

EX-i Series (TDD)

Digital Microwave Radios

Installation and Management Guide



Models:
EX-2.4i/EX-2.4i Lite
EX-2.4i-16/EX-2.4i-16 K
EX-4.9i
EX-5i/EX-5i Lite
EX-5i-16/EX-5i-16 K
EX-5i-DS3

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Table of Contents

Legal Notice	ii
Open-Source License Information	ii
List of Figures	vii
List of Tables	viii
About this Document	ix
Revision History	ix
Icons	x
Introduction	1
Related Documentation and Software	1
The Exalt i-Series Digital Microwave Radios	1
Pre-installation Tasks	6
Link Engineering and Site Planning	6
Familiarization with the i-Series Radios	6
Shipping Box Contents	7
Initial Configuration and Back-to-Back Bench Test	8
RF Output Power Setting	9
Time Division Duplex (TDD) Factors	9
Link Orientation and Synchronization	10
Radio A/B Configuration	11
Radio Synchronization	12
Synchronization Modes	12
Internal Synchronization	12
External Synchronization	13
Offset Timing	14
When Sync is Lost	15
LEDs	15
Virtual Local Area Network (VLAN)	15
Link Symmetry	16
Simple Network Management Protocol (SNMP)	17
System Installation and Initiation Process	18
Record Keeping	19
Installation	20
Mechanical Configuration and Mounting	20
Rack Mounting	20
Table or Rack Shelf Mounting the System	21
Radio Ports and Indicators	21
Connector Overview	22
LED Indicators	23
RMT (Remote) Button	25
Power	25
Terminating the RF Connector	25
AC Power	26
DC Power	26
Reset to Critical Factory Settings	28
Antenna/Transmission System	28
Initial Antenna Mounting	29

Transmission Line from Antenna to Egress	29
RF Lightning Arrestor	31
Transmission Line from Egress to Radio	32
Antenna Alignment	32
Configuration and Management	34
Command Line Interface (CLI)	34
Connect to the Radio with a Serial Connection	34
Telnet into the Command Line Interface (CLI)	34
Connect to the Radio in a Telnet Session	34
Exalt Graphical User Interface (GUI)	35
Preparing to Connect	35
Log In	36
Login Privileges	37
Quick Start	38
Navigating the GUI	39
Summary Status Section	39
Navigation Panel	40
Radio Information Page	42
Administration Settings Page	43
Simple Network Management Protocol (SNMP) Configuration	45
SNMP v1/v2c/v3 Support Options	45
SNMP Traps	46
File Transfer Page	48
File Activation Page	51
Access Security Page	52
System Configuration Page	54
MHS Configuration Page	58
Ethernet Interface Configuration Page	59
VLAN Configuration Page	60
T1/E1 Configuration Pages	62
T1 Interface Configuration Page	62
E1 Interface Configuration Page	63
T1/E1 Loopback	64
DS3 Configuration Page	65
GPS Information Page	66
Alarms Page	67
MHS Status Page	69
Performance Page	70
Event Log Page	72
User Throughput Page	73
Diagnostic Charts Page	75
Spectrum Analyzer Page	77
Ethernet Utilization Page	79
Reboot Page	80
Manual Page	81
Specifications	82
Physical Specifications	82

Common System Specifications	82
EX-2.4i System Specifications	83
EX-4.9i System Specifications	84
EX-5i System Specifications, 5.3GHz Band	85
EX-5i System Specifications, 5.4GHz Band	86
EX-5i System Specifications, 5.8GHz Band	87
Interfaces	88
Interface Connections	90
T1/E1 Connections	90
Ethernet Connections	91
Sync Connections	92
Alarm Connector	93
Console Connector	94
DC Power Connector	95
DIP Switch Settings (-16 Models Only)	96
Antennas	98
DC Coupler for Antenna Alignment	100
Required Items	100
Interconnections	100
Troubleshooting	102
General Practices	102
Typical Indications of Issues	103
Improper RF Cable Termination	104
Multipath Propagation	104
RF Interference	104
Path Obstruction	105
Misaligned Antenna	105
Faulty Antenna	105
Improper Grounding	106
Insufficient Link Margin	106
Moisture in the Transmission System	106
Back-to-back Bench Testing	107
Basic Test	107
Specification Performance Verification	108
General Compliance and Safety	110
Dynamic Frequency Selection	111
Safety Notices	112
Regulatory Notices	113
4.9GHz Model	113
United States Compliance	113
Federal Communications Commission (FCC), United States	113
Canada Compliance	114
Industry Canada (IC), Canada	115
Antennas Supported in Canada	115
Europe and ITU Country Compliance	115
Regulatory Compliance	117
Regulatory Domain Keys	119

EIRP Limits for the United States and Canada	120
EX-2.4i EIRP for the USA and Canada	120
EX-4.9i EIRP for the USA and Canada	120
EX-5i Series EIRP for the US and Canada	120
5250–5350 MHz Band	120
5470–5725 MHz Band	121
5725–5850 MHz Band	121
EIRP Limits for the European Union and ITU Countries	122
EX-2.4i-Series EIRP	122
EX-5i Series EIRP	123
5250–5350 MHz band	123
5470–5725 MHz band	124
5725–5850 MHz band	124
EIRP Limits for Australia	126
EX-5i Series EIRP for Australia	126
5470–5725 MHz Band	126
5725–5850 MHz Band	126
Declaration of Conformity to the R&TTE Directive	
1999/5/EC	127
EU WEEE	128
EU RoHS	128
END USER AGREEMENT	130
Copyright Notices	135
Index	139

