

XTS™ 2500
XTS™ 1500
MT 1500
700 - 800 MHz
Digital Portable Radios
Basic Service Manual



Foreword

This manual covers all models of the ASTRO™ Digital XTS 2500® Portable Radio, unless otherwise specified. It includes all the information necessary to maintain peak product performance and maximum working time, using the pass/fail service approach. This basic level of service is typical of some local service centers, self-maintained customers, and some distributors.

Included in this manual are: radio specifications for the 700/800 MHz frequency bands; a general description of ASTRO Digital XTS 2500 models; recommended test equipment, service aids, and tools; radio alignment procedures; fundamental disassembly/reassembly procedures; and general maintenance recommendations.

For details on the operation of the radio, or board or component-level troubleshooting, refer to the applicable manuals, available separately. To help you with your selection, a list is provided under “Related Publications” at the front of this manual.

Safety

Before operating an ASTRO XTS 2500 Radio, please read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 68P81095C98) to ensure compliance with RF energy exposure limits.

Manual Revisions

Changes which occur after this manual is printed are described in “FMRs.” These FMRs provide complete information on changes, including pertinent parts list data.

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Related Manuals

ASTRO XTS 2500 Digital Portable Radio Model I User Guide	68P81094C04
ASTRO XTS 2500 Digital Portable Radio Model II User Guide	68P81094C05
ASTRO XTS 2500 Digital Portable Radio Model III User Guide	68P81094C06
ASTRO XTS 2500 Digital Portable Radio Detailed Service Manual.	68P81094C10
ASTRO XTS 1500 Digital Portable Radio Model 1 User Guide	68P04113J52
ASTRO MT 1500 Analog Portable Radio Model 1 User Guide.	68P04113J71

Commercial Warranty



Limited Warranty

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I. What This Warranty Covers And For How Long

MOTOROLA INC. (“MOTOROLA”) warrants the MOTOROLA manufactured Communication Products listed below (“Product”) against defects in material and workmanship under normal use and service for a period of time from the date of purchase as scheduled below:

ASTRO Digital XTS2500 Portable Units	One (1) Year
Product Accessories	One (1) Year

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You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and, also, deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also call Motorola at 1-888-567-7347 US/Canada.

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- C) Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.
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- G) Rechargeable batteries if:
 - any of the seals on the battery enclosure of cells are broken or show evidence of tampering.
 - the damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.
- H) Freight costs to the repair depot.

- I) A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.
- J) Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- K) Normal and customary wear and tear.

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- B) that MOTOROLA will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and
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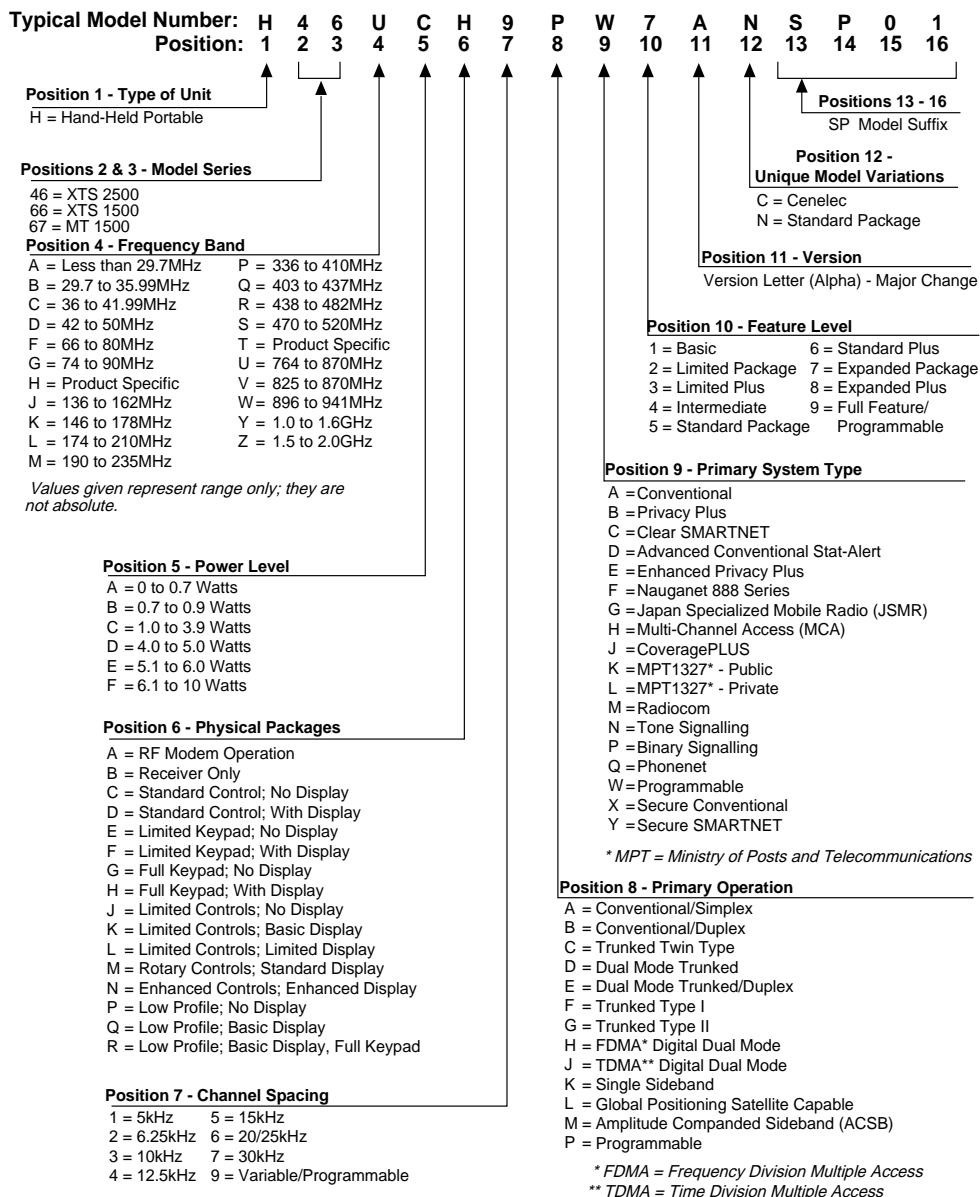
This Warranty is governed by the laws of the State of Illinois, USA.

Notes

Specifications



Portable Radio Model Numbering System



Specifications for 700 MHz/800 MHz Radios

All specifications are per Telecommunications Industries Association TIA-603 unless otherwise noted

GENERAL	RECEIVER	TRANSMITTER
FCC ID: 700/800 MHz: AZ489FT5804	Frequency Range: 700 MHz: 764 to 767; 773 to 776 MHz 800 MHz: 851 to 870 MHz	RF Power 806 - 870 MHz: 3 Watts 764 - 806 MHz: 2.5 Watts
Temperature Range: Operating: -30°C to +60°C Storage: -40°C to +85°C	Quieting Sensitivity (typical) (20dBQ): 0.23µV Usable Sensitivity (typical) (12dB SINAD): 0.25µV	Frequency Range: 700 MHz: 764 to 767; 773 to 776; 794 to 797; 803 to 806 MHz 800 MHz: 806 to 824; 851 to 870 MHz
Power Supply: Nickel-Cadmium Battery (NiCd) or Nickel-Metal-Hydride Battery (NiMH)	Intermodulation (typical): -74dB	Frequency Stability (typical) (-30 to +60°C; 25°C ref.): 1.5ppm
Battery Voltage Nominal: 7.5 Volts Range: 6 to 9 Volts	Selectivity (typical) (25kHz Channel): -72dB (12.5kHz Channel): -63dB	Emission (typical conducted): -75dBc<1GHz
Transmit Current Drain (Typical): 1250mA Receive Current Drain (Rated Audio): 220mA Standby Current Drain: 70mA	Spurious Rejection (typical): -75dB Frequency Stability (-30+60°C; 25°C reference): 1.5ppm	FM Hum and Noise (typical) (25 kHz channel): -43dB (12.5 kHz channel): -40dB
Recommended Battery: High-Capacity NiCd: NTN9815 or Ultra-High-Capacity NiMH: NTN9858 or High-Capacity NiCd FM: NTN9816* or Ultra-High-Capacity NiMH FM: NTN9857* <i>Optional FM (Factory Mutual) Battery:</i> * FM Intrinsicly Safe: Class I, II, III	Rated Audio: 500mW FM Hum and Noise (typical) (25kHz channel): -47dB (12.5kHz channel): -40dB	Distortion (typical): 2% Modulation Limiting: 25 kHz chnls ±5.0kHz 20 kHz chnls ±4.0kHz 12.5 kHz chnls ±2.5kHz
Dimensions <div style="text-align: center;">Height x Width x Depth</div> Radio Less Battery: 6.0" x 2.3" x 1.5" With NiCd Ultra-High Cap.: 6.0" x 2.3" x 2.0" With NiMH Ultra-High Cap.: 6.0" x 2.3" x 2.0"	Distortion (At Rated Audio; typical): 2.5% Channel Spacing: 12.5/20/25 kHz	Emissions Designators: 16K0F3E,11K0F3E, 8K10F1D, and 8K10F1E
Weight Radio Less Battery: 11.0 oz. With NiCd Ultra-High Capacity: 20.0 oz. With NiMH Ultra-High Capacity: 20.5 oz.		

ASTRO Digital XTS 2500 Model Chart

MODEL NUMBER			DESCRIPTION	
H46UCC9PW5AN			700/800 MHz, 1-3 Watts, ASTRO Digital XTS 2500 Model I	
H46UCF9PW6AN			700/800 MHz, 1-3 Watts, ASTRO Digital XTS 2500 Model II	
H46UCH9PW7AN			700/800 MHz, 1-3, Watts ASTRO Digital XTS 2500 Model III	
ITEM NUMBER			DESCRIPTION	
X	X	X	1505579Z01	Cover, Dust, Accessory Connector
X	X	X	4385665D01	Adapter, Remote Speaker Microphone
X	X	X	NTN9815	Hi Capacity NiCd Battery
X	X	X	NAF5037	1/2 Wave Whip Antenna, 800 MHz
X	X	X	HLN6853	2.250 inch Belt Clip
X			NTN9637	Front Cover Kit, Model I
	X		NTN9638	Front Cover Kit, Model II
		X	NTN9639	Front Cover Kit, Model III
X	X	X	NUF6541	RF/VOCON Board Kit
X			6881094C04	User's Guide, Model I
	X		6881094C05	User's Guide, Model II
		X	6881094C06	User's Guide, Model III

Notes:X=Item Included

ASTRO XTS 1500/MT 1500 Model Chart

MODEL NUMBER			DESCRIPTION	
H66UCC9PW5AN			700/800 MHz, 1-3 Watts, ASTRO Digital XTS 1500 Model I	
H67UCC9PW5AN			700/800 MHz, 1-3, Watts ASTRO Analog MT 1500 Model I	
ITEM NUMBER			DESCRIPTION	
X	X	X	1585746D04	Cover, Dust, Accessory Connector
X	X	X	4385665D01	Adapter, Remote Speaker Microphone
X	X	X	NTN9815_	Hi Capacity NiCd Battery
X	X	X	NAF5037_	1/2 Wave Whip Antenna, 800 MHz
X	X	X	HLN6853_	2.250 inch Belt Clip
X			PMTN4080_	Front Cover Kit, XTS1500 Model I
	X		PMTN4079_	Front Cover Kit, MT1500 Model I
X	X	X	PMUF6541_	RF/VOCON Board Kit
X			6804113J52	User's Guide, XTS1500 Model I
	X		6804113J71	User's Guide, MT1500 Model I

Notes:X=Item Included

Notes

General

This manual covers information needed for level one and two troubleshooting. Level one troubleshooting consists of radio programming, tuning (via CPS/tuner), knobs replacement, and installation and removal of antenna, belt clip, battery, and universal connector cover. Level two troubleshooting consists of everything listed in level one, plus the identification and replacement of Field Replaceable Units (FRUs). No soldering will be allowed; only board swapping.

Included in this manual are radio specifications for the 700/800 MHz frequency bands, a general description of ASTRO Digital XTS 2500 models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, and procedures for basic assembly and disassembly.

Notations Used in This Manual

Throughout the text in this publication, you will notice the use of warnings, cautions, and notes. These notations are used to emphasize that safety hazards exist, and care must be taken and observed.

NOTE: An operational procedure, practice, or condition, etc., which is essential to emphasize.



Caution

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in equipment damage.



WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or injury.



DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or injury.

Radio Description

The ASTRO Digital XTS 2500 radios are among the most sophisticated two-way radios available.

One of the newest in a long line of quality Motorola products, the ASTRO Digital XTS 2500 radio provides improved voice quality across more coverage area. The digital process, called “embedded signalling,” intermixes system signalling information with digital voice, resulting in improved system reliability, and the capability of supporting a multitude of advanced features. Such features add up to better, more cost-effective two-way radio communications.

ASTRO Digital XTS 2500 radios are available in three basic models. Table 1 describes their basic features.

Table 1. ASTRO XTS 2500 Basic Features

Feature	Model I	Model II	Model III
Display	None	LCD 6 lines/ 12 characters per line	LCD 6 lines/ 12 characters per line
Keypad	None	3 x 2 button with 4-Position Navigation button	3 x 6 button with 4-Position Navigation button
Channel Capability	48	160	160
Dialing from Prestored List	No	Yes	Yes
Programmable Softkeys	No	Yes	Yes

FLASHport

The ASTRO® Digital XTS 2500 radio utilizes Motorola’s revolutionary FLASHport™ technology. FLASHport makes it possible to add software that drives the radio’s capabilities both at the time of purchase and later on. Previously, changing a radio’s features and capabilities meant significant modifications, or buying a new radio. But now, just as a computer can be loaded with different software, the radio’s features and capabilities can be upgraded with FLASHport software.

Basic Maintenance

2

Introduction to This Section

This section of the manual describes preventive maintenance and handling precautions. Each of these topics provides information vital to the successful operation and maintenance of your radio.

Preventive Maintenance

ASTRO Digital XTS 2500 radios do not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is recommended.

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.

Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external surfaces of the radio. External surfaces include the housing assembly and battery case. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime.

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

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.

Handling Precautions

Complementary metal-oxide semiconductor (CMOS) devices, and other high-technology devices, are used in this family of radios. While these devices have many attributes, their characteristics make them susceptible to damage by electrostatic discharge (ESD) or high-voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for this radio, and are especially important in low-humidity conditions.

Never heat the RF PA above 210°C while performing repair or rework procedures to maintain its integrity. Utilizing a Chipmaster (R1319 or R1321) top-side set point of 215°C and a Dragon (R1427) bottom-side pre-heat set point of 180°C has proven to satisfy this condition during the rework of the RF PA (note: the RF PA temperature does not reach the Chipmaster's internal set point temperature). All other parts on the transceiver board can be reworked with Chipmaster top-side heat alone.

Basic Theory of Operation

3

General Overview

The ASTRO Digital XTS 2500 radio is a wideband, synthesized, fixed-tuned radio available in the 700/800 MHz bands. All XTS 2500 radios are capable of both analog operation (12.5 kHz or 25 kHz bandwidths) and digital ASTRO mode operation (12.5 kHz only).

The ASTRO Digital XTS 2500 radio includes the following major assemblies (see Figure 1):

- **Main Board:** contains the microcontrol unit (MCU) and its associated memory and memory management integrated circuit (IC), the audio power amplifier, and a switching regulator. The board also contains the digital signal processor (DSP) and its support IC and associated memories. It further contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator.
- **Universal Flex:** contains the universal connector, speaker, and microphone.
- **Display (Models II and III only):** a six-line, 12-character, liquid-crystal display (LCD).
- **Keypad (Models II and III only):**
 - Model II: a 3 x 2 keypad
 - Model III: a 3 x 6 keypad.

