



HT 1000,TM MT 2000,TM MTS 2000,TM
and MTX Series
Handie-Talkie[®] Portable Radios
Service Section



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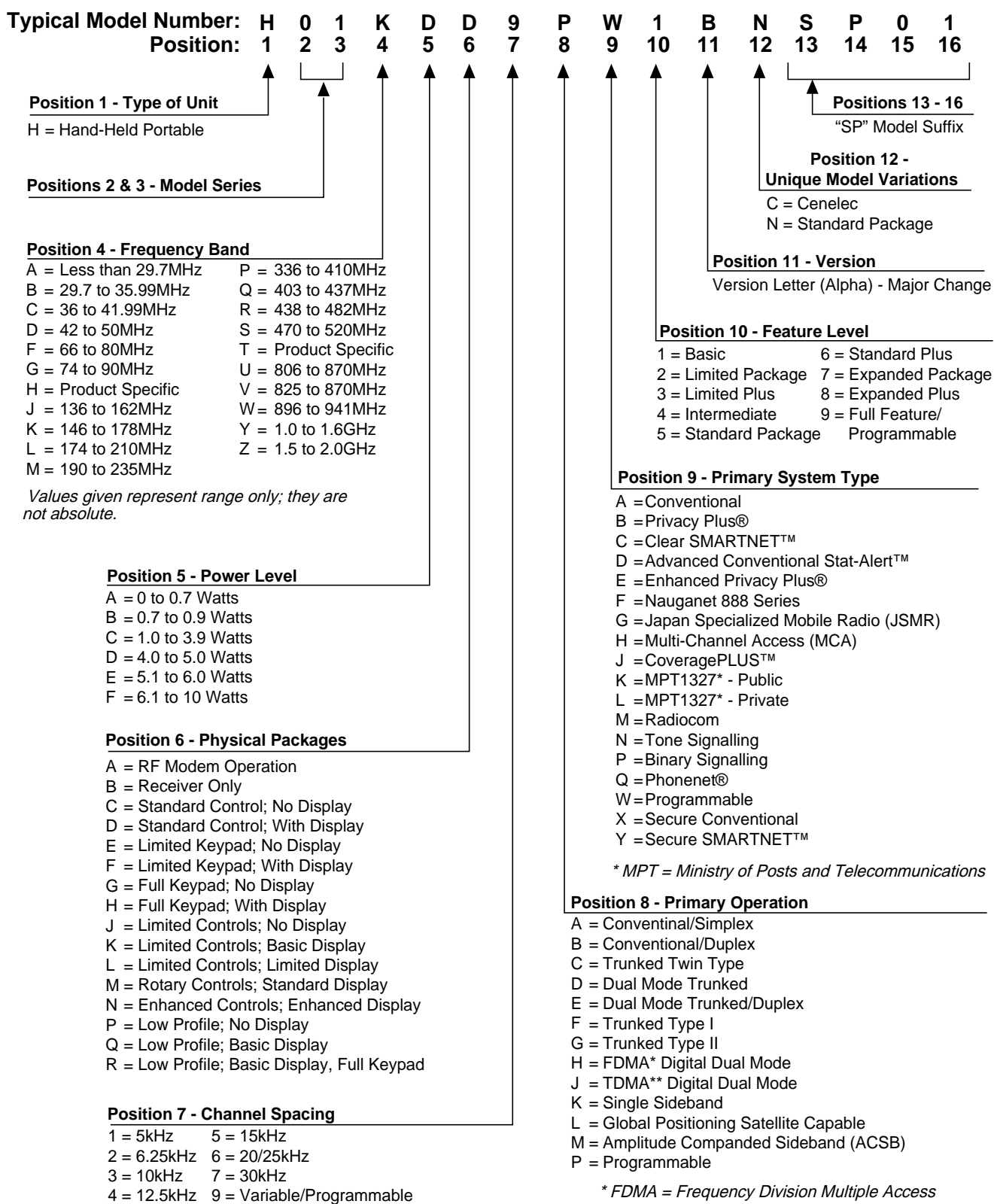
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RELATED PUBLICATIONS AVAILABLE SEPARATELY

Service Manual (early version radios; first issue- 4/92)	68P81200C20
Service Manual (later version radios; first issue- 4/93).....	68P81200C25
Service Manual (this publication; present version radios; first issue- 7/94)	68P81200C40
includes:	
• all servicing information	
• assembly / disassembly	
• maintenance	
Theory Manual.....	68P81200C15
includes:	
• theory of operation	
• troubleshooting information and troubleshooting charts	
Secure Modules Instruction Manual	68P81200C35
Operating Instructions	
• HT 1000 A Model Portable Radios.....	68P81071C70
• HT 1000 B Model Portable Radios.....	68P81079C50
• MT 2000 Portable Radios.....	68P81076C65
• MTS 2000 I Portable Radios	68P81072C15
• MTS 2000 II and III Portable Radios	68P81072C45
• MTX Series Model B3 Privacy Plus Portable Radios	68P81072C10
• MTX Series Model B4 Privacy Plus Portable Radios	68P81073C60
• MTX Series Model B5 and B7 Privacy Plus Portable Radios.....	68P81072C40
Mobile Vehicular Adapter (MTVA) Operating Instructions	68P81075C85
Mobile Vehicular Adapter (MTVA) Installation Instructions.....	68P81075C90
Mobile Vehicular Adapter (MTVA) Service Manual	68P81075C95
Remote Speaker Microphones NMN6191A / N MN6193A Operating Instructions.....	68P81073C40
Remote Speaker Microphones NMN6191A / N MN6193A Service Manual	68P81200C30
Public Safety Speaker Microphone NMN6228A Operating Instructions.....	68P81079C15
Public Safety Speaker Microphone NMN6228A Service Manual	68P81009C41

MODEL NUMBERING SYSTEM



LIST OF MODELS

CONVENTIONAL SYSTEMS RADIOS

HT 1000 Model Family

H01KDC9AA1BN 2-Freq., 5- to 1-Watt, 136 - 178 MHz
 H01KDC9AA3BN 16-Freq., 5- to 1-Watt, 136 - 178 MHz

H01RDC9AA1BN 2-Freq., 4- to 1-Watt, 403 - 470 MHz
 H01RDC9AA3BN 16-Freq., 4- to 1-Watt, 403 - 470 MHz

H01SDC9AA1BN 2-Freq., 4- to 1-Watt, 450 - 520 MHz
 H01SDC9AA3BN 16-Freq., 4- to 1-Watt, 450 - 520 MHz

H01UCC6AA1BN 2-Freq., 3-Watt, 806 - 870 MHz
 H01UCC6AA3BN 16-Freq., 3-Watt, 806 - 870 MHz

MT 2000 Model Family

H01KDD9AA4AN 16-Freq., 6-Character Top Display, 5- to 1-Watt, 136 - 178 MHz
 H01KDH9AA7AN 10-Zone, 16-Channel, 14-Character Front Display, Full Keypad, 5- to 1-Watt, 136 - 178 MHz

H01RDD9AA4AN 16-Freq., 6-Character Top Display, 4- to 1-Watt, 403 - 470 MHz
 H01RDH9AA7AN 10-Zone, 16-Channel, 14-Character Front Display, Full Keypad, 4- to 1-Watt, 403 - 470 MHz

H01SDD9AA4AN 16-Freq., 6-Character Top Display, 4- to 1-Watt, 450 - 520 MHz
 H01SDH9AA7AN 10-Zone, 16-Channel, 14-Character Front Display, Full Keypad, 4- to 1-Watt, 450 - 520 MHz

H01UCD6AA4AN 16-Freq., 6-Character Top Display, 3-Watt, 806 - 870 MHz
 H01UCH6AA7AN 10-Zone, 16-Channel, 14-Character Front Display, Full Keypad, 3 -Watt, 806 - 870 MHz

H01WCD4AA4AN 16-Freq., 6-Character Top Display, 2.9 Watt, 896 - 941 MHz
 H01WCH4AA7AN 10-Zone, 16-Channel, 14-Character Front Display, Full Keypad, 2.9 Watt, 896 - 941 MHz

PRIVATE SYSTEMS RADIOS

MTS 2000 Model Family

H01KDD9PW1BN 16-Mode, 6-Character Top Display, 5- to 1-Watt, 136 - 178 MHz
 H01KDF9PW1BN 16-Mode, 14-Character Front Display, Limited Keypad, 5- to 1-Watt, 136 - 178 MHz
 H01KDH9PW1BN 16-Mode, 14-Character Front Display, Full Keypad, 5- to 1-Watt, 136 - 178 MHz

H01RDD9PW1BN 16-Mode, 6-Character Top Display, 4- to 1-Watt, 403 - 470 MHz
 H01RDF9PW1BN 16-Mode, 14-Character Front Display, Limited Keypad, 4- to 1-Watt, 403 - 470 MHz
 H01RDH9PW1BN 16-Mode, 14-Character Front Display, Full Keypad, 4- to 1-Watt, 403 - 470 MHz

H01SDD9PW1BN 16-Mode, 6-Character Top Display, 4- to 1-Watt, 450 - 520 MHz
 H01SDF9PW1BN 16-Mode, 14-Character Front Display, Limited Keypad, 4- to 1-Watt, 450 - 520 MHz
 H01SDH9PW1BN 16-Mode, 14-Character Front Display, Full Keypad, 4- to 1-Watt, 450 - 520 MHz

H01UCD6PW1BN 16-Mode, 6-Character Top Display, 3-Watt, 806 - 870 MHz
 H01UCF6PW1BN 16-Mode, 14-Character Front Display, Limited Keypad, 3-Watt, 806 - 870 MHz
 H01UCH6PW1BN 16-Mode, 14-Character Front Display, Full Keypad, 3-Watt, 806 - 870 MHz

H01WCD4PW1BN 16-Mode, 6-Character Top Display, 2.9 Watt, 896 - 941 MHz
 H01WCF4PW1BN 16-Mode, 14-Character Front Display, Limited Keypad, 2.9 Watt, 896 - 941 MHz
 H01WCH4PW1BN 16-Mode, 14-Character Front Display, Full Keypad, 2.9 Watt, 896 - 941 MHz

LIST OF MODELS (cont.)

SHARED SYSTEMS RADIOS

MTX 838 Model Family

H01KDC9DB3AN	16-Mode, 5- to 1-Watt, 136 - 178 MHz
H01KDD9DB4AN	99-Mode, 6-Character Top Display, 5- to 1-Watt, 136 - 178 MHz
H01KDF9DB5AN	160-Mode, 14-Character Front Display, Limited Keypad, 5- to 1-Watt, 136 - 178 MHz
H01KDH9DB7AN	160-Mode, 4-Character Front Display, Full Keypad, 5- to 1-Watt, 136 - 178 MHz

H01RDC9DB3AN	16-Mode, 4- to 1-Watt, 403 - 470 MHz
H01RDD9DB4AN	99-Mode, 6-Character Top Display, 4- to 1-Watt, 403 - 470 MHz
H01RDF9DB5AN	160-Mode, 14-Character Front Display, Limited Keypad, 4- to 1-Watt, 403 - 470 MHz
H01RDH9DB7AN	160-Mode, 14-Character Front Display, Full Keypad, 4- to 1-Watt, 403 - 470 MHz

H01SDC9DB3AN	16-Mode, 4- to 1-Watt, 450 - 520 MHz
H01SDD9DB4AN	99-Mode, 6-Character Top Display, 4- to 1-Watt, 450 - 520 MHz
H01SDF9DB5AN	160-Mode, 14-Character Front Display, Limited Keypad, 5- to 1-Watt, 450 - 520 MHz
H01SDH9DB7AN	160-Mode, 14-Character Front Display, Full Keypad, 5- to 1-Watt, 450 - 520 MHz

MTX 8000/MTX 838 Model Family

H01UCC6DB3AN	16-Mode, 3-Watt, 806 - 870 MHz, Type I
H01UCD6DB4AN	99-Mode, 3-Watt, 6-Character Top Display, 806 - 870 MHz
H01UCF6DB5AN	160-Mode, 14-Character Front Display, Limited Keypad, 3-Watt, 806 - 870 MHz
H01UCH6DB7AN	160-Mode, 14-Character Front Display, Full Keypad, 3-Watt, 806 - 870 MHz
H01UCC6DF3AN	16-Mode, 3-Watt, 806-870MHz, Type II

MTX 9000 Model Family

H01WCC4DB3AN	16-Mode, 2.9 Watt, 896 - 941 MHz
H01WCD4DB4AN	99-Mode, 2.9 Watt, 6-Character Top Display, 896 - 941 MHz
H01WCF4DB5AN	160-Mode, 14-Character Front Display, Limited Keypad, 2.9 Watt, 896 - 941 MHz
H01WCH4DB7AN	160-Mode, 14-Character Front Display, Full Keypad, 2.9 Watt, 896 - 941 MHz

LIST OF ANTENNAS AND BATTERIES

ANTENNA KIT NOS.

DESCRIPTION

NAD6566*	Helical (136 - 151MHz)
NAD6567*	Helical (151 - 162MHz)
NAD6568*	Helical (162 - 174MHz)
NAD6563*	Helical Wideband (136 - 174MHz)
NAE6546*	Helical (403 - 435MHz)
NAE6547*	Helical (435 - 470MHz)
NAE6548*	Helical (470 - 512MHz)
NAE6549*	Whip (403 - 512MHz)
NAF5037*	Whip (800MHz)
NAF5038*	Whip (900MHz)
NAF5039*	Dipole (800MHz)
NAF5040*	Dipole (900MHz)
NAF5042*	Quarter Wave, Stubby (800MHz, 900MHz)

BATTERY KIT NOS.

DESCRIPTION

NTN7143	High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7144	Ultra-High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7146*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7147*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7341*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)
NTN7372*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)

* These accessories are approved as being intrinsically safe by Factory Mutual Research Corporation (FMRC). Refer to the radio label for intrinsic safety ratings and required batteries. Only the accessories and antennas noted (by *) may be used on approved radios.



WARNING

Substitution of components may impair the intrinsic safety of the radio.

MAINTENANCE SPECIFICATIONS FOR VHF RADIOS

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT3768	Frequency Range:	*136-178MHz	RF Power:	
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	42MHz	136-174MHz	1-5 Watts
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	174-178MHz	1-4 Watts
Nominal:	7.5 Volts	Usable Sensitivity (12dB SINAD):	0.35µV Max.	Frequency Range:	*136-178MHz
Range:	6 to 9 Volts	Intermodulation:	-70dB	Freq. Stability	
Battery Drain, Typical:		Selectivity (30kHz Adjacent Channel):	-70dB	(-30 to +60°C; 25°C ref.):	± .0005%
Standby:	56mA	Spurious Rejection:	-70dB	Emission (Conducted and Radiated):	-66dBw
Receive:	180mA	Freq. Stability		FM Hum and Noise	
Transmit:	2100mA	(-30 to +60°C; 25°C reference):	± 0.0005%	(Companion Receiver):	-45dB Typical
Temperature Range:		Rated Audio:	500mW	Distortion:	3% Typical
Operating:	-30°C to +60°C	Distortion (At Rated Audio):	3% Typical	Modulation Limiting:	±5kHz
Storage:	-40°C to +85°C	Channel Spacing:	30kHz	Recommended Battery:	
Duty Cycle (5-5-90):	1 Watt/5 Watts			High Capacity:	NTN7143
High Cap. Battery:	11.2 Hrs./8 Hrs.			Ultra-High Capacity:	NTN7144
Ultra-High Cap. Battery:	12.9 Hrs./9 Hrs.				
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 174-178MHz range are not permitted in the USA.

MAINTENANCE SPECIFICATIONS FOR UHF RADIOS

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT4781 (403-470MHz) AZ489FT4780 (450-520MHz)	Frequency Range:	403-470MHz *450-520MHz	RF Power:	
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	70MHz	403-470MHz	1-4 Watts
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	450-512MHz	1-4 Watts
Nominal:	7.5 Volts	Usable Sensitivity (12dB SINAD):	0.35µV Max.	512-520MHz	1-3 Watts
Range:	6 to 9 Volts	Intermodulation:	-70dB	Frequency Range:	403-470MHz *450-520MHz
Battery Drain, Typical:		Selectivity (25kHz Adjacent Channel):	-70dB	Freq. Stability	
Standby:	60mA	Spurious Rejection:		(-30 to +60°C; 25°C ref.):	± .0005%
Receive:	180mA	450-512MHz	-70dB	Emission (Conducted and Radiated):	-66dBw
Transmit:	1800mA	512-520MHz	-65dB	FM Hum and Noise	
Temperature Range:		Freq. Stability		(Companion Receiver):	-45dB Typical
Operating:	-30°C to +60°C	(-30 to +60°C; 25°C reference):	± 0.0005%	Distortion:	3% Typical
Storage:	-40°C to +85°C	Rated Audio:	500mW	Modulation Limiting:	±5kHz
Duty Cycle (5-5-90):	1 Watt/4 Watts	Distortion (At Rated Audio):	3% Typical	Recommended Battery:	
High Cap. Battery:	11 Hrs./8.4 Hrs.	Channel Spacing:	25kHz	High Capacity:	NTN7143
Ultra-High Cap. Battery:	12.7 Hrs./9.7 Hrs.			Ultra-High Capacity:	NTN7144
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 512-520MHz range are not permitted in the USA.

MAINTENANCE SPECIFICATIONS FOR 800MHz RADIOS

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5747	Frequency Range:	851–870MHz	RF Power:	3 Watts
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	19MHz	Frequency Range:	806–824MHz 851–869MHz
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	Freq. Stability	
Nominal:	7.5 Volts	Usable Sensitivity		(–30 to +60°C; 25°C ref.):	± .00025%
Range:	6 to 9 Volts	(12dB SINAD):	0.35µV Max.	(821-824MHz Capable):	± .00015%
Battery Drain, Typical:		Intermodulation:	–70dB	Emission (Conducted and Radiated):	–46dBw
Standby:	65mA	Selectivity		FM Hum and Noise	
Receive:	190mA	(25kHz Adjacent Channel):	–70dB	(Companion Receiver):	–40dB Typical
Transmit:	1900mA	Spurious Rejection:	–70dB	Distortion:	3% Typical
Temperature Range:		Freq. Stability		Modulation Limiting:	±5kHz
Operating:	–30°C to +60°C	(–30+60°C; 25°C reference):	± .00025%	(821-824MHz):	±4kHz
Storage:	–40°C to +85°C	(821-824MHz Capable):	±.00015%	Recommended Battery:	
Duty Cycle (5-5-90):		Rated Audio:	500mW	High Capacity:	NTN7143
High Cap. Battery:	8 Hours	Distortion (At Rated Audio):	3% Typical	Ultra-High Capacity:	NTN7144
Ultra-High Cap. Battery:	9 Hours	Channel Spacing:	25kHz		
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

MAINTENANCE SPECIFICATIONS FOR 900MHz RADIOS

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5748	Frequency Range:	935–941MHz	RF Power:	2.9 Watts
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	6MHz	Frequency Range:	896–902MHz 935–941MHz
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	Freq. Stability	
Nominal:	7.5 Volts	Usable Sensitivity		(–30 to +60°C; 25°C ref.):	± .00015%
Range:	6 to 9 Volts	(12dB SINAD):	0.35µV Max.	Emission (Conducted and Radiated):	–46dBw
Battery Drain, Typical:		Intermodulation:	–60dB	FM Hum and Noise	
Standby:	65mA	Selectivity		(Companion Receiver /	
Receive:	185mA	(12.5kHz Adjacent Channel):	–60dB	HEAR CLEAR):	–45dB Typical
Transmit:	1910mA	Spurious Rejection:	–60dB	Distortion:	3% Typical
Temperature Range:		Freq. Stability		Modulation Limiting:	±2.5kHz
Operating:	–30°C to +60°C	(–30+60°C; 25°C reference):	± .00015%	Recommended Battery:	
Storage:	–40°C to +85°C	Rated Audio:	500mW	High Capacity:	NTN7143
Duty Cycle (5-5-90):		Distortion (At Rated Audio):	3% Typical	Ultra-High Capacity:	NTN7144
High Cap. Battery:	8 Hours	Channel Spacing:	12.5kHz		
Ultra-High Cap. Battery:	9 Hours				
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

SECTION I. INTRODUCTION

This manual includes a model chart, specifications, fundamental disassembly/reassembly procedures; and all schematic diagrams, printed circuit board details, flex circuit diagrams, and several parts lists to completely cover the HT 1000, MT 2000, MTS 2000, and MTX series radios. Hereafter, the text will refer collectively to these radios as “this family of radios.” For maintenance/troubleshooting, theory, accessories, and operation of the radio, refer to the applicable manual available separately. To help you with your selection, a list is provided in this manual, titled “RELATED PUBLICATIONS AVAILABLE SEPARATELY.”

