LTR-Net™
7200 Series

SERVICE MANUAL

TRUNKED PORTABLE RADIO

LTR-Net™ 7243
UHF Portable

7.5VDC
1 and 4 Watts
Part No. 242-7243-xxx

EFJohnson®

First Issue
November 2001

7243
LTR-NET™ PORTABLE RADIO

SERVICE MANUAL

UHF, 430-470 MHz
Part No. 242-7243-633

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SECTION 1   GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains operation, programming, alignment, and service information for the E.F. Johnson 7243 LTR-Net™ portable transceiver.

1.2 TRANSCEIVER DESCRIPTION

The 7243 LTR-Net portable transceiver operates in the UHF 430-470 MHz frequency range. Power output is selectable for low (1 watt) and high (4 watt) levels.

A range of up to 16-100 systems are programmable, depending on the type and the number of groups in each. Systems can be programmed for LTR-Net, LTR, and conventional operation. Each system can be programmed with up to 99 groups. Currently, all transceivers have a telephone keypad and three programmable option switches. Refer to Section 2.1 for more information on operating features.

1.3 PART NUMBER BREAKDOWN

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

```
          242 - 72 x 3 - x  x  3
          Band                      Freq Range
1 = VHF*                       0 = Full band (800/
4 = UHF                             900 MHz)*
8 = 800 MHz*                   1 = 400-440 MHz*
9 = 900 MHz*                   3 = 430-470 MHz
                               5 = 470-512 MHz*
          Type
3 = High Tier, dual BW

          Signaling            * These configurations are
2 = LTR*                          currently not available.
4 = Multi-Net*
5 = SMARTNET/SmartZone*
6 = LTR-Net
```
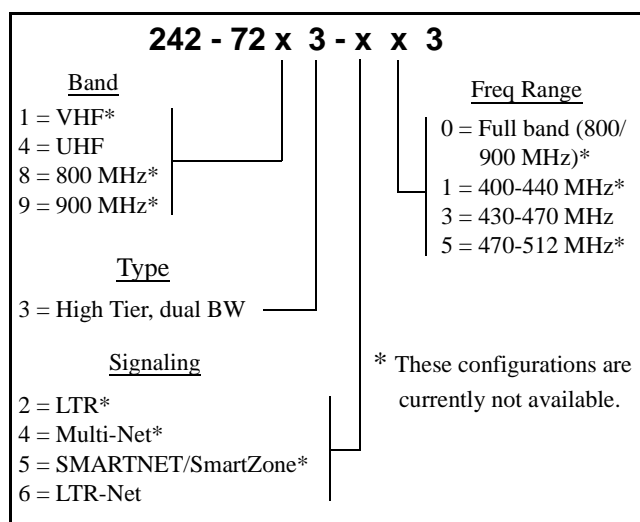
1.4 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a label that is attached to the chassis. The following information is contained in the identification number:

```
Model     Revision  Manufacture          Warranty
From P.N. Letter    Date       Plant     Number

7243   x     A      25  1       U        12345

6 = LTR-Net    Week No.
               of Year         Last Digit of Year
```

1.5 TRANSCEIVER TUNING

The field tuning procedure is described in Section 5.

Table 1-1   7243 Portable Accessories

Accessory	Part No.
Battery pack, nickel metal-hydride hi cap	587-7200-140
Rapid charger base, single unit with 120 VAC power supply	585-7200-023
Antenna, hybrid UHF	585-7200-044
Belt clip	585-7200-032
Extension Test Cable	Contact Cust Serv
Programming Accessories	
LTR-Net 7243/98xx programming software, CD	023-9998-457
PCTune software and test code, CD	023-9998-489
PCFlash soft. & LTR-Net op. code, CD	023-9998-501
Remote Prog Interface (RPI)	023-9800-000
Programming cable (RPI to xcvr)	597-7200-031
DB9 F to DB9 M 6-ft cable	597-5900-002
DB-25 M to DB-9 F 6-ft cable	597-0005-057
DB-25 F to DB-9 M adapter	515-9000-015

1.6 ACCESSORIES

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

Extension Test Cable - This cable is required to operate the transceiver when it has been opened to access internal components. It reconnects the keypad/display board to the audio/logic board.

Programming Hardware - The RPI provides the interface between the programming computer and

transceiver. The cables from the RPI to computer and transceiver are not included with the RPI and must be ordered separately.

Programming Software

The following three types of programming can be performed with 7243 portable transceivers:

Personality Programming - This programming sets the parameters that can be different for each transceiver such as channel frequencies, system and group information, and locality information. This programming is performed by the LTR-Net Programming software, Part No. 023-9998-457, and described in Section 3 of this manual.

Transceiver Tuning (PCTune) - Most transceiver adjustments are made electronically and stored by the logic. The software used to perform these adjustments is called PCTune, and it is described in Section 5.

NOTE: To run the PCTune software, the transceiver must first be re-flashed with temporary test operating software (see following).

Loading Different Operating Code (PCFlash) - The PCFlash software is used to upgrade the actual operating software of the transceiver. This software is stored in a reprogrammable Flash memory device, and is the basic operating code of the transceiver.

The LTR-Net operating software may be changed to upgrade features, correct bugs, or tune the transceiver. Section 5.2 describes how temporary test operating code is loaded to tune the transceiver and LTR-Net operating code is reloaded to restore normal operation. Test operating code is included on the PCTune CD, and LTR-Net operating code is included on the PCFlash CD (see Table 1-1).

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. Regular Customer Service hours are 7:30 a.m. - 5:30 p.m. Central Time, Monday-Friday. The Customer Service Department can be reached using the following telephone numbers:

Toll-Free: (800) 328-3911

FAX: (507) 835-6969

E-Mail: customerservice@efjohnson.com You can also e-mail a person directly if you know their first initial/last name (example: jsmith@efjohnson.com).

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

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 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 Customer Service Department before returning equipment. A service representative may be able to suggest a solution to the problem making return of the equipment unnecessary.

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 Customer Service (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. Include this form in the shipping container with each unit. Your telephone number and contact name are important as there are times when the technicians may 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 recommended that you 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 make 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. RA numbers are required for exchange units or if the Field Service Department wants 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.

For additional information on factory service, the Depot Service Department can be contacted at the following E-mail address:

depotrepair@efjohnson.com

1.9 REPLACEMENT PARTS

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 desig-

nator (C512, 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

1.10 INTERNET HOME PAGE

The E.F. Johnson Company has a site on the World Wide Web that can be accessed for information on the company about such things as products, systems, and regulations. The address is http://www.efjohnson.com.

1.11 DISASSEMBLING TRANSCEIVER

Proceed as follows to separate the front cover and chassis:

1. Remove the battery pack and antenna.

2. Remove the two screws located on the back.

3. The front cover and chassis hinge at the top, so carefully separate the lower end of the chassis from the cover and pivot the lower end outward.

4. When reassembling these parts, make sure that the rubber perimeter gasket is in the groove (if necessary, hold it in the curved area with your fingers).

NOTE: To operate the transceiver with the front and back separated, the extension test cable listed in Table 1-1 is required.

1.12 BATTERY CHARGER INFORMATION

1.12.1 GENERAL

The battery pack for the 7243 portable contains six nickel metal hydride (NiMH) batteries connected in series. Nominal battery pack voltage is 7.5 volts and battery capacity is 1450 mAH.

The 7243 charger shown in Figure 1-1 has two slots in which to place a battery. The back slot is for fast charging and the front slot is for slow charging. Only the battery can be inserted in the fast charge slot and the entire transceiver can be inserted in the slow charge slot if desired. Batteries can be charged in both slots at the same time. The operation of the LEDs is shown in Table 1-2.
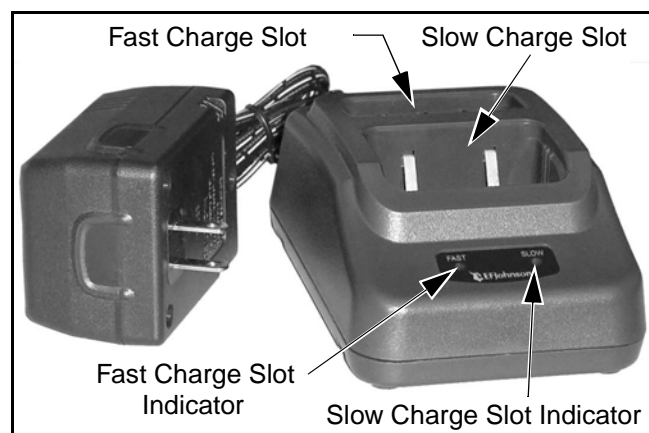
Figure 1-1   Battery Charger

1.12.2 FAST CHARGING

When a battery is placed in the fast charge slot, the fast charge indicator briefly flashes red while the battery is checked to determine if its temperature is within the required range (0 to +45° C/+32 to +113°F). If it is, fast charging begins and it changes to steady red. The fast charge rate is 1320 mA ±100 mA. When the battery is nearly fully charged, it switches to the trickle rate of 20-40 mA and the indicator turns green. It continues at the trickle rate until the battery is removed from the charger. Approximate charge time in this slot for a fully discharged battery is 1.5 hours.

Table 1-2   Charger Indicators

Indication	Indicator	
	Fast Charge	**Slow Charge**
Flashing Red [1]	Checking battery condition	N/A
Constant Red	Rapid charge mode	N/A
Constant Green	Trickle charge mode	Slow charge mode
Off [2]	No charging is occurring	No charging is occurring
[1] If condition persists, battery temperature may not within required range (0 to +45° C).		
[2] Possible causes are poor contact (clean the charger and battery contacts) or a defective battery.		

The charger uses the ΔT/Δt (change in temperature/change in time) method to sense that the battery is nearly fully charged and that switching to the trickle mode should occur. This method detects when the battery temperature begins increasing at a faster rate which normally provides the first indication that the battery is fully charged.

To provide fail-safe operation, the trickle rate is also selected if the battery temperature rises above +50° C (+122° F) or charge time in the rapid mode exceeds 90 minutes ±20%.

NOTE: Occasionally, a fully charged condition may be falsely detected and the trickle mode entered after only a few minutes of rapid charging. To resume normal rapid charging if this occurs, momentarily lift the battery out of the slot.

1.12.3 SLOW CHARGING

Batteries charged in the front slot are always charged at the slow rate of 100-120 mA. The slow charge indicator turns green when charging is occurring. Typical charge time in this slot for a fully discharged battery is 20 hours (with transceiver power turned off if applicable). If the transceiver power is on, this slot basically maintains the charge of the battery.

7243 SPECIFICATIONS

The following are general specifications intended for use in testing and servicing the transceiver. For current advertised specifications, refer to the 7243 product information sheet available from your E.F. Johnson sales representative. Specifications are subject to change without notice.

GENERAL

Operating Mode	LTR-Net/LTR (trunked), and conventional (non-trunked)
Frequency Range	430-470 MHz
Systems Programmable	Up to 16-100 depending on system type and number of groups
Groups Programmable	Up to 99 per system
Transmit/Receive Separation	Within channel spread, 0 MHz conventional talk-around
Channel Spacing	12.5 kHz - 2.5 kHz maximum deviation
	25 kHz - 5 kHz maximum deviation
Frequency Stability (tx and rx)	2.0 PPM –22° to +140° F (–30° to +60° C)
Dimensions (with battery and controls)	5.7" H x 2.2" W x 1.4" D
	145mm H x 55mm W x 35mm D
Weight (with battery)	15 oz. (410 g)
Power Source	7.5 VDC nickel metal-hydride (NiMH) battery pack, 1450 mAH
Typical Battery Life	(5-5-90) 7.3 hours (high power), 9.9 hours (low power)
Compliance	FCC parts 15 and 90
Circuit Protection	3-ampere fuse

RECEIVER

Sensitivity	0.35 µV (12 dB SINAD)
Selectivity	–65 dB at 25 kHz /–60 dB at 12.5 kHz
Spurious and Image Rejection	–65 dB
Intermodulation	–65 dB
Audio Output Power	Internal Speaker - 0.5 watt (16-ohm load)
	External - 1.5 V rms (680-ohm load)
Audio Distortion	Less than 5% at rated power (0.5 watt)
Audio Response	+1, –3 dB at 6 dB per octave de-emphasis characteristic
Channel Spread	40 MHz
Current Drain	Standby (squelched) - 100 mA maximum
	Rated Audio Output - 275 mA maximum

TRANSMITTER

High RF Power Output	4.0 watts
Low RF Power Output	1.0 watt
Spurious and Harmonic	–60 dB
FM Hum and Noise	–40 dB at 25 kHz, –34dB at 12.5 kHz
Audio Distortion	5% maximum at 1 kHz
Audio Frequency Response	+1, –3 dB from a 6 dB per octave pre-emphasis characteristic
Audio Modulation	11K0F3E, 16K0F3E
Channel Spread	40 MHz
Current Drain (maximum)	Low Power - 950 mA
	High Power - 2 A
Load Impedance	50 ohms
Duty Cycle (3-3-54 seconds)	5% (Transmit-Receive-Standby)

SECTION 2   OPERATION

Figure 2-1   Top Panel Controls

2.1 FEATURES

2.1.1 GENERAL FEATURES

The following features are available in all operating modes (LTR-Net/LTR/conventional).

- Up to 16-100 systems programmable depending on type (LTR-Net/LTR/conv) and number of groups in each.
- Up to 99 groups programmable per system
- LTR-Net^{TM}, LTR$^®$, and conventional operating modes
- Unique 8-character system and group identification tags
- System and group scanning
- User programmable system and group scan lists

- Menu mode to select functions
- Telephone mode for convenient number dialing
- Three programmable option switches
- Keypad lock (with and without password)
- Call indicator
- Time-out timer
- Receive-only groups
- Companding

2.1.2 LTR-NET FEATURES

The following features are available when an LTR-Net system is selected.

- Roaming (automatic locality search)
- Special calls including telephone, unique ID, and directed group
- Busy queuing of special calls by radio system
- Transmit inhibit
- Receive priority calls
- Standard group calls (mobile-to-mobile)
- Automatic registration/de-registration

2.1.3 LTR FEATURES

The following features are available when an LTR system is selected.

- Standard group and telephone calls
- Transmit inhibit
- Receive priority calls

2.1.4 CONVENTIONAL FEATURES

- Busy indicator
- Talk-around
- User-adjustable squelch level
- Monitor mode
- Call Guard$^®$ squelch control
- Transmit disable on busy

NOTE: Programming determines the availability of many of the preceding features.

System Scan List Phone Group Not Used Not Used Monitor Group Scan List

Dial Mode Low Power Scan Call Priority

S ⚏ ⌀ L Z ▲ C ◄ P₂ G

BUSY M ▬ + ▬ UID ♟ Tx

8-Character Alphanumeric Display Not Used Low Battery UID/Aux Group Transmitter Keyed

Conv Ch Busy Keypad Lock
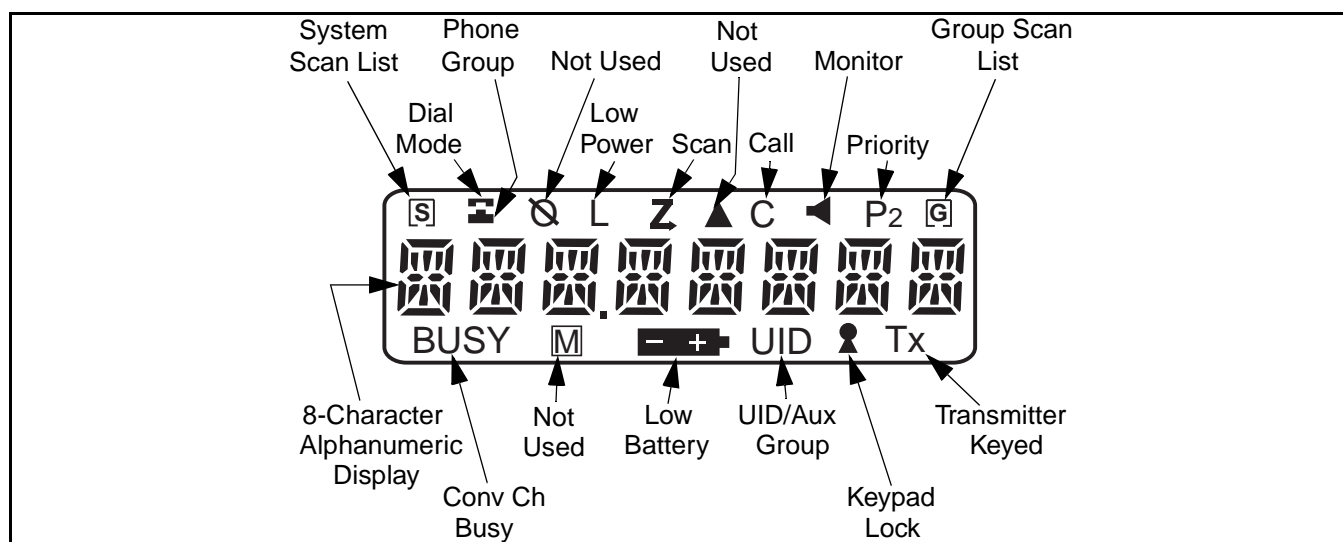
Figure 2-2   Display

2.2 CONTROLS AND DISPLAY

2.2.1 TOP AND SIDE CONTROLS

NOTE: These controls are shown in Figure 2-1.

On-Off Volume - Turning this knob clockwise turns power on and sets the volume level. Turning it counterclockwise to the detent turns power off. Power is on when information appears in the display. Refer to Section 2.3.3 for more information on setting volume.

Option Switch 1 - This switch can be programmed to control a specific function (see Section 2.5.1).

Antenna Jack - Connection point for the antenna.

Accessory Connector - When the protective cover is removed, this connector can be used to access PTT, speaker, and microphone lines for transceiver service and testing. It is also the connection point for the computer when programming the transceiver.

Battery Release Button (Not shown) - This button is located on the bottom end of the transceiver, and it is pressed to release the battery so that it can slide downward and be removed from the radio.

NOTE: Turn off transceiver power before removing the battery. This ensures that current settings are properly saved and the de-registration message is sent.

Option Switch 2 PTT Switch
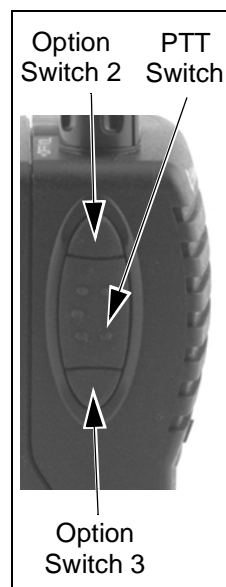
Option Switch 3

2.2.2 SIDE CONTROLS

Option Switch 2 - This switch can be programmed to control a specific function (see Section 2.5.1).

PTT (Push-To-Talk) - This switch keys the transmitter so that a message can be transmitted. The "Tx" icon is displayed when the transmitter is keyed.

Option Switch 3 - This switch can be programmed to control a specific function (see Section 2.5.1).

2.2.3 DISPLAY

8-Character Alphanumeric Display - This area of the display indicates the selected system and group (Section 2.3.4), dialed number (Section 2.7), error conditions, and other information (Section 2.12.4).

S - Indicates that the displayed system is in the scan list and scanned normally (see Section 2.6.7).

⚏ - The base portion of this icon is displayed when the displayed group is programmed for telephone calls, and the top portion (receiver) is displayed when the dial mode is selected (see Section 2.7).

○̸ **-** Not currently used.

L - Indicates that low transmit power is selected (see Section 2.4.8).

Z - Indicates that the scan mode is selected (see Section 2.6.1).

▲ **-** Not currently used.

C - Indicates that a call has been received on a group programmed for a call indicator (see Section 2.4.2). Press any key to turn this indication off.

◀ **-** Indicates that the monitor mode has been enabled by the Monitor option switch (see Section 2.11.2).

P2 - "P" indicates that the displayed group is an LTR-Net/LTR priority 1 group, and "P2" indicates that it is a priority 2 group (see Section 2.8.2).

G - Indicates that the displayed group is in the scan list and scanned normally (see Section 2.6.7).

BUSY - Indicates a carrier is being detected on the selected conventional channel.

M - Not currently used.

▬ ＋ ▬ - Indicates a low battery condition. The battery should be recharged soon after this indication appears (see Section 2.3.8).

UID - Indicates that the displayed group is programmed for an LTR-Net Unique ID or Directed Group call (see Section 2.9.1).

♟ - Indicates that the keypad has been locked by pressing FCN ◀ or FCN ▶ (see Sections 2.3.6 and 2.3.7).

Tx - Indicates that the transmitter is keyed. This occurs when the push-to-talk switch is pressed or a register/de-register message is sent (see Section 2.9.4).

2.2.4 FRONT PANEL KEYS

The front panel keys are shown in Figure 2-3 above. Most keys control two or more functions. The
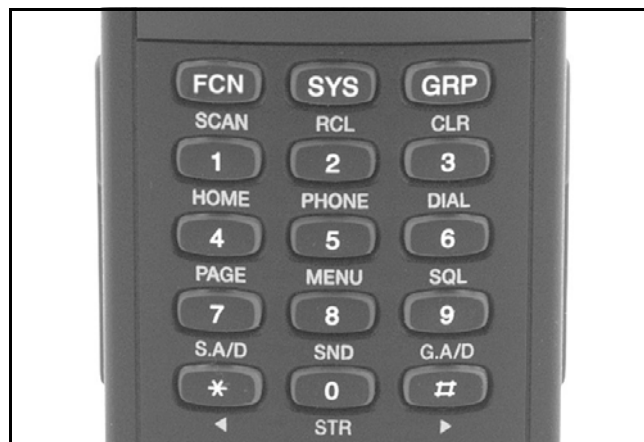
Figure 2-3   Front Panel Keys

function labeled on the key is usually selected by simply pressing the key, and the function labeled under the key is usually selected by first pressing another key such as the FCN (Function).

In addition, one set of key functions may be available in the standard mode and another in the dial mode (see Section 2.7). All key functions except 0-9 can also be assigned to an option switch and controlled by both as described in Section 2.5.1. Holding a key down causes repeating if applicable. These keys operate as follows:

FCN (SCAN)

Standard Mode
　FCN - Enables the alternate function of the next key that is pressed. This alternate function is active for 2 seconds or until another key is pressed, which-ever occurs first.
　FCN SCAN - Turns scanning on and off.
Dial Mode
　FCN - Selects the alternate function of various keys as described in the following information.

SYS (RCL)

Standard Mode
　SYS - Pressing repeatedly selects next higher system.
　SYS # - Selects the next higher system.
　SYS ✱ - Selects the next lower system.
　SYS (xx) - Directly selects specified system.
　FCN RCL - Momentarily displays the selected (revert) system if it is not being displayed.

Dial Mode

RCL - After recalling a number, scrolls through other numbers programmed in memory.

FCN RCL (0-9) - Recalls the number stored in the specified memory location.

FCN RCL ✱ - Recalls the last number recalled from memory.

FCN RCL # - Recalls the last number sent by FCN SND.

GRP (CLR)

Standard Mode

The GRP key changes or displays the selected group similar to the "SYS" key just described.

Dial Mode

CLR - Erases the last digit in the display.

FCN CLR - Erases the entire number in the display.

1 (HOME)

Standard Mode

FCN HOME - Selects the pre-programmed home system/group.

1 - Pressing this key with the PTT switch pressed transmits the "1" digit.

Dial Mode

1 - Dials the "1" digit.

2 (PHONE)

Standard Mode

FCN PHONE - Selects the dial mode and the first telephone group in the current system.

2 - Pressing this key with the PTT switch pressed transmits the "2" digit.

Dial Mode

2 - Dials the "2" digit.

FCN PHONE - Exits the dial mode and sends the call termination characters.

3 (DIAL)

Standard Mode

FCN DIAL - Selects the dial mode without changing the currently selected group.

3 - Pressing this key with the PTT switch pressed transmits the "3" digit.

Dial Mode

3 - Dials the "3" digit.

FCN DIAL - Exits the dial mode without sending the call termination characters.

4 (PAGE)

Standard Mode

FCN PAGE - The page function is currently not available.

4 - Pressing this key with the PTT switch pressed transmits the "4" digit.

Dial Mode

4 - Dials the "4" digit.

5 (MENU)

Standard Mode

FCN MENU - Selects the menu mode (Section 2.5.2).

5 - Pressing this key with the PTT switch pressed transmits the "5" digit.

Dial Mode

5 - Dials the "5" digit.

6 (SQL)

Standard Mode

FCN SQL - Selects the squelch adjust mode for conventional channels (Section 2.11.4).

6 - Pressing this key with the PTT switch pressed transmits the "6" digit.

Dial Mode

6 - Dials the "6" digit.

7 (S.A/D)

Standard Mode

FCN S.A/D (System Add/Delete) - Changes the scan list status of the currently displayed system. The system is in the scan list and scanned normally if "$\boxed{S}$" is displayed when not scanning.

7 - Pressing this key with the PTT switch pressed transmits the "7" digit.

Dial Mode

7 - Dials the "7" digit.

8 (SEND)

Standard Mode

8 - Pressing this key with the PTT switch pressed transmits the "8" digit.

Dial Mode
   8 - Dials the "8" digit.
   FCN SEND - Automatically transmits the number in the display (after the system has been accessed by briefly pressing the PTT switch).

9 (G.A/D)

Standard Mode
   FCN G.A/D (Group Add/Delete) - Changes the scan list status of the currently displayed group. The group is in the scan list and scanned normally if "⊡G⊡" is displayed when not scanning.
   9 - Pressing this key with the PTT switch pressed transmits the "9" digit.
Dial Mode
   9 - Dials the "9" digit.

0 (STR)

Standard Mode
   FCN STR - Changes between the numeric and alpha display modes (Section 2.3.4).
   0 - Pressing this key with the PTT switch pressed transmits the "0" digit.
Dial Mode
   0 - Dials the "0" digit.
   FCN STR (0-9) - Stores the displayed number in the specified memory location.

✳ (◀)

Standard Mode
   ✳ - Pressing this key with the PTT switch pressed transmits the "✳" digit.
   SYS ✳ - Selects the next lower system (see preceding "SYS" key description).
   GRP ✳ - Selects the next lower group (see preceding "GRP" key description).
   FCN ◀ - Selects keypad (password) lock feature.
Dial Mode
   ✳ - Dials the "✳" digit.
   FCN ◀ - Enters a pause when dialing a telephone number.
   FCN RCL ✳ - Recalls the last number recalled from memory.

(▶)
Standard Mode
   # - Pressing this key with the PTT switch pressed transmits the "#" digit.

   SYS # - Selects the next higher system (see preceding "SYS" key description).
   GRP # - Selects the next higher group (see preceding "GRP" key description).
   FCN ▶ - Selects the keypad (standard) lock feature.
Dial Mode
   # - Dials the "#" digit.
   FCN ▶ - Displays the overflow digits.
   FCN RCL # - Recalls the last number sent by FCN SND.

2.3 BASIC OPERATION

2.3.1 POWER-UP SEQUENCE

When power is turned on using the top panel on-off/volume control, a beep sounds, the backlight turns on, all segments and icons in the display are momentarily enabled, and the last seven digits of the transceiver part number (see Section 1.3) are very briefly displayed. The transceiver is then operational.

2.3.2 BACKLIGHT OPERATION

The display and keypad backlight automatically turns on for 3 seconds whenever any key is pressed or power is turned on. If the Backlight menu parameter is enabled (see Section 2.5.2), selecting "On" enables this operation and selecting "Off" disables it entirely.

2.3.3 SETTING VOLUME LEVELS

The relative volume level can be determined by noting the position of the index on the volume knob. A tone or background noise may also be enabled for use in setting the volume as follows:

- If key press tones are enabled, a short tone sounds whenever any key is pressed.

- If a conventional system is selected and the monitor option switch is programmed (see Section 2.11.2), press this switch. If someone is talking on the channel, voice is heard. If no one is talking, the squelch can be adjusted as described on Section 2.11.4 so that noise is heard. The transceiver cannot be manually unsquelched when an LTR-Net or LTR system is selected.

2.3.4 SYSTEM/GROUP DISPLAY MODE

Two system/group display modes can be selected. One is a numeric format and the other is an alpha tag format. To switch between these modes, press FCN STR or select the S/G DISPL menu parameter (see Section 2.5.2). Turning power off does not change the selected mode. These modes operate as follows:

Numeric Mode **-** The system and group numbers are displayed as "Sxx Gxx" and the group alpha tag is not displayed. For example, System 1 and Group 2 are displayed as follows. When system or group scanning is occurring, the numbers are replaced by dashes (see Section 2.6.2)
.

```
 ___   ___
|_   |   |_ ___|
|___|   |__ __|
```
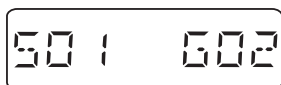
Numeric Display Mode

Alpha Tag Mode - The group alpha tag is displayed instead of the system and group numbers. For example, the "CAR 220" group is displayed as follows. When system or group scanning is occurring, the alpha tag is replaced by "SYS SCAN or "GRP SCAN" (see Section 2.6.2). To briefly display the selected system number, press FCN RCL.

```
 ___ ___ ___
|    |__| |__|
|___|  |  |  \
```

Alpha Tag Display Mode

2.3.5 SYSTEM AND GROUP SELECT

Systems and groups are selected as follows. When the system is changed, the last selected group in the new system is displayed.

- To increase the selected system, press SYS repeatedly or press SYS and then **#** (▶). Likewise, to increase the selected group, press GRP repeatedly or press GRP **#**. Holding the **#** key down causes the function to repeat. After the highest system or group is selected, wrap-around to the lowest system or group occurs.

- To decrease the selected system, press SYS and then ✱ (◀). Likewise, to decrease the selected group,

press GRP ✱. As when selecting a system, holding the ✱ key down causes the function to repeat, and after the lowest system or group is selected, wrap-around occurs.

- To directly select a system or group number, press SYS or GRP and then the number of the desired system or group. For example, to select Group 9, press GRP, 0, 9. A leading "0" must be entered to select systems and groups 1-9.

2.3.6 KEYPAD DISABLE (STANDARD)

Occasionally, the front panel keys may be accidentally pressed, for example, if the transceiver is carried on a belt and it brushes against an object. To prevent this from happening, the front panel keys and option switches can be quickly disabled by simply pressing FCN ▶. The disabled condition is indicated by the 🔒 icon.

If a key or option switch is then pressed, all that happens is "LOCKED" is displayed. The on-off/volume and PTT controls remain functional so that calls can be received and transmitted. To re-enable the keys and option switches, press FCN ▶ again. Turning power off does not change the selected mode.

2.3.7 KEYPAD DISABLE (USING PASSWORD)

To prevent unauthorized changing of the selected system and group and other operating parameters, the keypad and option switches can be disabled using a password. To select this disable mode, press FCN ◀. "PASSWORD" is then displayed to indicate that a four-digit unlock password must be entered. This password can be any four-digit number except "0000". The desired password must be entered twice (the second time is to confirm it). The keypad and option switches are then disabled as indicated by "LOCKED" and 🔒 in the display.

If a key or option switch is then pressed, all that happens is "PASS LCK" is displayed. To re-enable the keypad and option switches, press FCN ◀ again and re-enter the four-digit password. As with the disable mode described in the preceding section, the on-off/volume and PTT controls remain active so that calls can be received and transmitted normally.

NOTE: This password is not preprogrammed and there is no override procedure. Therefore, if it is forgotten, the transceiver must be reprogrammed to return it to normal operation.

2.3.8 LOW BATTERY INDICATION

When the battery voltage drops to the point where recharging is required, the ⊟+ icon is indicated in the bottom part of the display. In addition, a beep sounds when this indication initially appears and whenever the push-to-talk switch is released (if the key press tone is enabled). The battery should be recharged as soon as practical after this indication appears.

Low transmit power is automatically selected during a low battery condition (indicated by "**L**" in display), and the current settings of switches and other parameters continue to be saved in memory. The low-battery indication is reset by turning power off and then on again.

2.3.9 OPTION SWITCHES

This transceiver has three option switches that can be programmed to control various functions as described in Section 2.5.1. These switches are the push-button switch on the top panel, the switch immediately above, and the switch immediately below the PTT switch on the side panel.

2.3.10 DISPLAYING SOFTWARE REVISION NUMBER

To display the operating (Flash) software version number, turn power on with PTT switch pressed. The version number is displayed as "VER x.xx". To return to normal operation, press FCN RCL or cycle power. The software version number can also be read using the programmer by selecting the Transfer > Read Factory Info function (see Section 3.7).

2.3.11 LTR-NET, LTR, AND CONVENTIONAL OPERATION

Introduction

This transceiver can be programmed to operate in the LTR-Net, LTR, and conventional modes. Each selectable system can be programmed to select a

locality programmed for one of these modes. The type of operation that is programmed is determined by the type of repeater equipment being accessed. The differences in operation are described in the following information and also noted elsewhere as required.

LTR-Net and LTR Operation

The LTR-Net mode provides the most operating features. Some features available only in the LTR-Net mode include roaming (automatic locality search), unique ID calls, and directed group calls. LTR-Net features are described in Sections 2.8, and a general overview of LTR-Net operation is located in Section 6.

Operation in the LTR mode is similar to the LTR-Net mode except that the preceding and some other LTR-Net features are not available.The types of calls that can be placed in the LTR mode are standard group (mobile-to-mobile) and telephone. LTR features are described in Sections 2.8 and 2.10 and also in the LTR Application Note, Part No. 009-0001-020, Rev. 8 or later.

Both the LTR-Net and LTR modes provide automatic channel selection (trunking) and monitoring before transmitting. Special tones and display messages indicate busy and out-of-range conditions. Telephone calls can be placed almost as conveniently as with your home telephone. The information programmed in LTR-Net and LTR systems and groups is described in Section 2.3.12.

Conventional Operation

In the conventional mode, selecting a system selects a radio channel, and selecting a group selects the squelch control coding (CTCSS, CDCS, or carrier) and other parameters (see Section 2.3.12). The squelch level must be adjusted manually as described in Section 2.11.4 to properly receive conventional calls.

With conventional operation, an out-of-range condition is not indicated by a special tone or display message because there is no data handshake with a repeater that allows this condition to be detected. A busy condition is detected automatically if the Transmit Disable On Busy feature is used (see Section 2.11.3). Otherwise, it must be detected manually as follows. Refer to Section 2.11 for more information on conventional operation.

To manually monitor a conventional channel before transmitting to determine if it is being used by someone else, proceed as follows:

Using Busy Indicator - With scanning disabled and the squelch control adjusted as described in Section 2.11.4, note if "BUSY" is indicated in the lower part of the display. If it is, a carrier is being detected on the currently selected conventional system (channel). If this indication is not displayed, the channel is not busy and the message can be transmitted.

Using Monitor Mode - If scanning, pressing the Monitor option switch (see Section 2.5.1) disables scanning and enables the monitor mode indicated by ◀ in the display. The monitor mode disables squelch control features so that all messages are heard. If none are heard, the channel is free and the message can be transmitted. Refer to Section 2.11.2 for more information on monitoring.

2.3.12 LOCALITIES, SYSTEMS, AND GROUPS

When any call is placed, a locality, system, and group are selected. Definitions of these terms follow.

Localities

An LTR-Net or LTR locality is typically a single repeater site in which the repeaters are co-located and interconnected by a common bus to form a trunked channel group. A conventional locality may or may not include repeaters at the same physical site. A locality can include up to twenty repeaters.

Unique locality parameters include the channel frequencies and bandwidth of each repeater at the site, the status repeater (LTR-Net only), and the repeaters equipped with telephone interconnect (LTR only) and companding. Up to approximately 25 LTR-Net or 60 LTR/conventional localities can be programmed (the maximum number decreases as the number of banks, systems, and groups increases).

Systems

Systems are a collection of groups and other information unique to that system (see next paragraph). Each system is linked to one of the programmed localities, and up to 99 systems can be programmed. Each system is programmed with a

unique alpha tag and can have a different display number in each bank (see Section 2.4.1).

LTR-Net and LTR systems are programmed with the home repeater number, a collection of groups, and a transmit inhibit block of ID codes (see Section 2.8.4). The home repeater number and group ID code form the address for group calls. In addition, the home repeater is monitored for incoming call information (the status repeater serves as a backup with LTR-Net operation).

Conventional systems select a specific radio channel and include one or more groups, each of which can select unique coded squelch information on that channel (see following).

Groups

The groups assigned to a system select individual call information. Up to 99 groups can be assigned to each system. With all three types of operation, each group is programmed with a unique alpha tag, group scan, call indicator, and other information. The available group types are as follows.

LTR-Net Group Types

Dispatch - Used to place and receive standard group (mobile-to-mobile) calls. Encode and decode IDs from 1-239 can be specified.

Telco - Used to place and receive telephone calls.

Auxiliary - Used to place and receive unique ID and directed group calls.

Data - Currently not available.

LTR Group Types

Dispatch - Used to place and receive standard group (mobile-to-mobile) calls. Encode and decode IDs from 1-250 can be specified when accessing an LTR locality (site). If an LTR-Net locality is being accessed, IDs from 1-239 can be specified.

Telco - Used to place and receive telephone calls. A RIC (interconnect) ID is also specified. This code is one that has been reserved on the repeater system for telephone calls.

Conventional Group Types

Only dispatch calls can be programmed with conventional operation. Conventional groups select Call Guard squelch, group scan, call indicator, and other information.

2.3.13 PLACING AND RECEIVING STANDARD GROUP CALLS

General

These calls are between two or more mobile or control station transceivers. The main difference between these calls and the other types is that no number is dialed using the keypad. The following procedure applies to all three types of operation (LTR-Net, LTR, and conventional).

Placing a Standard Group Call

1. Turn transceiver power on and set the volume as described starting with Section 2.3.1. With conventional operation, also make sure that the squelch is properly set as described in Section 2.11.4.

2. Select the system and group of the mobile being called as described in Section 2.3.5.

3. If a conventional call is being placed, monitor the channel manually or automatically as described in Section 2.3.11.

4. Press (and hold) the microphone PTT (push-to-talk) switch to talk and release it to listen. Operation with LTR-Net, LTR, and conventional calls is as follows:

LTR-Net and LTR Operation

- If tones are enabled, the proceed tone sounds shortly after the PTT switch is pressed if the radio system was successfully accessed (see Section 2.4.9). If tones are disabled, no tone sounds when the system is successfully accessed.

- If the radio system is busy, the busy tone sounds (see Section 2.12) and "BUSY" is indicated in the display. If the PTT switch continues to be pressed, the system is accessed as soon as it is free.

- If the radio system could not be accessed because of an out-of-range condition or some other reason, the intercept tone sounds (see Section 2.12) and "NO ACCES" is indicated in the display. The PTT switch must then be released and pressed again to make another access attempt.

- When responding, busy or no access conditions may also occur the same as when placing a call because the system is re-accessed for each transmission with these calls.

Conventional Operation

- If the channel is busy and the Transmit Disable On Busy feature is programmed (see Section 2.11.3), "DSBL BSY" is indicated in the display and the transmitter is disabled. Any channel activity is heard while the PTT switch is pressed.

- Otherwise, busy and out-of-range conditions are not indicated and speaking can begin when the PTT switch is pressed (if the channel is not busy). If the proceed tone is enabled on conventional systems, it indicates when speaking can begin but does not indicate that the channel is free or has been successfully accessed.

2.3.14 RECEIVING A STANDARD GROUP CALL

1. Select or scan the system and group programmed for the call you want to receive (see Section 2.6.1 for scan information).

2. When the message is received, the display changes to the system and group of the call. Press the PTT switch to talk and release it to listen. If scanning or if a priority call is received, a response may not automatically occur on the group of the call. Refer to Section 2.6.10 for more information.

2.4 GENERAL FEATURES

2.4.1 BANK SELECT

A bank is a collection of selectable systems that have been set up for a specific application. For example, one bank could be programmed for operation in Minneapolis and another for operation in

Milwaukee. Up to sixteen banks can be programmed, and each bank is identified by a unique alpha tag.

Banks are selected by the BANK menu parameter. In the menu mode, select the "BANK SEL" parameter and then the desired bank as described in Section 2.5.2. If this menu parameter is not available, banks are not selectable.

When a different bank is selected, the last selected system in that bank is displayed, and the displayed group is the last selected group of that system. These are the only user selected functions that are stored on a per bank basis.

Any programmed system can be assigned to a bank, and the system numbering can be different for each bank. Only the systems in the currently selected bank are selected or scanned, and at least one bank is always programmed. Unique bank parameters include Home system/group (see Section 2.4.6), default scan enable status, and default scan list status of each system.

The default scan status of the bank is valid only until the first time it is changed by the scan enable (FCN SCAN) key. Cycling power or re-selecting the bank does not restore the programmed status.

Likewise, the default scan list parameter permits the default scan list status of each system to be set on a per bank basis. If the SCN SAVE menu parameter is then disabled and the default set to "Off", the scan list status of that system in that bank returns to the default status whenever power is cycled. Otherwise, the default status is valid only until the first time the scan list status is changed by the S.A/D function.

2.4.2 CALL INDICATOR

The call indicator is "**C**" in the upper part of the display (see following illustration). This indicator shows when a call was received while you were away from the radio. Individual groups can be programmed for this feature and it then turns on when a call is received on one of those groups.

