MOTOROLA *SOLUTIONS*

APX™ PORTABLE

TWO-WAY RADIO

APX N70 Basic Service Manual

Contents

List of Figures

List of Tables

Foreword

This manual includes all the information necessary to maintain peak product performance and maximum working time, using level 1 maintenance procedures.

⚠ **CAUTION:** These servicing instructions are for the use of qualified personnel only. To reduce the risk of electric shock, do not service parts other than those contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Product Safety and RF Exposure Compliance

⚠ **CAUTION:** Before using this product, read the Product Safety and RF Exposure booklet enclosed with your radio which contains important operating instructions for safe usage and RF energy awareness and control for compliance with applicable standards and regulations.

For a list of Motorola Solutions-approved antennas, batteries, and other accessories, visit http://www.motorolasolutions.com

Notations Used in This Manual

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

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

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

📝 **NOTE:** NOTICE indicates an operational procedure, practice, or condition that is essential to emphasize.

Document History

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

Version	Description	Date
MN009208A01-AA	This version is the initial version.	November 2022
MN009208A01-AB	Updated the following sections: ● Service Aids on page 34 ● Recommended Tools and Suppliers on page 71	October 2023
MN009208A01-AC	Added information for UHF band: ● Radio Description on page 16 ● Portable Radio Model Numbering System on page 21 ● General Specifications on page 21 ● Transmitter Typical Performance Specifications on page 24 ● LTE Technical Characteristics on page 27 ● Tuning Reference Oscillator on page 53 ● Performing RF Test on page 39 ● Checking Transmitter Performance on page 45 ● Receiver Typical Performance Specifications on page 25 ● Tuning Front End Gain on page 58 ● Tuning VLIF DCA Phase Error on page 59 ● Tuning IQME on page 61 ● Bit Error Rate on page 62 Updated the following topics: ● Replacement Parts Ordering on page 14 ● Service Aids on page 34 ● Inserting SIM Card Tray on page 78	June 2024

Related Publications

The following list contains part numbers and titles of related publications. To find and download the publications, visit https://learning.motorolasolutions.com.

Part Number	Title
6881095C98	*RF Energy Exposure Training and Product Safety Information for Portable Two-Way Radios*
MN003621A01	*ASTRO® 25 APX™ CPS Radio Management User Guide*
MN006056A01	*RadioCentral User Guide*
MN009207A01	*APX™ N70 User Guide*
PMLN8451_	*APX™ N70 Quick Start Guide*
MN009209A01	*APX N70 Detailed Service Manual*

Legal and Support

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The European Union's WEEE directive and the UK's WEEE regulation require that products sold into EU countries and the UK must have the crossed-out wheelie bin label on the product (or the package in some cases). As defined by the WEEE directive, this crossed-out wheelie bin label means that customers and end users in EU and UK countries should not dispose of electronic and electrical equipment or accessories in household waste.

Customers or end users in EU and UK countries should contact their local equipment supplier representative or service center for information about the waste collection system in their country.

Disclaimer

Please note that certain features, facilities, and capabilities described in this document may not be applicable to or licensed for use on a specific system, or may be dependent upon the characteristics of a specific mobile subscriber unit or configuration of certain parameters. Please refer to your Motorola Solutions contact for further information.

Warranty and Service Support

Warranty, Service, and Technical Support

Warranty and Service Support

Motorola Solutions 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.

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 before you ship 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.

Before shipping any radio back to the appropriate Motorola Solutions warranty depot, contact Customer Resources. 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 that no damage occurs in transit.

After Warranty Period

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

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

Further Assistance

You can also contact the Customer Help Desk through http://www.motorolasolutions.com.

Replacement Parts and Kits

This manual covers Level 1 and 2 Maintenance.

Level 1 maintenance is the assessment and/or repair of fault in terms of a faulty accessory or physical aspect of product; not including disassembly of the unit. It is limited to the replacement of antenna, battery, handset, external microphones, external knobs, all related frequency programming to customers, and sometimes alignment or tuning by the Customer Programming Software (CPS).

Level 2 maintenance includes all Level 1 activities plus assessment that require the disassembly of the radio and rectifying a fault by replacement of major mechanical parts (such as replacement of bezels).

Level 2 maintenance does not incorporate discrete component replacement.

To find out more about Motorola Solutions Service Center, visit http://www.motorolasolutions.com.

> **NOTE:** Only Motorola Solutions Service Center/Depot can perform Level 3 maintenance as it can deeply affect the performance of the radio.

Replacement Parts Ordering

Some replacement parts, spare parts, and/or product information can be ordered directly from the Motorola Solutions local distribution organization or through Motorola Online.

Basic Ordering Information

While parts may be assigned with a Motorola Solutions part number, they may not be available from the Motorola Solutions Radio Products and Solutions Organization (RPSO).

> **NOTE:** RPSO was formerly known as the Radio Products Services Division (RPSD) and/or the Accessories and Aftermarket Division (AAD).

Some parts may have become obsolete and are 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. Part numbers appended with an asterisk are serviceable by Motorola Solutions Depot only.

Place orders for replacement parts, kits, and assemblies directly on Motorola Solutions local distribution organization or through Motorola Online. When ordering replacement parts or equipment information, include the complete identification number. 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 of, and sufficient description of the desired component to identify it.

To identify non-referenced spare parts, request for help from the Customer Care organization of a Motorola Solutions local area representative.

Motorola Solutions Service and Support

For customer service call, 1-888-325-9336. Available from Monday to Friday, 8:00 AM to 5:00 PM (Central Standard Time).

Types of Orders	Contact Information
Mail Orders Mail orders are only accepted by the U.S. Federal Government Markets Division (USFGMD).	Motorola Solutions 7031 Columbia Gateway Drive 3rd Floor – Order Processing Columbia, MD 21046 U.S.A.
Telephone Orders and Parts Identification	Radio Products and Solutions Organization (RPSO) (United States and Canada) 7:00 AM to 7:00 PM (Central Standard Time) Monday through Friday (Chicago, U.S.A.) 1-847-538-8023 (United States and Canada)
	U.S. Federal Government Markets Division (USFGMD) 1-800-826-1913 Federal Government Parts (Credit Cards Only)

Types of Orders	Contact Information
	8:30 AM to 5:00 PM (Eastern Standard Time)
Fax Orders	Radio Products and Solutions Organization (RPSO) (United States and Canada) 1-800-622-6210 1-847-576-3023 (United States and Canada)
	U.S. Federal Government Markets Division (USFGMD) 1-800-526-8641

Product Customer Service

Radio Products and Solutions Organization (RPSO) (United States and Canada)

1-800-927-2744

Motorola Solutions Service Centers

For more information regarding to your radio, please contact the following Motorola Solutions Service Centers to submit your queries. To enable faster response time to customer issues, Motorola Solutions provides support from multiple countries around the world.

Table 1: North America Motorola Solutions Offices

Office	Address	Telephone Number
Motorola Solutions Service Center	1220 Don Haskins Drive, Suite A El Paso, TX 79936	1-800-422-4210
Motorola Solutions Federal Technical Center	10105 Senate Drive Lanham, MD 20706	1-800-969-6680
		Fax: 1-800-784-4113
Motorola Solutions Canadian Technical Logistics Center	41 Bentley Street Markham, Ontario L3R 3L1	416-997-2410

Chapter 1

Introduction

This manual contains information needed for Level One radio servicing. Level One servicing consists of radio programming, radio alignment, and installation and removal of the antenna, belt clip, battery, and universal connector cover.

NOTE: Level Two servicing covers disassembly and reassembly of the radio to replace circuit boards and is not covered in this Basic Service Manual.

1.1
Radio Description

The APX N70 radio is among the most sophisticated two-way radios available.

The radio provides improved voice quality across wide 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.

Table 2: Basic Features

Features	Description
Operation Modes	Digital Trunking: 9600 Baud APCO P25 Phase 1 FDMA and Phase 2 TDMA
	Digital Conventional: APCO 25
	Analog Trunking: 3600 Baud SmartNet®, SmartZone®, Omnilink®
	Analog Conventional: MDC 1200
	ASTRO® 25 Integrated Voice and Data
	SmartConnect Multi-net Connectivity[1]
Frequency Bands	700/800 MHz: Up to 3000 Channels Up to 200 Zones
	UHF: Up to 3000 Channels Up to 200 Zones
Additional Connectivity	Bluetooth (Version 5.0)
	Wi-Fi (802.11a/b/g/n/ac/d/h), 2.4 and 5 GHz Bands
	LTE (FirstNet®, Verizon®, and Bell Mobility-certified)[1]
	Near-Field Communications (NFC)[2]
Audio Features	3 W Speaker with Adaptive Equalization

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[1] Optional Feature
[2] Hardware-ready

Features	Description
	Three Microphones (Two Internal HDR, One Wind Mitigation)
	Adaptive Dual-sided Operation
	Adaptive Noise Suppression Intensity
	Adaptive Gain Control
	Adaptive Wind Porting
	IMPRES™ Audio Accessory Compatibility
Management	RadioCentral™
	Radio Managment
	Customer Programming Software (CPS)[1]
Location-Tracking	Built-in GNSS (GPS, A-GPS, GLONASS)
	SmartLocate and Indoor Positioning[1]
	SmartMapping[1]
Security	256-bit AES[1]
	Single-key ADP Encryption
	Software Key
	P25 Authentication[1]
	Multikey for 128 Keys and Multi-algorithm[1]
	Touchless Key Provisioning[3]
	Over-The-Air Rekeying (OTAR)[1]
Hazloc[1]	Class I, Division 1, Groups C, D
	Class II, Division 1, Groups E, F, G
	Class III, T3C Hazardous Locations
	Class I, Division 2, Groups A, B, C, D when used with 3650 mAh Div 1 Battery
Messaging	Canned Messages
	SmartMessaging[1]
ViQi Voice Interaction[1]	Customizable Voice Announcements
	Voice Control: 13 Actions with Intuitive Commands[1]
Energy	Standard 3200 mAh Battery
	IMPRES 2 Smart Battery Technology
Sensors	Ambient Light
	Accelerometer x2 (Display Orientation, Man Down/Fall Alert)
	Magnetometer (eCompass)
Other Features	Radio Profiles
	Enhanced Data[1]

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[3] Included with OTAR

Features	Description
	Multicast Voting Scan[1]
	Man Down/Fall Alert[1]
	DVRS PSU[1]
	Digital Tone Signaling[1]
	APX Personnel Accountability[1]
Ingress Protection	IP6x Dust
	IPx8 Submersion (2 m, 4 hrs)
	MIL-STD Delta-T, 512.X Procedure 1
User Interface	3.0" Mission-critical Glass Touchscreen: 360x600 TFT 24-bit Full Color Transflective Display
	Capacitive Touch Technology: Usable with Gloves Up to 4 mm Thick, Resistant to False Actuation from Fresh or Salt Water, Snow, Ice, Dirt, or Grease
	High Velocity User Interface: Large Touch Targets, Shallow Menu Hierarchy, Home Screen Information at a Glance, Integrated Applications
	1.2" Top Display: 200x112 TFT 18-bit Color Transflective Screen, 1 Line of Icons, 2 Lines of Text, 14 Characters per Line, 1.3 mm Toughened Glass Lens
	PTT Button: 1.26 x 0.55 in (32 x 14 mm)
	16-position Channel Selector
	Angled Power/Volume Knob
	Orange Emergency Button
	Three Programmable Side Buttons (1-dot, 2-dot, purple)
	Concentric 2-position Switch
	ABC Zone Switch
	ViQi Button (3-dot)
	Display On/Off/Home Button
	Six Programmable Keys Under Display

1.2
Radio Overview

This section describes the buttons and functions available on the radio.

Figure 1: Radio Overview

Table 3: Radio Overview Description

Number	Description	Description
1	RF Antenna	Transmits and receives electromagnetic waves during transmitting and receiving.
2	Status LED	Indicates the operating status of the radio.
3	ABC Switch	This switch is usually programmed for zone selection.
4	Touch Screen	The front radio display screen with touch sensitivity function.
5	Display Sleep/Wake (Short Press)\n\nHome button (Long Press)	Pressing this button wakes or puts the radio to sleep. Pressing and holding this button brings you back to the Home screen.

Number	Description	Description
6	P1 to P6 Programmable buttons	Use these programmable buttons to access programmed functions or, enable or disable features.
7	Battery Latch	This latch locks the battery in place.
8	2-Dot (Side Bottom) Feature button	Use this programmable button to access a programmed function or, enable or disable a feature.
9	1-Dot (Side Middle) Feature button	Use this programmable button to access a programmed function or, enable or disable a feature.
10	Push-to-Talk (PTT) button	Allows you to execute voice operations.
11	Purple (Side Top) button	Use this programmable button to access a programmed function or, enable or disable a feature.
12	High Dynamic Range (HDR) Mic 1	Converts sound into electric signals.
13	On/Off/Volume Control knob	Allows you to turn the radio on or off, and adjust the volume.
14	Channel Selector knob	Allows you to select channels.
15	2–Position Concentric Switch	This switch is usually programmed to enable or disable secure operation.
16	Top Display	The top radio display screen.
17	High Dynamic Range (HDR) Mic 2	Converts sound into electric signals.
18	3-Dot (Speaker Grill) Feature button	Use this programmable button to access a programmed function or, enable or disable a feature.
19	Speaker	Converts electric signals into sound and audio output.
20	Near Field Communication (NFC) Antenna	Allows two devices that are close to each other to connect and communicate.
21	Battery	Provides battery power for your radio.
22	Charging Contacts	Charging point for the battery.
23	Accessory Connector	Allows you to connect accessories to your radio.
24	Top (Orange) button	Allows you to turn on and off Emergency Operations. Besides the Emergency Operation, this button can also be configured for other features.

1.3
Portable Radio Model Numbering System

Table 4: Sales Model Nomenclature

Position	1	2	3	4	5	6	7	8	9	10	11	12
Model Number	H	3	5	U	C	T	9	P	W	8	A	N

Table 5: Sales Models – Description of Symbols

Position	Description	Value
1	Type of Unit	H = Hand-held Portable
2	Model Series	35 = APX N70
3		
4	Frequency Band	U = 762–870 MHz
		X = 380–520 MHz
5	Power Level	C = 1–3 W
		D = 1–5 W
6	Physical Packages	T = Touch Interface
7	Channel Spacing	9 = Variable/Programmable
8	Primary Operation	P = Programmable North America Models
9	Primary System Type	W = Programmable
10	Feature Level	8 = Expanded Plus
11	Version	Version Letter (Alpha) – Major Change
12	Unique Model Variations	N = Standard Package

1.4
Specifications

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

NOTE: Specifications are subject to change without notice.

1.4.1
General Specifications

Table 6: General Specifications

Parameter	Value
Dimensions	
Radio with Standard Battery, no Antenna	Height: 5.4 in. (136 mm)

Parameter	Value	
	Width: 2.4 in. (60.1 mm)	
	Depth: 1.6 in. (41.5 mm)	
	Weight: 16.8 oz (475 g)	
Battery		
	Capacity	**Availability**
Standard, PMNN4816	3200 mAh	Included
HAZLOC, PMNN4818[4]	3650 mAh	Optional
High Capacity, PMNN4817	4400 mAh	Optional
Encryption		
Supported Encryption Algorithms	ADP, AES-256, DES, DES-XL, DES-OFB, DVP-XL, Localized Algorithm	
Encryption Algorithm Capacity	8	
Encryption Keys per Radio	1024 Keys, Programmable for 64 Common Key References (CKR), upgradable to 128 CKRs, or 16 Physical Identifiers (PID)	
Encryption Keying	Local Key Loader and Over-the-Air Rekeying (OTAR)	
Synchronization	XL - Counter Addressing	
	OFB - Output Feedback	
Vector Generator	NIST-Approved Random Number Generator	
Encryption Type	Digital and SecureNet, TLS1.2, SRTP	
Key Storage	Tamper-protected Volatile or Non-volatile Memory	
Key Erasure	Keyboard Command and Tamper Detection	
Standards	FIPS 140-3 Level 1 and Level 3, and FIPS 197	
Device Certificates	x.509v3 ECC-P384, x.509v3 RSA-2048	
Cipher Suites	ECDHE_ECDSA_WITH_AES256_GCM_SHA384	
	TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	
	TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA	
	TLS_RSA_WITH_AES_256_GCM_SHA384	
	SRTP_AEAD_AES_256_GCM1	
Location Tracking		
Constellations	GPS, GLONASS, and Galileo.	
Tracking Sensitivity	-159 dBm	
Accuracy[5]	<5 m (95%)	

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[4] Listed by UL to the standards ANSI/TIA 4950-A and CAN/CSA C22.2 NO. 157-92 Classification Rating: Class I, Division 1, Groups C, D; Class II, Division 1, Group E, F, G; Class III, Hazardous (Classified) Locations. ANSI/ISA 12.12.01-2015 and CAN/CSA C22.2 No. 213-15; Class I, Division 2, Groups A, B, C, D; T3C.

