APX™ TWO-WAY RADIOS

APX 4000XH BASIC SERVICE MANUAL

Foreword

This manual covers all models of the ASTRO® APX™ 4000XH digital portable radio, unless otherwise specified. It includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, self-maintained customers, and distributors.

For details on radio operation or component-level troubleshooting, refer to the applicable manuals available separately. A list of related publications is provided in the section, “ Related Publications” on page xiii.

Product Safety and RF Exposure Compliance

Before using this product, read the operating instructions for safe usage contained in the Product Safety and RF Exposure booklet enclosed with your radio.

ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the guide enclosed with your radio which contains important operating instructions for safe usage and RF energy awareness and control for compliance and applicable standards and regulations.

For a list of Motorola Solutions-approved antennas, batteries, and other accessories, visit the following
web site: www.motorolasolutions.com/APX

Manual Revisions

Changes which occur after this manual is printed are described in PMRs (Publication Manual Revisions). These PMRs provide complete replacement pages for all added, changed, and deleted items. To obtain PMRs, go to https://businessonline.motorolasolutions.com.

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Intrinsically Safe Radio Information(only applies to IECEx radios)

Hazardous Location Safety Instruction and Approved Accesories Listing for Radio Models below:

- APX 4000XH (Full Keypad Model)

IECEx

The models listed above, when properly equipped with the battery NNTN8750_, are certified for use per the classification below:

- Ex ib IIA T3 Gb (Approved for Zone 1,2, Equipment group II, Gasgroup 2A, Temperature classs T3)

ATEX

The radio models listed above, when properly equipped with the battery NNTN8750_, are certified for use per the classification below:

- II 2G Ex ib IIA T3 Gb (Approved for Zone 1,2, Equipment group II, Gasgroup 2A, Temperature classs T3)

The radios listed above are certified for:

- Ambient temperature range: -20°C ≤ Tamb ≤ 55 °C
- Ingress protection level: IP67

Operational Cautions for Intrinsic Safe Equipment

Radios must ship from the Motorola Solutions manufacturing facility with the potentially explosive atmosphere capability and the intrinsic safety approval labelling (FM, UL, CSA, ATEX/IECEx or ATEX). Radios will not be upgraded to this capability and labeled once they have been shipped to the field. A modification changes the radio's hardware from its original design configuration. Modifications can only be made by the original product manufacturer.

- **Do not operate radio communications equipment in a potentially explosive atmosphere unless it is a type especially qualified (for example, FM, UL, CSA, or ATEX/IECEx or ATEX approved). An explosion or fire may result.**
- **Do not operate a radio unit that has been approved as intrinsically safe product in a potentially explosive atmosphere if it has been physically damaged (for example, cracked housing). An explosion or fire may result.**
- **Do not replace or charge batteries in a potentially explosive atmosphere. Contact sparking may occur while installing or removing batteries and cause an explosion or fire.**
- **Do not replace or change accessories in a potentially explosive atmosphere. Contact sparking may occur while installing or removing accessories and cause an explosion or fire.**
- **Turn the radio off before removing or installing a battery or accessory.**
- **Do not disassemble an intrinsically safe product in any way that exposes the internal circuits of the radio.**
- **Failure to use an intrinsically safe approved battery or Approved accessories specifically approved for the radio unit may result in the dangerously unsafe condition of an unapproved radio combination being used in a hazardous location.**
- **Unauthorized or incorrect modification of the intrinsically safe approved Product will negate the approval rating of the product.**
- **Incorrect repair or relabeling of any intrinsically safe Agency-approved radio could adversely affect the Approval rating of the radio.**
- **Use of a radio that is not intrinsically safe in a potentially explosive atmosphere could result in serious injury or death.**

Repairs of Motorola Solutions ATEX/IECEx certified intrinsically safe radios must be carried out ONLY by Motorola Solutions I.S. trained personnel, who are aware of the special parts required and the procedures necessary to maintain the ATEX/IECEx conformance of the product. The Motorola Solutions internal service centres undergo regular training and receive a Motorola Solutions internal certification that enables them to conduct ATEX repairs.

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Document History

The following major changes have been implemented in this manual since the previous edition:

Edition	Description	Date
MN002150A01-AA	Initial edition	Aug. 2015
MN002150A01-AB	Updated 800/900 MHz Model Chart table. Updated Front Kit Exploded View Parts List table.	Jan. 2016
MN002150A01-AC	Removed R-2670 Communication Analyzer information from the manual.	Dec. 2018
MN002150A01-AD	Updated the following sections in Chapter 6 Radio Alignment Procedures: • Reference Oscillator Alignment • Power Characterization Points • Power Characterization Tuning	Sep. 2019
MN002150A01-AE	Updated the Top Control Flex part number in the APX 4000XH Front Kit Exploded View Parts List table.	Apr. 2020
MN002150A01-AF	Added a note in Chapter 5 Performance Checks	Sep. 2022

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Commercial Warranty

For details on the regional Motorola Solutions Service Centers, Replacement Parts Ordering and Technical Support assistance, refer to the relevant regions in the Appendix section of this manual.

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Related Publications

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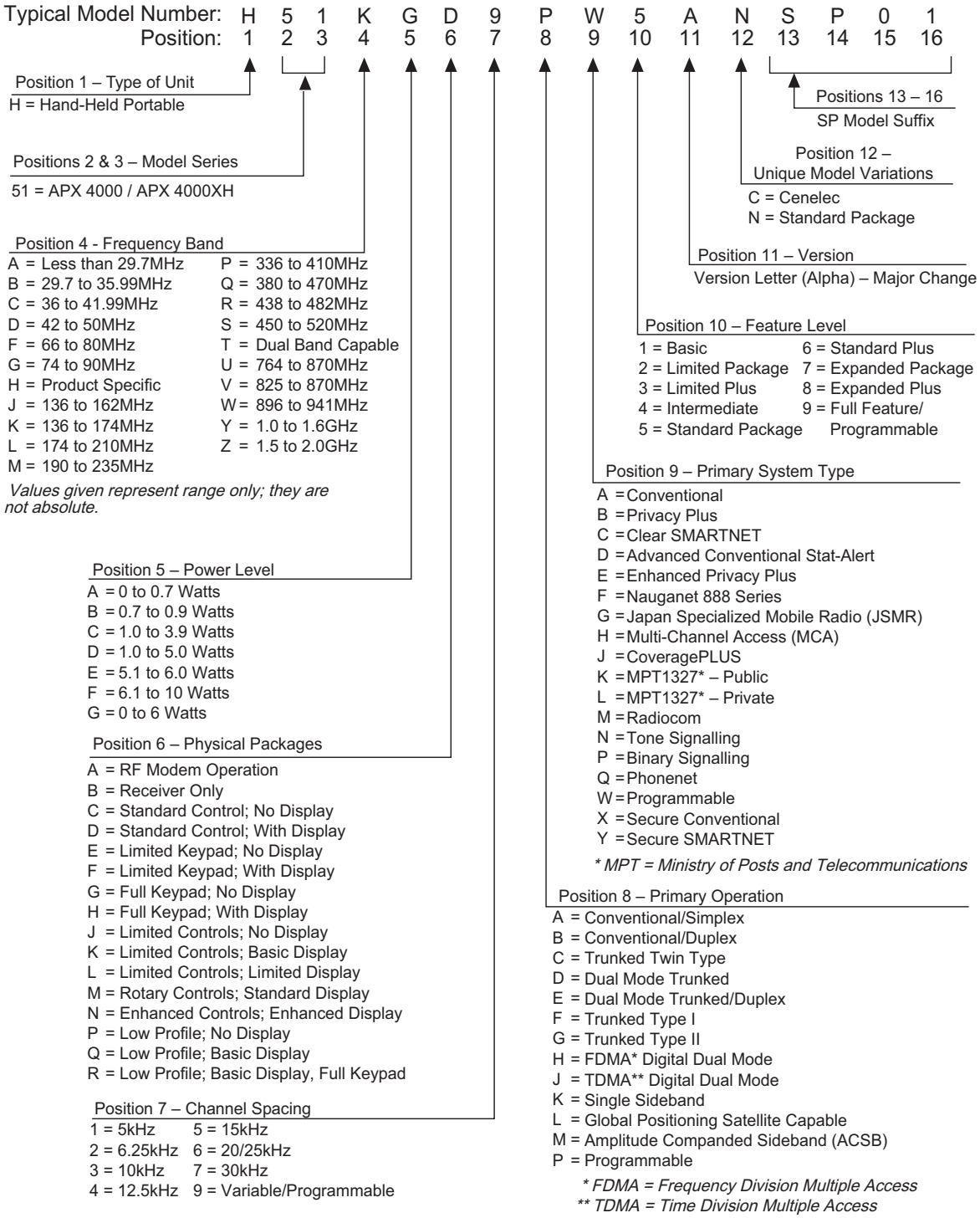
Model Numbering, Charts, and Specifications

Portable Radio Model Numbering System



ASTRO APX 4000XH 800/900 MHz Model Chart

	MODEL DESCRIPTION:	8/900 MHz, APX 4000XH
	FCC ID:	AZ489FT7063
	H51VCH9PW7AN	APX 4000XH 8/900 MHz, Full Keypad
	ITEM NUMBER	DESCRIPTION
X	PMLN7232_	Assembly, Front Kit
X	03012040001	Screw, Keypad Bezel
X	HN000516A01	Bezel, Keypad
X	KP000063A01	Keypad, Main
X	0104065J53	Assembly, Flex, Back Mic
X	3275002C03	Membrane, Back Mic
X	32012282001	Boot, Back Mic
X	HW000619A01	Backer, Back Mic
X	CH000087A01	Chassis
X	SL000166A01	Seal, Battery Contact
X	HN000642A01	Shroud
X	SL000148A01	O-ring, Main
X	PMLF4175_	Board Assembly, Service Kit, 8/900 MHz
X	HW000618A01	Audio, Pogo Pin Collar
X	HW000621A01	Battery Bumper
X	03012039004	Screw, RF cable
X	CB000238A01	Coax Cable, RF
X	FN000161A01	Screw, Chassis
X	3286058L01	Seal, Vacuum Port
X	54012298001	Label, Ventilation
X	LB000381A01	Label, Battery Warning
●	LB000577A01	Label, Back
O	LB000382A01	Label, CSA
O	LB000541A01	Label, ATEX
O	LB000541A02	Label, CEPEL
X	LB000383A01	Label, Tamper Proof
X	HW000535A01	Volume knob
X	HW000536A01	Channel knob
X	SL000144A01	Torque Enhancer
X	FN000169A01	Screw, Top bezel
X	HN000559A01	Bezel, Top Control
X	0104067J27	Dust cover
X	PMLN7349_	User Guide CD, APX 4000XH
X	HW000837A01	Pad, Thermal

Note:
X *= Item Included.*
● *= Option available. Can be serviced in depot and ordered thru AAD.*
O *= Option available. Can be serviced in depot and orderable by ATEX/IECEX qualified customers/dealers only.*
• *Refer* Appendix A *for antennas, batteries and other applicable accessories.*
* *The radio's model number and FLASHcode are required when placing an order for the Main Board.*
- *The model number and (sometimes) the FLASHcode can be found on the FCC label on the back of the radio.*
- *The model number and the FLASHcode can be found by putting a radio into the Test Mode.*
- *The model number and FLASHcode can be found by using the Programming Cable (PMKN4175_) and the CPS to read a radio.*

Specifications for APX 4000XH 800/900 MHz Radios

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

GENERAL

Temperature Range:
- **Operating:** -20°C to +55°C
- **Storage:** -57°C to +85°C

Power Supply:
Lithium-Ion Battery (Li-Ion)

Battery Voltage:
- **Nominal:** 7.6 Vdc
- **Range:** 6 to 8.4 Vdc

Transmit Current Drain (Typical): 1600 mA
Receive Current Drain (Rated Audio): 330 mA
Standby Current Drain: 136 mA

Recommended Battery:
Li-Ion (Standard): NNTN8750_
* FM Intrinsically Safe.

Dimensions (H x W x D):
- **Without Battery (Radio Only):**
  H = 5.86" (148.8 mm)
  W[1] = 2.93" (74.4 mm) / 2.60" (66.1 mm)
  D[2] = 0.83" (21.0 mm) / 1.29" (32.8 mm)
- **With Standard Battery:**
  H = 5.86" (148.8 mm)
  W[1] = 2.93" (74.4 mm) / 2.60" (66.1 mm)
  D[2] = 1.69" (42.9mm) / 1.68" (42.7mm)

Note:
H = Height; W = Width; D = Depth
1 = (Width @ Top) / (Width @ PTT)
2 = (Depth @ Bottom) / (Depth @ PTT)

Weight: (w/o Antenna):
- **Less Battery:** 11.04 oz (313g)
- **With Li-Ion Standard:** 18.80 oz (533g)

RECEIVER

Frequency Range:
- **800 MHz:** 851–870 MHz
- **900 MHz:** 935–941 MHz

Bandwidth:
- **800 MHz:** 19 MHz
- **900 MHz:** 6 MHz

Analog Sensitivity (typical)
(12 dB SINAD): 0.236µV

Digital Sensitivity (typical)
- **(1% BER):** 0.33 µV
- **(5% BER):** 0.222 µV

Intermodulation (typical): -76 dB

Selectivity (typical):
- **(25 kHz Channel):** -76 dB
- **(12.5 kHz Channel):** -67 dB

Spurious Rejection (typical): -80 dB

Frequency Stability
(-30+60°C; 25°C reference): ±0.0001%

Rated Audio:
- **Internal Speaker:** 500 mW
- **External Speaker:** 500 mW

FM Hum and Noise (typical):
25 kHz -51 dB
12.5 kHz -45 dB

Distortion (typical): 1.12 %

Channel Spacing: 12.5/25 kHz

TRANSMITTER

Frequency Range:
- **800 MHz:** 806–870 MHz, 851–870 MHz
- **900 MHz:** 896–902; 935–941 MHz

RF Power:
- **800 MHz:** 1–3.0 W
- **900 MHz:** 1–2.5 W

Frequency Stability (typical)
(-30 to +60°C; 25°C ref.):
- **800 MHz:** ±0.0001%
- **900 MHz:** ±0.0001%

Emission (typical conducted): -75 dBc

FM Hum and Noise (typical)
(Companion Receiver): 25 kHz -50 dB
12.5 kHz -45 dB

Distortion (typical): 1%

Modulation Limiting: 25 kHz chnls ±5 kHz
20 kHz chnls ±4 kHz
12.5 kHz chnls ±2.5 kHz

ACPR (typical): 25 kHz -72 dBc
12.5 kHz -66 dBc

Emissions Designators:
11K0F3E, 16K0F3E, 8K10F1D, 8K10F1E, 8K10F1W, 10K0F3E

Specifications subject to change without notice.

Notes

Chapter 1 Introduction

This manual contains information needed for Levels One and Two radio servicing. Level One servicing consists of radio programming, radio alignment, knobs replacement, and installation and removal of the antenna, belt clip, battery, and universal connector cover. Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards.

1.1 Manual Contents

Included in this manual is radio specification for the 800/900 MHz (806–941 MHz) frequency bands, a general description of ASTRO APX 4000XH models, recommended test equipment, service aids, radio alignment procedures, general maintenance recommendations, procedures for assembly and disassembly, and exploded views and parts lists.

1.2 Notations Used in This Manual

Throughout the text in this publication, you will notice the use of note, caution, warning, and danger notations. These notations are used to emphasize that safety hazards exist, and due care must be taken and observed.

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

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

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.

1.3 Radio Description

The ASTRO APX 4000XH radio provides improved voice quality across more coverage area. The digital process, called *embedded signaling*, intermixes system signaling information with digital voice, resulting in improved system reliability and the capability of supporting a multitude of advanced features.

ASTRO APX 4000XH radios are available in Single Display configuration. The following table describes their basic features.

Table 1-1. ASTRO APX 4000XH Basic Features

Feature	Full Keypad
Display	• Full bitmap color LCD display • 3 lines of text x 14 characters • 1 line of icons • 1 menu line x 3 menus • White backlight
Keypad	• Backlight keypad • 3 soft keys • 4 direction Navigation key • 4x3 keypad • Home and Data buttons
Channel Capability	512
FLASHport Memory	64MB

1.4 FLASHport®

The ASTRO APX 4000XH radio utilizes Motorola Solutions's 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.

Chapter 2 Basic Maintenance

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

2.1 General Maintenance

In order to avoid operating outside the limits set by the FCC, align the ASTRO APX 4000XH radio's reference oscillator every time the radio is taken apart, or once per year, whichever comes first. (See Section 6.5.1). Periodic visual inspection and cleaning is also recommended.

2.1.1 Inspection

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

2.1.2 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 in water.

Caution

Use all chemicals as prescribed by the manufacturer. Be sure to follow all safety precautions as defined on the label or material safety data sheet.

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.

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.

2.2 Safe Handling of CMOS and LDMOS Devices

Complementary metal-oxide semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) 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.

Caution

- The APX 4000XH radio has a vent port that allows for pressure equalization in the radio. Never poke this vent with any objects, such as needles, tweezers, or screwdrivers. This could create a leak path into the radio and the radio's submergibility will be lost.
- The pressure equalization vent is located adjacent to the battery contact opening of the main chassis. Never touch the equalization vent. Ensure that no oily substances come in contact with this vent.
- The APX 4000XH radio is designed to be submerged to a maximum depth of six (6) feet, with a maximum submersion time of 2 hours per U.S. MIL-STD. Exceeding either maximum limit may result in damage to the radio.

If the radio battery contact area has been submerged in water, dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water could short-circuit the radio.

If the radio has been submerged in water, shake the radio briskly so that any water that is trapped inside the speaker grille and microphone port can be removed. Otherwise, the water will decrease the audio quality of the radio.

Chapter 3 Basic Theory of Operation

This chapter discusses the basic operational theory of the ASTRO APX 4000XH radio. The ASTRO APX 4000XH radio, which is a single-band synthesized radio, is available in 800/900 MHz (806–941 MHz) band.

All ASTRO APX 4000XH radios are capable of analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only), X2-TDMA mode (25 kHz only) and Phase 2 TDMA mode (12.5 kHz only).

NOTE: The APX 4000XH radio do not support MACE function. As such, disregard all references to the functions mentioned above in “Chapter 3 Basic Theory of Operation”.

3.1 Major Assemblies

The ASTRO APX 4000XH radio includes the following major assemblies (See Figure 3-1.):

- **Main Board –** Contains all transmit, receive, and frequency generation circuitry, including the digital receiver back-end IC and the reference oscillator. The main board also contains a dual core processor, which includes both the microcontroller unit (MCU) and a digital signal processor (DSP) core, the processors's memory devices, an audio and power supply support integrated circuit (IC), a digital support IC and external power amplifier.
- **Expansion Board** – Contains Bluetooth controller (AVR IC), a 3-axes digital accelerometer as well as combination Global Positioning System (GPS) and Bluetooth 2.1 IC and front end circuitry.
- **Control Top** – Contains two knobs, Volume knob and Channel Knob, a push button switch used for Emergency call and a light bar. The control top also includes TX/RX LED that is solid amber upon receive and red on PTT.
- **Main Display** – 160 pixels x 90 pixels, transflective color LCD.
- **Keypad**
  - Full Keypad Version has 3 soft keys, 4 direction Navigation key, 3x4 alphanumeric keypad, Home and Data buttons.

