

# MOTOTRBO™ MTR3000 BASE STATION/REPEATER & SATELLITE RECEIVER



## BASIC SERVICE MANUAL





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## Foreword

This manual covers all versions of the MOTOTRBO MTR3000 Base Station/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 module replacement level and is typical of some local service centers, Motorola Authorized Dealers, self-maintained customers, and distributors.



**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.**

### General Safety Precautions

See "General Safety and Installation Standards and Guidelines," on page ii.

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# General Safety and Installation Standards and Guidelines

## ATTENTION!



WARNING

**WARNING:** For safe installation, operation, service and repair of this equipment, follow the safety precautions and instructions described below, as well as any additional safety information in Motorola's product service and installation manuals and the Motorola R56 Standards and Guidelines for Communications Sites manual (6881089E50). To obtain copies of these materials, please contact Motorola as directed at the end of this section. After installation, these instructions should be retained and readily available for any person operating or servicing this base station/repeater or working near it.


Failure to follow these safety precautions and instructions could result in serious injury or property damage.

The installation process requires preparation and knowledge of the site before installation begins. Review installation procedures and precautions in the Motorola R56 manual before performing any site or component installation. Personnel must use safe work practices and good judgment, and always follow applicable safety procedures, such as requirements of the Occupational Safety and Health Administration (OSHA), the National Electrical Code (NEC), and local codes.

The following are additional general safety precautions that must be observed:

- To continue compliance with any applicable regulations and maintain the safety of this equipment, do not install substitute parts or perform any unauthorized modifications.
- All equipment must be serviced by Motorola trained personnel.
- If troubleshooting the equipment while the power is on, be aware of live circuits which could contain hazardous voltage.
- Do not operate the radio transmitters unless all RF connectors are secure and all connectors are properly terminated.
- All equipment must be properly grounded in accordance with the Motorola R56 and specified installation instructions for safe operation.
- Slots and openings in the cabinet are provided for ventilation. Do not block or cover openings that protect the devices from overheating.
- Some equipment components can become extremely hot during operation. Turn off all power to the equipment and wait until sufficiently cool before touching.
- Maintain emergency first aid kits at the site.
- Never store combustible materials in or near equipment racks. The combination of combustible material, heat and electrical energy increases the risk of a fire hazard.
- Equipment shall be installed in a site that meets the requirements of a "restricted access location," per (UL60950-1 & EN60950-1), which is defined as follows: "Access can only be gained by service persons or by users who have

been instructed about the reasons for the restrictions applied to the location and about any precautions that shall be taken; and access is through the use of a tool or lock and key, or other means of security, and is controlled by the authority responsible for the location.”

- Burn hazard. The metal housing of the product may become extremely hot. Use caution when working around the equipment.
- RF energy burn hazard. Disconnect power in the cabinet to prevent injury before disconnecting and connecting antennas.
- Shock hazard. The outer shields of all Tx and Rx RF cables outer shields must be grounded per Motorola R56 manual.
- Shock hazard. DC input voltage shall be no higher than 60 VDC. This maximum voltage shall include consideration of the battery charging “float voltage” associated with the intended supply system, regardless of the marked power rating of the equipment.
- All Tx and Rx RF cables shall be connected to a surge protection device according to Motorola R56 manual. Do not connect Tx and Rx RF cables directly to an outside antenna.
-  Compliance with National and International standards and guidelines for human exposure to Electromagnetic Energy (EME) at Transmitter Antenna sites generally requires that persons having access to a site shall be aware of the potential for exposure to EME and can exercise control of exposure by appropriate means, such as adhering to warning sign instructions. See this installation manual and Appendix A of Motorola R56.

This product complies with the requirements set forth by the European R&TTE regulations and applicable CENELEC standards concerning human exposure to Electromagnetic Energy (EME) at Transmitter Antenna sites. "Appendix I" in this manual includes an EME exposure analysis of a typical system configuration for this product. However, the 800/900 MHz product was not certified to comply with the R&TTE regulations.

For a different system configuration than the typical configuration, compliance with applicable EME exposure standards (current versions of the EN50384 and EN50385 standards for occupational and general public exposure, respectively) can be evaluated by either employing the method illustrated in the typical system configuration EME exposure analysis included in "Appendix I" in this manual, or employing another suitable method among those described in the current version of the EN50383 standard.

Once the occupational and general public compliance boundaries are determined, means to ensure that workers and people are outside the respective boundaries, for instance using appropriate signage or restricted access, should be implemented; if this is not possible or practically achievable for the specific system configuration, the configuration should be modified in order to make it possible. The R56 Standards and Guidelines for Communications Sites (6881089E50) manual provides examples of signage that can be used to identify the occupational or general public compliance boundaries.

Refer to product specific manuals for detailed safety and installation instructions. Manuals can be obtained with product orders, downloaded from <https://businessonline.motorola.com>, or purchased through the Motorola Aftermarket & Accessory Department.



WARNING

**This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.**

# **MOTOTRBO MTR3000 Base Station/Repeater Supplemental Safety and Installation Requirements**

## **ATTENTION!**

The MOTOTRBO MTR3000 Base Station/Repeater must be installed in a suitable, in-building enclosure. A restricted access location is required when installing this equipment into the end system.

The base station/repeater contains a Class 1 built-in power supply component. It is equipped with an appliance inlet for connecting to an AC input, as well as DC input terminals which meet SELV DC circuit requirements.

When installing the equipment, all requirements of relevant standards and local electrical codes must be fulfilled.

The maximum operating ambient temperature of this equipment is 60°C. The maximum operating altitude is 3000 meters above sea level.

The 28.6 VDC output from the power supply to the PA is at an energy hazard level (exceeds 240 VA). When installing into the end system, care must be taken so as not to touch the output wires.

When the MOTOTRBO MTR3000 Base Station/Repeater is used in a DC reverting system, the DC power supply must be located in the same building as the MOTOTRBO MTR3000 Base Station/Repeater, and it must meet the requirements of a SELV circuit.

# Environmental Information

## Material Content

**Note** The Motorola MOTOTRBO MTR3000 Base Station/Repeater system and its subsystems have been created in compliance with the environmental goals of the European Union's **Restriction of Hazardous Substances (RoHS)** and the **Waste Electrical and Electronic Equipment (WEEE)** Directive 2002/96/EC as well as Motorola's corporate goals to minimize environmental impact of its products.

This Motorola 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.

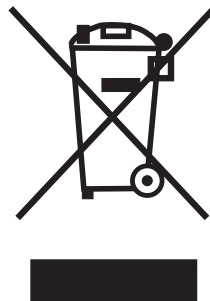
## Disposal of your Electronic and Electric Equipment

Please 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, please contact your local equipment supplier representative or service center for information about the waste collection system in your country.

## Disposal Guideline

The following symbol on a Motorola product indicates that the product should not be disposed of with household waste.



## Part 68 Information

### Part 68 FCC Guideline

This section applies when the MTR3000 Base Station/Repeater is equipped with the optional Wireline Interface Board.

This equipment complies with Part 68 of the FCC rules and the requirements adopted by the ACTA. On the rear of this equipment is a label that contains, among other information, the registration number:

**US:ABZNINANT3000**

If requested, this number must be provided to the telephone company.

The connector used to connect this equipment to the premises wiring and telephone network must comply with the applicable FCC Part 68 rules and requirements adopted by the ACTA. A compliant connector is provided with this product. See installation instructions for details.

**REN: N/A**

**Connector: RJ1DC**

**Authorized Network Port: 04NO2**

**Service Order Code: 7.0Y**

If the equipment causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. But if advance notice is not practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make necessary modifications to maintain uninterrupted service.

If you experience trouble with this equipment, please refer to "Appendix B", "Appendix C" or "Appendix D" for repair and warranty information. If the equipment is causing harm to the telephone network, the telephone company may request that you disconnect the equipment until the problem is resolved.

None of the circuit boards in this equipment are field repairable. For assistance in sending the boards back for repair, please contact the Service Center listed in "Appendix B", "Appendix C" or "Appendix D".

This equipment cannot be used on public coin phone service provided by the telephone company. Connection to party line service is subject to state tariffs. Contact the state public utility commission, public service commission or corporation commission for information.



## Document History

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

Edition	Description	Date
68007024096-A	Initial Release	January 2010
68007024096-B	<ul style="list-style-type: none"> <li>• Updated Appendix B (Contact details for Middle East and Africa)</li> <li>• Added labels in Chapter 13 (Top and Bottom Plate labels in Figure 13-6)</li> </ul>	February 2010
68007024096-C	<ul style="list-style-type: none"> <li>• Updated General Safety and Installation Standards and Guidelines section</li> <li>• Added Appendix G: MOTOTRBO Base Station/Repeater – EME ASSESSMENT</li> </ul>	April 2010
68007024096-D	Added 800/900 MHz frequency band information	August 2010
68007024096-E	<ul style="list-style-type: none"> <li>• Added VHF MHz frequency band information</li> <li>• Updated sections below:               <ul style="list-style-type: none"> <li>• Chapter 1: Section 1.2.1, Table 1-4</li> <li>• Chapter 4: Section 4.3, Added Figure 4-3</li> <li>• Appendix G: MOTOTRBO Base Station/ Repeater – EME ASSESSMENT</li> </ul> </li> </ul>	February 2011
68007024096-F	<ul style="list-style-type: none"> <li>• Added Chapter 2: MTR3000 Satellite Receiver</li> </ul>	March 2011
68007024096-G	<ul style="list-style-type: none"> <li>• Updated Appendix B: EMEA Contact details for Denmark and European Repair and Service Centre.</li> </ul>	July 2011
68007024096-H	<ul style="list-style-type: none"> <li>• Updated Chapter 12:Section 12.2 (Refer to new description for Part No. 3083191X02)</li> <li>• Updated Chapter 13:Section 13.3.2 (Refer to new description for Part No. 3083191X02)</li> <li>• Updated Appendix C (Address for Motorola Federal Technical Center)</li> <li>• Updated Appendix B (Technical Support details for Germany)</li> </ul>	Sept 2011
68007024096-J	<ul style="list-style-type: none"> <li>• Updated Chapter 7: Section 7.1.1, Section 7.1.1.2</li> <li>• Updated Chapter 9: Section 9.3.2.2.2</li> <li>• Updated Chapter 10: Section 10.1.1.4</li> <li>• Updated Chapter 12: Section 12.2</li> <li>• Updated Chapter 13: Section 13.3.2</li> <li>• Updated Chapter 14: Section 14.1, Section 14.4.1.2, Section 14.6.2</li> <li>• Updated Appendix A: Section A.1.2.5</li> <li>• Updated Appendix F: Section 7.4</li> <li>• Added Appendix G: MTR3000 Tn-nR Configurations</li> </ul>	November 2012

Edition	Description	Date
68007024096-K	<ul style="list-style-type: none"><li>• Updated Chapter 2: Added Section 2.5.1, Section 2.5.2 and Section 2.5.3</li></ul>	August 2014

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## Related Publications

MOTOTRBO MTR3000 Base Station/Repeater Installation and User Manual .....	68007024098
MOTOTRBO MTR3000 Base Station/Repeater Detailed Service Manual.....	68007024097

## Notes

## Summary of Bands Available

Table below lists the MTR3000 Base Station/Repeater bands available in this manual. For details, see Model Charts section.

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	8–100 W
UHF	403–470 MHz	8–100 W
	470–524 MHz	8–100 W
800/900 MHz	Rx : 806–825 MHz & 896–902 MHz	–
	Tx : 851–870 MHz & 935–941 MHz	8–100 W

The following table lists the MTR2000 MOTOTRBO Digital Upgrade bands that are available in this manual.

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	1–30 W (low power) 1–40 W (low power)
	136–154 MHz	25–100 W (high power)
	150–174 MHz	25– 100 W (high power)
UHF	403–470 MHz	2–30 W (low power) 2–40 W (low power)
	403–435 MHz	25–100 W (high power)
	435–470 MHz	25–100 W (high power)
800 MHz	Rx : 806–825 MHz	–
	Tx : 851–870 MHz	20–75 W
900 MHz	Rx : 896–902 MHz	–
	Tx : 935–941 MHz	20–75 W

## Notes



## **Commercial Warranty**

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

## Notes

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# Chapter 1 MTR3000 Base Station/Repeater

## 1.1 Notations Used in This Manual

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

**Note** An operational procedure, practice, or condition which is essential to emphasize.



Caution

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



WARNING

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

## 1.2 Description

The Motorola MTR3000 Base Station/Repeater (BR) provides a modular, flexible analog and digital station designed for today's communication systems and for the future. The station is available for use in these configurations:

- Analog Conventional
- Digital (MOTOTRBO)
  - MOTOTRBO DMR Tier 2 Conventional – Single Site
  - MOTOTRBO DMR Tier 2 Conventional – IP Site Connect
  - MOTOTRBO Capacity Plus Trunking
  - MOTOTRBO Connect Plus Trunking
  - MOTOTRBO Dynamic Mixed Mode (DMM)

**Note** Certain software features enabled via the CPS can be configured with the Online Help or with a regional representative. Refer to the regional Ordering Guide to determine the features available within the respective regions.

- LTR Trunking
- Passport Trunking

The base station/repeater can either be configured as a stand-alone base station/repeater or as a base station/repeater connected to a back-end network, as in the case of operating in IP Site Connect mode. As a base station/repeater, it listens on one uplink frequency, and then re-transmits on a downlink frequency, thus providing the RF interface to the field subscribers. When configured for analog station operation, the base station/repeater is designed to operate with most existing analog systems, which enables a smooth migration to the MOTOTRBO system.

When configured for digital operation, the base station/repeater offers additional services. The digital base station/repeater operates in TDMA mode, which essentially divides one channel into two virtual channels using time slots; therefore the user capacity is doubled. The base station/repeater utilizes embedded signaling to inform the field radios of the busy/idle status of each channel (time slot), the type of traffic, and even the source and destination information.

**Note** When configured in Digital Mode, the base station/repeater can only be used as a repeater.

The MTR3000 Base Station/Repeater is divided into functional modules that separate the frequency band specific and transmitter power specific circuits from other circuits and has separate modules for the control interface. These modules are self contained functional blocks with module-specific alarms. This design facilitates the field replaceable unit (FRU) concept of field repair to maximize system uptime.

The FRU architecture also allows another important feature, which is the upgrading of an existing MTR2000 Base Station/Repeater to support MOTOTRBO functionality. With MTR2000 MOTOTRBO Digital Upgrade kit, a current user of the MTR2000 Base Station/Repeater can upgrade their base station/repeater to support all MOTOTRBO digital functionality as that of a factory produced MTR3000 Base Station/Repeater.

Currently, the MTR2000 MOTOTRBO Digital Upgrade supports the following:

- VHF : 1–30 W (low power), 1–40 W (low power) and 25–100 W (high power)
- UHF : 2–30 W (low power), 2–40 W (low power) and 25–100 W (high power)
- 800/900 MHz : 20–75 W

Once the upgrade is performed, the MTR2000 Wireline and Auxiliary I/O board functionality will no longer be supported.

**Note** A MTR2000 MOTOTRBO Upgrade will only support the MTR3000 wireline card if the backplane interface board is replaced by model DLN6721.

A MTR2000 MOTOTRBO Digital Upgrade comprises the following:

- New Exciter Module
- New Receiver Module
- New Station Control Module
- New Front Bezel
- Regulatory Sticker

See [Figure 1-1](#) for the front view (with front bezel) and [Figure 1-2](#) for the front view (without front bezel) of MTR3000 Base Station/Repeater. [Figure 1-3](#) shows the rear view portion of the base station/repeater.

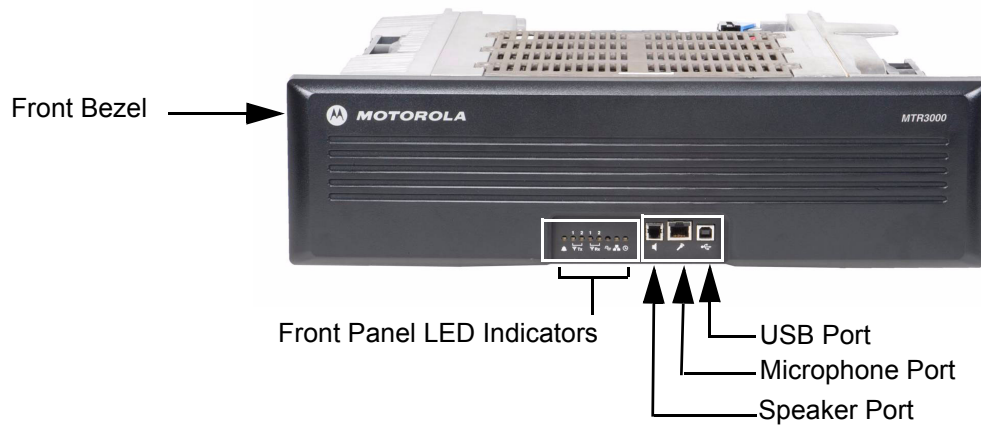


Figure 1-1 Front view (with front bezel) of the MTR3000 Base Station/Repeater

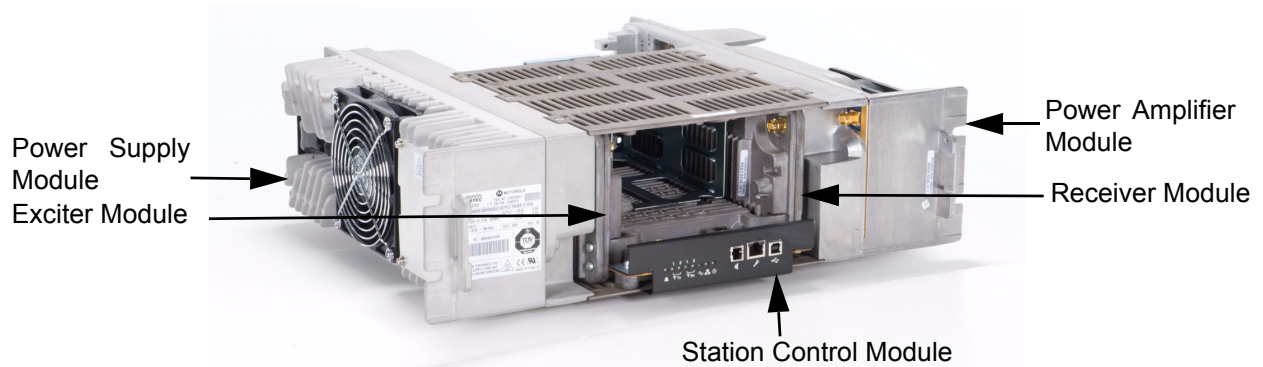


Figure 1-2 Front view (without front bezel) of the MTR3000 Base Station/Repeater

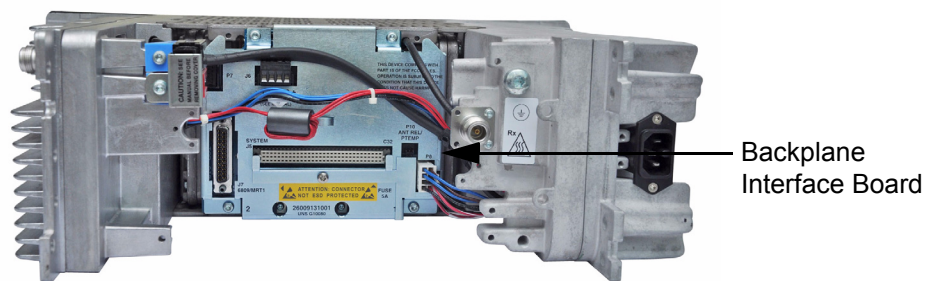


Figure 1-3 Rear view of the MTR3000 Base Station/Repeater

The MTR3000 model ships pre configured for analog conventional operation. Additional configurations can be selected and created through the Customer Programming Software (CPS) on a per-channel basis, based on the modulation type selected during station configuration.

## 1.2.1 Operating Features

The following are the standard features of a MTR3000 model:

- MOTOTRBO Conventional Operation (2-Slot TDMA, 4FSK Modulation)
- Analog Conventional Operation (FM)
- Continuous Duty Cycle Operation over -30°C to +60°C
- Meets or exceeds the following standards:
  - TIA603D
  - ETSI 086
  - ETSI 113
  - ETSI TS 102 361-1 Part 1: DMR Air Interface Protocol
  - ETSI TS 102 361-2 Part 2: DMR Voice and Generic Services and Facilities
  - ETSI TS 102 361-3 Part 3: DMR Packet Data Protocol
- Synthesized Frequency Generation
- Two Female N-type Antenna Connectors (Rx and Tx)
- Ethernet Port (Network)
- Front mounted USB Port (Service)
- Front mounted microphone port
- Front mounted speaker port
- 9 configurable GPIO/GPI ports
- Power for third party controllers (1 Amp)
- 1.5 PPM Frequency Stability (Temperature AND 1-Year Aging) (VHF and UHF)
- 0.1 PPM Frequency Stability (Temperature AND 1-Year Aging) (800/900 MHz)
- External Reference Capability
- Wireline Capability
- Switching Power Supply operates from 85–264 VAC (47–63 Hz)
- Multi-Power Source configurable (AC, DC, or AC with Battery Revert)
- Station Diagnostic Tests-Fixed Set of Tests Factory run upon Start-up
- Physical Dimensions: 5.25" H x 19" W x 16.5" D (133 x 483 x 419 mm) 3RU
- Weight: 40 pounds (19 kg) excluding cabinet or other peripheral equipment

Motorola Network Interface:

- IP Site Connect
- Repeater Diagnostics and Control (RDAC)
- Connect Plus

## Third Party Controller Interface:

- Phone Patch
- Multi Coded Squelch Interface (Repeater Panel)
- Tone Remote Adapter
- LTR Trunking
- Passport Trunking

**Note** The MTR3000 Base Station/Repeater only supports the third party controllers noted above when it is configured in analog mode.

Optionally, the MTR3000 station may be configured with

- External Pre-selector (Not available for the 800/900 MHz band)
- Antenna Relay
- Duplexer (Not available for the 900 MHz band)
- External Dual Circulator Tray (Not available for the 900 MHz band)
- Integrated Tone Remote Control (with Wireline option)
- Integrated DC Remote Control (with Wireline option)
- Analog Voting (with Wireline option)
- Simplex operation (Tx=Rx)

In addition, the following features are also included. These features are shipped in a preset condition, but may be altered through the use of the CPS.

- 16 Tx/Rx Frequencies – Factory Programmed with 1 Tx, 1 Rx
- 12.5 kHz or 25 kHz Operation – Factory Programmed to 12.5 kHz
- 1 Tx and 1 Rx (PL or DPL) Squelch Code per channel – Factory Programmed to CSQ
- Base Station Identification (BSI) – Factory Programmed as “BLANK” (“BLANK” disables BSI)
- Push-To-Talk (PTT) Priority – Factory Programmed to Repeat Path

## 1.2.2 Features not offered

Please disregard any references to the following items.

- Auxiliary I/O Option Board

## 1.2.3 Frequency Ranges and Power Levels

The MTR3000 Base Station/Repeater and MTR2000 MOTOTRBO Digital Upgrade is available in the following frequency ranges and power levels as specified in [Table 1-1](#) and [Table 1-2](#).

*Table 1-1 MTR3000 Frequency Ranges and Power Levels*

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	8–100 W
UHF	403–470 MHz	8–100 W
	470–524 MHz	8–100 W
800/900 MHz	Rx : 806–825 MHz & 896–902 MHz	–
	Tx : 851–870 MHz & 935–941 MHz	8–100 W

*Table 1-2 MTR2000 MOTOTRBO Digital Upgrade Frequency Ranges and Power Levels*

Frequency Band	Bandwidth	Power Level
VHF	136–174 MHz	1–30 W (low power) 1–40 W (low power)
	136–154 MHz	25–100 W (high power)
	150–174 MHz	25–100 W (high power)
UHF	403–470 MHz	2–30 W (low power) 2–40 W (low power)
	403–435 MHz	25–100 W (high power)
	435–470 MHz	25–100 W (high power)
800 MHz	Rx : 806–825 MHz	–
	Tx : 851–870 MHz	20–75 W
900 MHz	Rx : 896–902 MHz	–
	Tx : 935–941 MHz	20–75 W



## 1.3 Specifications

Table 1-3 shows the specifications of the MTR3000 Base Station/Repeater.

Table 1-3 MTR3000 Base Station/Repeater General Specifications (All Bands)

Parameter	Specifications
Number of Channels	16
Frequency Generation	Synthesized
Input Voltage AC	85–264 VAC (47–63 Hz)
Input Voltage DC	VHF and UHF: 28.6 VDC (25.7–30.7 VDC full rated output power) 800/900 MHz : 28.6 VDC (24.7–30.7 VDC full rated output power)
Power Supply Type	Switching
Station Weight	40 lbs (19 kg)
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Humidity Range	RH of 95%, non-condensing at 50°C (122°F)
Antenna Connectors Tx/Rx	N-Type
Modes of Operation	Simplex / Half-Duplex / Duplex
Rack Units	3
Height	5.25" (133 mm)
Width	19" (483 mm)
Depth	16.5" (419 mm)

Table 1-4 MTR3000 Base Station/Repeater Specifications

Parameter	Specifications		
	VHF	UHF	800/900 MHz
<b>Input Power (All Modulations)</b>			
Standby (AC Line 117 V / 220 V)	0.4 A / 0.4 A	0.4 A / 0.4 A	0.4 A / 0.4 A
100 W Transmit at Rated Power (AC Line 117 V / 220 V)	3.5 A / 1.9 A	3.3 A / 1.8 A	3.4 A / 1.9 A
Standby (28 VDC)	0.8 A	0.8 A	0.9 A
100 W Transmit at Rated Power (28 VDC)	12.2 A	11.5 A	12.0 A
<b>Frequency Reference</b>			
Internal Frequency Stability (PPM)	1.5 PPM	1.5 PPM	0.1 PPM
External Reference Capable	Yes	Yes	Yes
<b>Frequency Bands</b>			
Electronic Bandwidth	136–174 MHz	403–470 MHz (UHF R1), 470–524 MHz (UHF R2)	Rx : 806–825 MHz & 896–902 MHz Tx : 851–870 MHz & 935–941 MHz
<b>Receiver</b>			
Selectivity 25 kHz / 12.5 kHz	80 dB / 50 dB	75 dB / 45 dB	80 dB / 55 dB
Sensitivity* (12 dB Sinad)	0.3 uV	0.3 uV	0.28 uV
Sensitivity <sup>†**</sup> (5% BER)	0.3 uV	0.3 uV	0.28 uV
Sensitivity with External Peripherals (Antenna Relay and/or Preselector)	0.35 uV	0.35 uV	0.35 uV
Intermodulation Rejection 25 kHz / 12.5 kHz	85 dB	85 dB	85 dB
Spurious Rejection	85 dB (without External Preselector)	85 dB (without External Preselector)	90 dB (without External Preselector)
Spurious and Image Response Rejection with Narrow Preselector (Optional)	90 dB	90 dB	Option not offered
Audio Distortion	<3%	<3%	<3%
FM Hum and Noise 25 kHz / 12.5 kHz	50 dB / 45 dB	50 dB / 45 dB	50 dB / 45 dB
FCC Identifier	ABZ89FR3794 (136–174 MHz)	ABZ89FR4824 (UHF R1) or ABZ89FR4826 (UHF R2)	ABZ89FR5818 (806–902 MHz)
<b>Transmitter</b>			
Rated Output Power (Continuous Duty)	8–100 W	8–100 W	8–100 W
Intermodulation Attenuation	55 dB	55 dB	55 dB

Table 1-4 MTR3000 Base Station/Repeater Specifications (Continued)

Parameter	Specifications		
	VHF	UHF	800/900 MHz
Adjacent Channel Power 25 kHz / 12.5 kHz	75 dB / 60 dB	75 dB / 60 dB	75 dB / 60 dB
Wideband Noise (1 MHz)	-152 dBc/Hz	-152 dBc/Hz	-152 dBc/Hz
RSD 25 kHz / 12.5 kHz	5 kHz / 2.5 kHz	5 kHz / 2.5 kHz	5 kHz / 2.5 kHz
Spurious Harmonics and Emissions	-90 dBc	-90 dBc	-90 dBc (800 MHz), -86 dBc (900 MHz)
Audio Distortion	<3%	<3%	<3%
FM Hum and Noise 25 kHz / 12.5 kHz	50 dB / 45 dB	50 dB / 45 dB	50 dB / 45 dB
FCC Identifier	ABZ89FC3793 (136–174 MHz)	ABZ89FC4823 (403–470 MHz) or ABZ89FC4825 (470–524 MHz)	ABZ89FC5817 (851–870 MHz, 896–941 MHz)
Industry Canada <ul style="list-style-type: none"> <li>• IC certification / registration number</li> <li>• IC model number</li> <li>• Tx / Rx Frequency range</li> </ul>	109AB-3793 T3000-VHF Tx :136–174 MHz Rx :136–174 MHz	109AB-T3000 T3000-UHF R1 406.1–430 MHz, 450–470 MHz	109AB-5817 T3000-8/900 Rx : 806–824 MHz & 896–901 MHz Tx : 851–869 MHz & 935–940 MHz

All specifications noted above are in accordance to TIA603D unless otherwise noted as below.

**Note** (\*\*) Per TIA102 Method  
(‡) Without Rx peripherals attached

**Note** To determine the proper amount of air conditioning at a radio site, see “Power Dissipation” and “BTU Energy” specifications in the MTR3000 Product Planner located on Motorola on line (MOL), <http://www.motorola.com/businessonline>

The latest MTR3000 Product Planner can be located by the following path:  
MOL > Resource Center

## 1.4 Theory of Operation

The MTR3000 Base Station/Repeater (BR) provides the radio frequency (RF) link between the base station/repeater and the subscriber radios. The base station/repeater acquires inbound signals via its external receive (Rx) antenna and then amplifies, filters and demodulates the signals into data or voice packets. From that point, the data is either forwarded to the base station/repeater transmitter to be re-modulated and amplified for delivery to subscriber radios, and/or the data is delivered via a wired interface for distribution to networked base station/repeaters, consoles, or other networked infrastructure.

The MTR3000 base station/repeater consists of a Receiver module, Exciter module, Station Control Module (SCM), Power Amplifier (PA) and Power Supply (PS). These modules are also known as field replaceable units (FRU).

- The Receiver Module is a dual heterodyne Receiver which receives the RF signal from the subscriber's transmitter. It then converts the resulting final intermediate frequency (IF) from an analog signal to that of a digital word in IQ signal format. Finally, the Receiver delivers the IQ signal, via the SSI bus, to the SCM for demodulation. Additionally, the Receiver also provides for its own metering and diagnostics via software, as well as a self-contained calibration (no field tuning is needed for the Receiver Module).
- The Exciter Module converts a two-port base band data signal, sent over the SSI bus from the SCM, to an analog signal representation. The analog signal is then modulated with a low power RF transmitter carrier that is generated by the Exciter. The low power modulated RF carrier is then amplified and delivered to the PA at approximately +14 dBm for further amplification. The Exciter and PA constitute the transmitter of the MTR3000 Base Station/ Repeater. Additionally, the Exciter also provides its own metering and diagnostics via software, as well as a self-contained calibration (no field tuning is needed for the Exciter Module).
- The heart of the SCM Module is the two Texas Instruments OMAP1710 processors. Each OMAP processor contains an ARM Host and a C55 DSP processor. One of these OMAP processor is dedicated to Receiver DSP operations, while the other OMAP provides for all other operations, including the transmitter functions.  
In general, the SCM controls the entire coordination of the base station/repeater functions. Specifically, the SCM provides for the following functionalities:
  - Contains and runs the preloaded base station/repeater software
  - Manages inbound and outbound RF and Audio traffic
  - Provides external speaker and microphone ports
  - Provides an on-board USB port for local configuring, alignment and diagnostics via the following applications:
    - Customer Programming Software (CPS)
    - Tuner application
    - Repeater Diagnostic and Control (RDAC) software
  - Provides an Ethernet port for IP site connectivity and remote RDAC
  - Provides GPIO connectivity for third party controller interfaces
  - Provides for analog base station/repeater audio connectivity
  - Data and Control to the Receiver via the SPI and SSI respectively
  - Data and Control to the Exciter via the SPI and SSI respectively
  - Control of the PA's set power via the SPI
  - Generates the internal station reference
  - Provides control of the front panel status indicators.

- The PA Module amplifies the low level modulated RF signal from the Exciter module. It then delivers the amplified signal to the transmitter antenna port at a power level within the rated power band of the base station/repeater, for transmission to the subscriber radios. In addition to its primary task of amplification, the PA provides the following hardware functions for the base station/repeater.
  - Harmonic attenuation
  - Inter-modulation attenuation (IMA) suppression
  - VSWR detection
  - RF power control (primary means)
  - Self contained cooling fan and control circuit
  - Meters for diagnostics
  - Power rollback for temperature, VSWR, and voltage
  - Self-Contained calibration (no field alignment is needed for the PA Module).
- The PS Module provides DC power to the Receiver, Exciter, SCM and PA Module via one or more of the three DC output taps; 28.6 VDC, 14.2 VDC, and 5.1 VDC. It can also be used to provide auxiliary power (14 VDC) to a number of third party controllers. Additionally, it can operate in three different input modes:
  - AC Input Only
  - DC Input Only
  - AC with Battery Revert.

In addition to providing power to the noted FRU and controllers, the PS also provides the following:

  - AC Failure detect signaling to the SCM
  - Output over-current protection for all three outputs
  - Self contained cooling fan and control circuit (thermal shut down if the environmental temperatures exceed the cooling capacity provided by the fan).
- Specifically, the Wireline board provides for the following:
  - Tone Remote Control
  - DC Remote Control
  - Analog Voting
  - 4-wire balanced audio connection
  - 2-wire balanced audio connection
- Further details can be found in the individual "Theory of Operation" sections of the respective FRU chapters.

## 1.5 Model Chart

- The sales model includes the following items which are common to all stations:

*Table 1-5 Sales Model*

<b>T3000</b>	<b>T2003</b>
Station Control Module (SCM)	Station Control Module (SCM)
Front bezel	Front bezel
Power Supply (PS) Module	Exciter Module
Backplane Interface Board	Receiver Module
Backplane Interface Board hardware	–
Station chassis hardware	–
Cables	–
Exciter Module	–
Receiver Module	–
Power Amplifier (PA) Module	–

- A System Software Option can be selected for the MTR3000 Base Station/Repeater and MTR2000 MOTOTRBO Digital Upgrade as follows:

*Table 1-6 System Software Options*

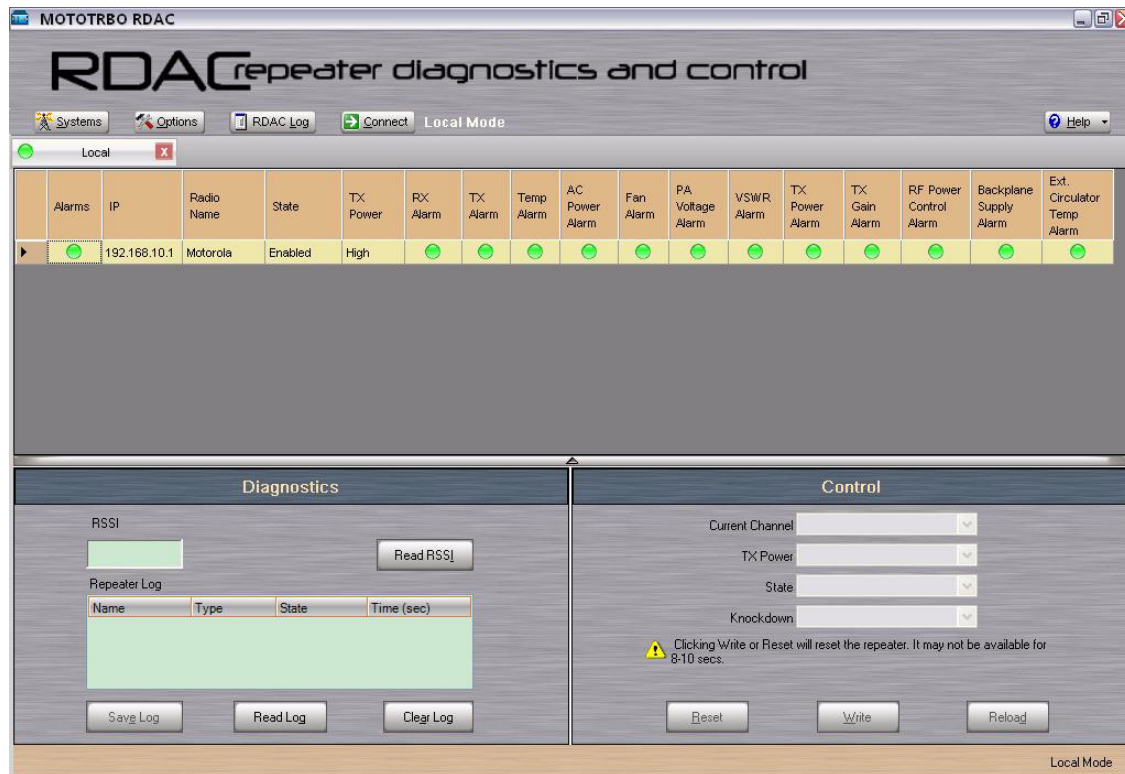
<b>System Type</b>
Upgrade your current station software to the latest version. (Available on MOL)
MTR3000 Capacity Plus SW Upgrade
MTR3000 IP Site Connect
MTR3000 Dynamic Mixed Mode

The latest pricing information and option descriptions can be located by the following path:  
MOL> Resource Center

- Note**
- To upgrade the software, select "Device update" followed by the correct version. Click "OK" and the software will then be upgraded.
  - To activate the software feature, see "Purchasing Radio Features" section in the Online Help of the Customer Programming Software (CPS).
  - To enable certain software features, a specific license key model needs to be ordered. Refer to the Ordering Guide for further details on the available software features.

## 1.6 Basic Troubleshooting

Diagnostic tests are available for the SCM, Exciter, PA, and Receiver Modules. If a problem occurs during station operation, it is logged as an alarm that is read with the Repeater Diagnostic and Control application (RDAC). See [Figure 1-4](#) for the RDAC diagnostic screen.



*Figure 1-4 RDAC Diagnostic Screen*

The station operator will then evaluate the problem locally or remotely, as the station will maintain an Alarm Log with the name of the alarm that has failed since the last power up. Via the RDAC application's Alarm Log, the alarm messages will aid in identifying the FRU that failed along with the fault condition.

After booting up the base station/repeater, the 6 LEDs (Power/Status, Tx Slot 1, Tx Slot 2, Rx Slot 1, Rx Slot 2 and the Mode LEDs) will flash in unison.

The general status and condition of the MTR3000 Base Station/Repeater can be obtained by observing the eight LED indicators on the front panel. [Table 1-7](#) shows the LED symbols and their meaning, while [Table 1-8](#) identifies the information conveyed via the LED indicators. [Table 1-9](#) shows the alarm diagnosis table and probable diagnosis to aid in identifying the fault.

Table 1-7 Front Panel LED indicators







LED	Definition
	Status
	Tx Slot 1 (for label number 1) Tx Slot 2 (for label number 2)
	Rx Slot 1 (for label number 1) Rx Slot 2 (for label number 2)
	Mode
	Ethernet Link
	Reference



Table 1-8 MTR3000 Software and Hardware Controlled LEDs

LED Function Name	LED Color	LED State	Status Indication
Power/Status, Tx Slot 1, Tx Slot 2, Rx Slot 1, Rx Slot 2 Mode	Amber	Flashing	Station booting up
	Blue		
Power/Status	Off	Off	Station Off
	Green	Flashing	Station Operating Normally, with DC power
		Solid	Station Operating Normally, with AC power
	Red	Flashing	Station Operational – Minor Alarm
		Solid	Station Not Operational – Major Alarm
	Amber	Flashing	Station in Service Mode
Solid		Station is Disabled (Dekeyed)	
Tx Slot 1 Tx Slot 2	Off	Off	Transmitter is not transmitting
	Green	Solid	Transmitter is transmitting
		Flashing	Transmitter is transmitting, but at reduced power
Rx Slot 1 Rx Slot 2	Off	Off	Receiver qualifier has not been met
	Green	Solid	Receiver qualifier has been met
Mode	Off	Off	Analog Mode (FM)
	Blue	Solid	Digital Mode (2 Slot TDMA, 4FSK)
	Blue	Flashing	DMM feature is active, but no calls are currently being processed.
Ethernet Link	Off	Off	No Ethernet connection
	Green	Solid	Linked
		Flashing	Network traffic
Reference	Off	Off	No external reference is present
	Green	Solid	Training process is completed, and the calibration data has been written to the EEPROM, or an external reference is present after training (which the base station/repeater has phase locked to).
	Amber	Solid	Locked to external reference, and training is in progress

**Note** The RDAC application will be needed when the Status LED is red (solid or flashing). This status indicates a minor or major alarm. The RDAC application is used to identify the specific alarm and probable diagnosis to aid in identifying the FRU at fault.

If the Reference LED remains amber for more than ten minutes during the alignment, then verify the integrity of the source used to train the base station/repeater's internal reference. If the integrity of the source is verified to be good, then the SCM will need to be replaced.

Table 1-9 MTR3000 Alarm Diagnosis Table

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Receiver	Rx Alarm	Major (locked)	Major (locked)	Major (locked)	Major (locked)	Yes	Yes	The Receiver PLL has lost lock.	<b>Local Dealer:</b> Replace the Receiver FRU  <b>Motorola Repair Depot:</b> Repair or replace the Receiver FRU
	Receiver EEPROM Corruption Type 1	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes	The Receiver EEPROM has incurred non-recoverable corruption in a semi-critical memory location.	<b>Local Dealer:</b> Replace the Receiver FRU  <b>Motorola Repair Depot:</b> Recalibrate the Receiver FRU
	Receiver EEPROM Corruption Type 2	Minor(enabled)	Minor(enabled)	Minor(enabled)	Minor(enabled)	No	Yes	The Receiver EEPROM has incurred a recoverable corruption in critical memory location or non-recoverable corruption in a non-critical area of memory.	No action needed. This is informational only.
	Receiver EEPROM Corruption Type 3	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The Receiver EEPROM has incurred non-recoverable corruption in a critical memory location.	<b>Local Dealer:</b> Replace the Receiver FRU  <b>Motorola Repair Depot:</b> Recalibrate the Receiver FRU
	Rx Revision	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The receiver hardware is incompatible with the currently loaded firmware version	<b>Local Dealer:</b> Replace receiver FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed receiver FRU.  <b>Motorola Repair Depot:</b> Replace receiver FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed receiver FRU.
Transmitter	Tx Alarm	Major (locked)	Major (locked)	Major (locked)	Major (locked)	Yes	Yes	The Exciter PLL has lost lock.	<b>Local Dealer:</b> Replace the Exciter FRU  <b>Motorola Repair Depot:</b> Repair/recalibrate or replace the Exciter FRU

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Transmitter	Fan Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	Yes	Yes	The PA fan has failed.	<p><b>Local Dealer:</b> Replace the PA fan</p> <p><b>Motorola Repair Depot:</b> Replace the PA fan</p> <p>Note: The PA and PS fans should be replaced in pairs.</p>
	Tx Power Minor Alarm	Minor (enabled)	Minor (enabled)	Minor (disabled)	Minor (disabled) <i>Will not switch to backup</i>	Yes	No	The PA output power is between 2 dB to 3 dB below the set output power, or the output power is more than 3 dB below the set output power with one or more of the following alarms already detected: Fan Alarm, Temp Alarm, PA Voltage Minor Alarm, PA Voltage Major Alarm, VSWR Minor Alarm or VSWR Major Alarm.	When this alarm is detected, check the Diagnostic Repeater Log to determine which failure – “Tx Power Minor Alarm (-2 dB)” or “Tx Power Minor Alarm (-3 dB)” – has occurred.
	Tx Power Major Alarm	Minor (enabled)	Major (locked)	Minor (disabled)	Minor (disabled) <i>Will not switch to backup</i>	Yes	No	The PA output power is more than 3 dB below the set output power.	<p><b>Local Dealer:</b> Remedy 1: Verify that the “Exciter to PA” cable is properly installed</p> <p>Remedy 2: If Remedy 1 does not solve this issue, replace the PA FRU</p> <p><b>Motorola Repair Depot:</b> Remedy 1: Verify that the “Exciter to PA” cable is properly installed</p> <p>Remedy 2: If Remedy 1 does not solve this issue, repair/recalibrate or replace the PA FRU</p>
	Tx Power Minor Alarm (-2 dB)	Minor (enabled)	Minor (enabled)	Minor (disabled)	Minor (disabled) <i>Will not switch to backup</i>	No	Yes Counterpart to “Tx Power Minor Alarm”	The PA output power is between 2 dB to 3 dB below the set output power of the station.	<p><b>Local Dealer:</b> Replace the PA FRU</p> <p><b>Motorola Repair Depot:</b> Repair/recalibrate or replace the PA FRU</p>

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Transmitter	Tx Power Minor Alarm (-3 dB)	Minor (enabled)	Minor (enabled)	Minor (disabled)	Minor (disabled) <i>Will not switch to backup</i>	No	Yes  Counterpart to "Tx Power Minor Alarm"	The PA output power is more than 3 dB below the set output power of the station, but at least one of the following "primary" alarms is also present: Fan Alarm, Temp Alarm, PA Voltage Minor Alarm, PA Voltage Major Alarm, VSWR Minor Alarm or VSWR Major Alarm.	<b>Local Dealer:</b> Attend to the primary alarms (see appropriate remedies at the relevant alarm sections)  <b>Motorola Repair Depot:</b> Attend to the primary alarms (see appropriate remedies at the relevant alarm sections)
	Tx Power Major Alarm (-3 dB)	Minor (enabled)	Major (locked)	Minor (disabled)	Major (locked)	No	Yes  Counterpart to "Tx Power Major Alarm"	The PA output power is more than 3 dB below the set output power.	<b>Local Dealer:</b> Remedy 1: Verify that the "exciter to PA" cable is properly installed.  Remedy 2: If no fault is found in Remedy 1, then replace the PA FRU  <b>Motorola Repair Depot:</b> Remedy 1: Verify that the "exciter to PA" cable is properly installed.  Remedy 2: If no fault is found in Remedy 1, Repair/recalibrate or replace the PA FRU
	Tx Gain Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	Yes	No	The transmitter gain is low, which is indicative of a failed or failing amplifier stage.	When this alarm is detected, check the Diagnostic Repeater Log to determine which failure -- "PA Gain Alarm", "Exciter Final Amp Alarm" or "Exciter Driver Amp Alarm" -- has occurred.
	PA Gain Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes  Counterpart to "Tx Gain Alarm"	The PA power control loop is near saturation or in saturation.	<b>Local Dealer:</b> Remedy 1: If an "Exciter Final Amp Alarm" and/or "Exciter Driver Amp Alarm" exist, then replace the Exciter FRU.  Remedy 2: If no fault is found in Remedy 1, then replace the PA FRU.  <b>Motorola Repair Depot:</b> Remedy 1: If an "Exciter Final Amp Alarm" and/or "Exciter Driver Amp Alarm" exist, then replace the Exciter FRU or Troubleshoot/Repair the Exciter's final/driver amplifier circuit.  Remedy 2: If no fault is found in Remedy 1, then repair (check PA final stage first) or replace the PA FRU.

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Transmitter	Exciter Final Amp Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes Counterpart to "Tx Gain Alarm"	The current draw of the exciter's final stage is outside of specification.	<b>Local Dealer:</b> Replace the Exciter FRU  <b>Motorola Repair Depot:</b> Replace the Exciter FRU or Troubleshoot/Repair the Exciter's final amplifier circuit.
	Exciter Driver Amp Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes Counterpart to "Tx Gain Alarm"	The current draw of the exciter's driver stage is outside of specification.	<b>Local Dealer:</b> Replace the Exciter FRU  <b>Motorola Repair Depot:</b> Replace the Exciter FRU or Troubleshoot/Repair the Exciter's driver amplifier circuit.
	RF Power Control Alarm	Minor (enabled)	Major (locked)	Minor (disabled)	Major (locked)	Yes	Yes	The transmitter is delivering power in a dekeyed state or delivering more power in a keyed state than tolerancing allows.	<b>Local Dealer:</b> Replace the PA FRU  <b>Motorola Repair Depot:</b> Repair/recalibrate or replace the PA FRU
	PA EEPROM Corruption Type 1	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes	The PA EEPROM has incurred non-recoverable corruption in a semi-critical memory location.  Note : Alarm is not applicable to the MTR2000 MOTOTRBO Digital Upgrade, as the MTR2000 Power Amplifier (PA) does not have an EEPROM	<b>Local Dealer:</b> Replace the PA FRU  <b>Motorola Repair Depot:</b> Recalibrate the PA FRU
	PA EEPROM Corruption Type 2	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes	The PA EEPROM has incurred recoverable corruption in a critical memory location or non-recoverable corruption in a non-critical area of memory.  Note : Alarm is not applicable to the MTR2000 MOTOTRBO Digital Upgrade, as the MTR2000 Power Amplifier (PA) does not have an EEPROM	No action needed. This is informational only.

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Transmitter	PA EEPROM Corruption Type 3	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The PA EEPROM has incurred non-recoverable corruption in a critical memory location.  Note : Alarm is not applicable to the MTR2000 MOTOTRBO Digital Upgrade, as the MTR2000 Power Amplifier (PA) does not have an EEPROM	<b>Local Dealer:</b> Replace the PA FRU  <b>Motorola Repair Depot:</b> Recalibrate the PA FRU
	PA Revision	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The PA hardware is incompatible with the currently loaded firmware version	<b>Local Dealer:</b> Replace PA FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed PA FRU.  <b>Motorola Repair Depot:</b> Replace PA FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed PA FRU.
	Exciter EEPROM Corruption Type 1	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes	The Exciter EEPROM has incurred non-recoverable corruption in a semi-critical memory location.	<b>Local Dealer:</b> Replace the Exciter FRU  <b>Motorola Repair Depot:</b> Recalibrate the Exciter FRU
	Exciter EEPROM Corruption Type 2	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes	The Exciter EEPROM has incurred recoverable corruption in a critical memory location or non-recoverable corruption in a non-critical area of memory.	No action needed. This is informational only.
	Exciter EEPROM Corruption Type 3	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The Exciter EEPROM has incurred non-recoverable corruption in a critical memory location.	<b>Local Dealer:</b> Replace the Exciter FRU  <b>Motorola Repair Depot:</b> Recalibrate the Exciter FRU

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Transmitter	Exciter Revision	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The exciter hardware is incompatible with the currently loaded firmware version	<p><b>Local Dealer:</b> Replace exciter FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed exciter FRU.</p> <p><b>Motorola Repair Depot:</b> Replace exciter FRU with a hardware version that supports the currently loaded firmware version, or load a version of firmware that supports the currently installed exciter FRU.</p>
	Reference Incompatibility	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	<p>A standard stability reference (1.5 ppm) SCM has been installed into a 800/900 MHz base station/repeater.</p> <p>Note: This alarm is only applicable to 800/900 MHz base station/repeater.</p>	<p><b>Local Dealer:</b> Replace the SCM FRU with a version (DLN6718) that provides a high stability reference (0.1 ppm).</p> <p><b>Motorola Repair Depot:</b> Replace the SCM FRU with a version (DLN6718) that provides a high stability reference (0.1 ppm).</p>
	Interoperability Between Exciter and PA	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The PA and Exciter do not have a compatible frequency range with each other.	<p><b>Local Dealer:</b> Remedy 1: Verify that the correct PA or exciter is installed in the station.</p> <p>Remedy 2: If no fault is found in Remedy 1, then verify that the backplane and PS cables to the PA are correctly installed.</p> <p>Remedy 3: If no fault is found in Remedy 1 or 2, then replace the exciter or PA FRU.</p> <p><b>Motorola Repair Depot:</b> Remedy 1: Verify that the correct PA or exciter is installed in the station.</p> <p>Remedy 2: If no fault is found in Remedy 1, then verify that the backplane and PS cables to the PA are correctly installed.</p> <p>Remedy 3: If no fault is found in Remedy 1 or 2, then repair/recalibrate or replace the exciter or PA FRU</p>





Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Power System	Backplane Supply Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	Yes	No	One or both of the backplane linear regulators are delivering potentials outside of their specified range.	When this alarm is detected, check the Diagnostic Repeater Log to determine which failure -- "8 Volt Supply Alarm" and/or "10 Volt Supply Alarm" -- has occurred.
	8 Volt Supply Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes Counterpart to "Backplane Supply Alarm"	The 8 volt backplane linear regulator is delivering a potential outside of its specified range.	<p><b>Remedy 1:</b> Verify that the 8V regulator is tightened to its specified torque value.</p> <p><b>Remedy 2:</b> If no fault is found in Remedy 1, then remove power from the station and remove the exciter/receiver/control board (core assembly) from the station. Next restore power to the station and verify if 8VDC is present at the regulator. If 8VDC is present, identify and repair/replace the fault core assembly FRU.</p> <p><b>Remedy 3:</b> If no fault is found in Remedy 2, then verify that the 8V regulator is receiving 14VDC. If not, check the backplane cable, backplane fuse, and Power Supply.</p> <p><b>Remedy 4:</b> If no fault is found in Remedy 4, then replace the 8VDC regulator.</p>
	10 Volt Supply Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	No	Yes Counterpart to "Backplane Supply Alarm"	The 10 volt backplane linear regulator is delivering a potential outside of its specified range.	<p><b>Remedy 1:</b> Verify that the 10V regulator is tightened to its specified torque value.</p> <p><b>Remedy 2:</b> If no fault is found in Remedy 1, then remove power from the station and remove the exciter/receiver/control board (core assembly) from the station. Next restore power to the station and verify if 10VDC is present at the regulator. If 10VDC is present, identify and repair/replace the fault core assembly FRU.</p> <p><b>Remedy 3:</b> If no fault is found in Remedy 2, then verify that the 10V regulator is receiving 14VDC. If not, check the backplane cable, backplane fuse, and Power Supply.</p> <p><b>Remedy 4:</b> If no fault is found in Remedy 4, then replace the 10VDC regulator.</p>

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Codeplug Configuration	Incorrect Carrier Frequency	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	At least one personality (analog or digital channel) exists in the codeplug which has a frequency outside of the supported electronic bandwidth of the Receiver, Exciter, or PA.	<b>Local Dealer:</b> Correct the invalid personality with the CPS application.  Note: Upon reading the codeplug, CPS will automatically set the invalid personality to a default value that falls within the valid limits of the hardware. The user must then set the defaulted personality to the required setting.
	Incorrect Codeplug for MTR2000 PA	Major (locked)	Major (locked)	Major (locked)	Major (locked)	No	Yes	The MTR3000 codeplug contains an unsupported MTR2000 PA.	<b>Local Dealer:</b> Correct the invalid MTR2000 sticker code with the Tuner application.
Environmental -- External to Station	Temp Alarm	Minor (enabled)	Minor (enabled)	Minor (enabled)	Minor (enabled)	Yes	Yes	The station has exceeded the temperature limit that will allow maximum rated output power from the PA	<b>Local Dealer:</b> Remedy 1: If the "Fan Alarm" is present, this can cause the "Temp Alarm" to be issued as a secondary alarm. If applicable, correct the "Fan Alarm" first, see "Fan Alarm".  Remedy 2: If the "Fan Alarm" is not present, cycle power/reset the station so that the FW can provide an up-to-date status on the integrity of the fan. This action is needed since the polling rate of the fan is substantially less than the polling rate for temperature.  Remedy 3: If no fault is found in Remedy 1, verify that there is not a problem with the site temperature itself. The station will clear the "Temp Alarm" and allow maximum rated output power when the temperature of the site is lowered.  Remedy 4: If no faults are found in Remedies 1 and 2, verify that the rack and cabinet installations of the station are in accordance with the product planner instructions.  Remedy 5: If no faults are found in Remedies 1, 2, 3, and 4; replace the PA FRU. <b>Motorola Repair Depot:</b> Remedy 1: If the "Fan Alarm" is present, this can cause the "Temp Alarm" to be issued as a secondary alarm. If applicable, correct the "Fan Alarm" first, see "Fan Alarm".  Remedy 2: If no fan fault is found in Remedy 1; repair/replace/recalibrate the PA FRU.

Table 1-9 MTR3000 Alarm Diagnosis Table (Continued)

Sub-system	Alarm Name	Alarm Class (repeater state) - without Backup Repeater - Single Repeater Capacity Plus System - All other Non Capacity Plus Systems	Alarm Class (repeater state) - with Backup Repeater - Non Capacity Plus System	Alarm Class (repeater state) - without Backup Repeater - Multi Repeater Capacity Plus System	Alarm Class (repeater state) - with Backup Repeater - Multi Repeater Capacity Plus System	Diag. View	Diag. Repeater Log	Diagnosis	Probable Remedy
Environmental – External to Station	VSWR Minor Alarm	Minor (enabled)	Minor (enabled)	Minor (disabled)	Minor (disabled) <i>Will not switch to backup</i>	Yes	Yes	The Voltage Standing Wave Ratio (VSWR), of the equipment the station is coupled to, is between a 3:1 to 5:1. If needed, the station will roll back power in order to protect the PA.	<b>Local Dealer:</b> Remedy 1: Verify the operational load the station is coupled to is better than a 2:1 VSWR (minimally). The load should be better than a 1.5:1.  Remedy 2: If no fault is found in Remedy 1, then replace the PA FRU.  <b>Motorola Repair Depot:</b> Replace/repair/recalibrate the PA FRU.
	VSWR Major Alarm	Minor (enabled)	Major (locked)	Minor (disabled)	Major (locked)	Yes	Yes	The Voltage Standing Wave Ratio (VSWR), of the equipment the station is coupled to, is greater than a 5:1. The station disables itself since very little power, if any, is being delivered to the transmitter antenna.	<b>Local Dealer:</b> Remedy 1: Verify the operational load the station is coupled to is better than a 2:1 VSWR (minimally). The load should be better than a 1.5:1.  Remedy 2: If no fault is found in Remedy 1, then replace the PA FRU.  <b>Motorola Repair Depot:</b> Replace/repair/recalibrate the PA FRU.
	Ext.Circulator Temp.	Minor (enabled)	Major (locked)	Minor (disabled)	Major (locked)	Yes	Yes	A high VSWR is present aft the external double circulator tray option.	<b>Local Dealer:</b> Remedy 1: Verify that the operational load (antenna port) the external circulator tray is coupled to is better than a 2:1 VSWR (minimally). The load should be better than a 1.5:1.  Remedy 2: If no fault is found in Remedy 1, then replace the circulator load/temp sensor assembly of the external circulator tray.

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## Chapter 2 MTR3000 Satellite Receiver

### 2.1 Description

The Motorola MTR3000 Satellite Receiver provides a modular, flexible analog only station designed for today's communication systems and for the future. The main purpose of the Satellite Receiver is to eliminate “dead zones” in a communications system by improving the “talk-in” coverage on a particular receive frequency when used in a receiver voting system.

The MTR3000 Satellite Receiver is divided into functional modules that separates the frequency band specific and control circuits. These modules are self-contained functional blocks with module-specific alarms. This design facilitates the field replaceable unit (FRU) concept of field repair to maximize system uptime.

The Satellite Receiver (T7713A) contains the following:

- Receiver Module
- Station Control Module
- Power Supply Module
- Backplane Interface Board
- Wireline Board (Standard)

**Note**

- For detailed information on these modules, see respective sections in this manual.
- For maximum flexibility and maintainability, these modules are identical to those used in the MTR3000 Base Station/Repeater (BR).
- The MTR3000 Satellite Receiver does not contain a transmitter. As such, the Exciter and PA modules are non-functional units (i.e. no electrical circuits).

See [Figure 2-1](#) for the front view (with front bezel) and [Figure 2-2](#) for the front view (without front bezel).

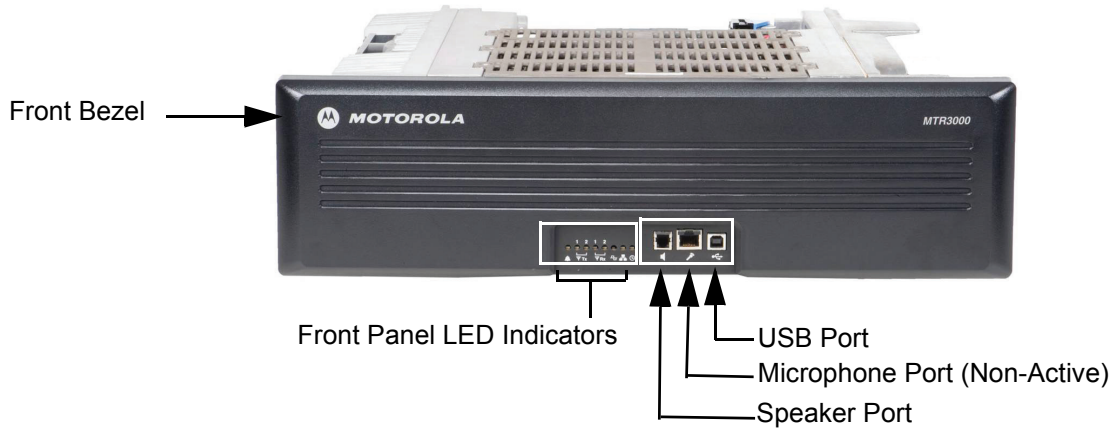


Figure 2-1 Front view (with front bezel) of the MTR3000 Satellite Receiver

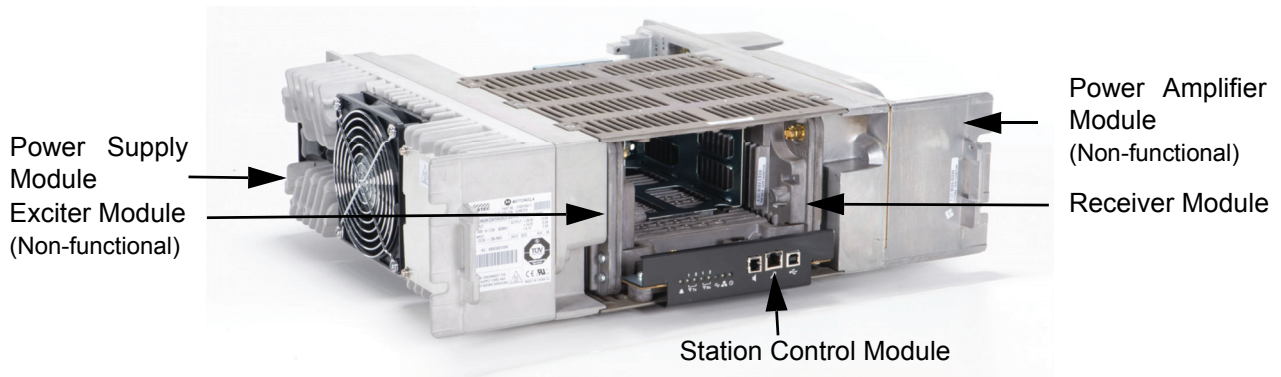


Figure 2-2 Front view (without front bezel) of MTR3000 Satellite Receiver

## 2.1.1 Operating Features

The following are the standard features of a MTR3000 Satellite Receiver:

- Analog Conventional Operation (FM)
- Digital (MOTOTRBO)
  - MOTOTRBO Satellite Receiver
- Continuous Duty Cycle Operation over -30°C to +60°C
- Meets or exceeds the following standards:
  - TIA603D
  - ETSI 086
- Synthesized Frequency Generation
- One Female N-type Antenna Connector (Rx)
- Ethernet Port (Network)
- Front mounted USB Port (Service)
- Front mounted speaker port
- 9 configurable GPIO/GPI ports
- Power for third party controllers (1 Amp)
- 1.5 PPM Frequency Stability (Temperature AND 1-Year Aging) (VHF and UHF)
- 0.1 PPM Frequency Stability (Temperature AND 1-Year Aging) (800/900 MHz)
- External Reference Capability
- Wireline Capability
- Switching Power Supply operates from 85–264 VAC (47–63 Hz)
- Multi-Power Source configurable (AC, DC, or AC with Battery Revert)
- Station Diagnostic Tests-Fixed Set of Tests Factory run upon Start-up
- Physical Dimensions: 5.25" H x 19" W x 16.5" D (133 x 483 x 419 mm) 3RU
- Weight: 40 pounds (19 kg) excluding cabinet or other peripheral equipment
- External Pre-selector (Optional) (Not available for the 800/900 MHz band)

### 2.1.2 Features not offered

Please disregard any references to the following items.

- Digital (MOTOTRBO)
  - MOTOTRBO DMR Tier 2 Conventional – Single Site
  - MOTOTRBO DMR Tier 2 Conventional – IP Site Connect
  - MOTOTRBO Capacity Plus Trunking
  - MOTOTRBO Connect Plus Trunking
  - MOTOTRBO Dynamic Mixed Mode (DMM)
  - MOTOTRBO Transmit Interrupt
  - MOTOTRBO Enhanced GPS
  - MOTOTRBO Digital Phone Patch
- LTR Trunking
- Passport Trunking
- MTR2000 MOTOTRBO Digital Upgrade

## 2.2 Specifications

Table 2-1 shows the specifications of the MTR3000 Satellite Receiver.

Table 2-1 MTR3000 Satellite Receiver General Specifications (All Bands)

Parameter	Specifications
Number of Channels	16
Frequency Generation	Synthesized
Input Voltage AC	85–264 VAC (47–63 Hz)
Input Voltage DC	21.6–32 VDC
Power Supply Type	Switching
Station Weight	40 lbs (19 kg)
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Humidity Range	RH of 95%, non-condensing at 50°C (122°F)
Antenna Connectors Rx	N-Type
Rack Units	3
Height	5.25" (133 mm)
Width	19" (483 mm)
Depth	16.5" (419 mm)



Table 2-2 MTR3000 Base Station/Repeater Specifications

Parameter	Specifications		
	VHF	UHF	800/900 MHz
<b>Input Power (All Modulations)</b>			
AC Line 117 V / 220 V	0.4 A / 0.4 A	0.4 A / 0.4 A	0.4 A / 0.4 A
28 VDC	0.8 A	0.8 A	0.9 A
<b>Frequency Reference</b>			
Internal Frequency Stability (PPM)	1.5 PPM	1.5 PPM	0.1 PPM
External Reference Capable	Yes	Yes	Yes
<b>Frequency Bands</b>			
Electronic Bandwidth	136–174 MHz	403–470 MHz (UHF R1), 470–524 MHz (UHF R2)	806–825 MHz & 896–902 MHz
<b>Receiver</b>			
Selectivity 25 kHz / 12.5 kHz	80 dB / 50 dB	75 dB / 45 dB	80 dB / 55 dB
Sensitivity* (12 dB Sinad)	0.3 uV	0.3 uV	0.28 uV
Sensitivity <sup>†**</sup> (5% BER)	0.3 uV	0.3 uV	0.28 uV
Sensitivity with External Peripherals (Antenna Relay and/or Preselector)	0.35 uV	0.35 uV	0.35 uV
Intermodulation Rejection 25 kHz / 12.5 kHz	85 dB	85 dB	85 dB
Spurious Rejection	85 dB (without External Preselector)	85 dB (without External Preselector)	90 dB (without External Preselector)
Spurious and Image Response Rejection with Narrow Preselector (Optional)	90 dB	90 dB	Option not offered
Audio Distortion	<3%	<3%	<3%
FM Hum and Noise 25 kHz / 12.5 kHz	50 dB / 45 dB	50 dB / 45 dB	50 dB / 45 dB
FCC Identifier	ABZ89FR3794 (136–174 MHz)	ABZ89FR4824 (UHF R1) or ABZ89FR4826 (UHF R2)	ABZ89FR5818 (806–902 MHz)

All specifications noted above are in accordance to TIA603D unless otherwise noted as below.

**Note** (\*\*) Per TIA102 Method  
(†) Without Rx peripherals attached

**Note** To determine the proper amount of air conditioning at a radio site, see “Power Dissipation” and “BTU Energy” specifications in the MTR3000 Product Planner located on Motorola on line (MOL), <http://www.motorola.com/businessonline>

The latest MTR3000 Product Planner can be located by the following path:  
MOL > Resource Center

## 2.3 Theory of Operation

The MTR3000 Satellite Receiver's theory of operation is similar to MTR3000 Base Station/Repeater (BR) with regards to the control, power supply, and receiver sub-systems. See [Section Chapter 1](#) for more details.

**Note** The MTR3000 Satellite Receiver does not support any transmitter sub-system functions. As such, disregard all references to the transmitter section in [Section Chapter 1](#) , or any transmitter signalling mentioned throughout this manual.

## 2.4 Model Chart

1. The sales model includes the following items which are common to all stations:

*Table 2-3 Sales Model*

<b>T7713 (Satellite Receiver)</b>
Station Control Module (SCM)
Front bezel
Power Supply (PS) Module
Backplane Interface Board
Backplane Interface Board hardware
Station chassis hardware
Cables
Exciter Module*
Receiver Module
Power Amplifier (PA) Module*

**Note** (\*) Non-functional unit

## 2.5 Configuration

### 2.5.1 Configuration with CPS versions 10.5 (Build 551) and newer

Other than setting the general personality configurations, one must additionally set the “Operation Mode” parameter under the “General Settings” menu in the CPS. This parameter is used to mask the transmitter alarms and fault management, that would result with absence of an active Exciter and Power Amplifier module. See [Figure 2-3](#) for the screenshot of the “Operation Mode” parameter.

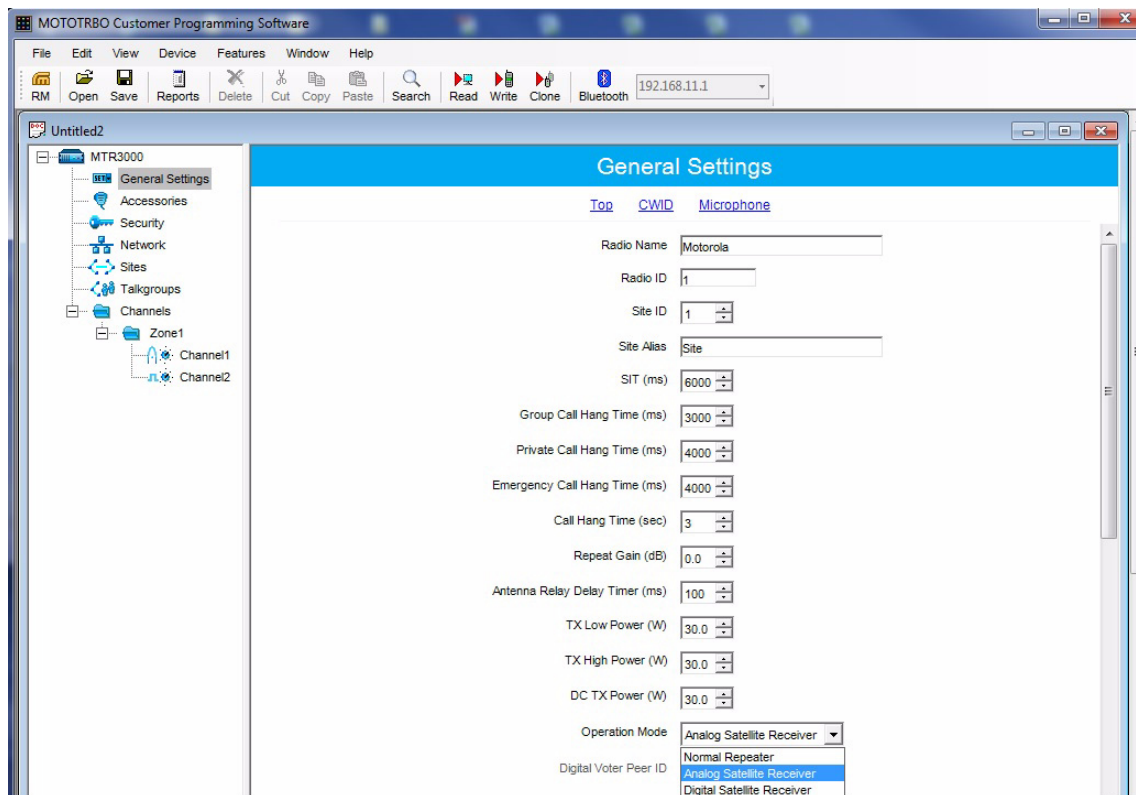


Figure 2-3 “Operation Mode” configuration for Satellite Receiver

**Note** The MTR3000 Satellite Receiver uses the same CPS tools suite as the MTR3000 Base Station/Repeater.

**Note** The MTR3000 Satellite Receiver must be configured as a Satellite Receiver (i.e. Analog Satellite Receiver or Digital Satellite Receiver to function)

If the “Operation Mode” of an MTR3000 Satellite Receiver is changed from “Analog Satellite Receiver” or “Digital Satellite Receiver” to that of “Normal Repeater” or “Digital Voter”, the MTR3000 Satellite Receiver will become disabled after the codeplug is written to. If such an event occurs, there are only two methods of recovery:

1. Write an archived configuration codeplug to the MTR3000 Satellite Receiver that reflects the correct setting of the “Operation Mode” parameter. See [Section 6.3.2](#) for more details.
2. Or install the MTR3000 Satellite Receiver’s misconfigured Station Control Board into a frequency band appropriate for MTR3000 Base Station/Repeater (BR) to allow correct configuration of the “Operation Mode” parameter. Once correctly configured, place the Station Control Board back into the MTR3000 Satellite Receiver.

## 2.5.2 Configuration with CPS versions 9.0 (Build 470) and prior

The difference in configuring the MTR3000 Satellite Receiver with CPS versions prior to 10.5 (Build 551), is that the satellite receiver operation is set by checking the “Rx Only” parameter. Additionally, the satellite receiver operation was limited to analog mode only.

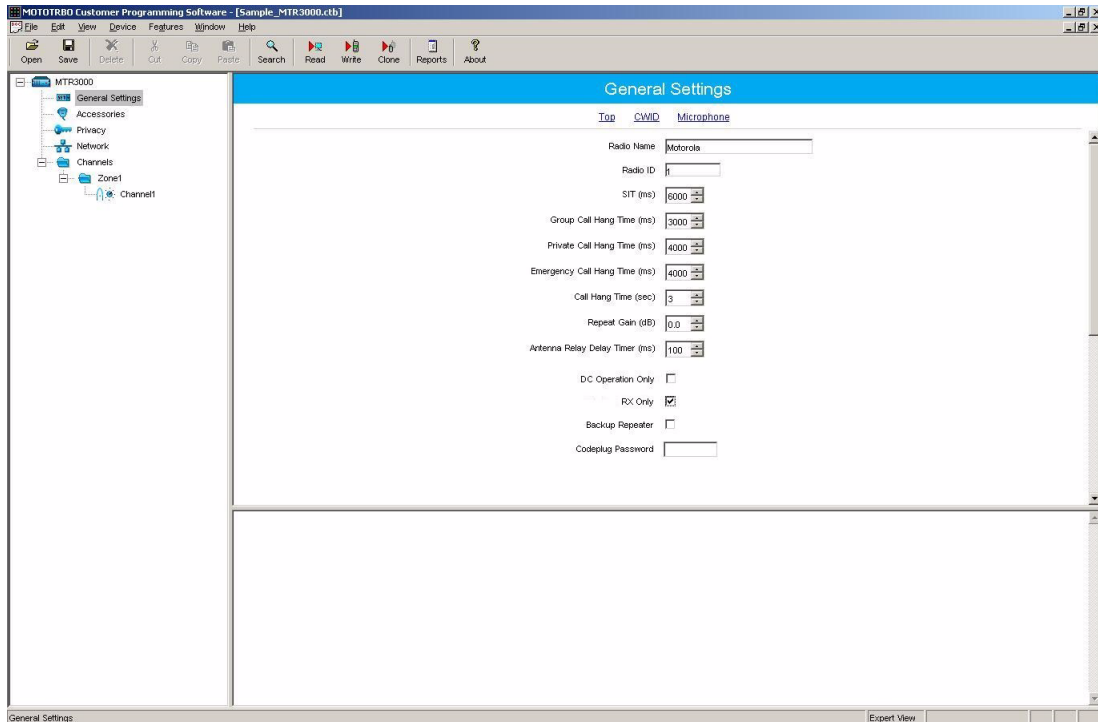


Figure 2-4 “Rx Only” configuration for Satellite Receiver

**Note** The MTR3000 Satellite Receiver uses the same CPS tools suite as the MTR3000 Base Station/Repeater.

**Note** The MTR3000 Satellite Receiver must be configured as a Satellite Receiver (i.e. “Rx Only” to function)

If the “Rx Only” parameter of an MTR3000 Satellite Receiver is unchecked, the MTR3000 Satellite Receiver will become disabled after the codeplug is written to. If such an event occurs, there are only two methods of recovery:

1. Write an archived configuration codeplug to the MTR3000 Satellite Receiver that reflects the correct setting of the “Rx Only” parameter. See [Section 6.3.2](#) for more details.
2. Or install the MTR3000 Satellite Receiver’s misconfigured Station Control Board into a frequency band appropriate for MTR3000 Base Station/Repeater (BR) to allow correct configuration of the “Rx Only” parameter. Once correctly configured, place the Station Control Board back into the MTR3000 Satellite Receiver.

## 2.5.3 Configuration with CPS versions 9.0 (Build 470) and prior

If CPS version 10.0 (Build 510) is presently used to configure the MTR3000 Satellite Receiver, upgrade the CPS to version 10.5 (Build 551) and follow the configuration instructions noted in [Section 2.5.1](#).

## 2.6 Basic Troubleshooting

The MTR3000 Satellite Receiver's troubleshooting procedures is similar to MTR3000 Base Station/ Repeater (BR) with regards to the control, power supply, and receiver sub-systems. See [Section Chapter 1](#) for more details.

**Note** The MTR3000 Satellite Receiver does not support any transmitter sub-system functions. As such, disregard all references to the transmitter section in [Section Chapter 1](#). This includes any transmitter related topics in the RDAC, the troubleshooting matrix charts, and the front panel LEDs.

**Note** In addition to the transmitter subsystem exceptions, the MTR3000 Satellite Receiver also does not support the Backplane Supply Alarm, the 8 V Supply Alarm, nor the 10 V Supply Alarm.

