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Basic Service Manual
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Related Publications

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SPECIFICATIONS FOR VHF RADIOS

All specifications are per Electronic Industries Association (EIA) 316B unless otherwise noted

GENERAL

FCC Designation: AZ489FT3790

Temperature Range:
- **Operating:** –30°C to +60°C
- **Storage:** –40°C to +85°C

Power Supply: Nickel-Cadmium Battery (NiCd)
or Nickel-Metal-Hydride Battery (NiMH)
or Lithium-Ion Battery (Li-Ion)

Battery Voltage:
- **Nominal:** 7.5 Volts
- **Range:** 6 to 9 Volts

Transmit Current Drain (Typical): 2300mA
Receive Current Drain (Rated Audio): 290mA
Standby Current Drain: 90mA

Recommended Battery:
- **Ultra-HIgh-Capacity NiCd:** NTN8294A

or **Ultra–High-Capacity NiCd FM:** NTN8295*
or **Ultra–High-Capacity NiMH FM:** NTN8299A*
Optional FM (Factory Mutual) Battery:
* FM Intrinsically Safe: Class I, II, III, Division 1, Groups C, D,E, F, and G. FM Non-incendive: Class 1, Division 2, Groups A, B, C, and D.

Dimensions (H x W x D)
Note: 2.44" = width at PTT; 2.34" = width at bottom; 1.83" = depth at speaker; 0.97" = depth at keypad
- **Less Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x 0.97"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 24.56mm)
- **With Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x1.65"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 41.97mm)

Weight: (w/Helical Antenna)
- **Less Battery:** 14.10oz. (383gm)
- **With Ultra-High Cap. NiCd:** 25.19oz. (693gm)
- **With Ultra-High Cap. NiMH:** 23.45oz. (644gm)

RECEIVER

Frequency Range: 136-178MHz

Bandwidth: 42MHz

Quieting Sensitivity (20dBQ): 0.35μV (typical)
Usable Sensitivity
(12dB SINAD): 0.25μV (typical)

Intermodulation: –78dB (typical)

Selectivity (typical)
(25/30kHz Channel): –78dB

Spurious Rejection: –70dB

Frequency Stability
(–30+60°C; 25°C reference): ±.0002%

Rated Audio: 500mW

Distortion (At Rated Audio): 2% Typical

Channel Spacing: 12.5/20/25/30kHz

TRANSMITTER

RF Power:
- **136-174MHz:** 1 Watt/5 Watts
- **174-178MHz:** 1 Watt/4 Watts

Frequency Range: 136-178MHz

Frequency Stability (typical)
(–30 to +60°C; 25°C ref.): ±.0002%

Emission (Conducted and Radiated): –70dBc

FM Hum and Noise (typical)
(Companion Receiver): 25/30kHz –48dB
12.5kHz –42dB

Distortion: 2% Typical

Modulation Limiting: 25/30kHz chnls ±5.0kHz
20kHz chnls ±4.0kHz
12.5kHz chnls ±2.5kHz

Emissions Designators:
20K0F1E, 16K0F3E, 11K0F3E,
8K10F1D, and 8K10F1E

Specifications subject to change without notice

SPECIFICATIONS FOR UHF RADIOS

All specifications are per Electronic Industries Association (EIA) 316B unless otherwise noted

GENERAL

FCC Designation: AZ489FT4828

Temperature Range:
- **Operating:** –30°C to +60°C
- **Storage:** –40°C to +85°C

Power Supply: Nickel-Cadmium Battery (NiCd)
or Nickel-Metal-Hydride Battery (NiMH)
or Lithium-Ion Battery (Li-Ion)

Battery Voltage:
- **Nominal:** 7.5 Volts
- **Range:** 6 to 9 Volts

Transmit Current Drain (Typical): 1700mA
Receive Current Drain (Rated Audio): 290mA
Standby Current Drain: 90mA

Recommended Battery:
- **Ultra-HIgh-Capacity NiCd:** NTN8294A

or **Ultra–High-Capacity NiCd FM:** NTN8295*
or **Ultra–High-Capacity NiMH FM:** NTN8299A*
Optional FM (Factory Mutual) Battery:
* FM Intrinsically Safe: Class I, II, III, Division 1, Groups C, D,E, F, and G. FM Non-incendive: Class 1, Division 2, Groups A, B, C, and D.

Dimensions (H x W x D)
Note: 2.44" = width at PTT; 2.34" = width at bottom; 1.83" = depth at speaker; 0.97" = depth at keypad

Less Battery:
6.58" x 2.44" x 1.83"/6.58" x 2.34" x 0.97"
(167.13mm x 61.90mm x 46.42mm/
167.13mm x 59.49mm x 24.56mm)

With Battery:
6.58" x 2.44" x 1.83"/6.58" x 2.34" x1.65"
(167.13mm x 61.90mm x 46.42mm/
167.13mm x 59.49mm x 41.97mm)

Weight: (w/Helical Antenna)
- **Less Battery:** 14.10oz. (383gm)
- **With Ultra-High Cap. NiCd:** 25.19oz. (693gm)
- **With Ultra-High Cap. NiMH:** 23.45oz. (644gm)

RECEIVER

Frequency Range: 403-520MHz

Bandwidth: 70MHz

Quieting Sensitivity (20dBQ): 0.316µV (typical)

Usable Sensitivity
(12dB SINAD): 0.25µV (typical)

Intermodulation: –78dB (typical)

Selectivity (typical)
- **(25/30kHz Channel):** –78dB
- **(12.5kHz Channel):** –68dB

Spurious Rejection: –75dB

Frequency Stability
(–30+60°C; 25°C reference): ±.0002%

Rated Audio: 500mW

Distortion (At Rated Audio): 1.5% Typical

Channel Spacing: 12.5/20/25/30kHz

TRANSMITTER

RF Power:
- **403-470MHz:** 1 Watt/5 Watts
- **450-520MHz:** 1 Watt/5 Watts

Frequency Range: 403-520MHz

Frequency Stability (typical)
(–30 to +60°C; 25°C ref.): ±.0002%

Emission (Conducted and Radiated): –70dBc

FM Hum and Noise (typical)
(Companion Receiver): 25/30kHz –48dB
12.5kHz –42dB

Distortion: 1.5% Typical

Modulation Limiting: 25/30kHz chnls ±5.0kHz
20kHz chnls ±4.0kHz
12.5kHz chnls ±2.5kHz

Emissions Designators:
20K0F1E, 16K0F3E, 11K0F3E,
8K10F1D, and 8K10F1E

Specifications subject to change without notice

SPECIFICATIONS FOR 800 MHz RADIOS

All specifications are per Electronic Industries Association (EIA) 316B unless otherwise noted.

