# 9700 Series

MULTI-NET® II MOBILE

SERVICE MANUAL

# SUMMIT® DM 975X / 977X 800 or 900 MHZ MOBILE RADIO

## MULTI-NET® II

*13.6 VDC, 15 or 30 Watts*
*Part No. 242-97xx-111*




EFJohnson®

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# MULTI-NET®
# SUMMIT® DM 975x/977x 800/900 MHz TRUNKED RADIO

**13.6 VDC, 15 or 30/35 Watts, FM**
**806-821 MHz Tx, 851-866 MHz Rx (975x)**
**896-902 MHz Tx, 935-941 MHz Rx (977x)**
**Part No. 242-97xx-111**

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# SECTION 1 GENERAL INFORMATION

## 1.1 SCOPE OF MANUAL

This service manual contains installation, operation, programming, alignment, and service information for the E.F. Johnson Summit® DM 975x and 977x transceivers.

*NOTE: The 900 MHz (977x) Summit DM model is no longer available.*

## 1.2 EQUIPMENT DESCRIPTION

### 1.2.1 GENERAL

The 975x/977x are full featured, high performance transceivers that operate in the Multi-Net®, LTR®, and conventional modes. The 975x is an 800 MHz transceiver which operates on the 760 trunked channels from 806-824 MHz (mobile transmit). The receive channels are 45 MHz above these frequencies (851-869 MHz). The 977x is a 900 MHz transceiver which operates on the 479 trunked channels from 896-902 MHz (mobile transmit). The receive channels are 39 MHz above these frequencies (935-941 MHz). Standard analog frequency modulation is utilized.

The last digit of the model number (97x3, 97x4, 97x5, and 97x6) denotes front or remote mounting and power output as shown in Table 1-2. This table also lists other E.F. Johnson Multi-Net transceivers and the distinguishing features of each.

Like all E.F. Johnson Multi-Net and LTR transceivers, the 975/977x is digitally synthesized and logic controlled. In the Multi-Net or LTR modes, all the user has to do to make a call is select the desired system and group and press the push-to- talk switch. If a busy or out-of-range condition is not indicated by special tones, the path to the other party is complete and speaking can begin. Channel selection, monitoring before transmitting, and squelch control are all performed by the logic.

### 1.2.2 PROGRAMMING

Transceiver programming is performed using a dealer-supplied personal computer and the E.F. Johnson RPI (Remote Programming Interface) and programming software listed in Table 1-1. Transceiver operating parameters are stored in an EEPROM reprogrammable memory. Refer to Section 4 for more programming information.

The operating code (firmware) for the microprocessor is stored in a flash-type memory device. This allows the operating program to be updated using E.F. Johnson Write-On™ programming software and the standard transceiver programming setup. This simplifies software updates because the microprocessor or an EPROM does not need to be changed. The latest Write-On software and operating code can be downloaded from the E.F. Johnson ACES℠ Bulletin Board System. Refer to Section 4.6 for more information on flash programming.

### 1.2.3 SELECTABLE SYSTEMS AND GROUPS

The maximum number of systems that can be programmed is determined by the type of system and the number of groups that are programmed. If only single-group systems are programmed, up to 73 Multi-Net, 66 LTR, or 100 conventional systems can be programmed. Then as more groups are programmed, the number of systems decreases. If the maximum number of groups are programmed (11 Multi-Net, 10 LTR/conventional), up to 32 Multi-Net, 30 LTR, or 32 conventional systems can be programmed. When data is being entered using the programming software, there is a running indication of the amount of EEPROM memory left.

With conventional operation, each system selects a channel, and the group switch selects the Call Guard (CTCSS or digital) signaling and other parameters on that channel.

### 1.2.4 FRONT AND REMOTE MOUNTING

The 97x3/97x5 transceivers are designed for front mounting within reach of the operator, and the 97x4/97x6 are designed for remote mounting in a location such as the trunk (see Table 1-2). The remote control unit cable connects to the remote interface pigtail coming from the back of the transceiver (see Figure 2-3). This pigtail is standard with remote mount transceivers only.

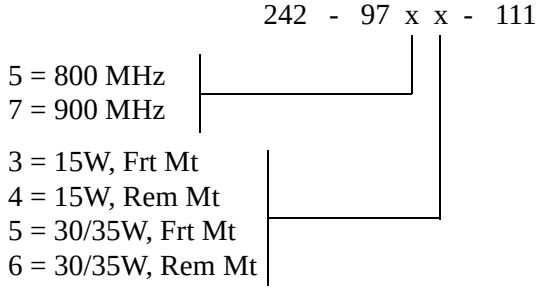
The remote control unit uses the same front panel assembly that is used on front mount transceivers. Therefore, it operates the same as a front-mount transceiver. A Remote Conversion Kit is available which converts the front panel of a front mount transceiver to a remote control unit (see Table 1-1). The remote control unit has an internal 5-watt speaker or an external 15-watt speaker can be used. Dual transceiver controls are also available when the remote control unit is connected to a standard front mount transceiver.

### 1.2.5 NPSPAC MODELS (800 MHZ ONLY)

All 800 MHz versions of this transceiver meet the stricter specifications established by NPSPAC (National Public Safety Panel Advisory Committee) for public safety frequencies from 821-824 and 866-869 MHz. Deviation is less on NPSPAC channels; however, no alignment change is required because it is automatically set for the correct level when a public safety channel is selected (see Appendix A.2).

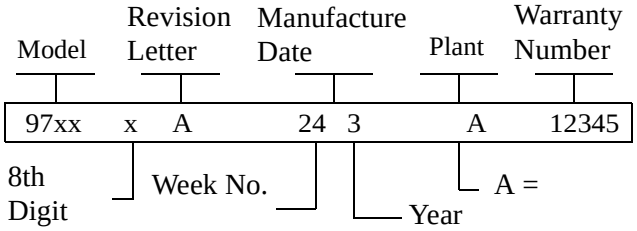
## 1.3 PART NUMBER BREAKDOWN

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




## 1.4 TRANSCEIVER IDENTIFICATION

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




## 1.5 ACCESSORIES

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

**Mounting Hardware -** The mounting hardware and DC power cable are shown in Figures 2-1 and 2-3 in Section 2. A 22-foot DC power cable is used for both front and remote mount applications. The cable is cut to the required length at installation and any excess discarded. The accessory cable is used to connect such things as an external speaker, public address, ignition sense input, and a horn alert to the transceiver. It includes two 22-foot and three 2-foot wires that are connected as required to external points. The adapter cable is used to connect a 86xx-series power cable to these transceivers.

**Key Cap Kit -** This kit includes key caps labeled for all the functions that can be controlled by the six front panel option switches. Also included are blank key caps for unused switches. An extraction tool for removing the key caps is included in the cable and hardware kit. Refer to Section 2.6 for key cap installation information.

**Lockable Mounting Tray -** This bracket allows the transceiver to be locked in place to guard against theft. In addition, it allows it to be easily unlocked and removed from the vehicle. Refer to Section 2.8 for installation information.

**Microphones and Speaker -** The microphones in Table 1-1 have an impedance of 620 ohms. All DTMF microphones are backlighted. The environmentally sealed microphones are sealed against such things as rain, sand, and dust.

The external 15-watt speaker can be used in place of the internal 5-watt speaker. It is non- amplified and weatherproof. This speaker is connected to pins 1 and 2 of the accessory connector pigtail on the back of the transceiver.

**Remote Kits -** The remote conversion kit converts the front panel of a front-mount transceiver to a remote control unit. It includes a blank cover plate with a programming jack for the transceiver, a housing with interface board to form the remote control unit, a remote pigtail cable, and a 17-foot control cable. The remote control unit uses the internal 5-watt speaker or

**Table 1-1 ACCESSORIES**

| Accessory | Part No. |
|---|---|
| Mounting Accessories [1] | |
| Mounting bracket & hardware kit | 023-9750-012 |
| DC power cable & hardware, 22' | 023-9750-010 |
| Accessory cable | 023-9750-011 |
| Key cap kit, Summit | 587-9650-008 |
| Lockable Mounting Tray | 585-7000-185 |
| Adapter cable (to use 86xx-series power cable with 97xx) | 023-9650-006 |
| Microphones | |
| Standard amplified dynamic | 250-0740-310 |
| Standard, environ sealed | 587-9650-010 |
| DTMF w/o memory | 589-0016-028 |
| DTMF w/o mem, env seal WR805 | 587-9650-015 |
| DTMF w/20 no. mem, envir seal | 587-9650-012 |
| Desk microphone | 250-0742-011 |
| External speaker, 5" 15W 3.2 ohm environmental sealed | 250-0151-006 |
| Remote conversion kit | 250-9701-001 |
| Remote control unit kit, Summit | 023-9701-002 |
| UD$^2$I universal interface cable | |
| Factory installed | 023-9750-001 |
| Field installed | 597-2002-245 |
| Compandor kit | |
| Factory installed | 023-9750-002 |
| Field installed | 250-9750-002 |
| Encryption kit | |
| Factory installed | 023-9750-003 |
| Field installed | 250-9750-003 |
| DC noise filter kit | |
| Factory installed | 023-9750-004 |
| Field installed | 542-5010-003 |
| Control station power supply | |
| 11 amp, 115 VAC, 60 Hz | 585-4001-201 |
| 15 amp, 115 VAC, 60 Hz | 585-4001-202 |
| 11 amp, 230 VAC, 50 Hz | 585-4001-203 |
| 15 amp, 230 VAC, 50 Hz | 585-4001-204 |

**Table 1-1 ACCESSORIES (Continued)**

| Accessory | Part No. |
|---|---|
| Programming Accessories | |
| Remote prog interface (RPI) | 023-9800-000 |
| Cable, RPI to transceiver | 023-9750-005 |
| Cable, xcvr-xcvr (cloning) | 597-2002-268 |
| Cable, RPI to cmptr, 6’ DB9 M - DB9 F | 597-5900-002 |
| Cable, RPI to cmptr, 6’ DB25 M - DB9F | 597-0005-057 |
| PC Programming software, 3.5” diskette | 023-9998-278 |
| [1] Included with all transceivers | |

the 15W external speaker. The remote control unit kit includes the Summit DM control unit, remote pigtail cable, and 17-ft. control cable. A microphone is not included. Dual transceiver controls are provided by connecting this control unit to a standard front mount transceiver.

**UD$^2$I Kit -** This is the Universal Digital and Data Interface pigtail cable that installs in the transceiver to provide connections to external data equipment. The Validation Key is no longer required to use this interface. Refer to Section 4.7 for more information.

**Compandor Kit -** The compandor kit includes a board which installs in the option slots of the transceiver. This board provides 2:1 compression of the transmit audio and 1:2 expansion of the receive audio to minimize noise in the audio signal.

*NOTE: Companding is not compatible with encryption, so those features cannot be used together.*

**Encryption Kit -** The encryption kit includes an encryption board which installs in the option slots of the transceiver. Voice encryption provides security from unauthorized monitoring of conversation by casual eavesdropping and analog scanners. Refer to Section 5.8.16 for more information on the encryption feature.

**DC Noise Filter Kit -** The DC noise filter kit includes a filter choke that installs in the transceiver in the main 13.8-volt supply line. This filter provides additional attenuation of vehicle electrical system noise. Installation is described in Section 2.7.

## Table 1-2 E.F. JOHNSON MULTI-NET TRANSCEIVERS

| Transceiver | Freq (MHz) | Type | Power Output | System/ Groups [1] | M-Net/LTR/ Conv Operation; Conv Talk-Around | Special Features |
|---|---|---|---|---|---|---|
| 8160 Avenger SK | 800 | Portable | 1 & 3W | 14/11 | Yes | Small size, Qk Sel Sw |
| 8161 Avenger SK | 800 | Portable | 1 & 2W | 14/11 | Yes | Small size, Qk Sel Sw, Intrin Safe |
| 8162 Avenger SK | 900 | Portable | 1 & 2W | 14/11 | Yes | Small size, Qk Sel Sw |
| 8163 Avenger SK | 900 | Portable | 1 & 2W | 14/11 | Yes | Small size, Qk Sel Sw, Intrin Safe |
| 8585 Viking CM | 800 | Portable | 1.8/3.0W | 14/11 | Yes | Hi Pwr, Quick Select Switch |
| 8586 Viking CM | 800 | Portable | 1.5/2.5W | 14/11 | Yes | Hi Pwr, Qk Sel Sw, Intrin Safe |
| 8587 Viking CM | 800 | Portable | 1.8/3.0W | 14/11 | Yes | Hi Pwr, Qk Sel Sw, NPSPAC |
| 8588 Viking CM | 800 | Portable | 1.5/2.5W | 14/11 | Yes | Hi Pwr, Qk Sel, Intrin Safe, NPSPAC |
| 8590 Viking CM | 900 | Portable | 1W | 14/11 | Yes | Quick Select Switch |
| 8591 Viking CM | 900 | Portable | 1W | 14/11 | Yes | Qk Sel Sw, Intrin Safe |
| 8605* | 800 | Frt Mount | 15W | 16/11 | Yes | Low Power |
| 8606* | 800 | Frt Mount | 15W | 16/11 | Yes | Low Power, NPSPAC |
| 8615* | 800 | Frt Mount | 35W | 16/11 | Yes | High Power |
| 8616* | 800 | Frt Mount | 35W | 16/11 | Yes | High Power, NPSPAC |
| 8620* | 800 | Rem Mount | 35W | 16/11 | Yes | High Power, Remote Mount |
| 8621* | 800 | Rem Mount | 35W | 16/11 | Yes | High Pwr, Rem Mt, NPSPAC |
| 8622* | 800 | Rem Mount | 12W | 16/11 | Talk-Arnd N/A | Full Duplex |
| 8655* | 900 | Frt Mount | 30W | 16/11 | Yes | High Power |
| 9753 Summit DM | 800 | Frt Mount | 15W | 32/11 | Yes | Hi Spec/Full Feature, Low Pwr |
| 9754 Summit DM | 800 | Rem Mount | 15W | 32/11 | Yes | Hi Spec/Full Feature, Low Pwr |
| 9755 Summit DM | 800 | Frt Mount | 35W | 32/11 | Yes | Hi Spec/Full Feature, Hi Pwr |
| 9756 Summit DM | 800 | Rem Mount | 35W | 32/11 | Yes | Hi Spec/Full Feature, Hi Pwr |
| 9773 Summit DM* | 900 | Frt Mount | 15W | 32/11 | Yes | Hi Spec/Full Feature, Low Pwr |
| 9774 Summit DM* | 900 | Rem Mount | 15W | 32/11 | Yes | Hi Spec/Full Feature, Low Pwr |
| 9775 Summit DM* | 900 | Frt Mount | 30W | 32/11 | Yes | Hi Spec/Full Feature, Hi Pwr |
| 9776 Summit DM* | 900 | Rem Mount | 30W | 32/11 | Yes | Hi Spec/Full Feature, Hi Pwr |
| 9883 | 800 | Frt Mount | 15 or 30W | 40/16 | Yes | Full Featured, dual BW, high tier |
| 9896 | 900 | Frt Mount | 15 or 30W | 40/16 | Yes | Full Featured, high tier |

[1] All except 98xx have up to 11 groups per Multi-Net system and up to 10 groups per LTR or conv system (the 98xx can have up to 16 groups with any type of system). The 97xx and 98xx transceiver maximum number of systems is variable. The minimum number is shown and the maximum number depends on the type and number of groups in each (see Section 1.2.3).
* Discontinued Models

**Control Station Power Supply -** The 11-ampere versions are used with the 15-watt transceivers only, and the 15-ampere models can be used with all models. The transceiver slides into the power supply housing and receives power from banana jacks on the back of the power supply. The standard power cable is used for connecting power, and the internal transceiver speaker provides speaker audio.

**Programming Hardware and Software -** The RPI provides the interface between the programming computer and transceiver. This RPI is used for programming both radio personality information and the Write-On™ flash memory (see Section 1.2.2).

The cables from the RPI to the computer and transceiver are not included with the RPI and must be ordered separately. The transceiver programming software is available for IBM PC or compatible computers only. The operating parameters are programmed using the software listed in Table 1-1, and the Write-On flash memory is programmed using different software available on the ACES$^{SM}$ system (see Section 4.6). The cloning cable allows one transceiver to program another with identical information. Refer to Section 4 for more programming information.

## 1.6 PRODUCT WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the Warranty Department, E.F. Johnson Company, 299 Johnson Avenue, P.O. Box 1249, Waseca, MN 56093-0514. This information may also be requested from the Warranty Department by phone as described in the next section. The Warranty Department may also be contacted for Warranty Service Reports, claim forms, or any other questions concerning warranties or warranty service.

## 1.7 FACTORY CUSTOMER SERVICE

The Customer Service Department of the E.F. Johnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. Customer Service hours are 7:30 a.m. - 4:30 p.m. Central Time, Monday - Friday. From within the continental United States, the Customer Service Department can be reached at the following toll-free number: **1-800-328-3911**

When your call is answered at the E.F. Johnson Company, you will hear a brief message informing you of numbers that can be entered to reach various departments. This number may be entered during or after the message using a tone-type telephone. If you have a pulse-type telephone, wait until the message is finished and an operator will come on the line to assist you. When you enter some numbers, another number is requested to further categorize the type of information you need. You may also enter the 4-digit extension number of the person that you want to reach if you know what it is.

If you are calling from outside the continental United States, the Customer Service telephone numbers are as follows:

**Customer Service Department -** (507) 835-6911
**Customer Service FAX Machine -** (507) 835-6969

*NOTE: Emergency 24-hour technical support is also available at the 1-800 and preceding numbers during off hours, holidays, and weekends.*

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

E.F. Johnson Company
Customer Service Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

## 1.8 FACTORY RETURNS

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

Be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired, whether it is in or out of warranty. These forms are available free of

charge by calling the repair lab (see Section 1.7) or by requesting them when you send a unit in for repair. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Then include a form in the shipping container with each unit. Your phone number and contact name are very important because there are times when the technicians have specific questions that need to be answered in order to completely identify and repair a problem.

When returning equipment for repair, it is also a good idea to use a PO number or some other reference number on your paperwork in case you need to call the repair lab about your unit. These numbers are referenced on the repair order and it makes it easier and faster to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been given one by the Field Service Department. They require RA numbers for exchange units or if they want to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request Form sent with the unit. The repair lab will then contact the Field Service Department when the unit arrives.

## 1.9 REPLACEMENT PARTS

E.F. Johnson replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number as described in Section 1.7. When ordering, please supply the part number and quantity of each part ordered. E.F. Johnson dealers also need to give their account number.

If there is uncertainty about the part number, include the designator (C112, for example) and the model number of the equipment the part is from.

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.7.

E.F. Johnson Company
Service Parts Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

# SUMMIT® DM 975x (800 MHz) SPECIFICATIONS

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

## GENERAL

| | |
|---|---|
| Operating Modes | Multi-Net, LTR, and Conventional |
| Frequency Range | Transmit - 806-824 MHz Std, 851-869 MHz conv talk-around<br>Receive - 851-869 MHz |
| Systems | Variable from 31-100 depending on type and number of groups |
| Groups | Up to 11 per system Multi-Net; up to 10 per system LTR and conv |
| Mounting Location | 9753/9755 - Dash, convertible to remote mount<br>9754/9756 - Remote |
| Transmit/Receive Separation | 45 MHz standard, 0 MHz conventional talk-around |
| Channel Spacing | 25 kHz standard, 12.5 kHz offset |
| Channel Increment | 12.5 kHz |
| Frequency Stability | 1.5 PPM (–30° to +60° C/–22° to +140° F) |
| Dimensions and Weight | 2.1" (5.3 cm) H, 7.2" (18.2 cm) W, 8.3" (21.1 cm) L, 5.0 lb (2.3 kg) |
| Power Requirement | 13.6 volts, negative ground |
| Compliance | FCC Parts 15 and 90 |

## RECEIVER

| | |
|---|---|
| Sensitivity (12 dB SINAD) | 0.30 microvolt |
| Selectivity | –75 dB |
| Intermodulation | –75 dB |
| Spurious and Image Rejection | –75 dB (–70 dB half IF) |
| Maximum Channel Spread | 18 MHz |
| Audio Response | 6 dB per octave de-emphasis per TIA 603 specification |
| Audio Power Output/Distortion | 12 watts with external 4-ohm speaker, distortion less than 3% |
| RF Input Impedance | 50 ohms |
| Current Drain (maximum) | 1.0 ampere (standby), 3.0 ampere (rated audio output) |

## TRANSMITTER

| | |
|---|---|
| RF Output Power (20% duty cycle) | 9753/9754 - 15 watts (12 watts talk-around)<br>9755/9756 - 35 watts (30 watts talk-around) |
| Power Output Range | 1-2 watts or 3 dB below rated (PC programmable) |
| Spurious and Harmonic Emissions | –78 dB (35W), –75 dB (15W) |
| FM Hum and Noise (TIA) | –48 dB |
| Audio Modulation | 16K0F1D, 16K0F3E, 16K0F3D, 14K0F1D, 14K0F3E, 14K0F3D |
| Audio Distortion | Less than 3% at 1 kHz |
| Audio Frequency Response | 6 dB per octave pre-emphasis per TIA 603 specification |
| Maximum Channel Spread | 18 MHz (no degradation); 63 MHz (talk-around .75 dB degrad) |
| Current Drain (maximum) | 9753/9754 (15W) - 8 amperes; 9755/9756 (35W) - 15 amperes |
| RF Output Impedance | 50 ohms |
| Circuit Protection | 15-ampere fuse in power cable |

# SUMMIT® DM 977x (900 MHz) SPECIFICATIONS

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

## GENERAL

| | |
|---|---|
| Operating Modes | Multi-Net, LTR, and Conventional |
| Frequency Range | Transmit - 896-902 MHz Std, 935-941 MHz conv talk-around<br>Receive - 935-941 MHz |
| Systems | Variable from 31-100 depending on type and number of groups |
| Groups | Up to 11 per system Multi-Net; up to 10 per system LTR and conv |
| Mounting Location | 9773/9775 - Dash, convertible to remote mount<br>9774/9776 - Remote |
| Transmit/Receive Separation | 39 MHz standard, 0 MHz conventional talk-around |
| Channel Spacing | 12.5 kHz |
| Channel Increment | 12.5 kHz |
| Frequency Stability | ±1.5 PPM (–30° to +60° C/–22° to +140° F) |
| Dimensions and Weight | 2.1" (5.3 cm) H, 7.2" (18.2 cm) W, 8.3" (21.1 cm) L, 5.0 lb (2.3 kg) |
| Power Requirement | 13.6 volts, negative ground |
| Compliance | FCC Parts 15 and 90 |

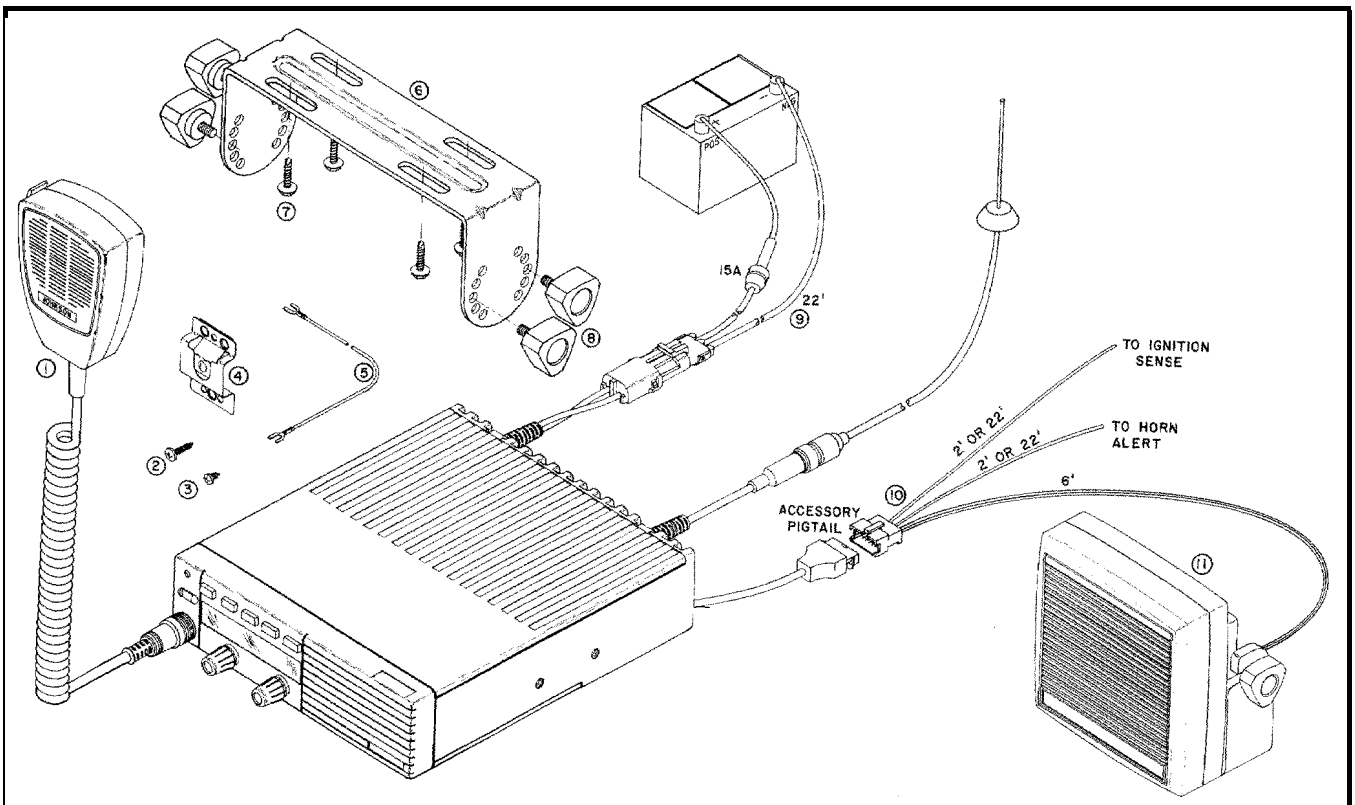
## RECEIVER

| | |
|---|---|
| Sensitivity (12 dB SINAD) | 0.30 microvolt |
| Selectivity | –70 dB |
| Intermodulation | –70 dB |
| Spurious and Image Rejection | –75 dB |
| Maximum Channel Spread | 6 MHz |
| Audio Response | 6 dB per octave de-emphasis per TIA 603 specification |
| Audio Power Output/Distortion | 12 watts with external 3-ohm speaker, distortion less than 3% |
| RF Input Impedance | 50 ohms |
| Current Drain (maximum) | 1.0 ampere (standby), 3.0 ampere (rated audio output) |

## TRANSMITTER

| | |
|---|---|
| RF Output Power (20% duty cycle) | 9773/9774 - 15 watts (12 watts talk-around)<br>9775/9776 - 30 watts (25 watts talk-around) |
| Power Output Range | 1-2 watts or 3 dB below rated (PC programmable) |
| Spurious and Harmonic Emissions | –67 dB (15-watt models), –70 dB (30-watt models) |
| FM Hum and Noise (TIA) | –45 dB |
| Audio Modulation | 11K0F3E, 11KOF1D, 11KOF3D |
| Audio Distortion | Less than 3% at 1 kHz |
| Audio Frequency Response | 6 dB per octave pre-emphasis per TIA 603 specification |
| Maximum Channel Spread | 6 MHz standard and talk-around |
| Current Drain (maximum) | 9773/9774 (15W) - 10 amperes; 9775/9776 (30W) - 15 amperes |
| RF Output Impedance | 50 ohms |
| Circuit Protection | 15-ampere fuse in power cable |

# SECTION 2 INSTALLATION




| Item No. | Description | Part No. | Item No. | Description | Part No. |
|---|---|---|---|---|---|
| 1 | Amplified dynamic mic | 250-0740-310 | 7 | Self-drilling screw (4) | 575-9077-565 |
| 2 | Screw, 4-20 x 5/8” thread frmg (3) | 575-5604-020 | 8 | Knob (4) | 547-0016-005 |
| 3 | Screw, 4-24 x 1/4” sheet metal (3) | 575-3604-008 | 9 | Power cable (22') and hardware | 023-9750-010 |
| 4 | Microphone hanger clip | 023-3514-001 | 10 | Accessory wire and hardware | 023-9750-011 |
| 5 | Mic hanger ground wire | 023-7171-911 | 11 | 5" remote speaker | 250-0151-006 |
| 6 | Transceiver mounting bracket | 017-2226-034 | --- | Butt splice connector (2) | 586-9008-061 |

**Figure 2-1 97xx Front Mount Installation Components**

## 2.1 GENERAL

### 2.1.1 SCOPE OF INSTRUCTIONS

Since each installation is somewhat unique, the following installation instructions are intended only as a general guide to installing this transceiver. Described are the intended use of the mounting hardware and the electrical connections that should be made.

### 2.1.2 PERFORMANCE TESTS

Although each transceiver is carefully aligned and tested at the factory, shipment can alter these settings or damage the transceiver. Therefore, it is good practice to check transceiver performance before it is placed in service. Performance tests are located in Sections 8.5 and 8.6.

### 2.1.3 TRANSCEIVER PROGRAMMING

The transceiver needs to be programmed before it is placed in service unless it was ordered as factory programmed. Programming instructions are located in Section 4. Transceivers not factory programmed are shipped programmed with test channels and other factory test parameters.

The control unit used with remote-mount models does not require special programming. However, it does have several programming switches that may need to be changed in some circumstances. Refer to Section 2.5 for more information.

### 2.1.4 POWER SOURCE

This transceiver is designed for installation only in vehicles which have a 12-volt, negative ground electrical system. This type of electrical system has the negative battery terminal connected directly to the vehicle chassis. Other types of electrical systems require a voltage converter.

### 2.1.5 SELECTING A MOUNTING LOCATION

The front-mount transceivers are designed for mounting in a location near the operator such as the dash, console, or transmission hump. The remote-mount transceivers are designed for mounting in a location such as the trunk.

***WARNING***

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

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

## 2.2 TRANSCEIVER INSTALLATION

### 2.2.1 GENERAL

Cable and Hardware Kit, Part No. 023-9750-010, includes a 22-foot power cable, microphone hanger, hanger ground wire, splice connectors, and all the hardware (such as screws) that is normally required for installation. Transceiver Mounting Kit, Part No. 023-9750-012, includes a mounting bracket with knobs and mounting screws. Accessory Wire Kit, Part No. 023-9750-011, includes a wire assembly that is used to connect the ignition sense input and accessories. These components are shown in Figures 2-1 and 2-3.

### 2.2.2 MOUNTING TRANSCEIVER

a. Check the area underneath the selected mounting area for wiring, brake and gas lines, or other components that could be damaged when the mounting bracket is installed. Then install the mounting bracket using the included self-drilling screws or other screws if desired.

b. Install the transceiver in the bracket using the included knobs.

c. With front-mount transceivers, install the microphone hanger in a convenient location using the screws for sheet metal or plastic. The hanger must be connected to chassis ground for proper operation of functions such as monitoring and scan. If required, ground the hanger using the included ground wire.

## 2.3 POWER CABLE INSTALLATION

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

*NOTE: Both leads of the power cable should be connected directly to the vehicle battery. Connection to other points may result in increased interference from the vehicle's electrical system. If noise is still a problem, an optional DC noise filter is available (see Table 1-1).*

b. Route the red power cable to the battery. If there is excess cable, cut it off at a convenient location and

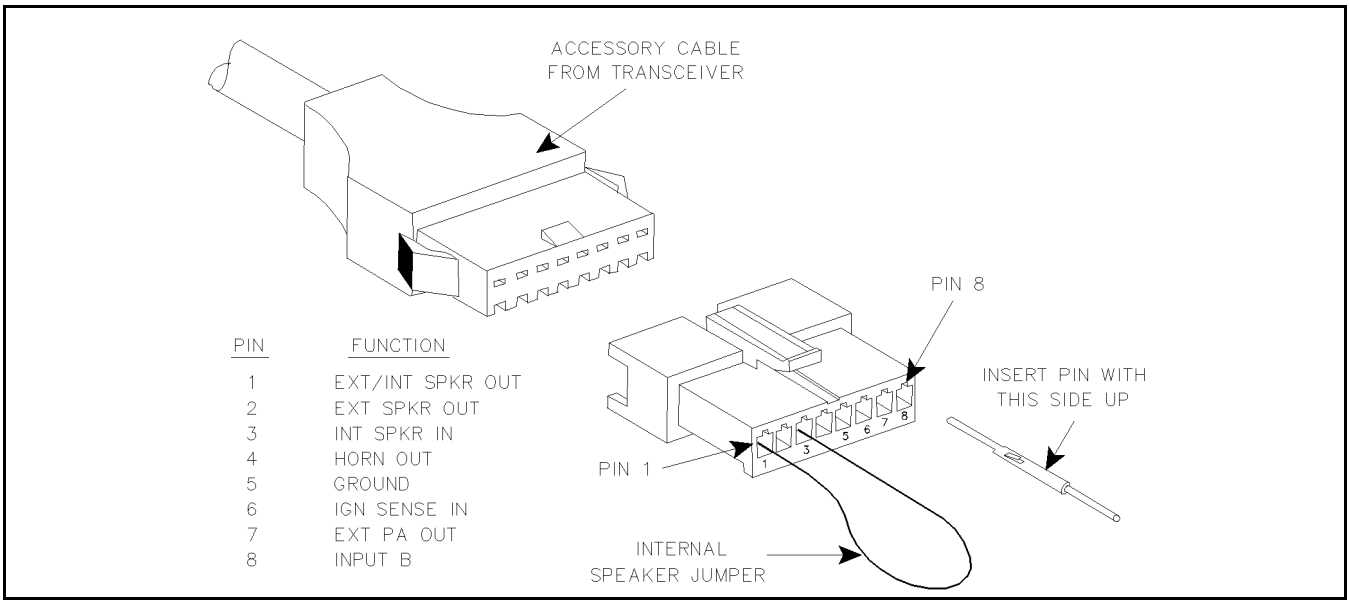



**Figure 2-2 Accessory Jack**

then splice it using the included butt splice connectors. You may also need to cut the cable if it must be routed through the firewall and there is no opening large enough to clear the fuseholder. If a hole is drilled in the firewall, be sure to seal it when the installation is complete.

c. Connect the red power cable to the positive (+) terminal of the battery.

d. Connect the blue cable to the negative (–) battery terminal.

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

f. Install the antenna according to the manufacturer's instructions. The transceiver has an “N” connector. Check VSWR. Reflected power should be less than 4% of forward power (VSWR less than 1.5 to 1).

## 2.4 ACCESSORY CABLE INSTALLATION

### 2.4.1 GENERAL

Accessory Cable Kit, Part No. 023-9750-011, is standard with Summit DM transceivers. This cable in this kit plugs into the accessory pigtail coming from the back of the transceiver. It is used for connecting the ignition sense input and the external speaker, horn alert, public address, and external emergency switch accessories.

Two 8-pin connectors are included. One has a jumper installed from pin 1 to 3 for routing audio to the internal speaker (see next section). Also included are two 22-foot and three 2-foot wires with attached pins that can be used as required. Refer to Figure 2-2 and install this cable as described in the following information.

*NOTE: The ignition sense input must always be connected because the transceiver does not operate if it is not. In addition, the speaker jumper must be installed to route audio to the internal speaker (except remote-mount models).*

### 2.4.2 INTERNAL/EXTERNAL SPEAKER

***CAUTION***

*Do not connect either speaker output to a supply voltage because serious damage to the audio amplifier will result. (The amplifier is designed to withstand momentary grounding of the speaker outputs.)*

Internal Speaker

To enable the internal speaker of front-mount transceivers, insert the plug with the jumper from pin 1 to 3 into the accessory jack. This routes the audio on

pin 1 back in to the internal speaker connected to pin 3. The other internal speaker terminal is internally connected to pin 2.

External Speaker

With front-mount transceivers, 4-ohm, 15-watt external speaker, Part No. 250-0151-006, or equivalent can be connected to pins 1 and 2 of the accessory connector. Proceed as follows:

a. Locate the connector included in the Accessory Wire Kit that does not have pins 1 and 3 jumpered.

b. If installing the external speaker listed above, the connector pins are already attached to the speaker wires. Insert one pin into the pin 1 location and the other into the pin 2 location. If installing some other speaker, use a 2- or 22-foot wire as required.

Remote-mount Transceivers

With remote-mount transceivers, two wires coming from the control cable connector are inserted into the pin 1 and 2 slots to apply speaker audio to the remote control unit. Refer to Section 2.5.3 for more information.

### 2.4.3 IGNITION SENSE

This ignition sense line is pin 6 of the accessory connector. It is connected using an included wire assembly. When the ignition sense input is connected to a source switched by the vehicle ignition switch, it provides the following functions.

a. Power automatically turns on and off with the ignition switch.

b. A turn-off delay can be programmed (see Section 3.6.7). An automatic turn-off delay may prevent accidental discharge of the vehicle battery if the transceiver is left on for extended periods (1 or 2 days). Standby current is approximately 1 ampere.

If these features are not used and transceiver power is to be controlled by the front-panel power switch only, the ignition sense input can be connected to an unswitched source.

### 2.4.4 HORN ALERT

The horn alert feature enables the vehicle horn or some other type of alert such as the lights when a call is received that is programmed for this feature. For more operation information, refer to Section 2.4.4.

When the horn alert is enabled, pin 4 of the accessory connector goes low for 0.5 second and then high for 0.5 second for three cycles. It then goes back to the disabled mode which is a high impedance state. Maximum sink current is 500 mA. Some type of dealer-supplied horn alert driver is required to use this output. To connect the horn alert driver circuit to pin 4, use an accessory cable wire. If connecting to the coil of a relay, a diode should be connected across the relay coil with the cathode to the battery side. This protects Q403 on the audio/logic board when the relay de-energizes.

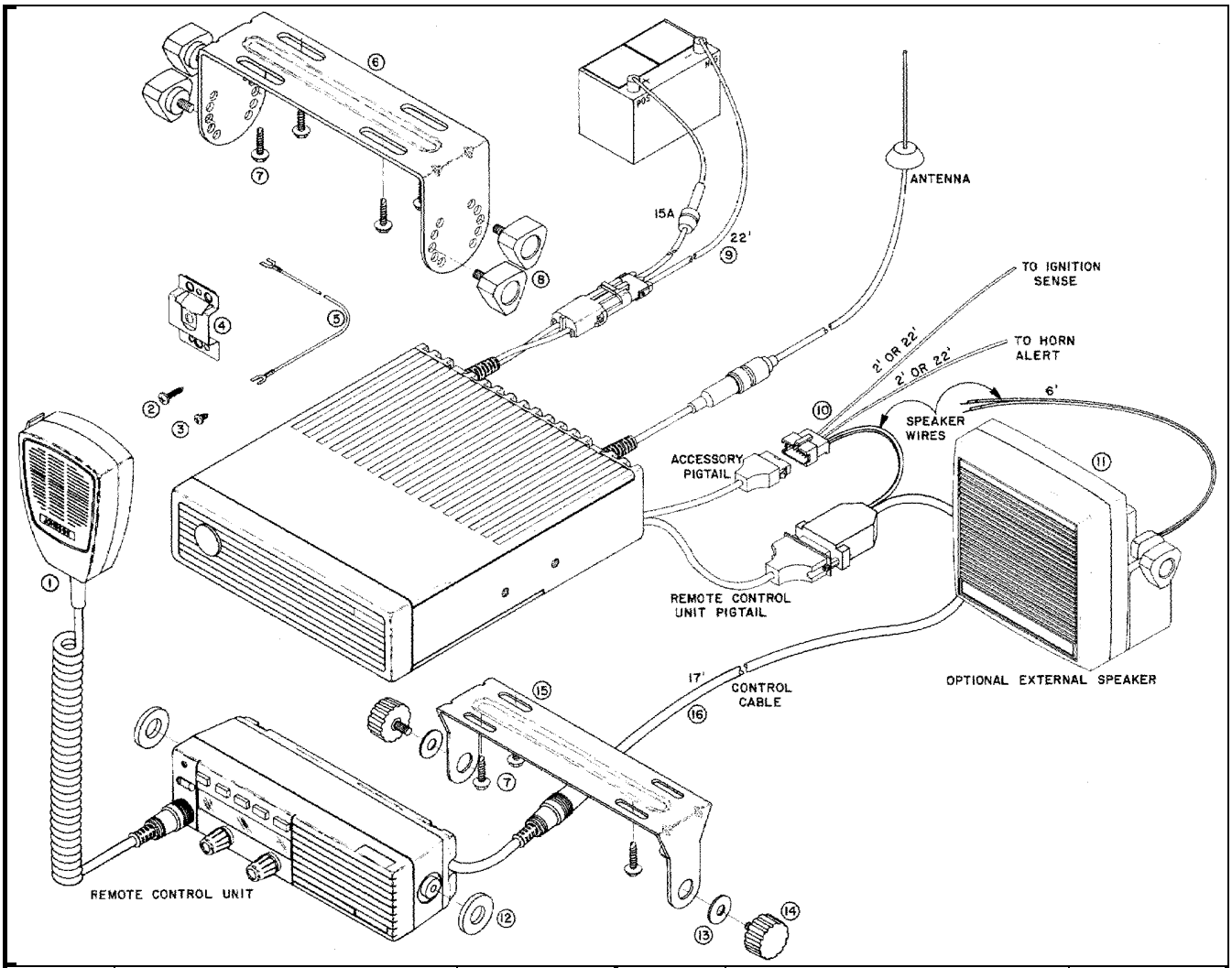
### 2.4.5 EXTERNAL PUBLIC ADDRESS

The speaker and microphone audio signals can be routed to an external public address system. A Public Address option button or menu parameter is required to control this feature. Refer to Section 3.5.10 for operation information.

The public address output is pin 7 of the accessory connector. This AC-coupled output is limited to 300-3000 Hz. The typical output level is 2.2 V P-P, and output impedance is less than 200 ohms. Use an included accessory cable wire assembly to connect this output.

### 2.4.6 INPUT B (EMERGENCY SWITCH)

An emergency switch can be used to set up a high priority call (see Section 3.6.8). A front-panel option button or an external switch such as a foot-operated type can be used. The external emergency switch input is pin 8 of the accessory connector. This input is active low and has an internal pull-up resistor. Therefore, a SPST normally open switch is used with one terminal connected to pin 8 and the other to chassis ground. (Chassis ground is available at pin 5 of the accessory connector.) Use an included accessory cable wire assembly to connect this switch. Refer to Section 4.7 for programming information.




| Item No. | Description | Part Number | Item No. | Description | Part Number |
|---|---|---|---|---|---|
| 1 | Amplified dynamic mic | 250-0740-310 | 8 | Knob (4) | 547-0016-005 |
| 2 | Screw, 4-20 x 5/8” thrd frmg (3) | 575-5604-020 | 9 | Power cable (22') and hard | 023-9750-010 |
| 3 | Screw, 4-24 x 1/4” sheet metal (3) | 575-3604-008 | 10 | Accessory wire and hardware | 023-9750-011 |
| 4 | Microphone hanger clip | 023-3514-001 | 11 | 5" remote speaker (optional) | 250-0151-006 |
| 5 | Mic hanger ground wire | 023-7171-911 | 12 | Plastic washer (2) | 596-6400-015 |
| 6 | Transceiver mounting bracket | 017-2226-034 | 13 | Stainless steel spring washer | 596-9260-001 |
| 7 | Self-drilling screw, 1.25" (4) | | 14 | Knob (2) | 032-0792-015 |
| | Transceiver 1/4” | 575-9077-565 | 15 | Control head mounting bracket | 017-2226-050 |
| | Control unit #10 | 575-9077-545 | 16 | Control cable (17') | 597-2002-262 |

**Figure 2-3 Remote Mount Installation Components**

## 2.5 REMOTE CONTROL UNIT INSTALLATION

### 2.5.1 SETTING PROGRAMMING SWITCHES

The remote control unit does not require any programming by the computer setup described in Section 4. However, there are DIP switches on the control unit interface board that configure the control unit for various applications. These switches are factory preset and should not need to be changed when installing a remote-mount transceiver. However, if you want to verify the position of these switches or

program special configurations, refer to the information which follows. The location of these switches is shown in Figure 2-4.

*NOTE: In the following information, an asterisk (*) indicates the factory default setting.*

IIC Driver U102 Configuration (S100 1-4)

| | S100 | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| U102 out* | On | Off | On | Off |
| U102 in | Off | On | Off | On |

S100, 1-4 are used to switch IIC bus driver U102 in or out of the circuit. Currently, this driver is not used, so it is always switched out.

Control Unit Address Programming (S101 5, 6)

| | S101 | | |
|---|---|---|---|
| **Address** | **5** | **6** | **R133** |
| 110* | Off | Off | In |

Currently, address information is not used, so any address can be programmed.

*NOTE: R133 should always be "in" because if it is "out" and TP100 is brought low to enter the setup mode, the control unit EEPROM memory is erased.*

Volume Control Configuration (S100 5, 6)

| | S100 | |
|---|---|---|
| | **5** | **6** |
| Remote (standard)* | Off | On |
| Disabled (dual control) | Off | Off |
| Local | On | Off |

S100, 5 and 6 select which unit controls the volume. With a remote-mount transceiver, the "Remote" configuration is selected so that the control unit volume control adjusts the volume of the internal or external speaker (see Section 2.5.4).

When a control unit is used with a front-mount transceiver to provide dual controls, "Remote" or "Disabled" is selected. When "Remote" is selected, the transceiver and control unit volume controls operate in parallel (the volume level is the sum of the levels set by both controls). When "Disabled" is selected, only the transceiver volume control sets the volume level. In the dual control configuration, the levels of the transceiver and control unit internal speakers are the same.

The "Local" setting provides a locally controlled audio output that can be routed to a separate audio amplifier. However, in the current configuration, this setting cannot be used because the signal is routed to the microprocessor and improper operation will result.

LCD Viewing Angle (S101 4)

| | **S101-4** |
|---|---|
| Settable by menu mode* | Off |
| Fixed viewing angle | On |

S101-4 programs if the LCD viewing angle can be set by the menu mode or is a fixed setting. If it is settable by the menu mode, that mode and the "VIEW ADJUST" parameter must be enabled by transceiver programming. Any change is then permanently stored in the control unit EEPROM memory. The displays of the transceiver or other control units are not affected because they can only be changed locally.

If "Fixed" is programmed, the factory default viewing angle is selected on power up. This default setting can be changed by the Setup Mode (see Section 2.5.2). If a change is made by the menu mode with "Fixed" programmed, that setting is retained only until power is turned off.

Backlight On-Off (S101-3)

| | **S101-3** |
|---|---|
| Settable by menu mode* | Off |
| Fixed (factory setting = on) | On |

S101-5 programs if the backlight can be turned on and off by the menu mode or is fixed. Operation is similar to the LCD viewing angle described in the preceding section. If "Fixed" is programmed, the factory default setting of "on" can be changed by the setup mode.

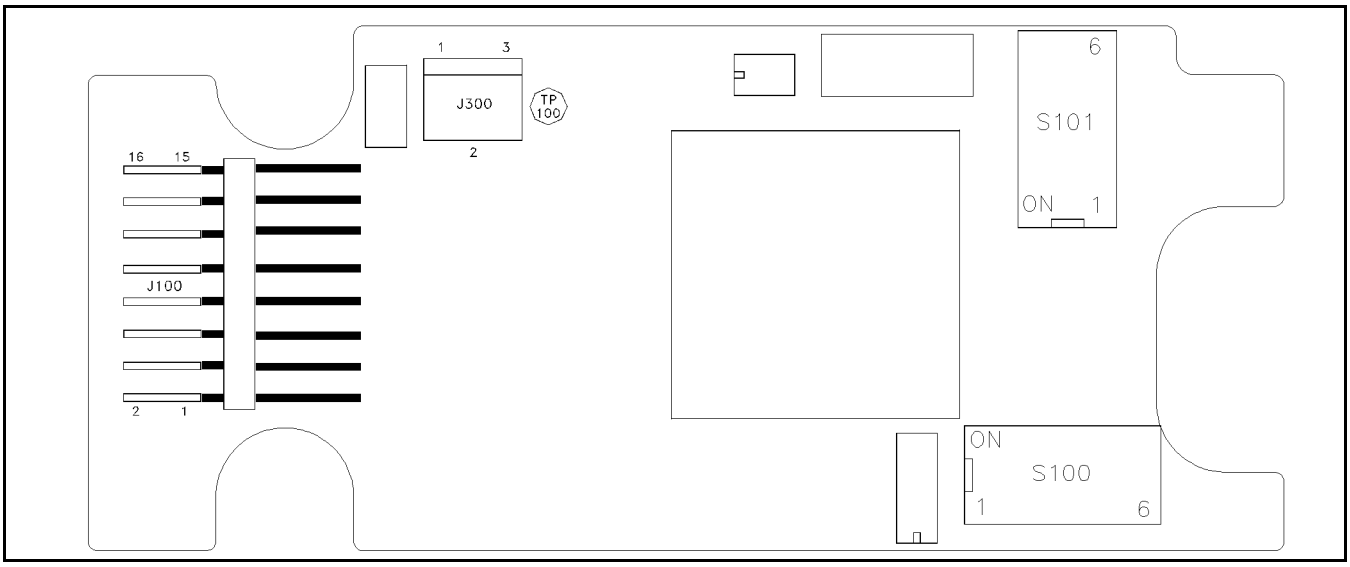



**Figure 2-4 Remote Control Unit Programming Switches**

Keypad and Knob Disable (S101-1, 2)

| | S101-1 | S101-2 |
|---|---|---|
| Select Knob Enabled | Off | --- |
| Select Knob Disabled | On | --- |
| Keypad Enabled | --- | Off |
| Keypad Disabled | --- | On |

S101-1 can be used to disable the Select knob and S101-2 can be used to disable the option keys. You may want to disable these controls in applications where the control unit acts as a slave and all control functions are performed by the master at another location.

### 2.5.2 USING SETUP MODE

The control unit has a setup mode that can be selected to program the default setting of the LCD viewing angle and backlight when "Fixed" is selected as described in the preceding information. Proceed as follows:

a. Remove the back cover of the control unit and locate TP100 on the interface board (see Figure 2-4).

b. With control unit power turned on, momentarily ground TP100 to select the setup mode.

c. To change the default backlight condition, press the Select switch so that the backlight is either on or off as desired.

d. To change the LCD viewing angle, rotate the Select switch in either direction to achieve the desired sharpness.

e. When the desired configurations have been selected, exit the setup mode by turning power off and then on again. The selected condition is stored in the EEPROM as it is selected.

### 2.5.3 MOUNTING REMOTE CONTROL UNIT

A diagram showing a remote transceiver installation is located in Figure 2-3. A control unit mounting bracket, 17-foot control cable, and mounting hardware are included with remote mount transceivers. Install the control unit as follows:

a. Check the area underneath the selected mounting location to make sure there is nothing that will be damaged when the mounting screws are installed. Then install the mounting bracket using the included self-drilling screws or other screws if desired.

b. Install the control unit in the bracket using the included plastic washers, spring washers, and knobs as shown in Figure 2-3.

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

d. Route the control cable from the transceiver to the control unit and plug it into both.

e. To route speaker audio to the control unit, insert the two wires on the transceiver end of the control cable into the slots for pins 1 and 2 of the accessory connector (see Figures 2-2 and 2-3). The order of these wires is not important.

*NOTE: If the control unit is being used with a front-mount transceiver to provide dual controls, a jumper must also be connected between pins 1 and 3 of the accessory connector to route audio to the transceiver speaker.*

### 2.5.4 USING AN EXTERNAL SPEAKER WITH A REMOTE CONTROL UNIT

A 12-watt external speaker (such as the one listed in Table 1-1) can be used in place of the 5-watt speaker in the control unit. Instead of connecting the two control cable wires to the accessory connector as described in step e above, connect the external speaker to pins 1 and 2 of that connector instead. It is not recommended that an external speaker be used if an internal speaker is also being used such as in dual control applications.

### 2.5.5 MICROPHONE HANGER SENSE

When the blank front panel is installed on a transceiver, the microphone hanger line goes to an off-hook (high) state. This is sensed by the microprocessor which may then initiate such actions as halting scanning or enabling the conventional monitor mode.

To prevent this from happening, the transceiver should be programmed as a remote-mount type by selecting “Yes” for the “Remote Trunk Mount” parameter on the Main Radio Parameters screen (see Section 4.3.2). The microprocessor then assumes that the hanger line is always in an on-hook state (low). This is the only special transceiver programming that is required to use the remote control unit.

In dual control applications, the hanger line is controlled by a microphone, so this parameter should be programmed “No”. The hanger line is not used in remote-mount configurations because the microprocessor detects the control unit hanger status from data on the serial data bus.

## 2.6 INSTALLING OPTION SWITCH KEY CAPS

A key cap kit included with each transceiver (see Table 1-1). This kit includes key caps labeled for each option that can be programmed and also blank keys for unused positions.

A key cap removal tool is included with each transceiver in the cable and hardware kit. This tool is simply a narrow strip of metal. To remove a key with this tool, hold it perpendicular to the front panel and then slide it under the lower side of the key. This releases the key so that it can be pulled out. To install a new key cap, simply press it into the opening.

## 2.7 INSTALLING DC NOISE FILTER KIT

The DC Noise Filter Kit is available as a field or factory installed option as described in Section 1.5. This kit contains filter choke, Part No. 542-5010-005, which is installed in the main 13.8-volt line on the PA board. To install this choke, proceed as follows:

a. Remove both the red and blue power cable leads from the PC board as shown in Figure 2-5. This provides the needed access to the front of the choke.

b. Prepare the leads of the choke so that they are approximately 1/8" below the lowest part of the choke.

c. Install the choke in the PC board holes provided and solder the leads using a soldering iron with a long, narrow tip. Removal of the PA board should not be required.

d. Install the blue and red power cable leads in the holes shown in Figure 2-5. Make sure that these wires or the choke leads do not extend too far into the board because a direct short to the chassis could result.

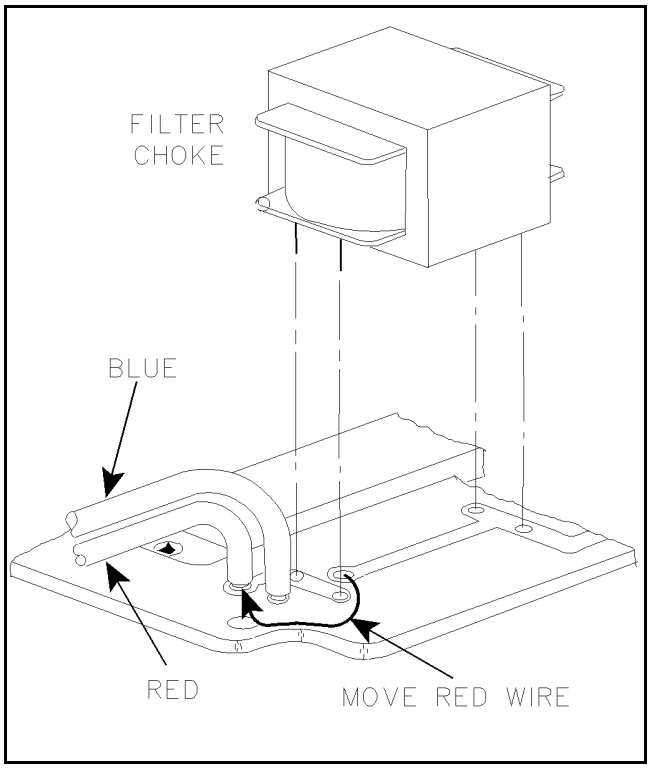



**Figure 2-5 DC Noise FIlter Installation**

## 2.8 TRANSCEIVER MOUNTING TRAY INSTALLATION

### 2.8.1 DESCRIPTION

Optional Transceiver Locking Tray, Part No. 585-7000-185, is a lockable mounting bracket for Summit DM transceivers and other transceivers that use that chassis. This bracket provides theft protection and allows the transceiver to be quickly removed from the vehicle.

### 2.8.2 INSTALLATION

Refer to Figure 2-6 and proceed as follows:

a. Install the transceiver in bracket MP2 using the four 10-32 x 1/2" screws (HW2) included. If desired, this mounting bracket can be used to mount the transceiver directly to the vehicle.

b. Install lock bracket MP1 using the four self-drilling screws (HW3) and washers (HW5) included. Make sure that there is nothing under the mounting location that will be damaged.

### 2.8.3 LOCKING AND UNLOCKING TRANSCEIVER

To insert the transceiver with attached mounting bracket into the locking bracket, set it over the locking bracket and push it rearward slightly if necessary so that it seats. Then pull it forward until it latches.

The lock operates in a manner similar to most glove compartment locks. To release the transceiver, press the button and at the same time push the transceiver rearward. The key locks the button so that it cannot be pressed.

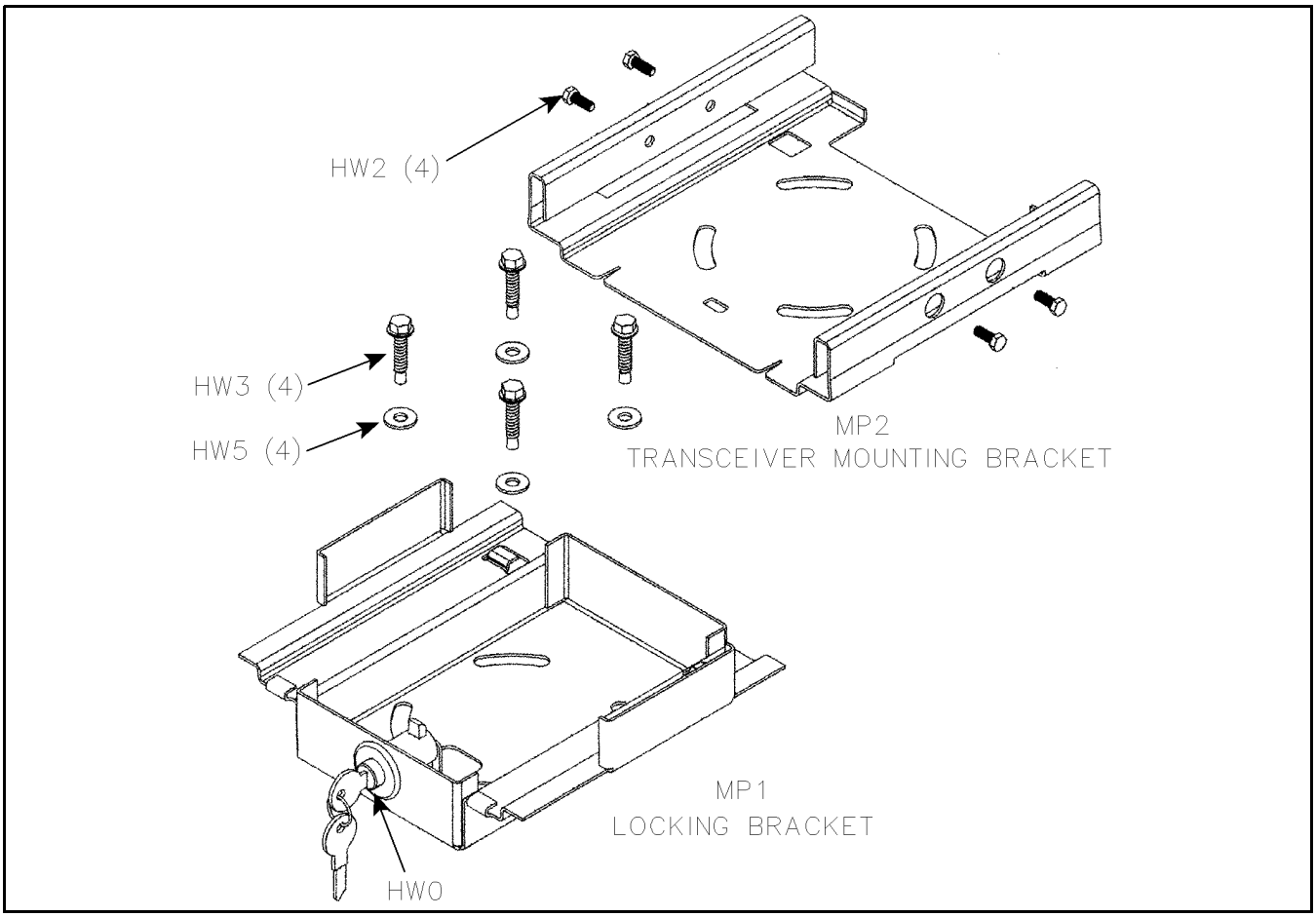



**Figure 2-6 Locking Tray Installation Diagram**

# SECTION 3 OPERATION

## 3.1 FEATURES

*NOTE: System operator programming determines the availability of some of the preceding features.*

### GENERAL FEATURES

- Up to 32-100 systems programmable (the maximum varies with type and no. of groups)
- Each system programmable for Multi-Net, LTR, or conventional operation
- Up to 11 (Multi-Net) or 10 (LTR and conventional) groups programmable per system
- Liquid Crystal Display (LCD) with backlight
- Six programmable option switches
- System scan
- Group scan (except some early versions)
- User programmable system and group scan list
- Phone mode
- Horn or light alert to signal when a call is received
- Call indicator
- Proceed (clear-to-talk) tone
- Emergency switch
- Banks of systems programmable
- Time-out timer
- Five different power levels programmable on each system
- Write-On™ flash memory for convenient software updates
- Voice encryption available
- UD$^2$I universal interface available (later models)
- Compatible with Summit control unit
- Cloning ability which allows one transceiver to program another with same information

### MULTI-NET FEATURES

- Busy queuing
- Auto-registration
- Status message transmission
- Unique ID calls to specific mobiles
- Transmit inhibit

### LTR FEATURES

- Free system ringback
- System search
- Transpond
- Transmit inhibit

### CONVENTIONAL FEATURES

- Busy indicator
- Tone (CTCSS) and digital Call Guard squelch
- Transmit disable on busy
- Monitor switch
- Repeater talk-around
- Priority group sampling
- Receive-only channels

## 3.2 FRONT PANEL CONTROLS AND DISPLAY

*NOTE: The remote control unit front panel is the same as the front panel on front mount transceivers.*

### 3.2.1 FRONT PANEL CONTROLS

#### FRONT PANEL CONTROLS

**On-Off/Volume -** Pressing this knob turns power on and off. The vehicle ignition switch may also control power (see Section 3.6.7). Rotating this control sets the volume level.

**Select Switch -** This switch changes the selected system or group number and is also used at other times, such as in the Menu Mode, to select parameters (see Section 3.5).

When it is used to change the selected system or group, turning it clockwise increases the system or group number and turning it counterclockwise decreases the system or group number. Only system/groups in the current bank can be selected (see Section 3.6.6). After the highest system or group is displayed, the display wraps around to the lowest system or group and vice versa. When wrap-around occurs, a beep sounds.

A bar above the system or group number indicates which is changed by this switch. To switch this bar between the system and group displays, press the Select switch. The transceiver can be programmed so that this bar defaults to either the system or group

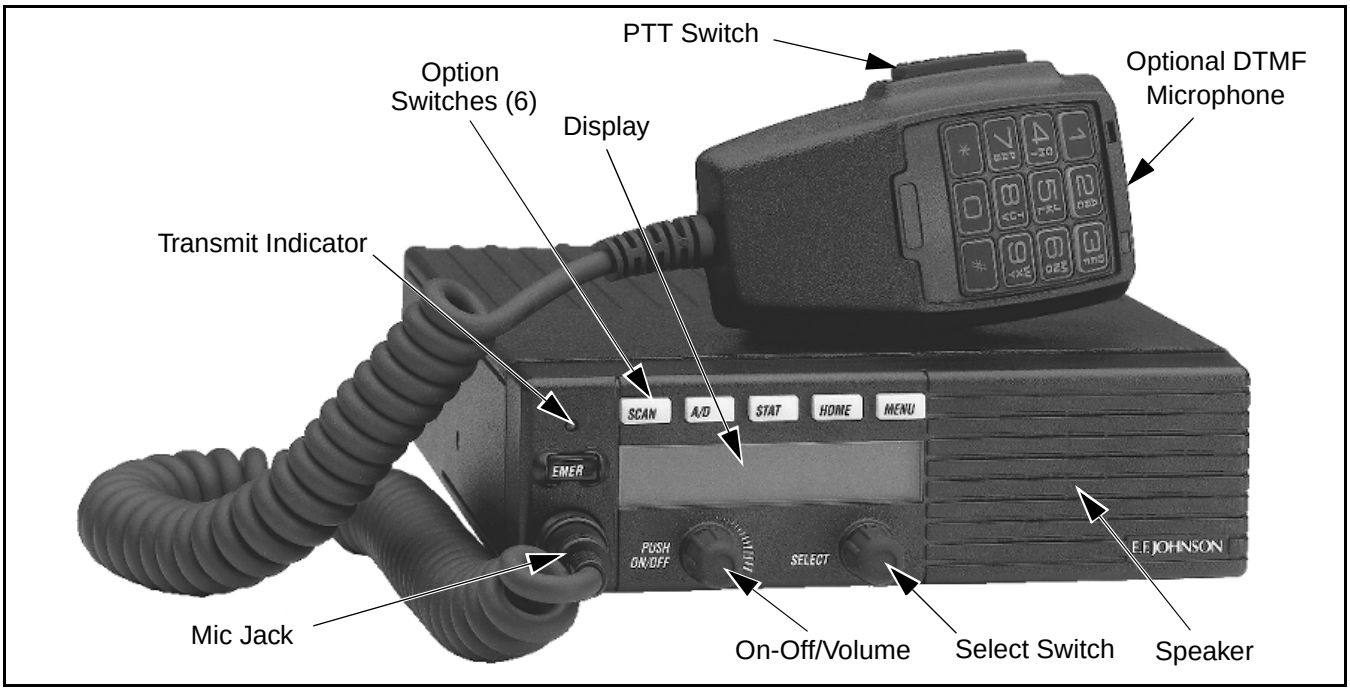



**Figure 3-1 Front Panel Controls**

display. In addition, the return time can be programmed for 1-15 seconds or infinite. (The return time is the time that elapses before the bar goes back to the default position.)

**Option Switches -** Up to six option switches can be individually programmed to control various functions. The function controlled by a key is indicated by the key cap. Refer to Section 3.5 for more information on the option switches.

**Transmit Indicator -** This red indicator shows when the transmitter is keyed.

**Microphone Jack -** Connection point for the microphone or the programming cable when programming the transceiver (see Section 4).

**Speaker -** There is a 5-watt, 16-ohm speaker located behind the grille. If higher power output is desired, an optional 4-ohm external speaker may be used to provide up to 12 watts of power. The internal speaker is disabled when an external speaker is used (see Sections 2.4.2 and 2.5.4).

## REAR PANEL JACKS AND CONNECTORS

**Antenna Jack -** Type N jack for connecting antenna.

**Power Jack -** Connection point for the 12-volt, negative ground power source.

**Accessory Jack -** Connection point for the ignition sense line and also accessories such as an external speaker and horn alert (see Section 2.4).

**Remote Control Unit Jack -** Connection point for the remote control unit. The pigtail with this jack is optional with front mount transceivers.

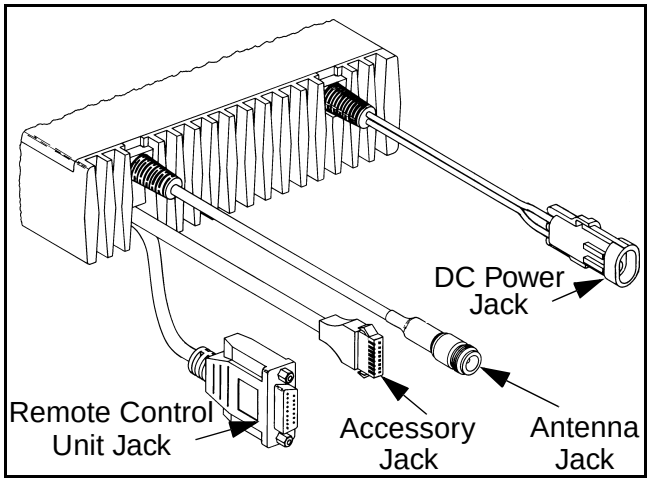



**Figure 3-2 Back Panel Jacks And Connectors**

### 3.2.2 DISPLAY

**Backlight -** The display has a backlight which can be programmed to automatically turn on with transceiver power or it can be controlled manually by the BKLHT option switch or Menu Mode "BACKLIGHT" parameter (see Section 3.5.5).

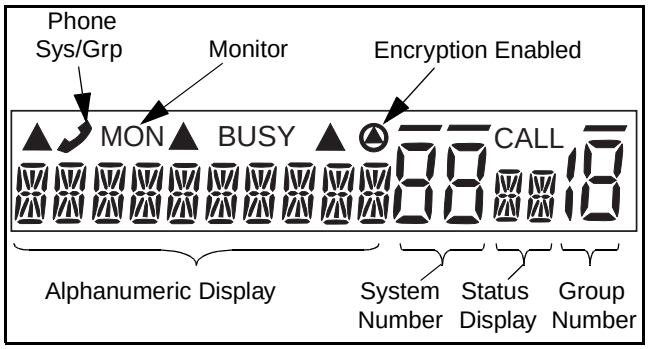



**Figure 3-3 Front Panel Display**

**System Number -** Indicates the currently selected system number. System numbers up to 99 can be programmed.

**Group Number -** Indicates the currently selected group number. Group numbers up to 11 (Multi- Net) or 1 (LTR/conventional) can be programmed.

**Alphanumeric Display -** This 10-character area of the display indicates the unique identification for the selected group. For example, "GAS TRUCK" can be displayed when a certain group is selected. It also displays telephone numbers in the phone mode and various error and status messages.

**Status Display -** These two characters indicate the following status information:

- Rotating clock-like symbols in both positions indicate that system scanning is occurring. This is also indicated during programming.

- This symbol in the left position indicates that the displayed system is in the scan list. Likewise, this symbol in the right position indicates that the displayed group is in the scan list.

- This symbol in the right position indicates that group scanning is occurring.

**P1/P2 -** When a conventional system is selected, "P1" indicates that a call is being received on a priority 1 group, and "P2" indicates that a call is being received on a priority 2 group. Refer to Section 3.5.17 for more information.

**ON/OF -** When the menu mode is selected by the MENU switch, "ON" indicates that the displayed parameter is active, and "OF" indicates that it is inactive.

- Indicates that the function controlled by the option switch above it is active. For example, this symbol below the Scan switch indicates that the scan mode is enabled. Only certain switches require this indicator.

- Indicates that the displayed system/group is programmed for telephone or special calls.

- Indicates that encryption is enabled.

**MON -** Indicates that the monitor mode has been enabled by taking the microphone off-hook or pressing the MON switch (conventional systems only). The monitor mode disables Call Guard squelch and scanning so that all messages are heard on the channel.

**BUSY -** Indicates when the selected system/group is busy (conventional systems only). If this indication appears but no message is heard and Call Guard squelch is programmed, a call for someone else was probably detected.

**CALL -** Indicates that a call was received while the user was away from the vehicle. It is turned off by pressing the Select switch, an option switch, or the microphone push-to-talk switch, or by turning power off and then on again. Refer to Section 3.6.2 for more information.

**"–" -** The bars above the system and group digits indicate which display will be changed if the Select switch is turned. Refer to the Select switch description in the preceding section for more information.



Revised February 1997
Part No. 001-9750-005

## 3.3 OPERATING MODES

### 3.3.1 INTRODUCTION

Each selectable system can be programmed with a unique set of transceiver operating parameters. One of these parameters is the operating mode which can be Multi-Net, LTR, or conventional. The type or types of operation programmed is determined by the radio equipment that is being accessed by that system. The basic operating differences between these system types are as follows.

### 3.3.2 MULTI-NET AND LTR MODES

The Multi-Net mode provides the most powerful operating features. Features available only with Multi-Net operation include Busy Queuing, Status Messages, Auto-Registration, and special calls (see Sections 5.7 and 5.8).

The LTR mode of operation is similar to the Multi-Net mode. The main difference is that the preceding features are not available. The features that are unique to LTR operation are described in Section 3.8. In both the Multi-Net and LTR modes, channel selection and monitoring before transmitting are performed automatically by the transceiver. Telephone calls (if available) can be placed almost as conveniently as with a standard telephone. Busy and out-of-range conditions are indicated by special tones and display messages.

### 3.3.3 CONVENTIONAL MODE

General

Selecting a conventional system selects a specific radio channel, and selecting a group (if available) selects the type of squelch control used on that channel such as carrier or Call Guard tone (CTCSS) or digital squelch. This selects the specific mobiles or group of mobiles being called and which calls are received on that channel.

Channel selection is performed manually by selecting a system. Monitoring can be performed automatically or manually (see next paragraph) When it is performed automatically, a special tone and display message indicate a busy condition. Otherwise, there are no tones or display messages to indicate busy and out-of-range conditions.

Monitoring Before Transmitting

If the Transmit Disable On Busy feature is programmed (see Section 3.9.1), monitoring is performed automatically. Otherwise, it is performed as follows:

- If not scanning, note if “BUSY” is being displayed. If it is not, the channel is free and a message can be transmitted.
- If scanning, take the microphone off-hook to halt scanning and enable the monitor mode (indicated by “MON” in display). The monitor mode (see Section 3.9.3) can also be selected by the MON switch if available. This mode disables any squelch control features so that all messages are heard. If no messages are heard, the channel is free and a message can be transmitted. If the transceiver is programmed to not detect an off-hook condition, the MON switch or the Transmit Disable On Busy feature must be used to perform monitoring.

### 3.3.4 MULTI-NET AND LTR SYSTEM/GROUPS

Systems

When the system is programmed for Multi-Net or LTR operation, information such as home repeater, all encode and decode ID codes, and call indicator and horn alert operation is programmed. The ID codes can be fixed priority, selectable, and block types. The types of ID codes and the number of ID codes that can be programmed in each category are as follows. Any combination of codes can be programmed and all codes can be different.

| **Decode (Receive)** | **Encode (Transmit)** |
|---|---|
| Fixed Priority | |
| 2 (M-Net & LTR) | --- |
| Selectable | |
| 11 (Multi-Net) | 11 (Multi-Net) |
| 10 (LTR) | 10 (LTR) |

| | Block |
|---|---|
| Up to all 225 (M-Net) | --- |
| Up to all 250 (LTR) | --- |

Groups

Each group switch position selects one of the selectable ID codes. Only the selected ID code is encoded when transmitting because it is not possible to encode more than one code. Group scan programming determines how the selectable ID codes are detected. Without group scan, only the selected ID code is decoded; with group scan, all selectable codes are decoded.

The fixed priority and block ID codes are always decoded regardless of which group is selected or group scan programming (if the system is selected or scanned). When a fixed priority ID code is detected, the selectable groups of that system are checked to see if any are programmed with the same code. If one is the same, the number and unique identification of that group are displayed. If none are programmed with the priority ID code, “PRIORITY 1” or “PRIORITY 2” is displayed and the group number does not change. When a block ID code is detected, the group number never changes and “BLOCK CALL” is displayed.

The Scan Resume Delay described in Section 3.4.3 determines how long the priority or block group is displayed after the call ends. In addition, if a priority call is received on a selectable group, the “Scan Revert Mode” programming described in Sections 3.4.4 and 3.4.5 determines if a response occurs on the displayed, last selected, or fixed group. With block calls and priority calls not on a selectable group, a response can be made by manually selecting a system/group programmed for that purpose.

Receive Priority ID Codes

The fixed, selectable, and block ID codes have a priority order so that an incoming call with a higher priority ID code can interrupt a lower priority call in progress. One use of receive priority is to allow a dispatcher to interrupt calls in progress with an important “all call” message. If the transceiver detects a call with a higher priority ID than the one it is receiving, it immediately drops that call and switches to another repeater to receive the higher priority call.

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

1. Fixed Priority ID Code 1
2. Fixed Priority ID Code 2
3. Selectable ID Codes (with last sel revert prog)
4. Block ID codes

For example, if a call is being received on selectable group 4 and a call is detected on priority ID 2, the call on group 4 is immediately dropped and the transceiver switches to the call on priority ID 2.

If the system is programmed for Multi-Net operation, incoming call information is received on both the status repeater and the repeater to which a mobile is trunked (refer to Section 5.6). Therefore, a priority call is not missed even if a mobile is not using its home repeater. With LTR operation, call information is received on only the home repeater. Therefore, priority calls are not detected while trunked to some other repeater. Other times when priority calls could be missed with both types of systems are when some other system not programmed with the priority ID is being monitored and while transmitting.

With Multi-Net operation, certain types of special calls may also interrupt standard or other special calls. Table 3-1 shows which Multi-Net calls can interrupt another type. Multi-Net operation also has an access priority which is discussed in Section 5.8.2.

Standard Calls

Standard calls are between mobiles or groups of mobiles assigned to the same home repeater. They use the standard group ID codes from 1-225 as described in Section 5.7 (1-250 with LTR calls). A standard call is placed by simply selecting a group programmed with the desired group ID and then pressing the PTT switch. No number is dialed using a keypad as with special calls. To receive a standard call, the mobile must be programmed to decode the group ID code being transmitted. With all Multi-Net calls, unique ID code information is also transmitted by the originating mobile. However, it is not decoded when receiving a standard call.

**Table 3-1 Multi-Net Standard And Special Call Receive Priority**

| | Interrupting Call | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Call in Progress** | **Standard Group** | **Intercon-nect** | **Auxiliary** | **Interro-gate** | **Kill** | **Reassign** | **Emer-gency** | **All Call** |
| Standard Group | [1] | [1] | [1] | Yes | Yes | Yes | Yes | Yes |
| Interconnect | No | No | No | No | Yes | Yes | Yes | Yes |
| Auxiliary | No | No | No | No | No | No | Yes | Yes |
| Interrogate | No | No | No | No | No | No | Yes | Yes |
| Kill | No | No | No | No | No | No | Yes | Yes |
| Reassignment | No | No | No | No | No | No | Yes | Yes |
| Emergency | No | No | No | No | No | No | --- | Yes |
| All Call | No | No | No | No | No | No | [2] | -- |

[1] With these calls, the priority order is determined by the type of ID code as described in Section 3.3.4.
[2] Since the "All Call" call goes out on all system repeaters, the emergency call is not sent until that call is finished.

## 3.4 SCAN (SYSTEM AND GROUP)

### 3.4.1 INTRODUCTION

The system scan feature monitors the programmed systems of the current bank. When a message is detected that the transceiver is programmed to receive, scanning stops and the message is received. Shortly after the message is complete, scanning resumes.

System scanning is turned on and off by the SCAN option switch (see Section 3.5.19). When system scanning is enabled by an option switch, a triangle ( Δ ) is indicated in the display below the switch. The microphone must also be on-hook for scanning to occur (unless off-hook detection has been disabled by programming). When system scanning is actually occurring, either "SNGLE SCAN" (single-site) or "MULTI SCAN" (multi-site) is indicated in the alphanumeric display (see next section). In addition, two rotating symbols are present in the status display between the system and group numbers as described in Section 3.2.

Scanning is sequential through the programmed systems in the current bank unless they have been deleted from the scan list or single-site scan is used. The selected system and group can be changed while scanning using the Select switch in the normal manner. Scanning temporarily halts while the change is being made.

While scanning is occurring (rotating symbols in the status display), the display always indicates the system/group on which a transmission would occur. However, when a call is received, the display changes to the system/group of the call and this may not be where a transmission occurs (see Section 3.5.21). When the delay period expires (see Section 3.4.3), the system/group on which transmissions occur is again displayed.

### 3.4.2 MULTIPLE- AND SINGLE-SITE SCAN

Each bank can be programmed for either Multi-Site or Single-Site scan. This can also be selected by the user if the Menu Mode "SCAN SELCT" parameter is available (see Section 3.5.21). The type of scanning currently selected is indicated by "SNGLE SCAN" or "MULTI SCAN" in the alphanumeric display when scanning is occurring. The single-site type should be used when only Multi-Net systems programmed with the same site number are to be scanned. Otherwise, the multiple-site type should be used. These types of scan operate as follows:

**Single-Site Scan -** Calls are detected on only systems in the current bank that are programmed with the site number of the revert system. For example, if System 2 was displayed when scanning was turned on, only systems programmed with the System 2 site number are scanned. For more information on sites, refer to Sections 4.4.4 and 5.4.

If LTR or conventional systems are also programmed, they are skipped in the scan sequence because only Multi-Net systems are scanned. If an attempt is made to enter scanning on with an LTR or conventional system displayed, scanning can be selected only if Multi-Net auto-registration is enabled. Auto-registration then occurs and scanning begins on that site. If auto-registration is not programmed, an error tone sounds, "NOT MULTI" is displayed, and the scan mode is not entered.

The single-site type of scanning is very efficient because only the status repeater of the site is monitored which means that no waiting is required to change channels. The data from the status repeater is checked against the home repeater/group ID codes of all selectable systems programmed with that site number. If there is a match, the transceiver switches to the appropriate repeater and receives the call.

If no traffic is detected on the status channel for a period of time, the transceiver begins scanning the home repeaters of all systems programmed with the site number being scanned. This ensures that scanning occurs even if the status repeater is not on the air. The status channel also continues to be scanned, and normal scanning of the status channel resumes when messages are again detected. When home repeaters are scanned, data messages are decoded for only as long as necessary to detect all calls on that repeater.

**Multiple-Site Scan -** This type of scan is programmed when more than one site is scanned or if LTR or conventional systems are to be scanned. The status channels of Multi-Net systems are scanned as are the home repeater of LTR systems and the channels of conventional systems. As with Single-Site Scan, if the status channel of a particular Multi-Net site is not in service, the home channels are scanned until messages are again detected on that status channel. All system/groups in the current bank (see Section 3.6.6) are scanned unless they are deleted from the scan list.

### 3.4.3 SCAN RESUME DELAY

*NOTE: The following timers are also used is some circumstances when not scanning, such as when priority or block calls are received as described in Section 3.3.4.*

Receive Delay

When a message is received while scanning, there is a programmable delay of 0-7 seconds before scanning resumes (if it has not been disabled, such as by taking the microphone off-hook). This delay is called Receive Delay Time and it prevents another message from being received before a response can be made. This delay is also in effect if a front panel control is changed while scanning such as to select another system/group. This timer is reset if another call is received.

Transmit Delay

The Receive Delay Time controls the scan delay until the transmitter is keyed and then the Call Delay Time controls the delay. This time is also programmable for 0-7 seconds and it ensures that a response to your message is heard instead of some other message occurring on another system/group. The Call Delay Timer remains active for the remainder of the conversation and controls when normal scanning resumes even if additional responses are received.

Scan Continue Timer

There is also a scan continue timer that can be programmed. This timer controls the maximum time that a call is received before scanning resumes. This prevents scanning from being delayed for long periods by lengthy calls. This time can be programmed for 0-60 seconds in 1-second increments. If "0" is programmed, there is no time limit and the entire message is always received.

### 3.4.4 TRANSMITTING IN THE SCAN MODE

*NOTE: If Auto-Registration is used, the revert system may change automatically. Refer to Section 3.7.2 for more information.*

Programming of the "Scan Revert Mode" radio parameter determines the system/group on which transmissions occur in the scan mode. In addition, if this programming causes the selected system/group to change, it affects the system/group that is selected when the scan mode is exited by pressing the Scan switch. An exception when it does not control the transmit system/group is if the bank is programmed

with a fixed transmit system/group as described in Section 3.4.5. The three programmable configurations are as follows:

**Last Selected System/Group -** Transmissions always occur on the system/group that was last selected by the Select switch. To respond to a call not on the selected system/group, the scan mode must be exited by pressing the scan switch. If this is done before scanning resumes, the system/group of the call becomes the selected system/group and it is not necessary to change it manually. The system/group of the call is displayed until the microphone is taken off-hook, the PTT switch is pressed, or the scan delay expires.

**Last Received -** The selected system/group changes to the system/group of a call. Therefore, the user can always respond to a call without having to manually change the system/group.

**Temporary Last Received -** The system/group changes to the system/group of a call for only the duration of the scan resume delay period described in Section 3.4.3. Then when the delay expires, the selected system/group is again displayed. Therefore, a response to a call can be made without changing the selected system/group if it occurs before scanning resumes.

*NOTE: If a transmit request is received from a data device, the preceding programming is overridden (see Section 3.6.11).*

### 3.4.5 FIXED TRANSMIT IN SCAN MODE

If a system and group are entered for the "Fixed System/Group Transmit During Scan" bank parameter, this programming may take precedence over the "Scan Revert Mode" programming described in the preceding section. If the transmitter then is keyed while scanning is occurring (rotating status display), transmissions occur on the programmed fixed system/group. In addition, it becomes the selected system/group. Since taking the microphone off-hook halts scanning unless off-hook detection is disabled, the transmitter must usually be keyed with the microphone on-hook. If the transmitter is keyed with scanning halted or when no system/group is programmed for this parameter, the programming described in the preceding section takes precedence.

### 3.4.6 SCAN LIST PROGRAMMING

Systems and groups can be added to or deleted from the scan list if the transceiver is equipped with an A/D (add/delete) option switch. The bar above the system or group indicates which will change when the A/D switch is pressed. To switch this bar between the system and group displays, press the Select switch.

The scan list status of a system or group is indicated in the status display. An  next to the system number indicates that the displayed system is in the scan list and scanned normally. Likewise, an  next to the group number indicates that the displayed group is in the scan list. When scanning is occurring, the scan list status is not indicated because the rotating scanning indicators are displayed.

The selected group is always scanned, even if it is deleted. Therefore, if all systems or groups are deleted, the selected group is still scanned. Systems and groups can be deleted from the scan list while listening to a message on the system or group by pressing the A/D key in the normal manner. Scanning resumes shortly after the system or group is deleted. Deleting a system only temporarily deletes the groups associated with that system. Therefore, when a system is added back into the scan list, the original group scan list is again active.

The transceiver can be programmed to either save or not save changes to the scan list. This programming can be done by the system operator or by the user if the Menu Mode "SCAN SAV" parameter is selectable. Changes are saved when "ON" is selected, and not saved when "OFF" is selected. Therefore, to store a list with the menu mode, select "ON", program the list, then select "OFF". When power is cycled, the scan list then returns to the status the existed when "OFF" was selected. If the menu parameter is not selectable, the scan list returns to the last selected status if "ON" is programmed, and to the dealer programmed default state if "OFF" is programmed.

### 3.4.7 GROUP SCAN

Each system can be programmed for Group Scan using the programming software. There is no switch for selecting this feature. Group scanning occurs whenever a system programmed for group scan is selected or scanned with the microphone on-hook (the scan mode

**Table 3-2 Menu Mode And Option Switch Functions**

| FUNCTION | MENU ITEM | OPTION SWITCH | SWITCH LABEL | FUNCTION | MENU ITEM | OPTION SWITCH | SWITCH LABEL |
|---|---|---|---|---|---|---|---|
| A/D (Scn List Prg) | | X | A/D | LTR System Search | X | | |
| Auto-Registration | X | | | Menu Mode Select | | X | MENU |
| Auxiliary 1 | X | X | AUX 1 | Monitor | | X | MON |
| Auxiliary 2 | X | X | AUX 2 | Phone Mode Select | X | X | PHONE |
| Backlight | X | X | BKLHT | Priority | X | X | PRI |
| Bank Select | X | X | BANK | Radio Tones | X | | |
| Call Guard Disable | | X | CG | Scan On/Off | | X | SCAN |
| Emergency | | X | EMER | Scan List Save | X | | |
| Encryption | X | X | ENCPT | Scan Type | X | | |
| Ext PA (Mic audio) | X | X | PA-MC | Siren (see Aux 1/2) | | X | SIREN |
| Ext PA (Rx audio) | X | X | PA-RX | Status Select | X | X | STAT |
| Home Sys/Grp | | X | HOME | Talk-Around | X | X | TA |
| Horn/Light Alert | X | X | HORN | Viewing Angle Adj | X | | |

does not need to be selected). If off-hook detection is disabled by programming, group scanning is always enabled if it is programmed. Group scanning is indicated when all the segments of the status display adjacent to the group number are on. There is no group scan indicator when system scanning because rotating symbols appear in both locations of the status display.

When group scan is occurring, calls are received on all selectable groups of a system regardless of which is selected. In addition, the display automatically changes to the group on which a call is received. Without group scan, calls are received on only the last selected group of each system. The group scan list can be programmed as described in the preceding section. In addition, the scan resume delay information described in Section 3.4.3 also applies to group scanning.

### 3.4.8 SCANNING THE VARIOUS TYPES OF SYSTEMS

Scanning Multi-Net and LTR Systems

Group scan programming described in the preceding section controls whether all groups or only the last selected group of Multi-Net and LTR systems are scanned. If fixed priority or block ID codes (see Section 3.3.4) or Multi-Net ID codes 236 or 237 (see Table 4-2) are programmed, calls on those ID codes are received regardless of which group is selected or group scan programming (if the system is selected or scanned).

Conventional Systems

Group scan programming also determines whether calls are received on all groups or only the last selected group of conventional systems. Call Guard squelch is detected on the selectable groups of conventional systems if the monitor mode is not enabled (see Section 3.9.3). If the monitor mode is enabled, all calls occurring on a system (channel) are received.

Priority groups can also be sampled when scanning conventional systems. This feature ensures that important calls on the priority group or groups are not missed while listening to calls on non-priority groups. See Section 3.5.17 for more information.

## 3.5 OPTION SWITCH AND MENU MODE FUNCTIONS

### 3.5.1 INTRODUCTION

This transceiver can be equipped with up to six option switches. The functions which can be controlled by these switches are indicated in Table 3-2 by an “X” in the “OPTION SWITCH” column.

If the transceiver is equipped with a MENU option switch, the Menu Mode can also be selected to control various functions. The functions that can be controlled by the Menu Mode are indicated in Table 3-2 by an "X" in the "MENU ITEM" column.

System operator programming controls which functions are displayed in the Menu Mode and also which option switches are available. Therefore, a function can be fixed by system operator programming by disabling that menu item, programming the default condition, and not programming an option switch to control it. Refer to Section 3.6.5 for more information on creating a radio profile. If a function is assigned to an option switch, it is not available as a menu item.

If a call is received or transmitted while in the Menu Mode, the Menu Mode is exited and any changes are saved. The menu mode is selected as follows. The Menu Mode and option switch functions are described in the following sections.

Selecting The Menu Mode

a. Press the MENU switch to select the Menu Mode. Then turn the Select switch to select the parameter to be modified.

b. If the parameter has only on/off choices, the current status is shown as "ON" or "OF" in the status display (located between the system and group numbers). To change the status, press the Select switch.

c. If the parameter has several choices, the current status is displayed by pressing the Select switch and changed by rotating the switch.

d. The Menu mode is exited and the changes saved by pressing the MENU switch or if a call is received or the transmitter keyed. Changes are automatically saved and the Menu mode exited 2 seconds after changing a parameter or 10 seconds after no activity.

### 3.5.2 A/D (SCAN LIST PROGRAMMING)

The A/D option switch is used to add system/groups to or delete them from the scan list. Pressing this switch changes the status of either the displayed system or group. The bar above the number indicates which is changed. To move this bar between the system and group, press the Select switch. An asterisk ✱ in the status display next to the system or group indicates that it is in the scan list. Refer to Section 3.4.6 for more information.

### 3.5.3 AUTO-REGISTRATION

This Menu mode feature is indicated by "MN AUTOREG", and it is used to turn Multi-Net auto-registration on and off (see Section 3.7.2).

### 3.5.4 AUXILIARY 1 AND 2

Up to two auxiliary functions can be turned on and off by the Menu Mode "AUX 1" and "AUX 2" parameters or the AUX 1 and AUX 2 option switches. (There is also a SIREN key cap that can be used for these switches.) When a switch is used, the on condition is indicated by a triangle in the display under the switch. The output lines for these functions come from optional universal interface connector J601. Auxiliary 1 is pin 14 (AUX 1), and Auxiliary 2 is pin 16 (OUTPUT B). These outputs are active high. Refer to Section 4.7 for programming information.

An appropriate driver circuit is required to utilize these outputs. Maximum source current of AUX 1 is 50 mA and the output voltage is 8 VDC ±10%. OUTPUT B is a TTL output that can provide approximately 10 mA of drive current.

### 3.5.5 BACKLIGHT

The Menu Mode "BACKLIGHT" parameter or the BKLHT option switch can be used to turn the display backlight on and off. This light allows the display and option keys to be seen in low-light conditions. If this feature is not controlled by the Menu mode or option switch, it is usually programmed "Enabled" so that it turns on with transceiver power.

### 3.5.6 BANK SELECT

If banks of systems have been programmed, the Menu Mode "BANK SELCT" parameter or the BANK option key is used to enable the bank select mode. The Select switch is then turned to move to the desired bank and then pressed to select that bank. Refer to Section 3.6.6 for more information.

### 3.5.7 CALL GUARD SQUELCH DISABLE

The CG option switch is used to disable both transmit and receive Call Guard squelch on the selected conventional system/group (if it has been programmed). It does not affect Call Guard squelch operation on other system/groups. The disable mode is indicated by a triangle in the display under the switch. See Section 3.6.2 for more information.

### 3.5.8 EMERGENCY

This switch is normally the switch on the left side of the display. It can also be an external type such as a foot-operated switch. The Emergency switch is pressed to transmit a high priority message. Refer to Section 3.6.8 for more information.

### 3.5.9 ENCRYPTION

The ENCYPT option switch or “ENCRYPTION” Menu Mode parameter allows the user to override the system operator programming on the group. The triangle/circle symbol indicates when encryption is enabled. Refer to Section 3.6.12 for more information.

### 3.5.10 EXTERNAL PA

If the vehicle is equipped with a public address system, this feature allows the transceiver microphone to be used to speak over that system. Either the Menu Mode “EXTERNL PA” or the PA-MC option switch can be used to activate this feature. When this feature is active, the transmitter is disabled and the alphanumeric display indicates “MIC TO PA”. The PA output is pin 7 of the accessory cable (see Section 2.4.5).

The receive audio signal can also be heard on the public address system (as well as from the regular speaker). Either the Menu Mode “EXTERNL PA” parameter or the PA-RX option switch can be used to activate this feature. The alphanumeric display indicates “RCV AUD PA” when this feature is active. The output for this function is also pin 7 of the accessory cable.

### 3.5.11 HOME SYSTEM/GROUP

Each bank can be programmed with a “home” system/group that can be selected by pressing the HOME option switch. This function can also be used in the scan mode (scanning halts for the length of the receive scan delay).

### 3.5.12 HORN/LIGHT ALERT

An external alert such as the vehicle's horn or lights can be used to signal a call. The Menu Mode “HORN/LIGHT” parameter or the HORN option switch can be used to turn this alert on or off. The on condition of the switch is indicated by a triangle in the display under the switch. See the Horn Alert description in Section 3.6.4 for more information.

### 3.5.13 LTR SYSTEM SEARCH SELECT

The Menu Mode “LTR SEARCH” parameter enables or disables the LTR system search feature (refer to Section 3.5.13). If it is enabled, the transceiver automatically searches for an in-range system whenever an out-of-range condition occurs when making an LTR telephone call.

### 3.5.14 MENU SELECT SWITCH

The MENU option switch selects the Menu mode described in Section 3.5.

### 3.5.15 MONITOR MODE SELECT SWITCH

The MON option switch is used to select the monitor mode described in Section 3.9.3.

