APX™ TWO-WAY RADIOS

APX 8500 MOBILE RADIO BASIC SERVICE MANUAL

Foreword

This manual covers the model of the ASTRO® 25 Subscribers, APX 8500 Mobile Radio. It includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, self-maintained customers, and distributors.

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

Product Safety and RF Exposure Compliance

ATTENTION!	**Before using this radio, read the guide 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 the following web site, which lists approved accessories: http://www.motorolasolutions.com/en_us/products/two-way-radios/project-25-radios.html

Manual Revisions

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

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Notes

Document History

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

Edition	Description	Date
MN003076A01-AA	Initial Release	Nov. 2016

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Related Publications

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

Commercial Warranty

Limited Warranty

MOTOROLA SOLUTIONS COMMUNICATION PRODUCTS

I. What This Warranty Covers And For How Long

MOTOROLA SOLUTIONS INC. (“MOTOROLA”) 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:

ASTRO APX 8500 Mobile Radio	One (1) Year
Product Accessories	One (1) Year

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

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

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

II. General Provisions

Notes

This warranty sets forth the full extent of MOTOROLA SOLUTIONS'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA SOLUTIONS's 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

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 1-888-567-7347 US/Canada.

V. What This Warranty Does Not Cover

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

B. Defects or damage from misuse, accident, water, or neglect.

C. Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.

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

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

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

G. Rechargeable batteries if:

- any of the seals on the battery enclosure of cells are broken or show evidence of tampering.
- the damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.

H. Freight costs to the repair depot.

I. A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA SOLUTIONS's published specifications or the FCC certification labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA SOLUTIONS.

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

K. Normal and customary wear and tear.

VI. Patent And Software Provisions

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 SOLUTIONS will pay those costs and damages finally awarded against the end user purchaser in any such suit which are attributable to any such claim, but such defense and payments are conditioned on the following:

A. that MOTOROLA SOLUTIONS will be notified promptly in writing by such purchaser of any notice of such claim;

B. that MOTOROLA SOLUTIONS will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and

C. should the Product or parts become, or in MOTOROLA SOLUTIONS's 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.

MOTOROLA SOLUTIONS will have no liability with respect to any claim of patent infringement which is based upon the combination of the Product or parts furnished hereunder with software, apparatus or devices not furnished by MOTOROLA SOLUTIONS, nor will MOTOROLA SOLUTIONS have any liability for the use of ancillary equipment or software not furnished by MOTOROLA SOLUTIONS which is attached to or used in connection with the Product. The foregoing states the entire liability of MOTOROLA SOLUTIONS with respect to infringement of patents by the Product or any parts thereof.

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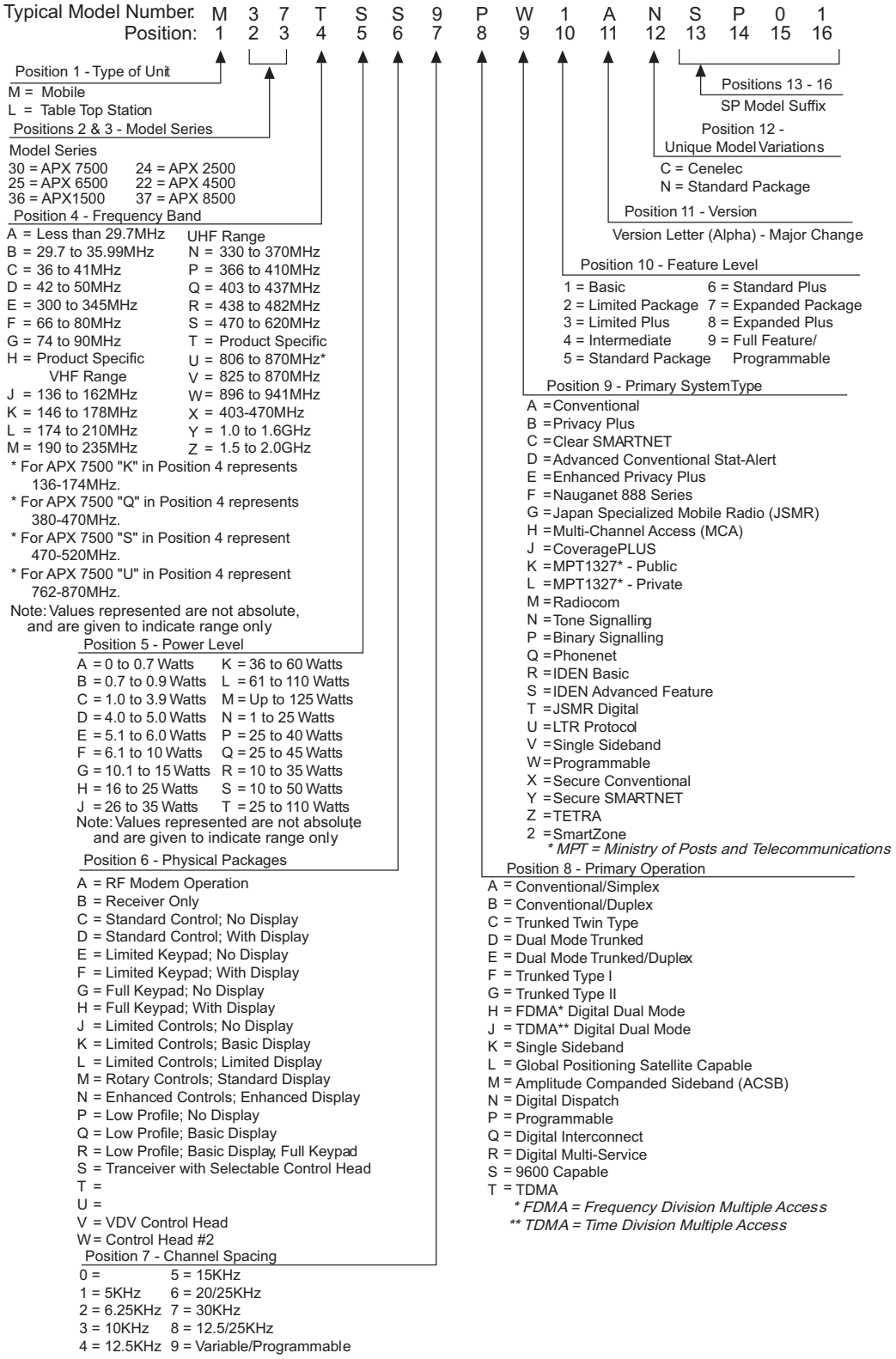
VII. Governing Law

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

Notes

Model Numbering, Charts, and Specifications

Mobile Radio Model Numbering Scheme



APX 8500 Model Charts

Please refer to appendix A to access ECAT (Electronic Catalog) to see the latest model options and kit numbers.

ASTRO APX 8500 Emergency Model Chart

M37TSS9PW1AN (APX 8500)

Option					Description
G235AC					ADD:PTT FOOTSWITCH APEX
	W470AT				ADD: EMERG ID EXT. FOOTSWITCH APEX
		W688AR			ADD: EXT EMERG PUSHBUTTON APEX
			GA00304AA		ADD: PUSHBUTTON PTT

					Item No.	Description
	X				GLN7278B	PTT FOOTSWITCH (XTL)
		X			HLN5113C	EMER FOOTSWITCH
			X		HLN5131C	EMERGENCY PUSH BUTTON SWITCH
				X	RLN5926A	PUSH BUTTON PTT

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Antennas Model Chart

M37TSS9PW1AN (APX 8500)

Option	Description
GA01513AA	ALL BAND MOBILE ANTENNA (7/8/V/U)
G335AZ	3DB MCYCLE 762-870MHZ
G174AG	3DB LOW PRO MCYC 762-870MH
GA00510AB	MCYCLE 1/4 WAVE WHIP 136-144
GA00511AB	MCYCLE 1/4 WAVE WHIP 144-150.8
GA00512AB	MCYCLE 1/4 WAVE WHIP 150.8-162
GA00513AB	MCYCLE 1/4 WAVE WHIP 162-174

								Item No.	Description
	X							AN000131A01	ANTENNA, WHIP,ALL BAND, MOBILE
		X						AN000197A10	ANTENNA, STAMPED METAL,3DB MCYCLE 762-870MHZ
			X					AN000197A11	ANTENNA, STAMPED METAL,3DB LOW PRO MCYC 762-870MH
				X				AN000197A01	ANTENNA, WHIP,MCYCLE 1/4 WAVE WHIP 136-144
					X			AN000197A02	ANTENNA, WHIP,MCYCLE 1/4 WAVE WHIP 144-150.8
						X		AN000197A03	ANTENNA, WHIP,MCYCLE 1/4 WAVE WHIP 150.8-162
							X	AN000197A04	ANTENNA, WHIP,MCYCLE 1/4 WAVE WHIP 162-174

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Antennas Model Chart (Cont.)

M37TSS9PW1AN (APX 8500)

Option	Description
G210AC	MCYCLE 1/4WAVE WHIP 380-433
GA00506AB	MCYCLE 1/4 WAVE WHIP 425-470
GA00507AB	MCYCLE 1/4 WAVE WHIP 450-482
GA00508AB	MCYCLE 1/4 WAVE WHIP 482-520
GA00509AB	MCYCLE LO PRO UNITY 450-512
GA00226AB	GPS WIFI ANTENNA
GA00269AB	GPS WIFI MCYCLE ANTENNA

								Item No.	Description
	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,GPS/BT/WIFI, SHARK FIN, DECK MOUNT
							X	AN000163A02	ANTENNA, STUBBY,GPS/BT/WIFI, MOTORCYCLE MOUNT

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Cables Model Chart

M37TSS9PW1AN (APX 8500)

Option								Item No.	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 FEET CAN CABLE
	X							54009321002	LABEL,DUAL RADIO PRIMARY AND SECONDARY LABEL
		X						HKN6246A	ASSEMBLY, 30 FEET SPEAKER EXTENSION CABLE
		X						54009321002	LABEL,DUAL RADIO PRIMARY AND SECONDARY LABEL
			X					KT000247A01	KIT, Y-CABLE, J2:J600/J2 APX8500
				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

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Cables Model Chart (Cont.)

M37TSS9PW1AN (APX 8500)

Option			Item No.	Description
G308AD				ADD:USB DATA INTFC CABLE-DASH APEX
	G309AC			ADD:USB DATA INTFC CABLE-TRK APEX
X			HKN6163C	CABLE, DATA, USB, 1-1/2M, XTL5000
	X		HKN6172C	CABLE, DATA, USB, 4-1/2M, XTL5000

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 CAN Model Chart

M37TSS9PW1AN (APX 8500)

Option	Description
G582AC	ADD: REMOTE MOUNT CABLE 131 FT APEX
G879AC	ADD:REMOTE MOUNT CBL 115 FEET APEX
G607AC	ADD:CBL REMOTE MOUNT 75 FEET APEX
G609AC	ADD: REMOTE MOUNT CBL 50 FEET APEX
G610AC	ADD: REMOTE MOUNT CBL 30 FEET APEX
G628AC	ADD: REMOTE MOUNT CABLE 17 FT APEX
G618AC	ADD:CBL REMOTE MOUNT 10 FEET APEX

G582AC	G879AC	G607AC	G609AC	G610AC	G628AC	G618AC	Item No.	Description
X							HKN6164B	CABLE, REMOTE MOUNT, 39.2M
	X						HKN6165B	CABLE, REMOTE MOUNT, 35M
		X					HKN6166B	CABLE, REMOTE MOUNT, 23M
			X				HKN6167B	CABLE, REMOTE MOUNT, 15M
				X			HKN6168B	CABLE, REMOTE MOUNT, 10M
					X		HKN6169B	CABLE, REMOTE MOUNT, 5M
						X	HKN6170B	CABLE, REMOTE MOUNT, 10 FT

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 DEK Model Chart

M37TSS9PW1AN (APX 8500)

Option	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

GA00260AA	GA00259AA	W355AS	W374AJ	W591AQ	W599BF	W614AT	Item No.	Description
X							3064153H02	CABLE,4500 MM,ASSEMBLY,CABLE,SHIELDED
X							3064153H05	CABLE,2850 MM,KEYPAD MIC WITH MMP
	X						40012006001	CIRCUIT BREAKER, 60A
	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
	X						40012006001	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

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 DEK Model Chart (Cont.)

M37TSS9PW1AN (APX 8500)

Option				Description
W615AW				ADD: 24 MODE DIRECT ENTRY APEX
	GA00812AA			ADD: DEK FOR WHELEN SIREN W/ O3 CH ONLY*
		GA00814AA		ADD: DEK FOR WHELEN SIREN
			Item No.	**Description**
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

** = Requires J600 (User Y-adapter CB000409A03 for a J600 connector)*
X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Housing Alarm PS Model Chart

M37TSS9PW1AN (APX 8500)

Option						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

						Item No.	Description
	X					NNTN7279B	ASSY,ACCY,SHIELD, SUN, MCYCLE
		X				HLN7022A	BLACK MOTORCYCLE ENCLOSURE WITH HDW
			X			56012023001	UNIT BOX SPECTRA ST
			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

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Mic Model Chart

M37TSS9PW1AN (APX 8500)

Option	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

Item No.	Description
RLN6551B	LONG RANGE WRLS MOBILE BT W/ VC
PMMN4097C	MOBILE MICROPHONE WITH BLUETOOTH GATEWAY
RLN6552B	LONG RANGE WRLS MOBILE BT NO PS
HMN4097A	MODEL III KEYPAD TELEPH HANDSET KIT
HMN1089B	ASSY:PRD OTH,HAND MIC,MMP,WTR REST
(REFERENCE)_A381	NO MICROPHONE
HMN4079G	XTL5000 KEYPAD MICROPHONE

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Mic Model Chart (Cont.)

M37TSS9PW1AN (APX 8500)

Option	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

Item No.	Description
HMN4109B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MIC, CYRILLIC
HMN4110B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MIC, ARABIC
HMN4108B	KEYPAD ASSEMBLY,ASSEMBLY, KEYPAD MICROPHONE
HMN1079B	MOD MOTORCYCLE WP MIC DB9 PIN CONN
HMN1090C	ASSY,MIC,FRNT,GRY,STD PALM MIC (GCA
RMN5070A	DESKTOP MIC (MMP)
RMN5054B	SMART VISOR MIC

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

ASTRO APX 8500 Speaker Model Chart

M37TSS9PW1AN (APX 8500)

Option	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 13W 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

B18CR	B18CS	G142AD	G831AD	G832AD	W432AG	GA01116AA	Item No.	Description
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
				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

X = Item Included
_ = the latest version kit. When ordering a kit, refer to your specific kit for the suffix number.

APX 8500 Radio Specifications

For APX 8500 radio product info, please visit:

- APX™ 8500 All-Band P25 Mobile Radio website at:

http://www.motorolasolutions.com/en_us/products/two-way-radios/project-25-radios/mobile-radios/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

Notes

Chapter 1 Introduction

1.1 Manual Notations

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

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

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

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

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

1.2 Radio Description

The ASTRO APX 8500 mobile radio are Motorola Solutions newest two-way mobile radio designed for your organization's most demanding needs. These radios are available in the following frequencies and power levels.

Table 1-1. APX 8500 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
700–800 MHz	764–870 MHz 806–870 MHz	1–30 W variable (2–3 W itinerant) 1–35 W variable

The APX 8500 mobile radio are among the most sophisticated two-way radios available. They have 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.

1.3 FLASHport®

All APX mobile radios are part of the FLASHport program and ship standard with a FLASH IC, which allows for feature and system upgrades. FLASHport Aftermarket Software is used to upgrade to the latest version of your System Enhancement Software Package, to upgrade to a different System Enhancement Software Package, or to order enhancements for existing APX mobile radios in the field.

1.4 O2/O3/O5/O7/O9 Control Head Descriptions

Each Control Head detailed function and operation is available in the individual User Guides.

Please refer to the related publications provided in Related Publications.

1.5 P25 Digital Vehicular Repeater System (DVRS)

Motorola Solutions offers an MSI Certified APX compatible, 3rd Party, P25 Digital Vehicular Repeater System (DVRS) that provides low cost portable radio coverage in areas, where only mobile radio coverage is available, and portable radio coverage is either intermittent or non-existent.

Chapter 2 Basic Maintenance

2.1 Introduction

This section of the manual describes preventive maintenance, handling precautions, and some basic repair procedures and techniques. Each of these topics provides information vital to the successful operation and maintenance of your radio.

2.2 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 six months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field. It is strongly recommended that the reference oscillator be checked 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. Refer to section 6.4.3 for reference oscillator alignment procedures.

2.2.1 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.

2.2.2 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 servicing 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**. Extreme etching to disintegration of the plastic can result.

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).

2.2.2.1 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. A soft, absorbent, lint-free cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

2.2.2.2 Cleaning Internal Circuit Boards and Components

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).

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.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process, since this could cause the liquid to puddle and collect in unwanted places.

Upon completion of the cleaning process, use a soft, absorbent, lint-free cloth to dry the area. Do not brush or apply any isopropyl alcohol to any plastic parts.

2.2.3 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.

2.2.4 RF Power Amplifier (RF PA) Heatsinking

You should never transmit unless the printed-circuit board (PCB) DC and RF connector clips and internal screws are installed in the chassis. Doing so can result in immediate failure of RF PA devices or greatly reduced RF PA device life.

2.3 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 the radio without first referring to the following CAUTION statement.

Caution

This radio contains static-sensitive devices. Do not open the 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. We recommend using a wrist strap, two ground cords, a table mat, a floor mat, 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.
- If at all possible, handle CMOS/LDMOS devices by the package and not by the leads. Prior to 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.

Notes

Chapter 3 Basic Theory of Operation

3.1 Introduction

The ASTRO APX8500 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.

3.2 General Overview

The APX8500 mobile radio is synthesized, fixed-tuned, all-band radios.

The APX 8500 radio is currently only available in a mid power model. It is capable of both analog operation at 12.5 kHz, 20 kHz, and 25 kHz bandwidths, and ASTRO mode operation at 12.5 kHz bandwidth.

The APX 8500 mobile radio contain the following assemblies and sections:

- O2 Control Head Assembly – The control head assembly contains the LCD display, User Interface, and OMAP microprocessor. For the dash mount configuration, the control head assembly is attached directly to the controller via a flex, and utilizes SSI to communicate. For remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB) via a flex and a CAN cable is used 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.
- O3 Control Head Assembly – The control head assembly contains the LCD display, User Interface, OMAP microprocessor. The O3 plugs directly into the Transceiver Interface Board (TIB) assembly mounted at the back of the 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 LCD display, User Interface, OMAP microprocessor. For the dash mount configuration, the control head assembly is attached directly to the controller via a flex, and utilizes SSI to communicate. For remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB) via a flex and a CAN cable is used 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.
- O7 Control Head Assembly – The control head assembly contains the LCD display, User Interface and OMAP microprocessor. For the dash mount configuration, the control head assembly is attached directly to the controller via a flex, and utilizes SSI to communicate. For remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB) via a flex and a CAN cable is used 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.
- O9 Control Head Assembly – The control head assembly contains the LCD display, User Interface, OMAP microprocessor. For the dash mount configuration, the control head assembly is attached directly to the controller via a flex, and utilizes SSI to communicate. For remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB) via a flex and a CAN cable is used 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.

- Transceiver Board – The controller portion of this board contains digital hardware (microcontroller, memory, logic, and supporting peripherals) governing radio operation, servicing all radio inputs and outputs, and processing all voice and data. It includes a dual-core processor (MCU and DSP cores), the processor's memory devices, an audio and power supply support IC, an audio CODEC and audio PA, and MACE (Type 3 Secure IC). In addition, it contains a GNSS (GPS/GLONASS) IC and support circuitry, a combination WLAN/Bluetooth capable IC and support circuitry, and supporting hardware for external accessory interfaces such as RS232, USB, SB9600, and logic signals.
- The CHIB contains a SSI-CAN FPGA, a 16 bit CODEC for audio processing, a Class D Audio PA, and three Controller Area Network (CAN) transceivers. Each CAN transceiver is used to communicate with the RF transceiver, one for audio, one for data, and one for system power-on commands.
- Transceiver Interface Board – Contains CAN transceivers and audio and digital routing for accessories. The TIB is used with the O3 Control Head for Dash and Remote Mount configuration and is only used for Remote Mount configuration with the O2, O5, O7, and O9 Control Head.
- Radio Frequency Transceiver Board
  - Power Amplifier (PA) section – Contains the antenna switch, directional coupler/ detector, and amplifier(s).
  - 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.

3.3 Controller Section

3.3.1 Introduction

The Controller is a section of the transceiver 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

Block diagrams of controller are shown below:

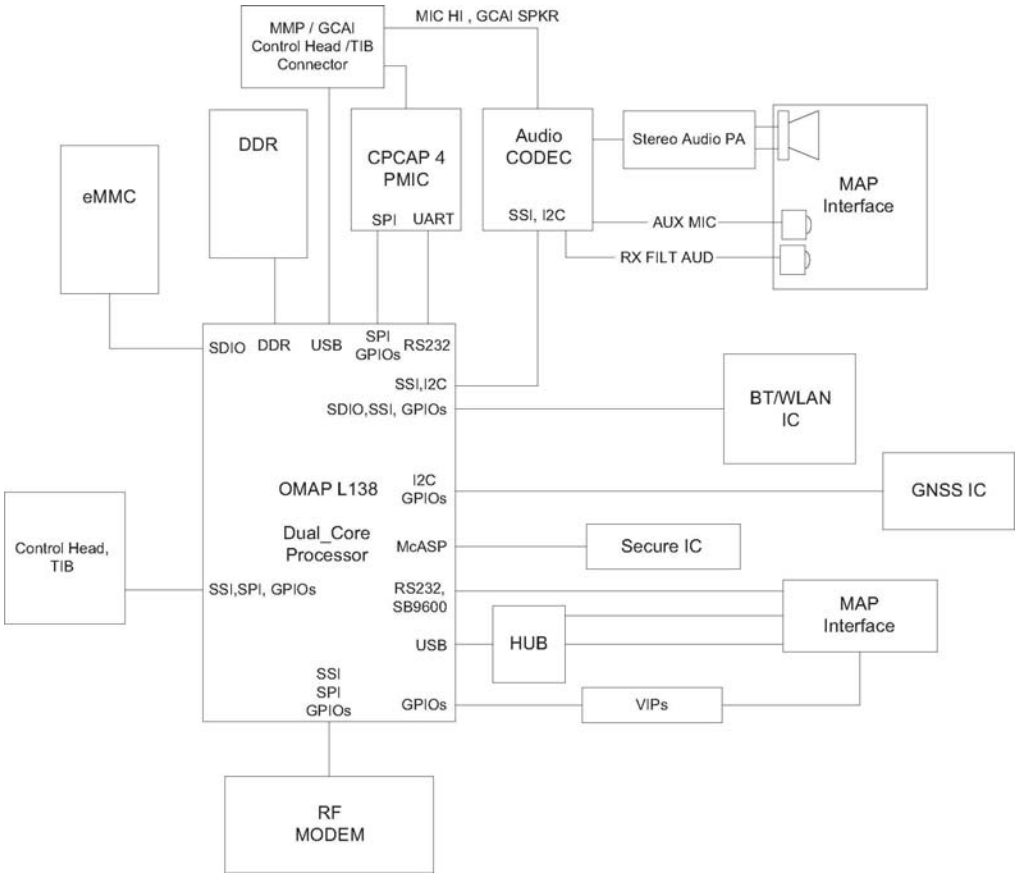


Figure 3-1. Mobile Controller Block Diagram

3.3.2 Controller Functional Blocks

The main functional blocks of the controller are a dual-core microprocessor consisting of an ARM-based controller and a DSP, Flash memory, and a Double-Data-Rate SDRAM memory. In addition, the controller includes a Type 3 encryption processor (MACE), a power management IC (CPCAP), and various external switching and linear voltage regulators. There are two primary clock sources (19.2 MHz and 32.768 kHz) from which all other controller digital clocks are derived. The audio section has a stereo CODEC and a class-D audio power amplifier that provides the radio with multiple internal microphone and speaker inputs/outputs. External interfaces/connectors provide communication and control to/from accessories, the control head, and the TIB.

The ARM controller core of the OMAP L138 processor handles the power-up sequence of all devices, including firmware upgrades, and all operating system tasks associated with FLASH and SDRAM memories and user interface/control-head communication. The FLASH memory (4GB eMMC) stores the firmware, tuning, and codeplug settings, which upon initialization gets read and stored into SDRAM (128 MB) for execution. The ARM and DSP core jointly control and configure audio, wireless and RF devices linked to the Serial Peripheral Interface (SPI) ans Synchronous Serial Interface (SSI) buses to enable 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 via the main processor to its internal FLASH memory.

The power to all the controller devices is provided by the CPCAP IC and the external switching and linear regulators on board. The CPCAP IC also provides the 32.768 kHz clock to the OMAP L138 and to the WLAN/Bluetooth IC, and provides a 4.8 MHz clock to the MACE encryption IC. OMAP L138's main reference clock, 19.2 MHz, is supplied from the FGU section of the transceiver board.

The radio has three external microphone input paths and an internal audio PA which provides audio to an external loudspeaker. There are line level analog audio outputs for monitoring/recording. The external speaker is driven by a Class D audio amplifier that is capable of delivering a rated power of 15W 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's ADC to deliver digital audio samples to the DSP controller.

Both the control head and TIB contain a universal accessory connector (MMP) that provides audio, USB, and RS232 interfaces to the radio, via the CPCAP power management IC and CODEC. Many of these same interfaces (in addition to other signals) are available on the radio accessory interface connector (MAP).

A GNSS IC consisting of a Global Postitioning System (GPS) and GLONASS receiver, an IC that combines a WLAN transceiver (IEEE 802.11 b/g/n) and a Bluetooth 4.0 capable transceiver, and a 3-axis accelerometer. The GNSS IC interfaces with the OMAPL138 processor through a shared I2C bus. The WLAN/Bluetooth IC interfaces with the OMAPL138 processor through a 4-bit SDIO bus.

The APX8500 radio has the ability to connect to a wireless network access point utilizing the WLAN/Bluetooth IC. The IC supports IEEE 802.11 b/g/n data rate standards as well as the 802.11i security standard. When this feature is enables, Wi-Fi allows the radio to be wirelessly updated with a new codeplug and radio software without the need for connecting the MMP or MAP USB cable. 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's Wi-Fi is actively connected to an AP, a receive signal strength indicator (RSSI) is shown on the control head display.

3.3.3 Voltage Distribution / Power On/Off

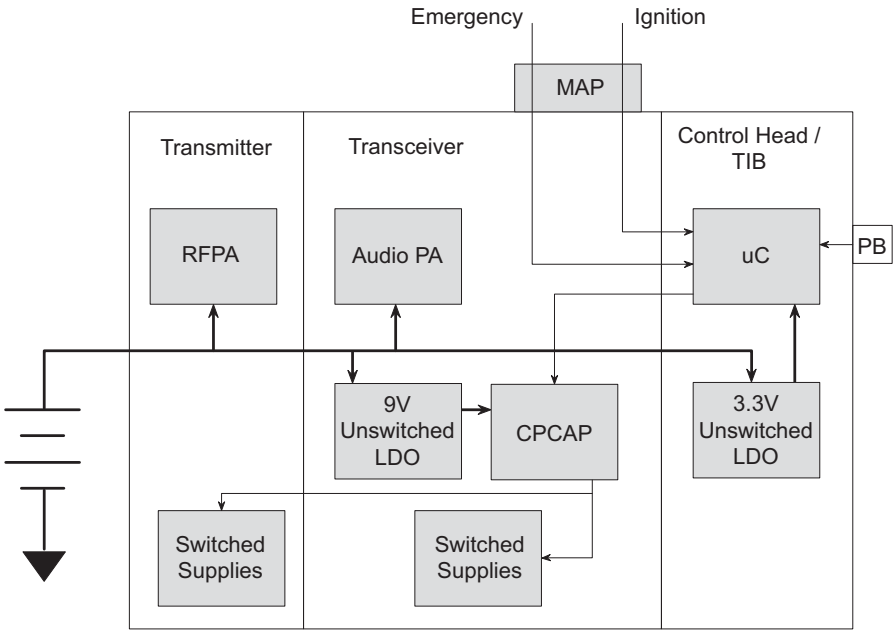


Figure 3-2. Voltage Distribution / Power Diagram

3.3.3.1 Voltage Distribution for Controller and RF Board

The APX mobile radios are powered by a 12V vehicle battery (negative ground), or a AC-to-DC desktop power adapter which enters at the rear of the radio transceiver at a dedicated 2-pin DC connector. This raw voltage, referred to as “A+”, is routed to both the transmitter and transceiver board circuitry for post-regulation.

3.3.3.2 Power On/Off

There are three methods that can be used to turn the radio on and off (depending on the codeplug setting); Power Button on the control head, Ignition sense (ACC) line (via the MAP accessory connector), and emergency (also via the MAP connector).

The transceiver regulators are controlled by the CPCAP (ASIC). This IC has a Power Management Controller (PMC) state machine that turns on and off all radio supplies and resets the OMAP L138 microprocessor at power-up, in response to user inputs at the control head or MAP.

3.3.4 Audio Circuitry

3.3.4.1 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 via 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.

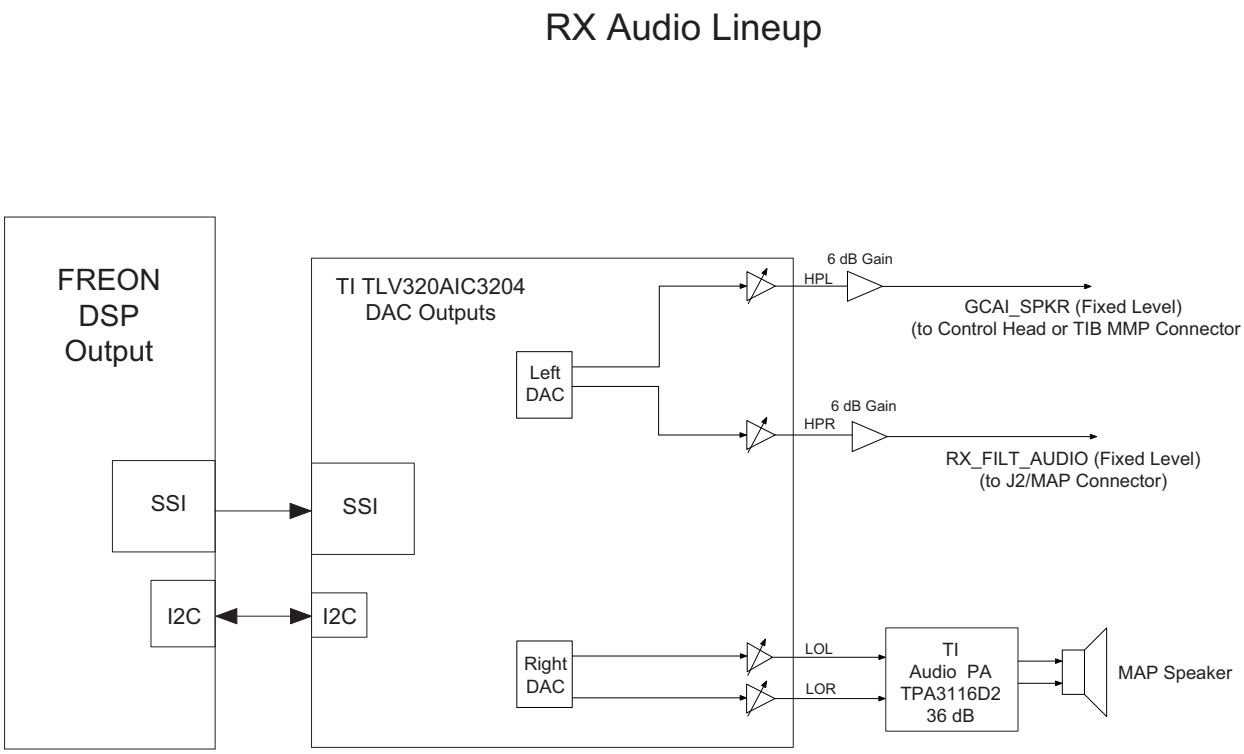


Figure 3-3. Receive Baseband Audio Path

3.3.4.2 TX Audio Path

Analog audio comes from the external Microphone attached to the radio via the control head mic port or the MAP rear accessory connector J2 (Mic_Hi or Aux_Mic). Analog audio is attenuated by 6dB and is then routed to the CPCAP, which converts the analog audio to digital and sends it to the main processor using the Audio SSI bus. OMAP L138 processes the audio which is then converted to Baseband audio and routed to the FGU and then to the transmitter board.

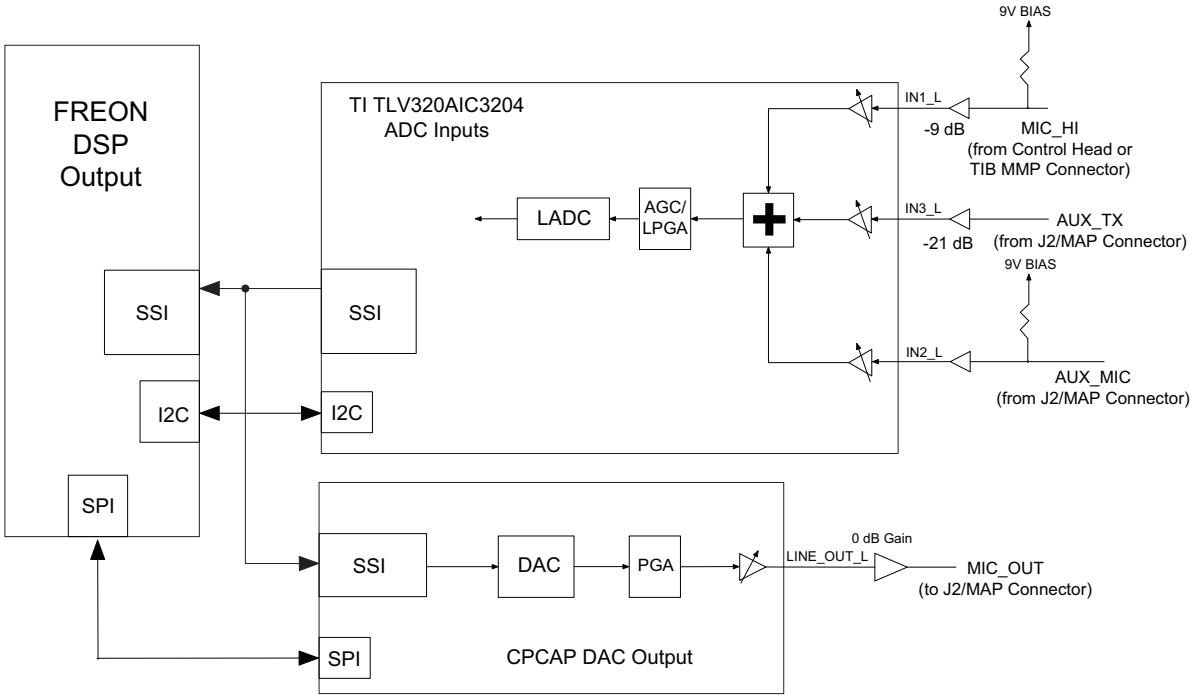


Figure 3-4. Transmit Baseband Audio Path

3.3.5 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 via 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 via 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 Section 7.2. The KEYLOADER signal comes in on MMP pin 9 of the control head or TIB J700 connector. It routed to the MACE via CPCAP. 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 will detect mechanical intrusion. A capacitor-backed supply maintains the static memory when all power to the transceiver is removed. This volatile key retention option will hold the key for between 5 and 10 minutes on the discharge of this capacitor.

3.3.6 GPS Overview

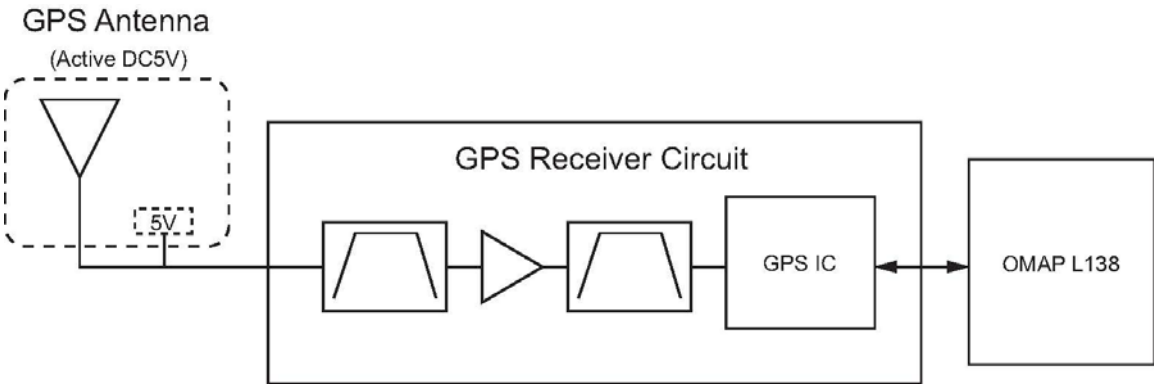


Figure 3-5. GPS Architecture

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 will operate in the autonomous mode only.

The GNSS receiver is setup in an autonomous one track always (OTA) mode, also known as continuous navigation. This means it will continuously track 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 will temporarily lose its position fix. It will 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 will be able to view the current latitude, longitude, and time/date stamp on the radio's display. The radio can also be configured to send its' location to the system at predetermined intervals (LRRP). Depending on system options, the user may be able to enable/disable the GNSS receiver.

If the GNSS receiver is unable to acquire a position try the following steps.

1. Make sure the unit is in an open sky environment to ensure the presence of GNSS signals (min 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 go to step 3.

3. Disconnect the GNSS antenna and make sure the center conductor on the antenna is not shorted to ground. If so, replace the GPS antenna.

4. Measure the voltage on the GNSS SMA connector located on the radio and ensure 5V is present. If 5V is not present then send the radio in for repair.

5. If steps 1 to 4 have been followed and the GNSS still does not obtain a position fix, then refer to the Detailed Service Manual for further instructions.

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 APX 8500 radio. Inserting non-Motorola Solutions parts or pins into these connectors is not recommended. Failure to do so can result in equipment damage.

3.3.7 Serial Interfaces

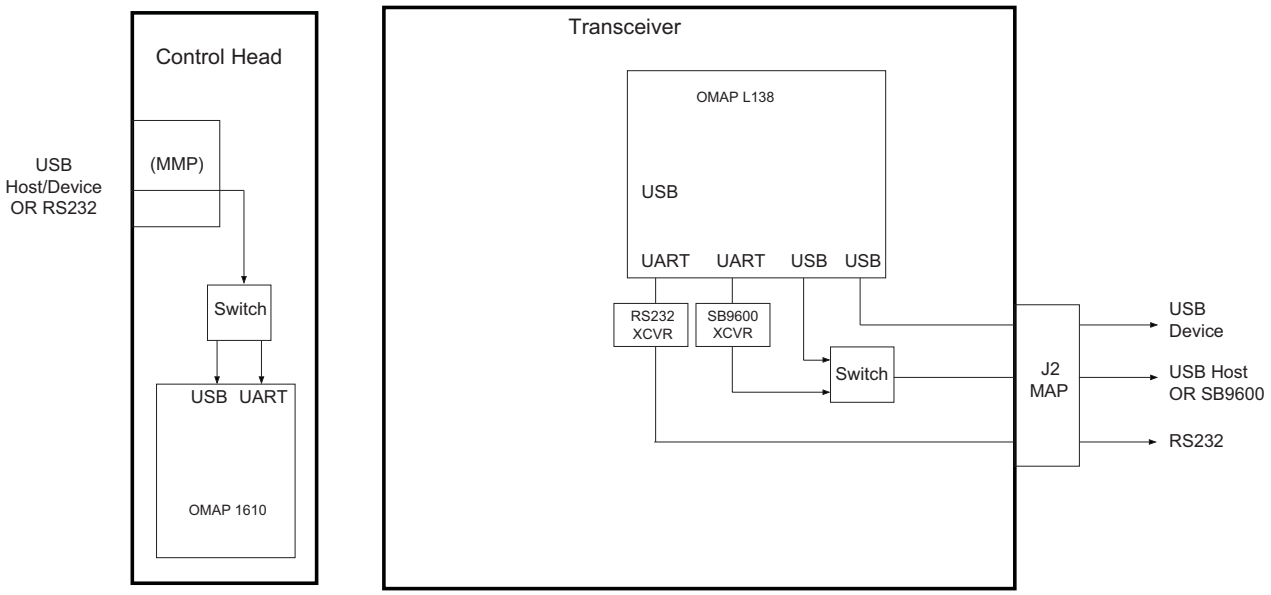


Figure 3-6. Dash-Mount Configuration

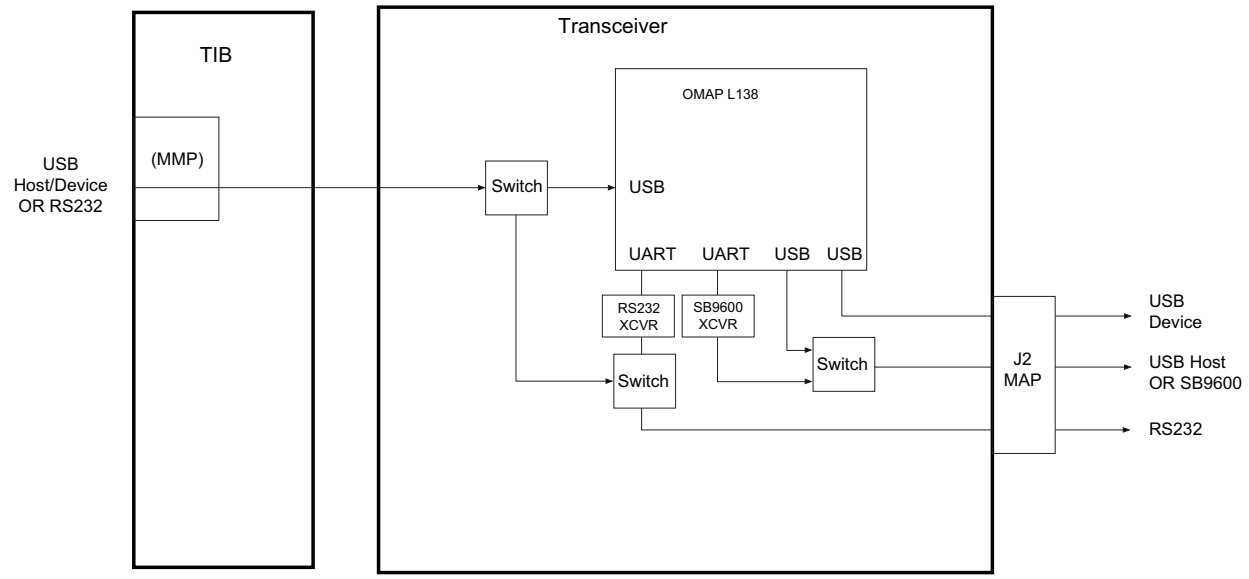


Figure 3-7. Remote-Mount Configuration

Several external serial interfaces are supported by the APX8500 transceiver, and shown in the previous figures for both dash and remote mount operation. These includes RS232, USB Device, USB Host, and SB9600 at the rear 26-pin J2 connector and RS232, and USB Device/Host, at the TIB external connector J700. Many of the 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. The 1-Wire ® IC is typically embedded in the cable/accessory for this purpose.

