MOTOROLA SOLUTIONS

APX™ P25 MOBILE

TWO-WAY RADIO

APX 8500 BASIC SERVICE MANUAL

NOVEMBER 2023

MN003076A01-AL

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Foreword

This manual includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 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

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European Union (EU) and United Kingdom (UK) Waste of Electrical and Electronic Equipment (WEEE) Directive

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.

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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.

Document History

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

Edition	Description	Date
MN003076A01-AA	Initial Release.	November 2016
MN003076A01-AB	Compliance with the new Motorola Solutions design standard.	September 2018
MN003076A01-AC	Updated RF board and Transceiver board part lists from: • PA000175A01 to PPHTW4000_ • PA000176A01 to PPHRW4000_	February 2019
MN003076A01-AD	Compliance with the new Motorola Solutions design standard.	June 2019
MN003076A01-AE	• Added E5 Control Head information. • Updated Table 22: Rx and Tx Test Frequencies on page 65. • Updated Aeroflex 3920 information.	June 2020
MN003076A01-AF	Included the control head Exploded Views and Parts List.	July 2020
MN003076A01-AG	• Added Control Head Interface Board (CHIB) on page 53 • Updated O2 CHIB and CHUC Parts List. • Updated Table 59: O7 CHIB and CHUC Parts List on page 196. • Updated Table 60: E5 CHIB and CHUC Parts List on page 198	May 2021
MN003076A01-AH	• Added Disassembling the Remote Mount Ethernet Faceplate on page 127. • Added Reassembling the Remote Mount Ethernet Faceplate on page 155. • Added Remote Mount Ethernet Faceplate Exploded View on page 213. • Added Remote Mount Ethernet Faceplate Parts List on page 213.	September 2021
MN003076A01-AJ	The following sections have been updated: • Model Charts on page 27 • Control Head Interface Board (CHIB) on page 53.	December 2022

Edition	Description	Date
	• O2 CHIB and CHUC Exploded View and Parts List on page 193. • O5 CHIB and CHUC Exploded View and Parts List on page 194 • O7 CHIB and CHUC Exploded View and Parts List on page 196. • E5 CHIB and CHUC Exploded View and Parts List on page 198.	
MN003076A01-AK	The following sections have been updated: • Control Head Interface Board (CHIB) on page 53 • O2 CHIB and CHUC Parts List. • Table 59: O7 CHIB and CHUC Parts List on page 196. • O2 Control Head Test Mode on page 66 • O7 Control Head Test Mode on page 71 • E5 Control Head Test Mode on page 74 • APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram on page 175 • Power-Up Error Codes on page 168	June 2023
MN003076A01-AL	New CN model supporting information. The following sections have been updated: • Mobile Radio Model Numbering Scheme on page 25 • Model Charts on page 27 • RF Transceiver Board (XCVR) on page 56 • APX Mobile Radio Transceiver Functional Block Diagram on page 173	November 2023

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.

Related Publications

The following list contains part numbers and titles of related publications.

- 68012006035, *ASTRO APX Mobile Radio O2 Control Head User Guide*
- 6875946M01, *ASTRO APX Mobile Radio O3 Control Head User Guide*
- 6875947M01, *ASTRO APX Mobile Radio O5 Control Head User Guide*
- 68012006034, *ASTRO APX Mobile Radio O7 Control Head User Guide*
- 68007024014, *ASTRO APX Mobile Radio O9 Control Head User Guide*
- MN006147A01, *ASTRO APX Mobile Radio E5 Control Head User Guide*
- MN003449A01, *Data Modem Tethering User Guide*
- MN003109A01, *ASTRO APX 8500 And O2, O3, O5, O7, O9 & E5 Control Head Installation Manual*
- MN003077A01, *APX 8500 Mobile Radio Detailed Service Manual*
- PMLN6193, *ASTRO APX Mobile Radio O2 Quick Reference Card*
- PMLN5591, *ASTRO APX Mobile Radio O3 Quick Reference Card*
- PMLN5592, *ASTRO APX Mobile Radio O5 Quick Reference Card*
- PMLN6194, *ASTRO APX Mobile Radio O7 Quick Reference Card*
- PMLN5711, *ASTRO APX Mobile Radio O9 Quick Reference Card*
- PMLN8210, *ASTRO APX Mobile Radio E5 Quick Reference Card*
- 6881095C99/NNTN7851, *ASTRO APX Mobile Safety Manual*
- MN001435A01/PMLN7688, *ASTRO APX Wi-Fi Provisioning Leaflet*

Commercial Warranty

Limited Warranty

For information on warranty terms, see the Support page at https://www.motorolasolutions.com.

I. What This Warranty Covers And For How Long

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

Mobile Radios	One Year
Product Accessories	One Year

The radios additionally ship with a standard 1-year Repair Service Advantage (RSA) (for U.S. customers) or 1-year Extended Warranty (for Canada customers). However, at the time of order, you may choose to omit these warranties. For more RSA or Extended Warranty information, please refer to the price pages.

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II. General Provisions

This warranty sets forth the full extent of Motorola Solutions responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at Motorola Solutions option, is the exclusive remedy.

This warranty is given in lieu of all other express warranties, implied warranties, including without limitation, implied warranties of merchantability and fitness for a particular purpose, are limited to the duration of this limited warranty. In no event shall Motorola Solutions be liable for damages in excess of the purchase price of the product, for any loss of use, loss of time, inconvenience, commercial loss, lost profits or savings or other incidental, special or consequential damages arising out of the use or inability to use such product, to the full extent such may be disclaimed by law.

III. State Law Rights (Applicable Only in U.S.A.)

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitation on how long an implied warranty lasts, so the above limitation or exclusions may not apply.

This warranty gives specific legal rights, and there may be other rights which may vary from state to state.

IV. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and, also, deliver or send the Product item, transportation, and insurance prepaid, to an authorized warranty service location.

Warranty service will be provided by Motorola Solutions through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service.

You can also call Motorola Solutions at 1-800-927-2744 US/Canada.

V. What This Warranty Does Not Cover

This warranty does not cover the following conditions:

- Defects or damage resulting from use of the Product in other than its normal and customary manner.
- Defects or damage from misuse, accident, water, or neglect.
- Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.
- Breakage or damage to antennas unless caused directly by defects in material workmanship.
- A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola Solutions supplied equipment) which adversely affect performance of the Product or interfere with Motorola Solutions normal warranty inspection and testing of the Product to verify any warranty claim.
- Product which has had the serial number removed or made illegible.
- Rechargeable batteries if:
  - Any of the seals on the battery enclosure of cells are broken or show evidence of tampering.
  - The damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.
- Freight costs to the repair depot.
- A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with Motorola Solutions published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from Motorola Solutions.
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- Normal and customary wear and tear.

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Motorola Solutions will defend, at its own expense, any suit brought against the end user purchaser to the extent that it is based on a claim that the Product or parts infringe a United States patent, and Motorola

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- Motorola Solutions will be notified promptly in writing by such purchaser of any notice of such claim.
- Motorola Solutions will have sole control of the defense of such suit and all negotiations for its settlement or compromise.
- Product or parts become, or in Motorola Solutions opinion be likely to become, the subject of a claim of infringement of a United States patent, that such purchaser will permit Motorola Solutions, at its option and expense, either to procure for such purchaser the right to continue using the Product or parts or to replace or modify the same so that it becomes noninfringing or to grant such purchaser a credit for the Product or parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or parts as established by Motorola Solutions.

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VII. Governing Law

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

Chapter 1

Introduction

This radio is a Motorola Solutions newest two-way mobile radio designed to meet your most demanding needs. It is available in the following frequencies and power levels.

Table 1: Frequency Ranges and Power Level

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	1– 50 W variable
UHF2	450-485 MHz	1-45 W variable
	485-512 MHz	1-40 W variable
	512-520 MHz	1-25 W variable
UHF	380–(< 485 MHz) 485–(< 512 MHz) 512–(< 520 MHz)	1– 45 W variable 1–40 W variable 1–25 W variable
700–800 MHz	764–870 MHz 806–870 MHz	1–30 W variable (2–3 W itinerant) 1–35 W variable
800-900 MHz	806-870 MHz	3-35 W variable
	896-941 MHz (PCS band: 901-902, MHz 940-941 MHz)	1-30 W variable(1-3 W PCS band)

The radio is among the most sophisticated two-way radio available. It has a new robust design for radio users who need high performance, quality, and reliability in their daily communications. This new architecture supports a multitude of legacy and advanced features resulting in a more cost-effective two-way radio communications solution.

1.1 Radio Description

The radio is a Motorola Solutions newest two-way mobile radio designed to meet your most demanding needs. These radios are available in the following frequencies and power levels.

Table 2: Frequency Ranges and Power Level

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	1– 50 W variable
UHF	380–(< 485 MHz) 485–(< 512 MHz) 512–(< 520 MHz)	1– 45 W variable 1–40 W variable 1–25 W variable

Frequency Band	Bandwidth	Power Level
700–800 MHz	764–870 MHz 806–870 MHz	1–30 W variable (2–3 W itinerant) 1–35 W variable

The radio is among the most sophisticated two-way radio available. It has a new robust design for radio users who need high performance, quality, and reliability in their daily communications. This new architecture supports a multitude of legacy and advanced features resulting in a more cost-effective two-way radio communications solution.

1.2 FLASHport®

All mobile radios are part of the FLASHport program and ship standard with a FLASH IC, which allows feature and system upgrades.

The FLASHport Aftermarket Software has the following features:

- Upgrade the System Enhancement Software Package to the latest version
- Upgrade to a different System Enhancement Software Package
- Order enhancements for existing mobile radios in the field

1.3 O2/O3/O5/E5/O7/O9 Control Head Description

The detailed function and operation of each Control Head is available in the User Guides.

See Related Publications on page 20 for more information.

1.4 P25 Digital Vehicular Repeater System

Motorola Solutions offers an MSI Certified APX compatible, third party, P25 Digital Vehicular Repeater System (DVRS).

This system provides low-cost portable radio coverage in the following areas:

- Only mobile radio coverage is available.
- Portable radio coverage is intermittent or nonexistent.

1.5 Model Numbering, Charts, and Specifications

This chapter cover the model numbering, charts, and specification for APX 8500 radio.

1.5.1 Mobile Radio Model Numbering Scheme

Table 3: Sales Model Nomenclature

Position	1	2	3	4	5	6	7	8	9	10	11	12

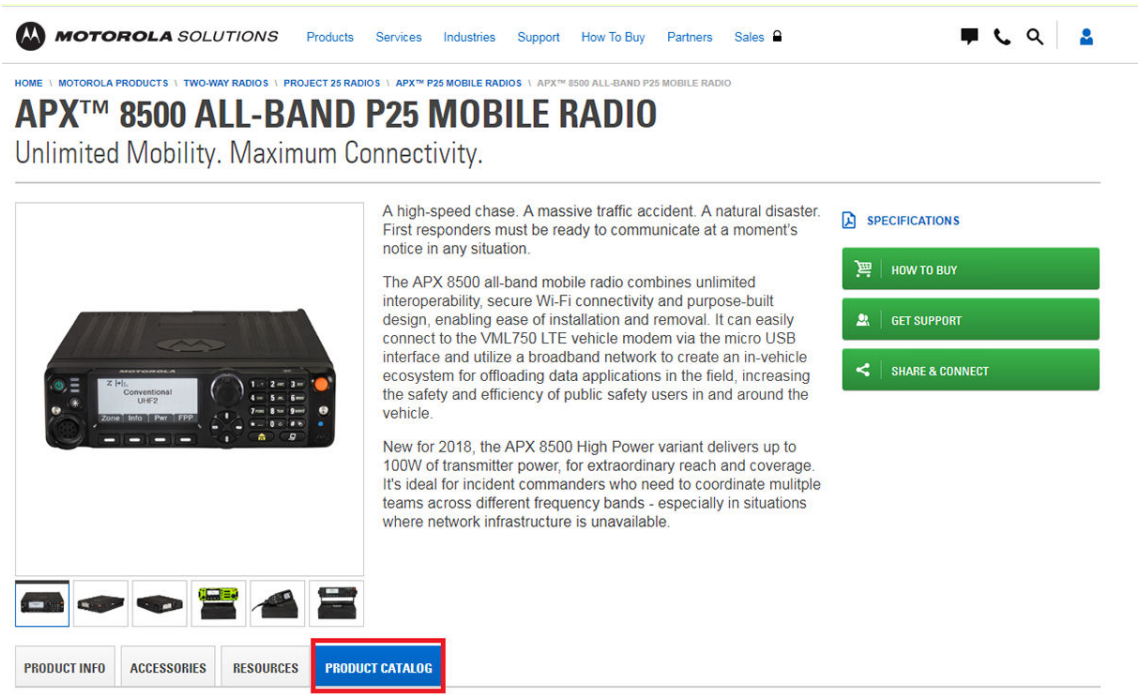
Typical Model Number	M	3	7	T	S	S	9	P	W	1	A	N

Table 4: Sales Models Description

Position	Description	Value
1	Type of Unit	M = Mobile
		L = Table Top Station
2 and 3	Model Series	37 = APX 8500
4	Frequency Band	K = 136–174 MHz
		Q = 403–437 MHz
		S = 470–620 MHZ
		T = Product Specific UHF Range
		U = 806–870 MHz
		V = 825–870 MHz
		Values given represent range only; they are not absolute.
5	Power Level	S = 10–50 W
		X = 1–110 W
6	Physical Packages	S = Transceiver with Selectable Control Head
7	Channel Spacing	9 = Variable/Programmable
8	Primary Operation	P = Programmable
9	Primary System Type	W = Programmable
10	Feature Level	6 = Standard Plus
		7 = Expanded Package
11	Version	Model Version - for example A, B, C (Major Change)
12	Unique Model Variations	N = Standard Package

1.5.2
APX 8500 Model Charts

Refer to Replacement Parts Ordering on page 216 to access PCAT (Product Catalog) to see the latest model options and kit numbers.



1.5.3

Model Charts

NOTE:
"X" = Part is compatible with checked model.

"_" = The latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

"*" = Requires J600 (User Y-adapter CB000409A03 for a J600 connector)

Table 5: ASTRO APX 8500 Emergency Model Chart

M37TSS9PW1AN / M37TSS9PW1CN					
Model/Item					Description
G235AC					ADD:PTT FOOTSWITCH APEX
	W470AT				ADD: EMERG ID EXT. FOOTSWITCH APEX
		W688AR			ADD: EXT EMERG PUSHBUTTON APEX
			GA00304AA		ADD: PUSHBUTTON PTT
X				GLN7278B	PTT FOOTSWITCH (XTL)
	X			HLN5113C	EMER FOOTSWITCH
		X		HLN5131C	EMERGENCY PUSH BUTTON SWITCH
			X	RLN5926A	PUSH BUTTON PTT

Table 6: ASTRO APX 8500 Antennas Model Chart

M37TSS9PW1AN / M37TSS9PW1CN									
Model/Item									Description
	GA01513AB								ALL BAND MOBILE ANTENNA (700/800/VHF/UHF)
		GA01513AC							ALL BAND MOBILE ANTENNA (700/800/VHF/UHF)
		G335AZ							3 DB MCYCLE 762–870 MHz
			G174AG						3 DB LOW PRO MCYC 762–870 MHz
				GA00510AB					MCYCLE 1/4 WAVE WHIP 136–144 MHz
					GA00511AB				MCYCLE 1/4 WAVE WHIP 144–150.8 MHz
						GA00512AB			MCYCLE 1/4 WAVE WHIP 150.8–162 MHz
							GA00513AB		MCYCLE 1/4 WAVE WHIP 162–174 MHz
X								AN000131 A02	ANTENNA, WHIP,ALL BAND FLEXIBLE-V/U/7800, MOBILE, 17 FT, QMA
	X							AN000131 A03	ANTENNA, WHIP,ALL BAND-V/U/7800, MOBILE
		X						AN000197 A10	ANTENNA, STAMPED METAL, 3 DB MCYCLE 762–870 MHz
			X					AN000197 A11	ANTENNA, STAMPED METAL, 3 DB LOW PRO MCYC 762–870 MHz
				X				AN000197 A01	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 136–144 MHz
					X			AN000197 A02	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 144–150.8 MHz
						X		AN000197 A03	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 144–150.8 MHz
							X	AN000197 A04	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 162–174 MHz

Table 7: ASTRO APX 8500 Antennas Model Chart (Cont.)

M37TSS9PW1AN / M37TSS9PW1CN									
Model/Item									Description
G210AC									MCYCLE 1/4WAVE WHIP 380–433 MHz
	GA00506AB								MCYCLE 1/4 WAVE WHIP 425–470 MHz
		GA00507AB							MCYCLE 1/4 WAVE WHIP 450–482 MHz
			GA00508AB						MCYCLE 1/4 WAVE WHIP 482–520 MHz
				GA00509AB					MCYCLE LO PRO UNITY 450–512 MHz
					GA00250AA				ADD: BLUETOOTH/WIFI/GNSS FLEXIBLE CABLE LMR195
						GA00250AB			ADD: BLUETOOTH/WIFI/GNSS FLEXIBLE CABLE LMR195 MOTORCYCLE
							GA01579AB		ADD: COVERT BLUETOOTH/WIFI GLASSMOUNT 2.4/5 GHZ
X								AN000197A05	ANTENNA, WHIP, MCYCLE 1/4WAVE WHIP 380–433
	X							AN000197A06	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 425–470
		X						AN000197A07	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 450–482
			X					AN000197A08	ANTENNA, WHIP, MCYCLE 1/4 WAVE WHIP 482–520
				X				AN000197A09	ANTENNA, STAMPED METAL, MCYCLE LO PRO UNITY 450–512
					X			AN000163A01	ANTENNA, STUBBY, BLUETOOTH/WIFI/GNSS LOW LOSS LMR240
						X		AN000163A02	ANTENNA, STUBBY, BLUETOOTH/WIFI/GNSS, M-CYCLE, QMA, 6FT, LMR195, FLEXIBLE, PVC FREE
							X	PMAN5101_	ANTENNA COVERT BLUETOOTH/WI-FI ON GLASS with QMA EXTENTION

Table 8: ASTRO APX 8500 Cables Model Chart

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
GA00589AA								ADD:MMP EXTENSION CABLE 2 FT
	GA01114AA							INT: DUAL RADIO CABLE KIT
		GA01118AA						INT: SPEAKER EXTENSION CABLE MP
			GA01515AA					ADD: J600 ADAPTOR CABLE
				GA01516AA				INT MMP TO MICRO USB DATA MODEM TETHERING CABLE
					G303AB			ADD: RS232 DATA INTFC CBL DASH APEX
						G304AC		ADD: RS232 DATA INTFC CBL TRK APEX
X							PMKN4093	O9, MMP EXTENSION CABLE
	X						HKN6245	ASSEMBLY, 1.5 FT CAN CABLE
	X						54009321002	LABEL,DUAL RADIO PRIMARY AND SECONDARY LABEL
		X					HKN6246A	ASSEMBLY, 30 FT SPEAKER EXTENSION CABLE
		X					54009321002	LABEL, DUAL RADIO PRIMARY AND SECONDARY LABEL
			X				KT000247A01	KIT, Y-CABLE, J2:J600/J2 APX 8500
				X			3064079H03	CABLE, PROGRAMMING, MMP TO MICRO USB DATA MODEM TETHERING CABLE
					X		HKN6160B	CABLE 6' RS232 W/IGNITION 26 PIN
						X	HKN6161B	CABLE KIT 20' REMOTE MOUNT DATA

Table 9: ASTRO APX 8500 Cables Model Chart (cont.)

M37TSS9PW1AN / M37TSS9PW1CN			
Model/Item			Description
G308AD			ADD:USB DATA INTFC CABLE–DASH APEX
	G309AC		ADD:USB DATA INTFC CABLE–TRK APEX
X		HKN6163C	O9, MMP EXTENSION CABLE
	X	HKN6172C	ASSEMBLY, 1.5 FT CAN CABLE

Table 10: ASTRO APX 8500 CAN Model Chart

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
G582AC								ADD: REMOTE MOUNT CABLE 131 FT APEX
	G879AC							ADD:REMOTE MOUNT CABLE 115 FT APEX
		G607AC						ADD:REMOTE MOUNT CABLE 75 FT APEX
			G609AC					ADD: REMOTE MOUNT CABLE 50 FT APEX
				G610AC				ADD: REMOTE MOUNT CABLE 30 FT APEX
					G628AC			ADD: REMOTE MOUNT CABLE 17 FT APEX
						G618AC		ADD: REMOTE MOUNT CABLE 10 FT APEX
X							HKN6164B	CABLE, REMOTE MOUNT, 39.2 M
	X						HKN6165B	CABLE, REMOTE MOUNT, 35 M
		X					HKN6166B	CABLE, REMOTE MOUNT, 23 M
			X				HKN6167B	CABLE, REMOTE MOUNT, 15 M
				X			HKN6168B	CABLE, REMOTE MOUNT, 10 M
					X		HKN6169B	CABLE, REMOTE MOUNT, 5 M
						X	HKN6170B	CABLE, REMOTE MOUNT, 10 FT

Table 11: ASTRO APX 8500 DEK Model Chart

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
GA00260AA								ADD: CABLE LIGHTBAR BOX TO TRANSCVR
	GA00259AA							ADD: UNIVERSAL RELAY CONTROLLER
		W355AS						ADD: STATUS/MESSAGE 8 APEX
			W374AJ					ADD: STATUS/MESSAGE 16 APEX
				W591AQ				ADD: AUXILIARY SWITCH PANEL APEX
					W599BF			ADD: 8 MODE DIRECT ENTRY APEX
						W614AT		ADD: 16 MODE DIRECT ENTRY APEX
X							3064153H02	CABLE, 4500 MM, ASSEMBLY, CABLE, SHIEL-DED
X							3064153H05	CABLE, 2850 MM, KEYPAD MIC WITH MMP
	X						4001200600 1	CIRCUIT BREAKER, 60 A
	X						PMKN4109A	WIRE, AWG 14
	X						PMLN5436A	O9 HUB, STD TILTING MOUNT
	X						PMLN5436A	O9 HUB, STD TILTING MOUNT
	X						PMUN1046A	HARDWARE KIT, 09 RLY CTRL BX

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
GA00260AA								ADD: CABLE LIGHTBAR BOX TO TRANSCVR
	GA00259AA							ADD: UNIVERSAL RELAY CONTROLLER
		W355AS						ADD: STATUS/MESSAGE 8 APEX
			W374AJ					ADD: STATUS/MESSAGE 16 APEX
				W591AQ				ADD: AUXILIARY SWITCH PANEL APEX
					W599BF			ADD: 8 MODE DIRECT ENTRY APEX
						W614AT		ADD: 16 MODE DIRECT ENTRY APEX
	X						4001200600 1	CIRCUIT BREAKER, 60A
		X					6880103W09	DIRECT ENTRY KEYBOARD INST MAN
		X					HKN6189B	CABLE, CH DEK
		X					HLN1228C	DEK STATUS SYS 9000
		X					HLN6938A	HDWR DEK MOUNTING
		X					HKN6189B	CABLE, CH DEK
			X				6880103W09	DIRECT ENTRY KEYBOARD INST MAN
			X				HKN6189B	CABLE, CH DEK
			X				HLN1229C	DEK STATUS/MESSAGE SYS 9000
			X				HLN6938A	HDWR DEK MOUNTING
			X				HKN6189B	CABLE, CH DEK
				X			HLN1196C	WILDCARD
					X		HKN6189B	CABLE, CH DEK
					X		HLN1362B	DEK 8 MODE SYS 9000
					X		HLN6938A	HDWR DEK MOUNTING
					X		HKN6189B	CABLE, CH DEK
						X	HKN6189B	CABLE, CH DEK
						X	HLN1362B	DEK 8 MODE SYS 9000
						X	HLN1363B	DEK 16 MODE SYS 9000
						X	HLN6938A	HDWR DEK MOUNTING

Table 12: ASTRO APX 8500 DEK Model Chart (Cont.)

M37TSS9PW1AN / M37TSS9PW1CN						
Model/Item						Description
W615AW						ADD: 24 MODE DIRECT ENTRY APEX
	GA00812AA					ADD: DEK FOR WHELEN SIREN W/O3 CH ONLY*
		GA00814AA				ADD: DEK FOR WHELEN SIREN
X			HKN6189B			PTT FOOTSWITCH (XTL)
X			HLN1362B			EMER FOOTSWITCH
X			HLN1363B			EMERGENCY PUSH BUTTON SWITCH
X			HLN1364B			PUSH BUTTON PTT
X			HLN6938A			HDWR DEK MOUNTING
	X		6880103W09			DIRECT ENTRY KEYBOARD INST MAN
	X		HBN6003A			PACKING BOX
	X		HKN4265A			FUSE CABLE
	X		HLN1241D			DEK HSNG ASEM SYS9000 SIREN/PA
	X		HLN5331A			DEK 9000E SIREN/PA SPARE BUT
	X		HLN6275A			DEK MTNG HDW
	X		HLN6938A			HDWR DEK MOUNTING
		X	HKN4265A			FUSE CABLE
		X	HKN6189B			CABLE, CH DEK
		X	HLN1241D			DEK HSNG ASEM SYS9000 SIREN/PA
		X	HLN5331A			DEK 9000E SIREN/PA SPARE BUT
		X	HLN6275A			DEK MTNG HDW
		X	HLN6938A			HDWR DEK MOUNTING
		X	HLN5157A			DEK MOUNTING HARDWARE

Table 13: ASTRO APX 8500 Housing Alarm PS Model Chart

M37TSS9PW1AN / M37TSS9PW1CN						
Model/Item						Description
GA00187AB						INT: O5 SHIELD, SUN, MOTORCYCLE
	W15AJ					ADD:WEATHER PROOF HSNG ENCLO BLK APEX
		W665BF				ADD: BASE STATION OP W/PS APEX
			B116BD			ADD:BUZZER 110MA APEX
				W116AQ		ADD: EXTERNAL ALARM RELAY AND CABLE APX
X					NNTN7279B	ASSY,ACCY,SHIELD, SUN, MCYCLE
	X				HLN7022A	BLACK MOTORCYCLE ENCLOSURE WITH HDW
		X			56012023001B	UNIT BOX SPECTRA ST

M37TSS9PW1AN / M37TSS9PW1CN						
Model/Item						Description
GA00187AB						INT: O5 SHIELD, SUN, MOTORCYCLE
	W15AJ					ADD:WEATHER PROOF HSNG ENCLO BLK APEX
		W665BF				ADD: BASE STATION OP W/PS APEX
			B116BD			ADD:BUZZER 110MA APEX
				W116AQ		ADD: EXTERNAL ALARM RELAY AND CABLE APX
		X			6880101W87	SPECTRA CTL STA INSTR MANUAL
		X			6880102W93	SPECTRA MAXTRAC CTRL BASE MAN
		X			HLN6042A	TRAY BASE SPECTRA
		X			HLN7024A	HDW INSTALLATION BASE TRAY
			X		HLN6953A	BUZZER KIT 110 MA
				X	HKN4258C	CABLE RELAY
				X	HLN6969A	XTL 5000, EXTERNAL ALARM RELAY
				X	HKN6196B	CABLE, VIP

Table 14: ASTRO APX 8500 Mic Model Chart

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
GA01354AA								ADD:WIRELESS RSM AND GATEWAY
	GA01438AB							ADD:GATEWAY RSM
		GA01439AB						ADD:GATEWAY RSM AND WIRELESS RSM
			GA00221AC					ADD: MODEL III MMP KEYPAD HANDSET
				G892AB				ENH:HAND MIC,MMP WTR RESISTANT APX
					G90AC			ADD: NO MICROPHONE NEEDED APEX
						W20CA		ADD: KEYPAD MIC MMP APEX
X							RLN6551B	LONG RANGE WRLS MOBILE BT W/ VC
	X						PMMN4097C	MOBILE MICROPHONE WITH BLUE-TOOTH GATEWAY
		X					RLN6552B	LONG RANGE WRLS MOBILE BT NO PS
			X				HMN4097A	MODEL III KEYPAD TELEPH HANDSET KIT
				X			HMN1089B	ASSY:PRD OTH,HAND MIC,MMP,WTR REST
					X		(REFERENCE)_A381	NO MICROPHONE
						X	HMN4079G	XTL5000 KEYPAD MICROPHONE

Table 15: ASTRO APX 8500 Mic Model Chart (Cont.)

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
W20CC								ADD: KPM MMP (CYRILLIC)
	W20CD							ADD: KPM MMP (ARABIC)
		W20CB						ADD: KPM MMP (Hebrew)
			W22BB					ADD: HAND MIC (MTRCYCLE WP MIC) APX
				W22BA				ADD: STD PALM MICROPHONE APEX
					W382AM			ADD: CONTROL STATION DESK MMP MIC
						W872AB		ADD:MIC VISOR STD APEX
X							HMN4109B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MIC, CYRILLIC
	X						HMN4110B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MIC, ARABIC
		X					HMN4108B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MICROPHONE
			X				HMN1079B	MOD MOTORCYCLE WP MIC DB9 PIN CONN
				X			HMN1090C	ASSY,MIC,FRNT,GRY,STD PALM MIC (GCA)
					X		RMN5070A	DESKTOP MIC (MMP)
						X	RMN5054B	SMART VISOR MIC

Table 16: ASTRO APX 8500 Speaker Model Chart

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
B18CR								ADD: AUXILIARY SPKR 7.5 WATT APEX
	B18CS							ADD: AUXILIARY SPKR SPEC MCYCL APEX
		G142AD						ADD: NO SPEAKER NEEDED APEX
			G831AD					ADD: SPKR 13 W WATER RESISTANT
				G832AD				ADD: SPKR 7.5W WTR RST APEX
					W432AG			ADD: AUXILARY SPKR 13 W (3.2 Ohm)
						GA01116AA		ADD: DUAL RADIO AUDIO COMBINER KIT
X							HSN4031B	SPEAKER MODULE ASSEMBLY,EXT SPKR 7.5 W
	X						HSN6003C	MCYCLE WP SPEAKER
		X					(REFERENCE)_A383	NO SPEAKER
			X				HSN4040A	3.2 OHM EXTERNAL SPEAKER ASSEMBLY

M37TSS9PW1AN / M37TSS9PW1CN								
Model/Item								Description
B18CR								ADD: AUXILIARY SPKR 7.5 WATT APEX
	B18CS							ADD: AUXILIARY SPKR SPEC MCYCL APEX
		G142AD						ADD: NO SPEAKER NEEDED APEX
			G831AD					ADD: SPKR 13 W WATER RESISTANT
				G832AD				ADD: SPKR 7.5W WTR RST APEX
					W432AG			ADD: AUXILARY SPKR 13 W (3.2 Ohm)
						GA01116AA		ADD: DUAL RADIO AUDIO COMBINER KIT
				X			HSN4038A	SPKR. 7.5 W REMOTE
					X		HSN4032B	SPEAKER MODULE ASSEMBLY,MCS EXT SPKR 13 W
						X	HKN6250A	DUAL RADIO ACCESSORY CABLE
						X	YLN4713B	AUDIO COMBINER KIT ASSEMBLY

1.5.4

APX 8500 Radio Specifications

For APX 8500 radio product information, visit:

- APX™ 8500 All-Band P25 Mobile Radio website at: http://www.motorolasolutions.com/en_us/products/two-way-radios/project-25-radios/mobileradios/apx8500.html
- APX™ 8500 All-Band P25 Mobile Radio specifications at: http://www.motorolasolutions.com/content/dam/msi/docs/products/apx/apx8500/APX8500_DataSheet.pdf

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 Preventive Maintenance

Radios are shipped from the factory with a worst-case frequency error of:

- ±250 Hz for VHF
- ±250 Hz for UHF
- ±600 Hz for 700–800 MHz
- ±600 Hz for 900 MHz

These specifications are tighter than the more stringent FCC requirements of:

- ±2.0 ppm for the 136–174 MHz band
- ±2.0 ppm for the 380–470 MHz band Range 1 / 450–520 MHz band Range 2
- ±1.5 ppm for the 700–800 MHz bands
- ±1.0 ppm for the 900 MHz band

For radios that have been in storage for over 6 months from the factory ship date, check the reference oscillator before deploying the radios to the field. It is strongly recommended to check the reference oscillator once a year or every time the radio is serviced. The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation. Improper adjustment can result in both poor performance and interference with users on adjacent channels.

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 be used when cleaning the external and internal surfaces of the radio.

External surfaces include the control head and radio chassis. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for service or repair.

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

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosol sprays, tuner cleaners, circuit board cleaners, alcohols, and other chemicals should not make contact with plastic or metal radio housings.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (100% by volume).

Cleaning External Plastic Surfaces

Apply the 0.5% detergent-water solution sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. Use a soft, absorbent, lintless cloth or tissue to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Cleaning Internal Circuit Boards and Components

Isopropyl alcohol (100%) may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio. Be careful not to break off electrical components.

Make sure that controls or tunable components are not soaked with alcohol. Do not use high-pressure air to hasten the drying process since this could cause the liquid to collect in unwanted places. After completing the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to any plastic parts.

NOTE:
The cleaning can only be done after all the internal circuit boards and components are removed from the radio chassis.

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

2.1.3 General Radio Care and Handling Precautions

- Avoid physical abuse: do not pound, drop, or throw the radio. Exposed parts, such as controls and connectors, might be damaged.
- Operating the radio without an antenna cable attached may lead to radio failure and may void the warranty.
- Do not mount anything on the radio chassis fins, which are used for heat dissipation.

2.1.4 RF Power Amplifier (RF PA) Heatsinking

To avoid immediate failure of RF Power Amplifier (RF PA) or reduce the life of RF PA devices, install the following components in the chassis before transmitting:

- Printed-Circuit Board (PCB) DC

- RF connector clips
- Internal screws

If it is properly used, you can transmit for short period of time with the chassis eliminator.

2.2 Safe Handling of CMOS and LDMOS Devices

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:
This radio contains static-sensitive devices. Do not open your radio unless you are properly grounded. Take the following precautions when working on this unit:

- Store and transport all CMOS/LDMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS/LDMOS devices into conventional plastic "snow" trays used for storage and transportation of other semiconductor devices.
- Ground the working surface of the service bench to protect the CMOS/LDMOS device. It is recommended that you use a wrist strap, two ground cords, a table mat, a floor mat, electrostatic discharge (ESD) shoes, and an ESD chair.
- Wear a conductive wrist strap in series with a 100k resistor to ground. Replacement wrist straps that connect to the bench top covering are Motorola Solutions part number 4280385A59.
- Do not wear nylon clothing while handling CMOS/LDMOS devices.
- Do not insert or remove CMOS/LDMOS devices with power applied. Check all power supplies used for testing CMOS/LDMOS devices to be certain that there are no voltage transients present.
- When straightening CMOS/LDMOS pins, provide ground straps for the apparatus used.
- When soldering, use a grounded soldering iron.
- Handle CMOS/LDMOS devices by the package and not by the leads. Before touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

Chapter 3

Basic Theory of Operation

The all-band mobile radio is a two-board assembly that consists of a transmitter board and a transceiver board.

The transmitter board consists of the transmitter circuitry, while the transceiver board consists of the receiver, frequency generation unit (FGU), and the controller circuitry.

3.1 General Overview

The mobile radio is a synthesized, fixed-tuned, and all-band radio.

The radio is available in a mid power and high-power model.

The radio is capable of the following operations:

- Analog operation at 12.5 kHz, 20 kHz, and 25 kHz bandwidths.
- ASTRO mode operation at 12.5 kHz bandwidth.

Mobile Radio Assemblies Sections

Radio	Description
O2 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● OMAP 5912 microprocessor For the dash mount configuration, the control head assembly is attached to the controller using a flex and uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). The TIB assembly plugs directly into the transceiver board at the back of the radio.
O3 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● OMAP microprocessor The O3 plugs directly into the Transceiver Interface Board (TIB) assembly mounted at the back of the

Radio	Description
	radio. The only difference between Dash mount and Remote Mount is the additional 17' Straight cable.
O5 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● OMAP microprocessor For the dash mount configuration, the control head assembly is attached directly to the controller using a flex and uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface the Remote Control Head to the Transceiver Interface Board (TIB). The TIB assembly plugs directly into the transceiver board at the back of the radio.
E5 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● Kinetics K32H microprocessor For the dash mount configuration, the control head assembly is attached to the controller through a flex. It uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). The TIB assembly plugs directly into the transceiver board at the back of the radio.
O7 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● OMAP 5912 microprocessor For the dash mount configuration, the control head assembly is attached to the controller using a flex. It uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head

Radio	Description
	Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). The TIB assembly plugs directly into the transceiver board at the back of the radio.
O9 Control Head Assembly	The control head assembly contains the following components: ● LCD display ● User Interface ● OMAP microprocessor For the dash mount configuration, the control head assembly is attached directly to the controller using a flex. It uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). The TIB assembly plugs directly into the transceiver board at the back of the radio.
Transceiver Board	The controller of this board contains the following digital hardware: ● Microcontroller ● Memory ● Logic ● Supporting peripherals The digital hardware performs the following functions: ● Governs radio operation. ● Service all radio inputs and outputs. ● Process all voice and data. The digital hardware contains the following components: ● A dual-core processor (MCU and DSP cores). ● Processor memory devices. ● Audio and power supply which support the Integrated Circuit (IC). ● Audio CODEC and audio PA. ● MACE (Type 3 Secure IC). ● GNSS (GPS/GLONASS) IC and supported circuitry.

Radio	Description
	• Combination of WLAN/Bluetooth capable IC. • Supported circuitry. • Supported hardware for external accessory interfaces such as RS232, USB, SB9600, and logic signals.
CHIB	The CHIB contains the following components: • SSI-CAN FPGA • 16-bit CODEC for audio processing • Class D Audio PA • Controller Area Network (CAN) transceivers. Each CAN transceiver is used to communicate with the RF transceiver, audio, data, and system power-on commands.
Transceiver Interface Board	The TIB contains the following components: • CAN transceivers and audio • Digital routing for accessories The TIB is used with the O3 Control Head for Dash and Remote Mount configuration. The Remote Mount configuration is used with the O2, O5, O7, O9, and E5 Control Heads.
Radio Frequency Transceiver Board	**Power Amplifier (PA) section** Contains the antenna switch, directional coupler/detector, and amplifier. **Front-End Receiver section** Contains the preselector, low-noise amplifier (LNA), and mixer. **IF section** Contains the receiver intermediate-frequency (IF) amplifier/filter and the digital receiver back-end integrated circuit (IC). **Frequency Generation section** Contains the synthesizer, voltage-controlled oscillators (VCOs), reference oscillator, and receive and transmit buffers.

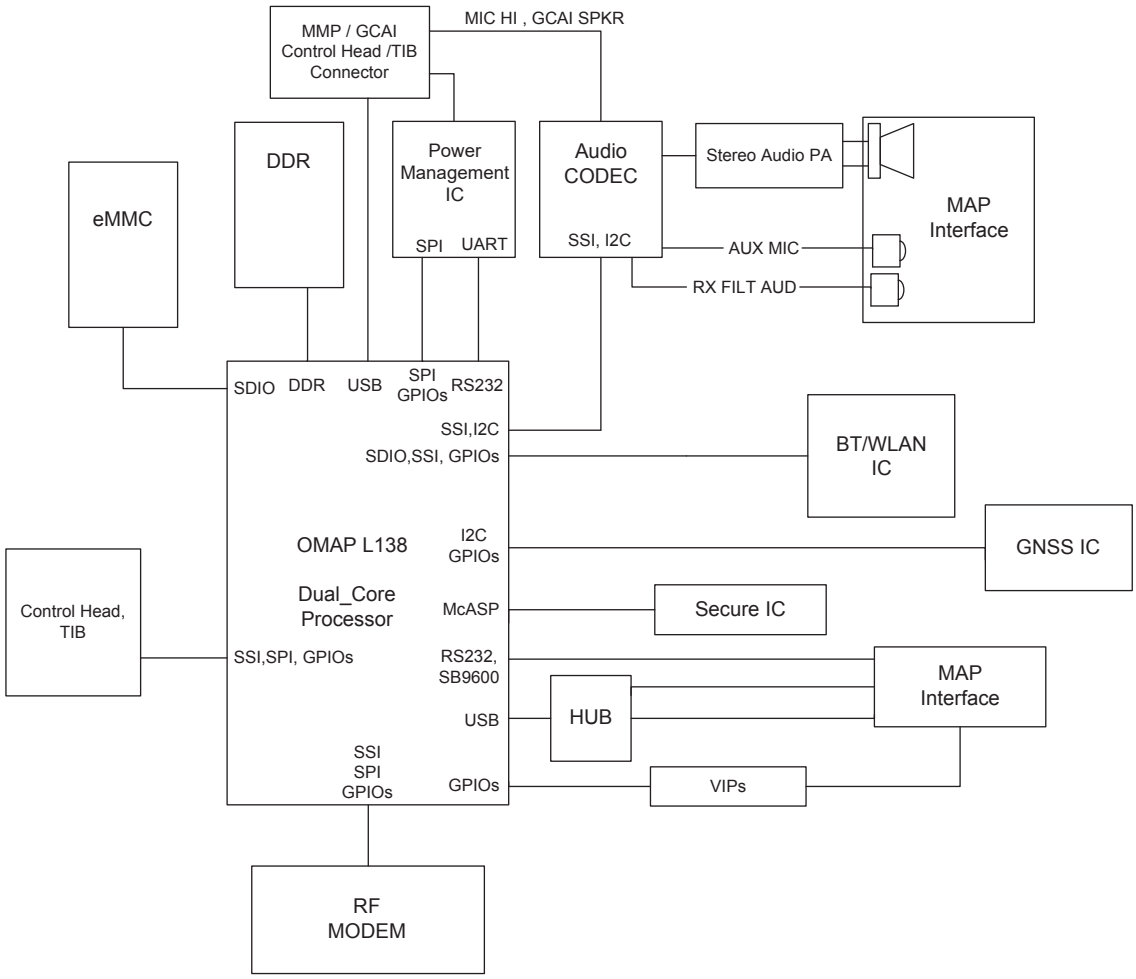
3.2 Controller Section

The Controller is a section of the radio that contains the following elements:

- Voltage regulators and data communication circuitry (RS232, USB, and SB9600)
- Microcontroller, FLASH IC, SDRAM IC
- Transmitter Board interface connector

- CODEC and Audio circuitry
- Power Management and Voltage Regulator IC
- Emergency circuitry
- Secure IC
- Edge connector interface for control head or Transceiver Interface Board (TIB)
- Rear accessory connector for additional accessories
- GNSS circuitry
- WLAN/Bluetooth circuitry

Figure 1: Mobile Controller Block Diagram



3.2.1

Controller Functional Blocks

The main functional blocks of the controller are a dual-core microprocessor. It consists of ARM-based controller and a DSP, Flash memory, and a Double-Data-Rate SDRAM memory.

The controller includes the following components:

- Type 3 encryption processor (MACE).
- Power Management IC.

- Various external switching and linear voltage regulators.

The primary clock sources (19.2 MHz and 32.768 kHz) to all other controller digital clocks.

The audio has a stereo CODEC and a class-D audio power amplifier that provides the radio with multiple internal microphone and speaker inputs or outputs. The external interfaces or connectors provide communication and control to the accessories, the control head, and the TIB.

The ARM controller core of the OMAP L138 processor handles the power-up sequence of all devices. This includes the following tasks:

- Firmware upgrades and operating system tasks with FLASH and SDRAM memories.
- User interface or control-head communication

The FLASH memory (4 GB eMMC) stores the firmware, tuning, codeplug settings, and gets read and stored into SDRM (128 MB) for execution upon initialization. The ARM and DSP control and configure audio, wireless, and RF devices linked to the Serial Peripheral Interface (SPI) and Synchronous Serial Interface (SSI) buses. This is to enable the radio FM modulation, and optional wireless communication protocols. For encryption, a separate ARM processor (MACE) is used to encode and decode encrypted packets coming in from the main OMAP L138 processor through the SSI interface. Its firmware is flashed through the main processor to its internal FLASH memory.

The Power Management IC and the external switching and linear regulators on board provides power to the controller devices. The Power Management IC provides the 32.768 kHz clock to the OMAP L138 and to the WLAN or Bluetooth IC, and provides a 4.8 MHz clock to the MACE encryption IC. The OMAP L138 main reference clock (19.2 MHz), is supplied from the FGU section of the transceiver board.

The three external microphone input paths and an internal audio PA provide audio to an external loudspeaker. There are line level analog audio outputs for monitoring or recording. The external speaker is driven by a Class D audio amplifier that delivers a rated power of 15 W to a 3.2-Ohm speaker. The speaker path uses the CODEC for volume control, and to convert the audio signal from digital DSP samples to analog. All microphone input paths use the CODEC ADC to deliver digital audio samples to the DSP controller.

The control head and TIB contain a universal accessory connector (MMP). The connector provides audio, USB, and RS232 interfaces to the radio by using the Power Management IC and CODEC. In addition to other signals, many of these interfaces are available on the radio accessory interface connector (MAP).

A GNSS IC has the following components:

- Global Positioning System (GPS) and GLONASS receiver.
- IC that combines a WLAN transceiver (IEEE 802.11 b/g/n) and a Bluetooth 4.0 capable transceiver.
- 3-axis accelerometer.

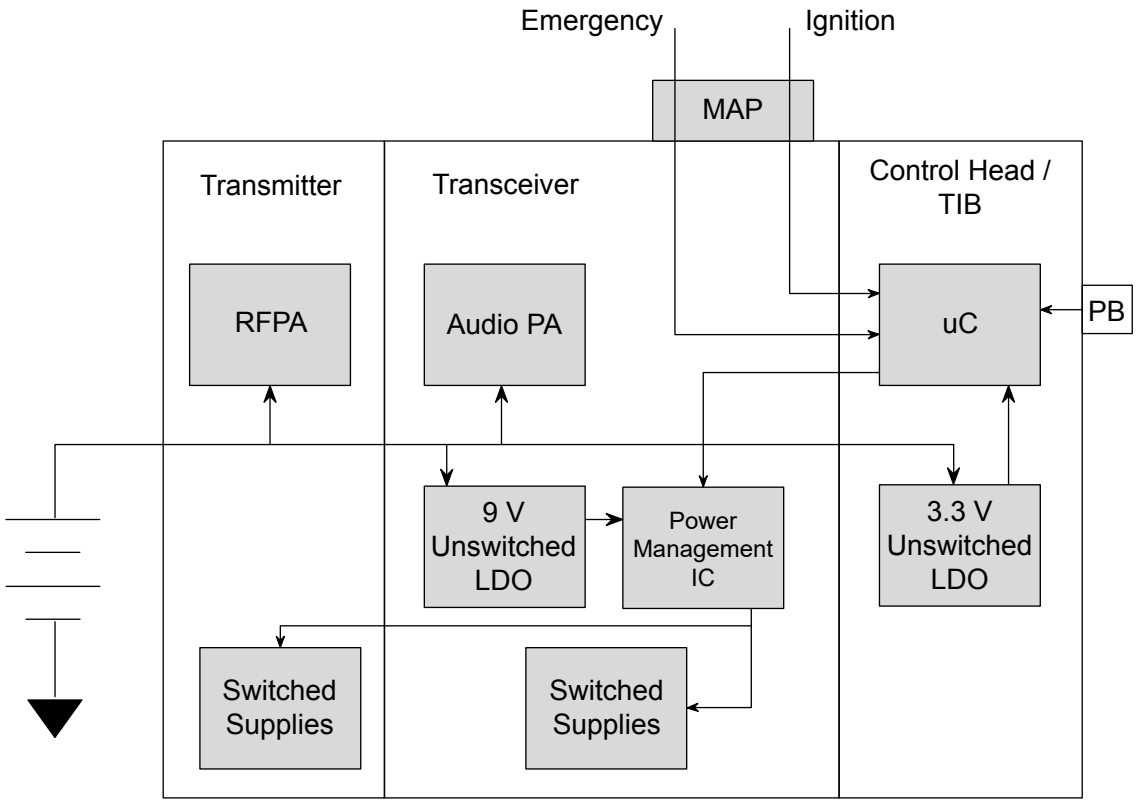
The GNSS IC interfaces with the OMAP L138 processor through a shared I2C bus.

The WLAN or Bluetooth IC interfaces with the OMAP L138 processor from a 4-bit SDIO bus.

The radio can be connected to a wireless network access point using the WLAN or Bluetooth IC. The IC supports IEEE 802.11 b/g/n data rate standards and the 802.11i security standard. When this feature is enabled, the radio is updated with a new codeplug and software through Wi-Fi. The Wi-Fi AP name and password need to be set in the codeplug and the radio management software enabled to provide wireless updates. When the radio Wi-Fi is actively connected to an AP, a Receive Signal Strength Indicator (RSSI) is shown on the control head display.

3.2.2
Voltage Distribution/Power On/Off

Figure 2: Voltage Distribution/Power Diagram



3.2.2.1
Voltage Distribution for Controller and RF Board

The APX mobile radios are powered by a 12 V vehicle battery (negative ground), or a AC-to-DC desktop power adapter. The power enters at the rear of the radio at a dedicated 2-pin DC connector.

This raw voltage known as A+ is routed to the transmitter and transceiver board circuitry for post-regulation.

3.2.2.2
Power On/Off

There are three methods that can be used to turn the radio on and off (depending on the codeplug setting).

The radio can be turned on and off with the Power Button on the control head.

It can also be turned on and off with the Ignition sense (ACC) line and emergency by using the MAP accessory connector.

The transceiver regulators are controlled by the Power Management IC (ASIC). This IC has a Power Management Controller (PMC) state machine that turns on and off all radio supplies.

The PMC also resets the OMAP L138 microprocessor at power-up, in response to user inputs at the control head or MAP.

3.2.3
Audio Circuitry

This topic covers the RX audio path and TX audio path.

3.2.3.1
RX Audio Path

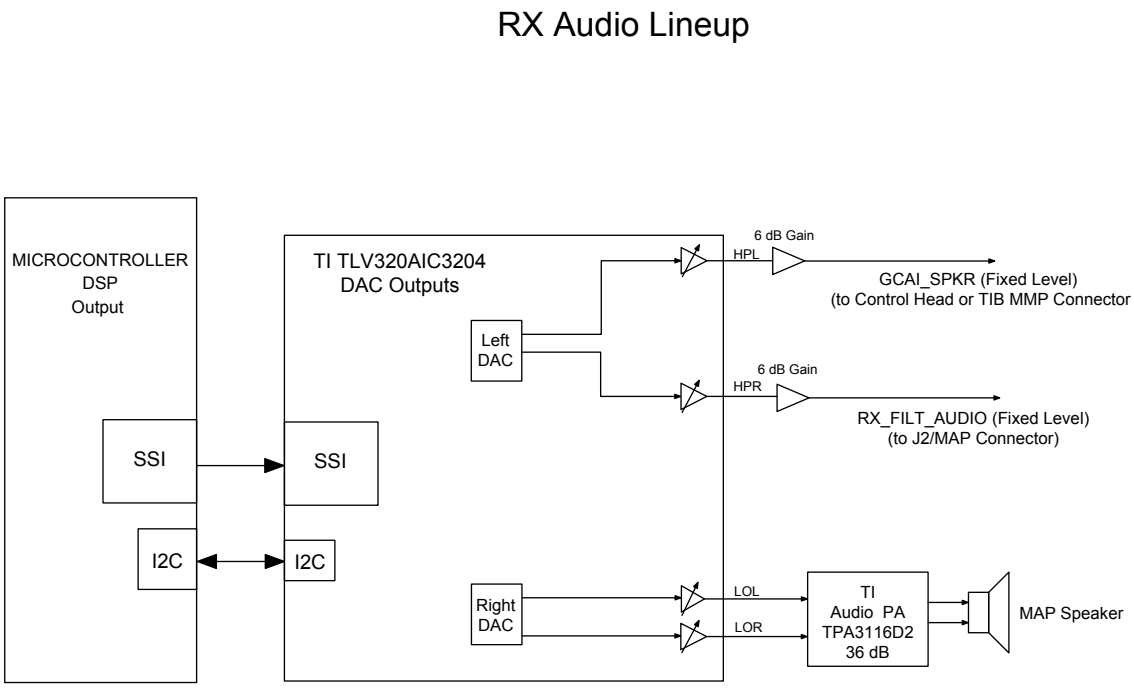
The receive audio path consists of the following main components:

- Texas Instruments OMAP L138
- Texas Instruments Audio CODEC TLV320AIC3204
- TI Audio PA TI TPA3116D2

The Digital audio signal comes from the DSP processor using SSI protocol. The Audio SSI bus is routed to TI CODEC. The CODEC converts the SSI digital data to analog. This audio is routed to both the MAP and MMP accessory interfaces to supply line-level audio for monitoring/recording. It is also routed to the Audio PA, with volume control being programmed using the I2C bus by the OMAP L138.

The Audio PA converts the analog signal to a PWM output, it also adds 36 dB of gain. The output low pass filter (LC), filters out the Audio PA switching frequency before the audio is routed to the speaker output.

Figure 3: Receive Baseband Audio Path



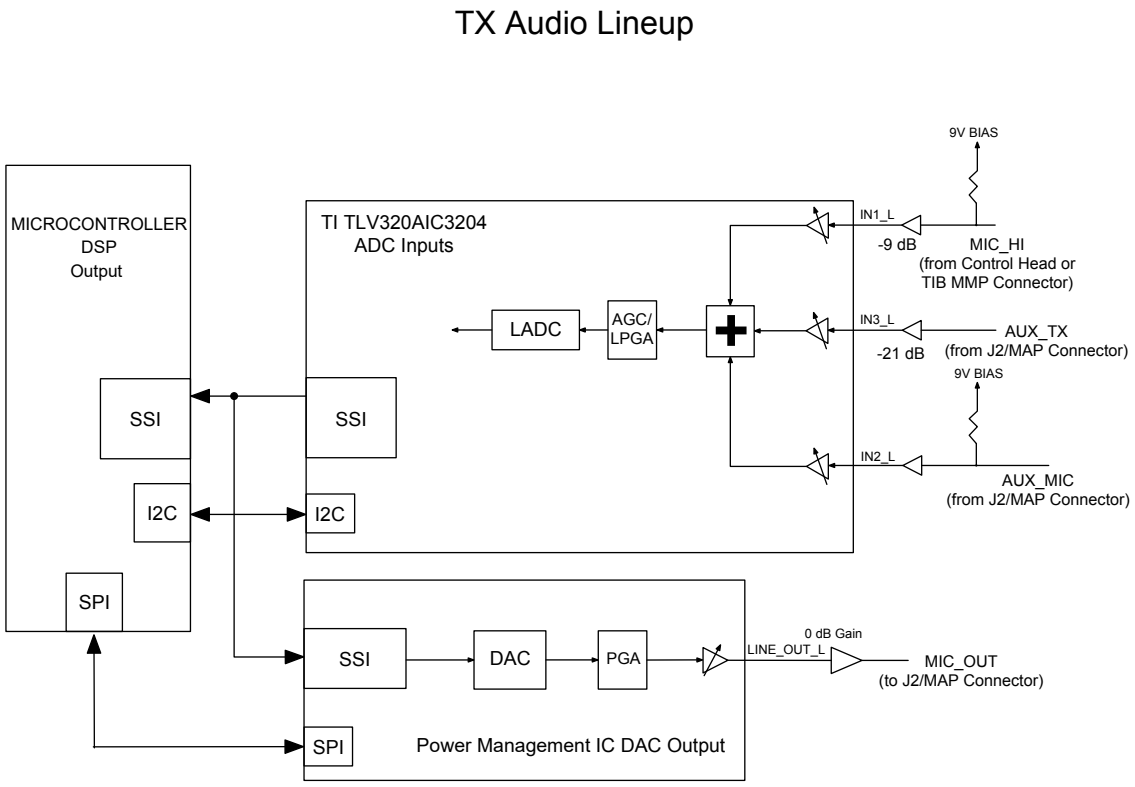
3.2.3.2
TX Audio Path

The analog audio comes from the external radio microphone that is attached through the control head's microphone port. It can also be attached through the MAP rear accessory connector J2 (Mic_Hi or Aux_Mic).

Analog audio is attenuated by 6 dB. It is routed to the Power Management IC, which converts the analog audio to digital. The converted audio is then sent it to the main processor using the Audio SSI bus.

OMAP L138 processes the audio that is then converted to Baseband audio and routed to the FGU. The audio is then sent to the transmitter board.

Figure 4: Transmit Baseband Audio Path



3.2.4
Secure

The controller board is able to perform secure encoding and decoding through the MACE IC.

In TX mode, the CODEC supplies the OMAP L138 DSP with audio. When a secure signal has been selected, it is routed to the MACE through the SSI bus. The encrypted audio is then sent back to the OMAP L138 which routes it to the FGU for transmission. In RX mode, the encrypted digital audio sent to the OMAP L138 is first routed to the MACE through the SSI bus. The decrypted audio is then sent back to the OMAP L138 which routes it to the CODEC to be sent to the speaker.

Keyloading

See Loading an Encryption Key on page 101. The KEYLOADER signal comes in on MMP pin 9 of the control head or TIB J700 connector. It routes to the MACE through the Power Management IC. There is an algorithm in the MACE which detects and stores the key as long as the radio is powered.

Tamper and key retention

The MACE has the option of infinite key retention. The key can be disabled by several means to avoid compromise. A tamper contact switch detects mechanical intrusion. A capacitor-backed supply maintains the static memory when all power to the radio is removed. This volatile key retention option holds the key for between 5 and 10 minutes on the discharge of this capacitor.

3.2.5
GPS Overview

The GNSS architecture employs a single chip GPS and GLONASS receiver which decodes signals at 1575.42 MHz.

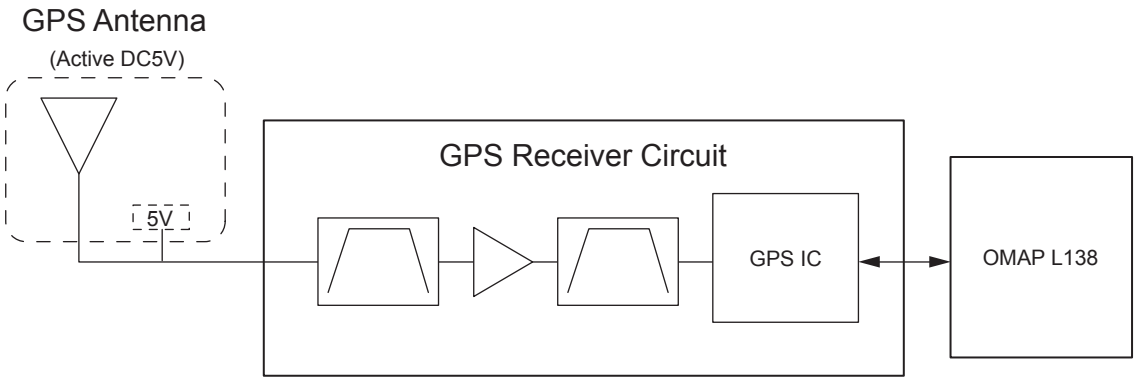
It is capable of producing a final position solution including full tracking and data decode capability. The receiver operates in the autonomous mode only.

The GNSS receiver is setup in an autonomous one track always (OTA) mode, also known as continuous navigation. The GNSS receiver continuously tracks satellites for as long as the radio is powered to ensure the best possible accuracy. In the event the radio loses visibility of the satellites due to terrain or environmental factors such as driving through a tunnel or in a parking garage, the receiver temporarily loses its position fix. It then begin to reacquire the signal and compute an updated position once the radio has moved back into an environment where GNSS signals are present.

The user is able to view the current latitude, longitude, and time/date stamp on the radio display. The radio can also be configured to send location to the system at predetermined intervals (LRRP). Depending on system options, the user may be able to enable/disable the GNSS receiver.

CAUTION: These custom connectors are optimized to meet voltage and current requirements for existing accessories and for the compatible flexes that are used with the radio. Inserting non-Motorola Solutions parts or pins into these connectors is not recommended. Failure to do so can result in equipment damage.

Figure 5: GPS Architecture



3.2.5.1
Acquiring a Position

Perform the following steps if the GNSS receiver is unable to acquire a position.

Procedure:

1. Make sure the radio is in an open sky environment to ensure the presence of GNSS signals (minimum 5 satellites in view at nominal power levels of -130 dBm).
2. Reset the radio. If a position fix does not occur within 2 minutes, proceed to step 3.
3. Disconnect the GNSS antenna. Replace the GPS antenna if the center conductor on the antenna is shorted to ground.
4. Measure the voltage on the GNSS SMA connector located on the radio and ensure that the result 5 V. If the result is not 5 V, send the radio for repair.