Special notices are incorporated into the text, alerting you to safety hazards and suggesting procedures. These notices are divided and labeled according to the information they contain so that you can become immediately aware of the type of information being presented. The three classifications are: **WARNINGS**, **CAUTIONS**, and **NOTES**.



WARNING

This is an operational procedure, practice, or condition, etc., which may result in injury or death if not carefully observed.



CAUTION

This is an operational procedure, practice, or condition, etc., which may result in damage to the equipment if not carefully observed.

NOTE

This is an operational procedure, practice, or condition, etc., which is essential to emphasize.

SECTION II. RECOMMENDED AND REQUIRED TEST EQUIPMENT, SERVICE AIDS, AND TOOLS LISTS

Table 40-1. Recommended Test Equipment

MOTOROLA MODEL NUMBER	DESCRIPTION	CHARACTERISTICS	APPLICATION
R2000 Series	System Analyzer	This monitor will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
R2600 Series	System Analyzer	This monitor will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1049A	Digital Multimeter		Digital voltmeter recommended for ac/dc voltage and current measurements
*R1150C	Code Synthesizer		Injection of audio and digital signalling codes
*S1053D *SKN6008A *SKN6001A	AC Voltmeter Power Cable for Meter Test Leads for Meter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R1094A	Dual-Trace Oscilloscope	20MHz bandwidth 5mV to 5V/division	Waveform measurements
*S1350C *ST1213B (VHF) *ST1223B (UHF)	Watt Meter Plug-in Element RF Dummy Load	50-ohm, ±5% accuracy 10 Watts, maximum 0-1000MHz, 300W	Transmitter power output measurements
R1065	Load Resistor	10-watt Broadband	For use with Wattmeter
S1339A	RF Millivolt Meter	100µV to 3V rf 10kHz to 1.2GHz	RF level measurements
*R1013A	SINAD Meter		Receiver sensitivity measurements
S1347D or S1348D (programmable)	DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc

Any of the R2000/R2600 series system analyzers will substitute for items with an asterisk ().

A. Recommended Test Equipment

The list of equipment contained in Table 40-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. Battery-operated test equipment is recommended when available. The "CHARACTERISTICS" column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

B. Service Aids and Recommended Tools

Refer to the "SERVICE AIDS" in Table 40-2 and "RECOMMENDED TOOLS LIST" in Table 40-3 for a listing and description of the service aids and tools designed specifically for servicing this family of radios, as well as the more common tools required to disassemble and properly maintain the radio. These kits and/or parts are available from the Motorola Communications Parts office listed in the "Replacement Parts Ordering" section of this manual.

MAV-PACK 3 (VID-952)/F.A.S.T. 60

The VID-952 Motorola Video Visual Package (MAV-PACK) is a video tape training program on leadless component repair techniques. This VHS format video

cassette and supplemental literature describe the removal and replacement of leadless components using the R-1070A surface-mounted IC removal station:

- 0180386A62 Heated Tweezers
- 0180356B79 Desoldering Station
- 0180371B30 Soldering Station

This MAV-PACK is strongly recommended for technicians who intend to service this and other Motorola radios using leadless components. This VHS videotape is in standard half-inch format.

National Service Training's Field Assist Service Training (F.A.S.T.) Video Tape #60 introduces this family of radios. Included on this tape are basic theory of operation, disassembly, and basic troubleshooting techniques.

The MAV-PACK 3 (VID-952), as well as others, and the F.A.S.T. 60 are available from:

**Motorola C&E, Inc.
National Service Training Center
1300 N. Plum Grove Road
Schaumburg, Illinois 60195**

C. Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the applicable "Radio Service Software User's Manual" for complete field programming information.

The following table lists service aids recommended for working on this family of radios. These items are available from the Motorola Parts Department.

Table 40-2. Service Aids

MOTOROLA PART NO.	DESCRIPTION	APPLICATION
RKN-4035A	RIB/Radio/test set cable	Connects radio to RTX-4005B Test Box and RIB.
RLN-1014A	Battery Eliminator	Interconnects radio to power supply.
RLN-1018A	Test Fixture	Provides for troubleshooting of the radio when the housing is removed.
RTX-4005B or both RTX-4005A and RPX-4665A Field Modification Kit	Portable Test Set	Enables connection to the universal connector. Allows switching for radio testing.
RLN-4008B	Radio Interface Box	Enables communications between the radio and the computer's serial communications adapter.
0180357A57 0180358A56	Wall-mounted Power Supply Wall-mounted Power Supply	Used to supply power to the RIB (120 VAC). Used to supply power to the RIB (220 VAC).
3080369B71 or 3080369B72	Computer Interface Cable	Use B72 for the IBM PC AT. All other IBM models use B71. Connects the computer's serial communications adapter to the RIB.
RKN-4036A	Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from one radio to another (HT 1000/MT 2000 Models Only).
RVN-4097A	Radio Service Software	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
RVN-4098A	Radio Service Software (HT 1000 Models Only)	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
5880348B33	SMA to BNC Adaptor	Adapts radio's antenna port to BNC cabling of test equipment.
F.A.S.T. 60	Video Tape, Radio Introduction	Includes operation, disassembly, and basic troubleshooting.
RLN-4201	Battery Tester	Tests battery charge.
RLN-4048	Battery Tester Adapter	Adapts HT 1000, MT 2000, MTS 2000, and MTX Series radio batteries to the RLN-4201 Battery Tester.
RTL-4208	RF Probe	50-ohm, high-frequency probe.
RT-5144/48/0	Test Probe (black)	Needle-fine test probes for high-density circuitry.
RT-5144/48/2	Test Probe (red)	

The following table lists the tools recommended for working on this family of radios; these tools are also available from Motorola. Note that the R-1319A solder/desolder workstation requires the use of some reflow nozzles. The nozzles' part numbers and general descriptions are listed in the table with the R-1319A.

Also note that the R-1070A workstation requires the use of a specific "heat focus head" for each of the components on which this item is used. **Each of these heat focus heads must be ordered separately.** The individual heat focus heads (and the components on which they are used) are listed at the end of the table.

Table 40-3. Recommended Service Tools

MOTOROLA PART NO.		DESCRIPTION	APPLICATION	
0180381B45	110VAC	MBT250 Surface-mount/ thru-hole repair station	Temperature-controlled, self-contained soldering/desoldering repair station for installation and removal of surface-mounted devices. Allows for the proper amount of flux to be applied to pad grid arrays for repair. For use with flux holder/applicator 8180369E97. Used during all radio assembly and disassembly procedures.	
or 0180300E06	220VAC	Flux holder/applicator		
8180369E97				
1105139W02		30cc plastic syringe and flux paste		
0180386A81		Miniature digital readout soldering station (incl. 1/64" micropoint tip)		
0180386A78		Illuminated magnifying glass with lens attachment		
0180386A82		Anti-static grounding kit		
6684253C72		Straight prober		
6680384A98		Brush		
1010041A86		Solder (RMA type), 63/37, 0.020" diameter- 1 lb. spool		
R-1319A (Supersedes R-1070A)		Surface-Mounted Device Rework Station	Removal of surface-mounted integrated circuits.	
6680332E82		R-1319A Reflow Nozzle	For IC removal (approximate size 0.8 in. x 0.8 in.)	
6680332E83		R-1319A Reflow Nozzle	For IC removal (approximate size 0.6 in. x 0.6 in.)	
6680332E84		R-1319A Reflow Nozzle	For IC removal (approximate size 0.5 in. x 0.5 in.)	
6680333E28		R-1319A Reflow Nozzle	For removal of RF PA	
R-1070A (Superseded by R-1319A)		Shields and surface-mounted component - IC removal/rework station (order all heat focus heads separately)	Removal of surface-mounted integrated circuits.	
HEAT-FOCUS HEADS	INSIDE DIMENSIONS OF HEADS	USED ON	MAXIMUM PRESCRIBED HEAT SETTING	
6680334B49	0.410" x 0.410"	U601, U702	Temperature settings using the R-1319A and the R-1070A are the same. Refer to Maintenance Sec- tion of Manual for prescribed heat setting.	
6680334B50	0.430" x 0.430"	U4, U5, U713		
6680334B51	0.492" x 0.492"	U3		
6680334B52	0.572" x 0.572"	U701, U705		
6680334B53	0.670" x 0.790"	* metal shields B, C, E, and F		
6680370B51	0.475" x 0.475"	U204		
6680370B54	0.710" x 0.710"	U710		
6680370B57	0.245" x 0.245"	U2, U201		
6680370B58	0.340" x 0.340"	U101, U102		
6680371B15	0.460" x 0.560"	* metal shields A, D, G, H, and I		
6680371B74	0.470" x 0.570"	U203		
6680332E45	0.591" x 0.315"	U714		
6680332E46	0.862 x 0.350"	U715		

* Refer to the SHIELDS LOCATION DETAIL and Shields Parts List in the rear of this manual to match the shield with the proper heat focus head.

SECTION III. TRANSCEIVER PERFORMANCE TESTING

A. General

The HT 1000, MT 2000, MTS 2000, and MTX series radios have been prepared to meet published specifications through their manufacturing process, with the use of laboratory-quality test equipment of highest accuracy. The recommended field service equipment approaches the accuracy of the manufacturing equipment with a few exceptions. Accuracy of the equipment must be maintained in compliance with the manufacturer's recommended calibration schedule.

B. Setup

Supply voltage can be connected from the battery eliminator. The equipment required for alignment procedures is connected as shown in the Radio Alignment Test Setup diagram.

Initial equipment control settings should be as indicated in the following table, and should hold for all alignment procedures except as noted in Table 40-4.

Table 40-4. Initial Equipment Control Settings

SERVICE MONITOR	TEST SET	POWER SUPPLY
Monitor Mode: Pwr Mon RF Attn: -70 AM, CW, FM: FM O'scope Source: Mod O'scope Horiz: 10mSec/Div O'scope Vert: 2.5kHz/Div O'scope Trig: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: mid CW Monitor Vol: 1/4 CW	Spkr set: A Spkr/load: Speaker PTT: OFF (center)	Voltage: 7.5Vdc DC on/standby: Standby Volt Range: 10 Current: 2.5

C. Test Mode

1. RF Test Mode, HT 1000 Radios

When the HT 1000 radio is operating in its normal environment, the radio's microcontroller controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcontroller will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or "air test," has been incorporated in the radio.

To enter test mode:

- (a) Turn the radio on.
- (b) Within ten seconds after the self test is complete, press the monitor button (side button 3, SB3) five times in succession. After the fifth press, a tone is emitted to indicate that the rf test mode has been entered.

- (c) Each additional press of SB3 will advance to the next test channel. (refer to Table 40-6), and a corresponding set of tones will indicate the channel.
- (d) Pressing SB2 will scroll through and access test environments as shown in Table 40-5.

NOTE

Transmit into a load when keying a radio under test.

To exit test mode, turn the radio off then back on.

Table 40-5. Test Environments, HT 1000 Radios

NO. OF BEEPS	DESCRIPTION	FUNCTION
1	Carrier Squelch	RX: if carrier detected TX: mic audio
3	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
4	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected

2. Control Head Test Mode, HT 1000 Radios

To check the buttons and the switches, perform the following tests:

- (a) Turn radio on
- (b) After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds. After the fifth press, a tone is emitted to indicate that the RF test mode has been entered.
- (c) Exit the RF test mode and enter the control head test mode by pressing and holding SB3 for more than three seconds. Upon entering the control head test mode, a tone is emitted and the green LED begins flashing. The green LED continues to flash until the control head test mode is exited.

NOTE

Return to the RF test mode by pressing and holding SB3 for more than three seconds. Then re-enter the control head test mode by pressing and holding SB3 for more than three seconds.

- (d) Test each switch (toggle, rotary, or button-actuated) by changing the position of the switch. A tone is emitted to indicate a "good test" each time a switch position is changed.

NOTES

1. Pressing and releasing a button-actuated switch are both considered switch-position changes.
2. No tone when a switch position is changed indicates a test failure.

Table 40-6. Test Frequencies, HT 1000 Radios

NO. OF BEEPS	TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800
1	TX #1	136.025	403.100	450.025	806.0125
	RX #1	136.075	403.150	450.075	851.0625
2	TX #2	142.125	424.850	465.225	815.0125
	RX #2	142.075	424.900	465.275	860.0625
3	TX #3	154.225	438.050	475.225	824.9875
	RX #3	154.275	438.100	475.275	869.9375
4	TX #4	160.125	444.050	484.975	851.0125
	RX #4	160.175	444.100	485.025	851.0625
5	TX #5	168.075	456.350	500.275	860.0125
	RX #5	168.125	456.400	500.225	860.0625
6	TX #6	173.975	463.700	511.975	869.9875
	RX #6	173.925	463.750	511.925	869.9375

- (e) Test the on/off volume potentiometer/switch by rotating the potentiometer clockwise and counter clockwise. The loudness of tone beeps will increase and decrease accordingly.

NOTE

During test mode, the volume level is not regulated to the same limits as during normal radio operation.

To exit test mode, turn the radio off then back on.

3. RF Test Mode, MT 2000, MTS 2000, and MTX Series Radios

When the MT 2000, MTS 2000, or MTX series radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcomputer will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or "air test," has been incorporated in the radio.

To enter test mode:

- (a) Turn the radio on.
- (b) After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
- (c) After "RF TEST" appears (on 14-character displays) or "RF TST" appears (on 6-character displays), press the orange button on top of the radio once. "1 CSQ" appears, indicating: test frequency 1, carrier squelch mode.
- (d) Each additional press of SB3 will advance to the next test channel. (Refer to Table 40-8.)
- (e) Pressing SB2 will scroll through and access test environments as shown in Table 40-7.

NOTES

- 1. Transmit into a load when keying a radio under test.
- 2. Radios without display indicate test-environment function by emitting a corresponding number of beeps. See Table 40-7.
- 4. Control Head Test Mode, MT 2000, MTS 2000, and MTX Series Radios
To check the display, the buttons, and the switches, perform the following tests:
 - (a) Turn radio on
 - (b) After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
 - (c) After "RF TEST" appears on the display, press side button 1 (SB1), "CH TEST" (14-character radio) or "CH TST" (6-character radio) appears on the display.
 - (d) Next, press and hold the orange button on top of the radio; all segments on the display will light, and the LED on the control top will illuminate a yellowish color.
 - (e) Release the orange button; "3/0" appears, which indicates that switch 3 is in the open condition.
 - (f) Press the orange button again; "3/1" appears, which indicates that switch 3 is in the closed condition.
 - (g) Rotate the mode selector knob; "4/0" thru "4/15" appears, which indicates that knob 4 is in mode position 1 thru 15.
 - (h) Rotate the concentric switch; "65/0" and "65/1" appears.
 - (i) Rotate the volume control; "2/0" thru "2/255" appears.
 - (j) Press SB1, view "96/1"; release, view "96/0"
 - (k) Press SB2, view "97/1"; release, view "97/0"

(l) Press SB3, view "98/1"; release, view "98/0"

(m) Keypad:

- Press **0**, view "48/1"; release, view "48/0"
- Press **1**, view "49/1"; release, view "49/0"
- Press **2**, view "50/1"; release, view "50/0"
- Press **3**, view "51/1"; release, view "51/0"
- Press **4**, view "52/1"; release, view "52/0"
- Press **5**, view "53/1"; release, view "53/0"
- Press **6**, view "54/1"; release, view "54/0"
- Press **7**, view "55/1"; release, view "55/0"

- Press **8**, view "56/1"; release, view "56/0"
- Press **9**, view "57/1"; release, view "57/0"
- Press *****, view "58/1"; release, view "58/0"
- Press **#**, view "59/1"; release, view "59/0"
- Press **<**, view "128/1"; release, view "128/0"
- Press **HOME**, view "129/1"; release, view "129/0"
- Press **>**, view "130/1"; release, view "130/0"

To exit test mode, turn the radio off then back on.

Table 40-7. Test Environments, MT 2000, MTS 2000, and MTX Series Radios

NO. OF BEEPS	DISPLAY	DESCRIPTION	FUNCTION
1*	CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
2	HC	Hear Clear**	RX: unsquelch if carrier detected TX: compressed mic audio
3	TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
4	DPL	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected
5	TLS	Trunking Low Speed	RX: unsquelch if carrier detected TX: mic audio + connect tone (105.8 Hz) @ correct deviation
6	THS	Trunking	RX: unsquelch if valid outbound signalling word (OSW) detected High Speed TX: 1500 Hz tone
7	DTM multiple freq.	dual-tone	RX: unsquelch if carrier detected TX: selected DTMF tone pair
8	M12	MDC1200	RX: unsquelch if carrier detected without DOS (1800 Hz); squelch if carrier detected with DOS (1800 Hz) TX: 1500 Hz tone
9	SEC	Secure***	RX: auto-coded clear TX: with key present - encrypted audio with key absent - constant unsquelch
12	USQ	Unsquelch****	RX: constant unsquelch TX: mic audio

* radios without display indicate function by emitting a number of beeps
** on 900 MHz radios only

*** on radios equipped with secure option
**** not available on all radios

Table 40-8. Test Frequencies, MT 2000, MTS 2000, and MTX Series Radios

TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800	900	R-BAND
TX #1	136.025	403.100	450.025	806.0125	896.0125	885.0125
RX #1	136.075	403.150	450.075	851.0625	935.0625	830.0125
TX #2	142.125	424.850	465.225	815.0125	899.0125	885.0125
RX #2	142.075	424.900	465.275	860.0625	938.0625	859.9875
TX #3	154.225	438.050	475.225	824.9875	901.9875	885.0125
RX #3	154.275	438.100	475.275	869.9375	940.9375	859.9875
TX #4	160.125	444.050	484.975	851.0125	935.0125	895.0125
RX #4	160.175	444.100	485.025	851.0625	935.0625	859.9875
TX #5	168.075	456.350	500.275	860.0125	938.0125	905.0125
RX #5	168.125	456.400	500.225	860.0625	938.0625	859.9875
TX #6	173.975	463.700	511.975	869.9875	940.9875	914.9875
RX #6	173.925	463.750	511.925	869.9375	940.9375	859.9875
TX #7	177.975	469.650	519.975	None	None	None
RX #7	177.925	469.700	519.925	None	None	None

Table 40-9. Receiver Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency [◇] Monitor: Frequency error Input at RF In/Out	TEST MODE, 4 CSQ output at antenna	PTT to continuous (during the performance check)	Frequency error to be $\pm 150\text{Hz}$
Rated Audio	Mode: GEN Output level: 1.0mV RF 4th channel test frequency [◇] Mod: 1kHz tone at 3kHz deviation Monitor: DVM: AC Volts	TEST MODE, 4 CSQ	PTT to OFF (center), meter selector to Audio PA	Set volume control to 3.74Vrms
Distortion	As above, except to distortion	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12dB SINAD.	As above	PTT to OFF (center)	RF input to be < 0.35 μV
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1mV RF	As above	PTT to OFF (center), meter selection to Audio PA, spkr/load to speaker	Set volume control to 3.74Vrms
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	out of TEST MODE; select a conventional system	As above	Unsquelch to occur at < 0.25 μV . Preferred SINAD = 8-10dB

[◇] See Table 40-6 or Table 40-8 as applicable.