## 2.7 Satellite Receiver System

The MTR3000 Satellite Receiver connects to either a Spectra-TAC™ comparator, DigiTAC™ comparator or a Voter Gateway Unit (VGU). [Figure 2-5](#) shows a typical voting system and the connections of the MTR3000 Satellite Receivers.

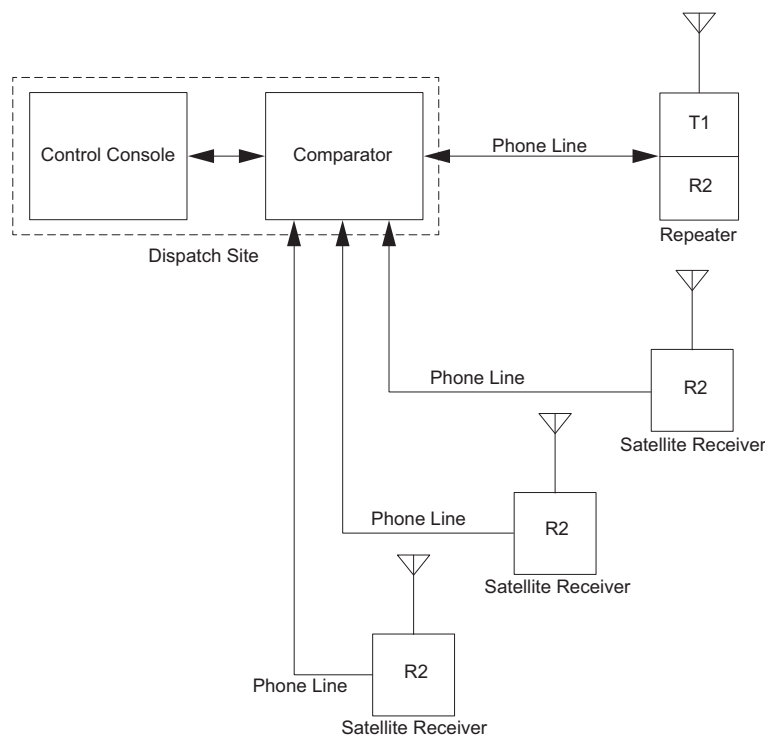


Figure 2-5 Satellite Receiver Connections Within a Voting System

## Notes

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## Chapter 3 MTR3000 Receiver Module

### 3.1 Description

The Receiver Module is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level.

#### 3.1.1 General Description

The Receiver Module consists of a Receiver RF board in a clamshell housing assembly. It provides the Receiver functionality for the MTR3000 Base Station/Repeater and performs highly-selective bandpass filtering and dual down-conversion of the desired RF signal. A custom Receiver IC then performs an analog-to-digital conversion of the desired received signal and outputs a differential data signal to the Station Control Module (SCM).

##### 3.1.1.1 Overview of Circuitry

The Receiver Module contains the following circuitry:

- Frequency Synthesizer Circuitry – Consists a phase-locked loop and Voltage-Controlled Oscillator (VCO), generates the first LO injection signal
- Varactor-tuned Preselector Filter (VHF / UHF)/ Fixed Preselector Filter (800/900 MHz) – Provides bandpass filtering of the station Receiver RF input
- Receiver Front End Circuitry – Performs filtering, amplification, and the first down conversion of the Receiver RF signal
- Receiver-specific IC Circuitry – Consists a receiver-specific IC which performs the second down conversion, filtering, amplification, and analog-to-digital conversion of the receive signal
- Analog to Digital Converter (ADC) Converter Circuitry – Converts analog Receiver status signals to digital format for transfer, upon request, to the SCM
- Local Power Supply Regulation – Accepts +8 V, +10 V and +14.2 V inputs and outputs +2.775 V, +3.3 V, +5 V, +10 V, and +14.2 V operating voltages

### 3.1.1.2 Input and Output Connections

Figure 3-1 shows the Receiver module input and output external connections.

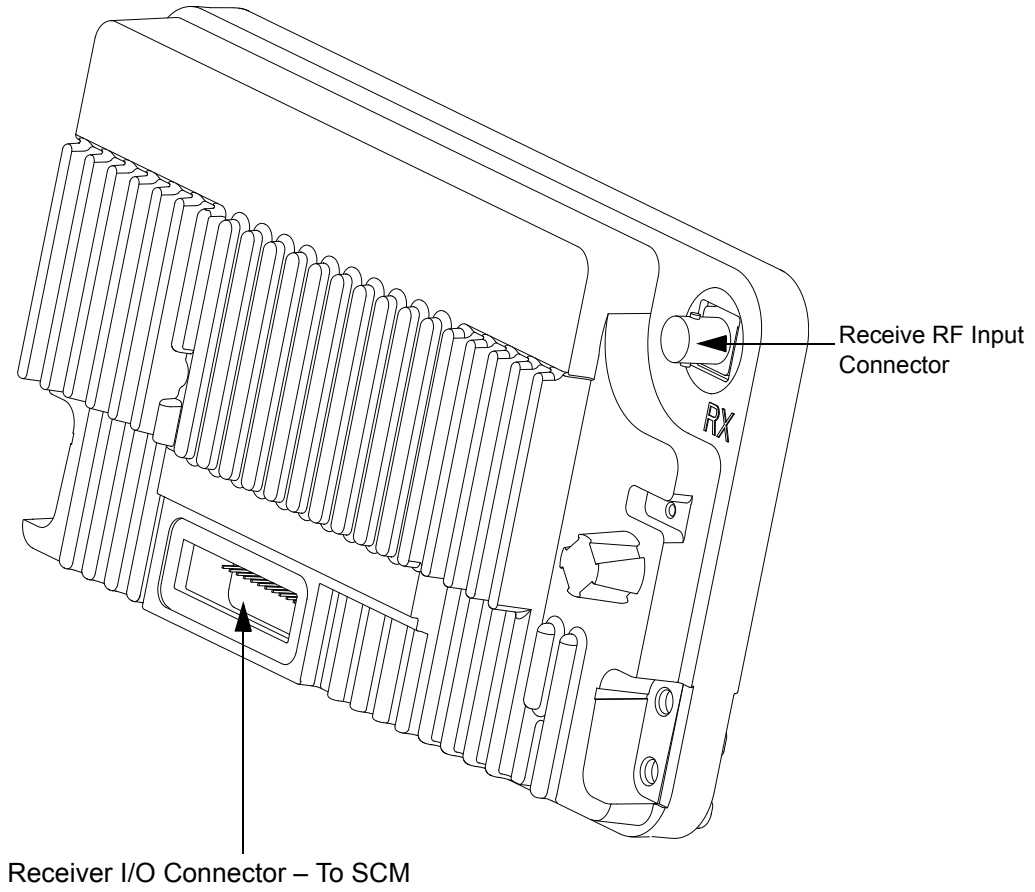


Figure 3-1 UHF Receiver Module Input/Output



## 3.2 Specifications

Table 3-1 shows the specifications of the MTR3000 Base Station/Repeater's Receiver Module.

Table 3-1 Specifications of MTR3000 Base Station/Repeater's Receiver

Parameter	Specification		
	VHF	UHF	800/900 MHz
Frequency Ranges	136–174 MHz	403–470 MHz (UHF R1) or 450–524 MHz (UHF R2)	806–825 MHz & 896–902 MHz
Electronic Bandwidth	Full Bandwidth	Full Bandwidth (UHF R1 and R2)	Full Bandwidth
Analog Sensitivity 12 dB SINAD, at Rx BNC connector	0.257 uV (-118.8 dBm)	0.257 uV (-118.8 dBm)	0.275 uV (-118.2 dBm)
Intermodulation Rejection	85 dB		
Selectivity 25 kHz / 12.5 kHz	80 dB / 50 dB	75 dB / 45 dB	80 dB / 55 dB
Spurious and Image Response Rejection	85 dB	85 dB	90 dB
Intermediate Frequencies	1st : 44.85 MHz 2nd : 2.25 MHz	1st : 73.35 MHz 2nd : 2.25 MHz	1st : 73.35 MHz 2nd : 2.25 MHz
Intermodulation Rejection	85 dB		
RF Impedance	50 Ω		
Current Draw (Maximum)	0.05A from 14.2 VDC supply 0.5A from 10 VDC supply 0.13A from 8 VDC supply		

**Note** All specs are per TIA 603D

## 3.3 Functional Theory of Operation

The base station/repeater's Receiver (Rx) is one Receiver on a single four-layer board. See [Figure 2-2](#) for the block diagram of the Receiver module for UHF band and [Figure 3-3](#) for 800/900 MHz band.

### 3.3.1 Functional Overview

#### 3.3.1.1 Receiver Front End Circuitry

The RF signal enters the Receiver through a BNC-type RF connector, located on the bottom side of the Receiver. The signal is then low-pass filtered, and the 1/2 IF and image frequency are filtered through the preselector filter. This signal is then amplified using a low-noise amplifier (LNA), and then further filtered to remove the image signal.

#### 3.3.1.2 Receiver Back End Circuitry

The signal after the image filter is then mixed down to the first IF, via a high performance (high IIP3) mixer, driven by the low-phase noise, voltage-controlled Colpitts oscillator (VCO). The mixed-down signal then passes through a 3-pole, crystal IF bandpass filter and an IF amplifier. The amplifier output signal passes through another 3-pole crystal bandpass filter, and the resultant signal passes through a digital step attenuator. The desired signal is then applied to the RF input of the backend Receiver-specific IC.

#### 3.3.1.3 Voltage Controlled Oscillator (VCO)

The Receiver Voltage Controlled Oscillator (VCO) generates a sinusoidal output signal that ranges from 180.85 MHz to 218.85 MHz (VHF), 476.35 MHz to 543.35 MHz (UHF R1), 523.35 MHz to 597.35 MHz (UHF R2), 732.65 MHz to 751.65 MHz (800 MHz) and 969.35 MHz to 975.35 MHz (900 MHz). The Receive Voltage-Controlled Oscillator (RXVCO) line-up consists of four sub-circuits: a Voltage-Controlled Oscillator (VCO), an attenuator, a buffer-amplifier, and a low pass filter (LPF).

The active device is from oscillator topology, utilizing a high-Q resonator or high-Q coil (for VHF), and four anti-parallel-configured, hyper-abrupt, tuning varactors.

The attenuator provides a broadband RF load for the VCO. The buffer-amplifier provides power-leveling and isolation. The LPF provides VCO harmonic attenuation.

#### 3.3.1.4 Synthesizer Circuitry

The Receiver synthesizer is a subcircuit within the receiver-specific IC, which when connected with a loop filter, VCO, buffer amplifier, lowpass filter, driver amplifier, unequal splitter, and feedback attenuator forms a phase-locked loop. The frequency and phase of the VCO is locked to a highly-stable external Temperature Compensated Crystal Oscillator (TCXO) reference (16.8 MHz). This IC contains the following integrated Phase locked loop (PLL) components: prescaler, fractional-N divider, reference divider, phase detector, and charge-pump (for the external loop-filter). The reference frequency is selected depending on the frequency band of operation, and will range from 3.36 MHz to 16.8MHz.

#### 3.3.1.5 Backend Receiver-specific IC Circuitry

The backend Receiver-specific IC provides additional amplification, filtering, and a second down-conversion. The second IF signal is converted to a digital signal, and output via either a differential or single-ended driver to the digital signal processor (DSP) in the SCM.

### 3.3.1.6 Memory Circuitry

The memory circuitry consists of an Electrically Erasable Programmable Read-Only Memory (EEPROM), located in the Receiver. The SCM performs memory read and write operations via the SPI bus. The Rx Front-End Filter tuning calibration is stored in the EEPROM. Therefore, no field tuning is ever required for the Receiver.

### 3.3.1.7 Analog to Digital (ADC) Converter Metering Circuitry

Analog signals from points throughout the Receiver are applied to the ADC converter. These analog signals are converted to digital signals and then sent to the SCM, via the Serial Peripheral Interface (SPI) lines, upon request of the SCM.

## 3.3.2 Data Communications

### 3.3.2.1 Communications with Station Control Module

Data communications between the Receiver and the Station Control Module microprocessor ( $\mu\text{P}$ ) is performed via a Serial Peripheral Interface (SPI) bus. This bus allows the SCM  $\mu\text{P}$  to send data to the synthesizer PLL IC (to select frequency) and to read the ADC Converter IC.

### 3.3.2.2 ADC Converter Circuitry

Analog signals from various strategic operating points throughout the Receiver board are fed to an ADC converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the Serial Peripheral Interface (SPI) bus.

## Notes

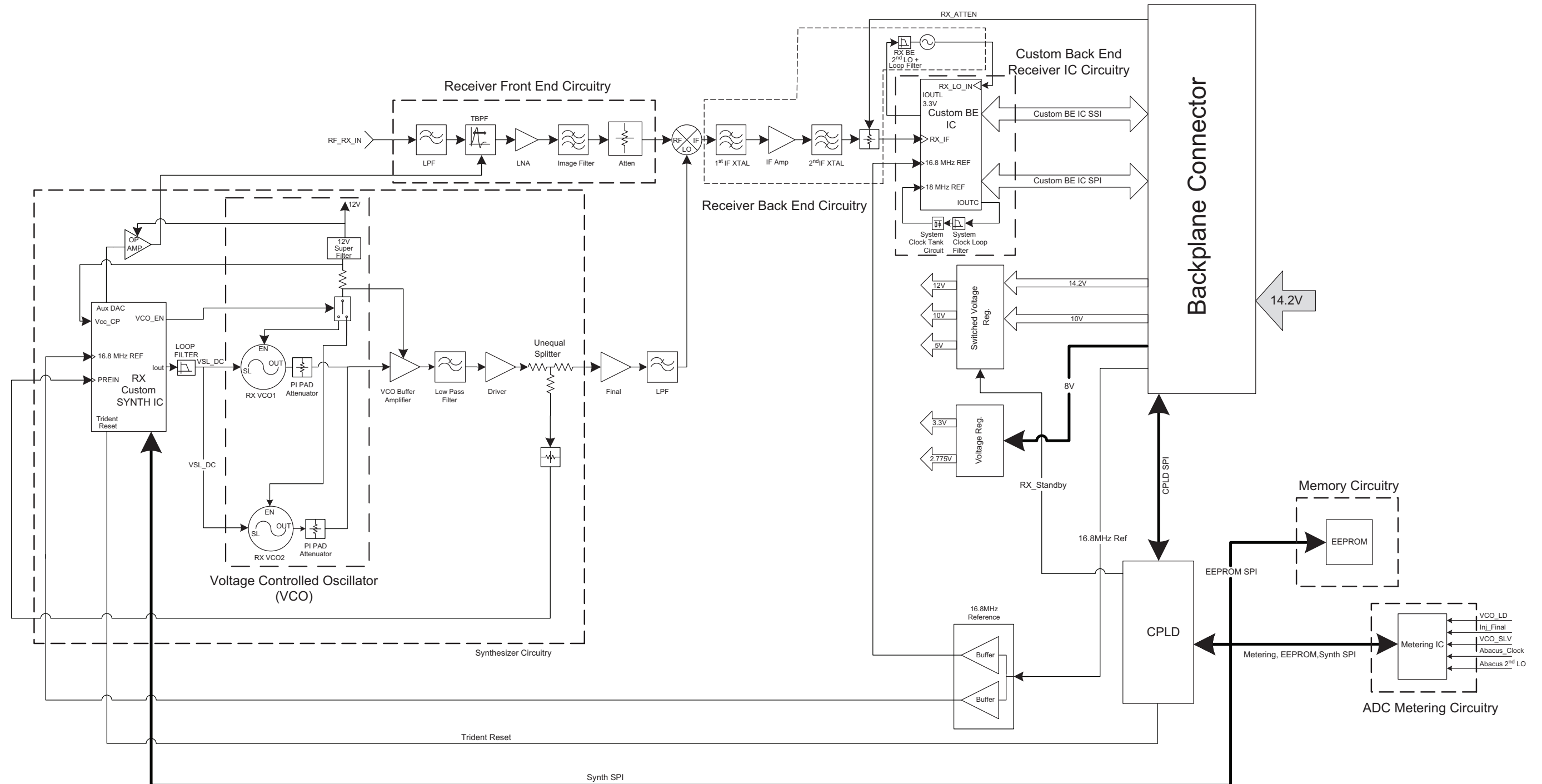


Figure 2-2 VHF and Receiver Module Functional Block Diagram (UHF)

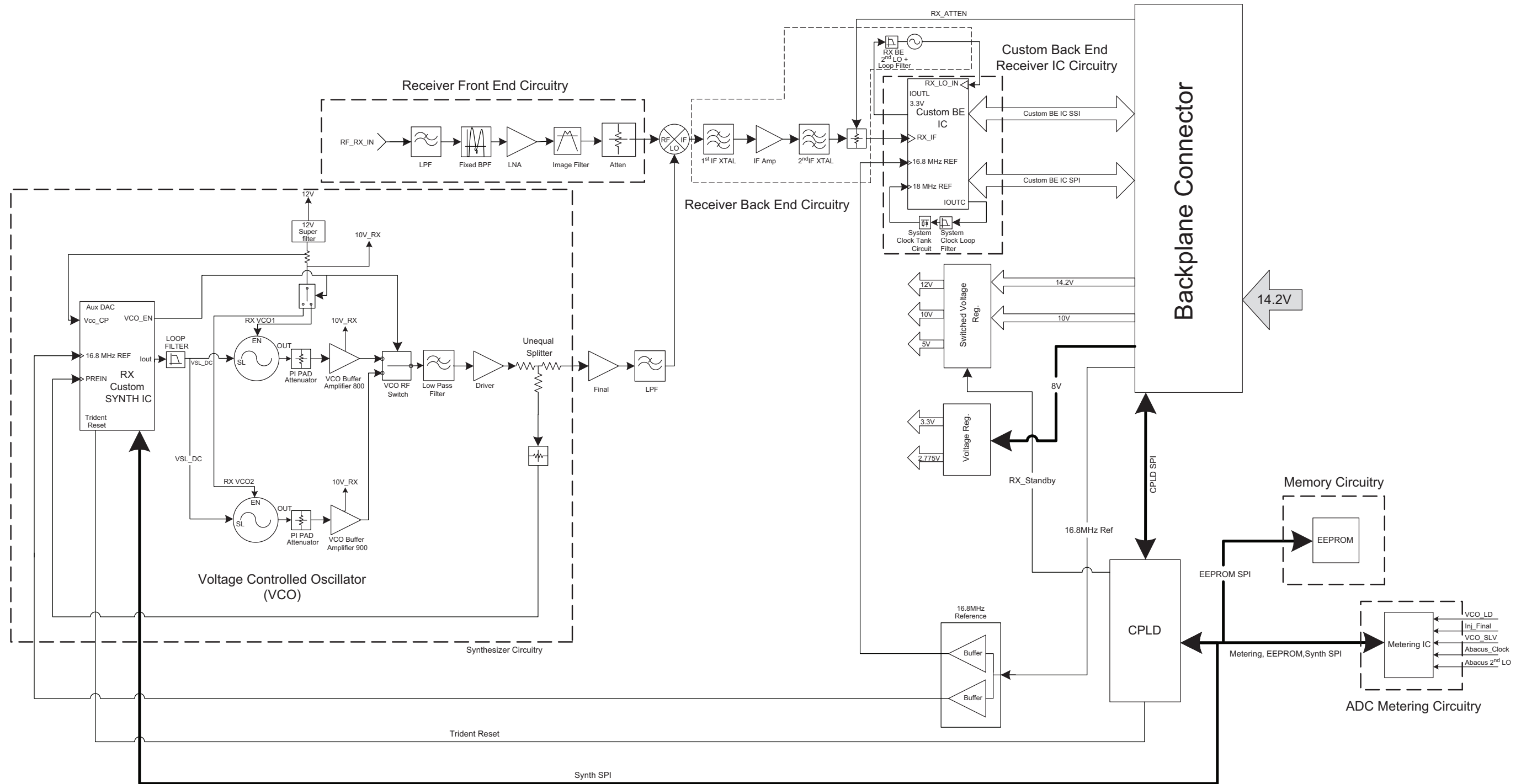


Figure 3-3 Receiver Module Functional Block Diagram (800/900 MHz)

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## 3.4 Basic Troubleshooting

### 3.4.1 Replacement Procedure

The RDAC application is used as a general guide for basic troubleshooting. Use this application to check the Receive (Rx) lock alarm, 8 V or 10 V Backplane Voltage Supply alarms as the initial step to identifying faults to the Receiver module.

For procedure to replace the Receiver module, see [Section 15.7.2.6](#).

## Notes



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# Chapter 4 MTR3000 Exciter Module

## 4.1 Description

The Exciter Module is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level.

### 4.1.1 General Description

The Exciter Module (in conjunction with the Power Amplifier Module) provides the transmitter functions for the station. Contained within a metal clamshell housing, the Exciter board generates a low-level modulated Radio Frequency (RF) signal which is input to the Power Amplifier module for further amplification and output to the transmit antenna. The Exciter Module interfaces directly with the Station Control Module (SCM), which provides control signals and monitoring, and routes transmit data to the Exciter.

The RF carrier is generated by a frequency synthesizer consisting of synthesizer circuitry and Voltage-Controlled Oscillator (VCO) circuitry. Exciter module control signals, monitoring, and audio processing are handled by the Station Control Module (SCM).

#### 4.1.1.1 Overview of Circuitry

The Exciter board contains the following circuitry:

- Frequency Synthesizer Circuitry – Consists of a phase-locked loop and Voltage-Controlled Oscillator (VCO), generates a modulated RF signal at the transmitter carrier frequency
- RF Isolation Switch – Allows the SCM to turn on/off the Exciter RF output signal to the Power Amplifier module
- Analog to Digital Converter (ADC) Converter Circuitry – Converts the analog Exciter status signals to the digital format for transfer, upon request, to the SCM
- Local Power Supply Regulation/Filtering – Accepts +8 V, +10 V and +14.2 V inputs and provides +5 V, +10 V, and +12 V operating voltages
- Low Level Amplifiers – Amplify and buffer the modulated RF signal from the VCO for delivery to the power amplifier module

### 4.1.1.2 Input and Output Connections

Figure 4-1 shows the Exciter module input and output external connections.

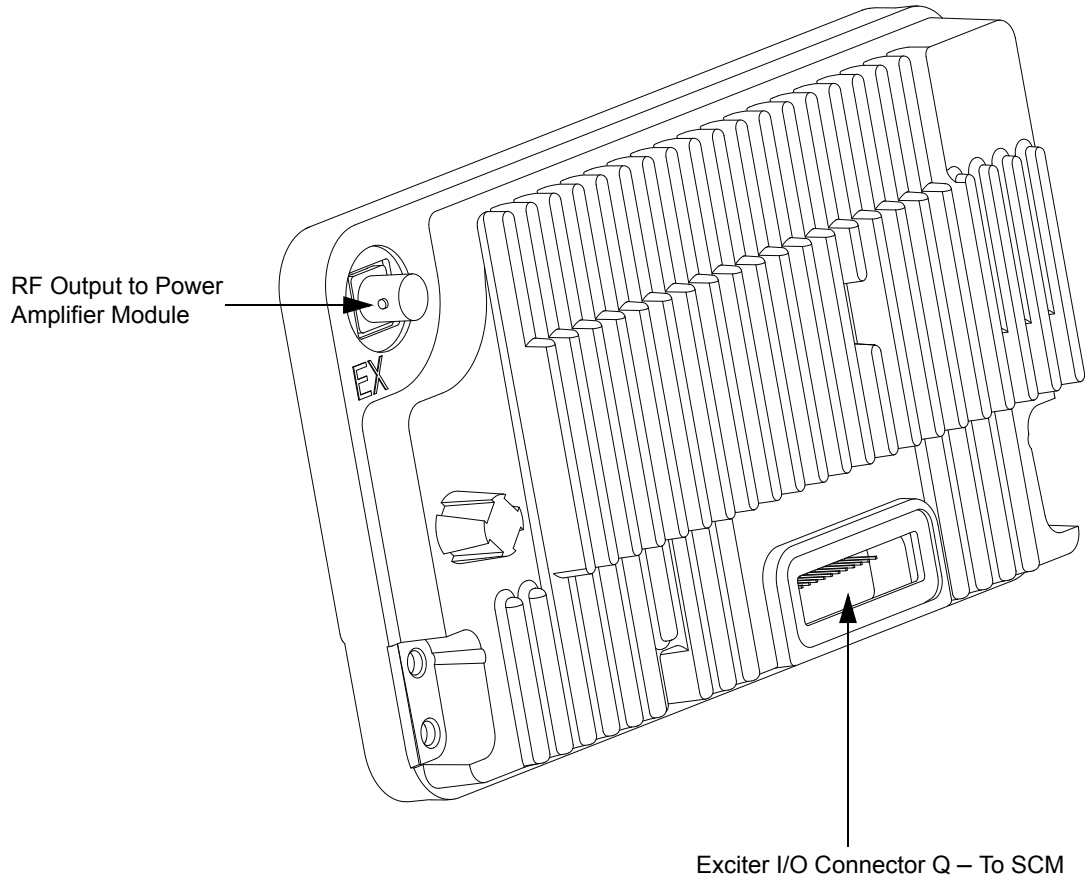


Figure 4-1 UHF Exciter Module Input/Output

## 4.2 Specifications

Table 4-1 shows the specifications of the MTR3000 Base Station/Repeater's Exciter Module.

Table 4-1 Specifications of Exciter Module

Parameter	Specification		
	VHF	UHF	800/900 MHz
Frequency Ranges	136–174 MHz	403–470 MHz (UHF R1) or 450–524 MHz (UHF R2)	851–870 MHz & 935–941 MHz
Electronic Bandwidth	Full Bandwidth	Full Bandwidth (UHF R1 and R2)	Full Bandwidth (851–870 MHz & 935–941 MHz)
Output Power	12–16 dBm	10–14 dBm	13–18 dBm (800 MHz), 14–18 dBm (900 MHz)
Current Draw (Maximum)	0.05 A from 14.2 VDC supply 0.15 A from 10 VDC supply 0.1 A from 8 VDC supply		
Harmonics	-20 dBc		

## 4.3 Functional Theory of Operation

The following theory of operation describes the operation of the Exciter circuitry at a functional level. See Figure 4-2 for the block diagram of the Exciter module.

### 4.3.1 Functional Overview

#### 4.3.1.1 Synthesizer and VCO Circuitry

##### 4.3.1.1.1 Phase-Locked Loop

The phase-locked loop (PLL) IC receives frequency selection data from the SCM microprocessor (via the SPI bus). Once programmed, the PLL IC compares a reference frequency signal with a divided-down feedback sample of the VCO output. The reference frequency is selected depending on the frequency band of operation, and will range from 3.36 MHz to 16.8 MHz. Depending on whether the feedback signal is higher or lower in frequency than the reference, up/down correction pulses are generated. (The width of these correction pulses depends on the quantitative difference between the reference and the VCO feedback.)

The up/down pulses from the PLL IC are fed to a charge pump which outputs a DC voltage proportional to the pulse widths. This DC voltage is then low-pass filtered and fed to the VCO as the control voltage.

**Note** If a frequency change is requested by the SCM microprocessor, the lowpass loop filter is momentarily bypassed to accelerate the frequency change (via a SYNTH ADAPT signal from the SCM).

#### 4.3.1.1.2 Voltage Controlled Oscillator (VCO)

The DC control voltage from the synthesizer is fed to dual VCOs which generate the RF carrier signal. Within each band, one VCO generates signals in the upper half of the band, while the other VCO generates signals in the lower half of the band. Only one VCO is active at a time. Selection of the active VCO is provided by a VCO\_SELECT signal from the PLL IC.

The active VCO responds to the DC control voltage and generates the appropriate RF signal. This signal is fed through impedance matching, amplification, and filtering and is output to the RF Switch Circuitry. A sample of the output is returned to the PLL IC to serve as a VCO feedback signal.

#### 4.3.1.1.3 Modulation

The Exciter uses dual-port FM modulator consisting of Digital Signal Processor (DSP), PLL low-port and high port blocks, fractional-N PLL, loop filter and the VCO. The modulator is calibrated once during factory test and its values are stored in the EEPROM. The modulator does not require any further tuning or maintenance.

#### 4.3.1.1.4 Amplifiers

The amplifiers consist of a driver amplifier and the final amplifier. The driver amplifier operates from a nominal 5 V supply and the final amplifier operates from a nominal 10 V supply. The driver amplifier amplifies the VCO output signal and provides the output signal to the final amplifier. There are fixed attenuators at the output of the driver and final amplifier to set the Exciter output power level. The final amplifier amplifies the signal and provides a constant signal level to the PA.

#### 4.3.1.1.5 RF Switch Circuitry

The modulated RF signal from the VCO is fed through a buffer, driver, attenuator and finally to an RF switch circuit. Signal EX\_ENABLE from the SCM controls the switch and final amplifier. The RF signal is passed through a LPF and to a BNC connector mounted in one corner of the module, just outside the module cover. A short coaxial cable connects the Exciter output to the PA module.

### 4.3.1.2 Data Communications

#### 4.3.1.2.1 Communications with Station Control Module

Data communications between the Exciter and the Station Control Module microprocessor ( $\mu$ P) is performed via a Serial Peripheral Interface (SPI) bus. This bus allows the SCM  $\mu$ P to send data to the synthesizer PLL IC (to select frequency) and to read the ADC Converter IC.

#### 4.3.1.2.2 ADC Converter Circuitry

Analog signals from various strategic operating points throughout the Exciter board are fed to an ADC converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the Serial Peripheral Interface (SPI) bus.

#### 4.3.1.3 Voltage Regulation/Filtering Circuitry

The voltage regulator circuitry consists of a +5 V, +3.3 V and +2.775 V regulators that supplies power to the digital circuitry and the PLL. The +12 V regulator is used to supply power to the VCO and the +10 V supplies power to the final device.

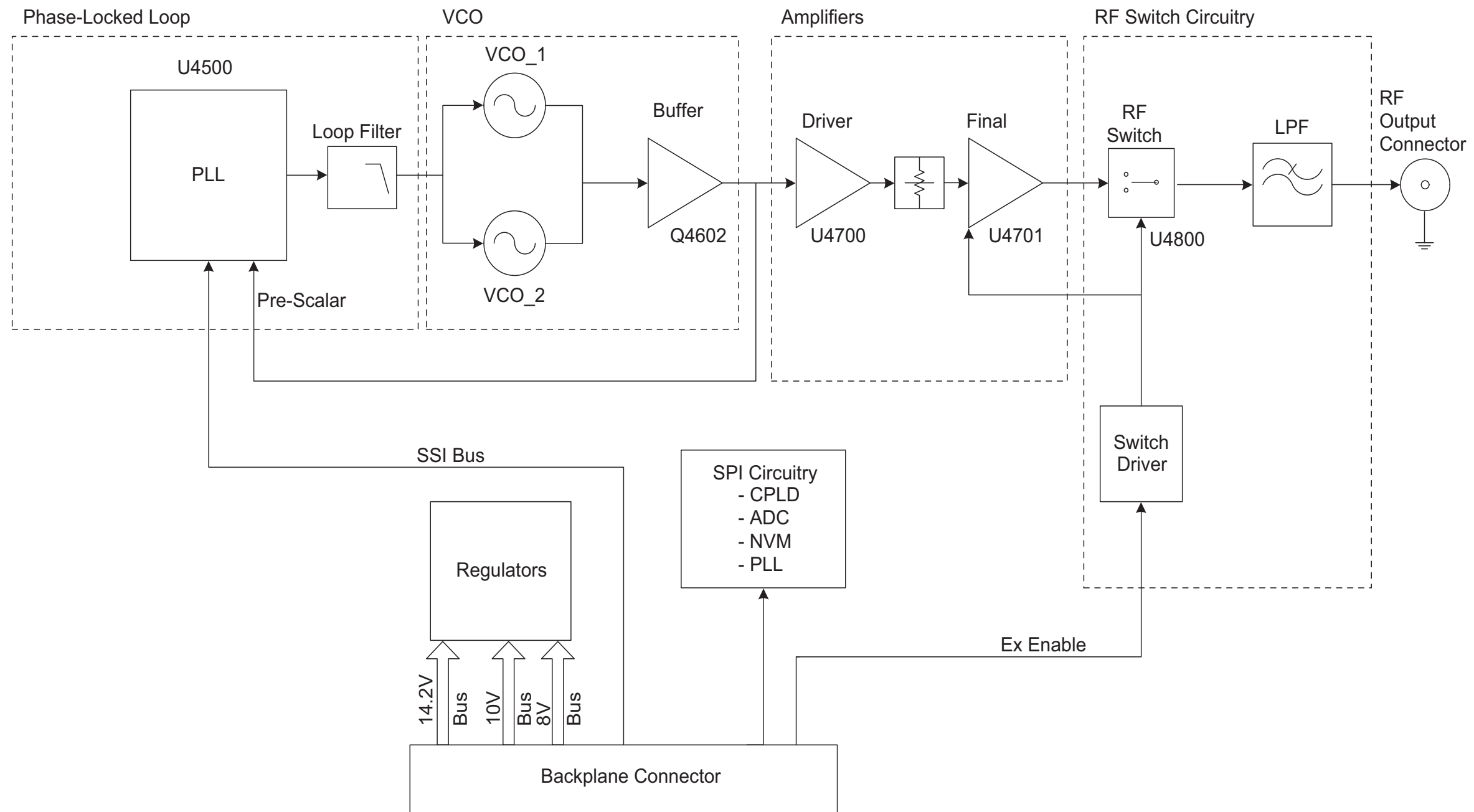


Figure 4-2 Exciter Module Functional Block Diagram

**Notes**

## 4.4 Basic Troubleshooting

### 4.4.1 Replacement Procedure

The RDAC application is used as a general guide for basic troubleshooting. Use this application to check the Transmit (Tx) lock alarm, Exciter Driver, Final Amplifier, 8V or 10V Backplane Voltage Supply alarms as the initial step to identifying faults to the Exciter module.

For procedure to replace the Exciter module, see [Section 15.7.2.4](#).

## Notes



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# Chapter 5 MTR3000 Power Amplifier

## 5.1 Description

**Note** If the station is an upgraded MTR2000, see MTR2000 Basic Service Manual (included with the original MTR2000 station) for all PA information.

The Power Amplifier (PA) is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level.

### 5.1.1 General Description

The Power Amplifier (PA) is a forced convection-cooled RF power amplifier. It accepts a low-level modulated RF signal from the Exciter Module, and amplifies it for transmission via the site transmit antenna port. The PA is non-linear, and is therefore used for continuous wave (CW) applications only. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located on the PA Input/Output boards.

#### 5.1.1.1 Overview of Circuitry

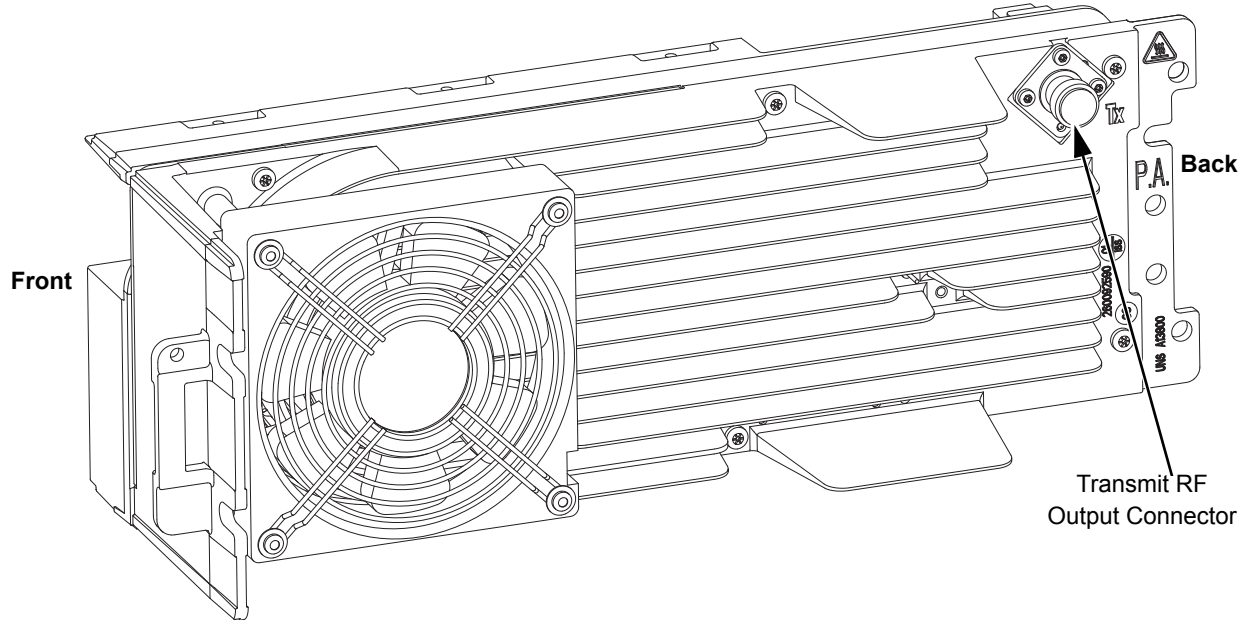
The Power Amplifier contains the following sub-circuits:

- DC Distribution Board – Main interface for the PA to the Station Control Module (SCM) and Power Supply (PS). This board contains PA SPI circuits including Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and Non-Volatile Memory (NVM) devices, and hardware (HW) metering circuitry
- RF Board – Provides RF signal amplification from the Exciter Module low-level signal to the MTR3000 Base Station/Repeater (BR) output power level
- Isolator – Protects the PA from damage when poor RF load conditions exist. Also assists with intermodulation attenuation performance
- Output Board – Performs harmonic filtering and RF power detection functions, and routes the RF signal to the antenna port

### 5.1.1.2 Input and Output Connections

Figure 5-1 shows the PA input and output external connections.

#### Outside View



#### Inside View

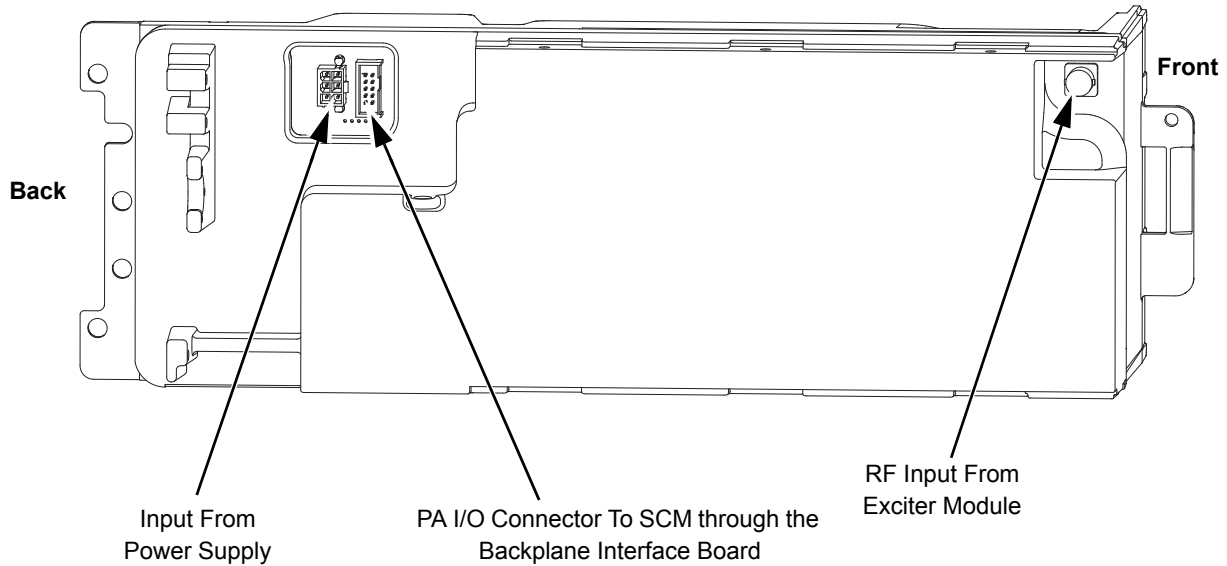


Figure 5-1 PA Input/Output

## 5.2 Specifications

Table 5-1 shows the specifications of MTR3000 Base Station/Repeater's Power Amplifier (PA).

Table 5-1 Specifications of Power Amplifier

Parameter	Specification		
	VHF	UHF	800/900 MHz
Operational Frequency Range	136-174 MHz	403–470 MHz (UHF R1) or 470–524 MHz (UHF R2)	851–941 MHz
Minimum Input Return Loss (Tx mode)	10 dB	7 dB	10 dB
Rated RF Input Power Range	11.8–16 dBm	9.8–14 dBm	12.8–18.5 dBm
Maximum Standby Power Consumption	1.5 W	1.2 W	1.5 W
Rated RF Output Power Range	8–100 W		
28.6 V Supply Nominal Voltage (AC Power)	28.6 V (+/- 4%)		
14.2 V Supply Nominal Voltage	14.2 V (+/- 3%)		
28.6 V Supply Maximum Current Draw	12.6 A		
14.2 V Supply Maximum Current Draw	2.0 A		

## 5.3 Functional Theory Of Operation

The Power Amplifier (PA) is designed for continuous-duty operation across each specified band and power level. All PA contain a multi-stage power amplifier board at the input (RF Board), a circulator with isolation load termination, a low-pass filter/directional coupler at the output (Output Board), and a DC Distribution Board incorporating circuitry for diagnostics and RF power control. The PA and its sub-circuits are broad-band devices and require no manual tuning or alignment to operate over the specified conditions.

The main interface between the PA and the rest of the base station/repeater is through the DC Distribution Board. The DC distribution board contains the PA external I/O's that connects to the power supply directly through a cable and to the control module through a cable to the backplane interface board. These I/O's are used to distribute the DC supply buses (28.6 V and 14.2 V nominal) from the power supply to within the PA as well as the various signals used for the control of the PA from the SCM such as the SPI bus signals, PA enable, and the reset line.

The DC Distribution Board contains the SPI circuitry as well as metering circuitry used by both SW and internal PA HW for determining when fault conditions are present and take appropriate action when needed. A brief description of the PA SPI devices is shown below.

- Complex Programmable Logic Device (CPLD): Main PA SPI interface, with all other PA SPI devices connected through this device
- Non-Volatile Memory (NVM): Used to store calibration data and identification information
- Digital to Analog Converter (DAC): Converts SW digital signals to analog within the PA. This controls the PA fan, power control circuit, and some other circuits within the PA
- Analog to Digital Converter (ADC): Converts analog signals within the PA to digital for SW interface. These signals are used by SW for HW metering

A combination of software (SW) and hardware (HW) controls are used to regulate the PA RF output power level. By way of software control, the SCM programs RF output power through the SPI bus. Once programmed, the PA power control loop will level the output power to the requested level, if possible. The requested output power may not be achievable if an alarm condition is present, and output power may be reduced by way of SW or HW control if alarm conditions are present.

Within the base station/repeater, the modulated RF signal passes from the Exciter Module to the driver amplifier within the PA. The driver amplifier is located on the RF Board and is a multi-stage amplifier circuit that amplifies the RF input signal up to a maximum of approximately 4 W, as needed to achieve the software requested base station/repeater RF output power. The RF signal from the driver amplifier is further amplified by the final amplifier stage, which is also located on the RF Board and consists of multiple paralleled RF devices with associated splitting and combining circuitry.

This RF signal then passes through a circulator and harmonic (low pass) filter, through an RF directional coupler, and is output to the site transmit antenna port. The circulator prevents a high Voltage Standing Wave Ratio (VSWR) at the PA output from damaging the final amplifier devices, and also improves intermodulation attenuation (IMA) performance by providing isolation to the final amplifier. The harmonic filter attenuates the harmonic levels generated by the preceding RF amplifier devices.

The RF directional coupler is a calibrated wattmeter, with its calibration information stored in the PA NVM. The forward and reverse power wattmeter provides a signal corresponding to the measured output power to the ADC for metering purposes so that SW can monitor the PA or base station/repeater output power. Also, this voltage is provided to the power control circuitry within the PA to serve as the feedback signal in the power control loop for setting output power. The forward power meter along with the reverse power meter is used by SW to measure the VSWR presented to the PA output and to determine when an alarm condition is present.

The SW requested power level may include one or more SW controlled adjustments based on various alarm conditions, if present, generated from monitored PA metering signals which are fed back to the SCM via an ADC converter. Using the A/D metering circuits, SW monitors for conditions such as high reflected power/VSWR, high/low supply voltage, low PA gain and RF control loop instability and takes action to reduce output power or dekey the station accordingly, when needed, in order to protect the HW from damage or improper operation.

Temperature monitoring circuitry is also contained within the PA. When the temperature reaches a certain threshold, the PA fan turns on to reduce the operating temperature of the PA. If the temperature continues to rise and reaches another predefined threshold, the base station/repeater output power may also be reduced in order to protect the HW from thermal failure. Both the fan control and the power control manipulation for thermal protection is fully HW controlled, and requires no SW interaction.

**Note** For procedure to replace the PA fan, see [Section 15.7.2.1 on page 15-7](#).

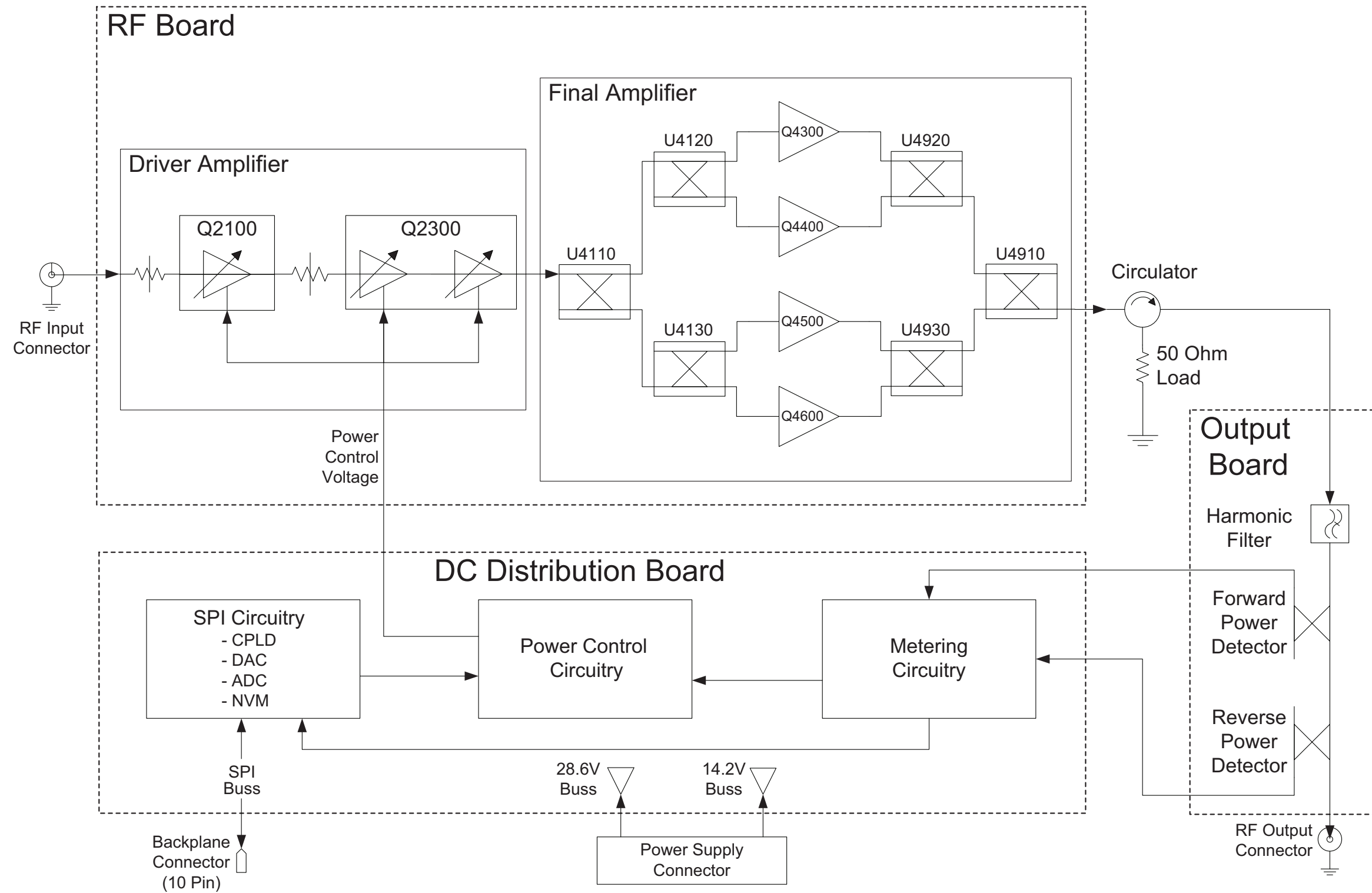


Figure 5-2 Power Amplifier Functional Block Diagram (UHF and 800/900 MHz)

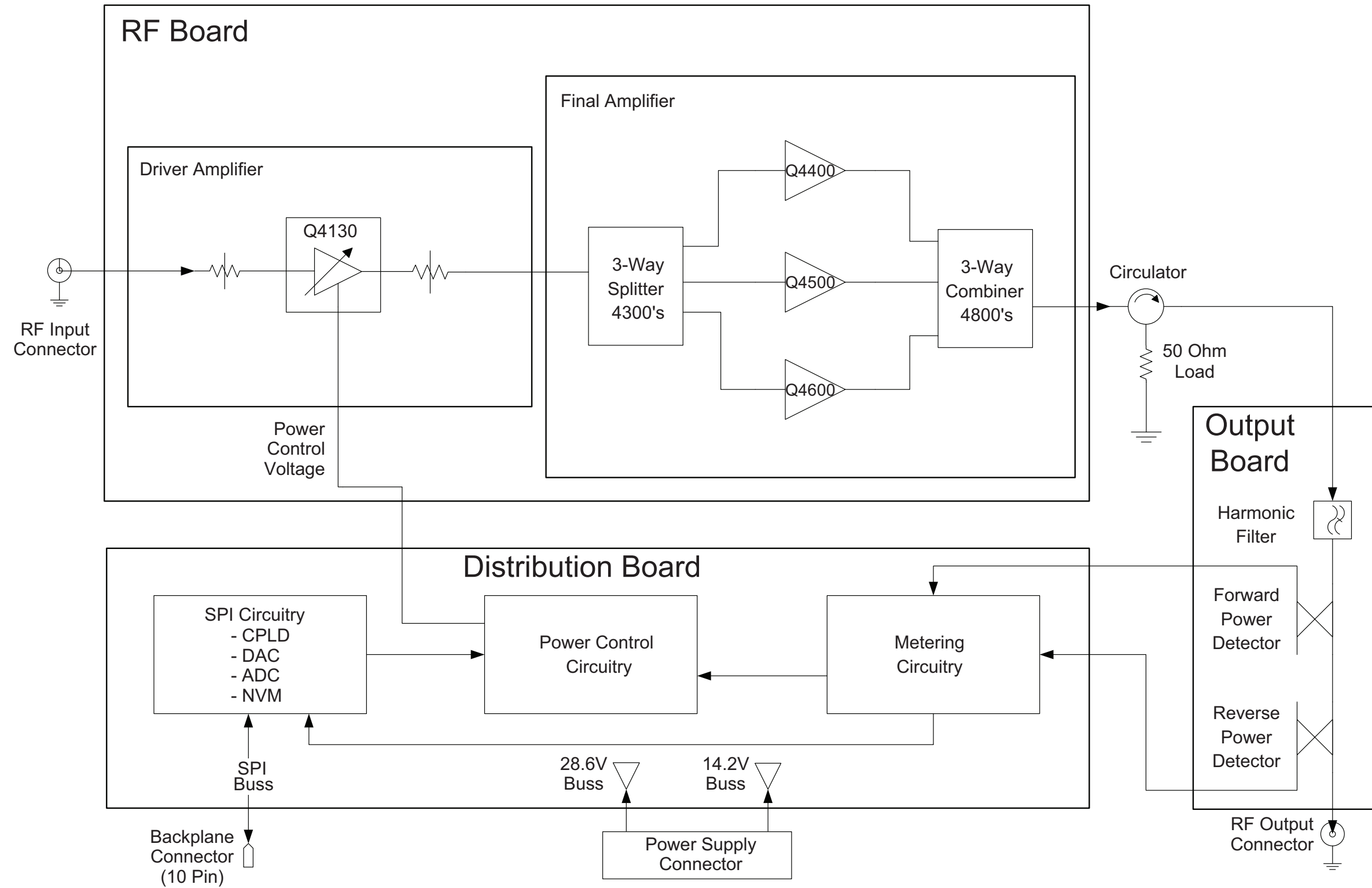


Figure 5-3 Power Amplifier Functional Block Diagram (VHF)

## 5.4 Basic Troubleshooting

### 5.4.1 Replacement Procedure

The RDAC application is used as a general guide for basic troubleshooting. Use this application to check the Low RF Output Power, VSWR, Voltage, Fan Failure, Low PA Gain, RF Control Loop Instability and temperature parameters, as the initial step to identify faults to the Power Amplifier.

For procedure to replace the Power Amplifier, see [Section 15.7.2.2](#).

## Notes



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# Chapter 6 MTR3000 Station Control Module

## 6.1 Description

The Station Control Module (SCM) is described in this section. A general description, identification of controls, indicators, and inputs/outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level.

### 6.1.1 General Description

The SCM circuitry performs the digital signal processing, data formatting and audio routing for the MTR3000 Base Station/Repeater (BR) and provides the external interfaces to the rest of the site.

The SCM uses two TI OMAP1710 processors

- One for transmit and overall base station/repeater control functionalities
- One for all receive functionalities

Both OMAP1710 processors have independent boot Flash and RAM and, therefore can boot independently.

General SCM functionality includes:

- Data and Control interface to the Receiver's Abacus III devices
- Data and Control interface to the Receiver's Trident chip set
- Data and Control interface to the Exciter's Trident chip set
- Audio Codec interface with MAKO IC
- Host memory size, speed, and types supported
- External ports (Ethernet, USB, speaker and microphone)
- External physical interfaces (connectors, LEDs, external references etc.)
- Tx/Rx DSP Multi-Channel Buffered Serial Port (MCBSP) interfaces
- Intermodule communication (using SPI)
- Internal station reference generation\*

**Note** (\*) See the Orderable Service FRU kit matrix.

### 6.1.1.1 Input and Output Connections

Figure 6-1 shows the SCM input and output external connections.

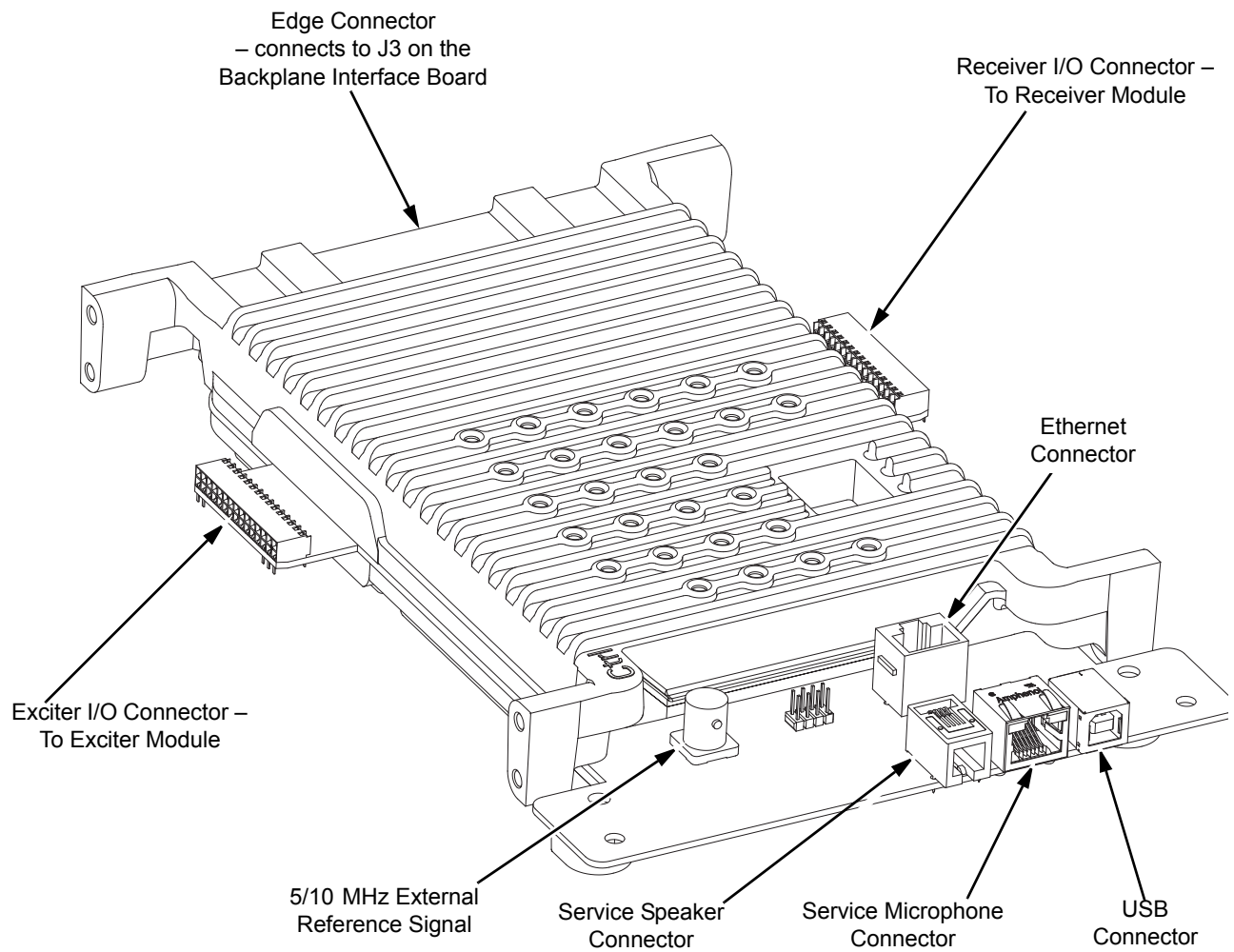


Figure 6-1 Station Control Module Indicators and Input/Output Connections

## 6.2 Functional Theory of Operation

The following theory of operation describes the operation of the SCM at a functional level. See [Figure 6-3](#) for the block diagram of the SCM supply voltage circuitry.

### 6.2.1 Tx OMAP

The Tx DSP is a TI OMAP Multimedia Processor. The OMAP1710 consists of a microprocessor unit (MPU) subsystem and a digital signal processor (DSP) subsystem.

OMAP1710 has dedicated external memory interface that allow point-to-point connection to standard mobile SDRAM/DDR and mobile flash devices. It is a low-power device (1.4 V Core and 1.8 V I/O supply). Tx OMAP handles all transmit tasks of the SCM.

#### 6.2.1.1 External Memory

Both transmit and receive DSP's support independent external memory banks.

##### 6.2.1.1.1 RAM

The SCM supports Mobile Double Data Rate SDRAM. It has the following basic characteristics:

- 32 MB organized as 4 Mb x 16 x 4 Banks
- Four internal banks for concurrent operation
- Programmable burst lengths: 2, 4, or 8 bytes
- Auto refresh and self refresh modes
- Selectable output drive (DS)
- VDD/VDDQ = 1.7–1.95 V

The maximum external clock rate for the DDR is 90 MHz. Since data is transferred on both clock edges, the effective data rate is 180 Mwords/s.

##### 6.2.1.1.2 Flash

The SCM supports 256 MB external flash memory. The device has the following basic characteristics:

- Four 32 KBytes Bottom Boot Sectors
- 128 KBytes main blocks (254 for 256 Mbit part, 514 for 512 Mbit part)
- 1.8V VCC and VCCO

#### 6.2.1.2 Serial Peripheral Interface (SPI)

The station local and Intermodule SPI Bus is controlled by both Tx and Rx OMAP1710 processors, which has an on-chip SPIF (fast SPI) interface. The OMAP1710 SPIF supports master and slave modes, programmable clock rate, phase, polarity, programmable word size, programmable bit ordering, and loopback.

Before an SPI data transfer can take place, the SPI master (initiator) must assert the select line of the slave (target) device. The OMAP1710 is always the SPI master for base station/repeater. To simplify overall SPI architecture for base station/repeater, address decoding is used instead of individual device chip signals. This approach not only minimizes the number of GPIOs needed for device chip select, it also provides flexibility for future expansion. This device address decoding is handled by an Field Programmable Gate Array (FPGA) on the SCM and a Complex Programmable Logic Device (CPLD) on each FRU's, except the Power Supply.

The FPGA SPI module performs address and chip select decoding, level shifting, and signal mixing for both the Tx OMAP SPI bus and the Rx OMAP SPI bus. Simultaneous Rx and Tx SPI accesses are allowed. The Tx and Rx SPI are 100% independent.

### 6.2.1.3 Station Reference

The SCM is offered in two versions, a TCXO version for VHF and UHF band, and an OCXO version for 800/900 MHz band. A TCXO provides the frequency reference for the base station/repeater for a TXCO controller kit. For the 800/900 MHz controller kit, an OCXO provides the frequency reference for the MTR3000 Base Station/Repeater. The TCXO/OCXO output is 16.8 MHz. The FPGA is used to create other clocks locked to the TCXO/OCXO which are needed by various devices on the SCM. The clocks are summarized in [Table 6-1](#):

[Table 6-2](#) summarizes the FCC required frequency stability requirements for various bands.

*Table 6-1 Station Control Module (SCM) FPGA output Frequencies*

Frequency	Destination
12 MHz	Tx OMAP, Rx OMAP
24.576 MHz	MAKO
32.768 kHz	Tx OMAP, Rx OMAP, MAKO

*Table 6-2 Station Control Module (SCM) FCC Frequency Stability Requirement*

Required Stability (ppm)	TCXO Service Interval	OCXO Service Interval
5	5 years	10 years
2.5	2 years	10 years
1.5	1 year	10 years
1	6 months	10 years
0.5	External Reference required	5 years
0.1	External Reference required	1 year

**Note** The TCXO version is for VHF and UHF band and the OCXO version is for 800/900 MHz band.

### 6.2.2 Rx OMAP

The Rx DSP is a TI OMAP Multimedia Processor. The OMAP1710 consists of a microprocessor unit (MPU) subsystem and a digital signal processor (DSP) subsystem. OMAP1710 has dedicated external memory interface that allows point-to-point connection to standard mobile SDRAM/DDR and mobile flash devices. It is a low-power device (1.4 V Core and 1.8 V I/O supply). The Rx OMAP handles receiving tasks of the SCM only.

### 6.2.3 MAKO

MAKO IC is a customized IC and the SCM uses this device to leverage some unique functionality that it provides.

Most of the MAKO functionalities are not used on the SCM. Only the MAKO codec, USB driver, ADC, DAC, and some voltage regulators are used on the MTR3000 Base Station/Repeater. The 9 channel general purpose ADC is used for various controller metering.

### 6.2.4 Field Programmable Gate Array (FPGA)

The SCM FPGA includes the following major functions:

- External reference watchdog
- SPI Address decoding and buffering
- TCXO Phase detection and compensation
- Clock generation
- Reset controller
- External Interface (Wireline SSI, LED, etc.)

FPGA field upgrade capability is also supported on the MTR3000 Base Station/Repeater.

### 6.2.5 Audio

There are four transmit inputs: Tx Audio, Tx Audio-Pre & Tx Data on the backplane interface board 25-Pin connector, and the microphone input on a front panel RJ45 connector.

Tx Audio is a flat (not pre-emphasized) input which is used if the incoming transmit audio signal is already pre-emphasized or if pre-emphasis is not needed. The Tx Audio-Pre input provides a hardware pre-emphasis filter. The Tx Data input is used for low speed data, Private-Line (PL) and Digital Private Line (DPL) signals.

The Tx Audio, Tx Audio-Pre and microphone inputs pass through a hardware modulation limiter and splatter filter before being summed with Tx Data, with the Tx Data bypassing the limiter and splatter filter. This summed signal is applied to the MAKO codec "mic" input. The audio signal without Tx Data is provided on the MAKO codec "aux\_mic" input.

There are three receive outputs: Rx Audio & Aux Rx Audio on the backplane interface board 25-Pin connector and speaker audio on a front panel RJ11.

The speaker audio is the sum of the MAKO codec output (demodulated audio) and transmit audio. A high pass filter removes any data, PL or DPL from the speaker audio. A programmable attenuator is used to adjust the speaker audio level before being output on the RJ11 connector.

Aux Rx Audio is the output of the MAKO codec (demodulated audio), and Rx Audio is the sum of the MAKO codec output and the microphone audio.

See [Figure 6-2](#) for audio paths and voltage levels.

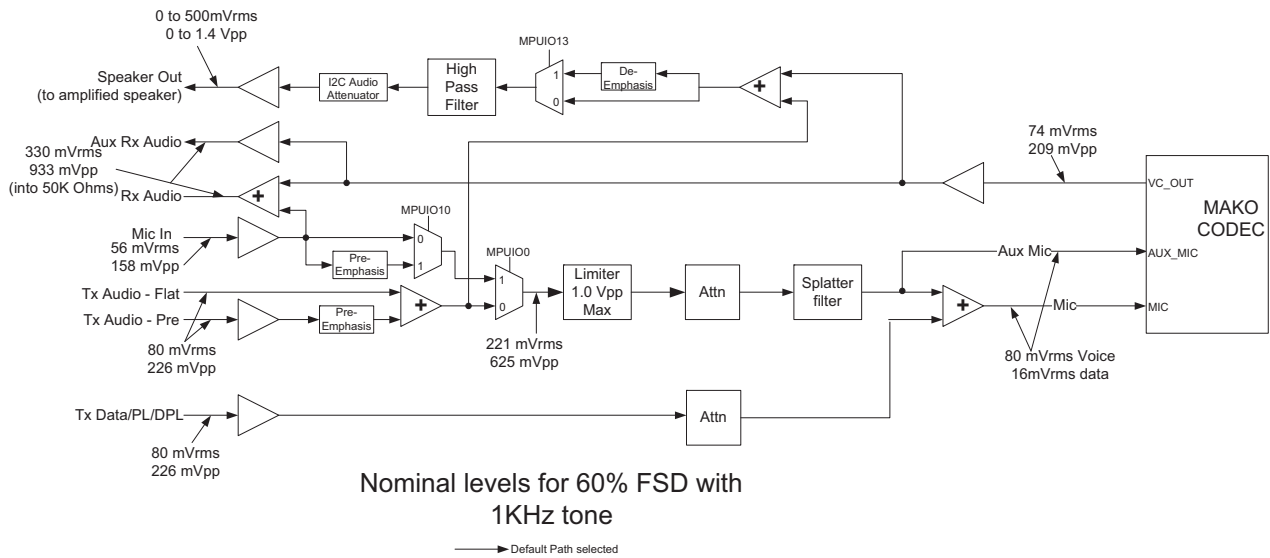


Figure 6-2. Station Control Module (SCM) Audio Path

See Table 6-3 for description on audio signals.

Table 6-3 Station Control Module (SCM) Audio Level

Audio Signal	Description
Tx Audio	The Tx Audio input provides no pre-emphasis. The nominal level of 80 mVrms (226 mVpp) produces 60% Relative Standard Deviation (RSD).
Tx Audio-Pre	The Tx Audio-Pre input provides a pre-emphasis network. The nominal level of 80 mVrms (226 mVpp) produces 60% RSD.
Tx Data	Transmit data, PL or DPL signaling. The nominal level of 80 mVrms (226 mVpp) produces 12% RSD.
Mic	Local microphone Input. Use microphone type GMN6147 (older model) or GMMN4063. Modulation sensitivity for 60% system deviation is typically 56 mVrms (158 mVpp).  Note : The Mic port is only supported in analog mode regardless of the Mic used. For older model of microphone (GMN6147), the 3 control buttons for speaker volume control, Rx monitor and Intercom control functions are not supported.
Rx Audio	An RF input signal with 60% RSD provides an Rx Audio output of 330 mVrms into 50 kΩ. Also a microphone input of 56 mVrms provides an Rx Audio output of 330 mVrms into 50 kΩ. The Rx Audio output has DC bias of 2.5 VDC.
Aux Rx Audio	An RF input signal with 60% RSD provides an Aux Rx Audio output of 330 mVrms into 50 kΩ. The Aux Rx Audio output has a DC bias of 2.5 VDC.
Speaker	Output to Powered Voice speaker. Adjustable between 0 to 500 mVrms [1.4 Vpp] across 2.4 kΩ @ 60% system deviation. Audio signal appears between Pins 3 and 4 on the connector. Must use speaker type HSN1000 (older model) or HSN1006 via adapter cable Part.No. 0185180U01.  Note : The Speaker port is only supported in analog mode regardless of the speaker used.

**Note** When using third party controllers, see "[Appendix F](#)" for CPS configuration in conjunction with the selection of the correct Tx Audio paths to prevent a double pre-emphasis.

### 6.2.6 Ethernet Interface

Since OMAP1710 does not support a direct Ethernet interface, a bridge device is needed to support Ethernet on the SCM. The bridge device is a high performance hi-speed USB 2.0 to 10/100 Ethernet controller. The device contains an integrated 10/100 Ethernet PHY, USB PHY, Hi-Speed USB 2.0 device controller, 10/100 Ethernet MAC, TAP controller, EEPROM controller and a FIFO controller with a total of 30 KBytes of internal packet buffering. The following is a list for functionality that the Ethernet Interface provides:

- Fully Compliant with IEEE 802.3 and 802.3u Compatible Ethernet Controller
- 10Base-T and 100Base-Tx support
- Integrated Media Access Control (MAC) and PHYSical (PHY)
- Supports one 10BT port with automatic polarity detection and correction
- Supports full and half duplex mode and flow control
- Universal Serial Bus (USB) and Joint Test Action Group (JTAG) parameters

### 6.2.7 Backplane Interface Board

The connector that connects the controller to the backplane interface board is a right angle, 96-Pin Connector. It provides connectivity between the MTR3000 controller and other station FRU, such as the Wireline card, the AUXIO card as well as, the third party equipment.

### 6.2.8 Exciter

The connector used to connect the controller to the Exciter and Receiver is a dual row, right angle, early entry receptacle, without flange, 30-Pin Connector. It provides 16.8 MHz reference clock, 14.2 V, 10 V and 8 V supply voltage, SPI, Trident SSI and other digital handshake signals with the Exciter.

### 6.2.9 Receiver

The connector used to connect the controller to the Exciter and Receiver is a dual row, right angle, early entry receptacle, without flange, 30-Pin Connector. It provides 16.8 MHz reference clock, 14.2 V, 10 V and 8 V supply voltage, SPI, Abacus SPI/SSI, Trident SPI and other digital handshake signals with the Receiver.

## 6.2.10 Front Panel (FP) Connectors

Table 6-4 to Table 6-9 describe the front panel connectors.

Table 6-4 Station Control Module (SCM) FP Connectors

Connector Name	Connector Type	Purpose
Service	USB Type B	Service Computer connection. This connector is accessible with front cover in place. VBUS (+5V) is not provided on the USB connector.
Mic	RJ45 (8 Pin)	Microphone connection. Compatible with microphone GMN6147 (older model) or GMMN4063. This connector is accessible with front cover in place.  Note : The Mic port is only supported in analog mode regardless of the Mic used. For older model of microphone (GMN6147), the 3 control buttons for speaker volume control, Rx monitor and Intercom control functions are not supported.
Speaker	4P4C	Speaker connection. Compatible with Service Speaker HSN1000 (older model) or HSN1006. This connector is accessible with front cover in place.  Note : The Speaker port is only supported in analog mode regardless of the speaker used.
Ethernet	RJ45 (8 Pin) (Vertical)	Network connection to Trunking Controller. The front cover must be removed to access this connector. An optional extension cable can also be used to route this input to the rear of the station. Alternatively, the Ethernet cable can also be routed out through the slots provided in the front panel.
Ext Ref	BNC (Vertical)	External reference input. The front cover must be removed to access this connector. Alternatively, an extension cable can be used to route this input to the rear of the station.

Table 6-5 Station Control Module (SCM) FP USB Connector Pin-out

Pin Number	Pin Name	I/O	Voltage Level (V)	Pin Description
1	VCC	VCC	5	Supply Voltage for USB Client mode
2	DM	I/O	3.3	Connects to MAKO USB1 transceiver
3	DP	I/O	3.3	Connects to MAKO USB1 transceiver
4	GND	GND	GND	Ground
G1	GND	GND	GND	Ground
G2	GND	GND	GND	Ground



Table 6-6 Station Control Module (SCM) FP Microphone Connector Pin-out

MIC Connector Pin Number	Schematic Pin Number	Pin Name	I/O	Voltage Level	Pin Description
1	5	NC	NC	NC	No Connect
2	4	RESERVED	Input	5V	Pin is reserved for future expansion.
3	6	MIC_PTT*	Input	0 to 5V	Voltage generated by PTT button.
4	3	MIC_AUDIO	Input	850mVpp	Audio Input, Level indicated here is the maximum value.
5	7	GND	GND	GND	Ground
6	2	NC	NC	NC	No Connect
7	8	NC	NC	NC	No Connect
8	1	NC	NC	NC	No Connect
G1	G1	GND	GND	GND	Ground
G2	G2	GND	GND	GND	Ground

From the MTR3000 Base Station/Repeater front view, the MIC connector pin 1 to pin 8 are arranged from right to left sequentially.

**Note** The schematic pin number and MIC pin number does not match due to imprecise geometry and this will remain, since it is widely used in other kits within Motorola.

Table 6-7 Station Control Module (SCM) FP Speaker Connector Pin-out

Pin Number	Pin Name	I/O	Voltage Level (V)	Pin Description
1	GND	GND	GND	Ground
2	14.2V	14.2V	14.2V	14.2V supplied to the speaker
3	GND	GND	GND	Ground
4	SPEAKER_AUDIO	Output	1.4Vpp	Audio Output. Level indicated here is the maximum value.
G1	GND	GND	GND	Ground
G2	GND	GND	GND	Ground

From the MTR3000 Base Station/Repeater front view, the SPEAKER connector pin 1 to pin 4 are arranged from left to right sequentially.

Table 6-8 Station Control Module (SCM) FP Ethernet Connector Pin-out

Pin Number	Pin Name	I/O	Voltage Level (V)	Pin Description
1	ENET_TXN_FP	Output	5	Ethernet Tx negative
2	ENET_TXN_FP	Output	5	Ethernet Tx positive
3	ENET_RXN_FP	Input	5	Ethernet Rx negative
4	GND	GND	GND	Ground
5	GND	GND	GND	Ground
6	ENET_RXP_FP	Input	5	Ethernet Rx positive
7	GND	GND	GND	Ground
8	GND	GND	GND	Ground
G1	GND	GND	GND	Ground
G2	GND	GND	GND	Ground

Table 6-9 Station Control Module (SCM) FP External Reference Connector Pin-out

Pin Number	Pin Name	I/O	Voltage Level (V)	Pin Description
C	EXT_REFERENCE	Input	5	5 MHz or 10 MHz external reference. This can be either a sine or a square wave.
G1	GND	GND	GND	Ground
G2	GND	GND	GND	Ground
G3	GND	GND	GND	Ground
G4	GND	GND	GND	Ground

### 6.2.11 Front Panel LEDs

For details on this section, see [Table 1-7](#).

### 6.2.12 Supply Voltage Circuitry

The SCM contains on-board regulator and filtering circuitry to generate the various operating voltages required by the SCM circuitry. The SCM routes +10 V and +8 V from two regulators on the backplane interface board to the Receiver and Exciter modules. +14.2 V and +5.1 V from the power supply (via the backplane interface board) are used as sources for the following supply voltage circuits:

- +14.2 V Regulator Circuitry – input to generate 9.3 V for MAKO, and 5 V analog for the audio circuit. This regulator also routes 14 VDC to the Receiver and Exciter modules.
- +5.1 V Regulator Circuitry – input to generate the following voltages: 3.3 V, 3.3 V analog, 2.775 V analog, 1.875 V, 1.4 V Core for Tx and Rx OMAP1710, 1.2 V Core for FPGA.

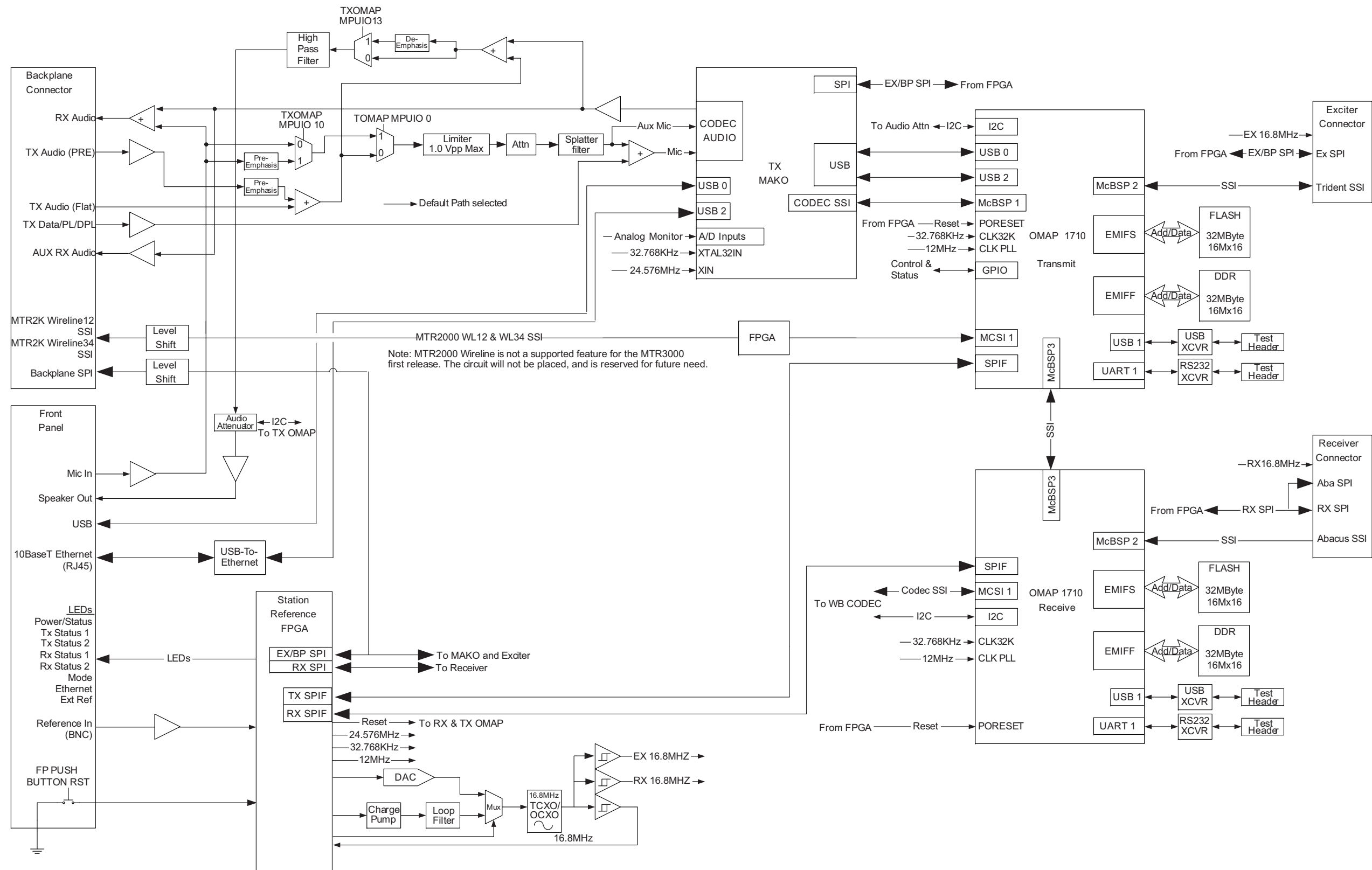


Figure 6-3. Station Control Module Functional Block Diagram – Station Control Circuitry

## Notes

## 6.3 Basic Troubleshooting

### 6.3.1 Replacement Procedure

The RDAC application is used as a general guide for basic troubleshooting, and should be used as the initial step to identifying faults to the SCM.