NOTE: Refer to the *Detailed Service Manual* for further instructions if GNSS does not obtain a position.

3.2.6

Serial Interfaces

RS232, USB Device, USB Host, and SB9600 are supported by the radio on the rear 26-pin J2 connection. While RS232 and USB Device/Host are supported on the TIB external connector J700.

Accessories that connect to the J700 and J2 connectors are identified through the 1-Wire ® serial protocol. This information tells the controller which serial bus to configure for the accessory.

Figure 6: Dash-Mount Configuration

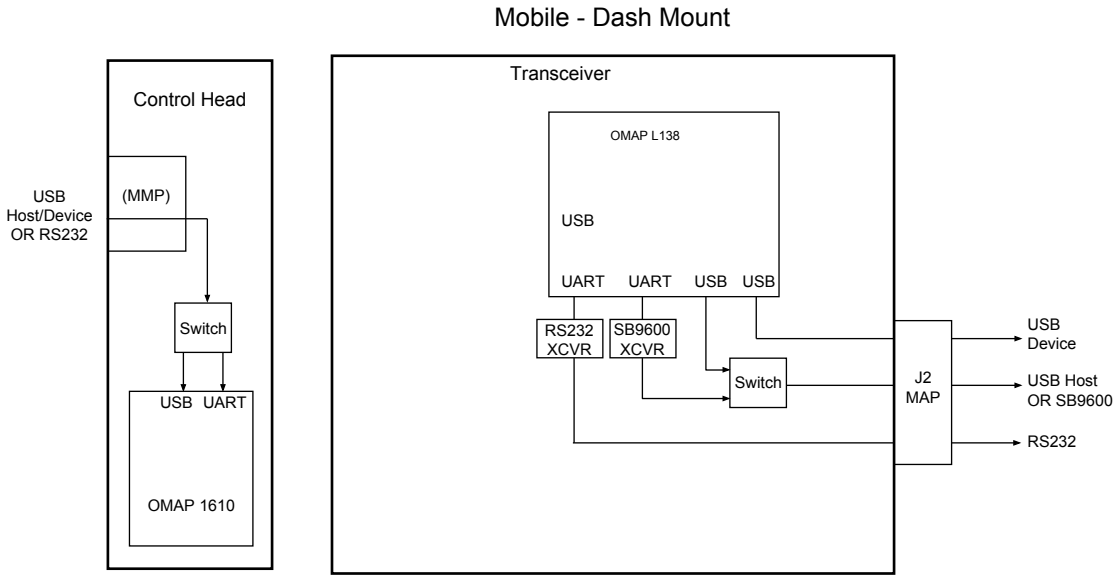
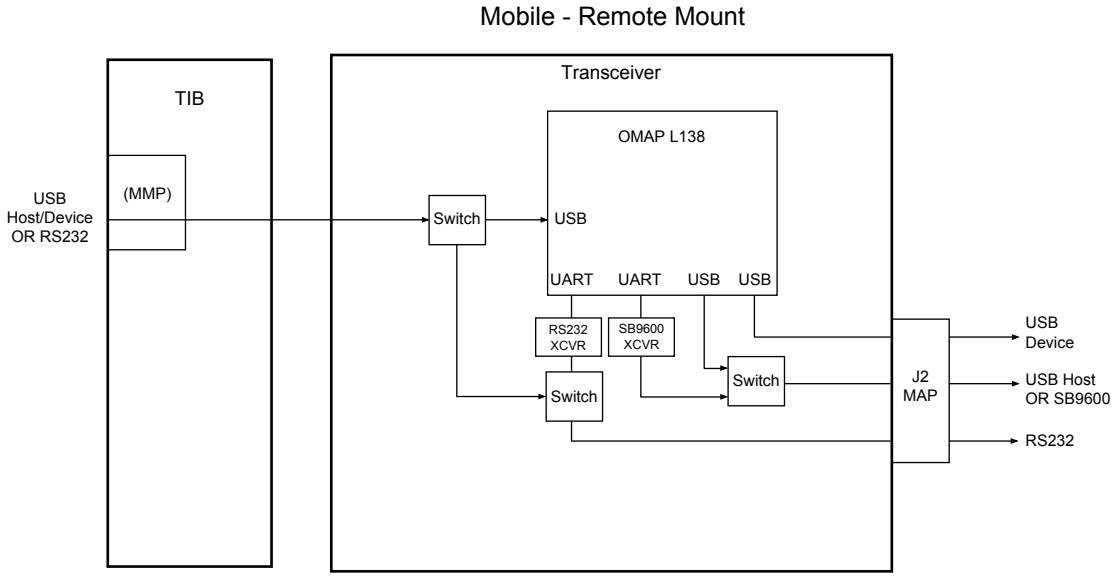


Figure 7: Remote-Mount Configuration



There are hardware design limitations that limit the number of serial interfaces that can be used simultaneously.

- RS232 – This serial interface is available at either the MAP/J2 (rear) connectors, or at the J700 (TIB) connector. When no 1-Wire ® accessory is added to the J700 connector, the MAP/J2 interface is the

default choice. It is compatible with industry-standard 12 V RS232 logic. If a 1-Wire ® compliant RS232 accessory is attached to the J700 connector, then the bus is no longer supported at MAP/J2. The J700 RS232 interface operates at 5 V logic. The voltage translation circuitry in the RS232 cable allows the bus to operate at 12 V.

- SB9600 – This is a Motorola Solutions proprietary bus used to communicate with certain legacy accessories. The bus is available at the J2 connector by default.
- USB – USB Host and Device functionality are available at the J700 MMP connector on the TIB. The type of accessory or cable identified by the 1-Wire ® interface determines the functionality once again. USB Device is also a dedicated interface at the MAP/J2 connector by default. In addition, USB Host can be optionally configured at the MAP/J2 connector through the SB9600 interface (the buses share common pins). The SB9600 bus is configured by default when MAP/J2 connector is connected with a 1-Wire ® compliant USB Device accessory or cable. However, USB Host is configured when a 1-Wire ® compliant USB Device accessory or cable is attached to the MAP/J2 connector.

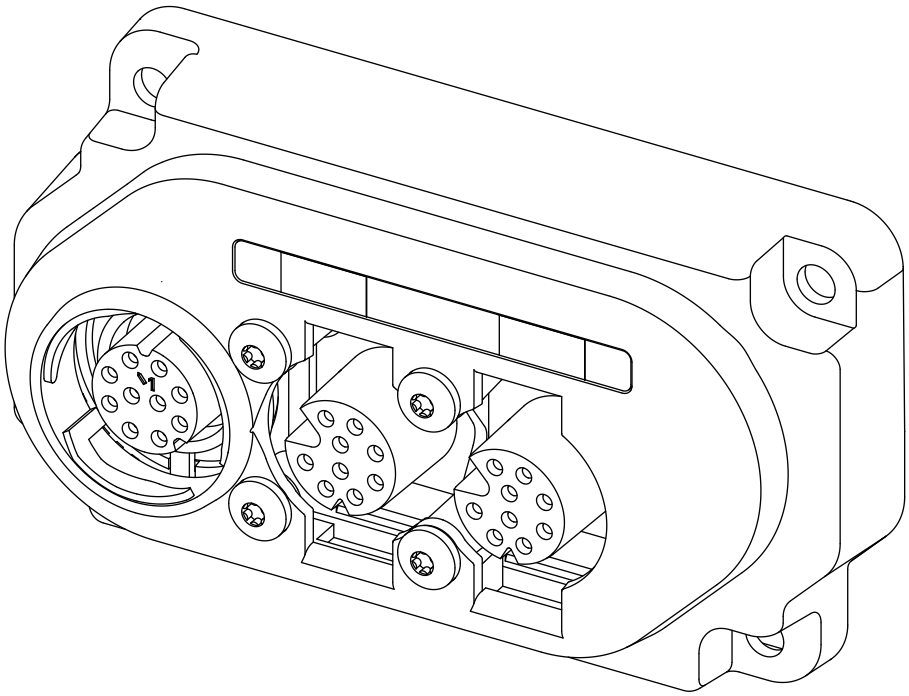
  NOTE: If a USB cable is attached to the TIB J700 connector, the RS232 link at the J2 can still be used. The J2 USB Host and Device interface can also be used if the J700 USB interface is for Host only.

3.3 Transceiver Interface Board (TIB)

The Transceiver Interface Board (TIB) provides connectivity between the CAN cable and the transceiver.

The TIB must convert the CAN protocol back to Synchronous Serial Interface (SSI) through an FPGA, which is sent to the microprocessor. External connectors on the TIB include the MMP J700 connection for accessories, data programming and secure key-loading of the transceiver. Power-ON, Power-OFF, and RESET of the transceiver is accomplished using an ATMEL AVR microcontroller as determined by commands from the Transceiver or from a remote device, such as a control head, connected to the CAN bus.

Figure 8: Transceiver Interface Board (TIB)



3.3.1
Quick Disconnect Circuit

The quick disconnect circuit located in the TIB provides immediate muting of all speaker audio by forcing the radio to reset. It occurs as a control head CAN cable is disconnected from the TIB or an extension cable is attached to the TIB.

If there is no other control heads connected to the TIB with CAN after the disconnection, the radio may be programmed to turn off automatically.

This programming is done through the CPS by selecting the Control Heads **Required for Power Up** field.

The **Control Heads Required for Power Up** field is selected in a configuration that has a single O3 control.

This may be required to immediately mute all speaker audio and turned off when the O3 control head is disconnected.

NOTE: If **Control Head Required for Power Up** field is not selected, the radio applies the standard power-up settings.

- At least one control head must be present in order for the radio to be turned on when it resets. For example, if a system with one control head is removed, the radio is turned off after it resets. If a system with two control heads is reset, the radio monitors the Ignition sense (ACC) line. The radio then compares it to the ignition CPS setting to decide whether it remains turned on or off. If a system with two control heads and both is removed, the radio is turned off after reset.
- If the field is 'blank' (typical usage), quick disconnect is not activated. For example, if a system with one control head is removed, the radio monitors the Ignition sense (ACC) line after being reset. The radio then compares to the ignition CPS setting to determine if it remains turned on or off. If a system with two control heads, and only one is removed, the radio is powered-on after reset. If both control heads are removed from a system with two control heads, the radio monitors the Ignition sense (ACC) line. It then compares it to the ignition CPS setting to determine if the system is turned on or off.

3.3.2
Controller Area Network (CAN) Transceivers

There are a total of three CAN twisted pairs located between the control head and the radio transceiver.

CAN pair one is used for digital Audio, CAN pair two is used for digital Data and CAN pair three is for digital Power ON/OFF/RESET pulses. If an O5 control head is used, a TIB and CHIB must be present. If an O3 control head is used, only a TIB must be present, since the O3 control head has the CAN transceivers located on its PCB. The CAN bus provides a 1 MB/s data link. Only the list of approved Motorola Solutions CAN cables are to be used for any remote mount installations.

3.3.3
CAN Termination

The CAN architecture requires that a termination resistor is connected only at the two end-points of the CAN bus.

The CAN cable contains a jumper that grounds a “detect pin” at the CAN connectors. Logic within the auto-termination circuit determines how many cables are attached and enables or disables the termination resistors, for each of the three twisted pairs. The O3 control head has the termination resistors enabled at all times, since it is always an end-node. The remote mount cables are able to be connected to either the left CAN connector or to the right CAN connector. The letter L and R next to the connector indicates Left or Right

CAN connector. It is not recommended to have CAN cables attached but dangling free at one end, during operation.

NOTE: Use Motorola Solutions fixed length CAN cables, as circuitry resides in each cable and the cable wiring impedance is unique to this remote cabling architecture as well.

3.4
Analog Mode of Operation

This topic covers Receive Operation and Transmit Operation.

Receive Operation

When the radio is receiving, the signal travels from the antenna through the RF PA output network. The output network is located in the power amplifier section to the front-end receiver assembly.

The signal is then filtered, amplified, and mixed with the first local oscillator signal generated by FGU. The resulting intermediate-frequency (IF) signal is fed to the IF circuitry where it is again filtered and amplified.

This amplified signal is passed to the back-end receiver IC where it is mixed with the second local oscillator to create the second IF.

The analog IF is processed by an analog-to-digital (A/D) converter. The converter is located within the digital back-end IC, where it is converted to a digital bit stream and decimated down to an I/Q digital sample.

This digital signal is then passed on to the DSP, where filtering and discrimination are performed in the software.

For voice signals, the DSP routes the digital voice data to the Codec. This is for volume gain control and conversion to an analog signal. The signal passes to the audio power amplifier, which drives the speaker.

For signaling information, the DSP decodes the message and passes it to the microprocessor.

Transmit Operation

When the radio is transmitting, the microphone audio travels to a gain control circuit. The audio is then sent to the Codec where the signal is digitized.

The Codec passes digital data to the DSP, where pre-emphasis and low-pass (splatter) filtering is done. The DSP may also add signaling information. As a modulation signal for the transmitter voltage-controlled oscillator, the digital synthesizer IC receives the digitized signal including both voice and signaling data.

A modulated carrier is provided to the RF power amplifier, which transmits the signal under dynamic power control.

3.5
Control Head Interface Board (CHIB)

The Control Head Interface Board (CHIB) is used to provide functionality and connectivity between the Control Head Universal Connector (CHUC), the transceiver, and the Control Head.

For the remote-mount operation to function, the Synchronous Serial Interface (SSI) used to communicate between the control head and the transceiver in a Dash-mount configuration is converted on the CHIB to a Controller Area Network (CAN) protocol. The CHIB accomplishes this conversion using a Field-Programmable Gate Array (FPGA). This CAN data is then sent down the remote cable from the CHIB, through the CHUC, into the Transceiver Interface Board (TIB), and finally into the transceiver. The CHIB also provides an audio power amplifier for driving a speaker, a USB host, a USB device transceiver, and an auto-termination circuit to terminate the CAN bus.

Table 17: Control Head and CHIB Compatibility

CHIB Kit Numbers	Compatible with Control Head
PHCN4003A	E5 Control Head
PMUN1057_	O2 and O7 Control Heads
PHCN4003E or greater	E5, O2, and O7 Control Heads

NOTE: PMUN4003E and above are not a direct replacement for PHCN4003A and PMUN1057_. Only qualified service personnel can perform Control Head upgrade procedures to replace PHCN4003A or PMUN1057_ with PHCN4003E and above. Failure to perform Control Head upgrade procedures properly can cause incompatibility issues between the Control Head and CHIB. For more information, contact Motorola Solutions Service Center or Depot.

3.6 ASTRO Mode of Operation

In the ASTRO mode (digital mode) of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying.

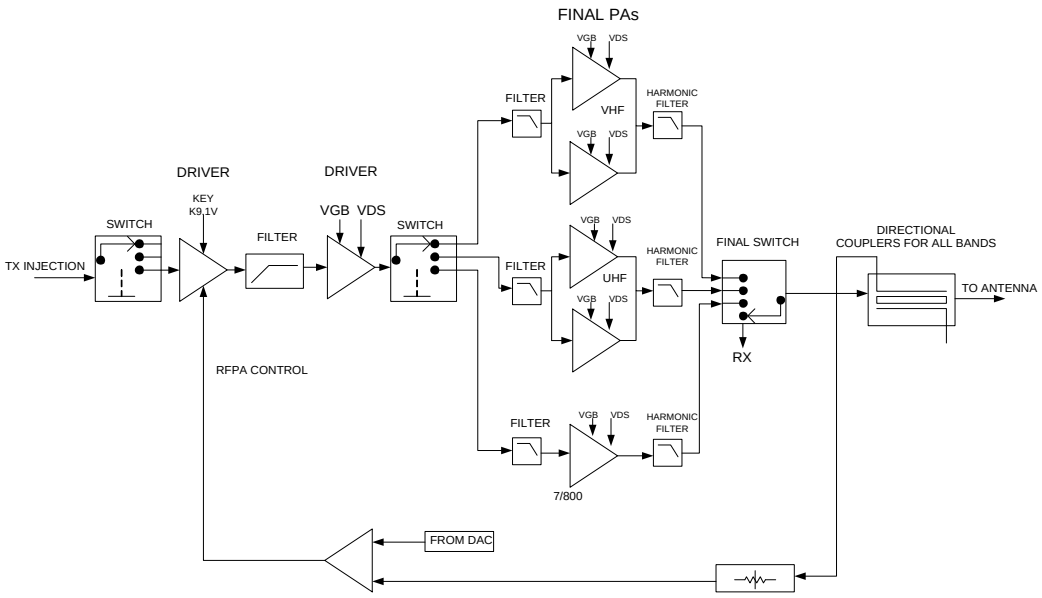
The receiver handles an
ASTRO-mode signal identically to an analog-mode signal up to the point where the DSP decodes the received data.

In the ASTRO receive mode, the DSP uses a specifically defined algorithm to recover information.

In the ASTRO transmit mode, microphone audio is processed the same way in analog mode. This is an exception for algorithm the DSP uses to encode the information. This algorithm results in deviation levels that are limited to discrete levels.

3.7 RF Transmitter Board (TX)

Figure 9: RF Transmitter Board



3.7.1
Radio-Frequency Power Amplifier (RF PA) and Output Network (ON)

The RF PA is a three-stage power amplifier consisting of a GaAs 2-stage amplifier IC, a LDMOS 2-stage amplifier IC and 3 discrete LDMOS transistors selectable by a 3 to 1 silicon switch.

Discrete inter-stage filters are in place for spur rejection:

- Controlled stage
- Driver stage
- Final stage

The RF PA is followed by the ON section, consisting of discrete circuitry with the following functions:

- Antenna switch
- Harmonic filter
- Power detector

3.7.2
Gain Stages

The controlled stage consists of a two-stage, wideband integrated amplifier with external matching and a high pass filter. This amplifies the input signal from the VCO buffer and provides drive to the driver stage.

Power is controlled through gate bias to the internal stages of the controlled stage. Drain bias is supplied via K9.1 V. The signal runs through a high pass filter to suppress spurs, before arriving at a wide band driver stage. The driver stage has a fixed gate bias and a fixed drain bias supplied by the VDS_DRIVER line, which is powered by a 28 V boost converter. The Driver stage then runs into a 3 to 1 silicon switch that selects between the 3 bands (VHF, UHF, and 7800).

Each band has its own low pass and high pass filter to reduce out of band spurs. From the filters, the signal travels to its respective narrowband final stage.

Each final stage has a single LDMOS transistor. Based on the output power level, the fixed gate biases and drain biases is supplied by the VDS_FINAL line. This is powered by the same 28 V boost converter as the driver

.

The output of the final stage feeds its respective harmonic filter and power detector before merging at the antenna switch. The antenna switch selects between the narrow band final stages and also isolates the RX in TX mode.

3.7.3
Power Control

The power control section regulates the RFPA output power by an automatic level control (ALC) circuit.

The transmitter ALC consist of the below components:

- Digital attenuator
- Voltage variable attenuator
- RF log amp
- Digital-to-analog converter (DAC)
- Buffer/amplifier

The APX 8500 has the addition of the RF Front End IC (FEIC) for programming GPO signals and supplying DAC control.

The power detector senses the incident power transferred to the antenna through a directional coupler in which the RF signal is fed to the digital attenuator, voltage variable attenuator and the RF log amp.

The RF log amp compares the input RF power from the directional coupler with the voltage set from the DAC to generate a DC voltage. The DC voltage is then gained by the buffer/amplifier and fed to the RFPA stage. The radio carrier power level is set by adjusting the DAC voltage set while monitoring the output power, which is saved in the radio memory.

3.7.4
Circuit Protection

The APX 8500 radio has various protection mechanisms while transmitting.

Monitored signals include:

- RFPA driver and final stage drain current
- RFPA final stage temperature
- RFPA control voltage
- Radio battery voltage sensed by the power control circuitry

If a fault condition is detected, the control voltage is reduced. The output power is then cut to a level that is safe to use.

3.7.5
RF Transmitter Board to Transceiver Board Interconnect

The connector carries multiple signals bridging control lines from the controller section to the PA board. The connections include A+, SSI, SPI, and I/O lines.

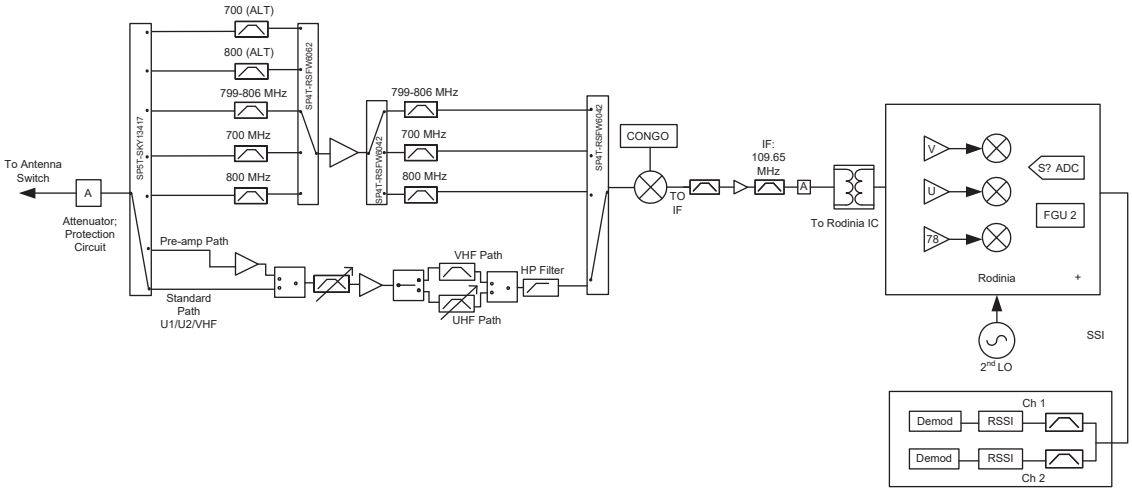
3.8
RF Transceiver Board (XCVR)

The primary duties of the receiver circuits are to detect, filter, amplify, and demodulate RF signals in the presence of strong interfering noise and unintended signals.

This receiver is an All-band receiver, covering the VHF, UHF1, UHF 2, and 700/800 bands. In addition, this model supports the industry Canada band. The receiver contains the following blocks:

- Front-end (preselectors and LNAs)
- Mixer
- IF
- Back-end

Figure 10: Receiver Block Diagram



3.8.1
VHF Receiver Front-End

The VHF receiver operates in the frequency range of 136 to 174 MHz.

The primary function of the receiver front-end is to optimize the rejection of the image frequency and other out-of-band frequencies while providing low-noise amplification of the received signal. The front-end uses varactor tuned filters and discrete LNAs. The varactor tuned filters cover from VHF to UHF ranges 1 and 2. The front-end has two possible configurations: standard mode, which provides the best intermodulation performance, and the optional pre-amp mode, which provides improved sensitivity at the cost of slightly reduced intermodulation performance. The front-end line-up for standard mode is: a variable 18 dB attenuator for AGC purposes, a tunable bandpass filter, a low-noise amplifier, and a fixed highpass filter. In pre-amp mode an additional LNA is added between the attenuator and the first bandpass filter.

3.8.2
UHF1 and UHF2 Receiver Front-End

The UHF R1 receiver operates in the frequency range of 380 to 470 MHz. The UHF R2 receiver operates in the frequency range of 450 MHz to 520 MHz.

The primary function of the receiver front-end is to optimize the rejection of the image frequency and other out-of-band frequencies while providing low-noise amplification of the received signal. The front-end uses varactor-tuned filters and discrete LNAs. The varactor tuned filters cover from VHF to UHF ranges 1 and 2. The front-end has two possible configurations:

- Standard mode provides the best intermodulation performance
- Pre-amp mode (optional), provides improved sensitivity at the cost of slightly reduced intermodulation performance.

The front-end line-up for standard mode:

- a variable 18 dB attenuator for AGC purposes
- a varactor-tuned image filter
- low-noise amplifier
- a second varactor tuned image filter

In pre-amp mode, an additional LNA is added between the attenuator and the first bandpass filter.

3.8.3
700–800 MHz and Industry Canada Receiver Front-End

The 700–800 MHz and Industry Canada receiver operates in three bands; 700 (762MHz - 776MHz), IC (799 MHz - 806MHz), 800 (851 MHz- 870 MHz).

Receiver front end optimizes image rejection and selectivity while providing the first conversion.

The front-end uses a multipole switch to select between the three bands and the alternate path (700/800 ALT applicable to CN models only). The front-end use saw-filter technology and include a wideband, monolithic amplifier.

The 700ALT (769MHz-775MHz) and 800ALT (851MHz-860MHz) use TC-SAW filter technology (LTE Broadband Protection Filter) to improve the Strong Signal Intermodulation Rejection performance.

The first filter reduces the image frequency response and limits some out-of-band interference. The second filter following the monolithic Low Noise Amplifier (LNA) provides additional image rejection.

3.8.4
Mixer

The receiver front-end signal is fed to the monolithic Mixer IC. It also down converted to an IF of 109.65 MHz.

The mixer is designed to provide low conversion loss and high intermodulation performance. The mixer is driven by the FGU receiver injection buffer. This efficiently drives the mixer over a wide temperature range with minimum power variation. The injection buffer provides 17 dBm to the mixer. The design maintains temperature stability, low insertion loss, and high out-of-band rejection.

3.8.5
IF Circuitry

The crystal filters provide IF selectivity and out-of-band signal protection to the back-end IC.

Two crystal filters of two-pole with center frequency of 109.65 MHz enables:

- receiver to meet specifications for gain
- close-in intermodulation rejection
- adjacent channel selectivity

NOTE: Two crystal filters of two-poles also isolate from one another by a discrete IF amplifier.

3.8.6
Receiver Back-End

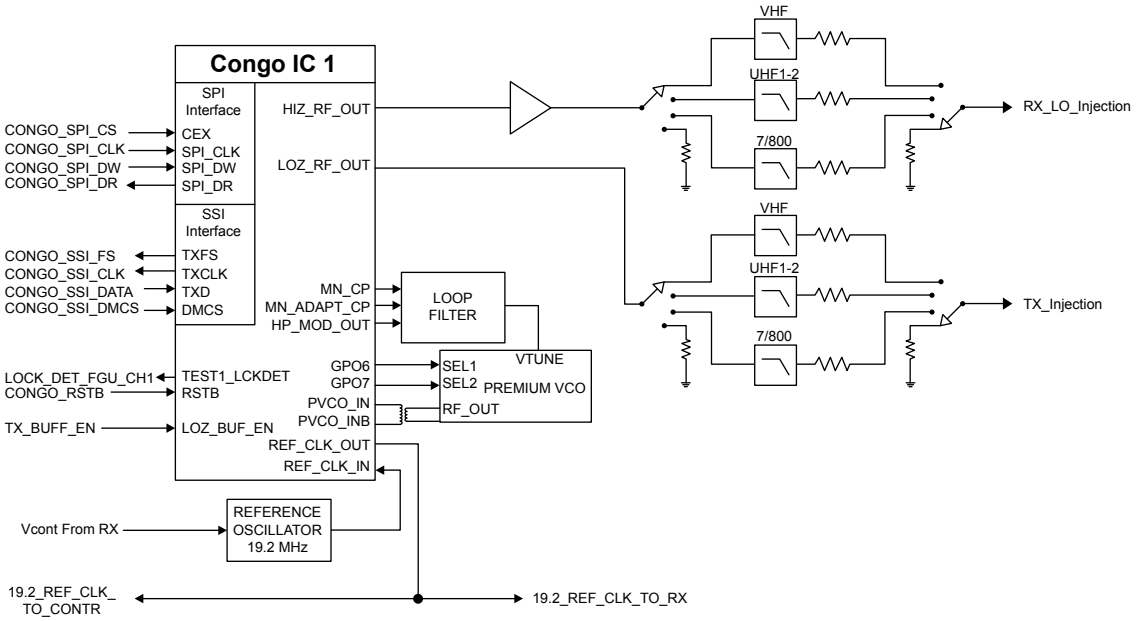
The output of the IF circuit is fed directly to the back-end receiver IC.

It is capable of down-converting analog and digital RF protocols into a baseband signal. It is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section. A second LO frequency is used to produce the second LO VCO. This VCO runs at low-side or high-side injection. The choice of frequency depends on known spurious interference related to the programmed received frequency.

3.9

Frequency Generation Unit

Figure 11: Configuration of the Frequency Generation Unit for APX 8500



The Frequency Generation Unit (FGU) in Figure 11: Configuration of the Frequency Generation Unit for APX 8500 on page 59 consists of the following:

- Congo synthesizer IC.
- Voltage Controlled Oscillator (VCO) module.
- Amplifiers and filter circuits.
- 19.2 MHz reference oscillator.
- Associated circuits.

The Reference oscillator provides a frequency standard for the fractional-N synthesizer IC, the back-end receiver IC, and the controller section. The synthesizer generates local oscillator injection (LO) frequency, or the transmitter (TX) carrier frequency.

The VCO is a non-serviceable module and containing two oscillator circuits.

In TX mode, the signal out of synthesizer IC is switched to a band dependent filter to reduce the harmonic levels of the signals. The output of the filters feed the power amplifier. In RX mode, the output of the synthesizer IC feeds an amplifier and then switched to band specific filter before feeding the receiver mixer.

Modulation is accomplished by direct digital programming of the Fractional-N synthesizer by the SSI (Serial Synchronous Interface) signals coming from the controller.

Chapter 4

Test Equipment, Service Aids, and Tools

This chapter provides lists of recommended test equipment, service aids, and tools. This also includes information that can be used in servicing and programming Motorola Solutions radios on the field.

4.1 Recommended Test Equipment

Equipments listed in this section are most of the standard test equipment required for servicing Motorola Solutions mobile radios. This list also includes several unique items designed specifically for servicing this family of radios.

Table 18: Recommended Non-Motorola Solutions Test Equipment

Model Number	Description	Application
N/A	1:1 Audio Transformer	Audio measurement (audio PA must NOT be grounded)
Agilent 6552	Power Supply (0–20 V, 0–25 A)	Mobile radio power supply and current measurements
Keysight N5765A	Power Supply (0–30 V, 0–50 A)	
Agilent 8901	Modulation Analyzer	Reference frequency measurements
AeroFlex 3920 or AeroFlex 8800SX	Digital Radio Test Set	Frequency, reference oscillator deviation digital tests and compensation measurements
Agilent U8903A and Rohde and Schwarz UPV	Audio Analyzer	Audio signal-level, SINAD, and distortion measurements
Keithly 2015-D	Audio Analyzing DMM	AC/DC voltage and distortion measurements
Fluke 187 or 189	Handheld Digital Multimeter (True RMS, AC, AC+DC, dB)	AC/DC voltage and current measurements
Fluke 190 Series	Handheld Oscilloscope (60–200 MHz Bandwidth, 2.5 GS/sec, Built-in 500-Count True RMS Multimeter)	Waveform measurements
Weinschel 49 30 43	30 dB RF Attenuator	For tests that require a modulation analyzer or wattmeter

4.2 Service Aids and Recommended Tools

This topic covers the listing and description of the service aids and tools designed specifically for servicing mobile radios, and the common tools required to disassemble and maintain the radio well. These kits and/or

parts are available from the Motorola Solutions parts division offices listed in Appendix A, B, C, and D accordingly.

Table 19: Service Aids for Mobile Radios

Motorola Solutions Part Number	Description	Application
DVN4236_	APX FLASHport Firmware CD	Kit with firmware to upgrade the radio, APX FLASHport CD.
DVN4237_	APX 7500 FLASHport Kit	Kit with firmware to upgrade the radio, APX FLASH port kit.
DVN4299_	APX 2500/APX 4500/APX 4500Li/APX 1500 FLASHport Kit	
RVN5224_	APX Customer Programming Software (CPS) and Tuner Software	Programming and radio alignment software.
HKN6160_	1.8 m (6 ft) 4-wire RS232 data cable	1.8 m (6 ft) cable used for RS232 data applications through the 26 pin rear accessory connector. Also provides an Ignition sense (ACC) wire.
HKN6161_	6.1 m (20 ft) 4-wire RS232 data cable	6.1 m (20 ft) cable used for RS232 data applications through the 26 pin rear accessory connector (J2).
HKN6163_	1.8 m (6 ft) USB data cable	1.8 m (6 ft) cable used for USB programming and data applications through the 26 pin rear accessory connector (J2) or the J100 remote control head connector. Also provides Ignition sense (ACC) and speaker wires. An emergency jumper wire must be installed between pins 15 (emergency) and 1 (gnd) when used in dash mount applications.
HKN6172_	4.5 m (15 ft) USB data cable	4.5 m (15 ft) cable used for USB programming and data applications through the 26 pin rear accessory connector (J2) or the J100 remote control head connector. An emergency jumper wire must be installed between pins 15 (emergency) and 1 (gnd) when used in dash mount applications.
HKN6182_	MMP Cable Adapter for Keyloader	Use with TIB MMP or dash-mount control head MMP. Must be combined with KVL cable TKN8531_
HKN6183_	2-wire MMP RS232 Data Cable	Cable for RS232 data applications through the control head or TIB MMP.

4.3 Mobile Radios Field Programming and Equipment

The mobile radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in Customer Programming Software (CPS) and Tuner Software (RVN5224_).

The radios use a flash-memory device to store information about frequencies, squelch codes, signaling codes, time-out timer durations, and other parameters and can be programmed in the field for any number of times without removing the flash memory from the radio.

The mobile radios can only be programmed using a USB. To program the radio, connect the USB cable HKN6184_ to the control head Mobile Microphone Port (MMP) connector. This is the 10-pin connector to which the microphone is commonly attached. The MMP connector is below the volume knob and to the left of the LCD display. HKN6163_ and HKN6172_ USB cables can also be used for radio programming, and can be connected at the remote control head J100 or radio rear J2 connectors. Refer to the *CPS Programming Installation Guide* (Motorola Solutions part number 6881095C44) for installation and setup procedures for the software.

Once the computer is connected to the radio, the prompts provided by the programming software can be followed. The following items, available through the Radio Products Services Division (except the computer), are required when programming mobile radios.

Table 20: Mobile Radios Field-Programming Items

Type or Part Number	Description
Customer Programming Software (CPS) and Tuner Software (RVN5224_)	This software enables you to program the radio features and align its parameters.
Personal Computer (PC)	Operating System ● Windows® 7 with Service Pack 1, or above ● Windows® 8 Minimum Hardware Requirements ● 1 GHz dual core or higher Pentium grade processor ● 8 GB RAM memory, excluding onboard graphics card memory usage ● 4 GB free hard disk space (for Standalone CPS) or 8 GB for CPS with Radio Management Suite. ● DirectX 9-class graphics card ● USB (Universal Serial Bus) Port radio communication ● USB (Universal Serial Bus) Port for iButton dongle ● DVD-ROM drive for software installation
USB Programming Cable	Used to connect radio directly to the computer, refer to Table 19: Service Aids for Mobile Radios on page 61.

Chapter 5

Performance Checks

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

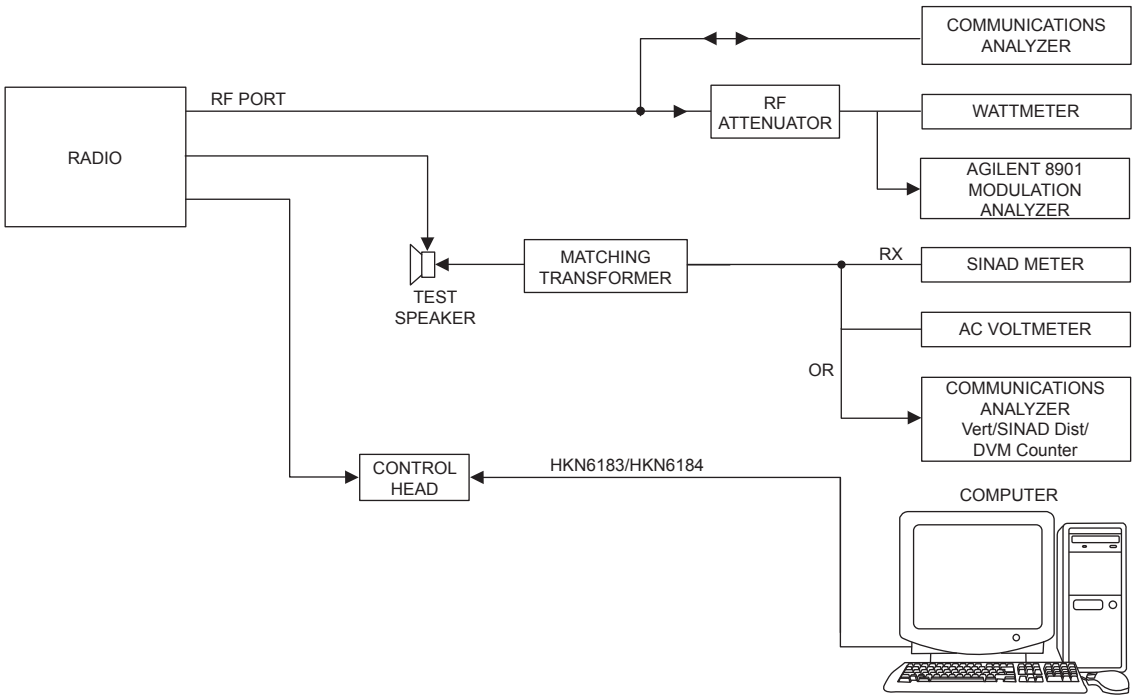
The recommended test equipment listed in the previous section is almost accurate to the manufacturing equipment. Maintenance of the test equipment must be aligned with the manufacturer recommended calibration schedule. Checks should be performed if radio performance declines.

5.1 Test 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 12: 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.

5.2 Test Mode

CAUTION: Be sure to transmit into a series load when keying a radio under test such as 30 dB RF pad). Failure to do so can result in test equipment damage.

5.2.1
Entering Test Mode

Procedure:

1. Turn the radio on.
2. Within 10 seconds after Self Test is complete, press the **Home Button** five times in succession for O2/O5/O7/O9/E5 Control Head (see O2 Control Head Test Mode on page 66 for O2, O5 Control Head Test Mode on page 70 for O5, O7 Control Head Test Mode on page 71 for O7 and O9 Control Head Test Mode on page 72 for O9 Control Head, see E5 Control Head Test Mode on page 74 for E5), or press the **Side Button 2** five times in succession for O3 Control Head (see O3 Control Head Test Mode on page 67).

   The radio shows a series of displays that gives information regarding various version numbers and subscriber-specific information. The displays are described in Table 21: Test-Mode Displays on page 64.

Table 21: Test-Mode Displays

Display Name	Description	Appears
SERVICE	Indicates radio has entered test mode	Always
HOST VERSION	Version of radio firmware	Always
DSP VERSION	Version of radio DSP firmware	Always
Secure Version	Firmware version for encryption	When radio is secure-equipped
Encryption Mode	Type of encryption being used	When radio is secure-equipped
CH VERSION	Version of Control Head firmware	Always
MCHB Version	Version of Control Head Board	Always
CHIB Version	Version of Control Head Interface Board	When auxiliary control head is present/radio is remote mount
Auxiliary Control Head	Firmware version for auxiliary control head	When auxiliary control head is present
Siren Version	Firmware version for siren	When siren is present
VRS Version Number	Firmware version for VRS	When VRS is present
MODEL NUMBER	Radio model number, as programmed in codeplug	Always
SERIAL NUMBER	Radio serial number, as programmed in codeplug	Always
ESN	Electronic Serial Number	Always
ROM Size	Memory capacity of flash part	Always
FLASHCODE	FLASHcodes, programmed as a part of radio codeplug	Always
RF BAND	Frequency band of radio	Always

Display Name	Description	Appears
TUNING VER	Version of Codeplug tuning	Always
PROCESSOR VER	Version of radio microprocessor	Always

NOTE:
All displays are temporary and expire without any user intervention. If the information is longer than the physical length of the control head display, it wraps around to the next display. After the last display, RF TEST is displayed.

Special attention: While information is scrolling in the test mode, if the **UP** button is pressed, the scrolling information pauses until the **DOWN** button is pressed again. Repeat with **UP** button to pause any other information. This makes recording radio version information easier.

3. Turn the **Mode** Rotary Knob for O2/O5/O7/O9/E5 Control Head.

   The display shows CH TEST.

4. Press the **Home** button to enter the RF test mode.

   The display shows 1 CSQ indicating test frequency 1, Carrier SQuelch mode.

5. For the O3 Control Head, press the programmed **Monitor** button to enable toggling between RF TEST and CH TEST.
6. Press the **Orange (EMERG)** button to select RF TEST.

   The display shows 1 CSQ indicating test frequency 1, Carrier SQuelch mode.

5.2.2
RF Test Mode

A special routine called **RF TEST MODE** or air test has been incorporated into the radio.

Procedure:

1. For the O2/O5/O7/O9/E5 Control Head, enter the RF test mode by pressing the **Home** button when the test mode menu RF TEST is displayed. If RF TEST is not displayed, use the **Mode** knob or the navigation button to scroll through the test mode menu until RF TEST is displayed.
2. For the O3 Control Head, enter the RF test mode by pressing the **Orange (EMERG)** button when the test mode menu RF TEST is displayed. If RF TEST is not displayed, use the **Monitor** button to toggle between RF TEST and CH TEST.
3. For the O2/O5/O7/O9/E5 Control Head, press the **Home** button to move the cursor back and forth between the frequency and signaling type. Use the **Mode** knob to scroll through the available selections.
4. For the O3 Control Head, press the **Monitor** button to select Channel Spacing (12.5 kHz or 25 kHz), press the **Side Button 1** to change signaling type, and press **Side Button 2** to change frequency.

Table 22: Rx and Tx Test Frequencies

Channel	Rx Frequency (MHz)	Tx Frequency (MHz)	Power (W)
F1	136.0750	136.0250	55.0
F2	154.2750	154.2250	55.0

Channel	Rx Frequency (MHz)	Tx Frequency (MHz)	Power (W)
F3	173.9250	173.9750	55.0
F4	380.0750	380.0250	49.5
F5	424.9750	424.9250	49.5
F6	484.9750	484.9250	49.5
F7	485.0750	485.0250	44.0
F8	495.0750	495.0250	44.0
F9	519.9250	519.9750	27.5
F10	764.0625	764.1250	33.0
F11	769.0625	794.1250	33.0
F12	805.9375	806.0125	38.5
F13	851.0625	823.9875	38.5
F14	860.0625	851.0125	38.5
F15	869.9375	869.8875	38.5

Table 23: Signaling Types

Display	Modulation	Demodulation	Type
CSQ	None	None	Carrier Squelch
TPL	192 Hz	192 Hz	Private-Line
AST	1200 Hz	N/A	ASTRO (digital)
USQ	None	None	Open Squelch

When in the transmit test mode, DTMF modulation produces a sidetone in the speaker. All signaling types continually modulates the transmitted signal for detection or measurement by external instruments.

5.2.3
O2 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Enter the control head test mode by pressing the **Power** button. Press the **Menu Select** button **1** and **4** simultaneously to enter control head STANDALONE TEST.

   CH firmware, CH FPGA, CH Flashzap version, and CH Board version are displayed before the unit enters the Control Head Test mode.

2. Press **Home** to enter sequential test.
3. In the **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (four borders test)

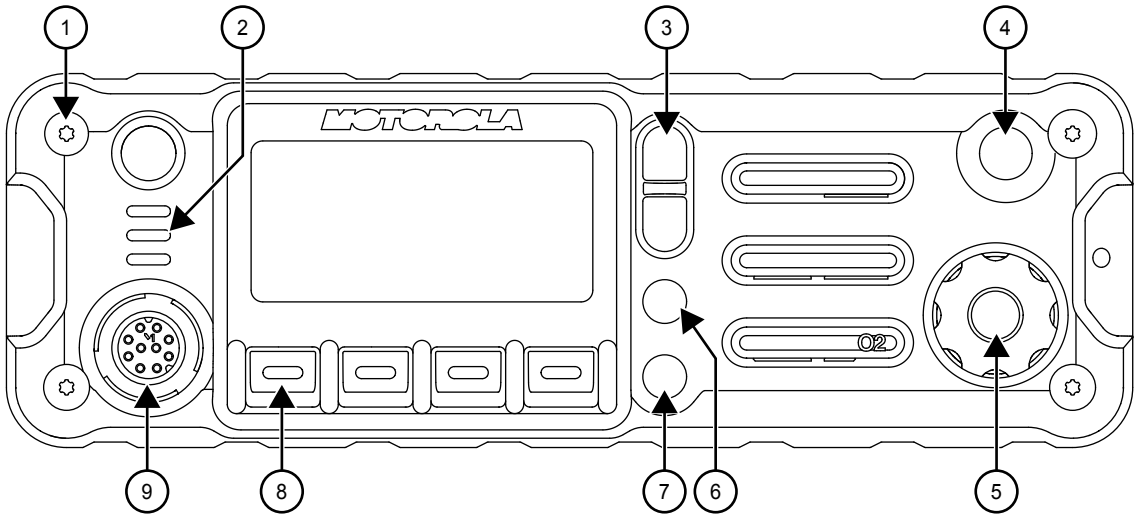
- Keypad LED test (green, amber, red, and common white LED test)

4. Press any button to activate the keypad test.

   All the ten buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD.

5. Press any key to enter **Multifunction Knob** test after all ten buttons are pressed.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 13: O2 Control Head



No.	Description
1	Power On/Off Button
2	LED Status Indicators
3	Up/Down Buttons
4	Emergency Button
5	Multi-Function Knob
6	Dim Button
7	Home Button
8	Menu Select Buttons
9	Accessory Port (Microphone)

5.2.4
O3 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Enter the control head test mode by pressing the **POWER ON/OFF** button while holding down the **1** and **3** button of the keypad. Release the **1** and **3** button when `Standalone Mode` is displayed.

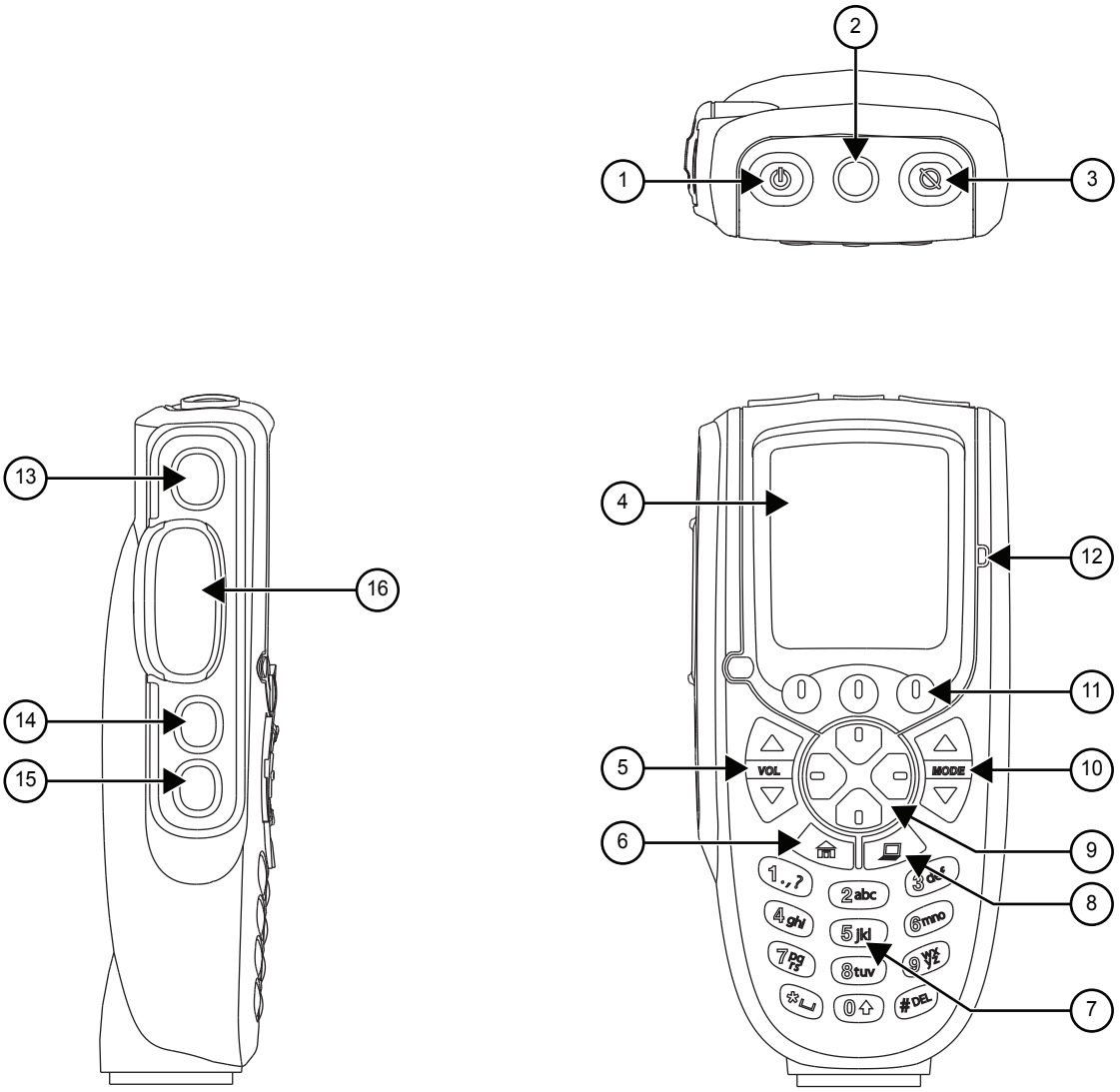
   The versions for CH Firmware, CH FPGA, CH Flashzap, and CH Board are displayed before the unit enters Factory Test.

2. In the **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (4 borders test)
3. After the LCD test, place the Hook Up and remove the Hook Up until Hook Off is shown.
4. Press any button to activate the 32 buttons to test the Keypad Buttons, Side Buttons, and Top Buttons.

   All the 32 Buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD. Radio displays `Test Completed` after all 32 buttons are pressed.

5. Press the **POWER ON/OFF** to turn the control head off.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 14: O3 Control Head



No.	Description
1	Power On/Off Button
2	Orange Button
3	Programmable Button
4	14-Character Display
5	Volume Rocker
6	Home Button
7	Keypad
8	Data Button
9	Navigation Keys
10	Mode Rocker

No.	Description
11	Programmable Soft Keys
12	LED Indicators
13	Programmable Button (Monitor)
14	Side Button 1 (Programmable)
15	Side Button 2 (Programmable)
16	Push-to-Talk Button

5.2.5

O5 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

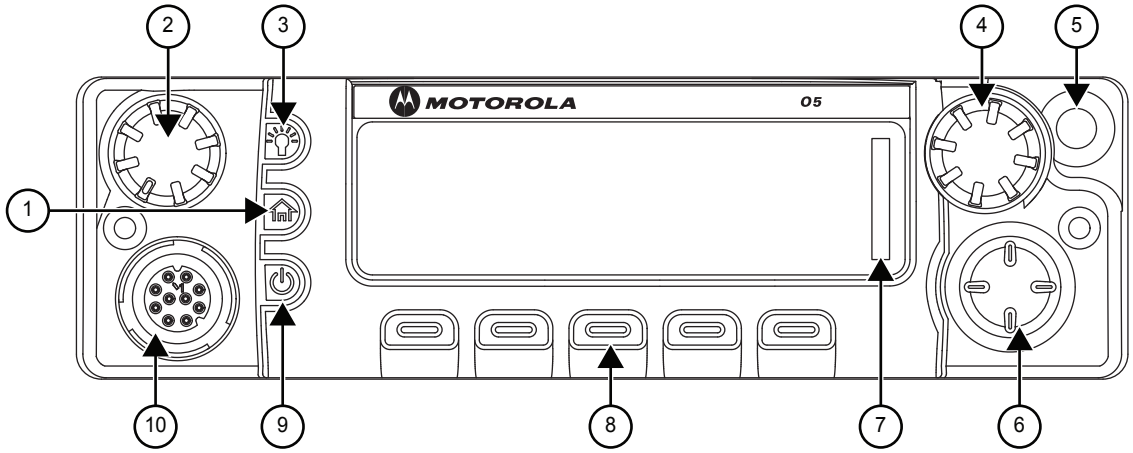
1. After power up, press the **HOME** button five times to enter the **Test Mode** menu.

   NOTE: Once **CH TEST** has been selected by pressing **Home**, turning the **Mode** knob does not change the control head test mode back to the RF test mode. You must turn the radio off and re-enter the RF test mode as described earlier.

2. When the control head test mode has been selected, all the icons across the top of the LCD are displayed briefly. The indicator LED on the right side will also light up briefly. Press any of the control head buttons or turn the knobs to display the button or knob ID. The value of the button or knob is also displayed. The value of a button is 1 for a press and 0 for a release.

3. Turn the radio off and then turn on the radio to exit test mode and return to normal radio operation.

Figure 15: O5 Control Head



No.	Description
1	Home
2	Volume Knob
3	Dim Button
4	Mode Knob

No.	Description
5	Emergency
6	Navigation Keys
7	Indicators
8	Soft Menu Keys
9	Power On/Off
10	MMP Connector

5.2.6
O7 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Power up the control head by pressing the **Power** button. Press the **Menu Select** button **1** and **4** simultaneously to enter control head **STANDALONE TEST**.

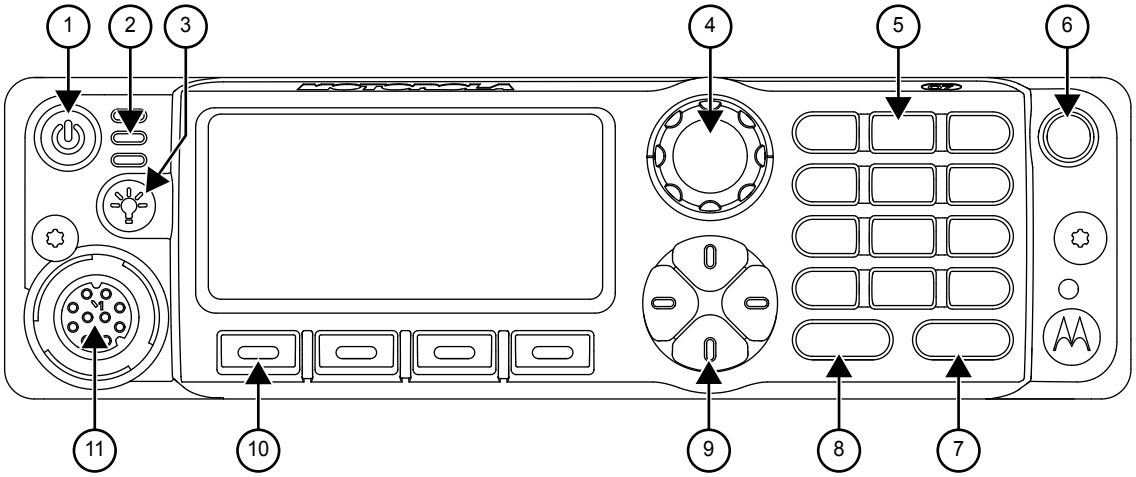
   CH firmware, CH FPGA, CH Flashzap version, and CH Board version are displayed before the unit enters the Control Head Test mode.

2. Press **Home** to enter sequential test.
3. In the **Factory Test** menu, pressing any buttons activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (four borders test)
   - Keypad LED test (green, amber, red, and common white LED test)
4. Press any button to activate the keypad test.

   All the 24 buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD.

5. Press any key to enter the **Multifunction Knob** test after all 24 buttons are pressed.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 16: O7 Control Head



No.	Description
1	Power On/Off Button
2	LED Status Indicators
3	Dim Button
4	Multi-Function Knob
5	DTMF Keypad
6	Emergency Button
7	Data Button
8	Home Button
9	Navigational Keys
10	Menu Select Buttons
11	Accessory Port (Microphone)

5.2.7

O9 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio and is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Power up the control head by pressing the **Power** Button. Press the **Soft Menu Keypad** buttons **2** and **5** simultaneously to enter control head **STANDALONE TEST**.

   CH firmware, CH FPGA version, CH Flashzap version, and CH Board version are displayed before the unit enters the
   Factory Test.

2. Press **Home** to enter sequential test.
3. In **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)

- Backlight test (Off, Medium, and On)
- LCD test (4 borders test)
- Keypad LED test (green, amber, red, and common white LED test)

4. Press any button to activate the keypad test.

   All the 48 buttons notations are displayed on the LCD and once the corresponding button is pressed, the notation disappears from the LCD.

5. Press any key to enter Rotary test after all 48 buttons are pressed. Response selector, Volume rotary, and Channel rotary functionality is tested by turning the knob.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 17: O9 Control Head

No.	Description
1	Programmable Buttons (Top)
2	Power On/Off Button
3	LED Indicators

No.	Description
4	Status Icons
5	Display Backlight Control Buttons
6	Menu Select Buttons
7	Volume Knob
8	Programmable Buttons (Bottom)
9	Home Button
10	Mode Knob
11	Data Feature Button
12	4-Way Navigation Button
13	Keypad
14	Public Address Button
15	Orange Button
16	Directional Buttons
17	Response Selector
18	Siren Control Buttons

5.2.8
E5 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation. For test mode, the control head must be standalone, not connected to brick.

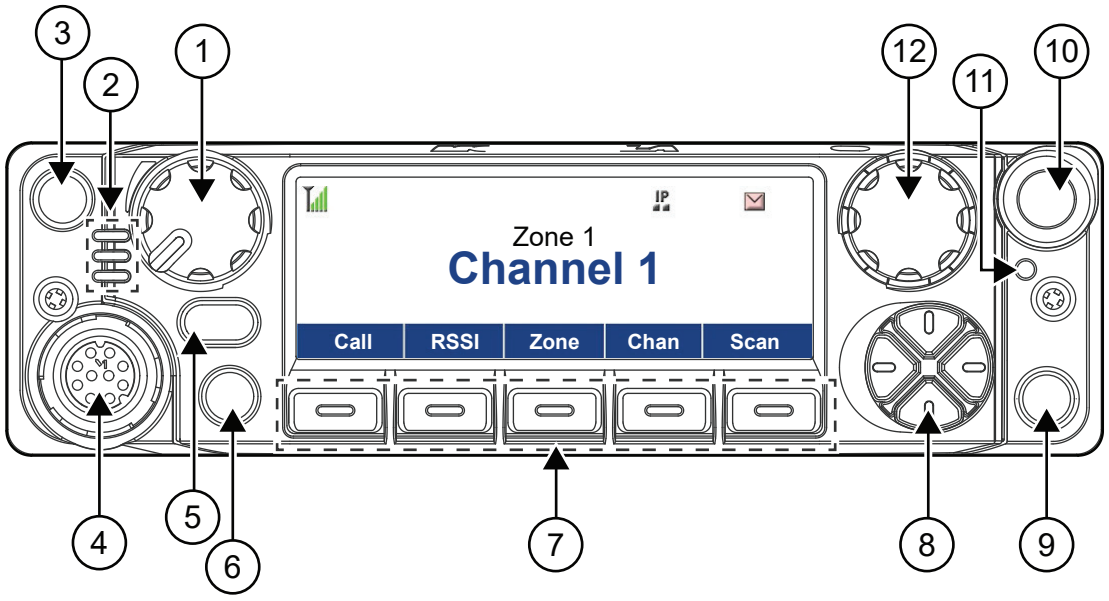
Procedure:

1. Press and hold the **Menu Select Buttons 2** and **Menu Select Buttons 5** simultaneously, then press the **Power** button to enter control head Standalone Test.

   The control head displays CH firmware, CH FPGA, CH Flashzap version, and CH Board version before entering the Control Head test mode.

2. Press **Home** button to enter sequential test.
3. In the **Factory Test** menu, pressing any buttons will activate the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (0%, 3%, 8%, 15%, 22%, 44%, 70%, 94%)
   - LCD test (4 borders test)
   - Keypad LED test (green, amber, red, and common white LED test)
4. Hit any button after this to activate the keypad test. Pressing any of the control head buttons or turning the knobs will display the button or knob ID. The display also shows the value of the button or knob. The value of a button is 1 for a press and 0 for a release.
5. Then press next to enter volume and frequency knob test.
6. Turn the radio off and then turn on the radio to exit test mode and return to normal radio operation.

