MOTOTRBO™ REPEATER
XPR™ 8300/XPR™ 8400
PROFESSIONAL DIGITAL TWO-WAY RADIO SYSTEM

MOTOTRBO™ Repeater Basic Service & Installation Manual

JUNE 2017

6816810H01-KB

Notice

Foreword

This manual covers all models of the XPR™ 8300/XPR™ 8400 Repeater, unless otherwise specified. It includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, Motorola Solutions Authorized Dealers, self-maintained customers, and distributors.

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

Product Safety and RF Exposure Compliance

CAUTION: Before using this product, XPR™ 8300/XPR™ 8400 Repeater, read the RF Exposure and Safety guide that ships with the repeater which contains important operating instructions for safe usage and RF energy awareness and control for Compliance with applicable Standards and Regulations.

Computer Software Copyrights

The Motorola Solutions products described in this manual may include copyrighted Motorola Solutions computer programs stored in semiconductor memories or other media. Laws in the United States and other countries preserve for Motorola Solutions certain exclusive rights for copyrighted computer programs, including, but not limited to, the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Motorola Solutions computer programs contained in the Motorola Solutions products described in this manual may not be copied, reproduced, modified, reverse-engineered, or distributed in any manner without the express written permission of Motorola Solutions. Furthermore, the purchase of Motorola Solutions products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Motorola Solutions, except for the normal non-exclusive license to use that arises by operation of law in the sale of a product.

Document Copyrights

No duplication or distribution of this document or any portion thereof shall take place without the express written permission of Motorola Solutions. No part of this manual may be reproduced, distributed, or transmitted in any form or by any means, electronic or mechanical, for any purpose without the express written permission of Motorola Solutions.

Disclaimer

The information in this document is carefully examined, and is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies. Furthermore, Motorola Solutions reserves the right to make changes to any products herein to improve readability, function, or design. Motorola Solutions does not assume any liability arising out of the applications or use of any product or circuit described herein; nor does it cover any license under its patent rights nor the rights of others.

Trademarks

MOTOROLA, MOTO, MOTOROLA SOLUTIONS and the Stylized M logo are trademarks or registered trademarks of Motorola Trademark Holdings, LLC and are used under license. All other trademarks are the property of their respective owners.

Environmental Information

The environmental information pertains to the restrictions of hazardous substances and proper disposal of electronic equipment and its guidelines.

Material Content

This is to declare that Motorola Solutions products comply with the EU Directive 2011/65/EU (Restriction of Hazardous Substance or RoHS-2) and India RoHS, including applicable exemptions, with respect to the following substances:

- Lead (Pb) < 0.1% by weight (1000 ppm)
- Mercury (Hg) < 0.1% by weight (1000 ppm)
- Cadmium (Cd) < 0.01% by weight (100 ppm)
- Hexavalent Chromium (Cr6+) < 0.1% by weight (1000 ppm)
- Polybrominated Biphenyls (PBB) < 0.1% by weight (1000 ppm)
- Polybrominated Diphenyl Ethers (PBDE) < 0.1% by weight (1000 ppm

NOTICE:

- The Motorola Solutions MOTOTRBO system and its subsystems have been created in compliance with the environmental goals of the European Union's Restriction of Hazardous Substances (RoHS 2) Directive 2011/65/EU and the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU as well as Motorola Solutions corporate goals to minimize environmental impact of its products.
- This Motorola Solutions policy is reflected throughout the entire design, procurement, assembly, and packaging process.
- In support of these efforts to provide environmentally-responsible products, please comply with the information in the following sections regarding product disposal for systems being replaced.

Disposal of your Electronic and Electric Equipment

Do not dispose of electronic and electric equipment or electronic and electric accessories with your household waste.

In some countries or regions, collection systems have been set up to handle waste of electrical and electronic equipment.

In European Union countries, contact your local equipment supplier representative or service center for information about the waste collection system in your country.

Disposal Guidelines

The European Union's WEEE directive symbol on a Motorola Solutions product indicates that the product should not be disposed of with household waste.

This page intentionally left blank.

Document History

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

Edition	Description	Date
6816810H01-A	Initial Release.	Dec. 2006
6816810H01-B	Added VHF High Power Band Information.	June 2007
6816810H01-C	Added VHF Low Power and UHF Low Power Band Information.	Nov. 2007
6816810H01-D	Added 20 kHz information to Chapter 1 and UHF Band 2 models.	June 2008
6816810H01-E	Changed Channel Capacity from 1 to 16 for all bands in Section 1.9 Specifications. Changed Windows 2000/XP to Windows Vista/XP in Chapter 4, Sections 4.1 and 4.3 and added Repeater Alignment Procedure.	June 2009
6816810H01-F	Added statements “VHF/UHF Brick Version A Models” and “VHF/UHF Brick Version B Models” in related sections. Removed Repeater Alignment Procedure.	Sept. 2010
6816810H01-G	Added Appendix C, Digital Telephone Patch (DTP) Tuning Guideline.	May 2011
6816810H01-H	Added detailed process for replacing and initializing service kits for repeaters in Section 6.2 Replacement Service Kit Procedures.	June 2013
6816810H01-J	Added new Transmit Radio Service Kit PMTE4026_S to UHF2 Model Chart and PMTE4028_S to UHF1 HP Model Chart. Added new Receive Radio Service Kit PMTE4016_S to UHF2 Model Chart and PMTE4013_S to UHF1 HP Model Chart.	Mar. 2014
6816810H01-J	Added new frequency bandwidth for 350 MHz.	May 2014
6816810H01-KA	Added Auto Test and Tune.	Nov. 2016
6816810H01-KB	Changed Motorola to Motorola Solutions	June 2017

This page intentionally left blank.

Contents

List of Figures

List of Tables

This page intentionally left blank.

List of Procedures

Notations Used in This Manual

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

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

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

This page intentionally left blank.

Notice

Limited Commercial Warranty

This limited commercial warranty describes the conditions under, and period during, which the repeater is repaired, replaced, and what is not covered.

I. What This Warranty Covers And For How Long

MOTOROLA SOLUTIONS INC. (“MOTOROLA”) warrants the MOTOROLA 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:

Repeater	Two (2) Years
Product Accessories	One (1) Year

Motorola, 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.

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

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

II. General Provisions

This warranty sets forth the full extent of MOTOROLA's responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA's option, is the exclusive remedy. THIS WARRANTY IS 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 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 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 Motorola at 1-888-567-7347 US/Canada..

V. What This Warranty Does Not Cover

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

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

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

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

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

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

Freight costs to the repair depot.

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

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

Normal and customary wear and tear.

VI. Patent And Software Provisions

MOTOROLA 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 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:

- that MOTOROLA will be notified promptly in writing by such purchaser of any notice of such claim;
- that MOTOROLA will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and
- should the Product or parts become, or in MOTOROLA's opinion be likely to become, the subject of a claim of infringement of a United States patent, that such purchaser will permit MOTOROLA, 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.

MOTOROLA 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, nor will MOTOROLA have any liability for the use of ancillary equipment or software not furnished by MOTOROLA which is attached to or used in connection with the Product. The foregoing states the entire liability of MOTOROLA with respect to infringement of patents by the Product or any parts thereof.

Laws in the United States and other countries preserve for MOTOROLA certain exclusive rights for copyrighted MOTOROLA software such as the exclusive rights to reproduce in copies and distribute copies of such Motorola software. MOTOROLA software may be used in only the Product in which the

software was originally embodied and such software in such Product may not be replaced, copied, distributed, modified in any way, or used to produce any derivative thereof. No other use including, without limitation, alteration, modification, reproduction, distribution, or reverse engineering of such MOTOROLA software or exercise of rights in such MOTOROLA software is permitted. No license is granted by implication, estoppel or otherwise under MOTOROLA patent rights or copyrights.

VII. Governing Law

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

This page intentionally left blank.

Chapter 1

MOTOTRBO Repeater Introduction

1.1 MOTOTRBO Repeater Description

The XPR 8300/XPR 8400 repeater is available in the following frequency ranges and power levels.

Table 1: Frequency Ranges and Power Levels

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	1–25 Watt 25–45 Watt
UHF B1	403–470 MHz	1–25 Watt 25–40 Watts
UHF B2	450–512 MHz	1–40 Watts

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

1.2 MOTOTRBO Repeater Model Numbering Scheme

The MOTOTRBO™ Repeater model numbering scheme identifies the repeater model and the various options available.

Table 2: Portable Radio Model Numbering Scheme

Position		1	2	3	4	5	6	7	8	9	10	11	12
Typical Model Number	AA	M	2	7	Q	P	R	9	J	A	7	A	N

Table 3: Sales Models – Description of Symbols

Position	Description	Value
N/A	Region	AZ = Asia AA = North America (except Mexico) LA = Latin America MD = Europe/Middle East/Africa/Australasia
1	Type of Unit	M = Repeater
2	Model Series	23 = MOTOTRBO Repeater

Table continued…

Position	Description	Value
3		
4	Band	J = 136–174 MHz Q = 403–470 MHz T = 450–512 MHz
5	Power Level	N = 1-25 Watt R = 1-40 Watt P = 25-40 Watt Q = 25-45 Watt
6	Physical Packages	R = Repeater
7	Channel Spacing	9 = Variable/Programmable
8	Primary Operation	J = without GPS L = with GPS
9	Primary System Type	A = Conventional
10	Feature Level	1 = Mini-U 2 = BNC 7 = Rack Mount
11	Version Letter	N/A
12	Unique Variation	N = Standard Package

1.3 VHF High Power MOTOTRBO Repeater (136–174 MHz) Model Chart

The model chart displays the model number of the VHF High Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

VHF 136–174 MHz, 25–45 W			
Model			**Description**
AAM27JQR9JA7AN			136–174 MHz, 25–45 W, XPR 8300 8 MB Repeater
	AAM27JQR9JA7BN		136–174 MHz, 25–45 W, XPR 8400 32 MB Repeater
		Item	**Description**
	X	PMLN5269_S	Repeater Indicator Board
X	X	PMLN5644_S	Connector Board Assembly
	X	PMLN5643_S	Repeater Indicator Board
X		PMTD4001_S	Repeater XCVR Service Kit
	X	PMTD4007_S	Repeater XCVR Service Kit

Table continued…

VHF 136–174 MHz, 25–45 W			
Model			**Description**
X	X	PMPN4001_	Power Supply
X	X	3087791G01	120V Line Cord
X	X	6816814H01	XPR 8300/XPR 8380/XPR 8400 Installation Guide
X	X	6881095C99	Product Safety and RF Exposure Booklet

X = Item Included

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

1.4

VHF Low Power MOTOTRBO Repeater (136–174 MHz) Model Chart

The model chart displays the model number of the VHF Low Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

VHF 136–174 MHz, 1–25 W			
Model			**Description**
AAM27JNR9JA7AN			136–174 MHz, 1–25 W, XPR 8300 8 MB Repeater
	AAM27JNR9JA7BN		136–174 MHz, 1–25 W, XPR 8400 32 MB Repeater
		Item	**Description**
	X	PMLN5269_S	Repeater Indicator Board
X	X	PMLN5644_S	Connector Board Assembly
	X	PMLN5643_S	Repeater Indicator Board
X		PMTD4002_S	Repeater XCVR Service Kit
	X	PMTD4006_S	Repeater XCVR Service Kit
X	X	PMPN4001_	Power Supply
X	X	3087791G01	120V Line Cord
X	X	6816814H01	XPR 8300/XPR 8380/XPR 8400 Installation Guide
X	X	6881095C99	Product Safety and RF Exposure Booklet

X = Item Included

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

1.5 UHF1 High Power MOTOTRBO Repeater (403–470 MHz) Model Chart

The model chart displays the model number of the UHF1 High Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

UHF1 403–470 MHz, 25–40 W			
Model			**Description**
AAM27QPR9JA7AN			403–470 MHz, 25–40 W, XPR 8300 8 MB Repeater
	AAM27QPR9JA7BN		403–470 MHz, 25–40 W, XPR 8400 32 MB Repeater
		Item	**Description**
	X	PMLN5269_S	Repeater Indicator Board
X	X	PMLN5644_S	Connector Board Assembly
	X	PMLN5643_S	Repeater Indicator Board
X		PMTE4004_S	Repeater XCVR Service Kit
	X	PMTE4013_S	Repeater UHF1 RX Radio Service Kit
	X	PMTE4028_S	Repeater UHF1 TX Radio Service Kit
X	X	PMPN4001_	Power Supply
X	X	3087791G01	120V Line Cord
X	X	6816814H01	XPR 8300/XPR 8380/XPR 8400 Installation Guide
X	X	6881095C99	Product Safety and RF Exposure Booklet

X = Item Included

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

1.6 UHF1 Low Power MOTOTRBO Repeater (403–470 MHz) Model Chart

The model chart displays the model number of the UHF1 Low Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

UHF1 403–470 MHz, 1–25 W			
Model			**Description**
AAM27QNR9JA7AN			403–470 MHz, 1–25 W, XPR 8300 8 MB Repeater
	AAM27QNR9JA7BN		403–470 MHz, 1–25 W, XPR 8400 32 MB Repeater
		Item	**Description**
X		PMLN5269_S	Repeater Indicator Board
X	X	PMLN5644_S	Connector Board Assembly
	X	PMLN5643_S	Repeater Indicator Board

Table continued…

UHF1 403–470 MHz, 1–25 W			
Model			**Description**
X		PMTE4005_S	Repeater XCVR Service Kit
	X	PMTE4014_S	Repeater XCVR Service Kit
X	X	PMPN4001_	Power Supply
X	X	3087791G01	120V Line Cord
X	X	6816814H01	XPR 8300/XPR 8380/XPR 8400 Installation Guide
X	X	6881095C99	Product Safety and RF Exposure Booklet

X = Item Included

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

1.7

UHF2 High Power MOTOTRBO Repeater (450–512 MHz) Model Chart

The model chart displays the model number of the UHF2 High Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

UHF2 450–512 MHz, 1–40 W			
Model			**Description**
AAM27TRR9JA7AN			450–512 MHz, 1–40 W, XPR 8300 8 MB Repeater
	AAM27TRR9JA7BN		450–512 MHz, 1–40 W, XPR 8400 32 MB Repeater
		Item	**Description**
X		PMLN5269_S	Repeater Indicator Board
X	X	PMLN5644_S	Connector Board Assembly
	X	PMLN5643_S	Repeater Indicator Board
X		PMTE4006_S	Repeater XCVR Service Kit
	X	PMTE4016_S	Repeater UHF2 RX Radio Service Kit
	X	PMTE4026_S	Repeater UHF2 TX Radio Service Kit
X	X	PMPN4001_	Power Supply
X	X	3087791G01	120V Line Cord
X	X	6816814H01	XPR 8300/XPR 8380/XPR 8400 Installation Guide
X	X	6881095C99	Product Safety and RF Exposure Booklet

X = Item Included

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

1.8

350 MHz High Power (350–400 MHz) Model Chart

The model chart displays the model number of the 350 MHz High Power Repeater and the operating Radio Frequencies (RF), output wattage, and additional kits supplied.

350–400 MHz, 25–40 W	
Model	**Description**
AZM27PPR9JA7AN	350–400 MHz, 25–40 W, MOTOTRBO Repeater
Item	**Description**
X PMUD2550_	XiR R8200 350 25–40 W, Repeater
X PMHN4064_	Housing Kit
X PMGN4003_	Front Panel
X PMLN5644_S	Connector Board Assembly
X PMLN5643_S	Repeater Indicator Board
X PMTD4005_S	Repeater XCVR Service Kit
X PMKN4009_	Internal Cable Kit
X PMPN4001_	Power Supply
X PMBN4076_	Packaging Kit
X NTN7373_R	US Line Cord
X NTN7374_R	Euro Line Cord
X NTN7375_R	UK Line Cord

Repeater XCVR Service Kit refers to Transmitter / Receiver Brick.

X = Item Included

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

350–400 MHz, 25–40 W	
Model	**Description**
	350–400 MHz, 25–40 W, MOTOTRBO Repeater
Item	**Description**
X PMLN5643_S	Repeater Indicator Board
X PMLN5644_S	Connector Board Assembly
X PMTD4005_S	Repeater XCVR Service Kit
X PMPN4001_	Power Supply
X 3087791G01	120V Line Cord
X HKLN4344_	User Guide CD

X = Item Included

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

1.9
Specifications

The following contains the MOTOTRBO™ Repeater Radio Frequency (RF) operating specifications.

General				
Specification	**VHF**	**UHF1**	**UHF2**	**350 MHz**
Channel Capacity	16			
Technical RF Output Low Power High Power	1–25 W 25–45 W	1–25 W 25–40 W	– 1–40 W	– 25–40 W
Frequency	136–174 MHz	403–470 MHz	450–512 MHz	350–400 MHz
Dimensions (HxWxL)	5.22” x 19” x 11.67” (132.6 mm x 482.6 mm x 296.5 mm)			
Weight	31 lbs (14 kg)			
Voltage Requirements	100–240 V AC 47–63 Hz (13.6 V DC)			
Current Drain: Standby:	1.0 A (100 V AC) 0.5 A (240 V AC) 1.0 A (typical)(13.4 V DC)			
Transmit : Low Power	3.0 A (100 V AC) 1.5 A (240 V AC) 10 A (typical)(13.4 V DC)			
Transmit : High Power	4.0 A (100 V AC) 1.8 A (240 V AC) 12 A (typical)(13.4 V DC)			
Operating Temperature Range	-30 °C to +60 °C			
Max Duty Cycle	100%			
FCC Description	1–25 W: ABZ99FT3026 25–45 W: ABZ99FT3025	1–25 W: ABZ99FT4026 25–40 W: ABZ99FT4025	1–40 W: ABZ99FT4027	–
IC Description	1–25 W: 109AB-99FT3026 25–45 W: 109AB-99FT3025	1–25 W: 109AB-99FT4026 25–40 W: 109AB-99FT4025	1–40 W: 109AB-99FT4027	–

Receiver				
Specification	**VHF**	**UHF1**	**UHF2**	**350 MHz**
Frequency	136–174 MHz	403–470 MHz	450–512 MHz	350-400 MHz
Channel Spacing	12.5 kHz/20 kHz/25 kHz			
Frequency Stability (-30 °C to +60 °C)	±0.5 ppm			
Analog Sensitivity	0.30 µV 0.22 µV (typical)			
Digital Sensitivity	5% BER: 0.3 µV			
Intermodulation (TIA603C)	78 dB	75 dB		
Adjacent Channel Selectivity: TIA603 TIA603C	65 dB @ 12.5 kHz, 80 dB @ 25 kHz, 50 dB @ 12.5 kHz, 80 dB @ 25 kHz	65 dB @ 12.5 kHz, 75 dB @ 25 kHz 50 dB @ 12.5 kHz, 75 dB @ 25 kHz		
Spurious Rejection (TIA603C)	80 dB	75 dB		
Audio Distortion @ Rated Audio	3% typical			
Hum and Noise	-40 dB @ 12.5 kHz -45 dB @ 20/25 kHz			
Audio Response				
Conducted Spurious Emission: (TIA603C)	-57 dBm			

Transmitter				
Specification	**VHF**	**UHF1**	**UHF2**	**350 MHz**
Frequency	136–174 MHz	403–470 MHz	450–512 MHz	350–400 MHz
Channel Spacing	12.5 kHz/20 kHz/25 kHz			12.5 kHz/25 kHz
Frequency Stability (-30 °C to +60 °C)	±0.5 ppm			
Power Output: Low Power Power Output: High Power	1–25 W 25–45 W	1–25 W 25–40 W	– 1–40 W	– 25–40 W
Modulation Limiting	±2.5 kHz @ 12.5 kHz ±4.0 kHz @ 20 kHz ±5.0 kHz @ 25 kHz			±2.5 kHz @12.5 kHz ±5.0 kHz @ 25 kHz

Table continued…

Transmitter				
Specification	**VHF**	**UHF1**	**UHF2**	**350 MHz**
Digital Modulation Fidelity (4FSK)	FSK Error 5% FSK Magnitude 1%			
FM Hum and Noise	-40 dB @ 12.5 kHz -45 dB @ 20/25 kHz			-40 dB @ 12.5 kHz -45 dB @ 25 kHz
Conducted/Radiated Emission	-36 dBm < 1 GHz -30 dBm > 1 GHz			
Adjacent Channel Power (TIA603C)	60 dB @ 12.5 kHz 70 dB @ 20/25 kHz			
Audio Response				
Audio Distortion			3%	
FM Modulation	25 kHz : 16K0F3E		12.5 kHz : 11K0F3E	
4FSK Digital Modulation	12.5 kHz Data & Voice : 7K60FXE		12.5 kHz Data Only : 7K60FXD	
Digital Vocoder Type			AMBE +2™	
Digital Protocol	ETSI TS 102 361-1 ETSI TS 102 361-2 ETSI TS 102 361-3			

Self-Quieter			
VHF	**UHF1**	**UHF2**	**350 MHz**
144 MHz	464.025 MHz	498.825 MHz	353.625 MHz
147.45 MHz	–	–	387.675 MHz
172.025 MHz +/- 5 kHz	–	–	

This page intentionally left blank.

Chapter 2

MOTOTRBO Repeater Test Equipment and Service Aids

The following table is a list of most of the standard test equipment required for servicing Motorola Solutions repeaters.

Table 4: Recommended Test Equipment

Equipment	Characteristic	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Aeroflex 3920, or equivalent	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter*	100 µV to 300 V 5 Hz to 1 MHz 10 Mega Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator*	100 MHz to 1 GHz -130 dBM to +10 dBM FM Modulation 0 kHz to 10 kHz	Agilent N5181 (www.agilent.com) or equivalent	Receiver measurements
Oscilloscope*	2 Channels 50 MHz Bandwidth 5 mV/div to 20 V/div	Tektronix TDS1001b (www.tektronix.com) or equivalent	Waveform measurements
Power Meter and Sensor*	5% Accuracy 100 MHz to 500 MHz 50 Watts	Bird 43 Thruline Watt Meter (www.bird-electronic.com) or equivalent	Transmitter power output measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 92EA (www.boonton.com) or equivalent	RF level measurements

Service Aids

The following table lists the service aids recommended for working on the repeater. While all of these items are available from Motorola Solutions, most are standard workshop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Motorola Part Number	Description	Application
RLN4460_	Test Box	Enables connection to audio/accessory jack. Allows switching for radio testing.

Table continued…

Motorola Part Number	Description	Application
RVN5115_	Customer Programming Software on CD-ROM	Allows servicer to program repeater parameters, tune and troubleshoot repeaters.
PMKN4010_	Mobile & Repeater Rear Programming Cable	Connects the radio's rear connector to a USB port for radio programming and data applications.
PMKN4016_	Mobile & Repeater Rear Accessory Programming and Test Cable	Connects the radio's rear connector to a USB port for radio programming, data applications, testing and alignment.
PMKN4018_	Mobile & Repeater Rear Accessory Connector Universal Cable	Connects the radio's rear connector to accessory devices such as desk sets. Cable contains all 26 wires and is unterminated at the user end.

Programming Cables

Figure 1: Mobile & Repeater Rear Programming Cable PMKN4010_

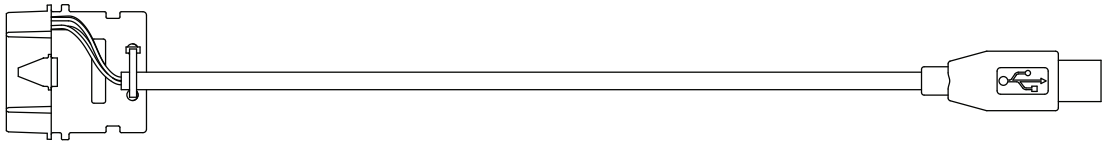


Figure 2: Mobile & Repeater Rear Accessory Programming and Test Cable PMKN4016_

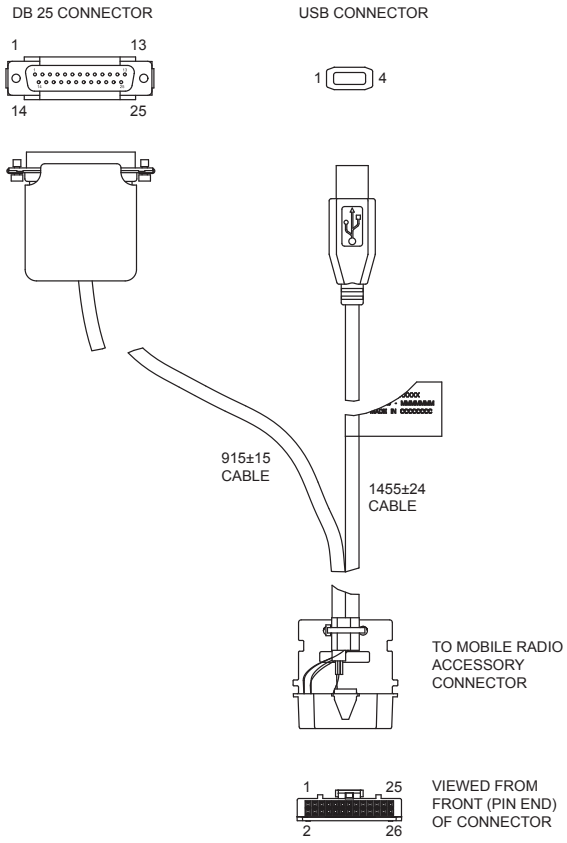


TABLE 2-3: WIRE DIAGRAM			
26 PIN ACCESSORY PORT CONNECTOR		USB	DB25P
PIN NO.	DESCRIPTION		
3	VCC (5v)	1	
2	DATA -	2	
1	DATA +	3	
4	GND	4	
	DRAIN WIRE AND BRAID	SHELL	
9	SPEAKER -		7
11	EXT MIC		17
17	DIGI IN I (EXT PTT)		20
16	GND		16
10	SPEAKER +		1

2.1 Recommended Test Equipment

The list of equipment contained in the following table includes most of the standard test equipment required for servicing Motorola Solutions repeaters.

Table 5: Recommended Test Equipment

Equipment	Characteristic	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Motorola R2670, 3920 or equivalent	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital RMS Multimeter*	100 µV to 300 V 5 Hz to 1 MHz 10 Meg Ohm Impedance	Fluke 179 or equivalent (www.fluke.com)	AC/DC voltage and current measurements. Audio voltage measurements
RF Signal Generator*	100 MHz to 1 GHz -130 dBM to +10 dBM FM Modulation 0 kHz to 10 kHz	Agilent N5181A (www.agilent.com), Ramsey RSG1000B (www.ramseyelectronics.com), or equivalent	Receiver measurements
Oscilloscope*	2 Channels 50 MHz Bandwidth 5 mV/div to 20 V/div	Leader LS8050 (www.leaderusa.com), Tektronix TDS1001b (www.tektronix.com), or equivalent	Waveform measurements
Power Meter and Sensor*	5% Accuracy 100 MHz to 500 MHz 50 Watts	Bird 43 Thruline Watt Meter (www.bird-electronic.com) or equivalent	Transmitter power output measurements
RF Millivolt Meter	100 mV to 3 V RF 10 kHz to 1 GHz	Boonton 92EA (www.boonton.com) or equivalent	RF level measurements

2.2 Service Aids

The following table lists the service aids recommended when performing testing, tuning, and troubleshooting on the repeater.

While all of these items are available from Motorola Solutions, most are standard workshop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 6: Service Aids

Motorola Part Number	Description	Application
RLN4460_	Test Set	Enables connection to audio/ accessory jack. Allows switching for radio testing.
RVN5115_	Customer Programming Software (CPS) on CD-ROM	Allows a technician to program, tune, and troubleshoot repeaters.
PMKN4010_	Mobile & Repeater Rear Programming Cable	Connects the rear connector to a USB port for programming and data applications.
PMKN4016_	Mobile & Repeater Rear Accessory Programming and Test Cable	Connects the rear connector to a USB port for programming, data applications, testing and alignment.
PMKN4018_	Mobile & Repeater Rear Accessory Connector Universal Cable	Connects the rear connector to accessory devices such as desk sets. Cable contains all 26 wires and is unterminated at the user end.

2.3 Programming Cables

The following cables are used to perform programing and testing on the repeater.