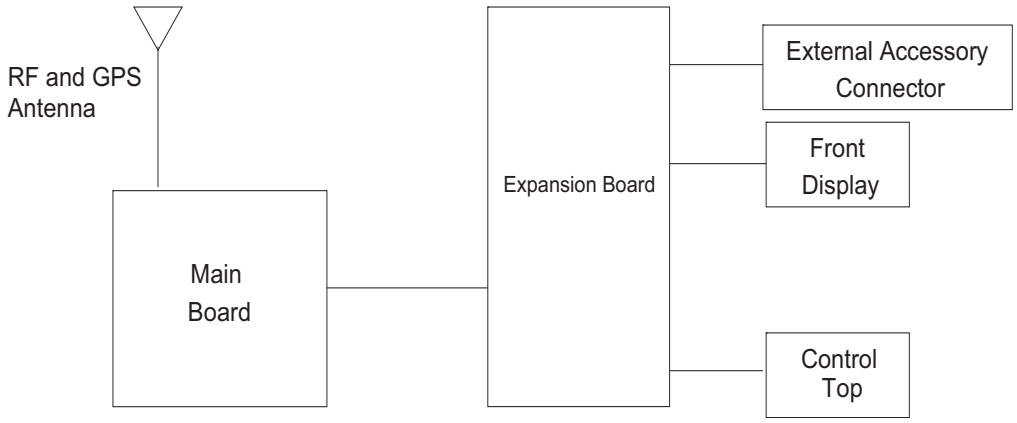


Figure 3-1. APX 4000XH Overall Block Diagram

3.2 Analog Mode of Operation

This section provides an overview of the analog mode receive and transmit theory of operation.

3.2.1 Receiving

The RF signal is received at the antenna and is routed through the Harmonic Filter, followed by the Antenna Switch and finally the 15dB Step Attenuator IC. The latter contains a switchable attenuator that is enabled at predetermined RF power thresholds present at the antenna port. See Figure 3-2.

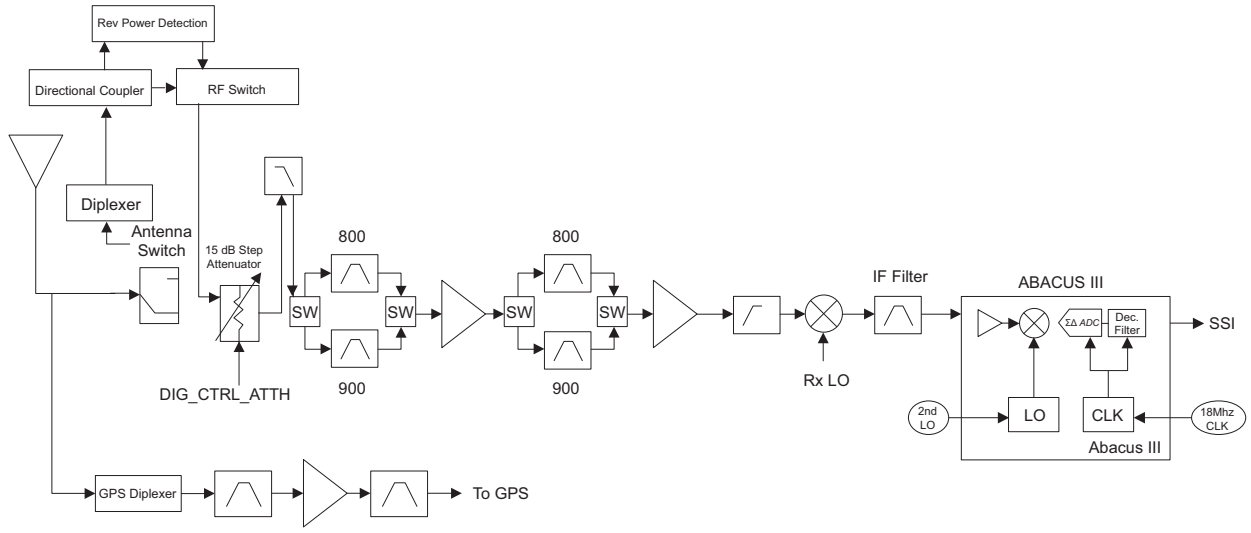


Figure 3-2. Receiver Block Diagram (800/900 MHz)

3.2.1.1 GPS

The GPS signal is tapped at the antenna port via a series resonant network (diplexer) which provides a very low capacitive load to the transceiver. The diplexer circuitry provides rejection to radio band signals up to ~1GHz which serves as isolation between the radio RF and GPS signal paths. The GPS signal is filtered though a GPS SAW filter - LNA – Saw filter chain before going into the TI GPS IC for processing.

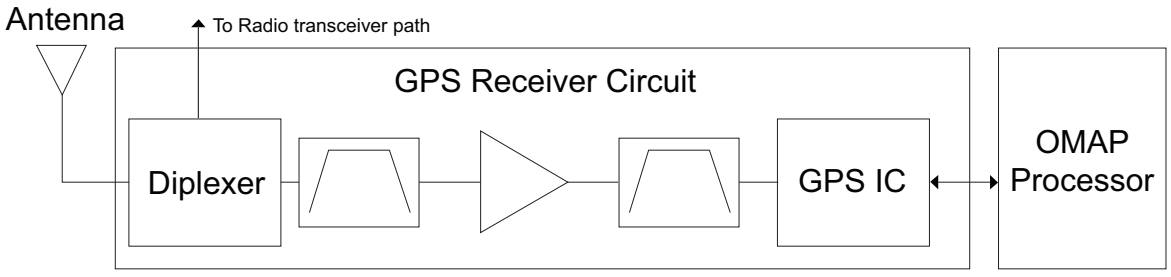


Figure 3-3. GPS Diagram

3.2.1.2 800/900 MHz Front-End

A 800/900 MHz band signal is routed to the first band SPST switch which selects the 800 or the 900 band signal, passing through the Harmonic Filter and routes it to the appropriate first pre-selector filter. A second band select switch selects the output of the appropriate filter and applies it to an LNA followed by a similar pre-selector filter/ band-select switch circuit. The signal is then routed to a second LNA whose output is applied to a discrete image filter. Both preselector filters are Surface Acoustic Wave designs used to band limit the received energy and suppress known spurious responses such as Image and the ½ IF spur. The output of the discrete image filter is applied to the RF port of the Mixer IC. The Mixer IC is also excited by a Local Oscillator (LO) signal at the LO port to down-convert the RF signal to a 109.65 MHz intermediate frequency (IF). The down converted IF signal is passed through a crystal filter which drives the input of the Abacus 3 Analog to Digital Converter IC (AD9864).

3.2.1.3 Analog To Digital Converter

The ADC IC's front end down converts the first IF to a second IF, a 2.25 MHz signal. The second IF is sampled at 18 MHz, a signal generated by an integrated clock synthesizer. The sampled signal is decimated by a factor of 900 to 20 kHz and converted to SSI format at the ADC's output. The Serial Synchronous Interface (SSI) serial data waveform is composed of a 16 bit in-phase word (I) followed by a 16 bit Quadrature word (Q). A 20 kHz Frame Synch and a 1.2 MHz clock waveform are used to synchronize the SSI IQ data transfer to the Digital Signal Processor IC (OMAP) for post-processing and demodulation.

3.2.2 Transmitting

When the radio is transmitting, microphone audio is digitized and then processed by the DSP and sent to the Trident IC (see Figure 3-4) via the SSI interface. The Trident IC processes the SSI data for application to the voltage controlled oscillator as a modulation signal.

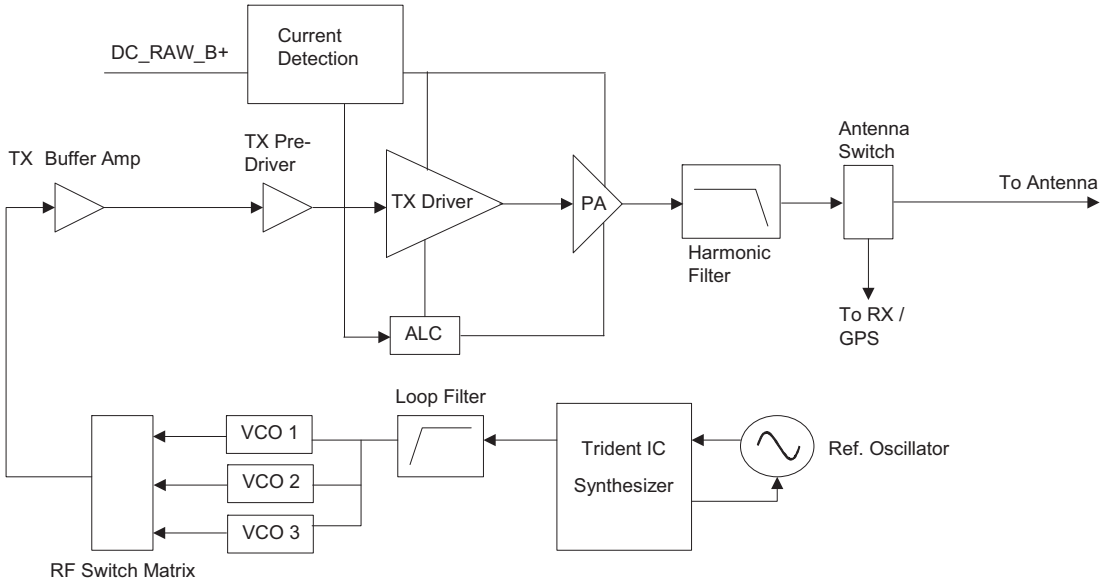


Figure 3-4. Transmitter (800/900 MHz) Block Diagram

3.2.2.1 800/900 MHz Transmit

Once a 800/900 MHz frequency for transmit has been selected, the Trident IC and accompanying logic circuitry enable the correct voltage controlled oscillator which then generates the desired transmit frequency. This transmit signal is then routed to the TX buffer amplifier which amplifies the signal. The signal is routed to the 8900 Pre-Driver amplifier, then to the discrete Driver power amplifier and then into the Final discrete power amplifier. The signal now goes through the harmonic filter which will filter out the harmonics of the carrier signal and this signal now goes through the antenna switch which routes to the antenna. The current detection circuit will be monitored the current drain of driver amplifier and final power amplifier and feedback to ALC circuitry to adjusts the control voltages to the driver amplifier and final power amplifier.

3.3 Digital (ASTRO) Mode of Operation

In the ASTRO (digital) mode of operation, the transmitted or received signal is limited to a discrete set of frequency deviation levels. 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 different algorithm to recover data.

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. Using this algorithm, transmitter FM deviation is limited to discrete levels.

3.4 Controller Section

The controller section (See Figure 3-5.) comprises of five functional sections that are split among two boards, which are the main and keypad boards. The main functional section consists of a dual core ARM and DSP controller, Flash memory, and a Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM) and CPLD for GPIO expander multiple clock generation and SSI interface for the radio system. The Power and Clocks section includes a power management IC (MAKO) and various external switching regulators, and three clock sources (12 MHz and 24.576 MHz) from which all other controller digital clocks are derived. The Audio section has a CODEC and a class-AB audio power amplifier that provides the radio with a microphone and speaker design. The User Interface section provides communication and control to the main Liquid Crystal Displays (LCD) on the radio, as well as a keypad and a side connector interface conforming to GCAI (Global Communications Accessory Interface) specifications. The GPS and Bluetooth section comprises of a Global Positioning Satellite(GPS) and Bluetooth combo chipset on the main board, and an AVR Bluetooth controller IC, SDRAM, LF wakeup IC and Accelerometer IC on the keypad board.

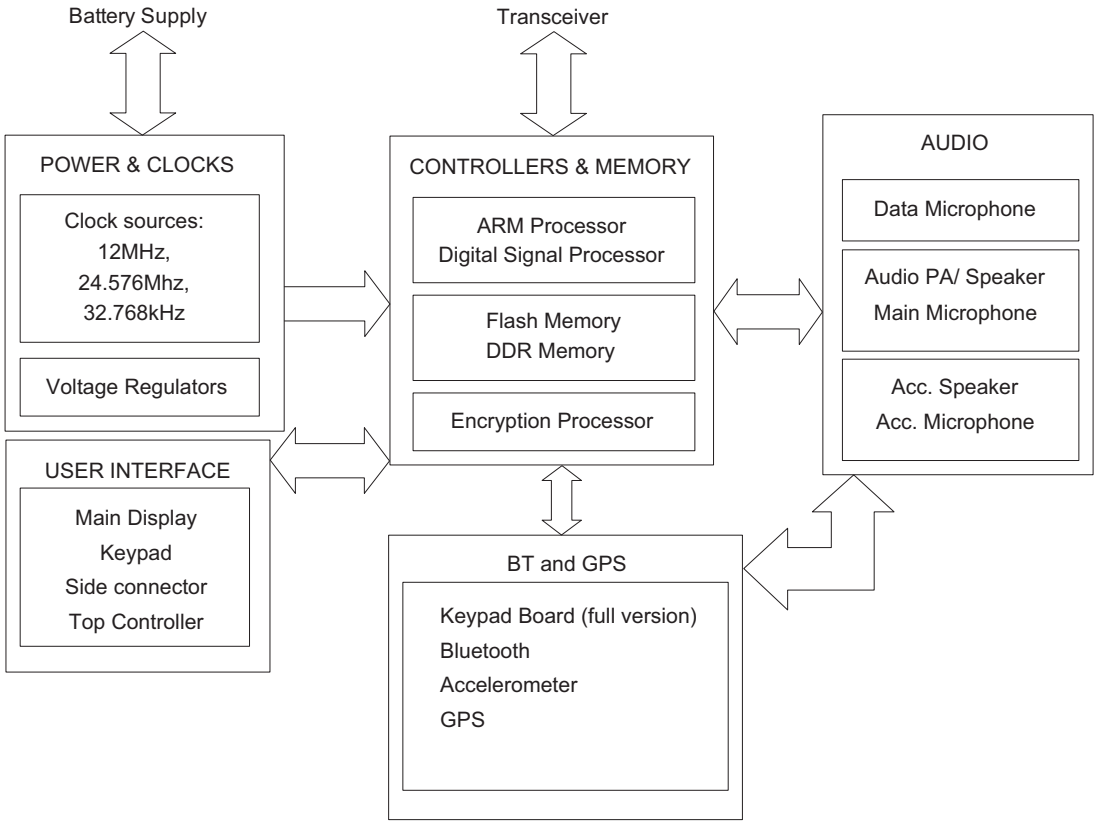


Figure 3-5. Controller Block Diagram

The ARM controller core of the OMAP processor handles the power up sequence of all devices, including firmware upgrades, and all operating system tasks that are associated with FLASH and SDRAM memories and user interface communication. The FLASH memory (64 MB) is required to store the firmware, tuning, and Codeplug settings, which upon initialization get read and stored into SDRAM (64 MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses to enable radio FM and optional wireless communication protocols.

The power and most clocks to the controller devices are provided by the MAKO IC and external switching and linear regulators on board. A Complex Programmable Logic Array (CPLD) IC divides the 24.576 MHz clock from MAKO to source OMAP's 32 kHz Real Time Clock. OMAP's main clock is supplied externally from an on board 12 MHz crystal.

The radio has two internal microphones and an internal speaker, as well as available microphone and speaker connections for external accessories. The internal 16 Ohm speaker is located on the same side as the main display and keypad of the radio. The internal speaker is driven by a Class AB audio amplifier located on the main board that is capable of delivering a rated power of 0.5 W. The external accessory speaker is driven by a Class AB audio amplifier on the MAKO IC that is capable of delivering 0.5 W of power into a 16 Ohm as a minimum load. Both speaker paths use the CODEC for volume control and to convert the audio signal from digital to analog. Both internal and external microphones use the CODEC's ADC to deliver digital audio samples to the DSP controller.

The user interface block consists of a main display, a keypad, top controls and the accessory side connector. The side connector (Universal Connector) provides audio, USB, RS232 communication for accessories. All signals to and from the connector go through the internal keypad board before reaching the microcontroller and other devices on the main board.

The radio has integrated feature of Global Positioning System (GPS) and Bluetooth with Man-down feature. The GPS and Bluetooth Combo RF chipset (NL5500) is located on the Expansion board together with the GPS/RF Diplexer circuitry located on the Main Board. The GPS receiver section of the GPS/BT combination IC interfaces with the OMAP processor through a dedicated UART port. The GPS receiver also has a dedicated reset controlled solely by the OMAP processor. The GPS/ Bluetooth IC (NL5500) taps the GPS signal from transceiver path and processes the location information before relaying to the OMAP processor via UART lines. The clock supplies to NL5500 included a 26 MHz TCXO and 32kHz clock from CPLD.

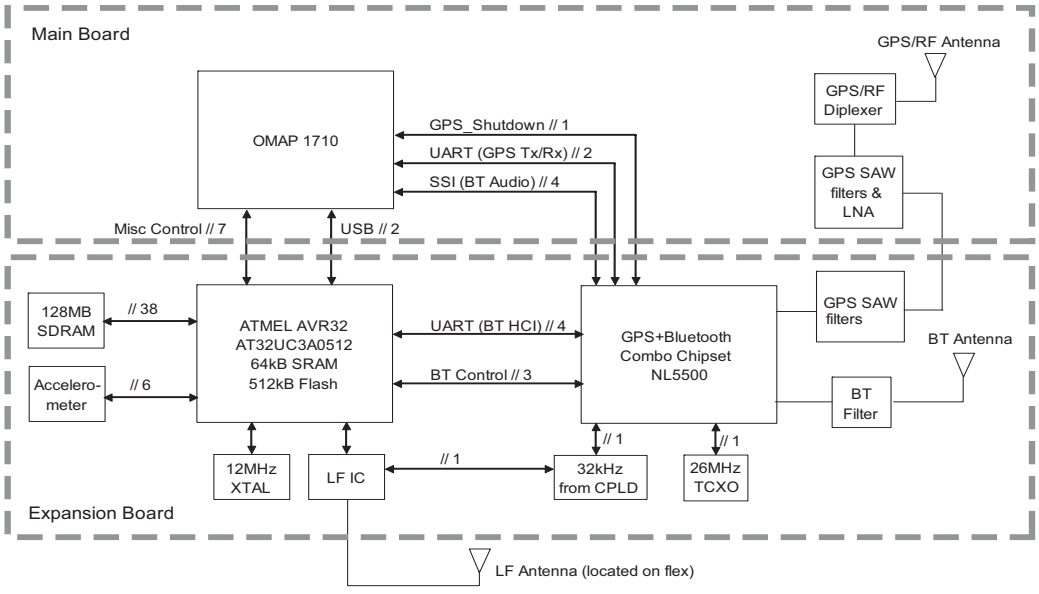


Figure 3-6. GPS/Bluetooth/Accelerometer Block Diagram

3.4.1 Expansion Board

The Expansion Board consists of a 3-axes digital accelerometer and the Bluetooth Controller IC (AVR) together with LF Wakeup IC (AS3930A) for Secure Pairing.

The radio also has the ability to connect to a wireless Bluetooth audio headset. This feature is implemented using a combination Bluetooth/GPS integrated circuit (NL5500 IC) located on the Expansion board. An optional accessory headset can connect using a low-data rate GFSK modulated signal hopping on 79 x 1 MHz wide Bluetooth channels from 2402 MHz to 2480 MHz in the ISM band. Bluetooth uses a frequency hopping spread spectrum (FHSS) technique to spread the RF power across the spectrum to reduce the interference and spectral power density. The frequency hopping allows the channel to change up to 1600 times a second (625 μs time slot) based on a pseudo random sequence. If a packet is not received on one channel, the packet will be retransmitted on another channel. The Bluetooth IC sends data to the AVR32 processor that is also located on the keypad board over an HCI UART link. The AVR32 processor communicates to the OMAP processor on the main board through a dedicated USB port.