Parameter	Value	
Cold Start[5]	<60 s (95%)	
Hot Start[5]	<5 s (95%)	
Mode	Autonomous (Assisted only)	
LTE		
Bands Supported	2, 4, 12, 13, 14	
Bands (Hardware-ready)	17	
Device Category	4	
Certifications[6]	First Net®, Verizon®, Bell Mobility	
Wi-Fi		
Standards Supported	802.11a/b/g/n/ac	
Frequency Range	2400–2472 MHz, 5180–5825 MHz	
Security	Supports WPA-2, WPA, WEP	
Capacity	Up to 20 SSIDs	
Bluetooth		
Version	5.0	
Frequency Range	2402–2480 MHz	
Security	128-bit AES-CCM Encryption	
Audio		
	Standard	**Upgrade**
Audio Output Power at Rated	1 W	3 W
Audio Output Power at Max	3 W	5 W
Audio Response (EIA)	+1, -3 dB	+1, -3 dB
Speech Loudness at 12 in (300 mm)	102 phon	105 phon
Audio Features	Adaptive Dual-sided Operation	Adaptive Noise Suppression Intensity
	Adaptive Equalization	Adaptive Windporting
	Adaptive Gain Control	Noise Sensing Volume Control
	IMPRES Audio	Receive Volume Leveling
Environmental		
Operating Temperature[7]	-30 ºC to +60 ºC (-22 ºF to +140 ºF)	

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[5] Measured conductively with >6 satellites visible at a nominal -130 dBm signal strength. Specs provided are 95th percentile values.

[6] SIM cards for the listed carriers can be pre-installed at Motorola Solutions factory or supplied by the end user via Bring Your Own SIM (BYOS) for certified carriers.

[7] LMR only. Front display, LTE, Wi-Fi, Bluetooth and GPS not available when radio internal temperature is below -20 ºC (-4 ºF). Batteries should be charged at 0 ºC to +45 ºC (+32 ºF to +113 ºF) and stored at +20 °C to +25 °C (+68 ºF to +77 ºF). Reference http://motorolasolutions.com/batterycare

Parameter	Value
Storage Temperature[7]	-40 ºC to +85 ºC (-40 ºF to +185 ºF)
Humidity	Per MIL-STD 810
ESD	IEC 801 - 2 kV
Dust Resistance	IP6X
Water Resistance (Submersion)	IPX8 (2 m, 4 hrs); MIL-STD Delta-T, 512.X Procedure 1
Regulatory	
FCC ID	700/800 MHz: AZ489FT7147 UHF: AZ489FT7176
ISED IC	700/800 MHz: 109U-89FT7147 UHF: 109U-89FT7176
LMR	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E, 16K0F3E, 20K0F1E
Bluetooth	1M18G1D, 1M1F1D, 2M1F1D
Wi-Fi	12M9G1D, 16M7D1D, 17M9D1D, 36M2D1D, 17M5D1D, 18M4D1D, 36M8D1D, 76M1D1D
LTE	Band 2 (1850.7–1910 MHz), Modulation: *G7D, *D7W
	Band 4 (1710.7–1755 MHz), Modulation: *G7D, *D7W
	Band 12 (699.7–716 MHz), Modulation: *G7D, *D7W
	Band 13: (777–787 MHz), Modulation *G7D, D7W
	Band 14 (788–798 MHz), Modulation: *G7D, *D7W
Single-Band Model Number	700/800 MHz: H35UCT9PW8AN UHF: H35XDT9PW8AN

1.4.2
Transmitter Typical Performance Specifications

Table 7: Transmitter LMR Typical Performance Specifications (700/800 MHz and UHF)

Transmitter Parameter	Value		
	700 MHz	**800 MHz**	**UHF**
Frequency Range/Bandsplits (MHz)	762–776	806–825	380–520
	792–806	851–870	
Channel Spacing (kHz)	12.5/20/25	12.5/20/25	12.5/20/25
Maximum Frequency Separation	Full Bandsplit	Full Bandsplit	Full Bandsplit
Rated RF Output Power (Adjustable) (W)[8]	1.0–2.5	1.0–3.0	1.0–3.0

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[8] Measured in the analog mode per TIA / EIA 603 under nominal conditions. Selectivity reflects newer 2-tone test method as defined in revision D TIA603-D issued in 2010.

Transmitter Parameter	Value		
	700 MHz	800 MHz	UHF
Frequency Stability (-30 °C to +60 °C; +25 °C Ref) (PPM)[8]	±1.0	±1.0	±1.0
Modulation Limiting (12.5/20/25 kHz Channel) (kHz)[8]	±2.5/±4/±5	±2.5/±4/±5	±2.5/±4/±5
Emissions (Conducted and Radiated) (dBc)[8]	-75	-75	-75
Audio Response (dB)[8]	+1, -3	+1, -3	+1, -3
FM Hum and Noise	25 kHz: -51 dB	25 kHz: -51 dB	25 kHz: -51 dB
	12.5 kHz: -45 dB	12.5 kHz: -45 dB	12.5 kHz: -45dB
Audio Distortion (12.5/25 kHz Channel) (%)[8]	1.00	1.00	1.00

1.4.3
Receiver Typical Performance Specifications

Table 8: Receiver LMR Typical Performance Specifications (700/800 MHz and UHF)

Receiver Parameter	Value		
	700 MHz	800 MHz	UHF
Frequency Range/Bandsplits (MHz)	762–776	851–870	380–520
	799–806		
Channel Spacing (kHz)	12.5/20/25	12.5/20/25	12.5/20/25
Maximum Frequency Separation	Full Bandsplit	Full Bandsplit	Full Bandsplit
Analog Sensitivity (12 dB SI-NAD) (µV)[9]	0.25 (-119.0dBm)	0.25 (-119.0dBm)	0.18 (-122.0dBm)
Digital Sensitivity (1% BER) (µV)[10]	0.375 (-115.5dBm)	0.375 (-115.5dBm)	0.24 (-119.0dBm)
Digital Sensitivity (5% BER) (µV)[10]	0.24 (-119.4dBm)	0.24 (-119.4dBm)	0.14 (-124.0dBm)
Selectivity (12.5/25 kHz Channel) (dB)[11]	-61.3/-75.2	-61.3/-75.2	-62.2/-76
Intermodulation Rejection (dB)	79.5	79.5	79.6
Spurious Rejection (dB)	76.6	76.6	95
FM Hum and Noise	25 kHz: -55 dB	25 kHz: -55 dB	25 kHz: -62 dB
	12.5 kHz: -51 dB	12.5 kHz: -51 dB	12.5 kHz: -57 dB
Audio Distortion (%)	1.00	1.00	0.9

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[9] Measured conductively in analog mode per TIA / EIA 603 under nominal conditions.

[10] Measured conductively in digital mode per TIA / EIA IS 102.CAAA under nominal conditions.

[11] Measured in the analog mode per TIA / EIA 603 under nominal conditions. Selectivity reflects newer 2-tone test method as defined in revision D TIA603-D issued in 2010.

Receiver Parameter	Value		
	700 MHz	800 MHz	UHF
Audio Output Power at Rated (W)[11]	3.0	3.0	3.0

1.4.4
Military Standards

Table 9: Military Standards – 810C/810D

Applicable MIL–STD	810C		810D	
	Methods	Procedures	Methods	Procedures
Low Pressure	500.1	I	500.2	II
High Temperature	501.1	I, II	501.2	I/A1, II/A1
Low Temperature	502.1	I	502.2	I/C3, II/C1
Temperature Shock	503.1	I	503.2	I/A1, C3
Solar Radiation	505.1	II	505.2	I
Rain	506.1	I, II	506.2	I, II
Humidity	507.1	II	507.2	II
Salt Fog	509.1	I	509.2	I
Blowing Dust	510.1	I	510.2	I
Blowing Sand	1 Proc	1 Proc	510.2	II
Submersion	512.1	I	512.2	I
Vibration	514.2	VIII/F, Curve-W	514.3	I/10, II/3
Shock	516.2	I, III, V	516.3	I, V, VI
Shock (Drop)	516.2	II	516.3	IV

Table 10: Military Standards – 810E/810F

Applicable MIL–STD	810E		810F	
	Methods	Procedures	Methods	Procedures
Low Pressure	500.3	II	500.4	II
High Temperature	501.3	I/A1, II/A1	501.4	I/Hot, II/Hot
Low Temperature	502.3	I/C3, II/C1	502.4	I/C3, II/C1
Temperature Shock	503.3	I/A1, C3	503.4	I
Solar Radiation	505.3	I	505.4	I
Rain	506.3	I,II	506.4	I, III
Humidity	507.3	II	507.4	1 Proc

Applicable MIL–STD	810E		810F	
	Methods	**Procedures**	**Methods**	**Procedures**
Salt Fog	509.3	I	509.4	1 Proc
Blowing Dust	510.3	I	510.4	I
Blowing Sand	510.3	II	510.4	II
Submersion	512.3	I	512.4	I
Vibration	514.4	I/10, II/3	514.5	I/24
Shock	516.4	I, V, VI	516.5	I, V, VI
Shock (Drop)	516.4	IV	516.5	IV

Table 11: Military Standards – 810G/H

Applicable MIL–STD	810G/H	
	Methods	**Procedure**
Low Pressure	500.5	II
High Temperature	501.5	I/A1, II/A1
Low Temperature	502.5	I/C3, II/C1
Temperature Shock	503.5	I/C
Solar Radiation	505.5	I/A1
Rain	506.5	I, III
Humidity	507.5	II/Aggravated
Salt Fog	509.5	1 Proc
Blowing Dust	510.5	I
Blowing Sand	510.5	II
Submersion	512.5	I
Vibration	514.6	I/24
Shock	516.6	I, V, VI
Shock (Drop)	516.6	IV

1.4.5

LTE Technical Characteristics

Table 12: H35UCT9PW8AN (700/800 MHz) and H35XDT9PW8AN (UHF) Models

Parameter	Value
Conducted Power Output	24 dBm (0.25 W) MAX
LTE Transmitter (Uplink) Frequency Range and Bandwidth	LTE Band 2: 1850–1910 MHz Bandwidth: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz LTE Band 4: 1710–1755 MHz

Parameter	Value
	Bandwidth: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
	LTE Band 12: 699–716 MHz Bandwidth: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz
	LTE Band 13: 777–787 MHz Bandwidth: 5 MHz, 10 MHz
	LTE Band 14: 788–798 MHz Bandwidth: 5 MHz, 10 MHz
	LTE Band 17: (Future Capability)
LTE Receiver (Downlink) Frequency Range	LTE Band 2: 1930–1990 MHz
	LTE Band 4: 2110–2155 MHz
	LTE Band 12: 729–746 MHz
	LTE Band 13: 746–756 MHz Bandwidth: 5 MHz, 10 MHz
	LTE Band 14: 758–768 MHz
	LTE Band 17: (Future Capability)
Frequency Stability	± 0.1 ppm
Emissions Designator	LTE Band 2: 1M10G7D, 1M08D7W, 2M67G7D, 2M68D7W, 4M48G7D, 4M47D7W, 8M94G7D, 8M95D7W, 13M5G7D, 13M5D7W, 18M0G7D
	LTE Band 4: 1M10G7D, 1M08D7W, 2M67G7D, 2M68D7W, 4M48G7D, 4M47D7W, 8M94G7D, 8M95D7W, 13M5G7D, 13M5D7W, 18M0G7D
	LTE Band 12: 1M10G7D, 1M08D7W, 2M67G7D, 2M68D7W,4M48G7D, 4M47D7W, 8M94G7D, 8M95D7W
	LTE Band 13: 4M48G7D, 4M47D7W, 8M94G7D, 8M95D7W
	LTE Band 14: 4M48G7D, 4M47D7W, 8M94G7D, 8M95D7W
	LTE Band 17: (Future Capability)
Maximum Spurious Emission	-30 dBm
Modulation Types	QPSK, 16QAM
Modulation Technology	SC-FDMA
DC Voltage and Current information	3.6 V Final RF amplifier stages up to 1 Amps
UE Category and Data Rate	3GPP CAT4 and up to 50 MHz uplink
Power Class	3
Certifications	FirstNet

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

To avoid operating outside the limits set by the FCC, align the reference oscillator of the radio every time the radio is taken apart, or once per year, whichever comes first.

Checking this parameter when the product 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. (See Aligning the Reference Oscillator on page 52). Periodic visual inspection and cleaning are 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.

NOTE: Verify that all dust covers are in place.

2.1.2
Cleaning Procedures

The following procedures describe the recommended cleaning agents and the methods to clean the external surfaces of your radio.

External surfaces include the front cover, housing assembly, and battery. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime.

CAUTION: Use all chemicals as prescribed by the manufacturer. 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. Avoid using aerosol sprays, tuner cleaners, and other chemicals.

2.1.2.1
Cleaning External Plastic Surface

Wear the radio in a carry case or inside the turnout coat (fire departments) to better protect the radio from prolong exposure to dirt, debris, heat and/or impacts.

Prerequisites: Mix one tablespoon of mild dishwashing detergent to one gallon of water (0.5% solution) to clean the external surfaces of the radio.

Procedure:

1. Use a stiff, nonmetallic, short-bristled brush to apply the solution sparingly to remove any loose dirt from the radio.

   Ensure that excess detergent does not get entrapped near the connectors, controls or crevices.

2. Dry the radio thoroughly with a soft, lint-free cloth.

3. If the radio battery contact area is exposed to water, dry and clean the radio battery contacts before attaching a battery to the radio.

4. If the radio is exposed to salt water, thoroughly rinse the radio with fresh water.

5. If the radio is submerged in water, shake the radio briskly to remove any water trapped inside the speaker grille and microphone port. Dry the radio following Step 2.

2.1.3
Cleaning in High Debris Environment

For high debris environments, additional cleaning steps are needed to maintain optimal radio performance. The speaker grille can trap dirt and debris, resulting in degraded audio quality and clarity. The control top can trap dirt and debris, resulting in reduced tactile feel in the buttons, switches, and knobs.

Procedure:

Clean the speaker grille and control top by performing the following actions:

Option	Actions
Speaker Grille	a. Attach a crevice nozzle to a vacuum cleaner to vacuum the speaker grille to maintain optimal audio performance. b. Avoid covering all the grille openings at once with the nozzle. Move the nozzle back and forth several times horizontally across the grille. c. Perform a "Talk or Listen" test, to confirm audio performance has returned to normal. d. If audio issues persist, send radio for servicing.

Control Top	a. Attach a crevice nozzle to a vacuum cleaner to vacuum all radio surfaces to maintain optimal tactile performance.
	
	b. Submersible radios ("R" or "XE" designators):
	
	   i. Turn the radio upside down and place the top of the radio into the water.
	
	   ii. With the control top submerged, shake the radio vigorously to loosen dirt and debris.
	
	   iii. Perform vacuuming again, to remove dirt, debris, and water.

2.1.4
Disinfecting Procedures

In response to the Coronavirus (COVID-19) pandemic, Motorola Solutions is providing recommended cleaning and disinfecting guidelines for your radio. These guidelines are based on current and best

understanding of radio hygiene. As per global health authorities, removing germs, dirt, and impurities from surfaces lowers the risk of spreading infection.

The following disinfectants can be used to disinfect your radio:

- Isopropyl alcohol 70%

- Ethanol 70%

- PDI Super Sani-Cloth Germicidal Disposable Wipe

- PDI Super Sani-Cloth Plus Wipes

For more information on recommended cleaning and disinfecting guidelines, refer to the following links:

- https://youtu.be/cYjxoUNCXZo

- https://newsroom.motorolasolutions.com/mediakits/recommended-cleaning-and-disinfecting-guidelines-for-our-radios-body-worn-cameras-and-accessories.htm

2.2
Handling Precautions

Complementary Metal Oxide Semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices are used in this family of radios, and are susceptible to damage by electrostatic 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 CMOS/LDMOS circuits and are especially important in low humidity conditions. Do not attempt to disassemble your radio without referring to the following caution statement.