This indicator is turned off by pressing any button or cycling power. If scanning and the "Last Received" configuration is programmed (see Section 2.6.10), the

system and group of the last call are displayed. Otherwise, the currently selected system/group is displayed.
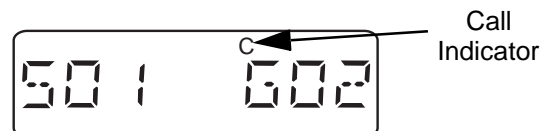
Call Indicator

Each selectable group can be programmed so that the Call indicator is activated when a call is received. With conventional operation, the Call indicator is activated if the transceiver unsquelches for 2 seconds or longer. Therefore, if Call Guard squelch is programmed, it must also be detected for the call indication to appear (unless it is disabled by the monitor mode).

2.4.3 COMPANDING

The companding feature is standard with this transceiver and is available if it is enabled by programming. Companding improves audio quality by decreasing the amount of noise present in the audio signal. It does this by providing a 2:1 compression of the audio signal on the transmit end and a 1:2 expansion on the receive end. Companding is especially recommended for 12.5 kHz bandwidth channels because audio quality improvement is usually significant.

If this feature is used, it must be utilized in both the transmitting and receiving mobile. The best results are obtained if companding is also used in the repeater; however, improvement still results if it is used in only the mobile and handheld transceivers. With telephone calls, companding must be utilized at the repeater if it is used in the mobile.

Each locality (site) channel can be individually programmed for companding. Whenever a call is received or transmitted on one of those channels, companding is automatically enabled. Companding is not selectable by the user, and the companding status is not indicated in the display.

2.4.4 EMERGENCY SWITCH

The emergency switch function is not available with this transceiver.

2.4.5 ENCRYPTION

Encryption is currently not available.

2.4.6 HOME SYSTEM/GROUP SELECT

The Home Select feature provides a home system/group quick select by pressing FCN HOME. The home system/group programmed for the current bank is then displayed and it becomes the selected system/group. If no home system/group has been programmed, this function is not available. If the home system/group is selected while scanning, scanning stops for the programmed scan delay period.

2.4.7 OPTION SELECT

Option select is currently not available.

2.4.8 POWER SELECT

Either high (4 watts) and low (1 watt) transmit power output is programmable on each locality (power output is not user selectable). When low power output is selected, "**L**" is indicated in the display. The low power mode usually increases battery life and decreases range, and the high power mode usually causes the opposite to occur. The low power mode is automatically selected during a low battery condition (see Section 2.3.8).

2.4.9 PROCEED (CLEAR-TO-TALK) TONE

This is a tone that sounds shortly after the PTT switch is pressed to indicate that the radio system has been accessed and speaking can begin. This tone can be programmed to be a single or distinctive (3-beep) tone.

This tone always sounds with LTR-Net and LTR standard group calls if tones are enabled (see Section 2.4.12). It can also be programmed to sound with LTR-Net/LTR telephone and auxiliary calls (first access only) and conventional calls as follows:

- To enable it on LTR-Net and LTR telephone and auxiliary calls, check the "Conversation Enabled" box in the Edit > Mobile Radio Parameters > Basic Parameters screen.

- To enable it on conventional calls, check the "Conventional Enabled" box in the same screen.

The proceed tone normally sounds almost immediately when the PTT switch is pressed. However, with some calls, such as wide area, the user should wait a short time after pressing the PTT switch before speaking. The proceed tone delay of 0-2.5 seconds can be programmed in the Timing Parameters screen. This delay can then be enabled on each group by checking the "Delayed Proceed Tone" box. If this box is not checked, no delay occurs.

On LTR-Net and LTR systems, if the radio system is busy when making a call, the busy tone sounds instead of the proceed tone and "BUSY" is indicated in the display. If an access attempt is unsuccessful, such as because of an out-of-range condition, the intercept tone sounds and "NO ACESS" is indicated in the display. Refer to Section 2.12 for more information on these conditions.

If the proceed tone is enabled on conventional systems and the Transmit Disable On Busy feature is used to automatically perform monitoring, the proceed tone does not sound if the channel is busy (see Section 2.11.3). Otherwise, it sounds even if the channel is busy.

2.4.10 RECEIVE-ONLY GROUPS

Receive (monitor) only groups can be programmed in all operating modes so that transmitting is automatically disabled. To program receive-only LTR-Net or LTR groups, program an encode ID of "Disabled". To program receive-only conventional groups, on the group screen select Tx Option = Disabled. If the PTT switch is pressed with one of these groups selected, the intercept tone sounds and "TX DISBL" is displayed.

2.4.11 TIME-OUT TIMER

The time-out timer disables the transmitter if it is keyed continuously for longer than the programmed time. It can be programmed for 0.5 - 5.0 minutes or disabled entirely. If the transmitter is keyed continuously for longer than the programmed time, the transmitter is disabled, "TIMEOUT" is indicated in the display and the intercept tone sounds. The timer and tone are reset by releasing the PTT switch.

Table 2-1   Menu Mode and Option Switch Functions

Function	Menu Item	Option Switch	See Description in Section:
Backlight mode select	BACKLGHT		2.3.2
Bank select	BANK SEL		2.4.1
Display mode	S/G DISPL		2.3.4
Monitor mode		X	2.11.2
Roaming on-off [3]	ROAMING		2.9.4
Scan type select	SCN TYPE		2.6.1
Scan continue on-off	SCN CONT		2.6.9
Scan list save mode	SCN SAVE		2.6.7
Tone type select	TONES		2.4.12
Any Keypad Function		[2]	

NOTES:
1. Functions left blank are not available.
[2] The option switches can also be programmed for any of the functions that are selectable by the keypad keys except 0-9. For example, scanning can be turned on and off by the FCN SCAN keys and by an option switch programmed for the Scan function (FCN does not need to be pressed when using the option switch). Programmable functions include: FCN, Scan, SYS, RCL, GRP, CLR, Home, Phone, Dial, Page Menu, Squelch Adj., S.A/D, G.A/D, Send, Store, ✱, #, ◀ , ▶ , and Monitor.
[3] Available with LTR-Net operation only.

One use of the time-out timer feature is to prevent a repeater from being kept busy for an extended period by an accidentally keyed transmitter. It can also prevent possible damage to the transmitter caused by transmitting for an excessively long period.

2.4.12 TONE SELECT

If the TONES menu parameter is selectable, the tones that sound can be selected. Otherwise, the tones that sound are fixed by programming. The following choices are available. Refer to Section 2.5.2 for more information on using the menu mode.

Silent - All tones are disabled.
Keys - Only the key press tones are enabled.
Alerts - All tones except the preceding key press tones are enabled.
All - Both the key press and alert tones are enabled.

2.5 OPTION SWITCHES AND MENU MODE

2.5.1 OPTION SWITCHES

The push-button switch on the top panel (see Section 2.2.1) and the two switches on the side panel immediately above and below the PTT switch (see

Section 2.2.2) are programmable. The functions which can be controlled by these switches are basically the functions that are selectable by the front panel keys plus monitor mode select (see "Option Switch" column in Table 2-1). This provides a way to "quick select" these functions. Functions may be controlled by both the option switch and the keypad key, and some or all option switches can be disabled if desired.

2.5.2 MENU MODE

Introduction

The menu mode is selected by pressing FCN MENU. Functions which can be controlled by the menu mode are indicated in Table 2-1 by an entry in the "Menu Items" column. More information on each function can be found in the section indicated in this table. Other menu mode information is as follows:

- Programming determines which parameters are displayed in the menu mode. Some functions can be controlled by both an option switch and the menu mode if desired.

- Some functions can be set in a fixed condition by not enabling the menu parameter or an option switch

and then programming a default condition in the menu mode programming screen. However, if a parameter can be changed by an option switch or menu parameter, the default condition is maintained only until the first time it is changed (cycling power does not reselect the default condition).

- Calls cannot be received or transmitted while the menu mode is selected.
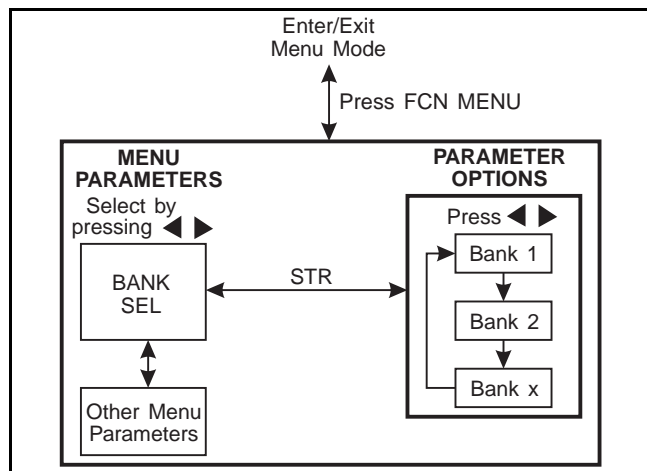
Menu Mode Flowchart

Using Menu Mode

Proceed as follows to select functions using the menu mode. A flowchart of the menu mode is shown above.

1. Select the menu mode by pressing FCN MENU. The first menu parameter is then displayed.

2. To scroll through the available menu parameters, press the ◀ (scroll down) and ▶ (scroll up) keys.

3. To display the option that is currently selected for the parameter, press the STR key.

4. To change the selected option, press the ◀ and ▶ keys.

5. To exit back to the parameter and save the selected option, press STR again.

6. When the desired condition of each menu parameter is selected, exit the menu mode by pressing FCN MENU again. The menu mode is also automatically

exited 2 seconds after a change is made or 8 seconds after no changes are made.

2.6 SYSTEM AND GROUP SCANNING

2.6.1 GENERAL

Introduction

The scan feature monitors, in sequence, the systems and/or groups in the scan list. 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 (unless it has been disabled). System and group scanning or group scanning only may be selected, and they operate as follows. Refer to Section 2.3.12 for more information on systems and groups.

System Scanning - Detects calls on all systems in the system scan list (see Section 2.6.8). If system scanning is not used, calls are detected on only the currently selected system.

Group Scanning - Detects calls on all groups in the group scan list. These groups are from the selected system and also from scanned systems if system scanning. If group scanning is not used, calls are detected on only the selected group and higher priority LTR-Net and LTR groups (see Section 2.8.2).

2.6.2 SCAN ON-OFF

System and/or group scanning are turned on and off by pressing FCN SCAN. When either type of scanning is enabled, **Z** is indicated in the display as shown in the following illustration. Then when system scanning is actually occurring with the numeric
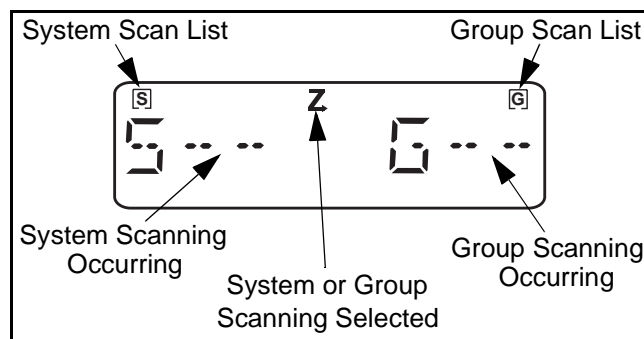
display mode selected, the system number is replaced by dashes and likewise for the group number when group scanning is occurring.

When the alpha tag display mode is selected, group scanning is indicated by "GRP SCAN" in the display, and system scanning is indicated by "SYS SCAN". The monitor mode must be disabled for scanning to occur (see Section 2.11.2).

2.6.3 SCAN TYPES

The type of scanning selected is determined by the menu mode SCN TYPE parameter (see Section 2.5.2). If this parameter is not selectable, the scan type is fixed by programming. The available scan types are as follows.

SYSTEMS - Both system and group scanning
GROUPS - Group scanning only
OFF - Both types disabled (scanning not selectable)

If the SCN TYPE menu parameter is disabled, the programmed default scan type is always selected. The selected system and group can be changed while scanning using the SYS and GRP keys in the normal manner. Scanning resumes shortly after the change is made.

When a call is received in the scan mode, the display changes to the system and group of the call. Programming determines if this change is temporary or permanent, and if a response occurs on the system/group of the call or the selected system/group. Refer to Section 2.6.10 for more information.

2.6.4 LTR-NET MODE SCANNING

If an LTR-Net system is selected and both roaming and system scan are enabled, registration on other localities can occur and the only systems scanned are LTR-Net systems that are in the scan list and programmed for the current locality.

However, if no LTR-Net locality could be located during locality search, LTR and conventional systems that are in the scan list are also scanned. If a signal is detected on one of those systems, the transceiver moves to it. However, searching continues for a programmed LTR-Net locality, and when one is

detected, registration on that site occurs and only LTR-Net systems are again scanned. This operation can provide uninterrupted operation when traveling through areas which have not yet been converted to LTR-Net operation.

Other scan operation in this mode is as follows:

- If Roaming = Off and System Scan = On with an LTR-Net system selected, LTR-Net systems that are in the scan list and programmed for the current locality are scanned and LTR and conventional systems are never scanned.

- If Roaming = On and System Scan = Off with an LTR-Net system selected, registration on other LTR-Net sites can occur, but no other systems are scanned. If an LTR or conventional system is selected, roaming is disabled.

- If Roaming and System Scan = On with an LTR or conventional system selected, only LTR-Net or LTR and conventional system types are scanned as described previously.

- If Roaming = Off and System Scan = On with an LTR or conventional system selected, only the LTR and conventional systems in the scan list are scanned.

2.6.5 LTR MODE SCANNING

When scanning with an LTR system selected and roaming disabled, only LTR and conventional systems in the scan list are scanned. LTR-Net systems are not scanned. If roaming is enabled, only LTR-Net systems are scanned if an LTR-Net locality is detected as described in the preceding section.

When LTR systems are scanned, the home repeater of each LTR system in the scan list is scanned. Scanning is sequential through all systems in the scan list. If several systems are programmed with the same LTR locality and home channel, channel selection occurs only once. Therefore, there is no delay to change channels which results in very efficient scanning. Each home repeater is scanned for only as long as necessary to detect all calls. Priority calls are also detected on LTR systems while scanning (see Section 2.8.2).

2.6.6 CONVENTIONAL MODE SCANNING

As with LTR mode scanning, if a conventional system is selected with roaming disabled, only conventional and LTR systems in the scan list are scanned. LTR-Net systems are not scanned. If roaming is enabled, only LTR-Net systems are scanned if an LTR-Net locality is detected (see Section 2.6.4).

Each conventional system selects a radio channel, each system is scanned in order. Call Guard squelch is detected if the monitor mode is disabled (see Section 2.11.2). If the monitor mode is enabled, all calls occurring on the channel are received.

A feature called Adaptive Tone Scan (ATS) is used when scanning conventional channels. If no carrier is detected, the channel is scanned for only 40 ms. If a carrier is detected, searching for Call Guard signaling occurs (if programmed). If the tone type of Call Guard squelch is programmed, the channel is monitored for 180-420 ms. The shorter time is when the tone is outside certain limits, and the longer time is if it is at or near the programmed value. If digital type is programmed, approximately 350 ms is required to determine an invalid code (less time is usually required to detect valid codes).

2.6.7 SCAN LIST PROGRAMMING

General

NOTE: The selected (displayed) system and group are always scanned, even if they have been deleted from the scan list.

NOTE: Deleting LTR-Net systems from the scan list also deletes them from locality searching when roaming, even if scanning is disabled (see Section 2.9.4).

The scan list status of the displayed system is changed by pressing FCN S.A/D, and the scan list status of the displayed group is changed by pressing FCN G.A/D. The displayed system is in the scan list and scanned normally when $\boxed{\text{S}}$ is displayed, and the displayed group is scanned when $\boxed{\text{G}}$ is displayed (see illustration in Section 2.6.2).

Deleting a system only temporarily deletes the groups associated with that system because when a system is added back into the scan list, the original group scan list is again active. Scan lists can be programmed even when scanning is disabled and while listening to a message. If a system or group is deleted while listening to a message, scanning resumes after the receive delay time expires (if applicable).

2.6.8 SAVING SCAN LIST

If the menu mode SCN SAVE parameter is enabled (see Section 2.5.2), the user can select if scan list changes are saved or not saved. If "On" is selected, changes are saved as they are made and the scan list does not change when power is turned off. Conversely, if "Off" is selected, they are not saved and the default scan list status of all systems and groups is reselected when power is turned on. If the menu SCN SAVE parameter is not selectable, the scan list save mode is fixed in the default mode selected by programming.

2.6.9 SCAN DELAY AND CONTINUE TIMERS

Receive Delay

When a message is received while scanning, there is a programmable delay of 0-7 seconds before scanning resumes. This delay is called the Receive Delay Time, and it prevents scanning from resuming or a message on some other system or group from being received before a response can be made. This delay is also in effect if a control is changed while scanning such as selecting another system/group. This timer is reset each time another call is received.

NOTE: Scanning does not resume if it is disabled, such as by selecting the monitor mode.

Call Delay Time

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 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

The scan continue 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 steps. If "0" is programmed, there is no time limit and the entire message is always received. If the SCN CONT menu parameter is available (see Section 2.5.2), this feature can be turned on and off by the user.

2.6.10 TRANSMITTING IN THE SCAN MODE

When messages are received while scanning, the programming of the "Scan Revert Mode" parameter determines if the selected system/group does not change or changes permanently or temporarily to the new system/group. This in turn affects the system/group on which responses occur. The display always indicates the system/group on which a call is being received, but this may not be the system/group on which a response occurs (see mode descriptions which follow).

When an LTR-Net/LTR priority call is received (see Section 2.8.2), the scan revert mode programming also determines if the selected group changes and if a response occurs on the displayed or selected group, even if scanning is disabled. The three programmable scan revert mode configurations operate as follows:

Last Selected - Transmissions always occur on the system/group that was selected manually by the SYS and GRP keys or automatically by roaming. Therefore, if a message is received when scanning that is not on the selected system/group, a response occurs on the selected system/group, not the system/group of the call. To respond to this type of call, select the system/group of the call as follows:

- Select it manually using the SYS and GRP keys.

- Before scanning resumes, exit the scan mode by pressing FCN SCAN. The system/group of the call then becomes the selected system/group and it is not necessary to change it manually.

Last Received - The selected system/group changes to the system/group of a call. Therefore, you can always

respond to a call without having to manually change the system/group. To return to the previously selected system/group, it must be manually selected using the SYS and GRP keys or FCN HOME if it was the home system/group.

Temporary Last Received - The system/group changes to the system/group of a call for only the duration of the receive delay period described in Section 2.6.9. Then when the delay expires and scanning resumes (if it is not disabled), transmissions occur on the selected system/group. Therefore, you can respond to a call without changing the selected system/group as long as you do so before scanning resumes.

2.7 DIAL MODE

2.7.1 INTRODUCTION

When placing calls that require dialing a number (telephone and auxiliary), using the dial mode provides the following features which make placing these calls more convenient:

- The eight-character alphanumeric display is cleared so that the dialed number can be displayed.

- Numbers can be entered at any convenient rate, dialing errors corrected, and then the number automatically transmitted when desired.

- Up to ten 16-digit numbers can be stored in memory and later recalled.

- System and group scan are disabled. Therefore, calls are received on only the selected system/group and also on any higher priority groups if applicable.

- The SYS and GRP keys become RCL (Recall) and CLR (Clear) keys. Therefore, the selected system and group cannot be changed with the dial mode selected.

Telephone and Auxiliary calls can also be placed without selecting the dial mode. However, the dialed number does not appear in the display and therefore cannot be stored or recalled. A number is manually transmitted as follows:

1. Access the radio system by briefly pressing the PTT switch.

2. When a dial tone is heard, dial the desired number while pressing the PTT switch. If too much time elapses between digits, the call terminates. Release the PTT switch and wait for a response.

NOTE: When receiving telephone and other types of calls, selection of the dial mode is optional because it does not enhance operation.

2.7.2 SELECTING DIAL MODE

Selecting Dial Mode and Telephone Group - To select the dial mode and a telephone group in the current system, press FCN PHONE. If there is more than one group programmed for telephone calls in the current system, the first higher numbered telephone group is selected. If there is no telephone group or a conventional system is selected, "NO PHONE" is displayed and an error tone sounds.

Selecting Dial Mode Only - To select the dial mode without changing the currently selected group, press FCN DIAL. This method should probably be used when placing auxiliary calls because the auxiliary call group must be selected, not a telephone group.

The dial mode is indicated when the handset portion ▬ of the telephone icon is displayed, and a telephone group is indicated when the base portion ▟ is displayed. Selecting the dial mode using FCN PHONE displays both icons. When an auxiliary call group is selected, "UID" is displayed.

2.7.3 DIALING A NUMBER

Enter the desired number by pressing the 0-9, **#**, and ✱ keys. Other dialing functions are as follows:

- Only the last eight digits dialed are displayed. To momentarily display the upper eight digits, press FCN ▶.

- To erase the last digit, press the CLR key. To erase the entire number, press FCN CLR.

- To enter a pause, press FCN ◀ (each pause equals one character).

2.7.4 SENDING THE NUMBER

Access the radio system by briefly pressing the PTT switch. Then when a dial tone is heard, send the number in the display by pressing FCN SND. The keypad remains active while in a conversation to allow additional numbers to be dialed. Simply press the PTT switch and dial the number. The number in the display does not change when a number is dialed in this manner.

The main difference in operation between LTR-Net/LTR and conventional systems is when the telephone number is sent (see following).

When an LTR-Net or LTR system is selected, the PTT switch is briefly pressed to initiate a system access. Then if the access is successful, the dial tone sounds and the number can be sent.

When a conventional system is selected, the telephone number can be sent at any time if a carrier is not being detected on the channel. If a carrier is detected, the number is sent only if the monitor mode is active. This ensures that the channel is monitored.

2.7.5 STORING NUMBERS IN MEMORY

Up to ten 16-digit numbers can be stored in memory and later recalled. Proceed as follows:

1. Enter the number as described in the preceding "Dialing a Number" section.

2. To store the number, press FCN STR and the memory location from 0-9.

3. If there is already a number in the selected location, it is replaced by the new number. To clear a memory location, simply store a blank display.

4. If an attempt is made to store a number in a locked position, "NOT AUTH" is displayed.

NOTE: The ✱ character is stored and sent normally (no pause occurs unless it is preceded by FCN), and the # character should not be stored because it may terminate the call when it is sent.

2.7.6 RECALLING NUMBERS FROM MEMORY

From Specific Location - FCN RCL 0-9 (location number)

Stored in Next Location - When a number is recalled as just described, the number in the next location can be displayed by simply pressing RCL.

Last Number Recalled from Memory - FCN RCL ✱

Last Number Sent by FCN SND - FCN RCL #

2.7.7 EXITING DIAL MODE

The dial mode is automatically exited when power is cycled or approximately 60 seconds after no keys are pressed. It can also be exited as follows:

Exiting Without Sending Call Termination Characters - Press FCN DIAL. The call termination characters should then be sent manually before exiting (see following).

Exiting and Automatically Sending Call Termination Characters - Press FCN PHONE and the call termination characters (✱ #) are automatically sent to indicate to the base equipment that the call is complete. Three beeps sound when the call is successfully terminated.

If the call is not terminated in this manner, the repeater being used is held until the end of the call is detected automatically, such as by the absence of voice. This occurs because with telephone and auxiliary calls, the repeater is held for the duration of the call instead of just for the duration of a transmission as with standard group calls.

2.8 LTR-NET AND LTR FEATURES

2.8.1 STANDARD GROUP CALLS

Standard group (dispatch) calls are between mobiles or groups of mobiles using the standard group ID codes from 1-239 (LTR-Net) or 1-250 (LTR) that are assignable to each home repeater. LTR-Net and LTR standard calls are very similar and are placed and received using the same procedure. Simply select a group programmed with the ID code of the mobile being called and then press the PTT switch. No number is dialed to place this type of call.

To receive a standard group call, the group programmed with the ID code being transmitted must be selected or scanned. Calls with a higher priority than the selected group are always received as described in Section 2.8.2. The procedure used to place and receive standard group calls is described in Section 2.3.13.

2.8.2 CALLS ON PRIORITY ID CODES

LTR-Net transceivers use a different receive priority scheme than has been used with other E.F. Johnson transceivers. Instead of programming each selectable system with one or two fixed priority ID codes, each group is assigned a priority number which determines if a call on that group can interrupt a call on another group in that system. The following priority information is programmed for each LTR-Net and LTR group:

- Priority number from 1-8.
- Interruptible or not interruptible.

The highest priority is programmed by "1" and the lowest priority by "8". When any priority 1 group in the current system is displayed, **P** is indicated in the upper part of the display, and when any priority 2 group is displayed, **P₂** is indicated. Priority 3-8 groups are not indicated.

If any type of call (standard, telephone, auxiliary) is detected on any group of the selected system that has a higher priority than the selected group or the call being received, it is received even if group scanning is not enabled. Exceptions are if the group is not in the group scan list or the current call is on a group programmed as not interruptible.

Standard group calls with a lower priority than the selected group are received only if group scanning is enabled. Telephone and auxiliary calls of any priority are always received if they are on a group in the group scan list and no other call is being received. If another call is being received, they are received only if they have a higher priority than the current call.

If calls on certain groups are not to be interrupted by higher priority calls, the group can be programmed as not interruptible (telephone and auxiliary calls are never interrupted by other calls). For example, if calls on a certain group are not to be interrupted, that group

can be programmed as not interruptible. This has the same affect as programming it with a "1" priority. However, if this was done instead of programming it as not interruptible, calls on that group would interrupt all other lower priority calls which may not be desirable.

The transceiver displays the system and group of the priority call while it is being received. The programming of the "Scan Revert Mode" parameter (see Section 2.6.10) determines if the change to the priority group is temporary or permanent and if a transmission occurs on the priority group.

With LTR-Net operation, incoming call information is received on the repeater to which a mobile is trunked as well as the home and status repeaters. Therefore, priority calls are detected when the transceiver is trunked to other repeaters.

With LTR operation, incoming call information is received on only the home repeater. Therefore, priority calls are not detected while trunked to some other repeater. To reach most mobiles with a priority message in this case, the operator can key the transmitter and then not begin speaking for several seconds. This allows trunked-out mobiles time to finish the transmission and return to the home repeater.

This operation still may not reach mobiles making telephone calls because they hold a repeater for the duration of a conversation (instead of the duration of the transmission as with dispatch calls). Other times when priority calls could be missed with both types of operation are when transmitting and when some other system not programmed with the priority ID is being monitored.

2.8.3 BLOCK ID CODES AND ACCESS PRIORITY

This transceiver does not use blocks of ID codes. However, with up to 99 groups programmable per system and group scanning, it is usually possible to program the transceiver to receive all desired calls.

Access priority to control which transceivers can access the system during busy periods is not available with this transceiver (all transceivers have equal

access). The preceding section describes receive priority which controls what calls are received.

2.8.4 TRANSMIT INHIBIT

The Transmit Inhibit feature prevents the transmitter from keying if the mobile being called is busy with a call not programmed for any group position. When the transmitter is disabled by this feature, the intercept tone sounds and "TX INHIB" is displayed (see following illustration).

This feature is enabled by programming LTR-Net and LTR systems with a block of transmit inhibit ID codes that can include all 239 or 250. If a code within this block is detected up to 5 seconds before the PTT switch is pressed, the transmitter is disabled as just described. Even though the 5-second timer counts down while the PTT switch is pressed, it is not possible to access the system without first releasing the PTT switch. A similar Transmit Disable On Busy feature is available on conventional systems (see Section 2.11.3).

2.9 LTR-NET FEATURES

NOTE: Other LTR-Net features are described in Section 2.8.

2.9.1 LTR-NET STANDARD CALLS

Refer to Section 2.8.1 for information on these calls.

2.9.2 LTR-NET SPECIAL CALLS

Introduction
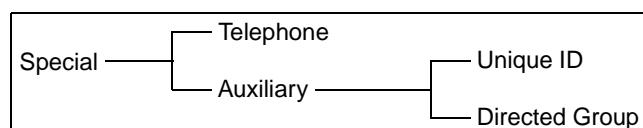
The LTR-Net special calls originated by the mobile include Telephone and Auxiliary as shown above. Most other special calls such as Interrogate,

Mobile Disable, and Reassignment are originated by the system operator or a dispatcher. Special LTR-Net calls use the special call group ID codes from 240-254. A telephone-type keypad and special programming are required to place special calls. More information on these calls follows.

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

Auxiliary - These calls allow a mobile to communicate with specific mobiles or groups at the same locality (site) or another LTR-Net locality when several LTR-Net repeater systems form a network. Calls to specific mobiles are called Unique ID calls, and calls to specific 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 code from 1-239.

Transceiver Programming For Special Calls

To originate a special call and then respond, the selected group must be programmed for the special call being made (Telephone or Auxiliary). The programming software automatically loads the correct ID codes for these calls. Refer to the following chart for more information.

Type of Call	Originating Mobile Encode/Decode ID	Receiving Mobile Decode/Encode ID
Telephone	Telephone	Telephone
Auxiliary		
Unique ID	Auxiliary	Auxiliary
Dir Group	Auxiliary	Group ID

To receive Telephone and Unique ID calls and then respond, a group must be programmed for the applicable call (Telephone or Auxiliary). However, this group usually does not need to be selected or scanned. Refer to Section 2.8.2 for more information.

The Directed Group call is received as a standard group call because it is converted to that type by the switch. Therefore, a group programmed with the ID specified by the originating mobile must be selected or scanned or be assigned to a higher priority group.

To receive landside originated telephone calls, the transceiver must be programmed for telephone calls even though the unique ID of the mobile may be specified when placing the call (see "Landside-Originated Calls" which follows).

With all special calls, the scan revert programming described in Section 2.6.10 also determines if transceiver does not change or changes temporarily or permanently to the group of the call.

Special Call Authorization

When a mobile is programmed to make Telephone calls, system authorization is needed before service is available. This authorization is performed by the system operator through the System and Subscriber Manager, and it 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.

Authorization is also required to make auxiliary calls. Unique ID calls can be made to any mobile in the same locality (site) or some other locality 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 following is the procedure for placing a special call. These calls require that a number be dialed using the front panel keypad.

1. Select an LTR-Net system programmed for the special call being made.

2. If placing a telephone call, select the dial mode and a telephone group by pressing FCN PHONE (see Section 2.7).

3. If placing a unique ID or directed group call, select the auxiliary group in the normal manner using the GRP key. Then select the dial mode by pressing FCN DIAL. The dial mode and a telephone or auxiliary group are indicated as follows:

- The handset portion ▬▬ of the telephone icon is displayed when the dial mode is selected.

- The base portion ▬▬ of the telephone icon is displayed when a telephone call group is selected.

- "UID" is indicated in the lower part of the display when a auxiliary call group is selected (either unique ID or directed group).

4. If a telephone call is being placed, dial the telephone number of the landside party you are calling. If a unique ID or directed group call is being made, the following 1-10 digit numbers are dialed to specify the destination of the call. Dial this number or recall it from memory as described in Section 2.7.

Unique ID Call (Current Locality)
   1-5 digit unique ID of mobile/dispatcher

Unique ID Call (Directed Locality)
   5-digit unique ID of mobile/dispatcher

Directed Group Call (Current Locality)
   3-digit home repeater number +
   3-digit group ID

Directed Group Call (Directed Locality)
   3-digit locality number +
   3-digit home repeater number +
   3-digit group ID

Unique ID Call (Using Telephone Number)
   10-digit telephone number of mobile being called

NOTE: Mobile-to-mobile unique ID calls can also be placed by dialing the mobile's telephone number if it has one.

5. When the desired number is displayed, briefly press the PTT switch and when the dial tone sounds, send it by pressing FCN SND. A beep should sound to indicate 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. If a system resource busy condition exists, the call is placed in a queue by the system (see Section 2.9.3).

6. The various types of calls then proceed as follows:

Telephone Call - The normal landside ringing or busy tone is heard. When the party answers, press the PTT switch to talk and release it to listen as with standard calls.

Unique ID Call - A "ringing" tone is heard which indicates that the mobile is being rung. If there is no answer, ringing stops after several rings or the call can be terminated by pressing the FCN PHONE or the * # keys (with PTT pressed). When the party answers, press the PTT switch to talk and release it to listen as with a standard call.

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). Press the PTT switch to talk and release it to listen.

NOTE: Since this transceiver operates half-duplex, you cannot hear the other caller while transmitting or speak to the other caller while receiving.

7. When the call is finished, terminate it by pressing the FCN PHONE or FCN DIAL (see Section 2.7.7). This tells the system that the call is complete and prevents additional billing for the time required by the system to automatically detect the end of the call.

Receiving Special Calls

   To receive a special call, all that is usually required is that the system programmed for the special call be selected. Refer to Section 2.8.2 for more information. When a Telephone or Unique ID call is received, "ringing" is heard. If it is a Directed Group call, only the voice of the calling party is heard because no ringing occurs.

Landside-Originate Special Calls

Calls can be also be made from any landside tele-phone to specific mobiles (Unique ID calls) or groups (Directed Group calls). Calls can also be placed to other sites 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 described in "Placing a Special Call". The landside telephone must produce standard 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 the mobile party. Three beeps indicate that the call has terminated.

2.9.3 BUSY QUEUING/FREE SYSTEM RINGBACK

This transceiver does not have the busy queuing or free system ringback features. Busy queuing places a call in a queue if all channels are busy, and free system ringback alerts the user when the repeater system is no longer busy.

However, busy queuing may be provided at the system level for LTR-Net telephone, unique ID, and directed group calls (but not standard group calls). If this feature is enabled by the System and Subscriber Manager and resources are not available when one of these calls are placed, a voice message informs the user that the call has been placed in a queue. This

message occurs when the PTT switch is released after dialing the digits.

If resources then become available, ringback is heard and the PTT switch can then be pressed to continue the call. If the call cannot be placed in the allotted time, it is terminated and another voice message informs the user that this has occurred.

2.9.4 ROAMING (AUTO-REGISTRATION)

General

The roaming (auto-registration) feature permits all types of LTR-Net calls to be automatically routed to the LTR-Net locality (site) in which the mobile is operating. To utilize roaming, the following must be selected:

- An LTR-Net system must be selected if system scanning is disabled (see Section 2.6.1).

- Roaming must be enabled by the ROAMING menu parameter or programming (if the menu parameter is not available).

- If system scanning is enabled, an LTR-Net system does not need to be selected. However, the trans-ceiver immediately roams to an LTR-Net locality in the system scan list if one can be detected (see Section 2.6.4)

NOTE: Deleting LTR-Net systems from the scan list also deletes them from locality searching when roaming, even when scanning is disabled (see Section 2.6.7).

When roaming is enabled or disabled by the menu mode, either "ON" or "OFF" is selected as described in Section 2.5.2. If communication is to be maintained on the current locality regardless of signal strength, turn roaming off.

Registering on a New Locality

When power is turned on with an LTR-Net system selected or if another LTR-Net system is selected, registration is attempted on the currently selected locality every 5 seconds if there is a free channel. The registration message includes the

mobile's unique ID and the home repeater to be used. The registration information is forwarded to the Call Processor which then knows its location. This automatic registration occurs regardless of whether roaming is on or off.

If the signal from a locality becomes weak (see "Dropout and Capture Parameters" which follows) or if two consecutive unsuccessful access attempts occur, "NO ACESS" is displayed and the transceiver begins automatic locality search. The unsuccessful access counter is reset whenever power is cycled, the selected system is changed, or a successful access occurs.

During locality search, the status channels of other LTR-Net localities in the system scan list are checked (see Section 2.6.7). During the first pass, "HSQ SRCH" (High Squelch Search) is displayed, the locality that was just dropped is not checked, and the Tight Squelch setting programmed for each locality is used (see "Dropout and Capture Parameters" which follows).

If no localities are found on the first pass that have a high enough signal level, the locality that was just dropped is added back into the search list and all localities in the scan list are checked using the Capture setting programmed for each locality. The display indicates "LCL SRCH", and searching continues until a strong enough locality is found. If none are found before the PTT switch is pressed again, the transmission is attempted on the last registered locality, and searching resumes when the transmission ends.

De-Registering

If an LTR-Net system is selected when power is turned off, a de-registration message is automatically sent that tells the system that the mobile is no longer in service. This increases system efficiency by reducing the number of system resources used in trying to reach out-of-service mobiles. Transceiver power is automatically held on until this message is sent. If power to the transceiver is switched off immediately, such as by removing the battery, this message cannot be sent.

Revert System/Group Selection After Registration

After registration on a new locality occurs, "LCL SRCH" is no longer displayed and the system of the

new LTR-Net locality is displayed. The new system is the next higher system with a different locality that could be accessed. For example, if System 3 was selected and System 5 is the next higher system with a different locality number, that becomes the selected system if it can be accessed (wrap-around occurs after the highest system is checked).

The selected group does not change when registration on a new locality occurs. This allows registration on a new locality to be nearly transparent to the user. Therefore, when programming the transceiver, the same group programming should be used in all LTR-Net systems that a mobile roams into. If the same group is not programmed in the new system, the last selected group on the new system is selected. A call can be received on the new locality before registration occurs if the call is already active on the new locality.

Dropout and Capture Parameters

The transceiver squelch is used to control when searching for a new locality begins and also when registration on a new locality occurs. A reference squelch level is set during alignment. In addition, three squelch levels called Dropout, Capture, and Tight Capture Percentage are programmed for each locality (see Table 3-2). These levels automatically tighten the squelch setting in certain operating modes. The tightened amount is the programmed percentage of the difference between the reference level and the maximum tight setting (equivalent to rotating a squelch knob fully clockwise). These squelch levels function as follows:

Dropout Percentage - This is the percentage that squelch is tightened when not in a call. This prevents the transceiver from staying on a weak locality when another stronger locality may be nearby. The default level is 33%, and setting higher levels may cause more missed calls during weak signal periods. If there is no other locality nearby, this parameter should be 0%.

Tight Capture Percentage - This is the percentage the squelch is tightened during the first pass when searching for a new locality (HSQ SRCH displayed). This parameter should always be greater than or equal to the Capture Percentage which follows, and it ensures that registration occurs on a strong locality if there is one. The default level is 80%.

Capture Percentage - This is the percentage that squelch is tightened on the second and later passes when searching for a new locality (LCL SRCH displayed). This parameter should always be greater than or equal to the Dropout Percentage, and it ensures that registration occurs on a stronger locality. The default level is 46%.

NOTE: The transceiver uses the value programmed for the locality being sampled, not the value programmed for the locality which was just dropped.

2.9.5 OVER-THE-AIR LOCALITY CHANNEL UPDATES

Localities are initially programmed with the channel numbers of all repeaters currently in use. These are then the channels that the transceiver can access when placing and receiving calls. If new channels are later added to a locality, over-the-air programming is used to update the transceivers with the new channels. This eliminates the need to bring them in for reprogramming.

2.9.6 TRANSCEIVER DISABLE

If a mobile is lost or stolen or is being used to interfere with communication, it can be temporarily or permanently disabled by the system operator as follows:

A mobile can be temporarily disabled by transmitting the Sleep command to the unique ID of the affected mobile. When a transceiver receives this command, SLEEPING is displayed continuously on the lower line and no calls can be received or transmitted. However, registration on new localities continues normally.The transceiver can be re-enabled again by the system operator by sending an Interrogate message. This is indicated when the display returns to indicating normal system/group information.

A mobile can be permanently disabled by sending the Kill command to the unique ID of the affected mobile. The transceiver then responds that it has received this message and then permanently disables itself. It is then totally inoperative and CALL SVC is displayed continuously. It must then be brought back in for reprogramming to make it operational again.

2.9.7 HOME CHANNEL ALIASING

Introduction

The home channel aliasing feature increases the number of standard group calls programmable on a locality by allowing calls to be programmed on non-existent home repeaters. Therefore, instead of being limited to just the 239 ID codes on each active home repeater, group calls can be programmed on each of the up to 20 home repeaters allowed per locality (the twentieth repeater is usually the status repeater which is typically not assigned as a home repeater). This permits up to 20 x 239 or 4780 group calls on each locality.

The active repeaters on each locality are designated by locality programming (see Section 3.4.4). They are programmed with a frequency and have the Active box checked, while non-existent repeaters do not have a frequency or this box checked. If repeaters are later added, they can be added to the locality by over-the-air programming (see Section 2.9.5).

Operation With Home Channel Aliasing

If a system programmed with a non-existent home repeater is selected, the next lower active home repeater is monitored for incoming calls and go-to repeater information. For example, if home repeater 6 is programmed on the selected system and the active repeaters are 1, 10, and 20, repeater 1 is monitored. In addition, all other mobiles on that locality with a selected system programmed for home repeaters 1-9 monitor that repeater.

If a group call is then placed, the home channel of the call is the home channel programmed for the selected system, not the repeater being monitored. The call is detected like any other group call (it is received if a system/group programmed for that home repeater/ group ID is selected or scanned).

NOTE: Since this feature does not increase system capacity, adding too many users may result in unsatisfactory operation due to frequent busy conditions.

Repeater Number Programming With Aliasing

Since the next lower numbered repeater is monitored when a system with a non-existent home repeater is selected, a numbering scheme should be used that equalizes, as much as possible, the gaps between the active repeaters. This equalizes the loading on the active channels.