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. The MAP/J2 interface is compliant with industry-standard 12V RS232 logic and is the default selection when no 1-Wire ® accessory is attached to the J700 connector. 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 is at 5V logic, while the RS232 cable contains the voltage translation circuitry to make the bus 12V compliant.
- **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 TIB. The functionality is again determined by the type of accessory/cable identified by the 1-Wire ® interface. 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 via the SB9600 interface (the buses share common pins). The SB9600 bus is configured by default, but USB Host will be configured when a 1-Wire ® compliant USB Device accessory/cable is attached to the MAP/J2 connector. (Note that 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).

3.4 Transceiver Interface Board (TIB)

The Transceiver Interface Board (TIB) provides connectivity between the CAN cable and the transceiver. Opposite to that of the CHIB, the TIB must convert the CAN protocol back to Synchronous Serial Interface (SSI) via 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.

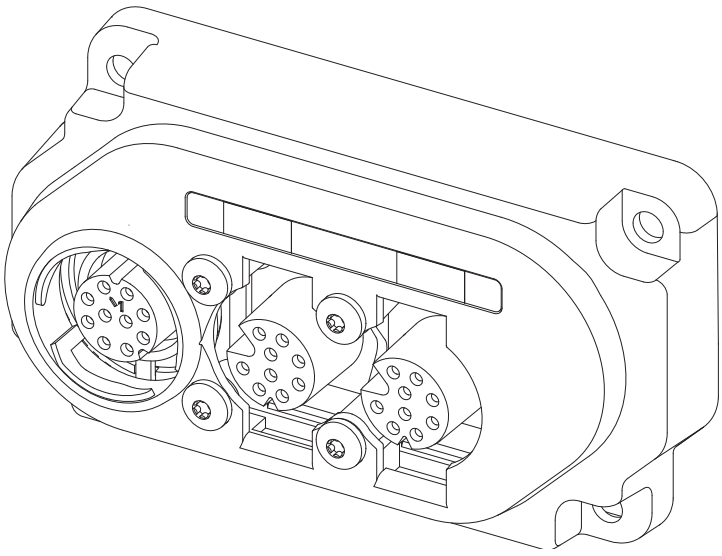


Figure 3-8. Transceiver Interface Board (TIB)

3.4.1 Quick Disconnect Circuit

The function of the quick disconnect circuit, located in the TIB, is to provide immediate muting of all speaker audio by forcing the radio to reset when a control head's CAN cable is disconnected from the TIB or from an extension cable that is attached to the TIB. After the disconnection, if there are no other control heads attached via CAN to the TIB, the radio may be programmed to automatically turn itself off (approximately 20seconds after the radio reset). This programming is done via the CPS by check marking the “Control Head(s) Required for Power Up” field. Note that if this field is NOT checked, the radio will apply its normal power up rules (e.g., ignition) to determine whether to stay on or to power-off after the reset. The “Control Head(s) Required for Power Up” field is typically 'check marked' in a configuration that has a single O3 control (that is attached to an extension cable attached to the TIB) where it is desired that the radio immediately mute all speaker audio and ultimately power-off when the O3 control head is disconnected.

- If the field is 'check marked', then at least one controlhead must be present for the radio to remain powered-on after it resets. For example, a system only had 1 control head, and it is removed, the radio will be powered-off after reset. A system had 2 control heads, and only 1 is removed, then after reset, the radio will monitor the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it will remain powered-on, or power-off. If it had 2 control heads, and both are removed, the radio will be powered-off after reset.
- If the field is 'blank' (typical usage), then quick disconnect is not activated. For example, if a system only had 1 control head, and it is removed, then after reset, the radio will monitor the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it will remain powered-on, or power-off. If a system had 2 control heads, and only 1 is removed, the radio will be powered-on after reset. If a system had 2 control heads, and both are removed, the radio will monitor the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it will remain powered-on, or power-off.

3.4.2 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 1 is used for digital Audio, CAN pair 2 is used for digital Data and CAN pair 3 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 1MB/s data link. Only the list of approved Motorola Solutions CAN cables are to be used for any remote mount installations.

3.4.3 CAN Termination

The CAN architecture requires that a termination resistor be connected only at the two end-points of the CAN bus. The CAN cable contains a jumper that will ground 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. That is why they have the same connector number, with the letter L and R next to the connector to indicate Left or Right CAN connector. It is not recommended to have CAN cables attached but dangling free at one end, during operation.

NOTE: Only 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.

3.5 Analog Mode of Operation

3.5.1 Receive Operation

When the radio is receiving, the signal comes from the antenna through the RF PA output network 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 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 a voice signal, the DSP routes the digital voice data to the Codec 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.

3.5.2 Transmit Operation

When the radio is transmitting, microphone audio is passed to the gain control circuit, and then 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 signalling information. The DSP then sends the resulting digitized signal containing both voice and signalling data to the digital synthesizer IC as a modulation signal for the transmitter voltage controlled oscillator. A modulated carrier is provided to the RF power amplifier, which transmits the signal under dynamic power control.

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 as in the analog mode with the exception of the algorithm the DSP uses to encode the information. This algorithm will result in deviation levels that are limited to discrete levels.

3.7 RF Transmitter Board (TX)

3.7.1 Radio-Frequency Power Amplifier (RF PA) & 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 which amplifies the input signal from the VCO buffer and provides drive to the driver stage.Power is controlled via gate bias to the internal stages of the controlled stage, and drain bias is supplied via K9.1V. 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 28V boost converter. The Driver stage then runs into a 3 to 1 silicon switch that selects between the 3 bands (VHF, UHF, 7800). Each band also has its own low pass/high pass filter to further reduce out of band spurs. From the filters, the signal travels to its respective narrowband final stage. Each final stage is a single LDMOS transistor with fixed gate biases and drain biases supplied by the VDS_FINAL line, which is also powered by the same 28V boost converter as the driver. The output of the final stage feed 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 consists of a digital attenuator, voltage variable attenuator, RF log amp, digital-to-analog converter (DAC) and 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 via 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’s carrier power level is set by adjusting the DAC voltage set while monitoring the output power, which is saved in the radio’s memory.

3.7.4 Circuit Protection

The APX8500 radio has various protection mechanisms while transmitting. Monitored signals include the RFPA driver and final stage drain current, the RFPA final stage temperature, the RFPA control voltage, and the radio battery voltage are sensed by the power control circuitry. If a fault condition is detected, the control voltage is reduced, which cuts back the output power to a level that is safe for the particular operation conditions.

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

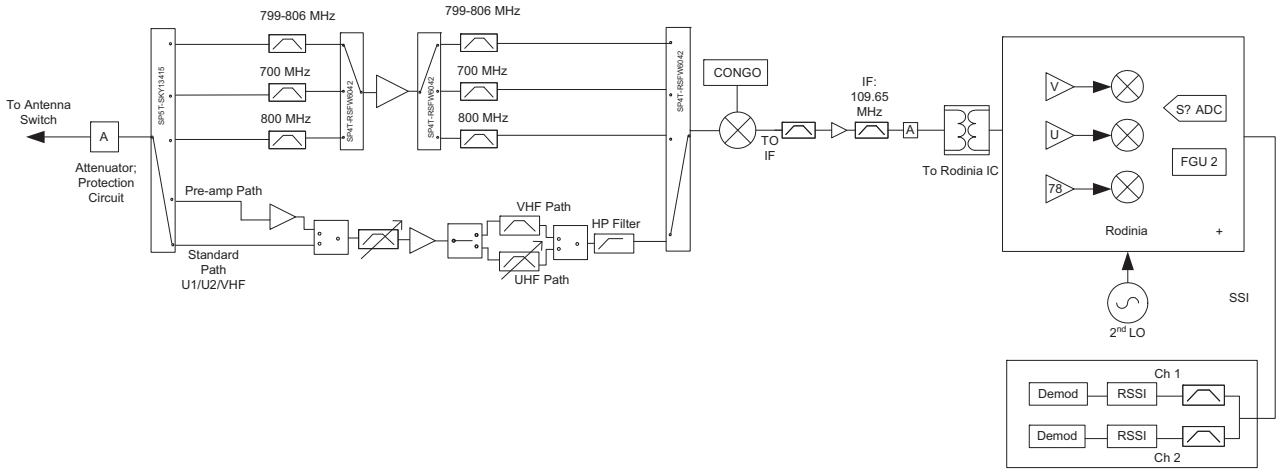


Figure 3-9. Receiver Block Diagram

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 and UHF R2 receiver operates in the frequency range of 450 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, which provides the best intermodulation performance; and
- Pre-amp mode (optional), 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 varactor-tuned image filter, low-noise amplifier, and finally a second varactor tuned image filter. In pre-amp mode, an additional LNA is added between the attenuator and the first bandpass filter.

3.8.3 700-800MHZ / Industry Canada Receiver Front-End

The 700–800 MHz and Industry Canada receiver front-end operates in three bands. The primary function of the receiver front-end is to optimize image rejection and selectivity while providing the first conversion. The front uses a multi-pole switch to select between the 3 bands. The front-end uses saw-filter technology and includes a wideband, monolithic amplifier. The first filter is a dual-switched filter that reduces the image frequency response and limits some of the 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 where it is 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 to efficiently drive 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. The use of two 2-pole crystal filters centered at 109.65 MHz, which are isolated from one another by a discrete IF amplifier, enable the receiver to meet specifications for gain, close-in intermodulation rejection, adjacent channel selectivity.

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, as well as digital, RF protocols into a baseband signal, which is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section using a second LO frequency produced by 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

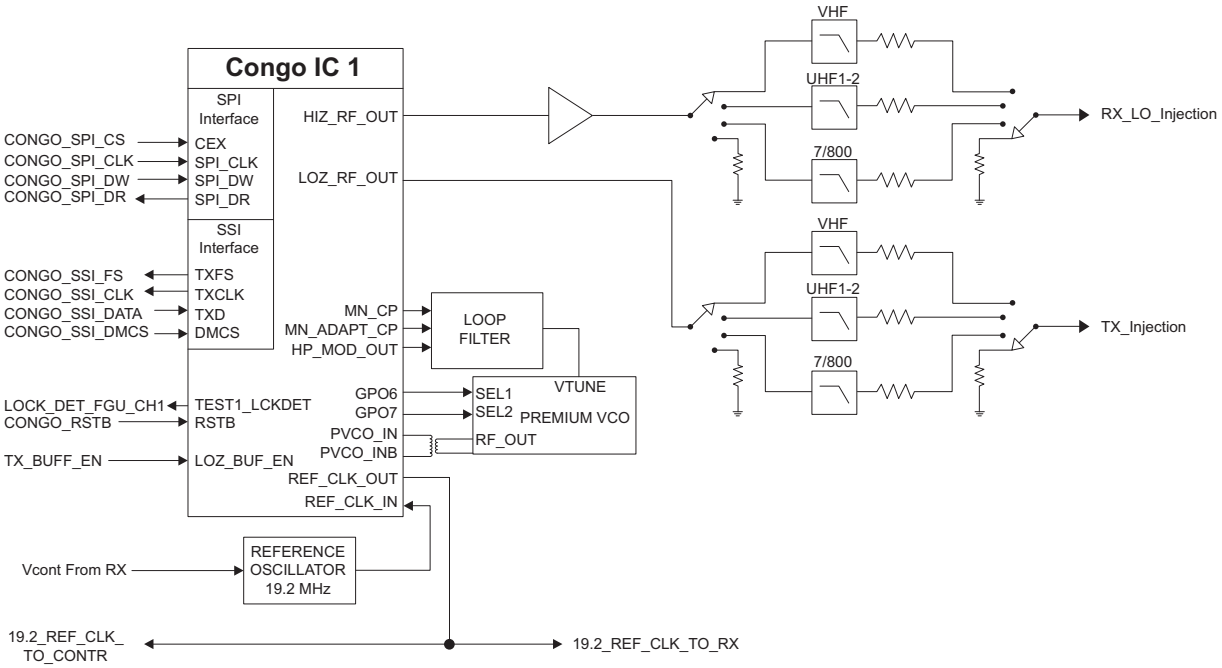


Figure 3-10. Configuration of the Frequency Generation Unit for APX 8500

The Frequency Generation Unit (FGU) in Figure 3-10 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

4.1 Recommended Test Equipment

The list of equipments contained in Table 4-1 includes most of the standard test equipment required for servicing Motorola Solutions APX mobile radios, as well as several unique items designed specifically for servicing this family of radios. The *Characteristics* column is included so that equivalent equipment can be substituted. However, when no information is provided in this column, the specific Motorola Solutions model listed is either a unique item or no substitution is recommended.

Table 4-1 contains a listing of non-Motorola Solutions test equipment recommended for servicing mobile radios.

Table 4-1. Recommended Non-Motorola Solutions Test Equipment

Model Number	Description	Application
BIRD Model 43	BIRD Wattmeter	Transmitter power measurements
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
Agilent 8901	Modulation Analyzer	Reference frequency measurements
*****General Dynamics R8000B	Digital Radio Test Set	Frequency, reference oscillator deviation digital tests and compensation measurements
Agilent U8903A and Rohde & 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

Refer to below tables in this section for listing and description of the service aids and tools designed specifically for servicing this APX 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 4-2. Service Aids for APX 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 / 4500 / 4500Li / 1500 FLASHport Kit	
RVN5224_	APX Customer Programming Software (CPS) and Tuner Software	Programming and radio alignment software.
HKN6160_	1.8m (6') 4-wire RS232 data cable	1.8m (6') cable used for RS232 data applications through the 26 pin rear accessory connector. Also provides an Ignition sense (ACC) wire.
HKN6161_	6.1m (20') 4-wire RS232 data cable	6.1m (20') cable used for RS232 data applications through the 26 pin rear accessory connector (J2).
HKN6163_	1.8m (6') USB data cable	1.8m (6') 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_	4.5m (15') USB data cable	4.5m (15') 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.
HKN6184_	MMP USB Programming Cable	Use with APX 7500 USB programming through the MMP on its control head or TIB. Can also be used for data terminal applications.

NOTE: Please refer Table 8-1 for required tools and supplies.

4.3 APX Mobile Radios Field Programming and Equipment

The APX 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 any number of times without removing the flash memory from the radio.

The APX mobile radios can only be programmed using USB. To program the radio, connect USB cable HKN6184_ to the control head's 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 APX mobile radios.

Table 4-3. APX 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's 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 • 8GB RAM memory, excluding onboard graphics card memory usage • 4GB free hard disk space (for Standalone CPS) or 8GB 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 4-2.

Notes

Chapter 5 Performance Checks

5.1 Introduction

This section covers performance checks used to verify that the radio meets published specifications. The recommended test equipment listed in Chapter 4 approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the equipment must be maintained in compliance with the manufacturer's recommended calibration schedule.

5.2 Test Setup

The equipment required for APX mobile radio performance checks is connected as shown in the following diagram.

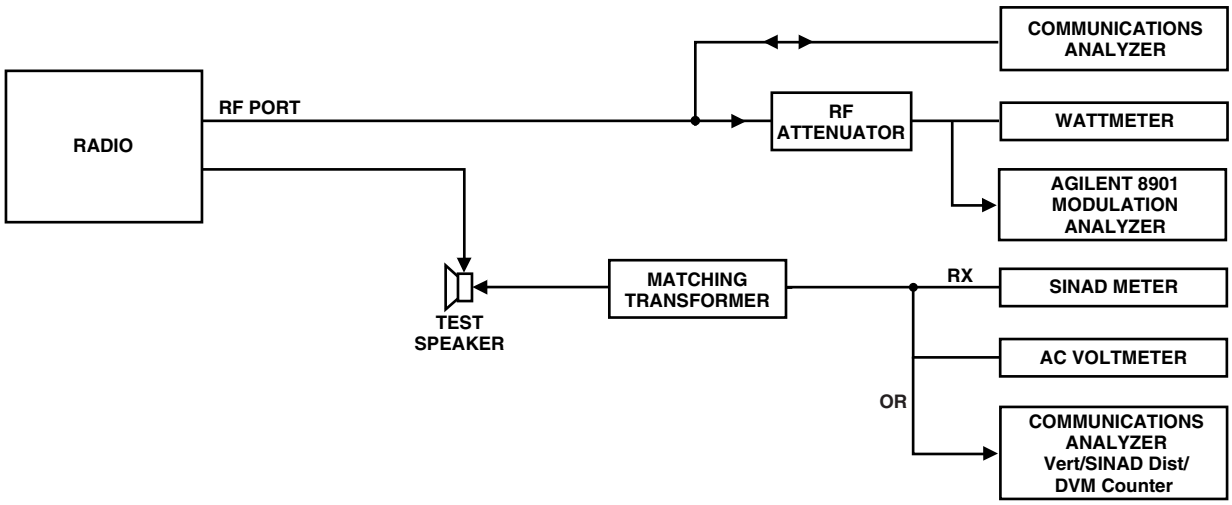


Figure 5-1. Performance Checks Test Setup

5.3 Test Mode

> **Caution** Be sure to transmit into a series load when keying a radio under test (e.g. 30dB RF pad). Failure to do so can result in test equipment damage.

5.3.1 Entering Test Mode

1. To enter test mode, 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 Control Head (see Figure 5-2 for O2, Figure 5-4 for O5, Figure 5-5 for O7 and Figure 5-6 for O9 Control Head), or press the **Side Button 2** five times in succession for O3 Control Head (see Figure 5-3).
3. The radio shows a series of displays that will give information regarding various version numbers and subscriber-specific information. The displays are described in Table 5-1.

Table 5-1. Test-Mode Displays

Display Name	Description	Appears
SERVICE	Indicates radio has entered test mode	Always
HOST VERSION	Version of transceiver firmware	Always
DSP VERSION	Version of transceiver 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's model number, as programmed in codeplug	Always
SERIAL NUMBER	Radio's 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's codeplug	Always
RF BAND	Frequency band of transceiver	Always
TUNING VER	Version of Codeplug tuning	Always
PROCESSOR VER	Version of transceiver 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 while in test mode, if the "UP" Navigation button is pressed, the scrolling information will pause until the "DOWN" Navigation button is pressed again. Repeat with "Up" button to pause any other information. This makes recording radio version information easier.

4. Turn the **Mode** Rotary Knob for O5 Control Head. The test mode menu, `CH TEST`, is displayed.
5. Pressing the **Home** button enters the RF test mode. The display shows `1 CSQ`, indicating test frequency 1, Carrier SQuelch mode.
6. For the O3 Control Head, pressing the programmed **Monitor** button enables toggling between `RF TEST` and `CH TEST`.
7. To select, press the **Orange (EMERG)** button. If the `RF TEST` is selected, display Shows `1 CSQ`, indicating test frequency 1, Carrier SQuelch mode.
8. Go to the **RF Test Mode** section.

5.3.2 RF Test Mode

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

1. For the O2/O5/O7/O9 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 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 Control Head, press the **Home** button to move the cursor back and forth between the frequency and signaling type (See Table 5-2). Use the **Mode** knob to scroll through the available selections.
4. For the O3 Control Head, press the **Monitor** button to select Channel Spacing (12.5Khz or 25kHz), press the **Side Button 1** to change signaling type and press **Side Button 2** to change frequency.

Table 5-2. Rx and Tx Test Frequencies

Channel	Rx Frequency (MHz)	Tx Frequency (MHz)	Po (W)
F1	136.0750	136.0250	55.0
F2	154.2750	154.2250	55.0
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	764.0125	33.0
F11	769.0625	794.0125	33.0
F12	806.0625	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 5-3. 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 will continually modulate the transmitted signal for detection/measurement by external instruments.

5.3.3 O2 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. This test mode allows you to perform button and display tests to verify proper operation.

1. Power up the control head by pressing the Power Button. Press the Menu Select Buttons 1 and 4 simultaneously to enter control head STANDALONE TEST. CH firmware, CH Nautilus, CH Flashzap version and CH Board version will be displayed before the unit enters the Control Head Test mode.
2. Press Home to enter sequential test.
3. In Factory Test menu, pressing any buttons will activate 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. Hit any button after this to activate the keypad test. All the 10 buttons notations will be displayed on the LCD and once the corresponding button is pressed, the notation will disappear from the LCD.
5. After all 10 buttons are pressed, hit any key to enter Multifunction Knob test.
6. Turn the radio off and back on to exit test mode and return to normal radio operation.

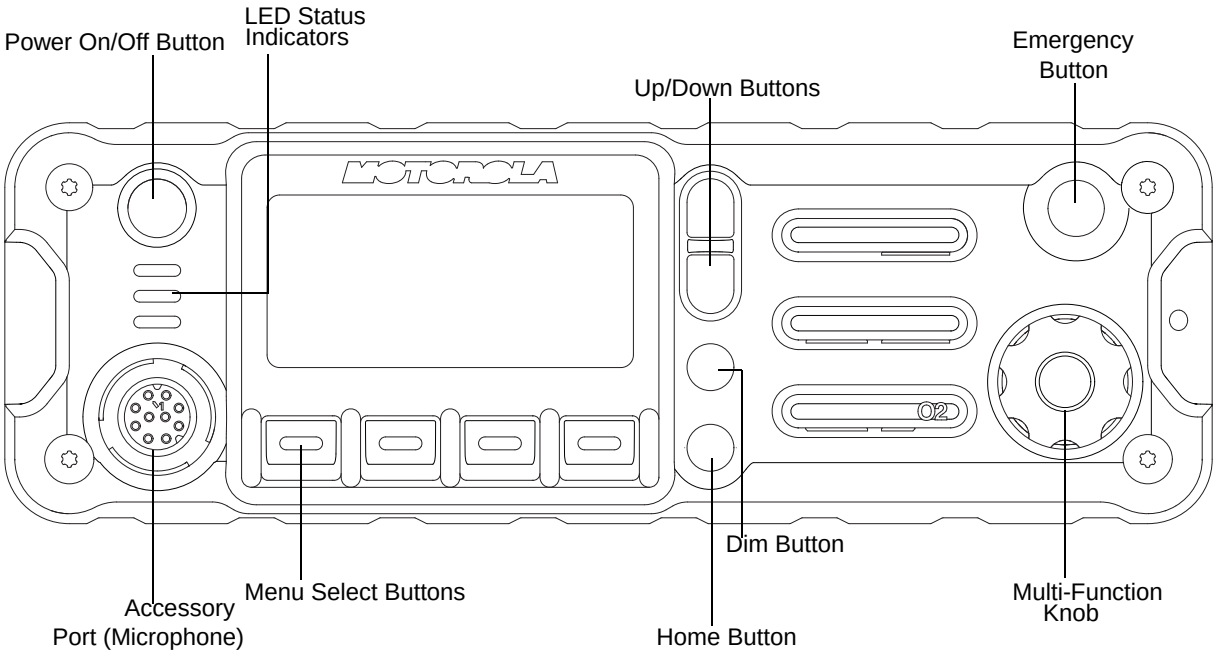


Figure 5-2. O2 Control Head

5.3.4 O3 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. This test mode allows you to perform button and display tests to verify proper operation.

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. Wait till Standalone Mode is displayed and release the 1 and 3 Button of the keypad. CH Firmware version, CH FPGA version, CH Flashzap version and CH Board version will be displayed before being able to be in Factory Test.
2. Once in Factory Test menu, pressing any buttons will activate the following tests:
   - LED test (green, red and yellow)
   - Backlight test (Off, Medium and On)
   - LCD test (4 borders test)

   For the Hook Up test that follows right after the LCD test has been completed, place the Hook Up and remove the Hook Up until Hook Off is shown. Hit any button after this to activate the 32 buttons test that will test the Keypad Buttons, Side Buttons and Top Buttons. All the 32 Buttons notations will be displayed on the LCD and once the corresponding button is pressed, the notation will disappear from the LCD. After all 32 Buttons are pressed, Test Completed will be displayed and to turn the CH off, press the ON/OFF button once.
3. Turn the radio off and back on to exit test mode and return to normal radio operation.

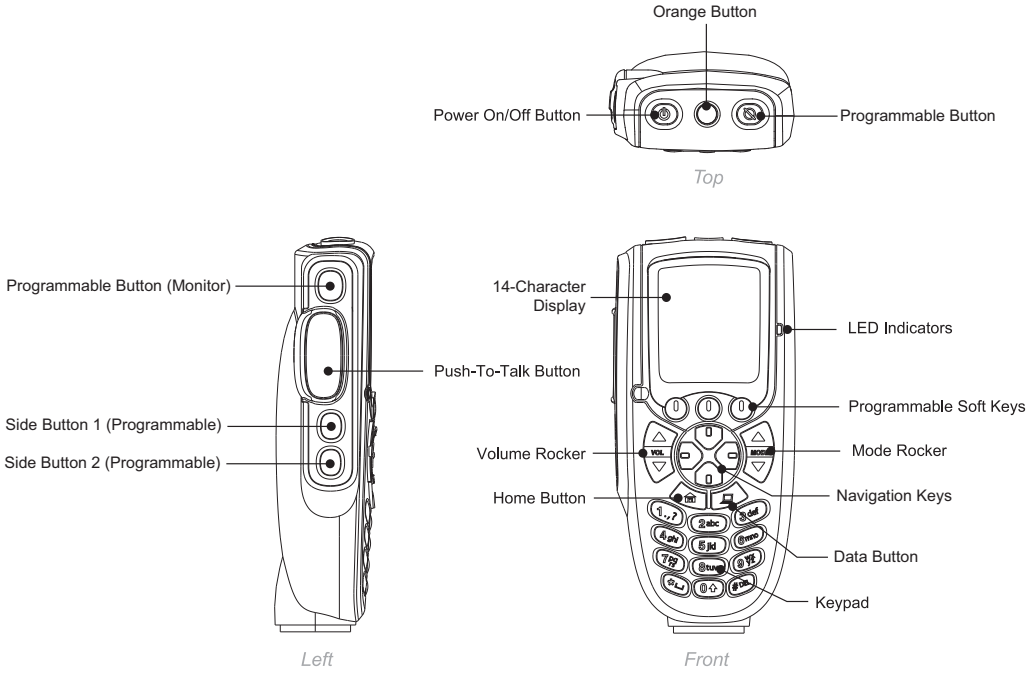


Figure 5-3. O3 Control Head

5.3.5 O5 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. This test mode allows you to perform button and display tests to verify proper operation.

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 will not change the control head test mode back to the RF test mode. You must turn the radio off and reenter 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 and the indicator LED's on the right side will light briefly. At this point, pressing any of the control head buttons or turning the knobs will display the button or knob ID and the value of the button or knob. The value of a button is 1 for a press and 0 for a release. The power button functions normally and will turn the control head off.
3. Turn the radio off and back on to exit test mode and return to normal radio operation.

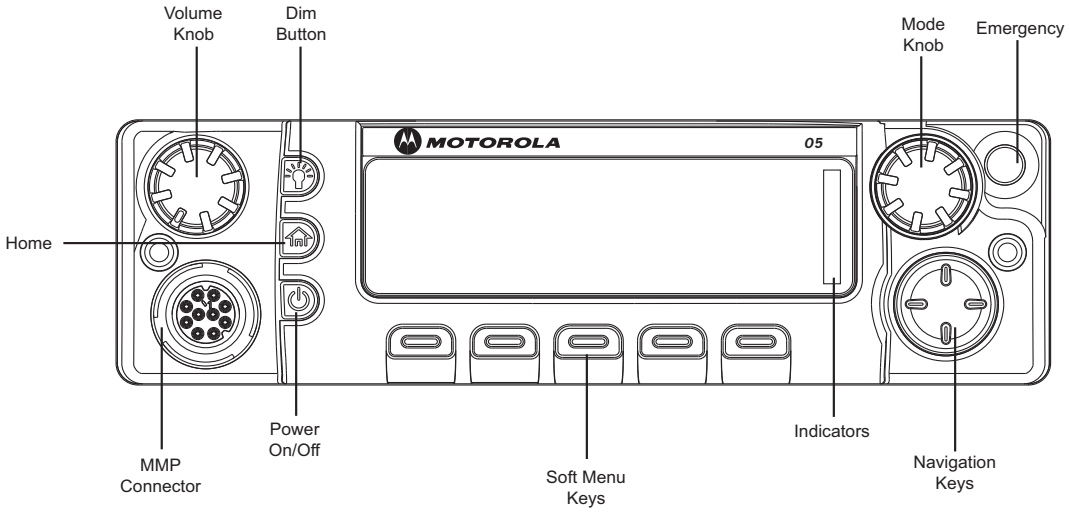


Figure 5-4. O5 Control Head

5.3.6 O7 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. This test mode allows you to perform button and display tests to verify proper operation.

1. Power up the control head by pressing the Power Button. Press the Menu Select Buttons 1 and 4 simultaneously to enter control head STANDALONE TEST. CH firmware, CH Nautilus, CH Flashzap version and CH Board version will be displayed before the unit enters the Control Head Test mode.
2. Press Home to enter sequential test.
3. In Factory Test menu, pressing any buttons will activate 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. Hit any button after this to activate the keypad test. All the 24 buttons notations will be displayed on the LCD and once the corresponding button is pressed, the notation will disappear from the LCD.
5. After all 24 buttons are pressed, hit any key to enter Multifunction Knob test.
6. Turn the radio off and back on to exit test mode and return to normal radio operation.

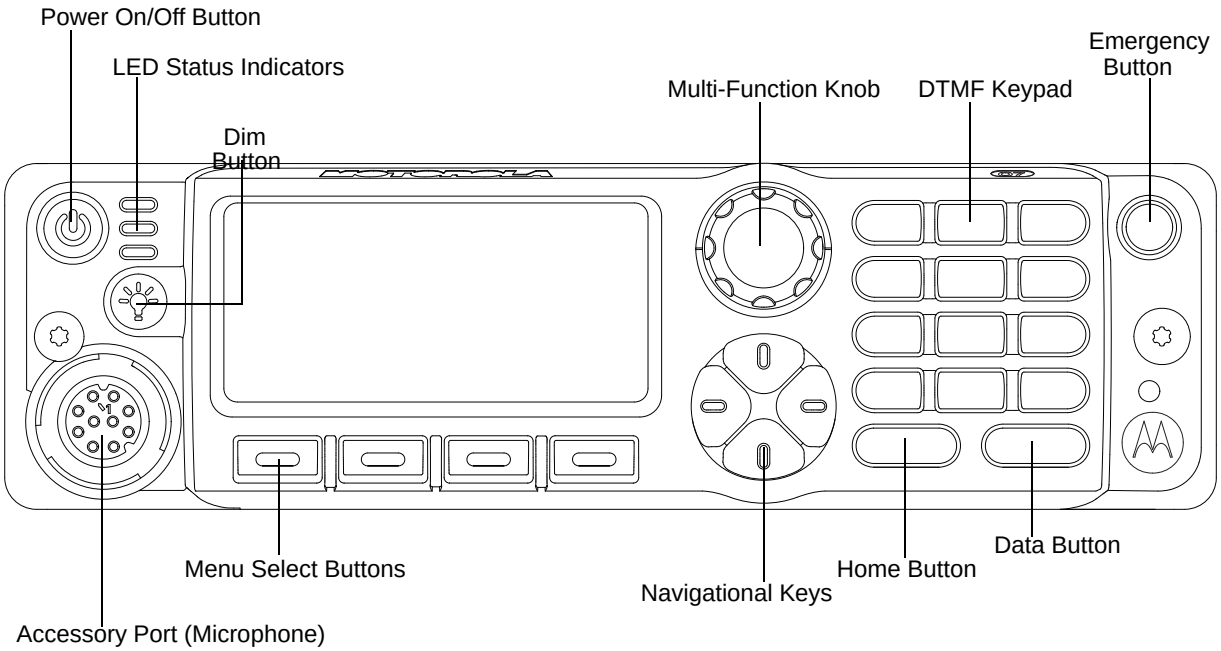


Figure 5-5. O7 Control Head

5.3.7 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. This test mode allows you to perform button and display tests to verify proper operation.

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 will be displayed before being able to be in Factory Test.
2. Press Home to enter sequential test.
3. In Factory Test menu, pressing any buttons will activate 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. Hit any button after this to activate the keypad test. All the 48 buttons notations will be displayed on the LCD and once the corresponding button is pressed, the notation will disappear from the LCD.
5. After all 48 buttons are pressed, hit any key to enter Rotary test. Response selector, Volume rotary and Channel rotary functionality is tested by turning the knob.
6. Turn the radio off and back on to exit test mode and return to normal radio operation.

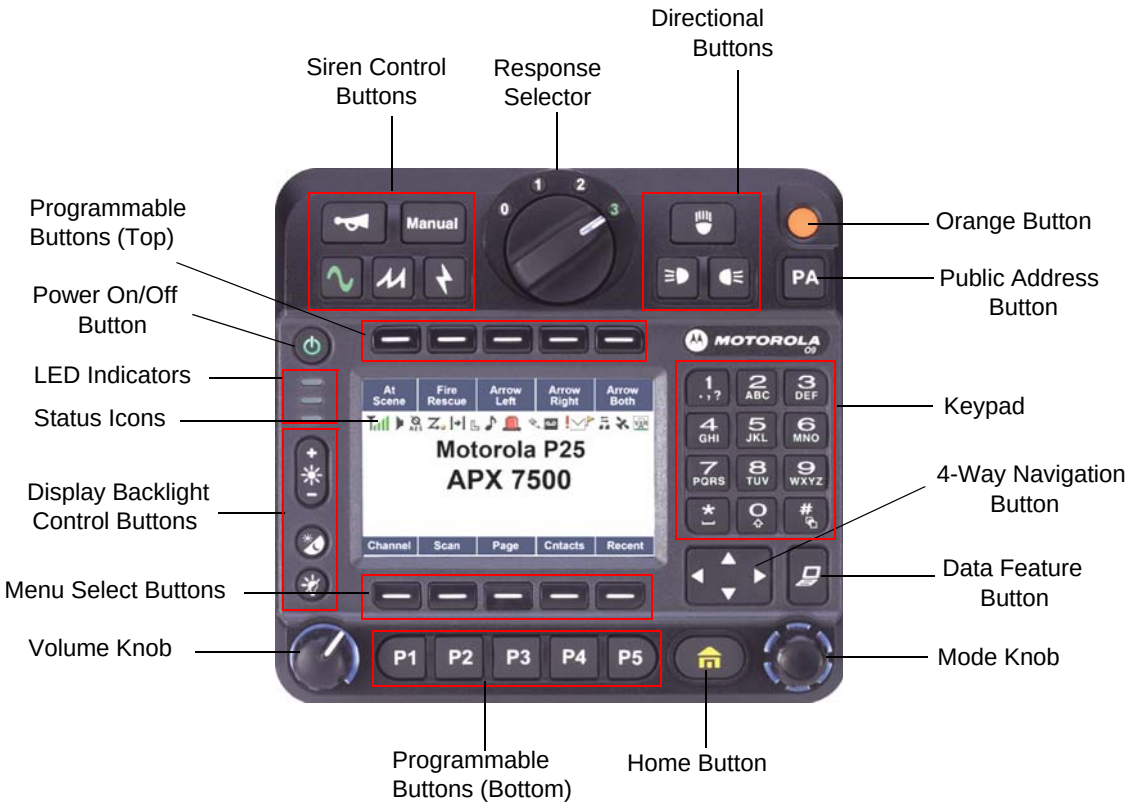


Figure 5-6. O9 Control Head

5.4 Receiver Performance Checks

Table 5-4. Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON 1st channel test frequency* Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ output at antenna.	Press and hold PTT switch.	Maximum Frequency error is ± 2.0 PPM for VHF and UHF ± 1.5 PPM for 700/800 MHz
Rated Audio	Mode: GEN Output level: 1.0 mV RF 1st channel test frequency* 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 ohm speaker or 7.75 Vrms across the 8 ohm 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
* Test frequencies are listed in Table 5-2.				

5.5 Transmitter Performance Checks

Table 5-5. Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON 1st channel test frequency** 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 7/800 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 1st channel test frequency** 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, 7/800 MHz: >=2.5 kHz but <= 3.5 kHz See the Detailed Service Manual for test equipment descriptions.
Voice Modulation External Microphone	Mode: PWR MON 1st channel test frequency** 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, 7/800 MHz: >= 2.5 kHz but <= 3.5 kHz See the Detailed Service Manual for test equipment descriptions.
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to 1st channel test frequency**; 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, 7/800 MHz: >= 500 Hz but <= 1000 Hz See the Detailed Service Manual for test equipment descriptions.

Table 5-5. Transmitter Performance Checks (Continued)

Test Name	System Analyzer	Radio	Test Condition	Comments
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, 7/800 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) *	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, 7/800 MHz: >= 3.6 kHz but <= 4.4 kHz See the Detailed Service Manual for test equipment descriptions.

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

** Test frequencies are listed in Table 5-2.

Chapter 6 Radio Alignment Procedures

6.1 Introduction

This section describes both receiver and transmitter radio alignment procedures.

6.2 ASTRO APX Mobile Radio Tuner Software

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. 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.

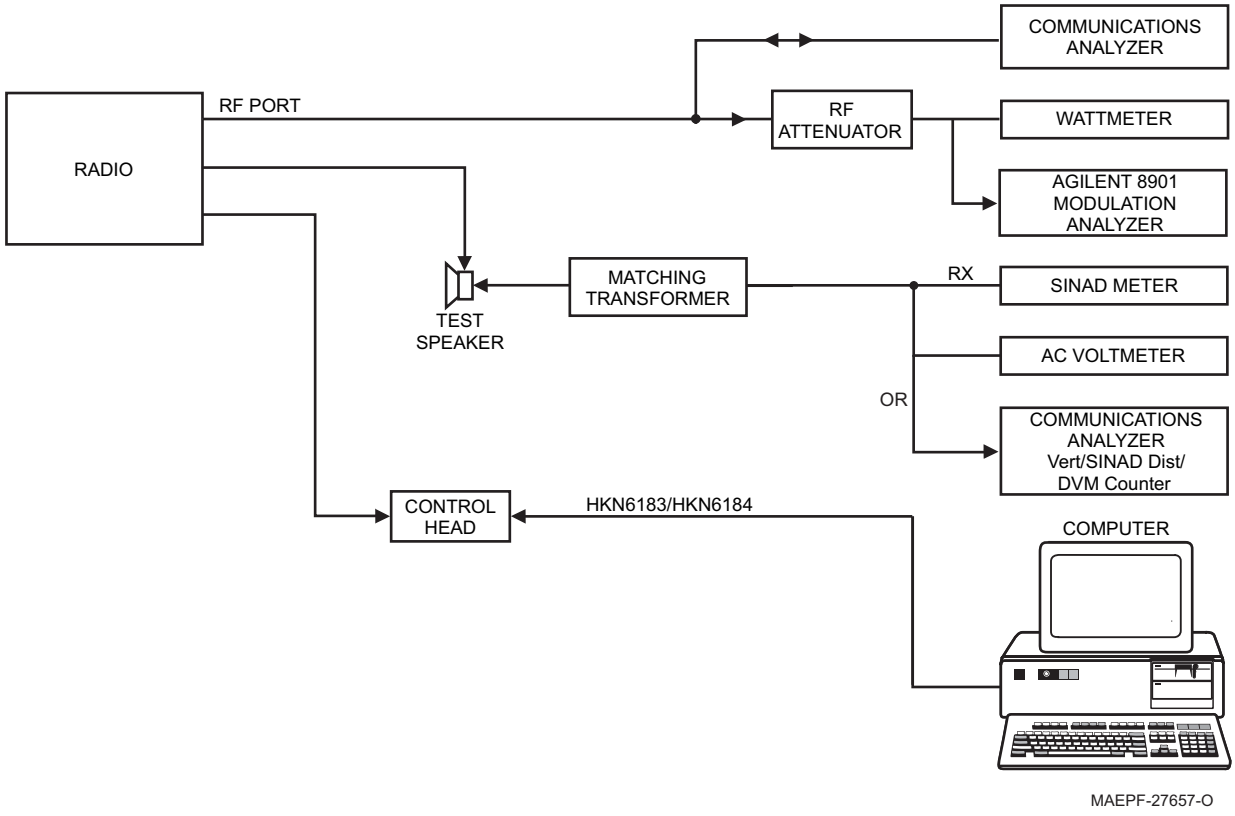


Figure 6-1. Radio Alignment Test Setup for APX Mobile Radio

Caution

These procedures should be attempted only by qualified service personnel who are operating as an FCC licensed technician, or are overseen by an FCC licensed technician. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

Select **Tuner** from the **Start** menu. To read the radio, click on the “read device” icon. Figure 6-2 illustrates how the alignment screens are organized. To access a screen, click on the desired screen name in the **Tuner** menu.