⚠ **CAUTION:**
The 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 loses its submergibility.

The pressure equalization vent is located next 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.

2.2.1
Care After Submerging

If the radio battery contact area has been submerged in water without a battery attached, shake out any trapped water. Dry and clean the radio battery contacts before attaching a battery to the radio. Otherwise, the water can short-circuit the radio.

If the radio has been submerged in water, shake the radio briskly so that any water trapped inside the speaker grille and microphone port can be removed. Otherwise, the water can decrease the audio quality of the radio. If an accessory or the Universal Connector Cover is covering the Universal Connector, check the interface to ensure no liquid has penetrated the seal. Water left in this interface can degrade the performance of the accessories.

Chapter 3

Operational Construction and Band Definition

This radio is capable of analog operation (12.5 kHz or 25 kHz bandwidths), ASTRO mode (digital) operation (12.5 kHz only), and Phase 2 TDMA mode (12.5 kHz only) and LTE.

The electrical assemblies of this radio are the Main Board (BP Board), Applications Board (AP Board) and Interconnect Board.

⚠ **CAUTION:** Do not disassemble the radio down to the board level.

📝 **NOTE:** For surface level or minor mechanical parts replacement, see Disassembly/Reassembly Procedures on page 69 for customer specific instructions for disassembly and reassembly of the radio.

For detailed information of board replacement, operational verification of the wireless connectivity and integrity after the reassembly is done, refer to *APX N70 Detailed Service Manual, MN009209A01*.

Chapter 4

Test Equipment and Service Aids

This section lists the recommended test equipment and service aids, and information on field programming equipment. You can use this information in servicing and programming radios.

4.1
Recommended Test Equipment

The list of equipment in the following table includes all the standard test equipment required for servicing two-way portable radios. The list includes several unique items designed specifically for servicing this family of radios.

The Characteristics column is included so that equivalent equipment can be substituted. However, if no information is provided in this column, the specific Motorola Solutions model listed is either a unique item or no substitution is recommended.

Table 13: List of Recommended Test Equipment

Equipment	Characteristics	Example	Application
DC Block	0.005–26.500 GHz	RF-Lamda RFDCBLK26SMA	To protect test equipments, a DC Block must be placed at the antenna port of the Radio at all times before connecting to the equipment.
Service Monitor	Can be used as a substitute	Viavi 3920 (https://www.viaviolutions.com/)[12]	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Audio Analyzer	-	Agilent U8903 (http://www.agilent.com)	Audio Analysis
Digital RMS Multimeter [13]	100 µV to 300 V 5 Hz to 1 MHz 10 Ω Impedance	Fluke 179 (www.fluke.com) or equivalent	AC/DC voltage and current measurements. Audio voltage measurements.
RF Signal Generator [13]	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 E4438 (http://www.agilent.com)	Receiver measurements
Modulation Analyzer	-	HP8901 or equivalent	Frequency Modulation measurements

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[12] Referenced in this manual as an example for test setup guidelines.
[13] You can use Service Monitor as a substitute.

Equipment	Characteristics	Example	Application
Oscillo-scope [13]	2 Channel 50 MHz Bandwidth 5 mV/div to 20 V/div	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.bkpreci-sion.com) or equiva-lent	Voltage supply
Power Meter and Sensor[13]	5% accuracy 100 MHz to 500 MHz 50 W	Agilent E4418 (www.agilent.com)	Transmitter power/RF wattage output measure-ments

4.2
Service Aids

The following table shows 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 Replacement Parts Ordering on page 14. While all 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 14: List of Service Aids

Motorola Solu-tions Part Num-ber	Description	Application
TL000173A01	SMA to MS147 Adapter	Adapts antenna port to SMA cabling of test equipment.
TL000163A01	APX N70 Battery Adapter	This four wired Battery Adapter is used in place of an actual battery, and should be used with a Power Supply that has +/- voltage sense lines for accurate voltage output into the radio. The bench power supply wattage can be 2 W or 4 W, with 4 W being preferred. The voltage/current output should not exceed 9 V/3 A.
TL000183A01	Vacuum Adapter	Submersible radios only. Connects the vac-uum/pressure hose to the radio.
NLN9839_	Vacuum Pump Kit	Submersible radios only. Vacuum pump with gauge and vacuum hose. Requires TL000183A01 Adapter Kit.
Service Package	RadioCentral	After purchasing a Device Managed Service package, an email is sent for download at My-View portal.

Motorola Solutions Part Number	Description	Application
PMKN4265_	Programming Cable (USB)	Used for Customer Programming Software (CPS) radio programming.
PMKN4231_	Audio Service Cable	Used with RLN4460_ for audio, modulation, and transmitter analysis only.
PMKN4291_	Mini GCAI Keyload Cable	Allows you to perform key loading on the radio.
PMLN8334_	GCAI Mini to GCAI Cable Adapter	GCAI mini adapter to allows standard GCAI cable usage.
RLN4460_	Portable Test Set	Used for radio performance checks. Enables connection to the universal connector and allows remote switching and signal injection/outputs for test equipment measurements.
WPLN6904 and PMLN8334_	Standard APX Keyload Cable and GCAI to GCAI Mini Adapter	Allows you to perform key loading on the radio.

4.3
Field Programming

This family of radios can be programmed in the field.

This requires specific equipment and special instructions. Refer to the online help in the RadioCentral tool for complete field programming information. A USB cable cannot be used.

Chapter 5

Performance Checks

This chapter covers performance checks used to ensure that the radio meets published specifications.

The recommended test equipment listed in the previous section is almost accurate to the manufacturing equipment. Maintenance of the test equipment must be aligned with the manufacturer recommended calibration schedule. Checks should be performed if radio performance declines.

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 the following figure.

Figure 2: Performance Checks Test Setup
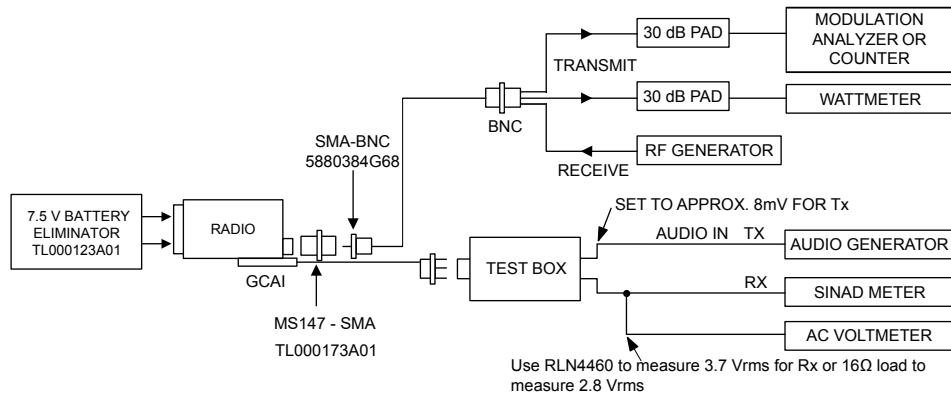
Initial equipment control settings should be as indicated in Table 15: Initial Equipment Control Settings on page 36 and should be the same for all performance checks procedures, except as noted.

Table 15: 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 **Meter** RF Display **Output Level** -47 dBm **Modulation** 1 kHz tone @ 1.5 kHz deviation for 12.5kHz ChSp, OR	**PTT** OFF (center)	**DC On/Standby** Standby
	Meter Out RX	**Volt Range** 10 Vdc
	``Opt Sel ON	**Current** 2.5 A

System Analyzer	Test Set	Power Supply

3 kHz deviation for 25 kHz ChSp
 	
Frequency
Set to selected radio RX frequency
Transmitter Checks
  RF Control
  Analyzer
 	
Frequency
Set to selected radio TX frequency
 	
Meter
RF Display
 	
Modulation Type
FM		

5.2
Accessing Test Mode

Procedure:

1. Turn on the radio.

2. When the top display shows the zone and channel of the radio, consecutively press the **2-Dot (Side Bottom) Programmable Feature Button** for five times.

   The top display of the radio shows a series of information regarding various version numbers and radio-specific information as shown in the following table. After that, the top display shows `RF Test`. The front display shows similar information in the **About Device** menu along with the following menus:

   ● **RGB Test**

   ● **Touchscreen Test**

   ● **Factory Reset**

Table 16: Test Mode Displays (Top Display)

Display	Description	Appearance
Service	Indicates that the radio has entered Test Mode	Always
Host Version	Displays the version of the host firmware	
DSP Version	Displays the DSP version of the firmware	
Secure Version	Displays the version of the encryption software and hardware	When the radio is secure equipped
Secure HW Type		
Secure HW Ver		

Display	Description	Appearance
`KG 1` algorithms name	Displays the type of encryption being used for Encryption Type 1.	When the radio is secure equipped
`KG 2` algorithms name	Displays the type of encryption being used for Encryption Type 2.	When the radio is secure equipped and 2 or more algorithms are loaded
`KG 3` algorithms name	Displays the type of encryption being used for Encryption Type 3.	When the radio is secure equipped and 3 or more algorithms are loaded
`KG 4` algorithms name	Displays the type of encryption being used for Encryption Type 4.	When the radio is secure equipped and 4 or more algorithms are loaded
`KG 5` algorithms name	Displays the type of encryption being used for Encryption Type 5.	When the radio is secure equipped and 5 or more algorithms are loaded
`KG 6` algorithms name	Displays the type of encryption being used for Encryption Type 6.	When the radio is secure equipped and 6 or more algorithms are loaded
`Model Number`	Displays the model number of the radio as programmed in the codeplug	Always
`Serial Number`	Displays the serial number of the radio as programmed din the codeplug	Always
`ESN`	Displays the unique Electronic Serial Number of the radio	Always
ROM Size	Displays the memory capacity of the host FLASH part	Always
`Flashcode`	Displays the FLASH codes as programmed in the codeplug	Always
`RF Band`	Displays the operating frequency of the radio: 700/800 MHz	Always
`Tuning Ver`	Displays the version of the tuning codeplug	Always
`Processor Ver`	Displays the version of the processor	Always
`AP Board Type`	Displays the application processor board type of the radio	Always

5.2.1
Performing RF Test

While performing this test, observe results on the top display of the radio.

Prerequisites: Enter Test Mode. See Accessing Test Mode on page 37

Procedure:

1. Press the **Purple (Side Top) Programmable Button** and scroll to `RF Test` on the top display.

2. To enter RF Test Mode, press the **Top (Orange) Button**.

3. Perform one of the following actions:

   - To scroll through the TX Deviation Frequency, press the **Purple (Side Top) Programmable Button**.

   - To scroll through the available test options, press the **1-Dot (Side Middle) Programmable Feature Button**.

Table 17: RF Test Options

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[14]
USQ	Carrier Unsquelch	RX: Unsquelch always TX: Mic audio

   - To advance to the next test channel, press the **2-Dot (Side Bottom) Programmable Feature Button**.

Table 18: Test Channel Frequencies for 700/800 MHz Band

Test Channel	RX Frequency (MHz)	TX Frequency (MHz)
1	762.0625	762.0125
2	769.0625	769.0875
3	775.9375	775.9875
4	799.0625	792.0125
5	802.0625	809.0125
6	805.9375	824.9875
7	851.0625	851.0125

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[14] All deviation values are based on the deviation tuning of this mode.

Test Channel	RX Frequency (MHz)	TX Frequency (MHz)
8	860.0625	860.0125
9	869.9375	869.8875

Table 19: Test Channel Frequencies for UHF Band

Test Channel	RX Frequency (MHz)	TX Frequency (MHz)
F1	380.075	380.025
F2	395.575	395.525
F3	410.075	410.025
F4	425.575	425.525
F5	440.975	440.925
F6	455.075	455.025
F7	470.575	470.525
F8	485.725	485.025
F9	500.575	500.525
F10	519.975	519.925

4. To exit RF Test Mode, turn off the radio.

5.2.2
Performing Control Top (CH) Test

This test mode is used to verify proper operation of the radio buttons and switches. Perform this test on the top display of the radio.

Prerequisites: Enter Test Mode. See

Procedure:

1. Press the **Purple (Side Top) Programmable Button** and scroll to `CH Test`.

2. To enter CH Test Mode, press and hold the **Top (Orange) Button**.

   The radio shows the top display icons and the LED lights amber.

3. Release the **Top (Orange) Button**

   The radio displays `148/0`.

4. Press and release the **Top (Orange) Button**.

   The radio displays `148/1` and `148/0`.

5. Rotate the **Channel Selector**.

   The radio displays `4/0` through `4/15` when the switch is in position 1 through 16.

6. Flip the **2-Position Concentric Programmable Switch**.

   The radio displays `65/0` and `65/1` when you change the position of the switch.

7. Change the position of the **ABC Programmable Switch**.

   The radio displays `67/0`, `67/1` and `67/2` when you change the position of the switch.

8. Rotate the **Volume Control Knob**.

   The radio displays `2/0` through `2/255`. Display values may vary slightly at the upper and lower limits.

9. Press and release the **Purple (Side Top) Programmable Button**.

   The radio displays `96/1` and `96/0`.

10. Press and release the **1-Dot (Side Middle) Programmable Feature Button**.

    The radio displays `97/1` and `97/0`.

11. Press and release the **2-Dot (Side Bottom) Programmable Feature Button**.

    The radio displays `98/1` and `98/0`.

12. Press and release the **PTT Button**.

    The radio displays `1/1` and `1/0`.

13. Press and release the **3-Dot (Speaker Grill) Programmable Feature Button**.

    The radio displays `101/1` and `101/0`.

14. To exit CH Test Mode, turn off the radio.

5.2.3
Performing RGB Test (Top Display)

Perform this test on the top display of the radio.

Prerequisites: Enter Test Mode. See Accessing Test Mode on page 37

Procedure:

1. Press the **Purple (Side Top) Programmable Button** and scroll to `RGB Test`.

2. To enter RGB Test Mode, press the **Top (Orange) Button**.

   The display turns black.

3. Press any key consecutively.

   After each key press, the display shows the following results:

   a. Crosstalk pattern appears.

   b. White screen appears.

   c. Red horizontal lines appear.

   d. After seven consecutive key presses, solid red screen appears

   e. After three consecutive key presses, green vertical lines appear.

   f. After nine consecutive key presses, solid green screen appears.

   g. Black screen appears.

   h. Blue screen appears.

   i. Vendor-specific display TEST PATTERN appears.

      j. `Test completed` appears.

4. To exit RGB Test Mode, turn off the radio.

5.2.4
Performing RGB Test (Front Display)

Perform this test on the front display of the radio.

Prerequisites: Enter Test Mode. See Accessing Test Mode on page 37

Procedure:

1. Tap **RGB Test** → **START**.

The display turns white.

2. Swipe left consecutively.

After each swipe, the display shows the following results:

- Black screen appears.
- Black screen with white border appears.
- White screen with black border appears.
- Black gradient screen appears.
- Crosstalk pattern appears.
- Crosstalk pattern with a lighter tone appears.
- Black screen with white horizontal bars appears.
- Red screen appears.
- Green screen appears.
- Blue screen appears.
- `RGB test completed` screen appears.

3. Tap **Done**.

4. To exit Test Mode, turn off the radio.

5.2.5
Performing Touchscreen Test

Perform this test on the front display of the radio.

Prerequisites: Enter Test Mode. See Accessing Test Mode on page 37

Procedure:

1. Tap **Touchscreen Test** → **START**.

The radio displays a black background with a blue letter "Z" in the foreground.

2. Trace the letter "Z" from the top left corner to the bottom right corner in one stroke.

A white line appears at the area that you have traced.

- If the screen has no dead cells, the white line is one continuous line from start to finish.

- If the screen has dead cells, the white line is broken where the dead cells are located.

3. Tap the screen.

   The white line disappears.

4. Swipe left to the Touchscreen Test completion screen.

5. Tap **Done**.

6. To exit Test Mode, turn off the radio.

5.3
Checking Receiver Performance

The following tables outline the performance checks for the receiver.

> **NOTE:** The following tests require a communications system analyzer with the ASTRO 25 test options. All radio interfaces are at the GCAI connector.