Figure 3: Mobile & Repeater Rear Programming Cable PMKN4010_

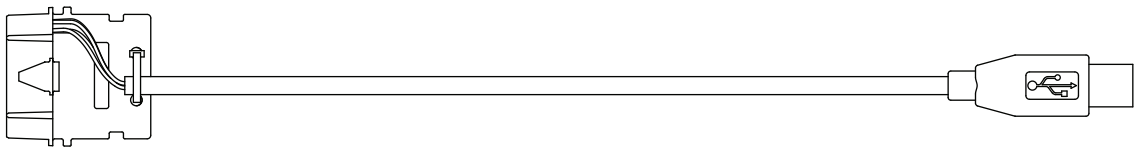


Figure 4: Mobile & Repeater Rear Accessory Programming and Test Cable PMKN4016_

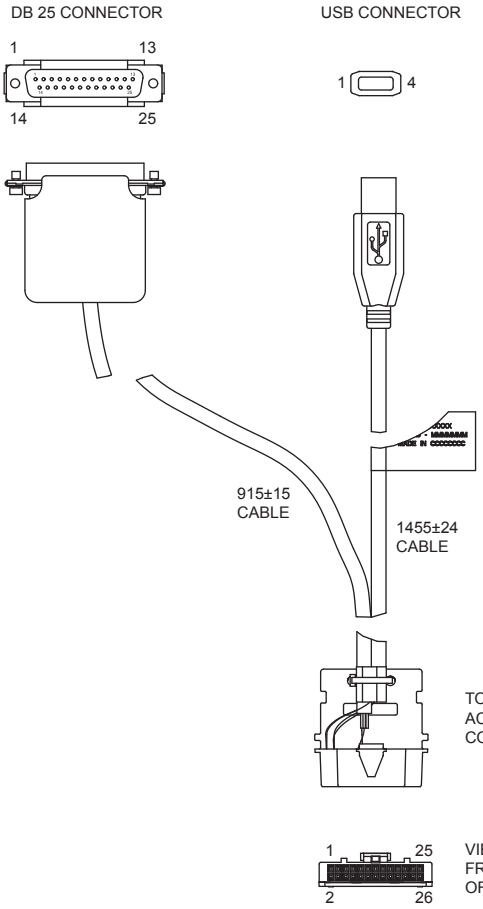


TABLE 2-3: WIRE DIAGRAM			
26 PIN ACCESSORY PORT CONNECTOR		USB	DB25P
PIN NO.	DESCRIPTION		
3	VCC (5v)	1	
2	DATA -	2	
1	DATA +	3	
4	GND	4	
	DRAIN WIRE AND BRAID	SHELL	
9	SPEAKER -		7
11	EXT MIC		17
17	DIGI IN I (EXT PTT)		20
16	GND		16
10	SPEAKER +		1

This page intentionally left blank.

Chapter 3

MOTOTRBO Repeater Transceiver Performance Testing

3.1 Performance Testing Accuracy

The MOTOTRBO Repeater meets published specifications through their manufacturing process by utilizing high-accuracy laboratory-quality test equipment.

The recommended field service equipment approaches the accuracy of the manufacturing equipment with few exceptions. This accuracy must be maintained in compliance with the manufacturer's recommended calibration schedule.

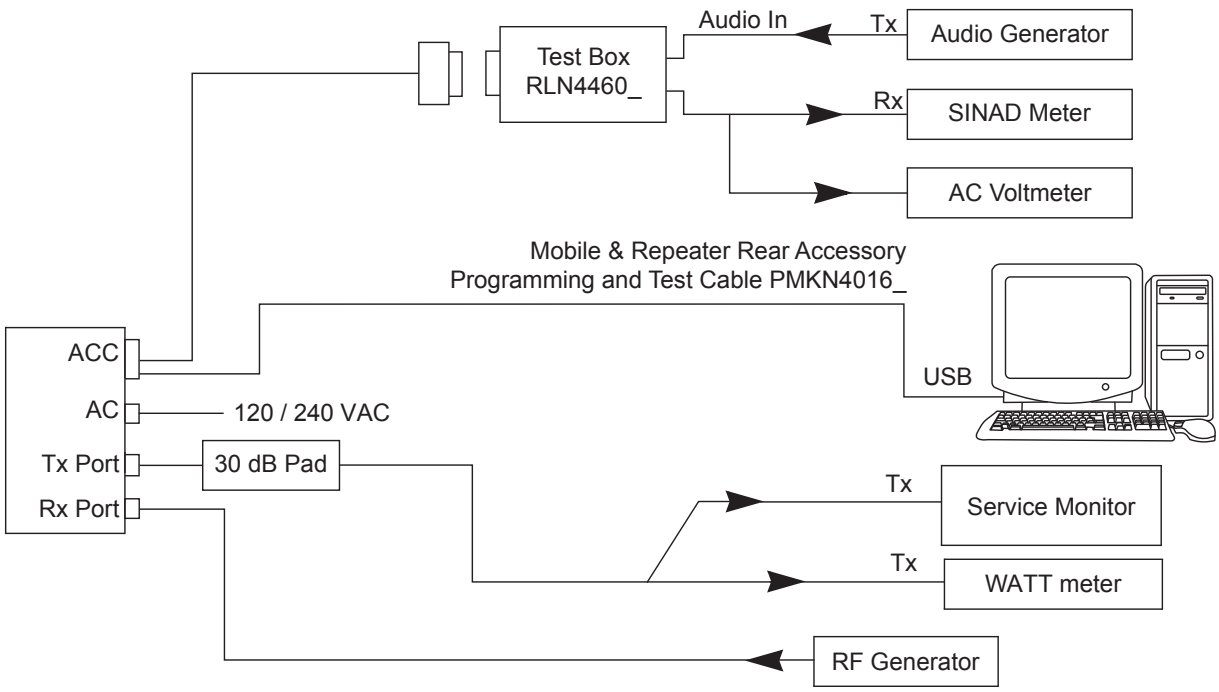
NOTICE: Although repeaters function in digital and analog modes, all testing is done in analog mode.

3.2 Transceiver Performance Testing Setup

To perform the testing procedures, the repeater must be connected to the PC and test equipment.

The equipment required for test procedures is connected as shown in the following figure. Supply voltage is 120/240 VAC.

Figure 5: Repeater Testing Equipment Setup



Initial equipment control settings should be as indicated in Table 7: Initial Equipment Control Settings on page 42. Table 8: Receiver Performance Checks on page 42 lists Receiver Performance Checks information.

Table 7: Initial Equipment Control Settings

Service Monitor	Test Set
Monitor Mode: Power Monitor	Speaker set: A
RF Attenuation: -70	Speaker/load: Speaker
AM, CW, FM: FM	PTT: OFF
Oscilloscope Source: Mod Oscilloscope Horizontal: 10 mSec/Div Oscilloscope Vertical: 2.5 kHz/Div Oscilloscope Trigger: Auto Monitor Image: Hi Monitor Bandwidth: Narrow Monitor Squelch: middle setting Monitor Vol: 1/4 setting	

Table 8: Receiver Performance Checks

Test Name	Communications Analyzer	Radio	Test Set	Comment
Rated Audio	Mode: GEN Output level: 1.0 mV RF Mod: 1 kHz tone at 3 kHz deviation Monitor: DVM: AC Volts	Use tuner tool to program repeater to an appropriate test frequency with carrier squelch.	PTT to OFF (center), meter selector to Audio PA	Set volume to 7.75 Vrms via tuner tool.
Distortion	As above, except to distortion	As above	As above	Distortion <5.0 %
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12 dB SINAD.	As above	PTT to OFF (center)	RF input to be <0.3 µV
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1 mV RF	As above	PTT to OFF (center), meter selection to Audio PA, speaker/load to speaker	Set volume to 7.75 Vrms via tuner tool.
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	out of TEST MODE; select a conventional system	As above	Unsquelch to occur at <0.25 µV. Preferred SINAD = 9-10 dB

3.3 Auto Test and Tune Support Alignment Instrument

Auto Test and Tune Support is an automated alignment instrument for the repeater.

The Auto Test and Tune Support instrument allows you to perform Test and Tune procedures in the right method that saves time and helps to achieve higher efficiency. To accomplish the overall Test and Tune procedures, the repeater must be tested in two test suites: Analog mode and Digital mode. These procedures include Tuning and Testing in Analog mode and Testing in Digital Mode.

NOTICE: Contact Motorola Solutions Customer Support for more details on this instrument.

This page intentionally left blank.

Chapter 4

MOTOTRBO Repeater Programming and Tuning

4.1 Customer Programming Software Introduction

The MOTOTRBO Customer Programming Software (CPS) as well as the Tuner application are used to program the repeater and are designed for use on Windows Vista/XP operating system. These programs are available in one kit as listed in the following table. An Installation Guide is also included with the kit.

NOTICE: Refer to the appropriate program on-line help files for the programming procedures.

Table 9: Repeater Software Program Kits

Description	Kit Number
MOTOTRBO CPS, Tuner and AirTracer Applications CD	RVN5115_

4.2 Customer Programming Software Setup

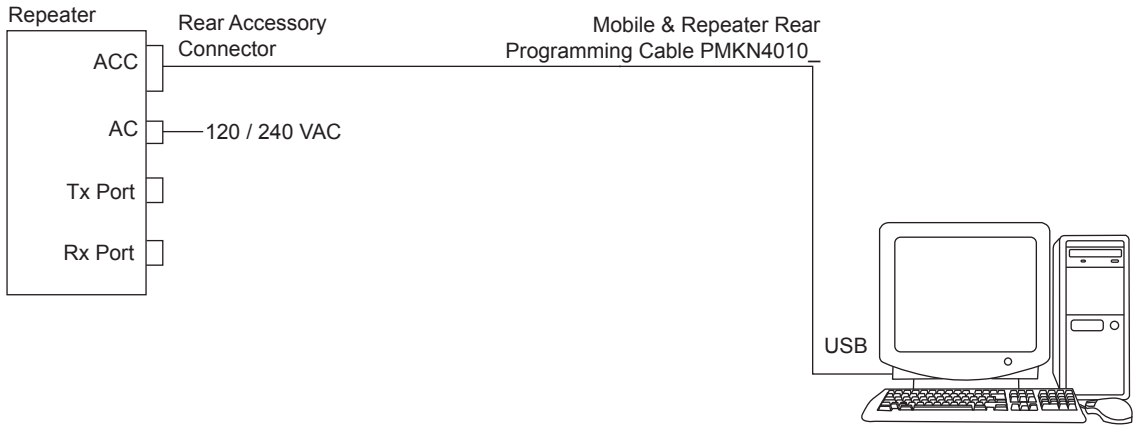
Customer Programming Software (CPS) is used to program and tune the repeater.

The setup is shown in Figure 6: Customer Programming Software Setup from Rear Accessory Connector on page 45.

NOTICE: See the appropriate program on-line help files for the programming procedures.

CAUTION: Computer USB ports can be sensitive to Electronic Discharge. Do not touch exposed contacts on cable when connected to a computer.

Figure 6: Customer Programming Software Setup from Rear Accessory Connector



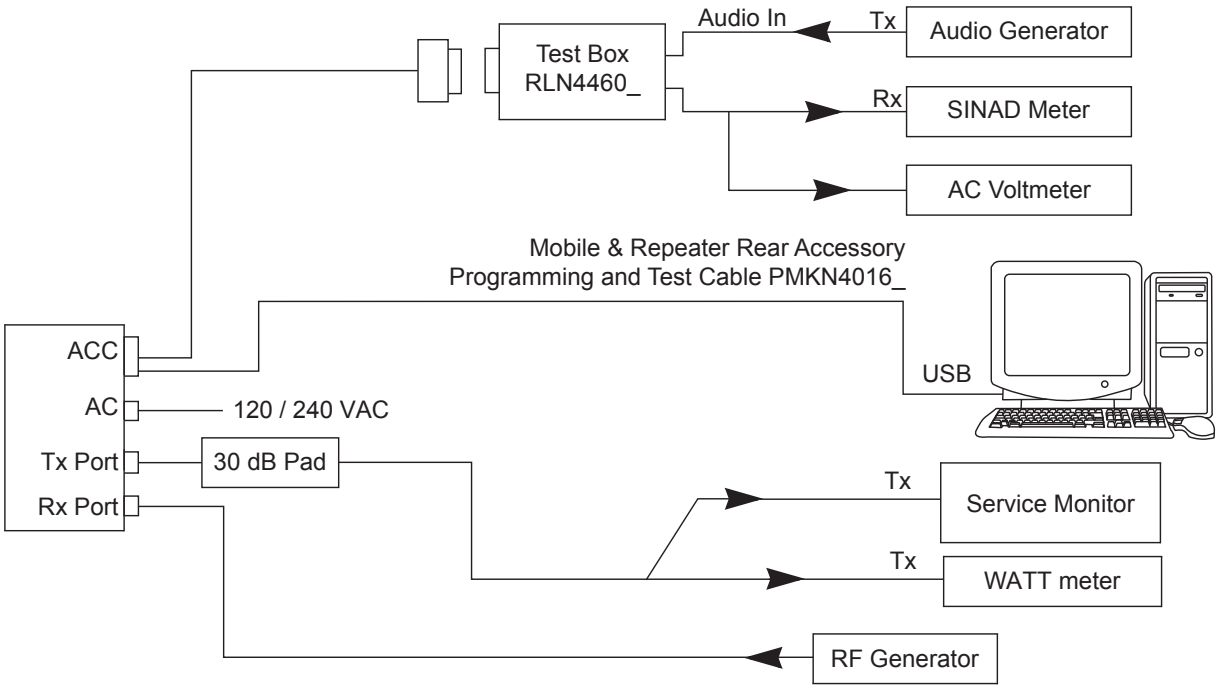
4.3

Repeater Tuning Setup

A personal computer (PC), Windows Vista/XP and a tuner program (which is available as part of the MOTOTRBO CPS kit) are required to tune the repeater.

To perform the tuning procedures, the repeater must be connected to the PC and test equipment setup as shown in the following figure.

Figure 7: Repeater Tuning Equipment Setup



4.4

Preparing and Configuring the Repeater

The repeater must be set-up with the proper connections to prepare for the alignment procedures.

Prerequisites:

NOTICE: Ensure that the repeater is configured for the analog mode of operation. If not, use the latest version of the Customer Programming Software (CPS) and program an analog channel as the first channel in the zone channel assignment screen. Save the codeplug as a precautionary measure.

Procedure:

1. Ensure the **On/Off** switch on the rear of the repeater is in the **Off** position.
2. Disconnect the AC power cable from the repeater.
3. Remove the five screws that hold the top cover onto the repeater chassis.
4. Remove the cover of the repeater.
5. Connect the MOTOTRBO Mobile/Repeater programming cable to the rear of the repeater.
6. Connect the AC power cable to the repeater.
7. Place the **On/Off** switch on the rear of the repeater, in the **On** position.

8 Ensure that the repeater goes through its normal power-up cycle and that the **Disable** LED is not illuminated.

9 Using the latest version of the Tuner, read the repeater tuning partition and save it as `Txtune`***<xxxx>***

where ***<xxxx>*** are the last four digits of the serial number of the repeater.

10 For transceiver alignment, connect a coaxial cable from the Tx output of the repeater to the communication analyzer RF I/O port. For receiver alignment, connect a coaxial cable from the Rx output of the repeater to the communication analyzer RF I/O port.

The communication analyzer is a suitable 50 ohm termination for the transmitter output, therefore no PA damage occurs while tuning the repeater as long as the repeater is NOT allowed to be left transmitting for extended periods of time.

11 Place the **On/Off** switch on the rear of the repeater, in the **Off** position.

12 Remove the repeater internal power supply cable from the rear of the Tx brick.

13 Connect an external 13.8 volt power supply to a MOTOTRBO mobile power cable. Set the current limit on the power supply to 15 amps (max current draw is 12 amps) and remove the fuse from the fuse block, on the cable.

14 Configure a Digital Volt Meter (DVM) for current measurements and connect the DVM to the fuse block on the power cable, which allows current to flow through the DVM and to the Tx brick.

15 Connect the external power cable to the rear of the Tx brick.

16 Turn on the Tx brick external power supply and place the **On/Off** switch on the rear of the repeater, in the **On** position at the exact same time.

NOTICE: The repeater requires that both the Tx and Rx bricks power up at approximately the same time. Ensure the repeater disabled LED is NOT on. If so, continue to power down and power up the repeater bricks. See step 16 simultaneously until the repeater has a normal power-up sequence.

4.5 Measuring the Transmit Current

Procedure:

1 Measure and record the standby current draw of the transceiver. The standby current draw should be approximately 520 mA.

2 Using the latest version of the Tuner application, read the repeater tuning partition.

3 If the tuner indicates that the repeater is in the **Single Board** configuration, perform the following actions:

a Click **OK**.

b Turn the repeater **On/Off** switch to the **Off** position.

c Turn off the Tx brick external power supply and then turn on both power supplies simultaneously.

IMPORTANT: The drain bias current level referenced in Aligning the Power Amplifier Bias on page 48 is the baseline level.

4.6 Tuning the Transmit Reference Oscillator Alignment

The reference oscillator of the repeater provides accurate signaling for GNSS satellites.

This alignment procedure should be done as maintenance schedules and regulations require.

Prerequisites:

NOTICE: Connect the radio antenna port to an attenuation pad, if necessary, before connecting the repeater to a communications analyzer to ensure that the maximum input power is not exceeded on the communications analyzer input port.

Procedure:

1. Launch the Tuner application.
2. Under the **TX** menu in the tree view, select **Ref Oscillator**.
3. Switch the communications analyzer to the Monitor mode.
4. Configure the communication analyzer for the current operating frequency that is displayed in the Ref. Oscillator screen of the tuner.
5. To key up the repeater, click **PTT**.
6. If necessary, adjust the softpot value until the error frequency read on the communications analyzer is as close to zero hertz as possible. Check the performance requirements.
7. To de-key the repeater, click **PTT**.
8. Click **Write** to write the updated softpot value.

4.7 Aligning the Power Amplifier Bias

Aligning the drain bias current in the RF power amplifier (PA) device is required after replacing or servicing the RF board. The PA Bias should always be checked before the power is aligned on a new board, serviced board, or when swapping the Tx and Rx bricks or boards.

Procedure:

1. Take the standby current value that was read in Measuring the Transmit Current on page 47 test and add the following device bias current to calculate the target PA bias current.

   Example: (520 mA + 700 mA = 1220 mA)
2. Launch the Tuner application.
3. Under the **TX** menu in the tree view, select **PA Bias 1**.
4. In the softpot value area, enter the lowest working softpot value to avoid damaging the PA.
5. Click **Write** to write the updated softpot value.
6. To key up the repeater, click **PTT Toggle**.

   NOTICE: A menu box appears indicating the power softpots in the repeater are reset once the repeater is keyed up.
7. Click **Write** to restore the power softpots, as specified in the next step. Click **OK**.
8. Adjust the working softpot value until the target PA bias current is achieved.

   (This value was calculated in step 4).
9. To de-key the radio, click **PTT Toggle**.
10. Click **Write** to save the tuned softpot value into the repeater codeplug.

4.8
Tuning the Power Levels

Perform the Transmit Low Power, Attenuated Low and High Power Tuning on the repeater to adjust signal loss.

Prerequisites:

NOTICE: The steps for Attenuated Low Power tuning are only applicable to the low power models. Attenuated Low Power is the measurement of the output power with an internal attenuator turned on. It is required to achieve accurate power output at power less than 5.0 W.

Procedure:

1. Launch the Tuner Application.
2. Begin with the first column and the first box (that is, the first frequency point from the top), by clicking the box.
3. As you perform the power alignment, enter each frequency into the analyzer or put the analyzer in the scan mode and ensure that the analyzer is programmed to scan the frequency band of the repeater being aligned.
4. To key up the repeater at the corresponding frequency point, click **PTT Toggle**.
5. Monitor the power level.
6. To de-key the repeater, click **PTT Toggle**
7. Enter the power measurement into the appropriate box on the Tuner screen.
8. Repeat the previous steps for the remaining frequencies ensuring to align each box in all rows and columns.
9. Click **Write** to save the tuned power values into the repeater codeplug.

4.9
Adjusting the Modulation Balance

Tune the deviation level across a specific frequency band.

Procedure:

1. Launch the Tuner application.
2. From the **PTT Tone** drop down list, select **Low Tone**.
3. Click the uppermost box (that is, the lowest frequency point from the top).
4. Enter the frequency into the Communication Analyzer.
5. To key up the repeater, click **PTT Toggle**.
6. Observe the FM deviation in avg rms (kHz) on the analyzer.

   The avg rms of the FM deviation value should be approximately 3.0 kHz. Denote this value.
7. To de-key the repeater, click **PTT Toggle**.
8. From the **PTT Tone** drop down list, select **High Tone**.
9. Key up the radio and observe the High Tone FM deviation (kHz) in avg rms.
10. To match the reading of the Low Tone that was recorded in a previous step, adjust the High Tone FM deviation (kHz) in avg rms.
11. De-key the radio.
12. Repeat this procedure for the remaining frequencies.

13 Click **Write** to save the tuned softpot values into the radio codeplug.

4.10 Preparing and Configuring the Repeater for Receiver Alignment

The repeater must be set-up with the proper connections to prepare for the receiver alignment procedures.

Prerequisites:

NOTICE: Ensure the repeater is configured for the analog mode of operation. If not, use the latest version of the CPS and program an analog channel as the first channel in the zone channel assignment screen.

Procedure:

Follow the setup procedures from Preparing and Configuring the Repeater on page 46 with the exception to connect a coaxial cable from the Rx output of the repeater to the communications analyzer RF I/O port.

4.11 Tuning the Receiver Reference Oscillator

The reference oscillator of the repeater provides accurate signaling for GNSS satellites.

This alignment procedure should be done as maintenance schedules and regulations require.

Procedure:

1. Launch the Tuner application.
2. Under the **RX** menu in the tree view, click **Ref Oscillator**.
3. Configure the communications analyzer to output a RF signal level of -50 dBm, without modulation (silent carrier), on the current operating frequency to be tuned.
4. Click **Auto Tune**. The Softpot values are automatically tuned.
5. To save the tuned softpot value into the repeater codeplug, click **Write**.

4.12 Adjusting the Front End Filter

MOTOTRBO Receivers have an adjustable Pre-Selector Filter Frequency Response. The purpose of this filtering is to provide attenuation of any “Out-of-Band” signals that may get picked-up by the receiver and cause unnecessary interference. The Tuner is used to align the frequency response of the Front End Filter appropriately. This procedure is the manual way of tuning.

Prerequisites:

NOTICE: The softpot ranges from the table below provide guidance for the best performance trade-off between optimum receiver sensitivity and maximum out-of-band attenuation. Typically, the softpot values that control this adjustment monotonically increase with frequency. Motorola Solutions recommends that you keep the adjusted softpot value within this range for normal operational use.

The Internal and External audio options can be used for radio testing purposes. For example, to test the radio receive sensitivity at a particular frequency point, the user can set the frequency and control the audio output either to internal or external.

Procedure:

1. Launch the Tuner application.

2 Under **RX** in the tree view, click **Front End Filter**.

3 On the tuner screen, the audio should be selected as **Mute** for the Front End Filter tuning.

4 Configure the Communications Analyzer to output a RF signal level of -70 dBm, without modulation (silent carrier), on the current operating frequency to be tuned.

5 Click the upper most box (that is. the first frequency point from the top) in the tuner.

6 Adjust the working softpot value down and then up, until an RSSI (dBm) value has been determined to be as close as possible to the -70dbm signal the communications analyzer is outputting.

7 Once the highest value (dbm level), has been determined, find the range of this value and then program the softpot for the middle of that range.

8 Repeat these steps for the remaining frequencies.

9 To save the tuned softpot values into the repeater codeplug, click **Write**.

4.13 Tuning the Rated Volume

Adjusting the rated volume allows the radio to output at the optimal volume output allowed for the repeater.

Procedure:

1 Launch the Tuner application.

2 Under **RX** in the tree view, click **Rated Volume**.

3 Connect the MOTOTRBO programming cable to the Test Input port of the RLN4460B test box.

4 Connect the AC/DC Meter port at the Test Box to the Communications Analyzer's Audio Input port.

5 Configure the Communications Analyzer to output a RF signal level of -50 dBm, with a 1 kHz tone modulation at 3.0 kHz, on the current operating frequency to be tuned.

6 On the Test Box Load Selector, select **MX**.

7 On the Test Box Meter Out, select **RX**.

8 On the Test Box, switch the **SPKR/LOAD** toggle to **Load**.

9 Adjust the working softpot value until audio output of approximately 7.75 V is obtained.

10 To save the tuned softpot value into the repeater codeplug. click **Write**.

4.14 Tuning the Front End Gain and Attenuation Control

This alignment sets a reference value allowing Gain and Attenuation Control circuity to auto adjust a weak or distorted signal entering the receiver front-end RF amplifier to provide a better quality signal.

Procedure:

1 Launch the Tuner application

2 Under **RX** in the tree view, click **Front End Gain Adjustment**.

3 Configure the Communications Analyzer to output an RF signal level of -80 dBm, without modulation (silent carrier), on the current operating frequency to be tuned.

4 To begin tuning, click **Auto Tune**.

Once the auto tune has finished, the softpot values are saved into the radio codeplug.

5 Close the **Tuner** screen for the repeater being aligned.

6 Place the AC power switch to the **Off** position (tuning off the repeater) then place the AC power switch to the **ON** position and ensure that the repeater goes through a normal power-up cycle.

7 Read the repeater with the tuner again.

8 To ensure that the Front End Gain and Attenuation Control tuning has been performed correctly, in the tree view under **RX**, select **Front End Filter**. On the tuner screen, the audio should be selected as **Mute** for the Front End Filter tuning. Click the up/down arrow (once) on any one of the manual slider bars. Configure the Communications Analyzer to output an RF signal level of -80 dBm, without modulation (silent carrier) on the carrier frequency of the slider bar that was selected, the displayed RSSI level on the tuner screen should read within +/-2 dB of -80 dBm.

4.15 Repeater Reassembly

Once programming and tuning of the repeater has been performed, the tuning equipment must be removed and the repeater reassembled and placed into working mode.

Procedure:

1 Place the **On/Off** switch on the rear of the repeater, in the **Off** position.

2 Remove the AC power cord from the repeater.

3 Remove the mobile power cable from the Tx brick and attach the internal power supply cable for the Tx brick to the Tx brick.

4 Attach the cover of the repeater.

5 Screw the top cover back onto the repeater using the five screws that hold the top cover onto the repeater chassis.

NOTICE: Please see Disassembly/Reassembly Procedures.

6 Disconnect the MOTOTRBO mobile/repeater programming cable to the rear of the repeater.

Chapter 5

Disassembly/Reassembly Procedures

This chapter provides details about the following:

- Preventive maintenance (inspection and cleaning).
- Safe handling of CMOS and LDMOS devices.
- Repair procedures and techniques.
- Disassembly and reassembly of the repeater.
- Disassembly and reassembly of the Transmit and Receive radios.

5.1 Preventive Maintenance

Periodic visual inspection and cleaning is recommended.

Inspection

Check that the external surfaces of the repeater are clean, and that all external controls and switches are functional. It is not recommended to inspect the interior electronic circuitry.

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 repeater. External surfaces include the top cover and repeater enclosure.

Periodically clean smudges and grime from exterior enclosure. Use a soft, non-abrasive cloth moistened in a mild soap and water solution. Rinse the surface using a second cloth moistened in clean water, and clean any dirt or debris from the fan grill and louvers on the front side.

NOTICE: Internal surfaces should be cleaned only when the repeater is disassembled for service or repair.

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

Cleaning Internal Circuit Boards and Components

Isopropyl alcohol (100%) may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the repeater. Make sure that controls or tunable components are not soaked with alcohol. Do not use high-pressure air to hasten the drying process since this could cause the liquid to collect in unwanted places. Once the cleaning process is complete, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the top cover and repeater enclosure.

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

5.2
Safe Handling of CMOS and LDMOS Devices

Complementary Metal Oxide Semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices are used in this family of repeaters, 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 repeater without first referring to the following CAUTION statement.

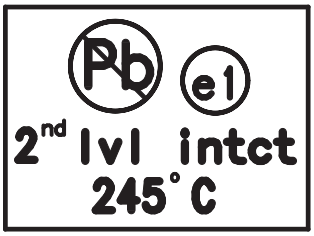
CAUTION: This repeater contains static-sensitive devices. Do not open the repeater unless you are properly grounded. Take the following precautions when working on this unit:

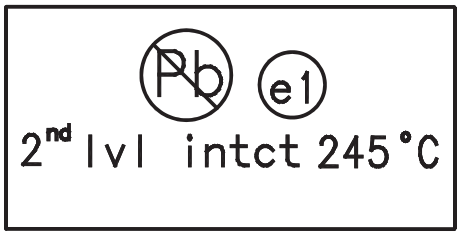
- Store and transport all CMOS/LDMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS/LDMOS devices into conventional plastic “snow” trays used for storage and transportation of other semiconductor devices.
- Ground the working surface of the service bench 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 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.

5.3
Repair Procedures and Techniques – General

Repairing repeaters requires special precautions. To guard against personal injury and/or damage to the equipment, follow the information in this section.