The Bluetooth feature is accompanied by a Low-Frequency (LF) detection circuit that is also located on the Expansion board. The LF circuit provides the ability of a secure pairing connection with a Bluetooth accessory. Once a radio has the Bluetooth feature enabled, a user can tap their LF enabled Bluetooth audio accessory with the radio at the pairing spot to establish a secure Bluetooth connection. The LF circuit uses a 125 kHz radiated signal to communicate the secure pairing information between the Bluetooth accessory and low-frequency receiver. The low-frequency receiver is programmed by the AVR32 processor through a dedicated SPI bus and transfers the pairing data through a dedicated UART.

There is a digital accelerometer on the keypad board that detects the 3-axis force of gravity which can be used to determine the radio's orientation. The accelerometer's position is communicated to the AVR32 processor through a SPI bus.

Chapter 4 Recommended Test Equipment and Service Aids

This chapter provides lists of recommended test equipment and service aids, as well as information on field programming equipment that can be used in servicing and programming ASTRO APX 4000XH radios.

4.1 Recommended Test Equipment

The list of equipment contained in Table 4-1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola Solutions model listed is either a unique item or no substitution is recommended.

Table 4-1. Recommended Test Equipment

Equipment	Characteristics	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Aeroflex 3920** (www.aeroflex.com)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment. (**) Referenced in this manual as an example for test setup guidelines.
Digital RMS Multimeter *	100 µV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator *	100 MHz to 1 GHz -130 dBm to +10 dBm FM Modulation 0 kHz to 10 kHz Audio Frequency 100 Hz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com, or equivalent	Receiver measurements
Oscilloscope *	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 9240 (www.boonton.com) or equivalent	Waveform measurements
Power Supply	0 V to 32 V 0 A to 20 A	B&K Precision 1790 (www.bkprecision.com) or equivalent	Voltage supply

4.2 Service Aids

Refer to Table 4-2 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 Radio Products and Solutions Organization offices listed in "Appendix B Replacement Parts Ordering" . While all of these items are available from Motorola Solutions, most are standard shop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 4-2. Service Aids

Motorola Solutions Part Number	Description	Application
PMNN4501_	Battery Adapter	Used in place of battery to connect radio to an external power supply.
TL000071A01	Chassis/Knob Opener	To remove chassis and knob from housing.
TL000072A01	Vacuum/Pressure Test Fixture	To connect the vacuum/pressure hose of the Vacuum/ Pressure Pump Kit to the radio.
NTN4265_	Pressure Pump Kit	For pressure test.
NLN9839_	Vacuum Pump Kit	Vacuum pump with gauge and vacuum hose.
5880384G68	SMA to BNC Adapter	Adapts radio's antenna port to BNC cabling of test equipment.
RVN5224_	Customer Programming Software (CPS) and Tuner Software	CPS allows customer-specific programming of modes and features. Tuner software required to perform alignment of radio parameters.
PMKN4175_	Programming/Service Cable	To program and service the radio through Customer Programming Software and Tuner Software.
RLN4460_	Portable Test Set	For radio performance checks. Connects to radio's universal connector and allows remote switching and signal injection/ outputs for test equipment measurements.

4.3 Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in the Customer Programming Software (CPS) for complete field programming information.

Chapter 5 Performance Checks

This chapter covers performance checks used to ensure that the ASTRO APX 4000XH radio meets published specifications.

NOTE: Radios coming from manufacturing do not need to be tuned. Reference oscillator should be checked and aligned (if necessary) for radios in storage for six months or more before commission for service.

The recommended test equipment listed in the previous section approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the test equipment must be maintained in compliance with the manufacturer's recommended calibration schedule. Checks should be performed if radio performance degradation is suspected.

5.1 Test Equipment Setup

Supply voltage can be connected from the battery eliminator. The equipment required for the performance checks is connected as shown in Figure 5-1.

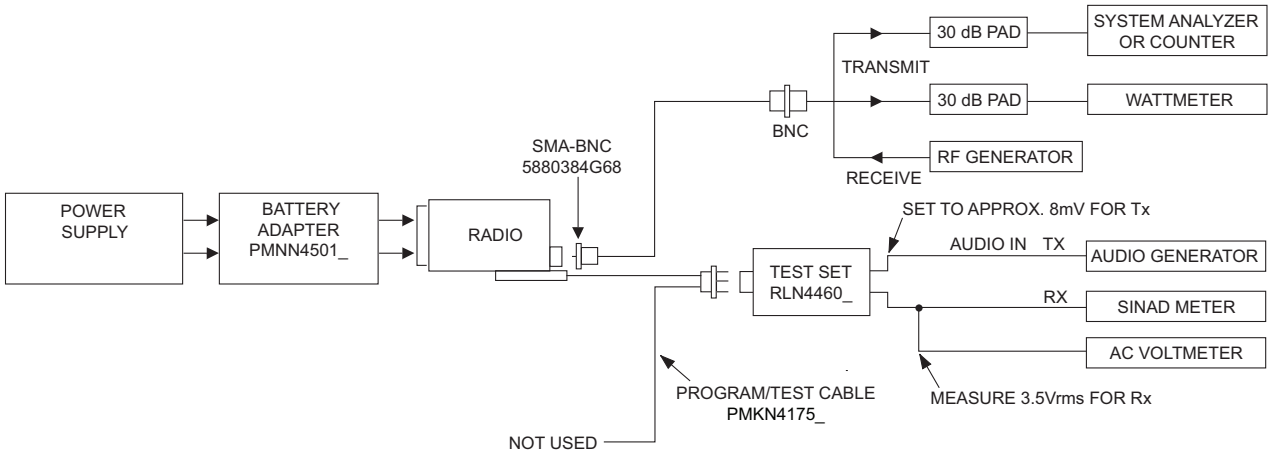


Figure 5-1. Performance Checks Test Setup

Initial equipment control settings should be as indicated in Table 5-1 and should be the same for all performance checks and alignment procedures, except as noted.

Table 5-1. Initial Equipment Control Settings

System Analyzer	Test Set	Power Supply
Mode: Analog Duplex*	**Spkr/Load:** Speaker	**Voltage:** 7.5 Vdc
Receiver Checks **RF Control:** Generator **Output Level:** -47 dBm **Modulation:** 1 kHz tone @3 kHz deviation **Frequency:** Set to selected radio RX frequency **Meter:** RF Display Transmitter Checks **RF Control:** Analyzer **Frequency:** Set to selected radio TX frequency **Meter:** RF Display **Modulation Type:** FM	**PTT:** OFF (center)	**DC On/Standby:** Standby
	Meter Out: RX	**Volt Range:** 10 Vdc
	Opt Sel: ON	**Current:** 2.5 A

* *Use "PROJ 25 STD" if testing ASTRO Conventional channels.*

5.2 Display Radio Test Mode

This section provides instructions for performing tests in display radio test mode.

5.2.1 Access the Test Mode

To enter the display radio test mode:

1. Turn the radio on.
2. Within 10 seconds, press **Side Button 2** five times in succession.

   The radio shows a series of displays that give information regarding various version numbers and subscriber specific information. The displays are described in Table 5-2.

Table 5-2. Test-Mode Displays

Name of Display	Description	Appears
Service	The literal string indicates the radio has entered test mode.	Always
Host version	The version of host firmware is displayed.	Always
DSP version	The version of DSP firmware is displayed.	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
ESN	The radio's unique electronic serial number	Always
ROM Size	The memory capacity of the host FLASH part	Always
FLASHcode	The FLASH codes as programmed in the codeplug	Always
RF band 1	The radio's operating frequency	Always
Tuning Ver	Version of Tuning codeplug	Always
Proc Ver	Version of Processor	Always
Option Board Type	Type of Expansion board being used	Always
Option Board Serial Number	Serial number of the Expansion board is displayed	Always
Option Board Bluetooth Addr	Bluetooth Address of the board is displayed	Always
Option Board Sw Version	Software version of the Expansion Board is displayed	Always
Exp Board Type	Type of Expansion Board is displayed	Always

NOTE: All displays are temporary and will expire 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" is displayed.

To freeze any of the displays, press the left arrow on the 4-Way Navigation Button. To resume automatic scrolling, press the right arrow on the 4-Way Navigation Button. To rapidly scroll forward through the displays, continue pressing the right arrow. You cannot scroll backwards.

NOTE: Press the **Top Side Button** (Purple button) to advance the test environments from "RF TEST", "CH TEST", "RGB TEST" then press the **Top Button** (Orange button) to confirm selection. Press any other buttons to advance the test.

Once a test is carried out, restart the radio to proceed to another test.

3. Do one of the following:
   - Press the **Top Side Button** to stop the displays and toggle between RF test mode and the Control Top and Keypad test mode. The test mode menu "CH TEST" is displayed, indicating that you have selected the Control Top and Keypad test mode. Go to Section 5.2.3.

     NOTE: Each press of the **Top Side Button** (Purple button) scrolls through "RF TEST", "CH TEST" and "RGB TEST".

   - Press the **Top Button** (Orange button) to stop the displays and put the radio into the RF test mode. The test mode menu, "1 CSQ", is displayed, indicating test frequency 1, Carrier SQuelch mode. Go to Section 5.2.2.

     NOTE: Once your radio is in a particular test mode, you must turn off the radio and turn it back on again to access the other test mode.

5.2.2 RF Test Mode

When the ASTRO APX 4000XH 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 using a special routine, called **RF TEST MODE**.

While in RF test mode:

- Each additional press of **Side Button 2** advances to the next test channel as shown in Table 5-3)
- Pressing **Side Button 1** scrolls through and accesses the test environments as shown in Table 5-4.
- Pressing **Top Side Button** scrolls through the Tx Deviation Frequency.

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

Table 5-3. Test Frequencies (MHz)– 800/900 MHz

Test Channel	800/900 MHz	
	RX	TX
F1	851.0625	806.0125
F2	862.0625	820.9875
F3	869.9375	824.9875
F4	935.0625	851.0125
F5	938.0625	865.9875
F6	940.9375	869.9875
F7	851.0625	896.0125
F8	869.9375	901.9875
F9	935.0625	935.0125
F10	940.9375	940.9875

Table 5-4. 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: Digital Voice***
USQ	Carrier Unsquelch	RX: unsquelch always TX: mic audio

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

5.2.3 Control Top and Keypad Test Mode

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

5.2.3.1 Control Top Checks

To perform the control top checks:

NOTE: Rotate the Channel Knob; “4/0" through "4/15" appears.

1. Press and hold the **Emergency Button** (Orange button); the radio icons are displayed, and the LED lights amber and lightbar LED light green.
2. Release the **Emergency Button**; “148/0” appears, which indicates that the **Emergency Button** is in the open position. Your radio is now in the Control Top and Keypad test mode.
3. Press the **Emergency Button** again; “148/1” appears, which indicates that the **Emergency Button** is in the closed position.
4. Rotate the **Volume Control**; “2/0” through “2/255” appear. The display values may vary slightly at the upper and lower limits.
5. Press the **Top Side Button**; “96/1” appears; release, “96/0” appears.
6. Press **Side Button 1**; “97/1” appears; release, “97/0” appears.
7. Press **Side Button 2**; “98/1” appears; release, “98/0” appears.
8. Press the **PTT Button**; “1/1” appears; release, “1/0” appears.

5.2.4 RGB Test Mode

To perform the RGB Color Test:

1. Press and release **Emergency Button** (Orange button)
2. Press any key; Crosstalk test patterns appears.
3. Press any key; White color test appears.
4. Press any key; Red color horizontal lines appears.
5. Press any key until all 10 red color horizontal lines appears.
6. Press any key; Green color vertical line appears.
7. Press any key until all 10 green color vertical lines appears.
8. Press any key; Black color test appears.
9. Press any key; Blue color test appears.
10. Press any key; Vendor specific display test appears.
11. Press any key; "Test completed" appears.

5.3 Receiver Performance Checks

The following tables outline the performance checks for the receiver.

Table 5-5. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Analyzer **Meter:** RF Display/ Frequency Offset **Freq:** Selected radio TX frequency	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check)	**800/900 MHz:** ±1.5ppm
Rated Audio	**RF Control:** Generator **Output Level:** -47 dBm **Freq:** Selected radio RX frequency **Mod:** 1 kHz tone @ 1.5 kHz deviation** **Meter:** RF Display/Audio Level	As above	**PTT** to OFF (center)	Set volume control to 3.5 Vrms
Distortion	As above, except **Meter:** RF Display/AF Meter Distn	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except **Meter:** RF Display/AF Meter SINAD **RF Output Level:** Adjust untill SINAD = 12 dB	As above	As above	RF input to be < 0.35 µV
Noise Squelch Threshold (only radios with conventional system need to be tested)	Set as for rated audio check	Out of TEST MODE; select a conventional system	As above	Set volume control to 3.5 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at < 0.25 µV. Preferred SINAD = 6-8 dB.

* *See* Table 5-4.

** *1 kHz tone @ 1.5 kHz deviation for 12.5 kHz ChSp, OR 3 kHz deviation for 25 kHz ChSp*

*Table 5-6. Receiver Tests for ASTRO Conventional Channels**

Test Name	System Analyzer	Radio	Test Set	Comments
Bit Error rate (BER) Floor	**Mode:** P25 **RF Control:** TX **Output Level:** -47 dBm **P25 Set:** Phase 1 C4FM **Pattern:** STD 1011 **Frequency:** Selected radio RX frequency	Radio Tuner Software (Bit Error Rate screen) is required	**PTT** to OFF (center)	BER < 0.01% (Use test setup shown in Figure 6-1)
Reference Sensitivity	As above; lower the output level until 5% BER is obtained	As above	As above	Output level < 0.35 µV (-116 dBm) (Use test setup shown in Figure 6-1)
Audio Output Distortion	**Mode:** P25 **RF Control:** TX **Output Level:** -47 dBm **P25 Set:** Phase 1 C4FM **Pattern:** STD 1011 **Frequency:** Selected radio RX frequency **Meter:** Audio Distortion	Radio Tuner Software not used; **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to OFF (center) Meter selector to **Audio PA** Spkr/Load to **Speaker**	Distortion < 3.0%
Residual Audio Noise Ratio	**Mode:** P25 **RF Control:** TX **Output Level:** -47 dBm **P25 Set:** Phase 1 C4FM **Pattern:** A)STD 1011 B) STD Silence **Frequency:** Selected radio RX frequency **Meter:** Audio Distortion	As above	As above	Residual Audio Noise Ratio -45 dB

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

5.4 Transmitter Performance Checks

The following tables outline the performance checks for the transmitter.

Table 5-7. Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	**RF Control:** Analyzer **Meter:** RF Display/ Frequency Offset **Frequency:** Selected radio TX frequency	TEST MODE CSQ channel* or programmed conventional channel	**PTT** to continuous (during the performance check).	**800/900 MHz:** ±1.5ppm
RF Power	As above except, **Meter:** RF Display/ Broadband Power	As above	As above	**800 MHz**: 1–3 Watt **900 MHz**: 1–2.5 Watt
Voice Modulation (external)	As above except, **Meter:** RF Display/FM Dev. Set Audio generator to fixed 1 kHz and audio level to 400 mV.	As above	As above	Deviation: (12.5 kHz) ≥ 2.1 kHz, but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz, but ≤ 5.0 kHz
Voice Modulation (internal)	**RF Control:** Analyzer **Meter:** RF Display/FM Dev. **Freq:** Selected radio TX frequency	As above	Remove modulation input. **PTT** to OFF (center)	Press **PTT** button on radio. Say “four” loudly into the radio mic. Measure deviation: (12.5 kHz) ≥ 2.1 kHz but ≤ 2.5 kHz (25 kHz) ≥ 4.1 kHz but ≤ 5.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	As Voice modulation Test except 300 Hz filter enabled	Conventional coded squelch personality (clear mode operation) or TPL channel (test mode*)	**PTT** to continuous (during the performance check)	Deviation: (12.5 kHz) ≥ 375 Hz but ≤ 500 Hz (25 kHz) ≥ 500 Hz but ≤ 1000 Hz
Secure Modulation (radios with conventional, secure mode, talkaround operation only)	As Voice Modulation	Programmed conventional channel (secure mode operation) Load key into radio.	As above	Deviation: ≥ 3.7 kHz but ≤ 4.3 kHz

* *See* Table 5-4.

Table 5-8. Transmitter Tests for ASTRO Conventional Channels

Test Name	System Analyzer	Radio	Test Set	Comments
RF Power	**Mode:** P25 **RF Control:** RX **P25 Set:** Phase 1 C4FM **Frequency:** Selected radio TX frequency **Meter:** UUT Measurements/ Broadband Power	Radio Tuner Software not used. **Radio:** Out of TEST MODE; Select a conventional ASTRO channel	**PTT** to continuous (during measurement).	**800 MHz**: 1–3 Watt **900 MHz**: 1–2.5 Watt
Frequency Error	**Mode:** P25 **RF Control:** RX **P25 Set:** Phase 1 C4FM **Frequency:** Selected radio TX frequency **Meter:** UUT Measurements/ Frequency Error	As above	As above	Error ≤ ±1.0 kHz
Frequency Deviation	**Mode:** P25 **RF Control:** RX Analog **Frequency:** Selected radio TX frequency **Meter:** UUT Measurements/FM Deviation	Radio Tuner Software (Transmitter Test Pattern screen) is required) **High use:** Symbol Rate PAT **Low use:** Low Symbol Rate P	**PTT** to OFF (center)	D_{HIGH} ≥ 2.543 kHz but ≤ 3.110 kHz D_{LOW} ≥ 0.841 kHz but ≤ 1.037 kHz (Use test setup shown in Figure 6-1)

* *These tests require a communications system analyzer with the ASTRO 25 test options.*

Chapter 6 Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

6.1 Test Setup

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. The radio alignment test setup is shown in Figure 6-1.

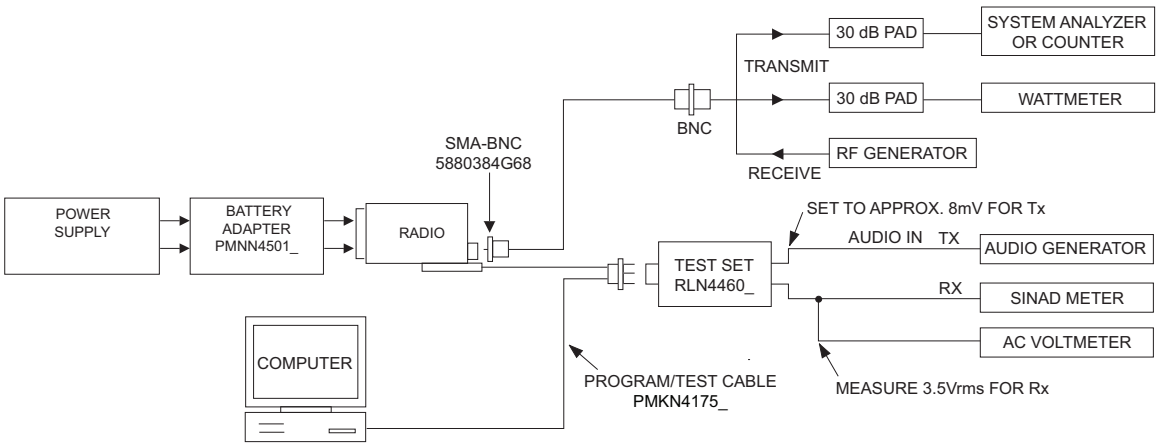


Figure 6-1. Radio Alignment Test Setup

Caution

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

6.2 Tuner Main Menu

Select **Tuner** from the **START** menu by clicking **Start** › **Program Files** › **Motorola Solutions** › **ASTRO 25 Products** › **ASTRO 25 Tuner**. To read the radio, use the F**ile** › **Read Device** menu or click on Read Device. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, double-click on the desired screen name in the **Tuner** menu.