Table 20: Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	RF Control: Analyzer Meter: RF Display/Freq Offset Frequency: Selected radio TX frequency	TEST MODE CSQ channel[15] or programmed conventional channel	PTT to continuous (during the performance check)	error ≤±0.8 ppm
Rated Audio at GCAI connector	RF Control: Generator Output Level: -47 dBm Frequency: Selected radio RX frequency Mod: 1 kHz tone @ 1.5 kHz deviation[16] Meter: RF Display/Audio Level	As above	PTT to OFF (center) Load Selector: A	Set volume control to 3.7 Vrms or 2.8 Vrms[16]
Distortion	As above, except Meter: RF Display/AF Meter Dist.	As above	As above	Distortion <3.0%

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[15] See Table 17: RF Test Options on page 39

[16] 1 kHz tone @ 1.5 kHz deviation for 12.5 kHz ChSp, OR 3 kHz deviation for 25 kHz ChSp. The rated audio output Vrms value is derived based upon the load and speaker wattage rating. If using RLN4460, this presumes 0.5 W @≅28 Ω: V = √(0.5x28) = 3.7 Vrms. If using load equivalent to PSM, 0.5 W @ 16 Ω: V = √(0.5x16) = 2.8 Vrms.

Test Name	System Analyzer	Radio	Test Set	Comments
Sensitivity (SI-NAD)	As above, except Meter: RF Display/AF Meter SI-NAD RF Output Level: Adjust until SI-NAD = 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 3.7 Vrms or 2.8 Vrms. Set RF level to -130 dBm and raise until radio unsquelches. Unsquelch to occur at <0.25 μV. Preferred SINAD = 6–8 dB.

Table 21: Receiver Tests for ASTRO Conventional Channels

Test Name	System Analyzer	Radio	Test Set	Comments
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: ● STD 1011 ● STD Silence	As above	As above	Residual Audio Noise Ratio -45 dB or better

Test Name	System Analyzer	Radio	Test Set	Comments
	Frequency: Selected radio RX frequency Meter: Audio Distortion			

5.4
Checking Transmitter Performance

The following tables outline the performance checks for the transmitter.

NOTE: The following tests require a communications system analyzer with the ASTRO 25 test options. All radio interfaces are at the GCAI connector.

Table 22: Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Set	Comments
Reference Frequency	RF Control: Analyzer Meter: RF Display/Freq Offset Freq: Selected radio TX frequency	TEST MODE CSQ channel or programmed conventional channel See Table 17: RF Test Options on page 39.	PTT to continuous (during the performance check).	error ≤±0.8 ppm
RF Power	As above, except Meter: RF Display/Broadband Power	As above	As above	700: 1–2.7 W 800: 1–3 W UHF: 1–5 W
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 the 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	As Voice Modulation Test (internal)	TEST MODE TPL channel or con-	Remove modulation input. PTT to OFF (center)	Press PTT on the radio.

Test Name	System Analyzer	Radio	Test Set	Comments
mode, coded squelch operation only)		ventional channel programmed for TPL operation See Table 17: RF Test Options on page 39.		Deviation: (12.5 kHz) ≥ 350 Hz but ≤ 600 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

Table 23: 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 Freq: 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).	VHF: 1–6 W UHF1: 1–5 W 700: 1–2.7 W 800: 1–3 W
Frequency Error	Mode: P25 RF Control: RX P25 Set: Phase 1 C4FM Freq: Selected radio TX frequency Meter: UUT Measurements/Frequency Error	As above	As above	±0.8 ppm

5.5
Checking Bluetooth Performance

Perform the following action on Bluetooth (BT) Performance Checks and measure the time accordingly.

Table 24: Time Measured on BT Performance Checks

Action	Time Measured
Reconnecting a pre-paired BT accessory upon powering up	1.5–3 seconds
Enabling BT on radio setting menu	5–6 seconds
BT Headset Pairing Time 📝 **NOTE:** Time between clicking on the "pair with device" popup window and producing the "Device Connected" chime on radio.	1.5–2.5 seconds
Routing time for Sennheiser Presence and Jabra Motion[17]	< 1 second
Routing time for Plantronics Voyager[17]	2–2.5 seconds
The stability of the BT dropping from an outside source 📝 **NOTE:** Leave radio and BT Headset on and connected for overnight.	12+ hours
📝 **NOTE:** Audio does not distort for at least 10 meters. Play a ringtone or otherwise continuous playing sound and walk away from the radio while listening to the BT headset.	n/a

5.6
Checking WLAN Performance

Procedure:

Check WLAN performance by using the following options:

Option	Actions
Checking Wi-Fi 2.4 GHz band connection	a. Configure and connect the radio to a 2.4 GHz Wi-Fi Access Point. b. Verify the Wi-Fi icon shows 📶 **Full Strength** when close to the Access Point, and it reduces as the radio is moved further away from the access point.

---

[17] Measure the time between audio ceasing to emit on the internal speaker and beginning to emit on the headset by connecting to a signal generator.

Option	Actions
Checking Wi-Fi 5 GHz band connection	a. Configure and connect the radio to a 5 GHz Wi-Fi Access Point. b. Verify the Wi-Fi icon shows 📶 **Full Strength** when close to the Access Point, and it reduces as the radio is moved further away from the access point.

5.7
Checking GNSS Performance

Procedure:

1. To check the GPS location acquisition, configure and enable the GPS of the radio.

2. Position the radio outdoor in an unobstructed open sky environment.

3. Turn on the radio and allow it to lock onto a GPS location.

   NOTE:
   It locks within 60 seconds in open sky environment or more than 5 minutes in an obstructed environment.

   The GPS icon only indicates that the GNSS feature is enabled. Use CommandCentral to see the coordinates of the radio.

Chapter 6

Radio Alignment Procedures

This chapter describes both receiver and transmitter radio alignment procedures.

For details of the product release of the standalone Tuner software, please contact the Product and Technical Support team at 1-800-MSI-HELP (1-800-674-4357).

Please be prepared to provide your radio's software version information. To do so, see Accessing Test Mode on page 37 and refer to the Host Version number and DSP Version number.

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 the following figure.

Figure 3: Radio Alignment Test Setup
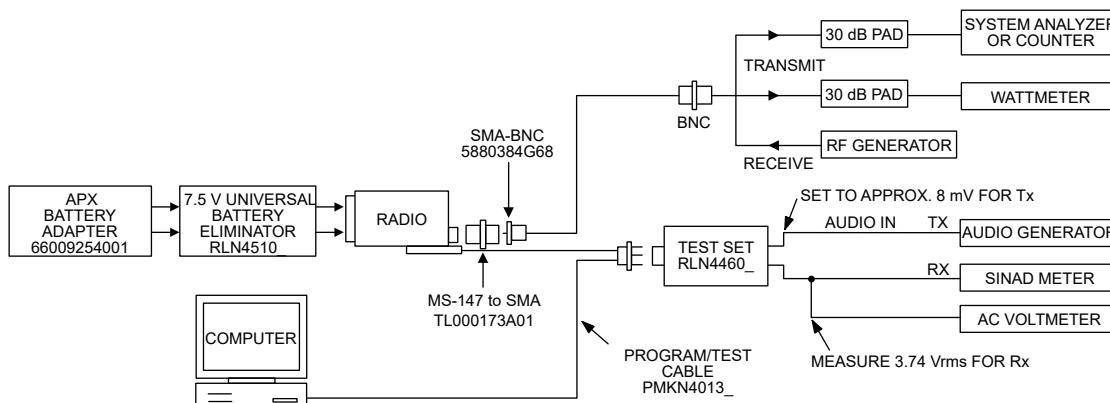
⚠️ **CAUTION:** These radio alignment procedures must only be attempted by qualified service personnels. Failure to perform alignment procedures properly can result in seriously degraded radio or system performance.

6.2
Tuner Main Menu

Prerequisites: Connect the radio to a computer and a universal test set.

Procedure:
1. From the **Start** menu select **Tuner**. Click **Start → Program Files → Motorola → ASTRO 25 Products → ASTRO 25 Tuner**.
2. Click **File → Read Device** or click on the **Read Device** button to read the radio.
3. Click on the desired screen name in the **Tuner Menu** to access a screen.

Figure 4: Tuner Software Main Menu for APX N70
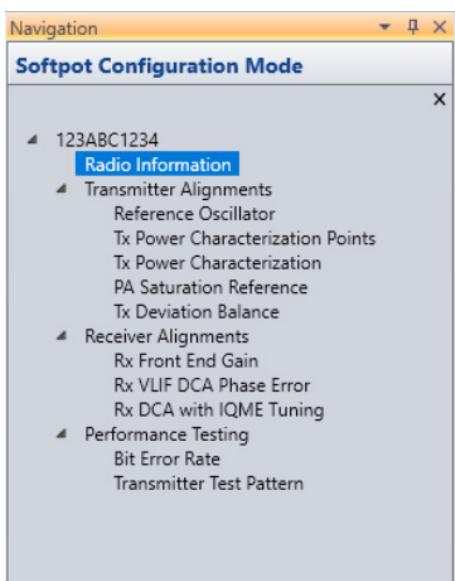
> ⓘ **IMPORTANT:** Tuning should follow the order of the Tuning tree view in descending order from top to bottom

> 📝 **NOTE:** If you are using a service monitor test equipment for automated testing, make sure to use the latest software version available for the equipment. Also make sure to follow test equipment setup guidelines such as accounting for cable loss specified by the manufacturer.

6.3
Softpot

The alignment screens introduce the concept of the softpot, an analog SOFTware-controlled POTentiometer 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 5: Typical Softpot Screen
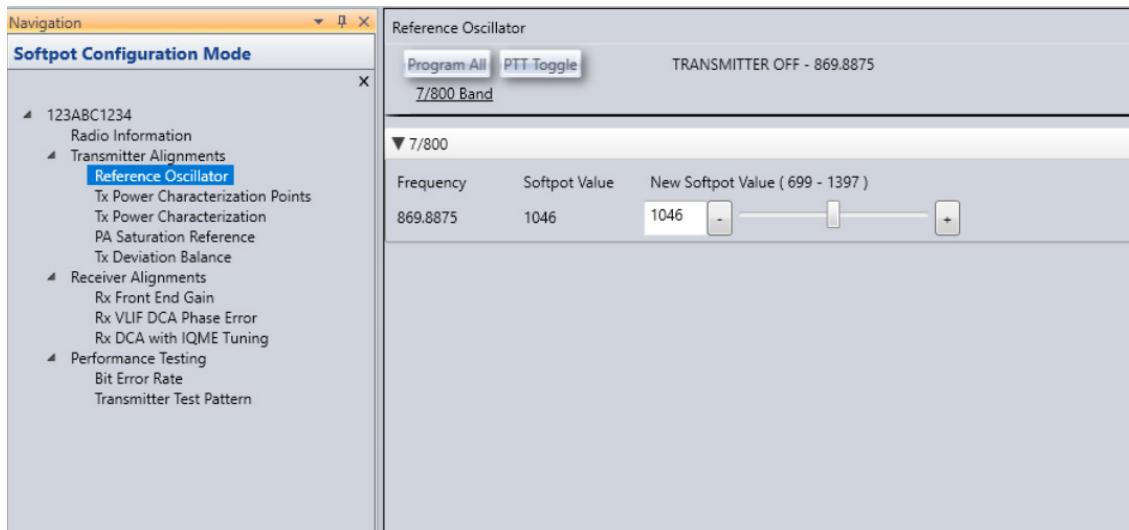
Adjusting the softpot value sends information to the radio to increase (or decrease) the voltage in the corresponding circuit. For example, left-clicking the UP spin button in the New Softpot Value scroll box on the **Reference Oscillator** screen instructs the microcomputer to increase the voltage across 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.

⚠ **CAUTION:** When keying the radio during a test, always transmit into a dummy load.

📝 **NOTE:** Some of the following screens can vary depending upon the radio under test and the version of tuner software you are using. Refer to the software online help.

6.4
Radio Information

The following figure shows a typical Radio Information screen. This screen is informational only and cannot be directly changed.

Figure 6: Radio Information Screen
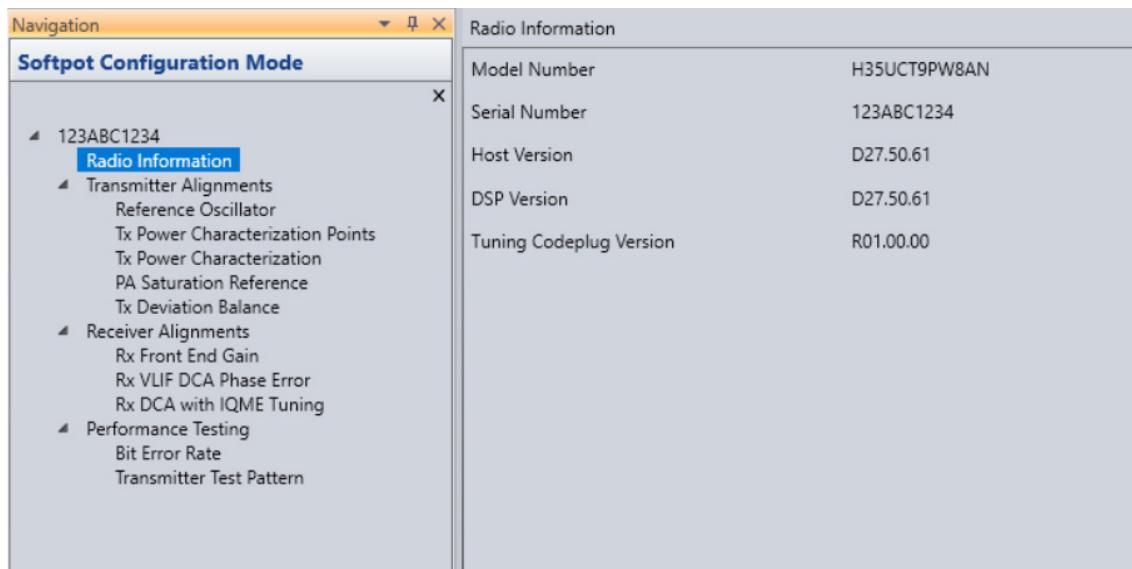
6.5
Transmitter Alignments

The Transmitter Alignment procedure consists the following:

- Reference Oscillator Alignment
- Power Characterization Points
- Power Characterization Tuning
- PA Saturation Reference Tuning
- Transmit Deviation Balance Alignment

6.5.1
Aligning the Reference Oscillator

The frequency counter used for this procedure must have stability of 0.1 ppm or better. This test can be done with either a Communication Analyzer or Modulation Analyzer. You are recommended to use a 10 MHz external reference. Check the parameter when the radio is placed in service. Perform the check if the product has been in storage for more than six months from being shipped from the factory and commissioned for service.
Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment results not only in poor operation, but also in a misaligned radio that interferes with other users operating on adjacent channels.

For this reason, the reference oscillator must be checked every time the radio is serviced, or once a year, whichever comes first.

NOTE: Reference oscillator alignment is required after servicing the transceiver board.

Prerequisites:

- Initial setup using the Communication Analyzer:
  - RF Control: Analyzer or RX

- ○ B/W: WB
- ○ Freq: CPS frequency under test
- ○ Attenuation: 20 dB (optional)
- ○ Mon RF in: RF I/O
- ○ Meter: Frequency Counter or Offset
- ○ Mode: Analog or P25 STD

6.5.1.1
Tuning Reference Oscillator

Procedure:

1. Ensure that the Communication Analyzer is in **Manual** mode.
2. Set the base frequency to the following:

Table 25: Base Frequencies

Band	Frequency
700/800 MHz	869.8875 MHz
UHF	519.925 MHz

3. Select the **Reference Oscillator** tuning screen.

Figure 7: Reference Oscillator Alignment Screen
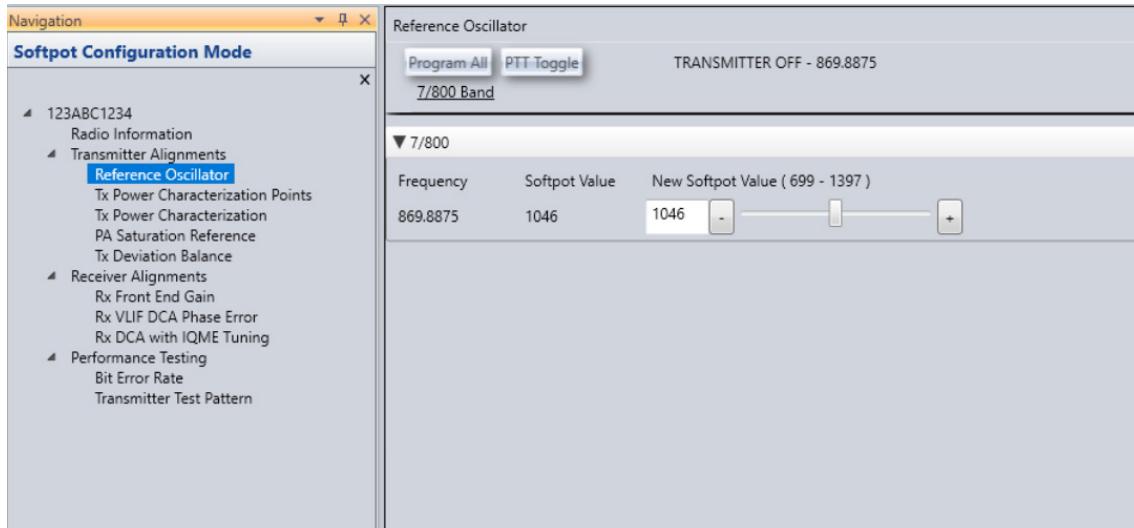
4. Adjust the reference oscillator softpot value with the slider until the measured value is as close as possible to the frequency shown on the screen. See Reference Oscillator Alignment

   ✎ **NOTE:** Increase the slider to decrease the frequency.