List of Figures

Figure 1	EX-2.4i Digital Microwave Radio	1
Figure 2	Indoor mount interconnection	4
Figure 3	Enclosure mount interconnection	4
Figure 4	Basic radio interconnectivity using internal synchronization	12
Figure 5	Collocated radios, one in AUTO SYNC mode to provide redundancy	13
Figure 6	Multiple-link site configuration, using AUTO SYNC for redundancy	13
Figure 7	GPS as primary sync source using AUTO SYNC	14
Figure 8	Synchronized GPS sources using AUTO SYNC	14
Figure 9	Radio installation tasks	18
Figure 10	Front flush mount configuration	20
Figure 11	Front projection mount configuration	20
Figure 12	Rear-mount locations	21
Figure 13	Front panel (EX-2.4i, EX-4.9i, or EX-5i)	21
Figure 14	Front panel (EX-2.4i-16 or EX-5i-16)	22
Figure 15	Front panel (EX-5i-DS3)	22
Figure 16	Primary front panel connectors (standard models)	22
Figure 17	EX-5i-DS3 connectors and grounding switches	23
Figure 18	DC connector	27
Figure 19	CLI root menu	35
Figure 20	Initiating the browser connection	36
Figure 21	Browser Login screens—model dependent	37
Figure 22	Radio Information page	38
Figure 23	Exalt GUI window description	39
Figure 24	Summary status information	40
Figure 25	Radio Information page	42
Figure 26	Administration Settings page	43
Figure 27	Changed fields and Update button	43
Figure 28	SNMP Configuration page	45
Figure 29	Trap Configuration page	46
Figure 30	File Transfer page	48
Figure 31	File Transfer page—download file link	49
Figure 32	File Activation page	51
Figure 33	Access Security page	52
Figure 34	System Configuration page	54
Figure 35	MHS Configuration page	58
Figure 36	Ethernet Interface Configuration page	59
Figure 37	VLAN Configuration page	60
Figure 38	T1 Interface Configuration page	63
Figure 39	E1 Interface Configuration page	63
Figure 40	External (remote) loopback	64
Figure 41	External (local) loopback	64
Figure 42	DS3 Configuration page	65
Figure 43	GPS Information page	66
Figure 44	Alarms page	67
Figure 45	MHS Status page	69
Figure 46	Performance page	70
Figure 47	Event Log page	72
Figure 48	User Throughput page	73
Figure 49	Aggregate User Throughput Help page	74

Figure 50	Diagnostic Charts page	75
Figure 51	Spectrum Analyzer page	77
Figure 52	Spectrum analyzer graph example	78
Figure 53	Ethernet Utilization page	79
Figure 54	Reboot page	80
Figure 55	Manual page	81
Figure 56	T1/E1 connectors	90
Figure 57	Ethernet connectors (MAIN and AUX)	91
Figure 58	Sync In connector	92
Figure 59	Sync Out connector	92
Figure 60	Alarm Connector	93
Figure 61	Console Connector	94
Figure 62	DC Power connector	95
Figure 63	DIP Switch Orientation	96
Figure 64	DC coupler interconnection	101
Figure 65	Basic back-to-back bench test configuration	107

List of Tables

Table 1	Factory default settings	11
Table 2	Connectors	22
Table 3	LED indicators	23
Table 4	Recommended transmission line	30
Table 5	Default login information	37
Table 6	Alarm status indicators	67
Table 7	DIP Switch Functions	96
Table 8	Standard Factory Defaults (-16 Models)	96
Table 9	Common DIP Switch Applications	97
Table 10	EX-2.4i supported antennas	98
Table 11	EX-5i supported antennas	99
Table 12	Product approvals	117
Table 13	Regulatory Domain Keys	119
Table 14	EU and ITU Country-Specific EIRP Levels for the EX-2.4i Series	122
Table 15	EU and ITU Country Specific EIRP Levels for EX-5i Series	124

About this Document

This manual provides a complete description of the EX-i Series (TDD) of Exalt Digital Microwave Radios and related software. This manual provides planners, engineers, installers, system administrators, and technicians general and specific information related to the planning, installation, operation, management, and maintenance of these devices.

Revision History

Date	Products and Release code
2006-04-28	EX-2.4i release 1.0
2006-05-03	EX-2.4i release 1.01 (also valid for 1.0.2)
2006-07-06	EX-5i release 1.0.0 (also valid for 1.0.1)
2006-09-01	EX-2.4i release 1.1.0 (Mode 2 feature release) EX-5i-16 release 1.0.0 EX-2.4i-16 release 1.0.0 EX-5i release 1.1.0 (SNMP feature release)
2006-09-27	EX-2.4i and EX-5i release 1.1.0 (SNMP feature release)
2006-10-27	EX-2.4i v1.2.0 (Sync and VLAN feature releases) EX-5i release v2.0.0 (Sync and VLAN feature releases) EX-2.4i and EX-5i-16 v1.1.1 (Sync feature release)
2007-02-28	EX-4.9i (initial release)
2007-04-20	EX-4.9i release v1.1.0 (AES and GPS Sync feature releases)
2007-05-07	EX-5i release v3.0.0 (Symmetry, Enhanced Event Log, and Legacy SNMP feature releases)
2007-07-16	EX-5i v3.1.0 (Regulatory Domain Key, Base License Key, and Dynamic Frequency Selection feature releases) EX-5i-16 v2.0.0 (Regulatory Domain Key, Base License Key, and Dynamic Frequency Selection feature releases)
2007-10-18	EX-5i-DS3 v1.0.0
2007-11-30	EX-5i release 3.2.0 (Spectrum Analyzer, AES-256, Enhanced CLI, SNMP Traps, MIB-II enhancements feature releases)
2008-05-16	Related documentation update.
2009-12-15	EX-2.4i-16 and EX-5i-16 release 4.0.0 (VLAN, User Throughput, Ethernet Utilization Diagnostics, SSL/SSH and DHCP feature releases)
2011-10-26	EX-5i-DS3 release v4.2.0 (major feature release and first release of management security feature)
2012-01-20	EX-5i release v4.2.1 (management security feature and other minor features)
2014-06-27	EX-5i release v4.3 (multiple SNMP server support)
2015-11-06	Updated to include current contact information
2016-05-24	Updated for FCC Class II Permissive Change