GENERAL

FCC Designation: AZ489FT5774

Temperature Range:
- **Operating:** –30°C to +60°C
- **Storage:** –40°C to +85°C

Power Supply: Nickel-Cadmium Battery (NiCd)
or Nickel-Metal-Hydride Battery (NiMH)
or Lithium-Ion Battery (Li-Ion)

Battery Voltage:
- **Nominal:** 7.5 Volts
- **Range:** 6 to 9 Volts

Transmit Current Drain (Typical): 1700mA
Receive Current Drain (Rated Audio): 280mA
Standby Current Drain: 90mA

Recommended Battery:
- **Ultra-HIgh Capacity NiMH:** H335AC

or **Ultra–High Capacity NiCd FM:** H223AX*
or **NiMH FM IS:** Q393AB
Optional FM (Factory Mutual) Battery:
* FM Intrinsically Safe: Class I, II, III, Division 1, Groups D, F, and G

Dimensions (H x W x D)
Note: 2.44" = width at PTT; 2.34" = width at bottom; 1.83" = depth at speaker; 0.97" = depth at keypad
- **Less Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x 0.97"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 24.56mm)
- **With Ultra-High Capacity NiMH Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x1.65"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 41.97mm)
- **With Ultra-High Capacity NiCd Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x1.65"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 41.97mm)
- **With NiMH FM IS Battery:**
  6.58" x 2.44" x 1.83"/6.58" x 2.34" x1.65"
  (167.13mm x 61.90mm x 46.42mm/
  167.13mm x 59.49mm x 41.97mm)

Weight: (w/Helical Antenna)
- **Less Battery:** 14.10oz. (383gm)
- **With Ultra-High Cap. NiMH:** 23.45oz. (644gm)
- **With Ultra-High Cap. NiCd:** 25.19oz. (693gm)
- **With NiMH FM IS:** 23.45oz. (644gm)

RECEIVER

Frequency Range: 851–870MHz

Bandwidth: 19MHz

Quieting Sensitivity (20dBQ): 0.5µV Max.

Usable Sensitivity
(12dB SINAD): 0.35µV Max.

Intermodulation: –70dB

Selectivity
(25kHz Adjacent Channel): –70dB

Spurious Rejection: –70dB

Frequency Stability
(–30+60°C; 25°C reference): ±.00015%

Rated Audio: 500mW

Distortion (At Rated Audio): 3% Typical

Channel Spacing: 25kHz

TRANSMITTER

RF Power: 3 Watts

Frequency Range: 806–825MHz
851–870MHz

Frequency Stability
(–30 to +60°C; 25°C ref.): ± .00015%

Emission (Conducted and Radiated): –46dBw

FM Hum and Noise
(Companion Receiver): –40dB

Distortion: 3% Typical

Modulation Limiting: ±5kHz
(821-824MHz): ±4kHz

Emissions Designators:
20K0F1E, 16K0F3E, 15K0F2D, 15K0F1D, and 8K10F1E

Specifications subject to change without notice

Introduction

1

General

This manual covers information needed for level one troubleshooting. Level one troubleshooting consists of radio programming, radio alignment, knobs replacement, and installation and removal of antenna, belt clip, battery, and universal connector cover. This will be the only level of service allowed for the service centers, self-maintained customers, and distributors for the first six months of the life of this product.

Included in this manual are radio specifications for the VHF, UHF, and 800MHz frequency bands, a general description of XTS 3500 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 indicates an imminently hazardous situation which, if not avoided, will result in death or injury.

Radio Description

The ASTRO Digital XTS 3500 radios are among the most sophisticated two-way radios available. The radio is presently available in the UHF R2 band; radios in the UHF R1, VHF, and 800MHz bands will be available by the end of 1999.

One of the newest in a long line of quality Motorola products, the ASTRO Digital XTS 3500 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 3500 radios are available in two basic models. Table 1 provides a description of their basic features.

Table 1 ASTRO XTS 3500 Basic Features

Feature	Model I	Model II	Model III
Display	None	LCD 4 lines/ 12 characters per line	LCD 4 lines/ 12 characters per line
Keypad	None	3 x 2 button	3 x 6 button
Channel Capability	48	255	255
Dialing from Prestored List	No	Yes	Yes
Programmable Softkeys	No	Yes	Yes

FLASHport

The ASTRO Digital XTS 3500 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, similar to how 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

The ASTRO Digital XTS 3500 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.

Caution

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

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 the attributes of these devices are many, 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.

At this time, troubleshooting and repair of the radio will not be supported by the field or self-maintained customer. ***DO NOT attempt to disassemble the radio.***

3

Recommended Test Equipment and Service Aids

Recommended Test Equipment

The list of equipment contained in Table 2 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 2 Recommended Test Equipment

Motorola Model Number	Description	Characteristics	Application
R2670 or R2600	System Analyzer	This monitor will substitute for items with an asterisk (*).	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment.
R1049A*	Digital Multimeter		Recommended for ac/dc voltage and current measurements
R1150C*	Code Synthesizer		Injection of audio and digital signalling codes
S1053D* SKN6008A* SKN6001A*	AC Voltmeter Power Cable for Meter Test Leads for Meter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R1094A	Dual-Trace Oscillo-scope	20MHz bandwidth 5mV to 5V/division	Waveform measurements
S1350C* ST1213B (VHF)* ST1223B (UHF)*	Wattmeter Plug-In Element RF Dummy Load	50-ohm, ±5% accuracy 10 watts, maximum 0-1000MHz, 300W	Transmitter power output measurements
R1065	Load Resistor	10-watt Broadband	For use with wattmeter
S1339A	RF Millivolt Meter	100µV to 3V RF	RF-level measurements
R1013A*	SINAD Meter		Receiver sensitivity measurements
S1347D or S1348D (programmable)	DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc

Service Aids

Refer to Table 3, "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 3 Service Aids

Motorola Part Number	Description	Application
RKN-4035D	RIB/Radio/Test Set Cable	Connects radio to RTX-4005B Test Box and RIB.
REX-4424	Battery Eliminator	Interconnects radio to power supply.
RLN-4460A, or RTX-4005B, or both RTX-4005A and RPX-4665A	Portable Test Set	Enables connection to the universal connector. Allows switching for radio testing.
Field Modification Kit RLN-1015A or RLN-4008B	Radio Interface Box	Enables communications between the radio and the computer's serial communications adapter.
01-80357A57	Wall-Mounted Power Supply	Used to supply power to the RIB (120 Vac).
01-80358A56	Wall-Mounted Power Supply	Used to supply power to the RIB (220 Vac).
30-80369B71 or 30-80369B72	Computer Interface Cable	Use B72 for the IBM PC AT. All other IBM models use B71. Connects the computer's serial communications adaptor to the RIB.
RVN-4100F	Radio Service Software	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
58-80348B33	SMA to BNC Adaptor	Adapts radio's antenna port to BNC cabling of test equipment.