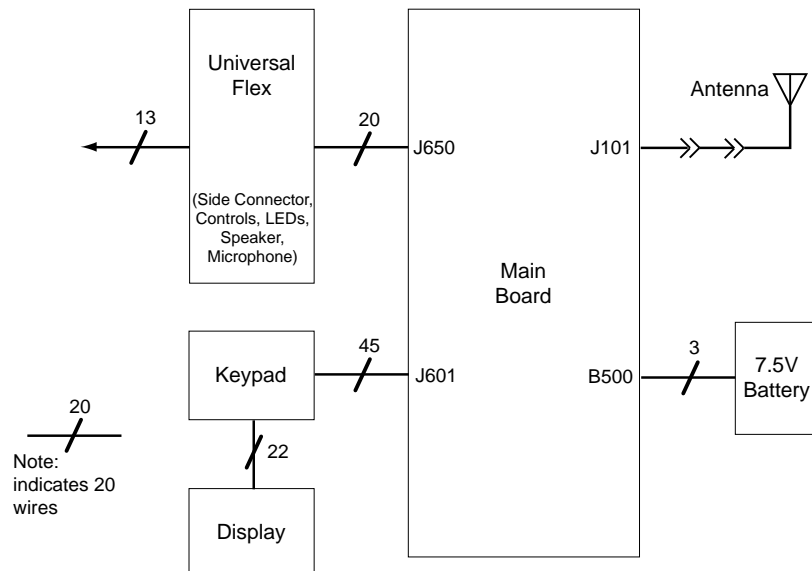


Figure 1. XTS 2500 Overall Block Diagram

Analog Mode of Operation

Receiving

When the radio is *receiving* (see Figure 2), the signal comes from the antenna connector to the radio board, passes through the RX/TX antenna switch and into the receiver front end. A 15dB step attenuator is included in the front end to provide additional protection against strong signals. The attenuator is controlled by a DSP based algorithm that continuously monitors signal strength. When the ON threshold is exceeded (approximately -95dBm), the attenuator is activated via a DAC in the PCIC by the host. The attenuator remains activated until the signal drops below the OFF threshold (approximately -115dBm including the 15dB attenuation). Hysteresis and timer functions are included in the algorithm to enhance performance. The algorithm controlling the attenuator is enabled via the CPS for each personality. When the algorithm is disabled, the attenuator is essentially a short circuit from input to output. The signal is then filtered, amplified, and mixed with the first local-oscillator signal generated by the voltage-controlled oscillator (VCO).

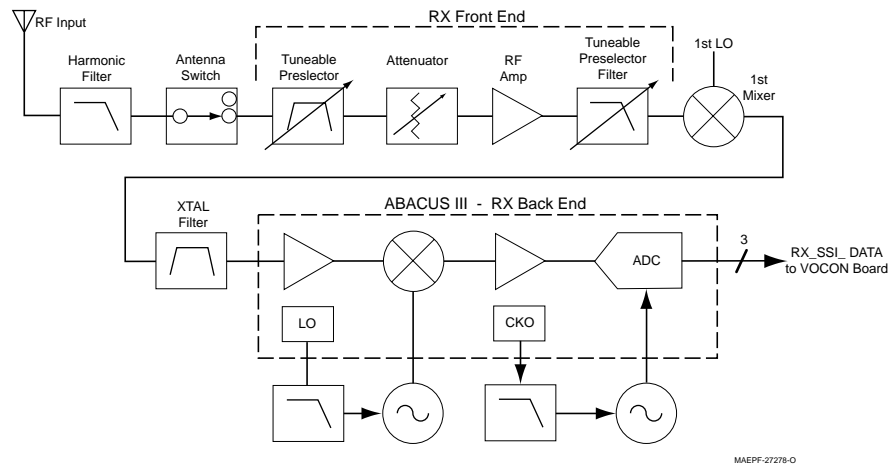


Figure 2. Receiver Block Diagram

The resulting intermediate frequency (IF) signal is fed to the IF circuitry, where it is again filtered and amplified. This amplified signal passes to the digital back-end IC, where it is mixed with the second local oscillator to create the second IF at 450 kHz. It is then converted to a digital bit stream and mixed a third time to produce a baseband signal. This signal is passed to the VOCON circuitry through a current-driven differential output.

In the VOCON circuitry, the digital-signal processor (DSP) support IC digitally filters and discriminates the signal, and passes it to the DSP. The DSP decodes the information in the signal and identifies the appropriate destination for it. For a voice signal, the DSP routes the digital voice data to the CODEC for conversion to an analog signal. The CODEC then presents the signal to the audio power amplifier, which drives the speaker. For signalling information, the DSP decodes the message and pass it to the microcontrol unit.

Transmitting

When the radio is *transmitting* (see Figure 3), microphone audio is passed through gain stages to the CODEC where the signal is digitized. The CODEC passes digital data to the DSP where pre-emphasis and low-pass (splatter) filtering are done. The DSP passes this signal to a digital-to-analog (D/A) converter where it is reconverted into an analog signal and scaled for application to the voltage-controlled oscillator as a modulation signal.

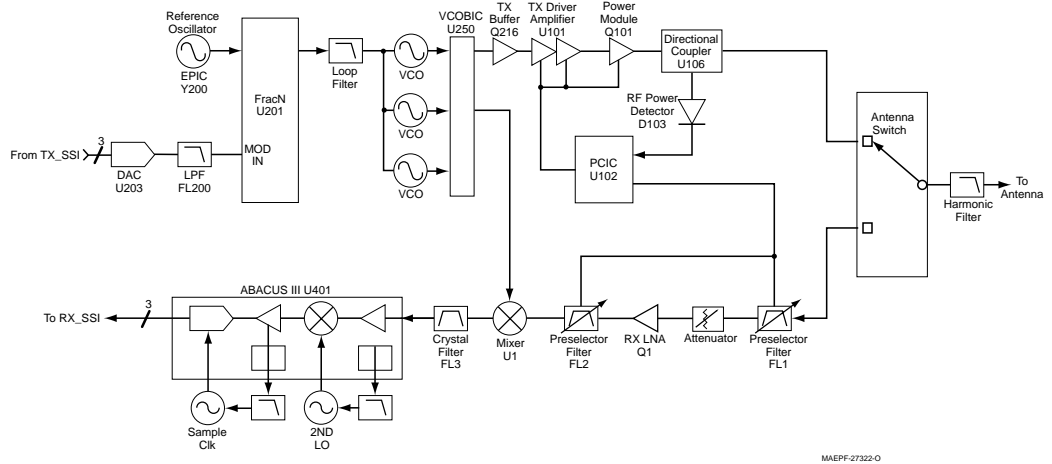


Figure 3. RF Block Diagram (Power and Control Omitted)

Transmitted signalling information is accepted by the DSP from the microcontrol unit, coded appropriately, and passed to the D/A converter, which handles it the same as a voice signal. Modulation information is passed to the synthesizer along the modulation line. A modulated carrier is provided to the RF PA, which transmits the signal under dynamic power control.

ASTRO Mode of Operation

In the ASTRO mode (digital mode) of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying. The receiver handles an ASTRO-mode signal identically to an analog-mode signal up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a specifically defined algorithm to recover information.

In the ASTRO transmit mode, microphone audio is processed identically to an analog mode with the exception of the algorithm the DSP uses to encode the information. This algorithm will result in deviation levels that are limited to discrete levels.

RF Basic Theory of Operation

The receiver front end consists of a preselector, an RF amplifier, a second preselector, and a mixer. Both preselectors are varactor-tuned, two-pole filters, controlled by the microcontroller unit through the D/A IC. The RF amplifier is a dual-gate, gallium-arsenide-based IC. The mixer is a double-balanced, active mixer, coupled by transformers. Injection is provided by the VCO through an injection filter. See Table 2 for local oscillator (LO) and first IF information.

Table 2. Local Oscillator and First IF Frequencies

	700 MHz	800 MHz
LO Frequency Range	--	--
First IF Frequency	109.65 MHz	109.65 MHz

The frequency generation function is performed by three ICs and associated circuitry. The reference oscillator provides a frequency standard to the synthesizer/prescaler IC, which controls the VCOB IC. The VCOB IC actually generates the first LO and transmit-injection

signals and buffers them to the required power level. The synthesizer/prescaler circuit module incorporates frequency-division and comparison circuitry to keep the VCO signals stable. The synthesizer/prescaler IC is controlled by the microcontrol unit through a serial bus.

The receiver back end consists of a two-pole crystal filter, an IF amplifier, a second two-pole crystal filter, and the digital back-end IC. The two-pole filters are wide enough to accommodate 4 kHz modulation. Final IF filtering is done digitally in the DSP.

The digital back-end IC consists of an amplifier, the second mixer, an IF analog-to-digital converter, a baseband down-converter, and a 2.4 MHz synthesis circuit to provide a clock to the DSP-support IC on the VOCON circuitry. The second LO is generated by discrete components external to the IC. The output of the digital back-end IC is a digital bit stream that is current driven on a differential pair for a reduction in noise generation.

The transmitter consists of an RF driver IC that gets an injection signal from the VCO and a final-stage power amplifier. Transmit power is controlled by a power-control IC that monitors the output of a directional coupler and adjusts PA control voltages correspondingly. The signal passes through a RX/TX switch that uses PIN diodes to automatically provide an appropriate interface to transmit or receive signals. Antenna selection is done mechanically in the control top.

VOCON Basic Theory of Operation

The vocoder and controller (VOCON) circuitry contains the radio's microcontrol unit with its memory and support circuits, the DSP, its memory devices, and the DSP-support IC, voltage regulators, audio, and power control circuits. Connected to the VOCON circuitry are the display board, RF circuitry, keypad board, and controls/universal flex.

The microcontrol unit controls receive/transmit frequencies, power levels, display, and other radio functions, using either direct logic control or serial communications paths to the devices. The microcontrol unit executes a stored program located in the FLASH ROM. Data is transferred to and from memory by the microcontrol unit data bus. The memory location from which data is read, or to which data is written, is selected by the address lines.

The DSP-support IC is supplied with a 16.8 MHz clock from the RF circuitry. Both the DSP and the microprocessor have their clocks generated by the DSP-support IC. They can both be adjusted so that the harmonics do not cause interference with the radio's receive channel.

The regulator and power-control circuits include 3.3-volt analog, 3.3-volt digital, and 5-volt regulators. The audio PA is sourced from 7.5V. The regulator's power-down mode is controlled by the microcontrol unit, which senses the position of the on/off switch. The 5-volt regulator has an error pin for low-voltage resets.

The DSP performs signalling and voice encoding and decoding, as well as audio filtering and volume control. This IC performs Private-Line®/Digital Private Line™ (PL/DPL) encode and alert-tone generation. The IC transmits pre-emphasis on analog signals and applies a low-pass (splatter) filter to all transmitted signals. It requires a clock on the EXTAL pin. An 8 kHz interrupt signal generated by the DSP-support IC is also required for functionality. It is programmed using parallel programming from the microcontrol unit.

The audio CODEC performs analog-to-digital (A/D), and digital-to-analog conversions on audio signals. The DSP controls squelch, deviation, and executes receiver and transmitter filtering. The DSP-support IC receives a 2.4 MHz clock, and also receives data, which it formats for the DSP.

Recommended Test Equipment and Service Aids

4

Recommended Test Equipment

The list of equipment contained in Table 3 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. 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.

Table 3. Recommended Test Equipment

Motorola Model Number	Description	Characteristics	Application
R2600 Series	Communications System Analyzer	This monitor will substitute for items with an asterisk (*).	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment.
Fluke 8012	Digital Multimeter		Recommended for ac/dc voltage and current measurements
R1150_*	Code Synthesizer		Injection of audio and digital signalling codes
R1377_*	AC Voltmeter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R1094_	Dual-Trace Oscilloscope	20 MHz bandwidth 5mV to 5V/division	Waveform measurements
S1350_* ST1213_ (VHF)* ST1223_ (UHF)*	Wattmeter Plug-In Element RF Dummy Load	50-ohm, ±5% accuracy 10 watts, maximum 0-1000 MHz, 300W	Transmitter power output measurements
R1065_	Load Resistor	10-watt Broadband	For use with wattmeter
S1339_	RF Millivolt Meter	100µV to 3V RF	RF-level measurements
R1013_*	SINAD Meter		Receiver sensitivity measurements
S1347_ or S1348_ (programmable)	DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc
*The R2600 Series monitor will substitute for these items.			

Service Aids

Refer to Table 4., “Service Aids,” for a listing and description of the service aids designed specifically for servicing this family of radios. These kits and/or parts are available from the Motorola Parts Division offices listed in the “Replacement Parts Ordering” section located on the inside back cover of this manual. While all of these items are available from Motorola, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4. Service Aids

Motorola Part Number	Description	Application
6685666D01	Chassis Opener Tool	Used to remove radio knobs and to separate chassis from Front Cover.
RKN-4106_	RS232/Radio/Test Set Cable	Connects radio to RLN4460 Test Box and to RS232 computer connector (DB9).
0180305G54	Battery Eliminator	Interconnects radio to power supply.
RLN-4460	Portable Test Set	Enables connection to the universal connector. Allows switching for radio testing.
RVN-4181_	Customer Programming Software	Customer Programming Software (CPS)/Tuner on one CD-ROM.
58-80348B33	SMA to BNC Adaptor	Adapts radio’s antenna port to BNC cabling of test equipment.
RKN4105	USB/Radio/Test Set Cable	Connects radio to RLN4460 test box and to USB computer connector.
8180384M37	Test Fixture	Provides for troubleshooting the radio board when the back casting is removed.

NOTE: The Radio Interface Box (RIB), Smart Radio Interface Box (SRIB), and any cables that connect with those boxes are incompatible with the XTS 2500 radio and should NOT be used.

Field Programming Equipment

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the applicable “CPS On-line Help” for complete field programming information.

Introduction to This Section

This section covers performance checks used to verify that the radio meets published specifications. The recommended test equipment listed in the previous section 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. Checks should be performed if radio performance degradation is suspected.

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 (Figure 4).

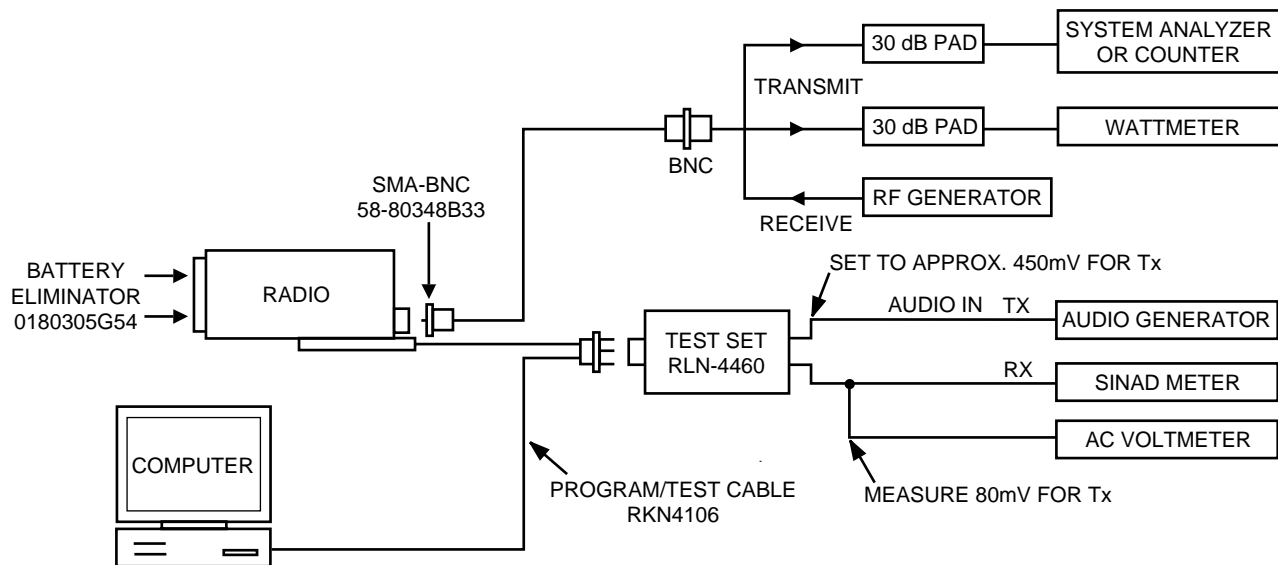


Figure 4. Radio Alignment Test Setup

Initial equipment control settings should be as indicated in the Table 5, and should hold for all alignment procedures except as noted.

Table 5. Initial Equipment Control Settings

System Analyzer	Test Set	Power Supply
Monitor Mode: Pwr Mon	Spkr Set: A	Voltage: 7.5Vdc
RF Attn: -70dB	Spkr/Load: Speaker	DC On/Standby: Standby
AM, CW, FM: FM	PTT: OFF (center)	Volt Range: 10Vdc
O'scope Source: Mod O'scope Horiz: 10mSec/Div O'scope Vert: 2.5 kHz/Div O'scope Trig: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: Mid CW Monitor Vol: 1/4 CW		Current: 2.5Amps

Display Radio Test Mode

Entering Display Radio Test Mode

1. Turn the radio on.
2. Within 10 seconds after “Self Test” is complete, press **Side button 3** five times in succession.
3. The radio will show a series of displays that will give information regarding various version numbers and subscriber specific information. The displays are described in Table 6.