### 3.5.16 PHONE MODE SELECT

The PHONE option switch or “TELEPHONE” menu parameter is used to select the phone mode which is used to place telephone calls. Refer to Section 3.6.13 for more information on this mode.

### 3.5.17 PRIORITY

The PRI option switch or Menu Mode “PRIORITY” parameter enables or disables priority group sampling on conventional systems if priority groups are programmed. Refer to Section 3.5.17 for more information.

### 3.5.18 RADIO SOUNDS

The Menu Mode “RADIO SNDS” parameter selects the tones that are heard when switches are pressed or busy or out-of-range conditions exist. If this menu item is not enabled, the tones that sound are fixed by system operator programming. The four available conditions are as follows:

**Silent -** No tones at all sound.
**Key Beeps Only-** Only the option switch and Select switch beeps sound.
**Alert Tones Only -** The proceed, busy, and intercept tones sound, but not the key beeps.
**All Tones -** All tones sound.

### 3.5.19 SCAN ON/OFF

The SCAN option switch can be used to turn the system scan feature on and off (see Section 3.4). The on condition is indicated by a triangle under the switch. Without this switch, scanning is not available.

### 3.5.20 SCAN LIST SAVE

The Menu Mode “SCAN SAV” parameter selects if changes to the scan list are saved when power is turned off. If “ON” is selected they are saved, and if “OF” is programmed they are not saved. Refer to Section 3.4.6 for more information.

### 3.5.21 SCAN TYPE

The Menu Mode “SCAN SELCT” parameter selects the type of system scanning that occurs when it is enabled by the SCAN switch. Either “MULTI SITE” or “SNGLE SITE” can be selected. The type of scanning is indicated in the alphanumeric display when scanning is occurring. Refer to Section 3.4.2 for more information.

### 3.5.22 STATUS SELECT

The Menu Mode “STATUS” parameter or STAT option switch is used to display or change the status message that is being transmitted each time the transmitter is keyed with a Multi-Net system selected. Up to eight status messages may be programmed by the programming software. The Select switch is rotated to choose the desired condition and then pressed to select that condition. Refer to Section 3.7.3 for more information.

### 3.5.23 TALK-AROUND

The Menu Mode “TALKAROUND” parameter or TA option switch is used to turn talk-around on and off on conventional groups. Refer to Section 3.9.4 for more information.

### 3.5.24 VIEWING ANGLE

The Menu Mode “VIEW ADJ” parameter sets the viewing angle of the display. This provides optimal intensity when the Liquid Crystal Display (LCD) is viewed from the selected viewing angle. If you have trouble viewing information in the display, especially in low-light conditions, try changing this parameter.

Viewing angles represented by 0-15 can be selected. “0” = -45° and “15” = +45° . Note that when toggling from “15” to “0”, the display may appear to indicate all 8's. However, this is not what is actually being displayed because the correct information is indicated when it is viewed from -45° .

## 3.6 GENERAL FEATURES

### 3.6.1 TIME-OUT TIMER

The Time-Out Timer automatically disables the transmitter if it is keyed continuously for longer than the programmed time. It is programmable using the programming software for 0.5-5 minutes in half-minute increments. It can also be disabled by programming “disabled”. When the timer times out, the transmitter is automatically disabled, the intercept tone sounds, and “TX TIMEOUT” is displayed. Five seconds before time-out occurs, a warning beep sounds. The timer is reset by releasing the PTT switch. This feature prevents a channel from being kept continuously busy by an accidentally keyed transmitter. It also prevents possible transmitter damage caused by transmitting for extended periods.

### 3.6.2 CALL INDICATOR

The call indicator is the word “CALL” in the display. The purpose of this indicator is to show when a call is received while the user was away from the

vehicle. To turn this indicator off, change any front panel control, take the microphone off-hook, press the PTT switch, or turn power off and then on again. The call indicator operates in both the scan and non-scan modes. It is disabled during the scan delay periods described in Section 3.4.3.

With Multi-Net and LTR operation, the call indicator can be programmed to activate on specific fixed priority and selectable ID codes. It does not activate when calls are received on block ID codes. With conventional operation, the call indicator can be programmed to activate on each group. If a group is programmed for carrier squelch or if the monitor mode is enabled, it turns on when a carrier is detected. If Call Guard squelch is used, it turns on when the Call Guard tone or code is detected.

### 3.6.3 PROCEED (CLEAR-TO-TALK) TONE

This is a short tone that sounds when the PTT switch is pressed. It indicates that the radio system has been successfully accessed (data handshake completed) and speaking can begin. It is available on LTR and Multi-Net systems without any special programming and can be enabled or disabled on conventional systems. This and other tones can also be enabled or disabled by the Radio Sounds parameter described in Section 3.5.18.

When making any type of Multi-Net or LTR call, if the busy tone sounds and "SYSTEM BSY" is displayed when the PTT switch is pressed, the system is busy. If the PTT switch is held down, the system is accessed and the proceed tone sounds when it is available. If an out-of-range or some other error condition exists, the intercept tone sounds and the error condition is displayed.

If the proceed tone has been programmed on conventional systems, it does not sound if the channel is busy, but does sound even if an out-of-range condition exists. This occurs because there is no handshake that can be used to detect this condition. The channel should still be monitored manually because the transmitter always keys when the PTT switch is pressed (unless the Transmit Disable On Busy feature is being used).

With later models, a proceed tone delay of 125 - 1875 ms can be programmed on each system and then individually enabled or disabled on each dispatch group (a fixed delay of approximately 500 ms occurs with interconnect and auxiliary calls). This feature can be used to delay speaking with calls which have a longer setup time. This delay is available only with transceiver software, Version 222 or later, and programming software, Version 206 or later.

### 3.6.4 HORN/LIGHT ALERT

General

This feature activates an external alert such as the vehicle's horn or lights when calls are received on groups or priority ID codes programmed for this feature. When enabled as described in this section, the alert turns on for 0.5 second and off for 0.5 second for three cycles (3 seconds). It then goes back to the disabled state. Installation is described in Section 2.4.4.

*NOTE: In early 1996, a new version of transceiver software began shipping that allows two modes of horn alert operation to be programmed. New programming software is also required to program the additional mode. The transceiver software is Version 213 or later (see Appendix A), and the programming software is Version 204 or later (see Section 4.1.5). Another change occurred with Version 214 software to make Mode A totally manual (Mode A-1 described below is then no longer available).*

Operation in Mode A and B

Horn alert operation of earlier models (versions prior to 213) is always Mode A-1. The revised transceiver software and programming software are required to program Mode B.

A power-off delay can be programmed to occur when power is turned off by the ignition switch (see Section 3.6.7). If the ignition switch does not control power, only the front panel power switch affects operation in the following modes. Once transceiver power is turned off by the power or ignition switch or turn-off delay, the horn alert is no longer functional.

**Mode A-1 (Automatic Off/Manual On)**
(Transceiver Software Version 213 and earlier)

Ignition Switch - The horn alert always turns off when the ignition switch is turned on (with the power switch

on) but does not automatically turn back on again when the ignition switch is turned off. Therefore, it must be manually turned on after starting the vehicle.

Power Switch - The current horn alert mode does not change when power is turned on and off using the front panel power switch.

**Mode A-2 (Manual On and Off)**
(Transceiver Software Version 214 and later)

The current horn alert mode does not change when power is turned on and off by either the power or ignition switch.

**Mode B (Automatic Off and On)**
(Transceiver Software Version 213 and later)

Ignition Switch - The horn alert is always off when the ignition switch is turned on, and always turns on when the ignition switch is turned off (if there is a power-off delay programmed).

Power Switch - The horn alert is always off when the power switch is turned on.

Option Switch and Menu Mode Control

The HORN option switch or Menu Mode "HORN/LIGHT" parameter (see Section 3.5.12) can be used to change the current condition. However, the automatic operation described in the preceding modes overrides an on or off condition that may have been selected by the switch or menu parameter.

Permanently Enabling Horn Alert

The profile programming for the horn alert in the Menu screen (see next section) is in effect only until the first time it is manually or automatically changed. If neither an option switch or menu parameter is programmed and the default is set to "disabled", operation is as follows:

**Mode A1** - If the ignition switch controls power, this mode cannot be used because the horn alert automatically turns off the first time the ignition switch is turned on and there is then no way to turn it back on. If the ignition switch does not control power, the horn alert is always enabled when transceiver power is on.

**Mode A2** - If the horn alert is to be always enabled when transceiver power is on, this mode could be used.

**Mode B** - This mode could be used if the ignition switch controls power. The horn alert is then always disabled when the ignition switch is on and enabled during the turn-off delay. However, if the ignition switch does not control power, it cannot be used because the horn alert turns off the first time power is turned on and there is no way to turn it back on.

### 3.6.5 PROFILE

When programming the menu described in Section 3.5, a default setting for most items can also be selected. This default setting can establish the power-on profile of the transceiver. For example, the backlight could be on when power is turned on.

However, if an item can be changed by the user in the Menu Mode or by an option switch, it returns to the condition that was last selected by the user. Therefore, the default setting is fixed only if the parameter is not controlled by the Menu Mode or an option switch. The functions that can be programmed in the profile are as follows. If a function is not programmable, it returns to the last selected state or the state it was in when power was turned off.

| | |
|---|---|
| Auto-Registration | Priority |
| Auxiliary 1 and 2 | Radio Sounds |
| Backlight Control | Scan List Save |
| Bank Select | Scan Type Select |
| Encryption | Talk-around |
| External PA | Status |
| LTR System Search | View Angle Adjust |

### 3.6.6 BANKS

Banks of systems can be programmed to allow the transceiver to operate with different radio personalities. For example, one bank could be programmed for operation in Chicago and another for operation in St. Louis. Each bank can contain any of the systems that have been programmed, and they can be numbered differently. Only the systems in the currently selected bank can be selected or scanned.

To initiate changing from one bank to another, the BANK option switch or Menu mode "BANK SELCT" parameter is used. The Select switch is then turned to move to the desired bank and pressed to select that bank. The current bank is identified by the unique identification which temporarily appears in the alpha-numeric display when the switch is pressed or the menu parameter selected. For example, "CHICAGO" and "ST LOUIS" could be displayed to identify the banks used for those cities.

Each bank can be programmed so that either the last selected or home system/group is displayed when the bank is selected or power is turned on. To have this feature, transceiver software Version 216 or later and programming software Version 205 or later are required. With earlier versions, the last selected system/group is always displayed.

### 3.6.7 POWER TURN-OFF DELAY

The transceiver can be programmed so that the vehicle ignition switch as well as the front-panel power switch controls transceiver power. With transceiver operating software Version 205 or earlier (see Appendix A), turn-off delays of Immediate, 10, 20, 30, 60, 120, or 240 minutes or Forever (no turn off) can be programmed. With Version 206 or later, delays of Immediate, 10 or 30 minutes, 1, 8, 10, or 12 hours or Forever can be programmed. The delay can be canceled at any time by turning power off using the front-panel switch or turning the ignition switch back on.

A delay allows features such as the horn alert and call indicator to remain active for the programmed delay time after the ignition switch is turned off. At the same time, advantages of ignition switch control can be utilized such as preventing battery discharge that may result if the transceiver is accidentally left on.

### 3.6.8 EMERGENCY CALLS

Introduction

The EMER (emergency) option switch is used to manually or automatically place a high-priority call. When this switch is programmed, it is the switch on the left side of the display because that switch is designed to make it less likely to be pressed accidentally. An external switch, such as a foot-actuated type, can also be used (see Section 2.4.6).

The general operation of Emergency Calls is described in Section 5.8.11. The two basic operating modes of the emergency switch are Manual Transmit and Automatic Transmit. Multi-Net systems can be programmed for either type; LTR and conventional systems can be programmed for the manual type only.

When the Emergency switch is pressed, "EMERGENCY" and the group identification are alternately displayed (unless the display of this message has been disabled by programming). The transceiver then looks at the emergency call information programmed in the currently selected system (or revert system if system scanning). If there is no emergency information programmed in that system, it looks at the default emergency information programmed for that bank. It then switches to the specified emergency system/group. Operation from this point is controlled by Manual/Automatic programming. Operation in those modes is as follows:

Manual Transmit

Automatic transmissions do not occur in the manual mode. However, this mode minimizes, as much as possible, the chance that the system will be busy when a call is placed. The transceiver locks on the emergency system/group (other system/groups cannot be selected), scanning is disabled, and all transmissions occur at access priority 1 (except on LTR and conventional systems which do not use access priority). The only calls received are those occurring on the emergency system/group or "all calls". Calls on the selectable, fixed priority, and block ID codes of that system are not received.

Other mobiles may also join in the conversation, either by selecting the emergency mode or selecting that system/group. In this case, all rules of normal transmission and reception apply. To exit the emergency mode and resume normal transceiver operation after the emergency call is completed, transceiver power is turned off and then on again.

Automatic Transmit

When the Emergency switch is activated with Automatic Transmit programmed, system and group selection and scanning are disabled and the transceiver begins automatically transmitting the Emergency Alert call. This call is transmitted on the programmed emer-

gency system/group every 10 seconds using access priority 1.

When the emergency call is received by the dispatcher, a warning tone sounds and the mobile's unique ID and other information is displayed on the console. The dispatcher then acknowledges the call by transmitting an Emergency Answer call. When this call is detected by the mobile, it halts automatic transmissions. However, system and group selection and scanning remain disabled until the emergency call sequence ends. In addition, any further transmissions occur at the access priority programmed for the group selected by the emergency switch.

The emergency call sequence ends and normal transceiver operation resumes when the dispatcher transmits an Emergency Termination call or transceiver power is turned off and then on again. If the push-to-talk switch is pressed before the Emergency Acknowledge call is received, the Emergency Alert transmissions continue only until the push-to-talk switch is released.

### 3.6.9 PROGRAMMABLE POWER OUTPUT

One of five power output levels can be programmed for each Multi-Net, LTR, and conventional system. The actual power output at each level is set in the test mode (see Section 3.11). For example, the power output could be programmed as follows:

1 = Rated Power
2 = 25 watts
3 = 20 watts
4 = 15 watts
2W = 2 watts

### 3.6.10 AUTOMATIC TRANSMITTER THERMAL FOLDBACK

The temperature of the power amplifier is monitored by the control logic when transmitting. If a temperature is detected that could damage the power amplifier module or other devices, power is automatically cut back to the 2-watt level (no message is displayed). After sufficient cooling occurs, power output returns to the full output level. This provides hysteresis so that power is not cut back again after only a short transmission.

If temperature continues to increase at the 2-watt level to the point where more serious damage could occur (this should seldom happen), the transmitter is disabled, a warning tone sounds, and “NO POWER” is displayed. The transmitter remains disabled until temperature decreases to the first temperature limit. Power output is then produced at the 2-watt level. The temperature limits are fixed in hardware.

### 3.6.11 DATA SYSTEM/GROUPS

When digital equipment such as a mobile data terminal is connected to the transceiver, the transceiver can be programmed so that data transmissions occur on a data system/group. Data transmissions can be enabled or disabled on each Multi-Net, LTR, and conventional group by programming.

If the selected system/group is not programmed for data transmissions, the first data group in the current system is selected. If there is no data group programmed in the current system, the bank data system/group is selected. If there is no data system/group programmed in the current bank, “NO DAT GRP” is displayed, an error tone sounds, and the original system/group continues to be displayed. Data transmissions are initiated by a signal on pin 1 of Universal Interface connector J601.

### 3.6.12 ENCRYPTION

*NOTE: Encryption is not compatible with companding; therefore, those features cannot be used together.*

As described in Section 1.5, voice encryption provides protection from casual eavesdropping and analog scanners. Each Multi-Net, LTR, or conventional group can be individually programmed by the system operator for encryption. Then when one of those groups is selected, encryption is automatically enabled or disabled.

Encryption can also be manually enabled or disabled by the ENCPT option switch or the Menu Mode “ENCRYPTION” parameter. This allows the user to override the group encryption programming if desired. Selecting another system or group causes this feature to revert to the dealer programmed state for that group. When encryption is enabled on the selected

group (by dealer programming or the user), the circle/ triangle symbol shown in Figure 3-3 is displayed.

If the transceiver has Version 206 or earlier software (see Appendix A), encryption must be enabled to transmit or receive an encrypted call. With Version 207 or later software, the transceiver can be programmed so that encrypted calls are received even if encryption is not enabled (encryption must be enabled only to transmit an encrypted call). To have this operation, the encryption parameter on the "Main Radio Parameters" screen must be programmed "Yes". The outputs which control encryption are J601, pin 15 of the universal interface cable and wire-out 7 (Output A).

### 3.6.13 PHONE MODE

*NOTE: The phone mode is available in transceivers which have Version 203 or later software (see Appendix A).*

The Phone Mode is selected by the PHONE option key or the Menu Mode "TELEPHONE" parameter. This mode makes placing telephone calls more convenient by displaying systems and groups programmed for RIC telephone calls. It also can be used to recall and dial prestored telephone numbers. Only RIC-type calls can be placed using this mode.

When the select switch is turned in the Phone Mode, Multi-Net and LTR system/groups and conventional systems in the current bank that are programmed for RIC calls are displayed. RIC calls can be placed on conventional systems with this transceiver if the repeater being accessed is equipped for RIC calls.

Up to ten 29-digit telephone numbers can be prestored by system operator programming. These numbers can then be recalled and dialed by the user without the need for a DTMF microphone. This limits calls to only the prestored numbers if desired. Calls can also be placed to other numbers using a DTMF microphone.

A unique identification of up to ten characters is stored with each number. This identification is then displayed when the number is recalled (the actual telephone number that is transmitted is not displayed). The identification could include, for example, up to ten digits of the number being dialed or the name of the person or place being called.

To use the Phone Mode, proceed as follows:

a. Press the PHONE switch or select the TELEPHONE menu parameter. This displays the first RIC system/group in the current bank. If none are programmed, "NO RIC" is displayed. The status display indicates "PH" until a system/group is selected.

b. To scroll through the available telephone system/ groups, turn the Select switch. RIC system/groups are indicated by the handset symbol in the display. When the desired system/ group is displayed, select it by pressing the Select switch.

c. The alphanumeric display then indicates "SELECT NBR". If you wish to manually dial the telephone number using a DTMF microphone, momentarily press the PTT switch to obtain a dial tone and then dial the number using a DTMF keypad. Proceed to step g.

d. If you wish to recall a prestored number, rotate the Select switch to scroll through the programmed numbers. The unique identification programmed with each number is indicated in the alphanumeric display.

e. When the desired number is displayed, select that number by pressing the Select switch.

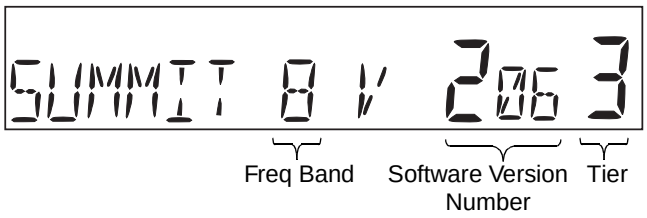
f. To transmit the displayed number, momentarily press the PTT switch to obtain a dial tone and then momentarily press it again to transmit the number.

g. To terminate the call by sending the # character and exit the Phone Mode, press the PHONE switch or if using the Menu Mode, press the MENU switch. The transceiver then returns to the system/group that was selected before the Phone Mode was entered.

There is also a 10-second timer that is active in the phone mode until the number is transmitted. If no activity is detected for 10 seconds, the Phone Mode is automatically exited.

### 3.6.14 DISPLAY OF SOFTWARE VERSION

When transceiver power is turned on, the transceiver software version number and other information is briefly displayed as shown in the following illustration. Currently, all Summit transceivers are Tier 3. The operating software can be updated by Write-On Flash programming as described in Section 4.6. Refer to Appendix A for information on the various versions that have been released.




## 3.7 MULTI-NET MODE FEATURES

### 3.7.1 BUSY QUEUING (MULTI-NET)

Introduction

Busy queuing places the call in a queue if the system is busy when the PTT switch is pressed. Then, when the system becomes available, the user is alerted by a tone and the call can be placed if desired. An available system is determined in the normal manner by the access priority of the selected group and the current access priority being transmitted by the repeater (see Section 5.8.2).

Busy queuing is a system parameter, so it is enabled or disabled on each Multi-Net system. It functions with both standard and special calls on Multi-Net systems only. The queue mode is entered automatically when the PTT switch is released with the busy tone sounding. The busy tone then stops sounding and "IN QUEUE" is displayed in the alphanumeric display.

When the system becomes available, the transceiver waits a random time and accesses the repeater. This random delay minimizes the chance of collisions with other mobiles in queue. If an access attempt is unsuccessful, another access is attempted after a random time delay. This continues until a successful access is completed. When the access is successful, a beep (standard and auxiliary calls) or a dial tone (telephone calls) sounds and the call can then be placed in the normal manner.

When auto-registration is active (see next section) and the transceiver software is Version 206 or later (see Section 3.6.14), the queue status is maintained even if registration on another site occurs. With earlier versions of software, the queue is suspended if this occurs.

When the access is successfully completed by the transceiver as described, the repeater hangtime indicator is set. This holds the repeater for the length of the hangtime programmed by the System Management Module. If no call is made by the user during this hangtime, the queue mode is exited and the transceiver returns to normal operation.

Exiting The Queue Mode

When the queue mode is exited, "IN QUEUE" is no longer displayed. This mode can be exited at any time by momentarily pressing the PTT switch (except if responding to a call on another group). It is also exited if any of the following occur.

- A call is received on the selected group
- Any of the front panel switches are changed or the PTT switch is pressed while no call is being received
- A Reassign Select command is received

Receiving Calls In The Queue Mode

While in the queue mode, calls are received normally. In addition, if group scanning is programmed on the selected system, calls are received on the other selectable groups. However, since system scanning is temporarily disabled, calls are not received on other programmed systems. If a call is received while in queue, the user can respond to the call in the usual manner and then normal queuing of a call resumes shortly after the call is finished. The length of the delay before queuing resumes is set by the receive scan delay timer.

## 3.7.2 AUTO-REGISTRATION (MULTI-NET)

Introduction

Auto-registration is also described briefly in Section 5.8.12. This feature permits telephone and unique ID calls to be automatically routed to the site in which a mobile is operating. Standard calls can also be routed if the Site Tracking Module (STM) in the RNT is configured appropriately. To utilize auto-registration, it must be enabled by system operator programming and system scanning must be enabled by the SCAN switch. In addition, it must be enabled by the Menu Mode "MN AUTOREG" parameter if it can be selected.

Auto-registration effectively controls the revert (selected) system when scanning (refer to Section 3.4.4). Therefore, auto-registration can be used with the "Last Selected" and "Temporary" modes but not "Last Received".

Upon entering the scan mode or if the signal from the currently registered site is weak, the transceiver begins checking all programmed status channels to locate one with suitable signal strength. When one is located, a registration message is sent to the repeater. The repeater then forwards the information to the RNT. The location of the mobile is then known and when a call to that mobile is placed, it is automatically routed to the correct site.

When the mobile is searching for a site on which to register, "AUTO REG" and the scan message are alternately displayed. If a user wants to maintain communication on a site regardless of signal strength, auto-registration or scanning can be turned off. This permits communication with a group in marginal signal conditions.

Revert System/Group After Registration

After registration occurs, "AUTO REG" is no longer displayed and the revert system is the next higher system with a different site number that could be accessed (wrap-around occurs after the highest system is checked). For example, if System 3 was selected and System 5 is the next system with a different site number, that system becomes the revert system if it can be accessed.

Revert group selection is determined by the programming of the bank "Wide Area Group Tracking" parameter. If this parameter is programmed "Yes", the revert group does not change (it is the same as it was before registration on the new site occurred). If this parameter is "No", the revert group is the group that was displayed when that system was last selected. Refer to Section 4.4.6 for more information on proper wide area group tracking programming.

*NOTE: The preceding "Wide Area Group Tracking" parameter is available only if the transceiver has software Version 206 or later (see Appendix A). With earlier versions, the "No" condition is always selected.*

Scanning With Auto-Registration

Auto-registration functions with both single- and multiple-site scan (see Section 3.4.2) and scanning continues in the normal manner. However, if LTR or conventional systems are scanned in addition to Multi-Net systems, registration occurs only on Multi-Net systems.

Scan Dropout Criteria

The point at which registration on another site occurs is controlled by the percentage of good data messages that must be received over a 10-second period to stay on the current site. With this transceiver, this percentage can be programmed for 50-100% on each Multi-Net site. The default is 75% (33 good messages out of 44). The higher the percentage, the sooner auto-registration occurs.

Wide Area Coverage Enhancements

With software Version 206 or later, the following enhancements have been made to provide better wide area coverage. The programming of the bank "Wide Area Group Tracking" parameter does not affect these features. (That parameter controls only the revert group that is selected after registration occurs.)

- The transceiver registers on a site even when not actively scanning (such as when the microphone is off-hook). Other requirements are that the single-site type of scanning must be selected and scanning must be enabled by the Scan switch.

- The transceiver can exit a site while receiving a call, register on a new site, and then continue receiving the call on the new site.

- A call can be received on a new site before registration occurs.

### 3.7.3 TRANSMITTING STATUS INFORMATION (MULTI-NET)

Status messages can be transmitted whenever the PTT switch is pressed with a Multi-Net system selected. The Menu Mode "STATUS" parameter or the STAT option switch is used to display or change the current status condition that is transmitted (see Section 3.5.22). When the status select mode is enabled using either of these methods, the current status condition is momentarily indicated in the alphanumeric display. The Select switch is then rotated to cycle through the available choices and pressed to select the desired choice.

For example, status conditions such as "AT SITE", "LEVNG SITE", or "UNLOADING" can be programmed. The status condition is then displayed on the dispatcher's console along with the mobile's ID number whenever the transmitter is keyed. The transmission of status messages is also described briefly in Section 5.8.14.

### 3.7.4 SPECIAL CALLS (MULTI-NET)

Introduction

Special calls use the special call group ID codes from 226-254 as described in Section 5.7. The special calls usually originated by a mobile are Interconnect and Auxiliary calls. Most other special calls such as Interrogate, Mobile Disable, and Reassignment are originated by the system operator or a dispatcher. The mobile-originate calls are described in the following information and the other special calls are described in Section 5.

Mobile-Originate Special Calls

**Interconnect -** These are telephone calls to or from a mobile made through the Public Switched Telephone Network (PSTN).

**Auxiliary -** These calls allow a mobile to communicate with any individual mobile or a group of mobiles at the same site or another Multi-Net site (when several Multi-Net systems form a network). Calls to specific mobiles are called Unique ID calls, and calls to groups are called Directed Group calls. Directed Group calls allow communication with groups that are otherwise not accessible because no selectable system has been programmed with the home repeater or group ID of those mobiles. Directed Group calls can be made to any home repeater on any group ID from 1-225.

Transceiver Programming For Special Calls

To originate a special call, the transceiver must have one of its selectable group positions programmed for the special call being made (Interconnect or Auxiliary) as shown in the following chart. ID code 236 programs Auxiliary calls and ID code 237 programs Interconnect calls. This chart also shows which ID must be programmed to hear a response or receive a special call. These IDs may be fixed or selectable as described in Section 3.3.4.

| Type of Call | Originating Mobile Encode ID | Receiving Mobile Decode ID |
|---|---|---|
| Interconnect | Interconnect | Interconnect |
| Auxiliary | | |
| Unique ID | Auxiliary | Auxiliary |
| Dir Group | Auxiliary | Group ID |

*NOTE: Auxiliary Calls = ID Code 236; Interconnect (Telephone) Calls = ID Code 237*

*NOTE: Even if ID codes 236 and 237 are selectable codes, they are treated like fixed codes when calls are received. Therefore, calls on those codes are received regardless of which group is selected or group scan programming (as long as the system is selected or scanned). Refer to Section 3.3.4 for more information.*

It can be seen from the chart that with special Directed Group calls, the auxiliary ID is encoded to place the call, and the specified group ID is decoded to receive the call. This is because the call is converted to a standard group call by the RNT. In addition, when a landside call is made to a specific mobile, it is always classified as an interconnect call even though the unique ID of the mobile may be specified (refer to "Landside-Originate Special Calls" which follows).

Special Call Authorization

When a mobile is programmed to make Interconnect calls, system authorization is needed before service is available. This authorization is performed by the system operator using the System Management Module of the RNT. This authorization also determines what type of service is available. For example, a mobile may be authorized to dial local numbers only. This authorization is keyed to the mobile's unique ID which is transmitted when any call is made.

With all Auxiliary calls, no special authorization is required. All that is needed is proper programming of the mobiles originating and receiving the call. Therefore, a Unique ID call can be made to any mobile in the same site or some other site that is programmed for Auxiliary calls. The same applies to Directed Group calls except that the mobile receiving the call does not need to be programmed for Auxiliary calls, just the standard group ID being transmitted.

Placing a Special Call

The procedure for placing a special call is as follows.

a. Select the group programmed for Interconnect or Auxiliary calls, whichever is to be made.

b. Momentarily press the PTT switch until the proceed tone sounds. A dial tone should be returned.

c. If an Interconnect call is being made, dial the telephone number of the landside party you are calling.

d. If an Auxiliary call is being made, dial the 4-8 digit number which specifies the destination of the call. The digits dialed for each type of call are as follows:

**Unique ID Call (Current Site)**

4-digit unique ID of mobile/dispatcher

**Unique ID Call (Directed Site)**

3-digit site ID +
4-digit unique ID of mobile/dispatcher

**Directed Group Call (Current Site)**

2-digit home repeater number +
3-digit group ID

**Directed Group Call (Directed Site)**

3-digit site number +
2-digit home repeater number +
3-digit group ID

e. Release the PTT switch if it was pressed to dial the number. A beep should then sound which indicates that the number was accepted by the system. If this beep does not sound, an unauthorized number may have been dialed or a dialing mistake may have been made.

f. **Interconnect Call -** The normal landside ringing or busy tone is then heard. After the party answers, press the PTT switch and respond.

**Unique ID Call -** A “ringing” tone is heard which indicates that the mobile is being rung. If there is no answer, the ringing stops after several rings and the call is automatically terminated by the system. When the party answers, press the PTT switch and respond.

**Directed Group Call -** A second beep sounds which indicates that the path to the mobile is complete and speaking can begin (no ringing of the other mobile occurs).

*NOTE: It is not possible to talk and listen at the same time because this transceiver operates half-duplex.*

g. When the call is finished, terminate it by pressing the # key. Three rapid beeps indicate that the call has been terminated.

Receiving Special Calls

When an Interconnect or Unique ID call is received, “ringing” is heard from the speaker. The call is then answered in the normal manner. If it is a Directed Group call, only the voice of the calling party is heard because no ringing occurs. The originating party usually terminates the call when it is finished. If the three beeps which indicate that the call has terminated are not heard, press the # key to terminate the call.

Landside-Originate Special Calls

Calls can be also be made from any landside telephone to specific mobiles (Interconnect calls) or groups (Directed Group calls). Calls can also be placed to other sites in a manner similar to when they are mobile dialed.

If the system has DID lines, the landside caller can dial a mobile directly because each mobile that can receive these calls is given its own phone number. If the system has standard trunk lines, the telephone number of the system is dialed. Then when the system answers, a short tone sounds to indicate that the digits specifying the destination of the call should be dialed. The same digits are dialed as when the call is mobile originated as described in “Placing a Special Call”. The landside telephone must generate DTMF tones to dial these digits.

After these digits are dialed, a beep is heard which indicates that the number was accepted by the system. Ringing then indicates that the mobile is being rung unless it is a Directed Group call. With those calls, no ringing of the mobile occurs and another beep is heard which indicates the path is complete and speaking should begin.

After the mobile answers, the landside party should respond in the normal manner. Remember that the mobile is operating half duplex and cannot hear the landside party while transmitting. When the call is finished, it should be terminated by one of the parties by pressing the # key. Three beeps indicate that the call has terminated.

### 3.7.5 TRANSMIT INHIBIT

This feature prevents the transmitter from keying if the party being called is busy with another call. To enable this feature, the transceiver is programmed with a block of transmit inhibit ID codes that can include up to all 225 standard ID codes with Multi-Net operation, or up to all 250 ID codes with LTR operation. If a code within this block has been detected up to 5 seconds before the PTT switch is pressed, the transmitter does not key, the intercept tone sounds, and “TX INHIBIT” is indicated in the alphanumeric display.

To make another call attempt, the PTT switch must be released and then pressed again. However, it is a good idea to wait a few seconds because the 5-second timer does not count down while the PTT switch is pressed. It is not possible to complete the call by keeping the PTT switch pressed with the intercept tone sounding.

One use of this feature is to prevent the accidental interruption of a call in progress. This could happen when the other transmitting party unkeys or if an ID code with a higher priority is transmitted. Another use of this feature could be to provide an audible indication that the party being called is busy. This feature is available only on Multi-Net and LTR systems. A similar Transmit Disable On Busy feature is available on conventional systems.

### 3.7.6 ACCESS PRIORITY (MULTI-NET)

Refer to Section 5.8.2.

### 3.7.7 CAMP-ON PREVENT

This feature prevents a user from “camping on” a channel by continuously pressing the PTT switch while a message is being received. When the Camp-On Prevent feature is programmed and the user presses the PTT switch while a message is being received, the transmitter is disabled, “TX DIS BSY” is displayed, and the dial tone sounds until the PTT switch is released. Therefore, accesses can be attempted only by pressing the PTT switch during quiet times.

This feature is available only when placing Multi-Net standard (mobile-to-mobile) calls. In addition, the selected encode ID must be the same as the ID on which the call is being received. It is not available with Multi-Net special calls or any type of LTR or conventional call. In addition, transceiver software, Version 223 or later and programming software, Version 207 or later, must are required.

When this feature is not used and the PTT switch is pressed while a message is being received, the message continues to be received normally and access is automatically attempted as soon as the message is complete. If a large number of mobiles do this during busy periods, collisions may occur and the “camping” mobiles may have a better chance getting a free channel.

## 3.8 LTR MODE FEATURES

### 3.8.1 FREE SYSTEM RINGBACK

If a busy condition exists when making an LTR telephone call, the Free System Ringback feature automatically signals when the system is no longer busy. If the busy tone sounds and "SYSTEM BSY" is displayed when the PTT switch is pressed, this feature is automatically selected when the PTT switch is released. A confirmation tone then sounds and "RINGBACK" is indicated in the alphanumeric display.

When a RIC-equipped repeater becomes available, a ringing tone sounds followed by a dial tone when the handshake is completed. The call should then go through if it is tried again. This mode can be canceled at any time by activating any user control. If scanning is enabled, it continues in the normal manner when the Free System Ringback mode is exited. No special programming is required to enable this feature, and it functions on LTR telephone calls only. RIC-equipped repeaters must be specified as described in Section 4.4.5 for proper operation of this feature.

### 3.8.2 SYSTEM SEARCH

If an out-of-range condition exists when attempting an LTR telephone call, this feature automatically searches for a system within range. The system search feature is available only with LTR telephone calls and only if it has been enabled by dealer programming or the user with the Menu mode "LTR SYSTEM SEARCH" parameter (see Section 3.5.13). If this feature is enabled and the intercept tone sounds when the PTT switch is pressed, it is automatically selected when the PTT switch is released. A confirmation tone sounds and "SYS SEARCH" is indicated in the display.

The transceiver then attempts to access, in succession, other systems that have a RIC ID programmed in any group position. As each system is searched, a beep sounds. Each system is accessed only once. If no system could be accessed, the intercept tone sounds, "NO RIC FND" is displayed, the feature deactivates, and the system/group does not change. If a system is accessed, the new system/group is selected and a dial tone sounds. If the number is not dialed within a few seconds, normal operation resumes. This mode can be canceled at any time by activating any user control.

### 3.8.3 TRANSPOND

Each of the selectable ID codes of an LTR system can be programmed for transpond. This feature allows the person making a call to determine if the mobile being called is in service. If a call is received on an ID code programmed for transpond, the transceiver waits until the originating transceiver unkeys. It then automatically transmits two data messages with the second containing the turn-off code. This causes the transceiver originating the call to briefly unsquelch. If the originating transceiver has a call indicator, it will also turn on if the ID code has been programmed for a call indicator. Transpond is not available on the fixed priority and block IDs.

### 3.8.4 TRANSMIT INHIBIT

The LTR Transmit Inhibit feature operates the same as the Multi-Net Transmit Inhibit feature described in Section 3.7.5.

## 3.9 CONVENTIONAL MODE FEATURES

### 3.9.1 TRANSMIT DISABLE ON BUSY

This feature disables the transmitter if the channel is busy (carrier present) when the PTT switch is pressed. When the transmitter is disabled by this feature, the busy tone sounds and "TX DIS BSY" is indicated in the alphanumeric display. It is not possible to access a channel by holding down the PTT switch until the channel is no longer busy. If this feature is disabled, the transmitter can be keyed even if the channel is busy.

This feature can be enabled or disabled on each conventional group by dealer programming. Some repeaters may have delayed drop-out (hang time) which would cause this feature to disable the transmitter even if no busy condition exists. To key the transmitter in this situation, release the PTT switch and press it again within 1 second.

### 3.9.2 CALL GUARD SQUELCH

Tone (CTCSS), digital, or inverted digital Call Guard squelch can be programmed on each conventional transmit and receive group in any order desired. A tone Call Guard reverse burst and digital Call Guard turn-off code can also be programmed to eliminate the squelch tail (noise burst) in the receiving transceiver when the PTT switch is released. The reverse burst and turn-off code are always detected by this transceiver on receive groups programmed with Call Guard squelch.

The Call Guard squelch feature eliminates distracting messages intended for others using the channel. This is done by using a subaudible tone or digital code to control the squelch. This tone or code is unique to an individual user or user group on that channel. This tone or code is transmitted with the voice signal, but is not heard because it is in the subaudible range and is attenuated by a filter. Call Guard squelch must be used in both the transmitting and receiving transceiver to be functional.

Tone-type Call Guard squelch utilizes subaudible tones from 67-250.3 Hz. Although there are 38 tones assigned, the top five are normally not used because of their close proximity to the voice band which starts at 300 Hz. A reverse burst can be transmitted when the push-to-talk switch is released to eliminate the squelch tail (noise burst) in the receiving transceiver. The reverse burst is a 180-degree phase reversal for a length of time determined by the tone frequency.

Digital Call Guard squelch uses digital data instead of subaudible tones to control the squelch. This data consists of continuous repetitions of 23-bit words. No bit or word synchronization information is used. When the push-to-talk switch is released, a turn-off code can be transmitted. This eliminates the squelch tail similar to the reverse burst with tone-type Call Guard squelch.

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 actually a seed for a special algorithm used to generate the 23-bit data word. The data is transmitted at a rate of 134.4 bits per second. Therefore, approximately six words are transmitted each second. When the data is decoded, 23-bit samples are taken and then the bits are rotated to determine if a valid code was received.

Digital Call Guard squelch can be programmed as normal or inverted. The only difference is that the wave-form is inverted when “IDCG” is selected. The inverted type may need to be programmed if the signal is inverted by the repeater or another transceiver. If standard noninverted digital Call Guard squelch does not function, try changing to the other type.

### 3.9.3 MONITOR MODE

The monitor mode allows all activity on a channel to be monitored when Call Guard squelch or other types of decoders are used to control the squelch. The monitor mode disables these features so that all messages on the channel are heard. To select the monitor mode, take the microphone off-hook or press the MON option switch if available. The monitor mode is indicated by “MON” in the display.

If off-hook detection has been disabled by programming, the MON switch must always be used to select the monitor mode or the Transmit Disable On Busy feature should be programmed. If scanning is occurring, the MON switch is not detected and monitoring is enabled only by taking the microphone off-hook if the selected (revert) system is a conventional system (and off-hook detection has not been disabled).

Call Guard squelch can also be disabled on the selected system/group by the Call Guard option switch if available (see Section 3.5.7). This switch disables both transmit and receive Call Guard signaling, while the monitor mode disables only receive Call Guard signaling.

### 3.9.4 REPEATER TALK-AROUND

Normally, all transmissions go through a repeater. However, there may be times when the user is out of range of the repeater system and is unable to talk to anyone even though the mobile being called is a short distance away. In this situation, the repeater talk-around feature can be used to transmit on the receive frequency so that transmissions do not have to go through a repeater. Any conventional group can be programmed for talk-around (unless it has been

disabled at the system level). Talk-around is then enabled by simply selecting one of those groups. The unique identification can be used to identify which groups are programmed with this feature.

If talk-around has not been disabled on the system by system operator programming, the Menu Mode "TALKAROUND" parameter or the TA option switch (see Section 3.5) can be used to turn talk-around on and off. In the Menu mode, talk-around is enabled when "ON" is indicated in the status display. With an option switch, a triangle is indicated under the switch if it is enabled by the switch or programmed on the selected system/group. If the switch is pressed with talk-around disabled, "NO TALK" is displayed. Changing the selected system or group causes the programmed default talk-around condition to be selected.

### 3.9.5 PRIORITY GROUP SAMPLING

Priority group sampling ensures that messages on conventional priority groups are not missed while listening to messages on other conventional groups. Both a first and second priority group can be designated in each bank by system operator programming. When a message is received on a priority 1 group, "P1" is indicated in the status display, and when a message is received on a priority 2 group, "P2" is indicated.

Priority group sampling occurs only when system scanning is enabled. In addition, it must be the "Multiple-Site" type as described in Section 3.4.2. The first priority system/group is sampled while listening to a message on the second priority group but not vice versa. The transceiver can be programmed so that the first priority group is sampled every 0.5, 1, or 2 seconds or not at all if "Disabled" is programmed. The second priority group is always sampled every 2 seconds. When a first priority system/group is sampled while listening to a message on some other system/group, a series of "ticks" are heard. These ticks are brief interruptions of the audio signal that occur when sampling takes place.

This feature is available only on conventional systems. In addition, sampling does not occur while listening to a Multi-Net or LTR call or when transmitting any type of call. Call Guard squelch is not detected on the first priority group but is detected on the second priority group if is programmed. If the PRI option switch or the Menu mode "PRIORITY" parameter is available (see Section 3.5.17), priority sampling can be turned on and off.

### 3.9.6 RECEIVE-ONLY GROUPS

Conventional groups can be programmed so that transmitting is disabled (monitor only). This is done using the TX DIS parameter on the group screen. If the PTT switch is pressed with one of these groups selected, the intercept tone sounds and "TX DISABLE" is displayed.

## 3.10 MISCELLANEOUS

### 3.10.1 SUPERVISORY TONES

There are supervisory tones that are heard at various times when operating the transceiver. Some or all of these tones can be enabled and disabled by system operator programming or by the user if the Menu Mode "RADIO SNDS" parameter is enabled (see Section 3.5.18). These tones are as follows and they are heard in only the Multi-Net and LTR modes unless stated otherwise.

**Busy Tone -** This tone is similar to the standard telephone busy tone, and it indicates that the radio system is currently busy. It consists of combined 480 Hz and 620 Hz tones switched on and off at approximately a 2 Hz rate. It sounds with all types of Multi-Net and LTR calls and also when the Multi-Net Busy Queuing feature is used. "SYSTEM BSY" is also displayed when this tone sounds.

**Intercept Tone -** This is a siren-like tone consisting of 700 Hz and 900 Hz tones alternating at approximately a 2 Hz rate. This tone indicates the following out-of-range or other error conditions:

- When this tone sounds 2-3 seconds after pressing the PTT switch and "OUT-OF-RNG" is also displayed, the data handshake with the repeater could not be completed. The usual cause of this is an out of radio range condition. Twelve attempts are made on Multi-Net systems and six access attempts are made on LTR systems before this tone sounds. No more

access attempts are then made until the push-to-talk switch is released and then pressed again.

- If this tone sounds after the transmitter has been keyed for an extended time and the transmitter turns off and "TX TIMEOUT" is displayed, the transmitter has been disabled by the Time-Out Timer feature (see Section 3.6.1).

- If this tone sounds as soon as the push-to-talk switch is pressed with a conventional channel selected and "TX DIS BSY" is displayed, the channel is busy and the transmitter was disabled by the Transmit Disable On Busy feature (see Section 3.9.1). If "TX DISABLE" is displayed instead, a conventional receive-only channel is selected (see Section 3.9.6).

- If the push-to-talk switch is pressed while receiving an LTR call, this tone sounds and "TX DIS BSY" is displayed.

**Proceed (Clear-To-Talk) Tone -** This is a 20 millisecond burst of the 700 Hz tone which sounds after the push-to-talk switch is pressed to indicate when talking can begin (see Section 3.6.3).

**Key Press Tone -** This is a 30 millisecond burst of the 700 Hz tone that sounds to indicate when a key or the Select switch is pressed or turned.

### MULTI-NET SPECIAL CALL TONES

*NOTE: The following tones are produced by the Multi-Net RNT and are heard only when placing special calls.*

**Confirmation Tone -** A short tone which sounds when the number dialed is accepted by the system.

**Call Proceed Tone -** With Multi-Net Directed Group calls, ringing does not occur after the number is dialed. Instead, this short tone sounds after the confirmation tone to indicate that the audio path is complete and speaking can begin.

**End Call Tone -** Three beeps which sound when the end of the call has been detected by the system.

**Proceed Dialing Tone -** When placing a landside-originate call to a mobile, the caller may dial the number of the system and then when the system answers, a number specifying the mobile being called. This tone sounds to indicate when the number of the mobile should be entered.

### LTR TELEPHONE CALL TONES

*NOTE: The following tones are produced by the LTR RIC interconnect equipment and are heard only when placing LTR telephone calls.*

**Reorder Tone -** Three beeps which indicate that the call has been terminated by the system.

**Return Time Warning Tone -** Two beeps which warn that you have not transmitted for an extended period. If you do not transmit within 5 seconds, the call is automatically terminated by the system. The time between transmissions is one of the parameters used by the system to detect the end of a call when the # character is not sent.

**Conversation Time-Out Tone -** Calls are limited to a certain length by the system. Thirty seconds before this time is reached, a "tick" begins sounding each second. When the 30-second time expires, the call is automatically terminated by the system.

**Turn-Around Tone -** This is a single beep which may be used to indicate to the landside party when to respond to your transmission. It sounds when you release the PTT switch, and you may partially hear this tone.

**Proceed Tone -** This tone consists of two beeps and it tells the landside caller when to enter the five-digit number specifying the mobile being called. Dialing of this number must be started within 5 seconds of hearing this tone, and a tone-type telephone must be used.

## 3.10.2 DISPLAY MESSAGES

The following messages may appear in the ten-character alphanumeric display.

**ALL CALL -** Indicates that the Multi-Net "All Call" special call is being received. This is a high priority call to all mobiles assigned to a site. If another call is being received, it is dropped to receive this call.

**AUTO REG -** Indicates that the transceiver is attempting to register on another system. Refer to "Auto-Registration" description on Section 3.7.2.

**BLOCK CALL -** Indicates that the call is being received on a Multi-Net or LTR block ID code (refer to Section 3.3.4).

**CLONING -** Indicates that one transceiver is programming another using the cloning feature described in Section 4.5.

**EMERGENCY -** Indicates that the emergency switch has been pressed (refer to Section 3.6.8).

**GPSCN DSBL -** Indicates that an attempt was made to delete a group from the scan list with group scanning disabled.

**HI BATTERY -** The transceiver senses the battery voltage and if it rises to a point where transceiver damage may result (above 18.5 VDC), the intercept tone sounds and this message is displayed.

**IN QUEUE -** Indicates that the call has been placed in a queue by the Multi-Net Busy Queuing feature (refer to Section 3.7.1).

**MIC TO PA -** Indicates that the microphone audio is being routed to the public address system (refer to Section 3.5.10).

**MULTI-SCAN -** Indicates that multiple-site scanning is occurring (refer to Section 3.4.2).

**NO DAT GRP -** Indicates that no valid data group could be found for the data transmission (refer to Section 3.6.11).

**NO NUMBERS -** Indicates that the Phone Mode is selected and no telephone numbers have been preprogrammed (refer to Section 3.6.13).

**NO POWER -** Indicates that the transmitter temperature is excessive and the transmitter has been shut down (refer to Section 3.6.10).

**NO RIC FND -** Indicates that no RIC system/groups could be found in the Phone Mode (refer to Section 3.6.13).

**NO TALK -** Indicates that talk-around has been disabled on the selected conventional system by programming (refer to Section 3.9.4).

**NOT MULTI -** Indicates that an attempt was made to enable a Multi-Net feature on an LTR or conventional system.

**NOT ON CONV -** Indicates that an attempt was made to enable a conventional mode feature on a Multi-Net or LTR system.

**OUT-OF-LOK -** Indicates that the synthesizer is unlocked. The transceiver is nonfunctional until lock is re-established. Troubleshoot the synthesizer if this indication persists for an extended period.

**NO ACCESS -** Indicates the inability to access the system, perhaps because of an out-of-range condition. Once this indication appears, no more access attempts are made until the PTT switch is released and then pressed again.

**PRIORITY 1 OR 2 -** Indicates that a Multi-Net or LTR call is being received on one of the fixed priority ID codes (refer to Section 3.3.4).

**PROG ERROR -** Indicates an EEPROM read error. Check the transceiver programming or EEPROM if this indication persists.

**PROG MODE -** Indicates that the transceiver is being programmed.

**RCV AUD PA -** Indicates that the receive audio signal is being routed to the public address system (refer to Section 3.5.10).

**REM ERROR -** Indicates that a non-Summit or early control unit is being used (see Appendix A.A.5).

**RING BACK -** Indicates that the LTR Free System Ringback mode has been entered (refer to Section 3.8.1).

**SELECT NBR -** Displayed in the Phone Mode to indicate that a preprogrammed telephone number should be selected or the number should be dialed manually (refer to Section 3.6.13).

**SNGLE SCAN -** Indicates that the single-site type of scanning is occurring (refer to Section 3.4.2.

**SUMMIT 8 or 9 V 2xx X -** This message is displayed for an instant when transceiver power is turned on. "SUMMIT" is the model of the transceiver, "8" indicates an 800 MHz mode, and "9" indicates a 900 MHz model. The number after "V" indicates the version of software being used by the transceiver, and the last digit indicates the tier level of the transceiver (refer to Section 3.6.14).

**SYS SEARCH -** Indicates that the LTR System Search mode has been entered (refer to Section 3.5.13).

**SYSTEM BSY -** Indicates that the radio system is currently busy.

**TYPE ERROR -** Indicates that an attempt was made to clone two different types of transceivers.

**TX DISABLE -** Indicates that the selected conventional system is programmed for monitoring only (refer to Section 3.9.6).

**TX DIS BSY -** Indicates that the transmitter has been disabled by the conventional Transmit Disable On Busy feature (refer to Section 3.9.1). This also indicates that the transmitter has been keyed while receiving an LTR call.

**TX INHIBIT -** Indicates that the transmitter has been disabled by the LTR/Multi-Net Transmit Inhibit feature (refer to Section 3.7.5).

**TX TIMEOUT -** Indicates that the transmitter has been disabled by the Time-Out Timer (refer to Section 3.6.1).

## 3.11 TEST MODE

### 3.11.1 INTRODUCTION

This transceiver has a test mode that is used to perform testing and alignment. This mode is enabled by turning transceiver power on with the RxD and TxD lines of the microphone connector shorted together (P2, pins 10 and 13). When the test mode is entered, the display indicates "RX-TX-RSSI" which is the first test function.

The various test functions are selected by pressing or rotating the front panel Select switch. The display indicates the mode that is currently selected and also such things as the selected frequency, power level, or operating mode. While in the test mode, the front panel option switches function as follows:

Center Switch - Selects the test channel bank as described in the next section.

Left Switch - The switch to the left of the display turns monitoring on and off.

All Other Option Switches - Adjust the display viewing angle.

The eight test functions that can be selected are as follows. These functions are described in more detail in the Sections 3.11.2 - 3.11.9.

- Receive-Transmit-RSSI
- Power Level 1 Set (Std band)
- Power Level 1 Set (T/A band)
- Power Levels 2, 3, 4, 2W Set
- Balance Adjust
- Transmit Hum and Noise
- DC Voltage Check
- Display Test

*NOTE: The alignment procedure in Section 8 describes how these test functions are used to make transceiver adjustments.*

### 3.11.2 RECEIVE-TRANSMIT-RSSI

The RX-TX-RSSI function is used to align the transmitter and receiver and set the RSSI detect level. This is the only test function in which both the microphone audio and transmit data signals are enabled. The data signal generated is the 151.4 Hz tone Call Guard frequency. The receiver squelch is controlled by noise only.

If the transceiver has Version 207 or later software (see Appendix A), a total of 18 test channels, arranged as three banks of six channels each, can be selected (see list on next page). With earlier software, only the channels in Bank 0 can be selected. The test channels are fixed and cannot be reprogrammed using the programming software.

**800 MHz TEST FREQUENCIES**

| Prog Ch No. | Rx Freq | Tx Freq |
|---|---|---|
| | **Block 0** | |
| 001 | 851.0125 MHz | 806.0125 MHz |
| 381 | 860.5125 MHz | 815.5125 MHz |
| 920 | 869.9875 MHz | 824.9875 MHz |
| 004 [TA] | 851.0875 MHz | 851.0875 MHz |
| 379 [TA] | 860.4625 MHz | 860.4625 MHz |
| 918 [TA] | 869.9625 MHz | 869.9625 MHz |
| | **Block 1** | |
| 003 | 851.0625 MHz | 806.0625 MHz |
| 373 | 860.3125 MHz | 815.3125 MHz |
| 903 | 869.7750 MHz | 824.7750 MHz |
| 007 [TA] | 851.1625 MHz | 851.1625 MHz |
| 375 [TA] | 860.3625 MHz | 860.3625 MHz |
| 912 [TA] | 869.8875 MHz | 869.8875 MHz |
| | **Block 2** | |
| 009 | 851.2125 MHz | 806.2125 MHz |
| 383 | 860.5625 MHz | 815.5625 MHz |
| 905 | 869.8000 MHz | 824.8000 MHz |
| 011 [TA] | 851.2625 MHz | 851.2625 MHz |
| 377 [TA] | 860.4125 MHz | 860.4125 MHz |
| 914 [TA] | 869.9125 MHz | 869.9125 MHz |

*[TA] = Talk-around channels (transmit frequency is the same as the receive frequency).*

**900 MHz TEST FREQUENCIES**

| Prog Ch No. | Rx Freq | Tx Freq |
|---|---|---|
| | **Block 0** | |
| 001 | 935.0125 MHz | 896.0125 MHz |
| 240 | 938.0000 MHz | 899.0000 MHz |
| 479 | 940.9875 MHz | 901.9875 MHz |
| 006 [TA] | 935.0750 MHz | 935.0750 MHz |
| 246 [TA] | 938.0750 MHz | 938.0750 MHz |
| 473 [TA] | 940.9125 MHz | 940.9125 MHz |
| | **Block 1** | |
| 003 | 935.0375 MHz | 896.0375 MHz |
| 242 | 938.0250 MHz | 899.0250 MHz |
| 475 | 940.9375 MHz | 901.9375 MHz |
| 008 [TA] | 935.1000 MHz | 935.1000 MHz |
| 250 [TA] | 938.1250 MHz | 938.1250 MHz |
| 469 [TA] | 940.8625 MHz | 940.8625 MHz |
| | **Block 2** | |
| 005 | 935.0625 MHz | 896.0625 MHz |
| 244 | 938.0500 MHz | 899.0500 MHz |
| 477 | 940.9625 MHz | 901.9625 MHz |
| 009 [TA] | 935.1125 MHz | 935.1125 MHz |
| 252 [TA] | 938.1500 MHz | 938.1500 MHz |
| 471 [TA] | 940.8875 MHz | 940.8875 MHz |

*[TA] = Talk-around channels (transmit frequency is the same as the receive frequency).*

The test channel block should be selected while one of the eight test functions listed above is displayed. This is done by pressing the center option switch above the display. The selected block (0, 1, 2) is indicated by the right-most character of the display.

The desired test frequency is then selected by pressing the Select switch with “RX-TX-RSSI” in the display and then turning the switch. The display indicates the channel that is selected. Talk-around channels are indicated by “TA” after the channel number. To return to the function select mode, press the Select switch.

The state of the RSSI detect line (U412, pin 7) is indicated in the display immediately to the right of the channel number. When a carrier is being detected, HI is indicated, and when no carrier is being detected, LO is indicated.

### 3.11.3 POWER LEVEL 1 SET (STD BAND)

The PWR SET function is used to set the maximum power output level for the standard (non talk-around) band. Two different power levels are set. PWR SET 1 sets the power output for the low end of the band (channel 1) and PWR SET 2 sets it for the high end of the band (channel 918 or 479). These settings allow the microprocessor to maintain arelatively constant power output over the entire operating band. When the system power level is programmed (see Section 4.3.5), this is the power level selected by Level 1.

Microphone audio, data, and the receiver are all disabled by this function. Power is adjusted by rotating the Select switch with the PTT switch pressed. The display indicates the relative set point from 0-127 (127 is maximum power).

To exit this mode, the power setting of both PWR SET 1 and PWR SET 2 must be checked by pressing the PTT switch. The settings are saved in memory when the mode is exited. The triangle/circle (encryption) symbol indicates if the current setting has been checked. The maximum power output that can be set is the rated power for the model of transceiver and the type of channel (standard or talk-around). Refer to Section 8 for more information.

### 3.11.4 POWER LEVEL 1 SET (TALK-AROUND BAND)

The TA PWR SET function is used to set the maximum power output for talk-around band. The procedure is the same as for standard channels described in Section 3.11.3 except that talk-around channels on each end of the band are selected.

### 3.11.5 POWER LEVELS 2, 3, 4, 2W

The PWR LEVELS function is used to set power levels 2, 3, 4, and 2W that can be selected for each system when programming the transceiver. These power levels apply to both standard and talk-around channels. Power level 1 is set by the PWR SET and TA PWR SET functions described in the preceding and following sections. When this function is selected, the data and microphone audio signals are disabled, and only channel 381 (800 MHz) or 240 (900 MHz) is selected.

To change the power levels, press the Select switch when PWR LEVELS is displayed. PWR LVL 2 - PWR LVL 4 and 2W PWR LVL are then selected by turning the Select switch. To change the power of the displayed parameter, turn the Select switch with the PTT switch pressed. The relative power output is indicated by 0-127 as described in Section 3.11.3. The settings are saved in memory when this mode is exited.

The power levels that can be set can be any power in the minimum to maximum range for that transceiver (see Section 8). The 2W setting can also be in this range or 1-2 watts.

### 3.11.6 MODULATION BALANCE

The BAL ADJUST function is used to set modulation balance over the entire standard and talk-around frequency bands. This allows the microprocessor to compensate for any changes that occur across the band. This function generates a 67 Hz square wave that is applied to the modulation circuitry. The microphone audio signal and receiver are disabled.

To enable the balance adjust function, press the Select switch when BAL ADJUST is displayed. BAL ADJ 1 is then displayed which indicates the first channel. The demodulated signal is viewed on the CRT of a communications monitor and the Select switch is rotated with the PTT switch pressed to achieve the best square wave.

The balance for the other channels is set by pressing the Select switch to select the next channel and then repeating this adjustment. BAL ADJ 1 - BAL ADJ 6 correspond to the six channels listed in Section 3.11.2. To exit this mode, all six channels must be checked. The triangle/circle (encryption) symbol indicates that the current channel has been checked. The settings are saved in memory when the mode is exited.

### 3.11.7 TRANSMITTER HUM AND NOISE

This function is used to check transmitter hum and noise. The six channels in Section 3.11.2 are selected by the Select switch, and the transmit audio signal and receiver are disabled.

### 3.11.8 DC VOLTAGE CHECK

This function displays the voltage of the 13.8V power supply. Transmit channel 1 is selected, and both microphone audio and transmit data are disabled.

### 3.11.9 DISPLAY TEST

This function tests all segments of the display in sequence. If the PTT switch is pressed, all segments are enabled but no power output is produced.

# SECTION 4 TRANSCEIVER PROGRAMMING

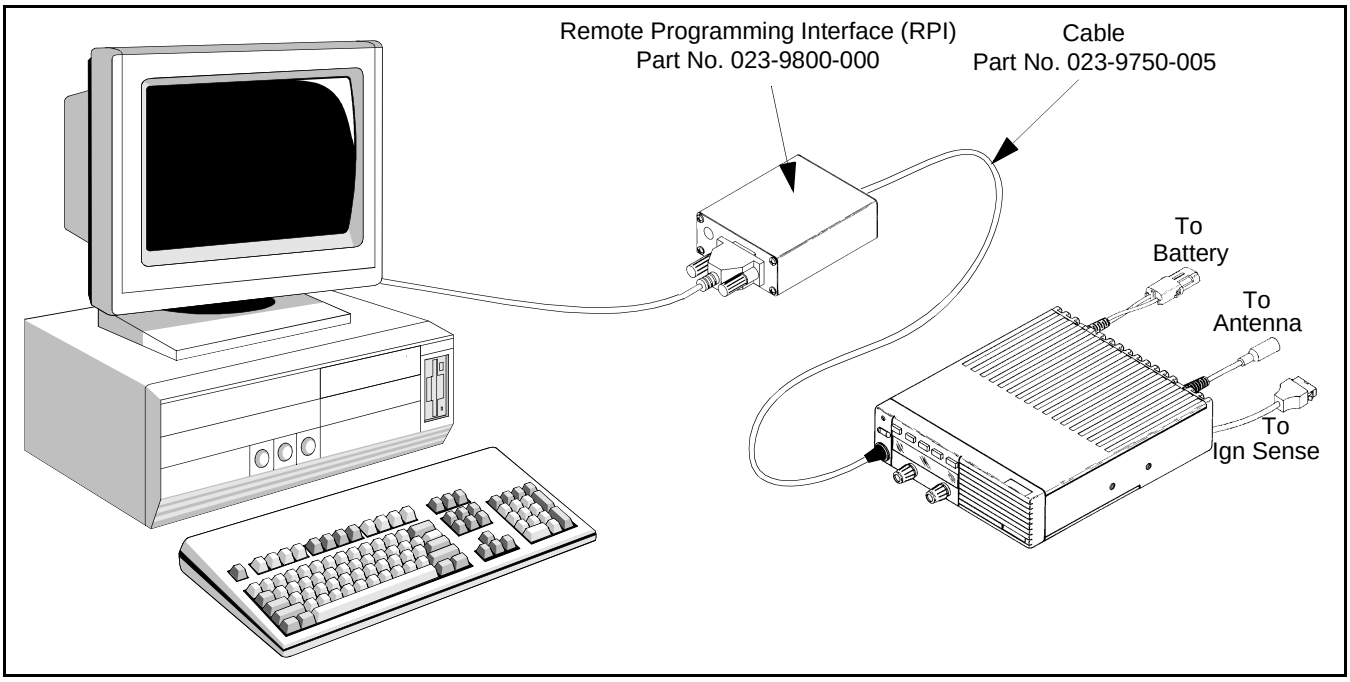



**Figure 4-1 Programming Setup**

## 4.1 GENERAL

### 4.1.1 PROGRAMMING SETUP

The following items are required to program the transceiver and control unit. The part numbers of this equipment are shown in Section 1-1 in Section 1. A programming set-up is shown above.

- IBM® PC or compatible personal computer
- E.F. Johnson Rem Prog Interface (RPI)
- Cables from the RPI to the computer and transceiver or control unit
- E.F. Johnson Summit programming software.

### 4.1.2 COMPUTER DESCRIPTION

The programming software is designed to run on an IBM PC or compatible computer that meets the following *minimum* requirements:

- A 3-1/2” disk drive and hard disk drive
- 640K of memory
- MS-DOS version 3.0 or higher
- An unused serial port

The cables from the RPI to the computer and transceiver are not included with the RPI. The 9800 RPI has a female DB9 connector for the computer connection. Since most computers have a male DB9 or DB25 connector, a male DB9 to female DB9 or DB25 cable is usually required. Earlier RPIs such as the 9750 have a female DB25 connector. These are standard cables available at most computer supply stores or suitable cables are listed in Table 1-1.

The cable from the RPI to the transceiver or control unit (remote versions) has a connector which plugs into the microphone jack. The cable for this application is also listed in Table 1-1.

### 4.1.3 REMOTE PROGRAMMING INTERFACE (RPI)

The RPI provides the required interface between the computer and transceiver. It converts the RS-232 logic levels from the computer to the TTL logic levels required by the transceiver microprocessor and vice versa. This RPI (P.N. 023-9800-000) programs standard personality information and also the Write-On™ flash memory (see next section).

With Summit DM and Viking® HT/GT transceivers, the switch on the RPI selects either the standard or Flash programming mode. The indicator is green when the standard mode is selected and red when the Flash mode is selected.

### 4.1.4 EEPROM DATA STORAGE

Information which changes from transceiver to transceiver is stored by EEPROM U406 on the audio/logic board. This type of device stores data indefinitely without the need for a constant power supply. The transceiver can be removed from the vehicle or even stored on a shelf indefinitely without affecting programming. Since an EEPROM is also reprogrammable, a new device is not needed if programming must be changed.

The operating program of the transceiver is stored by Flash memory U404 on the audio/logic board. If this program needs to be updated, reprogramming is performed using the same programming setup. However, special programming software is required. The procedure for reprogramming the Flash memory is located in Section 4.7.

### 4.1.5 SOFTWARE VERSION NUMBER

*NOTE: All transceivers with operating software Version 206 or later (see Appendix A) must be programmed using Version 202 or later programming software. Failure to do so may result in erratic transceiver operation.*

This section describes programming software Version 206 which became available in late 2000. The main features of this and earlier releases are as follows:

**Version 202 -** Had additional screens for programming the UD$^2$I (universal interface) and has an additional parameter in the bank screen for programming "Wide Area Group Tracking". Refer to Appendix A.4 for more information.

**Version 203 -** Became available in January 1995. This version has an additional question on the "Main Radio Parameters" screen for specifying if encryption is installed. See Section 3.6.12 for more information.

**Version 204 -** Became available in early 1996. This version has an additional parameter on the "Main Radio Parameters" screen for specifying the horn alert operating mode (see Section 3.6.4).

**Version 205 -** Became available mid 1997. This version added an additional "Start At Home" parameter on the Create/Edit Bank screen (see Section 3.6.6).

**Version 206 -** Became available in late 2000. This version added an additional proceed tone delay time screen that is selectable by pressing the F6 key from a group programming screen (see Section 3.6.3).

This programming software is backward compatible which means it can also program all transceivers with early versions of software. However, added features are not available unless the transceiver software is also updated. The files generated by an earlier programming software version are automatically converted to a new format hen they are opened and then saved or downloaded. Once a file is converted to the new format, it cannot be used by an earlier version. Refer to Appendix A.4 for more information on software revisions.

### 4.1.6 COMPUTERS RUNNING WINDOWS®

The Summit DM programming software is a DOS program that is not designed to run in Windows. Therefore, if applicable, Windows must be exited and the program run in the DOS mode.

### 4.1.7 SOFTWARE INSTALLATION

When you receive the programming software, make a backup copy and store the master in a safe place. You may want to create a separate directory for programming. For example, to create a directory called RADIOPRG on drive C: using DOS, type C: (Enter) to make it the current directory if necessary. Then type MD \RADIOPRG (Enter). To change to that directory, type CD \RADIOPRG.

The programming software is shipped in a compressed format. The name of the compressed file is SUMMIT2.EXE and unpacks into two files called SUMMIT.EXE and DM_PGMR.HLP. These files are approximately 454K and 78K in size, respectively.

To unpack these files so that they can be used, first make sure that the current directory is destination directory for these files. For example, if hard drive C: is the destination, make it the current directory (if required) by typing C: (Enter). Then if using a subdirectory, type CD as just described. Then insert the program disk in the computer and type A:SUMMIT2 (or B:SUMMIT2 if drive B: is being used). The two program files are then automatically unpacked into the current directory.

### 4.1.8 HARDWARE HOOKUP

The programming setup is shown in Figure 4-1. The cable from the RPI to the transceiver is connected to the microphone jack of the transceiver with front mount models. With remote mount models, it can be connected to either the microphone jack of the control unit or the programming jack on the blank front panel of the transceiver. The RPI has a switch which must be in the correct position. Make sure that the standard mode, indicated by a green light, is selected.

### 4.1.9 MINIMUM FREE MEMORY REQUIRED

Approximately 525K of free conventional memory is required to run this program (use the CHKDSK or MEM command to display the amount of free memory). If you have at least 640K of memory and not enough is available, there may be other programs that are also being loaded into conventional memory. Refer to your MS-DOS® manual for information on how these programs can be moved or disabled to make more space available.

### 4.1.10 STARTING THE PROGRAM

Turn the computer on as described in the computer instruction manual. Once the DOS prompt has been obtained, start the program by typing SUMMIT and pressing Enter. The SUMMIT.EXE and DM_PGMR.HLP files should be in the current directory as described in Section 4.1.10.

*NOTE: The program automatically detects most video cards. If it does not operate properly with a monochrome monitor, try starting it in the monochrome mode by typing SUMMIT M.*

### 4.1.11 HEADER INFORMATION

The following information is contained in the header area at the top of the screen.

Free Space - Displays the amount of space remaining in the transceiver EEPROM if it was programmed with the current information. The maximum number of systems that can be programmed is determined by the system type and the number of groups that are programmed in each system.

Radio Model - Displays the transceiver model and frequency range of the file being edited. This information is specified when a new file is created and cannot be changed later. The extension of the file name (xxxxxxxx.ext) indicates the model. For example, ".SM8" indicates that the file is for a Summit DM 800 MHz transceiver. To display the radio serial number, press the F7 key when in the Main menu (see Section 4.3).

File Name - Displays the name of the transceiver configuration file that is currently being edited. If a new file is created and it has not yet been saved, it is called "NEW".

### 4.1.12 SPECIAL KEYS

**Escape -** The Escape key is pressed to go back to the preceding screen. If information was changed in the current screen, the changes on that screen are saved in a buffer but not to a disk file.

**Return -** Pressing the Return key (or ENTER on some keyboards) usually executes the changes made to a parameter or screen. The change is saved in a buffer but not to a disk file.

**Arrow Keys -** The arrow keys are usually used to move the cursor or highlight bar to the next or previous parameter.

**Numbers/Letters Preceding Description -** An alternative method for quickly selecting screens or functions is to press the number or letter key preceding the description when applicable.

**F1 (Help Select) -** Displays help information on the selected parameter.

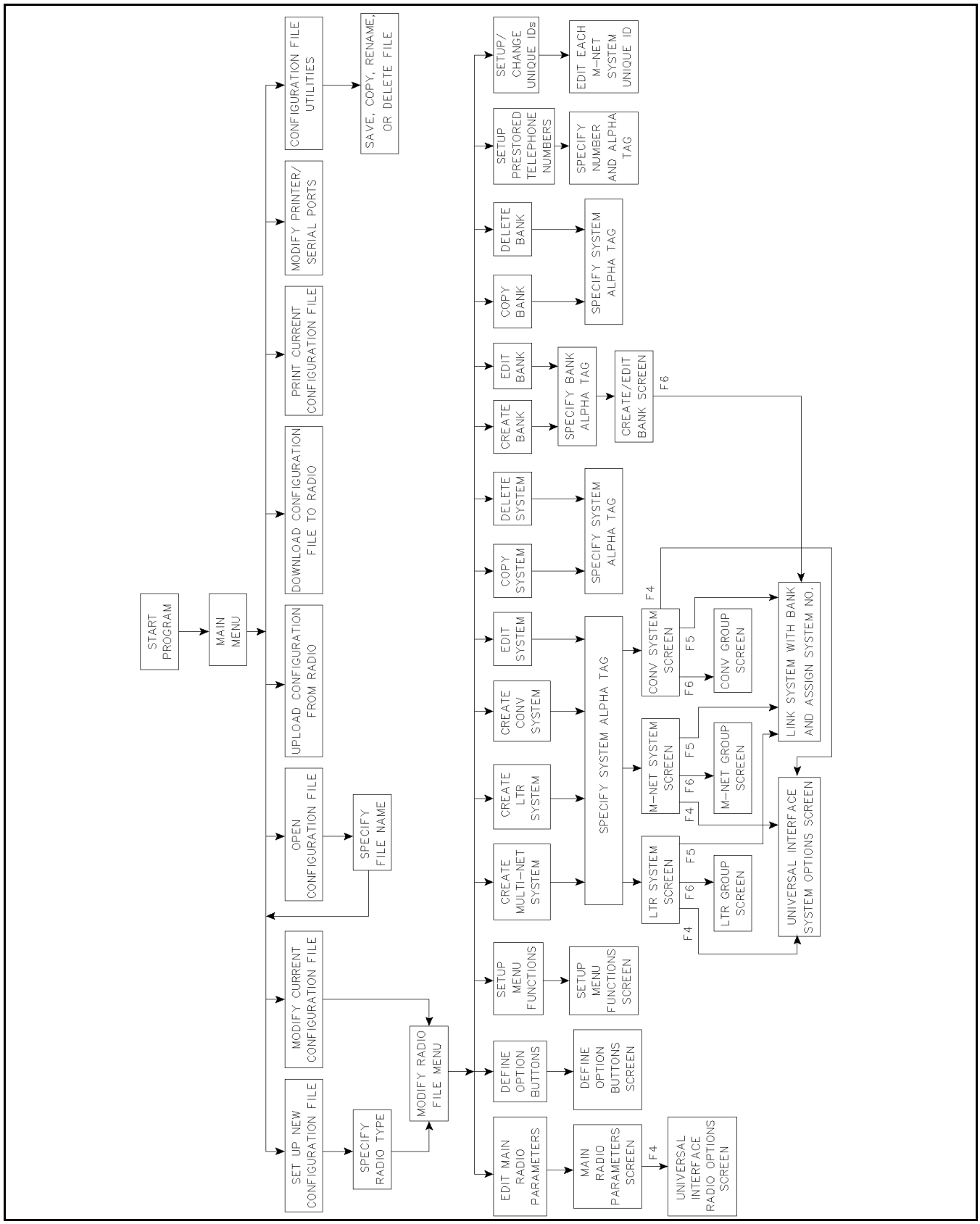



**Figure 4-2 Programming Software Menu Structure**

**F2 (Help Screen) -** Displays help information on the displayed screen.

**F3, F8 -** Not used.

**F4 - F6 -** Use varies according to the screen that is selected. Refer to the separate screen descriptions for more information.

**F7 -** When in the main menu, displays the serial number of the transceiver being programmed (see next section).

**F9 (Prev Menu) -** Returns to the previous menu or screen.

**F10 (Exit Program) -** Exits the program and returns to the operating system. Before exit occurs, a prompt appears to allow the current file to be saved. If it is not saved in this manner or has not been previously saved using "Configuration File Utilities" screen, all changes will be lost.

## 4.2 MAIN MENU

### 4.2.1 INTRODUCTION

The Main Menu appears when the program is started. This menu is used to select the function to be performed. It selects if a new configuration file is to be created, an old file edited, or the current file is to be printed, saved or downloaded to a radio. It is also used to upload a file from a radio, and to copy, rename, or delete a disk file. This menu is shown in Figure 4-3, and the parameters in it are described in the following information. A block diagram showing the structure of the program is shown in Figure 4-2.

The following function keys perform special functions in this menu. Other function keys that are active in this menu are described in the preceding section.

**F5 (Change Dir) -** Displays the screen that changes the current directory. When a configuration file is loaded from or saved to disk, it is always from or to the current directory. Therefore, if you need to change this directory, select this screen.

**F6 (Show Files) -** Displays the names of all radio configuration files that are in the current directory.

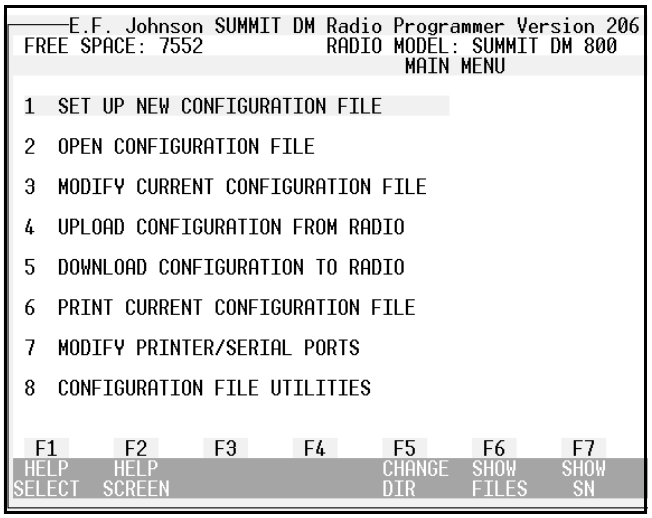



**Figure 4-3 Main Menu**

**F7 (Show SN) -** Displays the serial number of the transceiver. This number is the same as the identification number described in Section 1.4, and it is stored in memory and cannot be changed.

### 4.2.2 SET UP NEW CONFIGURATION FILE

This function is used to create a new configuration file. The type of radio is selected and then the Modify Radio File menu described in Section 4.3 is displayed. The radio type specified for a file cannot be changed after it is selected. Therefore, it is not possible to copy a file of one radio type and then edit it for use as another type.

### 4.2.3 OPEN CONFIGURATION FILE

This function is selected to open a configuration file stored on disk and load it into memory. The files in the current directory are displayed and then the arrow and Return keys are used to select the desired file. If the file is in another directory, press the Escape key and then F5 to change the current directory (see Section 4.2.1). After the file is opened, it can be edited, downloaded, printed, saved, copied, or renamed using the functions described in the next sections.

### 4.2.4 MODIFY CURRENT CONFIGURATION FILE

This function is selected to edit the file currently residing in memory. This file must have been previ-

ously loaded from disk as described in the preceding section or from a transceiver as described in the next section. If there is no file currently in memory, a message is displayed. This function displays the Modify Radio File menu described in Section 4.3. When the program is started, the last file edited is automatically loaded if it is in the current directory.

### 4.2.5 UPLOAD CONFIGURATION FROM RADIO

This function is selected to copy (upload) a file stored in a transceiver into the computer memory. It can be used to check transceiver programming or use the data stored in one transceiver as a basis for programming another transceiver. The screen displayed by this function is shown below.




### 4.2.6 DOWNLOAD CONFIGURATION TO RADIO

This function is selected to program the transceiver with the configuration file that is currently in memory. Follow the instructions on the screen. If some data is incorrect or has not been entered, a message is displayed and the file is not downloaded. When programming is occurring, “PROG MODE” and the rotating scan indicators are displayed.

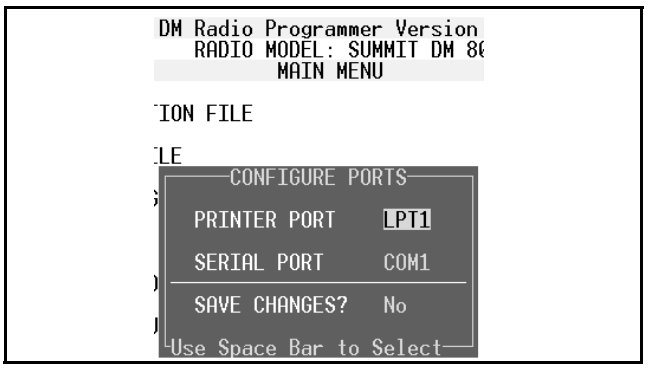
### 4.2.7 PRINT CURRENT CONFIGURATION FILE

This function is selected to print the information in the current file. The computer port used for the printer can be selected as described in the next section. The file information can also be printed to a disk file instead of the printer. It is always printed to a file called PRINTOUT.PRN. Therefore, if there is already a file by that name in the current directory, it will be overwritten. The screen displayed by this function follows.




### 4.2.8 MODIFY PRINTER/SERIAL PORTS

This function is used to specify the computer port used by the printer and RPI (see Section 4.1.3). The printer can be connected to either parallel port LPT1 or LPT2 (a serial port cannot be used). The RPI can be connected to serial port COM1 or COM2. There is also an option to either save or not save the selected configuration for the next time that the program is run. The screen displayed by this function is shown below. Use the arrow keys and spacebar to display the desired configuration and then press Return with “Save Changes” highlighted to select that configuration.

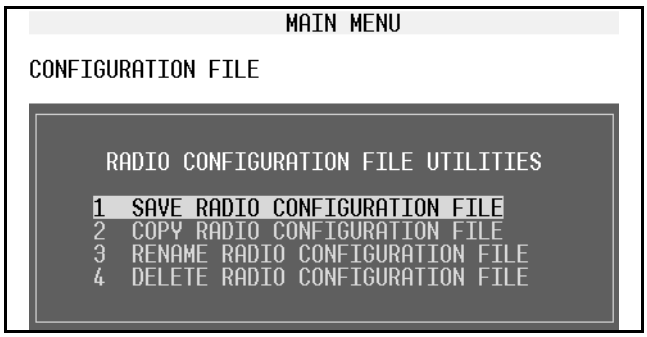



### 4.2.9 CONFIGURATION FILE UTILITIES

This function is selected to save, copy, rename, or delete a radio configuration file. The “Save” function saves the current configuration file to disk. This function should be used periodically while editing a file to ensure that all data is not lost if a power failure occurs or program execution is interrupted for some other reason.

The copy, rename, and delete functions are performed on disk files. The files in the current direc-

tory are listed and then the arrow and Return keys are used to select the file. When copying a file, it must be given a new name and/or destination in the destination box. The screen displayed by this function follows.




## 4.3 MODIFY RADIO FILE MENU

### 4.3.1 INTRODUCTION

The Modify Radio File menu is used to select the screens which program the various types of radio configuration information. This menu is shown in Figure 4-4, and the screens selected by this menu are described in the following information. The Main Menu functions described in Sections 4.2.2 and 4.2.4 select this menu.

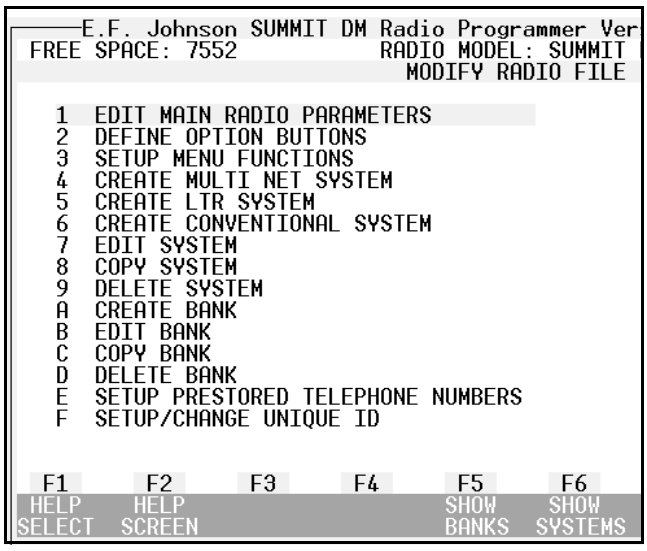



**Figure 4-4 Modify Radio File Menu**

The following keys have special functions in this menu. Other special keys are described in Section 4.1.12.

**Number/Letters Preceding The Parameter** - An alternate method for quickly selecting these screens is to press the number or letter key preceding the description. For example, to select the Setup Menu screen, press “3”.

**F5 (Show Banks) -** Displays the alpha tag of each bank programmed in the current radio file.

**F6 (Show Systems) -** Displays the alpha tag and type of all systems programmed in the current radio file. “M” = Multi-Net, “L” = LTR, and “C” = conventional.

### 4.3.2 EDIT MAIN RADIO PARAMETERS

This function selects the Main Radio Parameters screen which is used to program transceiver parameters that are the same for all banks and systems. This screen and the parameters it programs are described in Section 4-1.

The Status Definitions section of the screen is used to program the status conditions that are displayed by the STAT option switch or Menu Mode “STATUS” parameter. Status information is transmitted in the Multi-Net mode only (see Section 3.7.3).

The Universal Interface (UD$^2$I) Options screen is selected by pressing the F4 key while the Main Radio Parameters screen is displayed. If the Universal Interface feature is used, this screen programs the parameters that are the same for all systems. The Universal Interface parameters that can be different for each system are programmed by the screen displayed by pressing key from the system programming screen. Refer to Section 4.7 for more information on Universal Interface Programming.

### 4.3.3 DEFINE OPTION BUTTONS

The Define Option Buttons screen shown in Figure 4-5 programs the six option buttons on the front panel of the transceiver or control unit. The arrow keys select the button to be programmed and the Return key is pressed to move to the box on the right which lists the available choices for that button. Use the arrow and PgUp/PgDn keys to move the highlight block to the desired choice and select that choice by pressing the Return key.

An on-off indicator is available in the display for only the first three keys. Since some functions require this indicator, they are not displayed for the keys that do not have an indicator. Refer to Section 3.5 for more information on the option switches.

### 4.3.4 SETUP MENU FUNCTIONS

The Setup Menu screen is shown in Figure 4-6. This screen specifies which menu items can be selected by the user. Some functions are also controllable by an option switch. If an option switch has been programmed, the function cannot be enabled in the menu.

If an item is programmed as not selectable (INCL = No), it is fixed in the condition displayed in the Default column (if an option switch is not programmed). For example, if Backlight Control = No and Default = Enabled, the BACKLIGHT menu parameter is not selectable by the user and the backlight is always on when power is on.

If a menu item is selectable, the default condition exists only until that function is changed by the user (the last selected and not this default condition is selected when power is turned on). Use the arrow keys and spacebar to select the desired parameter in each column. Refer to Section 3.5 for more information on Menu Mode parameters.

### 4.3.5 CREATE/EDIT/COPY/DELETE SYSTEM

Create System

The Create System functions are used to create new LTR, Multi-Net, or conventional systems. The alpha tag for the new system is entered and then the Create/Edit System screen is displayed. The system alpha tag can be up to ten characters long, similar to the bank alpha tag. The system alpha tag is used only for programming and is not displayed by the transceiver.

Edit System

The Edit System function is used to change the parameters of a current system. The system to be edited is selected from a list of the current systems that is displayed. The arrow and Return keys are used to select the desired system.

The Multi-Net, LTR, and conventional Create/Edit System screens and descriptions of the parameters they program are located in the following tables:

**Multi-Net Screen -** Table 4-2
**LTR Screen -** Table 4-3
**Conventional Screen -** Table 4-4

Copy System

This screen is used to create a new system by copying information from another. The system to be copied is selected from a list and then the alpha tag for the new system is entered. This function does not copy anything to a disk file; it only copies to a new system in the buffer.

Delete System

This screen is used to delete a current system. The system to be deleted is selected from a list. This function does not delete anything on disk; it only deletes the selected system in the buffer.

Programming Group Information

The group parameter screen is displayed from the system screen by pressing F6. With LTR systems, this screen is also used to program channel information. The group screens and descriptions are shown in the tables listed in the preceding “Edit System” section. To return to the system screen, press the F9 or Escape key.

To program the PTT (proceed) tone delay time, press the F6 key from the applicable group screen. The following screen is then displayed to program the delay time for the system and select the group on which the delay is active. Numbers from 1-15 can be entered, with each number representing a delay of 125 ms. For example, entering “4” programs a delay of 4 x 125 or 500 ms.

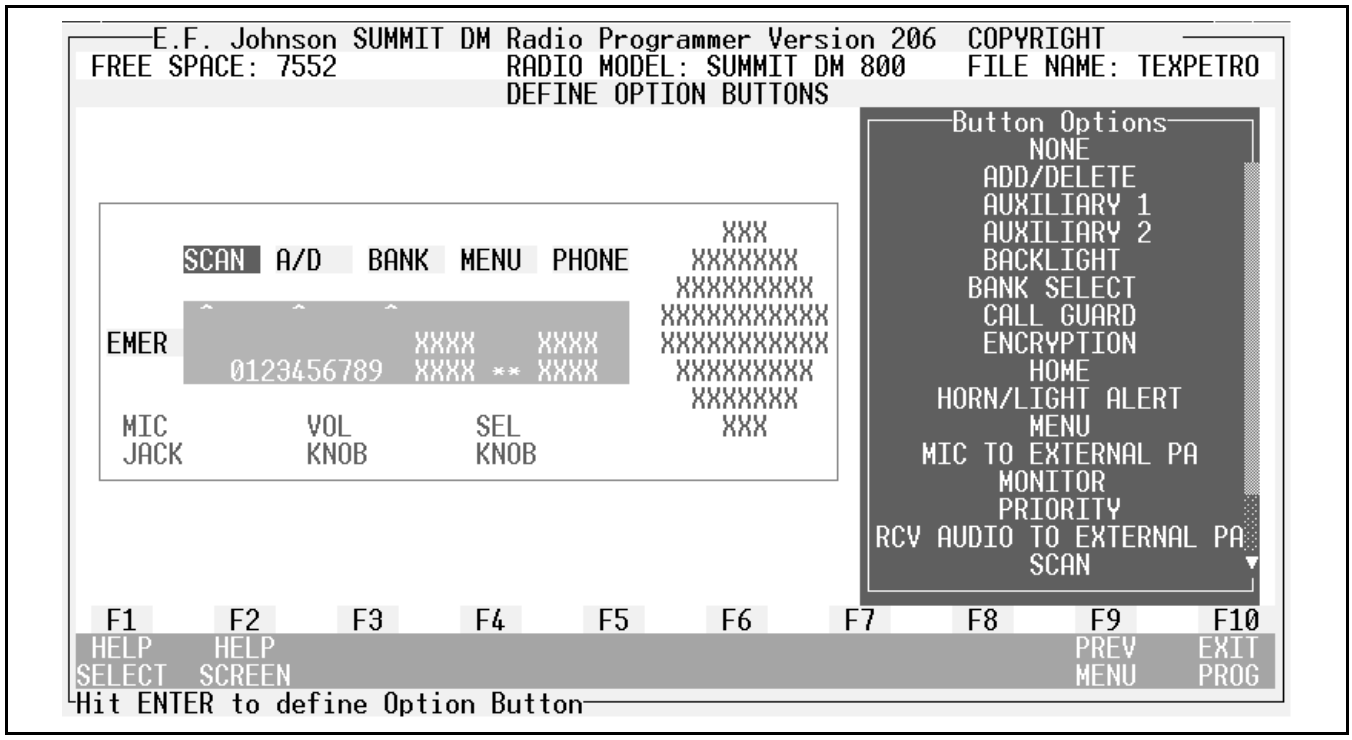



**Figure 4-5 Define Option Buttons Screen**

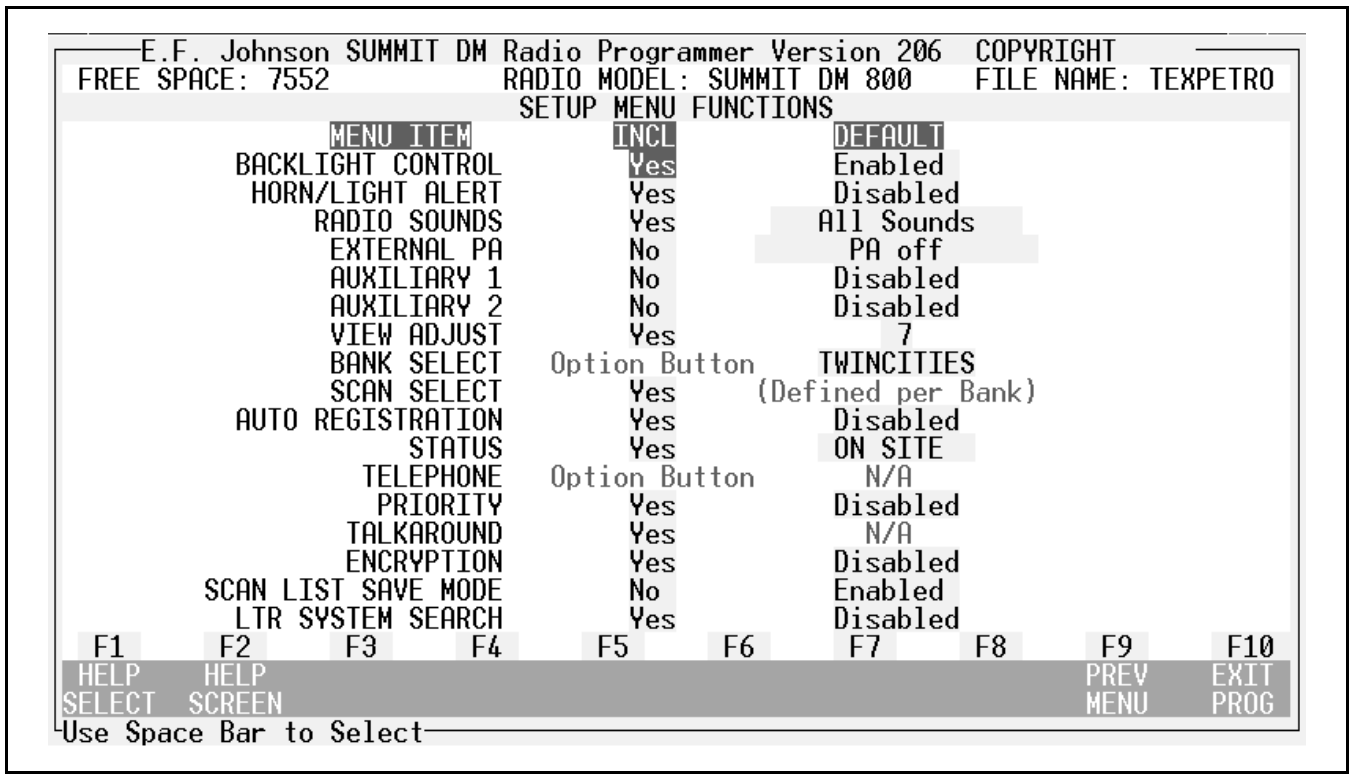
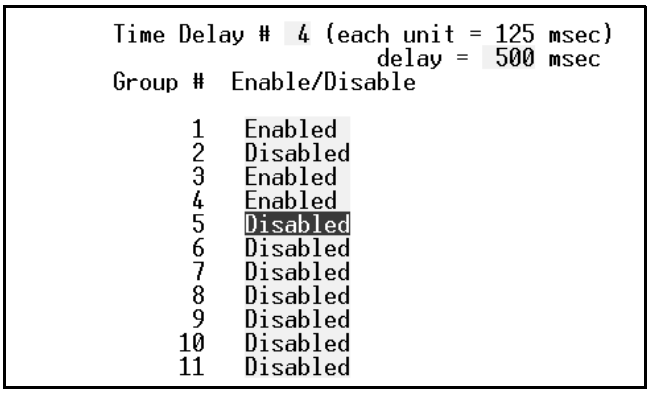



**Figure 4-6 Setup Menu Functions Screen**



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**PTT Tone Delay Programming Screen**

Linking Systems To A Bank

A system can be linked to a previously created bank from the Create/Edit System screen as follows or from the Create/Edit Bank screen described in Section 4.3.6. To do this, proceed as follows:

a. When system information is being programmed, the current banks are displayed on the right side of the screen. If the current system is in a bank, there is a system number to the right of the bank name. If it is not in the bank, "xx" is indicated.

b. To add or delete the current system, press the F5 key and then use the arrow keys to highlight the desired bank. To add the current system to that bank, press the "A" key; to delete it from that bank, press the "D" key.

c. If a system was added, the highlight bar moves to the system number column. This column programs the number of that system in the displayed bank. Enter the desired number from 1-99. Press the Return key once to make the change and press it again to go back to editing system information.

Programming System Universal Interface Options

To display the screen that programs the Universal Interface parameters for the system, press the F4 key. Refer to Section 4.7 for more information on Universal Interface programming.