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 "Radio Service Software User's Guide" for complete field programming information.

Performance Checks

4

Introduction to This Section

This section covers performance checks used to verify 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.

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 (page 13, Figure 1).

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

Table 4 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:** 2.5kHz/Div **O'scope Trig:** Auto **Monitor Image:** Hi **Monitor BW:** Nar **Monitor Squelch:** Mid CW **Monitor Vol:** 1/4 CW		**Current:** 2.5Amps

Test Mode

RF Test Mode

When the ASTRO Digital XTS 3500 radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcomputer will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called **TEST MODE** or "air test," has been incorporated in the radio.

To enter the test mode:

1. Turn the radio on and adjust the volume for a comfortable listening level. The volume level remains constant once in the test mode.
2. Within 10 seconds after the "**Self Test**" is complete, press **Side Button 3** five times in succession.
3. After "**RF TEST**" appears, press the **Top Programmable Button** (normally programmed as the emergency button) once. "**1 CSQ**" appears, indicating: test frequency 1, carrier squelch mode.
4. Each additional press of **Side Button 3** will advance to the next test channel. (Refer to Table 5.)
5. Pressing **Side Button 2** will scroll through and access test environments as shown in Table 6.

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

Table 5 Test Frequencies

Test Channel	UHF Band 2
TX #1	450.025
RX #1	450.075
TX #2	465.225
RX #2	465.275
TX #3	475.125
RX #3	475.275
TX #4	484.975
RX #4	485.025
TX #5	500.275
RX #5	500.225
TX #6	511.975
RX #6	511.925
TX #7	519.975
RX #7	519.925

Table 6 Test Environments

Display	Description	Function
CSQ	Carrier Squelch	**RX:** unsquelch if carrier detected **TX:** mic audio
TPL	Tone Private-Line	**RX:** unsquelch if carrier and tone (192.8 Hz) detected **TX:** mic audio + tone (192.8 Hz)
AST	ASTRO	**RX:** none **TX:** 1200Hz tone *

* All deviation values are based on deviation tuning of this mode.

Control Top and Keypad Test Mode

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

1. Turn the radio on and adjust the volume for a comfortable listening level. The volume level remains constant once in the test mode.
2. Within 10 seconds after the "**Self Test**" is complete, press **Side Button 3** five times in succession.
3. After "**RF TEST**" appears on the display, press **Side Button 1** once, "**CH TEST**" appears on the display.
4. Next, 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.
5. Release the **Top Programmable Button**; "**3/0**" appears, which indicates that the **Top Programmable Button** is in the open condition.
6. Press the **Top Programmable Button** again; "**3/1**" appears, which indicates that the **Top Programmable Button** is in the closed condition.
7. Rotate the **Mode/Zone Selector Switch**; "**4/0**" through "**4/15**" appears, which indicates that the selector switch is in mode/zone position 1 through 15.
8. Rotate the **Two-Position (A/B) Switch**; "**65/0**" and "**65/1**" appear.
9. Cycle through the **Three-Position Programmable Switch**; "**67/0,**" "**67/1,**" and "**67/2**" appear.
10. Rotate the **Volume Control**; "**2/0**" through "**2/255**" appear.
11. Press **Side Button 1**; "**96/1**" appears; release, "**96/0**" appears.
12. Press **Side Button 2**; "**97/1**"appears; release, "**97/0**" appears.
13. Press **Side Button 3**; "**98/1**"appears; release, "**98/0**" appears.
14. Press the **PTT Switch**; "**1/1**" appears; release, "**1/0**" appears.
15. Keypad Checks:
    - Press (0), "**48/1**" appears; release, "**48/0**" appears.
    - Press (1), "**49/1**" appears; release, "**49/0**" appears.
    - Press (2ABC), "**50/1**" appears; release, "**50/0**" appears.
    - Press (3DEF), "**51/1**" appears; release, "**51/0**" appears.
    - Press (4GHI), "**52/1**" appears; release, "**52/0**" appears.
    - Press (5JKL), "**53/1**" appears; release, "**53/0**" appears.
    - Press (6MNO), "**54/1**" appears; release, "**54/0**" appears.
    - Press (7PRS), "**55/1**" appears; release, "**55/0**" appears.
    - Press (8TUV), "**56/1**" appears; release, "**56/0**" appears.
    - Press (9WXY), "**57/1**" appears; release, "**57/0**" appears.
    - Press (*), "**58/1**" appears; release, "**58/0**" appears.
    - Press (#), "**59/1**" appears; release, "**59/0**" appears.
    - Press (◄), "**128/1**" appears; release, "**128/0**" appears.
    - Press (HOME), "**129/1**" appears; release, "**129/0**" appears.
    - Press (►), "**130/1**" appears; release, "**130/0**" appears.

- Press the left-hand ⊖ key on the top row of keys, "**131/1**" appears; release, "**131/0**" appears.
- Press the center ⊖ key, "**132/1**" appears; release, "**132/0**" appears.
- Press the right-hand ⊖ key, "**133/1**" appears; release, "**133/0**" appears.

Table 7 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 ≤ ±1.2kHz
Rated Audio	**Mode:** GEN **Output level:** 1.0mV RF 4th channel test frequency❖ **Mod:** 1kHz tone at 3kHz deviation **Monitor:** DVM: ac Volts	TEST MODE, 4 CSQ	PTT to OFF (center); meter selector to Audio PA	Set volume control to 3.74Vrms
Distortion	As above, except to distortion	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except SINAD; lower the RF level for 12dB SINAD	As above	PTT to OFF (center)	RF input to be < 0.35µV
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 < 0.25µV. Preferred SINAD = 8-10dB

❖ See Table 6

Table 8 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 ≤ ±1.2kHz.
Power RF	As above	As above, 4 CSQ	As above	Refer to Maintenance Specifications page in front of manual.
Voice Modulation	**Mode:** PWR MON 4th channel test frequency❖ atten to –70, input to RF In/Out. **Monitor:** DVM, ac Volts. Set 1kHz Mod Out level for 0.025Vrms at test set, 80mVrms at ac/dc test set jack	As above, 4 CSQ	As above, meter selector to mic	**Deviation: UHF:** ≥ 3.6kHz but ≤ 5.0kHz
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: UHF:** ≥ 3.8kHz but ≤ 5.0kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to a conventional transmit frequency; BW to narrow	Conventional coded squelch personality (clear mode operation) 4 TPL	As above	**Deviation: UHF:** ≥ 500Hz but ≤ 1000Hz
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 1kHz Mod Out level for 25mVrms at test set.	Conventional talkaround personality (clear mode operation) 1 CSQ	As above	**Deviation: UHF:** ≥ 3.8kHz but ≤ 5.0kHz
Talkaround Modulation (radios with conventional, secure mode, talkaround operation only) (**)	Change frequency to conventional talk-around frequency. **Mode:** PWR MON deviation, attenuation to –70, input to RF In/Out. **Monitor:** DVM, ac volts **Mod:** 1kHz out level for25mVrms at test set.	Conventional talkaround personality (secure mode operation). Load key into radio 1 sec.	As above	**Deviation: UHF:** ≥ 3.6kHz but ≤ 4.4kHz

** The secure mode, talkaround modulation test is only required for trac mode radios which do not have clear mode talkaround capability.