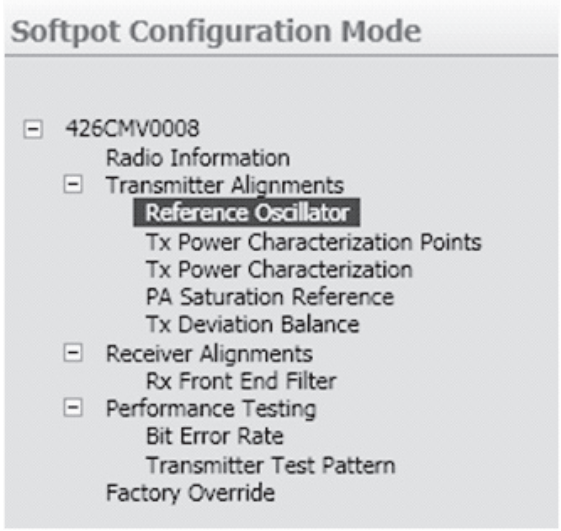


Figure 6-2. Tuner Software Main Menu

IMPORTANT: Tuning should follow the order of the Tuning tree view in descending order from top to bottom

6.3 Softpot

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

Caution

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 might 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 by entering the new value from the keyboard directly into the box. The slider bar indicates the current softpot value; see Figure 6-3.

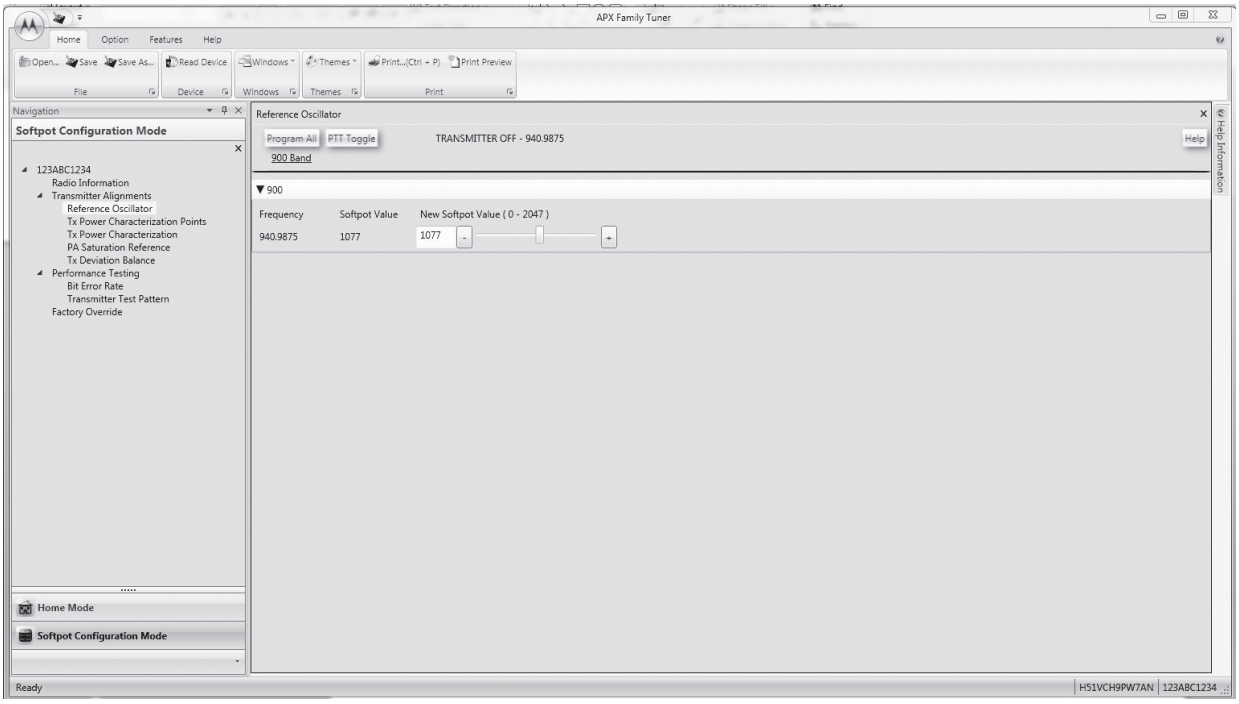


Figure 6-3. Typical Softpot Screen

Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box 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 online help.

Caution

When keying the radio during a test, always transmit into a dummy load.

6.4 Radio Information

Figure 6-4 shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

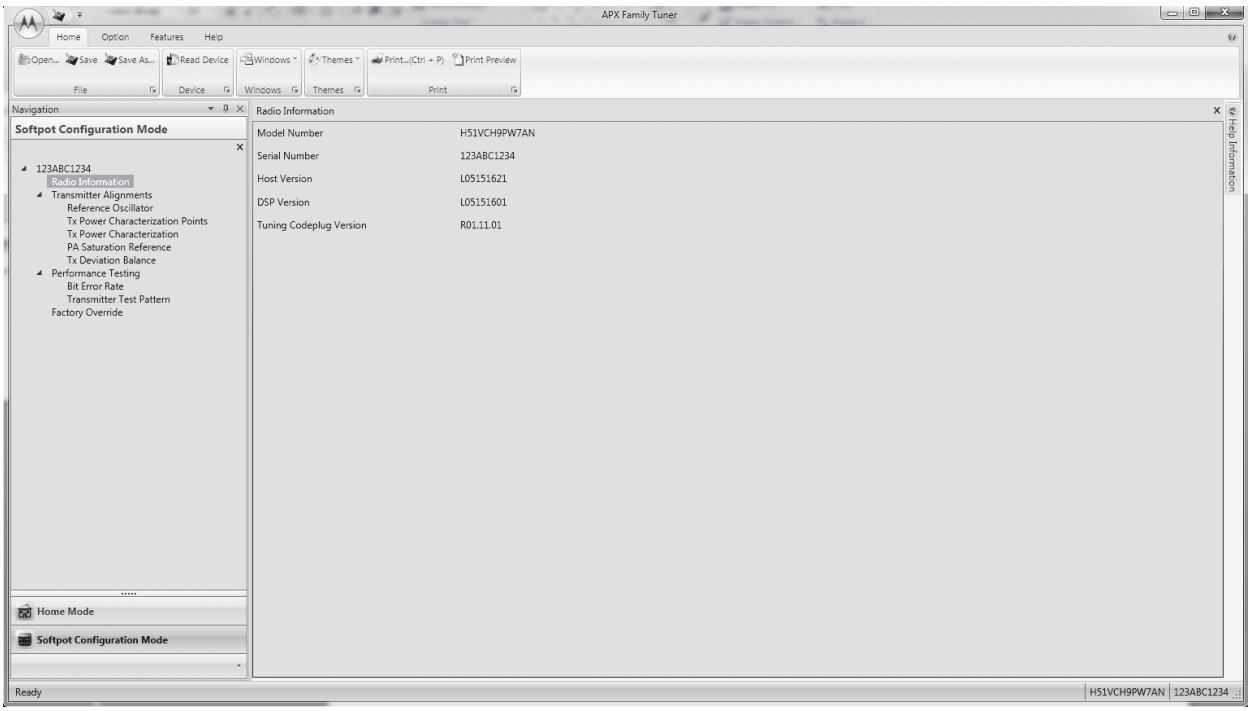


Figure 6-4. Radio Information Screen

6.5 Transmitter Alignments

6.5.1 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). Also, it is recommended to use a 10 MHz external reference. Checking this parameter when the radio is placed in service is important if the product has been in storage for six months or more between being shipped from the factory and commissioned for service.

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

This test can be done with a Communication Analyzer or Modulation Analyzer.

- Initial setup using the Communication Analyzer:
  - RF Control: Analyzer or RX
  - B/W: WB
  - Freq: CPS frequency under test
  - Attenuation: 20dB (optional)
  - Mon RF in: RF I/O
  - Meter: Frequency Counter or Offset
  - Mode: Analog or P25 STD
- 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:

Select the **Reference Oscillator** alignment screen. See Figure 6-5.

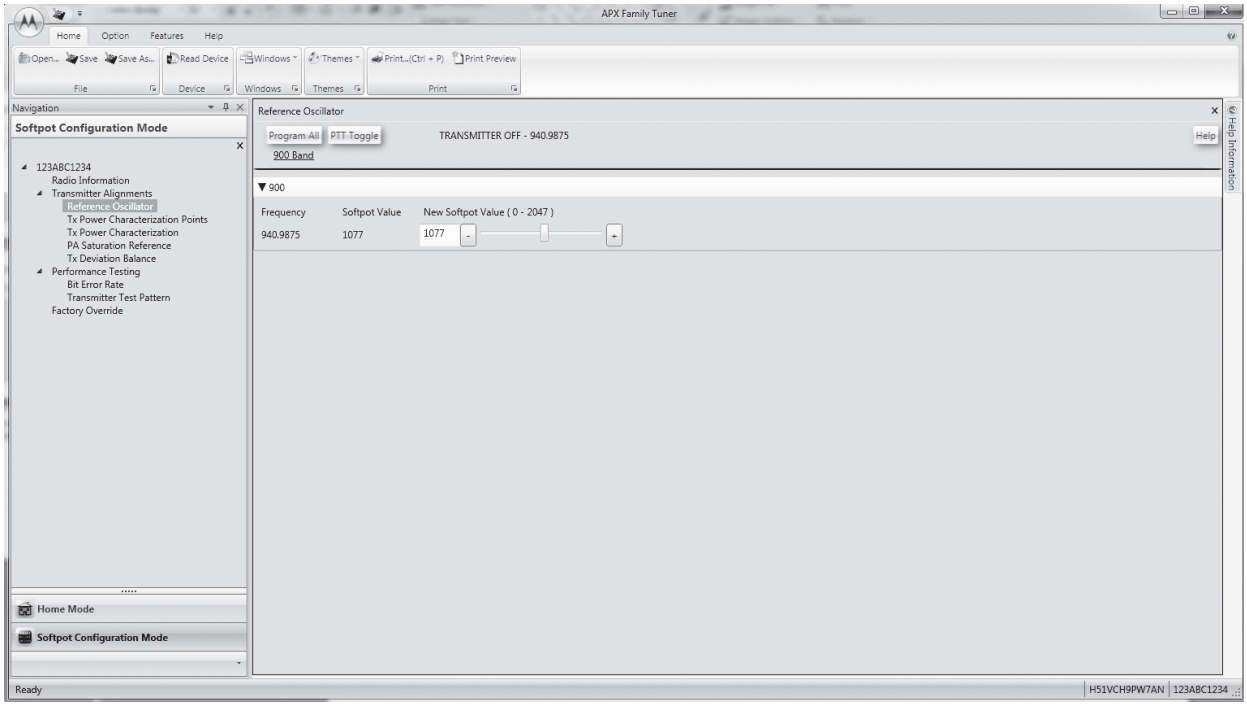


Figure 6-5. Reference Oscillator Alignment Screen (800/900 MHz)

1. Make sure the Communication Analyzer is in **Manual** mode.

   800/900 MHz

   - Set the base frequency to 940.9875 MHz

2. Adjust the reference oscillator's softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Table 6-1.

   NOTE: Increases the slider decreases the frequency and vice versa.

Table 6-1. Reference Oscillator Alignment

Band	Target
800/900 MHz	±100 Hz

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

6.5.2 Transmit Power Characterization Points

Tuning of the radio is done through **Power Characterization Points** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE:

a. The longer the RF cable, the more the attenuation of the power reading.

b. Ensure that the system is calibrated for cable loss.

c. Use a standard 50 ohm cable

d. Apply best practices for the equipment being used.

1. Select the **TX Power Characterization Points** alignment screen. See Figure 6-6.
2. Set power supply voltage and current limit.
3. Adjust softpot value by manipulating the slider bar, incrementing the "New Softpot Value" text box, or directly entering the desired value into the "New Softpot Value" text box until the rated power is indicated on the service Monitor. For rated power refer to the help text in the Tuner.
4. Repeat step 2 to 3 for all frequencies.
5. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

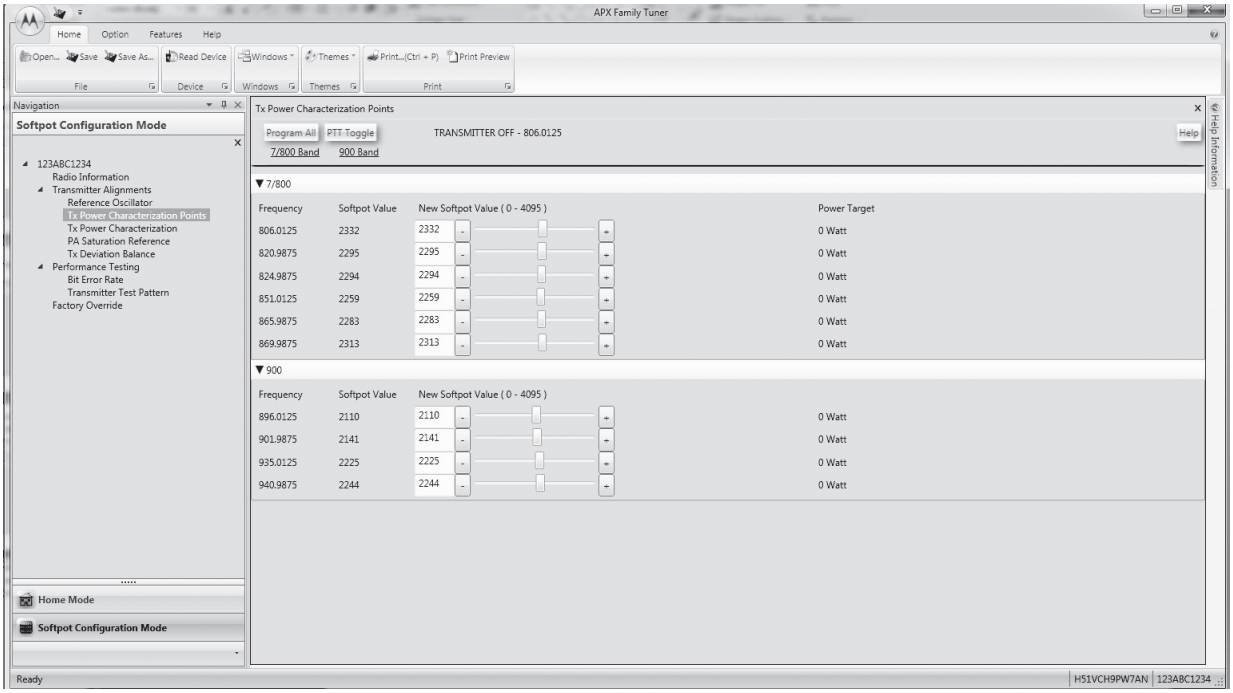


Figure 6-6. Transmit Power Characterization Points Alignment Screen (800/900 MHz)

6.5.3 Power Characterization Tuning

Tuning of the radio is done through **Power Characterization** tuning screen.

IMPORTANT: Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.

NOTE: a.The longer the RF cable, the more the attenuation of the power reading.

b. Ensure that the system is calibrated for cable loss.

c.Use a standard 50 ohm cable.

d. Apply best practices for the equipment being used.

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. See Figure 6-7.
2. Left-click the box under “Measure Power 1” for the desired frequency field. (The selected box is highlighted).
3. 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. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 1” box.
6. Left-click the box under “Measure Power 2” box for the same frequency field. (The selected box is highlighted).
7. Measure the transmit power of the radio with a service Monitor.
8. Input the transmit power in watts using two decimal places into the highlighted “Measure Power 2” box.
9. Repeat step 2 to 8 for all frequencies.

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

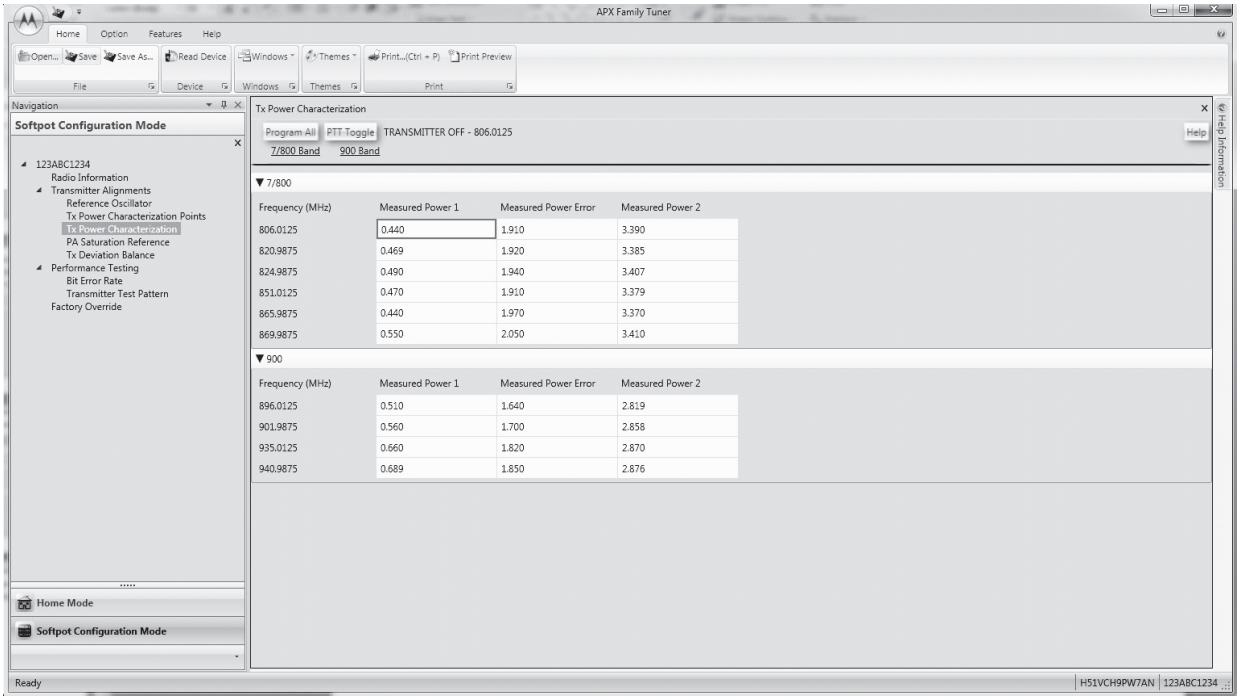


Figure 6-7. Transmit Power Characterization Alignment Screen (800/900 MHz)

6.5.4 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 main 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 alignment can be done with either Communication Analyzer or Modulation Analyzer.