When repeater 1 is reached, wrap-around to repeater 20 occurs. Therefore, the status repeater is always assigned as Repeater 20 and Repeater 1 as an active repeater. This prevents the status repeater from being used as a home repeater which is not desirable because it then has no backup repeater (see Section 6.6). Examples of repeater numbering schemes are as follows:

No. of Repeaters	Numbering
1	20
2	1, 20
3	1, 10, 20
4	1, 7, 14, 20
5	1, 5, 10, 15, 20
10	1, 3, 5, 7, 9, 11, 13, 15, 17, 20

2.10 LTR FEATURES

NOTE: Other LTR features are described in Section 2.8.

2.10.1 STANDARD GROUP CALLS

The two types of calls that can be placed with LTR operation are standard group and telephone. Standard group calls are described in Section 2.8.1, and telephone calls are described in the next section.

2.10.2 TELEPHONE CALLS

General

LTR localities which are set up for LTR telephone calls have a block of ID codes reserved for RIC (repeater interconnect) calls. For the transceiver to place and receive telephone calls on those localities, an LTR telephone group must be programmed with an ID code from this block. Then when this ID code is decoded (received) or a telephone group is selected to make a call, the transceiver enters the telephone operating mode.

To place an LTR telephone call, a telephone group must be selected, and to receive an LTR telephone call, the telephone ID must be selected or scanned or have a higher priority.

Since this transceiver operates half duplex, the PTT switch must be pressed to talk and released to listen the same time as with a dispatch call. Therefore, the mobile user cannot hear the landside caller while transmitting or speak to the landside caller while receiving.

Placing an LTR Telephone Call

1. Turn transceiver power on and set the volume as described starting with Section 2.3.1.

2. Select the desired LTR system if applicable. Then select the dial mode and a telephone group as follows:

   • To select the dial mode and a preprogrammed telephone group, press FCN PHONE.

   • To select the dial mode without changing the selected group, manually select a telephone group if required and then press FCN DIAL.

   When the dial mode is selected, the handset portion ▬▬ of the telephone icon is displayed, and then when a telephone group is selected, the base portion ▬▬ is displayed.

3. Dial the desired number using the keypad or recall it from memory by pressing FCN RCL and the location number (0-9). Refer to the dial mode description starting in Section 2.7 for more information.

4. When the desired number is displayed, briefly press the PTT switch and when the dial tone sounds, send it by pressing FCN SND. Landside ringing (or a landside busy condition) should then be heard. If the radio system is busy or could not be accessed, busy or no access conditions may be indicated the same as described for standard group calls in Section 2.3.13.

5. When the other party answers, press the PTT switch and respond. The PTT switch must be pressed to talk and released to listen the same as with standard group calls.

6. When the call is finished, it should be terminated and the dial mode exited. A call is usually terminated by transmitting either the **#** or **� #** characters (whichever is programmed). To automatically send these characters and exit the dial mode, press FCN PHONE. To exit the dial mode without sending these characters, press FCN DIAL. Termination is indicated by three beeps.

<u>Receiving LTR Telephone Calls</u>

1. Select or scan the system and group programmed for telephone calls. When a telephone group is selected, the base portion ▃▃ of the telephone icon is displayed.

2. When "ringing" is heard, press the PTT switch and respond. The PTT switch must be pressed to talk and released to listen the same as with standard calls.

3. When the call is finished, it should be terminated as in step 6 of the preceding section.

<u>Landside-Originate Telephone Calls</u>

Calls can be placed from a landside telephone to a mobile transceiver (if the transceiver and radio system have this capability). With most systems, a mobile user can be called directly (each has a unique telephone number). With others, the mobile being called must be specified as follows:

1. Dial the number of the radio system in which the mobile transceiver is operating.

2. When the system answers, a short tone sounds to indicate that the number of the mobile being called should be dialed. This number is usually five digits long and must be dialed using a tone-type telephone. The first two digits are the home repeater number of the mobile, and the last three digits are the telephone ID code of the mobile. With LTR interconnect equipment, the first digit must be dialed within 5 seconds of hearing the tone, and no more than 5

seconds must elapse between digits or the call is terminated.

3. Ringing is then heard by the landside caller while the mobile is being rung.

2.10.3 LTR FEATURES NOT AVAILABLE

The following LTR features are not available with this transceiver:

- Busy Queuing/Free System Ringback
- System Search
- Transpond

2.11 CONVENTIONAL FEATURES

2.11.1 BUSY INDICATOR

When a carrier is being detected on the current channel with scanning disabled, "BUSY" is indicated in the display (see following illustration). The squelch should be adjusted as described in Section 2.11.4 for proper operation of this indicator.

Busy Indicator

2.11.2 MONITOR MODE

The monitor mode disables Call Guard Squelch control (if programmed) so that all activity on the selected channel (system) can be monitored. The receiver unsquelches only if a carrier is detected. To select the monitor mode, one of the option switches must be programmed for the monitor function (see Section 2.5.1). Pressing this switch toggles the monitor mode on and off. When the monitor mode is enabled, ◀ is indicated in the display as shown in the following illustration.

Monitor Mode Selected
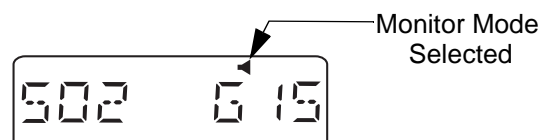
A conventional system must be selected to enable monitoring. If the Monitor option switch is pressed

with an LTR-Net or LTR system selected, scanning halts and "NOT CONV" is displayed, but monitoring is not enabled. Refer to Section 2.3.11 for more information on channel monitoring.

2.11.3 TRANSMIT DISABLE ON BUSY

The Transmit Disable On Busy feature automatically disables the transmitter if the selected system (channel) is busy and it has not been monitored when the PTT switch is pressed. When the transmitter is disabled by this feature, "DSBL BSY" is indicated in the display as follows:

```
┌─────────────────────────┐
│   DSBL    BSY           │
└─────────────────────────┘
```

While the PTT switch is pressed, the receiver is unsquelched so that activity on the channel can be monitored. The PTT switch must be released and then pressed again to make another call attempt. Occasionally, a busy condition may be detected even though no one is talking. To key the transmitter in this case, release the PTT switch and then immediately press it again.

Some repeaters may have delayed drop-out (hang time) which causes this feature to disable the transmitter even though no busy condition exists. If this is a problem, there is also a programmable option to allow transmitting with a busy channel if the correct Call Guard signal is detected.

The Transmit Disable On Busy feature is enabled or disabled on each conventional group by programming. If this feature is disabled or if the monitor mode is selected (see preceding section) the transmitter keys even if the channel is busy.

2.11.4 SQUELCH ADJUST

This function sets the squelch level used for conventional calls. The squelch level for LTR-Net and LTR calls is preset and cannot be changed. If conventional systems are programmed, adjust the squelch as follows:

1. Select a conventional system and group that is not busy.

2. Press FCN SQL to select the squelch adjust mode. The monitor mode is automatically selected in this mode. The currently selected level is indicated by "SQ xxx" in the display.

3. Press the ◄ key until receiver noise is heard and then press ► until the noise just mutes. To decrease or increase the selected level by 10 (or to the minimum or maximum level if that is not possible), press FCN ◄ or FCN ►, respectively.

NOTE: Slight readjustment may be required if weak messages are not heard or unsquelching occurs when no messages are present.

4. To exit this mode, press the FCN SQL again. This also occurs automatically 2 seconds after no activity.

5. If both narrow and wide band channels are used, perform this adjustment for each type because separate settings are maintained.

2.11.5 TALK-AROUND

Normally, all transmissions go through a repeater. However, there may be times when a user is out of range of the repeater and unable to talk to anyone even though the mobile being called is nearby. In this situation, the repeater talk-around feature can be used to transmit on the receive frequency to allow direct mobile-to-mobile communication.

Any conventional group can be programmed for talk-around. It is then enabled by simply selecting one of those groups. It is not selectable by an option switch or indicated in the display unless it is indicated by the group alpha tag. Talk-around is not available on LTR-Net and LTR systems.

2.11.6 CALL GUARD SQUELCH

Introduction

Tone, digital, or inverted digital Call Guard squelch can be programmed on each transmit and receive channel in any order desired. There is also an

option to disable the reverse burst or turn-off code on transmit channels programmed with Call Guard squelch. The reverse burst or turn-off code are always detected on receive channels programmed with Call Guard squelch (if it is sent).

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 a user or a 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. When the channel is monitored before transmitting, Call Guard squelch may be temporarily disabled by the monitor mode described in Section 2.11.2.

Tone Call Guard Squelch

Tone-type Call Guard squelch utilizes subaudible CTCSS tones from 67-254.1 Hz. Although there are 42 tones assigned, those above 33 are normally not used because of their close proximity to the voice band which starts at 300 Hz. In addition, tones 11, 39, 40, 41, and 42 are normally not used because they may cause interference with adjacent tones (see Table 3-6).

A reverse burst (turn-off code) can be transmitted when the push-to-talk switch is released to eliminate the squelch tail (noise burst) in the receiving transceiver. However, both the transmitting and receiving transceiver must be equipped with this feature for it to be utilized. The reverse burst is a 180-degree phase reversal for a period of time determined by the tone frequency.

Digital Call Guard Squelch

Digital Call Guard squelch (CDCSS) 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 is transmitted which eliminates the squelch tail similar to the reverse burst.

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 waveform 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 digital Call Guard squelch does not function, try changing to the other type.

2.11.7 EXTERNAL ENCODERS AND DECODERS

External encoders and decoders are currently not supported by the LTR-Net operating code.

2.12 SUPERVISORY TONES

2.12.1 GENERAL TONES

The following tones are heard at various times when operating this transceiver. Some or all of these tones can be disabled by the user if the menu "TONES" parameter is available (see Section 2.4.12). If the menu parameter is not available, the tones mode cannot be selected by the user and is fixed by programming.

Busy Tone - This tone is similar to the standard telephone busy tone, and it indicates that the LTR-Net or LTR radio system is currently busy. It is produced by turning combined 480 and 620 Hz tones on and off at a 4 Hz rate. This tone sounds with all types of LTR-Net/LTR calls (even if the proceed tone is enabled), and "BUSY" is indicated in the lower part of the display when it sounds. It does not sound on conventional systems.

Continued access attempts are made while this tone sounds. Therefore, it is possible to access the system by holding the PTT switch down with this tone sounding.

Intercept Tone - This is a siren-like tone (alternating high and low tones) consisting of 700 Hz and 800 Hz tones alternating at approximately a 2 Hz rate. This tone indicates the following no access and error conditions:

- No Access - If this tone sounds 2-3 seconds after pressing the PTT switch and "NO ACESS" is displayed, the data handshake with the repeater could not be completed. The usual cause is an out-of-range condition. Six attempts are made before this tone sounds. No more access attempts are then made until the PTT switch is released and pressed again.

- Time-Out Timer - If this tone sounds after the transmitter has been keyed for an extended period and "TIMEOUT" is displayed, the transmitter has been disabled by the Time-Out Timer feature (see Section 2.4.11). This tone sounds in all operating modes.

- Transmit Inhibit - If this tone sounds as soon as the PTT switch is pressed with an LTR system selected and "TX INHIB" is displayed, the transmitter has been disabled by the Transmit Inhibit feature (see Section 2.8.4).

- Receive-Only Group - If "TX DSBL" is displayed when this tone sounds, a receive-only group is selected (see Section 2.4.10).

Proceed (Clear-To-Talk) Tone - This is a short (700 Hz, 50 ms) or a distinctive (three beep) tone which sounds after the handshake is complete to indicate when talking can begin (see Section 2.4.9).

Key Press Tone - This is a short (700 Hz, 50 ms) tone that sounds to indicate when an option switch is pressed (in all modes).

Wrap-Around Tone - A 700 Hz, 80 ms tone followed by an 800 Hz, 80 ms tone which indicates that the highest or lowest programmed system or group was displayed and that wrap-around has occurred (see Section 2.3.5).

Error Tone - A 1050 Hz, 80 ms tone followed by a 700 Hz, 80 ms tone which indicates that an error condition occurred.

2.12.2 LTR-NET SPECIAL CALL TONES

NOTE: The following tones are produced by the LTR-Net switch and are heard only when placing special calls.

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

Call Proceed Tone - With LTR-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 (see Section 2.9.2).

2.12.3 LTR TELEPHONE CALL TONES

The following tones are generated by the LTR interconnect equipment and are heard when making 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.

2.12.4 DISPLAY MESSAGES

The following messages appear in the display to indicate various operating modes and error conditions. Selected system/group information appears in this display during normal operation (see Section 2.3.4).

72xx6xx - On power up, the last seven digits of the transceiver part number (see Section 1.3) are displayed on the top line very briefly. For example, a UHF 430-470 MHz, LTR-Net transceiver is indicated as "7243633". The eighth display digit is reserved for future use and is always blank.

✳ CODE xx - Indicates that an error condition has occurred. It is displayed very briefly at power up (see Section 2.14).

BUSY - Indicates that the LTR-Net/LTR radio system is currently busy (see "Busy Tone" in Section 2.12.1).

CALL SVC - Indicates that the transceiver has been totally disabled by an over-the-air message from the system operator. To return the transceiver to service, it must be reprogrammed (see Section 2.9.6).

DSBL BSY - Indicates that the transmitter is disabled by the conventional Transmit Disable On Busy feature (see Section 2.11.3). It also indicates that the transmitter was keyed while receiving an LTR call.

FCN - Indicates that the function select mode is selected by the FCN switch (see Section 2.2.4).

HSQ SRCH - Indicates the transceiver is currently on the first pass while searching for a new locality on which to register (see Section 2.9.4).

LCL SRCH - Indicates the transceiver is currently on the second or later pass while searching for a new locality on which to register (see Section 2.9.4).

NO ACESS - Indicates that the repeater system could not be accessed, 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 (see Section 2.12.1).

NO PHONE - Indicates that there is no telephone group programmed in the current system when the dial mode and telephone group are selected by FCN PHONE (Section 2.7.2).

NOT AUTH - Indicates that an attempt was made to store a telephone number in a locked memory location (see Section 2.7.5).

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

OUT-LOCK - Indicates that the synthesizer is unlocked. The transceiver is nonfunctional until lock is re-established.

PROG ERR - Indicates an EEPROM read error. Check transceiver programming or the EEPROM if this condition persists (see Section 3.7).

PRG MODE - Indicates that the transceiver is being programmed (see Section 3.7).

SLEEPING - Indicates that the transmitter has been temporarily disabled by an over-the-air message from the system operator (see Section 2.9.6).

SQUELCH - Indicates that the conventional squelch adjust mode is selected (see Section 2.11.4).

SYS SRCH - Indicates that searching is occurring for programmed system information.

TIMEOUT - Indicates that the transmitter has been disabled by the Time-Out Timer (see Section 2.4.11).

TYPE ERR - Indicates that the programming data is incompatible with the transceiver (see Section 3.7).

TX DSBL - Indicates that the selected group system is programmed for monitoring only (see Section 2.4.10).

TX INHIB - Indicates that the transmitter has been disabled by the Transmit Inhibit feature (see Section 2.8.4).

2.12.5 MENU MODE MESSAGES

The following messages are displayed in the menu mode that is described in Section 2.5.2. Enabled or yes is indicated by "ON", and disabled or no by "OFF".

BACKLGHT - Backlight on-off
- ON or OFF

BANK SEL - Bank select
- Alpha tag of programmed banks

ROAMING - LTR-Net roaming on-off
- ON or OFF

SCN CONT - Scan continue on-off
- ON or OFF

SCN SAVE - Scan list save
- ON = save, OFF = not saved

SCN TYPE - Selects type of scanning
- **SYSTEM -** Both system and group
- **GROUPS -** Group scanning only
- **OFF -** Scanning off, switch disabled

S/G DISPL - System/group display mode
- **ALPHA**
- **NUMERIC**

TONES - Tone type select
- **SILENT -** No tones sound
- **KEYS -** Only the Select switch and key press tones sound
- **ALERTS -** All tones except preceding Key Beep tones sound
- **ALL -** The preceding Key Beep and Alert tones sound

2.13 TEST FUNCTIONS

With the standard LTR-Net operating code, there is no test mode that can be selected to perform testing. To manually control the transceiver with this code, program temporary conventional channels. When the test operating code is loaded, several test functions are available. Refer to Section 5 for more information.

To display the software version number, turn power on with PTT switch pressed. The version number is displayed as "VER x.xx" (see Section 2.3.10). If any error codes are present (see next section), the most recent error code is displayed instead of the software version.

2.14 ERROR CODES

2.14.1 GENERAL

If error conditions occur during operation that interrupt normal program execution, reset occurs which usually restores normal operation, and information on the error condition is stored. Up to 11 error conditions can be stored. If more than 11 occur, the first 10 continue to be stored and only the 11th code is overwritten so it is always the most recent code. An error condition can be caused by such things as a defective memory chip or other hardware problems or software problems.

When power is turned on after an error condition has occurred, "✳CODE xx" is briefly displayed (see following example). The "xx" indicates the latest unread code.
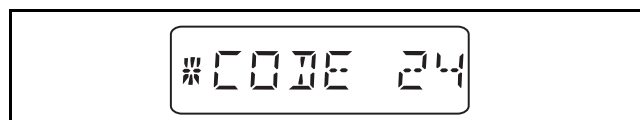
To display the most recent error code, turn power on with the PTT switch pressed and then release it. To mark a code as read, press FCN CLR. A beep then sounds and the next code is displayed if applicable. Once all stored codes are marked as read, they can no longer be displayed and "✳CODE xx" is not displayed at power up. However, they continue to be

stored and can be read using the programmer (see next section). To return to normal operation, cycle power without the PTT switch pressed or press FCN RCL.*

2.14.2 READING ERROR CODES

The up to 11 error codes that can be stored can be read out of the transceiver using the personality programming software described in Section 3.7. Connect the programming setup and then select

Transfer > Read * Codes or click the ▦ icon in the toolbar (see Section 3.7).

The screen shown in Figure 2-4 is then displayed which indicates various information about each stored error code. Contact the Customer Service Department as described in Section 1.7 for additional information on the displayed error codes. To permanently erase the current error codes from the transceiver, click the "Clear * Codes" button at the bottom of the screen.

LOC	*CODE	NAME	DOMAIN	OBJECT	EVENT	DATA	OPT1	OPT2	OPT3	DESCRIPTION
0	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
1	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
2	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
3	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
4	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
5	E6	PANIC_ILLEGAL	00	00	F1	0000	00	00	00	Illegal Opcode (Reflash
6	D3	DOMAIN_BAD_EVENT	04	03	00	0000	00	00	00	Invalid event was sent
7										
8										
9										
10										

[Clear *Codes] [Close]

Figure 2-4   Programmer Error Code Screen

SECTION 3   PROGRAMMING
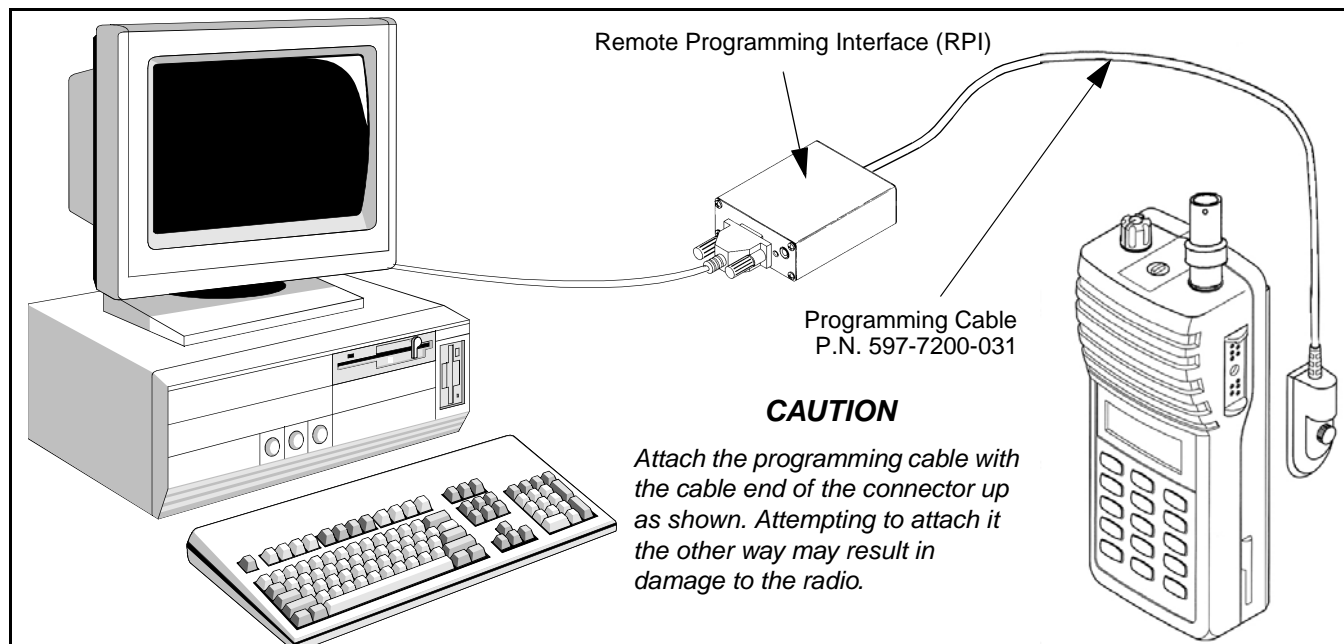
Figure 3-1   Programming Setup

3.1 GENERAL

3.1.1 PROGRAMMING SETUP

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

- IBM® PC or compatible personal computer
- E.F. Johnson Remote Programming Interface (RPI), Part No. 023-9800-000.
- Cables from the RPI to the computer and radio.
- E.F. Johnson programming software for 7200-series transceiver.

3.1.2 MINIMUM COMPUTER REQUIREMENTS

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

- Windows 95/98 or NT 4.0 operating system
- CD-ROM drive
- One unused serial port

The programming software requires a Windows 32-bit operating system such as Windows 95/98/2000 or NT 4.0 to run. A 16-bit operating system such as Windows 3.1 cannot be used.

Since the program is relatively small (approximately 600K), it will run properly with the amount of RAM recommended for the operating system. The data files are also relatively small (approximately 25K), so minimal hard disk space is also required.

3.1.3 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.

RPI (Part No. 023-9800-000) is backward compatible, so it can also be used to program most other E.F. Johnson transceivers which require an RPI. This new RPI is required for Flash programming described in Section 3.12, and it has phone jacks for

injecting the transmit audio signal and monitoring receive audio during alignment (see Section 5). Earlier RPI's, such as Part No. 023-5810-000 or 023-9750-000, can be used to perform the standard personality programming described in most of this section.

When programming this transceiver, the switch on the front panel of the RPI selects either the standard or Flash programming mode. The standard mode is selected when it is away from the LED and the indicator is green, and the Flash mode is selected when it is toward the LED and the indicator is amber. The standard mode should be selected for all but Flash programming.

With remote mount mobile transceivers, this switch is used to turn transceiver power on and off. A separate 9-16 VDC, 200 mA power supply (such as P.N. 563-0001-005) must then be plugged into the RPI power jack to provide power to the RPI.

3.1.4 RPI CABLES

The cables from the RPI to the computer and transceiver are not included with the RPI. The RPI has a female DB9 connector, and most computer serial ports have a male DB9 or male DB25 serial connector. Therefore, a male DB9 to either a female DB9 or female DB25 cable is usually required. This is a standard cable available at most electronic and computer supply stores. Suitable cables are also available from the E.F. Johnson Company as listed in Table 1-1.

The cable from the RPI to the transceiver has an 8-pin telephone style connector on the RPI end and a connector compatible with the accessory connector on the transceiver end. The cable for this application is also listed in Table 1-1.

3.1.5 EEPROM DATA STORAGE

Most personality information programmed in the following sections is stored in the EEPROM memory device (U150). EEPROM devices store data indefinitely without the need for a constant power supply. The battery can be removed from the transceiver indefinitely without affecting programming.

If the operating program needs to be updated, reprogramming is performed using special program-

ming software and the same setup used for personality programming. Refer to Sections 3.12 and 5.2 for more information.

3.1.6 HARDWARE HOOKUP

The programming setup is shown in Figure 3-1. The RPI-to-transceiver cable is connected from the 8-pin jack of the RPI to the accessory connector of the transceiver *(make sure it is connected with the cable end up as shown in Figure 3-1).* The RPI-to-computer cable is connected from the serial port of the computer to the DB9 connector on the RPI.

The RPI has a switch which selects standard or Flash modes. Turn on transceiver power and then make sure that the standard mode indicated by a green LED is selected (position away from LED).

If it is the first time the program is run and a port other than Serial Port 1 (COM1) is used, the serial port may have to be selected. Refer to Section 3.9 for more information.

3.2 MISCELLANEOUS PROGRAM INFORMATION

3.2.1 BASIC WINDOWS KNOWLEDGE

With the descriptions which follow in this section, it is assumed that you have a basic understanding of how to use your Windows-based operating system. If you are not familiar with some of the Windows functions described, refer to the Windows Help Screens and any manuals that may have been included with your Windows software.

3.2.2 SOFTWARE INSTALLATION

The programming software is supplied on a CD-ROM. Install this software as follows:

1. Make sure that there are no other Windows applications open during this installation procedure. This also includes programs represented by icons in the system tray (the area where the time is usually displayed). Also, make sure that the computer meets the minimum requirements listed in Section 3.1.2.

2. Insert the CD-ROM in the CD drive of your computer.

3. Select ▦Start > Run and then click the Browse button and select the "Setupex.exe" file on the CD.

4. Then click OK and follow the on-screen instructions to install the program.The default directory for the program is C:\Program Files\EFJohnson. If you wish to use some other directory, click Browse and select it or type the name to create a new one.

3.2.3 STARTING PROGRAM

From Start Menu

The program is started by clicking the shortcut icon for the program. This shortcut is automatically created when the program is installed, and is usually selected by clicking ▦Start > Programs > LTR-Net Programmer.

If this icon is not present or you want to create another, select Start > Settings > Taskbar. Then select the Start Menu Programs tab and click the Add button. Click the Browse button and locate the program file called LTRNetPgmr.exe where you installed it on your hard drive (see preceding information). Click the program name and continue following the instructions that are displayed.

From My Computer or Windows Explorer

To start the program from My Computer or Windows Explorer, locate the file LTRNetPgmr.exe and then double click it.

3.3 MAIN WINDOW DESCRIPTION

3.3.1 TITLE BAR

The title bar is located at the top of the window (see Figure 3-2) and indicates the following:

- [icon] Clicking this control icon displays the screen on the right which can be used to perform the indicated window control functions.

  Restore
  Move
  Size
  Minimize
  Maximize
  Close   Alt+F4

- Name of the current data file (Johnson_rad.mbl in Figure 3-2).

- Program name (LTR-Net Programmer)

- Window Minimize, Maximize, and Close buttons

3.3.2 MENU BAR

The menu bar (see Figure 3-2) displays the headings for the menus that are used to select program functions. Quick access to the most frequently used menu functions are provided by toolbar buttons. Refer to Sections 3.5 - 3.10 for descriptions of menu functions.

3.3.3 TOOLBAR

The toolbar (see Figure 3-2) provides quick access to the most frequently used menu functions. The toolbar can be turned on and off by selecting View > Toolbar in the menu bar. The function of these buttons and section in which the function is described are as follows:

[NEW] - Create a new programming file (Section 3.5).

[open] - Open a disk file (Section 3.5).

[save] - Save the current file (Section 3.5).

[Radio EDIT] - Edit radio parameters (Section 3.6.3).

[NEW] - Create a new locality (Section 3.6.8).

[EDIT] - Edit a current locality (Section 3.6.8).

[DELETE] - Delete a locality (Section 3.6.8).

[SYS NEW] - Create a new system (Section 3.6.9).

[SYS EDIT] - Edit a current system (Section 3.6.9).

[SYS COPY] - Copy a system (Section 3.6.9).

[SYS DELETE] - Delete a system (Section 3.6.9).

[GROUP] - Edit a group (Section 3.6.10).

[BANK NEW] - Create a new bank (Section 3.6.11).

[BANK EDIT] - Edit a current bank (Section 3.6.11).

[BANK DELETE] - Delete a bank (Section 3.6.11).

[READ icon] - Read the programming data from radio (Section 3.7).

[WRITE icon] - Write programming data to a radio (Section 3.7).

[*CODE icon] - Read error code information stored in radio (Section 2.14)

[INFO icon] - Read version information from the transceiver (Section 3.7).

3.3.4 MAIN WINDOW PANES

The left pane (Personality View) shown in Figure 3-2 displays the current programming information in a Locality, Bank, or System hierarchy that is selectable by clicking the applicable "View Type" button at the top of the pane. To turn this pane on and off, select View > Personality. Clicking a "+/– box or double clicking a bold item expands/contracts that branch. This pane always defaults to the on mode when the program is started.

The right pane displays the information contained in the current radio file. This information can be printed by selecting File > Print or saved to a text file by copying (Ctrl C) and pasting (Ctrl V) it into a word processor program. To quickly display the data for a locality, bank, or system, simply click it in the left pane.

3.3.5 STATUS BAR

The status bar is located at the bottom of the screen (see Figure 3-2), and it indicates the following information. The status bar can be turned on and off by selecting View > Status Bar in the menu bar.

Status/Function - When pointing to a function or tool, this area provides a brief description of it. At other times, it indicates the current program status.

Radio Model - Indicates the specific radio model that has been selected by the Edit > Radio Type menu (see Section 3.6.2). Only the parameters applicable to the selected radio are displayed on the various screens.

Personality - Displays a running total of the amount of space remaining in EEPROM memory of micropro-cessor U208 if the transceiver was programmed with the current information. If this number reaches zero before all data is entered, fewer localities/systems/

groups/banks must be programmed (see Section 2.3.12).

Saved Info/LTR-Net Locality - Functions like the Flash memory display just described to indicate the amount of space remaining in EEPROM U150 for saved information and LTR-Net localities.

3.4 PROGRAMMING PROCEDURE

3.4.1 INTRODUCTION

The following is a general procedure that can be used to program a 72xx-series portable transceiver. Detailed information on the screens mentioned in the procedure is located in Sections 3.5 - 3.10.

3.4.2 GETTING STARTED

1. Start the program as described in Section 3.2.3. The main window shown in Figure 3-2 is displayed when the program is started.

2. Choose the data file to be edited using one of the following methods:

   New File - When the program is started, a new file is automatically created that contains program defaults. This file is named "Untitled" until it is saved. A new file can also be created at any time by File > New or clicking [NEW icon] in the toolbar.

   From Disk File - If a file stored on disk is to be edited or used as a basis for programming another file, open it by selecting File > Open or clicking [open icon] in the toolbar.

   Read From Radio - If the data currently contained in a radio is to be used as a basis for programming another radio or is to be modified, it can be read into the program. To do this, select Transfer > Read Setup Params or click [READ icon] in the toolbar (see Section 3.7).

3.4.3 PROGRAMMING MAIN RADIO PARAMETERS

The Main Radio Parameters are parameters that are the same regardless of the selected bank/system/group. They are programmed as follows:
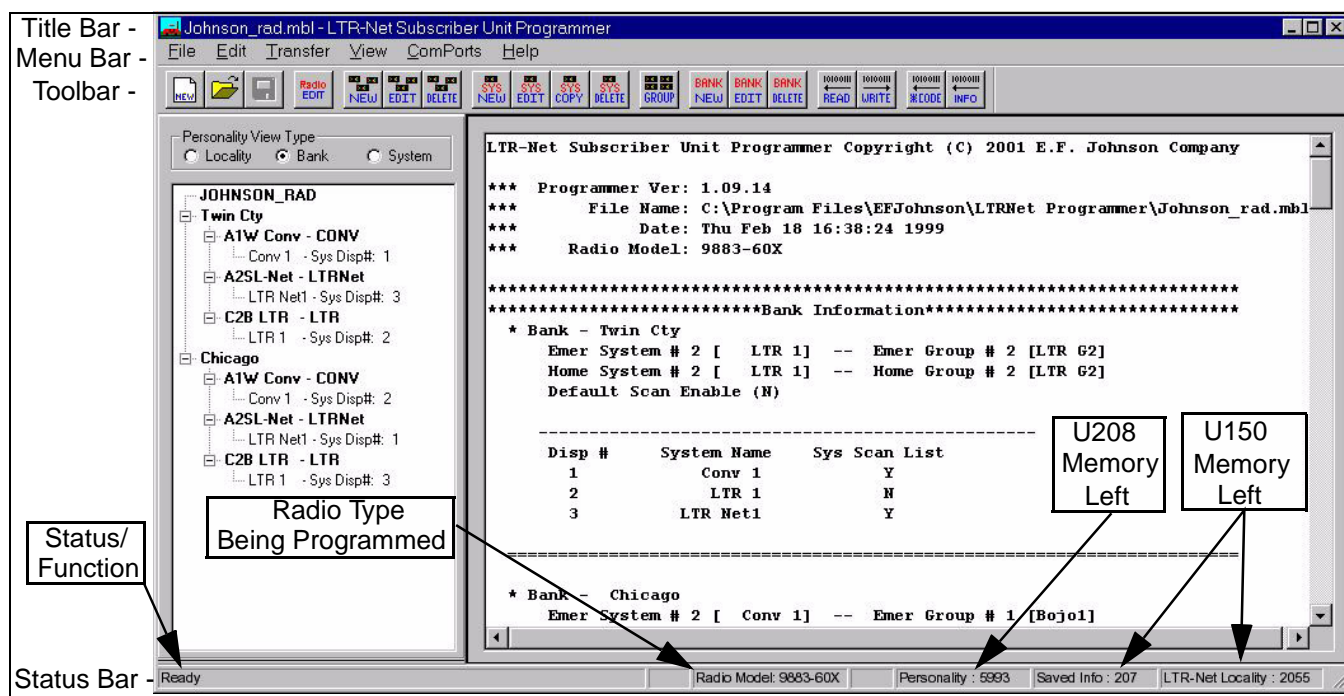
Figure 3-2 Main Window

1. Select Edit > Radio Type and the displayed screen selects the Type, Tier, Frequency Band, and Bandwidth of the programming file (Section 3.6.2).

2. Select Edit > Basic Radio Params (Parameters) or click [Radio EDIT] to display the following screens which program other radio-wide parameters:

   Basic Parameters - Select this screen by clicking the tab at the top, and choose the desired configuration for each parameter (Section 3.6.3).

   Timing Parameters - Select this screen by clicking the tab at the top, and choose the desired configuration for each parameter (Section 3.6.4).

   Menu Parameters - Select this screen by clicking the tab at the top. Checking the box enables the parameter in the menu mode, and the drop down menu programs the default configuration (Section 3.6.5).

   Portable Key - Select this screen by clicking the tab at the top and then choose the function for each key from the drop-down menu (Section 3.6.6).

   Telephone Numbers - Select this screen by clicking the tab at the top and then enter the preprogrammed telephone numbers. (Section 3.6.7).

3. When all parameters in the Radio Parameters Screens are programmed, click the OK button to save all changes or the Cancel button to exit without saving changes.

3.4.4 LOCALITY PROGRAMMING

In general, a locality is a repeater site. At least one Locality must be programmed before any Systems can be programmed, and at least one System must be programmed before a Group can be programmed and likewise for banks. Proceed as follows to program localities (Section 3.6.8):

Create New Locality - Select Edit > Localities > Create New or click [NEW] in the toolbar.

NOTE: The frequency band is selected in the radio type screen.

Edit Locality - Select Edit > Localities > Edit Existing or click [EDIT] in the toolbar.

Delete Locality - Select Edit > Localities > Delete Locality or click [DELETE] in the toolbar.

When all parameters in the Locality screen are programmed, click the OK button to save all changes

and exit, or click the Cancel button to exit without saving any changes.

3.4.5 SYSTEM PROGRAMMING

Each system is linked to one of the localities. Therefore, at least one locality must be created as just described before systems can be created. Groups are added to the systems by group programming described next. Proceed as follows (Section 3.6.9):

Create New System - Select Edit > Systems > Create New or click ⬚ in the toolbar.

Copy System - To copy a system that is already created for use as a basis in programming another, select Edit > Systems > Copy Existing or click ⬚ in the toolbar.

Delete System - Select Edit > Systems > Delete or click ⬚ in the toolbar.

When all parameters in the System screen are programmed, click the OK button to save the changes and exit, or click the Cancel button to exit without saving any changes. Repeat this procedure to add additional systems.

3.4.6 GROUP PROGRAMMING

Each group is linked to one of the systems. Therefore, at least one system must be created as just described before groups can be created. Groups program individual call parameters. Proceed as follows (Section 3.6.10):

1. To create a new group or edit a group, select Edit > Groups or click ⬚ in the toolbar.

2. A screen is then displayed which lists all current systems. Select the system to which a group is be added or in which a group is to be edited. Click the OK button to display the groups in that system.

3. In the Group No. box, select the number or the group to be added, edited, or deleted.

4. Program the group with the desired parameters.

5. Click the Add button if adding a new group, the Change button if editing a group, or the Delete

button if deleting a group. To exit without saving the current changes, click only the Done button.

6. Repeat until the system has been programmed with the desired groups. Then click the Done button to exit. Repeat to program other systems if applicable.

3.4.7 BANK PROGRAMMING

At least one locality, system, and group must be programmed before a bank can be programmed. Banks are collections of systems that may be selected for a unique application such as operation in different geographical areas. System numbering and other parameters can be different for each bank. At least one bank must always be programmed even if bank select is not used.

1. Create, Edit, or Delete a bank as follows:

Create a New Bank - Select Edit > Banks > Create New or click ⬚ in the toolbar.

Edit Bank - Select Edit > Banks > Edit Existing or click ⬚ in the toolbar.

Delete Bank - Select Edit > Banks > Delete or click ⬚ in the toolbar.

2. When the bank programming screen is displayed, select the display number of the system to be added, edited, or deleted. Then select the system to be assigned to that number if applicable. Also program default scan list status of the system and other bank information such as alpha tag and emergency and home system/group if applicable.

3. To make the selected changes to the system, click the Add, Change, or Delete button, whichever is applicable. To add, edit, or delete other systems, repeat this procedure. When finished programming the bank, click the Done button, or to exit without making any changes, click the Cancel button.

3.4.8 PROGRAMMING TRANSCEIVER

When all the programming described in the preceding sections is complete, the data is ready to be downloaded to the transceiver as follows:

1. Connect the computer to the transceiver as described in Section 3.1.6.

2. Download the data to the transceiver by selecting Transfer > Write Setup Params or click [icon] in the toolbar.

3. Click the Write button in the screen that is displayed. Messages and the data are displayed as programming occurs. Refer to Section 3.7 for more information.

3.5 FILE MENU
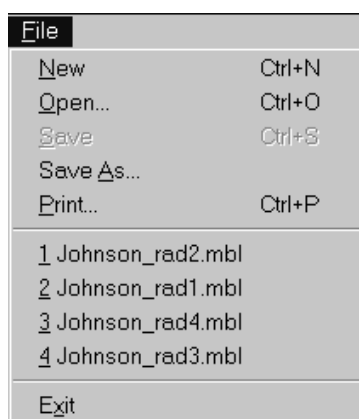
The File Menu shown in the preceding illustration is used to perform these file operations:

New - This menu parameter or toolbar icon creates a new programming data file that contains default parameters. If a file with unsaved changes is currently open, you are asked if you would like to save it before opening the new file. New files are automatically named "Untitled".

Open - This menu parameter or toolbar icon opens a data file that was previously saved to disk. This allows a disk file to be edited or used as a basis for programming another transceiver. If a file with unsaved changes is currently open, you are asked if you would like to save it before opening the new file. This function displays a screen listing all the files in the current directory with the .mbl extension.

Save - This menu parameter or toolbar icon saves the current programming data file to disk. If it is the first time it is being saved, a screen is displayed which allows a file name to be entered (similar to the Save As function which follows). The Save function

should be used periodically while editing a file to prevent the loss of data if a power failure occurs or program execution is interrupted for some other reason. Files are automatically given the .mbl extension.

Save As - Same as "Save" except you are prompted to enter a file name. This allows the current file to be renamed and saved to a new file.

Print - This menu selection or shortcut key (Ctrl+P) prints the current file. The information in the current file is displayed in the Data Display Pane of the main window. This information can also be saved to a text file by selecting it and then copying (Ctrl C) and pasting (Ctrl V) it to a word processor program.

Recent Files - The file names of the previous files opened by the program are listed. To open one of these files, simply click the name.

Exit - Closes the program. If the current file has unsaved changes, you are asked if you would like to save it before exiting.