Icons

The following icons denote specific types of information:



Note: This symbol means take note. Notes contain helpful suggestions or references to materials not contained in the manual.



Warning! This symbol means there is a risk of electric shock or bodily injury. Before working on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.



Caution! This symbol means be careful. There is a risk of doing something that might result in equipment damage or loss of data. This is a general warning, caution, or risk of danger.

Introduction

Exalt Wireless, Inc. thanks you for your purchase. Our goal is to build the highest quality, highest reliability digital microwave radio products. This commitment to quality and reliability extends to our employees and partners alike. We appreciate any comments on how we can improve our products, as well as your sales and Customer Care experience.

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Related Documentation and Software

This manual makes reference to other documentation and software files that may be necessary. To access all documents and software mentioned in this manual visit:

<http://login.exaltcom.com>

You must have a user account to view all downloads. Follow the online instructions to create a user account and request access.

The Exalt i-Series Digital Microwave Radios

The Exalt i-Series Digital Microwave Radios are the most advanced carrier-class point-to-point terrestrial radio communications devices operating in the 2400 to 2483.5 MHz, 4940 to 4990MHz, and 5250 to 5850MHz frequency bands, respectively. Figure 1 shows the EX-2.4i Digital Microwave Radio.



Figure 1 EX-2.4i Digital Microwave Radio

The i-Series radios connect voice and/or digital data from one location to another, obviating the need for copper or fiber connectivity, or enhancing existing connectivity by providing a redundancy solution, a primary solution, and/or additional capacity.

The following models of radios are covered in this manual:

- **EX-2.4i, 10/100 Ethernet + 4xT1/E1**
 - Configured for 100Mbps + 4xT1/E1 (32MHz/Mode2)
 - With license-key upgrade for 200Mbps capacity (64MHz/Mode2)
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-2.4i Lite, 10/100 Ethernet + 4xT1/E1**
 - Configured for 27Mbps (8MHz/Mode2 and 16MHz/Mode1)
 - With license-key upgrade for 55Mbps
 - With license-key upgrade for 100Mbps
 - With license-key upgrade for 2xT1/E1
 - With license-key upgrade for 4xT1/E1
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-2.4i-16 (or EX-2.4i-16 K, exclusively for Korea), 10/100 Ethernet + 16xT1/E1**
 - Configured for 4xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 8xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 12xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 16xT1/E1, 200Mbps (64MHz/Mode2)
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-4.9i, 10/100 Ethernet + 4xT1/E1**
 - Configured for 2xT1/E1, 27Mbps (10MHz/Mode2, 20MHz/Mode1)
 - With license-key upgrade for 4xT1/E1, 55Mbps (20MHz/Mode2)
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-5i, 10/100 Ethernet + 4xT1/E1**
 - Configured for 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 200Mbps capacity (64MHz/Mode2)
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-5i Lite, 10/100 Ethernet + 4xT1/E1**
 - Configured for 27Mbps (8MHz/Mode2 and 16MHz/Mode1)
 - With license-key upgrade for 55Mbps
 - With license-key upgrade for 100Mbps
 - With license-key upgrade for 2xT1/E1
 - With license-key upgrade for 4xT1/E1
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-5i-DS3 10/100 Ethernet + 1xDS3 + 16xT1/E1**
 - Configured for 100Mbps + 4xT1/E1 (32MHz/Mode2)

- With license-key upgrade for 200Mbps + 16xT1/E1 (64MHz/Mode2)
- With license-key upgrade for 200Mbps + 1xDS3 (64MHz/Mode2)
- With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption
- **EX-5i-16 (or EX-5i-16 K, exclusively for Korea), 10/100 Ethernet + 16xT1/E1**
 - Configured for 4xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 8xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 12xT1/E1, 100Mbps (32MHz/Mode2)
 - With license-key upgrade for 16xT1/E1, 200Mbps (64MHz/Mode2)
 - With license-key upgrade for FIPS-197 compliant 128-bit or 256-bit AES encryption

Generally, the i-Series models require a clear line-of-sight and proper path clearance to achieve a high-performance, reliable connection. Perform professional path engineering and site planning BEFORE installing this equipment.

The primary focus of this document is the installation and maintenance of the digital microwave radio, and assumes that path engineering and site planning were already performed.