Figure 6-2 shows the tuner main menu screen.

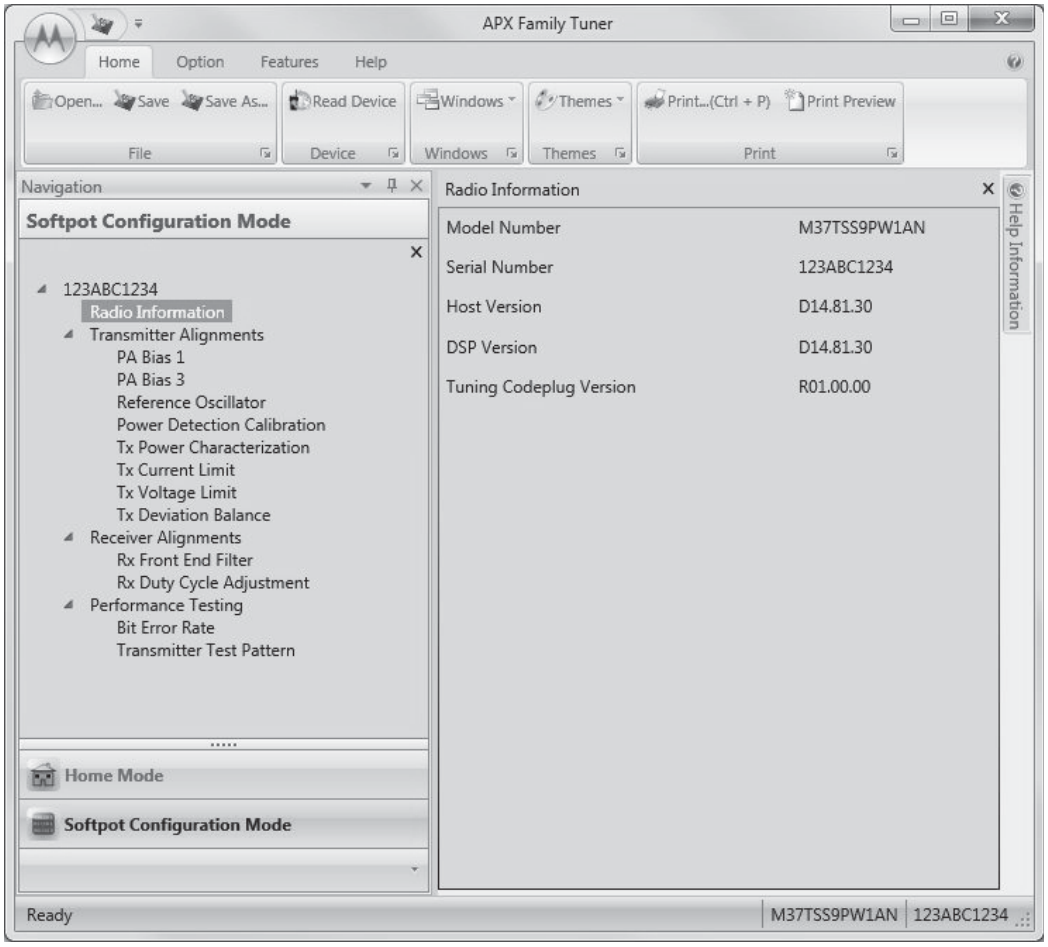


Figure 6-2. Tuner Main Menu

Caution

Do NOT switch radios in the middle of any alignment procedure. Left-click Close button [X] located in the top right corner of the alignment window to close the screen and 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 transceiver alignment controls.

Each alignment screen provides the ability to increase or decrease the softpot value by using the **slider** or the **spin buttons** (▲ and ▼), or by entering the new value from the keyboard. A graphical scale on the display indicates the minimum, maximum, and proposed value of the softpot.

6.3 Radio Information

Figure 6-3 shows a typical Radio Information screen. All of the data appearing here is informational and cannot be changed.

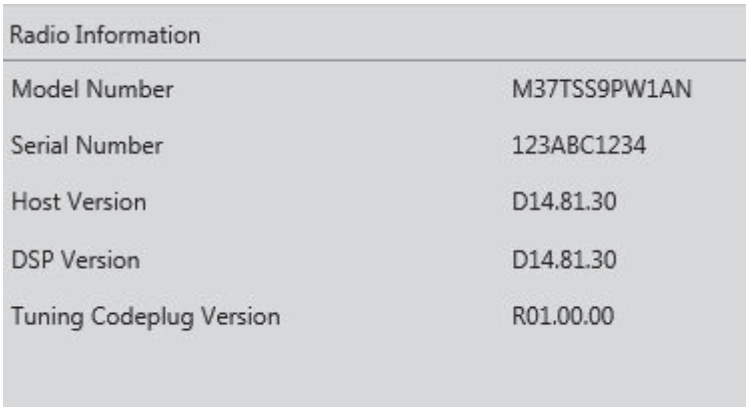


Figure 6-3. Radio Information Screen

6.4 Transmitter Alignments

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

6.4.1 PA Bias 1 Alignment

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

The PA Bias 1 alignment procedure adjusts the drain bias current in one of the RF power amplifier devices.

Table 6-1. PA Bias 1 Alignment RF Power Amplifier Devices

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

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

1. Set the power supply voltage as indicated in Table 6-2. Set power supply current limit to 3 A.

Table 6-2. Power Supply Voltage Settings

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

2. Select **PA Bias 1** from the Tuner Main Menu. When the screen is displayed, the radio enters a special bias tune mode, and radio current increases by approximately 190 mA.

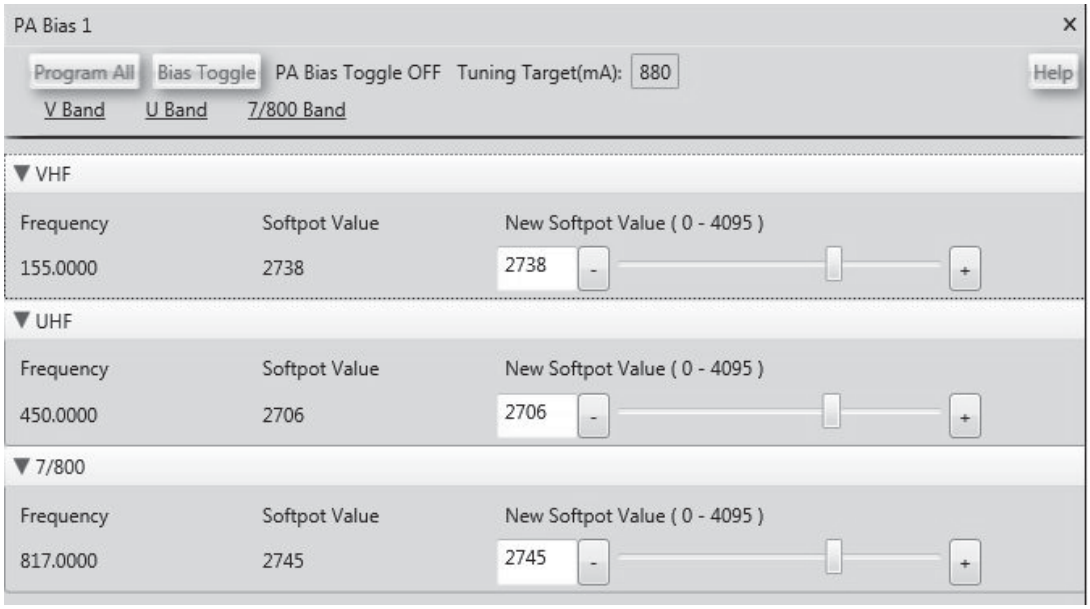


Figure 6-4. PA Bias 1 Alignment Screen

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

Table 6-3. PA Bias 1 Alignment Device Bias Current

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

5. Left-click the **Bias Toggle** button to apply bias to gate of device.
6. Adjust softpot value until target current is achieved within ±10%
7. Left-click the **Bias Toggle** button to remove bias from gate of device.
8. Left-click the **Program All** button to save tuned value.
9. Left-click **Close button [X]** located in the top right corner of the alignment window to close the screen and return to the Tuner Main Menu.

6.4.2 PA Bias 3 Alignment

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

The PA Bias 3 alignment procedure adjusts the drain bias current in one of the RF power amplifier devices.

Table 6-4. PA Bias 3 Alignment Amplifier Devices

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

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

1. Set the power supply voltage as indicated in Table 6-5. Set power supply current limit to 3 A.

Table 6-5. Power Supply Voltage Settings

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

2. Select **PA Bias 3** from the Tuner Main Menu. When the screen is displayed, the radio enters a special bias tune mode and radio current increases by approximately 190 mA.

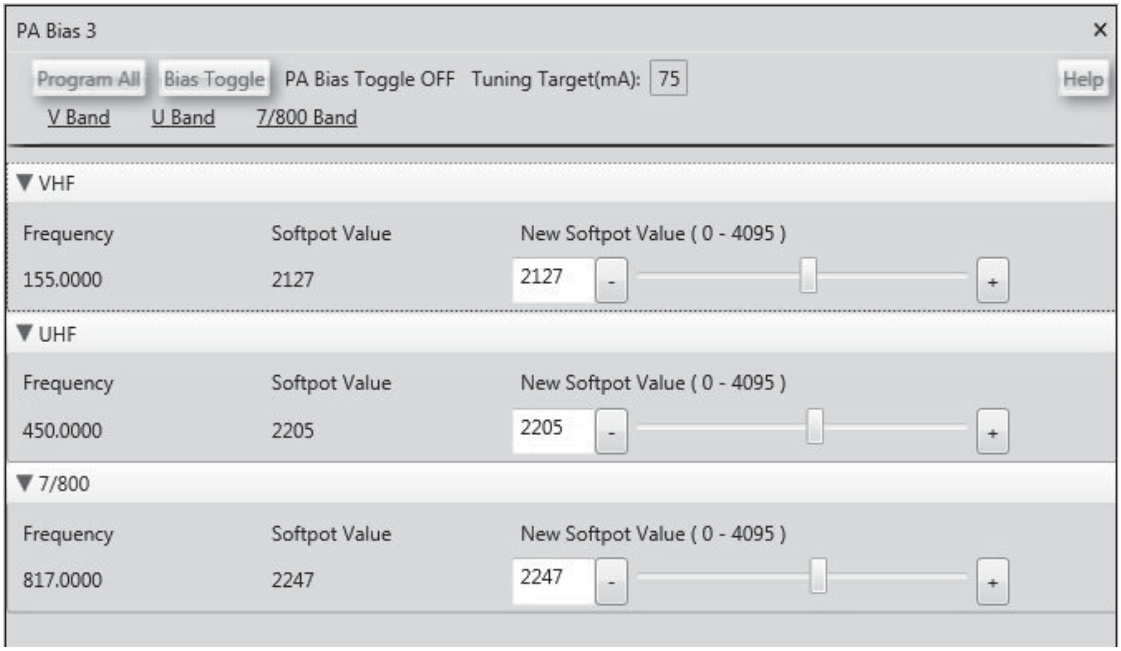


Figure 6-5. PA Bias 3 Alignment Screen

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

Table 6-6. PA Bias 3 Alignment Device Bias Current

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

5. Left-click the **Bias Toggle** button to apply bias to gate of device.
6. Adjust softpot value until target current is achieved within ±10%
7. Left-click the **Bias Toggle** button to remove bias from gate of device.
8. Left-click the **Program All** button to save tuned value.
9. Left-click **Close button [X]** located in the top right corner of the alignment window to close the screen and return to the Tuner Main Menu.

6.4.3 Reference Oscillator Alignment

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.

For radios that have been in storage for over six months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field. It is strongly recommended that the reference oscillator be checked 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 test can be done with either the R-2670 Communication Analyzer or the Agilent 8901 Modulation Analyzer.

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

- Initial setup using the Agilent 8901 Modulation Analyzer:
  - Press the green Automatic Operation button on the analyzer.
  - Press the **FREQ** key.
  - Type **7.1**, followed by the **SPCL** button, to set the 8901 Modulation Analyzer for maximum accuracy.

1. Select **Reference Oscillator** from the Tuner Main Menu (Figure 6-6).

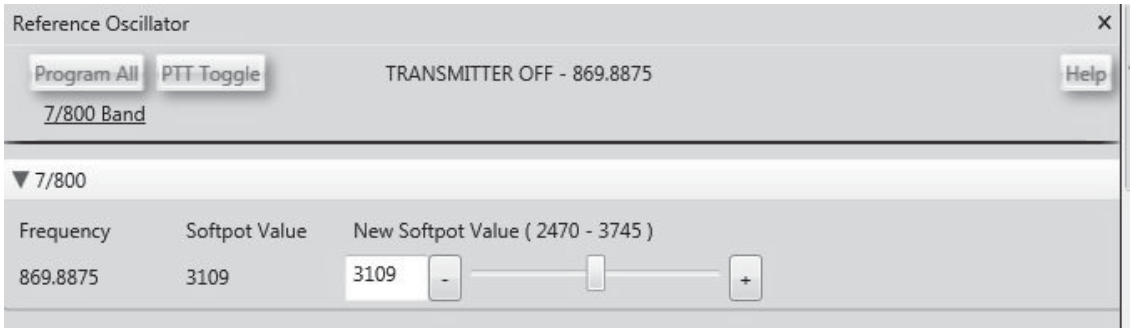


Figure 6-6. Reference Oscillator Window

2. If you are using the R-2670 analyzer, enter the frequency displayed on the Tuner screen in the "RF control" section of the R-2670. Under the "Meter" section of the display, choose RF DISPLAY.
3. Connect antenna port to the test equipment (See Figure 6-1). Left-click the **PTT Toggle** button on the screen to make the radio transmit. The screen indicates whether the radio is transmitting.
4. Wait five seconds until the analyzer reading stabilizes, and then record the transmitter frequency.
5. Adjust the reference oscillator's 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.
6. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.
7. Left-click **Close button [X]** located in the top right corner of the alignment window to close the screen and return to the Tuner Main Menu.

6.4.4 Power Detector Calibration

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

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

NOTE: The appropriate antenna port should be terminated with calibrated power meter through a 30 db RF pad.

1. Set the power supply voltage and current limit as indicated in Table 6-7.

Table 6-7. Power Supply Voltage Settings

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

Table 6-7. Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
700–800 MHz 35 W	13.6	15

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

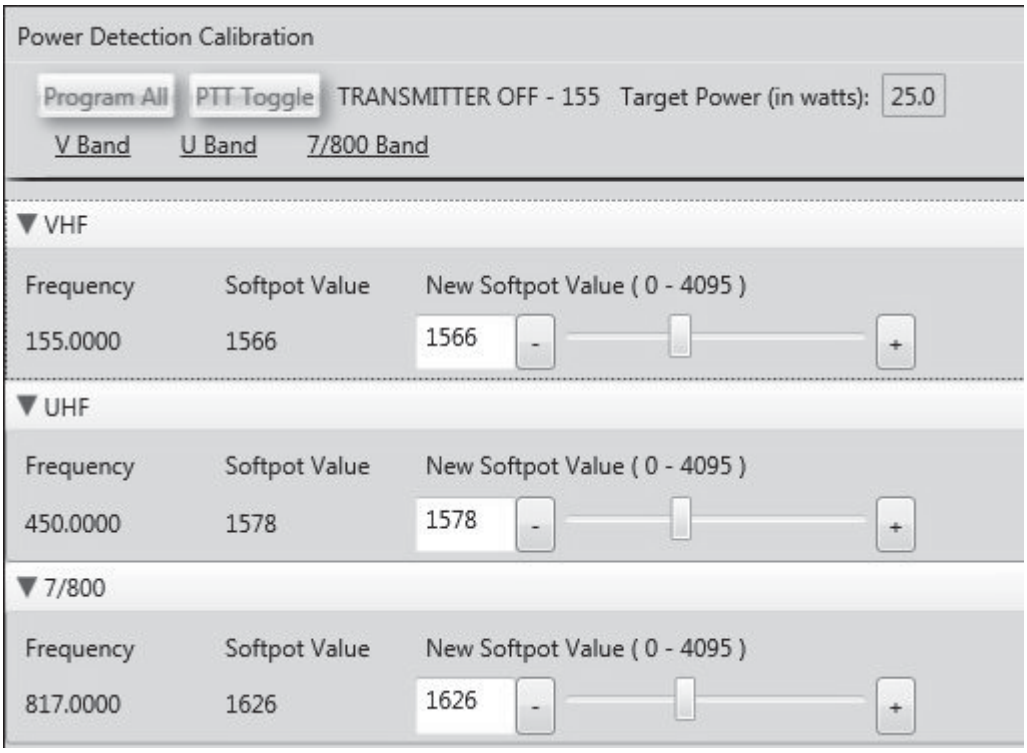


Figure 6-7. Power Detection Calibration Alignment Screen

3. Left-click the **PTT Toggle** button to transmit at indicated frequency.
4. Adjust softpot value until target power is achieved.
5. Left-click the **PTT Toggle** button to disable transmit mode.
6. Left-click the **Program All** button to save tuned value.
7. For dual band radio, switch antenna port and repeat the alignment procedure for the second frequency displayed in the tuning screen.

6.4.5 Tx Power Characterization

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

The Tx Power Characterization alignment procedure characterizes power tuning so that Tx power can be adjusted with CPS software. You will transmit at two power levels for each test frequency and record the measured power level with 0.1 W resolution.

NOTE: The appropriate antenna port should be terminated with a calibrated power meter through a 30 db RF pad.

1. Set the power supply voltage and current limit as indicated in Table 6-8.

Table 6-8. Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	15
UHF R2 45 W/40 W/25 W	13.6	15
700–800 MHz 35 W	13.6	15

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

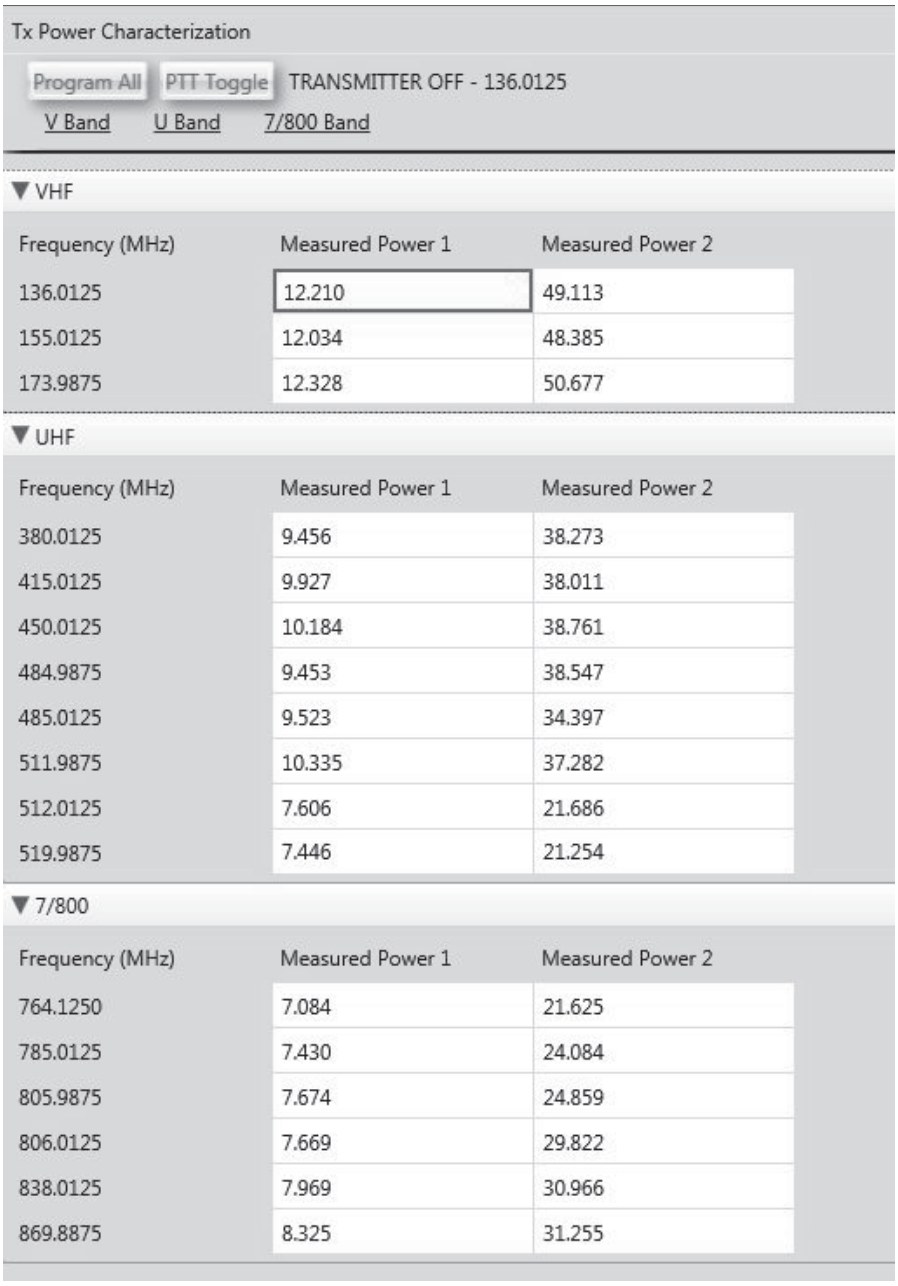


Figure 6-8. Tx Power Characterization Alignment Screen

3. Left-click in the first box of the Measured Power 1 column. The perimeter of the box will turn green indicating active characterization point.
4. Left-click the **PTT Toggle** button to transmit at indicated frequency and record power measurement with 0.1 W resolution. The perimeter of the box will turn red, indicating that the radio is transmitting.
5. Left-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. Left-click in the first box of the Measured Power 2 column. The perimeter of the box will turn green, indicating it has become the active characterization point.
8. Repeat steps 4-6.
9. Repeat steps 3-8 for the remaining frequencies.
10. Left-click the **Program All** button to save tuned value.
11. Left-click **Close button [X]** located in the top right corner of the alignment window to close the screen and return to the Tuner Main Menu.

6.4.6 Tx Current Limit

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

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

NOTE: The appropriate antenna port should be terminated with a calibrated power meter through a 30 dB RFpad.

1. Set the power supply voltage and current limit as per Table 6-9.

Table 6-9. Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50 W	13.6	15
UHF R2 45 W/40 W/25 W	13.6	15
700–800 MHz 35 W	13.6	15

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

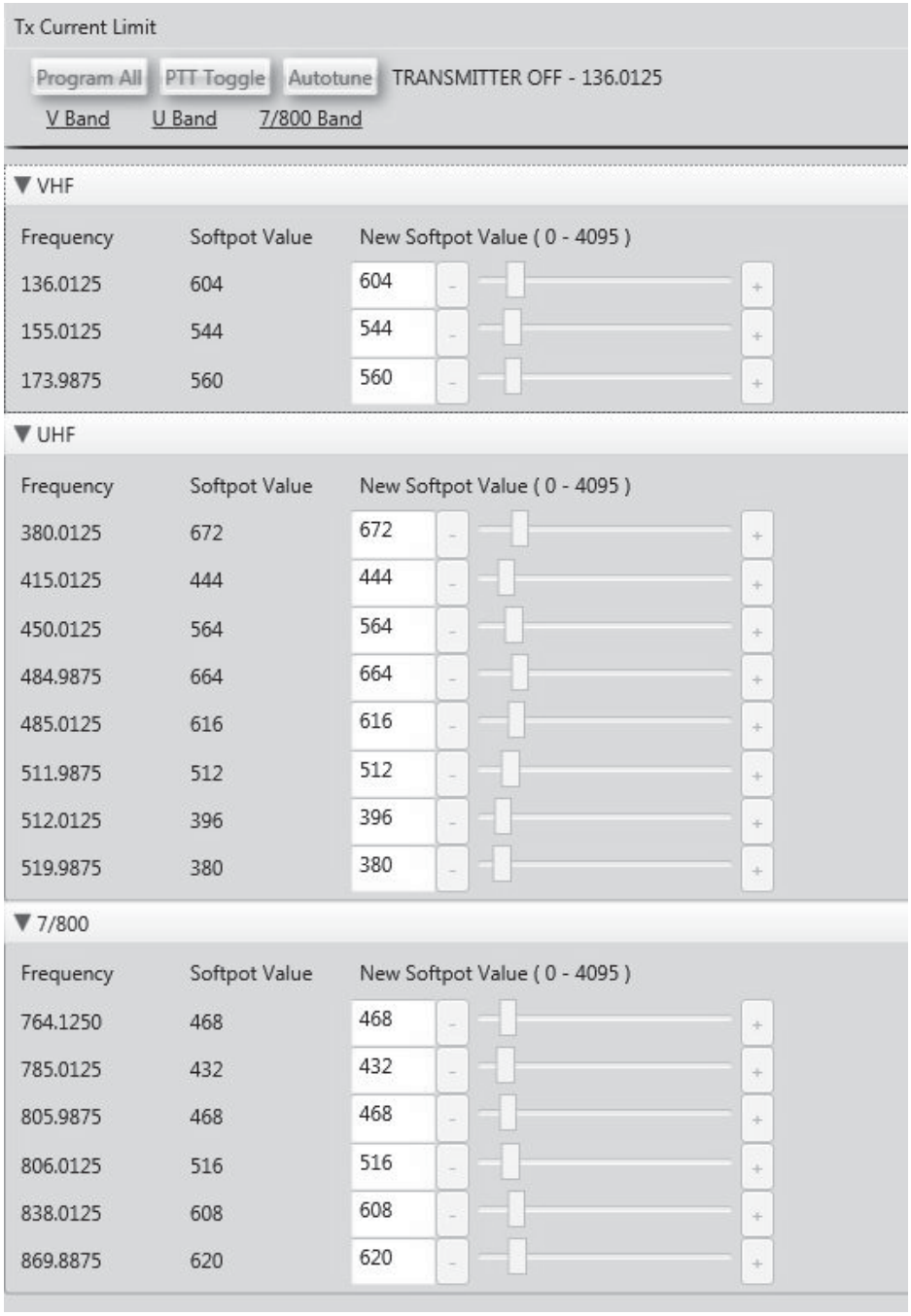


Figure 6-9. Tx Current Limit Alignment Screen

3. Select the first test frequency to tune.
4. Left-click the **PTT Toggle** button to transmit on the indicated frequency in the TX current limit alignment screen.
5. Left-click the auto tune.
6. Repeat steps 3 through 5 for all test frequencies in the TX current limit alignment screen.
7. Left-click the **Program All** button to save tuned values.

8. Left click the **Close** button to close screen and return to the Tuner Main Menu.

Table 6-10. Transmit Current Limit Devices

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

6.4.6.1 Tx Voltage Limit

NOTE: This alignment is required after replacing (or servicing) the Transceiver or Transmitter boards.

The Tx Voltage limit alignment procedure tunes the TX control voltage limiting protection.

NOTE: The antenna port should be terminated with a calibrated power meter through a 30 dB RF pad.

1. Set the power supply voltage and current limit as per Table 6-9.

2. Select TX Voltage limit from the Tuner Main Menu.

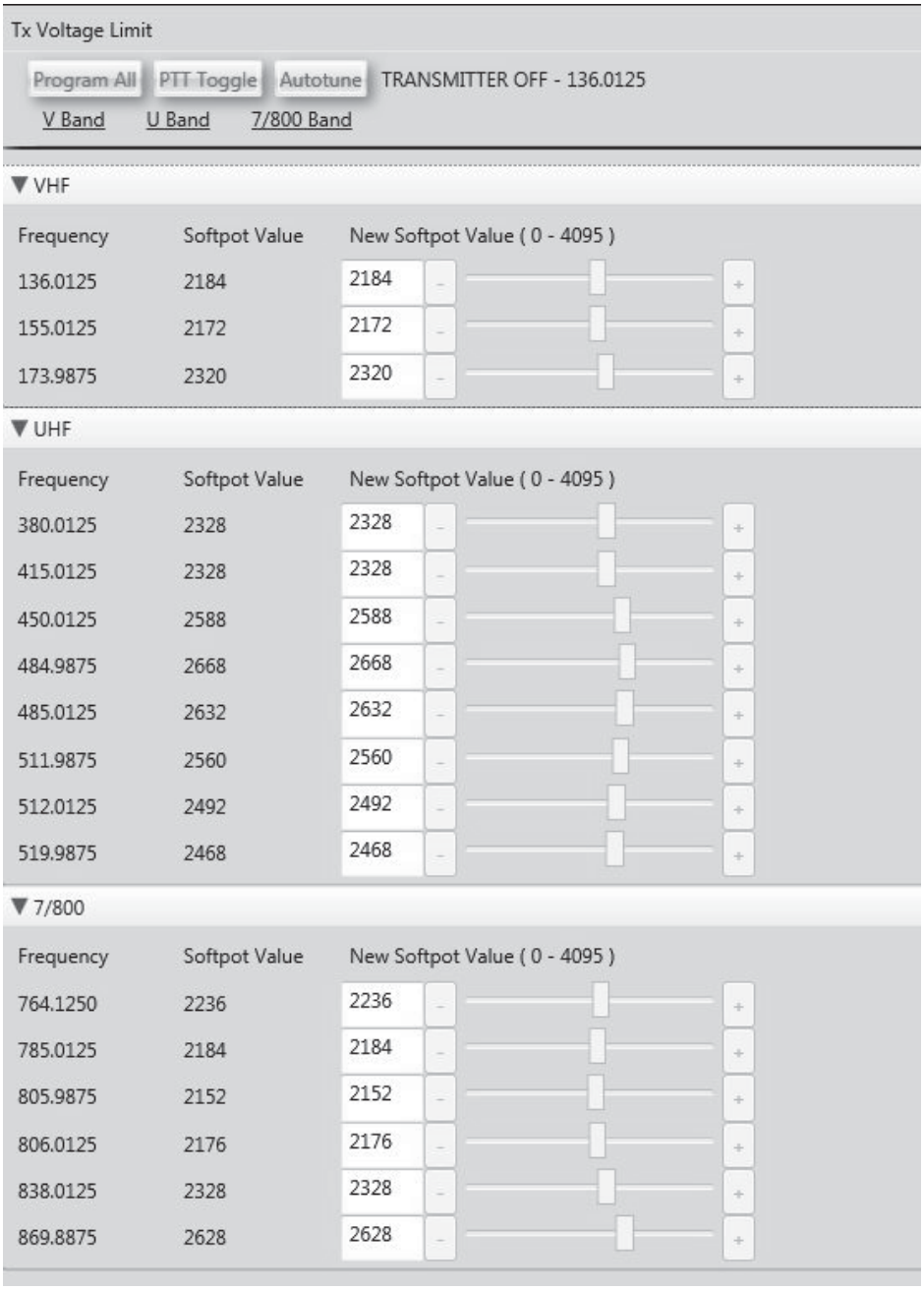


Figure 6-10. Tx Voltage Limit Alignment Screen

3. Select the first test frequency to tune.
4. Left-click the **PTT Toggle** button to transmit on the indicated frequency in the TX Voltage limit alignment screen.
5. Left-click the auto tune.
6. Repeat steps 3 through 5 for all test frequencies in the TX Voltage limit alignment screen.
7. Left-click the **Program All** button to save tuned values.
8. Left click the **Close** button to close screen and return to the Tuner Main Menu.

6.4.7 Tx Deviation Balance (Compensation)

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

The 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 very low frequency components (for example, DPL) and could result in distorted waveforms if improperly adjusted. This procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone. When performing this tuning procedure, the **PTT Tone Low** generates an 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 test can be done with either the R-2670 Communication Analyzer or the Agilent 8901 Modulation Analyzer. The method of choice is the R-2670 Analyzer.

- Initial setup using the R-2670 Communication Analyzer:
  - Connect a BNC cable between the "DEMOD OUT" port and the "VERT/SINAD DIST/DMM COUNTER IN" port on the R-2670.
  - Press the SPF key on the R-2670 to display the "SPECIAL FUNCTIONS MENU." Move the cursor to "High Pass," and select 5 Hz on the soft key menu. Select 20 kHz for the "Low Pass" setting.
  - In the "RF Control" section of the R-2670, enter the frequency displayed on the Tuner screen. Move the cursor to the "B/W" setting and select "WIDE ±100 kHz" on the soft key menu.
  - Place the R-2670 cursor in the "Display" zone. Select "AC VOLTS" on the soft key menu. Move the cursor to the "Range" setting and select "AUTO."
- Initial setup using the 8901 Modulation Analyzer:
  - Press the FM MEASUREMENT button. (The "Error 03-input level too low" indication is normal until an input signal is applied.)
  - Simultaneously press the Peak - and Peak + buttons. Both LEDs on the buttons should light.
  - Press the 15 kHz LP filter key.
  - Press the 50 Hz filter key.

1. Select **TX Deviation Balance (Compensation)** from the Tuner Main Menu. The screen will indicate the transmit frequencies to be used. Connect antenna port to the test equipment. See Figure 6-1.

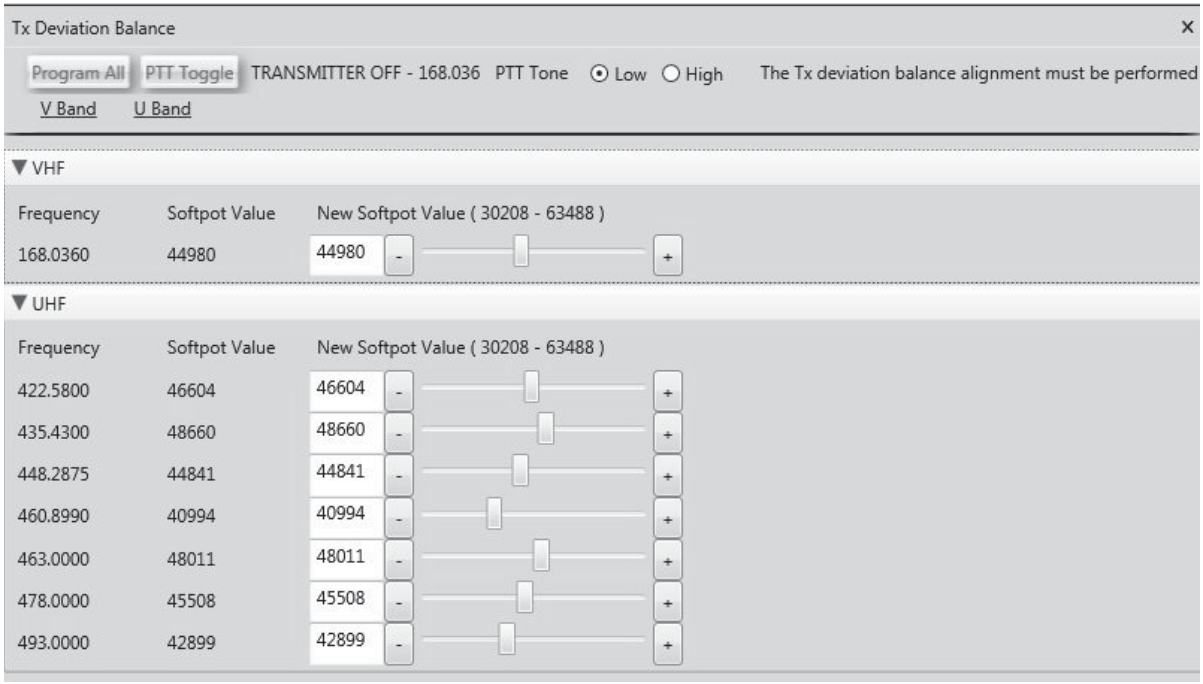


Figure 6-11. Tx Deviation Balance (Compensation) Alignment Screen

2. Left-click the first frequency field.
3. Left-click the **PTT Tone Low** button.
4. Left-click the **PTT Toggle** button on the screen to enable transmission. The screen indicates whether the radio is transmitting. Wait approximately 5 seconds until the voltage shown on R-2670, or the deviation shown on the 8901 Analyzer, stabilizes.
5. Measure and record the AC voltage value from the R-2670 Analyzer or the deviation value from the 8901 Analyzer.
6. Left-click the **PTT Tone High** button.
7. Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within ±0.2% of the value observed when using the low tone.
8. Repeat steps 3-7 for the remaining frequencies.
9. Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

6.5 Receiver Alignments

6.5.1 Front End Filter Alignment

Caution

This procedure should only be attempted by qualified service technicians.

The alignment procedure adjusts the front end receiver bandpass filters for the best receiver sensitivity and selectivity. This procedure should be performed for all test frequencies to allow for proper software interpolation of frequencies between the test frequencies in the band.
See Figure 6-12.

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

6.5.2 Procedure for VHF, UHF1 and UHF2 (Auto Tune)

Tuning of the radio is done through **Rx Front End Filter** tuning screen

1. Select the **Rx Front End Filter** alignment screen. See Figure 6-12.
2. Click on the slider or the "New Softpot Value" text box to select which frequency to tune.
3. Apply RF test signal input with no modulation at -90 dBm on the Test Signal Frequency displayed at the top of the screen.
4. Left-click the **Autotune** button.
5. Repeat the steps 2–4 for all frequencies.
6. Left-click the **Program All** button on the screen to save the tuned values in the radio.

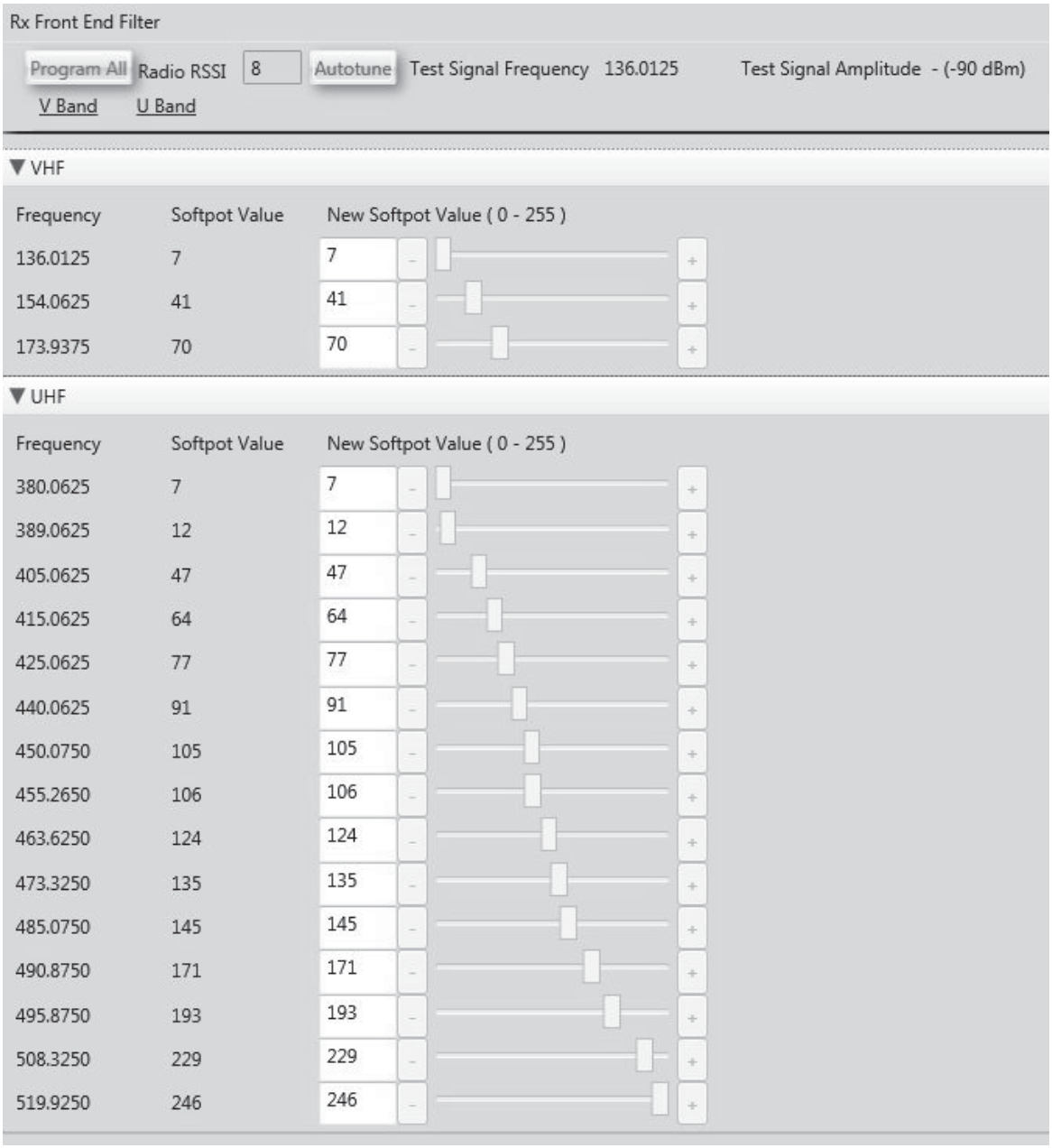


Figure 6-12. RX Front End Filter Alignment

6.5.3 RX Duty Cycle Adjustment

Tuning of the radio is done through the Rx Duty Cycle Adjustment tuning screen.

1. Select the Rx Duty Cycle Adjustment screen. See Figure 6-13.
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. Left-click the Autotune button.
4. Left-click the Program All button on the screen to save the tuned values in the radio.