For procedure to replace the SCM, see [Section 15.7.2.5](#).

### 6.3.2 Post-Replacement Optimization Procedure

1. Replacement Station Control Modules are shipped with a default data programmed into the codeplug (Flash EPROM located on board). After replacing a Station Control Module, download the codeplug data (unique to the particular station) to the replacement module codeplug. Simply retrieve the file from the archive and follow the instructions in the CPS online help facility for saving data to the codeplug.
2. Calibrate the reference oscillator (station reference) by performing the procedure in [Section 15.3.3](#).
3. Perform the Tx Deviation Gain Adjust alignment procedure located in the Tuner Service menu online help facility (also noted in [Section 14.6](#)).
4. If a MTR3000 Wireline Interface Board is installed, perform all relevant alignments according to the Tuner Service menu online help facility (also noted in [Section 14.5](#)).

## Notes

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## Chapter 7 MTR3000 Backplane

### 7.1 Description

The Backplane Interface Board provides the electrical interconnections between the Station Control Module (SCM), the Power Supply, the Power Amplifier, and any optional plug-in modules of the base station/repeater. The board also provides the connectors necessary to interface the base station/repeater to phone lines, peripheral RF equipment, and other communications and maintenance equipment. This section provides a general description, identification of inputs/outputs, and a pin-out listing for all connectors, including information on signal names, functions, and levels.

#### 7.1.1 General Description

The Backplane Interface Board (mounted across the rear of the base station/repeater) is constructed with connectors on both sides. The connectors on one side connects to various base station/repeater plug-in modules (such as the SCM, Wireline Interface Board and Auxiliary I/O option board); the connectors on the other side allow interface connections between the base station/repeater and the phone lines, Power Supply, PA control signals, antenna relay, and other communications and maintenance equipment. A metal shield mounts over the rear of the backplane interface board to provide protection for the circuit board foils and connector solder pads, as well as Electro Static Discharge (ESD) protection and EMI/RFI shielding, as shown in [Figure 7-1](#).

**Note** The Auxiliary I/O option board is not offered for sale at this time.

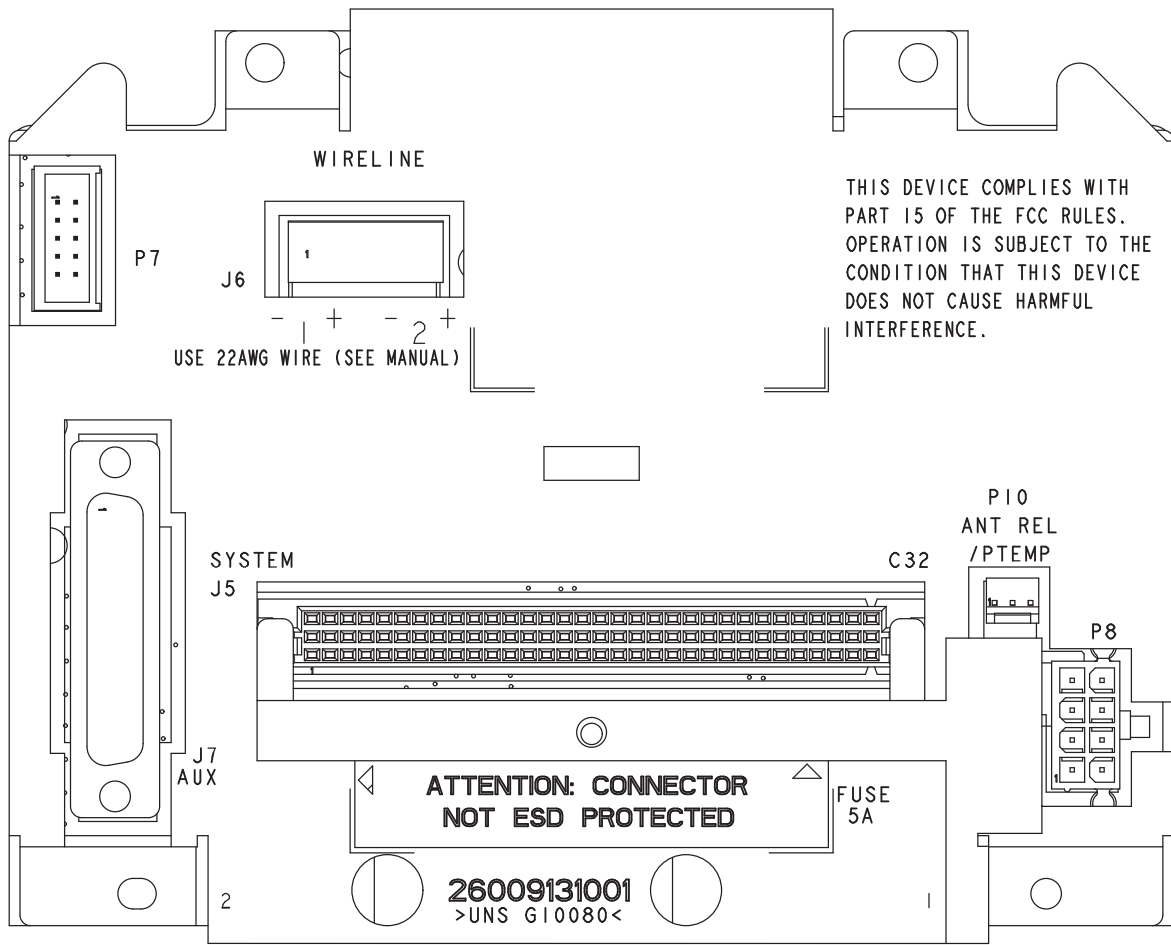


Figure 7-1 Backplane Interface Board



### 7.1.1.1 Location of Backplane Interface Board Connectors

Figure 7-2 shows the location of the connectors on each side of the Backplane Interface Board.

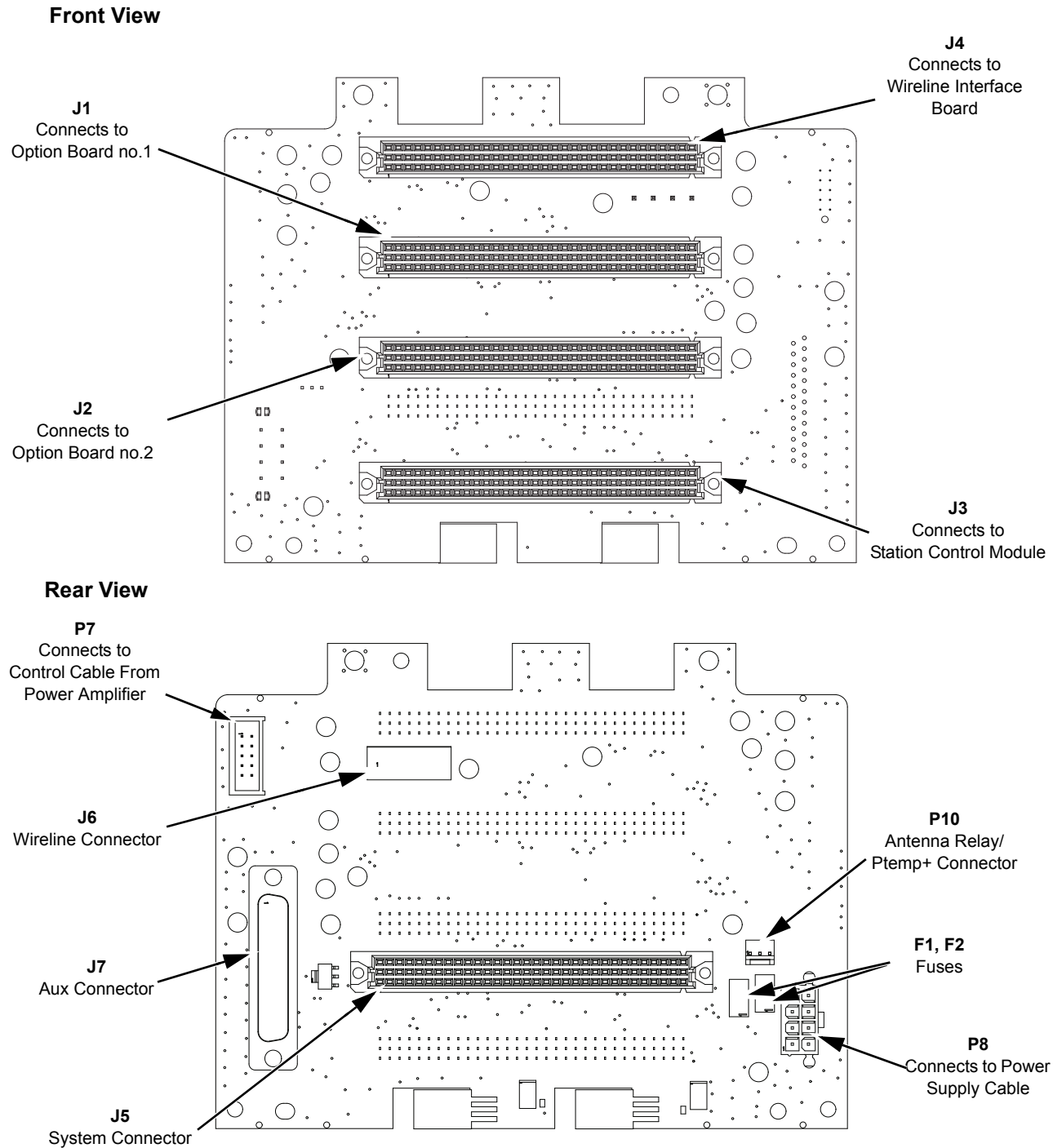


Figure 7-2 Backplane Interface Board Connector Locations (Front and Rear View)

### 7.1.1.2 Backplane Interface Board Connectors Information

Each connector on the backplane interface board has been assigned a connector designation number. For rear connectors, the connector number is stamped onto the metal shield covering the rear of the backplane interface board. Labels for connectors which accept the plug-in modules are viewable when the front panel is removed. [Table 7-1](#) lists each connector and its assigned designation number.

[Table 7-2](#) provides a detailed description of all of the backplane interface board signals, arranged in alphanumeric order.

**Note** An asterisk (\*) indicates an active on low signal.

As shown, each connector Pin is defined by signal name, input or output (with reference to connector), and the to/from location(s).

*Table 7-1 Assigned Connector Number Vs. Function/Location Information*

Connector	Function/Location
J1 <sup>†</sup>	96-Pin Eurocard connector; accepts plug-in Option Board 1 (From front of base station/repeater, behind front panel)
J2 <sup>†</sup>	96-Pin Eurocard connector; accepts plug-in Option Board 2 (From front of base station/repeater, behind front panel)
J3	96-Pin Eurocard connector; accepts plug-in Station Control Module (From front of base station/repeater, behind front panel)
J4	96-Pin Eurocard connector; accepts plug-in Wireline Interface Board (From front of base station/repeater, behind front panel)
J5	96-Pin Eurocard connector; provides System connection to external communications equipment (At the back of the base station/repeater)
J6	4-position terminal block with plug; accepts customer phone line connections. The plug accepts a wire diameter range of 12 to 26 AWG (At the back of the base station/repeater)
J7	25-Pin connector; for connecting to an external device such as a trunking controller, tone remote adaptor or phone patch.
P7	10-Pin connector; provides connection to Power Amplifier (PA); routes SPI bus and chip selects from Station Control Module to PA (At the back of the base station/repeater)
P8	8-Pin connector; provides connection to Power Supply (PS)
P10	Antenna Relay 3-Pin connector; supplies control signal and power to antenna relay module; provides connection to a peripheral temperature sensing device such as found in an external circulator (At the back of the base station/repeater)

**Note** Peripheral temperature sensing device is not available for the 900 MHz band.

**Note** <sup>†</sup>. The Auxiliary I/O option board is not offered for sale at this time.

Table 7-2 Backplane Interface Board Signal Descriptions

Signal Name	Type	Function/Signal Levels
5_VDC	Power	+5.1 VDC from Power Supply (2.0A total maximum)
8_VDC	Power	+8 VDC from Regulator U102-3 (0.25A total maximum)
10V_VDC	Power	+10 VDC from U101-3 to Exciter Module via SCM (0.70A total maximum)
10V_VDC	Power	+10 VDC from U101-3 to Receiver Module via SCM (0.70A total maximum)
14.2VDC	Power	+14.2 VDC from Power Supply (8A total maximum to PA and backplane interface board)
AC_Fail	Digital	AC status signal from power supply to SCM; Active high indicates AC Mains failure
Accessory_14.2VDC	Analog	+14.2 VDC from Power Supply to Systems connector J5 (1.0A total maximum)
Antenna_Relay	Digital	Open-collector control signal from Controller to SCM to antenna relay; Low to energize relay
Aux Rx Audio	Analog	Auxiliary Receive Audio – A received RF signal at 60% RSD produces a 330mVrms audio output.
Carrier Detect Switch	Digital	From SCM to indicate carrier present; TTL active high
Chassis GND	Power	Station ground
Emph Tx Audio	Analog	Emphasized Tx Audio - 80mVrms @ 1 kHz produces 60% transmit deviation.
Ext PTT*	Digital	Interrupt request to SCM to key transmitter; TTL active low
GND	Power	Station ground

Table 7-2 Backplane Interface Board Signal Descriptions (Continued)

Signal Name	Type	Function/Signal Levels
GPI_1	Digital	General purpose programmable inputs/ outputs which can be configured through CPS to one of several functions. See Table 7-22 for levels.
GPIO_2	Digital	
GPIO_3	Digital	
GPI_4	Digital	
GPIO_5	Digital	
GPIO_6	Digital	
GPIO_7	Digital	
GPIO_8	Digital	
GPIO_9**	Digital	
GPIO_10	Digital	
Line 1+	Analog	4-wire Phone Line (differential) inputs; 600 $\Omega$ typical impedance (country-specific)
Line 1-		
Line 2+	Analog	2-wire Phone Line (differential) inputs/outputs or, 4-wire Phone Line outputs; 600 $\Omega$ typical impedance (country-specific)
Line 2-		
MISO (Master In Slave Out)	Digital	SPI data from Slave devices to Master (SCM); standard TTL
MOSI (Master Out Slave In)	Digital	SPI data from Master (SCM) to Slave devices; standard TTL
OP1 CS1*	Digital	From SCM to Option 1 module; SPI bus chip selects; TTL active low
OP1 CS2*		
OP2 CS1*	Digital	From SCM to Option 2 module; SPI bus chip selects; TTL active low
OP2 CS2*		
Opt IRQ*	Digital	Interrupt request to SCM from Option cards; TTL active low
Option1 ID	Analog	Option 1 ID to SCM ADC; module ID determined by specific voltage; 0 to 5 VDC
Option2 ID	Analog	Option 2 ID to SCM ADC; module ID determined by specific voltage; 0 to 5 VDC
PA AD CS*	Digital	From SCM; during SPI signalling, selects ADC converter in PA; TTL active low
PA DA CS*	Digital	From SCM; during SPI signalling, selects DAC converter in PA; TTL active low
PA Enable*	Digital	From SCM; controls final module bias in PA; TTL active low

Table 7-2 Backplane Interface Board Signal Descriptions (Continued)

Signal Name	Type	Function/Signal Levels
PA Reset*	Digital	Resets logic devices within the PA; TTL active low
Ptemp+	Analog	Input to SCM from peripheral temperature sensing device on circulator
Reset*	Digital	System reset from SCM; TTL active low
RF Relay Control In	Digital	From Controller to Option 1 and Option 2 to signal RF Relay is activated; TTL active high
RF Relay Control Out	Digital	From Option 1 or Option 2 to SCM as open collector (active low) to indicate RF Relay is activated (or for some other control usages).
RSSI	Analog	From SCM; DC voltage proportional to the receive RF signal strength; 0 to 5 VDC
Rx Audio	Analog	Receive Audio – A received RF signal at 60% RSD produces a 330mVrms audio output. The local microphone is summed in with the receive audio.
Serial ID	Digital	Serial ID data to SCM from backplane interface board serial ID device
SPI CLK (Serial Peripheral Interface Clock)	Digital	SCM SPI bus clock; Low-to-high transition shifts data; 310 kHz (Minimum); standard TTL
Tx Audio	Analog	Transmit Audio – 80mVrms produces 60% transmit deviation.
Tx Data	Analog	Low Speed Trunking Data or PL or DPL – 80mVrms produces 12% transmit deviation
Wireline ID	Analog	To SCM ADC from WIB; module ID determined by specific voltage; 0 to 5 VDC
Wireline1 Latch CS*	Digital	Chip select for SPI latch on WIB; TTL active low

**Note** (\*\*) Not supported.

Table 7-3 J5 System Connector, Row A Pins

Pin #	Pin Assignment	Input/ Output	To/From	Signal Characteristics
1	Reserved	O	–	–
2	Reserved	O	J1-C31, J2-C31	–
3	N/C	O	–	–
4	AC Fail	O	P8-5, J1-C29, J2-C29, J3-C24	TTL output, active high
5	Reserved	I	J1-C28, J2-C28	–
6	Reserved	I	J1-C27, J2-C27	–
7	Reserved	I	J1-C26, J2-C26	–
8	Reserved	I	J1-C25, J2-C25	–
9	Reserved	I	J1-C24, J2-C24	–
10	Reserved	O	J1-C23, J2-C23	–
11	Reserved	O	J1-C22, J2-C22	–
12	Reserved	O	J1-B25, J2-B25	–
13	Antenna Relay	O	P10-1, J3-C26	OCO, 200mA, active low
14	Reserved	O	J3-C19	–
15	N/C	–	–	–
16	N/C	–	–	–
17	Reserved	I	J3-C16	–
18	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC
19	GND	–	Station ground	–
20	5 VDC	O	P8 pins 7, 8	+5.1 ± 0.25 VDC
21	Reserved	O	J3-C12	–
22	Spare	I	J1-C11, J2-C11	
23	N/C	–	–	–
24	N/C	–	–	–
25	N/C	–	–	–
26	Ext PTT-	I	J1-C7, J2-C7	Opto-Isolated PTT Input
27	GND	–	Station ground	–
28	Reserved	I/O	J1-C6, J2-C6	–
29	Ext PTT+	I	J1-C5, J2-C5	Opto-Isolated PTT Input
30	AC Fail Relay (NO)	O	J1-C4, J2-C4	Normally Open Relay Contact
31	GND	–	Station ground	–
32	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC

**Note** Any “Pin Assignment” on the J5 System Connector that only includes connectivity “To/From” “J1-xx” and/or “J2-xx” will not be functional without an Auxiliary I/O Option Board.

Table 7-4 J5 System Connector, Row B Pins

Pin #	Pin Assignment	Input/ Output	To/From	Signal Characteristics
1	Reserved	O	J1-B32, J2-B32	–
2	Reserved	O	J1-B31, J2-B31	–
3	Carrier Operated Relay (Common)	O	J1-B30, J2-B30	Common Relay Contact
4	Carrier Detect Switch	O	J1-B29, J2-B29, J3-B24	TTL output, active high
5	Reserved	I	J1-B28, J2-B28	–
6	Reserved	I	J1-B27, J2-B27	–
7	Reserved	I	J1-B26, J2-B26	–
8	Reserved	I	J3-B25	–
9	Reserved	I/O	J1-B24, J2-B24	–
10	N/C	–	N/C	–
11	Reserved	I/O	J1-B22, J2-B22	–
12	Reserved	I/O	J1-B23, J2-B23	–
13	Reserved	–	N/C	–
14	Reserved	I	J1-B19, J2-B19, J3-B19, J7-14	–
15	GND	–	Station ground	–
16	N/C	–	–	–
17	N/C	–	–	–
18	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC
19	GND	–	Station ground	–
20	5 VDC	O	P8 pins 7, 8	+5.1 ± 0.25 VDC
21	Reserved	O	J1-B12	–
22	N/C	–	–	–
23	N/C	–	–	–
24	N/C	–	–	–
25	N/C	–	–	–
26	N/C	I	J1-B7, J2-B7	–
27	GND	–	Station ground	–
28	Reserved	O	J4-C10	–
29	AC Fail Relay (Common)	O	J1-B4, J2-B4	Common relay contact
30	Reserved	O	J4-A9	–
31	GND	–	Station ground	–
32	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC

**Note** Any “Pin Assignment” on the J5 System Connector that only includes connectivity “To/From” “J1-xx” and/or “J2-xx” will not be functional without an Auxiliary I/O Option Board.

Table 7-5 J5 System Connector, Row C Pins

Pin #	Pin Assignment	Input/Output	To/From	Signal Characteristics
1	Reserved	O	J1-A32, J2-A32	–
2	Reserved	O	J1-A31, J2-A31, J3-A26	–
3	Carrier Operated Relay (Normally Open)	O	J1-A30, J2-A30	Normally Open Relay Contact
4	Reserved	O	J1-A29, J2-A29	–
5	Reserved	I	J1-A28, J2-A28	–
6	Reserved	I	J1-A27, J2-A27, J3-B26	–
7	Reserved	I	J1-A26, J2-A26	–
8	Reserved	I	J3-A25	–
9	RF Relay Control Out (Auxiliary I/O)	O	J1-B5, J2-B5	OCO, 200mA, 40V, active high
10	Ext PTT* Out (Auxiliary I/O)	I	J1-A23, J2-A23, J3-A23	TTL input
11	RSSI	O	J1-A22, J2-A22, J3-A22	Typically 0.5 VDC for -120dBm to 2.7 VDC for -60dBm carrier. Variation with carrier level at approximately 50mV/dBm.
12	Reserved	I/O	J1-A24, J2-A24	–
13	N/C	–	–	–
14	Aux Rx Audio	O	J1-A19, J2-A19, J3-A19, J7-3	–
15	GND	–	Station ground	–
16	GND	–	Station ground	–
17	Reserved	O	J1-A16, J2-A16, J3-A16	–
18	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC
19	GND	–	Station ground	–
20	5 VDC	O	P8 pins 7, 8	+5.1 ± 0.25 VDC
21	Reserved	O	J3-A12	–
22	N/C	–	–	–
23	N/C	–	–	–
24	GPIO_10	I/O	J1-A9, J2-A9, J3-A17	TTL input/output
25	N/C	–	–	–
26	N/C	–	–	–
27	GND	–	Station ground	–
28	Reserved	I	J4-C12	–
29	GPIO_9**	I/O	J1-A4, J2-A4, J3-A13	TTL input/output
30	Reserved	I	J4-A11	–
31	GND	–	Station ground	–
32	Accessory 14.2 VDC	O	P8 pins 3, 4 (through F2)	+14.2 VDC

**Note** Any “Pin Assignment” on the J5 System Connector that only includes connectivity “To/From” “J1-xx” and/or “J2-xx” will not be functional without an Auxiliary I/O Option Board.

**Note** (\*\*). Not supported.



Table 7-6 J4 Wireline Connector, Row A Pins

Pin #	Pin Assignment	To/From
1	Wireline MCLK	J3-B6
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	GPIO_9**	J1-A4, J2-A4, J5-C29, J3-A13
5	Wireline 1/2 TXD	J3-A5
6	Wireline 3/4 FSYNC	J3-A6
7	MOSI	P7-8, J1-A7, J2-A7, J3-A7
8	GND	Station ground
9	Reserved	J5-B30
10	GPI_4	J7-23
11	Reserved	–
12	GPIO_8	J7-21, J3-C29
13	Reserved	J7-6, J3-A27
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	GPI_1	J7-2, J3-C32
17	Tx Audio	J7-1, J3-B30
18	GPIO_3	J3-B31, J7-15
19	Tx_Data_PL_DPL	J3-B29, J7-13
20	GPIO_7	J3-C30, J7-10
21	Chassis GND	–
22	Spare 31	–
23	Spare 3	–
24	Spare 32	–
25	Spare 17	–
26	Line 2+	J6-4
27	Spare 4	–
28	Line 2-	J6-3
29	Spare 34	–
30	Line 1+	J6- 2
31	Spare 36	–
32	Line 1-	J6-1

**Note** (\*\*) Not supported.

Table 7-7 J4 Wireline Connector, Row B Pins

Pin #	Pin Assignment	To/From
1	Spare 5	–
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Wireline 3/4 TXD	J3-B4
5	Wireline 1/2 RXD	J3-B5
6	Reserved	J3-B7
7	Spare 18	–
8	MISO	J1-B8, J2-B8, J3-B8, P7-9
9	GND	Station ground
10	GPIO_5	J7-24, J3-C31
11	Spare 19	–
12	EMPH Tx AUDIO	J3-A29, J7-22
13	Reserved	J3-B27
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Reset*	J1-B16, J2-B16, J3-B16, P7-3
17	GPIO_10	J7-5, J3-A17, J5-C24, J2-A9, J1-A9
18	Spare 20	–
19	GPIO_6	J7-25, J7-8, J3-A22
20	Reserved	J1-B20, J2-B20, J3-B20
21	Chassis GND	–
22	Spare 40	–
23	Spare 7	–
24	Spare 41	–
25	Spare 21	–
26	Line 2+	J6-4
27	Spare 8	–
28	Line 2-	J6-3
29	Spare 43	–
30	Line 1+	J6-2
31	Spare 23	–
32	Line 1-	J6-1

Table 7-8 J4 Wireline Connector, Row C Pins

Pin #	Pin Assignment	To/From
1	Wireline BCLK	J3-C5
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Wireline 3/4 RXD	J3-C4
5	Spare 45	–
6	Wireline 1/2 FSYNC	J3-C6
7	Wireline1 Latch CS*	J3-C7
8	SPI CLK	P7-7, J1-C8, J2-C8, J3-C8
9	GND	Station ground
10	Reserved	J5-B28
11	Spare 10	–
12	Reserved	–
13	Spare 46	–
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Rx Audio	J3-A30, J7-7
17	GPIO_9**	J3-A13, J5-C29, J2-A4, J1-A4, J4-A4, J4-C17, J7-6
18	GPIO_2	J3-B32, J7-4
19	Wireline ID	J3-C22
20	Reserved	J1-C20, J2-C20, J3-C20
21	Chassis GND	–
22	Spare 27	–
23	Spare 11	–
24	Spare 48	–
25	Spare 49	–
26	Line 2+	J6-4
27	Spare 12	–
28	Line 2-	J6-2
29	Spare 26	–
30	Line 1+	J6-2
31	Spare 51	–
32	Line 1-	J6-1

**Note** (\*\*) Not supported.

Table 7-9 J3 Controller Connector, Row A Pins

Pin #	Pin Assignment	To/From
1	14.2 VDC	P8 pins 3, 4 (through F1)
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	8 VDC	U102-3
5	Wireline 1/2 Txd	J1-A5
6	Wireline 3/4 FSYNC	J1-A6
7	MOSI	P7-8, J1-A7, J3-A7, J4-A7
8	N/C	N/C
9	N/C	N/C
10	OP1 CS2*	J1-A10
11	OP2 CS2*	J2-A10
12	Reserved	–
13	GPIO_9**	J5-C29, J2-A4, J1-A4, J4-C17, J4-A4, J7-6
14	10 VDC	Station ground
15	10 VDC	P8 pins 3, 4 (through F1)
16	Spare	N/C
17	GPIO_10	J1-A9, J2-A9, J3-A17, J7-5
18	Ptemp+	P10-3
19	Reserved	J1-A19, J2-A19, J5-C14
20	N/C	N/C
21	GND	Station ground
22	RSSI	J1-A22, J3-A22, J5-C11
23	Ext PTT*	J1-A23, J3-A23, J5-C10
24	RF Relay Control	J1-B6, J2-B6
25	Reserved	–
26	Reserved	–
27	Reserved	J4-A3
28	GND	–
29	EMPH Tx AUDIO	J1-A29, J5-C4
30	Rx Audio	J1-A30, J5-C3
31	GPI_4	J4-A10, J7-23
32	GPIO_6	J4-B19, J7-25

**Note** (\*\*) Not supported.

Table 7-10 J3 Controller Connector, Row B Pins

Pin #	Pin Assignment	To/From
1	14.2 VDC	P8 pins 3, 4 (through F1)
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Wireline 3/4 TXD	J4-B4
5	Wireline 1/2 RXD	J4-B5
6	Wireline MCLK	J4-A1
7	Wireline2 Latch CS*	J4-B6
8	MISO	P7-9, J1-B8, J2-B8, J4-B8
9	N/C	N/C
10	N/C	N/C
11	OP1 CS1*	J1-B11
12	OP2 CS1*	J2-B11
13	PA D/A CS*	P7-6
14	10 VDC	Regulator U101-3
15	10 VDC	Regulator U101-3
16	Reset*	J1-B16, J2-B16, J4-B16, P7-3
17	N/C	N/C
18	Option2 ID	J2-C19
19	Reserved	–
20	Reserved	J1-B20, J2-B20, J4-B20
21	N/C	N/C
22	GND	Station ground
23	N/C	N/C
24	Carrier Detect Switch	J1-B29, J2-B29, J5-B4
25	Reserved	–
26	Reserved	–
27	Reserved	J4-B13
28	GND	Station ground
29	Tx_Data_PL_DPL	J7-13
30	Tx Audio	J7-1
31	GPIO_3	J7-15, J4-A18
32	GPIO_2	J7-4, J4-C18

Table 7-11 J3 Controller Connector, Row C Pins

Pin #	Pin Assignment	To/From
1	14.2 VDC	P8 pins 3, 4 (through F1)
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Wireline 3/4 RXD	J4-C4
5	Wireline BCLK	J4-C1
6	Wireline 1/2 FSYNC	J4-C6
7	Wireline1 Latch CS*	J4-C7
8	SPI CLK	P7-7, J1-C8, J2-C8, J4-C8
9	N/C	N/C
10	OP1 CS3*	J1-C10
11	OP2 CS3*	J2-C10
12	Reserved	–
13	PA A/D CS*	P7-10
14	GND	Station ground
15	GND	Station ground
16	Reserved	J1-C16, J2-C16, J5-A17
17	N/C	N/C
18	Option1 ID	J1-C19
19	Reserved	–
20	Reserved	J1-C20, J2-C20, J4-C20
21	GND	Station ground
22	Wireline ID	J4-C19
23	Opt IRQ*	J1-A25, J2-A25
24	AC Fail	P8-5, J1-C29, J2-C29, J5-A4
25	Serial ID	U100-2
26	Antenna Relay	P10-1, J5-A13
27	PA Enable*	P7-2
28	N/C	N/C
29	GPIO_8	J7-21
30	GPIO_7	J7-12, J7-10
31	GPIO_5	J7-24, J4-B10
32	GPI_1	J7-2, J7-11, J4-A16

Table 7-12 J2 Option 2 Connector, Row A Pins

Pin #	Pin Assignment	To/From
1	Spare A14	–
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	GPIO_9**	J1-A4, J3-A13, J4-A4, J5-C29
5	Spare A16	J1-A5
6	Spare A19	J1-A6
7	MOSI	P7-8, J1-A7, J3-A7, J4-A7
8	GND	Station ground
9	GPIO_10	J1-A9, J3-A17, J5-C24
10	OP2 CS2*	J3-A11
11	Spare	N/C
12	Spare	N/C
13	Spare	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Spare	N/C
17	GND	Station ground
18	GND	Station ground
19	Spare	N/C
20	Spare	N/C
21	GND	Station ground
22	RSSI	J1-A22, J3-A22, J5-C11
23	Ext PTT*	J1-A23, J3-A23, J5-C10
24	Reserved	–
25	OPT_IRQ*	J1-A25, J3-C23
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	Reserved	–
30	GP1 Out WCO	J1-A30, J5-C3
31	Reserved	–
32	Reserved	–

**Note** (\*\*) Not supported.

Table 7-13 J2 Option 2 Connector, Row B Pins

Pin #	Pin Assignment	To/From
1	Spare	N/C
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Spare81	J1-B4, J5-B29
5	RF Relay Control Out	J1-B5, J5-C9
6	RF Relay Control In	J1-B6, J3-A24
7	Spare316	J1-B7, J5-B26
8	MISO	P7-9, J1-B8, J3-B8, J4-B8
9	GND	Station ground
10	N/C	–
11	OP2 CS1*	J3-B12
12	N/C	–
13	N/C	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Reset*	J1-B16, J3-B16, J4-B16
17	N/C	N/C
18	GND	Station ground
19	N/C	–
20	Reserved	J1-B20, J3-B20, J4-B20
21	N/C	N/C
22	Reserved	–
23	Reserved	–
24	Reserved	–
25	Reserved	–
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	Carrier Detect Switch	J1-B29, J3-B24, J5-B4
30	Reserved	–
31	Reserved	–
32	Reserved	–



Table 7-14 J2 Option 2 Connector, Row C Pins

Pin #	Pin Assignment	To/From
1	N/C	–
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Spare313	J1-C4, J3-A3
5	Spare314	J1-C5, J5-A29
6	Reserved	–
7	Spare319	J1-C7, J5-A26
8	SPI CLK	P7-7, J1-C8, J3-C8, J4-C8
9	GND	Station ground
10	OP2 CS3*	J3-C11
11	Spare	J1-C11, J5-A22
12	N/C	N/C
13	N/C	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	N/C	N/C
17	N/C	N/C
18	N/C	N/C
19	Option2 ID	J3-B18
20	Reserved	J1-C20, J3-C20, J4-C20
21	GND	Station ground
22	Reserved	–
23	Reserved	–
24	Reserved	–
25	Reserved	–
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	AC Fail	P8-5, J1-C29, J3-C24, J5-A4
30	N/C	N/C
31	Reserved	–
32	Reserved	–

Table 7-15 J1 Option 1 Connector, Row A Pins

Pin #	Pin Assignment	To/From
1	Spare	–
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	GPIO_9**	J2-A4, J3-A13, J4-A4, J5-C29
5	Spare	J2-A5
6	Spare	J2-A6
7	MOSI	P7-8, J2-A7, J3-A7, J4-A7
8	GND	Station ground
9	GPIO_10	J2-A9, J3-A17, J5-C24
10	OP1 CS2*	J3-A10
11	Spare	N/C
12	Spare	N/C
13	Spare	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Spare	N/C
17	GND	Station ground
18	GND	Station ground
19	Spare	N/C
20	Spare	N/C
21	GND	Station ground
22	RSSI	J2-A22, J3-A22, J5-C11
23	Ext PTT*	J2-A23, J3-A23, J5-C10
24	Reserved	–
25	Opt_IRQ*	J2-A25, J3-C23
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	Reserved	–
30	GP1 OUT WCO	J2-A30, J5-C3
31	Reserved	–
32	Reserved	–

**Note** (\*\*) Not supported.

Table 7-16 J1 Option 1 Connector, Row B Pins

Pin #	Pin Assignment	To/From
1	Spare A12	J2-B1
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Spare81	J2-B4, J5-B29
5	RF Relay Control Out	J2-B5, J5-C9
6	RF Relay Control In	J2-B6, J3-A24
7	Spare316	J2-B7, J5-B26
8	MISO	P7-9, J2-B8, J3-B8, J4-B8
9	GND	Station ground
10	Reserved	–
11	OP1 CS1*	J3-B11
12	Spare305	J5-B21
13	Spare A18	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Reset*	J2-B16, J3-B16, J4-B16
17	Spare	N/C
18	GND	Station ground
19	Spare	N/C
20	Reserved	J2-B20, J3-B20, J4-B20
21	Spare	N/C
22	Reserved	–
23	Reserved	–
24	Reserved	–
25	Reserved	–
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	Carrier Detect Switch	J2-B29, J3-B24, J5-B4
30	GP2 OUT WCO	J2-B30, J5-B3
31	Reserved	–
32	Reserved	–

Table 7-17 J1 Option1 Connector, Row C Pins

Pin #	Pin Assignment	To/From
1	Spare A1	N/C
2	GND	Station ground
3	5 VDC	P8 pins 7, 8
4	Spare13	J2-C4, J3-A30
5	Spare314	J2-C5, J5-A29
6	Reserved	–
7	Spare319	J2-C7, J5-A26
8	SPI CLK	P7-7, J2-C8, J3-C8, J4-C8
9	GND	Station ground
10	OP1 CS3*	J3-C10
11	Spare	J2-C11, J5-A22
12	Spare	N/C
13	Spare	N/C
14	GND	Station ground
15	14.2 VDC	P8 pins 3, 4 (through F1)
16	Spare	N/C
17	Spare	N/C
18	Spare	N/C
19	Option1 ID	J3-C18
20	Reserved	J2-C20, J3-C20, J4-C20
21	GND	Station ground
22	Reserved	–
23	Reserved	–
24	Reserved	–
25	Reserved	–
26	Reserved	–
27	Reserved	–
28	Reserved	–
29	AC Fail	P8-5, J2-C29, J3-C24, J5-A4
30	Spare	N/C
31	Reserved	–
32	Reserved	–

Table 7-18 P7 PA Control Connector

Pin #	Pin Assignment
1	Voltage Forward
2	PA Enable*
3	PA Reset
4	V Control
5	GND
6	PA D/A CS*
7	SPI CLK
8	MOSI
9	MISO
10	PA A/D CS*

Table 7-19 P8 Power Supply Connector

Pin #	Pin Assignment
1	GND
2	GND
3	14.2 VDC
4	14.2 VDC
5	AC Fail
6	GND
7	5 VDC
8	5 VDC

Table 7-20 P10 Antenna Relay/PTemp+ Connector

Pin #	Pin Assignment
1	GND
2	GND
3	14.2 VDC
4	14.2 VDC
5	AC Fail
6	GND
7	5 VDC
8	5 VDC

Table 7-21 J6 Terminal Block Stacking Connector

Pin #	Pin Assignment
1	Line 1-
2	Line 1+
3	Line 2-
4	Line 2+

Table 7-22 J7 Aux Connector

Pin #	Pin Assignment	Input/Output	To/From	Signal Characteristics
1	Tx Audio	I	J3-B30, J4-A17	Transmit Audio – Nominal input level is 80 mVrms for 60% deviation with scaling factor set to 100%. 600 $\Omega$ input impedance.
2	GPI_1	I/O	J3-C32, J4-A16	Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
3	Aux Rx Audio	O	J3-A19	Auxiliary Receiver Audio – Nominal output level is 330 mVrms with a 60% deviation receive signal. 1000 $\Omega$ output impedance
4	GPIO_2	I/O	J3-B32, J4-C18	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
5	GPIO_10	I/O	J3-A17, J4-B17	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
6	GPIO_9**	I/O	J3-A13, J4-A4	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
7	Rx Audio	O	J3-A30, J4-C16	Auxiliary Receiver Audio – Nominal output level is 330mVrms with a 60% deviation receive signal. 1000 $\Omega$ output impedance.
8	GPIO_6	I/O	J3-A32, J4-B19	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
9	GND			
10	GPIO_7	I/O	J3-C30, J4-A20	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
11	GPI_1	I/O	J3-C32, J4-A16	Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC

Table 7-22 J7 Aux Connector (Continued)

Pin #	Pin Assignment	Input/Output	To/From	Signal Characteristics
12	GPIO_7	I/O	J3-C30, J4-A20	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
13	Tx Data	I	J3-B29, J4-A19	Transmit Data/PL/DPL – Nominal input level is 80 mVrms for 20% deviation with scaling factor set to 100%. 600 $\Omega$ input impedance.
14	Reserved	–	–	–
15	GPIO_3	I/O	J3-B31, J4-A18	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
16	GND	–	–	–
17	GND	–	–	–
18	GND	–	–	–
19	GND	–	–	–
20	Fused 14.2 VDC	–	–	1 Amp max
21	GPIO_8	I/O	J3-C29, J4-A12	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
22	Emph Tx Audio	I	J3-A29, J4-B12	Emphasized Transmit Audio – Nominal input level is 80 mVrms for 60% deviation with scaling factor set to 100%. 600 $\Omega$ input impedance.
23	GPI_4	I/O	J3-A31, J4-A10	Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
24	GPIO_5	I/O	J3-C31, J4-B10	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC
25	GPIO_6	I/O	J3-A32, J4-B19	Output Logic Low: 0.5 VDC max Output Logic High: Open Collector with 10K pull-up to 5 V Input Logic Low: 0 to 0.8 VDC Input Logic High: 3.0 to 14 VDC

**Note** (\*\*) Not supported.

## 7.2 Basic Troubleshooting

### 7.2.1 Replacement Procedure

The RDAC application is used as a general guide for basic troubleshooting. Use this application to check the 8 V and 10 V Backplane Supply Alarms as the initial step to identify faults to the Backplane Interface Board.

For procedure to replace the Backplane Interface Board, see [Section 15.7.2.8](#).

### 7.2.2 Fuse Check and Replacement Procedure

#### 7.2.2.1 14.2 VDC Internal and 14.2 VDC Accessory

This section illustrates the procedure to verify that the two 14.2 VDC backplane interface board fuses are in working condition. Fuse F1 (see [Figure 7-3](#)) protects the 14.2 VDC supply to the SCM, the Wireline Module and the Auxiliary I/O Module. Fuse F2 (see [Figure 7-3](#)) protects the 14.2 VDC supply to the J5 System Connector and J7 Aux Connector.

To check the fuse for failure, perform the following steps:

1. Turn off the base station/repeater power at source (e.g. AC breaker).
2. Remove the fuse cover plate located on the backplane interface board shield by unscrewing one M4 screw. See [Figure 7-3](#) for the location of the fuses.
3. Turn on base station/repeater power at source (e.g. AC breaker).
4. Measure the voltage at both terminals of Fuse 1 and Fuse 2. Ground one probe of the Voltmeter to the chassis or other convenient ground. Use the other probe of the Voltmeter to measure the voltage at both terminals of Fuse 1 and Fuse 2. In all four measurements, the voltage should be 14.2 VDC +/-3%.
5. If a voltage is present on one terminal of the fuse but not the other one, replace the fuse as it is most likely the result of a blown fuse.

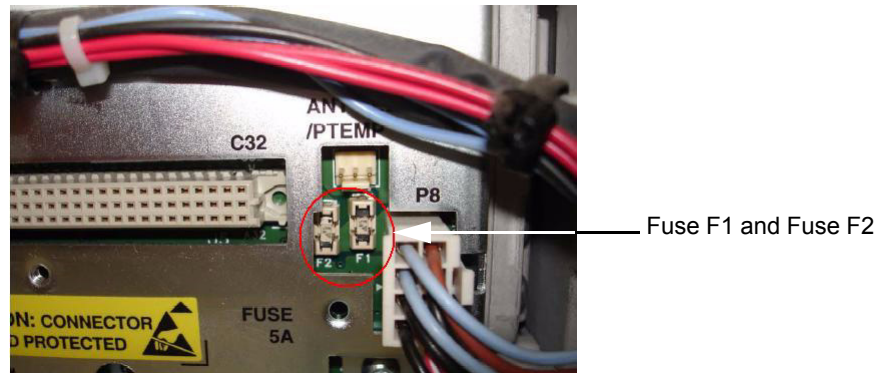


To avoid electrical shock, turn off base station/repeater power at source (e.g. AC breaker) before replacing any fuses.

6. Replace the fuse cover plate and secure in place with the M4 screw.



For procedure to check the fuses for the two 14.2 VDC (F1 and F2), see [Figure 7-3](#)



*Figure 7-3 Rear view with fuse cover plate removed*

To replace the fuse for failure, perform the following steps:

1. Turn off the base station/repeater power at source (e.g. AC breaker).
2. Remove fuse cover plate located on the backplane interface board shield by unscrewing one M4 screw.
3. Pull defective fuse carefully with a pair of small needle nose pliers.
4. Replace new fuse (6583049X16) carefully with a pair of small needle nose pliers.



Caution

For continued protection of the base station/repeater against risk of fire, replace the fuse only with the same type and rating of fuse.

5. Restore power to the base station/repeater.

## Notes

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## Chapter 8 MTR3000 Power Supply

### 8.1 Description

The Power Supply is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (See [Chapter 15](#) for detailed removal or installation procedures for all modules in the base station/repeater.)

The Power Supply has built in power factor correction and includes a connection for battery backup that also serves as the DC input when the supply is used in DC only input mode.

#### 8.1.1 General Description

The Power Supply accepts an AC or a DC input (AC input = 85 to 264 VAC, 50/60 Hz, DC input = 21.6 to 32 VDC) and generates three output DC voltages to power the base station/repeater modules: +28.6 VDC, +14.2 VDC and +5.1 VDC.

**Note** When used in DC input mode, the 28.6 VDC output equals the DC input within 0–0.5 VDC.

**Note** An external 24 V (nominal) battery system is required to support the battery backup feature so that when the AC power fails, the MTR3000 Base Station/Repeater (BR) can be powered from a DC battery source if it is connected to the PS. This results in uninterrupted radio service (for as long as battery power can be provided). As the PS does not have a battery charging function, when the AC power is restored, an external charger is required to recharge the battery.

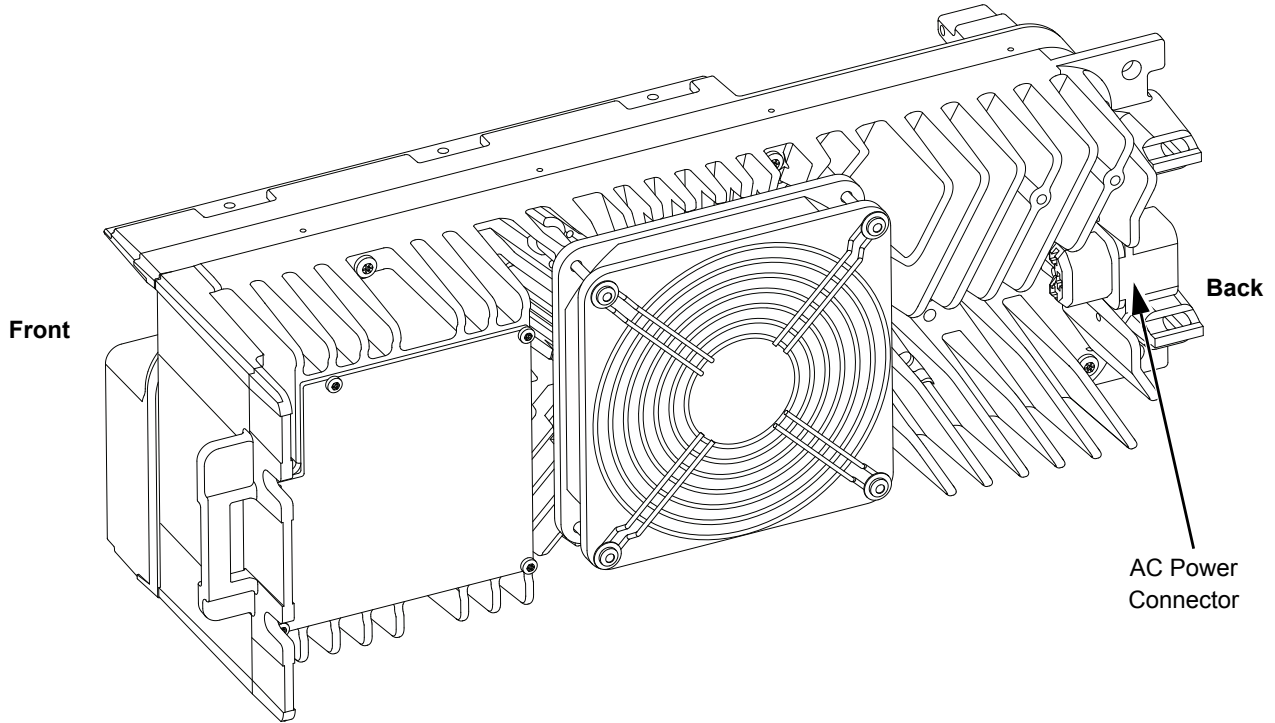
The Power Supply is a high-frequency switched mode design, all contained in a metal heat-sink, mounted on the left-hand side of the base station/repeater. The design provides for output over-voltage/over-current protection.

The AC input connection is made at the rear of the base station/repeater via an IEC-type connector keyed to accept only high temperature type mating connectors. Also provided is a Battery Backup connection (see DC mode above). Power supply cooling, when necessary, is provided by an external fan (located near the middle of the heatsink) which provides forced air across the power supply heatsink fins.

### 8.1.1.1 Identification of Inputs/Outputs

Figure 8-1 shows the Power Supply input and output external connections.

#### Outside View



#### Inside View

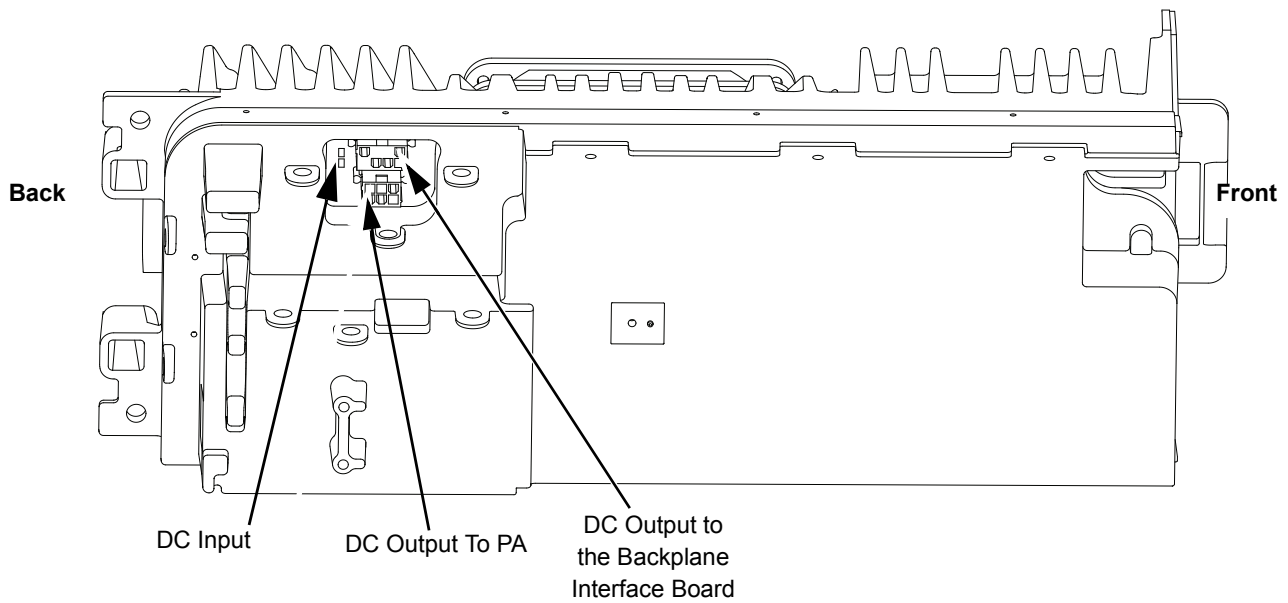


Figure 8-1 Power Supply Input/Output Connections

## 8.2 Specifications

Table 8-1 and Table 8-2 shows the electrical performance specifications for the Power Supply.

*Table 8-1 Power Supply AC Performance Specifications*

<b>Parameter</b>	<b>Value or Range</b>
Input Voltage Range	85 VAC to 264 VAC
Input Frequency Range	47–63 Hz
Steady State Output Voltage	28.6 V @ 13 A, 14.2 V @ 8 A, 5.1 V @ 2 A
Output Power (Rated)	500 W
Output Ripple: +28.6 VDC +14.2 VDC +5.1 VDC	50 mV p-p, @ 25°C (77°F) 50 mV p-p, @ 25°C (77°F) 100 mV p-p, @ 25°C (77°F)

*Table 8-2 Power Supply DC Performance Specifications*

<b>Parameter</b>	<b>Value or Range</b>
Input Voltage Range	21.6–32 VDC
Steady State Output Voltage	28.6 V @ 13 A, Input voltage dependent 14.2 V @ 8 A, Regulated 5.1 V @ 2 A, Regulated
Output Power (Rated)	500 W
Output Ripple: +28.6 VDC +14.2 VDC +5.1 VDC	Input voltage dependent (0–0.5 V below input) 50 mV p-p, @ 25°C (77°F) 100 mV p-p, @ 25°C (77°F)

## 8.3 Functional Theory Of Operation

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. See [Figure 8-2](#) for the block diagram of the power supply.

### 8.3.1 Supply Circuitry

#### 8.3.1.1 Output Over-Current Protection

An over-current condition on either the 28.6 VDC, 14.2 VDC or 5.1 VDC outputs will shut down the total supply and try to restart. If the over-current continues to exist, the power supply will 'hiccup' until the overload condition is removed, and will not be damaged by the overload. The power supply recovers automatically after the removal of the overload condition.

#### 8.3.1.2 Over-Voltage Detection and Shutdown

All DC output for either AC or DC inputs are protected from continuous over-voltages by detection circuits which shutdown the supply and then try to restart itself. If the over-voltage condition continues to occur, the power supply intermittently shut down and will try to restart. If the over-voltage condition is removed, the supply automatically recovers. In addition, the 14.2 VDC and the 5.1 VDC outputs are protected by crowbar circuits to limit peak overvoltage.

#### 8.3.1.3 AC Fail Detect

An AC Fail detect signal is provided to indicate (when used with battery backup option) that the power supply is operating from an external DC source rather than the ac mains. This signal is a TTL compatible output capable of sinking 1 mA with 10 k $\Omega$  pull-up to 5.1 VDC, and is routed to the Station Control Module. The active-low state indicates ac operation. For the nominal 120 VAC operation, the signal is active-high (indicating an AC mains failure) when the AC voltage is less than 85 Vrms, but more than the minimum voltage that guarantees that all outputs will be in regulation at full load.

**Note** To disable the AC Fail Detect alarm in cases where the base station/repeater is running on DC only input, see Online Help section in the CPS tool.

#### 8.3.1.4 Fan Control

The supply incorporates temperature sense/fan enable circuitry for controlling a 12 VDC fan mounted on the surface of the heatsink assembly. The power supply circuitry senses the internal temperature of the power supply. When the internal temperature exceeds a set limit, +12 V is enabled at J1-1 to turn on the fan. The +12 V fan supply is derived from the +14.2 V output. Power to the fan is off when the temperature is below the set limit. The fan turns for approximately 5 seconds when power is first applied as a diagnostic indicator that the fan is functional.

**Note** For procedure to replace the PS fan, see [Section 15.7.2.1](#).

#### 8.3.1.5 Over-temperature Protection

The power supply will turn off all outputs when the external temperature exceeds approximately 75°C with the PA operating at full power. The power supply will restart when the internal operating temperature is reduced below the set point.

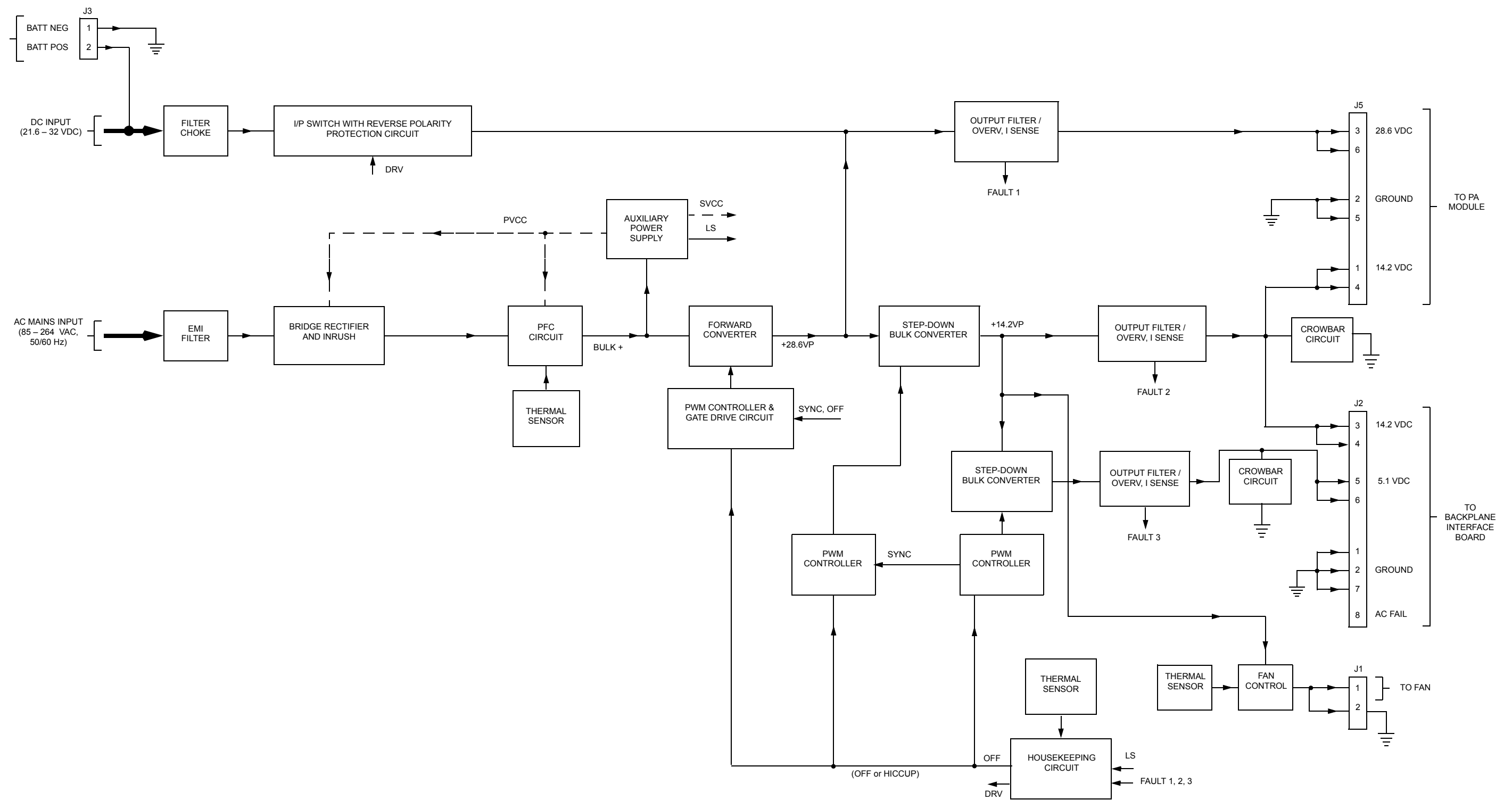


Figure 8-2 Power Supply Functional Block Diagram

**Notes**



## 8.4 Basic Troubleshooting

### 8.4.1 Replacement Procedure

For procedure to replace the Power Supply module, see [Section 15.7.2.3](#).

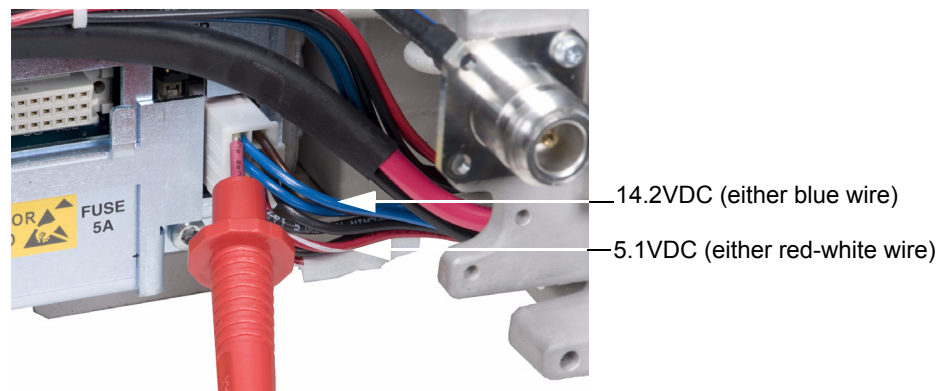
### 8.4.2 Basic Voltage Check Procedure

This section is to illustrate measurement of the 28.6 VDC, 14.2 VDC, and 5.1 VDC sources if a known good AC or DC source is applied to the Power Supply but there is no apparent activity from the base station/repeater.

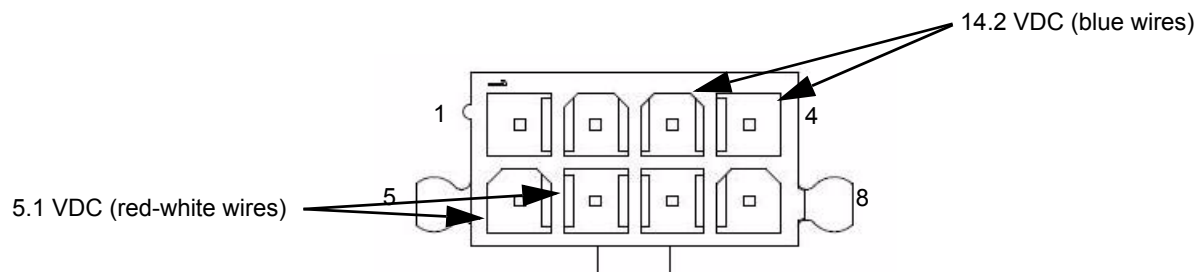
To check the basic voltage for base station/repeater failure, such as no power indicated to the base station/repeater when the AC and DC mains are connected, perform the following steps:

1. Turn on the base station/repeater power at source (e.g. AC or DC breaker).
2. Push a voltmeter probe into the power connector at the backplane interface board or PA adjacent to the indicated wires. Ensure enough of the probe tip is inserted to touch the metal Pin inside the connector housing.
3. Touch the other voltmeter probe anywhere on the chassis (or either casting) to complete the measurement circuit.

To measure the 14.2 VDC and 5.1 VDC, see [Figure 8-3](#). For the pin-out, see [Figure 8-4](#).



*Figure 8-3 Measuring 14.2 VDC and 5.1 VDC (other voltmeter probe to chassis)*



*Figure 8-4 Pin-out of connector (measuring 14.2 VDC and 5.1 VDC)*

To measure the 14.2 VDC and 28.6 VDC, see [Figure 8-5](#). For the pin-out, see [Figure 8-6](#).

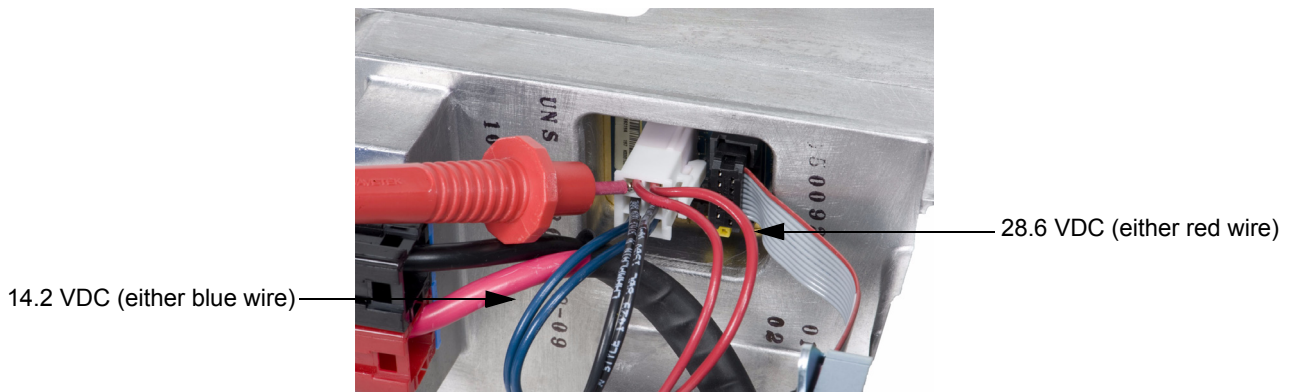


Figure 8-5 Measuring 14.2 VDC and 28.6 VDC (other voltmeter probe to chassis)

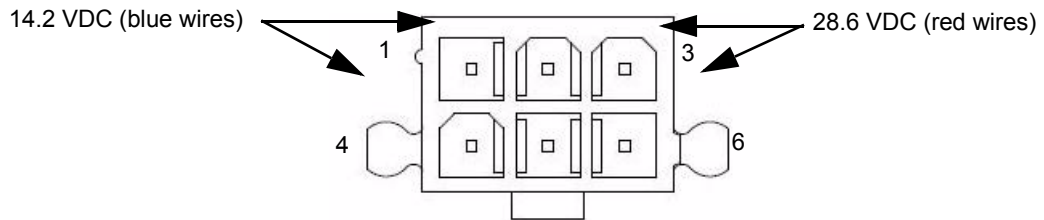


Figure 8-6 Pin-out of connector (measuring 14.2 VDC and 28.6 VDC)

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## Chapter 9 MTR3000 Wireline

### 9.1 Description

The Wireline Interface Board is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level.

#### 9.1.1 General Description

The MTR3000 Wireline board is used to connect an analog audio source and sink (such as a console) to the MTR3000 Base Station/Repeater. The Wireline board supports Tone Remote Control and DC Remote Control and analog voting modes. For remote control operation (2-wire or 4-wire), the Wireline board allows for channel selection and PTT signaling from compatible consoles, with Local PTT operation also being supported. Additionally for analog voting, the Wireline board supports the generation of Status Tone, Receive Guard Tone, and PTT signaling for use with compatible voting systems, which includes Spectra-TAC and Digi-TAC comparators.

Although the Wireline is installed as a card inside the MTR 3000 Base Station/Repeater, its interaction with the base station/repeater is similar to that of an external controller. The Wireline board drives the same GPIO signals that an external controller would drive if it were connected to the J7 DB-25 connector on the back of the base station/repeater. Though there are similarities with an external controller, almost all Wireline options are configured through the CPS and Tuner software configuration tools, just as the other base station/repeater options are.

### 9.1.1.1 Input and Output Connections

Figure 9-1 shows the location of the Wireline board jumpers and all input and output external connections.

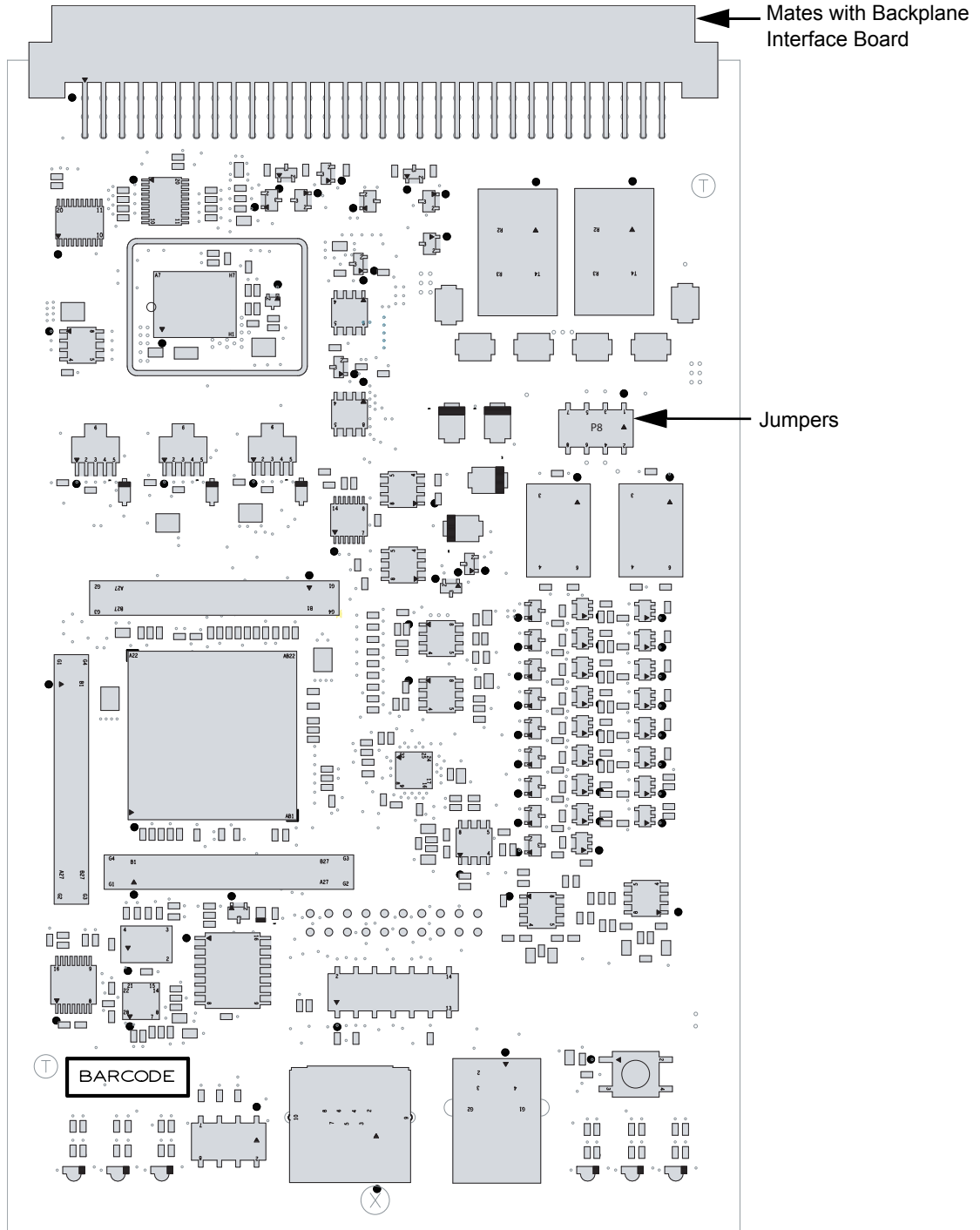


Figure 9-1 Wireline Board Jumpers and Input/Output Connections

## 9.2 Specifications

Table 9-1 shows the specifications of MTR3000 Wireline board.

Table 9-1 Specifications of Wireline board

Parameter	Specification
Wireline Transmit Level	+10 to -30 dBm
Wireline Receive Level	+7 to -30 dBm
Return Loss	> 20 dB
Distortion Introduced	< 0.5%

## 9.3 Functional Theory Of Operation

The following theory of operation describes the Wireline board at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. See Figure 9-6 for the block diagram of the Wireline board.

### 9.3.1 Functional Overview

#### 9.3.1.1 FPGA

The MTR 3000 Wireline board uses Digital Signal Processing (DSP) techniques to implement all required remote control functions, filtering algorithms, tone generation and audio adjustments. Audio enters and leaves the board as analog, but is converted to digital in the interim for processing.

The FPGA is responsible for handling all audio processing functions. It accepts digital audio data from the CODEC, applies the required filters and algorithms, and sends the resulting audio samples back to the CODEC to be converted back to analog. In addition to its audio processing functions, the FPGA also manages CODEC configuration, generates the CODEC master clock, drives and interprets backplane interface board GPIO signals, interprets decoded DC Remote Control signals, and services configuration requests from the Station Control Board via the backplane interface board SPI interface.

#### 9.3.1.2 CODEC

The Digital-to-Analog and Analog-to-Digital conversions for both the Tx and Rx paths are handled by a single stereo CODEC. The CODEC converts analog audio to digital samples which are sent to the FPGA for further processing. The FPGA will then return modified digital samples to the CODEC to be converted back to analog.

The CODEC is configured by the FPGA via an I2C interface. The FPGA synthesizes the CODEC master clock from the board's on-board oscillator. In return, the CODEC will generate the bit clock and word clock used to transfer digital audio data between the CODEC and FPGA.

Two-wire and Four-wire Tx audio use different analog input pins on the CODEC. The CODEC will select the appropriate input based on the "Wire Mode" setting in the CPS tool. When operating in 4-wire mode, the 2-wire Tx audio path is automatically disconnected from the CODEC input using an analog switch. This helps to reduce crosstalk and improve audio performance.

### 9.3.1.3 DC Control Decoder

The DC Control Decoder uses a collection of optocouplers and diodes to detect the amplitude and polarity of DC currents on the Wireline Tx pair. The optocouplers provide a set of logic signals to the FPGA that are used when the Wireline board is configured for DC Remote Control operation.

### 9.3.1.4 Surge Protection

The MTR3000 Wireline board implements 3 stages of surge protection on its Wireline port. In the first stage of protection, sidactors limit the instantaneous voltage at the beginning of a transient event by shunting current between voltage potentials. In the second stage of protection, Positive Temperature Coefficient (PTC) fuses disconnect the Wireline Tx and Rx paths from the base station/repeater backplane interface board when the transient current exceeds specified levels. In the third stage of protection, transient voltage suppression diodes will clamp line-to-line events that exceed 9V.

**Note** The PTC fuses are designed to automatically reset when line conditions return to normal. All surge protection components (including the PTC fuses) are not intended to be field serviceable.

### 9.3.1.5 Impedance Matching Network

The impedance matching network is intended to present a known configurable impedance to equipment connected at the far side of the Wireline cable. Line impedance is generally standardized by country or region. The matching network uses 24 analog switches to switch resistors and capacitors onto the receive and transmit audio paths. For any given impedance setting, 3 switches are closed. On the receive pair, impedances are switched in series with each line and on the transmit path impedances are switched in parallel. The line impedance setting is configured using the CPS software configuration tool. The Wireline's FPGA will close the correct switches based on the CPS configuration setting.

Table 9-2 shows the line impedance supported by the Wireline board based on the country or region.

Table 9-2 Impedance supported by Wireline board

Option	Functionality
High Impedance	For use with an external impedance matching
600 $\Omega$	For Argentina, Canada, Chile, Columbia, Ecuador, El Salvador, Guam, Hong Kong, India, Indonesia, Japan, Jordan, Kazakhstan, Kuwait, Macao, Malaysia, Mexico, Oman, Pakistan, Peru, Philippines, Russia, Saudi Arabia, Singapore, South Korea, Taiwan, Thailand, UAE, USA and Yemen
270 $\Omega$ + (150 nF    750 $\Omega$ )	For Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Bahrain, Croatia, Cyprus, Czech Republic, Egypt, Hungary, Israel, Latvia, Lebanon, Malta, Morocco, Nigeria, Poland, Romania, Slovakia and Slovenia
220 $\Omega$ + (115 nF    820 $\Omega$ )	For Australia, Bulgaria and South Africa
370 $\Omega$ + (310 nF    620 $\Omega$ )	For New Zealand

Table 9-2 Impedance supported by Wireline board (Continued)

Option	Functionality
900 $\Omega$	For Brazil
320 $\Omega$ + (230 nF    1050 $\Omega$ )	For United Kingdom
200 $\Omega$ + (100 nF    680 $\Omega$ )	For China
900 $\Omega$    30 nF	For legacy MTR2000

### 9.3.1.6 Backplane SPI Bus

The backplane SPI interface is used as the primary communication link between the Station Control Board and the Wireline board. This interface is used for configuring and upgrading the Wireline board.

### 9.3.1.7 GPIO Signals

The GPIO signals comprise both input and output signals that the Wireline FPGA uses to communicate control information with the Station Control Module. Inputs to the Wireline board inform the Wireline FPGA when an RF carrier has been detected or a PL tone has been decoded. Output signals from the Wireline board are used to select the base station/repeater transmit frequency, issue PTT, and activate the alternate CPS defined GPIO functions. These signals are generally activated in response to decoded DC currents or tone sequences, with the later being used for both remote control and analog voting operations. The PTT GPIO signal functions as both an input and an output. When used as an output, the signal will key up the base station/repeater's transmitter. When a backplane PTT condition is present, but not driven by the Wireline board, the signal may function as an input. This allows the Wireline to switch the direction of audio when configured for 2-wire half-duplex with no remote control.

### 9.3.2 Board Configuration

There is only one option on the Wireline board that must be configured through jumpers. All other configuration settings are modified using the Customer Programming Software (CPS).

#### 9.3.2.1 Jumper Configuration

When operating the Wireline board in DC Remote Control mode, the jumpers on header P8 must be set. These jumpers route DC Control currents from the correct Wireline pair to the DC Remote Decoder.

**Note** For maximum audio performance, the jumpers should be removed when operating in Tone Remote Control or no remote control mode.

Table 9-3 shows the jumper configuration while Figure 9-1 shows the location of jumpers on the P8 connector for the Wireline Interface Board.