## 4.3.6 CREATE/EDIT/COPY/DELETE BANK

Create Bank

This Create Bank function is used to create a new bank. At least one bank must be created even if banks are not going to be selected. Banks are identified by alpha tag and selected by the BANK option switch or "Bank Select" Menu Mode parameter. An alpha tag can have up to ten characters. Most printable ASCII characters can be used except the following:

**# & ( ) , . : ; [ ]**

After the alpha tag is entered, the Create/Edit Bank screen is displayed. This screen is used to edit information unique to a bank. This screen and the parameters it programs are described in Table 4-5.

Edit Bank

The Edit Bank function is used to change parameters of previously created banks. The bank to be edited is selected from a list of the current banks, and the arrow and Return keys are used to select the desired bank. The Create/Edit Bank screen is then displayed (see preceding "Create Bank" description).

Copy Bank

This screen is used to create a new bank by copying information from another bank. The bank to be copied is selected from a list and then the alpha tag for the new bank is entered. This does not copy anything to a disk file; only to another bank in the buffer.

Delete Bank

This function is used to delete a current bank. The bank to be deleted is selected from a list. This does not delete anything on disk; only the selected bank in the buffer.

Linking Systems To A Bank

Systems are created using the Create System screen or Copy System functions. The programmed systems can then be linked to a bank from either the

System programming screen (see Section 4.3.5) or the Create/Edit Bank screen.

Systems are identified by alpha tags, and numbers are assigned when a system is linked to a bank. Different system numbers can be assigned in each bank even if identical systems are used in the banks. To link a system to a bank from the Create/Edit Bank screen, proceed as follows:

a. When bank information is being programmed, the current systems are displayed on the right side of the screen. If a system is in the current bank, there is a system number to the right of the bank name. If it is not in the bank, "xx" is indicated.

b. To add or delete a system, press the F6 key and then use the arrow keys to highlight the desired system. To add that system to the current bank, press the "A" key; to delete it from that bank, press the "D" key.

c. If a system was added, the highlight bar moves to the system number column. This programs the number of that system in the current bank. Enter the desired number from 1-99. Press the Return key once to make the change and press it again to go back to editing bank information.

### 4.3.7 PROGRAMMING PRESTORED TELEPHONE NUMBERS

If the PHONE option switch or "TELEPHONE" menu parameter is programmed, the Phone Mode can be selected to place telephone calls (see Section 3.6.13). The Telephone Numbers screen shown in Figure 4-7 can then be used to prestore up to ten telephone numbers. This screen is selected by the "Setup Prestored Telephone Numbers" parameter in the Modify Radio File menu (see Figure 4-4).

The alpha tag and not the telephone number is displayed when a number is recalled. This alpha tag can include any ten characters except the ones listed in Section 4.3.6. Telephone numbers up to 29 digits long can be programmed. Do not enter dashes. The "*" and "#" characters program the DTMF tone for those characters. If "Assigned" is "No", the telephone number cannot be recalled by the user.

### 4.3.8 EDITING UNIQUE ID CODES

The unique ID code programmed for each Multi-Net system can be edited by selecting the "Setup/ Change Unique ID" parameter in the Modify Radio File menu (see Figure 4-4). This displays the screen shown in Figure 4-8. This screen allows all Multi-Net unique ID's to be conveniently edited without having to display each system screen.

```
 Johnson SUMMIT DM Radio Programmer Version 20
CE: 7552            RADIO MODEL: SUMMIT DM 800
                      TELEPHONE NUMBERS

    ASSIGNED  ALPHA TAG    TELEPHONE NUMBER
 1    Yes     EF JOHNSON   15078356222
 2    Yes     FRED SMITH   5151234
 3    No
 4    No
 5    No
 6    No
 7    No
 8    No
 9    No
10    No
```

**Figure 4-7 Telephone Numbers Screen**

```
      E.F. Johnson SUMMIT DM Radio Programmer
 FREE SPACE: 7552            RADIO MODEL: SUMM
                             SETUP/CHANGE UNIQ
SYSTEM     UID  SYSTEM     UID  SYSTEM     UI
AIRPORT    3210
```

**Figure 4-8 Setup/Change Unique ID Screen**

## 4.4 ADDITIONAL PROGRAMMING INFORMATION

### 4.4.1 REPEATER NUMBER PROGRAMMING (MULTI-NET AND LTR)

Each Multi-Net repeater site can have up to 30 repeaters, and each LTR repeater site can have up to 20 repeaters. The repeaters at the same site are assigned a unique number from 1-30 or 1-20. With Multi-Net systems, these numbers can be assigned arbitrarily as long as no two repeaters have the same number.

With LTR systems, they can also be assigned arbitrarily. However, for maximum system efficiency, a scheme should be used which equalizes, as much as possible, the gaps between numbers. For example, a five-repeater system should use numbers 1, 5, 9, 13, and 17. The number assigned to a repeater is programmed in the repeater, the mobiles assigned to that home repeater, and the System Management Module (Multi-Net only).

### 4.4.2 CHANNEL NUMBER PROGRAMMING

With LTR operation, the mobile transceiver is programmed with the channel number of each repeater it can access. With Multi-Net operation, this is not necessary because the mobile transceiver receives “go to” channel information over the air. The only channels that are programmed in Multi-Net systems are the home and status channels. This allows channels to be added to the system without reprogramming the mobiles.

Each Multi-Net system can be programmed with a different home repeater number if desired. However, systems with the same site number must be programmed with the same status channel number. Refer to Section 4.4.4 for more information on site numbers.

The channel numbers used to program this transceiver are listed at the end of this section. The channels used for programming channels 1-600 are the same as the FCC channel numbers. However, for channels above 600, a special programming channel number is used because some frequencies were skipped by the FCC scheme. A –12.5 kHz offset can be specified for channels 1-600 because they have a 25 kHz spacing. This offset does not apply to channels above 600 because they already have a 12.5 kHz spacing.

### 4.4.3 ACCESS PRIORITY PROGRAMMING (MULTI-NET ONLY)

Each Multi-Net encode (transmit) ID code is programmed with an access priority number from 1-5. As stated in Section 5.8.2, this access priority and the current system priority being transmitted by the repeater determine if the system can be accessed. If the priority number being transmitted is greater than the priority number assigned to the ID code being transmitted, the system cannot be accessed at that time. There are various schemes that the repeater may use to determine the current system priority. Refer to the setup section of the repeater service manual for more information.

### 4.4.4 SITE NUMBER PROGRAMMING (MULTI-NET ONLY)

Each Multi-Net repeater site must be assigned a number from 1-255. A repeater site is defined as a group of repeaters which share the same high-speed data bus (refer to Section 5.6). The site number programmed in the mobile is used for controlling scanning. A site number is also transmitted in the form of DTMF tones when a special call is made by a mobile to a different site. The System Management Module uses the site information to route the call. Refer to Section 5.7 for more information on special calls.

If there is only one site that can be accessed by the mobiles, the site number of the repeater system can be selected arbitrarily. Each selectable system of the mobile is then programmed with that site number. If there are several sites that can be accessed, each site must be assigned a unique number. Each selectable system of the mobile is then programmed with the number of the site that is accessed by that system.

### 4.4.5 SPECIFYING RIC-EQUIPPED REPEATERS

When programming the channel numbers of LTR systems, you can specify if the repeater is equipped with an E.F. Johnson RIC (repeater interconnect) controller. If a system with a transmit ID code programmed for RIC is then selected, the transceiver will attempt to access only repeaters specified as equipped with repeater interconnect. This allows both RIC and non-RIC repeaters to be programmed in each system.

Without this feature, the transceiver may trunk to a repeater not equipped with a RIC drawer when a RIC call is made. No dial tone or other supervision is then returned when the PTT switch is released which may be confusing to the user.

### 4.4.6 WIDE AREA GROUP TRACKING PROGRAMMING

When Wide Area Group Tracking is enabled with Multi-Net Auto-Registration (see Section 3.7.2), the same group remains selected when auto-registration on another system occurs. This allows a companion group to be automatically selected in the new system. For example, the transceiver can be programmed so that if a telephone group is selected and auto-registration occurs on a new system, a telephone group is also selected on the new system. Without wide area group tracking, the last selected group of the new system is selected.

With this type of operation, it is important that the same groups in all systems be programmed. If auto-registration occurs on a system that does not have the group programmed (ASN = No), the next higher programmed group is selected and displayed. The selected group then changes by one or more which is probably not the desired operation. This occurs because all groups that are higher in number are pulled down to fill the empty position(s). Therefore, the group also changes when auto-registration occurs on that system with a group selected that is higher than the unprogrammed group.

Therefore, when programming wide area group tracking, observe the following rules:

- Assign companion groups in sequence starting with Group 1 and make sure that the same groups are programmed in each participating system.

- If groups are programmed that are not companions with groups in other systems, program them above the companion range. Then do not leave one of those groups selected after using it for a call because if auto-registration occurs, an unexpected group may be selected.

When the transceiver is programmed, the programming software does not allow the transceiver to be programmed if all programmed systems do not have the same number of programmed groups. However, it does not check to make sure that the same groups are programmed in each system.

## 4.5 PROGRAMMING ONE TRANSCEIVER WITH ANOTHER (CLONING)

One transceiver can be used to program another with identical information. One use of this type of programming may be to reprogram a transceiver in the field where a computer is not available. Transceivers of different types cannot be used. For example, do not use an 800 MHz model to program a 900 MHz model. Proceed as follows:

a. Turn the power of both transceivers off. Connect Cloning Cable, Part No. 597-2002-268, between the microphone connectors of the transceivers.

b. Turn the power of the master (source) transceiver on. Then turn the power of the slave (destination) transceiver on.

c. Programming is indicated by “CLONING” in the alphanumeric display and the rotating scanning indicators in the status display of both transceivers. In addition, the system and group number are displayed by the master transceiver.

d. When programming is finished, the displays return to normal.

## 4.6 WRITE-ON FLASH PROGRAMMING

### 4.6.1 INTRODUCTION

The E.F. Johnson Write-On™ flash programming feature allows the transceiver operating software (firmware) to be updated without replacing the microcomputer or a memory device such as an EPROM.

This reprogramming of the operating software should not be confused with the programming of operating parameters described in the preceding sections. Although both programming procedures use essentially the same programming setup, the software and procedures are different.

Currently, the Write-On flash programming software is available only by downloading it from the E.F. Johnson ACES® Bulletin Board System. To access this system, dial toll-free from the U.S. and Canada 800-227-3997 (N, 8, 1, ANSI). From other countries, dial 507-835-8607. If you do not know your login ID

or have questions about accessing the ACES system, call 800-328-3911, extension 7 (USA and Canada) or 507-835-6222, extension 2100 (international).

### 4.6.2 PROGRAMMING FILES

The files required to flash program a transceiver are contained in a compressed self-extracting file called DMFLASH.EXE. This file is located in the MNFLASH download area of the ACES system. Once this file is downloaded, simply type DMFLASH (Enter) at the DOS prompt to extract the following files:

| File Name | Description |
|---|---|
| DM_LOAD.EXE | Flash loader program |
| READ.ME | Programming instructions |
| BOOTLOAD.S19 | Flash loader hex file |
| PREBOOT.S19 | Flash loader hex file |
| SUMMIT_1.S19 | Radio software hex file |
| SUMMIT_2.S19 | Radio software hex file |

The SUMMIT_x.S19 files contain the actual code that is loaded into the transceiver by the program. These are the files that are changed when the radio operating software is updated.

### 4.6.3 PROGRAMMING "A" MODEL TRANSCEIVERS

*NOTE: Before <u>any</u> Summit DM "A" revision letter transceiver and also "B" revision letter 9755 transceivers can be connected to the RPI module, pin 1 of power amplifier module U500 must be desoldered and lifted from the board.*

If this is not done with these transceivers, the transmitter may erroneously key when the RPI switch is moved to the flash position. This may result in excessive current draw that could damage the antenna switching circuitry. Diodes CR506 and CR507 and RF amplifier Q290 could be destroyed. Fuse F500 may also blow if the power supply can produce enough current. This problem has been corrected in later models, so this modification is not required.

### 4.6.4 PROGRAMMING PROCEDURE

a. Connect the programming hardware listed in setup as described in Section 4.1.1. Only RPI, Part No. 023-9750-000 or 023-9800-000, can be used (the earlier 023-5810-000 model will not work).

*NOTE: The RPI must always be connected to the front panel jack of the transceiver (it cannot be connected to the microphone jack of a remote control unit).*

b. Set the switch on the RPI so that it is toward the LED.

c. Start the program by typing DM_LOAD (Enter) at the DOS prompt. When the opening screen is displayed, turn transceiver power on. If power is already on, cycle power off and then on. The transceiver display should be blank and the RPI LED should be amber.

d. Highlight the first selection in the loader program's menu and then press the Enter key to begin the data transfer. Programming requires approximately 90 seconds.

e. Disconnect the programming cable from the transceiver and cycle power off and on. Verify that the new revision number is displayed momentarily when power is turned on (see Section 3.6.14).

## 4.7 UNIVERSAL INTERFACE PROGRAMMING

### 4.7.1 INTRODUCTION

The UD$^2$I™ (Universal Digital and Data Interface) feature is available on all Summit DM transceivers that have Version 207 or later operating software (see Appendix A). Optional universal interface pigtail cable assembly, Part No. 597-2002-245, is required to utilize this interface (Validation Key, Part No. 250-9750-050, is no longer required). This cable provides a female 25-pin D-type connector for interfacing with the data equipment.

This is a non-proprietary interface that can be used to connect various types of data equipment such as modems and data terminals to the transceiver. A detailed description on the operation of this interface is located in Appendix B. This information can be used to design and set up equipment for use with this interface.

Various aspects of this interface are programmable using the standard transceiver programming software (Version 202 or later). The parameters that

can be programmed and configurations that can be selected for each are described in the following information. Since the specific configuration of these parameters is determined by the equipment being used, detailed programming instructions are not included in this manual (this information should be provided by the equipment manufacturer).

*NOTE: All interface parameters should be left in the default condition (indicated by *) unless instructed otherwise in the installation information provided with the data equipment. Failure to do so may result in improper transceiver operation.*

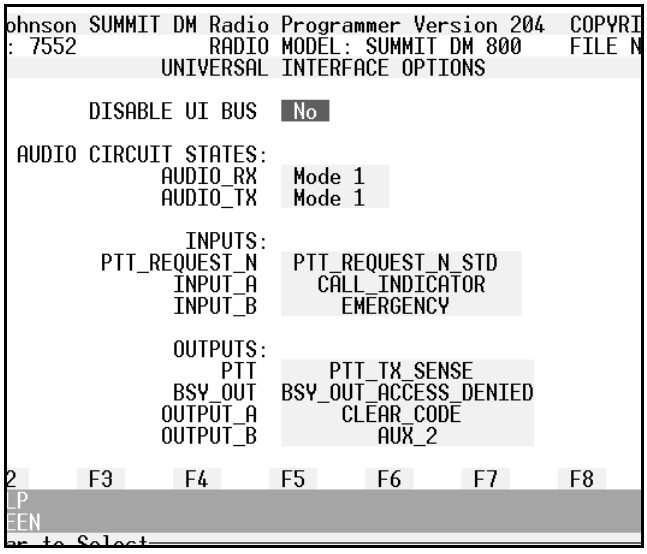



**Figure 4-9 Main Universal Interface Screen**

## 4.7.2 MAIN PARAMETERS SCREEN

Universal interface parameters that are the same for all systems are programmed using the main Universal Interface Options screen shown in Figure 4-9. This screen is selected by pressing the F4 key from the Main Radio Parameters screen (see Section 4.3.2). The parameters that can be programmed using this screen and the available choices are as follows:

*NOTE: For more information on the configuration selected by each option, refer to Appendix B.*

### MAIN PARAMETERS

**Disable UI Bus -** Yes, No*

**Audio Circuit States**

**Audio_Rx -** Modes 1*, 2, 3, 4
**Audio_Tx -** Modes 1*, 2, 3, 4

*NOTE: The system level programming described in the next section overrides the preceding Audio Rx/Tx programming except if "Undefined" is programmed.*

**Inputs**

**PTT_Request_N -** PTT_Request_N_Std*
PTT_Request_N_Inh
PTT_Request_N_Data
PTT_Request_N_Data_R
Undefined

**Input_A -** Call_Indicator*
Mic_Mute
Horn
Data_ARQ
Undefined

**Input_B -** Emergency*
Mic_Mute
Horn
Call_Indicator
Undefined

**Outputs**

**PTT -** PTT_Tx_Sense*
PTT_Standard
PTT_Tx_Sense
Undefined

**BSY_Out -** Bsy_Out_Access_Denied*
Busy_Out_RSSI
Undefined

**Output_A -** Clear_Code*
Clear-To_Send
Monitor_Hanger
Tx_Audio_En
Aux2
Undefined

**Output_B -** Aux2*
Rx_Data_Group
Clear_to_Send
Monitor_Hanger
Tx_Audio_En
Undefined

** Default condition. Do not select "Undefined" because improper operation may result.*

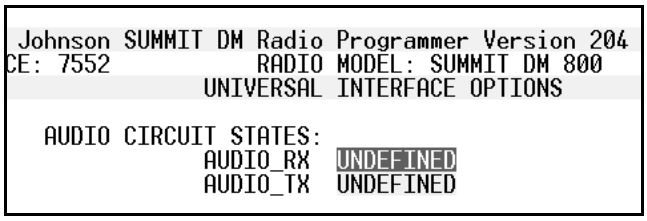



**Figure 4-10 System Universal Interface Screen**

### 4.7.3 SYSTEM PARAMETERS SCREEN

There are also two parameters that can be different for each system. These parameters are programmed using the system Universal Interface Options screen shown in Figure 4-10. This screen is selected from the applicable system programming screen by pressing the F4 key. The parameters that can be programmed using this screen and the available choices are as follows:

*NOTE: For more information on the configuration selected by each of the following parameters, refer to Appendix B.*

**SYSTEM PARAMETERS**

**Audio Circuit States**

**Audio_Rx -** Modes 1-4, Undefined*
**Audio_Tx -** Modes 1-4, Undefined*

** Default condition. If "Undefined" is selected, the radio-level parameter programmed in the preceding section is in effect.*

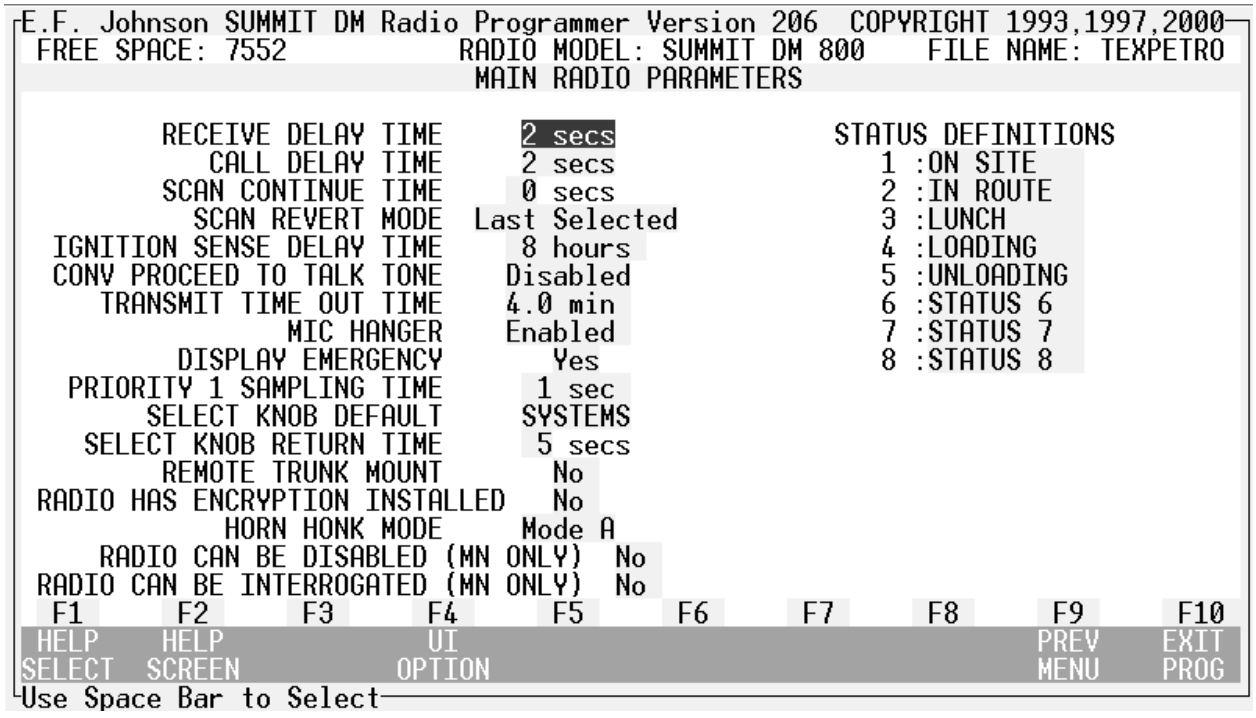
### 4.7.4 AUXILIARY AND EMERGENCY SWITCH PROGRAMMING

When the Auxiliary 2 function is programmed, it uses the OUTPUT B line of the universal interface (see Section 3.5.4). For proper operation of this switch, OUTPUT B must be programmed for the default condition of AUX2. Universal interface programming does not affect the Auxiliary 1 function.

*NOTE: The problem of the Auxiliary 2 output always going to the active state at power-up has been corrected with Version 206 and later transceiver operating software.*

When an external emergency switch is used, it is connected to INPUT B of the universal interface (see Section 2.4.6). For proper operation of this switch, INPUT B must be programmed for the default condition of EMERGENCY.

**Table 4-1 Main Radio Parameters Screen**

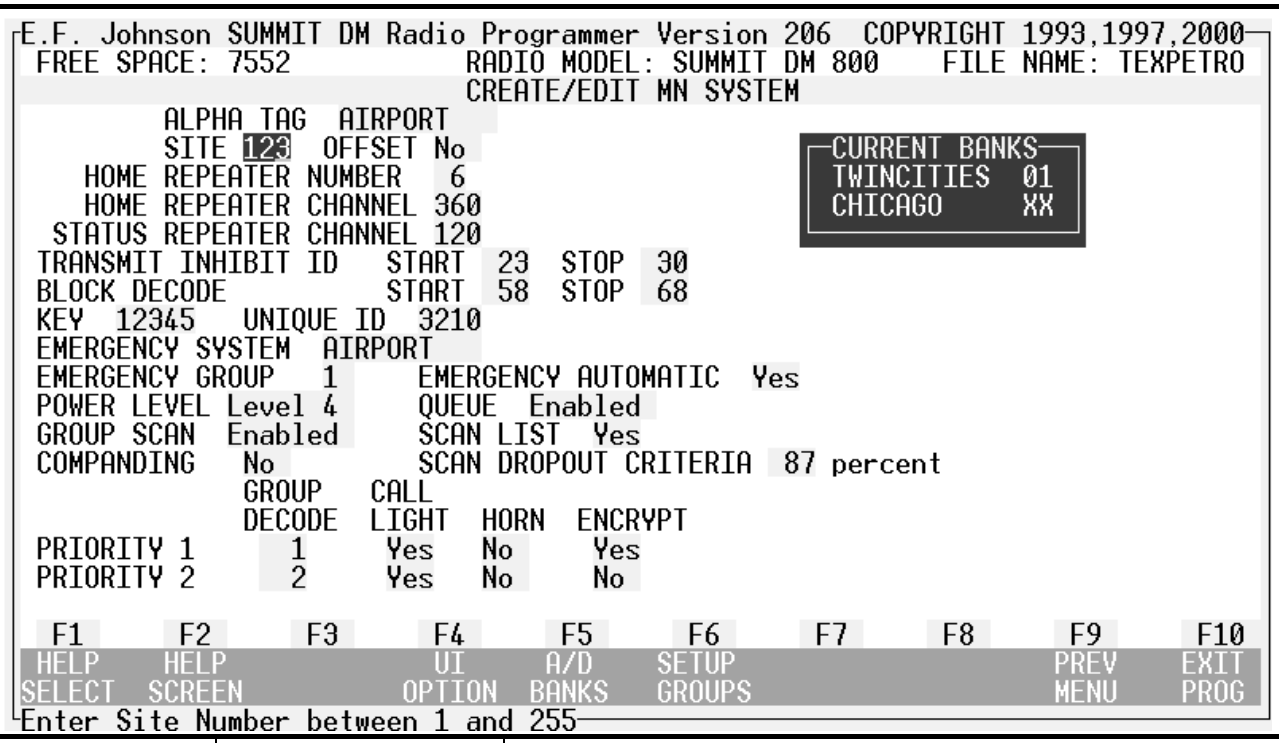



| Parameter | Acceptable Responses | Description |
|---|---|---|
| Receive Delay Time | 0, 1, 2, 3, 4, 5, 6, or 7 seconds | Time before scanning resumes after a message is received (Section 3.4.3). |
| Call Delay Time | 0, 1, 2, 3, 4, 5, 6, or 7 seconds | Time before scanning resumes after message is transmitted (Section 3.4.3). |
| Scan Continue Time | 0-60 seconds | Maximum time that a call is monitored before scanning resumes (Section 3.4.3). |
| Scan Revert Mode | Temporary, Last Received, Last Selected | Selects the system/group that is selected when the transmitter is keyed in the scan mode or the scan mode is exited (Sections 3.4.4 and 3.4.5). |
| Ignition Sense Delay Time | Forever, Immediate, 10, 30 minutes, 1, 8, 10, 12 hours | Selects power turn-off delay (Sections 2.4.3 and 3.6.7). If a transceiver with Version 205 or earlier operating software is programmed, the times are 10, 20, 30 minutes, 1, 2, or 4 hours. |
| Conv Proceed to Talk Tone | Enabled, Disabled | Enables or disables the proceed-to-talk tone on conventional systems. It is always enabled on Multi-Net and LTR systems (Section 3.6.3). |
| Transmit Time-Out Time | 0.5-5 minutes in 0.5 min steps, Disabled | Programs the Time-Out Timer (Section 3.6.1). |
| Mic Hanger | Enabled, Disabled | When “Disabled” is programmed, taking the microphone off-hook does not enable the monitor mode or disable system and group scanning. |
| Display Emergency | Yes, No | When “No” is programmed, the display does not indicate “EMERGENCY” when the Emergency switch is pressed (Section 3.6.8). |
| Priority 1 Sampling Time | Disabled, 500 ms, 1 or 2 seconds | Selects how often the Priority 1 system/group (if programmed) is sampled on conventional systems (Section 3.5.17). |
| Select Knob Default | Systems or Groups | Programs if the bar in the next parameter goes to the system or group display when power is turned on or the return time expires. |

**Table 4-1 Main Radio Parameters Screen (Continued)**

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Select Knob Return Time | 0-15 seconds in 1-sec steps | Programs the delay after a change is made before the bar returns to the default display programmed above. “0” programs no return. This bar indicates which display will be changed by the Select switch (Section 3.2). |
| Remote Trunk Mount | Yes, No | Programs the transceiver as a front or remote mount type. This is required for proper operation of the microphone hanger (seeSection 2.5.5). |
| Radio Has Encryption Installed | Yes, No | “Yes” is programmed if encryption is installed. This routes all receive audio to the encryption module so that encrypted calls are received even if encryption is disabled (Section 3.6.12). |
| Horn Honk Mode | Mode A or Mode B | Programs the horn alert operating mode (Section 3.6.4). |
| Radio Can Be Disabled (MN Only) | Yes, No | Selects if the transceiver can be disabled by the Multi-Net Mobile Disable message (Section 5.8.5). |
| Radio Can Be Interrogated (MN Only) | Yes, No | Selects if the transceiver can be interrogated to determine its status (Section 5.8.4). |
| Status Definitions | Up to 10 characters (A-Z, 0-9, etc.) | Programs the message that is displayed for up to eight status conditions (Section 3.7.3). |
| Dispatch Tx Camp-On | Yes, No | Selecting “No” disables camp-on. Then if the PTT switch is pressed while receiving a call, the transmitter is disabled and the busy tone sounds until the PTT switch is released (Section 3.7.7). |

**Table 4-2 Multi-Net System Parameters**

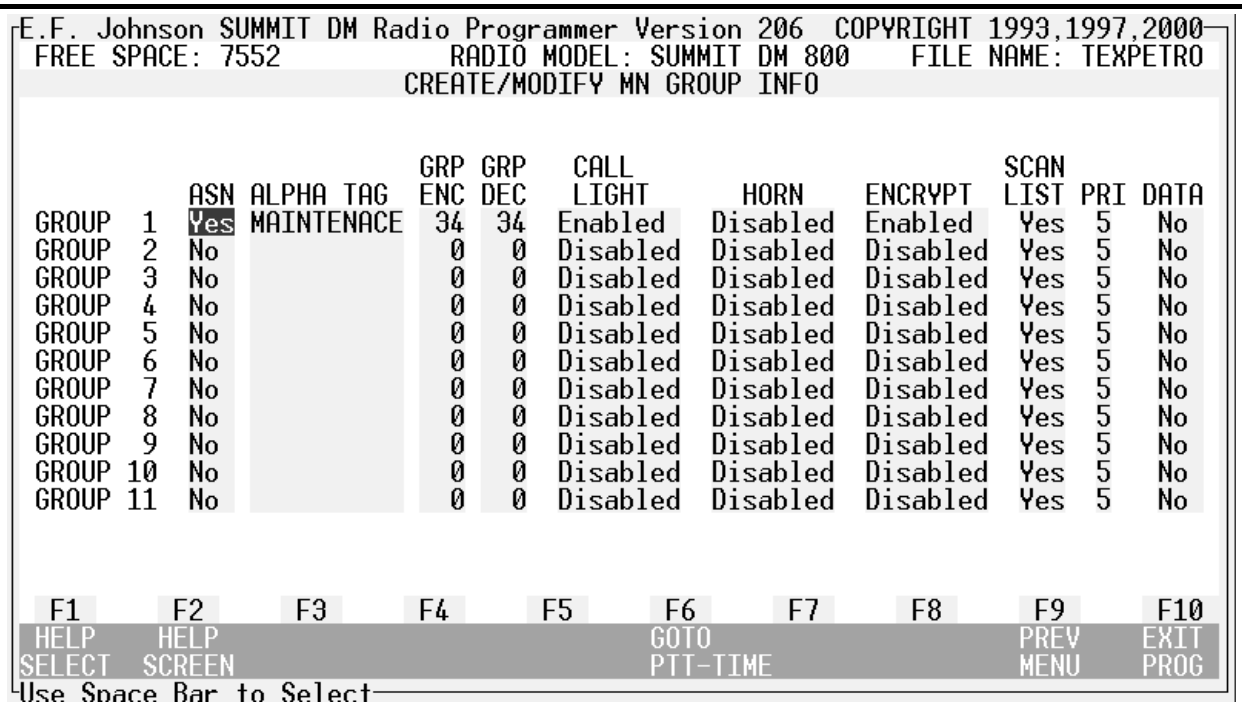



| Parameter | Acceptable Responses | Description |
|---|---|---|
| Alpha Tag | Any keyboard character | Changes the 10-character alpha tag for the selected system. The system alpha tag is used only for programming and is not displayed by the transceiver. |
| Site | 1-255 | Programs the site number of the system (Section 4.4.4). |

**Table 4-2 Multi-Net System Parameters (Continued)**

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Offset | Yes, No | Programs if channels are offset 12.5 kHz on the low side. This applies to channels 1-600 only (Section 4.4.2). |
| Home Repeater Number | 1-30 | Programs the number of the home repeater of the transceiver (Section 4.4.1). |
| Home Repeater Channel | 1-920 (800 MHz)<br>1-479 (900 MHz) | Programs the channel number of the home repeater (Section 4.4.2). Channel numbers are shown in the table at the end of this section. |
| Status Repeater Channel | 1-920 (800 MHz)<br>1-479 (900 MHz) | Programs the channel number of the status repeater (Section 5.3). Channel numbers are shown in the table at the end of this section. |
| Transmit Inhibit ID | 1-225 | Programs the block of transmit inhibit ID codes up to all 225. If an ID code within this block is decoded up to 5 seconds before the PTT switch is pressed, the transmitter does not key (Section 3.7.5). |
| Block Decode | 1-225 | Programs a block of ID codes up to all 225 that are decoded regardless of the group selected (Section 3.3.4). |
| Key | --- | This is a number unique to your system assigned by the E.F. Johnson Company (Section 5.8.9). |
| Unique ID | 1-8163 | Programs the unique ID of the mobile (Section 5.8.1). Each Multi-Net system can be programmed with a different unique ID if necessary. |
| Emergency System/ Group; Automatic | Any programmed system/ group; Auto = Yes or No | Programs the system/group on which emergency calls are made when the emergency switch is pressed, if applicable. Auto specifies if automatic transmitting occurs (Section 3.6.8). |
| Power Level | 1, 2, 3, 4, 2W | Programs the output power selected by this system. The power output produced by these numbers is set in the test mode. See Section 3.6.9 for more information. |
| Queue | Enabled, Disabled | Programs if busy queuing occurs on the system (Section 3.7.1). |
| Group Scan | Enabled, Disabled | Programs if group scanning occurs on the system (Section 3.4.7). |
| Scan List | Yes, No | Programs if the system is scanned (Section 3.4.6). |
| Companding | Yes, No | Programs if companding is used on the system (Section 1.5). |
| Scan Dropout Criteria | 50-100% | Programs the percentage of good data messages that must be detected to stay on the current site with auto-registration. The default is 75% (Section 3.7.2). |
| Priority 1/2 Decode | 1-225, 236, 237 [1] | Programs the priority decode (receive) ID codes (Section 3.3.4). |
| Call Light | Yes, No | Programs if the Call indicator lights when a call is received on that ID code (Section 3.6.2). |
| Horn | Yes, No | Programs if the horn sounds when a call is received on that ID code (Section 3.6.4). |
| Encryption | Yes, No | Programs if encryption is used on calls received on that ID code (Section 3.6.12). |

**Table 4-2 Multi-Net System Parameters (Continued)**



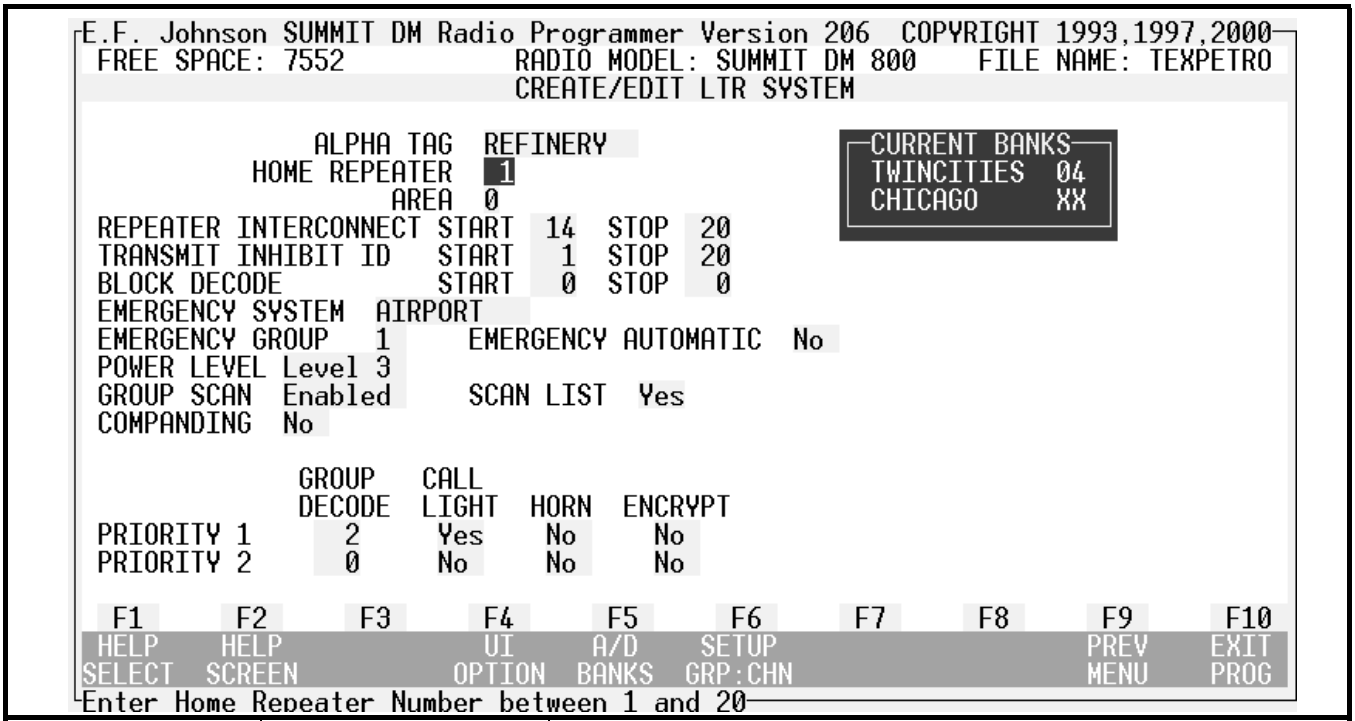

**MULTI-NET GROUP PARAMETERS**

(The Group Parameter screen is selected by pressing F6)

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Asn | Yes, No | Specifies if the group will be selectable. |
| Alpha Tag | A-Z, 0-9, etc. | Specifies the 10-character alpha tag that is displayed when the group is selected. |
| Group Enc/Dec | 1-225, 236, 237 [1] | Specifies the encode (transmit) and decode (receive) ID codes for that selectable group. |
| Call Light | Enabled, Disabled | Programs if the Call indicator lights when a call is received on that group (Section 3.6.2). |
| Horn | Enabled, Disabled | Programs if the horn sounds when a call is received on that group (Section 3.6.4). |
| Encrypt | Enabled, Disabled | Programs if encryption is used on calls received and transmitted on that group (Section 3.6.12). |
| Scan List | Yes, No | Programs if that group is scanned by the group scan feature (Section 3.4.7). |
| Pri (Priority) | 1-5 | Programs the transmit access priority for that group. “1” is the highest priority and “5” the lowest priority (Section 5.8.2). |
| Data | Yes, No | Programs if that group can be used for data transmissions (Section 3.6.11). |

[1] 236 = Auxiliary Calls, 237 = Telephone (Interconnect) Calls. See Section 3.7.4.

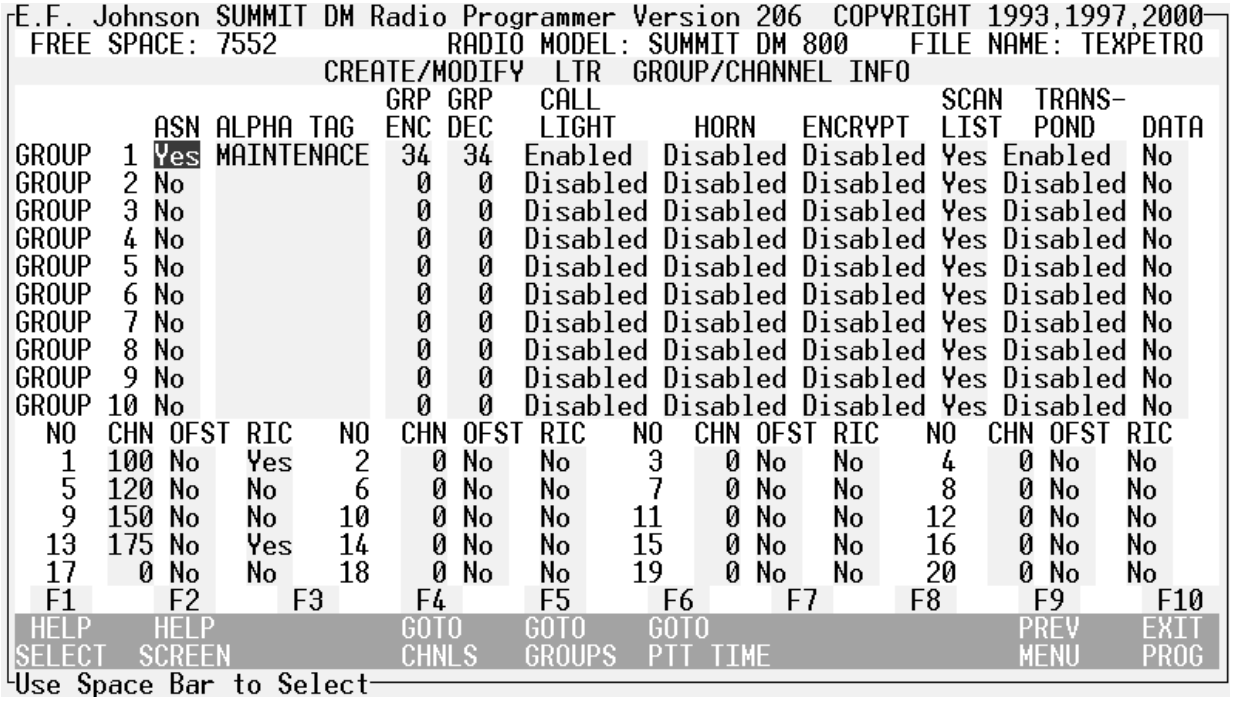
**Table 4-3 LTR System Parameters**




| Parameter | Acceptable Responses | Description |
|---|---|---|
| Alpha Tag | Any keyboard character | Changes the 10-character alpha tag for the selected system. The system alpha tag is used only for programming and is not displayed by the transceiver. |
| Home Repeater | 1-20 | Programs the number of the home repeater of the transceiver (Section 4.4.1). |
| Area | 0, 1 | Selects the area of the LTR system. “0” is usually programmed unless two systems are close enough to interfere with each other. One is then programmed “0” and the other “1”. |
| Repeater Interconnect | 1-250 | Programs the block of Repeater Interconnect (RIC) ID codes up to all 250. If an ID code within this block is selected or decoded, the transceiver enters the RIC operating mode and telephone calls can be placed or received. |
| Transmit Inhibit ID | 1-250 | Programs the block of transmit inhibit ID codes up to all 250. If an ID code within this block is decoded up to 5 seconds before the PTT switch is pressed, the transmitter does not key (Section 3.7.5). |
| Block Decode | 1-250 | Programs a block of ID codes up to all 250 that are decoded regardless of the group selected (Section 3.3.4). |
| Emergency System/ Group; Auto | Any programmed system/ group; Auto = Yes or No | Programs the system/group on which emergency calls are made when the emergency switch is pressed, if applicable. With LTR systems, automatic transmission are not available, so “Auto” = “No” (Section 3.6.8). |
| Power Level | 1, 2, 3, 4, 2W | Programs the output power selected by this system. The power output produced by these numbers is set in the test mode (Section 3.6.9). |
| Group Scan | Enabled, Disabled | Programs if group scanning occurs on the system (Section 3.4.7). |
| Scan List | Yes, No | Programs if the system is scanned (Section 3.4.6). |
| Companding | Yes, No | Programs if companding is used on the system (Section 1.5). |
| Priority 1/2 Decode | 1-250 | Programs the priority decode (receive) ID codes (Section 3.3.4). |
| Call Light | Yes, No | Programs if the Call indicator lights when a call is received on that ID code (Section 3.6.2). |

**Table 4-3 LTR System Parameters (Continued)**

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Horn | Yes, No | Programs if the horn sounds when a call is received on that ID code (Section 3.6.4). |
| Encrypt | Yes, No | Programs if encryption is used on calls received on that ID code (Section 3.6.12). |

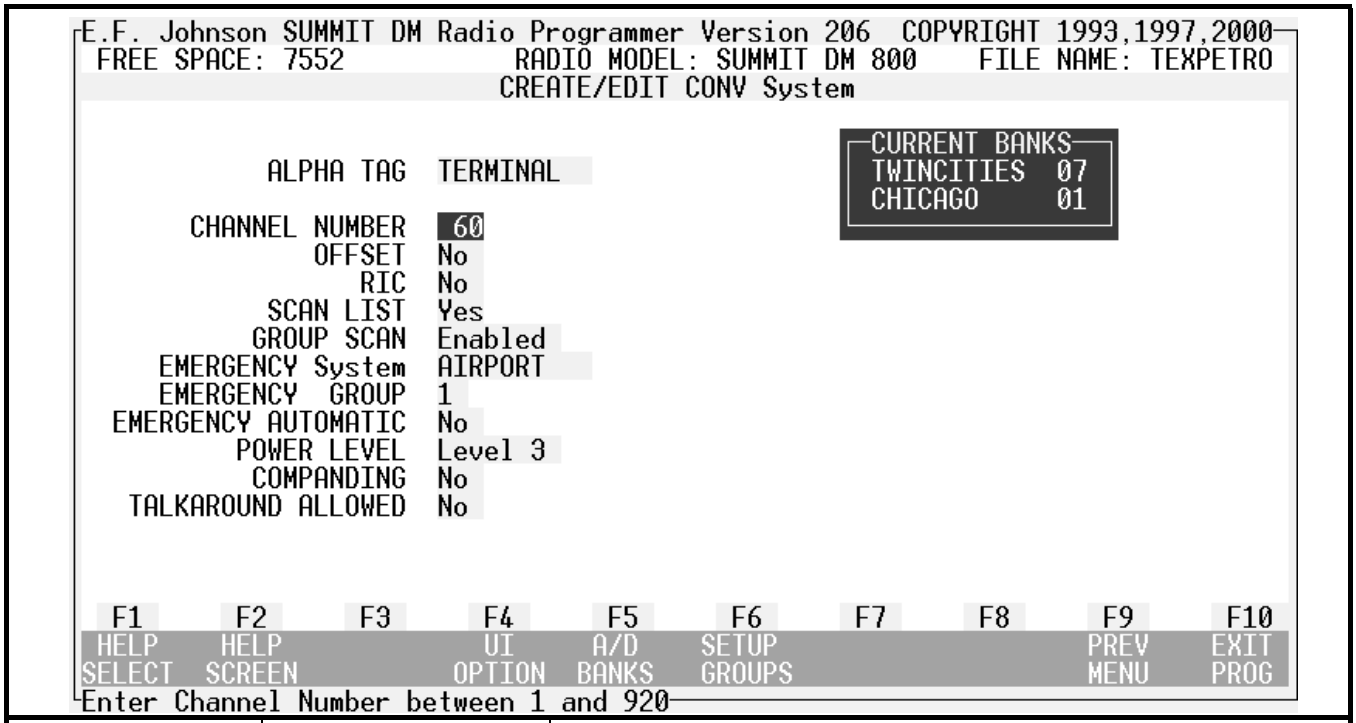



**LTR GROUP PARAMETERS**

(The Group Parameter screen is selected by pressing F6)

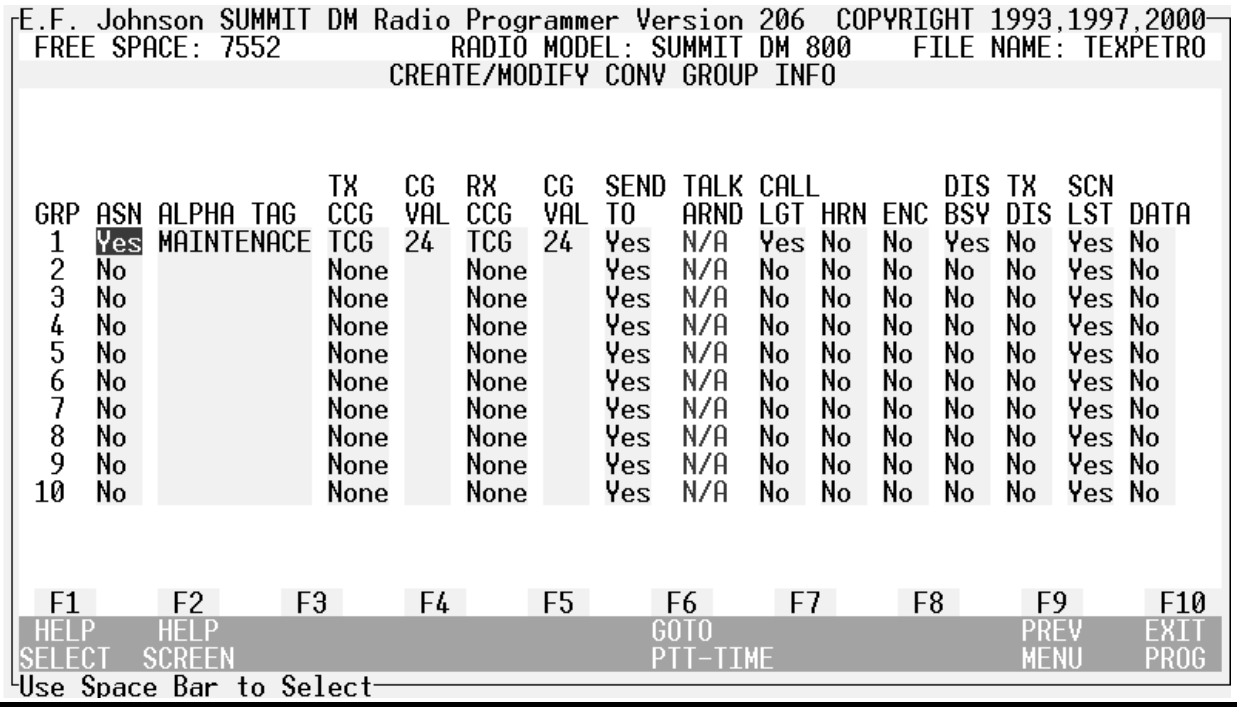
| | | |
|---|---|---|
| Asn | Yes, No | Specifies if the group will be selectable. |
| Alpha Tag | A-Z, 0-9, etc. | Specifies the 10-character alpha tag that is displayed when the group is selected. |
| Group Enc/Dec | 1-250 | Specifies the encode (transmit) and decode (receive) ID codes for that selectable group. |
| Call Light | Enabled, Disabled | Programs if the Call indicator lights when a call is received on that group (Section 3.6.2). |
| Horn | Enabled, Disabled | Programs if the horn sounds when a call is received on that group (Section 3.6.4). |
| Encrypt | Enabled, Disabled | Programs if encryption is used on calls received and transmitted on that ID code (Section 3.6.12). |
| Scan List | Yes, No | Programs if that group is scanned by the group scan feature (Section 3.4.7). |
| Transpond | Enabled, Disabled | Programs if transponding occurs when a call is received on that group (Section 3.8.3). |
| Data | Yes, No | Programs if that group can be used for data transmissions (Section 3.6.11). |
| Repeater Channel Number (Chn) | 1-920 (800 MHz)<br>1-479 (900 MHz) | Programs the channel number of each of the repeaters at the site (Section 4.4.2). Channel numbers are shown in the table at the end of this section. |
| Ofst (Offset) | Yes, No | Programs if channels are offset 12.5 kHz on the low side. This can be programmed for channels 1-600 only (Section 4.4.2). |
| RIC | Yes, No | Programs if the repeater is equipped with a RIC drawer (Section 4.4.5). |

**Table 4-4 Conventional System Parameters**




| Parameter | Acceptable Responses | Description |
|---|---|---|
| Alpha Tag | Any keyboard character | Changes the 10-character alpha tag for the selected system. The system alpha tag is used only for programming and is not displayed by the transceiver. |
| Channel Number | 1-920 (800 MHz)<br>1-479 (900 MHz) | Programs the channel number of that system. Channel numbers are shown in the table at the end of this section. |
| Offset | Yes, No | Programs if the channel is offset 12.5 kHz on the low side. This is programmable for 800 MHz channels 1-600 only (Section 4.4.2). |
| Alpha Tag | Any keyboard character | Changes the 10-character alpha tag for the selected system. The system alpha tag is used only for programming and is not displayed by the transceiver. |
| RIC | Yes, No | Programs if the repeater is equipped with RIC interconnect. |
| Scan List | Yes, No | Programs if the system is scanned (Section 3.4.6). |
| Group Scan | Enabled, Disabled | Programs if group scanning occurs on the system (Section 3.4.7). |
| Emergency System/ Group; Auto | Any programmed system/ group; Auto = Yes or No | Programs the system/group on which emergency calls are made when the emergency switch is pressed, if applicable. On conventional systems, automatic transmission are not available, so “Auto” = “No” (Section 3.6.8). |
| Power Level | 1, 2, 3, 4, 2W | Programs the output power selected by this system. The power output produced by these numbers is set in the test mode (Section 3.6.10). |
| Companding | Yes, No | Programs if companding is used on the system (Section 1.5). |
| Talk-Around Allowed | Yes, No | Programs if talk-around can be programmed on any of the groups in that system (Section 3.9.4). |

**Table 4-4 Conventional System Parameters (Continued)**




**CONVENTIONAL GROUP PARAMETERS**

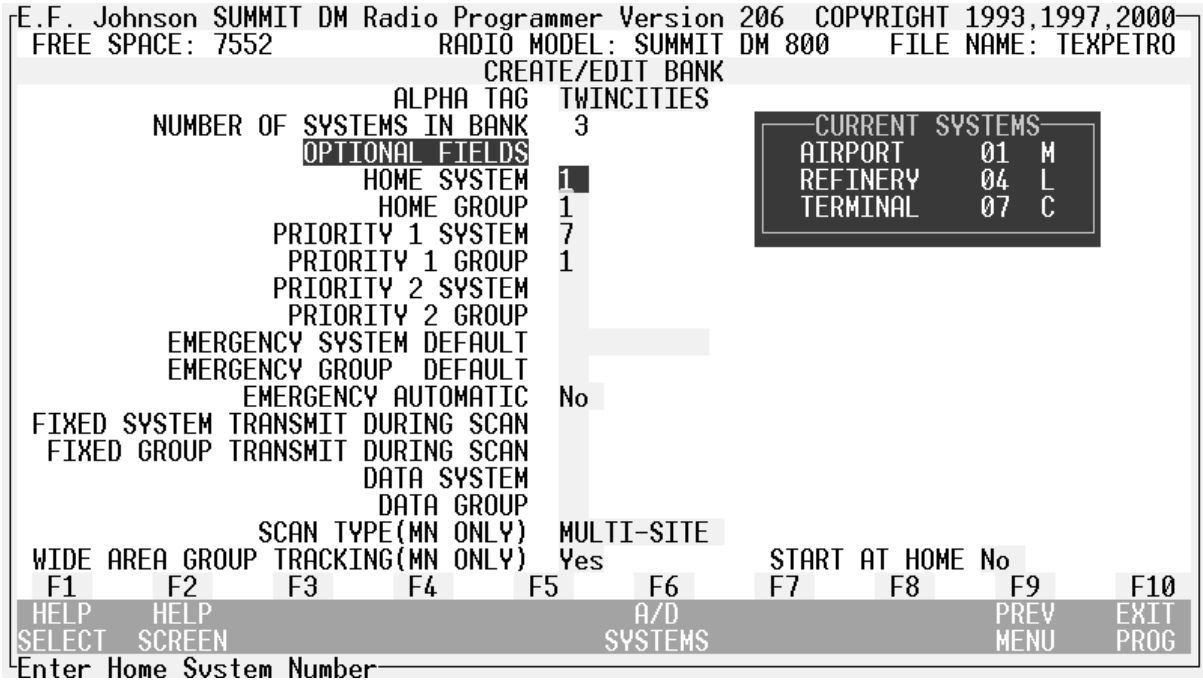
(The Group Parameter screen is selected by pressing F6)

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Asn | Yes, No | Specifies if the group will be selectable. |
| Alpha Tag | A-Z, 0-9, etc. | Specifies the 10-character alpha tag that is displayed when the group is selected. |
| Tx CG | None, CG, DCG, IDCG, EXT | Programs the type of transmit Call Guard squelch for the indicated group (Section 3.6.2). |
| CG = Tone (CTCSS), DCG = digital, IDCG = Inverted digital, EXT = External decoder (not supported) | | |
| CG Value | Tone number or digital code | If CG was selected, the tone number from 1-38 is entered. If digital was selected, the digital code is selected. These numbers are listed in Table 4-6. |
| Rx CG | None, CG, DCG, IDCG, EXT | Programs the type of Receive Call Guard squelch for the indicated group (Section 3.6.2). |
| CG Value | Tone number or digital code | If CG was selected, the tone number from 1-38 is entered. If digital was selected, the digital code is selected. These numbers are listed in Table 4-6. |
| Send TO (Transmit Turn-Off Code) | Yes, No | If “yes” is programmed, the Call Guard turn-off code is sent when the PTT switch is released (Section 3.6.2). |
| Talk-Around | Yes, No | If “yes” is programmed, transmission is on the receive frequency (Table 3.9.4). “NA” is displayed if talk-around was disabled on the system screen. |
| Call Light | Yes, No | Programs if the Call indicator lights when a call is received on that group (Section 3.6.2). |
| Horn | Yes, No | Programs if the horn sounds when a call is received on that group (Section 3.6.4). |
| Encryption | Yes, No | Programs if encryption is used on calls received and transmitted on that group (Section 3.6.12). |
| Disable-Busy | Yes, No | Programs if Transmit Disable On Busy feature is active on that group (Section 3.9.1). |
| Transmit Disable | Yes, No | Programs if group is receive-only (Section 3.9.6). |

**Table 4-4 Conventional System Parameters (Continued)**

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Scan List | Yes, No | Programs if that group is scanned by the group scan feature (Section 3.4.7). |
| Data | Yes, No | Programs if that group can be used for data transmissions (Section 3.6.11) |

**Table 4-5 Create/Edit Bank Screen Parameters**




| Parameter | Acceptable Responses | Description |
|---|---|---|
| Alpha Tag | A-Z, 0-9, etc. | Changes the alpha tag for the selected bank. |
| Number of Systems in Bank | --- | The number of systems that have been assigned to that bank. Systems are assigned by pressing F6 (see Section 4.3.6). |
| Home System/ Group | Any system/group in selected bank | Programs the system/group that is selected when the HOME key is pressed (Section 3.5.11). |
| Priority 1 System/ Group | Any conventional system/ group in selected bank | Programs the priority 1 system/group when priority group sampling is used on conventional systems (Section 3.5.17). |
| Priority 2 System/ Group | Any conventional system/ group in selected bank | Programs the priority 2 system/group (if used) when priority group sampling is used on conventional systems (Section 3.5.17). |
| Emergency System/ Group Default | Any system/group in the current configuration file | Programs the default system/group that is selected if no emergency system/group is programmed in the selected system (Section 3.6.8). |
| Emergency Automatic | Yes, No | Programs if manual or automatic transmit occurs when the emergency switch is pressed on Multi-Net systems (Section 3.6.8). |
| Fixed System/ Group Transmit During Scan | Any system/group in selected bank | If a system/group is entered, it has precedence over the Scan Revert Mode parameter in the General Radio Parameters Screen when this bank is selected. Transmissions in the scan mode then always occur on this system/group (Section 3.4.5). |

**Table 4-5 Create/Edit Bank Screen Parameters (Continued)**

| Parameter | Acceptable Responses | Description |
|---|---|---|
| Data System/Group | Any system/group in selected bank | Programs the default system/group that is selected for a data transmission if the selected group is not programmed for data (Section 3.6.11). |
| Scan Type | Multi-Site or Single-Site | Programs the type of scanning that occurs when the scan mode is selected (Section 3.4.2). This can also be changed by the user by the SCAN SELCT menu item (Section 3.5.19). |
| Wide Area Group Tracking (MN only) | Yes, No | If "Yes" is programmed, the selected group does not change when registration occurs. If "No" is programmed, it changes to the last selected group of the new system (Section 3.7.2). |
| Start At Home | Yes, No | If "Yes" is programmed, the bank home system/group is always selected when power is turned on or the bank is selected. If "No" is programmed, the last selected system/group is always displayed (Section 3.5.11). |