Table 26: Reference Oscillator Alignment

Band	Target
700/800 MHz	±50 Hz

Band	Target
UHF	±50 Hz

5. To dekey the radio and save the tuned values, click **Program All**.

6.5.2
Tuning Power Characterization Points

Prerequisites:

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

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

Ensure that the system is calibrated for cable loss.

Use a standard 50 Ω cable.

Apply best practices for the equipment being used.

Procedure:

1. Select the **TX Power Characterization Points** alignment screen.

Figure 8: Transmit Power Characterization Points Screen
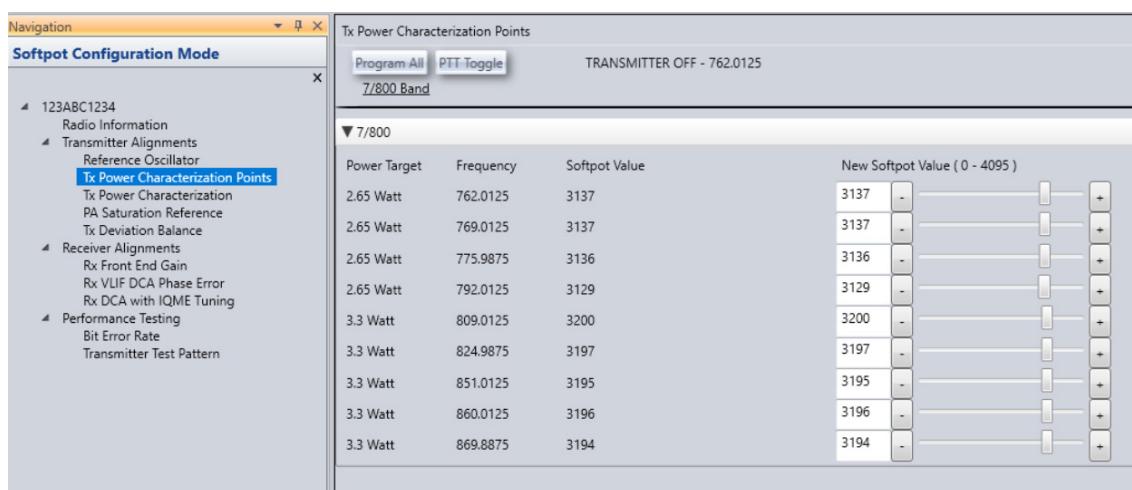
2. Set the power supply voltage and current limit.

3. Adjust the softpot value by performing one of the following:

- Manipulate the slider bar, incrementing the **New Softpot Value** text box.

- Directly enter desired value into the 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 and step 3 for all frequencies.

5. To dekey the radio and save the tuned values, click **Program All** button.

6.5.3
Tuning Power Characterization

Prerequisites:

⚠ **IMPORTANT:** Power Characterization Tuning Points must be tuned before tuning Power Characterization Tuning.
The longer the RF cable, the more the attenuation of the power reading.

Ensure that the system is calibrated for cable loss.

Use a standard 50 Ω cable.

Apply best practices for the equipment being used.

Procedure:

1. Select the **TX Power Characterization** alignment screen. The screen indicates the transmit power to be used. Refer to the following figure.

Figure 9: Transmit Power Characterization Alignment Screen

2. Click the box below **Measure Power 1** for the desired frequency field.

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 selected **Measure Power 1** field.

6. Repeat step 2 to step 5 for **Measure Power Error** and **Measure Power 2** for the same frequency field.

7. Repeat step 2 to step 5 for **Measure Power 2** for the same frequency field.

8. Repeat step 2 to step 6 for all frequencies.

9. To dekey the radio and save the tuned values, click **Program All** button.

6.5.4
Tuning PA Saturation Reference

Tuning is done through PA Saturation Referencing screen.

Procedure:

1. Select the **PA Saturation Reference** alignment screen.

   The screen indicates the transmit frequencies to be used.

   Figure 10: PA Saturation Referencing Alignment Screen
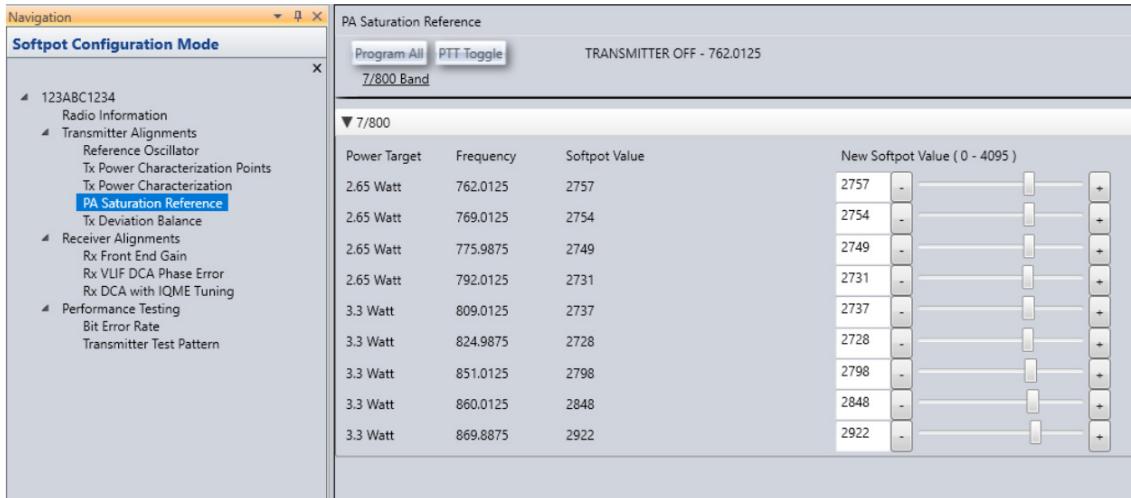
2. In Manual Mode, set the service monitor to the desired frequency as shown in the frequency list.

3. Adjust the PA Saturation Reference softpot value with the slider until the radio transmits as close as possible to the rated power. For rated power, refer to the help text in the Tuner.

4. Click the slider of the frequency selected. The frequency value must be similar as in step 2.

5. Click the **PTT Toggle** button to make the radio transmit.

   The screen indicates whether the radio is transmitting.

6. Repeat step 2 to step 5 for all frequencies.

7. To dekey the radio and save the tuned values, click the **Program All** button.

6.5.5
Aligning Transmit Deviation Balance

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 signaling schemes that have very low frequency components such as DPL and could result in distorted waveforms if adjusted improperly.

This procedure needs to be performed at multiple frequencies to allow 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.

Prerequisites:

Proper alignment requires a modulation analyzer or meter with a frequency response to less than 10 Hz modulating frequency. Set the modulation analyzer setting during this test to the following settings if the settings are supported:

- Average deviation
- 15 kHz low-pass filter
- No de-emphasis
- No high-pass filter

Procedure:
1. Perform the initial setup using the Communication Analyzer:

Parameter	Value
Mode	P25 Analog Mode 15 kHz LP filter enabled
RF Control	P25 RX
Meter	FM Deviation
Frequency	Selected radio TX frequency

2. Connect a BNC cable between the DEMOD OUT port and the Audio In 1 port on the service monitor.
3. Select the **TX Deviation Balance** alignment screen.

   The screen indicates the transmit frequencies to be used.

   Figure 11: Transmit Deviation Balance Tuning Screen
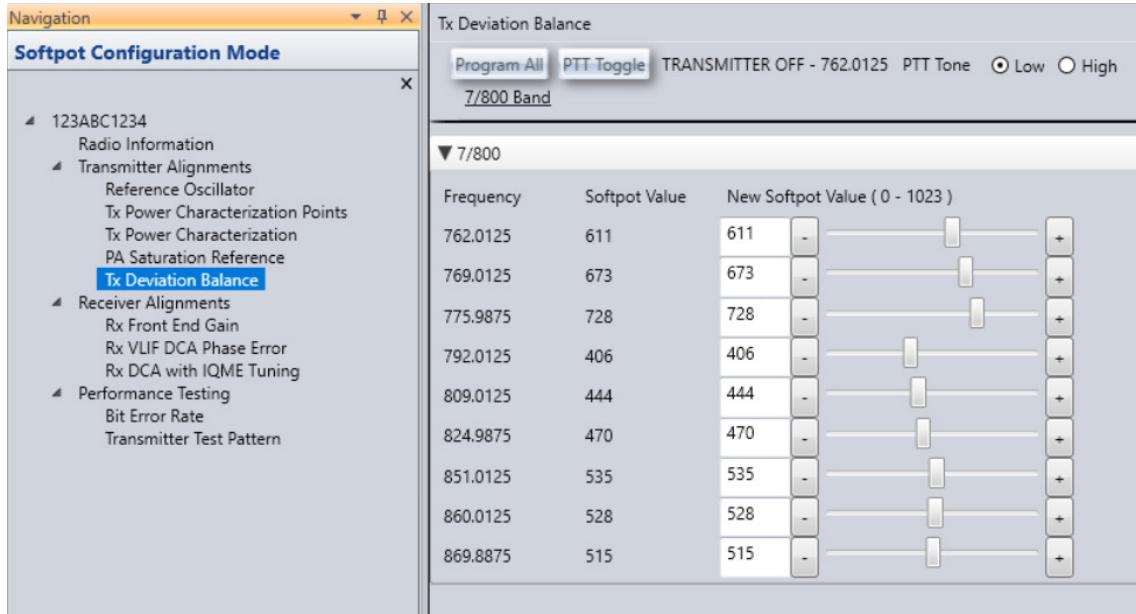
4. Set the service Monitor to the desired frequency as shown in the frequency list.
5. Select the **PTT Tone: Low** option.
6. Click the slider of the frequency selected.

   The frequency value must be similar as in step .
7. Click the **PTT Toggle** button 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 service monitor.

9. Select the **PTT Tone: High** option.

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. To de-key the radio, click the **PTT Toggle**.

12. Repeat step 4 to step 10 for all frequencies.

13. To dekey the radio and save the tuned values, click the **Program All** button.

6.6
Receiver Alignments

The Receiver Alignment procedure consists of Front-End Gain, VLIF Duty Cycle Adjustment (DCA) Phase Error, and Rx DCA with IQME tuning.

The Front-End Gain tuning purpose is to measure and store Front-End Gain value in the radio for Received Signal Strength Indicator (RSSI) accuracy. The VLIF DCA Phase Error and IQME tuning is to minimize I and Q quadrature phase error and improve Side Band Suppression (SBS). This procedure must be performed for all test frequencies to allow proper software interpolation of frequencies between the test frequencies in the band.

⚠ **CAUTION:** This procedure must only be attempted by qualified service technicians.

📝 **NOTE:** After replacing or servicing the transceiver board, the Rx Front-End Gain Alignment is required.

6.6.1
Tuning Front End Gain

Procedure:

1. Select the **Rx Front End Gain** alignment screen. See the following figure.

   Figure 12: Receiver Front End Gain Alignment Screen (700/800 MHz)
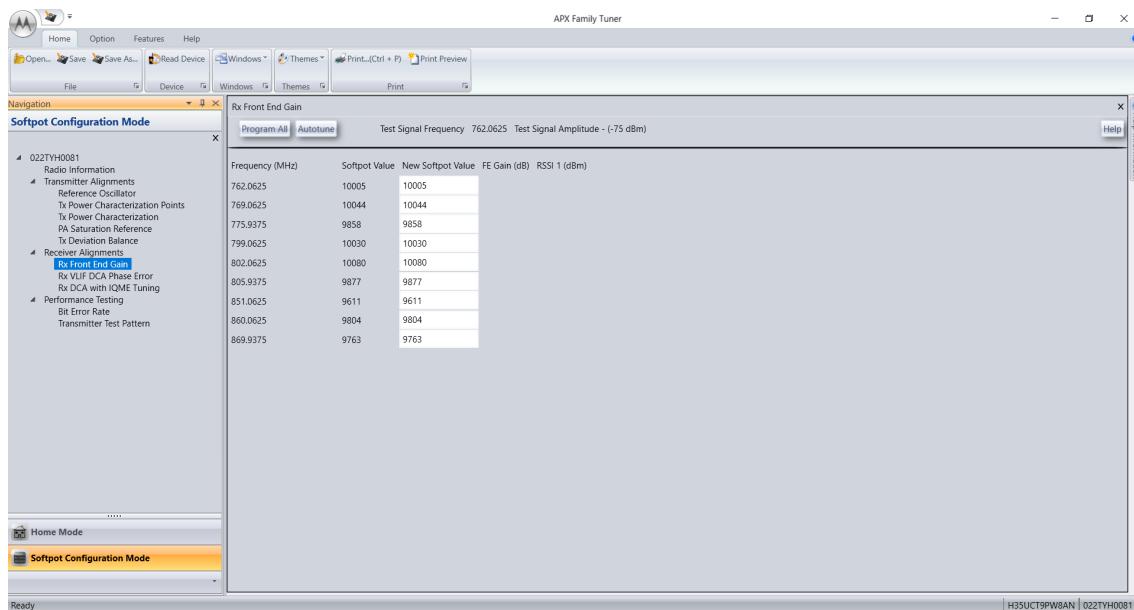
Figure 13: Receiver Front End Gain Alignment Screen (UHF)
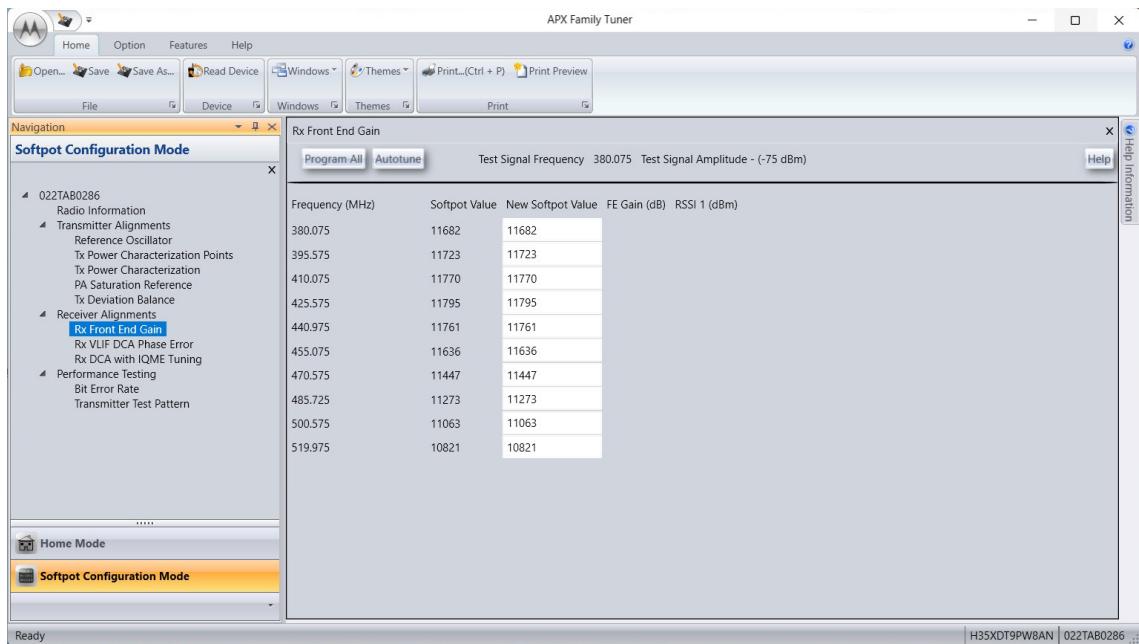
2. To select which frequency to tune, click the **New Softpot Value** text box.