Figure 18: E5 Control Head



No.	Description
1	Volume Knob
2	Led Status Indicators
3	Power On/Off
4	MMP Connector
5	Dim Button
6	P Button
7	Menu Select Buttons
8	4-Way Navigation Button
9	Home Button
10	Emergency Button
11	Bluetooth Pairing Location Indicator
12	Mode Knob

5.3 Receiver Performance Checks

Table 24: Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON channel test frequency (See RF Test Mode on page 65[1])	TEST MODE, 1 CSQ output at antenna.	Press and hold **PTT** switch.	Maximum Frequency error is ± 2.0 PPM for VHF and UHF

Test Name	System Analyzer	Radio	Test Condition	Comments
	Monitor: Frequency error Input at RF In/Out			± 1.5 PPM for 700/800 MHz and 800/900 MHz
Rated Audio	Mode: GEN Output level: 1.0 mV RF Channel test frequency (See RF Test Mode on page 65[1]) Mod: 1 kHz tone at 1.5 kHz deviation Monitor: DVM, AC Volts 900 MHz: 1 kHz tone at 1.5 kHz deviation	TEST MODE, 1 CSQ. 900 MHz only: Use 12.5 kHz channel spacing	Release **PTT** switch.	Set volume control to 6.45 Vrms across the 3.2 Ω speaker or 7.75 Vrms across the 8 Ω speaker
Distortion	As above, except to distortion	As above	Release **PTT** switch.	Distortion <= 3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12 dB SINAD	As above	Release **PTT** switch.	RF input to be < 0.25 µV (7/800) and < 0.31 µV (VHF, UHF1, and UHF2)
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1 mV RF	As above	Release **PTT** switch.	Set volume control to 3.16 Vrms across the speaker.
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	Out of TEST MODE; select a conventional system	Release **PTT** switch.	Unsquelch to occur at < 0.25 µV

[1] Test frequencies are listed in RF Test Mode

5.4

Transmitter Performance Checks

Table 25: Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON channel test frequency (See RF Test Mode on page 65 [1]) Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ.	Press and hold PTT switch.	Maximum Frequency error is ± 2.0 PPM for VHF and UHF ± 1.5 PPM for 700/800 MHz and 800/900 MHz
Power RF	As above	As above	Press and hold **PTT** switch.	Refer to the Radio Specifications in the front of the manual.
Voice Modulation	Mode: PWR MON first channel test frequency (See RF Test Mode on page 65[1]) attenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Set 1 kHz Mod Out level for 25 mVrms at test set, 80 mVrms at dummy microphone or load box input	As above	Press and hold **PTT** switch.	Deviation: VHF, UHF, 700/800 MHz: >=2.5 kHz but <= 3.5 kHz See the *Detailed Service Manual* for test equipment descriptions.
Voice Modulation External Microphone	Mode: PWR MON first channel test frequency (See RF Test Mode on page 65[1]) attenuation to -70, input to RF In/Out	As above	Connect external microphone. Press and hold **PTT**.	Press **PTT** switch on microphone and say “four” loudly into the radio mic. Measure deviation: VHF, UHF, 700/800 MHz: >= 2.5 kHz but <= 3.5 kHz See the *Detailed Service Manual* for test equipment descriptions.

Test Name	System Analyzer	Radio	Test Condition	Comments
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to channel test frequency (See RF Test Mode on page 65[1]) B/W to narrow	TEST MODE, 1 TPL	Remove modulation input from dummy microphone or load box. Press and hold **PTT** switch.	Deviation: VHF, UHF, 700/800 MHz: >= 500 Hz but <= 1000 Hz See the *Detailed Service Manual* for test equipment descriptions.
Talkaround Modulation (radios with conventional, clear mode, talkaround operation only)	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Set 1 kHz Mod Out level for 80 mVrms at dummy microphone or load box.	Conventional talkaround personality (clear mode operation) 1 CSQ	Press and hold **PTT** switch.	Deviation: VHF, UHF, 700/800 MHz: >= 2.5 kHz but <= 3.5 kHz See the *Detailed Service Manual* for test equipment descriptions.
Talkaround Modulation (radios with conventional, secure mode, talkaround operation only)[2]	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Mod: 1 kHz out level for 80 mVrms at dummy microphone or load box.	Conventional talkaround personality (secure mode operation). Load key into radio 1 sec.	Press and hold **PTT** switch.	Deviation: VHF, UHF, 700/800 MHz: >= 3.6 kHz but <= 4.4 kHz See the *Detailed Service Manual* for test equipment descriptions.

[2] The secure mode, talkaround modulation test is only required for radios that do not have clear mode talkaround capability.

Chapter 6

Radio Alignment Procedures

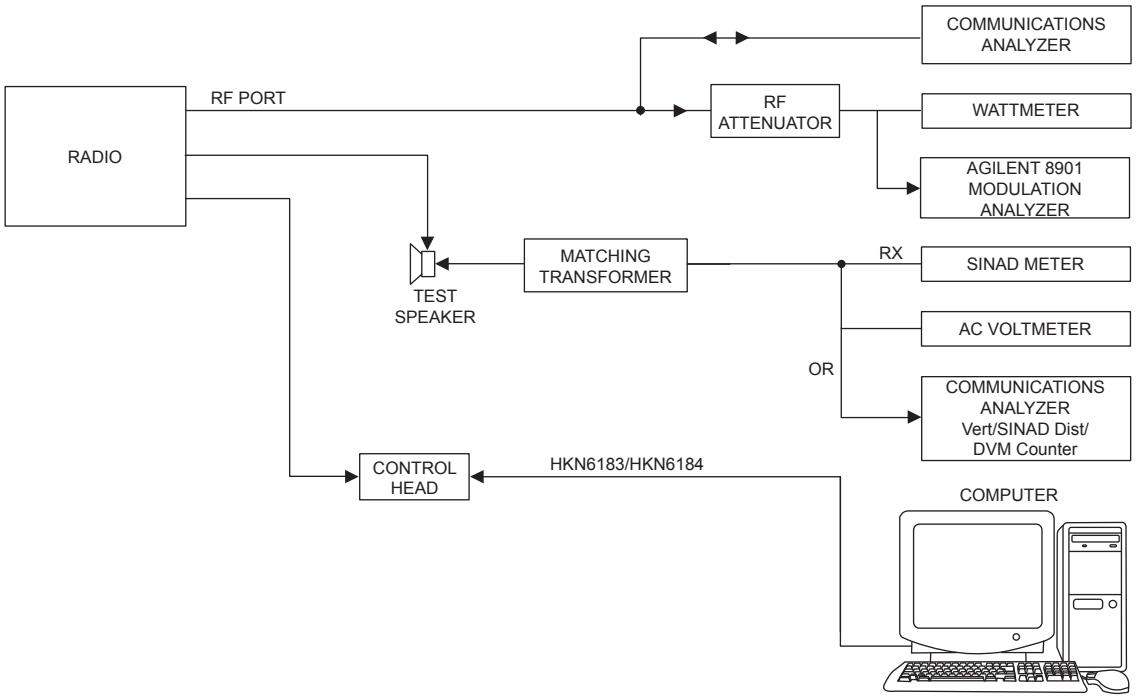
This section describes both receiver and transmitter radio alignment procedures. You are required to perform all the alignments in this section after replacing (or servicing) the transceiver or transmitter boards.

6.1 Navigating the Tuner Program

A personal computer (PC) and Tuner Software are required to align the radio. Refer to the CPS Programming Installation Guide (Motorola Solutions part number RVN5224_) for installation and setup procedures for the software.

Prerequisites: To perform the alignment procedures, the radio must be connected to the computer and to a universal test set, as shown in the following figure.

Figure 19: Radio Alignment Test Setup for Mobile Radios

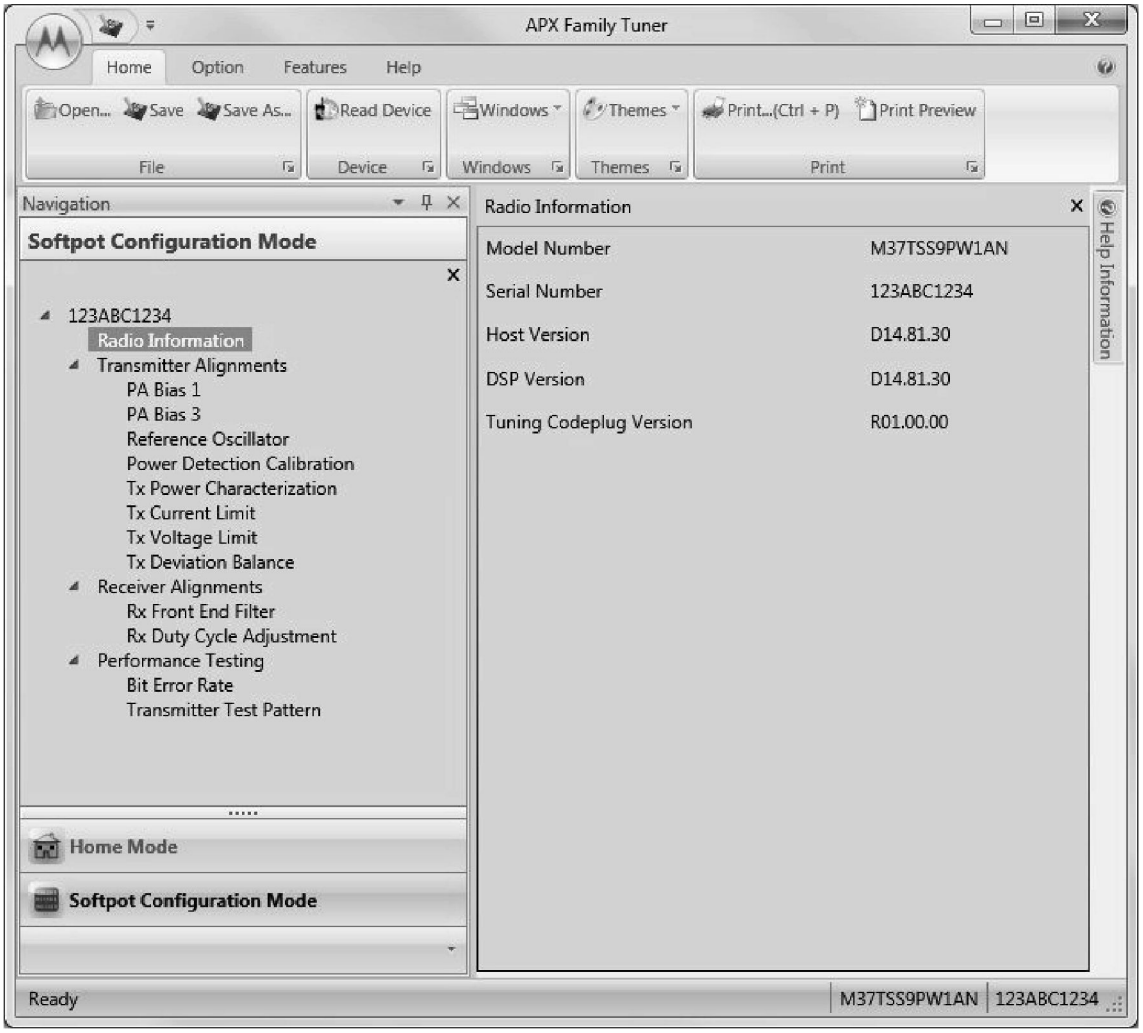


CAUTION: Only qualified service personnel who are operating as an FCC licensed technician or are overseen by an FCC licensed technician can perform the radio alignment procedures. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

Procedure:

1. From the **Start** menu, select **Tuner**.
2. Click the **Read Device** icon to read the radio.
3. Click on the desired screen name in the **Tuner Main Menu** to access a screen.

Figure 20: Tuner Main Menu



CAUTION: Do not switch radios in the middle of any alignment procedure.

4. After completing the alignment procedures, close the **Alignment** window to return to the **Tuner Main Menu**.

   Improper exits from the **Alignment** screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

   The **Alignment** screens utilize the “softpot”, an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all radio alignment controls.

   Use one of the following methods to increase or decrease the softpot value in each **Alignment** screen:

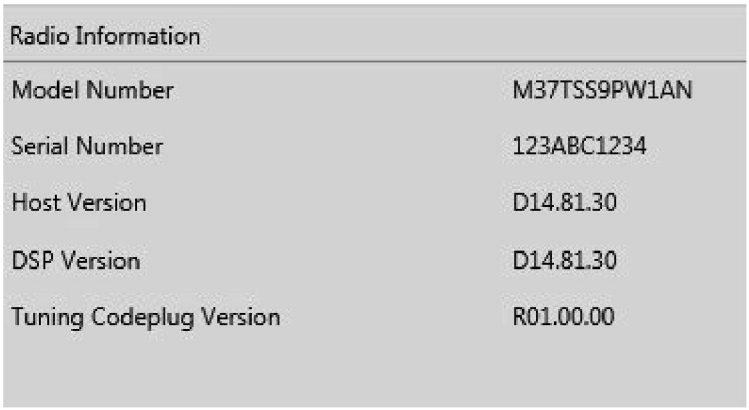
   - Slider
   - Spin buttons
   - Manually enter a new value

   A graphical scale on the display indicates the minimum, maximum, and proposed value of the softpot.

6.2
Radio Information

Figure 21: Radio Information Screen on page 81 shows a typical Radio Information screen. All of the data appearing here is informational and cannot be changed.

Figure 21: Radio Information Screen



6.3
Transmitter Alignments

This section covers the transmitter alignment. The PA Bias 1, 2, and 3 alignment procedures adjust the drain bias current in one of the RF power amplifier devices.

NOTE: Screen captures are representative. Actual screen may change with software version.

6.3.1
Aligning PA Bias 1

Prerequisites:

Table 26: PA Bias 1 Alignment RF Power Amplifier Devices

Band/Power Level	Device
VHF 50 W	Final 1
UHF 45/40/25 W	Final 1
700–800 MHz 35 W	Final 1

NOTE: The appropriate antenna port should be terminated with a 50 Ω load while tuning.

Procedure:

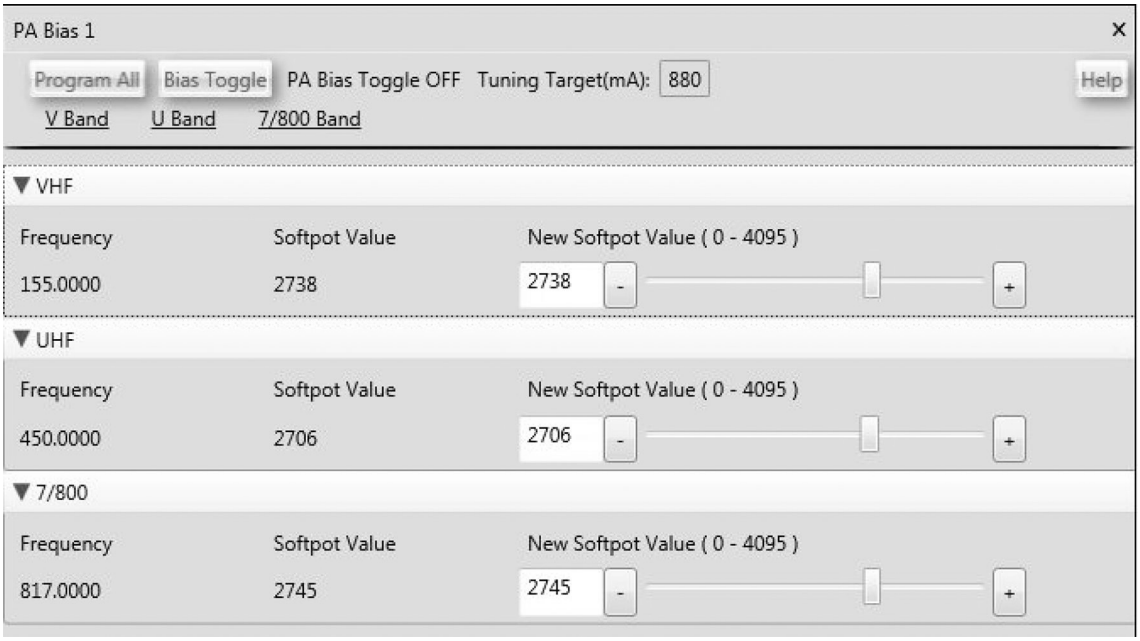
1. Set the power supply voltage as indicated in the following table. Set the power supply current limit to 3 A.

Table 27: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	3
UHF 45/40/25 W	13.6	3
700–800 MHz 35 W	13.6	3

2. Select **PA Bias 1** from the **Tuner Main Menu**.

Figure 22: PA Bias 1 Alignment Screen



When the screen is displayed, the radio enters a special bias tune mode, and radio current increases by approximately 190 mA.

3. Read the baseline current from the current meter on the power supply.
4. Add baseline current to device bias current to calculate the target current.

Table 28: PA Bias 1 Alignment Device Bias Current

Band/Power Level	Device Bias Current (mA)
VHF 50 W	880
UHF 45/40/25 W	650
700–800 MHz 35 W	880

5. Click **Bias Toggle** to apply bias to gate of device.
6. Adjust the softpot value until the target current is achieved within ±10%.
7. Click **Bias Toggle** to remove bias from gate of device.
8. Click **Program All** to save the tuned value.
9. Close the screen to return to the Tuner Main Menu.

6.3.2

Aligning PA Bias 3

Prerequisites:

Table 29: PA Bias 3 Alignment Amplifier Devices

Band/Power Level	Device
VHF 50 W	Driver
UHF 45/40/25 W	Driver
700–800 MHz 35 W	Driver

NOTE: The appropriate antenna port should be terminated with a 50 Ω load while tuning.

Procedure:

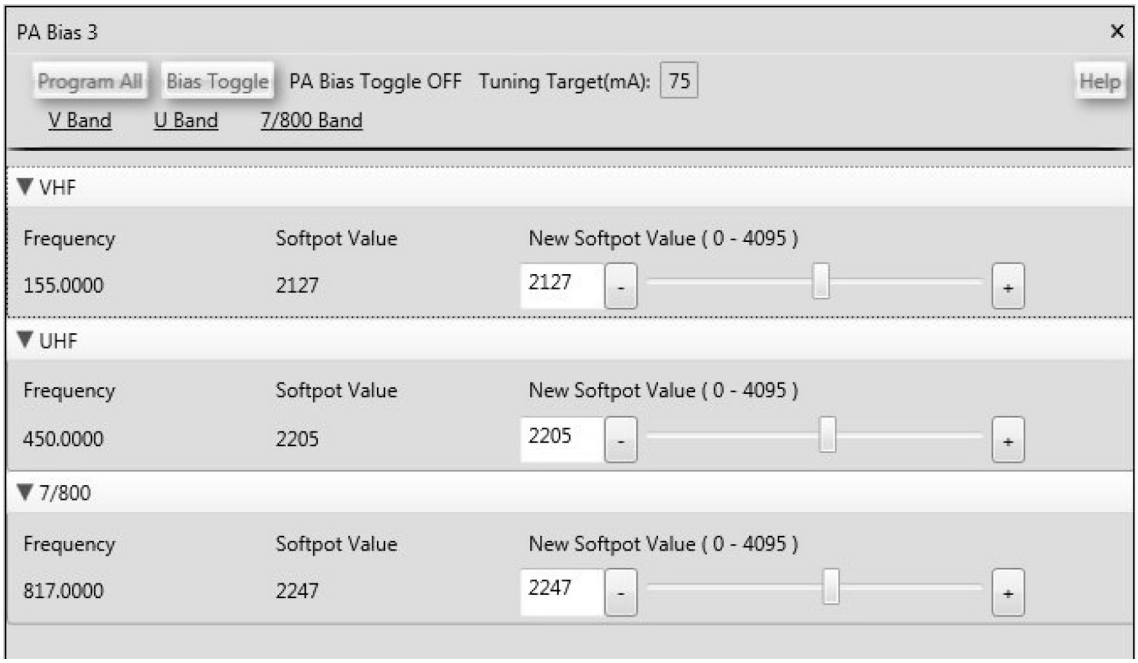
1. Set the power supply voltage as indicated in the following table. Set the power supply current limit to 3 A.

   Table 30: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	3
UHF 45/40/25 W	13.6	3
700–800 MHz 35 W	13.6	3

2. Select **PA Bias 3** from the **Tuner Main Menu**.

Figure 23: PA Bias 3 Alignment Screen



When the screen is displayed, the radio enters a special bias tune mode and the radio current increases by approximately 190 mA.

3. Read the baseline current from the current meter on the power supply.
4. Add baseline current to device bias current to calculate the target current.

Table 31: PA Bias 3 Alignment Device Bias Current

Band/Power Level	Device Bias Current (mA)
VHF 50 W	75
UHF 45/40/25 W	225
700–800 MHz 35 W	300

5. Click **Bias Toggle** to apply bias to gate of device.
6. Adjust the softpot value until the target current is achieved within ±10%.
7. Click **Bias Toggle** to remove bias from gate of device.
8. Click **Program All** to save the tuned value.
9. Close the screen to return to the **Tuner Main Menu**.

6.3.3
Aligning the Reference Oscillator

Radios are shipped from the factory with a worst-case frequency error of ±50 Hz. These specifications are tighter than the more stringent FCC requirements of ±2.0 ppm for VHF and UHF, and ±1.5 ppm for the 700–800 MHz bands.

Prerequisites:

Radios that have been in storage for over six months from the factory ship date requires the reference oscillator to be checked when the radio is deployed to the field. Check the reference oscillator every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in both poor performance and interference with other users operating on adjacent channels.

This procedure should be done with an Aeroflex 3920 service monitor or an acceptable substitute

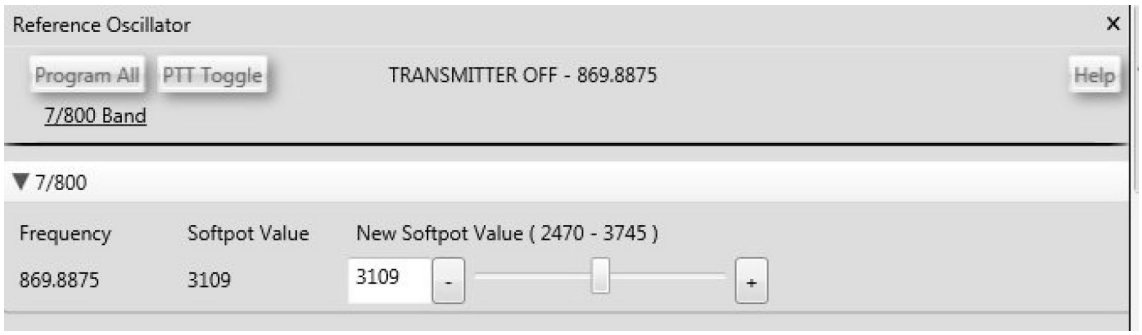
Procedure:

1. Initial setup using the Communication Analyzer:

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 **Reference Oscillator** from the **Tuner Main Menu**.

   Figure 24: Reference Oscillator Window



4. Set the base frequency of the service monitor to the frequency displayed on the Tuner Main Menu.
5. Connect the antenna port to the test equipment (see Figure 19: Radio Alignment Test Setup for Mobile Radios on page 79).
6. Click **PTT Toggle** to make the radio transmit.

   The screen indicates whether the radio is transmitting.
7. Wait five seconds until the analyzer reading stabilizes, then record the transmitter frequency.
8. Adjust the reference oscillator softpot value until the measured value is as close as possible to the frequency shown on the screen. Allow approximately five seconds for the analyzer frequency reading to stabilize after each change. The radio is capable of being tuned within 10 Hz of target frequency.
9. Click **Program All** to dekey the radio and save the tuned values.
10. Close the screen to return to the **Tuner Main Menu**.

6.3.4

Aligning the Power Detector Calibration

The power detector calibration alignment procedure adjusts the buffer gain for the forward power detector to minimize radio power variation from radio to radio.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

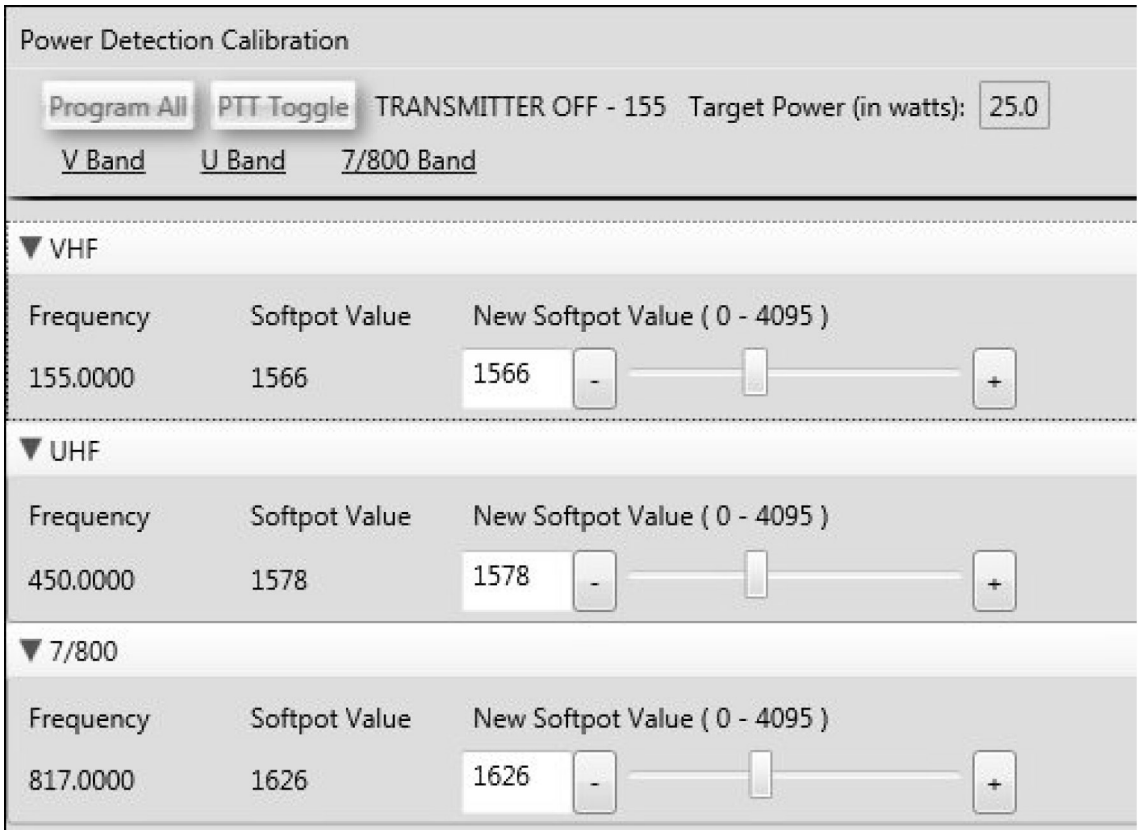
1. Set the power supply voltage and current limit as indicated in the following table.

Table 32: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	15
UHF R2 45 /40/25 W	13.6	15

2. Select **Power Detection Calibration** from the **Tuner Main Menu**.

Figure 25: Power Detection Calibration Alignment Screen



3. Click **PTT Toggle** on the screen to make the radio transmit.
4. Adjust the softpot value until the target power is achieved.
5. Click **PTT Toggle** to disable transmit mode.

6. Click **Program All** to save the tuned value.
7. For dual band radio, switch antenna port and repeat the alignment procedure for the second frequency displayed in the tuning screen.
8. Close the screen to return to the **Tuner Main Menu**.

6.3.5
Aligning the Transmit Power Characterization

The Transmit (Tx) Power Characterization alignment procedure characterizes power tuning so that Tx power can be adjusted with the CPS software. The radio transmits at two power levels for each test frequency and you are required to record the measured power level with 0.1 W resolution.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

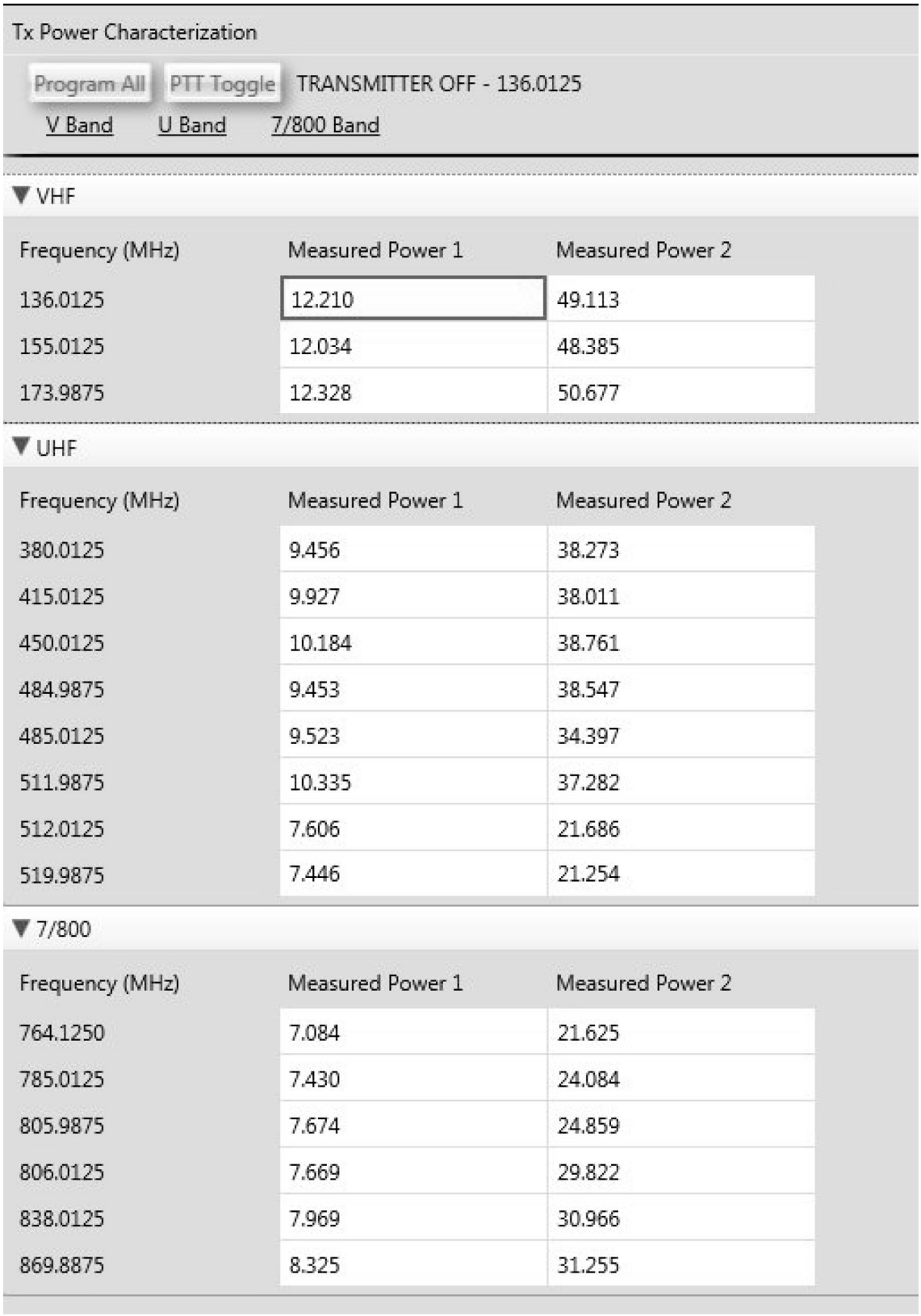
1. Set the power supply voltage and current limit as indicated in the following table.

Table 33: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	15
UHF R2 45/40/25 W	13.6	15

2. Select **Tx Power Characterization** from the **Tuner Main Menu**
.

Figure 26: Tx Power Characterization Alignment Screen



3. Click the first box of the Measured Power 1 column.

   The perimeter of the box turns green indicating active characterization point.

4. Click **PTT Toggle** to transmit at the indicated frequency, then record the power measurement with 0.1 W resolution.

   The perimeter of the box turns red, indicating that the radio is transmitting.

5. Click the **PTT Toggle** button to disable transmit mode.
6. Enter the power measurement with 0.1 W resolution, overwriting any value that may reside in the box from previous tuning.
7. Repeat step 3 through step 6 for Measured Power 2.
8. Repeat step 3 through step 7 for all frequencies.
9. Click **Program All** to save the tuned value.
10. Close the screen to return to the **Tuner Main Menu**.

6.3.6
Aligning the Transmit Current Limit

The Transmit (Tx) Current Limit alignment procedure tunes the Tx current-limiting protection.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

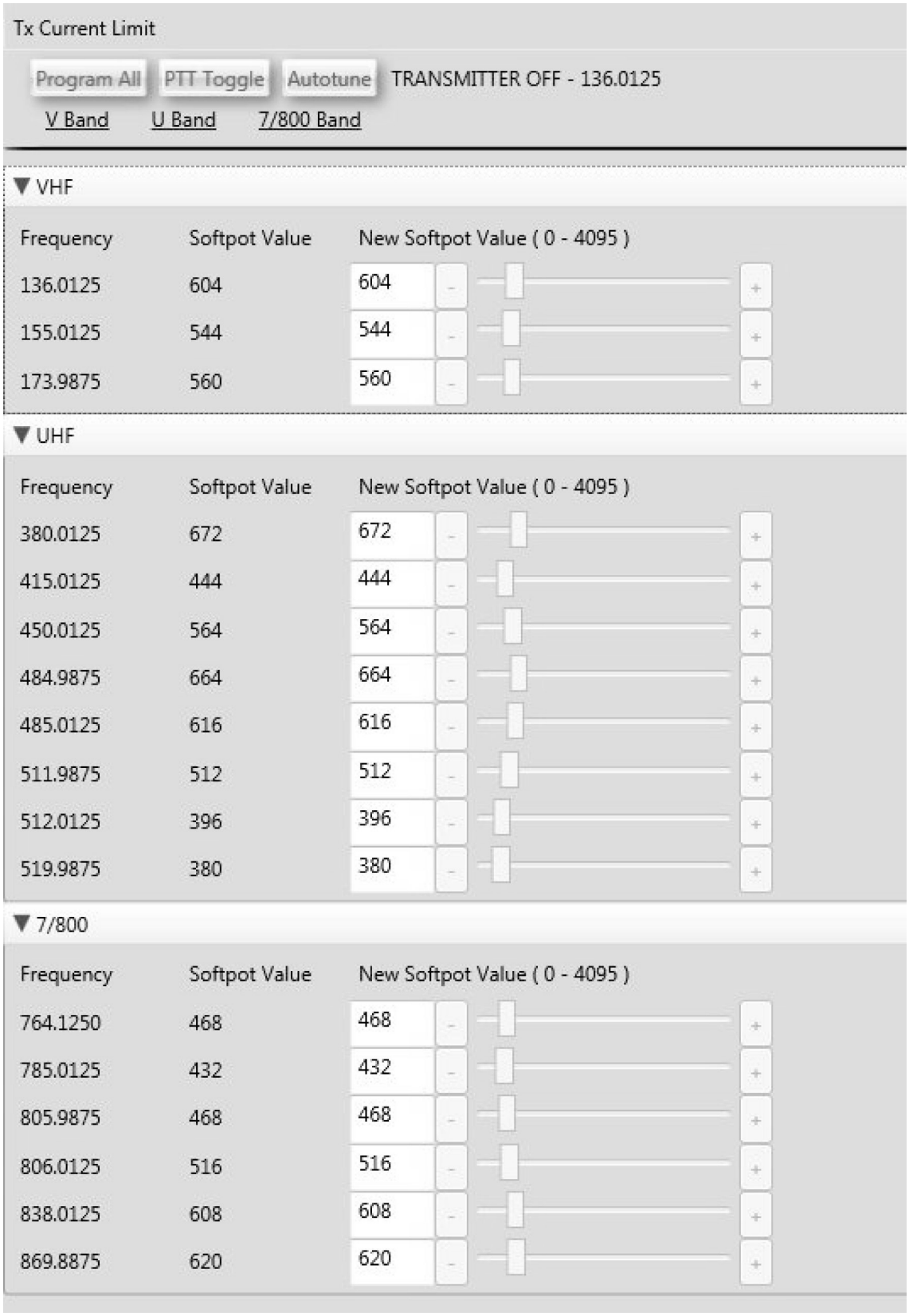
1. Set the power supply voltage and current limit as per the following table.

   Table 34: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	15
UHF R2 45/40/25 W	13.6	15

2. Select **Tx Current Limit** from the **Tuner Main Menu**.

Figure 27: Tx Current Limit Alignment Screen



3. Select the first test frequency to tune.

4. Click **PTT Toggle** to transmit at the indicated frequency.
5. Click **Autotune**.
6. Repeat step 3 through step 5 for all test frequencies.
7. Click **Program All** to save the tuned values.
8. Close the screen to return to the **Tuner Main Menu**.

Table 35: Transmit Current Limit Devices

Band/Power Level	Devices	
VHF 50 W	Final 1	Driver
UHF R2 45/40/25 W	Final 1	Driver
700–800 MHz 35 W	Final 1	Driver

6.3.6.1

Aligning the Transmit Voltage Limit

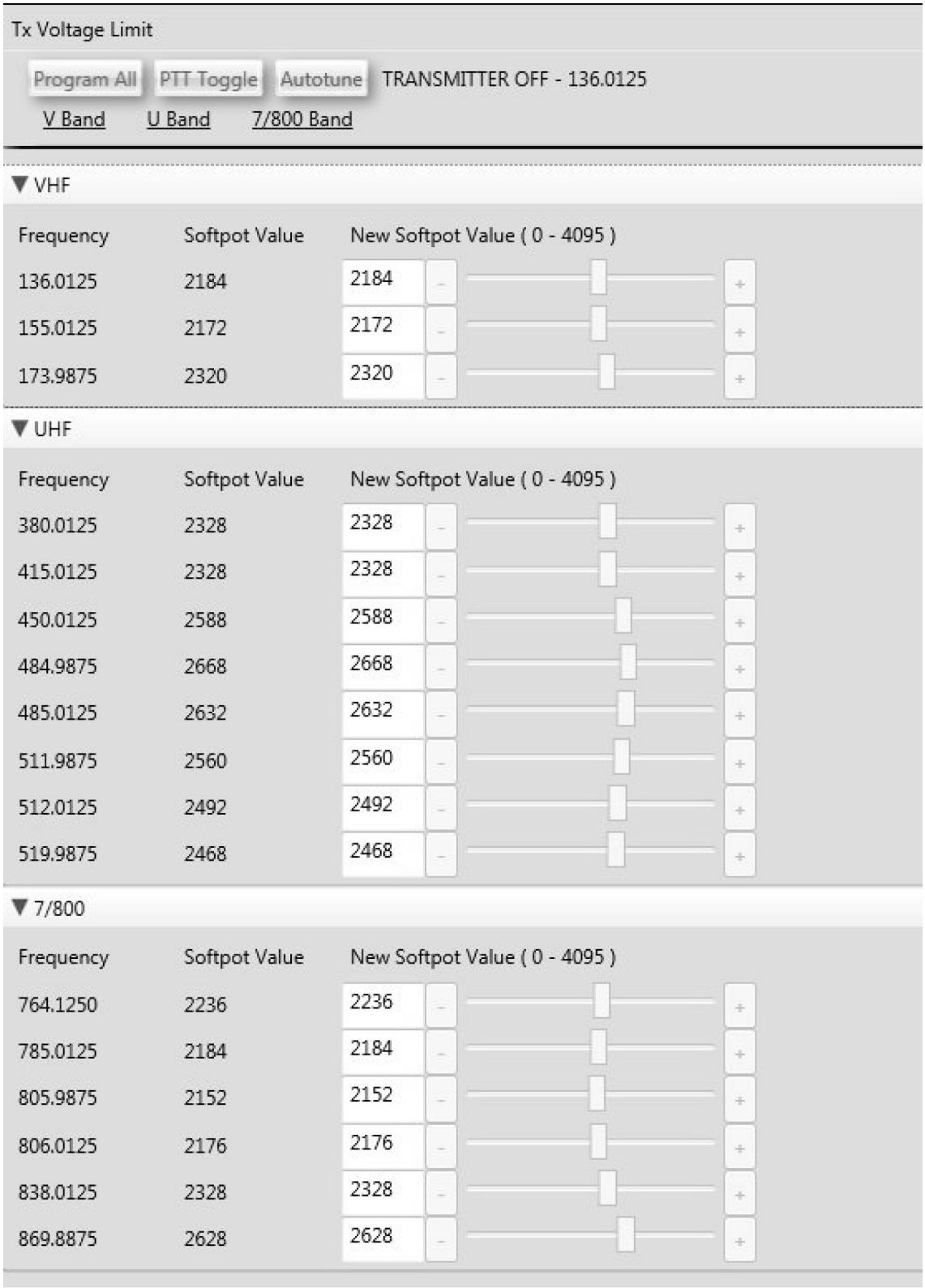
The Transmit (Tx) Voltage Limit alignment procedure tunes the Tx control voltage limiting protection.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

1. Set the power supply voltage and current limit as per the following table.
2. Select **Tx Voltage Limit** from the **Tuner Main Menu**.

Figure 28: Tx Voltage Limit Alignment Screen



3. Select the first test frequency to tune.
4. Click **PTT Toggle** to transmit at the indicated frequency.

5. Click **Autotune**.
6. Repeat step 3 through step 5 for all test frequencies.
7. Click **Program All** to save the tuned values.
8. Close the screen to return to the **Tuner Main Menu**.

6.3.7

Aligning the Transmit Deviation Balance (Compensation)

The Transmit (Tx) Deviation Balance (Compensation) 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 low frequency components (for example, DPL). If improperly adjusted, it could result in distorted waveforms.

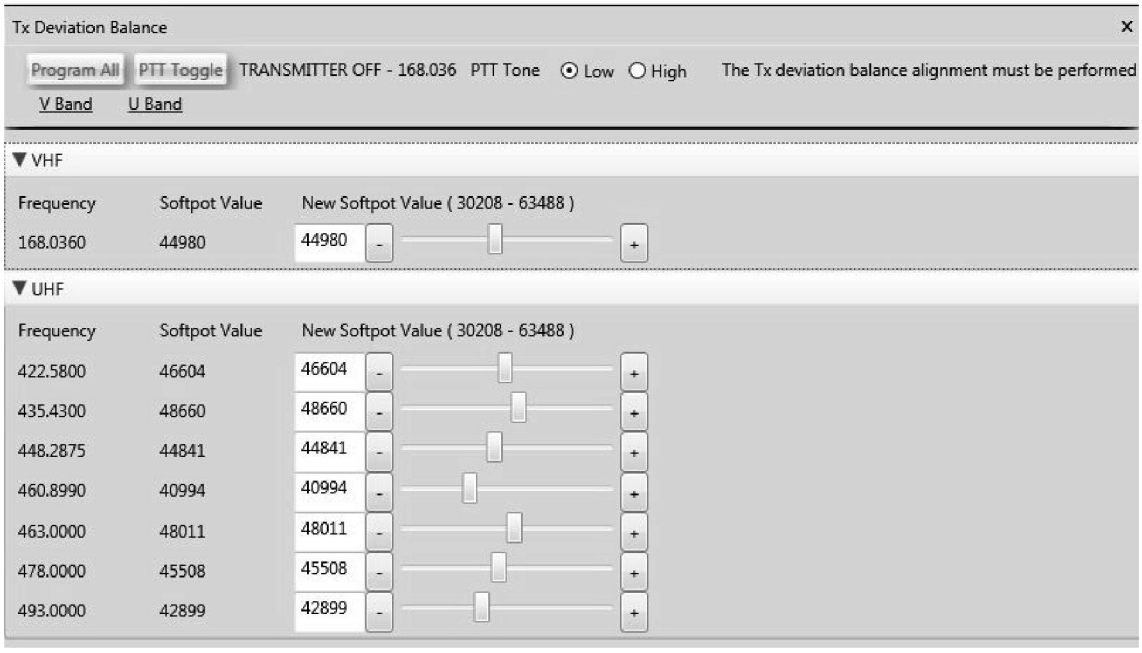
Prerequisites:
Perform this procedure at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone. When performing this tuning procedure, the PTT Tone Low generates a 300 Hz modulation frequency. The deviation level of this 300 Hz tone is used as the reference level for adjusting the deviation level of the PTT Tone High, which is a 3 kHz modulation frequency.

This procedure should be done with an Aeroflex 3920 service monitor or an acceptable substitute.

Procedure:

1. Select **Tx Deviation Balance (Compensation)** from the **Tuner Main Menu**.

   Figure 29: Tx Deviation Balance (Compensation) Alignment Screen



   The screen indicates the transmit frequencies to be used.

2. Connect the antenna port to the test equipment. See Figure 19: Radio Alignment Test Setup for Mobile Radios on page 79.
3. Click the first frequency field.

4. Click **Low** for PTT Tone.
5. Click **PTT Toggle** to transmit.

   The screen indicates whether the radio is transmitting. Wait approximately 5 seconds until the voltage or the deviation shown on the service monitor stabilizes.
6. Measure and record the AC voltage value or the deviation value from the service monitor.
7. Click **High** for PTT Tone.
8. Adjust the softpot value until the measured deviation/voltage when using high tone is within ±0.2% of the value observed when using low tone.
9. Repeat step 4 through step 8 for the remaining frequencies.
10. Click **Program All** to dekey the radio and save the tuned values.

6.4 Receiver Alignments

6.4.1 Front End Filter Alignment

The alignment procedure adjusts the front-end receiver bandpass filters for the best receiver sensitivity and selectivity.

CAUTION: Only qualified service technicians can peform this procedure.

Perform this procedure for all test frequencies to allow proper software interpolation of frequencies between the test frequencies in the band.
See Figure 30: RX Front-End Filter Alignment on page 95.

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

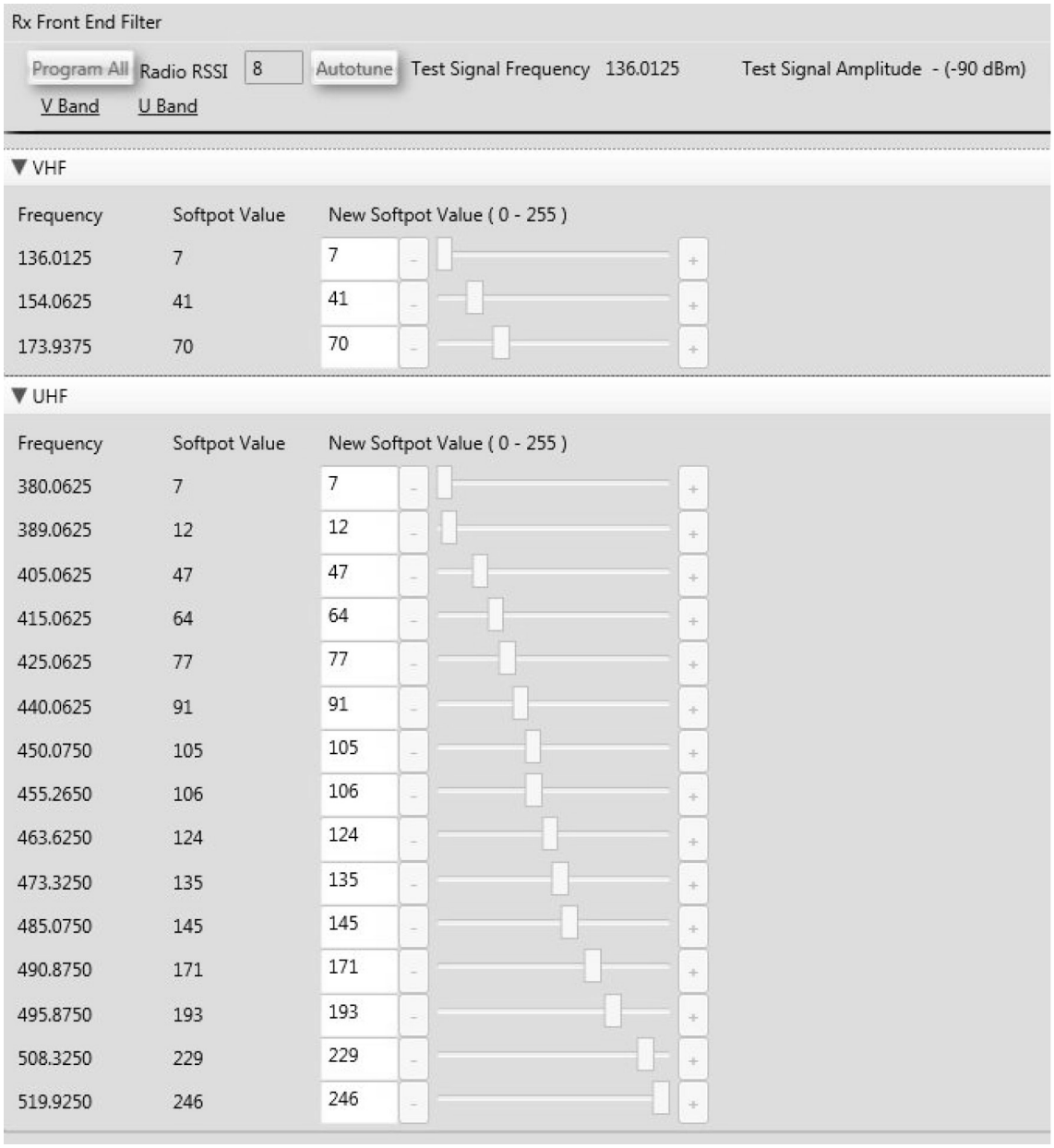
6.4.2 Tuning Procedure for VHF, UHF1 and UHF2 (Auto Tune)

Tuning of the radio is conducted from the Rx Front End Filter tuning screen.

Procedure:

1. Select the **Rx Front-End Filter** alignment screen. See Figure 30: RX Front-End Filter Alignment on page 95.
2. To select the required frequency to tune, click on the slider or the **New Softpot Value** text box.
3. Apply RF test signal input with no modulation at -90 dBm on the Test Signal Frequency.
4. Click the **Autotune** button.
5. Repeat step 2 to step 4 for all frequencies.
6. To save the tuned values in the radio, click the **Program All** button on the screen.

Figure 30: RX Front-End Filter Alignment



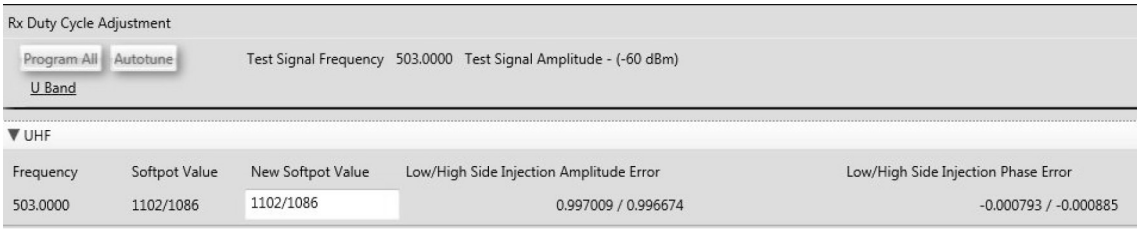
6.4.3

RX Duty Cycle Adjustment

Procedure:

1. Select the **Rx Duty Cycle Adjustment** screen.
2. Apply RF test signal input with no modulation at -60 dBm on the Test Signal Frequency displayed at the top of the screen.
3. Click **Autotune**.

Figure 31: RX Duty Cycle Adjustment AutoTune



4. Click **Program All** to save the tuned values in the radio.

6.5 Performance Testing

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

6.5.1 Bit Error Rate (BER) Test

This procedure tests the Bit Error Rate (BER) of the radio receiver at a desired frequency.

Figure 32: Bit Error Rate Screen

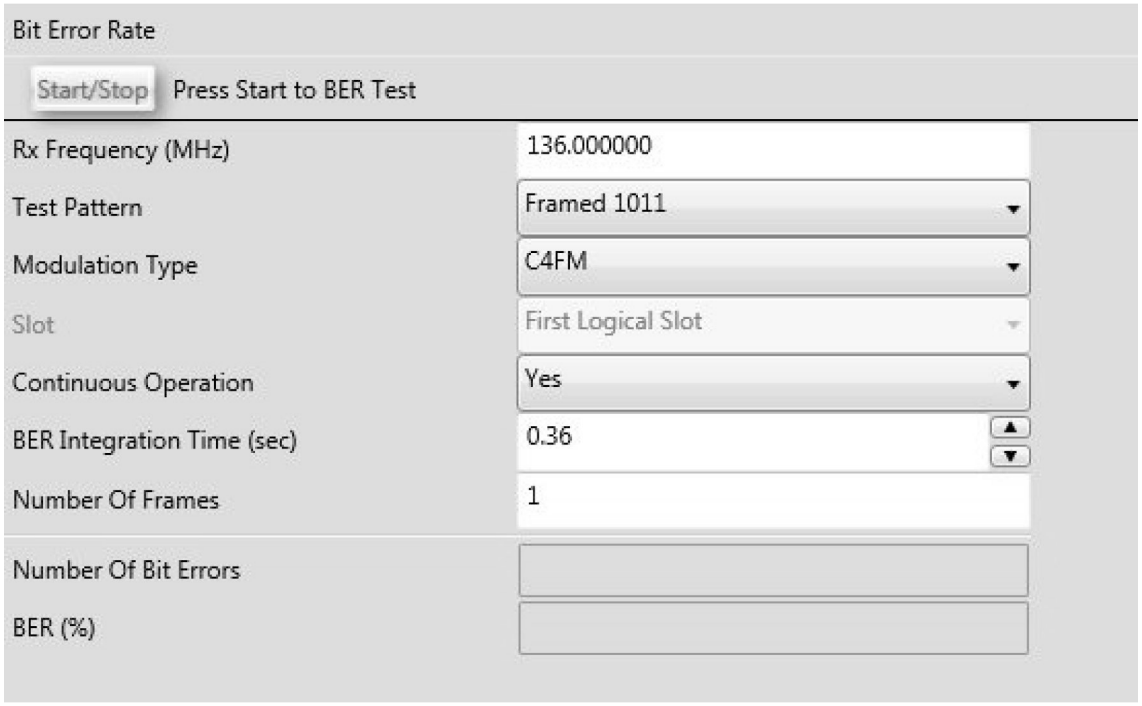


Table 36: Bit Error Rate Test Fields

Field	Description
Rx Frequency	Selects the Receive Frequency in MHz.
Test Pattern	Selects the Digital test pattern - TIA.

Field	Description
Modulation Type	Selects the digital modulation type of the incoming signal on which BER is to be calculated.
Continuous Operation	Allows the user to adjust the number of test repetitions. A selection of **Yes** causes the radio to calculate BER on a continuous basis indefinitely and update the results on this screen after each integration time. A selection of **No** causes the BER test to execute only one sample and then update the display. **NOTE:** When Continuous Operation = **Yes**, all fields are dimmed while the test is in progress. They are enabled when the test is complete, or if 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.
Audio	Allows the user to select the audio output during a test. Selecting **External** routes the same signal to the radio accessory connector audio output. Selecting **Internal** is not supported. Selecting **Mute** disables the audio output.
BER Integration Time	Represents the amount of time during which the Bit Error Rate is to be calculated. Remember that integration over a longer time period results in a more precise measurement, at the expense of more time per measurement. **NOTE:** This is especially useful in fading measurements. The range is from 0.360 to 91.8 seconds in increments of 0.360 seconds.

6.5.2
Transmitter Test Pattern

This procedure allows you to generate test patterns at selectable frequencies and channel spacing to check the transmitter.

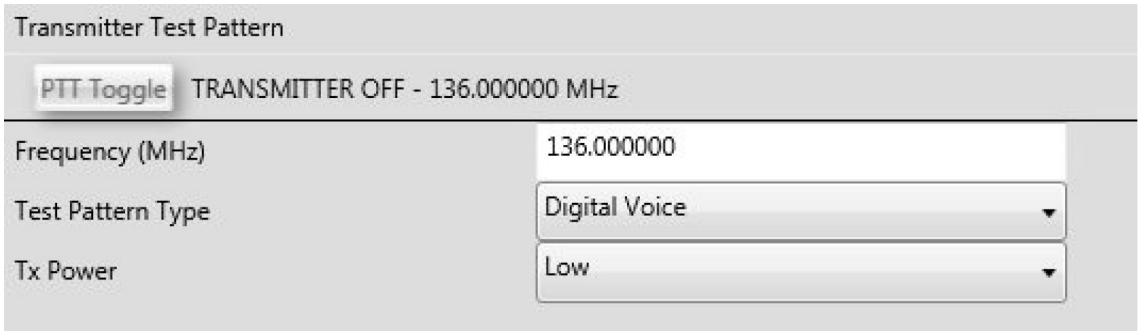
The procedure contains the fields described in the following table.

Table 37: Transmitter Test Pattern Fields

Field	Description
Tx Frequency	This field selects the Transmit Frequency directly in MHz.
Channel Spacing	This field allows you to select the desired transmit deviation in kHz.
Test Pattern Type	This field represents the type of test pattern that is transmitted by the radio when **PTT Toggle** is clicked.

NOTE: Test Pattern Type field is dimmed while the radio is transmitting.

Figure 33: Transmitter Test Pattern Screen



Chapter 7

Encryption

This chapter describes the encryption capability of your radio.

7.1 Motorola Advanced Crypto Engine Secure Options

NOTE: This information applies to both conventional and trunked systems.

The controller section contains the MACE (Motorola Advanced Crypto Engine) which encrypts and decrypts voice and data. MACE is a custom encryption IC and uses an encryption key variable to perform its encode or decode functions. The encryption key variable is loaded into the MACE using a key variable loader (KVL). Refer to the key-variable loader (KVL) manual for equipment connections and setup.

7.1.1 Secure Key Retention

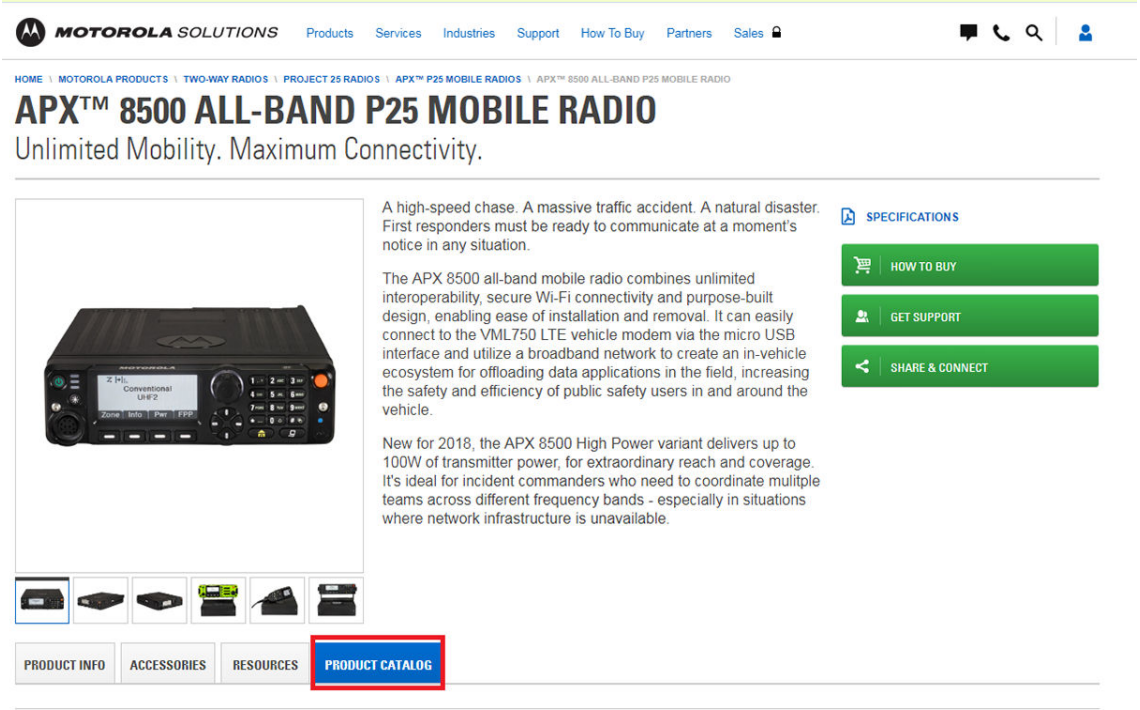
The radio comes with a standard 10 minutes or infinite key retention (CPS setting).

Table 38: Controller Boards with Programmed Secure Algorithms

Kit Number	Description
NNTN8905_	Controller board, APX8500 UCM
NNTN8906_	Controller board, AES/DVP-XL encryption
NNTN8907_	Controller board, DVP-XL encryption
NNTN8908_	Controller board, ASSY, APX, AES/DES/DES-XL/ DES-OFB encryption
NNTN8909_	Controller board, ASSY, APX, AES encryption
NNTN8920_	Controller board, APX, DES/DES-XL/DES-OFB encryption
NNTN8922_	Controller board, APX, ADP encryption

Refer to the PCAT (Product Catalog) for the various kit numbers required to program secure algorithms.

Figure 34: PCAT (Product Catalog) Portal



Refer to Replacement Parts Ordering on page 216 for customer support in identifying kit numbers.

7.1.2

Toggling Secure Dispatch Operation

This feature is for personalities or talkgroups that are programmed to secure-selectable.

