should be high except when the RPI (remote programming interface) is plugged into the transceiver. It should then be low.

## SECTION 6

# ALIGNMENT PROCEDURE AND PERFORMANCE TESTS

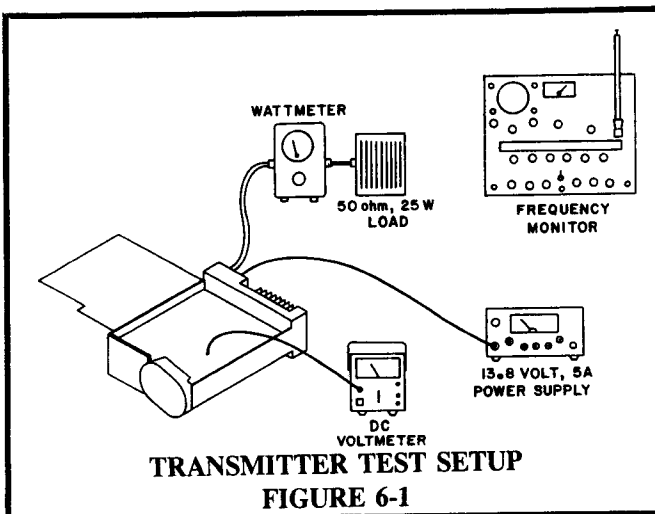
### 6.1 GENERAL

The transceiver alignment described in this section may be required if repairs are made that could affect the factory alignment or if channels are programmed that are outside the frequency bands tuned at the factory. Stocking transceivers are factory aligned for the frequency bands shown in Table 6-1. These transceivers also contain programming used for factory testing. This programming is shown in Table 6-2 and it may change without notice. Transceivers ordered with factory-programmed channels are factory aligned for the factory-programmed channels.

Even though transceivers are extensively tested at the factory before shipment, it is recommended that the performance checks described in Sections 6.6 and 6.7 be completed before placing the transceiver in service. These tests ensure that performance has not been affected by shipping.

**TABLE 6-1**  
**FACTORY PROGRAMMED FREQUENCY BANDS**

Mode	Low Freq	Center Freq	High Freq
Receive	459.100 MHz	463.100 MHz	467.100 MHz
Transmit	456.900 MHz	462.400 MHz	468.900 MHz



**TABLE 6-2**  
**FACTORY TEST CHANNEL PROGRAMMING**

Channel	Rx Freq	Tx Freq	Rx Call Guard	Tx Call Guard
1	458.100	454.900	021 (Tone)	021 (Tone)
2	459.750	457.500	033 (Tone)	033 (Tone)
3	461.250	460.100	365 (Digital)	365 (Digital)
4	463.100	462.400	None	None
5	463.200	462.500	None	None
6	464.750	465.100	None	None
7	466.250	467.500	None	None
8	468.100	469.900	None	None

Option Key 1 - Scan

Option Key 2 - Monitor

Time-Out Timer - 5 Minutes

Priority Channel - Channel 1

Key Beep - Enabled

Priority Channel Beep - Enabled

Scan Lockout Channels - None on any channel

Transmit Disable When Channel Is Busy - Disabled on all channels

*NOTE: An alignment point diagram is located in Figure 6-4.*

### 6.2 PRELIMINARY SETUP

- Refer to the test setup diagram in Figure 6-1. Connect a 13.8 volt DC power supply to power jack J102. Connect a 50 ohm load with a 15 watt or greater power rating to antenna jack J101.
- Program the transceiver with channel and option information (refer to Section 3.1). With multichannel transceivers, channels in the center of the transmit and receive frequency bands ( $\pm 200$  kHz) are required for alignment.
- Remove the five audio/logic board mounting screws, flip the board over, and hook it on the two pins located on the chassis. Adjust RF power control R103 for minimum power output (rotate index towards chassis). Make sure the two shields on the bottom of the main board are in place.

## PERFORMANCE TESTS

### 6.7 RECEIVER PERFORMANCE TESTS

#### 6.7.1 PRELIMINARY SETUP

- a. Connect the test setup shown in Figure 6-3. The 3.0 ohm load should be attached directly to the plug. Connect a distortion analyzer and a SINAD meter to the load.
- b. Connect a signal generator to the antenna jack.

#### CAUTION

*Do not transmit with the signal generator connected to the antenna jack because severe damage to the generator may result.*

#### 6.7.2 EIA SINAD SENSITIVITY

- a. Set the generator for the channel frequency, with an output level of 1000 microvolts modulated with 1 kHz at  $\pm 3$  kHz deviation.
- b. Adjust the volume control for 3.9 volts rms across the 3.0 ohm speaker load (5 watts).
- c. Decrease the generator output level to obtain a 12 dB reading on the SINAD meter. The generator output should be 0.30 microvolt maximum.
- d. With multichannel transceivers, also check SINAD on high and low frequency channels. The sensitivity should be 0.30 microvolt or better on all channels within a channel spread of 8 MHz.

#### 6.7.3 QUIETING SENSITIVITY

- a. Connect an AC voltmeter across the 3.0 ohm speaker load. With no signal generator output, adjust the volume control for a reference level of 2 volts rms.
- b. Set the signal generator output to the channel frequency and increase the unmodulated output to obtain a 20 dB decrease in the meter reading. The generator output should be 0.40 microvolt maximum.

#### 6.7.4 AUDIO OUTPUT

- a. Set the signal generator output for 60 dB higher than the 12 dB SINAD measured in Section 6.7.2. Set the generator modulation for 1 kHz at  $\pm 3$  kHz deviation.
- b. Audio power output should be 5 watts minimum. Distortion at 5 watts should be 5% or less.

#### 6.7.5 RECEIVE CALL GUARD

- a. Modulate the signal generator signal with the tone or digital Call Guard code programmed on the selected channel. Adjust the deviation for  $\pm 500$  Hz. Rotate the squelch control fully counterclockwise.
- b. Increase the generator output until the squelch opens. The generator output should be 0.25 microvolt or less.

### 6.8 TRANSMITTER PERFORMANCE TESTS

Connect the test setup shown in Figure 6-1.

#### 6.8.1 POWER OUTPUT

Key the transmitter and maximum power output should be 12.5-15.0 watts at 13.8 volts DC. Check all programmed channels. The power output should be within this range if the channel spread is 12 MHz or less. Output power should not be adjusted lower than 7.5 watts.

#### 6.8.2 TRANSMIT FREQUENCY

Key the transmitter and monitor the transmit frequency with a communications monitor. The frequency should be within  $\pm 5$  PPM (0.0005%).

#### 6.8.3 TRANSMITTER DEVIATION

- a. Key the transmitter and monitor the transmit signal with a communications monitor.
- b. If the selected channel is programmed for Call Guard, deviation without any microphone audio present should be  $\pm 600$  Hz  $\pm 100$  Hz. Then when speaking into the microphone with Call Guard present, peak deviation should be  $\pm 4.5$  kHz  $\pm 350$  Hz.
- c. Deviation when speaking into the microphone without Call Guard present should be  $\pm 4$  kHz  $\pm 350$  Hz.

## SECTION 7 PARTS LIST

SYMBOL NUMBER	DESCRIPTION	PART NUMBER	SYMBOL NUMBER	DESCRIPTION	PART NUMBER
<b>MAIN AND AUDIO/LOGIC BOARDS</b>					
C101	1000 pF $\pm 10\%$ 50V X7R cer chip	510-3606-102	C225	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C102	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C226	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C103	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C227	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103
C104	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C228	10 $\mu$ F 16V alum electrolytic	510-4216-100
C105	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C229	1000 $\mu$ F 16V alum electrolytic	510-4216-102
C107	47 $\mu$ F 25V alum electrolytic	510-4225-470	C230	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104
C108	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C231	1000 pF $\pm 10\%$ 50V X7R cer chip	510-3606-102
C109	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C232	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680
C110	47 $\mu$ F 25V alum electrolytic	510-4225-470	C233	6.8 $\mu$ F $\pm 20\%$ 35V tantalum	510-2245-689
C111	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C234	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104
C112	1000 pF $\pm 10\%$ 50V X7R cer chip	510-3606-102	C235	220 $\mu$ F 25V alum electrolytic	510-4225-221
C113	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C236	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103
C114	10 $\mu$ F 25V alum electrolytic	510-4125-100	C237	8.2 pF $\pm 5\%$ 50V NPO cer chip	510-3602-829
C115	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104	C238	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104
C116	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C239	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680
C117	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C240	4.7 pF $\pm 5\%$ 50V NPO sub cer	510-3113-479
C118	6.8 $\mu$ F $\pm 20\%$ 35V tant	510-2245-689	C241	150 pF $\pm 5\%$ 50V N750 cer disc	510-3220-151
C119	100 $\mu$ F 16V alum electrolytic	510-4216-101	C300	.0068 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-682
C120	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C301	.015 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-153
C121	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104	C302	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C122	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104	C303	.0068 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-682
C123	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C304	.0068 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-682
C124	1000 pF $\pm 10\%$ 50V X7R cer chip	510-3606-102	C305	.15 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-154
C125	100 pF $\pm 5\%$ 50V NPO cer chip	510-3602-101	C306	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C126	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C307	.01 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-103
C201	68 pF $\pm 5\%$ 50V NPO ceramic	510-3113-680	C308	.33 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-334
C202	10 $\mu$ F 16V alum electrolytic	510-4216-100	C309	1.0 $\mu$ F $\pm 20\%$ 35V tantalum	510-2245-109
C203	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C310	.018 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-183
C204	4.7 pF $\pm 5\%$ 50V NPO cer chip	510-3602-479	C311	.039 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-393
C205	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C312	.0018 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-182
C206	68 pF $\pm 5\%$ 50V NPO cer chip	510-3602-680	C313	.082 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-823
C207	6.8 pF $\pm 5\%$ 50V NPO cer chip	510-3602-689	C314	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C208	6.8 pF $\pm 5\%$ 50V NPO cer chip	510-3602-689	C315	.0027 $\pm 5\%$ 63V polyester	510-1033-272
C209	4.7 pF $\pm 5\%$ 50V NPO cer chip	510-3602-479	C316	1.0 $\mu$ F $\pm 20\%$ 35V tantalum	510-2245-109
C210	27 pF $\pm 5\%$ 50V NPO ax cer	510-3514-270	C318	.010 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-103
C212	27 pF $\pm 5\%$ 50V NPO cer chip	510-3602-270	C319	.010 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-103
C213	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C320	.010 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-103
C214	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C321	.0047 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-472
C215	39 pF $\pm 5\%$ 50V NPO cer chip	510-3602-390	C322	.1 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-104
C216	91 pF $\pm 5\%$ 50V NPO cer chip	510-3602-910	C323	.0027 $\pm 5\%$ 63V polyester	510-1033-272
C217	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C324	.0047 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-472
C218	.1 $\mu$ F $\pm 10\%$ 50V X7R ax cer	510-3554-104	C325	.001 $\mu$ F $\pm 5\%$ 63V polyester	510-1033-102
C220	.1 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3607-104	C326	47 $\mu$ F 25V alum electrolytic	510-4225-470
C221	.1 $\mu$ F $\pm 10\%$ 50V X7R ax cer	510-3554-104	C327	.1 $\mu$ F $\pm 10\%$ 50V X7R ax cer	510-3554-104
C222	.1 $\mu$ F $\pm 10\%$ 50V X7R ax cer	510-3554-104	C328	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103
C223	47 $\mu$ F 25V alum electrolytic	510-4225-470	C329	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103
C224	.01 $\mu$ F $\pm 10\%$ 50V X7R cer chip	510-3606-103	C330	.1 $\mu$ F $\pm 10\%$ 50V X7R ax cer	510-3554-104
			C331	220 $\mu$ F 25V alum electrolytic	510-4225-221
			C332	47 $\mu$ F 25V alum electrolytic	510-4225-470
			C333	10 $\mu$ F 25V alum electrolytic	510-4125-100
			C400	4700 pF $\pm 10\%$ 50V X7R cer chip	510-3606-472