NOTICE: Environmentally Preferred Products (EPP) (refer to the marking on the printed circuit boards – examples shown below) were developed and assembled using environmentally preferred components and solder assembly techniques to comply with the European Union's Restriction of Hazardous Substances (ROHS 2) Directive 2011/65/EU and Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU. To maintain product compliance and reliability, use only the Motorola Solutions specified parts in this manual.





Any rework or repair on Environmentally Preferred Products must be done using the appropriate lead-free solder wire and lead-free solder paste as shown in the following tables.

Table 10: Lead Free Solder Wire Part Number List

Motorola Part Number	Alloy	Flux Type	Flux Content by Weight	Melting Point	Supplier Part number	Diameter	Weight
1088929Y01	95.5Sn/3.8Ag/0.7Cu	RMA Version	2.7–3.2%	217°C	52171	0.015”	1lb spool

Table 11: Lead Free Solder Paste Part Number List

Motorola Part Number	Manufacturer Part Number	Viscosity	Type	Composition & Percent Metal	Liquid Temperature
1085674C03	NC-SMQ230	900–1000KCPs Brookfield (5rpm)	Type 3 (-325/+500)	(95.5%Sn–3.8%Ag–0.7%Cu) 89.3%	217°C

Parts Replacement and Substitution

When damaged parts are replaced, identical parts should be used. If the identical replacement part is not locally available, check the parts list for the proper Motorola Solutions part number and order the part. Refer to the nearest Motorola Solutions Radio Products and Solutions Organization listed in Appendix A : Replacement Parts Ordering on page 105 of this manual.

Rigid Circuit Boards

This repeater uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit. Therefore, exercise care to avoid pulling the plated circuit out of the hole.
When soldering near a connector:

- Avoid accidentally getting solder in the connector.
- Be careful not to form solder bridges between the connector pins.
- Examine your work closely for shorts due to solder bridges.

5.4
Repeater Disassembly and Reassembly – General

The following tools are required for disassembling the repeater:

- Small Flat Blade Screwdriver
- TORX™ T30 Driver Bit
- TORX™ T25 Driver Bit
- TORX™ T20 Driver Bit
- TORX™ T15 Driver Bit
- TORX™ T10 Driver Bit
- 7 mm Magnetic Socket Driver (extension of >150 mm)
- 16 mm Deep Well Socket Driver
- 19 mm Deep Well Socket Driver

If a unit requires more complete testing or service than is customarily performed at the basic level, please send repeater to a Motorola Solutions Service Center listed in Appendix B : Motorola Solutions Service Centers on page 107 .

The following disassembly procedures should be performed only if necessary.

5.5
Repeater Disassembly - Detailed

Disassembling the repeater consists of removing the Transmit radio, Receive radio, Repeater Indicator Board, connector board assembly and other miscellaneous parts.

The following are items to take into consideration before disassembling the repeater.

- Power cord and all external cables must be disconnected before opening up the repeater.
- Take the proper grounding precautions as stated in Safe Handling of CMOS and LDMOS Devices.
- When disassembling the repeater, retain all screws for reuse.

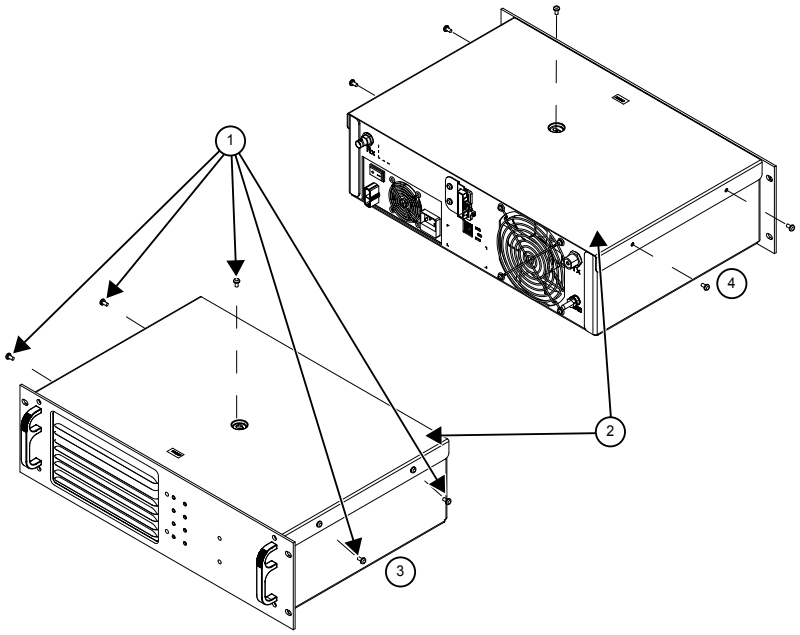
5.5.1
Removing the Cover

Remove the cover to either replace it or to disassemble the repeater further.

Procedure:

Remove the five screws that retain the cover to the housing using a T20 TORX driver. See the following figure.

Figure 8: Removing the Top Cover of Repeater Housing



Number	Description
1	Screws
2	Top Cover
3	Front View of Repeater
4	Back View of Repeater

5.5.2
Removing the Repeater Indicator Board

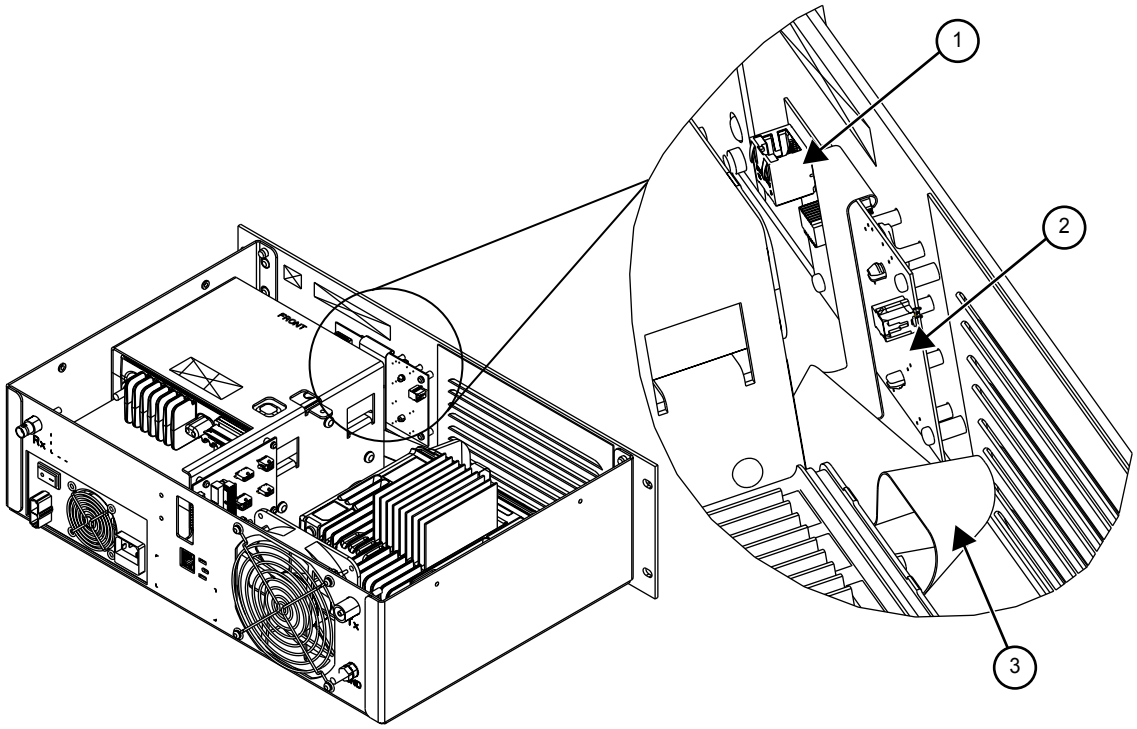
Remove the indicator board to either replace it or to disassemble the repeater further.

Procedure:

1. Disconnect the blue Ethernet cable from the Ethernet connector on the Repeater Indicator Board.
2. Disconnect the flex cable from the 30-position connector on the Repeater Indicator Board, noting orientation of cable which is identified with a solid black line.

   This is important for reassembly.

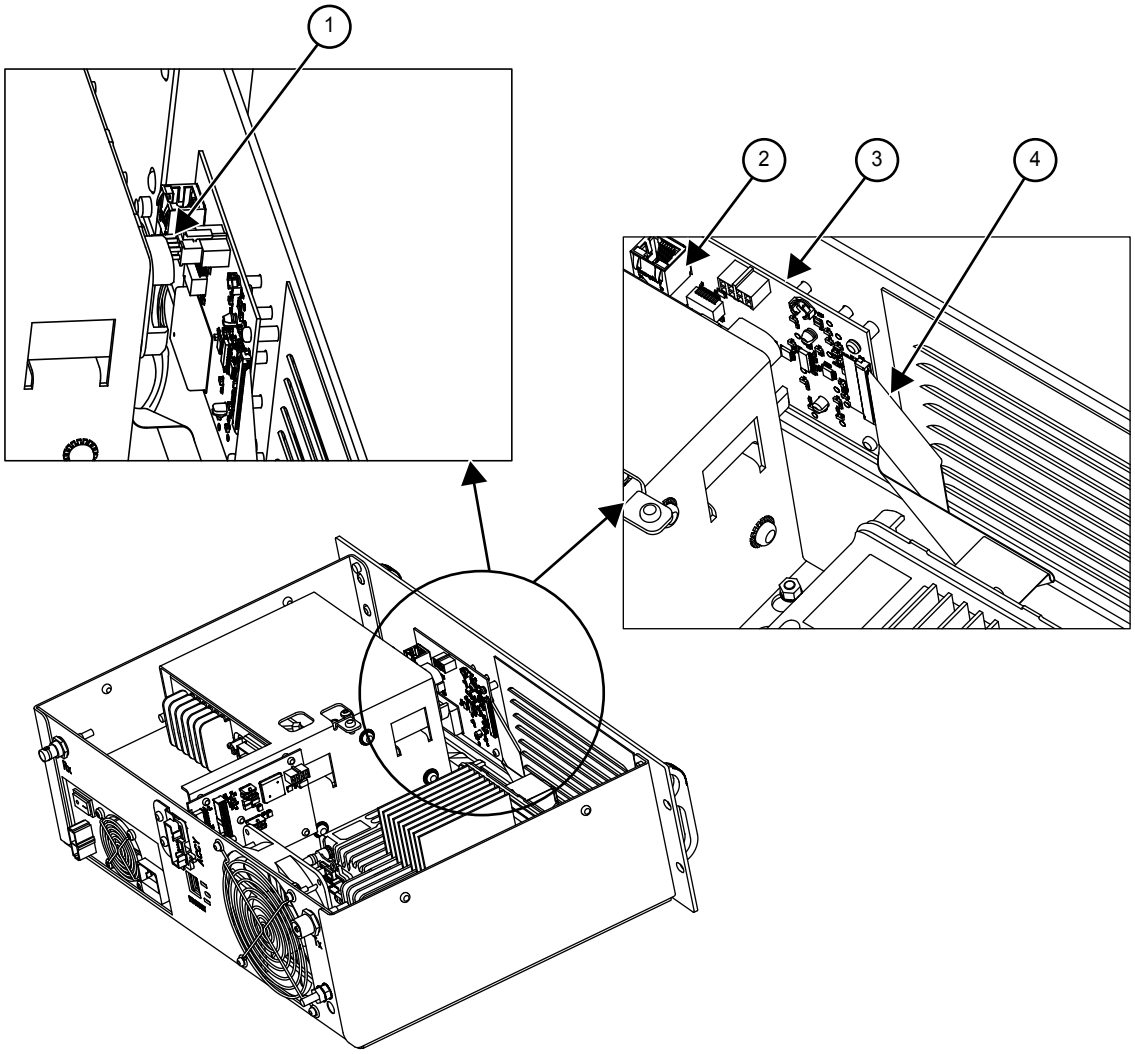
Figure 9: Disconnecting Ethernet Cable and Flex Cable



Number	Description
1	Ethernet Connector
2	Repeater, LED, and USB Converter Board
3	Flex Cable

3 For PMLN5643_, remove the ribbon cable from the 8-pin connector as well.

Figure 10: Disconnecting Ethernet Cable, Flex Cable and Ribbon Cable



Number	Description
1	8-Pin Ribbon Cable
2	Ethernet Connector
3	Repeater Indicator Board
4	Flex Cable

4 Detach the front panel by removing the four M6 screws located on the front face of panel using a T30 TORX driver.

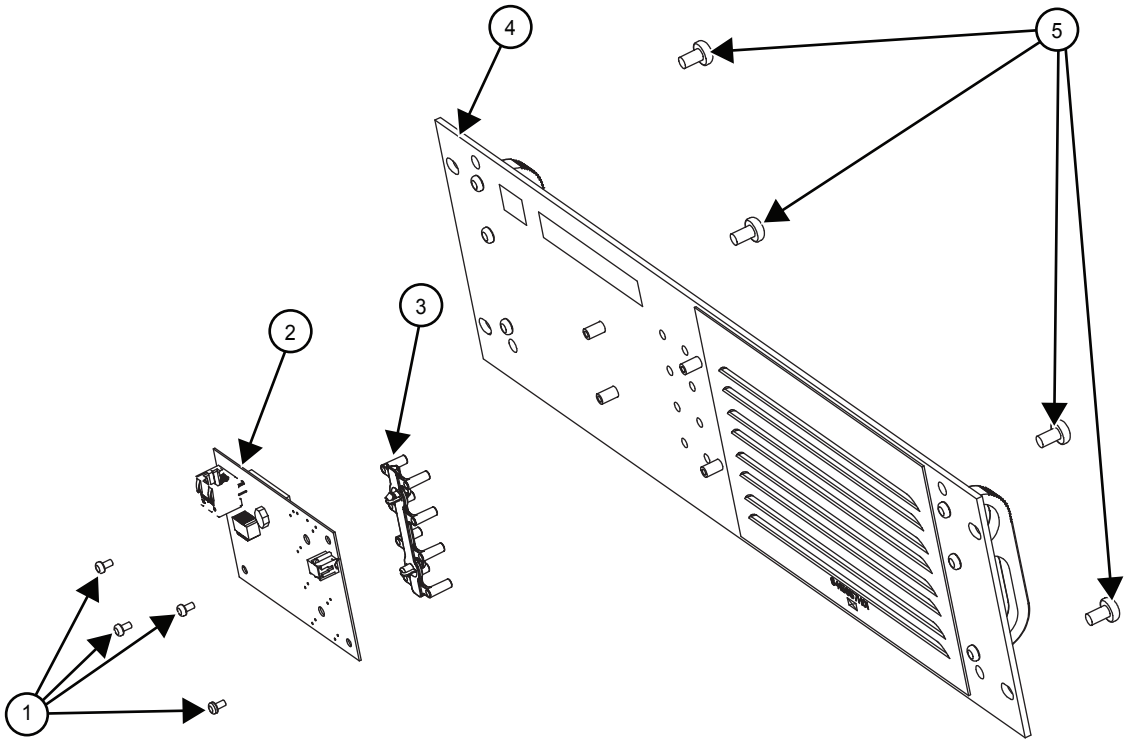
5 Place the front panel on a flat surface with the Repeater Indicator Board facing up.

6 Detach the Repeater Indicator Board from the front panel by removing the four M3 screws using a T10 TORX driver.

7 Hold the Repeater Indicator Board on its outer edge with your finger tips, squeeze together the catch of each clip and slightly press them through the board to remove the light guide.

8 Store Repeater Indicator Board in an anti-static bag when it is not being serviced.

Figure 11: Repeater Indicator Board Disassembly



Number	Description
1	M3 Screws (4)
2	Repeater Indicator Board
3	Light Guide
4	Front Panel
5	M6 Screws (4)

5.5.3

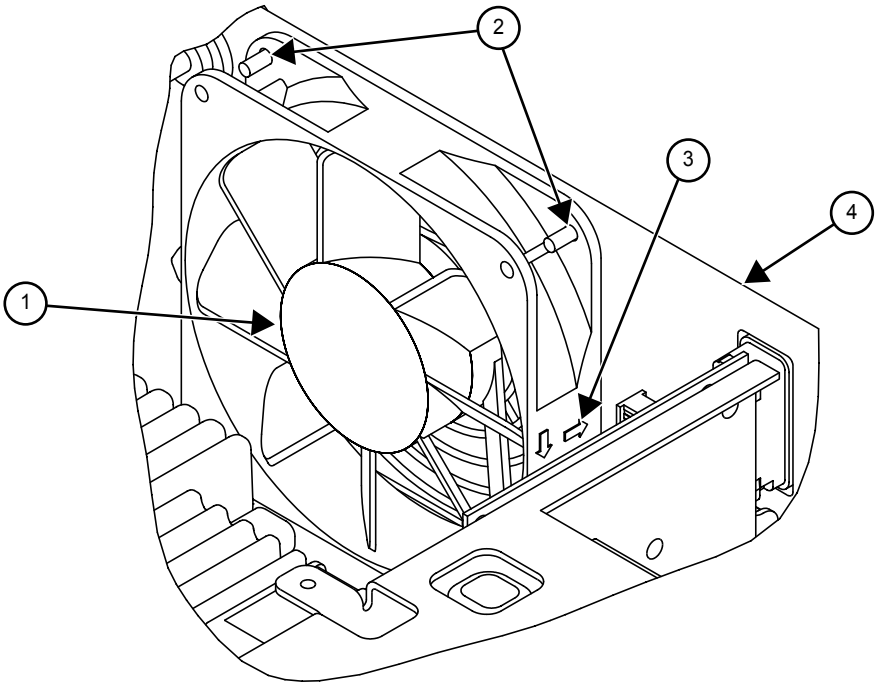
Removing the Fan

Remove the fan to either replace it or to disassemble the repeater further.

Procedure:

1. Unplug the fan cable from the mating connector on the connector board assembly.
2. Detach the fan assembly by removing the four screws that secure the fan grill and fan assembly to the back of the enclosure using a T15 TORX driver.
3. Carefully remove fan, noting position of arrow which identifies direction of air flow. This is important for reassembly.

Figure 12: Fan Orientation



Number	Description
1	Fan
2	Screws
3	Position of arrow
4	Back of Enclosure

5.5.4

Removing the Transmit Radio

Remove the transmit radio to either replace it or to disassemble the repeater further in order to replace the transceiver board.

Prerequisites: Refer to Figure 13: Tx Radio Disassembly on page 62.

Procedure:

1. Disconnect the flex cable from the 30-position connector on the Transmit radio, noting the orientation of the cable which is identified with a solid red line. This is important for reassembly.
2. Remove the flex cable (with double sided adhesive tape) from the power supply.
3. Make sure that the double sided adhesive tape material is completely removed from the power supply.
4. Disconnect the SSI flex cable from the connector on the Transmit radio, noting the orientation of the cable which is identified with a solid black line.

   This is important for reassembly.
5. Loosen the four M4 lock nuts that secure the Transmit radio assembly with a 7 mm socket driver.
6. Slide the Transmit radio assembly slightly forward before lifting it out of the enclosure.

7 Disconnect the power cable from the Transmit radio.

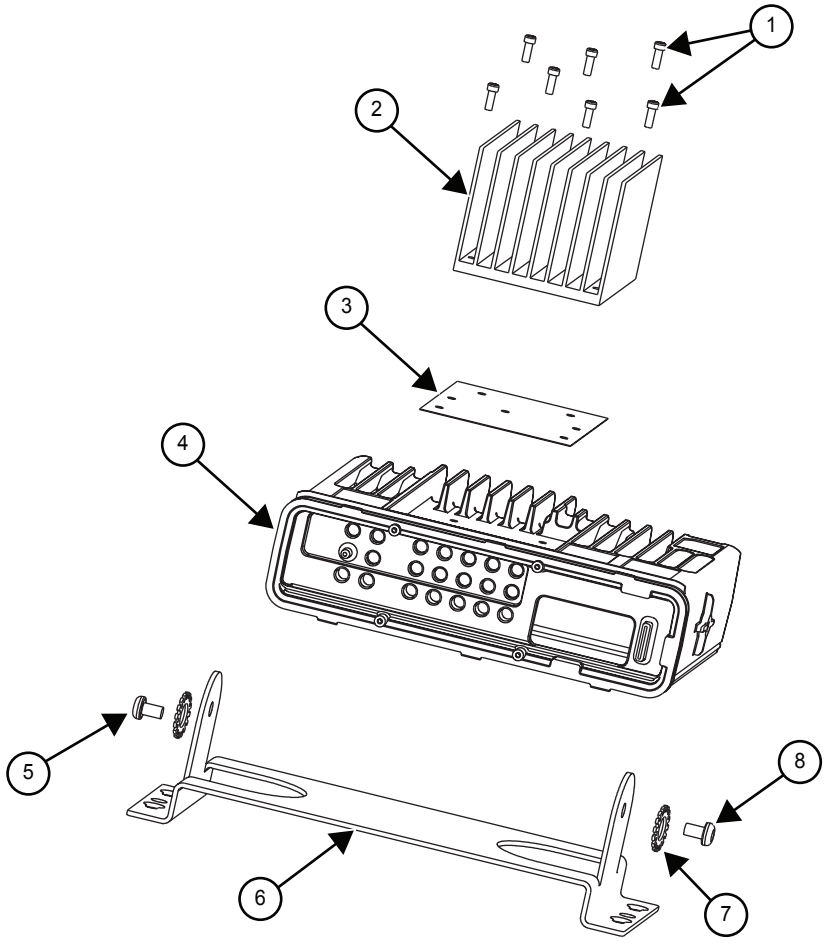
8 Disconnect the antenna cable from the Transmit radio.

9 Disconnect the accessory connector from the Transmit radio.

10 Lift the Transmit radio assembly out of the enclosure and place on a flat surface.

11 Loosen and remove the two M5 screws and washers that secure the Transmit radio to the bracket using a T25 TORX driver.

Figure 13: Tx Radio Disassembly



Number	Description
1	M3 Screws (7)
2	Heatsink
3	Thermal Pad
4	Transmit Radio
5	M5 Screw (1)
6	Transmit Bracket
7	Washer
8	M5 Screw (1)

5.5.4.1

Removing the Thermal Pad and Heatsink

Remove the heatsink to disassemble the repeater further. Remove the thermal pad, as a new pad is needed for reassembly.

Prerequisites: Refer to Figure 13: Tx Radio Disassembly on page 62.

Procedure:

1. Remove all of the seven screws which secure the heatsink to the Transmit radio using a T10 TORX driver.
2. Remove the heatsink from the Transmit radio.
3. Peel off and discard the thermal pad.
4. Replace all worn parts.

5.5.5

Removing the Receive Radio, Power Supply and Connector Board Assembly

Remove the receive radio, power supply, and connector board assembly to either replace them or to disassemble the repeater further in order to replace the receiver board.

Prerequisites: Refer to Figure 14: Receive Radio Removal on page 64.

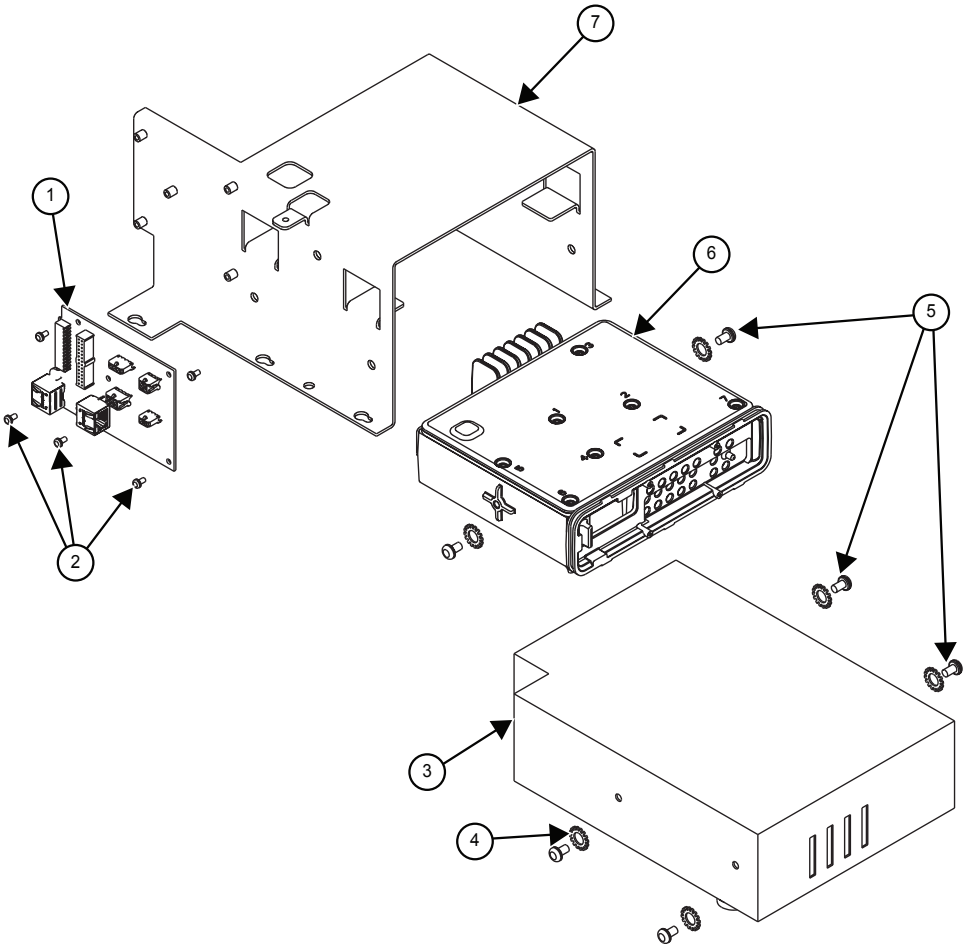
Procedure:

1. Disconnect the SSI flex cable from the connector on the Receive radio, noting the orientation of the cable which is identified with a dotted line.

   This is important for reassembly.
2. Disconnect the antenna cable from the Receive radio.
3. Disconnect the power cable from the Receive radio.
4. Remove the two screws securing the retainer clip using a T20 TORX driver.
5. Remove the accessory connector from the back side of the repeater by inserting a flat blade screwdriver into the slot located on the top of the connector.
6. Disconnect all of the cables from their mating connectors located on the connector board assembly.
7. Loosen the five M4 lock nuts that secure the Receive radio assembly using a 7 mm socket driver.

   NOTICE: The two lock nuts at the side on base require a magnetic lock nut driver with an extension of greater than 150 mm.
8. Slide the Receive radio assembly slightly forward before lifting it out of the enclosure.
9. Take precaution not to damage the power supply or the connector board assembly and place assembly on a flat surface.

Figure 14: Receive Radio Removal



Number	Description
1	Connector Board Assembly
2	M3 Screws (5)
3	Power Supply
4	Washer
5	Screws
6	Receive Radio
7	Receive Bracket

5.5.5.1

Removing the Receive Radio

Remove the receive radio to either replace it or to disassemble the repeater further in order to replace the receiver board.

Procedure:

1 With assembly on a flat surface, loosen and remove the two M5 screws and washers that secure the Receive radio to the bracket using a T25 TORX driver.

2 Slide the Receive radio out of the bracket.

5.5.5.2
Removing the Connector Board Assembly

Remove the connector board assembly to replace it.

Procedure:

1 With assembly on a flat surface, detach the connector board assembly from Receive radio assembly by removing the five M3 screws using a T10 TORX driver.

2 Store connector board assembly in anti-static bag when it is not being serviced.

5.5.5.3
Removing the Power Supply

Remove the power supply to replace it.

Procedure:

1 With assembly on a flat surface, loosen and remove the four M5 screws and washers that secure the power supply to the bracket using a T25 TORX driver.

2 Slide the power supply out from the bracket.

3 Disconnect the Y-split cable from the power supply before sending to the manufacturer.

NOTICE: The Power Supply should be serviced by the manufacturer.

5.5.6
Removing the Transceiver and Receiver Boards

Remove the transceiver or receiver boards to replace them.

Procedure:

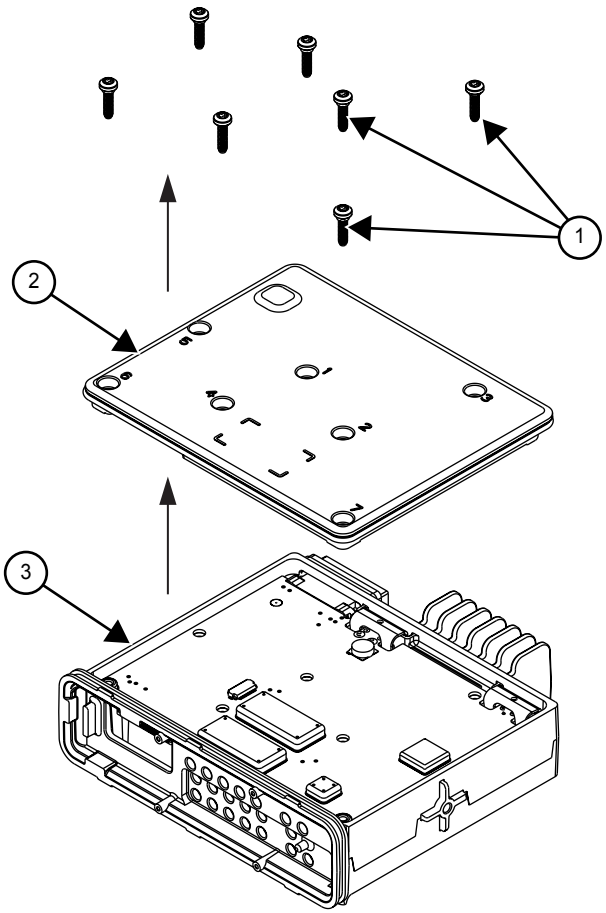
1 Remove the seven screws from the die cast cover using the T20 TORX driver as shown in Figure 15: Die Cast Cover Removal on page 66.