Procedure:

To toggle between secure or clear, press the programmed **Secure** button.

Result:

- An illuminated secure status annunciator indicates that the transmitted signal is encrypted when the PTT button is pressed.
- The absence of the secure status annunciator indicates that the transmitted signal is not going to be encrypted.

The secure status annunciator displays the transmit operation as either secure (encrypted) or clear (nonencrypted).

NOTE: You cannot change from secure to clear while the PTT button is pressed. The radio generates an illegal tone and the transmission is terminated.

Secure-equipped radios automatically determine whether a secure or clear voice message is being received.

You receive either type of messages without having to reset the programmable secure button.

7.1.3

Secure Emergency Operation

Clear or Secure emergency-call operation is determined by the selected mode, talkgroup, or the default emergency mode.

The transmit operation is controlled by the setting of the secure programmable button.

During an emergency call, you are not able to change from Secure to Clear, or from Clear to Secure operation.

7.2 Loading an Encryption Key

To load an encryption key into an APX mobile radio:

Procedure:

1. Ensure proper encryption algorithm has been flashed into the radio. (DES_XL, DES-OFB, AES256, and others)
2. Load an encryption key into the radio memory from a key-variable loader (KVL) using the correct loader for the radio encryption type.
3. Attach the keyloader cable to the control head MMP connector in the dash mount configuration and to the TIB MMP connector in the remote mount configuration.

   `KEYLOADING` is displayed on the radio display while the key transfer is in progress.

   For single-key radios, a short tone sounds when a key is successfully loaded.

   For multi-key radios, an alternating tone sounds for a few seconds after keys are successfully loaded.

   NOTE: An invalid encryption key aborts a secure transmission. Radio displays `KEYFAIL` and a keyfail tone (consecutive medium-pitched beeps) sounds until you release the **PTT** button.

4. If a mode is not programmed for either secure or clear-only operation, use the secure programmable button to select secure or clear transmission.

   NOTE: You cannot change from secure to clear, or from clear to secure, while pressing the **PTT** button.

7.3 Advanced Secure Operation

NOTE: The Advanced Secure feature is available only on radios that have been equipped by the factory to support it.

Advanced Secure incorporates the Multikey feature and a dual-encryption feature into the existing secure system. Multikey allows a radio to be equipped with multiple encryption keys. A default key is included and is associated with the current mode. The keys are strapped to a given mode or are operator-selectable and can be indexed into groups of keys called keysets. The keys are loaded using a manual keyloader.

In addition, your radio can support up to eight different encryption algorithms simultaneously.

7.3.1 Multikey Operation

Multikey applies for conventional and trunking.

Conventional

The encryption keys can be selectively strapped in each channel. Encryption keys are loaded into the radio through a KVL. The programmable radio features include operator-selectable keys, indices, and key erasure.

Trunking

Strap the encryption keys for trunking on a talkgroup or announcement group if the radio also uses conventional features. A different encryption key can be strapped to other features:

- Private Call
- Dynamic Regrouping
- Failsoft
- Interconnect
- System Wide
- Emergency talkgroup

7.4
Selecting Encryption Keys or Keysets

NOTE: The user navigation in this section might be different for every control head. Please refer to the respective control head user guide. See Related Publications.

Procedure:

1. Press either menu button labeled KEY or KSET if available on the display menu. Alternatively, press and hold the menu button labeled SEC until a tone sounds.
2. Then press the menu button labeled KEY to select a single key or KSET to select a keyset on the second menu that is displayed. The display shows the last user-selected and properly stored encryption key available.
3. Use the **NAV** key to scroll through the encryption keys until the key or keyset desired is displayed. If the desired key is erased the display flashes ERASED KEY and the key name alternately.
4. If a good key then Press **Select**.

Result:

- 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.

7.5
Erasing Keys

NOTE: The user navigation in this section might be different for every control head. Please refer to the respective control head user guide. See Related Publications.

Procedure:

1. Press the menu button labeled ERAS. Alternatively, press and hold the menu button labeled SEC until a tone sounds. Then press ERAS on the second menu that is displayed.
2. Use the **NAV** key to scroll through the encryption keys until the key to be erased is displayed. Alternatively, if a keypad microphone is used, press the numeric keys to jump to the desired encryption key.
3. Press the menu button labeled SNGL to erase the selected key.

4. Press the menu button labeled YES.

   The selected key is set to zero.

   ERASED is alternately displayed with the key name confirming the erasure.

5. To exit the menu without erasing a key, press the menu button labeled **ABRT**, the **PTT** button, or the **Home** button.

7.6 Erasing All Keys

NOTE: The user navigation in this section might be different for every control head. Please refer to the respective control head user guide. See Related Publications.

Procedure:

1. Press the menu button labeled ERAS. Alternatively, press and hold the menu button labeled SEC until a tone sounds. Then press ERAS on the second menu that is displayed.
2. Press the menu button labeled ALL.

   ERASE ALL KEYS is displayed.

3. Press the menu button labeled YES. All keys are erased.

   ERASED KEY is alternately displayed with the displayed key name confirming the erasure.

4. To exit the menu without erasing a key, press the menu button labeled **ABRT**, the **PTT** button, or the **Home** button.

7.7 Over-the-Air Rekeying

The Over-the-Air Rekeying (OTAR) feature allows the dispatcher to reprogram the encryption keys in the radio remotely.

NOTE: For more information, refer to the respective Control Head User Guide. See Related Publications.

Procedure:

1. Press the programmed **REKY** button.
2. Alternatively, press and hold the programmed **SEC** until a tone sounds.
3. Press the programmed **REKY** button.

   NOTE: Use the **NAV** key to scroll through the menus.

   REQUEST REKEY is displayed.

4. Press the **PTT** button to send the rekey request.

   `PLEASE WAIT` is displayed.

Result:
If the operation is successful, your radio shows one of the following indications:

- The radio sounds five tones when the dispatcher has received the request.

  NOTE: To exit the feature, perform one of the following actions:
  - Any subsequent press of the **PTT** button.
  - Press the **HOME** button.
  - Press the **Emergency** button.

- The display momentarily shows `REKEYED`.

If the operation is unsuccessful, your radio shows one of the following indications:

- The display momentarily shows `REKEY FAIL` and the bad-key tone sounds. This is because the radio does not contain the Unique Shadow Key (USK) or Unique Key Encryption Key (UKEK). You have to load the USK into the radio using the KVL before the radio can be reprogrammed over the air.

  NOTE: If you exit but stay on the current channel in the dispatch mode, your radio shows the following indications:
  - A tone sounds indicating the status of the rekey request.
  - The display shows `REKEYED` or `DENIED`.

- The display shows `NO ACK` and the bad-key tone sounds. Then, the dispatcher has not acknowledged your request after the radio has tried five times to send it. The radio returns to the display message in step 1, allowing you to retry the request.
- The display momentarily shows `DENIED` and the bad-key tone sounds. This means that the request has been denied by the dispatcher, and the radio returns to the home display.

Chapter 8

Disassembly/Reassembly Procedures

This section details the procedures necessary to remove and replace the printed circuit boards in APX mobile radios. After troubleshooting and determining what needs to be replaced, disconnect the test equipment, the antenna cable, and the power cable.

WARNING: Disconnect the power cable from the radio before opening and removing the PCB. Failure to remove power can result in unit damage caused by transients or accidental shorts, as well as presenting a shock hazard.

Locate the exploded view of the radio in Exploded Views and Parts Lists on page 181. Keep it handy for reference as you disassemble and reassemble the radio.

When installing a new circuit board, all mounting screws should be started before any are torqued. This will help ensure proper alignment.

After installing a new board, perform a complete alignment procedure as outlined in Radio Alignment Procedures on page 79.

8.1 Replacement Procedures

After performing alignment procedures, always exit the SERVICE menu entirely (to the MAIN MENU) to properly save all changes. Failure to do so can result in an alignment or other failure.

8.1.1 Required Tools and Supplies

Table 39: Required Tools and Supplies

Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
8 mm, 10 mm, 15 mm, 25 mm, and 28 mm Hex Nut bits	–	–
Anti-static grounding kit	–	–
Flat-blade screwdriver	–	–
Long Nose Plier	–	–
Magnetic screwdriver set with bits	0180320B16	–
Mini-UHF to N-type adapter cable	3085651A01	–
Net Runner M8	–	–
Philips PH2 screw bit	–	–
Plastic scraping tool	6686119B01	–
Removal and insertion tool	6680163F01	–

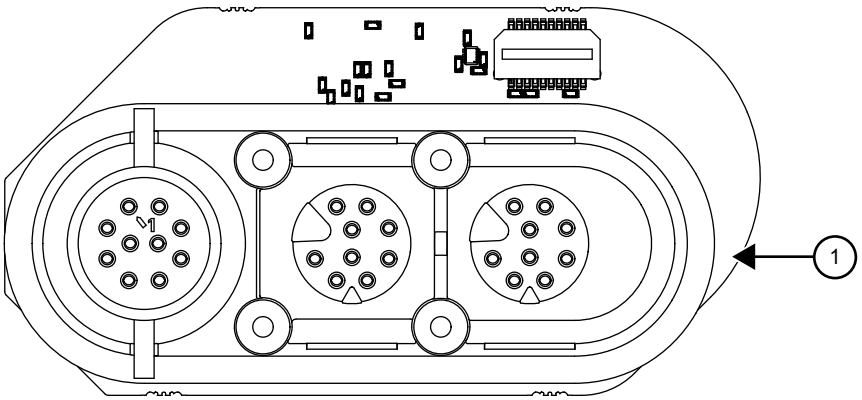
Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
Roto-Torq adjustable driver	–	RSX4043
Small, flat-blade screwdriver	–	–
Solder aid (black stick), HEXA-CON	–	MA-800G
Tohnichi 6RTD-A Analog Torque Driver (1-6 in-lbs)	–	–
Torx® bits for T8 for TIB; T10 for PCB; and T20 for cover screws; 9 mm thin wall, deep socket for all antenna connector nuts.	–	–
9 mm Hex Nut Bit (for GPS and QMA connector)	–	–
Tweezers	–	–
Wire Stripper	–	–
O2/O7 Knob Removal Tool	66012035001	–
Electromagnetic Interference (EMI) metallic shielding tape, or equivalent	–	–
QMA to QMA	CB000091A02	–
QMA to Mini-UHF	CB000091A03	–
QMA to SMA	CB000091A04	–
QMA to N-Type	CB000091A05	–

8.1.2
Transceiver Interface Board Disassembly/Reassembly

The Transceiver Interface Board (TIB) is not field serviceable. Note that the TIB seal part number is SL000048A01.

NOTE: If the screws are loosened, tighten to 6–8 inch-lbs. Over-torque of the screws can result in warping of the circuit board and possible board damage.

Figure 35: TUC Seal Placement



1	TIB Seal

CAUTION: Never attach or remove a flex with power supplied to the radio. Also, take care to avoid misalignment of Flex connector pins upon re-attachment. Failure to remove power or align properly can result in electrical shorting of the circuit board and possible component damage.

8.1.3
Radio Disassembly

8.1.3.1
APX 8500 Mid Power Model

Prerequisites:

CAUTION: step 1 through step 6 MUST be performed, before you remove the Controller and RF Board from the chassis. Otherwise damage to the transceiver Controller Board could occur.

Procedure:

1. Ensure that all accessory connections, power, antenna, and microphone are unplugged.

   If radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the transceiver.
2. For Remote Mount and O5 Control Head, remove the two front control head screws using a T-10 torx bit, do not discard screws.

Figure 36: Removing the O5 Control Head Screws

NOTE: Disassembly of O5 Control Head is shown for simplicity. For more information on the disassembly of other Control Head models, refer to the following sections:

- O2 Radio Disassembly on page 114
- O5 Radio Disassembly on page 117
- O7 Radio Disassembly on page 119
- Disassembling the E5 Control Head on page 122

3. Firmly grasp the control head front housing and frame seal or Remote Faceplate, and carefully remove from the radio. Be careful not to pull the attached flex on the O5 Control Head.
4. Lay the control head face down on a clean, flat surface, being careful not to scratch or mar the face of the display.
5. Carefully disconnect control head flex from edge card of the transceiver.

NOTE: “Carefully” means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, ensure that both mated pairs are pulled apart in a straight-forward [or “in-line”] direction parallel to the longitudinal axis of the connector pins.

Figure 37: Removing the Control Head Flex

6. Remove the TIB assembly by unscrewing the four (4) TIB assembly screws using a T-10 torx bit. Do not discard screws.

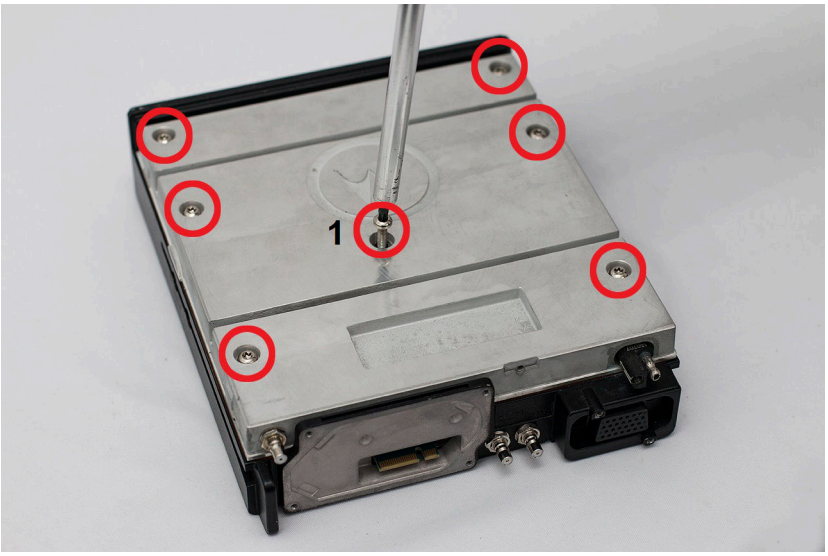
Figure 38: Removing the TIB Screws

7. Remove the Accessory Connector Cover, for example, HLN6863_ at J2 or J100 using the thumb screws at two of the corners. Do not discard the Accessory Connector Cover.
8. Remove the TX Grille from the radio using the Solder Aid (black stick). Place flat tip underneath the two small cutouts at one side and carefully pry the TX Grille away from the radio.

Figure 39: Removing the TX Grille

9. Radio must be oriented as shown in the following figure with the bottom of the radio facing up. Remove the seven (7) controller cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screw. Do not discard screws.

Figure 40: Removing the TX Casting Screws

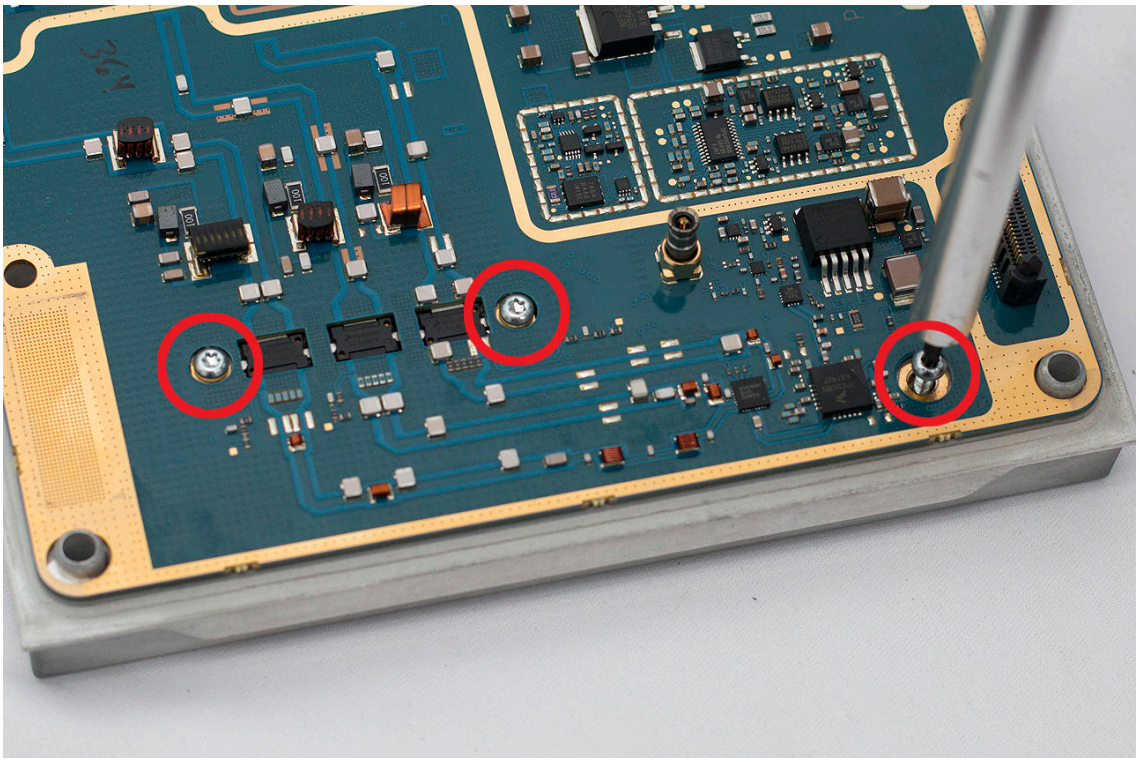


10. Remove the TX Casting from the radio. The seal between the two castings is now free to fall out. Remove the casting seal and place with TX Casting.

Figure 41: Removing the TX Casting

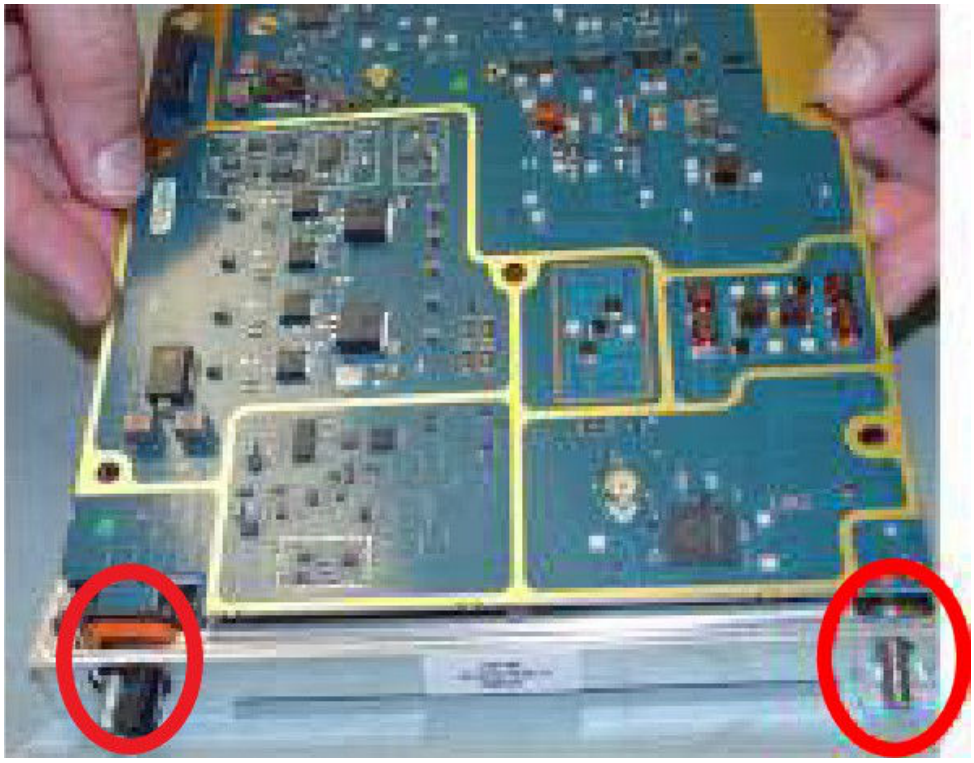
11. Remove the three board screws using a T-10 Driver.

Figure 42: Removing the Board Screws



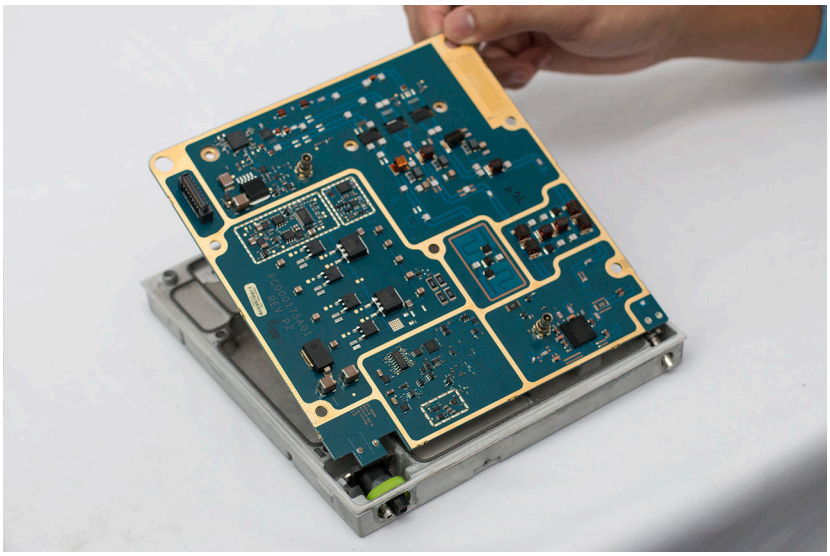
12. Remove the DC Connector Clip using the Solder Aid (black stick), and the RF Connector Nut and Washer.

Figure 43: Location of DC and RF Connectors



13. Remove the Transmitter Board by gently lifting the board at the opposite end of the RF and DC connectors. Handle the Transmitter Board by the edges only, and store it in an antistatic bag. Avoid contact with exposed thermal grease on the Transmitter Board. Thermal grease may be removed with a dry lint-free cloth.

Figure 44: Removing the Transmitter Board

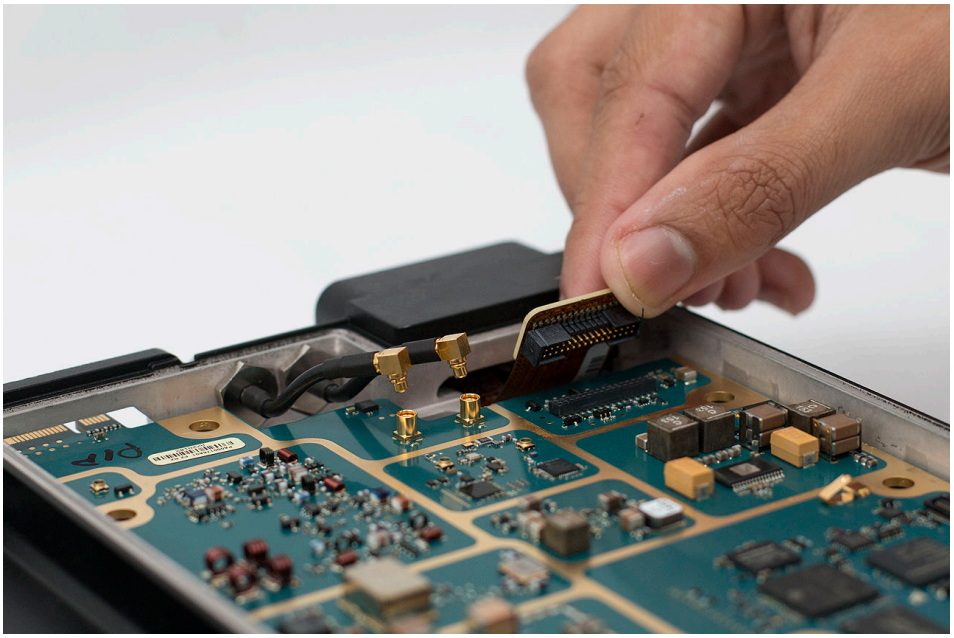


14. Flip over the radio.
15. Remove the eight (8) RF cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screw. Do not discard screws. Remove the XCVR Cover seal as well and place with the XCVR Cover.

Figure 45: Removing the XCVR Cover

16. Disconnect the GPS and Bluetooth/Wi-Fi cables from the controller board by gently holding the controller board in place and pulling up on the MMCX connector of the cable. Do not pull the cable section of the cable as damage may occur. Disconnect the rear accessory flex from the controller board.

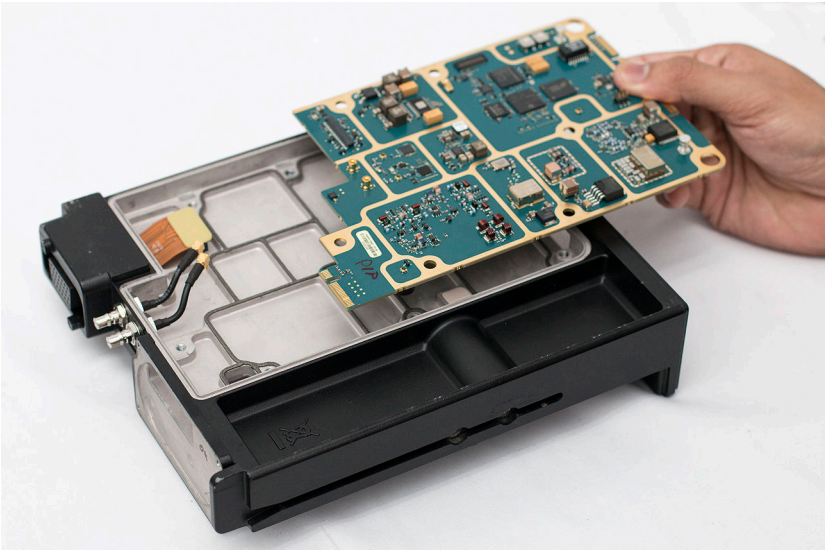
Figure 46: Removing the GPS Cable, Bluetooth/Wi-Fi Cable, and Accessory Flex



17. Remove the Transceiver Board by gently lifting the board by the handles. Handle the Transceiver Board by the edges only, and store it in an antistatic bag.

NOTE: If necessary, remove the GPS and Bluetooth/Wi-Fi SMA connector nut using a deep 5/16” socket or deep nutdriver. Remove the GPS and Bluetooth/Wi-Fi SMA connector lock washer. Do not discard the nut or lock washer. If necessary, remove the two screws from the Accessory Connector and gently pull through the hole in the casting.

Figure 47: Removing the Transceiver Board



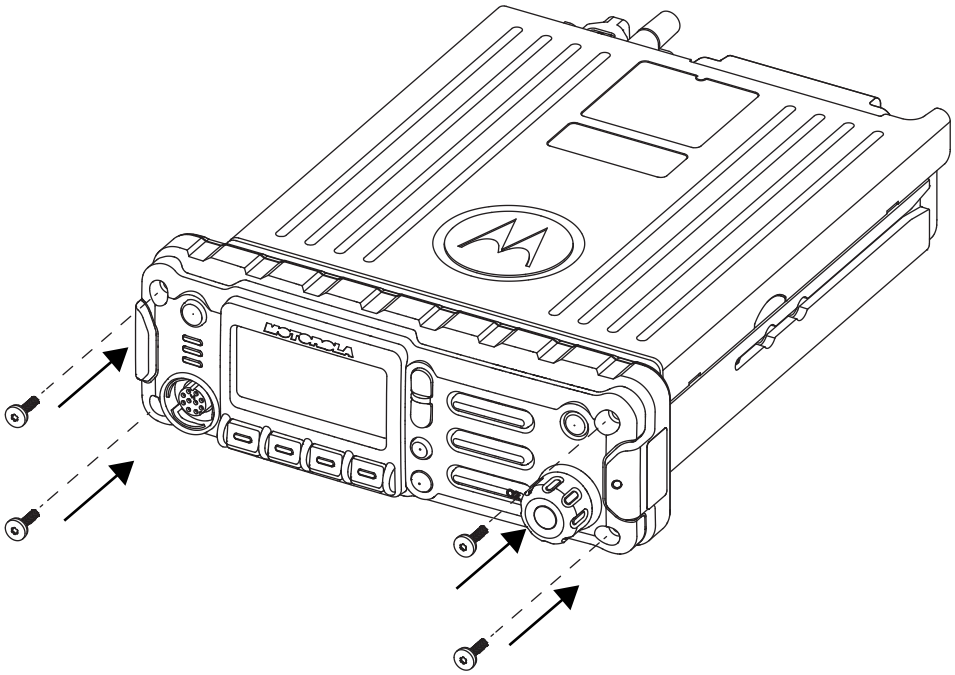
8.1.3.2

O2 Radio Disassembly

Procedure:

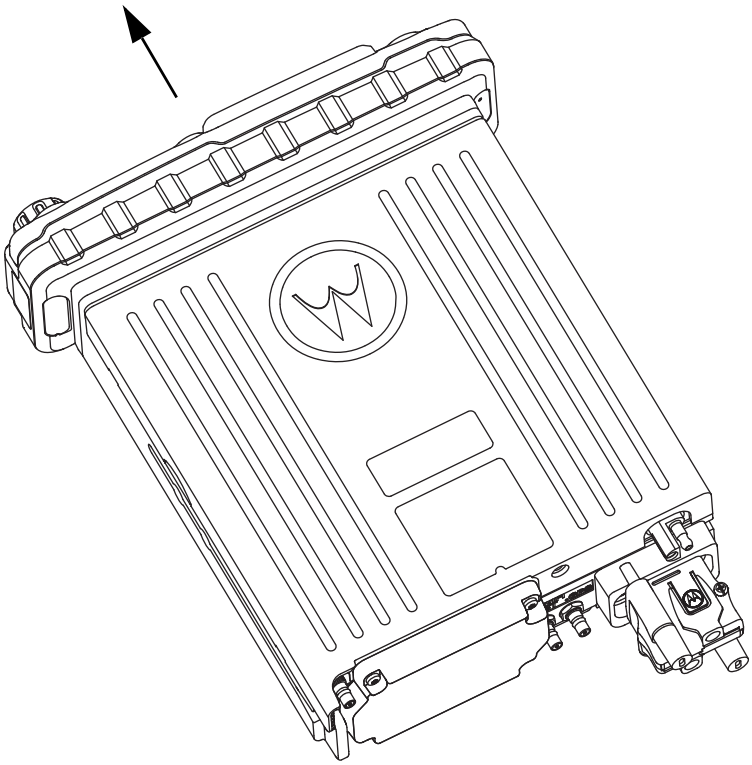
1. Ensure power, antenna, microphone and all accessory connections are unplugged. If the radio is a remote-mount radio, disconnect the remote-mount control cable from the front of the transceiver.
2. Remove the four front control head screws using a T20 and discard them.

   Figure 48: Removing the Control Head Screws



3. Firmly grasp the front panel of the control head or the Transceiver Interface Board (TIB) for remote mount, and carefully remove the front housing assembly from the back housing assembly. Be careful not to pull the attached flex.

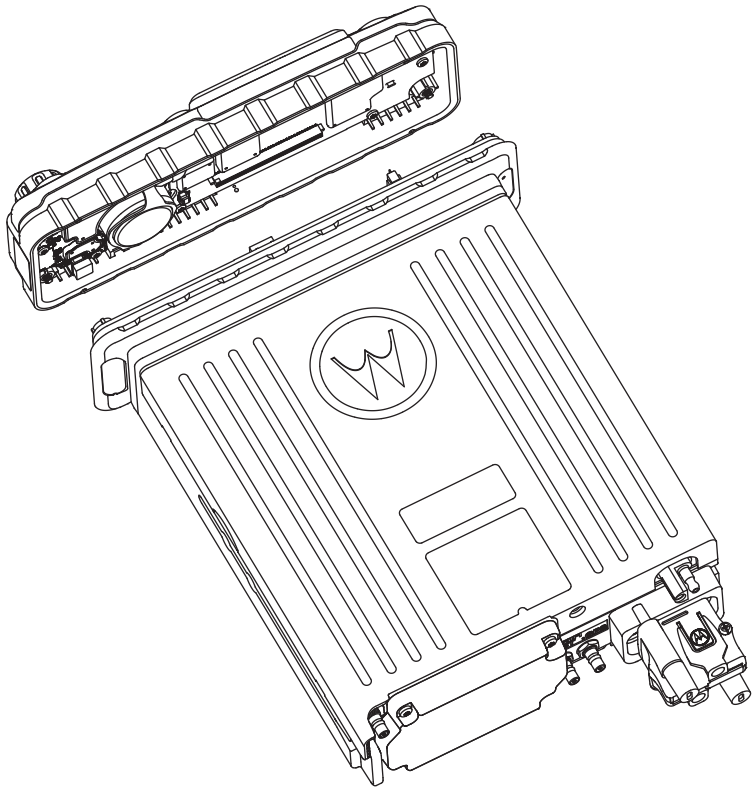
Figure 49: Removing the Control Head



4. Lay the control head or TIB face down on a clean, flat surface, being careful not to scratch or mar the surface of the display.
5. Carefully disconnect the transceiver flex from the front housing assembly or TIB and set the front housing assembly or TIB aside.

   NOTE: The O2/O7 knob removal tool can be used as a lever to simplify the task of disconnecting the transceiver flex and reduce the risk of damaging the connectors.

Figure 50: Disconnecting the Transceiver Flex from the Front Housing Assembly

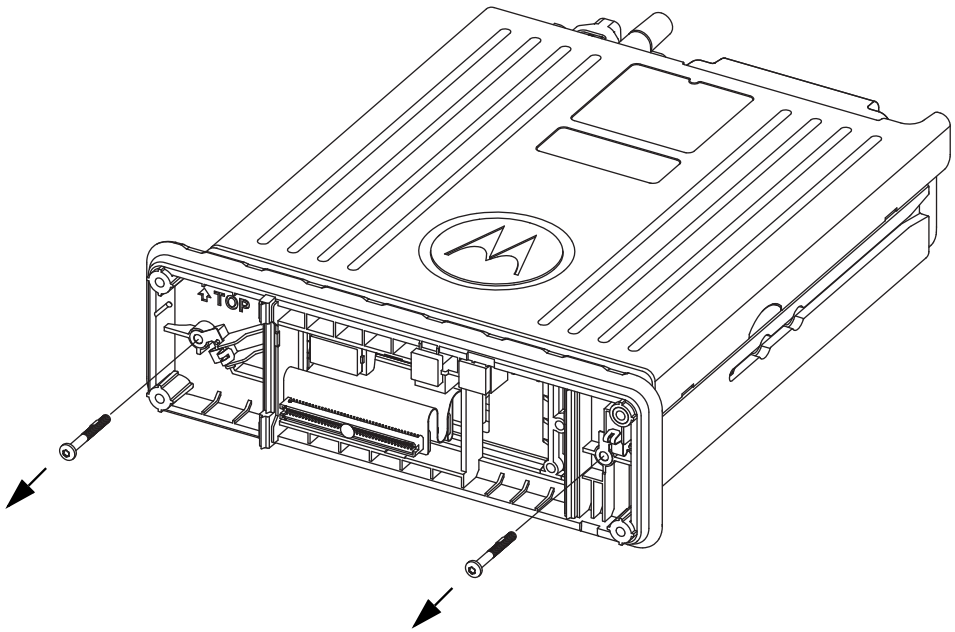


6. Remove the two transceiver screws using a T10 and pull the back housing assembly away from the transceiver. Do not reuse the transceiver screws.

   NOTE: Be careful to avoid pulling on the flex.

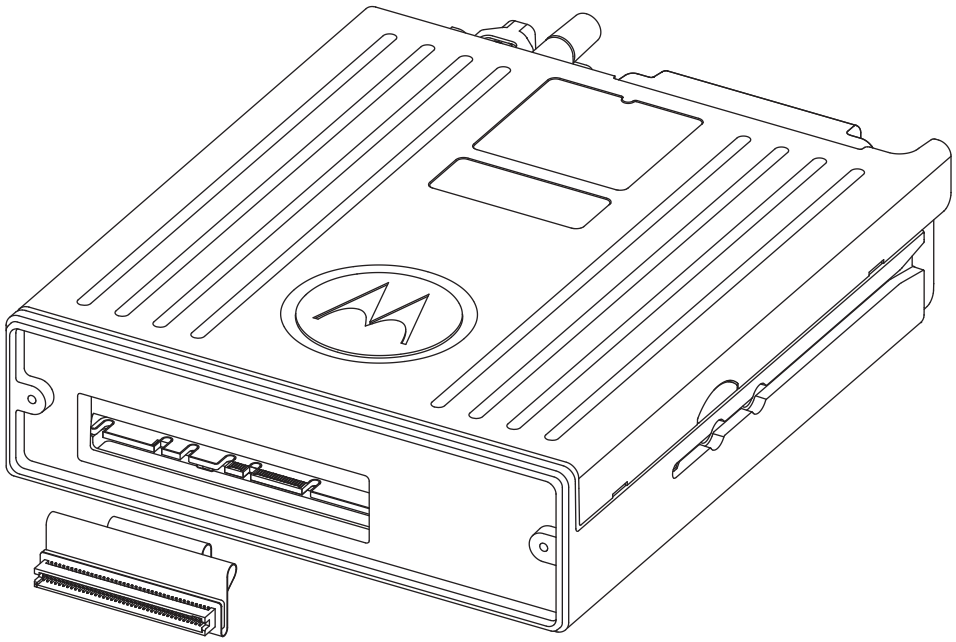
7. Carefully separate the I-seal, from the back housing assembly.

   Figure 51: Removing the Back Housing Assembly



8. Carefully remove the transceiver flex from the transceiver by grasping the provided handle and separating it from the connector.

Figure 52: Removing the Transceiver Flex



8.1.3.3
O5 Radio Disassembly

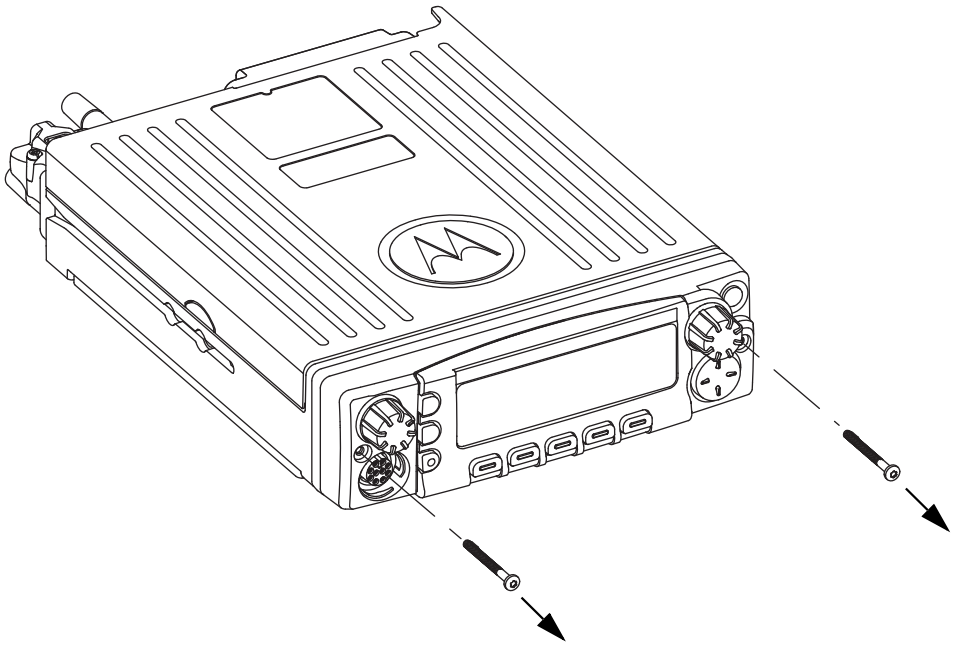
Use the following procedures to disassemble your radio:

Procedure:

1. Ensure all accessory connections, power, antenna, and microphone are unplugged.

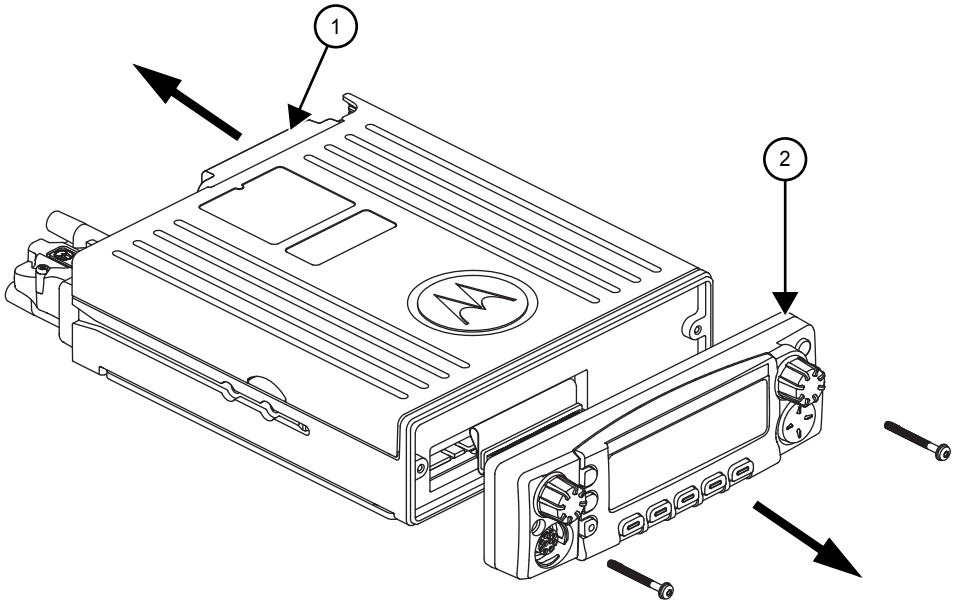
   If radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the transceiver.
2. Remove the two (2) front control head/TIB screws using a T-10 torx bit, do not discard screws.

Figure 53: Removing the Control Head Screws



3. Firmly grasp the control head/transceiver interface board (TIB) front housing and frame seal, and carefully remove from the radio. Be careful not to pull the attached flex, during control head/TIB removal.

Figure 54: Removing the Control Head/TIB



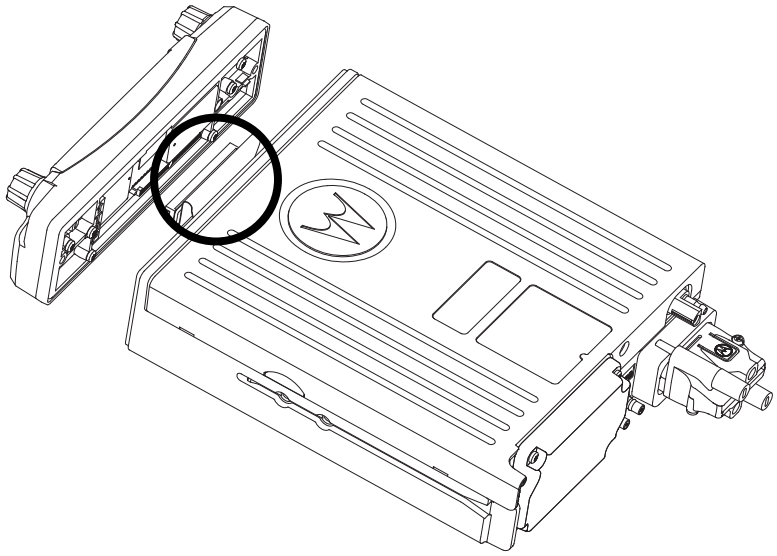
1	TIB
2	Control Head

4. Lay the control head or TIB face down on a clean, flat surface, being careful not to scratch or mar the face of the display.

5. Carefully disconnect control head/TIB flex from transceiver's edge card.

   NOTE: "Carefully" means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, make sure both mated pairs are pulled apart in a straight-forward (or "in-line") direction parallel to the longitudinal axis of the connector pins.

Figure 55: Removing the Control Head Flex



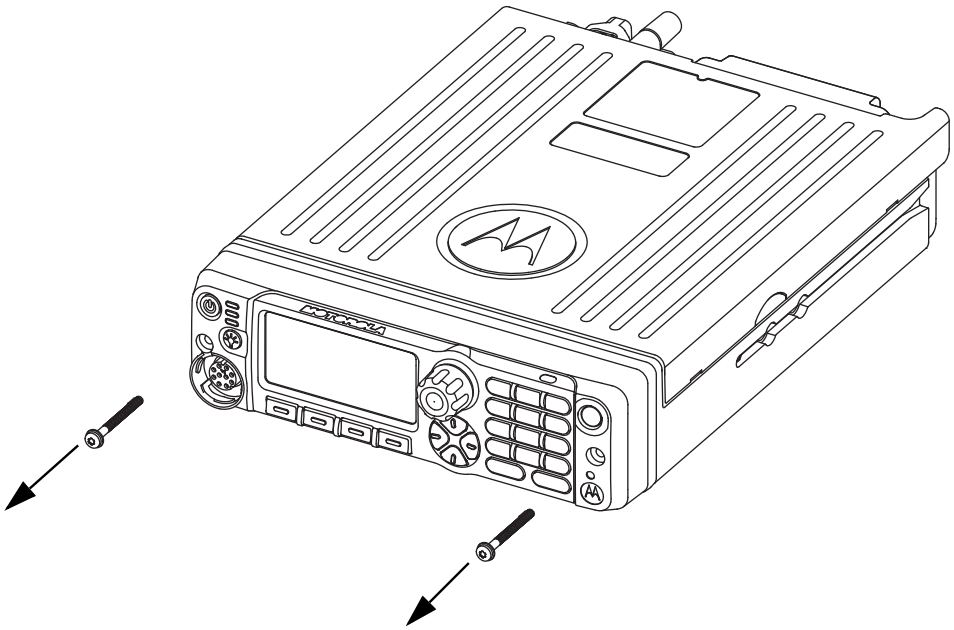
8.1.3.4
O7 Radio Disassembly

Use the following procedures to disassemble your radio:

Procedure:

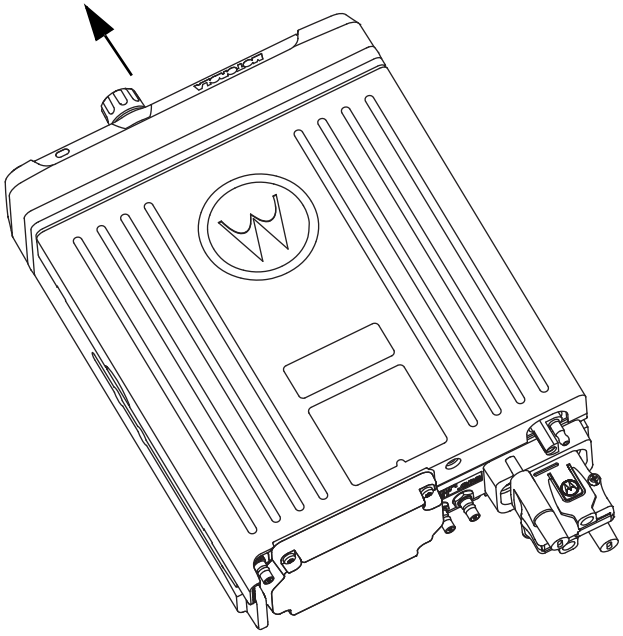
1. Ensure power, antenna, microphone and all accessory connections are unplugged. If the radio is a remote-mount radio, disconnect the remote-mount control cable from the front of the transceiver.
2. Remove the two transceiver screws using a T10 and discard them.

Figure 56: Removing the Transceiver Screws



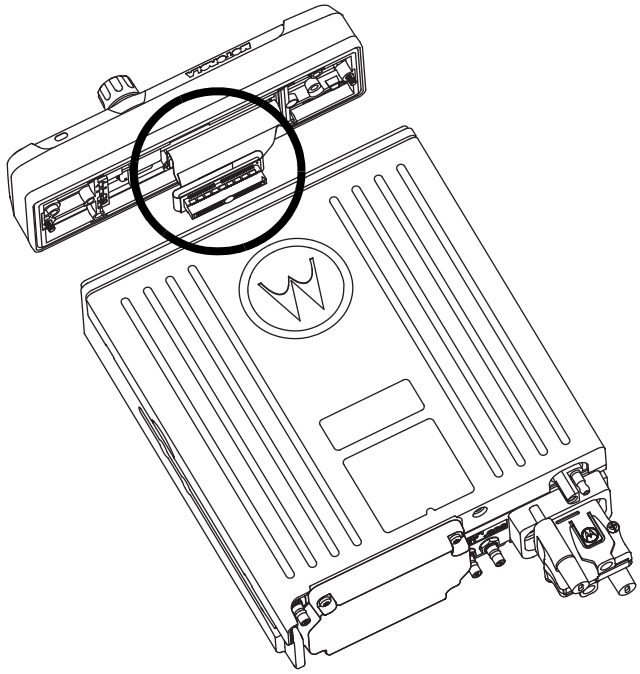
3. Firmly grasp the control head or the Transceiver Interface Board (TIB) for remote mount, and carefully remove the control head from the transceiver. Be careful not to pull on the attached flex.

Figure 57: Removing the Control Head



4. Lay the control head or TIB face down on a clean flat surface, and be careful not to scratch or mar the surface of the display.
5. Carefully remove the transceiver flex from the transceiver by grasping the provided handle and separating it from the connector. Set the transceiver aside.

Figure 58: Disconnecting the Transceiver Flex from the Transceiver



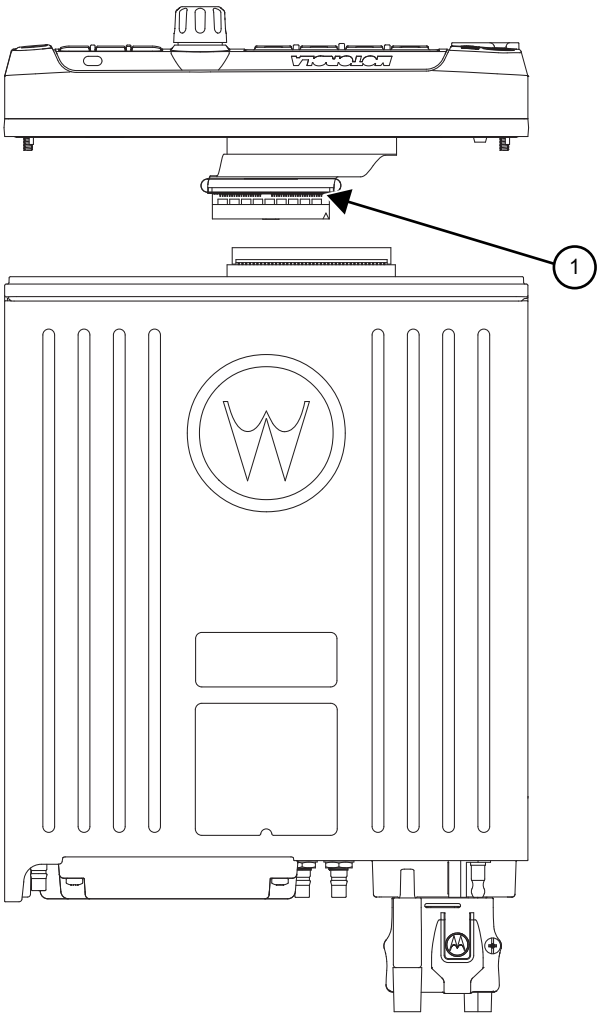
6. Carefully separate the I-seal from the control head or TIB.

   NOTE: Be careful not to damage the transceiver flex when separating the I-seal from the control head or TIB.

7. Carefully disconnect the transceiver flex from the control head or TIB.

   NOTE: The O2/O7 knob removal tool can be used as a lever to simplify the task of disconnecting the transceiver flex and reduce the risk of damaging the connectors.

Figure 59: Removing the Transceiver Flex



1	Transceiver Flex

8.1.3.5

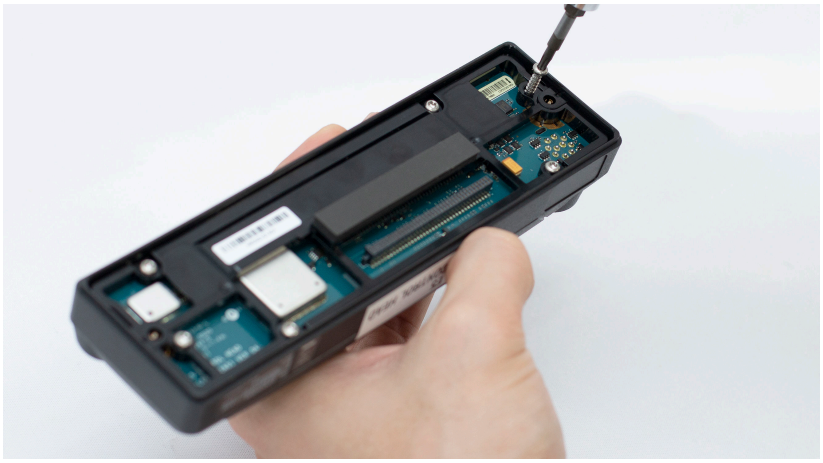
Disassembling the E5 Control Head

NOTE: Bracketed numbers are identical to item numbers shown in E5 Control Head Exploded View and Parts List on page 191.

Procedure:

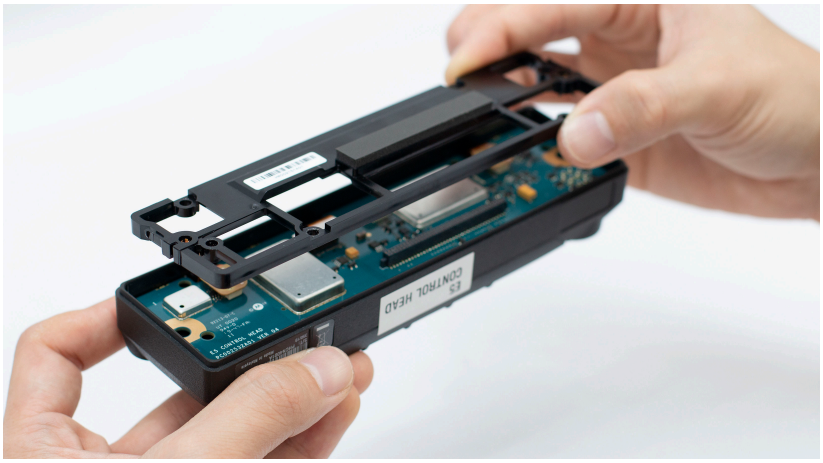
1. Lay the control head face down on a clean, flat surface being careful not to scratch or mar the display.
2. Using a Torx T10 screwdriver, remove the six main PCB retention screws [27] as shown in the following figure.

Figure 60: Main PCB Retainer Screws



3. Carefully separate the main PCB retainer [26] from the front housing assembly.

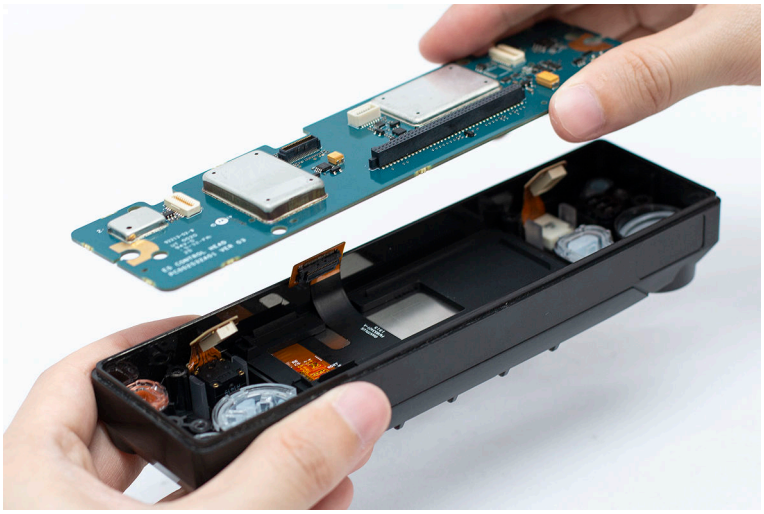
Figure 61: Main PCB Retainer



4. Carefully disconnect the frequency assembly, color display module encoder and the volume assembly flex assemblies.
5. After all the connectors have been unplugged, gently lift the main PCB up from the front housing assembly.

NOTE: Be careful not to damage the flex connectors when lifting up the main PCB.

Figure 62: Main PCB

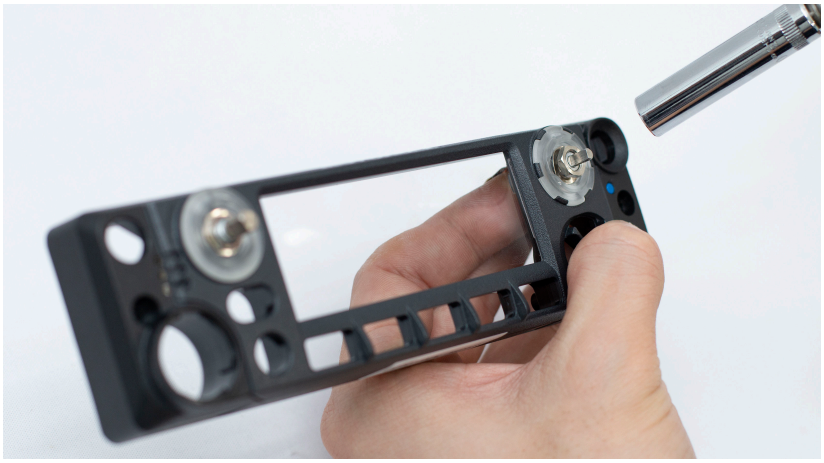


6. Remove the color display module from the front housing assembly.

Figure 63: Color Display Module

7. Using the knob removal tool, remove the encoder knob [1] from the front housing assembly.
8. Remove the torque washers and by using a hex nut driver, remove the encoder hex nut [4], followed by the 3 wave washers. Do not reuse the encoder hex nut.