Table 6. Front-Panel Access Test-Mode Displays

Name of Display	Description	Appears
“SERVICE”	The literal string indicates the radio has entered test mode.	Always.
Host Software Version	The version of host firmware.	Always.
DSP Software Version	The version of DSP firmware.	Always.
Model Number	The radio’s model number as programmed in the codeplug.	Always.
Serial Number	The radio’s serial number as programmed in the codeplug.	Always.
ROM Size	The memory capacity of the host FLASH part.	Always.
FLASHcode	The FLASH codes as programmed in the codeplug.	Always.

NOTE: All displays are temporary and will disappear without any user intervention. If information is longer than the physical length of the radio’s display, the information will wrap around to the next display. After the last display, “RF TEST” will be displayed. For **non-display** radios, refer to the CPS Radio Information Screen.

- 4a. Press **Side Button 1** to stop the displays and put the radio into the Control Top and Keypad test mode (display radio). The test mode menu “CH TEST” will be displayed. Go to the “Control Top and Keypad Test Mode (Display Radio)” section on page 14.

NOTE: Each press of **Side Button 1** will toggle between “CH TEST” and “RF TEST.”

OR

- 4b. Press the **Top Programmable Button** to stop the displays and put the radio into the RF test mode (display radio). The test mode menu “1 CSQ.” will be displayed, indicating test frequency 1, Carrier Squelch mode. Go to “RF Test Mode (Display Radio)” in the next section.

RF Test Mode (Display Radio)

When the ASTRO Digital XTS 2500 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting, according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment, or repair, it must be removed from its normal environment via a special routine, called **TEST MODE** or “air test.”

- Each additional press of **Side Button 3** will advance to the next test channel. (Refer to Figure 7.)
- Pressing **Side Button 2** will scroll through and access test environments as shown in Figure 8.

NOTE: Transmit into a load when keying a radio under test.

Table 7. Test Frequencies

Frequency	700/800 MHz RX	700/800 MHz TX
F1	764.0625	764.0125
F2	769.0625	769.0125
F3	775.9375	775.9875
F4	851.0625	794.0125
F5	860.0625	809.0125
F6	869.9375	823.9875
F7	851.0625	851.0125
F8	860.0625	860.0125
F9	869.9375	869.8875

Table 8. Test Environments

No. of Beeps	Display	Description	Function
1	CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
3	TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8 Hz) detected TX: mic audio + tone (192.8 Hz)
11	AST	ASTRO	RX: none TX: 1200Hz tone **
12	USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio
<i>** All deviation values are based on deviation tuning of this mode.</i>			

Control Top and Keypad Test Mode (Display Radio)

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

1. Press and hold the **Top Programmable Button**; all segments on the display will light, and the LED on the control top will illuminate a red color.
2. Release the **Top Programmable Button**; “3/0” appears, indicating that the **Top Programmable Button** is in the open condition.
3. Press the **Top Programmable Button** again; “3/1” appears, indicating that the **Top Programmable Button** is in the closed condition.
4. Rotate the **Mode/Zone Selector Switch**; “4/0” through “4/15” appears, indicating that the selector switch is in mode/zone position 1 through 16.
5. Rotate the **Three-Position Concentric Switch**; “65/0” through “65/2” appear.
6. Cycle through the **16-Position Programmable Switch**; “67/0,” “67/1,” and “67/2” appear.
7. Rotate the **Volume Control**; “2/0” through “2/255” appear.
8. Press **Side Button 1**; “96/1” appears; release, “96/0” appears.
9. Press **Side Button 2**; “97/1” appears; release, “97/0” appears.
10. Press **Side Button 3**; “98/1” appears; release, “98/0” appears.
11. Press the **PTT Switch**; “1/1” appears; release, “1/0” appears.
12. Keypad Checks:

Model III Only—

- Press 0, “48/1” appears; release, “48/0” appears.
- Press 1, “49/1” appears; release, “49/0” appears.
- Press 2, “50/1” appears; release, “50/0” appears.
- Press 3, “51/1” appears; release, “51/0” appears.
- Press 4, “52/1” appears; release, “52/0” appears.
- Press 5, “53/1” appears; release, “53/0” appears.
- Press 6, “54/1” appears; release, “54/0” appears.

- Press 7, “55/1” appears; release, “55/0” appears.
- Press 8, “56/1” appears; release, “56/0” appears.
- Press 9, “57/1” appears; release, “57/0” appears.
- Press *, “58/1” appears; release, “58/0” appears.
- Press #, “59/1” appears; release, “59/0” appears.

All Display Models—

- Press V, “128/1” appears; release, “128/0” appears.
- Press h, “129/1” appears; release, “129/0” appears.
- Press U, “130/1” appears; release, “130/0” appears.
- Press the left-hand D key on the top row of keys, “131/1” appears; release, “131/0” appears.
- Press the center E key, “132/1” appears; release, “132/0” appears.
- Press the right-hand F key, “133/1” appears; release, “133/0” appears.
- Press @ button, “134/1” appears; release, “134/0” appears.
- Press X (up arrow), “135/1” appears; release, “135/0” appears.
- Press Y (down arrow), “136/1” appears; release, “136/0” appears.

Non-Display Radio Test Mode

Entering Non- Display Radio Test Mode

1. Turn the radio on.
2. Within 10 seconds after the top green LED turns off, press **Side button 3** five times in succession.
- 3a. Press **Side Button 1** to put the radio into the Control Top and Keypad test mode (non-display radio). Go to the “Control Top and Keypad Test Mode (Non-Display Radio)” section on page 16.

NOTE: Each press of **Side Button 1** will toggle between Control Top and Keypad test mode (non-display radio) and RF test mode (non-display radio).

OR

- 3b. Press the **Top Programmable Button** to stop the displays and put the radio into the RF test mode (non-display radio). Go to “RF Test Mode (Non-Display Radio)” in the next section.

RF Test Mode (Non- Display Radio)

When the ASTRO Digital XTS 2500 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting according to the customer codeplug configuration. However, when the unit is on the bench for testing, alignment or repair, it must be removed from its normal environment via a special routine, called **TEST MODE** or “air test.”

1. Each additional press of **Side Button 3** will advance to the next test channel. (Refer to Table 7 on page 13.) The channel number is represented by the number of beeps

emitted by the radio after the button press (for example, five beeps indicates channel 5).

2. Pressing **Side Button 2** will scroll through and access test environments as shown in Table 8 on page 14. The test environment is represented by the number of beeps emitted by the radio after the button press (for example, 11 beeps indicate AST).

NOTE: Transmit into a load when keying a radio under test.

Control Top and Keypad Test Mode (Non-Display Radio)

This test mode is used to verify proper operation of all radio buttons and switches if a failure is suspected.

1. Press and hold the **Top Programmable Button**; the LED on the control top lights red, and the radio beeps.
2. Release the **Top Programmable Button**; the radio beeps again.
3. Press the **Top Programmable Button** again; the radio beeps, indicating that the **Top Programmable Button** is in the closed condition.
4. Rotate the **Three-Position Concentric Switch**; the radio beeps in each switch position.
5. Rotate the **Mode/Zone Selector Switch**; the radio beeps in each switch position.
6. Cycle through the **16-Position Programmable Switch**; the radio beeps in each switch position.
7. Rotate the **Volume Control**; the radio beeps at each new volume setting.
8. Press **Side Button 1**; the radio beeps.
9. Press **Side Button 2**; the radio beeps.
10. Press **Side Button 3**; the radio beeps.

Table 9. Receiver Performance Checks

Test Name	System 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 $\leq \pm 1.3$ kHz
Rated Audio	Mode: GEN Output level: 1.0mV RF 4th channel test frequency* Mod: 1 kHz tone at 3 kHz 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 μ V
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 μ V. Preferred SINAD = 5-8dB
*See Table 7 on page 13.				

Table 10. Transmitter Performance Checks

Test Name	System 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 $\leq \pm 1.3$ kHz.
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 1 kHz 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: ≥ 4.1 kHz but ≤ 5.0 kHz
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: ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to a conventional transmit frequency	Conventional coded squelch personality (clear mode operation) 4 TPL	As above	Deviation: ≥ 500 Hz but ≤ 1000 Hz
Talkaround 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 1 kHz Mod Out level for 25mVrms at test set.	Conventional talkaround personality (clear mode operation) 1 CSQ	As above	Deviation: ≥ 4.1 kHz but ≤ 5.0 kHz
*See Table 7 on page 13				

Radio Alignment Procedures

6

Introduction to This Section

This section describes both receiver and transmitter radio alignment procedures.


General

A personal computer (PC) and tuner software are required to align the radio. Refer to the applicable manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC and to a universal test set as shown in Figure 4. Radio Alignment Test Setup on page 11.



Caution

These procedures should only be attempted by qualified service personnel. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

Select **Tuner** from the **START** menu. To read the radio, use the **File** → **Read Device** menu or click on . Figure 5 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

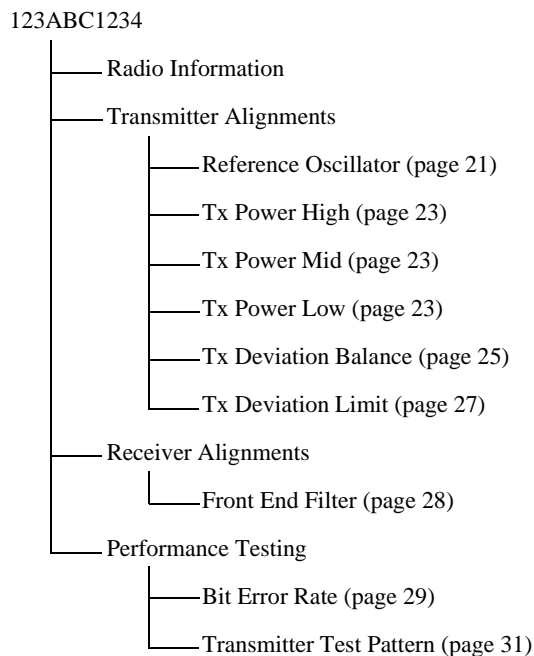


Figure 5. Tuner Menu Layout

The alignment screens introduce the concept of the “softpot,” an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all transceiver alignment controls.



Do **NOT** switch radios in the middle of any Alignment procedure. Always left-click the **Close** button on the screen to return to the **MAIN** menu screen before disconnecting the radio. Improper exits from the Alignment screens may leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

Each alignment screen provides the ability to increase or decrease the softpot value by using a slider or the screen’s UP/DOWN arrow keys (▲ ▼), or by entering the new value from the keyboard. A graphical scale on the display indicates the minimum, maximum, and proposed value of the softpot; see Figure 6.

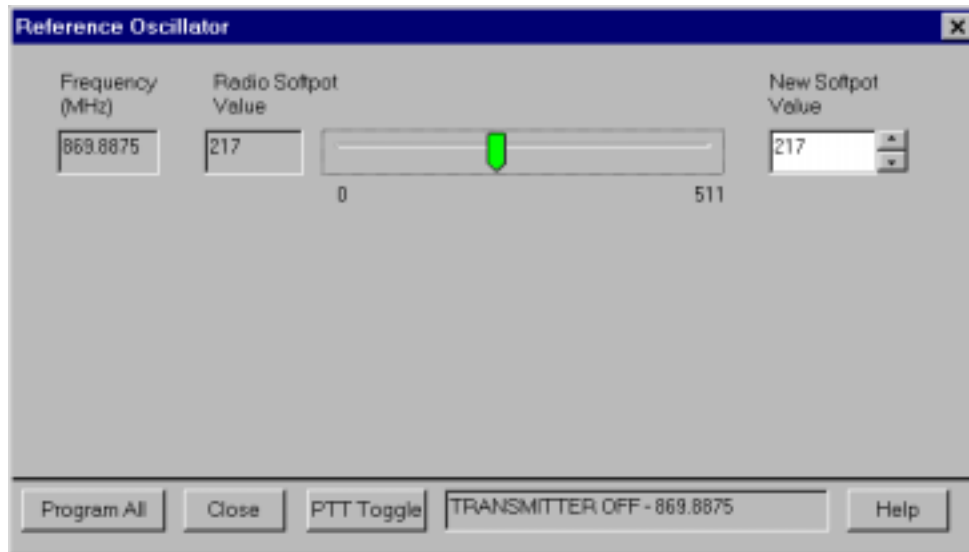


Figure 6. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) a voltage in the corresponding circuit. For example, left-clicking the UP arrow ▲ on the **Reference Oscillator** screen instructs the radio’s microcomputer to increase the voltage across a varactor in the reference oscillator, which increases the frequency.

In **ALL** cases, the softpot value is just a relative number corresponding to a digital-to-analog (D/A) generated voltage in the radio.

Perform the following procedures in the sequence indicated.

NOTE: Some of the following screens may vary depending upon the radio under test and the version of tuner software you are using. Refer to the software’s on-line help.

Radio Information

Figure 7 shows a typical Radio Information screen.

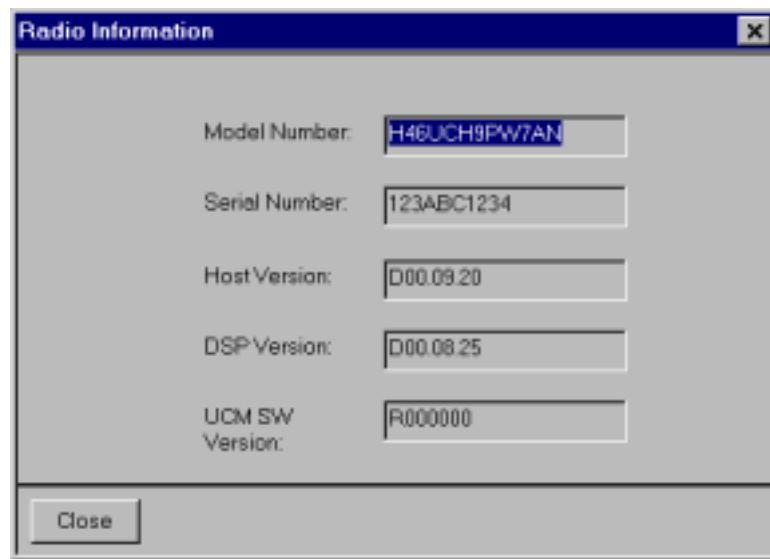


Figure 7. Radio Information Screen

Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will result not only in poor operation, but also in 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, or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

NOTE: Reference oscillator alignment is required after replacing (or servicing) the transceiver board.

This test can be done with either the R-2670 Communication Analyzer or the 8901_Modulation Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
 - RF Control: MONITOR
 - B/W: WB
 - Freq: CPS frequency under test
 - Attenuation: 20dB
 - Mon RF in: RF I/O
 - Meter: RF Display
 - Mode: STD
 - Input Level: uV or W
 - Display: Bar Graphs
 - Squelch: Mid-range or adjust as necessary
- Initial setup using the 8901_ Series Modulation Analyzer:

- Press the green **Automatic Operation** button on the analyzer.
- Press the **FREQ** key.
- Type **7.1** followed by **SPCL** button to set the 8901B_ modulation analyzer for maximum accuracy.

To align the reference oscillator:

1. Select the **Reference Oscillator** alignment screen. See Figure 8.

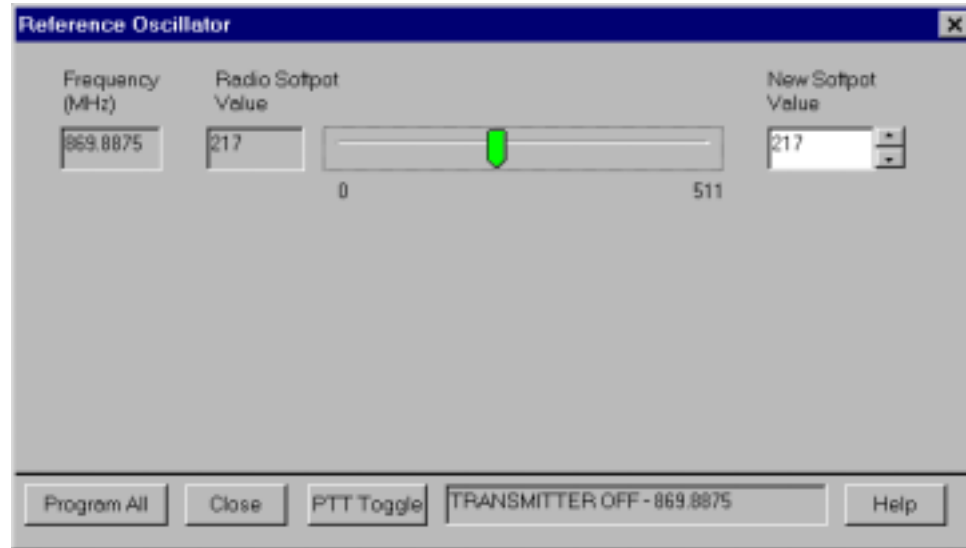


Figure 8. Reference Oscillator Alignment Screen

2. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
3. Measure the transmit RF frequency with your service monitor.
4. Adjust the reference oscillator's softpot value until the measured value is as close as possible to the frequency shown on the screen. See Table 11.