1. Initial setup using the Communication Analyzer:
   - **Mode:** P25 Analog Mode 15Khz LP filter enabled
   - **RF Control:** P25 RX
   - **Meter:** FM Deviation
   - **Frequency:** Selected radio TX frequency
2. Initial setup using a Modulation Analyzer such as the 8901_ Series Modulation Analyzer:
   - Press the **FM MEASUREMENT** button. (The "*Error 0input 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 6-8.
4. In the "RF Control" section, set the service Monitor to the desired frequency (as shown in the frequency list in the TX Deviation Balance alignment screen).
5. Left-click the **PTT Tone: Low** button.
6. Left-click the slider of the frequency selected (should be the same frequency as step 4).
7. Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
8. Measure and Record the Low Tone Tx Deviation value from the 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. Left-click the **PTT Toggle** to de-key the radio.
12. Repeat the steps 4 to 10 for all frequencies.
13. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

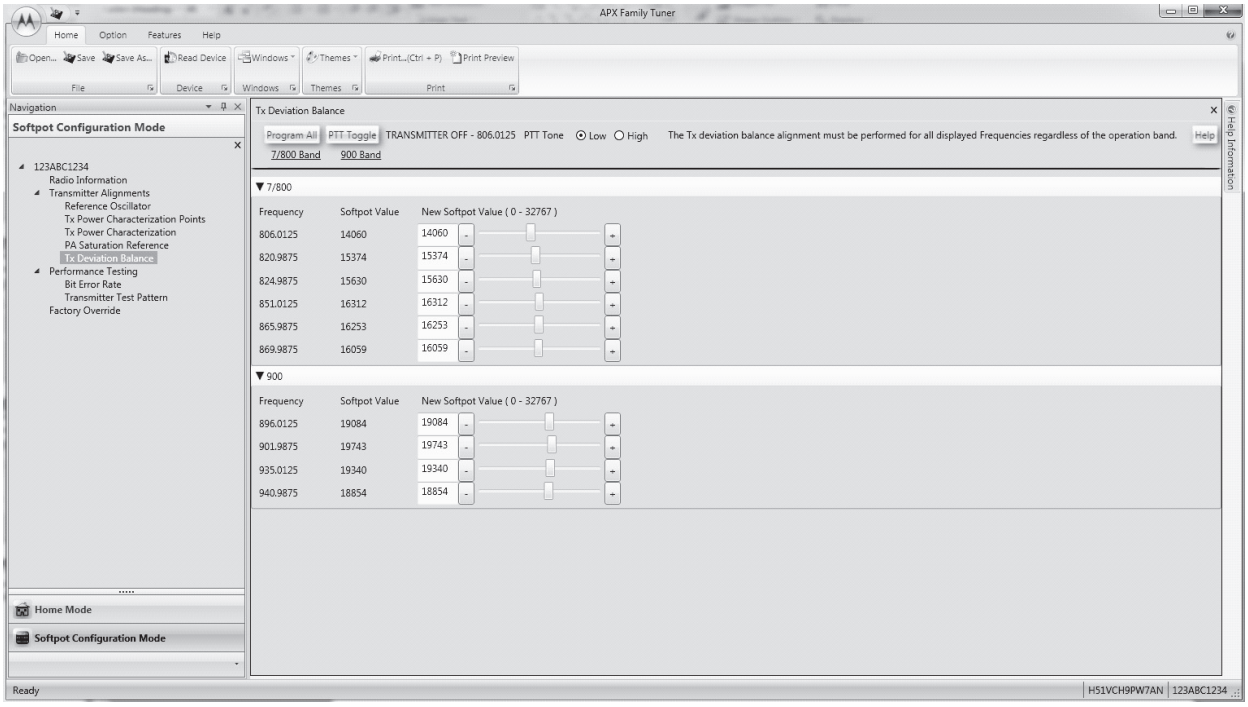


Figure 6-8. Transmit Deviation Balance Alignment Screen (800/900 MHz)

6.6 Performance Testing

6.6.1 Bit Error Rate

This section describes the Bit Error Rate (BER) test of the radio's receiver at a desired frequency (see Figure 6-9).

6.6.1.1 Bit Error Rate Fields

Set up the Communication Analyzer as follows:

1. Connect the RF Input port of the radio under test to the RF IN/OUT port of the Service Monitor.
2. Set up the Service Monitor:

Mode:	P25
RF Control:	TX/Generate
Output Level: :	-47 dBm
P25 Set:	Phase 1 C4FM
Pattern:	STD 1011
Frequency:	Test frequency (for example: 851.0625 MHz)

The bit error rate screen contains the following fields:

The bit error rate 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 to be received by the radio. Choices are: Standard Tone Test Pattern (Framed 1011), F2 1031, Standard Interface Test Pattern (CCITT V.52) and Phase 2 Digital (1031 Hz) Test Pattern.
- **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 the option to repeat the BER test 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.
- **BER Integration Time**:
  BER Integration Time carries with Test Pattern Type.
- **Number of Frames**
  Number of Frames over which bit error result are accumulated to produce the result.

NOTE: When **Continuous Operation = Yes**, all fields will be grayed out while the 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.

3. Press **Start/Stop** button to begin or end BER testing.

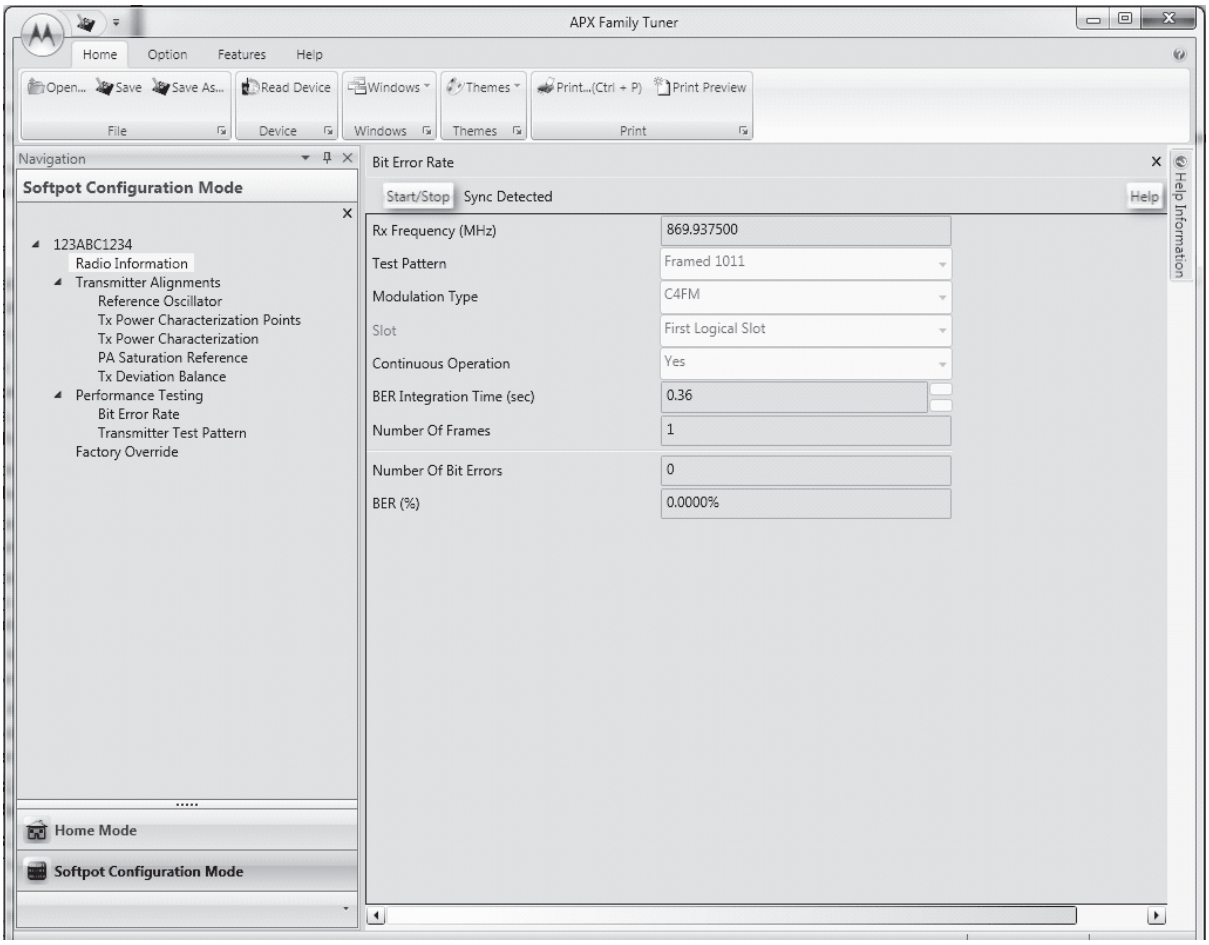


Figure 6-9. Bit Error Rate Screen (800/900 MHz)

6.6.2 Transmitter Test Pattern

The Transmitter Test Pattern test is used to transmit specific test patterns at a desired frequency so that the user can perform tests on the radio's transmitter (see Figure 6-10).

6.6.2.1 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 in kHz.
- **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 the radio is transmitting.

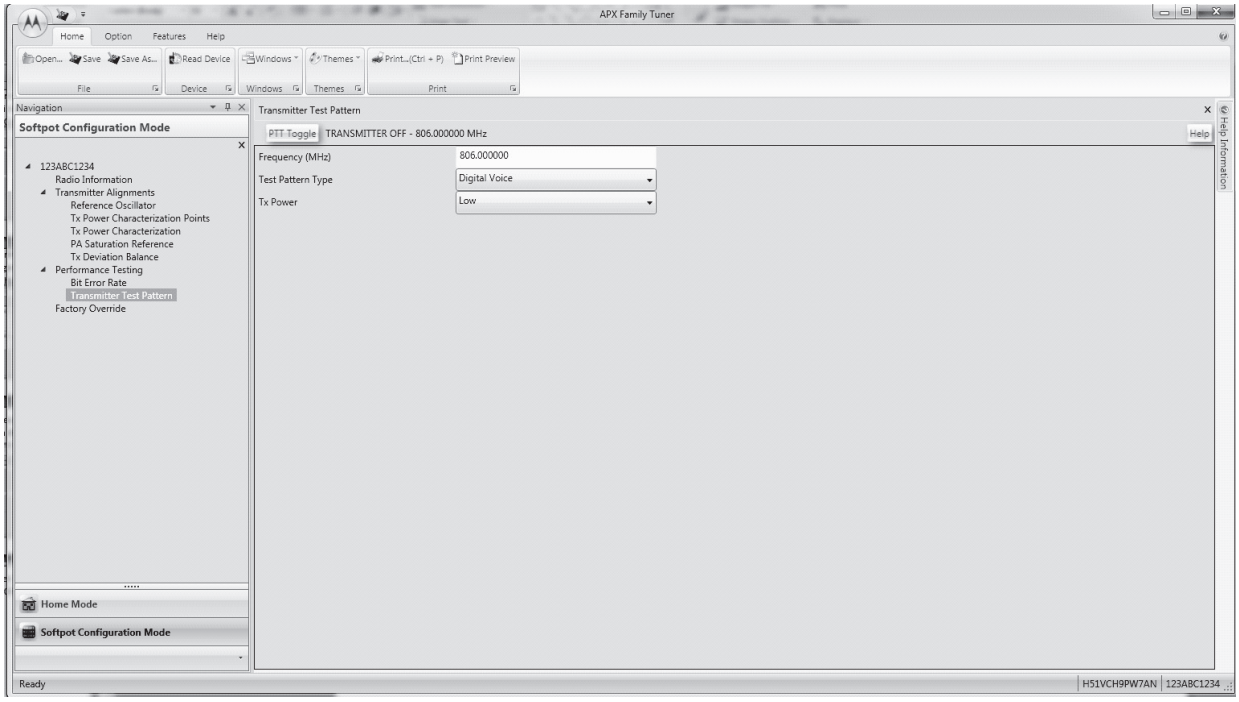


Figure 6-10. Transmitter Test Pattern Screen (800/900 MHz)

Chapter 7 Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring submergibility of the APX 4000XH radios. When performing these procedures, refer to "Chapter 9: Exploded Views and Parts Lists" and the diagrams that accompany the text. Items in parentheses ( ) throughout this chapter refer to item numbers in the exploded view diagrams and their associated parts lists.

This chapter also has procedures for removing and installing the APX 4000XH radio's standard accessories.

7.1 APX 4000XH Exploded View (Main Subassemblies)

Caution

When servicing electronics, always ensure that you are properly grounded with antistatic grounding system approved for electronics handling.

This section contains the APX 4000XH radio partially exploded views.

NOTES:

- Refer to Figure 7-1, the Partial Exploded View, and Table 7-1, the Partial Exploded View Parts List.
- Letters in parentheses ( ) refer to item letters in Figure 7-1 and Table 7-1.

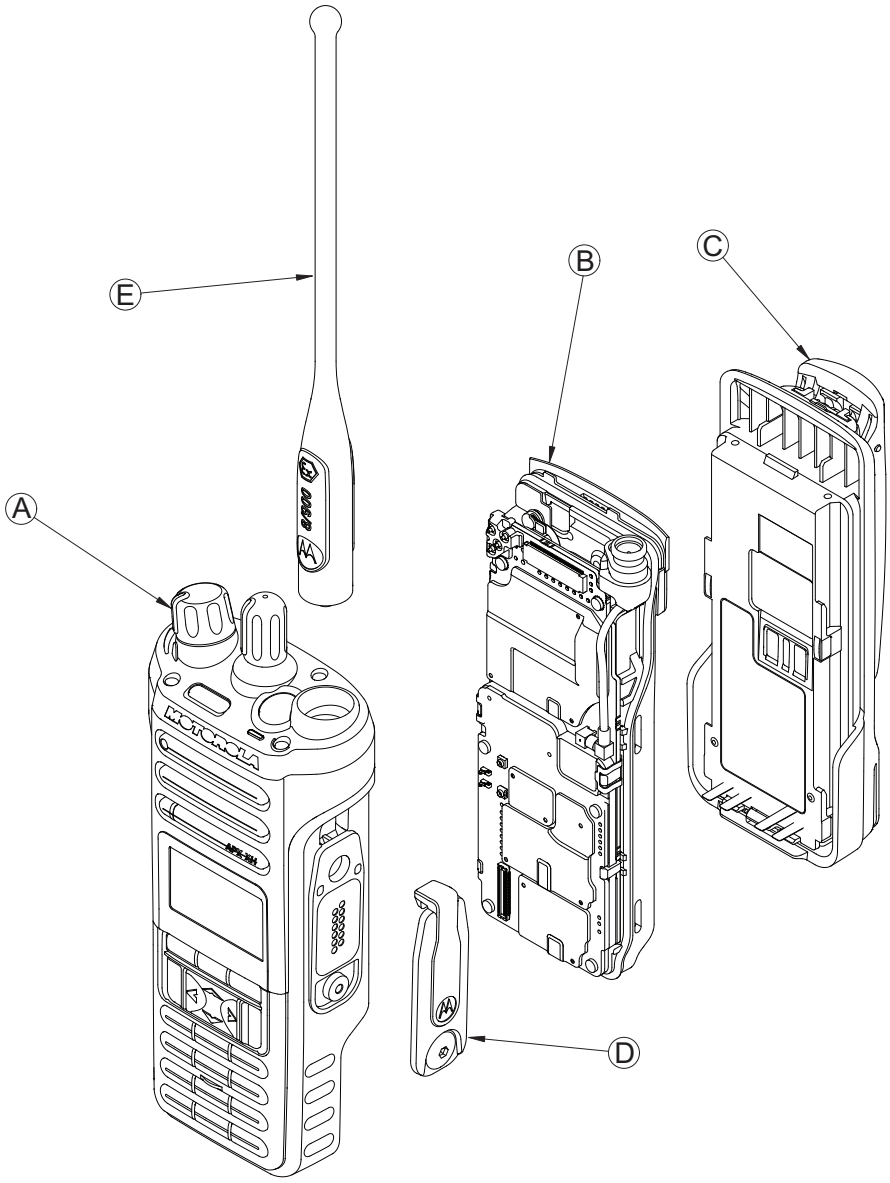


Figure 7-1. APX 4000XH Partial Exploded View

Table 7-1. APX 4000XH Partial Exploded View Parts List

Item Letter	Description	Exploded View and Parts List
A	Front Kit Assembly	Refer Figure 9-1.
B	Back Kit Assembly	Refer Figure 9-2.
C	Battery Assembly	Refer Figure 9-2.
D	Accessory-Connector Cover Assembly	Refer Figure 9-1.
E	Antenna Assembly	Refer Figure 9-1.

7.2 Required Tools and Supplies

Table 7-2. Required Tools and Supplies

Tools	Motorola Solutions Part Number	Supplier	Supplier Part Number	Remarks
Chassis/Knob Opener	TL000071A01	Horizon Land	MOT-15-0099	To remove chassis from housing and Volume/Channel Knob from radio.
Bit, Torx T6	–	–	–	For speaker retainer, back kit (chassis), top bezel and keypad bezel.
Driver, Torque	–	–	–	–
Round stick	–	Brusia	BE-MO-14383	For microphone membrane assembly.
ESD Table Mat	–	–	–	To place radio and components during disassembly and reassembly.
Vacuum/Pressure Test Fixture	TL000072A01	Horizon Land	MOT-15-0172	To connect the vacuum/pressure hose of the Vacuum/Pressure Pump Kit to the radio.
Pressure Pump Kit	NTN4265_	Motorola Solutions	–	For pressure test.
Vacuum Pump Kit	NLN9839_	Motorola Solutions	–	For vacuum test.

7.3 Fastener Torque Chart

Table 7-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 7-3. Required Tools and Supplies

Motorola Solutions Part Number	Description	Repair Torque (in-lbs)
FN000161A01	PCB Screw (35)	3.7
0386104Z04	Speaker Retainer Screw (5)	4.6
03012040001	Keypad Bezel Screw (26)	2.4
FN000169A01	Top Bezel Screw (23)	2.1

7.4 Radio Disassembly

This section contains instructions for disassembling the radio's main subassemblies.

Prepare the radio for disassembly:

- Turn off the radio by twisting the Volume Knob counter-clockwise (25) until a clicking sound is heard
- Remove the antenna, the battery, the Accessory-Connector cover (31), and any other accessory connected to the radio.

7.4.1 Remove Battery (54)

WARNING

To avoid a possible explosion:
- **DO NOT charge, remove, or attach the battery in an area labeled “hazardous atmosphere.”**
- **DO NOT discard batteries in a fire.**

Caution

If the radio is programmed for volatile-key retention, encryption keys will be retained for approximately 30 seconds after battery removal.

NOTE: The Motorola Solutions-approved battery shipped with the APX 4000XH radio is uncharged. Prior to using a new battery, charge it per the recommended procedure for the battery.

1. With the radio turned off, lift up the latch located at the bottom of the battery.

Figure 7-2. Lifting up the latch

2. While lifting the latch, remove the battery by sliding it out as shown in Figure 7-3.

Figure 7-3. Removing the Battery

7.4.2 Remove Antenna (33)

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

Figure 7-4. Removing the Antenna

7.4.3 Remove Volume Knob (25) and Channel Knob (24)

1. Hold the radio with the top facing upward.
2. With the Chassis Opener, grasp the knob and pull it upward, until it is free from its shaft.

Figure 7-5. Removing the Volume/Channel Knob

7.4.4 Remove Accessory-Connector Cover (31)

> **Caution** When the accessory connector is not in use, keep it covered with the Accessory-Connector Cover.

1. Unscrew the thumb screw. If the screw is too tight, use a screwdriver.

   NOTE: Do not remove the screw. It should remain captive in the cover.