3. Apply RF test signal input with no modulation at the signal level and on the **Test Signal Frequency** displayed at the top of the screen.

4. Click the **Autotune** button.

5. Repeat step 2 to step 4 for all the frequencies.

6. To save the tuned values in the radio, click the **Program All** button on the screen.

6.6.2
Tuning VLIF DCA Phase Error

Procedure:

1. Select the **Rx VLIF DCA Phase Error** alignment screen. See the following figure.

Figure 14: Receiver VLIF DCA Phase Error Alignment Screen (700/800 MHz)
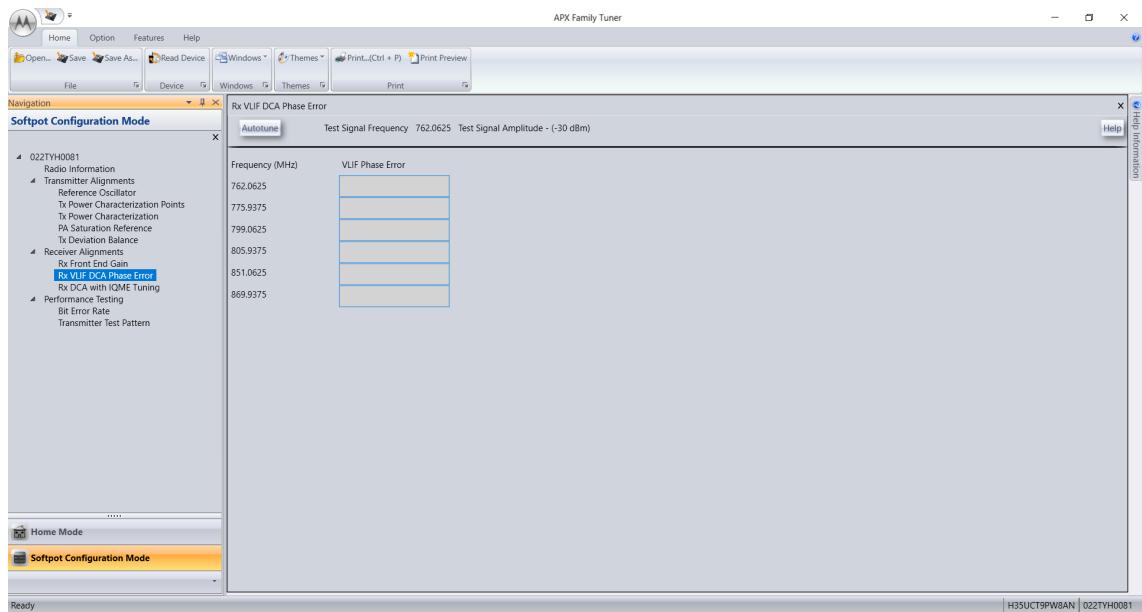
Figure 15: Receiver VLIF DCA Phase Error Alignment Screen (UHF)
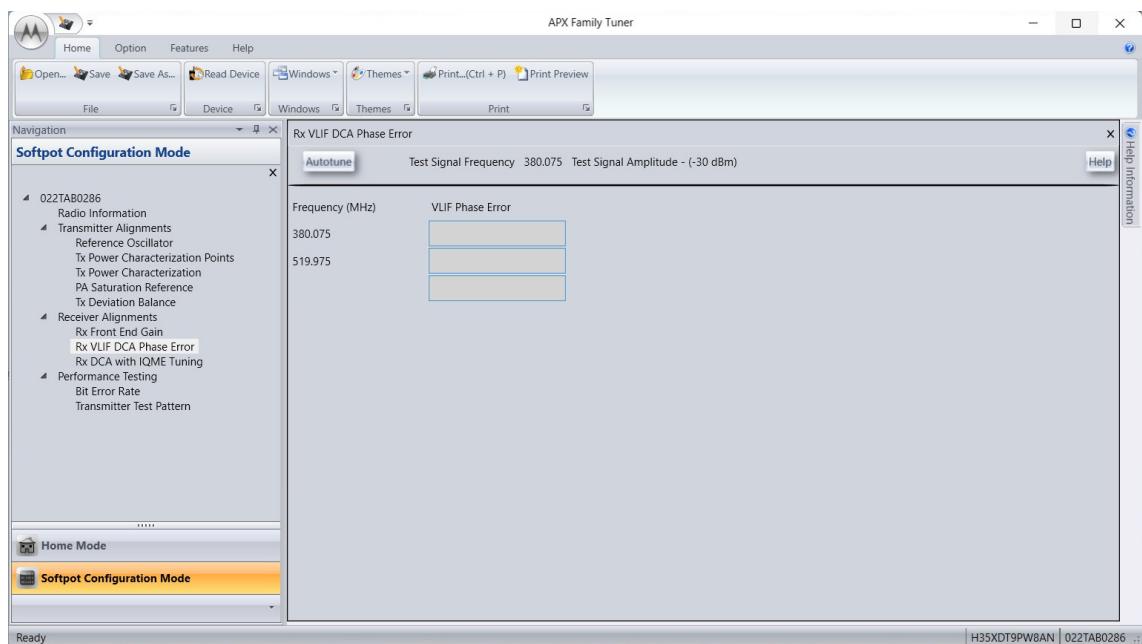
2. To select which frequency to tune, click the **VLIF Phase Error** text box.

NOTE: Tuning of VLIF DCA Phase error is disabled in the Tuner and the fields are non-editable at the moment.

3. Apply RF test signal input with no modulation at the signal level and on the **Test Signal Frequency** displayed at the top of the screen.

4. Click the **Autotune** button.

5. Repeat step 2 to step 4 for all the frequencies.

6.6.3
Tuning IQME

Procedure:

1. Select the **Rx DCA IQME Tuning** alignment screen. See the following figure.

Figure 16: Receiver IQME Alignment Screen (700 MHz)
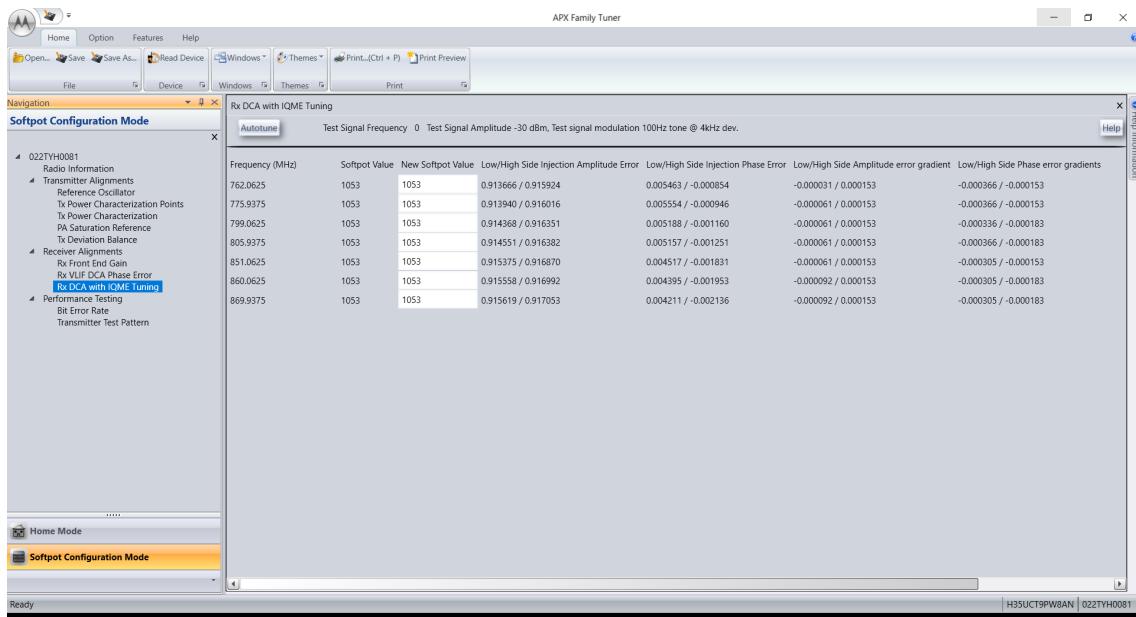
**Figure 17: Receiver IQME Alignment Screen (UHF)**
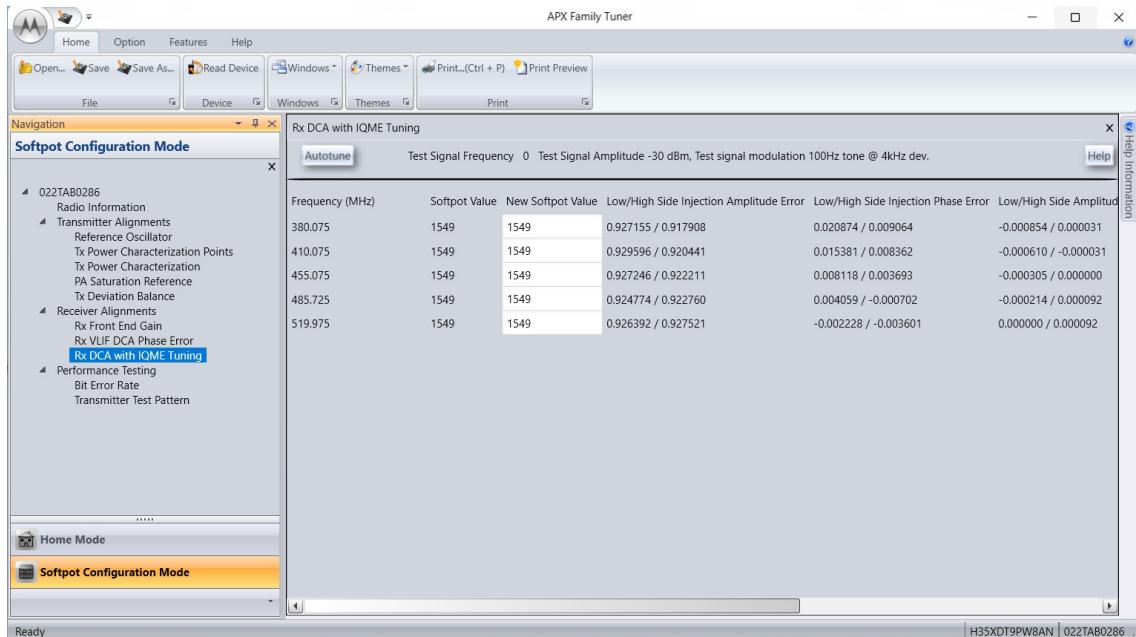
2. To select which frequency to tune, click the **IQME Tuning** text box.

3. Apply RF test signal input with both modulation and signal level shown on the **Test Signal Frequency** displayed at the top of the screen.

4. Click the **Autotune** button.

5. Repeat step 2 to step 4 for all the frequencies.

6.7
Performance Testing

This section describes the performance test procedures for Bit Error Rate and Transmitter Test Pattern of the radio.

6.7.1
Bit Error Rate

This section describes the Bit Error Rate (BER) test of the receiver at a desired frequency as shown in the following figures.

Figure 18: Bit Error Rate Testing Screen (700/800 MHz)
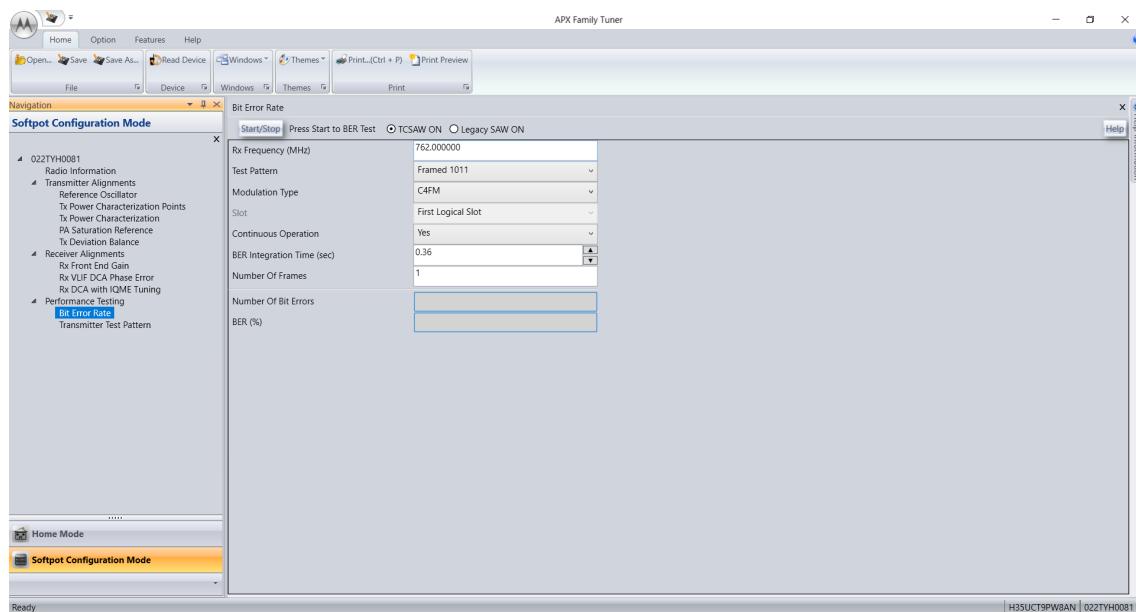
Figure 19: Bit Error Rate Testing Screen (UHF)
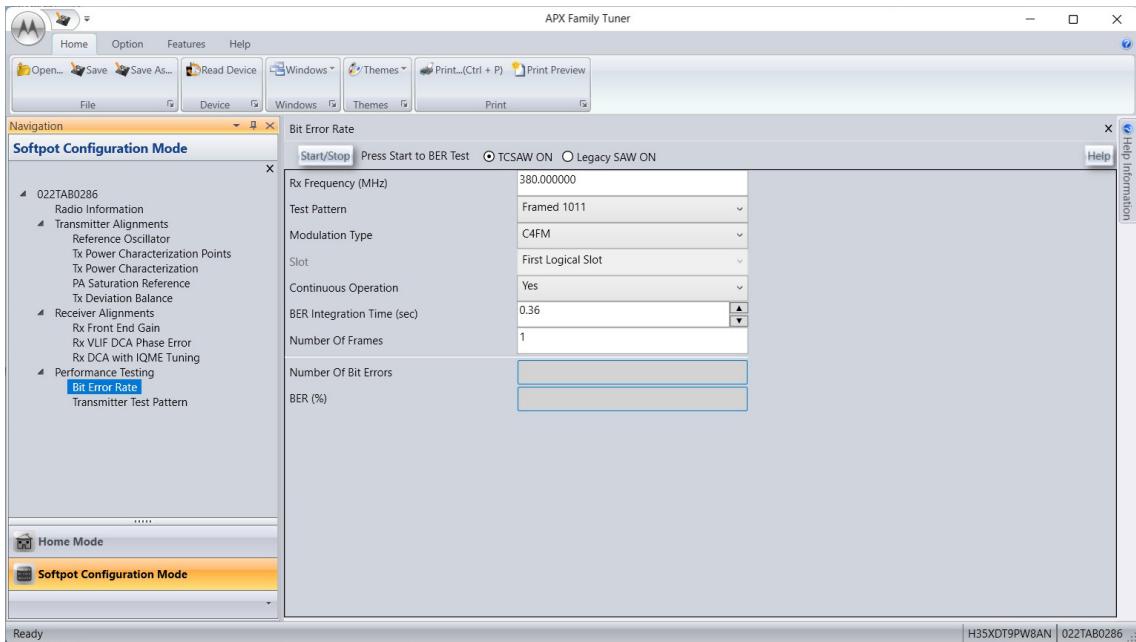
6.7.1.1
Bit Error Rate Fields

Before testing the BER of the receiver, some information is shown on the bit error rate screen. The explanation of each field is described in this section.

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.

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.

Continuous Operation
This field allows the user the option to repeat the BER test indefinitely. A selection of **Yes** causes the radio to calculate BER on a continuous basis and update the results on this screen after each integration time.

A selection of **No** causes the BER test to execute for only one sample of the integration time and then update the display.

> **NOTE:**
> When Continuous Operation = **Yes**, all fields are grayed out while the test is in progress. They are enabled when the STOP button is pressed.
>
> When Continuous Operation = **No**, a wait cursor is displayed while the test is in progress and return to normal when the test is done.

TCSAW ON is enabled by default and **Legacy SAW ON** is for testing purposes only.