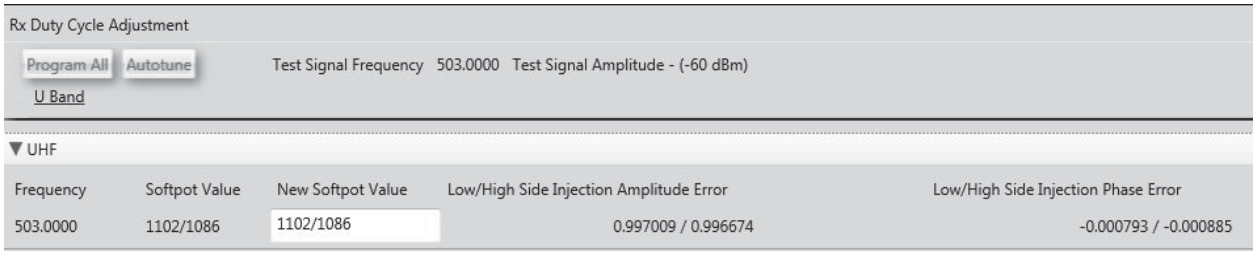


Figure 6-13. RX Duty Cycle Adjustment AutoTune

6.6 Performance Testing

6.6.1 Bit Error Rate (BER) Test

This procedure tests the Bit Error Rate (BER) of the radio's receiver at a desired frequency and contains the fields described in Table 6-11.

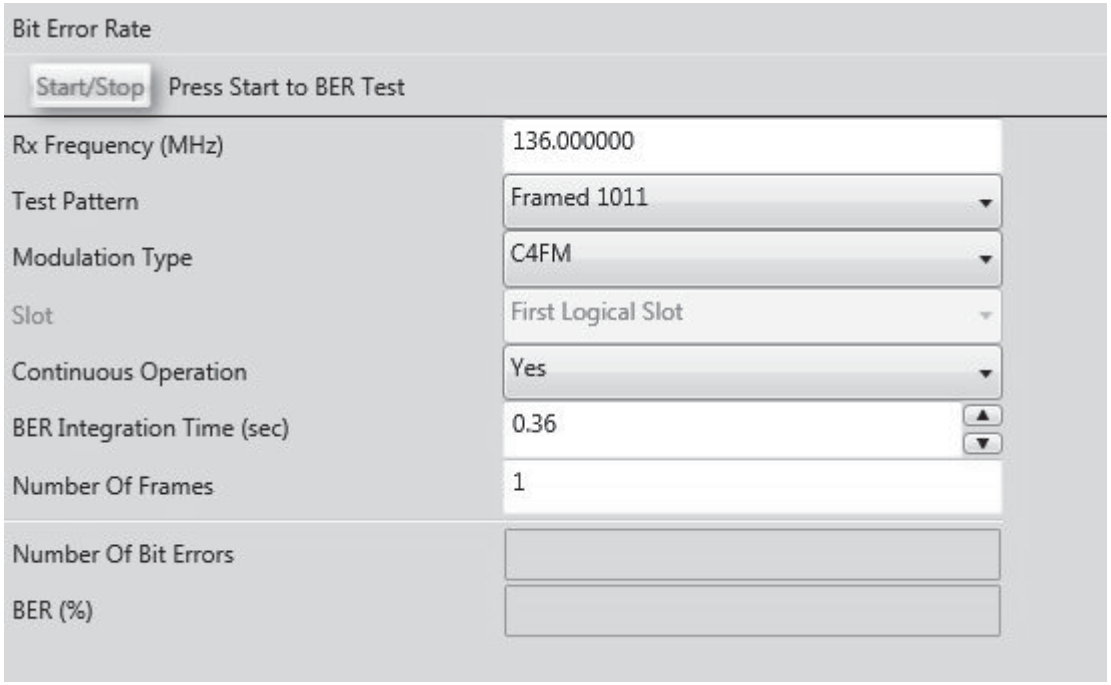


Figure 6-14. Bit Error Rate Screen

Table 6-11. Bit Error Rate Test Fields

Field	Description
Rx Frequency	Selects the Receive Frequency in MHz.
Test Pattern	Selects the Digital test pattern - TIA.
Modulation Type	Selects the digital modulation type of the incoming signal on which BER is to be calculated.

Table 6-11. Bit Error Rate Test Fields (Continued)

Field	Description
Continuous Operation	Allows the user to adjust the number of test repetitions. A selection of **Yes** will cause 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** will cause the BER test to execute only one sample and then update the display. **NOTE:** When Continuous Operation = Yes, all fields will be dimmed while the test is in progress. They will be enabled when the test is complete, or if the STOP button is pressed. When Continuous Operation = No, a wait cursor will be displayed while the test is in progress and return to normal when the test is done.
Audio	Allows the user to select the audio output during a test. Selecting **External** will route the same signal to the radio's accessory connector audio output. Selecting **Internal** is not supported. Selecting **Mute** will disable 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.

6.6.2 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 Table 6-12.

Table 6-12. Transmitter Test Pattern Fields

Field	Description
Tx Frequency	This field selects the Transmit Frequency directly in MHz.
Channel Spacing	This field allows the user to select the desired transmit deviation in kHz.
Test Pattern Type	This field represents the type of test pattern which will be transmitted by the radio when the PTT Toggle button is pressed.

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

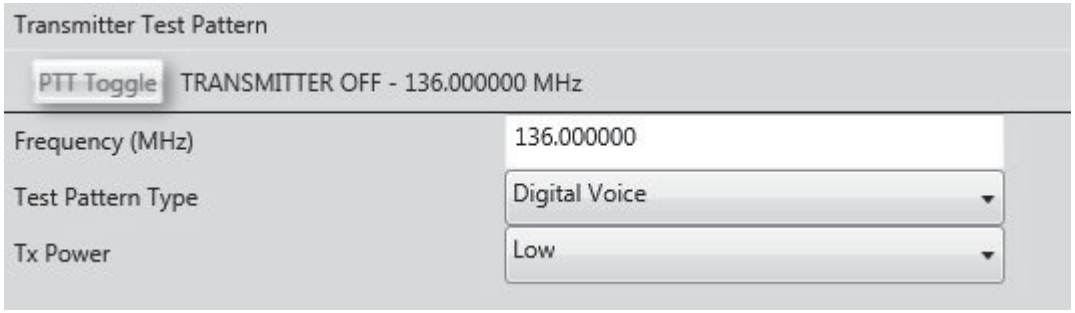


Figure 6-15. Transmitter Test Pattern Screen

Notes

Chapter 7 Encryption

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/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 APX 8500 comes standard with 10 minutes or infinite key retention (CPS setting).

Table 7-1. Controller Boards with Programmed Secure Algorithms for APX 8500

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

Please refer to the ECAT (Electronic Catalog) for the various kit numbers in order to program secure algorithms for the APX based 8500.

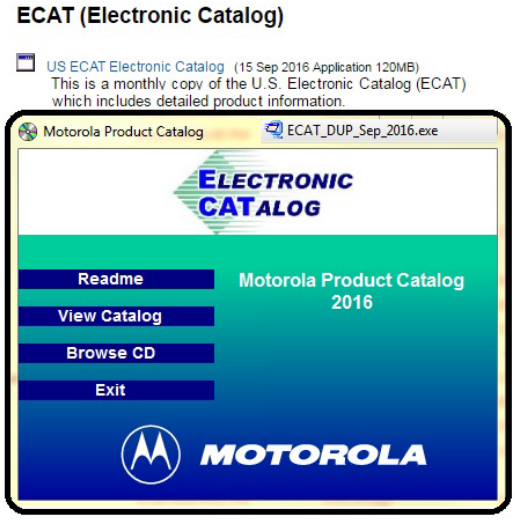


Figure 7-1. ECAT (Electronic Catalog) Portal

Please refer to Appendix A for customer support in identifying kit numbers.

7.1.2 Secure Dispatch Operation

For personalities or talkgroups that are programmed to be secure-selectable, press and release the *Secure* button to toggle between Secure and Clear.

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

Whether the current personality is strapped for secure or clear, the secure status annunciator correctly displays the transmit operation as being either secure (encrypted) or clear (non-encrypted).

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

Secure-equipped radios automatically determine whether a secure or clear voice message is being received. This allows you to receive either type of message without having to reset the programmable secure button.

7.1.3 Secure Emergency Operation

Clear or Secure emergency-call operation is determined by the programming of the selected mode (or talkgroup) or the default emergency mode, if set up. Otherwise, transmit operation is controlled by the setting of the secure, programmable button. You will not be able to change from Secure to Clear, or from Clear to Secure, operation during an emergency call.

7.2 Load an Encryption Key

To load an encryption key into an APX mobile radio:

1. Ensure proper encryption algorithm has been flashed into the radio. (DES_XL, DES-OFB, AES256, etc)
2. Load an encryption key into the radio's memory from a key-variable loader (KVL) using the correct loader for the radio's 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.
4. 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. KEYFAIL is displayed and a keyfail tone (consecutive medium-pitched beeps) sounds until you release the PTT button.

5. 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

The multikey feature can be used in both conventional and trunked applications.

- **Conventional Multikey** - The encryption keys can be selectively strapped, one per each channel. In addition, the programmable radio features include operator-selectable keys, operator-selectable indices, and operator-selectable key erasure. Encryption keys are loaded into the radio through a KVL.
- **Trunked Multikey** - If the radio is used for both conventional and trunked applications, the encryption keys have to be strapped for trunking on a talkgroup, or announcement group, basis. In addition, a different encryption key can be strapped to other features, such as Private Call, Dynamic Regrouping, Failsoft, Interconnect, System Wide, or Emergency Talkgroup.

7.4 Select an Encryption Key or Keyset

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.
   - If the selected key is erased, the display flashes 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 Erase a Single Key

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.

   ERASED KEY alternates with the key name if the displayed key is blank.
3. Press the menu button labeled SNGL to erase the selected key.

   ERASE SNGL KEY followed by the key name is displayed.

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 Erase All Keys

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 the keys, 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. The following steps describe how to use this feature.

1. Press the menu button labeled REKY. Alternatively, press and hold the menu button labeled SEC until a tone sounds. Then press REKY on the second menu that is displayed. If REKY or SEC is not on the current menu, use the NAV key to scroll through the available menus.

   REQUEST REKEY is displayed.
2. Press the **PTT** button to send the rekey request.

   PLEASE WAIT is displayed.

One of the following occurs:

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

NOTE: Any subsequent press of the **PTT** button will exit the OTAR feature and allow you to transmit in the normal manner. Pressing the **HOME** or emergency button also exits the feature.

If the display momentarily shows REKEY FAIL and the bad-key tone sounds, then the rekey operation failed 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 at this point, but stay on the current channel in the dispatch mode, the radio momentarily shows REKEYED or DENIED and sounds a tone indicating the status of the rekey request.

If 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 then returns to the display message in step 1, allowing you to retry the request.

If the request is accepted and the radio is successfully rekeyed, the display momentarily shows REKEYED.

If the display momentarily shows DENIED and the bad-key tone sounds, the request has been denied by the dispatcher, and the radio returns to the home display.

Notes

Chapter 8 Disassembly/Reassembly Procedures

8.1 Introduction

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.

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 Chapter 11. Exploded Views and Parts Lists. 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 Chapter 6. Radio Alignment Procedures.

8.2 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.

8.2.1 Required Tools and Supplies

Table 8-1. Required Tools and Supplies

Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
8mm, 10mm, 15mm, 25mm and 28mm Hex Nut bits	–	–
Anti-static grounding kit	0180386A82	–
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	–
Roto-Torq adjustable driver	–	RSX4043
Small, flat-blade screwdriver	–	–
Solder aid (black stick), HEXACON	–	MA-800G
Tohnichi 6RTD-A Analog Torque Driver (1-6 in-lbs)	–	–

Table 8-1. Required Tools and Supplies (Continued)

Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
Torx® bits for T8 for TIB; T10 for PCB; and T20 for cover screws; 9mm thin wall, deep socket for all antenna connector nuts.	–	–
9mm Hex Nut Bit (for GPS and QMA connector)	–	–
Tweezers	–	–
Wire Stripper	–	–
Chassis Opener	6685666D01	–
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	

8.2.2 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.

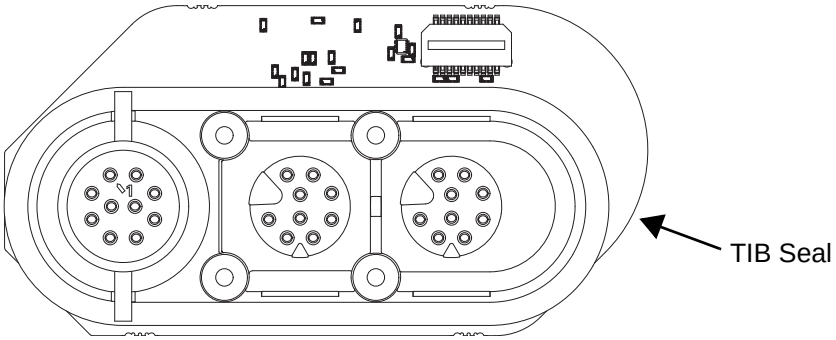


Figure 8-1. TUC Seal Placement

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.

8.2.3 Radio Disassembly

8.2.3.1 APX 8500 Mid Power Model

> **Caution** Steps 1 through 6 MUST be performed, prior to removal of the Controller and RF Board from the chassis. Otherwise damage to the transceiver Controller Board could occur.

Use the following procedures to disassemble your radio:

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 screws using a T-10 torx bit, do not discard screws.

Figure 8-2. Removing the Control Head Screws

3. Firmly grasp the control head front housing and frame seal, and carefully remove from the radio. Be careful not to pull the attached flex, to avoid option board damage during control head removal.

Figure 8-3. Removing the 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 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 8-4. 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 8-5. Removing the TIB Screws

7. Remove the Accessory Connector Cover (i.e. HLN6863_) at J2 or J100 using the thumb screws located on 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 located on one side and carefully pry the TX Grille away from the radio.

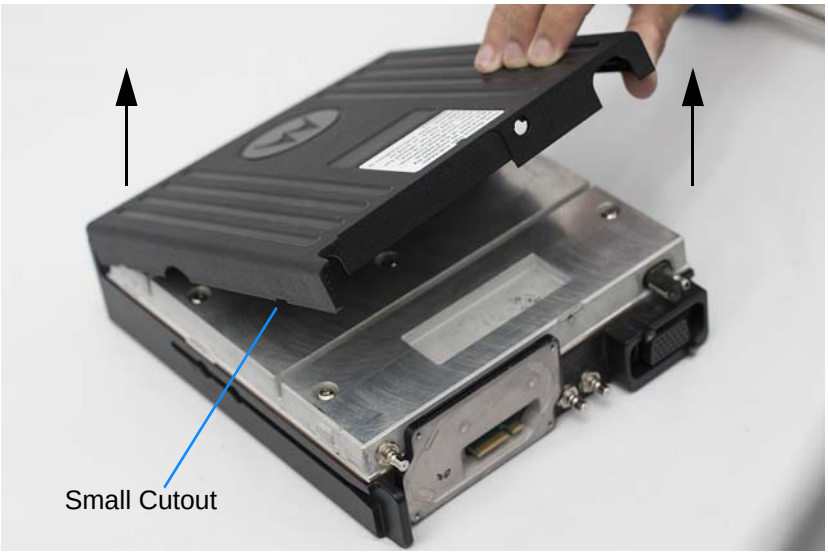


Figure 8-6. Removing the TX Grille

9. Radio must be oriented as shown below 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.

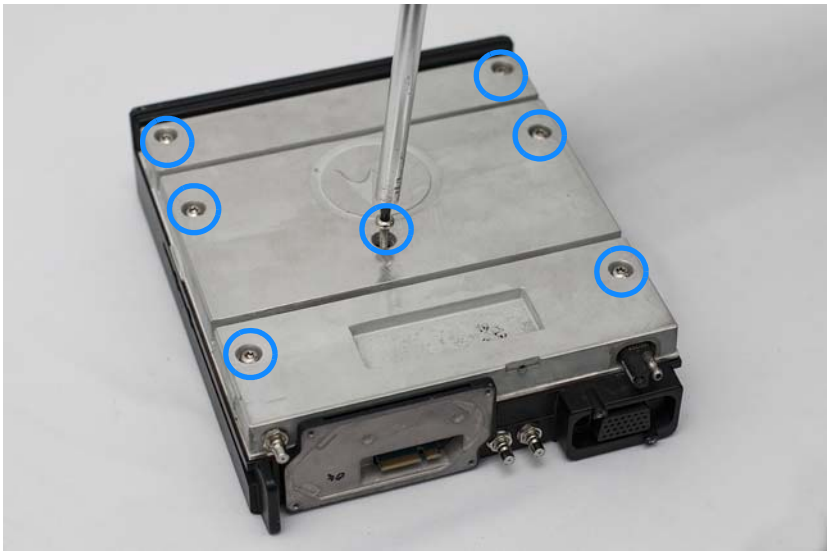


Figure 8-7. Removing the TX Casting Screws

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.

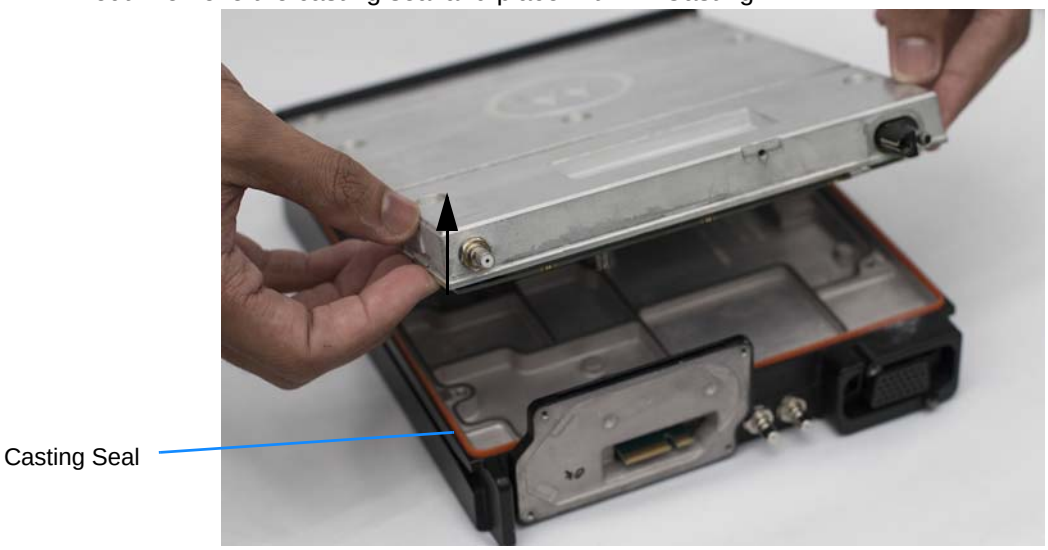


Figure 8-8. Removing the TX Casting

11. Remove the TX board by gently. Handle the TX board by the edges only, and store in an anti-static bag. Avoid contact with exposed thermal grease on TX board, thermal grease may be removed with a dry lint-free cloth.

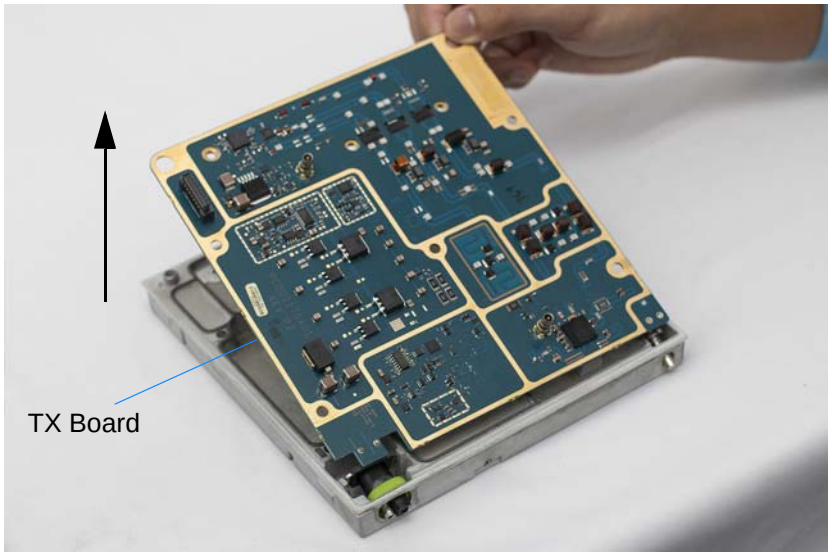


Figure 8-9. Removing the TX PCB

12. FLIP RADIO OVER: 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 8-10. Removing the XCVR Cover

13. Disconnect the GPS and BT/Wi-Fi cables from the controller board by gently holding the controller board in place and pulling up on the cable's MMCX connector. Do not pull on the cable section of the cable as damage may occur. Avoid contact with exposed thermal grease on controller board, thermal grease may be removed with a dry lint-free cloth. Remove GPS and BT/Wi-Fi SMA connector nut using a deep 5/16" socket or deep nut driver. Remove the GPS and BT/Wi-Fi SMA connector lock washer. Do not discard nut or lock washer. Disconnect the rear accessory flex from the controller board. Remove the two (2) screws from the Accessory Connector and gently pull through the hole in the casting.

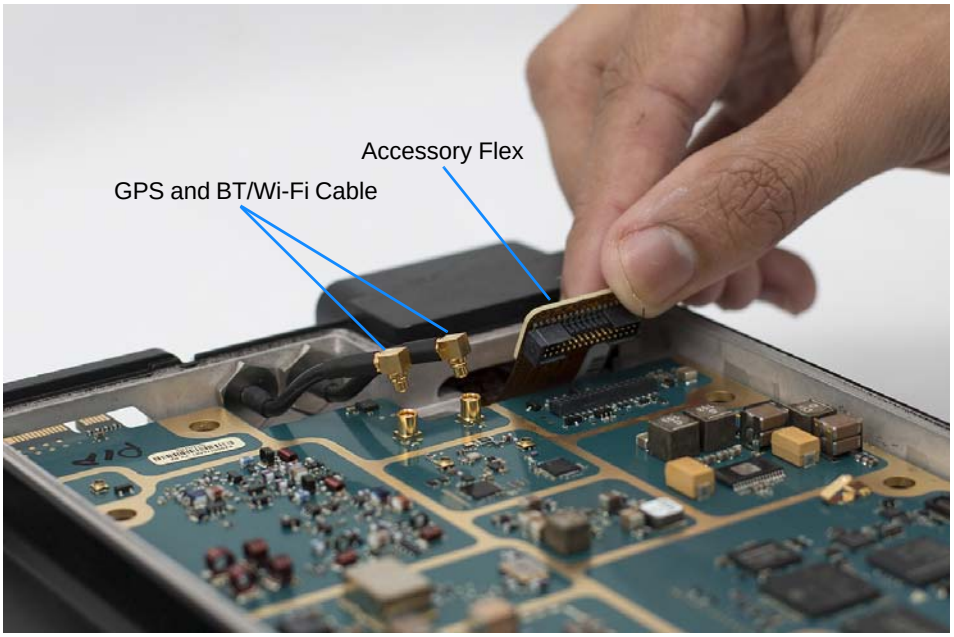


Figure 8-11. Removing the GPS Cable, BT/Wi-Fi Cable, and Accessory Flex

14. Remove the XCVR board by gently. Handle the XCVR board by the edges only, and store in an anti-static bag. Avoid contact with exposed thermal grease on XCVR board, thermal grease may be removed with a dry lint-free cloth.

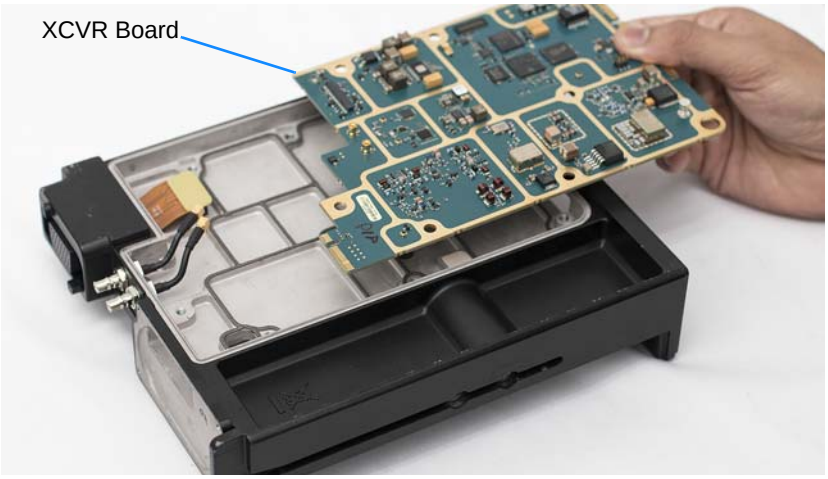


Figure 8-12. Removing the XCVR PCB

8.2.3.2 O2 Radio Disassembly

Use the following procedures to disassemble your radio:

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.

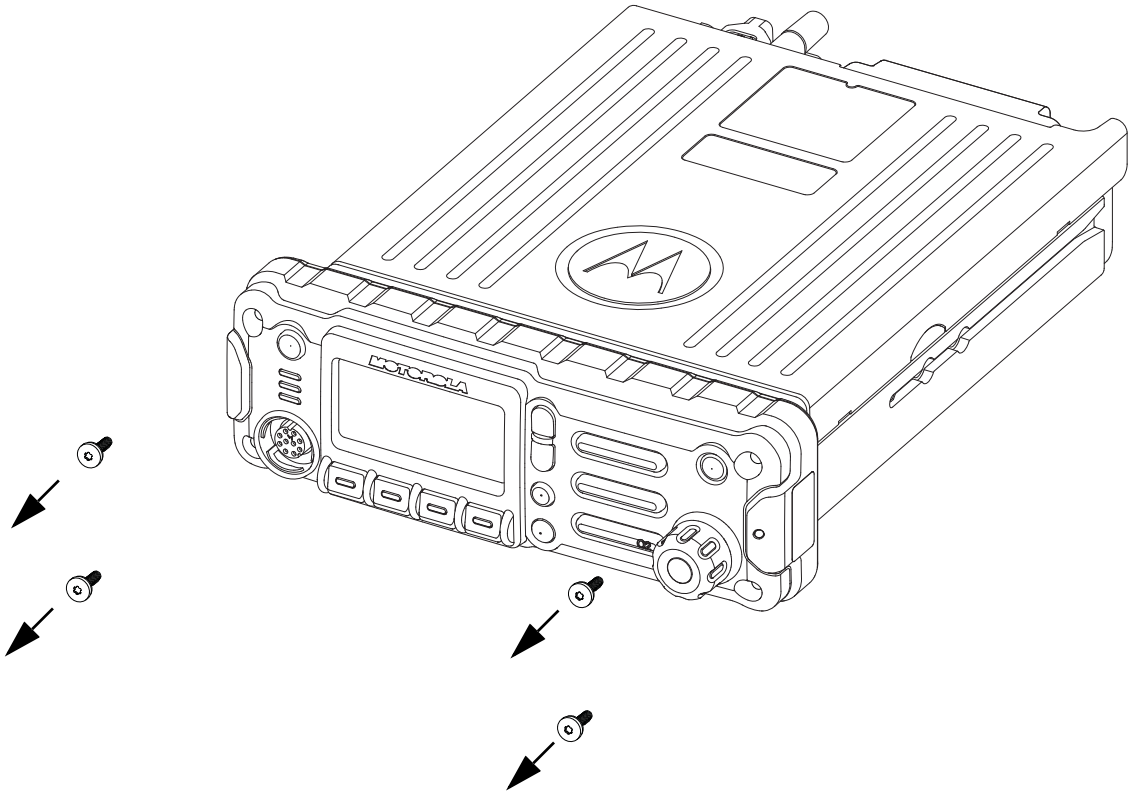


Figure 8-13. Removing the Control Head Screws

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.

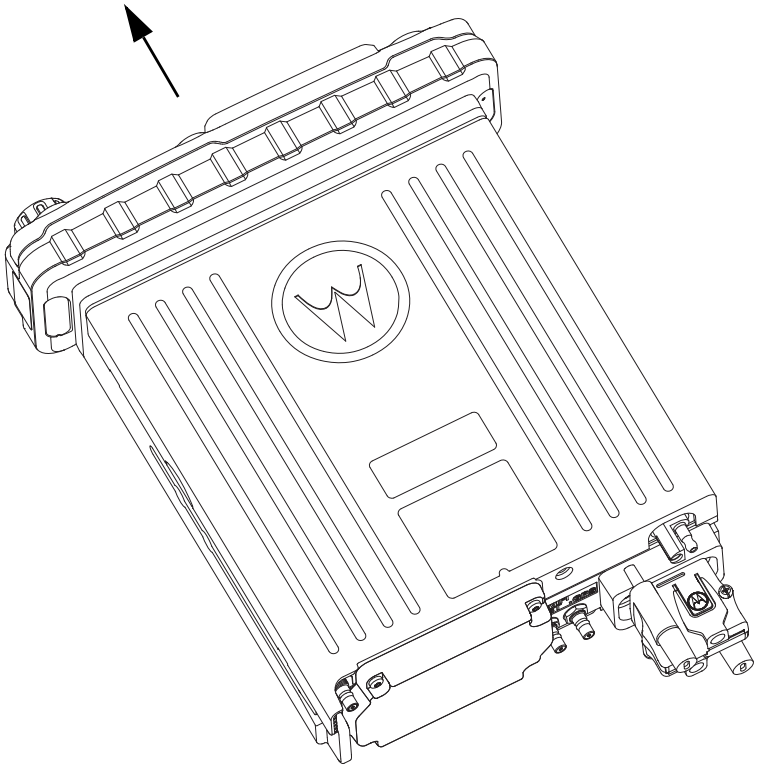


Figure 8-14. Removing the Control Head

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.

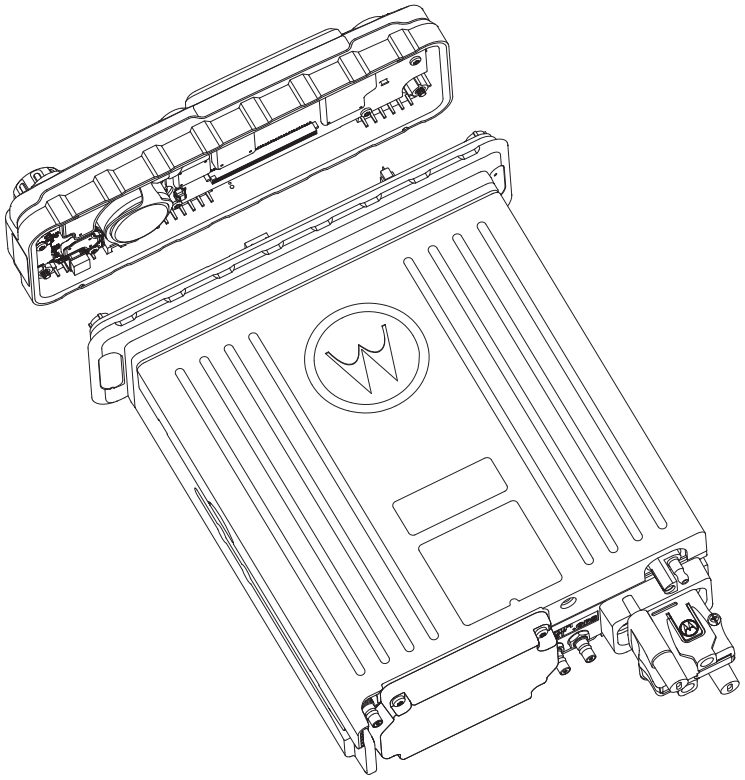


Figure 8-15. Disconnecting the Transceiver Flex from the Front Housing Assembly

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.

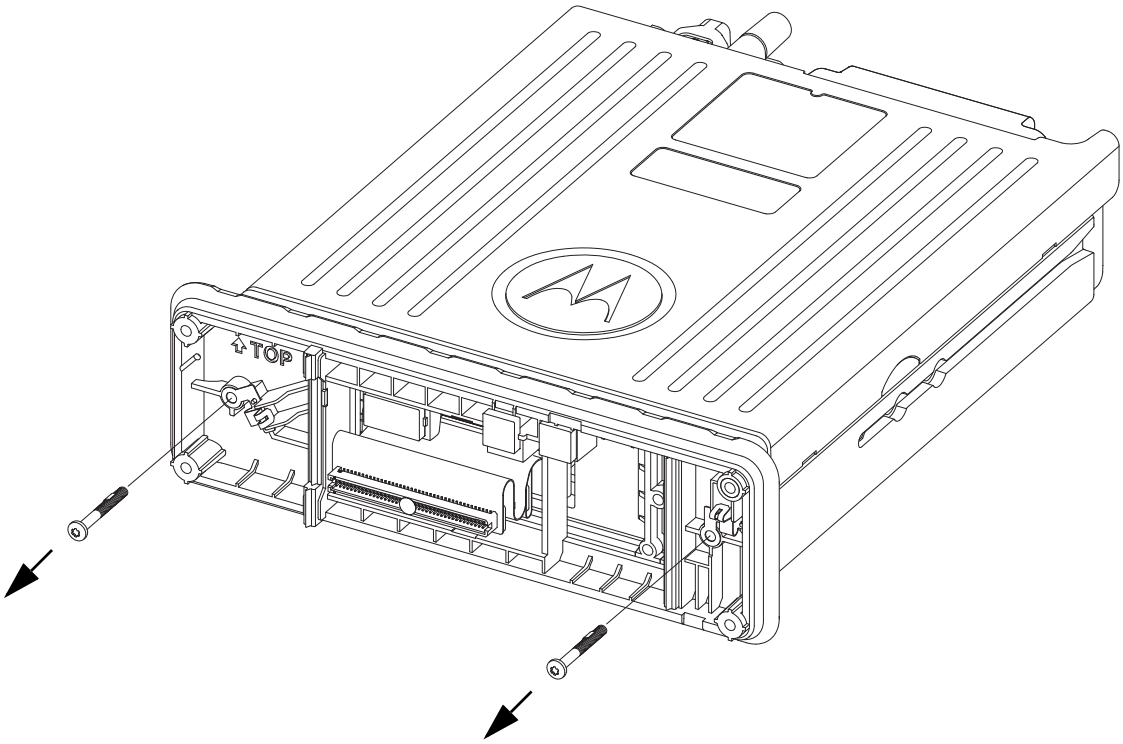


Figure 8-16. Removing the Back Housing Assembly

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

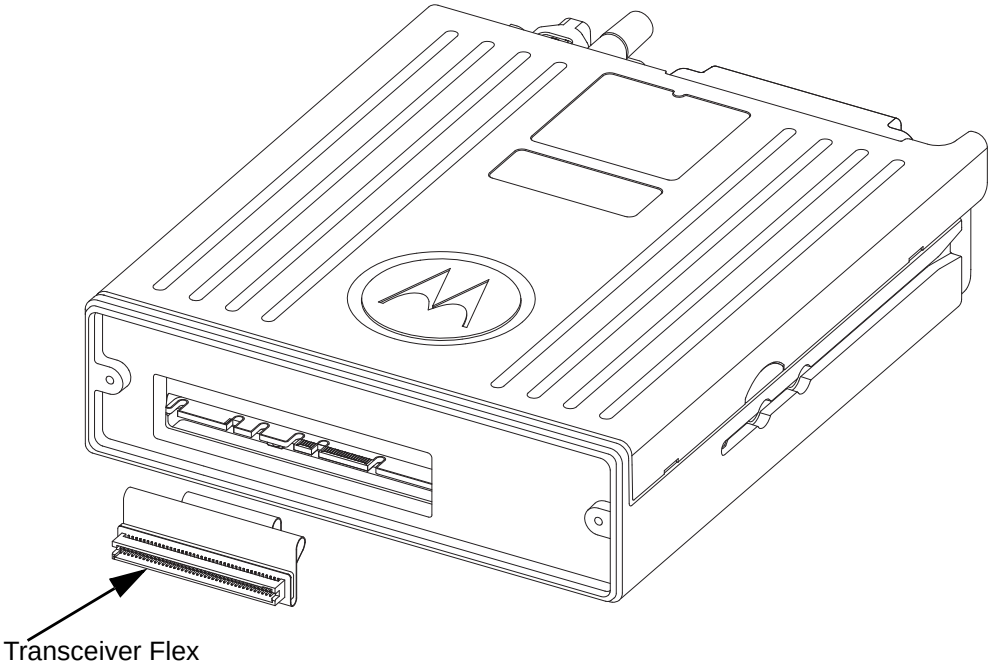


Figure 8-17. Removing the Transceiver Flex

8.2.3.3 O5 Radio Disassembly

Use the following procedures to disassemble your radio:

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.

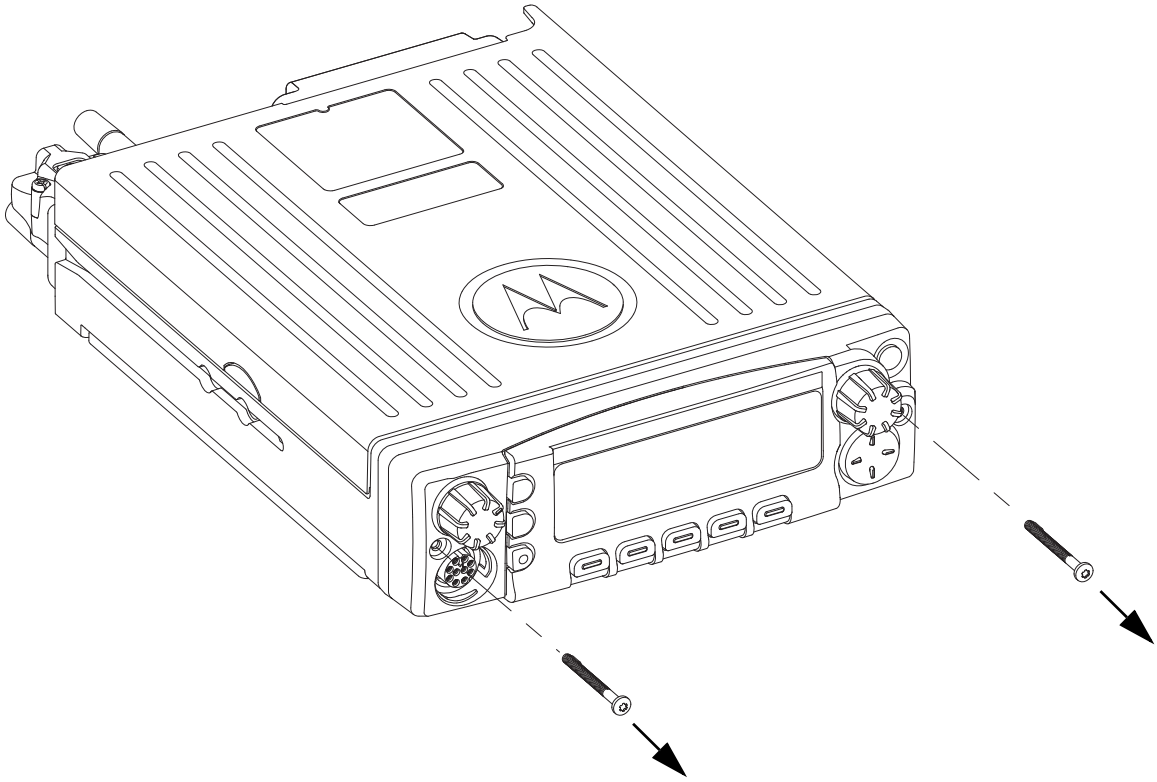


Figure 8-18. Removing the Control Head Screws

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.

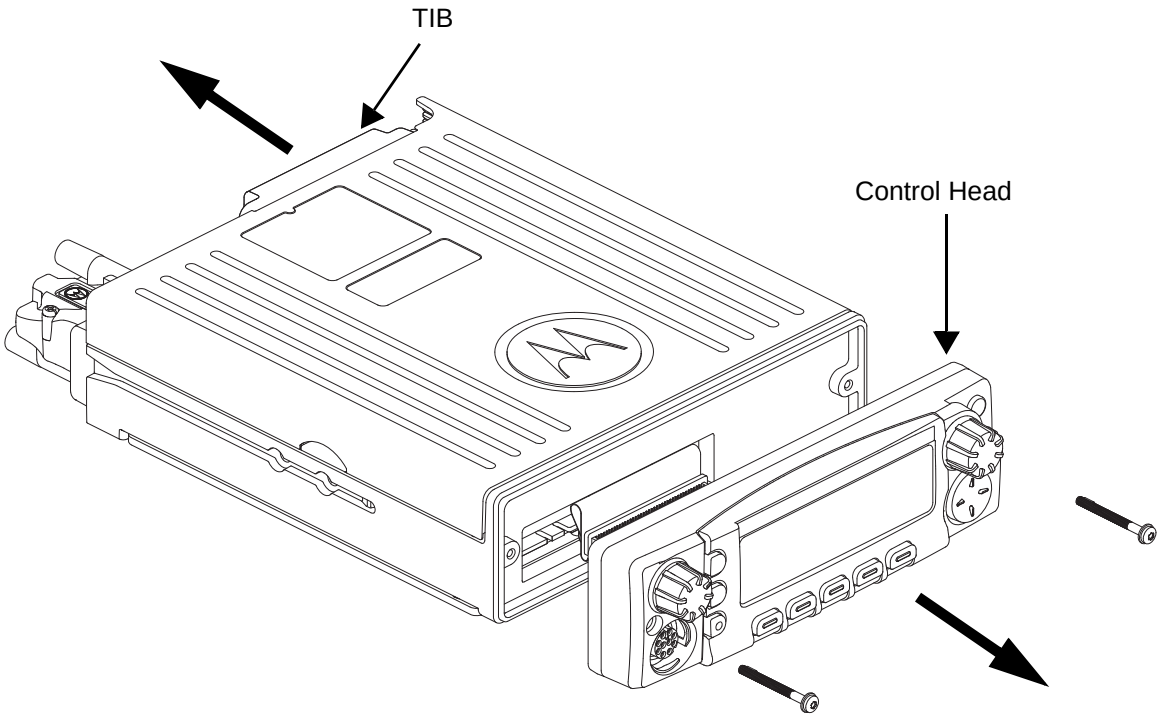


Figure 8-19. Removing the Control Head/TIB

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.