Table 9-3 Wireline Board Jumper Settings

Header P8	
No DC Remote	No jumpers installed
2-Wire DC Remote	Jumper pins : 5 to 6, 7 to 8
4-Wire DC Remote	Jumper pins : 1 to 2, 3 to 4

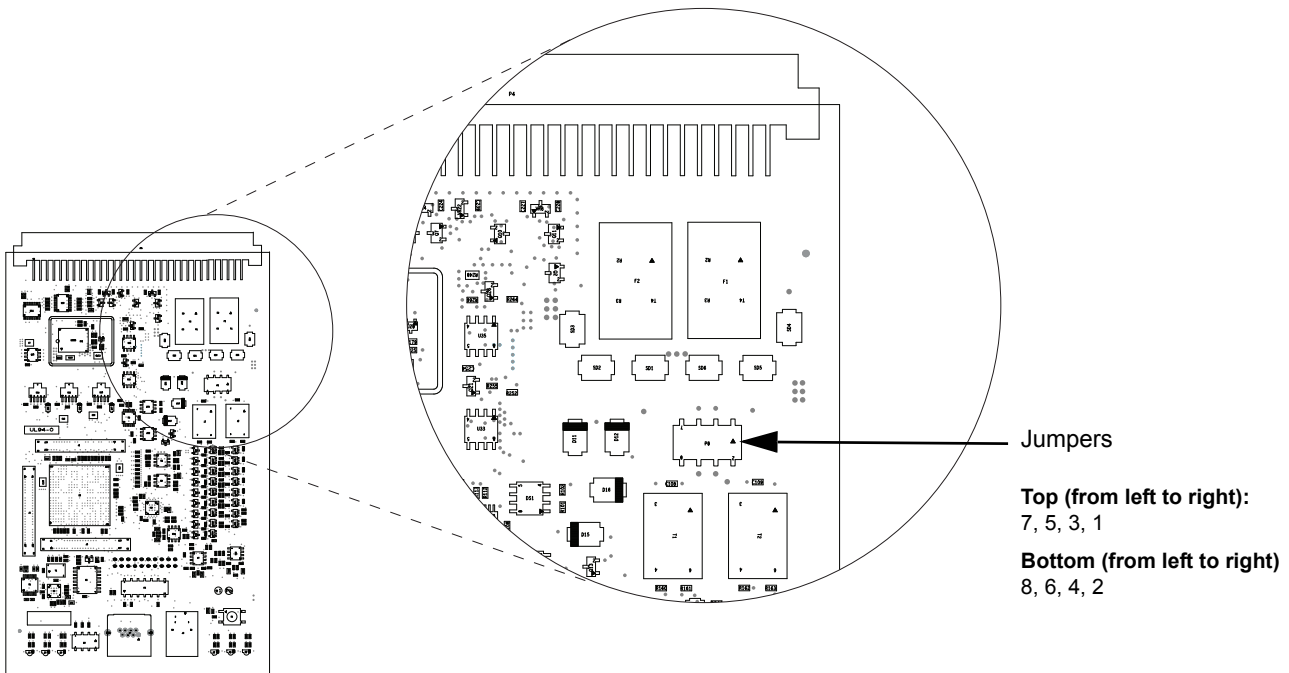


Figure 9-2 Location of jumpers on the P8 connector



### 9.3.2.2 CPS configuration

This section describes how to set up the Wireline board using the Customer Programming Software (CPS) tool. Ensure that the Wireline board is properly installed in the base station/repeater and that the CPS software is configured for “Expert View” before proceeding.

Configure the settings in CPS to match the appropriate table. Under the “Accessories” menu, select the “De & Pre” option under “Analog Accessory Emphasis”. For “Audio type”, select the “Rx & Tx Filtered Squelch” option. See [Figure 9-3](#).

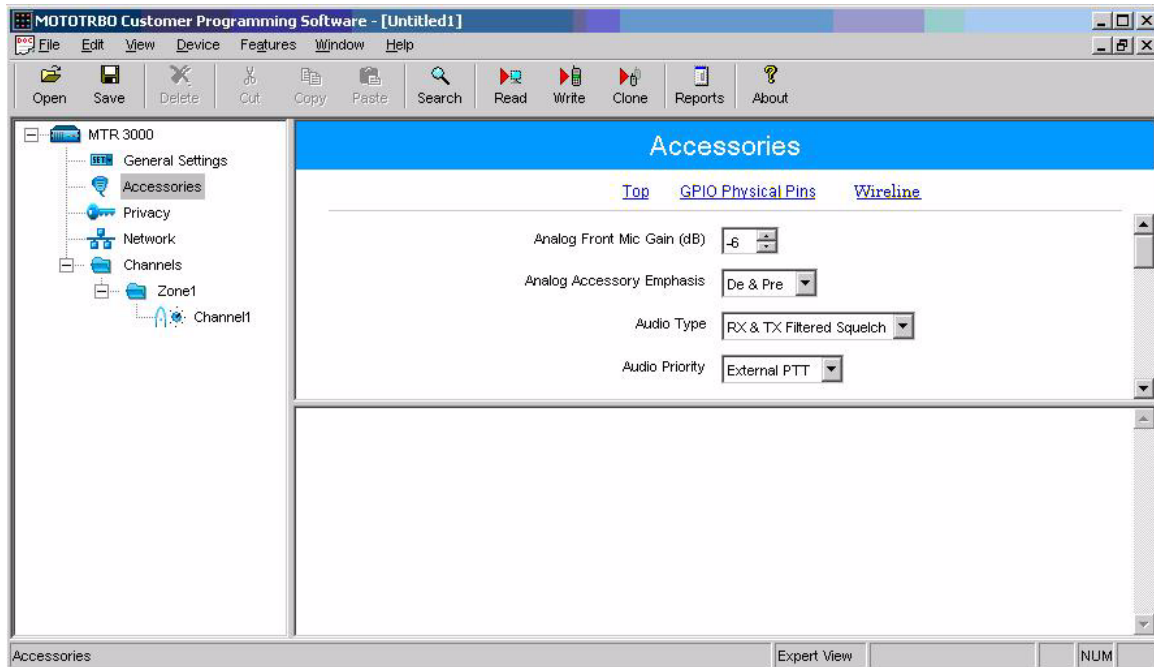


Figure 9-3 Choosing Remote Control Mode in CPS

All Wireline options appear under the “Accessories” menu of the CPS software, as shown in the screenshot below.

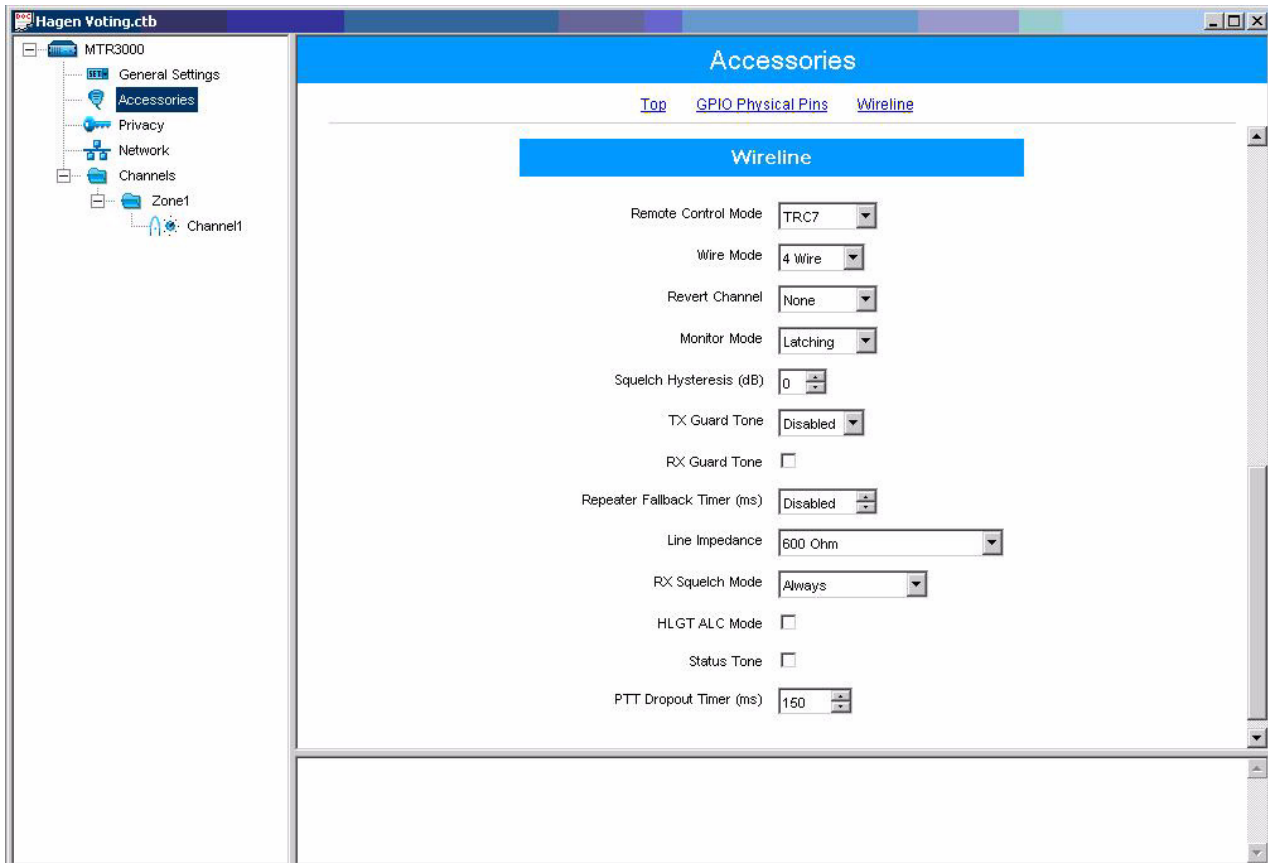


Figure 9-4 CPS configuration for Wireline board

#### 9.3.2.2.1 Choosing a Remote Control Mode

The first step in configuring the Wireline board in CPS is to choose a remote control mode. Select the appropriate mode from the “Remote Control Mode” option in the CPS Wireline configuration menu. For Tone Remote Control with 7 channels or less, choose TRC7. For Tone Remote Control with 8 to 15 channels, choose TRC15. For DC Remote Control, choose DC. If PTT is generated by a device other than the Wireline board (commonly known as Local PTT), choose ‘None’.

With a Remote Control Mode chosen, the “GPIO Physical Pins” must be configured to match. Locate the “GPIO Physical Pins” settings in CPS on the “Accessories” menu. [Table 9-4](#), [Table 9-5](#), and [Table 9-6](#) list the “GPIO Physical Pins” settings for each Remote Control Mode.

TRC7 supports the use of alternate CPS defined GPIO functions on Pin 5 and Pin 21. Select the desired function from the feature list or choose 'Unassigned' if no functionality is desired.

**Note** The “User Defined” functions in Table 9-5 (i.e. the functions on Pin 5 and Pin 21) will not support the “Enable/Disable” and “Tx Power Level High” functions.

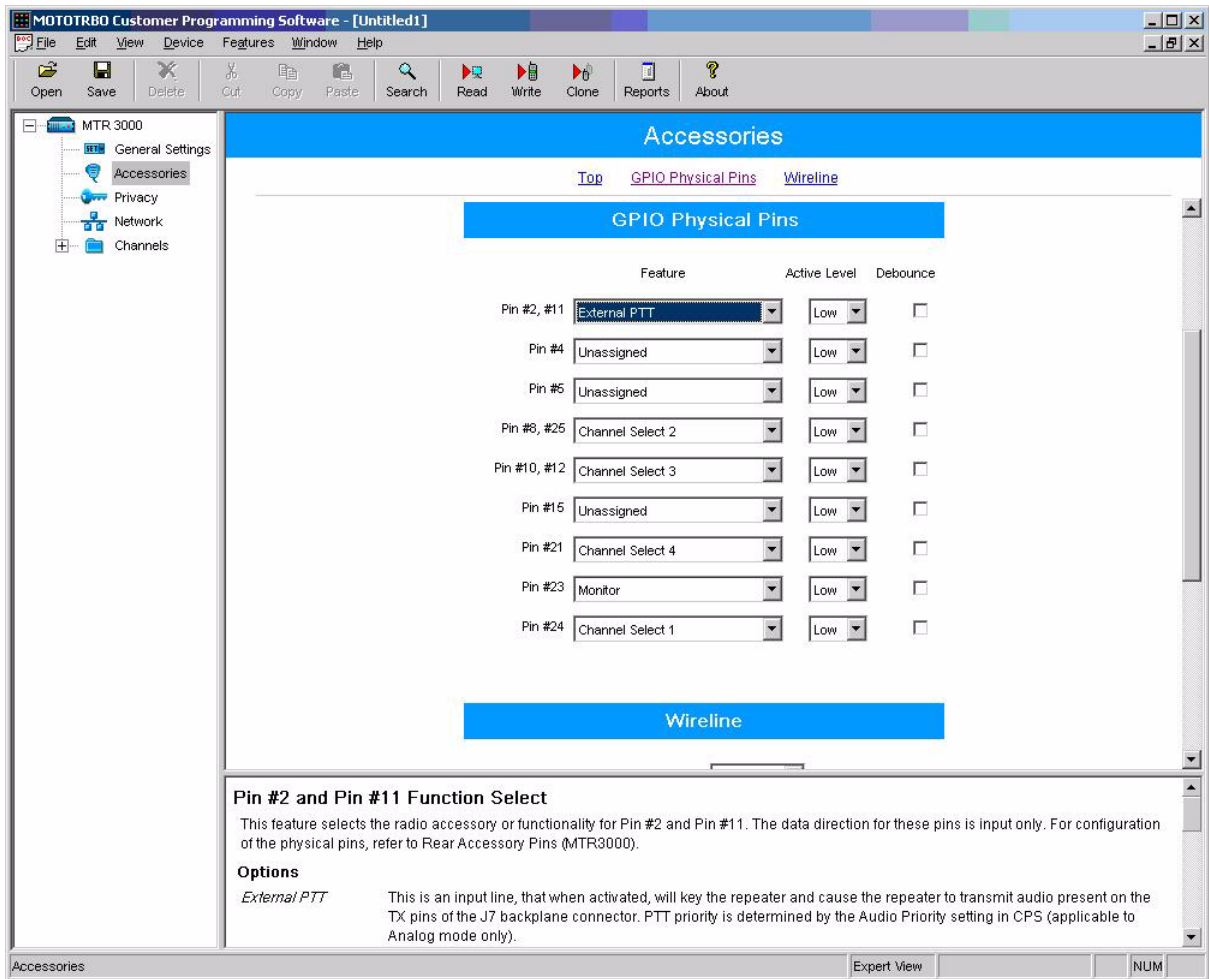


Figure 9-5 GPIO Physical Pin Configuration in CPS (example shown above is for TRC15)

### 9.3.2.2.2 Analog Voting Function

1. CPS configuration steps are required to enable the voting function within the MTR3000 base station/repeater. Specifically, under the “Wireline” section heading in the “Accessories” menu, select and set the following attributes:
  - a. Select “4-Wire” under the “Wire Mode” attribute. The “2-Wire” selection is not allowed for voting.
  - b. Select the desired control method under the “Remote Control Mode” attribute.
  - c. Check the “Status Tone” attribute -- Note, some comparator systems use the term “Pilot Tone” instead of “Status Tone”.
  - d. Check the “Rx Guard Tone” attribute for comparator systems that support this attribute.
  - e. Select the appropriate “Rx Squelch Mode” setting.
  - f. Select the appropriate “Repeater Fallback Timer” setting. Note, values greater than 20ms are required to prevent false repeater fallback with the Spectra-TAC comparator.

**Note** The Status Tone, Rx Guard Tone, Rx Squelch, and Repeater Fallback Timer attributes can not be configured if the Wire Mode attribute is not set in accordance to the above directive. Additionally, the explicit definitions of the Wireline attributes are listed in [Table 9-8](#).

2. Under the “Wireline” section heading in the “Accessories” menu, check the “Disable Repeater Path” attribute if the MTR3000 is a Base Station/Repeater. This action is not needed if the MTR3000 is a Satellite Receiver.
3. With a Remote Control Mode chosen, the “GPIO Physical Pins” must be configured accordingly. Locate the “GPIO Physical Pins” settings in CPS on the “Accessories” menu. [Figure 9-4](#), [Figure 9-5](#), [Figure 9-6](#) and [Figure 9-7](#) list the “GPIO Physical Pins” settings needed for proper voting operation.
4. Minimum firmware requirement for support of Analog Voting functionality.
  - Station FW Version: R01.07.01 (or later)
  - Wireline FW Version: R02.03.01.22 (or later)
  - CPS version 6.5 (or later)
  - Tuner version 6.0 (or later)

Table 9-4 CPS mapping table (TRC15)

J7 DB25 Pin No.	CPS GPIO Physical Pins Feature Setting	MTR3000 Signal
2, 11	External PTT	GPI_1
8, 25	Channel Select 2	GPIO_6
10, 12	Channel Select 3	GPIO_7
21	Channel Select 4	GPIO_8
23	Monitor	GPI_4
24	Channel Select 1	GPIO_5

Table 9-5 CPS mapping table (TRC7)

J7 DB25 Pin No.	CPS GPIO Physical Pins Feature Setting	MTR3000 Signal
2, 11	External PTT	GPI_1
5	User Defined (Alternate CPS defined GPIO functions)	GPIO_10
8, 25	Channel Select 2	GPIO_6
10, 12	Channel Select 3	GPIO_7
21	User Defined (Alternate CPS defined GPIO functions)	GPIO_8
23	Monitor	GPI_4
24	Channel Select 1	GPIO_5

Table 9-6 CPS mapping table (DC Remote)

J7 DB25 Pin No.	CPS GPIO Physical Pins Feature Setting	MTR3000 Signal
2, 11	External PTT	GPI_1
8, 25	Channel Select 2	GPIO_6
10, 12	Channel Select 3	GPIO_7
21	Unassigned	GPIO_8
23	Monitor	GPI_4
24	Channel Select 1	GPIO_5

Table 9-7 CPS mapping table (Voting)

J7 DB25 Pin No.	CPS GPIO Physical Pins Feature Setting	MTR3000 Signal
4	PL/Talkgroup Detect	GPIO_2
15	CSQ Detect	GPIO_3

### 9.3.2.2.3 Other Wireline Configuration Options

All remaining Wireline configuration options may be set per [Table 9-8](#).

Table 9-8 Wireline CPS definitions

CPS Function	Description
WL Line Impedance	This field sets the Wireline Rx audio (output) and Tx audio (input) impedance of the Wireline board. The impedance of the Wireline board must be set to match that of the backhaul interface.
WL 2 W/4 W Mode	<p>This field sets the Wireline interface for either 2-wire mode (half-duplex), or the 4-wire mode (full-duplex) operation.</p> <ul style="list-style-type: none"> <li>In 2-wire mode, the console audio to and from the base station/repeater will share a single pair of conductors. The MTR3000 Base Station/ Repeater will connect to Line 2 of the J6 backplane interface board connector.</li> <li>In 4-wire mode, the console will use two separate pairs of wires for transmit and receive audio. Tx audio (from the console) will connect to J6 Line 1. Rx audio (from the base station/repeater) will connect to J6 Line 2.</li> </ul>
WL Remote Control Mode	<p>See <a href="#">Section 9.3.2.2.1</a>.</p> <p>This field sets the type of remote control method that the Wireline will use to decode the function signals from the console.</p> <p>There are four options: Tone Remote 7 (TRC7), Tone Remote 15 (TRC15), Direct Current Remote (DC), and None.</p> <ul style="list-style-type: none"> <li>TRC7: Allows seven different channels to be selected, as well as the monitor function and three alternate CPS defined GPIO functions.</li> <li>TRC15: Allows 15 different channels to be selected, as well as the monitor function.</li> <li>DC: Allows 5 different channels to be selected, as well as the monitor function.</li> <li>None: Disables all remote control functions, though the transmit and receive audio paths are still supported via the Wireline. If "Local PTT" is used in 2-Wire mode (half duplex), this parameter must be set to "None" to allow the backplane PTT signal to control the direction of audio.</li> </ul>

Table 9-8 Wireline CPS definitions (Continued)

CPS Function	Description
WL Squelch Hysteresis	This field determines how much the level of transmit audio must drop below the squelch threshold before the squelch closes. Likewise, this parameter also indicates how much the level of transmit audio must rise above the squelch threshold before the squelch opens. This parameter aids in minimizing squelch chatter.
WL Tx Guard Tone	This field sets the guard tone frequency detector and notch on the transit path of the Wireline. When 2-wire or 4-wire tone remote control is desired (TRC7 or TRC15), the Wireline guard tone frequency must be set to the same guard tone frequency generated by the console. If tone remote control is not used, then set the guard tone frequency to "disabled" for full spectrum audio.
WL HLGT ALC Mode	This field, if enabled, automatically adjusts the transmit audio up to -4/+6dB to compensate for changes in the line levels. This adjustment is made when high level guard tone (HLGT) is detected. As such, the ALC cannot be used with the DC Remote Control or no remote control modes.
WL Monitor Mode	This field defines the behavior of the Monitor function as either latching or momentary. When set to latching, the base station/repeater receiver's squelch is opened until the next High Level Guard Tone (HLGT) is sent via the console. When set to momentary, the base station/repeater receiver's squelch is opened for four seconds.
WL PTT Dropout Timer	This field specifies the allowed hold over time after the loss of low level guard tone (LLGT) before the base station/repeater dekeys. This parameter allows for momentary LLGT loss without dekeying the base station/repeater. LLGT is a tone generated by the console or deskset which signals the Wireline to issue a push to talk (PTT) to the base station/repeater.
WL Revert Channel	This field selects the revert channel of the base station/repeater. The revert channel is the channel that the base station/repeater will return to after a call is completed. If the revert channel is set to "no revert", then after the call is complete, the base station/repeater will remain on the channel of the completed call.
WL Rx Squelch Mode	This field determines the receive qualifier(s) that must be met in order to interrupt the generation of Status Tone (if enabled) and the allowance of Rx Guard Tone (if enabled) generation.
WL Status Tone	This field, if enabled, allows a Status Tone of 2175Hz to be sent to the voting comparator which will indicate to the voting comparator that the receiver is squelched. When the receiver un-squelches, the audio which is absent of Status Tone, is sent to the voting comparator to be voted.
WL Rx Guard Tone	This field, if enabled, supplies a Guard Tone (1950Hz), along with the audio, to the voting comparator once the receive qualifier has been met. Rx Guard Tone is a configurable parameter that is used by some makes of comparators.
WL Repeater Fallback Timer	This field, if enabled, forces the station into repeater mode if a PTT is not received from the voting comparator within the selected time of a valid receive qualifier. This is a failsafe if the link between the comparator and the transmitting station has been compromised.

## Notes



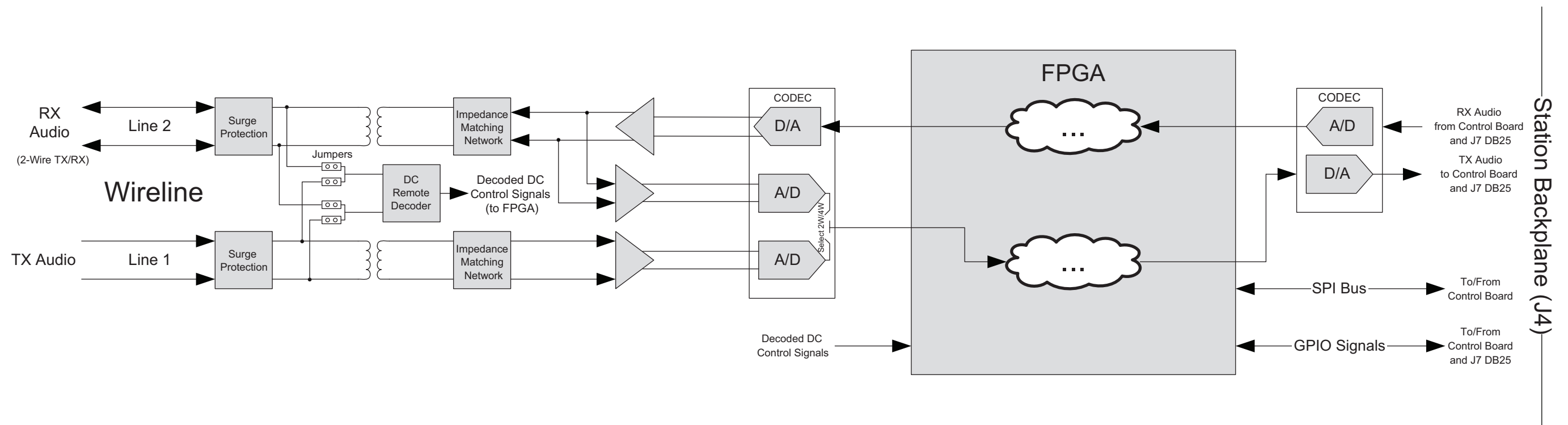


Figure 9-6 Wireline Functional Block Diagram

**Notes**

## 9.4 Basic Troubleshooting

### 9.4.1 LEDs

The Wireline LEDs can be used for basic troubleshooting and to identify faults on the Wireline board. If the power LED is on and the alarm LED is red, the Wireline board is faulty and needs to be repaired or replaced in its entirety. The procedure to replace the Wireline board can be found in [Section 15.7.2.9](#).

**Note** A MTR2000 MOTOTRBO Upgrade will only support the MTR3000 wireline card if the backplane interface board is replaced by model DLN6721.

Table 9-9 Wireline LED Indicators

LED Function Name	Reference Designator	LED Color	Status Indication
Power/FPGA Configured	D10	Green	Power present and FPGA configured
PTT	D1	Green	Wireline board is driving backplane PTT signal
Rx Squelch Qualifier	D2	Green	The Wireline board squelch qualifier has been met
Repeater Fallback Active	D3	Red	The base station/repeater is in repeater fallback
HLGT Detect (High Level Guard Tone Detect)	D7	Green	Wireline board has detected the presence of a tone on the Tx path that meets the amplitude and frequency requirements for High Level Guard Tone (HLGT)
LLGT Detect (Low Level Guard Tone Detect)	D8	Green	Wireline board has detected the presence of a tone on the Tx path that meets the amplitude and frequency requirements for Low Level Guard Tone (LLGT)
Alarm	D9	Green	Wireline board operating normally
		Red	A fault has been detected on the Wireline board

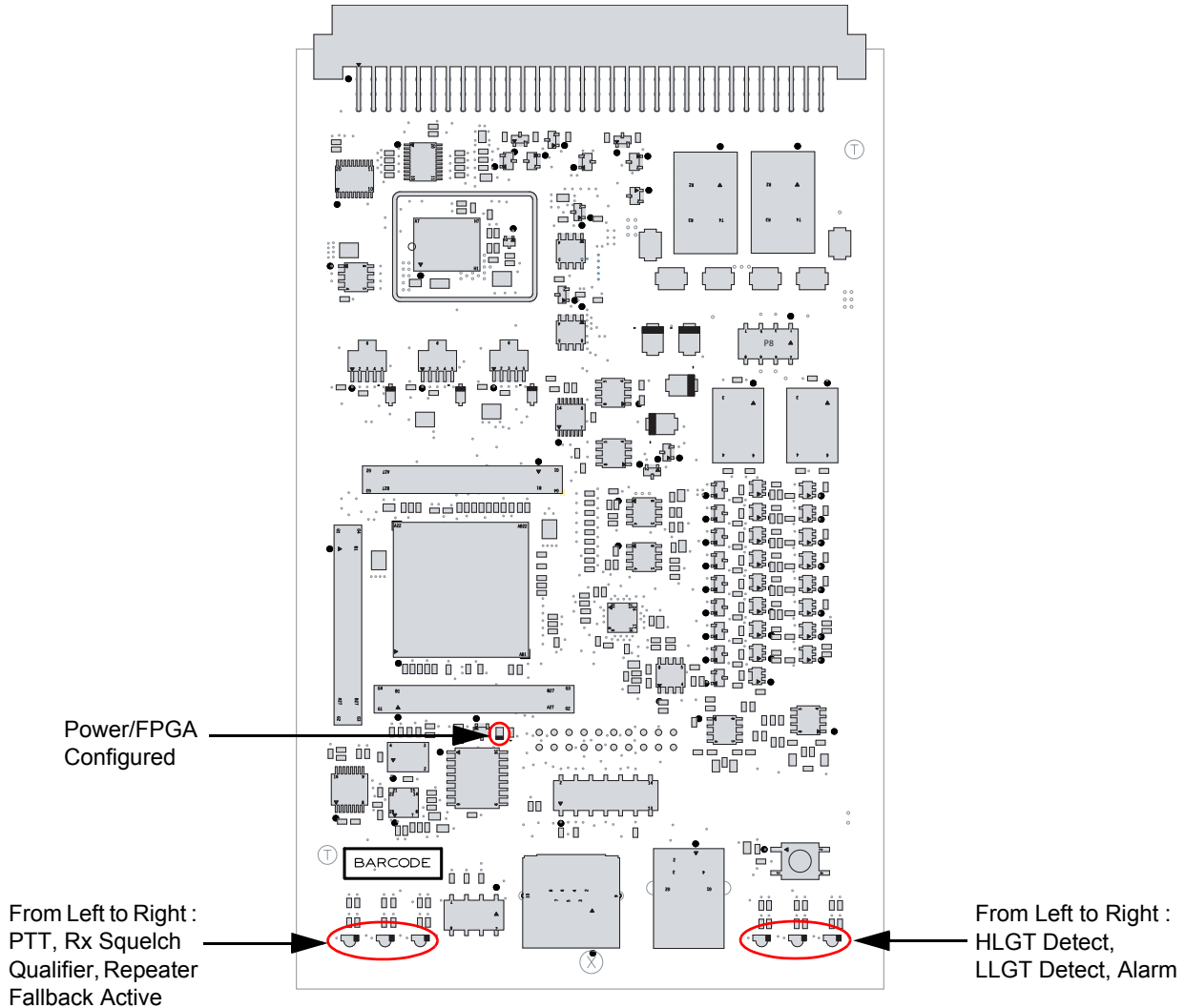
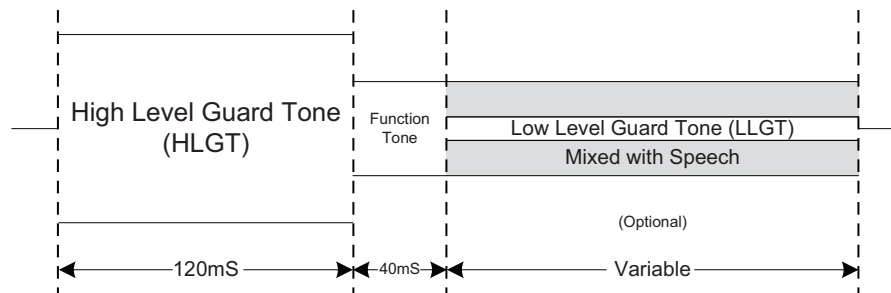


Figure 9-6 Location of LEDs

## 9.4.2 Tone Remote Control

A tone sequence must meet specific requirements for timing, amplitude, and frequency to be considered valid. The timing requirements for a tone sequence are defined in [Figure 9-7](#). All tone sequences must include a minimum of 120 mS of high level guard tone and 40 mS of function tone. i.e. Function tone is required (even on single frequency systems).

Low Level Guard Tone (LLGT) is not required. This allows the console to change frequencies or manipulate alternate CPS defined GPIO functions without keying up the base station/repeater. When Low Level Guard Tone is present (at the end of a tone sequence), the base station/repeater will key up and remain transmitting for as long as LLGT is present.



*Figure 9-7 Timing requirements for a Valid Tone Remote Control Sequence*

The required amplitude for HLGT in absolute terms is determined by the Wireline Tx Level alignment process. See [Section 14.5.4](#). HLGT is expected to be 6 dB above the Test Tone level used in the alignment process. Function Tone is expected to be 4 dB below the Test Tone Level and LLGT is expected to be 24 dB below the Test Tone level. See [Figure 9-8](#). The HLGT Detect and LLGT Detect LEDs on the front of the board may be used to determine if the Wireline is detecting the proper levels.

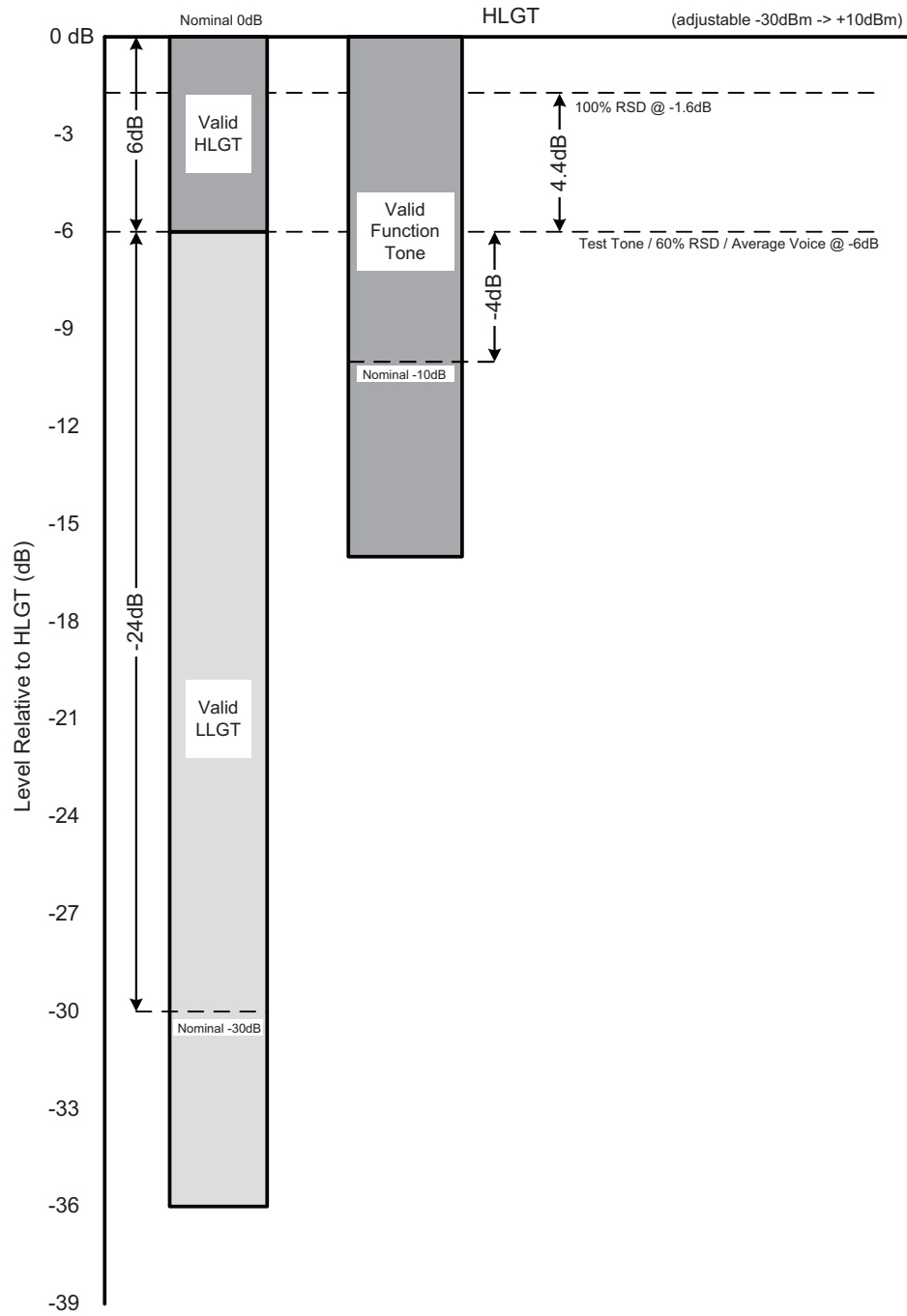


Figure 9-8 Valid amplitudes for Tone Remote Control signaling

All tones must be within +/- 10 Hz of the nominal expected frequency for guaranteed detection. The tone plans for TRC7 and TRC15 are listed in [Table 9-10](#) and [Table 9-11](#) for console configuration.

**Note** When configured for TRC7 operation there are 2 function tones that are not used. If a console sends these function tones to the Wireline as part of an otherwise valid tone sequence, the Wireline will key up the base station/repeater on the frequency associated with the last valid channel steering function tone received.

*Table 9-10 Function Tone Definition Table (Console) (TRC15)*

<b>Tone (Hz)</b>	<b>Function</b>
2050	Monitor
1950	Frequency 1
1850	Frequency 2
1750	Frequency 3
1650	Frequency 4
1550	Frequency 5
1450	Frequency 6
1350	Frequency 7
1250	Frequency 8
1150	Frequency 9
1050	Frequency 10
950	Frequency 11
850	Frequency 12
750	Frequency 13
650	Frequency 14
550	Frequency 15

Table 9-11 Function Tone Definition Table (Console) (TRC7)

Tone (Hz)	Function
2050	Monitor
1950	Frequency 1
1850	Frequency 2
1750	Frequency 3
1650	Frequency 4
1550	Frequency 5
1450	Frequency 6
1350	Frequency 7
1250	Not Used
1150	GPIO8 Assert
1050	GPIO8 De-assert
950 *	GPIO9 Assert
850 *	GPIO9 De-assert
750	GPIO10 Assert
650	GPIO10 De-assert
550	Not Used

**Note** (\*) Not supported

### 9.4.3 DC Remote Control

The signaling plan for DC Remote Control is shown in [Table 9-12](#) for console configuration. Ensure that the DC Remote Control routing jumpers are properly configured. See [Section 9.3.2.1](#). If the base station/repeater does not key up on the expected frequency, reverse the polarity of the wires on the Tx pair of the J6 connector on the back of the base station/repeater.

Table 9-12 Function Tone Definition Table (Console) (TRC7)

Tone (mA)	Function
-2.5 (+/- 20%)	Monitor
-5.5 (+/- 20%)	Frequency 3
-12 (+/- 20%)	Frequency 4
2.5 (+/- 20%)	Frequency 5
5.5 (+/- 20%)	Frequency 1
12.5 (+/- 20%)	Frequency 2



#### 9.4.4 Voting

Figure 9-9 displays the relative levels of Rx Guard Tone and Status Tone relative to that of Test Tone at 100% RSD. It should be noted that the Status Tone and Guard Tone levels are not individually adjustable. In other words, the level of Rx Guard Tone is always at the same level as that of Test Tone, and Status Tone is always 13 dB below the Test Tone level.

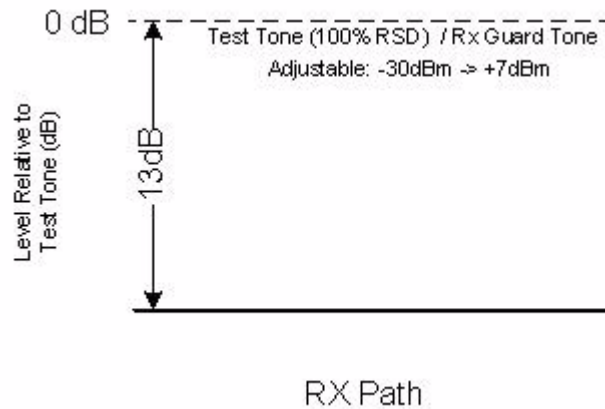


Figure 9-9 Rx Guard Tone and Status Tone Levels

## Notes

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# Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment

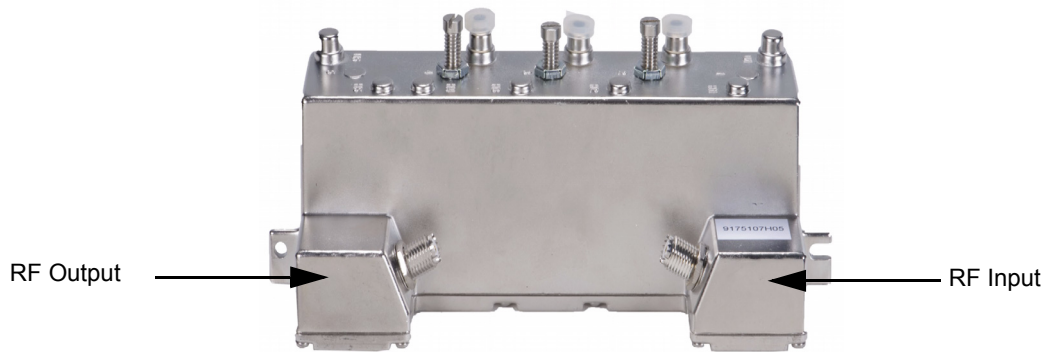
## 10.1 Description

The Radio Frequency Distribution System (RFDS) equipment included in your system depends on what options were purchased from Motorola. The following lists some examples of the RFDS equipment available for your system.

### 10.1.1 General Description

#### 10.1.1.1 Base Station/Repeater Preselectors

The preselector rejects unwanted signals including the transmitter signals from overloading the Receiver. The filter is usually not required when using a Receiver multicoupler system. This filter can be returned in the field.



*Figure 10-1 UHF Base Station/Repeater Preselector*

### 10.1.1.2 Duplexer

This optional filter provides the capability to use a single antenna for both transmitter and Receiver. Only one transmitter and Receiver can be combined.

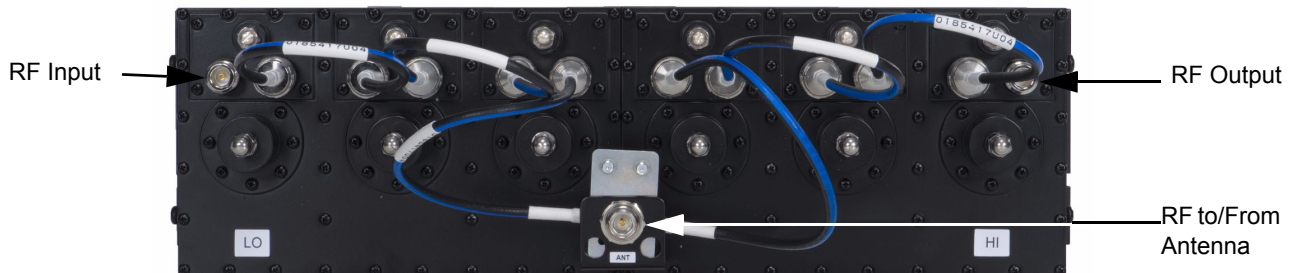


Figure 10-2 Duplexer (UHF)

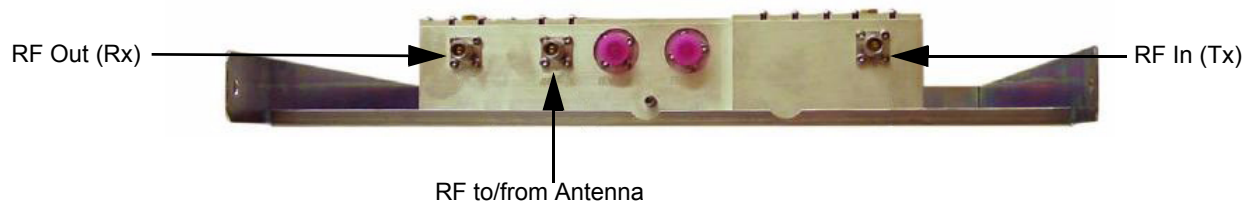


Figure 10-3 Duplexer (800 MHz)

**Note** A Duplexer is required when a base station/repeater Preselector is ordered.

### 10.1.1.3 External Dual Circulator Tray

An option for the MTR3000 Base Station/Repeater is an External Dual Circulator module which isolates the base station/repeater from the antenna, thus reducing the transmitter generated intermodulation. The circulator load dissipates reflected power. It includes a cable that connects to the RF Peripherals port on the base station/repeater backplane interface board to provide temperature monitoring in identifying antenna problems.

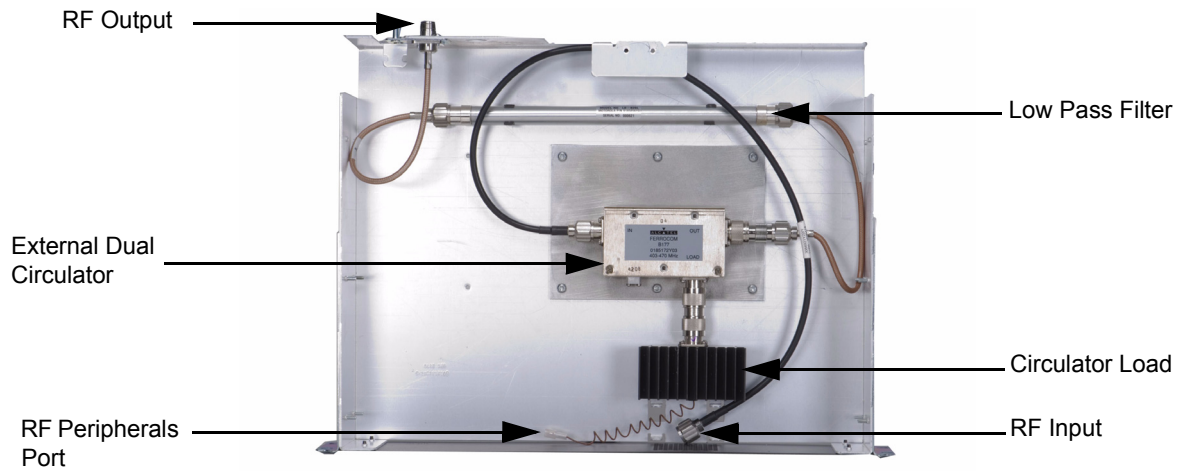


Figure 10-4 External Dual Circulator Tray (UHF)

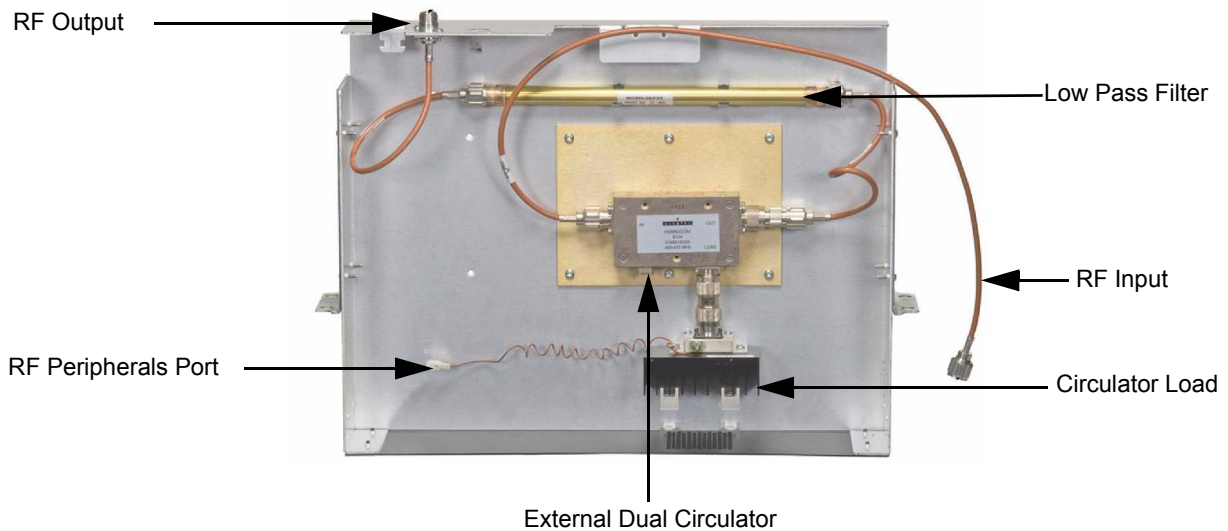


Figure 10-5 External Dual Circulator Tray (800 MHz)

### 10.1.1.4 Antenna Relay

The Antenna Relay module allows a single antenna to be used for both transmit and receive functions (base station/repeater applications only). The Antenna Relay is controlled by a signal from the Station Control Module to connect the antenna to either the PA (transmit) when activated/energized or Receiver Module (receive) when deactivated/de-energized. The Antenna Relay module is mounted on a flange provided on the rear of the PS.

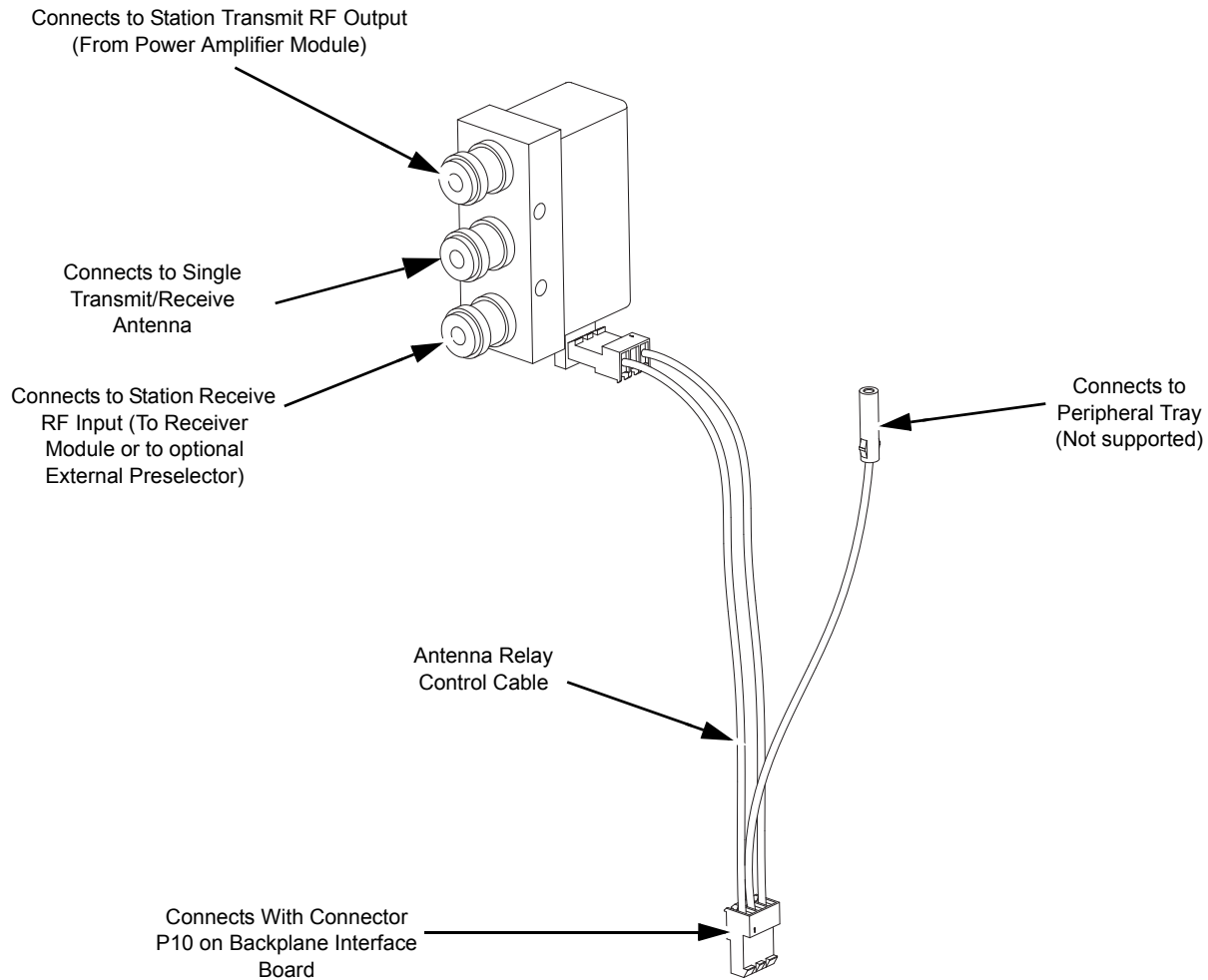


Figure 10-6 Typical Antenna Relay Module – Inputs/Outputs

- Note**
- Antenna Relay functionality is provided in analog mode only.
  - To enable functionality of the Antenna Relay, an available GPIO must be assigned to the “Antenna Relay” function within the “Accessories” field in the CPS

## 10.2 Specifications

### 10.2.1 Base Station/Repeater Preselectors

[Table 10-1](#) show the spec limits for the the VHF frequency band and [Table 10-2](#) for the UHF frequency band for the Preselector.

*Table 10-1 MTR3000 Base Station/Repeater Preselector Filter Specifications (VHF)*

Parameter	Preselector Spec Limit (VHF)	Typical
Tuning Range	136 MHz–154 MHz 150 MHz–174 MHz	–
Bandwidth	4 MHz	–
Insertion Loss	1.3 dB	1.1 dB
VSWR max.	1.9:1	–
Input Connector	Mini-UHF	–
Output Connector	Mini-UHF	–

*Table 10-2 MTR3000 Base Station/Repeater Preselector Filter Specifications (UHF)*

	Preselector Spec Limit (UHF)	Typical
Tuning Range	403 MHz–433 MHz, 435 MHz–470 MHz, 470 MHz–524 MHz	–
Bandwidth	4 MHz	–
Insertion Loss	2 dB	1.3 dB
VSWR max.	1.9:1	1.5:1
Input Connector	Mini-UHF	–
Output Connector	Mini-UHF	–

**Note** See [Appendix A](#) for the model number.

**Note** There is no external preselector for 800/900 MHz frequency band.

## 10.2.2 Duplexer

Table 10-3 shows the spec limit for Duplexer for VHF frequency band, Table 10-4 for UHF frequency band and Table 10-5 for 800/900 MHz frequency band.

Table 10-3 MTR3000 Duplexer Specifications (VHF)

Parameter	Duplexer Spec Limit	Typical	Notes
Frequency range	136 MHz–146 MHz, 144 MHz–160 MHz, 158 MHz–174 MHz	–	–
Insertion loss Tx	1.3 dB	0.7 dB	–
Insertion loss Rx	1.3 dB	0.5 dB	–
VSWR max.	1.5:1	1.2:1	–
Rx isolation	75 dB	80 dB	–
Tx isolation	75 dB	77 dB	–
Antenna Connector	N female	–	–
Rx/Tx Output Connector	N female	–	Reduced performance down to 1MHz spacing
Minimum Rx-Tx Frequency Spacing	1.5 MHz	–	–

Table 10-4 MTR3000 Duplexer Specifications (UHF)

	Duplexer Spec Limit	Typical	Notes
Frequency range	403 MHz–435 MHz, 435 MHz–470 MHz, 470 MHz–494 MHz, 494 MHz–512 MHz	–	–
Insertion loss Tx	1.3 dB	1.1 dB	–
Insertion loss Rx	1.3 dB	1.1 dB	–
VSWR max.	1.3:1	1.2:1	–
Rx isolation <470 MHz >470 MHz	100 dB 100 dB	–	R/T 5 MHz R/T 3 MHz
Tx isolation <470 MHz >470 MHz	100 dB 100 dB	–	R/T 5 MHz R/T 3 MHz
Antenna Connector	N female	–	–
Rx/Tx Output Connector	N female	–	–



Table 10-5 MTR3000 Duplexer Specifications (800 MHz)

	Duplexer Spec Limit	Typical	Notes
Frequency range	806 MHz–870 MHz	–	–
Insertion loss Tx	1.0 dB	0.8 dB	–
Insertion loss Rx	1.0 dB	0.8 dB	–
VSWR max.	1.5:1	1.3:1	–
Rx isolation <470 MHz >470 MHz	80 dB	–	–
Tx isolation <470 MHz >470 MHz	80 dB	–	–
Antenna Connector	QN	–	–
Rx/Tx Output Connector	QN	–	–

### 10.2.3 External Dual Circulator Tray

Table 10-6 shows the spec limit for External Dual Circulator Tray for VHF frequency band, Table 10-7 for UHF frequency band and Table 10-8 for 800 MHz frequency band.

Table 10-6 MTR3000 External Dual Circulator Specifications (VHF)

	External Dual Circulator Spec Limit	Typical
Operating Frequency Range	136–146 MHz, 144–160 MHz, 158–174 MHz	–
Insertion Loss	1.6 dB	0.7 dB
Input Return Loss	18 dB	25 dB
Reverse Isolation	40 dB	50 dB
Power (continuous)	200 W	–
Harmonic Attenuation <1 GHz	50 dB	–
Input Connector	RF cable with N male	–
Output Connector	N female	–

Table 10-7 MTR3000 External Dual Circulator Specifications (UHF)

	External Dual Circulator Spec Limit	Typical
Operating Frequency Range	403–435 MHz, 435–470 MHz, 470–524 MHz	–
Insertion Loss	1.6 dB	1.2 dB
Input Return Loss	18 dB	24 dB
Reverse Isolation	40 dB	50 dB
Power (continuous)	200 W	–
Harmonic Attenuation <10 GHz	70 dB (Typical: 80 dB)	–
Input Connector	RF cable with N male	–
Output Connector	N female	–

Table 10-8 MTR3000 External Dual Circulator Specifications (800 MHz)

	External Dual Circulator Spec Limit	Typical
Operating Frequency Range	762–870 MHz	–
Insertion Loss	1.6 dB	1.2 dB
Input Return Loss	18 dB	–
Reverse Isolation	40 dB	42 dB
Power (continuous)	200 W	–
Harmonic Attenuation	60 dB	–
Intermodulation (2 tone, 100 W each)	-75 dBc	–
Input Connector	RF cable with N male	–
Output Connector	N female	–

**Note** See [Appendix A](#) for the model number.

## 10.2.4 Antenna Relay

Table 10-9 shows the spec limit for Antenna Relay.

Table 10-9 MTR3000 Antenna Relay Specifications

	Antenna Relay Spec Limit
Operating Frequency	DC to 4 GHz @ 20°C
Maximum Input Power	500 W @ 1 GHz
Coil Specifications: Pull-in voltage Drop-out voltage Resistance	10.0 VDC minimum 2.0 VDC maximum 100 $\Omega$ $\pm$ 10% @ 20°C
Contact Specifications: Type Actuation Pull-in time Drop-out time (Includes remake of NC contact)	SPDT Fail-safe (Break before make) 20 ms maximum @ 20°C 20 ms maximum @ 20°C
Insertion Loss	0.3 dB maximum
Isolation	70 dB minimum
VSWR Maximum	1.3:1
Temperature Range	-30°C to +80°C
Terminations	Female N-Type
Input and Output Impedance	50 $\Omega$

**Note** See [Appendix A](#) for the model number.



**Caution**

Set the “Antenna Relay Delay Timer” minimally to 50 ms in the Customer Programming Software (CPS) to ensure that the Antenna Relay is physically in proper position during transmitter key-up. Damage to the antenna relay will result if a value less than 50 ms is entered into the CPS.

## 10.3 Functional Theory of Operation

### 10.3.1 Base Station/Repeater Preselectors

The Preselector rejects unwanted signals including the transmitter signals from overloading the Receiver. The filter is usually not required when using a Receiver multicoupler system. This filter can be retuned in the field.

### 10.3.2 Antenna Relay

The Antenna Relay Module contains a relay with a set of normally open and normally closed contacts. The relay coil is controlled by the Antenna Relay signal from the Station Control Module to connect either the Receiver Module or the PA to a single transmit/receive antenna.

**Note** With the relay de-energized, the antenna is connected to the Receiver Module. To connect the antenna to the PA, the Station Control Module must energize the relay (one side of which is connected to +14.2 VDC) by grounding the Antenna Relay signal.

### 10.3.3 External Dual Circulator Tray

The double circulator assembly accepts transmit RF output power from the PA and provides 40 to 50 dB of isolation between the PA and the transmit antenna. The assembly consists of two circulators in a single case, each with a 50  $\Omega$  load. Each circulator allows forward RF energy to pass through to the output, while routing any reflected RF energy to the corresponding 50  $\Omega$  load.

Most of the reflected energy is absorbed by the 50  $\Omega$  load (heat sink) mounted connected to the second circulator. A thermistor mounted on the heat sink provides a variable resistance signal proportional to the heat sink temperature. This signal is routed to the Station Control Module via the Temp Sense cable and the backplane interface board. If the heat sink temperature exceeds a preset threshold, the base station/repeater software enables *PA rollback* mode to a reduced output power.

### 10.3.4 Duplexer

The duplexer module allows a transmit and receive channel pair to share a common Tx/Rx antenna. Each duplexer module consists of six resonant cavities (three for transmit and three for receive) contained in a temperature-compensated copper enclosure designed to mount in a standard EIA 48.26 cm (19") equipment rack. Each set of three cavities is designed and tuned to pass the respective transmit or receive channel frequency (or bandwidths) while providing maximum Tx noise suppression at the Rx frequency and maximum Rx isolation at the Tx frequency.

## 10.4 Basic Troubleshooting

### 10.4.1 Replacement Procedure

**Note** For the correct procedure in handling static-sensitive parts, see [Section 15.4](#).

#### 10.4.1.1 Base Station/Repeater Preselectors


1. Wear an electrostatic discharge (ESD) strap and connect its cable to a verified good ground. This strap must be worn throughout this procedure to prevent ESD damage to any components.
2. Turn off the DC breaker, and/or pull the AC source power cord from the back of the base station/repeater.
3. Remove the base station/repeater preselector from the base station/repeater, as follows:
  - a. Remove the two screws which secure the base station/repeater preselector to the flange of the base station/repeater using a Torque Driver T30 bit.

- b. Label and disconnect the left and right coaxial cable mini-U connection (Male type) from the front of the base station/repeater preselector.
  4. Install the base station/repeater preselect to the base station/repeater, as follows:
    - a. Secure the preselector housing to the base station/repeater flange using the two screws which were previously removed.
    - b. Reconnect the left and right coaxial cable mini-U connection (Male type) to the base station/repeater preselector.

**Note** The base station/repeater preselector can be replaced without shutting the power down.

#### 10.4.1.2 Duplexer

1. Wear an electrostatic discharge (ESD) wrist strap and connect its cable to a verified good ground. This strap must be worn throughout this procedure to prevent ESD damage to any components.
2. Disable the channel that is using the base station/repeater in the system with the duplexer module which will be replaced.

 <b>Caution</b>	The base station/repeater needs to be taken out of service in order to carry out performance testing procedures. Unless the base station/repeater is already out of service, it is recommended to perform the procedures during off-peak hours in order to minimize disruption of service to the system subscribers.
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3. Turn off the DC breaker, and/or pull the AC source power cord from the back of the base station/repeater.
          4. Remove the duplexer from the base station/repeater, as follows:
            - a. Label and disconnect the Rx output, Tx input, antenna output, and ground cables from the duplexer.
            - b. Remove the four screws which secure the duplexer to the rack using a Torque Driver T30 bit.
          5. Install the duplexer to the rack, as follows:
            - a. Secure the duplexer to the rack using the four screws which were previously removed.
            - b. Reconnect the Rx output, Tx input, antenna output, and ground cables from the duplexer.
          6. Restore power to the base station/repeater.
          7. Enable the channel that is using the base station/repeater in the system with the duplexer.

#### 10.4.1.3 External Dual Circulator Tray

1. Wear an electrostatic discharge (ESD) strap and connect its cable to a verified good ground. This strap must be worn throughout this procedure to prevent ESD damage to any components.
2. Turn off the DC breaker, and/or pull the AC source power cord from the back of the base station/repeater.
3. Remove the filter tray from the rack, as follows:
  - a. Label and disconnect the RF input, RF output, and ground cables from the tray.

- b. Disconnect the Circulator Load temperature cable at the inline connector (which disconnects it from the cable leading to the RF Peripherals port on the base station/repeater backplane interface board).

**Note** Skip step 3(b) for the UHF band.

- c. Using a Torque Driver T30 bit, remove the two screws which secure the tray to the rack.
- d. Slide the tray out the front of the rack.
4. **IF** an individual External Dual Circulator module is replaced, perform the steps below. Otherwise, proceed to Step 5.
  - a. Label and disconnect the RF input and RF output cables from the External Dual Circulator module.
  - b. Unscrew the connector that secures the Circulator Load to the External Dual Circulator module.
  - c. Remove the screws that secure the circulator baseplate to the tray.
  - d. Remove the circulator module including the circulator load module that extends beyond the baseplate.
  - e. Place the new External Dual Circulator module in the tray in the same location and orientation as the module which will be replaced.
  - f. Secure the new External Dual Circulator module baseplate to the tray using the screws previously removed.
  - g. Connect the RF input and RF output cables to the new External Dual Circulator module.
  - h. Connect the Circulator Load to the External Dual Circulator module.
5. **IF** an individual Circulator Load is replaced, perform the steps below. Otherwise, proceed to Step 6.
  - a. Unscrew the connector that secures the Circulator Load to the External Dual Circulator module.
  - b. Remove the Circulator Load module.
  - c. Place the new Circulator Load module on the tray in the same position and orientation as the module which will be removed.
  - d. Secure the new Circulator Load to the External Dual Circulator module by tightening the connector.
  - e. Connect the Circulator load cable to the RF Peripherals port on the base station/repeater backplane interface board.

**Note** Skip step 5(e) for the UHF band.

6. **IF** an individual Low Pass/Harmonic Filter module is replaced, perform the steps below. Otherwise, proceed to Step 7.
  - a. Label and disconnect the RF input and RF output cables from the Low Pass/Harmonic Filter module.
  - b. Pull up firmly to release the Low Pass Filter module from the two semi-circular clips holding it in place.
  - c. Insert the new Low Pass Filter module into the semi-circular clips using the same orientation as the module which will be replaced.
  - d. Connect the RF input and RF output cables to the new Low Pass/Harmonic Filter module.

7. **IF** the entire tray including all of its modules are replaced, install the replacement tray in the rack.
8. Turn on the DC breaker, and/or connect the AC source power cord to the back of the base station/repeater.
9. Verify that the base station/repeater is operating properly using Customer Programming Software (CPS).

**Caution**

Shock Hazard. The MTR3000 Base Station/Repeater contains voltages which can cause damage to the base station/repeater or other equipment if a short circuit occurred. Turn off the DC breaker, and/or pull the AC source power cord from the back of the base station/repeater when servicing this component in the base station/repeater.

#### 10.4.1.4 Antenna Relay

The antenna relay module is not field repairable and should be replaced in its entirety if it is faulty. To replace it,

1. Turn off the base station/repeater power by turning off the breaker at the AC or DC source.
2. Remove the Antenna Relay module (installed on a flange on the rear of the PS module) by
  - disconnecting the control and RF coaxial cables and
  - using a Torque Driver T20 bit, remove the screws which secure the Antenna relay to the base station/repeater.
3. Ensure that the correct replacement Antenna Relay module is being installed.
4. Install the replacement Antenna Relay module by reversing the procedures outlined in step 2 above.
5. Restore power to the base station/repeater.

## 10.5 Field Tuning Procedures

### 10.5.1 Base Station/Repeater Preselectors

Depending on the configuration, the base station/repeater may have an External Preselector assembly with the always present internal preselector. The External Preselector assembly is a 3-pole bandpass filter equipped with tuning slugs to adjust the passband corresponding to the operating frequency (s) of the base station/repeater. For the internal preselector, circuitry in the Receiver Module provides a varactor-tuned bandpass filter which adapts to the required frequency range under the control of the Station Control Module.

The external preselector must be retuned if the preselector assembly or Receiver Module are replaced in the field, or if the base station/repeater operating frequency (s) are modified. The internal varactor-tuned preselector is factory-tuned to cover the relevant frequency band in its entirety. The internal preselector does not require field tuning even if the Receiver Module is replaced.

**Note** There is no External Preselector for 800/900 MHz frequency band.

### 10.5.1.1 External Preselector Tuning Procedure (with basic instruments)

**Note** Tuning for best SINAD response DOES NOT result in optimum tuning of the preselector assembly. Use this field tuning procedure to obtain optimum preselector performance.

#### 10.5.1.1.1 Test Equipment

The following test equipment are required to properly tune the external preselector assembly:

- RF signal generator – Aeroflex 3900 Series Communications System Analyzer (see note below), or HP8656A signal generator (or equivalent)
- Dip/Peak Monitor – HP435B Power Meter (or equivalent) with HP8484A sensitive power head, Boonton Model 92E with BNC input, or Aeroflex 3900 Series Communications System Analyzer using the spectrum analyzer function
- Torque Driver capable of delivering 1.36 Nm (12 in-lb) of torque with a 10 mm deep well socket
- Tuning probe
- Flat-blade screwdriver

**Note** When using Aeroflex 3900 Series Communications System Analyzer as the signal generator, the RF signal must be taken from the Antenna port.



### 10.5.1.1.2 Calculating Proper Alignment Frequency

Use one of the following two methods to calculate the alignment frequency to be generated by the signal generator.

For stations with a single receive frequency, see procedure below to calculate the alignment frequency:

1. From the site documentation or the CPS, determine the base station/repeater receive frequency. Add 200 kHz.
2. If the receive frequency is in the range of 403 MHz to 435 MHz, determine the alignment frequency as follows:
  - If frequency (from Step 1) is > 433 MHz, then alignment frequency = 433 MHz
  - If frequency (from Step 1) is < 405 MHz, then alignment frequency = 405 MHz
  - Otherwise, use the actual frequency from Step 1 (see note above).
3. If the receive frequency is in the range of 435 to 470 MHz, determine the alignment frequency as follows:
  - If frequency (from Step 1) is > 468 MHz, then alignment frequency = 468 MHz
  - If frequency (from Step 1) is < 437 MHz, then alignment frequency = 437 MHz
  - Otherwise, use the actual frequency from Step 1 (see note above).
4. If the receive frequency is in the range of 470 to 524 MHz, determine the alignment frequency as follows:
  - If frequency (from Step 1) is > 522 MHz, then alignment frequency = 522 MHz
  - If frequency (from Step 1) is < 472 MHz, then alignment frequency = 472 MHz
  - Otherwise, use the actual frequency from Step 1 (see note above).

For stations with multiple receive frequencies, see procedure below to calculate the alignment frequency:

1. From the site documentation or the CPS, note the receive frequency for each channel supported by the base station/repeater.
2. Calculate midpoint frequency as follows:
$$F_{\text{mid}} = (F_{\text{highest}} + F_{\text{lowest}}) \div 2$$
3. Using  $F_{\text{mid}}$  in place of the base station/repeater receive frequency, perform Step 1 through Step 3 from previous procedure (i.e., calculation of alignment for single receive frequency).

**Note** Bandwidth limitation in [Table 10-1](#) (i.e.  $(F_{\text{highest}} - F_{\text{lowest}}) \leq \text{Bandwidth}$ )

### 10.5.1.1.3 Preparing Equipment

1. If necessary, disconnect and remove the preselector assembly from the rear of the Station.
2. Connect the preselector, the base station/repeater, and test equipment as shown in [Figure 10-7](#).
3. Using the torque driver and deep well socket, loosen all three tension nuts on the tuning screws.
4. Detune the preselector by turning (ONLY) tuning screws 3 and 4 full clockwise until they just bottom out.

## 10.5.1.1.4 Tuning Procedure

1. Apply AC power to the base station/repeater PS (to provide an active 50  $\Omega$  termination).
2. Adjust the signal generator to the frequency calculated in the previous steps. Set the level to +5 dBm.
3. Insert tuning probe into cavity U2, and adjust tuning screw 2 for a **PEAK**.
4. Tighten tension nut on tuning screw 2 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 2 for a **PEAK**.
5. Keep tuning probe in cavity U2 and adjust tuning screw 3 for a **DIP**.
6. Tighten tension nut on tuning screw 3 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 3 for a **DIP**.
7. Insert tuning probe into cavity U3. Decrease output from signal generator to -5 dBm.
8. Adjust tuning screw 4 for a **DIP**.
9. Tighten tension nut on tuning screw 4 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 4 for a **DIP**.
10. Mount the preselector assembly in the Station, and reconnect the previously-removed cabling.

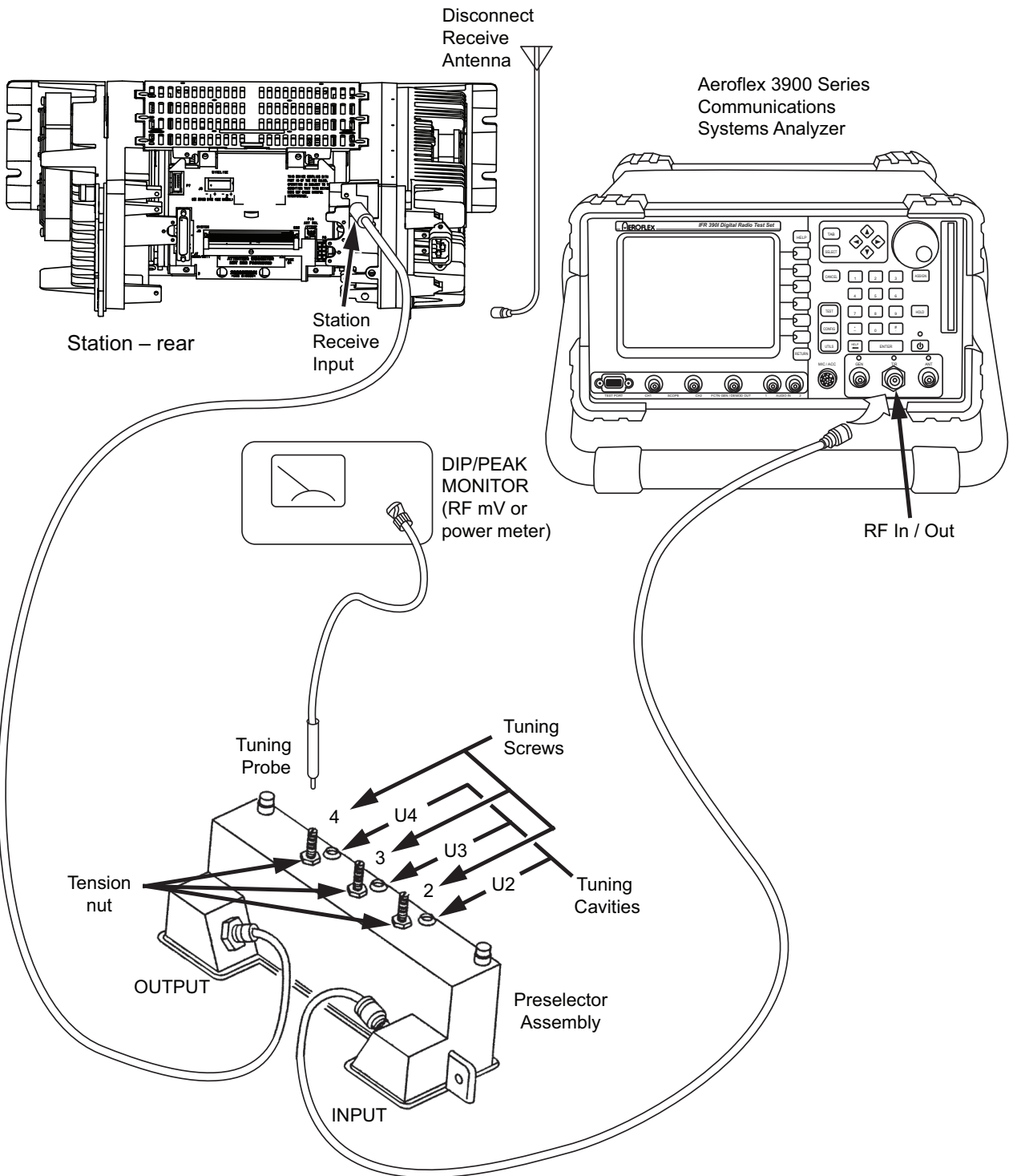


Figure 10-7 Test Equipment Setup for External Preselector Field Tuning

### 10.5.1.2 External Preselector Tuning Procedure (with advanced instruments)

Organization of this tuning procedure is as follows:

- [Section 10.5.1.2.1](#) identifies the test equipment needed.
- [Section 10.5.1.2.2](#) identifies the specific Network Analyzer (NWA) set-up steps for each of the 380–435 MHz, 435–470 MHz, and 470–524 MHz band preselectors.
- [Section 10.5.1.2.3](#) identifies detailed steps for tuning the 435–470 MHz preselector as an example of the process for also tuning the 380–435 MHz and 470–524 MHz band preselectors. Be sure to review the *Note* at the end of this section during each tuning procedure.

#### 10.5.1.2.1 Test Equipment

The following test equipment are required to properly tune the external preselector assembly:

- Network Analyzer – E5063A / E5071B / E5071C / or other series
- SMA-type calibrator – Agilent 85033E
- Tuning cable – N-type
- Screwdriver – Flat head
- Adaptor – MINI\_UHF / SMA\_JK
- Adaptor – N-SMA
- Torque measuring wrench

#### 10.5.1.2.2 Equipment Setup

For the **380–435 MHz** preselector,

1. **Initial frequency setup:** Press the START key, input 340 MHz, then press the STOP key and input 585 MHz.
2. **Marker Setup:** Enter the nine (9) marker frequencies shown below into the NWA memory.

*Table 10-10 Marker setup table for 380–435 MHz*

Mark No.	Frequency	Mark No.	Frequency	Mark No.	Frequency
Mark1	378 MHz	Mark4	437 MHz	Mark7	414.7 MHz
Mark2	382 MHz	Mark5	525 MHz	Mark8	469.7 MHz
Mark3	433 MHz	Mark6	580 MHz	Mark9	451.4 MHz

**Note** The frequencies in [Table 10-10](#) is with passband 378 MHz–382 MHz and 433 MHz–437 MHz.

3. **Output level setup:** Select MENU, press POWER and input 10 dBm.
4. **Sweep points setup:** Select MENU, press NUMBER OF POINTS soft key, and input 401.
5. **Display mode setup:** Select DISPLAY, press ALLOCATE CHANNELS soft key, then select “X1□”, next return DISPLAY page and press NUMBER OF TRACES and select 2; finally return DISPLAY page again and press ALLOCATE TRACES and select “X2□”.
6. **S-parameter plot setup:** Select S12 (S21), press SCALE REF key, then select REFERENCE POSITION soft key, and input 10/DIV, next press REFERENCEVALUE and input 0.

7. **Set S11 (S22) plot as return loss:** Press FORMAT key, select LOG MAG soft key, then select SCALE REF, press SCALE/DIVE and input 1/DIV, and turn to REFERENCEVALUE soft key and input -18.

For the **435–470 MHz** preselector,

1. **Initial frequency setup:** Press START key, input 400 MHz, then press STOP key and input 620 MHz.
2. **Marker Setup:** Enter the nine (9) marker frequencies shown below into the NWA memory.

*Table 10-11 Marker setup table for 435–470 MHz*

Mark No.	Frequency	Mark No.	Frequency	Mark No.	Frequency
Mark1	433 MHz	Mark4	472 MHz	Mark7	469.7 MHz
Mark2	437 MHz	Mark5	580 MHz	Mark8	504.7 MHz
Mark3	468 MHz	Mark6	615 MHz	Mark9	506.4 MHz

**Note** The frequencies in [Table 10-11](#) is with passband 433–437 MHz and 468–472 MHz.

3. See 380–435 MHz instrument setup (Step 3 to Step 7).

For the **470–524 MHz** preselector,

1. **Initial frequency setup:** Press START key, input 450 MHz, then press STOP key and input 670 MHz.
2. **Marker Setup:** Enter the nine (9) marker frequencies shown below into the NWA memory.