NOTICE: Do not remove the O-rings from the screws.

2 Lift the die cast cover from the chassis.

NOTICE: For VHF bricks only: check that the two thermal pads on the heat sink block are intact. Replace them if damaged. See Figure 26: Assembling of PA Heat Sink System (VHF 8 MB Brick) on page 75.

Figure 15: Die Cast Cover Removal

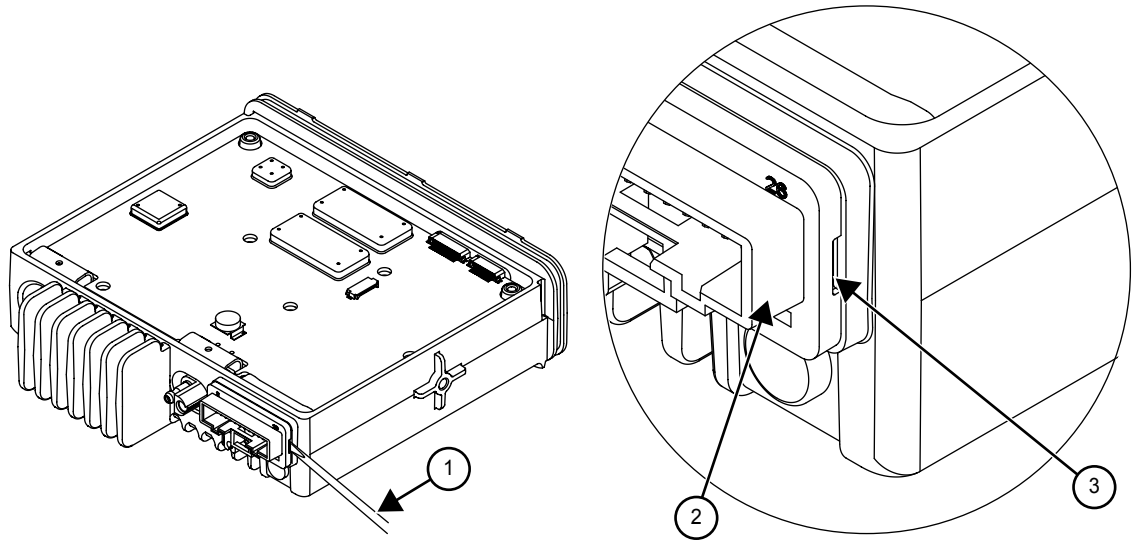


Number	Description
1	Screws (7)
2	Die Cast Cover
3	Radio Chassis

3 Remove the rear accessory connector from the radio assembly by inserting a flat-blade screwdriver into the slot on the side of the connector as shown in Figure 16: Rear Accessory Connector Removal on page 67.

CAUTION: The rear accessory connector should never be removed when the cover is still assembled to the radio.

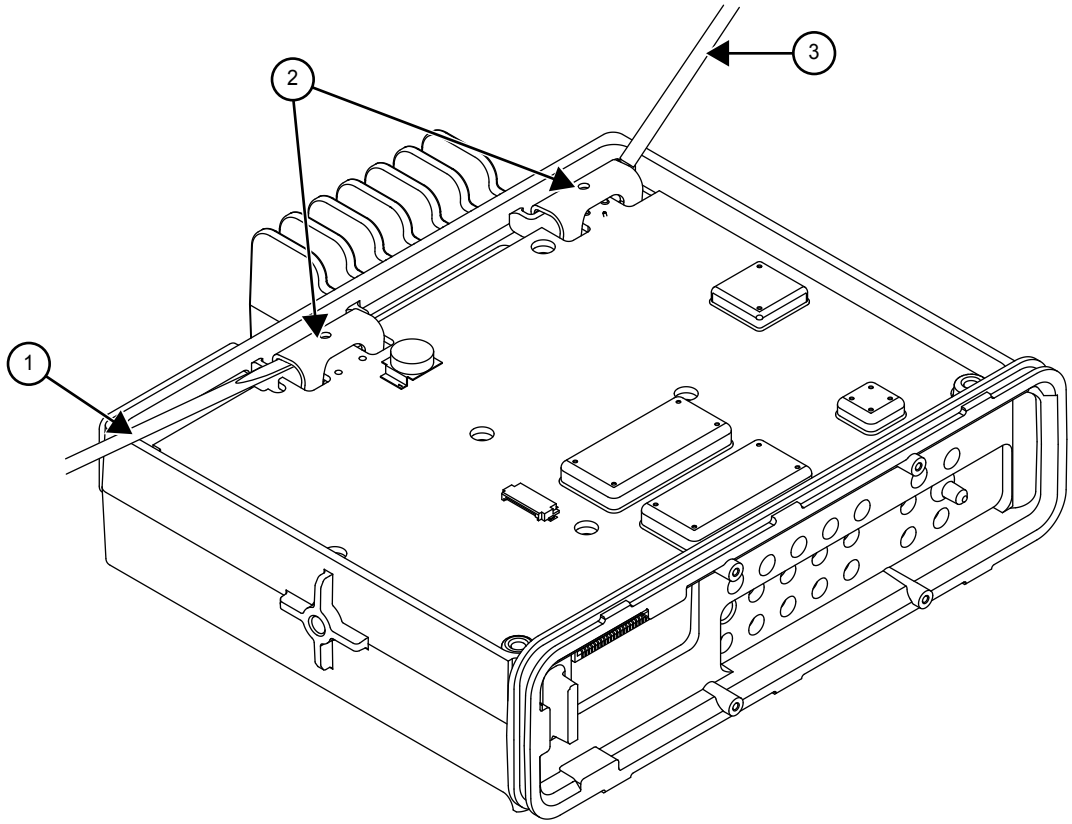
Figure 16: Rear Accessory Connector Removal



Number	Description
1	Flat-blade Screwdriver
2	Rear Accessory Connector
3	Slot

4 Remove the RF/DC retention clips by gently prying them out with a flat-blade screwdriver as shown in Figure 17: RF/DC Retention Clips Removal on page 68.

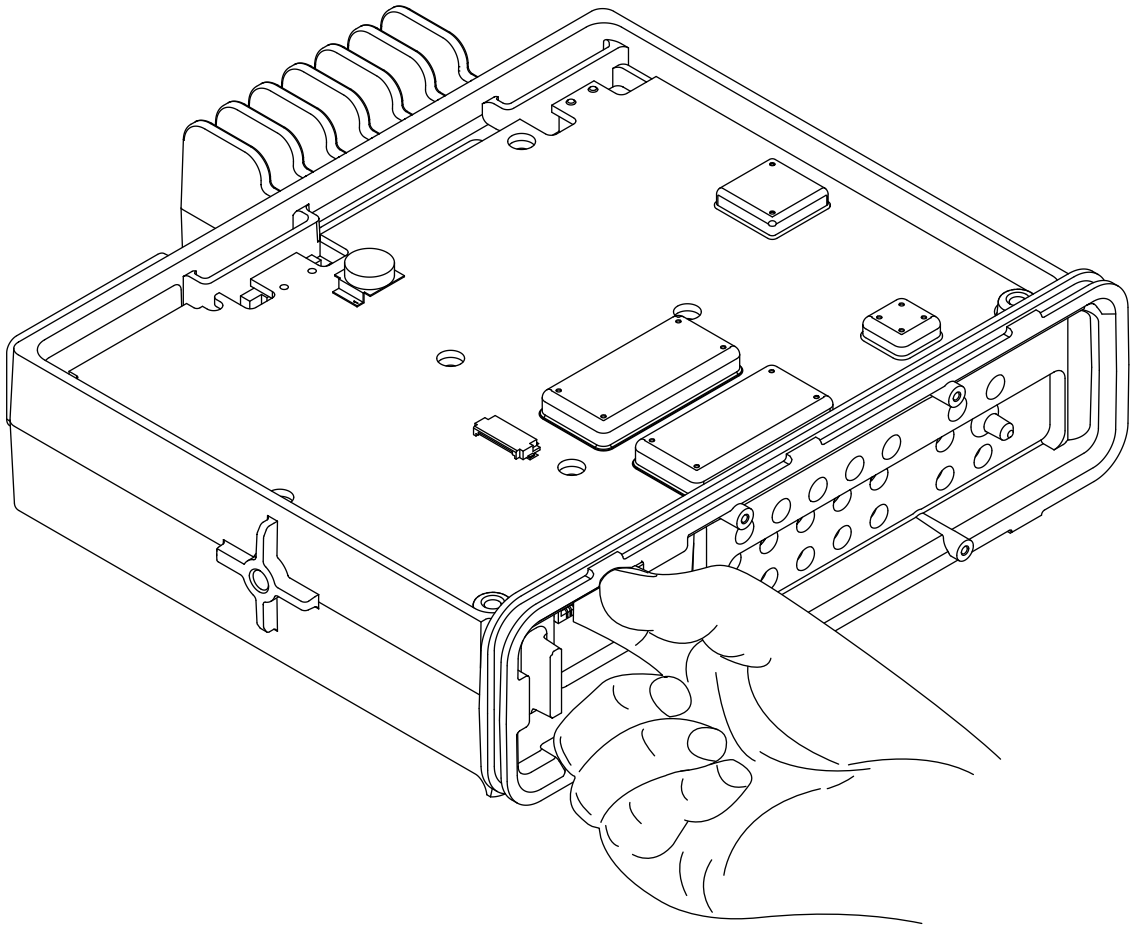
Figure 17: RF/DC Retention Clips Removal



Number	Description
1	Flat-blade Screwdriver
2	RF/DC Retention Clips
3	Flat-blade Screwdriver

5 Remove the transceiver board by sliding a finger into the opening provided at the front of the radio and gently pressing up on the 30-pin connector, lifting up the front of the board, as shown in Figure 18: Transceiver Board Removal on page 69.

Figure 18: Transceiver Board Removal



6 Slide the transceiver board towards the front of the radio to allow the RF/DC connectors to clear the chassis.

Handle the transceiver board by the edges only and store it in an antistatic bag.

CAUTION: The thermal pads can act as an adhesive and cause stress to critical components on the transceiver board if the transceiver board is lifted too quickly.

NOTICE: If the RF/DC connector gaskets remain in the chassis, remove them and place them back on the connectors.

5.6 Reassembling the Transmit and Receive Radio – Detailed

The following reassembly procedures are applicable to both the Transmit and Receive radios.

Procedure:

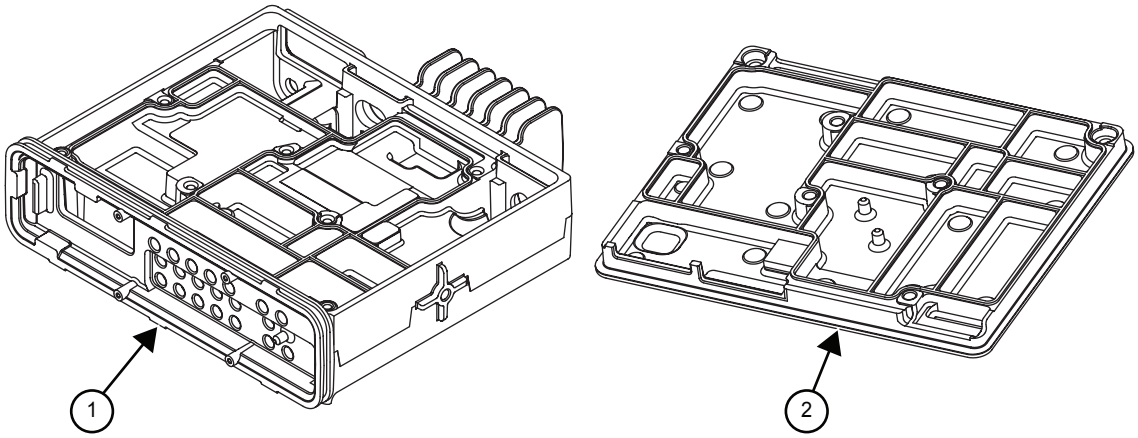
1 Before reassembling the radio, inspect all seals and sealing surfaces for damage (nicks, cuts, etc.) or debris.

See Repeater Exploded Mechanical Views and Parts Lists on page 90 for the correct part numbers and replace parts, as necessary.

2 Reseat all new seals on their respective parts.

3 For both the die cast cover and the chassis, thoroughly inspect the shield gasketing for damage and verify all thermal pads are in place and free from damage and debris. See Replacing the Harmonic Filter Thermal Pad and Replacing the Driver Thermal Pad to replace damaged pads.

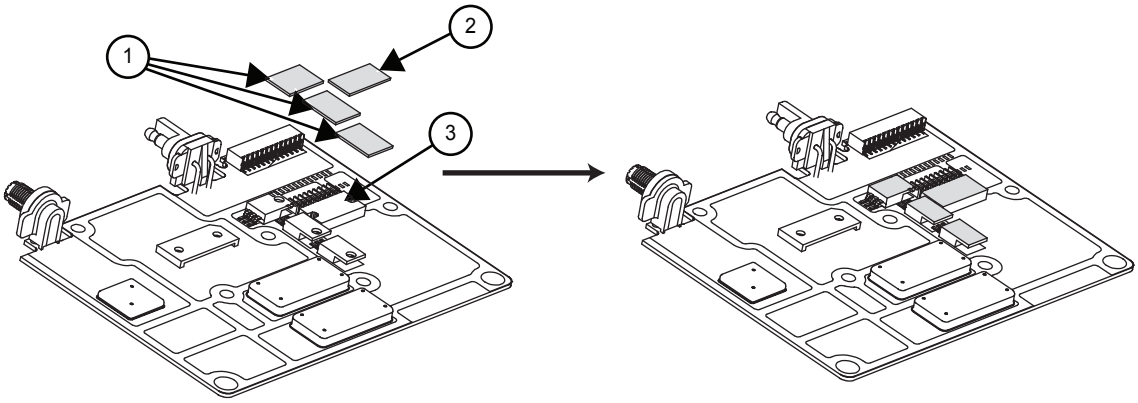
Figure 19: Thermal Pads and Shield Gasketing on Chassis and Die Cast Cover



Number	Description
1	Chassis with Thermal Pads and Shield Gasketing
2	Die Cast Cover with Thermal Pads and Shield Gasketing

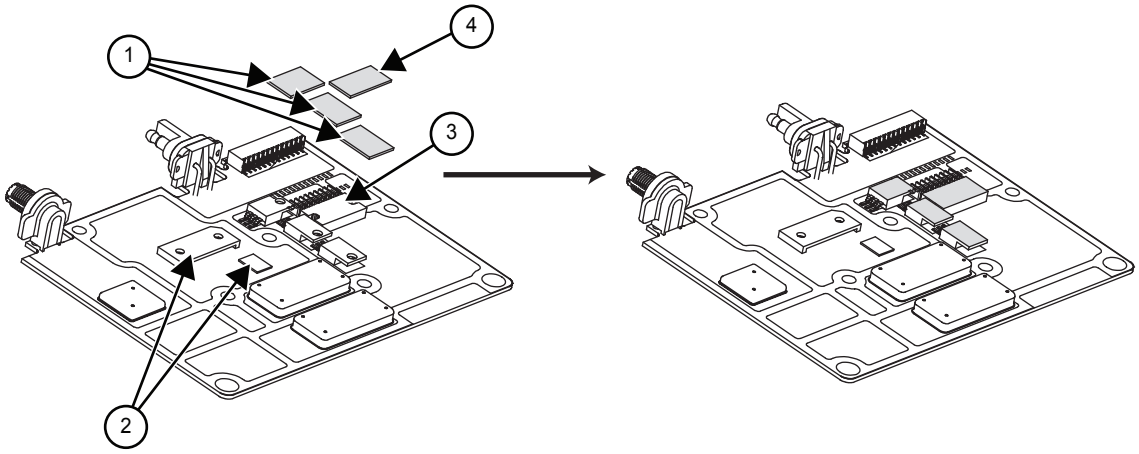
4 Thoroughly inspect the transceiver board and verify all thermal pads are in place and free from damage. See Replacing the Transistor Thermal and PA Thermal Pads to replace damaged pads. For VHF/UHF 32 MB bricks, see Figure 21: Transceiver Board with Thermal Pads (VHF/UHF 32 MB Bricks) on page 71.

Figure 20: Transceiver Board with Thermal Pads



Number	Description
1	Transistor Thermal Pads (75012018001)
2	PA Thermal Pad (75012015001)
3	Audio PA Component

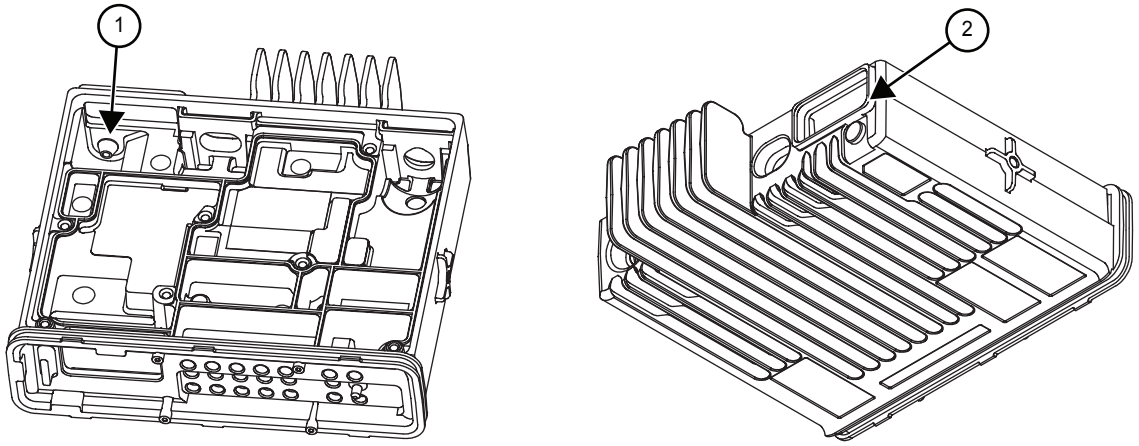
Figure 21: Transceiver Board with Thermal Pads (VHF/UHF 32 MB Bricks)



Number	Description
1	Transistor Thermal Pads (75012018001)
2	Apply Thermal Grease (1180113S01) on Final Heat Spreader and Driver Heat Sink
3	Audio PA Component
4	PA Thermal Pad (75012015001)

5 Assembly of the GPS Plug. Push the GPS plug into the chassis opening until it is fully seated. Refer to Figure 22: Replacing GPS Plug on page 71.

Figure 22: Replacing GPS Plug



Number	Description
1	GPS Plug
2	GPS Plug

5.6.1

Replacing the Transceiver and Receiver Boards

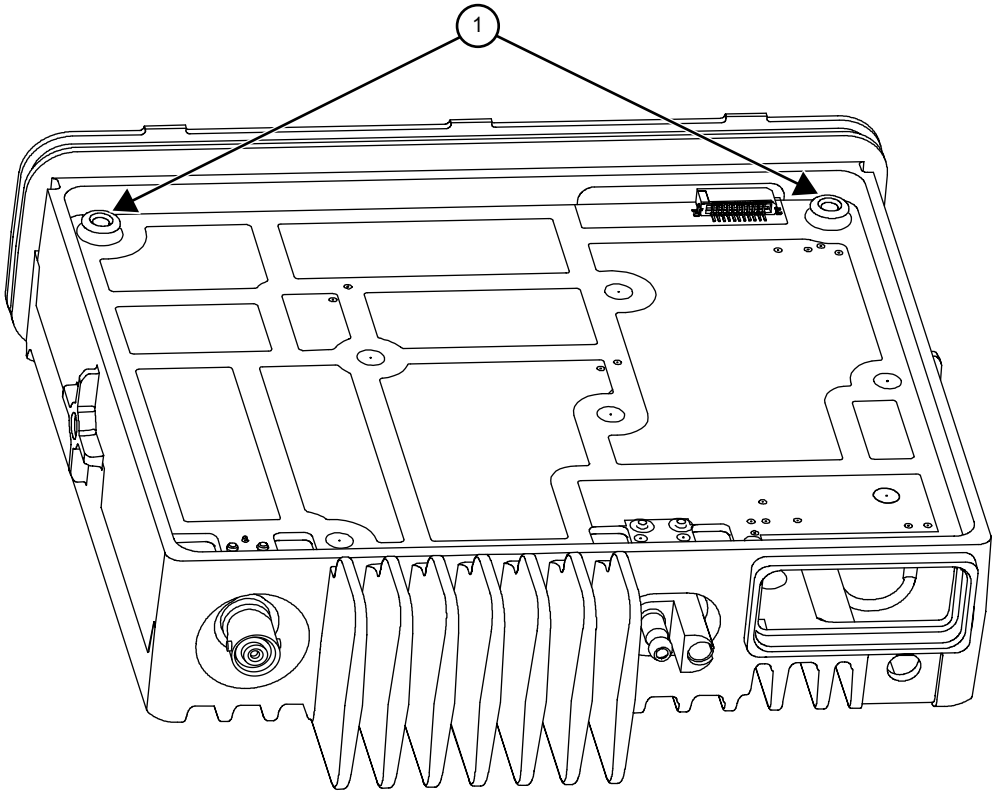
Install the replacement transceiver or receiver boards.

Procedure:

1 Insert the transceiver board into the chassis by tilting the transceiver board (approximately 30 degrees) and sliding it into place, taking care to line up the RF and DC connectors with the openings in the back of the chassis.

Ensure that the transceiver board alignment holes are positioned over the chassis alignment bosses and then push the board down to fully seat.

Figure 23: Placing the Transceiver Board in the Chassis

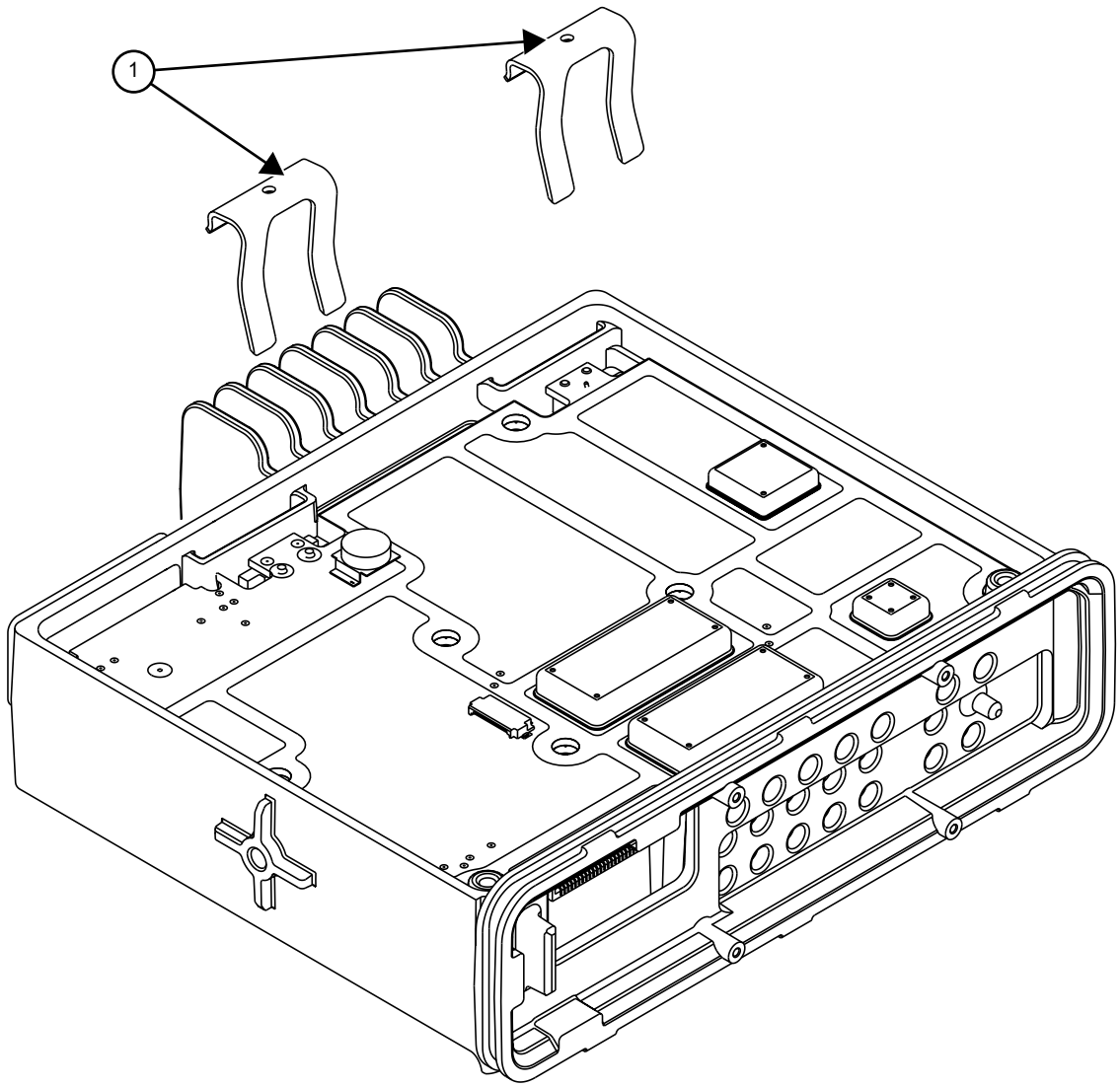


Number	Description
1	Locating Bosses

CAUTION: Do not leave the transceiver board in the chassis for extended periods of time without the RF/DC retention clips, or damage to the board connectors may occur.

2 Insert the RF/DC retention clips and fully seat them. The DC clip should be inserted first to properly locate the transceiver board. See Figure 24: Inserting RF/DC Retention Clips on page 73.

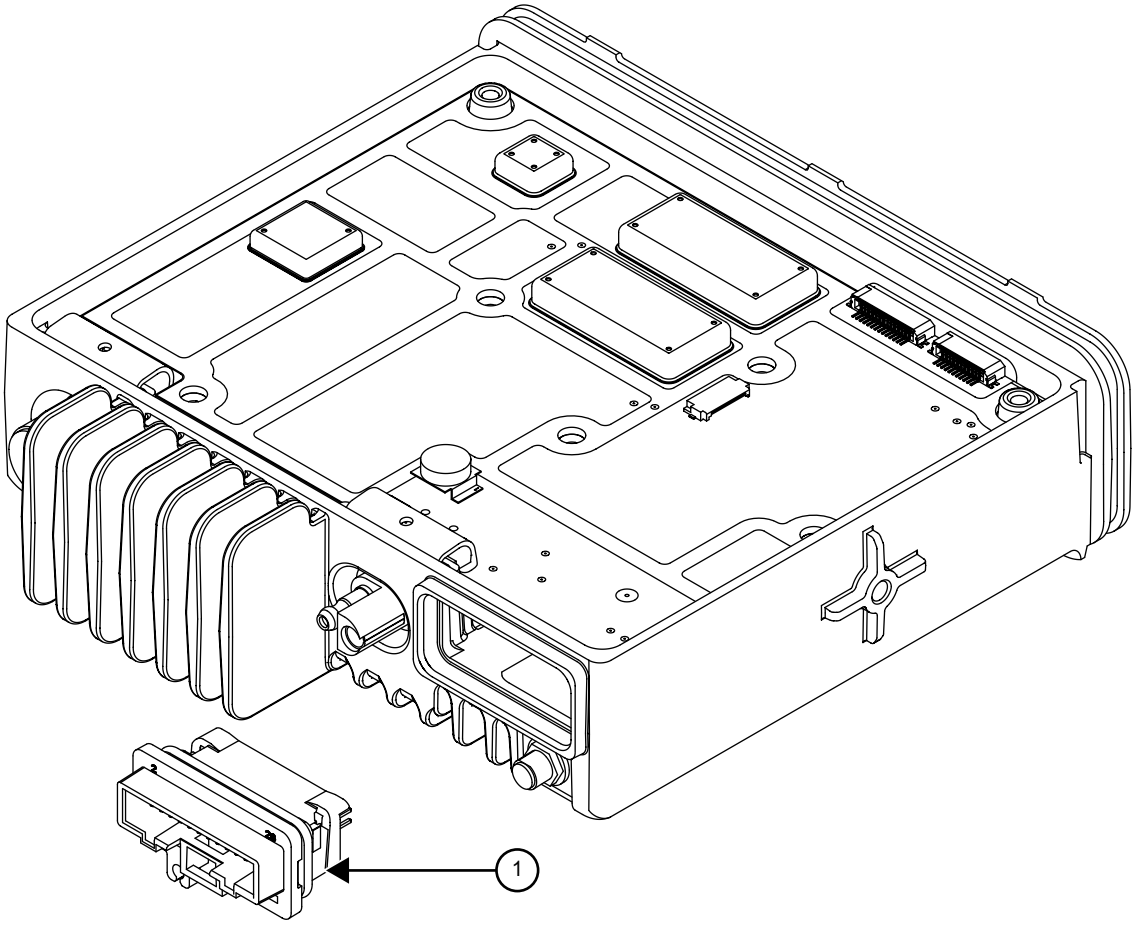
Figure 24: Inserting RF/DC Retention Clips



Number	Description
1	RF/DC Retention Clips

3 Insert the rear accessory connector into the radio assembly and press into place until the connector is flushed with the chassis. See Figure 25: Inserting Rear Accessory Connector on page 74.