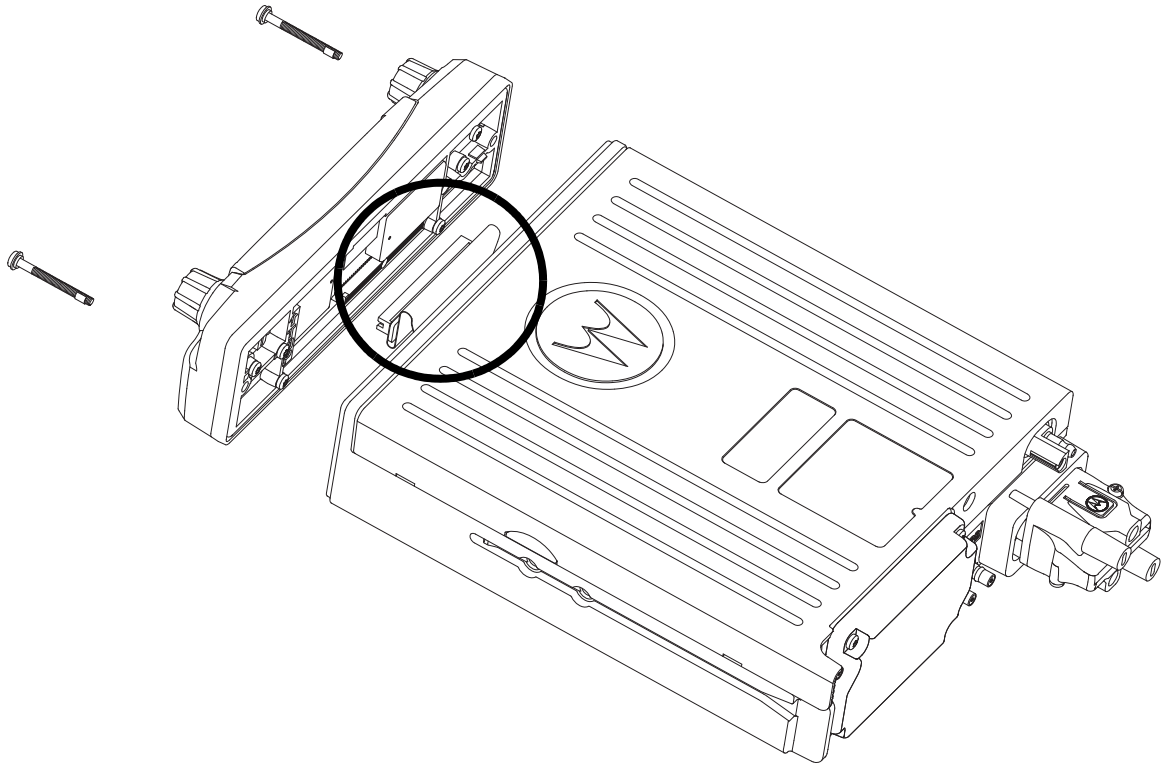


Figure 8-20. Removing the Control Head Flex

8.2.3.4 O7 Radio Disassembly

Use the following procedures to disassemble your radio:

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.

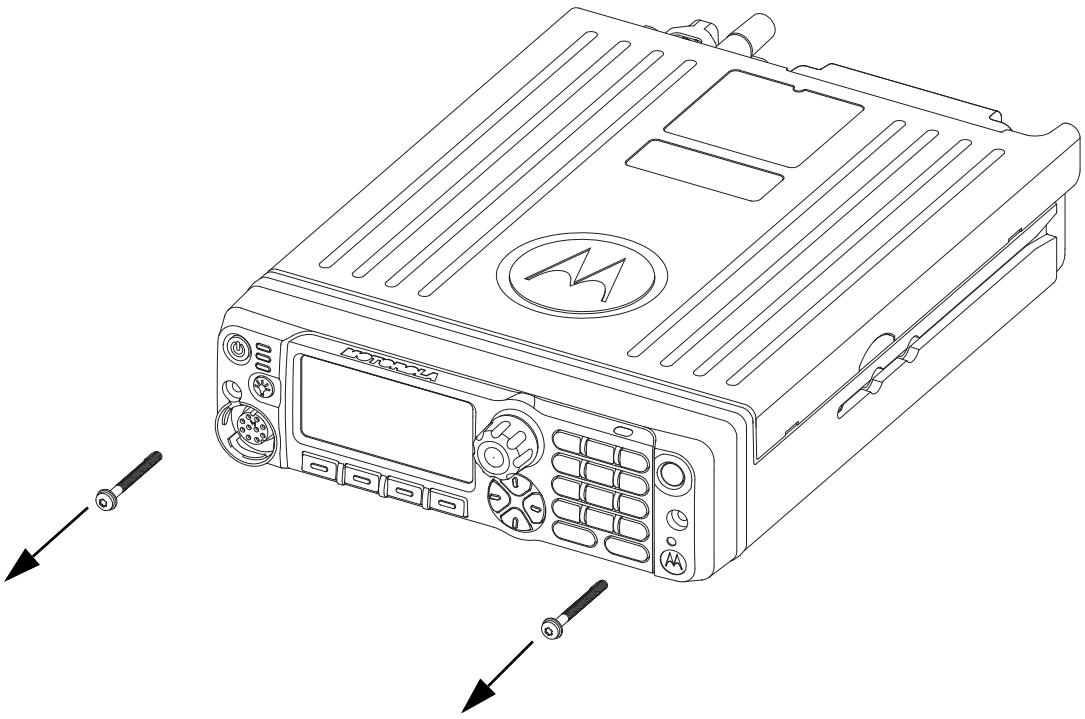


Figure 8-21. Removing the Transceiver Screws

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.

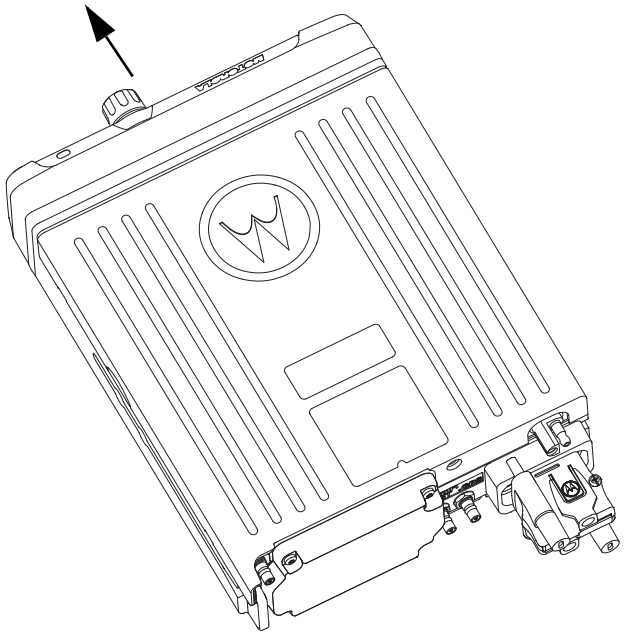


Figure 8-22. Removing the Control Head

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.

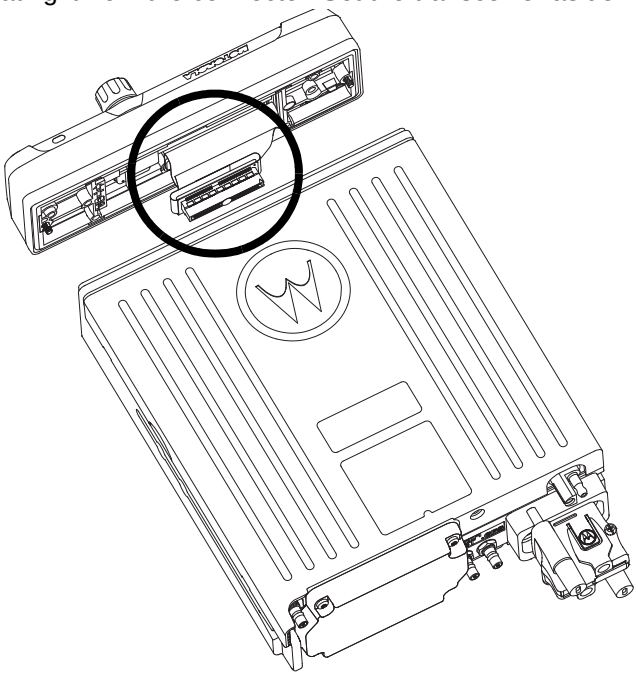


Figure 8-23. Disconnecting the Transceiver Flex from the Transceiver

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.

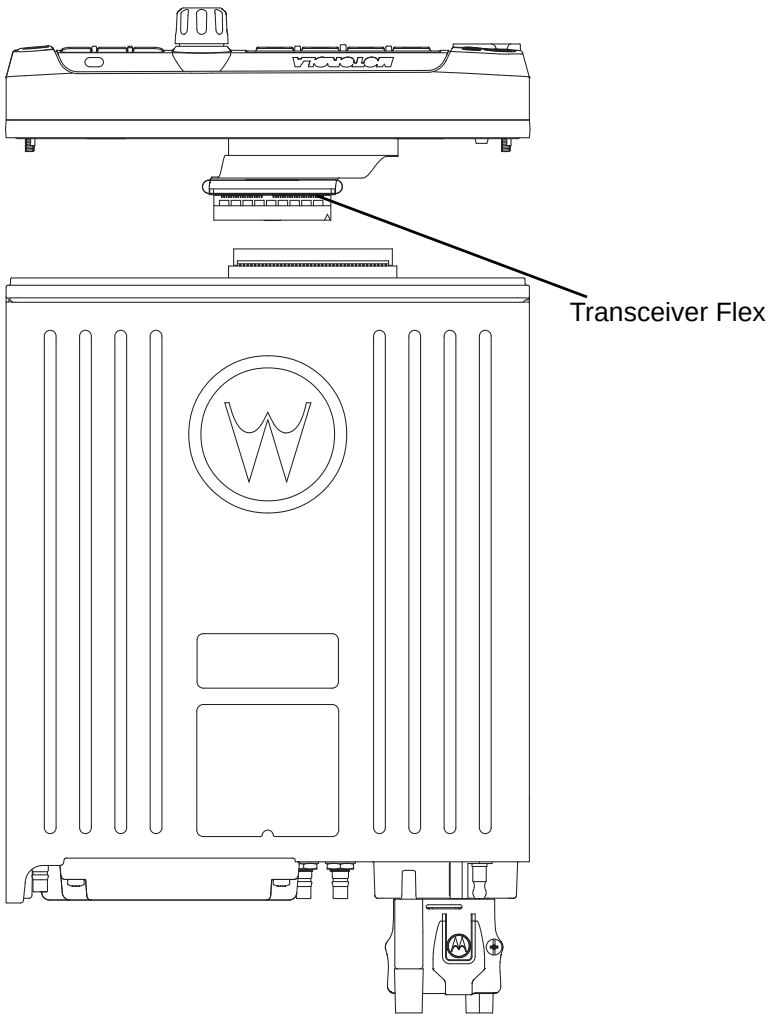


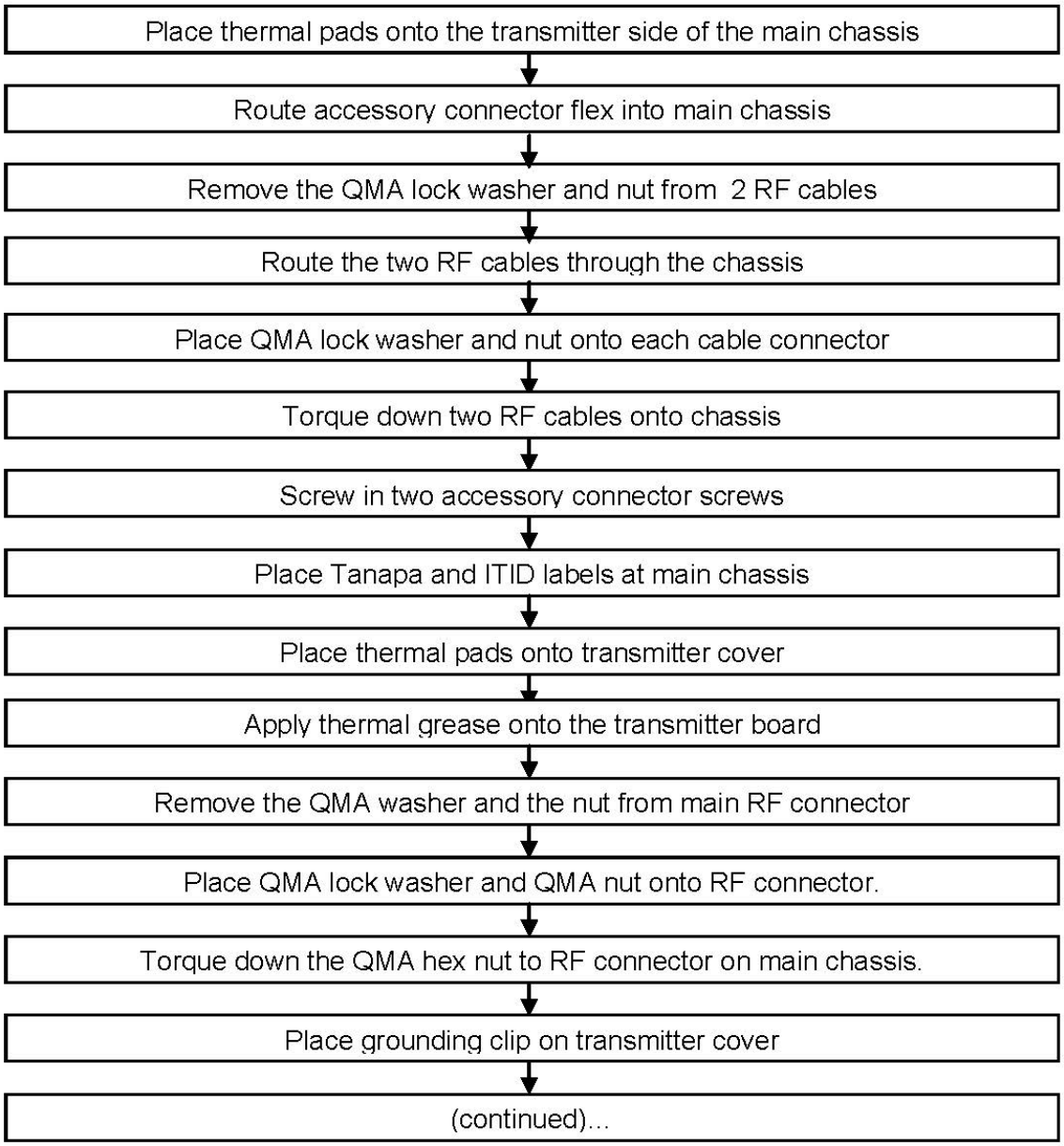
Figure 8-24. Removing the Transceiver Flex

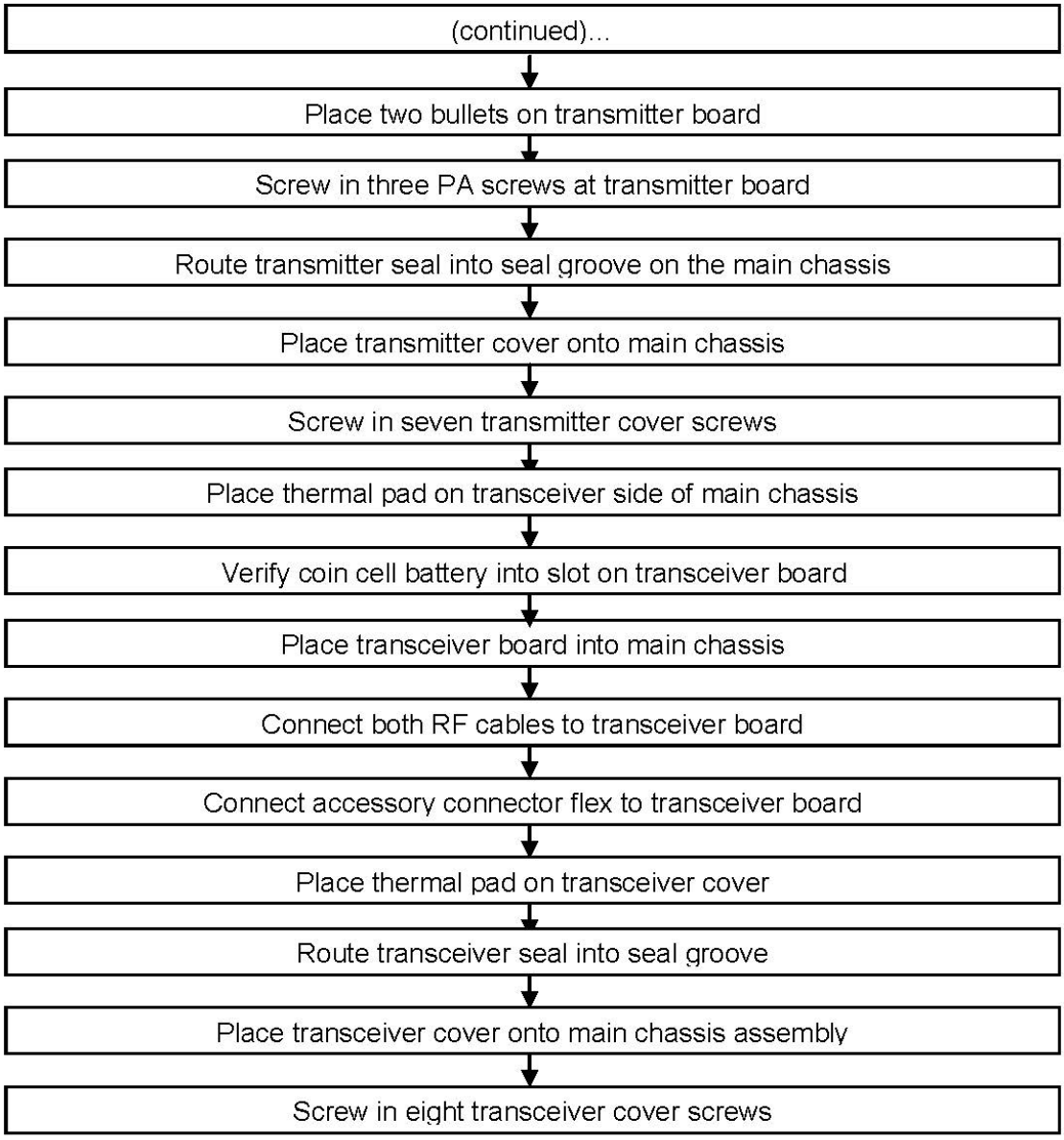
8.2.4 Radio Reassembly

8.2.4.1 APX 8500 Mid Power Model

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

Use the following procedures to reassemble your radio.




(continued)...
Place two bullets on transmitter board
Screw in three PA screws at transmitter board
Route transmitter seal into seal groove on the main chassis
Place transmitter cover onto main chassis
Screw in seven transmitter cover screws
Place thermal pad on transceiver side of main chassis
Verify coin cell battery into slot on transceiver board
Place transceiver board into main chassis
Connect both RF cables to transceiver board
Connect accessory connector flex to transceiver board
Place thermal pad on transceiver cover
Route transceiver seal into seal groove
Place transceiver cover onto main chassis assembly
Screw in eight transceiver cover screws

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

*Figure 8-25. Placing Thermal Pad (*7575935B01*) transmitter (TX) side of main chassis*

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

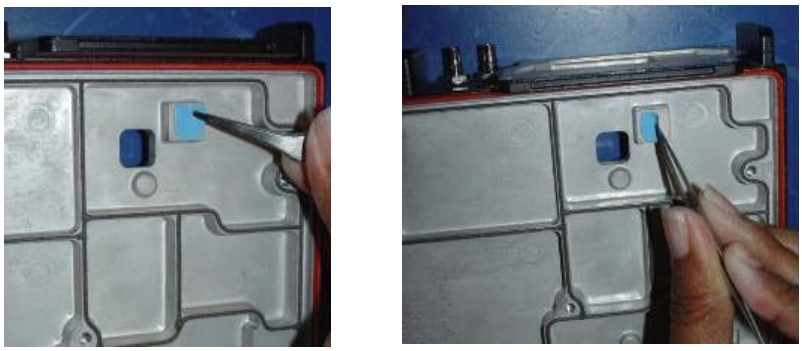


Figure 8-26. Placing Thermal Pad 7575767B01 on transmitter (TX) side of main chassis

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

*Figure 8-27. Placing the Thermal Pad (*HW000572A02*) on transmitter (TX) side of main chassis*

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

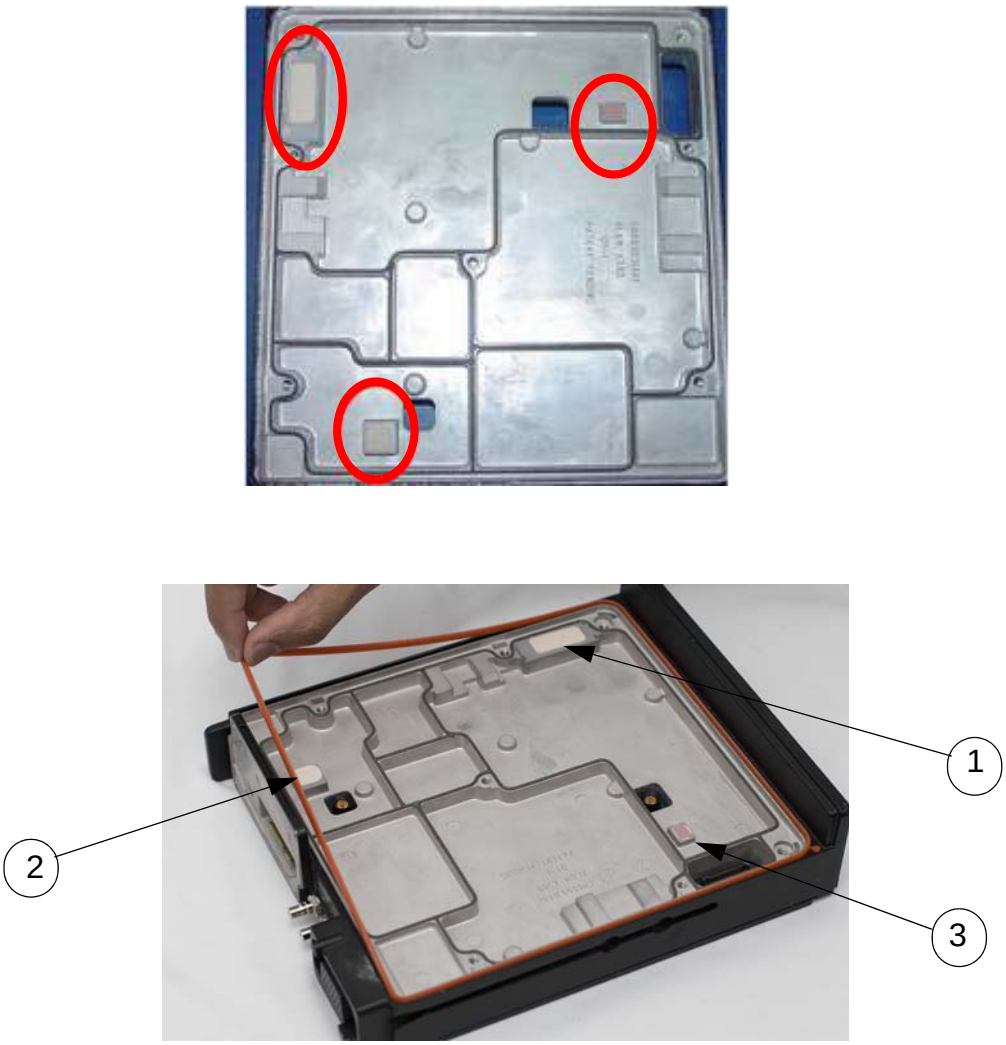


Figure 8-28. All 3 thermal pads located on transmitter (TX) side of main chassis. See Table 8-2*.*

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

Figure 8-29. Installing the Accessory Connector Flex into Main Chassis

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

Figure 8-30. Removing the QMA Lock Washer and QMA Nut

6. Install the 2 RF cables through the chassis. Make sure the RF cable connector body aligns with the chassis as shown in Figure 8-31.

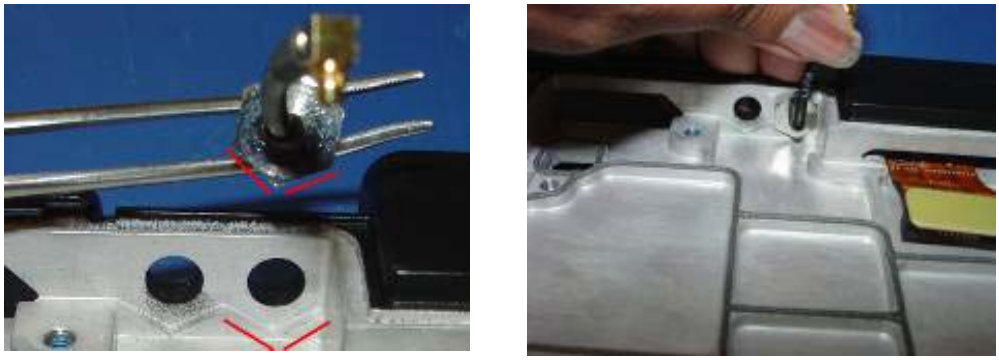


Figure 8-31. Installing two RF Cables into the Main Chassis

7. 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 8-32. Installing QMA Lock Washer and QMA Nut for each cable connector

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

NOTE: Make sure washer and seal are not missing.

Figure 8-33. Installing Accessory Connector Screws

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

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

Figure 8-34. Installing the two RF Cables

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

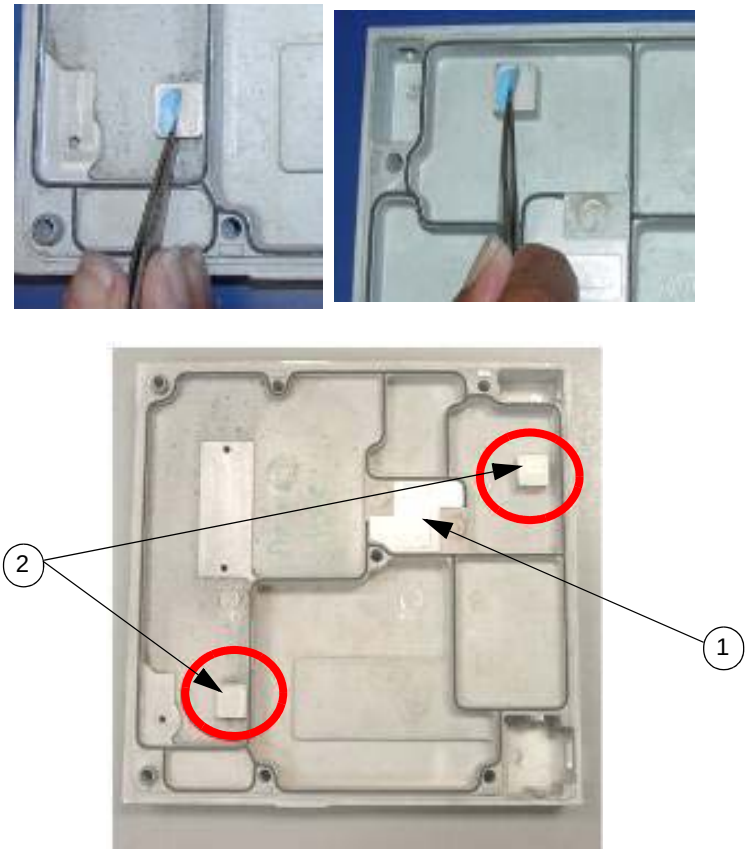


Figure 8-35. Placing the thermal pads 7575767B01 and 7575935B01 onto Transmitter (TX) Cover

11. Apply thermal grease (1110022D23) onto the dogbone and lollipop on the transmitter board (PA000175A01).

NOTE: Make sure dogbone and lollipop heatsink surface fully covered by a layer of thermal. compound as per picture.

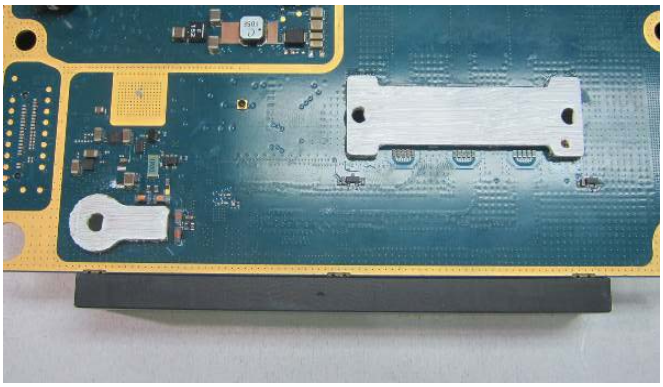


Figure 8-36. Applying the Thermal Grease onto the Transmitter Board

12. Before placing the transmitter board (PA000175A01) into the transmitter cover (CH000032A02) remove the QMA washer and the nut from main RF connector

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

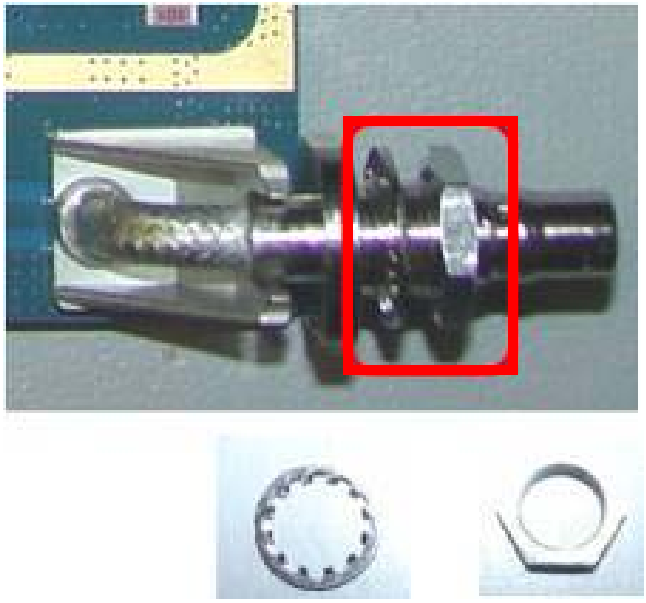


Figure 8-37. Removing the QMA Lock Washer and Nut from RF Connector

13. Thoroughly inspect the RF Housing shield gasketing for damage and verify all RF housing thermal pads are in place and free of damage. Install RF board by tilting and sliding into chassis using the edge of the board two (2) RF board handles, taking care to line up the one (1) two (2) RF and one (1) DC connectors through the rear holes of the chassis. To fully seat RF board, push back and down on the board using the two (2) RF board handles to slightly compress RF/DC seals. Ensure that the RF board alignment holes are positioned over the chassis alignment bosses and that the RF board is fully seated in chassis.

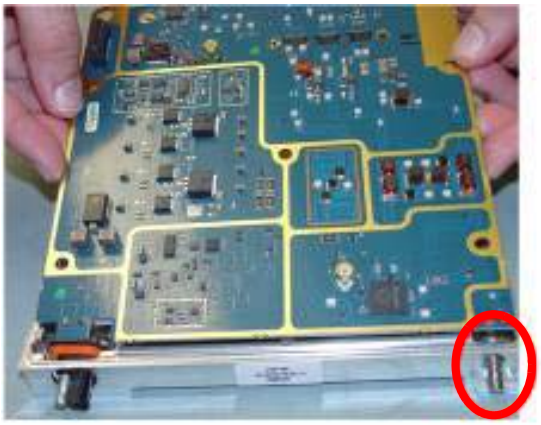


Figure 8-38. Placing the transmitter board onto the Transmitter Cover

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

NOTE: Ensure nut is fully tightened and flushed.

Figure 8-39. Installing the QMA Lock Washer and Nut into the RF Connector

15. Insert the DC retention clip and fully seat it. The clip must be inserted prior to the board screws to properly locate RF board. Place grounding clip (HW000571A01) on transmitter cover (CH000032A02).

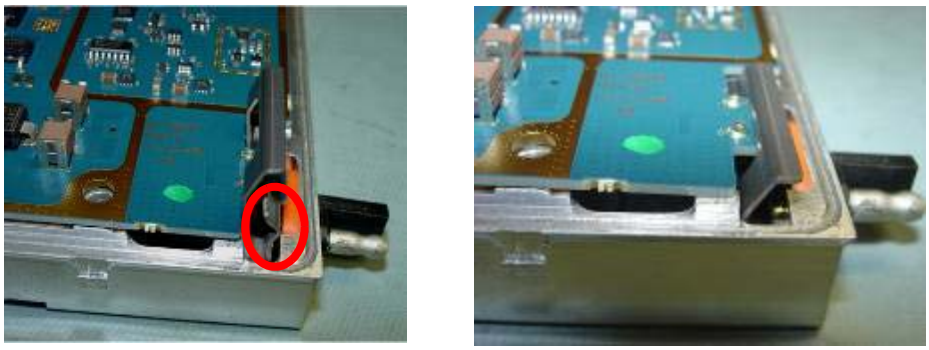


Figure 8-40. Installing the Grounding Clip on Transmitter Cover

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

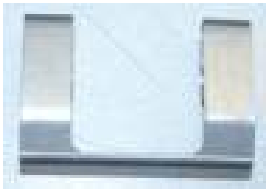


Figure 8-41. Grounding Clip on Transmitter Cover is critical to ensure DC connector stability

16. Place two CN000069A03 (bullets) into the two CN000069A01 hole on transmitter board (PA000175A01).

NOTE: Make sure the white side of the bullet is down. Inspect the bullets for any damage.

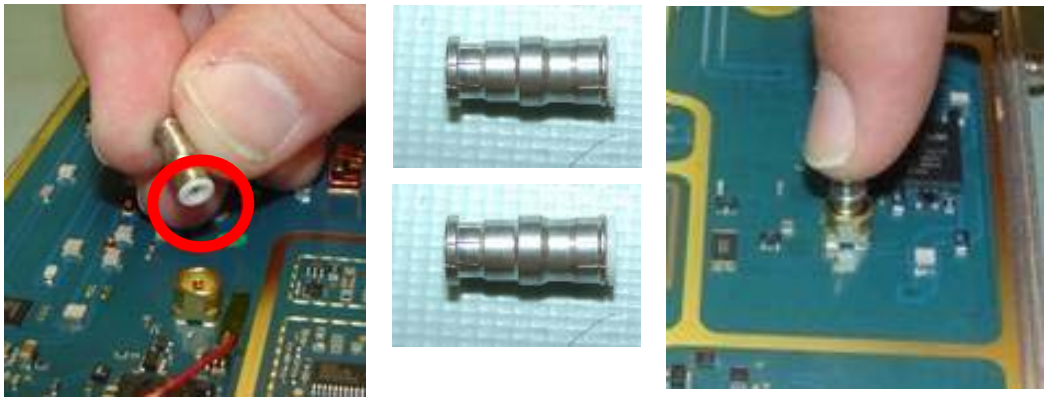


Figure 8-42. RF bullets used in the Transmitter Board

17. Install the three RF board screws.

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

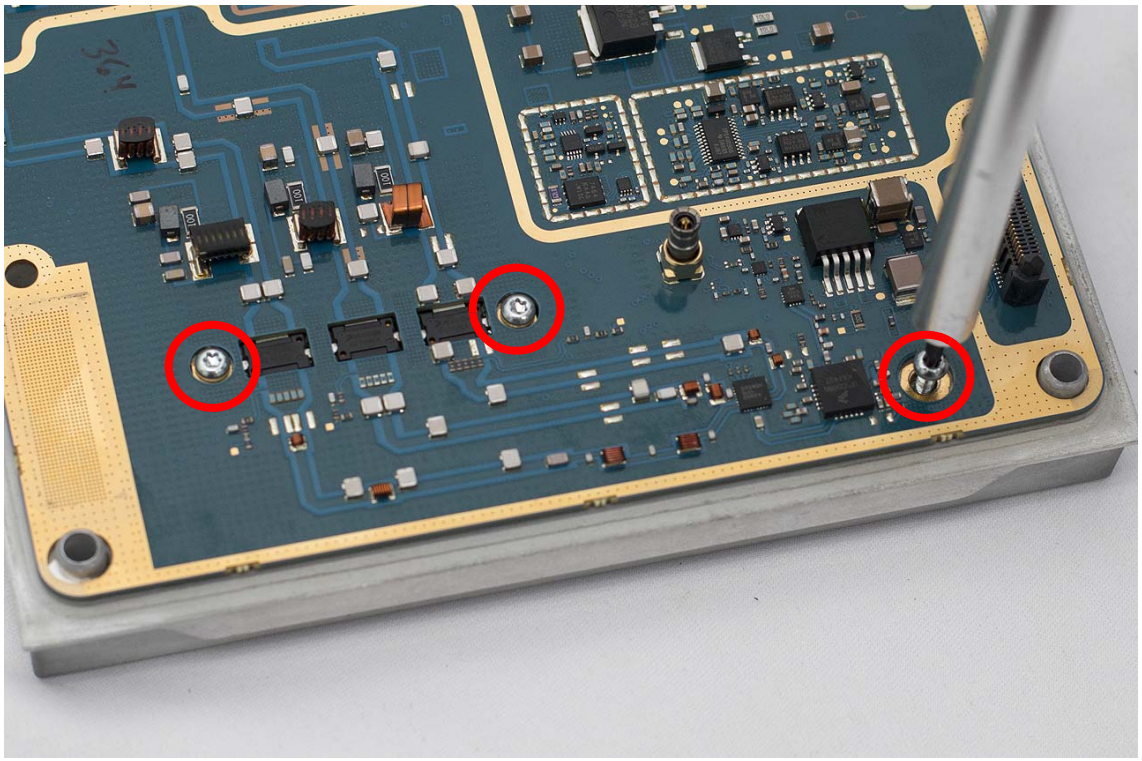


Figure 8-43. Installing PA Screws

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

NOTE: Inspect the thermal pad and ensure no foreign material on the thermal pad prior proceed next process step.

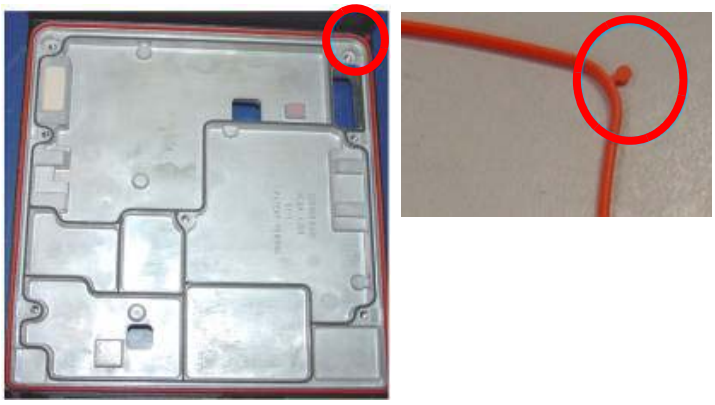


Figure 8-44. Placing the Transmitter Seal into the main Chassis

20. Place transmitter cover (CH000032A02) onto main chassis (CH000031A02).
21. Make sure the seal is not pinched.Be sure RF cover is properly aligned to chassis. The RF cover and chassis can be compressed together to squeeze seal into place.

Figure 8-45. Placing Transmitter Cover onto the Main Chassis

22. Inspect the sealing washers to the seven (7) RF cover screws, and then install the screws onto the RF cover/chassis. Screw in seven transmitter cover screws (0385870E01) to 36 in-lbs, be sure to torque screws using the indicated order to ensure RF cover is properly seated.

NOTE: Repeat torque order sequence at least twice.

NOTE: Ensure screws are fully tightened and flushed.

Figure 8-46. Securing the RF Cover to the Chassis

23. Once RF cover is fully installed, re-check the RF cover-chassis interface to ensure the RF cover seal is not pinched.
24. Place thermal pad (7575767B01) on transceiver (XVCR) side of main chassis (CH000031A02) and remove the blue liner.

*Figure 8-47. Placing Thermal Pad (*7575767B01*) on transceiver (XVCR) side of main chassis*

25. Confirm the coin cell battery (600092650001) is still present in slot on transceiver board (PA000176A01).

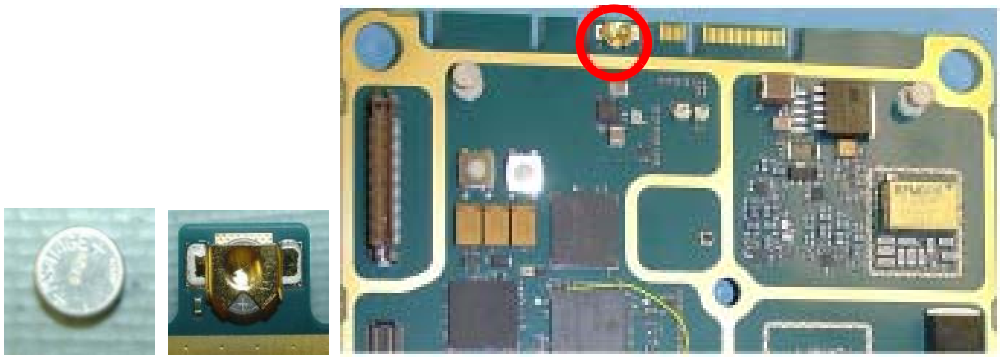


Figure 8-48. Installing the Coin Cell Battery into Transceiver Board

26. Place transceiver board (PA000176A01) into main chassis (CH000031A02), ensuring that the board to board connectors mate by pressing down as shown. Ensure all thermal pads are free from contamination before place board.