6.7.1.2
Testing Bit Error Rate

Set up the Communication Analyzer as follows:

Procedure:

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 by configuring as follows:

Table 27: Configuring Service Monitor

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

3. To begin or end BER testing, press the **Start/Stop** button.

6.8

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 transmitter.

Figure 20: Transmitter Test Pattern Screen
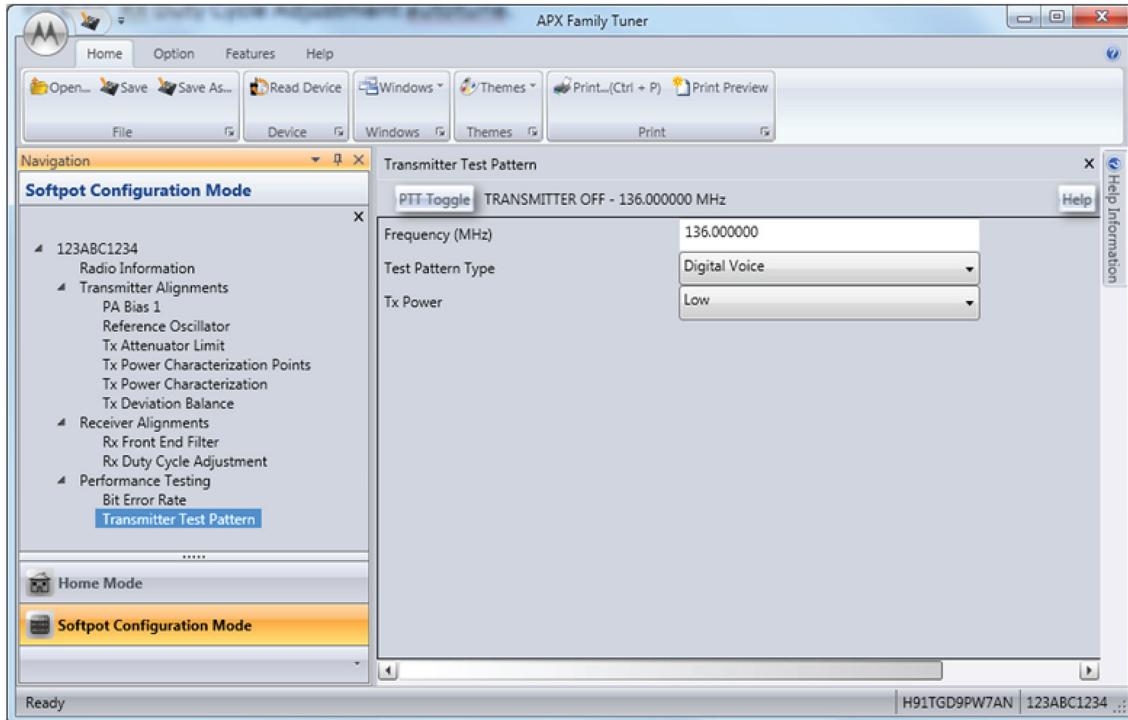
6.8.1

Transmitter Test Fields

This screen contains the following fields:

Tx Frequency
This field selects the Transmit Frequency directly in MHz.

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

Chapter 7

Encryption

This chapter provides procedures for using the encryption capability of your radio.

To validate the secure/encryption programming capability of your Radio's codeplug and firmware options, perform the following procedures:

- Loading an encryption key.

- Selecting an encryption key.

- Selecting an Index.

- Erasing an encryption key

For operational details on Keyload, Rekey, Erasing a Key (Zeroization), supported algorithms and so on, please refer to your specific *Key Variable Loader (KVL) User Guide*.

7.1
Toggling between Secure and Clear Transmission

Procedure:

Turn the **Secure/Clear** switch to the required position.

If the Secure/Clear selection differs from the security settings of the channel when you attempt to transmit, the **Radio Control Widget** shows `Secure Tx Only` or `Clear Tx Only`.

7.2
Selecting Encryption Keys (Conventional Only)

This feature allows you to change the encryption key from an active keyset.

✎ **NOTE:** Your codeplug must be enabled to make these Front Display menu visible.

Procedure:

1. From the **Home** screen, tap ●●● **More**.

2. Tap 🔑 **Select Key**, then select the required encryption key.

7.3
Changing Encryption Keysets

Procedure:

1. From the **Home** screen, tap ●●● **More**.

2. Tap 🔑🔑 **Change Keyset**, then select the required encryption keyset.

   3. Tap **Change** to confirm the request.

7.4
Infinite UKEK Retention

This feature enables Unique Key Encryption Key (UKEK) to be permanently stored in the radio even when all the encryption keys are erased. Without this UKEK key, the radio cannot be rekeyed over the air. The Infinite UKEK Retention settings can be different for each secure profile.

> **NOTE:** This feature must be programmed by a qualified radio technician. Check with your dealer or system administrator for more information.

7.5
Requesting Rekey

Over-the-Air Rekey (OTAR), allows the system administrator to remotely reprogram encryption keys in the radio. The Rekey Request feature allows you to request for the reprogramming of the encryption keys.

Prerequisites: Ensure that the Unique Key Encryption Key (UKEK) is loaded into the radio with the Key Variable Loader (KVL).

Procedure:

   1. From the **Home** screen, tap ●●● **More**.

   2. Tap **Request Rekey**.

   3. Tap **Continue** to confirm the request.

7.6
Erasing Encryption Key (Zeroize)

Procedure:

   1. From the **Home** screen, tap ●●● **More**.

   2. Tap **Erase Keys**.

   3. Tap at the required encryption key.

   4. Tap **Erase** to confirm the request.

7.7
Erasing All Encryption Keys (Method 1: Front Display Touch Screen Menu)

Erase all encryption keys at the same time (bulk erase) from the front display menu.

Procedure:

1. From the **Home** screen, tap **More**.

2. Tap **Erase Keys**.

3. Tap **Erase All Keys**.

4. Tap **Erase All** to confirm the request.

7.8
Erasing All Encryption Keys (Method 2: Radio Buttons)

Erase all encryption keys at the same time (bulk erase) by using radio buttons.

Procedure:

With the radio on, press and hold the **Top Side** button and, while holding down this button, press the **Top** button.

Before the keys are erased, the display shows `PLEASE WAIT`.
The display shows `ALL KEYS ERASED` when all the encryption keys have been erased.

7.9
Encryption Alerts and Tones

During encryption, you will get and hear the following alerts and tones:

● Clear Transmission Alert Tone is heard at PTT of a clear mode transmission on a radio which has the secure option enabled. The short 910 Hz tone is to alert the radio operator that the transmission is in the clear mode.

● If the selected key is erased, the display shows `KEY FAIL` and the radio sounds a momentary keyfail tone.

● If the selected key is not allowed, the display shows `ILLEGAL KEY` and the radio sounds a momentary illegal key tone.

● If the attempt to transmit an encrypted message (secure mode) and the encryption key has failed to load, you will hear the Key Fail Alert tone.

● If your radio is in standby mode and the encryption key has failed to load. you will hear the Key Fail Alert tone.

> **NOTE:**
> Key Fail Alert Tone is a 910 Hz tone which is repeated in 200 ms 50% duty cycle.
>
> Transmission/Reception Clear Alert and Periodic Keyfail tones are configurable inside the codeplug.

Chapter 8

Disassembly/Reassembly Procedures

This chapter provides detailed procedures for disassembling/reassembling and ensuring submergibility of the radio.

This chapter also has procedures for removing and installing the radio standard accessories and changing the Volume and Frequency Knobs.

8.1
Exploded View and Parts List

This section contains the radio partial exploded views.

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

Figure 21: APX N70 Exploded View
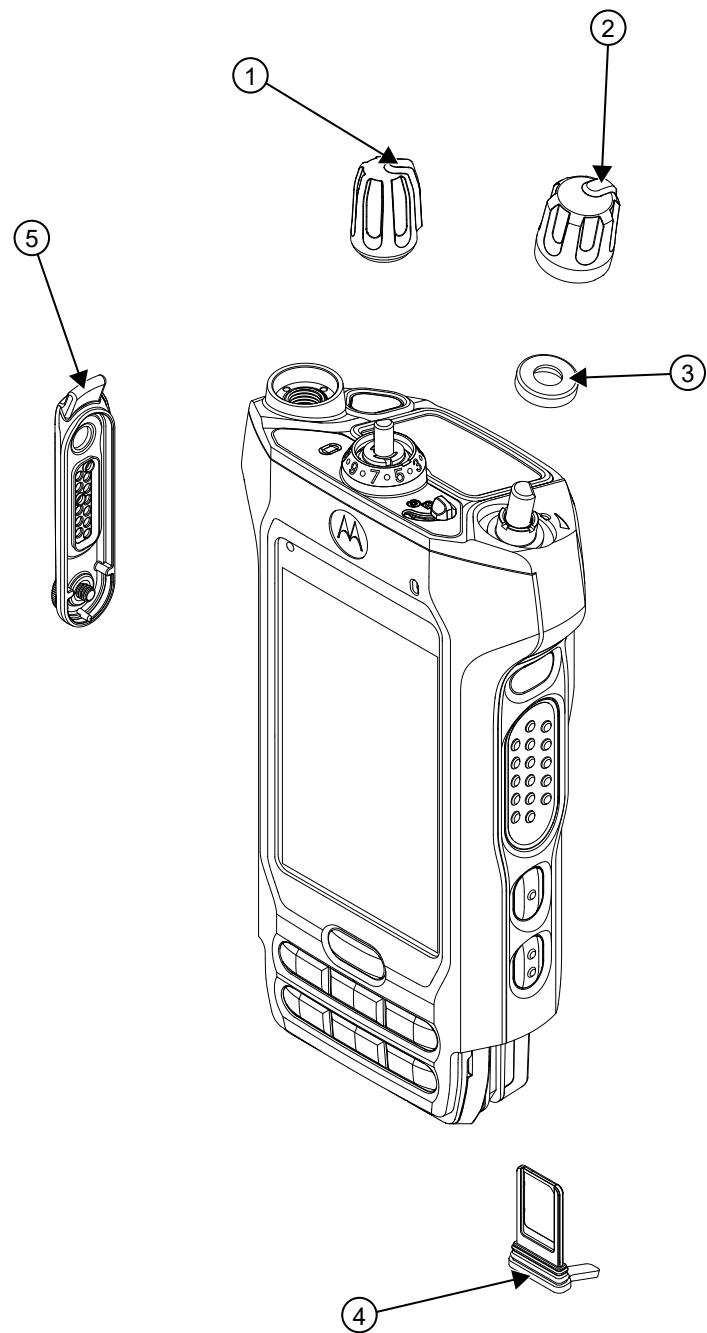
Table 28: APX N70 Parts List

Item No.	Motorola Solutions Part No.	Description
1	HW003222A01	Knob, Frequency, with D-Clip
2	HW003223A01	Knob, Volume, with D-Clip
3	3275377H02	Torque Adder Seal
4	HW003111A01	SIM Card Tray

Item No.	Motorola Solutions Part No.	Description
5	PMHN4429_	Mini GCAI Dust Cover

8.2
Recommended Tools and Suppliers

Table 29: Recommended Tools and Suppliers

Tools	Supplier	Part Number	Remarks
Bit, Torx 6	–	–	Torx T6 may be used with a Torque Driver
Nylon Spudger	Hexacon Electric Co.	MA-800G	–
Vacuum Pump Kit	Motorola Solutions	NLN9839_	For Vacuum Test
Vacuum Adapter	Motorola Solutions	TL000183A01	For Vacuum Test
Knob Remover	–	TL000161A01	For removing volume and frequency knob

8.3
Disassembling the Radio

This section contains instructions for disassembling the radio main subassemblies only.

✎ **NOTE:** If the Speaker Module assembly is disassembled, send the radio to a service depot to validate that the wireless performance is within nominal specifications.

8.3.1
Turning Off the Radio

Procedure:

To turn off the radio, rotate the **On/Off/Volume Control** knob counterclockwise until you hear a click.

To view the video for turning off radio, click Turning Off the Radio.

8.3.2
Removing the Battery

Procedure:

1. To remove the battery, press the latches on both sides.
2. Pull the battery away from the radio.

To view the video for removing battery, click Removing the Battery.

8.3.3
Removing the Antenna

Procedure:

To remove the antenna, turn the antenna counterclockwise, then remove it from the receptacle.

To view the video for removing antenna, click Removing the Antenna.

8.3.4
Removing the Universal Connector Cover

Procedure:

1. To remove the Accessory Connector Cover, rotate the thumbscrew counterclockwise until it disengages from the radio.

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

2. Rotate outwards and lift the connector cover to disengage it from the radio.

To view the video for removing universal connector cover, click Removing the Universal Connector Cover.

8.3.5

Removing the SIM Card Tray

Procedure:

Gently pull the tab to slide out the SIM card tray.

📝 **NOTE:** The SIM card tray must not be removed with a hook or prying tool.

To view the video for removing SIM card tray, click Removing the SIM Card Tray.

8.3.6

Removing the Knobs

Procedure:

1. Hold the radio firmly in one hand so that the top of the radio faces upward, and the front of the radio faces you.

2. Grasp the knobs with a pair of pliers and pull it upward, until it is free from the shaft.

   📝 **NOTE:**
   Knobs must only be removed when damaged.

   The knobs are designed to be difficult to remove. However, the knobs can come off. If the metal D-Clip stays with the knob post, remove the D-Clip before putting on a new knob.

To view videos for removing the knobs, click Removing the Knobs.

8.4
Reassembling the Radio

Prerequisites:

⚠️ **CAUTION:** Do not reassemble the radio without first performing the preliminary inspection procedure. Reassemble the radio according to the procedures and tighten all hardware that was loosened or removed.

8.4.1
Assembling the Radio Knobs

Procedure:

1. Place the knobs on their respective shafts. Ensure the D-shape of the post is aligned with the D-shape of the knob.

2. Press the knob into place.

   📝 **NOTE:** Considerable force is needed to press the knobs into place. Use a solid surface if required. Cover the surface with a clean rubbery covering, such as a mouse pad, to prevent markings to the knob.

Figure 22: Assembling Channel Selector Knob

Figure 23: Assembling On/Off/Volume Control Knob

To view videos for assembling the knobs, click Assembling the Radio Knobs.

8.4.2

Inserting SIM Card Tray

The following section is applicable to radios with LTE capabilities.

> 📝 **NOTE:** For more LTE SIM card information, see the "Connectivity" section in *APX N70 User Guide, MN009207A01*.

Prerequisites: Remove battery from the radio and hold the radio with the speaker grille facing up.

Procedure:

1. Gently pull out the SIM card door from the pocket.

2. Use a tweezer to grab and pull the SIM card tray out.

> 📝 **NOTE:** The SIM card tray should not be removed with a hook or prying tool.

3. Insert the SIM card in the SIM card tray where the letters "TOP" is facing away from the chassis of the radio.

4. Push the SIM card tray back into the radio. Avoid bending it sideways, up, or down.

5. Press the SIM card door back into the pocket.

> ⚠️ **CAUTION:** Press and ensure seal is evenly inserted into the opening. Failure to install seal evenly can result in possible leak.

Figure 24: Inserting SIM Card Tray

To view the video for inserting the SIM card tray, click Inserting the SIM Card Tray.

8.4.3
Attaching the Antenna

Procedure:

1. To attach the antenna, set the antenna in the receptacle.
2. Turn the antenna clockwise and tighten the antenna securely to the radio.

Figure 25: Attaching the Antenna

To view the video for attaching the battery, click Attaching the Antenna.

8.4.4
Attaching the Battery

Procedure:

1. To attach the battery, align the battery with the bottom rails on the back of the radio.
2. Slide the battery into the radio frame until the side latches click in place.

Figure 26: Attaching the Battery

To view the video for attaching the battery, click Attaching the Battery.

8.4.5
Attaching the Universal Connector Cover

Procedure:

1. Insert the hooked end of the cover into the pocket.

2. Engage the hook beneath the undercut and swing the cover down onto the radio.

3. Ensure that the cover is seated properly and the screw is aligned into the threaded hole.

Figure 27: Attaching Universal Connector Cover

4. Hand tighten the thumb screw clockwise until secured.

    📝 **NOTE:** Do not over-tighten the screw. The screw should be snug and not allow the cover to move.

Figure 28: Universal Connector Cover Thumb Screw

To view the video for attaching universal connector cover, click Attaching the Universal Connector Cover.