Figure 64: Removing Hex Nut



9. Carefully remove the following parts from the front housing:

Figure 65: Emergency Button [20] and Emergency Button Retainer [21]

Figure 66: Home Button [14] and Home Button Retainer [15]

Figure 67: Navigation Button [16] and Navigation Button Retainer [17]

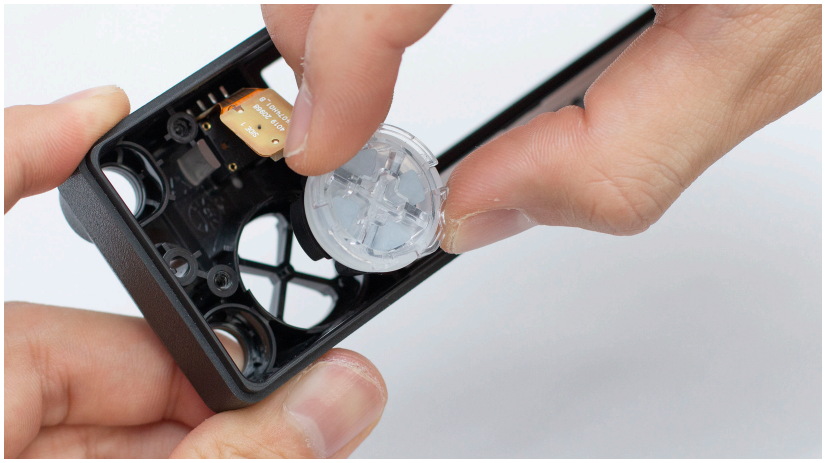


Figure 68: Menu Button [18] and Menu Button Retainer [19]

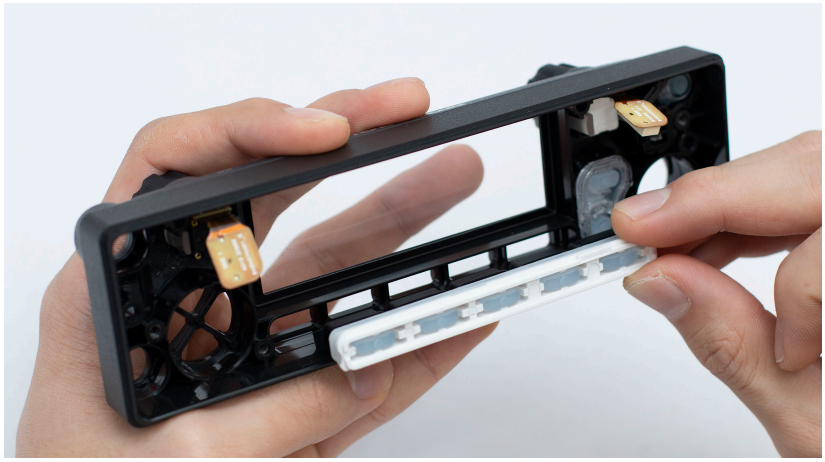
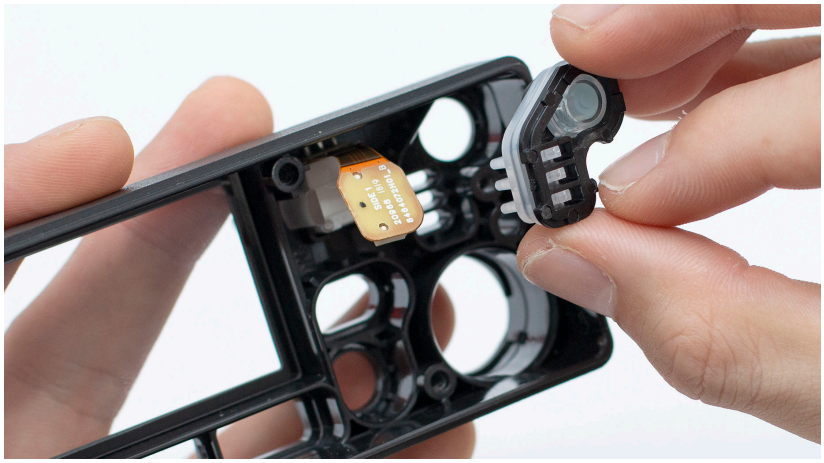


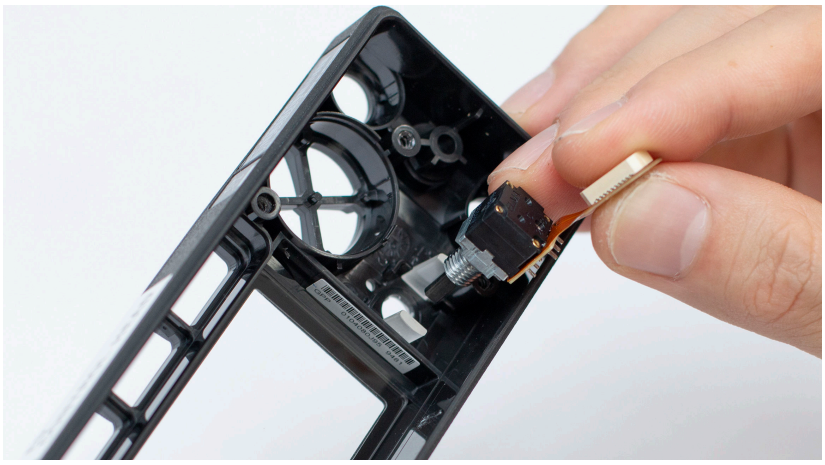
Figure 69: Programmable Button [12] and Programmable Button Retainer [13]

Figure 70: Power Button and Indicator Lights assembly [9][10][11]



10. Remove the volume assembly potentiometer and the frequency assembly switch from the front housing.

Figure 71: Volume Assembly Potentiometer



8.1.3.6
Disassembling the Remote Mount Ethernet Faceplate

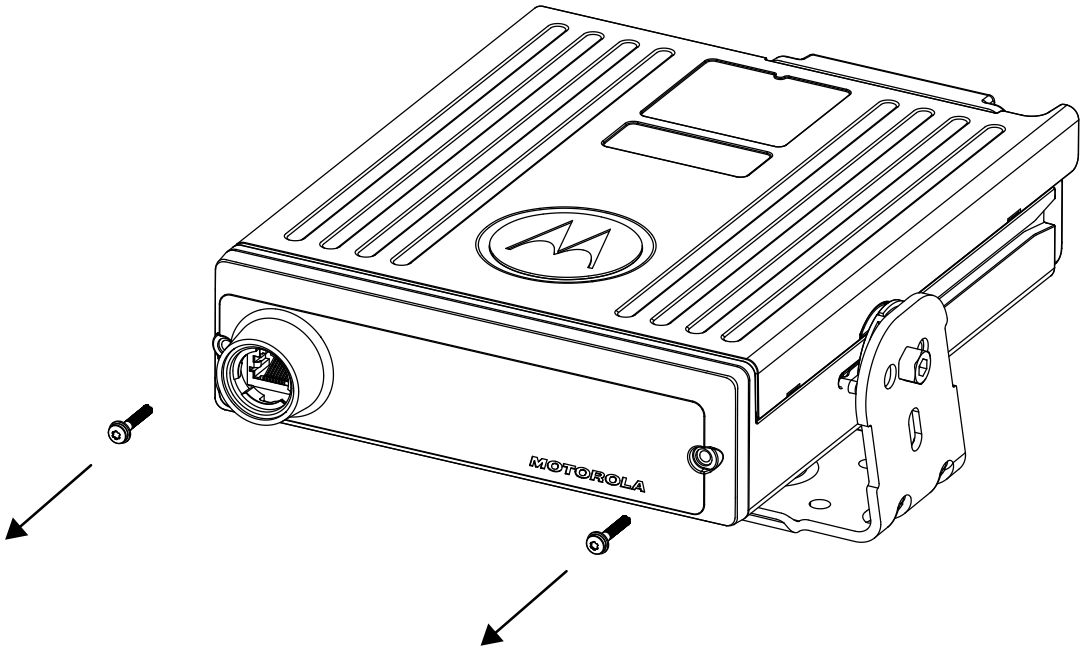
Prerequisites: Ensure that the power, antenna, microphone, and accessory connections are unplugged.

Procedure:

1. Disconnect the ethernet cable.
2. Remove the front control head screws or the TIB screws by using a T10 torx bit.

NOTE: Do not discard the screws.

Figure 72: Removing the Control Head Screws



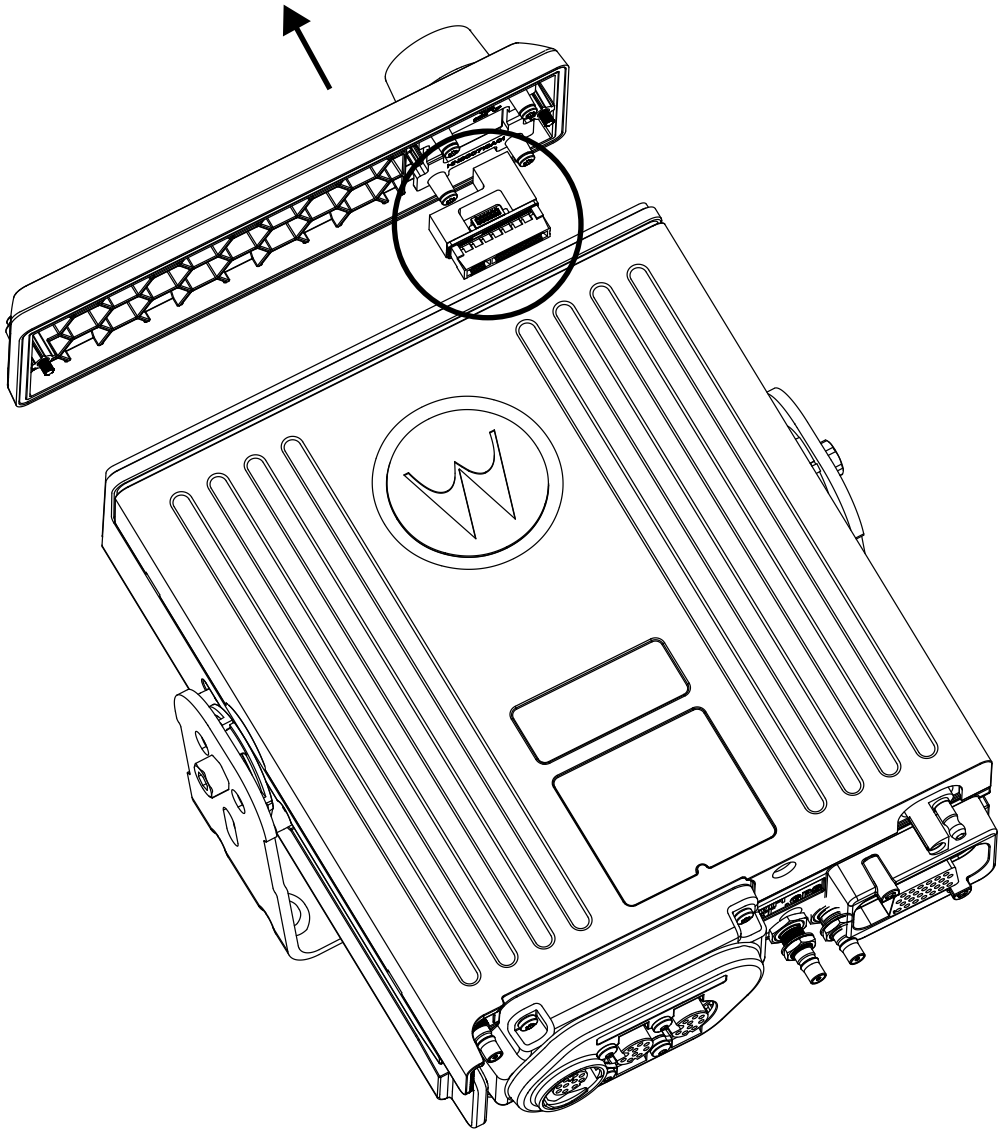
3. Firmly grasp the ethernet faceplate cover assembly, and remove it from the radio.

   NOTE: Do not pull the attached connector and wires when removing the cover.

4. To fully disconnect the edge card assembly from the transceiver board, apply pressure on the edge card assembly until it is fully disconnected.

   NOTE: Ensure that the card assembly is pulled in the parallel direction of the connector pins.

Figure 73: Removing the Ethernet Faceplate Assembly and Disconnecting It from the Radio



5. Set the ethernet faceplate assembly aside.

8.1.4
Radio Reassembly

NOTE: Prior to reassembling the radio, inspect all seals and sealing surfaces for damage (nicks, cuts, and so on) or dirt. Reseat all seals on their respective parts.

8.1.4.1
APX 8500 Mid Power Model

Prerequisites: step 1 through step 11 are necessary only if any of these parts were removed or have been damaged.

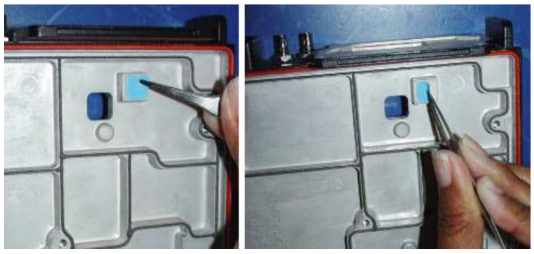
Procedure:

1. Place thermal pad (7575935B01) onto the transmitter side of the main chassis (CH000031A02) and remove the blue liner.

   Figure 74: Placing Thermal Pad (7575935B01)

2. Place thermal pad (7575767B01) onto the transmitter side of the main chassis (CH000031A02) and remove the blue liner.

   Figure 75: Placing Thermal Pad (7575767B01)

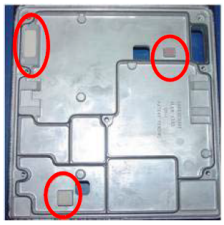


3. Place thermal pad (HW000572A02) onto the transmitter side of the main chassis (CH000031A02)

   Figure 76: Placing Thermal Pad (HW000572A02)

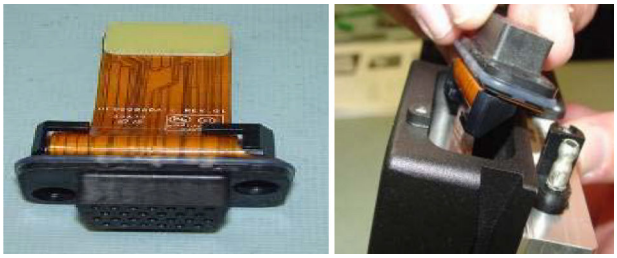
4. Make sure that a total of three thermal pads have been placed and their blue liner removed.

   Figure 77: Location of the Thermal Pads on the Transmitter (TX) Side of the Main Chassis



5. Route accessory connector flex (PA000850A01) into main chassis (CH000031A02).

Figure 78: Installing the Accessory Connector Flex into Main Chassis



6. Screw in two accessory connector screws (0371838H01) to 7 in-lbs.

NOTE: Ensure that the washer and seal are not missing.

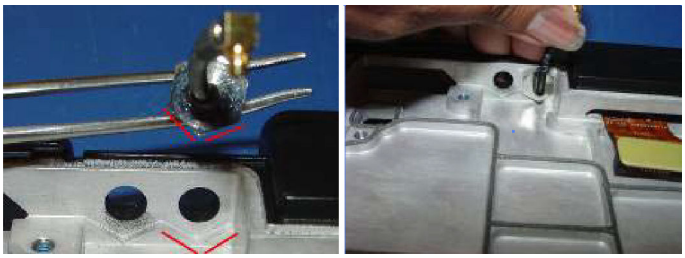
Figure 79: Installing Accessory Connector Screws

7. Remove the QMA lock washer and QMA nut before installing the two RF cables (CB000091A01) through chassis hole.

Figure 80: Removing the QMA Lock Washer and QMA Nut

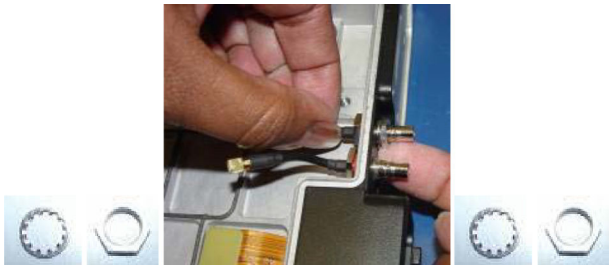
8. Install the two RF cables through the chassis. Make sure the RF cable connector body aligns with the chassis.

Figure 81: Installing the two RF Cables into the Main Chassis



9. Place QMA lock washer (HW000570A01) and QMA nut (FN000153A01) onto each cable connector in that order. Hand-turn the QMA hex nut to RF connector on main chassis.

Figure 82: Installing QMA Lock Washer and QMA Nut for each cable connector



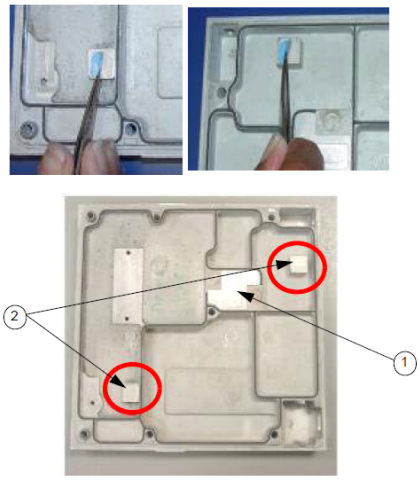
10. Torque down two RF cables to 13 in-lbs.

    NOTE: Ensure that the nuts are fully tightened and flushed and also torque driver is calibrated during model assembly.

Figure 83: Installing the two RF Cables

11. Place two thermal pads (7575767B01 and 7575935B01) onto transmitter (TX) cover and peel the blue liner.

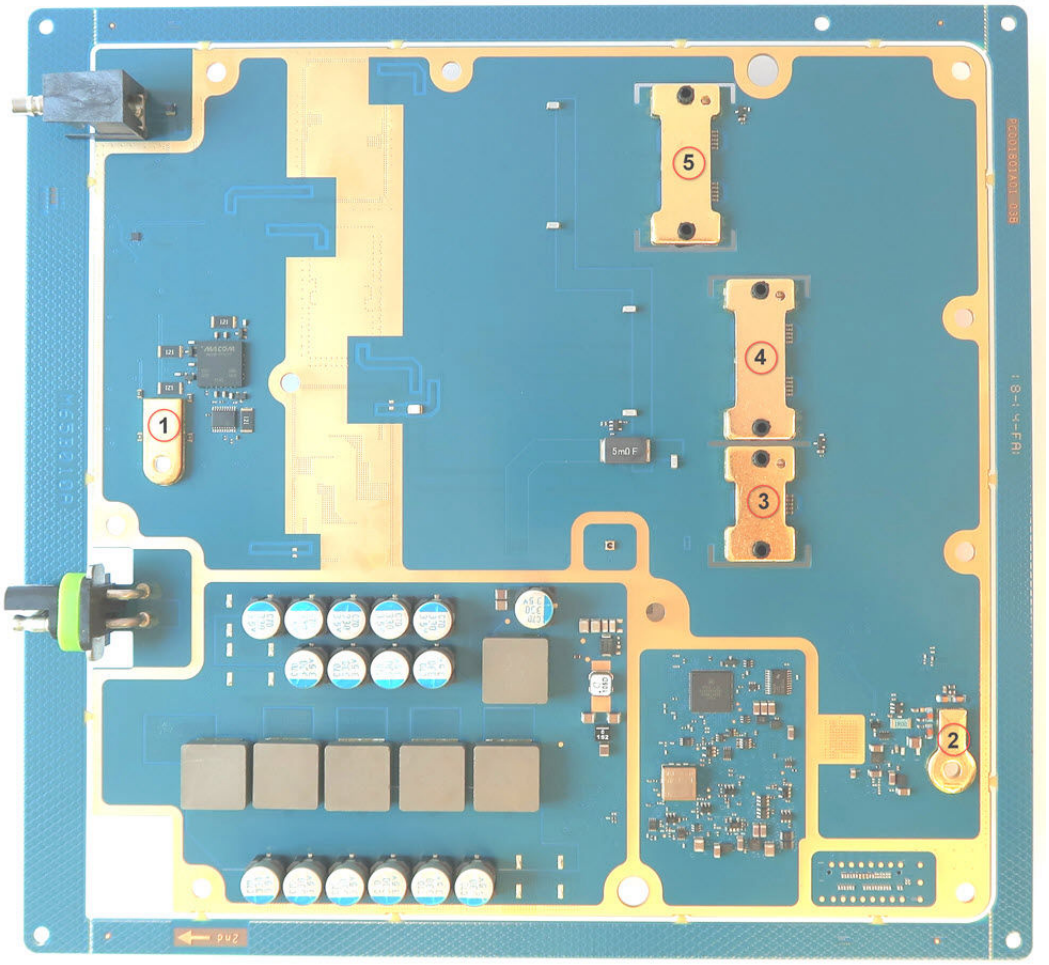
Figure 84: Placing the thermal pads 7575767B01 and 7575935B01 onto Transmitter (TX) Cover



12. Apply thermal grease (1110022D23) onto the dogbone and lollipop on the transmitter board (PPHTW4000_).

    NOTE: Ensure that the dogbone and lollipop heatsink surface are fully covered by a layer of thermal compound.

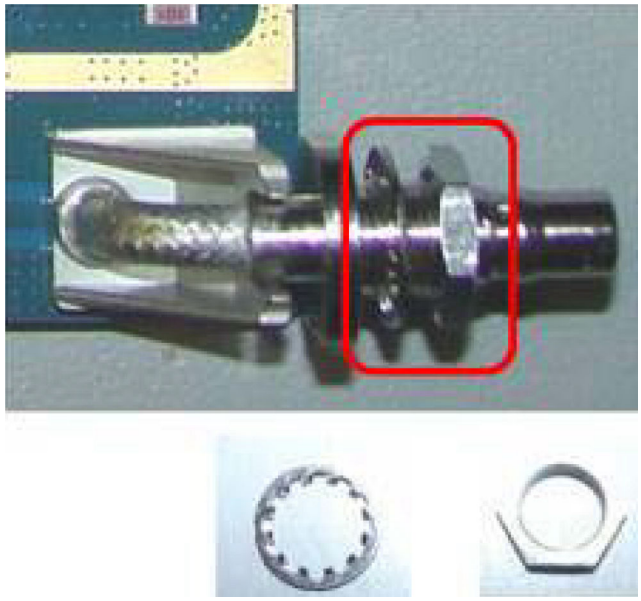
Figure 85: Applying Thermal Grease onto the Transmitter Board



13. Before placing the transmitter board (PPHTW4000_) into the transmitter cover (CH000032A03) remove the QMA washer and the nut from the main RF connector.

NOTE: Ensure that all thermal pads are free from contamination before placing the board and the O-ring around the main RF connector is in place.

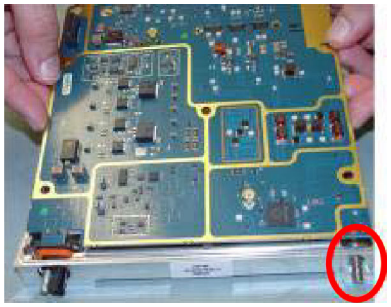
Figure 86: QMA Washer and Nut on Main RF Connector



14. Thoroughly inspect the casting shield gasketing for damage and verify that all casting thermal pads are in place and free of damage.
15. Install the Transmitter board by tilting and sliding the Transmitter board into the chassis using the edge of the board, taking care to line up the two RF and DC connectors with the rear holes of the chassis. To fully seat the Transmitter board, push back and down on the board using the outside gold track to slightly compress the RF and DC connector seals.

NOTE: Ensure that the Transmitter board alignment holes are positioned over the chassis alignment bosses and that the RF board is fully seated in the chassis.

Figure 87: Placing the transmitter board onto the Transmitter Cover



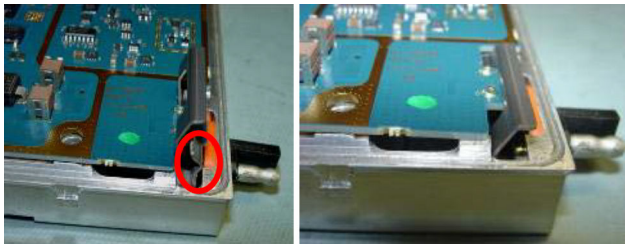
16. Place QMA lock washer (HW000570A01) and QMA nut (FN000153A01) in that order onto the RF connector. Tighten the QMA hex nut to RF connector on the main chassis. Torque down to 13 in-lbs.

NOTE: Ensure that nut is fully tightened and flushed.

Figure 88: Installing the QMA Lock Washer and Nut into the RF Connector

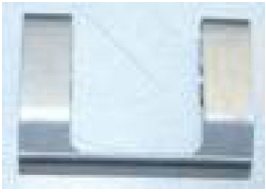
17. Insert the DC retention clip and fully seat it. Insert the clip before the board screws to properly locate the RF board. Place the grounding clip (HW000571A01) on the transmitter cover (CH000032A03).

Figure 89: Location of Grounding Clip



NOTE: The short lead side of the clip should be facing out to the connector.

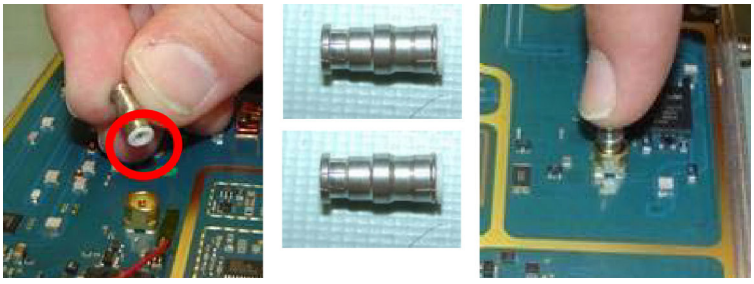
Figure 90: Installing the Grounding Clip on Transmitter Cover



18. Place two CN000069A03 (bullets) into the two CN000069A01 hole on transmitter board (PPHTW4000_).

NOTE: Ensure that the white side of the bullet is down. Inspect the bullets for any damage.

Figure 91: RF bullets used in the Transmitter Board

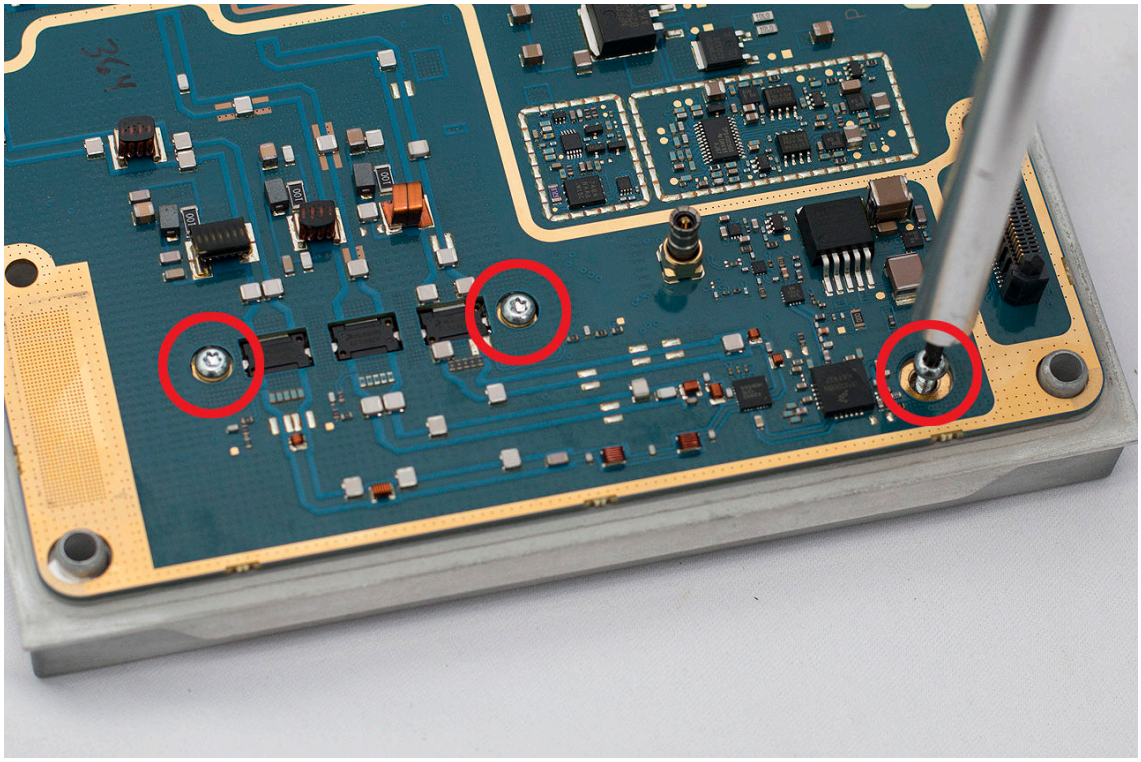


19. Install the three RF board screws.

Figure 92: RF bullet screws used in the Transmitter Board

20. Screw in three PA screws (0310909A33) using T-10 to 13 in-lbs. Ensure that the screws are fully tightened and flushed.

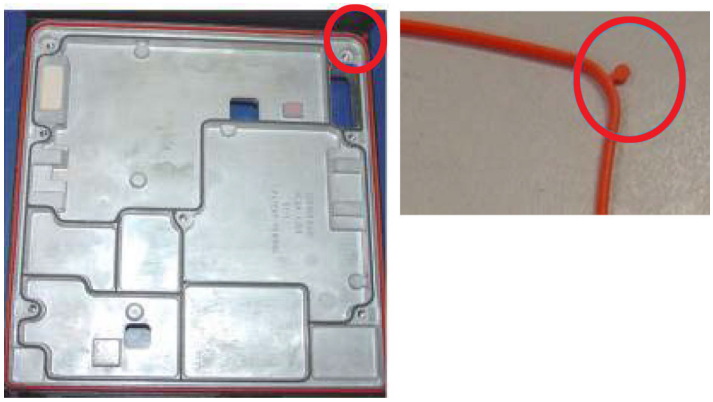
Figure 93: Installing PA Screws



21. Place the RF Seal in the main chassis and ensure that it is seated properly.

    NOTE: Inspect the thermal pad and ensure that there are no foreign material on the thermal pad.

Figure 94: Placing the Transmitter Seal into the main Chassis



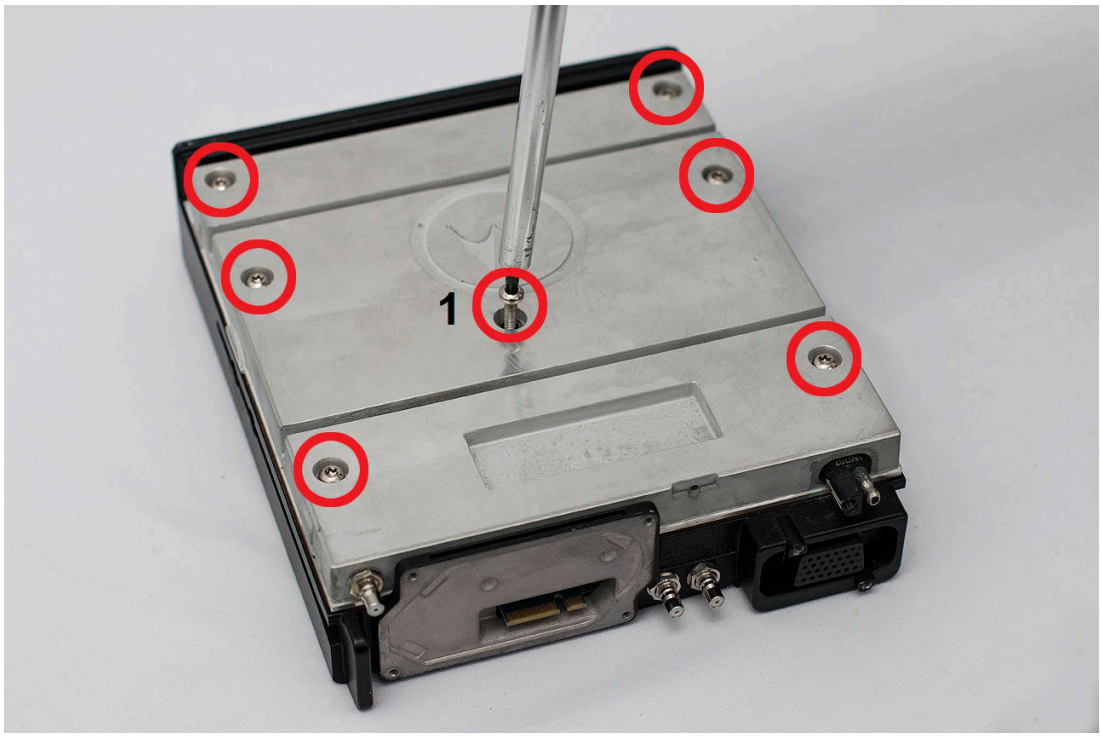
22. Place transmitter cover (CH000032A03) onto main chassis (CH000031A02).
23. Ensure that the seal is not pinched and the Transmitter cover is properly aligned to the chassis. Compress the Transmitter cover and chassis together to squeeze the seal into place.

Figure 95: Securing the Transmitter Cover to the Chassis

24. Inspect the sealing washers to the seven RF cover screws, and then install the screws onto the RF cover/chassis. Use a T-20 torx bit to torque the seven transmitter cover screws (0385870E01) to 36 in-lbs, starting with the center screw, then following a star pattern with the remaining screws.

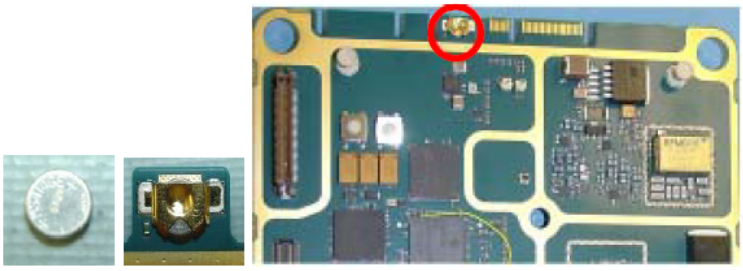
    NOTE: Repeat torque order sequence twice to ensure that the screws are fully seated.

Figure 96: Securing the RF Cover to the Chassis



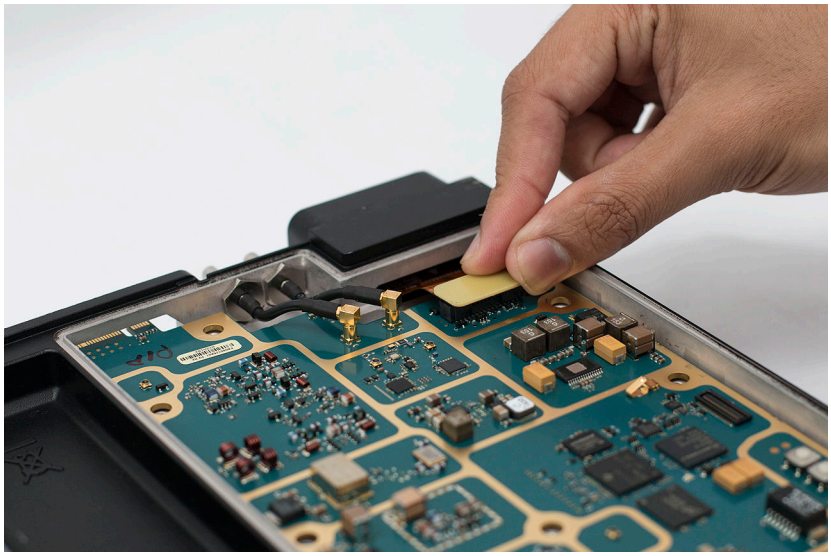
25. After the Transmitter cover is fully installed, check the Transmitter cover-chassis interface to ensure that the Transmitter cover seal is not pinched.
26. Confirm the coin cell battery (600092650001) is still present in slot on transceiver board (PPHRW4000_).

Figure 97: Installing the Coin Cell Battery into Transceiver Board



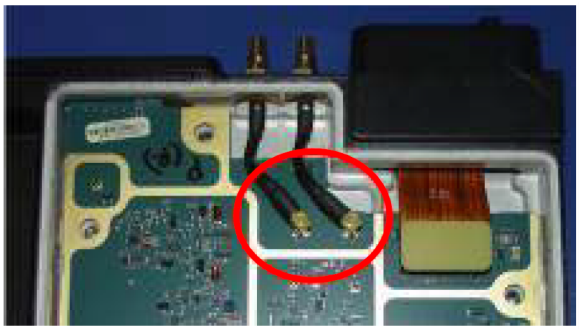
27. Begin with the chassis. Thoroughly inspect both sides of the chassis shield gasketing for damage and verify all chassis thermal pads are in place and free of damage. See Chassis Thermal Pad Replacement on page 160 to replace damaged pads.
28. Orient the chassis with the bottom facing upwards. Grab the transceiver board by the (2) handles and place the board backside first so that it can slide into the rear openings in the chassis. Ensure that the board seats properly and all the screw holes are lined up.
29. Connect rear accessory cable connector to the transceiver board.

Figure 98: Connecting Rear Accessory Connector Flex and GPS/BT/Wi-Fi Cables



30. Connect both RF cables (CB000091A01) to transceiver board (PPHRW4000_).

Figure 99: Connecting RF Cables to Transceiver Board

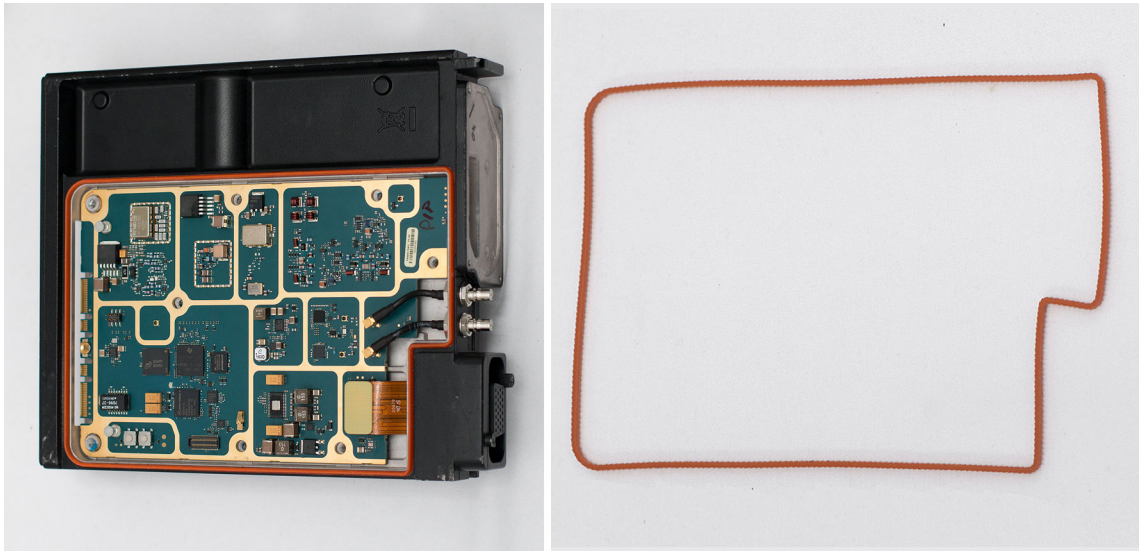


31. Place thermal pad (HW000572A02) on Transceiver cover (CH000033A02) and remove the blue liner.

Figure 100: Placing Thermal Pad on Transceiver Cover

32. Route transceiver seal (SL000052A01) into the seal groove.

Figure 101: Placing Transceiver Seal



33. Inspect the Transceiver cover (CH000033A02) to ensure that all thermal pads are free from contamination and that the sealing surface is free of debris or damage.

34. Place the Transceiver Cover Seal on the chassis and ensure that it is seated properly. Orient the Transceiver cover so that the screw holes line up in place on the chassis.
35. Using a T-20 torx bit, install the eight XCVR cover screws to 36 in-lbs, starting with the center screw and following a star pattern with the remaining screws.

    NOTE: Repeat torque order sequence twice to ensure that the screws are fully seated.

    Figure 102: Installing the Transceiver Cover

36. Ensure that the screws are flushed. Inspect all seals, Transmitter and Transceiver cover seals, RF and DC connector seals and ensure that they are not pinched.
37. Hook the RF Grille on the DC power side of the radio and snap into position.

    Figure 103: Installing the RF Grille

38. Install the TIB assembly by screwing in the four (4) TIB assembly screws using a T-10 torx bit.

Figure 104: Installing the TIB Assembly (Remote Mount shown)

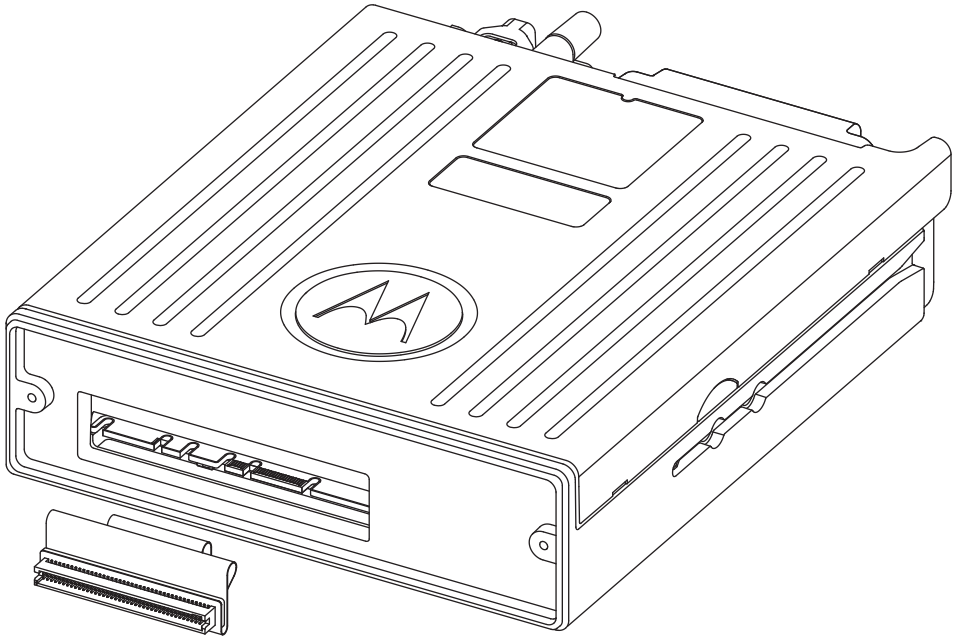
8.1.4.2

O2 Radio Reassembly

Procedure:

1. Grasp the handle on the transceiver end of the transceiver flex and plug the flex into the 50-pin connector on the side of the main board.

   Figure 105: Installing the Transceiver Flex onto the Transceiver

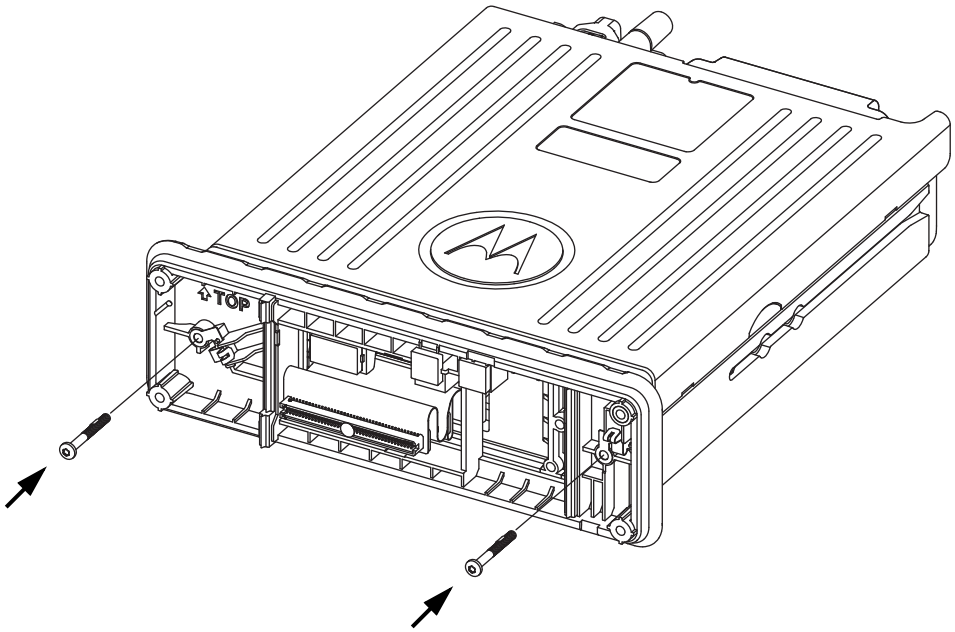


   IMPORTANT: Each Control Head has a unique Dash Mount flex. Do not mix and match. Only use the appropriate flex with its matching Control Head.

2. Align the I-seal with the back housing assembly, and push the I-seal into place.

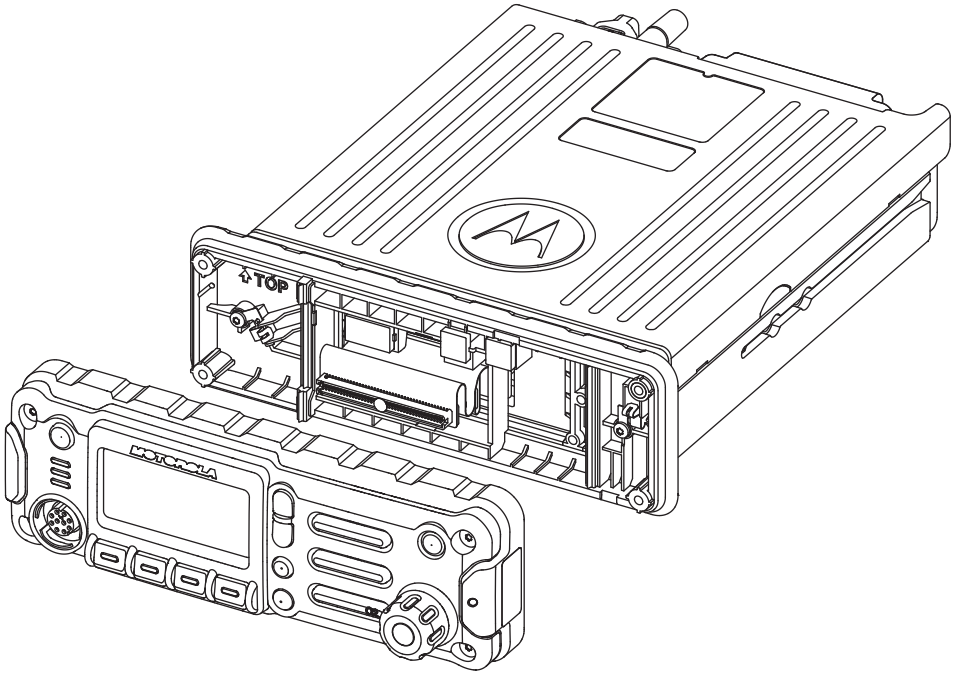
3. Align the back housing assembly with the transceiver, thread the flex through the back housing assembly, and push the back housing assembly into place.
4. Secure the back housing assembly to the transceiver with two new transceiver screws using the T10. Apply 13 in. lbs. of torque for each screw. Simultaneously, firmly press down on the center of the back housing, and this is to provide sufficient compression to the I-seal during assembly.

Figure 106: Installing the Back Housing Assembly onto the Transceiver



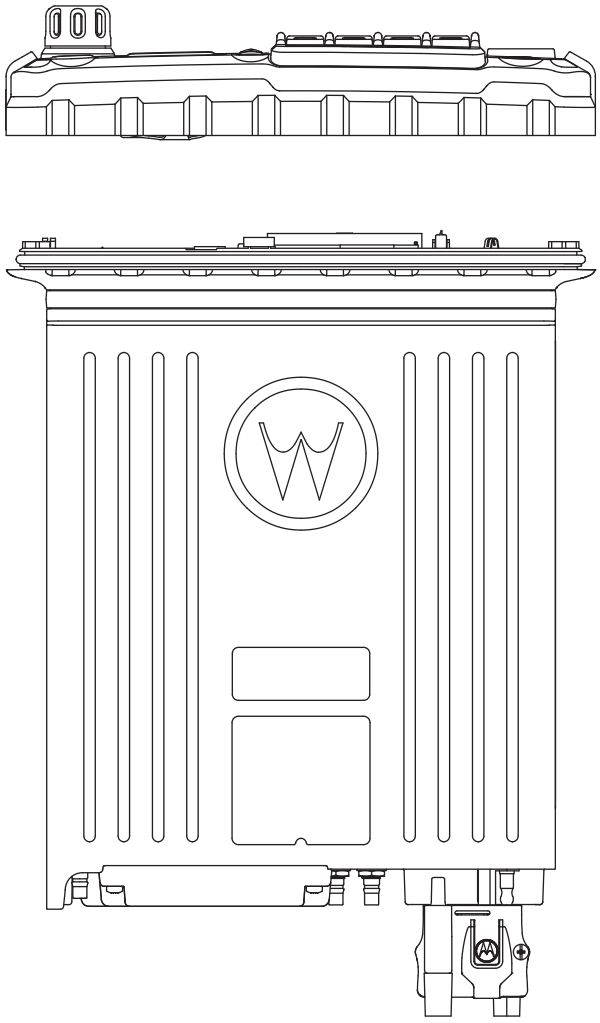
5. Install the control head flex to the control head. Align the connectors properly before connecting.

Figure 107: Installing the Transceiver Flex onto the Front Housing Assembly



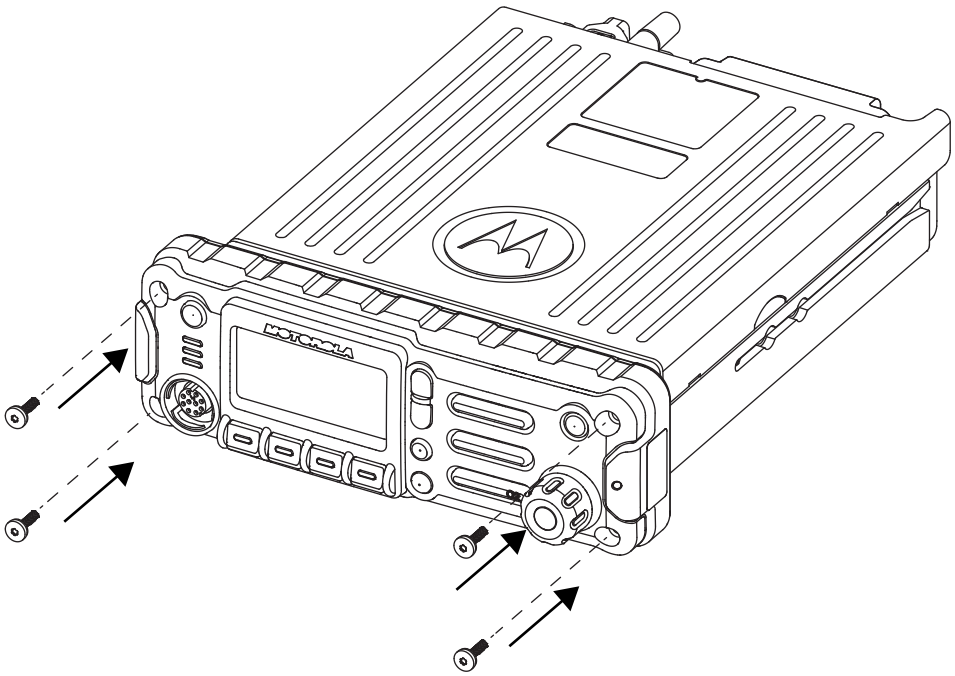
6. Attach the front housing assembly to the back housing assembly.

Figure 108: Attaching the Front Housing Assembly to the Back Housing Assembly



7. Secure the front housing assembly to the back housing assembly with four new control head screws using the T20. Apply 9 in. lbs. torque for each screw.

Figure 109: Attaching the Control Head Screws



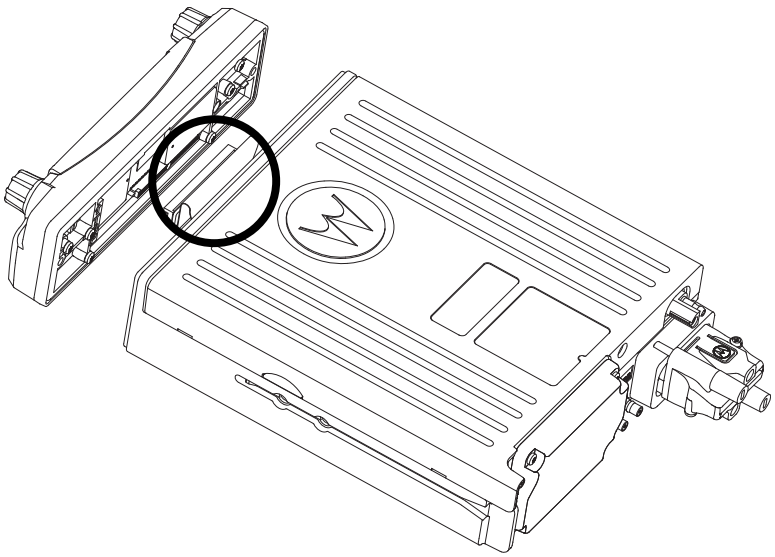
8.1.4.3

O5 Radio Reassembly

Procedure:

1. Attach the control head flex edge card connector to the edge card. Be sure to properly align the edge card connector to the exposed edge card.

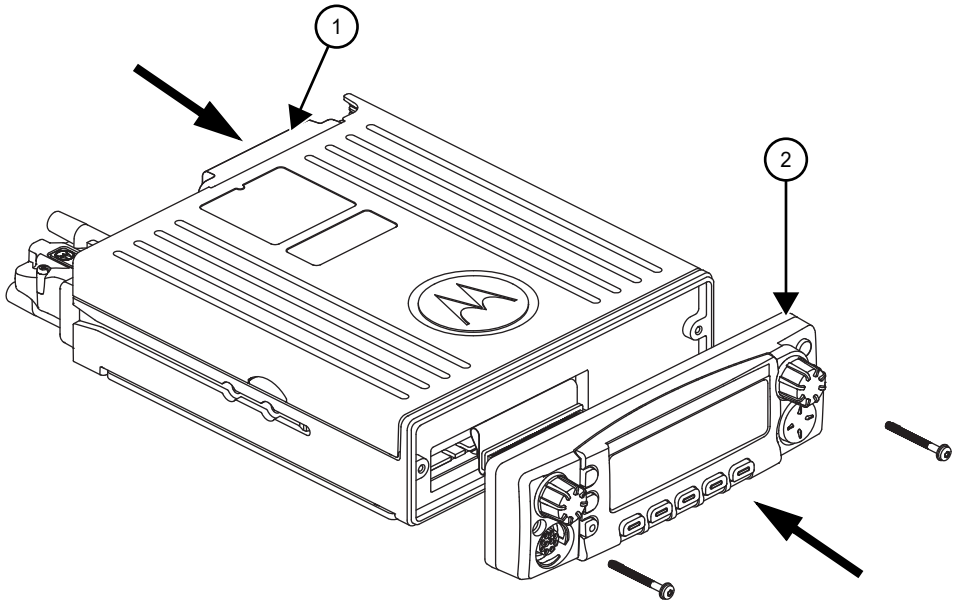
   Figure 110: Installing Flex into Controller PCB



IMPORTANT: Each Control Head has a unique Dash Mount flex. Do not mix and match. Only use the appropriate flex with its matching Control Head.

2. Install the control head flex to the control head. Align the connectors properly before connecting.

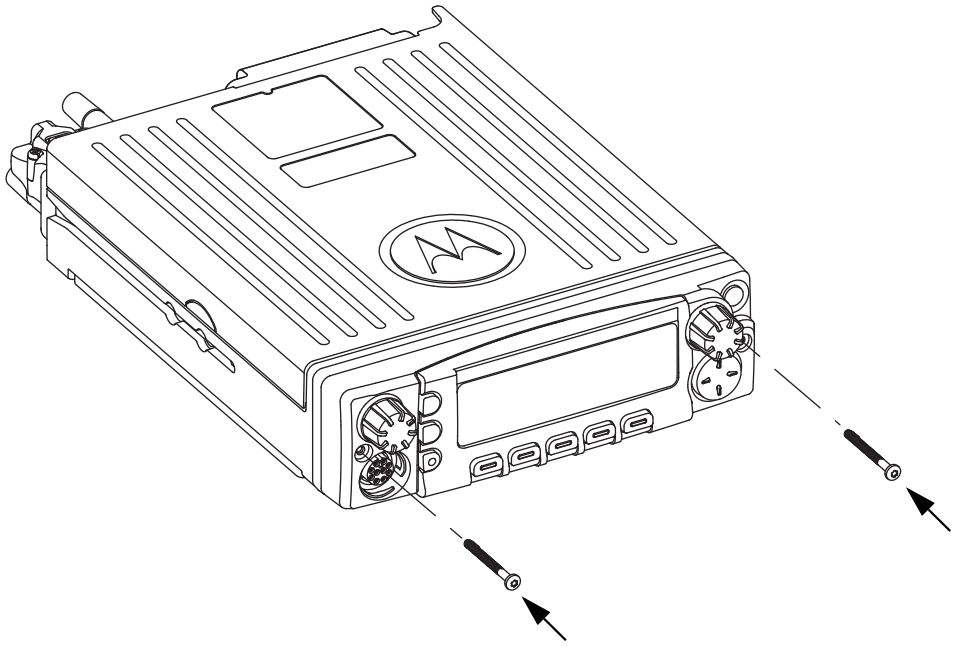
Figure 111: Installing Control Head/TIB Flex to Control Head/TIB



1	TIB
2	Control Head

3. Align control head to the front of the chassis using the frame seal. Install two control head screws. Ensure that the control head screws each have one washer and one seal installed. Torque the control head screws to 8–10 in-lbf.

Figure 112: Aligning Control Head/TIB front of chassis, and Installing the Control Head/TIB screws



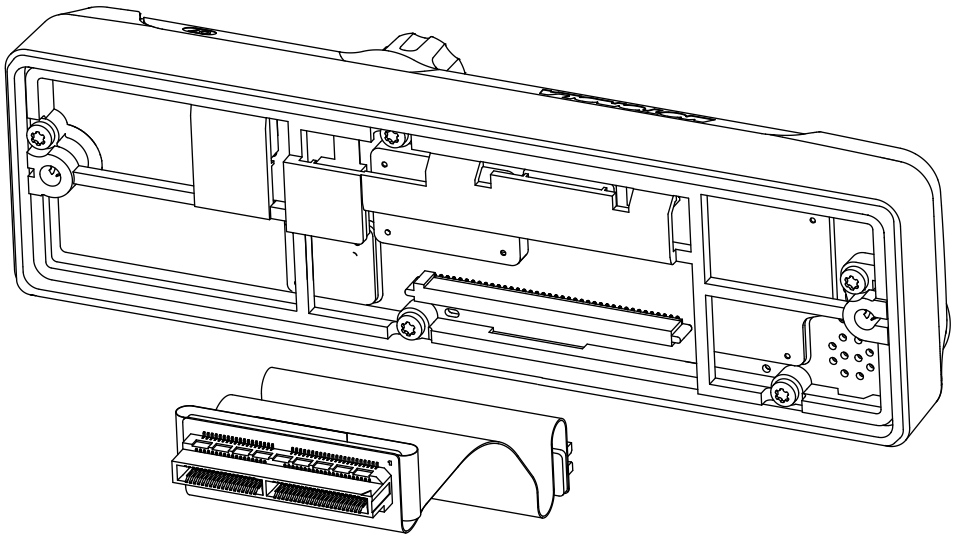
8.1.4.4

O7 Radio Reassembly

Procedure:

1. Attach the transceiver flex connector to the control head connector. Align the connectors properly before connecting.

   Figure 113: Installing the Transceiver Flex onto the Control Head

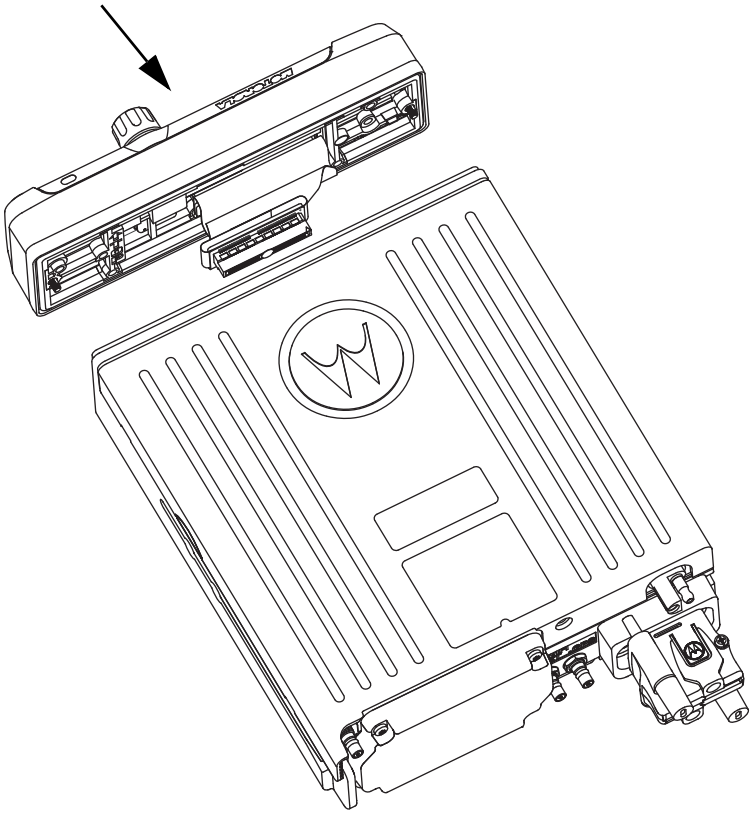
   IMPORTANT: Each Control Head has a unique Dash Mount flex. Do not mix and match. Only use the appropriate flex with its matching Control Head.

2. Align the I-seal with the control head and push the I-seal into place.

   NOTE: Be careful not to damage the transceiver flex when pushing the I-seal into place.

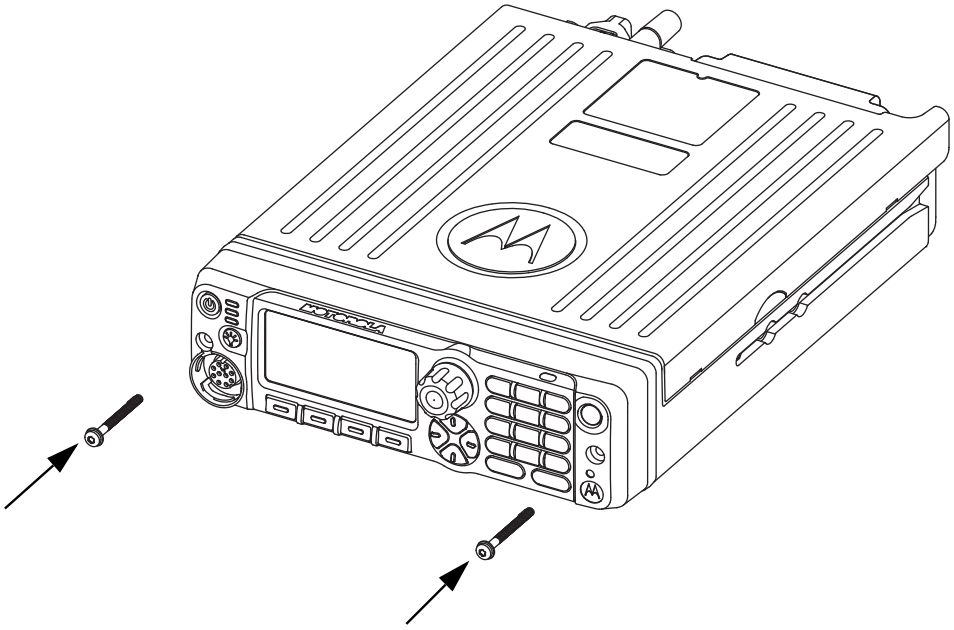
3. Grasp the handle at the transceiver end of the transceiver flex and plug the edge card connector onto the edge card.
4. Align the control head with transceiver and push the control head into place on the transceiver.