*Table 10-12 Marker setup table for 470–524 MHz*

Mark No.	Frequency	Mark No.	Frequency	Mark No.	Frequency
Mark1	468 MHz	Mark4	526 MHz	Mark7	504.7 MHz
Mark2	472 MHz	Mark5	615 MHz	Mark8	558.7 MHz
Mark3	522 MHz	Mark6	669 MHz	Mark9	541.4 MHz

**Note** The frequencies in [Table 10-12](#) is with passband 468–472 MHz and 522–526 MHz.

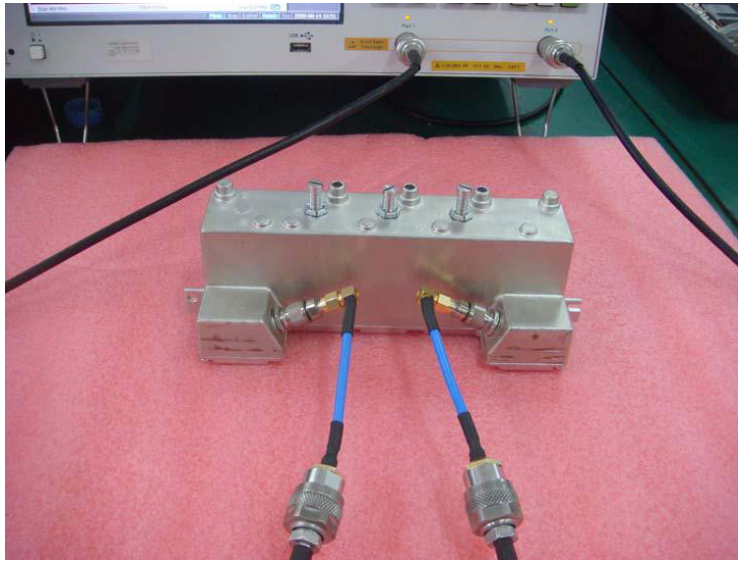
3. See 380–435 MHz instrument setup (Step 3 to Step 7).

#### 10.5.1.2.3 Tuning procedures and methods

After instrument setup, calibrate the instrument according to the standard template, then save all parameters into the memory before proceeding with unit tuning. Correctness and accuracy of calibration can be ensured before tuning process.

The procedures for tuning are the same for the 380–435 MHz, 435–470 MHz, and 470–524 MHz band preselectors. The example shown below applies for the 435–470 MHz band preselector.

1. Unit connection
  - a. If necessary, disconnect and remove the 435–470 MHz band preselector assembly from the rear of the base station/repeater.
  - b. Connect the 435–470 MHz band preselector to the NWA via the adaptors and cables shown in [Figure 10-8](#).
  - c. Using the torque driver and deep well socket, loosen all three tension nuts on the adjustment screws.
  - d. Detune the preselector by turning tuning (ONLY) screws 3 and 4 full clockwise until they just bottom out.



*Figure 10-8 Connection of the 435–470 MHz band preselector*

2. Unit Tuning
  - a. Initial Curve

With the detuned preselector, the NWA display should be similar to that shown in the full START-STOP bandwidth of [Figure 10-9](#).  
To expand and thus better display the curve, readjust the STOP band value to a lower value (such as 505 MHz as shown in [Figure 10-10](#)).

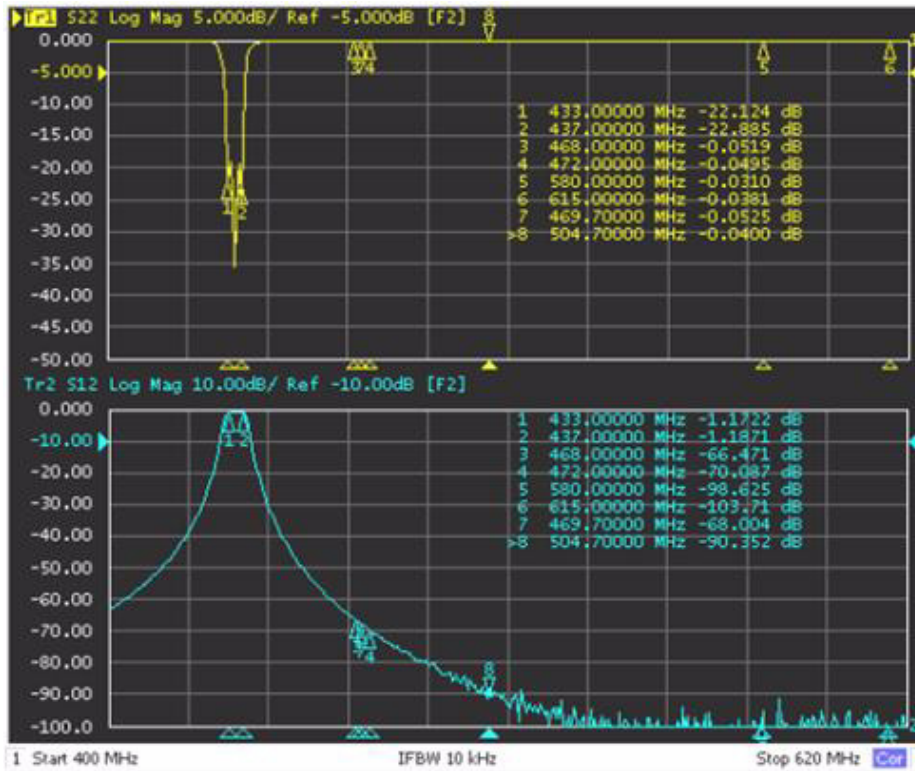


Figure 10-9 Initial curve (Start 400 MHz, Stop 620 MHz)

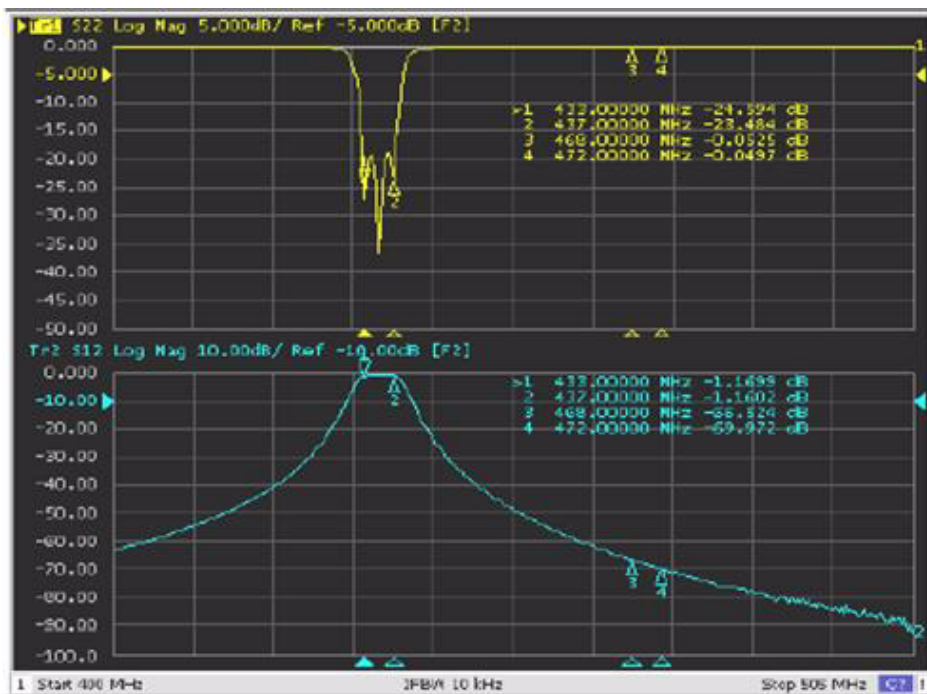


Figure 10-10 Initial curve (Start 400 MHz, Stop 505 MHz)

## b. Rough Tuning

- i. Adjustment of the tuning screws changes the position of the frequency peaks on the displayed curves. As an example, note that when screw 4 is adjusted counterclockwise, the resonance peak moves to the left and if turned clockwise, the peak moves to the right as indicated by the yellow arrow in [Figure 10-11](#).

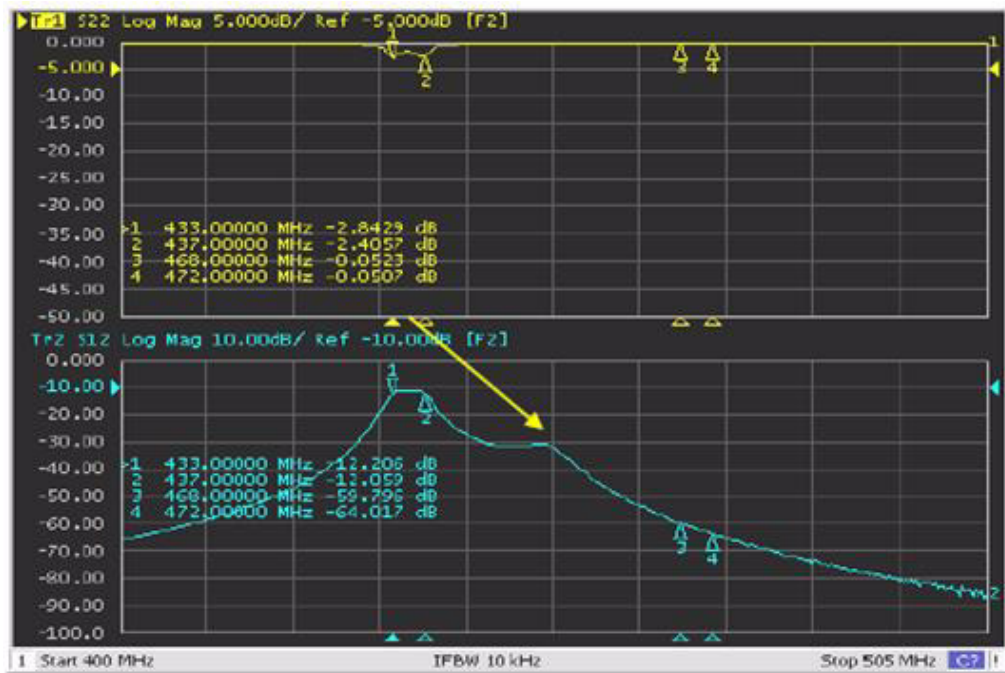


Figure 10-11 Passband tuning of tuning screw 4

- ii. Adjust tuning screw 4 until the peak moves into the 468–472MHz range (the area between Marker 3 and Marker 4). See [Figure 10-12](#).



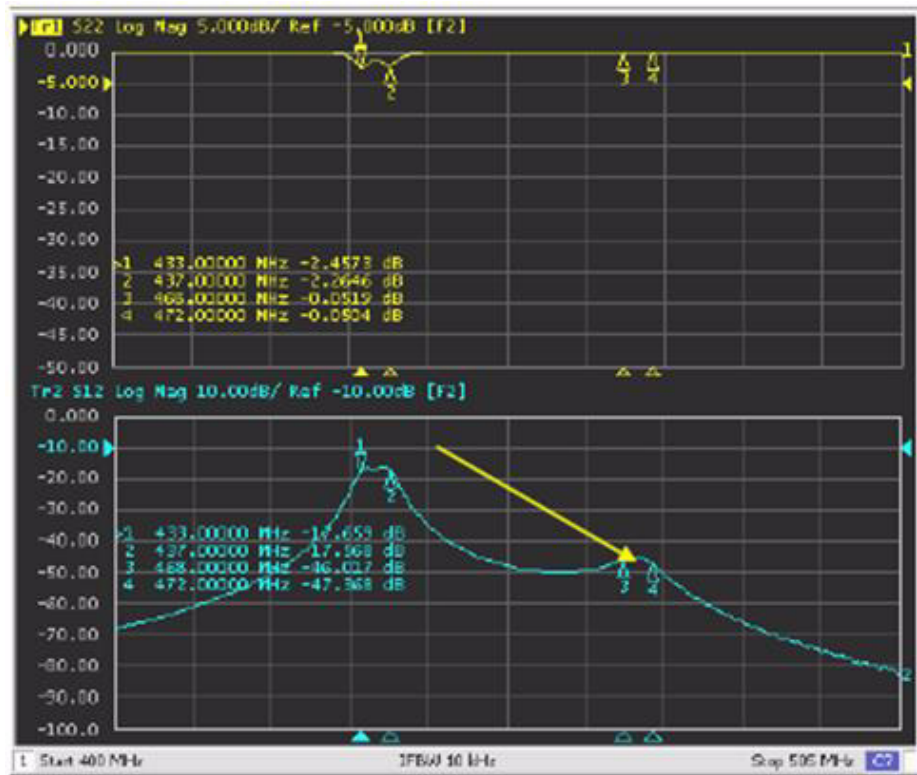


Figure 10-12 Passband tuned to required range (tuning screw 4)

- iii. Tune at screw 3 until the peak adjusted by it moves into the passband similar to that shown in Figure 10-13 and then into the area between Marker 3 and Marker 4. See Figure 10-14.

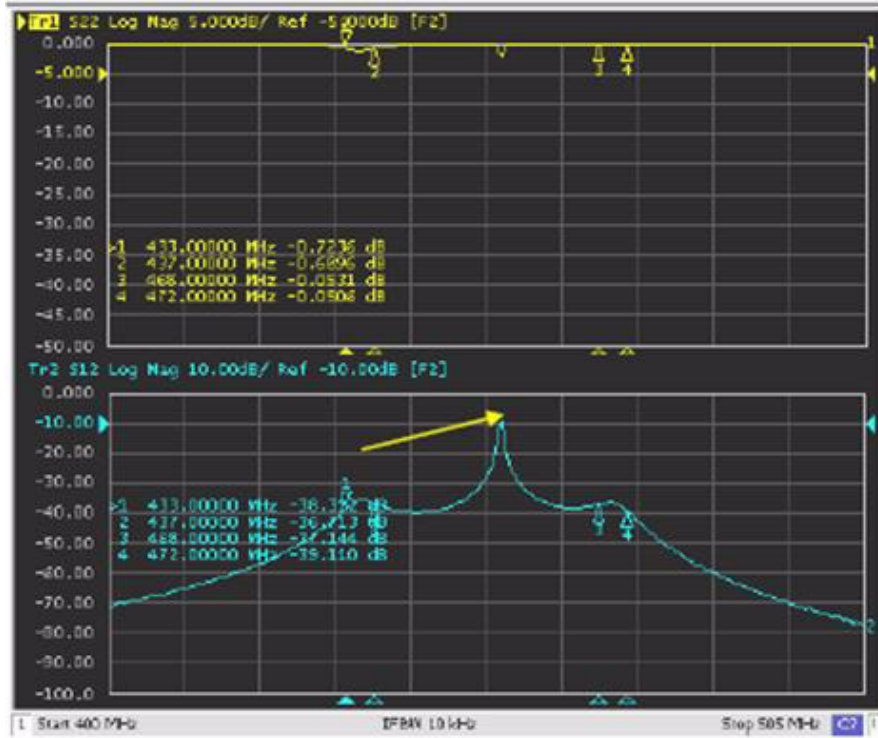


Figure 10-13 Passband tuning of tuning screw 3

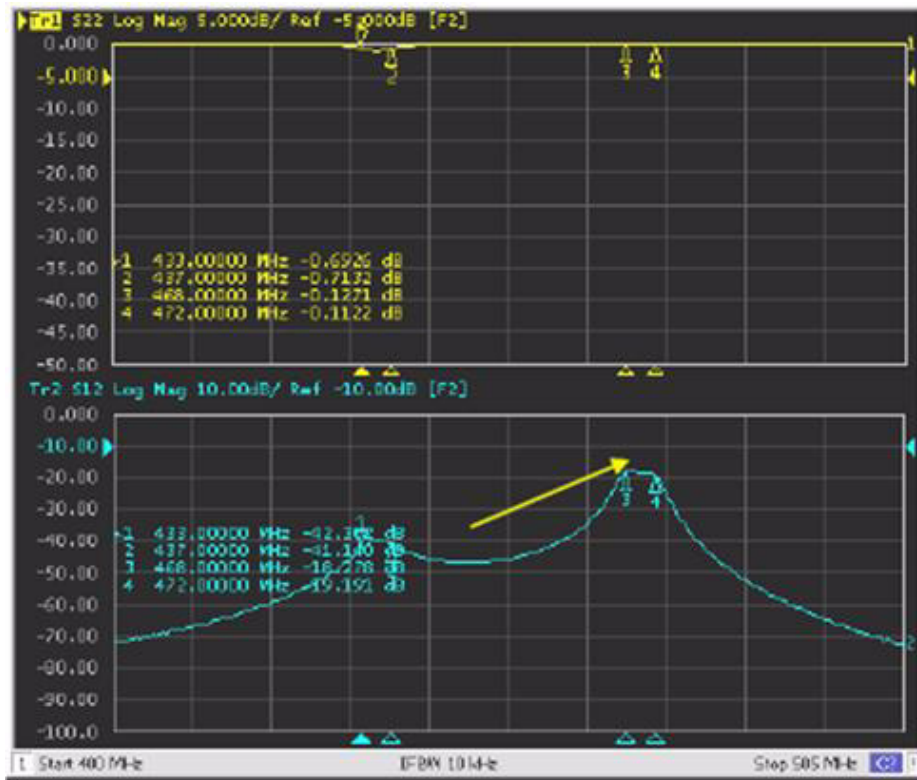


Figure 10-14 Passband tuned to required range (tuning screw 3)

- iv. Tune at screw 2 until the return loss curve dips in alignment with the passband similar to that shown in [Figure 10-15](#). This completes the Rough Tuning procedure.

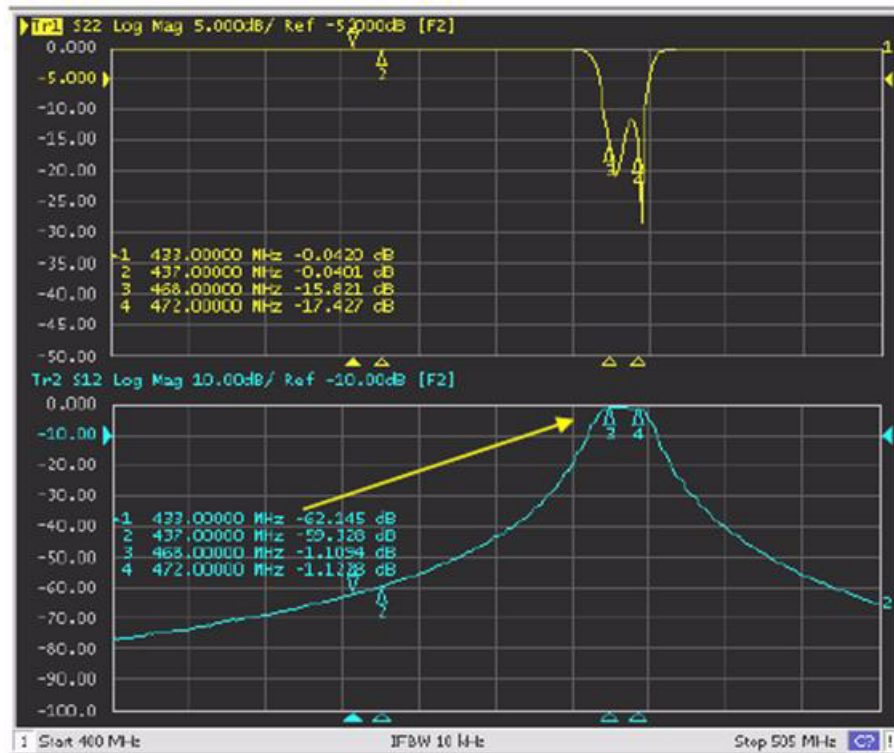


Figure 10-15 Passband tuned to required range (tuning screw 2)

- v. Tighten the three tuning nuts to approximately 1.0 Nm (10 in-lbs), until the tuning screws are not loose but still can be adjusted.

## c. Fine Tuning

- i. The 435–470 MHz band preselector is now roughly tuned to the required passband. See [Figure 10-16](#) and [Figure 10-17](#). The preselector performance will now be fine-tuned to specification-required frequencies and levels.

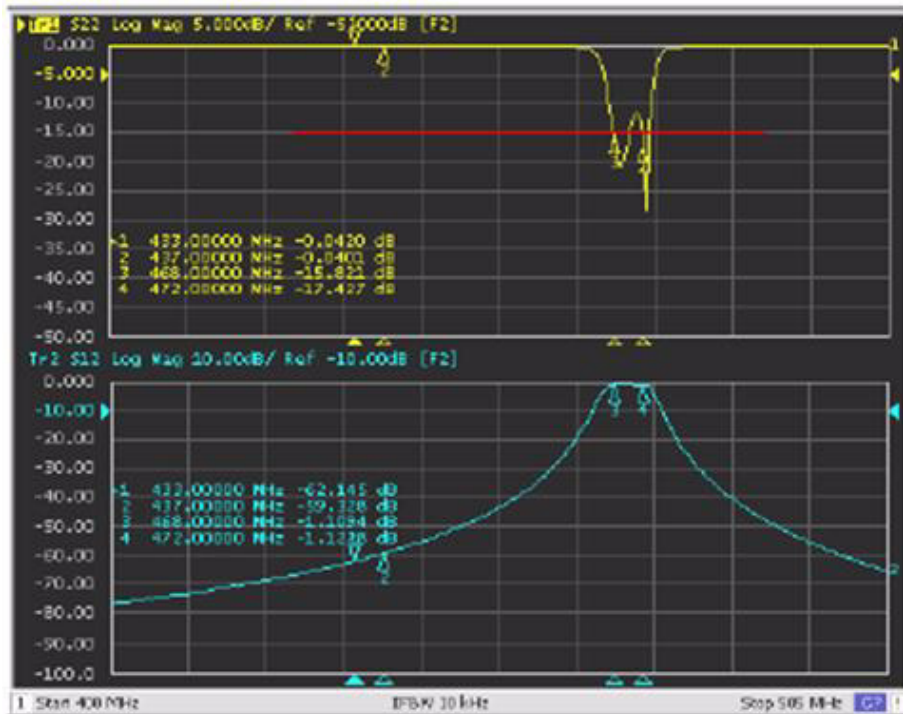


Figure 10-16 Passband and return loss after rough tuning



Figure 10-17 Return loss

- ii. In this process, make only small (less than  $10^\circ$ ) adjustments. Working with each of the tuning screws 2, 3, or 4 (one at a time), make slight adjustments in either direction while observing the return loss curve. For example, turning one of the screws clockwise may result in worse return loss such as shown in [Figure 10-18](#) or better as shown in [Figure 10-19](#).

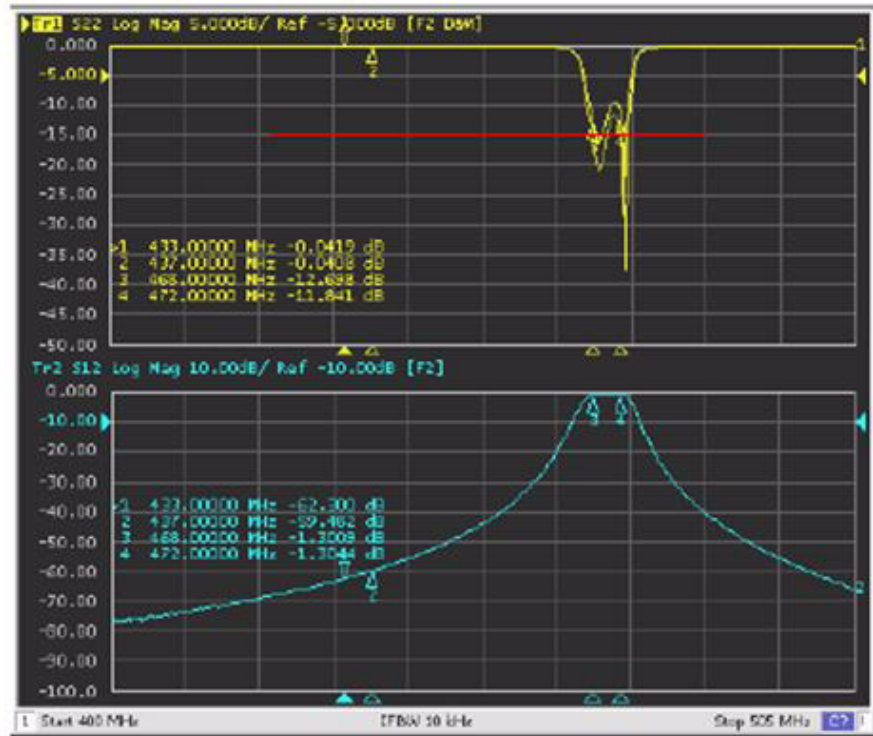


Figure 10-18 Turn screw clockwise

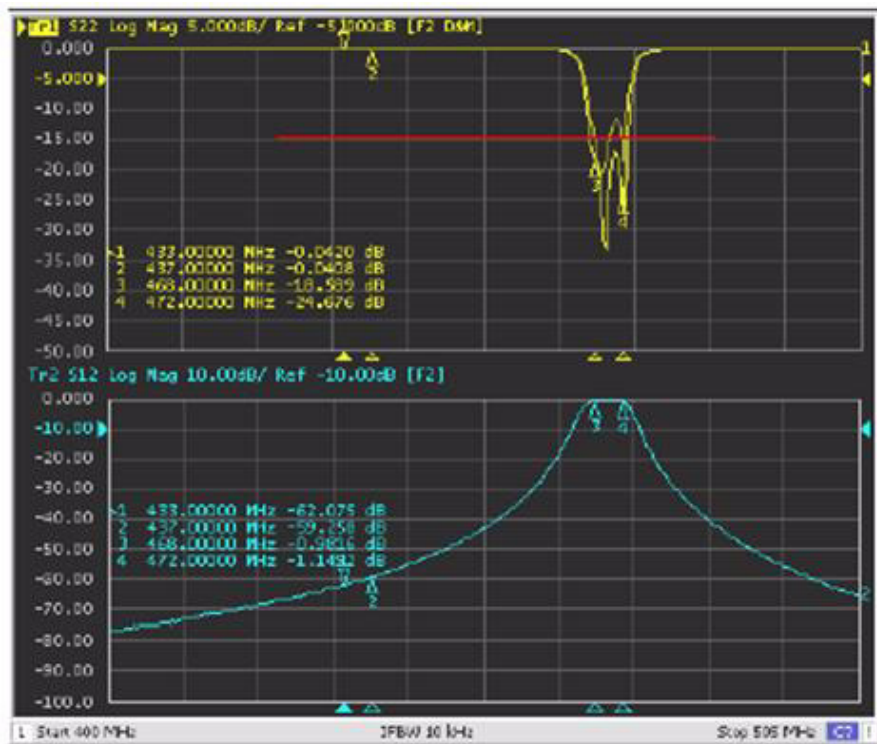


Figure 10-19 Turn screw counter clockwise

- iii. Continue this process of adjusting each of the screws one at a time by very small rotations until the optimized return loss performance is provided as shown in [Figure 10-20](#) where all of the return loss curve is well below the red limit line.

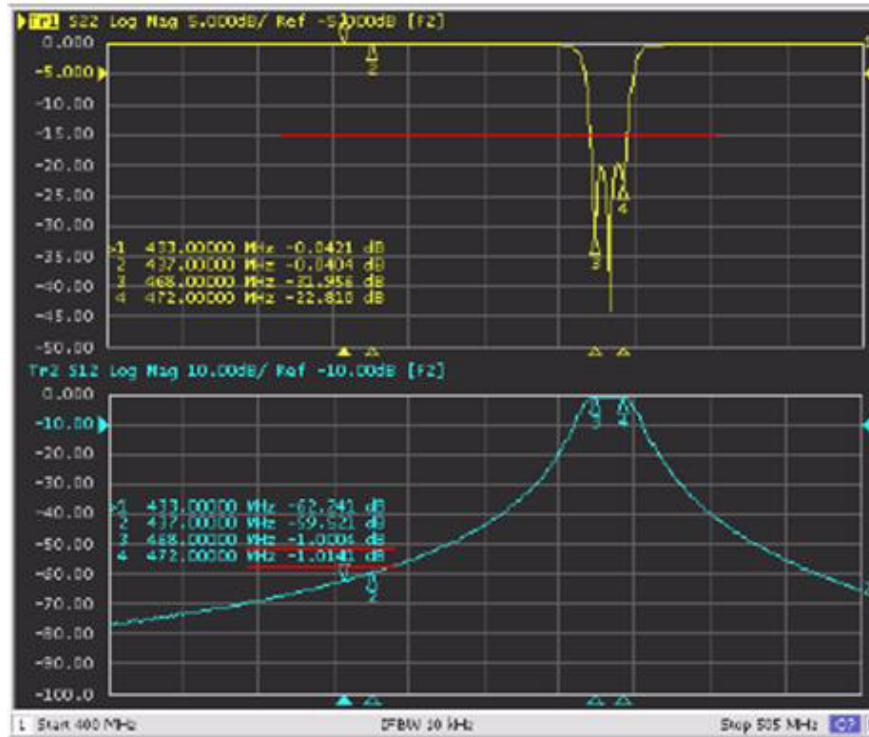


Figure 10-20 Result after fine tuning

3. Final Inspection
  - a. Inspect the final performance curves and parameter plot against the standard mask template needed to meet specifications. See [Figure 10-21](#).

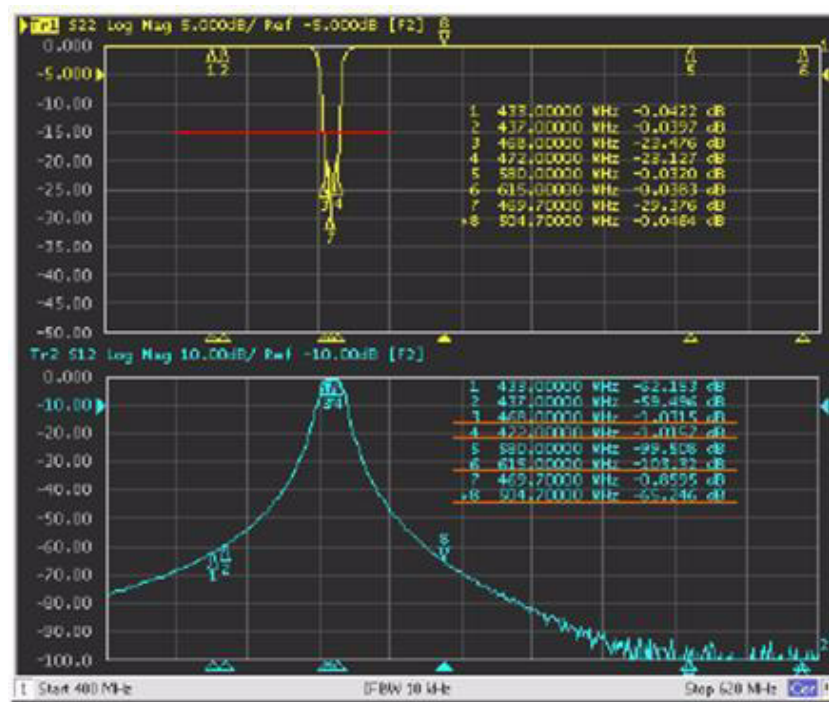


Figure 10-21 Inspect against mask template

- b. Tighten the tuning nuts to approximately 1.36 Nm (12 in-lbs), so the screws are secure. Make very slight adjustments at any of the screws to compensate for change tightening that screw causes.
4. Reassembly
    - a. Mount the preselector assembly in the Station, and reconnect the previously-removed cabling.


- Note**
- All instruments should be properly calibrated before operation.
  - All joints between cavity and instrument should be checked. Loose connections can greatly impact the tuning results.
  - Rejection meets specification requirements after passband and return loss are tuned, and it is needless to check one by one. However, the passband shall be tuned to the center frequency. In other words, insertion loss of two side frequencies of passband is approximate.
  - Lock the tension nut with proper torque force: 1.2 Nm~1.3 Nm. Excessive torque will lead to excessively tight locking (hard to tune) and inadequate to loose locking (tuning screw falling off)

## 10.5.2 Duplexer

Duplexer modules shipped with stations are tuned at the factory. If a duplexer must be replaced in the field, the unit must be installed and tuned specifically to the transmit and receive frequency pair for the particular base station/repeater.

The duplexer module is comprised of three low-pass/high-notch cavities and three high-pass/low-notch cavities. Each set of three cavities provides bandpass filtering for either the transmit RF signal or the receive RF signal. In general, the duplexer must be tuned so that the transmit cavity set passes the transmit signal and rejects the receive signal and, at the same time, the receive cavity set must be tuned to pass the receive signal and reject the transmit signal.

**Note** The 800 MHz duplexer module is fixed and does not require tuning.

 <b>Caution</b>	This tuning procedure is valid for channels with a bandwidth of 200 kHz or less. If the bandwidth is more than 200 kHz, the duplexer must be tuned by the service depot.
---	--

Tuning is performed by injecting RF signals and making tuning adjustments (using the tuning pass and notch and trimmer screws) while monitoring for maximum or minimum readings on the RF millivoltmeter. Field tuning the duplexer module requires the following general adjustments:

- Tune high-pass/low-notch cavities for maximum pass and reject response
- Tune low-pass/high-notch cavities for maximum pass and reject response
- Check high-pass/low-notch and low-pass/high-notch cavities for insertion loss
- Check high-pass/low-notch and low-pass/high-notch cavities for isolation

### 10.5.2.1 Duplexer Tuning Procedure (with basic instruments)

#### 10.5.2.1.1 Test Equipment

The following test equipment are required to properly tune the duplexer module:

- Aeroflex 3900 Series Communications System Analyzer (or equivalent)
- RF Millivoltmeter (Boonton 92E or equivalent)
- RF Signal Generator (HP8565B or equivalent)
- 50  $\Omega$  N-type terminator
- Tuning tool; 4 mm x 10.1 cm (5/32" x 4") screwdriver
- N-to-N bullet connector (UG29A/U or equivalent)
- 11 mm (7/16") Nutdriver
- 11 mm (7/16") Open End Wrench
- N-to-BNC Adapter (UG349A/U)
- N-to-N Connector (UG57B/U)



10.5.2.1.2 Setting Up for Tuning Duplexer

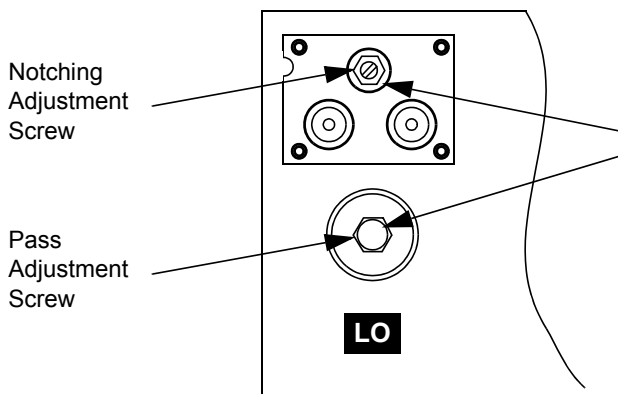
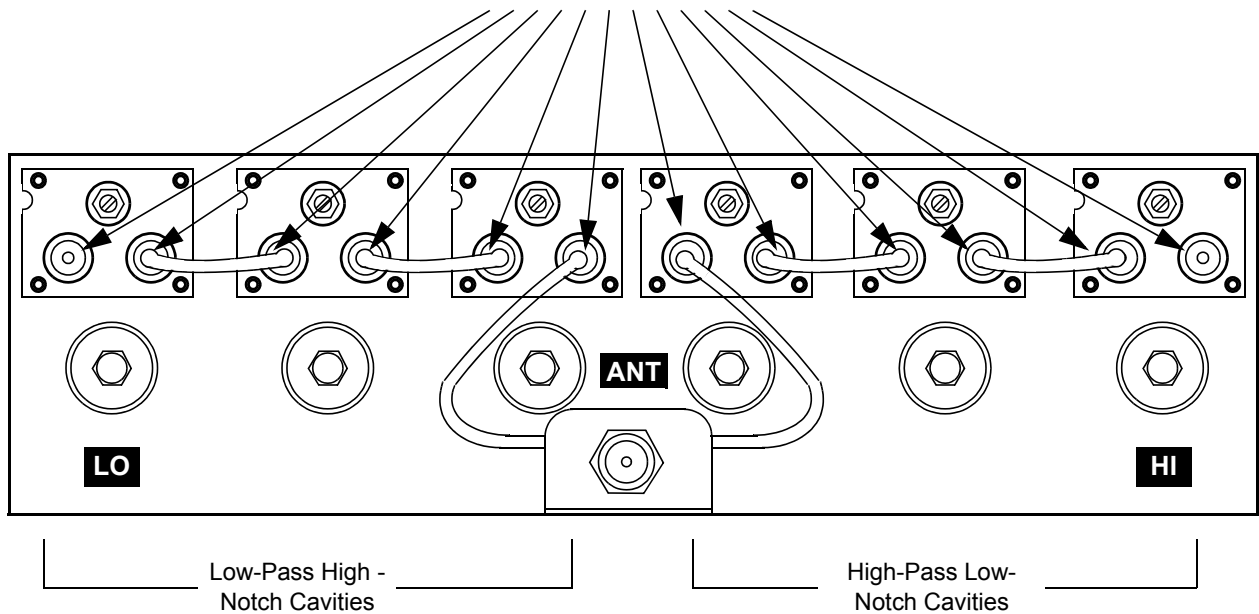
Perform the preliminary tasks shown in [Figure 10-22](#) to prepare the duplexer module for tuning.



Caution

Each Duplexer cable is unique and **must** be returned to the original position when removed. Use tape to label each end of each cable to ensure it is correctly replaced.

1. Disconnect twelve N-type connectors and remove six cables from cavities.



2. For each of the 6 cavities, use open-end wrench to loosen locknuts (2 per cavity).

Figure 10-22 Preliminary Tasks Prior to Tuning Duplexer

#### 10.5.2.1.3 Duplexer Tuning Procedure

The duplexer field tuning procedures are provided in [Figure 10-23](#) to [Figure 10-26](#). The procedures are most easily performed with the duplexer module removed from the base station/repeater rack or cabinet. Be sure to take note of the transmit and receive frequencies for the particular base station/repeater before beginning.

If the duplexer module is tuned according to instructions and does not meet specifications for return loss, insertion loss, and/or isolation, return the duplexer for repair.

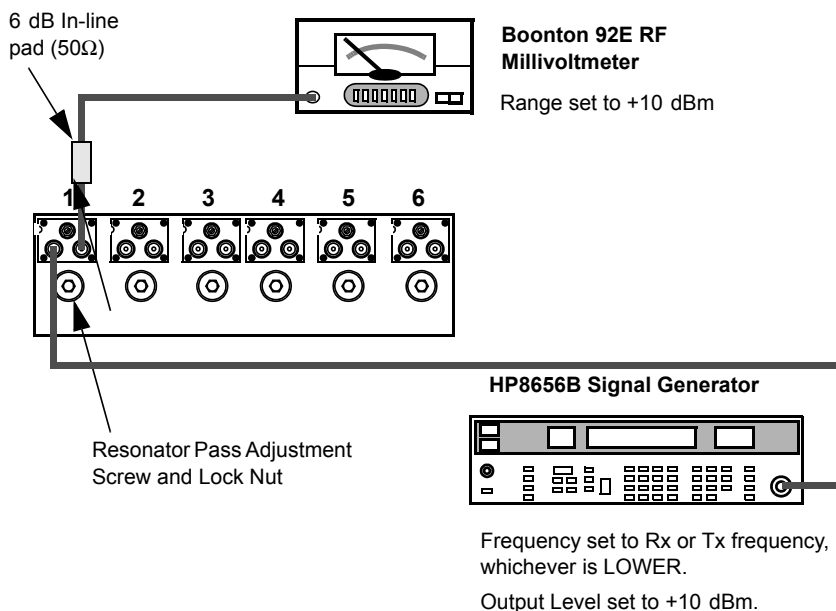
The notch (reject) frequency will maintain its spacing to the pass frequency when the pass adjustment of a cavity is moved several MHz. For example, a system operating at 455 MHz and 460 MHz, which is moved to 460 MHz and 465 MHz will require a minimum of readjustment if the pass adjustment is made first. It is therefore recommended that the pass adjustments be made first and that the procedures provided in [Figure 10-23](#) to [Figure 10-26](#) are followed.

## 1. To Start

Remove cables from the duplexer, noting and label the position of each cable. Each cable is unique and must be returned to the original position when tuning is complete.

## 2. Tuning Low Pass Resonators

1. Set up test equipment as shown, connecting to cavity no.1.
2. Use nut driver to adjust pass adjustment screw for cavity no.1 to obtain a peak reading on the millivoltmeter.
3. Use open end wrench and tighten lock nut carefully, making sure pass adjustment screw does not shift position.
4. Repeat steps 1–3 for cavities no.2 and no.3.



## 3. Tuning High Pass Resonators

1. Set up test equipment as shown, connecting to cavity no.4.
2. Use nut driver to adjust pass adjustment screw for cavity no.4 to obtain a **PEAK** reading on the millivoltmeter.
3. Use open end wrench and tighten lock nut carefully, making sure pass adjustment screw does not shift position.
4. Repeat steps 1–3 for cavities no.5 and no.6.

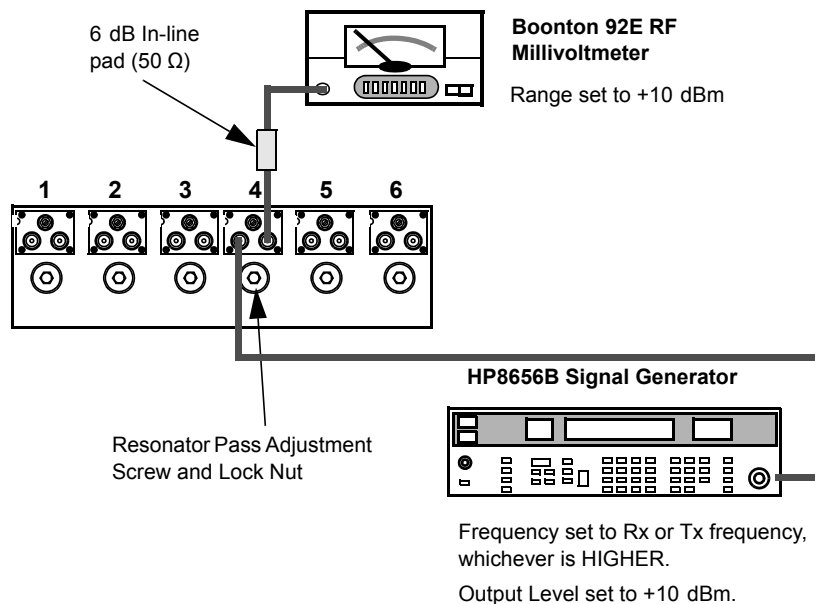
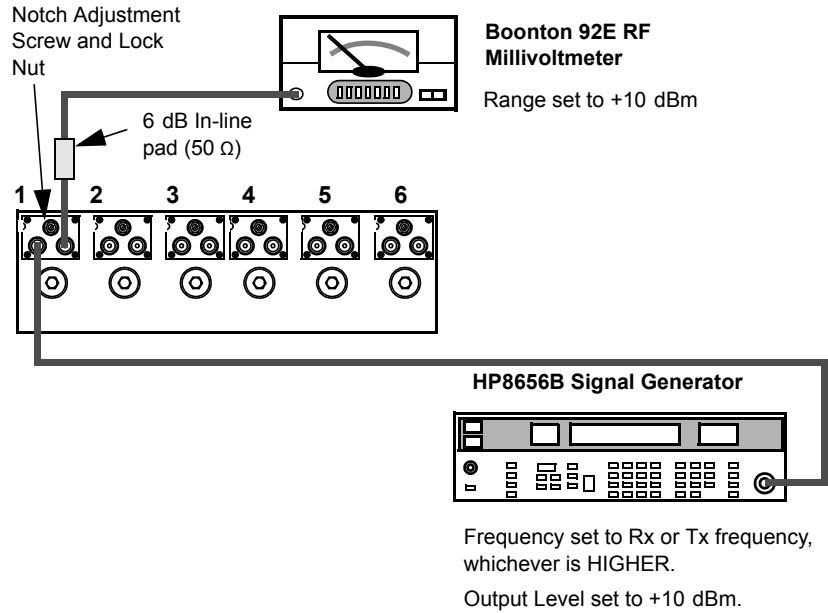


Figure 10-23 UHF Duplexer Field Tuning Procedure

## 4. Tuning High Notch Loop Assemblies

1. Set up test equipment as shown, connecting to cavity no.1.
2. Use screwdriver to adjust notch adjustment screw for cavity no.1 to obtain a minimum reading on the millivoltmeter. (Reduce the range on the millivoltmeter as necessary to reach true minimum reading.)
3. Use open end wrench and tighten lock nut carefully, making sure notch adjustment screw does not shift position.
4. Repeat steps 1–3 for cavities no.2 and no.3.



## 5. Tuning Low Notch Loop Assemblies

1. Set up test equipment as shown, connecting to cavity no.4.
2. Use screwdriver to adjust notch adjustment screw for cavity no.4 to obtain a minimum reading on the millivoltmeter. (Reduce the range on the millivoltmeter as necessary to reach true minimum reading.)
3. Use open end wrench and tighten lock nut carefully, making sure notch adjustment screw does not shift position.
4. Repeat steps 1–3 for cavities no.5 and no.6.
5. Reconnect the cables on the duplexer. Make sure that the cables are returned to their original position on the Duplexer.

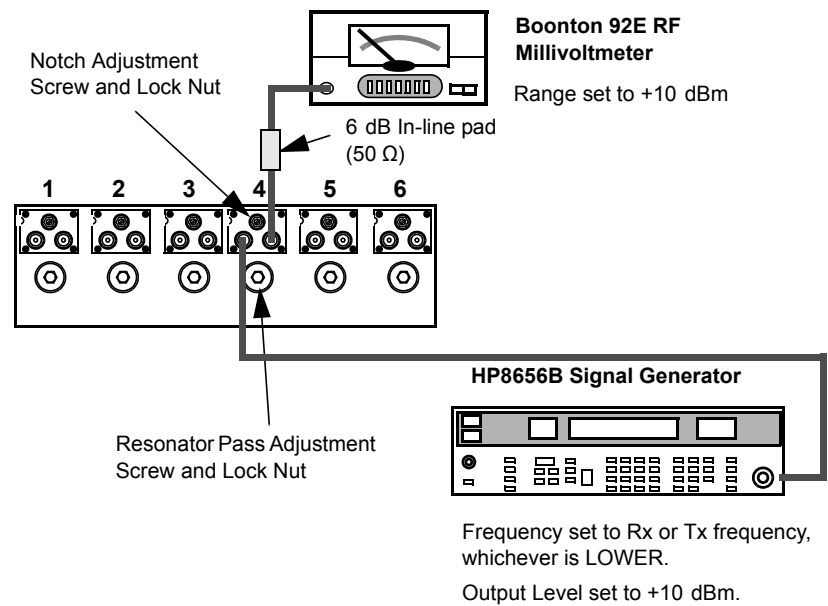
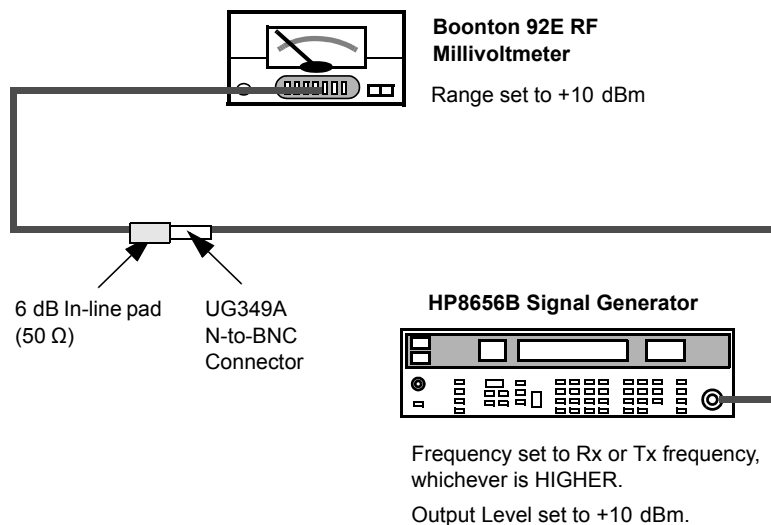


Figure 10-24 UHF Duplexer Field Tuning Procedure (continued)

## 6. Verifying Insertion Loss

1. Connect test equipment as shown.
2. Observe and note the level in dBm as shown on the millivoltmeter.



3. Connect the duplexer cables and test equipment to the duplexer as shown.
4. Observe and note the level in dBm as shown on the millivoltmeter.
5. Subtract the absolute number noted in Step 2 from the number noted in Step 4. The difference should be less than 1.3 dB to meet specification for Insertion Loss.
6. Repeat Steps 1–5 for Low- Pass/ High Notch cavities with the following exceptions:
  - a. Set Frequency Generator for Rx or Tx frequency, whichever is LOWER
  - b. Connect Signal Generator to Low Pass duplexer input (cavity no.1)
  - c. Connect terminator to cavity no.6.

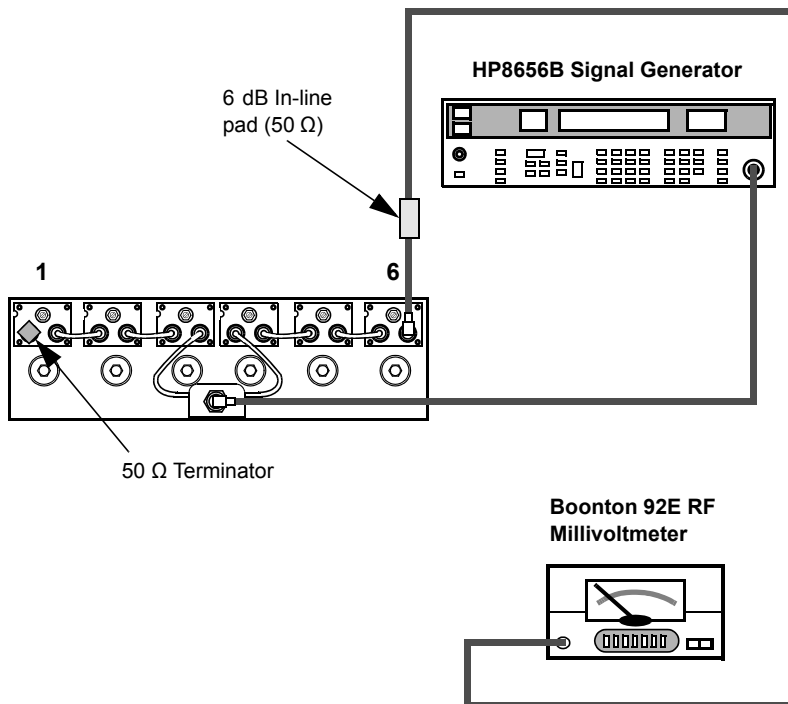
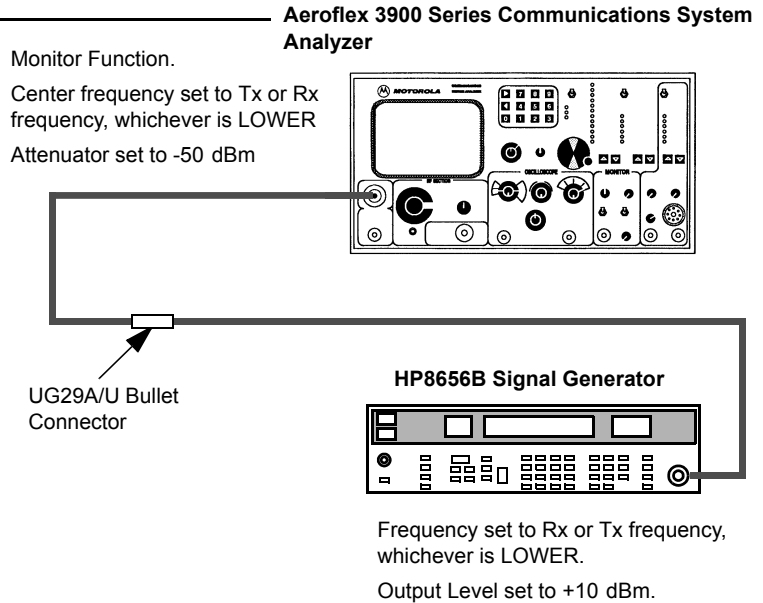


Figure 10-25 UHF Duplexer Field Tuning Procedure (continued)

## 7. Verifying Isolation

1. Connect test equipment as shown.
2. Observe and note the level in dBm as shown on the Aeroflex 3900 Series Communications System Analyzer display.



3. Connect the test equipment to the duplexer as shown.
4. Observe and note the level in dBm as shown on the Aeroflex 3900 Series Communications System Analyzer display. (If no number is displayed, consider isolation to be greater than 105 dB, which exceeds the specification.)
5. Subtract the absolute number noted in Step 4 from the number noted in Step 2. The difference should be higher than 100 dB to meet specification for Isolation.
6. Repeat Steps 1–5 for Low-Pass/High Notch cavities with the following exceptions:
  - a. Set Frequency Generator and Aeroflex 3900 Series Communications System Analyzer for Rx or Tx frequency, whichever is HIGHER
  - b. Connect Signal Generator to Low Pass duplexer input (cavity no.1)
  - c. Connect terminator to cavity no.6.

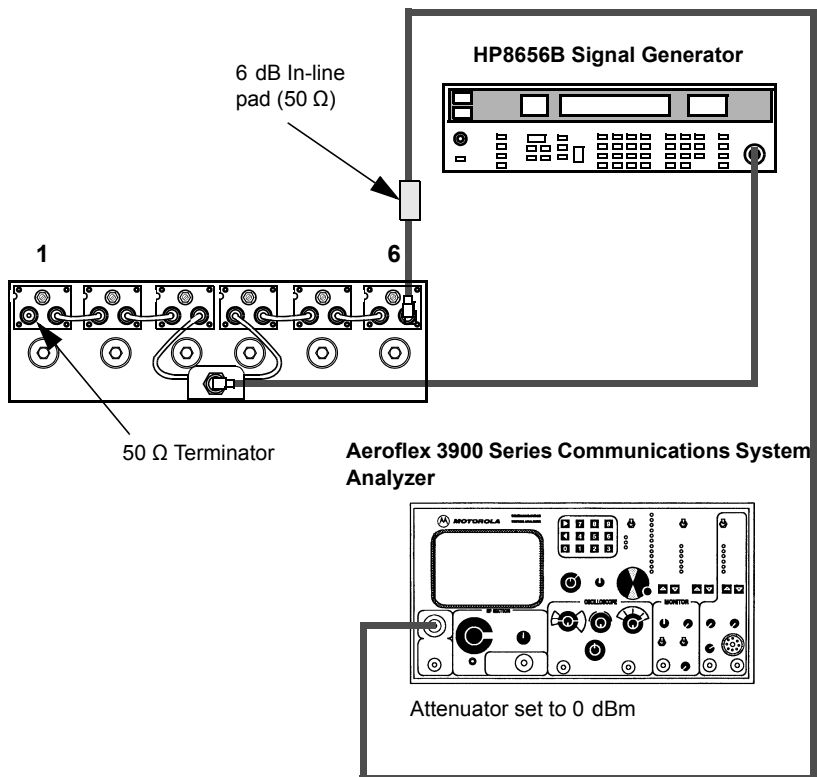


Figure 10-26 UHF Duplexer Field Tuning Procedure (continued)

## 8. Post-Tuning Checks

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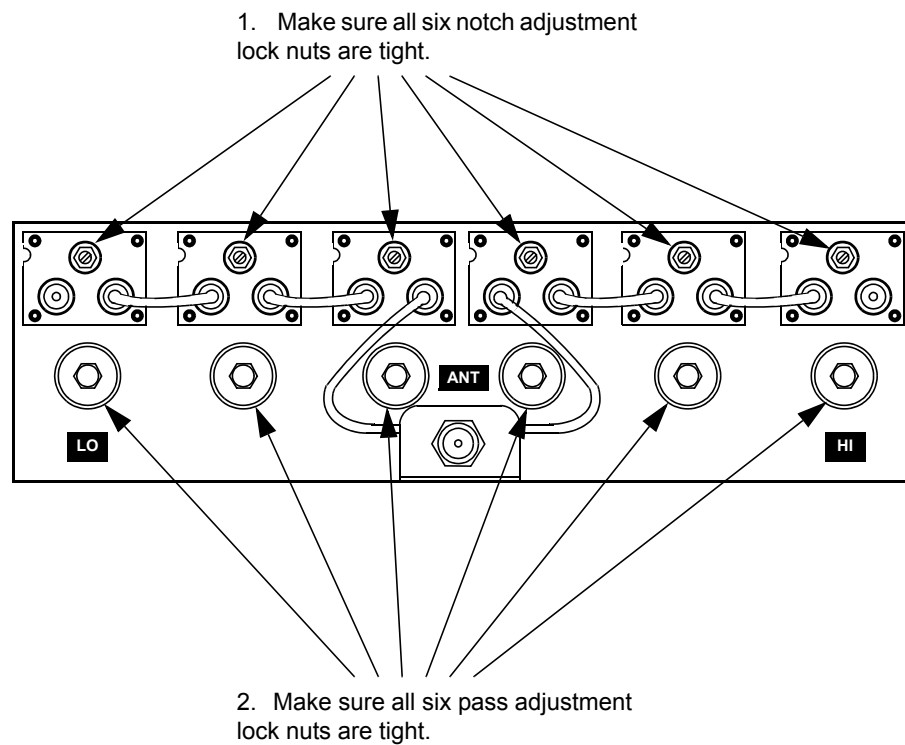


Figure 10-27 UHF Duplexer Field Tuning Procedure (continued)

This completes the Duplexer Tuning Procedure (with basic instruments). To obtain a more precise calibration, see [Section 10.5.2.2](#) to perform the Duplexer Tuning Procedure (with advanced instruments).

### 10.5.2.2 Duplexer Tuning Procedure (with advanced instruments)

#### 10.5.2.2.1 Initial Settings

1. Power up the Network Analyzer (NWA), HP 8753C or equivalent. Based on whether it is VHF (U01, U02, U03) or UHF (U04, U05, U06, U07), the NWA has to be calibrated to the appropriate frequency sub-bands. See [Table 10-13](#).


Table 10-13 Frequency Range (U01, U02, U03, U04, U05, U06, U07)

	Frequency
U01	136–146 MHz
U02	144–160 MHz
U03	158–174 MHz
U04	403–435 MHz
U05	435–470 MHz
U06	470–494 MHz
U07	494–512 MHz

2. If the unit to be tuned is one of the VHF sub-bands, unscrew all the tuning screw caps (two each for the LO side cavities, and one each for the HI side cavities). Use a torque wrench to loosen the screws by the side of the tuning rods.
3. Adjust the NWA START frequency, STOP frequency, SPAN etc., based on the LO and HI frequencies which has to be tuned on the unit. Set the NWA source power to 10 dBm.

#### 10.5.2.2.2 Tuning the LO side

**Note** Please note that the duplexer tuning procedures from [Section 10.5.2.2.2](#) to [Section 10.5.2.2.4](#) are applicable to UHF and VHF bands although the test frequencies represented in the figures below are for VHF bands.



Caution

Each Duplexer cable is unique and **must** be returned to the original position when removed. Use tape to label each end of each cable to ensure it is correctly replaced.

1. **For UHF units:** Connect the two N-type test cables hooked up on ports 1 and 2 of the NWA to the two N type female connectors of LO side Cavity 1. Set up markers on the NWA-Marker 1 (m1) to LO frequency on CH1 (S11–Reflection) and Marker 2 (m2) to HI frequency on CH2 (S21–Transmission).  
**For VHF units:** Connect the two N-type NWA test cables hooked up on the ports 1, 2 to a T and connect it to LO Cavity 1. Set up markers on the NWA-Marker 1 (m1) to LO Frequency on CH1 (S11–Reflection) and Marker 2 (m2) to HI Frequency on CH2 (S21–Transmission).

Initial NWA display may be similar to [Figure 10-28](#). Here the unit that is being tuned is a VHF unit, and the LO freq: 144 MHz, HI freq: 145.5 MHz.



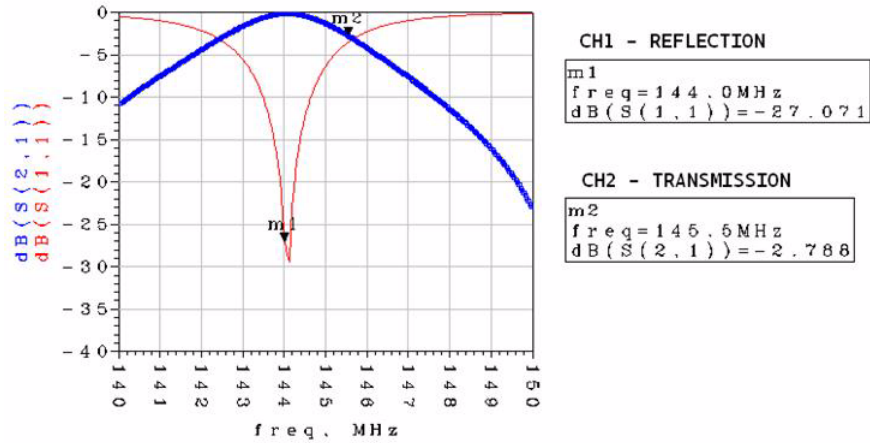


Figure 10-28 Untuned LO SIDE-Cavity 1

- Turn the notch screw until Marker 1 falls in the dip of the CH1 curve as shown in Figure 10-29. Lightly tighten the locknut in place to prevent further movement.

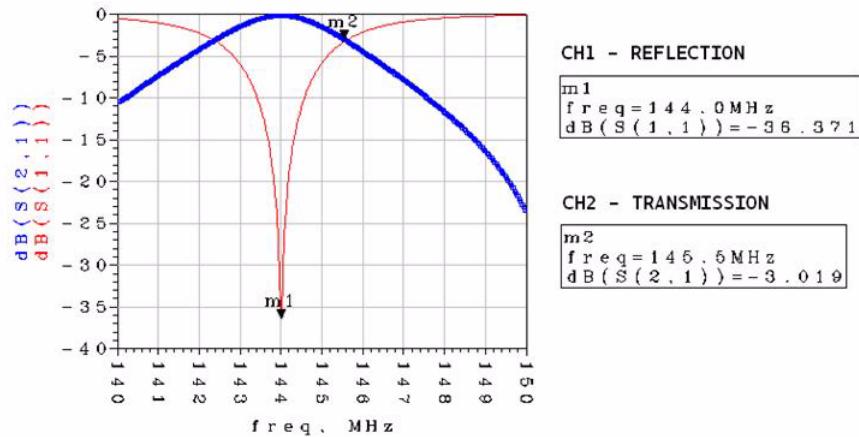


Figure 10-29 Tuned CH1 - LO SIDE-Cavity 1

- Turn the pass screw until Marker 2 falls in the dip of the CH2 curve as shown in Figure 10-30. Lightly tighten the locknut in place to prevent further movement.

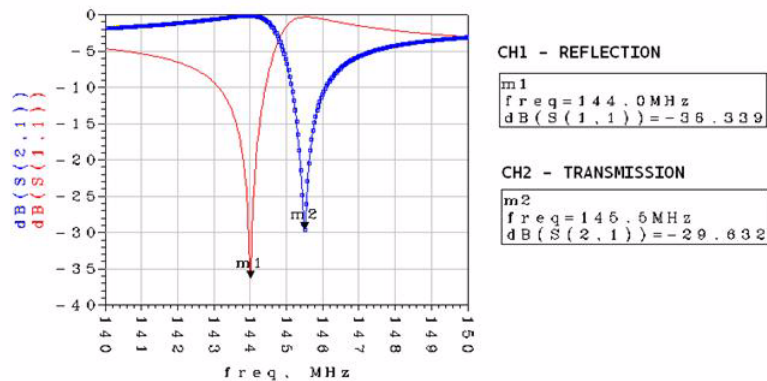


Figure 10-30 Tuned CH1, CH2 - LO SIDE-Cavity 1

- Do not change the settings on the network analyzer, just repeat Step 1, 2, and 3 for the other LO cavities 2 and 3 on the left.

10.5.2.2.3 Tuning the HI side

- For UHF units:** Connect the two N-type test cables hooked up on the ports 1,2 of the NWA to the two N type female connectors of HI cavity 4. Set up markers on the NWA-Marker 1 to HI Frequency on CH2 (S21–Transmission) and Marker 2 to LO Frequency on CH1 (S22–Reflection).

**For VHF units:** Connect the two N-type NWA test cables hooked up on the ports 1, 2 to a T and connect it to HI cavity 4. Set up markers on the NWA-Marker 1 to HI Frequency on CH2 (S21–Transmission) and Marker 2 to LO Frequency on CH1 (S22–Reflection).

Initial NWA display may be similar to [Figure 10-31](#). Here the unit that is being tuned is a VHF unit and the LO freq: 144 MHz, HI freq: 145.5 MHz.

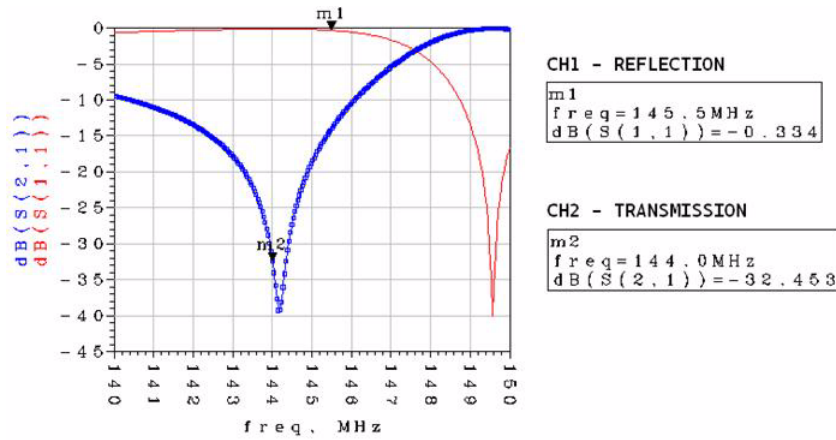


Figure 10-31 Untuned HI SIDE–Cavity 4

- Turn the notch screw until Marker 1 falls in the dip of the CH1 curve as shown in [Figure 10-32](#). Lightly tighten the locknut in place to prevent further movement.

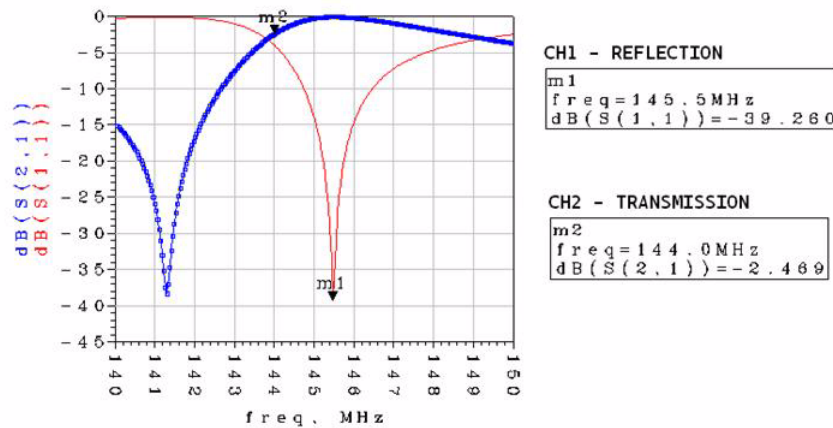


Figure 10-32 Tuned CH1 - HI SIDE–Cavity 4

3. Turn the pass screw until Marker 2 falls in the dip of the CH2 curve as shown in [Figure 10-33](#). Lightly tighten the locknut in place to prevent further movement.

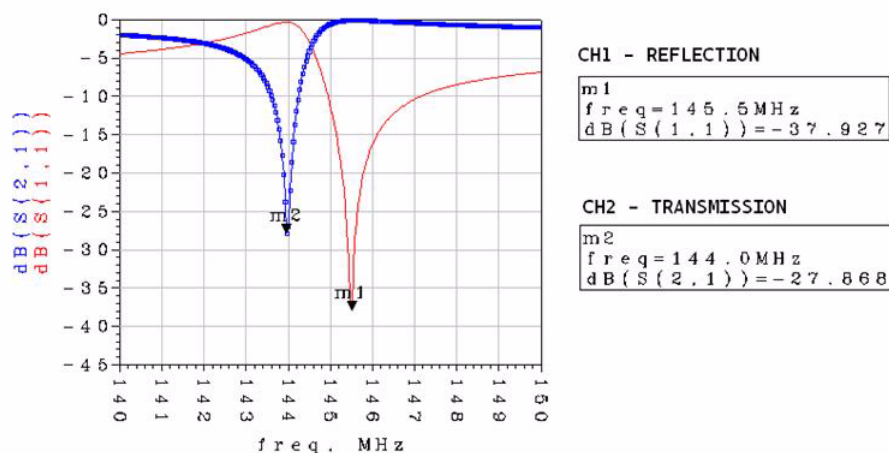


Figure 10-33 Tuned CH1, CH2 - HI SIDE-Cavity 4

4. Do not change the settings on the network analyzer, just repeat Step 5, 6, and 7 for the other HI cavities 5 and 6 on the right.

#### 10.5.2.2.4 Fine Tuning the Duplexer

1. When all 6 cavities have been tuned separately, connect the Port 1 NWA cable to the N connector of the LO side input cavity (cavity 1) and the Port 2 of NWA to the duplexer Antenna port (ANT) respectively.
  - a. Connect ports 1 and 2 of the NWA to the LO input side (far left) and ANT, respectively. The desired response on the NWA for m1 (return loss), m2 (insertion loss), and m3 (noise suppression) is as shown in [Figure 10-34](#).

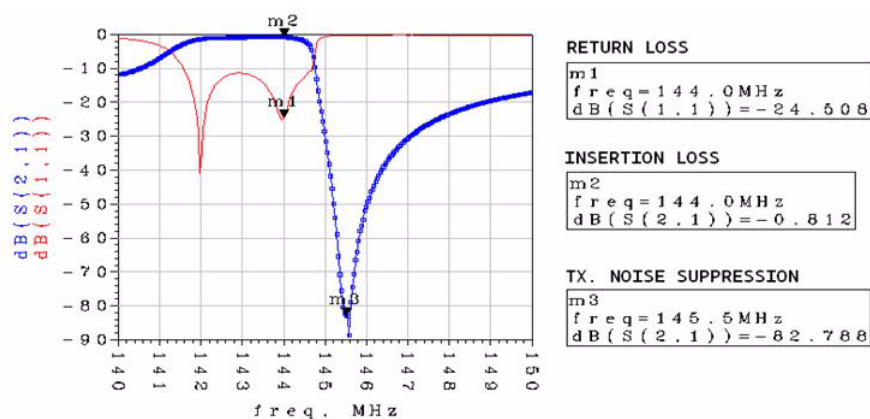


Figure 10-34 LO Side Response Curves

- b. Now connect ports 1 and 2 of the NWA to the ANT and the HI input side (far right), respectively. The desired response on the NWA for the m1 (return loss), m2 (insertion loss), and the m3 (noise suppression) markers is as shown in [Figure 10-35](#).

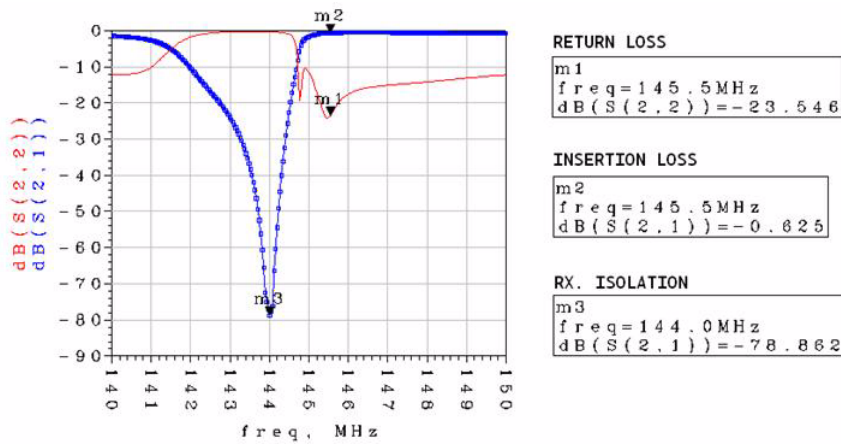


Figure 10-35 HI Side Response Curves

2. If all the specification limits are met with some margin, stop tuning the unit any further. With caution, fine tuning of the tuning notch and pass, and tuning screws can be done to improve the performance further in cases where the response seems to be marginal. This is more significant in cases where the T/R spacing is 1.5 MHz or lower. For the sample shown, fine tuning was done to improve the performance slightly, as shown by comparing Figure 10-34 to Figure 10-36 and Figure 10-35 to Figure 10-37.

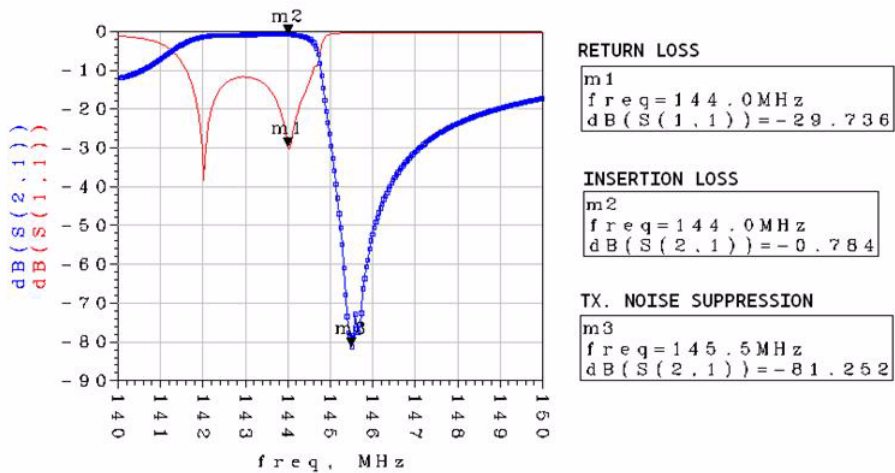


Figure 10-36 After Fine Tuning-LO Side Response Curves

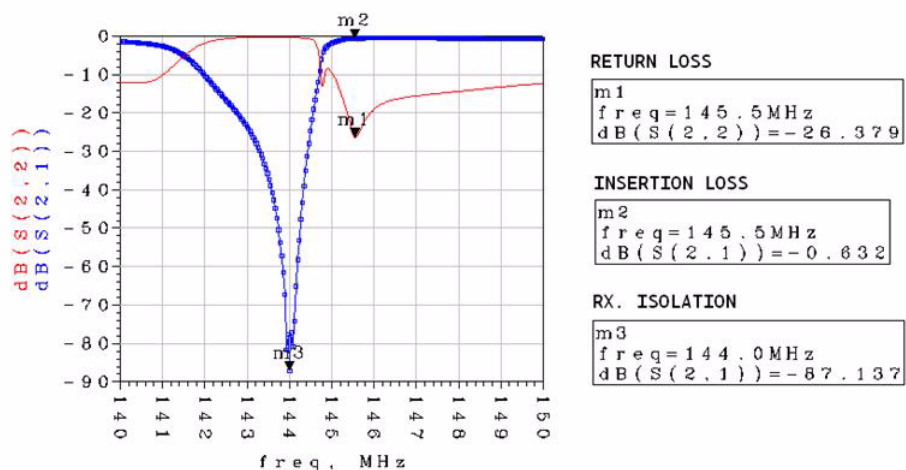


Figure 10-37 After Fine Tuning—HI Side Response Curves

3. See Figure 10-38 for the post-tuning checks.

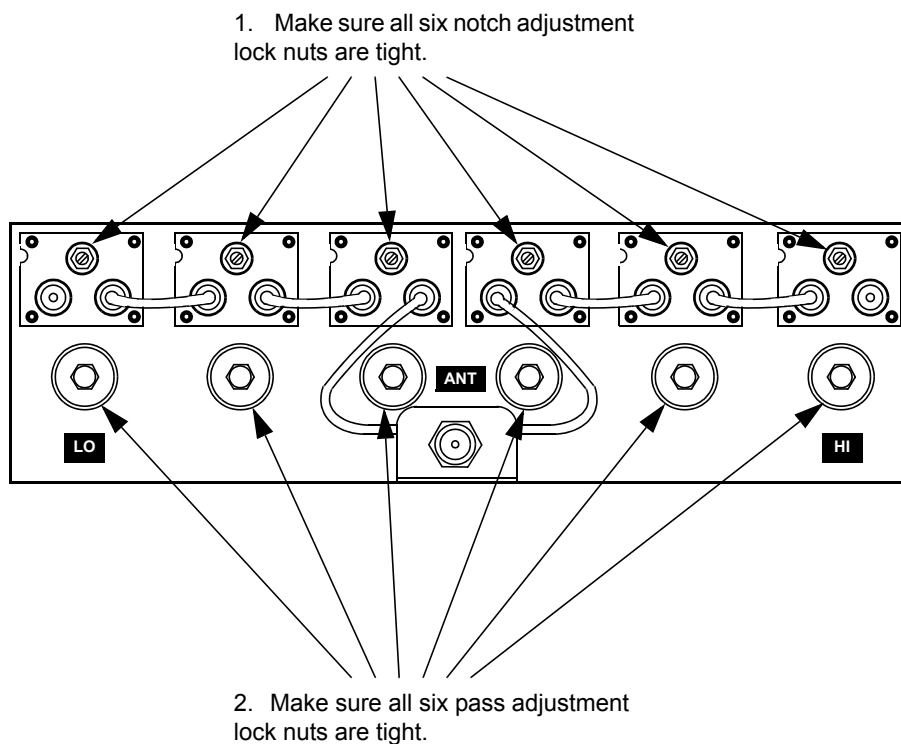


Figure 10-38 UHF Duplexer Field Tuning Procedure (continued)

This completes the Duplexer Tuning Procedure (with advanced instruments).