Figure 25: Inserting Rear Accessory Connector



Number	Description
1	Rear Accessory Connector

4 Place the PA pad on to the die cast cover by aligning the two holes in the PA pad with the alignment pins on the die cast cover. For VHF 32 MB and UHF bricks, see Figure 27: Assembling of PA Pad and O-ring (VHF 32 MB and UHF Bricks) on page 76.

See Replacing the Transistor Thermal and PA Thermal Pads for the instructions on how to replace the pad.

5 For VHF 8 MB bricks only: PA heat sink block and thermal pads need to be placed on to the pressure pad before it gets assembled to the die cast cover. See Figure 26: Assembling of PA Heat Sink System (VHF 8 MB Brick) on page 75 and Figure 28: Assembling of PA Pad and O-ring (VHF 8 MB Brick) on page 77. See Replacing the Transistor Thermal and PA Thermal Pads for the instructions on how to replace the pads.

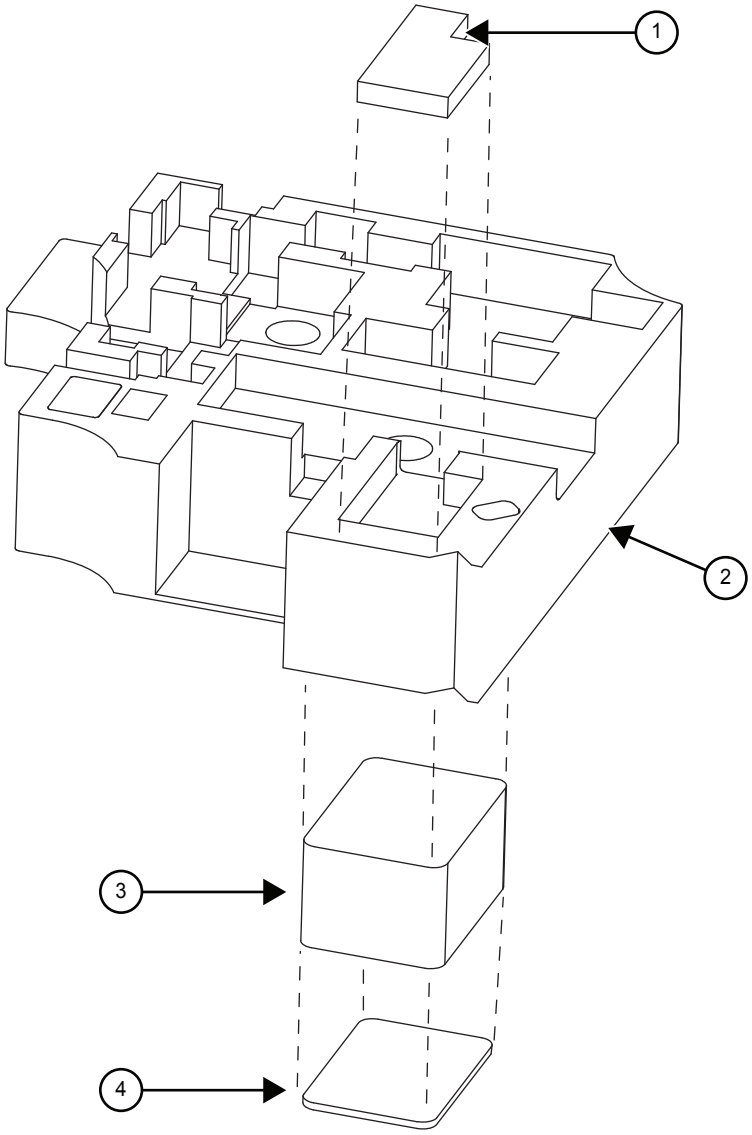
a Remove thermal pad (7571835M01) from the shipping liner and place it on to the heat sink block by aligning the rounded corners. Remove the protective liner from the exposed side of the thermal pad.

b Insert the heat sink block with the thermal pad attached into the compartment on the PA pressure pad, until it is fully seated. The attached thermal pad should be fully visible after assembly.

c Remove thermal pad (7571836M01) from the shipping liner and place it on to the exposed metal surface of heat sink block by orienting the thermal pad so its shape matches the opening on the pressure pad.

d Remove the protective liner from the exposed side of the thermal pad (7571836M01).

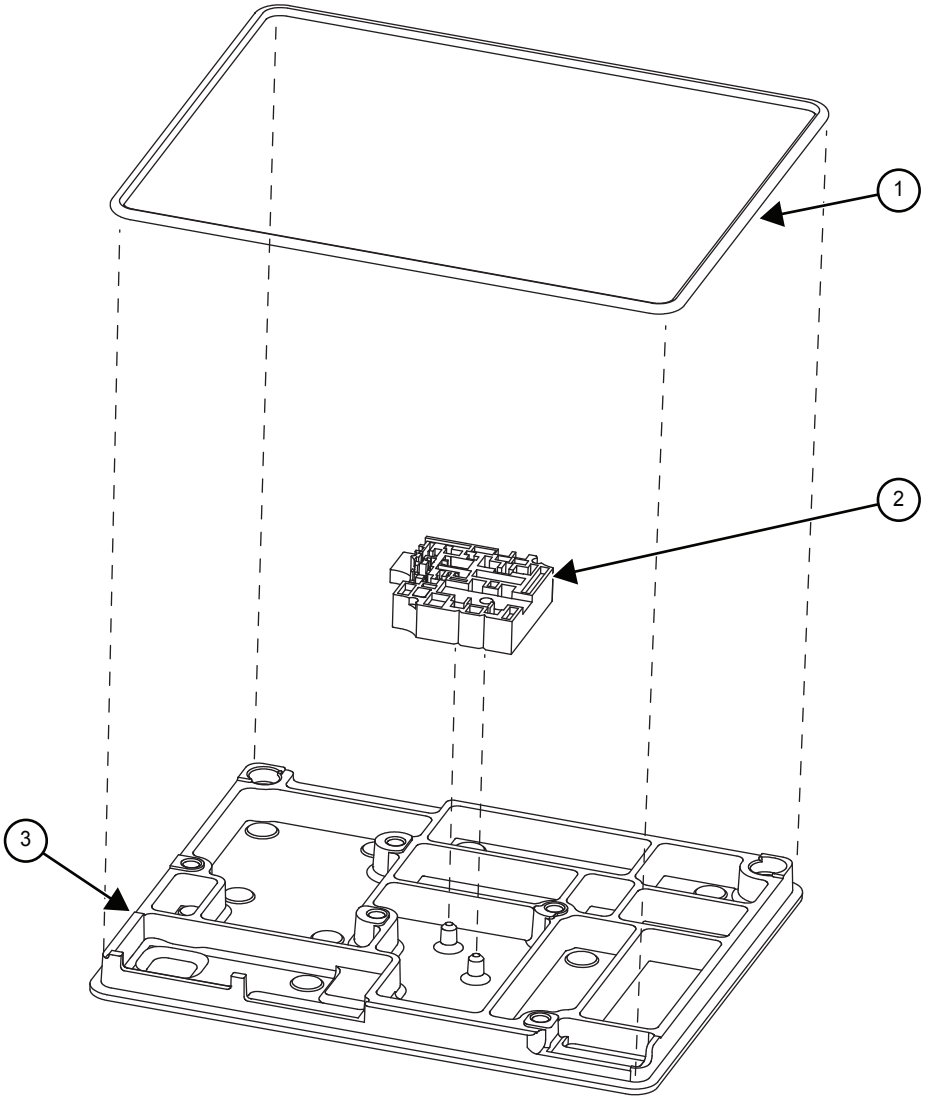
Figure 26: Assembling of PA Heat Sink System (VHF 8 MB Brick)



Number	Description
1	Thermal Pad (7571836M01
2	VHF Pressure Pad
3	Heat Sink (2671834M01)
4	Thermal Pad (7571835M01)

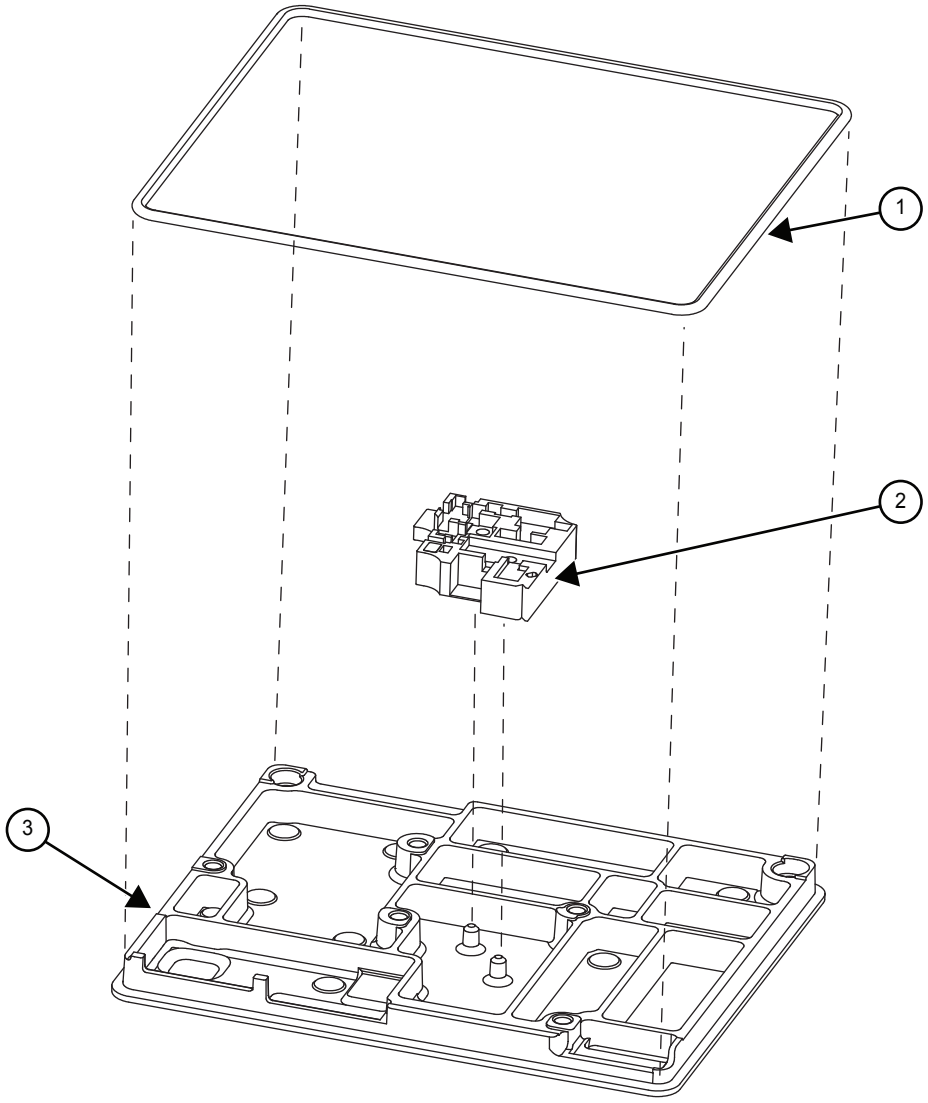
6 Fit the O-ring onto the die cast cover securely. See either Figure 27: Assembling of PA Pad and O-ring (VHF 32 MB and UHF Bricks) on page 76 or Figure 28: Assembling of PA Pad and O-ring (VHF 8 MB Brick) on page 77.

Figure 27: Assembling of PA Pad and O-ring (VHF 32 MB and UHF Bricks)



Number	Description
1	O-ring
2	PA Pad
3	Die Cast Cover

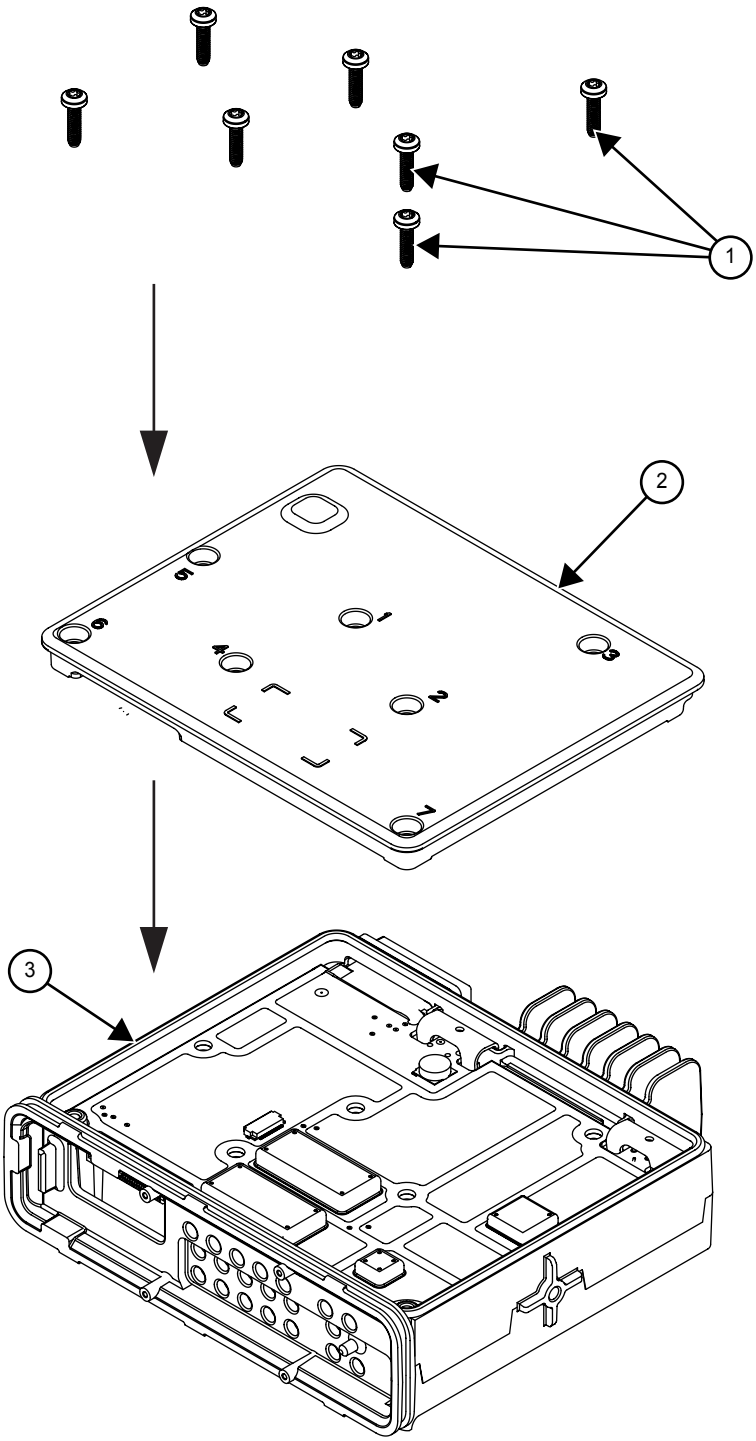
Figure 28: Assembling of PA Pad and O-ring (VHF 8 MB Brick)



Number	Description
1	O-ring
2	PA Pad
3	Die Cast Cover

7 Place the die cast cover onto the chassis orienting the die cast cover so that screw holes 6 and 7 align with the bosses on the chassis as shown in Figure 29: Assembling Die Cast Cover onto Chassis on page 78.

Figure 29: Assembling Die Cast Cover onto Chassis

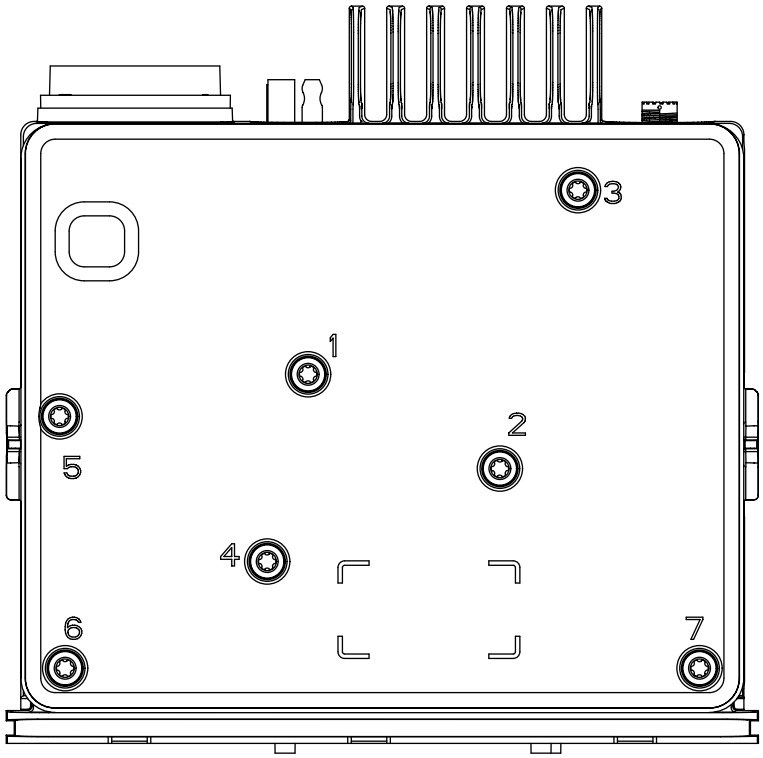


Number	Description
1	Screws (7)
2	Die Cast Cover
3	Radio Chassis

8 Using a T20 TORX driver, tighten the seven screws between 2.94 N-m (26 lbs-in.) in the order shown in Figure 30: Screw Sequence to Tighten Die Cast Cover on page 79.

9 Repeat tightening the seven screws in the order shown, otherwise the first three screws will likely be loose.

Figure 30: Screw Sequence to Tighten Die Cast Cover



5.6.1.1

Replacing the Harmonic Filter Thermal Pad

While replacing the transceiver board, the harmonic filter thermal pad must be replaced on the chassis.

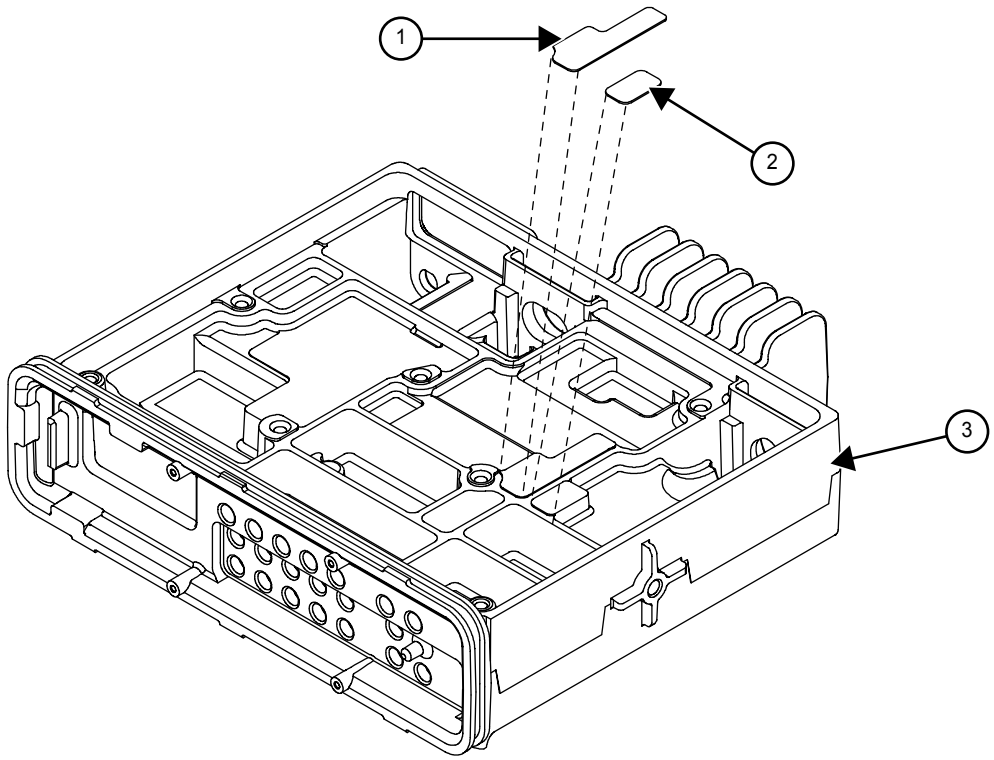
Procedure:

1 Use a plastic flat-edge tool to lift the pad from the chassis surface. Discard the old pad.

2 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, remove the new pad from the shipping liner, and place it white side down on the chassis as shown in Figure 31: Replacing Thermal Pads on page 80.

Figure 31: Replacing Thermal Pads



Number	Description
1	Harmonic Filter Pad (75012017001)
2	Harmonic Filter Pad (75012016001)
3	Radio Chassis

5.6.1.2

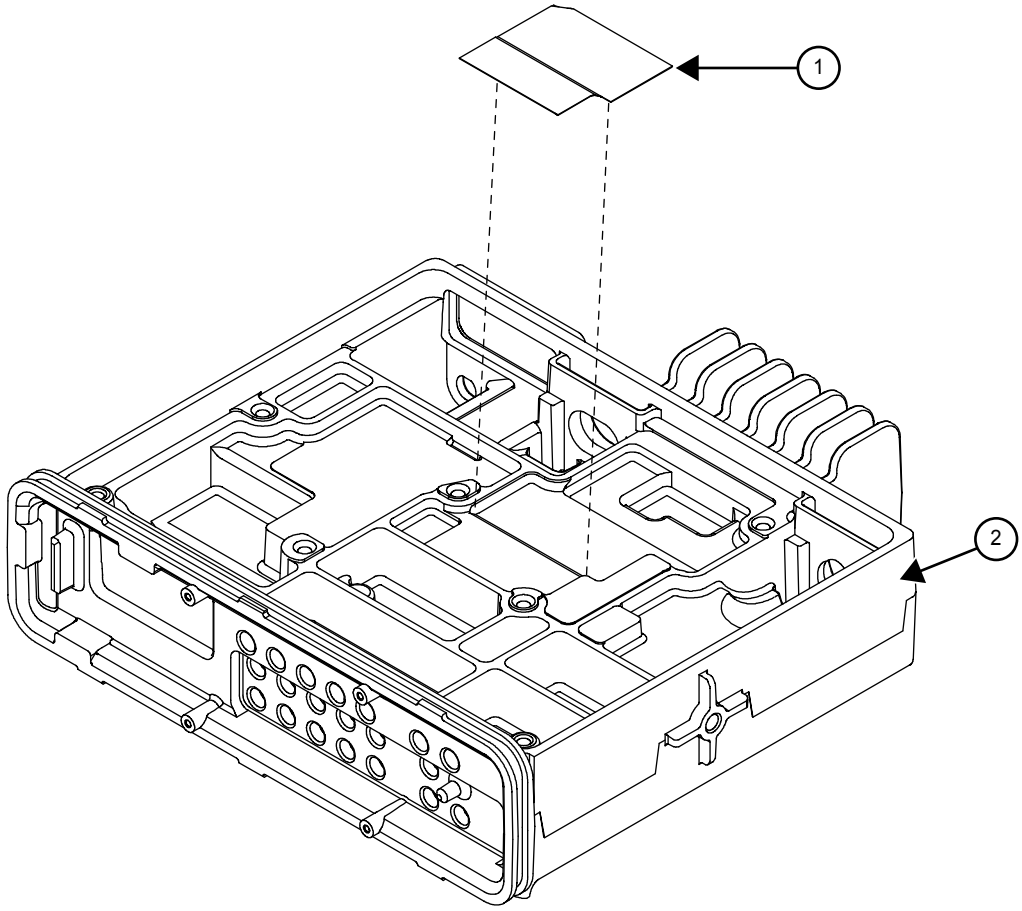
Replacing the Driver Thermal Pad

While replacing the transceiver board, the driver thermal pad must be replaced on the chassis.

Procedure:

1. Use a plastic flat-edge tool to lift the pad from the chassis surface. Discard the old pad.
2. 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, remove the new pad from the shipping liner, and place the pad on to the chassis, aligning the edges of the pad with the edges of the chassis, as shown in Figure 32: Aligning Driver Pad on Chassis on page 81.

Figure 32: Aligning Driver Pad on Chassis



Number	Description
1	Driver Pad (7515357H01)
2	Radio Chassis

4 Apply even pressure to the pad and remove the protective liner.

5.6.1.3

Replacing the Transistor Thermal and PA Thermal Pads

While replacing the transceiver board, the transistor thermal pad and PA thermal pad must be replaced on the transceiver board.

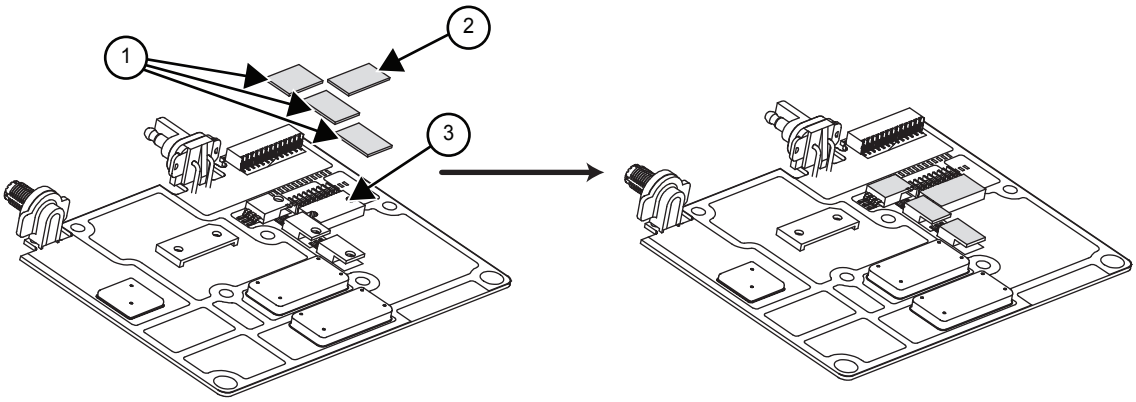
Procedure:

1 Use a plastic flat-edge tool to lift each pad from the transceiver board. Discard the old pads.

2 Use a soft cloth to remove any remaining residue. Alcohol can also be used, if necessary.

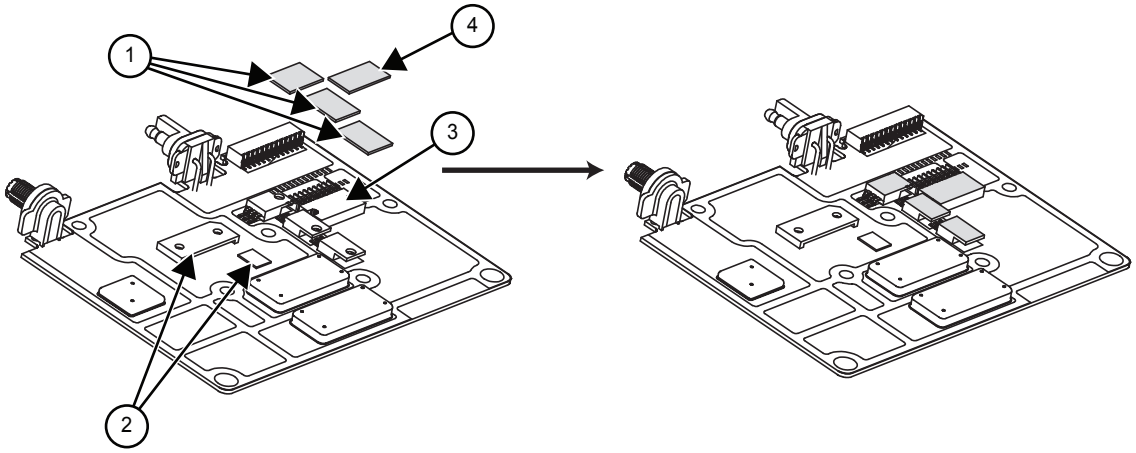
3 Once the surface is clean and dry, remove each new pad from the shipping liner, and place in the proper location on top of each transistor component and the audio PA with the white side down, see Figure 33: Placing Thermal Pads on PA and Transistor Components on page 82. For VHF/UHF 32 MB bricks, see Figure 34: Placing Thermal Pads on PA and Transistor Components (VHF/UHF 32 MB Bricks) on page 82.