❖ See Table 6

Radio Alignment Procedures

5

Introduction to This Section

This section describes both receiver and transmitter radio alignment procedures.

General

A personal computer (PC) and radio service software (RSS) are required to align the radio. Refer to the applicable RSS manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC, radio interface box (RIB), and a universal test set as shown in Figure 1.

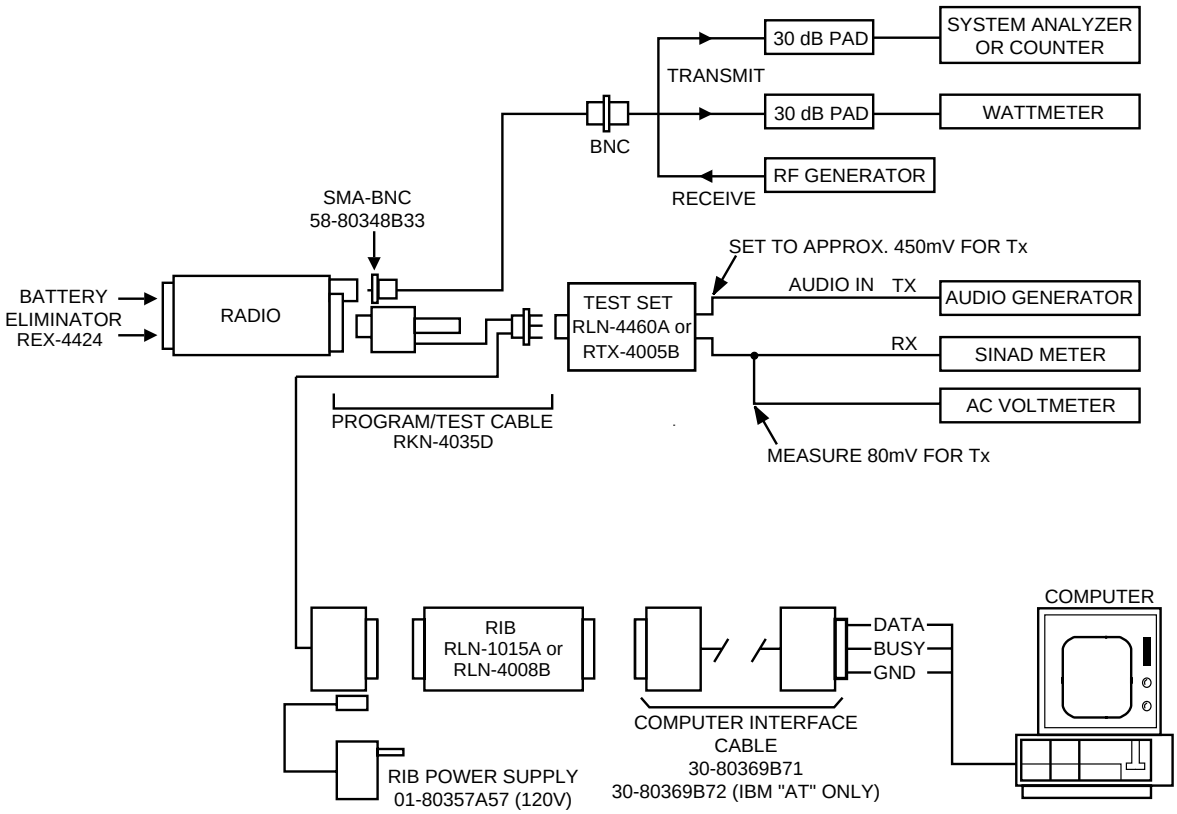


Figure 1 Radio Alignment Test Setup

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

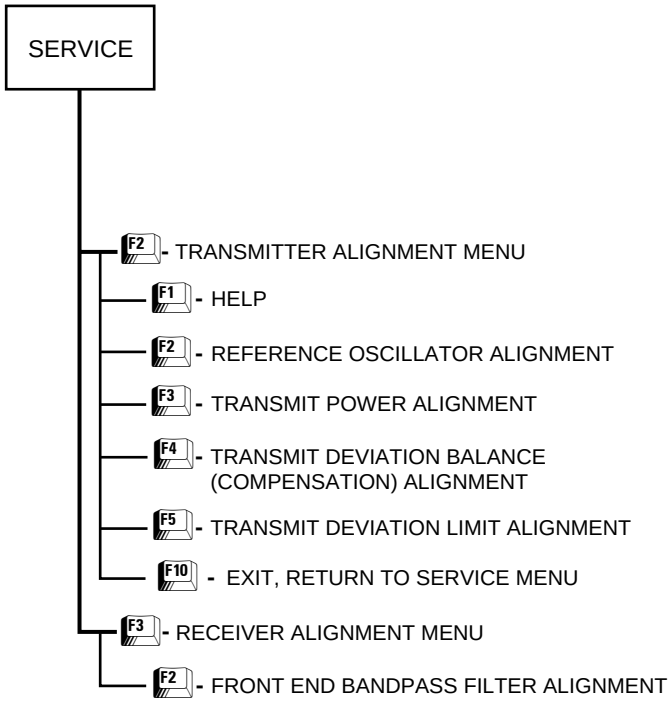


Figure 2 RSS Service Menu Layout

All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to use the SERVICE menus.

Caution

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

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

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

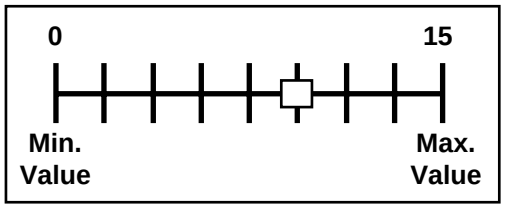


Figure 3 Softpot Concept

Adjusting the softpot value sends information to the radio to increase (or decrease) a dc voltage in the corresponding circuit. For example, pressing the UP arrow key at the Reference Oscillator screen instructs the radio'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 radio service software you are using. Refer to your radio service software user's guide.

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. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

1. From the SERVICE MENU, press F2 to select the TRANSMITTER ALIGNMENT MENU.
2. Press F2 again to select the REFERENCE OSCILLATOR alignment screen. See Figure 4.