## Notes

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# Chapter 11 MTR2000 MOTOTRBO Digital Upgrade

## 11.1 Overview

The MTR3000 platform supports a digital upgrade kit which allows fielded analog MTR2000 radios to be upgraded for enhanced system capability. The T2003 digital upgrade kit upgrades the station control module (SCM), Receiver, and Exciter modules in order to migrate the radio to a digital MOTOTRBO product. These modules are not assembled together when it is shipped. Rather, the T2003 digital upgrade kit is installed and optimized on site by authorized service personnel only.

An "upgraded base station/repeater" is comprised of a new front bezel, new Exciter module, new Receiver module, new SCM module, and utilizing the remaining components from the MTR2000 Base Station/Repeater (BR). Existing peripherals that are being utilized for the MTR2000 Base Station/Repeater can retrofit the MTR3000 Base Station/Repeater once it is upgraded. There is no need to purchase a new Duplexer, Preselector, External Dual Circulator or Antenna Relay.

The MTR2000 MOTOTRBO Digital Upgrade allows a MTR2000 customer to migrate from analog to digital. The available digital systems are:

- MOTOTRBO (2 slot TDMA digital over the air DMR standard)
- Capacity Plus
- IP Site Connect

The features that are upgradeable from MTR2000 are:

- Air Interface/Conventional – Analog Conventional
- Station Operation – Base Station Analog, Repeater Analog
- Channel Configuration – Half Duplex, Full Duplex
- Air Interface/Trunked – Analog Trunking (LTR and Passport)
- Frequency
  - Rx/Tx : 136–174 MHz (VHF)
  - Rx/Tx : 403–470 MHz (UHF)
  - Rx : 806–825 MHz (800 MHz), 896–902 MHz (900 MHz)
  - Tx : 851–870 MHz (800 MHz), 935–941 MHz (900 MHz)
- Transmitter Capability
  - VHF : 30 W (low power), 40 W (low power) or 100 W (high power)
  - UHF : 30 W (low power), 40 W (low power) or 100 W (high power)
  - 800/900 MHz : 75 W
- Hardware Peripheral Compatibility – Preselector, Duplexer, External Dual Circulator Tray, Antenna Relay, External Frequency Reference, Angus Battery Charger

The information below is an overview for installing the base station/repeater and ancillary equipment.

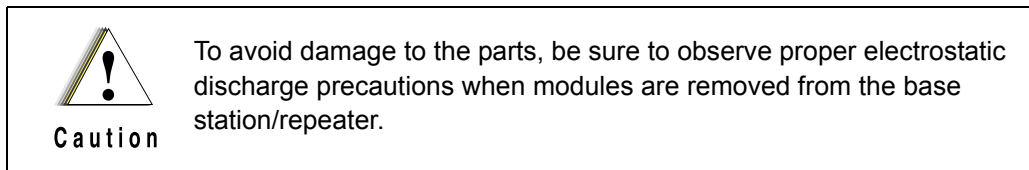
- Unpacking and inspecting the equipment
- Mechanically install the equipment at the site
- Make necessary electrical and cabling connections:
  - Audio
  - GPIO
  - Ethernet
- Perform Alignment
- Perform Configuration
- Perform a post-install functional checkout test to verify installation

**Note** For the correct procedure in handling static-sensitive parts, see [Section 15.4](#).

**Note** Once the upgrade is performed, the Wireline and Auxiliary I/O board functionality will no longer be supported.

## 11.2 Unpacking

This section describes the procedures to unpack the new front bezel, new SCM module, new Exciter and Receiver modules from the packaging prior to installing them.



### 11.2.1 Equipment Unpacking and Inspection

#### 11.2.1.1 Introduction

The new front bezel, new Exciter module, new Receiver module and new SCM module may be shipped by either air freight or electronic van (as specified by customer), except where noted.

Thoroughly inspect the equipment as soon as possible after delivery. If any part of the equipment is damaged during transit, immediately report the extent of the damage to the transportation company and to Motorola.

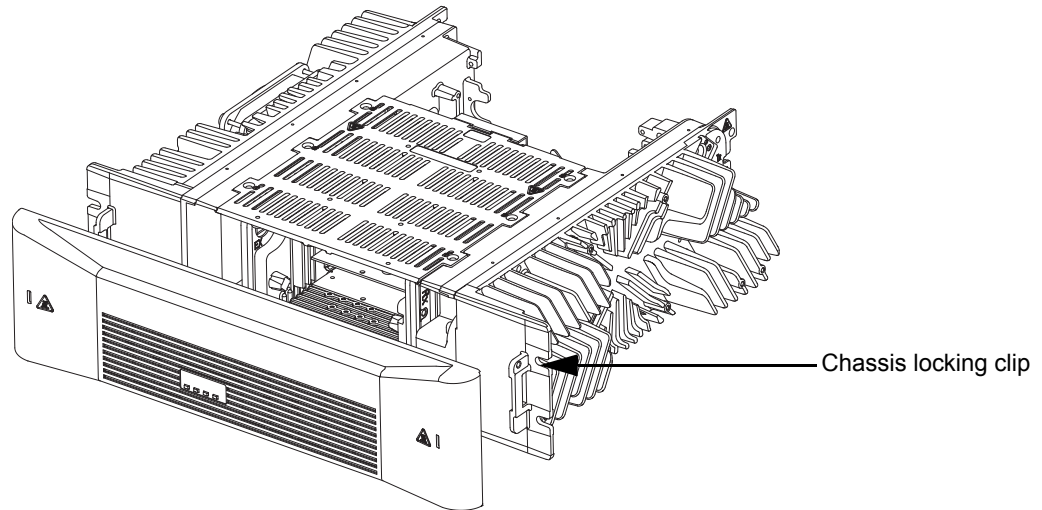
#### 11.2.1.2 Unpacking Equipment

The new front bezel, new Exciter Module, new Receiver Module and new Station Control Module are packed in four separate boxes which are packed together in a common box. The individual boxes are cushioned between corrugated cardboard in a common box.



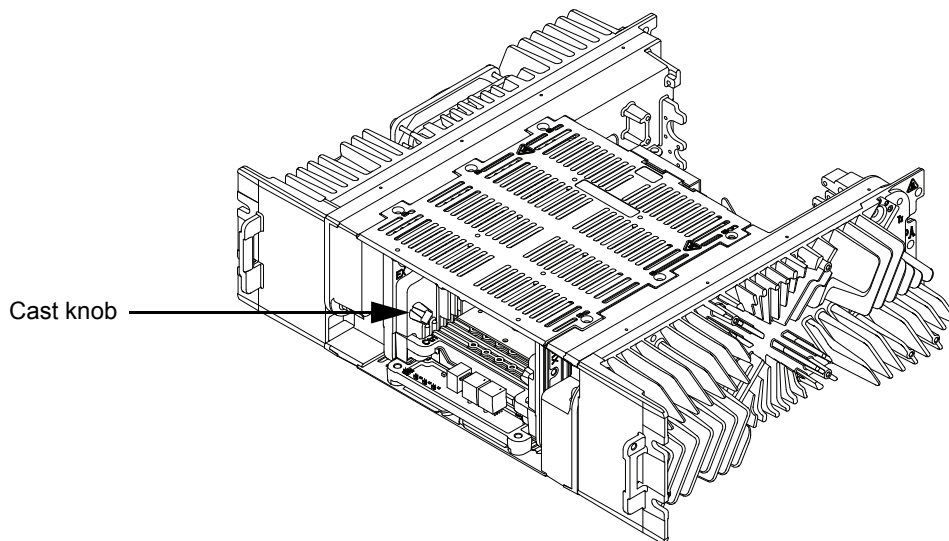
### 11.2.1.3 Analog to Digital Migration Path – Removal and Replacement

1. Remove the MTR2000 Base Station/Repeater front bezel from its chassis locking clip by carefully pulling the bezel forward (See [Figure 11-1](#)).



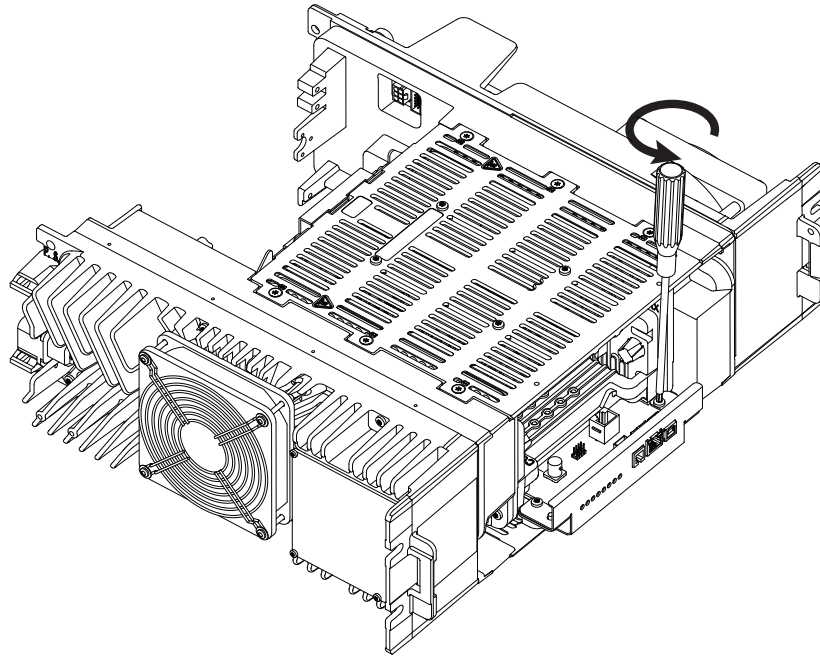
*Figure 11-1 Removing Front Bezel*

2. Disconnect the Exciter-to-PA Coaxial Cable and Rx Input Cable (See [Figure 11-2](#)). By disconnecting the cables, the Exciter Module, Receiver Module, Station Control Module (SCM) are accessible.



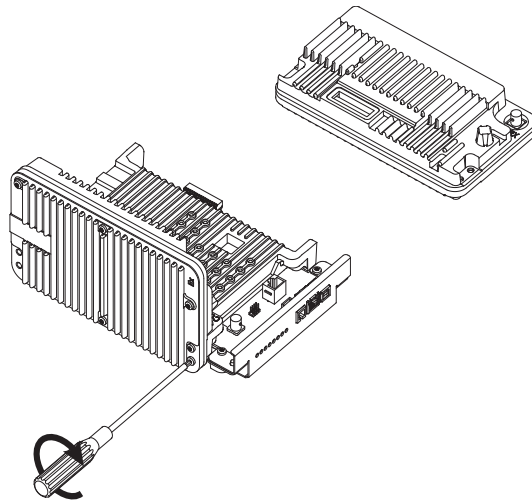
*Figure 11-2 Removing RF cable*

3. Remove the two screws securing the Transceiver (SCM, Exciter, and Receiver modules) to the bottom plate. Pull forward on the cast knobs, carefully slide the assembly out of the base station/repeater (See [Figure 11-3](#)) and place it aside.



*Figure 11-3 Removing two screws securing the Transceiver Assembly*

4. Remove the Wireline and Auxiliary I/O Card(s) (if any are installed) as the card(s) will not be supported in an upgraded MTR2000.
5. Secure the new Station Control Module (SCM), Exciter and Receiver Modules using the eight screws (See [Figure 11-4](#)) supplied with the MTR2000 MOTOTRBO Digital Upgrade kit to form the new Transceiver Assembly.



*Figure 11-4 Putting together new SCM, Exciter and Receiver*

6. Slide the new Transceiver Assembly into the MTR2000 Base Station/Repeater (along the guide rails) to mate with the connector on the backplane interface board.

7. Secure the Transceiver Assembly to the bottom plate by fastening the screws in Step 3 (See [Figure 11-3](#)).
8. Affix the provided T2003 Digital Upgrade Kit label to the area noted in [Figure 11-5](#).

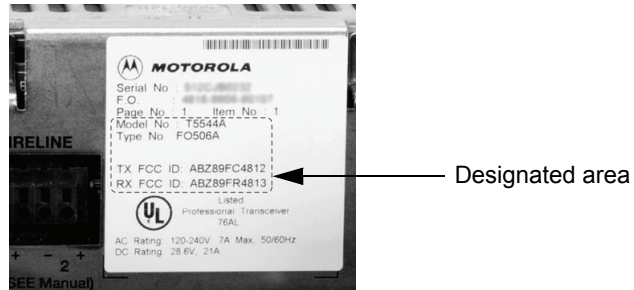


Figure 11-5 Location to affix the Digital Upgrade Kit label

**Note** The label must not cover the serial number of the MTR2000 Base Station/Repeater.

9. Affix the provided Part 68 label to the area noted in [Figure 11-6](#) (if not already present).

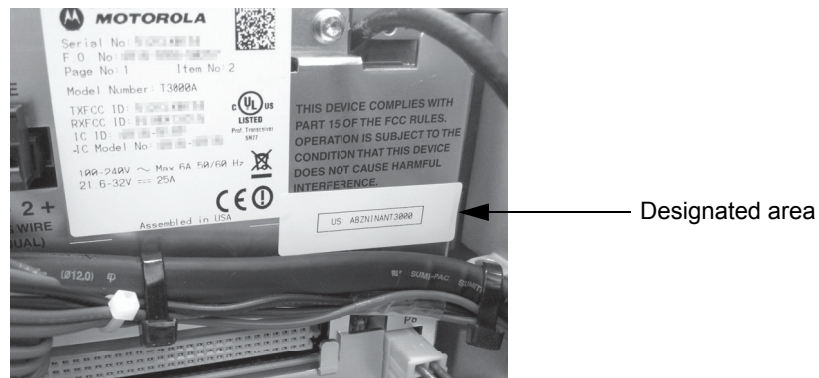


Figure 11-6 Location to affix the Part 68 label

**Note** The Part 68 label is supplied if the MTR3000 Wireline Card is ordered as an option with the MTR2000 MOTOTRBO Digital Upgrade Base Station/Repeater.

10. Reconnect the Exciter-to-PA Coaxial Cable and Rx Input Cable.

### 11.3 New Connections

After the base station/repeater equipment has been mechanically installed, connections must be made. This involves making the following new connections to:

- J7 Backplane Connector to support the following analog third party boxes (If applicable)
  - Community Repeater Panel
  - Tone Remote Controller (Console Connection)
  - LTR Trunking Controller
  - Passport (NTS) Controller
  - Phone Patch
  - Deskset

- Ethernet to support the following MOTOTRBO features
  - IP Site Connect
  - RDAC
  - Capacity Plus
  - Connect Plus

- Note**
1. It is not recommended to perform a digital upgrade and use the upgraded base station/ repeater in analog mode as certain analog functionality will be lost. See Product Planner for details.
  2. 14.2 VDC power (Pin 20) and GPIO\_10 (Pin 5) are not supported on an upgraded MTR2000 J7 backplane connector. If 12 VDC power is required on an upgraded MTR2000, then it must be obtained from Pin32 of connector J5. Alternately the MTR 2000 backplane can be replaced with DLN6721 for full support of pin 5 and pin 20.

### 11.3.1 AUX Connector

The location of the AUX connector is located at the base station/repeater rear panel. The following cables are the reference cables used for this connector:

- Auxiliary System Cable, Part no. X244AJ
- System Connector Cable, Part no. C540AD

### 11.3.2 System Connector

For details on the system connectors, see [Chapter 7](#).

### 11.3.3 Telephone Line Connections

For details on the telephone line connections, see [Chapter 7](#).

### 11.3.4 Station Maintenance Connections

[Table 11-1](#) provides a description of the maintenance connections located on the front of the Station Control Module.

*Table 11-1 Station Maintenance Connections on the SCM*

Connector Name	Function	Details
5/10 MHz External Reference (J3008)	For alignment and for receipt of external reference.	Achieved automatically and does not require configuration in the CPS. This is a 50 $\Omega$ input that is compatible with a 2Vpp (min) to 5Vpp (max) sine or square wave.
Service Speaker (J3010) <sup>1</sup>	Output to Power Voice speaker	Adjustable between 0 to 500 mV across 50 k $\Omega$ @60% system deviation. Audio signal appears between Pins 3 and 4 on the connector. Must use speaker type HSN1000 (older model) or HSN1006 via adapter cable Part.No. 0185180U01.  Note : The Speaker port is only supported in analog mode regardless of the speaker used.
Microphone (J3000) <sup>1</sup>	Local Microphone Input	Use local microphone type GMN6147 (older model) or GMMN4063. Modulation sensitivity for 60% system deviation is typically 56 mV rms.  Note : The Mic port is only supported in analog mode regardless of the Mic used. For older model of microphone (GMN6147), the 3 control buttons for speaker volume control, Rx monitor and Intercom control functions are not supported.

**Note** 1. Only work in analog mode.

## 11.4 Operational Verification

After the base station/repeater equipment has been mechanically installed and all electrical connections have been made, replace the new MTR3000 Base Station/Repeater front bezel by inserting one of the front bezel locking clip into corresponding latch on the base station/repeater housing, and carefully pressing the bezel on the opposite side until the second locking clip snaps into place.

### 11.4.1 Applying Power

Before applying power to the base station/repeater, make sure all modules are securely seated in the appropriate connectors on the backplane interface board and that all RF cables are securely connected.

Plug in the AC line cord that supplies power to the base station/repeater Power Supply, or switch on the DC-breaker to a base station/repeater with a DC power source to the Power Supply.

### 11.4.2 Alignment and Configuration

After the base station/repeater and ancillary equipment have been mechanically installed, properly cabled, and power applied, the equipment must be optimized before placing the base station/repeater in operation. Align (see [Chapter 14](#)) with the Tuner application followed by configuration with the CPS application.

- Note**
1. The base station/repeater will be locked after alignment with the Tuner application. To unlock it, the codeplug must be read and then written to by the CPS application.
  2. The base station/repeater reference must be aligned as shown in [Section 15.3.3](#), before the base station/repeater is placed on the air.

### 11.4.3 Verifying Radio Operation

See [Chapter 13](#) for procedures to verify Exciter and Receiver circuitry operation.

### 11.4.4 Verifying Proper Operation

For details in this section, see [Table 1-8](#).

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# Chapter 12 MTR3000 Test Equipment And Service Aids

## 12.1 Recommended Test Equipment

The list of equipment contained in [Table 12-1](#) includes most of the standard test equipment required for servicing Motorola base station/repeaters.

*Table 12-1 Recommended Test Equipment*

Equipment	Characteristic	Example	Application
Service Monitor	Can be used as a substitute for items marked with an asterisk (*)	Aeroflex 3900 Series Communications System Analyzer ( <a href="http://www.aeroflex.com">www.aeroflex.com</a> ), General Dynamics R8000 with optional DMR/MOTOTRBO options installed ( <a href="http://www.gdsatcom.com">www.gdsatcom.com</a> ) or equivalent	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
Digital rms Multimeter*	100 $\mu$ V to 300V 5 Hz to 1 MHz 10 Meg $\Omega$ Impedance	Fluke 179 or equivalent ( <a href="http://www.fluke.com">www.fluke.com</a> )	AC/DC voltage and current measurements. Audio voltage measurements
Oscilloscope*	2 Channel 100 MHz Bandwidth 5 mV/div to 20V/div	Leader LS8050 ( <a href="http://www.leaderusa.com">www.leaderusa.com</a> ), Tektronix TDS1001b ( <a href="http://www.tektronix.com">www.tektronix.com</a> ), or equivalent	Waveform measurements
Power Meter and Sensor*	5% Accuracy 100 MHz to 500 MHz 50 Watts	Bird 43 throughline Watt Meter ( <a href="http://www.bird-electronic.com">www.bird-electronic.com</a> ) or equivalent	Power Output measurements for use on "analog" channels
RF Millivolt Meter	100 mV to 3V RF 10 kHz to 1 GHz	Boonton 92EA ( <a href="http://www.boonton.com">www.boonton.com</a> ) or equivalent	RF level measurements

## 12.2 Service Aids

Table 12-2 lists the service aids recommended for working on the MTR3000 Base Station/Repeater (BR). While all of these items are available from Motorola, most are standard workshop equipment items, and any equivalent item capable of the same performance may be substituted for the item listed.

Table 12-2 Service Aids

Motorola Part Number	Description	Application
DDN9957A (EMEA/APAC) CLN8665A (NAG)	Standard Type "A" to Type "B" USB Programming cable	To connect a service computer to the MTR3000 Base Station/Repeater's front USB port for Programming, Testing and Alignment.
HSN1006	Speaker	To listen to any active audible alarms  Note : The speaker port on the base station/repeater is compatible with Service Speaker HSN1000 (older model) or HSN1006.
30009493001	RJ-11 to BNC cable / Receiver Audio Test Cable	Connects the external speaker RJ-45 jack to the Oscilloscope input BNC connector
GMMN4063	Microphone	To transmit voice by connecting it to microphone connector on SCM  Note : The microphone port on the base station/repeater is compatible with microphone GMN6147 (older model) or GMMN4063. The older model of microphone (GMN6147) only works in analog mode and does not support the 3 control buttons for speaker volume control, Rx monitor and Intercom control functions.
0185180U01	Speaker adapter cable	To connect the speaker to speaker connector on SCM
RVN5115 (NAG) GMVN5141 (EMEA/ANZ) PMVN4130 (APAC)	Customer Programming Software (CPS) Package	Program customer option and channel data
6683334X01	Option Card Tool	To pull the option boards (such as the Wireline Interface Boards or the Auxiliary Input/Output board)



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# Chapter 13 MTR3000 Performance Check or Testing

## 13.1 General

The MTR3000 Base Station/Repeater (BR) meets published specifications through the 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 equipment manufacturer's recommended calibration schedule.

**Note** Although these radios function in digital and analog modes, all testing is done in analog mode.

## 13.2 Verifying Transmitter Circuitry



**Caution**

The base station/repeater needs to be taken out of service in order to carry out performance testing procedures. Unless the base station/repeater is already out of service, it is recommended to perform the procedures during off-peak hours in order to minimize disruption of service to the system subscribers.

### 13.2.1 Introduction

While most module faults can be detected by running the base station/repeater diagnostics, the following procedure provides a more traditional method of troubleshooting the transmitter circuitry.

This procedure allows the service technician to make minor adjustments and verify proper operation of the base station/repeater transmit circuitry, including:

- Exciter Module
- Power Amplifier Module
- Power Supply Module
- Transmitter-related circuitry in the SCM

In general, the transmitter circuitry is exercised by injecting and measuring signals using a Aeroflex 3900 Series Communications System Analyzer (or equivalent). Incorrect measurement values indicate a faulty module(s); measurement values within the acceptable range verify proper operation of the above listed modules and circuitry.

### 13.2.2 Test Equipment

The following test equipment is required to perform the procedure:


- Aeroflex 3900 Series Communications System Analyzer (or equivalent)
- Microphone (GMMN4063)
- In-Line Wattmeter (Motorola Model S-1350 or equivalent)
- Dummy Load (50  $\Omega$ , base station/repeater wattage or higher)

### 13.2.3 Verifying Transmitter Circuitry Procedure

1. Connect and set up test equipment by performing Steps 1–5 shown in [Figure 13-1](#).

**Note** In the following steps, suspected faulty modules are ranked in order of most to least likelihood.

2. Apply input power (AC or DC) to the base station/repeater. The power supply and PA fans should both run a few seconds to confirm fan operation.
3. Press the PTT button of the microphone and observe the PA Keyed LED indicator on the Station Control Module.

LED	Definition
	Tx Slot 1 (for label number 1) Tx Slot 2 (for label number 2)

- If PA Keyed fails to light, suspect the following:
    - Faulty Power Amplifier Module
    - Faulty Exciter Module
    - Loose or bad Exciter-to-PA RF cable
    - Loose or bad PA-to-antenna RF output cable
    - Improperly terminated PA RF output cable
    - Faulty Station Control Module
    - Faulty Power Supply Module
    - Faulty Backplane Interface Board
    - Faulty Antenna Relay
4. Measure output power by pressing the PTT button and observing reading on an in-line wattmeter.
    - If PA output is not at proper power (as set for particular site), adjust the output power as described in the CPS online help.
  5. If PA output power is proper, set up Aeroflex 3900 Series Communications System Analyzer for spectrum analyzer display. Press the PTT button and observe the display. The display should show a single frequency carrier:
    - If the display shows multiple carriers evenly spaced about the carrier, suspect a faulty Exciter module or PA module.
    - If the display shows a solid carrier but it is off frequency, suspect the following:
      - Faulty Exciter or Station Control Module
      - Faulty external 5/10 MHz reference source (if used)
    - If the display shows a single carrier moving erratically, suspect:
      - Faulty Station Control Module
      - Faulty Exciter Module

6. If display is proper, set up Aeroflex 3900 Series Communications System Analyzer to display modulation. Using the microphone, push the PTT button and speak into the microphone. Verify that the display shows an audio signal.
  - If the proper display is not obtained, suspect faulty SCM or Exciter Module
7. Set the Aeroflex 3900 Series Communications System Analyzer for GEN/MON MTR. Press the PTT button and speak loudly into the microphone to cause maximum deviation. Display should read:
  - 4.60 kHz maximum for a 25 kHz system
  - 3.68 kHz maximum for a 20 kHz system
  - 2.30 kHz maximum for a 12.5 kHz system

**Note** The deviations are calculated with Relative Standard Deviation (RSD) set to 92% RSD (rated system deviation).

If the proper display is not obtained, suspect faulty SCM or Exciter Module.

8. This completes the Verifying Transmitter Circuitry test procedure. If all displays and measurements are correct, the transmitter circuitry may be considered to be operating properly. Remove test equipment, restore the base station/repeater to normal service, and (if applicable) return to the troubleshooting flow chart to resume troubleshooting sequence.

### 13.2.3.1 Station Reset

In the event the base station/repeater is powered from a DC source and repeatedly resets:

1. Disconnect DC power to PA and connect a load to the PA Module.
2. Power the base station/repeater from an AC source instead.
3. If the base station/repeater is not resetting, there is a problem with the PA or the DC source. If the base station/repeater is resetting, there is a problem with another module in the base station/repeater.
4. Reconnect DC power to the PA.
5. If the base station/repeater does not reset, key the base station/repeater.
6. If the base station/repeater is resetting, it "may" be a problem with the PA, or it could be a problem with the Exciter, or Power Supply as well.

### 13.2.3.2 Station Unable to Power Up with Live DC or AC mains

In the event that the base station/repeater is not powering up with live DC or AC mains present:

1. Look for the proper output voltage when the power supply is running (See [Section 8.4.2](#)).
2. Check the two fuses on the backplane interface board and ensure that they are not blown (See [Section 7.2](#)).

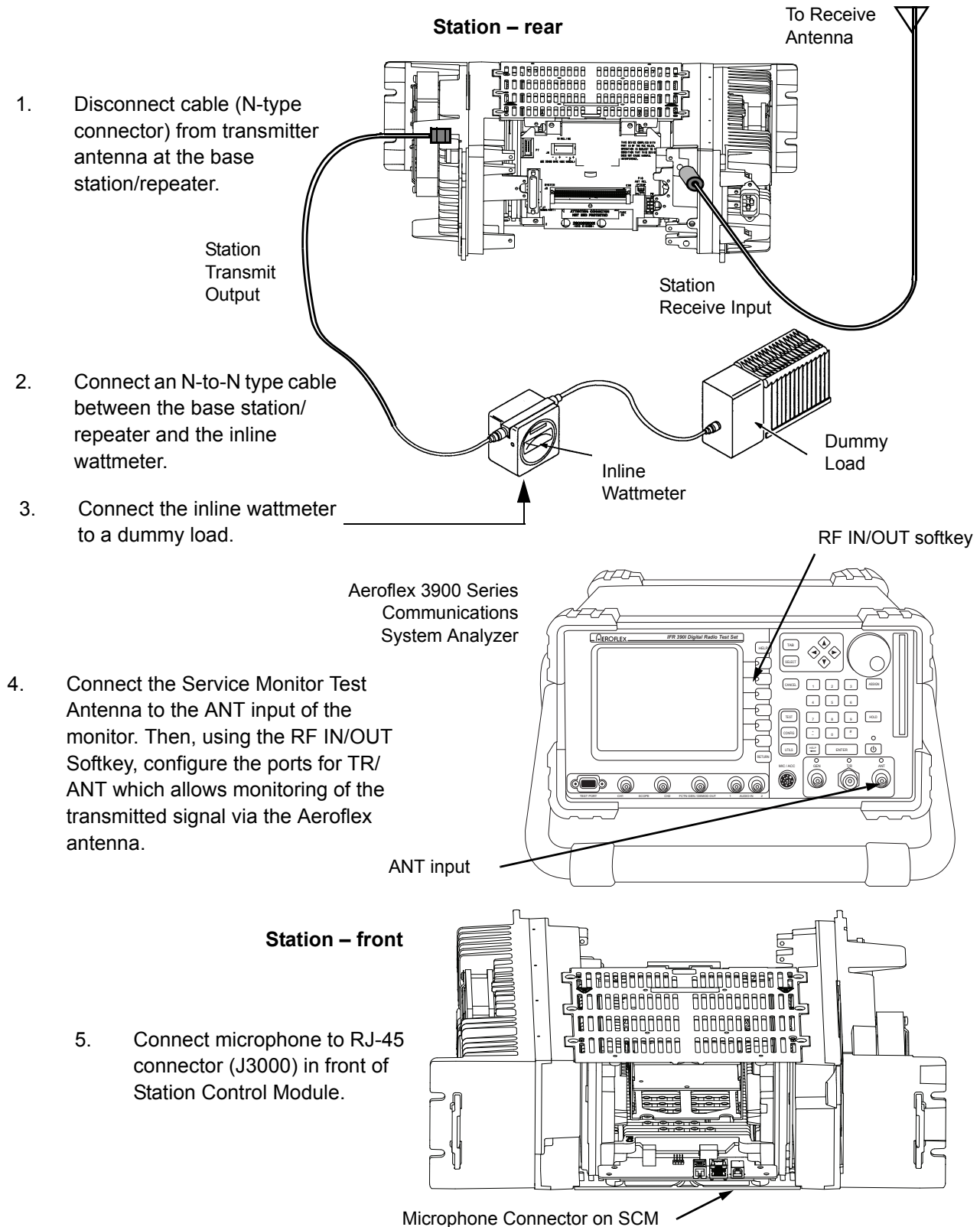


Figure 13-1 Test Equipment Setup for Verifying Transmitter Circuitry

## 13.3 Verifying Receiver Circuitry



**Caution**

Performing this procedure requires that the base station/repeater be taken out of service. It is recommended that, unless the base station/repeater is already out of service, this procedure be performed during off-peak hours so as to minimize the disruption of service to the system subscribers.



**Caution**

If the base station/repeater operates as a base station/repeater, the transmit output from the base station/repeater must be connected to a dummy load to prevent over-the-air broadcast during Receiver testing.

### 13.3.1 Introduction

While most module faults can be detected by running the base station/repeater diagnostics, the following procedure provides a more traditional method of troubleshooting the Receiver circuitry.

This procedure allows the service technician to make minor adjustments and verify proper operation of the base station/repeater receive circuitry, including:

- Receiver Module
- Station Control Module

In general, the Receiver circuitry is exercised by injecting and measuring signals using a Motorola R2001 or R2600 Communications Analyzer (or equivalent). Incorrect measurement values indicate a faulty module(s); measurement values within the acceptable range verify proper operation of the above listed modules and circuitry.

### 13.3.2 Required Test Equipment

The following test equipment is required to perform the procedure:

- Aeroflex 3900 Series Communications System Analyzer (or equivalent)
- Male N-type to Male N-type coaxial cable
- RJ-11 to BNC (6 feet) cable; part no. 30009493001
- Service Speaker; part no. HSN1006
- Service Speaker adaptor cable; part no. 0185180U01
- Dummy Load (50  $\Omega$ , base station/repeater wattage or higher) required for base station/repeaters only

### 13.3.3 Verifying Receiver Circuitry Procedure

1. Connect test equipment by performing Steps 1 to 3 shown in [Figure 13-2](#).
2. Using the CPS, disable PL and unsquelch the Receiver such that noise is heard through the external speaker. If no audio is heard, suspect the following:
  - Faulty Receiver Module
  - Faulty Station Control Module
  - Aeroflex 3900 Series Communications System Analyzer is outputting a carrier signal without modulation
3. Set Aeroflex 3900 Series Communications System Analyzer to generate a 1.0  $\mu$ V (-107 dBm) FM signal at the Receiver frequency, modulated by a 1 kHz tone at 3 kHz deviation for 25 /30 kHz channel spacing, or 1.5 kHz deviation for 12.5 kHz channel spacing. The 1 kHz tone should be audible through the external speaker. If no audio is heard, suspect the following:
  - Faulty Receiver Module
  - Faulty antenna-to-Receiver preselector RF cable (for the base station/repeater with external metal preselector)
  - Faulty Aeroflex 3900 Series Communications System Analyzer-to-station RF cable
  - Faulty Antenna Relay
  - Faulty Preselector

**Note** The fault on the preselector can be verified by bypassing the filter to test whether the Receiver meets its specifications. If it does not, see [Section 10.5.1.1](#) and retest the Receiver to ensure it meets specifications.

4. If audio is heard, connect the external speaker RJ-45 jack to the Oscilloscope input BNC connector, as shown in step 4 of [Figure 13-2](#).
5. Using the CPS, increase the audio volume to maximum. Measure the audio level using the Aeroflex 3900 Series Communications System Analyzer.
  - Audio level should measure approximately 0.75 to 1.5 Vpp. If not, suspect faulty SCM.
6. Change Aeroflex 3900 Series Communications System Analyzer injection signal level to the noted levels in [Table 1-4](#).
7. Measure the Receiver 12 dB SINAD sensitivity. Set the signal strength of the communications analyzer to the rated sensitivity according to [Table 1-4](#).
  - If the SINAD level is less than 12 dB, suspect faulty Receiver Module or SCM.
8. This completes the Verifying Receiver Circuitry test procedure. If all displays and measurements are correct, the Receiver circuitry may be considered to be operating properly. Remove test equipment, restore the base station/repeater to normal service, and (if applicable) return to the troubleshooting flow chart to resume troubleshooting sequence.

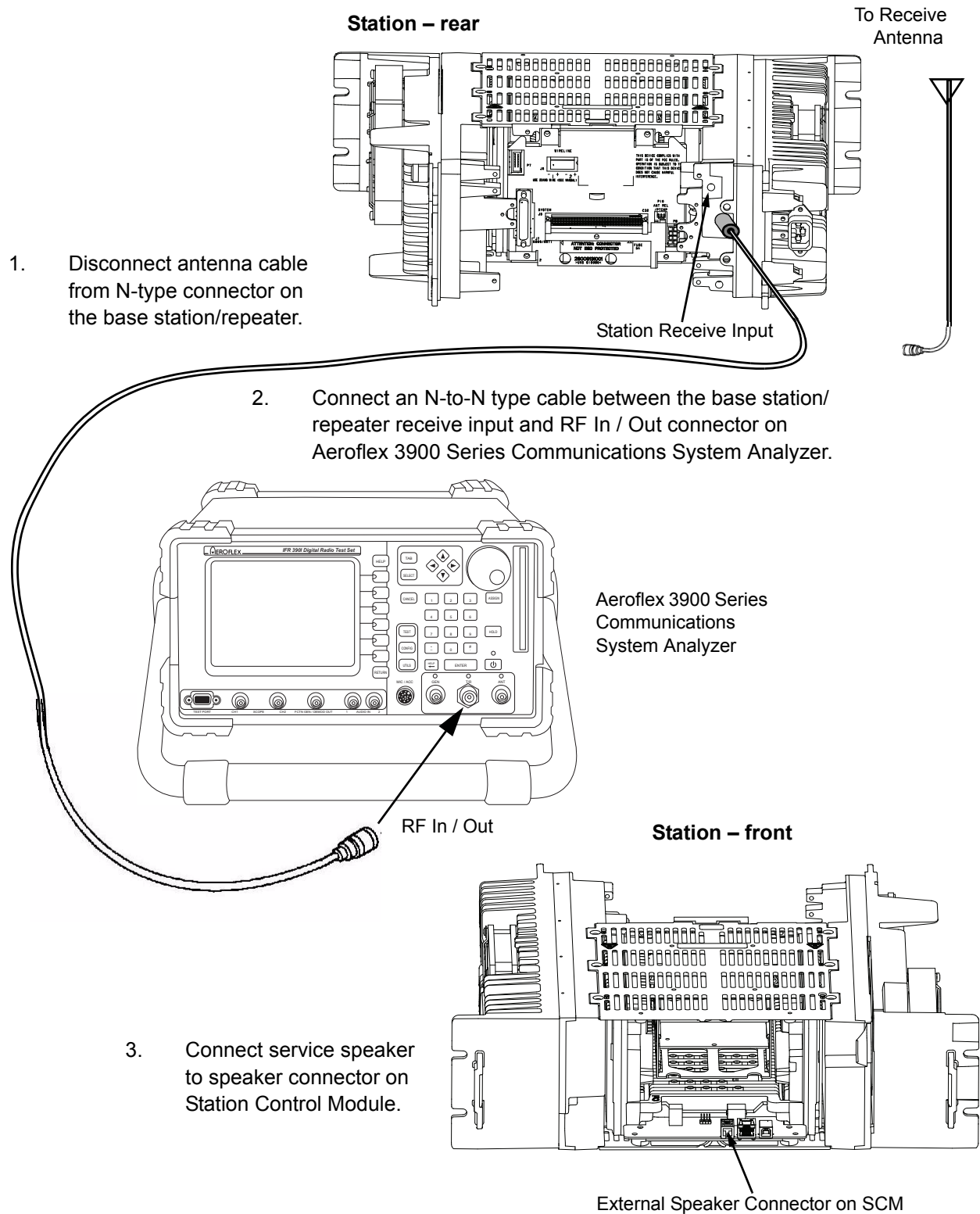


Figure 13-2 Test Equipment Setup for Verifying Receiver Circuit

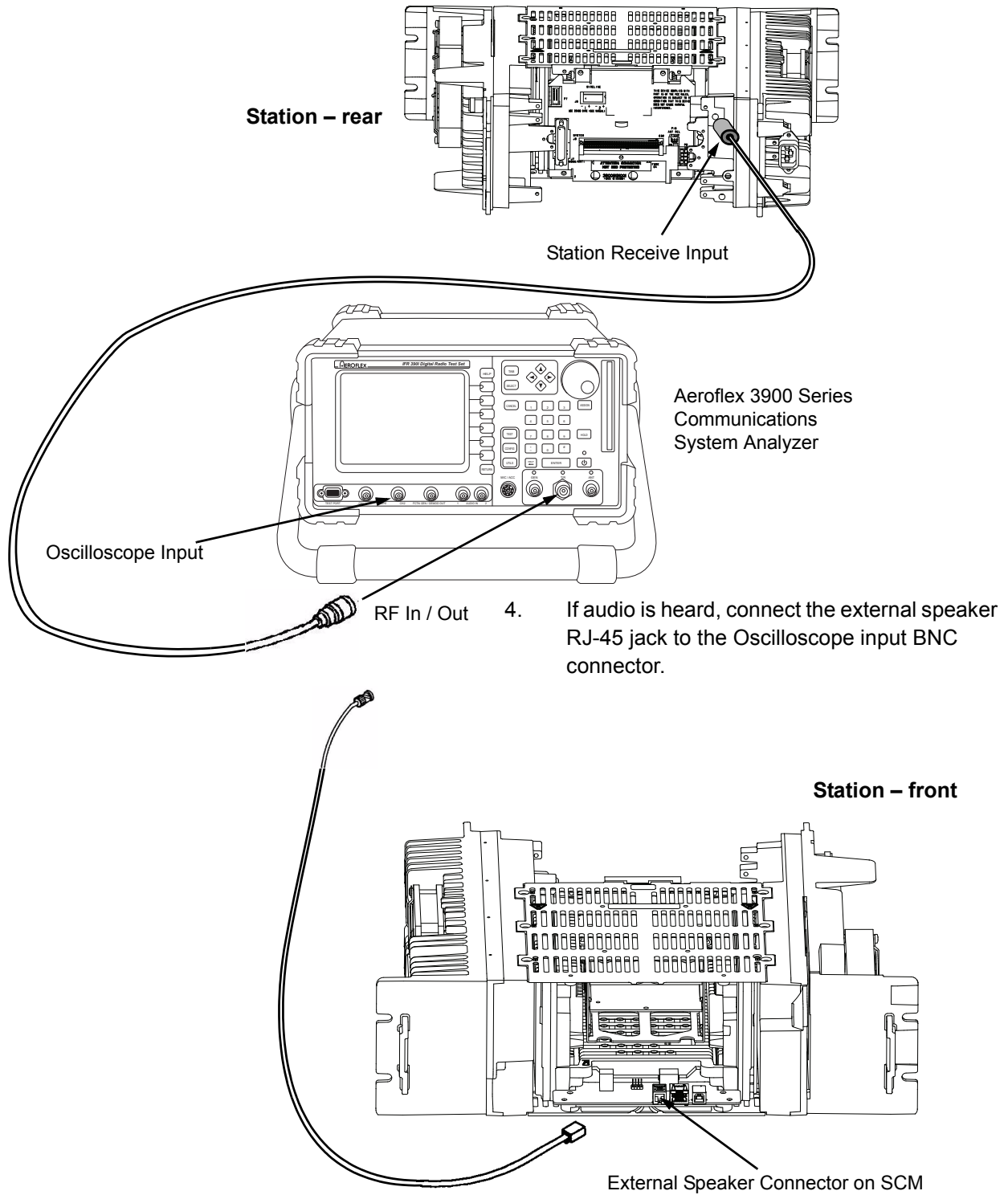


Figure 13-3 Test Equipment Setup for Verifying Receiver Circuitry (Continued)



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# Chapter 14 MTR3000 Programming and Tuning

## 14.1 Introduction


This chapter provides an overview of the MOTOTRBO Customer Programming Software (CPS) for the MTR3000 and MTR2000 MOTOTRBO Digital Upgrade, as well as the MOTOTRBO Tuner application for use on Windows XP™, Windows Vista Home Premium™, Windows Vista Business Edition™ 32 bit and 64 bit operating system, or Windows 7™.

**Note** See appropriate program on-line help files for the programming procedures.

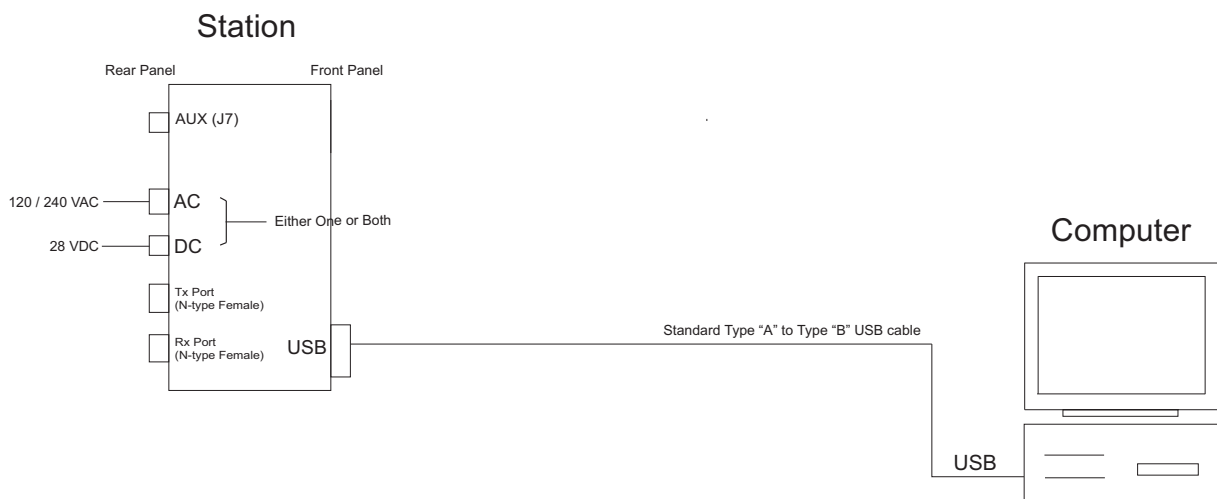
## 14.2 Customer Programming Software Setup

The Customer Programming Software setup, shown in [Figure 14-1](#) is used to program the base station/repeater. See [Figure 14-2](#) and [Figure 14-3](#) for the actual connectors on the front and rear panels of the base station/repeater.

**Note** See appropriate program on-line help files for the programming procedures.



**Caution** Computer USB ports can be sensitive to Electronic Discharge. Employ proper ESD practices (wrist strap, grounding, etc.) and do not touch exposed contacts on cables when connected to a computer.



*Figure 14-1 Customer Programming Software Setup from Rear Accessory Connector*



Figure 14-2 Front view (without front bezel) of MTR3000 Base Station/Repeater

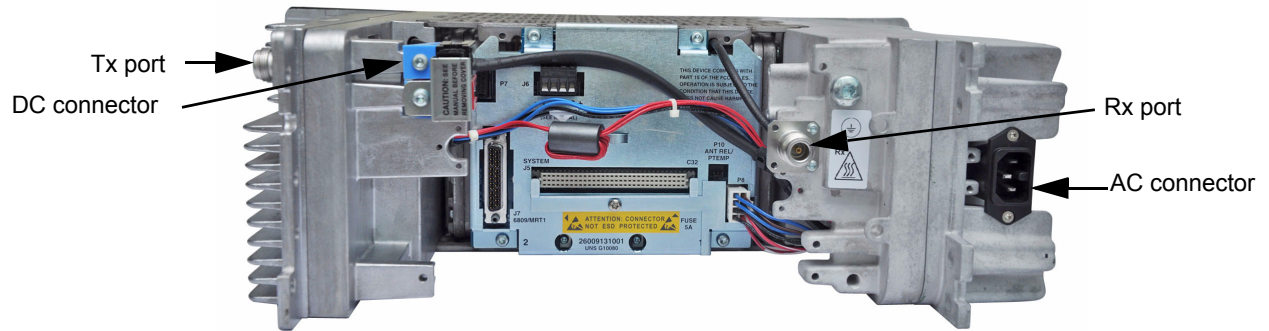


Figure 14-3 Rear view of MTR3000 Base Station/Repeater

## 14.3 Base Station/Repeater Tuning Setup

A personal computer (PC), Windows™ operating system, and the MOTOTRBO Tuner application are required to tune the Station. To perform the tuning procedures, the base station/repeater must be connected to the PC and test equipment setup as shown in [Figure 14-4](#).

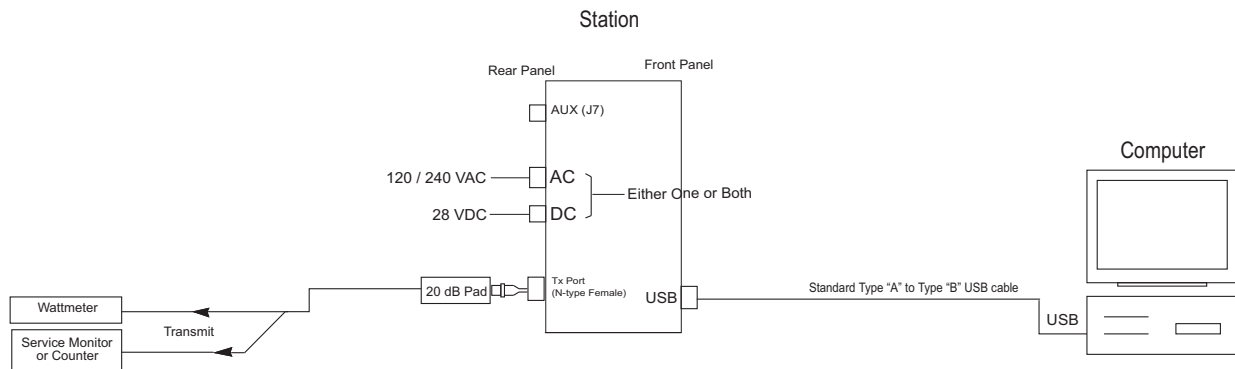


Figure 14-4 MTR3000 Base Station/Repeater Tuning Equipment Setup

## 14.4 Tuning Setup (MTR2000 MOTOTRBO Digital Upgrade)

**Note** [Section 14.4](#) only applies to an upgraded MTR2000 Base Station/Repeater.

### 14.4.1 MTR2000 Calibration Coefficient Entry

This feature is used to allow entry of the transmitter (Tx) output power coefficients of an MTR2000 Power Amplifier (PA) into the MTR3000 tuning codeplug.

Since an upgraded MTR2000 Base Station/Repeater does not have its PA upgraded, its PA calibration coefficients must be entered into the tuning codeplug, as the non-upgraded MTR2000 PA does not have an Electrically Erasable Programmable Read-only Memory (EEPROM). The calibration coefficients, which exist on a sticker on the face plate, consist of two 7 digit hexadecimal numbers and two 6 digit hexadecimal numbers. The sticker itself is created and applied at the factory in which the PA was calibrated.

### 14.4.1.1 Tuning Procedure

1. Power the Station from either an AC or DC source.
2. Launch the MOTOTRBO Tuner application on the computer.

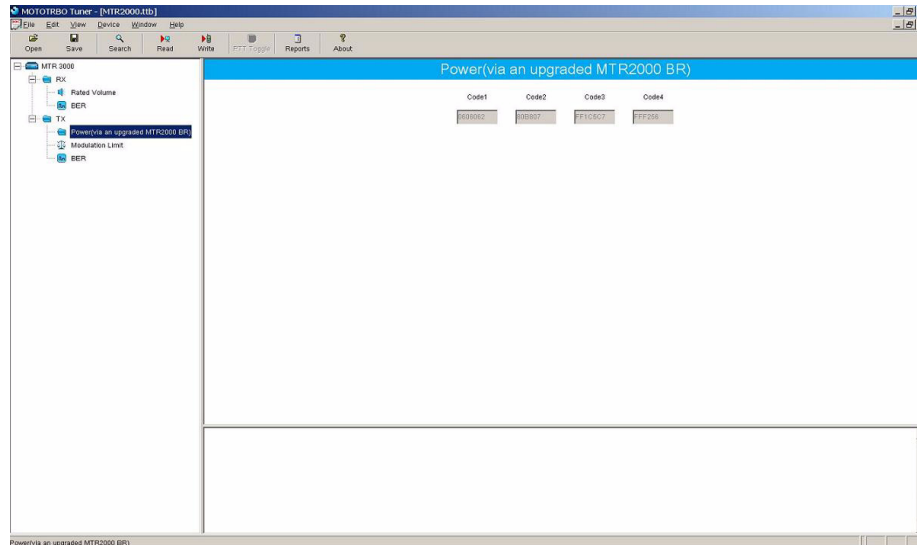


Figure 14-5 Tx Menu tree (Tuning Procedure)

3. Click the “Read” button in the Tuner to read the current code values from the radio’s tuning codeplug.
4. Select “Power” under the Tx menu in the tree view (See [Figure 14-5](#)).
  - If the returned codeplug values match the PA calibration sticker values, click the directory tree to exit from the “Power” menu, or click the “Write” button to save the tuned power values into the radio’s codeplug.
  - If the returned codeplug values do not match the PA calibration sticker value, proceed to Step 5 below. Otherwise, proceed to Step 9 to exit.
5. Enter the upper left code from the PA calibration sticker to Code 1.
6. Enter the upper right code from the PA calibration sticker to Code 2.
7. Enter the lower left code from the PA calibration sticker to Code 3.
8. Enter the lower right code from the PA calibration sticker to Code 4.
9. Click the “Write” button to save the tuned power values into the radio’s codeplug.
10. Exit from the Tuner application to reset the radio. After reset, the radio will be locked.
11. To unlock the radio, launch the CPS. Read the codeplug, then write to the codeplug.
  - CPS can be used to configure the codeplug prior to the write procedure (e.g. setting up frequency)
12. Alignment is complete.

### 14.4.1.2 Verification or Test Procedure for Low/High Power

1. Power the Station from either an AC or DC source.
2. Connect the radio's Tx antenna port, through an attenuation pad and calibrate the path loss, to the Communication Analyzer.
3. Via the CPS, program the radio with all user frequencies supported by the base station/ repeater in analog mode.
4. Enter the test frequency into the Communication Analyzer and set the analyzer in power meter mode.
5. Connect a Mic to the RJ45 connector at the front panel.
6. Press the PTT button on the Mic.
7. Measure the transmit power.
8. If the measured transmit power is not within the original MTR2000 specifications range, the PA must be replaced as it cannot be calibrated in the field.
9. Repeat Step 4 to Step 7 for the remaining frequencies.

**Note** Verification is performed outside of the Tuner application, i.e. in normal mode

## 14.5 Tuning Setup (Wireline)

### 14.5.1 Wireline Receive Level Tuning

The procedure outlined in this section is used to set the output level on the Wireline board's Rx path for a given RF signal deviation on the received signal. Perform this procedure during initial Wireline installation or any time the Rx audio level needs adjustment.

#### 14.5.1.1 Tuning Procedure

1. Connect the radio's receiver antenna port to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Launch the Tuner application and click the "Read" button to read the softpot values.
4. Select "Wireline Receive Level" under the Rx menu in the tree view (See [Figure 14-6](#)).

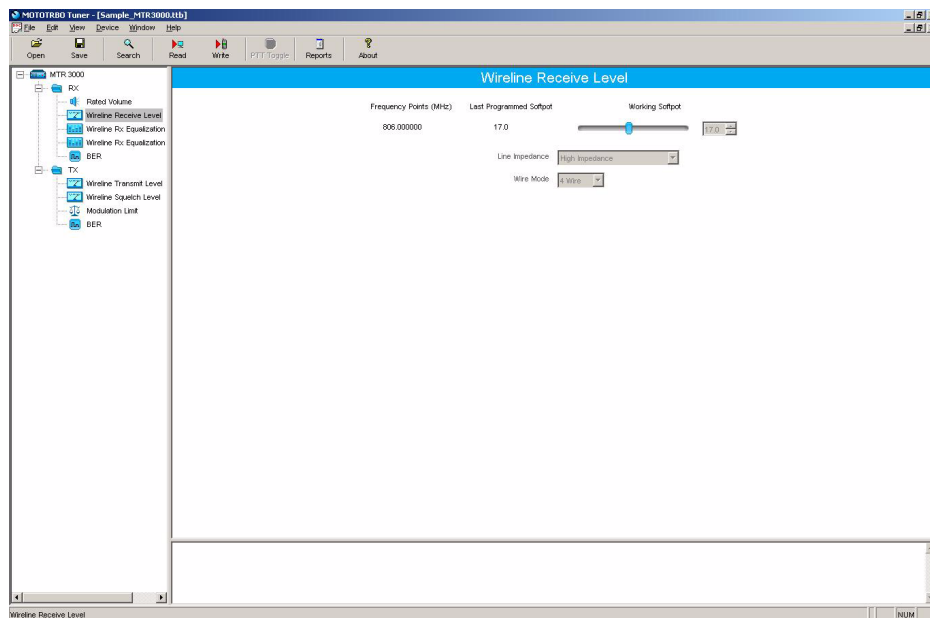


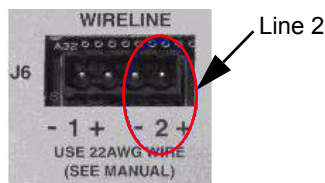
Figure 14-6 Rx Menu tree (Wireline Receive Level)

- Set the Communication Analyzer to output a -47 dBm RF signal modulated with a 1 kHz tone at 60% of full deviation on the tuning frequency. The tuning frequency is the value displayed on the Tuner GUI under the heading of "Frequency Points".

**Note** The Tuner aligns this parameter in a 12.5 kHz channel spacing, so 60% is 1.5 kHz of deviation. If the CPS is set for 25 kHz operation, the base station/repeater will automatically scale the deviation by a factor of two when it is outside the Tuner environment.

**Note** Programmed TPL and DPL squelch requirements are automatically disabled for the tuning frequency while in the Tuner environment.

- Adjust the softpot value until the desired receive audio level is achieved (-30 dBm to +7 dBm) across line two of the J6 Wireline backplane connector terminals.



**Note** It is imperative that the load the Wireline board is driving, matches that of the Wireline board's source impedance setting noted in the Tuner environment. Optimally, it is recommended to use the actual load which is used during normal operation of the radio.

- Click "Write" to save the new tuned softpot value into the radio's codeplug.

## 14.5.2 Wireline Rx Equalization – 2800 Hz Tuning

The Rx Equalization feature allows the frequency response adjustment of the Rx Audio relative to a specified rated system deviation, to compensate (equalize) for the response of the wireline backhaul network itself. This section outlines the procedure for high frequency adjustment. Perform this procedure only after setting the Wireline Receive Level. See [Section 14.5.1](#).

The Rx Equalizer is adjusted relative to the response at 1 kHz. Note the 1 kHz response observed when performing the tuning procedure for Wireline Receive Level. Equalizer adjustments are approximate. Typical adjustments range from 0 dB to approximately +6 dB.

### 14.5.2.1 Tuning Procedure

1. Connect the radio's receiver antenna port to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Launch the Tuner application and click the "Read" button to read the softpot values.
4. Select "Wireline Rx Equalization – 2800 Hz" under the Rx menu in the tree view (See [Figure 14-7](#)).

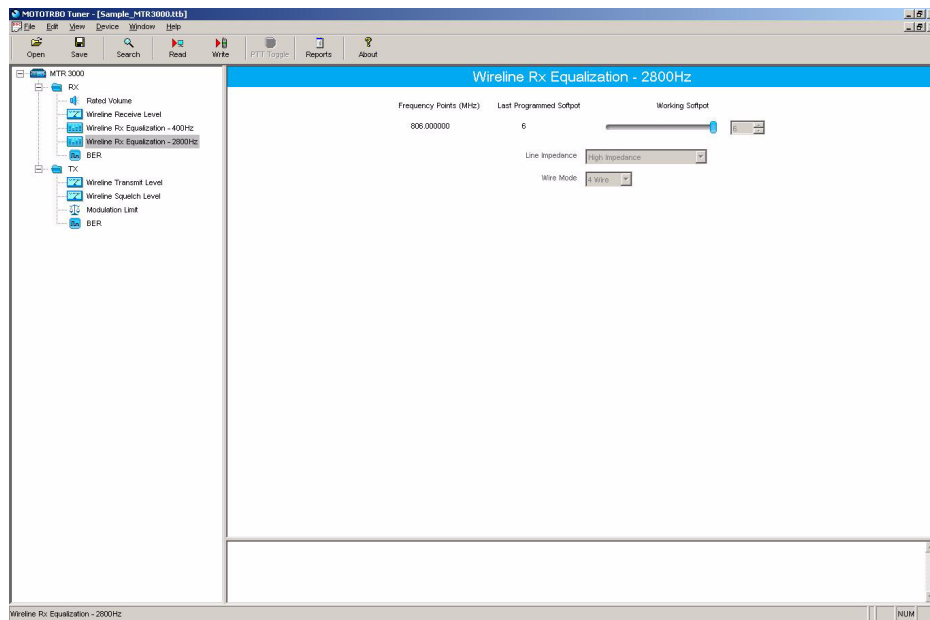


Figure 14-7 Rx Menu tree (Wireline Rx Equalization – 2800 Hz)

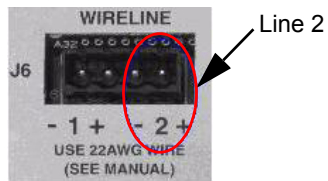
5. Set the Communication Analyzer to output a  $-47$  dBm RF signal modulated with a 2800 Hz tone at 60% of full deviation on the tuning frequency. The tuning frequency is the value displayed on the Tuner GUI under the heading of "Frequency Points".

**Note** The Tuner aligns this parameter in a 12.5 kHz channel spacing, so 60% is 1.5 kHz of deviation. If the CPS is set for 25 kHz operation, the base station/repeater will automatically scale the deviation by a factor of two when it is outside the Tuner environment.

**Note** The emphasis setting of the Communication Analyzer must be turned off for this alignment procedure.

**Note** Programmed TPL and DPL squelch requirements are automatically disabled for the tuning frequency while in the Tuner environment.

- Adjust the softpot value until the best equalization is achieved across line two of the J6 Wireline backplane connector terminals. Best equalization is achieved when the far side of the Wireline cable measures a flat response across the upper region of the audio spectrum. Compare the response at 2800 Hz with the response measured at 1000 Hz. The values should be approximately equal.



**Note** It is imperative that the load the Wireline board is driving, matches that of the Wireline board's source impedance setting noted in the Tuner environment. Optimally, it is recommended to use the actual load which is used during normal operation of the radio.

- Click "Write" to save the new tuned softpot value into the radio's codeplug.



### 14.5.3 Wireline Rx Equalization – 400 Hz Tuning

The Rx Equalization feature allows the frequency response adjustment of the Rx Audio relative to a specified rated system deviation, to compensate (equalize) for the response of the Wireline backhaul network itself. This section outlines the procedure for low frequency adjustment. Perform this procedure only after setting the Wireline Receive Level. See [Section 14.5.1](#).

The Rx Equalizer is adjusted relative to the response at 1 kHz. Note the 1 kHz response observed when performing the tuning procedure for Wireline Receive Level. Equalizer adjustments are approximate. Typical adjustments range from 0 dB to approximately +6 dB.

#### 14.5.3.1 Tuning Procedure

1. Connect the radio's receiver antenna port to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Launch the Tuner application and click the "Read" button to read the softpot values.
4. Select "Wireline Rx Equalization – 400 Hz" under the Rx menu in the tree view (See [Figure 14-8](#)).

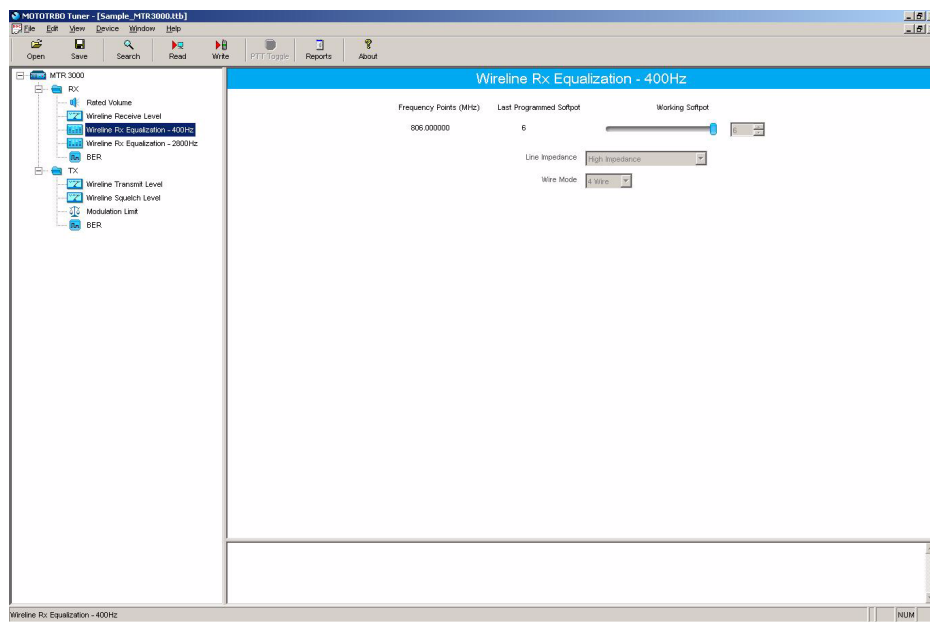


Figure 14-8 Rx Menu tree (Wireline Rx Equalization – 400 Hz)

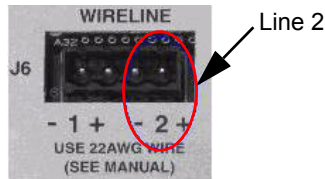
5. Set the Communication Analyzer to output a -47 dBm RF signal modulated with a 400 Hz tone at 60% of full deviation on the tuning frequency. The tuning frequency is the value displayed on the Tuner GUI under the heading of "Frequency Points".

**Note** The Tuner aligns this parameter in a 12.5 kHz channel spacing, so 60% is 1.5 kHz of deviation. If the CPS is set for 25 kHz operation, the base station/repeater will automatically scale the deviation by a factor of two when it is outside the Tuner environment.

**Note** The emphasis setting of the Communication Analyzer must be turned off for this alignment procedure.

**Note** Programmed TPL and DPL squelch requirements are automatically disabled for the tuning frequency while in the Tuner environment.

- Adjust the softpot value until the best equalization is achieved across line two of the J6 Wireline backplane connector terminals. Best equalization is achieved when the far side of the Wireline cable measures a flat response across the lower region of the audio spectrum. Compare the response at 400Hz with the response measured at 1000 Hz. The values should be approximately equal.



**Note** It is imperative that the load the Wireline board is driving, matches that of the Wireline board's source impedance setting noted in the Tuner environment. Optimally, it is recommended to use the actual load which is used during normal operation of the radio.

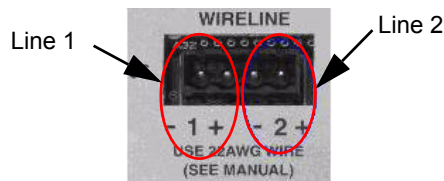
- Click "Write" to save the new tuned softpot value into the radio's codeplug.

#### 14.5.4 Wireline Transmit Level Tuning

The procedure outlined in this section is used to adjust the level the Wireline is expecting on the Tx pair of the J6 Wireline connector. Adjusting the expected level has the effect of increasing or decreasing RF signal deviation for a given Wireline Tx audio level. Perform this procedure during initial Wireline installation or any time the Tx audio level needs adjustment.

##### 14.5.4.1 Tuning Procedure

- Connect the radio's transmitter antenna port to the Communication Analyzer.
- Power the base station/repeater from either an AC or DC source.
- Apply a 1 kHz signal at the desired input level (-36 dBm to +4 dBm) to the J6 Wireline backplane connector terminals. This signal is known as "Test Tone" and corresponds with the level of average voice. Optimally, it is recommended to use the actual source which is used during normal operation of the radio to provide the signal.

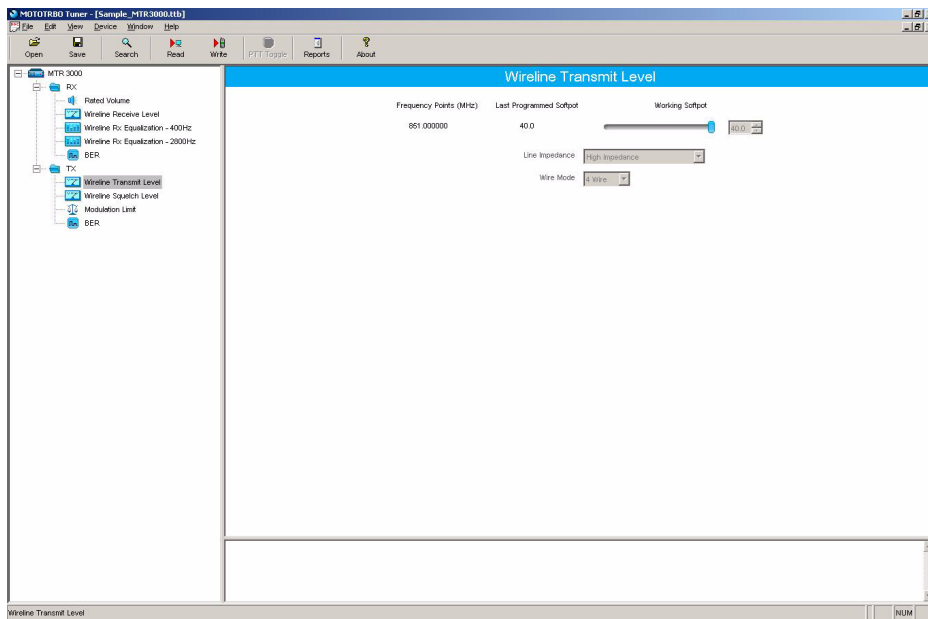


**Note** Most Motorola dispatch consoles can generate a 1 kHz tone at the correct level by using the "Alert Tone" feature. Consult the appropriate console manual for more information.

**Note** If the Wire Mode is set for 2 Wire operation, then inject the signal into the line two terminals of connector J6. Otherwise, inject the signal into the line one terminals of J6.

- Launch the Tuner application and click the "Read" button to read the softpot values.

5. Select “Wireline Transmit Level” under the Tx menu in the tree view (See [Figure 14-9](#)).



*Figure 14-9 Tx Menu tree (Wireline Transmit Level)*

6. Enter the tuning frequency into the Communication Analyzer (the value displayed on the Tuner GUI under the heading of “Frequency Points”).
7. Click the “PTT Toggle” button within the Tuner environment to key up the radio.
 

**Note** If enabled, the Wireline’s Automatic Level Control (ALC) and Wireline Squelch Hysteresis features are automatically turned off when the radio is keyed up from the “PTT Toggle” button within the Tuner environment. The features are automatically re-enabled when the radio is de-keyed by pressing the “PTT Toggle” button or when leaving the Tuner environment.
8. Adjust the softpot value until 60% of the rated system deviation (RSD) is achieved.
 

**Note** The Tuner aligns this parameter in a 12.5 kHz channel spacing, so 60% is 1.5 kHz of deviation. If the CPS is set for 25 kHz operation, the base station/repeater will automatically scale the deviation by a factor of two when it is outside the Tuner environment.
9. Click the “PTT Toggle” button within the Tuner environment to de-key the radio.
10. Click “Write” to save the new tuned softpot value into the radio’s codeplug.

## 14.5.5 Wireline Squelch Level Tuning

The Wireline Squelch feature is used to mute Wireline Tx audio when the audio level falls below a designated threshold. The procedure in this section is used to set the nominal squelch threshold. An additional hysteresis value can be added to the nominal squelch threshold by adjusting the “Squelch Hysteresis” setting in the Wireline configuration options of the CPS tool.

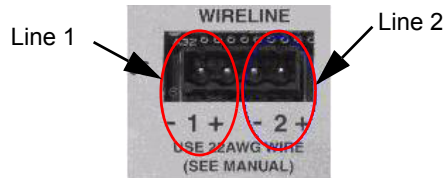
**Note** This calibration procedure should be performed after adjusting the Wireline Transmit Level. See [Section 14.5.4](#).

The Wireline Squelch level is adjusted relative to the expected audio level for High Level Guard Tone. This is true regardless of the Remote Control method selected. The expected level of High Level Guard Tone is 6 dB above the “Test Tone” level used during the Wireline Transmit Level tuning procedure of [Section 14.5.4](#).

**Note** It is possible to set the Wireline Squelch threshold higher than the level of average voice. Setting the Squelch threshold too high can result in unintended audio drop-outs or no audio at all.

### 14.5.5.1 Tuning Procedure

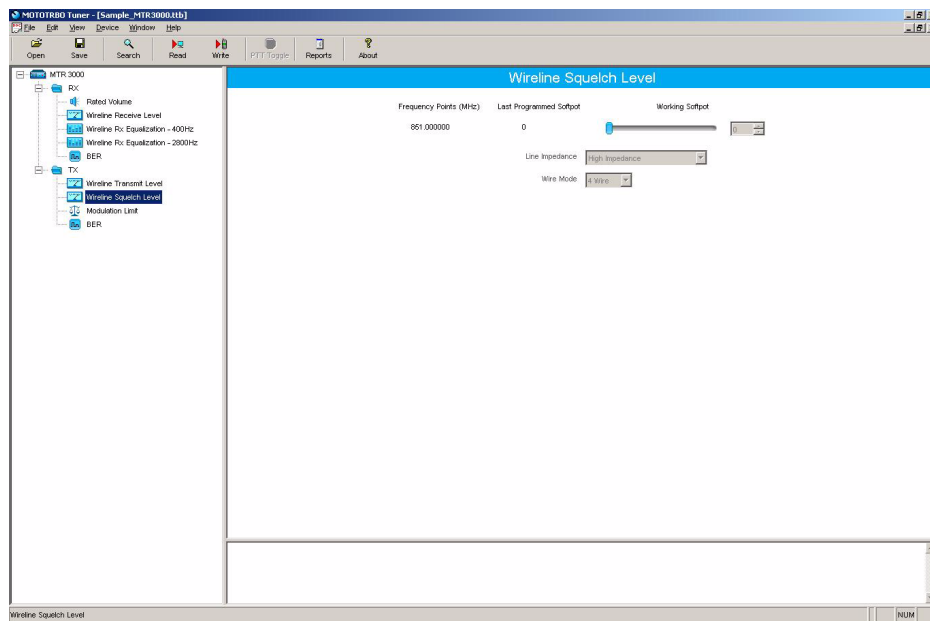
1. Connect the radio's transmitter antenna port to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Apply a 1 kHz signal, at the desired squelch threshold, to the J6 Wireline backplane connector terminals. Optimally, it is recommended to use the actual source which is used during normal operation of the radio to provide the signal.



**Note** If the Wire Mode is set for 2 Wire operation, then inject the signal into the line two terminals of connector J6. Otherwise, inject the signal into the line one terminals of J6. In addition, the Wire Mode used must be the same configuration as that was used in the Wireline Transmit Level alignment in [Section 14.5.4](#).

4. Launch the Tuner application and click the “Read” button to read the softpot values.

5. Select “Wireline Squelch Level” under the Tx menu in the tree view (See [Figure 14-10](#)).



*Figure 14-10 Tx Menu tree (Wireline Squelch Level)*

6. Enter the tuning frequency into the Communication Analyzer (the value displayed on the Tuner GUI under the heading of “Frequency Points”).
7. Click the backplane “PTT Toggle” button within the Tuner environment to key up the radio.

**Note** If enabled, the Wireline’s Automatic Level Control (ALC) and Wireline Squelch Hysteresis features are automatically turned off when the radio is keyed up from the “PTT Toggle” button within the Tuner environment. The features are automatically re-enabled when the radio is de-keyed by pressing the “PTT Toggle” button or when leaving the Tuner environment.

**Note** The Wireline’s Automatic Level Control (ALC) alignment procedure can result in a difference between the Wireline Squelch Threshold set during this procedure and the actual value observed in normal operation. This difference can be eliminated or minimized, by carefully following the Wireline Transmit Level tuning procedure found in [Section 14.5.4](#) to obtain an accurate alignment.

8. Adjust the softpot value until the Communication Analyzer indicates that the deviation has dropped out (< 100 Hz of deviation).
9. Click the “PTT Toggle” button within the Tuner environment to de-key the radio.
10. Click “Write” to save the new tuned softpot value into the radio’s codeplug.

## 14.6 Modulation Limit Alignment

This feature is to set the modulation limit of the radio for MTR3000 and MTR2000 MOTOTRBO Digital Upgrade.

**Note** A modulation limit alignment is not needed if the radio is used in repeat mode. This is always the case when the radio is in digital mode.

### 14.6.1 Tuning Procedure (with no Tx Data and no PL)

**Note**

1. Under the “Accessories” menu within the CPS, if the “Audio Type” is set to “Rx & Tx Filtered Squelch” and the “Analog Accessory Emphasis” is set to “De & Pre”, then a modulation limit alignment is not needed. In this configuration, the modulation limit is always set to 92% RSD by the base station/repeater software.
2. If data or PL signaling is applied to Pin 13 of the J7 connector, proceed to [Section 14.6.3](#).

1. Connect the radio's antenna port to the attenuation pad, if necessary, before connecting to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Apply a 1 kHz signal at 1.2 Vrms to Pin 1 of the J7 backplane connector.
  - Signal ground is Pin 9 of the J7 backplane connector.
4. Launch the Tuner application and click the “Read” button to read the softpot values.
5. Select “Modulation Limit” under the Tx menu in the tree view (See [Figure 14-11](#)).

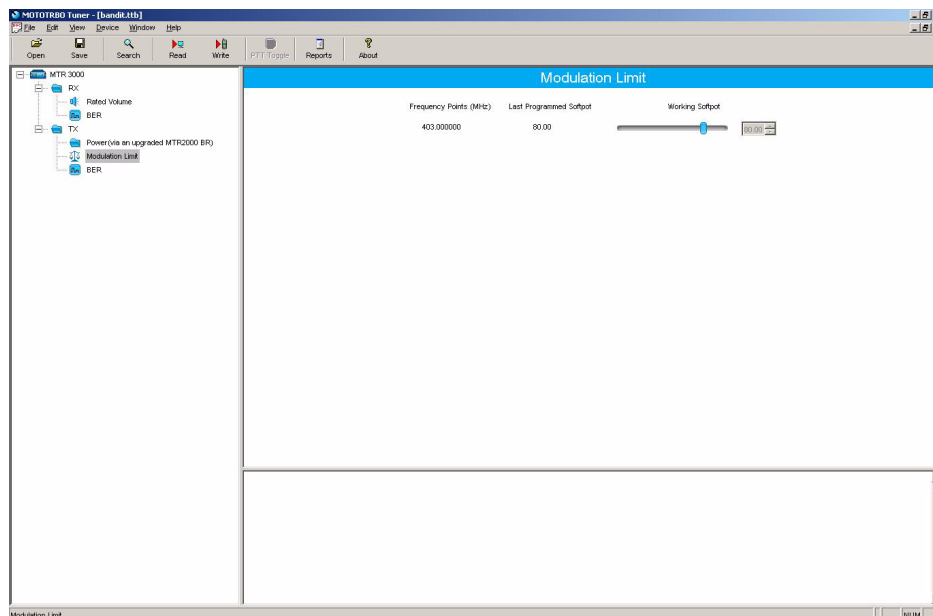


Figure 14-11 Tx Menu tree (Tuning Procedure with no Tx data)

6. Enter the tuning frequency into the Communication Analyzer (the value displayed on the Tuner GUI).
7. Click the “PTT Toggle” button within the Tuner environment to key up the radio.

8. Adjust the softpot value until the maximum deviation is 92% of the rated system deviation (RSD). This will be tested in a 12.5 kHz channel spacing, so 92% of 2.5 kHz is 2.3 kHz.

**Note** Set the modulation limit to 92% so that any additional deviation incurred by the transmitter VCOs over temperature is compensated for.