Figure 33: Placing Thermal Pads on PA and Transistor Components



Number	Description
1	Transistor Thermal Pads (75012018001)
2	PA Thermal Pad (75012015001)
3	Audio PA Component

Figure 34: Placing Thermal Pads on PA and Transistor Components (VHF/UHF 32 MB Bricks)



Number	Description
1	Transistor Thermal Pads (75012018001)
2	Apply Thermal Grease (1180113S01) on Final Heat Spreader and Driver Heat Sink
3	Audio PA Component
4	PA Thermal Pad (75012015001)

5.6.2

Replacing the Power Supply

Replace the power supply to reassemble the repeater when a transceiver or receiver board was replaced or when the power supply was replaced.

Procedure:

1. Visually inspect the repeater enclosure to ensure that no metal shavings or debris are found before replacing the power supply. See Figure 14: Receive Radio Removal on page 64.
2. Align the two mounting holes on each side of the bracket with the mounting holes on the power supply.
3. Secure the power supply and the bracket with the four M5 screws and washers.
4. Tighten the four M5 screws to 3.0 N-m.
5. Firmly connect the single connection end of Y-split cable to power cable of power supply.

5.6.3
Replacing the Receive Radio

Install the receive radio to reassemble the repeater after replacing the receive radio or replacing the receiver board.

Procedure:

1. Visually inspect the repeater enclosure to ensure that no metal shavings or debris are found before replacing the power supply. See Figure 14: Receive Radio Removal on page 64.
2. Insert the Receive radio into the top half of the bracket.
3. Align the mounting hole on each side of the receive chassis to the mounting holes on the bracket.
4. Secure the Receive radio and the bracket with the two M5 screws and washers.
5. Tighten the two M5 screws to 3.0 N-m.

5.6.4
Replacing the Connector Board Assembly

Install the connector board assembly to reassemble the repeater after replacing the receive radio.

Procedure:

1. Visually inspect the repeater enclosure to ensure that no metal shavings or debris are found before replacing the power supply. See Figure 14: Receive Radio Removal on page 64.
2. Align the five mounting holes on the connector board assembly to the five standoffs on the receive bracket.
3. Secure the connector board assembly with the five M3 screws.
4. Tighten the five M3 screws to 1.0 N-m.

5.6.5
Replacing the Receive Bracket Assembly to the Enclosure

Replace the receive bracket assembly to reassemble the repeater after replacing the receive radio or replacing the receiver board.

Procedure:

1. Visually inspect the repeater enclosure to ensure that no metal shavings or debris are found before replacing the power supply. See Figure 14: Receive Radio Removal on page 64.
2. Align and mount the receive bracket assembly onto the five stud screws in the enclosure.
3. Ensure that the dimple locator (bump) on the enclosure is nested within the hole on the receive bracket before installing and tightening the lock nuts.

4 Tighten the five lock nuts to 2.0 N-m.

NOTICE: The two lock nuts at the side on base require a magnetic lock nut driver with extension of greater than 150 mm.

5 Connect the antenna cable to the Receive radio.

6 Insert the BNC connector of the antenna cable through the back panel of the enclosure and secure it using a lock washer and nut.

7 Tighten the nut to 2.3 N-m using a 16 mm deep well socket driver.

8 Firmly connect one of the connectors from the dual end of Y-split cable to the Receive radio.

NOTICE: All cables (except the antenna cable), are routed at the bottom rear receive bracket.

9 Insert the accessory connector through the opening of the enclosure onto the edge of the connector board assembly.

10 Make sure that the accessory connector is inserted onto the connector board assembly and that the back-end surface of the accessory connector is flushed firmly against the back panel of enclosure.

11 Mount the retainer clip and secure it with the two M4 screws.

12 Tighten the screws to 2.0 N-m.

13 Insert the solder terminal end of the SSI cable into the 11-position connector at the front face of Receive radio. A dashed black line is visible from the top view.

5.6.6
Replacing the Transmit Radio

Install the transmit radio to reassemble the repeater after replacing the transmit radio or replacing the transceiver board.

Procedure:

1 Make sure that mating surfaces of Heatsink and Transmit radio are cleaned and free from any debris. See Figure 13: Tx Radio Disassembly on page 62.

2 Align the holes on the thermal pad to the screw holes in the Transmit radio and place the thermal pad onto the Transmit radio.

3 Align the holes on the heatsink to the screw holes in the Transmit radio and place the heatsink onto the thermal pad.

4 Secure, but do not tighten the seven screws previously removed.

5 When all seven screws are secured, tighten to 1.0 N-m. See Figure 30: Screw Sequence to Tighten Die Cast Cover on page 79.

5.6.7
Replacing the Transmit Bracket Assembly to the Enclosure

Replace the transmit bracket assembly to reassemble the repeater after replacing the transmit radio or replacing the transceiver board.

Procedure:

1 Position the Transmit radio onto the transmit bracket so that the label “FRONT” on bracket is facing the front face of radio. (See Figure 13: Tx Radio Disassembly on page 62)

2 Align the mounting holes on the Transmit radio and the transmit bracket on both sides.

3 Attach and secure the M5 screws and washers on each side of the bracket.

4 Tighten the screws to 3.0 N-m, making sure that the Transmit radio remains horizontal.

5 Align and mount the transmit bracket assembly onto the four stud screws in the enclosure.

6 Ensure that the dimple locator (bump) on the enclosure is nested within the hole on the transmit bracket before installing and tightening the lock nuts.

7 Secure the four lock nuts (two on each side) onto the stud screws.

8 Tighten the four lock nuts to 2.0 N-m.

9 Connect the antenna cable to the Transmit radio.

10 Insert the N-Type connector of the antenna cable through the back panel of the enclosure and secure it using a lock washer and nut.

11 Tighten the nut to 2.3 N-m using a 19 mm deep well socket driver.

12 Firmly connect one of the connectors from the dual end of Y-split cable to the Transmit radio.

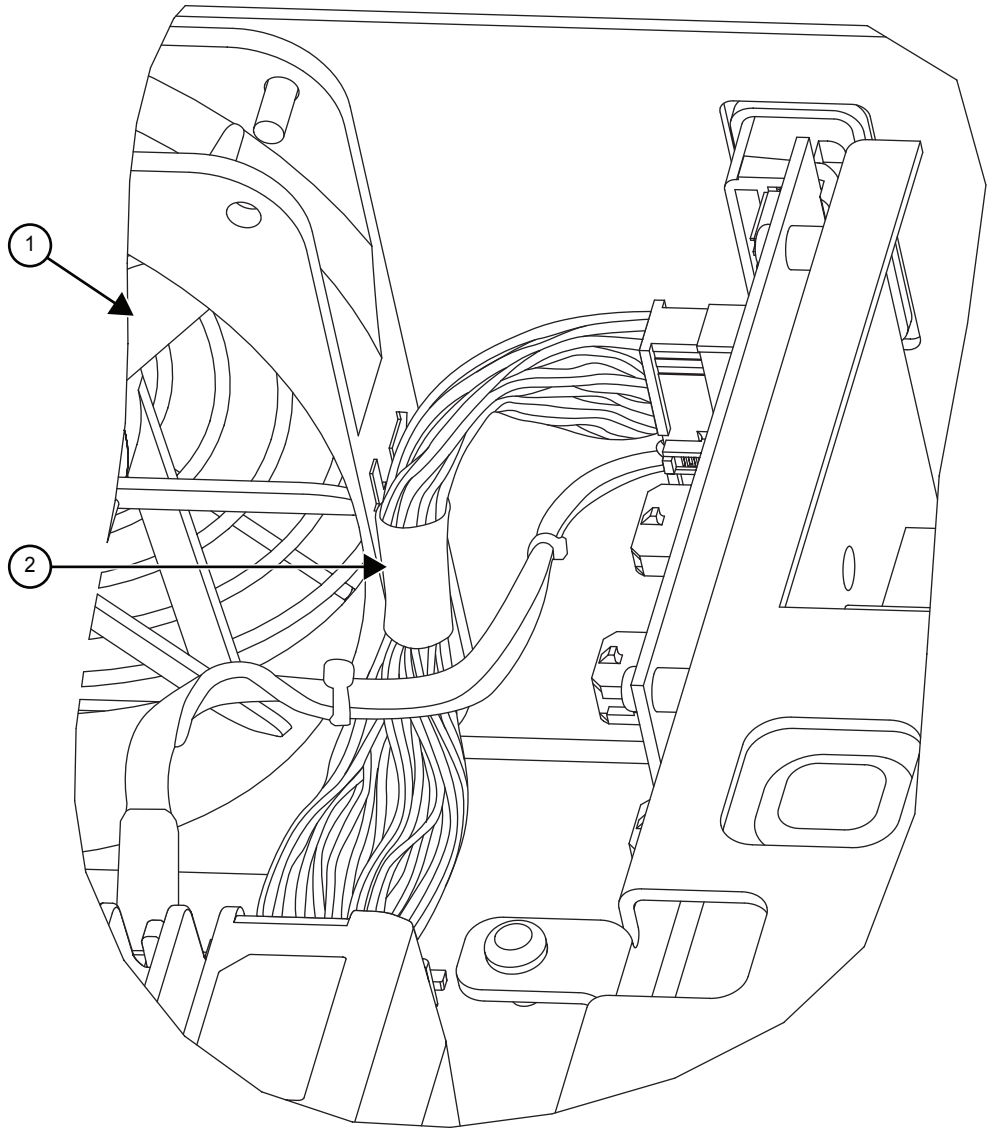
13 Connect the black colored end of accessory cable connector to rear of Transmit radio making sure that the locking connector tab is facing up.

14 Connect the white-colored end of the accessory cable connector to the connector board assembly making sure that the locking connector tab is facing toward the front of repeater.

NOTICE: Make sure that the accessory connectors at both ends are locked in place. A clicking sound can be heard from the locking tab.

15 Position the accessory cable harness against the side of fan body. See Figure 35: Accessory Cable Harness Assembly on page 86.

Figure 35: Accessory Cable Harness Assembly



Number	Description
1	Fan
2	Accessory Cable Harness

16 Insert the solder terminal end of the SSI flex cable (positioned bottom side of PCB) into the 11-position connector in the Transmit radio. A solid black line is visible from the top view.

17 Insert the solder terminal end of the flex cable (positioned top side of PCB) into the 30-position connector in the Transmit radio. A solid red line is visible from the top view.

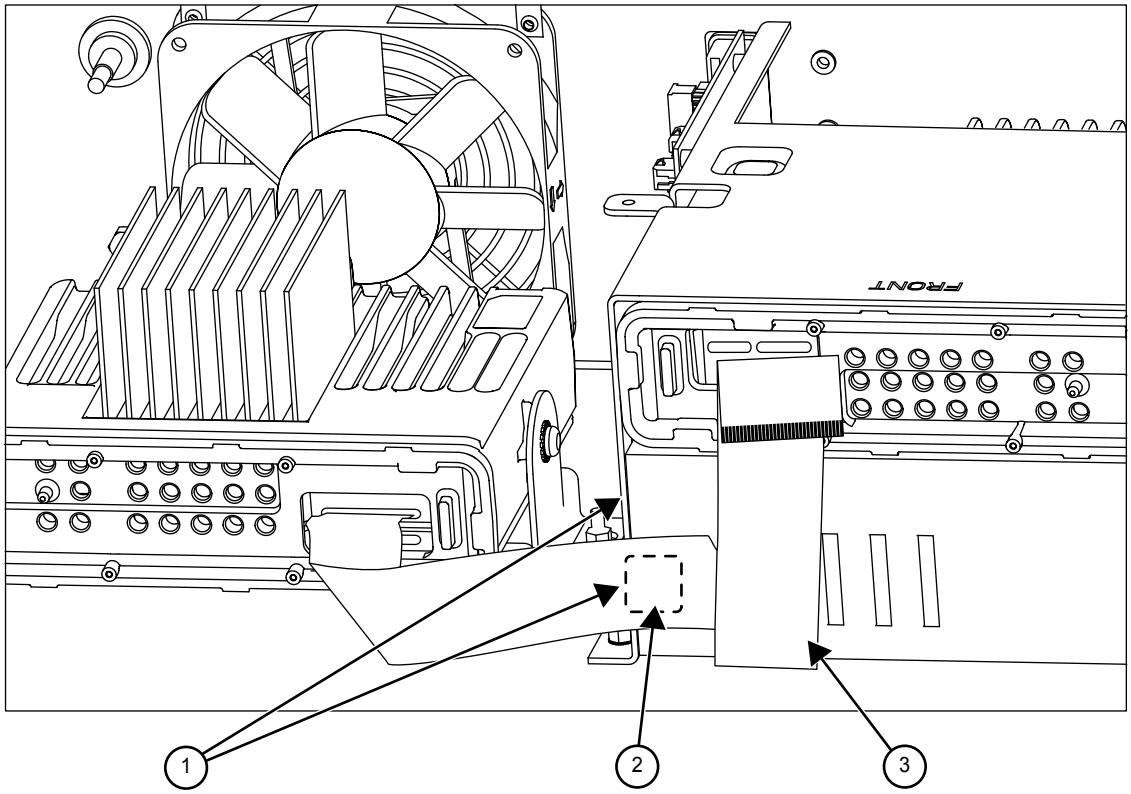
18 On the flex cable, peel the paper on the back of the adhesive tape. Not applicable for VHF/UHF 32 MB repeaters.

19 Make sure that the surface on the power supply is free of grease and debris where the flex cable adhesive tape is applied. Not applicable for VHF/UHF 32 MB repeaters.

20 Apply the adhesive tape so that the vertical left edge of the adhesive tape aligns with the left vertical edge of the power supply as shown in Figure 36: Mounting the Adhesive Tape Flex

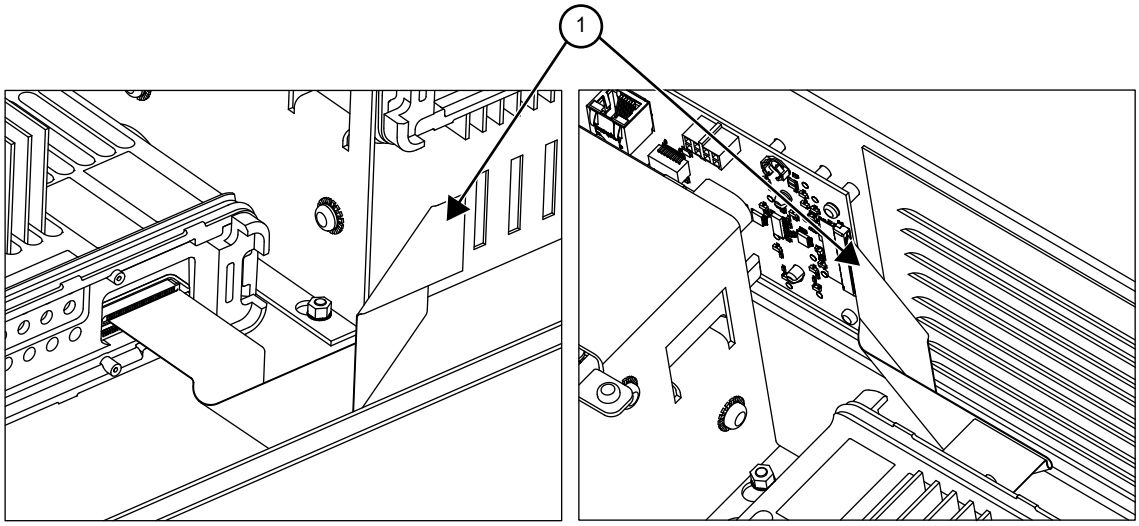
Cable to Power Supply on page 87. Notice that the bottom edge of the flat cable is touching or almost touching the bottom of the enclosure. Not applicable for VHF/UHF 32 MB repeaters.

Figure 36: Mounting the Adhesive Tape Flex Cable to Power Supply



Number	Description
1	Tape edge is located near edge of power supply
2	Adhesive tape location on the other side of cable
3	This edge touching or almost touching the bottom of the enclosure

Figure 37: Flex Cable Assembly (VHF/UHF 32 MB Repeaters)



Number	Description
1	Flex Cable

5.6.8

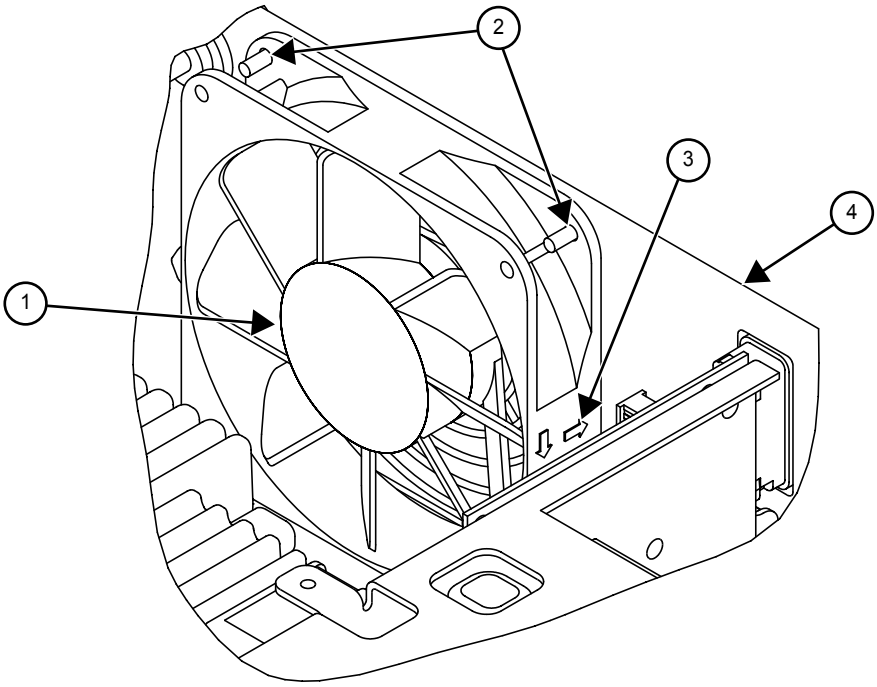
Replacing the Fan

Install the fan to reassemble the repeater after replacing the fan or replacing other parts of the repeater.

Procedure:

1 Position the fan in the enclosure with the arrow pointing outward and the wires on the fan at the bottom right corner of the fan.

Figure 38: Fan Orientation



Number	Description
1	Fan
2	Screws
3	Position of arrow
4	Back of enclosure

2 Position the fan grill outside of the enclosure aligning with the screw holes.

3 Install the four 3.5 mm screws through the fan grill and the rear panel of the enclosure.

4 Secure the fan and tighten the four screws to 1.6 N-m and into the threaded insert.

5 Plug the fan cable plug into the 4-position fan connector on the connector board assembly.

NOTICE: Dress and tie wrap the blue Ethernet cable and the fan cables.

5.6.9
Replacing the Repeater Indicator Board

Install the repeater indicator board to reassemble the repeater after replacing the fan or replacing other parts of the repeater.

Prerequisites: See Figure 11: Repeater Indicator Board Disassembly on page 60.

Procedure:

1 Holding the Repeater Indicator Board by the outer edge, insert the clips of light guide into mounting holes, making sure the light guide snaps into place.

2 Align the four mounting holes on the Repeater Indicator Board onto the four standoffs on the front panel.

3 Install and secure the four M3 screws.

4 Tighten the four M3 screws to 1.0 N-m.

5 Use the four M6 screws to secure the front panel onto the enclosure. Tighten the screws to 3.7 N-m.

6 Connect the blue Ethernet cable from the Connector board onto the Ethernet connector on the Repeater Indicator Board.

7 Insert the flex cable onto the 30-position connector on the Repeater Indicator Board.

The solder terminal end of the flex cable faces towards the front panel. A solid black line is visible from the top view.

8 Connect the 8-pin DC cable from the Connector board onto the 8-pin connector on the Repeater Indicator Board. Applicable for VHF/UHF 32 MB repeaters only.

5.6.10
Replacing the Cover

Install the cover to reassemble the repeater after replacing other parts of the repeater.

Procedure:

1 Place the cover on the housing.

2 Secure the two M4 screws on each side of the cover and one at the top. Tighten the screws to 2.0 N-m.

5.7
Repeater Exploded Mechanical Views and Parts Lists

The exploded mechanical views shown display a breakdown of all parts and assemblies of the repeater. The parts list provides a description of each part and its part number for ordering purposes.

Figure 39: Repeater Assembly Exploded View

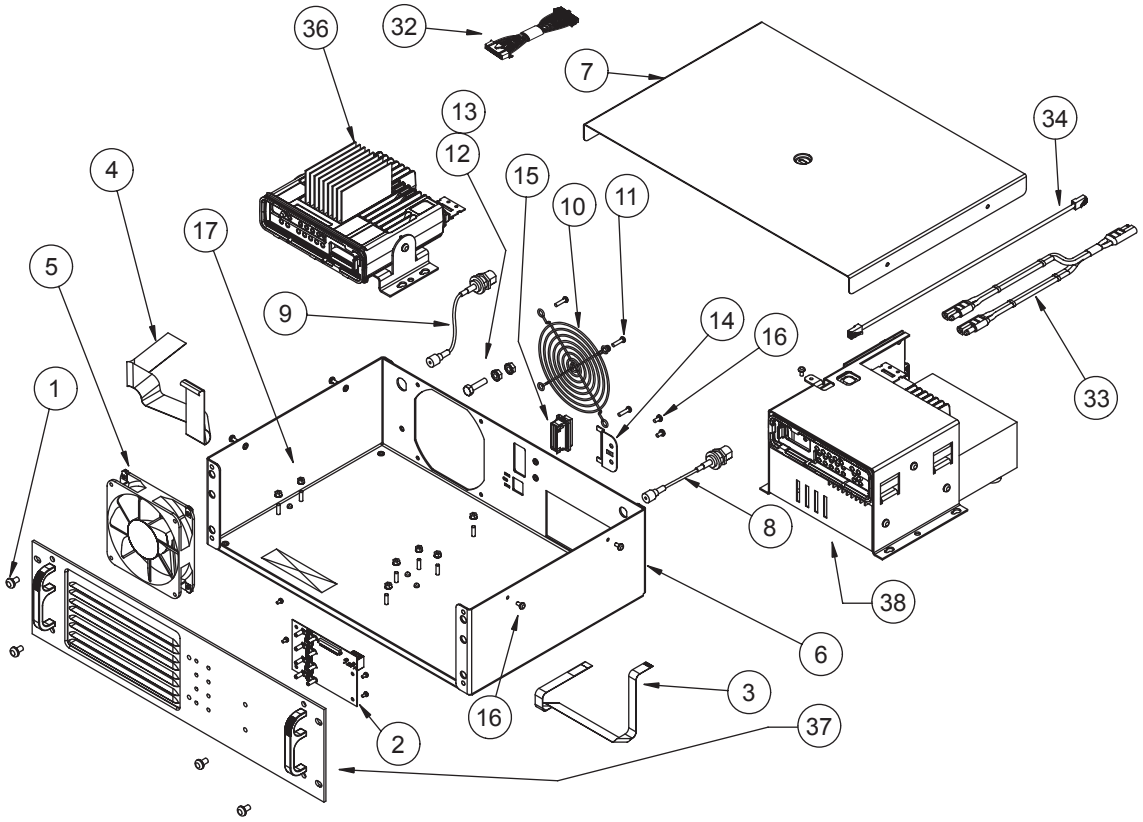


Figure 40: Repeater Assembly Exploded View (VHF/UHF 32 MB Repeaters)