Table 40-10. Transmitter Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency [◇] Monitor: Frequency error Input at rf In/Out.	TEST MODE, 4 CSQ	PTT to continuous (during the performance check).	Frequency error to be < 150Hz.
Power RF	As above.	As above, 4 CSQ	As above.	Refer to Maintenance Specifications page in front of manual.
Voice Modulation	Mode: PWR MON 4th channel test frequency [◇] atten to -70, input to RF In/Out, Monitor: DVM, AC Volts Set 1kHz Mod Out level for 0.025Vrms at test set, 80mVrms at AC/DC test set jack	As above, 4 CSQ	As above, meter selector to mic.	Deviation: VHF, UHF, and 800MHz: ≥ 3.6kHz but ≤ 5.0kHz. 900MHz: ≤ 2.5kHz.
Low-Speed Data Modulation 800/900 UHF	As above.	TEST MODE 4TLS output at antenna	PTT to continuous (during the performance check).	Deviation: UHF, 800MHz: ≥ 500Hz but ≤ 1000Hz.
Voice Modulation (internal)	Mode: PWR MON 4th channel test frequency [◇] atten to -70, input to RF In/Out.	TEST MODE, 4 CSQ, output at antenna.	Remove modulation input.	Press PTT switch on radio. Say "four" loudly into the radio mic. Measure deviation: VHF, UHF, and 800MHz: ≥ 3.8kHz but ≤ 5.0kHz. 900MHz: ≤ 2.5kHz.
High-Speed Data Modulation***	As above.	TEST MODE, 4 THS, output at antenna.	PTT to continuous (during the performance check).	Deviation: UHF and 800MHz: ≥ 2.4kHz but ≤ 3.6kHz. 900MHz: ≥ 1.52kHz but ≤ 1.95kHz.
DTMF Modulation	As above, 4th channel test frequency [◇]	TEST MODE, 4 DTMF, output at antenna.	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 3.8kHz but ≤ 5.0kHz. 900MHz: ≥ 1.5kHz but ≤ 1.9kHz.
PL/DPL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to a conventional transmit frequency, BW to narrow.	Conventional coded squelch personality (clear mode operation). 4 TPL 4 DPL	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 500Hz but ≤ 1000Hz. 900MHz: ≥ 250Hz but ≤ 500Hz.
Talk-around Modulation (radios with conventional, clear mode, talk-around operation only)	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC volts Set 1kHz Mod Out level for 25mVrms at test set.	Conventional talk-around personality (clear mode operation). 1 CSQ	As above.	Deviation: UHF and 800MHz: ≥ 3.8kHz but ≤ 5.0kHz. 900MHz: ≥ 1.95kHz but ≤ 2.45kHz.
Talk-around Modulation (radios with conventional, secure mode, talk-around operation only) (**)	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC volts Mod: 1kHz out level for 25mVrms at test set.	Conventional talk-around personality (secure mode operation) Load key into radio. 1 Sec.	As above.	Deviation: UHF and 800MHz: ≥ 3.6kHz but ≤ 4.4kHz.

* 800 MHz radios only

** The secure mode, talk-around modulation test is only required for trac mode radios which do not have clearmode talk-around capability.

*** Trunked Only

◇ See Table 40-6 or Table 40-8 as applicable.

IV. ERROR CODE DISPLAYS

A. Power-up Display Codes

At power-up, the radio performs cursory tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation, while non-fatal errors will not. Use Table 40-11 to aid in understanding particular power-up error code displays.

B. Operational Display Codes

During operation, the radio performs dynamic tests to determine if it is working properly. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 40-12 to aid in understanding particular operational error code displays.

Table 40-11. Power-up Display Codes

FAILURE DISPLAY		TYPE OF FAILURE	DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display			
FAIL 01/81	F01/81	FATAL	External ROM/Flash checksum error	Bad ROM data, Defective ROM
FAIL 01/82	F01/82	FATAL	External EEPROM checksum error	Bad external codeplug data, Defective external EEPROM
ERROR 01/02	E01/02	NON-FATAL	External EEPROM checksum error	Bad external codeplug data
FAIL 01/84	F01/84	FATAL	External EEPROM checksum blank	Unprogrammed external codeplug data
FAIL 01/88	F01/88	FATAL	External RAM error	Defective RAM
FAIL 01/90	F01/90	FATAL	Hardware failure	Defective IC
FAIL 01/92	F01/92	FATAL	Internal EEPROM checksum error	Bad internal codeplug data, Defective microcontroller
ERROR 01/12	E01/12	NON-FATAL	Internal EEPROM checksum error	Bad internal codeplug data
FAIL 01/94	F01/94	FATAL	Internal EEPROM checksum blank	Unprogrammed internal codeplug data
FAIL 01/98	F01/98	FATAL	Internal RAM error	Defective microcontroller

NOTE

Due to the nature of fatal ROM & RAM errors, it may not be possible to present an error code on the display. In these cases the radio will attempt to display the appropriate error code, generate an illegal mode tone for one second and then reset its microcontroller.

Table 40-12. Operational Display Codes

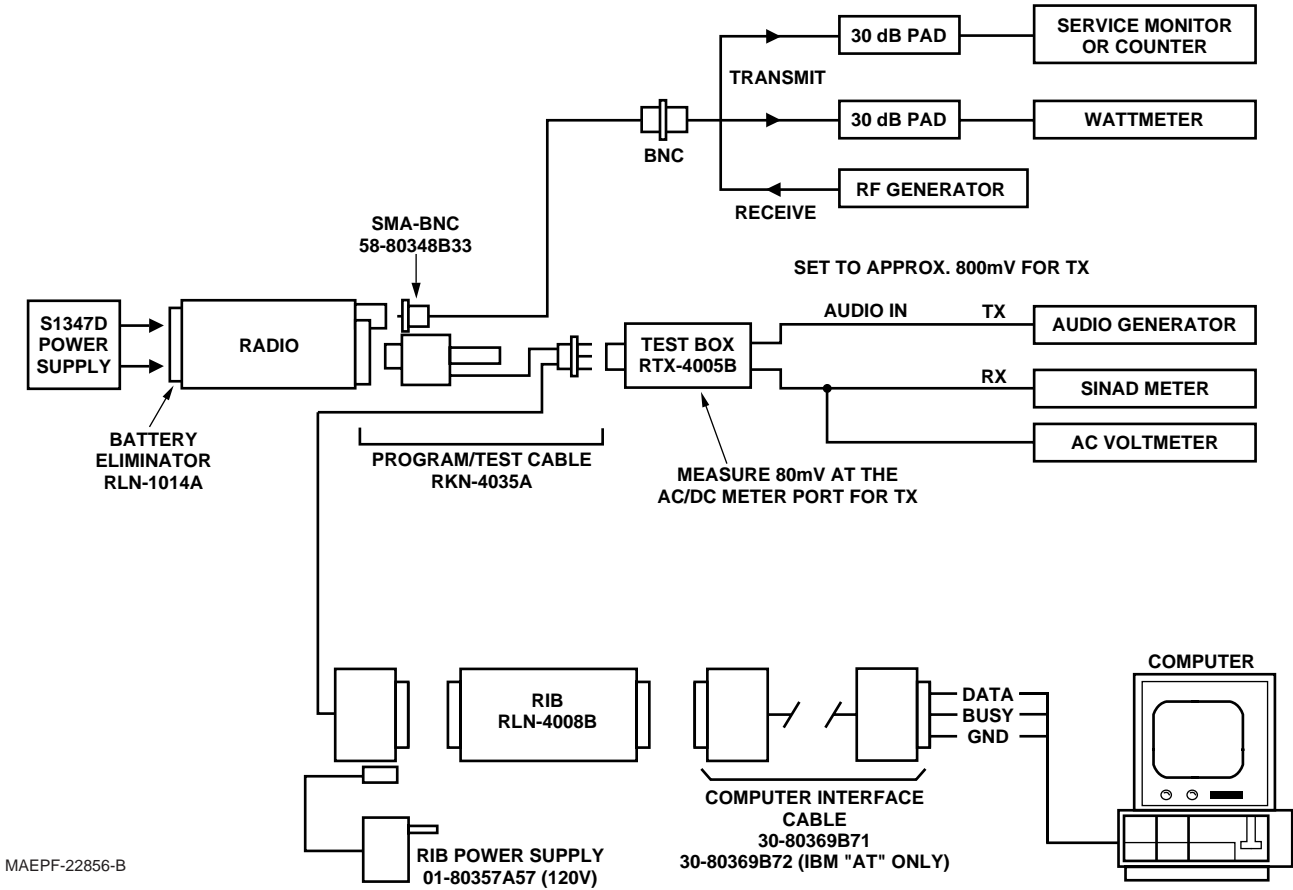
FAILURE CODE		DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display		
FAIL 001	F001	Synthesizer out of lock	Bad frequency data in codeplug; defective synthesizer
FAIL 002	F002	Selected Mode (Zone/Channel) codeplug checksum error	Bad codeplug data
FAIL 100	F100	Incompatible trunking software and hardware	Trunking hardware decoder disabled in codeplug; old SLIC IC version
FAIL 101	F101	Incompatible MDC1200 software and hardware	MDC 1200 hardware decoder disabled in codeplug; old SLIC IC version

SECTION V. RADIO ALIGNMENT PROCEDURE

A. General

An IBM PC (personal computer) and RSS (Radio Service Software) are required to align the radio. Refer to the applicable RSS manual for installation and setup

procedures for the software. To perform the alignment procedures, the radio must be connected to the PC, RIB (radio interface box), and Universal Test Set as shown in Figure 40-1.



MAEPF-22856-B

Figure 40-1. Radio Alignment Test Setup

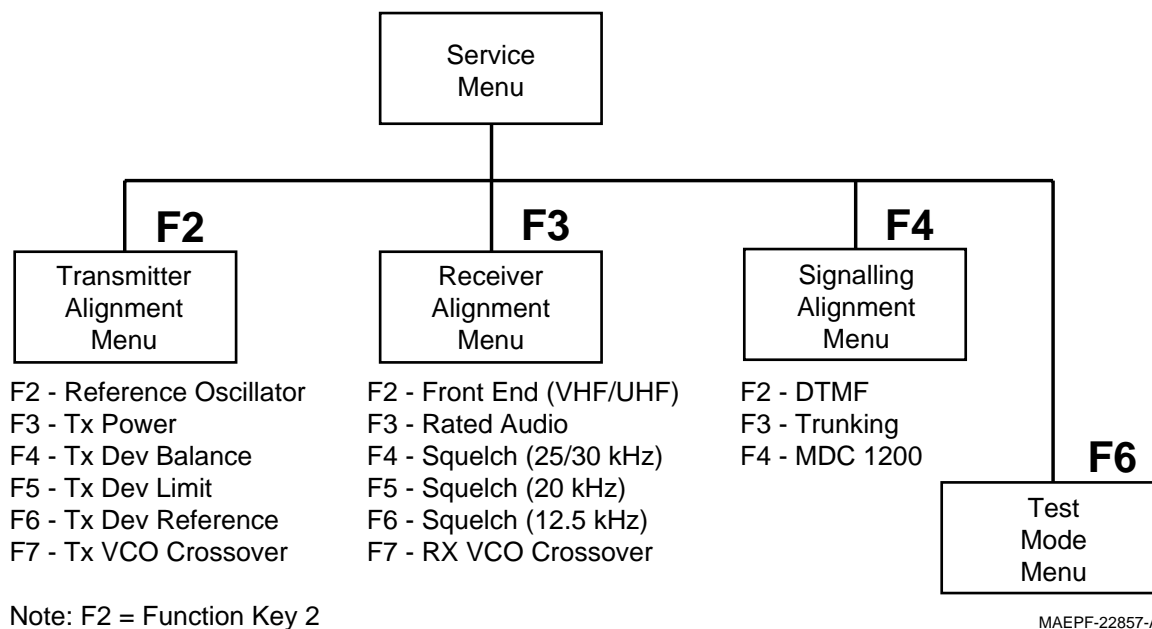


Figure 40-2. RSS Service Menu Layout

All service and tuning procedures are performed from the SERVICE menu, which is selected by pressing F2 from the MAIN MENU. Figure 40-2 illustrates how the RSS SERVICE screens are organized.

All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to use the SERVICE menus. You will be prompted at each screen to save changed values before exiting the screen. RSS references in this manual are to HT 1000 RSS. Some slight differences may be noted if you are using the MTS/MTX RSS.

The SERVICE screens introduce the concept of the “softpot”, an analog SOFTWARE controlled POTentiometer used for adjusting all transceiver alignment controls.

Each SERVICE screen provides the capability to increase or decrease the ‘softpot’ value with the keyboard UP/DOWN arrow keys respectively. A graphical scale is displayed indicating the minimum, maximum, and proposed value of the softpot, as shown in figure 40-3.

CAUTION

Do NOT switch radios in the middle of any SERVICE procedure. Always use the EXIT key to return to the MAIN menu screen before disconnecting the radio. Improper exits from the SERVICE screens may leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

The radio contains internal test modes that can be accessed from the RSS. The test modes permit the service technician to easily select various frequency, modulation, and transmit power combinations to verify proper operation of the radio. The test modes can be used to check both transmit and receive operation. From the Service Menu press F6 to navigate to the TEST MODE screen.

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Figure 40-3. Softpot Concept

Adjusting the softpot value sends information to the radio to increase (or decrease) a DC voltage in the corresponding circuit. For example, pressing the UP arrow key at the Reference Oscillator screen instructs the radio microprocessor to increase the voltage across a varactor in the reference oscillator to increase the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a D/A (Digital-to-Analog) generated voltage in the radio. All standard measurement procedures and test equipment are similar to previous radios.

Perform the following procedures in the sequence indicated.

B. Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will not only result in poor operation, but also a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F2 again to select the REFERENCE OSCILLATOR softpot.
3. Press F6 to key the radio. The screen will indicate that the radio is transmitting.
4. Measure the transmit frequency on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the reference oscillator per the targets shown in Table 40-13.

Table 40-13. Reference Oscillator Alignment

BAND	TARGET
VHF	± 150 Hz
UHF	± 150 Hz
800 /900 MHz	± 150 Hz

C. Front-End Pre-Selector (VHF/UHF only)

NOTE

This procedure is only required for tuning the front-end filter varactors in the VHF and UHF models. The 800 and 900 MHz models utilize a stripline pre-selector.

1. Set the Test Box (RTX4005B) meter selection switch to the "VOL" position, and connect a dc voltmeter capable of 1mV resolution on a 2V scale to the Test Box AC/DC meter port to monitor the Received Signal Strength Indicator (RSSI).
2. From the SERVICE menu, press F3 to select RECEIVER alignment.
3. Press F2 to select the FRONT END FILTER softpot. The screen will indicate the receive frequencies at which the filter is to be tuned.
4. Set the RF test generator to the first receive frequency +150 Hz. Set the RF level at the radio standard antenna port to 4.0 µVolts with no modulation.
5. Adjust the UP/DOWN arrow keys to obtain a peak voltage on the dc voltmeter.
6. Press F8 to program the softpot value.
7. Repeat steps 4-6 for the remaining test frequencies.

8. Press F10 and F2 to return to the RECEIVER menu.

D. Rated Audio

1. Set test box (RTX-4005B) meter selection switch to the "AUDIO PA" position and connect an ac voltmeter to the test box ac/dc meter port.
2. Press F3 to select the RATED AUDIO softpot. The screen will indicate the receive test frequency to be used.
3. Set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1mV modulated with standard test modulation (see Table 40-14).

Table 40-14. Standard Test Modulation (1 kHz Tone)

CHANNEL SPACING	DEVIATION
25/30 kHz	3.0 kHz
20 kHz	2.4 kHz
12.5 kHz	1.5 kHz

4. Adjust the UP/DOWN arrow keys to obtain rated audio (as close as possible to 3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
5. Press F8 to program the softpot value.
6. For 900 MHz radios, go to step 7; otherwise press F10 to return to the RECEIVER menu.
7. Now set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1mV modulated with a 1 kHz tone, 1.2 kHz deviation.
8. Select the Hear Clear RATED AUDIO softpot, and adjust the UP/DOWN arrow keys to obtain rated audio (3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
9. Press F8 to program the softpot value
10. Press F10 to return to the RECEIVER menu.

E. Squelch

1. Channel spacing determines the next key press. Press F4, F5, or F6 (as applicable) to select the SQUELCH softpot.
2. With no signal applied, decrease the softpot value until squelch opens. Set the RF test generator to the test frequency plus the following offset:
vhf: +200Hz uhf: +200Hz 800MHz: +500Hz
Adjust the generator for 8 to 10dB SINAD.
3. Increase the softpot until the squelch closes.
4. Monitor for squelch chatter. If chatter is present, increase the softpot until no chatter is detected. Press F8 to program the softpot value. Press ENTER to select the next softpot adjustment.
5. Repeat steps 2 thru 4 for all test frequencies shown on the screen.

- Press F10, F2, then F10 again to return to the service menu.

F. Transmitter Power

VHF and UHF radios require two power-level adjustments, a high-power or rated-power adjustment, and a low-power adjustment. The low power adjustment is required since the radio may be used in a reduced power mode, or with a vehicular adapter.

NOTE

All power measurements are to be made at the antenna port.

- From the SERVICE menu, press F2 to select TRANSMITTER alignment.
- Press F3 to select the TRANSMIT POWER softpot. The screen will indicate the transmit test frequencies to be used.
- Begin with the highest test frequency shown.
- Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the transmit power per the value shown in Table 40-15.
- Press F6 to dekey the radio, and then press F8 to program the value.
- Repeat steps 4-5 for the remaining test frequencies.
- Press F10, then F2 to return to the TRANSMIT menu.