Table 11. Reference Oscillator Alignment

Band	Target
VHF	±100 Hz
UHF R1 (380-470 MHz)	±100 Hz
700 MHz/800 MHz	±100 Hz

5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
6. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

Transmit Power Alignment

This alignment procedure adjusts the transmit power of the radio and must be performed for three different power levels (Low, Mid, High), at multiple frequencies for each power level, to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTES:

- The same softpot attenuation value will result in DIFFERENT radio output power levels at different frequencies.
 - All power measurements are to be made at the antenna port.
 - Transmit Power alignment is required after replacing (or servicing) the transceiver board.
1. Select the **TX Power** alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 9.
 2. Left-click the desired frequency field (starting with the highest frequency shown).
 3. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
 4. Measure the transmit power of the radio with a service monitor.
 5. Adjust the softpot value until the required power, as shown in Table 12, is indicated on the service monitor.

Table 12. Transmit Power Settings

Power Level	Test Frequencies
	700/800 MHz
Low (1 Watt)	1.2 - 1.4W
Mid (2 Watts)	2.5W - 2.7W
High (3 Watts)	3.2W - 3.4W

6. Repeat the above process for all frequencies and all power levels.

7. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

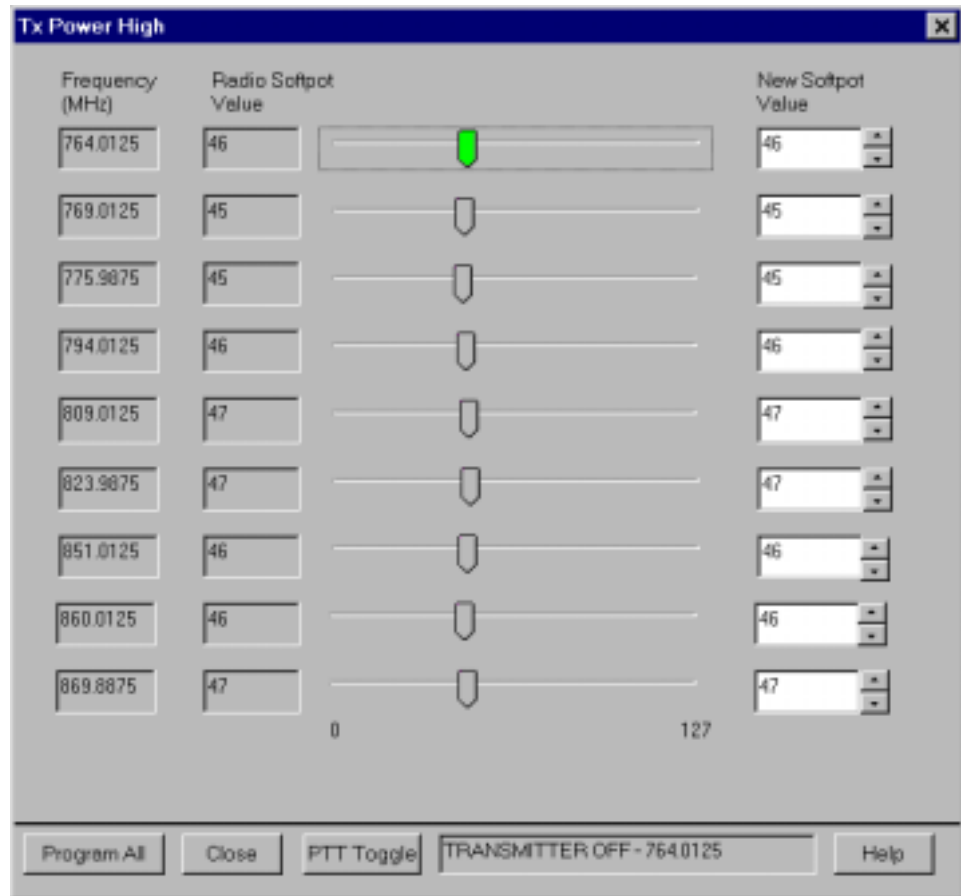


Figure 9. Transmit Power Alignment Screen (Typical)

Transmit Deviation Balance Alignment

This alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal. Proper alignment is critical to the operation of signalling schemes that have very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the VOCON board or the transceiver board.

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. The modulation analyzer settings during this test should be set for average deviation, a 15 kHz low-pass filter, no de-emphasis, and no high-pass filter, if these settings are supported.

This test can be done with either the R-2670 Communication Analyzer or the 8901_ Series Modulation Analyzer. The method of choice is the R-2670 analyzer.

1. Initial setup using the R-2670 Communication Analyzer:
 - Connect a BNC cable between the “DEMOD OUT” port and the “VERT/SINAD DIST/DMM COUNTER IN” port on the R-2670.
 - Press the **SPF** key on the R-2670 to display the “SPECIAL FUNCTIONS MENU.” Move the cursor to “High Pass,” and select 5 Hz on the soft key menu. Select 20 kHz for the “Low Pass” setting.
 - In the “RF Control” section of the R-2670, enter the frequency displayed on the RSS screen. Move the cursor to the “B/W” setting and select “WIDE +/- 100 kHz” on the soft key menu.
 - Place the R-2670 cursor in the “Display” zone. Select “AC VOLTS” on the soft key menu. Move the cursor to the “Range” setting and select “AUTO.”
2. Initial setup using the 8901_ Series Modulation Analyzer:
 - Press the **FM MEASUREMENT** button. (The “Error 03-input level too low” indication is normal until an input signal is applied.)
 - Simultaneously press the **Peak -** and **Peak +** buttons. Both LEDs on the buttons should light.
 - Press the 15 kHz LP filter key.
3. Select the **TX Deviation Balance** alignment screen. The screen indicates the transmit frequencies to be used. See Figure 10.
4. Left-click the desired frequency field (starting with the highest frequency shown).
5. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.

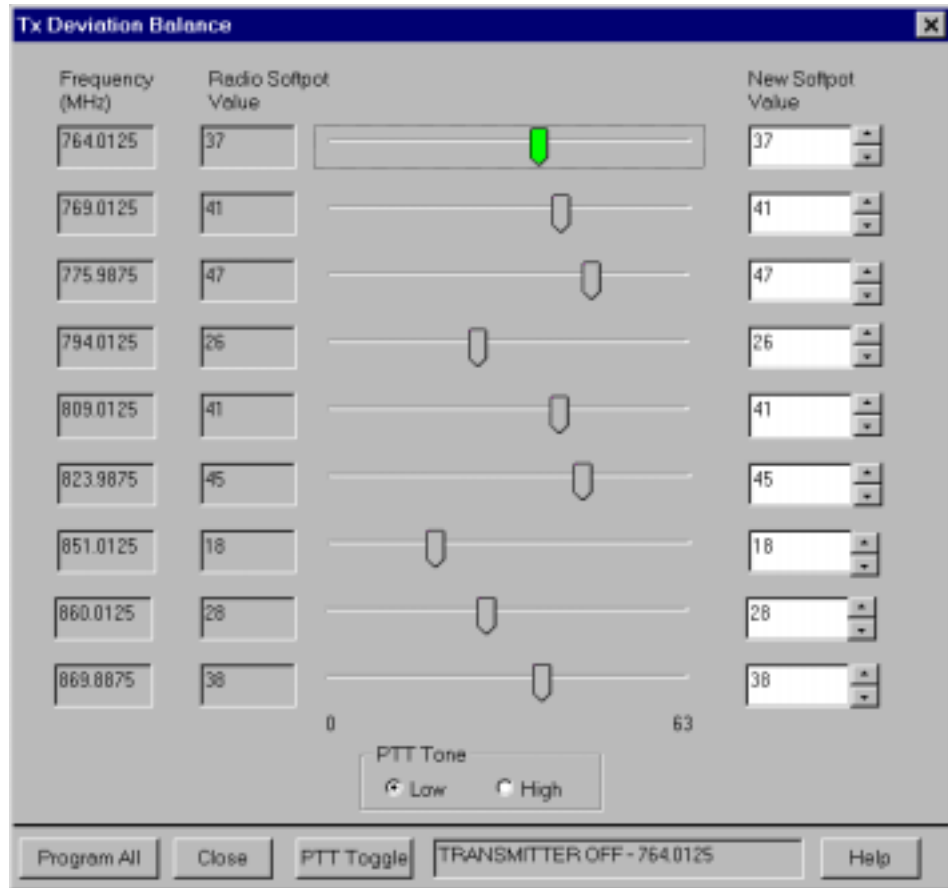


Figure 10. Transmit Deviation Balance Alignment Screen

6. Left-click the **PTT Tone: Low** button.
7. Left-click the **PTT Toggle** button on the screen to enable transmission. The screen indicates whether the radio is transmitting. Wait approximately 5 seconds until the voltage shown on R-2670, or the deviation shown on the 8901_ analyzer, stabilizes.
8. Measure and record the ac voltage value from the R-2670 analyzer or the deviation value from the 8901_ series analyzer.
9. Left-click the **PTT Tone: High** button.
10. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within +/- 1.5% of the value observed when using the low tone.
11. Repeat the above process for all frequencies.
12. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
13. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

Transmit Deviation Limit Alignment

This alignment procedure limits the modulation of a baseband signal. It is used for primary modulation limiting.

This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone.

NOTE: This alignment is required after replacing (or servicing) the VOCON board or the transceiver board.

1. Select the **TX Deviation Limit** alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 11.

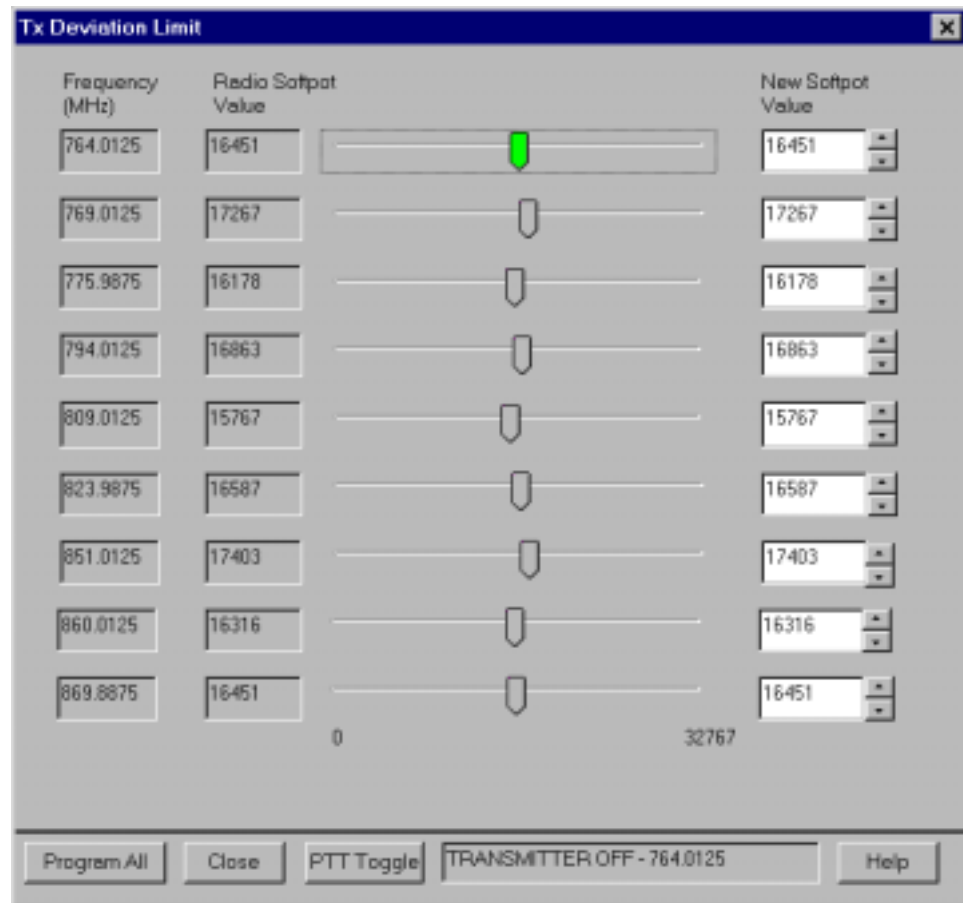


Figure 11. Transmit Deviation Limit Alignment Screen

2. Left-click the desired frequency field (starting with the highest frequency shown).
3. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Measure the transmitted signal deviation of the radio with a service monitor.
5. Adjust softpot value until the measured deviation is as close as possible to 2.83 kHz.
6. Repeat the above process for all frequencies.
7. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

8. Left-click the **Close** button on the screen to return to the **Transmitter Alignments** menu.

Front End Filter Alignment



Caution

Refer to your Radio Service Manual for alignment procedure details. This procedure should only be attempted by qualified service personnel.

Definition

This alignment procedure adjusts the front end receiver bandpass filters for best receiver sensitivity and selectivity. It should be performed for all test frequencies to allow for proper software interpolation for frequencies in between the test frequencies in the band (see Figure 12).

NOTE: Rx Front End Filter Alignment is required after replacing (or servicing) the transceiver board.

Procedure for 700 MHz Frequencies

1. Left-click the desired frequency field.
2. Apply an RF signal with no modulation at -90 dBm on the current operating frequency.
3. Start with a softpot value (approximately 10 or 20), increase softpot in ascending order, and note the RSSI values. The RSSI will reach a peak value and remain stable and then decrease. Allow the limits of the peak range to be defined as RSSI PEAK - 3. Choose the middle of the peak range and program the corresponding softpot value as the tuned softpot value.
4. Repeat the above process for all 700MHz frequencies.
5. Click on the “Program All” button to save the tuned values in the radio.

Procedure for 800 MHz Frequencies

1. Left-click the desired frequency field.
2. Apply an RF signal with no modulation at -90 dBm on the current operating frequency.
3. Start with a softpot value of 50, increase softpot in ascending order, and note the RSSI values. The RSSI will reach a peak value and remain stable and then decrease. Allow the limits of the peak range to be defined as RSSI PEAK - 3. Note the upper end of the peak range and program the corresponding softpot value as the tuned softpot value.
4. Repeat the above process for all 800MHz frequencies.
5. Click on the “Program All” button to save the tuned values in the radio.

Procedure for UHF/VHF

1. Left-click the desired frequency field.
2. Apply an RF signal with no modulation at -90 dBm on the current operating frequency.
3. Adjust the softpot value until the maximum RSSI value is found.
4. Repeat the above process for all frequencies.

Click on the “Program All” button to save the tuned values in the radio.

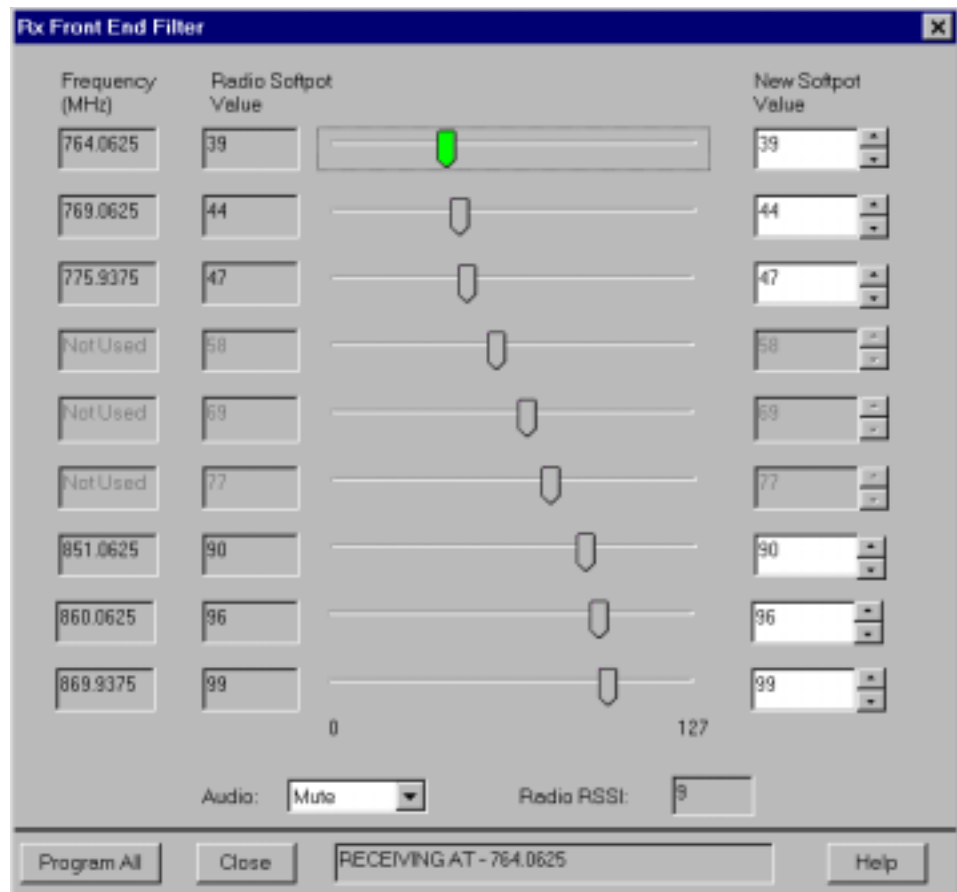


Figure 12. Front End Filter Alignment Screen

Bit Error Rate

Definition

This screen is used to test the Bit Error Rate (BER) of the radio’s receiver at a desired frequency.