The EX-2.4i models utilize radio frequencies in the range of 2400 to 2483.5MHz. The EX-5i models utilize radio frequencies in the range of 5250 to 5850 MHz. In most countries these frequency bands are considered as ‘license-exempt’ or ‘unlicensed.’ This means that virtually any user may use these frequencies freely, without paying for access, or any type of pre-notification, post-notification or registration. As a result of this designation, users may also move or change these systems at any time, with significant flexibility to the location, orientation and configuration of the system. However, also due to this designation, there may be uncontrolled interference from other similar devices occupying this spectrum. In these cases, it is up to engineering and maintenance personnel to design the system with existing and future interference sources in mind, recognizing that there is a chance that the interference conditions could be very dynamic, and outages may occur on the system as a result, and that, in some very rare cases, the system may cause interference into another system and may be required to be disengaged or modified/re-oriented to eliminate the interference.

If the spectrum in your country is designated as ‘license-exempt’ or similar, this does not infer that the installer may configure the system in any manner at any location. In most cases, there are regulations, or device-based conditions that limit the use of the device, such as maximum gain antenna, antenna types and maximum output power, as well as, in some cases, application limits, limited geography of use, and other unique regulations. The link design engineer and/or professional installer must determine these limitations and engineer/install the system within the confines of all local regulations. Also, it is required to examine any regulations that may apply to peripheral equipment, installation and cabling of the system that may be regulated for human safety, electrical code, air-traffic control, and other safety-related categories.

In certain countries, the spectrum for this product is NOT considered to be license-exempt. In these cases, there may be additional regulatory requirements concerning the location, frequency, power, orientation, configuration, and other aspects of the system, including, in some cases, a need for link registration, coordination, and fees that may apply to the system usage. Please consult your local regulatory organization(s) to determine usage requirements.

The EX-4.9i utilizes frequencies in the 4940–4990MHz range, and is typically a licensed band reserved for use by Public Safety agencies and applications.

In almost all cases, either for license-exempt or other designation, the product itself must be authorized for use in your country. Either Exalt or Exalt’s agent must have applied for certification or

authorization to allow the sale and deployment of the system within the country. It is also possible that only certain versions or configurations of the device are allowed within a particular country. Please contact Exalt or your authorized Exalt representative for information pertaining to your country.

 **Note: It is the professional installer's responsibility to ensure that the radio system is implemented in a legal fashion. Exalt is not liable for any unsafe or illegal installations.**