Figure 7-6. Removing the Thumb Screw

2. Slightly lift the Accessory-Connector Cover away from radio before sliding it upward to disengage the hook.

Figure 7-7. Lift the Accessory-Connector Cover

3. Pull the Accessory-Connector Cover away from the radio.

Figure 7-8. Pull the Accessory-Connector Cover away

7.5 Radio Reassembly

This section contains instructions for reassembling the radio.

7.5.1 Reassemble the Accessory-Connector Cover (31)

1. Insert the hooked end of the cover into the pocket. Engage the hook beneath the undercut and swing the cover down onto the radio. Ensure the cover is seated properly and the screw is aligned into the threaded hole.

Figure 7-9. Reassemble the Accessory-Connector Cover

2. Hand tighten the thumb screw clockwise until secured.

Figure 7-10. Hand tighten thumb screw

NOTE: Do not overtighten the screw. The screw should be snugged and does not allow the cover to move.

7.5.2 Reassemble Volume Knob (24) and Channel Knob (25)

1. Align the D-shaped part of the shaft with the D-shaped hole on the Volume/Channel knob. Press the knobs into place.

Figure 7-11. Reassemble the Volume/Channel Knob

7.5.3 Reassemble the Antenna (33)

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

Figure 7-12. Reassemble the Antenna

7.5.4 Reassemble the Battery (54)

1. With the radio turned off, slide up the battery into the radio's frame until the bottom latch clicks into place as shown in Figure 7-13.

Figure 7-13. Reattach the Battery – Slide into Position

7.6 Ensuring Radio Submergibility

This section discusses radio submergibility concerns, tests, and disassembly and reassembly of ASTRO APX 4000XH radios.

7.6.1 Standards

ASTRO APX 4000XH radio models meet the stringent requirements of IP67, which require the radio to maintain watertight integrity when immersed in one (1) metre water for 30 minutes.

7.6.2 Servicing

APX 4000XH radios shipped from the Motorola Solutions factory have passed vacuum testing and should not be disassembled. If disassembly is necessary, refer to qualified service personnel and service shops capable of restoring the watertight integrity of the radio.

Caution

It is strongly recommended that maintenance of the radio be deferred to qualified service personnel and service shops. This is of paramount importance as irreparable damage to the radio can result from service by unauthorized persons. If disassembly is necessary, unauthorized attempts to repair the radio may void any existing warranties or extended performance agreements with Motorola Solutions. It is also recommended that submergibility be checked annually by qualified service personnel.

7.6.3 Water Exposure

If the radio is exposed to water, shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating; otherwise, the sound may be distorted until the water has evaporated, or is dislodged from these areas.

7.6.4 Specialized Test Equipment

This section summarizes the specialized test equipment necessary for testing the integrity of ASTRO APX 4000XH radios.

To ensure that the radio is truly a watertight unit, special testing, test procedures, and specialized test equipment are required. The special testing involves a vacuum check of the radio and pressure testing (troubleshooting) for water leaks if the vacuum check fails. The specialized test equipment is needed to perform the vacuum check and pressure testing, if required.

7.6.4.1 Vacuum Pump Kit NLN9839_

The Vacuum Pump Kit includes a Vacuum Pump with gauge and a Vacuum Hose. The Vacuum Test Fixture (p/n TL000072A01) which connects the vacuum pump to the radio, must be ordered separately.

7.6.5 Disassembly

Disassemble the radio according to Section 7.4.

7.6.6 Reassembly


Caution

Do not reassemble the radio without first performing the following preliminary inspection procedure.

To reassemble the radio:

1. Inspect the Main O-Ring on the Chassis (42) for any damage or foreign material.
2. Inspect the Battery Contact Seal (50) on the Main Board Assembly (37†) for any damage.
3. Inspect the mating seal surfaces on the Chassis (42) for all of the above seals for damage or foreign material that might prevent the seals from sealing properly.

Continue reassembling the radio according to Section 7.5. Tighten all hardware that was loosened or removed.

7.6.7 Vacuum Test

The Vacuum Test uses a Vacuum Pump to create a negative pressure condition inside the radio. The gauge measures this pressure and is used to Monitor any pressure changes in the radio. A properly sealed, watertight radio should have minimal change in pressure during the test.

Before starting the vacuum test:

- Remove the battery and antenna.
- Remove the Vacuum Port Seal (47) and Ventilation Label (46) that cover the Vacuum port.

NOTE: Refer to the exploded view diagrams and parts lists found in "Chapter 9: Exploded Views and Parts Lists".

7.6.7.1 Vacuum Tool Setup

1. Attach one end of the hose to the Vacuum Pump. Attach the other side of the hose to the Vacuum Test Fixture (TL000072A01)
2. Tool Leak Test:
   i. Block the open end of the Vacuum Test Fixture.
   ii. Pull the knob on the Vacuum Pump to create vacuum.
   iii. Pump at least 15 inHg.
   iv. Watch the gauge for a minute. If there is any loss of vacuum, repair or replace the tool.
3. Ensure that the seal is attached to the Vacuum Test Fixture.

NOTE: The actual reading of the gauge at this point is not important; it is important that the gauge pointer remained steady, indicating that there are no vacuum leaks in the pump.

7.6.7.2 Test Procedure

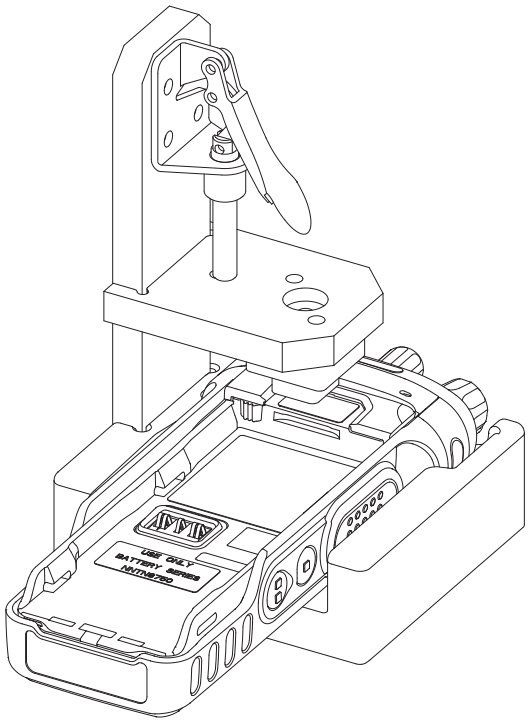


Figure 7-14. Attaching Vacuum Test Fixture

1. Place the radio in the vacuum test fixture. Ensure the radio position is lay perfectly into the mold.
2. Pull the knob on the Vacuum Pump to create vacuum. The vacuum test pressure should be 6.6 inHg.

> **Caution** Ensure that the vacuum pressure NEVER exceeds 7 inHg. The radio has pressure sensitive components that can be damaged if the pressure exceeds this limit.

3. Observe the gauge for approximately 2 minutes.
   - If the needle falls less than 0.5 inHg, the radio passes the vacuum test.
     i. If the seal passes this inspection, this radio is approved for submergibility. No additional testing is required.
     ii. Replace the vacuum port seal and ventilation label as described in the reassembly procedures.
   - If the needle falls more than 0.5 inHg, the radio fails the vacuum test and the radio might leak if submerged. Additional troubleshooting of the radio is required.

7.6.8 Pressure Test (using TL000072A01)

Pressure testing the radio is necessary only if the radio has failed the vacuum test. Do not perform the test until the vacuum test has been completed. Pressure test involves creating sealed condition inside the radio, submerging the radio in water, and observing the radio for a stream of bubbles (leak). Since all areas of the radio are being checked, observe the entire unit carefully for the possibility of multiple leaks before completing this test.

NOTES: When Radio is placed under the water there will be some air trapped which will be released. This is not a failure.

Refer to the exploded view diagrams and parts lists found in "Chapter 9: Exploded Views and Parts Lists".

To conduct the pressure test:

1. Observe is there is any torn on the Main O-ring and battery contact seal.
2. Ensure that the front kit and back kits are assembled properly.
3. Attach the pressure test fixture onto the vacuum port of the radio as shown in Figure 7-15.
4. Attach one end of the hose to the pressure pump. Attach the other side of the hose to the pressure test fixture (P/N: TL000072A01).
5. Operate the pump until the gauge reads approximately 1 psig.

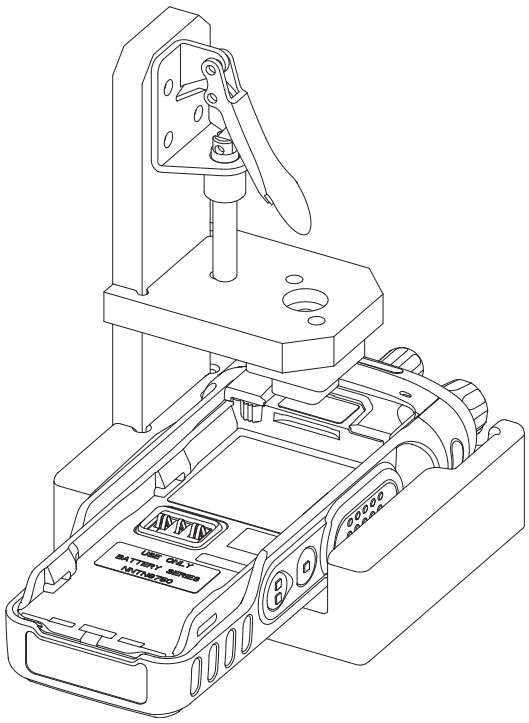


Figure 7-15. Attaching Pressure Test Fixture

6. Maintain the pressure around 1 psig and submerge the radio in a water-filled container.


Caution

Pressure must remain between 0.5 psig and 1.5 psig. Pressure lower than 0.5 psig may allow water into the radio, which will damage the radio.


Caution

Ensure that the pressure NEVER exceeds 1.5 psig. The radio has pressure sensitive components that can be damaged if the pressure exceeds this limit.

7. Watch for any continous series of bubbles. A steady stream of bubbles indicate a sign of leakage.


Caution

Some accumulation of air may be entrapped in the main housing which may cause a false diagnosis of a leak. Ensure there is a steady stream of bubbles before concluding there is a leak.

8. Note all of the seal areas that show signs of leakage. Rotate the radio to view all sides to pinpoint the problem(s) to one (or more) of the following areas:
   - Seal Interfaces
   - Battery Contact Seal
   - Front Housing, including the Top Bezel
   - Chassis
9. Remove the radio from the water container and dry the radio thoroughly. Be especially careful to dry the area around the vacuum Port and the battery contact seal area.


Caution

To avoid equipment damage, keep the area inside the Battery contact pocket is dry before assembling battery.

10. See Section 7.6.9.

7.6.9 Troubleshooting Leak Areas

Before repairing any leak, first read all of the steps within the applicable section. This will help to eliminate unnecessary disassembly and reassembly of a radio with multiple leaks.

NOTES: All disassembly and reassembly methods can be found in Section 7.4. and Section 7.5.

7.6.9.1 Seal Interfaces

- If leak occurs at one or more of the seal interfaces, disassemble the component(s) and inspect the interfaces to determine if there is any damage. If no damage is observed, re-assemble the radio as directed.
- If damage has occurred, replacement parts will be needed.

7.6.9.2 Battery Contact Seal

- If leak occurs due to damage to the Battery Contact Seal (50), it will need to be replaced.

7.6.9.3 Front Housing

- If leak occurs through anywhere on the Front Housing, replace the Front Kit Assembly (A).

7.6.9.4 Chassis

- If leak occurs through the Main O-Ring (41), it will need to be replaced.
- If leak occurs elsewhere on the Chassis (42), it will need to be replaced.

Chapter 8 Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that will help you to isolate a problem. Level one and two troubleshooting will support only radio alignment, programming, battery replacement, and knob replacement, and circuit board replacement.

Component-level service information can be found in the “ASTRO APX 4000XH Portable Radios Detailed Service Manual,” Motorola Solutions publication number MN002252A01.

8.1 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs self-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 will be presented at power-up by a single, low-frequency tone. The radio should be sent to the depot if cycling power and reprogramming the code plug do not solve the problem. 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. Use Table 8-1 to aid in understanding particular power-up error code displays.

Table 8-1. 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
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/84	External EEPROM Blank (or SLIC failure) Fatal Error	Send radio to depot
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
01/94	Internal EEPROM Blank Fatal Error.	Send radio to depot
01/98	Internal RAM Fail Fatal Error	Send radio to depot
01/A0	ABACUS Tune Failure Fatal Error	Send radio to depot
01/A2	Tuning Codeplug Checksum Fatal Error	Send radio to depot
02/81	DSP ROM Checksum Fatal Error	Send radio to depot

Table 8-1. Power-Up Error Code Displays (Continued)

Error Code	Description	Corrective Action
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
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
1E/10	Collaborative device is connected to the radio but the collaborative feature is not enabled in the codeplug.	Contact your Motorola Solutions Sales Representative/Partner on how to add Collaborative feature to your radios.
Note: *If the corrective action does not fix the failure, send the radio to the depot.*		

8.2 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. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 8-2 to aid in understanding particular operational error codes.

Table 8-2. Operational Error Code Displays

Error Code	Description	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	1. Reprogram external codeplug 2. Send radio to depot
FAIL 002	Selected Mode/Zone Codeplug Checksum Error	Reprogram external codeplug

8.3 Receiver Troubleshooting

Table 8-3 lists the possible causes of, and corrections for, receiver problems.

Table 8-3. Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
Radio Dead; Display Does Not Turn On	1. Dead Battery	Replace with charged battery
	2. Blown Fuse	Send radio to depot
	3. On/Off Switch	
	4. Regulators	
Radio Dead; Display Turns On	1. Keypad Board	Send radio to depot
	2. Main Board	
Radio On; Front Display Off	High operating temperature (above 80°C)	Allow radio to return to normal operating temperature.
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, etc.) 2. Check if radio able to unmute with Monitor function enabled
Audio Distorted or Not Loud Enough	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
RF Sensitivity Poor	1. Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; realign if off by more than ±1000 Hz
	2. Antenna Switch/ Connector	Send radio to depot
	3. Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off	Main Board	Send radio to depot

8.4 Transmitter Troubleshooting

Table 8-4 lists the possible causes of, and corrections for, transmitter problems.

Table 8-4. 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 tuner)
	2. No Injection To Power Amplifier	Send radio to depot
	3. Antenna Switch/Connector	
No Modulation; Distorted Modulation	1. Programming	Check deviation and compensation settings using the tuner
	2. Main Board	Send radio to depot
Bad Microphone Sensitivity	1. Check Deviation and Compensation	Realign if necessary
	2. Microphone	Send radio to depot
No/Low signaling (PL, DPL, MDC)	1. Programming	Check programming
	2. Main Board	Send radio to depot
Cannot Set Deviation Balance	Main Board	Send radio to depot

Chapter 9 Exploded Views and Parts Lists

This chapter contains exploded views and associated parts lists for the ASTRO APX 4000XH digital portable radios. The following table lists the exploded views for the radio in different configurations:

Table 9-1. APX 4000XH Exploded Views and Controller Kit

9.1 APX 4000XH Front Kit Exploded View

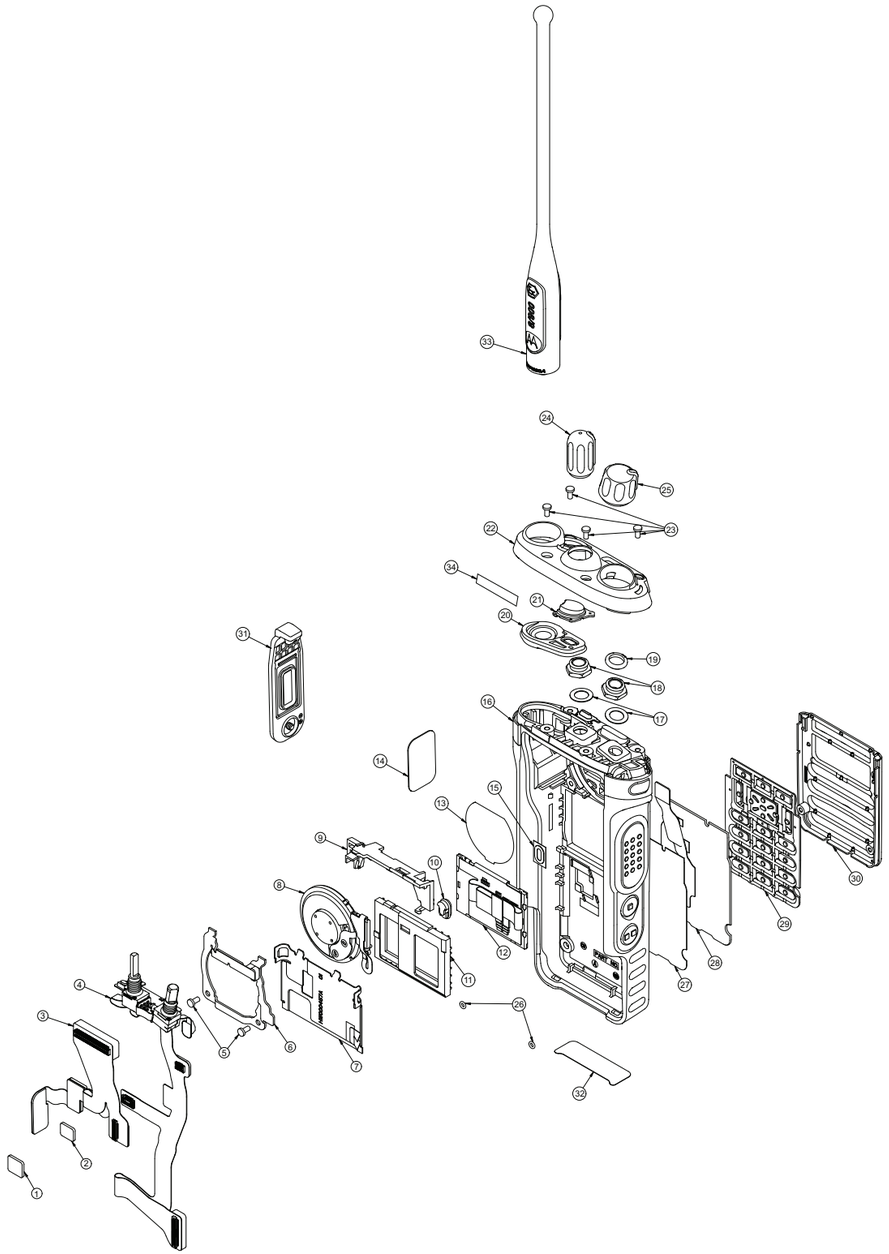


Figure 9-1. APX 4000XH Front Kit Exploded View

9.2 APX 4000XH Front Kit Exploded View Parts List

Item No.	Motorola Solutions Part Number	Description
1†	**HW000615A01**	Pad, Poron, 24 Pin, Keypad Flex
2†	**HW000614A01**	Pad, Poron, 10 Pin, Side Flex
3†	**0104063J76**	Assy, GCAI & LCD Flex
4†	**0104080J38**	Assy, Top Control Flex
5†	**0386104Z04**	Screw, Retainer, Speaker
6†	**BR000100A01**	Retainer, Speaker
7†	**HW000457A01**	Retainer, LCD
8†	**0104065J54**	Assy, Audio Flex
9†	**HN000560A01**	Holder, Top Control
10†	**SL000197A01**	Boot, Mic (front facing)
11†	**SL000159A01**	Boot, LCD
12†	**DM000033A01**	Assy, LCD
13†	**HW000495A01**	Mesh, Speaker
14†	**13012035001**	Escutcheon, GCAI
15†	**SL000198A01**	Membrane, Mic, front
16†	**HN000616A01**	Housing, Front
17†	**0402838X02**	Washer, 3 Waves
18†	**FN000129A01**	Nut, Switch
19††	**SL000144A01**	Torque Enhancer, Vol
20†	**SL000171A01**	Assy, Seal, Top
21†	**KP000079A01**	Button, Emergency
22††	**HN000559A01**	Top Bezel
23††	**FN000169A01**	Screw, Top bezel
24††	**HW000536A01**	Knob, Channel
25††	**HW000535A01**	Knob, Volume
26††	**03012040001**	Screw, Keypad Bezel
27†	**0104063J95**	Adhesive, Keypad Flex
28†	**HW000770A01**	Assy, Flex, Keypad
29††	**KP000063A01**	Keypad, Main
30††	**HN000516A01**	Bezel, Keypad
31	**0104067J27**	Dust Cover, GCAI
32†††	**LB000382A01** **LB000541A01** **LB000541A02**	Label, CSA Label, ATEX Label, CEPEL
33	**PMAF4020_**	Antenna
34	**LB000577A01**	Label, Back

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Front-Kit – PMLN7232_. Refer to the Model Charts on page xviii.