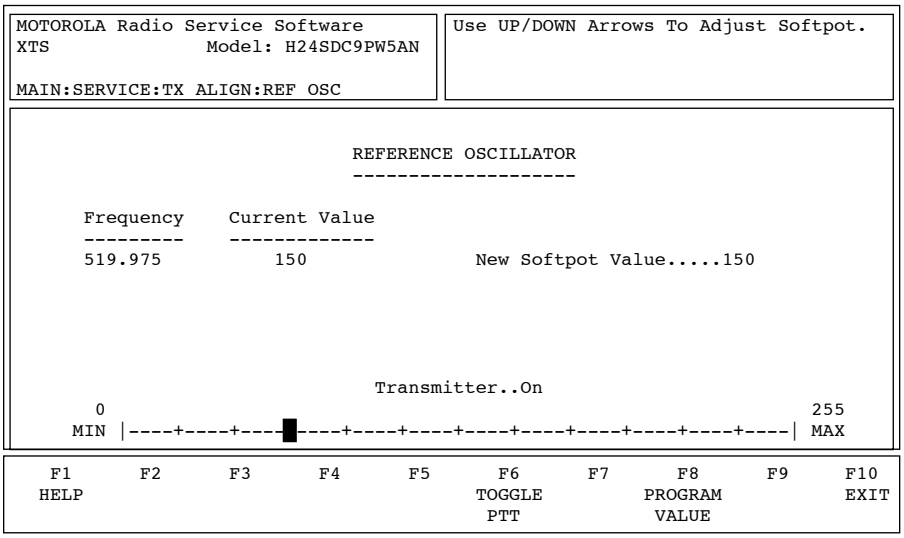


Figure 4 Reference Oscillator Alignment Screen

3. Press TAB (or ENTER or [**RETURN]**) to select a frequency field (starting with the highest frequency shown). Then, press F6 to key the radio. The screen will indicate that the radio is transmitting.

4. Measure the transmit frequency on your service monitor.
5. Use the ↑/↓ arrow keys to adjust the reference oscillator softpot value. See Table 9.

Table 9 Reference Oscillator Alignment

Band	Target
UHF	±100 Hz

6. Press F6 again to dekey the radio.
7. Press F8 to program the new softpot value.
8. Press F10 once to return to the TRANSMITTER ALIGNMENT MENU, or press F10 twice to return to the SERVICE MENU.

Transmit Power Alignment

NOTES:

- All power measurements are to be made at the antenna port.
- The transmitter power setting keeps the radiated power at or below the level specified in the exclusionary clause for low power devices of IEEE Standard C95.1-1991.

1. From the SERVICE MENU, press F2 to select the TRANSMITTER ALIGNMENT MENU.
2. Press F3 to select the TRANSMIT POWER alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 5.

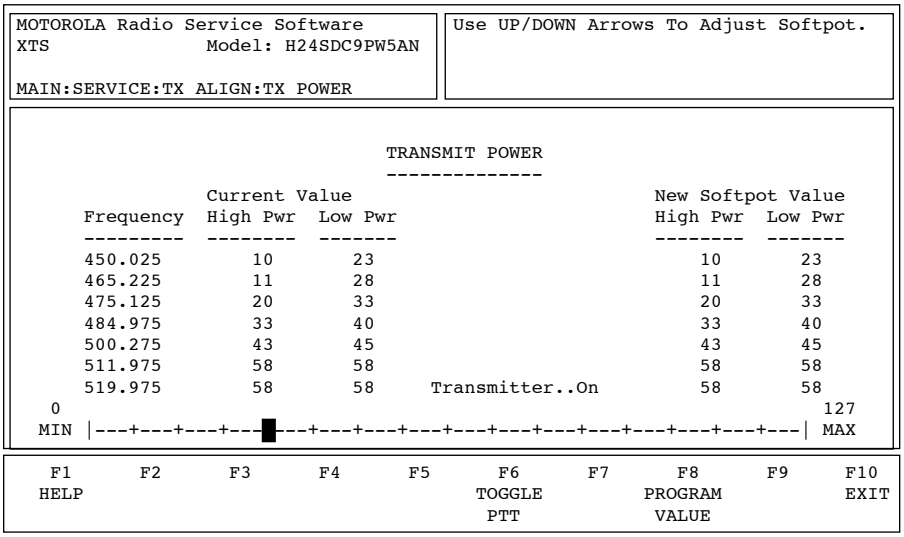


Figure 5 Transmit Power Alignment Screen

3. Press TAB (or ENTER or [**RETURN]**) to select a frequency field (starting with the highest frequency shown). Then, press F6 to key the radio. The screen will indicate that the radio is transmitting.
4. Use the ↑/↓ arrow keys to adjust the transmit power per the values shown in Table 10.

Table 10 Transmit Power Settings

UHF Power Level	Test Frequencies	
	450-512MHz	512-520MHz
1 Watt	1.2W - 1.4W	1.2W - 1.4W
5 Watts	5.2W - 5.4W	3.2W - 3.4W

5. Press F6 to dekey the radio.
6. Press F8 to program the value.
7. Repeat steps 3-6 for the remaining frequencies.
8. Press F10 once to return to the TRANSMITTER ALIGNMENT MENU, or press F10 twice to return to the SERVICE MENU.

Transmit Deviation Balance (Compensation) Alignment

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

1. From the SERVICE MENU, press F2 to select the TRANSMITTER ALIGNMENT MENU.
2. Press F4 to select the TRANSMIT DEVIATION BALANCE (COMPENSATION) alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 6.

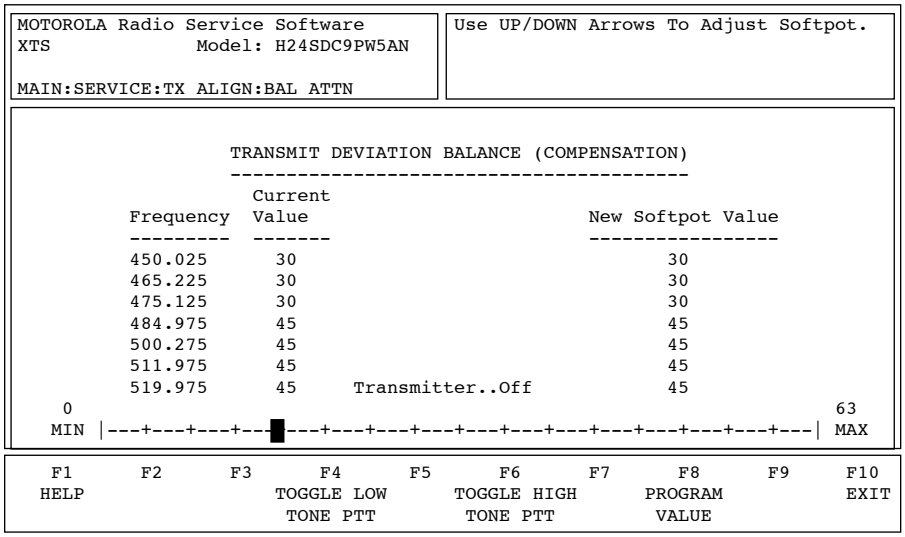


Figure 6 Transmit Deviation Balance (Compensation) Alignment Screen

3. Press TAB (or ENTER or [**RETURN]**) to select a frequency field (starting with the lowest frequency shown).
4. Press F4. This will cause the radio to key and the radio's DSP IC to inject an 80Hz tone into the RF board.
5. Measure the deviation and record this value.
6. Press F4 to dekey the radio.