**PARTS LIST (CONT.)**

<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>	<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>
C846	1.5 pF ±5% 50V NPO sub cer	510-3113-159	CR807	PIN diode	523-1504-013
	2.2 pF ±5% 50V NPO sub cer	510-3113-229	CR808	PIN diode	523-1504-013
	2.7 pF ±5% 50V NPO sub cer	510-3113-279	CR809	Varicap diode	523-1504-014
	3.3 pF ±5% 50V NPO sub cer	510-3113-339			
	3.9 pF ±5% 50V NPO sub cer	510-3113-399	DS400	Display, 7-seg .3" green	549-4002-020
	4.7 pF ±5% 50V NPO sub cer	510-3113-479			
	5.1 pF ±5% 50V NPO sub cer	510-3113-519	EP101	Bead, ferrite	517-2502-007
	5.6 pF ±5% 50V NPO sub cer	510-3113-569	EP102	Bead, ferrite	517-2502-007
	6.2 pF ±5% 50V NPO sub cer	510-3113-629	EP103	Bead, ferrite	517-2502-007
	6.8 pF ±5% 50V NPO sub cer	510-3113-689	EP201	Crystal pin insulator (Y801)	018-1080-001
	7.5 pF ±5% 50V NPO sub cer	510-3113-759	EP202	Crystal pin insulator (Z202)	018-1080-002
	8.2 pF ±5% 50V NPO sub cer	510-3113-829	EP400	LED block, 4-position	032-0791-017
	9.1 pF ±5% 50V NPO sub cer	510-3113-919	EP501	Bead, ferrite	517-2002-001
	10 pF ±5% 50V NPO sub cer	510-3113-100	EP502	Bead, ferrite	517-2002-002
	11 pF ±5% 50V NPO sub cer	510-3113-110	EP801	Vinyl crystal can cap (Y801)	574-6003-001
	12 pF ±5% 50V NPO sub cer	510-3113-120			
C847	3.5-15 pF variable	187-0109-005	F101	Fuse, 4 amp subminiature	534-0009-040
C848	4.7 pF ±5% 50V NPO sub cer	510-3113-479	F102	Fuse, 4 amp subminiature	534-0009-040
	10 pF ±5% 50V NPO sub cer	510-3113-100			
	15 pF ±5% 50V NPO sub cer	510-3113-150	HW003	Nut hex 5/8-24 (ant jack)	560-9078-028
C849	150 pF ±5% 50V NPO cer chip	510-3602-151	HW004	Lockwasher, 5/8 (ant jack)	596-9119-028
C850	150 pF ±5% 50V N750 cer	510-3120-151	HW008	Hole plug, 1/2"	537-9001-011
C851	1000 pF ±10% 50V X7R cer chip	510-3606-102	HW010	Rubber boot (prog jack)	032-0791-027
			HW101	Socket (for F401, F402)	515-5006-002
C852	68 pF ±5% 50V NPO cer chip	510-3602-680	HW200	Helical nut, tension lock	560-1804-008
C853	68 pF ±5% 50V NPO cer chip	510-3602-680	HW201	Helical screw, 4-40	575-1604-014
C854	.01 μF ±10% 50V X7R cer chip	510-3606-103	HW210	Coil retainer (helical)	013-1436-001
C855	1000 pF ±10% 50V X7R cer chip	510-3606-102			
			J101	Antenna connector assembly	023-6005-003
C856	1-3 pF variable	186-0603-005	J102	Power connector assembly includes:	023-4110-001
C857	1-3 pF variable	186-0603-005		Power connector contact	515-9033-006
				Power connector, dual	515-9033-012
CR101	Switching diode	523-1504-002	J103	Modular phone jack 6 pos	515-2006-010
CR102	8.2V ±5% 1W zen	523-2503-829	J105	3.6 mm mini phone jack	515-2001-011
CR103	Switching diode	523-1504-002	J403	Connector, 18-pin female	515-5012-018
CR104	Switching diode	523-1504-002			
CR105	Switching diode	523-1504-002			
CR201	Switching diode	523-1504-002			
CR300	UHF/VHF band sw diode	523-1504-012	K101	Relay, 6V SPDT	567-0022-002
CR301	UHF/VHF band sw diode	523-1504-012			
CR302	Hot carrier diode	523-1500-018	L204	4.5T coil 22 AWG	542-0010-045
CR303	Hot carrier diode	523-1500-018	L205	4.5T coil 22 AWG	542-0010-045
CR304	1N4148 silicon diode	523-1500-883	L209	2.4 μH variable inductor	542-1012-006
CR400	LED, red	549-4001-080	L212	2.4 μH variable inductor	542-1012-006
CR401	LED, green	549-4001-081	L501	8.5T coil 26 AWG	542-0001-085
CR402	LED, green	549-4001-081	L502	.056 μH RF choke	542-3006-001
CR403	LED, yellow	549-4001-082	L504	2T ferrite choke	517-2005-004
CR405	4.3 volt 1W zener	523-2503-439	L505	.056 μH RF choke	542-3006-001
CR802	Varicap diode	523-1504-015	L506	1.5T 18 AWG coil	016-1977-018
CR804	Varicap diode	523-1504-015	L507	1.5T 18 AWG coil	016-1977-018
CR805	PIN diode	523-1504-013	L508	1.5T 18 AWG coil	016-1977-018
CR806	3.3V ±5% 1W zener	523-2503-339	L801	1.0 μH RF choke	542-3508-109

**PARTS LIST (CONT.)**

<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>	<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>
R219	On/off/vol/sq pot	562-0018-051	R345	620 ohm $\pm 5\%$ 1/8W chip	569-0115-621
R220	470 ohm $\pm 5\%$ 1/8W chip	569-0115-471	R346	3k ohm $\pm 5\%$ 1/8W chip	569-0115-302
R221	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103	R347	2k ohm $\pm 5\%$ 1/8W chip	569-0115-202
R222	470k ohm $\pm 5\%$ 1/4W CF	569-0513-474	R348	390 ohm $\pm 5\%$ 1/8W chip	569-0115-391
R223	470 ohm $\pm 5\%$ 1/8W chip	569-0115-471	R349	3.3k ohm $\pm 5\%$ 1/8W chip	569-0115-332
R224	10 ohm $\pm 5\%$ 1/8W chip	569-0115-100	R352	15k ohm $\pm 5\%$ 1/8W chip	569-0115-153
R225	1 ohm $\pm 5\%$ 1/8W chip	569-0115-109	R400	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R300	36k ohm $\pm 5\%$ 1/8W chip	569-0115-363	R401	47k ohm $\pm 5\%$ 1/8W chip	569-0115-473
R301	36k ohm $\pm 5\%$ 1/8W chip	569-0115-363	R402	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R302	560k ohm $\pm 5\%$ 1/8W chip	569-0115-564	R403	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R303	180k ohm $\pm 5\%$ 1/8W chip	569-0115-184	R404	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R304	27k ohm $\pm 5\%$ 1/8W chip	569-0115-273	R405	2.2k ohm $\pm 5\%$ 1/8W chip	569-0115-222
R305	3.6k ohm $\pm 5\%$ 1/8W chip	569-0115-362	R406	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R306	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104	R407	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R307	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103	R408	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R308	470k ohm $\pm 5\%$ 1/8W chip	569-0115-474	R409	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104
R309	68k ohm $\pm 5\%$ 1/8W chip	569-0115-683	R410	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R310	270k ohm $\pm 5\%$ 1/8W chip	569-0115-274	R411	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R311	82k ohm $\pm 5\%$ 1/8W chip	569-0115-823	R412	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R312	330k ohm $\pm 5\%$ 1/8W chip	569-0115-334	R413	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R313	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104	R414	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R314	470k ohm $\pm 5\%$ 1/8W chip	569-0115-474	R415	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R315	22k ohm $\pm 5\%$ 1/8W chip	569-0115-223	R416	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R316	390k ohm $\pm 5\%$ 1/8W chip	569-0115-394	R417	300 ohm $\pm 5\%$ 1/8W chip	569-0115-301
R317	130k ohm $\pm 5\%$ 1/8W chip	569-0115-134	R418	390 ohm $\pm 5\%$ 1/8W chip	569-0115-391
R318	33k ohm $\pm 5\%$ 1/8W chip	569-0115-333	R419	390 ohm $\pm 5\%$ 1/8W chip	569-0115-391
R319	18k ohm $\pm 5\%$ 1/8W chip	569-0115-183	R420	390 ohm $\pm 5\%$ 1/8W chip	569-0115-391
R320	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103	R421	390 ohm $\pm 5\%$ 1/8W chip	569-0115-391
R321	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103	R422	56k ohm $\pm 5\%$ 1/8W chip	569-0115-563
R322	127k ohm $\pm 1\%$ 1/8W MF	569-0520-511	R423	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R323	127k ohm $\pm 1\%$ 1/8W MF	569-0520-511	R424	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104
R324	121k ohm $\pm 1\%$ 1/8W MF	569-0520-509	R425	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R325	82.5k ohm $\pm 1\%$ 1/8W MF	569-0520-489	R426	56k ohm $\pm 5\%$ 1/8W chip	569-0115-563
R326	82.5k ohm $\pm 1\%$ 1/8W MF	569-0520-489	R428	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R327	1.0M ohm $\pm 5\%$ 1/8W chip	569-0115-105	R429	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R328	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104	R430	36k ohm $\pm 5\%$ 1/8W chip	569-0115-363
R329	68k ohm $\pm 5\%$ 1/8W chip	569-0115-683	R431	100k ohm $\pm 5\%$ 1/8W chip	569-0115-104
R330	200k ohm pot	562-0115-204	R432	3.9k ohm $\pm 5\%$ 1/8W chip	569-0115-392
R331	220k ohm $\pm 5\%$ 1/8W chip	569-0115-224	R433	56k ohm $\pm 5\%$ 1/8W chip	569-0115-563
R332	20k ohm $\pm 5\%$ 1/8W chip	569-0115-203	R434	8.2k ohm $\pm 5\%$ 1/8W chip	569-0115-822
R333	130k ohm $\pm 5\%$ 1/8W chip	569-0115-134	R435	56k ohm $\pm 5\%$ 1/8W chip	569-0115-563
R334	3.3k ohm $\pm 5\%$ 1/8W chip	569-0115-332	R436	8.2k ohm $\pm 5\%$ 1/8W chip	569-0115-822
R335	470k ohm $\pm 5\%$ 1/8W chip	569-0115-474	R437	2.2k ohm $\pm 5\%$ 1/8W chip	569-0115-222
R336	15k ohm $\pm 5\%$ 1/8W chip	569-0115-153	R438	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R337	200k ohm pot	562-0115-204	R439	220 ohm $\pm 5\%$ 1/8W chip	569-0115-221
R338	68k ohm $\pm 5\%$ 1/8W chip	569-0115-683	R440	220 ohm $\pm 5\%$ 1/8W chip	569-0115-221
R339	27k ohm $\pm 5\%$ 1/8W chip	569-0115-273	R441	10k ohm $\pm 5\%$ 1/8W chip	569-0115-103
R340	27k ohm $\pm 5\%$ 1/8W chip	569-0115-273	R501	3.3k ohm $\pm 5\%$ 1/8W chip	569-0115-332
R341	27k ohm $\pm 5\%$ 1/8W chip	569-0115-273	R502	1k ohm $\pm 5\%$ 1/8W chip	569-0115-102
R342	1.2k ohm $\pm 5\%$ 1/8W chip	569-0115-122	R503	1k ohm $\pm 5\%$ 1/8W chip	569-0115-102
R343	1k ohm $\pm 5\%$ 1/8W chip	569-0115-102	R504	10 ohm $\pm 5\%$ 1/8W chip	569-0115-100
R344	620 ohm $\pm 5\%$ 1/8W chip	569-0115-621	R505	33 ohm $\pm 5\%$ 1/8W chip	569-0115-330
			R506	750 ohm $\pm 5\%$ 1/8W chip	569-0115-751