**Table 4-6 Call Guard (CTCSS/DCS) Codes and Tones**

| Recommended Tone Call Guard Codes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Code** | **Freq** | **Code** | **Freq** | **Code** | **Freq** | **Code** | **Freq** | **Code** | **Freq** |
| | | 09 | 91.5 | 18 | 123.0 | 27 | 167.9 | 36* | 233.6 |
| 01 | 67.0 | 10 | 94.8 | 19 | 127.3 | 28 | 173.8 | 37* | 241.8 |
| 02 | 71.9 | 11** | 97.4 | 20 | 131.8 | 29 | 179.9 | 38* | 250.3 |
| 03 | 74.4 | 12 | 100.0 | 21 | 136.5 | 30 | 186.2 | 39** | 69.3 |
| 04 | 77.0 | 13 | 103.5 | 22 | 141.3 | 31 | 192.8 | 40** | 206.5 |
| 05 | 79.7 | 14 | 107.2 | 23 | 146.2 | 32 | 203.5 | 41** | 229.1 |
| 06 | 82.5 | 15 | 110.9 | 24 | 151.4 | 33 | 210.7 | 42** | 254.1 |
| 07 | 85.4 | 16 | 114.8 | 25 | 156.7 | 34* | 218.1 | | |
| 08 | 88.5 | 17 | 118.8 | 26 | 162.2 | 35* | 225.7 | | |
| * These tones normally are not used because of their close proximity to the voice frequencies<br>** This tone is normally not used because it may cause interference with adjacent tones. | | | | | | | | | |
| **Recommended Digital Call Guard Codes** | | | | | | | | | |
| 023 | 065 | 131 | 172 | 261 | 346 | 431 | 532 | 654 | 743 |
| 025 | 071 | 132 | 174 | 263 | 351 | 432 | 546 | 662 | 754 |
| 026 | 072 | 134 | 205 | 265 | 364 | 445 | 565 | 664 | |
| 031 | 073 | 143 | 223 | 271 | 365 | 464 | 606 | 703 | |
| 032 | 074 | 152 | 226 | 306 | 371 | 465 | 612 | 712 | |
| 043 | 114 | 155 | 243 | 311 | 411 | 466 | 624 | 723 | |
| 047 | 115 | 156 | 244 | 315 | 412 | 503 | 627 | 731 | |
| 051 | 116 | 162 | 245 | 331 | 413 | 506 | 631 | 732 | |
| 054 | 125 | 165 | 251 | 343 | 423 | 516 | 632 | 734 | |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 1 | 1 | 851.0125 | 806.0125 |
| 2 | 2 | 851.0375 | 806.0375 |
| 3 | 3 | 851.0625 | 806.0625 |
| 4 | 4 | 851.0875 | 806.0875 |
| 5 | 5 | 851.1125 | 806.1125 |
| 6 | 6 | 851.1375 | 806.1375 |
| 7 | 7 | 851.1625 | 806.1625 |
| 8 | 8 | 851.1875 | 806.1875 |
| 9 | 9 | 851.2125 | 806.2125 |
| 10 | 10 | 851.2375 | 806.2375 |
| 11 | 11 | 851.2625 | 806.2625 |
| 12 | 12 | 851.2875 | 806.2875 |
| 13 | 13 | 851.3125 | 806.3125 |
| 14 | 14 | 851.3375 | 806.3375 |
| 15 | 15 | 851.3625 | 806.3625 |
| 16 | 16 | 851.3875 | 806.3875 |
| 17 | 17 | 851.4125 | 806.4125 |
| 18 | 18 | 851.4375 | 806.4375 |
| 19 | 19 | 851.4625 | 806.4625 |
| 20 | 20 | 851.4875 | 806.4875 |
| 21 | 21 | 851.5125 | 806.5125 |
| 22 | 22 | 851.5375 | 806.5375 |
| 23 | 23 | 851.5625 | 806.5625 |
| 24 | 24 | 851.5875 | 806.5875 |
| 25 | 25 | 851.6125 | 806.6125 |
| 26 | 26 | 851.6375 | 806.6375 |
| 27 | 27 | 851.6625 | 806.6625 |
| 28 | 28 | 851.6875 | 806.6875 |
| 29 | 29 | 851.7125 | 806.7125 |
| 30 | 30 | 851.7375 | 806.7375 |
| 31 | 31 | 851.7625 | 806.7625 |
| 32 | 32 | 851.7875 | 806.7875 |
| 33 | 33 | 851.8125 | 806.8125 |
| 34 | 34 | 851.8375 | 806.8375 |
| 35 | 35 | 851.8625 | 806.8625 |
| 36 | 36 | 851.8875 | 806.8875 |
| 37 | 37 | 851.9125 | 806.9125 |
| 38 | 38 | 851.9375 | 806.9375 |
| 39 | 39 | 851.9625 | 806.9625 |
| 40 | 40 | 851.9875 | 806.9875 |
| 41 | 41 | 852.0125 | 807.0125 |
| 42 | 42 | 852.0375 | 807.0375 |
| 43 | 43 | 852.0625 | 807.0625 |
| 44 | 44 | 852.0875 | 807.0875 |
| 45 | 45 | 852.1125 | 807.1125 |
| 46 | 46 | 852.1375 | 807.1375 |
| 47 | 47 | 852.1625 | 807.1625 |
| 48 | 48 | 852.1875 | 807.1875 |
| 49 | 49 | 852.2125 | 807.2125 |
| 50 | 50 | 852.2375 | 807.2375 |
| 51 | 51 | 852.2625 | 807.2625 |
| 52 | 52 | 852.2875 | 807.2875 |
| 53 | 53 | 852.3125 | 807.3125 |
| 54 | 54 | 852.3375 | 807.3375 |
| 55 | 55 | 852.3625 | 807.3625 |
| 56 | 56 | 852.3875 | 807.3875 |
| 57 | 57 | 852.4125 | 807.4125 |
| 58 | 58 | 852.4375 | 807.4375 |
| 59 | 59 | 852.4625 | 807.4625 |
| 60 | 60 | 852.4875 | 807.4875 |
| 61 | 61 | 852.5125 | 807.5125 |
| 62 | 62 | 852.5375 | 807.5375 |
| 63 | 63 | 852.5625 | 807.5625 |
| 64 | 64 | 852.5875 | 807.5875 |
| 65 | 65 | 852.6125 | 807.6125 |
| 66 | 66 | 852.6375 | 807.6375 |
| 67 | 67 | 852.6625 | 807.6625 |
| 68 | 68 | 852.6875 | 807.6875 |
| 69 | 69 | 852.7125 | 807.7125 |
| 70 | 70 | 852.7375 | 807.7375 |
| 71 | 71 | 852.7625 | 807.7625 |
| 72 | 72 | 852.7875 | 807.7875 |
| 73 | 73 | 852.8125 | 807.8125 |
| 74 | 74 | 852.8375 | 807.8375 |
| 75 | 75 | 852.8625 | 807.8625 |
| 76 | 76 | 852.8875 | 807.8875 |
| 77 | 77 | 852.9125 | 807.9125 |
| 78 | 78 | 852.9375 | 807.9375 |
| 79 | 79 | 852.9625 | 807.9625 |
| 80 | 80 | 852.9875 | 807.9875 |
| 81 | 81 | 853.0125 | 808.0125 |
| 82 | 82 | 853.0375 | 808.0375 |
| 83 | 83 | 853.0625 | 808.0625 |
| 84 | 84 | 853.0875 | 808.0875 |
| 85 | 85 | 853.1125 | 808.1125 |
| 86 | 86 | 853.1375 | 808.1375 |
| 87 | 87 | 853.1625 | 808.1625 |
| 88 | 88 | 853.1875 | 808.1875 |
| 89 | 89 | 853.2125 | 808.2125 |
| 90 | 90 | 853.2375 | 808.2375 |
| 91 | 91 | 853.2625 | 808.2625 |
| 92 | 92 | 853.2875 | 808.2875 |
| 93 | 93 | 853.3125 | 808.3125 |
| 94 | 94 | 853.3375 | 808.3375 |
| 95 | 95 | 853.3625 | 808.3625 |
| 96 | 96 | 853.3875 | 808.3875 |
| 97 | 97 | 853.4125 | 808.4125 |
| 98 | 98 | 853.4375 | 808.4375 |
| 99 | 99 | 853.4625 | 808.4625 |
| 100 | 100 | 853.4875 | 808.4875 |
| 101 | 101 | 853.5125 | 808.5125 |
| 102 | 102 | 853.5375 | 808.5375 |
| 103 | 103 | 853.5625 | 808.5625 |
| 104 | 104 | 853.5875 | 808.5875 |
| 105 | 105 | 853.6125 | 808.6125 |
| 106 | 106 | 853.6375 | 808.6375 |
| 107 | 107 | 853.6625 | 808.6625 |
| 108 | 108 | 853.6875 | 808.6875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 109 | 109 | 853.7125 | 808.7125 |
| 110 | 110 | 853.7375 | 808.7375 |
| 111 | 111 | 853.7625 | 808.7625 |
| 112 | 112 | 853.7875 | 808.7875 |
| 113 | 113 | 853.8125 | 808.8125 |
| 114 | 114 | 853.8375 | 808.8375 |
| 115 | 115 | 853.8625 | 808.8625 |
| 116 | 116 | 853.8875 | 808.8875 |
| 117 | 117 | 853.9125 | 808.9125 |
| 118 | 118 | 853.9375 | 808.9375 |
| 119 | 119 | 853.9625 | 808.9625 |
| 120 | 120 | 853.9875 | 808.9875 |
| 121 | 121 | 854.0125 | 809.0125 |
| 122 | 122 | 854.0375 | 809.0375 |
| 123 | 123 | 854.0625 | 809.0625 |
| 124 | 124 | 854.0875 | 809.0875 |
| 125 | 125 | 854.1125 | 809.1125 |
| 126 | 126 | 854.1375 | 809.1375 |
| 127 | 127 | 854.1625 | 809.1625 |
| 128 | 128 | 854.1875 | 809.1875 |
| 129 | 129 | 854.2125 | 809.2125 |
| 130 | 130 | 854.2375 | 809.2375 |
| 131 | 131 | 854.2625 | 809.2625 |
| 132 | 132 | 854.2875 | 809.2875 |
| 133 | 133 | 854.3125 | 809.3125 |
| 134 | 134 | 854.3375 | 809.3375 |
| 135 | 135 | 854.3625 | 809.3625 |
| 136 | 136 | 854.3875 | 809.3875 |
| 137 | 137 | 854.4125 | 809.4125 |
| 138 | 138 | 854.4375 | 809.4375 |
| 139 | 139 | 854.4625 | 809.4625 |
| 140 | 140 | 854.4875 | 809.4875 |
| 141 | 141 | 854.5125 | 809.5125 |
| 142 | 142 | 854.5375 | 809.5375 |
| 143 | 143 | 854.5625 | 809.5625 |
| 144 | 144 | 854.5875 | 809.5875 |
| 145 | 145 | 854.6125 | 809.6125 |
| 146 | 146 | 854.6375 | 809.6375 |
| 147 | 147 | 854.6625 | 809.6625 |
| 148 | 148 | 854.6875 | 809.6875 |
| 149 | 149 | 854.7125 | 809.7125 |
| 150 | 150 | 854.7375 | 809.7375 |
| 151 | 151 | 854.7625 | 809.7625 |
| 152 | 152 | 854.7875 | 809.7875 |
| 153 | 153 | 854.8125 | 809.8125 |
| 154 | 154 | 854.8375 | 809.8375 |
| 155 | 155 | 854.8625 | 809.8625 |
| 156 | 156 | 854.8875 | 809.8875 |
| 157 | 157 | 854.9125 | 809.9125 |
| 158 | 158 | 854.9375 | 809.9375 |
| 159 | 159 | 854.9625 | 809.9625 |
| 160 | 160 | 854.9875 | 809.9875 |
| 161 | 161 | 855.0125 | 810.0125 |
| 162 | 162 | 855.0375 | 810.0375 |
| 163 | 163 | 855.0625 | 810.0625 |
| 164 | 164 | 855.0875 | 810.0875 |
| 165 | 165 | 855.1125 | 810.1125 |
| 166 | 166 | 855.1375 | 810.1375 |
| 167 | 167 | 855.1625 | 810.1625 |
| 168 | 168 | 855.1875 | 810.1875 |
| 169 | 169 | 855.2125 | 810.2125 |
| 170 | 170 | 855.2375 | 810.2375 |
| 171 | 171 | 855.2625 | 810.2625 |
| 172 | 172 | 855.2875 | 810.2875 |
| 173 | 173 | 855.3125 | 810.3125 |
| 174 | 174 | 855.3375 | 810.3375 |
| 175 | 175 | 855.3625 | 810.3625 |
| 176 | 176 | 855.3875 | 810.3875 |
| 177 | 177 | 855.4125 | 810.4125 |
| 178 | 178 | 855.4375 | 810.4375 |
| 179 | 179 | 855.4625 | 810.4625 |
| 180 | 180 | 855.4875 | 810.4875 |
| 181 | 181 | 855.5125 | 810.5125 |
| 182 | 182 | 855.5375 | 810.5375 |
| 183 | 183 | 855.5625 | 810.5625 |
| 184 | 184 | 855.5875 | 810.5875 |
| 185 | 185 | 855.6125 | 810.6125 |
| 186 | 186 | 855.6375 | 810.6375 |
| 187 | 187 | 855.6625 | 810.6625 |
| 188 | 188 | 855.6875 | 810.6875 |
| 189 | 189 | 855.7125 | 810.7125 |
| 190 | 190 | 855.7375 | 810.7375 |
| 191 | 191 | 855.7625 | 810.7625 |
| 192 | 192 | 855.7875 | 810.7875 |
| 193 | 193 | 855.8125 | 810.8125 |
| 194 | 194 | 855.8375 | 810.8375 |
| 195 | 195 | 855.8625 | 810.8625 |
| 196 | 196 | 855.8875 | 810.8875 |
| 197 | 197 | 855.9125 | 810.9125 |
| 198 | 198 | 855.9375 | 810.9375 |
| 199 | 199 | 855.9625 | 810.9625 |
| 200 | 200 | 855.9875 | 810.9875 |
| 201 | 201 | 856.0125 | 811.0125 |
| 202 | 202 | 856.0375 | 811.0375 |
| 203 | 203 | 856.0625 | 811.0625 |
| 204 | 204 | 856.0875 | 811.0875 |
| 205 | 205 | 856.1125 | 811.1125 |
| 206 | 206 | 856.1375 | 811.1375 |
| 207 | 207 | 856.1625 | 811.1625 |
| 208 | 208 | 856.1875 | 811.1875 |
| 209 | 209 | 856.2125 | 811.2125 |
| 210 | 210 | 856.2375 | 811.2375 |
| 211 | 211 | 856.2625 | 811.2625 |
| 212 | 212 | 856.2875 | 811.2875 |
| 213 | 213 | 856.3125 | 811.3125 |
| 214 | 214 | 856.3375 | 811.3375 |
| 215 | 215 | 856.3625 | 811.3625 |
| 216 | 216 | 856.3875 | 811.3875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 217 | 217 | 856.4125 | 811.4125 |
| 218 | 218 | 856.4375 | 811.4375 |
| 219 | 219 | 856.4625 | 811.4625 |
| 220 | 220 | 856.4875 | 811.4875 |
| 221 | 221 | 856.5125 | 811.5125 |
| 222 | 222 | 856.5375 | 811.5375 |
| 223 | 223 | 856.5625 | 811.5625 |
| 224 | 224 | 856.5875 | 811.5875 |
| 225 | 225 | 856.6125 | 811.6125 |
| 226 | 226 | 856.6375 | 811.6375 |
| 227 | 227 | 856.6625 | 811.6625 |
| 228 | 228 | 856.6875 | 811.6875 |
| 229 | 229 | 856.7125 | 811.7125 |
| 230 | 230 | 856.7375 | 811.7375 |
| 231 | 231 | 856.7625 | 811.7625 |
| 232 | 232 | 856.7875 | 811.7875 |
| 233 | 233 | 856.8125 | 811.8125 |
| 234 | 234 | 856.8375 | 811.8375 |
| 235 | 235 | 856.8625 | 811.8625 |
| 236 | 236 | 856.8875 | 811.8875 |
| 237 | 237 | 856.9125 | 811.9125 |
| 238 | 238 | 856.9375 | 811.9375 |
| 239 | 239 | 856.9625 | 811.9625 |
| 240 | 240 | 856.9875 | 811.9875 |
| 241 | 241 | 857.0125 | 812.0125 |
| 242 | 242 | 857.0375 | 812.0375 |
| 243 | 243 | 857.0625 | 812.0625 |
| 244 | 244 | 857.0875 | 812.0875 |
| 245 | 245 | 857.1125 | 812.1125 |
| 246 | 246 | 857.1375 | 812.1375 |
| 247 | 247 | 857.1625 | 812.1625 |
| 248 | 248 | 857.1875 | 812.1875 |
| 249 | 249 | 857.2125 | 812.2125 |
| 250 | 250 | 857.2375 | 812.2375 |
| 251 | 251 | 857.2625 | 812.2625 |
| 252 | 252 | 857.2875 | 812.2875 |
| 253 | 253 | 857.3125 | 812.3125 |
| 254 | 254 | 857.3375 | 812.3375 |
| 255 | 255 | 857.3625 | 812.3625 |
| 256 | 256 | 857.3875 | 812.3875 |
| 257 | 257 | 857.4125 | 812.4125 |
| 258 | 258 | 857.4375 | 812.4375 |
| 259 | 259 | 857.4625 | 812.4625 |
| 260 | 260 | 857.4875 | 812.4875 |
| 261 | 261 | 857.5125 | 812.5125 |
| 262 | 262 | 857.5375 | 812.5375 |
| 263 | 263 | 857.5625 | 812.5625 |
| 264 | 264 | 857.5875 | 812.5875 |
| 265 | 265 | 857.6125 | 812.6125 |
| 266 | 266 | 857.6375 | 812.6375 |
| 267 | 267 | 857.6625 | 812.6625 |
| 268 | 268 | 857.6875 | 812.6875 |
| 269 | 269 | 857.7125 | 812.7125 |
| 270 | 270 | 857.7375 | 812.7375 |
| 271 | 271 | 857.7625 | 812.7625 |
| 272 | 272 | 857.7875 | 812.7875 |
| 273 | 273 | 857.8125 | 812.8125 |
| 274 | 274 | 857.8375 | 812.8375 |
| 275 | 275 | 857.8625 | 812.8625 |
| 276 | 276 | 857.8875 | 812.8875 |
| 277 | 277 | 857.9125 | 812.9125 |
| 278 | 278 | 857.9375 | 812.9375 |
| 279 | 279 | 857.9625 | 812.9625 |
| 280 | 280 | 857.9875 | 812.9875 |
| 281 | 281 | 858.0125 | 813.0125 |
| 282 | 282 | 858.0375 | 813.0375 |
| 283 | 283 | 858.0625 | 813.0625 |
| 284 | 284 | 858.0875 | 813.0875 |
| 285 | 285 | 858.1125 | 813.1125 |
| 286 | 286 | 858.1375 | 813.1375 |
| 287 | 287 | 858.1625 | 813.1625 |
| 288 | 288 | 858.1875 | 813.1875 |
| 289 | 289 | 858.2125 | 813.2125 |
| 290 | 290 | 858.2375 | 813.2375 |
| 291 | 291 | 858.2625 | 813.2625 |
| 292 | 292 | 858.2875 | 813.2875 |
| 293 | 293 | 858.3125 | 813.3125 |
| 294 | 294 | 858.3375 | 813.3375 |
| 295 | 295 | 858.3625 | 813.3625 |
| 296 | 296 | 858.3875 | 813.3875 |
| 297 | 297 | 858.4125 | 813.4125 |
| 298 | 298 | 858.4375 | 813.4375 |
| 299 | 299 | 858.4625 | 813.4625 |
| 300 | 300 | 858.4875 | 813.4875 |
| 301 | 301 | 858.5125 | 813.5125 |
| 302 | 302 | 858.5375 | 813.5375 |
| 303 | 303 | 858.5625 | 813.5625 |
| 304 | 304 | 858.5875 | 813.5875 |
| 305 | 305 | 858.6125 | 813.6125 |
| 306 | 306 | 858.6375 | 813.6375 |
| 307 | 307 | 858.6625 | 813.6625 |
| 308 | 308 | 858.6875 | 813.6875 |
| 309 | 309 | 858.7125 | 813.7125 |
| 310 | 310 | 858.7375 | 813.7375 |
| 311 | 311 | 858.7625 | 813.7625 |
| 312 | 312 | 858.7875 | 813.7875 |
| 313 | 313 | 858.8125 | 813.8125 |
| 314 | 314 | 858.8375 | 813.8375 |
| 315 | 315 | 858.8625 | 813.8625 |
| 316 | 316 | 858.8875 | 813.8875 |
| 317 | 317 | 858.9125 | 813.9125 |
| 318 | 318 | 858.9375 | 813.9375 |
| 319 | 319 | 858.9625 | 813.9625 |
| 320 | 320 | 858.9875 | 813.9875 |
| 321 | 321 | 859.0125 | 814.0125 |
| 322 | 322 | 859.0375 | 814.0375 |
| 323 | 323 | 859.0625 | 814.0625 |
| 324 | 324 | 859.0875 | 814.0875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 325 | 325 | 859.1125 | 814.1125 |
| 326 | 326 | 859.1375 | 814.1375 |
| 327 | 327 | 859.1625 | 814.1625 |
| 328 | 328 | 859.1875 | 814.1875 |
| 329 | 329 | 859.2125 | 814.2125 |
| 330 | 330 | 859.2375 | 814.2375 |
| 331 | 331 | 859.2625 | 814.2625 |
| 332 | 332 | 859.2875 | 814.2875 |
| 333 | 333 | 859.3125 | 814.3125 |
| 334 | 334 | 859.3375 | 814.3375 |
| 335 | 335 | 859.3625 | 814.3625 |
| 336 | 336 | 859.3875 | 814.3875 |
| 337 | 337 | 859.4125 | 814.4125 |
| 338 | 338 | 859.4375 | 814.4375 |
| 339 | 339 | 859.4625 | 814.4625 |
| 340 | 340 | 859.4875 | 814.4875 |
| 341 | 341 | 859.5125 | 814.5125 |
| 342 | 342 | 859.5375 | 814.5375 |
| 343 | 343 | 859.5625 | 814.5625 |
| 344 | 344 | 859.5875 | 814.5875 |
| 345 | 345 | 859.6125 | 814.6125 |
| 346 | 346 | 859.6375 | 814.6375 |
| 347 | 347 | 859.6625 | 814.6625 |
| 348 | 348 | 859.6875 | 814.6875 |
| 349 | 349 | 859.7125 | 814.7125 |
| 350 | 350 | 859.7375 | 814.7375 |
| 351 | 351 | 859.7625 | 814.7625 |
| 352 | 352 | 859.7875 | 814.7875 |
| 353 | 353 | 859.8125 | 814.8125 |
| 354 | 354 | 859.8375 | 814.8375 |
| 355 | 355 | 859.8625 | 814.8625 |
| 356 | 356 | 859.8875 | 814.8875 |
| 357 | 357 | 859.9125 | 814.9125 |
| 358 | 358 | 859.9375 | 814.9375 |
| 359 | 359 | 859.9625 | 814.9625 |
| 360 | 360 | 859.9875 | 814.9875 |
| 361 | 361 | 860.0125 | 815.0125 |
| 362 | 362 | 860.0375 | 815.0375 |
| 363 | 363 | 860.0625 | 815.0625 |
| 364 | 364 | 860.0875 | 815.0875 |
| 365 | 365 | 860.1125 | 815.1125 |
| 366 | 366 | 860.1375 | 815.1375 |
| 367 | 367 | 860.1625 | 815.1625 |
| 368 | 368 | 860.1875 | 815.1875 |
| 369 | 369 | 860.2125 | 815.2125 |
| 370 | 370 | 860.2375 | 815.2375 |
| 371 | 371 | 860.2625 | 815.2625 |
| 372 | 372 | 860.2875 | 815.2875 |
| 373 | 373 | 860.3125 | 815.3125 |
| 374 | 374 | 860.3375 | 815.3375 |
| 375 | 375 | 860.3625 | 815.3625 |
| 376 | 376 | 860.3875 | 815.3875 |
| 377 | 377 | 860.4125 | 815.4125 |
| 378 | 378 | 860.4375 | 815.4375 |
| 379 | 379 | 860.4625 | 815.4625 |
| 380 | 380 | 860.4875 | 815.4875 |
| 381 | 381 | 860.5125 | 815.5125 |
| 382 | 382 | 860.5375 | 815.5375 |
| 383 | 383 | 860.5625 | 815.5625 |
| 384 | 384 | 860.5875 | 815.5875 |
| 385 | 385 | 860.6125 | 815.6125 |
| 386 | 386 | 860.6375 | 815.6375 |
| 387 | 387 | 860.6625 | 815.6625 |
| 388 | 388 | 860.6875 | 815.6875 |
| 389 | 389 | 860.7125 | 815.7125 |
| 390 | 390 | 860.7375 | 815.7375 |
| 391 | 391 | 860.7625 | 815.7625 |
| 392 | 392 | 860.7875 | 815.7875 |
| 393 | 393 | 860.8125 | 815.8125 |
| 394 | 394 | 860.8375 | 815.8375 |
| 395 | 395 | 860.8625 | 815.8625 |
| 396 | 396 | 860.8875 | 815.8875 |
| 397 | 397 | 860.9125 | 815.9125 |
| 398 | 398 | 860.9375 | 815.9375 |
| 399 | 399 | 860.9625 | 815.9625 |
| 400 | 400 | 860.9875 | 815.9875 |
| 401 | 401 | 861.0125 | 816.0125 |
| 402 | 402 | 861.0375 | 816.0375 |
| 403 | 403 | 861.0625 | 816.0625 |
| 404 | 404 | 861.0875 | 816.0875 |
| 405 | 405 | 861.1125 | 816.1125 |
| 406 | 406 | 861.1375 | 816.1375 |
| 407 | 407 | 861.1625 | 816.1625 |
| 408 | 408 | 861.1875 | 816.1875 |
| 409 | 409 | 861.2125 | 816.2125 |
| 410 | 410 | 861.2375 | 816.2375 |
| 411 | 411 | 861.2625 | 816.2625 |
| 412 | 412 | 861.2875 | 816.2875 |
| 413 | 413 | 861.3125 | 816.3125 |
| 414 | 414 | 861.3375 | 816.3375 |
| 415 | 415 | 861.3625 | 816.3625 |
| 416 | 416 | 861.3875 | 816.3875 |
| 417 | 417 | 861.4125 | 816.4125 |
| 418 | 418 | 861.4375 | 816.4375 |
| 419 | 419 | 861.4625 | 816.4625 |
| 420 | 420 | 861.4875 | 816.4875 |
| 421 | 421 | 861.5125 | 816.5125 |
| 422 | 422 | 861.5375 | 816.5375 |
| 423 | 423 | 861.5625 | 816.5625 |
| 424 | 424 | 861.5875 | 816.5875 |
| 425 | 425 | 861.6125 | 816.6125 |
| 426 | 426 | 861.6375 | 816.6375 |
| 427 | 427 | 861.6625 | 816.6625 |
| 428 | 428 | 861.6875 | 816.6875 |
| 429 | 429 | 861.7125 | 816.7125 |
| 430 | 430 | 861.7375 | 816.7375 |
| 431 | 431 | 861.7625 | 816.7625 |
| 432 | 432 | 861.7875 | 816.7875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 433 | 433 | 861.8125 | 816.8125 |
| 434 | 434 | 861.8375 | 816.8375 |
| 435 | 435 | 861.8625 | 816.8625 |
| 436 | 436 | 861.8875 | 816.8875 |
| 437 | 437 | 861.9125 | 816.9125 |
| 438 | 438 | 861.9375 | 816.9375 |
| 439 | 439 | 861.9625 | 816.9625 |
| 440 | 440 | 861.9875 | 816.9875 |
| 441 | 441 | 862.0125 | 817.0125 |
| 442 | 442 | 862.0375 | 817.0375 |
| 443 | 443 | 862.0625 | 817.0625 |
| 444 | 444 | 862.0875 | 817.0875 |
| 445 | 445 | 862.1125 | 817.1125 |
| 446 | 446 | 862.1375 | 817.1375 |
| 447 | 447 | 862.1625 | 817.1625 |
| 448 | 448 | 862.1875 | 817.1875 |
| 449 | 449 | 862.2125 | 817.2125 |
| 450 | 450 | 862.2375 | 817.2375 |
| 451 | 451 | 862.2625 | 817.2625 |
| 452 | 452 | 862.2875 | 817.2875 |
| 453 | 453 | 862.3125 | 817.3125 |
| 454 | 454 | 862.3375 | 817.3375 |
| 455 | 455 | 862.3625 | 817.3625 |
| 456 | 456 | 862.3875 | 817.3875 |
| 457 | 457 | 862.4125 | 817.4125 |
| 458 | 458 | 862.4375 | 817.4375 |
| 459 | 459 | 862.4625 | 817.4625 |
| 460 | 460 | 862.4875 | 817.4875 |
| 461 | 461 | 862.5125 | 817.5125 |
| 462 | 462 | 862.5375 | 817.5375 |
| 463 | 463 | 862.5625 | 817.5625 |
| 464 | 464 | 862.5875 | 817.5875 |
| 465 | 465 | 862.6125 | 817.6125 |
| 466 | 466 | 862.6375 | 817.6375 |
| 467 | 467 | 862.6625 | 817.6625 |
| 468 | 468 | 862.6875 | 817.6875 |
| 469 | 469 | 862.7125 | 817.7125 |
| 470 | 470 | 862.7375 | 817.7375 |
| 471 | 471 | 862.7625 | 817.7625 |
| 472 | 472 | 862.7875 | 817.7875 |
| 473 | 473 | 862.8125 | 817.8125 |
| 474 | 474 | 862.8375 | 817.8375 |
| 475 | 475 | 862.8625 | 817.8625 |
| 476 | 476 | 862.8875 | 817.8875 |
| 477 | 477 | 862.9125 | 817.9125 |
| 478 | 478 | 862.9375 | 817.9375 |
| 479 | 479 | 862.9625 | 817.9625 |
| 480 | 480 | 862.9875 | 817.9875 |
| 481 | 481 | 863.0125 | 818.0125 |
| 482 | 482 | 863.0375 | 818.0375 |
| 483 | 483 | 863.0625 | 818.0625 |
| 484 | 484 | 863.0875 | 818.0875 |
| 485 | 485 | 863.1125 | 818.1125 |
| 486 | 486 | 863.1375 | 818.1375 |
| 487 | 487 | 863.1625 | 818.1625 |
| 488 | 488 | 863.1875 | 818.1875 |
| 489 | 489 | 863.2125 | 818.2125 |
| 490 | 490 | 863.2375 | 818.2375 |
| 491 | 491 | 863.2625 | 818.2625 |
| 492 | 492 | 863.2875 | 818.2875 |
| 493 | 493 | 863.3125 | 818.3125 |
| 494 | 494 | 863.3375 | 818.3375 |
| 495 | 495 | 863.3625 | 818.3625 |
| 496 | 496 | 863.3875 | 818.3875 |
| 497 | 497 | 863.4125 | 818.4125 |
| 498 | 498 | 863.4375 | 818.4375 |
| 499 | 499 | 863.4625 | 818.4625 |
| 500 | 500 | 863.4875 | 818.4875 |
| 501 | 501 | 863.5125 | 818.5125 |
| 502 | 502 | 863.5375 | 818.5375 |
| 503 | 503 | 863.5625 | 818.5625 |
| 504 | 504 | 863.5875 | 818.5875 |
| 505 | 505 | 863.6125 | 818.6125 |
| 506 | 506 | 863.6375 | 818.6375 |
| 507 | 507 | 863.6625 | 818.6625 |
| 508 | 508 | 863.6875 | 818.6875 |
| 509 | 509 | 863.7125 | 818.7125 |
| 510 | 510 | 863.7375 | 818.7375 |
| 511 | 511 | 863.7625 | 818.7625 |
| 512 | 512 | 863.7875 | 818.7875 |
| 513 | 513 | 863.8125 | 818.8125 |
| 514 | 514 | 863.8375 | 818.8375 |
| 515 | 515 | 863.8625 | 818.8625 |
| 516 | 516 | 863.8875 | 818.8875 |
| 517 | 517 | 863.9125 | 818.9125 |
| 518 | 518 | 863.9375 | 818.9375 |
| 519 | 519 | 863.9625 | 818.9625 |
| 520 | 520 | 863.9875 | 818.9875 |
| 521 | 521 | 864.0125 | 819.0125 |
| 522 | 522 | 864.0375 | 819.0375 |
| 523 | 523 | 864.0625 | 819.0625 |
| 524 | 524 | 864.0875 | 819.0875 |
| 525 | 525 | 864.1125 | 819.1125 |
| 526 | 526 | 864.1375 | 819.1375 |
| 527 | 527 | 864.1625 | 819.1625 |
| 528 | 528 | 864.1875 | 819.1875 |
| 529 | 529 | 864.2125 | 819.2125 |
| 530 | 530 | 864.2375 | 819.2375 |
| 531 | 531 | 864.2625 | 819.2625 |
| 532 | 532 | 864.2875 | 819.2875 |
| 533 | 533 | 864.3125 | 819.3125 |
| 534 | 534 | 864.3375 | 819.3375 |
| 535 | 535 | 864.3625 | 819.3625 |
| 536 | 536 | 864.3875 | 819.3875 |
| 537 | 537 | 864.4125 | 819.4125 |
| 538 | 538 | 864.4375 | 819.4375 |
| 539 | 539 | 864.4625 | 819.4625 |
| 540 | 540 | 864.4875 | 819.4875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 541 | 541 | 864.5125 | 819.5125 |
| 542 | 542 | 864.5375 | 819.5375 |
| 543 | 543 | 864.5625 | 819.5625 |
| 544 | 544 | 864.5875 | 819.5875 |
| 545 | 545 | 864.6125 | 819.6125 |
| 546 | 546 | 864.6375 | 819.6375 |
| 547 | 547 | 864.6625 | 819.6625 |
| 548 | 548 | 864.6875 | 819.6875 |
| 549 | 549 | 864.7125 | 819.7125 |
| 550 | 550 | 864.7375 | 819.7375 |
| 551 | 551 | 864.7625 | 819.7625 |
| 552 | 552 | 864.7875 | 819.7875 |
| 553 | 553 | 864.8125 | 819.8125 |
| 554 | 554 | 864.8375 | 819.8375 |
| 555 | 555 | 864.8625 | 819.8625 |
| 556 | 556 | 864.8875 | 819.8875 |
| 557 | 557 | 864.9125 | 819.9125 |
| 558 | 558 | 864.9375 | 819.9375 |
| 559 | 559 | 864.9625 | 819.9625 |
| 560 | 560 | 864.9875 | 819.9875 |
| 561 | 561 | 865.0125 | 820.0125 |
| 562 | 562 | 865.0375 | 820.0375 |
| 563 | 563 | 865.0625 | 820.0625 |
| 564 | 564 | 865.0875 | 820.0875 |
| 565 | 565 | 865.1125 | 820.1125 |
| 566 | 566 | 865.1375 | 820.1375 |
| 567 | 567 | 865.1625 | 820.1625 |
| 568 | 568 | 865.1875 | 820.1875 |
| 569 | 569 | 865.2125 | 820.2125 |
| 570 | 570 | 865.2375 | 820.2375 |
| 571 | 571 | 865.2625 | 820.2625 |
| 572 | 572 | 865.2875 | 820.2875 |
| 573 | 573 | 865.3125 | 820.3125 |
| 574 | 574 | 865.3375 | 820.3375 |
| 575 | 575 | 865.3625 | 820.3625 |
| 576 | 576 | 865.3875 | 820.3875 |
| 577 | 577 | 865.4125 | 820.4125 |
| 578 | 578 | 865.4375 | 820.4375 |
| 579 | 579 | 865.4625 | 820.4625 |
| 580 | 580 | 865.4875 | 820.4875 |
| 581 | 581 | 865.5125 | 820.5125 |
| 582 | 582 | 865.5375 | 820.5375 |
| 583 | 583 | 865.5625 | 820.5625 |
| 584 | 584 | 865.5875 | 820.5875 |
| 585 | 585 | 865.6125 | 820.6125 |
| 586 | 586 | 865.6375 | 820.6375 |
| 587 | 587 | 865.6625 | 820.6625 |
| 588 | 588 | 865.6875 | 820.6875 |
| 589 | 589 | 865.7125 | 820.7125 |
| 590 | 590 | 865.7375 | 820.7375 |
| 591 | 591 | 865.7625 | 820.7625 |
| 592 | 592 | 865.7875 | 820.7875 |
| 593 | 593 | 865.8125 | 820.8125 |
| 594 | 594 | 865.8375 | 820.8375 |
| 595 | 595 | 865.8625 | 820.8625 |
| 596 | 596 | 865.8875 | 820.8875 |
| 597 | 597 | 865.9125 | 820.9125 |
| 598 | 598 | 865.9375 | 820.9375 |
| 599 | 599 | 865.9625 | 820.9625 |
| 600 | 600 | 865.9875 | 820.9875 |
| 601 | - | 866.0000 | 821.0000 |
| 602 | 601 | 866.0125 | 821.0125 |
| 603 | - | 866.0250 | 821.0250 |
| 604 | 602 | 866.0375 | 821.0375 |
| 605 | 603 | 866.0500 | 821.0500 |
| 606 | 604 | 866.0625 | 821.0625 |
| 607 | 605 | 866.0750 | 821.0750 |
| 608 | 606 | 866.0875 | 821.0875 |
| 609 | 607 | 866.1000 | 821.1000 |
| 610 | 608 | 866.1125 | 821.1125 |
| 611 | 609 | 866.1250 | 821.1250 |
| 612 | 610 | 866.1375 | 821.1375 |
| 613 | 611 | 866.1500 | 821.1500 |
| 614 | 612 | 866.1625 | 821.1625 |
| 615 | 613 | 866.1750 | 821.1750 |
| 616 | 614 | 866.1875 | 821.1875 |
| 617 | 615 | 866.2000 | 821.2000 |
| 618 | 616 | 866.2125 | 821.2125 |
| 619 | 617 | 866.2250 | 821.2250 |
| 620 | 618 | 866.2375 | 821.2375 |
| 621 | 619 | 866.2500 | 821.2500 |
| 622 | 620 | 866.2625 | 821.2625 |
| 623 | 621 | 866.2750 | 821.2750 |
| 624 | 622 | 866.2875 | 821.2875 |
| 625 | 623 | 866.3000 | 821.3000 |
| 626 | 624 | 866.3125 | 821.3125 |
| 627 | 625 | 866.3250 | 821.3250 |
| 628 | 626 | 866.3375 | 821.3375 |
| 629 | 627 | 866.3500 | 821.3500 |
| 630 | 628 | 866.3625 | 821.3625 |
| 631 | 629 | 866.3750 | 821.3750 |
| 632 | 630 | 866.3875 | 821.3875 |
| 633 | 631 | 866.4000 | 821.4000 |
| 634 | 632 | 866.4125 | 821.4125 |
| 635 | 633 | 866.4250 | 821.4250 |
| 636 | 634 | 866.4375 | 821.4375 |
| 637 | 635 | 866.4500 | 821.4500 |
| 638 | 636 | 866.4625 | 821.4625 |
| 639 | 637 | 866.4750 | 821.4750 |
| 640 | 638 | 866.4875 | 821.4875 |
| 641 | - | 866.5000 | 821.5000 |
| 642 | 639 | 866.5125 | 821.5125 |
| 643 | - | 866.5250 | 821.5250 |
| 644 | 640 | 866.5375 | 821.5375 |
| 645 | 641 | 866.5500 | 821.5500 |
| 646 | 642 | 866.5625 | 821.5625 |
| 647 | 643 | 866.5750 | 821.5750 |
| 648 | 644 | 866.5875 | 821.5875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 649 | 645 | 866.6000 | 821.6000 |
| 650 | 646 | 866.6125 | 821.6125 |
| 651 | 647 | 866.6250 | 821.6250 |
| 652 | 648 | 866.6375 | 821.6375 |
| 653 | 649 | 866.6500 | 821.6500 |
| 654 | 650 | 866.6625 | 821.6625 |
| 655 | 651 | 866.6750 | 821.6750 |
| 656 | 652 | 866.6875 | 821.6875 |
| 657 | 653 | 866.7000 | 821.7000 |
| 658 | 654 | 866.7125 | 821.7125 |
| 659 | 655 | 866.7250 | 821.7250 |
| 660 | 656 | 866.7375 | 821.7375 |
| 661 | 657 | 866.7500 | 821.7500 |
| 662 | 658 | 866.7625 | 821.7625 |
| 663 | 659 | 866.7750 | 821.7750 |
| 664 | 660 | 866.7875 | 821.7875 |
| 665 | 661 | 866.8000 | 821.8000 |
| 666 | 662 | 866.8125 | 821.8125 |
| 667 | 663 | 866.8250 | 821.8250 |
| 668 | 664 | 866.8375 | 821.8375 |
| 669 | 665 | 866.8500 | 821.8500 |
| 670 | 666 | 866.8625 | 821.8625 |
| 671 | 667 | 866.8750 | 821.8750 |
| 672 | 668 | 866.8875 | 821.8875 |
| 673 | 669 | 866.9000 | 821.9000 |
| 674 | 670 | 866.9125 | 821.9125 |
| 675 | 671 | 866.9250 | 821.9250 |
| 676 | 672 | 866.9375 | 821.9375 |
| 677 | 673 | 866.9500 | 821.9500 |
| 678 | 674 | 866.9625 | 821.9625 |
| 679 | 675 | 866.9750 | 821.9750 |
| 680 | 676 | 866.9875 | 821.9875 |
| 681 | - | 867.0000 | 822.0000 |
| 682 | 677 | 867.0125 | 822.0125 |
| 683 | - | 867.0250 | 822.0250 |
| 684 | 678 | 867.0375 | 822.0375 |
| 685 | 679 | 867.0500 | 822.0500 |
| 686 | 680 | 867.0625 | 822.0625 |
| 687 | 681 | 867.0750 | 822.0750 |
| 688 | 682 | 867.0875 | 822.0875 |
| 689 | 683 | 867.1000 | 822.1000 |
| 690 | 684 | 867.1125 | 822.1125 |
| 691 | 685 | 867.1250 | 822.1250 |
| 692 | 686 | 867.1375 | 822.1375 |
| 693 | 687 | 867.1500 | 822.1500 |
| 694 | 688 | 867.1625 | 822.1625 |
| 695 | 689 | 867.1750 | 822.1750 |
| 696 | 690 | 867.1875 | 822.1875 |
| 697 | 691 | 867.2000 | 822.2000 |
| 698 | 692 | 867.2125 | 822.2125 |
| 699 | 693 | 867.2250 | 822.2250 |
| 700 | 694 | 867.2375 | 822.2375 |
| 701 | 695 | 867.2500 | 822.2500 |
| 702 | 696 | 867.2625 | 822.2625 |
| 703 | 697 | 867.2750 | 822.2750 |
| 704 | 698 | 867.2875 | 822.2875 |
| 705 | 699 | 867.3000 | 822.3000 |
| 706 | 700 | 867.3125 | 822.3125 |
| 707 | 701 | 867.3250 | 822.3250 |
| 708 | 702 | 867.3375 | 822.3375 |
| 709 | 703 | 867.3500 | 822.3500 |
| 710 | 704 | 867.3625 | 822.3625 |
| 711 | 705 | 867.3750 | 822.3750 |
| 712 | 706 | 867.3875 | 822.3875 |
| 713 | 707 | 867.4000 | 822.4000 |
| 714 | 708 | 867.4125 | 822.4125 |
| 715 | 709 | 867.4250 | 822.4250 |
| 716 | 710 | 867.4375 | 822.4375 |
| 717 | 711 | 867.4500 | 822.4500 |
| 718 | 712 | 867.4625 | 822.4625 |
| 719 | 713 | 867.4750 | 822.4750 |
| 720 | 714 | 867.4875 | 822.4875 |
| 721 | - | 867.5000 | 822.5000 |
| 722 | 715 | 867.5125 | 822.5125 |
| 723 | - | 867.5250 | 822.5250 |
| 724 | 716 | 867.5375 | 822.5375 |
| 725 | 717 | 867.5500 | 822.5500 |
| 726 | 718 | 867.5625 | 822.5625 |
| 727 | 719 | 867.5750 | 822.5750 |
| 728 | 720 | 867.5875 | 822.5875 |
| 729 | 721 | 867.6000 | 822.6000 |
| 730 | 722 | 867.6125 | 822.6125 |
| 731 | 723 | 867.6250 | 822.6250 |
| 732 | 724 | 867.6375 | 822.6375 |
| 733 | 725 | 867.6500 | 822.6500 |
| 734 | 726 | 867.6625 | 822.6625 |
| 735 | 727 | 867.6750 | 822.6750 |
| 736 | 728 | 867.6875 | 822.6875 |
| 737 | 729 | 867.7000 | 822.7000 |
| 738 | 730 | 867.7125 | 822.7125 |
| 739 | 731 | 867.7250 | 822.7250 |
| 740 | 732 | 867.7375 | 822.7375 |
| 741 | 733 | 867.7500 | 822.7500 |
| 742 | 734 | 867.7625 | 822.7625 |
| 743 | 735 | 867.7750 | 822.7750 |
| 744 | 736 | 867.7875 | 822.7875 |
| 745 | 737 | 867.8000 | 822.8000 |
| 746 | 738 | 867.8125 | 822.8125 |
| 747 | 739 | 867.8250 | 822.8250 |
| 748 | 740 | 867.8375 | 822.8375 |
| 749 | 741 | 867.8500 | 822.8500 |
| 750 | 742 | 867.8625 | 822.8625 |
| 751 | 743 | 867.8750 | 822.8750 |
| 752 | 744 | 867.8875 | 822.8875 |
| 753 | 745 | 867.9000 | 822.9000 |
| 754 | 746 | 867.9125 | 822.9125 |
| 755 | 747 | 867.9250 | 822.9250 |
| 756 | 748 | 867.9375 | 822.9375 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 757 | 749 | 867.9500 | 822.9500 |
| 758 | 750 | 867.9625 | 822.9625 |
| 759 | 751 | 867.9750 | 822.9750 |
| 760 | 752 | 867.9875 | 822.9875 |
| 761 | - | 868.0000 | 823.0000 |
| 762 | 753 | 868.0125 | 823.0125 |
| 763 | - | 868.0250 | 823.0250 |
| 764 | 754 | 868.0375 | 823.0375 |
| 765 | 755 | 868.0500 | 823.0500 |
| 766 | 756 | 868.0625 | 823.0625 |
| 767 | 757 | 868.0750 | 823.0750 |
| 768 | 758 | 868.0875 | 823.0875 |
| 769 | 759 | 868.1000 | 823.1000 |
| 770 | 760 | 868.1125 | 823.1125 |
| 771 | 761 | 868.1250 | 823.1250 |
| 772 | 762 | 868.1375 | 823.1375 |
| 773 | 763 | 868.1500 | 823.1500 |
| 774 | 764 | 868.1625 | 823.1625 |
| 775 | 765 | 868.1750 | 823.1750 |
| 776 | 766 | 868.1875 | 823.1875 |
| 777 | 767 | 868.2000 | 823.2000 |
| 778 | 768 | 868.2125 | 823.2125 |
| 779 | 769 | 868.2250 | 823.2250 |
| 780 | 770 | 868.2375 | 823.2375 |
| 781 | 771 | 868.2500 | 823.2500 |
| 782 | 772 | 868.2625 | 823.2625 |
| 783 | 773 | 868.2750 | 823.2750 |
| 784 | 774 | 868.2875 | 823.2875 |
| 785 | 775 | 868.3000 | 823.3000 |
| 786 | 776 | 868.3125 | 823.3125 |
| 787 | 777 | 868.3250 | 823.3250 |
| 788 | 778 | 868.3375 | 823.3375 |
| 789 | 779 | 868.3500 | 823.3500 |
| 790 | 780 | 868.3625 | 823.3625 |
| 791 | 781 | 868.3750 | 823.3750 |
| 792 | 782 | 868.3875 | 823.3875 |
| 793 | 783 | 868.4000 | 823.4000 |
| 794 | 784 | 868.4125 | 823.4125 |
| 795 | 785 | 868.4250 | 823.4250 |
| 796 | 786 | 868.4375 | 823.4375 |
| 797 | 787 | 868.4500 | 823.4500 |
| 798 | 788 | 868.4625 | 823.4625 |
| 799 | 789 | 868.4750 | 823.4750 |
| 800 | 790 | 868.4875 | 823.4875 |
| 801 | 791 | 868.5000 | 823.5000 |
| 802 | 792 | 868.5125 | 823.5125 |
| 803 | 793 | 868.5250 | 823.5250 |
| 804 | 794 | 868.5375 | 823.5375 |
| 805 | 795 | 868.5500 | 823.5500 |
| 806 | 796 | 868.5625 | 823.5625 |
| 807 | 797 | 868.5750 | 823.5750 |
| 808 | 798 | 868.5875 | 823.5875 |
| 809 | 799 | 868.6000 | 823.6000 |
| 810 | 800 | 868.6125 | 823.6125 |
| 811 | 801 | 868.6250 | 823.6250 |
| 812 | 802 | 868.6375 | 823.6375 |
| 813 | 803 | 868.6500 | 823.6500 |
| 814 | 804 | 868.6625 | 823.6625 |
| 815 | 805 | 868.6750 | 823.6750 |
| 816 | 806 | 868.6875 | 823.6875 |
| 817 | 807 | 868.7000 | 823.7000 |
| 818 | 808 | 868.7125 | 823.7125 |
| 819 | 809 | 868.7250 | 823.7250 |
| 820 | 810 | 868.7375 | 823.7375 |
| 821 | 811 | 868.7500 | 823.7500 |
| 822 | 812 | 868.7625 | 823.7625 |
| 823 | 813 | 868.7750 | 823.7750 |
| 824 | 814 | 868.7875 | 823.7875 |
| 825 | 815 | 868.8000 | 823.8000 |
| 826 | 816 | 868.8125 | 823.8125 |
| 827 | 817 | 868.8250 | 823.8250 |
| 828 | 818 | 868.8375 | 823.8375 |
| 829 | 819 | 868.8500 | 823.8500 |
| 830 | 820 | 868.8625 | 823.8625 |
| 831 | 821 | 868.8750 | 823.8750 |
| 832 | 822 | 868.8875 | 823.8875 |
| 833 | 823 | 868.9000 | 823.9000 |
| 834 | 824 | 868.9125 | 823.9125 |
| 835 | 825 | 868.9250 | 823.9250 |
| 836 | 826 | 868.9375 | 823.9375 |
| 837 | 827 | 868.9500 | 823.9500 |
| 838 | 828 | 868.9625 | 823.9625 |
| 839 | 829 | 868.9750 | 823.9750 |
| 840 | 830 | 868.9875 | 823.9875 |
| 841 | - | 869.0000 | 824.0000 |
| 842 | - | 869.0125 | 824.0125 |
| 843 | - | 869.0250 | 824.0250 |
| 844 | - | 869.0375 | 824.0375 |
| 845 | - | 869.0500 | 824.0500 |
| 846 | - | 869.0625 | 824.0625 |
| 847 | - | 869.0750 | 824.0750 |
| 848 | - | 869.0875 | 824.0875 |
| 849 | - | 869.1000 | 824.1000 |
| 850 | - | 869.1125 | 824.1125 |
| 851 | - | 869.1250 | 824.1250 |
| 852 | - | 869.1375 | 824.1375 |
| 853 | - | 869.1500 | 824.1500 |
| 854 | - | 869.1625 | 824.1625 |
| 855 | - | 869.1750 | 824.1750 |
| 856 | - | 869.1875 | 824.1875 |
| 857 | - | 869.2000 | 824.2000 |
| 858 | - | 869.2125 | 824.2125 |
| 859 | - | 869.2250 | 824.2250 |
| 860 | - | 869.2375 | 824.2375 |
| 861 | - | 869.2500 | 824.2500 |
| 862 | - | 869.2625 | 824.2625 |
| 863 | - | 869.2750 | 824.2750 |
| 864 | - | 869.2875 | 824.2875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 865 | - | 869.3000 | 824.3000 |
| 866 | - | 869.3125 | 824.3125 |
| 867 | - | 869.3250 | 824.3250 |
| 868 | - | 869.3375 | 824.3375 |
| 869 | - | 869.3500 | 824.3500 |
| 870 | - | 869.3625 | 824.3625 |
| 871 | - | 869.3750 | 824.3750 |
| 872 | - | 869.3875 | 824.3875 |
| 873 | - | 869.4000 | 824.4000 |
| 874 | - | 869.4125 | 824.4125 |
| 875 | - | 869.4250 | 824.4250 |
| 876 | - | 869.4375 | 824.4375 |
| 877 | - | 869.4500 | 824.4500 |
| 878 | - | 869.4625 | 824.4625 |
| 879 | - | 869.4750 | 824.4750 |
| 880 | - | 869.4875 | 824.4875 |
| 881 | - | 869.5000 | 824.5000 |
| 882 | - | 869.5125 | 824.5125 |
| 883 | - | 869.5250 | 824.5250 |
| 884 | - | 869.5375 | 824.5375 |
| 885 | - | 869.5500 | 824.5500 |
| 886 | - | 869.5625 | 824.5625 |
| 887 | - | 869.5750 | 824.5750 |
| 888 | - | 869.5875 | 824.5875 |
| 889 | - | 869.6000 | 824.6000 |
| 890 | - | 869.6125 | 824.6125 |
| 891 | - | 869.6250 | 824.6250 |
| 892 | - | 869.6375 | 824.6375 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 893 | - | 869.6500 | 824.6500 |
| 894 | - | 869.6625 | 824.6625 |
| 895 | - | 869.6750 | 824.6750 |
| 896 | - | 869.6875 | 824.6875 |
| 897 | - | 869.7000 | 824.7000 |
| 898 | - | 869.7125 | 824.7125 |
| 899 | - | 869.7250 | 824.7250 |
| 900 | - | 869.7375 | 824.7375 |
| 901 | - | 869.7500 | 824.7500 |
| 902 | - | 869.7625 | 824.7625 |
| 903 | - | 869.7750 | 824.7750 |
| 904 | - | 869.7875 | 824.7875 |
| 905 | - | 869.8000 | 824.8000 |
| 906 | - | 869.8125 | 824.8125 |
| 907 | - | 869.8250 | 824.8250 |
| 908 | - | 869.8375 | 824.8375 |
| 909 | - | 869.8500 | 824.8500 |
| 910 | - | 869.8625 | 824.8625 |
| 911 | - | 869.8750 | 824.8750 |
| 912 | - | 869.8875 | 824.8875 |
| 913 | - | 869.9000 | 824.9000 |
| 914 | - | 869.9125 | 824.9125 |
| 915 | - | 869.9250 | 824.9250 |
| 916 | - | 869.9375 | 824.9375 |
| 917 | - | 869.9500 | 824.9500 |
| 918 | - | 869.9625 | 824.9625 |
| 919 | - | 869.9750 | 824.9750 |
| 920 | - | 869.9875 | 824.9875 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 1 | 1 | 935.0125 | 896.0125 |
| 2 | 2 | 935.0250 | 896.0250 |
| 3 | 3 | 935.0375 | 896.0375 |
| 4 | 4 | 935.0500 | 896.0500 |
| 5 | 5 | 935.0625 | 896.0625 |
| 6 | 6 | 935.0750 | 896.0750 |
| 7 | 7 | 935.0875 | 896.0875 |
| 8 | 8 | 935.1000 | 896.1000 |
| 9 | 9 | 935.1125 | 896.1125 |
| 10 | 10 | 935.1250 | 896.1250 |
| 11 | 11 | 935.1375 | 896.1375 |
| 12 | 12 | 935.1500 | 896.1500 |
| 13 | 13 | 935.1625 | 896.1625 |
| 14 | 14 | 935.1750 | 896.1750 |
| 15 | 15 | 935.1875 | 896.1875 |
| 16 | 16 | 935.2000 | 896.2000 |
| 17 | 17 | 935.2125 | 896.2125 |
| 18 | 18 | 935.2250 | 896.2250 |
| 19 | 19 | 935.2375 | 896.2375 |
| 20 | 20 | 935.2500 | 896.2500 |
| 21 | 21 | 935.2625 | 896.2625 |
| 22 | 22 | 935.2750 | 896.2750 |
| 23 | 23 | 935.2875 | 896.2875 |
| 24 | 24 | 935.3000 | 896.3000 |
| 25 | 25 | 935.3125 | 896.3125 |
| 26 | 26 | 935.3250 | 896.3250 |
| 27 | 27 | 935.3375 | 896.3375 |
| 28 | 28 | 935.3500 | 896.3500 |
| 29 | 29 | 935.3625 | 896.3625 |
| 30 | 30 | 935.3750 | 896.3750 |
| 31 | 31 | 935.3875 | 896.3875 |
| 32 | 32 | 935.4000 | 896.4000 |
| 33 | 33 | 935.4125 | 896.4125 |
| 34 | 34 | 935.4250 | 896.4250 |
| 35 | 35 | 935.4375 | 896.4375 |
| 36 | 36 | 935.4500 | 896.4500 |
| 37 | 37 | 935.4625 | 896.4625 |
| 38 | 38 | 935.4750 | 896.4750 |
| 39 | 39 | 935.4875 | 896.4875 |
| 40 | 40 | 935.5000 | 896.5000 |
| 41 | 41 | 935.5125 | 896.5125 |
| 42 | 42 | 935.5250 | 896.5250 |
| 43 | 43 | 935.5375 | 896.5375 |
| 44 | 44 | 935.5500 | 896.5500 |
| 45 | 45 | 935.5625 | 896.5625 |
| 46 | 46 | 935.5750 | 896.5750 |
| 47 | 47 | 935.5875 | 896.5875 |
| 48 | 48 | 935.6000 | 896.6000 |
| 49 | 49 | 935.6125 | 896.6125 |
| 50 | 50 | 935.6250 | 896.6250 |
| 51 | 51 | 935.6375 | 896.6375 |
| 52 | 52 | 935.6500 | 896.6500 |
| 53 | 53 | 935.6625 | 896.6625 |
| 54 | 54 | 935.6750 | 896.6750 |
| 55 | 55 | 935.6875 | 896.6875 |
| 56 | 56 | 935.7000 | 896.7000 |
| 57 | 57 | 935.7125 | 896.7125 |
| 58 | 58 | 935.7250 | 896.7250 |
| 59 | 59 | 935.7375 | 896.7375 |
| 60 | 60 | 935.7500 | 896.7500 |
| 61 | 61 | 935.7625 | 896.7625 |
| 62 | 62 | 935.7750 | 896.7750 |
| 63 | 63 | 935.7875 | 896.7875 |
| 64 | 64 | 935.8000 | 896.8000 |
| 65 | 65 | 935.8125 | 896.8125 |
| 66 | 66 | 935.8250 | 896.8250 |
| 67 | 67 | 935.8375 | 896.8375 |
| 68 | 68 | 935.8500 | 896.8500 |
| 69 | 69 | 935.8625 | 896.8625 |
| 70 | 70 | 935.8750 | 896.8750 |
| 71 | 71 | 935.8875 | 896.8875 |
| 72 | 72 | 935.9000 | 896.9000 |
| 73 | 73 | 935.9125 | 896.9125 |
| 74 | 74 | 935.9250 | 896.9250 |
| 75 | 75 | 935.9375 | 896.9375 |
| 76 | 76 | 935.9500 | 896.9500 |
| 77 | 77 | 935.9625 | 896.9625 |
| 78 | 78 | 935.9750 | 896.9750 |
| 79 | 79 | 935.9875 | 896.9875 |
| 80 | 80 | 936.0000 | 897.0000 |
| 81 | 81 | 936.0125 | 897.0125 |
| 82 | 82 | 936.0250 | 897.0250 |
| 83 | 83 | 936.0375 | 897.0375 |
| 84 | 84 | 936.0500 | 897.0500 |
| 85 | 85 | 936.0625 | 897.0625 |
| 86 | 86 | 936.0750 | 897.0750 |
| 87 | 87 | 936.0875 | 897.0875 |
| 88 | 88 | 936.1000 | 897.1000 |
| 89 | 89 | 936.1125 | 897.1125 |
| 90 | 90 | 936.1250 | 897.1250 |
| 91 | 91 | 936.1375 | 897.1375 |
| 92 | 92 | 936.1500 | 897.1500 |
| 93 | 93 | 936.1625 | 897.1625 |
| 94 | 94 | 936.1750 | 897.1750 |
| 95 | 95 | 936.1875 | 897.1875 |
| 96 | 96 | 936.2000 | 897.2000 |
| 97 | 97 | 936.2125 | 897.2125 |
| 98 | 98 | 936.2250 | 897.2250 |
| 99 | 99 | 936.2375 | 897.2375 |
| 100 | 100 | 936.2500 | 897.2500 |
| 101 | 101 | 936.2625 | 897.2625 |
| 102 | 102 | 936.2750 | 897.2750 |
| 103 | 103 | 936.2875 | 897.2875 |
| 104 | 104 | 936.3000 | 897.3000 |
| 105 | 105 | 936.3125 | 897.3125 |
| 106 | 106 | 936.3250 | 897.3250 |
| 107 | 107 | 936.3375 | 897.3375 |
| 108 | 108 | 936.3500 | 897.3500 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 109 | 109 | 936.3625 | 897.3625 |
| 110 | 110 | 936.3750 | 897.3750 |
| 111 | 111 | 936.3875 | 897.3875 |
| 112 | 112 | 936.4000 | 897.4000 |
| 113 | 113 | 936.4125 | 897.4125 |
| 114 | 114 | 936.4250 | 897.4250 |
| 115 | 115 | 936.4375 | 897.4375 |
| 116 | 116 | 936.4500 | 897.4500 |
| 117 | 117 | 936.4625 | 897.4625 |
| 118 | 118 | 936.4750 | 897.4750 |
| 119 | 119 | 936.4875 | 897.4875 |
| 120 | 120 | 936.5000 | 897.5000 |
| 121 | 121 | 936.5125 | 897.5125 |
| 122 | 122 | 936.5250 | 897.5250 |
| 123 | 123 | 936.5375 | 897.5375 |
| 124 | 124 | 936.5500 | 897.5500 |
| 125 | 125 | 936.5625 | 897.5625 |
| 126 | 126 | 936.5750 | 897.5750 |
| 127 | 127 | 936.5875 | 897.5875 |
| 128 | 128 | 936.6000 | 897.6000 |
| 129 | 129 | 936.6125 | 897.6125 |
| 130 | 130 | 936.6250 | 897.6250 |
| 131 | 131 | 936.6375 | 897.6375 |
| 132 | 132 | 936.6500 | 897.6500 |
| 133 | 133 | 936.6625 | 897.6625 |
| 134 | 134 | 936.6750 | 897.6750 |
| 135 | 135 | 936.6875 | 897.6875 |
| 136 | 136 | 936.7000 | 897.7000 |
| 137 | 137 | 936.7125 | 897.7125 |
| 138 | 138 | 936.7250 | 897.7250 |
| 139 | 139 | 936.7375 | 897.7375 |
| 140 | 140 | 936.7500 | 897.7500 |
| 141 | 141 | 936.7625 | 897.7625 |
| 142 | 142 | 936.7750 | 897.7750 |
| 143 | 143 | 936.7875 | 897.7875 |
| 144 | 144 | 936.8000 | 897.8000 |
| 145 | 145 | 936.8125 | 897.8125 |
| 146 | 146 | 936.8250 | 897.8250 |
| 147 | 147 | 936.8375 | 897.8375 |
| 148 | 148 | 936.8500 | 897.8500 |
| 149 | 149 | 936.8625 | 897.8625 |
| 150 | 150 | 936.8750 | 897.8750 |
| 151 | 151 | 936.8875 | 897.8875 |
| 152 | 152 | 936.9000 | 897.9000 |
| 153 | 153 | 936.9125 | 897.9125 |
| 154 | 154 | 936.9250 | 897.9250 |
| 155 | 155 | 936.9375 | 897.9375 |
| 156 | 156 | 936.9500 | 897.9500 |
| 157 | 157 | 936.9625 | 897.9625 |
| 158 | 158 | 936.9750 | 897.9750 |
| 159 | 159 | 936.9875 | 897.9875 |
| 160 | 160 | 937.0000 | 898.0000 |
| 161 | 161 | 937.0125 | 898.0125 |
| 162 | 162 | 937.0250 | 898.0250 |
| 163 | 163 | 937.0375 | 898.0375 |
| 164 | 164 | 937.0500 | 898.0500 |
| 165 | 165 | 937.0625 | 898.0625 |
| 166 | 166 | 937.0750 | 898.0750 |
| 167 | 167 | 937.0875 | 898.0875 |
| 168 | 168 | 937.1000 | 898.1000 |
| 169 | 169 | 937.1125 | 898.1125 |
| 170 | 170 | 937.1250 | 898.1250 |
| 171 | 171 | 937.1375 | 898.1375 |
| 172 | 172 | 937.1500 | 898.1500 |
| 173 | 173 | 937.1625 | 898.1625 |
| 174 | 174 | 937.1750 | 898.1750 |
| 175 | 175 | 937.1875 | 898.1875 |
| 176 | 176 | 937.2000 | 898.2000 |
| 177 | 177 | 937.2125 | 898.2125 |
| 178 | 178 | 937.2250 | 898.2250 |
| 179 | 179 | 937.2375 | 898.2375 |
| 180 | 180 | 937.2500 | 898.2500 |
| 181 | 181 | 937.2625 | 898.2625 |
| 182 | 182 | 937.2750 | 898.2750 |
| 183 | 183 | 937.2875 | 898.2875 |
| 184 | 184 | 937.3000 | 898.3000 |
| 185 | 185 | 937.3125 | 898.3125 |
| 186 | 186 | 937.3250 | 898.3250 |
| 187 | 187 | 937.3375 | 898.3375 |
| 188 | 188 | 937.3500 | 898.3500 |
| 189 | 189 | 937.3625 | 898.3625 |
| 190 | 190 | 937.3750 | 898.3750 |
| 191 | 191 | 937.3875 | 898.3875 |
| 192 | 192 | 937.4000 | 898.4000 |
| 193 | 193 | 937.4125 | 898.4125 |
| 194 | 194 | 937.4250 | 898.4250 |
| 195 | 195 | 937.4375 | 898.4375 |
| 196 | 196 | 937.4500 | 898.4500 |
| 197 | 197 | 937.4625 | 898.4625 |
| 198 | 198 | 937.4750 | 898.4750 |
| 199 | 199 | 937.4875 | 898.4875 |
| 200 | 200 | 937.5000 | 898.5000 |
| 201 | 201 | 937.5125 | 898.5125 |
| 202 | 202 | 937.5250 | 898.5250 |
| 203 | 203 | 937.5375 | 898.5375 |
| 204 | 204 | 937.5500 | 898.5500 |
| 205 | 205 | 937.5625 | 898.5625 |
| 206 | 206 | 937.5750 | 898.5750 |
| 207 | 207 | 937.5875 | 898.5875 |
| 208 | 208 | 937.6000 | 898.6000 |
| 209 | 209 | 937.6125 | 898.6125 |
| 210 | 210 | 937.6250 | 898.6250 |
| 211 | 211 | 937.6375 | 898.6375 |
| 212 | 212 | 937.6500 | 898.6500 |
| 213 | 213 | 937.6625 | 898.6625 |
| 214 | 214 | 937.6750 | 898.6750 |
| 215 | 215 | 937.6875 | 898.6875 |
| 216 | 216 | 937.7000 | 898.7000 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 217 | 217 | 937.7125 | 898.7125 |
| 218 | 218 | 937.7250 | 898.7250 |
| 219 | 219 | 937.7375 | 898.7375 |
| 220 | 220 | 937.7500 | 898.7500 |
| 221 | 221 | 937.7625 | 898.7625 |
| 222 | 222 | 937.7750 | 898.7750 |
| 223 | 223 | 937.7875 | 898.7875 |
| 224 | 224 | 937.8000 | 898.8000 |
| 225 | 225 | 937.8125 | 898.8125 |
| 226 | 226 | 937.8250 | 898.8250 |
| 227 | 227 | 937.8375 | 898.8375 |
| 228 | 228 | 937.8500 | 898.8500 |
| 229 | 229 | 937.8625 | 898.8625 |
| 230 | 230 | 937.8750 | 898.8750 |
| 231 | 231 | 937.8875 | 898.8875 |
| 232 | 232 | 937.9000 | 898.9000 |
| 233 | 233 | 937.9125 | 898.9125 |
| 234 | 234 | 937.9250 | 898.9250 |
| 235 | 235 | 937.9375 | 898.9375 |
| 236 | 236 | 937.9500 | 898.9500 |
| 237 | 237 | 937.9625 | 898.9625 |
| 238 | 238 | 937.9750 | 898.9750 |
| 239 | 239 | 937.9875 | 898.9875 |
| 240 | 240 | 938.0000 | 899.0000 |
| 241 | 241 | 938.0125 | 899.0125 |
| 242 | 242 | 938.0250 | 899.0250 |
| 243 | 243 | 938.0375 | 899.0375 |
| 244 | 244 | 938.0500 | 899.0500 |
| 245 | 245 | 938.0625 | 899.0625 |
| 246 | 246 | 938.0750 | 899.0750 |
| 247 | 247 | 938.0875 | 899.0875 |
| 248 | 248 | 938.1000 | 899.1000 |
| 249 | 249 | 938.1125 | 899.1125 |
| 250 | 250 | 938.1250 | 899.1250 |
| 251 | 251 | 938.1375 | 899.1375 |
| 252 | 252 | 938.1500 | 899.1500 |
| 253 | 253 | 938.1625 | 899.1625 |
| 254 | 254 | 938.1750 | 899.1750 |
| 255 | 255 | 938.1875 | 899.1875 |
| 256 | 256 | 938.2000 | 899.2000 |
| 257 | 257 | 938.2125 | 899.2125 |
| 258 | 258 | 938.2250 | 899.2250 |
| 259 | 259 | 938.2375 | 899.2375 |
| 260 | 260 | 938.2500 | 899.2500 |
| 261 | 261 | 938.2625 | 899.2625 |
| 262 | 262 | 938.2750 | 899.2750 |
| 263 | 263 | 938.2875 | 899.2875 |
| 264 | 264 | 938.3000 | 899.3000 |
| 265 | 265 | 938.3125 | 899.3125 |
| 266 | 266 | 938.3250 | 899.3250 |
| 267 | 267 | 938.3375 | 899.3375 |
| 268 | 268 | 938.3500 | 899.3500 |
| 269 | 269 | 938.3625 | 899.3625 |
| 270 | 270 | 938.3750 | 899.3750 |
| 271 | 271 | 938.3875 | 899.3875 |
| 272 | 272 | 938.4000 | 899.4000 |
| 273 | 273 | 938.4125 | 899.4125 |
| 274 | 274 | 938.4250 | 899.4250 |
| 275 | 275 | 938.4375 | 899.4375 |
| 276 | 276 | 938.4500 | 899.4500 |
| 277 | 277 | 938.4625 | 899.4625 |
| 278 | 278 | 938.4750 | 899.4750 |
| 279 | 279 | 938.4875 | 899.4875 |
| 280 | 280 | 938.5000 | 899.5000 |
| 281 | 281 | 938.5125 | 899.5125 |
| 282 | 282 | 938.5250 | 899.5250 |
| 283 | 283 | 938.5375 | 899.5375 |
| 284 | 284 | 938.5500 | 899.5500 |
| 285 | 285 | 938.5625 | 899.5625 |
| 286 | 286 | 938.5750 | 899.5750 |
| 287 | 287 | 938.5875 | 899.5875 |
| 288 | 288 | 938.6000 | 899.6000 |
| 289 | 289 | 938.6125 | 899.6125 |
| 290 | 290 | 938.6250 | 899.6250 |
| 291 | 291 | 938.6375 | 899.6375 |
| 292 | 292 | 938.6500 | 899.6500 |
| 293 | 293 | 938.6625 | 899.6625 |
| 294 | 294 | 938.6750 | 899.6750 |
| 295 | 295 | 938.6875 | 899.6875 |
| 296 | 296 | 938.7000 | 899.7000 |
| 297 | 297 | 938.7125 | 899.7125 |
| 298 | 298 | 938.7250 | 899.7250 |
| 299 | 299 | 938.7375 | 899.7375 |
| 300 | 300 | 938.7500 | 899.7500 |
| 301 | 301 | 938.7625 | 899.7625 |
| 302 | 302 | 938.7750 | 899.7750 |
| 303 | 303 | 938.7875 | 899.7875 |
| 304 | 304 | 938.8000 | 899.8000 |
| 305 | 305 | 938.8125 | 899.8125 |
| 306 | 306 | 938.8250 | 899.8250 |
| 307 | 307 | 938.8375 | 899.8375 |
| 308 | 308 | 938.8500 | 899.8500 |
| 309 | 309 | 938.8625 | 899.8625 |
| 310 | 310 | 938.8750 | 899.8750 |
| 311 | 311 | 938.8875 | 899.8875 |
| 312 | 312 | 938.9000 | 899.9000 |
| 313 | 313 | 938.9125 | 899.9125 |
| 314 | 314 | 938.9250 | 899.9250 |
| 315 | 315 | 938.9375 | 899.9375 |
| 316 | 316 | 938.9500 | 899.9500 |
| 317 | 317 | 938.9625 | 899.9625 |
| 318 | 318 | 938.9750 | 899.9750 |
| 319 | 319 | 938.9875 | 899.9875 |
| 320 | 320 | 939.0000 | 900.0000 |
| 321 | 321 | 939.0125 | 900.0125 |
| 322 | 322 | 939.0250 | 900.0250 |
| 323 | 323 | 939.0375 | 900.0375 |
| 324 | 324 | 939.0500 | 900.0500 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 325 | 325 | 939.0625 | 900.0625 |
| 326 | 326 | 939.0750 | 900.0750 |
| 327 | 327 | 939.0875 | 900.0875 |
| 328 | 328 | 939.1000 | 900.1000 |
| 329 | 329 | 939.1125 | 900.1125 |
| 330 | 330 | 939.1250 | 900.1250 |
| 331 | 331 | 939.1375 | 900.1375 |
| 332 | 332 | 939.1500 | 900.1500 |
| 333 | 333 | 939.1625 | 900.1625 |
| 334 | 334 | 939.1750 | 900.1750 |
| 335 | 335 | 939.1875 | 900.1875 |
| 336 | 336 | 939.2000 | 900.2000 |
| 337 | 337 | 939.2125 | 900.2125 |
| 338 | 338 | 939.2250 | 900.2250 |
| 339 | 339 | 939.2375 | 900.2375 |
| 340 | 340 | 939.2500 | 900.2500 |
| 341 | 341 | 939.2625 | 900.2625 |
| 342 | 342 | 939.2750 | 900.2750 |
| 343 | 343 | 939.2875 | 900.2875 |
| 344 | 344 | 939.3000 | 900.3000 |
| 345 | 345 | 939.3125 | 900.3125 |
| 346 | 346 | 939.3250 | 900.3250 |
| 347 | 347 | 939.3375 | 900.3375 |
| 348 | 348 | 939.3500 | 900.3500 |
| 349 | 349 | 939.3625 | 900.3625 |
| 350 | 350 | 939.3750 | 900.3750 |
| 351 | 351 | 939.3875 | 900.3875 |
| 352 | 352 | 939.4000 | 900.4000 |
| 353 | 353 | 939.4125 | 900.4125 |
| 354 | 354 | 939.4250 | 900.4250 |
| 355 | 355 | 939.4375 | 900.4375 |
| 356 | 356 | 939.4500 | 900.4500 |
| 357 | 357 | 939.4625 | 900.4625 |
| 358 | 358 | 939.4750 | 900.4750 |
| 359 | 359 | 939.4875 | 900.4875 |
| 360 | 360 | 939.5000 | 900.5000 |
| 361 | 361 | 939.5125 | 900.5125 |
| 362 | 362 | 939.5250 | 900.5250 |
| 363 | 363 | 939.5375 | 900.5375 |
| 364 | 364 | 939.5500 | 900.5500 |
| 365 | 365 | 939.5625 | 900.5625 |
| 366 | 366 | 939.5750 | 900.5750 |
| 367 | 367 | 939.5875 | 900.5875 |
| 368 | 368 | 939.6000 | 900.6000 |
| 369 | 369 | 939.6125 | 900.6125 |
| 370 | 370 | 939.6250 | 900.6250 |
| 371 | 371 | 939.6375 | 900.6375 |
| 372 | 372 | 939.6500 | 900.6500 |
| 373 | 373 | 939.6625 | 900.6625 |
| 374 | 374 | 939.6750 | 900.6750 |
| 375 | 375 | 939.6875 | 900.6875 |
| 376 | 376 | 939.7000 | 900.7000 |
| 377 | 377 | 939.7125 | 900.7125 |
| 378 | 378 | 939.7250 | 900.7250 |
| 379 | 379 | 939.7375 | 900.7375 |
| 380 | 380 | 939.7500 | 900.7500 |
| 381 | 381 | 939.7625 | 900.7625 |
| 382 | 382 | 939.7750 | 900.7750 |
| 383 | 383 | 939.7875 | 900.7875 |
| 384 | 384 | 939.8000 | 900.8000 |
| 385 | 385 | 939.8125 | 900.8125 |
| 386 | 386 | 939.8250 | 900.8250 |
| 387 | 387 | 939.8375 | 900.8375 |
| 388 | 388 | 939.8500 | 900.8500 |
| 389 | 389 | 939.8625 | 900.8625 |
| 390 | 390 | 939.8750 | 900.8750 |
| 391 | 391 | 939.8875 | 900.8875 |
| 392 | 392 | 939.9000 | 900.9000 |
| 393 | 393 | 939.9125 | 900.9125 |
| 394 | 394 | 939.9250 | 900.9250 |
| 395 | 395 | 939.9375 | 900.9375 |
| 396 | 396 | 939.9500 | 900.9500 |
| 397 | 397 | 939.9625 | 900.9625 |
| 398 | 398 | 939.9750 | 900.9750 |
| 399 | 399 | 939.9875 | 900.9875 |
| 400 | 400 | 940.0000 | 901.0000 |
| 401 | 401 | 940.0125 | 901.0125 |
| 402 | 402 | 940.0250 | 901.0250 |
| 403 | 403 | 940.0375 | 901.0375 |
| 404 | 404 | 940.0500 | 901.0500 |
| 405 | 405 | 940.0625 | 901.0625 |
| 406 | 406 | 940.0750 | 901.0750 |
| 407 | 407 | 940.0875 | 901.0875 |
| 408 | 408 | 940.1000 | 901.1000 |
| 409 | 409 | 940.1125 | 901.1125 |
| 410 | 410 | 940.1250 | 901.1250 |
| 411 | 411 | 940.1375 | 901.1375 |
| 412 | 412 | 940.1500 | 901.1500 |
| 413 | 413 | 940.1625 | 901.1625 |
| 414 | 414 | 940.1750 | 901.1750 |
| 415 | 415 | 940.1875 | 901.1875 |
| 416 | 416 | 940.2000 | 901.2000 |
| 417 | 417 | 940.2125 | 901.2125 |
| 418 | 418 | 940.2250 | 901.2250 |
| 419 | 419 | 940.2375 | 901.2375 |
| 420 | 420 | 940.2500 | 901.2500 |
| 421 | 421 | 940.2625 | 901.2625 |
| 422 | 422 | 940.2750 | 901.2750 |
| 423 | 423 | 940.2875 | 901.2875 |
| 424 | 424 | 940.3000 | 901.3000 |
| 425 | 425 | 940.3125 | 901.3125 |
| 426 | 426 | 940.3250 | 901.3250 |
| 427 | 427 | 940.3375 | 901.3375 |
| 428 | 428 | 940.3500 | 901.3500 |
| 429 | 429 | 940.3625 | 901.3625 |
| 430 | 430 | 940.3750 | 901.3750 |
| 431 | 431 | 940.3875 | 901.3875 |
| 432 | 432 | 940.4000 | 901.4000 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 433 | 433 | 940.4125 | 901.4125 |
| 434 | 434 | 940.4250 | 901.4250 |
| 435 | 435 | 940.4375 | 901.4375 |
| 436 | 436 | 940.4500 | 901.4500 |
| 437 | 437 | 940.4625 | 901.4625 |
| 438 | 438 | 940.4750 | 901.4750 |
| 439 | 439 | 940.4875 | 901.4875 |
| 440 | 440 | 940.5000 | 901.5000 |
| 441 | 441 | 940.5125 | 901.5125 |
| 442 | 442 | 940.5250 | 901.5250 |
| 443 | 443 | 940.5375 | 901.5375 |
| 444 | 444 | 940.5500 | 901.5500 |
| 445 | 445 | 940.5625 | 901.5625 |
| 446 | 446 | 940.5750 | 901.5750 |
| 447 | 447 | 940.5875 | 901.5875 |
| 448 | 448 | 940.6000 | 901.6000 |
| 449 | 449 | 940.6125 | 901.6125 |
| 450 | 450 | 940.6250 | 901.6250 |
| 451 | 451 | 940.6375 | 901.6375 |
| 452 | 452 | 940.6500 | 901.6500 |
| 453 | 453 | 940.6625 | 901.6625 |
| 454 | 454 | 940.6750 | 901.6750 |
| 455 | 455 | 940.6875 | 901.6875 |
| 456 | 456 | 940.7000 | 901.7000 |

| Prog Chan. No. | FCC Chan. No. | Mobile Rx Freq. | Mobile Tx Freq |
|---|---|---|---|
| 457 | 457 | 940.7125 | 901.7125 |
| 458 | 458 | 940.7250 | 901.7250 |
| 459 | 459 | 940.7375 | 901.7375 |
| 460 | 460 | 940.7500 | 901.7500 |
| 461 | 461 | 940.7625 | 901.7625 |
| 462 | 462 | 940.7750 | 901.7750 |
| 463 | 463 | 940.7875 | 901.7875 |
| 464 | 464 | 940.8000 | 901.8000 |
| 465 | 465 | 940.8125 | 901.8125 |
| 466 | 466 | 940.8250 | 901.8250 |
| 467 | 467 | 940.8375 | 901.8375 |
| 468 | 468 | 940.8500 | 901.8500 |
| 469 | 469 | 940.8625 | 901.8625 |
| 470 | 470 | 940.8750 | 901.8750 |
| 471 | 471 | 940.8875 | 901.8875 |
| 472 | 472 | 940.9000 | 901.9000 |
| 473 | 473 | 940.9125 | 901.9125 |
| 474 | 474 | 940.9250 | 901.9250 |
| 475 | 475 | 940.9375 | 901.9375 |
| 476 | 476 | 940.9500 | 901.9500 |
| 477 | 477 | 940.9625 | 901.9625 |
| 478 | 478 | 940.9750 | 901.9750 |
| 479 | 479 | 940.9875 | 901.9875 |

# SECTION 5 MULTI-NET SYSTEM OVERVIEW

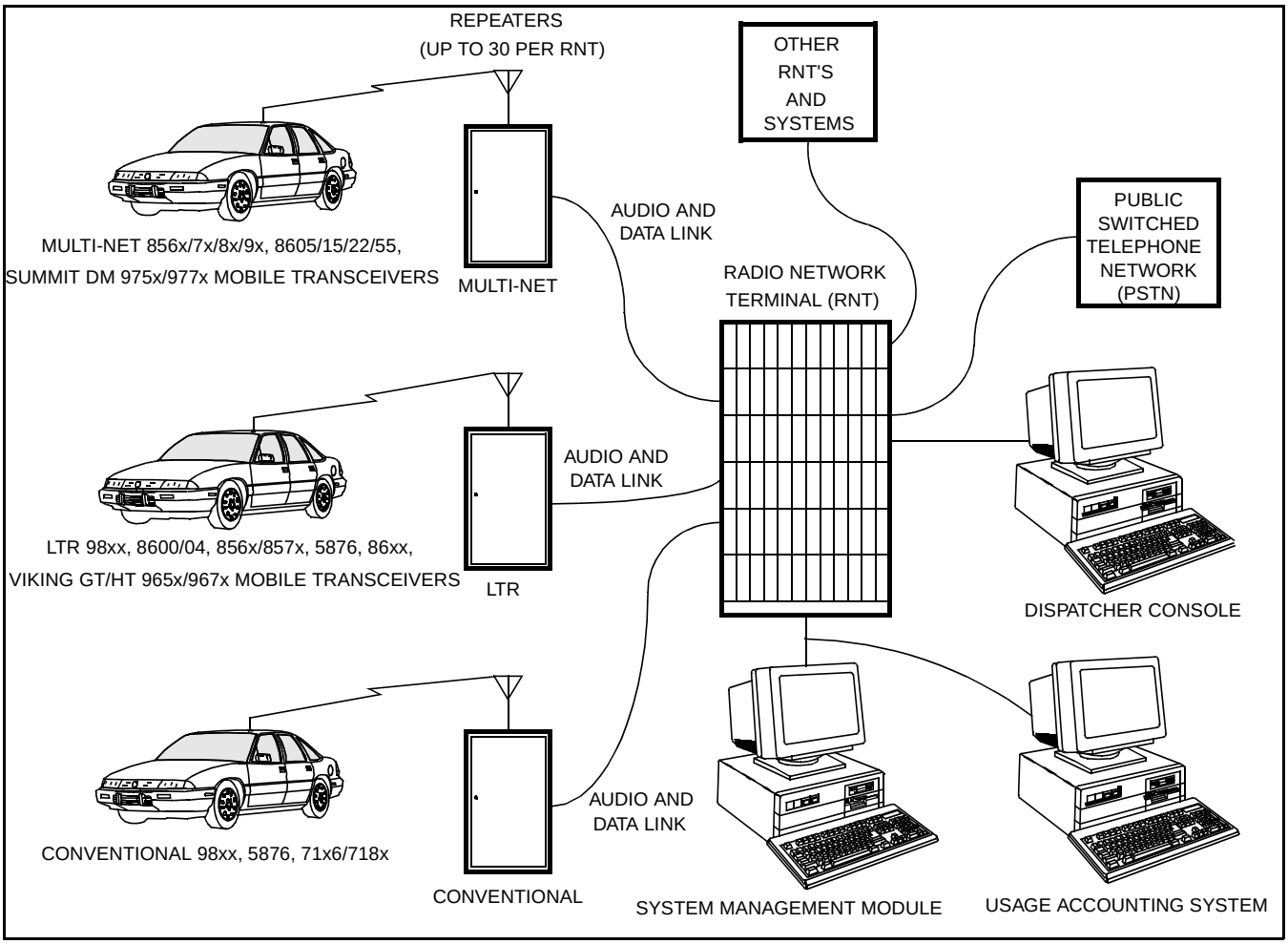



**Figure 5-1 Multi-Net System Components**

## 5.1 MULTI-NET SYSTEM COMPONENTS

*NOTE: For more information on Multi-Net systems, refer to the Multi-Net Application Note, Part No. 009-3039-003.*

### 5.1.1 INTRODUCTION

The basic components of a Multi-Net system are shown in Figure 5-1. Because of the built-in adaptability of a Multi-Net system, one can be designed to meet the communication needs of almost any type of user. The following are some operating features that a Multi-Net system can provide:

1. Advanced features such as up to 8000 Unique ID codes, automatic mobile identification, roaming, and five levels of priority access are available if Multi-Net signaling is used.

2. Users of different types of radio equipment can talk to each other. For example, a mobile operating on a Multi-Net 800 MHz channel could talk to a mobile operating on a conventional UHF channel.

3. Wide area radio coverage can be provided so that a mobile could talk to another mobile that is using a repeater that may be hundreds of miles away. That repeater may be part of the same Multi-Net system

or another Multi-Net system. Phone lines or some other type of link can be used to provide a communication path.

Multi-Net systems are not restricted to a certain type of signaling. For example, an entire Multi-Net system could be designed using conventional channels which use tone or digitally controlled squelch. The various types of signaling can also be mixed in a system. For example, there could be ten channels using Multi-Net signaling, ten channels using LTR signaling, and ten channels using conventional signaling. Your E.F. Johnson representative can provide more information on the capabilities of Multi-Net systems.

The following information describes the Multi-Net components shown in Figure 5-1.

### 5.1.2 MOBILE TRANSCEIVERS

The mobile and handheld transceivers used in a Multi-Net system must be compatible with the type of signaling being used (Multi-Net, LTR, or conventional) and also the frequency range of the system (800 or 900 MHz). E.F. Johnson mobile transceivers that can be programmed for Multi-Net signaling are listed in Table 1-2. All Multi-Net transceivers are triple mode which means that they can be programmed for Multi-Net, LTR, and conventional (non-trunked) operation. There are also many other E.F. Johnson transceivers available that can be programmed for LTR and/or conventional operation.

### 5.1.3 REPEATERS

The specific E.F. Johnson Summit® QX repeater model that is used in a Multi-Net system is determined by frequency range and desired RF power output. Models are available for the 800 and 900 MHz frequency ranges and with standard or high power output. One repeater is required for each RF channel.

The Summit QX contains a main processor card which controls signaling on that channel. This card also allows the RNT to control the repeater. The specific card that is used is determined by the type of signaling used (Multi-Net, LTR, or conventional).

### 5.1.4 RADIO NETWORK TERMINAL (RNT)

The RNT along with the SMM (System Management Module) control the Multi-Net system. The SMM is an IBM® PC or compatible computer that is running Multi-Net software. This computer connects to the RNT and is used by the system manager to control the system. The SMM also continuously monitors RNT operation and maintains usage information which can be monitored by the Usage Accounting System. Such activities as dynamic reprogramming of mobiles and disabling of lost or stolen mobiles are also performed by the SMM.

A single RNT can control up to 30 repeaters which is the maximum allowed by the FCC at one site. The RNT is configured with one Channel Interface Module (CIM) for each repeater it controls and an Intelligent Dispatch Module (IDM) for each E.F. Johnson Dispatch Console. It also contains a Telephone Interface Module (TIM) for each telephone line used for interconnect calls and other modules.

### 5.1.5 DISPATCH CONSOLES

One or more E.F. Johnson Dispatch Consoles or other consoles can be connected to the RNT using direct connection, phone lines, or other types of links. Depending on the capabilities of the particular console, the dispatcher can perform such functions as placing calls to specific mobiles, placing calls to other dispatchers, patching mobiles together so they can talk to each other, and monitoring status messages from mobiles.

### 5.1.6 PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)

When telephone (interconnect) calls are placed by transceivers, the RNT routes the call to the PSTN. The specific transceivers which can place calls and other interconnect parameters are controlled by the system manager through the SMM and also by the programming of the transceivers.

The option to route telephone calls through a Private Automatic Branch Exchange (PABX) is available. The calling features of the PABX can then be utilized.

## 5.2 DEFINITIONS OF MULTI-NET TERMS

**Conventional System -** A type of radio system that is licensed to operate on only a single channel. There is no automatic access to several channels.

**Home Repeater -** All Multi-Net mobiles have one of the site repeaters assigned as their "home" repeater. When standard dispatch (group) calls are placed, the home repeater and group ID code identify the mobile or group of mobiles that receive the call.

**Logic Trunked Radio (LTR) -** This E.F. Johnson radio system provides the basis for the Multi-Net radio system. Both LTR and Multi-Net systems utilize a channel management concept called trunking (see "Trunked Radio System" which follows). Logic circuitry in the mobile transceivers and repeaters controls trunking. It continually monitors the system and generates data messages which update the mobiles and repeaters as to which repeaters are free and which mobiles are receiving calls.

**Mobile -** This term refers to a transceiver mounted in a vehicle but it can also be applied to other types of transceivers because they all operate basically the same. The other types of transceivers are portables and control stations. A control station is essentially a mobile transceiver used at a stationary location such as at an office site.

**Monitor Repeater -** This is the repeater that a mobile is currently monitoring for update messages. This repeater may be either the mobile's home repeater or the site status repeater. When a mobile is not receiving a call, it continually monitors the update messages for incoming call and free repeater information. When making a call, the mobile may be trunked to any of the site repeaters that are not busy.

**Multi-Net System -** An advanced radio system which provides enhanced operating features such as auto-registration (roaming), busy queuing, emergency messages, and priority access. It utilizes trunking similar to an LTR system.

**Public Safety -** A radio service used by the Local Government, Police, Fire, Highway Maintenance, Forestry Conservation, and Special Emergency Radio services.

**Radio Network Terminal (RNT) -** The RNT together with the System Management Module provide control of a Multi-Net system. The RNT can interconnect several different forms of communication to form a communication network. Refer to Section 5.1.4 for more information.

**Selectable Group -** Each selectable system can be programmed with several selectable groups. Each selectable group contains ID codes which specify the mobile or group of mobiles being called, which calls are received, and other call information (see Section 3.3.4).

**Selectable System -** This usually refers to one of the systems selectable by the transceiver System Select function. Each selectable system can be programmed with a unique set of operating parameters such as home repeater, group ID codes, and unique ID (see Section 3.3.4).

**Site -** Repeaters that are physically located together and connected to the same high-speed data bus.

**Specialized Mobile Radio System (SMRS) -** A conventional or trunked radio system owned by an entrepreneur who makes a profit by selling service on the system. The entrepreneur is licensed for a base/mobile relay facility and all users of mobiles or control stations on his system are licensed as SMRS "users". The entrepreneur can also be licensed as a user on his own system. An SMRS may provide service to any of the radio services in the Public Safety and Industrial/Land Transportation (PSIT) categories. In addition, the Federal Government and individuals may be licensed to use an SMRS.

**Status Repeater -** One Multi-Net repeater at a site is designated to transmit update information for all calls occurring at that site. This repeater is also available for voice traffic, but is not assigned as a home repeater for any mobiles because none of its mobiles would have home channel backup (see Sections 5.3 and 5.4).

**Trunked Radio System -** A radio system which utilizes multiple radio channels and automatic channel switching to allow all system uses to access any channel that is not in use. This results in minimum waiting to make a call and maximum utilization of system channels.

## 5.3 HOME AND STATUS REPEATERS

When a mobile transceiver is programmed, it is assigned “home” and “status” repeaters. The status repeater is used by a mobile as its primary source of incoming call and free repeater information. When a mobile is not receiving a call, it is continually monitoring its status or home repeater for this information. In addition, the home repeater and group ID code are used to identify mobiles when standard group calls are placed.

One repeater at a site is designated as the status repeater. This repeater transmits update information for all calls occurring at that site. The status repeater is also available for voice traffic, but is usually not assigned as a home repeater for any mobiles. The reason for this is that mobiles assigned to the status repeater would not have home channel backup. However, no degradation in system calling efficiency occurs if this is done.

The status repeater transmits continuous update messages at all times. A home repeater transmits continuous update messages when it is in use or if any of its mobiles are trunked out to another repeater. During idle times, non-status repeaters transmit update messages every 10 seconds. Therefore, a mobile just coming into service quickly receives information as to which channel to use.

If the home repeater is being monitored and it is not busy, it is used to make a call. Otherwise, the transceiver may be trunked to any repeater at the site to make a call. The repeater to which a mobile is trunked is selected randomly.

Group ID codes 1-225 are assignable on each home repeater for standard dispatch calls. For example, if the system has ten channels, up to 2250 different group ID codes can be assigned. Group ID codes specify the specific mobile or group of mobiles being called and the mobile or group of mobiles from which calls are received.

## 5.4 HOME CHANNEL BACKUP

### 5.4.1 INTRODUCTION

If mobiles were limited to just their home repeater to receive update information and that repeater became inoperative, all the mobiles assigned to that home repeater would not be able to place or receive calls. To prevent this from happening, each site utilizing Multi-Net signaling has a repeater called a status repeater which transmits update messages for all calls occurring at the site. All mobiles assigned to the site can receive update messages from either the status or home repeater. Therefore, if a home repeater fails, the status repeater can still be monitored for the information needed to place and receive calls.

### 5.4.2 SELECTING REPEATER TO MONITOR

Each selectable Multi-Net system of a mobile is programmed with the channel numbers of the status and home repeaters. When transceiver power is turned on, it checks the status repeater. If valid data is detected, that repeater becomes the monitor repeater. If valid data is not detected, the home repeater is monitored. The monitor repeater does not change unless valid data is no longer detected or a system programmed for a different site is selected. Transceiver performance is not affected by which repeater is being monitored.

### 5.4.3 ASSIGNING THE STATUS CHANNEL

Each selectable system of a mobile is programmed with a status channel and also the number of the site that is accessed by that system. For proper mobile operation, the same status channel must be programmed in all systems which access that site. For example, if systems 1, 3, and 4 access site 128, those systems must be programmed with the same status channel.

### 5.4.4 DETECTING DEFECTIVE REPEATERS

If a repeater is defective, it is important that it is taken off the air as quickly as possible to ensure that all transceivers are receiving quality service. To detect improper operation, calls can be periodically placed through an optional test mobile by the System Analyzer. A test mobile is simply a transceiver located off-site that has attenuated power output.

These calls use the Interrogate special call described in Section 5.8.4, and they are placed through each repeater in the site. This call exercises the repeater RF receive, RF transmit, and logic circuitry. If the proper response is not received from the repeater

by the RNT, the SMM alerts the system operator. The faulty repeater may then be automatically or manually shut down by the SMM.

## 5.5 MOBILE-REPEATER DATA SIGNALING

The setup and control of a call is performed by exchanging data messages between the mobile and repeater. This data signaling occurs continuously with voice because it is at the subaudible frequency of 150 Hz. This allows operation without a dedicated control channel. Therefore, all channels can be used for voice communication.

When a mobile initiates a call, a data “handshake” occurs with the repeater. This handshake occurs in only half a second, and it tells the mobile that the system has been successfully accessed and that the signal is not occurring on the wrong channel because of intermodulation. One advantage of using a handshake to access a channel is that it prevents a mobile with a stronger signal from capturing a channel in use.

Data messages are continuously transmitted to the repeater by the calling mobile while a conversation is in progress. A repeater is held for only the duration of the transmission with standard dispatch (mobile-to-mobile) calls. Some special calls, such as telephone and unique ID, hold the repeater for the duration of the call.

When a mobile is trunked to another repeater to receive a call, additional data messages are transmitted continuously by that mobile's home repeater, the status repeater (see Section 5.4), and the repeater to which the mobile was trunked. The messages on the home and status repeaters tell mobiles just coming into service which repeater to switch to in order to receive the call. Messages on the repeater being used by the transceiver keep it updated on what calls are being received by other mobiles assigned to its home repeater. Therefore, calls with a higher receive priority are not missed even when trunked to another repeater.

The sequence of data messages transmitted on a home or status repeater follows: Every third data message is the message to the mobile using that repeater. Then alternating between those messages are the messages to the other mobiles receiving calls.

If it is a home repeater, these messages are for its assigned mobiles that are being trunked to other repeaters. If it is the status repeater, messages to all mobiles currently using the site are transmitted. If it has assigned mobiles, this includes messages to those mobiles. For example, assume that five different transceivers are making calls. If all have Repeater 1 as their home repeater, the data message order on Repeater 1 is as follows: 1 2 3 1 4 5 1 2 3 and so on. Therefore, in this case, the maximum number of data messages that would occur before repeating is six.

The calls that can be placed and received are determined by the ID codes programmed into the transceiver by the system operator. Therefore, other users in the system cannot eavesdrop on conversations of other groups. Although traffic can be monitored by a receiver tuned to the channels being used, that may even be difficult because a complete conversation may include several exchanges occurring on various channels.

Since Multi-Net and LTR signaling is different, the mobile must be programmed for the type of signaling being used. For example, if the selectable system of the mobile is programmed for Multi-Net operation, it cannot be selected to place calls on an LTR system and vice versa. However, since all current Multi-Net transceivers can be programmed for Multi-Net, LTR, and conventional operation, all the user has to do to place a different type of call is select another system.

## 5.6 REPEATER DATA BUS SIGNALING

A single-line, high-speed serial data bus interconnects the control logic of the repeaters at a site. Control information is exchanged between repeaters via this bus. Repeaters in a Multi-Net system utilize a logic control technique called distributive processing in which the logic of each repeater performs all the control functions on that channel. This eliminates the need for a separate controller at each site.

When a repeater is in use, it places information on this data bus which includes the home repeater number and the group and unique ID code of the mobile using the channel. This information is monitored by the other repeaters at the site so that they can determine which repeaters are free and also if any of their assigned mobiles are trunked to other repeaters.

With Multi-Net signaling, repeater data bus synchronization is done distributively. Therefore, no single repeater is responsible for data bus synchronization. If any of the repeaters at the site become inoperative, the others continue to operate normally.

## 5.7 STANDARD AND SPECIAL CALLS

Introduction

The two types of calls that can be made with Multi-Net signaling are Standard (dispatch) and Special. Group ID codes 1-225 are used for Standard calls, and group ID codes 226-255 are used for Special Calls. The following information describes these calls.

Standard Calls

As stated earlier, up to 225 group ID codes are assignable on each Multi-Net home repeater. When a transceiver monitors its home or status repeater, it receives data messages containing a home repeater number, group ID, and unique ID code (see Section 5.8.1). When it detects its home repeater and a group ID from 1-225 that it is programmed to decode, it unsquelches and the call is received. The correct unique ID code does not need to be detected to receive a Standard Call.

Standard Calls can be placed only to mobiles assigned to the same home repeater. However, each selectable system of a transceiver can be programmed with a different home repeater which allows calls to mobiles assigned to other repeaters. Refer to Section 3.3.4 for more information on standard calls.

Special Calls

If a group ID from 226-255 is received, a Special Call is indicated and the transceiver responds according to the type of call. Special calls are used to perform many of the special Multi-Net features described later in this section. The special calls usually originated by a mobile are Interconnect and Auxiliary. Most other special calls such as Interrogate, Mobile Disable, and Reassignment are originated by the system operator or a dispatcher. Generally, a transceiver must decode its unique ID code to respond to a Special Call. Refer to Section 3.7.4 for more information on special calls.

## 5.8 OTHER MULTI-NET FEATURES

### 5.8.1 UNIQUE ID CODES

Each selectable system of a transceiver is programmed with a unique ID code in addition to the group ID codes. Unique ID codes are assigned on a site-wide basis, not on a repeater basis as with group IDs. Up to 8000 unique ID codes can be assigned per RNT.

Whenever a transceiver makes a call, it always transmits the unique ID programmed in the system in addition to the selected group ID. Any control point equipped with a console that can receive the call then displays the ID of the calling unit. This provides automatic identification of transceivers making calls.

Unique IDs also permit individual mobile units to be called. This is done using the special calls described in the preceding section. Calls can also be made to individual transceivers using standard call group IDs 1-225 if an ID code is assigned to only one transceiver.

### 5.8.2 ACCESS AND RECEIVE PRIORITY

The priority access feature allows users that have a greater need to communicate, access to the system first. There are five levels of priority, with 1 the highest priority and 5 the lowest priority. Each repeater determines the current priority level using an algorithm that is selected by the programming of the main processor card. The access priority information is then transmitted in the data messages to the mobiles monitoring that repeater.

When a transceiver is programmed, a priority level between 1 and 5 is assigned to each group ID that is encoded (transmitted). If the priority level transmitted by the repeater is higher than that programmed for the selected group, a busy indication is produced when the PTT switch is pressed and the call cannot be placed at that time.

There is also a priority order when receiving messages if the selected system of the transceiver is programmed with two or more receive group ID codes. This permits a call with a higher priority ID code to interrupt a call with a lower priority ID code. Receive priority occurs only with standard group calls.

Telephone and other special calls cannot be interrupted by standard calls. Refer to Section 3.7.4 for more information.

### 5.8.3 ALL CALL

"All Call" is another of the special calls described earlier. This call goes out to all mobiles assigned to the site. It can be transmitted by the system operator or by a dispatcher that is authorized to do so. It is received by all mobiles assigned to the site because it goes out to all repeaters simultaneously and has the highest priority. Therefore, all calls in progress are dropped to receive it. If a mobile is turned on, the only time that this message can be missed is while it is in the transmit mode.

### 5.8.4 INTERROGATE

A dispatcher with the proper authority can interrogate any mobile unit in the field. A special interrogate message is sent that contains the unique ID code of the affected mobile. If that mobile is turned on, it will automatically transmit a message back to the dispatcher that identifies it and sends one of eight status indications which are then displayed at the dispatch point (see Section 5.8.14). This feature can be used for such things as determining if a transceiver is in service or assisting in the recovery of lost or stolen units. It is also used to detect defective repeaters (see Section 5.4.4).

### 5.8.5 MOBILE DISABLE

If a transceiver is lost or stolen or is being used to interfere with communications or monitor sensitive transmissions, it can be temporarily or permanently disabled by the system manager using the Mobile Disable special call. After this call is sent, verification is returned by the transceiver indicating that it has been successfully disabled. To make a permanently disabled transceiver operational again, it must be returned for reprogramming.

### 5.8.6 DYNAMIC REPROGRAMMING OF GROUP 11

Group 11 of each selectable system can be dynamically reprogrammed over the air. That group is the only one that can be reprogrammed over the air and also by the PC programmer. Making only one group reprogrammable in this manner prevents the transceiver from becoming inoperative because of a programming error caused by a poor RF signal.

Dynamic reprogramming is performed by the system manager. The data transmitted to the mobile includes the selectable system to be changed, the new encode and decode ID codes, and the access priority of the encode code. One use of this feature is to allow a transceiver to place or receive calls for which it was not originally programmed.

### 5.8.7 DYNAMIC MOVE TO NEW SYSTEM/ GROUP

The dynamic reprogramming feature just described does not change the currently selected group of the transceiver. This can be done using the dynamic move to system/group special call. The procedure is similar to that used for dynamic reprogramming. When this message is detected by the mobile, it automatically switches to the system and group number contained in the message. One use of this feature is to make sure that mobiles are set to the correct system/ group to receive an important "all call" message. It can also be used in conjunction with the dynamic reprogramming command to send a special message.

### 5.8.8 ID VALIDATION

ID validation is the process of making sure that only the mobiles authorized service on the system can use it. This function is performed by the System Management Module. Both group and unique ID codes are checked. If an ID code is detected that is not authorized for service, a turn-off code is transmitted to the mobile or mobiles receiving the call. This effectively disables the unauthorized mobile because its calls are not received.

### 5.8.9 SYSTEM KEY

The system repeaters and all mobiles are programmed with a unique System Key. The function of the System Key is to ensure that only authorized users can access a Multi-Net system. The repeater System Key is programmed at the factory, and the mobile system key is programmed into the transceiver by the system operator. The System Key is a number that is used by both the repeaters and the mobiles to encode the data stream. If both are not programmed

with the proper key, communication is not possible. The System Key is provided to the system operator by the E.F. Johnson Company.

### 5.8.10 DYNAMIC CHANNEL ASSIGNMENT

When channels (repeaters) are added to a Multi-Net system, mobiles do not have to be brought back in for reprogramming because they are informed over the air as to which channel number to use to place or receive a call. The only channel numbers programmed into the mobiles are the home and status channels.

### 5.8.11 EMERGENCY CALLS

An emergency switch is available with all Multi-Net transceivers. This switch can be used in emergency situations to quickly place calls or transmit an emergency code. The transceiver can be programmed so that the emergency message is transmitted either automatically or manually.

When automatic operation is programmed, the transceiver automatically transmits the emergency code on the designated system/group until an acknowledgment is received from the dispatcher. When manual operation is programmed, the transceiver goes to the designated system/group but no message is automatically transmitted. This ensures that when the user does transmit the message, it is transmitted at the highest priority. Refer to Section 3.6.8 for more information.

### 5.8.12 AUTO-REGISTRATION (ROAMING)

Auto-registration (roaming) can be used to automatically track the location of mobiles in multi-site systems. Calls can then be automatically routed to the correct site. This eliminates the need to enter the site of the mobile when placing a call.

Auto-registration occurs only when the mobile is in the system scanning mode. If the mobile moves out of radio range of the site in which it is currently registered, it begins searching for another site. When one is found, it automatically registers on the new site. When the transceiver is searching for a new site, the user is alerted by a message in the display. Refer to Section 3.7.2 for more information.

Most Multi-Net transceivers also have a programmable parameter called Auto-Registration Dropout Criteria. This parameter determines the point at which the mobile attempts to register on another site. This is controlled by the percentage of good data messages that the mobile receives over a 10-second period. If it is programmable, it can be set for 50-100%. If it is not, it is fixed at 50%. This percentage sets the number of good messages that must be received to stay on the current site. Therefore, the higher the percentage, the sooner auto-registration occurs.

### 5.8.13 BUSY QUEUING

The busy queuing feature places the call in a queue if the system is busy when the PTT switch is pressed. Then when the system becomes available, the user is alerted by a tone and the call can be placed if desired. An available system is determined in the normal manner by the access priority of the selected group and the current access priority being transmitted by the repeater. Refer to Section 3.7.1 for more information on this feature.

### 5.8.14 SENDING STATUS INFORMATION

One of up to eight preprogrammed status conditions can be transmitted to the dispatcher. Conditions such as “AT SCENE” or “IN PURSUIT” can be selected by the user. Then when the transmitter keys, a number representing that status is transmitted and a message along with the mobile's unique ID are displayed on the dispatcher's console. Refer to Section 3.7.3 for more information.

### 5.8.15 TRANSMIT INHIBIT

The Transmit Inhibit feature prevents the transmitter from keying if the mobile being called is busy with another call. The transceiver is programmed with a block of transmit inhibit ID codes that can include up to all 225. If a code within this block is detected up to 5 seconds before the push-to-talk switch is pressed, the transmitter does not key and the user is alerted by a tone and message in the display if applicable. Refer to Section 3.7.5 for more information.

## 5.8.16 VOICE ENCRYPTION

*NOTE: Voice encryption is currently not available for E.F. Johnson 900 MHz transceivers.*

Optional voice encryption provides security from unauthorized monitoring of conversations by casual eavesdropping and analog scanners. Multi-Net encryption employs Continuous Sync™ technology to provide fast synchronization and decoding of messages. This means that calls can be received even if the transceiver is turned on in the middle of a message or if a call is entered from the scan mode.

Encryption encodes the audio signal using a special code sequence. Over five-billion different codes are available, and only other mobiles with the same code sequence can receive a call. Encryption is available on both group and telephone calls (either mobile- and landside-originated). With telephone calls, dialing is normally completed before encryption is enabled.

Encryption can be used with Multi-Net, LTR, and conventional operation. Each group can be programmed for encryption and then when that group is selected, encryption is automatically enabled. The user can also manually turn encryption on and off. The encryption mode is indicated in the display or by a front-panel indicator.

*NOTE: Encryption is not compatible with companding; therefore, those features cannot be used together.*

An OTAR (Over-The-Air-Reprogramming) system is available which allows the system operator to periodically change part of the encryption code and certain other parameters. This system uses a specially-equipped mobile transceiver, modem, IBM® PC or compatible computer, and special OTAR software.

™ Continuous Sync is a trademark of Transcrypt International

# SECTION 6 CIRCUIT DESCRIPTION

## 6.1 GENERAL TRANSCEIVER DESCRIPTION

### 6.1.1 INTRODUCTION

The Summit 97xx transceiver contains the following PC board assemblies: RF, PA (power amplifier), audio/logic, and display. The RF board contains the synthesizer and receiver sections, and the PA board contains the transmitter section. The audio/logic board contains the digital control and audio and data processing circuitry. The display board is used in front-mount models and the remote control unit of remote-mount models. General descriptions follow and more detailed descriptions are located in Sections 6.2-6.7. A transceiver block diagram is shown in Figure 6-1.

Circuit protection is provided by a 15-ampere fuse in the power cable and a 4-ampere fuse on the PA board and also by regulators which automatically limit current. The fuse on the PA board protects low-power circuits such as the audio power amplifier and the 5-, 8-, and 9-volt regulators. The power cable fuse protects the high-power circuits in the transmitter such as the driver and final.

### 6.1.2 SYNTHESIZER

The synthesizer output signal is the transmit frequency in the transmit mode and the receive first injection frequency in the receive mode. This signal is routed by a switching circuit to either first mixer Q206 on the RF board or power amplifier module U500 on the PA board.

Channels are selected by programming the counters in synthesizer chip U801 to divide by a certain number. This data comes from microprocessor U401 located on the audio/logic board. The frequency stability of the synthesizer is determined by the stability of TCXO (temperature compensated crystal oscillator) A800. The stability of A800 is ±1.5 PPM for both 800 and 900 MHz from –22° to +140° F (–30° to +60° C).

### 6.1.3 RECEIVER

The receiver is a double-conversion type with intermediate frequencies of 52.950 MHz and 450 kHz. Receiver selectivity is enhanced by two 52.950 MHz crystal filters and a 450 kHz ceramic filter. Two bandpass filters in the front end attenuate the image, half IF, injection, and other frequencies which could degrade receiver performance.

### 6.1.4 TRANSMITTER

The transmitter amplifies the +10 dBm synthesizer signal to produce a power output of 15 or 30/35 watts, depending on model. All data and audio modulation of the transmit signal occurs in the synthesizer. The power control circuit allows the microprocessor to directly control transmitter power output. This permits each selectable system to be programmed with a different setting if desired. The ambient temperature of 30/35-watt models is also monitored by the microprocessor so that power can be cut back if temperature becomes excessive.

### 6.1.5 AUDIO/LOGIC BOARD

Microprocessor-based logic on the audio/logic board controls such functions as synthesizer programming, scan, data encoding and decoding, and the display. In addition to the digital control circuitry, the audio/logic board contains analog circuits which provide amplification, filtering, and other processing of the audio, data, and Call Guard signals.

Information which changes from transceiver to transceiver such as channels to be selected and various operating parameters is programmed into the transceiver by a personal computer connected to the front-panel microphone jack. This information is stored in EEPROM U406. Since this type of memory device is nonvolatile and reprogrammable, battery backup or extra PROMs are not required.

The operating program is stored in flash EPROM U404. This type of memory can be reprogrammed by

the microprocessor similar to an EEPROM. This allows the operating program to be updated using the standard programming setup and special software. This eliminates the need to change a ROM or the microprocessor to update software.

## 6.2 SYNTHESIZER CIRCUIT DESCRIPTION

### 6.2.1 INTRODUCTION

A block diagram of the synthesizer is shown in Section 6-1. The synthesizer output signal is produced by a VCO (voltage-controlled oscillator) located on a separate module. The frequency of this oscillator is controlled by a DC voltage produced by the phase detector in synthesizer chip U801. The phase detector senses the phase and frequency of two input signals and if they are not the same, the VCO control voltage increases or decreases until they are synchronized. The VCO is then "locked" on frequency.

One input to the phase detector is the reference frequency (fR) derived from the TCXO. The TCXO frequency is divided by 1400 by the reference counter in U801 to produce a reference frequency of 12.5 kHz. This frequency is the same for all channels. In addition, the third harmonic of the TCXO frequency is used to lock the receiver second injection oscillator on frequency.

The other input signal to the phase detector (fV) is derived from the VCO signal. The VCO signal is divided by prescaler U800 and the N counter in U801 to produce this signal. The prescaler and N counter are programmed for each channel to produce an input frequency to the phase detector that is the same as the fR input when the VCO is oscillating on the correct frequency.

### 6.2.2 VOLTAGE-CONTROLLED OSCILLATOR MODULE

*NOTE: The VCO module is not repairable because it is a hybrid with many of the components printed on a ceramic substrate.*

VCO (Q920), Buffer Amplifier (Q930, Q940)

Q920 is a bipolar transistor configured as a common collector oscillator. It oscillates on the transmit frequency in the transmit mode and 52.950 MHz below the receive frequency in the receive mode. Therefore, its operating band is approximately 798-869 MHz (800 MHz models) or 882-941 MHz (900 MHz models). Transistor bias is provided by R920 and R921, and stabilization is provided by R922. L921 is an RF choke and C926 is a bypass capacitor. C922, C923, and R924 provide feedback to start and maintain oscillation and also match the oscillator to the tank circuit.

The tank circuit consists of a section of microstrip; varactor diodes CR901, CR903, and CR904; capacitors C920, C921, C901, C903, C905, C909; and several other components. The microstrip is a shortened half-wave line which provides series inductance and shunt capacitance.

The output signal on the collector of Q920 is coupled by C932 to buffer amplifier Q930/Q940. This is a shared-bias amplifier which provides amplification and also isolation between the VCO and the stages which follow. The signal is coupled from Q930 to Q940 by C935. The resistors in this circuit provide biasing and stabilization, and C931 and C934 are bypass capacitors. C932, C933, and C937 provide impedance matching and DC blocking.

Frequency Control and Modulation

The VCO frequency is controlled in part by the DC voltage applied across varactor diode CR901. As the voltage across a reverse-biased varactor diode increases, its capacitance decreases. The result is that the VCO frequency increases as the control voltage increases and vice versa. The control line is isolated from tank circuit RF by choke L901 and decoupling capacitor C902. The amount of frequency change produced by CR901 is set by series capacitor C901.

The VCO frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode CR903. This varies the VCO frequency at an audio rate. The amount of modulation is set by C903 along with varactor diode CR904 and capacitor C912 (see next paragraph). R901 provides a DC ground on the anodes of CR903 and CR904, and isolation is provided by R900, C904, and C852.

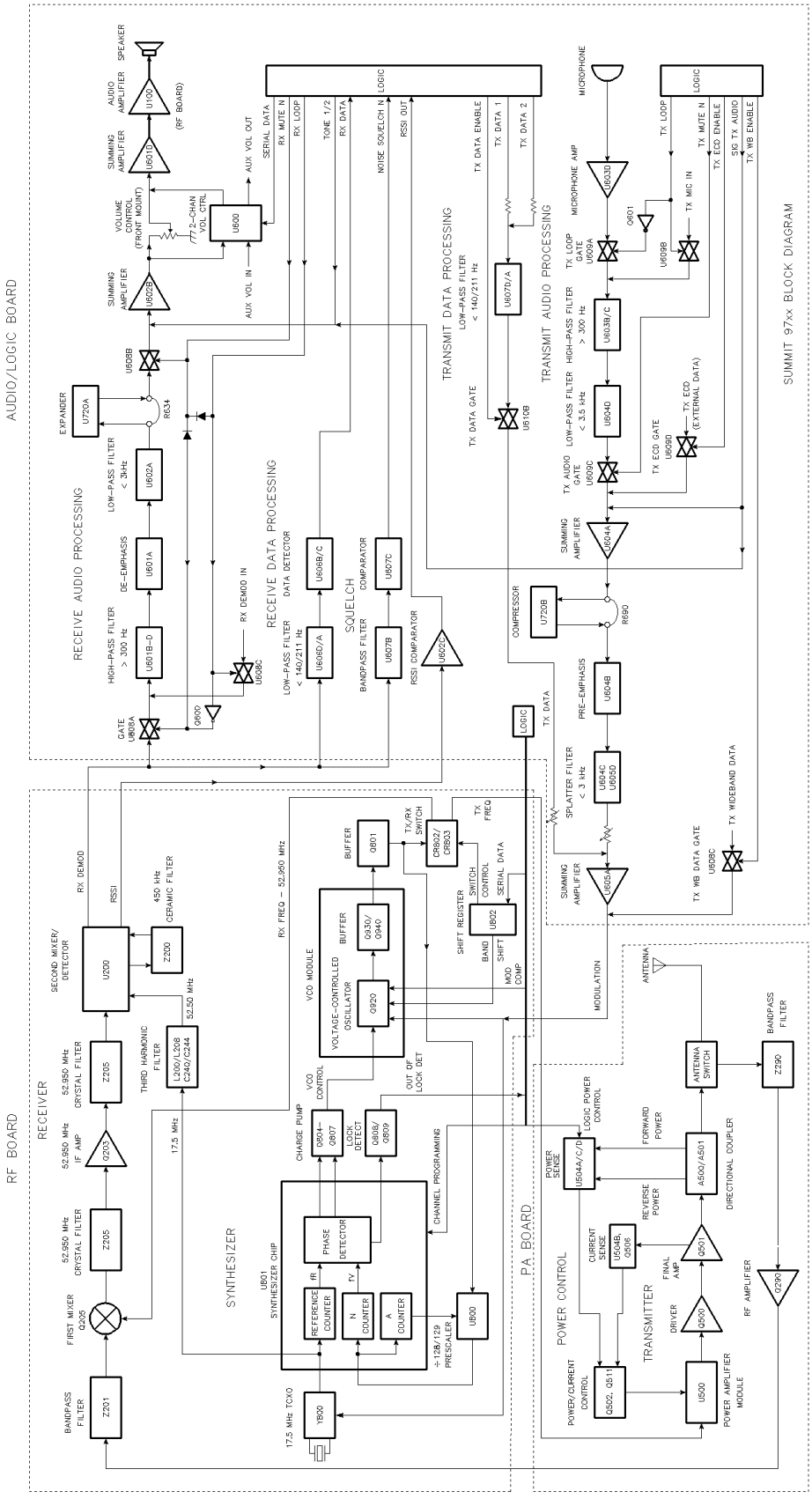



**Figure 6-1 Transceiver Block Diagram**

The DC voltage applied across CR904 provides compensation to keep modulation relatively flat over the entire bandwidth of the VCO. This compensation is required because modulation tends to increase as the VCO frequency gets higher (capacitance of CR901 gets lower). CR904 also balances the modulation signals applied to the VCO and TCXO (see next section).

The DC voltage applied across CR904 comes from a D/A converter on the audio/logic board. This D/A converter is formed by a resistor network controlled by shift register U450 and the microprocessor. As the VCO frequency increases, this DC voltage also increases which lowers the amount of capacitance applied to the tank circuit and therefore the amount of modulation produced. R802 applies a DC biasing voltage to CR903; C834 provides DC blocking; and C850 attenuates AC signals applied through R802. RF isolation is provided by C912, R902, C846, and R805.

VCO Frequency Shift

The VCO must be capable of producing frequencies from approximately 798-869 MHz (800 MHz models) or 882-941 (900 MHz models) to produce the required receive injection, transmit, and repeater talk-around frequencies. If this large of a shift was achieved by varying the VCO control voltage, the VCO gain would be undesirably high. Therefore, capacitance and inductance is switched in and out of the tank circuit to provide a coarse shift in frequency.

This switching is controlled by shift register U802 and PIN diodes CR905 and CR909. When a PIN diode is forward biased, it presents a very low impedance to RF; and when it is reverse biased, it presents a very high impedance. The capacitive and inductive legs of the tank circuit are switched as follows:

| **Mode** | **Switching** |
|---|---|
| Transmit | Neither switched in |
| Receive | C leg switched in |
| Talk-Around | L leg switched in |

*NOTE: The C and L legs are never switched in at the same time.*

The capacitive leg is formed by C905, PIN diode CR905, and C906. When the Q6 output of U802 is a high level and the Q7 output is a low level, CR905 is forward biased and C905 and C906 are effectively connected to the tank circuit. This decreases the resonant frequency of the tank circuit. L905/L906 and C907/C908 provide isolation. The inductive leg is formed by C909, a section of microstrip (which provides series inductance), and by C910. When this leg is switched into the tank circuit, the resonant frequency increases.

### 6.2.3 VCO AND TCXO MODULATION

Both the VCO and TCXO are modulated to achieve the required frequency response. If only the VCO was modulated, the phase detector in U801 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change, especially at the lower audio frequencies. If only the TCXO was modulated, the VCO frequency would not change fast enough, especially at the high audio frequencies. Modulating both the VCO and TCXO produces a flat response. One function of the DC voltage applied to J200, pin 20 is to balance these signals so that modulation of the VCO is equal to that of the TCXO. The other is frequency compensation described in the preceding section.

### 6.2.4 ACTIVE FILTER (Q800), BUFFER AMPLIFIER (Q801, Q802)

Q800 functions as a capacitance multiplier to provide a filtered 8-volt supply to the VCO module and shift register U802. R801 provides bias and C802 provides the capacitance that is multiplied. If a noise pulse or other voltage change appears on the collector, the base voltage does not change significantly because of C802. Therefore, base current does not change and the voltage on the emitter remains constant. R800 provides isolation, and C800, C801, and C836 decouple RF.

The output signal on pin 2 of the VCO module is at a level of approximately 0 dBm and is applied to the base of Q801. This stage amplifies the signal to approximately 12 dBm and also provides additional isolation. Impedance matching between the VCO module and Q801 is provided by a section of microstrip and C808. Q802 provides a Q801 bias current that

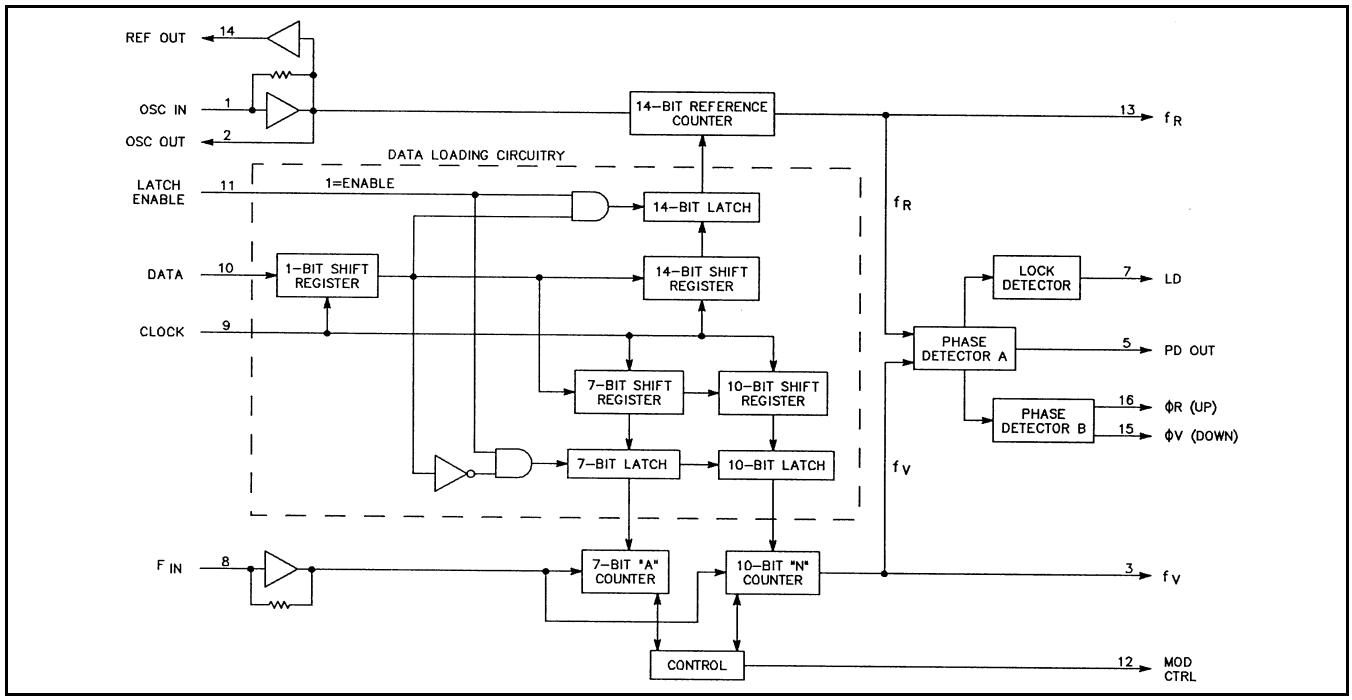



**Figure 6-2 U801 Block Diagram**

remains stable over changes in temperature. flows so that the voltage drop across R809 equals the drop across R815 and the base- emitter junction of Q802.

Impedance matching with the RF coupler on the output of Q801 is provided by an inductor formed by microstrip and by C810. R807 across the section of microstrip lowers the gain of Q801 so that it remains stable. C811 and C812 are RF decoupling capacitors.

The circuit on the output of the coupler switches the synthesizer signal to either the receiver or transmitter. In the transmit mode, the Q4 output of shift register U802 is high and the Q3 output is low. Current then flows through R812, L803, CR802, CR803, and R813 which forward biases both diodes. The quarter-wave line between the two diodes is then effectively AC grounded through CR803 and C815. When one end of a quarter-wave line is grounded, the other end presents a high impedance to the quarter-wave frequency. This effectively blocks the RF signal from the receiver, and CR802 provides a low-impedance path through C814 to the transmitter.

In the receive mode, the Q4 and Q3 outputs of U802 are the opposite states, so both diodes are reverse biased. The quarter-wave line is then no longer grounded and provides a low-impedance path to the receiver, and CR902 presents a high-impedance into the transmitter. L800/C841 and L803/C813 neutralize the slight capacitance of the diode when it is reverse biased to improve isolation.

### 6.2.5 PRESCALER (U800)

U800 is a dual-modulus prescaler. A prescaler is a counter capable of operating at high frequencies, and dual modulus refers to the two divide numbers, 128 and 129. This counter divides an input signal in the 800 MHz range down to the 6 MHz range so that it is within the operating range of the counters in U801. The prescaler divides by 128 when the control input (pin 6) is high, and by 129 when it is low. The RF coupler on the input couples the forward power component of the synthesizer signal. Other parts on the input of U800 provide impedance matching and the required input level.

### 6.2.6 SYNTHESIZER INTEGRATED CIRCUIT (U801)

Introduction

A block diagram of synthesizer U801 is shown in Figure 6-2. This device contains reference (R), N, and A counters; phase and lock detectors, and counter

programming circuitry. The basic operation was described in Section 6.2.1.

Channel Programming

Channels are selected by programming the R, N, and A counters in U801 to divide by a certain number. The programming of these counters is performed by the microprocessor using data stored in EEPROM U406. These counters are programmed as follows:

Data to be loaded into U801 is first clocked through shift register U802. It is fed into U801 on the DATA input (pin 10) and clocked in a bit at a time by a low-to-high transition on the CLOCK input (pin 9). Data is first loaded into the 1-bit register (see Figure 6-2) and then into the 7-, 10-, and 14-bit registers. The last bit is present in the 1-bit register, and it determines which counter will be programmed. If this bit is a 1, the data is latched by all three counters when the latch ENABLE input (pin 11) goes high. If it is a 0, it is latched by only the A and N counters.

U801 Operation

As stated earlier, the divide numbers of the counters in U801 are chosen so that when the VCO is operating on the correct frequency, the fR and fV phase detector inputs are the same frequency.

The fR input is produced by dividing the 17.500 MHz TCXO frequency on pin 1 by 1400. This produces an fR frequency of 12.5 kHz. Using this frequency allows channels to be changed in 12.5 kHz steps. A 12.5 kHz fR frequency is used for all channels. The TCXO frequency is buffered and then fed out of U801 again on pin 14 to the voltage multiplier and second injection circuits. The stability of the TCXO frequency determines the stability of the transmit and receive signals.