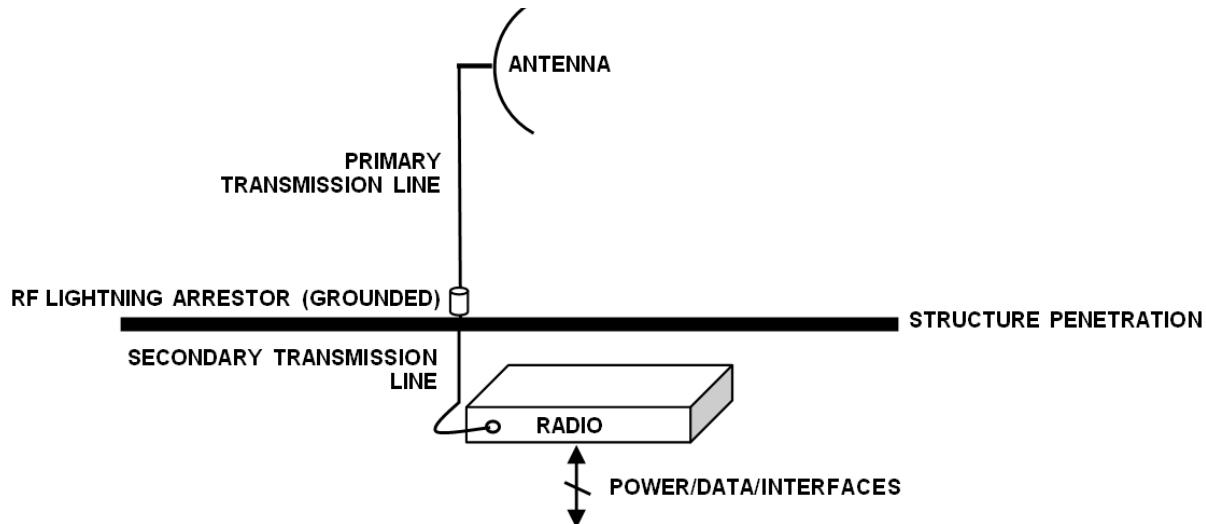


Figure 2 Indoor mount interconnection

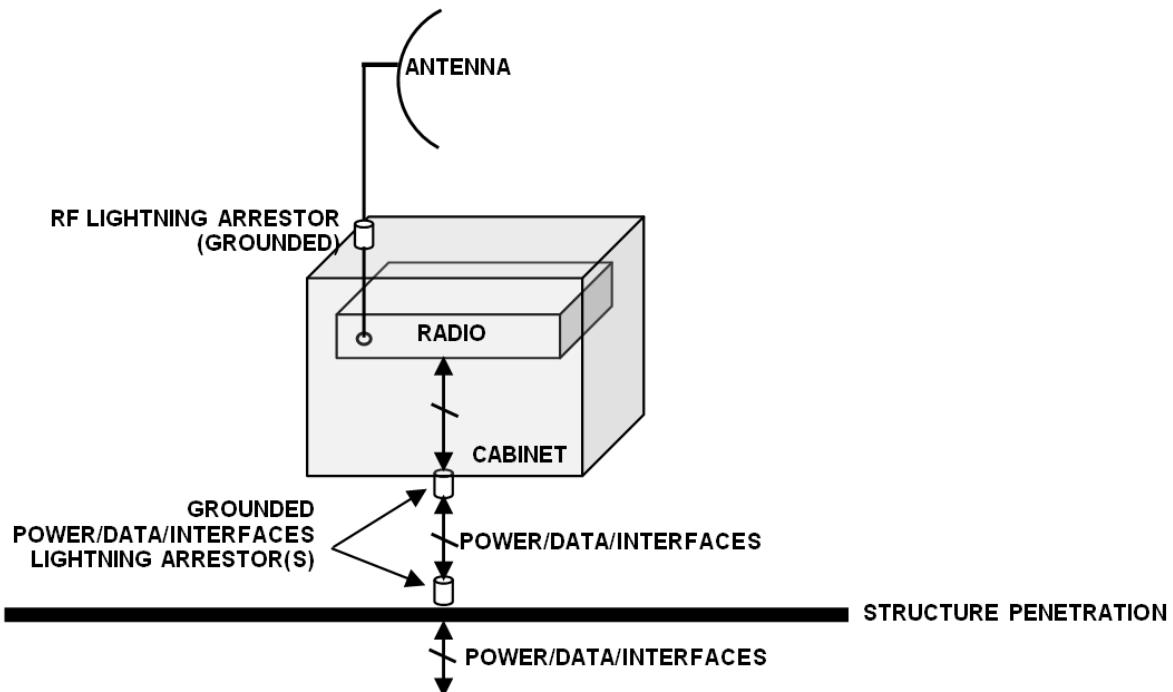


Figure 3 Enclosure mount interconnection

For highest performance and reliability, it is advised to minimize the length of RF cable and associated transmission system losses between the antenna and the radio's antenna port.

Depending on model, combinations of the following data communication interfaces are provided:

- 10/100BaseT Ethernet
- Up to 16xT1/E1 interfaces for synchronous voice traffic (number of TDM interfaces is determined by specific model and license-key configuration)
- Up to 1xDS-3 interface for synchronous voice traffic

The i-Series radios feature a wide-mouth direct DC connection (24V or 48V), and are also provided with an external AC adapter.

All models provide the following primary features and benefits:

- Low-latency optimization and control for voice and data connections
- Very high throughput and flexible interface configurations with voice+data combinations
- Encryption for extreme wireless security
- Easy-to-use management and configuration
- Flexible utilized channel bandwidth selection for interference avoidance and frequency coordination
- Flexible center frequency tuning for interference avoidance and frequency coordination

Pre-installation Tasks

This section describes the steps necessary to prepare a site for the installation of the Exalt Digital Microwave Radio.

Link Engineering and Site Planning

Design all terrestrial wireless links prior to purchase and installation. Generally, professional wireless engineering personnel are engaged to determine the viability and requirements for a well-engineered link to meet the users' needs for performance and reliability.

The reader is referred to the Exalt document, *Guidance for Engineering and Site Planning of Terrestrial Wireless Links*. This document and calculator aid in the pre-planning and engineering required to determine following attributes:

- Antenna type/gain at each end of the link
- Antenna mounting height/location for proper path clearance
- Antenna polarization orientation
- RF cabling type, length, connectors, route, and mounting
- Antenna system grounding
- Lightning arrestor type(s), location(s), and grounding
- Radio mounting location and mechanisms
- Radio grounding
- Radio transmitter output power setting
- Anticipated received signal level (RSL) at each end
- Anticipated fade margin and availability performance at each end
- Radio settings for TDD frame length and occupied bandwidth
- Anticipated throughput performance (TDM circuit support and Ethernet)
- Anticipated system latency

With respect to radio path and site planning, these radios are generally identical to other microwave terrestrial wireless systems. Engineering of these systems requires specific knowledge about the radios, including:

- RF specifications (transmitter output power, receiver threshold, occupied channel bandwidth, and carrier-to-interference tolerance)
- Regulatory limitations on transmitter output power setting and antenna type/gain
- Noise/interference profile for the intended location

Familiarization with the i-Series Radios

The Exalt i-Series radios utilize time division duplex (TDD) radio transmission. This means that the transmitted signal in both directions uses the same center frequency and transmits in one direction for a period of time, and then in the opposite direction for another period of time. This total period of time is referred to as the *frame length* or *TDD frame length*, and is further discussed in [Time Division Duplex \(TDD\) Factors](#).

The two radio terminals are identical hardware, except for the TDD setting in software. When the radios are in their default state, both radios are configured as Radio B. **One end of the link must be configured as Radio A before the two ends of the radio system can communicate.**

It can be considered that Radio A is the primary radio in the link. Radio A provides the master clock and control to Radio B. For most applications, it is not important how the radio link is oriented, only that one end is configured for Radio A and the other for Radio B. For some applications (such as, multi-radio hub sites or repeaters), the orientation of the radio systems may be more critical. See [Link Orientation and Synchronization](#).

There are three ways to configure the radios for Radio A/B determination:

- 1 Use the Exalt browser-based graphical user interface (GUI) – preferred.
- 2 Use the [Command Line Interface \(CLI\)](#) through Telnet on the AUX port or a Serial connection to the Console port.
- 3 Use the front panel DIP switch, in case of emergency (EX-2.4i-16 model only).

Exalt recommends using the Exalt GUI for radio configuration. This interface requires a computer with an Ethernet port and web browser software, such as Microsoft Internet Explorer 5.0 or above. See [Configuration and Management](#) for details on how to connect to and use the browser-based GUI interface.