G. Transmit Deviation Balance (Compensation)

Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. The compensation algorithm is critical to the operation of signalling schemes that have very low frequency components (e.g. DPL) and could result in distorted waveforms if improperly adjusted.

NOTE (Secure-Equipped Only)

If a secure module is currently installed in the radio being aligned, refer to the appendix at the rear of this manual. Read section III, "Secure Alignment Procedure", before performing the transmit deviation balance (compensation) procedure.

- Press F4 to select the TRANSMIT DEVIATION BALANCE softpot. The screen will indicate the transmit test frequencies to be used.
- Begin with the lowest test frequency shown on the screen.
- Set the Test Box (RTX4005B) meter selector switch to the "MX DISC" position, and inject an 80 Hz tone at 100 mVrms into the AC/DC MTR port. Keep the ac voltmeter in parallel to ensure the proper input signal level.
- Press F6 to key the radio, and measure deviation. Record this measurement.
- Change the input tone to 3 kHz, 100 mVrms and use the UP/DOWN arrow keys to adjust the deviation to within $\pm 2\%$ of the value recorded in step 4.
- Change the input tone back to 80Hz and measure the deviation.
- Repeat steps 5 and 6 until the 3 kHz tone deviation is within $\pm 2\%$ of the 80Hz tone deviation.
- Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to next softpot value.
- Repeat steps 3-8 for the remaining test frequencies.
- Press F10 to return to the TRANSMIT menu.

NOTE

- The step size change for step 5 is approximately 2.5% per softpot value.
- This adjustment should only be made to the 3kHz deviation. Do not adjust the 80Hz deviation.

H. Transmit Deviation Limit

- Press F5 to select the TRANSMIT DEVIATION LIMIT softpot. The screen will indicate the transmit test frequencies to be used.
- Begin with the lowest test frequency shown on the screen.

Table 40-15. Transmit Power Setting

VHF			UHF		
Power Level	Test Frequencies		Power Level	Test Frequencies	
	136-174MHz	177.975MHz		450-512MHz	512-520MHz
5 W	5.2 - 5.4	4.2 - 4.4	4 W	4.2 - 4.4	3.2 - 3.4
1 W	1.2 - 1.4	1.2 - 1.4	1 W	1.2 - 1.4	1.2 - 1.4
800 MHz			900 MHz		
Power Level	All Test Frequencies		Power Level	All Test Frequencies	
3 W	3.20-3.40		2.9 W	2.80 - 3.00	

3. With the meter selector switch (RTX4005B) set to MIC, inject a 1 kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
4. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per the values shown in Table 40-16.

Table 40-16. Transmit Deviation Limit

BAND	DEVIATION (KHZ)
VHF/UHF/800 MHz	4.30 - 4.60
900 MHz	2.20 - 2.30

5. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to the next softpot value.
6. Repeat steps 3-5 for the remaining frequencies shown on the screen.
7. Press F10 to return to the TRANSMIT menu.

I. Transmit Deviation Limit Reference

NOTE

1. This procedure is not required for 900 MHz models.
2. This procedure is required for VHF, UHF, and 800 MHz models with 20 kHz channel spacing and VHF and UHF models with 12.5 kHz channel spacing.

1. Press F6 to select the TRANSMIT DEVIATION LIMIT REFERENCE softpot.
2. With the meter selector switch (RTX4005B) set to MIC, inject a 1 kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
3. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per Table 40-17.

Table 40-17. Transmit Deviation Limit Reference

CHANNEL SPACING	DEVIATION (KHZ)
20 KHz	3.40 - 3.60
12.5 KHz	2.20 - 2.30

4. Press F6 to dekey the radio, and press F8 to program the softpot value.
5. Press F10 to return to the TRANSMIT menu.

J. VCO Crossover Frequency

NOTE

This procedure is only required after the field repair of a VHF or UHF VCO.

In order for a phase-locked-loop to tune very wide bandwidths, both negative and positive control voltages (Vcntl) are required. This procedure sets the crossover frequency at which the negative Vcntl (or -Vee) switches from zero to negative.

TX VCO Crossover

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F7 to select the TRANSMIT VCO CROSSOVER softpot. The screen will indicate the transmit test frequency to be used.
3. Connect a dc voltmeter capable of 1mV resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, press F6 to key the transmitter, and adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ±0.1 volts. The frequency will increment in steps of 50kHz.
5. Press F6 again to dekey the transmitter, and press F8 to program the softpot value.

6. Press F10 twice to return to the SERVICE menu.

RX VCO Crossover

1. From the SERVICE menu, press F3 to select RECEIVER alignment.
2. Press F5 to select the RECEIVE VCO CROSSOVER softpot. The screen will indicate the receive test frequency to be used.
3. Connect a dc voltmeter capable of 1mVolt resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ±0.1 volts.
5. Press F8 to program the softpot value.
6. Press F10 twice to return to the SERVICE menu.

K. Signalling Deviation

Transmit deviation balance compensation and transmit deviation limit adjustments should be completed before signalling deviation is adjusted.

DTMF Tuning

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F4 again to select the DTMF softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the DTMF deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the DTMF deviation per table 40-16.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

Trunking High Speed Signalling

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F3 to select the TRUNKING HIGH SPEED softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the TRUNKING HIGH SPEED deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the TRUNKING HIGH SPEED deviation per Table 40-18.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

MDC 1200

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F4 to select the MDC softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the MDC deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the MDC deviation per table 40-16.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 twice to return to the SERVICE menu.

The radio alignment procedure is now complete; the radio may be disconnected and returned to service.

Table 40-18. Signalling Deviation

CHANNEL SPACING (KHZ)	DTMF	TRUNKING	MDC
25 / 30	3.05-3.45	2.5-3.5	3.40-3.75
20 (VHF/UHF)	2.44-2.76	2.0-2.8	2.6-3.0
20 (821-824, 866-869)	2.44-2.76	2.0-2.8	2.6-3.0
12.5	1.55-1.85	1.40-1.75	1.640-1.875

SECTION VI. DISASSEMBLY AND REASSEMBLY



CAUTION

THIS RADIO CONTAINS STATIC-SENSITIVE DEVICES. DO NOT OPEN THE RADIO UNLESS PROPERLY GROUNDED. TAKE THE FOLLOWING PRECAUTIONS WHEN WORKING ON THIS UNIT.

1. Store and transport all complementary metal-oxide semiconductor (CMOS) devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic "snow" trays used for storage and transportation of other semiconductor devices.
2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the Motorola Static Protection Assembly (part number 0180386A82), which includes a wrist strap, two ground cords, a table mat, and a floor mat.
3. Wear a conductive wrist strap in series with a 100k resistor to ground. Replacement wrist straps that connect to the bench top covering are Motorola part number RSX-4015.
4. Do not wear nylon clothing while handling CMOS devices.
5. Neither insert nor remove CMOS devices with power applied. Check all power supplies that are to be used for testing CMOS devices to be certain that there are no voltage transients present.
6. When straightening CMOS pins, provide ground straps for apparatus used.
7. When soldering, use a grounded soldering iron.
8. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

A. General

Since this product disassembles and reassembles without the use of any screws, it is important for the technician to pay particular attention to the snaps and tabs, and how parts align with each other.

NOTE

In the disassembly/reassembly procedure, the numbers in parentheses refer to call-out numbers in the referenced figures.

B. Disassembly to Board Level

1. Turn off the radio.
2. Remove the battery (see Figure 40-4).
 - a. Hold the radio such that the battery is tilted down.
 - b. Press down on the two battery-release levers.
 - c. With the release levers pulled down, the top of the battery will fall away from the radio.
 - d. Remove the battery completely from the radio.

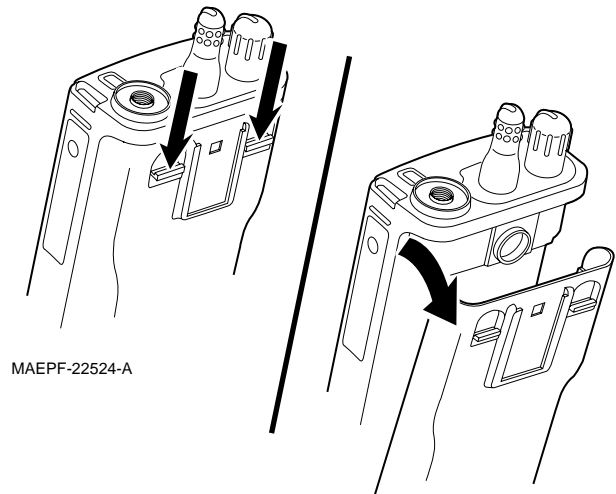


Figure 40-4.

3. Loosen the antenna by turning it in a counterclockwise direction, and remove it from the radio.
4. Remove the volume on/off knob and the channel selector switch knob by pulling them off their respective switch shafts.

NOTE

Both knobs **slide** on and off but fit very snug on their respective switch shafts. A small flat blade screwdriver may be necessary to help pry the knobs loose. Take care not to mar the surrounding radio surface.

5. Separate the front cover assembly from the internal electronics (chassis) (see Figure 40-5).

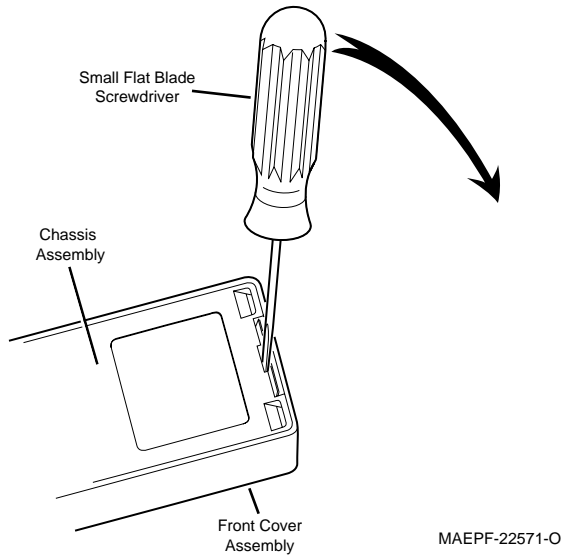


Figure 40-5.

- a. Insert a small, flat-blade screwdriver or like instrument in the slotted area at the bottom center of the radio. Take care not to mar the O-ring sealing area on the housing.
- b. Pry the bottom of the chassis free from the cover by pushing the screwdriver down and rotating the handle of the screwdriver over and behind the base of the radio. This prying action forces the thin inner plastic wall toward the base of the radio, which releases the two chassis base tabs.

NOTE

A flexible ribbon cable (front cover/display flex), which connects to the front cover assembly and the chassis, keeps you from completely separating the two units.

- c. Lay the chassis down, and rotate the front cover back and partially away from the chassis (see Figure 40-6).

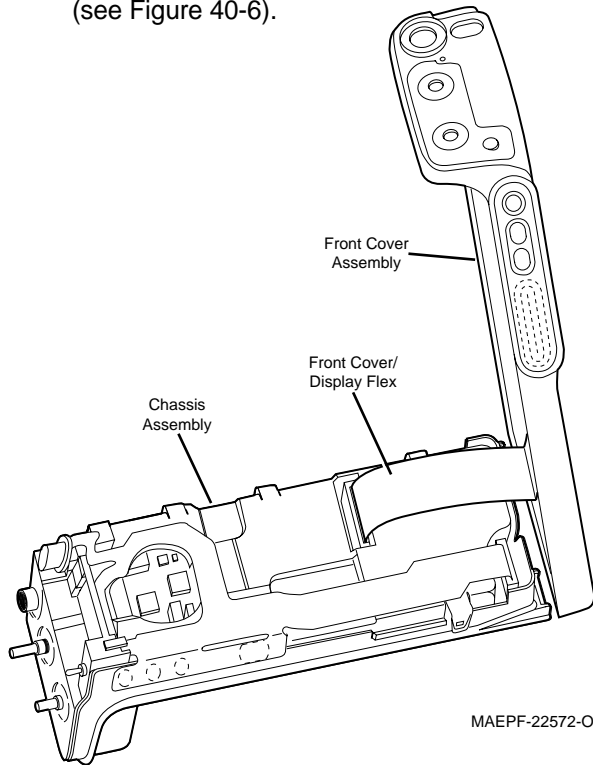


Figure 40-6.

6. Disconnect the front cover display flex from the connector on the chassis.

NOTE

A special locking connector secures the flex to the chassis (see Figure 40-7).

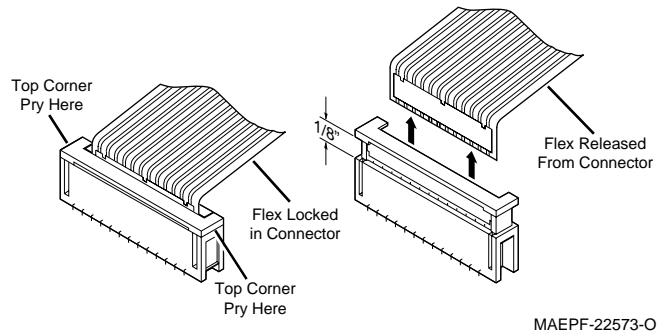


Figure 40-7.

- a. Use a small, thin, flat-blade screwdriver (or like instrument) to help raise the sliding portion of the connector approximately 1/8 of an inch from its seated position. A slight prying action, alternating back and forth on the top corners of the connector, achieves the best results for unlocking the connector.
 - b. Remove the flex from the chassis connector.
7. Remove the contoured O-ring/antenna bushing seal from the chassis.
 8. Disconnect the controls flex from the connector on the controller board by following the procedure in step 6a and 6b.

NOTE

A large portion of the controls flex is attached to the large metal shield (front shield) with adhesive. Do not remove the controls flex from the front shield unless it is absolutely necessary.

9. As a unit, separate the control top, the front shield, and the controls flex from the chassis and circuit boards (see Figure 40-8).

NOTE

Four large tabs secure the front shield to the chassis and hold the RF board and the controller board in the chassis.

MOTOROLA			
DESCRIPTION Fig. 20-6			
Jedi Disassembly P			
ILLUSTRATOR	DATE	ENG	
EH	2/21/92	C	
EDITOR	DATE	CHK	
JWB	3/4/92		
LETTERING S			

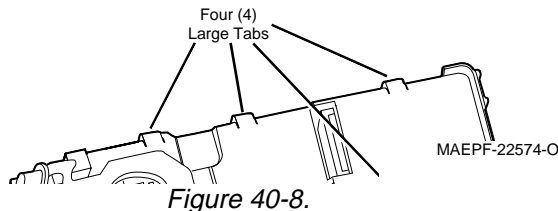


Figure 40-8.

- a. Loosen the front shield by prying each of the four tabs away from the chassis. Be careful not to pry the tabs any more than is necessary to free them from their respective retaining slots. To completely loosen the shield from the chassis, a slight lifting and clockwise twisting action may be required.
- b. Insert a small, flat-blade screwdriver in the recessed area of the control top and pry the control top slightly away from the chassis.
- c. Completely remove the control top/front shield/controls flex unit from the chassis.

10. Carefully remove the RF board and the controller board from the chassis.

NOTE

The RF board and the controller board are connected together with a jumper flex. The connection is made more rigid using a hard plastic cover that snaps across the top of the jumper flex (see Figure 40-9).

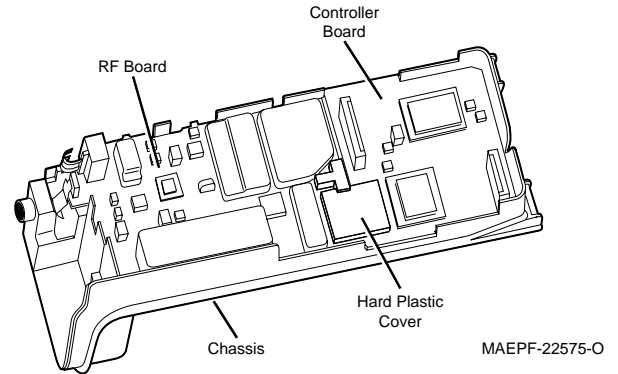


Figure 40-9.

C. Disassembly of Control Top

1. Remove the rubber controls seal from the control top.
2. Turn the control top such that the black switch housing cover is facing up.
 - a. Five retaining clips hold the switch housing cover to the switch housing. Clips 1, 2, and 3 are important during disassembly (see Figure 40-10).

NOTE

To perform step 2b, two tools will be required; your thumbnail or small, flat-blade screwdriver, and a pen, pencil, or another small, flat-blade screwdriver.

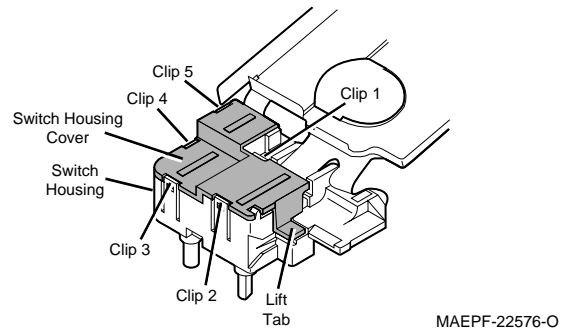


Figure 40-10.

- b. Using your thumbnail or small, flat-blade screwdriver, lift the tab that covers the base of the LED approximately 1/16 of an inch from its seated position. While applying constant lifting pressure there, (in order) release clips 1, 2, and 3 with the other tool.

- c. The cover will pop loose from the switch housing.
- 3. Push the three switches and the LED out of the switch housing.
- 4. The remainder of the controls flex is attached to the switch housing with adhesive. Do not remove the flex from the switch housing unless it is absolutely necessary.

D. Disassembly of Front Cover Assembly

- 1. On top display model radios only, release the display board by using a “press and pull” action on the top two corners of the display board. Press down on the two top corners of the display board and pull the top of the board away from the two corner retaining tabs. The display board will free itself from the retaining tabs and two retaining slots in the front cover housing.
- 2. Remove the edge connector (part of the front cover flex, located behind the universal connector), by sliding it out of the plastic rails that hold it in place. A slight prying action, alternating back and forth on the bottom corners of the connector, achieves the best results.
- 3. Remove the speaker retainer bracket, speaker, microphone, and front cover flex from the front cover housing (see Figure 40-11).

NOTE

The speaker and front cover flex are held in position with a three-leg retainer bracket. The legs of the bracket are secured by slots in the front cover. When removing the retainer bracket, use caution not to damage the speaker.

- a. Disengage the retainer bracket leg that points toward the bottom of the front cover from its retaining tab.