**PARTS LIST (CONT.)**

<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>	<b>SYMBOL NUMBER</b>	<b>DESCRIPTION</b>	<b>PART NUMBER</b>
<b>HARDWARE AND CABLE KIT</b>					
<b>Part No. 023-7171-918</b>					
A002	DC power cable assembly	023-4143-002	CR001	1N4448 Si diode	523-1500-883
A003	Mic clip ground wire	023-7171-911	HW101	Chassis	014-0777-020
HW001	Screw, 4-28 Phil sheet met	575-3604-008	HW112	Polarizing key	515-7109-010
HW002	Screw, 4-20 Phil	575-5604-020	J101	Connector, 25-pin	515-0506-010
HW003	Screw, 10-24 x 5/8 hex hd	575-8911-020	J102	Connector, 10-pin	515-7104-005
HW004	Self-drilling screw	575-9077-565	J103	2-pin header	515-7100-002
MP001	HD mic clip	023-3514-001	J104	2-pin header	515-7100-002
<b>DC POWER CABLE ASSEMBLY</b>			MP102	End plate (J102)	017-2206-010
<b>Part No. 023-4143-002</b>			MP103	End plate (J101)	017-2206-015
EP003	Contact 14-16 AWG	534-1004-037	MP107	Spacer, 4-40 hex male/fem	013-1160-103
EP101	Ring terminal 12-10 AWG	586-0007-010	P103	Shorting socket	515-5010-001
EP103	Power connector contact	515-9033-006	P104	Shorting socket	515-5010-001
F101	Fuse 7A 32V FB AGC	534-0003-043	PC100	RPI PC board	035-5800-001
MP001	Fuseholder body	534-1004-031	U001	Line receiver (quad) 1489	544-2023-006
MP002	Fuseholder knob	534-1004-032	U002	Line driver (quad) 1488	544-2023-007
MP003	Fuseholder spring	534-1004-035	U003	Voltage converter 7660	544-2019-060
P101	Power connector, dual	515-9033-012	U004	Regulator 5V 100 mA 78L05	544-2003-039
W101	Wire 12 AWG blue	597-7021-206	U005	Regulator 9V 100 mA 78L09	544-2003-014
W102	Wire 12 AWG red	597-7021-202	<b>15 WATT SPEAKER (BLACK)</b>		
<b>REMOTE PROGRAMMING INTERFACE</b>			<b>Part No. 250-0151-005</b>		
<b>Part No. 023-5800-000</b>			A001	Strain relief (near spkr plug)	023-3784-010
A001	Interface cable (RPI to xcvr)	023-5800-011	HW000	Screw, self-drilling	575-9077-543
C001	10 $\mu$ F 25V alum electrolytic	510-4325-100	HW001	Strain relief (in case back)	574-0003-008
C002	10 $\mu$ F 25V alum electrolytic	510-4325-100	HW003	Screw, 4-20 Philips	575-5604-016
C003	.1 $\mu$ F $\pm$ 20% 25V Z5U ax cer	510-3546-104	HW005	Foam gasket	018-1126-001
C004	10 $\mu$ F 25V alum electrolytic	510-4325-100	HW006	Retaining washer	596-9210-012
C005	.1 $\mu$ F $\pm$ 20% 25V Z5U ax cer	510-3546-104	LS001	5" 15W 3.2 ohm speaker	589-1016-001
C006	10 $\mu$ F 25V alum electrolytic	510-4325-100	MP000	Mounting bracket (black)	032-0760-004
C007	.1 $\mu$ F $\pm$ 20% 25V Z5U ax cer	510-3546-104	MP000	Tri knob 10-32 x 3/4	547-0016-004
C008	470 $\mu$ F 16V alum electrolytic	510-4316-471	MP001	Case front (black)	032-0758-004
			MP002	Case back (black)	032-0759-004
			NP	Overlay, speaker front	559-0072-001
			P001	Miniature phone plug	515-0020-003
			W001	Cable, 2-cond 18 AWG	597-2006-001

# SECTION 8

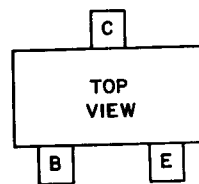
## SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

### TRANSISTORS

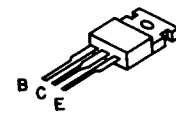
(Bottom View Unless Otherwise Specified)

TRANSISTOR BASING DIAGRAM REFERENCE TABLE	
Transistor Part Number	Basing Diagram
576-0001-300	1
576-0002-021	2
576-0003-063	3
576-0003-600	1
576-0003-605	1
576-0003-628	1
576-0003-634	1
576-0003-650	1
576-0003-657	1
576-0003-658	1
576-0003-659	1
576-0004-086	4
576-0004-092	5
576-0006-019	6