Figure 114: Attaching the Control Head to the Transceiver



5. Secure the control head to transceiver with two new transceiver screws using T10. Apply 9 in.lbs. torque for each screw.

Figure 115: Attaching the Transceiver Screws



8.1.4.5

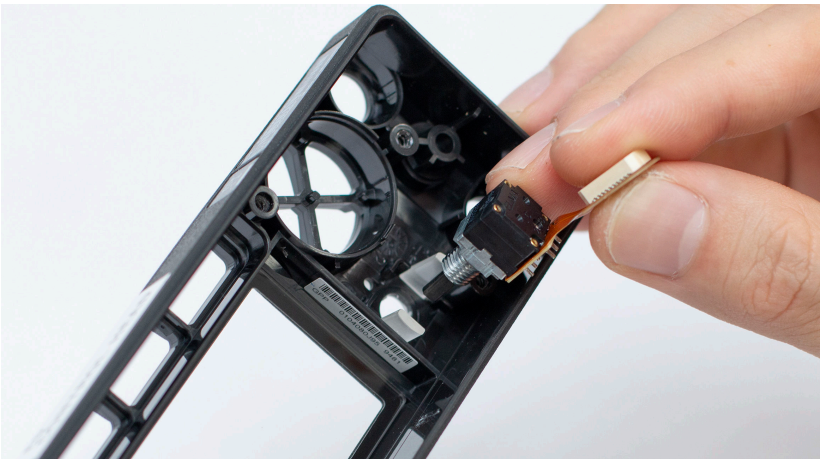
Reassembling the E5 Control Head

NOTE: Bracketed numbers are identical to item numbers shown in E5 Control Head Exploded View and Parts List on page 191.

Procedure:

1. To reassemble, ensure that the front housing is clean from any dust or debri.
2. Insert the volume assembly potentiometer and the frequency assembly switch on the front housing.

   Figure 116: Volume Assembly Potentiometer



3. Place the 3 Wave washers and using a hex nut driver, fasten the new encoder hex nut [torque to 4.5 in. lbs.].

   Figure 117: Installing 3 Wave Washers

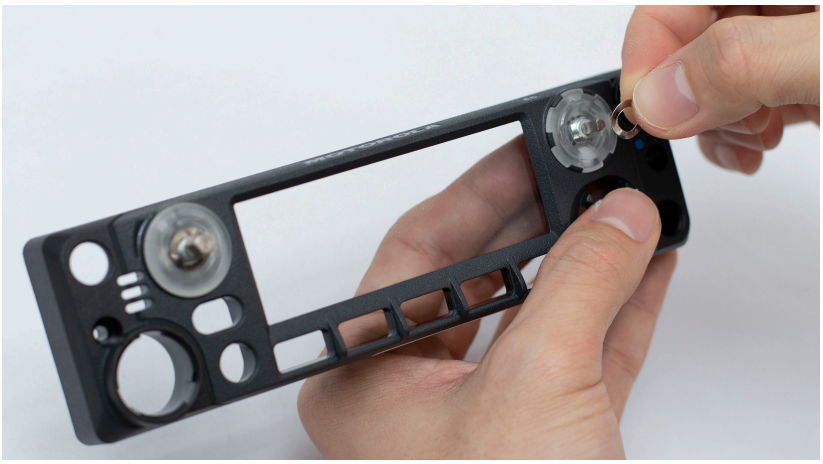
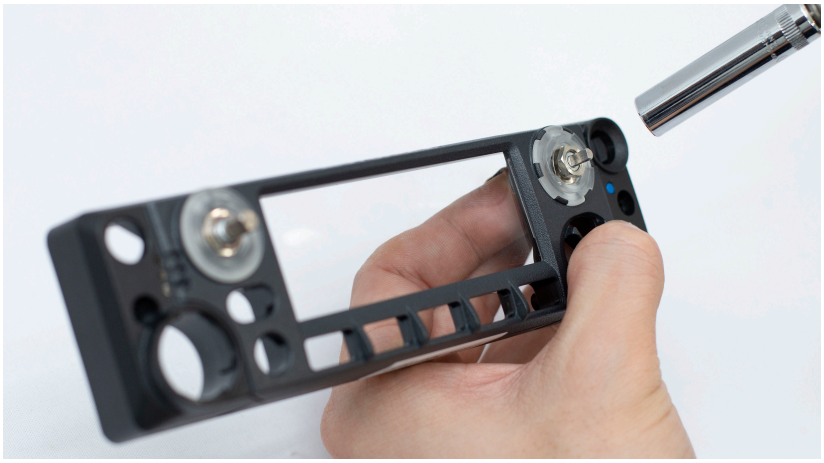


Figure 118: Fastening Hex Nut



4. Slot in the torque washers and install both the volume and frequency knobs.

Figure 119: Torque Washer

Figure 120: Installing Volume and Frequency Knobs

5. Slot in the following parts and ensure that they are fully seated into the front housing:

Figure 121: Power Button and Indicator Lights assembly [9][10][11]

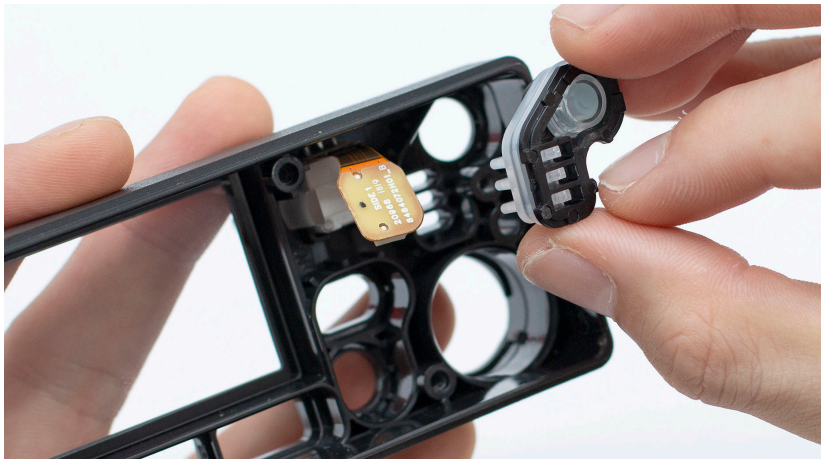


Figure 122: Programmable Button [12] and Programmable Button Retainer [13]

Figure 123: Menu Button [18] and Menu Button Retainer [19]

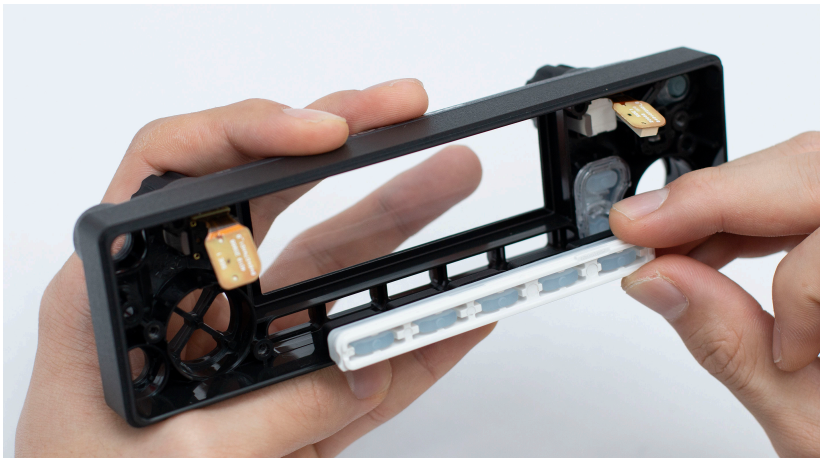


Figure 124: Navigation Button [16] and Navigation Button Retainer [17]

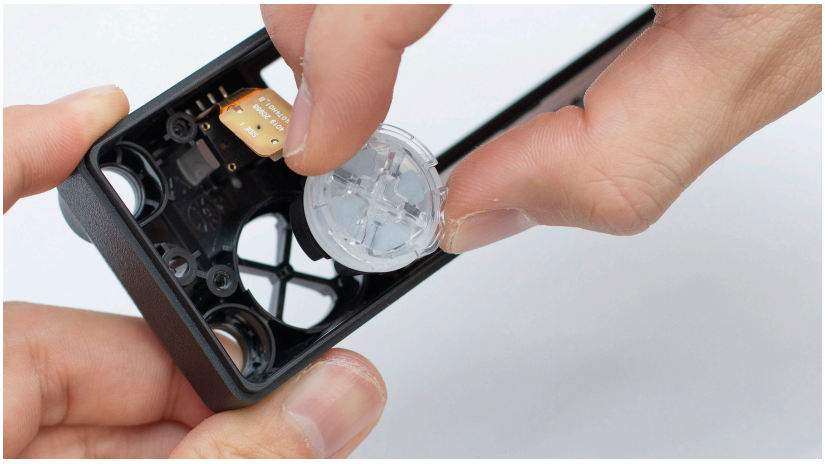


Figure 125: Home Button [14] and Home Button Retainer [15]

Figure 126: Emergency Button [20] and Emergency Button Retainer [21]

6. Install the color display module in the front housing.

Figure 127: Color Display Module

7. Place the Main Board PCB and Main Board retainer in the front housing and ensure that the flex assemblies are not covered.

Figure 128: Main Board PCB

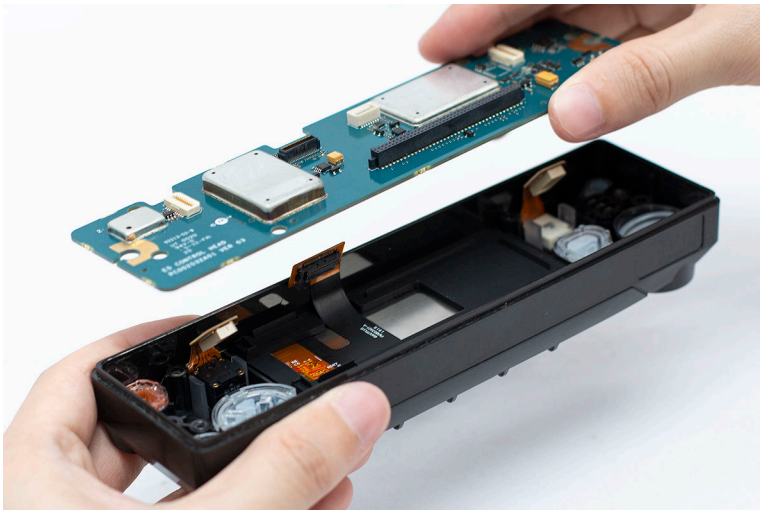
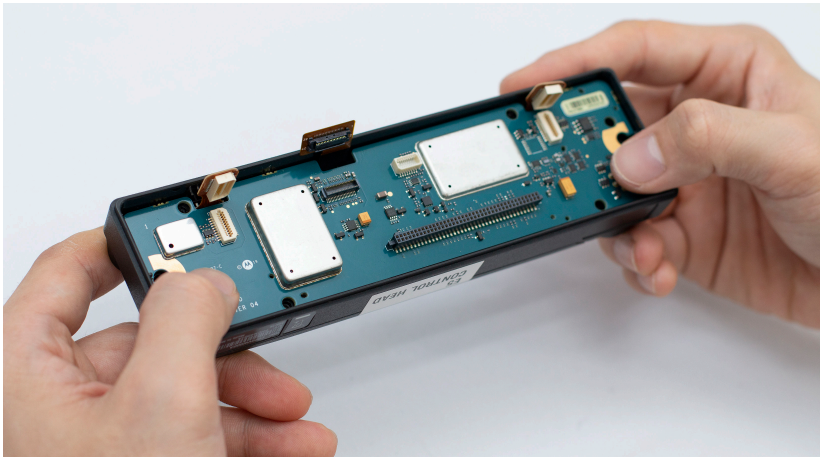


Figure 129: Volume, Frequency and Color Display Module Flex Assemblies



8. Plug in the frequency assembly flex, color display module encoder flex, and the volume assembly flex onto the Main Board PCB.

Figure 130: Frequency Assembly Flex

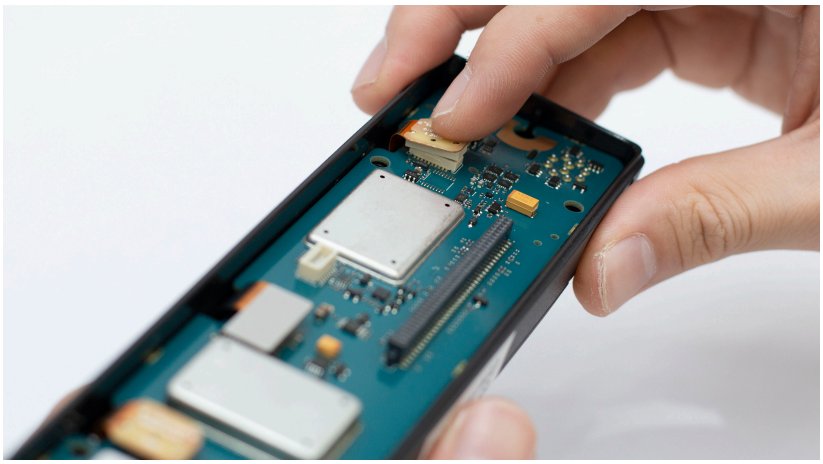


Figure 131: Color Display Module Flex

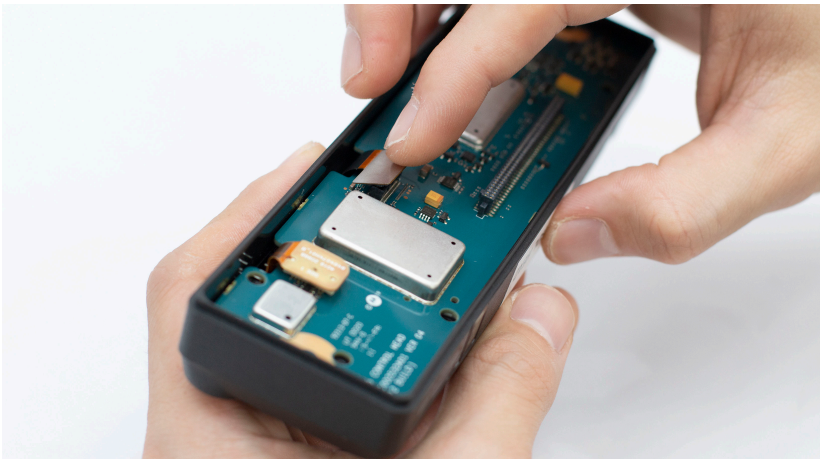
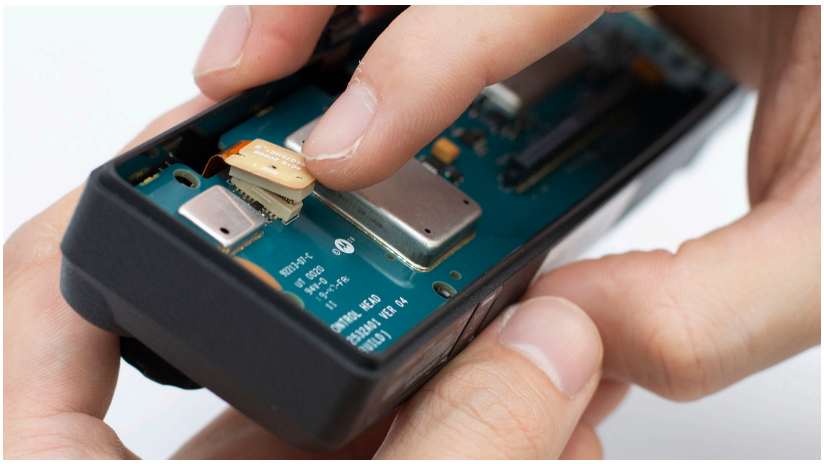
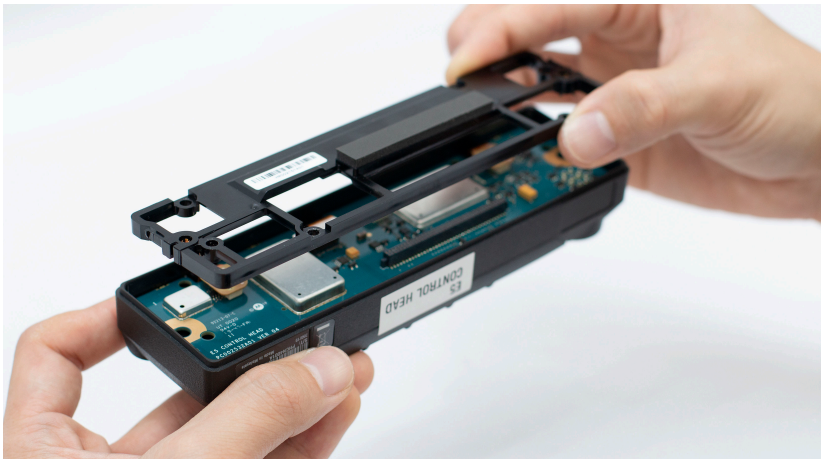


Figure 132: Volume Assembly Flex



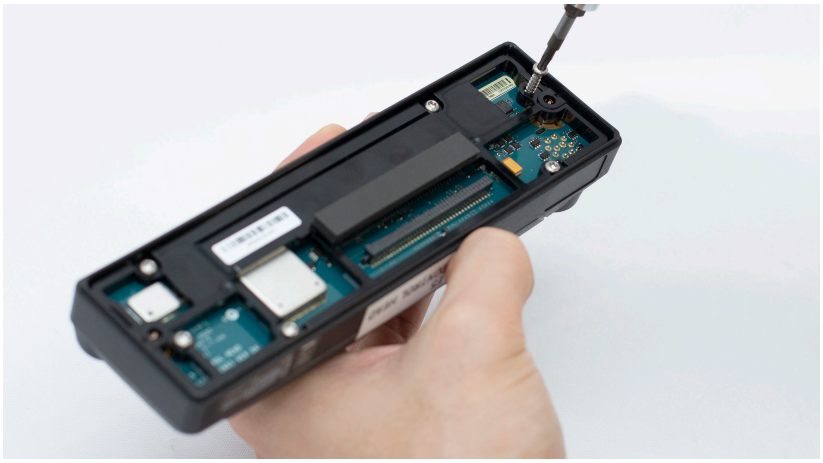
9. Place the main PCB retainer in the front housing, and it all the way to the left to ensure the screw bosses align with the corresponding holes in PCB and retainer.

Figure 133: Main PCB Retainer



10. Using a Torx T10 screwdriver, fasten the six PCB screws (torque to 6 in. lbs.).

Figure 134: Main PCB Retainer Screws



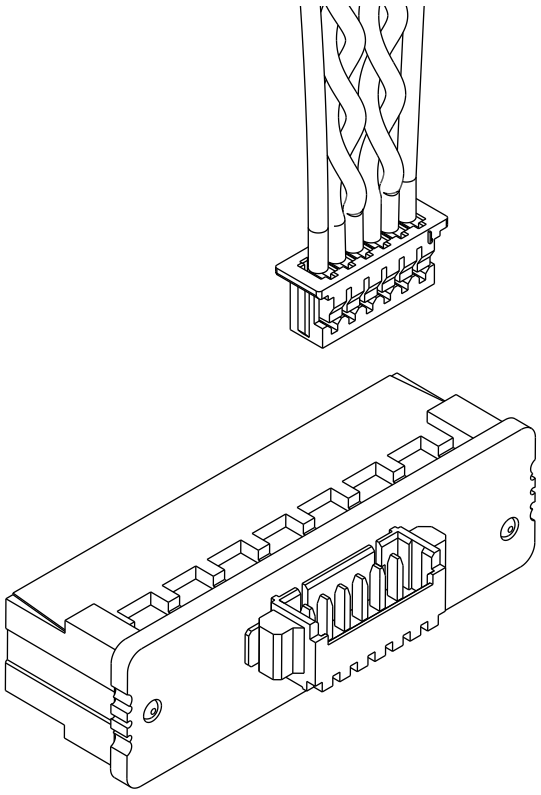
8.1.4.6

Reassembling the Remote Mount Ethernet Faceplate

Procedure:

1. Ensure that the frame seal is in place.
2. Attach the ethernet faceplate assembly connector to the edge card.

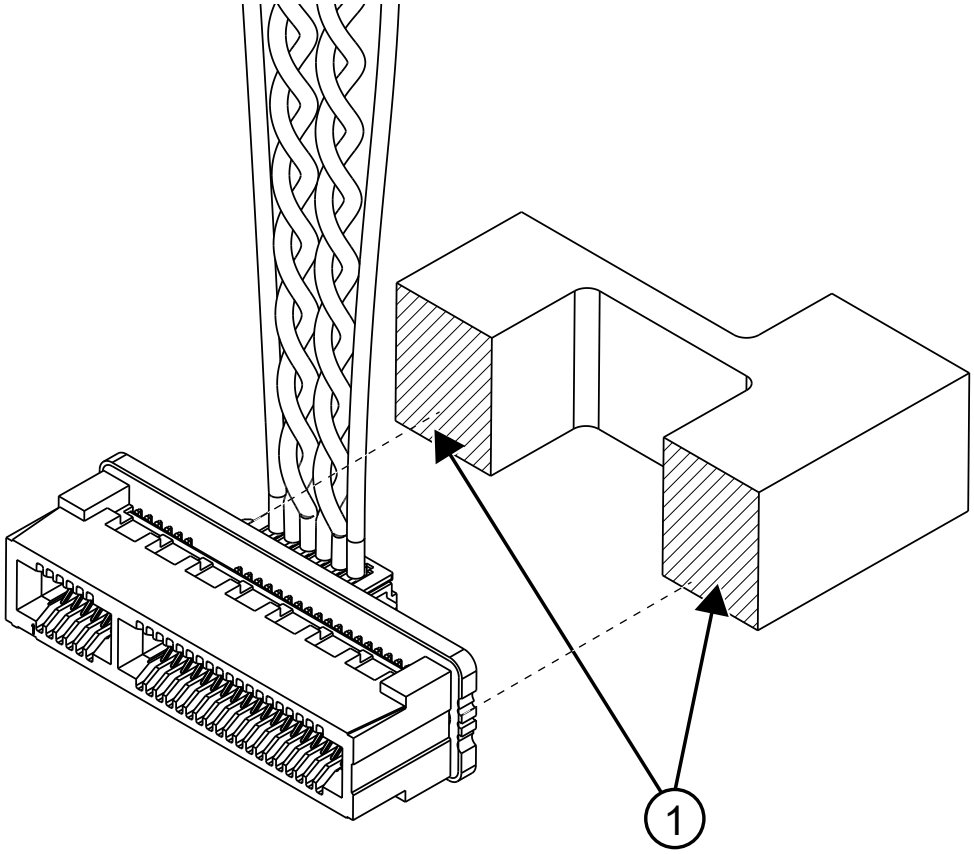
   Figure 135: Connecting the Ethernet Faceplate Assembly to the Edge Card



3. Remove the adhesive liners from the support pad.

4. Attach the support pad to the edge card.

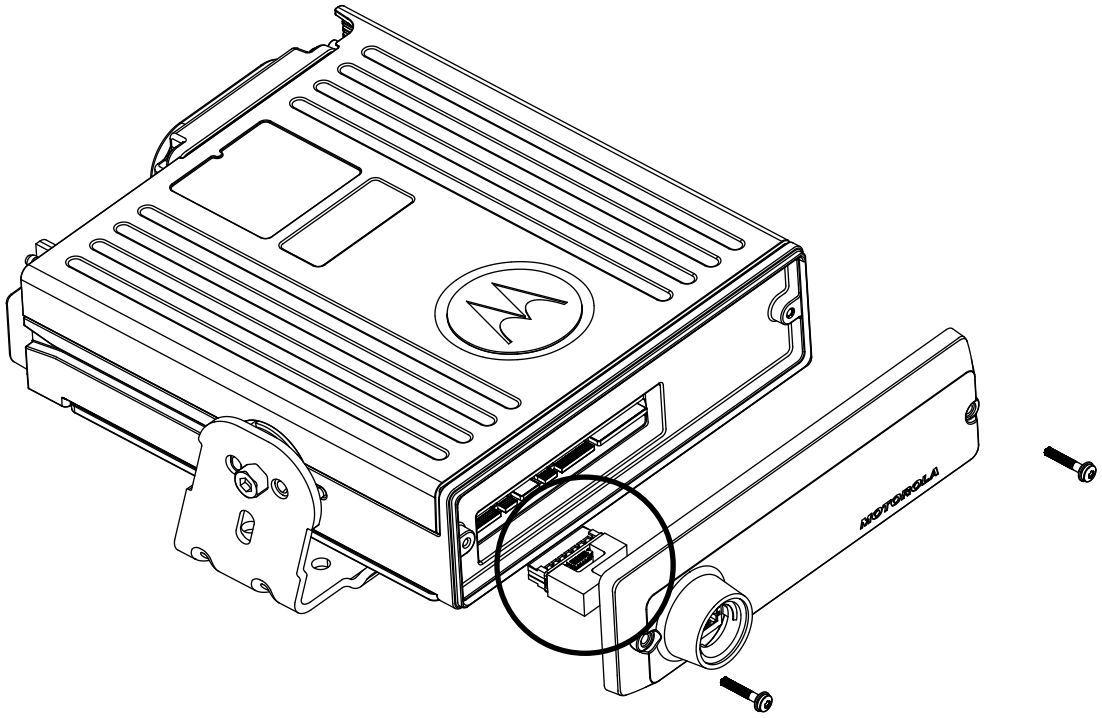
Figure 136: Attaching the Support Pad to the Edge Card



Number	Description
1	Support Pad Adhesive Liners

5. Attach the ethernet faceplate edge card assembly to the transceiver. Ensure to align the connector to the exposed edge card.

Figure 137: Attaching the Edge Card to the Transceiver

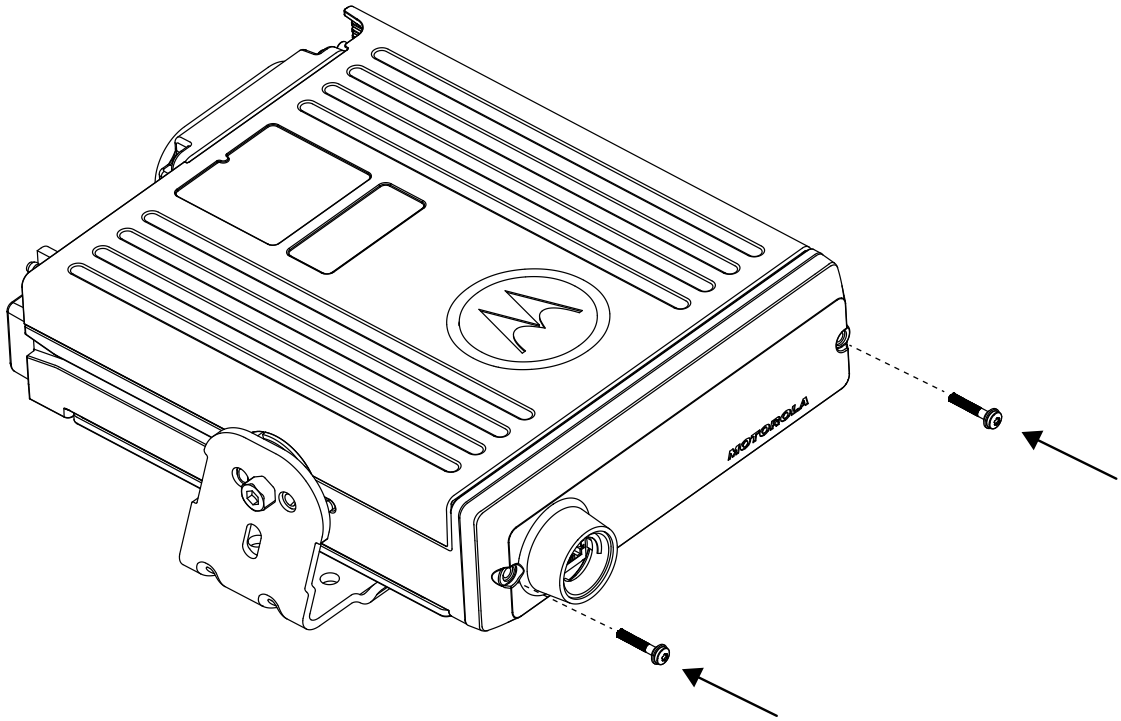


6. Align the ethernet faceplate assembly to the front chassis by the frame seal.
7. Install the control head screws or the TIB screws.

   NOTE: Ensure that each screw has one washer, and one seal installed.

8. Torque the control head screws or the TIB screws to 8-10 in-lbf.

Figure 138: Aligning Ethernet Faceplate Assembly to Front Chassis, and Installing the Control Head Screws or TIB Screws



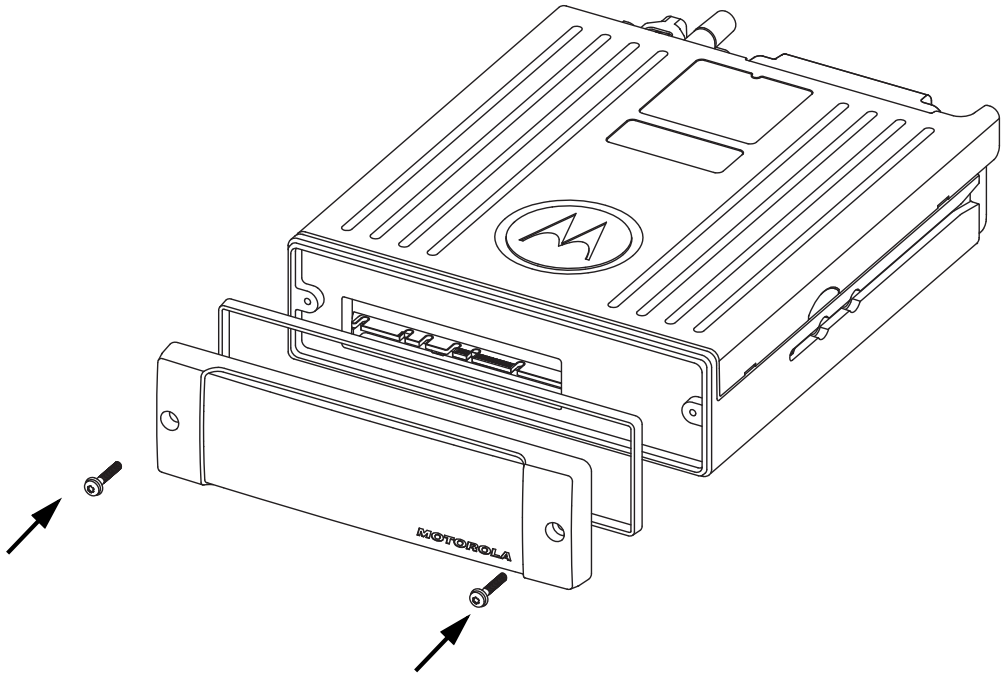
8.1.4.7

Reassembling the Remote Mount Standard Faceplate

Procedure:

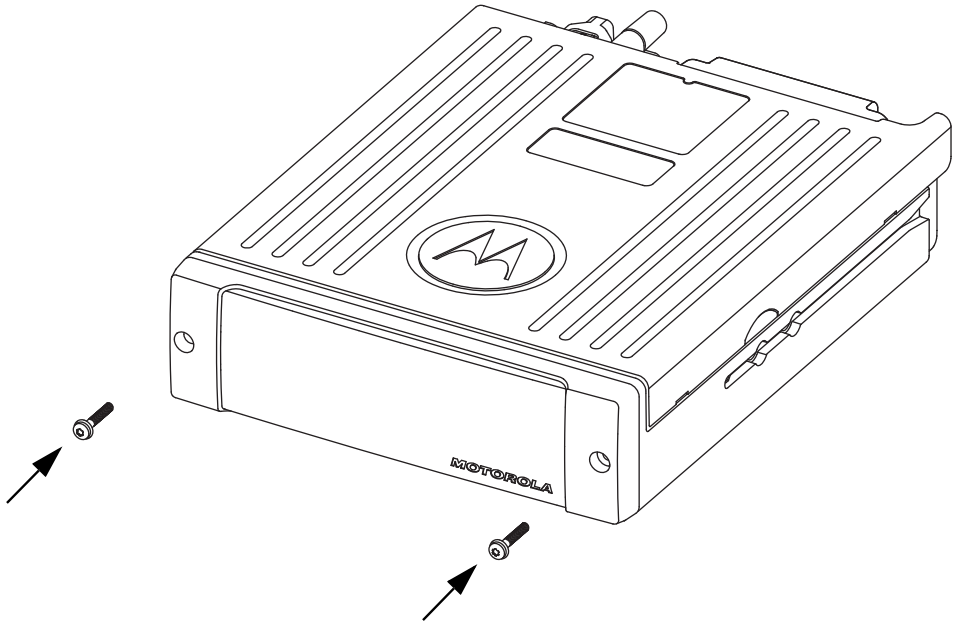
1. Align Remote Front Cover Plate to front of chassis. Ensure that the seal is fully seated in the cover plate.

Figure 139: Reinstalling Remote Front Cover Plate



2. Install two control head screws. Ensure that the control head screws each have one washer and one seal installed. Torque control head screws to 8-10 in-lbf.

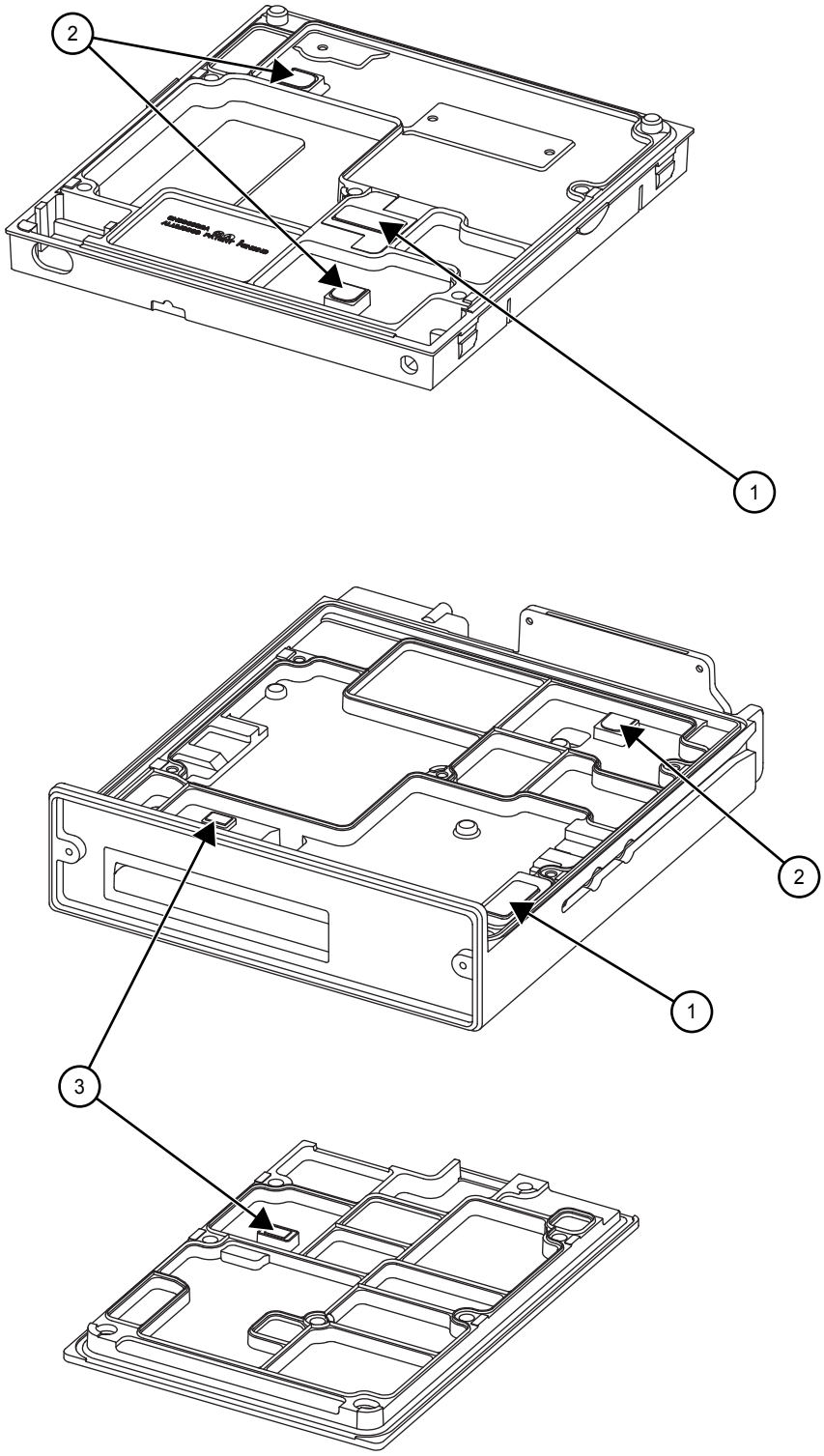
Figure 140: Attaching the remote screws



8.2

Chassis Thermal Pad Replacement

Figure 141: Chassis Thermal Pad and Grease Locations



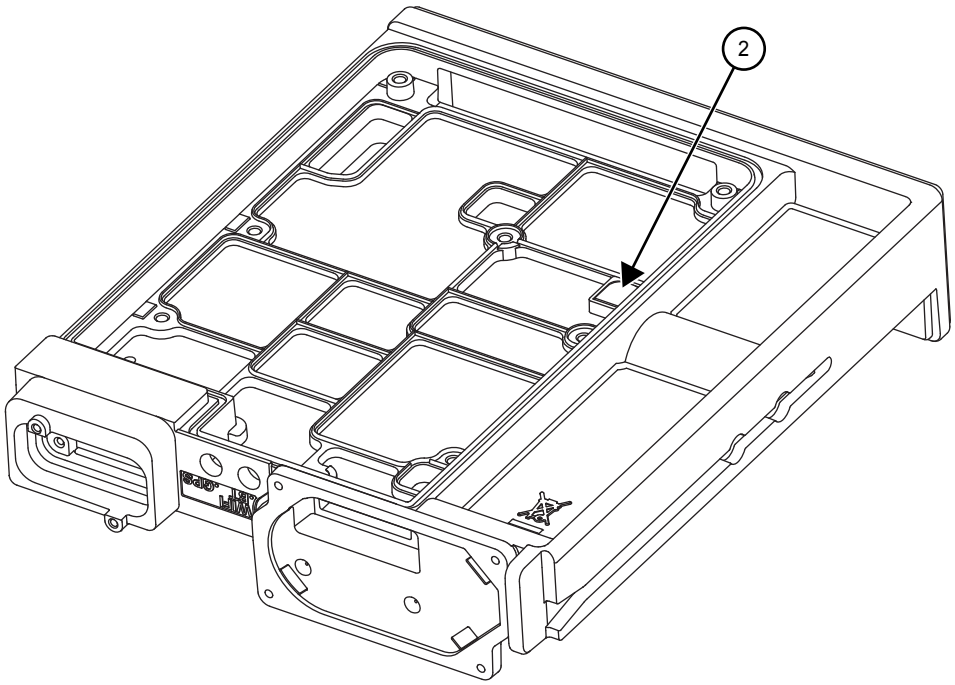


Table 40: Chassis Thermal Pad and Grease Part Numbers

Item No.	Part No.	Description
1	7575935B01	Pad, Thermal, Harmonic Filter
2	7575767B01	Pad, Thermal, Regulator
3	HW000572A02	Pad, Thermal, TX
n/a	1110022D23	Thermal Grease

8.2.1
Replacing the Chassis Thermal Pad-Mid Power Models

Procedure:

1. Use a plastic flat-edge tool (like a black-stick solder aid) to lift the pad from the chassis surface.
2. Discard the old pad. Use a soft cloth to remove any remaining residue. Alcohol can also be used, if necessary. Care should be taken to minimize any cleaning-agent contact with the surrounding shield gasket.
3. Once the surface is clean and dry, use a pair of tweezers to remove a new pad from the shipping liner, and place it yellow-side down on the chassis.
4. Apply pressure to the pad to activate the pressure-sensitive adhesive. If applicable, remove the blue liner with a pair of tweezers.

CAUTION: Use of a metal tool will scratch the heat sink surface and reduce the thermal effectiveness of the thermal pad which is used to heat sink heat-sensitive components. Loss of thermal effectiveness of the thermal pads could result in the overheating of heat-sensitive radio components and result in their damage.

8.3

Fastener Torque Chart

Table 41: Fastener Torque Chart on page 162 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 41: Fastener Torque Chart

Part Number	Description	Repair Torque (in.–lbs.)	Locations Used In A Radio
0310909A33	Screw, Torx M3x10	12–14	RF Board / Accessory Connector to Chassis
0385870E01	Screw, Torx M4.0xP0.7x25	34–36	RF Covers and Controller Covers
0364332H02	Screw, Torx M3.0xP0.5x32.5	8–10	O5 Control Head
0364332H04	Screw, Torx M3.0xP0.5x18.0	8–10	Remote Front Coverplate Screws
0371838H01	Screw, Torx M2.5xP0.45x12.0	6–8	Accessory Connector to External Chassis
0371859H01	Screw, Torx M6.0xP1.0x25.0	50–52	Trunnion Mounting
02009258001	GPS Hex Nut	12–14	GPS/BT/Wi-Fi Connector
03012052001	Screw, Torx M3.0xP0.5x26.0	12–14	O2 Rear Housing
03012063001	Screw, Torx M4.0xP0.7x18.0	8–10	O2 Front Housing
03012062001	Screw, Torx M3.0xP0.5x38.0	8–10	O7 Control Head

Chapter 9

Radio PINOUT Functions, Error Codes, and Basic Troubleshooting

This section can help you isolate a problem to the board level. Board-level troubleshooting does not attempt to isolate problems to the component level.

Component-level service information can be found in the respective detailed service manual. (See Related Publications on page 20 section of this manual for the specific manual number.)

NOTE: To access the various connector pins, use the housing eliminator/test fixture along with the diagrams found in this section of the manual. (See Service Aids and Recommended Tools on page 60 for the appropriate Motorola Solutions service aids and tools parts numbers.)

CAUTION:
Except for some inputs on service monitors, a suitable attenuator rated at 100 W or more should always be used with all test equipment connected to the RF connector. Failure to do so can result in test equipment damage.

When performing both transmit and receive tests, the radio transmitter can possibly damage the equipment. Damages could occur under the following conditions:

- Trunking-mode affiliation
- Missing emergency jumper
- Defective PTT button
- Unintentional PTT activations
- Circuit board malfunction

Therefore, an attenuator is always recommended.

9.1 External Connectors

This section describes the external connectors that are supported on this radio.

9.1.1 J700 TIB – Mobile Microphone Port

The Mobile Microphone Port (MMP) connector is on the O2, O7, O5, O9, and E5 control heads and the Transceiver Interface Board (TIB).

The following figure and table illustrate the connector and the function of each pin.

Figure 142: J700 MMP Connector

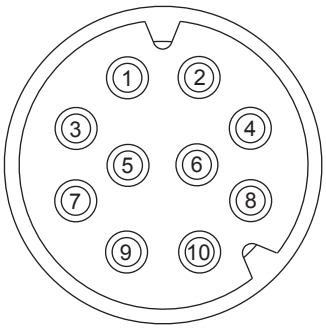


Table 42: MMP Connector Signal Descriptions

Pin #	Pin Name		Pin Function
	Control Head (J1)	TIB (J700)	
1	1-Wire®	1-Wire®	Signal used to identify an accessory.
2	PTT	PTT_GPIO3	Active low Push-To-Talk input. Asserting this input results in MIC_HI microphone input use. Distinguished from PTT at the rear J2 MAP connector, which uses the AUX_MIC microphone input.
3	SPK	SPK	Receive audio out designed to drive a 150 Ω load.
4	USB_D-/ RS232_RX_5v	USB_D-/ RS232_RX_5v	Multiplexed USB D- and RS232 receive signal. The interface used is based on a 1-Wire® read of the connected accessory. The RS232 signals are CMOS levels, 0-5 V.
5	GND	GND	Ground.
6	VBUS/OPT_5V	VBUS/OPT_5V	On both the control head and the TIB, when the MMP port is configured as a device, this pin is the VBUS input used for enumeration. When the MMP port is configured as a host, this pin is the VBUS output, capable of sourcing 500 mA.
7	MIC_HI	MIC_HI	Microphone audio input (80 mVrms nominal) associated with the PTT signal at pin 2. Distinguished from AUX_MIC at the rear J2 MAP connector.
8	USB_D+/ RS232_TX_5v	USB_D+/ RS232_TX_5v	Multiplexed USB D+ and RS232 transmit signal. The interface used is based on a 1-Wire® read of the connected accessory. The RS232 signals are CMOS levels, 0–5 V.
9	HUB/KEYFAIL	KEYFAIL/ GPIO_4	Multiplexed HUB and KEYFAIL lines on the control head. The TIB has KEYFAIL or GPIO_4 functionality.
10	GPIO_0	GPIO_0	General Purpose Input/Output 0.

9.1.2

J2 Mid Power Transceiver – Data and Audio Rear Interface

J2 or MAP interface is located at the back of the radio.

The following figure and table illustrate the connector and the function of each pin. Order the Male crimping pin according to the wire gauge for the accessory. Order part number 3980034F05 for 22–28 gauge wire and 3980034F04 for 18–20 gauge wire.

Figure 143: J2 Rear Accessory Connector

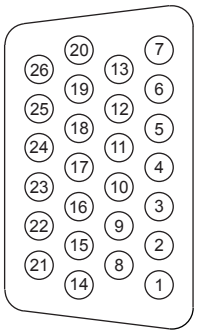


Table 43: J2 Rear Accessory Connector Signal and Voltage Descriptions

Pin #	Pin Name		Pin Function
1	GROUND	Ground	Preferred ground for any digital lines on J2.
2	BUS+ or USB2+	SB9600 BUS+ or USB2+	Part of the Motorola Solutions SB9600 communications bus to connect external devices. It is used for the USB host interface. Defaults to BUS+. Idles at +5 V.
3	BUS- or USB2-	SB9600 BUS- or USB2-	Part of the Motorola Solutions SB9600 communications bus to connect external devices. It is used for the USB host interface. Defaults to BUS-. Idles at 0 V.
4	RS232_TX_9V	RS232 Transmit Data	Part of the 4-wire RS232 interface to the external data accessories, programming cables, and other accessories.
5	RS232_RX_9V	RS232 Receive Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, and other accessories.
6	USB-	USB-Data	Part of the 2-wire USB device differential data bus that is used to connect to items such as a programming cable or a modem.
7	USB+	USB+Data	
8	RESET/ USB2_VBUS_H	SB9600 RESET or	Part of the Motorola Solutions SB9600 communications bus to connect to the external devices. In

Pin #	Pin Name		Pin Function
		USB2_VBUS_HOST	USB Host mode, this signal is the 5 V VBUS supply to a downstream device. Defaults to RESET.
9	BUSY	SB9600 BUSY	Part of the Motorola Solutions SB9600 communications bus to connect to the external devices. Defaults to BUSY.
10	RS232_RTS_9V or AUX_TX	RS232 Request-To-Send or AUX_TX	Part of the 4-wire RS232 interface to external data accessories. An output of normally +9 V no load. It is also known as TX_audio. This pin is an input to the radio. This input is routed to the transmitter through multiplexed lines that are controlled by the microprocessor. Nominal input level is 300 mVrms.
11	RS232_CTS_9V	RS232 Clear-To-Send	Part of the 4-wire RS232 interface to external data accessories. An input normally at +9 V no load.
12	USB_VBUS_D	USB_VBUS_DEVICE	5 V VBUS input for USB connectivity, supplied by the USB Host such as a programming cable.
13	CHAN ACT	Channel Activity	Active low output used to indicate detection or unsquelching of a qualified received signal (idles at 5 V). It can be configured as an optional logic input or output signal.
14	GROUND	Ground	Preferred ground for any of the analog lines on J2.
15	EMERGENCY	Emergency	Input used to detect emergency activation. This pin must be connected to the ground by a cable if emergency is disabled. If enabled, this line must be grounded through a switch that is normally closed.
16	AUX PTT	Push-To-Talk	Pulling this line to ground activates PTT function, normally selecting the AUX_MIC input.
17	ONE WIRE	1-Wire® data	0–5 V bidirectional data used for identification of smart accessories or cables.
18	VIP OUT 1	Vehicular Interface Output	High-voltage open drain output used for enabling relays used for accessories such as horn/lights.
19	VIP OUT 2	Vehicular Interface Output	
20	SPKR+	Speaker +	Used along with SPKR- to connect an external speaker. The audio PA is a bridge amplifier. See Radio Specifications for speaker impedance and loads.
21	RX FILT AUDIO	Receive Filtered Audio Out	Signal is a fixed level (independent of volume level) received audio signal, including alert tones. Flat or de-emphasis is programmed by the CPS. Output voltage is approximately 100 mVrms per 1 kHz of deviation.

Pin #	Pin Name		Pin Function
22	MONITOR	Monitor over-rides PL	Active low input used to detect when a rear micro-phone accessory is taken 'off-hook' to over-ride PL to alert the user to busy traffic before transmitting (idles at 5 V). It can be configured as an optional logic input or output signal.
23	AUX MIC or MIC OUT	Rear micro-phone input or microphone out-put	The nominal input level is 80 mVrms for 60% devi-ation for motorcycle and support 300 mVrms for future APCO accessories. The DC impedance is 1560 Ω and the AC impedance is 560 Ω, 1 Vrms max. 9 VDC with no input load. This pin can be configured as a line level output of the microphone audio in a siren (PA mode) or an external recorder. The nominal amplitude is 75 mVrms.
24	SW B+	Switched Battery Voltage	A+ battery voltage is available when the radio is switched on. Used as supply for certain J2 accessories.
25	IGN sense (ACC)	Vehicle Ignition sense (ACC)	Connecting to the ACC line controlled by the vehi-cle ignition switch that allows CPS ignition features such as “ignition required for turn on” to be used. Connecting this line to the car battery defeats the CPS ignition features.
26	SPKR-	Speaker -	Used with SPKR+ to connect an external speak-er. The audio PA is a bridge amplifier. See Radio Specifications for speaker impedance and loads.

9.1.3

J800 TIB – Controller Area Network (CAN) Interface

The J800L and J800R are on the Transceiver Interface Board (TIB). These two connectors are identical, to aid in future daisy-chaining of other CAN bus accessories. They provide the data, digital audio, and power on/off/reset commands for the control head to radio communications.

Refer to the *Installation Manual* to order part numbers for various lengths of the CAN remote mount cables. The following figure and table illustrate the connector and the function of each pin.

Figure 144: J800 Controller Area Network (CAN) Connector on TIB

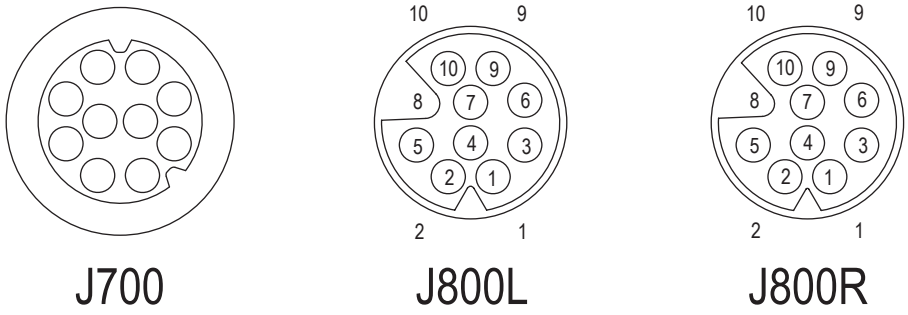


Table 44: J800 Controller Area Network Connector Pin Functions

Pin #	Pin Name	Pin Function
1	CAN_1_HIGH	TX+ (AUDIO)
2	CAN_1_LOW	TX- (AUDIO)
3	CAN_3_HIGH	TX+ (PWR) Dedicated for System ON/OFF/RESET commands.
4	CAN termination detect pin	Pin 4 shorted to GND inside each end of the CAN cable.
5	A+	Only routed on the “03” CAN cable
6	CAN_3_LOW	TX- (PWR) Dedicated for System ON/OFF/RESET commands.
7	GND	Drain wire wrapped around GND shield
8	NO PIN	N/A
9	CAN_2_HIGH	TX+ (DATA)
10	CAN_2_LOW	TX- (DATA)

9.2 Replacement Board Procedures

Once a problem has been isolated to a specific board, use one of the following recommended repair procedures:

- Install a good board from your inventory into the radio.
- Order a replacement board from Radio Products Services Division at 1-800-422-4210. Refer to Replacement Parts Ordering on page 216 for further information.

9.3 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs cursory tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio display.

The presence of an error should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors inhibit user operation and non-fatal errors do not inhibit user operation. Use the following table to aid in understanding particular power-up error code displays.

Table 45: Power-Up Error Codes

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.

Error Code	Description	Corrective Action
01/81	Host ROM Checksum Fatal Error	Send radio to depot.
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug.
01/88	External RAM Fatal Error **NOTE:** Not a checksum failure	Send radio to depot.
01/90	General Hardware Failure Fatal Error	Turn off the radio, then turn it 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/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	Send radio to depot.
02/90	General DSP Hardware Failure (DSP startup message not received correctly)	Turn the radio off, then turn it on.
09/10	Secure Hardware Error	Turn the radio off, then turn it on. May have keyload required in CPS for encryption.
09/90	Secure Hardware Fatal Error	Turn the radio off, then turn it on.
15/10	External Accessory Non-Fatal Error External Accessory is not present on power-up or did not power up correctly, and the external accessory feature is enabled in the codeplug.	Verify that the external accessory is connected and powered up. Turn the radio off, then turn it on.
15/90	External Accessory Fatal Error External Accessory is not present on power-up or did not power up correctly, and the external accessory feature is enabled in the codeplug.	Verify that the external accessory is connected and powered up. Turn the radio off, then turn it on.
SW/HW Mismatch	Control Head hardware does not match the radio software.	Update the radio software to a version that matches the Control Head hardware. Send the radio to depot if issue persists.

9.4 Operational Error Codes

The radio performs dynamic tests to determine if the radio is working properly when it is in operation. Problems detected during these tests are presented as error codes on the radio display.

The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted.

Table 46: Operational Error Codes

Error Code	Description	Error Type	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	NON-FATAL	Reprogram the code-plug. Send the radio to depot if issue persists.
FAIL 002	Personality checksum or system block error	NON-FATAL	Reprogram the code-plug.

9.5 Transmitter Troubleshooting

The following table can help you troubleshoot problems that might occur in the transmitter section of your radio.

Table 47: Transmitter Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
No RF Power Output	Tx Power Level Programming	Check Tx power level programming (from the appropriate Customer Programming Software).
	Radio Transceiver or Transmitter Board	• Refer to the *Detailed Service Manual*. • Send radio to depot for repair.
Distorted Modulation	Bandwidth	• Ensure that the correct bandwidth is selected (use the appropriate Customer Programming Software). • Ensure that the radio is properly tuned. (See Radio Alignment Procedures on page 79)
	Compensation Not Set/Working (DPL Distorted)	Check the compensation setting. If compensation will not adjust, refer to "Cannot Set Compensation".
	Radio Transceiver or Transmitter Board	• Refer to the *Detailed Service Manual*. • Send radio to depot for repair.
No Modulation, Bad Microphone Sensitivity	Check Deviation and Compensation	Retune, if necessary. (See Radio Alignment Procedures on page 79)
	Microphone	• Verify that the microphone is correctly plugged into the MMP connector. Replace if necessary.

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
		• Otherwise, refer to the *Detailed Service Manual*. • Send radio to depot for repair.
No/Low Signaling (PL, DPL, Trunking, MDC)	Check Programming or Radio Transceiver Board	• Refer to the *Detailed Service Manual*. • Send radio to depot for repair.
Cannot Set Compensation	Deviation and Compensation	Vary deviation and compensation controls from maximum to minimum using softpots in the **Tx Deviation Balance** screen and **Tx Deviation Limit** screen (using the appropriate radio-programming software – see Radio Alignment Procedures on page 79).
	Radio Transceiver Board	• Refer to the *Detailed Service Manual*. • Send radio to depot for repair.

9.6

Receiver Troubleshooting

The following table can help you troubleshoot problems that might occur in the receiver section of your radio.

Table 48: Receiver Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Radio does not power-up	Blown power fuse	Check the fuse in the red cable.
	Blown ignition fuse	Check the fuse in the ignition cable, yellow cable from CHIB, red cable from transceiver J2 connection. Note that the IGNITION field in the codeplug would need to be set to REQUIRED or IGN ONLY for the ignition fuse to affect power-up.
	Control Head	Refer to the *Detailed Service Manual* for control head troubleshooting. In addition, if the control head powers-up then powers-down roughly 8 seconds later (without displaying an error), the control head has failed. There may also be a failure on the dash flex between the head and the radio. Send control head to depot.
	Radio transceiver or transmitter board	If the radio does not draw at least 1 A during power-up, there may be a failure on either the transceiver board or the A+ connection between the transmitter/transceiver boards. Send radio to depot.
	CAN Cable	Ensure that the CAN cable is connected in remote systems.
Radio does not power-down	Radio Transceiver Board	Send radio to depot.
No Receiver Audio or Receive Does	Code Plug	Check the codeplug to ensure correct frequency and signaling (PL, DPL) is enabled (use the appropriate radio-programming software).

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Not Unsquelch	Speaker	Check for speaker leads shorted to ground or open speaker wires. Replace, if necessary.
	Radio Transceiver Board	Refer to the *Detailed Service Manual*. Send radio to depot.
Audio Distorted or Not Loud Enough	Codeplug	Ensure the codeplug is properly configured, including bandwidth and signaling.
	Synthesizer Not On Frequency/Working	See Aligning the Reference Oscillator on page 84.
	Radio Transceiver	Refer to the *Detailed Service Manual*. Send radio to depot.
RF Sensitivity Poor	Synthesizer Not On Frequency/Working	Check the local oscillator frequency. See Aligning the Reference Oscillator on page 84.
	Radio Transceiver	Refer to the *Detailed Service Manual*. Send radio to depot.
Radio does not Squelch	Codeplug	Check the offending channel for spurious activity by monitoring with a known-good radio or service monitor. If possible, remove the offending source (computer, etc.). If not, increase the squelch level using the appropriate radio-programming software.

9.7 Controller Troubleshooting

The following table helps you to troubleshoot problems that might occur in the controller section of your radio.

Table 49: Controller Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Control head display says `Maintenance Mode`	Remote mount CAN cable attached may be disconnected.	Verify that all cables are securely attached, including power to the radio.
	Flexes inside radio or control head may be loose.	Open Control Head and check if flex is securely attached.
Radio resets when PTT	Vehicle battery voltage too low to allow radio to transmit.	Try radio on bench with power tuned down, and power supply rated to at least 20 A. Try new vehicle battery.
Radio will not turn on	Incorrect codeplug setting for vehicle Ignition sense (ACC).	Reprogram the radio through CPS and refer to the Help section on possible Ignition settings and their functions. Verify that the Ignition sense (ACC) wire is attached at either the control head or the radio.