††. Items can be ordered individually, but they are included in their respective kits (if ordered).

†††. Item can only be ordered by authorized Motorola Solutions Service Center.

9.3APX 4000XH Back Kit Exploded View

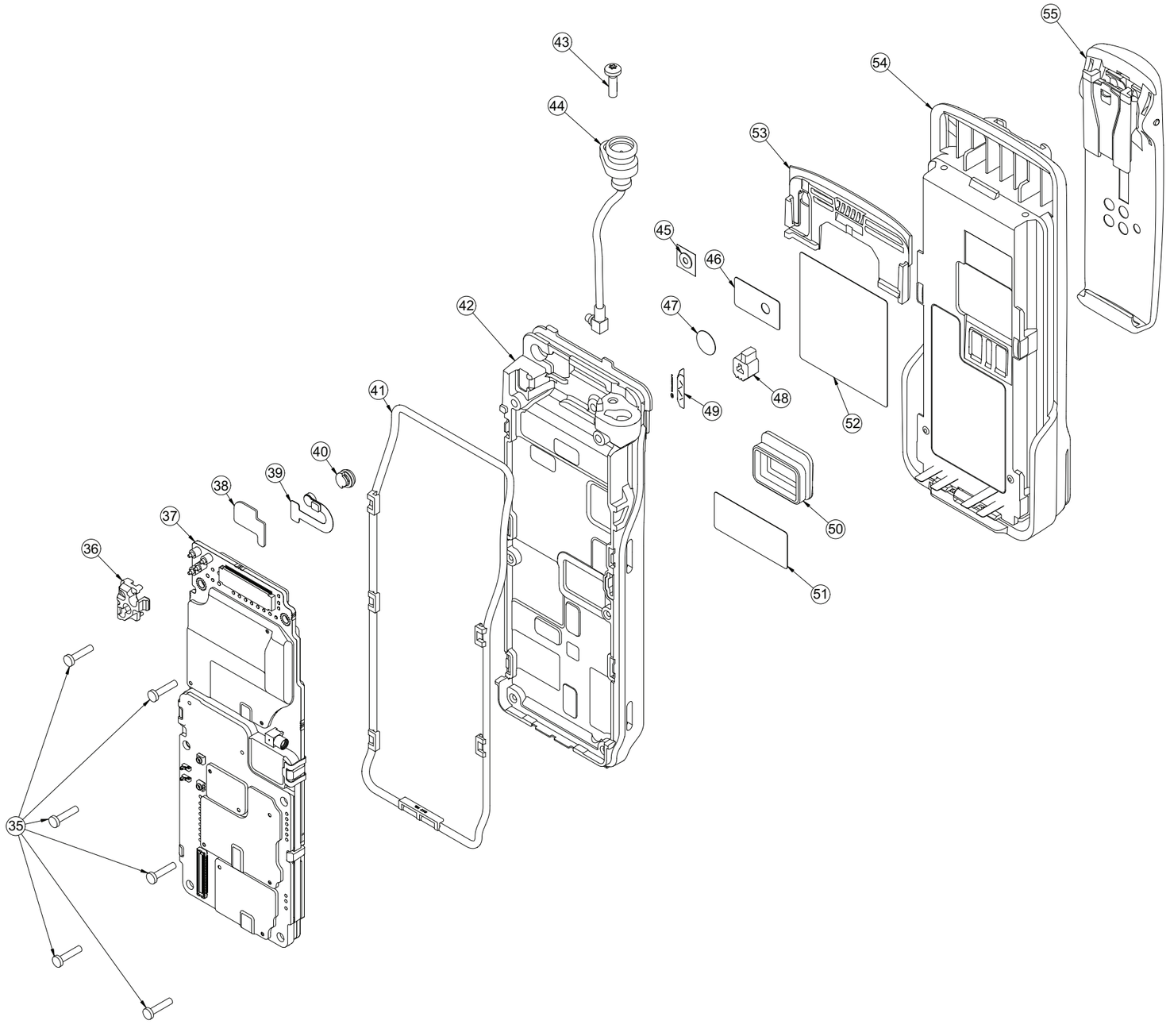


Figure 9-2. APX 4000XH Back Kit Exploded View

9.4 APX 4000XH Back Kit Exploded View Parts List

Item No.	Motorola Solutions Part Number	Description
35	**FN000161A01**	Screw, PCB
36	**HW000618A01**	Audio, Pogo Pin Collar
37†	**PMLF4150_**	Assy, Main Board, Encap
38	**HW000619A01**	Backer, Back Mic
39	**0104065J53**	Assy, Flex, Rear Mic
40	**32012282001**	Boot, Rear Mic
41	**SL000148A01**	O-ring, Main
42	**CH000087A01**	Chassis (with thermal pad)
43	**03012039004**	Screw, RF cable
44	**CB000238A01**	Coax Cable, RF
45	**3275002C03**	Membrane, Back Mic
46	**54012298001**	Label, Ventilation
47	**3286058L01**	Vacuum port seal
48	**HW000621A01**	Battery Bumper
49	**LB000383A01**	Label, Tamper Proof
50	**SL000166A01**	Seal, Battery Contact
51	**LB000381A01**	Label, Battery Warning
52††	**LB000456A01**	Label, FCC
53	**HN000642A01**	Shroud
54	**NNTN8750_**	Battery, Standard
55	**PMLN4651_** **PMLN6086_**	Clip, Belt (2”) Clip, Belt (2.5”)

NOTE:

†. Items cannot be ordered individually. They are included in the Assembly, Service Kit – PMLF4175_. Refer to the Model Charts on page xviii.

††. Items is not orderable.

Notes

Appendix A Accessories

Motorola Solutions provides the following approved optional accessories to improve the productivity of the APX 4000XH portable radio.

For a complete list of Motorola Solutions-approved antennas, batteries, and other accessories, visit the following web site: http://www.motorolasolutions.com/APX

Notes

Appendix B EMEA Warranty, Service and Technical Support

B.1 Warranty and Service Support

MOTOROLA SOLUTIONS, INC. (“MOTOROLA”) offers long term support for its products. This support includes full exchange and/or repair of the product during the warranty period, and service/ repair or spare parts support out of warranty. Any "return for exchange" or "return for repair" by an authorized Motorola Solutions Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorized Motorola Solutions Dealer.

B.1.1 Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Solutions Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only.

In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola Solutions. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any radio back to the appropriate Motorola Solutions warranty depot, please contact Customer Resources (Please see page B-3). All returns must be accompanied by a Warranty Claim Form, available from your Customer Services representative. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

B.1.2 After Warranty Period

After the Warranty period, Motorola Solutions continues to support its products in two ways.

1. Motorola Solutions's Managed Technical Services (MTS) offers a repair service to both end users and dealers at competitive prices.
2. MTS supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

B.2 European Radio Support Centre (ERSC)

The ERSC Customer Information Desk is available through the following service numbers:

Austria:	08 00 29 75 41	Italy:	80 08 77 387
Belgium:	08 00 72 471	Luxemburg:	08 00 23 27
Denmark:	80 88 58 80	Netherlands:	08 00 22 45 13
Finland:	08 00 11 49 910	Norway:	80 01 11 15
France:	08 00 90 30 90	Portugal:	08 00 84 95 70
Germany:	08 00 18 75 240	Spain:	90 09 84 902
Greece:	00 80 04 91 29 020	Sweden:	02 07 94 307
UK :	08 00 96 90 95	Switzerland:	08 00 55 30 82
Ireland:	18 00 55 50 21	Iceland:	80 08 147

Or dial the European Repair and Service Centre:
Tel: +49 30 6686 1555
Fax: +49 30 6686 1579
Email: ERSC@motorolasolutions.com

Please use these numbers for repair enquiries only.

B.3 Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola Solutions part number is assigned to the part, it is available from Motorola Solutions Radio Products and Solutions Organization (RPSO). If no part number is assigned, the part is not normally available from Motorola Solutions. If the part number is appended with an asterisk, the part is serviceable by Motorola Solutions Depot only. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

Orders for replacement parts, kits and assemblies should be placed directly on Motorola Solutions's local distribution/dealer organisation or via Motorola Solutions Online at: https://emeaonline.motorolasolutions.com/

* The Radio Products and Solutions Organization (RPSO) was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).

B.4 Technical Support

Motorola Solutions Product Services is available to assist the dealer/distributors in resolving any malfunctions which may be encountered.

North Europe – Stephen Woodrow
Telephone: +44 (0) 1256 488 082
Fax: +44 01256 488 080
Email: CSW066@motorolasolutions.com

Central and East Europe – Siggy Punzenberger
Telephone: +49 (0) 6128 70 2342
Fax: +49 (0) 6128 95 1096
Email: TFG003@motorolasolutions.com

Russia and Belarus – Andrey Nagornykh
Telephone: +7 495 787 8910
Fax: +7 495 785 0185
Email: MWCB47@motorolasolutions.com

Germany – Customer Connect Team
Telephone: +49 (0) 30 6686 1539
Fax: +49 (0) 30 6686 1916
Email: ESSC@motorolasolutions.com

Middle East and Africa – Wayne Holmes
Telephone: +49 (0)6126 957 6237
Fax: +49 (0)6126 957 6826
Email: wayne.holmes@motorolasolutions.com

Italy – Ugo Gentile
Telephone: +39 0 2822 0325
Fax: +39 0 2822 0334
Email: C13864@motorolasolutions.com

France – Armand Roy
Telephone: +33 1 6935 7868
Fax: +33 1 6935 7808
Email: armand.roy@motorolasolutions.com

France – Laurent Irrmann
Telephone: +33 1 6935 7866
Fax: +33 1 6935 7808
Email: laurent.irrmann@motorolasolutions.com

B.5 Further Assistance From Motorola Solutions

You can also contact the Customer Help Desk through the following web address.
https://www.motorolasolutions.com

Notes

Appendix C LACR Replacement Parts Ordering and Motorola Solutions Service Centers

C.1 Commercial Warranty

Limited Warranty

MOTOROLA COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

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

ASTRO APX 4000XH Digital Portable Units	Three (3) Years
Product Accessories	One (1) Year

Motorola Solutions will at its option and at no charge either repair the defective Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the defective Product during the warranty period provided it is returned before the expiration of the warranty period and in accordance with the terms of this warranty. Replaced Product, parts or boards are warranted for the balance of the original applicable warranty period. All replaced Product, parts of boards shall become the property of MOTOROLA.

This express limited warranty is extended by MOTOROLA to the original end user purchasing the Product for commercial, industrial or governmental use only and is not assignable or transferable to any other party. This is the complete warranty for the Product manufactured by MOTOROLA. MOTOROLA assumes no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of MOTOROLA. Unless made in a separate agreement between MOTOROLA and the original purchaser, MOTOROLA does not warrant the installation, maintenance or service of the Product.

MOTOROLA is not responsible in any way for any ancillary equipment not furnished by MOTOROLA which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use the Product is unique, MOTOROLA disclaims liability for range, coverage, or operation of the system in part or as a whole under this warranty.

II. General Provisions

This warranty sets forth the full extent of MOTOROLA'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA'S option, is the exclusive remedy. THIS WARRANTY IS THE COMPLETE WARRANTY FOR THE PRODUCT AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES. MOTOROLA DISCLAIMS ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY COMMERCIAL LOSS; INCONVIENCE; LOSS OF USE, TIME, DATA, GOOD WILL, REVENUES, PROFITS OR SAVINGS; OR OTHER SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES IN ANY WAY RELATED TO OR ARISING FROM THE SALE OR USE OF THE PRODUCT.

III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola Solutions 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 open a *Contact Us* case on Motorola Solutions Online (http://www.motorolasolutions.com/businessonline).

IV. What This Warranty Does Not Cover

This warranty does not cover:

A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.

B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.

C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.

D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.

E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola Solutions supplied equipment) which adversely affect performance of the Product or interfere with Motorola Solutions's normal warranty inspection and testing of the Product to verify any warranty claim.

F. Product which has had the serial number removed or made illegible.

G. Freight costs to ship the product to the repair depot.

H. Batteries (because they carry their own separate limited warranty) or consumables.

I. Customer’s failure to comply with all applicable industry and OSHA standards.

J. 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.

K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.

L. Normal and customary wear and tear.

V. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

C.2 Replacement Parts Ordering

C.2.1 Basic 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.

C.2.2 Motorola Solutions Online

Motorola Solutions Online users can access our online catalog at http://www.motorolasolutions.com/businessonline

To register for online access:

- Have your Motorola Solutions Customer number available.
- Please go to http://www.motorolasolutions.com/businessonline and click on “Sign Up Now.”
- Complete form and submit it.
- Contact your BDM to complete set-up and it will be done within 24 to 48 hours.

C.3 Motorola Solutions Service Centers

C.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radio to a Motorola Solutions Service Center as listed below.

C.3.2 Motorola Solutions de México, S.A.

Bosques de Alisos 125
Col. Bosques de las Lomas CP 05120
México D.F.
México
Tel: +52-55-5257-6700

C.3.3 Motorola Solutions de Colombia, Ltd.

Carrera 98 No. 25G-20 Of 105
Bogota
Colombia
Tel: +57-1-602-2111

Notes

Appendix D NAG Replacement Parts Ordering and Motorola Solutions Service Centers

D.1 Commercial Warranty

Limited Warranty

MOTOROLA COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

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

ASTRO APX 4000XH Digital Portable Units	One (1) Year
Product Accessories	One (1) Year

Motorola Solutions will at its option and at no charge either repair the defective Product (with new or reconditioned parts), replace it (with a new or reconditioned Product), or refund the purchase price of the defective Product during the warranty period provided it is returned before the expiration of the warranty period and in accordance with the terms of this warranty. Replaced Product, parts or boards are warranted for the balance of the original applicable warranty period. All replaced Product, parts of boards shall become the property of MOTOROLA.

This express limited warranty is extended by MOTOROLA to the original end user purchasing the Product for commercial, industrial or governmental use only and is not assignable or transferable to any other party. This is the complete warranty for the Product manufactured by MOTOROLA. MOTOROLA assumes no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of MOTOROLA. Unless made in a separate agreement between MOTOROLA and the original purchaser, MOTOROLA does not warrant the installation, maintenance or service of the Product.

MOTOROLA is not responsible in any way for any ancillary equipment not furnished by MOTOROLA which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use the Product is unique, MOTOROLA disclaims liability for range, coverage, or operation of the system in part or as a whole under this warranty.

II. General Provisions

This warranty sets forth the full extent of MOTOROLA'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA'S option, is the exclusive remedy. THIS WARRANTY IS THE COMPLETE WARRANTY FOR THE PRODUCT AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES. MOTOROLA DISCLAIMS ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY COMMERCIAL LOSS; INCONVIENCE; LOSS OF USE, TIME, DATA, GOOD WILL, REVENUES, PROFITS OR SAVINGS; OR OTHER SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES IN ANY WAY RELATED TO OR ARISING FROM THE SALE OR USE OF THE PRODUCT.

III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola Solutions 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 open a *Contact Us* case on Motorola Solutions Online (http://www.motorolasolutions.com/businessonline).

IV. What This Warranty Does Not Cover

This warranty does not cover:

A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.

B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.

C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.

D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.

E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola Solutions supplied equipment) which adversely affect performance of the Product or interfere with Motorola Solutions's normal warranty inspection and testing of the Product to verify any warranty claim.

F. Product which has had the serial number removed or made illegible.

G. Freight costs to ship the product to the repair depot.

H. Batteries (because they carry their own separate limited warranty) or consumables.

I. Customer’s failure to comply with all applicable industry and OSHA standards.

J. 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.

K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.

L. Normal and customary wear and tear.

V. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

D.2 Replacement Parts Ordering

D.2.1 Basic 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.

D.2.2 Motorola Solutions Online

Motorola Solutions Online users can access our online catalog at

https://businessonline.motorolasolutions.com

To register for online access, please call 1-800-422-4210 (for U.S. and Canada Service Centers only). International customers can obtain assistance athttps://businessonline.motorolasolutions.com

D.2.3 Mail Orders

Mail orders are only accepted by the US Federal Government Markets Division (USFGMD).

Motorola Solutions
7031 Columbia Gateway Drive
3rd Floor - Order Processing
Columbia, MD 21046
U.S.A.

D.2.4 Telephone Orders

Radio Products and Solutions Organization*
(United States and Canada)
7:00 AM to 7:00 PM (Central Standard Time)
Monday through Friday (Chicago, U.S.A.)
1-800-422-4210
1-847-538-8023 (United States and Canada)

U.S. Federal Government Markets Division (USFGMD)
1-877-873-4668
8:30 AM to 5:00 PM (Eastern Standard Time)

D.2.5 Fax Orders

Radio Products and Solutions Organization*
(United States and Canada)
1-800-622-6210
1-847-576-3023 (United States and Canada)

USFGMD
(Federal Government Orders)
1-800-526-8641 (For Parts and Equipment Purchase Orders)

D.2.6 Parts Identification

Radio Products and Solutions Organization*
(United States and Canada)
1-800-422-4210

D.2.7 Product Customer Service

Radio Products and Solutions Organization (United States and Canada)
1-800-927-2744

* The Radio Products and Solutions Organization (RPSO) was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).

D.3 Motorola Solutions Service Centers

D.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radios to a Motorola Solutions Service Center as listed below.

D.3.2 Motorola Solutions Service Center

Motorola Solutions Repair
2214 Galvin Drive
Elgin, IL 60123
Tel: 1-800-221-7144

D.3.3 Motorola Solutions Federal Technical Center

10105 Senate Drive
Lanham, MD 20706
Tel: 1-800-969-6680
Fax: 1-800-784-4133

D.3.4 Motorola Solutions Canadian Technical Logistics Center

Motorola Solutions Canada Ltd.
8133 Warden Avenue
Markham, Ontario, L6G 1B3
Tel: 1-800-543-3222
Fax: 1-888-331-9872 or 1-905-948-5970

Appendix E Asia-Pacific Warranty, Service and Technical Support

E.1 Replacement Parts Ordering

Some replacement parts, spare parts, and/or product information can be ordered directly. While parts may be assigned with a Motorola Solutions part number, this does not guarantee that they are available from Motorola Solutions Radio Products and Solutions Organization (RPSO). Some parts may have become obsolete and no longer available in the market due to cancellations by the supplier. If no Motorola Solutions part number is assigned, the part is normally not available from Motorola Solutions, or is not a user-serviceable part.