8.5
Ensuring Radio Submergibility

This section discusses radio submergibility concerns, tests, disassembly, and reassembly of the radios.

8.5.1
Standards

The radio models meet the stringent requirements of U.S. Mil-Std 810 Revisions C, D, E, F, and G, Method 512.X Procedure 1, which requires the radio to maintain watertight integrity when radio temperature is elevated to +27 °C above water temperature and immersed in 1 meter of water for 2 hours. The radio has an IP68 rating with increased immersion limits up to 2 meters for 4 hours.

8.5.2
Servicing

The 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.

8.5.3
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.

If a conductive medium is present in the water, ensure to thoroughly rinse the radio to remove all the conductive medium, then shake the radio to remove the excess water from the speaker grille and microphone ports areas before operating.

8.5.4
Specialized Test Equipment

This section summarizes the specialized test equipment necessary for testing the integrity of ASTRO 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 for water leaks. The specialized test equipments and instruments mentioned in Service Aids on page 34 is used to perform the vacuum check. Do not use any equipment, tool, or instrument that is mentioned in this chapter to perform these tests.

8.5.4.1
Vacuum Pump Kit NLN9839

The Vacuum Pump Kit includes a Vacuum Pump with gauge and a Vacuum Hose. The Vacuum Adapter which connects the vacuum pump to the radio, must be ordered separately.

Table 30: Vacuum Adapter Part Number

Vacuum Adapter	TL000183A01

8.5.5
Vacuum Test

A Vacuum Pump is used 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 Universal Connector Cover or any other accessories to expose the universal connector.

8.5.5.1
Vacuum Tool Setup

Procedure:

1. Attach one end of the hose to the Vacuum Pump. Attach the other side of the hose to the Vacuum Adapter.

2. Follow the procedures to perform Tool Leak Test:

    a. Block the open end of the Vacuum Adapter.

    b. Pull the knob on the Vacuum Pump to create vacuum.

    c. Pump at least 15 inHg.

    d. 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 Adapter.

8.5.5.2
Test Procedure

Procedure:

1. Remove the SIM Card door from the main chassis with a black stick.

2. Attach the Vacuum Adapter onto the radio in the same manner as a radio battery. Ensure that both latches are clicked into place.

3. Pull the knob on the Vacuum Pump to create vacuum. The vacuum test pressure should be between 5–7 inHg.

⚠ **CAUTION:** Ensure that the vacuum pressure never exceeds 7 inHg. If the pressure exceeds this limit, the radio has pressure sensitive components that can be damaged.

4. Observe the gauge for approximately 2 minutes.

Result:
If the needle falls less than 0.25 inHg (1/2 a tick mark on the Vacuum Pump), the radio passes the vacuum test. If the seal passes this inspection, this radio is approved for submergibility. No additional testing is required. You must assemble the vacuum port back in place after testing. You can proceed to reinsert the SIM card before turning on the radio.

If the needle falls more than 0.25 inHg, the radio fails the vacuum test. The radio can leak if submerged. More troubleshooting is required. The radio needs to be sent to an authorized service center for additional diagnosing and repair. You must follow your department repair procedures regarding the retainment or return of SIM cards, after an AP board return/replacement.

Chapter 9

Basic Troubleshooting

This section of the manual contains troubleshooting charts and error codes that helps you to isolate a problem.

9.1
Power-Up Error Codes

When the radio is turned on (powered-up), the radio performs cursory tests to determine if its basic electronics and software are in working order.

📝 **NOTE:** Send the radio to the depot if the corrective action does not fix the failure.

Table 31: 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
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
09/10	Secure Hardware Error	Turn the radio off, then on

Error Code	Description	Corrective Action
09/90	Secure Hardware Fatal Error	Turn the radio off, then on
Wi-Fi Error	Unexpected Wi-Fi Non-Fatal Error Example: 204, 400, 401, 403, 404, 500, and others.	Turn the radio off, then on. Otherwise, send radio to depot.

9.2
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 display of the radio.

The presence of an error code can prompt a user that a problem exists and that a service technician must be contacted. Use the following table to aid in understanding particular operational error codes.

Table 32: Operational Error Code Displays

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

9.3
Receiver Troubleshooting

The following table lists the possible causes and corrections for receiver problems.

Table 33: Receiver Troubleshooting Solution

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
No Receive Audio, or Receiver Does Not Unmute	Programming	1. Check if transmitted signal matches the receiver configuration (PL, DPL, CSQ, or others). 2. Check if radio is 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; if off by more than ±1000 Hz, send radio to depot.
RF Sensitivity Poor	Synthesizer Not On Frequency	Check synthesizer frequency by measuring the transmitter frequency; if off by more than ±1000 Hz, send radio to depot.
	Antenna Switch/Connector	Send radio to depot

Symptom	Possible Cause	Correction or Test (Measurements at Room Temperature)
	Receiver Front-End Tuning	Check RF front-end tuning for optimum sensitivity using the tuner
Radio Will Not Turn Off		Send radio to depot
Times out during PTT	Time-out-timer set is too small.	Change the time-out-timer for PTT maximum duration before it dekeys automatically.

9.4
Transmitter Troubleshooting

The following table lists the possible causes and corrections for transmitter problems.

Table 34: Transmitter Troubleshooting Solution

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Out	Incorrect Power Level or Frequency	Check TX power level and frequency programming
	No Injection To Power Amplifier	Send radio to depot
	Antenna Switch/ RF Connector	
No Modulation; Distorted Modulation	Programming	Check radio programming and ensure correct modulation is selected
	Microphone	Send radio to depot
	Incorrect Signal Processing	
No/Low signaling (PL, DPL, MDC)	Programming	Check programming and ensure correct modulation is selected
	Incorrect Signal Processing	Send radio to depot

9.5
Bluetooth Connectivity Troubleshooting

The following table lists the possible causes and corrections for Bluetooth connectivity problems.

Table 35: Bluetooth Connectivity Troubleshooting Solution

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No Bluetooth (BT) Setting on Settings menu	The default codeplug does not enable BT on the ST launcher.	Change the codeplug setting to enable Bluetooth (under Radio-Wide).
Audio Emits from the Internal Speaker when BT headset is paired	The Active Mic for Radio PTT in codeplug might be set to Internal.	Change the codeplug setting of the Active Mic for Radio PTT (field under Radio Ergonomics Wide) to Wireless Mic.

9.6
Encryption Troubleshooting

The following table lists the possible causes and corrections for encryption problems.

Table 36: Encryption Troubleshooting Chart

Symptom	Possible Cause	Corrective Action
No `KEYLOADING` on Radio/External Display When Keyloading Cable is Attached to the Radio Side Connector	Defective Keyload Cable	Send radio to depot
	Defective Radio	
Keyloader Displays `FAIL`	Wrong Keyloader Type	Use correct keyloader type. Refer to *Keyloader User Guide* for more information
	Bad Keyloader	Try another keyloader
	Defective Radio	Send radio to depot

9.7
Wireless Connectivity Troubleshooting

The following table lists the possible causes and corrections for wireless connectivity problems.

Table 37: Bluetooth Connectivity Troubleshooting Solution

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Unable to toggle Wi-Fi	The default codeplug does not have Wi-Fi enabled.	Change the codeplug setting to enable Wi-Fi (under DataWide).
Unable to turn off Wi-Fi	The default codeplug does not have Allow User Control enabled.	Change the codeplug setting to enable Allow User Control (under DataWide).
No pre-configured Wi-Fi networks	The default codeplug does not configure any network list.	Add network list (under DataWide's Configured Network List) to the codeplug setting.

9.8
Near Field Communication Troubleshooting

Near Field Communication (NFC) is a standard-based wireless connectivity technology that uses magnetic field induction to enable communication between electronic devices. The NFC supports 13.56 MHz passive and active mode communication. Expected range is up to 40 mm depending on the tag.

If the read range is less than 35 mm, check the battery contact and make sure that they are in the correct position since the NFC antenna is in the battery. Since the NFC hardware is located inside both the battery and the radio, try to swap the battery to see if the issue tracks the battery. Do the same with swapping the radio. If the issue is with the radio, send radio to depot for diagnosis and repair if needed.

9.9

Global Navigation Satellite System Troubleshooting

It is not possible to observe the latitude and longitude data on the radio itself to verify on the Global Navigation Satellite System (GNSS) hardware. Customer software restricts loading and installing an unapproved aftermarket application. If the GNSS icon does not appear, consult the RadioCentral management tool to confirm that the codeplug is configured for GNSS support.

9.9.1

Checking GNSS CPE

Procedure:

Test your radio in an open-air environment.

> **NOTE:** Make sure no buildings or trees nearby.

Result: The time to first fix (TTFF) should be less than 45 seconds and C/N0 signal strength of 39 or higher on at least one SV.

9.10

LTE Troubleshooting

In a well provisioned LTE area, for normal operation, your radio shows in the notification bar at the top right of the touchscreen indicating the 4G LTE signal strengths.

Table 38: LTE Troubleshooting

Icon	Icon Description	Possible Cause	Solution
	No SIM	Missing SIM card	Insert the correct/original SIM card.
		Improperly inserted SIM card	
		Damaged or corrupted SIM card	Contact Customer Service
	LTE No Service	Access Point Name (APN) is not set up	Contact Customer Service
		Wrong SIM card for radio	Insert the correct/original SIM card.
		LTE is not provisioned for radio	Contact Customer Service
		LTE is off to ensure mission critical LMR capability	Charge battery
	Data Disabled	Mobile data is turned off	Contact Customer Service
	LTE Low Signal	Out of good coverage	Move to an area with better coverage

Chapter 10

Accessories

Not all accessories are FCC certified to operate with all radio models, band splits, or both. See the radio price pages for a list of FCC certified accessories or contact your sales representative for accessory compatibility.

See https://www.motorolasolutions.com to know more about the accessories supported by this radio.

MN009208A01-AC
Glossary

Glossary

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

Active Channel
A channel that has traffic on it.

Analog Refers to a continuously variable signal or a circuit or device designed to handle such signals.

Analog-to-Digital Converter A device that converts analog signals into digital data. Also known as codec.

| **Abbreviation:**ADC

Automatic Gain Control (AGC) A process or means by which gain is automatically adjusted in a specified manner as a function of a specified parameter, such as received signal level.

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.

Ball Grid Array (BGA)
A type of IC package characterized by solder balls arranged in a grid that are located on the underside of the package.

Band Frequencies allowed for a specific purpose.

Bluetooth A wireless protocol utilizing short-range communications over short distances.

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."

CommandCentral
Trusted and unified suite of public safety software developed by Motorola Solutions.

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 The multiple frequencies/talkgroups that a Consolette station can support.

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.

Coder/Decoder (CPCAP)
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.

Conventional Scan List
A scan list that includes only conventional channels.

CMOS Complementary Metal-Oxide Semiconductor

Cursor
A visual tracking marker (a blinking line) that indicates a location on a display.

Customer Programming Software (CPS) This software tool is not compatible with APX NEXT. Please use the enhanced RadioCentral tool.

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.

Default A pre-defined set of parameters.

Device Managed Service A Motorola Solutions software programming management and maintenance services to maximize the effectiveness of your APX NEXT solution while reducing maintenance risk workload and total cost of ownership.

Abbreviation:DMS

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.

Digital-to-Analog Converter
A device that converts digital data into analog signals.

Digital Private-Line (DPL) 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 (DSP) A special-purpose microprocessor that can perform math calculations very rapidly.

Dispatcher
An individual who has radio-system management duties and responsibilities.

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.

Electrically Erasable Programmable Read-Only Memory (EEPROM) Integrated circuit used
to store data, which can be erased by electrical methods.

Failsoft
A backup system that allows communication in a non-trunked, conventional mode if the trunked system fails.

FCC
Federal Communications Commission.

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.

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.

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.

Global Navigation Satellite System (GNSS) GNSS uses satellites from the GPS and GLONASS, systems.

- Global Positioning System (GPS)
- Global Navigation Satellite System (GLONASS)

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 a subscriber radio. The host is responsible for control-oriented tasks such as decoding and responding to user inputs.

IMBE
A sub-band, voice-encoding algorithm used in digital voice.

Inbound Signaling Word
Data transmitted on the control channel from a subscriber unit to the central control unit.

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.

Key-Variable Loader
A device used to load encryption keys into a radio.

kilohertz (kHz) One thousand cycles per second. Used especially as a radio-frequency unit.

LDMOS Laterally Diffused Metal Oxide Semiconductor

Light Emitting Diode (LED)
An electronic device that lights up when electricity is passed through it.

Liquid-Crystal Display (LCD) 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.

Long Term Evolution
A term for wireless broadband communication technology.

| **Abbreviation:**LTE

MDC
Motorola Solutions Digital Communications.

Motorola Digital Communications (MDC) A Motorola Solutions proprietary signaling scheme permitting the transfer of data communications at the rate of 1200 bits per second. Designed specifically for high reliability in the land-mobile radio environment. Digital encoding allows a much greater amount of information to pass over the channel with each message than with alternative tone encoding methods. Some features include: PTT ID, Emergency, Call Alert, Emergency Alarm, Voice Selection Call (SelCall), Radio Check, and Monitor.

Megahertz (MHz) One million cycles per second. Used especially as a radio-frequency unit.

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.

Microcontroller Unit (MCU)
MCU-Also written as µC. A microprocessor that contains RAM and ROM components, as well as communications and programming components and peripherals.

Mode A programmed combination of operating parameters; for example, a channel or talkgroup.

Mode Secondary 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.

Multiplexer
An electronic device that combines several signals for transmission on some shared medium.

Network Access Code
Network Access Code (NAC) operates on digital channels to reduce voice channel interference between adjacent systems and sites.

Near Field Communication
A term for a short range wireless connectivity standard.

| **Abbreviation:**NFC

Non-tactical/revert

The user will talk on a preprogrammed emergency channel. The emergency alarm is sent out on this same channel.

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.

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.

Personality
A set of unique features specific to a radio.

Printed Circuit Board (PC Board)
A circuit manufactured so that many or all of the components are attached to a nonconductive circuit board with copper strips on one or both sides to replace wires.

Phase-locked Loop (PLL)
A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.

Preprogrammed
A software feature that has been activated by a qualified radio technician.

Private (Conversation) Call
A feature that lets you have a private conversation with another radio user in the group.

Private-Line Tone Squelch (PL)
A continuous sub-audible tone that is transmitted along with the carrier.

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.

Programming Cable A cable that allows the computer to communicate directly with certain radios using USB.

Push-to-Talk The switch or button on the radio which, when pressed, causes the radio to transmit. When the switch or button is released, the unit returns to receive operation.
┃**Abbreviation:**PTT

RadioCentral™
Device Managed Service for supported radios.

Radio Frequency (RF) 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.
┃**Abbreviation:**RFPA

Random Access Memory (RAM)
A type of computer memory that can be accessed randomly; that is, any byte of memory can be accessed without touching the preceding bytes.

Read-only memory (ROM)
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).

RESET
Reset line: an input to the microcontroller that restarts execution.

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.

RSSI
Received Signal Strength Indicator.

RX DATA
Receive digital data line.

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.

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.

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.

Software Potentiometer Softpot-A computer-adjustable electronic attenuator.

Spectrum Frequency range within which radiation has specific characteristics.

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.

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 (SSI)
DSP interface to peripherals that consists of a clock signal line, a frame synchronization signal line, and a data line.

System Central Controllers
Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units.

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 (TOT) A timer that limits the length of a transmission.

Tone A continuous, sub-audible tone transmitted with the carrier.

Transceiver Transmitter-receiver: A device that both transmits and receives signals.
Abbreviation: 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.

Trunking Priority Monitor scan list
A scan list that includes talkgroups that are all from the same trunking system.

Ultra-High Frequency (UHF) The term for the International Telecommunication Union (ITU) Radio Band with a frequency range of 300 to 3000 MHz.

USK
Unique shadow key.

Universal Asynchronous Receiver Transmitter (UART)
A computer peripheral used to send and receive data. It is asynchronous in that a clock is not used and a device connected to this peripheral can send data at any time.

Universal Serial Bus (USB) An external bus standard that supports data transfer rates of 12 Mbps.

VHF
Very-High Frequency.

Vocoder
An electronic device for synthesizing speech by implementing a compression algorithm particular to voice.

Vocoder/Controller
A PC board that contains a 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.

Voltage-controlled Oscillator (VCO)
An oscillator in which the frequency of oscillation can be varied by changing a control voltage.

Wi-Fi
Wireless Data Transmission protocol 802.11.