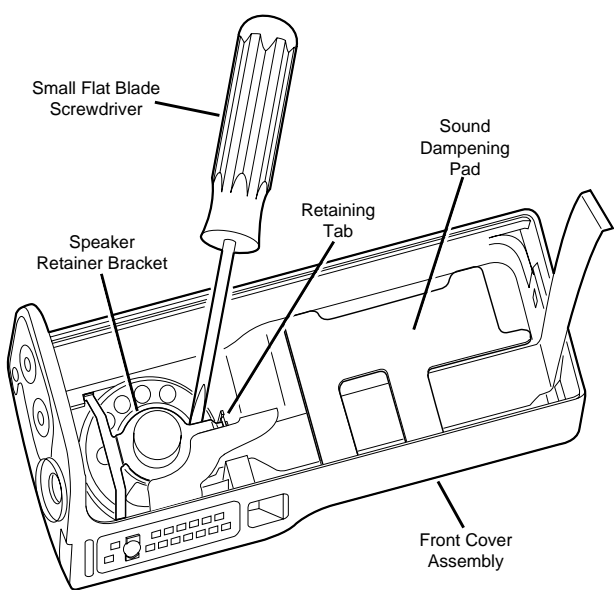


Figure 40-11.

- (1) Insert a small, flat-blade screwdriver under the base of the bracket leg near the ring.
- (2) Lift the bracket leg until it pops loose from under its retaining tab.
- b. Lift the freed leg of the retainer bracket and use it to pull the remaining two legs of the bracket out and away from their respective slots in the front cover housing.
- c. Pull the rubber microphone boot, containing the microphone, from its seated position. Unless you are replacing the microphone, leave the microphone in the boot.
- 4. Remove, if necessary, and replace the sound dampening pad.
- 5. As necessary, replace the speaker and/or microphone while out of the front cover housing.

NOTE

If the microphone is replaced, ensure that the microphone is reinstalled back into the rubber boot with the microphone port facing the round hole at the bottom of the boot.

- 6. On front display model radios only, notice that the keypad/display board is secured to the front cover housing using six tabs, three small tabs on one side and three larger tabs on the universal connector side. Remove the keypad/display board by inserting a small flat-blade screwdriver in the circuit board slot provided (slot nearest the top retaining tab on the universal connector side of the radio, see Figure 40-12). A slight prying action will release the keypad/display board. If applicable, remove the rubber keypad.

NOTE

Be careful not to mar the front cover housing O-ring sealing area. Doing so will compromise the sealing integrity of the radio.

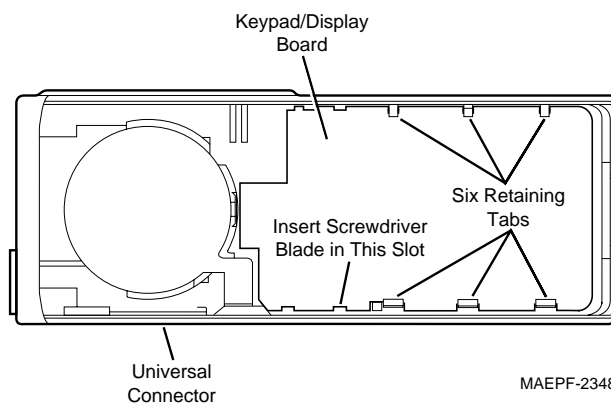


Figure 40-12.

E. Reassembly

Reassembly is the reverse of disassembly. Some suggestions and illustrations are provided to help you more easily reassemble the radio.

1. Keypad/Display Board
(front display model radios only)
 - a. If applicable, replace the rubber keypad.
 - b. Place the keypad/display board into the front cover housing at an angle such that the three small slots on the edge of the board slide under the three mating retaining tabs. Ensure that the board slides **under** the tabs.
 - c. Near the three larger slots on the other side of the board, use finger pressure to push and press that side of the board down until it snaps into place under the three large retaining tabs.
2. Front Cover Assembly
 - a. Place the speaker and microphone into their respective positions in the front cover. Make sure that the speaker is seated properly in the recessed area provided.
 - b. Press the rubber microphone boot into its respective recessed area in the front cover housing. The little rubber flap in the back of the rubber boot should fold up to cover the microphone insertion opening.
 - c. Reinstall the speaker retainer bracket (see Figure 40-13).

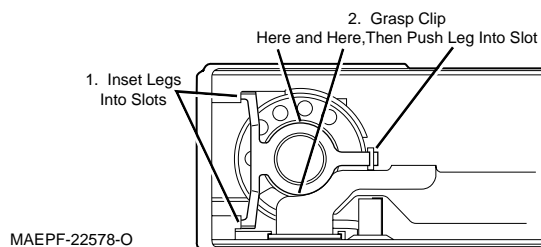


Figure 40-13.

- (1) Position the spring bracket over the speaker, and toward the top of the front cover housing; insert the appropriate two legs of the bracket into their respective slots
 - (2) Grasp the center portion of the spring bracket (ring area) with thumb and forefinger.
 - (3) While holding the ring area of the spring bracket at approximately the same height as the speaker's base, push the remaining leg down and into its respective slot.
- d. Orient the edge connector so that its gold contacts face the gold contacts of the housing. Align the edge connector with the respective

slots in the housing, and slide the connector down into place. Ensure that the edge connector is fully seated into position.

- e. On top display model radios only, seat the display board by inserting the two display board tabs into their mating slots in the front cover housing. Push the top of the display board toward the top of the radio until the front cover housing retaining tabs engage the display board and secure it into position.
3. Chassis
Inside of the chassis where the RF board fits is a protruding block that functions as the PA heatsink. To help provide maximum heat transfer, ensure that the PA heatsink block (top surface) is coated with a thin film of thermal compound (Motorola part number 1110022A55).
Place the RF board and controller board into the chassis. Ensure that the plastic cover that more rigidly holds the two boards together is snapped into place.
 4. Control Top
 - a. Reinstall the switches and LED into the switch housing.
 - b. Reinstall the switch housing cover onto the switch housing by sliding tabs 4 and 5 of the cover into their respective clips on the housing. Then press down on the cover to engage tabs 1, 2, and 3.
 5. Control Top/Front Shield/Controls Flex as a Unit to Chassis
 - a. Slide the control top into the appropriate position in the chassis, and place the front shield into position over the chassis and circuit boards.
 - b. Check to see that the four large tabs of the front shield are aligned with the respective slots on the sides of the chassis, then snap the front shield in place. Ensure that the shield is fully seated, especially in the PTT switch area.
 - c. Slide the connector end of the controls flex into the special locking connector mounted on the control board. Ensure that the flex is fully seated into the board connector and secure the connection.

NOTE

View the flex connection at a slight angle from the **bottom** of the radio (see Figure 40-14). If the flex is fully seated, the orange circuit plating will be parallel with the connector top surface and three reliefs in the plating will make the flex plating appear to be separated. If the orange plating of the flex is not parallel with the connector's top surface, or the three reliefs are raised enough to see plating under them, then the flex is not fully seated.

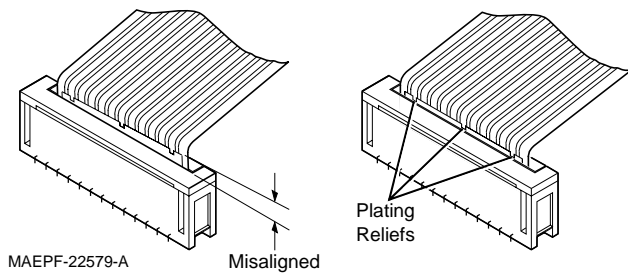


Figure 40-14.

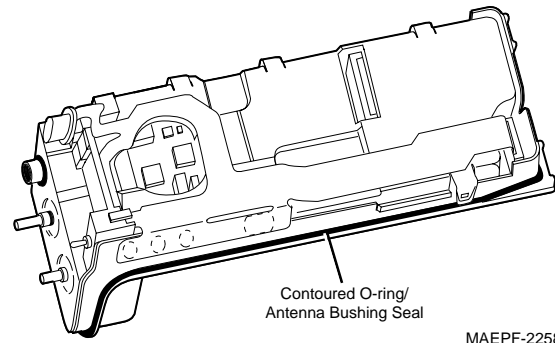


Figure 40-15.

- d. Reinstall the rubber controls top seal on the control top.

NOTE

Two tabs are provided in the emergency button area to help hold the seal in place.

6. Front Cover Assembly to Chassis

- a. Install the contoured O-ring/antenna bushing seal around the antenna and in the groove provided (see Figure 40-15).
- b. Orient the front cover assembly with the chassis, and insert the front cover/display flex connector into the locking connector of the controller board (refer back to Figure 40-6). Secure the connection. View the flex connection at a slight angle from the **top** of the radio and ensure that the flex connector is fully seated into the locking connector as described in step 4c.
- c. Check to make sure that the O-ring is in place, and slide the chassis (switch end first) into the

front cover assembly. Check to ensure that the orange emergency button seal slides into position freely.

NOTE

When performing the next part of this step, pay particular attention to the O-ring near the bottom of the radio to ensure that it does not raise up and get pinched between the front cover clip and the chassis. With the top of the chassis fully seated, lower the bottom of the chassis and press it into the front cover assembly until it snaps into place.

- d. Check the emergency button again. If it is cocked to one side, repositioning it may be necessary.
- 6. Reinstall the switch knobs and antenna; the shorter knob with the volume on/off switch, the taller knob with the channel selector switch.
- 7. Reinstall the battery.

SECTION VII. MAINTENANCE

A. Introduction

This section of the manual describes preventive maintenance, safe handling of CMOS devices, and repair procedures and techniques. Each of these topics provides information vital to the successful operation and maintenance of your radio.

B. Preventive Maintenance

The HT 1000, MT 2000, MTS 2000, and MTX series radios do not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is recommended.

1. Inspection

Check that the external surfaces of the radio are clean, and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed or desired.

2. Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, chassis (rear cover), and battery case. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for servicing or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent, such as JOY®, in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (70% by volume).



CAUTION

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

a. Cleaning External Plastic Surfaces

(The detergent-water solution should be applied sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. A soft, absorbent, lintless cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

b. Cleaning Circuit Boards and Components

Isopropyl alcohol may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-

to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process, since this could cause the liquid to puddle and collect in unwanted places.

Upon completion of the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

NOTE

Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

C. Safe Handling of CMOS Devices

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios. While the benefits of CMOS are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, you must take special precautions to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for CMOS circuits, and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without first referring to the CMOS CAUTION paragraph in the Disassembly and Reassembly section of the manual.

D. Repair Procedures and Techniques

Refer to the Disassembly and Reassembly section of the manual for pertinent information prior to replacing and substituting parts.

1. General

a. Parts Replacement and Substitution

Special care should be taken to be as certain as possible that a suspected component is actually the one at fault. This special care will eliminate unnecessary unsoldering and removal of parts, which could damage or weaken other components or the printed circuit board itself.

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper Motorola part number and order the component from the nearest Motorola Communications Parts office listed in the "Replacement Parts Ordering" section of this manual.

b. Rigid Circuit Boards

This family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit. Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the module socket pins, use care to avoid accidentally getting solder in the socket. Also, be careful not to form solder bridges between the module socket pins. Closely examine your work for shorts due to solder bridges. When removing modules with metal enclosures, be sure to desolder the enclosure ground tabs as well as the module pins.

c. Flexible Circuits

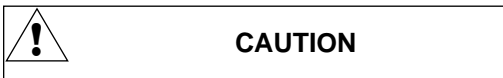
The flexible circuits are made from a different material than the rigid boards, and different techniques must be used when soldering. Excessive prolonged heat on the flexible circuit can damage the material. Avoid excessive heat and excessive bending. For parts replacement, use the ST-1087 Temperature-Controlled Solder Station with a 600 or 700 degree tip, and use small diameter solder such as ST-633. The smaller size solder will melt faster and require less heat being applied to the circuit.

To replace a component on a flexible circuit, grasp the edge of the flexible circuit with seizers (hemostats) near the part to be removed, and pull gently. Apply the tip of the soldering iron to the component connections while pulling with the seizers. Do not attempt to puddle out components. Prolonged application of heat may damage the flexible circuit.

2. Specific

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8" above the printed circuit board when removing or replacing the device.



If neighboring OMPAC components are heated above 365 degrees F. (185 degrees C.), they will suffer die-bond delamination and possible "popcorn" failure.

a. Strip Connector (P301/P704)

On the latest version HT 1000, MT 2000, MTS 2000, and MTX series radios, a strip connector, two female connectors and a strain relief electrically connect the RF board with the controller board. On earlier versions of these radios, the RF board and controller board were connected using a jumper flex that soldered directly to the circuit board solder pads.

An interconnect kit, REX4035A, is available to retrofit earlier version jumper-flex radios with the later version strip connector parts. The REX4035A kit includes the following items:

- CONNECTOR, Female (J301) 0905461X01
- CONNECTOR, Female (J704) 0905461X01
- CONNECTOR, Male (P301/P704) 0905461X01
- STRAIN RELIEF 4205507X01
- INSTRUCTIONS 6880309F14

b. Jumper Flex (on radios shipped prior to 7/94)

Jumper flexes are not available. They are replaced with connectors as described in paragraph "a" of this section. If the jumper flex needs to be replaced, order Interconnect Kit REX4035A. The retrofit kit includes all of the parts required and detailed instructions on the removal of the old jumper flex, and the installation of the new connector arrangement.

c. RF Switch (S101):

Refer to the applicable exploded view and to your radio's RF board (antenna contact area) to locate the RF switch components.

NOTE

The RF switch spring and the RF switch piston must be ordered separately.

To remove the RF switch:

- (1) On VHF and UHF radios, unsolder the two tabs of the RF switch bracket that secure the RF switch to the RF board. On 800MHz and 900MHz radios, use a #2 slotted screwdriver to straighten the two tabs of the RF switch bracket that wrap around the RF board. Use your forefinger to hold the RF switch bracket to the RF board while straightening the tabs to avoid lifting the solder tabs on the opposite end of the RF switch bracket.

- (2) Refer to Figure 40-16 and use a small heat-focus head to distribute heat over the area occupied by the three solder tabs until the solder softens.

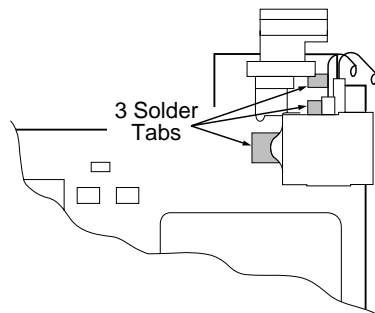


Figure 40-16.

- (3) Carefully lift the RF switch assembly away from the rf board. Notice that the RF switch circuit board remains attached (soldered) to the RF board.
- (4) Using the same heat-focus head as in step (3), unsolder the RF switch circuit board and remove it from the RF board using forceps.
- (5) In the RF switch circuit board area, reflow all the solder pad areas on the main RF board such that similarly shaped pads have uniform solder heights. Add or remove solder as required. Clean the RF board thoroughly. Then swab on a minimum amount of flux to each of the solder pads.

To replace the RF switch:

- (1) Place the RF switch assembly on the RF main board and gently heat. Visually inspect to make sure no flux migrated onto the gold plated areas of the RF switch board. The guide pins should provide self alignment between the two circuit boards. Visually inspect the plastic switch housing to ensure that it has not warped due to overheating.
- (2) While holding the RF switch bracket firmly against the RF board:
 - VHF and UHF radios - solder the two leads of the housing to the solder pads on the RF board.
 - 800MHZ and 900MHz radios - bend the two tabs around the side of the RF board as close to the board edge as possible to hold the bracket down tightly.


- (3) Insert the new RF switch spring and RF switch piston into the RF switch assembly. The contacts of the piston should be facing the gold-plated pads of the RF switch board. Once the spring and piston are inserted into the RF switch, they will be retained by the switch.


d. Chip Components

Use either the RLN-4062 Hot-Air Repair Station or the Motorola 0180381B45 Repair Station for chip component replacement. When using the 0180381B45 Repair Station, select the TJ-65 mini-thermojet hand piece. On either unit, adjust the temperature control to 700 degrees F. (370 degrees C), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

- (1) **To remove a chip component**, select a hot- air hand piece and position the nozzle of the hand piece approximately 1/8" (0.3cm) above the component to be removed. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers. Using solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.
- (2) **To replace a chip component using a soldering iron**, select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads. Using a pair of tweezers, position the new chip component in place while heating the fresh solder. Once solder wicks onto the new component, remove the heat from the solder. Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.
- (3) **To replace a chip component using hot air**, select the hot-air hand piece and reflow the solder on the solder pads to smooth it. Apply a drop of solder paste flux to each pad. Using a pair of tweezers, position the new component in place. Position the hot-air hand piece approximately 1/8" (0.3cm) above the component and begin applying heat. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

e. Over-Molded Pad-Array Carrier (OMPAC)


	CAUTION
<p>All pad-array carriers in these radios, except for the IF IC (U3), are OMPAC. Prior to use, all OMPACs must be kept in the sealed bag (with moisture-indicator card) as supplied by the Motorola Parts Department. Once the sealed bag is opened and/or the OMPAC subjected to ambient humidity (for an unknown amount of time or for more than 96 hours) then that OMPAC must be baked in an oven for at least eight hours at 260 degrees F. (125 degrees C.)</p>	

	CAUTION
<p>If neighboring OMPAC components are heated above 365 degrees F. (185 degrees C.), they will suffer die-bond delamination and possible "popcorn" failure.</p>	

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8"-1/4" (0.3cm-0.6cm) above the printed circuit board when removing or replacing the device.

(1) **To remove an OMPAC**, select the R-1319 Rework Station and the appropriate heat-focus head (approximately the same size as the OMPAC). Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F (215 degrees C); 445 degrees F (230 degrees C) maximum. Apply the solder paste flux around the edge of the OMPAC. Place the circuit board in the circuit board holder, and position the OMPAC under the heat-focus head. Lower the vacuum tip and attach it to the OMPAC by turning on the vacuum pump. Lower the heat-focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the carrier. Turn on the heater and wait until the OMPAC lifts off the circuit board. Once the part is off, grab it with a pair of tweezers and turn off the vacuum pump. Remove the circuit board from the R-1070's circuit board holder.

	CAUTION
<p>The application of heat to the OMPAC device, beginning at ambient air temperature and ending with the OMPAC lifting from the circuit board, should take longer than 60 seconds. If the OMPAC lifts from the circuit board earlier than 60 seconds:</p> <ul style="list-style-type: none">• check the temperature control setting on the rework station, and if OK• lift the heat-focus head an additional 1/8" from nominal setting, and• check the circuit board plating for possible damage.	

(2) **To replace an OMPAC**, the solder pads on the board must first be cleaned of all solder to ensure alignment of the new chip carrier. Prepare the site by using solder wick and a soldering iron to remove all solder from the solder pads on the circuit board. If a power desoldering tool is available, it can be used instead of the solder wick. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux in the trench of the flux block and spread it using a one-inch putty knife. Flux the OMPAC by placing it in the trench of the flux block. Once the flux is applied, place the OMPAC on the circuit board, making certain that it is oriented correctly on the board. Position the heat-focus head over the OMPAC and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) over the carrier. Using the same heat setting used to remove the OMPAC, turn on the heater and wait for the carrier to reflow (heating and reflow should take longer than 60 seconds). Watch the OMPAC reflow and note that when a proper reflow has taken place, the OMPAC will drop (usually one side, then the other). The end result is that both sides have reflowed, and the OMPAC is sitting parallel to the circuit board.

Once the carrier reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

f. Thin Small Outline Package (TSOP)
Components

Removing and replacing a TSOP component will be done with the R-1319, using the same procedure used to remove and replace an OMPAC.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Position the TSOP component under the heat-focus head. Lower the vacuum tip and attach it to the component by turning on the vacuum pump. Lower the focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the component. Turn on the heater and wait until the TSOP lifts off the circuit board.