3.6 EDIT MENU

3.6.1 INTRODUCTION

The Edit Menu shown in Figure 3-3 or equivalent buttons in the toolbar select screens that program various transceiver functions. The following information describes the screens selected by the Edit Menu.
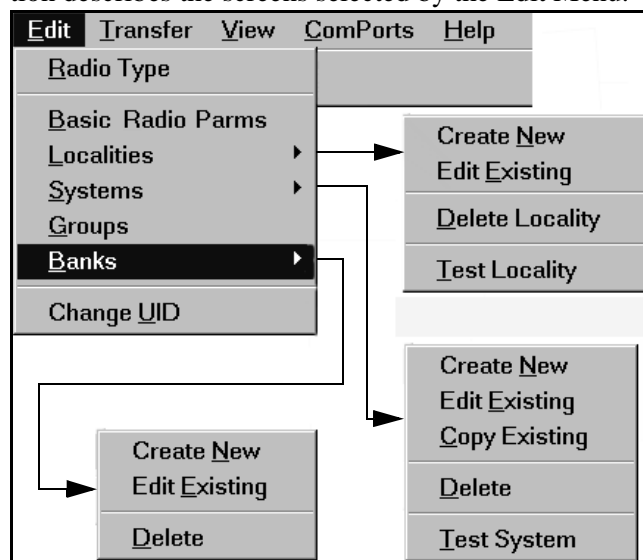
Figure 3-3   Edit Menu

3.6.2 EDIT RADIO TYPE SCREEN

The Radio Type screen shown below selects the type, tier, frequency band, and bandwidth parameters of the programming file. This must match the radio being programmed. If you are unsure of the capabilities of a radio, note the model number on the transceiver identification label or the number that is briefly displayed when power is turned on. Then refer to Sections 1.3 or 1.4 to determine radio type information
.
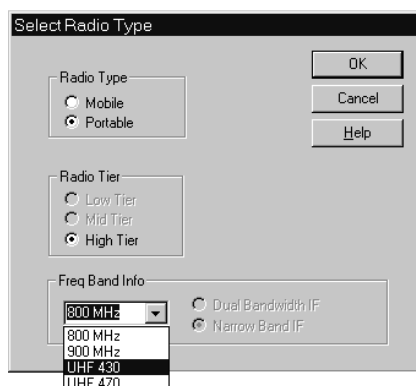
Edit Radio Type Screen

NOTE: The screens described in Sections 3.6.3 - 3.6.6 which follow are displayed by selecting Edit > Basic Mobile Parms or clicking [Radio EDIT] *and then clicking the tab at the top.*

3.6.3 BASIC PARAMETERS SCREEN
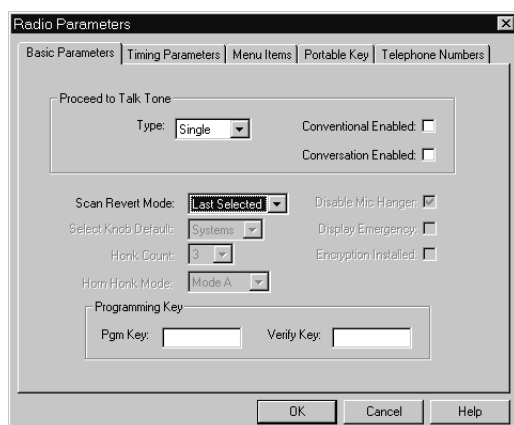
Proceed-To-Talk Tone

Type - Selects either a single (standard) or distinctive (triple) proceed-to-talk tone (Section 2.4.9).

Conventional Enabled - When selected, the proceed tone sounds with conventional calls in addition to LTR-Net/LTR standard calls.

Conversation Enabled - When selected, the proceed tone also sounds with LTR-Net/LTR telephone and auxiliary calls (initial access only).

Scan Revert Mode - Selects the system/group on which transmissions occur in the scan mode (Section 2.6.10).

Last Selected - Always on the selected.
Last Received - Always on the last received.
Temporary - On the last received if the transmitter is keyed before scanning resumes.

Display Emergency - Currently, this parameter is not used.

Encryption Installed - Encryption is currently not available.

Pgm (Program) Key - To prevent unauthorized reading of programming data from a transceiver, a code consisting of up to eight keyboard characters can be entered in this box. If this box is left blank, no protection is used (Section 3.11.1).

Verify Key - The exact code entered in the Pgm Key box must be re-entered in this box for it to be accepted as valid code.

3.6.4 TIMING PARAMETERS SCREEN
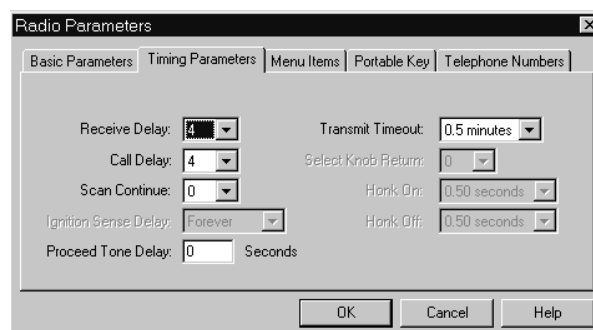
Receive Delay - Selects the time from 0-7 seconds before scanning resumes after receiving a message (Section 2.6.9).

Call Delay - Selects the time from 0-7 seconds before scanning resumes after transmitting a message (Section 2.6.9).

Scan Continue - Selects the maximum time from 0-60 seconds that a call is monitored before scanning resumes (Section 2.6.9).

Proceed Tone Delay - Programs how long the proceed tone is delayed after the PTT switch is pressed on groups that have the delayed proceed tone feature enabled. Times of 0-2.5 seconds can be programmed (Section 2.4.9).

Transmit Time-Out - Programs the time-out timer (Section 2.4.11).

3.6.5 MENU ITEMS SCREEN
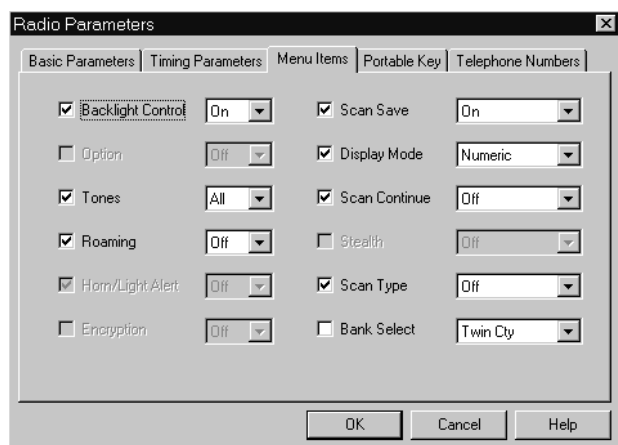
The Menu Items screen shown above programs the parameters that are selectable in the menu mode. It also programs the default status of parameters not controlled by the menu mode or an option switch. Some functions can be controlled by both an option switch and the menu mode.

If a function is programmed as not selectable (no check in the check box), it is fixed in the condition selected in the drop-down list. For example, if "Tones" is not checked and "All" is selected, the Tones menu parameter is not selectable and all tones always sound.

If a menu item is selectable by the menu mode or an option switch, the default condition exists only until the first time that function is changed manually or automatically. The last selected and not the default

condition is selected when power is turned on. Refer to Section 2.5.2 for more menu mode information, and to Table 3-1 for brief descriptions of items programmed in the Menu Items screen.

3.6.6 KEY ASSIGNMENT SCREEN

The Key Assignment screen shown above programs the three option switches. To program a switch, select the desired function from the drop-down list for that switch. When finished, click the OK button to exit and save the changes or Cancel to exit without saving.

All functions that are selectable by the keypad (except 0-9) can also be assigned to an option switch to allow them to be quickly selected. For example, scanning could be turned on and off by pressing FCN SCAN or the option switch on the top panel (FCN is not pressed when the option switch is used). The option switch functions that can be programmed are listed in Table 3-1.

3.6.7 EDIT TELEPHONE NUMBERS SCREEN

The Telephone Numbers screen which follows pre-programs up to 10 telephone numbers that can be recalled from memory using the dial mode. If the box to the right of the number is checked, it can be repro-

grammed by the user. Numbers of up to 16 digits can be entered, and entering a "@" produces a 1-second pause (each "@" counts as one of the 16 characters).

Telephone Numbers Screen

3.6.8 EDIT LOCALITY SCREEN

The Edit > Localities menu parameter (see Figure 3-3) or equivalent buttons in the toolbar are used to select the screen that sets up and edits localities. As

described in Section 2.3.12, a locality is a single repeater site, and it is programmed with the repeaters at that site. Up to approximately 25 LTR-Net or 60 LTR or conventional localities can be programmed. The functions that can be selected by Edit > Localities menu are as follows:

Edit > Localities > Create New - Creates a new locality. The screen that is displayed and its parameters are described in Table 3-2. The frequency band is selected on the radio type screen (see Section 3.6.2).

Edit > Localities > Edit Existing - Edits a current locality. The locality to be edited is selected from a list. The screen that is displayed and its parameters are described in Table 3-2.

Edit > Localities > Delete Locality - Deletes a locality.

Edit > Localities > Test Locality - Creates a locality that is used for test purposes. Currently, test localities are not used.

Table 3-1   Menu and Option Switch Parameter Descriptions

Parameter	Menu Item	Option Switch [1]	Description
Backlight	X		On = Turns on briefly when a key is pressed, Off = Always disabled.
Bank Select	X		Selects banks when two or more are programmed (Section 2.4.1).
Display Mode Select	X	X	Selects the alpha or numeric display mode. The display mode can also be toggled by FCN STR or STR option switch (Section 2.3.4).
Monitor		X	Turns the monitor mode on and off (Section 2.11.2).
Roaming On-Off	X		Turns roaming on and off (Section 2.9.4).
Scan Type Select	X		Selects group, system/group, or no scanning (Section 2.6.3).
Scan Continue	X		Turns the scan continue feature on and off. This timer limits the amount of time a message is received while scanning (Section 2.6.9).
Scan List Save	X		When "on" is selected, changes to the scan list are saved (Section 2.6.7).
Tone Type Select	X		Selects the tones that sound (All, Alert, Key, Silent). See Section 2.4.12.
Any Keypad Function except 0-9		[1]	Programmable Functions: FCN, Scan, SYS, RCL, GRP, CLR, Home, Phone, Dial, Menu, Squelch Adj., S.A/D, G.A/D, Send, Store, ✱, #, ◀ , ▶ , and Monitor.
[1] The option switches can also be programmed for any of the functions that are selectable by the keypad keys except 0-9. For example, scanning can be turned on and off by the FCN SCAN keys and by an option switch programmed for the Scan function. (The FCN key is not pressed when the alternate function of a key is selected by an option switch.)			

3.6.9 EDIT SYSTEM SCREEN

The Edit > Systems menu parameter (see Figure 3-3) or equivalent buttons in the toolbar select the screen that sets up and edits systems. As described in Section 2.3.12, a system is programmed with one or more selectable groups and other unique information. Up to 99 systems can be programmed. Groups are added to systems using the group edit function described in the next section. For a system to be selected or scanned, it must be linked to a bank (Section 3.6.11).

The system programming functions that can be selected by the Edit > Systems menu are as follows:

Edit > Systems > Create New - Creates a new system. The screen that is displayed is described in Table 3-3.

Edit > Systems > Edit Existing - Edits a current system. The system to be edited is selected from a list. The screen that is displayed is described in Table 3-3.

Edit > Systems > Copy Existing - Creates a new system by copying one of the current systems. The system to be copied is selected from a list. The screen that is displayed is described in Table 3-3.

Edit > Systems > Delete - Deletes a system.

Edit > Systems > Test System - Currently, test systems are not used.

3.6.10 EDIT GROUPS SCREEN

NOTE: Refer to Table 3-4 for descriptions of the Edit Group screens.

The Edit > Groups menu parameter (see Figure 3-3) or button in the toolbar is used to display the screens that set up and edit the groups assigned to each system. The following screen is displayed to select the system in which groups are to be added or edited. After the desired system is selected, click the OK button and the group editing screen in Table 3-4 is displayed. Up to 99 groups can be assigned to each system or to any one locality.
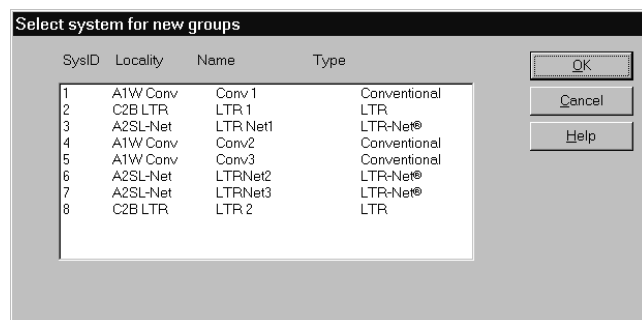
3.6.11 EDIT BANKS SCREEN

The Edit > Banks menu parameter (see Figure 3-3) or equivalent buttons in the toolbar are used to select the screen that sets up and edits banks. As described in Section 3.4.7, banks are collections of systems that may be selected, for example, for operation in different geographical areas.

Up to sixteen banks can be programmed. System numbering and other parameters can be different for each bank. At least one bank must be programmed even if bank select is not used. The functions that can be selected by the Edit > Banks menu are as follows:

Edit > Banks > Create New - Creates a new bank. The screen that is displayed is described in Table 3-5.

Edit > Banks > Edit Existing - Edits a current bank. The bank to be edited is selected from a list. The screen that is then displayed is described in Table 3-5.

Edit > Banks > Delete - Deletes a bank.

3.6.12 EDIT UNIQUE ID SCREEN

This function displays a screen that can be used to edit the transceiver unique ID codes assigned to each LTR-Net locality. This makes unique ID editing more convenient than selecting each locality individually.

3.7 TRANSFER MENU

The Transfer menu which follows is used to Read (upload) data from the transceiver to the computer and also to Write (download) data from the computer to the transceiver. It is also used to read error information and version information stored in the transceiver. More information follows:
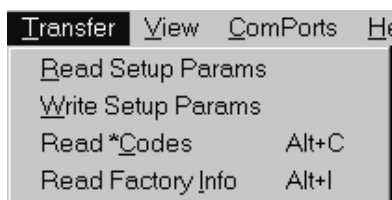
Read Setup Params - Reads the data contained in a transceiver. This function can be used to check transceiver programming or use the data in one transceiver as the basis for programming another. Proceed as follows:

1. Connect the transceiver to the computer using the RPI as described in Section 3.1.6.

2. Select Transfer > Read Setup Params or click the toolbar button.

3. A screen is then displayed which indicates the progress of the read operation.

4. If the transceiver contains a Program Key, you are prompted to enter this key before the data is read. Refer to Section 3.11.1 for more information.

Write Setup Params - Programs a transceiver with the data that has been entered in the program. Proceed as follows:

1. Connect the transceiver to the computer using the RPI as described in Section 3.1.6.

2. Select Transfer > Write Setup Params or click the toolbar button.

3. A screen is then displayed which indicates the progress of the write operation.

4. The following messages may be displayed by the transceiver:

PGM MODE - Standard message while programming is occurring.

TYPE ERR - Indicates that the programming data is incompatible with the transceiver. A possible reason for this is using a version of the programming software that is not compatible with the transceiver software.

PROG ERR - Indicates that an error was detected when verifying the data programmed into the transceiver.

Read Codes - This menu item or toolbar button reads the error code log stored in the radio and displays it. Refer to Section 2.14 for more information.

Read Factory Info - This menu item or toolbar button displays the following screen and version information for the transceiver connected to the computer:

ESN - Indicates the electronic serial number of the transceiver that is stored in the logic.

Warranty Info - This is the transceiver identification number described in Section 1.4.

Radio Config - These are digits 4-10 of the transceiver part number described in Section 1.3.

Software Version - Indicates the version of operating software contained in the radio.

3.8 VIEW MENU

This View menu is shown above, and it is used to enable and disable portions of the main screen shown in Figure 3-2. More information follows:

View Toolbar - Enables and disables the toolbar (see Section 3.3.3).

View Status Bar - Enables and disables the status bar at the bottom of the screen (see Section 3.3.5).

View Personality - Enables or disables the left pane in the main part of the screen which displays the current programming information in a Locality, Bank, or System hierarchy (see Section 3.3.4).

3.9 COMPORTS MENU
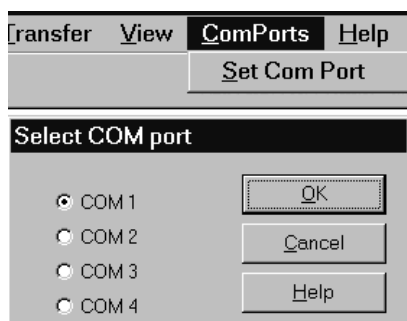
The ComPorts menu is shown above, and it is used to select which computer serial port is used by the RPI (see Section 3.1.3). The default is COM 1. If another port is used, select it using this function. The new port then becomes the default port, so this function only needs to be used when the port is changed.

3.10 HELP MENU

Displays help information on the program. Most screens also have a Help button that can be clicked to display help on that screen.

3.11 ADDITIONAL PROGRAMMING INFORMATION

3.11.1 PROGRAM KEY

An eight-character Programming Key can be entered in the Basic Parameters screen (see Section 3.6.3) to prevent unauthorized reading of transceiver data. If a transceiver is programmed with a data file containing a key in this location, the programming data cannot be read from that transceiver unless the same key is entered.

Any keyboard character can be used when entering this key (including spaces), and letter case is considered. For example, entering "A" instead of "a" that was programmed results in an invalid entry. Characters entered are displayed as asterisks (****). A key must be re-entered in the Verify box to be accepted.

To disable this feature so that no key is required to read data from the transceiver, do not enter any characters in the Pgm Key box, or if there already is a code in this box, delete all characters. Then program the transceiver with the data file. If the key is lost, contact Customer Service as described in Section 1.7 for information on how this feature can be overridden.

3.11.2 MULTIPLE HOME REPEATERS

Systems linked to the same locality should not be programmed with different home repeaters as missed calls may result. With LTR-Net and LTR operation, each home repeater transmits incoming call information only for its mobiles and not for all mobiles assigned to the locality. Therefore, calls on another home repeater are not received while monitoring some other home repeater. In addition, calls will be delayed and access collisions will occur more often.

If this type of system is necessary, select the LTR-Net Multiple Home type of locality. This forces the radio to monitor the status repeater instead of the home repeater. Since the status repeater transmits incoming call information for all home repeaters assigned to a locality, this ensures that calls are not missed. However, there is then no backup for that repeater (see Section 6.6).

3.11.3 CHANNEL NUMBER PROGRAMMING

In the UHF band, the channel frequencies are always entered and channel numbers are not used. Therefore, the "channel" display mode is not selectable on the locality screen.

Be sure to enter the repeater frequency and not the mobile frequency. The bandwidth of 12.5 or 25 kHz is also specified with UHF channels. The frequency band is selected in the Radio Type screen before any localities are programmed (see Section 3.6.2).

3.11.4 REPEATER NUMBERING

With LTR-Net and LTR repeaters, the repeaters at a locality are assigned a unique number from 1-20. Although these numbers can be assigned arbitrarily, 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 be numbered 1, 5, 10, 15, and 20. These numbers are programmed in the repeater and also each mobile locality (see Section 3.6.8).

If Home Channel Aliasing is used (see Section 2.9.7), the status repeater should be repeater 20 and repeater 1 should be an active repeater. The other repeaters should then be spaced evenly from 1-20.

3.11.5 SPECIFYING RIC-EQUIPPED REPEATERS

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

Without this feature, the transceiver may trunk to a repeater not equipped with an interconnect controller when a telephone 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.

3.11.6 TEST LOCALITY

Currently, the test locality programmed by Edit > Locality > Test Locality as described in Section 3.6.8 is not used. The sixteen channels programmed in this locality are selected by the test mode which is also currently not available (see Section 2.13).

3.12 UPDATING RADIO SOFTWARE

3.12.1 INTRODUCTION

The transceiver operating software (firmware) can be updated in the field without replacing the

microcontroller or a memory device such as an EPROM. For example, the radio software may be updated to correct software bugs or add feature enhancements. This is possible because a reprogrammable Flash memory device is used for program storage.

The same basic hardware setup used to program personality information is also used to update radio software. One requirement though is that only Remote Programming Interface (RPI), Part No. 023-9800-000, can be used. Other RPI's such as the 023-9750-000, 023-5810-000, and 023-5300-000 do not work.

Programming is performed using separate PCFlash programming software. The program requires a special data file which contains the updated radio software (see next section). Refer to Section 5.2 for more information on loading new operating code.

3.12.2 DATA FILE

To update the radio software, the data file containing the new radio software is required. The filename of this data file is 00342xx0.S19. The "xx" characters indicate the version number of the software.

Contact your Customer Service or your sales representative concerning the availability of a software update for this transceiver. It may be available on a CD with the PCFlash software (see Table 1-1) or on the E.F. Johnson ACES® Bulletin Board System for downloading. To access this system, dial toll-free 1-800-227-3997 (N, 8, 1, ANSI).

If you do not know your login ID or have questions or would like to sign up for service on this system, call 1-800-328-3911, extension 7. Once the data file is obtained, it must be copied to the directory containing the program.

Table 3-2   Locality Programming Screen Description

This screen is used to create a new locality or edit a current locality. It is displayed by selecting the Edit > Localities menu (see Section 3.6.8) or clicking one of the ![EDIT] buttons in the toolbar. In general, a locality is a repeater site.

Parameter	Description
Locality Name	This is an eight-character name given to the locality to identify it during programming. It is not displayed by the transceiver.
Number	The number from 1-1023 assigned to LTR-Net localities. Each LTR-Net locality that a mobile can access must have a different locality number, and the same scheme must be used to program the mobiles and repeaters.
Type	Selects the type of locality (LTR-Net, LTR-Net Multiple Home, LTR, or Conventional) when new localities are created (see Section 3.11.2).
Band	The frequency band in which the locality operates. The frequency band selected when the first locality is created or before any localities are created by the Radio Type screen (see Section 3.6.2). Once a locality is created, the band cannot be changed.
UID	With LTR-Net localities, programs the unique ID of the mobile when it accesses that locality. Numbers from 1-65503 can be programmed.
Area	"0" is usually programmed unless two LTR or LTR-Net localities are close enough to interfere with each other. One locality is then programmed "0" and the other "1".
Rx/Tx Base Frequency	This is a non-editable field shown for reference only. It indicates the base receive and transmit frequency used to derive the frequency of each channel.
Power	Programs the power output that is selected when the transceiver accesses that locality. High (4 watts) or low (1 watt) levels can be selected (Section 2.4.8).
Dropout Percentage	Programs the percentage that the squelch is tightened when no call is occurring. The higher the percentage, the sooner automatic locality search occurs. The default value is 33%. If there is no other site nearby, this percentage should always be 0% (Section 2.9.4).
Capture Percentage	Programs the percentage that the squelch is tightened after the first pass when searching for a new site ("LCL SRCH" displayed). The higher the percentage, the stronger the signal must be in order to attempt registration on a site. This parameter should always be greater than or equal to the preceding Dropout Percentage. The default value is 46% (Section 2.9.4).
Tight Capture Percentage	Programs the percentage squelch is tightened during the first pass when searching for a new site ("HSQ SRCH" displayed). The higher the percentage, the stronger the signal must be in order to attempt registration on a site. This parameter should always be greater than or equal to the preceding Capture Percentage. The default value is 80% (Section 2.9.4).

Table 3-2 Locality Programming Screen Description (Continued)

Parameter	Description
Display Mode	Selects if repeater frequencies are entered as programming Channel numbers or channel Frequencies. With the UHF band, only channel frequencies can be used, so "Channel" is not selectable.
Frequency	Programs the frequency of each repeater at the locality (Section 3.11.3). *Note that repeater frequencies are entered, not mobile frequencies.*
Bandwidth	Either 12.5 kHz (narrow band) or 25 kHz (wideband) can be selected for each repeater. Then when the transceiver accesses that repeater, it is automatically configured for the proper bandwidth.
Status	With LTR-Net operation only, one of the locality repeaters is designated as the status repeater.
Active	Only repeaters marked as active can be accessed by the transceiver.
Companding	Programs if the repeater is equipped with a compandor. Companding is then automatically enabled whenever that repeater is accessed (Section 2.4.3).
RIC	With LTR operation only, programs if the repeater is equipped with a RIC/TIC (interconnect) module. This prevents attempted accesses on non-RIC repeaters to make telephone calls (Section 3.11.5).

Table 3-3 System Programming Screen Description
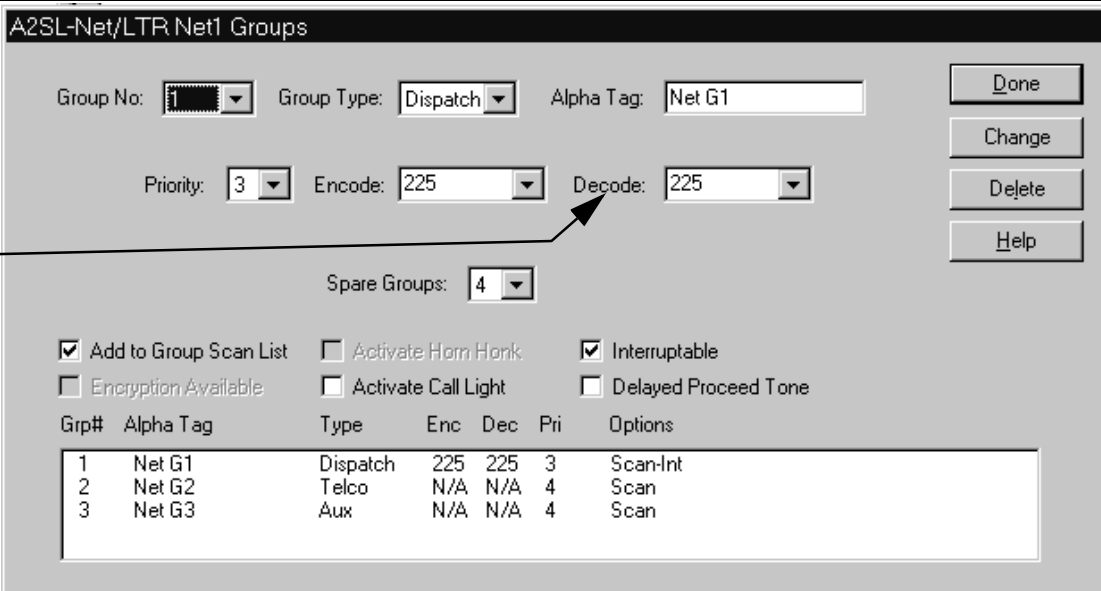
This screen is used to create a new system or edit a current system. It is displayed by selecting the Edit > Systems menu (see Section 3.6.9) or clicking one of the buttons in the toolbar. Groups are added using the Edit > Groups function. For a system to be selected or scanned, it must be linked to a bank using the bank programming screen described in Table 3-5.

Parameter	Description
System Name	This is an eight-character name given to the system. It is displayed briefly if the alpha display mode is selected (Section 2.3.4). Otherwise, it is used only to identify it during programming.
Locality ID	This drop-down list selects the locality to which the system is linked.
Home	Selects the home repeater when the system is linked to an LTR or LTR-Net locality, or the repeater number when it is linked to a conventional locality.
Transmit Inhibit	With LTR-Net and LTR systems, selects the block of transmit inhibit ID codes up to all 250 (LTR localities) or 239 (LTR-Net localities). If an ID within this block is detected up to 5 seconds before the PTT switch is pressed, the transmitter does not key (Section 2.8.4).

Table 3-4   Group Programming Screen Description

This screen is used to add groups to a system or edit groups already assigned to a system. It is displayed by selecting the Edit > Groups menu or clicking the 🔳 button in the toolbar (see Section 3.6.10). In the following screens, first select the Group No. to be added or edited from the drop-down list or the list at the bottom. Then select the desired parameters and make the changes by clicking the Change button (this is an Add button if adding a Group). To delete a group, select the Group No. and then click the Delete button. When finished programming the system, click the Done button.

LTR and LTR-Net Group Programming Screen

RIC ID
(if LTR and
RIC group
type
selected)

Parameter	Description
Group No.	This drop-down list selects the group to be added or edited in the screen.
Group Type	This drop-down list selects one of the following call types: **LTR-Net Systems -** Dispatch (standard group call), Telco (telephone call), Auxiliary (unique ID or directed group call). Data calls are not currently available. See Sections 2.8.1 and 2.9.2. **LTR Systems -** Dispatch (standard group call), RIC (telephone call). See Sections 2.8.1 and 2.10.2.
Alpha Tag	This specifies the eight-character alpha tag that is displayed when the group is selected.
Priority	Selects the receive priority of the group. Priority numbers of 1-8 are selectable with LTR-Net and LTR groups (Section 2.8.2).
Encode ID	With dispatch (group) calls, selects the ID code that is transmitted. Codes 1-239 can be programmed with LTR-Net systems, and 1-250 can be programmed with LTR systems (Section 2.8.1). When "Disabled" is selected, transmitting is disabled, so the group is receive only.
Decode ID	Similar to Encode ID except selects the receive code that must be decoded to receive a call on the group.
RIC ID	With LTR RIC group types only, selects the ID code on which a telephone call is received (Section 2.10.2).
Spare Groups	With LTR-Net systems only, selects the number of additional groups that can be added to the system by over-the-air programming. This reserves space in memory so additional groups can be added. Space for 0-8 groups can be reserved. Currently, over-the-air programming is not available, so this value should always be "0".
Add to Grp Scan List	Selects the default scan list status of the group. This programming can be overridden by the scan list A/D key if available (Section 2.6.7).
Encryption Available	Encryption is currently not available.
Activate Call Light	Selects if the call indicator is activated when a call is received on the group (Section 2.4.2).
Interruptible	Selects if calls on the group can be interrupted by higher priority calls (Section 2.8.2).
Delayed Proceed Tone	Selects if the proceed tone is delayed by the time programmed on the Timing Parameters screen when a call is placed on the group (Section 2.4.9).

Table 3-4   Group Programming Screen Description (Continued)
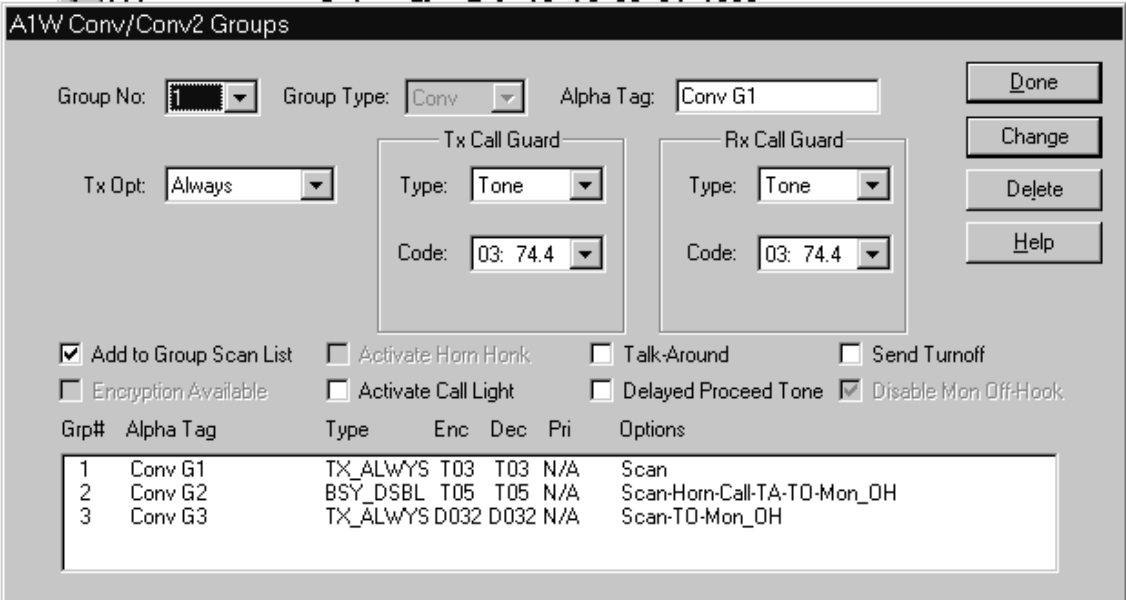
Conventional Group Programming Screen

Parameter	Description
Group Number	This drop-down list selects the group to be added or edited in the screen.
Alpha Tag	This specifies the eight-character alpha tag that is displayed when the group is selected.
Tx Option	**Always** = Tx enabled, TDOB (Transmit Disable On Busy) disabled **Disable Busy** = Tx and TDOB enabled, no transmit with carrier even with valid Call Guard **On Valid CG** = Tx and TDOB enabled, transmit with carrier allowed only with valid Call Guard **Disabled** = Tx disabled (receive-only channel). See Sections 2.4.10 and 2.11.3.
Tx Call Guard Type	Selects the type of transmit Call Guard squelch control as Tone (CTCSS), digital (DCS), inverted digital, or none (carrier). See Section 2.11.6.
Tx Call Guard Code	If tone or digital encode Call Guard squelch was selected above, selects the tone frequency or digital code that is transmitted. These tones and codes are listed in Table 3-6.
Rx Call Guard Type	Selects the type of receive Call Guard squelch control as Tone (CTCSS), digital (DCS), inverted digital, or none (carrier). See Section 2.11.6.
Rx Call Guard Code	If tone or digital decode Call Guard squelch was selected above, selects the tone frequency or digital code that must be decoded to receive a call. These tones and codes are also listed in Table 3-6.
Add to Grp Scan List	Selects the default scan list status of the group. This programming can be overridden by the scan list A/D key if available (Section 2.6.7).
Encryption Available	Encryption is currently not available.
Activate Call Light	Selects if the call indicator is activated when a call is received on the group (Section 2.4.2).
Talk-Around	Selects if the talk-around mode is selected when transmissions are made on the group (Section 2.11.5).
Delayed Proceed Tone	Selects if the proceed tone is delayed by the time programmed on the Timing Parameters screen when a call is placed on the group (Section 2.4.9).
Send Turn-off	Selects if the Call Guard turn-off code is sent when the PTT switch is released (Section 2.11.6).

Table 3-5   Bank Programming Screen Description

This screen is used to create a new bank or edit a current bank. It is displayed by selecting the Edit > Banks menu (see Section 3.6.11) or clicking one of the [BANK EDIT] buttons in the toolbar. In the above screen, select the number of the system to be added or edited in the System Display No. drop-down list and then select the desired parameters. Then make the changes by clicking the Change button (this is an Add button if adding a system). To delete a system from the bank, select it from the drop-down list or in the list at the bottom of the screen and then click the Delete button. When finished programming the bank, click the Done button or click Cancel to exit without saving any changes. At least one bank must be programmed even if bank select is not used.

Parameter	Description
Bank Name	This is an eight-character name given to the bank. It is displayed when banks are selected (Section 2.4.1). Otherwise, it is used only to identify it during programming.
Emergency System/Grp	The emergency switch is not available with this transceiver.
Home System/Grp	Selects the home system/group selected by the Home select function on the bank (Section 2.4.6).
Bank Scan Enable	Programs the default scan status (on or off) when the bank is selected (Section 2.4.1).
System Display No.	Systems can be assigned unique display numbers in each bank. This drop-down list selects the number that is displayed when the system is selected in the bank.
System	This is a drop-down list of all currently programmed systems that selects the system being added to the bank or edited. Systems can also be selected by clicking them in the list at the bottom of the screen.
Add To Scan List	Selects the default scan list status of the selected system in the bank. This status is valid only until the first time it is changed by the FCN S.A/D switch. Cycling power does not reselect the default status (Section 2.6.7).
Change/Add Button	This is a Change button when editing a system and an Add button when adding a system. It is clicked to make the changes to the selected system.
Delete Button	Deletes the currently selected system from the bank.

Table 3-5   Bank Programming Screen Description (Continued)

Parameter	Description
Done Button	Click this button when finished editing the bank to save the changes.
Cancel Button	Click this button to exit the screen without saving any changes to the bank.
Default Bank Button	A default bank can be programmed in the Menu Items screen (Section 3.6.5). Clicking this button assigns the current bank as the default without having to select that screen. One use of default banks is when the Bank menu parameter is disabled. Several banks can then be programmed and the desired bank can be selectively enabled on a per transceiver basis. This button is displayed only if two or more banks are programmed and the selected bank is not already the default.

Table 3-6   Call Guard Codes and Tones

Recommended Tone Call Guard Codes									
Code	**Freq**	**Code**	**Freq**	**Code**	**Freq**	**Code**	**Freq**	**Code**	**Freq**
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		
09	91.5	18	123.0	27	167.9	36*	233.6		
* These tones normally are not used because of their close proximity to the voice frequencies. ** 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	

SECTION 4   CIRCUIT DESCRIPTION

NOTE: A block diagram of the RF and logic boards is located on page 8-8.

4.1 POWER SWITCHING AND REGULATION

4.1.1 POWER SWITCHING

Unswitched battery voltage is applied to the RF power amplifier and power control stages on the RF board. Otherwise, all power is switched by P-channel MOSFETs Q205 and Q206 on the audio/logic board. When the on-off switch is turned on, the SW BAT supply is applied to switching transistor Q206. That transistor then turns on and pulls the gates of Q205A and Q205B low. This turns Q205A and Q205B on and applies switched 7.5 volts to 5-volt regulators U205 and U206 and other parts of the transceiver.

When the power switch is turned off, the base of Q206 is pulled low by R226 which turns Q206 off. However, because of diode D201, Q205A and Q205B do not turn off until C233 charges through R221. This provides a slight turn-off delay to give the microprocessor time to take over power off control. The microprocessor immediately detects power turn off from the signal on pin 32. It then changes the P_HOLD output on pin 71 to a high level which turns Q206 again on until current settings have been saved to memory and other required power down functions have been performed.

4.1.2 FIVE-VOLT REGULATORS (U205, U206)

Regulator U206 in the logic unit provides the L5V logic supply, and regulator U205 provides the +5V supply. The +5V supply is in turn switched by Q202-Q204 to provide the R5V, T5V, and +5S supplies. These transistors are controlled by signals from the microprocessor.

The low battery detect signal is provided by a voltage divider formed by R237 and R238. These resistors divide down the 7.5V battery supply to produce the signal that is applied to pin 95 of the microprocessor.

Regulator U601 on the RF board provides the C5V supply, and regulator U602 provides the T5V and R5V supply. The T5V supply is enabled when the DPTT (delayed PTT) signal goes low, and the R5V supply is enabled when it goes high. The DPTT signal is from pin 85 of the microprocessor, and it also controls R5V supply switch Q204 on the audio/logic board.

4.2 SYNTHESIZER DESCRIPTION

4.2.1 INTRODUCTION

The synthesizer output signal is produced separate receive and transmit VCOs on the RF board. The frequency of these VCOs is controlled by a DC voltage produced by the phase detector in synthesizer chip U202. The phase detector senses the phase and frequency of the two input signals. One signal is the reference frequency from TCXO U201, and the other is from the VCO. If these signals are not the same frequency, the phase detector changes the VCO control voltage which changes the VCO frequency until both signals are synchronized. The VCO is then "Locked" on frequency.

Channels are selected by programming the counters in U202 to divide by different numbers. This programming data comes from the microprocessor on the logic board. The frequency stability of the synthesizer in both the receive and transmit modes is determined by the stability of TCXO U201. The stability of this device is 1.5 PPM from –22° to +140° F (–30° to +60°). The receive VCO output signal is buffered and then fed to the receiver as the first injection signal, and the transmit VCO signal is also buffered and fed to the transmitter as the transmit signal.

4.2.2 RECEIVE AND TRANSMIT VCOS, BUFFER AMPLIFIERS (Q503, Q533-Q535)

There are separate receive and transmit VCOs on the RF board. The VCO control voltage is applied to both VCOs, but only one is active at a time because they are powered by separate R5V (receive) and T5V (transmit) power sources.

With the receive VCO, Q501 produces the first injection signal in the range of 385-425 MHz which is then amplified by Q502. With the transmit VCO, Q531 produces the transmit frequency in the range of 430-470 MHz) which is then amplified by Q532.

In the receive mode, part of the Q502 output signal is fed back through C227 and R210 to pin 10 of U202, and then other part is applied to buffer Q503. Filtering is provided by L506, C520, and C521, and the signal is then applied to one of the gates of dual gate GaAs FET mixer Q302. This is the first injection signal, and it is 45.3 MHz below the receive frequency.

In the transmit mode, part of the Q532 output signal is fed back through buffer amplifier Q535 to pin 10 of U202, and the other part is applied to a buffer amplifier formed by Q533 and Q534. This is a cascode amplifier formed by common-emitter stage (Q533) and common-base stage (Q534). A cascode amplifier provides amplification also good isolation. The output signal from Q534 is then applied to amplifier Q101 in the transmitter.

4.2.3 VCO AND TCXO MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U202 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (especially at the lower audio frequencies). Conversely, if only the TCXO was modulated, the VCO frequency would not change fast enough (especially at the higher audio frequency).

However, by modulating both the VCO and TCXO, the two phase detector inputs remain in phase and no frequency shift is sensed. This produces a relatively flat audio response. Potentiometer 4 of U147 on the logic board balances these signals, and potentiometers 1 and 3 set the data and audio deviation levels. R203/R204 set the frequency of the TCXO by adjusting the DC bias on pin 3.

4.2.4 SYNTHESIZER CHIP (U202)

Synthesizer chip U202 contains a prescaler, A, N, and reference counters, and a phase detector, and charge pump. Channels are selected by programming

the A, N, and reference counters to divide by a certain number. This programming is performed by the microprocessor via the serial data bus which consists of the Clock, Data, and Latch Enable lines (pins 11-14 of U202).

The divide numbers are chosen so that when the VCO is operating at the correct frequency, the VCO-derived input to the phase detector is the same frequency as the TCXO-derived input. The TCXO-derived is produced by the reference counter in U202. This counter divides the 12.8 MHz TCXO frequency by 2388 to produce a 6.25 kHz input to the phase detector. Using a 6.25 kHz reference frequency allows channels to be changed in 6.25 kHz steps.