Bit Error Rate Fields

This screen contains the following fields:

Rx Frequency:

This field selects the Receive Frequency directly in MHz.

Test Pattern:

This field selects the Digital test pattern — TIA. Choices are: Standard Tone Test Pattern (framed 1011) and Standard Interface Test Pattern (CCITT V.52).

Modulation Type:

This field represents the digital modulation type of the incoming signal on which BER is to be calculated.

Continuous Operation:

This field allows the user to make the BER test repeat indefinitely. A selection of Yes will cause the radio to calculate BER on a continuous basis and update the results on this screen after each integration time. A selection of No will cause the BER test to execute for only one sample of the integration time and then update the display.

Audio:

This field allows the user to select the audio output during a test. Selecting Internal will cause the radio's built-in speaker to unmute to any signals at the desired frequency which are present during the test. Selecting External will route the same signal to the radio's accessory connector audio output. Selecting Mute will disable the audio output.

Integration Time:

This field represents the amount of time over which the Bit Error Rate is to be calculated. The range is from 0.360 to 91.8 seconds in increments of 0.360 seconds.

NOTE: When Continuous Operation = Yes, all fields will be grayed out while test is in progress. They will be enabled when the STOP button is pressed.

When Continuous Operation = No, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.

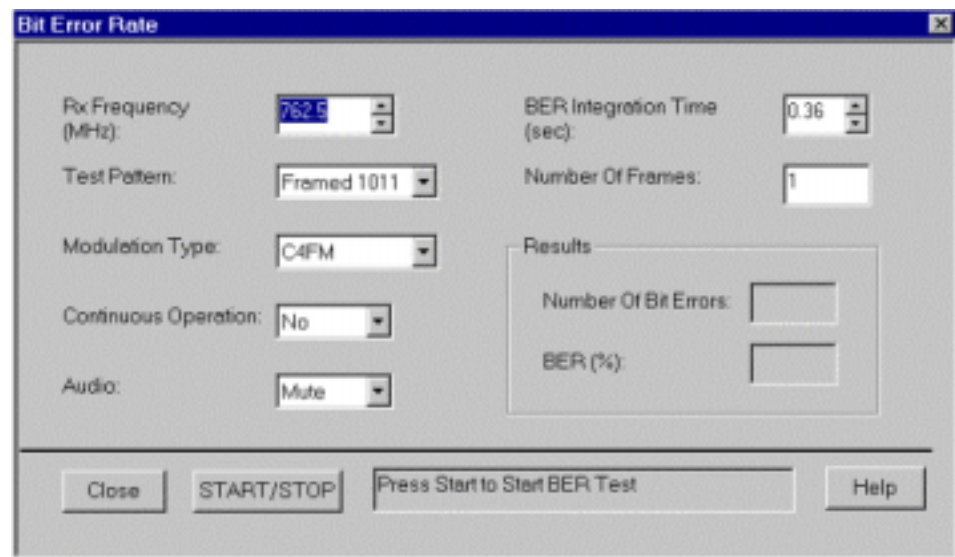


Figure 13. Bit Error Rate Screen

Transmitter Test Pattern

Definition

This screen is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter.

Transmitter Test Fields

This screen contains the following fields:

Tx Frequency:

This field selects the Transmit Frequency directly in MHz.

Channel Spacing:

This field allows the user to select the desired transmit deviation.

Test Pattern Type:

This field represents the type of test pattern which will be transmitted by the radio when "PTT TOGGLE" button is pressed.

NOTE: Channel Spacing and Test Pattern Type fields will be grayed out while radio is transmitting.

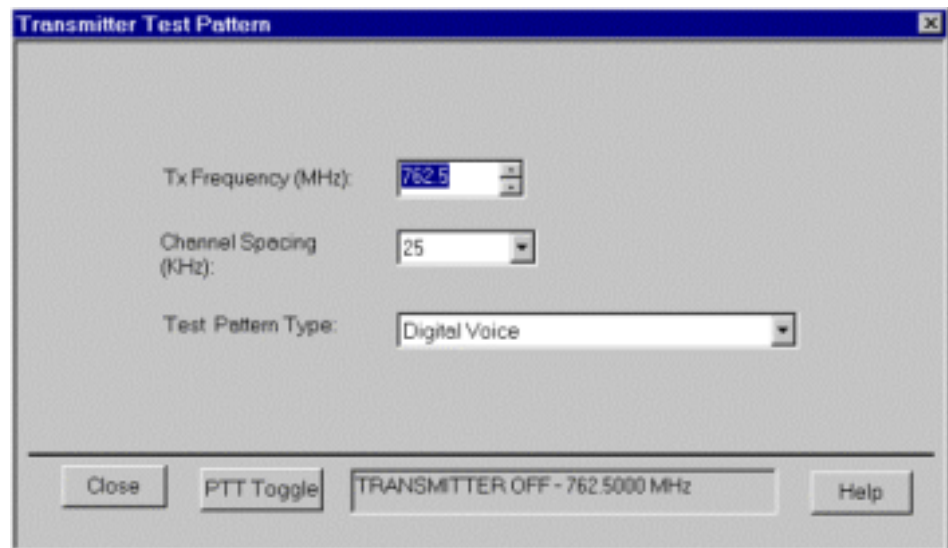
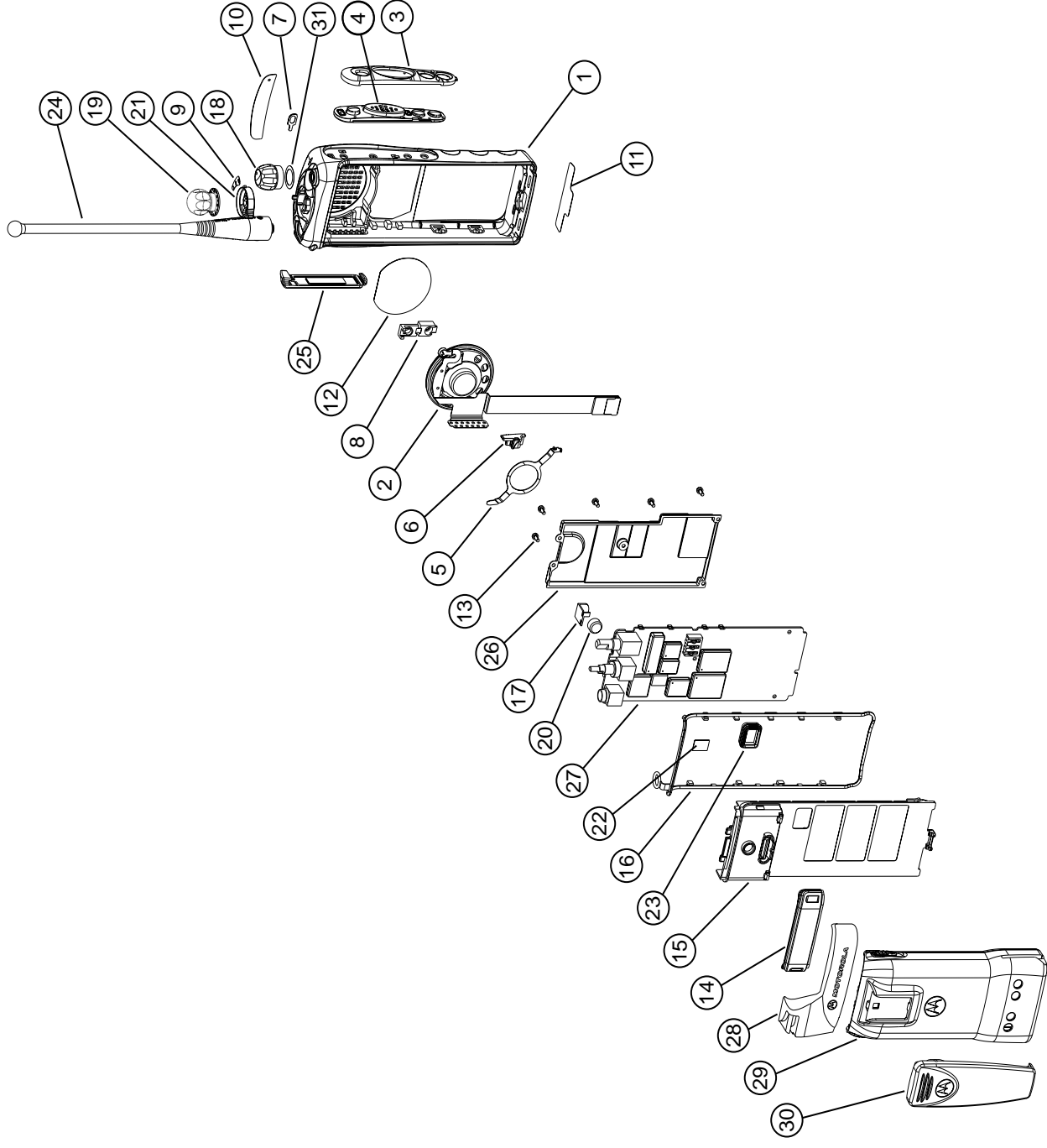


Figure 14. Transmitter Test Pattern Screen

Notes

XTS 2500/XTS 1500/MT 1500 Exploded View and Parts List

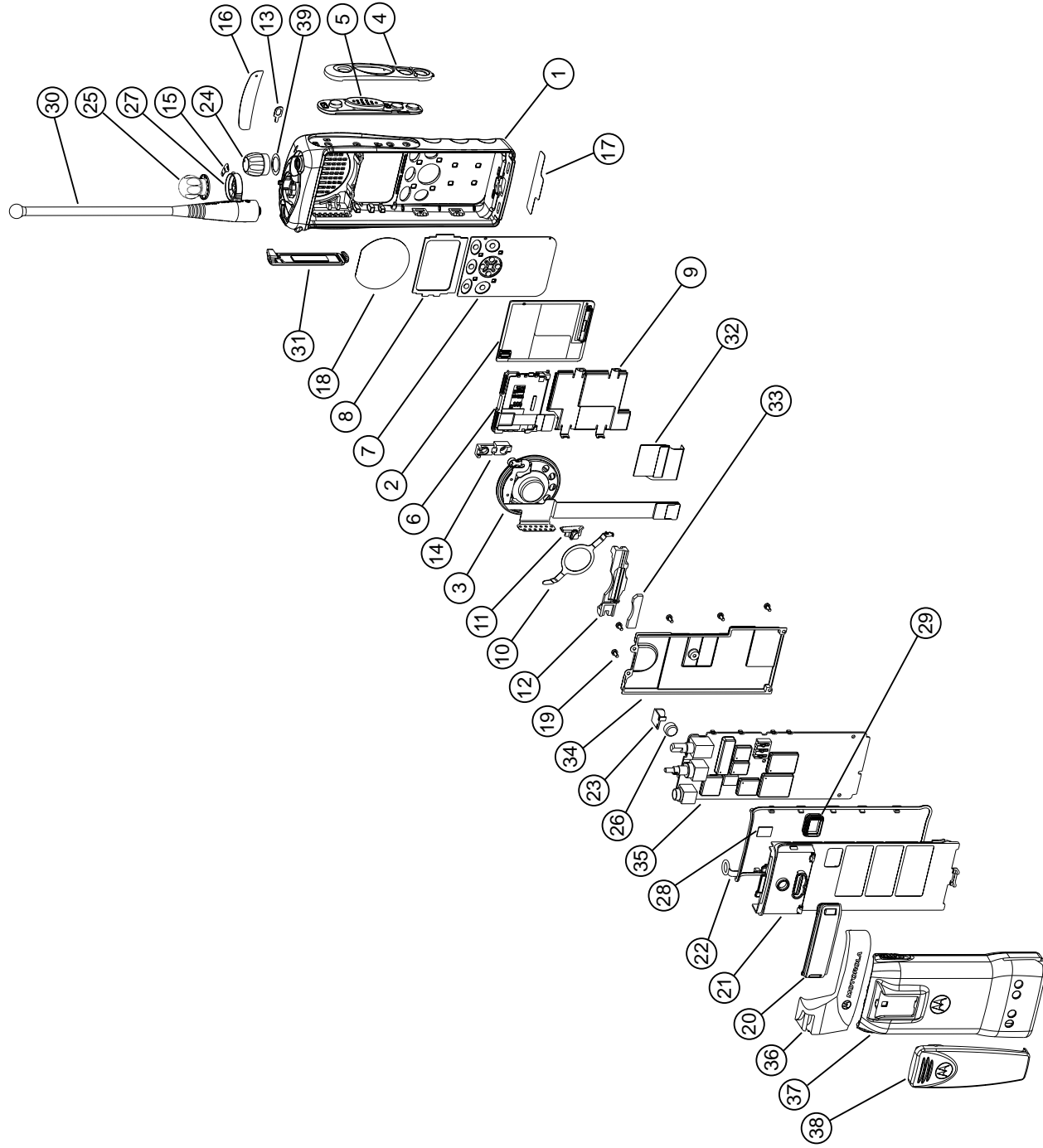


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Table 13. Model I Exploded View Parts List

Item Number	Motorola Part Number	Description	Item Number	Motorola Part Number	Description
1	1585746D01	Cover, Front Assembly Kit (XTS2500)	26	2685785C01	Main Shield
	1585746D04	Cover, Front Assembly Kit (XTS1500/MT1500)	27	Typical	Main Board
2	8485939D01	Assembly, Speaker/Microphone/Universal Connector Flex	28	4385665D01	Adaptor, Remote Speaker Mic.
3	1385149D01	Bezel, PTT	29	Typical	Battery
4	7585959C01	Keypad, PTT/Side Controls	30	Typical	Belt Clip
5	4285446D01	Retainer, Speaker	31	0485667D01	Washer, Teflon
6	4285632D01	Retainer, Microphone Boot			
7	3585469D01	Microphone Felt			
8	1485218D01	Boot, Microphone			
9	1385855C01	Label, ABC			
10	3385466D01	Nameplate, Front (XTS2500)			
	3386597Z01	Nameplate, Front (XTS1500)			
	3386597Z02	Nameplate, Front (MT1500)			
11	3385511D01	Label, Bottom			
12	3585339D01	Speaker Mesh			
13	0385563D01	Screw			
14	1585405D01	Shroud			
15	2785787C01	Chassis Cover, Rear			
16	3285270D01	Seal, Main O-ring			
17	4285633D01	Retaining Clip			
18	3680529Z01	Knob, Volume			
19	3685779C01	Knob, Frequency (W/D-Clip)			
20	6003710K08	Battery, Backup			
21	4585782C01	Lever, Concentric Switch			
22	7585382D01	Pad, Thermal			
23	3280534Z01	Seal, Contact			
24	Typical	Antenna			
25	1505579Z01	Dust Cover, Universal Conn.			