The fV input is produced by dividing the VCO frequency using prescaler U800 and the N counter in U801. As described in Figure 6.2.5, the prescaler divides by 128 or 129. This divide number is controlled by the N and A counters as follows:

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

To illustrate the operation of the prescaler, N, and A counters, a example will be used. Assume a transmit frequency of 813.4875 (800 MHz channel 300) is selected. Since the VCO oscillates on the transmit frequency in the transmit mode, this is the frequency that must be produced by the VCO. To produce this frequency, the N and A counters are programmed as follows:

N = 508 A = 55

To determine the overall divide number of the prescaler, the number of input pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 129 for 129 x 55 or 7095 input pulses. It then divides by 128 for 128 x (508 - 55) or 57,984 input pulses. The overall divide number K is therefore 57,984 + 7095 or 65,079. The VCO frequency of 813.4875 MHz divided by 65,079 equals 12.5 kHz which is equal to the fR input to the phase detector.

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

$$K = 128N + A$$

Where: N = N counter divide number
A = A counter divide number

*NOTE: The formula for determining the N and A counter divide numbers is described in Section 7.2.5.*

## 6.2.7 LOCK DETECT (Q808, Q809)

When the synthesizer is locked on frequency, the lock detect output on U801, pin 7 is basically a high voltage because only very narrow negative-going pulses are present. If the synthesizer is out-of-lock, the negative-going pulses widen as the difference between fR and fV increases.

This lock detect signal is integrated by Q808 and Q809. C831 charges through R830 and R832 and discharges through C831 and Q808. When the negative-going lock detect pulses widen, C831 discharges to the turn-off point of Q809. The collector of Q809 then goes high and this signal is applied to the 5D pin of input latch U411 on the audio/logic board.

Therefore, a high signal indicates an out-of- lock condition and a low signal a locked condition. When an out-of-lock condition is detected by the microprocessor, transmitting is inhibited so that an improper frequency is not transmitted.

### 6.2.8 CHARGE PUMP (Q804-Q807)

The charge pump circuit charges and discharges C805, C806, and C807 in the loop filter to produce the VCO control voltage. Pulses which control the charge pump are fed out of U801 on pins 15 and 16. When both inputs to the phase detector are in phase, the output signals on pins 15 and 16 are high except for a very short period when both pulse low in phase. If the frequency of the fR input to the phase detector is higher than that of the fV input (or if the phase of fR leads fV), the VCO frequency is too low. The negative-going pulses on the UP output (pin 16) then become much wider and the DOWN output (pin 15) stays essentially high. If the frequency of fV is higher than that of fR (VCO frequency is high), the opposite occurs.

C803 provides DC blocking to enhance balanced operation of the charge pump. Q805 and Q806 are level translators which make the 5-volt levels of U801 compatible with the 9- and 25-volt supplies to Q804 and Q807. When a negative-going pulse appears on pin 16, Q805 turns on which turns Q804 on. The loop filter capacitors then charge through Q804 and R819 which increases the VCO control voltage. When a negative-going pulse occurs on pin 15, Q806 turns on which turns Q807 on. The loop filter capacitors then discharge through Q807 and R828 which decreases the control voltage.

The loop filter formed by C805-C807, R806, R845, and C836 provides low-pass filtering of the signal from the charge pump. This filtering controls synthesizer stability and lock-up time and suppresses the reference frequency (12.5 kHz).

### 6.2.9 VOLTAGE MULTIPLIER (CR804A/B, CR805A/B)

The voltage multiplier circuit provides a supply voltage of approximately 25 volts to the charge pump circuit. This supply voltage is required so that the charge pump can provide the required voltage swing to the VCO. The AC input signal to the multiplier is the buffered 17.500 MHz TCXO signal from pin 14 of U801. This signal is approximately 8 volts P-P and is coupled by C822 to CR805A which provides rectification. This results in a voltage across C823 of approximately 9 volts. Also applied to C823 is a 9-volt supply fed through R814 and CR805B. Therefore, the voltage across C823 is the sum of these two 9-volt signals minus the voltage drop of the diodes or approximately 16 volts.

CR804A/B, C821, and C824 form another voltage adder circuit similar to the one just discussed. The voltage across C824 is the 16-volt supply from C823 plus the 9-volt supply rectified by C821 and CR804A.

## 6.3 RECEIVER CIRCUIT DESCRIPTION

### 6.3.1 RF AMPLIFIER (Q290)

*NOTE: Bandpass filter Z290 and RF amplifier Q290 are located on the PA board.*

The receive signal is fed from the antenna jack through the harmonic filter and antenna switch (see Section 6.4.3) to bandpass filter Z290. With 800 MHz models, this is a three-pole filter with a center frequency of 860 MHz and bandwidth of 18 MHz. With 900 MHz models, it is a two-pole filter with a center frequency of 938 MHz and a bandwidth of 6 MHz. This filter attenuates the image and other unwanted frequencies and also prevents the injection signal from being fed back to the antenna.

From Z290 the signal is fed to RF amplifier Q290. This stage amplifies the receive signal to recover filter loses and improve sensitivity. Impedance matching between Z290 and Q290 is provided by two sections of microstrip and C297. Diode CR290 protects the base-emitter junction of Q290 from damage caused by high-level input signals. A constant bias current is provided by Q291. Transistor Q290 is

biased so that the voltage drop across R297 is equal to the drop across R294 and the base- emitter of Q291. This arrangement provides a bias that remains stable as changes occur in temperature.

Impedance matching with filter Z201 on the RF board is provided by a section of microstrip and C296. R295 lowers the gain of Q290 so that it remains stable. C293, C294, C291, C292, and C298 decouple various RF signals.

### 6.3.2 FIRST MIXER (Q205)

Bandpass filter Z201 on the RF board is similar to Z290 and provides additional filtering of the receive signal. The output of Z201 is applied to a 50-ohm, 3-dB pad formed by R203-R204. This pad is used to set the input level to mixer Q206. Impedance matching between the pad and Q206 is provided by a section of microstrip and C204. Q206 is biased using the same method as used with Q290. The injection signal is applied to the emitter of Q206 and is at a level of approximately 10 dBm. It is 52.950 MHz below the receive frequency in order to produce a first IF of 52.950 MHz. Filtering of the injection signal is provided by Z202. This is a two-pole bandpass filter with a center frequency of 807 MHz and a bandwidth of 18 MHz (800 MHz models) or a center frequency of 885 MHz and a bandwidth of 6 MHz (900 MHz models).

The 52.950 MHz output of Q205 is matched by L203, C201, and C202 to a 50-ohm, 3-dB pad formed by R215, R217, and R218. R210 is used to lower the Q of L203. Matching between the pad and crystal filter Z205 is provided by C221, C207, and L202.

### 6.3.3 CRYSTAL FILTERS (Z205, Z206), IF AMPLIFIER (Q203)

Z205 is a four-pole crystal filter with a –3 dB bandwidth of 15 kHz (800 MHz) or 8 kHz (900 MHz). This filter attenuates wideband noise, adjacent channels, frequencies resulting from inter modulation, and other undesired frequencies.

The output of this filter is applied to IF amplifier Q203. Matching between this stage and filter Z205 is provided by C220, L205, and C217. A constant bias current is provided by Q202 similar to Q291 described in Section 6.3.1. The output of the IF amplifier is applied to a 6 dB pad and then to crystal filter Z206. This is a two-pole filter with a bandwidth of 18 kHz (800 MHz) or 10 kHz (900 MHz) at the –3 dB points.

### 6.3.4 SECOND MIXER/DETECTOR (U200)

U200 contains second mixer and oscillator, limiter, detector, audio preamplifier, squelch, and RSSI stages. The second injection signal is 450 kHz below the 52.950 MHz IF signal or 52.500 MHz. Coarse frequency adjustment for the internal oscillator in U200 is provided by L206 and C239. Fine adjust is provided by the third harmonic of the TCXO frequency (17.500 MHz x 3 = 52.500 MHz). A two-pole filter formed by C240-C244, L208, and L200 is tuned to that frequency, and the output locks the oscillator to 52.500 MHz.

The 450 kHz output of the internal double-balanced mixer is fed out on pin 19 and back in again on pin 17. It is then applied to another mixer which is used in this application for amplification only. The output of this mixer is fed out on pin 6 and applied to a four-pole ceramic filter which is used to attenuate wideband noise. The 450 kHz signal is then fed back into U200 on pin 7 and applied to a limiter/amplifier stage. This limiter amplifies the 450 kHz signal and then limits it to a specific value. This eliminates amplitude variations present in the signal.

From the limiter the signal is fed to the quadrature detector. An external phase shift network connected to pin 12 shifts the phase of one of the detector inputs 90 degrees at 450 kHz (the other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted signal. The detector, which has no output with a 90-degree phase shift, converts this phase shift into an audio signal. T204 is tuned to provide maximum undistorted output from the detector.

The detected audio signal is fed out of U200 on pin 13 and amplified by U201A which has a gain of approximately three at 800 MHz or six at 900 MHz. R207 and R213 provide a bias voltage of approximately 3.0 volts. The output of this stage is fed to the receive audio processing circuitry on the audio/logic board.

Pin 10 of U200 is the output of an internal RSSI (receive signal strength indicator) circuit. It provides a high-impedance current sink that increases in conduction in proportion to increases in the IF signal level. The result is that the voltage on pin 10 decreases as the IF signal strength increases and vice versa. This signal is buffered by U201B and then fed to comparator U602C on the audio/logic board. The microprocessor uses this indication and the noise squelch indication to control receiver muting and data detection.

### 6.3.5 AUDIO POWER AMPLIFIER (U100)

The audio signal from the front panel volume control (front mount) or digital volume control U600 on the audio/logic board (remote mount) is applied to amplifier U100. This is a bridge amplifier which provides up to 12 watts of power into a 4-ohm speaker. CR100, R109, R110, and C115 provide the biasing voltage, and the output is stabilized by R107/C118 and R108/C119. When an external speaker is used, it is connected by a wire harness to J101, pins 1 and 2. When the internal 16-ohm speaker is used, a jumper is installed between pins 1 and 3 of J101 and the speaker is connected to J100. R120 limits power to this speaker to approximately 5 watts to prevent damage to the speaker.

### 6.3.6 13.8-VOLT SWITCH (Q100, Q103, Q106-Q108)

The 13.8-volt switch circuit is controlled by the front panel or remote control unit power switch. When power is turned on, the power switch grounds the emitter of Q402 on the audio/logic board. Then if this transistor is turned on by the ignition sense line or the 4Q output of latch U409, a low voltage is applied to the base of Q103 on the RF board. The 13.8-volt switch circuit is then turned on and approximately 13 volts appear on the collector of series-pass transistor Q100.

The 0.8-volt drop of this circuit provides about 30 dB attenuation of noise pulses less than 1.6-volt P-P that are present in the 13.8-volt supply from the vehicle. This lessens the amount of vehicle noise in circuits powered by the 13.8-volt supply such as audio amplifier U100.

## 6.4 TRANSMITTER CIRCUIT DESCRIPTION

*NOTE: RF amplifier Q290 is described in Section 6.3.1.*

### 6.4.1 POWER AMPLIFIER MODULE (U500)

The RF input signal to the transmitter on J501, pin 18, is at a level of approximately +10 dBm. This signal is applied to a 11 dB pad formed by R506-R508 which sets the correct input level to U500. Power amplifier module U500 amplifies this signal to approximately 6 watts. VS1, VCTRL, and VS2 are supply inputs to separate amplifier stages in U500. Controlling the voltage on the VCTRL input controls the power output of the transmitter. Various capacitors on these supply inputs isolate the supply from various AC signals present in U500.

### 6.4.2 DRIVER (Q500), FINAL AMPLIFIER (Q501)

Driver Q500 amplifies a 6-watt input signal to approximately 20 watts. C558, C559, and C519 provide impedance matching with U500. Inductor L500 provides self biasing of Q500. Supply current to Q500 flows through R587, and the voltage drop across this resistor is monitored by U504B in the power control circuit (see Section 6.4.4). L501 is an RF choke, and C517, C518, and C555 isolate the supply voltage from AC signals present in Q500.

If the transceiver is a 15-watt model, the output signal from Q500 is applied to the directional coupler and Q501 is not used. If it is a 30/35-watt model, final amplifier Q501 amplifies the Q500 output signal to approximately 35/40 watts. Impedance matching between Q500 and Q501 is provided by L501, C539, and three sections of microstrip. L503 provides self biasing of Q501. Capacitors and a section of microstrip on the collector of Q501 provide impedance matching with the directional coupler.

### 6.4.3 ANTENNA SWITCH (CR502, CR506, CR507)

The output signal of Q501 is fed through the directional coupler (next section) and then applied to an antenna switching network. This network connects the antenna to the receiver in the receive mode and the transmitter in the transmit mode.

In the transmit mode, Q507 and Q514 are turned on. Current then flows through Q507, L506, CR506, and shunt networks CR507/L508/R514 and CR502/ L507/ R528. Diodes CR502, CR506, and CR507 are PIN diodes. This type of diode has a very low impedance to RF when forward biased and a very high impedance to RF when reverse biased. Therefore, in the transmit mode the RF signal has a low-impedance path through CR506 to the antenna.

The sections of microstrip connected to the cathode of CR507 are quarter-wave lines. In the transmit mode, one end of these lines is effectively grounded by CR502/C532 and CR507/C531. When one end of a quarter-wave line is grounded, the other end presents a high impedance to the quarter-wave frequency. Therefore, there is a high-impedance path into the receiver for the transmit signal. Two quarter-wave sections are used to provide the required isolation. L506-L508 and the 39 pF and 0.01 µF capacitors isolate the supply voltage from RF signals. R528 and R514 provide current limiting.

In the receive mode, Q507 and Q514 are off, so the PIN diodes are reverse biased. Therefore, the receive signal has a high-impedance path into the transmitter and a low-impedance path into the receiver because the quarter-wave lines are no longer grounded. L510 and C561 neutralize the small capacitance of CR506 in the receive mode to improve isolation.

A harmonic filter is formed by a section of microstrip and C549, C502, C500, and C567. This is a low-pass filter which attenuates frequencies above the transmit band. R527 dissipates any static electricity that may build up on the antenna.

### 6.4.4 POWER CONTROL (U504, Q511, Q502, Q506)

General

The power control circuit senses forward and reverse power and also current to driver Q500 to control transmitter power output. Instead of using a potentiometer to provide a fixed power output, a D/A converter is used so that it can be controlled by the microprocessor. Each selectable system can be programmed for a different power level. There are five power levels that can be programmed using the test mode (see Section 3.11). Power output is controlled by varying the supply voltage to one of the amplifier stages in power amplifier module U500. The microprocessor also monitors transmitter temperature and if it is not in the normal range, power is automatically cut back to prevent damage.

Directional Coupler, Forward/Reverse Power Amplifiers

A directional coupler is used to sense the forward and reverse power components of the RF signal. A sample of the forward power signal is rectified by CR505. Current flows through R538, R539, CR505, R541, and R566. RF in the DC signal is attenuated by R541, C571 and C552. Frequency compensation is provided by C544. The reverse power component is detected in a similar manner.

U504A and U504C are configured as non-inverting amplifiers. Therefore, an increase in the level of the forward or reverse power causes the output to increase. U504A has unity gain and U504C has a gain of approximately four. C542 and C536 attenuate RF frequencies by causing them to be applied to both inputs. They then become common mode signals that are not amplified.

Summing Amplifier (U504D), Current Sense (U504B)

The output of U504D is the sum of the input signals from the forward and reverse power amplifiers. Since this is also a non-inverting amplifier, the output increases as the input increases. The gain is set at about two by R563 and R500.

Current to driver Q500 is sensed by detecting the voltage drop across R587. U504B is a differential amplifier with a gain of ten set by R568/R561 and R585/R586. As current to Q500 increases, the output of U504B increases and vice versa.

Amplifiers (Q511, Q502, Q506), Shift Register (U503)

Q511 is a series-pass transistor which controls the supply voltage to an amplifier stage in U500. Transistor Q502 provides drive to Q511. The emitter voltage of Q502 is controlled by R580 and summing

amplifier U504D. The base voltage of Q502 is controlled by current sense amplifier Q506 and a D-A converter formed by shift register U503 and a resistor network.

As the voltage from the D-A converter increases, Q502 and Q511 turn on more which causes power output to increase. If current becomes excessive, Q506 turns on more which lowers the base voltage of Q502 and lowers power output. If forward or reverse power increase, the output of summing amplifier U504D increases. This increases the emitter voltage of Q502 which then turns off more and lowers power output. C584 delays power output for a few milliseconds to stabilize the power control loop. C540 provides negative feedback to stabilize the circuit.

Shift register U503 controls the output voltage to the power control circuit by changing the logic levels applied to the resistor network connected to the O0-O6 pins. It also controls transmit switch Q507/Q514 which is connected to the Q7 pin. R558 and C565 form an RC network which prevents momentary power output when transceiver power is turned on. These components hold the OE (output enable) input low for a short time which disables the O0-O7 outputs.

## 6.5 AUDIO/LOGIC BOARD DIGITAL CIRCUIT DESCRIPTION

### 6.5.1 MICROPROCESSOR (U401)

General

The control logic for this transceiver is based on an MC68HCP11A0 eight-bit microprocessor. This particular device has an internal 256-byte static RAM but no internal ROM or EEPROM. Therefore, all program memory is stored in external memory devices. Besides several general purpose inputs and outputs, this device has an eight-channel A/D (analog-to-digital) converter and synchronous and asynchronous serial ports. The A/D converter allows it to monitor analog voltages such as the 13.8-volt supply and the transmitter temperature.

The microprocessor operates in the expanded mode which is selected by a high level on the MODA and MODB pins. This mode allows external memory and peripheral devices to be accessed by a multiplexed address/data bus. Multiplexing allows the eight pins of the data bus (AD0-AD7) to be used for memory addressing as well as data input and output. For more information, see “Address/Data Bus” description which follows.

The operating speed of the microprocessor is set by crystal Y300. The 8 MHz frequency of this crystal is divided by four by an internal divider to produce as internal operating frequency of 2 MHz.

Memory

The operating program is stored in external flash EPROM U404. This is a 128K x 8 memory device which contains the instructions used by the microprocessor to provide transceiver control. The use of a flash EPROM allows the operating program to be updated using the standard programming setup and special software. This eliminates the need to remove the transceiver and change a ROM or the microprocessor to update software. When reprogramming of this EPROM occurs, the MODA/ MODB inputs of the microprocessor are pulled low to put it in a special bootstrap mode. In addition, a 12 VDC Vpp voltage generated by the RPI is applied to U404.

Information which changes from transceiver to transceiver is stored in EEPROM (electrical erasable memory) U406. This device contains the information loaded into the transceiver by the personal computer programming described in Section 4. An EEPROM can be reprogrammed by the microprocessor many times, and it maintains stored data without the need for a continuous power supply.

***CAUTION:*** *EEPROM U406 is not replaceable because it is cemented to the PC board. Attempting to remove this part may seriously damage the board.*

Temporary data storage is provided by RAM U405. This device is used as a “scratchpad” by the microprocessor while it is controlling the transceiver. This is a static-type RAM which means that it does not require periodic refreshing to maintain its contents. However, the data is lost when transceiver power is turned off.

Reset

The microprocessor is reset when transceiver power is turned on and also when the 5-volt supply

drops below the normal range. Reset clears several internal registers and restarts the operating program. This prevents improper operation resulting from low-voltage conditions.

Power-on reset occurs automatically for 4064 clock cycles whenever power is applied to the VDD input of the microprocessor. Low-voltage reset is initiated by low-voltage sensor U400. When the 5-volt supply drops below the normal range, the output applied to the RESET input goes low. This resets the microprocessor and also inhibits operation for as long as it is low. The microprocessor also has internal reset circuits which cause reset if problems occur with the clock signal, illegal op codes, or a watchdog timer circuit.

Address/Data Bus

**A/D0-A/D7 -** To minimize the number of pins required, the lower eight bits of the sixteen-bit address are multiplexed with the eight data bits. During the first half of a bus cycle, address bits A0-A7 are present, and during the second half, the bus is used as a bi-directional data bus. The eight address bits are latched by address latch U402 when a pulse occurs on the AS pin.

**AS (Address Strobe) -** The address information on AD0-AD7 is latched by U402 when a high-to-low transition occurs on this output.

**E -** This output is used to enable external devices during the second half of the bus cycle. It goes high when the external device can place data on the data bus.

**R/$\overline{W}$ -** This output indicates the direction of data on the data bus. It is high for read operations and low for write operations.

A/D Converter Inputs

**VREFH/VREFL -** These inputs provide the reference voltages for the A/D converter circuitry. R403 and C402 attenuate noise present in the 5-volt supply applied to VREFH.

**PE0 -** Analog DC voltage of 0-5 volts from thermistor RT500 on the PA board (30/35-watt models only). This voltage decreases as power amplifier temperature increases.

**PE1 -** Analog DC voltage of 0-5 volts from the directional coupler on the PA board that increases with the reflected power. This and the PE2 input are currently not used.

**PE2 -** Analog DC voltage of 0-5 volts from the directional coupler on the PA board that increases with forward power.

**PE3 -** Analog DC voltage of 0-5 volts that senses the 13.8 VDC battery voltage. This voltage is divided down to the 0-5 volt range by R781 and R793, and noise is attenuated by C822.

**PE4 -** Analog DC voltage of 0-5 volts from the remote control unit volume control. The microprocessor senses this level to digitally control speaker volume using volume control IC U600. R785 pulls this input low when a remote control unit is not used so that the output level of U600 is minimum. R792 and C621 attenuate noise on the line. This input is not used with front-mount transceivers because volume is controlled by the front panel volume control.

**PE5, PE6, PE7 -** Not used.

Serial IIC Interface

The serial IIC port provides data communication with the front panel and the remote control unit. With the front panel, data communication is only one-way (towards the panel). With the remote control unit, it is bi-directional. Whenever the front panel or remote control unit requires service from the microprocessor, it issues a request on the SRV REQ RM N (remote) or SRV REQ FP N (front panel) input of latch U411.

**PA5 (IIC SCL) -** Buffered clock output to front panel and remote control unit.

**PA6 (IIC SDA Out) -** Data output to front panel and remote control unit.

**PA7 -** See “Serial Peripheral Interface” description.

**PA0 (IIC SDA In) -** Data input from remote control unit.

Serial RS-232 Interface

The serial RS-232 port has three functions. First, it provides data communication with the computer used to program the transceiver. Connection is made via the microphone connector on either the front panel or remote control unit.

Second, it is used for reprogramming the flash memory (see preceding "Memory" description). This type of programming can be done only from the microphone jack of front-mount units or the jack on the front panel of remote-mount units. (It cannot be done from the microphone jack of the remote control unit.)

Third, it provides communication via the universal interface. This allows external equipment to control transceiver functions. Communication can not occur simultaneously with both sources.

This port is an asynchronous full-duplex type using a standard NRZ (nonreturn-to-zero) data format (one start bit, eight or nine data bits, and one stop bit).

**PD0 (RxD) -** Serial data input.

**PD1 (TxD) -** Serial data output.

Serial Peripheral Interface

This serial port is used for communication with the digital signal processor circuit. This is a synchronous port which means that a separate clock signal is used to indicate when data on the data line is valid. Either a master or slave configuration may be used. In the master configuration, the microprocessor generates the clock and other control signals. In the slave configuration, these signals are generated by the digital signal processor circuit.

**PD2 (MISO), PD3 (MOSI) -** These pins are used for transmitting and receiving the serial data. MOSI stands for Master Out Slave In and MISO stands for Master In Slave Out. When this port is configured as a master, MISO is the data input and MOSI is the data output. When the port is configured as a slave, the role of these pins is reversed.

**PD4 (SCK) -** This pin is the serial clock output in the master configuration and the serial clock input from the digital signal processor circuit in the slave configuration.

**PD5 ($\overline{\text{SS}}$) -** In the slave configuration, this is the slave select input and the master forces it low when it is ready to transfer data. In the master configuration, it can be used as a general-purpose output.

**PA7** - Slave select input.

Software Serial Bus

A serial bus created using general purpose outputs and controlled by software provides programming data for shift registers U450-U452 and volume control U600 on the audio/logic board, shift register U802 and synthesizer U801 on the RF board, and shift register U503 on the PA board. The data is latched by these devices by strobe pulses on the 1Q, 2Q, and 3Q outputs of latch U408. This allows three different destinations to be programmed.

**PA3 -** Serial clock output. Data on PA4 is clocked through the shift registers by low-to-high transitions on this line.

**PA4 -** Serial data output.

## 6.5.2 MEMORY AND I/O ADDRESSING

Several memory devices (U404-U406) and other input/output devices (U408-U412) are connected to the parallel data bus of the microprocessor (AD0-AD7). To direct data on this bus to or from the desired device, the specific device involved must be selected. This is done using a memory mapping technique. Not all of the 128K of memory addressable by sixteen bits (A0-A15) plus a page bit (PA3) is used by 128K EPROM U404. This allows the unused addresses to be used for chip select.

Decoding of chip select information on the address bus is performed by PALs U403 and U407. A PAL (programmable array logic) device is custom programmed to provide the desired outputs when specific inputs are applied. U403 decodes the chip select signals for the memory chips and also generates write enable and output enable signals. U407 decodes the chip select signals for the latches. In addition, it provides reset protected chip select for EEPROM

U406. This prevents inadvertent writing to that device. The F7 output of U407 is not used.

### 6.5.3 DIGITAL SIGNAL PROCESSOR (U300-U302)

The digital signal processor circuit is not used in early units. It is used to generate DTMF tones when telephone numbers are recalled and transmitted in the Phone Mode. It is not used to generate tone (CTCSS) or digital Call Guard signaling.

U300 is a special microprocessor optimized for math-type operations. A digital signal processor circuit converts an analog input to digital data, performs digital processing on this data, and then converts to digital data back into an analog output. PAL U302 is used to control serial data communication with microprocessor U401. A/D converter U304 converts the input tones to digital data, and latch U301 and the resistor network provide the D/A conversion. U305A and U305B provide low-pass filtering of the input and output tones.

## 6.6 AUDIO/LOGIC BOARD RECEIVE SIGNAL PROCESSING

### 6.6.1 RECEIVE AUDIO PROCESSING

Gating Circuit (U608A, U608C)

The demodulated receive audio signal from the RF board is fed onto the audio/logic board on J300, pin 11. The signal is fed to the following circuits: (1) receive audio circuit, (2) receive data circuit, (3) squelch circuit, (4) digital signal processing circuit, and (5) universal interface (J403, pin 1). The following information describes the receive audio circuit and later sections describe the other circuits.

A gating circuit consisting of U608A and U608C routes either the audio signal from the receiver or from J403, pin 2 of the universal interface to the high-pass filter. Normally, the RX LOOP signal applied to inverter Q600 is low. Q600 is then off and an 8 volt level is applied to the control input (pin 13) of gate U608A. The gate then passes the receiver signal to the filter. The low level on the control input of gate U608C causes that gate to block the signal from J403, pin 2. If the RX LOOP signal is high, the opposite occurs.

R644, R645, and C639 are used to minimize the "click" heard when the gate opens and closes. R625 and C638 attenuate noise present in the logic signal. Diode CR601 closes both U608A and U608C whenever mute gate U608B is closed. This improves isolation.

High-Pass and Low-Pass Filtering

A six-pole high-pass filter consisting of U601B, U601C, and U602D attenuates LTR data, Call Guard tones or data, and other frequencies below 300 Hz that are present in the receive audio signal. The overall gain of this filter is approximately unity. The signal is then fed to U601A which provides 6 dB per octave de-emphasis of the signal. This removes the pre-emphasis that was put in when it was transmitted. The signal is then fed to U602A which provides three poles of low-pass filtering. This attenuates noise and other frequencies above 3 kHz.

Expander (U100A)

*NOTE: The compandor board is optional.*

If optional companding is used, jumper R634 is removed and the compandor board is installed. Companding is the compressing and then expanding of the audio signal to reduce noise. This also increases the dynamic range of the audio signal which is otherwise limited by channel spacing. The signal undergoes a 2:1 compression in the transmitter and then a 1:2 expansion in the receiver to return it to the original condition. For example, a +1 dB change in audio level at the input of the expander produces a +2 dB change on the output.

Gates U102C and U102D bypass expander U100A when companding is not used on a selectable system or when performing testing. U101B provides buffering, and C111 couples the signal to pin 3 of U100A which is the input of an internal variable gain stage. Likewise, C110 couples the signal to pin 2 which is the input of an internal rectifier. The output of this rectifier is averaged across C109 and then used to control the gain of the variable gain stage.

The value of C109 controls the rate at which gain changes in response to changes in the input level. Pin 5 is the inverting input of an internal operational amplifier and pin 7 is the output of this amplifier. R108 sets amplifier gain, and C108 minimizes distortion in the expander.

Mute Gate (U608B), Summing Amplifier (U602B)

Gate U608B mutes the receive audio signal when no signal is being received or if the message is intended for someone else. This gate is controlled by the Q6 output of shift register U451. The microprocessor has total control over receiver squelch because there is no control input from the squelch circuit. The line to CR601 closes gates U608A and U608C when U608B is closed. This improves isolation in the squelched mode.

Summing amplifier U602B amplifies the following signals: (1) receive audio, (2) supervisory tones 1 and 2 from latch U409, (3) receive audio from the universal interface, and (4) tones from the digital signal processor circuit. The gain of the amplifier is controlled by R640 and R639.

Volume Control (U600), Summing Amplifier (U801D)

With front-mount transceivers, volume is controlled by the front panel volume control in the standard manner. The output of summing amplifier U602B is fed to the top of the volume connected to J401, pin 21 and then back in on J401, pin 19 from the wiper. This signal is then coupled by C624 to pin 13 of summing amplifier U601D.

With remote-mount transceivers, the volume is controlled by integrated circuit U600. The output signal of summing amplifier U602B is coupled by C600 to pin 2 which is the input of one of the channels of U600. The controlled output is fed out on pin 8 and coupled by C625 to pin 13 of the summing amplifier.

The volume control of the remote control unit actually controls a DC voltage applied to the microprocessor on PE4 (pin 44). The microprocessor then programs U600 for the desired volume level using the serial bus on the PA3 and PA4 pins.

This channel of U600 is normally not used with front-mount transceivers and is programmed for maximum attenuation because the PE4 input is pulled low by R785. An exception may be when a remote control unit is used with a front-mount transceiver to provide dual controls. The volume controls of both units can then operate in parallel so that the volume is the sum of both controls (see Section 2.5.1). The second channel of U600 is not used at this time.

### 6.6.2 RECEIVE DATA PROCESSING (U606A-D)

The receive audio signal on J300, pin 11 is also fed to a receive data processing circuit consisting of U606A-U606D. U606D and U606A form a four-pole low-pass filter which attenuates voice and harmonic frequencies above the data band. The passband of this filter is controlled by Q610. When LTR data, digital Call Guard data, or low frequency tone Call Guard tones are received, Q610 is turned on and the cut-off frequency is approximately 150 Hz. Then when a high-frequency tone Call Guard tone is received, Q610 is turned off and the cut-off frequency is approximately 220 Hz. Turning Q610 on switches additional capacitance into the circuit.

U606B and U606C form a DC restoration circuit which converts the data from AC floating at half supply to a digital signal at 0- and 5-volt levels which can be detected by the microprocessor. U606B is a standard noninverting amplifier with the gain set by R726 and R786 (R726 is AC grounded by C710). Diodes CR610A/B charge and discharge C710 to establish a DC reference on U606C, pin 9 and U606B, pin 6. This reference is the average of the positive- and negative-going alternations of the data signal.

The output signal from U606B is applied to U606C which functions as a comparator. When pin 10 rises above the reference on pin 9, the output on pin 8 goes to a high level. Conversely, when the level on pin 10 falls below the reference, the output goes to a low level. R728 and R729 provide 0- and 5-volt output levels to the logic.

### 6.6.3 SQUELCH CIRCUIT (U607B, U607C)

The microprocessor uses inputs from this circuit and the RSSI circuit to determine when to mute or unmute the receive audio and also to determine when

valid data may be present. The squelch circuit is controlled by the amount of noise present in the receive audio signal. When no signal or a weak signal is being received by the receiver, there is a large amount of noise present. Conversely, when a strong signal is being received, there is very little noise present.

Part of the receive audio signal on J300, pin 11 is fed to a squelch circuit consisting of U607B and U607C. This filter attenuates voice, LTR data, and Call Guard frequencies so that only noise frequencies from 7-8 kHz are passed. The output of this filter is applied across a resistor network which sets the input level to the rectifier. Potentiometer R748 sets the threshold level of the circuit, and RT600 provides temperature compensation.

C722 and C723 charge through R765 and CR620A. The discharge path of C722 is through CR620B, and the discharge path of C723 is through R751. When the voltage across C723 rises above the reference on U607C, pin 10 the output on pin 8 goes low. Conversely, when the voltage across C723 falls below the reference on pin 10, the output goes high. R754 provides hysteresis to the triggering level to prevent an intermittent squelch signal when receiving a weak or fading signal.

### 6.6.4 RSSI COMPARATOR (U602C)

The RSSI (receive signal strength indicator) signal is applied to comparator U602C. The level of this signal is inversely proportional to receive signal strength. Therefore, it decreases as signal strength increases. The reference level on U602C, pin 10 is set to be a resistor network. Potentiometer U758 sets the threshold level of the circuit. When the level of the received signal rises so that the RSSI voltage drops to the threshold level, the output of U602C goes high.

## 6.7 TRANSMIT AUDIO/DATA PROCESSING

### 6.7.1 MICROPHONE AMPLIFIER (U603D), FILTER (U603B, U603C, U604D)

The signal from the microphone of front- mount transceivers is coupled by C661 to summing amplifier U603D. R655, R656, and C660 provide a bias supply to the microphone.

If the remote control unit is used, a 600-ohm balanced line is used to apply the audio signal to differential amplifier U603A. Using a balanced line minimizes the affect of common mode noise signals picked up by the cable to the control unit. R660/ R661 provide a 600-ohm input impedance, C662/C663 provide DC blocking, and R662-R666 set the gain.

The output of the microphone amplifier is fed to J403, pin 5 of the universal interface and also to transmit loop gate U609A. That gate and gate U609B route either the microphone or the universal interface/ wire-out 4 transmit audio signal to U603B. The microphone signal is enabled when TX LOOP is low, and the other signal is enabled when it is high.

A four-pole high-pass filter formed by U603B and U603C attenuates frequencies less than 300 Hz that could cause interference with LTR data and Call Guard signals that are in that band. The signal is then fed to U604D which is a three-pole low- pass filter which attenuates noise and harmonics. The output of this filter is fed to mute gate U609C and also to the external PA switching circuit.

### 6.7.2 MUTE GATE (U609C), SUMMING AMPLIFIER (U604A)

Gate U609C is used to block the microphone audio signal when other signals are being transmitted such as DTMF tones. A high level on the control input (pin 6) passes the signal and a low level blocks the signal.

The microphone audio signal is then applied to summing amplifier U604A. Other inputs to this amplifier are the transmit audio signal from the digital signal processor circuit and the ECD (external coded data) signal from J403, pin 7 of the universal interface. The ECD signal is passed when the TX ECD ENABLE signal on the control input of gate U609D is a high level. The relative gain of these inputs is set by a series resistor and by R683. The ECD input provides an input point after the filter and before the limiter for data from external sources.

### 6.7.3 COMPRESSOR (U100B), LIMITER (U604C)

*NOTE: The compandor board is an optional accessory.*

If optional companding is used, jumper R690 is removed and the compandor board is installed. Companding is the compressing and then expanding of the audio signal to reduce noise. This also increases the dynamic range of the audio signal which is otherwise limited by channel spacing. The signal undergoes a 2:1 compression in the transmitter and then a 1:2 expansion in the receiver to return it to the original condition. For example, a +2 dB change in audio level at the input of the compressor produces a +1 dB change on the output.

Gates U102A and U102B bypass expander U100B when companding is not used on a selectable system or when performing testing. U101A provides buffering, and C101 couples the signal to pin 11 of U100B which is the input of an internal summing point. Pin 10 of U100B is the output of an internal operational amplifier, and pin 12 is the inverting input of this amplifier.

A portion of the output signal is coupled by C103 to pin 15, and by C104 to pin 14. Pin 15 is the input of an internal rectifier, and pin 14 is the input of an internal variable gain stage. The output of the rectifier is averaged across C106 and then used to control the gain of the variable gain stage. The value of C106 controls the rate at which the gain changes in response to changes in the input level. C107 minimizes distortion in the compressor.

The output of the compressor is applied to U604B which provides limiting and 6 dB per octave pre-emphasis. Limiting prevents over-modulation caused by high-level input signals. This stage is an amplifier which limits by saturating. R692 sets the gain of this amplifier. R693 and R694 set the input level to the next stage, and C685 provides DC blocking.

### 6.7.4 SPLATTER FILTER (U604C, U605D), SUMMING AMPLIFIER (U605A)

U604C and U605D form a five-pole low-pass splatter filter which attenuates frequencies over 3 kHz. This prevents adjacent channel interference caused by harmonic frequencies produced by amplitude limiting.

Summing amplifier U605A amplifies the sum of the transmit audio, transmit data, and wideband data signals. The audio and data modulation levels are adjusted by R701 and R703. A 2.5-volt bias voltage is provided by R708 and R709. The output of the summing amplifier is fed to the synthesizer on the RF board.

The wideband data input from J403, pin 8 of the universal interface allows data to be injected after the limiter circuit. If DC coupling is desired, jumper resistors R707 and R705 can be installed and R706 removed. Data injected at this point is gated by U606C which passes the signal when the control input (pin 12) is a high level.

A DC bias of 2.5 VDC ±2% (50 mV) must be applied to the wideband data input (J403-8) if DC coupling is used. This bias keeps the TCXO on frequency since this input is a direct coupled path to the TCXO. The TCXO frequency may also need to be readjusted if DC coupling is used.

*NOTE: The use of the wideband data input requires that the user provide modulation limiting and splatter filter circuitry and then obtain FCC reapproval of the transmitter.*

### 6.7.5 TRANSMIT DATA CIRCUIT (U607D, U607A)

The transmit LTR data and Call Guard tone/data signal is generated by the microprocessor on the 7Q and 8Q outputs of output latch U409. The four logic combinations possible on these two lines are applied to a resistor network formed by R732-R735. This network produces a four-step approximation of a sine wave which is then applied to a low-pass filter formed by U607D and U607A. This filter attenuates harmonics present in the sine wave which provides smoothing of the stepped sine wave.

The passband of this filter is controlled by Q612. When LTR data, digital Call Guard data, or low-frequency tone Call Guard tones are transmitted, Q612 is turned on and the cut-off frequency is approximately 150 Hz. Then when a high-frequency tone Call Guard tone is transmitted, Q612 is turned off and the cut-off frequency is approximately 220 Hz. Turning Q612 on switches additional capacitance into the circuit.

U610B provides gating of the data signal. When the control input (pin 5) of this gate is a high level, the data signal is passed to summing amplifier U605A. Test gate U610A is used in the test mode to bypass the data around the data filter so that modulation balance can be set.

# SECTION 7 SERVICING

## 7.1 GENERAL

### 7.1.1 PERIODIC CHECKS

This transceiver should be put on a regular maintenance schedule to ensure that it continues to operate properly. Important checks are receiver sensitivity and transmitter frequency, deviation, and power output. Performance tests for checking these and other parameters are located in Sections 8.5 and 8.6.

### 7.1.2 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts for the various PC boards used in this transceiver are located in the back of this manual. There are schematics for the RF, power amplifier, audio/logic, and display boards. There is also an interconnect schematic which shows the interconnections between these boards.

The component layouts permit easy location of components and measurement points. A component locator guide and PC board grid are also provided to aid in locating components on the RF, PA, and audio/logic boards. This guide lists the grid location of the parts on these boards.

### 7.1.3 REPLACEMENT PARTS

A replacement parts list for this transceiver is located in Section 9. The parts for all PC boards and the chassis are combined together in one listing. Parts are listed alphanumerically according to designator. For information on ordering parts, refer to Section 1.9. Also included at the end of Section 9 are exploded views which show the location of the mechanical parts.

### 7.1.4 CONFIGURING TRANSCEIVER FOR TESTING

This transceiver has a test mode which is selected to perform testing. This test mode is described in Section 3.11 and it permits the transceiver to be operated like a standard dispatch transceiver. The test mode is especially useful when the transceiver is programmed for LTR operation because the logic inhibits operation until a handshake is completed with a repeater.

### 7.1.5 SURFACE-MOUNTED COMPONENTS

Surface-mounted components are used extensively in this transceiver. Because of the small size of these components and PC board traces on which they are mounted, special care must be used when replacing surface-mounted devices. Multi-leaded components such as integrated circuits must usually be removed using a heat gun or some other type of heat source that heats the entire component. Care must then be used so that any nearby heat-sensitive components are not damaged. Surface-mounted components should not be reused since they may be damaged by the unsoldering process. For information on identifying surface-mounted components, refer to Section 7.6.

### 7.1.6 CMOS HANDLING TECHNIQUES

Several of the integrated circuits used in this transceiver, including the microprocessor, are CMOS devices. The part number of CMOS integrated circuits usually has a “3” as the fourth digit (544-3xxx-xxx). CMOS devices have a very high open circuit impedance, so are particularly susceptible to damage from static charges. Damaging static charges may be present even if no static arcs are observed. In addition, damage may not be immediately apparent because the device may only be weakened. Therefore, when handling CMOS devices, observe the following precautions:

- Before touching the transceiver or a CMOS device, discharge any built-up static charge on your body by touching a good earth ground.
- Ground all test equipment and make sure that the soldering iron tip is grounded.
- Connect ground leads before test probes. Leave the CMOS device in its conductive shipping container until it is inserted in the PC board.

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

## 7.2 SYNTHESIZER TROUBLESHOOTING

### 7.2.1 INTRODUCTION

When there is a synthesizer malfunction, the VCO is usually not locked on frequency. When the VCO is unlocked, the collector of Q809 on the RF board goes high and this signal is applied to the 5D of input latch U411 on the audio/logic board. When an unlocked condition is detected by the logic, transmitting and receiving are disabled and "OUT-OF-LOK" is indicated in the alphanumeric display.

When the VCO is unlocked, the fR and fV inputs to the phase detector are usually not the same frequency (refer to Figure 6-1). The phase detector in U801 then causes the VCO control voltage to go to the high or low end of its operating range. This in turn causes the VCO to oscillate at the high or low end of its frequency range.

As shown in Figure 7-1, a loop is formed by VCO Q920, prescaler U800, and the N counter and phase detector in U801. Therefore, if any of these components begin to operate improperly, improper signals appear throughout the loop. However, correct operation of the counters can still be verified by measuring the input and output frequencies to check the divide number. Proceed as follows to check the input and output signals of the synthesizer to determine if it is operating properly.

### 7.2.2 TCXO (Y800)

Check the signal at pin 5 of TCXO (temperature compensated crystal oscillator) Y800. It should be 17.500 MHz at a level of approximately 1.5 V P-P. If this signal is not present replace the TCXO because it is not serviceable.

### 7.2.3 VCO MODULE AND PRESCALER

Supply Voltage

The supply voltage on pin 4 of the VCO modules should be 8.0 VDC.

Output Level

The output level of the VCO module can be measured at pin 2 of the module. Use an RF voltmeter or some other type of high-impedance meter. The minimum output level at this point should be 0 dBm.

Control Voltage

Check the DC voltage at pin 12 of the VCO module with a channel near the center of the band selected. If the VCO is locked on frequency, it should be a steady DC voltage near 9.5 volts ± 2.0 volts. If it is not locked on frequency, it should be near the lower or upper end of its range (3 or 18 volts).

Frequency Shift Circuit

The levels on pins 5, 6, 7, and 8 of the VCO module should be as follows for the various operating modes:

| Mode | Pin 5 | Pin 6 | Pin 7 | Pin 8 |
|---|---|---|---|---|
| Transmit | L | H | H | L |
| Receive | L | H | L | H |
| Talk-Around | H | L | H | L |

Prescaler (U800)

Since the VCO frequency is in the 800 or 900 MHz range, it may be difficult to measure. However, the output frequency of prescaler U800 can be checked to see if it is in the correct range. If it is not, the prescaler or the VCO module may be defective.

The VCO frequency in the receive mode should be in the 798-817 MHz range (800 MHz models) or in the 882-888 MHz range (900 MHz models). (The VCO frequency in receive mode is 52.950 MHz less than the channel frequency.) The prescaler divide

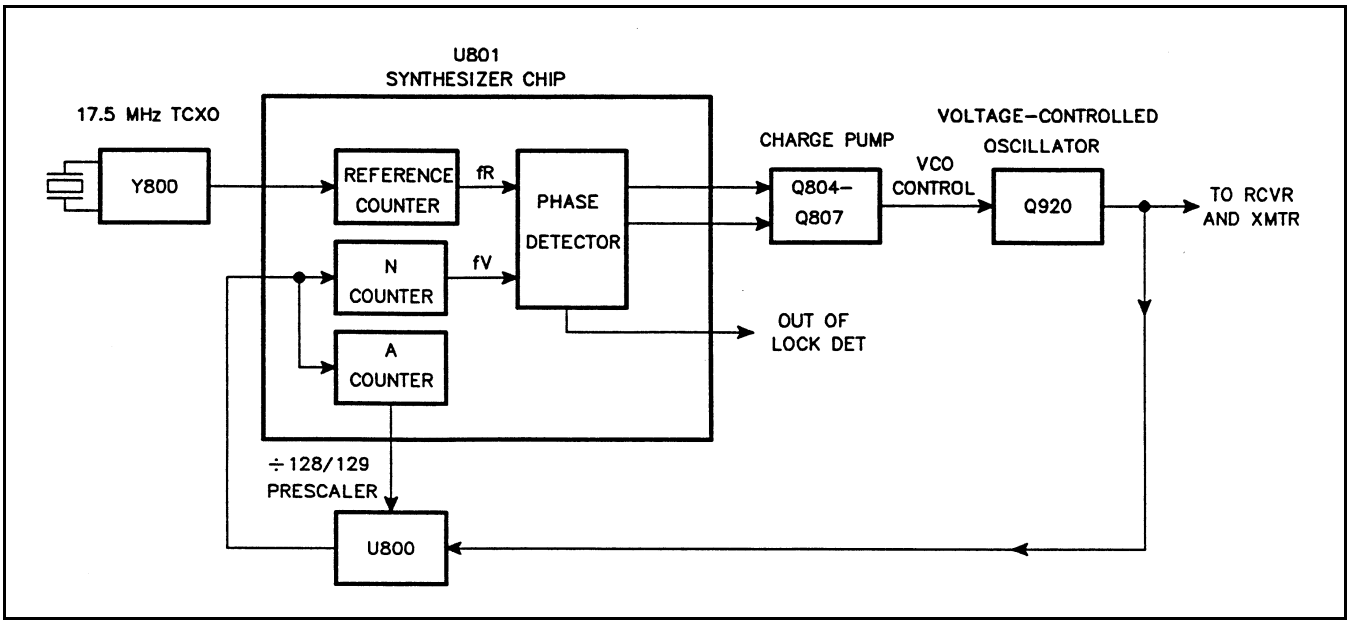



**Figure 7-1 Simplified Synthesizer Block Diagram**

number can be determined as follows (calculation of A and N is described in Section 7.2.5).

Prescaler Div No. = 128 + A/N

For example, for 800 MHz channel 300 (transmit), Prescaler Div No. = 128 + 55/508 or 128.108.

### 7.2.4 SYNTHESIZER (U801)

**Reference Counter -** If the reference oscillator checked out okay in Section 7.2.2, the reference counter in U801 can be checked. The reference counter divides by 1400 for all channels (17.500 MHz ÷1400 = 12.5 kHz).

The fR frequency can be measured at U801, pin 13 (see Figure 6-2), and it should be present even if the VCO is not locked on frequency. If the reference oscillator frequency is correct and the frequency on pin 13 is not correct, U803 may be defective or the control logic may be programming the reference counter with the wrong divide number.

**N Counter -** To check the operation of the N counter, the input and output frequencies can be measured to check the divide number. The divide number for the channel you have selected is calculated as described in Section 7.2.5. The input and output frequencies can be measured as follows:

$$\frac{\text{U801, pin 8 Frequency}}{\text{U803, pin 3 Frequency}} = \text{N Counter Div No.}$$

For example, the N counter divide number for 800 MHz channel 300 (transmit) is 508. If the VCO is locked on frequency, the following frequencies should be measured. If the VCO is not locked on frequency, the input and output frequencies may be different, but the divide number should be the same.

$$\frac{6.350\ \text{MHz}}{12.5\ \text{kHz}} = 508$$

*NOTE: If a changing control voltage is causing the VCO frequency to be unstable, temporarily ground the control line which is pin 12 of the VCO module.*

The preceding frequencies may not be exactly as calculated due to counter accuracy and resolution limitations. If the divide number is not correct, U801 may be defective or the control logic may be programming the N counter with the wrong number. If the

divide number is correct, continue the checks which follow.

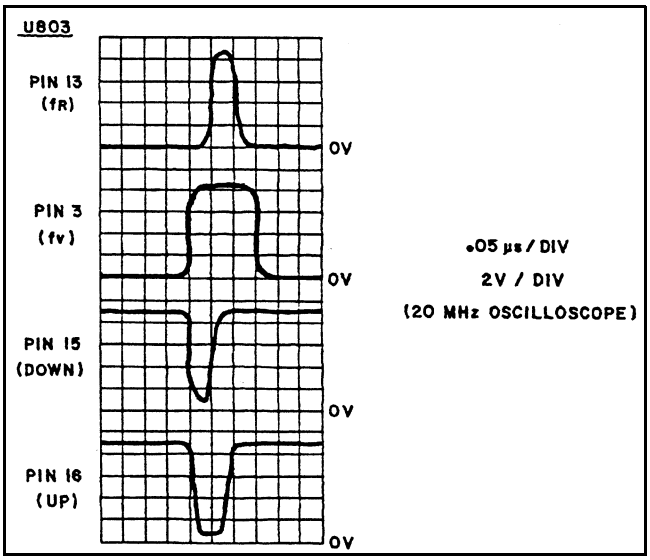
Phase Detector - When the VCO is not locked on frequency, the fR and fV inputs to the phase detector are probably not the same frequency. Measure the frequency at fR (pin 13) and fV (pin 3) and then check the phase detector outputs (DOWN and UP pins). If the phase detector is operating properly, these outputs should be as follows:

fV greater than fR - The negative-going pulses on the DOWN output (pin 15) should be much wider than the negative-going pulses on the UP output (pin 16). The DC voltage on pin 12 of the VCO module should be near 1 volt.

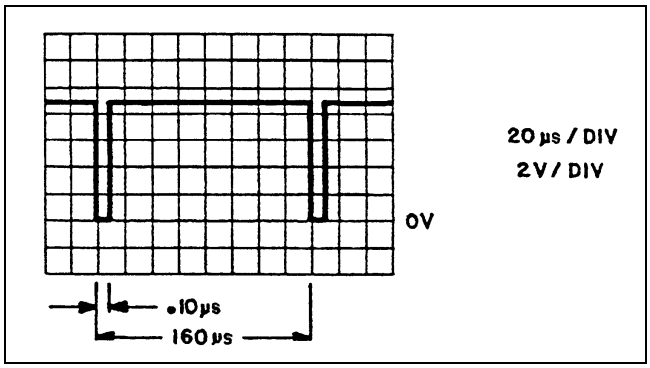
fV less than fR - The negative-going pulses on the UP output (pin 16) should be much wider than the negative-going pulses on the DOWN output (pin 15). The DC voltage on pin 12 of the VCO should be near 20 volts.

If the preceding phase detector output signals are not measured when the VCO is out of lock, U801 or the charge pump circuit may be defective. If the phase detector and charge pump are operating properly, check the lock detector and prescaler as described in the following information.

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



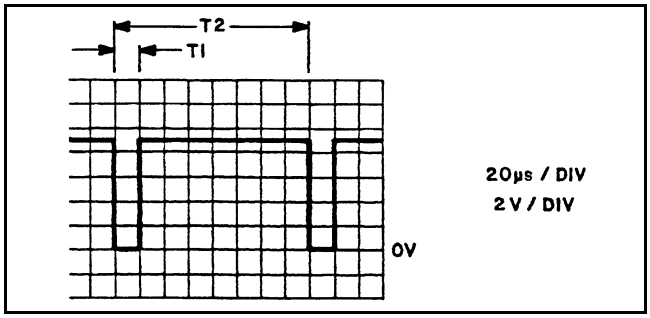

**Lock Detector** - When the VCO is locked on frequency, the waveform at U801, pin 7 should be as follows. The lock detect signal on the collector of Q809 should then be low. When the VCO is unlocked, the negative-going pulses should be much wider than those shown and the signal on the collector of Q809 should be high (5V).




**Modulus Control Signal** - The frequency of the modulus control output on U801, pin 12 should be equal to the N counter output frequency on pin 3 (either in or out of lock). When the VCO is in lock, this frequency should be the fR frequency (12.5 kHz).

The duty cycle of the modulus control signal determines the divide number of the prescaler. The duty cycle should be as follows:

$$\frac{T1}{T2} = \frac{\text{A counter divide number}}{\text{N counter divide number}}$$




If the modulus control signal is not correct, U801 may be defective or the logic may not be programming the correct divide number.



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### 7.2.5 DETERMINING COUNTER DIVIDE NUMBERS

The R, N, and A counter divide numbers can be determined as follows:

**R (Reference) Counter**

R = 17.500 MHz ÷12.5 kHz or 1400 (all channels)

**N Counter**

First, determine overall divide number Nt:

Nt = VCO Freq ÷ 12.5 kHz

Then determine N as follows:

N = Integer (whole number) Nt ÷ 128

For example, for 800 MHz transmit channel 300 the VCO oscillates at 813.4875 MHz. Nt = 813.4875 ÷ 128 or 65,079. N = 65,079 ÷ 128 or 508.43. Integer of 508.43 = 508.

**A Counter**

A = Nt – (128 x N)

For example, for channel 300, 128 x N = 128 x 508 or 65,024. A = 65,079 – 65,024 or 55.

## 7.3 RECEIVER TROUBLESHOOTING

To isolate a receiver problem to a defective section, check the DC and RF voltages shown on the schematic diagram.

## 7.4 TRANSMITTER TROUBLESHOOTING

To isolate a transmitter problem to a defective section, check the DC and RF voltages shown on the schematic diagram.

*NOTE: With 30/35-watt transceivers, make sure that the leads of thermistor RT500 do not loop near Q502 or Q511 because spurious breakup may result.*

## 7.5 AUDIO/LOGIC BOARD TROUBLESHOOTING

### 7.5.1 DIGITAL CIRCUITS

Because of the complexity of the digital portion of the audio/logic board, troubleshooting may be difficult. Special test equipment and a thorough understanding of the operating software may be needed to isolate a problem. Therefore, if a problem is suspected with the digital circuitry, verify that the 5-volt and 8-volt supply voltages are correct and then replace the audio/logic board.

### 7.5.2 ANALOG CIRCUITS

The analog circuits on the audio/logic board can be checked by measuring the AC and DC voltages shown on Part 2 of the audio/logic board schematic diagram.

## 7.6 SURFACE MOUNTED DEVICES (SMDs)

### 7.6.1 SERVICING TECHNIQUES

Most of the components used in this transceiver are the surface mounted type. Since these components and the circuit traces on which they are mounted are very small in size, special care must be used when they are replaced. Multi-leaded components such as integrated circuits must usually be removed using a heat gun or some other type of heat source that heats the entire device. Take care so that nearby components are not damaged. Surface mounted components should not be reused since they may be damaged by the unsoldering process.

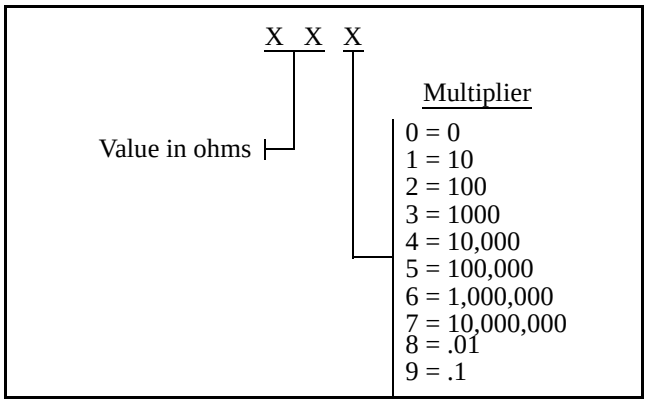
### 7.6.2 IDENTIFYING SMD RESISTORS

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

<u>± 5% And ± 10% Resistors (P.N. 569-0115-XXX)</u>

The three-digit number used to identify ±5% and ±10% resistors corresponds to the last three digits of the E.F. Johnson part number. This number is derived

as follows. For example, “273” indicates a 27k ohm resistor and “339” indicates a 3.3 ohm resistor.




± 1% Resistors (P.N. 569-0111-xxx)

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

## 7.6.3 SMD CAPACITOR IDENTIFICATION

Ceramic SMD Capacitors (P.N. 510-36xx-xxx)

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

The Japanese standard may also utilize a bar to indicate the temperature coefficient. The following coefficients are indicated by this bar. For example, “A2” indicates a 100 pF NPO capacitor.

$\overline{XX}$ = NPO  $\overline{X}X$ = N150  $X\overline{X}$ = N220

$\underline{XX}$ = N330  $\underline{X}X$ = N470  $X\underline{X}$ = N750

|XX = X7R

**Table 7-1 Ceramic SMD Capacitor Identification**

| American EIA Standard | | Japanese EIA Standard | |
|---|---|---|---|
| **First Letter/ Number** | **Value (pF)** | **First Letter/ Number** | **Value (pF)** |
| A | 10 | A | 1.0 |
| B | 11 | B | 1.1 |
| C | 12 | C | 1.2 |
| D | 13 | D | 1.3 |
| E | 15 | E | 1.5 |
| H | 16 | F | 1.6 |
| I | 18 | G | 1.8 |
| J | 20 | H | 2.0 |
| K | 22 | J | 2.2 |
| L | 24 | K | 2.4 |
| N | 27 | L | 2.7 |
| O | 30 | M | 3.0 |
| R | 33 | N | 3.3 |
| S | 36 | P | 3.6 |
| T | 39 | Q | 3.9 |
| V | 43 | R | 4.3 |
| W | 47 | S | 4.7 |
| X | 51 | T | 5.1 |
| Y | 56 | U | 5.6 |
| Z | 62 | V | 6.2 |
| 3 | 68 | W | 6.8 |
| 4 | 75 | X | 7.5 |
| 7 | 82 | Y | 8.2 |
| 9 | 91 | Z | 9.1 |

| **Color** | **Multiplier** | **Second Number** | **Multiplier** |
|---|---|---|---|
| Orange | 0.1 | 0 | 1 |
| Black | 1 | 1 | 10 |
| Green | 10 | 2 | 100 |
| Blue | 100 | 3 | 1000 |
| Violet | 1000 | 4 | 10,000 |
| Red | 10,000 | 5 | 100,000 |

Tantalum SMD Capacitors (P.N. 510-26xx-xxx)

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

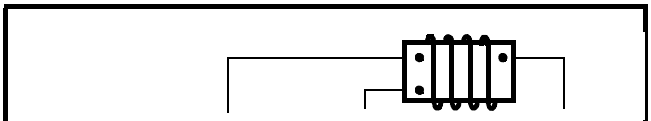
### 7.6.4 SMD INDUCTOR IDENTIFICATION

SMD inductors (P.N. 542-9000-xxx) use three colored dots to indicate the value. The two dots on the left side indicate the first and second digits of the value in nanohenries, and the single dot on the right side indicates the multiplier (see Table 7-2). For example, brown, black, and red dots indicate a value of 10 nH x 100 which is 1000 nH (1.0 μH). The last three digits of the part number are also the value and multiplier.

### 7.6.5 TRANSISTOR/DIODE IDENTIFICATION

Surface mounted transistors and diodes are identified by a special number. Refer to page 10-1 for more information.

**Table 7-2 SMD Inductor Identification**



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

# SECTION 8 ALIGNMENT PROCEDURE AND PERFORMANCE TESTS

## 8.1 GENERAL

### 8.1.1 INTRODUCTION

The following alignment should be performed if repairs are made that could affect the factory alignment. Performance tests are located in Sections 8.5 and 8.6, and it is recommended that these tests be run on transceivers before they are placed in service.

To perform this alignment, the test mode described in Section 3.11 must be selected. This mode configures the transceiver as required to perform the various adjustments. A special test mode is required because the transceiver does not unsquelch or key up in the LTR mode until the proper data handshake occurs.

The test mode is selected by turning power on with the RxD and TxD lines of the microphone connector shorted together (P2, pins 10 and 13). When the test mode is selected, "RX-TX-RSSI" (the first test function) is displayed continuously. The Bank 0 test channels should be used for this alignment. See Section 3.11.2 for more information.

### 8.1.2 TEST CABLES

**CAUTION**

*Applying a positive DC voltage to either audio amplifier output (even momentarily) will seriously damage the device. Momentarily grounding an output should not result in damage.*

Two test cables are required to perform transceiver alignment. One cable connects to the accessory pigtail and the other connects to the microphone jack. These cables are shown in Figure 8-1.

For transceiver power to turn on, the ignition sense input of the accessory pigtail (J100, pin 6) must be connected to 13.8 volts. To perform receiver alignment, a 4.0-ohm, 15-watt speaker load must be connected to the external speaker outputs of this cable (pins 1 and 2). The microphone cable is required to select the test mode, inject the transmit audio signal, and key the transmitter.

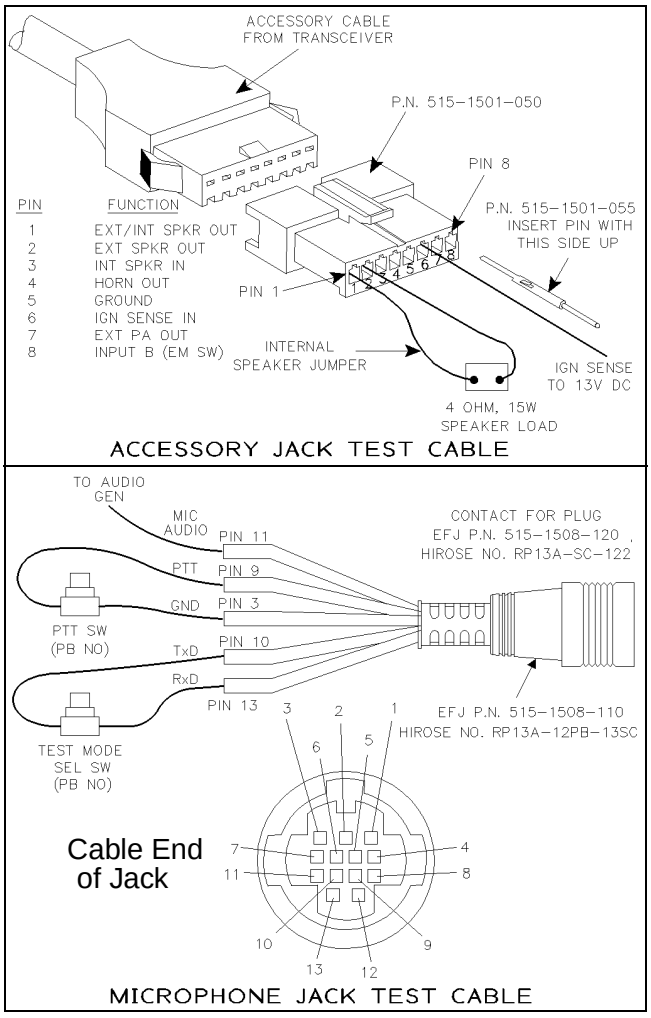



**Figure 8-1 Test Cables**

*NOTE: Transceivers with Version 207 or later software have three banks of test channels. Select Bank 0 for this alignment (see Section 3.11.2).*

## 8.2 FREQUENCY ADJUSTMENT

a. Connect the test setup shown in Figure 8-2. Select the test mode and Ch 381 (860.5125) or Ch 240* (938.0000) of the RX-TX-RSSI function (see Section 3.11.2).

b. Connect a DC voltmeter to the wire-out on the collector of Q804/Q807 on the RF board (see alignment points diagram in Figure 8-4).

* Setting with 900 MHz models

c. The meter reading should be 9.5V ± 2.0V. Also check the other receive test channels. The voltage should be 3-18 VDC. If this voltage is not within these ranges, there is a problem with the synthesizer (the VCO control voltage is not adjustable).

d. Key the transmitter and monitor the transmit signal with a communications monitor set to the transmit frequency (815.5125 or 899.0000* MHz). Adjust the capacitor in TCXO Y800 for the transmit frequency ± 150 Hz.

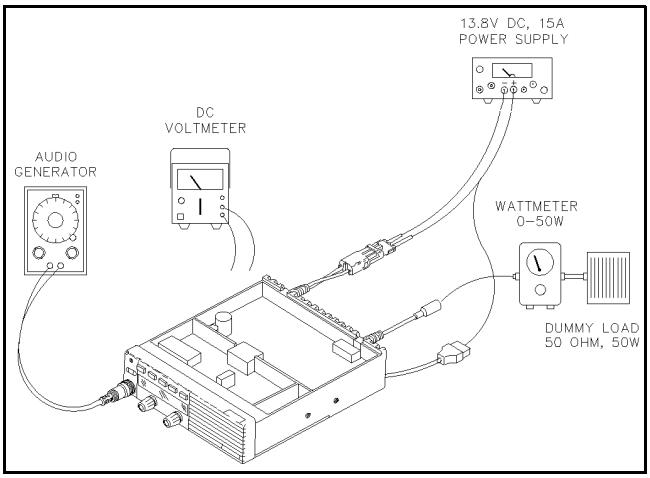



**Figure 8-2 Transmitter Test Setup**

## 8.3 TRANSMITTER TUNEUP

### 8.3.1 C511 ADJUSTMENT (30 OR 35 WATT MODELS ONLY)

*NOTE: Do not key the transmitter for extended periods when performing the following adjustments.*

*NOTE: For accurate power measurement at 800 and 900 MHz, use a minimum number of connectors with a teflon or better dielectric. If coaxial cable is used, it should be a minimum length of a low-loss type.*

a. Connect the test setup shown in Figure 8-2. Select the test mode and Ch 001 (851.0125) or Ch 001* (935.0125) of the RX-TX-RSSI function (see Section 3.11.2). An alignment points diagram is located in Figure 8-4.

b. The test mode POWER SET and TA PWR SET functions must be preset for maximum power (127). Refer to Section 8.3.2 for information on how to make these adjustments.

*NOTE: A tuning tool with a 0.030" square tip (JCM 4193) is required to adjust C511 in the next step. This tool is available from the Service Parts Dept. by ordering P.N. 721-0015-171.*

c. Key the transmitter and adjust C511 for maximum power output.

d. Rotate the Select switch until the display indicates Ch 918 TA (869.9625) or Ch 473 TA* (940.9125) to select the talk-around mode. Key the transmitter and power output should be greater than the following levels. If not, readjust C511.

| | |
|---|---|
| 800 MHz | 32W |
| 900 MHz | 27W |

### 8.3.2 POWER LEVEL 1 ADJUSTMENT

This adjustment sets the power level 1 power output. Both POWER SET and TA PWR SET are selected. POWER SET sets the power output on the low and high ends of the standard band, and TA PWR SET sets it on the high and low ends of the talk-around band. This parameter should always be set to the rated power output because it is used to adjust the power level across the band.

a. Press and rotate the Select switch to select the POWER SET function of the test mode (see Section 3.11.3). Press the Select switch to display PWR SET 1.

b. Key the transmitter and rotate the Select switch to set the power output for the following level (several rotations may be required). The relative power output is indicated by 0-127 in the display (127 is maximum power). Unkey the transmitter to store the setting.

| | **15W Models** | **30/35W Models** |
|---|---|---|
| 800 MHz | 15W | 35W |
| 900 MHz | 15W | 30W |

c. Rotate the Select switch to display PWR SET 2 and repeat the preceding adjustment.

d. Press and rotate the Select switch to select the TA PWR SET function (see Section 3.11.4). Press the Select switch to display TA PWR 1.

e. Key the transmitter and rotate the Select switch to set the power output for the following level. Unkey the transmitter to store the setting.

| | 15W Models | 30/35W Models |
|---|---|---|
| 800 MHz | 12W | 30W |
| 900 MHz | 12W | 25W |

f. Rotate the Select switch to obtain TA PWR SET 2 and repeat the preceding adjustment.

### 8.3.3 POWER LEVEL 2-4, 2W ADJUSTMENT

This adjustment sets the power levels selected when the system is programmed for power levels 2-4 or 2W. The rated power output level is shown in step b of the preceding section.

a. Press and rotate the Select switch to select the POWER LEVELS function of the test mode (see Section 3.11.5). Press the Select switch to display PWR LVL 2.

b. Key the transmitter and turn the Select switch to obtain the desired power output for that level. Any power level from half rated to rated can be selected. Unkey the transmitter to store the setting.

c. Rotate the Select switch to display PWR LVL 3 and set the power output for the desired level from half rated to rated. Unkey the transmitter to store the setting.

d. Rotate the Select switch to display PWR LVL 4 and set the power output the desired level from half rated to rated. Unkey the transmitter to store the setting.

e. Rotate the Select switch to display 2W PWR LVL and set the power output for 1.8 watts (or other levels from 1-2 W if desired). Unkey the transmitter to store the setting.

### 8.3.4 MODULATION BALANCE

This adjustment sets modulation balance across the standard and talk-around frequency bands.

a. Press and rotate the Select switch to select the BAL ADJUST function of the test mode (see Section 3.11.6). Press the Select switch to display BAL ADJ 1.

b. Key the transmitter and view the demodulated signal on the CRT of a communications monitor. Adjust R703 on the audio/logic board for a deviation of 3 - 5 kHz (800 MHz) or 2 - 3 kHz (900 MHz).

c. Rotate the Select switch so that the demodulated signal is a square wave with no tilt or overshoot. Unkey the transmitter to store the setting.

d. Repeat the preceding adjustment for BAL ADJ 2 through BAL ADJ 6.

### 8.3.5 TRANSMIT DATA LEVEL ADJUSTMENT

a. Press and rotate the Select switch to select the RX-TX-RSSI function (see Section 3.11.2). Press and rotate the Select switch to display Ch 918TA (869.9625) or Ch 473TA* (940.9125).

b. Key the transmitter and monitor the transmit signal with a communications monitor. Adjust R703 on the audio/logic board for a deviation of 1.0 kHz ± 50 Hz (800 MHz) or 800 Hz ± 50 Hz (900 MHz).

### 8.3.6 TRANSMIT AUDIO LIMITING ADJUST

a. Inject a 1 kHz, 2V rms signal at pin 11 of microphone jack P2. (The test channel is the same as that used in the preceding section.)

b. Adjust R701 on the audio/logic board so that total deviation (data + audio) is as follows. See Section 1.2.5 for more NPSPAC information.

| | Total Deviation |
|---|---|
| 800 MHz Std and NPSPAC Models | 4.7 kHz ± 100 Hz |
| 900 MHz Models | 2.3 kHz ± 50 Hz |

c. Check deviation on the other test frequencies. It must be within the preceding ranges. If it is not, readjust R701.

* Setting with 900 MHz models

## 8.4 RECEIVER ALIGNMENT

### 8.4.1 FRONT END ALIGNMENT

***CAUTION***

*Do not transmit with the signal generator connected because severe generator damage could result.*

a. Connect the test setup shown in Figure 8-3. Select the test mode and Ch 001 (851.0125) or Ch 001* (935.0125) of the RX-TX-RSSI function (see Section 3.11.2). An alignment points diagram is located in Figure 8-4.

b. Connect the RF signal generator to the antenna jack. Set it to the channel frequency with an output level which provides –50 dBm (700 mV) at the transceiver.

c. Adjust the transceiver volume control for approximately 1/3 volume. If necessary, unsquelch the receiver by adjusting R748 on the audio/logic board clockwise. The option button to the left of the display can also be used to unsquelch the transceiver in the test mode.

**800 MHz Models**

d. Set the generator modulation for 1 kHz at 3 kHz deviation. Tune Z204 on the RF board for maximum audio output.

e. Tune L201, L202, and L205 for minimum distortion. Repeat if necessary. (L201 is not used in later models; see Appendix A.)

f. Retune L201 for best SINAD sensitivity (if applicable). Do not readjust L202 or L205. Distortion should remain below 3%.

**900 MHz Models**

g. Set the generator modulation for 1 kHz at 1.5 kHz deviation. Tune Z204 on the RF board for maximum audio output.

h. Connect an oscilloscope or RF voltmeter (that is capable of responding to 53 MHz signals) to the IF test point which is the Q203, collector wire-out (see Figure 8-4).

i. Tune L202, L205, and L209 for a maximum IF level. Repeat if necessary. Remove the oscilloscope or voltmeter.

j. Tune L201 for minimum audio distortion which should be 3% or less.

### 8.4.2 RSSI DETECT ADJUST

a. With the signal generator and test mode setting used in the preceding section, adjust the generator output level for 6 dB SINAD.

b. Observe the area of the display immediately to the right of the frequency. Either LO or HI is indicated to show the status of the carrier detect line.

c. If necessary, adjust R758 on the audio/logic board counterclockwise so that LO is indicated. Then slowly turn R758 clockwise until HI is displayed continuously.

d. Remove the signal generator input signal. The display should change to LO. If RSSI trip points do not occur at these levels, repeat steps a-c.

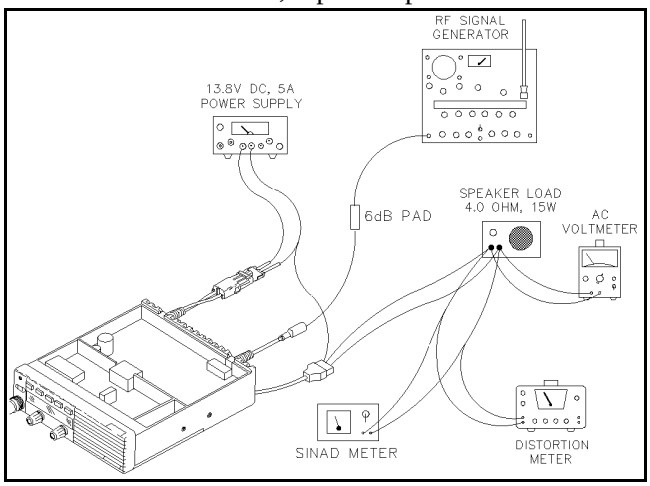



**Figure 8-3 Receiver Test Setup**

### 8.4.3 SQUELCH ADJUST

a. With the signal generator and test mode setting used in the preceding section, adjust the generator output level for 5 dB SINAD.

b. The receiver should be unsquelched (audio enabled). If not, rotate R748 clockwise. Then slowly turn R748 counterclockwise until the audio just squelches (mutes).

* Setting with 900 MHz models

c. Increase the generator output until the receiver unsquelches. This should occur by 9 dB SINAD ± 2 dB. Then decrease the output until the receiver squelches. This should occur by 5 dB ± 2 dB. If not, repeat the preceding step.

### 8.4.4 LOCAL TONE LEVEL ADJUST

R643 adjusts the level of the tone which indicates such things as when a key is pressed. To enable this tone, press a front panel key or turn the Select switch. Adjust R643 for the desired tone level (approximately midrange).

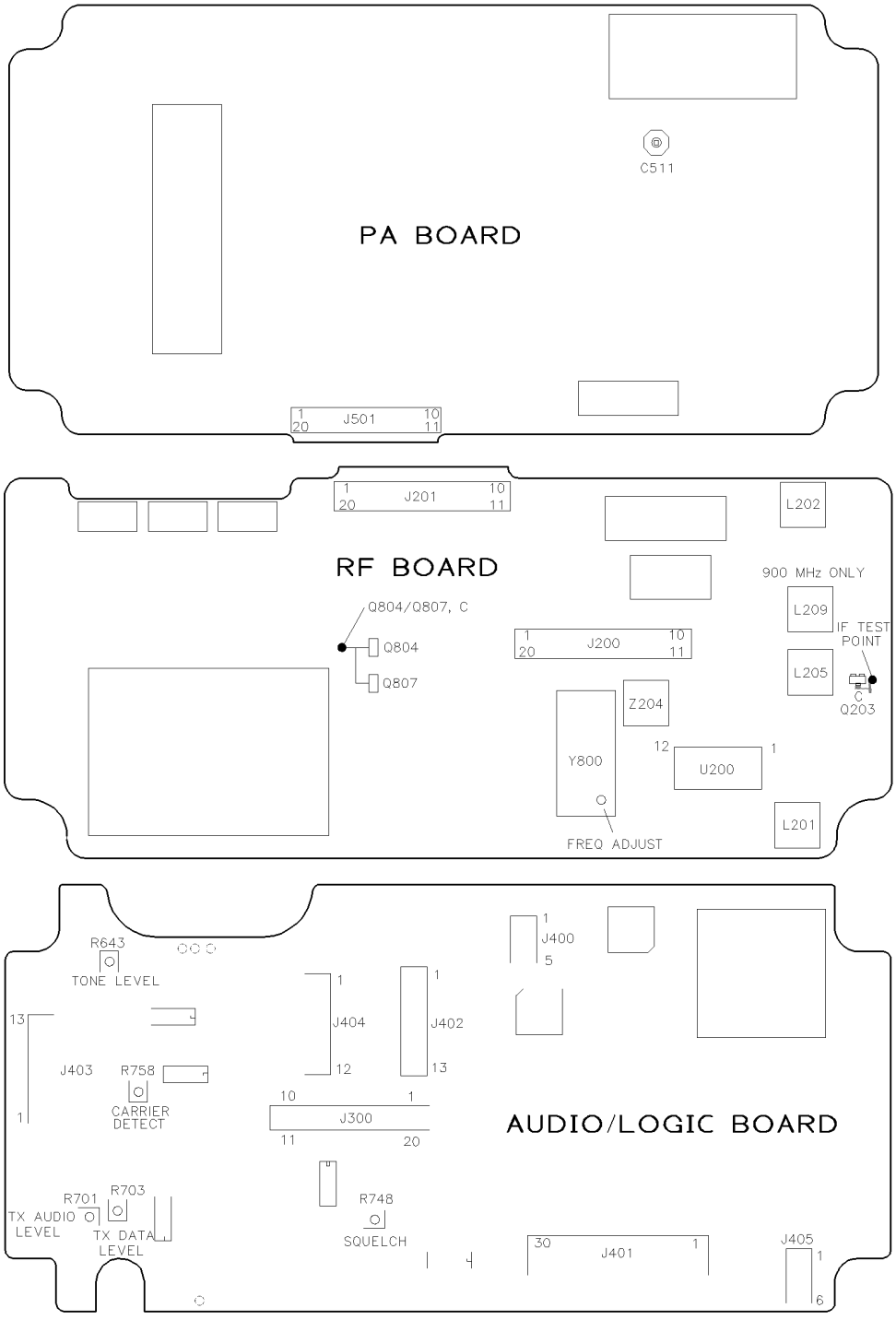



**Figure 8-4 Alignment Point Diagrams**

# PERFORMANCE TESTS

## 8.5 RECEIVER PERFORMANCE TESTS

***CAUTION***

*Do not transmit with the signal generator connected because severe generator damage could result.*

*Applying a positive DC voltage to either audio amplifier output (even momentarily) will seriously damage the device. Grounding an output should not result in damage.*

a. Connect the test cables shown in Figure 8-1 to the microphone and accessory jacks. Connect the test setup shown in Figure 8-3.

b. Select the test mode RX-TX-RSSI function as described in Section 8.1.1. Press and turn the Select switch to select Ch 381 (860.5125) or Ch 240* (938.0000).

c. Connect the RF signal generator to the antenna jack. Set it to the channel frequency with an output of –47 dBm (1000 mV) modulated with 1 kHz at 3 kHz deviation (800 MHz) or 1.5 kHz deviation (900 MHz).

d. Adjust the volume control for an audio output level of 6.9V rms across a 4-ohm load (12W). Distortion should be less than 3%.

e. Decrease the generator output to obtain 12 dB SINAD. The generator output should be –111 dBm (0.63 mV) maximum (with a 6 dB pad).

f. Also check the channels at the low and high ends of the band.

## 8.6 TRANSMITTER PERFORMANCE TESTS

*NOTE: For accurate power measurement at 800 and 900 MHz, use a minimum number of connectors with a teflon or better dielectric. If coaxial cable is used, it should be a minimum length of a low-loss type.*

a. Connect the test cables shown in Figure 8-1 to the microphone and accessory jacks. Connect the test setup shown in Figure 8-2.

b. Select the test mode RX-TX-RSSI function as described in Section 8.1.1. Press and turn the Select switch to select Ch 381 (860.5125) or Ch 240* (938.0000).

c. Key the transmitter and note the power output on the six test channels. Power output on the three standard channels should be as indicated in Section 8.3.2, step b and power output on the talk-around channels should be as indicated in step e of that section. (Talk-around channels have “TA” after the channel number or frequency.)

d. If some systems are to be programmed for less than standard power output, check power levels 2-4 and 2W as described in Section 8.3.3.

e. Select Ch 381 (860.5125) or Ch 240* (938.0000) and monitor the transmit signal with a communications monitor set to 815.5125 or 899.0000* MHz. The transmit frequency should be within ± 1.5 PPM (800 and 900 MHz). (At room temperature, it should be within ± 150 Hz.) This also checks the receive frequency.

f. With no microphone audio input signal, monitor the transmit data signal. Deviation should be 1 kHz ± 50 Hz (800 MHz) or 800 Hz ± 50 Hz (900 MHz).

g. Inject a 2V rms 1 kHz signal at pin 11 of microphone jack P2. Total deviation (audio + data) should be as indicated in Section 8.3.6, step b. Also check the other test channels.