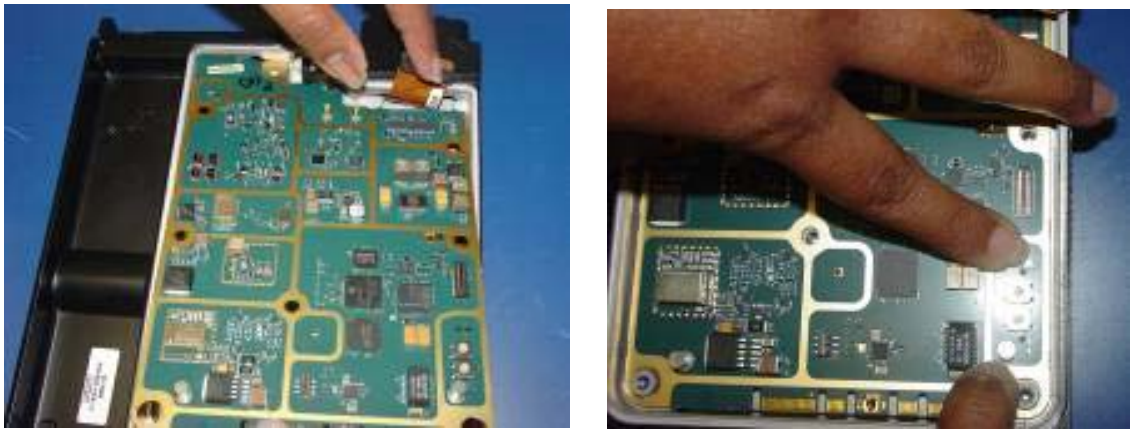


Figure 8-49. Securing the Transceiver Board into the Chassis

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 section 8.3: Chassis Thermal Pad Replacement Procedure on page 8-51 to replace damaged pads.
28. Orient the chassis with the bottom facing upwards. Grab the XCVR board by the (2) handles and place the board backside first so that it can slide into the rear openings in the chassis. Make sure the board seats properly and all the screw holes line up.
29. After inspecting the GPS/BT/Wi-Fi cable and seating the seal on the SMA connector ferrule, insert the GPS/BT/Wi-Fi SMA connector through the GPS/BT/Wi-Fi cable chassis opening, ensuring the notch on the GPS/BT/Wi-Fi connector is down and aligned with the protrusion on the chassis. Install the lock washer. Install the GPS/BT/Wi-Fi nut using a 9 mm nut driver and torque nut to 12–14 in-lbf.

30. Insert free end of GPS/BT/Wi-Fi cable through the chassis opening. Connect cables to the XCVR board.
31. Insert rear accessory flex through rear chassis opening. Be sure flex is oriented with components facing up. Insert free end of accessory flex through chassis opening.
32. Install the two (2) rear accessory connector screws using a T-10 torx bit. Be sure the rear accessory screws each have one (1) washer and one (1) seal. Torque rear accessory connector screws to 6-8 in-lbf
33. Connect rear accessory cable connector to the XCVR board.

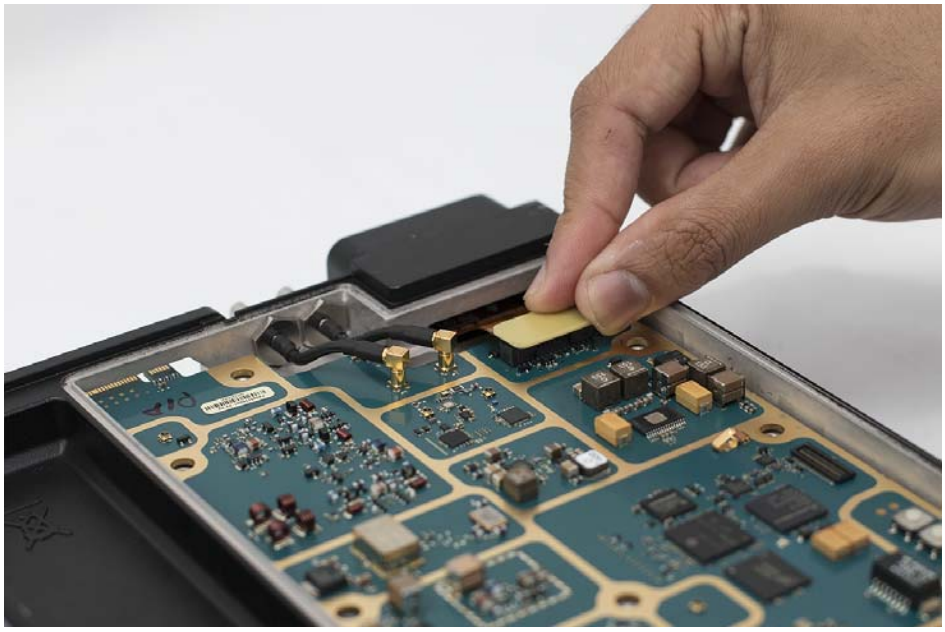


Figure 8-50. Connecting Rear Accessory Connector Flex and GPS/BT/Wi-Fi Cables

34. Connect both RF cables (CB000091A01) to transceiver board (PA000176A01).

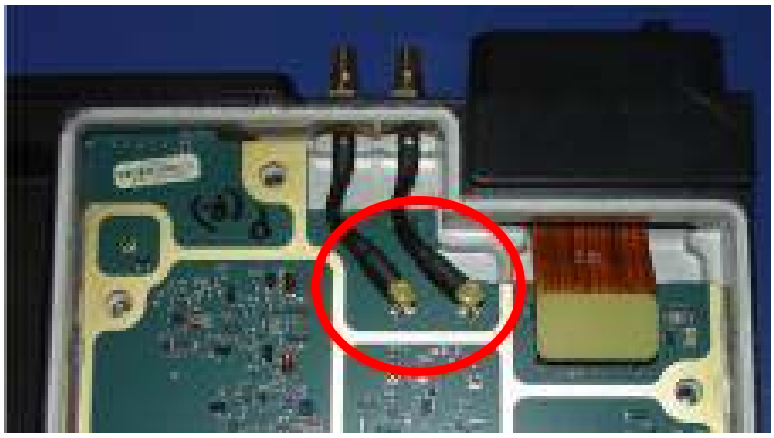


Figure 8-51. Connecting RF Cables to Transceiver Board

35. Place thermal pad (HW000572A02) on transceiver (XCVR) cover (CH000033A02) and remove the blue liner.

Figure 8-52. Placing Thermal Pad on Transceiver (XCVR) Cover

36. Route transceiver seal (SL000052A01) into seal groove.

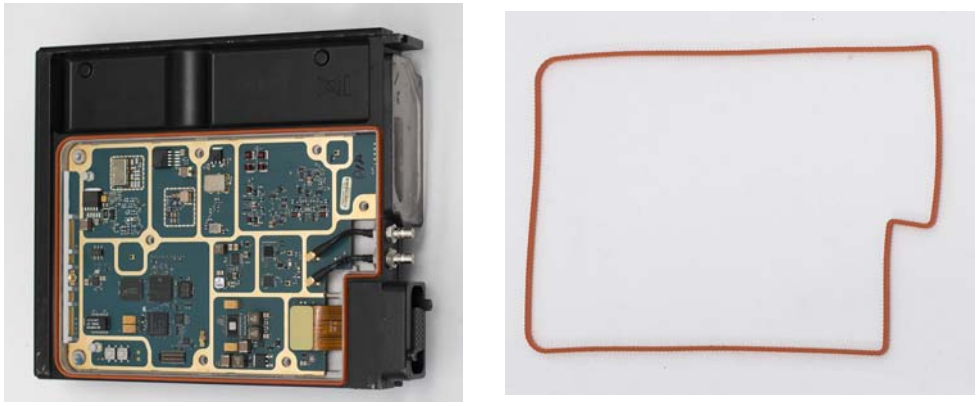


Figure 8-53. Placing Transceiver Seal

37. Place transceiver cover (CH000033A02) onto main chassis assembly. Ensure all thermal pads are free from contamination before place board.

38. Place XCVR cover seal on the chassis and make sure it is seated properly. Orient the XCVR cover so that the screw holes line up and place on chassis. Install the eight (8) XCVR cover screws using a T-20 torx bit making sure they all have their necessary sealing washers.

Figure 8-54. Installing the Transceiver Cover

39. Ensure screws are fully tightened and flushed. Once the Transceiver (XCVR) cover is fully installed, re-check the cover-chassis interface from the sides to ensure the Transceiver cover seal was not pinched and that it remained seated in the main chassis so there is no gasket sealing gap.

40. Check that the DC connector seal on the RF board is properly seated.
41. Check that the RF connector seal on the RF board is properly seated.
42. Once RF cover is fully installed, check the RF cover-chassis interface to ensure the RF cover seal is not pinched.
43. Hook the RF Grille on the DC power side of the radio and snap into position.

Figure 8-55. Installing the RF Grille

44. Install the Accessory Connector Cover (i.e. HLN6863_) at J2 or J100 by pushing into position and then securing it with the thumb screws located on two of the corners.
45. Install the TIB assembly by screwing in the four (4) TIB assembly screws using a T-10 torx bit

Figure 8-56. Installing the TIB Assembly

46. Attach the control head/TIB flex edge card connector to edge card. Be sure to properly align edge card connector to exposed edge card.

Figure 8-57. Installing Flex into Controller PCB

NOTE: Each Control Head has a unique DASH MOUNT flex. Do not mix and match. Only use the appropriate FLEX with its matching Control Head.

47. Attach the control head/TIB flex edge card connector to edge card. Be sure to properly align edge card connector to exposed edge card.
48. Install control head flex to control head. Be sure to properly align connectors prior to connecting.

Figure 8-58. Installing Flex into Controller PCB

49. Align control head to front of chassis using the frame seal. Install two (2) control head screws. Be sure the control head screws each have one (1) washer and one (1) seal installed. Torque down control head screws to 8-10 in-lbf.

Figure 8-59. Aligning Control Head front of chassis, and Installing the Control Head screws

8.2.4.2 O2 Radio Reassembly

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.

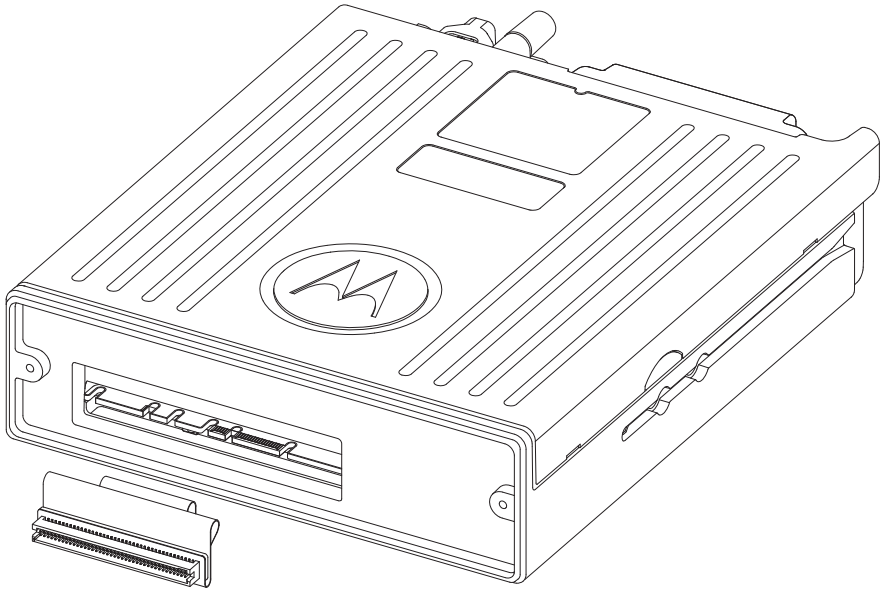


Figure 8-60. Installing the Transceiver Flex onto the Transceiver

NOTE: 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.

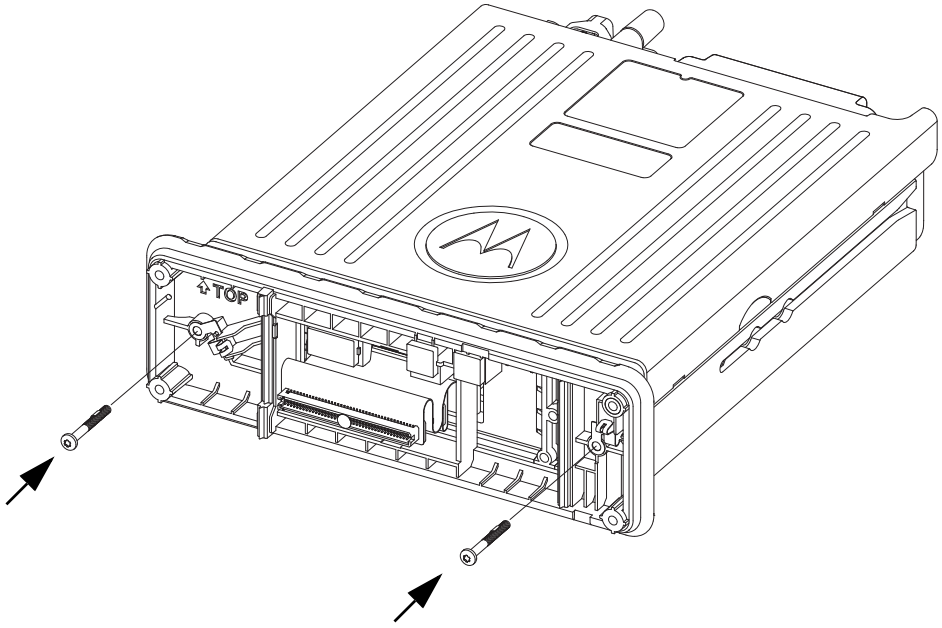


Figure 8-61. Installing the Back Housing Assembly onto the Transceiver

NOTE: Each Control Head has a unique DASH MOUNT flex. Do not mix and match. Only use the appropriate FLEX with its matching Control Head.

5. Reinstall the transceiver flex onto the front housing assembly or TIB flex onto the TIB connector.

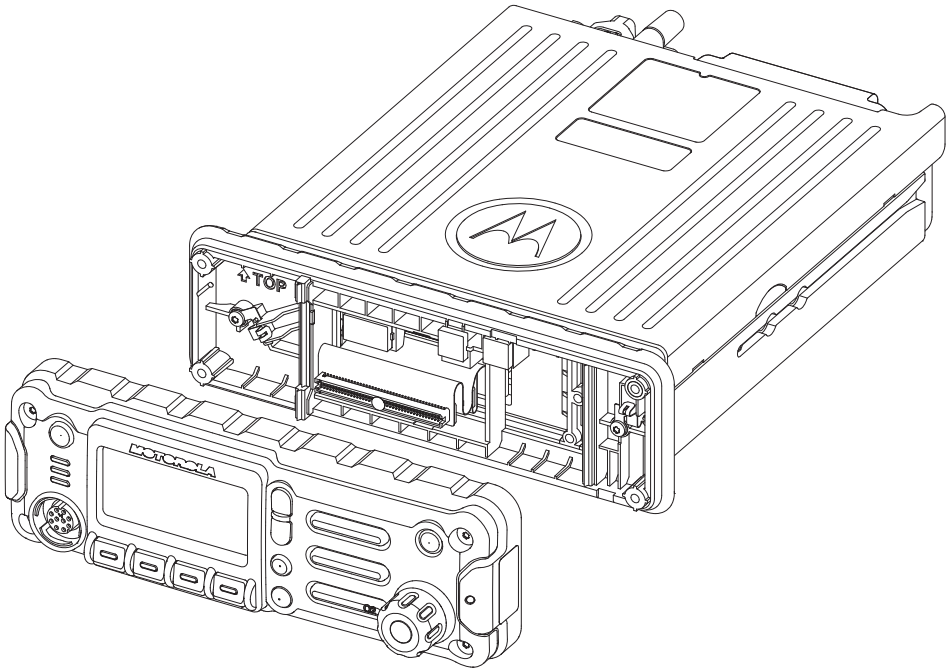


Figure 8-62. Installing the Transceiver Flex onto the Front Housing Assembly

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

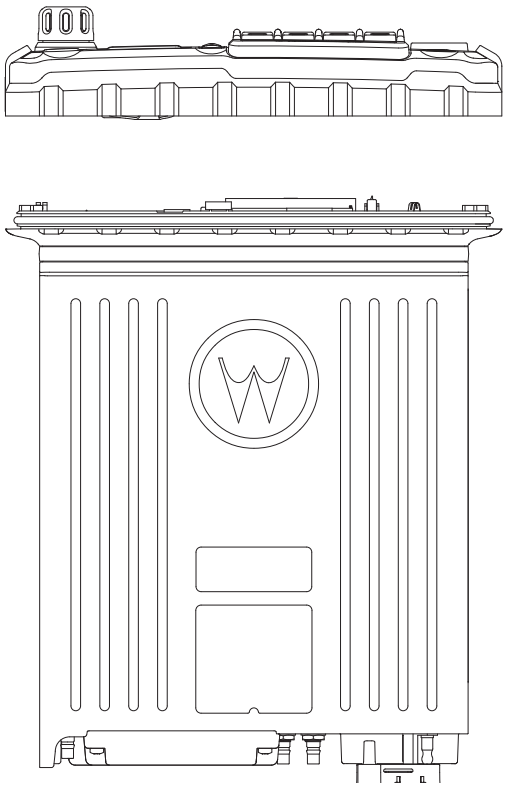


Figure 8-63. Attaching the Front Housing Assembly to the Back Housing Assembly

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.

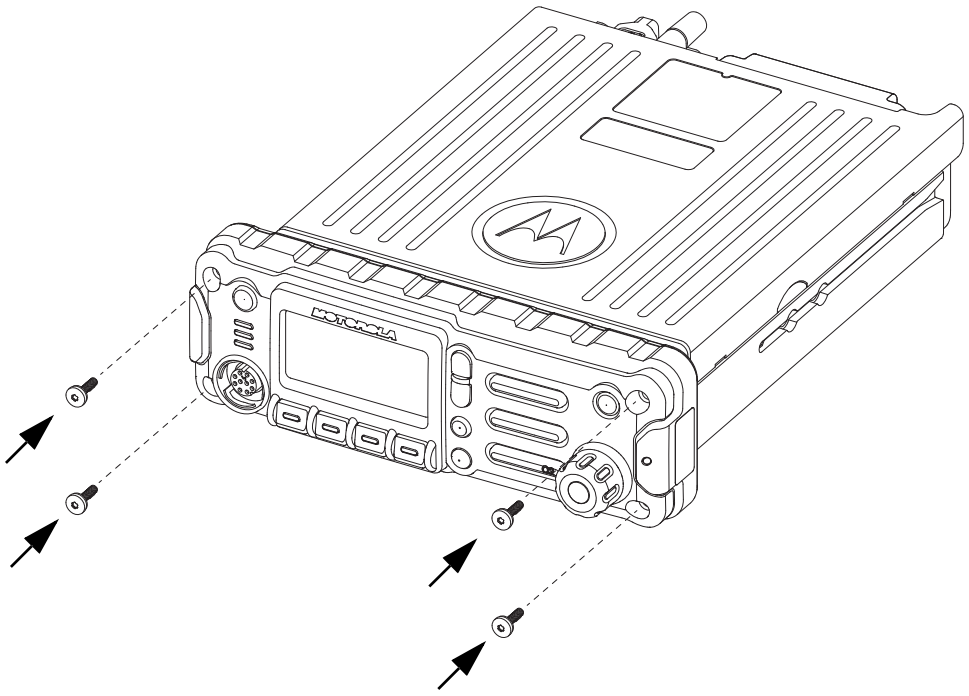


Figure 8-64. Attaching the Control Head Screws

8.2.4.3 O5 Radio Reassembly

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

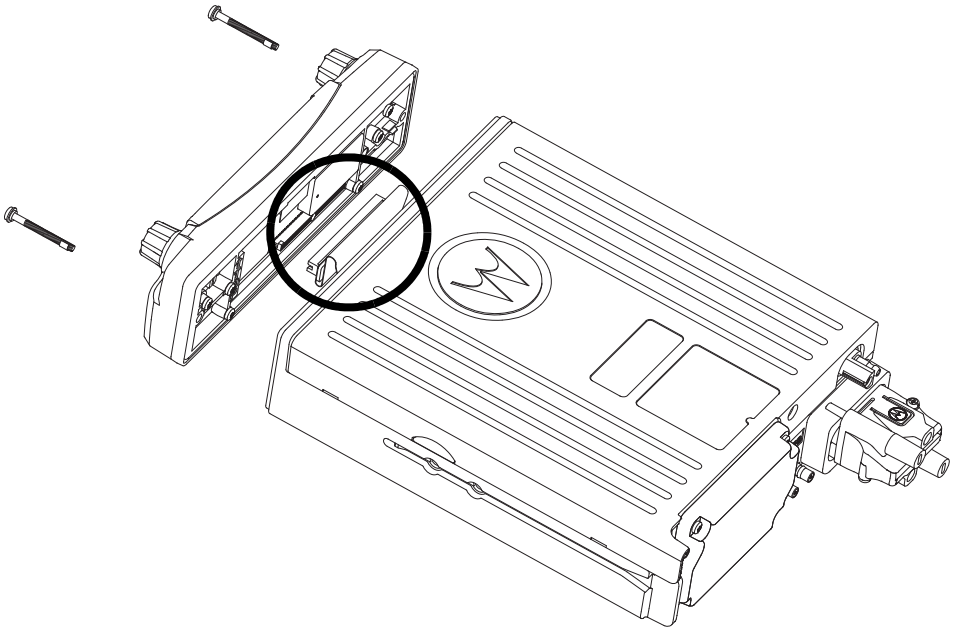


Figure 8-65. Installing Flex into Controller PCB

NOTE: 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 control head/TIB flex to control head/TIB. Be sure to properly align the connectors prior to connecting.

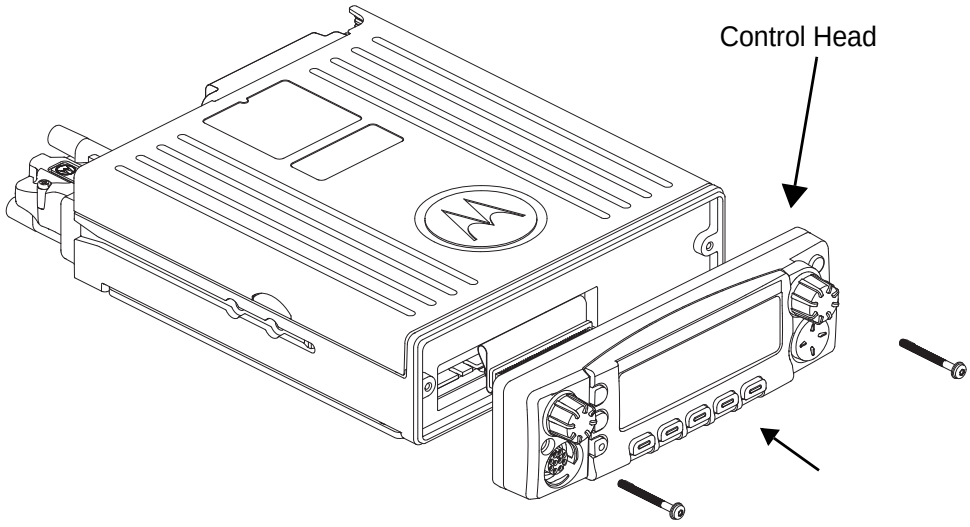


Figure 8-66. Installing Control Head/TIB Flex to Control Head/TIB

3. Align control head/TIB to front of chassis using the frame seal. Install two (2) control head/TIB screws. Be sure the control head/TIB screws each have one (1) washer and one (1) seal installed. Torque down control head/TIB screws to 8-10 in-lbf.

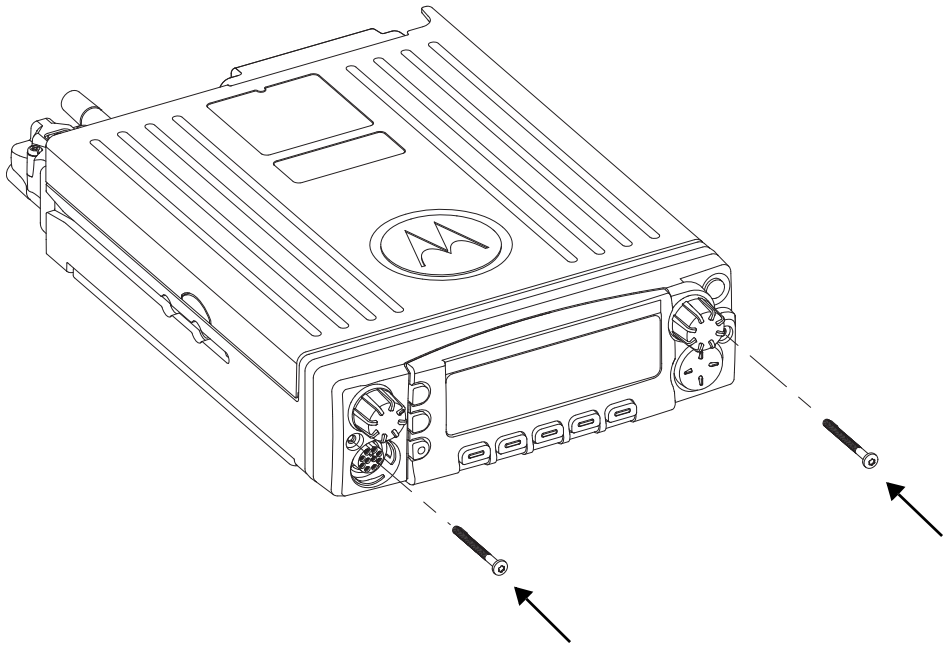


Figure 8-67. Aligning Control Head/TIB front of chassis, and Installing the Control Head/TIB screws

8.2.4.4 O7 Radio Reassembly

1. Reinstall the transceiver flex onto the control head or TIB flex onto the TIB connector.

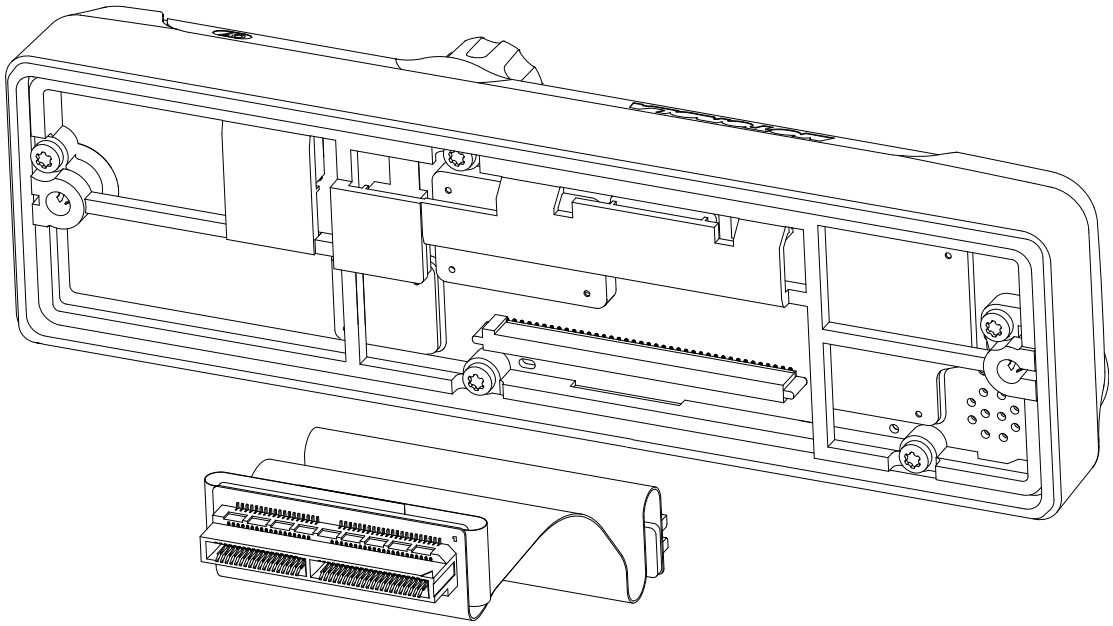


Figure 8-68. Installing the Transceiver Flex onto the Control Head

NOTE: 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 transceiver end of the transceiver flex and plug the flex into the 50-pin connector on main board side.
4. Align the control head with transceiver and push the control head into place on the transceiver.

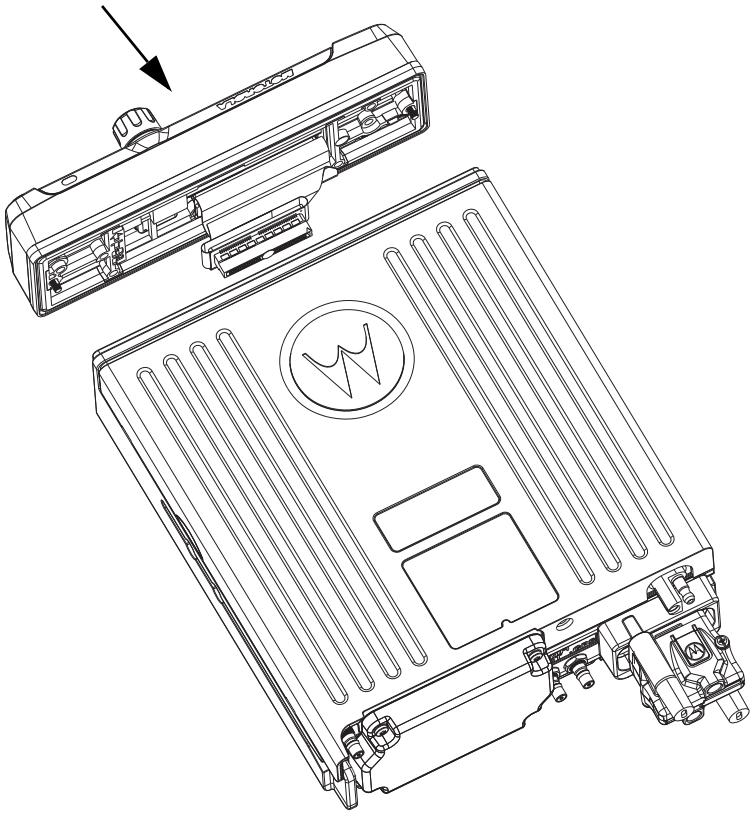


Figure 8-69. Attaching the Control Head to the Transceiver

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

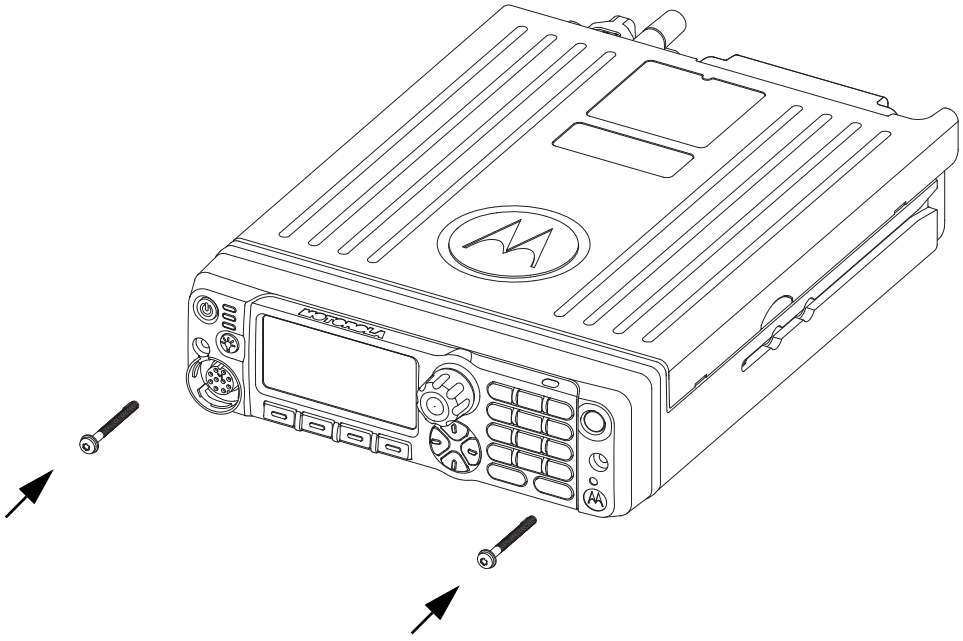


Figure 8-70. Attaching the Transceiver Screws

8.2.4.5 Remote Reassembly

1. Align Remote Front Cover Plate to front of chassis using the frame seal. Install two (2) control head screws. Be sure the control head screws each have one (1) washer and one (1) seal installed. Torque down control head screws to 8-10 in-lbf.

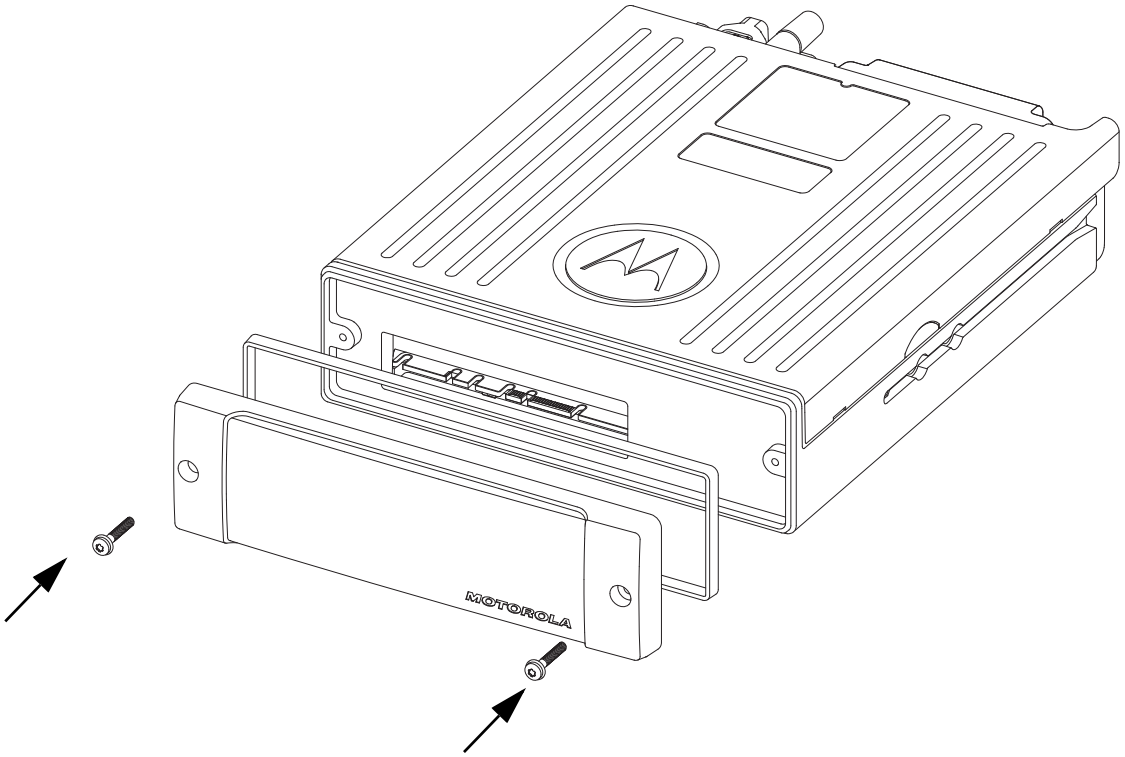


Figure 8-71. Reinstalling Remote Front Cover Plate

2. Install two (2) control head screws. Be sure the control head screws each have one (1) washer and one (1) seal installed. Torque down control head screws to 8-10 in-lbf.

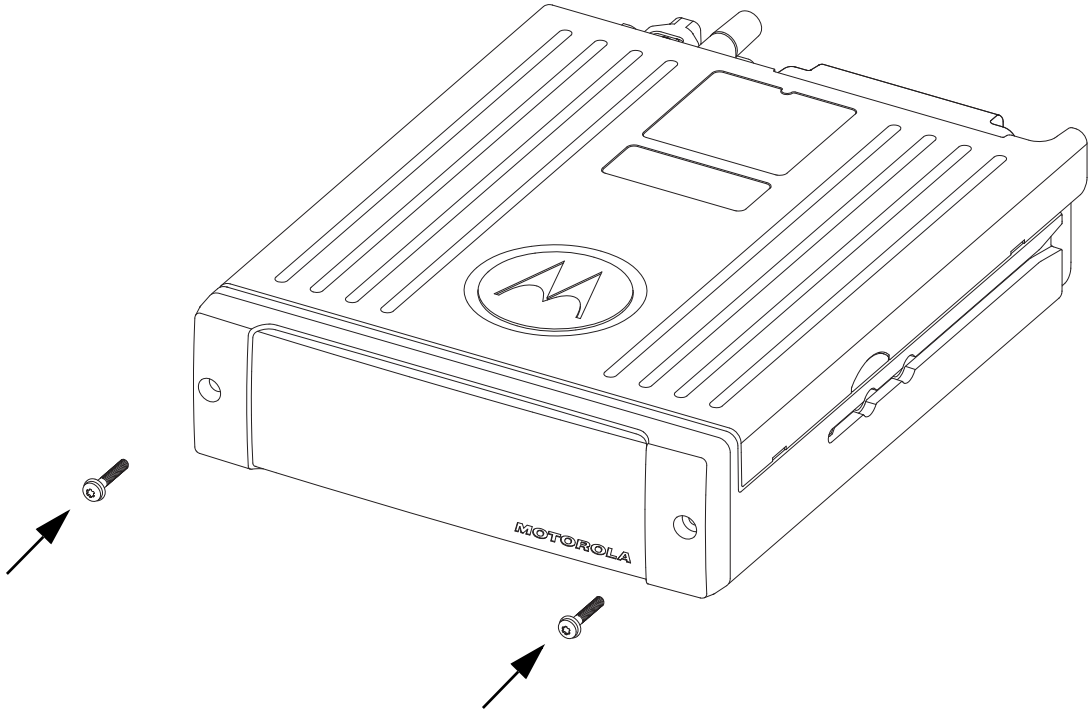
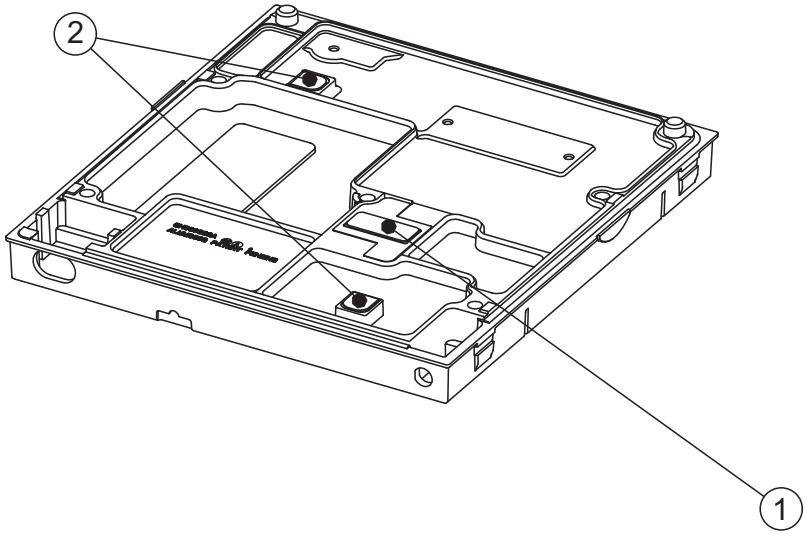
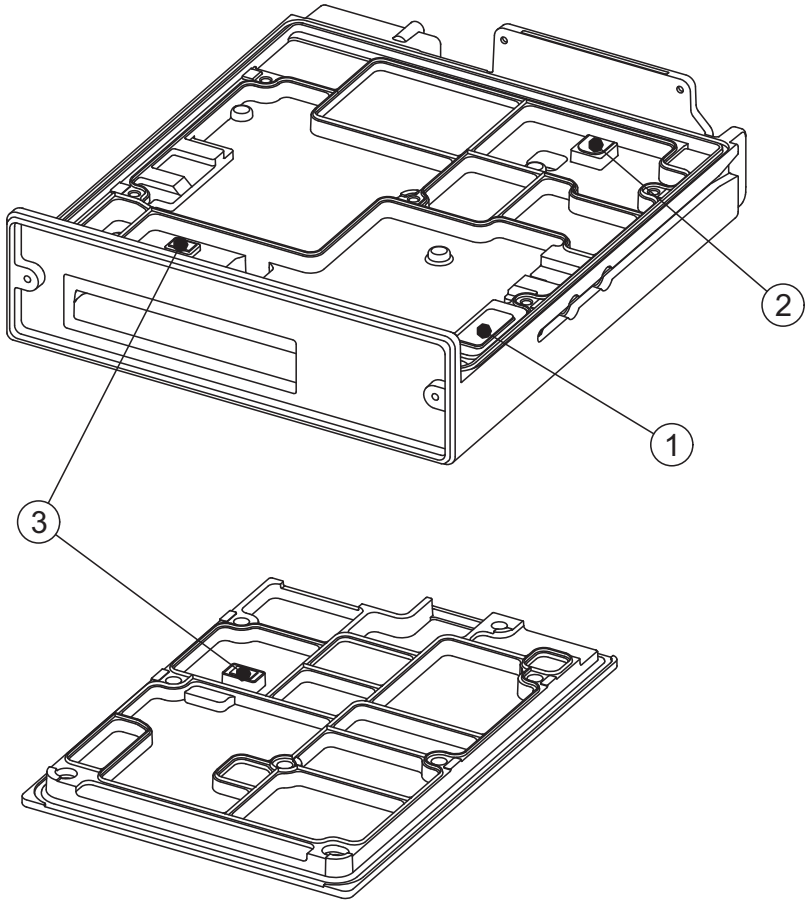


Figure 8-72. Attaching the remote screws

8.3 Chassis Thermal Pad Replacement Procedure

8.3.1 Mid Power Models





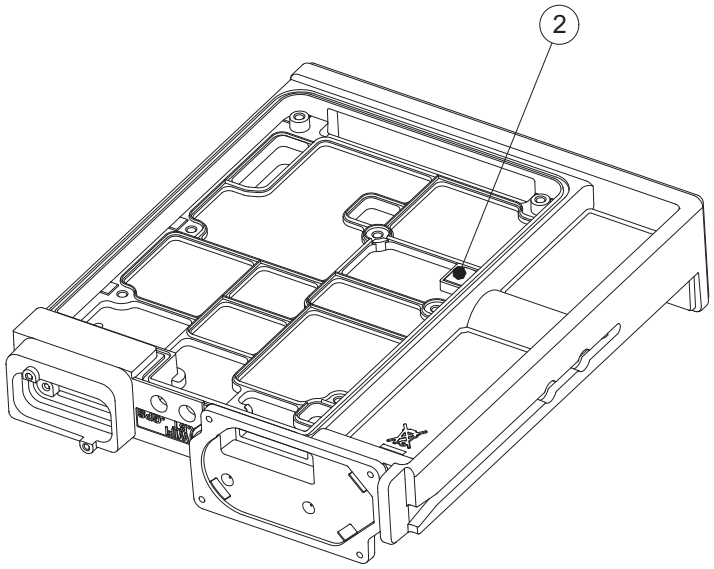


Figure 8-73. Chassis Thermal Pad and Grease Locations

Table 8-2. 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
4	1110022D23	Thermal Grease

Use the following procedures for replacing the chassis thermal pads. To replace the thermal pads:

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 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 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.