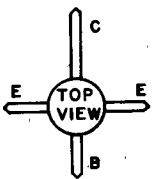
└─┬─┘  
Number on Schematic



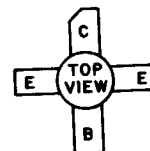
1



2



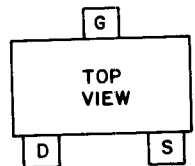
3



4



5

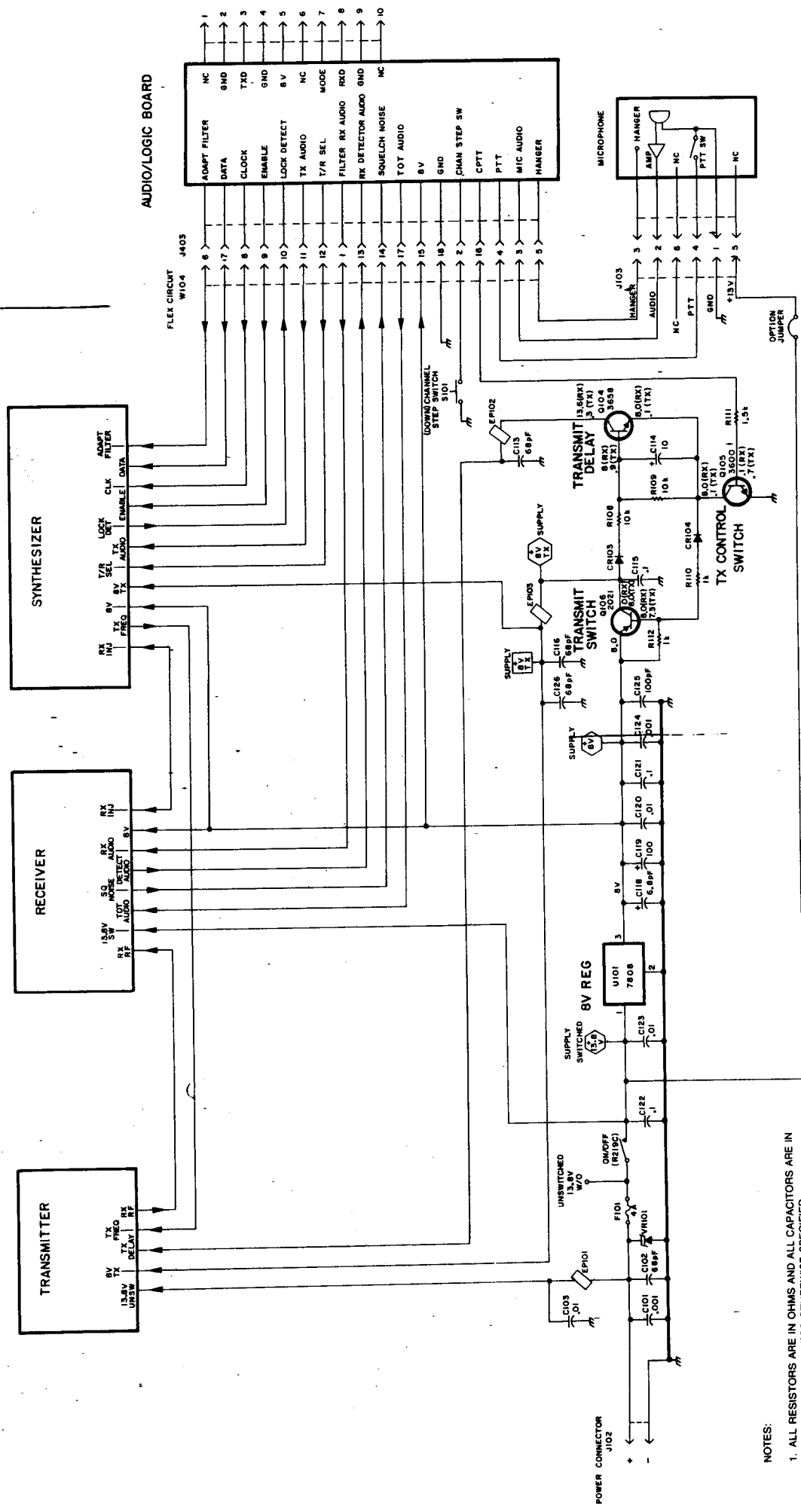


6

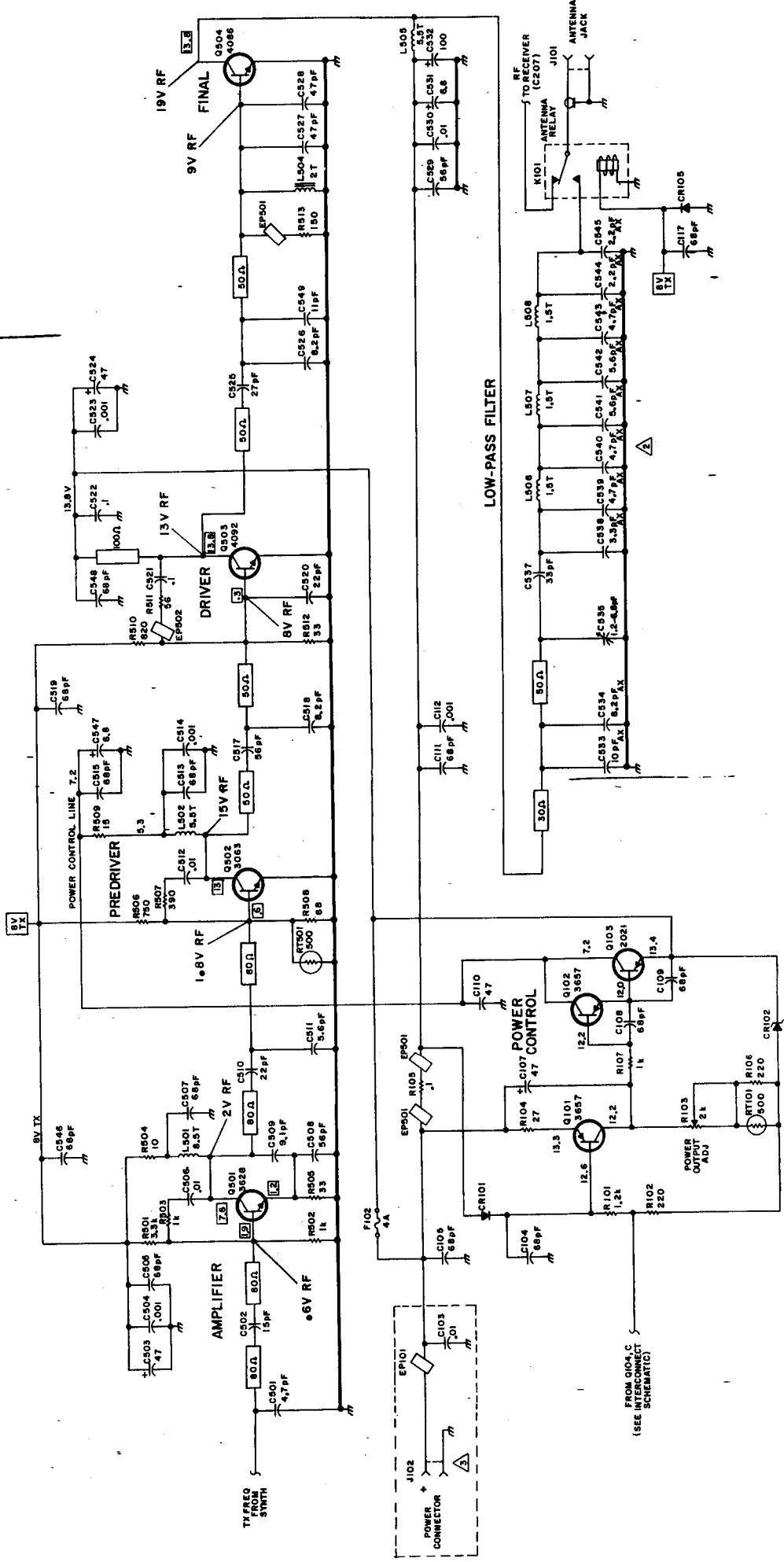
### INTEGRATED CIRCUITS



Typical Integrated Circuit Pin Numbering

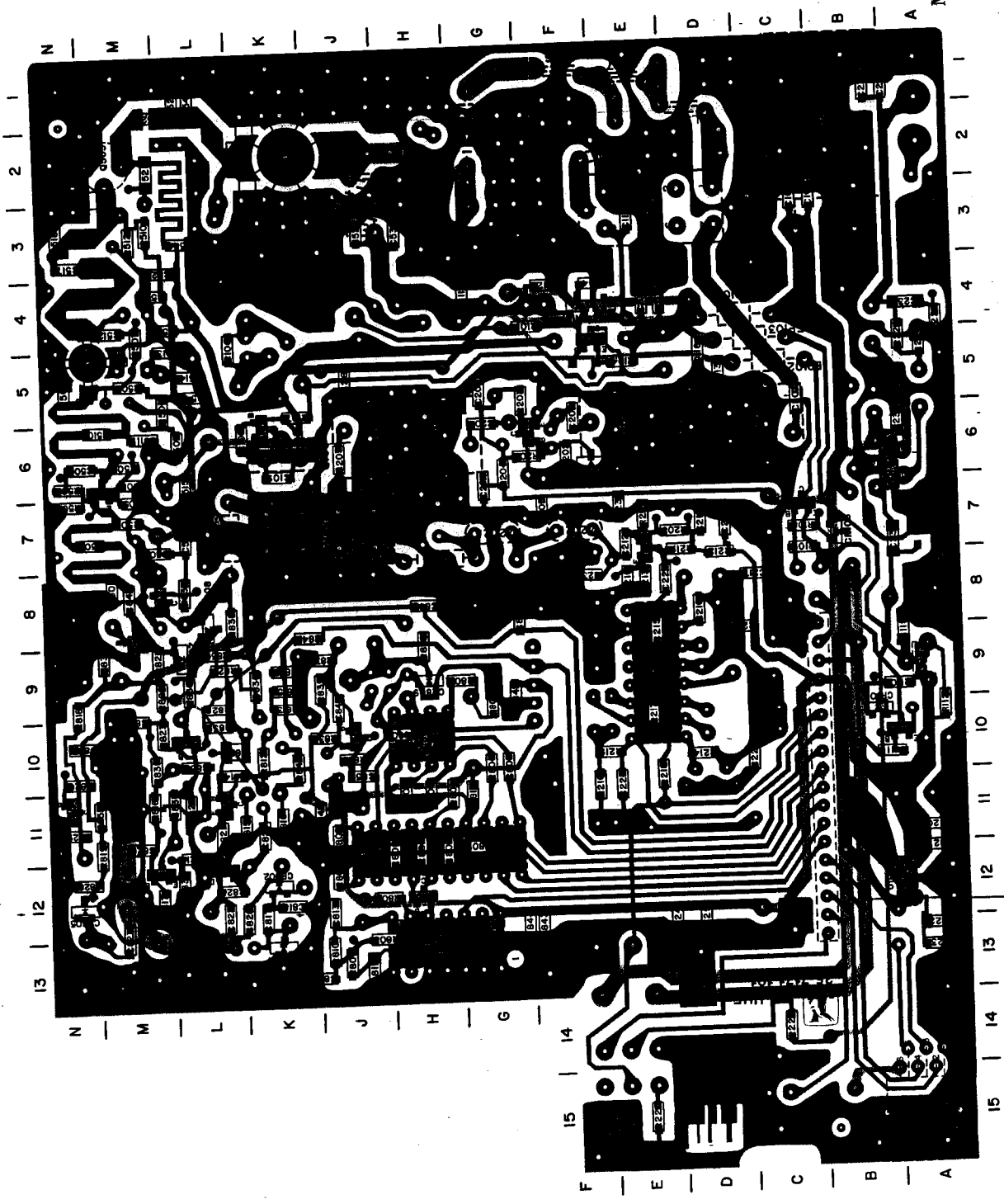


- NOTES:
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

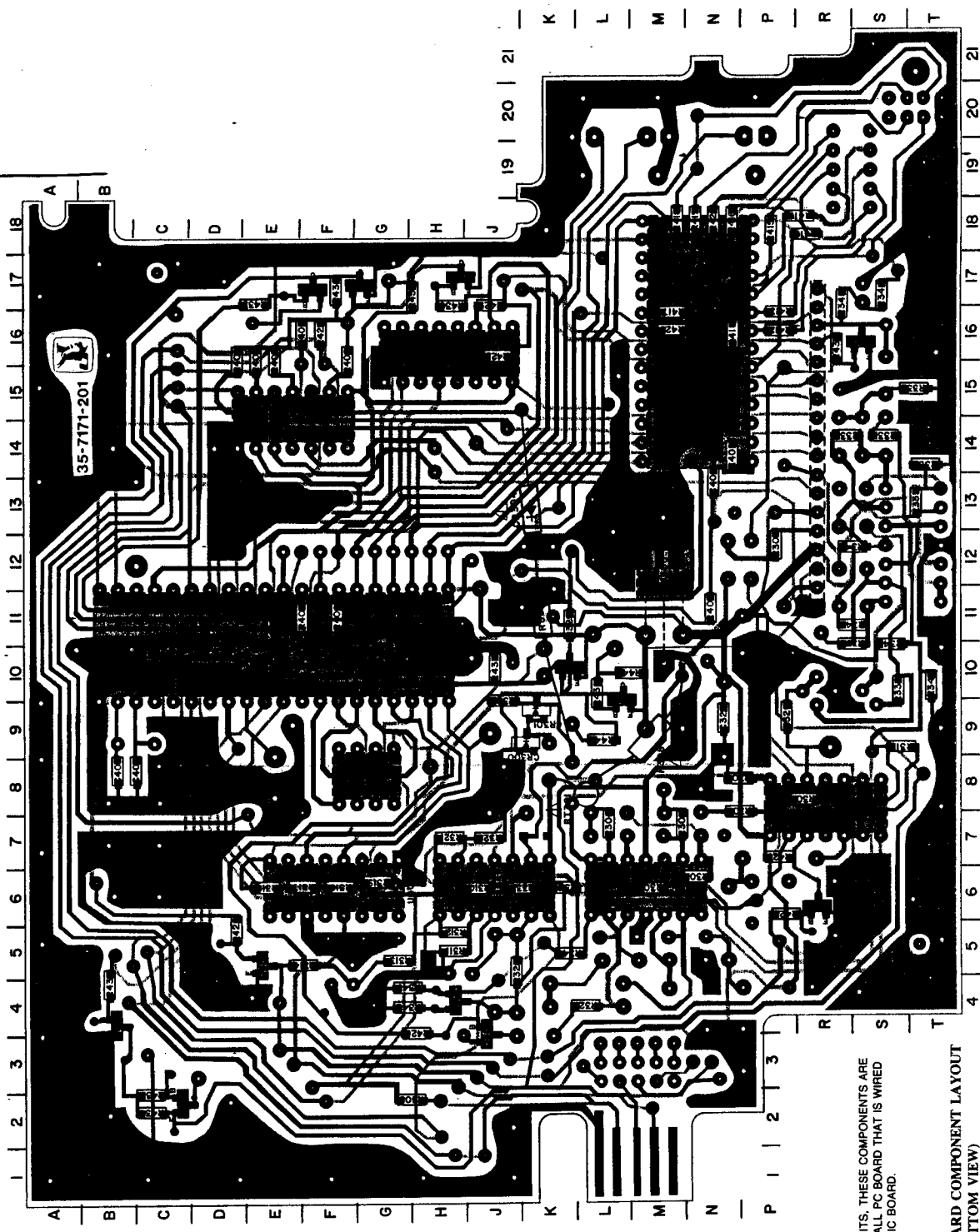


TRANSMITTER SCHEMATIC

- NOTES:
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
  2. "AX" DESIGNATES AXIAL-LEADED COMPONENTS LOCATED ON TOP OF PC BOARD.
  3. △ SHOWN FOR REFERENCE ONLY (REFER TO INTERCONNECT SCHEMATIC).
  4. □ INDICATES DC VOLTAGE WITH NO RF PRESENT (C501 SHORTED); OTHER DC VOLTAGES MEASURED WITH 15 WATT POWER OUTPUT.



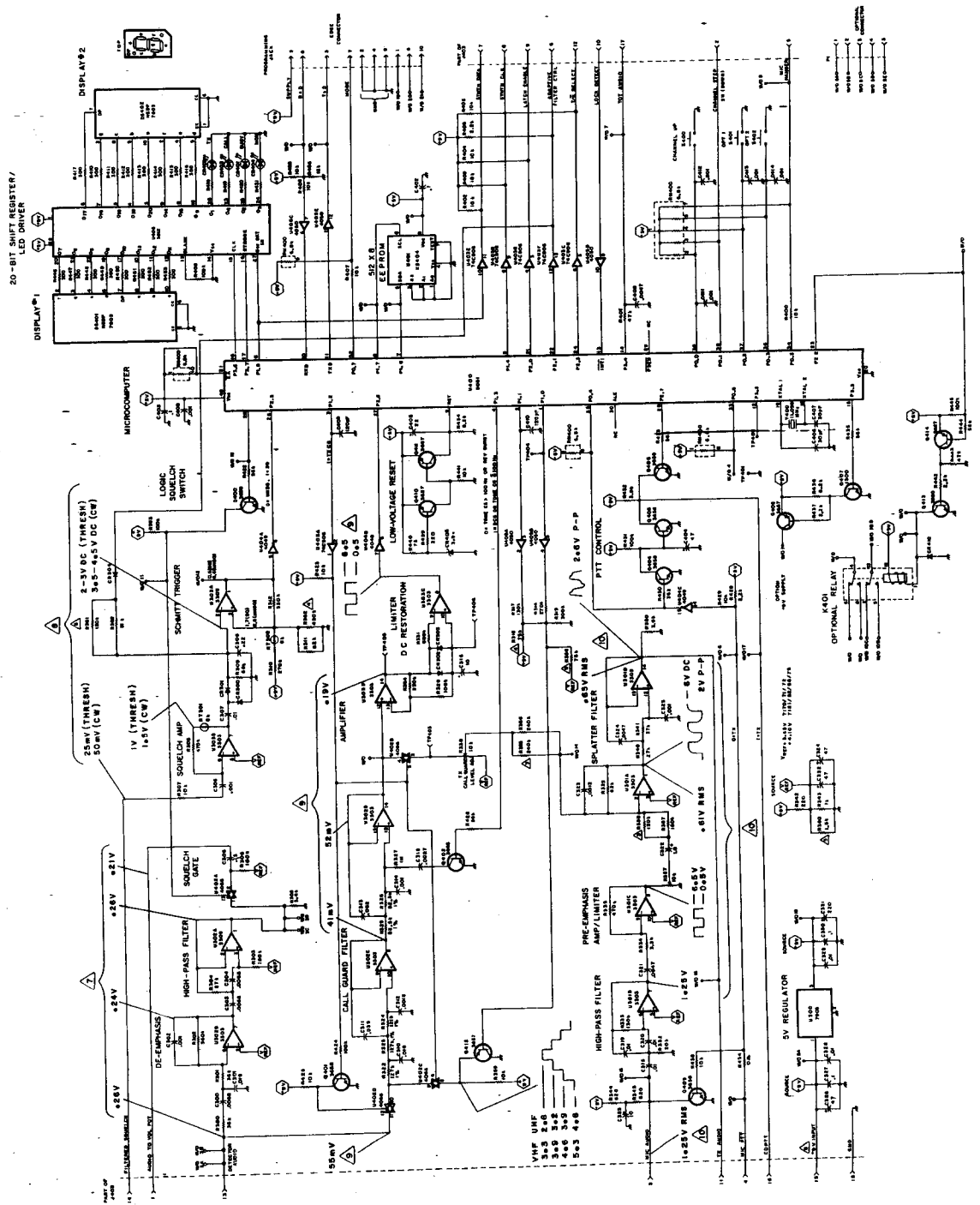
MAIN BOARD COMPONENT  
LAYOUT, BOTTOM VIEW  
(Top View on Next Page)



△ IN SOME LATER UNITS, THESE COMPONENTS ARE LOCATED ON A SMALL PC BOARD THAT IS WIRED TO THE AUDIOLOGIC BOARD.

AUDIO/LOGIC BOARD COMPONENT LAYOUT (BOTTOM VIEW)





NOTES:

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

IC	+5V	GND
U301	4	11
U302	4	11
U303	4	11
U304	14	7
U305	14	7
U306	1	8, 3, 9, 11
U307	1	8, 14

- △ VIN = 715/152  
OUT = 71707/172
- △ VIN = 715/152  
OUT = 71707/172
- △ VIN = 71707/172  
OUT = 715/152
- △ BV = 715/152  
BV = 71707/172

- △ RECEIVE AUDIO RMS VOLTAGES MEASURED WITH 1 MILIVOLT INPUT SIGNAL MODULATED WITH 1 KHZ AT 3 HZ DEVIATION.
- △ SQUELCH NOISE VOLTAGES ARE RMS UNLESS OTHERWISE SPECIFIED AND ARE MEASURED WITH NO SIGNAL INPUT.
- △ CALL GUARD RMS VOLTAGES MEASURED WITH 1 MILIVOLT INPUT SIGNAL MODULATED WITH 100 KHZ AT 600 HZ DEVIATION.
- △ TRANSMIT AUDIO VOLTAGES MEASURED WITH 1 KHZ, 1.25 V RMS SIGNAL INJECTED AT PIN 2 OF MICROPHONE JACK J10.

## 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
L504	L3	T	R103	K5	T	R505	M7	B	R830	L9	B