Once the part is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Prepare the circuit board for the new component by applying solder paste flux to the solder pads. Position the circuit board under the heat-focus head, lower the head to approximately 1/8"-1/4" (0.3cm-0.6cm) above the board, and turn on the heat. When the solder left behind on the pads reflows, turn off the heat and raise the heat-focus head. Remove the circuit board from the holder and inspect the pads to ensure that the solder has flattened out and that there are no solder shorts. Clean the area with alcohol and a small brush.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the solder pads and place the new component on the circuit board. Position the heat-focus head over the component and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the carrier. Turn on the heater and wait for the component to reflow.

Once the component reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

g. Shields

Removing and replacing the shields will be done with the R-1319, using the same procedure used to remove and replace TSOP and OMPAC components.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Add solder paste flux around the base of the shield. Position the shield under the heat-focus head. Lower the vacuum tip and attach it to the shield by turning on the vacuum pump. Lower the

focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait until the shield lifts off the circuit board. Once the shield is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Remove the circuit board from the circuit board holder.

To replace the shield, add solder to the shield if necessary, using a micro-tipped soldering iron. Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board. Place the circuit board back in the circuit board holder. Place the shield on the circuit board using a pair of tweezers. Position the heat-focus head over the shield and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait for the solder to reflow.

Once complete, turn off the heat, raise the heat-focus head, and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

h. RF PA (U105)

The procedure for removing and replacing the RF PA is very similar to the procedure for removing and replacing an OMPAC or a TSOP component. But because the device is large, extra heating time is required to flow the pads. And as a result, neighboring components (especially those on the opposite side of the circuit board) will heat, reflow, and may inadvertently move. Be careful when performing the following procedure.

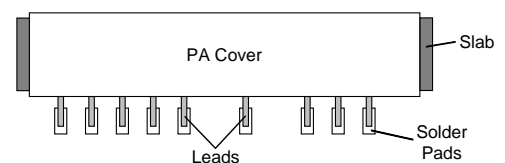


Figure 40-17.

- (1) Refer to Figure 40-17 for RF PA nomenclature.

To remove the RF PA, add flux to the leads of the device, and use a soldering iron and pair of tweezers to heat and lift each lead free and clear of its respective solder pad on the circuit board. Use the R-1319 Rework Station and the heat-focus head designed especially for removal of the RF PA. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F

(215 degrees C) 445 degrees F (230 degrees C) maximum. Apply solder paste to the exposed solder pads under the PA. Place the circuit board in the circuit board holder, and position the RF PA under the heat-focus head. Lower the heat-focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the PA cover. Turn on the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the part has reflowed, before trying to remove the PA, **carefully** lower the circuit board holder as follows:

- Loosen the thumbscrew on the shaft of the circuit board holder,
- push the spring-loaded holder down and away from the heat-focus head, and
- retighten the thumbscrew with the holder in the bottomed position.

Grab the PA with a large pair of tweezers and remove it from the circuit board. Let the circuit board cool for approximately two minutes. Then remove the circuit board from the circuit board holder.

- (2) **To replace the RF PA;** if necessary, add solder to the PA ground plane on the printed circuit board. Then clean each PA lead

solder pad on the circuit board to ensure alignment of the new RF PA. Prepare the sight by using solder wick and a soldering iron to remove all solder from the solder pads. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the ground plane and to the leads' solder pads. Once the flux is applied, place the new RF PA on the circuit board, making certain that the PA heatsink sits flush on the board. Position the heat-focus head over the RF PA and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the PA cover. Turn on the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the RF PA reflows, raise the heat-focus head and wait approximately two minutes for the part to cool. Remove the circuit board and inspect the solder joint between the slab and the ground plane. No cleaning should be necessary. Use the soldering iron and add solder to each of the RF PA leads and associated pads. Inspect the lead/pad bond for opens and solder shorts.

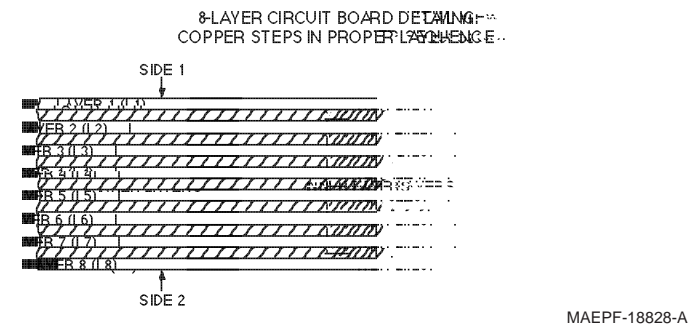
SCHEMATIC AND CIRCUIT BOARD NOTES

- * COMPONENT IS FREQUENCY SENSITIVE. REFER TO THE ELECTRICAL PARTS LIST FOR VALUE AND USAGE.
- UNLESS OTHERWISE STATED, RESISTANCES ARE IN OHMS (k = 1000), AND CAPACITANCES ARE IN PICO FARADS (pF) OR MICROFARADS (uF).
 - DC VOLTAGES ARE MEASURED FROM POINT INDICATED TO CHASSIS GROUND USING A MOTOROLA DC MULTIMETER OR EQUIVALENT. TRANSMITTER MEASUREMENTS SHOULD BE MADE WITH A 1.2 uF CHOKE IN SERIES WITH THE VOLTAGE PROBE TO PREVENT CIRCUIT LOADING.
 - REFERENCE DESIGNATORS ARE ASSIGNED IN THE FOLLOWING MANNER:
 UNITS SERIES = RECEIVER
 100 SERIES = TRANSMITTER
 200 SERIES = FREQUENCY GENERATION
 300 SERIES = MISCELLANEOUS
 400 SERIES = HOUSING/ESCUTCHEON
 500 SERIES = DISPLAY
 600 SERIES = HEAR CLEAR OPTION
 700 SERIES = CONTROLLER
 - INTERCONNECT TIE POINT LEGEND:
 5V REG = REGULATED FIVE VOLTS
 B+ = BATTERY VOLTAGE (7.5V)
 R5 = RECEIVER FIVE VOLTS
 T5 = TRANSMITTER FIVE VOLTS
 CLK = CLOCK
 D = DATA
 DAC = DIGITAL TO ANALOG CONVERTER
 DAC RST = DAC RESET
 LCK = LOCK
 NC = NO CONNECTION
 SYN = SYNTHESIZER
 VR = VOLTAGE REGULATOR

INSERT DIAGRAMS
 (L1) BEPF-24631-O (20% BLK, 133 LINE)
 (OL) BEPF-24632-O (100% BLK.)
 R.T. 50%

INSERT SCHEMATIC DIAGRAM
 63D81200C31-O (100% BLK.)
 (OL) DEPF-24635-O (100% RED)
 R.T.

INSERT DIAGRAMS
 (L8) BEPF-24633-O (20% BLK., 133 LINE)
 (OL) BEPF-24634-O (100% BLK.)
 R.T. 50%



INSERT SCHEMATIC
63D81200C32-O (100% BLK.)
(OL) DEPF-24640-O (100% RED)
SHOOT AT 100%

INSERT SCHEMATIC DIAGRAM
63D81200C33-O (100% BLK.)
(OL) DEPF-24645-O (100% RED)
R.T. 94%

INSERT SCHEMATIC
63D81200C34-O (100% BLK.)
(OL) DEPF-24650-O (100% RED)
SHOOT AT 86%

INSERT SCHEMATIC
63D81200C38-O (100% BLK.)
(OL) DEPF-24655-O (100% RED)
R.T. 81%

INSERT SCHEMATIC
63D81200C42-A (100% BLK.)
(OL) DEPF-24495-A (100% RED)
SHOOT AT 100%

Electrical Parts List TPLF- 4210-A
 NTN7089A, Controller (JT 1000 Models Only)
 NTN7092A, Controller (HT 1000 Models Only)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C608, 609, 611	-----	CAPACITOR, Fixed: pF ±5%; 50V unless stated
C674, 675	-----	Not Placed
C677 thru 686	-----	Not Placed
C688	-----	Not Placed
C701	2113743K15	0.1µF
C702, 703	2113743E07	.022µF
C704	2113740F51	100
C705, 706	2113743A19	0.1µF
C707	-----	Not Placed
C708	2113743K15	0.1µF
C709	2113740F51	100
C710	2113743A23	0.22µF
C711	2311049J11	4.7µF; 16V
C712	2113743K15	0.1µF
C713	2311049A01	0.1µF; 35V
C714	2113743K15	0.1µF
C715, 716	2113743A45	.01µF
C717	-----	Not Placed
C718	2113743K15	0.1µF
C719	2113741F49	.01µF
C720	2311049A01	0.1µF; 35V
C721	2113740F51	100
C722	2311049J23	10µF; 6V
C723	2113743K15	0.1µF
C724	2113741F49	.01µF
C725	2113743K15	0.1µF
C726	-----	Not Placed
C727	2113743K15	0.1µF
C728	2113741F49	.01µF
C729	2311049A42	3.3µF; 6V
C730	2113743K15	0.1µF
C731	2113740F51	100
C732	2113743K15	0.1µF
C733, 734, 735	2113740F51	100
C736	-----	Not Placed
C737 thru 746	2113740F51	100
C747 thru 754	-----	Not Placed
C755 thru 760	2113740F51	100
C761	2113741F49	.01µF
C762	2311049J25	10µF; 16V
C763	2113741F49	.01µF
C764	2113741F41	.0047µF
C765	2311049J11	4.7µF; 16V
C766 thru 768	2113740F51	100
C769	2311049A07	1µF; 16V
C770	2113743B23	0.33µF
C771	2311049A07	1µF; 16V
C772	2113743B23	0.33µF
C773	2311049A07	1µF; 16V
C774	2113741F17	470
C775	2113741F13	330
C776	2311049A08	1µF; 35V
C777	2113741F17	470
C778	2113740F51	100
C779	2113743A19	0.1µF
C780	2113741F49	.01µF
C786	2113740F51	100
C787	-----	Not Placed
C788	2113741F25	.001µF
C789 thru 793	2113740F51	100
C794	2113741F13	330
C795	-----	Not Placed
C796 thru 799	2113740F51	100
J701	0905257V04	JACK: Connector, 26 pins; to P701 on Front Cover/Display Flex
J703	0905257V03	Connector, 18 pins; to P703 on Control Flex
J704	-----	Circuit plating on early version radios, 20-contacts; to P704 on Jumper Flex
	or 0905461X01	Connector on later version radios, 20-contacts; to P704 Strip Connector
L701 thru 712	2462587Q42	COIL, RF: 0.39µH
Q701	-----	TRANSISTOR: Not Placed
Q702	4802245J04	PNP
Q703	-----	Not Placed
R620 thru 626	-----	RESISTOR, Fixed: Ω ± 5% .0625W unless stated Not Placed

R628	-----	Not Placed
R700	0660257A57	2.2k
R701	0662057A56	2k
R702, 703	0662057A41	470
R704	0662057A65	4.7k
R705 thru 707	-----	Not Placed
R708	0662056G13	100k ± 1% (NTN7089A)
	or 0662057G07	75k ± 1%; 0.1W (NTN7092A)
R709	0662057G08	82.5k ± 1%; 0.1W
R710 thru 712	0662057A89	47k
R713	0662057A25	100
R714, 715, 716	0662057A73	10k
R717	0662057A65	4.7k
R718, 719	0662057A29	4.7k
R721 thru 725	0662057B47	0 (NTN7089A Only)
	or -----	Not Used (NTN7092A)
R726	-----	Not Placed
R727	0662057A97	100k
R729	0662057R92	47.5k ± 1%; 0.1W
R730	0662057A97	100k
R731	0662057A65	4.7k
R733	0683962T45	68
R735, 737	0662057A73	10k
R738	0662057A81	22k
R753	-----	Not Placed
R754	0662057B47	0
R755	0662057A73	10k
R756	0662057A56	2k
U601	-----	MODULE: Not Placed
U701	5105835U14	Audio Signalling Filter
U702	-----	Not Placed
U704	4805921T07	NPN NPN
U705	5105835U22	Microcomputer (NTN7089A)
	or 5105835U17	Microcomputer (NTN7092A)
U706	5105662U62	Audio PA
U708	-----	Not Placed
U709	5105469E65	5V Regulator
VR701	4813830A15	DIODE, Zener: 5.6V
VR702	4805117Y01	Dual, 6.2V
VR703 thru 714	4813830A15	5.6V
VR715	4813830A28	15V
VR716	4813830A15	5.6V
VR718, 719	4805117Y01	Dual, 6.2V
VR720	4813830A28	15V
VR721, 722	4805117Y01	Dual, 6.2V
VR723	4813830A15	5.6V

Note: "Not Placed" means that component is for future use and is not placed on the circuit board at this time.

JUMPER FLEX 8405247V01
 (on early version radios; later version radios use STRIP CONNECTOR, P301/P704)

INSERT DIAGRAMS
 (L1) AEPF-22532-O (20% RED, 133 LINE)
 (L2) AEPF-22533-O (20% BLK., 133 LINE)
 (OL) AEPF-22534-O (100% BLK.)
 R.T. 50%

Electrical Parts List Miscellaneous TPLF- 4078-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C401	2113740F45	CAPACITOR, Fixed: 56pF ±5%; 50V
J403	-----	JACK: Circuit Plating, 13 contacts on Front Cover/Display Flex (to Universal Connector P403)
J501	-----	Circuit Plating, 11 contacts on Front Cover/Display Flex (to Expansion Board)
LS401	5005213W02	SPEAKER: 28-Ohm
MK401	5005227J07	MICROPHONE: Miniature Electret, Noise Cancelling
P301 (See Note)	2805680X01	PLUG: 20-pin; (double-plug) connector strip, includes P704
P403	-----	Universal Connector, 13 pins; not field repairable, order Front Cover
P701	-----	Circuit Plating, 26 contacts on Front Cover/Display Flex (to P701 on Controller Board)
P703	-----	Circuit Plating, 18 contacts on Controls Flex (to J703 on Controller Board)
P704 (See Note)	2805680X01	20-pin; (double-plug) connector strip, includes P301
R401	1805629V01	RESISTOR: Potentiometer, 50k; Volume; includes S403
S401	4002622J03	SWITCH: Rotary, Frequency; 16-position
S402	or 4002622J04	Rotary, Frequency; Continuous
S403	4005572W01	Toggle, 3-position; Mode On/Off, part of R401
S404	-----	Monitor
S405	*	Side Button 1
S406	*	PTT
S407	*	Emergency
S408	*	Side Button 2

* Push-actuated switch contact is made with mechanical parts and circuit plating. Refer to exploded view and exploded view parts list for part numbers and description.

Note: On later version radios, P301 and P704 are physical pins, at either end (and part of) a strip connector. They plug into counterpart jacks (physical connectors) on the RF board and the controller board, J301 and J704 respectively. On early version radios, P301 and P704 are solder pads at either end of a jumper flex that solder directly to their counterpart jacks (solder pads) on the RF board and controller board, J301 and J704 respectively.

CONTROLS FLEX

INSERT DIAGRAMS
 (L1) BEPF-22538-A (20% RED, 133 LINE)
 (L2) BEPF-22539-A (20% BLK., 133 LINE)
 (OL) BEPF-22540-B (100% BLK.)
 R.T. 50%

FRONT COVER/DISPLAY FLEX

INSERT DIAGRAMS
 (L1) BEPF-22535-O (20% RED, 133 LINE)
 (L2) BEPF-22536-O (20% BLK., 133 LINE)
 (OL) BEPF-22537-O (100% BLK.)
 R.T. 50%

FRONT COVER/DISPLAY FLEX

INSERT DIAGRAMS
 (L1) BEPF-23258-O (20% RED, 133 LINE)
 (L2) BEPF-23259-O (20% BLK., 133 LINE)
 (OL) BEPF-23260-O (100% BLK.)
 R.T. 50%

INSERT DIAGRAMS
 (L1) BEPF-24548-O (20% BLK., 133 LINE)
 (OL) BEPF-24549-O (100% BLK.)
 R.T. 50%

INSERT DIAGRAMS
 (L6) BEPF-24550-O (20% BLK., 133 LINE)
 (OL) BEPF-24551-O (100% BLK.)
 R.T. 50%

INSERT SCHEMATIC
63D81200C43-O (100% BLK.)
SHOOT AT 87%

INSERT SCHEMATIC
63D81200C44-O (100% BLK.)
SHOOT AT 100%

Electrical Parts List
NTN7620B Controller

TPLF-4213-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed: pF ±5%; 50V unless stated
C700 thru 708	2113741F17	470
C709	2113743A23	0.22µF
C710	2311049A09	2.2µF
C711	2311049J11	4.7µF
C712, 713	2113743A19	0.1µF
C714, 715	2113743K15	0.1µF
C716, 717	2113741A45	.01µF
C718	2113743K15	0.1µF
C719	2311049A01	0.1µF
C720	2113741F49	10nF
C721	2113743K15	0.1µF
C722	2311049A09	2.2µF
C723	2113743A23	0.22µF
C724	2113740F36	24
C725	2311049A07	1µF
C726	2113743F12	0.33µF
C727	2311049A07	1µF
C728	2113743F12	0.33µF
C729	2311049A07	1µF
C730	2113741F41	4.7nF
C731	2113743K15	0.1µF
C732	2311049J11	4.7µF
C733	2113743K15	0.1µF
C734	2311049J23	10µF
C735 thru 738	2113741F17	470
C739	2113740F39	33
C740, 741, 742	2113741F17	470
C743	2113741A49	15nF
C744	2113741F49	10nF
C745	2113740F39	33
C746 thru 757	2113741F17	470
C758	2113743K15	0.1µF
C759, 760, 761	2113741F17	470
C762	2113743K15	0.1µF
C763, 764	2113740F36	24
C765	2113743K15	0.1µF
C766	2311049A42	3.3µF
C767	2113743K15	0.1µF
C768	2113741F49	10nF
C769	2113741F17	470
C770	2311049J23	10µF
C771	2113743K15	0.1µF
C772	2311049A42	3.3µF
C774, 775	2113741F17	470
C776	2113743K15	0.1µF
C777	2311049A07	1µF
C778	2113743K15	0.1µF
C779	-----	Not Placed
C780 thru 786	2113741F17	470
C787	2113740F39	33
C788 thru 791	2113741F17	470
C792	2113741F13	330
C793	2113743A19	0.1µF
C794	2113743K15	0.1µF
C795	2311049A56	4.7µF
C804	2113741F41	4700
C805	2113743A23	0.22µF
C808	2113741F17	470
		DIODE:
CR701	4880236E05	Schottky
CR702, 703, 704	4805218N57	Dual
CR705	4813833C02	Dual
CR706	4805218N57	Dual
		JACK:
J701	0905257V04	Connector, 26-pin; to P701 on Front Cover Display Flex
J702	0913915A11	Connector, 25-pin
J703	0905257V03	Connector, 18-pin; to P703 on Controls Flex