The VCO-derived input is produced by dividing the VCO frequency using the prescaler and N counter in U202. The divide number of the prescaler is controlled by the output signal from the A counter. The A and N counters function as follows:

Both the A and N counters begin counting down from the programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. When the A counter is counting down, the control output to the prescaler causes the prescaler to divide by 129. Then when the A counter is halted, the control output changes states and the prescaler divides by 128.

4.2.5 LOCK DETECT (Q201)

When the synthesizer is locked on frequency, the LD (Lock Detect) output of U202 on pin 8 is a high signal. This turns lock detect transistor Q201 off and the Lock Detect signal fed to the microprocessor is low. When an unlocked condition is indicated, low-going pulses appear on pin 8 which turns Q201 on and causes the Lock Detect signal to go high. The transceiver is then disabled by the control logic and an error condition is indicated in the display.

4.2.6 DC-DC CONVERTER (U203), LOOP FILTER

The supply voltage to an internal charge pump in U202 on pin 4 is produced by DC-DC converter U203. The DC-DC converter produces a 9.3-volt supply from

the C5V input voltage. This converter has a built-in relaxation oscillator and rectifier. The frequency of operation is determined by L201. The built-in rectifier combined with an internal temperature compensated reference provide a stable output voltage with a minimum number of external components. The output voltage on pin 4 in U203 is filtered by R215, C218, C220 and then fed to pin 4 in U202.

The charge pump output on pin 6 of U202 charges and discharges C214 and C215 in the loop filter to produce the VCO control voltage. The loop filter is formed by R218-R221 and C214-C216. This is a low-pass filter which controls synthesizer stability and lock-up time and suppresses the 6.25 kHz reference frequency.

4.3 RECEIVER CIRCUIT DESCRIPTION

NOTE: A block diagram of the RF and logic boards is located on page 8-8.

4.3.1 RF AMPLIFIER (Q301), FIRST MIXER (Q302)

The receive signal from the antenna is fed through the harmonic rejection filter (L107-L110, C113-C118) and the PIN diode antenna switch (D101, D102, L112) to RF amplifier Q301. The bandpass filter on the input of this stage attenuates the image and other unwanted frequencies and also prevents the injection signal from being fed out to the antenna. The passband of this filter is controlled by a signal from pin 102 of the microprocessor. This voltage changes the capacitance of varactor diodes D302 and D303 to vary the center frequency from 430 to 470 MHz.

Impedance matching with RF amplifier Q301 is provided by C308, C314, and S301. The RF amplifier stage is used to recover filter losses and improve receiver sensitivity. The output of Q301 is fed to another bandpass filter that is similar in design. Impedance matching with this bandpass filter is provided by C318-C322 and L304.

The output of second bandpass filter is applied to gate 1 of first mixer Q302. This is a dual-gate GaAs FET device which mixes the receive frequency with the first injection frequency to produce a first IF of 45.3 MHz (low-side injection is used). The injection

frequency is from the synthesizer, and it is fed through a low pass filter (C520, C521, L506) which attenuates harmonic frequencies present in the injection signal.

Impedance matching on the input of Q302 is provided by C328, L307, and L308. Likewise, impedance matching on the output is provided by C341, C337, C338, and L312. The first IF signal is then fed to monolithic crystal filter XFL401/XFL402. This filter attenuates wideband noise, adjacent channels, frequencies resulting from intermodulation, and other frequencies close to the receive channel.

4.3.2 IF AMPLIFIER (Q401), LIMITER/MIXER/ DETECTOR (U401)

From crystal filter XFL401/XFL402, the IF signal is fed to IF amplifier Q401 and then to limiter/ mixer/detector U401. This device contains second mixer and oscillator, limiter, detector, squelch, and RSSI stages.

The IF signal is fed in on pin 16 which is the input of an internal mixer. The 45.3 MHz first IF signal is mixed with the 44.845 MHz second injection signal to produce a second IF of 455 kHz. The second injection signal is produced by an internal oscillator and controlled by crystal X401.

The 455 kHz second IF is fed out of U401 on pin 3 and applied to ceramic filters XFL403 and XFL404 which attenuate wideband noise. A switching network consisting of D401A/B and D402A/B routes the IF signal through XFL403 with wide band channels, and through XFL404 with narrow band channels. This switching network is controlled by the narrow/wide signal from pin 45 of the microprocessor. This signal is high for wideband channels and low for narrow band channels. Therefore, with wideband channels, U402B is on and U402A is off which forward biases D401A/D402A and reverse biases D401B/D402B. With narrow band channels, the opposite occurs.

The 455 kHz signal from these filters is then fed back into U401 on pin 5 and applied to a limiter-amplifier stage. From the limiter the signal is fed to the quadrature detector. An external phase-shift network connected to pins 10 and 11 shifts the phase of one of the detector inputs by 90° at 455 kHz (the

other inputs are unshifted in phase). This network consists of C410 and ceramic discriminator T401. The detected audio signal is then amplified and fed out of U401 on pin 9.

4.3.3 SQUELCH CIRCUIT (U401)

The audio output signal on pin 9 of U401 contains audio and also high-frequency noise. This signal is fed to the receive audio and data processing circuits on the logic board and also to the squelch circuit which is part of U401. The amount of noise in this signal tends to be inversely proportional to signal strength (the higher the noise level, the lower the signal strength and vice versa). Therefore, it can be used for squelch control.

A bandpass filter that passes only noise frequencies occurring above the audio band is formed by an op amp in U401 and external components. The input to this filter is pin 8 and the frequency determining components are connected to pin 7 (R410-R412, C415, C416).

The audio/noise input level to the filter is adjusted by VR401 which sets the squelch threshold level. The detected noise output is on pin 13, and it is applied to pin 108 of the microprocessor in the logic unit.

4.4 TRANSMITTER DESCRIPTION

NOTE: A block diagram of the RF and logic boards is located on page 8-8.

4.4.1 DRIVER AMPLIFIER (Q101), POWER AMPLIFIER MODULE (U101)

In the transmit mode, the output signal from the transmit VCO is the transmit frequency. This signal is buffered by cascode amplifier Q533/Q534 (see Section 4.2.2) and then fed to driver Q101 which provides the required input level to power amplifier module U101. Impedance matching between Q101 and U101 is provided by L102 and C106.

Power amplifier module U101 provides up to 4 watts of RF power at the antenna jack. It contains two internal amplifier stages, each of which has a separate supply voltage (Vcc, Vbb Control). The supply

voltage to the first stage (Vbb Control) is from the power control circuit, and the supply voltage to the last stages (Vcc) is the unswitched battery supply.

4.4.2 ANTENNA SWITCH AND LOW-PASS FILTER

The antenna is switched between the receiver and transmitter by an antenna switch consisting of D101, D102 and several other components. In the transmit mode, the T5V supply is enabled and current flows through R105, L106, D101, L112, and D102. Since D101 is forward biased, the transmit signal has a low impedance path to the antenna.

L106/C112/D101 and L112/D102 each form discrete quarter-wave line that is AC grounded at one end. When one end of a quarter-wave line is AC grounded, the other end presents a high impedance to the quarter-wave frequency. Therefore, L106/C112 isolate the 5-volt supply from transmitter RF, and the other two circuits isolate the receiver. In the receive mode, D101 and D102 are no longer forward biased so the receive signal has a high impedance path into the transmitter and a low impedance path into the receiver. From the antenna switch the transmit signal is fed to a low-pass filter consisting of C113-C116, C118, and L107-L110. This filter attenuates harmonic frequencies occurring above the transmit band.

4.4.3 POWER CONTROL

The power output circuit maintains a steady power output level by controlling the supply voltage to the first stage in power module U101 (Vbb Control). The output power is monitored using a directional coupler consisting of a microstrip two-line coupler, C123, D103, C124 and several other components. Reflected power is dissipated by R107 and forward power is detected by C123 and D103. These components produce a DC voltage that increases with forward power.

The rectified DC level is buffered by voltage follower U102A and fed through R115 to pin 6 of U102B. This stage amplifies the difference between the forward power signal on pin 6 and the reference voltage on pin 5. This reference voltage controls the power output, and it is set by the control logic through potentiometer 2 of U147 on the logic board.

As forward power increases, the output voltage on pin 7 decreases. U103 then turns off more which decreases the supply voltage applied to Vbb Control of U101. This decreases power to maintain a stable output level. The opposite occurs if forward power decreases.

4.5 CONTROL LOGIC AND DISPLAY

NOTE: A block diagram of the RF and logic boards is located on page 8-8.

4.5.1 CONTROL LOGIC

The digital control logic is based on 16-bit CMOS microprocessor U208. The operating speed is set by 9.8304 MHz crystal Y202. A clock shift signal is applied to Q207. This signal goes high to shift the clock frequency slightly on channels in which the second harmonic interferes with the receive signal.

A serial data bus formed by MSI, MSO, and SER_CLOCK (pins 89-91) is used to transfer data to and from three external devices. They are 16K x 8 EEPROM U150, digital potentiometer U147, and LCD driver U501 on the keypad/display board.

Another serial port formed by pins 54 and 56 is used to transfer programming data to and from an external computer. This port is fed out of the transceiver on pins 3 and 4 of the accessory connector (UDC connector). Data is transferred to DTMF encoder U201 by another serial bus formed by TxD0 and RxD0 (pins 53 and 57). Descriptions of the U208 pins are located in Table 4-1.

4.5.2 DISPLAY ASSEMBLY DESCRIPTION

U501 on the display board is an intelligent LCD display controller/driver. It communicates with the microprocessor on the logic board over a serial bus consisting of MSCK (serial clock, pin 91), MSO (serial data, pin 89), and DISST (display strobe, pin 43) signals. U501 is set for 1/3 bias and 1/5 duty cycle and drives an 8-character, 14-segment display at a 98 Hz frame frequency. LCD display EH1 has 128 segments that are driven by a 34-segment signal with four common lines.

Table 4-1   Microprocessor U208 Pin Descriptions

Pin No.	Port Name	In/Out	Descriptions	Active
1	VCC	-	Supply voltage (L5V)	-
2	OPTB	Output	Optional signal	Low
3	CLR/CODE	Output	Optional encryption control signal	Low
4	KEYS0	Output	Key matrix scan out	-
5	KEYS1	Output	Key matrix scan out	-
6	Vss	-	Ground	-
7	KEYS2	Output	Key matrix scan out	-
8	KEYS3	Output	Key matrix scan out	-
9	KEYS4	Output	Key matrix scan out	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-
13	BKLED	Output	LCD backlight control signal	Low
14	-	-	-	-
15	Vss	-	Ground	-
16	-	-	-	-
17	DISEN	Output	LCD driver chip enable signal	-
18	-	-	-	-
19	-	-	-	-
20	KEYR0	Input	Key matrix scan in	-

Table 4-1   Microprocessor U208 Pin Descriptions (Continued)

Pin No.	Port Name	In/Out	Descriptions	Active
21	KEYR1	Input	Key matrix scan in	-
22	KEYR2	Input	Key matrix scan in	-
23	KEYR3	Input	Key matrix scan in	-
24	Vss	-	Ground	-
25	-	-	-	-
26	PTT_OUT	Input	PTT switch	Low
27	-	-	-	-
28	CLK_SHIFT	Output	Clock shift control (H = shift)	High
29	KEYPAD_INT	Input	Keypad control	Low
30	-	-	External pull-up	-
31	-	-	-	-
32	OFFREQIN	Input	Main voltage supply switch	Low
33	Vcc	-	L5V	-
34	DTMFT	Output	DTMF mute control signal	Low
35	-	-	-	-
36	RMUTE	Output	Receive audio mute control signal	Low
37	AMUTE	Output	Audio amplifier supply voltage control	High
38	Vss	-	Ground	-
39	-	-	-	-
40	-	-	-	-
41	-	-	-	-
42	-	-	-	-
43	DISST	Output	LCD driver chip enable signal	-
44	PT	Output	Compander control signal	Low
45	W_N	Output	Wide/narrow band switching	High
46	PLLSK	Output	PLL clock	-
47	Vss	-	Ground	-
48	PLLSO	Output	PLL data	-
49	PLLST	Output	PLL strobe	-
50	-	-	-	-
51	ULOCK	Input	PLL unlocked signal	High
52	Vcc	-	L5V	-
53	DTMFSO	Output	DTMF data	-
54	TXD	Output	Programming data out	-
55	-	-	-	-
56	RXD	Input	Programming data in	-
57	DTMFCK	Output	Clock signal for DTMF	-
58	-	-	-	-
59	Vss	-	Ground	-
60	S5C	Output	+5C supply control signal	High
61	-	-	-	-
62	SN_TR	Output	SMARTNET circuit control signal	High
63	FEPCS	Output	EEPROM chip select signal	-

Table 4-1   Microprocessor U208 Pin Descriptions (Continued)

Pin No.	Port Name	In/Out	Descriptions	Active
64	-	-	External pull-up	-
65	BEEP	Output	Audio beep tone	-
66	-	-	-	-
67	-	-	-	-
68	-	-	-	-
69	-	-	-	-
70	-	-	-	-
71	P_HOLD	-	-	-
72	FWE	Input	Flash memory Write Enable	-
73	RESET	Input	Reset pulse input	-
74	-	-	External pull-up	-
75	L5V	-	-	-
76	Vcc	-	L5V	-
77	X-TAL	Input	System clock connection terminal	-
78	EX-TAL	Input	System clock connection terminal	-
79	Vss	-	Ground	-
80	-	-	-	-
81	Vcc	-	L5V	-
82	TMUT	-	Not used	-
83	T5C	Output	T5V supply control signal	High
84	DPTT	Output	Delayed PTT signal	Low
85	R5C	Output	R5V supply control signal	High
86	-	-	-	-
87	-	-	-	-
88	NPSPAC	Output	Controls NPSPAC channel audio level	High
89	MSO	Output	Serial data output	-
90	MSI	Input	Serial data input	-
91	SER_CLOCK	Output	Serial data clock	-
92	-	-	-	-
93	Avcc	-	L5V	-
94	Vref	-	L5V	-
95	BATT(VCC)	Input	Low battery voltage detection	-
96	RSSI	Input	RSSI (Receive Signal Strength Indicator)	-
97	L5V	-	L5V	-
98	Ground	-	Ground	-
99	-	-	External pull-up	-
100	-	-	External pull-up	-
101	-	-	External pull-up	-
102	VVC_LVL	-	-	-
103	AVss	-	Ground	-
104	Vss	-	Ground	-
105	TEST	Output	Bypass transmit data filter	High
106	TXPREC	Output	Subaudible signaling tone/damp signal output	-

Table 4-1   Microprocessor U208 Pin Descriptions (Continued)

Pin No.	Port Name	In/Out	Descriptions	Active
107	MICMUTE	Output	Mutes microphone audio signal	Low
108	SQUELCH	Input	Squelch control	-
109	BWC	Output	Transmit/receive data filter bandwidth signal output	High
110	RXDATA	Input	Receive data input	-
111	TXDATA	Output	Subaudible tone/main audio signal output	-
112	SN_RX	Input	SMARTNET receive data input	-
113	MD0	-	External pull-up	-
114	MD1	-	External pull-up	-
115	BOOT1	Input	Flash ROM data import control	Low
116	DPOTST	Output	Digi-pot strobe signal	-
117	-	-	-	-
118	-	-	-	-
119	EXT_DC	Input	Option signal input	-
120	-	-	-	-

4.6 RECEIVE AUDIO PROCESSING

4.6.1 INTRODUCTION

The receive audio and data signal from the limiter/detector module on the RF board is applied to the following circuits:

- Receive Audio Processing - Pin 2 of U101A (see following information)
- Receive Data Processing - Pin 3 of U102A (see Section 4.7)
- SMARTNET™ Data Processing - Pin 2 of U141B (see Section 4.9)

4.6.2 BANDPASS FILTER (U101)

U101A and U101B form a bandpass filter which passes frequencies from 300-3000 Hz. This attenuates low frequency Call Guard (CTCSS/DCS) signaling and high frequency harmonics. This filter also provides de-emphasis of the audio signal.

On the input of U101A, Q102 provides wide and narrow band compensation. The base of Q102 is high in the wideband mode and low in the narrow band mode. Therefore, R103 is grounded in the wideband mode which lowers the input level to U101A. This

maintains a constant audio output level since the higher deviation in the wideband mode results in a higher input level.

Also on the input of U101A, Q101 provides NPSPAC compensation. The base of Q101 is high when a NPSPAC channel is selected and low at other times. This grounds R102 in the NPSPAC mode to lower the input level since NPSPAC channel deviation is higher than narrow band deviation.

4.6.3 EXPANDER (U204)

From U101A/B the signal is fed to pin 7 of the expander in U204. When companding is enabled by a low input on the PT input (pin 8) of U204, this stage provides 1:2 expansion of the audio signal to remove the 2:1 compression that occurred when it was transmitted. This compression and then expansion reduces the amount of noise present in the audio signal. When the PT input is high, companding is disabled and the signal if fed through U204 without expansion.

The audio signal is fed out of U208 on pin 15 and then fed to audio mute gate U202. This gate is controlled by the RMUTE output (pin 36) of the microprocessor. The audio is also muted by the audio amplifier as described in the information which follows.

Also applied at this point are the DTMF and beep tones. Muting of the DTMF tones is provided by Q201 which is controlled by the pin 34 output of the microprocessor. The beep tones are synthesized by 5V and 0V levels from the microprocessor on pin 65.

4.6.4 AUDIO AMPLIFIER (U101, U102)

From mute gate U202, the audio signal is fed through the keypad/display board to volume control VR901 which sets the input level to the audio amplifiers. This signal from VR901 is fed back to the keypad/display board and applied to pin 7 of audio amplifiers U101 and U102.

With normal operation when the internal speaker is used, U101 provides the required amplification. However, when an external speaker is used, U101 is disabled and U102 provides the required amplification. When any load of approximately 1k ohm or less is connected to pin 10 of the accessory jack, Q106 turns on and Q102 turns off. This removes supply voltage from U101 and applies it to U102.

The supply voltage to the audio amplifiers is also controlled by Q103 and Q105. When the audio is muted such as when no tones are sounding or no message is being received, the AMUT (pin 37) output of the microprocessor is low. This turns off both Q103 and Q105 and removes supply voltage from the audio amplifiers which helps conserve battery power. The receive audio signal is also muted by gate U202 as previously described.

4.7 RECEIVE AND TRANSMIT DATA PROCESSING

4.7.1 RECEIVE DATA FILTER/DETECTOR (U102A/B, U103A/B)

The receive data (and audio) signal from the limiter/detector on the RF board is routed to a receive data filter formed by U102A and U102B. This is a low-pass filter which attenuates voice and other harmonic frequencies above the data band. The passband of this filter is controlled by the bandwidth control signal applied to Q103A. When digital Call Guard data or a low-frequency Call Guard tone is being detected, this signal is high which turns on Q103A. The cut-off frequency of the filter is then

approximately 150 Hz. Then when a high-frequency Call Guard tone is received, Q103A turns off and the cut-off frequency is approximately 190 Hz. This switches additional capacitance into the circuit which lowers the filter cut-off frequency.

From the filter the data signal is applied to a DC restoration circuit formed by U103B and U103A. This circuit converts the data signal from AC floating at half supply to a digital signal at 0 and 5-volt levels that can be read by the microprocessor. U103B is a standard noninverting amplifier with a gain of approximately 5.6 set by R127 and R126 (R126 is AC grounded by C120). Diodes D101 and D102 charge and discharge C120 to establish a DC reference on pins 2 and 6 of U103 that is the average of the positive and negative going alternations of the data signal.

The amplified data signal is applied to pin 3 of U103A. When this level rises above the reference level on pin 2, the output on pin 1 goes high (5 volts). Conversely, when the data signal falls below the reference level, the output goes low (0 volts). In the transmit mode, Q103B is turned on which effectively grounds pin 3 of U103A and forces the output on pin 1 low.

4.7.2 TRANSMIT DATA FILTER (U145A/B)

The transmit data signal is produced by the TXDATA and TXPREC outputs of the microprocessor (pins 111 and 106). A pseudo sine wave is produced by the four voltage levels that can be produced by these outputs. This signal is fed to a transmit data filter formed by U145A/B. This filter is the same as the receive data filter described in the preceding section. It attenuates harmonics present in the waveform produced by the microprocessor.

The input and output signals of the data filter are fed to gate U141A. This gate is used to bypass the transmit data circuit during alignment so that a wide range of harmonic frequencies are passed for use in setting modulation balance. The control signal to this gate is the TEST signal from pin 105 of the microprocessor. This signal is low when the transmit data filter is bypassed.

The signal is then routed to pin 3 on gate U141C where either it or the SMARTNET™ data signal from

U143A is selected. The data output signal on U141C, pin 4 is then applied to pin 24 of U147 which is the input of the digitally controlled potentiometer 1 in that device. The data modulation level is set during alignment and controlled by the logic. The output of this potentiometer on pins 22 and 23 is then fed to U148A where it is combined with the transmit audio signal (see Section 4.8.3).

4.8 TRANSMIT AUDIO PROCESSING

4.8.1 GATE (U203), HIGH-PASS FILTER (U151)

The internal microphone audio signal is applied to pin 6 of gate U201B on the keypad/display board, and the external microphone signal from pin 2 of the accessory connector is applied to pin 2 of gate U201A. This gate is controlled by the Mic Sense signal from pin 7 of the accessory connector. When no external microphone is connected, this input is pulled high by R202 and U201B is enabled and U201A disabled. Q202 is controlled by the T5C signal and therefore is on in the transmit mode and off in the receive mode.

The microphone audio signal is then applied to mic audio mute gate U203B on the logic board. This gate is controlled by the signal on pin 107 of the microprocessor (low = mute).

The transmit DTMF tones from pin 5 of U201 are combined with the beep tones fed through R204 and then applied through C204 and R203 to pin 2 of gate U203A. This gate and Q201 are controlled by pin 34 of the microprocessor (low = mute).

The microphone audio signal from U203B and the DTMF tones from U203A are then combined and applied to pin 3 of the compander in U204. When companding is enabled by a low input on the PT input (pin 8) of U204, this stage provides 2:1 compression of the audio signal. This compression and then re-expansion when it is received reduces the amount of noise present in the audio signal. When the PT input of U204 is high, companding is disabled and the signal is fed through U204 without compression.

The transmit audio/DTMF signal is fed out of U204 on pin 2 and applied to a high-pass filter formed by U151B. This filter has a –3dB cutoff frequency of approximately 300 Hz to attenuate frequencies that could cause interference with the Call Guard signals.

4.8.2 LIMITER (U151A)

Pre-emphasis of the DTMF tone and microphone audio signals is provided by C160/R168. U151A is an amplifier functioning as a limiter (limiting occurs when it saturates). Limiting prevents overmodulation caused by high input levels from the internal or external microphone. The bias voltage to this stage and also to U151B is produced by voltage divider R170/R171.

4.8.3 LOW-PASS FILTER (U146A/B)

U146A and U146B from a low-pass splatter filter which attenuates frequencies above approximately 3 kHz. This prevents adjacent channel interference caused by the harmonic frequencies which that result from amplitude limiting.

The output signal from this filter is applied to digital potentiometer 3 on pin 20 of U147 which sets the transmit audio/DTMF deviation level. This level is set via the control logic when the transceiver is aligned.

The transmit audio/DTMF signal is then combined with the transmit data signal by U148A. The output signal on pin 1 of U148A is fed to the TCXO on the RF board and also to digital potentiometer 4 on pin 7 of U147. The output signal from this potentiometer on pin 8 is applied to the VCO on the RF board. The level of this signal is set via the control logic during alignment to balance the TCXO and VCO modulation signals.

4.9 SMARTNET DATA PROCESSING

NOTE: The SMARTNET™*/SmartZone*® *data processing circuit is not currently used.*

A filter formed by U142A/B and U143A provides filtering of both the transmit and receive SMARTNET/ SmartZone data signals. Switching of these signals is provided by gate U141B which is controlled by pin 62 of the microprocessor. When this signal is low, the

transmit data signal on pin 2 is selected is routed to the filter, and when it is high the receive data signal on pin 1 is routed to the filter.

U142B, U142A, and U143A form a 1800 Hz low-pass filter which attenuates unwanted frequencies above the SMARTNET/SmartZone data band. The output of this filter on U143A, pin 1 is fed to U144A/B which provide DC restoration when data is being received. The signal is also fed to gate U141C in the transmit data circuit to be transmitted when applicable.

The DC restoration circuit formed by U144A/B and U143B is similar in function to the receive data circuit described in Section 4.7.1. It converts the data

signal from AC floating at half supply to DC levels of 0 and 5 volts that can be detected by the microprocessor. Diodes D141 and D142 charge and discharge C148 and C150 to establish a DC reference on pin 6 of comparator U143B that is the average of the positive and negative going alternations. Q141 turns on in the transmit mode which grounds pin 6 and disables this circuit.

In the transmit mode, gate U141C selects either the SMARTNET data signal or the LTR/Call Guard data signal. It is controlled by the same signal that controls U141B. The output signal on pin 4 is then applied to potentiometer 1 in U147. Refer to Section 4.7.2 for more information on the rest of this circuit.

SECTION 5   ALIGNMENT PROCEDURE
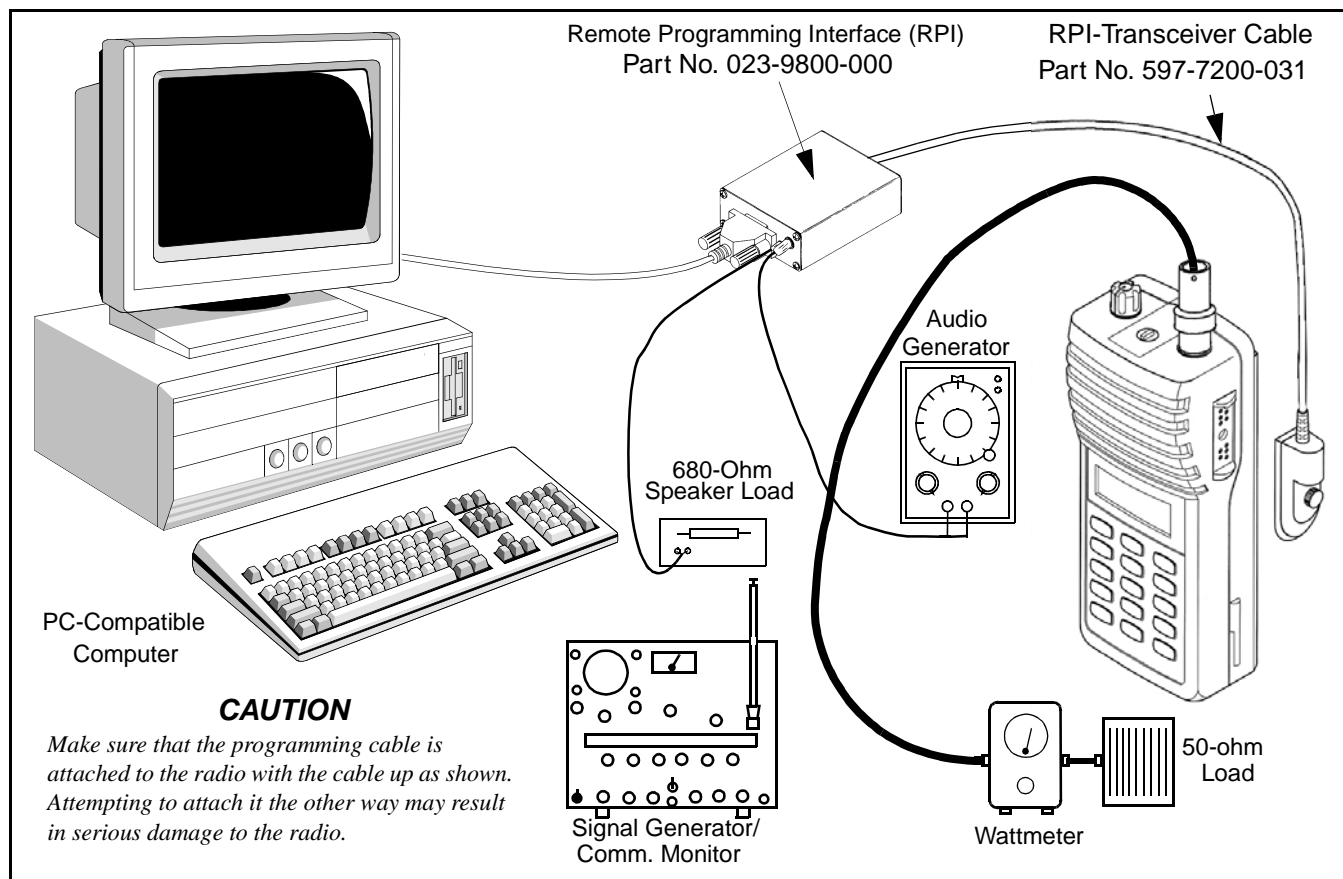
Figure 5-1   Alignment Setup Diagram

5.1 GENERAL

NOTE: Special test operating code must be loaded before this transceiver can be aligned using PCTune. Refer to Section 5.1.2 for more information.

5.1.1 INTRODUCTION

The alignment procedure described in this section should be performed if repairs are made that could affect the factory alignment. In addition, before a transceiver is initially placed in service, the performance tests in Sections 5.14 and 5.15 should be performed.

To perform the alignment described in this section, special PCTune and PCFlash software is required (see Table 1-1). The setup is basically the

same as that used for programming. This equipment is shown above and also described in Section 3.1.

Only two adjustments are made manually and the others are made digitally using the PCTune software. The manual adjustments are squelch sensitivity and TCXO frequency, and if they do not need to be reset, the transceiver can be tuned without any disassembly or the need for a special test cable.

5.1.2 SPECIAL TEST CODE REQUIRED

This transceiver does not have a test mode that is selected for alignment. Instead, special test operating code is loaded and the PCTune program then automatically selects the frequencies and other test conditions that are required to perform the alignment. Then when

alignment is complete, the LTR-Net operating software is reloaded. The procedure is described in the following section.

If the transceiver must be manually controlled to perform testing or troubleshooting, program temporary conventional channels or use the special test features available with the test code (see Section 5.16).

5.2 LOADING OPERATING CODE

5.2.1 GENERAL

Introduction

This section describes how to re-Flash the transceiver with test operating code and then re-Flash it again with LTR-Net operating code when alignment is complete.

PCFlash and PCTune Software Installation

The PCFlash and PCTune programs are shipped on separate CDs as shown in Table 1-1. These programs are installed separately as follows:

1. Close all applications that are currently running. Insert the disk containing the software in the CD drive.

2. To install the PCFlash program, select from the Windows® taskbar, Start > Run and then Browse to the drive containing the CD and select the "PCFlash.exe" file. Click OK and follow the on-screen instructions to install the program and data files.

3. To install the PCTune program, insert the CD containing that program in the CD drive and select the "PCTune.exe" file and follow the on-screen instructions as in the preceding step.

Test Setup

The same basic computer setup used to perform personality programming is used to perform the alignment procedure described in the following information. Only Remote Programming Interface (RPI), Part No. 023-9800-000, can be used for alignment because this is the only RPI that has Flash programming capa-

bility and microphone and speaker audio jacks that are required for alignment. Connect the test setup as shown in Figure 5-1. Refer to Section 3.1 for more information.

Starting PCFlash and PCTune

Select Start > Programs > EFJohnson and then click the PCFlash 72xx or PCTune icon as applicable.

5.2.2 SAVING PERSONALITY INFORMATION

When temporary test operating software is loaded using PCFlash, any personality information previously programmed in the transceiver (see Section 3) is lost. Therefore, if you wish to restore this information after the alignment is complete, save the personality information to a disk file as follows before the test software is loaded:

1. Start the personality program as described in Section 3.2.3. Connect the test setup and make sure that the switch on the RPI is away from the LED so that it indicates green.

2. With the test setup connected, upload the parameters stored in the transceiver by selecting the Transfer > Read Setup Params in the menu bar as described in Section 3.7.

3. Save the parameters to a disk file by selecting File > Save As in the menu bar (see Section 3.5).

4. When alignment is complete and the LTR-Net operating software has been reloaded, open the saved file by selecting File > Open. Then reprogram the transceiver by selecting Transfer > Write Setup Params as described in Section 3.7.

5.2.3 LOADING TEST CODE

NOTE: If the transceiver contains personality information that you want to restore after the alignment is complete, be sure to save it to a disk file as described in the preceding section before performing this procedure.

Proceed as follows to load the temporary test operating (Flash) code required to run the PCTune program (see Section 5.1.2).

1. Connect the test setup and make sure that the switch on the front of the RPI is set to the Flash programming position (toward the LED so that it indicates amber).

2. Cycle transceiver power. This display will be blank when it powers up.

3. Start the PCFlash program as described in Section 5.2.1. The main screen which follows is then displayed. (Clicking "PC Flash 72xx" instead of "PC Flash" automatically selects the 72xx Boot Loader file as described in the next step.)

PCFlash Main Screen

4. Select the Boot Loader file if required by clicking the Set File button and selecting the "72XX_loader.s19" file. This file contains the information required by PCFlash to program 7243 models. (This file and the Flash File should have automatically copied to the PCFlash directory when the program was installed.)

5. Select the Flash File by clicking the Set File button and selecting the "00342xx0.s19" file (the "xx" indicates the software version number). This file contains the test code that is loaded into the transceiver. It is included with the PCTune software, and it also should have been automatically copied when the program was installed.

6. Make sure that the correct serial port is selected and then click the "Program Radio" button to program the transceiver with test software. When downloading is complete, PCTune can be used to tune the transceiver as described in Section 5.4.

NOTE: The test operating code also provides several transceiver test functions that are described in Section 5.16.

7. When alignment is complete, reload the LTR-Net operating code by clicking the "Set File" button and selecting the "00352xx0.s19" file. Then click the "Program Radio" button. This file is included with the PCFlash program and should have been automatically copied when the program was installed.

8. Reprogram the personality parameter as described Section 5.2.2, step 4, if they were previously saved or as described in Section 3 if they were not saved.

5.3 PCTUNE DESCRIPTION

5.3.1 PCTUNE MENU BAR
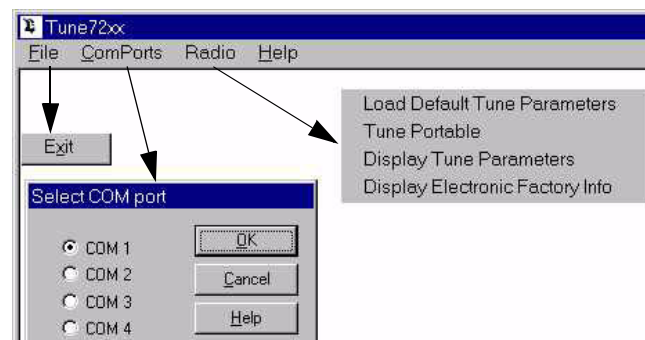
The main PCTune screen menu bar is shown above. The following menus are selected:

File - Selects "Exit" which closes the PCTune program.

ComPorts - Displays a screen which selects the computer serial port being used.

Radio

Load Default Tune Parameters - Downloads to the transceiver default settings for the various electronic adjustments.

Tune Portable - Displays the screen shown in Figure 5-2 which selects the various alignment functions. Refer to Section 5.3.2 for more information.
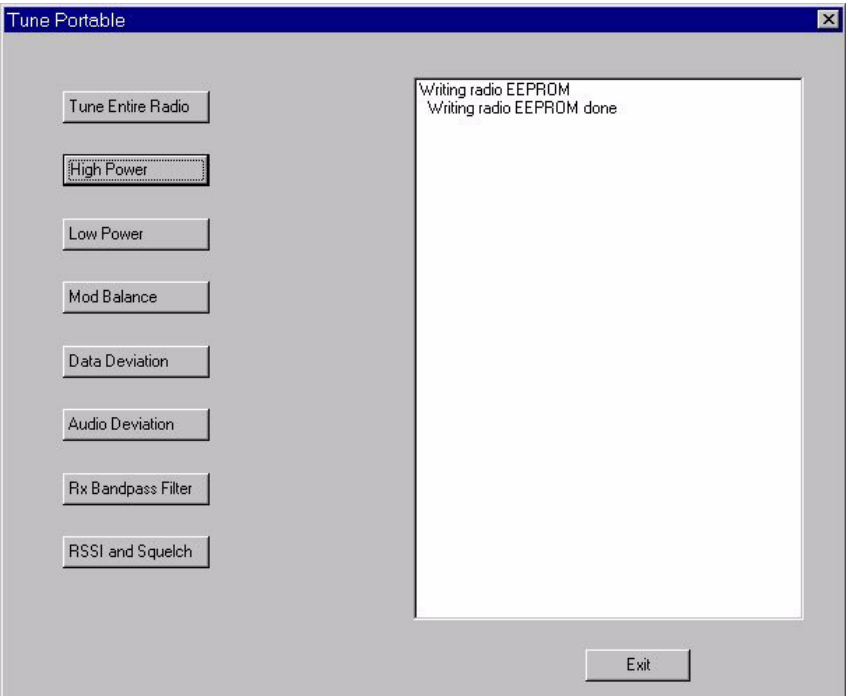
Figure 5-2   PCTune Tune Radio Screen

Display Tune Parameters - Displays the following screen which indicates the settings currently programmed into the transceiver.
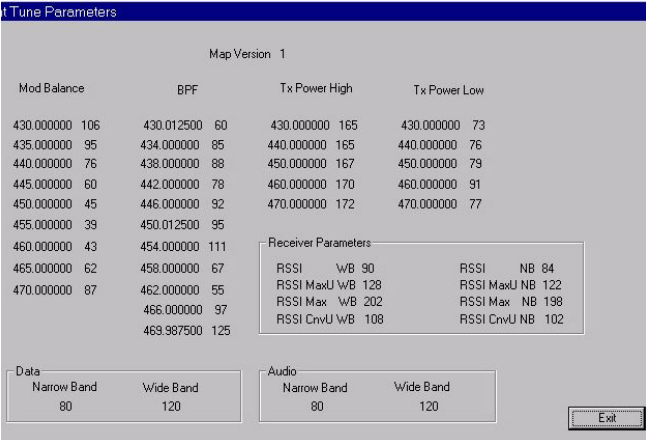
Display Electronic Factory Info - Displays the following screen which indicates the model number, serial number, and other information programmed in the transceiver (see Sections 1.3 and 1.4).

Help - Displays the PCTune version number.
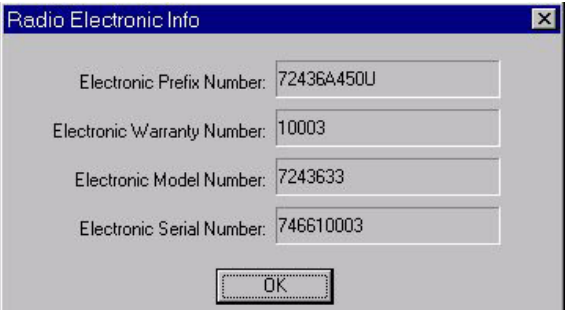
Display Factory Info Screen

5.3.2 RADIO TUNE SCREEN

CAUTION

Clicking any of the top six buttons on the Radio Tune screen in Figure 5-2 selects that test and immediately keys the transmitter. Therefore, make sure that no test equipment is connected to the antenna jack that could be damaged. Click the "Disable Transmit" button to turn the transmitter off.

The Radio Tune screen shown in Figure 5-2 selects the various alignment functions. This screen is displayed by selecting Radio > Tune Portable in the menu bar (see preceding section). The various adjust-

ments that are performed are shown on the eight buttons on the left side. To perform just one adjustment or perform the adjustments individually, click the applicable button for that adjustment. Alternatively, to have the program automatically step through all adjustments, click the "Tune Entire Radio" button on the top.
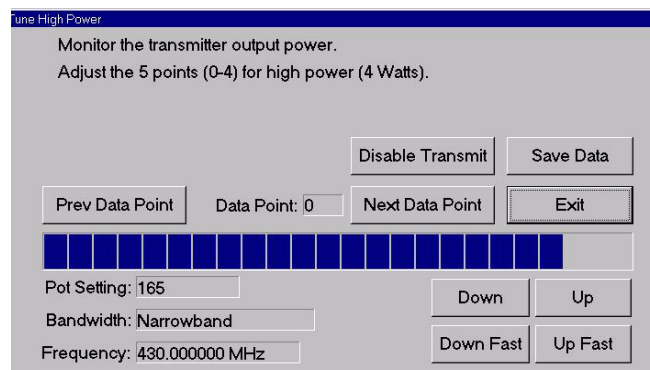
Power Adjust Screen

A typical adjustment screen is shown above. The general function of the buttons in this screen are as follows:

- The Down, Down Fast, Up, and Up Fast buttons change the setting.

- The Next Data Point button selects the next frequency or test point and the Prev Data Point button selects the previous frequency or data point.

- The Save Data button is clicked if the new tuning values will be used.

- The Exit button exits the tuning step. If the Save Data button has not been pressed, another window is then displayed to select if the data should be saved. If "No" is selected, the new tune values are ignored and the old values continue to be used.

5.4 ALIGNMENT PROCEDURE

5.4.1 TEST SETUP

Connect the test setup shown in Figure 5-1. Additional information follows on equipment in this setup.

Antenna Jack Adapter - The transceiver antenna jack is an SMA female type. Therefore, some sort of

adapter may be required to connect test equipment to this jack. An SMA male to BNC female adapter is available by ordering Part No. 515-3102-060.