-16 and -DS3 models: The front panel DIP switch provides a fast temporary means for Radio A/ Radio B configuration. EX-5i-16 and EX-5i-DS3 models may also require installation of the Regulatory Domain Key prior to DIP switch operation. See [DIP Switch Settings \(-16 Models Only\)](#).



Note: Models with the Access Security management feature ignore DIP switch configurations after any reset. See the [Access Security Page](#).

Shipping Box Contents

Unless purchased as a spare terminal, the radios are shipped as a complete *hop* (that is, a radio link pair consisting of two terminals). An outer box has labeling that indicates the contents of the box, with the part number and serial number details for both radio terminals.

Inside the outer box are two identical boxes, each of these boxes is also marked with the part number and serial number of the individual terminal contained inside the box. The terminal box contains the following items:

- Radio terminal (configured as Radio B)
- AC adapter
- Accessory kit
 - Rack mount flanges
 - Flange mounting hardware (4 x M4 screws; 4 x M4 wave washers)
 - DC power connector (1)
 - Grounding hardware (1 x M5 screw; 1 x M5 wave washer; 2 x M5 flat washers)
- Registration card
- Quick-start guide

Inspect the outer packaging and the contents of the boxes upon receipt. If you suspect any shipping damage or issues with the contents, contact Exalt Customer Care.



Note: Register your system as soon as possible. A 2-year Warranty period applies to products registered within 90 days of purchase. The Warranty period is reduced to 1-year for unregistered products and products registered after the first 90 days. See [Exalt Limited Hardware Warranty](#).

Initial Configuration and Back-to-Back Bench Test

Every Exalt digital microwave radio goes through extensive quality testing and performance evaluation over the full operating temperature range prior to shipment. However, before installation, it is strongly advised to perform several tests and tasks that are much more difficult to perform once the radio link endpoints are distant from one another. A back-to-back bench test and pre-configuration will provide confidence that the radio link is operational and properly configured *prior* to installation, so that if troubleshooting is necessary, the radio hardware and configuration settings are eliminated from the troubleshooting process. Verify the following in the back-to-back testing:

- Confirm that the radio system is generally operational
 - Radios power-up with planned power and wiring solutions
 - Regulatory Domain Key (RDK) entry successful



Note: Exalt radios with the RDK function are DISABLED when initially shipped. To ENABLE the radio, a valid RDK must be entered on the [Administration Settings Page](#) of the Exalt GUI. The RDK references the unit's serial number and is provided based on the country and/or region where the radio system will be deployed. The RDK is obtained through your Exalt Authorized distributor or reseller.

- RF link connects in both directions
- Traffic passes across the link



Note: Some countries require Dynamic Frequency Selection (DFS), which delays the transmitter turn-on time during the initial Clear Channel Assessment period of 1 minute. In accordance with these regulations, the radios boot up, and then wait for 1 minute before linking.

- Configure connected equipment and cabling
 - Test Ethernet (CAT5) cabling, and/or T1/E1 cabling, any auxiliary connector cabling and configure all interfaces
 - Configure IP settings for configuration and management
 - Configure passwords and security modes
 - Become familiar with the configuration and management interfaces through the Exalt GUI interface
 - Configure radio parameters, including installing any optional software license keys and configuring features controlled by license keys
 - Set transmitter output power to engineered or allowed level (see [RF Output Power Setting](#))
 - Set operating center frequency

- Set link distance, occupied channel bandwidth, and frame length
- Make detailed radio performance measurements
 - Measure transmitter output power
 - Measure receiver threshold performance
 - Confirm unfaded error-free performance

Some of these tasks may not be possible or practical within a bench test environment due to the nature of the remote connectivity of peripheral equipment. However, it is good practice to perform as much as possible in this environment to minimize field/installation time and troubleshooting efforts.

Detailed performance measurements are usually not required for pre-installation, but can be easily performed at this stage and may be helpful for later troubleshooting efforts or for internal records. During troubleshooting, there may often be a point at which a back-to-back bench test should be performed to verify many or all of the above items, and in the case of a suspected faulty device, to help confirm the fault and determine which end of the system is at fault and in need of repair or replacement.



Note: See [Back-to-back Bench Testing](#) for detailed instructions.

RF Output Power Setting

The maximum RF output power is bounded by one of the following criteria:

- Maximum RF output power setting capability of the radio device
- Maximum RF output power allowed/authorized by the local government regulations and for this specific device
- Maximum effective isotropic radiated power (EIRP) of the transmission system allowed/authorized by the local government regulations and for this specific device
- Desired RSL to not exceed the maximum RSL allowed by the device
- Desired RSL to minimize/eliminate interference into neighboring systems

Time Division Duplex (TDD) Factors

The i-Series radios are very dynamic, allowing the installer to optimize and control the performance of the radio system for the intended application. The following parameters must be carefully determined during the link engineering phase:

- Link distance
- Bandwidth
- TDD frame size
- Mode (modulation)

The setting of the above parameters determines the following performance factors:

- Number of supported T1/E1/DS3 channels
- Ethernet throughput

- System latency (delay)

The following generalizations can be made with regards to these factors:

- The shorter the TDD frame size, the lower the latency
- The shorter the link distance, the lower the latency, the higher the throughput
- The longer the TDD frame size, the higher the throughput
- The higher the bandwidth, the higher the capacity
- The higher the mode, the higher the capacity



Note: Disable all T1/E1/DS3 ports if there are no T1/E1/DS3 interfaces connected. This shifts all available throughput to the Ethernet interface.