XTS 2500/XTS 1500/MT 1500 Model I Exploded View



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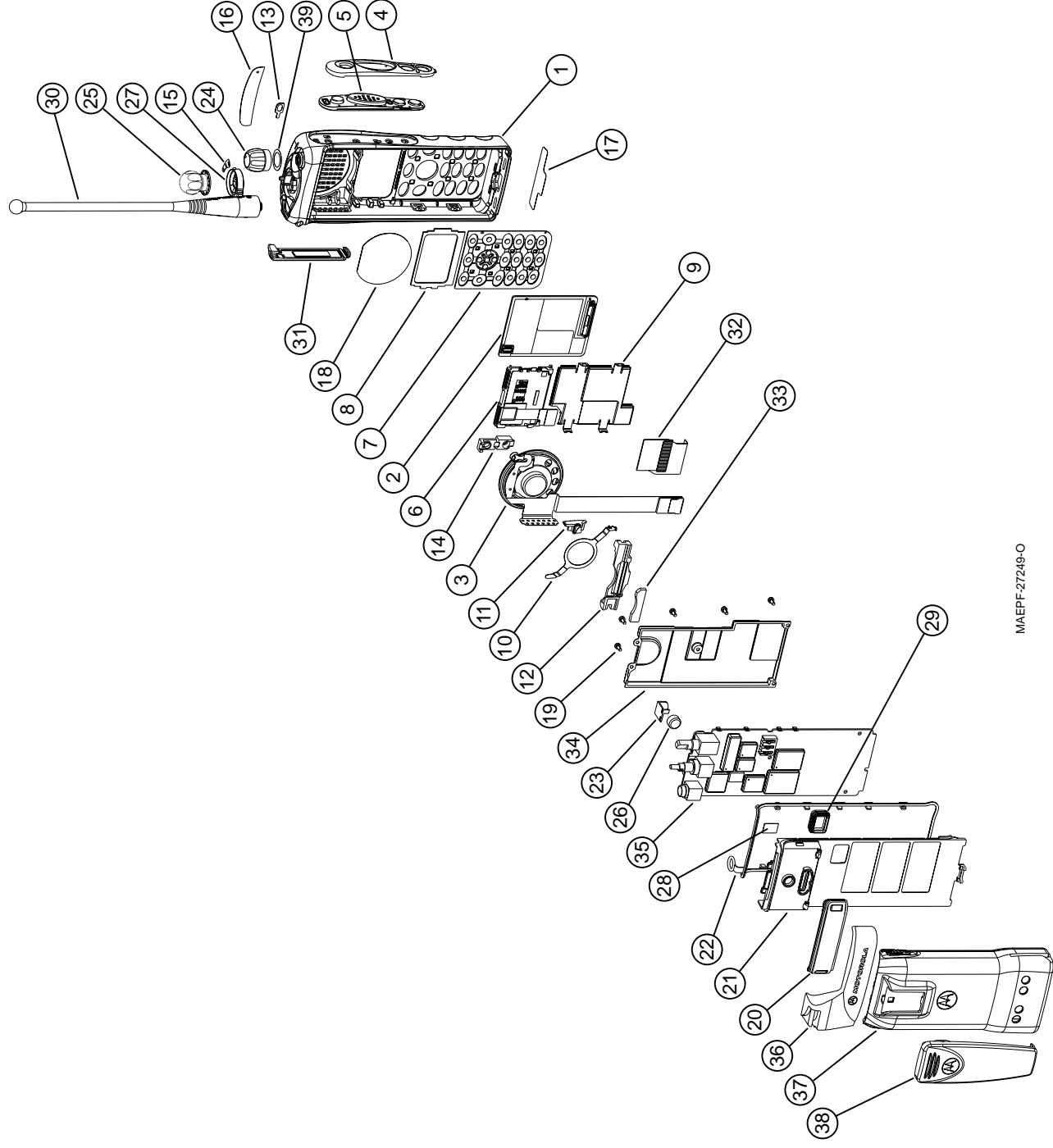
Table 14. Model II Exploded View Parts List

Item Number	Motorola Part Number	Description	Motorola Part Number	Description
1	1585746D02	Cover, Front Assembly Kit	30	Antenna
2	0185947D01	Board, Model II	31	Dust Cover, Universal Conn.
3	8485939D01	Assembly, Speaker/Microphone/Universal Connector Flex	32	Board, Jumper Flex
4	1385149D01	Bezel, PTT	33	Spacer Pad
5	7585959C01	Keypad, PTT/Side Controls	34	Main Shield
6	7285726C01	Display Module	35	Main Board
7	7585776C02	Keypad, Limited	36	Adaptor, Remote Speaker Mic.
8	7585915C01	Pad, Shock LCD	37	Battery
9	4285214D01	Retainer, Keypad	38	Belt Clip
10	4285446D01	Retainer, Speaker	39	Washer, Teflon
11	4285632D01	Retainer, Microphone Boot		
12	4385717D01	Spacer, Plastic		
13	3585469D01	Microphone Felt		
14	1485218D01	Boot, Microphone		
15	1385855C01	Label, ABC		
16	3385466D01	Nameplate, Front		
17	3385511D01	Label, Bottom		
18	3585339D01	Speaker Mesh		
19	0385563D01	Screw		
20	1585405D01	Shroud		
21	2785787C01	Chassis Cover, Rear		
22	3285270D01	Seal, Main O-ring		
23	4285633D01	Retaining Clip		
24	3680529Z01	Knob, Volume		
25	3685779C01	Knob, Frequency (W/D-Clip)		
26	6003710K08	Battery, Backup		
27	4585782C01	Lever, Concentric Switch		
28	7585382D01	Pad, Thermal		
29	3280534Z01	Seal, Contact		

XTS 2500 Model II Exploded View

Table 15. Model III Exploded View Parts List

Item Number	Motorola Part Number	Description	Item Number	Motorola Part Number	Description
1	1585746D03	Cover, Front Assembly Kit	30	Typical	Antenna
2	0185948D01	Keypad Board, Model III	31	1505579Z01	Dust Cover, Universal Conn.
3	8485939D01	Assembly, Speaker/Microphone/Universal Connector Flex	32	8485268D01	Board, Jumper Flex
4	1385149D01	Bezel, PTT	33	7585737D01	Spacer Pad
5	7585959C01	Keypad, PTT/Side Controls	34	2685785C01	Main Shield
6	7285726C01	Display Module	35	Typical	Main Board
7	7585776C01	Keypad, Full	36	4385665D01	Adaptor, Remote Speaker Mic.
8	7585915C01	Pad, Shock LCD	37	Typical	Battery
9	4285214D01	Retainer, Keypad	38	Typical	Belt Clip
10	4285444D01	Retainer, Speaker	39	0485667D01	Washer, Teflon
11	4285632D01	Retainer, Microphone Boot			
12	4385717D01	Spacer, Plastic			
13	3585469D01	Microphone Felt			
14	1485218D01	Boot, Microphone			
15	1385855C01	Label, ABC			
16	3385466D01	Nameplate, Front			
17	3385511D01	Label, Bottom			
18	3585339D01	Speaker Mesh			
19	0385563D01	Screw			
20	1585405D01	Shroud			
21	2785787C01	Chassis Cover, Rear			
22	3285270D01	Seal, Main O-ring			
23	4285633D01	Retaining Clip			
24	3680529Z01	Knob, Volume			
25	3685779C01	Knob, Frequency (W/D-Clip)			
26	6003710K08	Battery, Backup			
27	4585782C01	Lever, Concentric Switch			
28	7585382D01	Pad, Thermal			
29	3280534Z01	Seal, Contact			



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XTS 2500 Model III Exploded View

Introduction to This Section

This section contains basic procedures for removing and installing the following components of the XTS 2500 radio:

- Antenna
- Battery
- Belt Clip
- Universal Connector Cover
- Remote Speaker Microphone Adapter
- Radio Disassembly—Detailed
- Radio Reassembly—Detailed

Antenna

Attach the Antenna

With the radio off, turn the antenna clockwise to attach it.

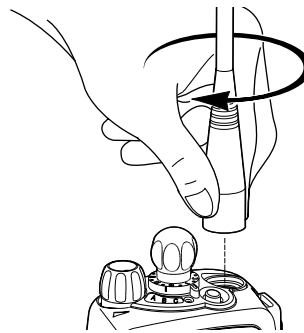


Figure 15. Attaching the Antenna

Remove the Antenna

With the radio off, turn the antenna counter-clockwise to remove it.

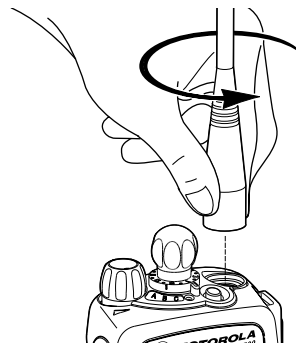


Figure 16. Removing the Antenna

Battery

Attach the Battery

1. With the radio off, fit the three extensions at the bottom of the battery into the bottom slots on the radio.

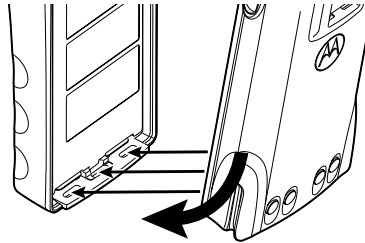


Figure 17. Step 1, Attaching the Battery

2. Press the top of the battery against the radio until both latches click into place.

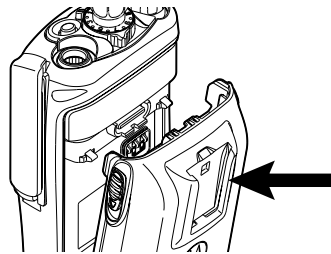


Figure 18. Step 2, Attaching the Battery

Remove the Battery

1. With the radio off, slide down the latches on the sides of the battery.

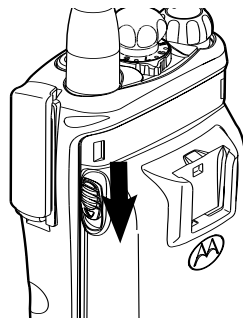


Figure 19. Step 1, Removing the Battery

2. Pull the top of the battery away from the radio.

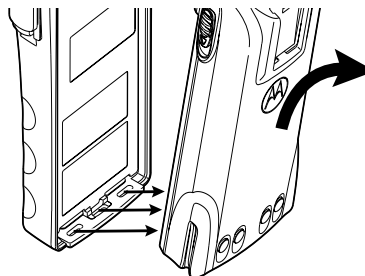


Figure 20. Step 2, Removing the Battery

Belt Clip

- Attach the Belt Clip
1. Align the grooves of the belt clip with those of the battery.

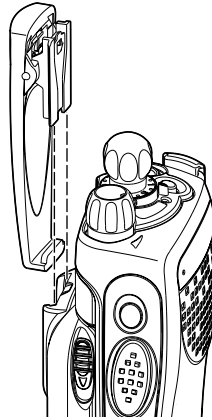


Figure 21. Attaching the Belt Clip

2. Press the belt clip downward until you hear a “click.”

Remove the Belt Clip

1. Use a flat-bladed object to press the belt clip tab away from the battery.

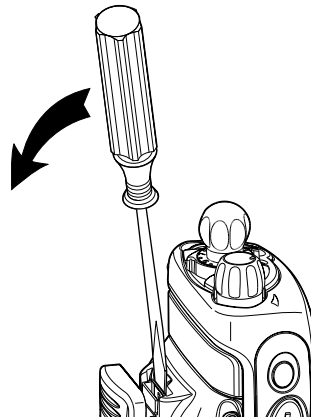


Figure 22. Removing the Belt Clip

2. Slide the belt clip upward to remove it.

Universal Connector Cover

The universal connector cover is located on the antenna side of the radio. It is used to cover the connector when not in use.

NOTE: To prevent damage to the connector, shield it with the connector cover when not in use.

Remove the Universal Connector Cover

1. Insert a flat-blade screwdriver into the area between the bottom of the cover and the slot below the connector.

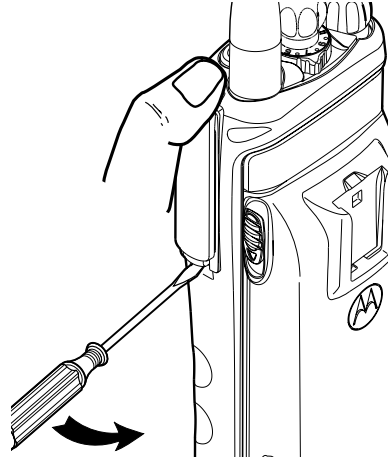


Figure 23. Removing the Universal Connector Cover

2. Hold the top of the cover with your thumb while you pry the bottom of the cover away from the radio with the screwdriver.

Attach the Universal Connector Cover

1. Insert the, hooked end of the cover into the top of the connector.

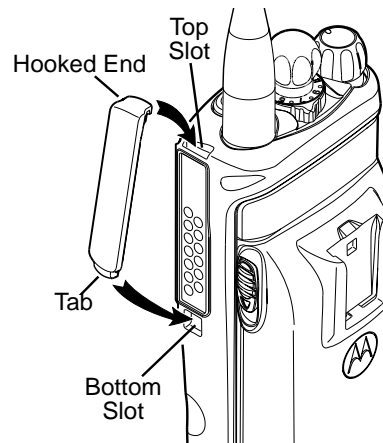


Figure 24. Attaching the Universal Connector Cover

2. Press downward on the top of the cover to seat it into the slot.
3. Press the lower tab of the cover below the connector until it snaps in place.

Remote Speaker Microphone Adapter

The Remote Speaker Microphone (RSM) adapter is located on the back of the radio, just above the battery. **It must be used to connect the RSM to the radio. If the RSM is not used, the adapter must be removed.**

Remove the Adapter

Lift the larger side (below the antenna port) of the adapter away from the radio using your finger.

If you cannot easily remove the adapter with your finger, use a small, flat bladed screwdriver to pry the larger end side of the adapter away from the radio.

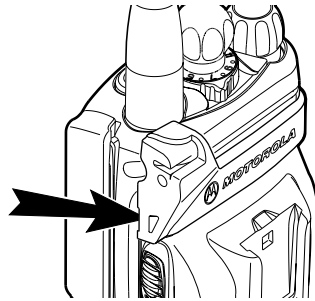


Figure 25. Removing the RSM Adapter

Attach the Adapter

1. With the Motorola side of the adapter facing out, snap the smaller end of the adapter into place in the shroud indent, below the On/Off Volume Control Knob.

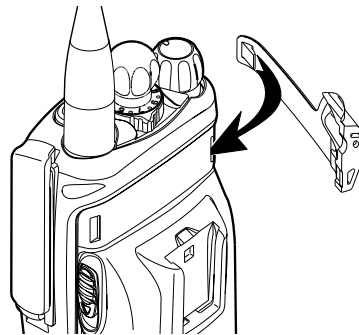


Figure 26. Step 1, Attaching the RSM Adapter

2. Snap the larger end of the adapter into place in the shroud indent, below the antenna port.

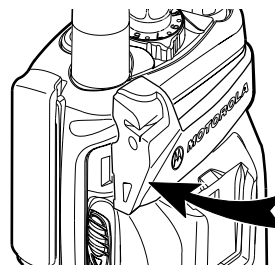


Figure 27. Step 2, Attaching the RSM Adapter

Radio Disassembly— Detailed

When disassembling and reassembling the radio, pay particular attention to the snaps and tabs and how parts align with each other.

The following steps describe how to disassemble the radio. This includes the following major components:

- Front Cover
- Chassis
- Backup Battery
- Keypad
- Keypad/option board
- Display
- Speaker, microphone, universal flex connector
- PTT

Required Tools

- Small, flat-bladed screwdriver
- TORX™ T7-IP screwdriver
- Chassis Opener/Knob removal tool (Motorola part number 6685666D01)

Front Cover from Chassis Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio.

Table 16. Front Cover from Chassis Disassembly

Exploded View Item Number	Motorola Part Number	Description
1	1585746D03	Cover, Front Assembly Kit
3	8485939D01	Assembly Speaker/Microphone/Universal Connector Flex
21	2785787C01	Chassis Cover, Rear
24	3680529Z01	Knob, Volume
25	3685779C01	Knob, Frequency (16-Position Select)
27	4585782C01	Lever, Concentric Switch
30	Typical	Antenna
32	8485268D01	Board, Jumper Flex
37	Typical	Battery
39	0485667D01	Washer, Teflon

1. Turn off the radio.
2. Remove the battery completely from the radio (see Figure 19 and Figure 20 on page 38).
3. Remove the antenna (see Figure 16 on page 37).

- Pull the **16-Position Select** and the **On/Off/Volume Control** knobs off their shafts using the Chassis Opener tool.

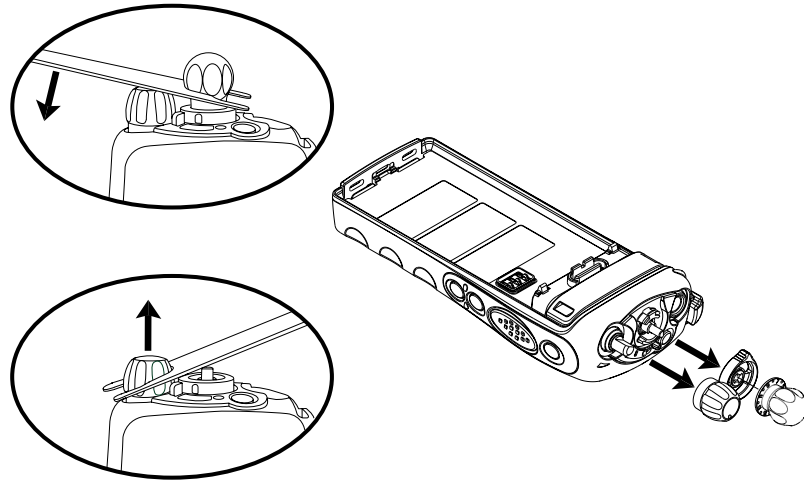


Figure 28. Knob Removal

- After you remove the **On/Off/Volume Control** knob, remove the Teflon® washer and set it aside.
- Separate the chassis from the front cover by inserting the chassis opener between the thin, plastic retaining wall and the metal chassis at the bottom of the radio.