Test Cable - An extension test cable (see Table 1-1) is required to operate the transceiver when it is opened. This cable reconnects the keypad/display board to the audio/logic board.

RF Signal Generator - When connecting the generator to the antenna jack, use at least a 6 dB pad between the generator and transceiver. This protects the generator if the transmitter is accidentally keyed and also ensures that a 50-ohm load exists. The input levels listed in the PCTune screens are at the antenna jack, so increase the generator output accordingly.

Power Source - If a battery is used to provide transceiver power during alignment, make sure it is in good condition and fully charged. Power output levels are with 7.5 volts applied to the transceiver. Typical current when transmitting at high power is 2.0 A.

Wattmeter/Load - The wattmeter and dummy load must measure and dissipate approximately 4 watts.

Audio Generator - The audio generator is connected to the larger (1/8") mono phone jack of the RPI shown in the following illustration.
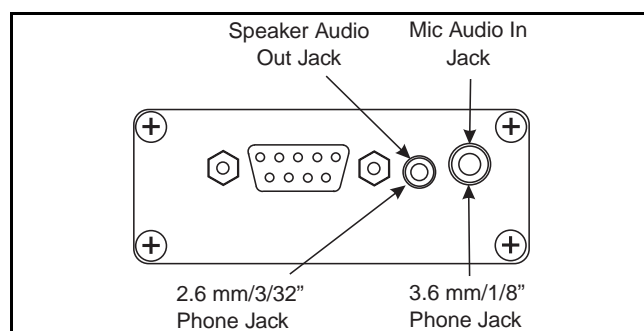
Speaker Load - The speaker load is connected to the smaller (3/32") mono phone jack of the RPI as shown above. This is a low level audio output that requires a load of approximately 680 ohms.

Computer and RPI - The RPI is connected to the computer and transceiver as described in Section 3.1. Note that RPI, Part No. 023-9800-000 must be used. Other RPI's do not have the jacks required to inject mic audio and monitor speaker audio with a computer

connected to the accessory jack. Make sure that the switch on the RPI is away from the LED so that it indicates green.

The following sections describe the adjustments that are made to align the transceiver.

5.5 FREQUENCY CHECK/ADJUST

NOTE: The transmitter immediately keys when the following function is selected. To turn the transmitter on and off, click the "Disable Transmit" button (see screen which follows).

The transmit frequency should be checked with the ambient temperature near the TCXO calibration reference of 77° F (25° C). This ensures that the frequency will be within tolerance at the temperature extremes. At room temperature, this frequency should be within ± 400 Hz. Checking the transmit frequency also checks the receive frequency. Proceed as follows:

1. Connect a wattmeter and dummy load to the antenna jack as shown in Figure 5-1.

2. Click the "Tune Entire Radio" button to automatically step through all adjustments or click the "High Power" button to perform only this adjustment.

3. Monitor the transmit frequency with a communications monitor set to the frequency displayed on the screen.

4. If readjustment is required, the transceiver must be opened to access the manual adjustment point as described in Section 5.13. Adjust capacitor in TCXO U201 for the correct frequency (see Figure 5-3).

5.6 HIGH RF POWER ADJUST

1. The high power test should already be selected for the preceding adjustment.

2. Set the high power output for 4.0 watts at all data points by clicking the Down/Down Fast or Up/Up Fast buttons on the screen.

5.7 LOW RF POWER ADJUST

1. If manually selecting each test, click the "Low Power" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the preceding High Power adjustment.

2. Set the low power output for 1.0 watt at all data points.

5.8 MODULATION BALANCE

1. If manually selecting each test, click the "Mod Balance" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the Low Power adjustment.

2. View the transmit modulation waveform on the CRT of a communication monitor. If applicable, set the monitor for de-emphasis off, high-pass/bandpass filter off, low-pass filter 15 kHz, and FM peak detection active.

3. The detected signal should be a 100 Hz square wave at a deviation of approximately 700 Hz. Follow the instructions on the screen and adjust at all data points for the best demodulated square wave with minimum tilt and overshoot.

5.9 DATA DEVIATION

1. If manually selecting each test, click the "Data Deviation" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the preceding Modulation Balance adjustment.

2. Monitor the transmit modulation signal with a communication monitor set as in the preceding step. Adjust the wideband and narrow band data deviation at all data points for the levels indicated on the screen.

5.10 AUDIO DEVIATION

1. If manually selecting each test, click the "Audio Deviation" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the preceding Data Deviation adjustment.

2. Inject a 1 kHz signal at the level indicated on the screen into the Mic Audio jack of the RPI (see Section 5.4.1).

3. Monitor the transmit modulation signal with a communication monitor and adjust the wideband and narrow band deviation at all data points for the levels indicated on the screen.

5.11 RECEIVE BANDPASS FILTER ADJUST

1. If manually selecting each test, click the "Rx Band-pass Filter" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the preceding Audio Deviation adjustment.

2. Set the signal generator to the indicated frequency with an unmodulated output at a level of –95 dBm.

3. Click the Fast Up and Fast Down buttons to determine the peak reading. If there are several peaks, use the center value.

4. Adjust the D/A Setting at all data points for half the highest real time RSSI level that was observed.

5.12 RSSI AND SQUELCH ADJUST

The first part of this adjustment electronically sets the RSSI, and the second part is used to manually set the squelch threshold. Proceed as follows:

1. If manually selecting each test, click the "RSSI and Squelch" button in the screen shown in Figure 5-2. Otherwise, this function is selected automatically after completing the preceding Rx Bandpass Filter adjustment.

2. Connect a SINAD meter to the speaker output jack of the RPI (see Section 5.4.1) and inject the channel frequency and signal level indicated on the screen.

3. Follow the instructions on the screen to sample the RSSI level at several data points.

4. When all the data points have been set, click the Exit button. The squelch adjust screen is then displayed. If the squelch sensitivity must be adjusted, the trans-

ceiver must be opened as described in the next section to access the adjustment point.

5. Set the signal generator for the output signal displayed on the screen and slowly adjust squelch potentiometer VR401 (see Figure 5-3) until the receiver just squelches (audio mutes).

5.13 OPENING TRANSCEIVER

NOTE: The following procedure needs to be performed only if the frequency and squelch sensitivity described in Sections 5.5 and 5.12 need to be adjusted.

1. If applicable, remove the programming cable from to the accessory connector. Then open the transceiver as described in Section 1.11.

2. Connect the optional extension test cable (see Table 1-1) between the jacks on the keypad/display and audio/logic boards. This cable is required for the transceiver to operate.

3. Reattach the battery pack to provide power to the transceiver.

4. Temporarily reattach the programming cable to the accessory connector (a rubber band can be used to hold it in place). Perform the frequency and squelch adjustments as described in the preceding sections.
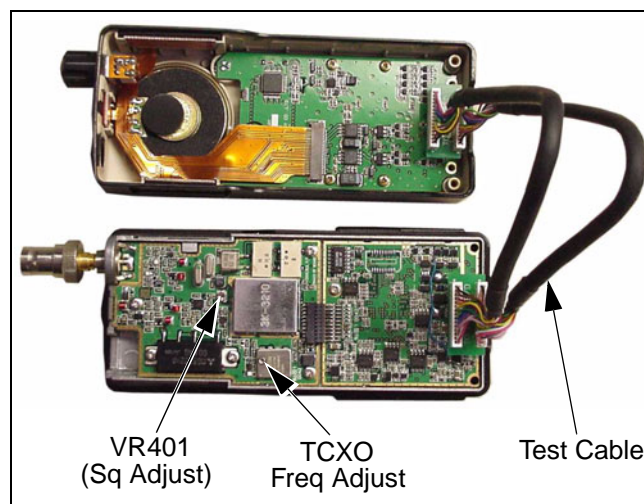
Figure 5-3   Internal Adjustment Points

PERFORMANCE TESTS

5.14 RECEIVER PERFORMANCE TESTS

5.14.1 PRELIMINARY SETUP

With the standard LTR-Net operating code, the transceiver does not have a special test mode that can be selected to perform testing. Therefore, program temporary conventional channels or use the functions available with the test code to perform this function.

If programming test channels, program channels near the low, middle, and high ends of the band (wideband, narrow band or both) and with and without Call Guard (CTCSS/DCS) squelch as applicable. In addition, to check high and low power and talk-around operation, program High/Low Power and Repeater Talk-Around option switches.

When the temporary special test code is loaded as described in 5.2, there are several test channels and functions that can be selected. Refer to Section 5.16 for information on these test functions.

Proceed as follows to check receiver operation:

1. Select the channel near the center of the band (around 450 MHz).

2. Connect the signal generator to the antenna jack (see Section 5.4.1 for more information). Set the output to the channel frequency, modulated with 1 kHz at 3 kHz (wideband channels) or 1.5 kHz deviation (narrow band channels).

5.14.2 SINAD SENSITIVITY

NOTE: The audio output level of the accessory connector is at a lower level than at the internal speaker. In addition, the internal speaker automatically mutes when a load of approximately 1k ohm or less is connected to this output.

1. Connect a SINAD meter to the speaker output of the RPI (see Section 5.4.1).

2. Decrease the signal generator output to obtain a 12 dB reading on the SINAD meter. The signal generator output should be 0.35 µV maximum.

3. Check both wide and narrow band channels if applicable, and also check the channels on each end of the band.

5.14.3 SQUELCH SENSITIVITY

With the test setup used for the preceding test, slowly increase the signal generator output until the squelch just opens (audio is enabled). Then decrease the signal generator output until it just closes. The squelch should open after 12 dB SINAD and close before 6 dB SINAD.

5.14.4 AUDIO POWER AND DISTORTION

To measure audio output power, the actual level across the speaker must be measured because full output power is not available at the accessory connector. If a load of approximately 1k ohm or less is connected to the speaker output of the accessory connector, it must be disconnected to enable the internal speaker. Proceed as follows:

1. Open the transceiver as described in Section 5.13 and connect a 16-ohm load in place of the speaker. Connect an AC voltmeter and distortion meter across the load (both should have floating inputs).

2. Set the signal generator output for –60 dBm (220 µV). Minimum audio power should be 0.5 watt across the 16-ohm load (2.8 V rms). Distortion should be less than 5% at 0.5 watt.

5.14.5 RECEIVER CURRENT DRAIN

Maximum transceiver current with 0.5-watt audio output is 275 mA. With the receiver squelched, it should be 100 mA maximum.

5.15 TRANSMITTER PERFORMANCE TESTS

5.15.1 POWER OUTPUT

Refer to Section 5.14.1 for information on test channels. Proceed as follows:

1. Connect a wattmeter and dummy load to the antenna jack as described in Section 5.4.1.

2. Key the transmitter and high power output should be 3.8 - 4.2 watts. Check channels on both ends of the band and in the talk-around mode.

3. Select a low power channel and power output should be 0.8-1.2 watt in the standard and talk-around modes.

5.15.2 TRANSMIT FREQUENCY

Monitor the transmit frequency with a communication monitor set to the channel frequency. At room temperature, the frequency should be within ± 400 Hz. This also checks the receive frequency.

5.15.3 TRANSMIT MODULATION

1. Select a channel not programmed for Call Guard (CTCSS/DCS) squelch and monitor the transmit signal with a communication monitor. Speak into the microphone with a normal voice and modulation should be approximately 3.4 kHz (wideband) or 1.4 kHz (narrow band).

2. Select a channel programmed for Call Guard squelch and with no voice or other microphone input signal, data deviation should be 1.0 kHz (wideband) or 0.8 kHz (narrow band) ± 200 Hz.

3. Speak into the microphone with a channel programmed for Call Guard squelch selected. Maximum total audio and Call Guard deviation should be 4.7 kHz (wideband) or 2.3 kHz (narrow band).

5.15.4 TRANSMITTER CURRENT DRAIN

Maximum current drain in the transmit mode should be as follows:

High Power - 2.0 A
Low Power - 950 mA

5.16 TEST CODE FUNCTIONS

5.16.1 GENERAL

When the special test operating code has been loaded as described in Section 5.2.3, various test channels and test functions can be selected. The functions selected by the various keys and the section in which they are described are as follows:

Key	Function (See Section)
SYS	Channel select mode (5.16.2)
GRP	Modulation select mode (5.16.3)
FCN SYS	RF power toggle (5.16.4)
FCN GRP	Wide/Narrow band select (5.16.4)
FCN 1	Microphone mute (5.16.4)
FCN 4	Carrier squelch (5.16.4)
Red Button	Parameter Edit Mode (5.16.5)

Table 5-1   Test Channels

Channel	Tx/Rx Freq. (MHz)
1	430.0125
2	432.5375
3	435.1125
4	437.5375
5	440.0125
6	442.5375
7	445.1125
8	447.5375
9	450.0125
10	452.5375
11	455.1125
12	457.5375
13	460.0125
14	462.5375
15	465.1125
16	467.5375
17	469.9875

5.16.2 TEST CHANNELS

Up to 17 test channels can be selected. To select the channel select mode, press the SYS key and then press the "*" key to increase the channel number and the "#" key to decrease the channel number. The selected channel frequency is indicated by the left-most six characters of the display (the right digit indicates the group number as described in the next section). The last selected channel is saved at power down. The test channels are listed in Table 5-1.

5.16.3 MODULATION MODES

Up to seven different subaudible modulation signals can be selected. To select the modulation select mode, press the GRP key. The selected modulation signal is indicated by the group number displayed as the right-most digit in the display. Press the "*" key to increase the group number and the "#" key to decrease the group number.

The last selected group is saved at power down, and the DCS/CTCSS schemes of Groups 4-7 are also active in the receive mode. The modulation signals selected by Groups 1-7 are as follows:

Group	Modulation Signal
1	No transmit subaudible modulation
2	134 Hz square wave
3	Tx data filter bypassed, 134 Hz square wave
4	DCS (Digital Call Guard squelch) 023 code
5	CTCSS (Tone CG squelch) 67.0 Hz code
6	CTCSS (Tone CG squelch) 100.0 Hz code
7	CTCSS (Tone CG squelch) 210.7 Hz code

5.16.4 MISCELLANEOUS FUNCTIONS

The following functions can be selected by pressing the FCN key and then another key:

FCN SYS - Toggles RF output power. Low power is indicated by the "**L**" icon in the display.

FCN GRP - Toggles receive IF bandwidth. Narrow band is indicated by "**C**" in the display.

FCN 1 - Toggles microphone mute. The microphone is muted when ♟ is indicated in the display.

FCN 4 - Selects carrier controlled squelch regardless of the CTCSS/DCS code selected by the Group function. This mode is indicated when M is displayed.

5.16.5 PARAMETER EDIT MODES

General

Some levels set during alignment can be manually controlled by selecting the Parameter Edit mode. This mode is selected and controlled by the following keys:

Red Button on Top Panel - Enables and disables the Parameter Edit mode indicated by the ▲ icon in the display.

"*"/"#" - Press the "*" key to increase the setting and the "#" key to decrease the setting.

FCN 0 - Saves the current setting and exits the Parameter Edit mode.

FCN 3 - Does not save the current setting, restores previous setting, and exits the Parameter Edit mode.

FCN GRP - Changes the edit value to "0".

Selecting Parameters

The parameters that can be selected and the key sequence used to select each are as follows:

FCN 5 (Receive RF Bandpass Filter) - Changing the number changes the center frequency.

FCN 6 (Receiver Squelch) - Increasing the number selects a tighter squelch setting for the currently selected channel bandwidth.

FCN 7 (Modulation Balance) - Increasing the number increases the signal level at the modulation summing point.

FCN 8 (Audio Deviation) - Increasing the number increases the transmit audio level.

FCN 9 (Data Deviation) - Increasing the number increases the data deviation level.

FCN 0 (RF Power Output) - Increasing the number increases the power output level for the selected range.

SECTION 6   LTR-NET OVERVIEW
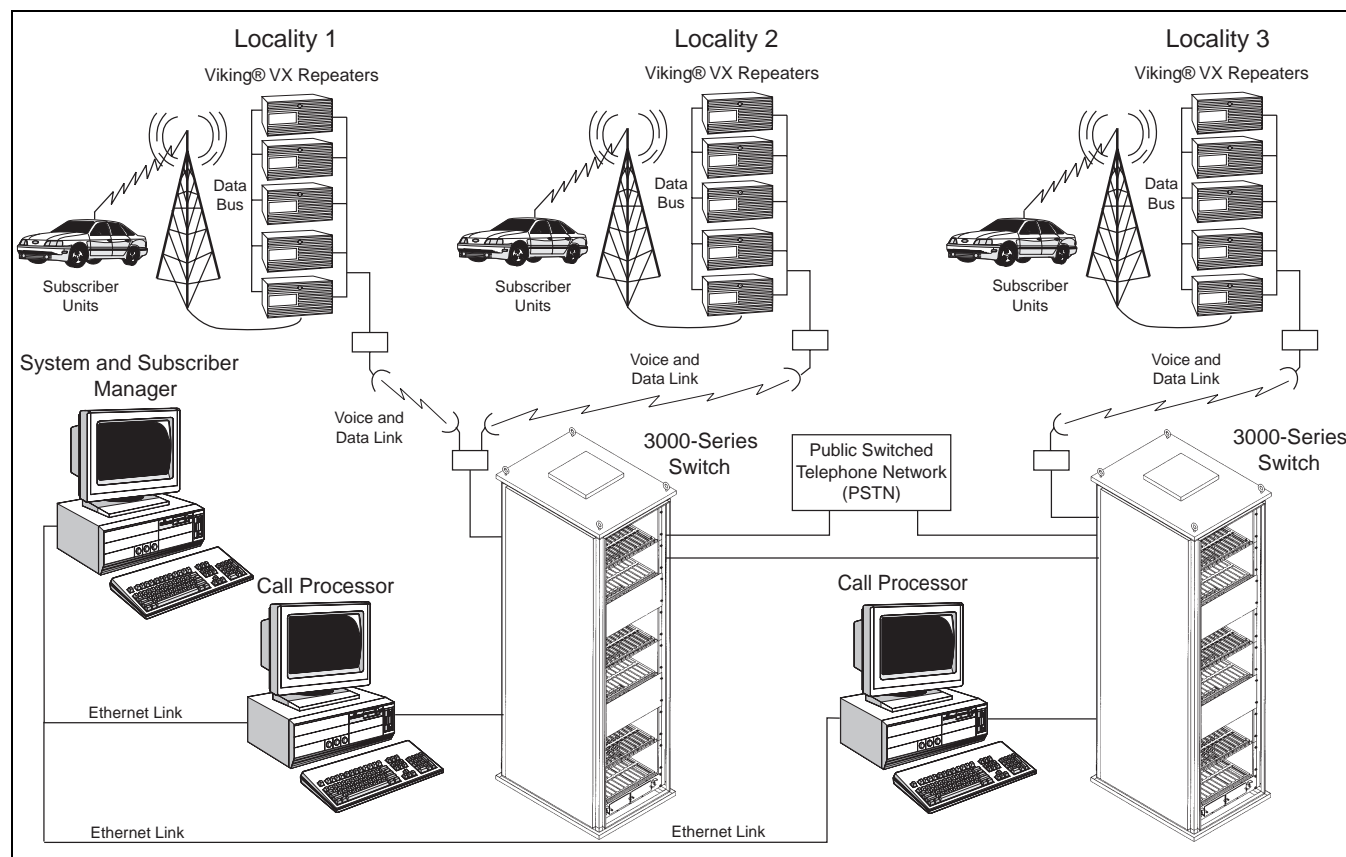
Figure 6-1   LTR-Net System Diagram

6.1 INTRODUCTION

6.1.1 GENERAL

LTR-Net™ is the next generation of LTR® trunked radio signaling. It provides many new enhanced operating features while maintaining compatibility with most current LTR equipment. Some new LTR-Net features include roaming, unique ID calls, and over-the-air reprogramming. Equipment changes include the addition of an LTR-Net 3000-Series switch and System and Subscriber Manager to provide system control. A diagram of an LTR-Net system is shown in Figure 6-1.

6.1.2 COMPATIBILITY WITH LTR

LTR Subscriber Units Operating in LTR-Net Systems

- Standard group calls occur in the normal manner. These calls can be to other LTR subscriber units or between LTR and LTR-Net subscriber units.

- Wide area group calls can be placed and received (see Section 6.4).

- LTR telephone calls can be placed and received in the normal manner.

- Enhanced LTR-Net features such as roaming and unique ID calls are not available.

- Current LTR subscriber units can remain in service and LTR-Net subscriber units added gradually. This makes upgrading to LTR-Net very convenient and less costly.

LTR-Net Subscriber Units Operating on LTR Systems

- LTR-Net subscriber units can be programmed for LTR operation. Therefore, they can place and receive LTR group and telephone calls in the normal manner.

- Enhanced LTR-Net features such as roaming and unique ID calls are not available to LTR-Net subscriber units operating on LTR systems.

6.1.3 LTR-NET FEATURES

Networking

- Multiple LTR-Net and LTR localities may be linked together to provide wide-area coverage.

- LTR-Net subscriber units can roam between LTR-Net localities and register and de-register automatically when entering and exiting.

    Calls from one type of subscriber unit can be patched to another type of subscriber unit at another locality. For example, an LTR-Net subscriber unit could talk to a conventional subscriber unit. Calls can even be cross-band, for example, an UHF conventional subscriber unit could talk to an 800 MHz LTR-Net subscriber unit.

Special Calls

- **Unique ID (UID) -** Calls to be placed to specific subscriber units in the same locality or some other locality.

- **Directed Group -** Calls can be placed to any group in the same locality or some other locality.

- **Telephone -** Calls can be placed over the public switched telephone network (PSTN).

- **Data -** Data can be transmitted to specific location selected by unique ID code (not currently available).

System Control

- When new channels are added to a locality, subscriber units can be updated with those channels over the air. This eliminates the need to bring them back in for reprogramming.

- Over-the-air subscriber unit programming allows the ID codes of up to 99 systems and 99 groups to be changed.

- The system/group currently selected by a subscriber unit can be changed over the air.

A temporary UID keyed to the ESN can be assigned to a subscriber unit when it roams to a new radio system (this feature has not yet been implemented).

- Unauthorized subscriber units can be temporarily or permanently disabled.

- A subscriber unit can be interrogated to determine if it is currently in service. It can also be interrogated for its ESN or unique ID code (see following).

Security

- Each LTR-Net subscriber unit is assigned a unique Electronic Serial Number (ESN), and no two subscriber units in existence should have the same ESN. This number can be interrogated as stated above and is used for such things as assigning a temporary UID.

- Over 65,500 unique ID codes can be assigned in each system. Each subscriber unit in a locality is usually assigned a different unique ID code although more than one can have the same code if desired.

- Unique ID and group validation (by home repeater/group ID) is performed. If an unauthorized ID is detected, the call is terminated.

Miscellaneous

- Home channel backup is provided by the use of a status channel at each locality. The status channel can be used for voice traffic the same as normal channels, but is usually not assigned as a home channel.

- Typical access time for group calls is the same as with LTR operation.

- Priority access, automatic emergency calls, status messaging, and system security keys are not available.

6.1.4 DEFINITIONS

The following are some terms that are used frequently when describing LTR-Net operation:

Group - A subscriber unit has selectable systems and groups. Each system can have several groups. The group selects the call type and the subscriber unit or units which receive the call. Refer to Section 2.3.12 for more information.

Home Repeater - Each selectable system of LTR and LTR-Net subscriber units has one of the locality repeaters assigned as their "home" repeater. This is the repeater from which "free" and "channel-in-use" information is received (see Section 6.6). In addition, with standard group calls, the home repeater number and a group ID form the "address" of the recipient of a call.

Locality - A group of co-located repeaters typically connected by a common data bus. Refer to Sections 6.2.3 and 2.3.12 for more information.

LTR Signaling - This popular EFJohnson radio trunking system provides the basis for the LTR-Net system. For a complete description of LTR trunking, refer to the LTR Application Note, Part No. 009-0001-002, Revision 8 or later.

Mobile - A transceiver mounted in a vehicle. This term may also be used generically to refer to any transceiver, either mobile or portable, since both operate basically the same. See also "Subscriber Unit".

Portable - A small handheld transceiver usually battery powered and carried by a person. See also "Subscriber Unit".

Site - See "Locality".

Status Repeater - The repeater at a locality designated to provide home channel backup. It transmits call information for all subscriber units on that locality. Refer to Section 6.6 for more information.

System, Radio - This refers to the radio equipment and other infrastructure that is accessed when a call is placed.

System, Selectable - A subscriber unit has selectable systems and groups. Each selectable system consists or one or more groups and is programmed with a unique home repeater (see Section 2.3.12 for more information). A radio system refers to the radio equipment that is accessed when calls are placed.

Subscriber Unit - A generic term referring to both the mobile and portable transceivers being used in the radio system.

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

Unique ID - A unique number from 1-65503 assigned to each subscriber unit. Although this number is assignable on a per locality basis, the same number is typically assigned on each locality a subscriber unit can access.

6.2 SYSTEM ARCHITECTURE

6.2.1 INTRODUCTION

A diagram of a typical LTR-Net system is shown in Figure 6-1. The number or localities, repeaters per locality, number of 3000-series switches, and other system parameters are determined by the requirements of the particular system. The following is more information on the components shown in Figure 6-1.

6.2.2 SUBSCRIBER UNITS

Subscriber units operating in an LTR-Net locality must be the LTR-Net or LTR type. They may be the mounted in a vehicle (mobiles) and or carried (portables). The features available with each type are as follows:

LTR-Net Subscriber Units

These subscriber units are designed for operation in an LTR-Net radio system and therefore have all LTR-Net features. An optional DTMF keypad is required to place telephone, directed group, and unique ID calls. These subscriber units can also be programmed for LTR and conventional operation, so will operate in those types of radio systems. Standard group and also telephone calls can be placed when operating in an LTR system.

LTR Subscriber Units

These transceivers are designed for operation in LTR and conventional radio systems. They can also be used in an LTR-Net radio system to make standard and wide area group calls and telephone calls. Standard group calls are to mobiles in the same locality, and wide area group calls are to mobiles in some other locality. Enhanced LTR-Net features such as unique ID calls and full roaming capability are not available.

6.2.3 REPEATERS

Viking® VX 2000-series repeaters are used in an LTR-Net system. Currently, models are available for the UHF, 800 MHz, and 900 MHz frequency bands. One repeater is required for each radio channel.

As with standard LTR repeaters, all the signal processing for the channel is performed by the logic unit in each repeater. This is referred to as distributive processing, and it eliminates the need for a separate controller at each locality.

Audio (voice) and data signals are routed from each repeater to a 3000-series switch. This allows the switch to route the call to other localities and also control certain repeater functions. The link to the switch may be a direct connection if the switch is at the same location or some other type such as microwave, fiber optic, RF, or telephone line. The audio interface to the switch is a standard 600-ohm, four-wire path (transmit and receive pair). The data signal can use an RS-232 interface or it can be FSK tones using the same or a different audio path than the voice.

A "locality" refers to repeaters at the same location that are interconnected by a common high-speed data bus. Up to 20 repeaters can be interconnected, so a locality can include up to 20 repeaters. Although more than 20 repeaters could be co-located, they would be considered separate localities because they are not interconnected by the same data bus. A single data bus can be up to 500 feet long.

Standard LTR and conventional Viking VX and 8000-series repeaters can also be connected to the 3000-Series switch. However, since they would not be using LTR-Net software, the only enhanced LTR-Net feature provided would be wide area group calling (see Section 6.4).

6.2.4 3000-SERIES SWITCH

The 3000-Series Switch connects several different forms of communication together to form a communications network. Each switch is controlled by a Call Processor and System and Subscriber Manager (see next sections). A switch can consist of up to three racks, each containing up to eight shelves. Since each shelf has 12-16 device slots, up to 96-128 slots per rack and up to 288-384 slots per switch are available. Many different modules are available for installation in these slots. The exact number and type required is determined by the requirements of each system.

A single 3000-Series Switch can control up to 30 repeaters. Therefore, if a LTR-Net network consisting of several localities has more than 30 repeaters, one switch is required for every 30 repeaters. A switch can be located at one of the repeater localities or it can be at a separate location. An audio and data link connects the switch to each repeater as described in the preceding section.

When a call is made by a subscriber unit in one locality to a subscriber unit in another locality, the switch provides the necessary patch. Likewise, when a telephone call is placed by a subscriber unit, the switch routes it to the Public Switched Telephone Network (PSTN). Calls can also be routed to a PABX (Private Automatic Branch Exchange). The dial access codes and least cost routing facilities of the PABX can then be utilized.

6.2.5 CALL PROCESSOR

The Call Processor is a Windows NT-based personal computer running switch management software. The Call Processor serves as an interface between the switch and the System and Subscriber Manager (see next section). It contains the database used to process calls on the switch and also logs call information from the switch. The Call Processor performs such tasks as processing wide area calls, subscriber unit registration, and Interrogate and Reassign requests. One Call Processor is required per switch, and it is connected to the switch by two 19,200 baud data links.

6.2.6 SYSTEM AND SUBSCRIBER MANAGER

The System and Subscriber Manager (SSM) is also a Windows NT-based personal computer. It runs the software which provides overall system control. One or more SSMs may be used to control the system. This allows, for example, the system administrator to have overall system control and then permit other operators limited control privileges. Access is by password only, and only functions authorized to a particular user can be accessed. This ensures that only authorized personnel can modify and monitor system resources.

Some SSM functions are as follows:

- Set up and authorize auxiliary and telephone interconnect calls on a unique ID basis. Also authorize group calls on a locality/home/group basis.

- Track the location of individual LTR-Net subscriber units by unique ID.

- Control wide area auxiliary calls by unique ID.

- Track wide area group calls by locality/home/group or unique ID.

- Set up command calls such as Reassign, Interrogate, Mobile Disable, and others.

- Monitor and display information on system activity.

- Record information on individual subscriber unit system usage in a standard database format. This

information can then be exported and used by billing software to generate customer billing.

6.3 STANDARD GROUP CALLS

Standard group calls are between subscriber units at the same locality and use ID codes 1-239 that are assignable on each home repeater. A group ID can be assigned to one subscriber unit or a group of subscriber units as desired. To place a standard group call, all the user does is select the group programmed for the group being called and press the PTT switch. No number is dialed using a DTMF keypad as with special calls described in Section 6.5.

Selectable groups used to make standard group calls are programmed with a group ID code, and the selectable system is programmed with a home repeater number. This home repeater/ID code form the "address" of the group call. Since each selectable system can be programmed with a different home repeater, standard group calls can be placed to any group in a locality.

Standard group calls hold a repeater for only the duration of a transmission, not for the entire call. This provides maximum system efficiency because the time between transmissions can be used by others.

6.4 WIDE AREA GROUP CALLS

The wide area group calling feature allows standard group calls from LTR or LTR-Net subscriber units to be routed to any locality in the LTR-Net system.

Specific locality/home/group ID combinations can be programmed in the SSM (see Section 6.2.6) for wide area calls. Then when a standard group call is detected on one of these combinations, it is automatically routed to the specified localities as well as occurring on the home locality. The home/group can be different on each wide area locality if desired.

Each wide area locality/home/group involved in a wide area call can be programmed as follows:

- The call is always routed to the specified locality, home, and group (if resources are available).

- The call is routed to a specified locality only if a call on the home/group has been recently detected. This results in more efficient use of system resources.

- The call is routed to a specific locality if a tracked unique ID is registered on that locality.

Wide area group calls can also be made over standard LTR and conventional Viking VX repeaters that are connected to a 3000-series LTR-Net switch. However, no other LTR-Net enhanced features are available with those repeaters.

Wide area group calls continue to be received while registration on a new locality occurs. For example, the transceiver can exit a locality while receiving a call, register on a new locality, and then continue receiving the call on the new locality. In addition, a call can be received on the new locality before registration occurs if the call is already active on the new locality.

6.5 SPECIAL CALLS

6.5.1 GENERAL

LTR-Net subscriber units can place Auxiliary, Telephone, and Data special calls. These calls are not available to LTR subscriber units being used on an LTR-Net system. When a special call is placed, a number is dialed which specifies the recipient of the call. The DTMF keypad used to dial this number may be optional, and it is located on the microphone with mobile subscriber units and on the front panel with portable units. Special calls hold the channel until the entire call is complete, not just until the transmission is complete as with group calls. More information on each special call follows.

6.5.2 AUXILIARY CALLS

Auxiliary calls include Unique ID and Directed Group calls. Unique ID calls allow calls to be selectively placed to an individual subscriber unit in any locality. Likewise, Directed Group calls allow standard group calls allow group calls to be selectively placed to any group in any locality. Refer to Section 2.9.2 for more information on these calls.

6.5.3 TELEPHONE CALLS

Telephone calls allow calls to be placed over the public switched telephone network. After the system is accessed, a dial tone sounds and the telephone number being called is entered using the DTMF keypad. Since most subscriber units are half-duplex (do not transmit and receive at the same time), it is not possible for the mobile user to talk and listen at the same time.

If a unique telephone number has been assigned to subscriber unit, it can be called directly from a land-side telephone. If not, the radio system is called and then the unique ID of the mobile must be overdialed similar to when a unique ID call is placed by a subscriber unit.

If a subscriber unit has been assigned a unique telephone number, that number can also be used for unique ID calls. This allows mobile-to-mobile unique ID calls to be made by simply dialing the telephone number of the desired subscriber unit.

6.5.4 DATA CALLS

NOTE: Data calls are not currently available.

Data calls allow data to be transmitted to a specific unique ID. The audio of the receiving equipment is automatically muted as data is received. Data may be transmitted back and forth several times until the entire data exchange is complete because the channel is held for the duration of the call. To transmit a data call, a group programmed for the data special call is selected and then the unique ID is entered, usually automatically by the data equipment. Data calls are received the same as unique ID calls.

6.6 HOME CHANNEL BACKUP

6.6.1 INTRODUCTION

An LTR-Net repeater locality (site) consists of up to twenty interconnected repeaters (see Section 6.2.3). One of these repeaters is usually designated as status repeater and the others are designated as home repeaters (see following). The subscriber units are programmed with the channel numbers of these repeaters. Data signaling can occur continuously with

voice on any repeater because the data occupies the subaudible frequencies below the voice band.

6.6.2 HOME REPEATERS

The home repeater is used by the subscriber unit as its primary source of incoming call and free repeater information. When not receiving or transmitting a call, it is monitoring this repeater. The home repeater is always used to make a call if it is not busy. In addition, if roaming mobiles searching for a new locality cannot locate a suitable status repeater, the home repeater is monitored (see Section 2.9.4). As previously mentioned, up to 239 group ID codes can be assigned on each home repeater, and the home repeater and ID code form the "address" when making group calls. All programmable systems which access the same locality should be programmed with the same home repeater (see Section 3.11.2).

6.6.3 STATUS REPEATERS

General

One repeater at each locality is designated the status repeater. The primary function of this repeater is to provide backup for the other repeaters at a locality that are assigned as home repeaters. It continuously transmits call information for all calls occurring at that locality. The status repeater is used for voice traffic, but is usually not assigned as a home repeater because there would then be no home channel backup on that repeater (see following). Roaming mobiles searching for a new locality monitor the status repeaters. Then after registration occurs, the home repeater is monitored.

Backup Operation

If subscriber units were limited to only their home repeater to receive update information and that repeater became inoperative, all subscriber units that were assigned to that repeater would then be unable to place or receive calls. To prevent this from happening, the status repeater can also be monitored for call information.

If the signal from the home repeater is lost or falls below a minimum threshold, the subscriber unit automatically begins monitoring the locality status repeater. If a usable signal is detected from the status

repeater, it continues to monitor that repeater. If a message is detected that has its home repeater as the "channel-in-use" or "free" repeater, the subscriber unit then returns to monitoring its home repeater.

A roaming subscriber unit also monitors the status repeater in this manner when the home repeater signal drops below the threshold level. However, the status repeater signal level will probably also be below the threshold, so the subscriber unit then begins searching for a new locality.

6.6.4 HOME CHANNEL ALIASING

The LTR-Net Home Channel Aliasing feature increases the number of addresses available on a locality for group calls. It does this by allowing calls to be programmed on non-existent home repeaters.

Each home repeater can be programmed with up 1-239 group ID codes. Assume a locality has four active repeaters and one of these is the status repeater (which is normally not assigned as a home repeater as described in Section 6.6.3). The number of groups that can be programmed are then as follows:

Without Aliasing - 3 x 239 or 717 groups
With Aliasing - 20 x 239 or 4780 groups

When a call is placed on a non-existent home repeater, the subscriber unit automatically uses the next lower numbered active repeater. Refer to Section 2.9.7 for more information.

NOTE: Since this feature does not increase system capacity, adding too many users may result in unsatisfactory operation due to frequent busy conditions.

6.7 OTHER LTR-NET FEATURES

6.7.1 UNIQUE ID CODES

Each LTR-Net subscriber unit in an LTR-Net system is assigned a unique ID (a different unique ID can be programmed for each locality if desired). Up to 65,504 user ID codes are assignable in each locality, and a few other codes are used for system functions. When an LTR-Net subscriber unit places a special call, it transmits its unique ID code along with other information such as the call type. This data is received by the repeater and passed on to the SSM.

Uses of unique ID codes include registering and de-registering on a locality, unit identification, airtime billing, and unique ID calls (see "Unique ID Calls" in Section 6.5.2). A call can also be made to individual subscriber units using a group call if the group is assigned to only one subscriber unit.

A temporary unique ID code can also be assigned over-the-air. This may be required to allow a full roaming subscriber unit to access a locality that is not part of its network. Temporary unique ID codes are keyed to the ESN of the subscriber unit (see next section). A roaming subscriber unit may also request a temporary unique ID code. If no response is received from the system after two temporary ID requests, it is interpreted as a denied access and the mobile then selects another locality.

NOTE: The preceding feature has not yet been implemented.

6.7.2 ELECTRONIC SERIAL NUMBER (ESN)

Each subscriber unit, both mobile and portable, is given an electronic serial number at the factory. No two LTR-Net subscriber units should ever have the same ESN. This is a 32-bit number with the first 7 bits reserved for the manufacturer code and the other 25 for the serial number. This allows for up to 128 manufacturers and over 33.5 million serial numbers per manufacturer. The ESN can be interrogated over the air as described next.

6.7.3 ESN AND UNIQUE ID REQUESTS

The system operator can request the Electronic Serial Number (see preceding section) or unique ID (see Section 6.7.1) that is programmed in a subscriber unit. If the ESN is desired, the unique ID code of the subscriber unit is specified, and vice versa. The subscriber unit then responds with the requested information.

6.7.4 INTERROGATE

A system manager can interrogate any subscriber unit in the field to determine if it is in service. The unit is selected by specifying its unique ID code. If it is in service, it automatically responds with an acknowl-

edge message, and this will be indicated on the system manager's screen.

6.7.5 KILL AND SLEEP

If a subscriber unit has been lost or stolen or is being used to interfere with communications, it can be permanently disabled by the kill command or temporarily disabled by the Sleep command. If the Kill command is sent, the unit responds indicating that it has received the message and then it permanently disables itself. It must then be brought back in for reprogramming to make it functional again. If the sleep command is sent instead, the transceiver is disabled until the Interrogate command is sent. Refer to Section 2.9.6 for more information.

6.7.6 AUTO-REGISTRATION AND DE-REGISTRATION

LTR-Net subscriber units are programmed with the locality information of all localities they can roam into. This includes the channel number or frequency of the status repeater of each locality. The repeaters that are active at each site can then be determined by automatic channel update messages (see Section 6.7.7). Roaming must be enabled and an LTR-Net system selected for roaming to occur (it is not necessary to enable scanning).

Normally, a subscriber unit monitors its home channel for incoming call and free channel information. When moving out of range of a locality, the signal from the home repeater decreases below a programmable threshold level. With all transceivers except the 8170 portable, this threshold level is determined by squelch levels, and with the 8170, it is determined by the percentage of good data messages received over a certain period.

When the home repeater signal strength drops below the threshold, the status channel of that locality is then monitored (see Section 6.6). If its signal strength is also below the threshold, the subscriber unit then begins searching for another locality by checking the status repeater of other programmed localities. If one is located with a signal above the programmed threshold, it will attempt to register on the locality. If no suitable status repeaters could be located, the programmed home repeaters are monitored.

When a new locality is located, the subscriber unit registers on the locality by sending messages indicating its unique ID code and the home channel it will monitor. The system then knows the location of that subscriber unit and will automatically route unique ID calls to the new locality.

Automatic locality search can be automatically initiated if two consecutive unsuccessful access attempts occur. This feature is always enabled except with 8170 portable transceivers where it can be enabled or disabled by programming.

When a subscriber unit is no longer in service (power is turned off), a de-registration message is automatically sent if possible. This prevents the system from wasting resources trying to reach out-of-service units. Power is automatically held on until this message is sent. De-registration is not available with 8170 portable transceivers.

6.7.7 NEW CHANNEL UPDATES

New subscriber units are initially programmed with the channel numbers of all repeaters at each locality. These are then the channels that can be accessed when placing and receiving calls on that locality. If new channels are later added, the subscriber units can be updated with the new channels over the air. This eliminates the need to bring subscriber units back in for reprogramming. Refer to Section 2.9.5 for more information.