8.4 Fastener Torque Chart

Table 8-3 lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 8-3. 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

Notes

Chapter 9 Radio PINOUT functions, Error Codes, and Basic Troubleshooting

9.1 Introduction

This chapter contains pin-out information for the radio, error codes, and system level troubleshooting suggestions. 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 *APX Mobile Radios And O3, O5 & O9 Detailed Service Manual*. (See the "Related Publications" 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 the section, "Service Aids and Recommended Tools", for the appropriate Motorola Solutions service aids and tools parts numbers.)

Caution

With the exception of 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, it is still possible that equipment might be damaged by the radio's transmitter. This could occur under the following conditions: trunking-mode affiliation, missing emergency jumper, a defective PTT button, unintentional PTT activations, or circuit board malfunction. Therefore, an attenuator is always recommended.

9.2 Accessory Connectors

9.2.1 J700 TIB– Mobile Microphone Port (MMP)

The MMP connector is located on the O2,O7,O5 and O9 control heads and the transceiver interface board (TIB). Table 9-1 describes the name and function of each pin.

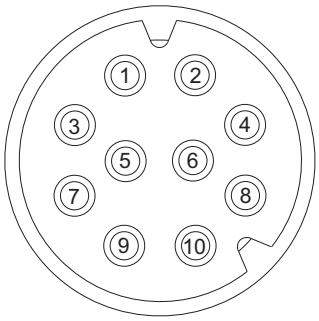


Figure 9-1. J700 MMP Connector

Table 9-1. MMP Connector Signal Descriptions

Pin #	Pin Name		Pin Function
	Control Head (J1)	TIB (J700)	
1	1-Wire ®	1-Wire ®	Signal used to identify 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 rear J2 MAP connector, which uses the AUX_MIC microphone input.
3	SPK	SPK	Receive audio out designed to drive a 150Ω 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 is the VBUS input used for enumeration. When the MMP port is configured as a host, this is the VBUS output, capable of sourcing 500mA.
7	MIC_HI	MIC_HI	Microphone audio input (80 mV rms 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 I/O 0.

9.2.2 J2 Mid Power Transceiver – Data and Audio Rear Interface

J2 (also known as the MAP interface) is located on the back of the transceiver. Table 9-2 describes the function of each pin. The Male crimping pin can be ordered, according to the wire gauge for the accessory. Please select part number 3980034F03 for 22-28 gauge wire and 3980034F01 for 18 to 20 gauge wire.

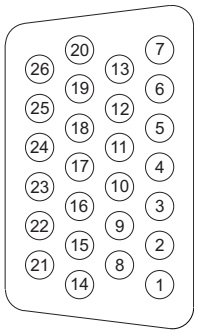


Figure 9-2. J2 Rear Accessory Connector

Table 9-2. 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+ / USB2+ /	SB9600 BUS+ / USB2+ /	Part of the Motorola Solutions SB9600 communications bus to connect external devices. Also used for USB host interface. Defaults to BUS+.
3	BUS- / USB2- /	SB9600 BUS- / USB2- /	Part of the Motorola Solutions SB9600 communications bus to connect external devices. Also used for USB host interface. Defaults to BUS-.
4	RS232_TX_9V	RS232 Transmit Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, etc.
5	RS232_RX_9V	RS232 Receive Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, etc.
6	USB-	USB - Data	Part of the 2-wire USB device differential data bus for connecting to items such as a PC (programming cable) or a modem.
7	USB+	USB + Data	Part of the 2-wire USB device differential data bus for connecting to items such as a PC (programming cable) or a modem.
8	RESET / USB2_VBUS_H /	SB9600 RESET / USB2_VBUS_HOST /	Part of the Motorola Solutions SB9600 communications bus to connect external devices. In USB Host mode, this signal is the 5V VBUS supply to a downstream device. Defaults to RESET.
9	BUSY	SB9600 BUSY	Part of the Motorola Solutions SB9600 communications bus to connect external devices.

Table 9-2. J2 Rear Accessory Connector Signal and Voltage Descriptions (Continued)

Pin #	Pin Name		Pin Function
10	RS232_RTS_9V / AUX_TX	RS232 Request-To-Send / AUX_TX	Part of the 4-wire RS232 interface to external data accessories. An output normally +9V no load. Also, formerly called 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 300mVrms
11	RS232_CTS_9V	RS232 Clear-To-Send	Part of the 4-wire RS232 interface to external data accessories. An input normally at +9V no load.
12	USB_VBUS_D	USB_VBUS_DEVICE	5V VBUS input for USB connectivity, supplied by the USB Host (i.e. a PC).
13	CHAN ACT	Channel Activity	Active low output used to indicate detection/unsquelching of a qualified received signal (idles at 5V). Can also 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 ground by a cable if emergency is disabled, even if disabled by CPS. If enabled, this line must be grounded via a switch, which is normally closed.
16	AUX PTT*	Push To Talk	Pulling this line to ground will activate PTT function normally selecting the AUX_MIC input.
17	ONE WIRE	1-Wire ® data	0-5V bidirectional data used for identification of smart accessories/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	High voltage open drain output used for enabling relays used for accessories such as horn/lights.
20	SPKR+	Speaker +	Used along with SPKR- to connect an external speaker. The audio PA is a bridge amplifier. Refer to Radio Specifications page for speaker impedances 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 are programmed by CPS. Output voltage is approximately 100 mVrms per 1kHz of deviation.
22	MONITOR	Monitor overrides PL	Active low input used to detect when a rear microphone accessory is taken 'off-hook', to over-ride PL to alert the user to busy traffic prior to transmitting (idles at 5V). Can also be configured as an optional logic input or output signal.
23	AUX MIC / MIC OUT	Rear microphone input / Microphone output	The nominal input level is 80mVrms for 60% deviation when used for motorcycle, but can also support 300 mVrms for future APCO accessories. The DC impedance is 1560 ohms and the AC impedance is 560 ohms, 1Vrms max. 9V DC with no input load. Alternatively, can be configured as a line level output of the microphone audio, for use in a siren (PA mode) or for an external recorder. The nominal amplitude is 75mV rms
24	SW B+	Switched Battery Voltage	A+ battery voltage is available when the radio is switched on. Used as supply for certain J2 accessories.

Table 9-2. J2 Rear Accessory Connector Signal and Voltage Descriptions (Continued)

Pin #	Pin Name		Pin Function
25	IGN sense (ACC)	Vehicle Ignition sense (ACC)	Connecting to the ACC line controlled by the vehicle's ignition switch will allow CPS ignition features such as “ignition required for turn on” to be used. Connecting this line to the car battery will defeat CPS ignition features.
26	SPKR-	Speaker -	Used along with SPKR+ to connect an external speaker. The audio PA is a bridge amplifier. Refer to Radio Specifications page for speaker impedances and loads.

9.2.3 J800 TIB – Controller Area Network (CAN) Interface

J800L and J800R are located on the transceiver interface board (TIB). These two connectors are identical, in order 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 transceiver communications. Please refer to the installation manual for ordering part numbers for various lengths of the CAN remote mount cables. Figure 9-3 illustrates the J800 connector while Table 9-3 describes the function of each pin.

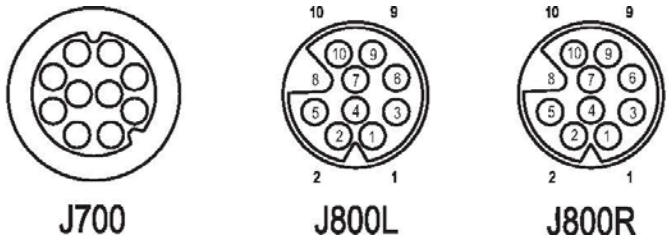


Figure 9-3. J800 Controller Area Network (CAN) Connector on TIB

Table 9-3. 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	
9	CAN_2_HIGH	TX+ (DATA)
10	CAN_2_LOW	TX- (DATA)

9.3 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 Appendix "Replacement Parts Ordering" for further information.

9.4 Power-Up Error Codes

When the radio is turned on (power-up), the radio performs cursory tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio's display. 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; non-fatal errors do not. Use the following tables to aid in understanding particular power-up error code displays.

Table 9-4. 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
01/81	Host ROM Checksum Fatal Error	Send radio to depot
01/82	FLASH ROM Codeplug Checksum Fatal Error	Reprogram the codeplug
01/88	External RAM Fatal Error **Note:** Not a checksum failure	Send radio to depot
01/90	General Hardware Failure Fatal Error	Turn the radio off, then on
01/92	Security Partition Checksum Fatal Error	Send radio to depot
01/93	FLASHport Authentication Code Failure	Send radio to depot
01/94	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 on
09/10	Secure Hardware Error	Turn the radio off, then on. May have keyload required in CPS for encryption
09/90	Secure Hardware Fatal Error	Turn the radio off, then on
15/10	External Accessory Non-Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.
15/90	External Accessory Fatal Error External Accessory is not present on power up or did not power up correctly, and external accessory feature is enabled in codeplug.	Verify external accessory is connected and powers up. Turn the radio off, then on.

9.5 Operational Error Codes

During radio operation, the radio performs dynamic tests to determine if the radio is working properly. Problems detected during these tests are presented as error codes on the radio's display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 9-5 to aid in understanding particular operational error codes.

Table 9-5. Operational Error Codes

Error Code	Description	Error Type	Corrective Action
FAIL 001	Synthesizer Out-of-Lock	NON-FATAL	1. Reprogram the codeplug. 2. Send radio to depot
FAIL 002	Personality checksum or system block error	NON-FATAL	Reprogram the codeplug.

9.6 Transmitter Troubleshooting

Table 9-6 can help you troubleshoot problems that might occur in the transmitter section of your radio.

Table 9-6. 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	Is the correct bandwidth selected (use the appropriate Customer programming software)? Is radio properly tuned? (See *Chapter 6: Radio Alignment Procedures*.)
	Compensation Not Set/ Working (DPL Distorted)	Check the compensation setting. If compensation won't adjust, go to "Can't Set Compensation" below.
	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 *Chapter 6: Radio Alignment Procedures*.)
	Microphone	Verify that the microphone is correctly plugged into the MMP connector. Replace if necessary. 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	Reprogram the codeplug or refer to the Detailed Service Manual. Send radio to depot for repair.

Table 9-6. Transmitter Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Can't 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 *Chapter 6: Radio Alignment Procedures*).
	Radio Transceiver Board	Refer to the Detailed Service Manual. Send radio to depot for repair.

9.7 Receiver Troubleshooting

Table 9-7 can help you troubleshoot problems that might occur in the receiver section of your radio.

Table 9-7. 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 powerup.
	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 1A 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 will not power-down	Radio Transceiver Board	Send radio to depot.
No Receiver Audio or Receive Does Not Unsquelch	Code Plug	Check the codeplug to ensure correct frequency and signaling (PL, DPL) is enabled (use the appropriate radio-programming software).
	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.

Table 9-7. Receiver Troubleshooting Chart (Continued)

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Audio Distorted or Not Loud Enough	Codeplug	Ensure the codeplug is properly configured, including bandwidth and signaling.
	Synthesizer Not On Frequency/Working	See "Reference Oscillator Alignment".
	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 "Reference Oscillator Alignment".
	Radio Transceiver	Refer to the Detailed Service Manual. Send radio to depot.
Radio Will 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.

9.8 Controller Troubleshooting

Table 9-8 can help you troubleshoot problems that might occur in the controller section of your radio.

Table 9-8. 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 all cables securely attached, including power to the radio transceiver.
	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 won't turn on	Incorrect codeplug setting for vehicle Ignition sense (ACC).	Reprogram the radio via CPS and refer to 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 transceiver.

Chapter 10 Functional Block Diagrams and Connectors

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

Table 10-1. Table of Functional Block Diagrams and Connectors

10.1 APX Mobile Radio Transceiver Functional Block Diagram

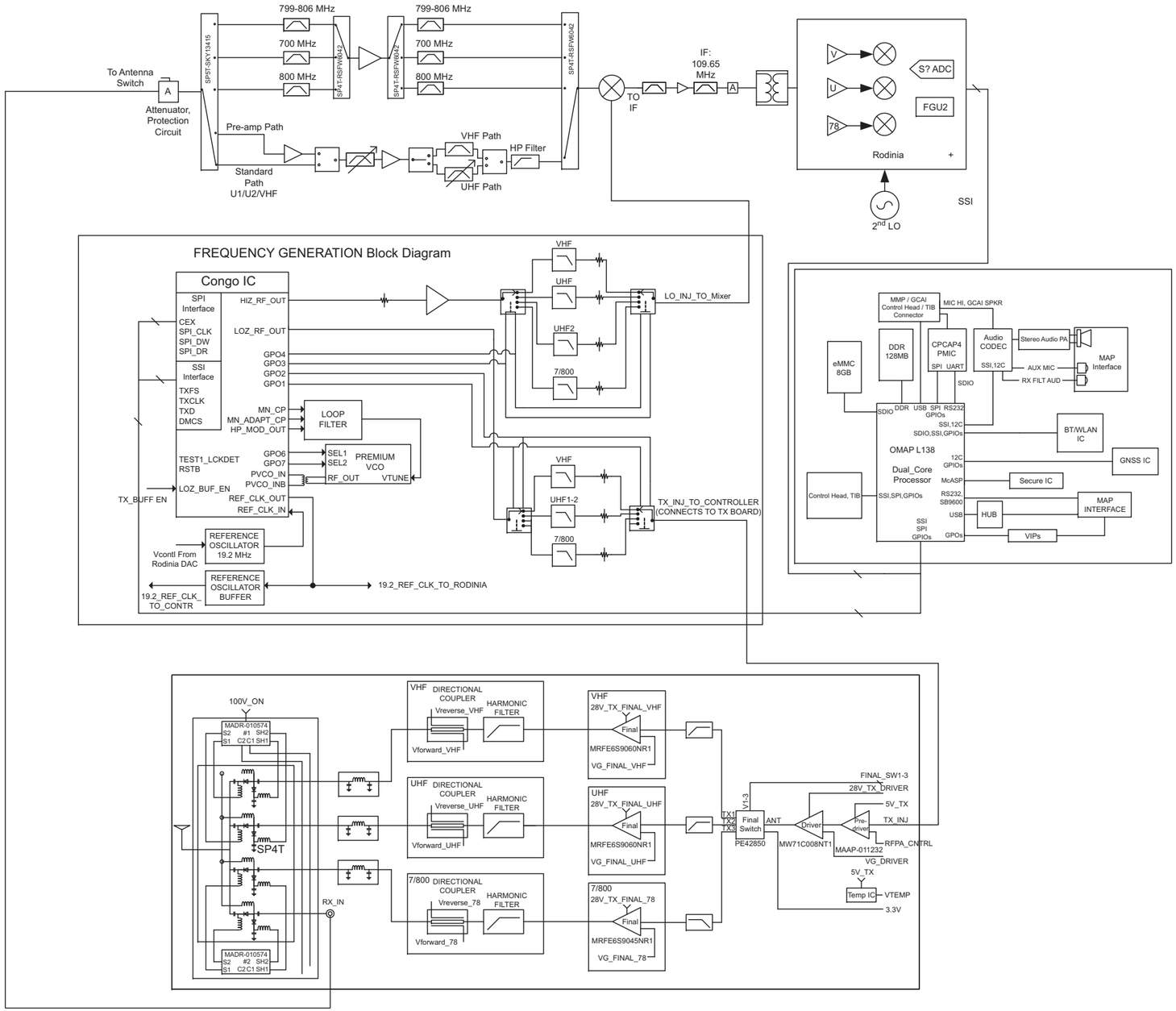


Figure 10-1. APX Mobile Radio Transceiver Functional Block Diagram

10.2 O3 Dash and Remote Control Head Functional Block Diagram

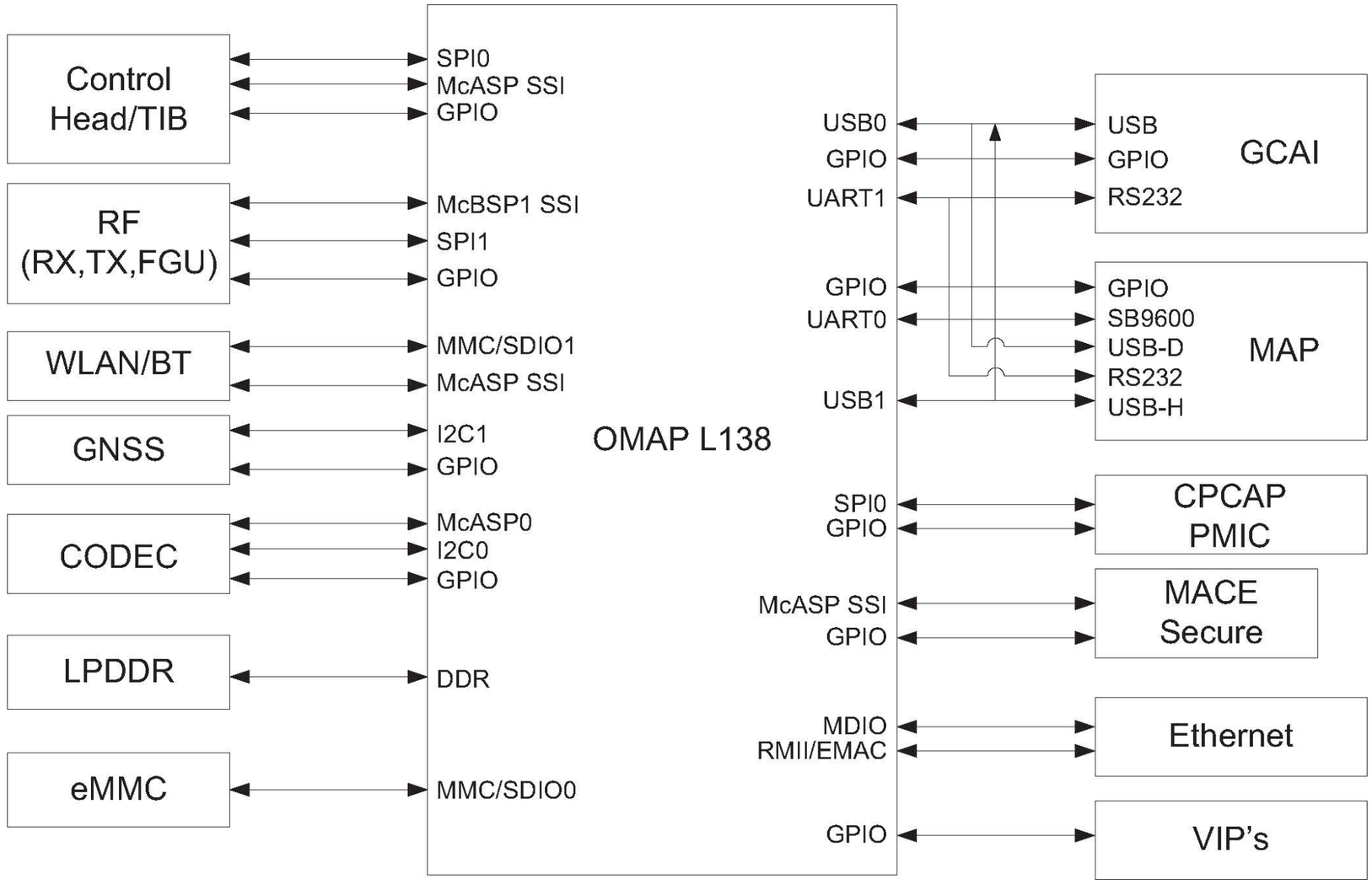


Figure 10-2. O3 Dash and Remote Control Head Functional Block Diagram

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

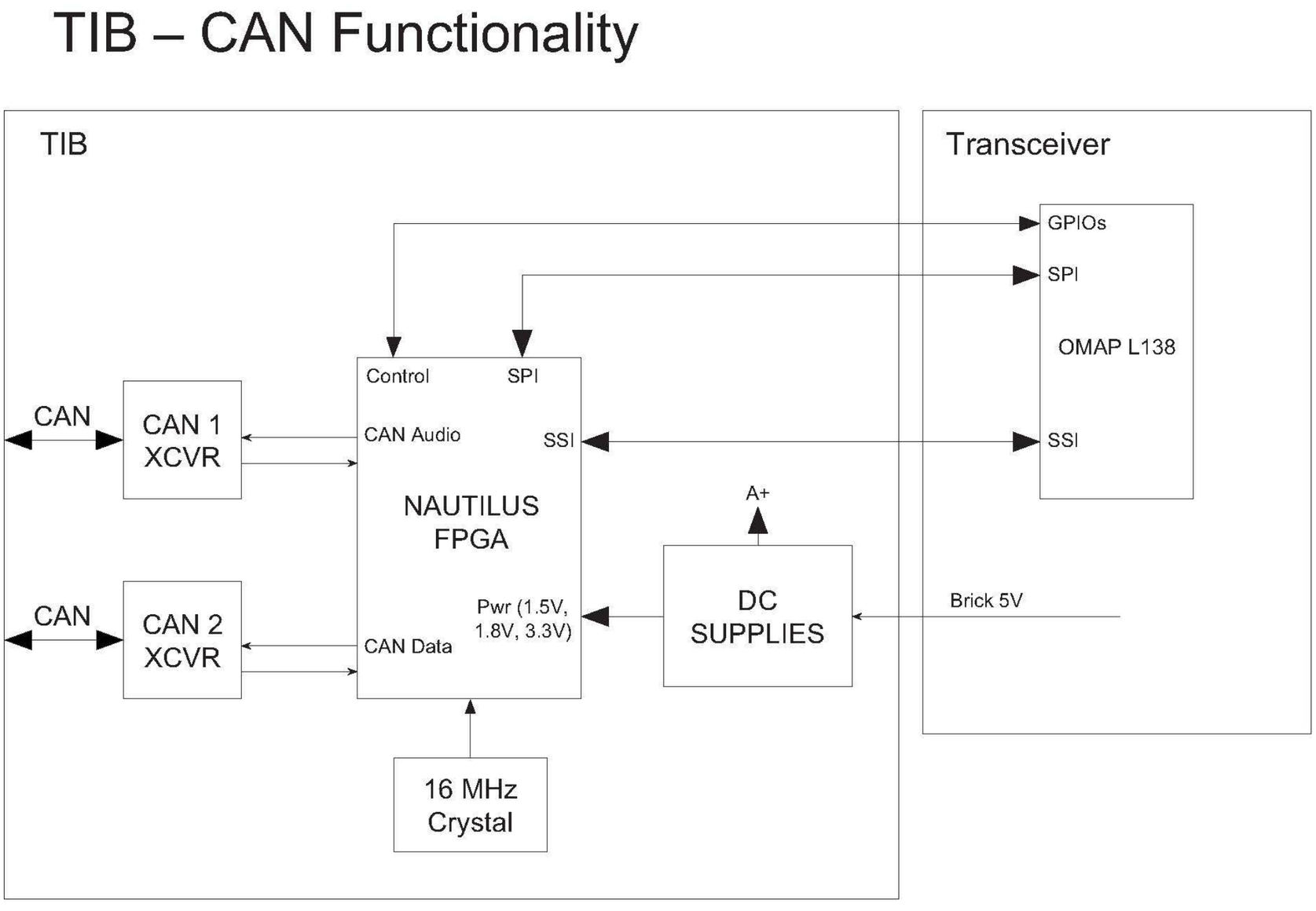


Figure 10-3. Transceiver Interface Board (TIB) CAN Functional Block Diagram

TIB – Power On/Off Functionality

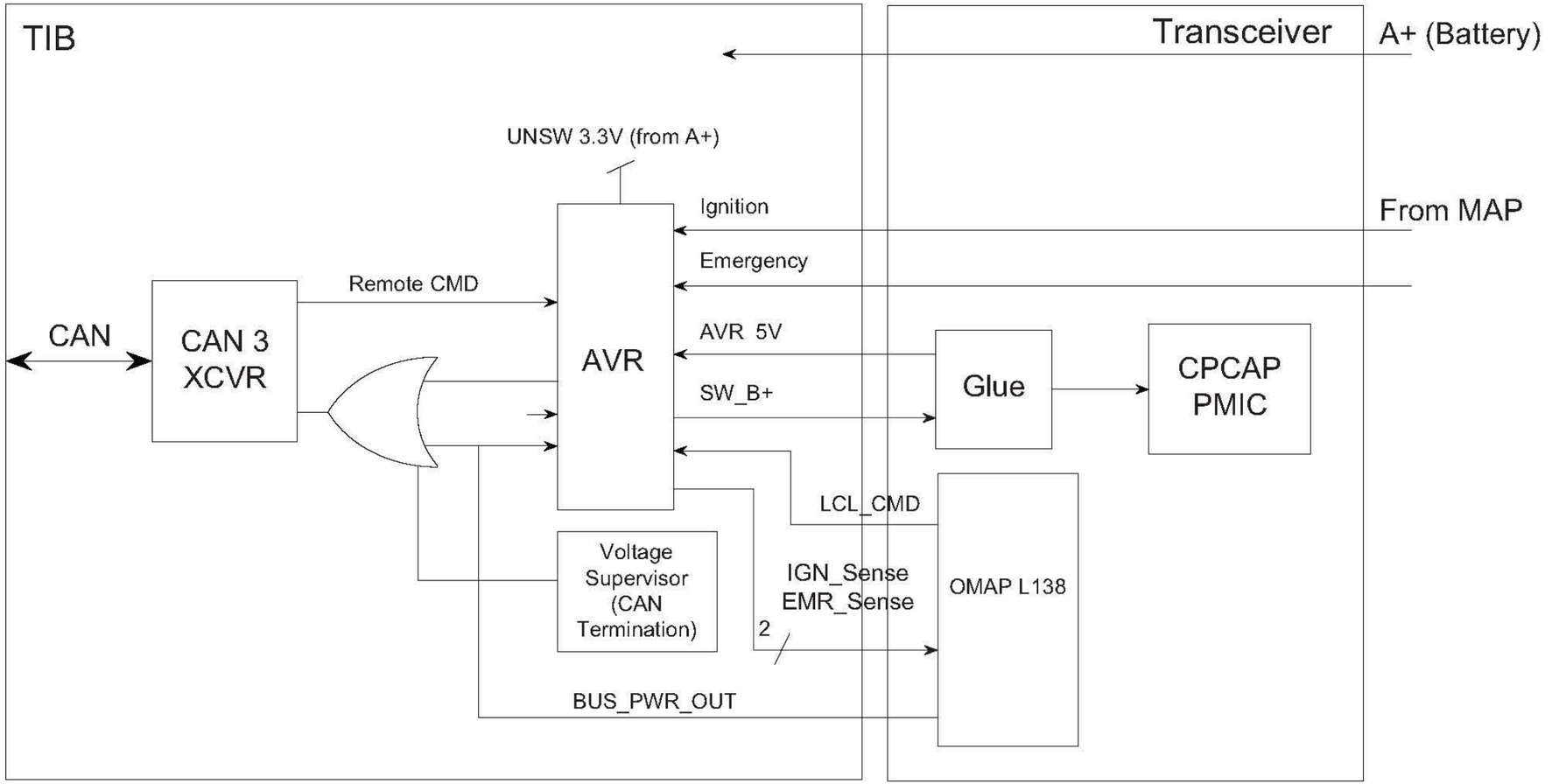


Figure 10-4. Transceiver Interface Board (TIB) Power On/Off Functional Block Diagram

10.4 O3 Radio Connector Locations

10.4.1 Mid Power Only

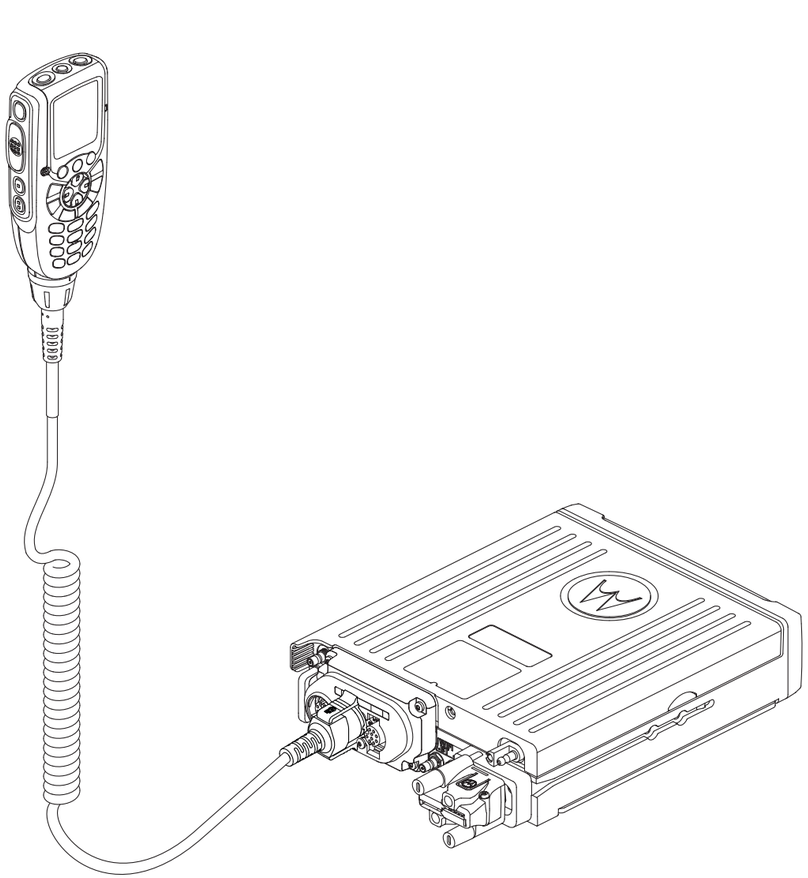


Figure 10-5. O3 Dash-Mount Radio Connector Locations (Mid Power Only)

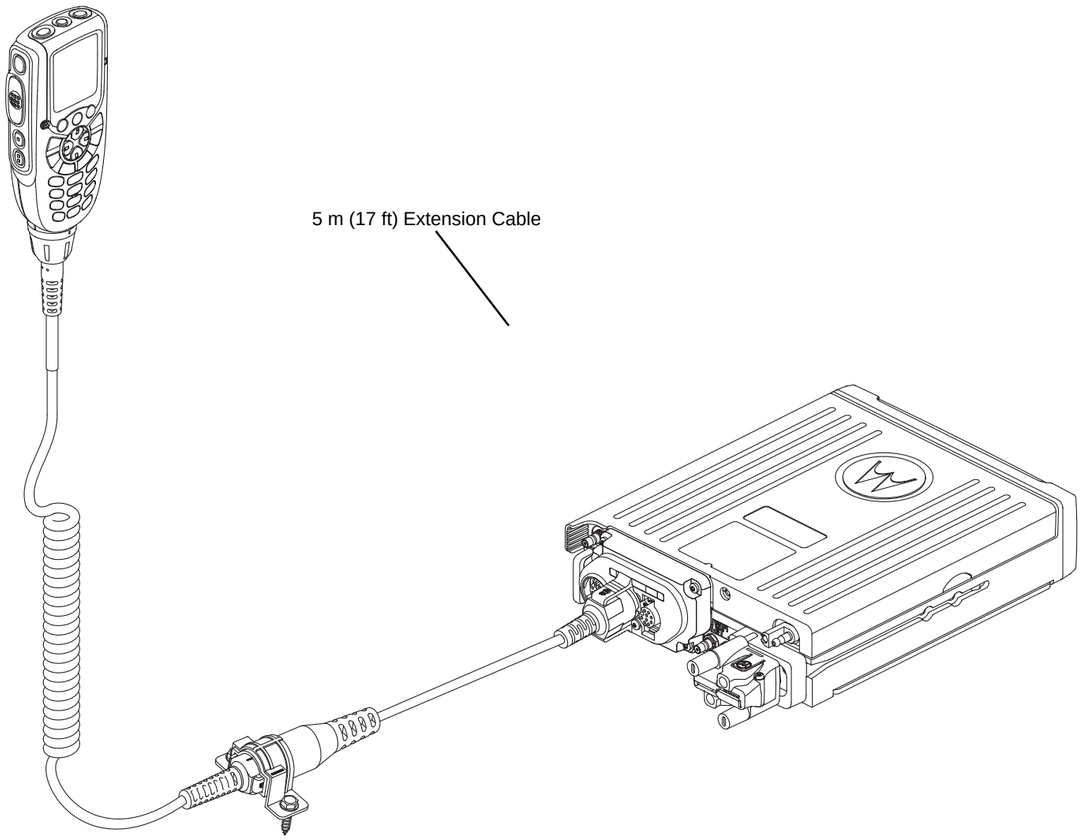


Figure 10-6. O3 Remote-Mount Radio Connector Locations

10.5 O5 Radio Connector Locations

10.5.1 Mid Power Only

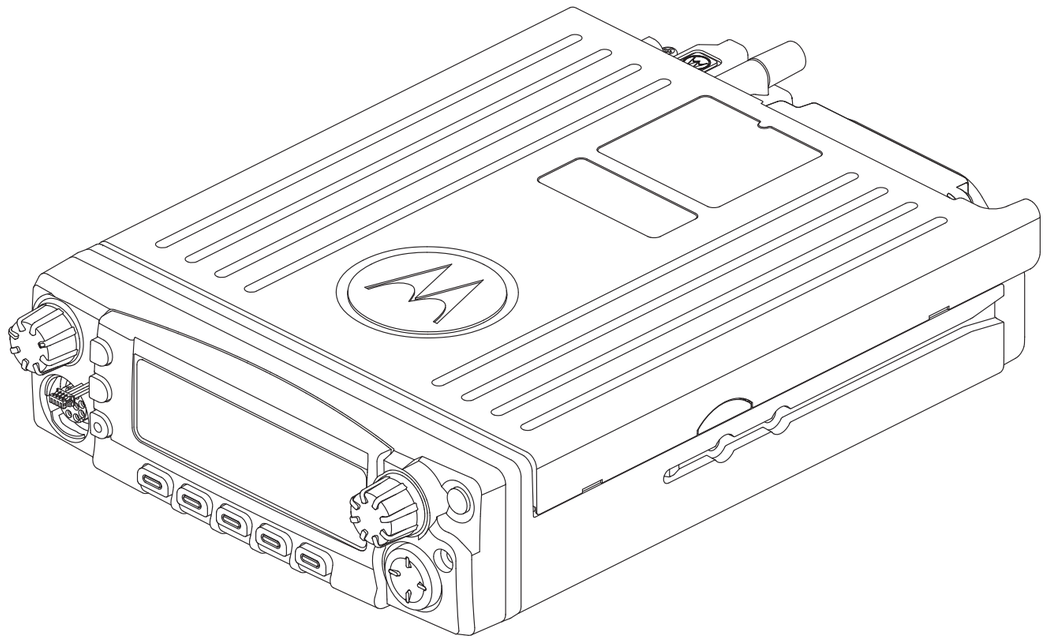


Figure 10-7. O5 Dash-Mount Radio Connector Locations (Mid Power Only)

10.5.2 High Power Only

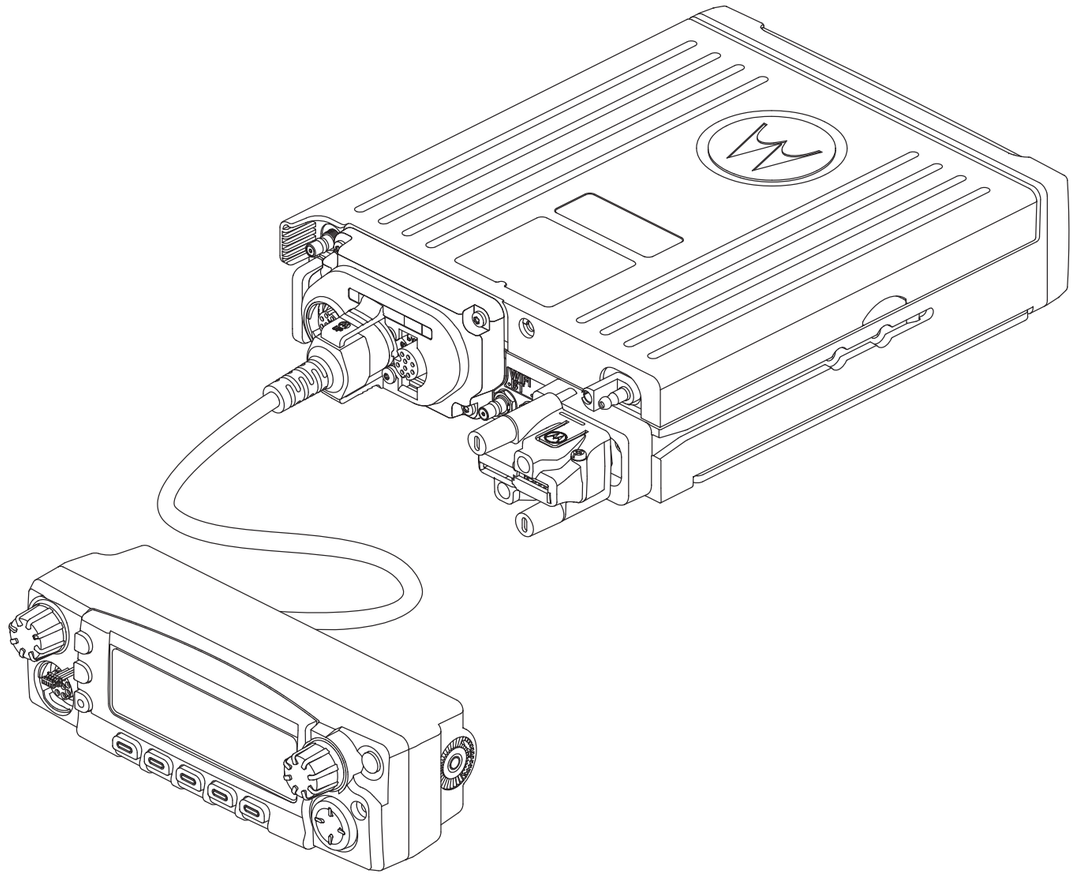


Figure 10-8. O5 Remote-Mount Radio Connector Locations (High Power Only)

10.6 O9 Transceiver Interface

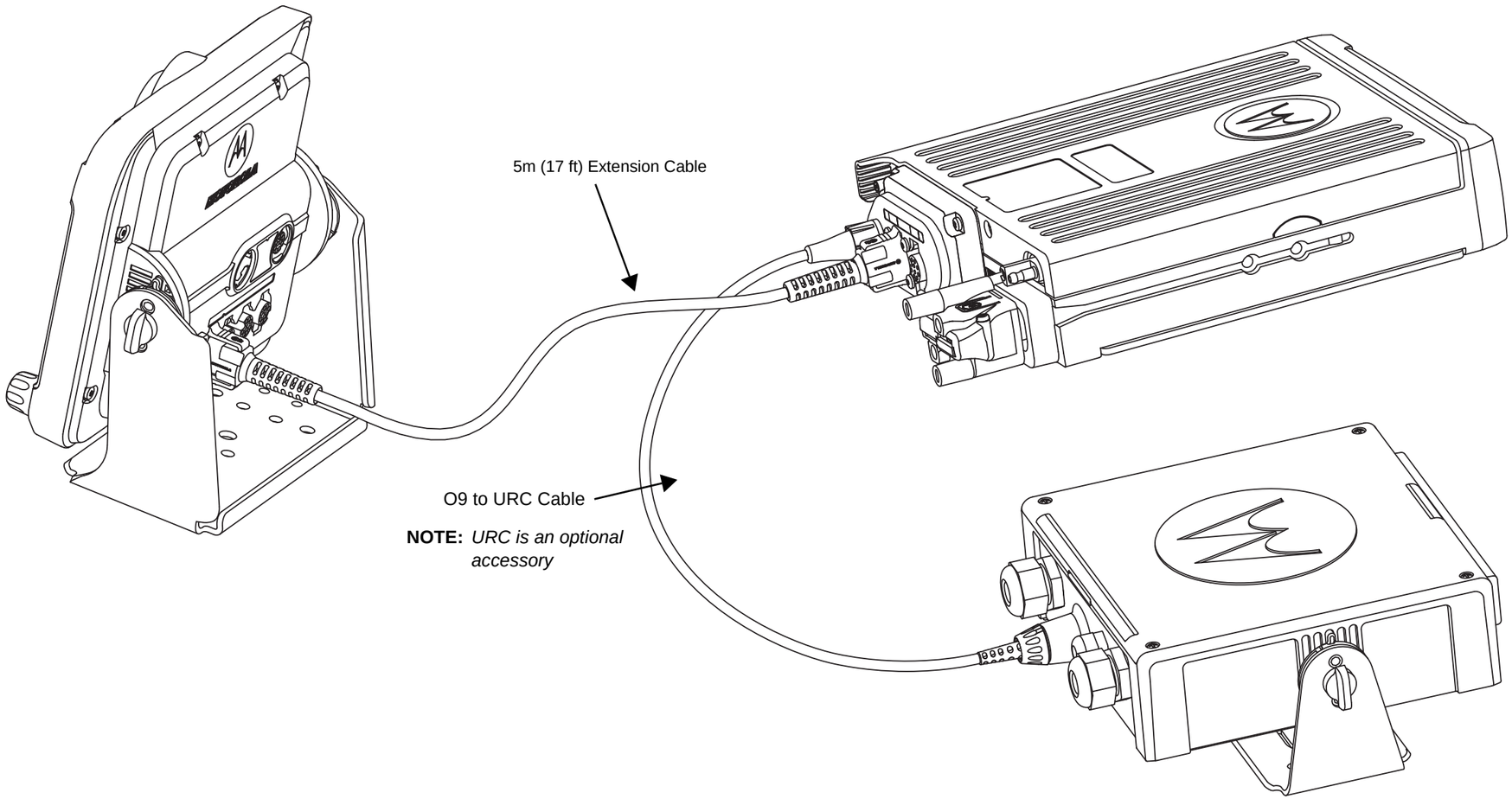


Figure 10-9. Transceiver Interface Board (TIB), Universal Relay Controller & Control Head View.