* Setting with 900 MHz models

# SECTION 9 PARTS LIST

| Ref No. | Description | Part No. |
|---|---|---|
| | **RF AND PA BOARDS, HARDWARE AND MISCELLANEOUS** | |
| A 001 | Stabilization board, 800 MHz PA | 023-9884-533 |
| | 0.01 µF X7R ±10% 50V cer smd | 510-3606-103 |
| | 0.01 µH smd inductor | 542-9001-107 |
| A 301 | Pigtail cable, remote/accessory (standard w/remote mount) | 597-2002-250 |
| | Pigtail cable, accessory only (standard w/front mount) | 597-2002-230 |
| | Pigtail cable, universal interface | 597-2002-245 |
| A 902 | VCO assembly, 800 MHz | 023-9650-911 |
| | VCO assembly, 900 MHz | 023-9670-911 |
| C 100 | 15 µF 20V tantalum smd | 510-2626-150 |
| C 101 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 102 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 103 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 104 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 105 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 106 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 107 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 108 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 109 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 110 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 111 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 112 | 39 pF ±5% NPO 0805 smd | 510-3615-390 |
| C 113 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 114 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 115 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 116 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 117 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 118 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 119 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 120 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 121 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 200 | 100 pF ±5% NPO 50V cer smd | 510-3601-101 |
| C 201 | 33 pF ±5% NPO cer smd | 510-3601-330 |
| C 202 | 33 pF ±5% NPO cer smd | 510-3601-330 |
| C 204 | 100 pF ±5% NPO 50V cer smd | 510-3601-101 |
| C 205 | 39 pF ±5% NPO 50V cer smd | 510-3601-390 |
| C 206 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 207 | 39 pF ±5% NPO cer smd | 510-3601-390 |
| C 208 | 6.8 pF ±5% NPO 50V cer smd (900 MHz only) | 510-3601-689 |
| C 210 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 212 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 213 | 6.8 pF ±5% NPO 50V cer smd | 510-3601-689 |
| C 215 | 100 pF ±5% NPO 50V cer smd | 510-3601-101 |
| C 217 | 12 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-120 |
| | 10 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-100 |
| C 220 | 39 pF ±5% NPO 50V cer smd | 510-3601-390 |
| C 221 | 10 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-100 |
| | 7.5 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-759 |
| C 222 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 223 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 225 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 229 | 5.6 pF ±5% NPO 50V cer smd (w/Z206, see Table A-2) | 510-3601-569 |
| | .001 µF ±5% NPO cer smd (w/o Z206, see Table A-2) | 510-3601-102 |
| C 230 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 231 | 2.7 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-279 |
| | 4.7 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-479 |
| C 232 | 8.2 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-829 |
| | 6.8 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-689 |
| C 233 | 15 pF ±5% NPO 50V cer smd | 510-3601-150 |
| C 234 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 235 | .001 µF ±5% NPO cer smd (w/o Z206, see Table A-2) | 510-3601-102 |
| C 237 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 239 | 15 pF ±5% NPO 50V cer smd | 510-3601-150 |
| C 240 | 15 pF ±5% NPO 50V cer smd | 510-3601-150 |
| C 241 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 242 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| C 243 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 244 | 15 pF ±5% NPO 50V cer smd | 510-3601-150 |
| C 246 | 4.7 pF ±5% NPO 50V cer smd | 510-3601-479 |
| C 247 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 248 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 249 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 251 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 253 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 254 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 255 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 256 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 257 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 258 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 259 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 260 | 22 pF ±5% NPO 50V cer smd | 510-3601-220 |
| C 291 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 292 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 293 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 294 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 296 | 2.7 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-279 |
| | 2.2 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-229 |
| C 297 | 8.2 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-829 |
| | 5.6 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-569 |
| C 298 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 500 | 2.7 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-279 |
| | 2.2 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-229 |
| C 501 | .1 µF ±10% X7R 50V cer smd (800 MHz) | 510-3607-104 |
| | .001 µF ±5% NPO 50V cer smd (900 MHz) | 510-3602-102 |
| C 502 | 2.7 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-279 |
| | 2.2 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-229 |
| C 504 | .1 µF ±10% X7R 50V cer smd (800 MHz) | 510-3607-104 |
| | .001 µF ±5% NPO 50V cer smd (900 MHz) | 510-3602-102 |

| Ref No. | Description | Part No. |
|---|---|---|
| C 505 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C506 | 12 pF hi q cer smd (30/35W models only) | 510-3663-120 |
| C 507 | 12 pF hi q cer smd (30/35W models only) | 510-3663-120 |
| C 508 | 20 pF 250V mini mica (800 MHz 35W models) | 510-0020-200 |
| | 15 pF 250V mini mica (900 MHz 30W models) | 510-0020-150 |
| C 509 | 18 pF 250V mini mica (800 MHz 35W models) | 510-0020-180 |
| | 15 pF 250V mini mica (900 MHz, 30W models) | 510-0020-150 |
| C 510 | 2.7 pF ±5% NPO 50V cer smd | 510-3615-279 |
| C 511 | 3.3 pF ±5% NPO 50V cer smd (800 MHz, 35W revised board) | 510-3602-339 |
| | 1.0 -4.5 pF variable capacitor (800 MHz, 35W unrevised board) | 187-0103-175 |
| | 1.0 to 4.5 pF smd variable (900 MHz, 30W models) | 512-1008-001 |
| C 512 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 513 | 39 pF ±5% NPO 50V cer smd (900 MHz only) | 510-3615-390 |
| C 514 | 470 µF 25V electrolytic | 510-4064-471 |
| C 515 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 516 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 517 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 518 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 519 | 4.3 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-439 |
| | 4.7 pF ±5% NPO 50V cer smd (900 MHz) | 510-3615-479 |
| C 520 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 521 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 522 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 523 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 524 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 525 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 526 | 2.7 pF ±5% NPO 50V cer smd (30/35W only) | 510-3615-279 |
| C 527 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 528 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 529 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| C 530 | 2.7 pF ±5% NPO 50V cer smd (800 MHz 15W) | 510-3615-279 |
| | 4.3 pF ±5% NPO 50V cer smd (800 MHz 35W) | 510-3615-439 |
| | 1 pF ±5% NPO 50V cer smd (900 MHz 30W) | 510-3615-109 |
| C 531 | 5.6 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-569 |
| | 4.7 pF 250V mini mica (900 MHz) | 510-3615-479 |
| C 532 | 4.7 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-479 |
| | 3.3 pF ±5% NPO 50V cer smd (900 MHz) | 510-3615-339 |
| C 533 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 534 | 1.2 pF ±5% NPO 50V cer smd | 510-3615-129 |
| C 535 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 536 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 537 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 538 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 539 | 15 pF ±5% NPO 50V cer smd (800 MHz 15W) | 510-3615-150 |
| | 6.8 pF ±5% NPO 50V cer smd (800 MHz 35W) | 510-3615-689 |
| | 6.8 pF ±10% 50V high Q smd (900 MHz 15W) | 510-3663-689 |
| | 3.9 pF ±5% NPO 50V cer smd (900 MHz 30W) | 510-3615-399 |
| C 540 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 541 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 542 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 543 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 544 | 1.2 pF ±5% NPO 50V cer smd | 510-3615-129 |
| C 545 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 546 | 2.7 pF ±5% NPO 50V cer smd (800 MHz 15W) | 510-3615-279 |
| | 3.9 pF ±5% NPO 50V cer smd (900 MHz 15W) | 510-3614-399 |
| C 547 | 39 pF ±5% NPO 50V cer smd (30/35W) | 510-3615-390 |
| C 548 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 549 | 3.9 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-399 |
| | 3.3 pF ±5% NPO 50V cer smd (900 MHz) | 510-3615-339 |

| Ref No. | Description | Part No. |
|---|---|---|
| C 550 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 551 | 2200 µF 25V electrolytic | 510-4064-222 |
| C 552 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 553 | .047 µF ±5% 100V polyester (900 MHz 15W only) | 510-1031-473 |
| C 554 | 4.7 µF 20V tantalum smd | 510-2626-479 |
| C 555 | 4.7 µF 20V tantalum smd | 510-2626-479 |
| C 556 | 3.9 pF ±5% NPO 50V cer smd (900 MHz 15W) | 510-3614-399 |
| C 557 | 39 pF ±5% NPO 50V cer smd | 510-3601-390 |
| C 558 | 12 pF ±5% NPO 50V cer smd (800 MHz) | 510-3614-120 |
| | 5.6 pF ±5% NPO 50V cer smd (900 MHz) | 510-3614-569 |
| C 559 | 12 pF ±5% NPO 50V cer smd (800 MHz) | 510-3614-120 |
| | 10 pF ±5% NPO 50V cer smd (900 MHz 15W) | 510-3614-100 |
| | 6.8 pF ±5% NPO 50V cer smd (900 MHz 30W) | 510-3614-689 |
| C 560 | 22 µF 16V tantalum smd | 510-2625-220 |
| C 561 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 562 | 9.1 pF ±10% 50V high Q smd (800 MHz 15W) | 510-3663-919 |
| | 15 pF ±10% 50V high Q smd (30/35W) | 510-3663-150 |
| | 12 pF ±10% 50V high Q smd (900 MHz 15W) | 510-3663-120 |
| C 563 | 15 pF ±10% 50V high Q smd (All except following) | 510-3663-150 |
| | 12 pF ±10% 50V high Q smd (900 MHz 15W) | 510-3663-120 |
| C 564 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 565 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 567 | 3.9 pF ±5% NPO 50V cer smd (800 MHz) | 510-3615-399 |
| | 3.3 pF ±5% NPO 50V cer smd (900 MHz) | 510-3615-339 |
| C 568 | 56 pF ±10% 50V high Q smd (800 MHz, 35W) | 510-3663-560 |
| | 39 pF ±5% NPO 50V cer smd (900 MHz, 30W) | 510-3615-390 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| C 569 | 56 pF ±10% 50V high Q smd (800 MHz, 35W) | 510-3663-560 |
| | 39 pF ±5% NPO 50V cer smd (900 MHz, 30W) | 510-3615-390 |
| C 570 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 571 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 572 | 1.0 µF ±10% X7R 50V cer smd | 510-3606-105 |
| C 579 | 4.7 µF 20V tantalum smd | 510-2626-479 |
| | 47 µF 20V tantalum smd (revised 800 MHz PA boards) | 510-2624-470 |
| C 584 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 586 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 590 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 593 | 820 pF ±5% NPO 50V cer smd | 510-3601-821 |
| C 594 | 820 pF ±5% NPO 50V cer smd | 510-3601-821 |
| C 595 | 47 µF 20V tantalum smd | 510-2624-470 |
| C 596 | 0.1 µF ±10% X7R 50V cer smd | 510-3606-104 |
| | | |
| C 800 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 801 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 802 | 22 µF 16V tantalum smd | 510-2625-220 |
| C 803 | 1.0 µF 35V tantalum smd | 510-2628-109 |
| C 805 | .01 µF ±5% 63V polyester | 510-1033-103 |
| C 806 | .22 µF ±5% 63V polyester | 510-1033-224 |
| C 807 | .001 µF ±5% 63V polyester | 510-1033-102 |
| C 808 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 809 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 810 | 2.2 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-229 |
| | 1.5 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-159 |
| C 811 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 812 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 813 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 814 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 815 | 4.7 pF ±5% NPO 50V cer smd | 510-3601-479 |
| C 818 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 819 | 4.7 pF ±5% NPO 50V cer smd | 510-3601-479 |
| C 820 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 821 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 822 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 823 | 1.0 µF 35V tantalum smd | 510-2628-109 |
| C 824 | 1.0 µF 35V tantalum smd | 510-2628-109 |
| C 826 | 2.2 pF ±5% NPO 50V cer smd | 510-3601-229 |
| C 827 | .001 µF ±5% NPO cer smd | 510-3601-102 |

| Ref No. | Description | Part No. |
|---|---|---|
| C 828 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 829 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 831 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 832 | 27 pF ±5% NPO cer smd | 510-3601-270 |
| C 834 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 836 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 837 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 838 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 839 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 840 | .001 µF ±5% NPO cer smd | 510-3601-102 |
| C 841 | 10 pF ±5% NPO 50V cer smd | 510-3601-100 |
| C 842 | .001 µF ±5% NPO 50V cer smd | 510-3601-102 |
| C 843 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 844 | 5.6 pF ±5% NPO 50V cer smd | 510-3601-569 |
| C 846 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 850 | 1.0 µF 35V tantalum smd | 510-2628-109 |
| C 852 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 853 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| | | |
| CH 101 | Chassis, black | 015-0905-021 |
| | | |
| CR 100 | Switching diode SOT-23 | 523-1504-002 |
| CR 101 | Switching diode SOT-23 | 523-1504-002 |
| CR 102 | 6.2V zener ±5% SOT | 523-2016-629 |
| CR 103 | Switching diode SOT-23 | 523-1504-002 |
| CR 290 | Switching diode SOT-23 | 523-1504-002 |
| CR 500 | Switching diode SOT-23 | 523-1504-002 |
| CR 502 | Switching diode SOT-23 | 523-1504-001 |
| CR 503 | Transient suppressor | 523-2906-001 |
| CR 504 | HC diode SOT-23 | 523-1504-016 |
| CR 505 | HC diode SOT-23 | 523-1504-016 |
| CR 506 | PIN diode | 523-1504-032 |
| CR 507 | PIN diode | 523-1504-032 |
| CR 508 | Switching diode SOT-23 | 523-1504-002 |
| CR 509 | Switching diode SOT-23 | 523-1504-002 |
| CR 802 | Switching diode SOT-23 | 523-1504-001 |
| CR 803 | Switching diode SOT-23 | 523-1504-001 |
| CR 804 | Dual switching diode SOT-23 | 523-1504-023 |
| CR 805 | Dual switching diode SOT-23 | 523-1504-023 |
| | | |
| EP 205 | Miniature crystal pin insulator | 010-0345-280 |
| EP 500 | .37 x .37 ferrite bead | 517-2002-003 |
| | | |
| F 500 | Fuse, 4-amp subminiature | 534-0009-040 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| HW 001 | Captive screw, covers | 537-9007-045 |
| HW 002 | Screw, 6-32 x 5/16" Torx | 575-0006-010 |
| HW 003 | Plug, option cable hole | 032-0792-075 |
| HW 004 | Heat sink clip | 017-2226-030 |
| HW 005 | O-ring 1/8"x 1/4" | 574-2002-001 |
| HW 006 | Washer, .16 ID nylon | 596-4408-015 |
| HW 007 | 1/8" ID rub split grommet | 574-0002-015 |
| HW 008 | Rubber bumper | 574-1008-002 |
| HW 008 | Ground clip | 017-2226-040 |
| | (900 MHz, 30W only) | |
| HW 009 | Flat steel washer, .167 x .277 | 596-9408-009 |
| HW 015 | Grommet | 574-0002-007 |
| HW 016 | Grommet | 574-0002-007 |
| HW 017 | Plug, accessory cable hole | 032-0792-075 |
| HW 150 | Screw, 4-40 x .3125 pan head | 575-0604-010 |
| HW 300 | Bottom shield snubber | 018-1134-135 |
| HW 500 | Socket, fuse | 515-5006-002 |
| | | |
| J 002 | RF board to PA board connector | 515-9006-110 |
| J 003 | 20-pin RF to A/L board header | 515-7181-025 |
| J 200 | 20-pin connector | 515-7111-230 |
| J 201 | 20-pin connector | 515-7111-230 |
| J 501 | 20-pin connector | 515-7111-230 |
| | | |
| L 200 | 0.39 µH smd inductor | 542-9001-398 |
| L 201 | 0.9 µH variable inductor | 542-1012-008 |
| L 202 | 0.9 µH variable inductor | 542-1012-008 |
| L 203 | 0.39 µH smd inductor | 542-9001-398 |
| L 204 | 0.047 µH smd inductor | 542-9001-477 |
| L 205 | 0.9 µH variable inductor | 542-1012-008 |
| L 206 | 0.39 µH smd inductor | 542-9001-398 |
| L 207 | .39 µH smd inductor | 542-9001-398 |
| L 208 | 0.39 µH smd inductor | 542-9001-398 |
| L 209 | .9 µH variable inductor | 542-1012-008 |
| | (900 MHz only) | |
| L 500 | 8T 22 AWG smd inductor | 542-0016-008 |
| | (800 MHz) | |
| | 6T 22 AWG smd inductor | 542-0015-006 |
| | (900 MHz) | |
| L 501 | 8T 22 AWG smd inductor | 542-0016-008 |
| | (All except the following) | |
| | 4T 22 AWG smd inductor | 542-0015-004 |
| | (900 MHz, 15W) | |
| L 503 | 8T 22 AWG smd inductor | 542-0016-008 |
| | (800 MHz 35W) | |
| | 6T 22 AWG smd inductor | 542-0015-006 |
| | (900 MHz 30W) | |
| L 504 | 4T 22 AWG smd inductor | 542-0015-004 |
| | (800 MHz 35W) | |
| | 2T 22 AWG smd inductor | 542-0015-002 |
| | (900 MHz 30W) | |
| L 506 | 6T 22 AWG smd inductor | 542-0015-006 |
| | (800 MHz 15W) | |
| | 8T 22 AWG smd inductor | 542-0016-008 |
| | (All others) | |
| L 507 | 6T 22 AWG smd inductor | 542-0015-006 |
| | (800 MHz 15W) | |
| | | |
| | 8T 22 AWG smd inductor | 542-0016-008 |
| | (800 MHz 35W) | |
| | 5T 22 AWG smd inductor | 542-0015-005 |
| | (900 MHz) | |
| L 508 | 6T 22 AWG smd inductor | 542-0015-006 |
| L 510 | 6T 22 AWG smd inductor | 542-0015-006 |
| L 520 | 70 µH 15A filter choke | 542-5010-003 |
| L 800 | .047 µH smd inductor | 542-9001-477 |
| L 801 | .01 µH smd inductor | 542-9001-107 |
| L 803 | .047 µH smd inductor | 542-9001-477 |
| | | |
| MP 000 | Keycap set, Summit | 587-9650-008 |
| MP 002 | Top cover, black | 015-0905-026 |
| MP 003 | Bottom cover, black | 015-0905-031 |
| MP 156 | Top cover gasket | 032-0792-060 |
| MP 157 | Bottom cover gasket | 032-0792-064 |
| MP 200 | Insulator, filter Z201 | 018-1132-095 |
| MP 300 | Foam tape | 574-3002-013 |
| MP 500 | Shield, low-pass filter | 017-2226-036 |
| MP 501 | Shield, coax ground | 017-2226-017 |
| MP 502 | Transistor ground tab | 017-2225-527 |
| MP 503 | Transistor ground tab | 017-2225-527 |
| MP 504 | Transistor ground tab | 017-2225-527 |
| MP 505 | Transistor ground tab | 017-2225-527 |
| MP 506 | Jumper strap, 15W | 017-2224-340 |
| | (15W only) | |
| MP 508 | Transistor ground tab | 017-2225-527 |
| MP 509 | Transistor ground tab | 017-2225-527 |
| MP 510 | Module shield | 017-2226-019 |
| MP 990 | Mic gasket | 574-3002-121 |
| MP 991 | Seal, mic connector | 032-0792-129 |
| NP 008 | Summit DM label | 559-9001-334 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| | | |
| P 100 | 2-pin header | 515-9031-201 |
| P 101 | 3-pin header | 515-9031-202 |
| | | |
| PC 210 | PC board, RF | 035-9650-210 |
| PC 500 | PC board, PA unrevised | 035-9650-510 |
| | PC board, PA revised | 035-9650-530 |
| | | |
| Q 100 | PNP TO-220 | 576-0002-057 |
| Q 101 | NPN low-noise amp | 576-0001-300 |
| Q 102 | PNP 6-amp power | 576-0002-603 |
| Q 103 | PNP low-noise amp | 576-0003-657 |
| Q 104 | NPN low-noise amp | 576-0001-300 |
| Q 106 | NPN amplifier | 576-0003-658 |
| Q 107 | NPN low-noise amp | 576-0001-300 |
| Q 108 | NPN low-noise amp | 576-0001-300 |
| Q 200 | PNP low-noise amp | 576-0003-650 |
| Q 201 | P-channel JFET | 576-0006-020 |
| Q 202 | PNP low noise amp | 576-0003-650 |
| Q 203 | NPN VHF/UHF amp | 576-0003-634 |
| Q 205 | NPN wideband amp | 576-0003-649 |
| Q 290 | NPN wideband amp | 576-0003-649 |
| Q 291 | PNP low noise amp | 576-0003-650 |
| Q 500 | NPN 20W 870 MHz amp | 576-0004-805 |
| | (800 MHz) | |
| | NPN 20W 900 MHz amp | 576-0004-901 |
| | (900 MHz) | |
| Q 501 | NPN 45W 870 MHz amp | 576-0004-817 |
| | (800 MHz 35W) | |
| | NPN 45W 896-940 MHz amp | 576-0004-818 |
| | (900 MHz 30W) | |
| Q 502 | NPN low-noise amp | 576-0001-300 |
| Q 503 | NPN low-noise amp | 576-0001-300 |
| Q 504 | NPN low-noise amp | 576-0001-300 |
| Q 506 | NPN low-noise amp | 576-0001-300 |
| Q 507 | NPN amplifier | 576-0003-658 |
| Q 510 | PNP switching | 576-0003-612 |
| Q 511 | PNP 6-amp power | 576-0002-603 |
| Q 514 | PNP switching | 576-0003-612 |
| Q 800 | NPN low-noise amp | 576-0001-300 |
| Q 801 | NPN wideband amp | 576-0003-649 |
| Q 802 | PNP low noise amp | 576-0003-650 |
| Q 804 | PNP low noise amp | 576-0003-650 |
| Q 805 | PNP low-noise RF amp | 576-0003-608 |
| Q 806 | PNP low-noise RF amp | 576-0003-608 |

| Ref No. | Description | Part No. |
|---|---|---|
| Q 807 | NPN low-noise amp | 576-0001-300 |
| Q 808 | PNP low noise amp | 576-0003-650 |
| Q 809 | PNP low noise amp | 576-0003-650 |
| | | |
| R 100 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 101 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 102 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 103 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 104 | 27k ohm ±5% 1/8W smd | 569-0105-273 |
| R 105 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 106 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 107 | 2.7 ohm ±5% 1/8W smd | 569-0105-279 |
| R 108 | 33 ohm ±5% 1/8W smd | 569-0105-330 |
| R 109 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 110 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 111 | 33k ohm ±5% 1/8W smd | 569-0105-333 |
| R 112 | 33k ohm ±5% 1/8W smd | 569-0105-333 |
| R 113 | 54.9k ohm ±1% 1/8W smd | 569-0111-472 |
| R 114 | 100k ohm ±1% 1/8W smd | 569-0111-501 |
| R 115 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 116 | 17.8k ohm ±1% 1/8W smd | 569-0111-425 |
| R 117 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 118 | 7.5k ohm ±1% 1/8W smd | 569-0111-385 |
| R 120 | 2.2 ohm ±5% 1W smd | 569-0175-229 |
| | | |
| R 200 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 201 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 202 | 18 ohm ±5% 1/8W smd | 569-0105-180 |
| R 203 | 270 ohm ±5% 1/8W smd | 569-0105-271 |
| R 204 | 270 ohm ±5% 1/8W smd | 569-0105-271 |
| R 205 | 91k ohm ±5% 1/8W smd | 569-0105-913 |
| | (800 MHz) | |
| | 56k ohm ±5% 1/8W smd | 569-0105-563 |
| | (900 MHz) | |
| R 206 | 270k ohm ±5% 1/8W smd | 569-0105-274 |
| R 207 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 208 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 209 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 210 | 560 ohm ±5% 1/8W smd | 569-0105-561 |
| R 211 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 212 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 213 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| | (800 MHz) | |
| | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| | (900 MHz) | |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| R 214 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 215 | 270 ohm ±5% 1/8W smd | 569-0105-271 |
| R 216 | 0 ohm jumper | 569-0105-001 |
| | (900 MHz only) | |
| R 217 | 18 ohm ±5% 1/8W smd | 569-0105-180 |
| R 218 | 270 ohm ±5% 1/8W smd | 569-0105-271 |
| R 220 | 330 ohm ±5% 1/8W smd | 569-0105-331 |
| R 221 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 222 | 1.8k ohm ±5% 1/8W smd | 569-0105-182 |
| R 223 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 224 | 150 ohm ±5% 1/8W smd | 569-0105-151 |
| R 225 | 33 ohm ±5% 1/8W smd | 569-0105-330 |
| R 226 | 150 ohm ±5% 1/8W smd | 569-0105-151 |
| R 230 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 232 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 234 | 39k ohm ±5% 1/8W smd | 569-0105-393 |
| R 235 | 330k ohm ±5% 1/8W smd | 569-0105-334 |
| R 236 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 237 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 290 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 291 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 294 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 295 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 297 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| | | |
| R 500 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 501 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 503 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 506 | 91 ohm ±5% 1/8W smd | 569-0105-910 |
| R 507 | 82 ohm ±5% 1/8W smd | 569-0105-820 |
| R 508 | 91 ohm ±5% 1/8W smd | 569-0105-910 |
| R 510 | 330 ohm ±5% 1W smd | 569-0175-331 |
| | (All except 900 MHz 15W) | |
| R 511 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 512 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 513 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| | (Unrevised PA board) | |
| | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| | (Revised PA board) | |
| R 514 | 100 ohm 3/4W smd | 569-0135-101 |
| R 515 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 516 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 517 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 519 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 521 | 10k ohm ±5% 1/8W smd | 569-0105-103 |

| Ref No. | Description | Part No. |
|---|---|---|
| R 522 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 525 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 526 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 527 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 528 | 470 ohm ±5% 1/8W smd | 569-0105-471 |
| R 531 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 534 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 536 | 330 ohm ±5% 1/8W smd | 569-0105-331 |
| R 537 | 100 ohm 3/4W smd | 569-0135-101 |
| R 538 | 100 ohm 3/4W smd | 569-0135-101 |
| R 539 | 330 ohm ±5% 1/8W smd | 569-0105-331 |
| R 540 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 541 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 543 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 544 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 545 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 546 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 547 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 548 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 550 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 551 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 552 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 553 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 554 | 20k ohm ±5% 1/8W smd | 569-0105-203 |
| R 555 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 558 | 1M ohm ±5% 1/8W smd | 569-0105-105 |
| R 559 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 560 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 561 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 563 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 564 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 565 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 566 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 568 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| | (800 MHz 15W) | |
| | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| | (All others) | |
| R 571 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 575 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 576 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| | (All 800 MHz) | |
| | 43 ohm ±5% 1/8W smd | 569-0105-430 |
| | (900 MHz 15W) | |
| | 39 ohm ±5% 1/8W smd | 569-0105-390 |
| | (900 MHz 30W) | |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| R 577 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| | (800 MHz 15W) | |
| | 1.5k ohm ±5% 1/8W smd | 569-0105-152 |
| | (800 MHz 35W) | |
| | 330 ohm ±5% 1/8W smd | 569-0105-331 |
| | (900 MHz, 15W) | |
| | 680 ohm ±5% 1/8W smd | 569-0105-681 |
| | (900 MHz 30W) | |
| R 580 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 585 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| | (800 MHz 15W) | |
| | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| | (All others) | |
| R 586 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 587 | .03 ohm ±5% 2W smd | 569-2019-307 |
| R 589 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 590 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 591 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R592 | 0 ohm jumper | 569-0105-001 |
| R 800 | 10 ohm ±5% 1/8W smd | 569-0105-100 |
| R 801 | 1.8k ohm ±5% 1/8W smd | 569-0105-182 |
| R 802 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| | (800 MHz, w/-500 Y800) | |
| | 39k ohm ±5% 1/8W smd | 569-0105-393 |
| | (900 MHz, w/-500 Y800) | |
| | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| | (all w/-521 Y800, see Table A-2) | |
| R 803 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| | (800 MHz, w/-500 Y800) | |
| | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| | (800 MHz, w/-521 Y800, see Table A-2) | |
| | 820k ohm ±5% 1/8W smd | 569-0105-824 |
| | (900 MHz, w/-500 Y800) | |
| | 560k ohm ±5% 1/8W smd | 569-0105-564 |
| | (900 MHz, w/-521 Y800, see Table A-2) | |
| R 805 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 806 | 18k ohm ±5% 1/8W smd | 569-0105-183 |
| R 807 | 180 ohm ±5% 1/8W smd | 569-0105-181 |
| R 808 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 809 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 810 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 811 | 150 ohm ±5% 1/8W smd | 569-0105-151 |

| Ref No. | Description | Part No. |
|---|---|---|
| R 812 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 813 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 814 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 815 | 33k ohm ±5% 1/8W smd | 569-0105-333 |
| R 819 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| | (800 MHz) | |
| | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| | (900 MHz) | |
| R 820 | 820 ohm ±5% 1/8W smd | 569-0105-821 |
| | (800 MHz) | |
| | 910 ohm ±5% 1/8W smd | 569-0105-911 |
| | (900 MHz) | |
| R 821 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 822 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 823 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 824 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 826 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 827 | 820 ohm ±5% 1/8W smd | 569-0105-821 |
| | (800 MHz) | |
| | 910 ohm ±5% 1/8W smd | 569-0105-911 |
| | (900 MHz) | |
| R 828 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| | (800 MHz) | |
| | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| | (900 MHz) | |
| R 829 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 830 | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| R 831 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 832 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 833 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 834 | 150 ohm ±5% 1/8W smd | 569-0105-151 |
| R 835 | 2.0k ohm ±5% 1/8W smd | 569-0105-202 |
| R 836 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 837 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 838 | 10 ohm ±5% 1/8W smd | 569-0105-100 |
| R 840 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 842 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 843 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 844 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 845 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| | (800 MHz) | |
| | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| | (900 MHz) | |
| R 846 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |

## RF and PA Boards, Misc

| Ref No. | Description | Part No. |
|---|---|---|
| R 847 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 848 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 849 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 851 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| RT 500 | Thermistor, 10k ohm (30/35W) | 569-3012-001 |
| U 100 | Audio amp, 20W 7240A | 544-2006-018 |
| U 101 | Regulator, 5V, 0.5A 78M05 | 544-2003-079 |
| U 102 | Regulator, +8V 1.5A 7808 | 544-2003-009 |
| U 200 | FM IF system 3362 | 544-2026-016 |
| U 201 | Op amp, dual 532 | 544-2019-004 |
| U 500 | Power amp module 6W (800 MHz, unrevised PA) | 544-4001-047 |
| | Power amp module 6W (800 MHz, revised PA) | 544-4001-048 |
| | Power amp module 6W (900 MHz) | 544-4001-049 |
| U 503 | Shift register, 8-stage 4094 | 544-3016-094 |
| U 504 | Op amp, quad 224 | 544-2020-014 |
| U 800 | Prescaler ÷128/129 MC12052 | 544-3954-040 |
| U 801 | Synthesizer 145158 | 544-3016-058 |
| U 802 | Shift register, 8-stage 4094 | 544-3016-094 |
| W 003 | Remote control cable, 17 ft. | 597-2002-262 |
| W 150 | Prog jack/cable assy (rem xcvr) | 023-2002-266 |
| W 501 | PA deck DC power cable assembly | 597-2002-235 |
| W 502 | PA deck RF cable assembly | 597-2002-240 |
| Y 800 | TCXO 17.500 MHz 1.5 PPM (Later models, see Table A-2) | 518-7009-521 |
| Z 200 | 450 kHz 15 kHz ceramic filter (800 MHz) | 532-2006-032 |
| | 450 kHz 9 kHz ceramic filter (900 MHz) | 532-2006-034 |
| Z 201 | 860 MHz 20 MHz bw 3P filter (800 MHz) | 532-2007-011 |
| | 938 kHz 6 MHz bw 3P filter (900 MHz) | 532-2007-012 |
| Z 202 | 807 MHz 18 MHz bw 2P filter (800 MHz) | 532-2006-011 |
| | 885 kHz 6 MHz bw 2P filter (900 MHz) | 532-2006-014 |
| Z 204 | 455 kHz variable inductor w/cap | 542-1012-010 |
| Z 205 | 52.95 MHz 15 kHz bw 4P filter (800 MHz) | 532-0009-009 |
| | 52.95 MHz 8 kHz bw 4P filter (900 MHz) | 532-0009-011 |
| Z 206 | 52.95 MHz 18 kHz bw 2P filter (800 MHz) | 532-0009-010 |
| | 52.95 MHz 10 kHz bw 2P filter (900 MHz) | 532-0009-012 |
| Z 290 | 860 MHz 20 MHz bw 3P filter (800 MHz) | 532-2007-011 |
| | 938 MHz 6 MHz bw 2P filter (900 MHz) | 532-2006-015 |

| Ref No. | Description | Part No. |
|---|---|---|
| | **AUDIO/LOGIC BOARD** | |
| C 300 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 302 | 470 pF ±5% NPO cer smd | 510-3601-471 |
| C 303 | 470 pF ±5% NPO cer smd | 510-3601-471 |
| C 304 | 470 pF ±5% NPO cer smd | 510-3601-471 |
| C 305 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 306 | 470 pF ±5% NPO cer smd | 510-3601-471 |
| C 400 | 30 pF ±5% NPO cer smd | 510-3601-300 |
| C 401 | 30 pF ±5% NPO cer smd | 510-3601-300 |
| C 402 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 403 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 404 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 405 | .001 µF X7R ±10% 50V cer smd | 510-3605-102 |
| C 406 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 407 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 408 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 409 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 410 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 411 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 412 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 413 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 415 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 416 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 417 | 39 pF ±5% NPO cer smd | 510-3601-390 |
| C 418 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 600 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 601 | 1.0 µF 16V tantalum smd | 510-2625-109 |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| C 602 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 603 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 604 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 605 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 606 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 607 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 608 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 609 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 610 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 611 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 612 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 613 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 614 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 615 | .001 µF ±10% X7R 50V cer smd | 510-3606-102 |
| C 616 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 617 | .1 µF ±10% X7R 50V cer smd | 510-3607-104 |
| C 618 | 39 pF ±5% NPO cer smd | 510-3601-390 |
| C 619 | 39 pF ±5% NPO cer smd | 510-3601-390 |
| C 620 | 39 pF ±5% NPO cer smd | 510-3601-390 |
| C 621 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 622 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 624 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 625 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 626 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 627 | .0022 µF X7R ±10% 50V cer | 510-3605-222 |
| C 628 | .0068 µF X7R ±10% 50V cer | 510-3605-682 |
| C 629 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 630 | .0082 µF X7R ±10% 50V cer | 510-3605-822 |
| C 631 | .0068 µF X7R ±10% 50V cer | 510-3605-682 |
| C 632 | .0033 µF X7R ±10% 50V cer | 510-3605-332 |
| C 633 | .0068 µF X7R ±10% 50V cer | 510-3605-682 |
| C 634 | .0068 µF X7R ±10% 50V cer | 510-3605-682 |
| C 635 | .0056 µF X7R ±10% 50V cer | 510-3605-562 |
| C 636 | .0068 µF X7R ±10% 50V cer | 510-3605-682 |
| C 638 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 639 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 640 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 641 | .039 µF ±10% X7R 50V cer smd | 510-3606-393 |
| C 642 | .0022 µF X7R 50V cer smd | 510-3605-222 |
| C 643 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 644 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 645 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 646 | 100 pF ±5% NPO 50V cer smd | 510-3601-101 |
| C 647 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 648 | .0068 µF X7R 50V cer smd | 510-3605-682 |

| Ref No. | Description | Part No. |
|---|---|---|
| C 650 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 651 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 652 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 653 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 660 | 4.7 µF 20V tantalum smd | 510-2626-479 |
| C 661 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 662 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 663 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 664 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 665 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 666 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 667 | .001 µF X7R ±10% 50V cer smd | 510-3605-102 |
| C 668 | 680 pF ±5% NPO 50V cer smd | 510-3601-681 |
| C 669 | .001 µF X7R ±10% 50V cer smd | 510-3605-102 |
| C 670 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 671 | .0068 µF X7R 50V cer smd | 510-3605-682 |
| C 672 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 673 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 674 | .039 µF ±10% X7R 50V cer smd | 510-3606-393 |
| C 675 | .0022 µF X7R 50V cer smd | 510-3605-222 |
| C 676 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 677 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 678 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 679 | 4.7 µF 20V tantalum smd | 510-2624-479 |
| C 680 | 4.7 µF 20V tantalum smd | 510-2624-479 |
| C 681 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 682 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 683 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 684 | .0012 µF X7R 50V cer smd | 510-3605-122 |
| C 685 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 686 | .0033 µF X7R 50V cer smd | 510-3605-332 |
| C 687 | 560 pF ±5% NPO cer smd | 510-3601-561 |
| C 688 | .0047 µF X7R ±10% 50V smd | 510-3605-472 |
| C 689 | 56 pF ±5% NPO cer smd | 510-3601-560 |
| C 690 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 691 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 692 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 693 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 694 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 695 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 696 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 697 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 698 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 705 | .01 µF X7R ±5% cer smd | 510-3609-103 |
| C 706 | .01 µF X7R ±5% cer smd | 510-3609-103 |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| C 707 | 0.1 µF X7R ±5% 50V cer smd | 510-3610-104 |
| C 708 | .0033 µF X7R ±5% cer smd | 510-3609-332 |
| C 709 | .0022 µF X7R ±5% cer smd | 510-3609-222 |
| C 710 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 711 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 712 | .01 µF X7R ±5% cer smd | 510-3609-103 |
| C 713 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |
| C 714 | 0.1 µF X7R ±5% 50V cer smd | 510-3610-104 |
| C 715 | .0033 µF X7R ±5% cer smd | 510-3609-332 |
| C 716 | .0022 µF X7R ±5% cer smd | 510-3609-222 |
| C 717 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 719 | .01 µF X7R ±5% cer smd | 510-3609-103 |
| C 720 | 1200 pF X7R ±10% 50V cer smd | 510-3605-122 |
| C 721 | 1200 pF X7R ±10% 50V cer smd | 510-3605-122 |
| C 722 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 723 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 730 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 731 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 732 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 733 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 734 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 735 | .01 µF X7R ±10% 50V cer smd | 510-3605-103 |
| C 736 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 783 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 786 | 4.7 µF 20V tantalum smd | 510-2624-479 |
| C 788 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| | | |
| CR 400 | Dual switching, common cathode | 523-1504-022 |
| CR 401 | Switching diode | 523-1504-017 |
| CR 500-CR516 | 18V ±5% zener diode | 523-2016-180 |
| CR 600 | Dual switching, common anode | 523-1504-024 |
| CR 601 | Dual switching, common cathode | 523-1504-022 |
| CR 610 | Dual sw diode (unrevised bd) | 523-1504-023 |
| | UHF/VHF band sw diode (rev bd) | 523-1504-012 |
| CR 611 | UHF/VHF band sw diode (rev bd) | 523-1504-012 |
| CR 620 | Dual switching diode | 523-1504-023 |
| | | |
| J 001 | Solderless pin | 586-3502-002 |
| J 002 | Solderless pin | 586-3502-002 |
| J 300 | 20-pin connector | 515-7111-230 |
| J 400 | 5-pin connector | 515-7111-254 |
| J 401 | 30-pin zif connector | 515-7111-283 |
| J 402 | 13-pin connector | 515-7111-262 |
| J 403 | 13-pin connector | 515-7111-262 |

| Ref No. | Description | Part No. |
|---|---|---|
| J 404 | 12-pin connector | 515-7111-261 |
| J 405 | 6-pin connector | 515-7111-255 |
| | | |
| PC 313 | PC board, audio/logic | 035-9750-320 |
| | | |
| Q 300 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 400 | PNP digital w/res SOT-23 | 576-0003-621 |
| Q 401 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 402 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 403 | N-channel MOSFET enhanc mode | 576-0006-114 |
| Q 404 | NPN dual digital w/res SOT-25 | 576-0003-626 |
| Q 450 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 451 | PNP switching SOT-23 | 576-0003-612 |
| Q 452 | PNP digital w/res SOT-23 | 576-0003-621 |
| Q 600 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 601 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 602 | NPN low noise amplifier | 576-0001-300 |
| Q 610 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 612 | NPN amplifier SOT-23 | 576-0003-616 |
| | | |
| R 300 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 301 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 302 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 303 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 304 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 305 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 306 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 307 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 308 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 309 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 310 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 311 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 312 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 313 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 314 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 315 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 316 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 317 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 318 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 319 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 320 | 82k ohm ±5% 1/8W smd | 569-0105-823 |
| R 321 | 82k ohm ±5% 1/8W smd | 569-0105-823 |
| R 322 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 323 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 324 | 22k ohm ±5% 1/8W smd | 569-0105-223 |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| R 325 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 326 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 400 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 401 | 10M ohm ±5% 1/8W smd | 569-0105-106 |
| R 402 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 403 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 404 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 405 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 406 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 407 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 408 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 409 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 410 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 411 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 412 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 413 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 414 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 415 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 416 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 417 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 418 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 419 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 420 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 422 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 423 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 424 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 425 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 426 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 427 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 428 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 429 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 430 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 431 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 432 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 433 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 434 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 435 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 436 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 437 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 438 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 439 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 440 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 441 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 442 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 444 | 100k ohm ±5% 1/8W smd | 569-0105-104 |

| Ref No. | Description | Part No. |
|---|---|---|
| R 445 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 446 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 447 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 448 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 449 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 450 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 451 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 452 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 453 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 454 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 455 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 456 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 457 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 458 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 459 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 460 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 461 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 462 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 463 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 464 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 465 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 466 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 467 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 468 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 469 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 470 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 471 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 472 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 473 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 474 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 475 | 150 ohm ±5% 1/8W smd | 569-0105-151 |
| R 480 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 481 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 482 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 483 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 484 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 485 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 486 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 487 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 488 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 489 | 220 ohm ±5% 1/8W smd | 569-0105-221 |
| R 490 | 100 ohm ±5% 1/8W smd | 569-0105-101 |
| R 492 | 6.8k ohm ±5% 1/8W smd | 569-0105-682 |
| R 493 | 6.8k ohm ±5% 1/8W smd | 569-0105-682 |
| R 494 | 11k ohm ±5% 1/8W smd | 569-0105-113 |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| R 500 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 501 | 1k ohm ±5% 1/8W smd | 569-0105-102 |
| R 502 | Zero ohm jumper | 569-0105-001 |
| R 503 | 1k ohm ±5% 1/8W smd | 569-0105-102 |
| R 601 | 6.8k ohm ±5% 1/8W smd | 569-0105-682 |
| R 602 | 5.1k ohm ±5% 1/8W smd | 569-0105-512 |
| R 606 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 607 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 608 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 609 | 27k ohm ±5% 1/8W smd | 569-0105-683 |
| R 610 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 612 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 613 | 820k ohm ±5% 1/8W smd | 569-0105-824 |
| R 614 | 1k ohm ±5% 1/8W smd | 569-0105-102 |
| R 615 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 616 | 2.7k ohm ±5% 1/8W smd | 569-0105-272 |
| R 617 | 1M ohm ±5% 1/8W smd | 569-0105-105 |
| R 618 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 619 | 12k ohm ±5% 1/8W smd | 569-0105-123 |
| R 620 | 560k ohm ±5% 1/8W smd | 569-0105-564 |
| R 621 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 622 | 18k ohm ±5% 1/8W smd | 569-0105-183 |
| R 623 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 624 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 625 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 627 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 628 | 27k ohm ±5% 1/8W smd | 569-0105-273 |
| R 630 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 631 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 632 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 633 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 634 | Zero ohm ±5% 1/8W smd | 569-0105-001 |
| R 635 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 636 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 637 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 639 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 640 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 641 | 1k ohm ±5% 1/8W smd | 569-0105-102 |
| R 642 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 643 | 220k ohm smd trimmer | 562-0130-224 |
| R 644 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 645 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 646 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 647 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 648 | 100k ohm ±5% 1/8W smd | 569-0105-104 |

| Ref No. | Description | Part No. |
|---|---|---|
| R 650 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 655 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 656 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 657 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 658 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 659 | 620k ohm ±5% 1/8W smd | 569-0105-624 |
| R 660 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 661 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 662 | 110k ohm ±5% 1/8W smd | 569-0105-114 |
| R 663 | 110k ohm ±5% 1/8W smd | 569-0105-114 |
| R 664 | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| R 665 | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| R 666 | 110k ohm ±5% 1/8W smd | 569-0105-114 |
| R 667 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 668 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 669 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 670 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 671 | 180k ohm ±5% 1/8W smd | 569-0105-184 |
| R 672 | 820k ohm ±5% 1/8W smd | 569-0105-824 |
| R 673 | 7.5k ohm ±5% 1/8W smd | 569-0105-752 |
| R 674 | 560k ohm ±5% 1/8W smd | 569-0105-564 |
| R 675 | 1.2k ohm ±5% 1/8W smd | 569-0105-122 |
| R 676 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 677 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 678 | 3.9k ohm ±5% 1/8W smd | 569-0105-392 |
| R 679 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 680 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 681 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 682 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 683 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 684 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 685 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 686 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 687 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 688 | 27k ohm ±5% 1/8W smd | 569-0105-273 |
| R 689 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 690 | Zero ohm ±5% 1/8W smd | 569-0105-001 |
| R 691 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 692 | 560k ohm ±5% 1/8W smd | 569-0105-564 |
| R 693 | 390 ohm ±5% 1/8W smd | 569-0105-391 |
| R 694 | 680 ohm ±5% 1/8W smd | 569-0105-681 |
| R 695 | Zero ohm ±5% 1/8W smd | 569-0105-001 |
| R 696 | 39k ohm ±5% 1/8W smd | 569-0105-393 |
| R 697 | 82k ohm ±5% 1/8W smd | 569-0105-823 |
| R 698 | 68k ohm ±5% 1/8W smd | 569-0105-683 |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| R 699 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 700 | 82k ohm ±5% 1/8W smd | 569-0105-823 |
| R 701 | 470k ohm smd trimmer | 562-0130-474 |
| R 702 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 703 | 220k ohm smd trimmer | 562-0130-224 |
| R 704 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| | (w/-500 Y800, see Table A-2) | |
| | 18k ohm ±5% 1/8W smd | 569-0105-183 |
| | (w/-521 Y800, see Table A-2) | |
| R 705 | 0 ohm jumper smd | 569-0105-001 |
| R 706 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 707 | 0 ohm jumper smd | 569-0105-001 |
| R 708 | 1.50k ohm ±1% 1/8W smd | 569-0111-318 |
| R 709 | 1.50k ohm ±1% 1/8W smd | 569-0111-318 |
| R 710 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 711 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 712 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 713 | 33k ohm ±5% 1/8W smd | 569-0105-333 |
| R 714 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 715 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 716 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 717 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 718 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 719 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 720 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 721 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 722 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 723 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 724 | 330k ohm ±5% 1/8W smd | 569-0105-334 |
| R 726 | 100k ohm ±5% 1/8W (unrev bd) | 569-0105-104 |
| | 75k ohm ±5% 1/8W (rev bd) | 569-0105-753 |
| R 727 | 270k ohm ±5% 1/8W smd | 569-0105-274 |
| R 728 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 729 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 730 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 731 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 732 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 733 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 734 | 1.50k ohm ±1% 1/8W smd | 569-0111-318 |
| R 735 | 1.50k ohm ±1% 1/8W smd | 569-0111-318 |
| R 736 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 737 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 738 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 739 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 740 | 330k ohm ±5% 1/8W smd | 569-0105-334 |
| R 745 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 746 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 747 | 270k ohm ±5% 1/8W smd | 569-0105-274 |
| R 748 | 10k ohm smd trimmer | 562-0130-103 |
| R 749 | Zero ohm ±5% 1/8W smd | 569-0105-001 |
| R 751 | 180k ohm ±5% 1/8W smd | 569-0105-184 |
| R 752 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 753 | 820 ohm ±5% 1/8W smd | 569-0105-821 |
| R 754 | 33k ohm ±5% 1/8W smd | 569-0105-333 |
| R 755 | 8.2k ohm ±5% 1/8W smd | 569-0105-822 |
| R 756 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 757 | 3.3k ohm ±5% 1/8W smd | 569-0105-332 |
| R 758 | 1k ohm smd trimmer | 562-0130-102 |
| R 759 | Zero ohm jumper smd | 569-0105-001 |
| R 760 | 56k ohm ±5% 1/8W smd | 569-0105-563 |
| R 761 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 763 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 764 | 22k ohm ±5% 1/8W smd | 569-0105-223 |
| R 765 | 0 ohm jumper | 569-0105-001 |
| R 767 | 1.2k ohm ±5% 1/8W smd | 569-0105-122 |
| R 768 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 770 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 771 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 772 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 773 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 774 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 775 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 776 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 777 | 47k ohm ±5% 1/8W smd | 569-0105-473 |
| R 778 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 779 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 780 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 781 | 11.0k ohm 1% 1/8W smd | 569-0101-405 |
| R 782 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 785 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 786 | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| R 789 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 790 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 791 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 792 | 1.0k ohm ±5% 1/8W smd | 569-0105-102 |
| R 793 | 3.4k ohm ±1% 1/8W smd | 569-0101-352 |
| R 795 | 11k ohm ±5% 1/8W smd | 569-0105-113 |
| R 796 | 620k ohm ±5% 1/8W smd | 569-0105-624 |
| | (900 MHz only) | |

## Audio/Logic Board

| Ref No. | Description | Part No. |
|---|---|---|
| RT 600 | Thermistor 1k ohm | 569-3013-002 |
| U 300 | Microprocessor, DSP TMS320C17 | 544-5003-150 |
| U 301 | Latch, 3-state 74HC573 | 544-3766-573 |
| U 302 | Prgmble array logic I/O custom | 544-9017-005 |
| U 304 | Serial A/D converter 145040 | 544-2034-003 |
| U 305 | Op amp, dual 532 | 544-2019-004 |
| U 400 | Low voltage sensor 33164 | 544-2003-074 |
| U 401 | Microprocessor, 8-bit 68HC11 | 544-5011-301 |
| U 402 | Latch, 3-state, octal 74HC573 | 544-3766-573 |
| U 403 | Prg array logic, address decoder | 544-9017-003 |
| U 404 | EPROM 128K x 8 flash 28F010 | 544-5011-589 |
| | (flash reprogramming required after replacement) | |
| U 405 | Static RAM 8K x 8 4464 | 544-5002-115 |
| U 406 | EEPROM 8K x 8 28C64 | Not Replaceable |
| | (return radio to E.F. Johnson Depot Repair for service) | |
| U 407 | Prgrmble array logic I/O decoder | 544-9017-004 |
| U 408 | D F-F 3-state, octal 74HC574 | 544-3766-574 |
| U 409 | D F-F 3-state, octal 74HC574 | 544-3766-574 |
| U 410 | Latch, 3-state, octal 74HC573 | 544-3766-573 |
| U 411 | Latch, 3-state, octal 74HC573 | 544-3766-573 |
| U 412 | Latch, 3-state, octal 74HC573 | 544-3766-573 |
| U 413 | Buffer, hex open drain 74C906 | 544-3716-906 |
| U 414 | Buffer, hex open drain 74C906 | 544-3716-906 |
| U 415 | Regulator, 5V 0.5A 78M05 | 544-2003-079 |
| U 450 | Shift register, 8-stage 4094 | 544-3016-094 |
| U 451 | Shift register, 8-stage 4094 | 544-3016-094 |
| U 452 | Shift register, 8-stage 4094 | 544-3016-094 |
| U 600 | Volume control, 2-channel 87032 | 544-0004-208 |
| U 601 | Op amp, quad 224 | 544-2020-014 |
| U 602 | Op amp, quad 224 | 544-2020-014 |
| U 603 | Op amp, quad 224 | 544-2020-014 |
| U 604 | Op amp, quad 224 | 544-2020-014 |
| U 605 | Op amp, quad 224 | 544-2020-014 |
| U 606 | Op amp, quad 224 | 544-2020-014 |
| U 607 | Op amp, quad 224 | 544-2020-014 |
| U 608 | Analog switch, quad 4066 | 544-3016-066 |
| U 609 | Analog switch, quad 4066 | 544-3016-066 |
| U 610 | Analog switch, quad 4066 | 544-3016-066 |
| X 401 | Socket, 32-pin | 515-5020-002 |
| Y 300 | 8.0 MHz crystal | 521-0008-001 |

| Ref No. | Description | Part No. |
|---|---|---|
| | **FRONT PANEL ASSEMBLY (Both Front and Remote Models)** | |
| A 151 | Front panel assembly, black | 587-9650-002 |
| C 101 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| DS 100 | Liquid crystal display assembly | 549-4501-010 |
| DS 101-DS 120 | LED, green smd | 549-4003-011 |
| DS 121-DS 126 | LED, green smd | 549-4001-145 |
| DS 127 | LED, red smd | 549-4101-001 |
| HW 010 | Washer | 596-9410-010 |
| HW 011 | Spanner nut, 3/8” x 7mm | 013-1313-018 |
| J 101 | 18-pin connector | 515-7111-266 |
| J 102 | Elastomeric connector | 515-9900-002 |
| J 103 | 2-pin connector, speaker wire | 515-9031-281 |
| LS 001 | Speaker, 2 x 3” 16-ohm | 589-1015-006 |
| MP 101 | Display bezel | 017-2226-046 |
| MP 102 | Display gasket | 018-1136-120 |
| MP 103 | Light pipe | 032-0792-032 |
| MP 108 | Support, keypad | 017-2226-090 |
| MP 151 | Gasket, front lens | 018-1136-108 |
| MP 152 | Control knob | 032-0792-010 |
| MP 153 | Control knob | 032-0792-010 |
| MP 154 | Speaker membrane | 018-1136-112 |
| MP 155 | Pad, display board | 018-1136-122 |
| MP 158 | Front panel lens | 032-0792-034 |
| MP 161 | Keypad, standard | 032-0792-030 |
| MP 162 | Speaker retainer | 016-2187-250 |
| NP 007 | Johnson label | 559-9001-310 |
| P 002 | 13-pin microphone connector | 515-1009-025 |
| PC100 | PC board, display | 035-9650-110 |
| PC150 | Flex circuit | 035-9650-150 |
| Q 101 | PNP low noise amp | 576-0003-650 |
| R 101 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 102 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 103 | 180k ohm ±5% 1/8W smd | 569-0105-184 |
| R 105 | 62 ohm 3/4W smd | 569-0135-620 |
| R 106 | 62 ohm 3/4W smd | 569-0135-620 |
| R 107 | 62 ohm 3/4W smd | 569-0135-620 |
| R 108 | 62 ohm 3/4W smd | 569-0135-620 |

| Ref No. | Description | Part No. |
|---|---|---|
| S 154 | 10k ohm volume pot/push-on sw | 562-0018-075 |
| S 155 | Switch, rotary and push | 583-2042-001 |
| | | |
| U101 | LCD driver 8576 | 544-2027-010 |
| U102 | LCD driver 8676 | 544-2027-010 |

| Ref No. | Description | Part No. |
|---|---|---|
| | **COMPANDOR KIT** | |
| | **Part No. 250-9750-002** | |
| C 100 | .22 µF ±10% X7R 50V cer smd | 510-3607-224 |
| C 101 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 102 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 103 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 104 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 105 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 106 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 107 | 220 pF ±5% NPO 50V cer smd | 510-3601-221 |
| C 108 | 220 pF ±5% NPO 50V cer smd | 510-3601-221 |
| C 109 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| C 110 | 1.0 µF ±10% X7R 16V cer smd | 510-3606-105 |
| C 111 | 1.0 µF ±10% X7R 16V cer smd | 510-3606-105 |
| C 112 | .015 µF ±10% X7R 50V cer smd | 510-3605-153 |
| C 113 | .015 µF ±10% X7R 50V cer smd | 510-3605-153 |
| C 114 | 1.0 µF 16V tantalum smd | 510-2625-109 |
| | | |
| DS 100 | LED, green | 549-4003-011 |
| HW 001 | Foam strip | 042-0361-342 |
| J 001 | Socket, 7-pin female | 515-5006-280 |
| J 100 | Terminal strip, 7-pin | 515-7110-440 |
| PC 100 | PC board, compandor | 035-9750-010 |
| Q 100 | NPN general purpose | 576-0003-616 |
| | | |
| R 100 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 101 | 220k ohm ±5% 1/8W smd | 569-0105-224 |
| R 102 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 103 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 104 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 105 | 270k ohm ±5% 1/8W smd | 569-0105-274 |
| R 106 | 560k ohm ±5% 1/8W smd | 569-0105-274 |
| R 107 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 108 | 33k ohm ±5% 1/8W smd | 569-0105-683 |

| Ref No. | Description | Part No. |
|---|---|---|
| R 109 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 110 | 68k ohm ±5% 1/8W smd | 569-0105-683 |
| R 111 | 390 ohm ±5% 1/8W smd | 569-0105-391 |
| R 112 | 6.8k ohm ±5% 1/8W smd | 569-0105-682 |
| R 113 | 5.1k ohm ±5% 1/8W smd | 569-0105-512 |
| R 114 | 1.5k ohm ±5% 1/8W smd | 569-0105-682 |
| R 115 | 1.5k ohm ±5% 1/8W smd | 569-0105-682 |
| R 116 | 1.5k ohm ±5% 1/8W smd | 569-0105-682 |
| R 117 | 1.5k ohm ±5% 1/8W smd | 569-0105-682 |
| | | |
| U 100 | Compandor SO-16 SA571D | 544-2022-005 |
| U 101 | Op amp (dual) 532 | 544-2019-004 |
| U 102 | Analog switch 4066B | 544-3016-066 |
| | **HARDWARE AND CABLE KIT** | |
| | **Part No. 023-9750-010** | |
| A 001 | Fused DC power cable | 023-9650-008 |
| | (see separate listing which follows) | |
| A 002 | Mic clip ground wire | 023-7171-911 |
| EP 002 | Ring terminal, 3/4” 10-12 AWG | 586-0001-036 |
| EP 003 | Ring terminal, 3/8” 10-12 AWG | 586-0001-019 |
| F 101 | Fuse, 15 amp 32V | 534-0016-015 |
| HW 000 | Key extraction tool | 017-2226-000 |
| HW 001 | Butt splice insulated (2) | 586-9008-061 |
| HW 002 | Screw, 4-40 x 3/8” pan head (1) | 575-0604-012 |
| HW 003 | Screw, 4-24 x 5/16” phil (3) | 575-3604-010 |
| HW 004 | Screw, 4-20 x 5/8” phil (3) | 575-5604-020 |
| MP 001 | Heavy-duty mic clip | 023-3514-001 |
| | | |
| | Fused DC Power Cable | |
| | Part No. 023-9650-008 | |
| EP 101 | Female crimp pin | 515-9032-540 |
| FH 001 | Fuse holder in-line includes: | |
| | Contact | 534-1004-037 |
| | Body | 534-1004-031 |
| | Knob | 534-1004-032 |
| | Spring | 534-1004-035 |
| HW 101 | Wire seal | 574-9025-035 |
| ML 001 | Neg ative ground warning tag | 559-4014-001 |
| ML 002 | Jump start warning label | 559-4057-010 |
| P 101 | 2-pin female power connector | 515-9032-535 |
| W 101 | Wire, 12 AWG stranded blue | 597-7021-206 |
| W 102 | Wire, 12 AWG stranded red | 597-7021-202 |

| Ref No. | Description | Part No. |
|---|---|---|
| | **ACCESSORY WIRE KIT** | |
| | **Part No. 023-9750-011** | |
| | Fuseholder components: | |
| EP 001 | Contact | 586-9004-001 |
| F 001 | Fuse, 1A 250V FB AGC | 534-0003-020 |
| MP001 | Fuseholder body | 534-1004-031 |
| MP002 | Fuseholder knob | 534-1004-032 |
| MP003 | Fuseholder spring | 534-1004-035 |
| HW 001 | Pin contact, crimp type | 515-1501-055 |
| P 101 | 8-pin receptacle housing | 515-1501-050 |
| | **TRANSCEIVER MOUNTING KIT** | |
| | **Part No. 023-9750-012** | |
| HW 001 | Self-drilling screw 1/4" (4) | 575-9077-565 |
| HW 002 | Self-drilling screw #10 (4) | 575-9077-545 |
| MP 101 | Knob 10-32 1/2" | 547-0016-003 |
| MP 201 | Transceiver mounting bracket | 017-2226-034 |

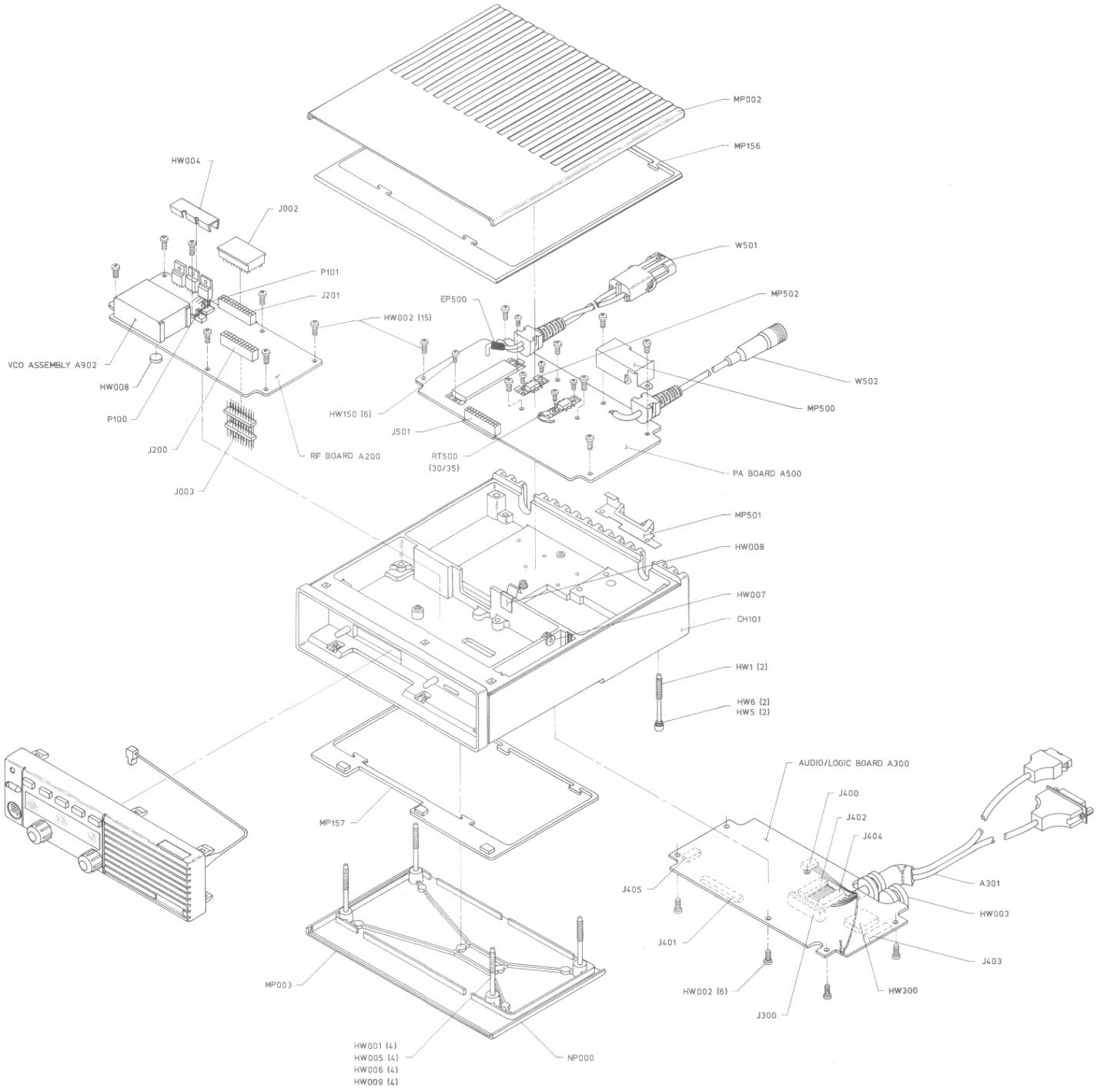
| Ref No. | Description | Part No. |
|---|---|---|
| | **REMOTE CONTROL UNIT AND REMOTE KIT** | |
| A 000 | Front panel assembly (See separate listing) | |
| C 100 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 101 | 18 pF ±5% NPO cer smd | 510-3601-180 |
| C 102 | 18 pF ±5% NPO cer smd | 510-3601-180 |
| C 103 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 200 | 15 µF 20V tantalum smd | 510-2626-150 |
| C 201 | 15 µF 20V tantalum smd | 510-2626-150 |
| C 202 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 203 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 204 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 205 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 206 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 207 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 208 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 209 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 210 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 211 | 10 µF 16V tantalum smd | 510-2625-100 |
| C 212 | .015 µF X7R ±10% 50V cer smd | 510-3605-153 |
| C 213 | 39 pF ±5% NPO 50V cer smd | 510-3615-390 |
| C 214 | 560 pF ±5% NPO cer smd | 510-3601-561 |
| C 215 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 216 | .01 µF ±10% X7R 50V cer smd | 510-3606-103 |

| Ref No. | Description | Part No. |
|---|---|---|
| C 300 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 301 | .047 µF ±10% X7R 50V cer smd | 510-3606-473 |
| C 302 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 303 | .015 µF ±10% X7R 50V cer smd | 510-3606-153 |
| C 304 | 4.7 µF 10V tantalum smd | 510-2624-479 |
| C 305 | .015 µF ±10% X7R 50V cer smd | 510-3606-153 |
| F 200 | Fuse, 0.6A smd | 534-5001-002 |
| HW 001 | Screw, self drill #10 | 575-9077-545 |
| HW 002 | Screw, captive .75 | 575-9606-018 |
| HW 005 | Polyethylene washer .937 | 596-6400-015 |
| HW 006 | Washer, spring ss 3/4" OD | 596-9260-001 |
| J 001 | Solderless pin | 586-3502-002 |
| J 002 | Solderless pin | 586-3502-002 |
| J 100 | Connector, 16-pin | 515-7000-668 |
| J 200 | Connector, 30-pin | 515-7111-283 |
| J 300 | Connector, 3-pin | 515-7000-643 |
| MP 001 | Housing, control head black | 032-0792-130 |
| MP 002 | Mounting bracket, control head | 017-2226-050 |
| MP 003 | Gasket, transceiver block-off nil | 032-0792-068 |
| MP 004 | Block-off fort panel, xcvr black | 032-0792-007 |
| MP 005 | Seal, mic connector | 032-0792-129 |
| MP 006 | Knob, control unit mounting | 032-0792-015 |
| MP 007 | Rear cover, control unit black | 032-0792-135 |
| MP 010 | Gasket, control unit rear cover | 032-0792-066 |
| NP 008 | Johnson label | 559-9001-310 |
| P 100 | 8-pin receptacle housing | 515-1501-050 |
| PC 100 | PC board, remote interface | 035-9701-100 |
| Q 100 | NPN amplifier SOT-23 | 576-0003-616 |
| Q 101 | PNP digital w/res SOT-23 | 576-0003-621 |
| Q 102 | NPN dual digital w/res SOT-25 | 576-0003-626 |
| Q 103 | PNP switching SOT-23 | 576-0003-612 |
| R 100 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 101 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 102 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 103 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 104 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 105 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 106 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 107 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 108 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 109 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 110 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 111 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 112 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 113 | 10k ohm ±5% 1/8W smd | 569-0105-103 |

## Remote Control Unit/Remote Kit

| Ref No. | Description | Part No. |
|---|---|---|
| R 114 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 115 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 116 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 117 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 118 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 119 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 120 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 121 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 122 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 123 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 124 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 125 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 126 | 330k ohm ±5% 1/8W smd | 569-0105-334 |
| R 127 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 128 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 129 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 130 | 10m ohm ±5% 1/8W smd | 569-0105-106 |
| R 131 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 132 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 133 | Jumper | 569-0105-001 |
| R 134 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 135 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 136 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 137 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 138 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 139 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 140 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 141 | 15k ohm ±5% 1/8W smd | 569-0105-153 |
| R 142 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 143 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 144 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 145 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 146 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 147 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 148 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 149 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 150 | 2.2k ohm ±5% 1/8W smd | 569-0105-222 |
| R 151 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 152 | 560 ohm ±5% 1/8W smd | 569-0105-561 |
| R 153 | 560 ohm ±5% 1/8W smd | 569-0105-561 |
| R 155 | 5.6k ohm ±5% 1/8W smd | 569-0105-562 |
| R 157 | 5.6k ohm ±5% 1/8W smd | 569-0105-562 |
| R 158 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 159 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 162 | 10k ohm ±5% 1/8W smd | 569-0105-103 |
| R 163 | 10k ohm ±5% 1/8W smd | 569-0105-103 |

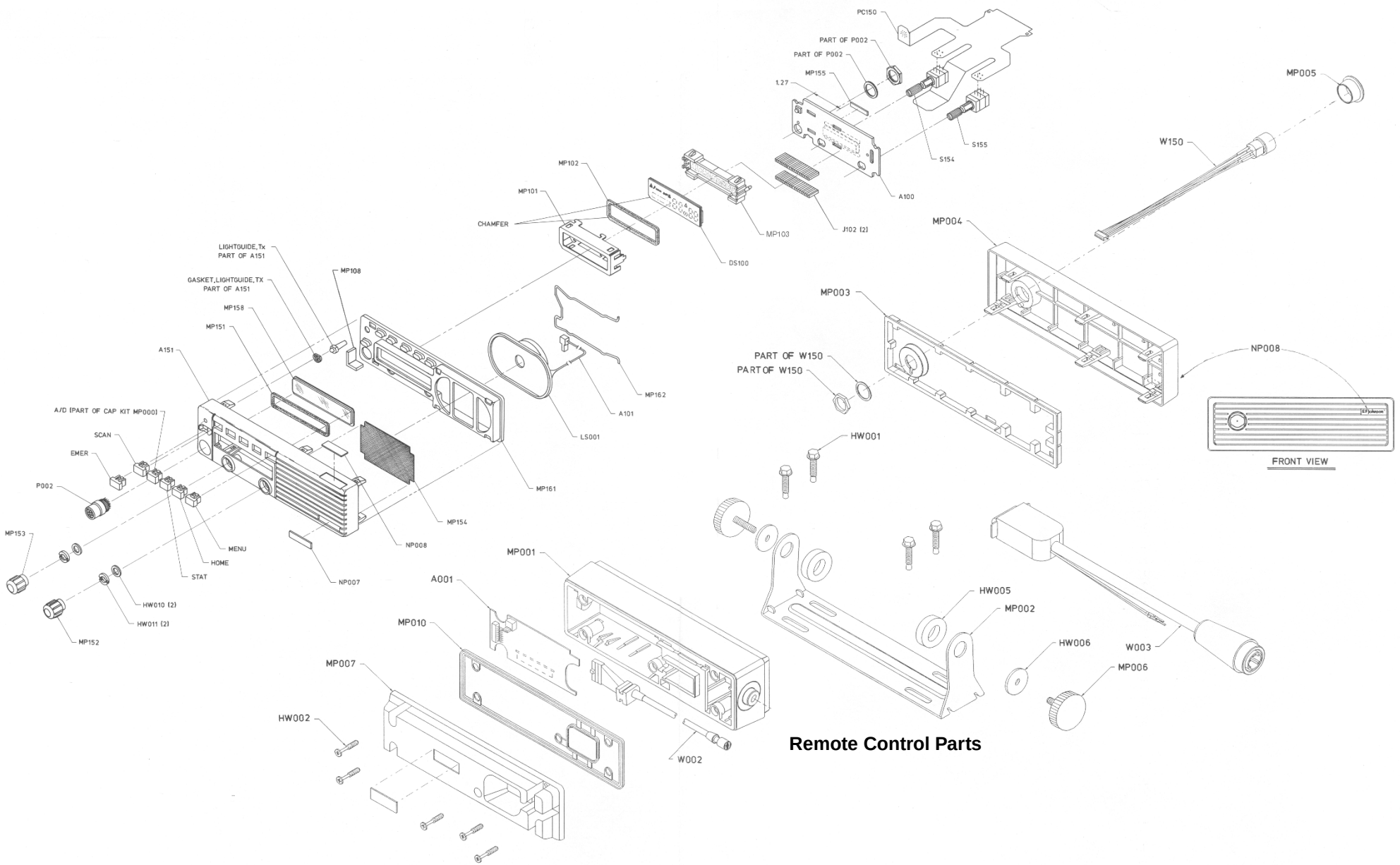
| Ref No. | Description | Part No. |
|---|---|---|
| R 164 | 150 ohm ±5% 1/8W smd | 569-0105-151 |
| R 200 | Jumper | 569-0105-001 |
| R 201 | Jumper | 569-0105-001 |
| R 202 | Jumper | 569-0105-001 |
| R 203 | Jumper | 569-0105-001 |
| R 204 | 39 ohm ±5% 1/8W smd | 569-0115-390 |
| R 205 | 1 ohm ±10% cer smd | 569-0115-109 |
| R 206 | 2.7 ohm ±5% 1/8W smd | 569-0115-279 |
| R 207 | 6.8k ohm ±5% 1/8W smd | 569-0105-682 |
| R 208 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 209 | Jumper | 569-0105-001 |
| R 210 | Jumper | 569-0105-001 |
| R 300 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 301 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 302 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 303 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 304 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 305 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 306 | 470k ohm ±5% 1/8W smd | 569-0105-474 |
| R 307 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 308 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 309 | 100k ohm ±5% 1/8W smd | 569-0105-104 |
| R 310 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 311 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 312 | 150k ohm ±5% 1/8W smd | 569-0105-154 |
| R 313 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 |
| R 314 | 620 ohm ±5% 1/8W smd | 569-0105-621 |
| R 315 | 2.2 ohm ±5% 1W smd | 569-0175-229 |
| | | |
| S 100 | DIP switch 6-position | 583-5100-106 |
| S 101 | DIP switch 6-position | 583-5100-106 |
| U 100 | Microprocessor w/Summit rem soft | 023-9998-324 |
| U 101 | Low voltage sensor MC33164D | 544-2003-074 |
| U 102 | IIC bidirectional xcvr P828715TD | 544-5001-329 |
| U 103 | Buffer, open drain 744C906 | 544-3716-906 |
| U 200 | Regulator, 5V 100 mA LM78l05 | 544-2603-039 |
| U 201 | Regulator, 8V 500 mA 78M08 | 544-2003-081 |
| U 202 | Regulator, 8V 500 mA 78M08 | 544-2003-081 |
| U 300 | Op amp, dual SO-8 532 | 544-2019-004 |
| U 301 | Analog switch 4066 | 544-3016-066 |
| | | |
| W 002 | Control head pigtail cable | 597-2002-264 |
| W 003 | Control cable, 17 ft. | 597-2002-262 |
| W 150 | Prog jack/cable assy (xcvr) | 597-2002-266 |
| X 100 | Socket, PLCC 44-pin smd | 515-5020-004 |
| Y 100 | Crystal, 4.0 MHz | 521-0004-002 |




**TRANSCEIVER EXPLODED VIEW (PART 1)**



Revised December 2000
Part No. 001-9750-007




**Remote Control Parts**

**TRANSCEIVER EXPLODED VIEW (PART 2)**

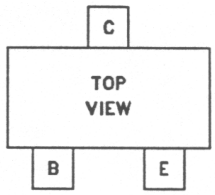


Revised January 1995
Part No. 001-9750-003

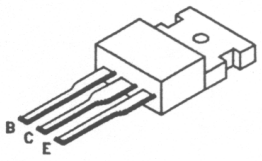
# SECTION 10 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

## BASING DIAGRAMS

| TRANSISTORS | | |
|---|---|---|
| **Part Number** | **Basing Diagram** | **Identification** |
| 576-0001-300 | 1 | 1R |
| 576-0002-057 | 2 | - |
| 576-0003-603 | | - |
| 576-0003-608 | 3 | 7F |
| 576-0003-612 | 1 | 2T |
| 576-0003-616 | 1 | - |
| 576-0003-618 | 1 | 10 |
| 576-0003-621 | 4 | - |
| 576-0003-626 | 1 | - |
| 576-0003-634 | 5 | 3B |
| 576-0003-650 | 1 | - |
| 576-0003-657 | 1 | 2A |
| 576-0003-658 | 1 | 1A |
| 576-0004-805 | 6 | - |
| 576-0004-817 | 6 | - |
| 576-0004-818 | 6 | - |
| 576-0004-901 | 6 | - |
| 576-0006-114 | 7 | - |
| Number on Schematic | | |
| **DIODES** | | |
| 523-1504-001 | - | 4D |
| 523-1504-002 | - | 5A |
| 523-1504-012 | - | A2 |
| 523-1504-016 | - | 5F |
| 523-1504-017 | - | 5D |
| 523-1504-022 | - | 5B |
| 523-1504-023 | - | A7 |
| 523-1504-024 | - | A1 |
| 523-1504-032 | - | - |



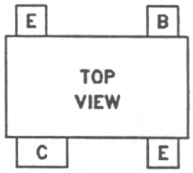

1



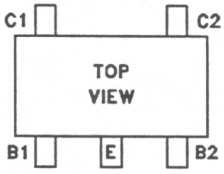

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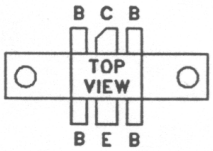

3




4




5




6

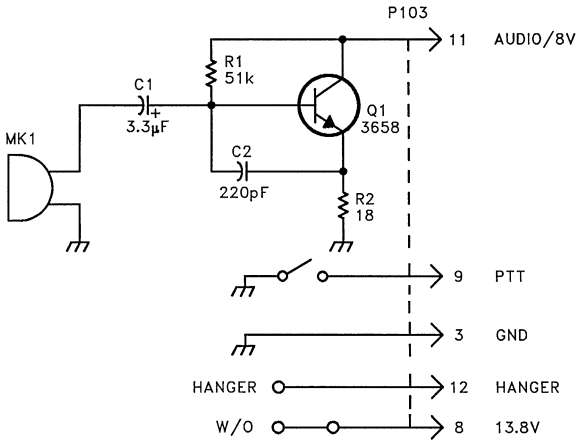


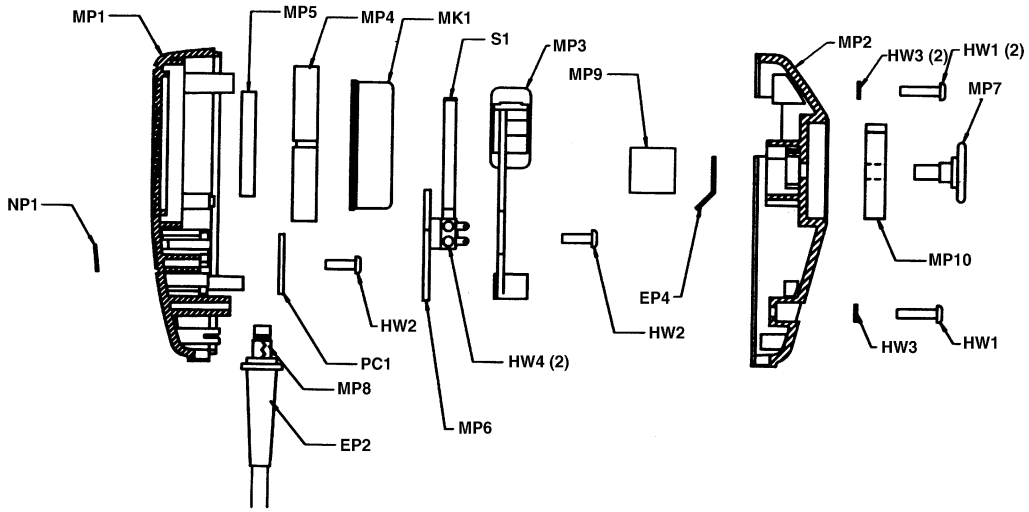

7



Revised January 1995
Part No. 001-9750-003

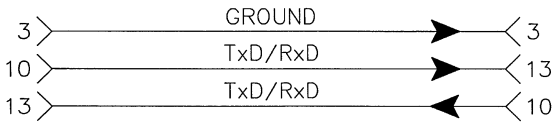
# STANDARD AMPLIFIED DYNAMIC MICROPHONE
## Part No. 250-0740-310



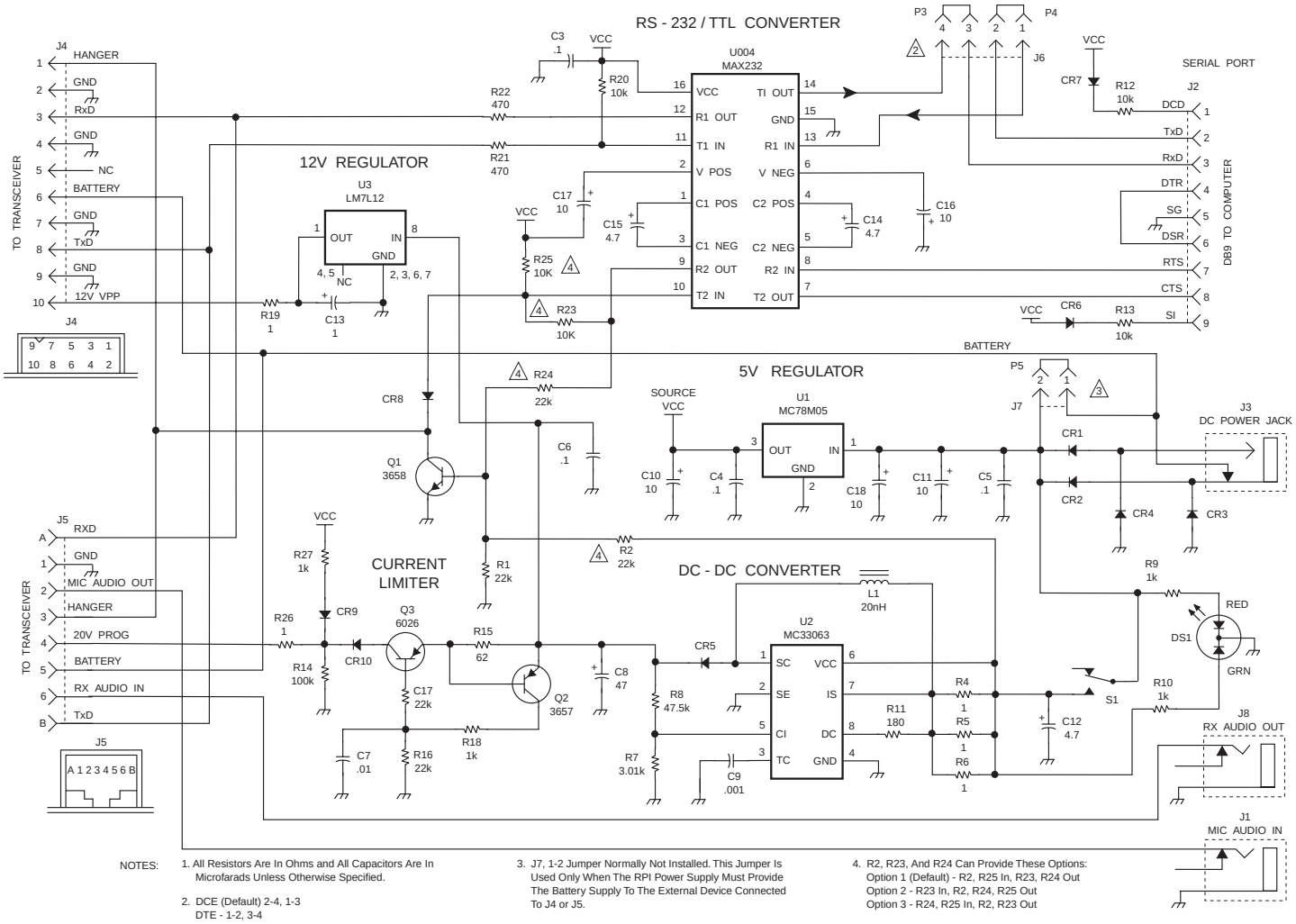




| Ref No. | Description | Part No. |
|---|---|---|
| | **Amplified Dynamic Microphone Part No. 250-0740-310** | |
| C 001 | 3.3 µF 16V tantalum chip | 510-2625-339 |
| C 002 | 220 pF ±5% NPO 50V cer chip | 510-3602-221 |
| EP002 | Mic cord w/Hirose connector | 597-2002-255 |
| EP004 | Terminal (on hanger) | 022-0069-011 |
| HW001 | Screw 4-20 x 3/8 | 575-5604-012 |
| HW004 | Screw 2-56 x 3/8 | 575-1602-012 |
| MK001 | Dynamic mic cartridge | 589-1011-003 |
| MP001 | Case front black | 032-0426-100 |
| MP002 | Case back black | 032-0427-100 |
| MP003 | Actuator black | 032-0428-050 |
| MP004 | Cartridge gasket | 032-0429-075 |
| MP005 | Blast filter | 018-1033-002 |

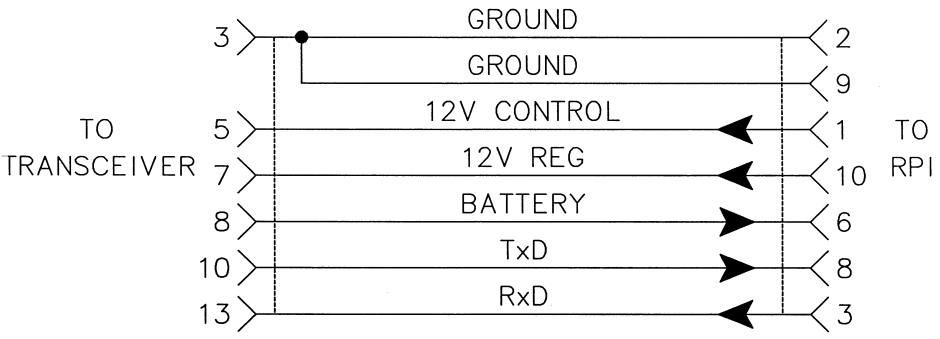
| Ref No. | Description | Part No. |
|---|---|---|
| MP006 | Switch bracket | 017-1885-030 |
| MP007 | Hanger button | 013-1216-005 |
| MP008 | Crimp retainer | 017-2222-006 |
| MP009 | Rubber bumper | 018-0798-009 |
| MP010 | Backing plate | 015-0876-026 |
| MP011 | Strain relief, mic cord | 032-0429-086 |
| MP012 | Shim support, rubber bumper | 017-2222-007 |
| MP020 | Foam support | 018-0798-012 |
| NP001 | Nameplate | 559-0039-026 |
| PC001 | PC board, amplifier | 035-0441-020 |
| Q 001 | NPN amplifier SOT-23 | 576-0003-658 |
| R 001 | 51k ohm ±5% 1/8W chip | 569-0115-513 |
| R 002 | 18 ohm ±5% 1/8W chip | 569-0115-180 |
| S 001 | Leaf switch SPST | 583-1004-031 |



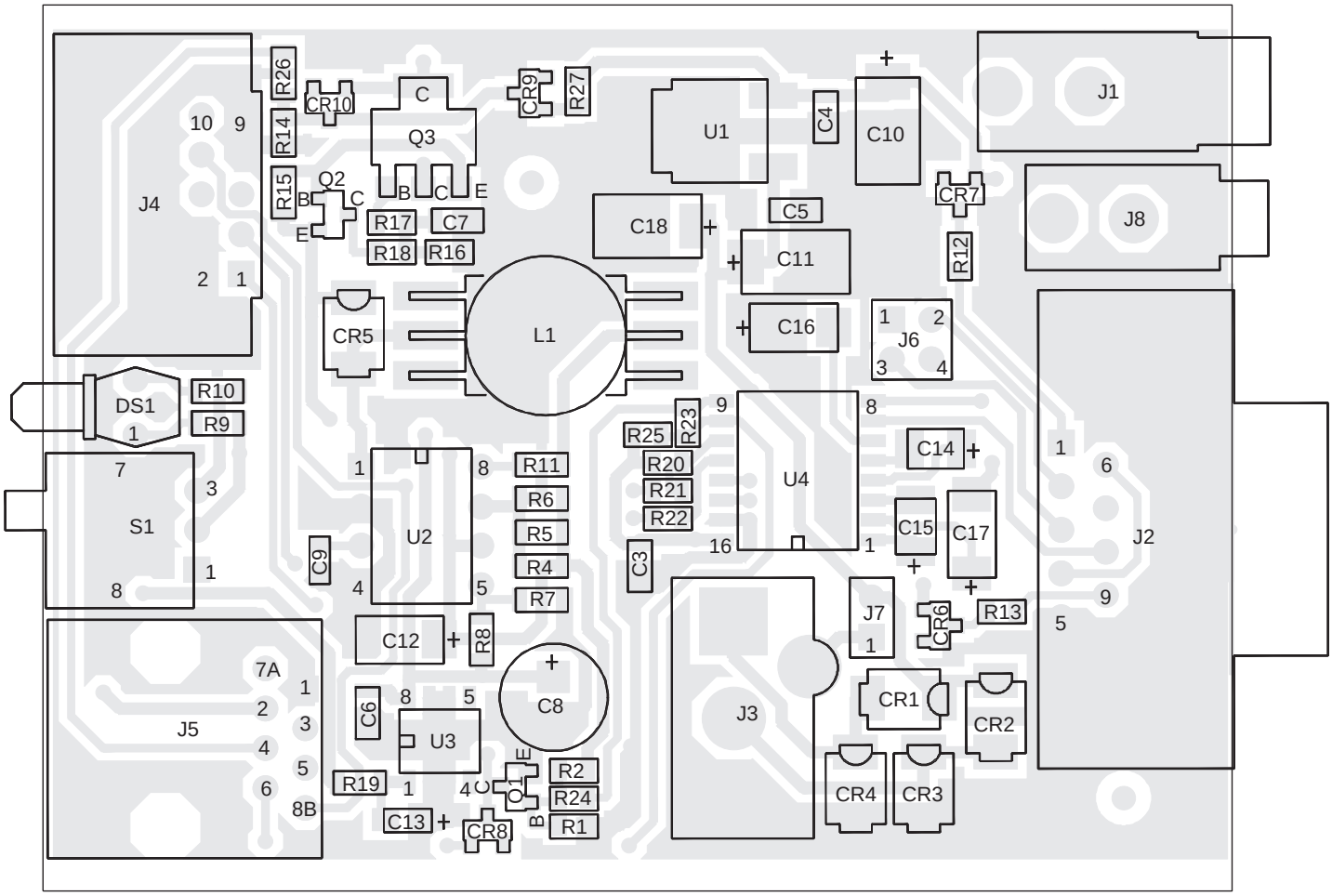

## TRANSCEIVER-TO-TRANSCEIVER CLONING CABLE
## PART NO. 597-2002-268




## RPI (PART NO. 023-9800-000) SCHEMATIC




**RPI-TO-TRANSCEIVER PROGRAMMING CABLE**
**Part No. 023-9750-005**




**RPI (PART NO. 023-9800-000) BOARD LAYOUT**

# RF AND PA BOARD COMPONENT LOCATOR GUIDE

The following guide can be used to locate components on the RF and PA boards. Refer to the grid around the board to determine the approximate location of a component.

| Com | Loc | Board |
|---|---|---|
| A 902 | A2 | RF |
| C 100 | C1 | RF |
| C 101 | C3 | RF |
| C 102 | B1 | RF |
| C 103 | C1 | RF |
| C 104 | C2 | RF |
| C 105 | B1 | RF |
| C 106 | C1 | RF |
| C 107 | B1 | RF |
| C 108 | B5 | RF |
| C 109 | C3 | RF |
| C 110 | A5 | RF |
| C 111 | C3 | RF |
| C 112 | C3 | RF |
| C 113 | C3 | RF |
| C 114 | C2 | RF |
| C 115 | C2 | RF |
| C 116 | C2 | RF |
| C 117 | C2 | RF |
| C 118 | C2 | RF |
| C 119 | C2 | RF |
| C 120 | C3 | RF |
| C 121 | C3 | RF |
| C 200 | B6 | RF |
| C 201 | C6 | RF |
| C 202 | C6 | RF |
| C 204 | C6 | RF |
| C 205 | B6 | RF |
| C 206 | B5 | RF |
| C 207 | C6 | RF |
| C 208 | C6 | RF |
| C 210 | B6 | RF |
| C 212 | B6 | RF |
| C 213 | C5 | RF |
| C 215 | C6 | RF |
| C 217 | B6 | RF |
| C 220 | B6 | RF |
| C 221 | C6 | RF |
| C 222 | C6 | RF |
| C 223 | C5 | RF |

| Com | Loc | Board |
|---|---|---|
| C 225 | C6 | RF |
| C 229 | B6 | RF |
| C 230 | B6 | RF |
| C 231 | A6 | RF |
| C 232 | A6 | RF |
| C 233 | A6 | RF |
| C 237 | B6 | RF |
| C 239 | A6 | RF |
| C 240 | A5 | RF |
| C 241 | A5 | RF |
| C 242 | A5 | RF |
| C 243 | A5 | RF |
| C 244 | A5 | RF |
| C 246 | A5 | RF |
| C 247 | A6 | RF |
| C 248 | A5 | RF |
| C 249 | A5 | RF |
| C 251 | A5 | RF |
| C 253 | B5 | RF |
| C 254 | B5 | RF |
| C 255 | A5 | RF |
| C 256 | B6 | RF |
| C 257 | B6 | RF |
| C 258 | B6 | RF |
| C 259 | B6 | RF |
| C 260 | A5 | RF |
| C 291 | B4 | PA |
| C 292 | B4 | PA |
| C 293 | B5 | PA |
| C 294 | B5 | PA |
| C 296 | A4 | PA |
| C 297 | A5 | PA |
| C 298 | B5 | PA |
| C 500 | D6 | PA |
| C 501 | C6 | PA |
| C 502 | D6 | PA |
| C 504 | B6 | PA |
| C 505 | D2 | PA |
| C 506 | D4 | PA |
| C 507 | C4 | PA |

| Com | Loc | Board |
|---|---|---|
| C 508 | D4 | PA |
| C 509 | C4 | PA |
| C 510 | B6 | PA |
| C 511 | C5 | PA |
| C 512 | C7 | PA |
| C 513 | A5 | PA |
| C 514 | A1 | PA |
| C 515 | C2 | PA |
| C 516 | C2 | PA |
| C 517 | C4 | PA |
| C 518 | C4 | PA |
| C 519 | D3 | PA |
| C 520 | C7 | PA |
| C 521 | D5 | PA |
| C 522 | D5 | PA |
| C 523 | C2 | PA |
| C 524 | B2 | PA |
| C 525 | B4 | PA |
| C 526 | C5 | PA |
| C 527 | C7 | PA |
| C 528 | C6 | PA |
| C 529 | B6 | PA |
| C 530 | C4 | PA |
| C 531 | B7 | PA |
| C 532 | A6 | PA |
| C 533 | B6 | PA |
| C 534 | C5 | PA |
| C 535 | B6 | PA |
| C 536 | C6 | PA |
| C 537 | B3 | PA |
| C 538 | B2 | PA |
| C 539 | C4 | PA |
| C 540 | C5 | PA |
| C 541 | C2 | PA |
| C 542 | C6 | PA |
| C 543 | B6 | PA |
| C 544 | C6 | PA |
| C 545 | B6 | PA |
| C 546 | C4 | PA |
| C 547 | C5 | PA |

| Com | Loc | Board |
|---|---|---|
| C 548 | D1 | PA |
| C 549 | D7 | PA |
| C 550 | C6 | PA |
| C 551 | B1 | PA |
| C 552 | C6 | PA |
| C 553 | C3 | PA |
| C 554 | D5 | PA |
| C 555 | C3 | PA |
| C 556 | C4 | PA |
| C 558 | D3 | PA |
| C 559 | C3 | PA |
| C 560 | B3 | PA |
| C 561 | C7 | PA |
| C 562 | C3 | PA |
| C 563 | D3 | PA |
| C 564 | C5 | PA |
| C 565 | B3 | PA |
| C 567 | D5 | PA |
| C 568 | D7 | PA |
| C 569 | D7 | PA |
| C 570 | C6 | PA |
| C 571 | C6 | PA |
| C 579 | B3 | PA |
| C 584 | B4 | PA |
| C 586 | B6 | PA |
| C 590 | D3 | PA |
| C 800 | B1 | RF |
| C 801 | A1 | RF |
| C 802 | B1 | RF |
| C 803 | A4 | RF |
| C 805 | C2 | RF |
| C 806 | C2 | RF |
| C 807 | B2 | RF |
| C 808 | B3 | RF |
| C 809 | B3 | RF |
| C 810 | B3 | RF |
| C 811 | B3 | RF |
| C 812 | B3 | RF |
| C 813 | C3 | RF |
| C 814 | C3 | RF |

## RF and PA Board Component Locator Guide (Cont'd)

| Com | Loc | Board |
|---|---|---|
| C 815 | C5 | RF |
| C 818 | A4 | RF |
| C 819 | B4 | RF |
| C 820 | B4 | RF |
| C 821 | A4 | RF |
| C 822 | A4 | RF |
| C 823 | A4 | RF |
| C 824 | A4 | RF |
| C 826 | B3 | RF |
| C 827 | B4 | RF |
| C 828 | B4 | RF |
| C 829 | B4 | RF |
| C 831 | C4 | RF |
| C 832 | B4 | RF |
| C 834 | B3 | RF |
| C 836 | B1 | RF |
| C 837 | A3 | RF |
| C 838 | A3 | RF |
| C 839 | A3 | RF |
| C 840 | A3 | RF |
| C 841 | C4 | RF |
| C 842 | B3 | RF |
| C 843 | B4 | RF |
| C 844 | B4 | RF |
| C 846 | B2 | RF |
| C 850 | B2 | RF |
| C 852 | B2 | RF |
| C 853 | B2 | RF |
| CR 100 | C2 | RF |
| CR 101 | C1 | RF |
| CR 102 | B1 | RF |
| CR 103 | C1 | RF |
| CR 290 | B5 | PA |
| CR 500 | B5 | PA |
| CR 502 | B6 | PA |
| CR 503 | B1 | PA |
| CR 504 | C6 | PA |
| CR 505 | C6 | PA |
| CR 506 | D7 | PA |
| CR 507 | B7 | PA |
| CR 508 | C6 | PA |
| CR 509 | B6 | PA |
| CR 802 | C3 | RF |
| CR 803 | C5 | RF |
| CR 804 | A4 | RF |
| CR 805 | A4 | RF |
| EP 205 | A6\C6 | RF |
| EP 500 | D1 | PA |
| F 500 | A2 | PA |
| J 002 | C3/A3 | RF/PA |
| J 003 | B5 | RF |
| J 200 | B5 | RF |
| J 201 | C3 | RF |
| J 501 | A3 | PA |
| L 200 | A5 | RF |
| L 201 | A6 | RF |
| L 202 | C6 | RF |
| L 203 | C6 | RF |
| L 204 | C6 | RF |
| L 205 | B6 | RF |
| L 206 | A6 | RF |
| L 207 | B6 | RF |
| L 208 | A5 | RF |
| L 209 | B6 | RF |
| L 500 | D3 | PA |
| L 501 | C4 | PA |
| L 503 | D4 | PA |
| L 504 | D5 | PA |
| L 506 | C7 | PA |
| L 507 | B6 | PA |
| L 508 | B7 | PA |
| L 510 | C7 | PA |
| L 520 | C1 | PA |
| L 800 | C5 | RF |
| L 801 | B3 | RF |
| L 803 | C3 | RF |
| MP502 | B2 | PA |
| MP503 | D2 | PA |
| MP504 | D3 | PA |
| MP505 | C3 | PA |
| MP506 | C4 | PA |
| P 100 | B3 | RF |
| P 101 | C3 | RF |
| Q 100 | C1 | RF |
| Q 101 | C1 | RF |
| Q 102 | B1 | RF |
| Q 103 | C1 | RF |
| Q 104 | C1 | RF |
| Q 106 | C1 | RF |
| Q 107 | C1 | RF |
| Q 108 | C1 | RF |
| Q 200 | B6 | RF |
| Q 202 | B6 | RF |
| Q 203 | B6 | RF |
| Q 205 | C6 | RF |
| Q 290 | A5 | PA |
| Q 291 | B5 | PA |
| Q 500 | D3 | PA |
| Q 501 | C4 | PA |
| Q 502 | B5 | PA |
| Q 503 | B3 | PA |
| Q 504 | B5 | PA |
| Q 506 | B5 | PA |
| Q 507 | B5 | PA |
| Q 510 | B6 | PA |
| Q 511 | B4 | PA |
| Q 514 | B5 | PA |
| Q 800 | B1 | RF |
| Q 801 | B3 | RF |
| Q 802 | B3 | RF |
| Q 804 | B3 | RF |
| Q 805 | B4 | RF |
| Q 806 | B3 | RF |
| Q 807 | B3 | RF |
| Q 808 | C4 | RF |
| Q 809 | C4 | RF |
| R 001 | D1 | PA |
| R 002 | D1 | PA |
| R 100 | C1 | RF |
| R 101 | C1 | RF |
| R 102 | C1 | RF |
| R 103 | C1 | RF |
| R 104 | B1 | RF |
| R 105 | C1 | RF |
| R 106 | B1 | RF |
| R 107 | C2 | RF |
| R 108 | C2 | RF |
| R 109 | C2 | RF |
| R 110 | C2 | RF |
| R 111 | C2 | RF |
| R 113 | C1 | RF |
| R 114 | C1 | RF |
| R 115 | C1 | RF |
| R 116 | C2 | RF |
| R 117 | C2 | RF |
| R 118 | C2 | RF |
| R 120 | C3 | RF |
| R 200 | B6 | RF |
| R 201 | B5 | RF |
| R 202 | C6 | RF |
| R 203 | C6 | RF |
| R 204 | C6 | RF |
| R 205 | B6 | RF |
| R 206 | B6 | RF |
| R 207 | B6 | RF |
| R 208 | C6 | RF |
| R 209 | B6 | RF |
| R 210 | C6 | RF |
| R 211 | C6 | RF |
| R 212 | C6 | RF |
| R 213 | B5 | RF |
| R 214 | B5 | RF |
| R 215 | C6 | RF |
| R 216 | C6 | RF |
| R 217 | C6 | RF |
| R 218 | C6 | RF |
| R 220 | B6 | RF |
| R 221 | B6 | RF |
| R 222 | B6 | RF |
| R 223 | B6 | RF |
| R 224 | B6 | RF |
| R 225 | B6 | RF |
| R 226 | B6 | RF |
| R 232 | A5 | RF |
| R 234 | B5 | RF |
| R 235 | B5 | RF |
| R 236 | A6 | RF |
| R 237 | A6 | RF |
| R 290 | B5 | PA |
| R 291 | B5 | PA |
| R 294 | B5 | PA |
| R 295 | B5 | PA |
| R 297 | B5 | PA |
| R 500 | C5 | PA |
| R 501 | B5 | PA |
| R 503 | B5 | PA |
| R 506 | B3 | PA |
| R 507 | B3 | PA |
| R 508 | B3 | PA |
| R 510 | C3 | PA |

## RF and PA Board Component Locator Guide (Cont'd)

| Com | Loc | Board |
|---|---|---|
| R 511 | C5 | PA |
| R 512 | C6 | PA |
| R 513 | C6 | PA |
| R 514 | B6 | PA |
| R 515 | C6 | PA |
| R 516 | C5 | PA |
| R 517 | B5 | PA |
| R 519 | C5 | PA |
| R 521 | C6 | PA |
| R 522 | B3 | PA |
| R 525 | B3 | PA |
| R 526 | B4 | PA |
| R 527 | D7 | PA |
| R 528 | B6 | PA |
| R 531 | B5 | PA |
| R 534 | B4 | PA |
| R 536 | C6 | PA |
| R 537 | C5 | PA |
| R 538 | C6 | PA |
| R 539 | C6 | PA |
| R 540 | C6 | PA |
| R 541 | C6 | PA |
| R 543 | B4 | PA |
| R 544 | B4 | PA |
| R 545 | B4 | PA |
| R 546 | B4 | PA |
| R 547 | B3 | PA |
| R 548 | B4 | PA |
| R 550 | B4 | PA |
| R 551 | B4 | PA |
| R 552 | B4 | PA |

| Com | Loc | Board |
|---|---|---|
| R 553 | B4 | PA |
| R 554 | B4 | PA |
| R 555 | B3 | PA |
| R 558 | B3 | PA |
| R 559 | A3 | PA |
| R 560 | B3 | PA |
| R 561 | B6 | PA |
| R 563 | B5 | PA |
| R 564 | B5 | PA |
| R 565 | B5 | PA |
| R 566 | C6 | PA |
| R 568 | C6 | PA |
| R 571 | B5 | PA |
| R 575 | B5 | PA |
| R 576 | B5 | PA |
| R 577 | B5 | PA |
| R 580 | B5 | PA |
| R 585 | B6 | PA |
| R 586 | B6 | PA |
| R 587 | C3 | PA |
| R 589 | B5 | PA |
| R 590 | C5 | PA |
| R 591 | B6 | PA |
| R 800 | B1 | RF |
| R 801 | B1 | RF |
| R 802 | B2 | RF |
| R 803 | B2 | RF |
| R 805 | B2 | RF |
| R 806 | B1 | RF |
| R 807 | A3 | RF |
| R 808 | B3 | RF |

| Com | Loc | Board |
|---|---|---|
| R 809 | B3 | RF |
| R 810 | B3 | RF |
| R 811 | C3 | RF |
| R 812 | C3 | RF |
| R 813 | C4 | RF |
| R 814 | A4 | RF |
| R 815 | B3 | RF |
| R 819 | B3 | RF |
| R 820 | B3 | RF |
| R 821 | B4 | RF |
| R 822 | B4 | RF |
| R 823 | B4 | RF |
| R 824 | B3 | RF |
| R 826 | B3 | RF |
| R 827 | B3 | RF |
| R 828 | B3 | RF |
| R 829 | C3 | RF |
| R 830 | C4 | RF |
| R 831 | C4 | RF |
| R 832 | C4 | RF |
| R 833 | C4 | RF |
| R 834 | B4 | RF |
| R 835 | B3 | RF |
| R 836 | B4 | RF |
| R 837 | B4 | RF |
| R 838 | B4 | RF |
| R 840 | A3 | RF |
| R 842 | A3 | RF |
| R 843 | A3 | RF |
| R 844 | A3 | RF |
| R 845 | B2 | RF |

| Com | Loc | Board |
|---|---|---|
| R 846 | A3 | RF |
| R 847 | A3 | RF |
| R 848 | A3 | RF |
| R 849 | A3 | RF |
| R 851 | B4 | RF |
| RT 500 | C4 | PA |
| RT 501 | B5 | PA |
| RT 502 | B5 | PA |
| U 100 | C2 | RF |
| U 101 | C4 | RF |
| U 102 | C2 | RF |
| U 200 | A5 | RF |
| U 201 | B5 | RF |
| U 500 | C2 | PA |
| U 503 | B4 | PA |
| U 504 | C6 | PA |
| U 800 | B4 | RF |
| U 801 | A4 | RF |
| U 802 | A3 | RF |
| W 501 | D1 | PA |
| W 502 | D5 | PA |
| Y 800 | A4 | RF |
| Z 200 | B5 | RF |
| Z 201 | C5 | RF |
| Z 202 | C5 | RF |
| Z 204 | B5 | RF |
| Z 205 | C6 | RF |
| Z 206 | A6 | RF |
| Z 290 | A5 | PA |