SECTION 7   PARTS LIST

KEYPAD/DISPLAY BOARD ASSEMBLY

Ref No	Description	Part No.
COMPLETE ASSEMBLIES		
A001*	Keypad/display board 51300081	022-3909-002
A002*	Logic board 51300035	022-3909-016
A003*	RF board 51300013	022-3909-023
A004*	Plastic front cover 20101361 (includes items 1-14 on page 6-11)	022-3909-025
A005*	Flex cable w/microsw 51300134	022-3909-053
FLEXIBLE CABLE ASSEMBLY		
C902	GRM39Y5V104Z25PT capacitor	022-3909-074
C903	GRM39Y5V104Z25PT capacitor	022-3909-074
R902	CR 1/16W 103JV resistor	022-3909-006
S901	Dome switch 4K-2928	-
S902	Dome switch 4K-2928	-
S903	Dome switch 4K-2928	-
S904	Dome switch 4K-2928	-
VR901*	20k ohm vol control/on-off switch 7007A203001	022-3909-162
KEYPAD/DISPLAY BOARD ASSEMBLY		
C101	GRM39Y5V104Z25PT capacitor	022-3909-074
C102	ECS-T1CY475 capacitor	022-3909-111
C103	GRM39X7R103K50PT capacitor	022-3909-073
C104	ECS-T1CY475 capacitor	022-3909-111
C105	GRM39Y5V104Z25PT capacitor	022-3909-074
C106	GRM39Y5V104Z25PT capacitor	022-3909-074
C107	GRM39Y5V224Z16PT capacitor	022-3909-087
C108	GRM39Y5V104Z25PT capacitor	022-3909-074
C109	ECS-T1CY475 capacitor	022-3909-111
C110	GRM39COG101J50PT capacitor	022-3909-071
C111	ECS-T1AC226M capacitor	022-3909-110
C113	GRM39Y5V104Z25PT capacitor	022-3909-074
C115	ECS-T1AD476M capacitor	022-3909-112
C202	GRM39Y5V104Z25PT capacitor	022-3909-074
C203	GRM39Y5V224Z16PT capacitor	022-3909-087
C204	GRM39COG330J50PT capacitor	022-3909-089

KEYPAD/DISPLAY BOARD ASSEMBLY

Ref No	Description	Part No.
C205	ECS-T1CX106 capacitor	022-3909-109
C206	ECS-T1CY105 capacitor	022-3909-108
C207	ECS-T1CY105 capacitor	022-3909-108
C501	GRM39X7R182K50PT capacitor	022-3909-233
C502	GRM39Y5V104Z25PT capacitor	022-3909-074
D303	17-21VGC/TR8 backlight LED	022-3909-202
D304	17-21VGC/TR8 backlight LED	022-3909-202
D305	17-21VGC/TR8 backlight LED	022-3909-202
D306	17-21VGC/TR8 backlight LED	022-3909-202
D307	17-21VGC/TR8 backlight LED	022-3909-202
D308	17-21VGC/TR8 backlight LED	022-3909-202
D309	17-21VGC/TR8 backlight LED	022-3909-202
D310	17-21VGC/TR8 backlight LED	022-3909-202
D401	DA114 diode to key switch	022-3909-191
D402	DA114 diode to key switch	022-3909-191
D403	DA114 diode to key switch	022-3909-191
D404	DA114 diode to key switch	022-3909-191
D405	DA114 diode to key switch	022-3909-191
D901	94-22VGC LCD backlight LED	022-3909-200
D902	94-22VGC LCD backlight LED	022-3909-200
EH1*	12000020 LCD 1710T4138001	022-3909-201
J801	AXN330130P logic bd connector	022-3909-121
J802	04-6206-020-000-800 flex circuit connector	022-3909-124
MK1	31.5 x 1.5 x 2.5 zebra	022-3909-120
MK2	21600024 (3K-2684) reflector	022-3909-141
MK3	22000060 (3K2687) LCD brkt	022-3909-143
Q101	BCX51-16TR driver SOT89	022-3909-165
Q102	UMT3904 switching SC-70	022-3909-170
Q103	UMT3904 switching SC-70	022-3909-170
Q104	BCX51-16TR driver SOT89	022-3909-165
Q105	UMT3904 switching SC-70	022-3909-170
Q106	UMT3906 switching SC-70	022-3909-171
Q201	DTC144EUA switching SC-70	022-3909-172
Q202	DTC144EUA switching SC-70	022-3909-172
Q301	UMT3906 switching SC-70	022-3909-171
Q302	UMT3904 switching SC-70	022-3909-170
Q401	DTA123EUA switching SC-70	022-3909-226

KEYPAD/DISPLAY BOARD ASSEMBLY

Ref No	Description	Part No.
Q402	DTA123EUA switching SC-70	022-3909-226
Q403	DTA123EUA switching SC-70	022-3909-226
Q404	UMT3904 switching SC-70	022-3909-170
R101	CR 1/16W 104JV resistor	022-3909-007
R102	CR 1/16W 473JV resistor	022-3909-042
R103	CR 1/16W 220JV resistor	022-3909-019
R104	CR 1/16W 473JV resistor	022-3909-042
R105	CR 1/16W 4R7JV resistor	022-3909-245
R106	CR 1/16W 4R7JV resistor	022-3909-245
R107	CR 1/16W 104JV resistor	022-3909-007
R108	CR 1/16W 473JV resistor	022-3909-042
R109	CR 1/16W 220JV resistor	022-3909-019
R110	CR 1/16W 473JV resistor	022-3909-042
R111	CR 1/16W 273JV resistor	022-3909-026
R112	CR 1/16W 4R7JV resistor	022-3909-245
R115	CR 1/16W 273JV resistor	022-3909-026
R116	CR 1/16W 473JV resistor	022-3909-042
R201	CR 1/16W 104JV resistor	022-3909-007
R202	CR 1/16W 223JV resistor	022-3909-022
R203	CR 1/16W 333JV resistor	022-3909-031
R204	CR 1/16W 103JV resistor	022-3909-006
R205	CR 1/16W 123JV resistor	022-3909-010
R206	CR 1/16W 123JV resistor	022-3909-010
R207	CR 1/16W 272JV resistor	022-3909-227
R208	CR 1/16W 272JV resistor	022-3909-227
R301	CR 1/16W 221JV resistor	022-3909-020
R302	CR 1/16W 221JV resistor	022-3909-020
R303	CR 1/16W 221JV resistor	022-3909-020
R304	CR 1/16W 221JV resistor	022-3909-020
R305	CR 1/16W 221JV resistor	022-3909-020
R306	CR 1/16W 221JV resistor	022-3909-020
R307	CR 1/16W 472JV resistor	022-3909-041
R308	CR 1/16W 104JV resistor	022-3909-007
R310	CR 1/16W 104JV resistor	022-3909-007
R311	CR 1/16W 000JV resistor	022-3909-001
R401	CR 1/16W 473JV resistor	022-3909-042
R402	CR 1/16W 473JV resistor	022-3909-042
R403	CR 1/16W 473JV resistor	022-3909-042
R404	CR 1/16W 473JV resistor	022-3909-042
R408	CR 1/16W 104JV resistor	022-3909-007
R409	CR 1/16W 104JV resistor	022-3909-007
R411	CR 1/16W 104JV resistor	022-3909-007
R412	CR 1/16W 104JV resistor	022-3909-007
R413	CR 1/16W 104JV resistor	022-3909-007

RF BOARD ASSEMBLY

Ref No	Description	Part No.
R414	CR 1/16W 104JV resistor	022-3909-007
R415	CR 1/16W 104JV resistor	022-3909-007
R416	CR 1/16W 473JV resistor	022-3909-042
R501	CR 1/16W 104JV resistor	022-3909-007
R502	CR 1/16W 473JV resistor	022-3909-042
R503	CR 1/16W 562JV resistor	022-3909-045
R504	CR 1/16W 123JV resistor	022-3909-010
R505	CR 1/16W 332JV resistor	022-3909-030
R506	CR 1/16W 332JV resistor	022-3909-030
R508	CR 1/16W 332JV resistor	022-3909-030
RT509	NTCC16Y 473K 410H thermistor	022-3909-231
U005*	CMS27P44 internal microphone 13200025	022-3909-204
U101*	NJM2073M external audio amp 11100048	022-3909-179
U102*	NJM2073M internal audio amp 11100048	022-3909-179
U201	TC4W66FU in/ext mic sel sw SSOP-8	022-3909-189
U501	LC75834W LCD driver, SQFP48	022-3909-117

RF BOARD ASSEMBLY

Ref No	Description	Part No.
C102	GRM39COG050C50PT capacitor	022-3909-065
C105	GRM39COG471J50PT capacitor	022-3909-096
C106	GRM39COG050C50PT capacitor	022-3909-065
C108	GRM39X7R102K50PT capacitor	022-3909-072
C109	ECS-T1CY475 capacitor	022-3909-111
C110	GRM39Y5V104Z25PT capacitor	022-3909-074
C112	GRM39X7R102K50PT capacitor	022-3909-072
C113	GRM39COG050C50PT capacitor	022-3909-065
C114	GRM39COG080D50PT capacitor	022-3909-068
C115	GRM39COG1R5C50PT capacitor	022-3909-246
C116	GRM39COG080D50PT capacitor	022-3909-068
C118	GRM39COG050C50PT capacitor	022-3909-065
C120	GRM39COG220J50PT capacitor	022-3909-083
C122	GRM39COG220J50PT capacitor	022-3909-083
C123	GRM39COG101J50PT capacitor	022-3909-071
C124	GRM39COG331J50PT capacitor	022-3909-090
C125	GRM39COG221J50PT capacitor	022-3909-084
C126	GRM39COG471J50PT capacitor	022-3909-096
C127	GRM39X7R102K50PT capacitor	022-3909-072
C130	GRM39X7R223K50PT capacitor	022-3909-086
C132	GRM39X7R102K50PT capacitor	022-3909-072

RF BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.	Ref No	Description	Part No.
C136	ECS-T1CY475 capacitor	022-3909-111	C322	GRM39COG050C50PT capacitor	022-3909-065
C137	GRM39X7R103K50PT capacitor	022-3909-073	C323	GRM39COG050C50PT capacitor	022-3909-065
C138	GRM39COG471J50PT capacitor	022-3909-096	C324	GRM39COG090D50PT capacitor	022-3909-069
C140	GRM39X7R102K50PT capacitor	022-3909-072	C325	GRM39COG040C50PT capacitor	022-3909-064
C141	GRM39Y5V224Z25PT capacitor	022-3909-087	C326	GRM39COG060D50PT capacitor	022-3909-066
C142	ECS-T1CY475 capacitor	022-3909-111	C327	GRM39COG120J50PT capacitor	022-3909-077
C143	GRM39COG221J50PT capacitor	022-3909-234	C328	GRM39COG030C50PT capacitor	022-3909-063
C144	ECS-T1CX106 capacitor	022-3909-109	C330	GRM39COG020C50PT capacitor	022-3909-062
C145	GRM39COG101J50PT capacitor	022-3909-238	C331	GRM39X7R103K50PT capacitor	022-3909-073
C201	ECS-T1CY106 capacitor	022-3909-239	C333	GRM39COG030C50PT capacitor	022-3909-063
C202	GRM39Y5V104Z25PT capacitor	022-3909-074	C336	GRM39COG471J50PT capacitor	022-3909-096
C203	ECS-T1CY475 capacitor	022-3909-111	C337	GRM39COG050C50PT capacitor	022-3909-065
C206	ECS-T1CX106 capacitor	022-3909-109	C338	GRM39COG030C50PT capacitor	022-3909-063
C207	GRM39X7R102K50PT capacitor	022-3909-072	C340	GRM39X7R102K50PT capacitor	022-3909-072
C208	GRM39COG471J50PT capacitor	022-3909-096	C341	GRM39COG240J50PT capacitor	022-3909-
C210	GRM39Y5V224Z25PT capacitor	022-3909-087	C401	GRM39COG160J50PT capacitor	022-3909-081
C211	GRM39X7R103K50PT capacitor	022-3909-073	C403	GRM39COG050C50PT capacitor	022-3909-065
C214	GRM39Y5V104Z25PT capacitor	022-3909-074	C404	ECS-T1CX106 capacitor	022-3909-109
C215	ECS-T1CY225 capacitor	022-3909-240	C406	GRM39COG220J50PT capacitor	022-3909-083
C216	GRM39Y5V104Z25PT capacitor	022-3909-074	C407	GRM39Y5V474Z25PT capacitor	022-3909-099
C218	GRM39Y5V104Z25PT capacitor	022-3909-074	C408	GRM39Y5V224Z25PT capacitor	022-3909-087
C219	ECS-T1CY475 capacitor	022-3909-111	C410	GRM39COG820J50PT capacitor	022-3909-106
C220	ECS-T1CY475 capacitor	022-3909-111	C411	GRM39X7R102K50PT capacitor	022-3909-072
C221	GRM39Y5V104Z25PT capacitor	022-3909-074	C412	ECS-T1CY475 capacitor	022-3909-111
C222	ECS-T1CX106 capacitor	022-3909-109	C413	GRM39X7R223K25PT capacitor	022-3909-086
C223	GRM39X7R473K50PT capacitor	022-3909-098	C414	GRM39X7R472K50PT capacitor	022-3909-097
C224	ECS-T1CY475 capacitor	022-3909-111	C415	GRM39COG221J50PT capacitor	022-3909-084
C225	GRM39Y5V104Z25PT capacitor	022-3909-074	C416	GRM39COG221J50PT capacitor	022-3909-084
C227	GRM39COG050C50PT capacitor	022-3909-065	C417	GRM39X7R473K50PT capacitor	022-3909-098
C301	GRM39COG070D50PT capacitor	022-3909-067	C418	GRM39X7R103K50PT capacitor	022-3909-073
C302	GRM39COG070D50PT capacitor	022-3909-067	C420	GRM39X7R102K50PT capacitor	022-3909-072
C303	GRM39COG180J50PT capacitor	022-3909-082	C421	GRM39Y5V104Z25PT capacitor	022-3909-074
C304	GRM39COG030C50PT capacitor	022-3909-063	C422	GRM39X7R472K50PT capacitor	022-3909-097
C305	GRM39COG030C50PT capacitor	022-3909-063	C423	GRM39X7R472K50PT capacitor	022-3909-097
C306	GRM39COG180J50PT capacitor	022-3909-082	C424	GRM39X7R103K50PT capacitor	022-3909-073
C307	GRM39COG050C50PT capacitor	022-3909-065	C425	GRM39COG220J50PT capacitor	022-3909-083
C308	GRM39COG030C50PT capacitor	022-3909-063	C426	GRM39COG390J50PT capacitor	022-3909-092
C312	GRM39X7R103K50PT capacitor	022-3909-073	C427	GRM39X7R103K50PT capacitor	022-3909-073
C313	GRM39X7R103K50PT capacitor	022-3909-073	C428	GRM39X7R103K50PT capacitor	022-3909-073
C314	GRM39COG030C50PT capacitor	022-3909-063	C429	GRM39X7R103K50PT capacitor	022-3909-073
C315	GRM39COG150J50PT capacitor	022-3909-079	C500	GRM39COG100D50PT capacitor	022-3909-070
C316	GRM39X7R102K50PT capacitor	022-3909-072	C501	GRM39X7R223K25PT capacitor	022-3909-086
C317	GRM39COG471J50PT capacitor	022-3909-096	C502	GRM39COG040C50PT capacitor	022-3909-064
C318	GRM39COG030C50PT capacitor	022-3909-063	C503	GRM39COG3R3C50PT capacitor	022-3909-247
C320	GRM39COG120J50PT capacitor	022-3909-077	C504	GRM39COG471J50PT capacitor	022-3909-096
C321	GRM39COG090D50PT capacitor	022-3909-069	C505	GRM39COG080D50PT capacitor	022-3909-068

RF BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.
C506	GRM39COG220J50PT capacitor	022-3909-083
C507	GRM39COG070D50PT capacitor	022-3909-067
C508	GRM39COG471J50PT capacitor	022-3909-096
C510	GRM39COG471J50PT capacitor	022-3909-096
C511	GRM39COG070D50PT capacitor	022-3909-067
C512	GRM39COG050C50PT capacitor	022-3909-065
C513	GRM39COG050C50PT capacitor	022-3909-065
C514	GRM39COG020C50PT capacitor	022-3909-062
C515	GRM39X7R102K50PT capacitor	022-3909-072
C516	GRM39COG330J50PT capacitor	022-3909-089
C517	GRM39COG050C50PT capacitor	022-3909-065
C518	GRM39COG471J50PT capacitor	022-3909-096
C520	GRM39COG130J50PT capacitor	022-3909-078
C521	GRM39COG150J50PT capacitor	022-3909-079
C529	GRM39COG561J50PT capacitor	022-3909-101
C530	GRM39COG090D50PT capacitor	022-3909-069
C531	GRM39X7R223K25PT capacitor	022-3909-086
C532	GRM39COG040C50PT capacitor	022-3909-064
C533	GRM39COG030C50PT capacitor	022-3909-063
C534	GRM39X7R103K50PT capacitor	022-3909-073
C535	GRM39COG070D50PT capacitor	022-3909-067
C536	GRM39COG220J50PT capacitor	022-3909-083
C537	GRM39COG070D50PT capacitor	022-3909-067
C538	GRM39COG471J50PT capacitor	022-3909-096
C539	GRM39COG1R5C50PT capacitor	022-3909-246
C540	GRM39COG471J50PT capacitor	022-3909-096
C541	GRM39COG050C50PT capacitor	022-3909-065
C544	GRM39COG050C50PT capacitor	022-3909-065
C545	GRM39COG471J50PT capacitor	022-3909-096
C546	GRM39COG471J50PT capacitor	022-3909-096
C547	GRM39COG471J50PT capacitor	022-3909-096
C548	GRM39COG030C50PT capacitor	022-3909-063
C550	GRM39COG050C50PT capacitor	022-3909-065
C551	GRM39COG030C50PT capacitor	022-3909-063
C601	ECS-T1CY475 capacitor	022-3909-111
C602	GRM39Y5V104Z25PT capacitor	022-3909-074
C603	GRM39X7R103K50PT capacitor	022-3909-073
C604	GRM39X7R103K50PT capacitor	022-3909-073
C605	ECS-T1CY475 capacitor	022-3909-111
C606	GRM39Y5V104Z25PT capacitor	022-3909-074
C607	ECS-T1CY475 capacitor	022-3909-111
C608	ECS-T1CY475 capacitor	022-3909-111
C610	GRM39X7R103K50PT capacitor	022-3909-073
C611	GRM39X7R103K50PT capacitor	022-3909-073
C612	ECS-T1CY105 capacitor	022-3909-108

Ref No	Description	Part No.
C613	GRM39X7R103K50PT capacitor	022-3909-073
C614	GRM39X7R103K50PT capacitor	022-3909-073
C615	ECS-T1CY475 capacitor	022-3909-111
C616	GRM39Y5V104Z25PT capacitor	022-3909-074
D101	UPP9401 RF power switching, PIN diode	022-3909-197
D102	UPP9401 RF power switching, PIN diode	022-3909-197
D103	HSM88AS Schottky diode, SC-59	022-3909-195
D301	HSM88AS Schottky diode, SC-59	022-3909-195
D302	1SV270 variable capacitor	022-3909-199
D303	1SV270 variable capacitor	022-3909-199
D305	1SV270 variable capacitor	022-3909-199
D306	1SV270 variable capacitor	022-3909-199
D401	MA862 switching diode	022-3909-196
D402	MA862 switching diode	022-3909-196
D501	1SV270 variable capacitor	022-3909-199
D531	1SV270 variable capacitor	022-3909-199
D533	1SV270 variable capacitor	022-3909-199
J1	CLP-110-02-F-DH connector	022-3909-122
L101	0805CIH21T18NJ chip coil	022-3909-208
L102	0805CIH21T22NJ chip coil	022-3909-209
L105	SBY201209T320Y-S chip bead	022-3909-128
L106	0805ASR47K01 chip coil	022-3909-206
L107	351604TL chip air coil	022-3909-205
L108	351604TL chip air coil	022-3909-205
L110	351604TL chip air coil	022-3909-205
L112	45144TL chip air coil	022-3909-127
L201	LQH4N122K04M coil molded	022-3909-215
L215	0805CIL21J2R2K chip coil	022-3909-103
L301	351604TL chip air coil	022-3909-205
L302	351604TL chip air coil	022-3909-205
L303	0805CIH21T27NJ chip coil	022-3909-210
L304	0805CIH21T18NJ chip coil	022-3909-208
L305	351604TL chip air coil	022-3909-205
L306	351604TL chip air coil	022-3909-205
L307	0805CIH21T18NJ chip coil	022-3909-208
L308	0805CIH21T22NJ chip coil	022-3909-209
L310	0805CIH21T39NJ chip coil	022-3909-212
L312	0805CIL21TR39K chip coil	022-3909-214
L404	0805ASR47K01 chip coil	022-3909-206
L501	0805ASR15K01 chip coil	022-3909-244

RF BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.	Ref No	Description	Part No.
L503	0805CIH21T33NJ chip coil	022-3909-211	R115	CR 1/16W 333JV resistor	022-3909-031
L504	0805CIH21T15NJ chip coil	022-3909-207	R116	CR 1/16W 333JV resistor	022-3909-031
L505	0805CIH21T27NJ chip coil	022-3909-210	R117	CR 1/16W 124JV resistor	022-3909-011
L506	0805CIH21T15NJ chip coil	022-3909-207	R120	CR 1/16W 683JV resistor	022-3909-051
L510	300905TR chip air coil	022-3909-241	R121	CR 1/16W 153JV resistor	022-3909-014
L531	0805ASR47K01 chip coil	022-3909-206	R122	CR 1/16W 821JV resistor	022-3909-056
L532	260904TL chip air coil	022-3909-125	R125	CR 1/16W 182JV resistor	022-3909-017
L533	0805CIH21T27NJ chip coil	022-3909-210			
L534	0805CIH21T22NJ chip coil	022-3909-209	R202	CR 1/16W 152JV resistor	022-3909-013
L535	0805CIH21T27NJ chip coil	022-3909-210	R203	CR 1/16W 823JV resistor	022-3909-058
			R204	CR 1/16W 124JV resistor	022-3909-011
MK1	22000025 (3K-3210) can, VCO	022-3909-146	R205	CR 1/16W 242JV resistor	022-3909-024
			R206	CR 1/16W 100JV resistor	022-3909-003
Q101	2SC3357 NPN tx power driver, SOT-89	022-3909-166	R207	CR 1/16W 333JV resistor	022-3909-031
Q201	KRA102S PNP switching, SOT23	022-3909-168	R210	CR 1/16W 390JV resistor	022-3909-034
Q301	AT-41533 NPN low noise amp, SOT-23L	022-3909-113	R216	CR 1/16W 102JV resistor	022-3909-005
			R217	CR 1/16W 100JV resistor	022-3909-003
Q302	3SK240 first mixer, GaAs N-Ch. MES FET	022-3909-177	R218	CR 1/16W 471JV resistor	022-3909-040
Q401	2SC4226 NPN first IF amp, SC-70	022-3909-167	R219	CR 1/16W 680JV resistor	022-3909-048
Q501	2SC4226 NPN rx oscillator, SC-70	022-3909-167	R220	CR 1/16W 122JV resistor	022-3909-009
Q502	2SC4226 NPN rx VCO amp, SC-70	022-3909-167	R221	CR 1/16W 152JV resistor	022-3909-013
			R223	CR 1/16W 103JV resistor	022-3909-006
Q503	2SC3356 rx VCO buffer, SOT-23	022-3909-242	R301	CR 1/16W 104JV resistor	022-3909-007
Q531	2SC4226 NPN tx oscillator, SC-70	022-3909-167	R302	CR 1/16W 104JV resistor	022-3909-007
Q532	2SC4226 NPN tx VCO amp, SC-70	022-3909-167	R303	CR 1/16W 681JV resistor	022-3909-049
			R304	CR 1/16W 822JV resistor	022-3909-057
Q533	2SC4226 NPN tx predriver amp, SOT-23	022-3909-167	R305	CR 1/16W 332JV resistor	022-3909-030
			R306	CR 1/16W 123JV resistor	022-3909-010
Q534	2SC4226 NPN tx predriver amp, SOT-23	022-3909-167	R307	CR 1/16W 104JV resistor	022-3909-007
			R308	CR 1/16W 104JV resistor	022-3909-007
Q535	2SC4226 NPN tx VCO buffer, SOT-23	022-3909-167	R310	CR 1/16W 821JV resistor	022-3909-056
			R312	CR 1/16W 151JV resistor	022-3909-012
Q601	KRA105S PNP switching, SOT-23L	022-3909-169	R313	CR 1/16W 101JV resistor	022-3909-004
			R314	CR 1/16W 000JV resistor	022-3909-001
			R315	CR 1/16W 100JV resistor	022-3909-003
			R317	CR 1/16W 000JV resistor	022-3909-001
R101	CR 1/16W 000JV resistor	022-3909-001	R400	CR 1/16W 331JV resistor	022-3909-029
R102	CR 1/16W 822JV resistor	022-3909-057	R401	CR 1/16W 184JV resistor	022-3909-018
R103	CR 1/16W 362JV resistor	022-3909-033	R402	CR 1/16W 152JV resistor	022-3909-013
R104	CR 1/16W 562JV resistor	022-3909-045	R403	CR 1/16W 104JV resistor	022-3909-007
R105	CR 1/16W 221JV resistor	022-3909-020	R404	CR 1/16W 152JV resistor	022-3909-013
R107	CR 1/16W 820JV resistor	022-3909-055	R405	CR 1/16W 392JV resistor	022-3909-036
R108	CR 1/16W 472JV resistor	022-3909-041	R406	CR 1/16W 104JV resistor	022-3909-007
R110	CR 1/16W 153JV resistor	022-3909-014	R409	CR 1/16W 223JV resistor	022-3909-022
R111	CR 1/16W 122JV resistor	022-3909-009	R410	CR 1/16W 563JV resistor	022-3909-046

RF BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.
R411	CR 1/16W 154JV resistor	022-3909-015
R412	CR 1/16W 472JV resistor	022-3909-041
R413	CR 1/16W 153JV resistor	022-3909-014
R414	CR 1/16W 153JV resistor	022-3909-014
R415	CR 1/16W 223JV resistor	022-3909-022
R416	CR 1/16W 153JV resistor	022-3909-014
R417	CR 1/16W 153JV resistor	022-3909-014
R418	CR 1/16W 223JV resistor	022-3909-022
R420	CR 1/16W 392JV resistor	022-3909-036
R421	CR 1/16W 103JV resistor	022-3909-006
R422	CR 1/16W 103JV resistor	022-3909-006
R501	CR 1/16W 100JV resistor	022-3909-003
R502	CR 1/16W 392JV resistor	022-3909-036
R503	CR 1/16W 682JV resistor	022-3909-050
R504	CR 1/16W 331JV resistor	022-3909-029
R505	CR 1/16W 682JV resistor	022-3909-050
R506	CR 1/16W 562JV resistor	022-3909-045
R507	CR 1/16W 391JV resistor	022-3909-035
R510	CR 1/16W 332JV resistor	022-3909-030
R511	CR 1/16W 822JV resistor	022-3909-057
R512	CR 1/16W 123JV resistor	022-3909-010
R513	CR 1/16W 561JV resistor	022-3909-044
R514	CR 1/16W 100JV resistor	022-3909-003
R526	CR 1/16W 680JV resistor	022-3909-048
R530	CR 1/16W 333JV resistor	022-3909-031
R531	CR 1/16W 100JV resistor	022-3909-003
R532	CR 1/16W 332JV resistor	022-3909-030
R533	CR 1/16W 682JV resistor	022-3909-050
R534	CR 1/16W 221JV resistor	022-3909-020
R535	CR 1/16W 682JV resistor	022-3909-050
R536	CR 1/16W 331JV resistor	022-3909-029
R537	CR 1/16W 332JV resistor	022-3909-030
R539	CR 1/16W 154JV resistor	022-3909-015
R540	CR 1/16W 393JV resistor	022-3909-037
R543	CR 1/16W 000JV resistor	022-3909-001
R545	CR 1/16W 123JV resistor	022-3909-010
R546	CR 1/16W 221JV resistor	022-3909-020
R547	CR 1/16W 562JV resistor	022-3909-045
R548	CR 1/16W 182JV resistor	022-3909-017
R550	CR 1/16W 820JV resistor	022-3909-055
R551	CR 1/16W 124JV resistor	022-3909-011

Ref No	Description	Part No.
R552	CR 1/16W 820JV resistor	022-3909-055
RT401	NTCC16Y 103 J370H thermistor	022-3909-232
T401*	CDB455CX24 resonator 12700037	022-3909-220
U101*	M68723HA RF power module 11200353	022-3909-181
U102	TA75W01F tx low pass filter, op amp, SSOP8	022-3909-178
U103	UMD6N switching array transistor, SC-88A	022-3909-174
U201*	12.8 MHz oscillator 12700029	022-3909-219
U202	LMX1511TM PLL, MTC20	022-3909-185
U203*	TK11817M charge pump, DC/DC up converter, 11100108	022-3909-115
U204	UMH9N NPN narrow/wide switching, SC-88A	022-3909-175
U401	BA4116FV IF IC	022-3909-183
U402	UMH9N narrow/wide switching array, SC-88A	022-3909-175
U601*	R1120N501B C5V, +5V regulator, SOT-23-5 11100135	022-3909-180
U602*	R1120N501B T5V, +5V regulator, SOT-23-5 11100135	022-3909-180
U603	UMC5N R5V, switching array, SC-88A	022-3909-173
VR401	EVM-ISSX50B54 volume	022-3909-060
X401*	44.845 MHz 2nd local xtal osc 12700032	022-3909-130
XFL401*	45R12B4 (UM-5) 1st IF xtal filter 12800254	022-3909-218
XFL402*	45R12B4 (UM-5) 1st IF xtal filter 12800254	022-3909-218
XFL403*	CFWC455E-TC 2nd IF ceramic filter, wideband 12700002	022-3909-216
XFL404*	CFWC455H-TC 2nd IF ceramic filter, narrow band 12700004	022-3909-217

LOGIC BOARD ASSEMBLY

Ref No	Description	Part No.
	LOGIC BOARD ASSEMBLY	
C047	GRM39X7R103K50PT capacitor	022-3909-073
C101	GRM39X7R103K50PT capacitor	022-3909-073
C102	GRM39COG471J50PT capacitor	022-3909-096
C103	GRM39X7R821K50PT capacitor	022-3909-107
C104	GRM39Y5V104Z25PT capacitor	022-3909-074
C105	GRM39X7R393K50PT capacitor	022-3909-094
C106	GRM39X7R103K50PT capacitor	022-3909-073
C107	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C108	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C110	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C111	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C112	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C113	GRM39Y5V104Z25PT capacitor	022-3909-074
C114	GRM39X7R103K50PT capacitor	022-3909-073
C115	GRM39X7R103K50PT capacitor	022-3909-073
C116	GRM39X7R222K50PT capacitor	022-3909-085
C117	GRM39Y5V104Z25PT capacitor	022-3909-074
C118	GRM39X7R332K50PT capacitor	022-3909-091
C120	ECS-T1CY475M capacitor	022-3909-111
C121	GRM39Y5V104Z25PT capacitor	022-3909-074
C141	GRM39X7R682K50PT capacitor	022-3909-105
C142	GRM39X7R153K50PT capacitor	022-3909-080
C143	GRM39X7R681K50PT capacitor	022-3909-104
C144	GRM39X7R392K50PT capacitor	022-3909-093
C145	GRM39X7R332K50PT capacitor	022-3909-091
C146	GRM39X7R562K50PT capacitor	022-3909-102
C147	GRM39X7R332K50PT capacitor	022-3909-091
C148	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C150	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C151	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C152	GRM39X7R103K50PT capacitor	022-3909-073
C153	GRM39X7R103K50PT capacitor	022-3909-073
C154	GRM39Y5V104Z25PT capacitor	022-3909-074
C155	GRM39X7R222K50PT capacitor	022-3909-085
C156	GRM39X7R332K50PT capacitor	022-3909-091
C157	GRM39Y5V104Z25PT capacitor	022-3909-074
C160	GRM39X7R562K50PT capacitor	022-3909-102
C161	GRM39Y5V104Z25PT capacitor	022-3909-074
C162	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C163	GRM39COG330J50PT capacitor	022-3909-089
C164	GRM42-6Y5V105Z25PT capacitor	022-3909-076

Ref No	Description	Part No.
C165	GRM39X7R272K50PT capacitor	022-3909-235
C166	GRM39X7R681K50PT capacitor	022-3909-104
C167	GRM39X7R333K50PT capacitor	022-3909-236
C168	GRM39X7R392K50PT capacitor	022-3909-093
C170	GRM39COG680J50PT capacitor	022-3909-237
C171	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C173	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C174	GRM39COG330J50PT capacitor	022-3909-089
C176	GRM39COG330J50PT capacitor	022-3909-089
C177	GRM39COG330J50PT capacitor	022-3909-089
C180	GRM39COG330J50PT capacitor	022-3909-089
C181	GRM39Y5V104Z25PT capacitor	022-3909-074
C182	GRM39COG330J50PT capacitor	022-3909-089
C183	GRM39Y5V104Z25PT capacitor	022-3909-074
C186	GRM39COG330J50PT capacitor	022-3909-089
C188	GRM39COG330J50PT capacitor	022-3909-089
C203	GRM39X7R103K50PT capacitor	022-3909-073
C204	GRM39Y5V104Z25PT capacitor	022-3909-074
C205	GRM39X7R103K50PT capacitor	022-3909-073
C206	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C207	GRM39X7R472K50PT capacitor	022-3909-097
C208	GRM39X7R682K50PT capacitor	022-3909-105
C210	GRM39X7R682K50PT capacitor	022-3909-105
C211	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C212	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C221	ECS-T1CY475M capacitor	022-3909-111
C222	GRM39X7R102K50PT capacitor	022-3909-072
C223	GRM39X7R102K50PT capacitor	022-3909-072
C224	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C225	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C226	ECS-T1CY475M capacitor	022-3909-111
C227	GRM39Y5V104Z25PT capacitor	022-3909-074
C228	ECS-T1CY475M capacitor	022-3909-111
C230	GRM39Y5V104Z25PT capacitor	022-3909-074
C231	ECS-T1CX106R capacitor	022-3909-109
C232	GRM39Y5V104Z25PT capacitor	022-3909-074
C233	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C234	ECS-T1CY475M capacitor	022-3909-111
C235	GRM39X7R102K50PT capacitor	022-3909-072
C236	GRM39COG330J50PT capacitor	022-3909-089
C237	GRM42-6Y5V105Z25PT capacitor	022-3909-076
C238	ECS-T1CY475M capacitor	022-3909-111
C239	GRM39Y5V104Z25PT capacitor	022-3909-074
C240	GRM39COG330J50PT capacitor	022-3909-089

LOGIC BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.
C241	GRM39X7R103K50PT capacitor	022-3909-073
C242	GRM39Y5V104Z25PT capacitor	022-3909-074
C243	GRM39COG270J50PT capacitor	022-3909-088
C244	GRM39COG270J50PT capacitor	022-3909-088
C245	GRM39COG030C50PT capacitor	022-3909-063
C246	GRM39Y5V104Z25PT capacitor	022-3909-074
C247	GRM39Y5V104Z25PT capacitor	022-3909-074
C248	GRM39Y5V104Z25PT capacitor	022-3909-074
C250	GRM39Y5V104Z25PT capacitor	022-3909-074
C251	GRM39Y5V104Z25PT capacitor	022-3909-074
C252	GRM39Y5V104Z25PT capacitor	022-3909-074
C253	GRM39COG330J50PT capacitor	022-3909-089
C254	GRM39COG330J50PT capacitor	022-3909-089
C255	GRM39COG330J50PT capacitor	022-3909-089
C256	GRM39Y5V104Z25PT capacitor	022-3909-074
C257	GRM39COG330J50PT capacitor	022-3909-089
C258	GRM39COG330J50PT capacitor	022-3909-089
C260	GRM39COG330J50PT capacitor	022-3909-089
C261	GRM39COG330J50PT capacitor	022-3909-089
C262	GRM39COG330J50PT capacitor	022-3909-089
C263	GRM39COG330J50PT capacitor	022-3909-089
C264	GRM39COG330J50PT capacitor	022-3909-089
C265	GRM39COG330J50PT capacitor	022-3909-089
C266	GRM39COG330J50PT capacitor	022-3909-089
C267	GRM39COG330J50PT capacitor	022-3909-089
C268	GRM39COG330J50PT capacitor	022-3909-089
C270	GRM39Y5V104Z25PT capacitor	022-3909-074
D101	DA114 switching diode, SC-70	022-3909-191
D102	DA114 switching diode, SC-70	022-3909-191
D141	DA114 switching diode, SC-70	022-3909-191
D142	DA114 switching diode, SC-70	022-3909-191
D201	DA114 switching diode, SC70	022-3909-191
D202	DA114 switching diode, SC70	022-3909-191
D203	S1A reflector diode	022-3909-198
D204	DA114 switching diode, SC70	022-3909-191
D205	UDZ3.9B 3.9V zener, SC76	022-3909-193
D206	UDZ16B 16V zener, SC76	022-3909-192
D207	UDZ5.6B 5.6V zener, SC76	022-3909-194
D208	UDZ5.6B 5.6V zener, SC76	022-3909-194
D209	UDZ5.6B 5.6V zener, SC76	022-3909-194
D211	UDZ5.6B 5.6V zener, SC76	022-3909-194
D213	DA114 switching diode, SC70	022-3909-191
F201*	TR3216CP (3A) fuse 19700005	022-3909-221

Ref No	Description	Part No.
J1	FLSH-110-01-F-DH connector	022-3909-122
J2	AXN430430P connector	022-3909-123
J3	AXN420330S connector	-
MK1	21300032 (3K-3217) battery contact	022-3909-138
MK2	22500088 (3K-3208) battery gasket	022-3909-152
Q101	UMT3904 NPN switching transistor, SC-70	022-3909-170
Q102	UMT3904 NPN switching transistor, SC-70	022-3909-170
Q103	UMH9N two-array switching transistor, SC-88A	022-3909-175
Q141	DTC144EUA NPN switching transistor, SC-70	022-3909-172
Q142	DTC144EUA NPN switching transistor, SC-70	022-3909-172
Q201	DTC144EUA NPN switching transistor, SC-70	022-3909-172
Q202	UMC5N two-array switching transistor, SC-88A	022-3909-173
Q203	UMC5N two-array switching transistor, SC-88A	022-3909-173
Q204	UMC5N two-array switching transistor, SC-88A	022-3909-173
Q205	SI9953DY dual N-channel FET, SO-8	022-3909-176
Q206	UMT3904 NPN switching transistor, SC-70	022-3909-170
Q207	UMT3904 NPN switching transistor, SC-70	022-3909-170
Q208	UMT3904 NPN switching transistor, SC-70	022-3909-170
R101	CR 1/16W 103JV resistor	022-3909-006
R102	CR 1/16W 563JV resistor	022-3909-046
R103	CR 1/16W 104JV resistor	022-3909-007
R104	CR 1/16W 103JV resistor	022-3909-006
R105	CR 1/16W 154JV resistor	022-3909-015
R106	CR 1/16W 104JV resistor	022-3909-007
R107	CR 1/16W 000JV resistor	022-3909-001
R108	CR 1/16W 473JV resistor	022-3909-042
R110	CR 1/16W 473JV resistor	022-3909-042
R111	CR 1/16W 104JV resistor	022-3909-007