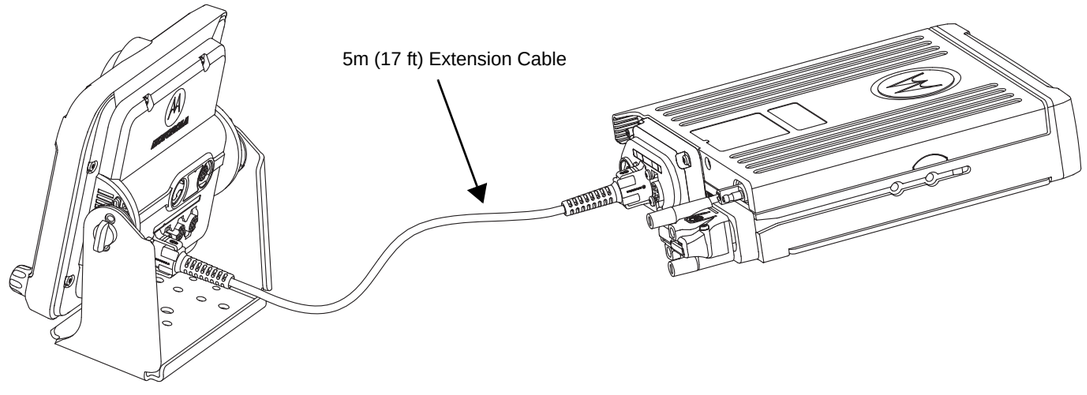


Figure 10-10. Remote-Mount Configuration with 100W or Higher Power Radio

Notes

Chapter 11 Exploded Views and Parts Lists

This chapter contains the exploded views and associated parts lists for the ASTRO APX Mobile radio and accessories. Tables containing pushbutton parts lists are also included at the end of this chapter.

Table 11-1. Table of Exploded Views

11.1 Remote Exploded View and Parts List

This illustration (Figure 11-1) represents the interface board for all remote mount configurations.

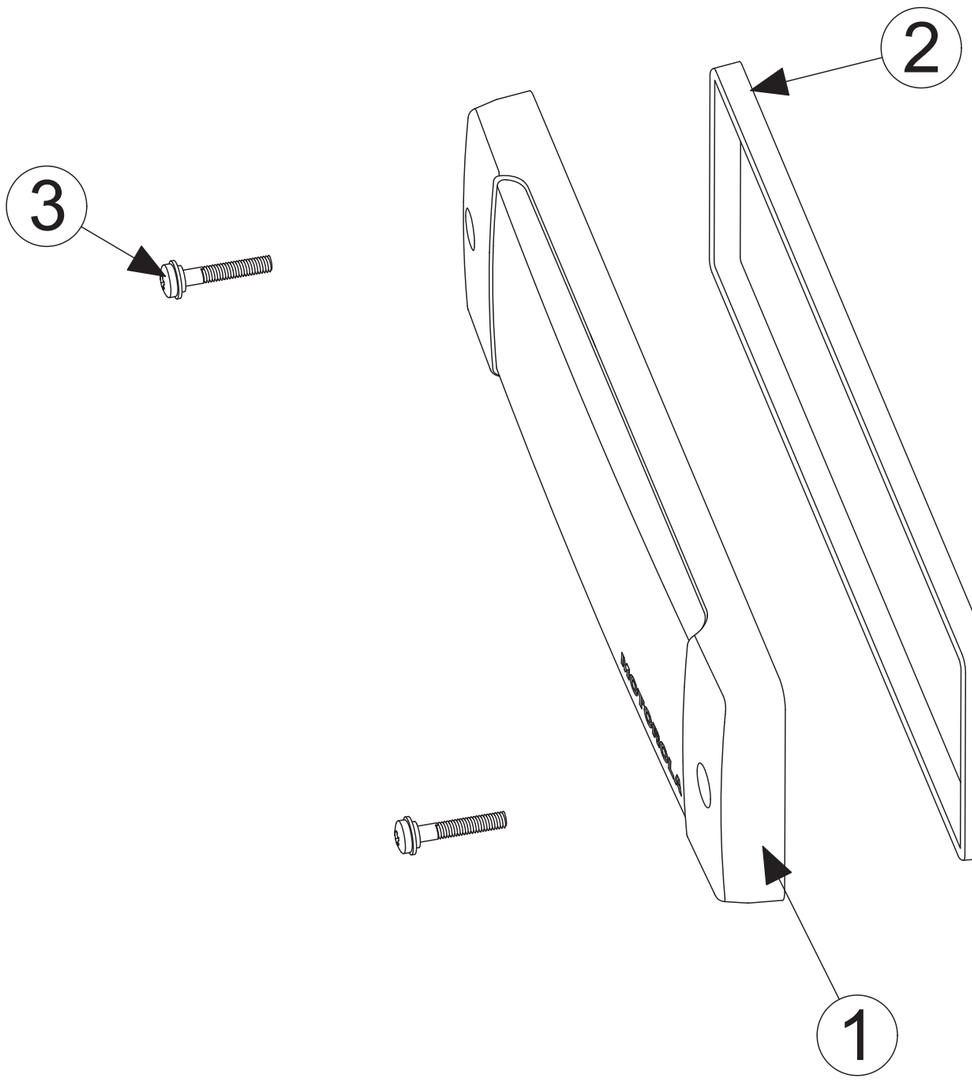


Figure 11-1. Remote Exploded View

Table 11-2. Remote 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 APX 8500 O2 Dash Mount Radio Exploded View and Parts List

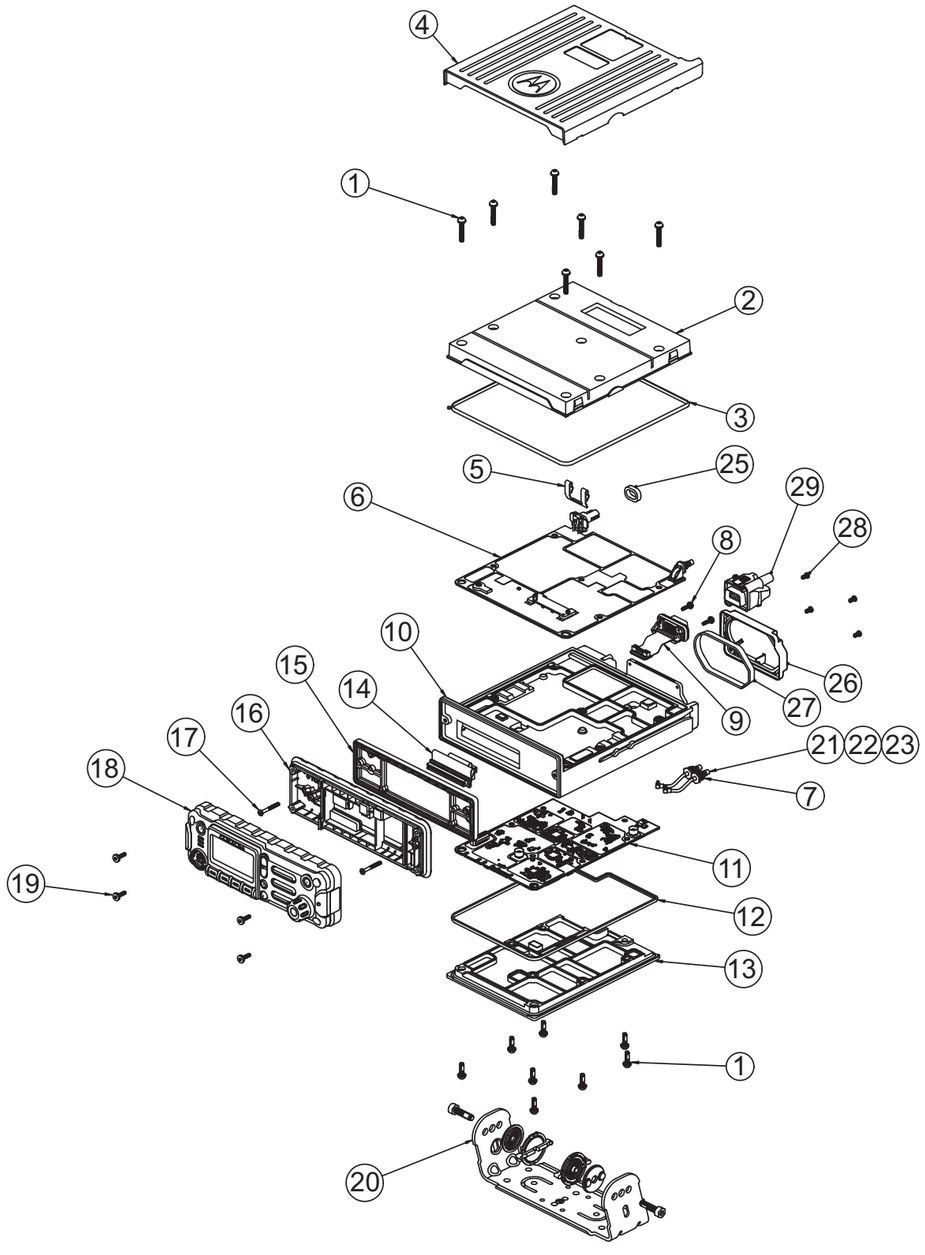


Figure 11-2. APX 8500 O2 Dash Mount Radio Exploded View

Table 11-3. 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	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 W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention * Option Board For APX Mobiles
11	PA000176A01	XCVR 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_ PMHN4195_	O2 Control Head Grey 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	03012052001	Screw, TIB
29	–	MAP accessory cables
30	–	FCC Label

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.

11.3 APX 8500 O3 Radio Exploded View and Parts List

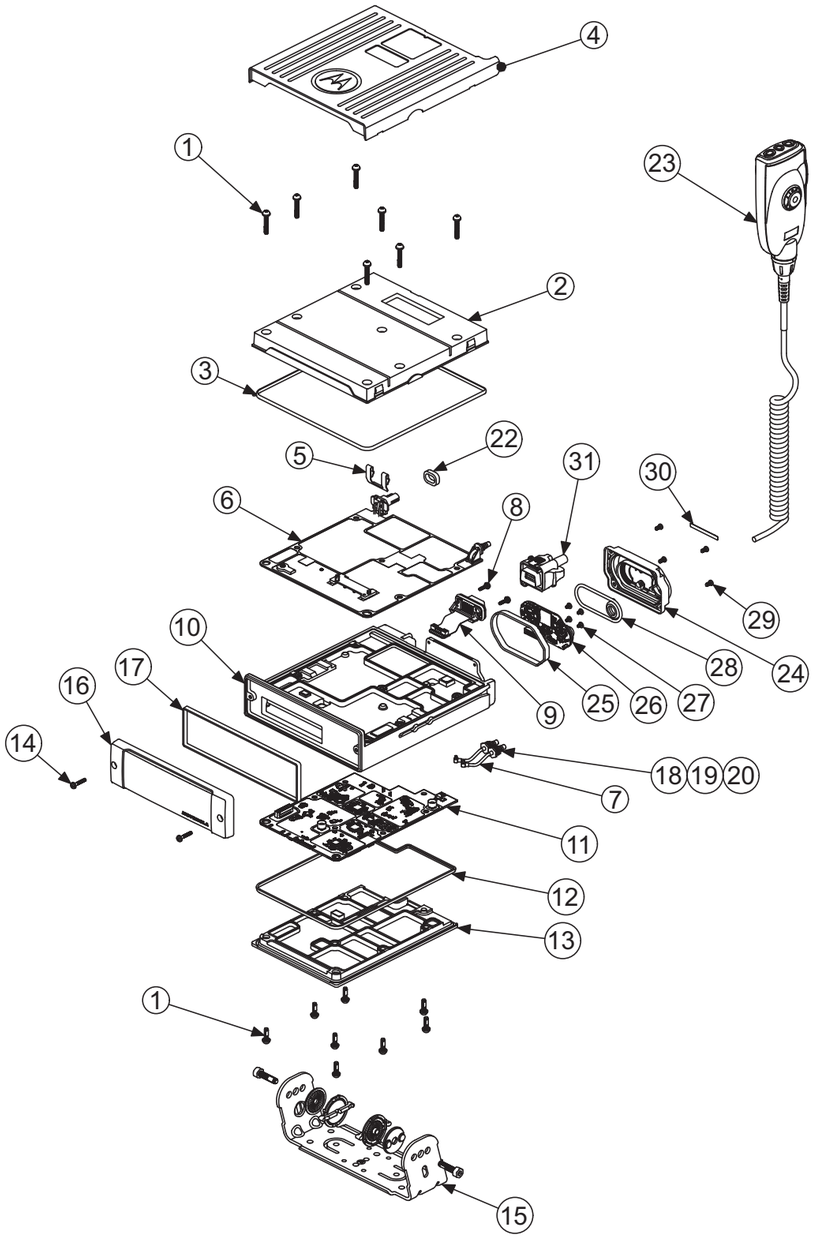


Figure 11-3. APX 8500 O3 Radio Exploded View

Table 11-4. 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	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 W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention * Option Board For APX Mobiles
11	PA000176A01	XCVR 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_ PMUN1052_ PMUN1053_ PMUN1054_ PMUN4227_	O3 Control Head (English) O3 Control Head (Hebrew) O3 Control Head (Cyrillic) O3 Control Head (Arabic) O3 Control Head (Siren & Lights)
24	HN000096A02	Cover, TIB, Remote
25	SL000048A01	Seal, TIB
26	PA000178A01	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

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 APX 8500 O5 Dash Mount Radio Exploded View and Parts List

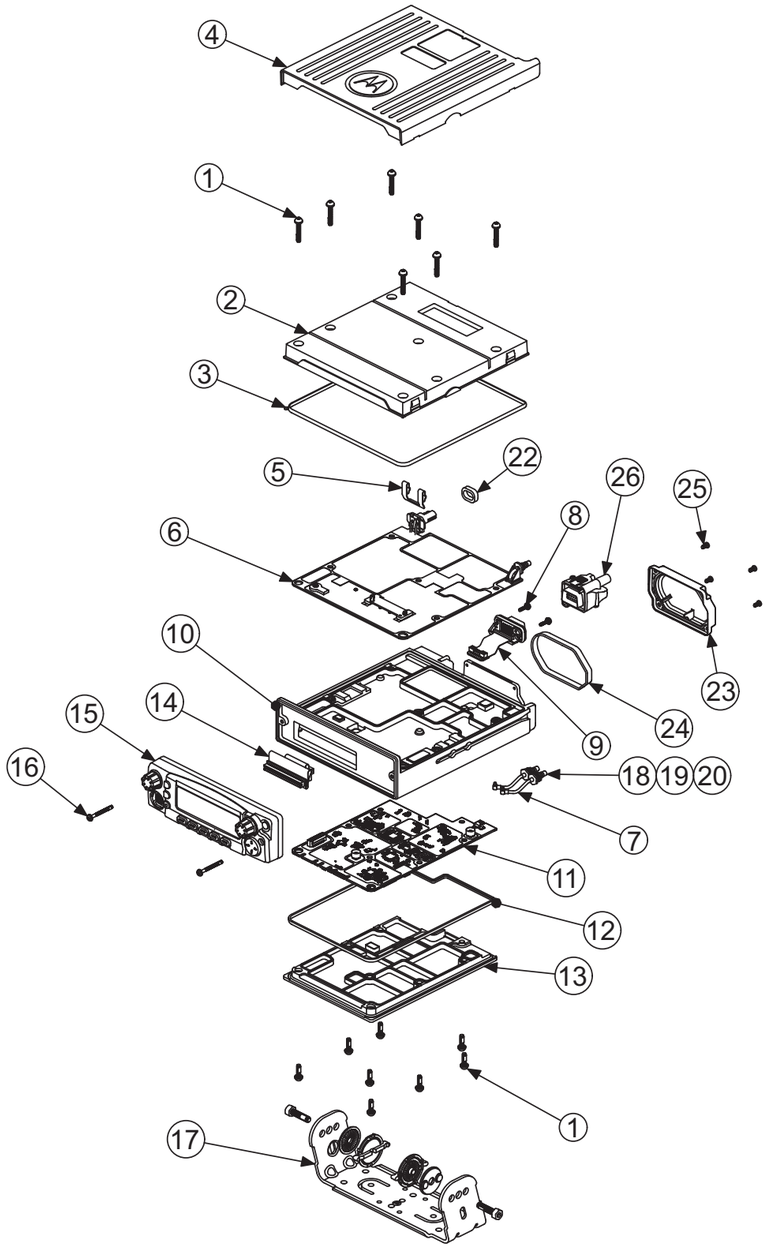


Figure 11-4. APX 8500 O5 Dash Mount Radio Exploded View

Table 11-5. 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	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 W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention * Option Board For APX Mobiles
11	PA000176A01	XCVR 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	03012052001	Screw, TIB
26	–	MAP accessory cables
27	–	FCC Label

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 APX 8500 O7 Dash Mount Radio Exploded View and Parts List

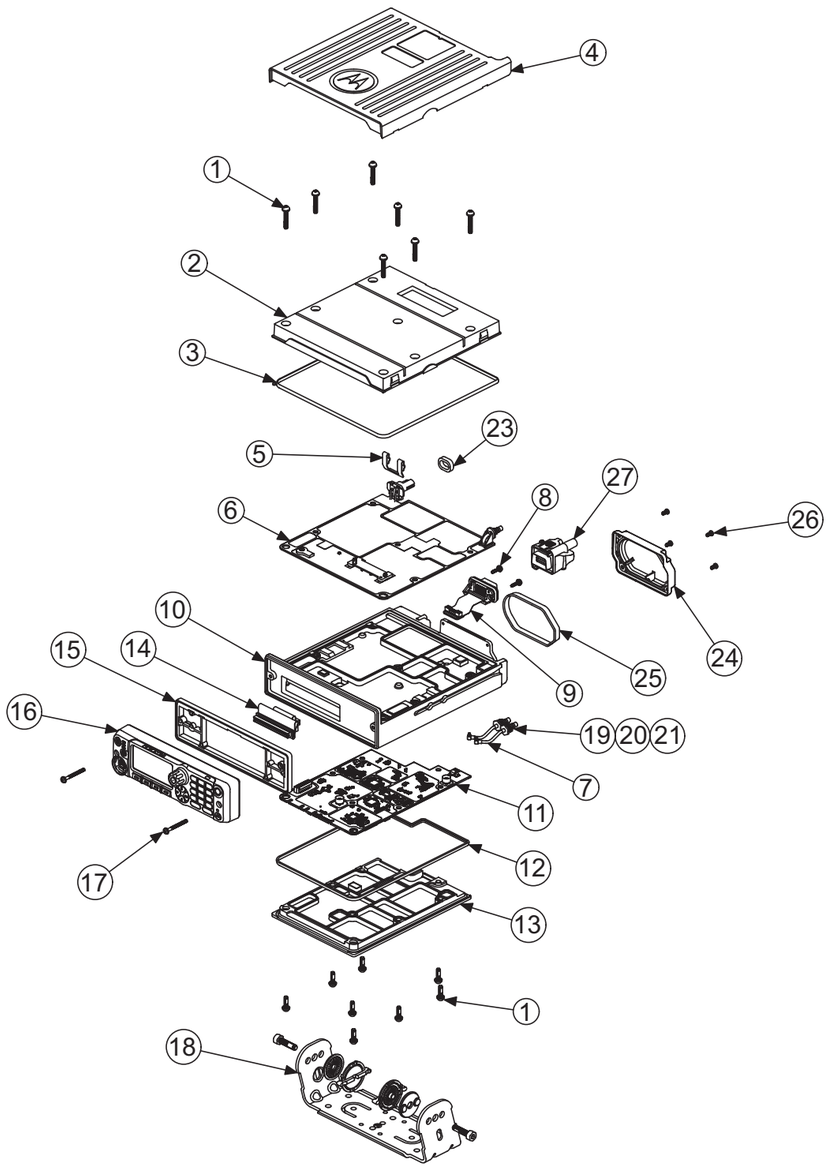


Figure 11-5. APX 8500 O7 Dash Mount Radio Exploded View

Table 11-6. 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	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 W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention * Option Board For APX Mobiles
11	PA000176A01	XCVR Board
12	SL000052A01	Seal, XCVR Cover
13	CH000033A02	Cover, XCVR W/Choform
14	PA001123A_	Dash Mount Flex Assembly
15	3264059H01	I-Seal
16	PMHN4194_ PMHN4192_ PMHN4197_ PMHN4196_ PMHN4191_ PMHN4229_	O7 Control Head English O7 Control Head English_Chinese O7 Control Head English_Cyrillic O7 Control Head English_Hebrew O7 Control Head Siren and Light 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
25	SL000048A01	Seal, TIB
26	03012052001	Screw, TIB
27	–	MAP accessory cables
28	–	FCC Label

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.

Appendix A Replacement Parts Ordering

A.1 Basic Ordering Information

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

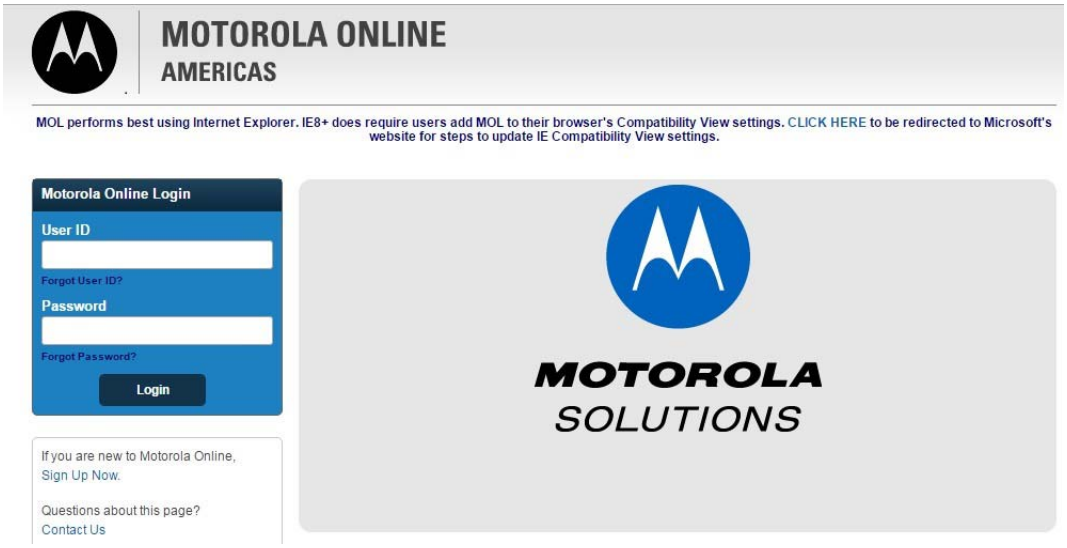
The ASTRO APX Mobile Radio Basic Service Manual includes complete parts lists and part numbers.

Refer to Table of Content for applicable manual numbers.

A.2 Motorola Online Service and Support

For general support, users can access

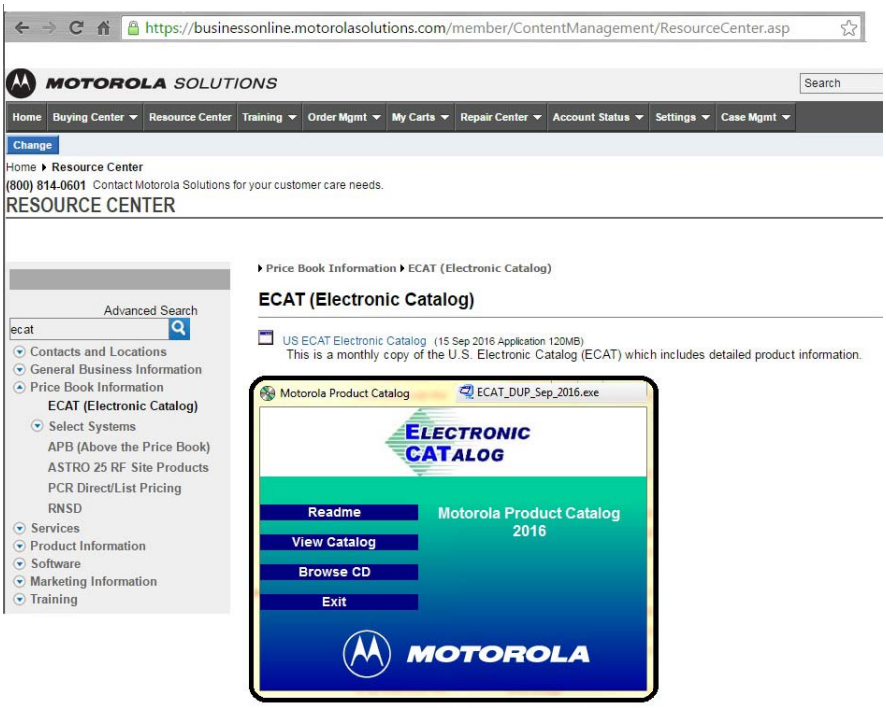
- http://www.motorolasolutions.com/en_us/support.html
- http://www.motorolasolutions.com/en_us/contact-us.html
- http://www.motorolasolutions.com/en_us/products/two-way-radios/project-25-radios/mobile-radios/apx8500.html
- Motorola Online Website: https://businessonline.motorolasolutions.com/



To register for online access:

- Domestic customers: please call 800-814-0601 (U.S. and Canada).
- International customers: please go to https://businessonline.motorolasolutions.com/ and click on “Sign Up Now.”

- ECAT



As a registered user, you have access to the electronic catalogue for purchasing accessories and radios.

A.3 Accessories Aftermarket Division (AAD)

The Accessories Aftermarket Division (AAD) is able to provide Motorola Solutions Branded accessories for all your radio needs. Contact Motorola Solutions after you have a KIT number, identified from the Motorola Online website and/or the ECAT catalog.
You can contact them at:800-422-4210.

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

For a complete list of Motorola-approved antennas, cables, and other accessories, visit the following web site: **http://www.motorolasolutions.com/en_us/products/two-way-radios/project-25-radios.html**

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 transceiver 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. Please contact Motorola Solutions at 1-888-567-7347 or your local sales representative for rebate
  programs and for the latest disassembly and recycling strategies.
- Please do not dispose of this product into a landfill.

Notes

Appendix C Maritime Radio Use in the VHF Frequency Range

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, e.g.:

   - *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
  - Semiduplex 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.

Channel Number	Frequency (MHz)	
	Transmit (Tx)	Receive (Rx)
1	156.050	160.650
2	156.100	160.700
*	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**	156.650	156.650
14	156.700	156.700
15**	156.750	156.750
16	156.800	156.800
17**	156.850	156.850

Channel Number	Frequency (MHz)	
	Transmit (Tx)	Receive (Rx)
18	156.900	161.500
19	156.950	161.550
20	157.000	161.600
*	157.050	161.650
22	157.100	161.700
*	157.050	161.650
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
*	156.075	160.675
62	156.125	160.725
63	156.175	160.775
*	156.225	160.825
65	156.275	160.875
66	156.325	160.925
67**	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	***	***
76	***	***
77**	156.875	–

Channel Number	Frequency (MHz)	
	Transmit (Tx)	Receive (Rx)
78	156.925	161.525
79	156.975	161.575
80	157.025	161.625
*	157.075	161.675
*	157.125	161.725
*	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

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

** Low power (1 W) only.

*** Guard band.

NOTE: A – in the Receive (Rx) column indicates that the channel is transmit (Tx) only.

Master Glossary

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

The **Doc** column is for information only and identifies the type of publication in which the term might be appropriately listed. The **Doc** codes are listed at the end of the glossary. Do not include the **Doc** column information in any other publications.

Term	Definition
A/D	*See analog-to-digital conversion.*
active channel	A channel that has traffic on it.
ACK	Acknowledgment of communication.
ADC	*See analog-to-digital converter.*
ALC	*See automatic level control.*
analog-to-digital conversion	Conversion of an instantaneous dc voltage level to a corresponding digital value. *See also D/A.*
analog-to-digital converter	A device that converts analog signals into digital data. *See also DAC.*
ASTRO 25 trunking	Motorola Solutions standard for wireless digital trunked communications.
ASTRO conventional	Motorola Solutions standard for wireless analog or digital conventional communications.
APCO 25	A standard of digital two-way radio communications, developed by the Association of Public-Safety Communications Officials, providing maximum radio spectrum efficiency; competition in system life cycle procurements; effective, efficient and reliable intra-agency and inter-agency communications; and “user friendly” equipment. *See also Association of Public-Safety Communications Officials.*
Association of Public-Safety Communications Officials	An association dedicated to an industry-wide effort (known as APCO 25 or Project 25) to set the recommended voluntary standards of uniform digital two-way radio technology for public safety organizations. This allows radio interoperability with multiple vendor products which are all APCO 25 compatible. *See also APCO 25.*
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.

Term	Definition
autoscan	A feature that allows the radio to automatically scan the members of a scan list.
band	Frequencies allowed for a specific purpose.
BBP	*See baseband interface port.*
baseband interface port	Synchronous serial interface to the transceiver board used to transfer transmit and receive audio data.
BGA	*See ball grid array.*
ball grid array	A type of IC package characterized by solder balls arranged in a grid that are located on the underside of the package.
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	Controller Area Network protocol. The CAN cable is the remote communications cable which provides audio, data, and power signaling information between the Control head and the Transceiver.
CHIB	Control Head Interface Board. Used to provide functionality / connectivity between the CHUC and control head.
CHUC	Control Head Universal Connector. A separate board which provides connectivity to the CHIB and control head.
CODEC	*See coder/decoder.*
coded squelch	Used on conventional channels to ensure that the receiver hears only those communications intended for the receiver.
coder/decoder	A device that encodes or decodes a signal.
control channel	In a trunking system, one of the channels that is used to provide a continuous, two-way/data-communications path between the central controller and all radios on the system.
conventional	Typically refers to radio-to-radio communications, sometimes through a repeater. Frequencies are shared with other users without the aid of a central controller to assign communications channels. *See also trunking.*

Term	Definition
conventional scan list	A scan list that includes only conventional channels.
CPS	*See Customer Programming Software.*
cursor	A visual tracking marker (a blinking line) that indicates a location on a display.
Customer Programming Software	Software with a graphical user interface containing the feature set of an ASTRO radio.
D/A	*See digital-to-analog conversion.*
DAC	*See digital-to-analog converter.*
deadlock	Displayed by the radio after three failed attempts to unlock the radio.The radio must be powered off and on prior to another attempt.
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. *See also A/D.*
digital-to-analog converter	A device that converts digital data into analog signals. *See also ADC.*
Digital Private-Line	A type of digital communications that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.
digital signal processor	A microcontroller specifically designed for performing the mathematics involved in manipulating analog information, such as sound, that has been converted into a digital form. DSP also implies the use of a data compression technique.
digital signal processor code	Object code executed by the Digital Signal Processor in an ASTRO subscriber radio. The DSP is responsible for computation-intensive tasks, such as decoding ASTRO signaling.
dispatcher	An individual who has radio-system management duties and responsibilities.
DPL	*See Digital Private-Line. See also PL.*
DSP	*See digital signal processor.*
DSP code	*See digital signal processor code.*

Term	Definition
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.
FGU	*See frequency generation unit.*
flash	A non-volatile memory device similar to an EEPROM. Flash memory can be erased and reprogrammed in blocks instead of one byte at a time.
FLASHcode	A 13-digit code which uniquely identifies the System Software Package and Software Revenue Options that are enabled in a particular subscriber radio. FLASHcodes are only applicable for radios which are upgradeable through the FLASHport process.
FLASHport	A Motorola Solutions term that describes the ability of a radio to change memory. Every FLASHport radio contains a FLASHport EEPROM or FLASH 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 master clock and other derived synchronization clocks that are distributed throughout the communication network.
FPGA	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.

Term	Definition
GNSS	Global Navigation Satellite System: Standard generic term for satellite navigation systems that provide geo-spatial positioning with global coverage. This term includes GPS, GLONASS, Galileo, Beidou and other regional systems. GNSS is a term used worldwide The advantage to having access to multiple satellites is accuracy, redundancy and availability at all times.
GPIO	*See General-Purpose Input/Output.*
GPS	Global Positioning System: U.S.A.'s Satellite based radio navigation system developed by the U.S. Department of Defense and operated by the U.S. Air Force, which consists of at least 24 operational satellites which fly in medium Earth orbit at an altitude of approximately 20,180 km. Each satellite circles the Earth twice a day. GPS provides Time and Location to anywhere on Earth, where there is an unobstructed line of sight to four or more GPS satellites. A GPS receiver triangulates its position using these satellites.
hang up	Disconnect.
home display	The first information display shown after a radio completes its self test.
host code	Object code executed by the host processor in an ASTRO subscriber radio. The host is responsible for control-oriented tasks such as decoding and responding to user inputs.
IC	*See integrated circuit.*
IF	Intermediate Frequency.
IMBE	A sub-band, voice-encoding algorithm used in ASTRO digital voice.
inbound signaling word	Data transmitted on the control channel from a subscriber unit to the central control unit.
integrated circuit	An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.
ISW	*See inbound signaling word.*
key-variable loader	A device used to load encryption keys into a radio.
kHz	*See kilohertz.*
kilohertz	One thousand cycles per second. Used especially as a radio-frequency unit.
KVL	*See key-variable loader.*
LED	*See light emitting diode.*
light emitting diode	An electronic device that lights up when electricity is passed through it.

Term	Definition
LO	See 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.
LSH	*See low-speed handshake.*
MAP	Mobile Accessory Port (26 pin Trapazoid). Used to connect accessories and programming cables to the radio
Master In Slave Out	SPI data line from a peripheral to the MCU.
Master Out Slave In	SPI data line from the MCU to a peripheral.
MCU	*See microcontroller unit.*
MDC	Motorola Digital Communications.
MDI	MCU/DSP Interface internal to the microprocessor IC.
menu entry	A software-activated feature shown at the bottom of the display. Selection of a feature is controlled by the programming of the buttons on the side of the radio.
MHz	*See Megahertz.*
Megahertz	One million cycles per second. Used especially as a radio-frequency unit.
microcontroller unit	Also written as µC. A microprocessor that contains RAM and ROM components, as well as communications and programming components and peripherals.
MISO	*See Master In Slave Out.*
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 slaving	A radio programmed to automatically provide the proper operation for a given selected mode.
monitoring	Used in conventional operation where the programmed monitor button is pressed to listen to another user who is active on a channel. This prevents one user from interfering with another user’s conversation.
MOSI	*See Master Out Slave In.*
multiplexer	An electronic device that combines several signals for transmission on some shared medium (e.g., a telephone wire).

Term	Definition
MUX	*See multiplexer.*
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.
O2	Mobile Control Head.
O3	Hand Held Control head for XTL 5000 and APX 5500 / 6500 / 7500 / 6500Li / 2500 radios.
O5	Mobile Control Head.
O7	Mobile Control Head.
O9	Mobile Control Head.
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.
OSW	*See outbound signaling word.*
OTAR	*See over-the-air rekeying.*
outbound signaling word	Data transmitted on the control channel from the central controller to the subscriber unit.
over-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.
PCIC	*See Power Control IC.*
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.
PL	*See private-line tone squelch.*
PLL	*See phase-locked loop.*

Term	Definition
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 (Conversatiion) Call	A feature that lets you have a private conversation with another radio user in the group.
PMR	*See Publication Manual Revision*
private-line tone squelch	A continuous sub-audible tone that is transmitted along with the carrier. *See also DPL.*
programmable	A radio control that can have a radio feature assigned to it.
Programmable Read-Only Memory	A memory chip on which data can be written only once. Once data has been written onto a PROM, it remains there forever.
programming cable	A cable that allows the CPS to communicate directly with the radio using RS232 or USB.
Project 25	*See APCO 25.*
PTT	*See Push-to-Talk.*
Publication Manual Revision	A publication that provides supplemental information for its parent publication before it is revised and reissued.
Push-to-Talk	The switch or button usually located on the left side of the radio which, when pressed, causes the radio to transmit. When the PTT is released, the unit returns to receive operation.
radio frequency	The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).
radio frequency power amplifier	Amplifier having one or more active devices to amplify radio signals.
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).

Term	Definition
repeater/talkaround	A conventional radio feature that permits communication through a receive/transmit facility, which re-transmits received signals in order to improve communication range and coverage.
RESET	Reset line: an input to the microcontroller that restarts execution.
RF	*See radio frequency.*
RF PA	*See radio frequency power amplifier.*
RPT/TA	*See repeater/talkaround.*
RS232	A common interface standard for data communications equipment.
RSSI	Received Signal Strength Indicator.
RTC	*See real-time clock.*
RX	Receive.
RX DATA	Recovered digital data line.
SAP	*See Serial Audio Port.*
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	A serial interface comprised of two data lines and a clock line. This interface is typically used to communicate with other modules and ICs in the radio.
signal	An electrically transmitted electromagnetic wave.
Signal Qualifier mode	An operating mode in which the radio is muted, but still continues to analyze receive data to determine RX signal type.
softpot	*See software potentiometer.*
software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
software potentiometer	A computer-adjustable electronic attenuator.
spectrum	Frequency range within which radiation has specific characteristics.
SPI	*See Serial Peripheral Interface.*

Term	Definition
squelch	Muting of audio circuits when received signal levels fall below a pre-determined value. With carrier squelch, all channel activity that exceeds the radio's preset squelch level can be heard.
SRAM	*See static RAM.*
SSI	*See Synchronous Serial Interface.*
Standby mode	An operating mode in which the radio is muted but still continues to monitor data.
static RAM	A type of memory used for volatile, program/data memory that does not need to be refreshed.
status calls	Pre-defined text messages that allow the user to send a conditional message without talking.
Synchronous Serial Interface	DSP interface to peripherals that consists of a clock signal line, a frame synchronization signal line, and a data line.
system central controllers	Main control unit of the trunked dispatch system; handles ISW and OSW messages to and from subscriber units *(See ISW and OSW)*.
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.
TIB	Transceiver Interface Board. Provides connectivity between transceiver and the CAN cable. Also, interface for accessories when TIB is used on a highpower transceiver.
time-out timer	A timer that limits the length of a transmission.
tone	A continuous, sub-audible tone transmitted with the carrier.
TOT	*See time-out timer.*
transceiver	Transmitter-receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
transmitter	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.

Term	Definition
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. *See also conventional.*
trunking priority monitor scan list	A scan list that includes talkgroups that are all from the same trunking system.
TSOP	*See thin small-outline package.*
TX	Transmit.
UART	*See Universal Asynchronous Receiver Transmitter.*
UHF	Ultra-High Frequency.
USK	Unique shadow key.
Universal Asynchronous Receiver Transmitter	A microchip with programming that controls a computer's interface to its attached serial devices.
UCM	Universal Crypto Module
Universal Serial Bus	An external bus standard that supports data transfer rates of 12 Mbps.
USB	*See Universal Serial Bus.*
VCO	*See voltage-controlled oscillator.*
VCOB IC	Voltage-Controlled Oscillator Buffer IC.
VHF	Very-High Frequency.
VIP	Vehicle Interface Port.
VOCON	*See vocoder/controller.*
vocoder	An electronic device for synthesizing speech by implementing a compression algorithm particular to voice. *See also voice encoder.*
vocoder/controller	A PC board that contains an ASTRO radio’s microcontroller, DSP, memory, audio and power functions, and interface support circuitry.

Term	Definition
voice encoder	The DSP-based system for digitally processing analog signals, and includes the capabilities of performing voice compression algorithms or voice encoding. *See also vocoder.*
voltage-controlled oscillator	An oscillator in which the frequency of oscillation can be varied by changing a control voltage.
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.

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Notes

Motorola Solutions, Inc.
1303 East Algonquin Road
Schaumburg, Illinois 60196 U.S.A.

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