J704	-----	Circuit Plating on early version radios, 20 contacts, to P704 on Jumper Flex
	or 0905461X01	Connector on later version radios, 20 contacts; to P704 Strip Connector
L703 thru 706	2462587Q40	COIL, RF: 270 nH
		TRANSISTOR:
Q701	4805128M40	PNP
Q703	4880048M01	NPN
		RESISTOR, Fixed: Ω ±5%; .0625W unless stated
R700	0662057A65	4.7k
R701	0662057A56	2k
R702	0662057A81	22k
R703	0662057A56	2k
R704	0662057A41	470
R705	0662057R92	47.5k
R706	0662057A56	2k
R707	0662057A41	470
R708	0662057B47	0
R710	0662057A89	47k
R711	0662057A97	100k
R712	0662057B47	0
R713	0662057A81	22k
R714	0683962T45	68
R715	0662057A97	100k
R716, 717	0662057A81	22k
R718	0662057A97	100k
R719	0662057B02	150k
R720, 721, 722	0662057A89	47k
R723	0662057A49	1k
R724	0662057A89	47k
R725	0662057G07	75k
R726	0662057G08	82.5k
R727	0662057A81	22k
R728, 729	0662057A89	47k
R730, 731	0662057C55	150
R732	0662057A73	10k
R736	0662057A81	22k
R737	-----	Not Placed
R738	0662057A81	22k
R739	0662057A73	10k
R740, 741	0662057A81	22k
R743	0662057A73	10k
R746	0662057A97	100k
R747	0662057B02	150k
R749	0662057A73	10k
R750	0662057A97	100k
R754	0662057B47	0
R755	-----	Not Placed
R757	0662057A81	22k
R758	0662057A97	100k
R759	0662057A81	22k
R760	0662057B47	0
R761	0662057A73	10k
R762	0662057B47	0
R763 thru 768	-----	Not Placed
R769	0662057A81	22k
R770	2113741F49	Capacitor, 10nF
R771	0662057B47	0
R772	-----	Not Placed
R773	0662057A41	470
R801	0660076E56	2k
R802, 803	0662057A56	2k
R804	0662057A65	4.7k
R805	0662057A41	470
		MODULE:
U701	5105835U14	Audio Signalling Filter
U702	5105662U62	Audio PA
U703	4805921T09	Dual Transistor
U704	4805921T07	Transistor, NPN
U705	5105662U52	Microcomputer
U708	5105469E65	5V Regulator
U709	5105750U28	Mux
U710	5105457W06	SLIC IV
U711	5113806A20	Multiplexer

U712	4805718V01	Transistor Package
U713	5105662U58	EEPROM
U714	5105662U54	SCRAM
U715, 716	5105329V30	256 x 8 FLASH
U717	-----	Not Placed
		DIODE, Zener:
VR701, 702	4813830A23	10V
VR703	4813830A18	6.8V
VR704 thru 711	4813830A15	5.6V
VR712	4813830A33	20V
VR713	4813830A23	10V
VR714	4813830A18	6.8V
VR715	4813830A14	5.1V
VR716	4813830A15	5.6V
VR717	4813830A27	14V
VR718	4813830A15	5.6V

Note: "Not Placed" means that the components are for future use, and are not placed on the circuit board at this time.

INSERT DIAGRAMS
(L1) BEPF-24431-O (20% BLK., 133 LINE)
(OL) BEPF-24432-O (100% BLK.)
R.T. 50%

INSERT DIAGRAMS
(L8) BEPF-24433-O (20% BLK., 133 LINE)
(OL) BEPF-24434-A (100% BLK.)
R.T. 50%

INSERT SCHEMATIC
63D81200C41-A (100% BLK.)
SHOOT AT 100%

INSERT EXPLODED VIEW CEPF-22751-C

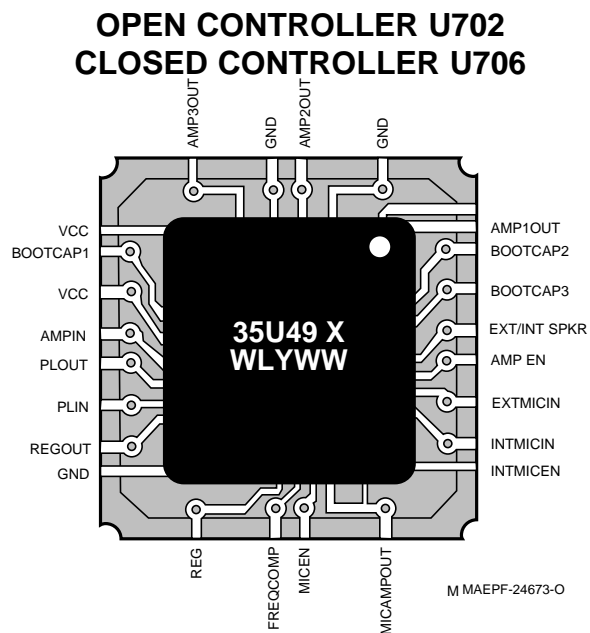
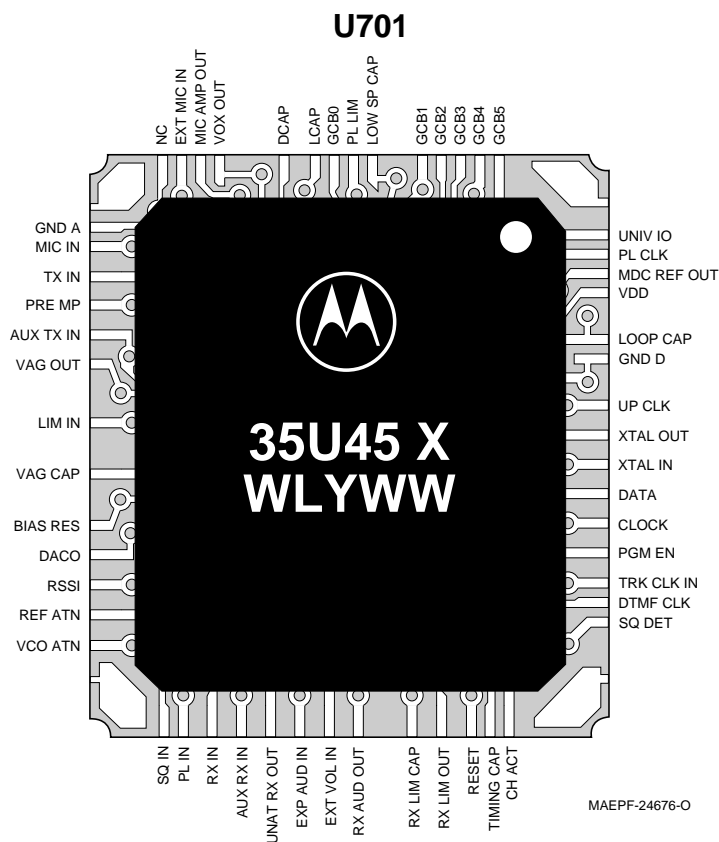
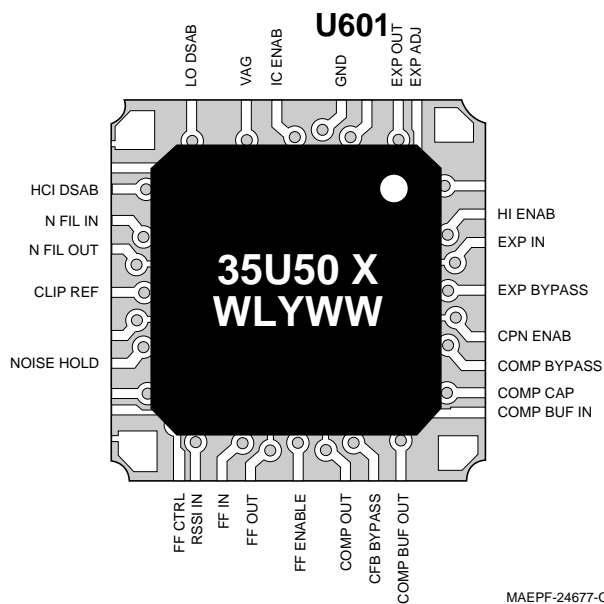
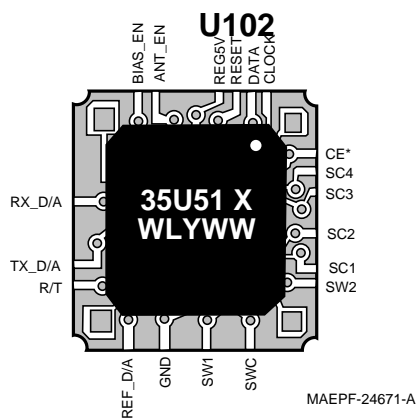
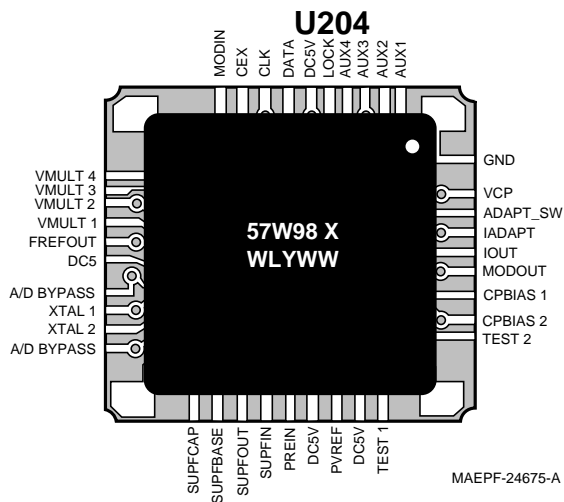
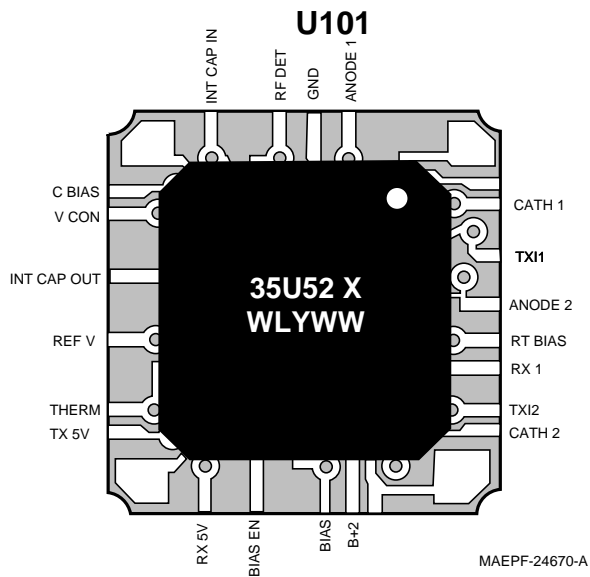
Keypad Radio Exploded View Parts List TPLF-4085-D

ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3A	1505637V01	COVER, Front; Full Keypad
3B	1505637V02	COVER, Front; Limited Keypad
4	-----	LABEL, Agency Approval; not field replaceable
5A	7505870U01	KEYPAD, 15-key
5B	7505870U02	KEYPAD, 6-key
6	5105238U83	MODULE, Display
7	3305183R55	LABEL, Motorola
8	3305183R70	LABEL, MTS2000
	or 3305183R71	LABEL, MTS2000
	or 3305183R94	LABEL, MTX
9	3505535X02	FELT, Speaker
10	See Note 1	SPEAKER (LS401)
11	0705470V01	BRACKET, Speaker Retainer
12	See Note 1	MICROPHONE (MK401)
13	1405330W02	BOOT, Microphone
14	8405310W01	FLEX, Front Cover/Display
15	8405151Y01	FLEX, Controls
16	3905517V01	POPPLE, PTT (p/o S406)
17	3605253V01	KNOB, On/Off/Volume
18	3605636V01	KNOB, Frequency
19	1305633V01	RING, Concentric; Escutcheon
20	3605635V01	KNOB, Concentric Ring
21	1305698V01	ESCUTCHEON, Control Top
22	3205160W01	SEAL, Actuator; for S101

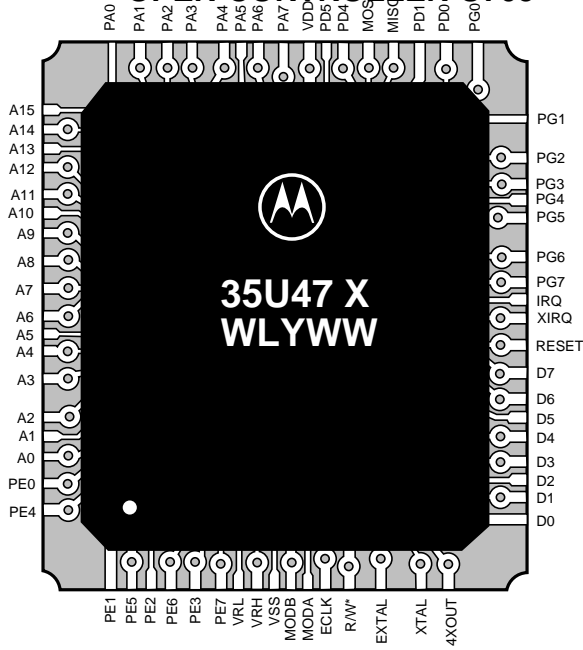
23	2205159W01	PIN, Actuator; for S101
24	3205514W01	SEAL, Accessory Connector
25	3205292W01	SEAL, Control Top
26	3205293W01	SEAL, Emergency Button
27	2705877U01	HOUSING, Switch
28	See Note 1	SWITCH, Toggle (S402)
29	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
30	3905329W01	POPPLE, Emergency Button
31	See Note 1	LED (CR702A/CR702B)
32	See Note 1	SWITCH, Frequency (S401)
33	1505632V01	COVER, Switch Housing
34	-----	SPRING, PA; not field replaceable, order front shield (item 41)
35	4205507X01	STRAIN RELIEF
36	See Note 1	CONNECTOR, Strip (P301/P704)
	or 8405247V01	FLEX, Jumper (early version radios)
37	See Note 2	PLUG, Connector (P404)
38	3205820V02	SEAL, Connector Plug
39	-----	LABEL, Rear; Information; not field replaceable
40	3205126W01	O-RING, Contoured/SEAL, Antenna
41	2605891U02	SHIELD, Front
42	See Note 1	SWITCH, RF (S101)
43	-----	LABEL, Barcode; not field replaceable
44	4105266V01	SPRING, RF Switch
45	4405524V01	PISTON, RF Switch
46	1405307X01	INSULATOR
47	1505892U01	CHASSIS (Rear Cover)
48	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
49	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
50	7505393N33	PAD, Shock

Notes:

1. Refer to electrical parts list (miscellaneous) for part number and complete description.
2. Refer to electrical parts list (transceiver board) for part number and complete description.

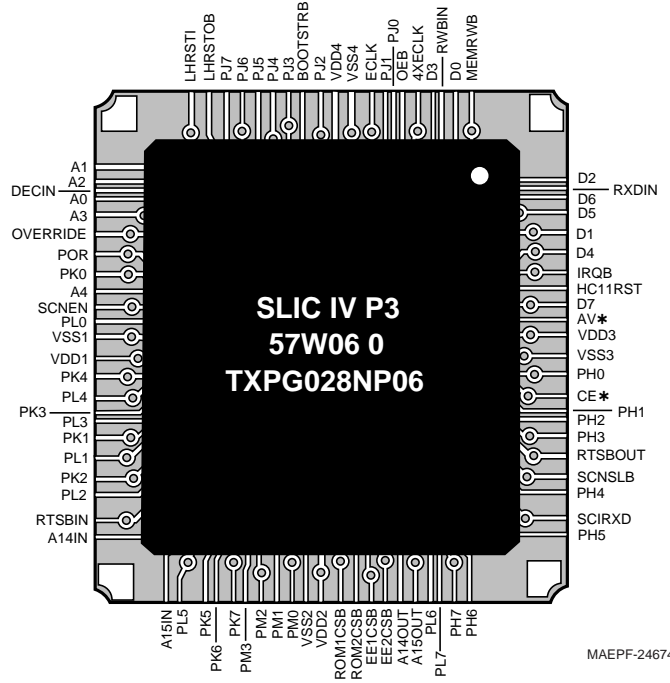


OPEN CONTROLLER U705



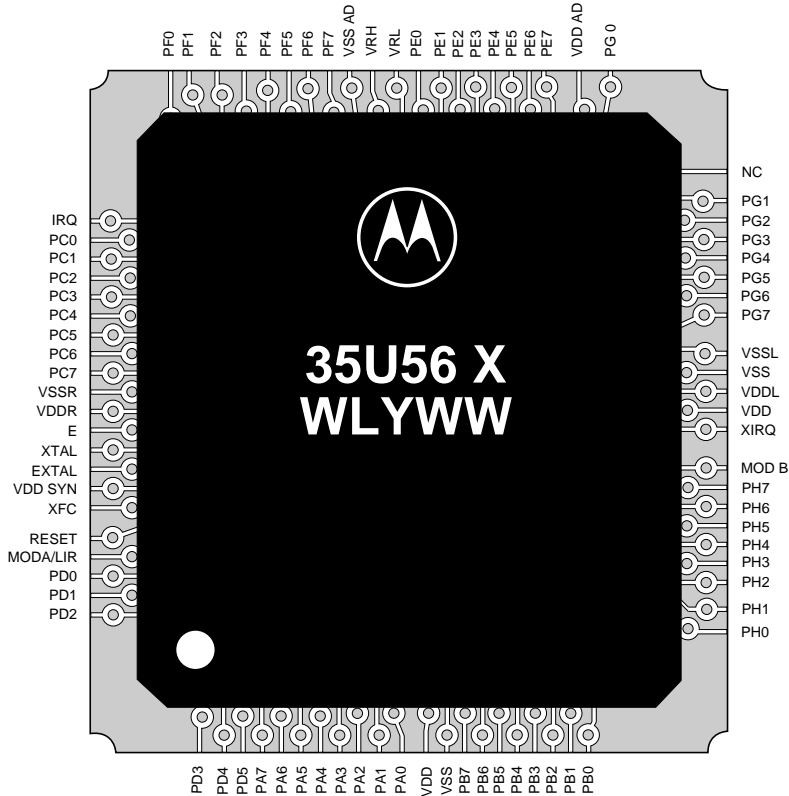
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OPEN CONTROLLER U710



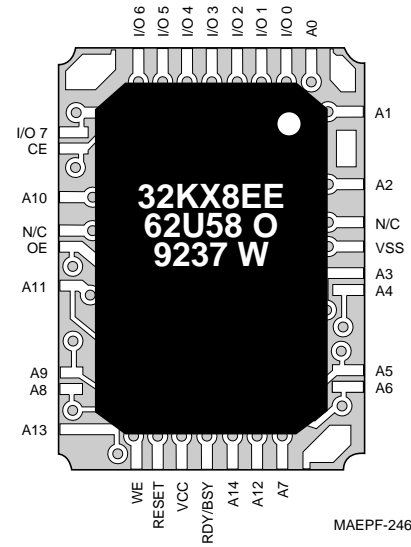
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CLOSED CONTROLLER U705



MAEPF-24678-A

U713



MAEPF-24688-O

APPENDIX

Secure Modules: NTN7279A, NTN7280A, NTN7281A, NTN7282A, and NTN7283A for MTS 2000 Radios

NOTE

The Secure Module is NOT serviceable. The information contained in this appendix is only meant to help determine whether a problem is due to the Secure Module or the radio itself.