L505	J3	T	R104	E5	B	R506	M5	B	R831	L8	B
L506	F1	T	R105	E4	T	R507	M4	B	R832	M8	T
L507	E1	T	R106	L5	B	R508	N5	B	R833	L8	B
L508	D1	T	R107	K5	B	R509	M6	T	R834	H9	B
L801	J12	T	R108	C7	B	R510	M3	B	R835	J9	B
L803	K11	T	R109	C7	B	R511	M3	T	R836	J10	B
L804	K11	T	R110	A9	B	R512	M3	B	R837	J9	B
L806	L12	T	R111	B10	B	R513	L1	T	R838	J10	B
L807	K11	T	R112	A10	B	R801	H11	B	R839	M10	B
L808	N12	T	R201	F6	B	R802	J11	B	R840	K10	B
L809	M11	T	R202	F6	B	R803	J12	B	R841	K8	B
L810	L10	T	R203	G5	B	R804	G10	B	RT101	K4	T
Q101	F5	B	R204	G6	B	R805	H11	B	RT501	M5	T
Q102	K6	B	R208	E7	B	R806	G9	B	RT801	H10	T
Q103	K6	T	R209	E7	B	R807	J12	B	S101	C15	T
Q104	C7	B	R210	E8	B	R808	J13	B	T201	C6	T
Q105	A10	B	R211	D7	B	R809	J13	B	T202	D6	T
Q106	A9	T	R212	D7	B	R810	J13	B	T203	E6	T
Q201	F6	B	R213	D8	B	R811	K10	T	T204	H6	T
Q203	E7	B	R214	D10	B	R812	K10	B	T205	J6	T
Q501	M6	B	R215	E10	B	R813	K9	B	T213	D11	T
Q502	M5	B	R216	F11	B	R814	L10	B	U101	A12	T
Q503	M2	T	R217	E10	B	R815	K11	B	U201	J7	T
Q504	K2	B	R218	E10	B	R816	M11	B	U202	E9	T
Q801	H12	B	R219	E14	T	R817	M12	B	U203	A6	T
Q802	L11	B	R220	E15	B	R818	N9	B	U801	H11	T
Q803	L12	B	R221	C14	B	R819	M11	B	U802	H10	T
Q804	N11	B	R222	B8	T	R820	N10	B	U803	H13	T
Q805	M12	B	R223	A5	B	R821	L11	B	VR101	B6	T
Q806	L10	B	R224	A5	B	R822	M9	B	W104	C10	T
Q807	M8	B	R225	A4	B	R823	M10	B	Y201	D8	T
Q808	M9	B	R501	M7	B	R824	L11	B	Y801	J9	T
Q809	J10	B	R502	N7	B	R825	L9	B	Z202	F7/G7	T
R101	F4	B	R503	N6	B	R826	L9	B	Z203	D9	T
R102	K4	T	R504	M5	B	R829	M9	B			

# CHALLENGER® 71xx SERVICE MANUAL ADDENDUM

## SECTION 1 GENERAL INFORMATION

COMMUNICATIONS  
ELECTRONICS

### 1.1 SCOPE OF ADDENDUM

This is an addendum to the current service manuals for Challenger® 7151, 7152, 7170/7171, and 7172 transceivers. It contains information on the enhanced audio/logic board that will become standard in these transceivers beginning in 1988. This enhanced board replaces the two different audio/logic boards currently being used in these transceivers.