Be careful not to mar the O-ring sealing area on the housing. Marring the front cover O-ring sealing areas will prevent the radio from sealing properly.

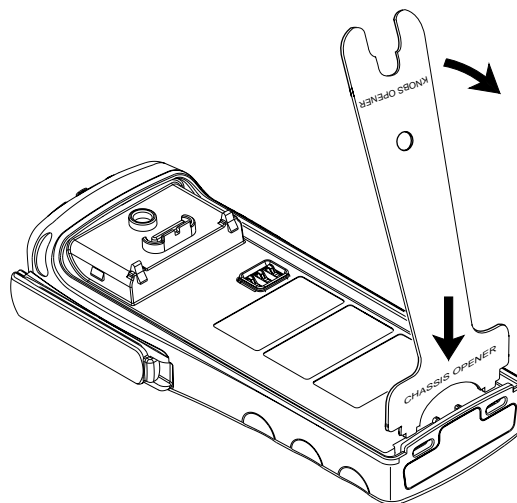


Figure 29. Chassis Removal

7. Slowly pry the bottom of the chassis away from the front cover by pushing the chassis opener tool down. Rotate the handle of the tool over and behind the base of the radio. This prying action forces the thin inner plastic wall toward the base of the radio, releasing the two chassis tabs.
8. Remove the chassis assembly by holding the chassis in one hand while **slowly**, with a firm side-to-side motion, removing the chassis.



The chassis assembly has switches that can be damaged if the chassis is removed too quickly. Be careful not to damage the switches at the top of the board.

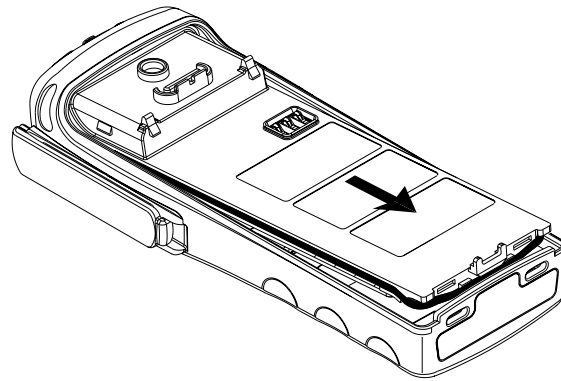


Figure 30. Chassis Separation

9. Lay the chassis down. Rotate the front cover backward and slightly away from the chassis.



Flexible ribbon circuits (flexes) connecting the front cover assembly and the chassis prevent you from completely separating the two units. Display radios and radios with option boards have two flexes.

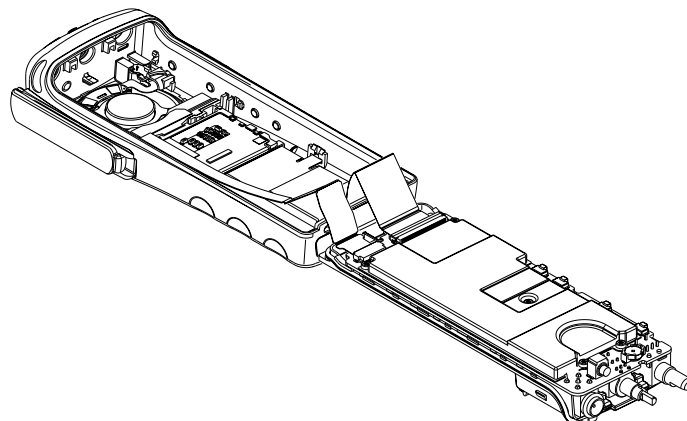


Figure 31. Unlatching the Flex Connectors

10. Carefully lift the latches on the main circuit board to release the flexible circuits from their connectors.

NOTE: For proper reassembly, note how the flex circuits are folded.

11. Remove the concentric lever from the front cover assembly.

Chassis Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio.

Table 17. Chassis Disassembly

Exploded View Item Number	Motorola Part Number	Description
19	0385563D01	Screw (5 required)
21	2785787C01	Chassis Cover, Rear
22	3285270D01	Seal, Main O-ring
34	2685785C01	Main Shield
35	Typical	Main Board

1. If disassembly of the chassis or the main board is required, then use a TORX™ screwdriver with a T7-IP head to remove the five screws holding the main board and shield to the chassis.



Caution

Refer to the Handling Precautions on page 4 before removing the main board. Be sure to use ESD protection when handling circuit boards.

2. Remove the O-ring from around the bushing at the antenna connector
3. Lift the main board from the chassis as shown in Figure 32.

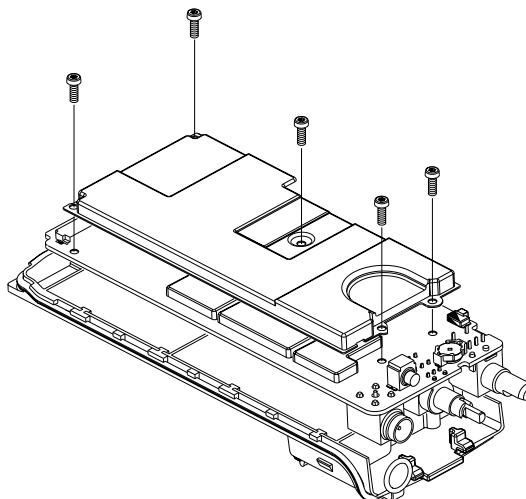


Figure 32. Removing the Main Board from the Chassis

4. Most repairs to the main board can be performed without further disassembly of the chassis. If it is necessary to replace the O-ring, remove the small O-ring retainers from their slots in the chassis. Note the alignment of the retainers for reassembly.
5. Remove the O-ring.

Backup Battery Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio.

Table 18. Backup Battery Disassembly

Exploded View Item Number	Motorola Part Number	Description
23	4285633D01	Retaining Clip
26	6003710K08	Battery, Backup

1. The backup battery can be removed without disassembling the board or the chassis.
2. Remove the backup battery retaining clip by sliding it away from the main circuit board, as shown in Figure 33.
3. Insert a small, flat head screwdriver between the battery and the battery holder. Gently pry the battery out of the battery holder.

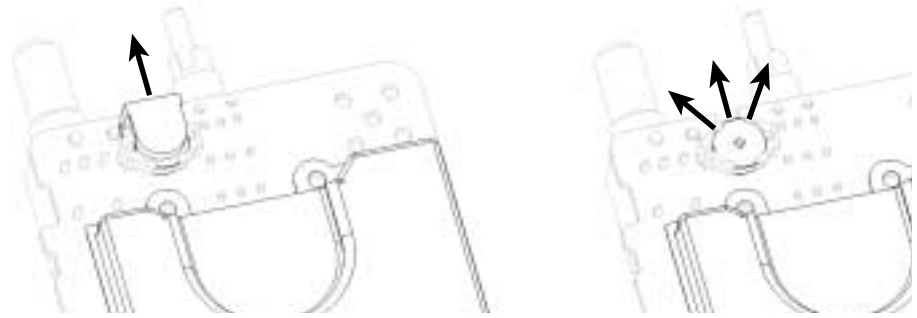


Figure 33. Remove the Backup Battery

Keypad and Keypad/Option Board Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio. (For the Model II keypad, please refer to the exploded view and parts list on page 34.)

Table 19. Keypad and Keypad/Option Board

Exploded View Item Number	Motorola Part Number	Description
2	0185948D01	Keypad Board, Model III
3	8485939D01	Assembly Speaker/Microphone/Universal Connector Flex
6	7285726C01	Display Module
7	7585776C01	Keypad, Full (for Model III only)
9	4285214D01	Retainer, Keypad
22	3285270D01	Seal, Main O-ring

1. The keypad and keypad board can be disassembled without the disassembly of the display or speaker/microphone flex assembly.
2. If the disassembly of the keypad or the keypad printed circuit board is required, lift the microphone flex circuit up to move it out of the way.
3. Disconnect the display connector, and move the tail of flex circuit out of the way.
4. To remove the keypad retainer shield, insert the tip of a “penknife size,” flat-bladed screwdriver in the opening at the end of the keypad retainer arm tab. Pry the tab away from the side of the front cover until it moves past the ledges on the side wall. Repeat this procedure for the four remaining retainer arm tabs.



Be careful not to mar the O-ring sealing area on the housing. Marring the front cover O-ring sealing areas will prevent the radio from sealing properly.

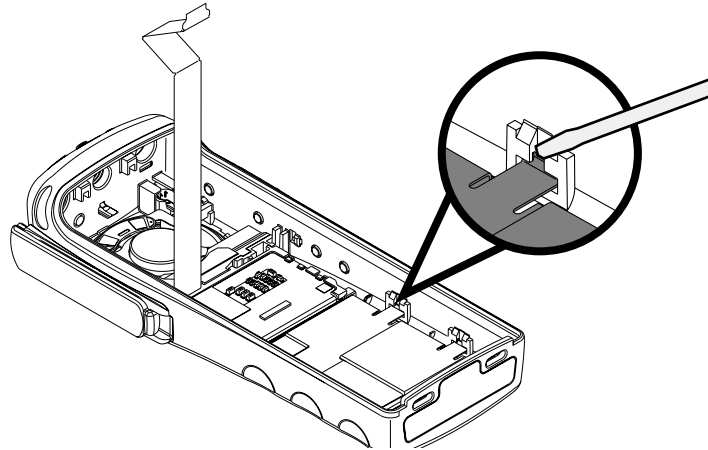


Figure 34. Retainer Removal

5. Lift the keypad retainer out of the front cover.
6. The keypad/option board and the keypad can be removed without the use of tools.

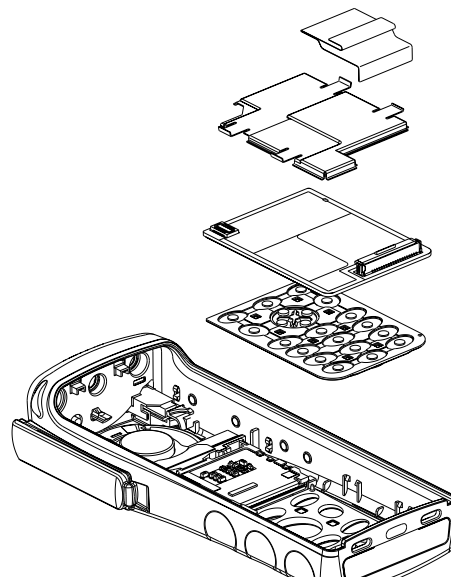


Figure 35. Keypad Retainer and Boards Removal

Display Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio. (For the Model II display, please refer to the exploded view and parts list on page 34.)

Table 20. Display Disassembly

Exploded View Item Number	Motorola Part Number	Description
1	1585746D03	Cover, Front Assembly Kit (Model III)
2	0185948D01	Keypad Board, Model III
6	7285726C01	Display Module
9	4285214D01	Retainer, Keypad

1. The display assembly can be removed without the disassembly of the keypad board or the speaker-microphone flex assembly. If the disassembly involves the removal of the display module, disconnect the display flex from the keypad option board connector.



Caution

Take care not to damage the display. Do not cut, bend, or pinch the heat seal. Display modules contain CMOS devices. Be sure to use ESD protection.

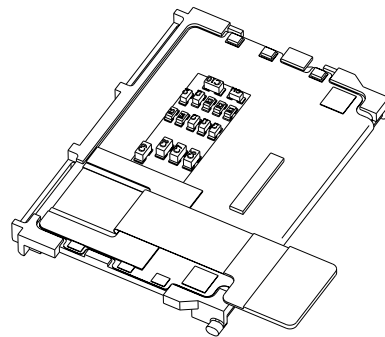


Figure 36. Display Disassembly

2. The display module snaps into the front cover assembly. Insert two flat-bladed screwdrivers between the flexible beam at the top of the display module (one on each side). Deflect the beam down until it moves past the hooks on the front cover. The display module is hooked to the front cover at the base of the display. Lift the top of the display module past the hooks and remove it from the front cover.

Speaker, Microphone, and Universal Connector Flex Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio.

Table 21. Speaker, Microphone, and Universal connector Flex Disassembly

Exploded View Item Number	Motorola Part Number	Description
1	1585746D03	Cover, Front Assembly Kit
3	8485939D01	Assembly Speaker/Microphone/Universal Connector Flex
10	4285446D01	Retainer, Speaker
11	4285632D01	Retainer, Microphone Boot
12	4385717D01	Spacer, Plastic
14	1485218D01	Boot, Microphone

1. The speaker-microphone assembly can be removed without the disassembly of the display or the keypad assemblies. If disassembly of the speaker-microphone assembly is necessary, removal of the universal connector dust cover is optional (see Figure 23 on page 40).
2. Remove the plastic spacer at the bottom of the speaker. The spacer can be removed by pulling upward with a slight, side-to-side motion until it clears the retaining ribs in the front cover. Take special care to prevent damage to the tail of the speaker flex circuit while the flex is still in place.
3. Using a screwdriver, push down on the portion of the speaker retainer bracket that is pointing toward the bottom of the radio. Then, remove the retainer by slightly pushing it toward the top of the radio until you slide it past the front cover slot.
4. Remove the microphone boot retainer by inserting a penknife-sized screwdriver in the notch between the retainer and the housing. Pry the retainer away from the housing and remove the clip.
5. Remove the microphone rubber boot by sliding it out of the pocket in the front cover. Take care not to pull on the flex cable while pulling on the microphone boot. Unless you are replacing the microphone, leave it in the boot. At this point, the speaker and microphone are disconnected, but the assembly is still attached to the universal connector by 13 pins in the printed circuit backer board.
6. To remove the speaker-microphone flex circuit from the universal connector, carefully grasp the flex circuit at a point directly across from the universal connector pins. Applying firm pressure, gradually pull the flex away from the pins.

NOTE: There are notches on the ends of the 13-pin printed circuit backer board. If necessary, you can insert a small screwdriver in one of the notches to pry the backer board away from the front cover.

After the universal connector portion of the speaker-microphone flex circuit is detached, the assembly can be completely removed. If it is necessary to replace the speaker or the microphone, or both, do it while the flex circuit is removed from the front cover.

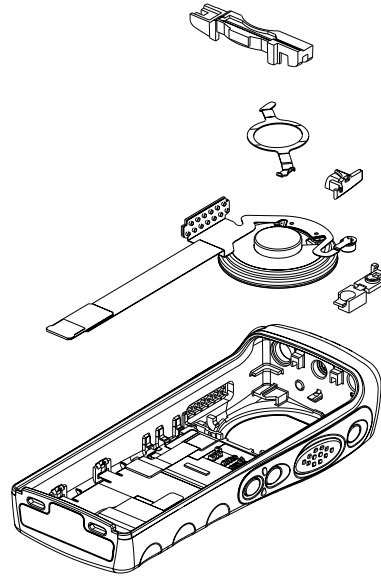


Figure 37. Speaker-Microphone Removal

PTT Disassembly

For this section, please refer to the Model III exploded view and parts list on page 35 for part numbers and more information on the location of parts in the radio.

Table 22. PTT Disassembly

Exploded View Item Number	Motorola Part Number	Description
1	1585746D03	Cover, Front Assembly Kit
4	1385149D01	Bezel, PTT
5	7585959C01	Keypad, PTT/Side Controls

1. If required, the PTT bezel and the PTT seal assembly can be disassembled using a small screwdriver.
2. Remove the PTT bezel by pushing the snaps out at the top and pulling the bezel up toward the top of the front cover so that the T-tab slides up and out.
3. The PTT seal can be easily lifted from the bezel without the use of tools.

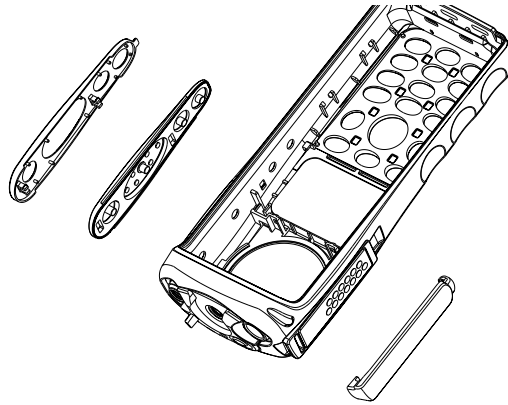


Figure 38. PTT Removal

Radio Reassembly— Detailed

The following steps describe how to reassemble the radio. This includes the following major components:

- PTT
- Keypad/option board
- Display
- Speaker, microphone, universal connector flex
- Chassis
- Backup Battery
- Chassis and front cover

PTT Reassembly

1. Put the PTT seal in the PTT bezel.
2. Align the PTT bezel and seal to the front cover housing so that the bottom tabs will engage with the opening in the front cover.
3. Slide the PTT bezel down so that the T-tab engages into the front cover opening.
4. Snap the top snaps.