7. Press F6. This will cause the radio's DSP IC to change the injection tone to 3kHz, 100mVrms. Use the ↑/↓ arrow keys to adjust the deviation to within ±2% of the value recorded in step 5.
8. Repeat steps 4-7 until the 3kHz tone deviation is within ±2% of the 80Hz tone deviation.
9. Press F6 again to dekey the radio.
10. Press F8 to program the new softpot value.
11. Repeat steps 3-10 for the remaining frequencies.
12. Press F10 once to return to the TRANSMITTER ALIGNMENT MENU, or press F10 twice to return to the SERVICE MENU.

Transmit Deviation Limit Alignment

IMPORTANT NOTE:

Put the radio in the RF test mode and scroll to the ASTRO test environment, indicated by "AST" on the display (refer to the "Performance Checks" section for details). All other deviation values are derived from the ASTRO test environment mode transmit deviation limit.

1. From the SERVICE MENU, press F2 to select the TRANSMITTER ALIGNMENT MENU.
2. Press F5 to select the TRANSMIT DEVIATION LIMIT alignment screen. The screen will indicate the transmit frequencies to be used. See Figure 7.

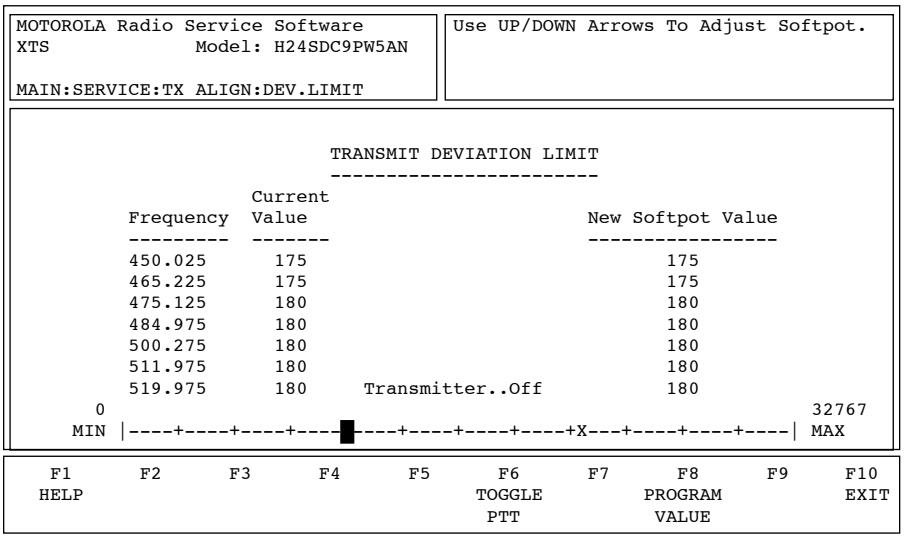


Figure 7 Transmit Deviation Limit Alignment Screen

3. Press TAB (or ENTER or [**RETURN]**) to select a frequency field (starting with the lowest frequency shown).
4. Press F6 to key the radio. Then use the ↑/↓ arrow keys to adjust for a deviation per the values shown in Table 11.

Table 11 Transmit Deviation Limit

Band	Deviation (Hz)
UHF	2785 - 2885

5. Press F6 again to dekey the radio.
6. Press F8 to program the softpot value.
7. Repeat steps 3-6 for the remaining frequencies.
8. Press F10 once to return to the TRANSMITTER ALIGNMENT MENU, or press F10 twice to return to the SERVICE MENU.

Basic Removal/Installation Procedures

6

Introduction to This Section

This section gives basic procedures for removing and installing the XTS 3500 radio's:

- Antenna,
- Battery,
- Belt Clip,
- Universal Connector Cover,
- Volume Knob, and
- Frequency Knob.

Antenna

Installing the Antenna

Screw the threaded end of the antenna into the antenna receptacle on the top of the radio. Rotate the antenna clockwise until it seats firmly against the bushing.

Removing the Antenna

Rotate the antenna counterclockwise until its threaded end unscrews from the radio's antenna receptacle.

Battery

NOTE: The battery is shipped uncharged, and must be charged for at least 16 hours before use.

WARNING

To avoid a possible explosion:

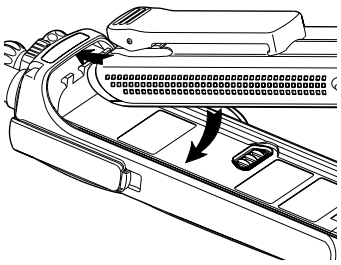
- DO NOT replace the battery in an area labeled "hazardous atmosphere."
- DO NOT discard batteries in a fire.

Caution

If your radio is programmed with volatile-key retention (consult your service technician), encryption keys will be retained for approximately 30 seconds after battery removal.

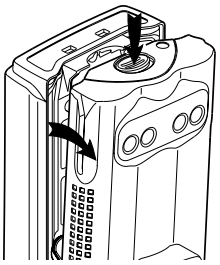
Installing the Battery

1. Turn off the radio and hold it with the back of the radio facing upward
2. Insert the top edge of the battery into the area at the top of the radio between the radio's case and chassis. Make sure the three tabs on the radio chassis align with the three slots under the top edge of the battery.
3. Rotate the battery toward the radio, and squeeze the battery and radio together until the battery "clicks" in place.



Removing the Battery

1. Turn off the radio and hold it so that the release button on the bottom of the battery is facing upward.
2. Press downward on the release button so the battery disengages from the radio.
3. Remove the battery completely away from the radio

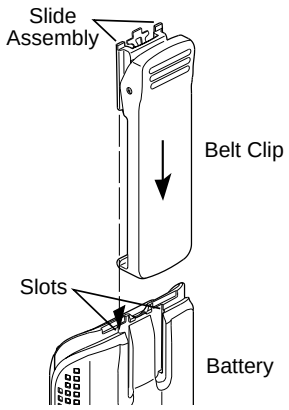


Belt Clip

NOTE: The battery must be removed from the radio before the belt clip can be installed or removed.