# AUDIO/LOGIC BOARD COMPONENT LOCATOR GUIDE

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

| Comp | Loc | Top/Bot |
|---|---|---|
| C 300 | B4 | TOP |
| C 302 | D4 | BOT |
| C 303 | D4 | BOT |
| C 304 | D4 | BOT |
| C 305 | D5 | BOT |
| C 306 | D4 | BOT |
| C 400 | D3 | TOP |
| C 401 | D3 | TOP |
| C 402 | E2 | TOP |
| C 403 | B4 | TOP |
| C 404 | B3 | TOP |
| C 405 | B3 | TOP |
| C 406 | D1 | TOP |
| C 407 | B1 | BOT |
| C 408 | D1 | TOP |
| C 409 | C2 | BOT |
| C 410 | B3 | TOP |
| C 411 | B2 | BOT |
| C 412 | B2 | TOP |
| C 413 | B2 | BOT |
| C 415 | E5 | TOP |
| C 416 | A1 | BOT |
| C 417 | A1 | BOT |
| C 418 | D2 | TOP |
| C 600 | D8 | BOT |
| C 601 | C8 | BOT |
| C 602 | D7 | TOP |
| C 603 | D7 | TOP |
| C 604 | E6 | TOP |
| C 605 | D6 | TOP |
| C 606 | A4 | BOT |
| C 607 | A4 | BOT |
| C 608 | A4 | TOP |
| C 609 | A4 | BOT |
| C 610 | A6 | TOP |
| C 611 | A7 | TOP |
| C 612 | B8 | TOP |
| C 613 | D7 | TOP |
| C 614 | D8 | BOT |
| C 615 | D6 | BOT |
| C 616 | E5 | TOP |
| C 617 | B4 | TOP |

| Comp | Loc | Top/Bot |
|---|---|---|
| C 618 | B4 | TOP |
| C 619 | D8 | TOP |
| C 620 | D1 | BOT |
| C 621 | E2 | TOP |
| C 622 | B3 | BOT |
| C 624 | C7 | TOP |
| C 625 | C7 | TOP |
| C 626 | B7 | BOT |
| C 627 | D7 | TOP |
| C 628 | C7 | TOP |
| C 629 | B7 | BOT |
| C 630 | B7 | BOT |
| C 631 | B7 | BOT |
| C 632 | B8 | TOP |
| C 633 | B8 | TOP |
| C 634 | B7 | BOT |
| C 635 | D6 | TOP |
| C 636 | B7 | BOT |
| C 638 | B7 | BOT |
| C 639 | D4 | BOT |
| C 640 | C7 | BOT |
| C 641 | D7 | TOP |
| C 642 | C7 | BOT |
| C 643 | B7 | BOT |
| C 644 | B8 | BOT |
| C 645 | C7 | TOP |
| C 646 | D7 | TOP |
| C 647 | D7 | BOT |
| C 648 | D7 | BOT |
| C 650 | B7 | TOP |
| C 651 | D7 | TOP |
| C 652 | E6 | TOP |
| C 653 | C8 | TOP |
| C 660 | B4 | TOP |
| C 661 | A4 | TOP |
| C 662 | B4 | BOT |
| C 663 | B4 | TOP |
| C 664 | A4 | BOT |
| C 665 | A6 | BOT |
| C 666 | B6 | BOT |
| C 667 | B5 | BOT |
| C 668 | A5 | TOP |

| Comp | Loc | Top/Bot |
|---|---|---|
| C 669 | B5 | BOT |
| C 670 | A5 | TOP |
| C 671 | A5 | BOT |
| C 672 | A5 | TOP |
| C 673 | A5 | BOT |
| C 674 | A5 | BOT |
| C 675 | A5 | BOT |
| C 676 | A5 | TOP |
| C 677 | A5 | BOT |
| C 678 | A6 | TOP |
| C 679 | B6 | TOP |
| C 680 | B6 | BOT |
| C 681 | A6 | TOP |
| C 682 | B5 | BOT |
| C 683 | A6 | BOT |
| C 684 | A4 | BOT |
| C 685 | A7 | TOP |
| C 686 | A6 | TOP |
| C 687 | A7 | BOT |
| C 688 | A7 | BOT |
| C 689 | A7 | BOT |
| C 690 | A7 | TOP |
| C 691 | B7 | BOT |
| C 692 | C6 | BOT |
| C 693 | B6 | TOP |
| C 694 | C6 | BOT |
| C 695 | C7 | BOT |
| C 696 | B7 | TOP |
| C 697 | A7 | TOP |
| C 698 | A7 | TOP |
| C 705 | D7 | BOT |
| C 706 | D7 | BOT |
| C 707 | C7 | BOT |
| C 708 | C7 | BOT |
| C 709 | C7 | BOT |
| C 710 | D7 | BOT |
| C 711 | B6 | BOT |
| C 712 | B5 | BOT |
| C 713 | A6 | TOP |
| C 714 | A5 | TOP |
| C 715 | B6 | TOP |
| C 716 | B6 | TOP |

| Comp | Loc | Top/Bot |
|---|---|---|
| C 717 | A7 | BOT |
| C 719 | B5 | BOT |
| C 720 | B6 | TOP |
| C 721 | B6 | TOP |
| C 722 | B5 | TOP |
| C 723 | B5 | TOP |
| C 730 | A6 | TOP |
| C 731 | A6 | BOT |
| C 732 | A6 | BOT |
| C 733 | A6 | BOT |
| C 734 | A7 | TOP |
| C 735 | A7 | BOT |
| C 736 | D4 | BOT |
| C 783 | A4 | BOT |
| C 786 | E3 | BOT |
| C 788 | D7 | TOP |
| CR 400 | E5 | TOP |
| CR 401 | E2 | BOT |
| CR 500 | A1 | TOP |
| CR 501 | A2 | TOP |
| CR 502 | A3 | TOP |
| CR 503 | C5 | BOT |
| CR 504 | A3 | TOP |
| CR 505 | D1 | BOT |
| CR 506 | A2 | TOP |
| CR 507 | A2 | TOP |
| CR 508 | D5 | BOT |
| CR 509 | D3 | TOP |
| CR 510 | A3 | TOP |
| CR 511 | E4 | TOP |
| CR 5 12 | E4 | BOT |
| CR 513 | D5 | BOT |
| CR 514 | D5 | BOT |
| CR 515 | D5 | BOT |
| CR 516 | A1 | BOT |
| CR 600 | B8 | BOT |
| CR 601 | B6 | BOT |
| CR 610 | D6 | BOT |
| CR 620 | B5 | TOP |
| J 001 | A4 | BOT |
| J 002 | A2 | BOT |
| J 300 | C5 | TOP |

## Audio/Logic Board Component Locator Guide (Cont'd)

| Comp | Loc | Top/Bot |
|---|---|---|
| J 400 | E4 | TOP |
| J 401 | A3 | TOP |
| J 402 | D5 | TOP |
| J 403 | C8 | TOP |
| J 404 | D6 | TOP |
| J 405 | A1 | TOP |
| Q 300 | C3 | TOP |
| Q 400 | D3 | TOP |
| Q 401 | D3 | TOP |
| Q 402 | E5 | TOP |
| Q 403 | E5 | TOP |
| Q 404 | E5 | TOP |
| Q 450 | B4 | BOT |
| Q 451 | B3 | BOT |
| Q 452 | B3 | BOT |
| Q 600 | B6 | BOT |
| Q 601 | A6 | BOT |
| Q 602 | B7 | TOP |
| Q 610 | C7 | BOT |
| Q 612 | C7 | BOT |
| R 300 | B4 | TOP |
| R 301 | B3 | BOT |
| R 302 | B3 | BOT |
| R 303 | B3 | BOT |
| R 304 | B3 | BOT |
| R 305 | C3 | BOT |
| R 306 | C3 | BOT |
| R 307 | C3 | BOT |
| R 308 | C3 | BOT |
| R 309 | C3 | BOT |
| R 310 | C3 | BOT |
| R 311 | C3 | BOT |
| R 312 | C3 | BOT |
| R 313 | C3 | BOT |
| R 314 | C3 | BOT |
| R 315 | C3 | BOT |
| R 316 | C3 | BOT |
| R 317 | C4 | BOT |
| R 318 | D4 | BOT |
| R 319 | C4 | BOT |
| R 320 | D4 | BOT |
| R 321 | D4 | BOT |
| R 322 | D5 | BOT |
| R 323 | D3 | TOP |
| R 324 | B3 | TOP |
| R 325 | D3 | BOT |
| R 326 | B3 | TOP |
| R 400 | D1 | TOP |
| R 401 | D3 | TOP |
| R 402 | D1 | TOP |
| R 403 | E3 | TOP |
| R 404 | B2 | BOT |
| R 405 | C1 | BOT |
| R 406 | C1 | BOT |
| R 407 | C1 | BOT |
| R 408 | C2 | BOT |
| R 409 | A2 | BOT |
| R 410 | A2 | BOT |
| R 411 | A3 | BOT |
| R 412 | A3 | BOT |
| R 413 | A3 | BOT |
| R 414 | A3 | BOT |
| R 415 | A2 | BOT |
| R 416 | A2 | BOT |
| R 417 | A3 | BOT |
| R 418 | A2 | BOT |
| R 419 | A3 | BOT |
| R 420 | B3 | TOP |
| R 422 | B1 | TOP |
| R 423 | B1 | TOP |
| R 424 | B1 | TOP |
| R 425 | E4 | TOP |
| R 426 | E4 | TOP |
| R 427 | E4 | TOP |
| R 428 | E4 | TOP |
| R 429 | B1 | TOP |
| R 430 | B1 | TOP |
| R 431 | B1 | TOP |
| R 432 | A1 | TOP |
| R 433 | A1 | TOP |
| R 434 | A1 | TOP |
| R 435 | A1 | TOP |
| R 436 | A1 | TOP |
| R 437 | E4 | BOT |
| R 438 | E3 | TOP |
| R 439 | E4 | TOP |
| R 440 | E4 | BOT |
| R 441 | E4 | BOT |
| R 442 | E3 | TOP |
| R 44=i | D7 | TOP |
| R 4:15 | E2 | TOP |
| R 446 | E5 | TOP |
| R 447 | B2 | BOT |
| R 448 | B3 | BOT |
| R 449 | E5 | TOP |
| R 450 | D6 | BOT |
| R 451 | D6 | BOT |
| R 452 | D6 | BOT |
| R 453 | D6 | BOT |
| R 454 | D6 | BOT |
| R 455 | D6 | BOT |
| R 456 | D6 | BOT |
| R 457 | D6 | BOT |
| R 458 | D6 | BOT |
| R 459 | D6 | BOT |
| R 460 | E6 | BOT |
| R 461 | D5 | BOT |
| R 462 | E6 | BOT |
| R 463 | E4 | BOT |
| R 464 | E4 | BOT |
| R 465 | E4 | BOT |
| R 466 | E4 | BOT |
| R 467 | E4 | BOT |
| R 468 | E4 | BOT |
| R 469 | E4 | BOT |
| R 470 | E4 | BOT |
| R 471 | E4 | BOT |
| R 472 | E4 | BOT |
| R 473 | B4 | BOT |
| R 474 | B3 | BOT |
| R 475 | B3 | BOT |
| R 480 | B3 | BOT |
| R 481 | A3 | BOT |
| R 482 | E3 | BOT |
| R 483 | D6 | BOT |
| R 484 | D5 | BOT |
| R 485 | E3 | BOT |
| R 486 | D5 | BOT |
| R 487 | D5 | BOT |
| R 488 | C5 | BOT |
| R 489 | C5 | BOT |
| R 490 | A2 | BOT |
| R 492 | A3 | BOT |
| R 493 | B3 | BOT |
| R 494 | B3 | BOT |
| R 500 | E4 | TOP |
| R 501 | A2 | TOP |
| R 502 | B1 | TOP |
| R 503 | A1 | TOP |
| R 601 | A4 | BOT |
| R 602 | A4 | BOT |
| R 606 | C7 | TOP |
| R 607 | C7 | TOP |
| R 608 | C7 | TOP |
| R 609 | C7 | TOP |
| R 610 | C6 | TOP |
| R 612 | B7 | BOT |
| R 613 | B8 | TOP |
| R 614 | D6 | TOP |
| R 615 | D4 | BOT |
| R 616 | C6 | TOP |
| R 617 | C7 | TOP |
| R 618 | C7 | TOP |
| R 619 | B8 | TOP |
| R 620 | B7 | TOP |
| R 621 | B7 | TOP |
| R 622 | B7 | BOT |
| R 623 | D6 | TOP |
| R 624 | D6 | TOP |
| R 625 | B6 | BOT |
| R 627 | D7 | TOP |
| R 628 | D7 | TOP |
| R 630 | C7 | BOT |
| R 631 | C7 | BOT |
| R 632 | B7 | BOT |
| R 633 | E7 | TOP |
| R 634 | C7 | TOP |
| R 635 | C8 | TOP |
| R 636 | B7 | BOT |
| R 637 | B7 | BOT |
| R 639 | C7 | TOP |
| R 640 | D7 | TOP |
| R 641 | E7 | TOP |
| R 642 | B6 | BOT |
| R 643 | E7 | TOP |
| R 644 | D4 | BOT |
| R 645 | D4 | BOT |
| R 646 | C8 | TOP |
| R 647 | B6 | BOT |
| R 648 | D7 | TOP |
| R 650 | C6 | TOP |
| R 655 | A4 | TOP |
| R 656 | A4 | TOP |
| R 657 | A4 | TOP |

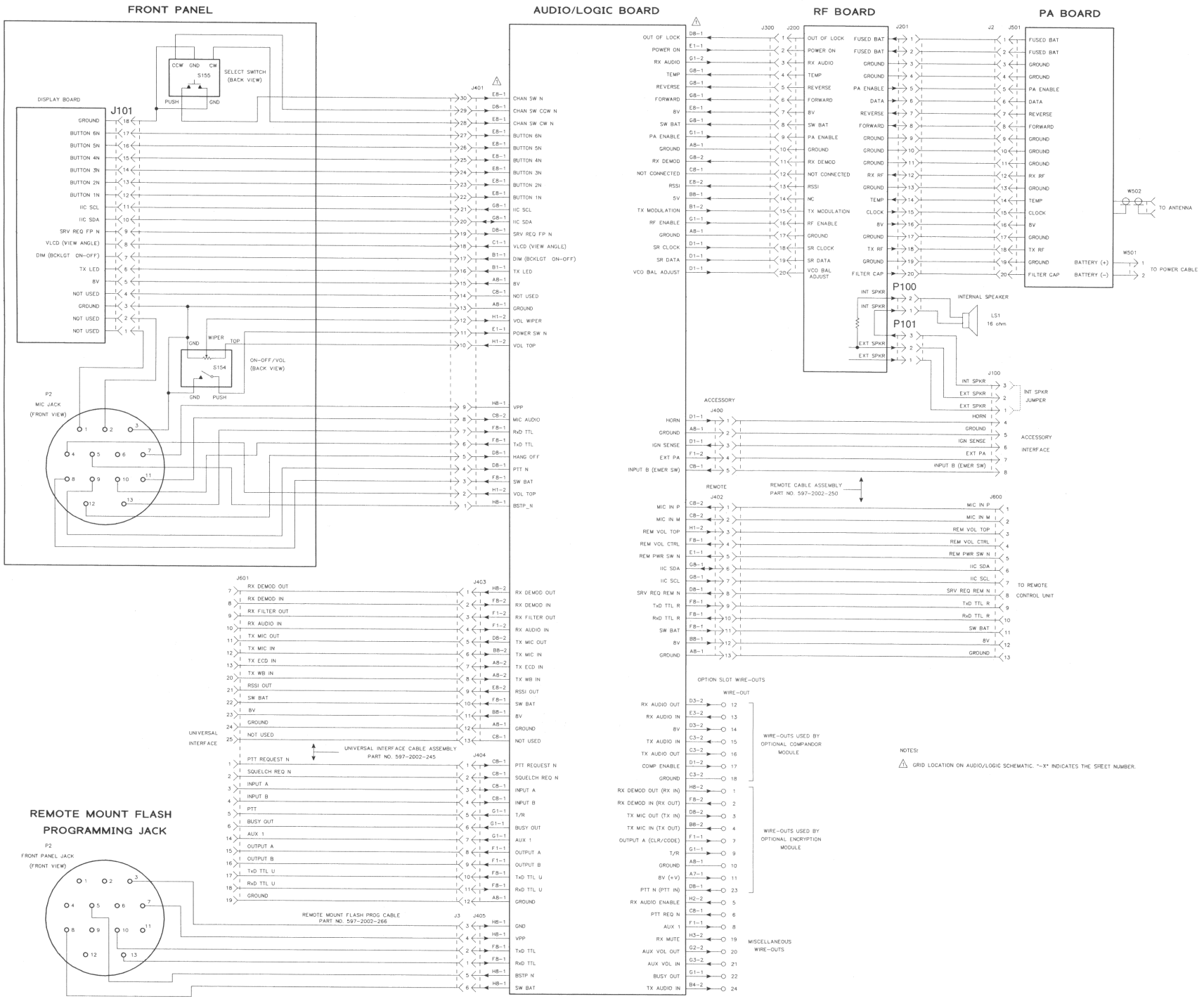
## Audio/Logic Board Component Locator Guide (Cont'd)

| Comp | Loc | Top/Bot |
|---|---|---|
| R 658 | A4 | BOT |
| R 659 | A4 | TOP |
| R 660 | D6 | BOT |
| R 661 | D6 | BOT |
| R 662 | A4 | BOT |
| R 663 | A5 | TOP |
| R 664 | A4 | TOP |
| R 665 | A5 | TOP |
| R 666 | A4 | TOP |
| R 667 | A5 | BOT |
| R 668 | B5 | BOT |
| R 669 | B5 | BOT |
| R 670 | B6 | BOT |
| R 671 | B5 | BOT |
| R 672 | A5 | TOP |
| R 673 | A5 | TOP |
| R 674 | A5 | TOP |
| R 675 | A7 | TOP |
| R 676 | A4 | TOP |
| R 677 | A5 | BOT |
| R 678 | A5 | BOT |
| R 679 | A5 | BOT |
| R 680 | A5 | TOP |
| R 681 | A6 | TOP |
| R 682 | A6 | TOP |
| R 683 | B6 | TOP |
| R 684 | A6 | TOP |
| R 685 | A6 | TOP |
| R 686 | A6 | TOP |
| R 687 | B5 | BOT |
| R 688 | A6 | BOT |
| R 689 | A6 | BOT |
| R 690 | B6 | TOP |
| R 691 | A6 | BOT |
| R 692 | B6 | TOP |
| R 693 | A7 | TOP |
| R 694 | B6 | TOP |
| R 695 | A7 | TOP |
| R 696 | A6 | TOP |
| R 697 | A6 | TOP |
| R 698 | A7 | BOT |
| R 699 | A7 | BOT |
| R 700 | A8 | TOP |
| R 701 | B8 | TOP |
| R 702 | A7 | BOT |
| R 703 | B7 | TOP |
| R 704 | A7 | BOT |

| Comp | Loc | Top/Bot |
|---|---|---|
| R 705 | B7 | BOT |
| R 706 | B7 | BOT |
| R 707 | B7 | BOT |
| R 708 | B6 | TOP |
| R 709 | B8 | TOP |
| R 710 | A7 | TOP |
| R 711 | C6 | BOT |
| R 712 | B8 | TOP |
| R 713 | B8 | TOP |
| R 714 | A5 | BOT |
| R 715 | A5 | TOP |
| R 716 | A5 | BOT |
| R 717 | A6 | TOP |
| R 718 | C4 | BOT |
| R 719 | A6 | TOP |
| R 720 | D7 | BOT |
| R 721 | B7 | BOT |
| R 722 | C7 | BOT |
| R 723 | C7 | BOT |
| R 724 | C7 | BOT |
| R 726 | D6 | BOT |
| R 727 | D7 | BOT |
| R 728 | D6 | BOT |
| R 729 | D6 | BOT |
| R 730 | B6 | BOT |
| R 731 | A6 | BOT |
| R 732 | B5 | BOT |
| R 733 | B5 | BOT |
| R 734 | B5 | BOT |
| R 735 | B5 | BOT |
| R 736 | B5 | BOT |
| R 737 | B5 | BOT |
| R 738 | A5 | TOP |
| R 739 | A5 | TOP |
| R 740 | B6 | TOP |
| R 745 | B6 | TOP |
| R 746 | B6 | TOP |
| R 747 | A6 | TOP |
| R 748 | B5 | TOP |
| R 749 | B5 | TOP |
| R 751 | B5 | TOP |
| R 752 | B5 | TOP |
| R 753 | B6 | TOP |
| R 754 | B5 | TOP |
| R 755 | B5 | TOP |
| R 756 | B5 | BOT |
| R 757 | C7 | TOP |

| Comp | Loc | Top/Bot |
|---|---|---|
| R 758 | C7 | TOP |
| R 759 | C7 | BOT |
| R 760 | C7 | BOT |
| R 761 | C8 | BOT |
| R 762 | C8 | BOT |
| R 763 | C7 | BOT |
| R 764 | C8 | BOT |
| R 765 | B5 | TOP |
| R 766 | C6 | TOP |
| R 767 | B7 | TOP |
| R 768 | B7 | TOP |
| R 770 | A6 | TOP |
| R 771 | A6 | BOT |
| R 772 | A7 | B07 |
| R 773 | A7 | BOT |
| R 774 | A6 | BOT |
| R 775 | A7 | B07 |
| R 776 | A6 | TOP |
| R 777 | A6 | TOP |
| R 778 | A7 | BOT |
| R 779 | A7 | BO7 |
| R 780 | B7 | TOP |
| R 781 | B3 | BOT |
| R 782 | E4 | BOT |
| R 785 | E2 | TOP |
| R 786 | D6 | B0T |
| R 789 | E2 | TOP |
| R 790 | E2 | TOP |
| R 791 | E2 | TOP |
| R 792 | E2 | TOP |
| R 793 | B3 | BOT |
| R 795 | E2 | TOP |
| RT 600 | B5 | TOP |
| U 300 | C4 | TOP |
| U 302 | D4 | TOP |
| U 304 | D3 | BOT |
| U 305 | D4 | BOT |
| U 400 | D1 | BOT |
| U 401 | D2 | TOP |
| U 402 | D2 | BOT |
| U 403 | B1 | BOT |
| U 404 | C2 | TOP |
| U 405 | C1 | TOP |
| U 406 | C3 | TOP |
| U 407 | E3 | TOP |
| U 408 | D3 | BOT |
| U 409 | C2 | BOT |

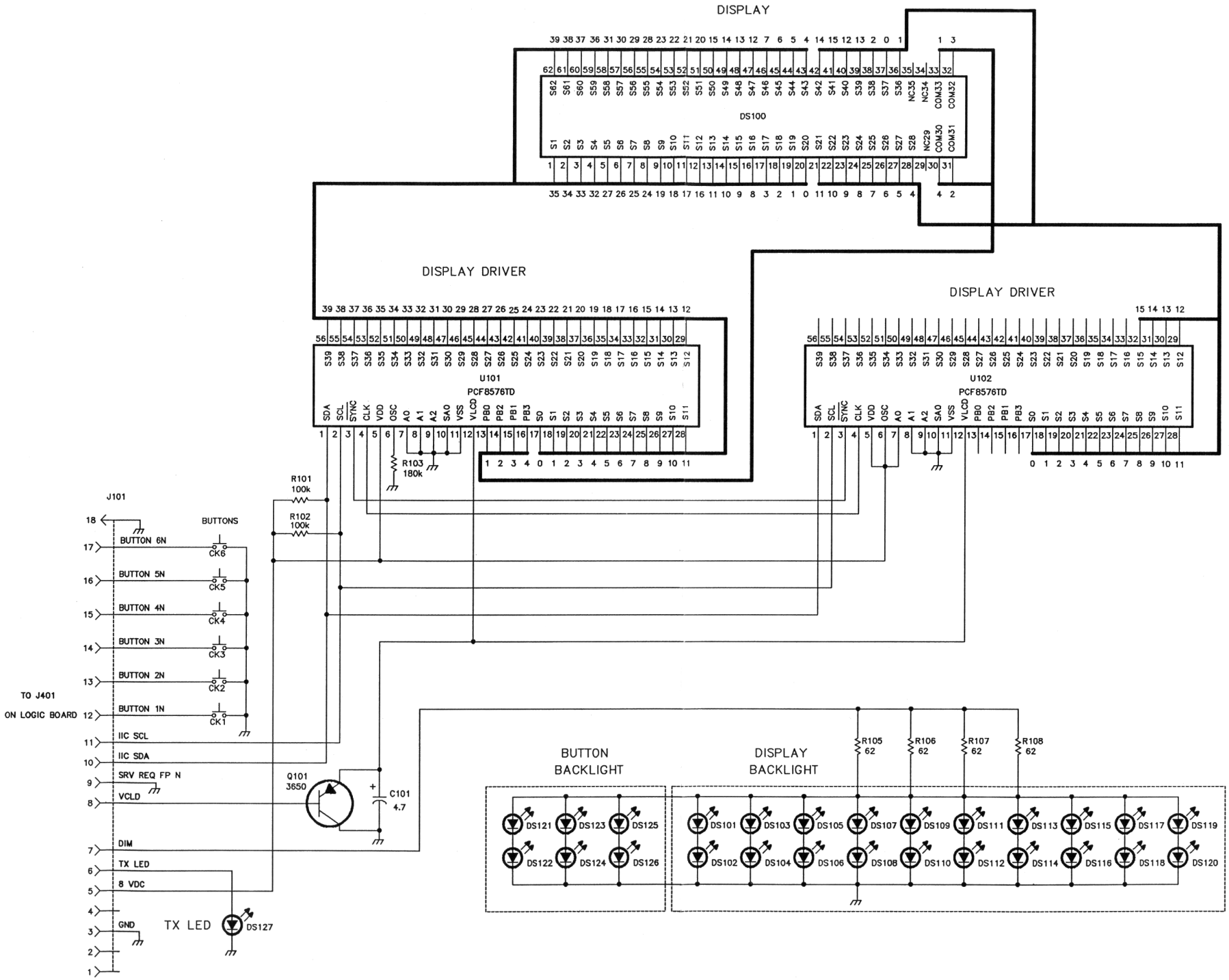
| Comp | Loc | Top/Bot |
|---|---|---|
| U 410 | B2 | BOT |
| U 411 | B2 | TOP |
| U 412 | E3 | BOT |
| U 413 | B2 | BOT |
| U 414 | E3 | BOT |
| U 415 | A1 | BOT |
| U 450 | E5 | BOT |
| U 451 | E5 | BOT |
| U 452 | B4 | BOT |
| U 600 | D8 | BOT |
| U 601 | C7 | TOP |
| U 602 | D7 | TOP |
| U 603 | A4 | TOP |
| U 604 | A6 | TOP |
| U 605 | B7 | TOP |
| U 606 | D7 | BOT |
| U 607 | B6 | TOP |
| U 608 | B7 | BOT |
| U 609 | A5 | BOT |
| U 610 | A6 | BOT |
| Y 300 | D2 | TOP |
| WO 001 | B8 | TOP |
| WO 002 | B8 | TOP |
| WO 003 | B8 | TOP |
| WO 004 | B8 | TOP |
| WO 005 | B6 | TOP |
| WO 006 | B6 | TOP |
| WO 007 | B6 | TOP |
| WO 008 | B6 | TOP |
| WO 009 | A8 | TOP |
| WO 010 | C8 | TOP |
| WO 011 | B8 | TOP |
| WO 012 | B8 | TOP |
| WO 013 | B8 | TOP |
| WO 014 | B8 | TOP |
| WO 015 | B8 | TOP |
| WO 016 | B5 | TOP |
| WO 017 | B8 | TOP |
| WO 018 | A8 | TOP |
| WO 019 | C8 | TOP |
| WO 020 | E7 | TOP |
| WO 021 | E7 | TOP |
| WO 022 | E7 | TOP |
| WO 023 | A7 | TOP |






**INTERCONNECT SCHEMATIC**

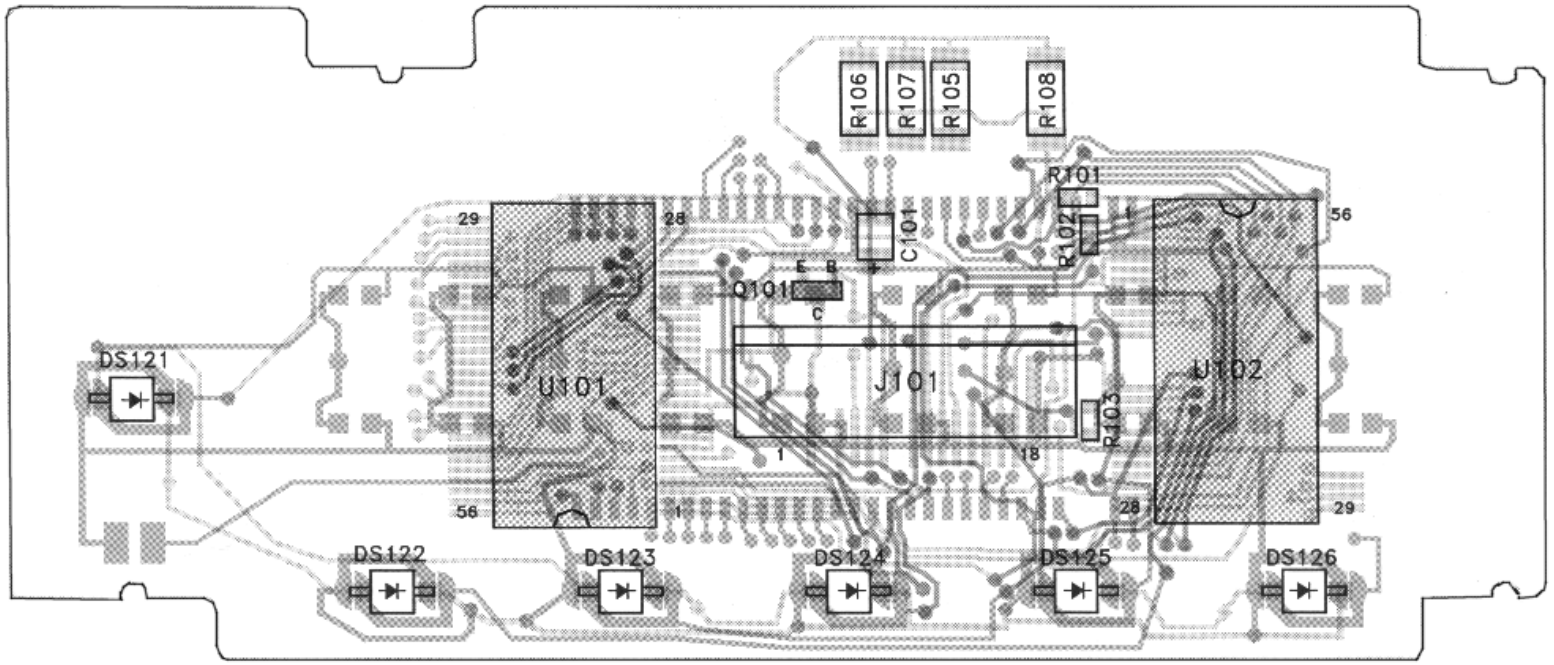
Revised January 1995
Part No. 001-9750-003



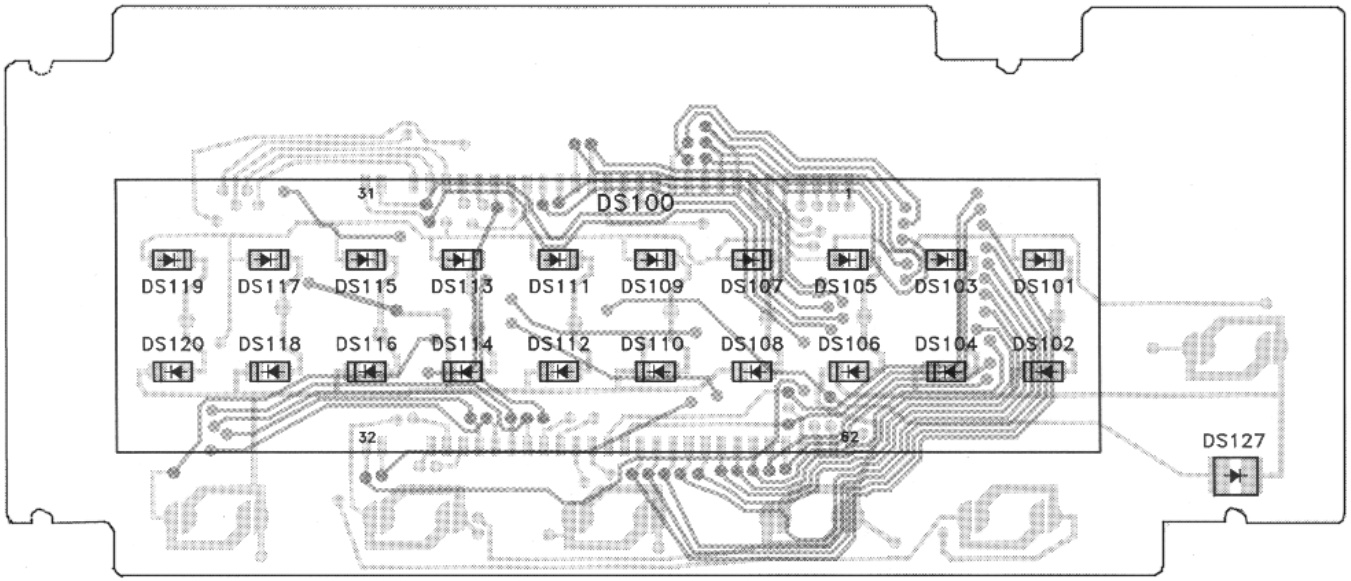

**DISPLAY BOARD SCHEMATIC**



Revised January 1995
Part No. 001-9750-003



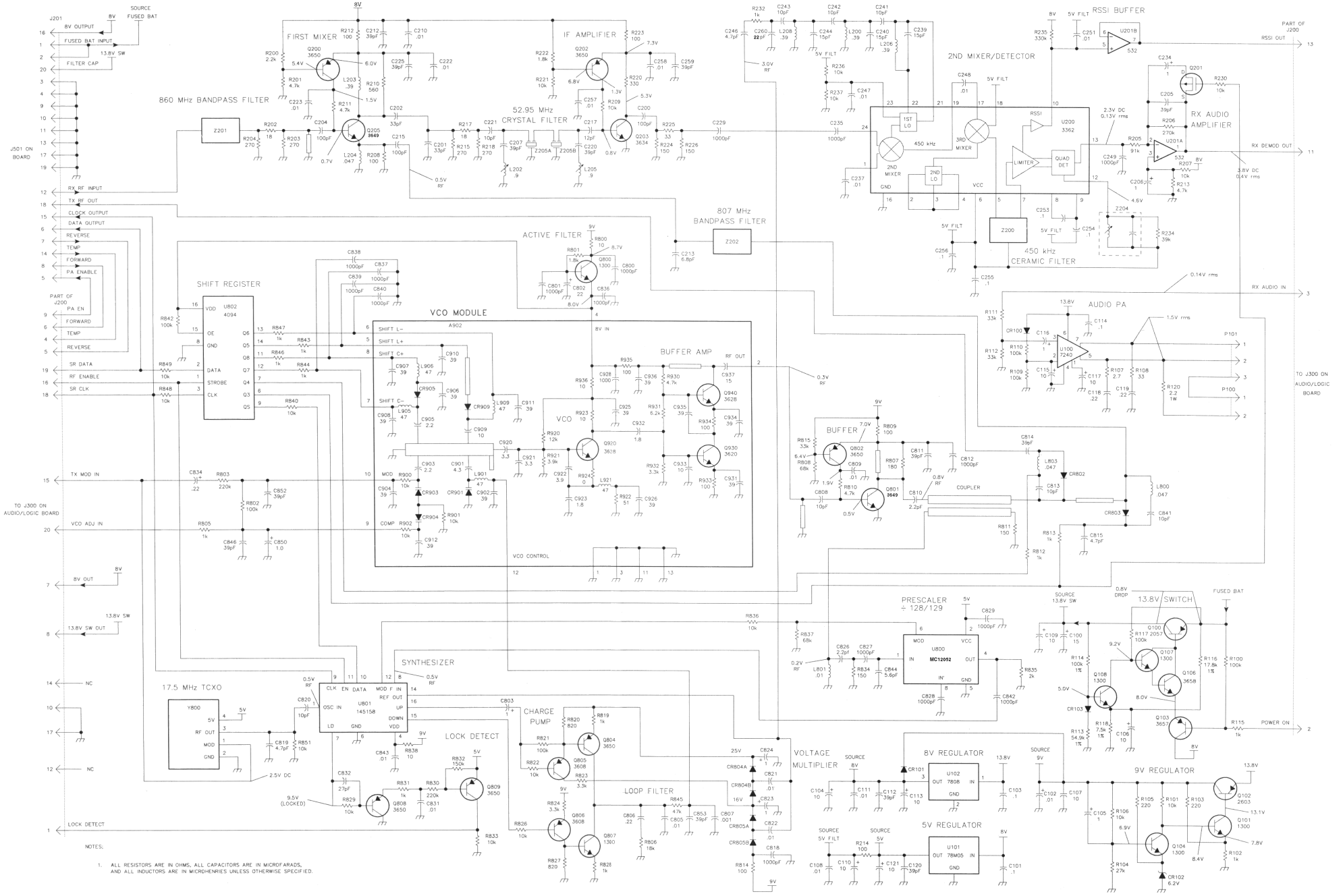

**DISPLAY BOARD TOP VIEW**




**DISPLAY BOARD BOTTOM VIEW**



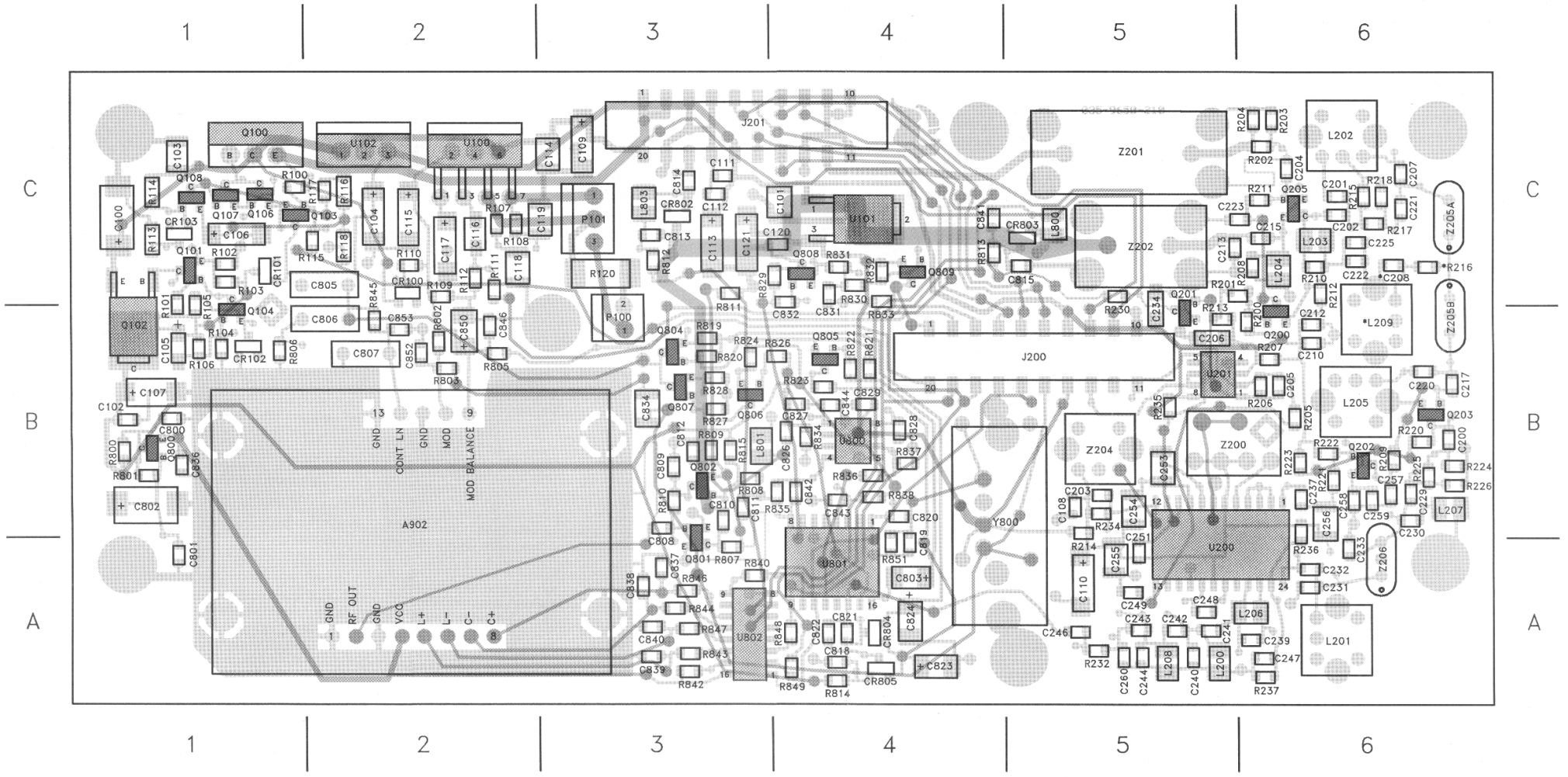
Revised January 1995
Part No. 001-9750-003




**RF BOARD SCHEMATIC (REVISED 800 MHZ)**



Revised January 1995
Part No. 001-9750-003

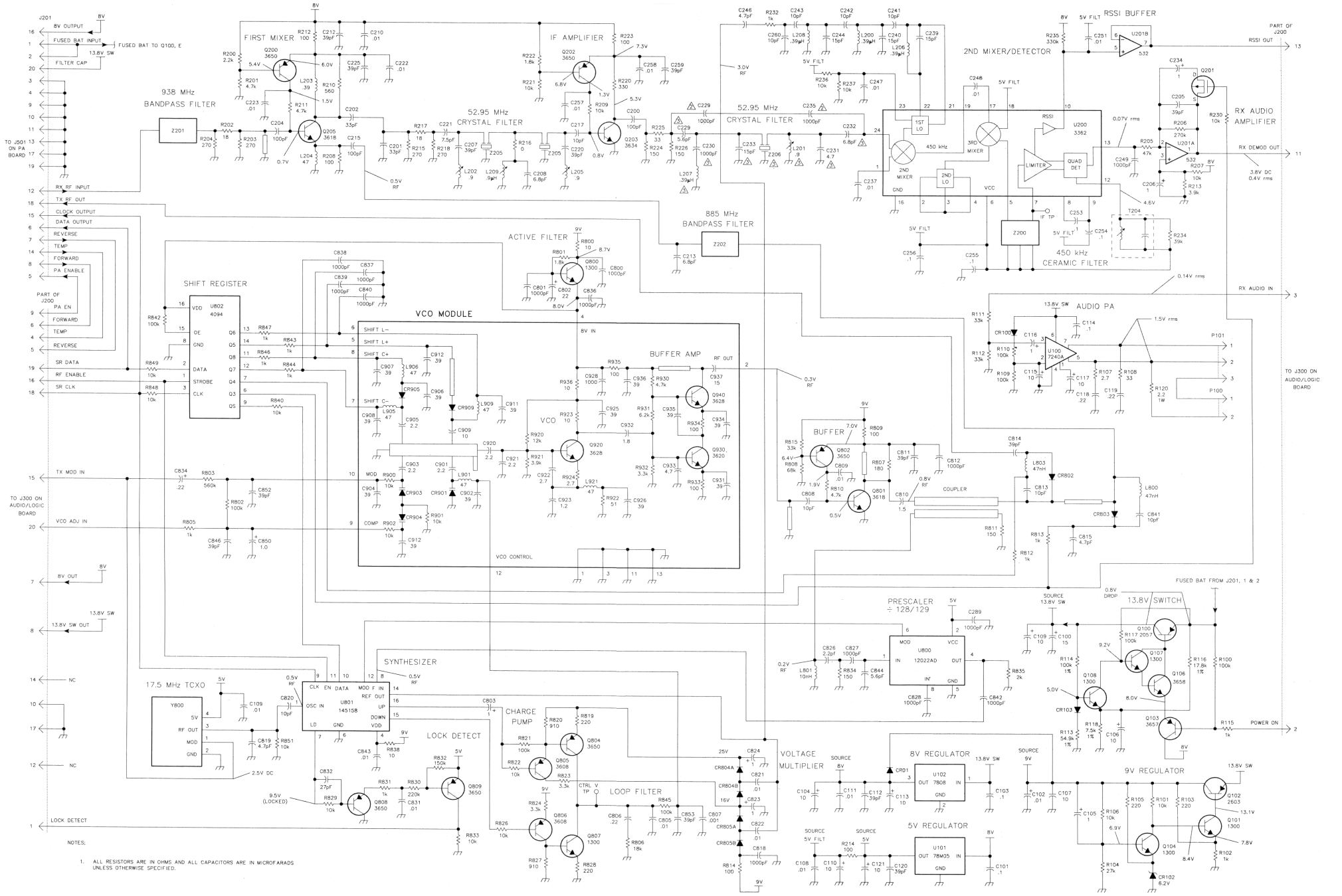



NOTE: C208, L209 & R216 ARE USED IN THE 900 MHz ONLY.

**RF BOARD BOARD LAYOUT (ALL 800/900 MHZ)**



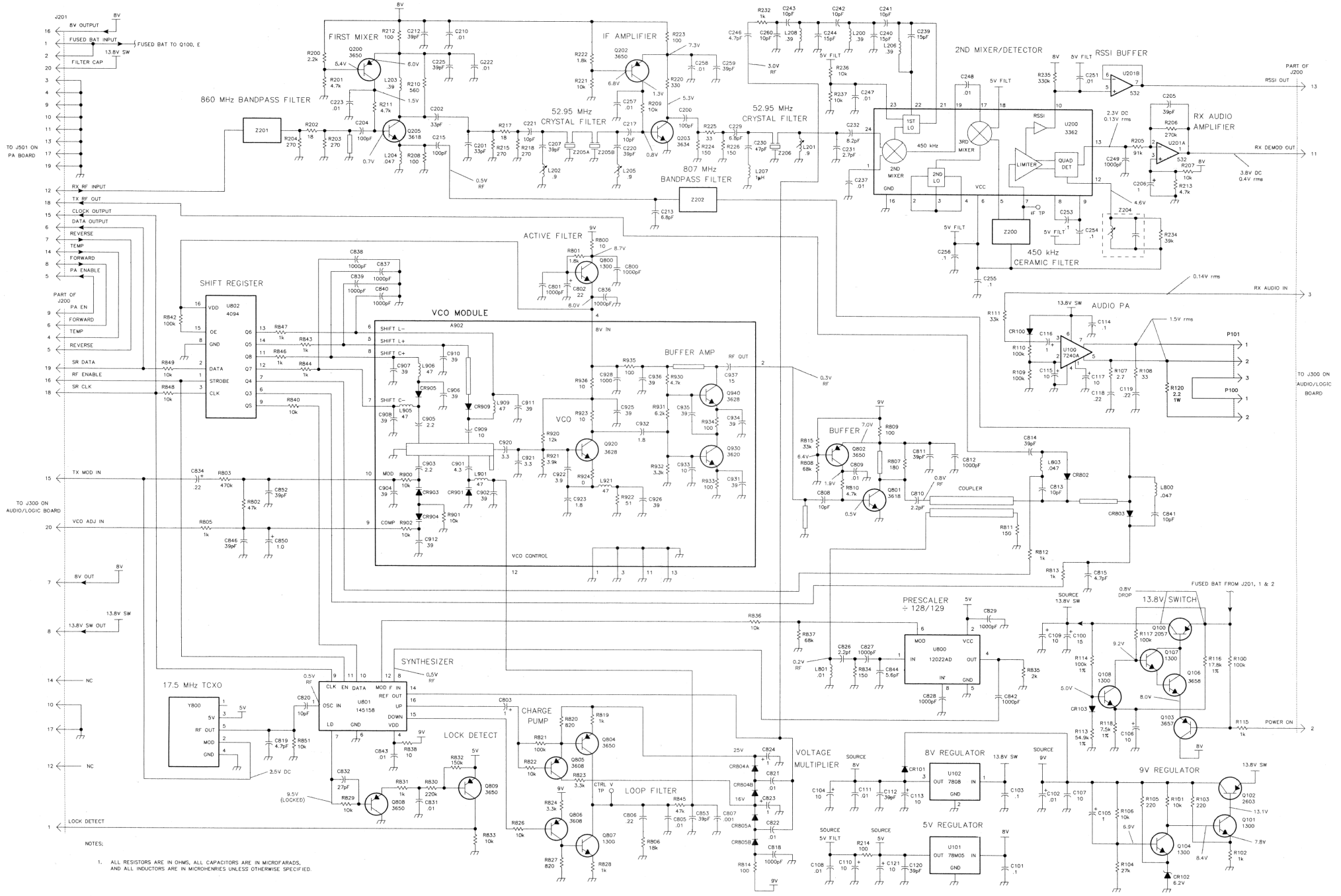
Revised January 1995
Part No. 001-9750-003




**RF BOARD BOARD SCHEMATIC (900 MHZ)**



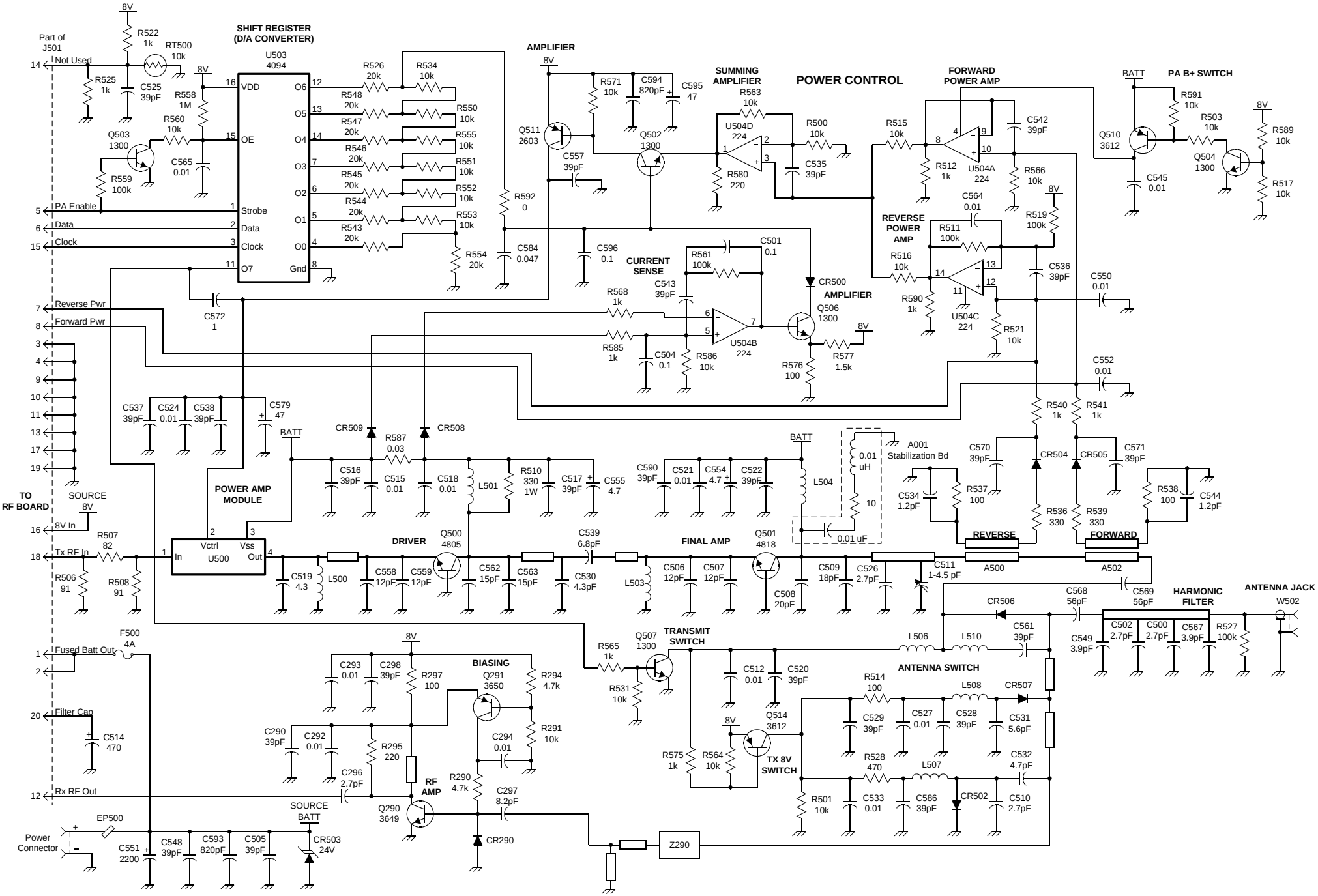
Revised January 1995
Part No. 001-9750-003




**RF BOARD BOARD SCHEMATIC (UNREVISED 800 MHZ)**



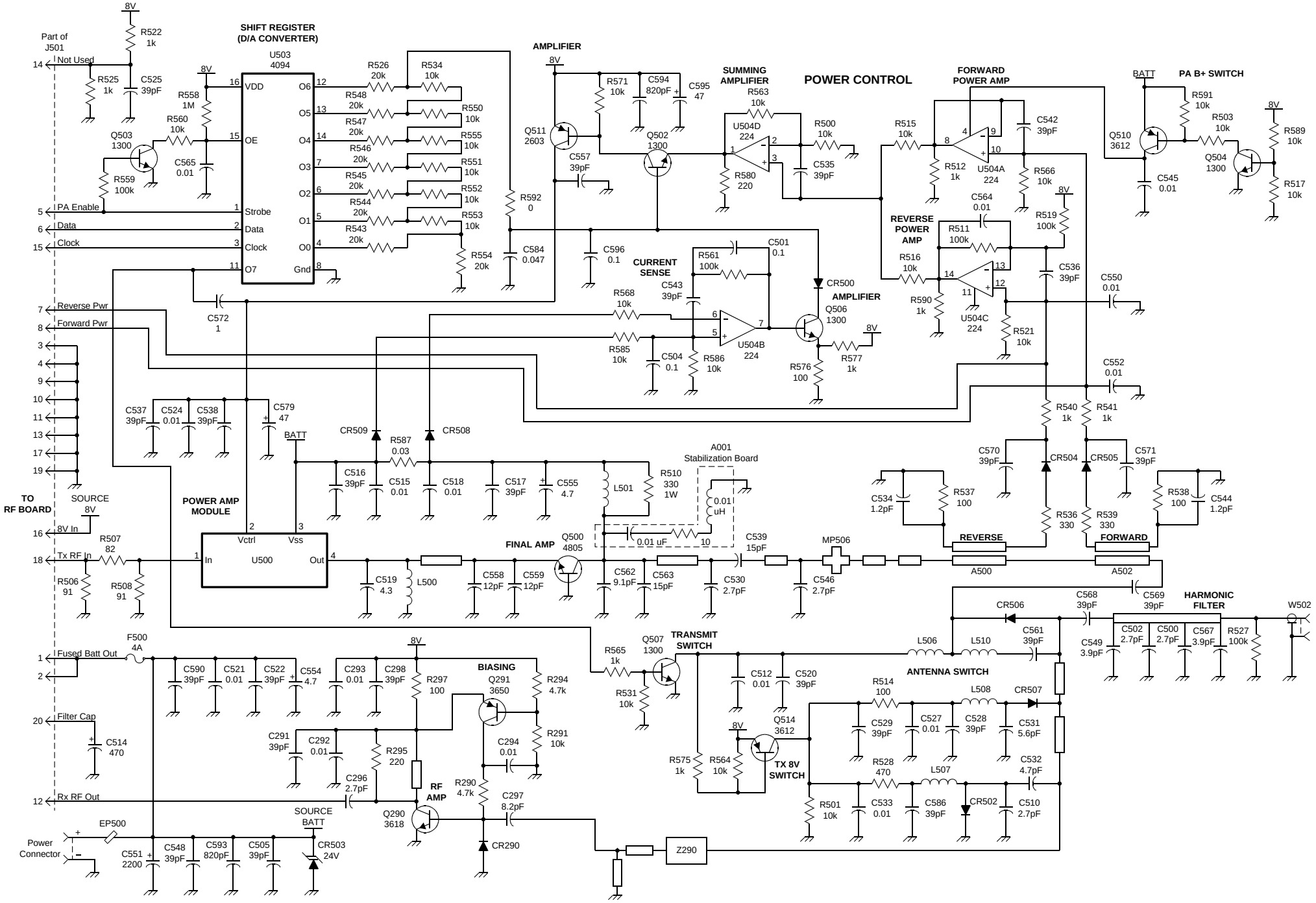
Revised January 1995
Part No. 001-9750-003




**PA BOARD BOARD SCHEMATIC (REVISED 800 MHZ, 35W)**



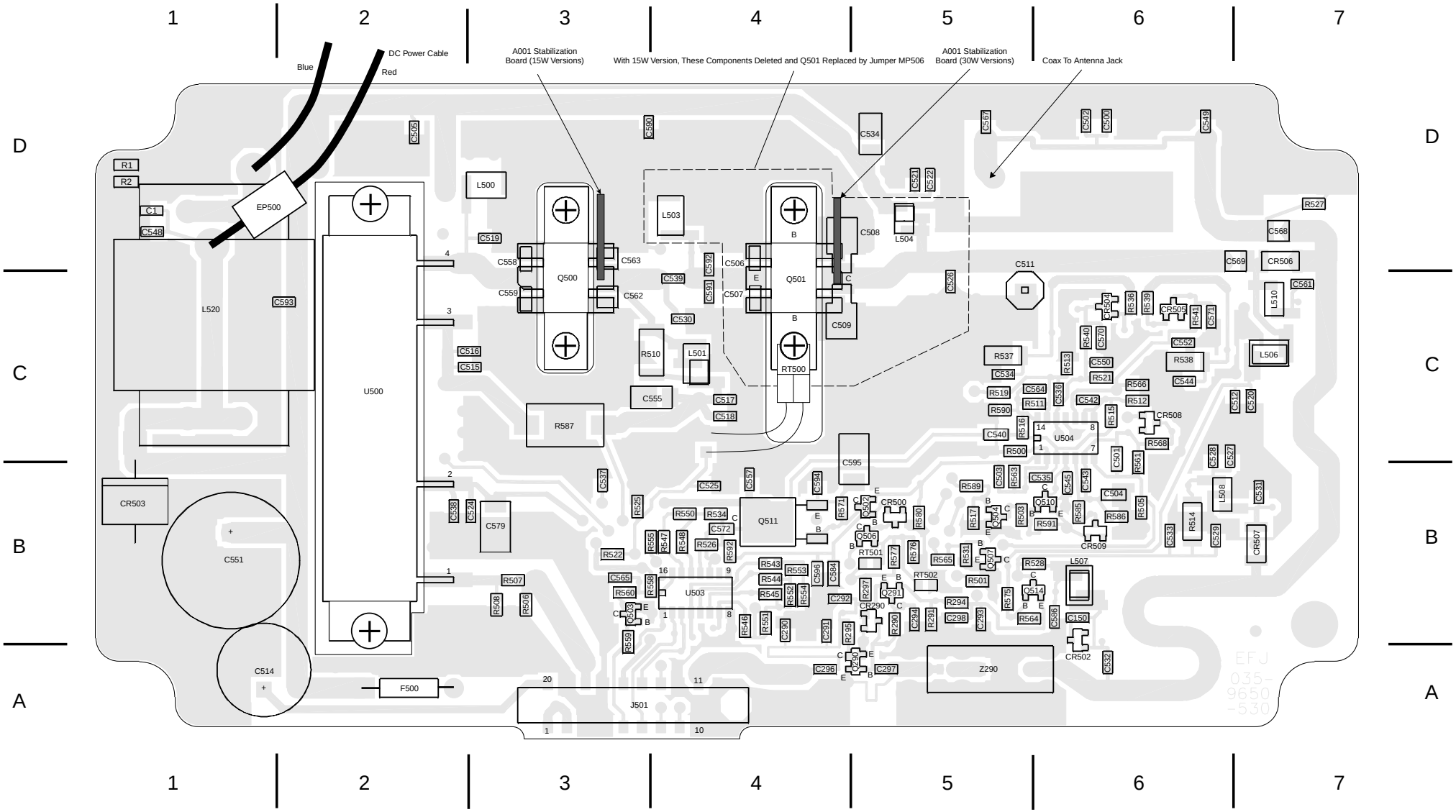
Revised December 2000
Part No. 001-9750-007

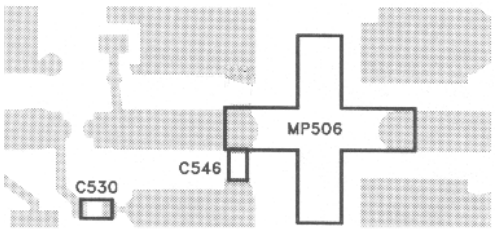



**PA BOARD BOARD SCHEMATIC (REVISED 800 MHZ, 15W)**



Revised December 2000
Part No. 001-9750-007



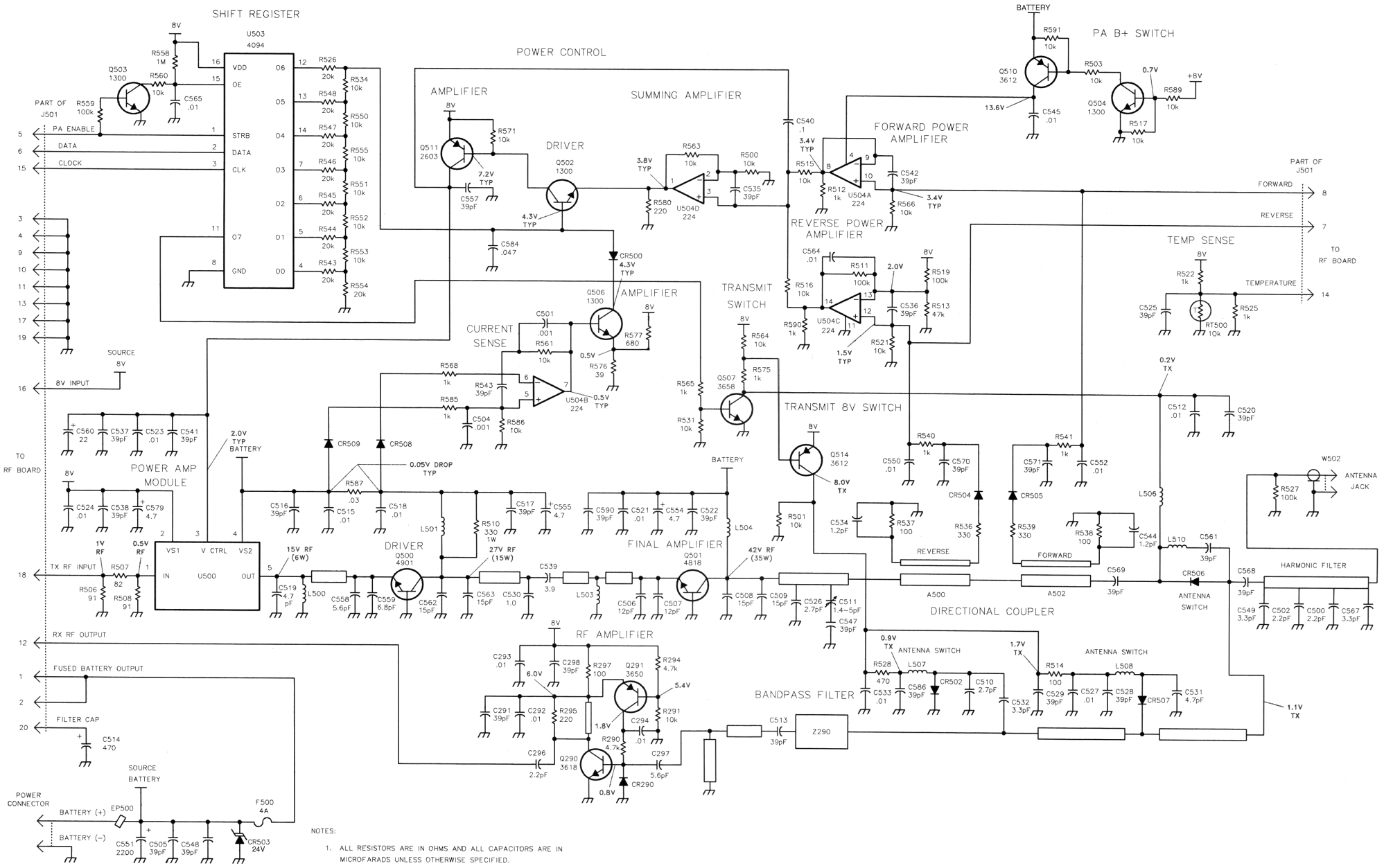




**15W MODELS**

## PA BOARD BOARD LAYOUT (REVISED 800 MHZ, 15W/35W)



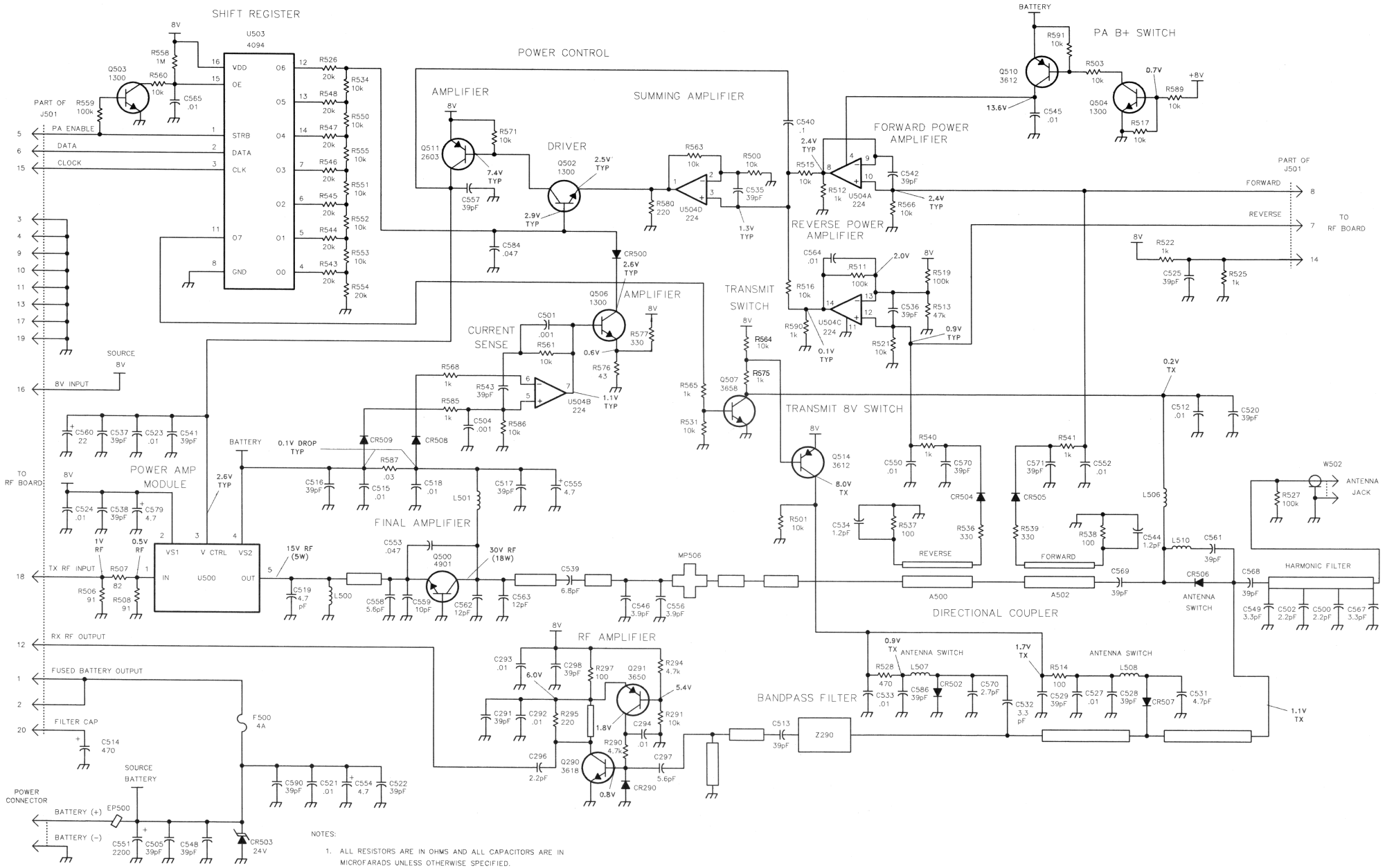
Revised December 2000
Part No. 001-9750-007




**PA BOARD SCHEMATIC (900 MHZ, 30W)**



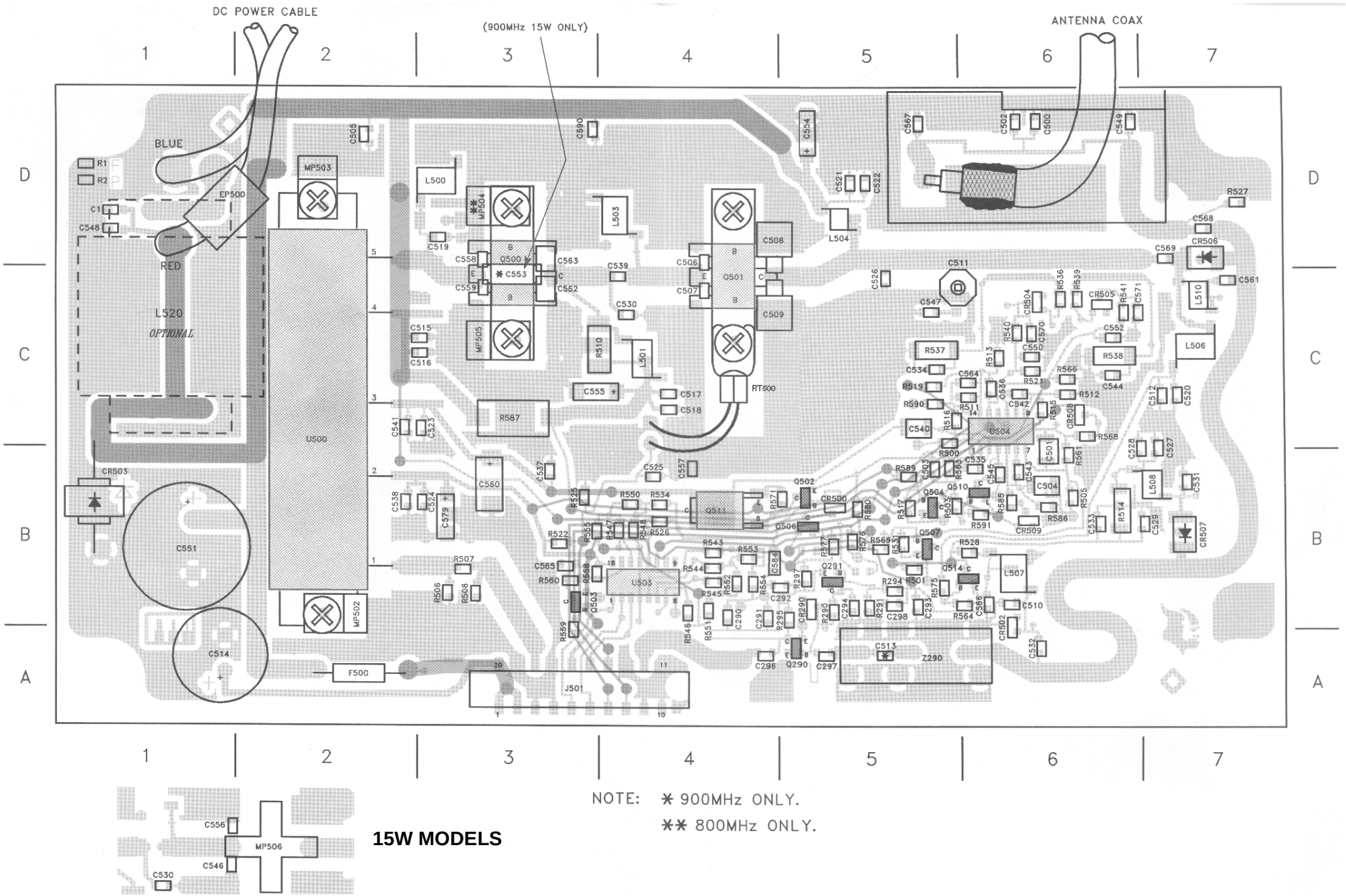
Revised January 1995
Part No. 001-9750-003




**PA BOARD SCHEMATIC (900 MHZ, 15W)**



Revised January 1995
Part No. 001-9750-003



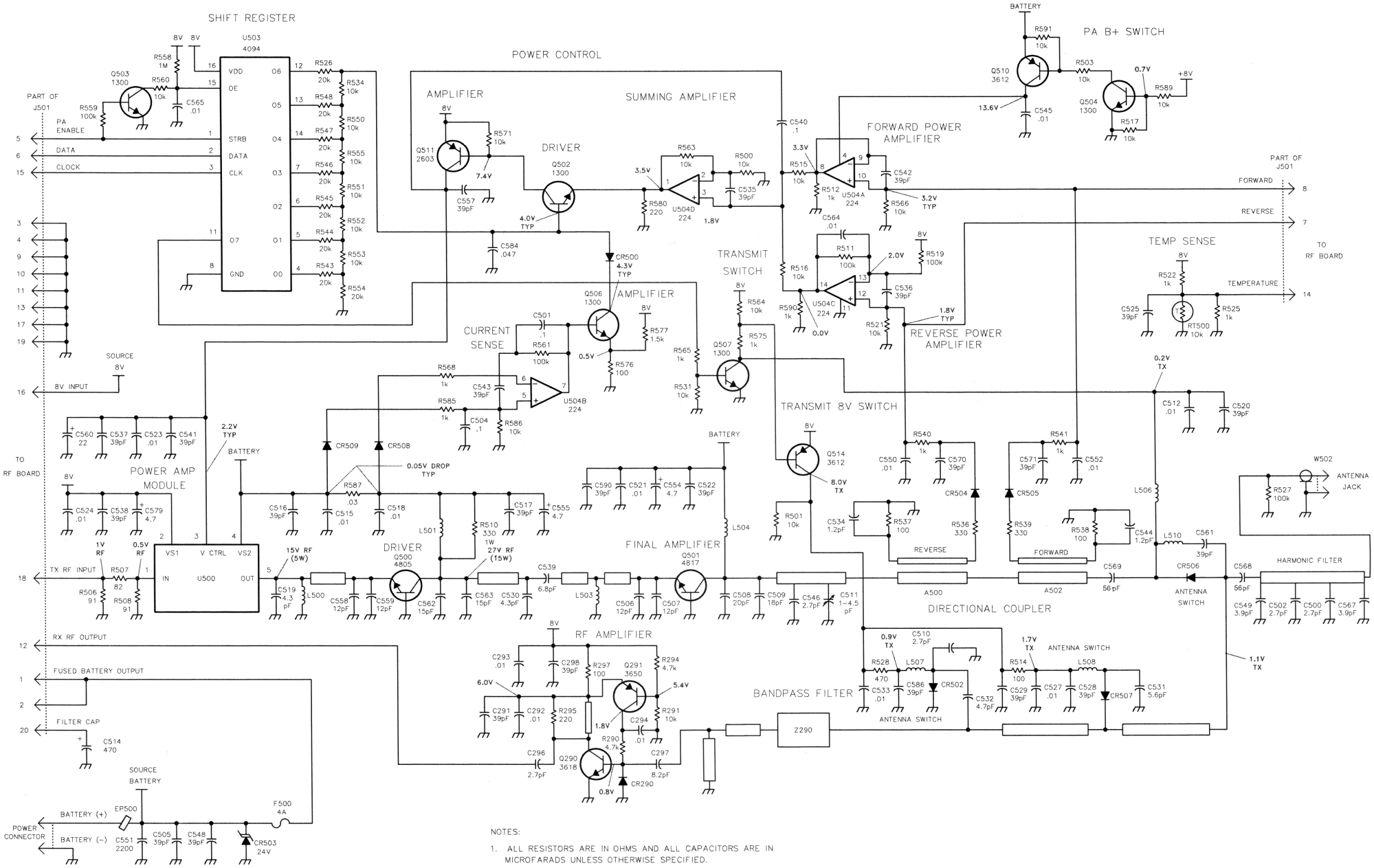

NOTE: ✱ 900MHz ONLY.
✱✱ 800MHz ONLY.

**15W MODELS**

**PA BOARD BOARD LAYOUT (900 MHZ/UNREVISED 800 MHZ, 15W/30W/35W)**



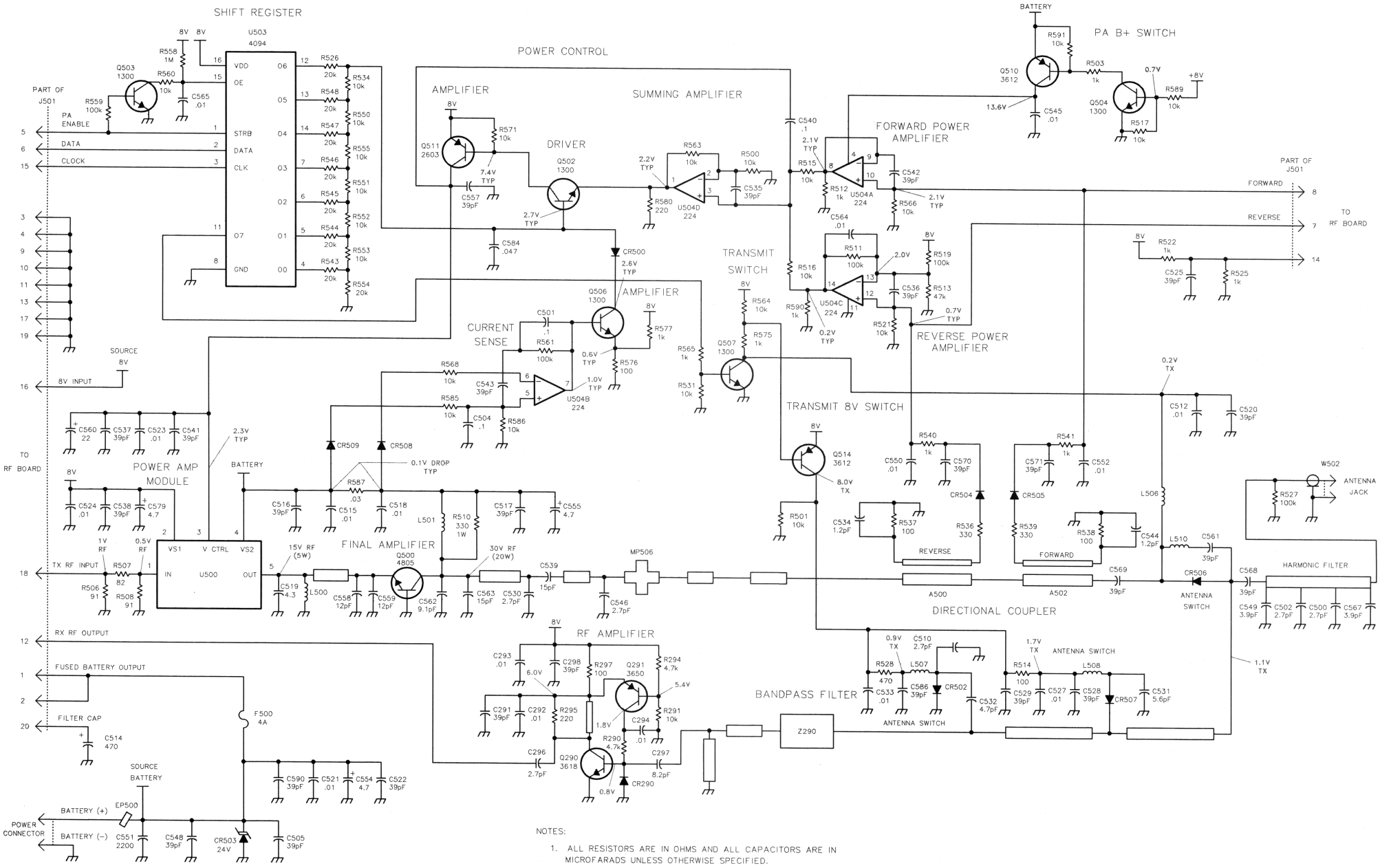
Revised January 1995
Part No. 001-9750-003




**PA BOARD SCHEMATIC (UNREVISED 800 MHZ, 35W)**



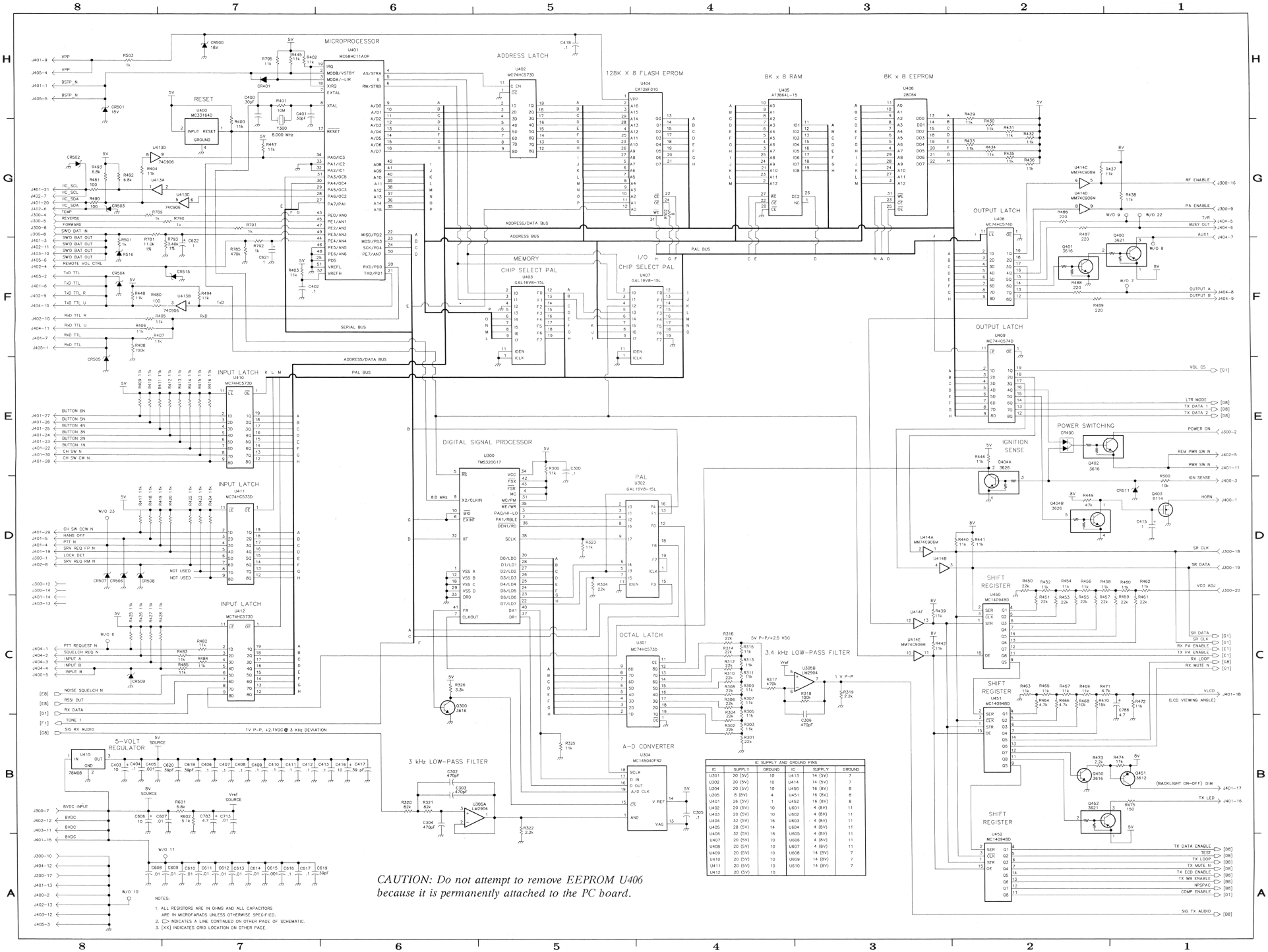
Revised January 1995
Part No. 001-9750-003




**PA BOARD SCHEMATIC (UNREVISED 800 MHZ, 15W)**



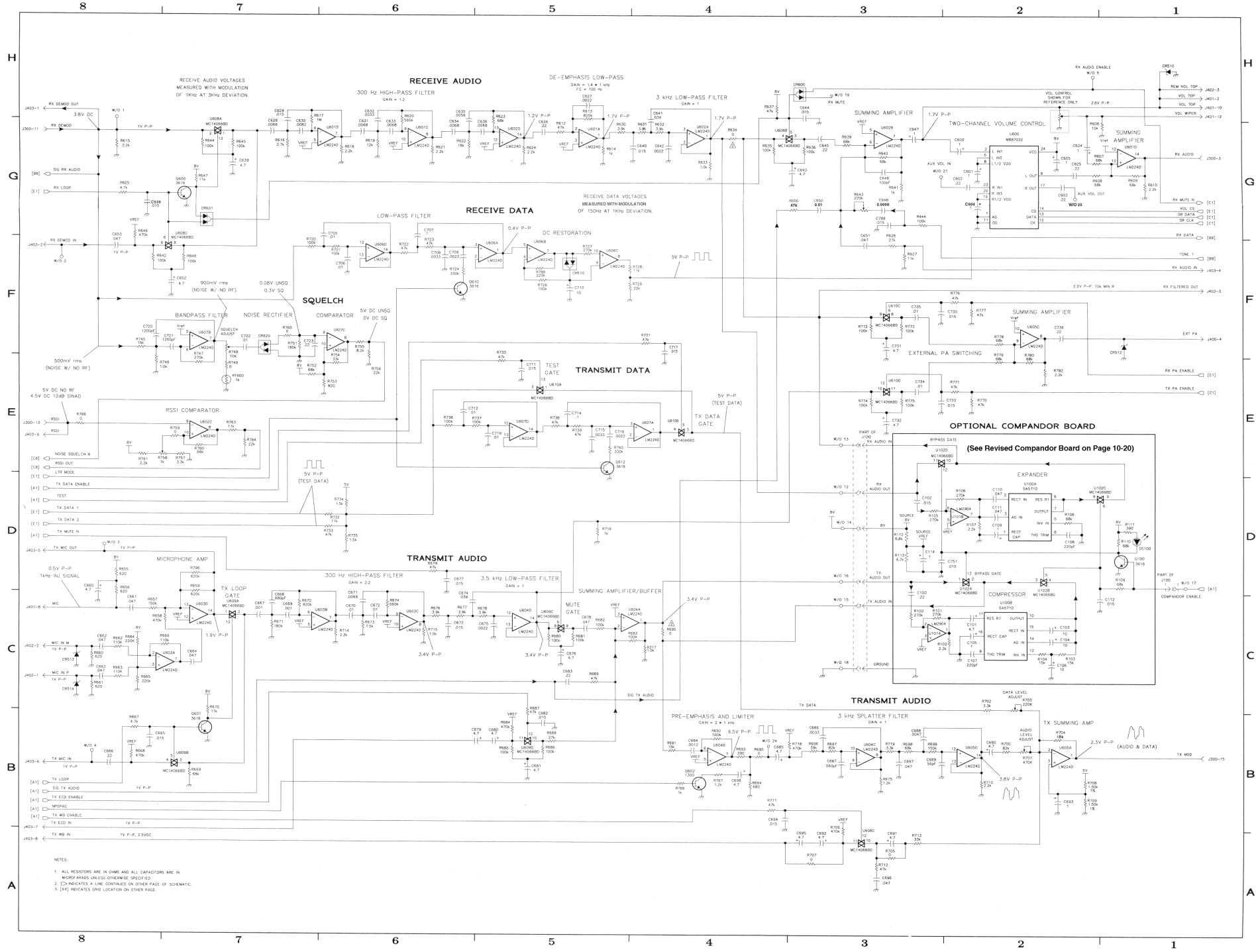
Revised January 1995
Part No. 001-9750-003




**AUDIO/LOGIC BOARD SCHEMATIC (PART 1 OF 2)**



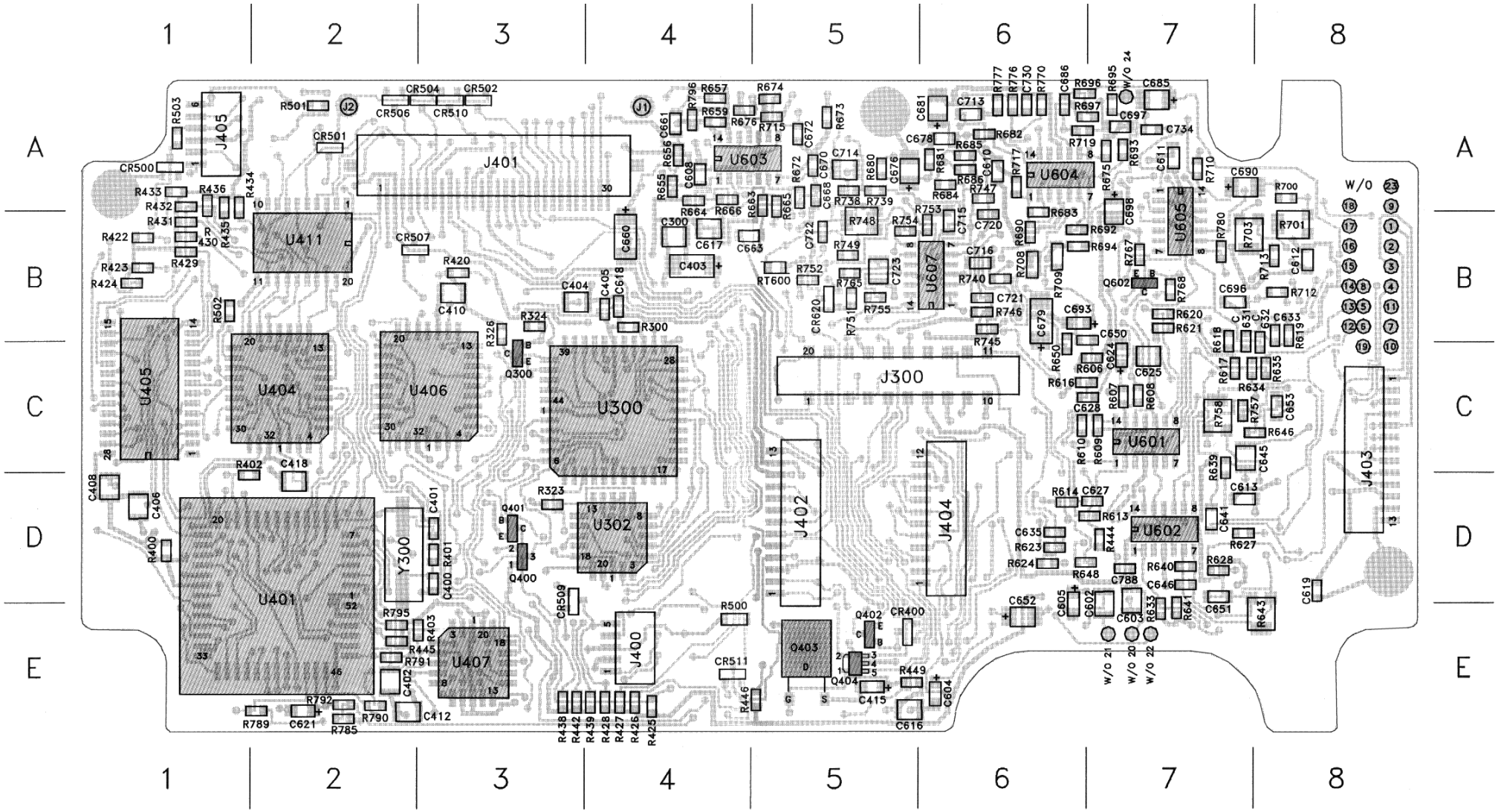
Revised January 1995
Part No. 001-9750-003




**AUDIO/LOGIC BOARD SCHEMATIC (PART 2 OF 2)**



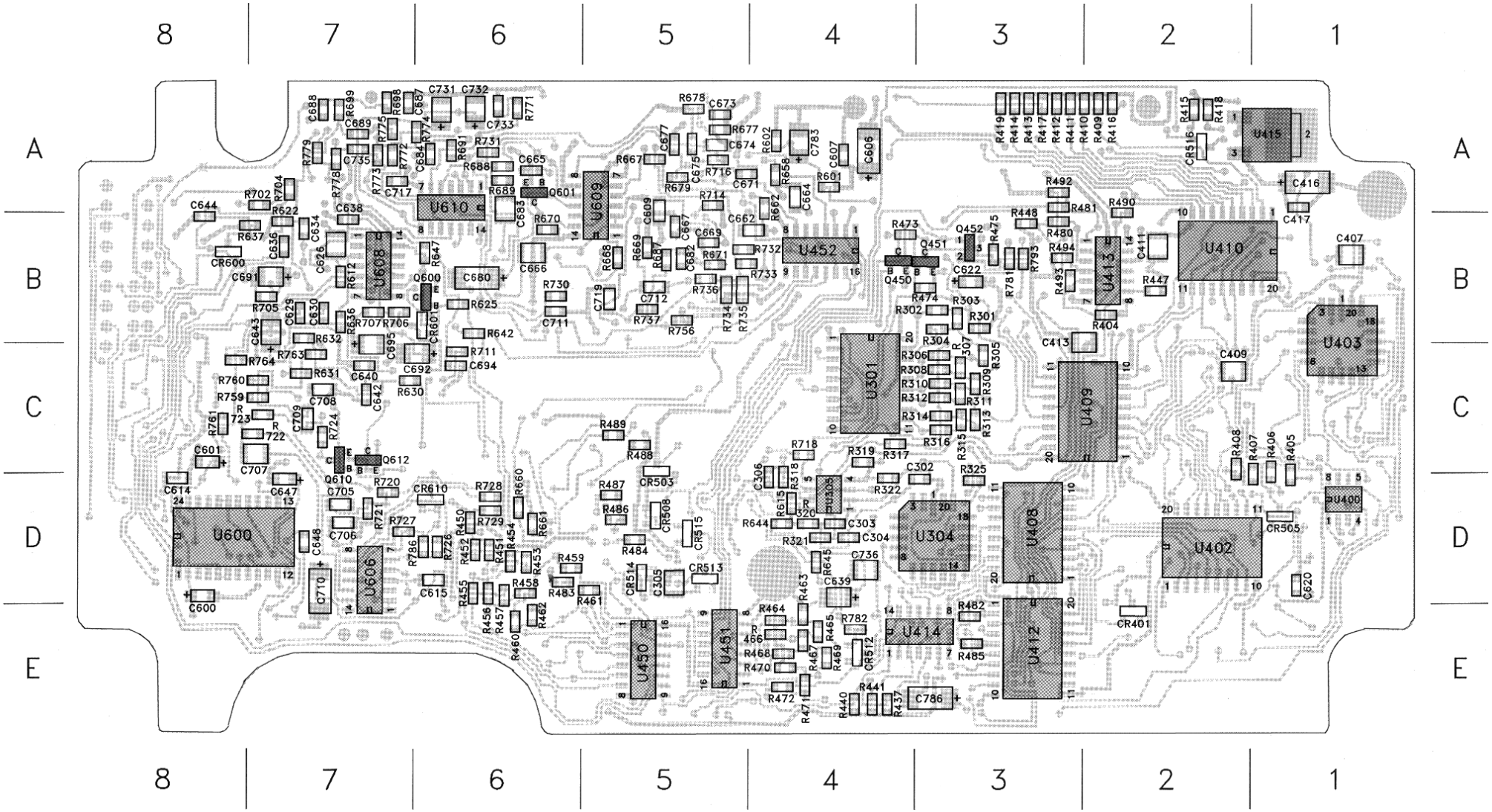
Revised January 1995
Part No. 001-9750-003