Note: If a selected combination of the Link Distance, Frame Size, Bandwidth, and Mode parameters cannot support all the desired TDM ports, the ports that cannot be supported are automatically disabled. Priority is placed on the DS3 port, and then the T1/E1 port number. That is, the first port to be disabled, if necessary, is the highest T1/E1 port number, such as Port 4 for the standard models, and Port 16 for -16 or -DS3 models (assuming that the DS3 and/or all 16 TDM interfaces are licensed for use). See [T1/E1 Configuration Pages](#) for more information.

Link Orientation and Synchronization

Link *orientation* refers to the Radio A and Radio B placement in your network. Link *synchronization* refers to using external or internal timing to coordinate multiple links.

For every link, one end of the radio link must be configured as Radio A, while the other end is configured as Radio B. In single-link systems, it does not matter which end of the system is mounted at which end of the link, and there is typically no requirement for any link synchronization.

Link orientation and synchronization are more important for networks with site(s) where there is more than one link of the same type or for sites using the same type of radio that are very close to each other at one or both ends.

Configure collocated radio terminals for the same link orientation. That is, configure all radios at the same location as Radio A or Radio B.

It can be advantageous to utilize link synchronization for collocated links. The radios allow the use of an optional GPS synchronization kit. This synchronization controls the transmitter and receiver frame timing so that collocated radios are transmitting at the same time and receiving at the same time. This can substantially reduce the opportunity for self-interference. Without synchronization, collocated radios may be transmitting and receiving at the same time, incurring near-end interference.



Note: It is not always necessary to synchronize collocated radios. If antennas are substantially separated or blocked from one another and/or frequency separation tuning is used, the opportunity for near-end interference can be eliminated.



Note: The GPS sync feature is not available on all models. Contact your Exalt Wireless representative for details.

Radio A/B Configuration

Use the Exalt GUI to configure the radio terminals for Radio A and Radio B orientation. Since many other parameters also need to be set, and the Exalt GUI is needed for these configurations, this is the best way to completely configure the radio terminals.

Radios arrive from manufacture in default configuration, orientated as Radio B and configured as shown in Table 1.

Table 1 Factory default settings

Parameter	EX-2.4i	EX-4.9i	EX-5i
Frequency	2441 MHz	4965 MHz	5788 MHz; 5600 or 5785 MHz if the regulatory domain does not allow 5788 MHz
Transmit Power	+7dBm	+4dBm	+4dBm
Bandwidth	8MHz	10MHz	8MHz; 10MHz for some regulatory domains
Mode	Mode 1		
Link Distance	<10 miles		
TDD Frame Size	2ms		
Link Security Key	000000000000		
Administration Password	password		
User Password ^a	password		
IP Address	10.0.0.1		
IP Mask	255.0.0.0		
IP Gateway	0.0.0.0		
Ethernet Interfaces	MAIN: Alarm Enabled, 100/Full; AUX: Alarm Disabled, 100/Full		
AUX port NMS Access	In-Band		
T1/E1 Settings	All Enabled, T1, B8ZS, AIS		

a. Some firmware releases use passwords of admin and user instead of the global password.



Note: In many cases, the system design will not be identical to the factory default configuration, and in some cases, these differences prohibit the installation of the radio. If at all possible, obtain a computer and configure the radio terminals using the browser-based GUI. See [Exalt Graphical User Interface \(GUI\)](#).

DIP Switch Configuration (-16 and -DS3 Models only)

The -16 and -DS3 models have a DIP switch to allow temporary configuration for Radio A and Radio B. See [DIP Switch Settings \(-16 Models Only\)](#) for information on DIP switch functions.



Note: Models with the Access Security management feature ignore DIP switch configurations after any reset. See the [Access Security Page](#).

Radio Synchronization

The radio synchronization feature improves the performance of Exalt radios operating in the same frequency band and that are collocated (such as in repeater and hub configurations). Radio synchronization ties radio systems together to operate off of a common clock system, ensuring that all radios simultaneously transmit and receive, and thus eliminating near-field interference issues and related radio system coupling.



Note: The synchronization function is not currently available on all Exalt radio models. A firmware upgrade may be required for models without sync if sync is desired. Contact your Exalt representative for details.

Synchronization Modes

Synchronization can be accomplished using either an *internal* or *external* source. In either case, one radio in the network must be defined as the primary sync source (A) radio.

A Global Positioning System (GPS) kit from Exalt is required to implement external source synchronization. GPS synchronization is not available on all radio models. Contact your Exalt representative for details.

Synchronization implementation only requires one synchronization source for any interconnected network. The system also implements a redundancy configuration to maintain a majority of the synchronization functions in case of primary radio failure.

For internal synchronization, the primary radio is designated SYNC SOURCE. This radio provides the master timing for all interconnected radios. SYNC SOURCE radios and collocated radios must be configured as Radio A.

Collocated radios must be in SYNC RECIPIENT mode; they receive sync signaling from the SYNC SOURCE, either directly or daisy-chained with other collocated radios. Alternatively, the radio(s) can be placed in AUTO SYNC mode. AUTO SYNC synchronizes the radios to any source provided on the SYNC IN port. However, if an appropriate synchronization signal is unavailable, the radio becomes the SYNC SOURCE for all connected radios.

Internal Synchronization

Figure 4 illustrates the basic interconnectivity of a radio system using internal synchronization. In this scenario, there are two radios collocated at one site.