Included in this addendum is operating information and also information needed to service this board, such as a parts list, schematic diagram, and component layout. If more copies of this addendum are needed, order Part No. 001-7175-100 from the Service Parts Department.

### 1.2 ENHANCED BOARD DESCRIPTION

#### 1.2.1 IDENTIFYING ENHANCED BOARD

Transceivers with the new audio/logic board can be distinguished from models with the earlier board by noting the type of channel display and the arrangement of the indicator LEDs. The enhanced version has a two-digit channel display and the indicator LEDs arranged vertically, while the earlier version has a one-digit display and the LEDs arranged in a square-shaped pattern. In addition, for a time, there will be a bright orange sticker on the shipping boxes which says "NEW, IMPROVED".

A revision letter change will also be made to the transceiver when this board is used. The revision letter is located after the model number on the warranty number sticker attached to all transceivers. The revision letter changes as follows:

Transceiver	New Revision Letter
7151, 7152, 7170, 7172	B
7171	C

#### 1.2.2 NEW FEATURES

The main change is to the software which is the program that controls the operation of the transceiver. There is also an entirely new board layout including several part changes. All the features currently available with Challenger Plus 7152/7172 transceivers are available with the enhanced board plus there are several new ones. The following are the new features provided by this board:

- Up to 20 channels standard and up to 99 channels available with optional 99-channel board.
- 2-digit channel display to directly display all channels.
- The status of all option switches as well as the channel display is now stored in nonvolatile memory so that it is not necessary to reset switches when power is turned back on.
- The scan rate when no carrier is detected has been increased from 19 to 43 channels per second.
- The interruption of the audio signal when the priority channel is scanned has been decreased from 60+ milliseconds to 45 milliseconds (if Call Guard® squelch is not detected).
- When an option switch is programmed for the Call function, it now only turns the Call indicator off. Previously, it was used to disable the Call function so that the Call indicator would not light at all. The Call indicator is functional even if this switch is not programmed.

#### 1.2.3 NEW PROGRAMMABLE FEATURES

The following are new dealer-programmable functions:

- Scan delay after receiving a message is programmable in steps from 0 to 4 seconds (refer to Section 2.8.2).

## SECTION 2 TRANSCEIVER OPERATION

### COMMUNICATIONS ELECTRONICS

#### 2.1 CHANNEL PROGRAMMING AND SELECTION

##### 2.1.1 CHANNEL PROGRAMMING

In the standard configuration, up to 20 channels can be programmed. If the optional 99-channel board is installed, up to 99 channels can be programmed. The optional board contains two additional EEPROMs.

As with the early audio/logic board, each channel can be programmed for different transmit and receive frequencies. A channel can also be programmed as receive-only (to monitor a weather channel, for example). Since the RF sections on the main board of the transceivers are basically unchanged, the transmit and receive bandwidths and channel spacing specifications remain the same.

##### 2.1.2 CHANNEL SELECTION

When the transceiver is turned on, the microprocessor retrieves information from memory on the last channel selected. It then loads and displays that channel. When a channel select switch is pressed, the next higher or lower programmed channel is displayed. After the highest programmed channel is displayed, the display "rolls over" to the lowest programmed channel and vice versa.

If the channel select switch is held down for 1 second or longer, channel scrolling begins. It begins at a rate of three channels per second and after ten channels have been displayed, the rate increases to 30 channels per second. Channels can be changed only in the receive mode.

Channels can also be changed when the scan mode is selected (refer to Section 2.8.3). When a channel switch is pressed once, scanning halts and the selected channel is displayed along with priority and lockout information (refer to Section 2.9.2). If a channel switch is pressed again within 2 seconds, the selected channel changes. Scanning resumes 2 seconds after the channel is changed.

#### 2.2 FRONT PANEL OPTION SWITCHES

There are front panel option switches that can be dealer-programmed for the following functions. Since there are only two switches, any two of these functions can be programmed. These switches may also be disabled if desired. The Call indicator, Monitor, and Channel Lockout functions are available without a switch, but a switch enhances the operation of these functions.

**Scan Enable/Disable** - This switch turns scanning on and off. It must be programmed to have the scan feature.

**Channel Lockout** - This switch allows the user to lock channels out of the scan sequence and also unlock channels locked out by dealer programming. The Scan switch must have been programmed in order to program this switch. Refer to Section 2.8.5 for more information.

**Call Indicator Reset** - This switch is used to turn the Call indicator off. It performs the same function as taking the microphone off-hook. The Call indicator is functional even if this switch is not programmed. Refer to Section 2.3.2 for more information.

**Monitor** - This switch is used to disable Call Guard squelch so that the channel can be monitored before transmitting. It performs the same function as taking the microphone off-hook. Refer to Section 2.3.1 for more information.

**Auxiliary** - Allows a front-panel switch to control power to an external option such as a DTMF decoder or horn alert. The auxiliary power output is wireout 1 (Q408 collector) on the audio/logic board. When auxiliary power is switched on by this switch, "Au" is flashed in the display and an 8 volt supply appears at the auxiliary power output. When auxiliary power is switched off by this switch, "Au" is not flashed and the auxiliary power output goes to a high-impedance state. Power at the auxiliary power output is automatically cycled when EXT+/EXT- is programmed. Refer to Section 2.4.2 for more information.

EXT+/EXT- is programmed, power at this output cycles (turns off and then on again) and resets the decoder whenever the microphone is placed on-hook or transceiver power is turned on. This operation also occurs when the Auxiliary option switch is programmed along with EXT+/EXT-. However, power must be switched on by this switch (refer to Section 2.2).

### Transceiver Squelch Control

The decoder detect line can be connected to the EXT +/- input of the microprocessor which is the P0.6 pin (wireout 4). The transceiver can then be programmed to unsquelch when this input goes high (EXT +) or low (EXT -). The transceiver remains in the unsquelched condition until the Auxiliary switch is pressed or the microphone is placed back on-hook (even if the EXT +/- input changes states or carrier is no longer detected).

### Scanning with an External Decoder

A scan delay can be programmed so that scanning can be used with decoders which have a relatively long detect time. This delay can be programmed in steps from 0-60 seconds. If a carrier is detected on a channel, scanning halts and the status of the EXT +/- input is not checked for the length of the delay period.

If priority channels are desired, only a first priority channel or a second priority channel without Call Guard squelch should be programmed. The decoder should then be used only on that channel. If not, and the priority channel is scanned while the external decoder is in the process of detecting a code on another channel, the code may not be properly detected. If a second priority channel is scanned for Call Guard squelch, the external decoder is detected on that channel if EXT +/- is programmed. An interruption of a nonpriority signal will occur that is as long as the programmed scan delay (0-60 seconds).

## 2.5 TIME-OUT TIMER

The time-out timer can be used to prevent possible transmitter damage caused by keying the transmitter for an extended period of time. It can also be used to prevent a blocked channel caused by an accidentally keyed transmitter. If the transmitter is keyed continuously for longer than the programmed time, the transmitter is disabled, the display flashes, and an alternating tone (800 Hz/1 kHz) sounds. The timer is reset by releasing the push-to-talk switch. It can be programmed in steps from 0.5 to 5 minutes. It cannot be disabled entirely.

## 2.6 TRANSMIT DISABLE ON BUSY

This feature automatically disables the transmitter if a carrier is detected on the displayed channel. Some, none, or all channels can be programmed with this feature. There is also an option with this feature to allow transmission with a carrier present if the receive. Call Guard tone or digital code programmed on the displayed channel is detected. This may allow the Transmit Disable On Busy feature to be used with a repeater system that has delayed dropout. This delayed dropout would otherwise prevent users with the Transmit Disable On Busy feature from answering each other until the repeater transmitter turned off.

If the transmitter is disabled by this feature, the display flashes and a beeping tone is heard. The Busy indicator may also be lighted in the receive mode. The push-to-talk switch must be released and then pressed again to make another attempt. It is not possible to access a busy channel by holding down the push-to-talk switch until the channel is no longer busy. Make sure that the Squelch control is set properly with this feature.

## 2.7 KEY ACKNOWLEDGE BEEP

The transceiver can be programmed by the dealer so that a beep sounds when the channel or option switches are pressed. If a switch is pressed when it is disabled, such as when transmitting, no beep sounds.

## 2.8 SCAN

### 2.8.1 INTRODUCTION

To have the scan function, one of the front panel option switches must be programmed for scan. When the scan mode is enabled by this switch, two dashes (—) appear in the channel display. A channel number is displayed in the scan mode only when a message is received. All programmed channels are scanned unless they are locked out of the scan sequence by dealer programming or the Scan Lockout switch (refer to Section 2.8.5). Channels are scanned in sequence, starting with the currently selected channel.

Call Guard squelch is detected when scanning if the microphone is on-hook and the monitor mode is not selected by the Monitor switch (if programmed). An exception is priority channels which are discussed in Section 2.8.6.

selected channel. Operation with the Stop Scan When Microphone Is Off-Hook option enabled and disabled is as follows:

When that option is enabled, scanning halts and the selected channel is displayed whenever the microphone is off-hook. Since Call Guard squelch is also disabled, the channel can be monitored before transmitting.

When the Stop Scan When Microphone Is Off-Hook option is disabled, scanning continues when the microphone is taken off-hook (although Call Guard squelch is still disabled). If the push-to-talk switch is pressed while a message is being received, transmission always occurs on the selected channel, even if the message is being received on another channel. Since the selected channel is not monitored if this occurs (which is illegal), a first priority channel should be programmed that follows the selected channel. This would ensure that messages are always heard on the selected channel. The Transmit Disable On Busy function can also be dealer programmed to prevent transmission in this situation (refer to Section 2.6).