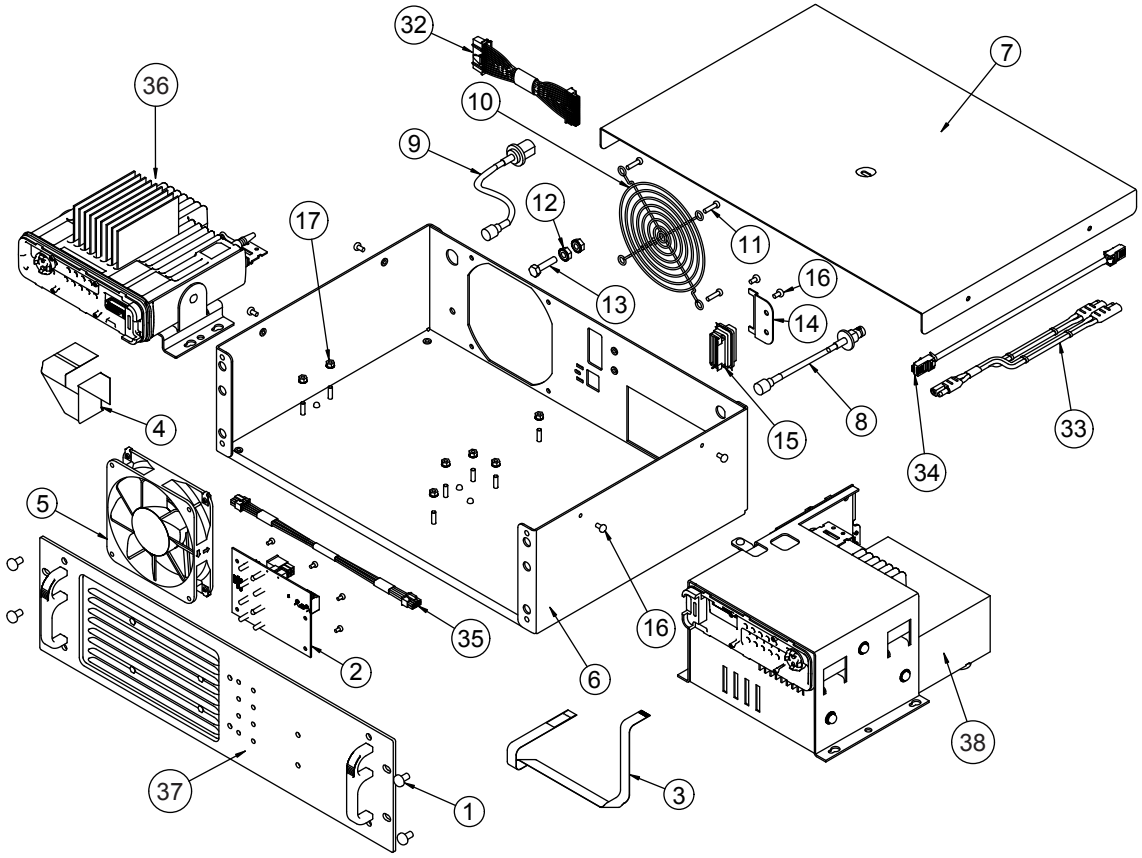


Figure 41: Receive Bracket and Radio Assembly Exploded View

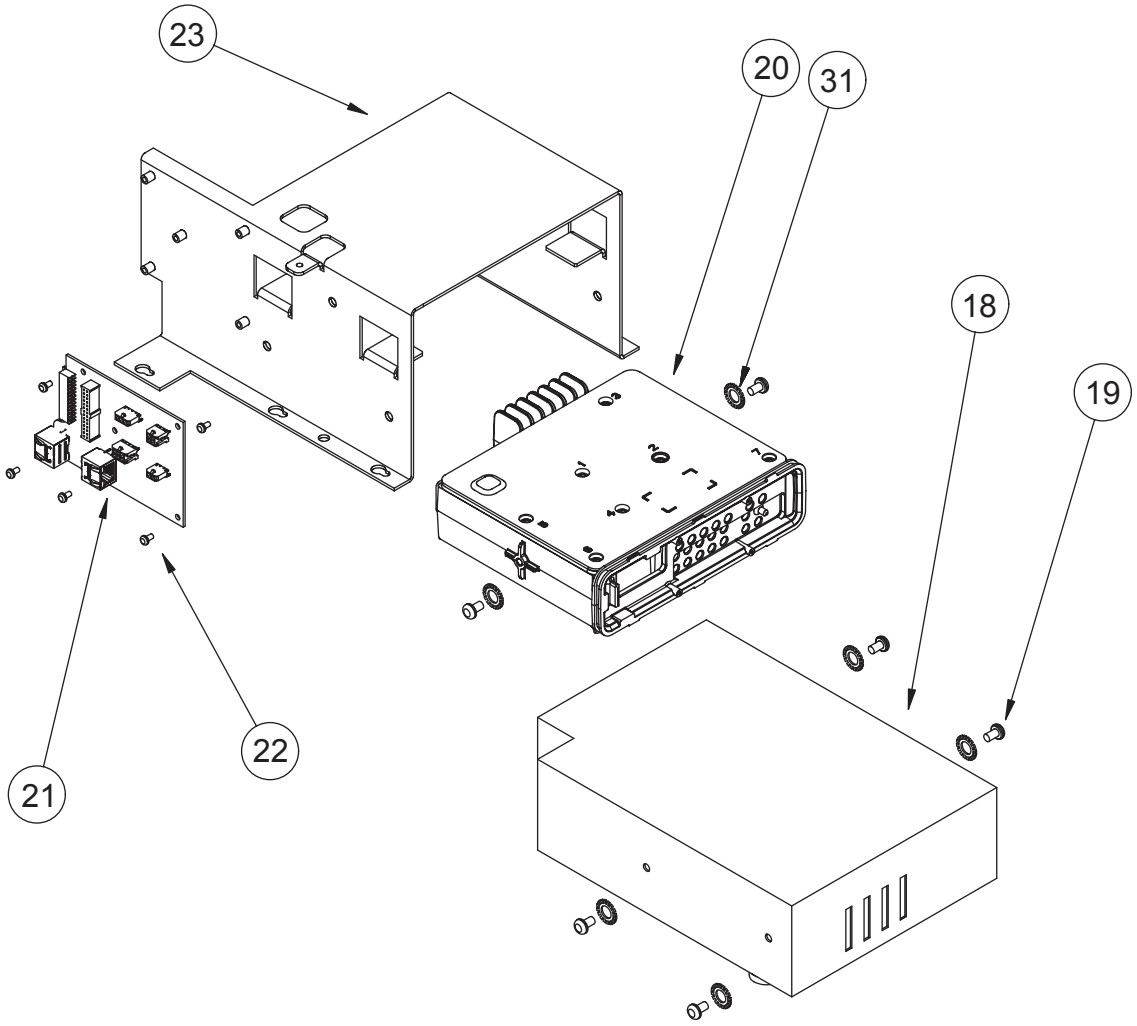


Figure 42: Transmit Bracket and Radio Assembly Exploded View

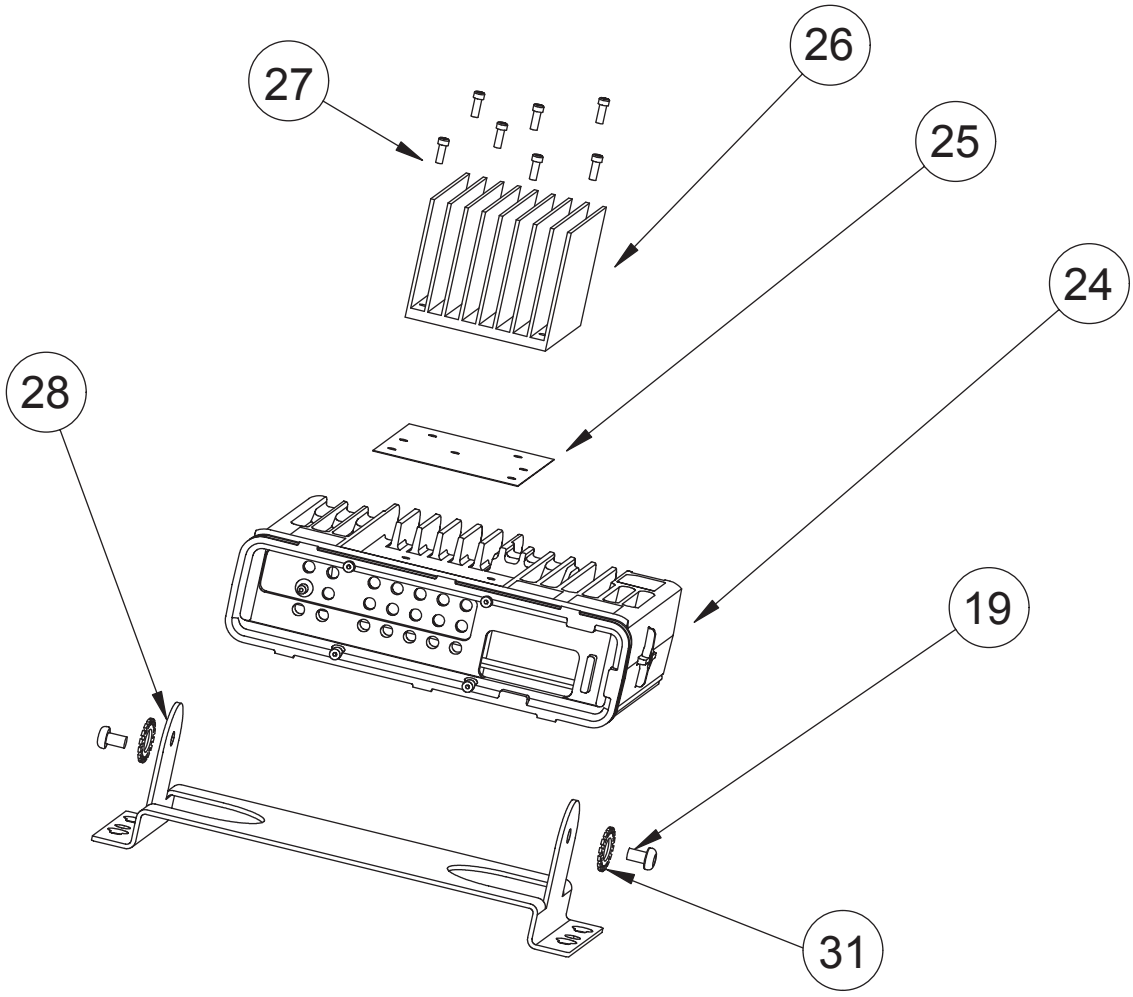


Figure 43: Front Panel Complete Assembly Exploded View

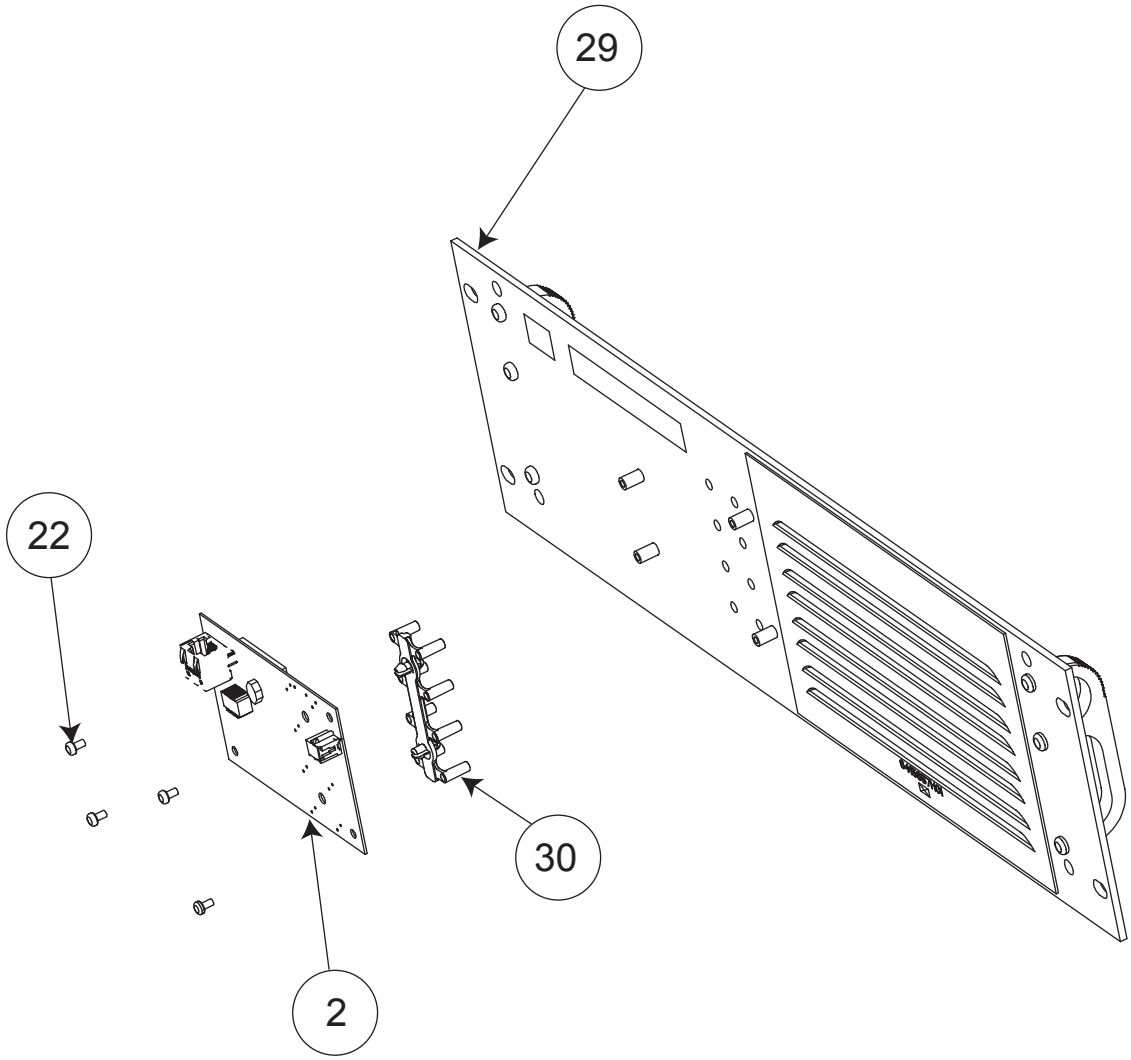


Table 12: Repeater Exploded View Parts List

Item No.	Description	Part Number
1	Screw, TT6x1.0x10, Starpan, EM6219 (black)	0312016A54
2	Repeater Indicator Board (VHF/UHF 8 MB Repeaters) Repeater Indicator Board (VHF/UHF 32 MB Repeaters)	PMLN5269_ PMLN5643_
3	Cable, Flex SSI	3015639H01
4	Cable, Flex 30-Position (VHF/UHF 8 MB Repeaters) Cable, Flex 30-Position (VHF/UHF 32 MB Repeaters)	3015634H01 3015634H02
5	Fan Assembly	5915618H01

Table continued…

Item No.	Description	Part Number
6	Enclosure Assembly	1515837H01
7	Top Cover	1515655H01
8	Cable, RF Rx, W/BNC	3015574H01
9	Cable, RF Tx, W/N-Type	3015573H01
10	Fan Grill	1383852R01
11	Screw, TT3.5x0.6x16, Star SLT Pan	0371805M01
12	M6 Ground Nut	0285854Y01
13	M6 Ground Screw	0310909A95
14	Accessory Retainer Clip	4216361H01
15	Rear Accessory Connector	0178042A01
16	Screw, M4x0.7x13.0, Starpan STLZNC	0310909E63
17	Lock Nut M4	0285854Y02
18	Power Supply	PMPN4001_
19	Screw, M5x0.8x8.0, Starpan STLZNC	0310909A74
20	Receive Radio Brick Assembly	See the following sections to identify proper Repeater XCVR Service Kit: • VHF Low Power MOTOTRBO Repeater (136–174 MHz) Model Chart on page 27 • VHF High Power MOTOTRBO Repeater (136–174 MHz) Model Chart on page 26 • UHF1 Low Power MOTOTRBO Repeater (403–470 MHz) Model Chart on page 28 • UHF1 High Power MOTOTRBO Repeater (403–470 MHz) Model Chart on page 28 • UHF2 High Power MOTOTRBO Repeater (450–512 MHz) Model Chart on page 29 • 350 MHz High Power (350–400 MHz) Model Chart on page 30

Table continued…

Item No.	Description	Part Number
21	Connector Board Assembly (For use with 8 MB and 32 MB Repeaters)	PMLN5644_
22	Screw, M3x0.5x5, Starpan STLZNC	0310909A30
23	RX Bracket Assembly	0715656H01
24	Transmit Radio Brick Assembly	See the following sections to identify proper Repeater XCVR Service Kit: • VHF Low Power MOTOTRBO Repeater (136–174 MHz) Model Chart on page 27 • VHF High Power MOTOTRBO Repeater (136–174 MHz) Model Chart on page 26 • UHF1 Low Power MOTOTRBO Repeater (403–470 MHz) Model Chart on page 28 • UHF1 High Power MOTOTRBO Repeater (403–470 MHz) Model Chart on page 28 • UHF2 High Power MOTOTRBO Repeater (450–512 MHz) Model Chart on page 29 • 350 MHz High Power (350–400 MHz) Model Chart on page 30
25	Thermal Pad	7515633H01
26	Heatsink	2615620H01
27	Screw, M3x0.5x10, Starpan STLZNC	0310909A33
28	Tx Bracket	0715654H01
29	Front Panel Assembly only (handles not included)	6415658H04
30	Light Guide	6116326H01
31	Washer	0400002647
32	Cable Assembly, Tx to Connector Board	3015570H01

Table continued…

Item No.	Description	Part Number
33	Cable, Power, Y-Split	3085859M01
34	Cable, Ethernet	3015575H01
35	Cable, DC (VHF/UHF 32 MB Repeaters)	30009303001
36	Transmit Bracket & Radio assembly. See Figure 42: Transmit Bracket and Radio Assembly Exploded View on page 94 for breakdown.	
37	Front Panel complete assembly. See Figure 43: Front Panel Complete Assembly Exploded View on page 95 for breakdown.	
38	Receive Bracket & Radio assembly. See Figure 41: Receive Bracket and Radio Assembly Exploded View on page 93 for breakdown.	

5.8
Torque Chart

The following table lists the various nuts and screws by part number and description, followed by the torque values in different units of measure. Torque all screws to the recommended value when assembling the repeater.

Table 13: Torque Specifications for Nuts and Screws

Part Number	Description	Driver/ Socket	Torque		
			N-m	lbs-in	kg-cm
0285854Y01	Grounding Nut, M6	10 mm dip socket	2.0	17.70	20.4
0285854Y02	Lock Nut, M4 x 0.8, ext tooth	7 mm socket	2.0	17.70	20.4
0310909A30	Screw, M3.0 x 0.5 x 5 mm	T10 Torx	1.0	8.9	10.2
0310909A33	Screw, M3 x 0.5 x 10 mm	T10 Torx	1.0	8.9	10.2
0310909A74	Screw, M5 x 0.8 x 8 mm	T25 Torx	3.0	26.6	30.6
0371805M01	Screws, M3.5 x 0.5 x 16 mm	T15 Torx	1.6	14.2	16.3
0310909A95	Grounding Screw, M6 x 1 x 25	T30 Torx	2.0	17.7	20.4
0312016A54	Screws, TT6 x 1.0 x 10 mm Star Thread Rolling Screw	T30 Torx	3.7	32.7	37.7
0310909E63	Screw, M4 x 0.7 x 7 mm, Slotted Star	T20 Torx	2.0	17.7	20.4
3015574H01	BNC Type connector	16 mm deep well socket	2.3	20.4	23.5
3015573H01	N Type connector	19 mm deep well socket	2.3	20.4	23.5

Chapter 6

Basic Troubleshooting

This chapter contains error codes and board replacement procedures. If the repeater does not pass all the performance checks in MOTOTRBO Repeater Transceiver Performance Testing on page 41 send the repeater to a Motorola Solutions Service Center listed in Appendix B : Motorola Solutions Service Centers on page 107.

To access the various connector pins, use the housing eliminator/test fixture along with the diagrams found in this section of the manual. (See Service Aids on page 35 for the appropriate Motorola Solutions service aids and tools part numbers.)

6.1 High Power RF Precaution

The repeater might transmit while the technician believes the radio is in receive mode under the following conditions: radio failure, digital affiliation, a defective PTT button, or other unintentional activations.

To avoid possible equipment damage, when performing both transmit and receive tests, a suitable attenuator rated at 100 W or more should always be used with test equipment connected to the RF connector. The only exception to this is when the equipment's input power rating is higher than the maximum output power of the repeater.

6.2 Replacement of Service Kits

Once a problem has been isolated to a specific board, install the appropriate service kit.

See VHF High Power MOTOTRBO Repeater (136–174 MHz) Model Chart on page 26, which is orderable from Motorola Solutions Parts Organization, at 1-800-422-4210.

Refer to https://businessonline.motorolasolutions.com for further information.

If a board is replaced, it does not need to be retuned if it has been purchased through Motorola Solutions Parts, as it is already factory tuned. It should however be checked for performance before being placed into service.

CAUTION:
The Tuner Tool only allows the serial number of a blank board to be entered once. Be very attentive during this procedure.

6.2.1 Replacing and Initializing Service Kits for XPR 8300/XPR 8400 Repeaters

Once a problem has been isolated to a specific board, install the appropriate service kit.

Procedure:

1. Note the firmware version in the repeater, before beginning the service kit replacement.
2. Archive the existing Codeplug that is programmed in the repeater.
3. Remove the Defective Transmit Radio per the instructions in Removing the Transmit Radio on page 61.

4 Verify the Firmware version in the new Transmit Radio. If it is the same as the existing Receive Radio, proceed to Step 7.

NOTICE: Ignition Sense voltage (13.5 Vdc) needs to be applied to pin 25 in order for the radio to power up in the XPR 8400 Repeater.

5 If the firmware version in the repaired Transmit Radio is newer than the version in the Receive Radio, the Receive Radio must be upgraded prior to installing the new replacement Transmit Radio. To upgrade the Receive Radio independently, remove the RSSI cable from the front of the transceiver and connect the programming cable directly to the Rear Accessory Connector of the Receive Radio.

NOTICE: Ignition Sense voltage (13.5 Vdc) needs to be applied to pin 25 in order for the radio to power up in the XPR 8400 Repeater. Use the CPS to upgrade the Receive Radio to the same version as the new Transmit Radio.

CAUTION: When upgrading the repeater radios individually, you must ALWAYS use the Repeater firmware package from MOL. Never attempt to upgrade a repeater radio with the Mobile firmware packages.

6 If the replacement Transmit Radio has an older version than the original Receive Radio, repeat the above upgrade process with the replacement Transmit Radio.

7 Install the new Transmit Radio according to the reassembly instructions in Replacing the Transmit Radio on page 84.

8 The replacement Transmit Radio requires that the Serial Number of the Repeater be entered before it can be read or programmed with the CPS. Connect the repeater to the MOTOTRBO Tuner and follow the instructions to enter the serial number noted on the back label of the repeater, into the newly installed Transmit Radio. Tuning is not required, as the Transmit and Receive Radios have been factory tuned for both TX and RX parameters

9 After powering on the repeater and verifying functionality, either program with the existing archive, or read and reprogram the repeater with a new configuration. This is necessary since the programming information is stored in the Transmit Radio.

6.3 LED Indicator Descriptions

This table provides the Status and Functional Descriptions of each LED on the repeater. The LEDs indicate the activity and health of the repeater.

Table 14: LED Indicator Descriptions

LED	Status	Description
Power	Solid GREEN	Repeater powered by AC
	Solid RED	Repeater powered by back-up battery
	Off	Repeater powered off
Repeater Disable	Solid RED	Repeater function disabled
	Blinking RED	Repeater in self test mode
	Off	Repeater in normal operational mode
Digital	Solid BLUE	Repeater in Digital mode
Analog	Solid YELLOW	Repeater in Analog mode
TX-A	Solid GREEN	Repeater transmitting (Analog)

Table continued…

LED	Status	Description
	Solid GREEN	Repeater transmitting on Slot A (Digital)
RX-A	Solid YELLOW	Repeater receiving (Analog)
	Solid YELLOW	Repeater receiving on Slot A (Digital)
TX-B	Solid GREEN	Repeater transmitting on Slot B (Digital)
RX-B	Solid YELLOW	Repeater receiving on Slot B (Digital)

6.4

Ethernet LED Indicator Descriptions

This table provides the Status and Activity of the LEDS for the Ethernet connections on the repeater.

NOTICE: The Ethernet LED Indicator is only applicable for VHF/UHF 32 MB Repeaters.

Table 15: Ethernet LED Indicator Descriptions

LED	Status	Description
Yellow	Solid YELLOW	Link valid
	Blinking YELLOW	Tx/Rx activity
Green	Solid GREEN	100 Mbits speed
	Off	10 Mbits speed

This page intentionally left blank.

Chapter 7

Accessories

Motorola Solutions provides the following approved accessories to improve the productivity of your repeater.

For a list of Motorola Solutions-approved accessories, visit the following web site: http://www.motorolasolutions.com.

Antennas

- VHF, 150–158 MHz, 3 dB Gain Antenna, (RDD4527_)
- UHF, 488–512 MHz, 3.8 dB Gain Omni Antenna, (RDE4554_)
- UHF, 470–488 MHz, 3.8 dB Gain Omni Antenna, (RDE4555_)
- UHF, 450–470 MHz, 3.8 dB Gain Omni Antenna, (RDE4556_)
- UHF, 403–420 MHz, 3.8 dB Gain Omni Antenna, (RDE4557_)

Cables

- Mobile & Repeater Rear Programming Cable, (PMKN4010_)
- Mobile & Repeater Rear Accessory Programming and Test Cable, (PMKN4016_)
- Mobile & Repeater Rear Accessory Connector Universal Cable, (PMKN4018_)
- Battery Back-up Cable, (RKN4152_)

Miscellaneous Accessories

- Wall Mount Kit for MOTOTRBO Repeater (PMLE4476_)
- Rack Mount for 1 Duplexer and 1 Preselector (PMLE4548_)
- Tower Mounting Hardware for RRX4038 (RRX4032_)
- RF Surge Suppressor (RRX4038_)
- UHF, 450–470 MHz, Untuned Duplexer, (RFE4000_)
- UHF, 406–450 MHz, Untuned Duplexer, (HFE8400_)
- UHF, 470–512 MHz, Untuned Duplexer, (HFE8401_)
- UHF, 490–527 MHz, Untuned Duplexer, (HFE8454_)
- UHF, 440–474 MHz, Preselector, (HFE8459_)
- UHF, 474–527 MHz, Preselector, (HFE8460_)
- VHF, 144–155 MHz, Duplexer, (min & max freq sep 4.5 MHz/6 MHz), (HFD8188_)
- VHF, 155–162 MHz, Duplexer, (min & max freq sep 4.5 MHz/6 MHz), (HFD8189_)
- VHF, 162–174 MHz, Duplexer, (min & max freq sep 4.5 MHz/6 MHz), (HFD8190_)
- VHF, 144–160 MHz, Preselector, (HFD8461_)
- VHF, 160–174 MHz, Preselector, (HFD8462_)

This page intentionally left blank.

Appendix A : Replacement Parts Ordering

Some replacement parts, spare parts, and/or product information can be ordered directly.

Basic Ordering Information

While parts may be assigned with a Motorola Solutions part number, this does not guarantee that they are available from Motorola Radio Products and Solutions Organization (RPSO). Some parts may have become obsolete and no longer available in the market due to cancellations by the supplier. If no Motorola Solutions part number is assigned, the part is normally not available from Motorola Solutions, or is not a user-serviceable part. Part numbers appended with an asterisk are serviceable by the Motorola Solutions Depot only.

Motorola Online

Motorola Online users can access our online catalog at

https://businessonline.motorolasolutions.com

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

Mail Orders

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

Motorola

7031 Columbia Gateway Drive

3rd Floor - Order Processing

Columbia, MD 21046

U.S.A.

Telephone Orders

Radio Products and Solutions Organization [1]

(United States and Canada)

7:00 AM to 7:00 PM (Central Standard Time)

Monday through Friday (Chicago, U.S.A.)

1-800-422-4210

1-847-538-8023 (United States and Canada)

U.S. Federal Government Markets Division (USFGMD)

1-877-873-4668

8:30 AM to 5:00 PM (Eastern Standard Time)

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

Fax Orders

Radio Products and Solutions Organization [1]

(United States and Canada)

1-800-622-6210

1-847-576-3023 (United States and Canada)

USFGMD

(Federal Government Orders)

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

Parts Identification

Radio Products and Solutions Organization [1]

(United States and Canada)

1-800-422-4210

Product Customer Service

Radio Products and Solutions Organization (United States and Canada)

1-800-927-2744

Appendix B : Motorola Solutions Service Centers

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

Servicing Information

Type of Centers	Address	Contact Number
Motorola Service Center	1220 Don Haskins Drive Suite A El Paso, TX 79936	Tel: 915-872-8200
Motorola Federal Technical Center	10105 Senate Drive Lanham, MD 20706	Tel: 1-800-969-6680 Fax: 1-800-784-4133
Canadian Technical Logistics Center	181 Whitehall Drive Markham, Ontario, L3R 9T1	Toll Free: 800-543-3222

This page intentionally left blank.

Appendix C : Digital Telephone Patch (DTP) Tuning Guidelines

The Digital Telephone Patch (DTP) Tuning Guidelines consist of hardware connections, jumpers, programming, tuning, and setting up input and output signal levels the MTRI2000, Zetron M30 and Zetrol M735 equipment.

MRTI 2000 Phone Patch

The MRTI 2000 (Mobile Radio Telephone Interconnect), Model PL1877A, is a highly advanced DSP-based tool to connect radio systems to public or private telephone networks. Used with repeaters or base stations, the unit initiates calls (with properly equipped portables and mobiles) and/or receives landline/mobile-initiated calls. The PL1877A allows wireless users to keep in contact with landline or mobile phone users.

Connecting the MRTI 2000 Hardware

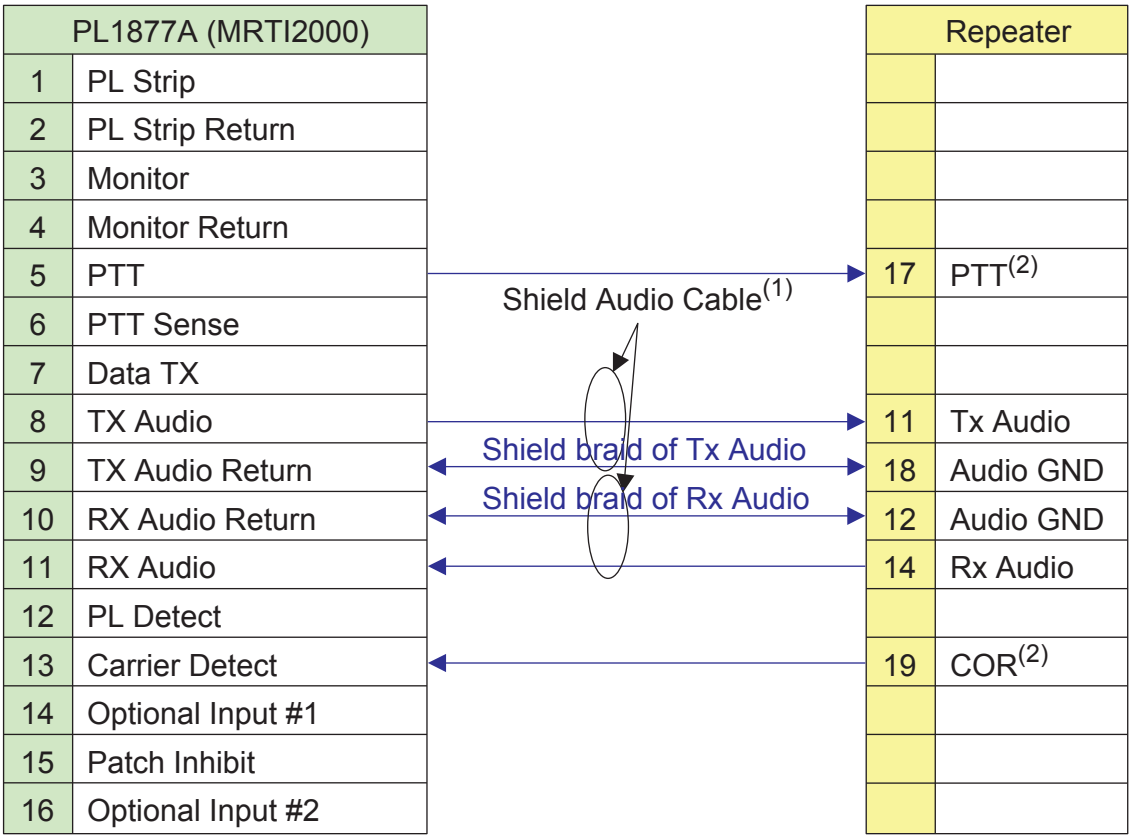
Set up the pin connections between the MRT1 2000 and the repeater to tune and program the phone patch.