**AUDIO/LOGIC BOARD LAYOUT (TOP VIEW)**



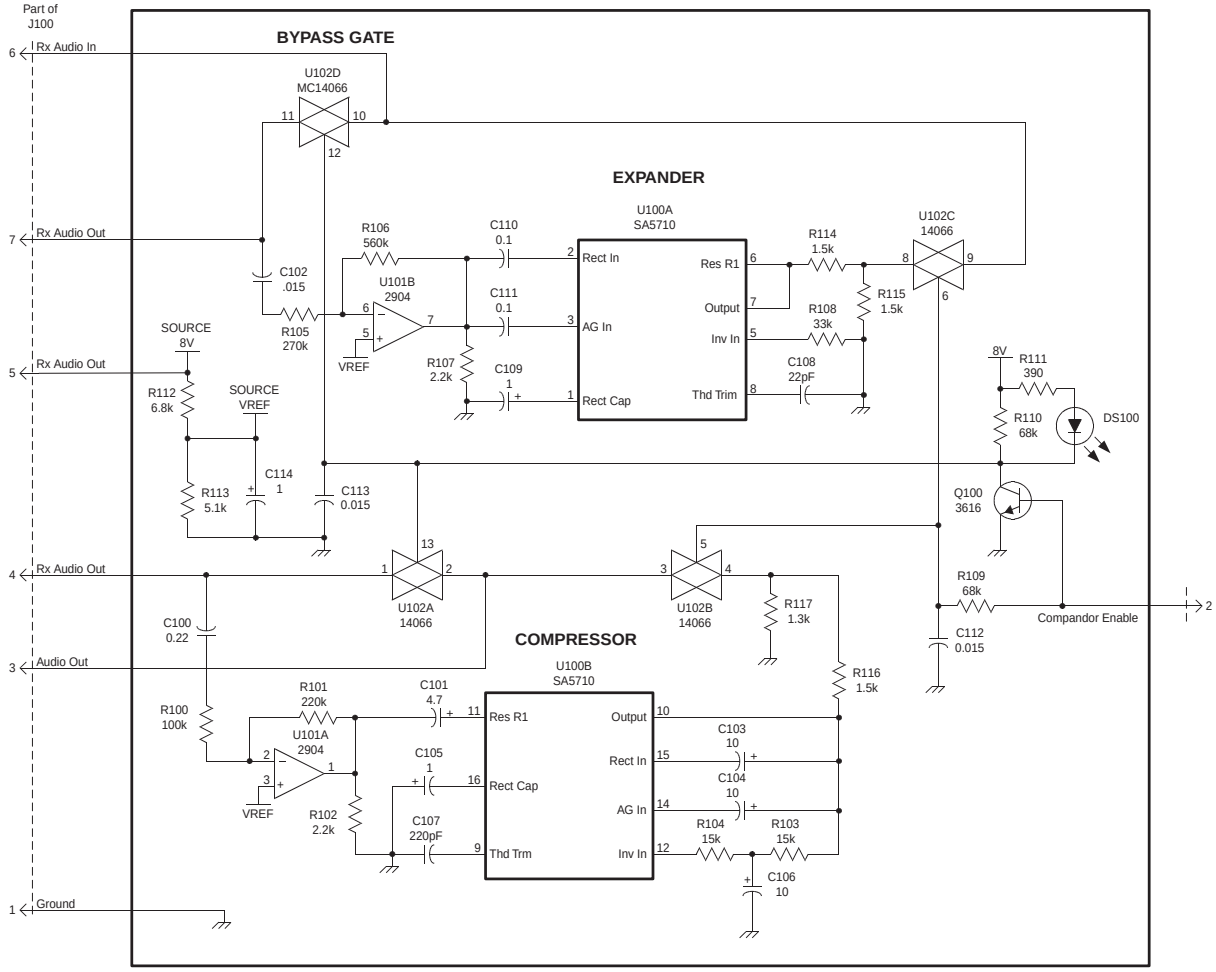
Revised January 1995
Part No. 001-9750-003



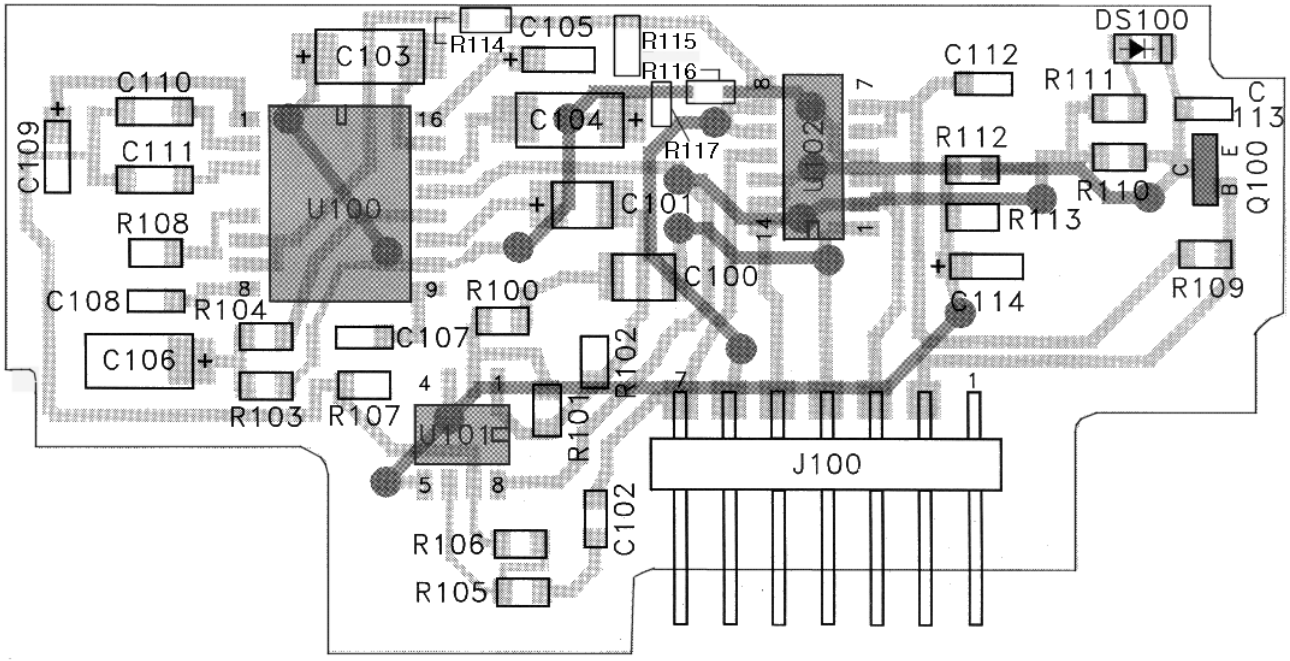

**AUDIO/LOGIC BOARD LAYOUT (BOTTOM VIEW)**



Revised January 1995
Part No. 001-9750-003

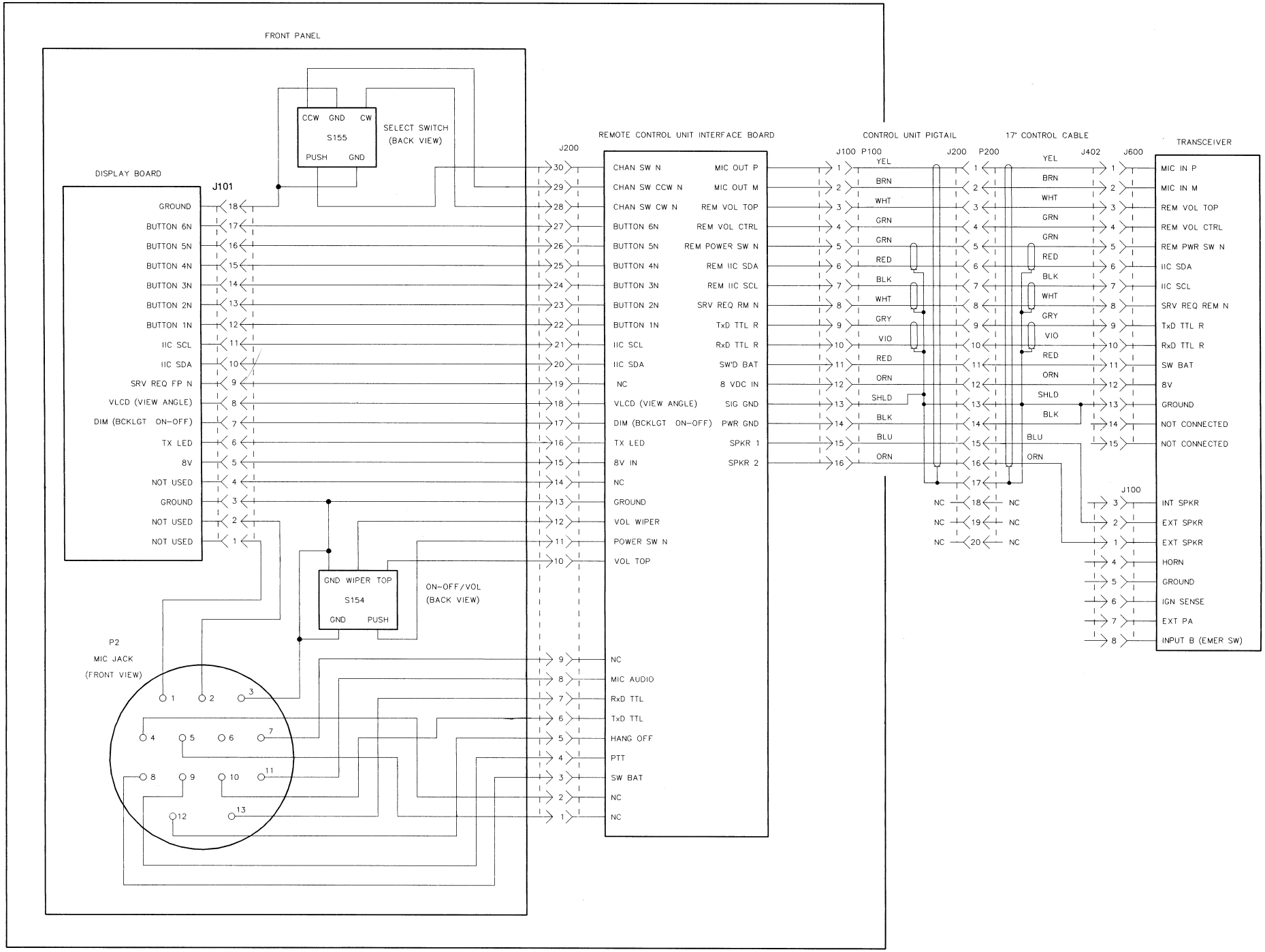



**REVISED COMPANDOR BOARD SCHEMATIC**




**REVISED COMPANDOR BOARD LAYOUT**

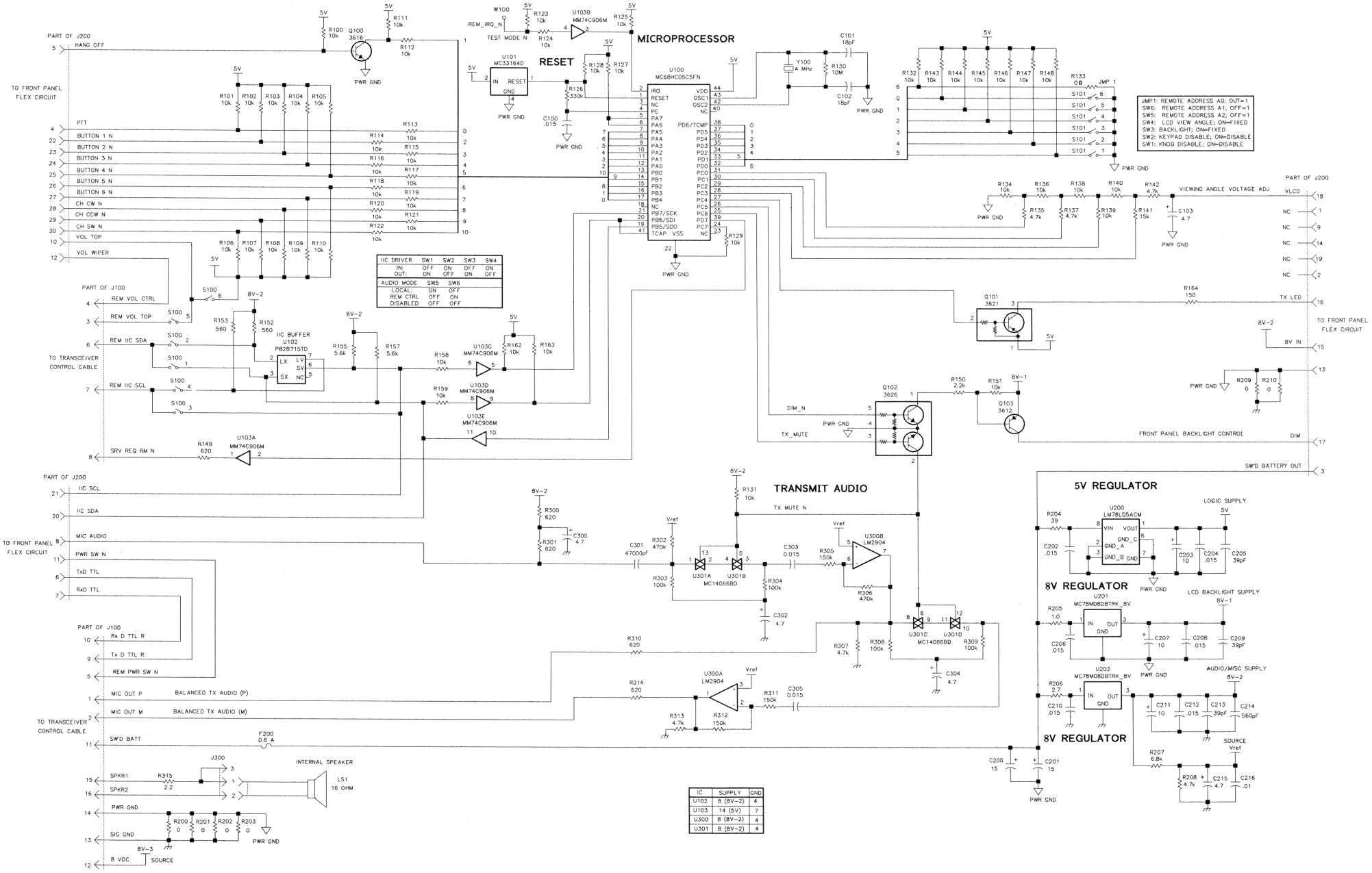
# REMOTE CONTROL UNIT




**REMOTE TRANSCEIVER INTERCONNECT SCHEMATIC**



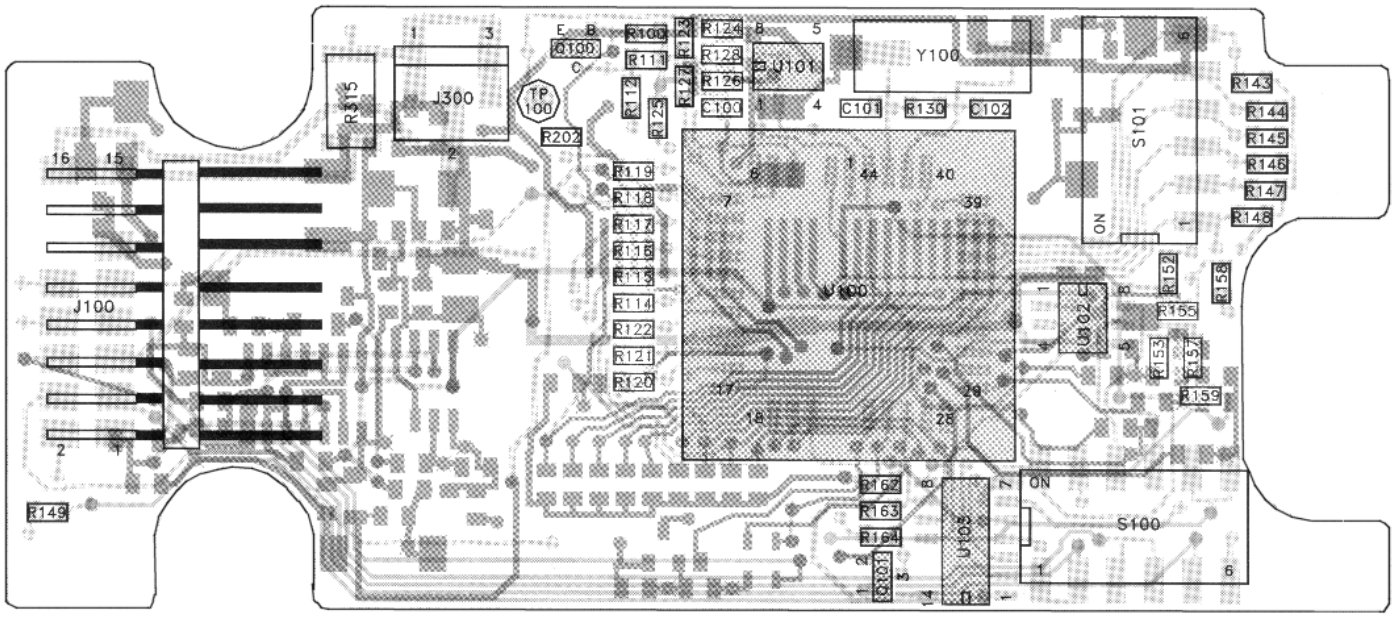
Revised January 1995
Part No. 001-9750-003



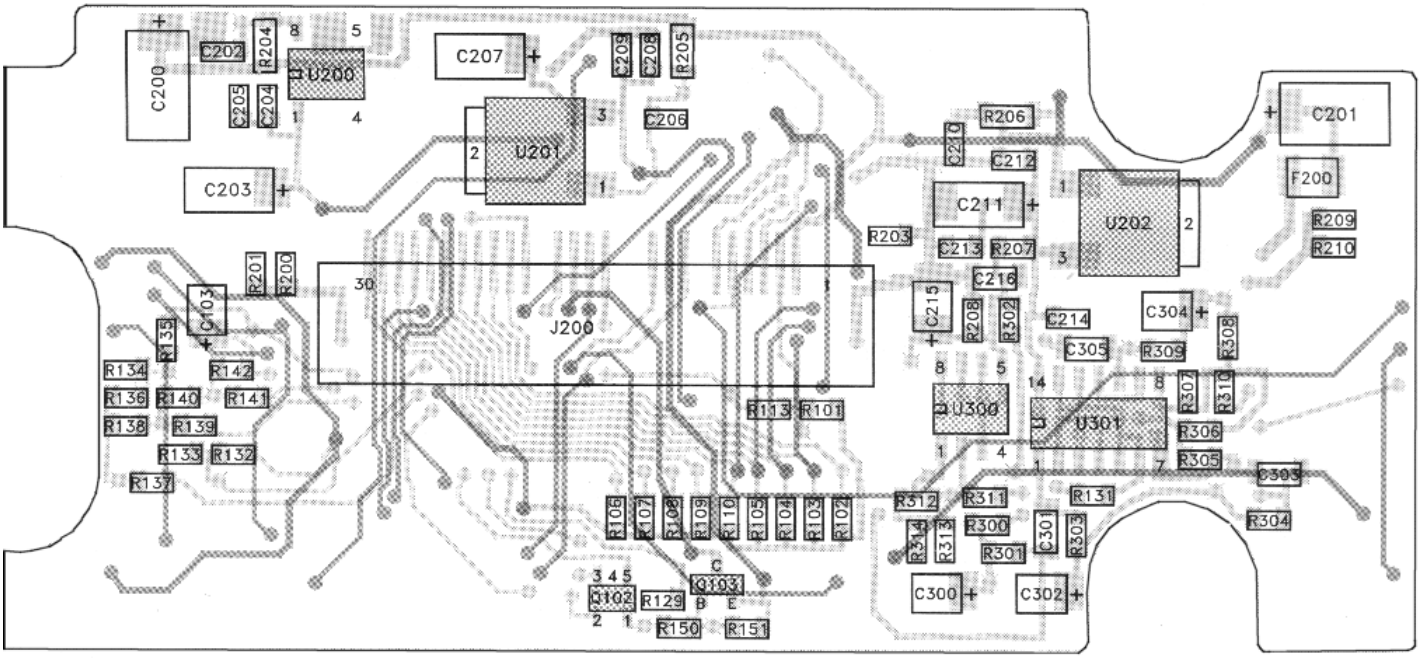

# REMOTE CONTROL UNIT INTERFACE BOARD SCHEMATIC



Revised January 1995
Part No. 001-9750-003




**REMOTE CONTROL UNIT INTERFACE BOARD TOP VIEW**




**REMOTE CONTROL UNIT INTERFACE BOARD BOTTOM VIEW**

# APPENDIX A REVISION SUMMARY

## A.1 INTRODUCTION

This appendix describes the changes that have been made to the Summit DM transceivers and programming software through May 1998. The component changes that have been made through January 1995 are listed in Table A-2, and additional component changes made through May 1998 are listed in Table A-3.

## A.2 TRANSCEIVER OPERATING SOFTWARE UPDATES

There have been several updates to the transceiver operating software since the Summit DM transceivers began shipping. The version number of the software is briefly displayed when power is turned on (see Section 3.6.14).

The operating software can be updated in the field by Write-On™ Flash Programming as described in Section 4.7. The transceiver operating software should not be confused with the programming software described in the rest of Section 4. Table A-1 lists the versions of transceiver operating software that have been released and describes the main changes that occurred with each.

## A.3 REVISION LETTER CHANGES

### A.3.1 TRANSCEIVER REVISION LETTER

The transceiver revision letter is part of the identification number described in Section 1.4. The changes that occurred with each revision letter change are as follows:

"B" (9755 only) - These models have an updated PA board that eliminated the need to cut a pad to install the optional DC line filter. This was never required on other models.

"B" (all except 9755), "C" (9755) - These models have an updated PA board that eliminated the need to lift the lead of U500, pin 1 before flash programming (see Section 4.7).

"C" (all except 9755), "D" (9755) - These models have Version 204 software that supports the horn alert feature for interconnect and Multi-Net unique ID calls (see Table A-1).

"E" (all models) - These models have the Version 206 software described in Table A-1. In addition, they have a small add-on board which provides static protection diodes on certain accessory cable lines. (Revision letter "D" was skipped on all but 9755 so that all models would have the same revision letter.)

"F" (all models) - These models have an audio/logic board that is upgraded with static protection diodes CR500-CR515 to eliminate the need for the add-on board implemented with "E" models.

"G" (all models) - These models have the Version 214 software described in Table A-1. In addition, diode CR601 on the audio/logic board has been deleted.

"H" (all models) - These models have the Version 215 software described in Table A-1. No hardware changes occurred.

### A.3.2 CONTROL UNIT REVISION LETTER

The changes that occurred with each control unit revision letter change are as follows:

"B" - These models include U102 (IIC buffer). "A" models do not include this part because it was not available. Currently, this device is not used.

"C" - These models have upgraded software to make them compatible with Summit transceivers which have Version 206 or later operating software. Refer to Section A-5 for more information.

## A.4 PROGRAMMING SOFTWARE CHANGES

Version 202 Software

Version 202 of the programming software was released in November 1994. This or a later version is required to program transceivers with Version 206 or

## Table A-1 Operating Software Version Numbers

| Version Number | Approx Release Date | Description | NOTES |
|---|---|---|---|
| 201 | 9/93 | Original release | |
| 202 | 11/93 | Added automatic NPSPAC deviation adjust and fixed various minor problems. | |
| 203 | 2/94 | Added telephone mode and provided NPSPAC deviation in test mode. Also fixed various minor problems. | |
| 204 | 3/94 | Added horn alert for interconnect and unique ID calls. Fixed minor problems. | Revision letter* changed to "C" except for 9755 which changed to "D". |
| 205 | 4/94 | Fixed various minor problems. | |
| 206 | 11/94 | Changed power turn-off delay times, added auto-registration wide area group tracking features, and fixed various minor problems. | Version 202 or later programming software must be used. In addition, only Summit control units with a revision letter of "C" or later can be used. Transceiver revision letter changed to "E" (all models). |
| 207 | 1/95 | Added UD$^2$I (universal interface) features and additional channels to test mode. Also added the ability to decode encrypted calls even if encryption is not enabled. | Version 203 or later programming software must be used to have the new encryption feature. |
| 208 | 6/95 | Fixed several minor problems. | |
| 209 | 7/95 | Fixed several minor problems. | |
| 210 | 9/95 | Added UD$^2$I validation indication and fixed minor problems. | |
| 211, 212 | --- | These revision numbers were skipped. | |
| 213 | 4/96 | Added horn alert modes and fixed minor problems. | |
| 214 | 12/96 | Added UD$^2$I support for the Status Message Unit (SMU), changed Mode A horn alert operation, and fixed several minor problems. | Revision letter* to "G". When transceivers with revision letter "F" or earlier are upgraded with this software and the UD$^2$I feature is used, diode CR601 must be removed for proper operation of that interface. |
| 215 | 1/97 | Fixed a minor problem. | Transceiver revision letter to "H". |
| 216 | 5/97 | Added "Start At Home" bank feature (see Section 7) and fixed minor problems. | Programming software Version 205 or later is required to program this feature. |
| 217 | 7/97 | Changed UD$^2$I lockout commands to allow a system number to be specified and fixed several minor problems. | |
| 218 | 9/97 | Fixed a minor ignition sense problem. | |
| 219 | 2/98 | Fixed Data PTT/ARQ arbitration problem and several minor UD$^2$I and other problems. | |
| 220 | 5/98 | Fixed a minor conventional scanning problem. | |
| 221 | 6/98 | Fixed a minor problem with transmit keying during time out period. | |
| 222 | 9/00 | Added per group variable proceed tone delay and fixed other minor problems. | Programming software Version 206 or later is required to the program variable delay feature. |

* Refer to Section 1.4 for revision letter information.

later operating software (see Section A.2). If the earlier version (201) is used to program those transceivers, erratic operation will result.

The Version 202 software has added screens for programming the UD²I universal interface features that became available with these transceivers. Other enhancements are a unique ID programming screen and system key verification before Multi-Net system data can be uploaded from a transceiver (see Section 4.1.5). It also has new times for the turn-off delay.

This software is backward compatible which means it can be used to program earlier model transceivers. The unique interface and wide area group tracking programming are ignored by earlier transceivers. The new power turn-off delay times are determined by the transceiver software and not the programming software (see following).

If the transceiver has Version 205 or earlier operating software, the programming software times of 10 or 30 minutes and 1, 8, 10, or 12 hours actually program times of 10, 20, or 30 minutes and 1, 2, or 4 hours, respectively. (For example, 1 hour programs 30 minutes.)

Files generated by Version 201 programming software are automatically converted to a new format when they are loaded and then saved or downloaded by the new software. Once a file is converted to the new format, it cannot be used by the Version 201 software. Refer to Section 4.1.5 for more information.

Version 203 Software

Version 203 of the programming software was released in January 1995. The only change to this software is an additional question on the Main Radio Parameters screen which asks if the encryption option is installed. Refer to Section 3.6.12 for more information on encryption operation.

Version 204 Software

Version 204 of the programming software was released in early 1996. The only change to this software is an additional question on the Main Radio Parameters screen to select the horn alert mode. Refer to Section 3.6.4 for more information on horn alert operation.

Version 205 Software

Version 205 of the programming software was released mid 1997. The only change to this software is an additional question on the Create/Edit Bank screen to program the “Start At Home” feature added to the transceiver. Refer to Section 7 for more information.

Version 206 Software

Version 206 of the programming software was released in October 2000. The only change was to add the variable delay programming screen. This screen is displayed by pressing the F6 key when a group programming screen is displayed (see Section 4.3.5).

## A.5 REMOTE CONTROL UNIT COMPATIBILITY

As indicated in Table A-1, if the transceiver has Version 206 or later operating software, it will operate only with Summit control units that have a revision letter of “C” or later. If an earlier control unit is used, it displays “RMT ERROR” on power up and is nonfunctional. The new “C” or later Summit control units will also work with earlier Summit transceivers.

To use earlier “A” or “B” control units with this software, microcomputer U100 in the control unit must be replaced with a new device containing the upgraded software. The new part number of U100 is 023-9998-324.

*NOTE: If a transceiver with Version 205 or earlier software is flash programmed with newer software, the remote control unit software must also be updated (if applicable).*

## A.6 WIDE AREA GROUP TRACKING PROGRAMMING

When Wide Area Group Tracking is enabled with Multi-Net Auto-Registration (see Section 3.7.2), the same group remains selected when auto-registration on another system occurs. This allows a companion

group to be automatically selected in the new system. For example, the transceiver can be programmed so that if a telephone group is selected and auto-registration occurs on a new system, a telephone group is also selected on the new system. Without wide area group tracking, the last selected group of the new system is selected. With this type of operation, it is important that the same groups in all systems be programmed. Refer to Section 4.4.6 for more information.

## A.7 NEW FEATURES

### A.7.1 BANK START AT HOME FEATURE

The bank "Start At Home" feature was added with the release of Version 216 transceiver software in May of 1997 (see Table A-1). When this feature is programmed "Yes", the bank home system/group is displayed when the bank is selected or power is turned on. Conversely, if it is programmed "NO", the last selected system/group is displayed.

Programming software Version 205 or later is required to program this feature (see Section 4). If earlier versions of the transceiver or programming software are used, the "NO" configuration is always selected.

### A.7.2 GROUP PROCEED TONE DELAY

A proceed tone delay time programmable on each system and selectable on a per group basis was added with the release of Version 222 transceiver software in September 2000. Programming software, Version 206 or later is required to program this feature. Refer to Section 3.6.3 for more information.

**Table A-2 Summit DM Part Changes Through January 1995**

| Component No. | Old Description (New Description of Added Parts) | Old Part No. (Location) | New Part No. | Action |
|---|---|---|---|---|
| | | | | |
| **RF AND PA BOARDS, HARDWARE/MISCELLANEOUS** | | | | |
| C 208 | 5.6 pF ±5% NPO 50V cer smd | 510-3601-569 | 510-3601-689 | Changed |
| C 217 | 10 pF ±5% NPO 50V cer smd (800 MHz) | 510-3601-100 | 510-3601-120 | Changed |
| | 9.1 pF ±5% NPO 50V cer smd (900 MHz) | 510-3601-919 | 510-3601-100 | Changed |
| C 221 | 9.1 pF ±5% NPO 50V smd (900 MHz) | 510-3601-919 | 510-3601-759 | Changed |
| C 229 | 6.8 pF ±5% NPO smd (800 MHz) | 510-3601-689 | 510-3601-569 | Changed |
| | 6.2 pF ±5% NPO smd (900 MHz) | 510-3601-629 | 510-3601-569 | Changed |
| C 230 | 47 pF ±5% NPO 50V smd (800 MHz) | 510-3601-470 | 510-3601-102 | Changed |
| C 233 | 15 pF ±5% NPO 50V cer smd (800 MHz) | (Z206) | 510-3601-150 | Added |
| C 234 | 1 µF 16V tantalum | (U201A, pin 2) | 510-2625-109 | Changed |
| C 260 | 10 pF ±5% NPO cer smd | 510-3601-100 | 510-3601-220 | Changed |
| C 557 | 39 pF ±5% NPO cer smd | (Q511, C) | 510-3601-390 | Added |
| HW 8 | Rubber bumper | --- | 574-1008-002 | Added |

## Table A-2 Summit DM Part Changes Through January 1995 (Continued)

| Component No. | Old Description (New Description of Added Parts) | Old Part No. (Location) | New Part No. | Action |
|---|---|---|---|---|
| HW 8 | Ground clip (900 MHz only) | --- | 017-2226-040 | Added |
| HW 9 | .167 x .277 steel flat washer | (cover screws) | 596-9408-009 | Added |
| L 207 | 1.0 µH smd inductor (800 MHz) | 542-9001-109 | 542-9001-398 | Changed |
| L 501 | 8T 22 AWG smd inductor (900 MHz, 15W only) | 542-0015-008 | 542-0016-004 | Changed |
| MP501 | Shield, coax ground | --- | 017-2226-017 | Added |
| Q 201 | P-channel JFET | (U201A, pin 1) | 576-0006-020 | Added |
| R 112 | 33k ohm ±5% 1/8W smd | (Near U100, pin 3) | 569-0105-333 | Added |
| R 230 | 10k ohm ±5% 1/8W smd | (U802, pin 6) | 569-0105-103 | Added |
| R 577 | 430 ohm ±5% 1/8W smd (900 MHz, 15W) | 569-0105-431 | 569-0105-331 | Changed |
| RT501 | Thermistor, 10k ohm (900 MHz only) | 569-3013-007 | --- | Deleted |
| RT502 | Thermistor, 1k ohm (900 MHz only) | 569-3013-002 | --- | Deleted |
| **AUDIO/LOGIC BOARD** | | | | |
| C 630 | .0068 µF X7R ±10% 50V cer smd | 510-3605-682 | 510-3605-822 | Changed |
| CR500-CR516 | 18V zener ±5% SOT | --- | 523-2016-180 | Added |
| R 500 | 10k ohm ±5% 1/8W smd | (J400, pin 3) | 569-0105-103 | Added |
| R 501 | 1k ohm ±5% 1/8W smd | (J300, pin 8) | 569-0105-102 | Added |
| R 502 | Zero ohm jumper smd | (U404, pin 24) | 569-0105-001 | Added |
| R 503 | 1k ohm ±5% 1/8W smd | (J401, pin 9) | 569-0105-102 | Added |
| R 602 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 | 576-0105-512 | Changed |
| R 606 | 4.7k ohm ±5% 1/8W smd | 569-0105-472 | 569-0105-103 | Changed |
| R 643 | 220k ohm smd trimmer | 562-0138-224 | 562-0130-224 | Changed |
| R 694 | 390 ohm ±5% 1/8W smd | 569-0105-391 | 569-0105-681 | Changed |
| R 701 | 470k ohm smd trimmer | 562-0138-474 | 562-0130-474 | Changed |
| R 703 | 220k ohm smd trimmer | 562-0138-224 | 562-0130-224 | Changed |
| R 748 | 10k ohm smd trimmer | 562-0138-103 | 562-0130-103 | Changed |
| R 758 | 1k ohm smd trimmer | 562-0138-102 | 562-0138-102 | Changed |
| R 767 | 1.5k ohm ±5% 1/8W smd | 569-0105-152 | 569-0105-122 | Changed |
| R 768 | 1.5k ohm ±5% 1/8W smd | 569-0105-152 | 569-0102-102 | Changed |
| R 796 | 620k ohm ±5% 1/8W smd (900 MHz) | (U603D, pin 13) | 569-0105-624 | Added |
| U 300 | Microprocessor, DSP | 544-5003-101 | 023-9998-309 | Changed |
| U 403 | Prog array logic, address decoder | 023-9998-271 | 544-9017-003 | Changed |
| U 407 | Prog array logic, I/O decoder | 023-9998-272 | 544-9017-004 | Changed |
| **FRONT PANEL ASSEMBLY** | | | | |
| MP108 | Support, keypad | --- | 017-2226-090 | Added |
| R 101 | 10k ohm ±5% 1/8W smd | 569-0105-103 | 569-0105-104 | Changed |
| R 102 | 10k ohm ±5% 1/8W smd | 569-0105-103 | 569-0105-104 | Changed |

## Table A-2 Summit DM Part Changes Through January 1995 (Continued)

| Component No. | Old Description (New Description of Added Parts) | Old Part No. (Location) | New Part No. | Action |
|---|---|---|---|---|
| **TCXO CHANGE** | | | | |
| In early 1995, a running change was made to the TCXO of all models. When the new TCXO is used (the part number is printed on the case), the value of three resistors must also be changed. The parts that changed are as follows. The new (-521) TCXO can also be used with early models because no PC board change was required. | | | | |
| R 802 | 47k ohm ±5% 1/8W smd (800 MHz) | 569-0105-473 | 569-0105-104 | Changed |
| | 39k ohm ±5% 1/8W smd (900 MHz) | 569-0105-393 | 569-0105-104 | Changed |
| R 803 | 470k ohm ±5% 1/8W smd (800 MHz) | 569-0105-474 | 569-0105-224 | Changed |
| | 820k ohm ±5% 1/8W smd (900 MHz) | 569-0105-824 | 569-0105-564 | Changed |
| R 704 | 47k ohm ±5% 1/8W smd (on audio/logic board) | 569-0105-473 | 569-0105-183 | Changed |
| Y 800 | TCXO, 17.500 MHz, 1.5 PPM | 518-7217-500 | 518-7009-521 | Changed |
| **Z206 FILTER CHANGE** | | | | |
| Also in early 1995, a running change was made to 2-pole crystal filter Z206 in the receiver of 800 MHz models. This filter is being deleted in all 800 MHz Summit DM transceivers (it continues to be used in all 900 MHz models). No degradation in performance results at 800 MHz when this filter is deleted. The following parts are changed when this filter is not used: | | | | |
| C 229 | 5.6 pF ±5% 50V cer smd | 510-3601-569 | 510-3601-102 | Changed |
| C 230 | .001 µF ±5% NPO 50V smd | 510-3601-102 | --- | Deleted |
| C 231 | 2.7 (800)/4.7 (900) pF ±5% NPO smd | 510-3601-x79 | --- | Deleted |
| C 232 | 8.2 (800)/6.8 (900) pF ±5% NPO smd | 510-3601-xx9 | --- | Deleted |
| C 233 | 15 pF ±5% 50V cer smd | 510-3601-150 | --- | Deleted |
| C 235 | .001 µF ±5% NPO 50V smd | (C229-U200, pin 24) | 510-3601-102 | Added |
| L 201 | 0.9 µH variable inductor | 542-1012-008 | --- | Deleted |
| L 207 | .39 µH smd inductor | 542-9001-398 | --- | Deleted |
| Z 206 | 52.95 MHz 2-pole filter (Summit DM 800 MHz only) | 532-0009-01x | --- | Deleted |

*NOTE: The changes in the following table have been made to the schematics and parts list in this manual.*

**Table A-3 Additional Summit DM Part Changes Through May 1998**

| Component No. | New Description | New Part No. | Old Part No. | Action |
|---|---|---|---|---|
| | | | | |
| **RF AND PA BOARDS** | | | | |
| C 260 | 22 pF ±5% NPO 50V cer smd | 510-3601-220 | Same | Error on schematic (10 pF should be 22 pF) |
| C 506 | 12 pF ±10% 50V hi Q smd (800 MHz, 35W only) | 510-3663-120 | 510-3614-120 | Changed type |
| C 507 | 12 pF ±10% 50V hi Q smd (800 MHz, 35W only) | 510-3663-120 | 510-3614-120 | Changed type |
| C 511 | Variable capacitor (800 MHz, 35W only) | 187-0103-175 | 512-1008-001 | Changed |
| C 547 | 39 pF ±5% NPO 50V cer smd (800 MHz, 35W only) | --- | 510-3615-390 | Deleted |
| C 568 | 56 pF ±10% 50V high Q smd (800 MHz, 35W only) | 510-3663-560 | 510-3615-390 | Changed |
| C 569 | 56 pF ±10% 50V high Q smd (800 MHz, 35W only) | 510-3663-560 | 510-3615-390 | Changed |
| R 205 | 56k ohm ±5% 1/8W smd (900 MHz) | 569-0105-563 | 569-0105-473 | Changed |
| R 513 | 47k ohm ±5% 1/8W smd (800 MHz, 35W only) | --- | 569-0105-473 | Deleted |
| **HARDWARE AND CABLE KIT (Part No. 023-9750-010)** | | | | |
| EP 002 | Ring terminal, 3/4” 10-12 AWG | 586-0001-036 | 586-0007-022 | Changed |
| EP 003 | Ring terminal, 3/8” 10-12 AWG | 586-0001-019 | 586-0007-010 | Changed |
| **ACCESSORY WIRE KIT (Part No. 023-9750-011)** | | | | |
| | Fuseholder includes: | | | Added fuse and holder |
| EP 001 | Contact | 586-9004-001 | -- | -- |
| F 001 | Fuse, 1A 250V FB AGC | 534-0003-020 | --- | --- |
| MP001 | Fuseholder body | 534-1004-031 | --- | --- |
| MP002 | Fuseholder knob | 534-1004-032 | --- | --- |
| MP003 | Fuseholder spring | 534-1004-035 | --- | --- |
| **TRANSCEIVER MOUNTING KIT (Part No. 023-9750-012)** | | | | |
| MP101 | Knob 10-32 x 1.18 | 547-0016-007 | 574-0016-003 | Changed |

## A.8 OTHER LATE CHANGES

This manual (Part No. 001-9750-007) has been updated with changes that have been made through November 2000. A summary of late hardware changes follows.

**Revised 800 MHz PA Board -** In mid 2000 a new 800 MHz PA board was implemented. The main change to this board was a different power module (U500). A stabilization board was also added across final amplifier Q501. This manual contains new schematics and board layout for this revised board.

**Compandor Board -** Several part changes have been made to the optional compandor board. The current schematic and board layout are shown on page 10-20.

# APPENDIX B UNIVERSAL DIGITAL AND DATA INTERFACE

## B.1 GENERAL INFORMATION

### B.1.1 SCOPE

This appendix describes the Universal Digital and Data Interface (UD$^2$I™) as it functions with Summit® DM Multi-Net® transceivers. This interface is also available for Viking® HT. However, operation with this transceiver is slightly different (the logic levels of some lines are inverted).

Although this interface is available for Summit DM transceivers with software Version 207 or later, this description applies specifically to operation with software Version 214 or later. Therefore, there may be slight operation differences with the earlier versions of software. Refer to Appendix A for more information on software revisions. Transceiver software can easily be updated using Flash programming. Refer to Section 4.7 for more information.

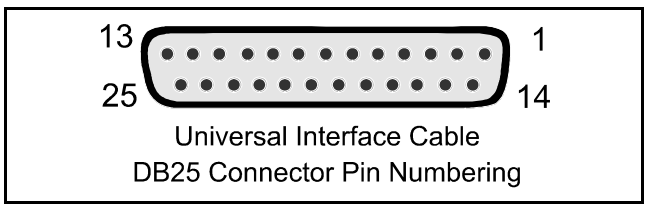
### B.1.2 UNIVERSAL INTERFACE DESCRIPTION

The universal interface provides a means of conveniently connecting external equipment to the transceiver. Types of equipment that may be connected include modems and data terminals.

To utilize the Universal Interface, the optional universal interface cable (see Table 1-1) must be factory or field installed in the transceiver. This cable is approximately 1-foot long and connects to J403 and J404 on the audio/logic board. It has a standard female DB-25 connector (see below) for connecting the external equipment. Also required is transceiver software Version 207 or later as described in the preceding section.

*NOTE: Validation Key, Part No. 250-9750-050, is no longer required to use this interface.*

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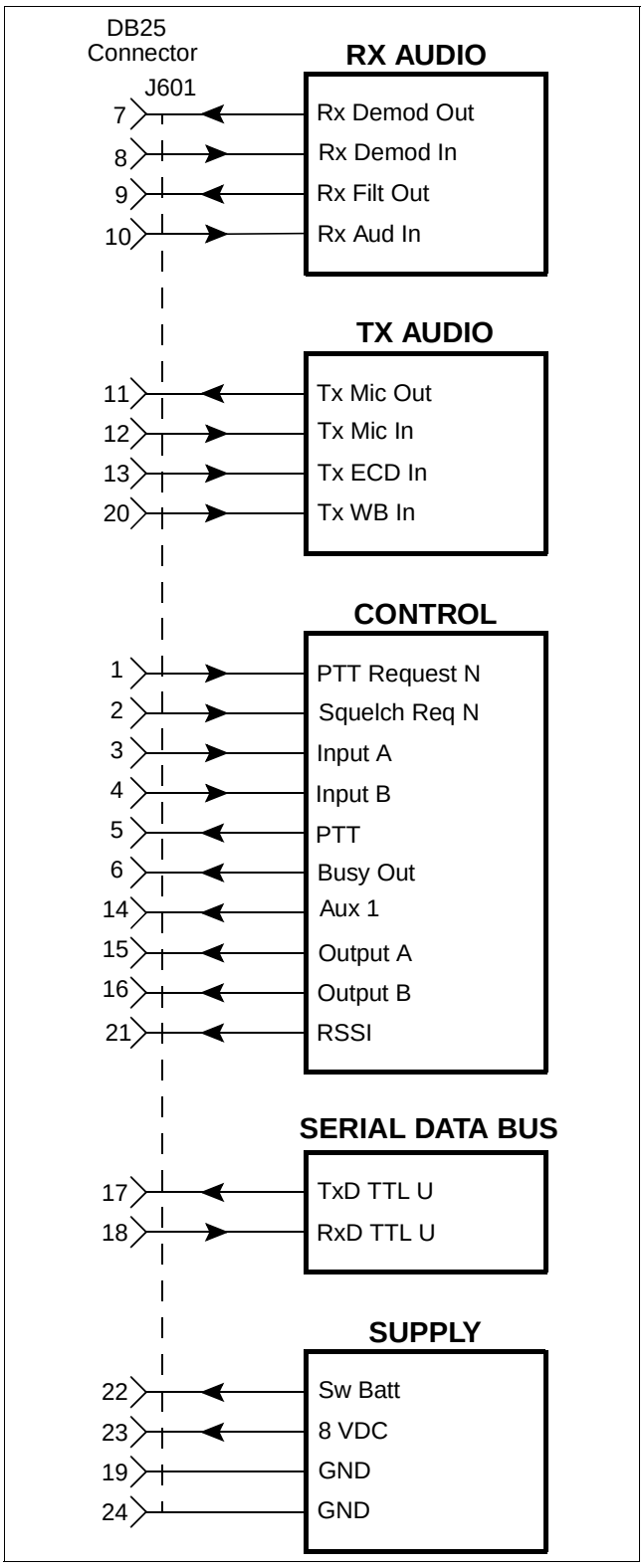




**Figure B-1 Universal Interface Pin Designations**



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*CAUTION: The DB25 universal interface connector is a non-standard port. Therefore, do not connect any equipment to this port not specially designed for this interface because equipment damage may result.*

Normally, there is no need to make internal modifications to the transceiver because connection points commonly used are available at the connector and programmable internal gating circuits provide the required routing of audio signals. The programming of the universal interface functions is performed using the same software used to program the transceiver as described in Section 4. Universal interface programming is described in Section 4.8.

Gating of the receive and transmit audio signals in Figure 1 is programmable on a system by system basis (each selectable system can be programmed for a different configuration) and are also controllable dynamically by the Serial Data Bus. The control functions are programmable only on a radio-wide basis (they are the same for all selectable systems and groups). Refer to Sections B.3, B.4, and B.5 for more information on the audio and control signals.

## B.2 POWER SUPPLY

**Table B-1 Power Supply Pin Description**

| Function | Pin | Description |
|---|---|---|
| Switched Battery | 22 | Standard battery voltage fused by 4-ampere fuse F500 on the PA board. Maximum source current is 300mA. |
| 8 volts DC | 23 | Regulated 8-volt supply (±5%). Maximum source current is 300mA. |
| Ground | 19, 24 | Radio chassis ground. |

A description of the power supply lines is located in Table 1. Since the Switched Battery and 8-volt power sources used by the universal interface also provide power to other accessories, the total power consumption of all accessories must not exceed the limits stated in Table 1. Other accessories which use the universal interface power sources are as follows:

- Equipment connected to the remote interface (J402) such as a remote control unit.
- Internal accessories installed in the option slots such as encryption or compandor modules.

## B.3 RECEIVE AUDIO SIGNALS

### B.3.1 PIN DESCRIPTIONS

Descriptions of the receive audio pins are located in Table 2, and a block diagram showing how these signals are internally routed to the receive audio processing and gating circuitry is shown in Figure 2.

### B.3.2 RECEIVE AUDIO GATING

The receive audio gating circuitry has been designed to provide several choices for receive audio routing (such as injecting before or after filtering and de-emphasis). The receive audio routing for the universal interface can be programmed for the four modes shown in Table 3. Each mode enables and disables the gates (indicated by “Mx”) so that the audio output signal from the external equipment (indicated by “Device x”) is routed to the desired filtering circuit. These modes are programmed for each selectable system as described in Section 4.8.3. The desired mode can also be selected by data on the Serial Data Bus (see Section B.8).

## B.4 TRANSMIT AUDIO SIGNALS

### B.4.1 PIN DESCRIPTIONS

Descriptions of the transmit audio pins are located in Table 4, and a block diagram showing how these signals are internally routed to the transmit audio filtering and gating circuitry is shown in Figure 3.

### B.4.2 TRANSMIT AUDIO PROGRAMMING

As with the receive audio circuitry, the transmit audio circuitry has been designed to provide several choices for routing (such as injecting before or after bandpass the bandpass filter). The transmit audio routing can be programmed for the four modes shown in Table 5. These modes are programmed for each selectable system as described in Section 4.8.3. The desired mode can also be selected by data on the Serial Data Bus (see Section B.8).

**Table B-2 Receive Audio Pin Description**

| Function | Pin | Description |
|---|---|---|
| Rx Demod Out | 7 | Buffered discriminator output before any filtering. DC coupled with 3.8-volt DC bias. Output impedance less than 600 ohms. Output level 1V P-P at 60% system deviation. Response +1/-3 dB DC - 5 kHz. This output is shared with internal option wire-out 1. |
| Rx Filt Out | 9 | Output from 300-3000 Hz bandpass filter and de-emphasis circuits. AC coupled with 3.2-volt DC bias. Output impedance less than 600 ohms. Output level 2.0V P-P at 60% system deviation. Response 300-3000 Hz TIA. This output is shared with internal option wire-out 13. |
| Rx Demod In | 8 | Input to 300-3000 Hz bandpass filter and de-emphasis circuits. AC coupled with input impedance greater than 25k ohms. Input level 1-volt P-P nominal. Signal is subjected to 300-3000 Hz TIA filter and de-emphasis. This input is shared with internal option wire-out 2. |
| Rx Aud In | 10 | Input to final audio amplifier chain after the mute gate and filtering but before volume control. AC coupled with input impedance greater than 10k ohms. Input level 0.7-volt P-P nominal. |

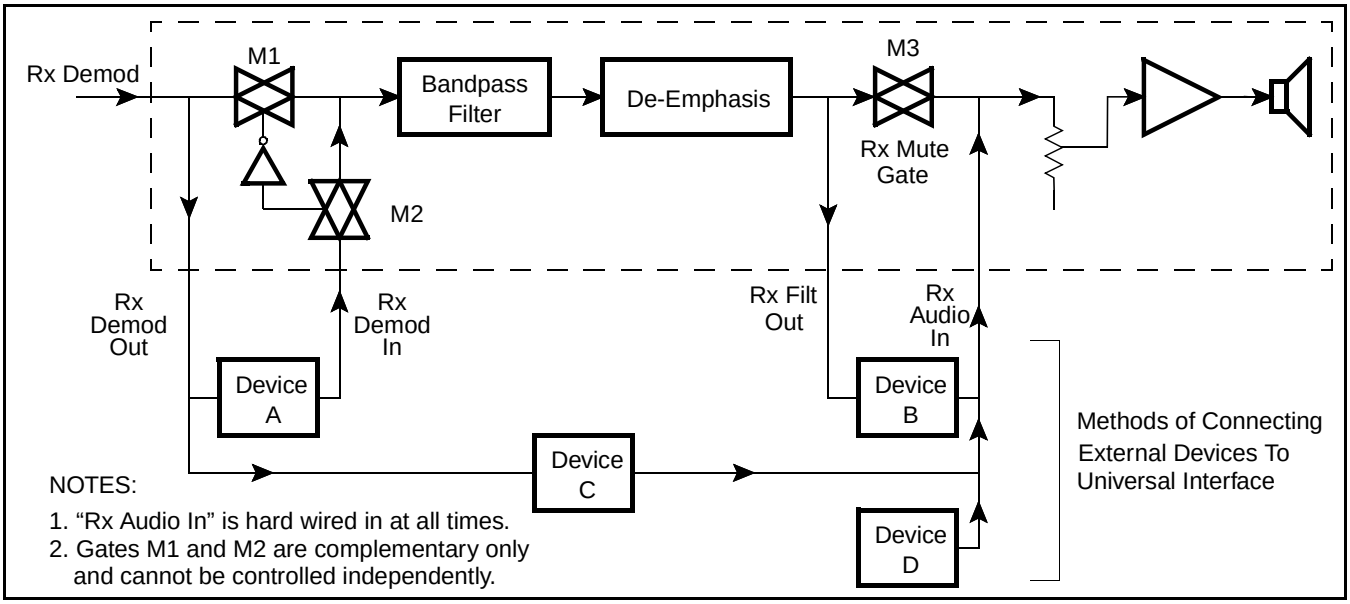



**Figure B-2 Receive Audio Signal Routing**

**Table B-3 Receive Audio Programming**

| Device | Mode | M1 | M2 | M3 |
|---|---|---|---|---|
| (Default) | 1 | Closed | Open | Squelch Ctrl |
| Device A | 2 | Open | Closed | Closed |
| Device B | 3 | Closed | Open | Open |
| Device C | 4 | Open | Closed | Open |
| Device D | 4 | Open | Closed | Open |

**Table B-4 Transmit Audio Pin Description**

| Function | Pin | Description |
|---|---|---|
| Tx Mic Out | 11 | Buffered single-ended microphone signal before any filtering. DC coupled with 3.2-volt DC bias. Output impedance less than 200 ohms. Output level 1V P-P nominal. This output is shared with internal option wire-out 3. |
| Tx Mic In | 12 | Input before 300-3000 Hz TIA bandpass filtering, pre-emphasis, and limiting. Therefore, this input signal will pass through these circuits. The input impedance is greater than 24k ohms, and the nominal input level is 1-volt P-P at 60% system deviation. This input is shared with internal option wire-out 4. |
| Tx ECD In | 13 | This External Coded Data input bypasses bandpass filtering but not pre-emphasis and limiting. It could be used for modems and other equipment that produce signaling in the 4 Hz - 3000 Hz range. AC coupled with input impedance greater than 20k ohms, and nominal input level is 1-volt P-P at 60% system deviation. |
| Tx WB In | 20 | This wideband data input permits direct modulation of the transmit signal since it is after the filtering and deviation limiting circuitry. When the standard DC coupling is used, a DC bias of 2.5 volts ±2% (50 mV) must be applied to this input. This keeps the TCXO on frequency since there is then a DC path directly to the TCXO modulation input. The TCXO frequency may need to be readjusted when DC coupling is used. Nominal input level is 1-volt P-P at 60% system deviation. Optional AC coupling is available by removing jumper R707 on the audio/logic board. AC coupled input impedance is greater than 20k ohms. Frequency response is DC - 4800 Hz (DC coupled) or 4 Hz - 4800 Hz (AC coupled). ***NOTE: Since signals on this input bypass the deviation limiting circuitry, the user assumes all responsibility for FCC compliance when this port is used.*** |

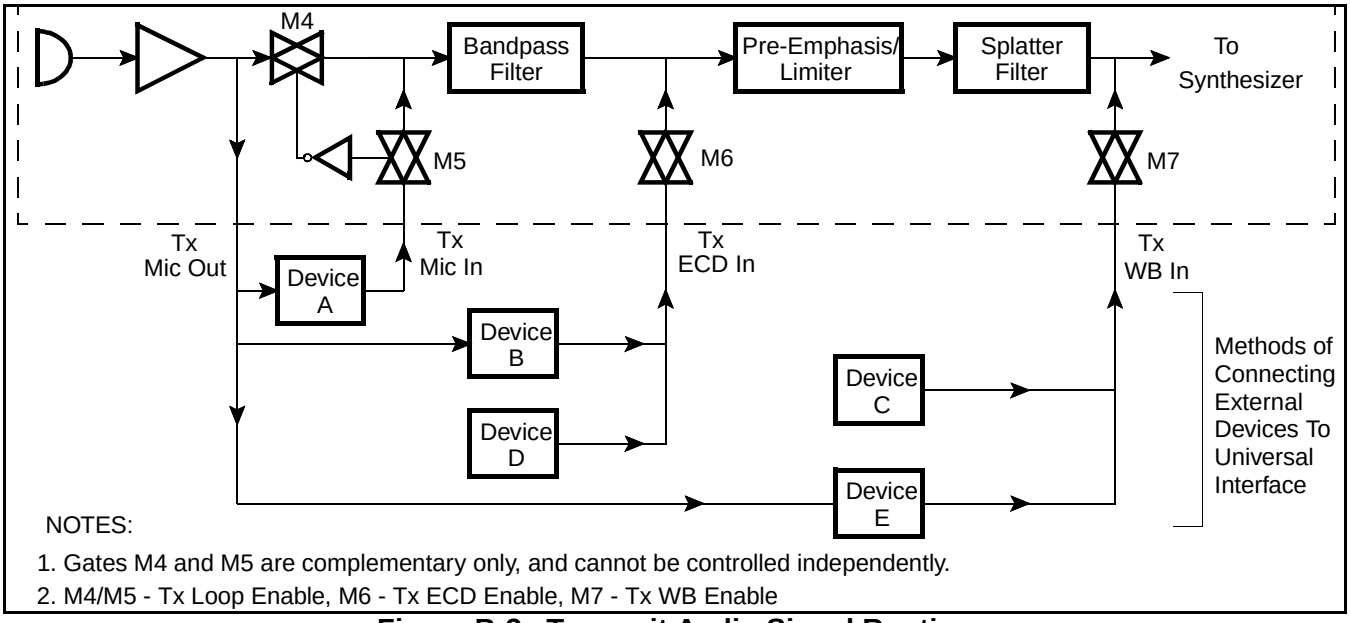



**Figure B-3 Transmit Audio Signal Routing**

**Table B-5 Transmit Audio Programming**

| Device | Mode | M4 | M5 | M6 | M7 |
|---|---|---|---|---|---|
| (Default) | 1 | Closed | Open | Open | Open |
| Device A | 2 | Open | Closed | Open | Open |
| Device B | 3 | Open | Closed | Closed | Open |
| Device C | 4 | Open | Closed | Open | Closed |
| Device D | 3 | Open | Closed | Closed | Open |
| Device E | 4 | Open | Closed | Open | Closed |

## B.5 INPUT CONTROL SIGNALS

The universal interface has four input control signals. Two of these signals are dedicated to push-to-talk and squelch functions, and the other two (Input A/B) are user programmable for various functions. All programmable control input functions are set on a radio-wide basis (they are the same for all selectable systems and groups).

All control inputs are CMOS and are internally pulled to 5-volts by 11k-ohm resistors. Also, all operate without any switch debounce. Refer to the first part of Table 6 for a description of the input control signals. Programming of these signals is described in Section 4.8.2.

## B.6 OUTPUT CONTROL SIGNALS

The universal interface has six output control signals. One of these signals is an analog output dedicated to the RSSI (Received Signal Strength Indicator) function, three are digital outputs dedicated to special functions, and two are user programmable functions. All programmable control output functions are set on a radio-wide basis.

All outputs except RSSI and AUX1 are CMOS outputs. Therefore, they have a 220-ohm output impedance and can source 20 mA maximum. Refer to the last part of Table 6 for a description of the output control signals. Programming of these signals is described in Section 4.8.2.

**Table B-6 Control Signal Description**

| Function | Pin | Description |
|---|---|---|
| | | **INPUTS** |
| PTT Req N | 1 | Active low input which allows external control of transmitter keying. This line is shared with option wire-out 6. This input has four programmable options as follows:<br><br>**Standard (default) -** Standard PTT operation like that of the microphone PTT signal.<br>**Inhibit -** When activated, the radio ignores the microphone PTT signal.<br>**Data -** When used in conjunction with the INPUT A "DATA ARQ" option, the radio goes to the data priority system/group and waits for activity on the DATA ARQ input. Microphone audio is muted. Upon completion of the transmission, that radio remains on the system/group on which the data transmission occurred. Refer to Section 7.3 for more information on ARQ arbitration.<br>**Data R (Revert) -** Same as the preceding function except that upon completion of the transmission, the radio returns to the previous system/group. |
| Squelch Req N | 2 | Active low input which mutes the receive audio. Activation of this input mutes the receive audio immediately, regardless of its current state. This input has no programmable options. |
| Input A | 3 | Active low multi-purpose input line programmable for the following functions:<br><br>**Call Indicator (default) -** When activated, the call indication "CALL" is displayed. It is turned off by pressing a front panel key or taking the microphone off-hook. This function is also programmable for Input B.<br>**Mic Mute -** When activated, the microphone audio signal is muted regardless of the current status. This function is also programmable for Input B.<br>**Horn -** When activated, the horn alert output of the accessory interface is enabled for three cycles and then goes to the disabled state in the normal manner described in Section 3.6.4. This function is also programmable for Input B.<br>**Data ARQ -** When used in conjunction with the preceding PTT Req N "Data" option, the radio uses this line to arbitrate data packet transmission and reception on an LTR or Multi-Net system. Refer to Section 7.3 for more information on ARQ arbitration. |
| Input B | 4 | Active low multi-purpose input line programmable for the following functions:<br><br>**Emergency (default) -** When activated, produces the same result as pressing the front panel emergency switch.<br>**Mic Mute -** Same as the preceding Input A function.<br>**Horn -** Same as the preceding Input A function.<br>**Call Indicator -** Same as the preceding Input A function. |

**Table B-6 Control Signal Description (Continued)**

| Function | Pin | Description |
|---|---|---|
| | | **OUTPUTS** |
| RSSI Out | 21 | Direct analog RSSI (Received Signal Strength Indicator) output. The DC voltage of this output decreases from 8 - 0 volts as signal strength increases. Output impedance is greater than 100k ohms. |
| AUX1 | 14 | Active high output which is controlled by the AUX 1 option switch or menu parameter (see Section 3.5.4). This output can be used to control an external accessory. The output levels are 0 and 8 volts DC ±10%. Maximum source current is 50 mA. Therefore, a driver circuit of some type may be required. This output is shared with the option wire-out 8. |
| PTT | 5 | Active low output which provides the PTT signal to an external device. This output is shared with the option wire-out 9. Programmable options are as follows. (With the Viking HT, this signal is active high.)<br><br>**Tx Sense (default) -** Indicates that the transmitter is currently activated.<br>**Standard -** Indicates that the microphone PTT switch is pressed (the transmitter may or may not be activated, depending on the current mode). |
| Busy Out | 6 | This output which provides channel/system information to an external device. Programmable options are as follows:<br><br>**Access Denied (default) -** When accessing the system/channel, this output indicates a busy or out-of-range condition. This output is active low.<br>**RSSI -** Output from the RSSI (Receive Signal Strength Indicator) circuit. This is a logic output that reacts faster than noise squelch. Therefore, it is also subject to more falsing. Typical noise squelch response at -116 dB is 50 ms with 6 dB of hysteresis, and typical RSSI response at this level is 5 ms with 4 dB hysteresis. This output is active high. |
| Output A | 15 | Multi-purpose output programmable for the following functions. This is a CMOS output that can source up to 20 mA as described in Section 6. It is shared with option wire-out 7. ***NOTE: When the encryption option is installed, this option is dedicated to the Clear Code function and the other options are not available.***<br><br>**Clear Code (default) -** Active high output that indicates that the transmit audio signal is to be encrypted.<br>**Clear-to-Send -** Active low output that indicates that a trunking channel has been accessed and all overhead activities completed. This function is also programmable for Output B.<br>**Monitor Hanger -** Active low output that indicates that the microphone is on-hook (a high indicates that it is off-hook). This function is also programmable for Output B.<br>**Tx Audio Enable -** Active high output that indicates that the internal transmit audio signal is muted. This function is also programmable for Output B.<br>**Auxiliary 2 -** Same as the following Output B function. |
| Output B | 16 | Multi-purpose output programmable for the following functions. This is a CMOS output that can source up to 20 mA as described in Section 6.<br><br>**Auxiliary 2 (default) -** Active high output which is controlled by the AUX2 option switch or menu parameter (see Section 3.5.4). This output can be used to control an external accessory. The preceding Output A parameter can also be programmed for this function.<br>**Rx Data Group -** Active low output that indicates that a call is being received on a group programmed for data signaling (see Section 3.6.11).<br>**Clear-to-Send -** Same as preceding Output A function.<br>**Monitor Hanger -** Same as preceding Output A function.<br>**Tx Audio Enable -** Same as preceding Output A function. |

## B.7 INTERFACING WITH A DATA MODEM

### B.7.1 GENERAL

The following information describes how an external data modem can be connected to the universal interface. Described are the lines that are used and how they should be programmed for proper modem operation.

### B.7.2 MODEM CONTROL LINES

The following control lines should be programmed as indicated in parentheses for proper modem operation. For more information on these lines, refer to Sections B.5 and B.6 and Table 6.

**PTT Request N (Data) -** This input is used for transmit/receive arbitration.

**Input A (Data ARQ) -** This input is also used for transmit/receive arbitration.

**PTT (Tx Sense) -** This output indicates to the data modem the current state of the power amplifier (if it is keyed or not).

**Output A (Clear-to-Send) -** This output may be programmed if desired to indicate to the modem when the transmit channel is connected and available for data transmission. Note that this function is restricted to the Clear Code function when encryption is used (see description in Table 6).

**Output B (Rx Data Group) -** This output indicates to the modem that a call is occurring on a "data" group.

**Busy Out (Access Denied or RSSI) -** This output can be programmed for either of the available options. If "Access Denied" is programmed, it indicates to the modem that an access failure has occurred because of a busy or out-of-range condition. If "RSSI" is programmed, this output can be used to indicate to the modem a busy condition on a conventional channel. This can be used to determine channel availability in the receive mode.

### B.7.3 ARQ ARBITRATION

Introduction

ARQ is used on all LTR and Multi-Net data channels, but not on conventional channels. Its purpose is to provide an efficient scheme for ACK/NACK responses to each block of a multi-block message. It eliminates the normal repeater handshake interval usually required to change transmitting stations. The scheme takes advantage of a repeater time-out that terminates repeater transmission after a 1 second (minimum) interruption of the repeater received subaudible data stream.

To use this facility, the transmitting modem, on reaching end-of-block, briefly pauses the radio RF transmission (for less than 1 second) to listen for the ACK/NACK response. The receiving modem, on detecting end-of-block, inserts its RF transmitted ACK/NACK response. The transmitting modem resumes transmission with the next data block. This sequence is repeated for each data block in the multi-block message.

To implement this feature it is necessary for the modem to operate two radio input signals rather than the single "DATA PTT" signal that might be expected. This is necessary in order to define the various state changes that the radio must execute. Therefore, if LTR or Multi-Net data channels are used, both radio input signals must be operated even if the ACK/NACK feature is not used.

The DATA ARQ and DATA PTT lines must be used to set up a data transmission when operating in the LTR or Multi-Net modes (this protocol does not apply to conventional operation). Data transmissions cannot be set up using any of the other lines.

When a block of data is received, ARQ arbitration can also be used to provide a quick acknowledgment without the overhead of a repeater handshake. LTR and Multi-Net repeaters monitor for embedded data from the transmitting mobile and stop transmitting if this data is not detected for a fixed time (1 second minimum). The ARQ protocol utilizes this time-out delay to send a short acknowledgment to the

transmitting mobile. Normal embedded data flow then resumes before time-out occurs.

Modem Initiated Transmission

1. A data transmission is initiated by the modem by activating (grounding) the DATA PTT (PTT REQ N) line followed by activating (grounding) the DATA ARQ (INPUT A) line. The DATA PTT signal must lead the DATA ARQ signal by at least 3 ms (5 ms typical), and the DATA PTT line must remain active for the entire data transmission/acknowledge session.

2. After successfully accessing the system/channel, the modem must release the DATA ARQ line and then transmit a data block. A successful access is indicated by a high signal on the CLEAR-TO-SEND (OUTPUT A) line.

3. When ACKs or NACKs are expected, the modem must activate (ground) the DATA ARQ line. During this time the radio receives, but does not decode, subaudible data.

4. For all subsequent low-to-high transitions on the DATA ARQ line, the radio transmits modem data and encodes subaudible data.

5. For all subsequent high-to-low transitions on the DATA ARQ line, the radio receives ACKs or NACKs without decoding subaudible data.

6. The data session is completed by releasing the DATA PTT line (the DATA ARQ line must be released first if not already in that state). At this time the radio transmits the turn-off code and returns to the idle state.

Modem Initiated Reception

1. A data reception is initiated by the modem by activating (grounding) the DATA ARQ (INPUT A) line while receiving a call on a data group. A call on a data group is indicated by a low signal on the RX DATA GROUP (OUTPUT B) line. The DATA ARQ signal must lead the DATA PTT signal by at least 3 ms (5 ms typical), and the DATA ARQ signal must remain active for the entire data transmission/acknowledge session.

2. The modem must then activate (ground) the DATA PTT (PTT REQ N) line for the transmission of any ACKs or NACKs. During this time, the radio does not encode any subaudible data.

3. For the reception of any more data, the modem must release the DATA PTT line. During this time, the radio decodes subaudible data.

4. For all subsequent high-to-low transitions on the DATA PTT line, the radio transmits without decoding subaudible data.

5. For all subsequent low-to-high transitions on the DATA PTT line, the radio receives and decodes subaudible data.

6. The data session is completed by releasing the DATA ARQ line (the DATA PTT line must be released first if not already in that state).

## B.8 SERIAL BUS PROTOCOL

### B.8.1 INTRODUCTION

The information which follows defines the serial bus command and response protocol supported by the universal interface of the Summit® DM transceiver. (The protocol for the Viking® HT is different.)

**Table B-7 Serial Bus Pin Description**

| Function | Pin | Description |
|---|---|---|
| Rx D TTL U | 18 | Serial receive data line (unbuffered). TTL voltage levels are used. |
| Tx D TTL U | 17 | Serial transmit data line (unbuffered). TTL voltage levels are used. |

The serial bus is a component of the universal interface which also includes the discrete signals described earlier in this appendix. The serial bus provides direct control of various transceiver functions and also duplicates most of the functions provided by the discrete lines. Therefore, a very dynamic and flexible interface is provided by using only the serial bus and appropriately conditioning audio input and output signals.

This serial bus is the same bus that is used for transceiver programming and remote control. It is available on the following connectors:

Universal Interface (J601) - TxD TTL U, RxD TTL U

Remote Interface (J600) - TxD TTL R, RxD TTL R

Microphone Jack (J2) - TxD TTL, RxD TTL

Flash Programming Jack (J405) - TxD TTL, RxD TTL

## B.8.2 PHYSICAL SIGNAL PATH

The electrical characteristics of the signals which implement the serial bus are described in the preceding table. These characteristics apply to the serial bus signals on all four connectors described in the preceding section. The serial interface is a full-duplex asynchronous serial port providing a standard NRZ format at standard baud rates. Timing conforms to the standard RS-232 protocol, but the levels are TTL only.

## B.8.3 CHARACTER LEVEL PROTOCOL

The character level protocol for data exchange between the radio and an external device has the following characteristics:

1. The character format is one start bit, 8 data bits, one stop bit, no parity.

2. Transmission speed is 9600 baud.

3. No hardware or software flow control is used.

4. All data exchange is binary using a sync escape protocol.

## B.8.4 MESSAGE LEVEL PROTOCOL

General

The message level information exchange protocol uses a variable length command and response message structure. All commands and responses share a common format. The following is a description of the message elements.

| Sync | Supervision | Length | Message | Checksum |
|---|---|---|---|---|
| 1 byte | 1 byte | 1 byte | 0 to N bytes | 1 byte |

**Sync -** The first message character of each command or response is a unique sync character (0x7E). If the sync character or the escape character appear at any other position in the message format, it must be preceded by an inserted escape character (0x81).

**Supervision -** The second character of each message contains the command or response Supervision Type.

**Length -** The third character is the message length of the entire command/response message, not counting the initial sync or any inserted escape characters that must be sent for embedded sync/escape characters. The checksum character is, however, included in the length calculation. No message length can exceed 32 bytes.

**Message -** The next block of characters is the event message data which is sent to or from the radio. This character block contains the event message and always begins with an Event Type character. Each Event Type is associated with a fixed format and length for the remainder of the message data block.

**Checksum -** The last message character is the two's compliment of the sum of characters of the entire message. Excluded are inserted escape characters that must be sent for embedded sync characters. A message is considered complete when all the bytes have been received.

Distinguishing Embedded Sync and Escape Characters

Figure 4 illustrates the encoding/decoding process described in the preceding information. The following example list shows how embedded sync and escape characters are distinguished from the primary use of these characters (see preceding "Sync" description).

**<ESCAPE> <SYNC> -** Embedded sync character in the data stream. The first escape character is absorbed and only the sync remains.

## Serial Port Command Messages

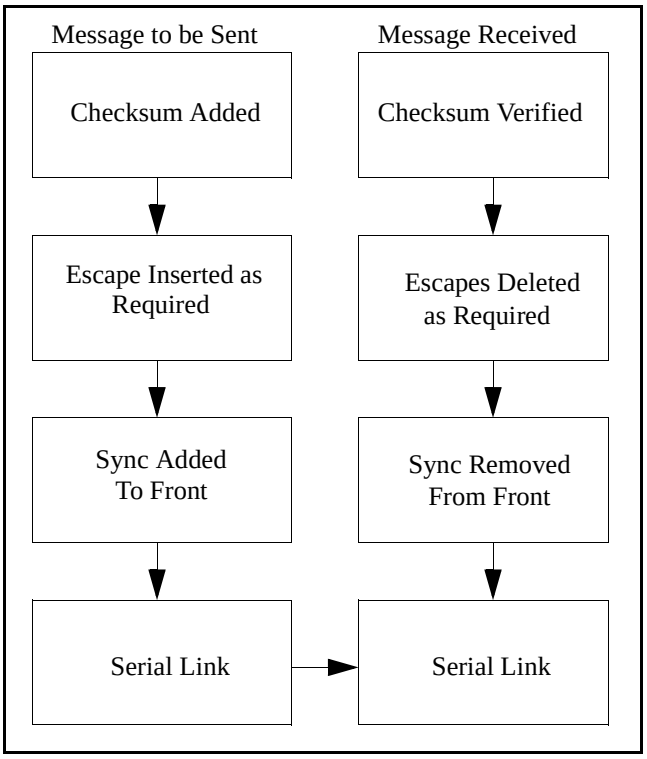



**Figure B-4 Serial Bus Encode/Decode Diagram**

**<ESCAPE> <ESCAPE> -** Embedded escape character in the data stream. The first escape character is absorbed and only the second escape remains.

**<ESCAPE> <ESCAPE> <ESCAPE> <SYNC> -** Embedded escape character followed by another embedded sync character. The first and third escapes are absorbed and the original data remains.

**<NON ESCAPE> <SYNC> -** This is the normal end of one message and the start of another.

**<SYNC> <NON SYNC>** - This is the normal start of a message.

**<NON ESCAPE> <NON SYNC>** - This is normal data.

### B.8.5 MESSAGE SUPERVISION TYPES

*NOTE: The last two digits of the number in parentheses are the hexadecimal code for the message. For example, 0x20 is equal to decimal 32.*

The following commands have been defined for the universal interface.

**ACK (0x01) -** This message tells the external device that the previous message was received correctly.

**NACK (0x02) -** This command tells the external device that the previous message as received contained errors.

**UI_CMD (0x10) -** This command tells the radio that the specified event (and data, if any) has occurred and the radio should respond to it.

**UI_RSP (0x0D) -** This command is response to a UI_CMD or it informs an external device that an event has occurred.

### B.8.6 SERIAL PORT COMMAND MESSAGES

The following events must have the Supervision of <UI_CMD> (0x10). The first byte of the data field contains the command subcode. The data field of each command subcode is shown.

**AUDIO_GATE**

| AUDIO_GATE | Gate | State |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to open or close the specified audio gate (see Sections 3 and 4). Transmit gate changes are ignored if not in the transmit mode, and the gates revert to the previous state when the transmit mode is exited.

AUDIO_GATE = 0x01
Gate = Gate (M) number 0x01 - 0x07
State = New state (0 = closed, non 0 = open)

**AUDIO_PA**

| AUDIO_PA | State |
|---|---|
| 1 byte | 1 byte |

This tells the radio to route the receive or transmit audio to the external PA port or to mute the external PA.

AUDIO_PA = 0x03
State = New state (0 = mute, 1 = rx audio, 2 = tx audio)

## Serial Port Command Messages (Cont'd)

**AUDIO_PATH**

| AUDIO_PATH | Mode | Path |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to set the specified receive or transmit audio path mode (see Sections 3 and 4). Transmit audio path changes are ignored if not in the transmit mode, and the gates revert to the previous state when the transmit mode is exited.

AUDIO_PATH = 0x04
Mode = Mode being set (1 = rx path, 2 = tx path)
Path = Path being set for mode 0x01 - 0x06

**BLOCK_DECODE**

| BLOCK_DECODE | State |
|---|---|
| 1 byte | 1 byte |

This directs the radio to disable block decoding. If the radio is in a call, this function will not go into effect until the current call has ended. This command is global with all non-conventional systems.

BLOCK_DECODE = 0x1A
State = New state (1 = off, 0 = on)

**BUTTON_PRESSED**

| BUTTON_PRESSED | Button |
|---|---|
| 1 byte | 1 byte |

This tells the radio to simulate that the specified button has been pressed.

BUTTON_PRESSED = 0x05
Button = Button number 0x01-0x05 (left to right)

**CALL_IND**

| CALL_IND | State |
|---|---|
| 1 byte | 1 byte |

This tells the radio to turn the call indicator on or off.

CALL_IND = 0x06
State = New state (0 = off, non 0 = on)

**CHANGE_SYS_GRP**

| CHANGE_SYS_GRP | System | Group |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to change to the specified system and group. The radio responds with the SYS_GRP response message

CHANGE_SYS_GRP = 0x07
System = New system number
Group = New group number

**CLEAR_LOCKOUT_GID**

| CLEAR_LOCKOUT_GID | Decode ID | System No. |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to clear the lock out of a selected GID (group ID) from block decoding. This reverses the action of a SET_LOCKOUT_GID. If the ID is not locked out, no action is taken.

CLEAR_LOCKOUT_GID = 0x1E
Decode ID = Group decode ID to lock out of the block decode range
System Number = System of group ID to be cleared. This parameter is available with Version 217 and later software. System number 255 (0xFF) is a wild card and matches any system. With old format messages, the system number defaults to 255 for backwards compatibility.

**DISPLAY_MESSAGE**

| Display_Message | String |
|---|---|
| 1 byte | 10 bytes |

This tells the radio to display the specified message. Note that the string must be 10 bytes when included or garbage characters will appear on the radio's display. Only upper case or numeral ASCII characters should be sent. A message displayed in this manner will not be preempted until one of the following occurs:

## Serial Port Command Messages (Cont'd)

- An operator action occurs
- An operator action is simulated
- A DISPLAY_MESSAGE is sent with no string (the data field contains only the sub-op code DISPLAY_MESSAGE)

DISPLAY_MESSAGE = 0x08
String = 10-character string to display

**GET_DISPLAY_UPDATE**

| GET_DISPLAY_UPDATE |
|---|
| 1 byte |

This requests an UPDATE_DISPLAY response be sent with the current display contents.

GET_DISPLAY_UPDATE = 0x20

**GET_LOCKOUT_GID**

| GET_LOCKOUT_GID |
|---|
| 1 byte |

This tells the radio to send a LOCKOUT_GID message containing the block decode IDs that are currently locked out from the receive mode.

GET_LOCKOUT_GID = 0x1F

**GET_RADIO_STATUS**

| GET_RADIO_STATUS |
|---|
| 1 byte |

This tells the radio to send a RADIO_STATUS message containing the current status of several radio options.

GET_RADIO_STATUS = 0x23

**MIC_HANGER**

| Mic Hanger | State |
|---|---|
| 1 byte | 1 byte |

This tells the radio that the mic hanger has been placed on or off hook. This message is ignored if the microphone is actually off-hook.

MIC_HANGER = 0x09
State = New state (0 = off-hook, non 0 = on-hook)

**INTERCEPT_TONE**

| INTERCEPT_TONE | State |
|---|---|
| 1 byte | 1 byte |

This tells the radio to turn the intercept tone on or off. Note that the tone is generated by the radio's microprocessor and can be distorted if the radio is commanded to perform another action while the tone is turned on.

INTERCEPT_TONE = 0x0A
State = New state (0 = off, non 0 = on)

**NOTIFY_ENABLE_FLAGS**

| NOTIFY_EVENT _FLAGS | Event Group 1 | Event Group2 | Event Group3 | Event Group4 |
|---|---|---|---|---|
| 1 byte | 1 byte | 1 byte | 1 byte | 1 byte |

This message controls which, if any, asynchronous notification messages are to be enabled. When enabled, radio events such as button pushes are reported in the <UI_RSP> RADIO_NOTIFY message. A logic 1 enables reporting and a logic 0 disables reporting. Refer to the UI_DISCONNECT message description for information on how it affects the flags.

NOTIFY_ENABLE_FLAGS = 0x0B
Event Group 1-3 = Refer to RADIO_NOTIFY message description for definitions.

**PTT_EVENT**

| PTT Event | State |
|---|---|
| 1 byte | 1 byte |

This tells the radio that the PTT switch has been pressed or released.

## Serial Port Command Messages (Cont'd)

PTT_EVENT = 0x0C
State = New state (0 = released, non 0 = pressed)

**RESET**

| RESET |
|---|
| 1 byte |

This tells the radio to configure event flags, I/O options, and audio path options to default states.

RESET = 0x0D

**RETURN_GRP_ID**

| RETURN_GRP_ID |
|---|
| 1 byte |

This tells the radio to reply with the current Group ID data items using the GRP_ID response message.

RETURN_GRP_ID = 0x0E

**RETURN_LAST_RX_GROUP**

| RETURN_LAST RX_GROUP |
|---|
| 1 byte |

This tells the radio to reply with the Group Decode ID and Home Repeater Number for the last received call using the LAST_RX_GROUP response message.

RETURN_LAST_RX_GROUP = 0x1C

**RETURN_RX_UNIQUE_ID**

| RETURN_RX_UNIQUE_ID |
|---|
| 1 byte |

This tells the radio to reply with the Unique ID (or UID) of the current or most recent call using the RX_UNIQUE_ID response message.

RETURN_RX_UNIQUE_ID = 0x0F

**RETURN_SYS_GRP**

| RETURN_SYS_GRP |
|---|
| 1 byte |

This tells the radio to reply with the radio's current system and group using the SYS_GRP response message.

RETURN_SYS_GRP = 0x10

**RETURN_UNIQUE_ID**

| RETURN_UNIQUE_ID |
|---|
| 1 byte |

This tells the radio to reply with the Unique ID (or UID) of the current Multi-Net system using a UNIQUE_ID message.

RETURN_UNIQUE_ID = 0x22

**SELECT_KNOB_EVENT**

| SELECT_KNOB_EVENT | Knob Event |
|---|---|
| 1 byte | 1 byte |

This tells the radio that the select knob has been rotated up, rotated down, or pushed.

SELECT_KNOB_EVENT = 0x11
Knob Event = 0 = down, 1 = up, 2 = push

**SEND_DTMF_DIGITS**

| SEND_DTMF_DIGITS | Digits |
|---|---|
| 1 byte | 2 to 28 bytes |

This tells the radio to send the specified DTMF digits (approximately 70 ms on, 70 ms off).

SEND_DTMF_DIGITS = 0x12
Digits = 1 to 27 digits followed by a NULL byte. Digits are encoded as the ASCII characters "0" to "9", "*", and "#".

## Serial Port Command Messages (Cont'd)

### SET_AUTO_DISPLAY

| SET_AUTO_DISPLAY | Status |
|---|---|
| 1 byte | 1 byte |

This tells the radio to send and UPDATE_ DISPLAY message whenever the contents of the radio display change.

SET_AUTO_DISPLAY = 0x24
Status = New status (0 = off, 1 = on)

### SET_LOCKOUT_GID

| SET_LOCKOUT_GID | Decode ID | System No. |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to lock out a selected GID (group ID) from block decoding. A LOCKOUT_GID_ RSP message is sent in response to this message. Up to five decode IDs may be locked out at any time.

SET_LOCKOUT_GID = 0x1D
Decode ID = Group decode ID to lock out of the block decode range
System Number = System of group ID to be locked out. This parameter is available with Version 217 and later software. System number 255 (0xFF) is a wild card and matches any system. With old format messages, the system number defaults to 255 for backwards compatibility.

### SET_PTT

| SET_PTT | Option |
|---|---|
| 1 byte | 1 byte |

This tells the radio to set the specified PTT_ REQUEST_N input option.

SET_PTT = 0x14
Option = PTT_REQUEST_N option:
- 0 = Standard PTT operation
- 1 = Inhibit PTT operation
- 2 = Data PTT (no revert operation)
- 3 = Data PTT (revert operation)
- 4 = Release serial override (return to programmed operation)
- 15 = Undefined (disable signal)

### SET_RX_TX_GROUP_ID

| SET_RX_TX_GROUP_ID | Decode ID | Encode ID |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This tells the radio to set the Group Decode ID (used for received calls) and Group Encode ID (used for transmit calls) to the specified values. If the radio is scanning, this command is ignored. If the radio is involved in a call, the changes take effect when the call is concluded. Priority calls are not affected. If scanning is enabled after this command has been sent, the specified values are in effect for all non-conventional systems. If either of the parameter values is zero, this command has the effect of canceling any previous SET_RX_TX_GROUP_ID commands.

SET_RX_TX_GROUP_ID = 0x1B
Decode ID = New decode ID (0 = reset to programmed value)
Encode ID = New encode ID (0 = reset to programmed value)

### SET_STATUS_FIELD

| SET_STATUS_FIELD | Status |
|---|---|
| 1 byte | 1 byte |

This tells the radio to display the specified message in the two digit status field.

SET_STATUS_FIELD = 0x15
State = Displayed status value

### SOUND_BEEP

| SOUND_BEEP |
|---|
| 1 byte |

This tells the radio to sound a beep.

SOUND_BEEP = 0x16

### SOUND_HORN

| SOUND_HORN |
|---|
| 1 byte |

## Serial Port Response Messages (Cont'd)

This tells the radio to enable its internal horn switch (pulse on for 0.5 second and off for 0.5 second for 3 cycles). Note that many internal actions can cancel this operation including many serial commands. Once sent, no other serial commands should be sent for three seconds to allow the sequence to complete.

SOUND_HORN = 0x17

**SOUND_RING**

| SOUND_RING |
|---|
| 1 byte |

This tells the radio to produce a 1 second ringing tone. Several internal operations can cause this tone to be distorted since it is produced directly by the microprocessor, so no serial commands should be sent during the one second period that this tone sounds.

SOUND_RING = 0x18

**TOGGLE_BACKLIGHT**

| TOGGLE_BACKLIGHT |
|---|
| 1 byte |

This tells the radio to toggle the backlight. Note that the current backlight status can be retrieved in the response to a GET_RADIO_STATUS message.

TOGGLE_BACKLIGHT = 0x21

**UI_DISCONNECT**

| UI_DISCONNECT |
|---|
| 1 byte |

This tells the radio that the external device will be disconnecting itself from the radio after sending this message. This command causes all RADIO_ ENABLE_NOTIFY flags to be returned to the power-on default configuration (all flags set to zero). Any pending outgoing messages are purged.

UI_DISCONNECT = 0x19

### B.8.7 RESPONSE MESSAGES

The following responses must have a Supervision of <UI_RSP> (0x0D). The first byte of the data field contains the response subcode. The data field of each response subcode is shown.

**DTMF_DIGITS_SENT**

| DTMF_DIGITS_SENT |
|---|
| 1 byte |

This is a response to a SEND_DTMF_ DIGITS<digits> message, and it informs an external device that the requested DTMF digits have been sent.

DTMF_DIGITS_SENT = 0x01

**GRP_ID**

| GRP_ID | Tx Encode ID | Rx Decode ID | Home Rptr |
|---|---|---|---|
| 1 byte | 1 byte | 1 byte | 1 byte |

This is a response to a RETURN_GRP_ID message, and it provides the external device with information on the requested Group ID data items. If the radio is scanning when this message is sent, information on the revert system and group is returned.

GRP_ID = 0x03
Tx encode ID = Encode ID that was set
Rx decode ID = Decode ID that was set
Home Rptr = Home repeater that was set

**LAST_RX_GROUP**

| LAST_RX_GROUP | Rx Encode ID | Home Rptr |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to a RETURN_LAST_RX_ GROUP message.

LAST_RX_GROUP = 0x0A
Rx decode ID = Decode ID of last non-conventional call received
Home Rptr = Home repeater number of last non-conventional call received

## Serial Port Response Messages (Cont'd)

### LOCKOUT_GID

| LOCKOUT_GID | Count | Decode IDs | System No. |
|---|---|---|---|
| 1 byte | 1 byte | Count bytes | 1 byte |

This is a response to a GET_LOCKOUT_GID message.

LOCKOUT_GID = 0x0D
Count = Number of decode IDs in this message
Decode ID = Decode IDs that are now locked out (0 indicates an empty lockout slot)
System Number = System of each locked out group ID. This parameter is available with Version 217 and later software. System number 255 (0xFF) is a wild card and matches any system. With old format messages, the system number defaults to 255 for backwards compatibility. Also for compatibility, this message contains all (count) decode IDs followed by all (count) system numbers in the same order.

### LOCKOUT_GID_RSP

| LOCKOUT_GID_RSP | Decode ID | System No. |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to a LOCKOUT_GID message.

LOCKOUT_GID_RSP = 0x0E
Decode ID = Decode ID that is now locked out (0 indicates failed to lockout requested ID)
System Number = System of the locked out group ID. This parameter is available with Version 217 and later software. System number 255 (0xFF) is a wild card and matches any system. With old format messages, the system number defaults to 255 for backwards compatibility.

### PTT_RESULT

| PTT_RESULT |
|---|
| 1 byte |

This is a response to a PTT_EVENT (pressed), informing an external device that the attempt to access the channel/system has succeeded or failed because the channel/system was busy or out of range.

PTT_RESULT = 0x04
Result = Result of PTT press (1 = success, 2 = busy, 3 = out of range)

### RADIO_READY

| RADIO_READY |
|---|
| 1 byte |

This is a response to a RESET<–> message informing an external device that the radio is reset and ready for universal interface operation.

RADIO_READY = 0x05

### RADIO_NOTIFY

| RADIO_NOTIFY | Event Group 1 | Event Group2 | Event Group3 | Event Group4 |
|---|---|---|---|---|
| 1 byte | 1 byte | 1 byte | 1 byte | 1 byte |

This is a response to a radio event. The message is transmitted only if the enable flag associated with the event has been enabled (see NOTIFY_ENABLE_ FLAGS command). A "1" bit indicates the associated event occurred and a "0" bit indicates the inactive state.

RADIO_NOTIFY = 0x06

Event group 1 = Bit field (Bit 0 = LSB)

Bit 0 = Button 1 pressed (left)
Bit 1 = Button 2 pressed
Bit 2 = Button 3 pressed
Bit 3 = Button 4 pressed
Bit 4 = Button 5 pressed
Bit 5 = Button 6 pressed
Bit 6 = ZERO (reserved)
Bit 7 = ZERO (reserved)

Event group 2 = bit field (Bit 0 = LSB)

Bit 0 = Select knob rotate down
Bit 1 = Select knob rotate up
Bit 2 = Select knob push
Bit 3 = PTT pressed
Bit 4 = PTT released

## Serial Port Response Messages (Cont'd)

Bit 5 = Rx valid call started
Bit 6 = Rx valid call ended
Bit 7 = ZERO (reserved)

Event group 3 = Bit field (Bit 0 = LSB)

Bit 0 = Rx on data group started
Bit 1 = Rx on data group ended
Bit 2 = Tx audio mute
Bit 3 = Tx audio unmute
Bit 4 = Mic off hook
Bit 5 = Mic on hook
Bit 6 = Clear to send asserted
Bit 7 = Clear to send released

Event group 4 = Bit field (Bit 0 = LSB)

Bit 0 = System scan started
Bit 1 = System scan stopped
Bit 2 = Group scan started
Bit 3 = Group scan stopped
Bits 4 - 7 = Zero (reserved)

**RADIO_STATUS**

| RADIO_STATUS | Status 1 | Status 2 | Status 3 |
|---|---|---|---|
| 1 byte | 1 byte | 1 byte | 1 byte |

This is a response to a GET_RADIO_STATUS message. Note that many of these bits reflect the current status of a physical universal interface connector signal.

RADIO_STATUS = 0x0C
Status 1 = Bit field (Bit 0 = LSB)

Bit 0 = PTT_REQ_IN
Bit 1 = SQUELCH_REQ_IN
Bit 2 = INPUT_A
Bit 3 = INPUT_B
Bit 4 = BSY_OUT
Bit 5 = PTT
Bit 6 = OUTPUT_A
Bit 7 = OUTPUT_B

Status 2 = Bit field (Bit 0 = LSB)

Bit 0 = Scanning Enabled
Bit 1 = MIC On Hook
Bit 2 = Call Light
Bit 3 = Encryption
Bit 4 = System
Bit 5 = Transmitting
Bit 6 = Phone Group
Bit 7 = Backlight

Status 3 = Bit field (Bit 0 = LSB)

Bit 0 = Rx Valid Call
Bit 1 = Group scan active
Bit 2 = System scan active
Bits 3 - 7 = (Reserved)

**RX_UNIQUE_ID**

| RX_UNIQUE_ID | UID High Byte | UID Low Byte |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to a RETURN_RX_UNIQUE _ID message, informing an external device of the last received Unique ID (UID).

RX_UNIQUE_ID = 0x07
UID high byte = High order byte of the UID
UID low byte = Low order byte of the UID

**SYS_GRP**

| SYS_GRP | System | Group |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to RETURN_SYS_GRP and CHANGE_SYS_GRP messages, informing an external device of the currently active system and group numbers. If the radio is scanning when this message is sent, the revert system and group is returned.

SYS_GRP = 0x08
System = Currently active system number
Group = Currently active group number

**SYS_GRP_INVALID**

| SYS_GRP_INVALID | System | Group |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to a CHANGE_SYS_GRP message, informing an external device that the requested system/group does not exist. The parameter

## Serial Port Response Messages (Cont'd)

field includes the requested system and group numbers.

SYS_GRP_INVALID = 0x09
System = Currently active system number
Group = Currently active group number

**UNIQUE_ID**

| UNIQUE_ID | UID High Byte | UID Low Byte |
|---|---|---|
| 1 byte | 1 byte | 1 byte |

This is a response to a RETURN_UNIQUE_ID message, informing an external device of the current system's Unique ID (UID). The returned ID is 0xFFFF if the current system is not a Multi-Net system.

UNIQUE_ID = 0x0F
UID high byte = High order byte of the UID
UID low byte = Low order byte of the UID

**UPDATE_DISPLAY**

| UPDATE_DISPLAY | Compressed String |
|---|---|
| 1 byte | 9 bytes |

This is a response to either a GET_DISPLAY_ UPDATE or SET_AUTO_DISPLAY message which is used to display the specified information in the 10-character alphanumeric and 2-character status display.

UPDATE_DISPLAY = 0x0B

The Compressed String is a series of three 3-byte message blocks as shown in Table 8 which follows. Each block contains four display characters in a compressed ASCII format. The display characters in the message are as follows:

**ADx =** Alphanumeric display characters. AD0 is the left-most character and AD9 is the right-most character.

**SDx =** Status display characters. SD0 is the left character and SD1 the right character.

The character to be displayed is in a compressed ASCII format encoded as follows:

**Compressed Code =** ASCII code – (minus) 0x20

*NOTE: The two digits after the "x" in 0x20 above are the hexadecimal code. For example, 0x20 is equal to decimal 32.*

### Table B-8 UPDATE_DISPLAY Message Coding

**Message Block 0**

| Byte | 1 | | | | | | | | 2 | | | | | | | | 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| | AD0 Character | | | | | | | | AD1 Character | | | | | AD2 Character | | | | | | AD3 Character | | | | |

**Message Block 1**

| Byte | 4 | | | | | | | | 5 | | | | | | | | 6 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| | AD4 Character | | | | | | AD5 Character | | | | | | AD6 Character | | | | | | AD7 Character | | | | | |

**Message Block 2**

| Byte | 7 | | | | | | | | 8 | | | | | | | | 9 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 |
| | AD8 Character | | | | | | AD9 Character | | | | | | SD0 Character | | | | | | SD1 Character | | | | | |



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