Orders for replacement parts should be placed directly on Motorola Solutions Online. For Level 2 maintenance, only Motorola Solutions Service Centers can perform these functions. Any tampering by nonauthorized Motorola Solutions Service Centers voids the warranty of your radio. To find out more about Motorola Solutions Service Centers, please visit http://www.motorolasolutions.com

E.2 Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Solutions Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only. In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola Solutions. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any radio back to the appropriate Motorola Solutions warranty depot, please contact Customer Resources or your Motorola Solutions dealer, distributor or reseller. All returns must be accompanied by a Warranty Claim Form, available from your Customer Service representative or Motorola Solutions Online (MOL) or your Motorola Solutions dealer, distributor or reseller. Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

ASTRO APX 4000XH Digital Portable Units	One (1) Year
Product Accessories	One (1) Year

E.3 Motorola Solutions Service Centers

E.3.1 Servicing Information

If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, please send the radios to a Motorola Solutions Service Center as listed below.

E.3.2 Motorola Solutions Singapore Pte. Ltd.

c/o Azure Engineering,
49 Jalan Pemimpin,
#03-11 APS Industrial Building,
Singapore 577203

Contact: Mareen Phua
E-mail: mareen@azure.com.sg
Tel: +65-6352-6383
Enquiry: Tay Yong Hock
E-mail: yonghock.tay@motorolasolutions.com

E.3.3 Motorola Solutions Sdn. Bhd.

Level 14, Persoft Tower,
No. 68, Pesiaran Tropicana,
47410 Petaling Jaya,
Selangor Darul Ehsan,
Malaysia

Contact: Koh Tiong Eng
E-mail: A21001@motorolasolutions.com
Tel: +603-7809-0000

E.3.4 PT. Motorola Solutions Indonesia

30th Floor, Gedung BRI II, Suite 3001,
Jl. Jend. Sudirman Kav. 44-46,
Jakarta 10210,
Indonesia.

Contact: Eko Haryanto
E-mail: Eko.Haryanto@motorolasolutions.com
Tel: +62-21-3043-5239

E.3.5 Motorola Solutions (Thailand) Ltd.

142 Two Pacific Place Suite 2201,
3220 Sukhumvit Road,
Klongtoey,
Bangkok 10110.

Contact: Nitas Vatanasupapon
E-mail: Nitas@motorolasolutions.com
Tel: +662-653-220
Fax: +668-254-5922

E.3.6 Motorola Solutions India Pvt. Ltd.

C/o Communication Test Design India Private Limited,
#4, 5 Maruthi Industrial Estate,
Rajapalya, Hoodi Village,
Bangalore – 560048,
India.

Contact: K. Umamaheswari
E-mail: umamaheshwari@motorolasolutions.com
Tel: +91-9844218850

E.3.7 Motorola Solutions (China) Co. Ltd.

No. 1 East of Wang Jing Road,
Chao Yang District,
Beijing, 100102,
P.R. China

Contact: Sophy Wang
E-mail: C18170@motorolasolutions.com
Tel: +86-10-8473-2106

E.3.8 Motorola Solutions Asia Pacific Ltd.

Unit 1807–1812, 18/F, Two Harbourfront,
22 Tak Fung Street,
Hunghom, Kowloon,
Hong Kong.

Contact: Judy Leung
E-mail: Judy.Leung@motorolasolutions.com
Tel: 852-2966-4823

E.3.9 Motorola Solutions Communications Philippines, Inc.

Unit 2102, One Global Place Building,
5th Ave., Bonifacio Global City,
Taguig, Philippines 1634.

Contact: Arthur Nieves
E-mail: Arthur.Nieves@motorolasolutions.com
Tel: +632 858-7500
Fax: +632 841-0681

E.3.10 Motorola Solutions Korea, Inc.

9th Floor, Hibrand Building,
215, Yangjae-Dong, Seocho-Gu,
Seoul, 137-924,
Korea.

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Glossary

This glossary contains an alphabetical listing of terms and their definitions that are applicable to ASTRO portable and mobile subscriber radio products.

Term	Definition
A/D	*See **analog-to-digital conversion.***
Abacus IC	A custom integrated circuit providing a digital receiver intermediate frequency (IF) backend.
active channel	A channel that has traffic on it.
ACK	Acknowledgment of communication.
ADC	*See **analog-to-digital converter.***
ADDAG	*See Analog-to-Digital, Digital-to-Analog and Glue.*
analog	Refers to a continuously variable signal or a circuit or device designed to handle such signals. *See also digital.*
Analog-to-Digital, Digital-to-Analog and Glue	An integrated circuit designed to be an interface between the radio's DSP, which is digital, and the analog transmitter and receiver ICs.
analog-to-digital conversion	Conversion of an instantaneous dc voltage level to a corresponding digital value. *See also **D/A.***
analog-to-digital converter	A device that converts analog signals into digital data. *See also DAC.*
ASTRO 25 trunking	Motorola Solutions standard for wireless digital trunked communications.
ASTRO conventional	Motorola Solutions standard for wireless analog or digital conventional communications.
automatic level control	A circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.
autoscan	A feature that allows the radio to automatically scan the members of a scan list.
band	Frequencies allowed for a specific purpose.
BGA	*See ball grid array.*
ball grid array	A type of IC package characterized by solder balls arranged in a grid that are located on the underside of the package.

Term	Definition
Call Alert	Privately paging an individual by sending an audible tone.
carrier squelch	Feature that responds to the presence of an RF carrier by opening or unmuting (turning on) a receiver's audio circuit. A squelch circuit silences the radio when no signal is being received so that the user does not have to listen to “noise.”
central controller	A software-controlled, computer-driven device that receives and generates data for the trunked radios assigned to it. It Monitors and directs the operations of the trunked repeaters.
channel	A group of characteristics, such as transmit/receive frequency pairs, radio parameters, and encryption encoding.
CMOS	Complementary metal-oxide semiconductor.
CODEC	*See **coder/decoder.***
coded squelch	Used on conventional channels to ensure that the receiver hears only those communications intended for the receiver.
codeplug	Firmware that contains the unique personality for a system or device. A codeplug is programmable and allows changes to system and unit parameters. *See also **firmware.***
coder/decoder	A device that encodes or decodes a signal.
control channel	In a trunking system, one of the channels that is used to provide a continuous, two-way/data-communications path between the central controller and all radios on the system.
conventional	Typically refers to radio-to-radio communications, sometimes through a repeater. Frequencies are shared with other users without the aid of a central controller to assign communications channels. *See also trunking.*
conventional scan list	A scan list that includes only conventional channels.
CPS	*See **Customer Programming Software.***
cursor	A visual tracking marker (a blinking line) that indicates a location on a display.
Customer Programming Software	Software with a graphical user interface containing the feature set of an ASTRO radio. *See also **RSS.***
D/A	*See digital-to-analog conversion.*
DAC	*See digital-to-analog converter.*
deadlock	Displayed by the radio after three failed attempts to unlock the radio.The radio must be powered off and on prior to another attempt.

Term	Definition
default	A pre-defined set of parameters.
digital	Refers to data that is stored or transmitted as a sequence of discrete symbols from a finite set; most commonly this means binary data represented using electronic or electromagnetic signals. *See also analog.*
digital-to-analog conversion	Conversion of a digital signal to a voltage that is proportional to the input value. *See also **A/D.***
digital-to-analog converter	A device that converts digital data into analog signals. *See also ADC.*
Digital Private Line	A type of digital communications that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.
digital signal processor	A microcontroller specifically designed for performing the mathematics involved in manipulating analog information, such as sound, that has been converted into a digital form. DSP also implies the use of a data compression technique.
digital signal processor code	Object code executed by the Digital Signal Processor in an ASTRO subscriber radio. The DSP is responsible for computation-intensive tasks, such as decoding ASTRO signaling.
dispatcher	An individual who has radio-system management duties and responsibilities.
DPL	*See Digital Private Line. See also **PL.***
DSP	*See digital signal processor.*
DSP code	*See digital signal processor code.*
dynamic regrouping	A feature that allows the dispatcher to temporarily reassign selected radios to a single special channel so they can communicate with each other.
EEPOT	Electrically Programmable Digital Potentiometer.
EEPROM	*See Electrically Erasable Programmable Read-Only Memory.*
Electrically Erasable Programmable Read-Only Memory	A special type of PROM that can be erased by exposing it to an electrical charge. An EEPROM retains its contents even when the power is turned off.
Failsoft	A backup system that allows communication in a non-trunked, conventional mode if the trunked system fails.
FCC	Federal Communications Commission.

Term	Definition
firmware	Code executed by an embedded processor such as the Host or DSP in a subscriber radio. This type of code is typically resident in non-volatile memory and as such is more difficult to change than code executed from RAM.
FGU	*See frequency generation unit.*
flash	A non-volatile memory device similar to an EEPROM. Flash memory can be erased and reprogrammed in blocks instead of one byte at a time.
FLASHcode	A 13-digit code which uniquely identifies the System Software Package and Software Revenue Options that are enabled in a particular subscriber radio. FLASHcodes are only applicable for radios which are upgradeable through the FLASHport process.
FLASHport	A Motorola Solutions 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.
FMR	*See **Florida Manual Revision.***
Florida Manual Revision	A publication that provides supplemental information for its parent publication before it is revised and reissued.
frequency	Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).
frequency generation unit	This unit generates ultra-stable, low-phase noise primary clock and other derived synchronization clocks that are distributed throughout the communication network.
General-Purpose Input/Output	Pins whose function is programmable.
GPIO	*See **General-Purpose Input/Output.***
hang up	Disconnect.
home display	The first information display shown after a radio completes its self test.
host code	Object code executed by the host processor in an ASTRO subscriber radio. The host is responsible for control-oriented tasks such as decoding and responding to user inputs.
IC	*See integrated circuit.*
IF	Intermediate Frequency.
IMBE	A sub-band, voice-encoding algorithm used in ASTRO digital voice.
inbound signaling word	Data transmitted on the control channel from a subscriber unit to the central control unit.

Term	Definition
integrated circuit	An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.
ISW	*See inbound signaling word.*
key-variable loader	A device used to load encryption keys into a radio.
kHz	*See kilohertz.*
kilohertz	One thousand cycles per second. Used especially as a radio-frequency unit.
LCD	*See liquid-crystal display.*
LDMOS	Laterally Diffused Metal Oxide Semiconductor.
LED	*See LED.*
light emitting diode	An electronic device that lights up when electricity is passed through it.
liquid-crystal display	An LCD uses two sheets of polarizing material with a liquid-crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.
LO	Local oscillator.
low-speed handshake	150-baud digital data sent to the radio during trunked operation while receiving audio.
LSH	*See low-speed handshake.*
MCU	*See microcontroller unit.*
MDC	Motorola Solutions Digital Communications.
menu entry	A software-activated feature shown at the bottom of the display. Selection of a feature is controlled by the programming of the buttons on the side of the radio.
MHz	*See Megahertz.*
Megahertz	One million cycles per second. Used especially as a radio-frequency unit.
microcontroller unit	Also written as µC. A microprocessor that contains RAM and ROM components, as well as communications and programming components and peripherals.
MISO	*See Primary In Secondary Out.*
mode	A programmed combination of operating parameters; for example, a channel or talkgroup.

Term	Definition
mode slaving	A radio programmed to automatically provide the proper operation for a given selected mode.
Monitoring	Used in conventional operation where the programmed Monitor button is pressed to listen to another user who is active on a channel. This prevents one user from interfering with another user's conversation.
MOSI	*See Primary Out Secondary In.*
MFK	Multi Function Knob
multiplexer	An electronic device that combines several signals for transmission on some shared medium (e.g., a telephone wire).
MUX	*See multiplexer.*
Network Access Code	Network Access Code (NAC) operates on digital channels to reduce voice channel interference between adjacent systems and sites.
NiCd	Nickel-cadmium.
NiMH	Nickel-metal-hydride.
non-tactical/revert	The user will talk on a preprogrammed emergency channel. The emergency alarm is sent out on this same channel.
OMPAC	*See over-molded pad-array carrier.*
open architecture	A controller configuration that utilizes a microprocessor with extended ROM, RAM, and EEPROM.
oscillator	An electronic device that produces alternating electric current and commonly employs tuned circuits and amplifying components.
OSW	*See outbound signaling word.*
OTAR	*See over-the-air rekeying.*
outbound signaling word	Data transmitted on the control channel from the central controller to the subscriber unit.
over-molded pad-array carrier	A Motorola Solutions custom IC package, distinguished by the presence of solder balls on the bottom pads.
over-the-air rekeying	Allows the dispatcher to remotely reprogram the encryption keys in the radio.
PA	Power amplifier.
page	A one-way alert with audio and/or display messages.
paging	One-way communication that alerts the receiver to retrieve a message.
PC Board	Printed Circuit Board. Also referred to as a PCB.
personality	A set of unique features specific to a radio.

Term	Definition
phase-locked loop	A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PL	*See private-line tone squelch.*
PLL	*See phase-locked loop.*
preprogrammed	A software feature that has been activated by a qualified radio technician.
Primary In Secondary Out	SPI data line from a peripheral to the MCU.
Primary Out Secondary In	SPI data line from the MCU to a peripheral.
Private (Conversatiion) Call	A feature that lets you have a private conversation with another radio user in the group.
private-line tone squelch	A continuous sub-audible tone that is transmitted along with the carrier. *See also **DPL.***
programmable	A radio control that can have a radio feature assigned to it.
Programmable Read-Only Memory	A memory chip on which data can be written only once. Once data has been written onto a PROM, it remains there forever.
PROM	*See Programmable Read-Only Memory.*
PTT	*See Push-to-Talk.*
Push-to-Talk	The switch or button usually located on the left side of the radio which, when pressed, causes the radio to transmit. When the PTT is released, the unit returns to receive operation.
radio frequency	The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).
radio frequency power amplifier	Amplifier having one or more active devices to amplify radio signals.
Radio Interface Box	A service aid used to enable communications between a radio and the programming software.
Radio Service Software	DOS-based software containing the feature set of an ASTRO radio. *See also CPS.*
random access memory	A type of computer memory that can be accessed randomly; that is, any byte of memory can be accessed without touching the preceding bytes.
RAM	*See random access memory.*

Term	Definition
read-only memory	A type of computer memory on which data has been prerecorded. Once data has been written onto a ROM chip, it cannot be removed and can only be read.
real-time clock	A module that keeps track of elapsed time even when a computer is turned off.
receiver	Electronic device that amplifies RF signals. A receiver separates the audio signal from the RF carrier, amplifies it, and converts it back to the original sound waves.
registers	Short-term data-storage circuits within the microcontroller unit or programmable logic IC.
repeater	Remote transmit/receive facility that re-transmits received signals in order to improve communications range and coverage (conventional operation).
repeater/talkaround	A conventional radio feature that permits communication through a receive/transmit facility, which re-transmits received signals in order to improve communication range and coverage.
RESET	Reset line: an input to the microcontroller that restarts execution.
RF	*See radio frequency.*
RF PA	*See radio frequency power amplifier.*
RIB	*See **Radio Interface Box.***
ROM	*See **read-only memory.***
RPCIC	Regulator/power control IC.
RPT/TA	*See repeater/talkaround.*
RSS	*See Radio Service Software.*
RSSI	Received Signal Strength Indicator.
RTC	*See real-time clock.*
RX	Receive.
RX DATA	Recovered digital data line.
SAP	*See Serial Audio CODEC Port.*
SCI IN	Serial Communications Interface Input line.
selective call	A feature that allows you to call a selected individual, intended to provide privacy and to eliminate the annoyance of having to listen to conversations of no interest to you.

Term	Definition
selective switch	Any digital P25 traffic having the correct Network Access Code and the correct talkgroup.
Serial Audio CODEC Port	SSI to and from the GCAP II IC CODEC used to transfer transmit and receive audio data.
Serial Communication Interface Input Line	A full-duplex (receiver/transmitter) asynchronous serial interface.
SCI IN	*See Serial Communication Interface Input Line.*
Serial Peripheral Interface	How the microcontroller communicates to modules and ICs through the CLOCK and DATA lines.
signal	An electrically transmitted electromagnetic wave.
Signal Qualifier mode	An operating mode in which the radio is muted, but still continues to analyze receive data to determine RX signal type.
softpot	*See software potentiometer.*
software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
software potentiometer	A computer-adjustable electronic attenuator.
spectrum	Frequency range within which radiation has specific characteristics.
SPI	*See Serial Peripheral Interface.*
squelch	Muting of audio circuits when received signal levels fall below a pre-determined value. With carrier squelch, all channel activity that exceeds the radio's preset squelch level can be heard.
SRAM	*See static RAM.*
SRIB	Smart Radio Interface Box. *See RIB.*
SSI	*See Synchronous Serial Interface.*
Standby mode	An operating mode in which the radio is muted but still continues to Monitor data.
static RAM	A type of memory used for volatile, program/data memory that does not need to be refreshed.
status calls	Pre-defined text messages that allow the user to send a conditional message without talking.
Synchronous Serial Interface	DSP interface to peripherals that consists of a clock signal line, a frame synchronization signal line, and a data line.

Term	Definition
system central controllers	Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units *(See ISW and OSW)*.
system select	The act of selecting the desired operating system with the system-select switch (also, the name given to this switch).
tactical/non-revert	The user will talk on the channel that was selected before the radio entered the emergency state.
TalkAround	Bypassing a repeater and talking directly to another unit for local unit-to-unit communications.
talkgroup	An organization or group of radio users who communicate with each other using the same communications path.
talkgroup scan list	A scan list that can include both talkgroups (trunked) and channels (conventional).
thin small-outline package	A type of dynamic random-access memory (DRAM) package that is commonly used in memory applications.
time-out timer	A timer that limits the length of a transmission.
tone	A continuous, sub-audible tone transmitted with the carrier.
TOT	*See time-out timer.*
transceiver	Transmitter-receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
transmitter	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.
trunking	The automatic sharing of communications paths between a large number of users. Allows users to share a smaller number of frequencies because a repeater or communications path is assigned to a talkgroup for the duration of a conversation. *See also conventional.*
trunking priority Monitor scan list	A scan list that includes talkgroups that are all from the same trunking system.
TSOP	*See thin small-outline package.*
TX	Transmit.
UART	*See also Universal Asynchronous Receiver Transmitter.*
UHF	Ultra-High Frequency.
USK	Unique shadow key.

Term	Definition
Universal Asynchronous Receiver Transmitter	A microchip with programming that controls a computer's interface to its attached serial devices.
Universal Connector	Interface point for all accessories to the radio.
Universal Serial Bus	An external bus standard that supports data transfer rates of 12 Mbps.
USB	*See Universal Connector.*
VCO	*See voltage-controlled oscillator.*
vector sum excited linear predictive coding	A voice-encoding technique used in ASTRO digital voice.
VOCON	*See vocoder/controller.*
vocoder	An electronic device for synthesizing speech by implementing a compression algorithm particular to voice. *See also voice encoder.*
vocoder/controller	A PC board that contains an ASTRO radio’s microcontroller, DSP, memory, audio and power functions, and interface support circuitry.
voice encoder	The DSP-based system for digitally processing analog signals, and includes the capabilities of performing voice compression algorithms or voice encoding. *See also **vocoder.***
voltage-controlled oscillator	An oscillator in which the frequency of oscillation can be varied by changing a control voltage.

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MN002150A01-AF