#### Scanning For An Open Channel

The Scan For An Open Channel option can be enabled by dealer programming. If this option is enabled and a carrier is detected on the selected channel when the push-to-talk switch is pressed, the next channel in the scan sequence is checked for a carrier. When a channel without a carrier is detected, the transmitter keys on that channel. Channels locked out of scanning are not checked.

When the microphone is taken off-hook with this function programmed, scanning continues and Call Guard squelch (if programmed) is not disabled. The reason that Call Guard squelch is not disabled is that channel monitoring is effectively performed by the transceiver. If option "a" or "b" discussed in the preceding information is also programmed, the function is performed, but Call Guard squelch is not disabled when the microphone is taken off-hook. If you should want to determine if the selected channel is busy in this situation, look at the Busy indicator or press the Monitor switch (if programmed) which remains functional.

#### 2.8.5 CHANNEL LOCKOUT IN SCAN

##### General

Channels can be locked out of the scan sequence by dealer programming or by the user if an option switch

has been programmed for scan lockout. Channels that have been locked out of scanning are indicated by "Lo" flashed in the channel display when the channel is first displayed.

When a Channel Lockout switch is programmed, a channel is locked or unlocked by pressing the switch when the channel number is displayed. If an "Lo" is flashed in the display after the switch is pressed, the channel was just locked out of scanning. If an "Lo" is not flashed, the channel was just unlocked and will be scanned normally.

The selected channel is always scanned, even if it is locked out. Therefore, the selected channel must normally be changed after locking a channel out. Channels locked out of scanning by dealer programming can be unlocked by the channel lockout switch. If priority channels are locked out, the priority status takes precedence and they are scanned. Refer to Section 2.8.6 for more information. Since there must always be one active channel, the transceiver inhibits the lockout of all channels.

#### Locking Out Channels While Scanning

When the scan mode is selected, channels cannot be unlocked. However, a channel can be locked out when listening to a message on that channel. When the Lockout switch is pressed in this situation, the audio is immediately squelched and scanning resumes (unless it is the selected channel).

#### Saving Lockout Status in Memory

The transceiver can be dealer programmed to either save or not save the channel lockout status of all channels when power is turned off. If it is saved, the lockout status returns to the previous state when power is turned back on. If it is not saved, channels revert to the unlocked status unless they are locked out by dealer programming.

#### 2.8.6 PRIORITY CHANNELS

##### General

This transceiver can be programmed so that there are priority channels when scanning. The purpose of priority channels is to ensure that messages on priority channels are not missed with listening to messages on other channels.

## 2.9 CHANNEL DISPLAY

### 2.9.1 CHANNEL INFORMATION

Up to 20 channels can be selected with the standard transceiver and up to 99 channels can be selected when the optional 99-channel board is installed. These channels are directly displayed by the two-digit display. When power is turned on, the selected channel is the channel that was selected when power was turned off.

Besides the channel number, information on the lockout and priority status of selected channel may be displayed. This information is flashed in the display when the channel is changed, when the scan mode is exited, or when power is turned on. The information displayed is as follows:

**“Lo”** - Indicates that the selected channel is locked out of the scan sequence by either dealer programming or the Channel Lockout switch. Refer to Section 2.8.5 for more information.

**“P1”** - Indicates that the selected channel is a first priority channel. This information is displayed when the priority channel is selected by dealer programming, but not when the priority channel follows the selected channel.

**“P2”** - Indicates that the selected channel is a second priority channel. This information is displayed when the priority channel is selected by dealer programming, but not when the priority channel follows the selected channel.

### 2.9.2 OPTION SWITCH INFORMATION

When a Scan select, Channel Lockout, or Auxiliary option switch is pressed, the display flashes information which indicates the mode selected by the switch. The following information is displayed when one of these switches are pressed.

**“— —”** - Indicates that the scan mode is selected by the Scan Select switch. Refer to Section 2.8.1 for more information.

**“Lo”** - Indicates that the selected channel was just locked out of the scan sequence by the Channel Lockout switch. If “Lo” is not displayed when this switch is pressed, then the selected channel was just unlocked and will be scanned normally. Refer to Section 2.8.5 for more information.

**“Au”** - Indicates that the auxiliary function has been enabled by the Auxiliary switch. Refer to Section 2.2 for more information.

### 2.9.3 PROGRAMMING MODE INFORMATION

When the transceiver is being programmed by the dealer, the programming mode is indicated by “Pr” in the display.

### 2.9.4 ERROR CONDITIONS

A flashing display and a special tone are used to indicate the following error conditions:

**Out-Of-Lock Synthesizer** - If the synthesizer is out-of-lock in the receive mode, the channel display flashes and a beeping tone is heard from the speaker. In the transmit mode, the transmitter is disabled in addition to the flashing display and beeping tone. The out-of-lock indication differs from the time-out timer indication in that a beeping (on-off) tone sounds instead of alternating tones. In the receive mode only, when the synthesizer is unlocked, the logic automatically reloads the synthesizer once per second to attempt to reacquire lock. One nonhardware cause of an unlocked synthesizer is programming an invalid channel frequency.

**Time-Out Timer Expired** - If the time-out timer expires, the selected channel number begins flashing, an alternating 800 Hz/1000 Hz tone sounds, and the transmitter is disabled. The push-to-talk switch must be released to rekey the transmitter and reset the timer and tone. Refer to Section 2.5 for more information.

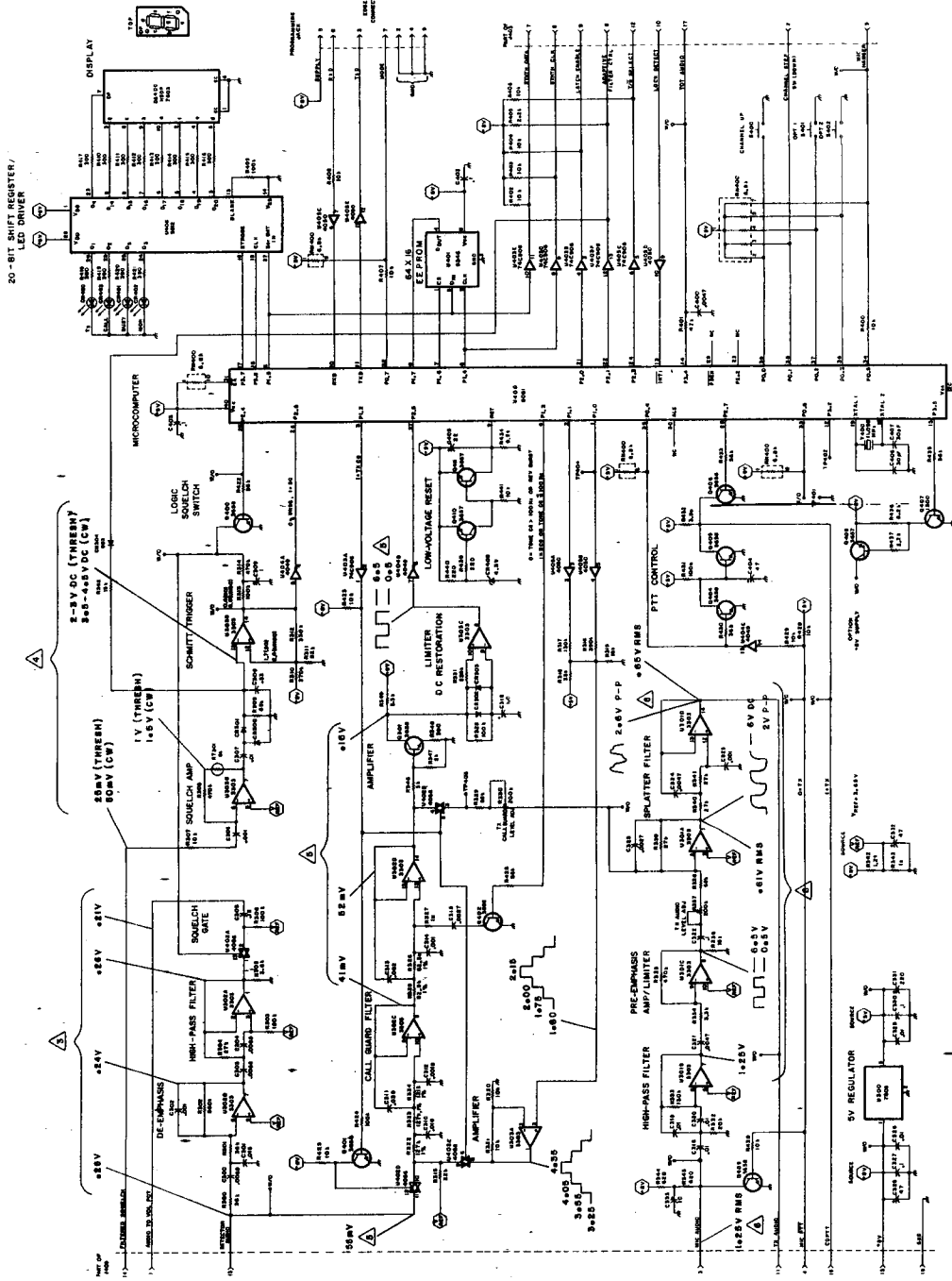
**Transmitter Keyed On A Channel Not Programmed For Transmit** - Receive-only channels can be programmed. If the push-to-talk switch is pressed on one of these channels, the display flashes the selected channel number, a beeping tone sounds, and the transmitter is disabled.

**Channel Busy When Transmitter Is Keyed** - If the Transmit Disable On Busy feature has been programmed and the channel is busy when the push-to-talk switch is pressed (Busy indicator lighted), the transmitter is disabled, the display flashes the selected channel number, and a beeping tone sounds. If the Busy indicator remains on, check to make sure that the Squelch control is properly adjusted. Refer to Section 2.6 for more information.