LOGIC BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.	Ref No	Description	Part No.
R112	CR 1/16W 394JV resistor	022-3909-038	R171	CR 1/16W 333JV resistor	022-3909-031
R113	CR 1/16W 124JV resistor	022-3909-011	R172	CR 1/16W 105JV resistor	022-3909-008
R114	CR 1/16W 273JV resistor	022-3909-026	R173	CR 1/16W 102JV resistor	022-3909-005
R115	CR 1/16W 564JV resistor	022-3909-047	R174	CR 1/16W 821JV resistor	022-3909-056
R116	CR 1/16W 154JV resistor	022-3909-015	R175	CR 1/16W 474JV resistor	022-3909-043
R117	CR 1/16W 562JV resistor	022-3909-045	R176	CR 1/16W 303JV resistor	022-3909-027
R118	CR 1/16W 103JV resistor	022-3909-006	R177	CR 1/16W 823JV resistor	022-3909-058
R119	CR 1/16W 154JV resistor	022-3909-015	R178	CR 1/16W 332JV resistor	022-3909-030
R120	CR 1/16W 223JV resistor	022-3909-022	R180	CR 1/16W 823JV resistor	022-3909-058
R121	CR 1/16W 104JV resistor	022-3909-007	R181	CR 1/16W 124JV resistor	022-3909-011
R122	CR 1/16W 104JV resistor	022-3909-007	R182	CR 1/16W 562JV resistor	022-3909-045
R123	CR 1/16W 473JV resistor	022-3909-042	R183	CR 1/16W 683JV resistor	022-3909-051
R124	CR 1/16W 473JV resistor	022-3909-042	R184	CR 1/16W 563JV resistor	022-3909-046
R125	CR 1/16W 334JV resistor	022-3909-032	R185	CR 1/16W 473JV resistor	022-3909-042
R126	CR 1/16W 104JV resistor	022-3909-007	R186	CR 1/16W 103JV resistor	022-3909-006
R127	CR 1/16W 334JV resistor	022-3909-032	R187	CR 1/16W 103JV resistor	022-3909-006
R128	CR 1/16W 104JV resistor	022-3909-007	R188	CR 1/16W 000JV resistor	022-3909-001
R129	CR 1/16W 104JV resistor	022-3909-007	R192	CR 1/16W 000JV resistor	022-3909-001
R141	CR 1/16W 103JV resistor	022-3909-006	R193	CR 1/16W 683JV resistor	022-3909-051
R142	CR 1/16W 103JV resistor	022-3909-006	R196	CR 1/16W 103JV resistor	022-3909-006
R143	CR 1/16W 103JV resistor	022-3909-006	R197	CR 1/16W 103JV resistor	022-3909-006
R144	CR 1/16W 333JV resistor	022-3909-031	R202	CR 1/16W 000JV resistor	022-3909-001
R145	CR 1/16W 123JV resistor	022-3909-010	R203	CR 1/16W 205JV resistor	022-3909-054
R146	CR 1/16W 123JV resistor	022-3909-010	R204	CR 1/16W 103JV resistor	022-3909-006
R147	CR 1/16W 223JV resistor	022-3909-022	R205	CR 1/16W 104JV resistor	022-3909-007
R148	CR 1/16W 103JV resistor	022-3909-006	R207	CR 1/16W 473JV resistor	022-3909-042
R149	CR 1/16W 103JV resistor	022-3909-006	R208	CR 1/16W 103JV resistor	022-3909-006
R150	CR 1/16W 223JV resistor	022-3909-022	R212	CR 1/16W 393JV resistor	022-3909-037
R151	CR 1/16W 153JV resistor	022-3909-014	R213	CR 1/16W 223JV resistor	022-3909-022
R152	CR 1/16W 333JV resistor	022-3909-031	R214	CR 1/16W 274JV resistor	022-3909-228
R153	CR 1/16W 333JV resistor	022-3909-031	R215	CR 1/16W 182JV resistor	022-3909-017
R154	CR 1/16W 103JV resistor	022-3909-006	R216	CR 1/16W 102JV resistor	022-3909-005
R155	CR 1/16W 104JV resistor	022-3909-007	R218	CR 1/16W 474JV resistor	022-3909-043
R156	CR 1/16W 474JV resistor	022-3909-043	R220	CR 1/16W 104JV resistor	022-3909-007
R157	CR 1/16W 273JV resistor	022-3909-026	R221	CR 1/16W 104JV resistor	022-3909-007
R158	CR 1/16W 273JV resistor	022-3909-026	R222	CR 1/16W 104JV resistor	022-3909-007
R160	CR 1/16W 104JV resistor	022-3909-007	R223	CR 1/16W 104JV resistor	022-3909-007
R161	CR 1/16W 104JV resistor	022-3909-007	R224	CR 1/16W 222JV resistor	022-3909-021
R162	CR 1/16W 473JV resistor	022-3909-042	R225	CR 1/16W 103JV resistor	022-3909-006
R163	CR 1/16W 473JV resistor	022-3909-042	R226	CR 1/16W 103JV resistor	022-3909-006
R164	CR 1/16W 334JV resistor	022-3909-032	R227	CR 1/16W 102JV resistor	022-3909-005
R165	CR 1/16W 103JV resistor	022-3909-006	R228	CR 1/16W 104JV resistor	022-3909-007
R167	CR 1/16W 000JV resistor	022-3909-001	R229	CR 1/16W 104JV resistor	022-3909-007
R168	CR 1/16W 562JV resistor	022-3909-045	R230	CR 1/16W 104JV resistor	022-3909-007
R170	CR 1/16W 563JV resistor	022-3909-046	R231	CR 1/16W 104JV resistor	022-3909-007

LOGIC BOARD ASSEMBLY (CONT'D)

Ref No	Description	Part No.
R233	CR 1/16W 104JV resistor	022-3909-007
R234	CR 1/16W 472JV resistor	022-3909-041
R235	CR 1/16W 471JV resistor	022-3909-040
R236	CR 1/16W 105JV resistor	022-3909-008
R237	CR 1/16W 684JV resistor	022-3909-052
R238	CR 1/16W 334JV resistor	022-3909-032
R240	CR 1/16W 104JV resistor	022-3909-007
R241	CR 1/16W 104JV resistor	022-3909-007
R242	CR 1/16W 104JV resistor	022-3909-007
R243	CR 1/16W 000JV resistor	022-3909-001
R244	CR 1/16W 000JV resistor	022-3909-001
R251	CR 1/16W 471JV resistor	022-3909-040
R252	CR 1/16W 471JV resistor	022-3909-040
R255	CR 1/16W 104JV resistor	022-3909-007
R256	CR 1/16W 471JV resistor	022-3909-040
R257	CR 1/16W 000JV resistor	022-3909-001
R261	CR 1/16W 104JV resistor	022-3909-007
R262	CR 1/16W 220JV resistor	022-3909-019
R263	CR 1/16W 104JV resistor	022-3909-007
R265	CR 1/16W 104JV resistor	022-3909-007
R266	CR 1/16W 473JV resistor	022-3909-042
R267	CR 1/16W 473JV resistor	022-3909-042
R280	CR 1/16W 000JV resistor	022-3909-001
R301	CR 1/16W 000JV resistor	022-3909-001
R302	CR 1/16W 000JV resistor	022-3909-001
R303	CR 1/16W 000JV resistor	022-3909-001
R304	CR 1/16W 000JV resistor	022-3909-001
R305	CR 1/16W 000JV resistor	022-3909-001
R306	CR 1/16W 000JV resistor	022-3909-001
U101	TA75W01FU bandpass filter op amp, SSOP8	022-3909-178
U102	LM2904 rx data LPF, SO-8	022-3909-243

Ref No	Description	Part No.
U103	LM2904 rx DC restoration, SO-8	022-3909-243
U141	C4053DT analog s/w, SOP-16	022-3909-186
U142	LM2904 rx/tx data LPF, SO-8	022-3909-243
U143	LM2904 data LPF, SO-8	022-3909-243
U144	LM2904 DC restoration, SO-8	022-3909-243
U145	LM2904 tx data LPF, SO-8	022-3909-243
U146	TA75W01FU tx LPF, SSOP8	022-3909-178
U147	AD8403ARU100 tx data/audio digital volume TSSOP (RU24)	022-3909-118
U148	LM2904 tx combiner, SO-8	022-3909-243
U150	X25138-S14I EEPROM, SOIC	022-3909-119
U151	TA75W01FU tx high pass filter, op amp, SSOP8	022-3909-178
U201	PCD3312CT DTMF/tone generator, SO8	022-3909-184
U202	TC4S66F single analog switch, SSOP5	022-3909-188
U203	TC4W66FU analog sw, SSOP8	022-3909-189
U204	MC33111D low voltage compander, SO-16	022-3909-116
U205*	R1120N501B 5V regulator, SOT-23-5 11100135	022-3909-180
U206*	R1120N501B 5V regulator, SOT-23-5 11100135	022-3909-180
U207	TPS3801L50 reset, SC-70	022-3909-182
U208	HD64F2357TE20 CPU, TFP120	022-3909-190
U210	BU4S11F NAND gate, SSOP5	022-3909-187
Y201*	FCX-01, 3.579545 MHz crystal 12700044	022-3909-129
Y202*	FCX-01, 9.8304 MHz crystal 12700059	022-3909-131

* Service Parts

MECHANICAL PARTS

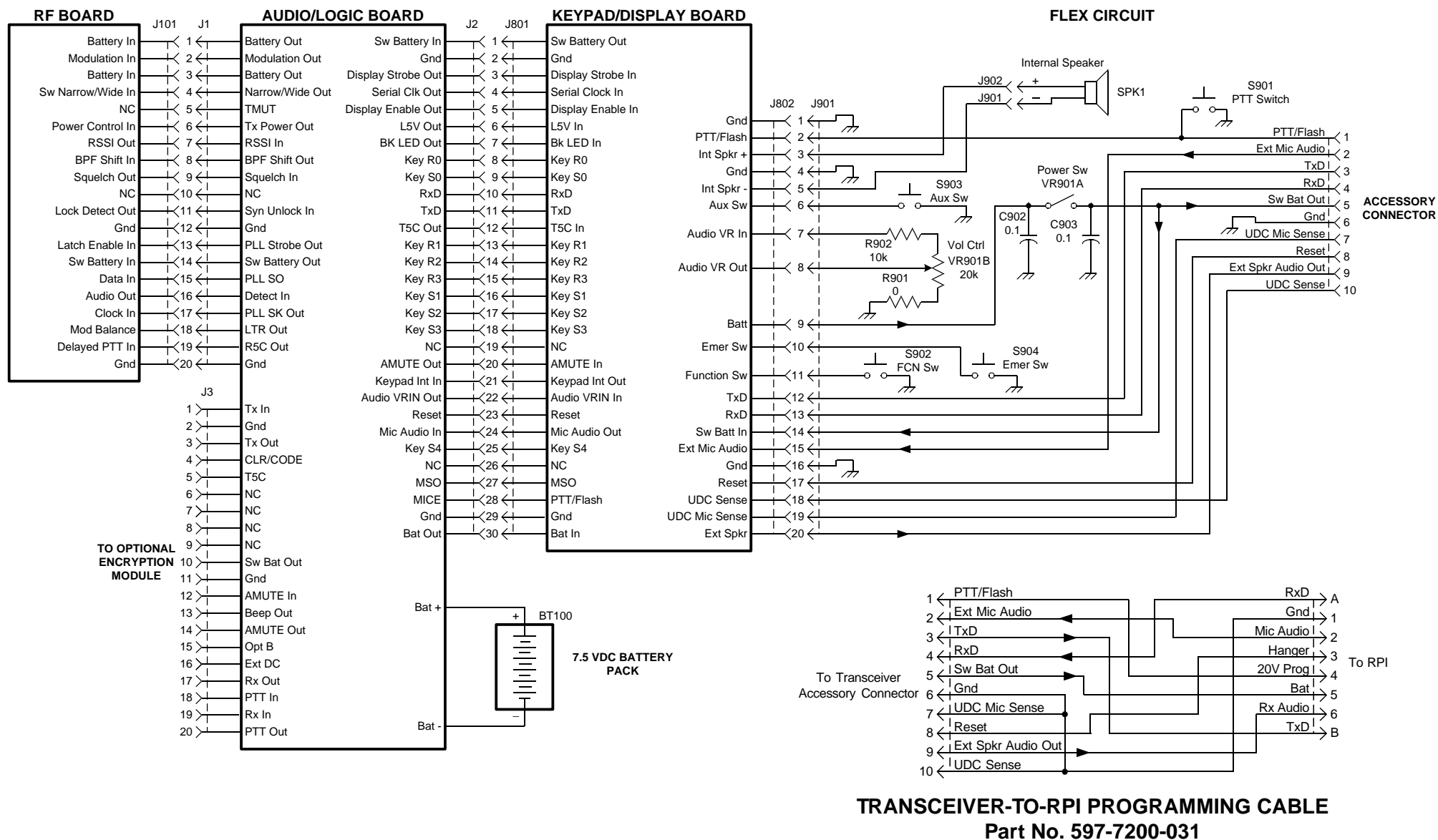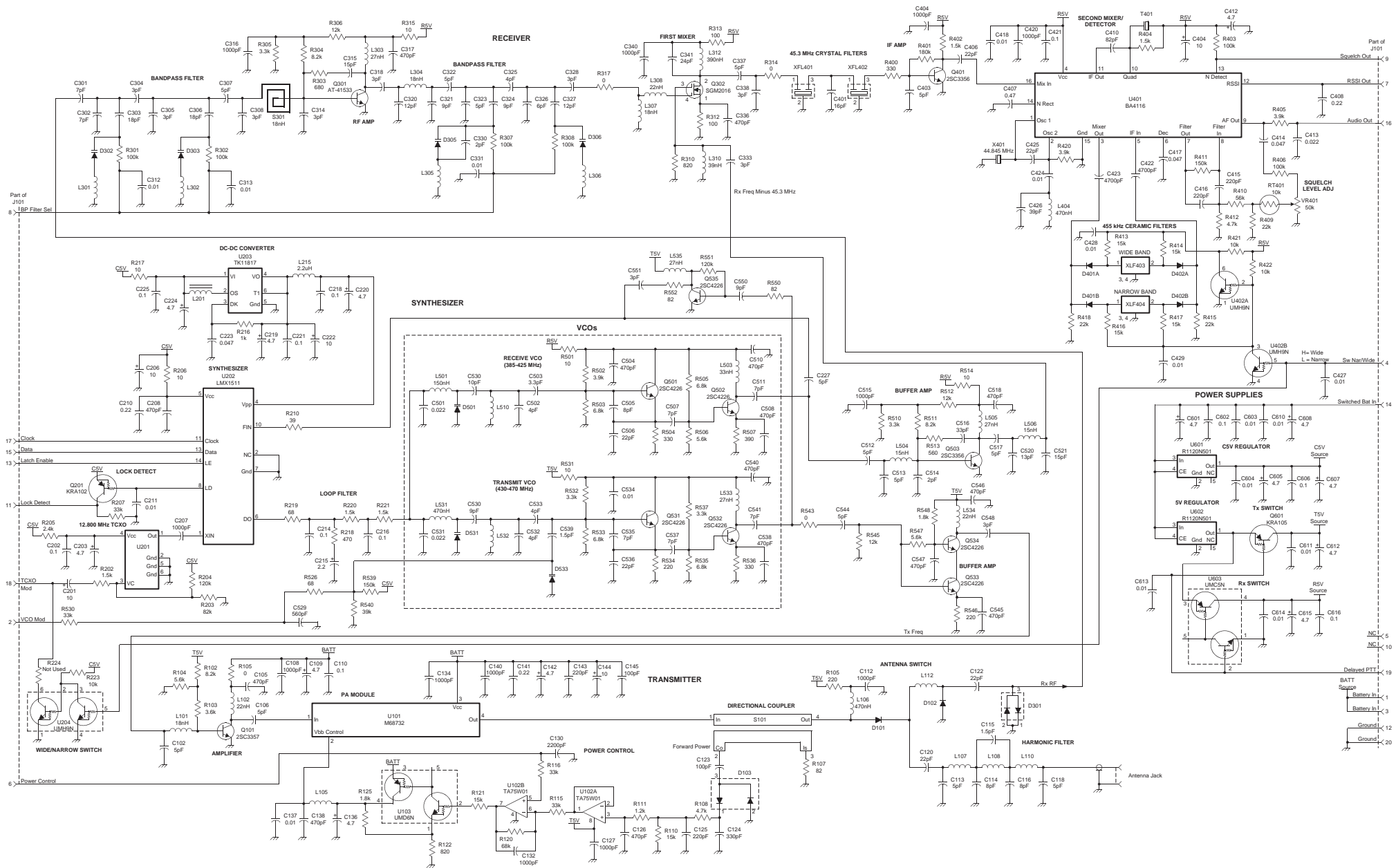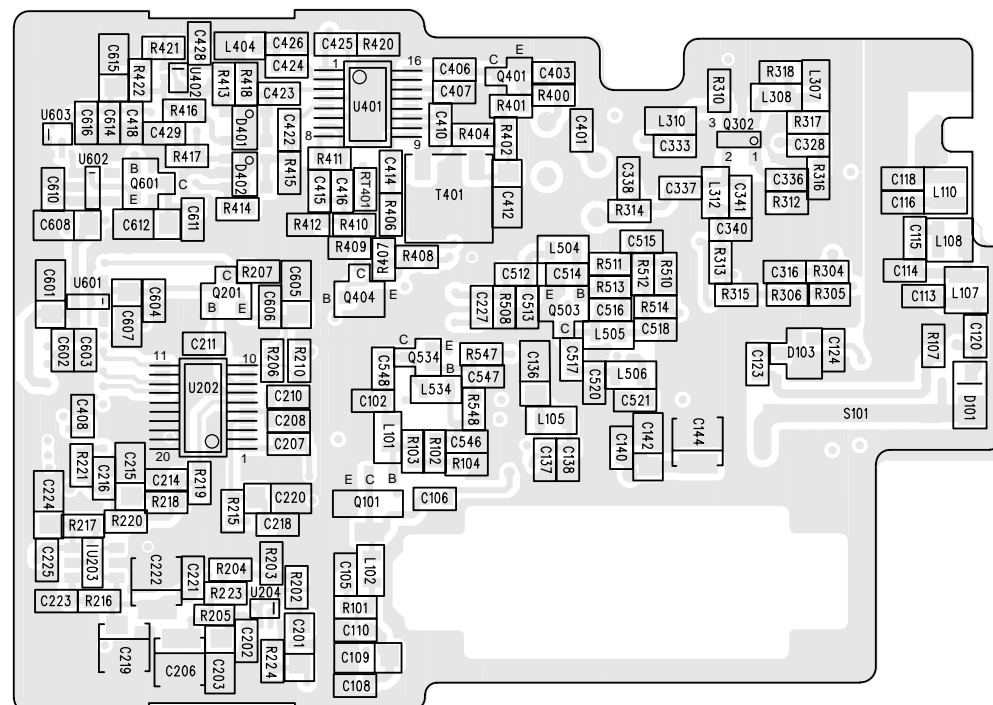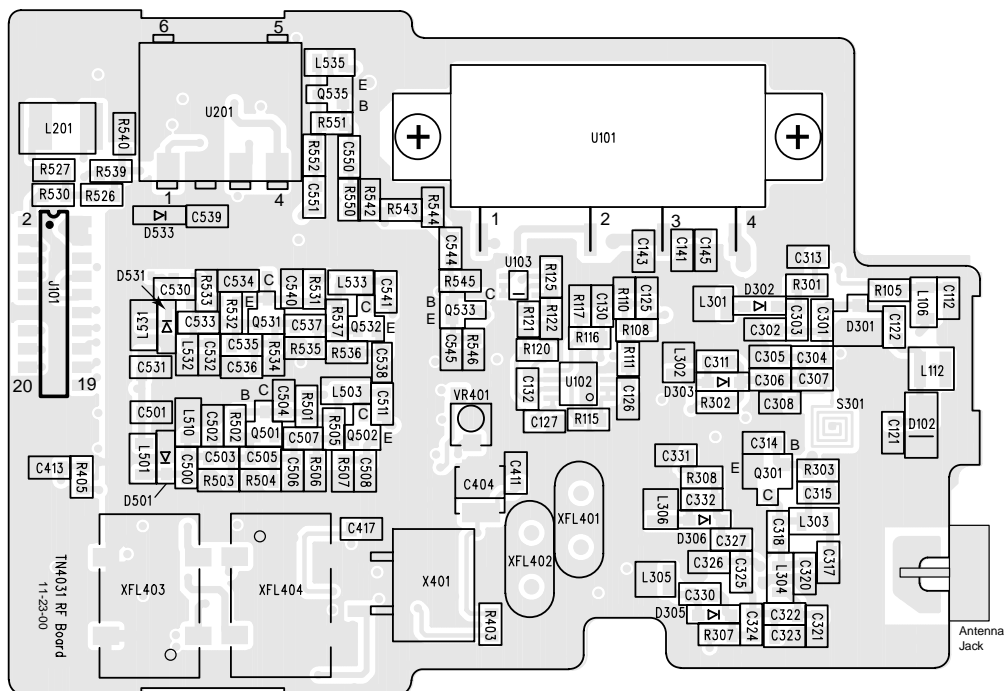| Item No. From Pg 6-12	Desig. / Locator	Assembly	Description	Part No.
1	A004*	Complete assy's	20101361 Plastic front cover assembly (includes items 1-14)	022-3909-025
2	MK7*	Front Panel	216000074 (3K-3146) window, LCD	022-3909-142
3	MK8*	Front Panel	23300432 (4K-2855) nut, volume	022-3909-160
4	MK10*	Front Panel	22300055 (#1500) knob, spring (included w/item 5)	022-3909-149
5	MK4*	Front Panel	21400096 knob and spring (item 4)	022-3909-135
6	S90x*	Flex Circuit	29801715 dome switch (4K-2928)	022-3909-137
7	MK6*	Front Panel	21400033 (3K-3144) button, PTT	022-3909-139
8	VR901*	Flex Circuit	07007A203001 20k ohm vol control/on-off switch	022-3909-162
9	A005*	Complete assy's	51300134 flex cable assy (complete w/microswitches)	022-3909-053
10	MK11*	Front Panel	22500112 (3K-2692) gasket, UDC	022-3909-150
11	SPK1*	Front Panel	13200062 40-16BB-07 speaker	022-3909-203
12	MK12*	Front Panel	22600031 (4K-2849) felt, speaker	022-3909-154
13	MK5*	Front Panel	21400014 (3K-3209) button, emergency	022-3909-140
14	MK9*	Front Panel	21800061 (4K-2887) insert	022-3909-147
15	MK2*	Misc	23300188 (4K-2489) screw, lock-A	022-3909-148
16	MK1*	Misc	20100784 (2K-2539) cover, UDC	022-3909-132
17	MK13*	Front Panel	22900163 (3K-3142) rubber keypad	022-3909-157
18	MK3*	Front Panel	21200047 (4K-2988) bushing, mic	022-3909-136
19	U5*	Key/Dsply Bd	13200025 CMS27P44 internal microphone	022-3909-204
20	MK3*	Key/Dsply Bd	21900145 (3K2687) LCD bracket	022-3909-143
21	EH1*	Key/Dsply Bd	12000020 LCD 1710T4138001	022-3909-201
22	MK1*	Key/Dsply Bd	12200490 31.5 x 1.5 x 2.5 zebra	022-3909-120
23	MK2*	Key/Dsply Bd	21600024 (3K-2684) reflector	022-3909-141
24	A001*	Complete assy's	51300081 Keypad/Display PC Board (complete)	022-3909-002
25	MK14*	Front Panel	23300494 (BH2,4L) fastener, t/p screw	022-3909-225
26	MK1*1	Chassis	22900183 (4K-2993) cushion, RF	022-3909-061
27	MK4*	Chassis	22000013 (3K-3014) can, control shield	022-3909-145
28	MK3*	Chassis	22000060 (3K-3347) can, RF shield	022-3909-144
29	MK1*	RF board	22000025 (3K-3210) can, VCO	022-3909-146
30	MK9*	Chassis	23300220 (BHM2, 4L) fastener, m/c screw	022-3909-224
31	A003*	Complete assy's	51300013 RF PC board assembly (complete)	022-3909-023
32	A002*	Complete assy's	51300035 Logic PC board assembly (complete)	022-3909-016
33	MK1*	Logic board	21300022 (3K-3217) battery contact	022-3909-138
34	MK5*	Chassis	22500095 (3K-3192) gasket, main	022-3909-151
35	MK2*	Logic board	22500088 (3K-3208) battery contact gasket	022-3909-152
36	MK6*	Chassis	22500092 (4K-2495) gasket, frame	022-3909-153
37	MK2*	Chassis	20500171 (1K-0011) frame	022-3909-223
38	MK14*	Chassis	SMA jack nut	022-3909-100
39	MK10*	Chassis	23300437 (4K-2947) washer, plate	022-3909-161
40	MK3*	Misc	23101070 (4K-2930) label, spec	022-3909-158
41	MK13*	Chassis	22000059 antenna connector ground clip	022-3909-095
42	MK11*	Chassis	19800077 antenna connector (w/o nut, washer)	022-3909-039
43	MK4*	Misc	23300200 (CHM2.6, 8L) screw, machine	022-3909-159
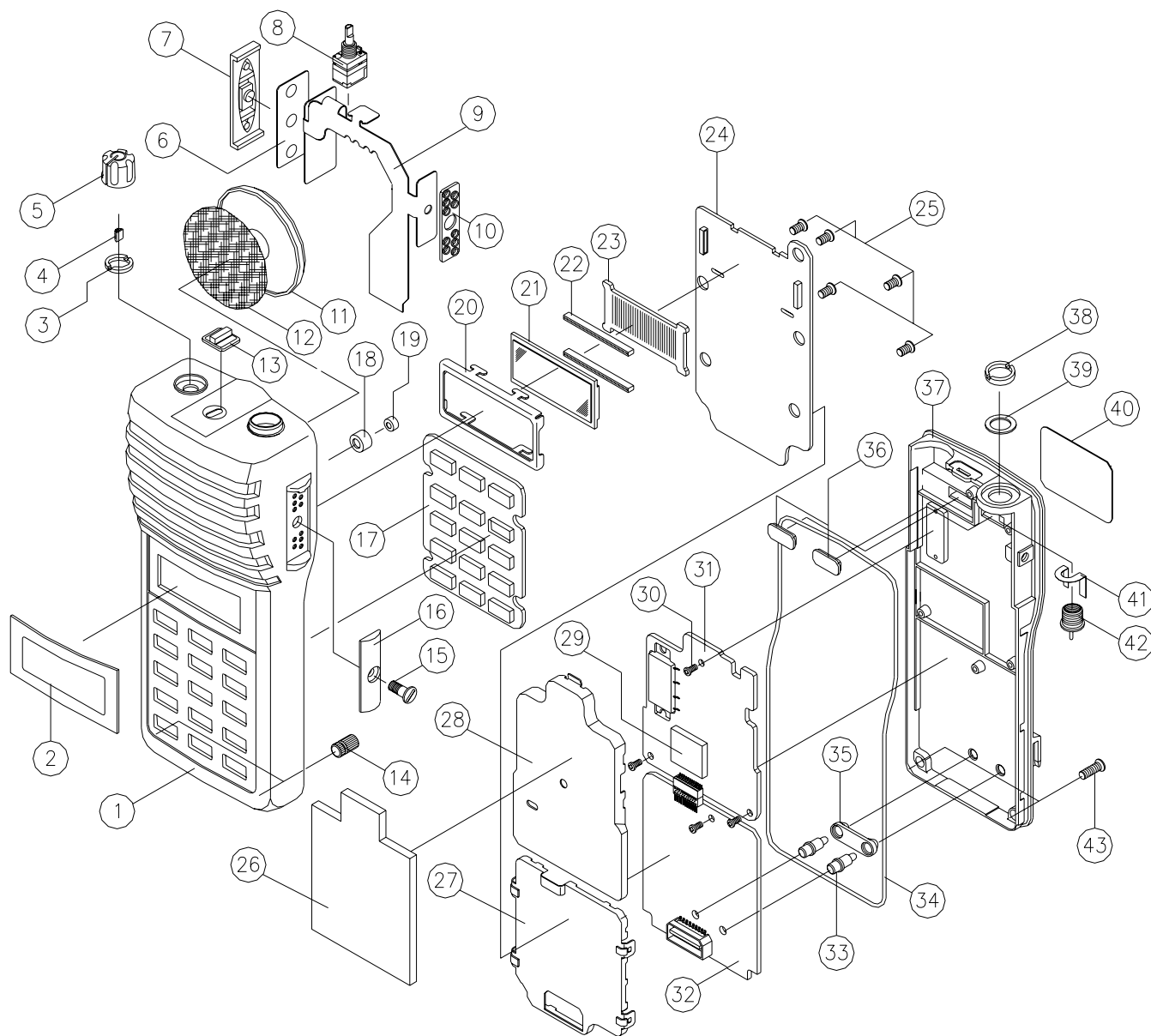
EXPLODED VIEW

SECTION 8 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

RF BOARD

J101 J1

Battery In	1	Battery Out
Modulation In	2	Modulation Out
Battery In	3	Battery Out
Sw Narrow/Wide In	4	Narrow/Wide Out
NC	5	TMUT
Power Control In	6	Tx Power Out
RSSI Out	7	RSSI In
BPF Shift In	8	BPF Shift Out
Squelch Out	9	Squelch In
NC	10	NC
Lock Detect Out	11	Syn Unlock In
Gnd	12	Gnd
Latch Enable In	13	PLL Strobe Out
Sw Battery In	14	Sw Battery Out
Data In	15	PLL SO
Audio Out	16	Detect In
Clock In	17	PLL SK Out
Mod Balance	18	LTR Out
Delayed PTT In	19	R5C Out
Gnd	20	Gnd

J3

1	Tx In
2	Gnd
3	Tx Out
4	CLR/CODE
5	T5C
6	NC
7	NC
8	NC
9	NC
10	Sw Bat Out
11	Gnd
12	AMUTE In
13	Beep Out
14	AMUTE Out
15	Opt B
16	Ext DC
17	Rx Out
18	PTT In
19	Rx In
20	PTT Out

TO OPTIONAL ENCRYPTION MODULE

AUDIO/LOGIC BOARD

J2 J801

Sw Battery In	1	Sw Battery Out
Gnd	2	Gnd
Display Strobe Out	3	Display Strobe In
Serial Clk Out	4	Serial Clock In
Display Enable Out	5	Display Enable In
L5V Out	6	L5V In
BK LED Out	7	Bk LED In
Key R0	8	Key R0
Key S0	9	Key S0
RxD	10	RxD
TxD	11	TxD
T5C Out	12	T5C In
Key R1	13	Key R1
Key R2	14	Key R2
Key R3	15	Key R3
Key S1	16	Key S1
Key S2	17	Key S2
Key S3	18	Key S3
NC	19	NC
AMUTE Out	20	AMUTE In
Keypad Int In	21	Keypad Int Out
Audio VRIN Out	22	Audio VRIN In
Reset	23	Reset
Mic Audio In	24	Mic Audio Out
Key S4	25	Key S4
NC	26	NC
MSO	27	MSO
MICE	28	PTT/Flash
Gnd	29	Gnd
Bat Out	30	Bat In

Bat +

Bat -

BT100

7.5 VDC BATTERY PACK

KEYPAD/DISPLAY BOARD

J802 J901

Gnd	1	
PTT/Flash	2	
Int Spkr +	3	
Gnd	4	
Int Spkr -	5	
Aux Sw	6	
Audio VR In	7	
Audio VR Out	8	
Batt	9	
Emer Sw	10	
Function Sw	11	
TxD	12	
RxD	13	
Sw Batt In	14	
Ext Mic Audio	15	
Gnd	16	
Reset	17	
UDC Sense	18	
UDC Mic Sense	19	
Ext Spkr	20	

FLEX CIRCUIT

Internal Speaker

J902 +
J901 −   SPK1

S901
PTT Switch

Power Sw
VR901A

S903
Aux Sw

C902 C903
0.1   0.1

R902
10k   Vol Ctrl
       VR901B
R901   20k
0

S902
FCN Sw

S904
Emer Sw

ACCESSORY CONNECTOR

PTT/Flash	1
Ext Mic Audio	2
TxD	3
RxD	4
Sw Bat Out	5
Gnd	6
UDC Mic Sense	7
Reset	8
Ext Spkr Audio Out	9
UDC Sense	10

INTERCONNECT SCHEMATIC

To Transceiver Accessory Connector

1	PTT/Flash	
2	Ext Mic Audio	
3	TxD	
4	RxD	
5	Sw Bat Out	
6	Gnd	
7	UDC Mic Sense	
8	Reset	
9	Ext Spkr Audio Out	
10	UDC Sense	

To RPI

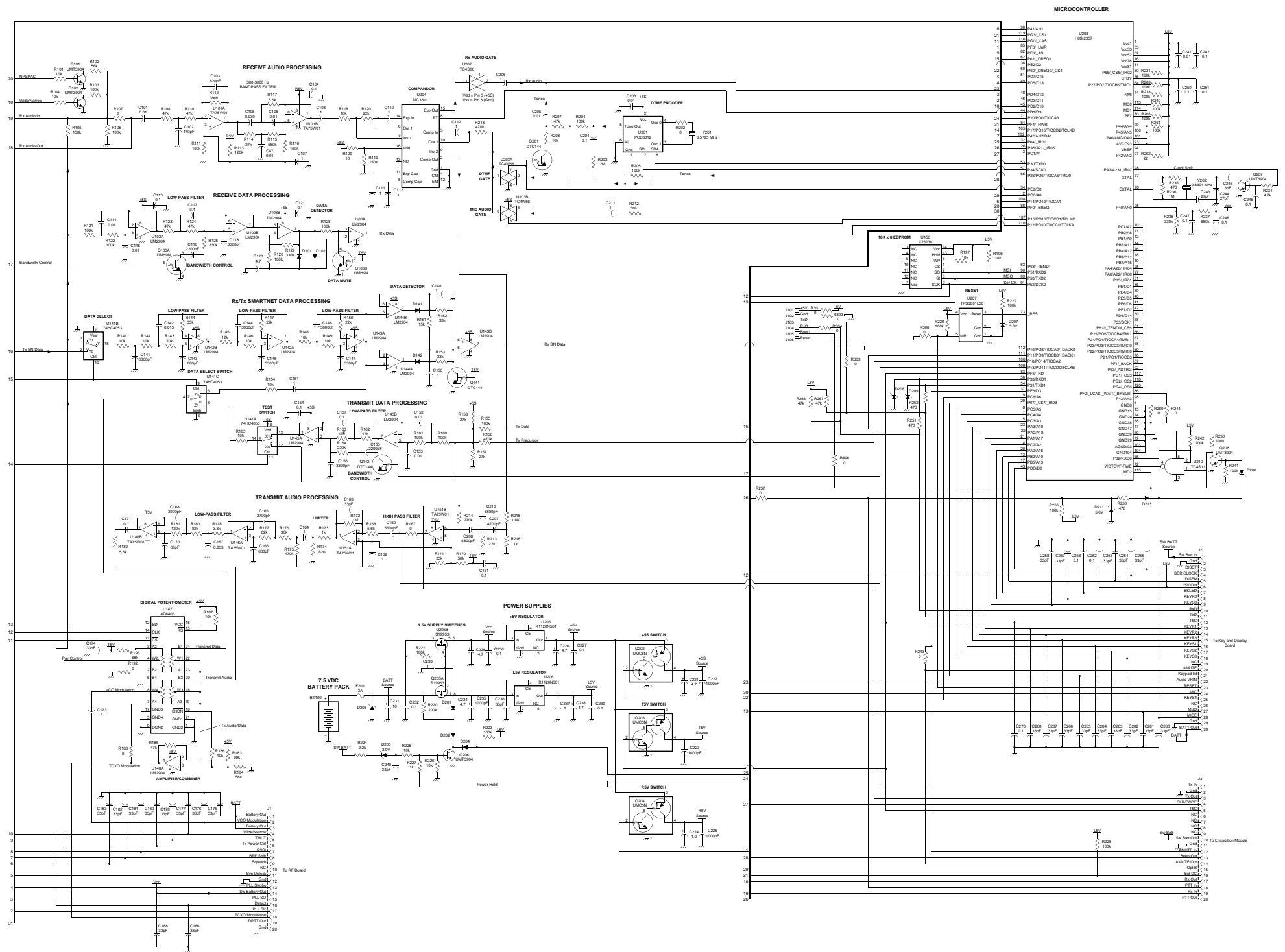|		
RxD	A	
Gnd	1	
Mic Audio	2	
Hanger	3	
20V Prog	4	
Bat	5	
Rx Audio	6	
TxD	B	

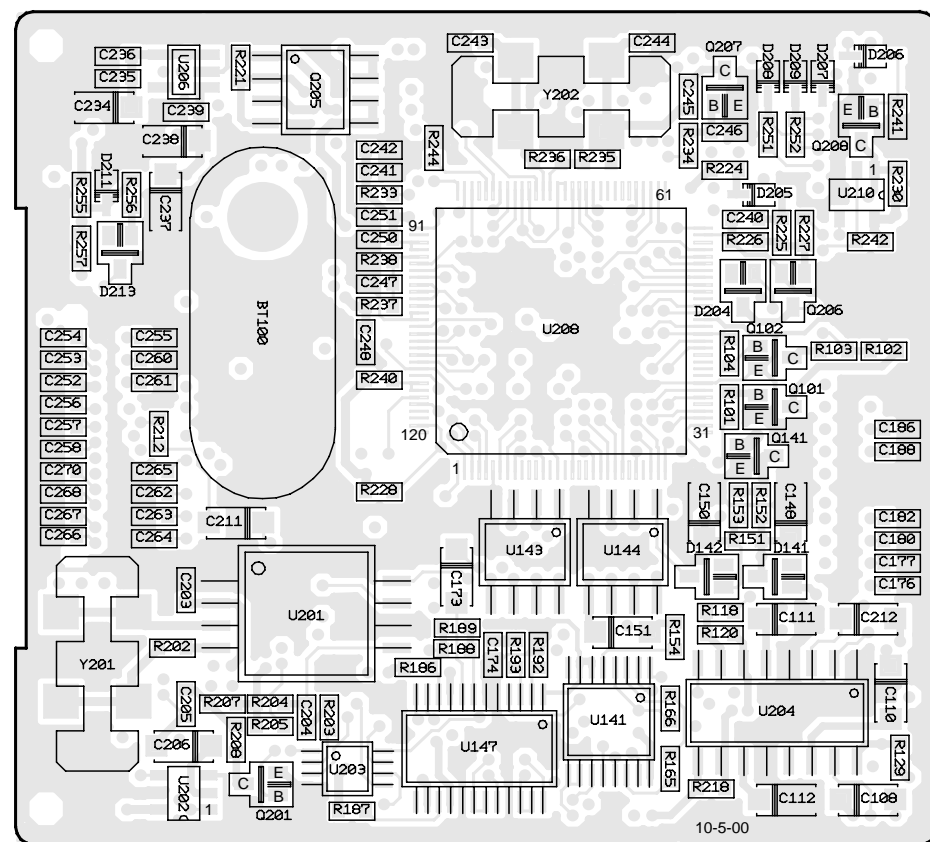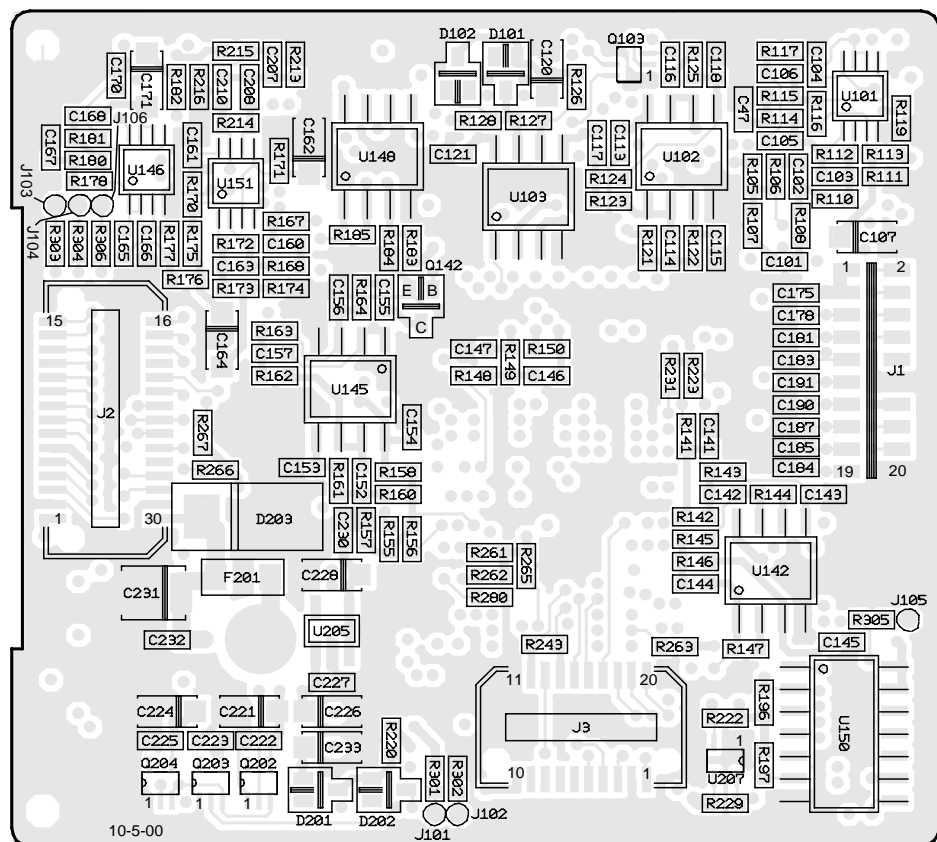**TRANSCEIVER-TO-RPI PROGRAMMING CABLE
Part No. 597-7200-031**

RF BOARD SCHEMATIC

RF BOARD TOP VIEW

RF BOARD BOTTOM VIEW

TN4031 RF Board
11-23-00

Antenna Jack

LOGIC BOARD SCHEMATIC

8-4

LOGIC BOARD TOP VIEW

LOGIC BOARD BOTTOM VIEW

November 2001
Part No. 001-7240-001

DISPLAY/KEYPAD BOARD SCHEMATIC

DISPLAY/KEYPAD BOARD BOTTOM VIEW

TN4031 KEY/DISPLAY
SER.NO.
10-5-00

DISPLAY/KEYPAD BOARD TOP VIEW

U5
Mic

22   1
D901   EH1   D902
23   44

S13   S14   S15
FCN   SYS   GRP

D304   D303
S1   S2   S3
1   2   3

D306   D305
S4   S5   S6
4   5   6

D308   D307
S7   S8   S9
7   8   9

D310   D309
S10   S11   S12
*   0   #

FLEX CIRCUIT LAYOUT

VR901
R902
C902   C903
S904
Top Panel
Option Sw
KP52
C901
To Accessory
Connector
J901 J902
To Speaker
S902   Upper Opt Sw
S901   PTT Sw
S903   Lower Opt Sw
J901
To J802 (Keypad/Display Bd)

TRANSCEIVER BLOCK DIAGRAM

EFJohnson®