NOTE: Look inside the front cover to be sure the T-tab and snaps are fully engaged with the front cover.

Keypad and Keypad Option Board Reassembly

1. Insert the keypad into the front cover. Align the keypad to the pins in the front cover.
2. Replace the board on the locator pins.
3. Replace the keypad retainer legs on the PTT side first. Then, press the retainer down and snap the other two legs into place on the universal connector side; make sure that all four legs snap into place. If necessary, use a small, flat-bladed screwdriver to put pressure on the corner bend of each retainer leg.

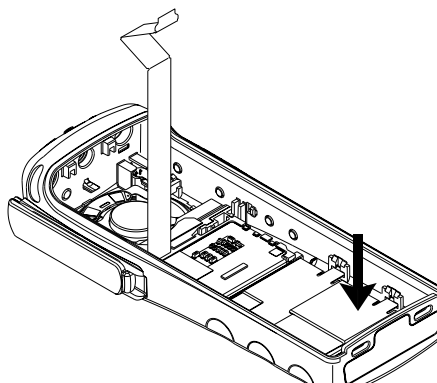


Figure 39. Lock Retainer Catches to Radio Body

Display Reassembly

1. Slide the two bottom tabs of the display module, with the LCD facing the front housing lens, into the grooves located above the keypad assembly area in the front cover housing. Gently press on the upper portion of the display until it snaps into place past the two small hooks in the housing.
2. Connect the display flex to the keypad option board connector.

Speaker, Microphone, and Universal Connector Flex Reassembly

1. Insert the microphone boot into the pocket in the front cover housing.
2. Insert the microphone boot plastic retainer. Make sure the retainer is securely hooked to the front cover.
3. Center the speaker in the speaker recess. Make certain the speaker is correctly nested inside the front cover.
4. Before you replace the speaker retainer, be sure the retainer is placed between the speaker-microphone flex circuit and the speaker. Insert the flat end of the speaker retainer into the opening in the front cover. Press the other end of the retainer against the speaker. Hold the retainer in place with your thumb while pushing down on the retainer with a flat-bladed screwdriver. Use the screwdriver to push down on the portion of the speaker retainer that is pointing toward the bottom of the radio. Move the retainer by pushing it toward the bottom of the radio. Slide it into the front cover slot above the display.
5. Connect the universal flex to the pins and press into place.

Chassis Assembly Reassembly

Before you assemble the main board to the chassis, make sure that the following steps are done to the chassis.

1. Replace the O-ring. The tabs on the O-ring should reach into the chassis and point down.
2. Stretch the O-ring to place it into the retaining pocket at the bottom end of the chassis.

NOTE: When properly assembled, the retainers on the O-ring should align with the slots on the chassis. If this is not the case, remove and replace the O-ring until it is aligned with the chassis and completely seated in place around the perimeter.

3. Replace the battery contact seal (if necessary) surrounding the battery contact.

NOTE: Be sure the battery contact seal protrudes through the chassis and is not pinched under the chassis.

4. Make sure the thermal pad is placed on top of the RF Power Amplifier on the main board.
5. Use the notch in the bottom of the main board and the protrusion at the bottom of the casting to align the board to the casting. Place the board against the casting. Make sure that the five screw holes are aligned.
6. Place the main shield assembly on the main board. Again, make sure that the five screw holes are aligned.
7. Use the TORX T7-IP screwdriver to fasten the screws holding the main board and shield to the chassis. Do not over torque. Torque limit is 4 inch-lbs.
8. Place the O-ring at the antenna connector over the antenna connector bushing.

Backup Battery Reassembly

1. Insert the backup battery (positive side up) into the battery holder, as shown in Figure 40.
2. Replace the retaining clip by sliding it into its recess on the board.



Figure 40. Reassemble the Backup Battery

Chassis and Front Cover Reassembly

1. Align the chassis assembly end-to-end with the front cover assembly.
2. Insert the tails of the flex circuits into their respective connectors at the bottom of the

chassis assembly.

3. Push down the latches on the connectors to hold the flex circuits to the main board.

NOTE: Be sure the concentric lever is not in place on the frequency knob shaft when reassembling the chassis with the front cover assembly.

4. Align the volume knob shaft and the frequency switch shaft with their respective holes in the front cover. Slowly reassemble the chassis and front cover assemblies. Slowly slide the volume knob and frequency switch shafts into their respective holes in the front cover.

NOTE: Make sure the flex circuits are correctly folded in place. Take special care to prevent pinching or excess binding of these flexes.

5. Push the chassis assembly completely into the top of the front cover until it settles in place.

NOTE: Be sure the O-ring is properly seated.

6. Press down at the bottom of the chassis until the chassis snaps into place in the front cover.

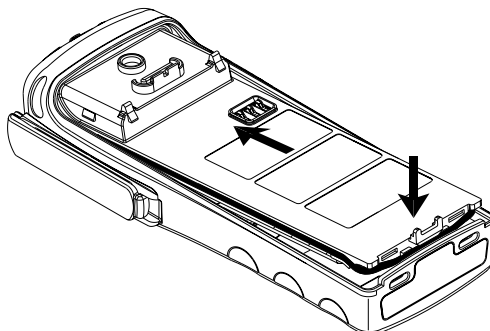


Figure 41. Fastening the Chassis

7. Reassemble the concentric lever to the frequency knob shaft by aligning the protrusions in the lever with the openings in the shaft. The triangular-shaped side of the lever should point toward the back of the radio.
8. Reassemble the Teflon washer to the volume knob shaft. Reassemble the knobs, dust cover, antenna, and battery.

Notes

Radio-Level Troubleshooting

9

Introduction to This Section

This section of the manual contains troubleshooting charts and error codes that will help you to isolate problems. Level one troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement. If the radio needs further troubleshooting, it must be sent to the depot.

Board-level, component-level, and service information can be found in the *ASTRO Digital XTS 2500 Portable Radios Detailed Service Manual*, Motorola publication number 68P81094C10.

Power-Up Error Codes

When the radio is turned on (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's display. For non-display radios, the problem is indicated at power-up by a single, low-frequency tone. If cycling power and code plug reprogramming do not fix the error, the radio should be sent to the depot for repair. The presence of an error 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; non-fatal errors will not. Table 23. lists their descriptions and suggested corrective action.

Table 23. Power-Up Error Code Displays

Error Code	Description	Corrective Action
01/02	FLASH ROM Codeplug Checksum Non-Fatal Error	Reprogram the codeplug.
01/12	Security partition Checksum Non-Fatal Error	Send Radio to Depot.
01/22	Tuning Codeplug Checksum Non-Fatal Error	Send Radio to Depot.
01/81	Host ROM Checksum Fatal Error	Send Radio to Depot.
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug.
01/88	External RAM FATAL Error -- Note: not a checksum failure	Send radio to depot.
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on.
01/92	Security Partition Checksum Fatal Error	Send radio to depot.
01/93	Flashport AUTHENTICATION CODE failure	Send radio to depot.
01/98	Internal RAM Fail Fatal Error	Send radio to depot.
01/A0	ABACUS Tune failure Fatal Error	Turn the radio off, then on.
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot.
02/10	DSP Support IC Checksum Non-Fatal Error	Turn the radio off, then on.
02/81	DSP ROM Checksum Fatal Error	Send radio to depot.
02/88	DSP RAM Fatal Error -- Note: not a checksum failure	Turn the radio off, then on.
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then on.

NOTE: If the corrective action does not fix the failure, send the radio to the depot.

Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. An error code indicates that a problem exists and that a service technician should be contacted. Operational error codes are listed in Table 24..

Table 24. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	a. Reprogram external codeplug b. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

Table 25. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Radio dead; Display does not light up	1. Dead Battery	Replace with charged battery.
	2. Blown Fuse	Send radio to depot.
	3. On/Off Switch	
	4. Regulators	
Radio dead; display lights up	1. VOCON	Send radio to depot.
	2. RF	
No receiver audio or receiver does not unmeet	Programming	a. Does the transmitted signal match the receiver configuration (PL, DPL, etc.)? b. With the monitor function enabled, can the radio be unmuted?
Audio distorted or not loud enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; if off by more than $\pm 1000\text{Hz}$, realign.
RF sensitivity poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; if off by more than $\leq \pm 1000\text{Hz}$, realign.
	2. Antenna Switch	Send radio to depot.
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the CPS.
Radio will not turn off	VOCON	Send radio to depot.

Table 26. Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF power out	1. TX Power Level or Frequency	Check TX power level and frequency programming (from CPS).
	2. No PTT From Control Top	Send radio to depot.
	3. No Injection To Power Amplifier	
No modulation; Distorted modulation	1. Programming	Check deviation and compensation settings using the CPS.
	2. VOCON	Send radio to depot.
Bad microphone sensitivity	1. Check Deviation and Compensation	Realign if necessary.
	2. Microphone	Send radio to depot.
No/Low signalling (PL, DPL, MDC)	1. Programming	Check programming.
	2. VOCON	Send radio to depot.
Cannot set deviation balance	RF	Send radio to depot.

Notes

General

Motorola provides the following approved accessories to improve the productivity of your XTS 2500 portable two-way radio.

Antennas

NAF5037	806-870 MHz Whip, Half-wave, 7 inch
NAF5042	806-870 MHz Quarter Wave, 3 inch, Stubby
NAF5080	764-870 MHz Whip, Half-wave, 6.5 inch

Audio

Headsets

BDN6635	Boom Mic Headset with VOX (Adapter BDN6673)
BDN6636	Throat Mic Headset with VOX (Adapter BDN6673)
BDN6645	Noise-Canceling Boom Mic Headset with PTT on earcup
BDN6673	Headset Adapter Cable for use with BDN6645, BDN6635, and BDN6636
NMN6258	Over the Head Headset w/ In Line PTT
NMN6259	Medium Weight Dual Headset with NC Mic
RMN4049	Temple Transducer

Earpieces

BDN6677	Ear mic, standard, noise up to 95dB, black (must order Interface module)
BDN6641	Ear mic, high noise level up to 105dB, grey (must order interface module)

Remote Speaker Microphones

NMN6193	Remote Speaker Microphone
NMN6191	RSM Noise Cancelling Includes: 6.0' coiled cord assembly, 3.5mm earjack, swivel clip, quick disconnect

Surveillance

BDN6671	PTT and VOX Interface Module for use with BDN6677, BDN6678, and BDN6641
BDN6677	Ear Microphone, Standard 95 dB (Black)
BDN6678	Ear Microphone, Standard 95 dB (Beige)
BDN6708	PTT Interface Module for use with BDN6677, BDN6678, and BDN6641

Batteries

NTN9815	NiCd High Capacity
NTN9816	NiCd High Capacity, Factory Mutual Intrinsically Safe
NTN9857	NiMH Ultra-High Capacity, Factory Mutual Intrinsically Safe
NTN9858	NiMH Ultra-High Capacity

Belt Clips

HLN6853	Belt Clip, 2 1/4 inch
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Carrying Cases

NNTN4115	Carrying case, Bonded leather with 3" Swivel Belt Loop and T-strap
NNTN4116	Carrying case, Bonded leather with 2.5" Swivel Belt Loop and T-strap
NNTN4117	Carrying case, Bonded leather with 3" Belt Loop and T-strap

Chargers

NTN1177	Multi-Unit, Dual Rate, Rapid: 110 V
NTN1178	Multi-Unit, Dual Rate, Rapid: 240 V (3-prong UK plug)
NTN1179	Multi-Unit, Rapid, 240V (UK 13 MAP Plug)
NTN1667	Tri-Chemistry, 110V
NTN1668	Tri-Chemistry, 220V Single Unit Charger (2 Prong Euro Plug)
NTN1669	Tri-Chemistry, 230V
NTN1873	IMPRES™ Rapid, 110V Single Unit Charger
NTN1874	IMPRES™ Rapid, 220V Single Unit Charger
NTN1875	IMPRES™ Rapid, 240V Single Unit Charger
NTN7209	Single-Unit Dual Rate, Rapid w/o Cord
WPLN4111_R	IMPRES™ Single-Unit Smart Charger, 110V

NOTE: Charge only the battery, not the radio with the battery attached, with NTN1177, NTN1178, and NTN1179.

Charger Mounting Kits

NLN7967	Wall Mount Kit for Multi-unit (6-pocket) Charger
NLN7968	Charger, Rack Mount for 6 Unit

Enhanced and Multi-Unit Line Cords

NTN7373	110 V Interchangeable Line
NTN7374	220 V Interchangeable Line (2 prong Euro plug)
NTN7375	240 V Interchangeable Line (3 prong Euro plug)

Notes

Glossary



A/D	Analog-to-Digital converter; converts an instantaneous dc voltage level to a corresponding digital value.
ABACUS IC	Custom integrated circuit providing a digital receiver IF backend.
CPS	Customer Programming Software
CODEC	Coder/Decoder IC for analog-to-digital and digital-to-analog conversion.
D/A	Digital-to-Analog converter; converts a digital value to a corresponding dc voltage value.
DTMF	Dual-Tone Multi-Frequency
DPL	Digital Private-Line™
DSP	Digital Signal Processor ; microcontroller specifically tailored for signal processing computations. In this case refers specifically to Motorola DSP56603.
Firmware	Software or a software/hardware combination of computer programs and data, with a fixed logic configuration stored in a read-only memory; information can not be altered or reprogrammed.
FGU	Frequency Generation Unit
FLASHport™	A Motorola term that describes the ability of a radio to change memory. Every FLASHport radio contains a FLASHport EEPROM memory chip that can be software written and rewritten to, again and again.
Host	Motorola HC12A4 microcontrol unit U204 (see MCU).
Host Port	Parallel memory mapped interface consisting of eight registers in the DSP56603.
IC	Integrated Circuit
IMBE	Improved Multi-Band Excitation ; a sub-band, voice encoding algorithm used in ASTRO digital voice.
MCU	MicroControl Unit
MDC	Motorola Digital Communications
MISO	Master In Slave Out ; used by the slave device to send data to the master device
MOSI	Master Out Slave In ; used by the master device to send data to the slave device.
Open Architecture	A controller configuration that utilizes a microprocessor with extended ROM and RAM.
PC Board	Printed Circuit board
PCIC	Power Control IC
PL	Private-Line® tone squelch; a continuous sub-audible tone that is transmitted along with the carrier.
PLL	Phase-Locked Loop ; a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.

Glossary

PTT	Push-To-Talk ; the switch located on the left side of the radio which, when pressed, causes the radio to transmit.
Registers	Short-term data-storage circuits within the microcontrol unit or programmable logic IC.
Repeater	Remote transmit/receive facility that re-transmits received signals in order to improve communications coverage.
RESET	Reset line; an input to the microcontroller that restarts execution.
RF PA	R adio F requency P ower A mplifier
RPT/TA	R e P e A ter/ T alk- A round
RX DATA	Recovered digital data line.
Signal Qualifier Mode	An operating mode whereby the radio is muted but still continues to analyze receive data to determine RX signal type.
SCI IN	S erial C ommunication I nterface I Nput line
Softpot	Software potentiometer; a computer-adjustable electronic attenuator.
Software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
SPI	S erial P eripheral I nterface; how the microcontroller communicates to modules and ICs through the C LOCK and D ATA lines.
Squelch	Muting of audio circuits when received signal levels fall below a pre-determined value.
SRAM	S tatic- R AM chip used for volatile, program/data memory.
Standby Mode	An operating mode whereby the radio is muted but still continues to monitor data.
System Select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).
TOT	T ime- O ut T imer; a timer that limits the length of a transmission.
TSOP	T hin S mall- O utline P ackage
UART	U niversal A synchronous R eceiver T ransmitter.
μC	Microcontrol unit (see MCU).
VCO	V oltage- C ontrolled O scillator; an oscillator whereby the frequency of oscillation can be varied by changing a control voltage.
Vocoder	V oice en C ODER; the DSP-based system for digitally processing the analog signals, includes the capabilities of performing voice compression algorithms or voice encoding.
VSWR	V oltage S tanding W ave R atio

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REPLACEMENT PARTS ORDERING

ORDERING INFORMATION

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number in which the part is used.

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