Procedure:

1. Apply shielded audio cable for Tx and Rx Audio connections to avoid any possible interference to speech signal.

   The connection of the shielded cable braid is indicated in the following figure.

Figure 44: MRTI 2000 and Repeater Hardware Connection



2 The GPIO pin for PTT and COR function is configured in the Customer Programming Software (CPS). Confirm that the CPS setting matches the Pin information. See Figure 44: MRTI 2000 and Repeater Hardware Connection on page 110.

See the MRTI 2000 service manual (Pub. 43004-019B) to install and program the phone patch for initial setup. See MTRI 2000 Programming and Tuning on page 110 for more information on how to setup the Digital Telephone Patch application.

MRTI 2000 Jumpers on Phone Patch

JU202 – out (default), to support low Rx Audio input level.

MTRI 2000 Programming and Tuning

Customer Programming Software (CPS) programs and tunes the MTRI1200. The MTRI 2000 can also enter a diagnostic test mode to adjust the Tx softpot.

Programming the MRTI 2000 Phone Patch with a PC Tool Provided by Gai-Tronics

Customer Programming Software (CPS) programs the installation parameters of the MRTI 2000 phone patch.

Figure 45: MRTI2000 Rx Audio Path Setting on page 111 configures RX audio path, Figure 46: MRTI2000 Operation Mode Setting on page 111 configures the phone patch to work under Half-Duplex mode and Figure 47: MRTI2000 Access/Deaccess Setting on page 112 configures the Access and Deaccess code.

Figure 45: MRTI2000 Rx Audio Path Setting

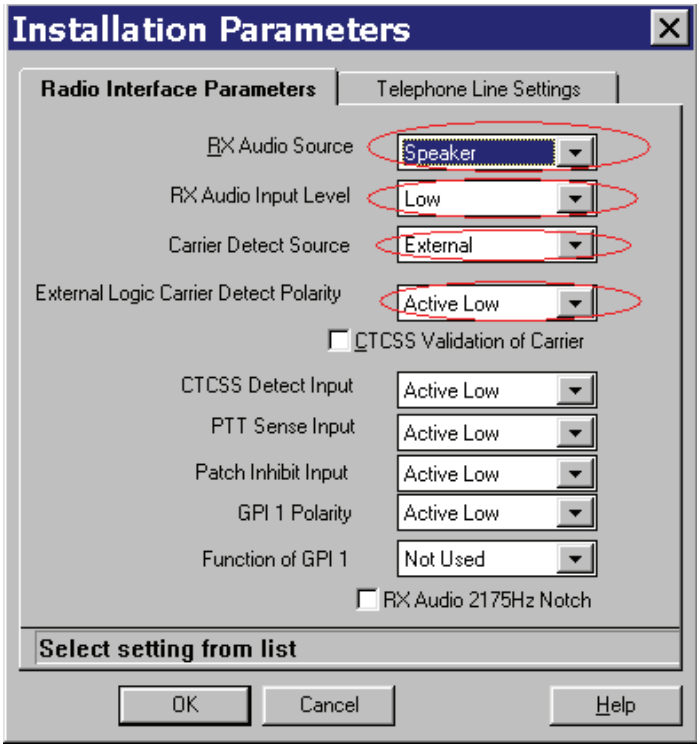


Figure 46: MRTI2000 Operation Mode Setting

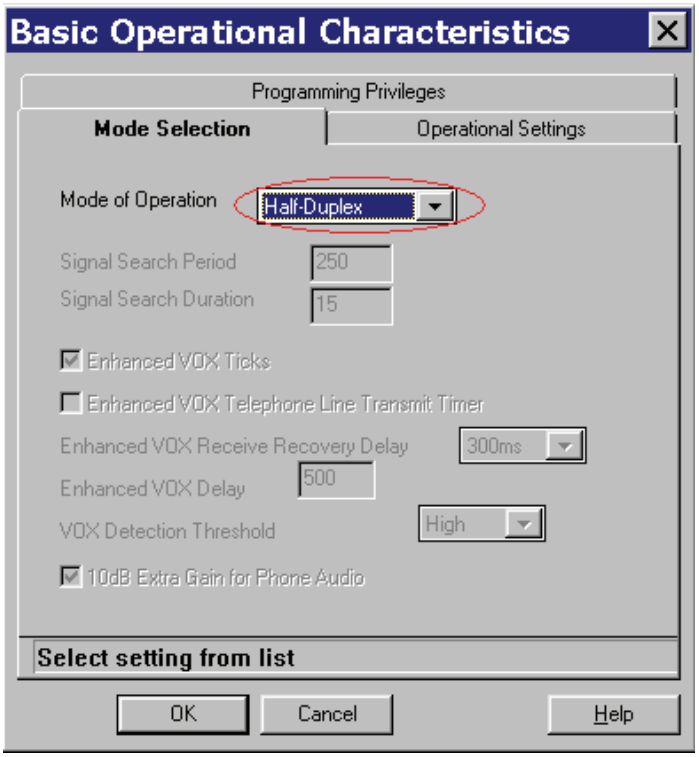
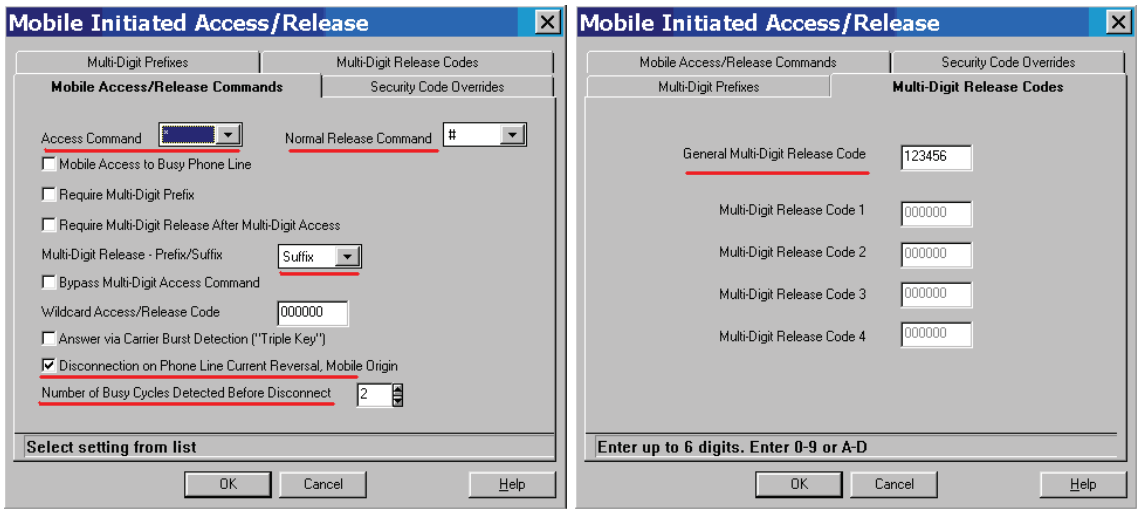


Figure 47: MRTI2000 Access/Deaccess Setting



Entering the MRTI 2000 into Diagnostic Test Mode

The MRTI 2000 can be placed into diagnostic test mode to set the Tx Audio.

Procedure:

1. To enter Diagnostic Test Mode, on the MRTI 2000, simultaneously press the UP and DOWN buttons.
2. To enter another test when at Diagnostic Test Mode, press the PATCH ON/OFF button.
3. To exit test mode, press both the UP and PATCH ON/OFF buttons simultaneously.

   Each time a new test is selected, a test timer is set to 15 minutes. If this timer reaches zero, the patch resets itself to idle, ready for normal operation.

Adjusting the MRTI 2000 Tx Softpot

Sets the Tx Audio.

Procedure:

1. To enter Diagnostic Test 1, on the MRTI 2000, press both the UP and DOWN buttons simultaneously.

   This procedure also activates PTT, and generates a 1000 Hz tone to the transmitter.
2. Press the UP or DOWN button to adjust the transmit level.

   Monitor the Tx Audio line to reach 226 mVpp at Tx Audio line.
3. After the desired level is achieved, press the PATCH ON/OFF button.

   The value set remains stored in memory unless it is changed through an adjustment in Test 1.
4. To exit the test, press both the UP and PATCH ON/OFF buttons simultaneously.

Setting the MRTI 2000 Mobile-to-Phone Audio Path

The Customer Programming Software (CPS) sets the Rx Audio path.

Procedure:

Rx Audio path setting is performed as indicated in Figure 45: MRTI2000 Rx Audio Path Setting on page 111, no additional tuning is required.

Zetron M30 Phone Patch

The Zetron M30 is a low-cost open channel telephone interconnect designed for installation with simplex and half-duplex interconnections for small radio systems to connect radio systems to public or private telephone networks. Zetron M30 allows wireless users to keep in contact with landline or mobile phone users.

Connecting the Zetron M30 Hardware

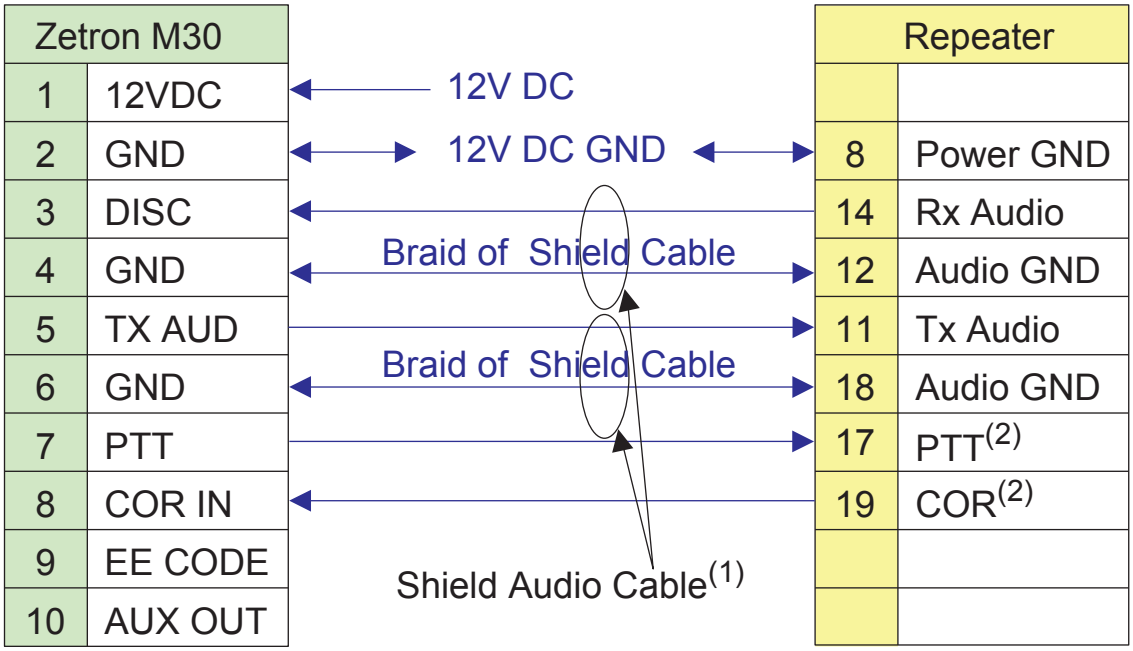
Set up the pin connections between the Zetron M30 and the repeater to tune and program the phone patch.

Procedure:

1 Apply shielded audio cable for Tx and Rx Audio connections to avoid any possible interference to speech signal.

The connection of the shielded cable braid is indicated in the following figure.

Figure 48: Zetron M30 Hardware Connection



2 The GPIO pin for PTT and Carrier Operated Relay (COR) function is configured in the Customer Programming Software (CPS).

Confirm that the CPS setting matches the Pin information in Figure 48: Zetron M30 Hardware Connection on page 113.
See the Zetron M30 service manual (part number 025-9140P) to install and program the phone patch for initial setup. See Setting up the Zetron M30 Input and Output Signal Levels on page 114 for more information on how to setup the Digital Telephone Patch application.

Zetron M30 Jumpers on Phone Patch

JP8 – C, COR polarity, low active; JP7 – B, external COR

Setting up the Zetron M30 Input and Output Signal Levels

There are two ways to access the required Zetron M30 test mode. The preceding procedures for setting up the signal levels is performed using a DTMF telephone. To access using a PC or terminal, see the Zetron manual.

Equipment Required:

- MOTOTRBO radio
- Local DTMF (Touch-Tone) phone and analog PSTN phone line
- Oscilloscope
- Signal Generator (optional - dependent on tuning method used. See section B.2.3.6 on page B-1)
- Audio Box (optional - dependent on tuning method used. See Setting the Zetron M30 Receive Level on page 115)

Setting up the Zetron M30 Hardware

Set up the pin connections between the Zetron M30 and the repeater to tune and program the phone patch.

Procedure:

1. Connect the Phone Patch to the repeater according to Figure 48: Zetron M30 Hardware Connection on page 113.
2. Connect an analog telephone line from the PSTN or from a local PBX to the phone patch.
3. Power up both.

   The power LEDs light on both the Zetron M30 and the repeater.

Resetting the Zetron M30 to Factory Default Settings

Resetting to factory default settings clears any configuration changes that have been made.

Procedure:

On the front of the Analog Phone Patch (APP), press and hold the **Connect** button until the phone light starts blinking (about four seconds), then release.

Entering the Zetron M30 Program Mode

Programming for half duplex mode, Tx audio gain, Rx level, and other peripherals are performed using program mode.

NOTICE: Disconnect the repeater to enter program mode to avoid base radio assertion of Carrier Operated Relay (COR) even when the base radio is powered off.

Procedure:

1. Dial the line number of APP.
2. Hold for about 14 rings until a two-beep prompt tone is heard.
3. Enter the program mode access code, 12123.

Programming the Zetron M30 to Half Duplex Mode and COR to Answer

Procedure:

1. Enter programming mode. See Entering the Zetron M30 Program Mode on page 114.
2. Enter 40# – Program operation mode to “Half Duplex Mode”
3. Enter 60# – Program mobile answer mode to “COR To Answer”

Setting the Zetron M30 Transmit Audio Gain

Procedure:

1. Enter programming mode. See Entering the Zetron M30 Program Mode on page 114.
2. At jumper JP-3 in the “B” (LOW Gain), enter the DTMF command 92#.

   The transmitter is keyed and a 1-kHz test tone is generated for 30 seconds.
3. Using the oscilloscope to monitor the Tx Audio line tone signal, adjust the Transmit Level pot (R5) to 226 mVpp at Tx Audio line.
4. If the desired deviation of 226 mVpp cannot be achieved, move JP-3 to the “A” (HI Gain) position and repeat step 2 and step 3.

Setting the Zetron M30 Receive Level

Receive Level setting impacts the speech volume heard at the phone end. The following settings are recommended and adjustment is allowed depending on requirement. Two calibration methods are available. Use either Method 1 or Method 2 to do the tuning.

Prerequisites:

- Method 1 – Since the Motorola repeater has the same Rx Audio output level under digital and analog mode, see the Zetron M30 service manual, (Chapter 5 Installation) to set the Rx level under analog mode first and then switch to digital mode directly when the setting is ready. No additional setting is required.
- Method 2 – Tuning with injected sine tone from MOTOTRBO subscriber, under digital mode. Equipment: Oscilloscope, MOTOTRBO Portable/Mobile subscriber, Audio Box (Motorola part number: RLN4460B), Signal Generator

  NOTICE: Disable **Digital Mic AGC** on MOTOTRBO subscriber with the Customer Programming Software (CPS) before calibration.

Procedure:

1. Enter programming mode Entering the Zetron M30 Program Mode on page 114.
2. Open the shell of M30 and connect the oscilloscope probe to U1 PIN 14.
3. Setup DTP connection and verify that phone call is setup correctly.
4. If a MOTOTRBO Portable radio is used:
   a. Configure the Signal Generator to output 1031 Hz sine tone, amplitude set as 22.6 mVpp (8 mVrms).
   b. Inject the signal to the Audio Box audio input port.
   c. Attach the Audio Box GCAI connector to the accessory port of the MOTOTRBO subscriber .
   d. Setup a phone call and during the phone call, assert PTT knob on Audio Box to transmit from radio, phone should hear the tone.

5 If a MOTOTRBO Mobile radio is used,

   a Configure the Signal Generator to output 1031 Hz sine tone, amplitude set as 226.3 mVpp (80 mVrms).

   b Inject the signal to the MOTOTRBO mobile radio rear port, PIN 11 Tx Audio, Signal Generator's ground connects to MOTOTRBO mobile radio rear port, PIN 18 Audio ground.

   c Setup a phone call and during the phone call, assert MOTOTRBO mobile radio's external PTT with rear port PIN 17 PTT to transmit from radio, phone should hear the tone.

6 While MOTOTRBO subscriber radio (Portable or Mobile) is transmitting with the tone, verify that the repeater Rx Audio output is close to 1.0 Vpp and adjust the RECEIVE GAIN (R4) on M30 for a 1.0 Vpp tone signal at U1 PIN 14. If this level with JP-1 in position A is not reached, move it to position B.

Zetron M735 Phone Patch

The Zetron M735 is an open channel telephone interconnect designed for installation with simplex and half-duplex interconnection to connect radio systems to public or private telephone networks. Zetron M735 allows wireless users to keep in contact with landline or mobile phone users.

Connecting the Zetron M735 Hardware

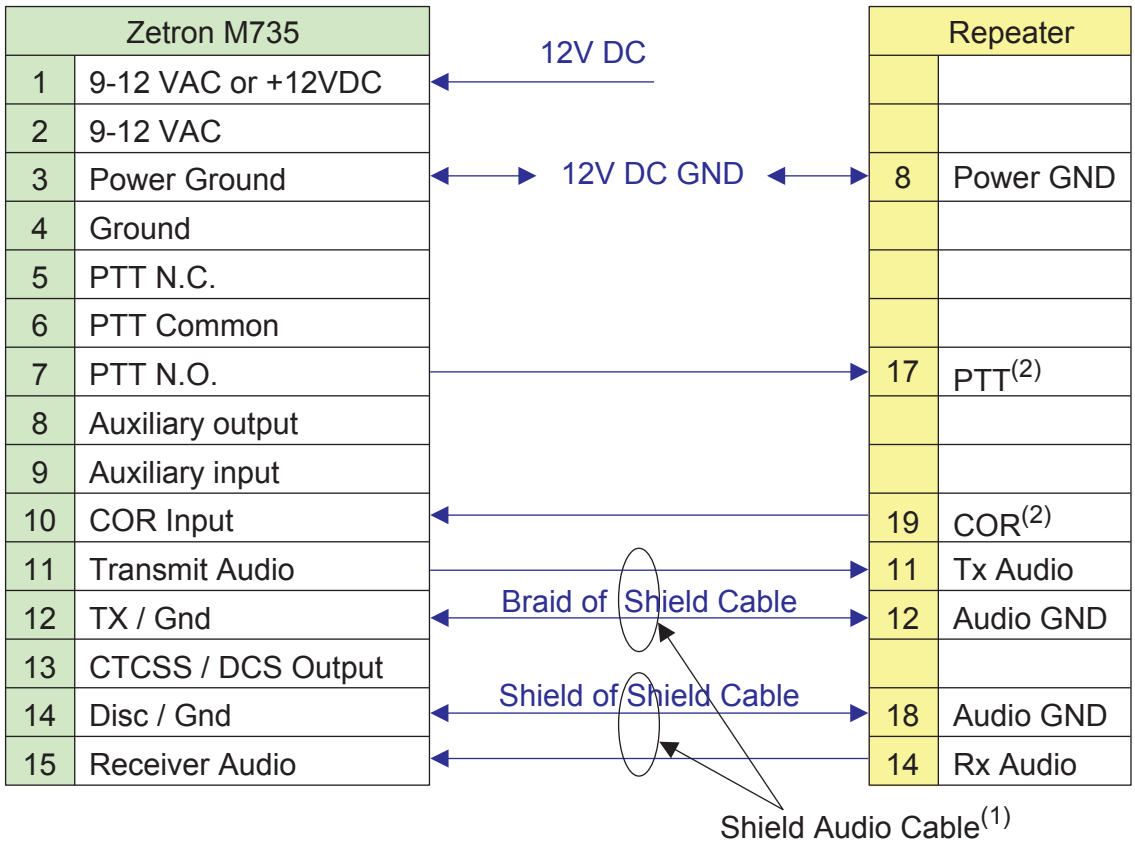
Set up the pin connections between the Zetron M735 and the repeater to tune and program the phone patch.

Procedure:

1 Apply shielded audio cable for Tx and Rx Audio connections to avoid any possible interference to speech signal.

   The connection of the shielded cable braid is indicated in the following figure.

Figure 49: Zetron M735 Hardware Connection



2 The GPIO pin for PTT and COR function is configured in the Customer Programming Software (CPS).

Confirm that the CPS setting matches the Pin information. See Figure 49: Zetron M735 Hardware Connection on page 117.

See the Zetron M735 service manual (part number 025-9369E.1) to install and program the phone patch for initial setup. See Setting up the Zetron M735 Input and Output Signal Levels on page 117 for more information on how to setup the Digital Telephone Patch application.

Zetron M735 Jumpers on Phone patch

JP21 – B, External COR; JP31 – A, negative COR; JP24 – A, flat output at Tx Audio

Setting up the Zetron M735 Input and Output Signal Levels

There are two ways to access the required Zetron M735 test mode. The preceding procedures for setting up the signal levels is performed using a DTMF telephone. To access using a PC or terminal, see the Zetron manual.

Equipment Required:

- MOTOTRBO radio
- Local DTMF (Touch-Tone) phone
- Oscilloscope

Setting up the Zetron M735 Hardware

Set up the pin connections between the Zetron M735 and the repeater to tune and program the phone patch.

Procedure:

1. Connect Phone Patch to the repeater according to Figure 49: Zetron M735 Hardware Connection on page 117 .
2. Connect analog telephone line from the PSTN or from a local PBX to the phone patch.
3. Power up both.

   the power LEDs light on both the Zetron M735 and the repeater.

Entering the Zetron M735 Program Mode

Programming the Tx audio level, the communication parameters, and other function are performed using program mode.

Entering program mode can be performed in one of two ways:

- Calling the Zetron M735 phone number, or
- Connecting the Zetron M735 to a personal computer through an RS-232 cable.

Procedure:

1. To enter program mode using the Zetron M735 phone number, perform the following actions:
   a. Call the M735 phone number.
   b. When prompted by the M735 (925 Hz beep) to over-dial a user number or ANI, enter the program access code (12735 by default).

      A high pitched modem tone is heard.

   c. Enter the DTMF #.

      The
      M735 stops looking for a modem.

   Five short beeps are heard to confirm access to the DTMF programming mode.
2. To enter program mode with the Zetron M735 connected to a personal computer through an RS-232 cable, perform the following actions:
   a. Connect M735 to a PC via RS-232 cable.
   b. Open the settings menu and select Communications.
   c. Set the following parameters:
      - Baud rate = 2400
      - Data bits = 8
      - Stop bits = 1
      - Parity = None
      - Flow Control = XON/XOFF
      - COM Port = the port the modem is connected to or configured for these parameters set up the basic rules of communication between the modem and the PC. If there is no connection, change the Baud rate to 4800.

Resetting the Zetron M735

Resetting clears any configuration changes that have been made.

Procedure:

1. Enter program mode. See Entering the Zetron M735 Program Mode.
2. Enter command 10#.

   Two beeps sound.
3. Enter command 12345# to confirm.

   Five beeps sound.

Setting the Zetron M735 Tx Audio Level

Procedure:

1. Enter programming mode. See Entering the Zetron M735 Program Mode on page 118.
2. Input command 111#.

   The transmitter is keyed, and a 250 Hz tone is generated from the transmitter. Each time any DTMF digit other than “#” or “*” is pressed, the M735 cycles to the next tone in the list (250, 500, 1K, 2K, 3K).
3. Set the Tx audio level by performing the following actions:
   a. Press a key twice to go to the 1 kHz tone.
   b. Monitor Tx Audio output signal with an oscilloscope.
   c. Adjust R60 (TX AUD) to reach 226 mVpp for the 1 kHz tone.

      JP25 can be used to increase or decrease the output if needed. JP25 in position A increases the output and decreases it in position B.
   d. Once the level is set for a 1 kHz tone, cycle through the tones and verify a flat response.

      JP24 can be used to set the tones for a flat response.
4. To exit the test mode, press #.
5. Set up a Radio-to-Phone call, monitor the ring back tone and busy disconnect tone from the phone line at Tx Audio PIN, and make sure that there is no clipping or other distortion on the signals.

Existing the Zetron M735 Program Mode

Procedure:

Input command 99#.

Adjusting the Zetron M735 Discriminator Input Level

The Receive Level setting impacts the speech volume heard at the phone end. Adjustment is allowed, depending on requirements. Two calibration methods are available. Use either Method 1 or Method 2 to do the tuning.

Prerequisites:

- **Method 1** – Since the Motorola Solutions repeater has the same Rx Audio output level under digital and analog mode,see the Zetron M735 service manual, (Section II Installation) to set the Rx level

under analog mode first and then switch to digital mode directly when the setting is ready. No additional setting is required.

- **Method 2** – Tuning with injected sine tone from MOTOTRBO subscriber under digital mode. Equipment: Oscilloscope, MOTOTRBO Portable/Mobile subscriber, Audio Box (Motorola part number: RLN4460B), Signal Generator

  NOTICE: Disable **Digital Mic AGC** on a portable subscriber with CPS.

Procedure:

1. Enter programming mode Entering the Zetron M735 Program Mode on page 118.
2. Open the shell of M735 and connect the oscilloscope probe to TP4 on the M735 board.
3. Setup a DTP connection and verify that the phone call is setup correctly.
4. If a MOTOTRBO Portable radio is used:
   a. Configure the Signal Generator to output a 1031 Hz sine tone, amplitude set as 22.6 mVpp (8 mVrms).
   b. Inject the signal to the Audio Box audio input port.
   c. Attach the Audio Box GCAI connector to the accessory port of the MOTOTRBO portable radio.
   d. Setup a phone call and during the phone call, assert the PTT knob on the Audio Box to transmit from the radio. The phone should hear the tone.
5. If a MOTOTRBO Mobile radio is used:
   a. Configure the Signal Generator to output a 1031 Hz sine tone, amplitude set as 226.3 mVpp (80 mVrms).
   b. Inject the signal to the MOTOTRBO mobile radio, rear port, PIN 11 Tx Audio. The Signal Generator ground connects to the MOTOTRBO mobile radio, rear port, PIN 18 Audio ground.
   c. Setup a phone call and during the phone call, assert the MOTOTRBO mobile radio external PTT with rear port PIN 17 PTT to transmit from the radio. The phone should hear the tone.
6. While the MOTOTRBO subscriber radio (Portable or Mobile) is transmitting with the tone, verify that the repeater Rx Audio output is close to 1.0 Vpp and then adjust R59 on M735 for a 1.0 Vpp tone signal at TP4.

Glossary

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

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

Band Frequencies allowed for a specific purpose.

CMOS
Complementary Metal Oxide Semiconductor.

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

Default A pre-defined set of parameters.

Digital Refers to data that is stored or transmitted as a sequence of discrete symbols from a finite set; most commonly this means binary data represented using electronic or electromagnetic signals.

Digital Private-Line (DPL) A type of digital communications that utilizes privacy call, as well as memory channel and busy channel lock out to enhance communication efficiency.

Federal Communications Commission (FCC) Regulates interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia, and U.S. territories. It was established by the Communications Act of 1934 and operates as an independent U.S. government agency overseen by Congress. The commission is committed to being a responsive, efficient and effective agency capable of facing the technological and economic opportunities of the new millennium.

Frequency Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).

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

Integrated Circuit (IC) 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.

Intermediate Frequency (IF) Intermediate Frequency.

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

Liquid-Crystal Display (LCD) An LCD uses two sheets of polarizing material with a liquid-crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.

LDMOS
Laterally Diffused Metal Oxide Semiconductor.

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

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

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

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

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

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

Programming Cable A cable that allows the CPS to communicate directly with the radio using USB.

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.

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

Radio Frequency (RF) The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).

RX Receive.

Signal An electrically transmitted electromagnetic wave.

Spectrum Frequency range within which radiation has specific characteristics.

Squelch Muting of audio circuits when received signal levels fall below a pre-determined value. With carrier squelch, all channel activity that exceeds the radio's preset squelch level can be heard.

Time-out Timer (TOT) A timer that limits the length of a transmission.

Tone Private Line (TPL) A continuous tone-coded squelch, which contains 29 codes. It is not compatible with DPL, and is common among all radio manufacturers.

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.

TX Transmit.

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

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

VHF
Very High Frequency.

VIP
Vehicle Interface Port.

XPR
Refers to Digital Professional Repeater model names in the MOTOTRBO Professional Digital Two-Way Radio System.

This page intentionally left blank.