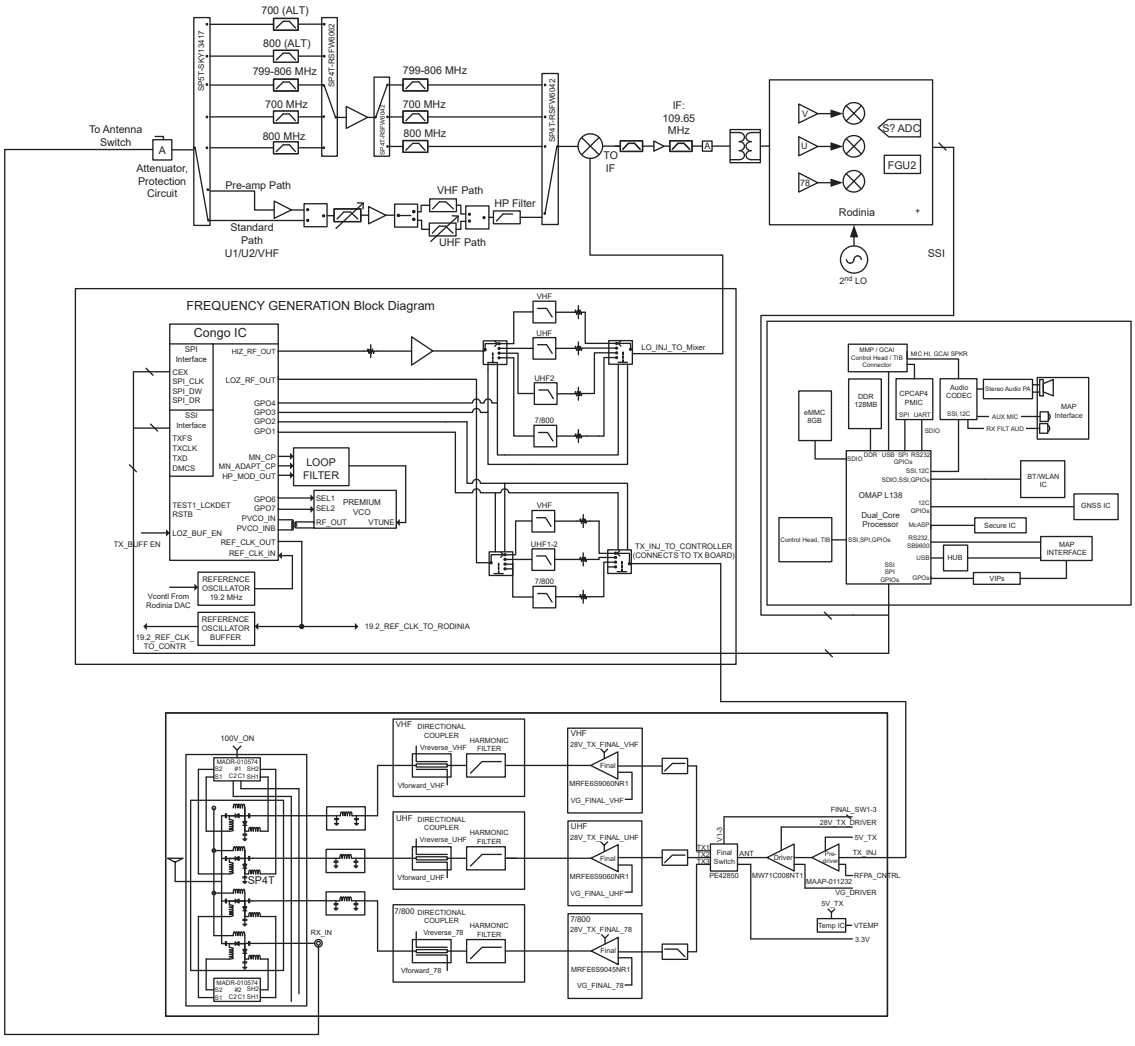
Chapter 10

Functional Block Diagrams and Connectors

This chapter contains the APX Mobile Radio functional block diagrams and connector locations.

10.1 APX Mobile Radio Transceiver Functional Block Diagram

Figure 145: APX Mobile Radio Transceiver Functional Block Diagram

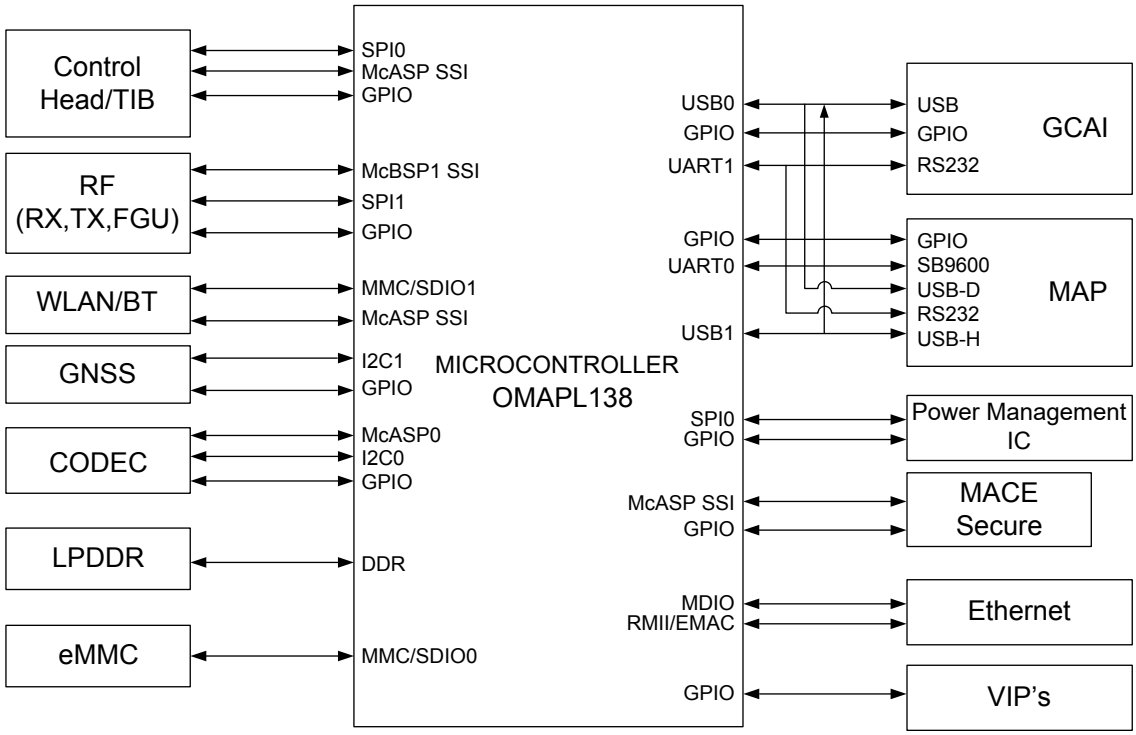


NOTE: Receiving ALT path (700ALT/800ALT) applicable to CN models only.

10.2

O3 Dash and Remote Control Head Functional Block Diagram

Figure 146: O3 Dash and Remote Control Head Functional Block Diagram



10.3

APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram

Figure 147: Transceiver Interface Board (TIB) CAN Functional Block Diagram

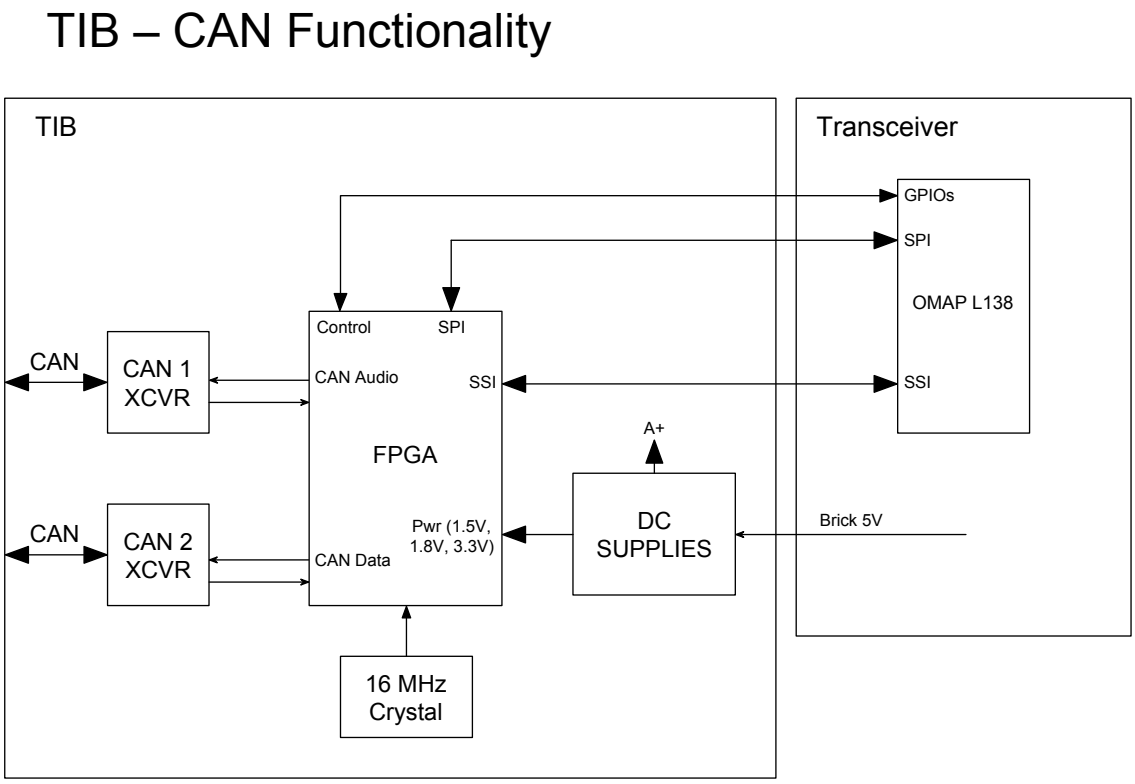


Figure 148: Transceiver Interface Board (TIB) CAN Functional Block Diagram Applicable to AS000016A_rev06 and Onwards

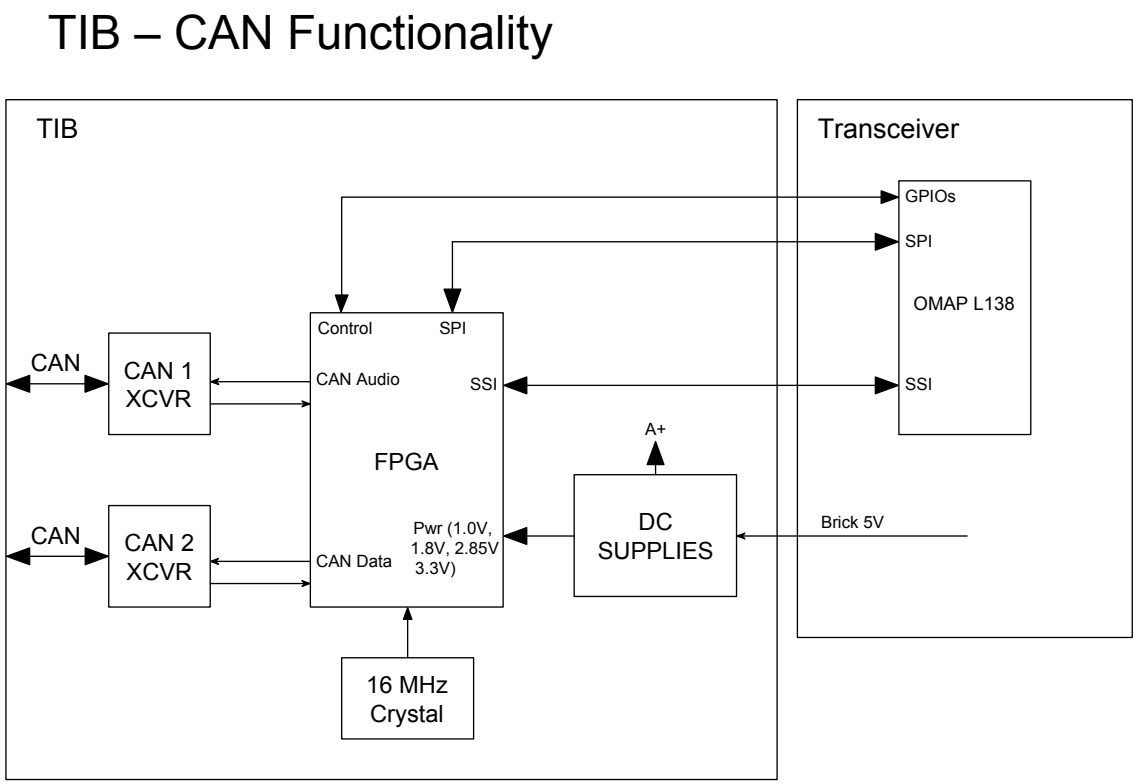
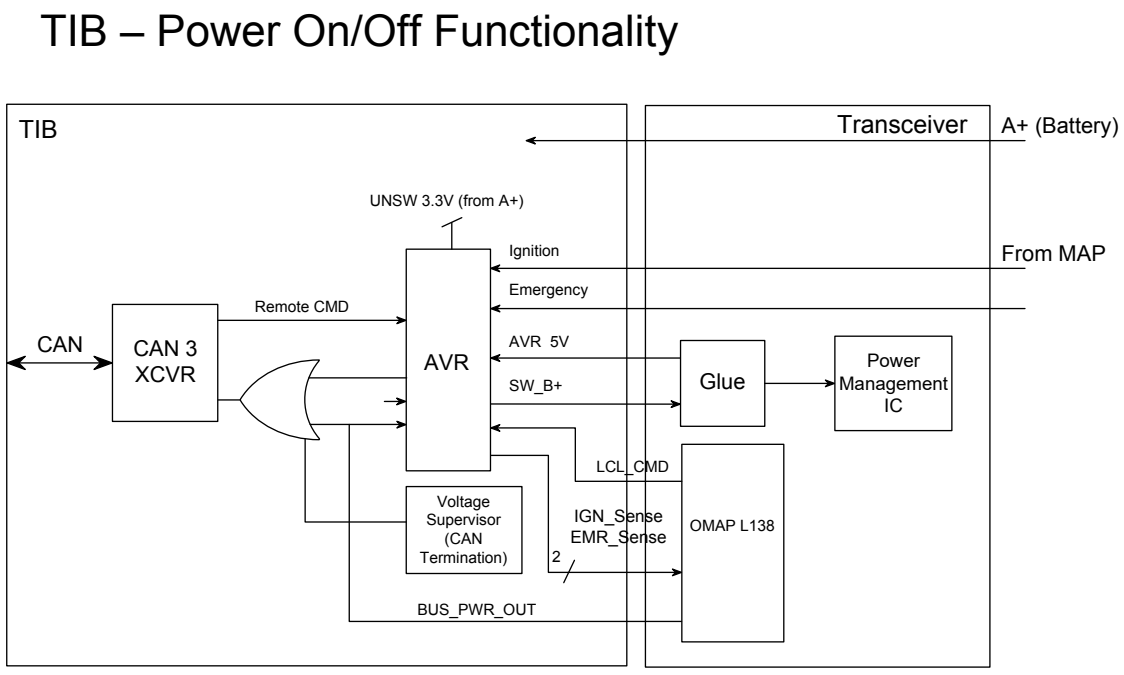


Figure 149: Transceiver Interface Board (TIB) Power On/Off Functional Block Diagram



10.4

O3 Radio Connector Locations

Figure 150: O3 Dash-Mount Radio Connector Locations (Mid Power Only)

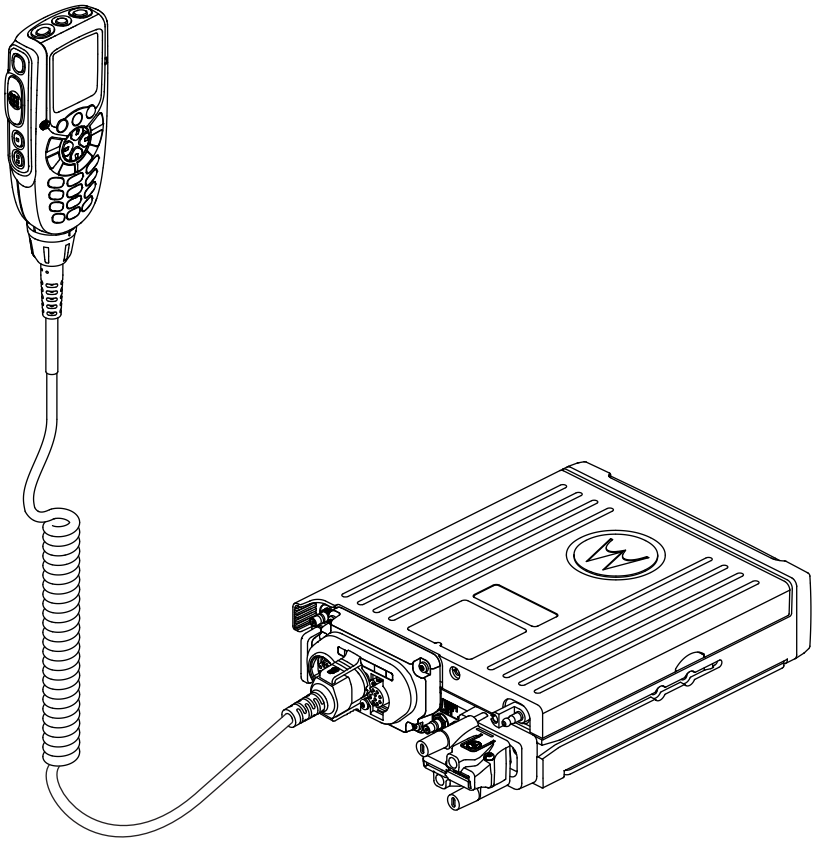
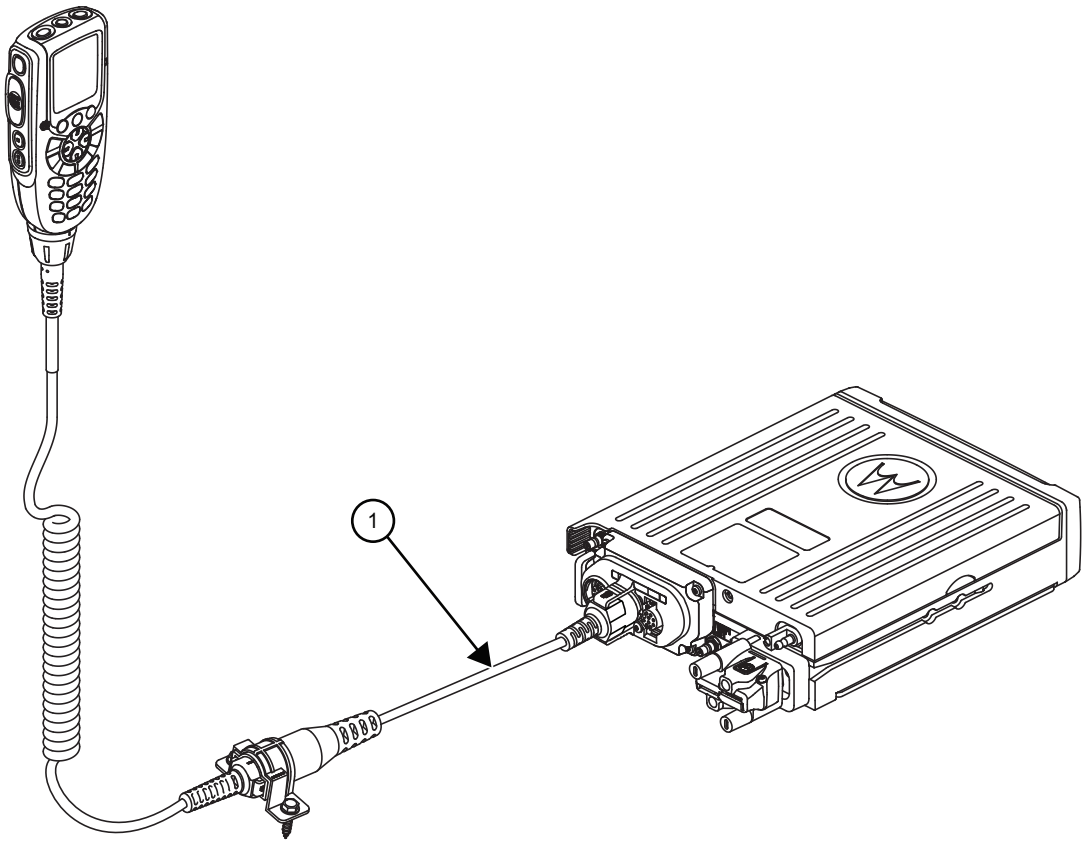


Figure 151: O3 Remote-Mount Radio Connector Locations

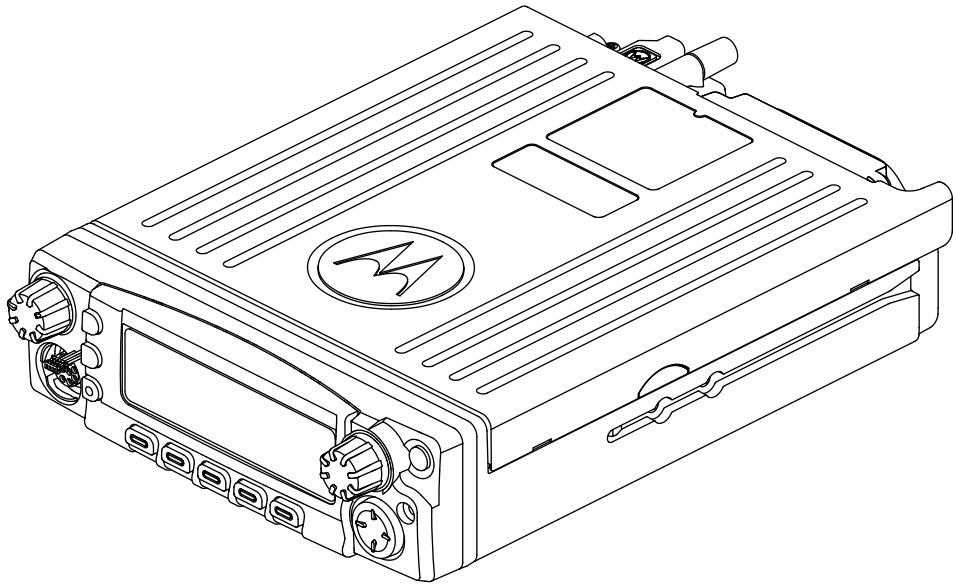


No.	Description
1	5 m (17 ft) Extension Cable

10.5
O5 Radio Connector Locations

Mid Power Only

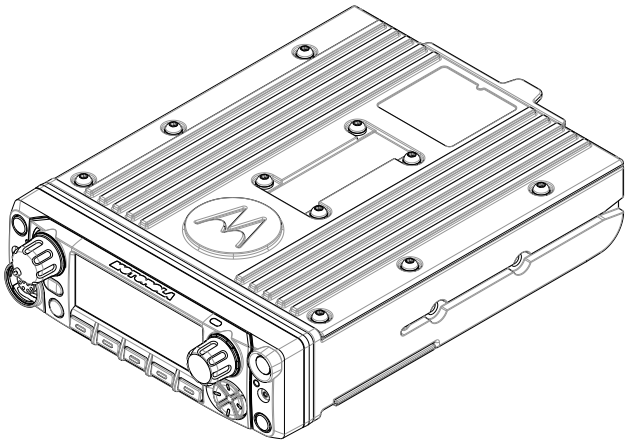
Figure 152: O5 Dash-Mount Radio Connector Locations



10.6
E5 Radio Connector Locations

Mid Power Only

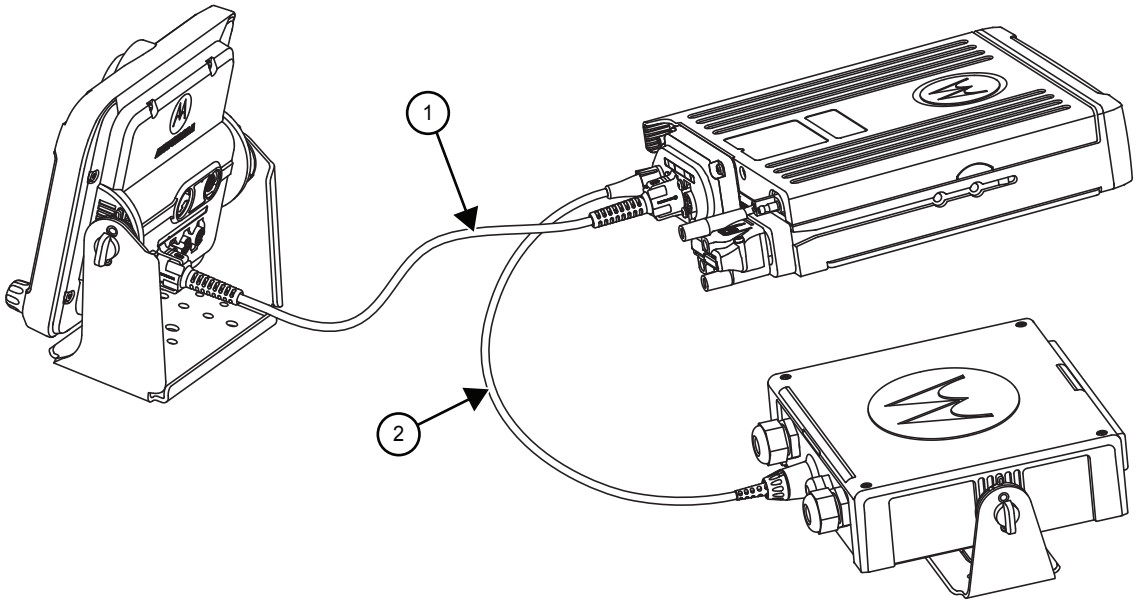
Figure 153: E5 Dash-Mount Radio Connector Locations



10.7

O9 Transceiver Interface

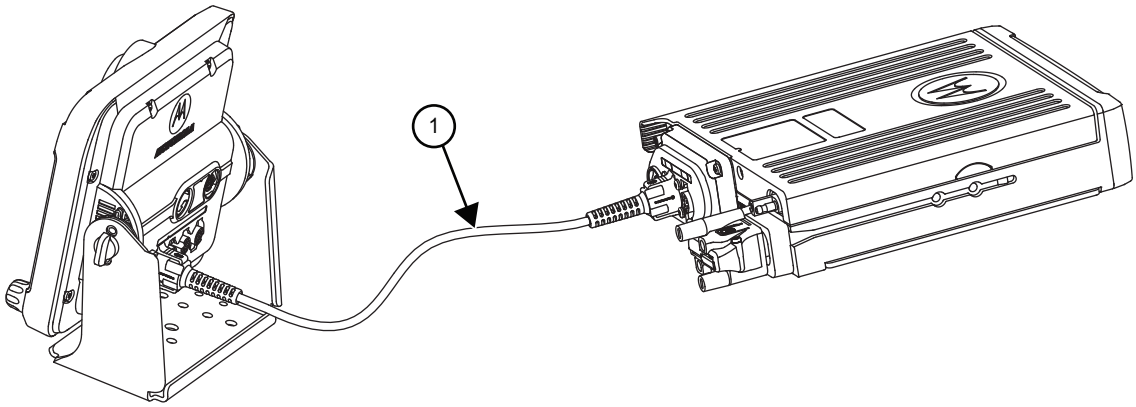
Figure 154: Transceiver Interface Board (TIB), Universal Relay Controller and Control Head View



No.	Description
1	5 m (17 ft) Extension Cable
2	O9 to URC Cable

NOTE: URC is an optional accessory

Figure 155: Remote-Mount Configuration with 100W or Higher Power Radio



No.	Description
1	5 m (17 ft) Extension Cable

Chapter 11

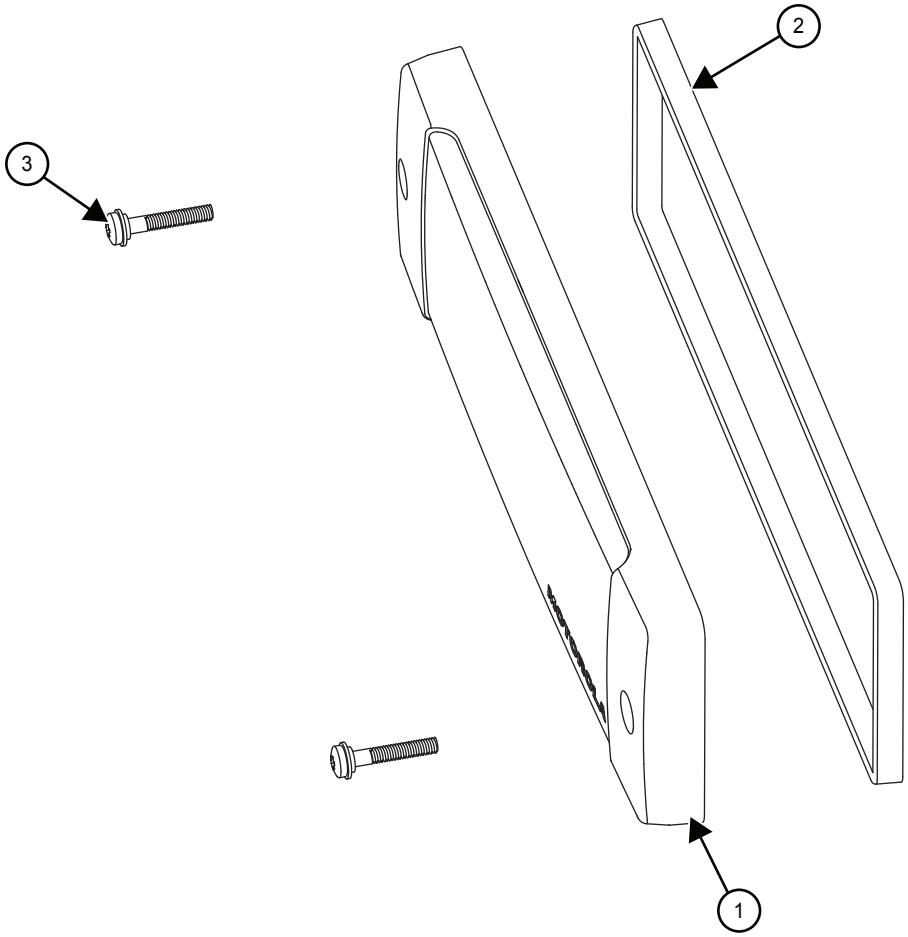
Exploded Views and Parts Lists

This chapter contains the exploded views and associated parts lists for the ASTRO mobile radios and accessories.

11.1 Remote Standard Faceplate Exploded View

This illustration represents the interface board for all remote mount configurations.

Figure 156: Remote Standard Faceplate Exploded View



11.1.1
Remote Standard Faceplate Parts List

Table 50: Remote Standard Faceplate Parts List

Item No.	Motorola Solutions Part No.	Description
1	HN000704A01	Cover, Remote
2	SL000052A03	Seal, Remote Cover
3	0364332H04	Screw, Zinc Plated, Screw Assy, Sealing

11.2
O2 Control Head Exploded View and Parts List

Figure 157: O2 Control Head Exploded View

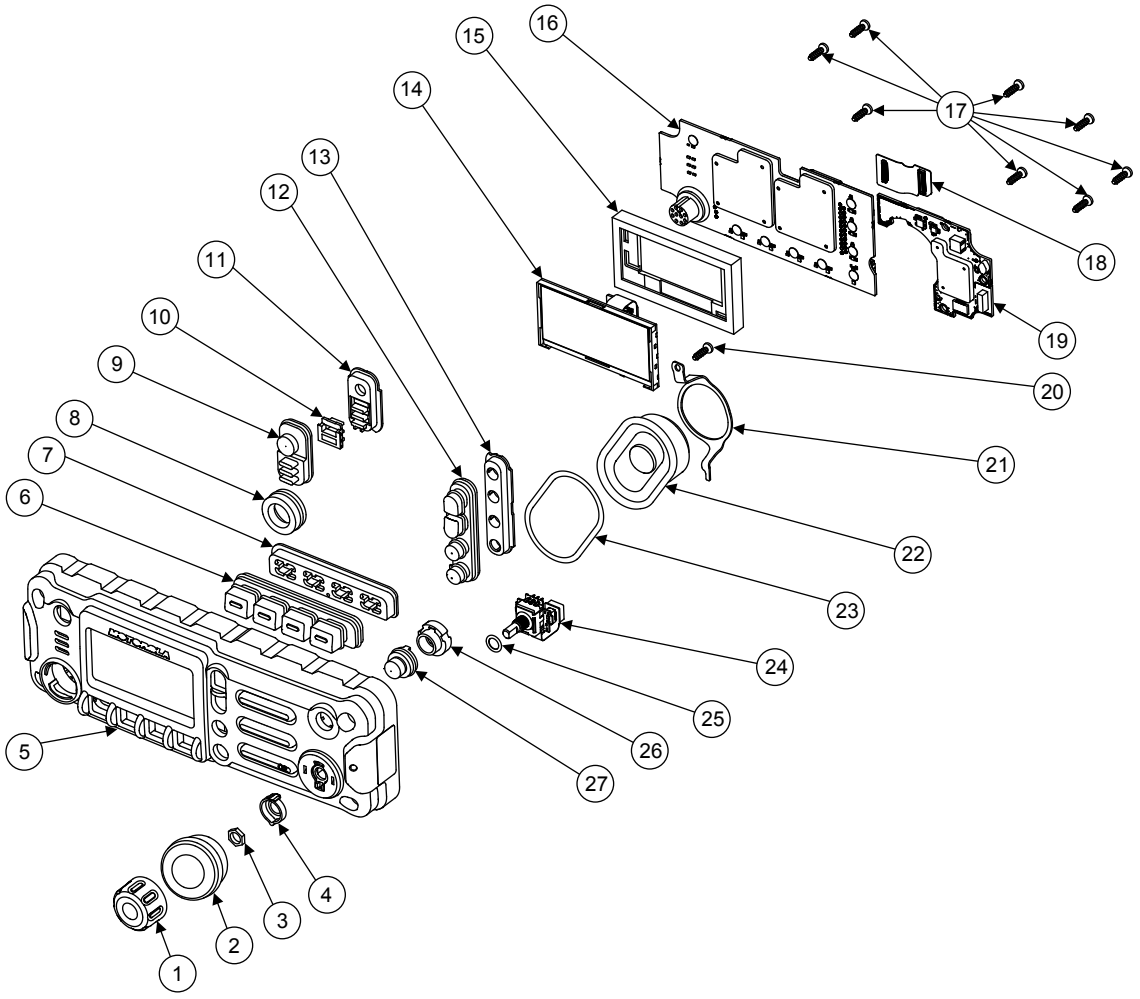


Table 51: O2 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	36012023002	Knob, Encoder
2	36012035001	Knob[3], Emergency
3	02012021001	Nut, Hex
4	42012071001	Spring, Detent
5	0104058J01 (Grey) 0104058J02 (Green)	Housing, Front Assembly (Includes LIGHT GUIDE, Encoder, 61012062001 and LENS, Display, 61012060001)
6	75012155002	Keypad, Soft Key
7	42012066002	Retainer, Soft Key Keypad
8	3264133H01	Seal, GCAI
9	38012028001	Keypad, Power and Status Indicator
10	07012039001	Light Isolator, Status Indicator
11	07012040001	Retainer, Power and Status Indicator Keypad
12	38012029002	Keypad, Home, Dimmer, P1 and P2
13	07012038001	Retainer, Home, Dimmer, P1 and P2 Keypad
14	72012018002	Display Module, LCD
15	75012151001	Dampener, LCD Display Module
16	PMLN5901_[4]	PCB, Control Head, Main
17	03012055001	Screw, PCB, Main and Option Board
18	0104046J24	Flex, Option Board
19	PMLN6054_[5]	PCB, Option Board
20	03012055001	Screw, Speaker Retention
21	42012070001	Retainer, Speaker
22	5015134H01	Speaker
23	11012103001	Adhesive, Speaker
24	0104046J20	Potentiometer, Encoder Assembly
25	32012152001	Seal, O-ring, Encoder
26	07012041001	Retainer, Emergency Button Keypad
27	38012030001	Keypad, Emergency Button

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[3] This is an optional part, and it can only be used with APX 6500/6500Li/4500/4500Li/1500. This item cannot be ordered individually. It is included in the O2 EMERGENCY KNOB KIT_PMBN4135.
[4] These items cannot be ordered individually. They are included in PMLN6342_.
[5] These items cannot be ordered individually. They are included in PMLN6341_.

11.3

O3 Control Head Exploded View and Parts List

Figure 158: O3 Control Head Exploded View

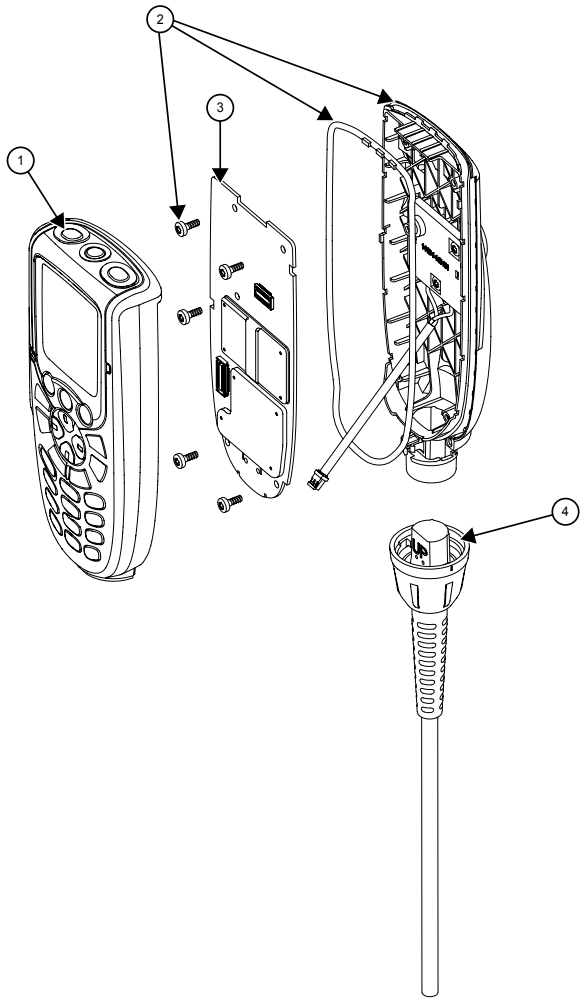


Table 52: O3 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	PMHN4082_	Housing, Front, Service Kit for PMUN1034A & PMUN1034B (English)
	PMHN4174_	Housing, Front, Service Kit for PMUN1034C or above (English)
	PMHN4199_	Housing, Front, Service Kit for PMUN1052B or above (Hebrew)
	PMHN4198_	Housing, Front, Service Kit for PMUN1053A or above (Cyrillic)
	PMHN4202_	Housing, Front, Service Kit for PMUN1054A or above (Arabic)
	PMHN4235_	Housing, Front, Service Kit for PMUN4227A or above (Siren & Lights)
2	PMHN4083_	Housing, Back, Service Kit (Includes O-ring [Quantity 1] and screws, 0310944A02 [Quantity 5])

Item No.	Motorola Solutions Part No.	Description
3	PMLN5035_	PCB Service Kit (for PMUN1034A and PMUN1034B)
	PMLN5848_	PCB Service Kit (for PMUN1034C or above, PMUN1052B or above, PMUN1053A or above, PMUN1054A or above, PMUN4227A or above)
4	PMLN4961_	Cable, Coiled, Kit

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.4

O5 Control Head Exploded View and Parts List

Figure 159: O5 Control Head Exploded View

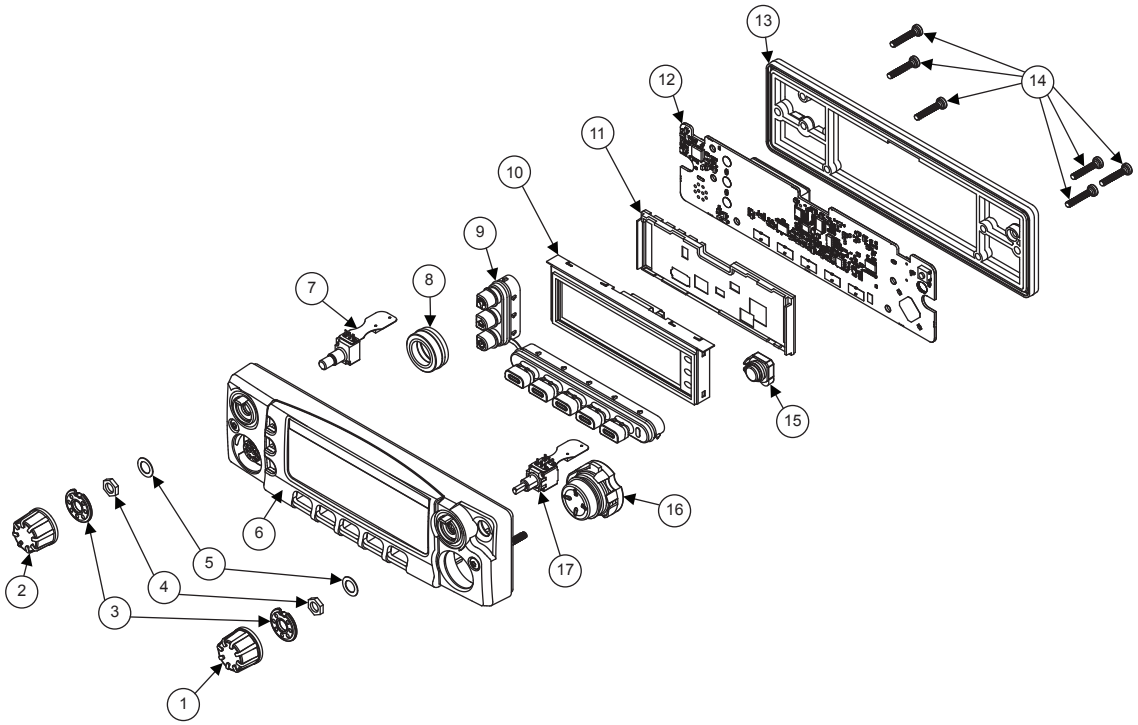


Table 53: O5 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	3664445H01	Knob, Mode
2	3664022H01	Knob, Volume
3	0415285H01	Washer, Torque
4	0215000C01	Nut, Hex, Special
5	0402838X01	Washer, 3 Wave

Item No.	Motorola Solutions Part No.	Description
6	1564047H06	Housing, Front Assembly (Includes Light pipe, Vol/Select, 6164056H02, [Quantity 2])
7	1864069H01	Potentiometer, Volume Assembly
8	3264133H01	Seal, O-Ring, MMP
9	3864503H05	Buttons, Main Assembly
10	7264052H05	Display, LCD
11	2675960A01	Shield, LCD
12	HLN6911_	PCB, Control Head Main
13	3264059H02	Seal, Overmolded Frame
14	0310944A14	Screws, Mounting
15	3864502H02	Button, Emergency
16	3864499H04	Button, Navigation Assembly
17	4064073H01	Switch, Frequency Assembly

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.5

O7 Control Head Exploded View and Parts List

Figure 160: O7 Control Head Exploded View

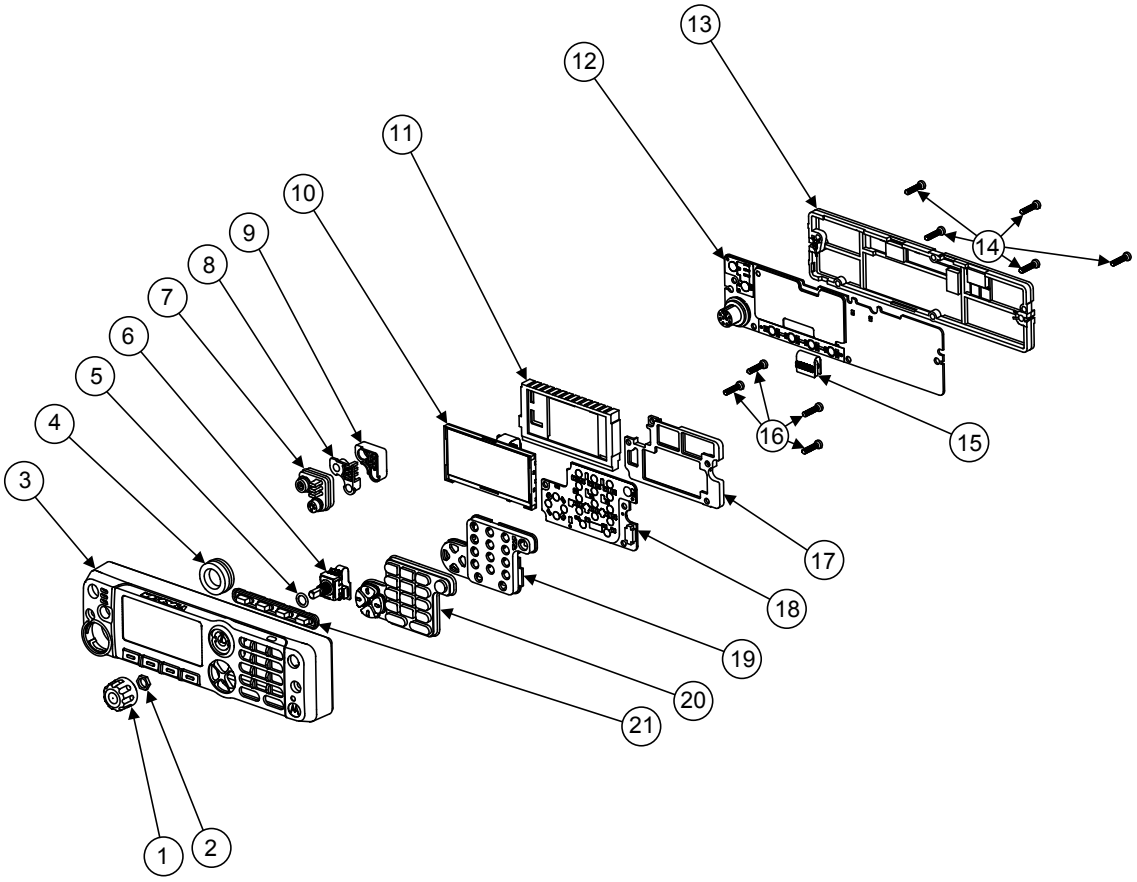


Table 54: O7 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	36012022001	Knob, Encoder
2	02012021001	Nut, Hex
3	0104047J41	Housing, Front Assembly (Includes LIGHT GUIDE, Encoder, 61012059001, LENS, Display, 61012061001 and SNAP PLUNGERS, Softkey, 55012025001)
4	3264133H01	Seal, GCAI
5	32012152001	Seal, O-ring, Encoder
6	0104046J14	Potentiometer, Encoder Assembly
7	75012149001	Keypad, Power, Dimmer and Status Indicator
8	61012058001	Light Guide, Power, Dimmer and Status Indicator
9	42012065001	Retainer, Power, Dimmer and Status Indicator Keypad
10	72012018002	Display Module, LCD

Item No.	Motorola Solutions Part No.	Description
11	75012152001	Dampener, LCD Display Module
12	PMLN5900_[6]	PCB, Control Head, Main
13	42012067001	Retainer, PCB, Main
14	0371370L02	Screws, Retention, PCB, Main
15	0104046J27	Flex, Bluetooth
16	03012055001	Screws, Retention, PCB, Bluetooth
17	42012069001	Retainer, PCB, Bluetooth
18	PMLN5983_[7]	PCB, Bluetooth
19	42012068001	Retainer, DTMF Keypad
20	75012157001 (English) 75012157002 (English_Chinese) 75012157003 (English_Cyrillic) 75012157004 (English_Hebrew) 75012157005 (Siren and Light) 75012157006 (English_Arabic)	Keypad, DTMF
21	75012153001	Keypad Rubber, Soft Key

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[6] These items cannot be ordered individually. They are included in PMLN6340_.
[7] These items cannot be ordered individually. They are included in PMLN6343_.

11.6

O9 Control Head Exploded View and Parts List

Figure 161: O9 Control Head Exploded View

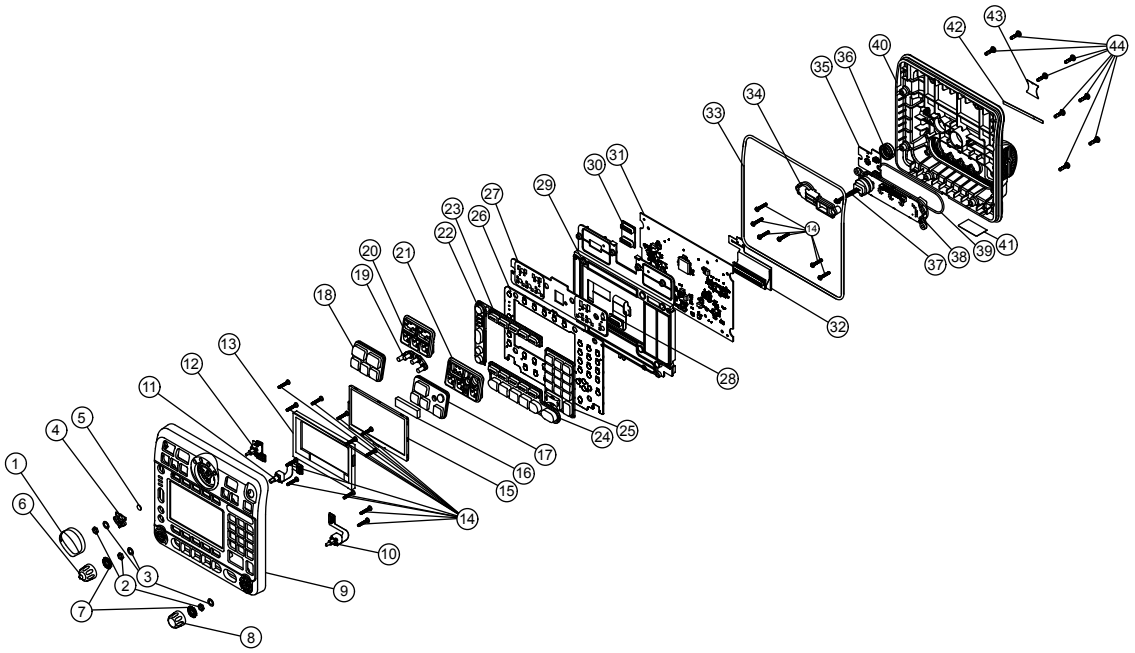


Table 55: O9 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	3675872M02	Top Pursuit Knob
2	0215000C01	Nut
3	0402838X01	Washer
4	42012000001	Pursuit Spring
5	3205472M02	Gore Port Seal
6	3675893M01	Volume Knob
7	3275895M01	Torque Enhancer
8	3675898M01	Frequency Knob
9	PMHN4143_	Front Housing Assembly (with light guides)
10	0104031J86	Frequency Flex Assembly
11	0104031J85	Volume Flex Assembly
12	0104033J49	Top Pursuit Switch Flex Assembly
13	7575913M01	Rubber jacket/ Rubber Boot
14	0371370L02	Screw, Tapping, K30X1.34X16
15	7275224M01	LCD Module/Display
16	32012043001	Conductive Pad, LCD

Item No.	Motorola Solutions Part No.	Description
17	7575866M01	Top Pursuit Light Bar Keypad
18	7575867M01	Top Pursuit Siren Keypad
19	6175865M01	Indicator Light Guide
20	4275869M01	Top Pursuit Siren Keypad Retainer
21	4275868M01	Top Pursuit Light Bar Keypad Retainer
22	7575911M02	Menu, Brightness Control Keypad
23	7575912M02	DEK Silicone Keypad
24	7575911M01	Programmable Control Keypad
25	7575912M01	Alpha Numeric Silicone Keypad
	7575912M03	Alpha Numeric Silicone Keypad, Arabic
26	PMLN5601_	Front Keypad PCB Kit (with mylar)
27	PMLN5602_	Top keypad PCB Kit (with mylar)
28	0104033J13	Front Keypad Flex
29	2775878M02	Chassis with Thermal Pad
30	0104031J84	Top Keypad Flex Assembly
31	PMLN5637_	Main PCB Kit
32	0104033J12	Main Flex Assembly
33	3275880M01	Main O-ring
34	4278089A01	USB/GCAI Retainer
35	PMLN5638_	GCAI PCB Kit
36	3264133H01	GCAI Seal
37	0964098H01	USB Overmold
38	HLN6914_	CHUC PCB Kit
39	3264096H01	CHUC Seal
40	1575879M02	Back Housing with Screw Insert
41	54012001001	Label, Serial
42	3364425H01	Label Color Code
43	5475881M01	Label Connector
44	0378014A01	Screw Assembly (M3X0.5X14 mm)

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.7

E5 Control Head Exploded View and Parts List

Figure 162: E5 Control Head Exploded View

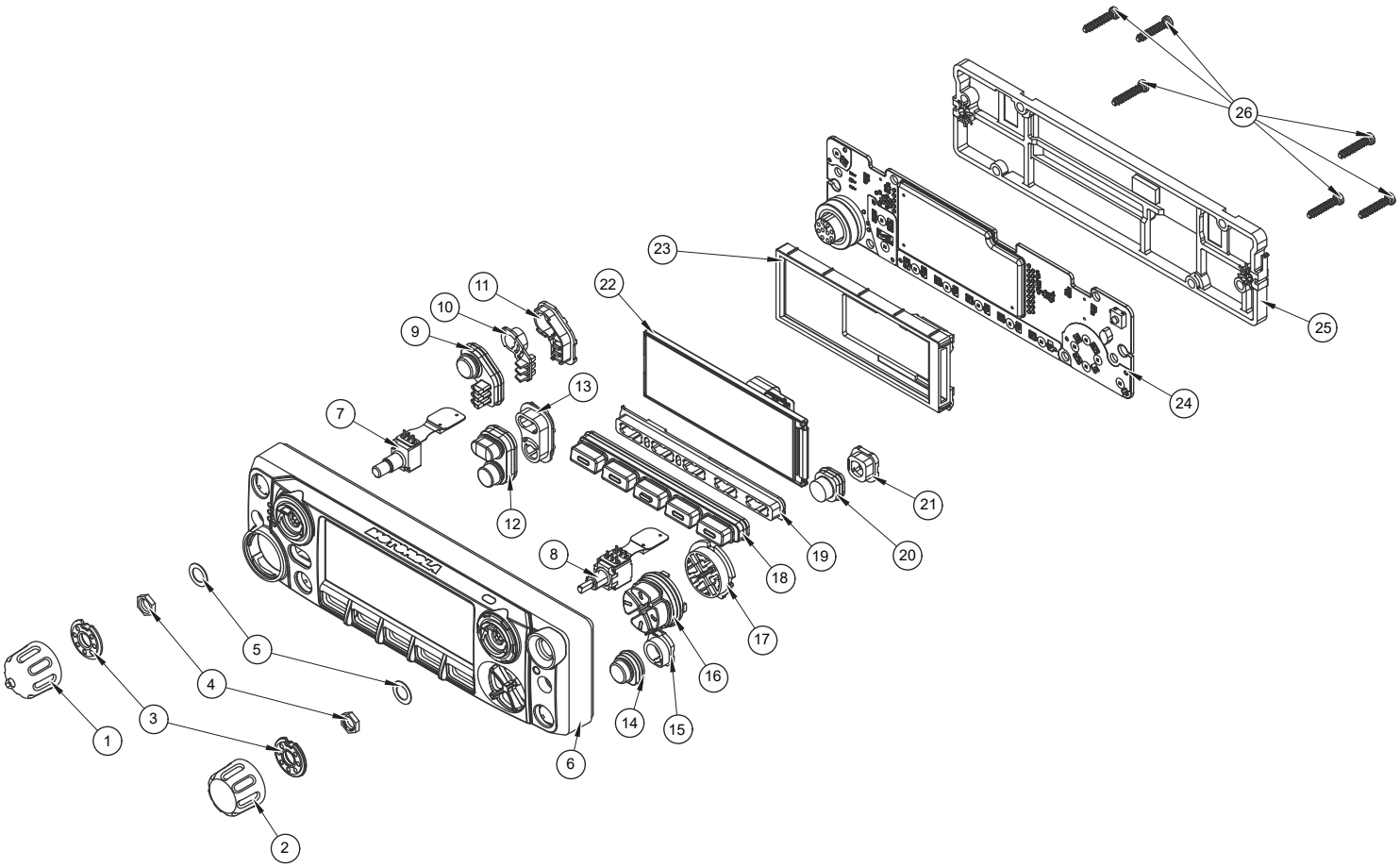


Table 56: E5 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	HW002144A01	Knob, volume, E5
2	HW002145A01	Knob, Frequency, E5
3	0415285H01	Washer, Torque
4	0215000C01	Nut, Hex, M6, Steel, Hex, Special
5	0402838X01	Washer, 3 Wave
6	0104080J95	E5 Front Housing Assembly
7	1864069H01	Potentiometer, Volume Assembly
8	4064073H01	Switch, Frequency Assembly
9	KP000186A01	Button, Light Indicator, Power

Item No.	Motorola Solutions Part No.	Description
10	HW002156A01	Light Guide, Power
11	HW002150A01	Retainer, Power Button
12	KP000183A01	Button, Programmable
13	HW002147A01	Retainer, Programmable
14	KP000188A01	Button, Home
15	HW002163A01	Retainer, Home
16	KP000184A01	Button, Navigation
17	HW002148A01	Retainer, Navigation
18	KP000182A01	Button, Menu
19	HW002146A01	Retainer, Menu
20	KP000185A01	Button, Emergency
21	HW002149A01	Retainer, Emergency
22	DM000141A01	Color Display Module, 160 RGBx480 TFT, Transmissive
23	HW002169A01	Display Rubber Boot
24	PMLN7988_[8]	PCB, Main Board
25	HW002151A01	PCB Retainer
26	0371370L02	Screw, K30 PT Thread

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[8] This item cannot be ordered individually. It is included in PPMLN7988_

11.8

O2 CHIB and CHUC Exploded View and Parts List

Figure 163: O2 CHIB and CHUC Exploded View

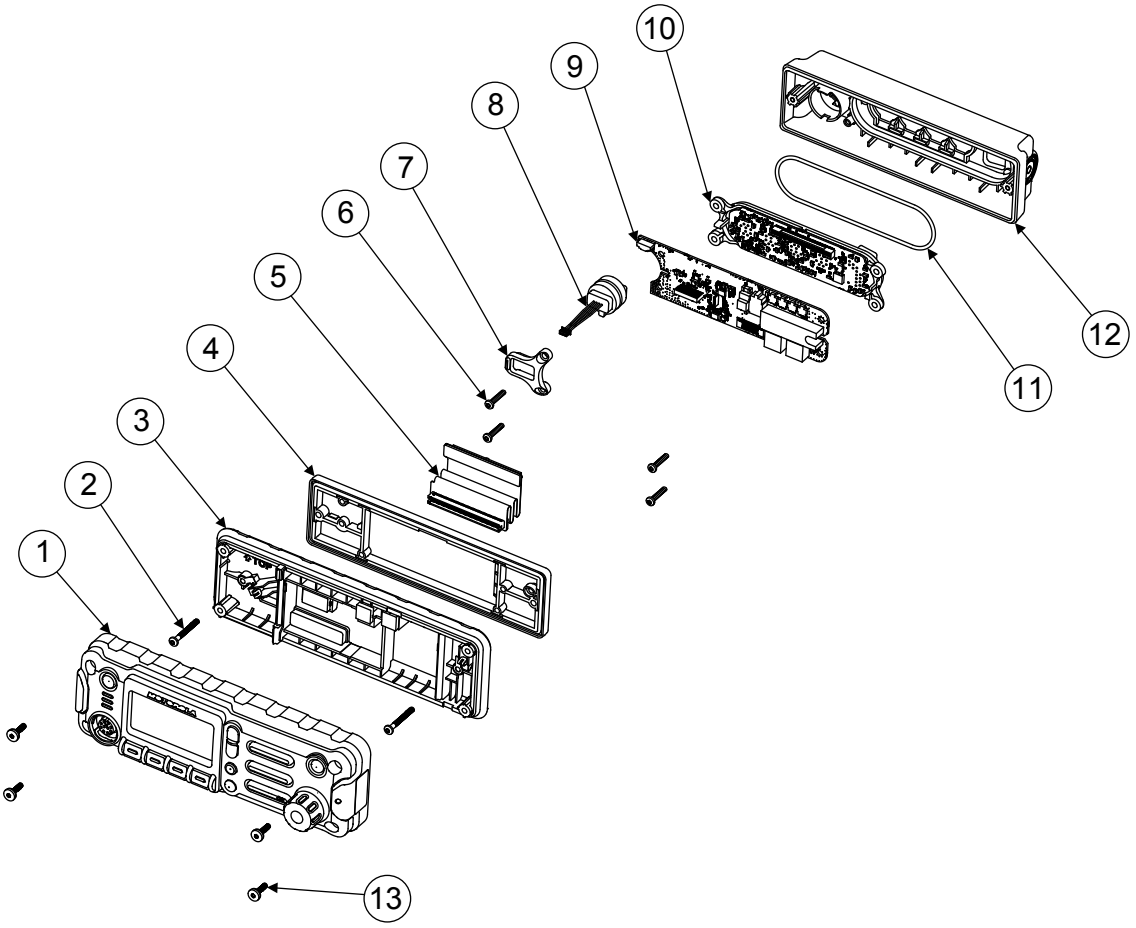


Table 57: O2 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.	Description
1	PMHN4193_ PMHN4195_	O2 Control Head Grey O2 Control Head Green
2	03012052001	Transceiver Screws
3	0104046J72	O2 Back Housing Sub-assembly
4	3264059H03	I-Seal
5	0104046J13	Remote Mount Flex Assembly
6	0310909F21	Screw, Tapping (4)
7	PMUN1057_/ PHCN4003_**[9]	0764091H01	Bracket, USB Connector
8	0964098H01	USB Connector[10]

[9] When ordering, refer to your specific kit number and suffix letter to ensure compatibility.