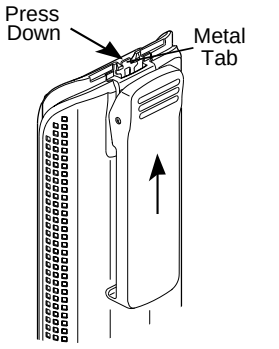
Installing the Belt Clip

1. Hold the battery in one hand so that the top of the battery faces upward, and the back of the battery faces you.
2. Holding the belt clip in the other hand with its top facing upward, align the slide assembly on the front of the belt clip with the slots on the back of the battery.
3. Slide the belt clip downward toward the bottom of the battery until the belt clip "clicks" in place.



Removing the Belt Clip

1. Hold the battery (with belt clip installed) in one hand so that the top of the battery faces upward, and the front (radio side) of the battery faces you.
2. At the top of the battery, press down on the belt clip's metal tab and slide the belt clip upward until it disengages from the battery.
3. Continue to slide the belt clip upward until it is free from the battery.



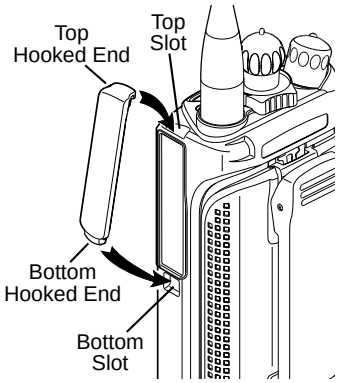
Universal Connector Cover

Caution

When the universal connector is not in use, keep it covered with the universal connector cover.

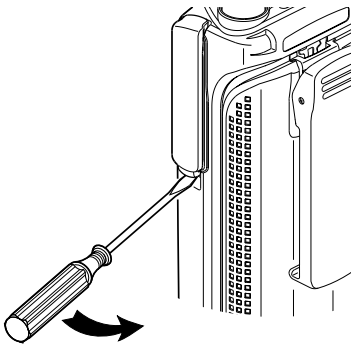
Installing the Universal Connector Cover

1. Looking at the antenna side of the radio, insert the top (flat) hooked end of the cover into the slot on the top of the radio, above the universal connector. Press downward on the cover's top to seat it in the slot.
2. While holding the cover seated in the top slot, insert the cover's bottom (rounded) hooked end into the slot below the universal connector. Press firmly inward on the cover's bottom until it snaps in place.



Removing the Universal Connector Cover

1. Looking at the antenna side of the radio, insert a flat-bladed screwdriver into the area between the lower end of the universal connector cover and the slot below the universal connector.
2. Pry upward on the cover's lower end until it disengages from the radio.



Frequency Knob

NOTES:

- Refer to Figure 8, the Partial Exploded View, and Table 12, the Partial Exploded View Parts List. Numbers in parentheses ( ) refer to item numbers in Figure 8 and Table 12.
- The battery (7) should be removed from the radio before installing or removing the frequency knob (1).

Removing the Frequency Knob

1. Hold the radio in one hand so that the top of the radio faces upward, and the front of the radio faces you.
2. With the other hand, grasp the frequency knob (1) and pull it upward, while pushing it toward the back of the radio, until it is free from the frequency insert (3).
3. While pressing the insert's (3) two snap tabs away from the frequency control shaft so that the insert disengages from the shaft, use needle-nosed pliers to lift the insert up and off of the frequency control shaft.
4. Remove the secure lever (4) and the lightpipe (5).

Installing the Frequency Knob

1. Hold the radio so that the top of the radio faces upward, and the front of the radio faces you.

2. Align the lightpipe (5) so that its straight tab is over the slot for the illuminated pointer. Push the tab down into the slot so that it is securely seated.
3. Place the secure lever (4) on the frequency control shaft, aligning it so that its pointer is at the front of the radio and its two inner slots line up with the two keys on the shaft**.** Slide the secure lever down to the bottom of the shaft.
4. If you are replacing the escutcheon (2), remove the backing paper from the escutcheon, align its alignment marker with the alignment notch (between numbers **4** and **5**) on the insert, and adhere it to the insert.
5. Place a new frequency insert (3) and escutcheon (2) on the frequency control shaft, aligning the insert's D-shaped hole with the D-shaped shaft**.** Press downward firmly on the insert until it "snaps" in place on the shaft.
6. Place the frequency knob (1) on the frequency insert (3), aligning it's pointer with the number "**1**" on the escutcheon (2). Press firmly downward on the knob until it seats securely in place.

Volume Knob

NOTES:

- Refer to Figure 8, the Partial Exploded View, and Table 12, the Partial Exploded View Parts List. Numbers in parentheses ( ) refer to item numbers in Figure 8 and Table 12.
- The battery (7) should be removed from the radio before installing or removing the volume knob (8).

Removing the Volume Knob

1. Hold the radio in one hand so that the top of the radio faces upward, and the front of the radio faces you.
2. With the other hand, grasp the volume knob (8) and pull it upward, while pushing it toward the back of the radio, until it is free from the volume insert (9).
3. While pressing the volume insert's (9) two snap tabs away from the volume control shaft so that the insert disengages from the shaft, use needle-nosed pliers to pull the insert up and off of the volume control shaft. Discard the removed volume insert.
4. Using needle-nosed pliers or some other pointed instrument, remove the o-ring (21).

Installing the Volume Knob

1. Place the o-ring (21) inside a new volume insert (9), and press it downward until it seats securely at the bottom of the insert.
2. Hold the radio so that the top of the radio faces upward, and the front of the radio faces you.
3. Place the volume insert (9) on the volume control shaft, aligning its D-shaped hole with the D-shaped shaft**.** Press downward firmly on the insert until it "snaps" in place on the shaft.
4. Place the volume knob (8) on the volume insert (9), aligning the two lugs on the inside of the knob with the insert's two snap tabs. Press firmly downward on the knob until it seats securely in place.