I. INTRODUCTION

The Secure Module is designed to digitally encrypt and decrypt voice data in Motorola's MTS 2000 Series Handie-Talkie™ Portable Radios. The Secure Module uses a custom encryption integrated circuit (IC) and an encryption key variable to perform its encode/decode function. The encryption key variable is loaded into the Secure Module via the radio's universal (side) connector from a hand held key variable loader. The encryption IC corresponds to the particular encryption algorithm purchased. The encryption algorithms and their corresponding kit numbers are:

- Data Encryption Standard (DES) NTN7279A
- DES-XL NTN7280A
- Digital Voice Protection (DVP) NTN7281A
- DVP-XL NTN7282A
- DVI-XL NTN7283A

II. CIRCUIT DESCRIPTION

The Secure Module, shown in Figure 1, operates from two power supplies. The first 5 volt supply (Vdd)

is received from the controller board through connector plug P1 pin 2. This Vdd supply is turned on and off with the radio on/off switch. The second supply (UNSW B+) is received from the controller board through connector Plug P1 pin 1. UNSW B+ provides power to the Secure Module as long as the radio battery is in place.

Key variables are loaded into the Secure Module through connector P1 pins 13, 15, and 16. One key variable can be stored in the module at a time. The key variable is stored in volatile electronic memory, so it can only remain in memory as long as the radio is connected to a charged battery. If the battery is removed or if the battery fails, then a capacitor will allow the module to retain the key variable for at least 30 seconds while the battery is being replaced.

The radio's host processor communicates with the Secure Module on the Serial Peripheral Interface (SPI) bus. The host processor is the master on this bus, while the Secure Module is a slave on the bus. The SPI bus consists of five signal lines. Refer to Table 1 for the signal information. A communications failure between the host processor and the Secure Module will be indicated as an "ERROR 09/10" message on the radio display.

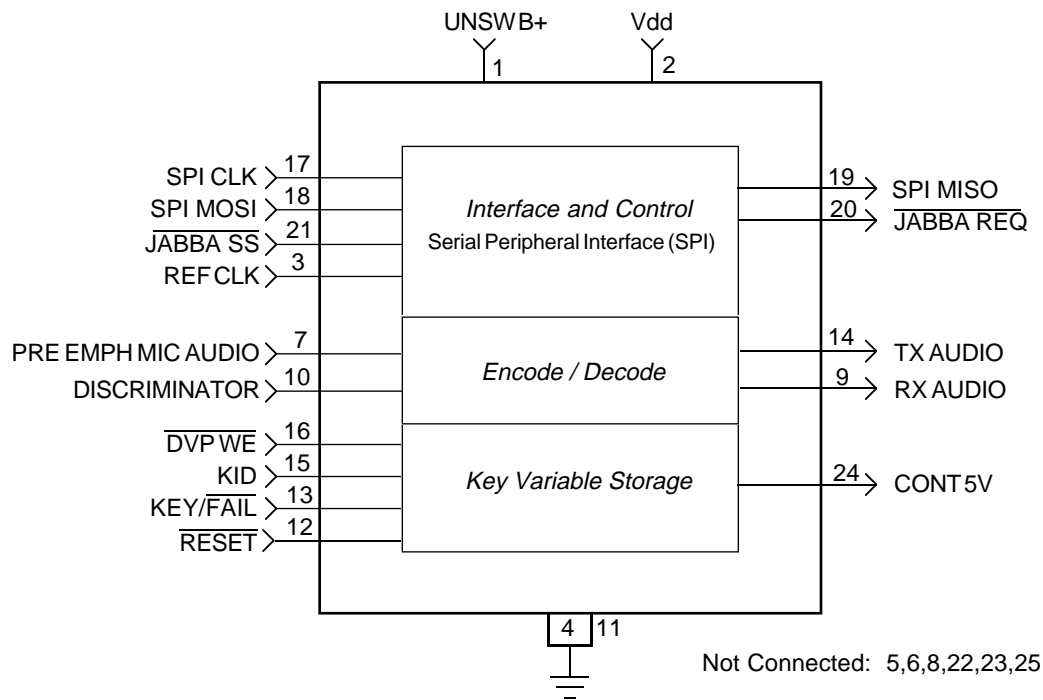


Figure 1. MTS 2000 Single Key Secure Module Block Diagram

Table 1. MTS 2000 Single Key Secure Module I/O Definition

SIGNAL NAME	CONNECTOR PLUG P1 PIN NUMBER	FUNCTION
UNSW B+	1	Unswitched battery voltage
Vdd	2	Switched 5 volt supply
REF CLK	3	2.1/2.4 MHz clock signal
GROUND	4	Ground
PRE EMPHMIC AUDIO	7	Transmit Clear Audio
RX AUDIO	9	Receive Clear Audio
DISCRIMINATOR	10	Receive Encrypted Audio
GROUND	11	Ground
RESET	12	Radio Reset - Does NOT reset module
KEY/FAIL	13	Keyloading Signal
TX AUDIO	14	Transmit Encrypted Audio
KID	15	Keyloading Signal
DVP WE	16	Keyloading Signal
SPI CLK	17	SPI Data Clock
SPI MOSI	18	SPI Data from Host
SPI MISO	19	SPI Data to Host
JABBA REQ	20	SPI Secure Interrupt Request
JABBA SEL	21	SPI Secure Slave Select
CONT 5V	24	Continuous 5 Volt Regulator Output
	5,6,8,22,23,25	Not Used

III. Troubleshooting Secure Operations

Refer elsewhere in this radio service manual for disassembly and reassembly information, and refer to the radio theory/troubleshooting manual for a general overview of troubleshooting information and procedures. A key variable loader and oscilloscope are needed to troubleshoot the Secure Module.

NOTE

The Secure Module itself is NOT serviceable. If the Secure Module is found to be defective then it must be replaced.

A. ERROR 09/10

The MTS 2000 Series Handie-Talkie™ Portable Radio automatically performs a self test on every power-up. Should the radio fail the self tests, the display will show "ERROR XX/XX" (where XX/XX is alphanumeric) accompanied by a short beep. If the display shows "ERROR 09/10" or "E09/10", then the radio failed the secure power-up self tests and the host microcontroller is unable to communicate with the Secure Module via the SPI bus. Turn off the radio, check the battery connection, and turn the radio back on. If the radio still does not pass the self tests, then a problem exists with the secure operations of the radio.

Since the module is removable, a good first step in troubleshooting secure operation is simply to replace the suspect Secure Module with a known

working module. If this does not fix the problem, then the original module is probably not the cause of the problem. If the new module does fix the problem, then the original module must be replaced.

A complete procedure for troubleshooting this error is listed below:

1. Turn the radio off, check the battery connection, and turn the radio back on.
2. If the error condition still exists, check that a Secure Module is installed and make sure that it is properly connected to the controller board. To do this, refer to the disassembly and reassembly sections of this manual.
3. Turn the radio back on.
4. If the error condition still exists and a working secure module with the same kit number is available, replace the suspect module with the working module.
5. If the problem persists, disassemble the radio and check the encryption connector SPI pins (listed in Table 1) for data transitions when the radio is turned on and off. If activity is not seen on all five lines, check both sides of the connector for broken connections.
6. Troubleshoot the Controller Board.

B. Keyloading Problems

Use the following procedure to troubleshoot keyloading problems:

1. Verify that the correct Key Variable Loader (KVL) is being used for the particular encryption algorithm present in the radio. Refer to the following chart:

Secure Module Kit	KVL Kit	Description
NTN7279A	T3011_X	DES
NTN7280A	T3011_X	DES-XL
NTN7281A	T3010_X	DVP
NTN7282A	T3014_X	DVP-XL
NTN7283A	T3012_X	DVI-XL

2. Connect the KVL to the radio via the TDN9390A keyloader cable. When the cable is connected to the radio, the radio should enter the keyloading mode of operation, and the radio should display "KEYLOADING" or "KEYLDG" and make a beep tone.
3. If the radio displays "ERROR 09/10" or "E09/10" then go to the ERROR 09/10 troubleshooting section.
4. If the radio does not go into keyloading mode, detach and reattach the keyloader cable.
5. If there is still a problem, refer to the universal connector illustration found in the schematic and circuit board section of this manual, and short pins 8, 10, and 12 on the universal connector together. If this causes the radio to go into keyloading mode, then replace the keyloader cable.
6. If the radio still does not go into keyloading mode, check the continuity of the the Front Cover/Display Flex and make sure that the Flex is properly connected to the Universal Connector and to the Controller Board.
7. If the radio does go into keyloading mode, but after starting the keyloading process the KVL display indicates "X FAIL", then check to see if there are transitions on pins 13, 15, and 16 of connector P1 on the Secure Module during a keyload.
8. If there are no transitions on any one of these lines during a keyload, check the integrity and continuity of the Expansion Board Connector. If it is OK, try replacing the Controller Board.
9. If there are transitions on these lines, try replacing the Secure Module.
10. If the KVL display indicates "X PASS" but you cannot hear a keyload verification tone, then check the volume of the radio. If the volume is OK, troubleshoot the receive routing paths in the radio.

IV. SERVICE AID

A cable, Motorola kit number TDN9390A, connects the MTS 2000 radio universal connector to the keyloader.

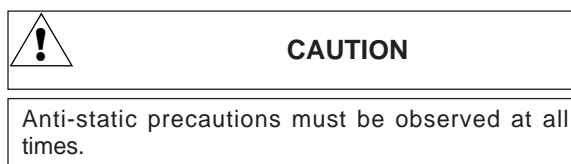
V. RETROFIT INSTRUCTIONS

A. General

This section gives instructions on retrofitting a secure module into a secure-capable MTS 2000 radio. The following paragraphs give directions on how to physically install the secure module, how to enable the secure options by updating the codeplug, and how to tune the radio for optimum secure performance.

B. Physical Retrofit of Secure Module

The radio must be partially disassembled to install the secure module.



Follow the disassembly procedures in section VI, located toward the front of this manual. Proceed through paragraph B (Disassembly to Board Level) step 8, where the front cover has been removed and the controls flex has been disconnected from the controller board.

Continue through step 9a, to loosen the front shield. **Do not completely remove the front shield.** Simply raise the lower portion of the shield while the opposite end is still connected to the top of the radio. With the front shield raised, observe the controller board which takes up the bottom third of the radio. On the lower right corner of the controller board is an empty female connector, which will be used to mate the controller board to the secure module. Place the secure module (component side toward controller board) over the controller board with the secure module's male connector placed above and aligned to the female connector on the controller board. Interlock the connectors by pressing down on the back of the the secure module. The secure module has now been installed. Reassemble the radio according to the reassembly instructions in section VI, located toward the front of this manual. Begin with paragraph E, step 5b.

C. Update Codeplug Through RSS

1. General

Once the secure module is installed, the radio's codeplug must be reprogrammed so that the new hardware can be used. There will also be some secure options that the user may or may not want to activate. Table 3, at the end of this appendix, gives a quick reference to several properties and a

brief description for each parameter. Refer to the RSS manual for general instructions in the use of RSS.

2. Set Secure-Equipped Field

The radio must be reprogrammed to utilize the secure module. At the RSS main menu, press **F4** for the CHANGE/CREATE/VIEW menu. Press **F3** for the Radio Wide Buttons, Switches, Display, Scan, Phone screen. Press **F2** for Radio Wide Options screen. Here, press tab to reach the Secure Equipped field. Press up/down arrow keys to select YES.

3. Set XL IC Present Field

If the secure module has an XL IC (the Range Extension or -XL option), the radio must be reprogrammed to show that this IC is present. While still in the Radio Wide Options screen, press **F6** to see Secure Options. Press Tab until the XL IC Present field is highlighted. Press up/down arrow keys to select YES. If the secure module does not have an XL IC, set the XL IC Present field to NO.

4. Enable Secure On Desired Channels

To actually use the secure option, Secure must be enabled on the channels for which it is desired. A channel can be strapped to secure-only, or clear-only, or secure/clear-selectable.

For conventional channels, proceed as follows: Press **F4** at the Main Menu to see the CHANGE/CREATE/VIEW menu. Press **F6** to see Conventional Systems, Personalities, MDC, Options. Press **F3** to see Conventional Personalities, Options. Press **F6** to see the SECURE OPTIONS screen. Press Tab to select the Secure/Clear Strapping field.

For trunking channels, proceed as follows: Press **F4** at the Main Menu to see the CHANGE/CREATE/VIEW menu. Press **F4** to see Trunking Systems, Personalities, Call Lists, Options screen. Press **F4** to see Trunking Personalities: Talk Groups, Emergency Options, etc. Press Tab to select the Strapping field. An Announcement Group must be specified for the Strapping parameter to appear. This selects the Announcement Group Strapping. Press **F7** to select Talk Groups. Press Tab to select the strapping of each Talk Group.

5. Other Secure Options

There are other secure options that can be changed on a per-channel basis, such as: Proper Code Detection, Transmit XL, or CFB. For conventional channels, these options are found on the same screen as Secure/Clear Strapping (**F4/F6/F3/F6**). These options are XL Transmit, Scan Holdoff Strapping, RX Modulation, and Proper Code Detect. For trunking channels, the only

selectable option is Proper Code Detect. This can be found by going to the MORE OPTIONS screen (**F9**) from the screen that was used to select secure/clear Strapping for trunking channels.

D. Secure Retrofit Tuning

After installing a secure-retrofit board into a radio, the secure TX deviation and the secure RX discriminator level must be tuned. Follow the procedure outlined in section III of this publication for the tuning of these two secure-related alignments.

The TX deviation balance (compensation) does not need to be performed as part of the secure retrofit procedure. Use the transmit deviation balance (compensation) procedure as outlined in this appendix, section III paragraph B, only when a complete radio alignment is being performed with a secure board installed.

VI. SECURE ALIGNMENT PROCEDURE

A. General

For optimum radio performance, the secure transmit deviation and the receive discriminator level must be set. Refer to SECTION V, RADIO ALIGNMENT PROCEDURE, for a description of the radio alignment test setup, an RSS service menu overview, and for general radio tuning procedures. All normal radio tuning should be performed in the proper sequence before proceeding with secure tuning.

Note that the transmit deviation balance (compensation) tuning must be performed differently if a secure board is installed in the radio. Follow the procedure changes outlined below when tuning transmit deviation balance, and complete the normal tuning. Then proceed with the additional tuning for secure TX deviation and secure RX discriminator level tuning.

B. Transmit Deviation Balance (Compensation)

When tuning with a secure board installed, the coupling capacitor inside the RKN4035A Test Cable will cause rolloff of the low port modulation. To fix this, the cable should be dc coupled ("VOL" position) and an external coupling capacitor (1.3 μ F or larger) must be placed in series with the signal source input to the AC/DC MTR.

Follow the Transmit Deviation Balance (Compensation) procedure outlined in section V paragraph G, except change step 3 as follows:

3. Set the RTX4005B Test Box meter selector switch to the "VOL" position, and connect the signal source to the AC/DC MTR port thru a 1.3 μ F capacitor. Inject an 80 Hz tone at 100mVrms thru this capacitor. Keep the ac voltmeter in parallel to the AC/DC MTR input to ensure the proper input signal level.

C. Secure TX Deviation

Transmit deviation balance compensation and transmit deviation limit adjustments should be completed before secure deviation is adjusted. Remember to use the new transmit deviation balance procedure outlined in paragraph B before performing the following steps.

1. From the SERVICE menu, press **F2** to select TRANSMITTER alignment.
2. Press **F8** to select the SECURE TX DEV softpot.
3. Press **F6** to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the secure deviation on your service monitor.
5. Use the up/down arrow keys to adjust the secure deviation per Table 2.

Table 2. Secure Deviation

Channel Spacing (KHz)	Secure Deviation (KHz)
25 / 30	2.91 - 3.06
20 (VHF/UHF)	1.69 - 1.84
20 (821-824, 866-869)	1.69 - 1.84
12.5	N/A

6. Press **F6** to dekey the radio. Press **F8** to program the softpot value.
7. Press **F10** to return to the TRANSMITTER menu.

D. Secure RX Discriminator Level

1. Set the RTX4005B Test Box meter selector switch to the "MX DISC" position, and connect an ac voltmeter (capable of 1mV resolution on a 2V scale) to the test box AC/DC meter port.
2. From the SERVICE menu, press F3 to select RECEIVER alignment.
3. Press **F8** to select the SECURE DISCRIMINATOR LEVEL softpot. The screen will indicate the receive test frequency to be used.
4. Set the RF test generator to the receive test frequency. Set the RF level at the radio standard antenna port to 1mV (-47dBm) modulated with 3.0 kHz FM deviation of a 1 kHz tone.
5. Use the UP/DOWN arrow keys to obtain a discriminator level between 206 - 218mVrms (target value of 212 mVrms) observed on the ac volt-meter.
6. Press **F8** to program the softpot value.
7. Press **F10** to return to the RECEIVER menu.

Table 3. RSS Secure Parameters

Parameter	Default	Possible Settings	Radio Wide/ Per Channel	Used in Conv/Trunk	Description
Secure Equipped	No	Yes/No	Radio Wide	Both	Notifies radio that Secure Module is present
XL IC Present	No	Yes/No	Radio Wide	Both	Notifies radio that Secure Module contains XL IC
Secure/Clear Strapping	Select	Select/ Clear/ Secure	Per Channel	Conv	Sets channel to Clear-Only or Secure-Only or user Selectable
Strapping	Clear	Select/ Clear/ Secure	Per Channel	Trunk	Sets channel to Clear-Only or Secure-Only or user Selectable
XL Transmit	Enable	Enable/ Disable	Per Channel	Conv	Enables TX XL operation or disables for CFB
Scan Select	Non-XL&XL	Non-XL/ Non-XL&XL	Per Channel	Conv	Selects between Non-XL and XL Scan Unsilence Duration
Scan Holdoff Strapping	Both	Both/ Clear Only/ Secure Only	Per Channel	Conv	Scan for Clear or Secure or Both on a particular channel
RX Modulation	2-Level Rx	Auto Rx/ 2-Level Rx	Per Channel	Conv	Tells radio to look for 2&4-level signals or 2-level signals only
Proper Code Detect (Conv)	Enabled	Enabled/ Disabled	Per Channel	Conv	Enables RX proper code detection
Proper Code Detect (Trunk)	Disabled	Enabled/ Disabled	Per Channel	Trunk	Enables RX proper code detection
TX Clear Alert Tones	Enabled	Enabled/ Disabled	Radio Wide	Both	Enables alert tone when PTT is pressed while in the Clear mode
Periodic Keyfail Alert Tone	Enabled	Enabled/ Disabled	Radio Wide	Both	Enables a Keyfail Alert Tone to sound periodically in a key-fail condition
Non-XL Scan Unsilence Duration	275mS	0-6375ms	Radio Wide	Both	The time after an activity detect that radio will wait on channel without an unsilence in Non-XL mode
XL Scan Unsilence Duration	875mS	0-6375ms	Radio Wide	Both	The time after an activity detect that radio will wait on channel without an unsilence in XL mode



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