## PARTS LIST (CONT.)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER	SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 305	3.6k ohm $\pm 5\%$ 1/8W smd	569-0115-362	R 408	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 306	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104	R 409	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104
R 307	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103	R 410	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 308	470k ohm $\pm 5\%$ 1/8W smd	569-0115-474	R 411	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 309	68k ohm $\pm 5\%$ 1/8W smd	569-0115-683	R 412	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 310	270k ohm $\pm 5\%$ 1/8W smd	569-0115-274	R 413	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 311	82k ohm $\pm 5\%$ 1/8W smd	569-0115-823	R 414	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 312	330k ohm $\pm 5\%$ 1/8W smd	569-0115-334	R 415	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 316	270k ohm $\pm 5\%$ 1/8W smd	569-0115-274	R 416	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 317	130k ohm $\pm 5\%$ 1/8W smd	569-0115-134	R 417	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 318	75k ohm $\pm 5\%$ 1/8W smd	569-0115-753	R 418	390 ohm $\pm 5\%$ 1/8W smd	569-0115-391
R 319	300k ohm $\pm 5\%$ 1/8W smd	569-0115-304	R 419	390 ohm $\pm 5\%$ 1/8W smd	569-0115-391
R 322	127k ohm $\pm 1\%$ 1/8W mf	569-0520-511	R 420	390 ohm $\pm 5\%$ 1/8W smd	569-0115-391
R 323	127k ohm $\pm 1\%$ 1/8W mf	569-0520-511	R 421	390 ohm $\pm 5\%$ 1/8W smd	569-0115-391
R 324	121k ohm $\pm 1\%$ 1/8W mf	569-0520-509	R 422	56k ohm $\pm 5\%$ 1/8W smd	569-0115-563
R 325	82.5k ohm $\pm 1\%$ 1/8W mf	569-0520-489	R 423	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 326	82.5k ohm $\pm 1\%$ 1/8W mf	569-0520-489	R 424	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104
R 327	1M ohm $\pm 5\%$ 1/8W smd	569-0115-105	R 425	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 328	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104	R 426	56k ohm $\pm 5\%$ 1/8W smd	569-0115-563
R 330	10k ohm sgl turn pot	562-0115-103	R 428	2.2k ohm $\pm 5\%$ 1/8W smd	569-0115-222
R 331	680k ohm $\pm 5\%$ 1/8W smd	569-0115-684	R 429	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 332	20k ohm $\pm 5\%$ 1/8W smd	569-0115-203	R 430	36k ohm $\pm 5\%$ 1/8W smd	569-0115-363
R 333	130k ohm $\pm 5\%$ 1/8W smd	569-0115-134	R 431	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104
R 334	3.3k ohm $\pm 5\%$ 1/8W smd	569-0115-332	R 432	3.9k ohm $\pm 5\%$ 1/8W smd	569-0115-392
R 335	470k ohm $\pm 5\%$ 1/8W smd	569-0115-474	R 433	56k ohm $\pm 5\%$ 1/8W smd	569-0115-563
R 337	10k ohm sgl turn pot	562-0115-103	R 434	8.2k ohm $\pm 5\%$ 1/8W smd	569-0115-822
R 338	150k ohm $\pm 5\%$ 1/8W smd	569-0115-154	R 435	56k ohm $\pm 5\%$ 1/8W smd	569-0115-563
R 339	62k ohm $\pm 5\%$ 1/8W smd	569-0115-623	R 436	8.2k ohm $\pm 5\%$ 1/8W smd	569-0115-822
R 340	27k ohm $\pm 5\%$ 1/8W smd	569-0115-273	R 437	2.2k ohm $\pm 5\%$ 1/8W smd	569-0115-222
R 341	27k ohm $\pm 5\%$ 1/8W smd	569-0115-273	R 438	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 342	220 ohm $\pm 5\%$ 1/8W smd	569-0115-221	R 439	220 ohm $\pm 5\%$ 1/8W smd	569-0115-221
R 343	1k ohm $\pm 5\%$ 1/8W smd	569-0115-102	R 440	75 ohm $\pm 5\%$ 1/8W smd	569-0115-750
R 344	620 ohm $\pm 5\%$ 1/8W smd	569-0115-621	R 441	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 345	620 ohm $\pm 5\%$ 1/8W smd	569-0115-621	R 442	2.2k ohm $\pm 5\%$ 1/8W smd	569-0115-222
R 350	3.9k ohm $\pm 5\%$ 1/8W smd	569-0115-392	R 443	47k ohm $\pm 5\%$ 1/8W smd	569-0115-473
R 352	51k ohm $\pm 5\%$ 1/8W smd	569-0115-513	R 444	56k ohm $\pm 5\%$ 1/8W smd	569-0115-563
R 353	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104	R 445	100k ohm $\pm 5\%$ 1/8W smd	569-0115-104
R 354	330k ohm $\pm 5\%$ 1/8W smd	569-0115-334	R 446	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 355	240k ohm $\pm 5\%$ 1/8W smd	569-0115-244	R 447	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 356	240k ohm $\pm 5\%$ 1/8W smd	569-0115-244	R 448	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 357	150k ohm $\pm 5\%$ 1/8W smd	569-0115-154	R 449	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 358	75k ohm $\pm 5\%$ 1/8W smd	569-0115-753	R 450	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 359	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103	R 451	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 360	1.5k ohm $\pm 5\%$ 1/8W smd	569-0115-152	R 452	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 361	120k ohm $\pm 5\%$ 1/8W smd	569-0115-124	R 453	300 ohm $\pm 5\%$ 1/8W smd	569-0115-301
R 362	430k ohm $\pm 5\%$ 1/8W smd	569-0115-434	R 454	Zero ohm jumper	569-0115-001
R 400	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103	R 455	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103
R 401	47k ohm $\pm 5\%$ 1/8W smd	569-0115-473	R 456	12k ohm $\pm 5\%$ 1/8W smd	569-0115-123
R 402	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103			
R 403	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103	RN400	6.8k ohm 9-resistor network	569-6000-010
R 404	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103			
R 405	2.2k ohm $\pm 5\%$ 1/8W smd	569-0115-222			
R 406	10k ohm $\pm 5\%$ 1/8W smd	569-0115-103	RT301	8k ohm thermistor	569-3001-001
R 407	20k ohm $\pm 5\%$ 1/8W smd	569-0115-203	RT302	8k ohm thermistor	569-3001-001





NOTES:

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

2. IC CONNECTIONS NOT SHOWN:

IC	+5V	GND
U301	4	11
U302	4	11
U402	4	7
U403	14	7
U404	14	7
U405	1	8, 9, 11
		8, 14

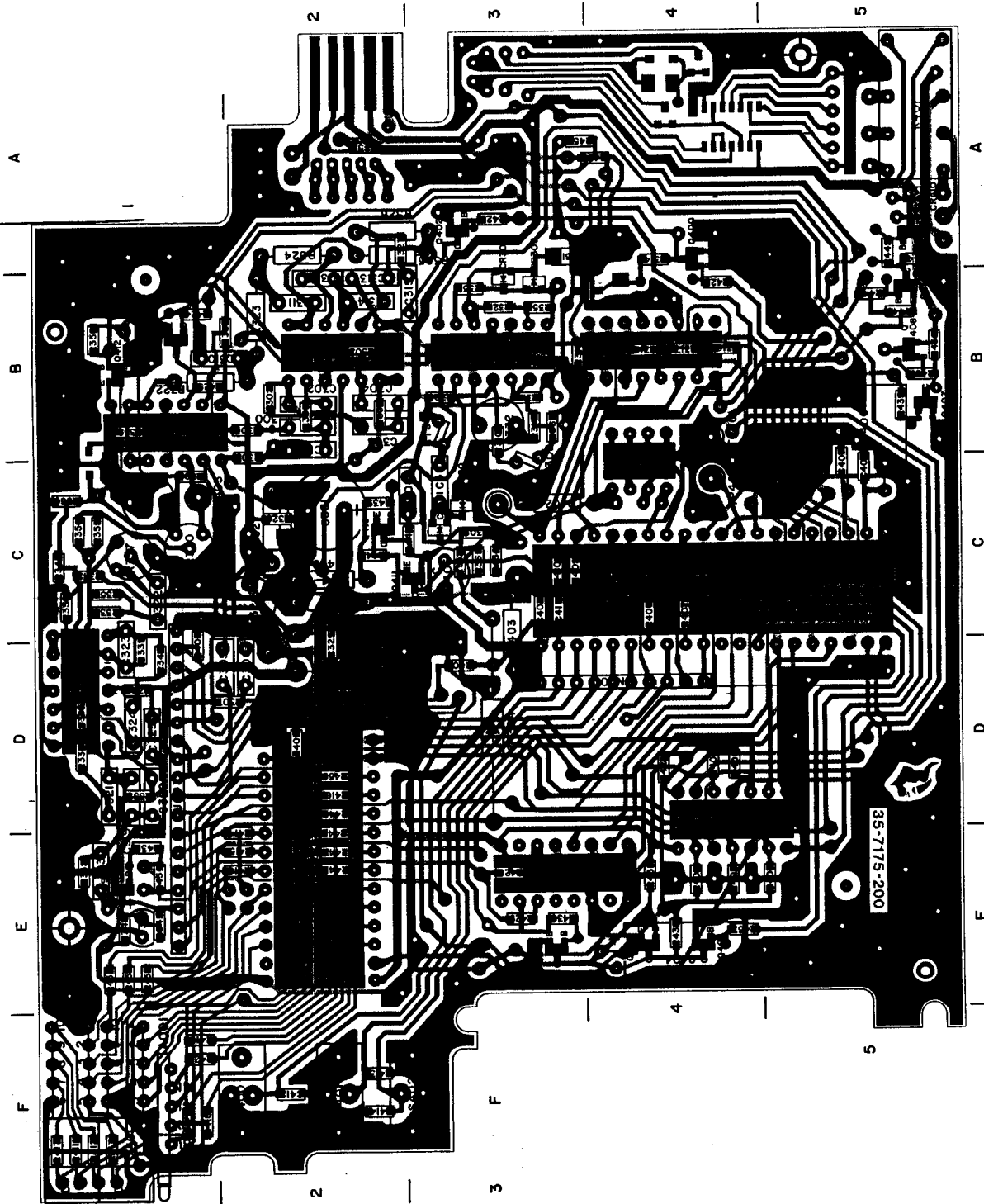
RECEIVE AUDIO RMS VOLTAGES MEASURED WITH 1 MHz AT 3 MILLIVOLT INPUT SIGNAL MODULATED WITH 100 Hz AT 3 MHz DEVIATION.

SCUECH NOISE VOLTAGES ARE RMS UNLESS OTHERWISE SPECIFIED AND ARE MEASURED WITH NO SIGNAL INPUT.

CALL GUARD RMS VOLTAGES MEASURED WITH 1 MILLIVOLT INPUT SIGNAL MODULATED WITH 100 Hz AT 600 Hz DEVIATION.

TRANSMIT AUDIO VOLTAGES MEASURED WITH 1 MHz 1.25 V RMS SIGNAL INJECTED AT PIN 2 OF MICROPHONE JACK J103.

AUDIO/LOGIC BOARD



AUDIO/LOGIC BOARD BOTTOM VIEW

NOTE: COMPONENTS IN BLUE ARE LOCATED ON THE TOP SIDE OF THE PC BOARD.

FOLDOUT →

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