Item No.	Motorola Solutions Part No.		Description
9	PMUN1057_/ PHCN4003_**[9]	PMLN5927_ / PMLN8045_[11]	CHIB Board Assembly
10		HLN6914_	CHUC Board Assembly
11		3264096H01	Seal, Moisture, Silicone
12		1564090H01	Housing
13		03012063001	Housing Retention Screws
*		KT000246A01	Kit, Dust Caps, Remote, APX8500

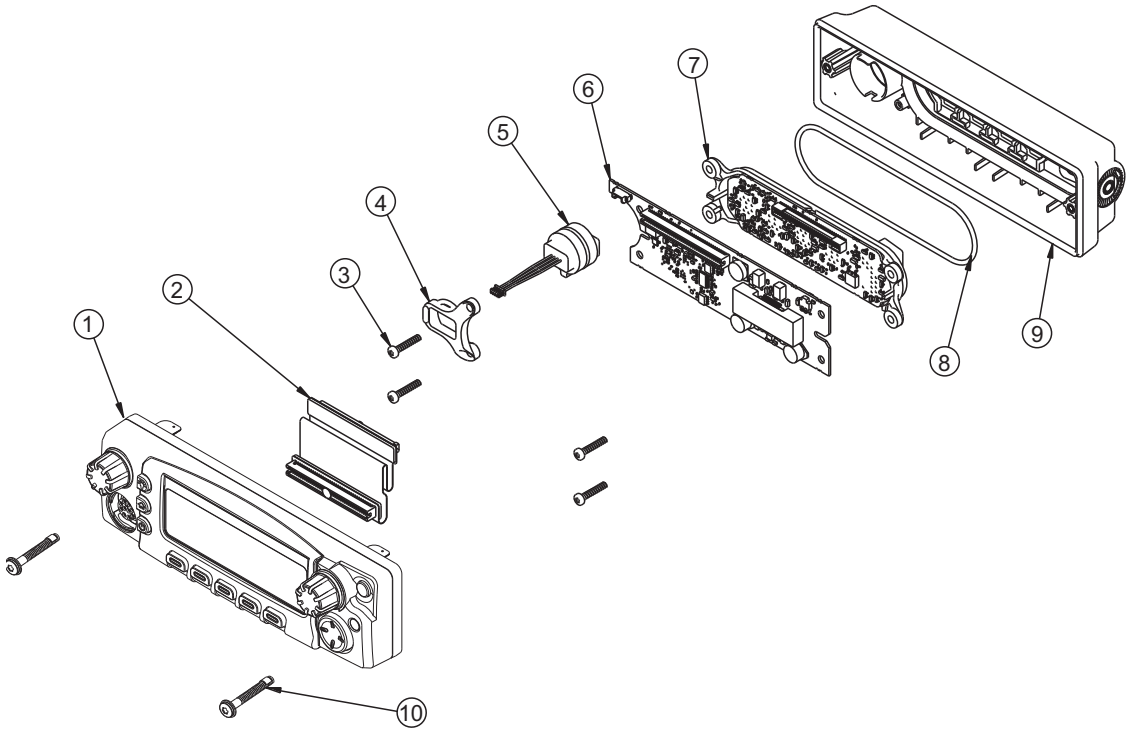
NOTE:

- The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.
- The double asterisk (**) indicates newer kit revision than PHCN4003E.

For more information on the compatibiliy of the Control Head and CHIB, refer to Table 17: Control Head and CHIB Compatibility on page 54.

11.9 O5 CHIB and CHUC Exploded View and Parts List

Figure 164: O5 CHIB and CHUC Exploded View



[10] This item is not applicable for PHCN4003_**.
[11] This item cannot be ordered individually. This item is included in PMUN1057_/ PHCN4003_**.

Table 58: O5 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.	Description
1	PHCN4000_	Control Head
2	HKN6191_	Flex Assembly
3	PHLN1002_ 0310909F21	Screw
4	0764091H01	Retainer Bracket
5	0964098H01	USB Adapter
6	HLN7041_[12]	CHIB
7	HLN6914_	CHUC
8	3264096H01	Moisture Seal
9	1564090H01	Rear Housing
10	0364332H02	Main Screws
*	KT000246A01	Kit, Dust Caps, Remote, APX8500
*	NNTN7279_	Sun Shield

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[12] This item cannot be ordered individually. It is included in PHLN1002_.

11.10

O7 CHIB and CHUC Exploded View and Parts List

Figure 165: O7 CHIB and CHUC Exploded View

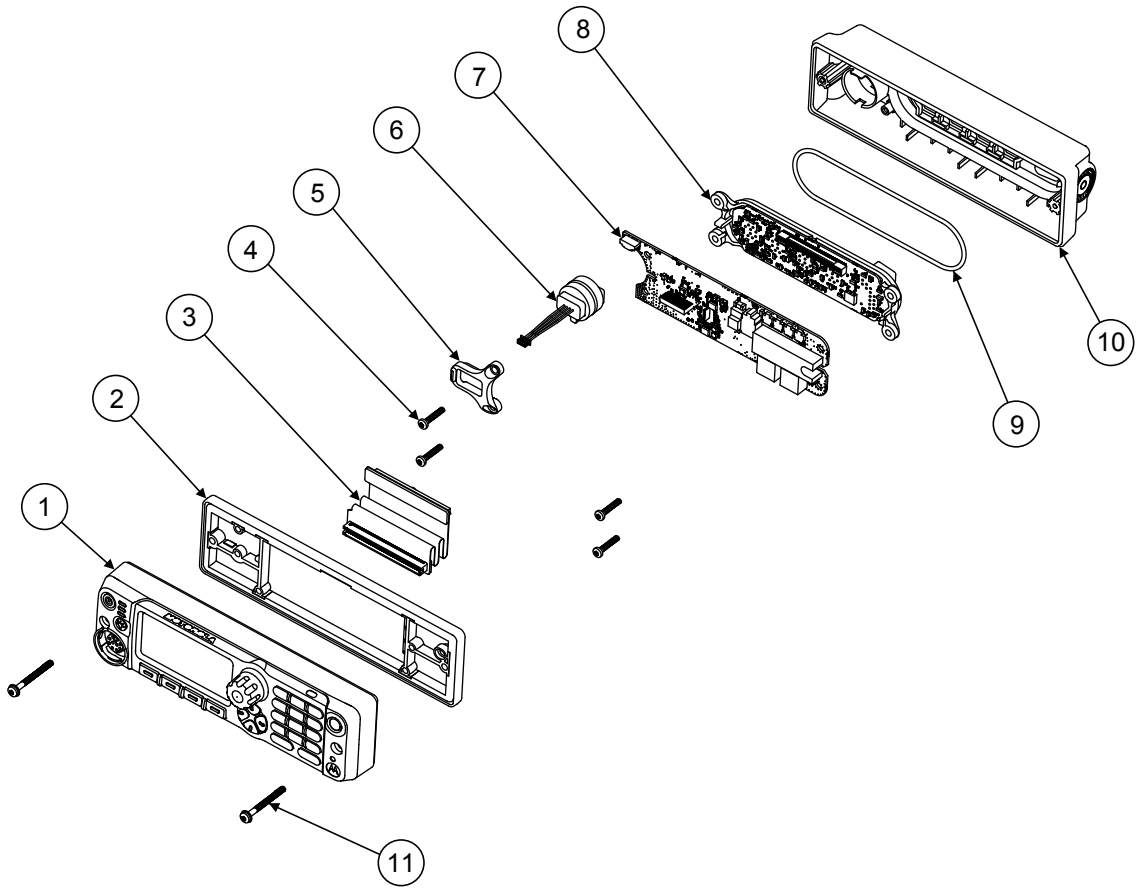


Table 59: O7 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.		Description
1		PMHN4194_	O7 Control Head English
		PMHN4192_	O7 Control Head English_Chinese
		PMHN4197_	O7 Control Head English_Cyrillic
		PMHN4196_	O7 Control Head English_Hebrew
		PMHN4191_	O7 Control Head Siren and Light
		PMHN4229_	O7 Control Head English_Arabic
2		3264059H03	I-Seal
3		0104046J13	Remote Mount Flex Assembly
4	PMUN1057_/ PHCN4003_**[13]	0310909F21	Screw, Tapping (4)
5		0764091H01	Bracket, USB Connector

[13] When ordering, refer to your specific kit number and suffix letter to ensure compatibility.

Item No.	Motorola Solutions Part No.		Description
6		0964098H01	USB Connector[14]
7	PMUN1057_/ PHCN4003_**[13]	PMLN5927_/ PMLN8045_[15]	CHIB Board Assembly
8		HLN6914_	CHUC Board Assembly
9		3264096H01	Seal, Moisture, Silicone
10		1564090H01	Housing
11		03012062001	Transceiver Screws
*		KT000246A01	Kit, Dust Caps, Remote, APX8500

NOTE:

- The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.
- The double asterisk (**) indicates newer kit revision than PHCN4003E.

For more information on the compatibiliy of the Control Head and CHIB, refer to Table 17: Control Head and CHIB Compatibility on page 54.

[14] This item is not applicable for PHCN4003_**.
[15] This item cannot be ordered individually. This item is included in PMUN1057_/ PHCN4003_**.

11.11

E5 CHIB and CHUC Exploded View and Parts List

Figure 166: E5 CHIB and CHUC Exploded View

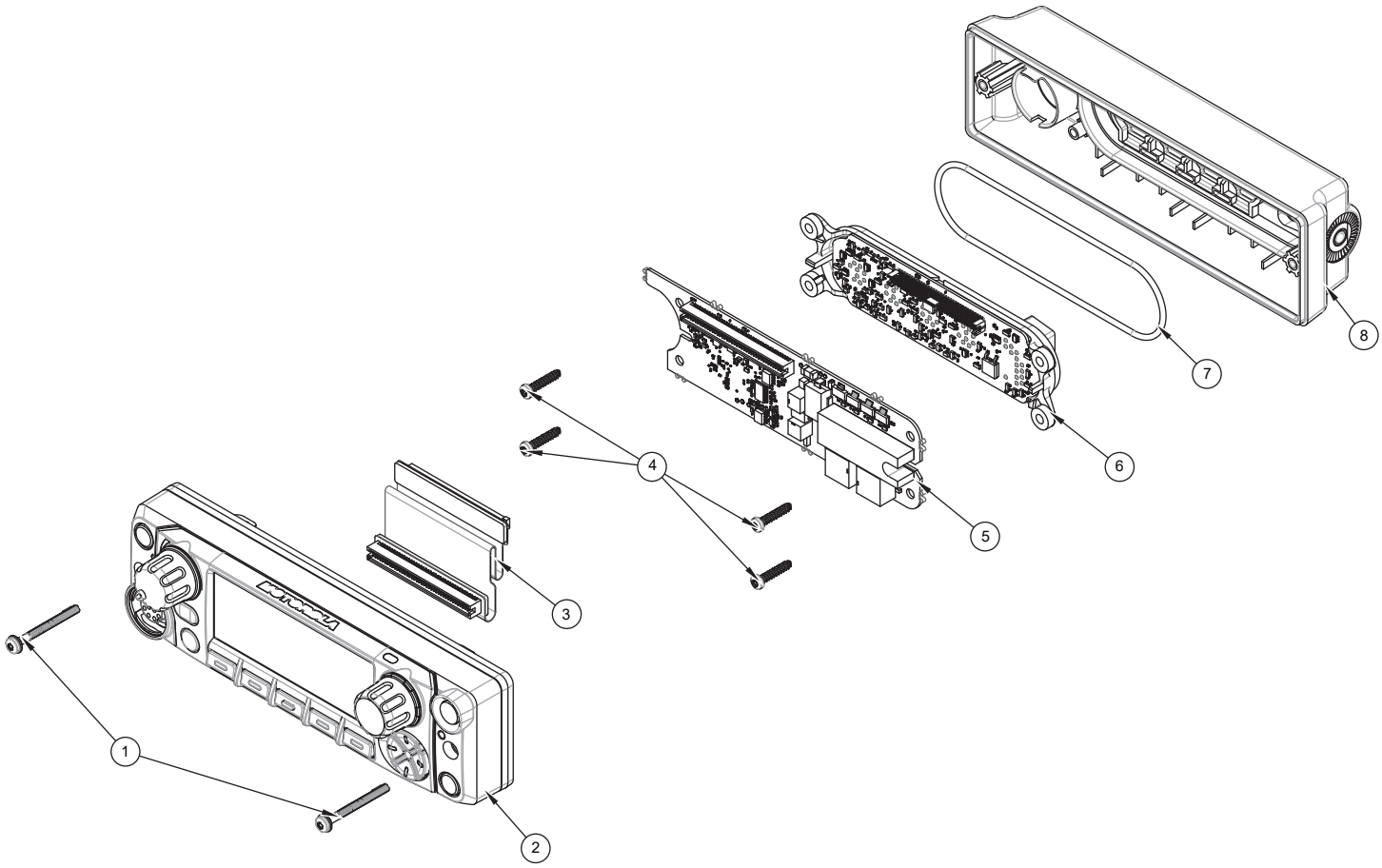


Table 60: E5 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.	Description
1	3012062002	Screw Assembly, Transceiver, E5
2	PHCN4001A	E5 Control Head
3	PA002638A01	E5 Remote Flex
4	0310909F21[16]	Screw
5	PMLN8045_[16]	E5 CHIB Board
6	PMLN8052A[16]	E5 CHUC Board
7	3264096H01[16]	Seal, O-ring CHUC
8	1564090H02[16]	E5 Remote Mount Housing

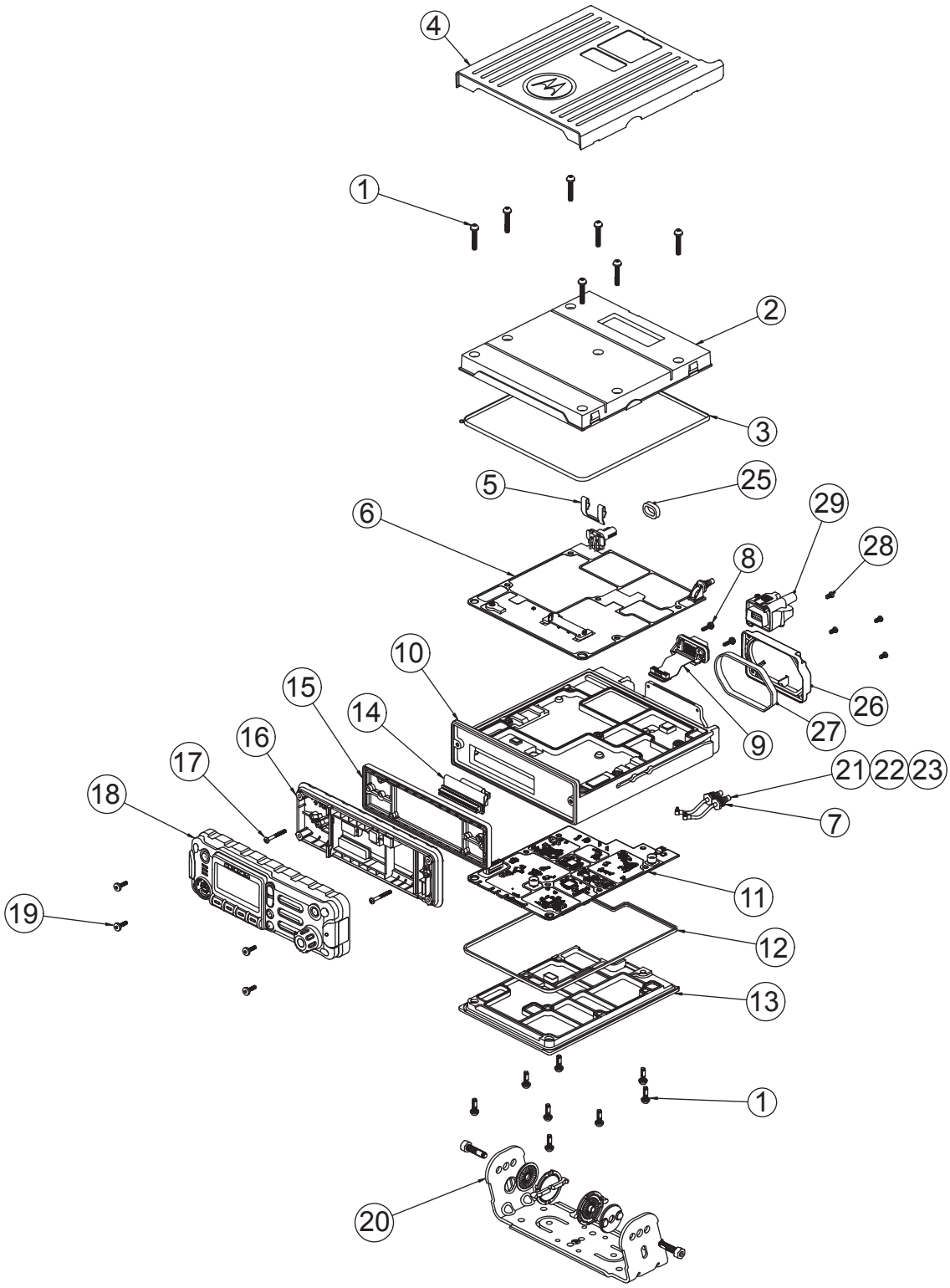
[16] This item cannot be ordered individually. It is included in PHCN4003_.

Item No.	Motorola Solutions Part No.	Description
*	KT000246A01	Kit, Dust Caps, Remote, APX8500

11.12

APX 8500 O2 Dash Mount Radio Exploded View

Figure 167: APX 8500 O2 Dash Mount Radio Exploded View



11.12.1

APX 8500 O2 Dash Mount Radio Parts List

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Table 61: APX 8500 O2 Dash Mount Radio Parts List

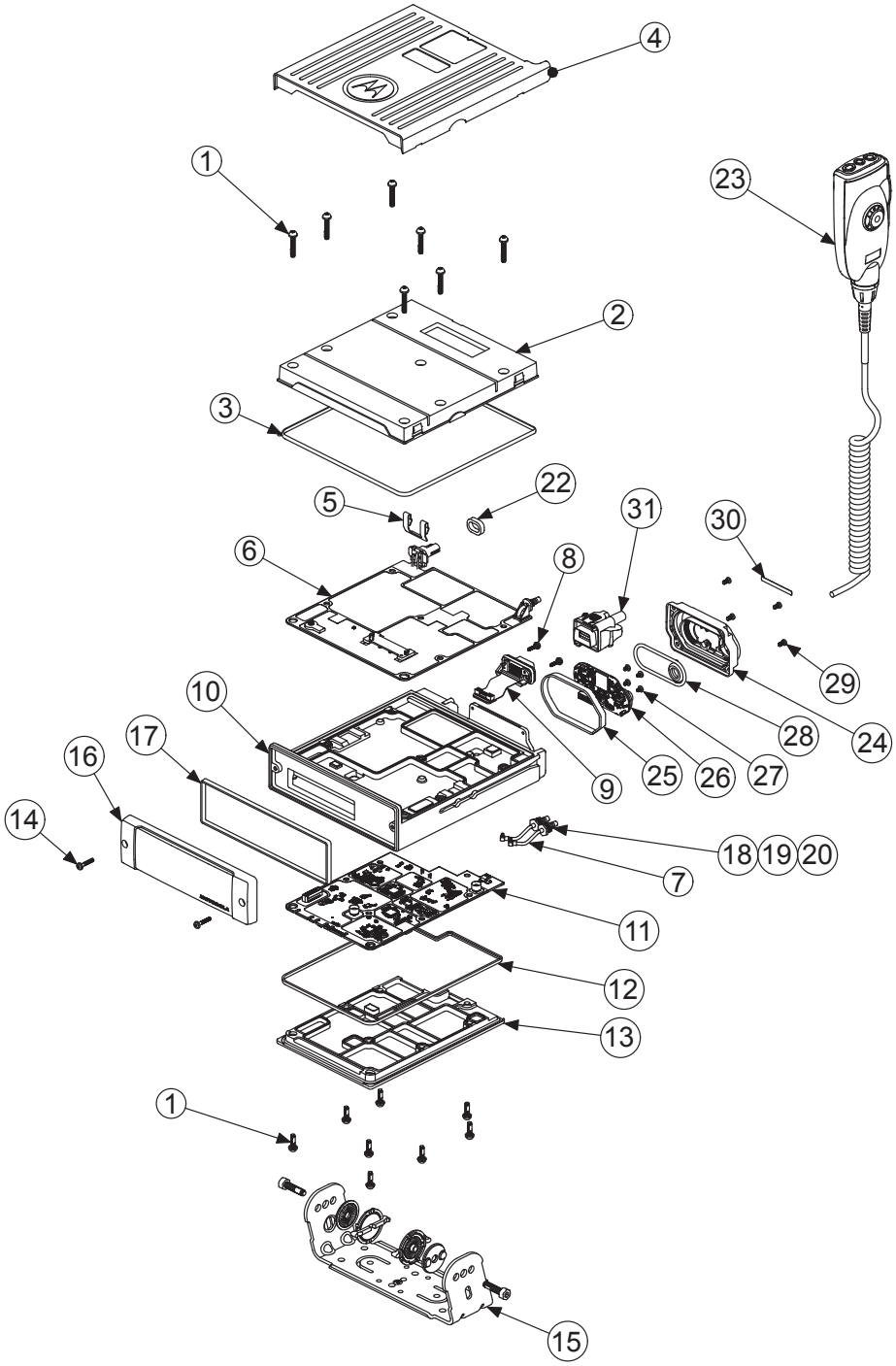
Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF And XCVR Cover Screws
2	CH000032A02	Cover, RF Main W/Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Conn
6	PPHTW4000_	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention
	MHLN7000_S	*Option Board For APX Mobiles
11	PPHRW4000_	Transceiver Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR W/Choform
14	PA001123A_	Dash Mount Flex Assembly
15	3264059H01	I-Seal
16	0104046J72	O2 Back Housing Assembly
17	03012052001	Transceiver Screws
18	PMHN4193_	O2 Control Head Grey
	PMHN4195_	O2 Control Head Green
19	03012063001	Housing Retention Screws
20	HLN7002_	Mid Power Installation Kit
21	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
22	32009266001	Seal, GPS/BT/Wi-Fi
23	02009258001	Nut, GPS/BT/Wi-Fi
24	3275731B01	Seal, RF Connector
25	3285744E01	Seal, DC Connector
26	HN000096A01	Cover, TIB
27	SL000048A01	Seal, TIB
28	0308390Y88	Screw, TIB

Item No.	Motorola Solutions Part No.	Description
29	–	MAP accessory cables
30	–	FCC Label

11.13

APX 8500 O3 Radio Exploded View

Figure 168: APX 8500 O3 Radio Exploded View



11.13.1

APX 8500 O3 Radio Parts List

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Table 62: APX 8500 O3 Radio Parts List

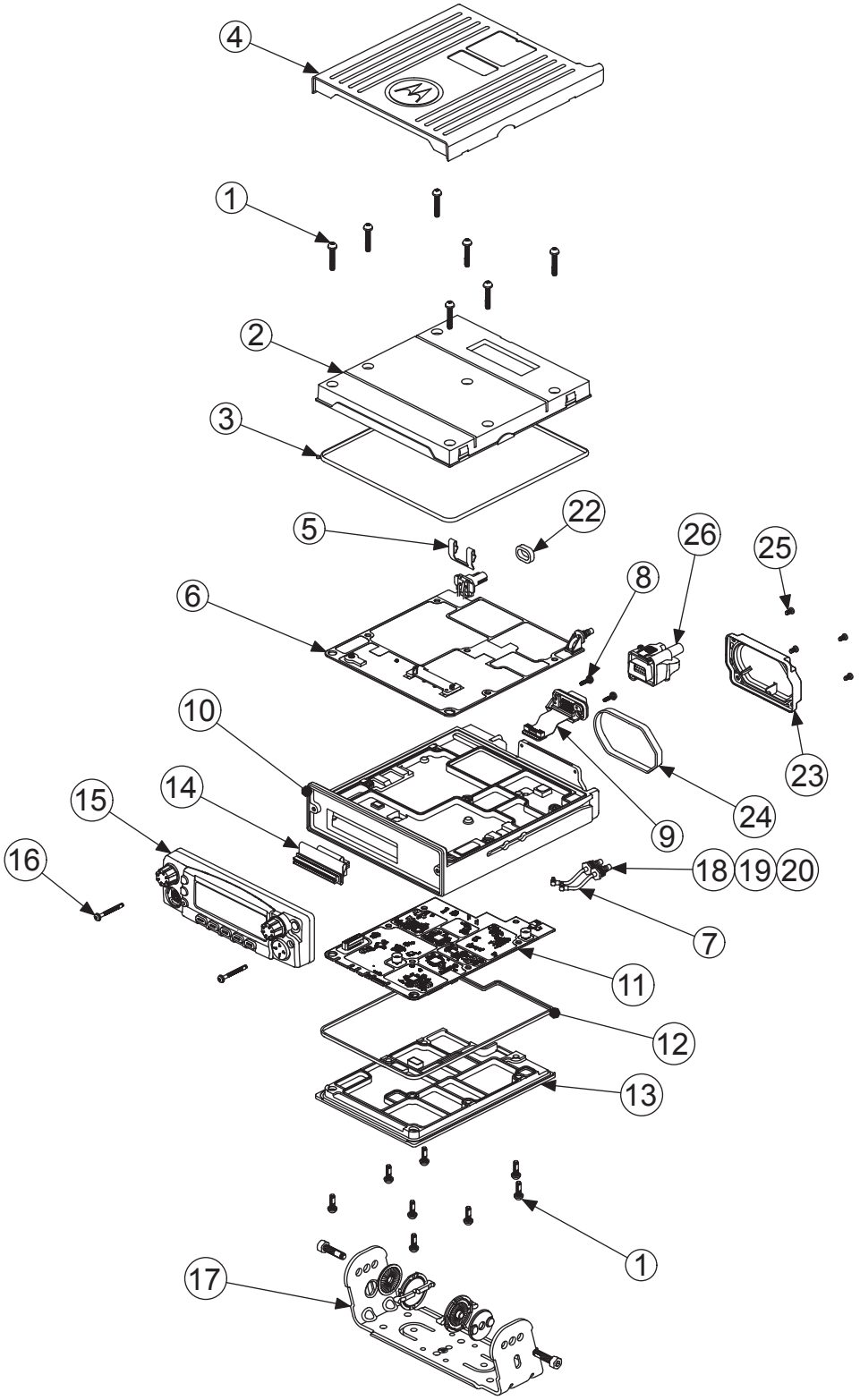
Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF And XCVR Cover Screws
2	CH000032A02	Cover, RF Main W/Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Conn
6	PPHTW4000_	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention
	MHLN7000_S	*Option Board For APX Mobiles
11	PPHRW4000_	Transceiver Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR W/Choform
14	0364332H04	Screw, Remote
15	HLN7002_	Mid Power Installation Kit
16	HN000704A01	Cover, Remote
17	SL000052A03	Seal, Remote
18	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
19	32009266001	Seal, GPS/BT/Wi-Fi
20	02009258001	Nut, GPS/BT/Wi-Fi
21	3275731B01	Seal, RF Connector
22	04009258001	Washers, * GPS/BT/Wi-Fi Internal Tooth
23	PMUN1034_	O3 Control Head (English)
	PMUN1052_	O3 Control Head (Hebrew)
	PMUN1053_	O3 Control Head (Cyrillic)
	PMUN1054_	O3 Control Head (Arabic)
	PMUN4227_	O3 Control Head (Siren & Lights)
24	HN000096A02	Cover, TIB, Remote
25	SL000048A01	Seal, TIB

Item No.	Motorola Solutions Part No.	Description
26	PA000178A_	PCB, TIB
27	03009304001	Screw, PCB, TIB
28	Non Field Replaceable	Seal, TIB Connector
29	0308390Y88	Screw, TIB
30	3364474H_	Label, TIB
31	–	MAP accessory cables
32	–	FCC Label

11.14

APX 8500 O5 Dash Mount Radio Exploded View

Figure 169: APX 8500 O5 Dash Mount Radio Exploded View



11.14.1

APX 8500 O5 Dash Mount Radio Parts List

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

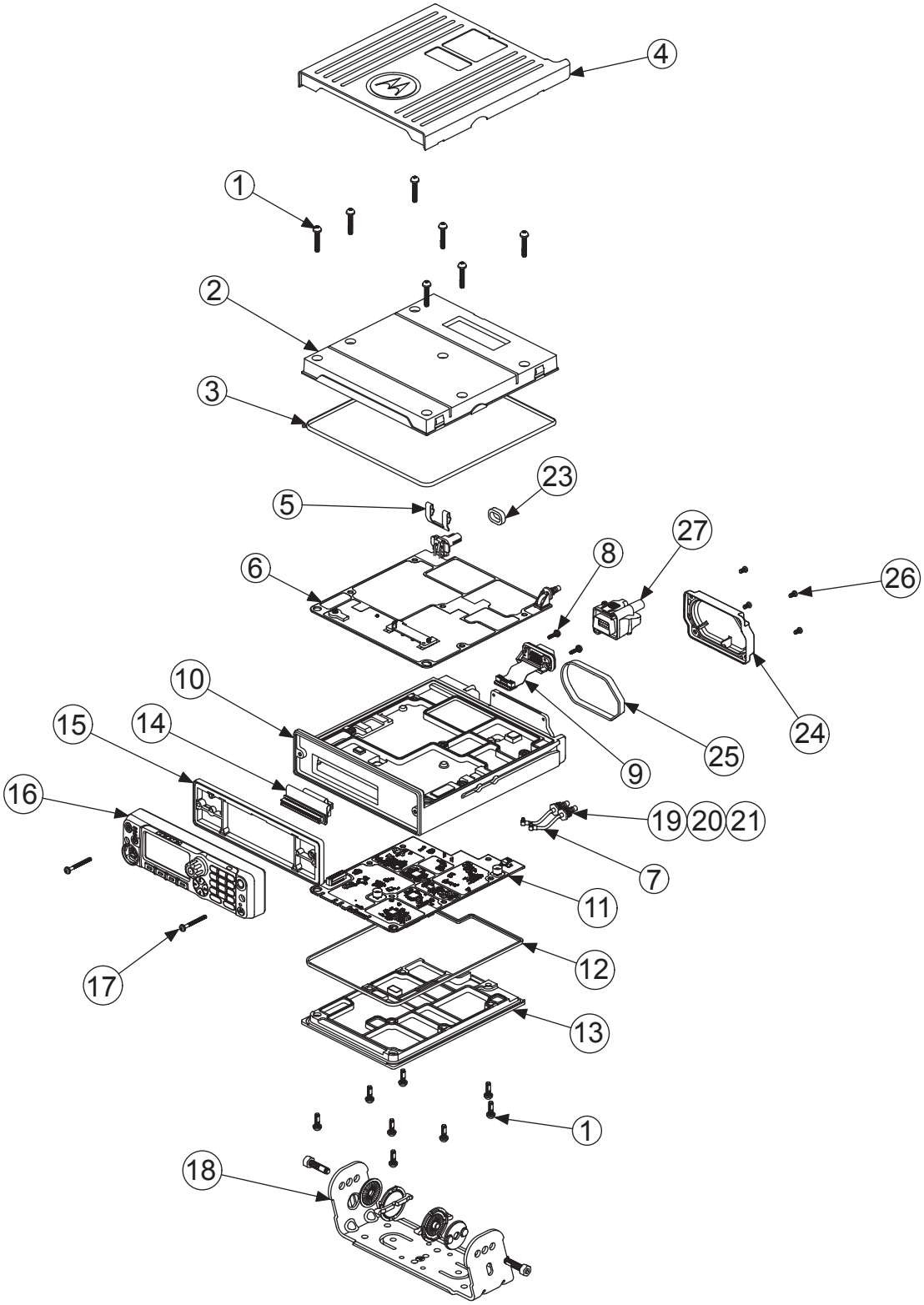
Table 63: APX 8500 O5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF And XCVR Cover Screws
2	CH000032A02	Cover, RF Main W/Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Conn
6	PPHTW4000_	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention
	MHLN7000_S	*Option Board For APX Mobiles
11	PPHRW4000_	Transceiver Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR W/Choform
14	PA001123A_	Dash Flex Kit
15	PHCN4000_	O5 Control Head
16	0364332H02	TIB Screws (TIB Housing To Chassis) Assembly
17	HLN7002_	Mid Power Installation Kit
18	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
19	32009266001	Seal, GPS/BT/Wi-Fi
20	02009258001	Nut, GPS/BT/Wi-Fi
21	3275731B01	Seal, RF Connector
22	3285744E01	Seal, DC Connector
23	HN000096A01	Cover, TIB
24	SL000048A01	Seal, TIB
25	0308390Y88	Screw, TIB
26	–	MAP accessory cables
27	–	FCC Label

11.15

APX 8500 O7 Dash Mount Radio Exploded View

Figure 170: APX 8500 O7 Dash Mount Radio Exploded View



11.15.1

APX 8500 O7 Dash Mount Radio Parts List

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Table 64: APX 8500 O7 Dash Mount Radio Parts List

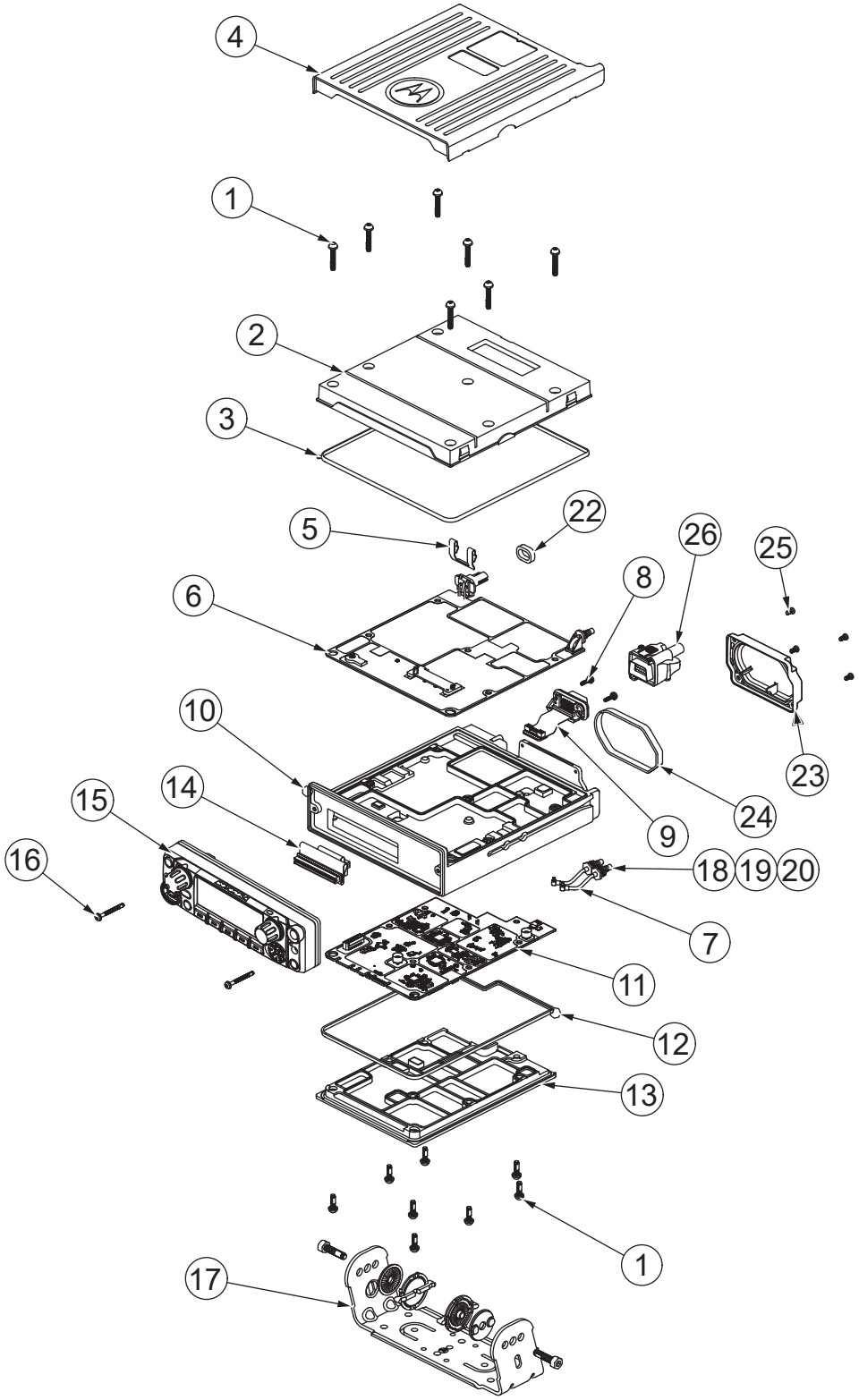
Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF And XCVR Cover Screws
2	CH000032A02	Cover, RF Main W/Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Conn
6	PPHTW4000_	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention
	MHLN7000_S	*Option Board For APX Mobiles
11	PPHRW4000_	Transceiver Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR W/Choform
14	PA001123A_	Dash Mount Flex Assembly
15	3264059H01	I-Seal
16	PMHN4194_	O7 Control Head English
	PMHN4192_	O7 Control Head English (Chinese)
	PMHN4197_	O7 Control Head English (Cyrillic)
	PMHN4196_	O7 Control Head English (Hebrew)
	PMHN4191_	O7 Control Head Siren and Light
	PMHN4229_	O7 Control Head English (Arabic)
17	0364332H02	Transceiver Screws
18	HLN7002_	Mid Power Installation Kit
19	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
20	32009266001	Seal, GPS/BT/Wi-Fi
21	02009258001	Nut, GPS/BT/Wi-Fi
22	3275731B01	Seal, RF Connector
23	3285744E01	Seal, DC Connector
24	HN000096A01	Cover, TIB

Item No.	Motorola Solutions Part No.	Description
25	SL000048A01	Seal, TIB
26	0308390Y88	Screw, TIB
27	–	MAP accessory cables
28	–	FCC Label

11.16

APX 8500 E5 Dash Mount Radio Exploded View

Figure 171: APX 8500 E5 Dash Mount Radio Exploded View



11.16.1

APX 8500 E5 Dash Mount Radio Parts List

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

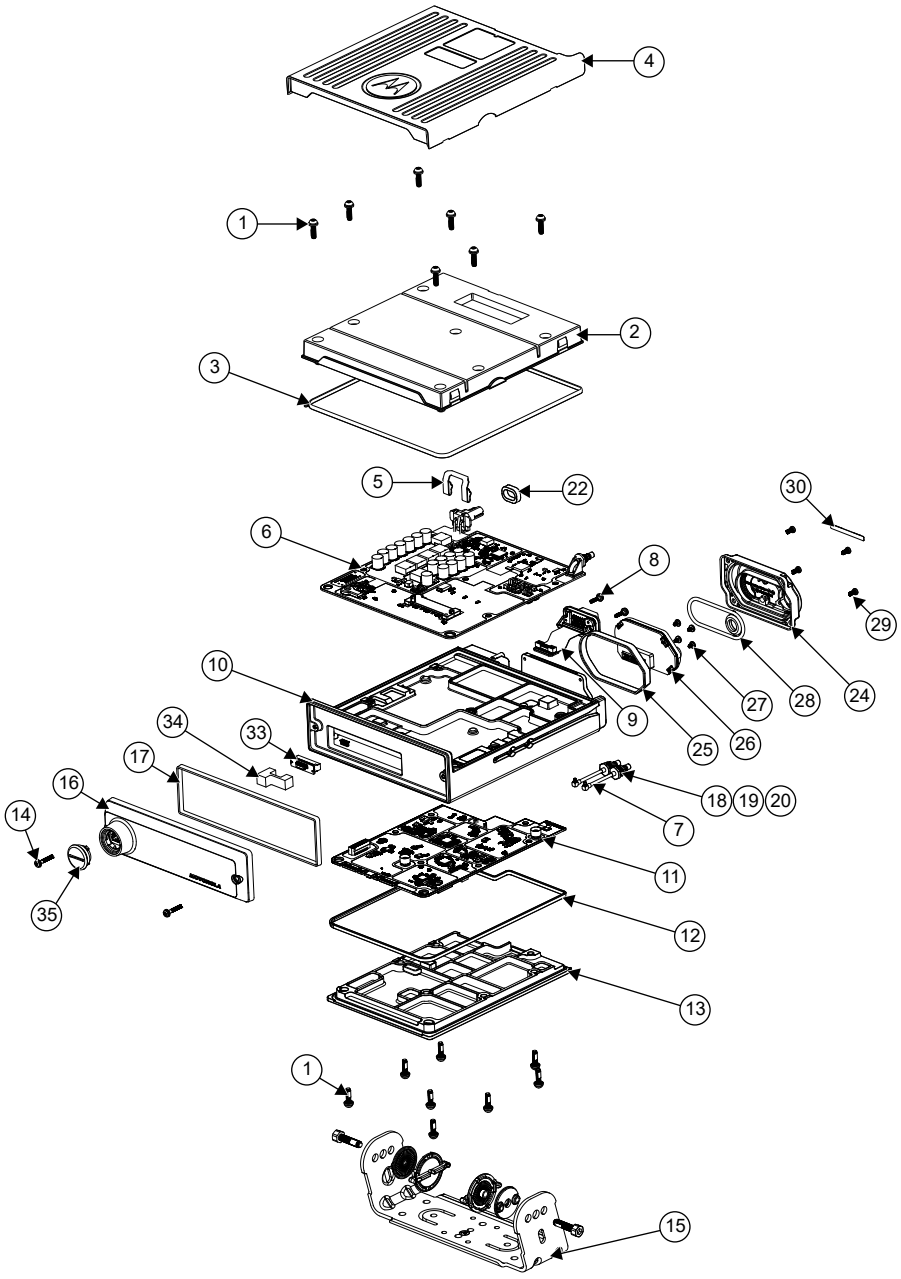
Table 65: APX 8500 E5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF And Transceiver Cover Screws
2	CH000032A02	Cover, RF Main W/Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Conn
6	PPHTW4000_	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention
	MHLN7000_S	*Option Board For APX Mobiles
11	PPHRW4000_	Transceiver Board
12	SL000052A01	Seal, Transceiver Cover
13	CH000033A02	Cover, Transceiver W/Choform
14	PA001123A_	Dash Flex Kit
15	PHCN4001_	E5 Control Head
16	03012062002	Transceiver Screw
17	HLN7002_	Mid Power Installation Kit
18	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
19	32009266001	Seal, GPS/BT/Wi-Fi
20	02009258001	Nut, GPS/BT/Wi-Fi
21	3275731B01	Seal, RF Connector
22	3285744E01	Seal, DC Connector
23	HN000096A01	Cover, TIB
24	SL000048A01	Seal, TIB
25	0308390Y88	Screw, TIB
26	–	MAP accessory cables
27	–	FCC Label

11.17

Remote Mount Ethernet Faceplate Exploded View

Figure 172: Remote Mount Ethernet Faceplate Exploded View



11.17.1

Remote Mount Ethernet Faceplate Parts List

Table 66: Remote Mount Ethernet Faceplate Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	RF and XCVR Cover Screws

Item No.	Motorola Solutions Part No.	Description
2	CH000032A02	Cover, RF Main with Choform
3	SL000052A02	Seal, RF Cover
4	HN000622A01	RF Cover Grille
5	HW000571A01	Clip, DC Connector
6	PA000175A01	RF Board
7	CB000091A01	Cable, GPS/BT/Wi-Fi Coax Assembly
8	0371838H01	Screw Assembly, Accessory Header
9	PA000850A_	Flex Assembly, Accessory Connector
10	CH000031A02	Chassis, Main with Choform
11	MHLN6999_S	Option Board with 3 Day Retention
	MHLN7000_S	Option Board for APX Mobiles
	PA000176A01	XCVR Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR with Choform
14	0364332H04	Screw, Remote
15	HLN7002_	Mid Power Installation Kit
16	HN001985A01[17]	Ethernet Faceplate Assembly
17	SL000052A03	Seal, Remote
18	04009258001	Washers, GPS/BT/Wi-Fi Internal Tooth
19	32009266001	Seal, GPS/BT/Wi-Fi
20	02009258001	Nut, GPS/BT/Wi-Fi
22	3285744E01	Seal, DC Connector
24	HN000096A02	Cover, TIB, Remote
25	SL000048A01	Seal, TIB
26	PA000178A_	PCB, TIB
27	03009304001	Screw, PCB, TIB
28	SL000048A02	Seal, TIB Connector
29	03012052001	Screw, TIB
30	3364474H_	Label, TIB
31	–	MAP Accessory Cables
32	–	FCC Label
33	KMEW5002A	Edge Card Assembly
34	HW002724A01	Support Pad

[17] When ordering the Ethernet Faceplate Assembly, order kit number HN001998A01. This includes item number 14,16,17,33,34,35.

Item No.	Motorola Solutions Part No.	Description
35	1515327H02	Ethernet Dust Cover

NOTE: The underscore at the end of the kit number is replaced with the kit revision letter. Refer to your specific kit for this suffix letter when placing an order.

Appendix A

Replacement Parts Ordering

Basic Ordering Information

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

The ASTRO APX Mobile Radio Basic Service Manual includes complete parts lists and part numbers.

Refer to Table of Content for applicable manual numbers.

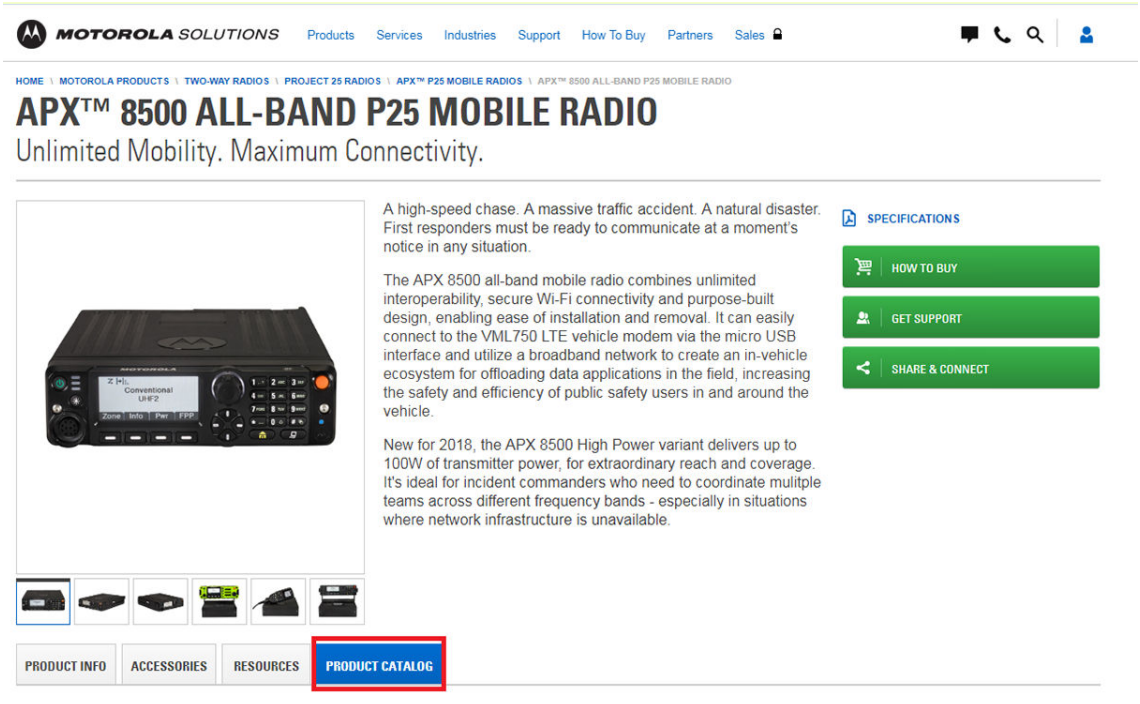
Motorola Solutions Service and Support

For general support, users can access:

- Motorola Solutions Products and Services Support
- Contact Motorola Solutions
- APX™ 8500 All-Band P25 Mobile Radio

To register for online access:

- Domestic customers: please call 800-814-0601 (U.S. and Canada).
- PCAT (Product Catalog)



As a registered user, you have access to the product catalog for purchasing accessories and radios. Visit the following web site: APX™ 8500 All-Band P25 Mobile Radio.

On the website, go to **Motorola Products → Two-Way Radios → Project 25 Radios → APX™ P25 Mobile Radios → APX™ 8500 All-Band P25 Portable Radio → Product Catalog**

Accessories Aftermarket Division (AAD)

The Accessories Aftermarket Division (AAD) is able to provide Motorola Solutions Branded accessories for all your radio needs. After you have a KIT number from the Motorola Solutions website, contact Motorola Solutions at: 1-888-325-9336.

Motorola Solutions provides the following approved optional accessories to improve the productivity of the APX Mobile Radios.

For a complete list of Motorola Solutions-approved antennas, cables, and other accessories, visit the following web site: APX Series P25 Two-Way Radios

On the website, search for APX Mobile Radios and you will see the accessories information beside the specifications of the radio. You can also contact your dealer for more details.

Appendix B

Environmental Information

The ASTRO Digital APX mobile radios control head and radio was designed using Design for Environment (DfE) principles.

- Motorola Solutions has used halogen-reduced printed circuit board material in the production of this product.
- Motorola Solutions has used No-lead solder in the production of this product.
- There are no embedded batteries in this product.
- Motorola Solutions encourages reuse or recycling of the material used to manufacture this product. Contact Motorola Solutions at 1-888-567-7347 or your local sales representative for rebate programs and for the latest disassembly and recycling strategies.
- Do not dispose this product into a landfill.

Appendix C

Maritime Radio Use in the VHF Frequency Range

Special Channel Assignments

C.1
Special Channel Assignments

C.1.1
Emergency Channel

If you are in imminent and grave danger at sea and require emergency assistance, use VHF Channel 16 to send a distress call to nearby vessels and the United States Coast Guard. Transmit the following information, in this order:

1. "MAYDAY, MAYDAY, MAYDAY."
2. "THIS IS _____, CALL SIGN _____."
   State the name of the vessel in distress 3 times, followed by the call sign or other identification of the vessel, stated 3 times.
3. Repeat "MAYDAY" and the name of the vessel.
4. "WE ARE LOCATED AT _____."
   State the position of the vessel in distress, using any information that will help responders to locate you, in example.:
   - latitude and longitude
   - bearing (state whether you are using true or magnetic north)
   - distance to a well-known landmark
   - vessel course, speed or destination
5. State the nature of the distress.
6. Specify what kind of assistance you need.
7. State the number of persons on board and the number needing medical attention, if any.
8. Mention any other information that would be helpful to responders, such as type of vessel, vessel length and/or tonnage, hull color, etc.
9. "OVER."
10. Wait for a response.
11. If you do not receive an immediate response, remain by the radio and repeat the transmission at intervals until you receive a response. Be prepared to follow any instructions given to you.

C.1.2
Non-Commercial Call Channel

For non-commercial transmissions, such as fishing reports, rendezvous arrangements, repair scheduling, or berthing information, use **VHF Channel 9**.

C.2
Operating Frequency Requirements

A radio designated for shipboard use must comply with Federal Communications Commission Rule Part 80 as follows:

- On ships subject to Part II of Title III of the Communications Act, the radio must be capable of operating on the 156.800 MHz frequency.
- On ships subject to the Safety Convention, the radio must be capable of operating in the:
  - Simplex mode on the ship station transmitting frequencies specified in the 156.025–157.425 MHz frequency band, and
  - Semi-duplex mode on the two frequency channels specified in the table below.

NOTE: Simplex channels 3, 21, 23, 61, 64, 81, 82, and 83 **cannot be lawfully** used by the general public in US waters.

Additional information about operating requirements in the Maritime Services can be obtained from the full text of FCC Rule Part 80 and from the US Coast Guard.

Table 67: VHF Marine Channel List

Channel Number	Frequency (MHz)	
	Transmit	Receive
1	156.050	160.650
2	156.100	160.700
3	156.150	160.750
4	156.200	160.800
5	156.250	160.850
6	156.300	–
7	156.350	160.950
8	156.400	–
9	156.450	156.450
10	156.500	156.500
11	156.550	156.550
12	156.600	156.600
13[18]	156.650	156.650
14	156.700	156.700
15[18]	156.750	156.750

[18] Low power (1 W) only.

16	156.800	156.800
17[18]	156.850	156.850
18	156.900	161.500
19	156.950	161.550
20	157.000	161.600
21	157.050	161.650
22	157.100	161.700
23	157.150	161.750
24	157.200	161.800
25	157.250	161.850
26	157.300	161.900
27	157.350	161.950
28	157.400	162.000
60	156.025	160.625
61	156.075	160.675
62	156.125	160.725
63	156.175	160.775
64	156.225	160.825
65	156.275	160.875
66	156.325	160.925
67[18]	156.375	156.375
68	156.425	156.425
69	156.475	156.475
71	156.575	156.575
72	156.625	–
73	156.675	156.675
74	156.725	156.725
75	Guard band	Guard band
76	Guard band	Guard band
77[18]	156.875	–
78	156.925	161.525
79	156.975	161.575
80	157.025	161.625
81	157.075	161.675
82	157.125	161.725
83	157.175	161.775
84	157.225	161.825

85	157.275	161.875
86	157.325	161.925
87	157.375	161.975
88	157.425	162.025

NOTE: A – in the Receive column indicates that the channel is transmit only.

Glossary

This glossary contains an alphabetical listing of terms and their definitions that are applicable to portable and mobile subscriber radio products. All terms do not necessarily apply to all radios, and some terms are merely generic in nature.

Active Channel
A channel that has traffic on it.

ACK
Acknowledgment of communication.

analog-to-digital conversion
Conversion of an instantaneous dc voltage level to a corresponding digital value.

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

Abbreviation:ADC

Automatic Level Control
A circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.

Autoscan
A feature that allows the radio to automatically scan the members of a scan list.

Band Frequencies allowed for a specific purpose.

Baseband interface port
Synchronous serial interface to the transceiver board used to transfer transmit and receive audio data.

Call Alert
Privately paging an individual by sending an audible tone.

Carrier Squelch
Feature that responds to the presence of an RF carrier by opening or unmuting (turning on) a receiver's audio circuit. A squelch circuit silences the radio when no signal is being received so that the user does not have to listen to “noise.”

Central Controller
A software-controlled, computer-driven device that receives and generates data for the trunked radios assigned to it. It Monitors and directs the operations of the trunked repeaters.

Channel
A group of characteristics, such as transmit/receive frequency pairs, radio parameters, and encryption encoding.

CAN
A group of characteristics, such as transmit/receive frequency pairs, radio parameters, and encryption encoding.

CHIB
Control Head Interface Board.

CHUC
Control Head Universal Connector. A separate board which provides connectivity to the CHIB and control head.

Coded Squelch Used on conventional channels to ensure that the receiver hears only those communications intended for the receiver.

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.

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

Customer Programming Software (CPS) Software with a graphical user interface containing the feature set of a radio.

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.

DEK
Direct Entry Keyboard

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 conversion

Conversion of a digital signal to a voltage that is proportional to the input value.

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
A microcontroller specifically designed for performing the mathematics involved in manipulating analog information, such as sound, that has been converted into a digital form. DSP also implies the use of a data compression technique.

Digital signal processor code
Object code executed by the Digital Signal Processor in a subscriber radio. The DSP is responsible for computation-intensive tasks, such as decoding signaling.

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.

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.

FGPA
Field Programmable Gate Array.

General-Purpose Input/Output
Pins whose function is programmable.

GLONASS
GLObalnaya NAvigatsionnaya Sputnikovaya Sistema, The Russian Global Navigation satellite system: Consisting of at least 24 operational satellites which fly in medium Earth orbit at an altitude of approximately 19,130 km. Each satellite circles the Earth slightly faster than twice a day. GLONASS provides Time and Location to anywhere on Earth, where there is an unobstructed line of sight to four or more GPS satellites. A GLONASS receiver triangulates its position using these satellites.

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

- Global Positioning System (GPS)
  - It includes Satellite Based Augmentation System (SBAS).
  - Method of location based on reception of multiple satellite signals by a device on the ground or in an airplane.
- Global Navigation Satellite System (GLONASS)
- BeiDou Navigation Satellite System (BDS)
  - Chinese Satellite Navigation System.

Global Positioning System (GPS) System of 24 satellites that identify earth locations, launched by the U.S. Department of Defense. By triangulating signals from three of the satellites, a GPS receiving unit can pinpoint its current location anywhere on earth to within a few meters.

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.

IF
Intermediate Frequency.

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.

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

LO
Local oscillator.

Local Oscillator
Oscillator used in a super heterodyne receiver to down-convert a received signal to the intermediate frequency.

Low-speed Handshake 150-baud digital data sent to the radio during trunked operation while receiving audio.

MAP
Mobile Accessory Port (26 pin Trapazoid). Used to connect accessories and programming cables to the radio.

Secondary In Primary Out
SPI data line from a peripheral to the MCU.

Primary Out Secondary In
SPI data line from the MCU to a peripheral.

MDC
Motorola Solutions Digital Communications.

MDI
MCU/DSP Interface internal to the microprocessor.

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.

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

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.

MMP
Mobile Microphone Port 10 pin round. Used to connect accessories and programming cables to the control head and the TIB.

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.

Non-tactical/revert
The user will talk on a preprogrammed emergency channel. The emergency alarm is sent out on this same channel.

OMAP
An ARM core microcontroller.

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-The-Air Rekeying
Allows the dispatcher to remotely reprogram the encryption keys in the radio.

PA
Power amplifier.

Page
A one-way alert with audio and/or display messages.

Paging One-way communication that alerts the receiver to retrieve a message.

PC Board
Printed Circuit Board. Also referred to as a PCB.

Personality
A set of unique features specific to a radio.

phase-locked loop
A circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.

Power Control IC
The power control IC is intended for closed-loop bias control of power amplifiers. The device facilitates accurate control of the current delivered to the power amplifier (PA) via a control voltage.

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

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.

Real-time Clock
A module that keeps track of elapsed time even when a computer is turned off.

Receiver Electronic device that amplifies RF signals. A receiver separates the audio signal from the RF carrier, amplifies it, and converts it back to the original sound waves.

Registers
Short-term data-storage circuits within the microcontroller unit or programmable logic IC.

Repeater Remote transmit/receive facility that re-transmits received signals in order to improve communications range and coverage (conventional operation).

Repeater/Talkaround
A conventional radio feature that permits communication through a receive/transmit facility, which re-transmits received signals in order to improve communication range and coverage.

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

RS232
A common interface standard for data communications equipment.

RSSI
Received Signal Strength Indicator.

RX
Receive.

RX DATA
Receive digital data 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 Port
SSI to and from the CODEC used to transfer transmit and receive audio data.

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
Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.

software potentiometer
A computer-adjustable electronic attenuator.

Spectrum Frequency range within which radiation has specific characteristics.

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.

SSI Synchronous Serial Interface

Standby mode
An operating mode in which the radio is muted but still continues to Monitor data.

Static RAM
A type of memory used for volatile, program/data memory that does not need to be refreshed.

Status Calls
Pre-defined text messages that allow the user to send a conditional message without talking.

Synchronous Serial Interface (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.

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.

Transceiver Interface Board (TIB) Provides connectivity between radio and the CAN cable. Also, interface for accessories when TIB is used on a highpower radio.

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.

Triangulation
A method of determining the relative positions of points in space by measuring the distances, and sometimes angles, between those points and other reference points whose positions are known. Triangulation involves the use of trigonometry. It is commonly used in the navigation of vehicles, aircraft and boats, and is the method used in the Global Positioning System, in which the reference points are satellites.

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.

TX
Transmit.

UHF
Ultra-High Frequency.

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.

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

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

UCM Universal Crypto Module

VCOB IC
Voltage-Controlled Oscillator Buffer IC.

VHF
Very-High Frequency.

VIP
Vehicle Interface Port.

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.

Waypoint
Geographic Coordinates of a specific location. It can also be an Intermediate point on a route or line of travel.

Wi-Fi
Wireless Data Transmission protocol 802.11.