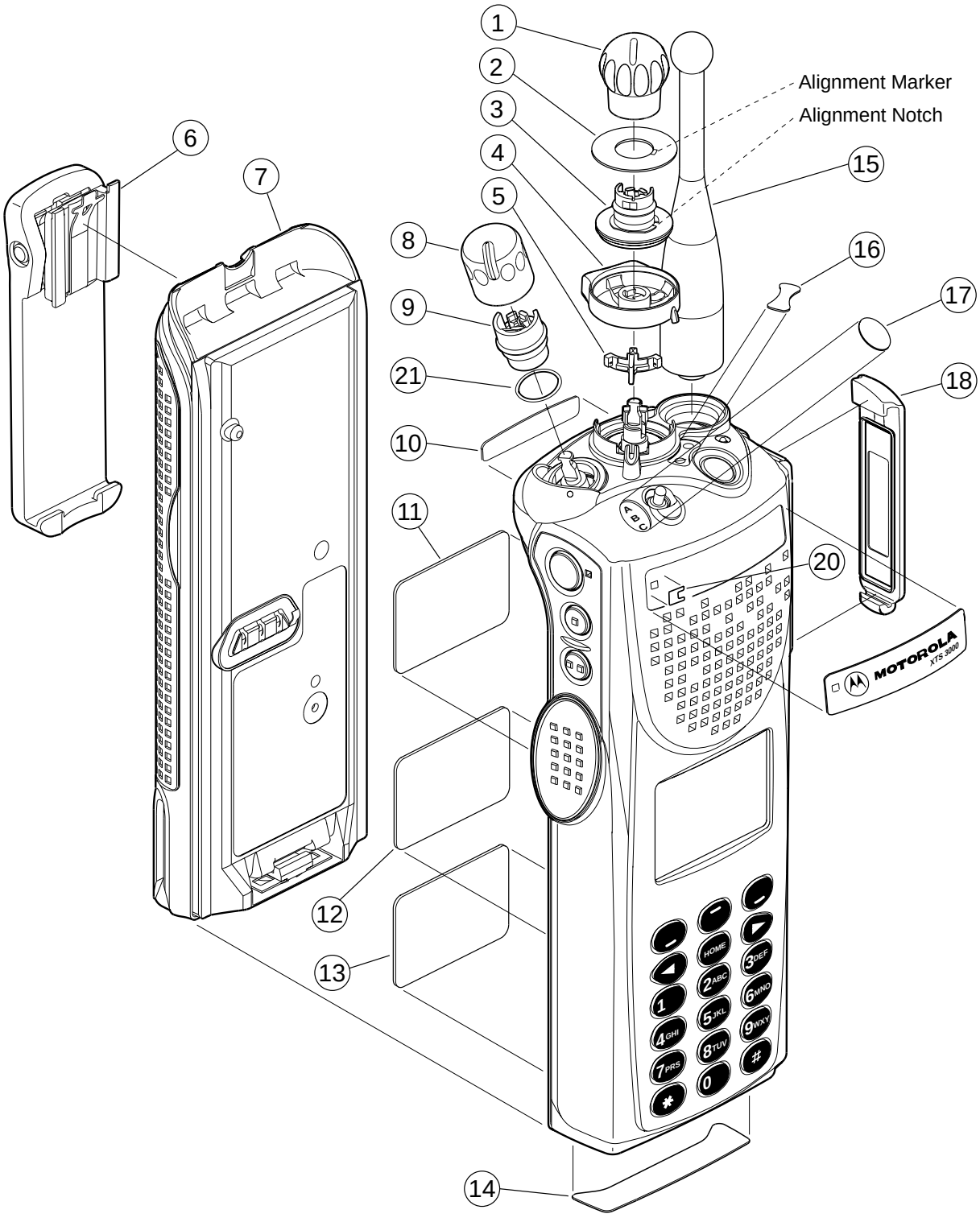


Figure 8 Partial Exploded View

Table 12 Partial Exploded View Parts List

ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	3605370Z01	KNOB, Frequency
2	1305374Z01	ESCUTCHEON, Frequency
3	4305373Z01	INSERT RETAINER, Frequency Knob
4	4305375Z01	LEVER, Secure Frequency
5	6105376Z01	LIGHTPIPE INDICATOR/STOP, Frequency
6	NTN8266A	CLIP, Belt
7	NTN8298A	Battery, NiCd
8	3605371Z01	KNOB, Volume
9	4305372Z01	INSERT RETAINER, Volume Knob
10	3305574Z01	LABEL, Motorola, Back
11	- - - - - - - - - -	LABEL, Flashport
12	- - - - - - - - - -	LABEL, Radio Serial Number
13	- - - - - - - - - -	LABEL, Approval Agency
14	3305630Z02	LABEL, Bottom
15	NAF5037A or NAF5039A or NAF5042A	ANTENNA, 800MHz Whip (806-870 MHz) ANTENNA, 800MHz Dipole (806-870 MHz) ANTENNA, 800MHz Stubby Quarterwave (806-870 MHz)
16	- - - - - - - - - -	ESCUTCHEON, Concentric Switch (optional)
17	- - - - - - - - - -	ESCUTCHEON, Toggle (optional)
18	1505579Z01	COVER, Dust, Universal Connector
19	3305573Z01	LABEL, Motorola, Front
20	3505586Z01	Gortex
21	3205379W01	O-Ring

Basic Theory of Operation

7

General Overview

The ASTRO Digital XTS 3500 radio is a wideband, synthesized, fixed-tuned radio available in the UHF band. All ASTRO Digital XTS 3500 radios are capable of both analog operation and ASTRO mode (digital) operation in 12.5kHz or 25kHz bandwidths.

The ASTRO Digital XTS 3500 radio includes the following major assemblies:

- VOCON 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.
- RF Board - contains all transmit, receive, and frequency generation circuitry including the digital receiver back-end IC and the reference oscillator.
- Controls/Universal Flex - contains volume/on/off switch, frequency selector switch, push-to-talk (PTT) switch, monitor button, several function-selectable switches, universal connector, speaker, and microphone.
- Display (Full-Featured Model Only) - a four-line, 12-character liquid crystal display (LCD).
- Keypad (Full-Featured Model Only) - a 3 x 6 keypad.

Analog Mode of Operation

When the radio is *receiving*, the signal comes from the antenna connector to the RF board, passes through the RX/TX switch and the receiver front end. The signal is then filtered, amplified, and mixed with the first local-oscillator signal generated by the voltage-controlled oscillator (VCO).

The resulting intermediate frequency (IF) signal is fed to the IF circuitry, where it is again filtered and amplified. This amplified signal is passed to the digital back-end IC, where it is mixed with the second local oscillator to create the second IF at 450kHz. 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 board through a current-driven differential output.

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

When the radio is *transmitting*, 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/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.

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 Board Basic Theory of Operation

The receiver front end consists of a preselector, an RF amplifier, a second preselector, and a mixer. 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 13 for local oscillator (LO) and first IF information.

Table 13 Local Oscillator and First IF Frequencies

	UHF
LO Frequency Range	376.65-446.65MHz
First IF Frequency	73.35MHz

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. Most of the synthesizer circuitry is enclosed in rigid metal cans on the RF board to reduce microphonic effects.

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 4kHz 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 2.4MHz synthesis circuit to provide a clock to the DSP-support IC on the VOCON board. 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 Board Basic Theory of Operation

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

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 16.8MHz clock from the RF board. 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 8kHz 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 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 2.4MHz clock, and receives data and formats it for the DSP.