Channel Spacing	RSD	92% of RSD	Tolerance
12.5 kHz	2.5 kHz	2.3 kHz	+0Hz / -50Hz

9. Click the “PTT Toggle” button within the Tuner environment to de-key the radio.
10. Click “Write” to save the new tuned softpot value into the radio’s codeplug.

### 14.6.2 Verification (with no Tx Data and no PL)

1. Connect the radio’s antenna port to the attenuation pad, if necessary, before connecting to the Communication Analyzer.
2. Power the base station/repeater from either an AC or DC source.
3. Via CPS, program the radio with any frequency within the specified range of the base station/repeater under test, and set the radio for low power and disable the repeat path.
4. Apply a 1 kHz signal at 1.2 Vrms to Pin 1 of the J7 backplane connector.
  - Signal ground is Pin 9 of the J7 backplane connector.
5. Key up the radio and measure the deviation
  - Key the radio by grounding Pin 2 of the J7 backplane connector.
  - CPS must have Pin 2 configured as an active low with the PTT function.
6. De-key the radio.

The deviation shall meet the limits shown in the table below.

Channel Spacing	Relative Standard Deviation (RSD)	92% of RSD	Tolerance
12.5 kHz	2.5 kHz	2.3 kHz	+0Hz / -50Hz
20.0 kHz	4.0 kHz	3.68 kHz	+0Hz / -80Hz
25.0 kHz	5.0 kHz	4.6 kHz	+0Hz / -100Hz

**Note**

- The base station/repeater will be factory-tuned in accordance to the above procedure and specification.
- Verification is performed outside of the Tuner application, i.e. in normal mode.

### 14.6.3 Tuning Procedure (with Tx Data or PL)

1. Connect the radio's antenna port to the attenuation pad, if necessary, before connecting to the Communication Analyzer.
2. Turn on the base station/repeater using an AC or DC source.
3. Click the "Read" button on the Tuner application to read the radio's softpot values.
4. Select "Modulation Limit" under the Tx menu in the tree view.
5. Enter the tuning frequency into the Communication Analyzer (the value displayed by the Tuner application).
6. Click the "PTT Toggle" button within the Tuner environment to key up the radio.
7. Apply a 1 kHz signal at 1.2Vrms to Pin 22 of the J7 backplane connector.
  - Signal ground is Pin 9 of the J7 backplane connector.
  - If the manufacturer of the third party controller specifies that the Tx Audio is not to be pre-emphasized, use Pin 1 instead of Pin 22.
8. Adjust the Modulation Limit softpot to a value that limits the maximum deviation to "X"% RSD, where "X" is equal to "92% RSD" minus "Tx Data's % RSD".
 

E.g. If Tx Data deviation is equal to 17%,  
 $X = 92\% - 17\% = 75\%$  as the maximum deviation limit.

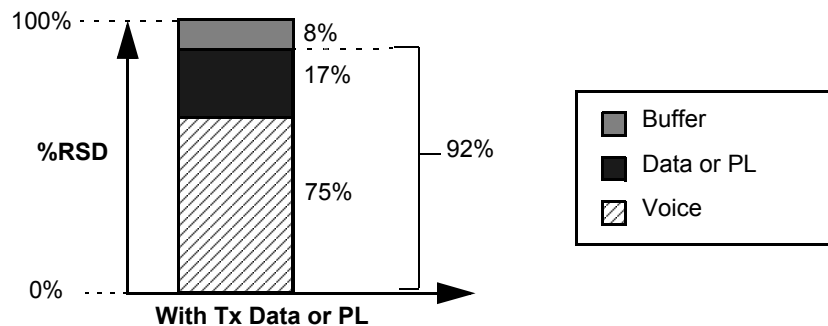


Figure 14-12 Example of maximum deviation limit calculation

9. Click the "PTT Toggle" button within the Tuner environment to de-key the radio.
10. Click "Write" to save the newly tuned softpot value into the radio's codeplug.
11. Alignment is complete.

**Note** See [Figure 6-2](#) for details regarding the audio and data flow.

**Note** Set the modulation limit to 92% to compensate for any additional deviation incurred by the transmitter VCOs over temperature.

**Note** The Tuner application always aligns the Modulation Limit parameter in a 12.5 kHz channel spacing regardless of the CPS setting, so calculate the tuning % RSD accordingly. If the CPS is set for 25 kHz operation, the base station/repeater will automatically scale the deviation by a factor of two when outside of the Tuner environment.



#### 14.6.4 Verification (with Tx Data or PL)

See [Section 14.6.2](#) with the following exceptions:

- The same Tx data signal level determined (obtained from Step 8 in [Section 14.6.3](#)), is applied to Pin 13 during the validation process.
- Pin 22 may be used instead of Pin 1, depending on the recommendation by the manufacturer of the third party controller.

## Notes

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# Chapter 15 MTR3000 Maintenance and Disassembly/ Reassembly

## 15.1 Introduction

This chapter provides details about the following:

- Routine maintenance
- Preventive maintenance (inspection and cleaning)
- Safe handling of Complementary Metal-Oxide Semiconductor (CMOS) devices
- Disassembly and reassembly of the base station/repeater
- Repair procedures and techniques.

## 15.2 Routine Maintenance

**Note** It is recommended that the base station/repeater is cleaned with a soft dry cloth while in service.

The base station/repeater and ancillary equipment have been designed with state-of-the-art technology and operate under software control, thus requiring minimal routine maintenance. Virtually all base station/repeater operating parameters are monitored and self-corrected by the Station Control Module (SCM) and the firmware it runs, which makes adjustments and tuning virtually unnecessary.

Provided that the equipment is installed in an area which meets the specified environmental requirements, the only routine maintenance task required is the calibration of the base station/repeater reference oscillator circuit.

## 15.3 Preventive Maintenance

Periodic visual inspection and cleaning is recommended.

### 15.3.1 Inspection

Check that the external surfaces of the base station/repeater are clean, and that all external controls and connections are in order. It is not recommended to inspect the interior electronic circuitry.

### 15.3.2 Cleaning Procedures

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the 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 0.5% solution of mild dishwashing detergent 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.

**Note** Internal surfaces should be cleaned only when the base station/repeater is disassembled for service or repair.

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 base station/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 base station/repeater enclosure.

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

### 15.3.3 Station Reference Alignment Procedure

The base station/repeater reference needs to be aligned yearly to maintain optimum functionality.

To align the base station/repeater reference:

1. Remove the front bezel of the base station/repeater.
2. Connect the External Reference to J3008M7 of the SCM. The SCM accepts a 5 MHz or 10 MHz sine or square wave with a level of 2 Vpp (min) to 5 Vpp (max).



The 800/900 MHz base station/repeater must be in a powered state (AC/DC applied) for a minimum of 10 minutes prior to applying an external reference for the purpose of alignment. Failure to comply to the 10 minutes wait time will result in an inaccurate reference frequency alignment.

3. The reference LED on the SCM will turn solid amber to indicate that the alignment is in progress.
4. The reference LED on the SCM will turn solid green to indicate that the alignment is completed successfully.
5. Remove the External Reference from J3008M7, and the reference LED will turn off.
6. Replace the front bezel of the base station/repeater.

## 15.4 Safe Handling of CMOS Devices

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of stations, 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 circuits and are especially important in low humidity conditions.

DO NOT attempt to disassemble the base station/repeater without first referring to the following CAUTION statement.



Caution

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

- Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS 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 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 can be ordered using the Motorola part number 4280385A59).
- Do not wear nylon clothing while handling CMOS devices.
- Do not insert or remove CMOS devices with power applied. Check all power supplies used for testing CMOS devices to be certain that there are no voltage transients present.
- When straightening CMOS Pins, provide ground straps for the apparatus used.
- When soldering, use a grounded soldering iron.
- Where possible, handle CMOS 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.

## 15.5 Repair Procedures and Techniques – General

**Note** The Motorola MOTOTRBO MTR3000 Base Station/Repeater system and its subsystems have been created in compliance with the environmental goals of the European Union's **Restriction of Hazardous Substances (RoHS)** and the **Waste Electrical and Electronic Equipment (WEEE)** Directive 2002/96/EC as well as Motorola's corporate goals to minimize environmental impact of its products.

This Motorola 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 any rework or repair on RoHS-compliant products.

Any rework or repair on RoHS-compliant products must be done using the appropriate lead-free solder wire and lead-free solder paste as stated in the following table:

*Table 15-1 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	RMAVersion	2.7-3.2%	217C	52171	0.015	1lb spool

*Table 15-2 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

**Note** MTR3000 Power Amplifier with Solder Wire Part Number 1010041C24 and Solder Paste Part Number 1010041C20 uses leaded solder.

### 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 part number and order the part from the nearest Motorola Radio Products and Solutions Organization listed in the respective Appendix chapters in this manual.

### Rigid Circuit Boards

This base station/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.

## 15.6 Disassembly and Reassembly – General

Station modules suspected of being faulty must be replaced with known good modules to restore the base station/repeater to proper operation. The following are typical procedures to remove each of the base station/repeater modules.

1. Power cord (and battery backup power, if used) and all external cables must be disconnected before opening up base station/repeater. Label each removed cable as required to ensure it is properly reconnected.
2. Take the proper grounding precautions as stated in [Section 15.4](#).
3. When disassembling base station/repeater, retain all screws for reuse.

The following tools are required for disassembly and reassembly the base station/repeater:

- Small Flat Blade Screwdriver
- Torque Drivers (T10, T15 and T20). See [Section 15.10](#) for the different size fasteners of screw torques.
- Cable Ties
- Hand-held tool/Side Cutters to cut Cable Ties

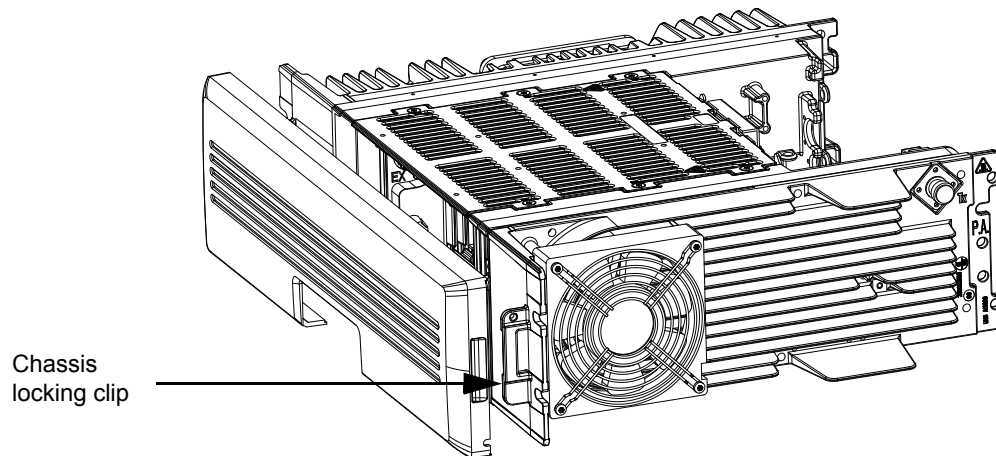
If a unit requires more complete testing or service than is customarily performed at the basic level, send the base station/repeater or FRU to a Motorola Service Center.

The following disassembly procedures should be performed only if necessary.

## 15.7 Disassembly and Reassembly – Detailed

### 15.7.1 Front Bezel Disassembly and Reassembly

1. Remove the base station/repeater front bezel from its chassis locking clip by carefully pulling it forward (See [Figure 15-1](#)).



*Figure 15-1 Removing Front Bezel*

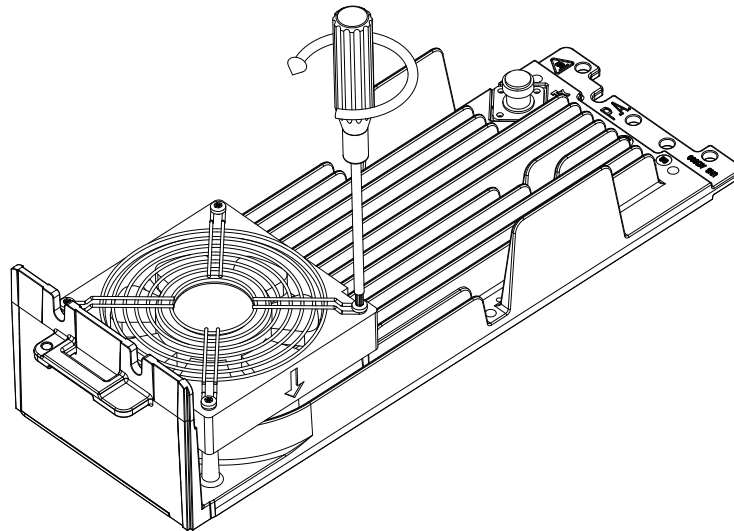
2. Replace the base station/repeater front bezel by inserting one of the front bezel locking clips into corresponding latch on the base station/repeater housing, and carefully pressing the panel on the opposite side until the second locking clip snaps into place.



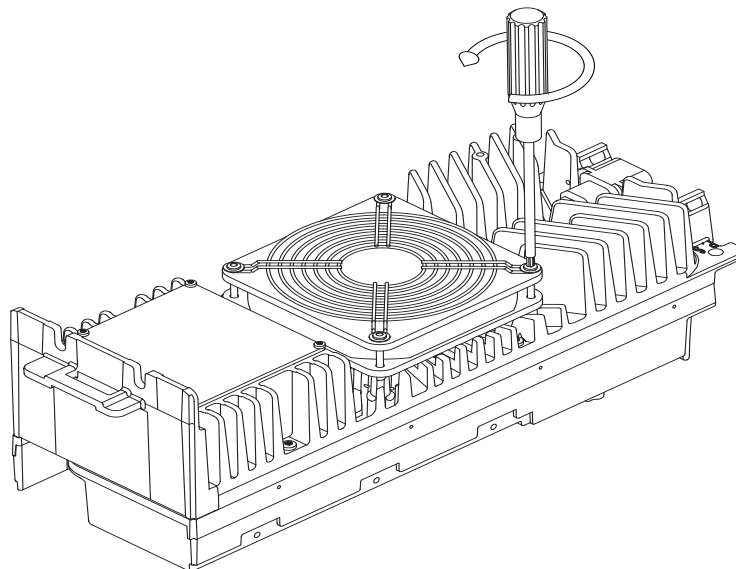
## 15.7.2 Module Disassembly and Reassembly

### 15.7.2.1 Fans

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Remove the four screws securing the fans to Power Supply or the five screws to the PA casting (See [Figure 15-2](#) and [Figure 15-3](#)).



*Figure 15-2 Removing five screws from PA fan*



*Figure 15-3 Removing four screws from PS fan*

3. Make sure of the connector orientation and unplug the fan electrical power connector.
4. Lift the fan away from the casting.
5. Ensure that the correct fan is being installed.
6. Position the fan on the casting and position the fan grill over the fan.

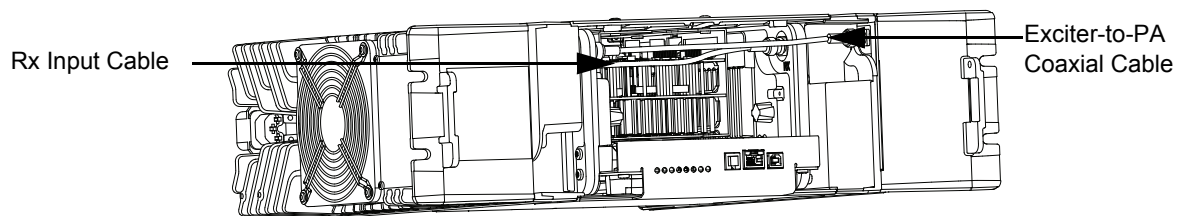
7. Secure the fan to the Power Supply casting with the four screws or PA casting with the five screws.
8. Orient the connector as before and push the power connector into the plug on the casting.
9. Restore power to the base station/repeater and ensure the fan runs briefly at power-on.

**Note** The PA and PS fans have different fan terminations. The PA fan has a fifth screw to terminate its ground wire.

**Note** When the PA fan is replaced, it is recommend to replace the PS fan as well since the PS fan is not alarmed upon its failure.

### 15.7.2.2 Power Amplifier Module

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Remove the base station/repeater from the rack or cabinet.
3. If the base station/repeater is equipped with an External Preselector, label and disconnect the corresponding RF coax cables to the Preselector and remove the screws securing the Preselector to the base station/repeater.
4. Remove the two screws securing the battery backup connector to the PA casting.
5. Disconnect the Exciter-to-PA coaxial cable from the PA module (See [Figure 15-4](#)) by pushing in on the outer ring and turning.

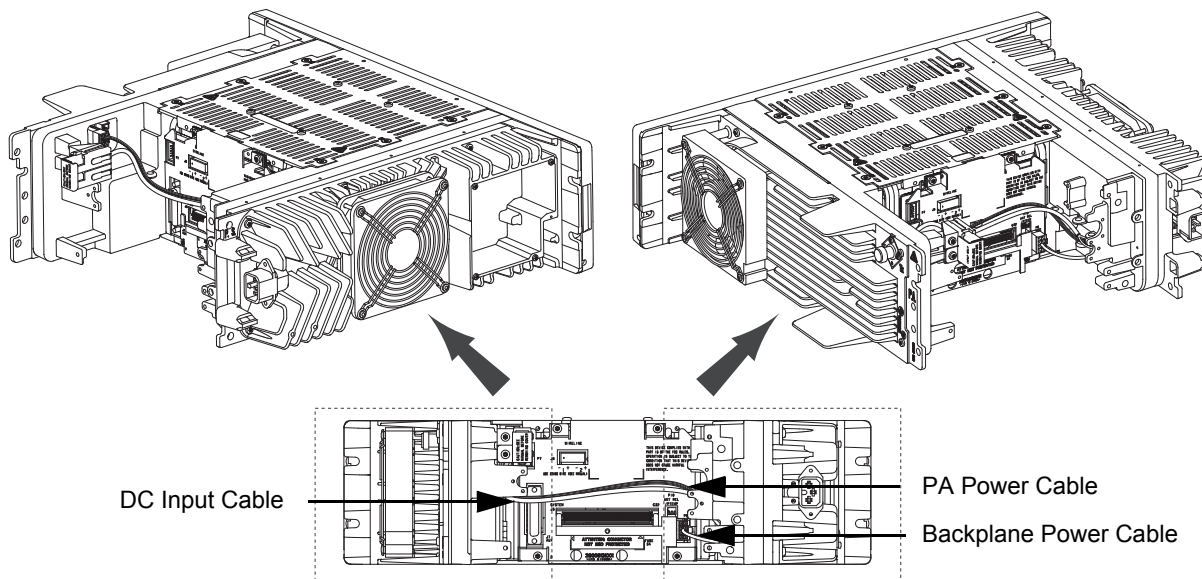


*Figure 15-4 Removing two cables from the front*

6. Remove the six screws securing the top and bottom plates to the PA Cover.
7. Ensure that the correct PA Module is being installed.
8. Install the replacement PA Module.
9. Line up holes in the PA cover with the corresponding holes in the top and bottom plates.
10. Secure the PA Module to the casting with the six screws.
11. Reconnect all cables.
12. Secure the battery backup connector to the PA casting.
13. Replace the optional Preselector with the two screws and reconnect the cables.
14. Restore power to the base station/repeater.

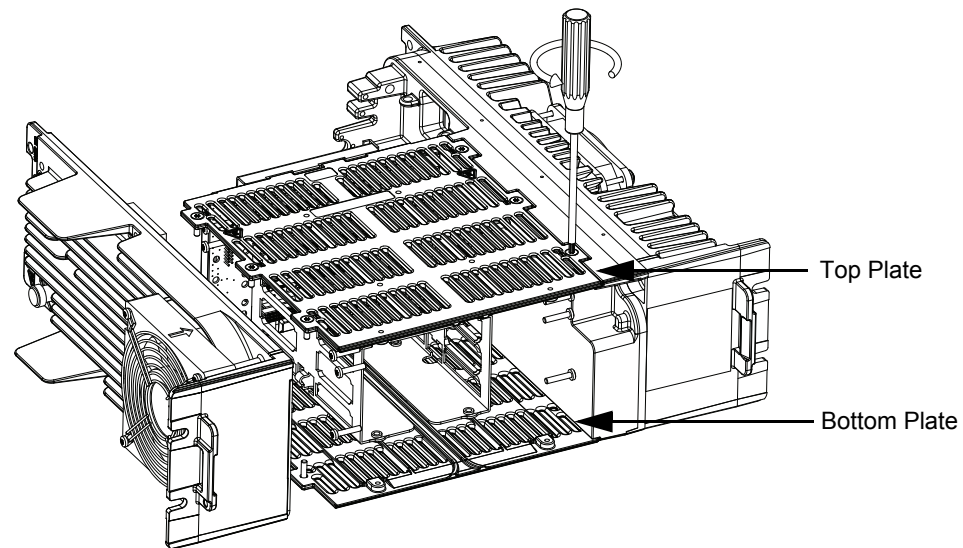
### 15.7.2.3 Power Supply Module

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Remove the base station/repeater from the rack or cabinet.
3. If the base station/repeater is equipped with an External Preselector and/or Antenna Relay, label and disconnect the corresponding RF coax cables to the Preselector and/or Antenna Relay. Then remove the screws securing Preselector and/or Antenna Relay to the base station/repeater.
4. Remove the two screws securing the battery backup connector to PA casting.
5. Disconnect all cables (See [Figure 15-5](#)), as follows:
  - Backplane Interface Board Power Cable
  - PA Power Cable
  - DC Input Cable



*Figure 15-5 Removing three cables from the back*

6. Remove the six screws securing the top and bottom plates to the Power Supply casting and remove the Power Supply Module (See [Figure 15-6](#)).

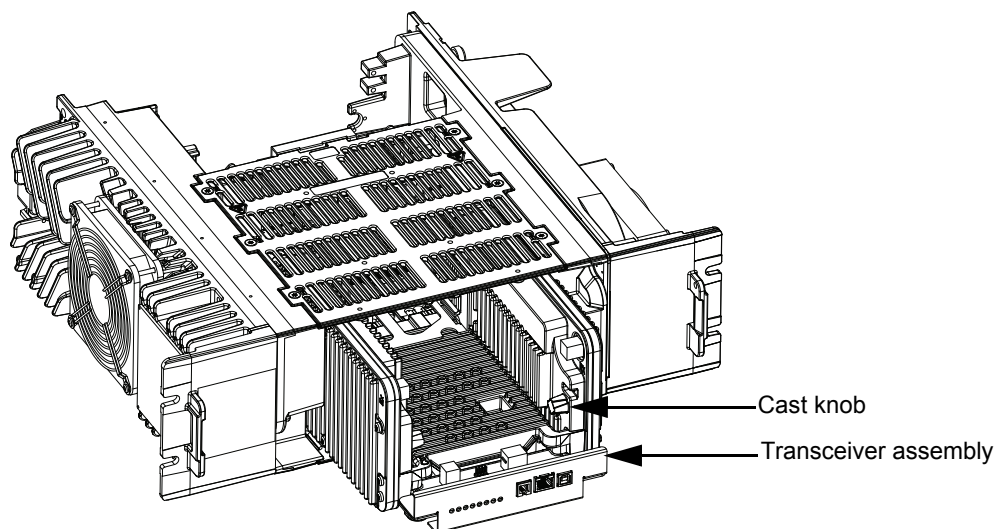


*Figure 15-6 Removing Top and Bottom Plates*

7. Ensure that the correct Power Supply Module is being installed.
8. Install the replacement Power Supply Module.
9. Line up the holes in the Power Supply casting with the corresponding holes in the top and bottom plates.
10. Secure the Power Supply Module to the casting with the six screws.
11. Reconnect all the cables and peripherals (if installed).
12. Restore power to the base station/repeater.

### 15.7.2.4 Exciter Module

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Disconnect the following cables (See [Figure 15-4](#)):
  - Rx cable from Receiver Module
  - Exciter-to-PA coaxial cable
3. Remove the two screws holding the transceiver assembly to the bottom plate.
4. Pull forward on the cast knobs (above the front panel that projects horizontally from the Exciter and Receiver module), carefully slide the transceiver assembly (Exciter Module, Receiver Module, Station Control Module (SCM)) out of base station/repeater (See [Figure 15-7](#)).



*Figure 15-7 Sliding Station Control transceiver assembly out*

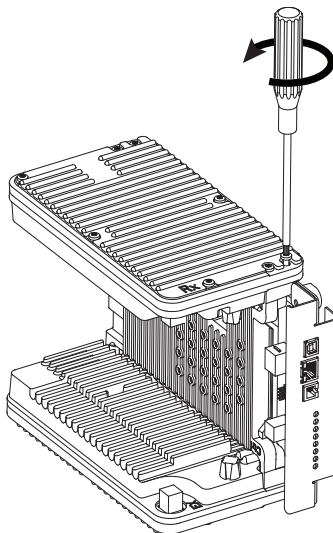
5. Remove the four screws securing the Exciter Module to the transceiver assembly and disconnect the Exciter Module from the Station Control Module (SCM).
6. Ensure that the correct Exciter Module is being installed.
7. Install the replacement Exciter Module by plugging the module into the connector on the SCM, replacing four screws, and sliding the transceiver assembly back into the base station/repeater (along the guide rails) to mate with the connector on the backplane interface board.

**Note** Do not slam the base station/repeater control transceiver assembly against the backplane interface board or push any harder than necessary to seat the connector.

8. Reconnect all the cables.
9. Fasten the transceiver assembly into unit using two screws.
10. Restore power to the base station/repeater.

### 15.7.2.5 Station Control Module

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Disconnect the cables, as follows:
  - Rx cable from Receiver Module
  - Exciter-to-PA coaxial Cable
3. Remove the two screws holding the transceiver assembly to the bottom plate.
4. Pull forward on the cast knobs (above the front panel that projects horizontally from the Exciter and Receiver module), carefully slide the transceiver assembly (Exciter Module, Receiver Module, Station Control Module (SCM)) out of the base station/repeater (See [Figure 15-7](#)).
5. Remove four screws securing Exciter Module, and four screws securing Receiver Module to the SCM, and disconnect both modules from the SCM (See [Figure 15-8](#)).



*Figure 15-8 Removing screws securing Exciter Module, Receiver Module and SCM*

6. Ensure that the correct Station Control Module is being installed.
- Note** If the Station Control Module is replaced, contact the Motorola System Support Center to obtain the updated License Key if any premium features were purchased, see “Purchasing Radio Features” section in the Online Help of the Customer Programming Software (CPS) for further details.
7. Install the replacement Station Control Module by plugging the Exciter Module and the Receiver Module into the respective connectors on the new SCM. Tighten the screws and slide the transceiver assembly back into the base station/repeater (along the guide rails) to mate with the connector on the backplane interface board.
- Note** Do not slam the transceiver assembly against the backplane interface board or push any harder than necessary to seat the connector.
8. Reconnect all the cables.
  9. Fasten the transceiver assembly into the unit using the two screws.
  10. Restore power to the base station/repeater.

### 15.7.2.6 Receiver Module

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Disconnect all the cables, as follows:
  - Rx cable from Rx Module
  - Exciter-to-PA coaxial cable
3. Remove the two screws holding the transceiver assembly to bottom plate.
4. Pull forward on the cast knobs (above the front panel that projects horizontally from the Exciter and Receiver module), carefully slide the transceiver assembly (Exciter Module, Receiver Module, Station Control Module (SCM)) out of the base station/repeater.
5. Remove the four screws securing the Receiver Module to the transceiver assembly and disconnect Receiver Module from the Station Control Module (SCM).
6. Ensure that the correct Receiver Module is being installed.
7. Install the replacement Receiver Module by plugging the module into the connector on SCM, replacing four screws, and sliding the transceiver assembly back into the base station/repeater (along the guide rails) to mate with the connector on the backplane interface board.

**Note** Do not slam the transceiver assembly against the backplane interface board or push any harder than necessary to seat the connector.

8. Reconnect all cables.
9. Fasten the transceiver assembly into the unit with the two screws.
10. Restore power to the base station/repeater.



### 15.7.2.7 External Preselector Module

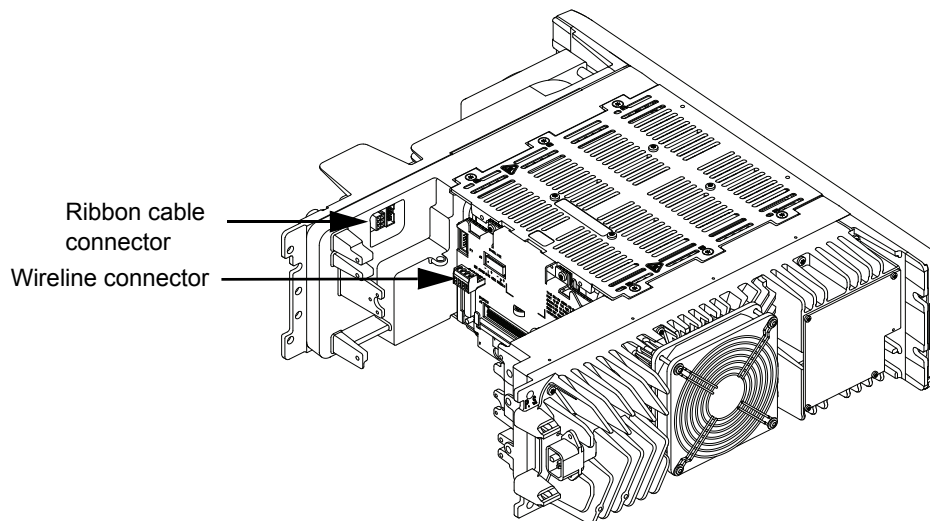
1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Disconnect cable to Receiver antenna connection and cable to Receiver Module.
3. Remove the two screws securing External Preselector to the back of the base station/repeater.
4. Ensure that the correct External Preselector is being installed.
5. Install the replacement External Preselector by reconnecting the two cables and secure the External Preselector to the base station/repeater with the two screws.
6. Restore power to the base station/repeater.

### 15.7.2.8 Backplane Interface Board

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Disconnect all cables (See [Figure 15-5](#)), as follows:
  - Backplane Interface Board Power Cable
  - PA Power Cable
  - DC Input Cable
3. Pull forward on transceiver assembly pull tabs, carefully slide the transceiver assembly (Exciter Module, Receiver Module, Station Control Module (SCM)) out of the base station/repeater.
4. If the base station/repeater is equipped with an External Preselector, label and disconnect the corresponding RF coax cables to the Preselector and remove the screws securing the Preselector to the base station/repeater.
5. If the base station/repeater is equipped with an antenna relay, disconnect the control and coaxial cables and remove the screws securing relay to the base station/repeater.
6. Remove the DC Input cable from the base station/repeater.
7. Disconnect and remove the cable ties from all cables connected to PA module.

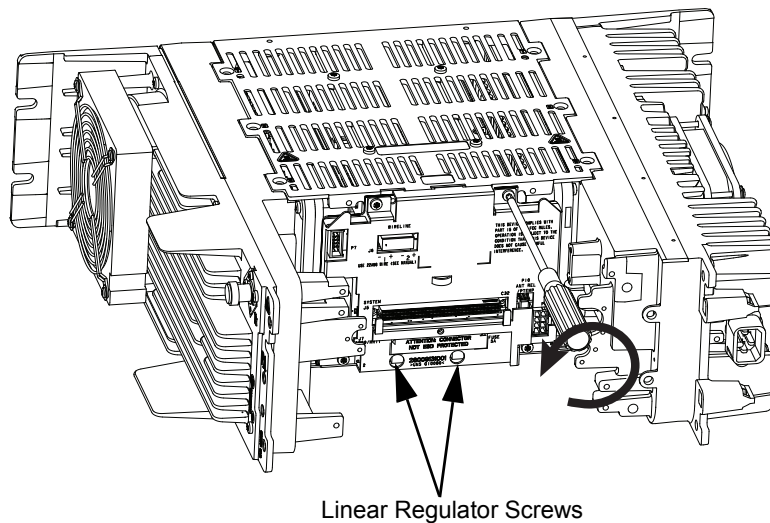
**Note** Label all cables before disconnecting them.

8. Remove the ribbon cable and Wireline connector from the backplane interface board metal shield (See [Figure 15-9](#)).



*Figure 15-9 Removing ribbon cable and Wireline connector*

9. Remove the four screws which secure the metal shield and the backplane interface board to the top and bottom plates (See [Figure 15-10](#)).



*Figure 15-10 Removing metal shield/metal cover*

10. Remove the backplane interface board shield.
11. Remove the two linear regulator screws (See [Figure 15-10](#)) at the bottom centre of the backplane interface board.



Caution

To control the amount of preload and to prevent under or over torque, see [Section 15.10](#) (Backplane M3 screws) for the size fastener of screw torque to be applied on the two linear regulator screws.

12. Place the backplane interface board to the side.
13. Ensure the correct backplane interface board is being installed.
14. Install the replacement backplane interface board and shield with the six screws.
15. Reconnect all the cables which were removed previously according to the disassembly steps (See step 2 to step 8).
16. Restore power to the base station/repeater.

### 15.7.2.9 Wireline Interface Board

1. Make sure the base station/repeater power is turned off at the breaker to the AC or DC source.
2. Ensure that an ESD cable is connected to the base station/repeater.
3. Remove the Wireline Interface Board from the top option card slot by carefully pulling it straight out from the base station/repeater (BR). Use the Option Card tool (part # 6683334X01) to pull the card out. Make sure that the board is placed on properly grounded anti-static surface.
4. Set the 2-wire and 4-wire DC Remote control jumpers on the replacement board to match those on the faulty board.
5. Install the replacement Wireline Interface Board by sliding the board into top option card slot, and firmly seating the board Euro-card connector into the mating backplane interface board connector. (Do not slam the board against the backplane interface board or push any harder than necessary to seat the connectors).
6. Affix the provided Part 68 label to the area noted in [Figure 15-11](#) (if not already present).

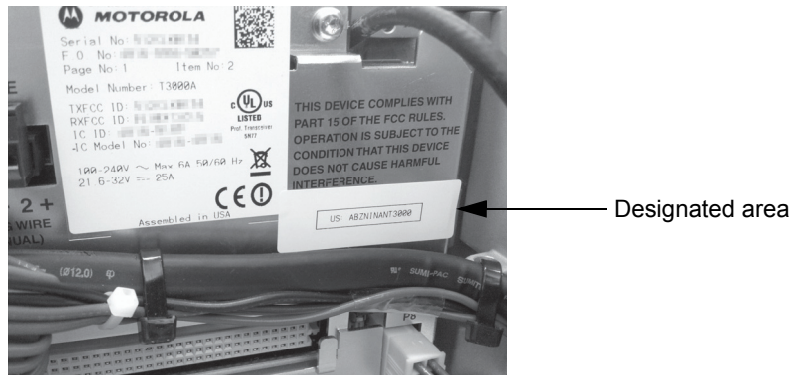


Figure 15-11 Location to affix the Part 68 label

**Note** The Part 68 label is supplied if the MTR3000 Wireline Card is ordered as an option with the MTR3000 base station/repeater.

7. Restore power to the base station/repeater.

## 15.8 Exploded Mechanical View

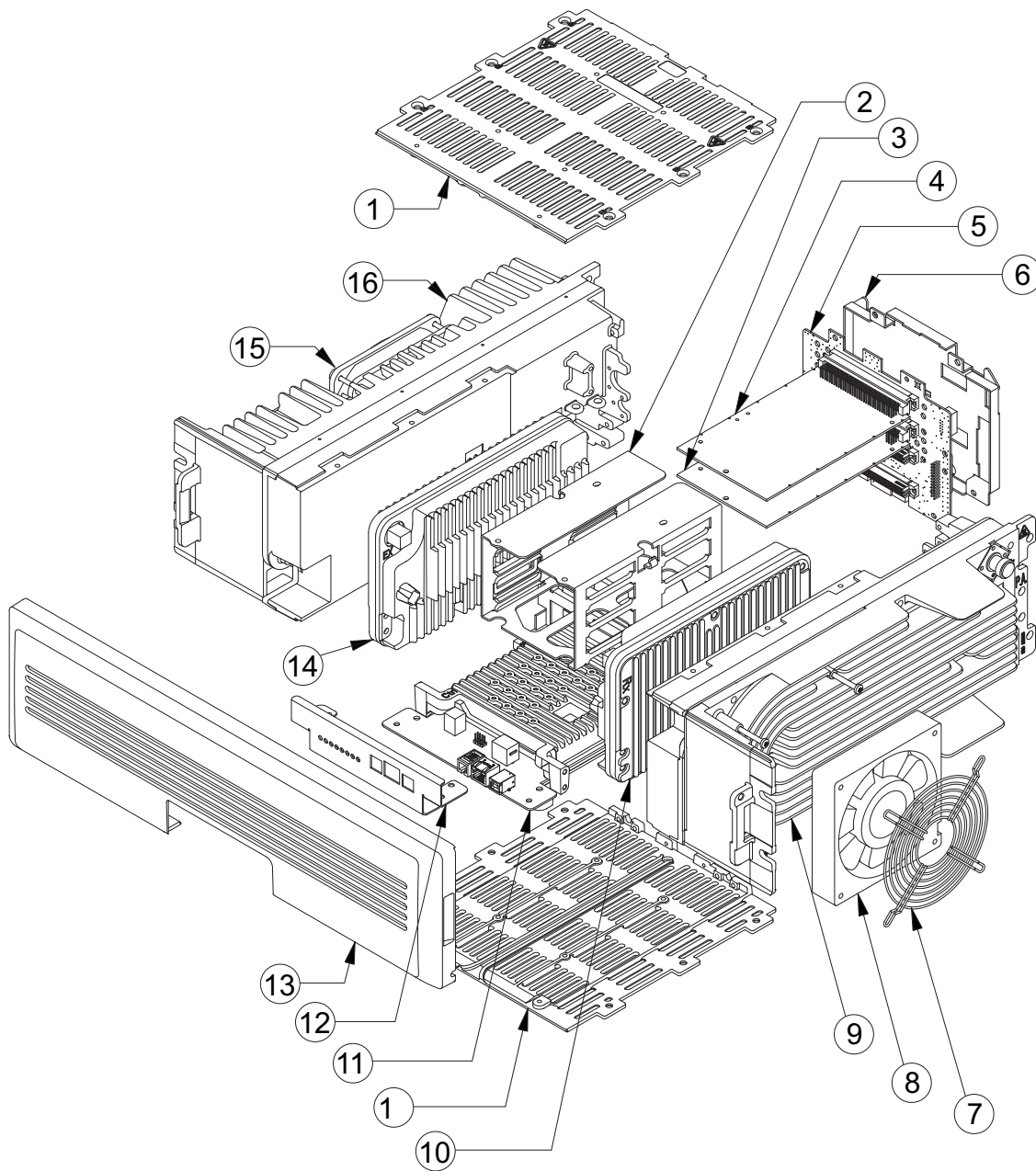


Figure 15-12 MTR3000 Assembly Exploded View

## 15.9 Parts List

Table 15-3 MTR3000 Exploded View Parts List

Item No.	Description	Part Number
1	Top/Bottom Chassis Plate	15009086001
2	Option Card Bracket	0782635X03
3	Auxiliary I/O Board (FRU)*	CLN1206_
4	2/4-wire Wireline Board	DLN6720_
5	Backplane Interface Board	CLN8499_
6	Backplane Interface Board Shield	26009131001
7	Fan Grille (Power Amplifier or Power Supply)	1383852R01
8	Power Amplifier Fan	59009254002
9	Power Amplifier (FRU)	See <a href="#">Section A.1.1</a>
10	Receiver Module (FRU)	See <a href="#">Section A.1.1</a>
11	Station Control Module (FRU)	See <a href="#">Section A.1.1</a>
12	Station Control Module Front Panel	64009266001
13	Front Bezel	6475414H01
14	Exciter Module (FRU)	See <a href="#">Section A.1.1</a>
15	Power Supply Fan	59009254001
16	Power Supply (FRU)	DLN6707_

**Note** (\*) Not available for the 800/900 MHz band.

## 15.10 Torque Chart

Table 15-4 lists the various screws by description and torque values in different units of measure. Torque all screws to the recommended value when assembling the base station/repeater.

Table 15-4 Torque Specifications for Nuts and Screws

Assembly	Description	Bit Size	Torque		
			N-m	lbs-in	kg-cm
Exciter	M4 screws	T20	2.8	25	28.8
Receiver					
Station Control Module					
Power Amplifier					
Base Radio	M4 screws	T20	2.3	20	23.0
Backplane	M4 screws	T20	2.3	20	23.0
Power Amplifier	M3.5 screws	T15	1.7	15	17.3
Power Amplifier	M3 screws	T10	1.1	10	11.5
Base Radio	M3 screws	T10	1.1	17	11.5
Backplane	M3 screws	T10	1.1	17	11.5

## Notes



## Appendix A Accessories

### A.1 Introduction

Motorola provides the following approved accessories to improve the productivity of your base station/repeater.

For a list of Motorola-approved accessories, visit the following web site:  
<http://www.motorola.com/governmentandenterprise>

#### A.1.1 MOTOTRBO MTR3000 FRU

##### A.1.1.1 Power Amplifier, Exciter and Receiver

Part No.	Description
DLN6710_	VHF 100W PA (136–154 MHz)
DLN6711_	VHF 100W PA (150–174 MHz)
DLN6712_	VHF Exciter, (136–174 MHz)
DLN6713_	VHF Receiver, (136–174 MHz)
DLN6701_	UHF 100W PA (403–470 MHz)
DLN6702_	UHF 100W PA (470–524 MHz)
DLN6703_	UHF Exciter (403–470 MHz)
DLN6704_	UHF Exciter (450–524 MHz)
DLN6705_	UHF Receiver (403–470 MHz)
DLN6706_	UHF Receiver (450–524 MHz)
DLN6714_	800/900 MHz 100W PA
DLN6715_	800/900 MHz Exciter
DLN6716_	800/900 MHz Receiver

##### A.1.1.2 Power Supply

Part No.	Description
DLN6707_	AC/DC Power Supply

### A.1.1.3 Control/Wireline/Backplane/Miscellaneous

Part No.	Description
DLN6719_	Station Control TCXO (NAG)
DLN6718_	Station Control OCXO (NAG)
DLN6756_	Station Control TCXO (LACR)
DLN6757_	Station Control OCXO (LACR)
DLN6759_	Station Control TCXO (APAC)
DLN6758_	Station Control OCXO (APAC)
DLN6761_	Station Control TCXO (EMEA)
DLN6760_	Station Control OCXO (EMEA)
DLN6720_	2 Wire/4 Wire Wireline
DLN6721_	Backplane Interface Board
DLN6776_	Receiver Exciter
DLN6777_	Receiver PA

### A.1.1.4 Manuals

Part No.	Description
CLN8629	MOTOTRBO MTR3000 Installation and User CD

- Note** The Manual Install and User CD contains:
- MOTOTRBO MTR3000 Installation and User Manual (Including MTR2000 to MTR3000 MOTOTRBO Upgrade Kit)
  - MOTOTRBO MTR3000 Basic Service Manual

## A.1.1.5 Microphones/Speakers

Part No.	Description
GMMN4063	Noise Cancelling Mic
0185180U01	Cable For External Speaker
HSN1006	Speaker

## A.1.1.6 Miscellaneous Accessories

Part No.	Description
RRX4025	ISB50LNC2 Bulkhead Arrestor 125-100
RRX4032	T-1 ISB50 Series Round Member Mount
RRX4021	Lightning/Surge Arrestor
RRX4034	Lightning/Surge Arrestor (110/220V AC Line Surge Protector)
TRN4589	Dual Line Suppressor
3083908X02	Cbl, Field System Adapter

## A.1.1.7 Antenna Relay Kits

Part No.	Description
CLN1317*	Antenna Relay
CLN1316**	Antenna Relay For Preselector

**Note** (\*) Includes Antenna Relay and required cables for stations without X265, Preselector  
(\*\*) Includes Antenna Relay and required cables for stations that include X265, Preselector

## A.1.1.8 Preselector Cable Kits

Part No.	Description
CKN1039*	Preselector Cable Kit
CKN1040**	Preselector Cable For Antenna Relay

**Note** (\*) Order this cable for stations without X371, Antenna Relay  
(\*\*) Order this cable for stations with X371, Antenna Relay

### A.1.1.9 Cabinets/Racks and Hardware

Part No.	Description
THN6700	12 inch Indoor Cabinet
THN6701	30 inch Indoor Cabinet
THN6702	46 inch Indoor Cabinet
THN6752	30 inch Modular Rack (16 RK U)
THN6753	45 inch Modular Rack (24 RK U)
THN6754	52 inch Modular Rack (27 RK U)
THN6788_	Slides Motorola Cabinet
CLN6679_	Rack Mount Hardware

**Note** All cabinets and racks are ordered through aftermarket accessories and are not factory installed. To order, please call 1-800-422-4210.

## A.1.2 MTR2000 MOTOTRBO Upgrade Kit FRU

### A.1.2.1 Exciter and Receiver

Part No.	Description
DLN6712_	VHF Exciter, (136–174 MHz)
DLN6713_	VHF Receiver, (136–174 MHz)
DLN6703_	UHF Exciter, (403–470 MHz)
DLN6705_	UHF Receiver (403–470 MHz)
DLN6715_	800/900 MHz Exciter
DLN6716_	800/900 MHz Receiver

### A.1.2.2 Power Supply

Part No.	Description
DLN6707_	AC/DC Power Supply

### A.1.2.3 Control/Miscellaneous

Part No.	Description
DLN6719_	Station Control TCXO (NAG)
DLN6718_	Station Control OCXO (NAG)
DLN6756_	Station Control TCXO (LACR)
DLN6757_	Station Control OCXO (LACR)
DLN6759_	Station Control TCXO (APAC)
DLN6758_	Station Control OCXO (APAC)
DLN6761_	Station Control TCXO (EMEA)
DLN6760_	Station Control OCXO (EMEA)
DLN6721_*	Backplane Interface Board

**Note** (\*) Order this backplane interface board to use the MTR3000 Wireline Card on the MTR2000 MOTOTRBO Upgrade.

### A.1.2.4 Manuals

Part No.	Description
CLN8629	MOTOTRBO MTR3000 Installation and User CD

## A.1.2.5 Cables

Part No.	Description
DDN9957A	6 feet High speed USB cable (Type A -B)
3083908X02	System Connector Cable
30009314003	Community Repeater Panel Cable
30009314001	Auxiliary System Cable
30009314006	Phone Patch Cable (Analog)
30009314007	Phone Patch Cable (Digital)

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## Appendix B EMEA Warranty, Service and Technical Support

### B.1 Warranty and Service Support

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

#### B.1.1 Warranty Period and Return Instructions

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

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

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

#### B.1.2 After Warranty Period

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

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

## B.2 European Radio Support Centre (ERSC)

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

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

Or dial the European Repair and Service Centre:

Tel: +49 30 6686 1555

Fax: +49 30 6686 1579

Email: ERSC@motorolasolutions.com

Please use these numbers for repair enquiries only.

## B.3 Piece Parts

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

Orders for replacement parts, kits and assemblies should be placed directly on Motorola's local distribution/dealer organization or via Motorola Online at: <http://www.motorola.com/emeaonline>

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



## B.4 Technical Support

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

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

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

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

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

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

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

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

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

## B.5 Further Assistance From Motorola

You can also contact the Customer Help Desk through the following web address.  
[http://www.motorola.com/Business/US-EN/Pages/Contact\\_Us](http://www.motorola.com/Business/US-EN/Pages/Contact_Us)

## **Notes**

## Appendix C LACR Replacement Parts Ordering and Motorola Service Centers

### C.1 Commercial Warranty

#### Limited Warranty

#### MOTOROLA COMMUNICATION PRODUCTS

##### I. What This Warranty Covers And For How Long

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

Base Station/Repeater	Two (2) Years
Product Accessories	One (1) Year

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

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

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

## II. General Provisions

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

## III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also open a *Contact Us* case on Motorola Online (<http://www.motorola.com/businessonline>).

## IV. What This Warranty Does Not Cover

This warranty does not cover:

- A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.
- B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.
- C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.
- D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.
- E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola 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.
- F. Product which has had the serial number removed or made illegible.
- G. Freight costs to ship the Product to the repair depot.
- H. Batteries (because they carry their own separate limited warranty) or consumables.
- I. Customer's failure to comply with all applicable industry and OSHA standards.
- J. A Product which due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.
- K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- L. Normal and customary wear and tear.

## V. Governing Law

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

## C.2 Replacement Parts Ordering

### C.2.1 Basic Ordering Information

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

### C.2.2 Motorola Online

Motorola Online users can access our online catalog at <http://www.motorola.com/businessonline>

To register for online access:

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

## C.3 Motorola Service Centers

### C.3.1 Servicing Information

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

### C.3.2 Motorola de México, S.A.

Bosques de Alisos 125  
Col. Bosques de las Lomas CP 05120  
México D.F.  
México  
Tel: (5) 257-6700

### C.3.3 Motorola de Colombia, Ltd.

Carrera 7 No. 71-52  
Bogota - Colombia  
Tel: (571) 376-6990

## Notes

## Appendix D NAG Replacement Parts Ordering and Motorola Service Centers

### D.1 Commercial Warranty

#### Limited Warranty

#### MOTOROLA COMMUNICATION PRODUCTS

##### I. What This Warranty Covers And For How Long

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Base Station/Repeater	Two (2) Years
Product Accessories	One (1) Year

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

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

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

## II. General Provisions

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

## III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also open a *Contact Us* case on Motorola Online (<http://www.motorola.com/businessonline>).

## IV. What This Warranty Does Not Cover

This warranty does not cover:

- A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.
- B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.
- C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.
- D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.
- E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola 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.
- F. Product which has had the serial number removed or made illegible.
- G. Freight costs to ship the Product to the repair depot.
- H. Batteries (because they carry their own separate limited warranty) or consumables.
- I. Customer's failure to comply with all applicable industry and OSHA standards.
- J. A Product which due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.
- K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- L. Normal and customary wear and tear.

## V. Governing Law

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



## **D.2 Replacement Parts Ordering**

### **D.2.1 Basic Ordering Information**

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

### **D.2.2 Motorola Online**

Motorola Online users can access our online catalog at

<http://motorola.com/businessonline>

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 <http://motorola.com/businessonline>

### **D.2.3 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.

### **D.2.4 Telephone Orders**

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

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

### **D.2.5 Fax Orders**

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

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

### **D.2.6 Parts Identification**

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

## **D.2.7 Product Customer Service**

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

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

## **D.3 Motorola Service Centers**

### **D.3.1 Servicing Information**

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

### **D.3.2 Motorola Service Center**

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

### **D.3.3 Motorola Federal Technical Center**

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

### **D.3.4 Motorola Canadian Technical Logistics Center**

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

# Appendix E Asia-Pacific Warranty, Service and Technical Support

## E.1 Commercial Warranty

### Limited Warranty

#### MOTOROLA COMMUNICATION PRODUCTS

##### I. What This Warranty Covers And For How Long

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

Base Station/Repeater	Two (2) Years
Product Accessories	One (1) Year

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

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

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

## II. General Provisions

This warranty sets forth the full extent of MOTOROLA'S responsibilities regarding the Product. Repair, replacement or refund of the purchase price, at MOTOROLA'S option, is the exclusive remedy. THIS WARRANTY IS THE COMPLETE WARRANTY FOR THE PRODUCT AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS. MOTOROLA DISCLAIMS, TO THE FULL EXTENT PERMISSIBLE BY LAW, ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, MOTOROLA SHALL NOT IN ANY EVENT BE LIABLE, FOR ANY COMMERCIAL LOSS, INCONVENIENCE, LOSS OF USE, TIME, DATA, GOOD WILL, REVENUES, PROFITS OR SAVINGS, INCREASED EXPENSE OF OPERATION, OR OTHER SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL LOSSES OR DAMAGES IN ANY WAY RELATED TO OR ARISING FROM THE SALE, USE OR OPERATION OF THE PRODUCT.

## III. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and deliver or send the Product item, transportation and insurance prepaid, to an authorized warranty service location before the expiration of the warranty period. Warranty service will be provided by Motorola through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service. You can also open a *Contact Us* case on Motorola Online (<http://www.motorola.com/businessonline>).

Any dispute arising out of or in connection with this warranty which the parties cannot amicably resolve will be subject to the dispute resolution procedures set out in the agreement under which the Product was supplied. If no such procedure exists, then such dispute shall be referred to and finally resolved by the courts of the Republic of Singapore, to whose non exclusive jurisdiction the parties submit.

## IV. What This Warranty Does Not Cover

This warranty does not cover:

- A. Defects or damage resulting from use of the Product in other than its normal customary or authorized manner.
- B. Defects or damage from misuse, accident, liquid, lightning, neglect or act of God.
- C. Defects or damage from testing, maintenance, installation, alteration, modification, or adjustment not provided or authorized in writing by MOTOROLA.
- D. Breakage or damage to antennas unless caused directly by defects in material or workmanship.
- E. A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola 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.
- F. Product which has had the serial number removed or made illegible.
- G. Freight costs to ship the Product to the repair depot.
- H. Batteries (because they carry their own separate limited warranty) or consumables.
- I. Customer's failure to comply with all applicable industry and OSHA standards.
- J. A Product which due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with MOTOROLA's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from MOTOROLA.

- K. Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- L. Normal and customary wear and tear.

## V. After Warranty Period

After the Warranty Period, Motorola continues to support its Products in two ways.

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

## E.2 Asia-Pacific Customer Interaction Centre (APCIC)

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

Australia		1-800-457-439
China	Northern Area	10-800-713-0885
	Southern Area	10-800-130-0867
	Local In-Country	+86 21 6108 6109
	Alternate Number	10-800-152-1206
Hong Kong		30027861
India		000-800-100-3098
Indonesia		001-803-015-202-0530
Japan	Toll Free	00531-13-1127
	Local In-Country	(81) 335-708-643
Korea South		080-681-0880
Malaysia		1-800-812-384
New Zealand	Toll Free	0800-448-472
	Local In-Country	9-913-1029
Phillipines		1-800-1441-0546
Singapore		64155110
Taiwan		0080-114-8690
Thailand		001-800-441-0950

## E.3 Further Assistance from Motorola

You can also contact the Customer Help Desk through the following web address.  
<http://www.motorola.com/Business/US-EN/Support/Support+Contacts/Phone+Support>

**Notes**

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# Appendix F MTR3000 Third Party Controllers

## F.1 Overview

The MTR3000 Base Station/Repeater (BR) is capable of interfacing to a number of third party controllers via the four-wire and GPIO/GPI interface afforded by the J7 backplane AUX connector. This section covers the connections and signal levels between the third party controllers and the base station/repeater, as well as the audio path configuration needed via CPS. Note that this section is not a substitute for a more comprehensive instruction detailed in the vendor's manuals of their respective third party controllers.

The third party controllers supported by MTR3000 Base Station/Repeater are as follows:

- Community Repeater Panel (Zetron Model 38-Max)
- Phone Patch (Zetron Model 30)
- Tone Remote Adapter (Motorola Model L3276)
- LTR (Trident Model Raider and Marauder)
- Passport (Trident Model NTS) (see Note)



Caution

Do not hot swap any of the third party controllers as this could (at a minimum) cause a malfunction with the base station/repeater.

**Note** The MTR3000 Base Station/Repeater only support the third party controllers noted above when it is configured in analog mode. The screen capture below shows the CPS location to configure the MTR3000 Base Station/Repeater for analog mode.

**Note** If the third party controllers are supplied power by the MTR3000 Base Station/Repeater, then the MTR3000 Base Station/Repeater needs to be in a powered off state when establishing (or removing) the connection to the MTR3000's J7 backplane connector.

**Note** The MTR3000 Base Station/Repeater must have a modulation limit alignment before it is used with any third party controllers. The modulation limit alignment is accomplished via the Tuner application, with the procedure itself noted in the Tuner application's online help as well as in [Chapter 14](#).

**Note** 14.2 VDC Power (Pin 20) and GPIO 10 (Pin 5) are not supported on an upgraded MTR2000 J7 backplane connector.

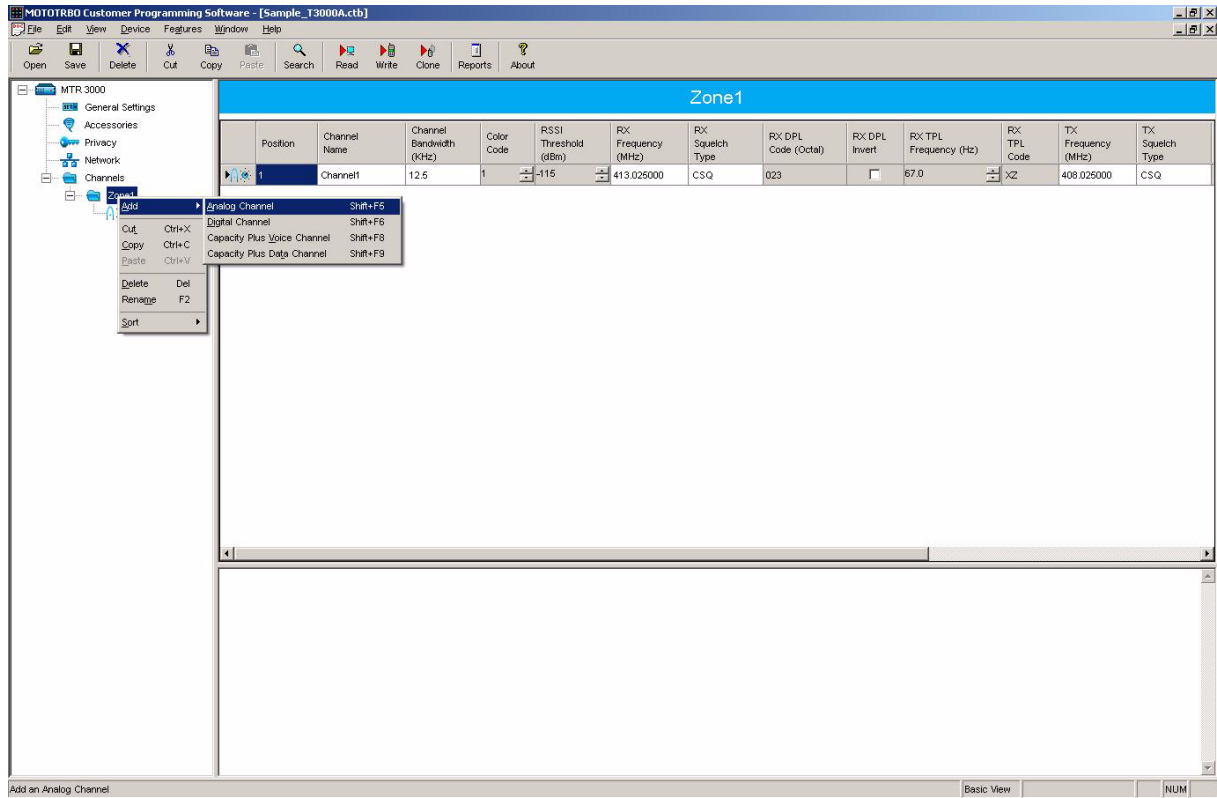


Figure F-1 CPS settings to configure MTR3000 Base Station/Repeater for analog mode

## F.2 Community Repeater Panel

### F.2.1 Description

The MTR3000 Base Station/Repeater is capable of Multi Coded Squelch through the Zetron Model 38 Repeater Panel. The Model 38 Repeater Panel interconnects to the MTR3000 Base Station/Repeater and provides 38 PL tones and 22 DPL tones standard.

See Zetron Model 38 Repeater Panel Instruction Manual (supplied with the panel) for panel specifications, operation, installation, alignment, programming, and repair information.



Figure F-2 Model Zetron 38 Repeater Panel

### F.2.2 Compatibility

Zetron Model 38 Repeater Panel is compatible for all versions of MTR3000 Software and Hardware.



### F.2.3 Hardware Connections

The connections between the MTR3000 Base Station/Repeater and the community repeater panel are facilitated with a multi-conductor cable connected between the J7 MTR3000 25-Pin connector and that of the community repeater panel. The connection provides the following signals:

- Transmit Audio
- Receiver Audio
- Push-to-talk (PTT)
- Carrier Operated Relay (COR)
- 14.2 VDC (See note)
- Ground

**Note** If this connection is used, the external equipment must draw less than 1A. This connection must be accessed by Pin C32 of connector J5 on an upgraded MTR2000.

Signal connections are noted in [Figure F-1](#). The MTR3000 connector and physical Pin locations are noted in the backplane interface board section of this manual. See Zetron Model 38 Repeater Panel manual for its connector and physical Pin locations. The part number for a pre-fabricated cable is noted in the MTR3000 ordering guide.

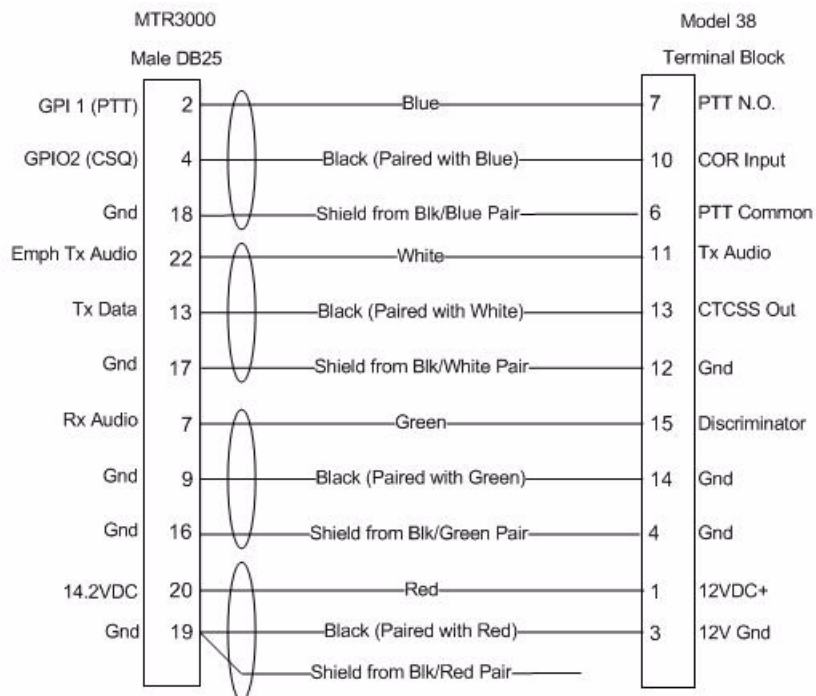


Figure F-3 Signal Connections between MTR3000 Base Station/Repeater and Community Repeater Panel

## F.2.4 CPS Configuration

The MTR3000 Base Station/Repeater will need to be configured via the CPS application as shown in [Figure F-4](#) and [Figure F-5](#). More specifically, the affected parameters are as follows:

- Audio Type
  - Rx and Tx Flat
- Disable Repeat Path
  - Checked
- GPIO Pin number 2, 11
  - Ext Mic PTT
  - Active Low
- GPIO Pin number 4
  - Carrier Squelch (CSQ) Detect
  - Active High
- Squelch Type (Rx)
  - CSQ
- Squelch Type (Tx)
  - CSQ

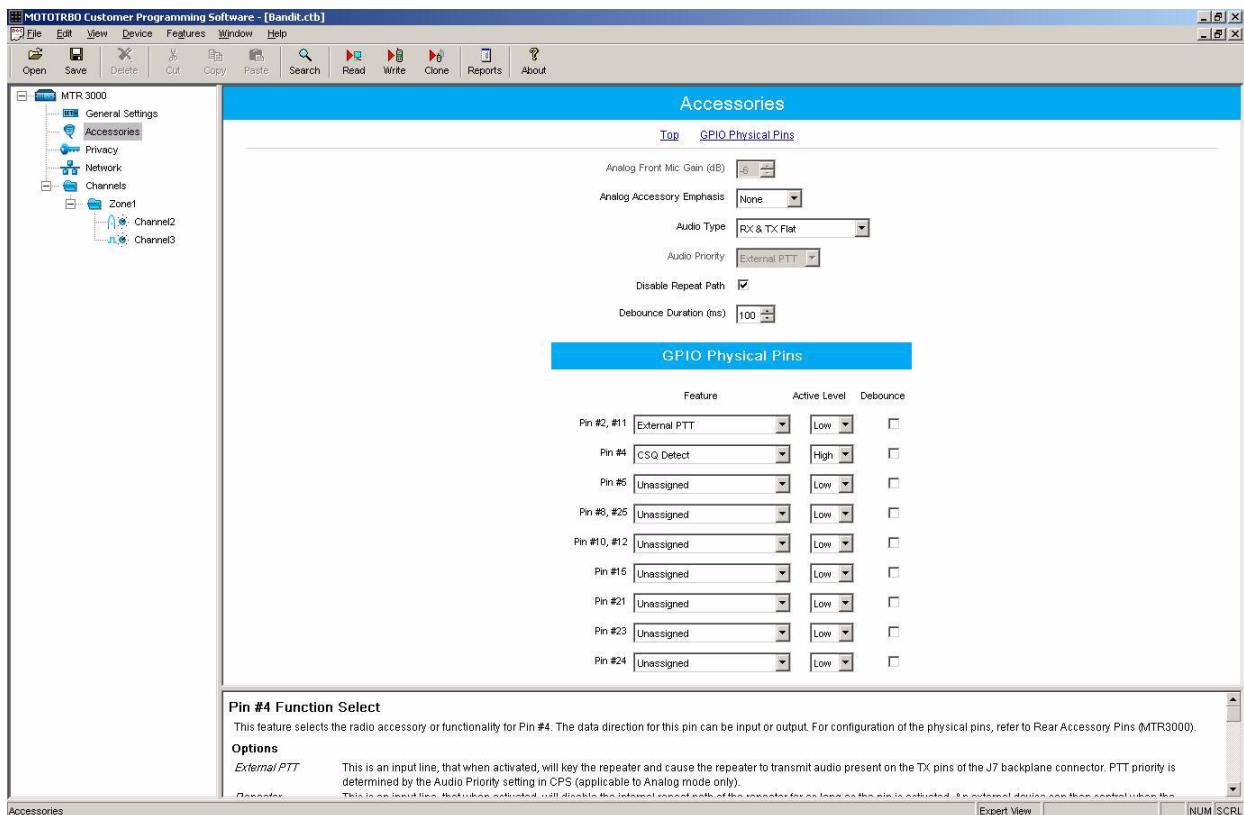


Figure F-4 CPS Configuration for Community Repeater Panel (1 of 2)

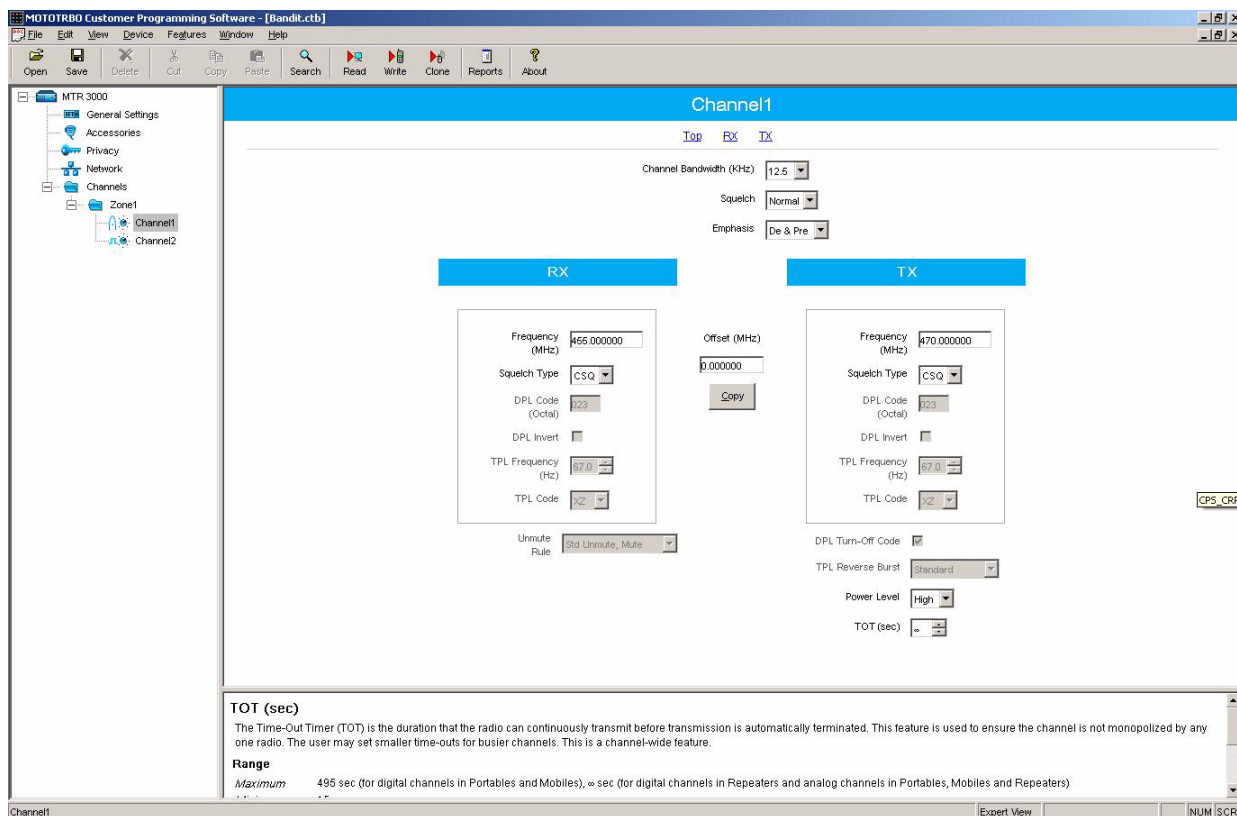


Figure F-5 CPS Configuration for Community Repeater Panel (2 of 2)

## F.2.5 Community Repeater Panel Settings

The input and output levels should be adjusted per the community repeater panel's instructions. The summary below gives a brief overview of the high level characteristics and community repeater panel settings for configuration with the MTR3000 Base Station/Repeater.

### F.2.5.1 Discriminator

The MTR3000 Base Station/Repeater's Receiver audio will yield 330mV rms into 50 kΩ with an RF input signal deviating at 60% RSD. With the community repeater panel's own loading impedance, the "Discriminator" signal delivered to the community repeater panel is at a high enough drive level to leave the community repeater panel's "Rx Audio Gain High/Low" switch in the factory default position (back panel Switch 1).

**Note** Under the System Programming, turn on the DCS Rx data.

### F.2.5.2 Tx Audio

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Emph Tx Audio port. The "Tx Audio" signal delivered by the community repeater panel is at a high enough drive level to leave the community repeater panel's "Tx Audio Gain High/Low" switch in the factory default position (back panel Switch 4).

**Note** Under the System Programming, turn on the DCS Tx data.

### F.2.5.3 Continuous Tone-Controlled Squelch Systems (CTCSS) Out

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Tx Data port. The "CTCSS" signal delivered by the community repeater panel is at a high enough drive level to leave the community repeater panel's "Encode gain high/low" switch in the factory default position (back panel Switch 3).

### F.2.5.4 Tx Audio Pre-Emphasis

Set the "Encode flat/ De-emphasized" switch to the Up position on the community repeater panel.

### F.2.5.5 Carrier Operated Relay (COR)

For use with the MTR3000 Base Station/Repeater, configure the specified back panel switches on the community repeater panel as follows:

- Switch 6 "COR source internal/external" (set to the Down position)
- Switch 7 "COR polarity positive/negative" (set to the Up position)
- Switch 8 "COR pull-up on/off" (set to the Up position)

## F.3 Phone Patch

### F.3.1 Description

The MTR3000 Base Station/Repeater is capable of multi-mode telephone interconnect through the Zetron Model 30 Phone Patch. The Zetron Model 30 Phone Patch interconnects to the MTR3000 Base Station/Repeater and allow users to initiate and receive land line telephone calls via the subscriber radios. When properly configured, subscribers can initiate and answer telephone calls. Via selective signaling, calls from land line users can be directed to any subscriber or to a specific user. Additionally, access control is also afforded by the Zetron Model 30 Phone Patch.

See Zetron Phone Patch Manual (supplied with the phone patch) for specifications, operation, installation, alignment, programming, and repair information.



Figure F-6 Zetron Model 30 Phone Patch

### F.3.2 Compatibility

Zetron Model 30 Phone Patch is compatible for all versions of MTR3000 Software and Hardware.

### F.3.3 Hardware Connections

The connections between the MTR3000 Base Station/Repeater and the phone patch are facilitated with a multi-conductor cable connected between the J7 MTR3000 25-Pin connector and that of the phone patch. The connection provides for the following signals:

- Transmit Audio
- Receiver Audio
- PTT
- COR
- 14.2 VDC (see Note)
- Ground

**Note** If this connection is used, the external equipment must draw less than 1A. This connection must be accessed by Pin C32 of connector J5 on an upgraded MTR2000.

Signal connections are noted in [Figure F-2](#). The MTR3000 Base Station/Repeater connector and physical Pin locations are noted in the backplane interface board section of this manual. See Zetron Model 30 manual for its connector and physical Pin locations. The part number for a pre-fabricated cable is noted in the MTR3000 ordering guide.

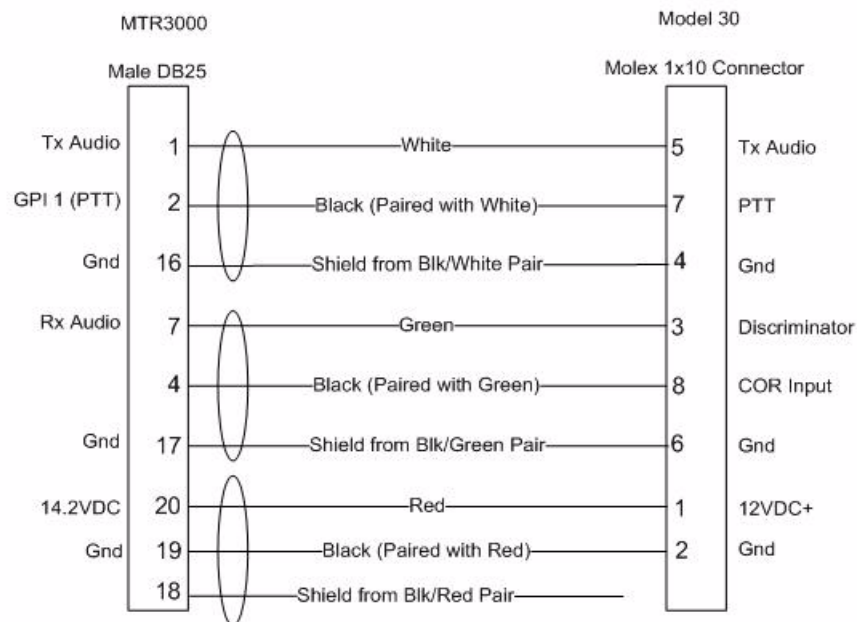


Figure F-7 Signal Connections between MTR3000 Base Station/Repeater and Zetron Model 30 Phone Patch (Analog Phone Patch Cable)

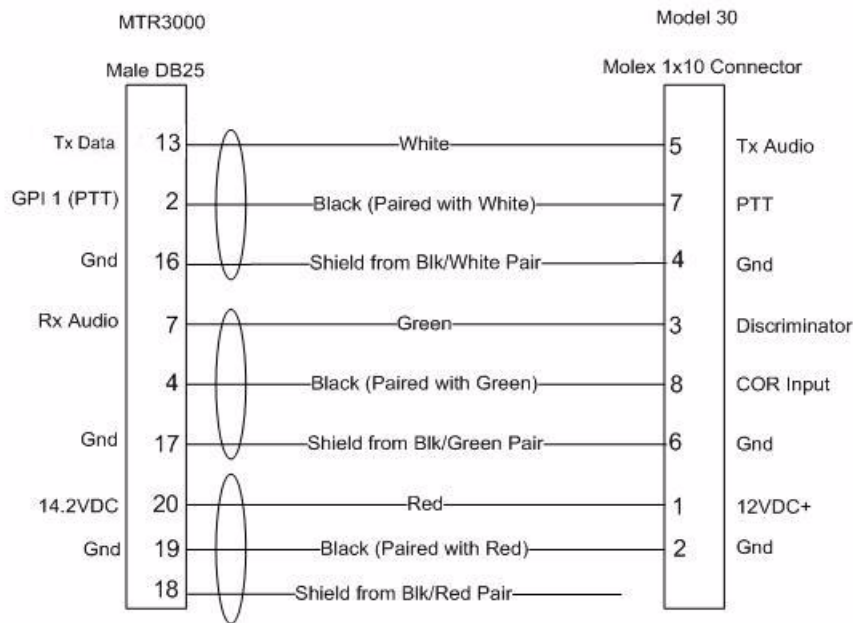


Figure F-8 Signal Connections between MTR3000 Base Station/Repeater and Zetron Model 30 Phone Patch (Digital Phone Patch Cable)

### F.3.4 CPS Configuration

The MTR3000 Base Station/Repeater will need to be configured via the CPS application as shown in Figure F-4 and Figure F-5. More specifically, the affected parameters are as follows:

- Audio Type
  - Rx & Tx Filtered Squelch
- Analog Accessory Emphasis
  - De & Pre
- Disable Repeat Path
  - Un-Checked
- Audio Priority
  - Repeat Path
- GPIO Pin number 2, 11
  - Ext Mic PTT
  - Active Low
- GPIO Pin number 4
  - PL/Talkgroup Detect
  - Active Low
- Squelch Type (Rx)
  - TPL
- Squelch Type (Tx)
  - TPL

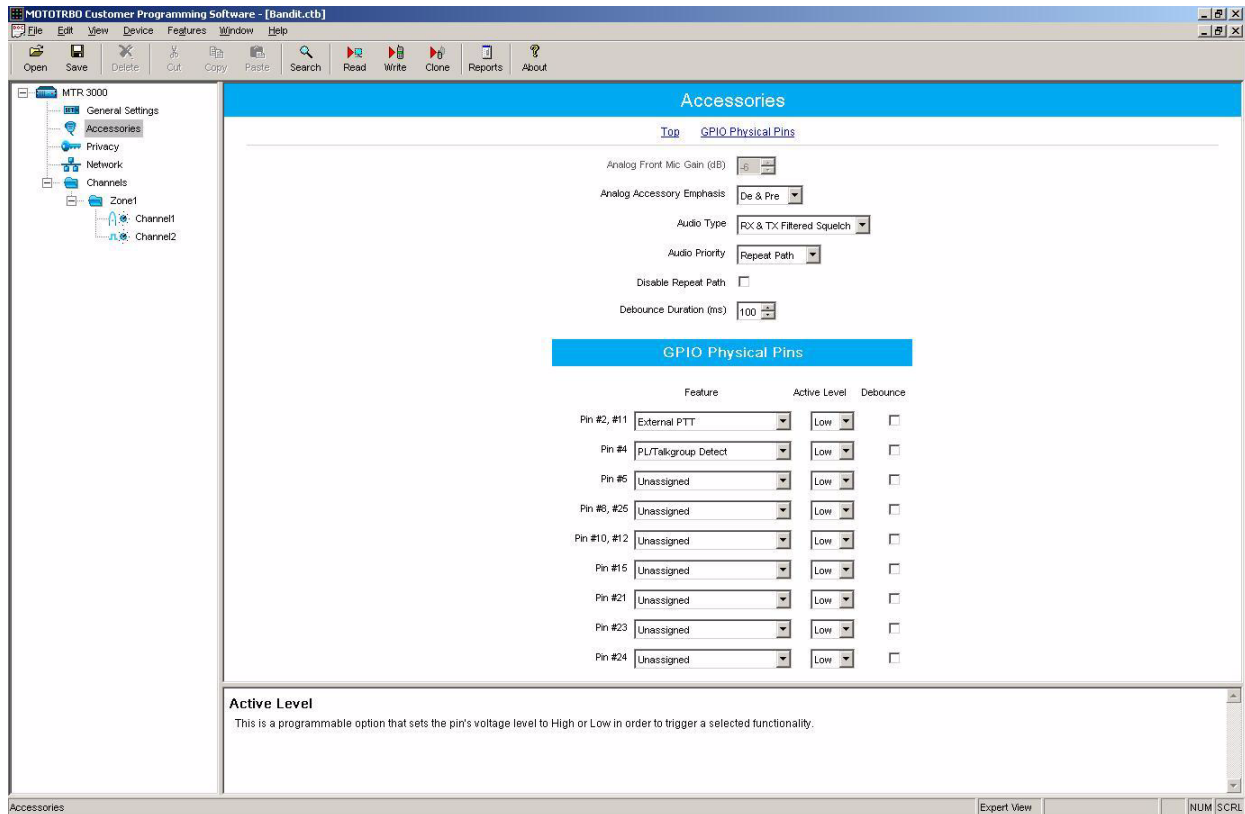


Figure F-9 CPS Configuration for Phone Patch (1 of 2)

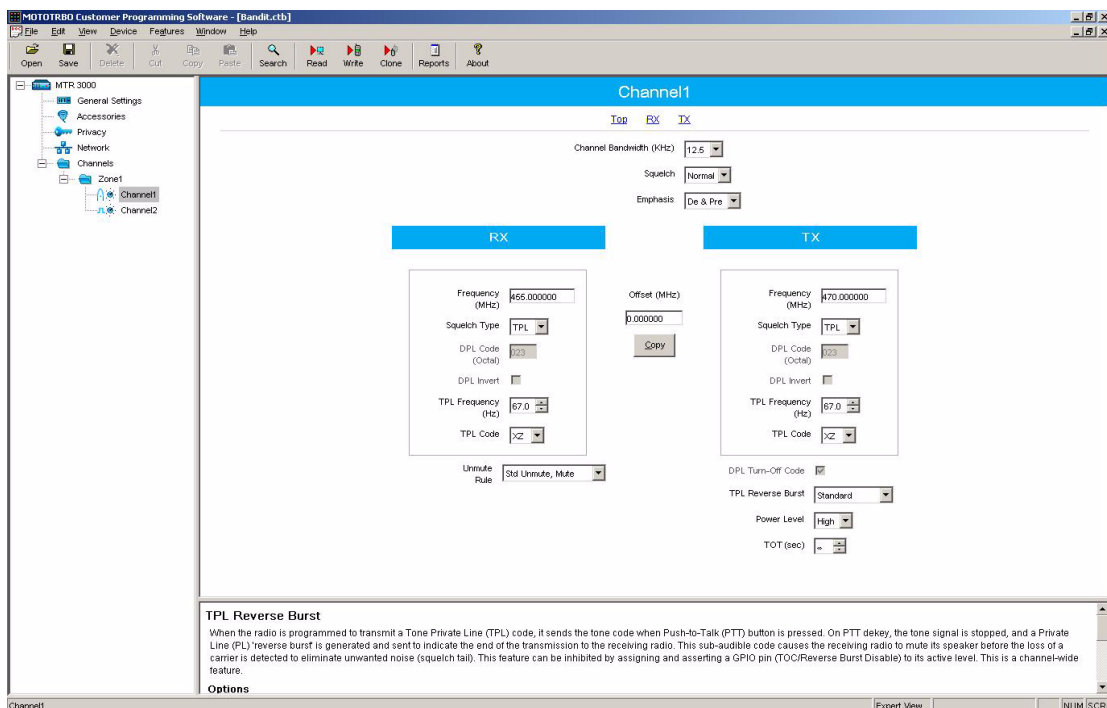


Figure F-10 CPS Configuration for Phone Patch (2 of 2)

### F.3.5 Phone Patch Level Settings

The input and output levels should be adjusted per the phone patch's instructions. The summary below gives a brief overview of the high level characteristics and phone patch settings for configuration with the MTR3000.

#### F.3.5.1 Disc

The MTR3000 Base Station/Repeater's Receiver audio will yield 330mV rms into 50 k $\Omega$  with an RF input signal deviating at 60% RSD. With the phone patch's own loading impedance, the "Disc" signal delivered to the phone patch is at a high enough drive level to leave jumper JP1 in the factory default position (position A).

#### F.3.5.2 Tx Audio

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Tx Audio port. The "Tx Aud" signal delivered by the phone patch is at a high enough drive level to leave jumper JP3 in the factory default position (position B).

#### F.3.5.3 CTCSS / DCS DECODE INPUT / COR

Set jumper JP6 to position A, to match the MTR3000's active low indication of a PL/DPL detect.

Set jumper JP7 to position B, to external squelch indication.

Set jumper JP8 to position C, to match the MTR3000's active low indication of a COR detect.

## F.4 Tone Remote Adapter

### F.4.1 Description

When a dispatch console or deskset sends out signals to a remote base station/repeater, it does so over a Wireline. Two types of signals are sent:

- Audio signal
- Command signals (function tones) that are used to perform the remote control functions.

The MTR3000 Base Station/Repeater is capable of decoding function tones, sent over a Wireline from a remote analog deskset or console, via the Motorola Tone Remote Adapter (Model L3276). When properly configured, the Tone Remote Adapter will perform the following functions in conjunction with the MTR3000 Base Station/Repeater:

- Transmit and Receive Audio
- PTT
- Monitor
- Channel Select (up to 15 frequencies)
- Wildcard (e.g. Repeater Knockdown)

See Motorola Tone Remote Adapter Manual (supplied with the Tone Remote Adapter) for specifications, operation, installation, alignment, programming, alternate configurations, and repair information.



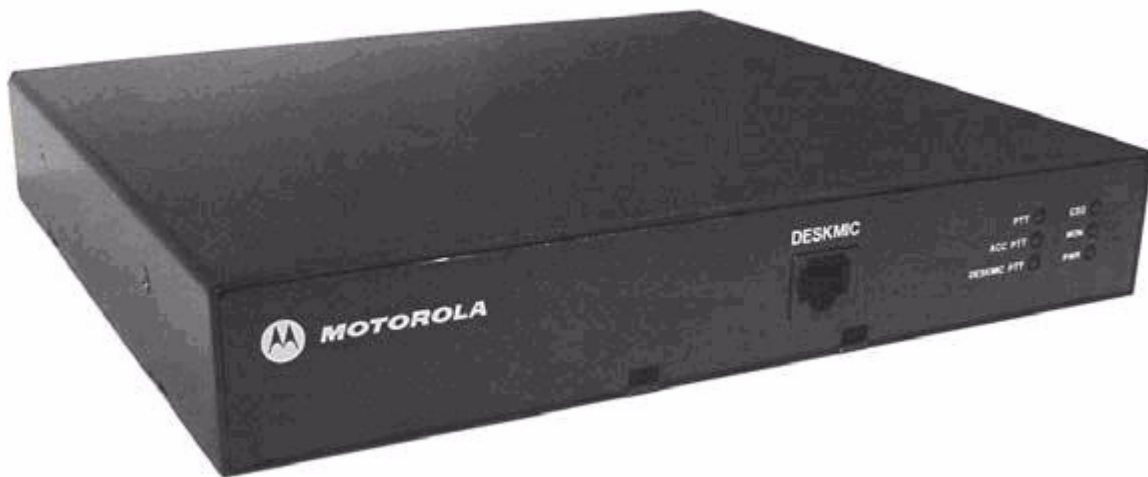


Figure F-11 Model L3276 Tone Remote Adapter

## F.4.2 Compatibility

Model L3276 Tone Remote Adapter is compatible for all versions of MTR3000 Software and Hardware.

## F.4.3 Hardware Connections

The connections between the MTR3000 Base Station/Repeater and the Tone Remote Adapter are facilitated with a multi-conductor cable connected between the J7 MTR3000 25-Pin connector and that of the Tone Remote Adapter. The connection provides for the following signals:

- Transmit Audio
- Receiver Audio
- PTT
- COR
- Monitor
- Channel Steering
- Wild Card (E.g. Repeater Knockdown)
- Ground

Signal connections are noted in [Figure F-3](#). The MTR3000 Base Station/Repeater connector and physical Pin locations are noted in the backplane interface board section of this manual. See Motorola L3276 25-Pin manual for its connector and physical Pin locations. The part number for a pre-fabricated cable is noted in the MTR3000 ordering guide.

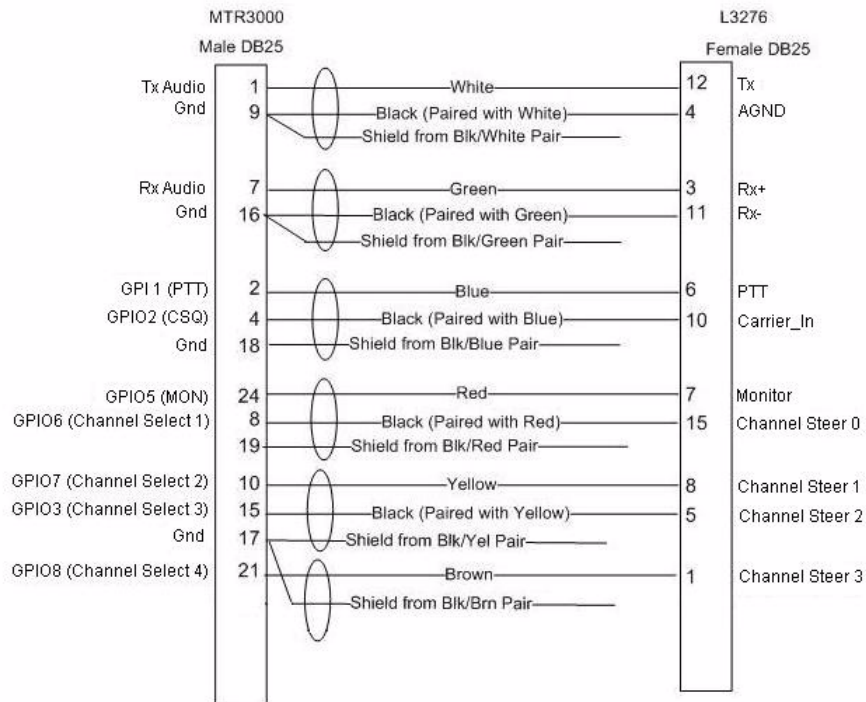


Figure F-12 Signal Connections between MTR3000 Base Station/Repeater and Motorola L3276 25-Pin connector for a 15 Channel Remote Control

#### F.4.4 CPS Configuration (For a 15 Channel Remote Control)

The MTR3000 Base Station/Repeater will need to be configured via the CPS application as shown in [Figure F-13](#). More specifically, the affected parameters are as follows:

- Audio Type
  - Rx and Tx Filtered Squelch
- Analog Accessory Emphasis
  - De & Pre
- Disable Repeat Path
  - Un-Checked or Checked
- Audio Priority
  - Set to "Ext PTT" for console priority
  - Set to "Repeat Path" for repeat priority
- GPIO Pin number 2, 11
  - Ext Mic PTT
  - Active Low
- GPIO Pin number 4
  - CSQ Detect or PL/Talk group Detect
  - Active Low

- GPIO Pin number 24
  - Monitor
  - Active Low
- GPIO Pin number 8, 25
  - Channel Select 1
  - Active Low
- GPIO Pin number 10, 12
  - Channel Select 2
  - Active Low
- GPIO Pin number 15
  - Channel Select 3
  - Active Low
- GPIO Pin number 21
  - Channel Select 4
  - Active Low

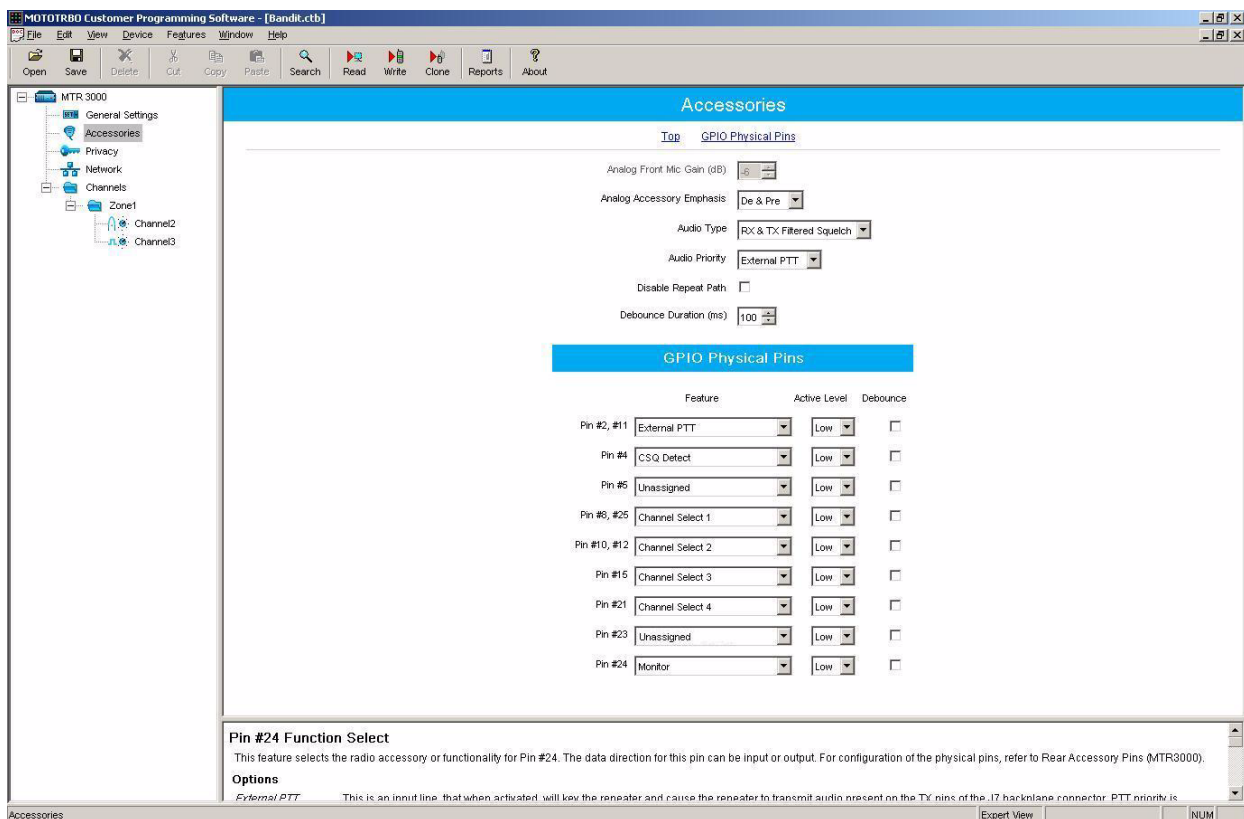


Figure F-13 CPS Configuration for L3276 Tone Remote Adapter  
(For a 15 Channel Remote Control)

**Note** The above configuration is considered typical. The L3276 Remote Tone Adapter provides alternate configurations that are supported by MTR3000 Base Station/Repeater as well. See L3276 Remote Tone Adapter Manual for additional details.

## F.4.5 Tone Remote Adapter settings

The input and output levels should be adjusted per the Tone Remote Adapter's instructions. The summary below gives a brief overview of the high level characteristics and typical Tone Remote Adapter settings for configuration with the MTR3000 Base Station/Repeater.

### F.4.5.1 Radio Rx

The MTR3000 Base Station/Repeater's Receiver audio will yield 330mV rms into 50 k $\Omega$  with an RF input signal deviating at 60% RSD. With the Remote Tone Adapter's own loading impedance, the "Radio Rx" signal delivered to the phone patch is at a high enough drive level to leave jumper S10 in the factory default position (position is "out").

### F.4.5.2 Radio Tx

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Tx Audio port. The "Radio Tx" signal delivered by the Remote Tone Adapter is at a high enough drive level to leave jumper S9 in the factory default position (position A).

### F.4.5.3 Channel Steering

Leave jumper S7 in position B (factory default) to match the MTR3000 Base Station/Repeater's active low setting for the Channel Steering 1, Channel Steering 2, Channel Steering 3, and Channel Steering 4 GPIO signaling.

### F.4.5.4 Monitoring

Leave jumper S8 in the "IN" position (factory default) to match the MTR3000's active low setting for the Monitor GPIO signaling.

### F.4.5.5 PTT

Leave jumper S5 in the "IN" position (factory default) to match the MTR3000's active low setting for the PTT GPIO signaling.

### F.4.5.6 Wildcard 1 (optional)

Leave jumper S6 in position A (factory default) to match the MTR3000's active low setting for the Repeater Disabled GPIO signaling.

## F.5 Trunking Controllers

### F.5.1 Description

The MTR3000 Base Station/Repeater is capable of supporting LTR trunking operations with the Trident's Marauder and Raider controllers. Additionally, the MTR3000 Base Station/Repeater also supports Passport trunking as well with Trident's NTS controller.

See respective Trident Instruction Manuals (supplied with the controllers) for specifications, operation, installation, alignment, programming, and repair information.



Figure F-14 Model Trident's Marauder



Figure F-15 Model Trident's Raider



Figure F-16 Model Trident's NTS

## F.5.2 Compatibility

Trident Model Raider, Marauder and NTS are compatible for all versions of MTR3000 Software and Hardware.

## F.5.3 Hardware Connections

The connections between the MTR3000 Base Station/Repeater and the trunking controllers are facilitated with a multi-conductor cable connected between the J7 MTR3000 25-Pin connector and that of the connector on the trunking controller. The connection provides for the following signals:

- Transmit Audio
- Transmit Data
- Receiver Audio
- PTT
- 14.2 VDC (see Note)
- Ground

**Note** If this connection is used, the external equipment must draw less than 1A. This connection is not supported for the NTS controller. This connection must be accessed by Pin C32 of connector J5 on an upgraded MTR2000.

Signal connections are noted in [Figure F-4](#). The MTR3000 Base Station/Repeater connector and physical Pin locations are noted in the backplane interface board section of this manual. See the Trident manuals for their respective connector and physical Pin locations. The part number for a pre-fabricated cable is provided in the respective Trident manuals.

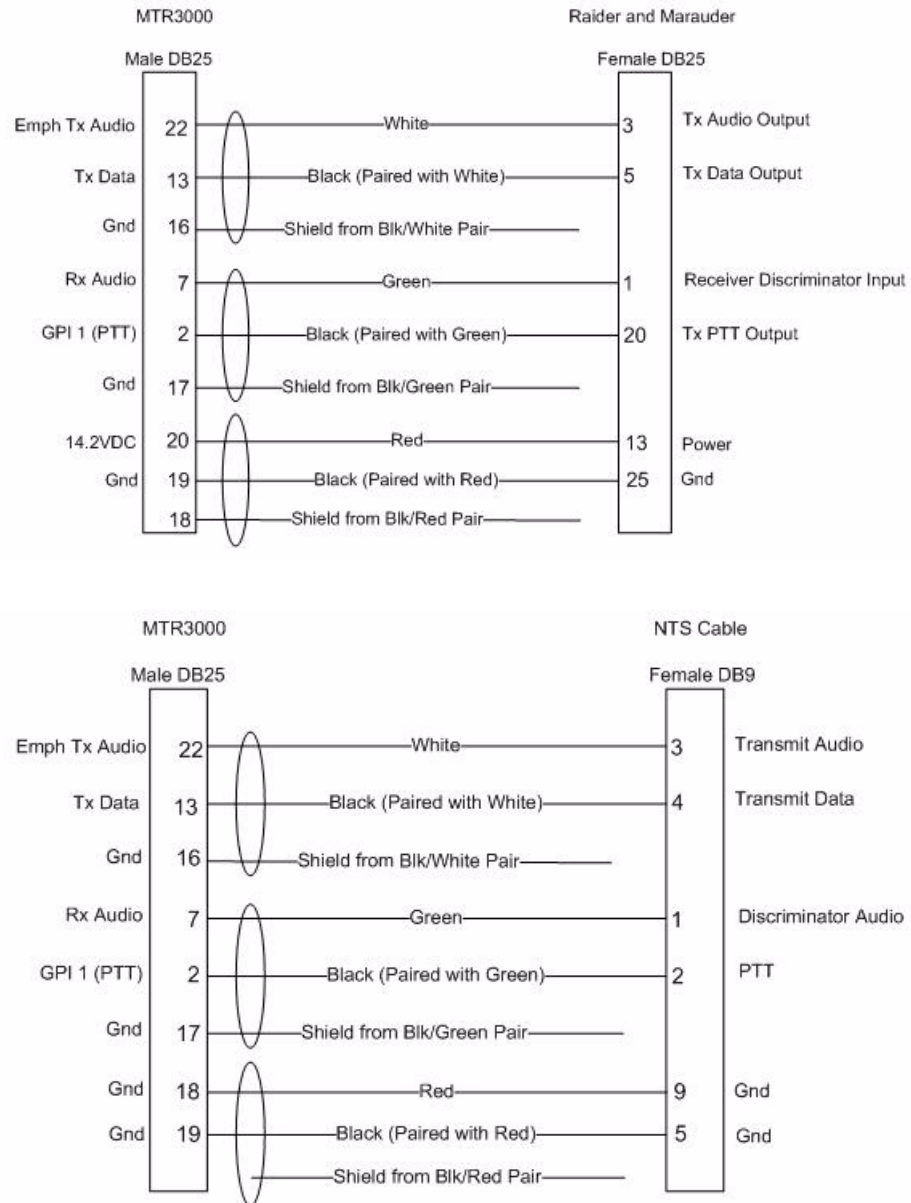


Figure F-17 Signal connections between MTR3000 Base Station/Repeater, Trident Model Raider, Marauder and NTS

### F.5.4 CPS Configuration

The MTR3000 will need to be configured via the CPS application as shown in the figures below. More specifically, the affected parameters are as follows:

- Audio Type
  - Flat Unsilenced
- Disable Repeat Path
  - Checked
- GPIO Pin number 2
  - Ext Mic PTT
  - Active Low

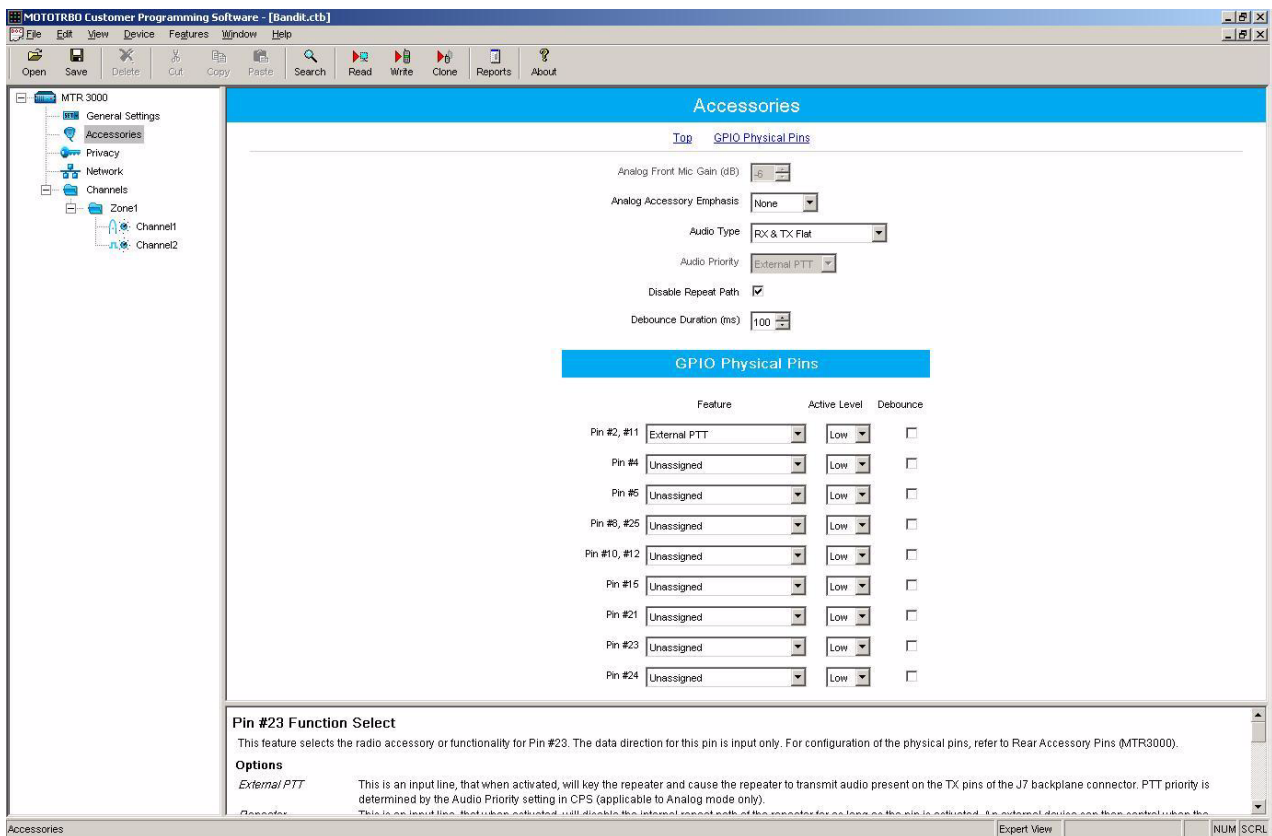


Figure F-18 CPS Configuration for Trident Model Raider, Marauder and NTS



## F.5.5 Trunking Controller Settings

The input and output levels should be adjusted per the trunking controller's instructions. The summary below gives a brief overview of the high level characteristics and trunking controller settings for configuration with the MTR3000 Base Station/Repeater.

### F.5.5.1 Discriminator

The MTR3000 Base Station/Repeater's Receiver audio will yield 330mV rms into 50 k $\Omega$  with an RF input signal deviating at 60% RSD. With the trunking controllers own loading impedance, the "Discriminator" signal delivered to the trunking controller will need to be boosted by setting the following jumpers in the noted position:

- Marauder and Raider
  - W22: OUT position
  - W30: IN position

### F.5.5.2 Tx Audio

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Emph Tx Audio port. No range setting is provided in the trunking controller for the Tx Audio, rather the level is solely controlled by a singular potentiometer or soft-potentiometer.

### F.5.5.3 Tx Data

The MTR3000 Base Station/Repeater's transmitter will yield 60% RSD with 80mV rms into the Tx Data port. No range setting is provided in the trunking controller for the Tx Data, rather the level is solely controlled by a singular potentiometer or soft-potentiometer.

- Marauder, Raider and NTS
  - Data needs to be inverted
  - NTS needs to be set for DSP operation (Channel card setting)

## Note

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# Appendix G MTR3000 Tn-nR Configurations

## G.1 Overview

In analog mode, the MTR3000 Base Station/Repeater (BR) system is capable of providing simplex operation while receiving simultaneously on two or more separate RF channels, when configured with a single antenna. A single MTR3000 Base Station/Repeater is the transmitter and first receiver, while one or more MTR3000 Satellite Receivers (Receive Only Stations) are used for the additional receiver channels. This is often referred to as a Tn-nR configuration. The number of MTR3000 Satellite Receivers that can be supported are dependent on the remote control method employed – See [Table G-1](#).

*Table G-1 Remote Control Method*

Remote Control	Number of Receive Only Stations	Tn-nR
Tone Remote Control (TRC15)	2	T3-3R
Tone Remote Control (TRC7)	1	T2-2R
DC Remote	3	T4-4R

- Note**
- [Table G-1](#) is contingent on the TRC and DC remote controls being configured as stated in [Chapter 9 MTR3000 Wireline](#). Additionally, the voting functions of “Statues Tone” and “Rx Guard Tone” must be disabled.
  - The TRC15 configuration can be modified to allocate its “Channel Select 4” CPS GPIO mapping to that of “Wireline Mute”. This modification can support up to 3 MTR3000 Satellite Receivers (T4-4R). However, the resulting channels that can be remotely controlled is reduced to seven.
  - The TRC7 configuration can be modified to allocate either (or both) of the “User Defined” CPS GPIO mappings to that of “Wireline Mute”. This modification can support up to 3 MTR3000 Satellite Receivers (T4-4R).
  - MTR3000 Base Station/Repeaters configured for receive only and/or MTR3000 Satellite Receivers can be used interchangeably for the receive only function within a Tn-nR configuration.
  - The MTR3000 Wireline Board (X216AR) is required in both the MTR3000 Base Station/ Repeater and MTR3000 Satellite Receiver(s). The MTR3000 Satellite Receiver comes standard with an MTR3000 Wireline Board.
  - The MTR3000 Base Station/Repeater requires the Antenna Relay (X371BA) to be installed.
  - Further instructions within this section will be written in accordance to [Table G-1](#).
  - Minimum Station FW version for Tn-nR support: R02.02.00 – CPS version 8.5.
  - Minimum Wireline FW version for Tn-nR support: 02.03.01.23

## G.2 Cabling for Tn-nR

When configured for Tn-nR operation, a control cable is needed between the MTR3000 Base Station/Repeater and Satellite Receiver(s) – and it is via the control cable that the receiver wireline mute signaling is selectively asserted. In all cases, the control cable interfaces to the J7 backplane connector of the MTR3000 Base Station/Repeater and Satellite Receiver(s) for receiver wireline mute signaling conveyance.

Figure G1 shows the cabling needed to convey the signaling required for a typical T3-3R configuration – with the T2-2R and T4-4R counterparts being wired and cabled similarly.

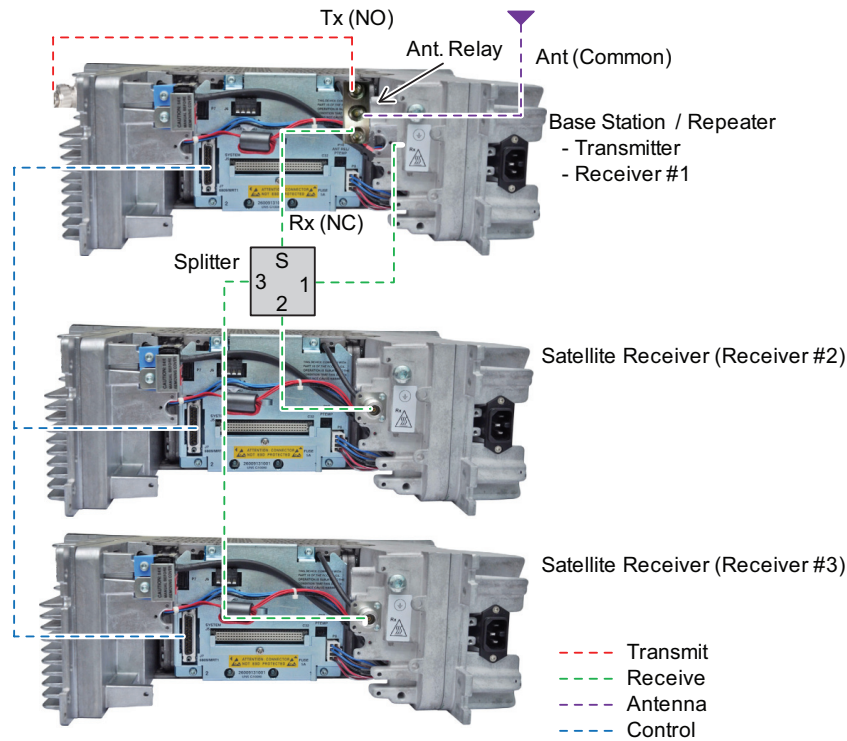


Figure G-1 Cabling example for T3-3R

### G.3 Backplane Wiring and GPIO mapping for Tn-nR

To enable the MTR3000 Base Station/Repeater for support of Tn-nR functionality, via the CPS one needs to map the “Wireline Mute” function to the appropriate GPIO’s of the J7 backplane connector. [Table G-2](#), [Table G-3](#) and [Table G-4](#) are examples that can be used for the “Wireline Mute” functions mapping.

To enable the MTR3000 Satellite Receiver (Receive Only Station) for support of Tn-nR functionality, via the CPS, one needs to map Pin 4 of the J7 backplane connector to the value of “Unassigned”. This mapping is required for each MTR3000 Base Station/Receiver configured for receive only and/or each MTR3000 Satellite Receiver in a Tn-nR configuration. [Table G-5](#) shows an example of the pertinent mapping required for the receive only station(s).

**Note** [Table G-2](#), [Table G-3](#) and [Table G-4](#) allow the preservation of the various remote control methods outlined in [Chapter 9 MTR3000 Wireline](#).

*Table G-2 TRC15 – MTR3000 Base Station/Repeater*

J7 Pin	GPIO	T2-2R	T3-3R	Comment
2	GPI_1	External PTT	External PTT	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
4	GPIO_2	Wireline Mute	Wireline Mute	Signal to Receiver #2 for Wireline Mute conveyance.
5	GPIO_10	Antenna Relay	Antenna Relay	Enables Antenna Relay for simplex support. See <a href="#">Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment</a> .
8	GPIO_6	Channel Select 2	Channel Select 2	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
10	GPIO_7	Channel Select 3	Channel Select 3	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
15	GPIO_3	–	Wireline Mute	Signal to Receiver #3 for Wireline Mute conveyance.
21	GPIO_8	Channel Select 4	Channel Select 4	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
23	GPI_4	Monitor	Monitor	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
24	GPIO_5	Channel Select 1	Channel Select 1	See <a href="#">Chapter 9 MTR3000 Wireline</a> .

Table G-3 TRC7 – MTR3000 Base Station/Repeater

J7 Pin	GPIO	T2-2R	Comment
2	GPI_1	External PTT	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
4	GPIO_2	Wireline Mute	Signal to Receiver #2 for Wireline Mute conveyance.
5	GPIO_10	User Defined	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
8	GPIO_6	Channel Select 2	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
10	GPIO_7	Channel Select 3	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
15	GPIO_3	Antenna Relay	Enables Antenna Relay for simplex support. See <a href="#">Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment</a> .
21	GPIO_8	User Defined	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
23	GPI_4	Monitor	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
24	GPIO_5	Channel Select 1	See <a href="#">Chapter 9 MTR3000 Wireline</a> .

Table G-4 DC Remote – MTR3000 Base Station/Repeater

J7 Pin	GPIO	T2-2R	T3-3R	T4-4R	Comment
2	GPI_1	External PTT	External PTT	External PTT	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
4	GPIO_2	Wireline Mute	Wireline Mute	Wireline Mute	Signal to Receiver #2 for Wireline Mute conveyance.
5	GPIO_10	–	Wireline Mute	Wireline Mute	Signal to Receiver #3 for Wireline Mute conveyance.
8	GPIO_6	Channel Select 2	Channel Select 2	Channel Select 2	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
10	GPIO_7	Channel Select 3	Channel Select 3	Channel Select 3	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
15	GPIO_3	–	–	Wireline Mute	Signal to Receiver #4 for Wireline Mute conveyance.
21	GPIO_8	Antenna Relay	Antenna Relay	Antenna Relay	Enables Antenna Relay for simplex support. See <a href="#">Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment</a> .
23	GPI_4	Monitor	Monitor	Monitor	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
24	GPIO_5	Channel Select 1	Channel Select 1	Channel Select 1	See <a href="#">Chapter 9 MTR3000 Wireline</a> .

Table G-5 MTR3000 Satellite Receiver (All Cases)

J7 Pin	GPIO	T2-2R	Comment
2	GPI_1	–	–
4	GPIO_2	Unassigned	Set to “Unassigned” to allow the Wireline Mute function.
5	GPIO_10	–	–
8	GPIO_6	–	–
10	GPIO_7	–	–
15	GPIO_3	–	–
21	GPIO_8	–	–
23	GPI_4	–	–
24	GPIO_5	–	–

## G.4 Mapping the GPIO's within the CPS application

Figure G-2, Figure G-3, Figure G-4 and Figure G-5 illustrate the GPIO mapping within the CPS for T3-3R support in a TRC15 configuration.

- Figure G-2 shows that Pin 4 and Pin 15 are configured to the “Wireline Mute” function within the CPS “Accessories” field. Additionally, the Active Level of the “Wireline Mute” function must be set to “Low”. This applies to the MTR3000 Base Station/Repeater.
- Figure G-3 shows that Pin 4 and Pin 15 are mapped to Channel 2 and Channel 3 respectively within the CPS “Zone1” field under “Channels”. This applies to the MTR3000 Base Station/ Repeater.
- Figure G-4 shows an alternate method to map a GPIO pin to its associated channel within the CPS “Zone1” field under “Channels”. This applies to the MTR3000 Base Station/Repeater.
- Figure G-5 shows that Pin 4 is configured as “Unassigned” within the CPS “Accessories” field. The Pin 4 configuration assignment of “Unassigned” applies to each MTR3000 Base Station/ Repeater configured for receive only and/or each MTR3000 Satellite Receiver.
- The T2-2R and T4-4R counterparts are configured similarly.
- TR7 and DC Remote are configured similarly.

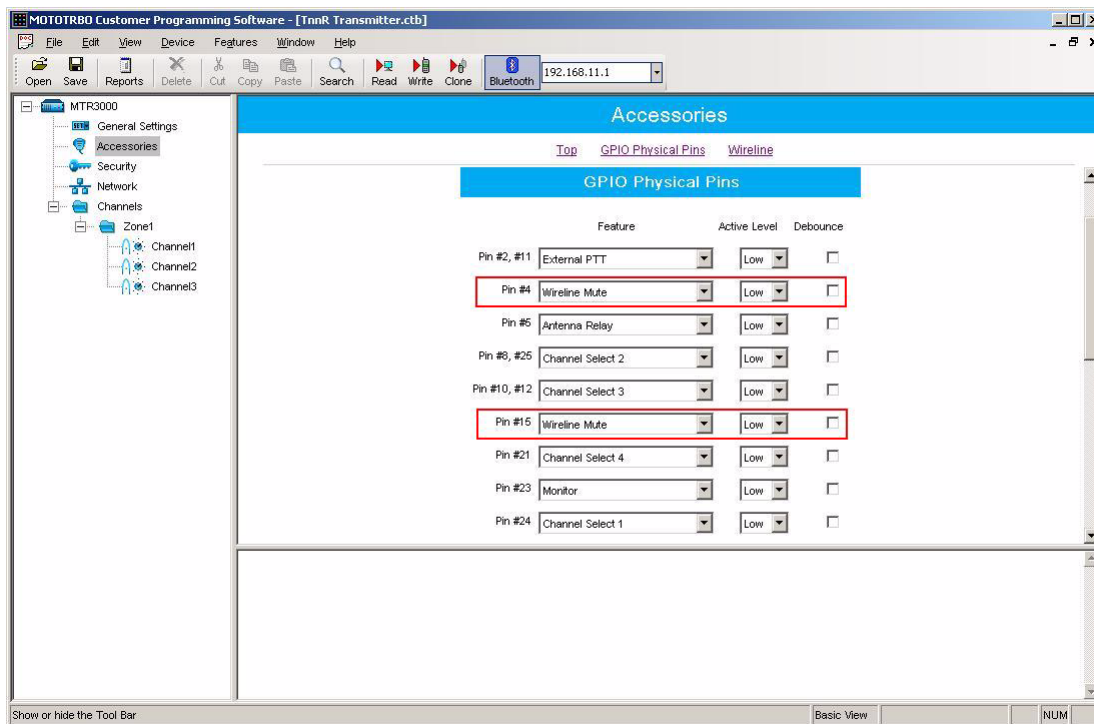


Figure G-2 GPIO mapping within the CPS “Accessories” field (For MTR3000 Base Station/Repeater)



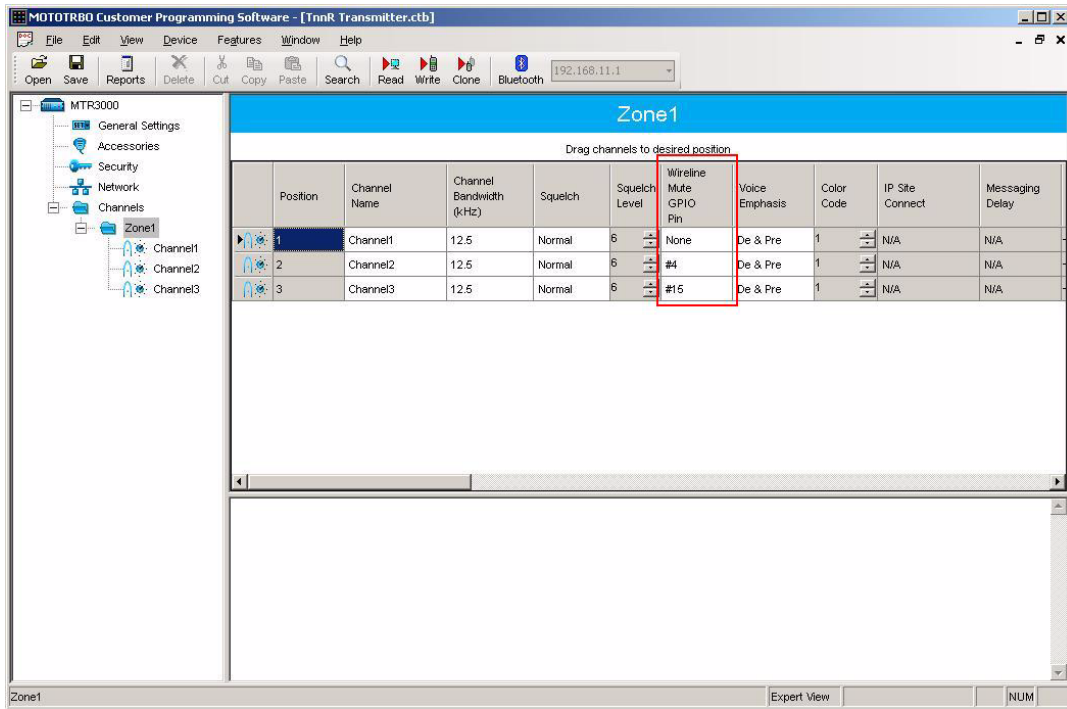


Figure G-3 GPIO mapping within the CPS “Zone1” field (For MTR3000 Base Station/Repeater)

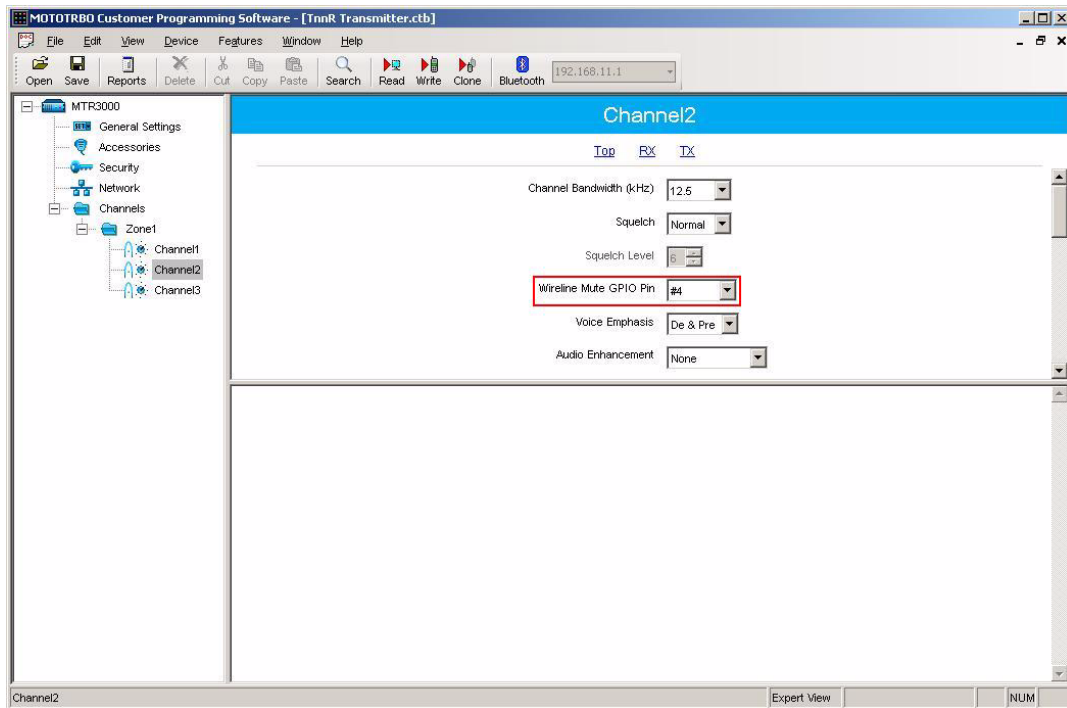


Figure G-4 Alternate method of GPIO mapping within the CPS “Zone1” field (For MTR3000 Base Station/Repeater)

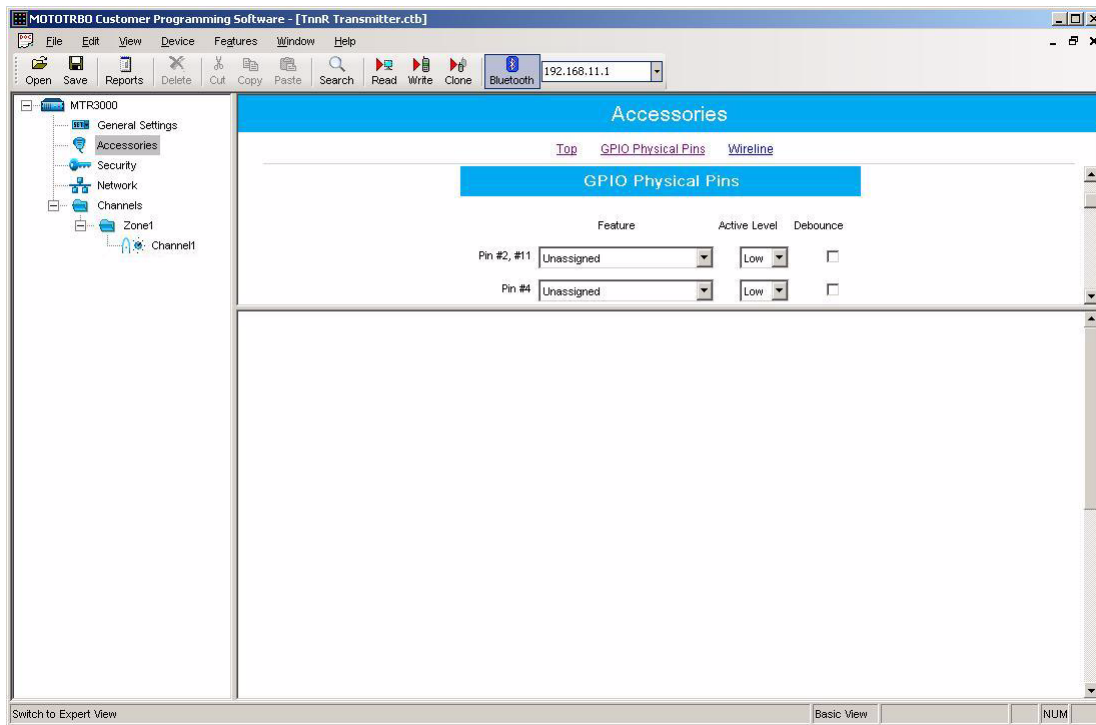


Figure G-5 GPIO mapping within the CPS "Accessories" field (For MTR3000 Satellite Receiver)

## G.5 Rx Muting in voting arrangements

Though not common, the MTR3000 Base Station/Repeater and the MTR3000 Satellite Receive can be configured to mute the receive wireline audio, including Status Tone and/or Rx Guard Tone, when operating in an analog voting arrangement. In this arrangement, it is not the MTR3000 Base Station/Repeater which sends the “Wireline Mute” signal to the designated receiver to be muted, rather the “Wireline Mute” signal is generated by a customer supplied “controlling element.”

- Note**
- [Table G-6](#) and [Table G-7](#) allow the preservation of TRC15 and DC remote control methods outlined in [Chapter 9 MTR3000 Wireline](#).
  - Though not shown in the following tables, the TRC7 configuration from [Chapter 9 MTR3000 Wireline](#) can be modified to support Rx Muting in voting arrangements by allocating either of the “User Defined” CPS GPIO mappings to that of “Antenna Relay” – if Antenna Relay functionality is needed.
  - Reminder – The “2-Wire” selection for the CPS “Wire Mode” field is not allowed for voting configurations.
  - Important exceptions to the voting configuration noted in [Chapter 9 MTR3000 Wireline](#).
    - One must map the CPS setting of GPIO Pin 4 to the value of “Unassigned”, which means the CPS “Rx Squelch Mode” settings of “Carrier and PL/DPL” and “Carrier or PL/DPL” cannot be supported.
    - If desired, “PL” or “DPL” can effectively be used as an Rx qualifier, but GPIO Pin 15 will alternately be mapped to “PL/Talk group Detect” instead of the CPS “CSQ Detect” mapping stated in [Chapter 9 MTR3000 Wireline](#).

[Table G-6](#), [Table G-7](#) and [Table G-8](#) are examples that can be used for Wireline muting in an analog voting arrangement. Once configured as the examples in [Table G-6](#), [Table G-7](#) and [Table G-8](#) illustrate, the MTR3000 Base Station/Repeater and MTR3000 Satellite Receive will mute any receive Wireline audio activity when the J7 backplane connector’s Pin 4 is pulled to a logic low state.

*Table G-6 TRC15 – MTR3000 Base Station/Repeater*

J7 Pin	GPIO	T2-2R	Comment
2	GPI_1	External PTT	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
4	GPIO_2	Unassigned	Set to “Unassigned” to allow the Wireline Mute function.
5	GPIO_10	Antenna Relay	Enables Antenna Relay for simplex support. See <a href="#">Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment</a> .
8	GPIO_6	Channel Select 2	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
10	GPIO_7	Channel Select 3	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
15	GPIO_3	CSQ Detect	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
21	GPIO_8	Channel Select 4	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
23	GPI_4	Monitor	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
24	GPIO_5	Channel Select 1	See <a href="#">Chapter 9 MTR3000 Wireline</a> .

Table G-7 DC Remote – MTR3000 Base Station/Repeater

J7 Pin	GPIO	T2-2R	Comment
2	GPI_1	External PTT	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
4	GPIO_2	Unassigned	Set to “Unassigned” to allow the Wireline Mute function.
5	GPIO_10	–	–
8	GPIO_6	Channel Select 2	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
10	GPIO_7	Channel Select 3	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
15	GPIO_3	CSQ Detect	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
21	GPIO_8	Antenna Relay	Enables Antenna Relay for simplex support. See <a href="#">Chapter 10 MTR3000 Radio Frequency Distribution System (RFDS) Equipment</a> .
23	GPI_4	Monitor	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
24	GPIO_5	Channel Select 1	See <a href="#">Chapter 9 MTR3000 Wireline</a> .

Table G-8 MTR3000 Satellite Receiver (All Cases)

J7 Pin	GPIO	T2-2R	Comment
2	GPI_1	–	–
4	GPIO_2	Unassigned	Set to “Unassigned” to allow the Wireline Mute function.
5	GPIO_10	–	–
8	GPIO_6	–	–
10	GPIO_7	–	–
15	GPIO_3	CSQ Detect	See <a href="#">Chapter 9 MTR3000 Wireline</a> .
21	GPIO_8	–	–
23	GPI_4	–	–
24	GPIO_5	–	–

---

# Appendix H Audio Enhancement

## H.1 Overview

The Hear Clear, Flutter Fighter, and Companding features improve analog audio quality in a multi-path fading environment. The Hear Clear (Companding and Flutter Fighter activated together) and Flutter Fighter features are only available in the 800 and 900 MHz bands, while the Companding feature is available for all bands.

### H.1.1 Hear Clear feature with the third party controllers

The Hear Clear feature is only available to third party controllers without the data such as phone patch and Tone remote Adaptor.

Third Party Controller	Hear Clear Configuration for Third Party Box	Flutter Fighter
Community Repeater Panel	Not selectable	Selectable
Trident's Marauder controller	Not selectable	Selectable
Trident's Raider controller	Not selectable	Selectable
Phone Patch	Selectable	Selectable
Tone Remote Adaptor	Selectable	Selectable

### H.1.2 Third party controller and the subscriber configuration for Hear Clear feature

The Hear Clear feature requires matching configuration between the MTR3000 Base Station/ Repeater that supports third party controllers and the subscribers.

MTR3000 with Phone Patch/ Tone Remote Adapter	Subscriber
Hear Clear	Hear Clear
Flutter Fighter	Flutter Fighter
None	None

### H.1.3 Hear Clear feature configuration in repeater mode

The Hear Clear feature requires matching configurations between the subscribers.

Repeater mode		
Subscriber 1	Repeater	Subscriber 2
Hear Clear	Hear Clear	Hear Clear
Flutter Fighter	Hear Clear	Flutter Fighter
None	Hear Clear	None

### H.1.4 Companding feature configuration between third party controllers and subscriber

The companding feature requires matching configuration between the third party controllers and the subscriber.

MTR3000 with Phone Patch/ Tone Remote Adapter	Subscriber
Companding	Companding
None	None

### H.1.5 Companding feature configuration between the repeater and subscribers

The companding feature requires matching configurations between the subscribers.

Repeater mode		
Subscriber 1	Repeater	Subscriber 2
Companding	Hear Clear	Companding
None	Hear Clear	None

# Appendix I      MOTOTRBO Base Station/Repeater – EME ASSESSMENT

**NOTE:** The example given in this Appendix applies for a UHF band system. For different frequency bands, applicable band-specific figures should be employed to carry out the computations yielding band-specific compliance boundaries.

## I.1 Executive Summary

The Electromagnetic Energy (EME) compliance boundaries in a typical system configuration of the Motorola MOTOTRBO MTR3000 Base Station/Repeater described in the following are derived.

Compliance is established with respect to the applicable limits defined in the ICNIRP guidelines [1], the United States regulations [2]-[3], and in the CENELEC Standards EN50384:2002 [5] and EN50385:2002 [6]. These standards and regulations apply to *occupational* and *general public* EME exposure.

The assessment was carried out using a computational method described in the CENELEC Standard EN50383:2002 [4], which is referenced by the EN50385:2002, and this report has been drafted in accordance with its requirements. Thus the assessment and report address the European Radio and Telecommunications Terminal Equipment (R&TTE) Directive requirements concerning EME exposure.

The following table provides the compliance distances for *general public* and *occupational-type* exposure, for the UHF frequency band, antenna, and parameters considered in this analysis, based on a typical system configuration:

*Figure I-1 EME Compliance Distances Based on Example UHF Evaluation*

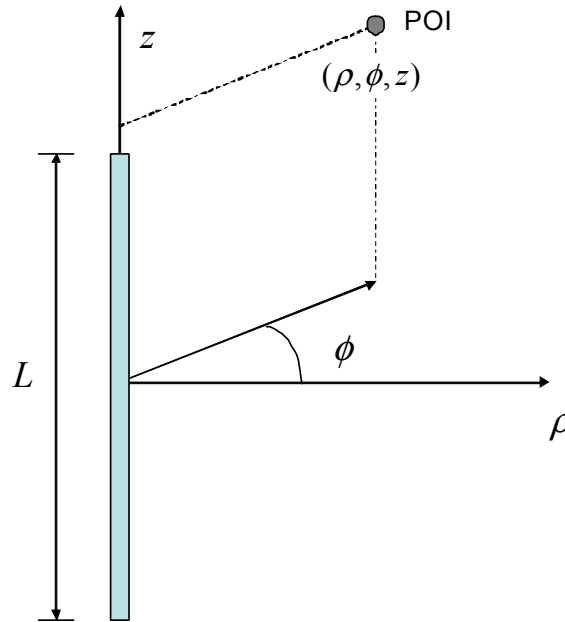
Compliance distances	Antenna front (Andrew mod. DB408)	Ground level (20 m below antenna)
General public exposure	6 m	Always compliant
Occupational-type exposure	1.2 m	Always compliant

## I.2 Exposure Prediction Model

### I.2.1 Exposure in Front of the Antenna

The cylindrical-wave model defined in Clause 8.3.4 of the EN50383:2002 standard is applied to determine the compliance boundaries for workers and general public for a typical system configuration of the MOTOTRBO MTR3000 Base Station/Repeater.

Figure I-2 Reference frame for the point of interest (POI) cylindrical co-ordinates



Per the reference frame in [Figure I-2](#), the cylindrical-wave model is applicable in the volume described in cylindrical co-ordinates  $(\rho, \phi, z)$  as follows:

$$\lambda/4 \leq \rho \leq \min\{r_c, 2L^2/\lambda\}, \quad |\phi| \leq \delta/2, \quad |z| \leq L/2,$$

where  $\lambda$  is the wavelength in  $m$ ,  $L$  is the antenna largest dimension in  $m$ ,  $\delta$  is the angle in *degrees* defining the -3 dB beamwidth of a directional antenna (for an omni-directional antenna  $\delta$  is equal to 360 degrees), and

$$r_c = G_A \cdot L \cdot \delta / 720$$

where  $G_A$  is the antenna maximum gain relative to an isotropic antenna. The power flux density ( $S$ ), expressed in  $W/m^2$ , is calculated as follows:

$$S_{cyl} = \frac{P}{\pi L \rho} \frac{180}{\delta} \quad (1)$$

where  $P$  is the input power to the antenna. In the region where,

$$\lambda/4 \leq r_c \leq 2L^2/\lambda$$

the power flux density is calculated as the maximum between the cylindrical and spherical-wave models, where the latter is expressed as follows:

$$S_{sph} = \frac{PG_A}{4\pi\rho^2} \quad (2)$$

Spatial power density averaging, which is required by some regulations, is embedded in the cylindrical-wave model formulation, therefore it does not require additional considerations.



### I.2.2 Exposure at Ground Level

Several methods can be employed to determine the EME exposure at ground level. Such an assessment is not necessary if the mounting height of the antenna is larger than the compliance distance *in front* of the antenna, computed using the EN50383:2002 methodology outlined in [Section I.2.1](#). If this is not feasible, then the following approach can be employed.

At ground level exposure occurs in the antenna far-field. The antenna phase center is assumed to be the mounting height. The resulting predictive equation for the power density is:

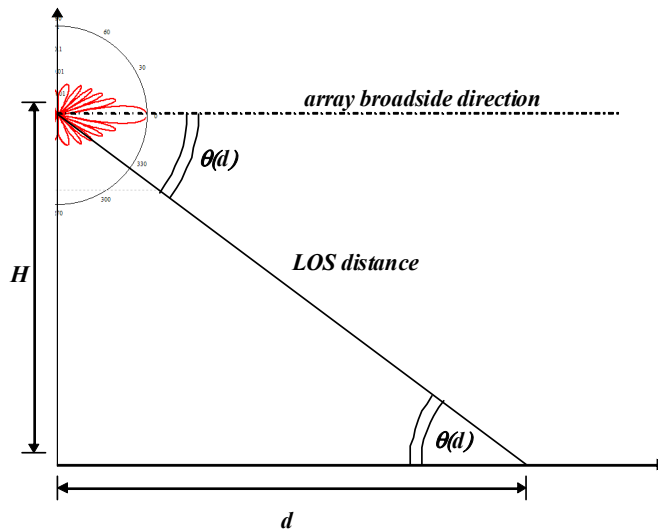
$$S(d) = (2.56) \frac{P \cdot G(\theta)}{4\pi(H^2 + d^2)} \tag{3}$$

where  $G(\theta)$  is the elevation gain pattern, which is approximated by the following expression:

$$G(\theta) = G_A \left| \frac{\sin\left(\frac{k_0 L}{2} \sin\theta\right)}{\frac{k_0 L}{2} \sin\theta} \right|^2 \tag{4}$$

where  $k_0 = 2\pi / \lambda$  is the free-space wavenumber and  $L$  is the *effective* antenna length yielding the appropriate vertical beamwidth, while  $H$  is the antenna height above ground and  $d$  is the *point of interest* (POI) distance from the vertical antenna projection to ground (see [Figure I-3](#)). The multiplicative factor 2.56 is introduced to enforce near-perfect, in-phase ground reflection as recommended in [2]. In this case, spatial averaging is not carried out to make the EME exposure assessment more conservative.

Figure I-3 Schematic of the ground-level exposure model adopted for the assessment



### I.3 Typical System Configuration

The MOTOTRBO MTR3000 Base Station/Repeater operates in different frequency ranges with different channels transmitting 100 W radio frequency (RF) power. The typical system configuration comprises an omnidirectional array antenna featuring 6–10 dBd gain, installed at or above 20 m from ground level, and fed by the MTR3000 Base Station/Repeater through a combiner characterized by a typical 3 dB transmission loss, and a 30 m 7/8" coaxial cable characterized by a typical 2.7 dB/100m loss, resulting in a total 3.9 dB transmission loss. Based on these characteristics, the RF power at the antenna input is about 200 W.

Since shorter antennas provide a conservative EME exposure assessment from equation (1), the parameters of a typical 6.6 dBd antennas are employed. Such an antenna (e.g., Andrew DB408) would exhibit a typical elevation beamwidth of about 14 degrees.

### I.4 Exposure Limits

Based on the MTR3000 operating frequency range, the most conservative power density limits are those defined in the ICNIRP guidelines [1]. They are 10.1 W/m<sup>2</sup> for occupational exposure, and 2.02 W/m<sup>2</sup> for general public exposure. They will be used for the EME exposure assessment.

### I.5 EME Exposure Evaluation

#### I.5.1 Exposure in Front of the Antenna

The assessment is based on the following characteristics of the Andrew DB408 antenna:

$$G_A = 10^{\frac{6.6+2.15}{10}} = 7.5 \quad P = 200 \text{ W} \quad \delta = 360^\circ \quad L = 2.7 \text{ m}$$

The compliance boundary distance is computed, from equation (1), as follows:

$$\rho = \frac{P}{\pi L S_{\text{lim}}} \frac{180}{\delta}$$

where  $S_{\text{lim}}$  is the applicable power density limit. For occupational exposure, this equation gives:

$$\rho_{\text{OCC}} = \frac{200 \text{ W}}{\pi \cdot 2.7 \text{ m} \cdot 10.1 \text{ W/m}^2} \frac{180}{360} = 1.2 \text{ m}$$

while for general public exposure it gives:

$$\rho_{\text{GP}} = \frac{200 \text{ W}}{\pi \cdot 2.7 \text{ m} \cdot 2.02 \text{ W/m}^2} \frac{180}{360} = 6 \text{ m}$$

#### I.5.2 Exposure at Ground Level

Since the antenna installation height above ground level in the typical system configuration (20 m) is larger than either of the compliance boundaries determined in [Section I.5.1](#), the EME exposure at ground level is always compliant with the exposure limits defined in the ICNIRP guidelines.

## I.6 Compliance Boundary Description

Based on the analysis in [Section I.5](#), the compliance boundaries for *occupational* and *general public* exposure are defined as cylinders enclosing the antenna (see [Figure I-4](#)), extending 75 cm (one wavelength) above and below the physical antenna, with radii:

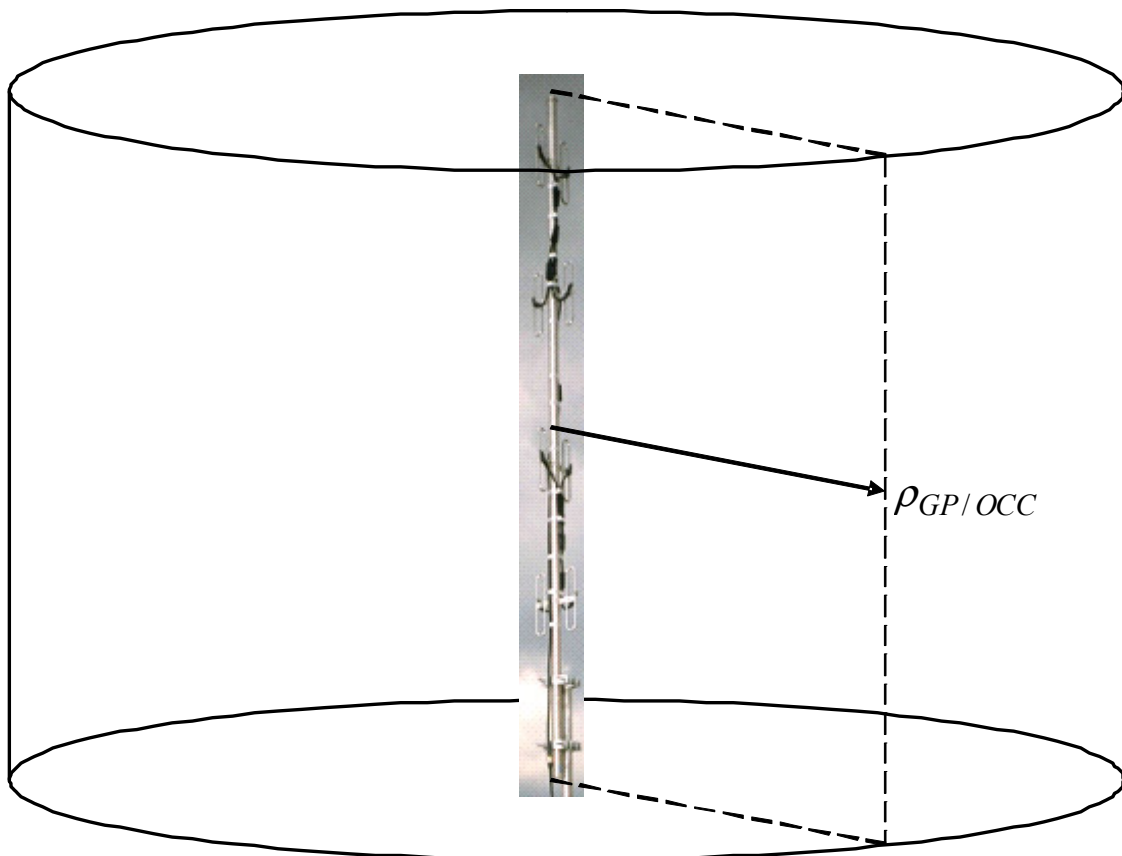
Occupational exposure:

$$\rho_{OCC} = 1.2 \text{ m}$$

General Public exposure:

$$\rho_{GP} = 6 \text{ m}$$

Figure I-4 Compliance boundary for general public (GP) and occupational (OCC) exposure



## I.7 References

1. International Commission on Non-Ionizing Radiation Protection (ICNIRP), "Guideline for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields," Health Physics, vol. 74, no. 4, pp. 494-522, April 1998.
2. United States Federal Communication Commission, "Evaluating compliance with FCC guidelines for human exposure to radio frequency electromagnetic fields," OET Bulletin 65, Ed. 97-01, Section 2 (Prediction Methods), August 1997.
3. US Code of Federal Regulations, Title 47, Volume 1, Sec. 1.1310 Radio frequency radiation exposure limits (Revised as of October 1, 2003).  
[http://edocket.access.gpo.gov/cfr\\_2003/octqtr/47cfr1.1310.htm](http://edocket.access.gpo.gov/cfr_2003/octqtr/47cfr1.1310.htm).

4. EN 50383:2002. Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunications system (110 MHz - 40 GHz). CENELEC (European Committee for Electrotechnical Standardization).
5. EN 50384:2002. Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz). Occupational. CENELEC (European Committee for Electrotechnical Standardization).
6. EN 50385:2002. Product standard to demonstrate the compliances of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz). General public. CENELEC (European Committee for Electrotechnical Standardization).

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# Glossary of Terms and Acronyms

This glossary contains an alphabetical listing of terms and their definitions that are applicable to base station/repeater products. All terms do not necessarily apply to all radios, and some terms are merely generic in nature.

Term	Definition
<b>AGC</b>	Automatic Gain Control
<b>Alert tone</b>	Audio signal produced by the station, providing feedback to the user.
<b>Analog</b>	Refers to a continuously variable signal or a circuit or device designed to handle such signals.
<b>ASIC</b>	Application Specific Integrated Circuit
<b>AUX</b>	Auxiliary
<b>Band</b>	Frequencies allowed for a specific purpose.
<b>BR</b>	Base Station/Repeater
<b>CCI</b>	Control Channel Indicate
<b>CDCSS</b>	Continuous Digital-Controlled Squelch Systems (DPL)
<b>CTCSS</b>	Continuous Tone-Controlled Squelch Systems (PL)
<b>CIT</b>	Central Interconnect Terminal. Used to provide telephone interconnect capability in a trunked station.
<b>CIU</b>	Console Interface Unit. Interface between operator console and station to provide encryption/decryption functions.
<b>Clear</b>	Channel modulation type in which voice information is transmitted over the channel using analog modulation.
<b>Code detect</b>	Traditional term used to indicate that a 12kbps CVSD signal is being received on the RF channel.
<b>Conventional</b>	Term used for standard non-trunked radio system (usually using TRC/DC console).
<b>CPI</b>	Console Priority Interface - option allowing console control of a trunked station.
<b>CPS</b>	Customer Programming Software: Software with a graphical user interface containing the feature set of a radio.
<b>DDM</b>	Dual Device Module
<b>Default</b>	A pre-defined set of parameters.
<b>Digital</b>	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.

<b>Term</b>	<b>Definition</b>
<b>DPL</b>	Digital Private Line (See PL)
<b>DSP</b>	Digital Signal Processor, microprocessor specifically designed to perform digital signal processing algorithms.
<b>DVP</b>	Digital Voice Protection, or Digital Voice Privacy, applies to the Vulcan encryption algorithm and the Motorola product in which it is sold.
<b>EIA</b>	Electronic Industries Association
<b>E/M</b>	Telephone circuit signalling lines (Ear/Mouth, Ernie/Mary)
<b>EOM</b>	End-Of-Message, 6 kHz signal transmitted at the end of a 12 kbps CVSD signal that is used by the receiving unit for fast muting of the speaker audio for squelch tail elimination.
<b>ESD</b>	Electro Static Discharge
<b>ETS</b>	European Telecommunications Standards
<b>EU</b>	European Union
<b>Failsoft</b>	Trunked station mode entered when central controller fails
<b>FCC</b>	Federal Communications Commission.
<b>FFSK</b>	Fast FSK
<b>FM</b>	Frequency Modulation
<b>Frequency</b>	Number of times a complete electromagnetic-wave cycle occurs in a fixed unit of time (usually one second).
<b>FRU</b>	Field Replaceable Unit
<b>FSK</b>	Frequency Shift Keying
<b>GPI</b>	General Purpose Input
<b>GPO</b>	General Purpose Output
<b>HLGT</b>	High Level Guard Tone
<b>IC</b>	Integrated Circuit, An assembly of interconnected components on a small semiconductor chip, usually made of silicon. One chip can contain millions of microscopic components and perform many functions.
<b>IF</b>	intermediate frequency
<b>I/O</b>	Input or Output
<b>IRB</b>	Inbound Recovery Board used with the Trunking Controller
<b>IRQ</b>	Interrupt Request.
<b>kHz</b>	kilohertz: One thousand cycles per second. Used especially as a radio-frequency unit.

Term	Definition
<b>LCD</b>	Liquid-Crystal Display: An LCD uses two sheets of polarizing material with a liquid-crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.
<b>LED</b>	Light Emitting Diode: An electronic device that lights up when electricity is passed through it.
<b>LLGT</b>	Low Level Guard Tone
<b>MAN_CS</b>	Manual Channel Select.
<b>MDC</b>	Motorola Data Communications. 1200 or 4800 baud data signalling scheme.
<b>MHz</b>	Megahertz: One million cycles per second. Used especially as a radio-frequency unit.
<b>MISO</b>	Master In, Slave Out.
<b>MON</b>	Monitor.
<b>MOSI</b>	Master Out, Slave In.
<b>MRTI</b>	Microprocessor Radio-Telephone Interconnect; a Motorola system that provides a repeater connection to the telephone network (The MRTI allows the radio to access the telephone network when the proper access code is received).
<b>MSK</b>	Minimum Shift Keying
<b>OCXO</b>	Oven Controlled Oscillator
<b>OSW</b>	Outbound Signalling Word, data packet transmitted on the outbound Trunking control channel by the central controller that contains call assignment information for the subscriber.
<b>PA</b>	Power Amplifier that transmits final RF signal to transmit antenna
<b>Paging</b>	One-way communication that alerts the Receiver to retrieve a message.
<b>PC Board</b>	Printed Circuit Board. Also referred to as a PCB.
<b>PFC</b>	Power Factor Correction
<b>PL</b>	Private-Line tone squelch; a continuous subaudible tone that is transmitted along with the carrier (A radio that has PL on the receive frequency will require both the presence of carrier and the correct PL tone before it will unmute). Also, if there is PL on the transmit frequency, all transmissions by the radio will be modulated with the PL tone. Modulation will be continuous.
<b>PLL</b>	Phase locked loop; a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
<b>Programming Cable</b>	A cable that allows the CPS to communicate directly with the radio using USB.
<b>PSTN</b>	Public Switched Telephone Network
<b>PTC</b>	Positive Temperature Coefficient

Term	Definition
<b>PTT</b>	Push-to-talk; the switch located on the left side of the radio which, when pressed causes the radio to transmit.
<b>QN</b>	Quick – N
<b>RA/RT</b>	Remote Access/Remote Transmit
<b>RAC</b>	Repeater Access Control
<b>RdStat</b>	Receiver Data Status
<b>Receiver</b>	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.
<b>Repeater</b>	Remote transmit/receive facility that retransmits received signals in order to improve communications range and coverage.
<b>RF</b>	Radio Frequency, The portion of the electromagnetic spectrum between audio sound and infrared light (approximately 10 kHz to 10 GHz).
<b>RSS</b>	Radio Service Software; the software application used to program and service the station.
<b>RSSI</b>	Received Signal Strength Indicator; a dc voltage proportional to the received RF signal strength.
<b>Rx</b>	Receive.
<b>SCM</b>	Station Control Module; station controller.
<b>Signal</b>	An electrically transmitted electromagnetic wave.
<b>SINAD</b>	Acronym for the ratio of signal plus noise plus distortion and noise plus distortion.
<b>SMR</b>	Schaumburg Manual Revision
<b>Smart Repeater</b>	Trunking system in which channel control is distributed among several repeaters.
<b>Spectra-TAC</b>	Analog Total Area Coverage voting comparator used to select wide area receivers.
<b>Spectrum</b>	Frequency range within which radiation has specific characteristics.
<b>SPI</b>	Serial Peripheral Interface (clock and data lines); simple synchronous serial interface for data transfer between processors and peripheral ICs.
<b>Squelch</b>	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.
<b>SRAM</b>	Static RAM, memory chip used for scratchpad memory.
<b>TCC</b>	Trunking Central Controller; main control unit of the trunked dispatch system; handles ISW and OSW messages to and from radios in the field (See ISW and OSW).



Term	Definition
<b>TCXO</b>	Temperature Compensated Oscillator
<b>TOC</b>	Turn Off Code; alternating binary pattern used by DPL signalling to provide fast muting of the receiving radio.
<b>TOT</b>	Time-out Timer: A timer that limits the length of a transmission.
<b>TPL</b>	Tone Private Line.
<b>Transceiver</b>	Transmitter-Receiver. A device that both transmits and receives analog or digital signals. Also abbreviated as XCVR.
<b>Transmitter</b>	Electronic equipment that generates and amplifies an RF carrier signal, modulates the signal, and then radiates it into space.
<b>TRC</b>	Tone Remote Control
<b>Trunking</b>	Radio control system which permits efficient frequency utilization and enhanced control features.
<b>Tx</b>	Transmit.
<b>Type II Trunking</b>	Motorola trunking system which provides extended features.
<b>UHF</b>	Ultra High Frequency
<b>USB</b>	Universal Serial Bus: An external bus standard that supports data transfer rates of 12 Mbps.
<b>VCO</b>	Voltage-Controlled Oscillator; an oscillator whereby the frequency of oscillation can be varied by changing a control voltage.
<b>VGU</b>	Voter Gateway Unit
<b>VHF</b>	Very High Frequency
<b>VIP</b>	Vehicle Interface Port.
<b>VOX</b>	Voice Operated Switch; Used with MRTI.
<b>VSWR</b>	Voltage Standing Wave Ratio.
<b>WCI</b>	Wildcard Input
<b>WCO</b>	Wildcard Output
<b>WFI</b>	Word Frame Interrupt; used to synchronize trunking data messages in a Smart Repeater system.
<b>Wide Area</b>	Wide area systems allow expanded radio coverage by using multiple receivers and/or transmitters.
<b>WL</b>	Wireline
<b>WL Rx</b>	Wireline Receive; information from station RF Receiver sent to wireline equipment.
<b>WL Tx</b>	Wireline Transmit; information from wireline equipment sent to station RF transmitter.

<b>Term</b>	<b>Definition</b>
<b>XPR</b>	Refers to Digital Professional Repeater model names in the MOTOTRBO Professional Digital Two-Way Radio System.





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