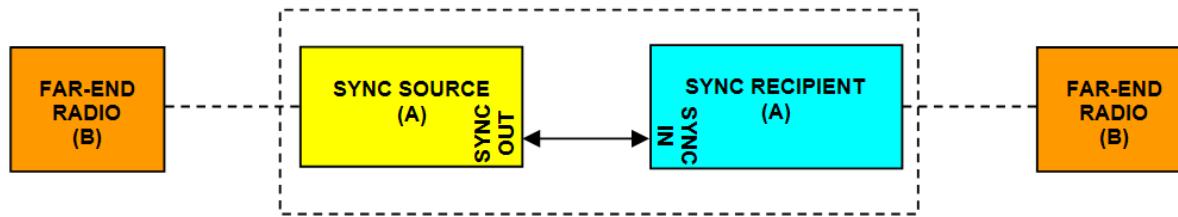


Figure 4 Basic radio interconnectivity using internal synchronization

In Figure 5, there are three collocated radios. In this configuration it may be desirable to make one radio a secondary sync source using AUTO SYNC. This provides redundancy if the primary sync source radio (A) loses power or experiences any other failure.

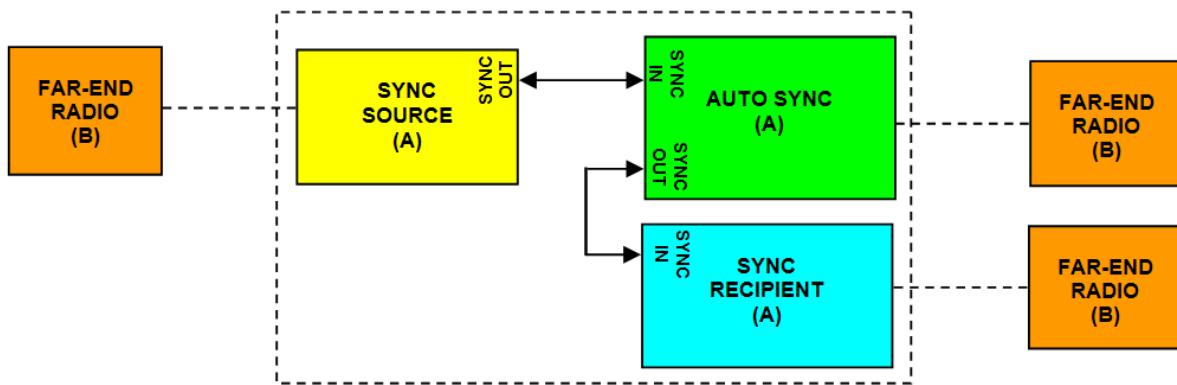


Figure 5 Collocated radios, one in AUTO SYNC mode to provide redundancy

The synchronization function can be carried across links to additional collocation sites. For example, Figure 6 illustrates a multi-link backbone with two hub sites.

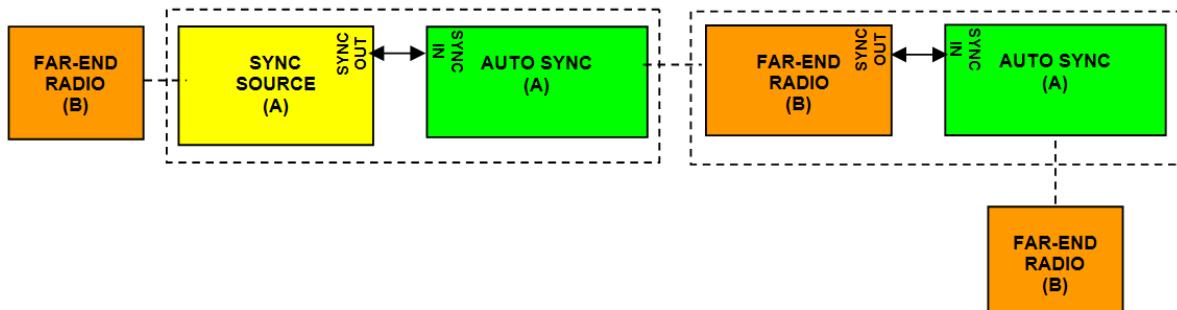


Figure 6 Multiple-link site configuration, using AUTO SYNC for redundancy

 **Note:** Currently, the configuration shown in Figure 6 is not supported in all models. Consult your Exalt representative for details.

Virtually any combination of hubs and repeater sites, star configurations, and/or backbones can be implemented with synchronization using these configurations. It is typically necessary or ideal in each configuration to match the following parameters on every radio in the network:

- Link Distance – Match to the longest distance link in the network.
- Frame Length – Match to the lowest frame length to optimize total system latency (for example, for TDM networks) or match to a highest frame length to optimize user throughput. Choose an intermediate value to compromise between latency and throughput.
- Mode – It is desirable, but not always necessary, to match the mode for all collocated links.
- Bandwidth – It is desirable, but not always necessary, to match the bandwidth for all collocated links.

For complex networks, an Exalt engineer should review multi-link networks before deployment as several factors can optimize the network for desired performance.

External Synchronization

Use an external GPS source as an alternative to the internal synchronization source for system synchronization. This is ideal for links that are nearby each other, but are not directly collocated at the

same site. Figure 7 illustrates using a GPS source for the primary synchronization at a typical site with collated radios.



Note: When GPS Sync is enabled, link initiation typically takes 1 to 3 minutes to allow for the radio to properly synchronize to the available GPS satellites.

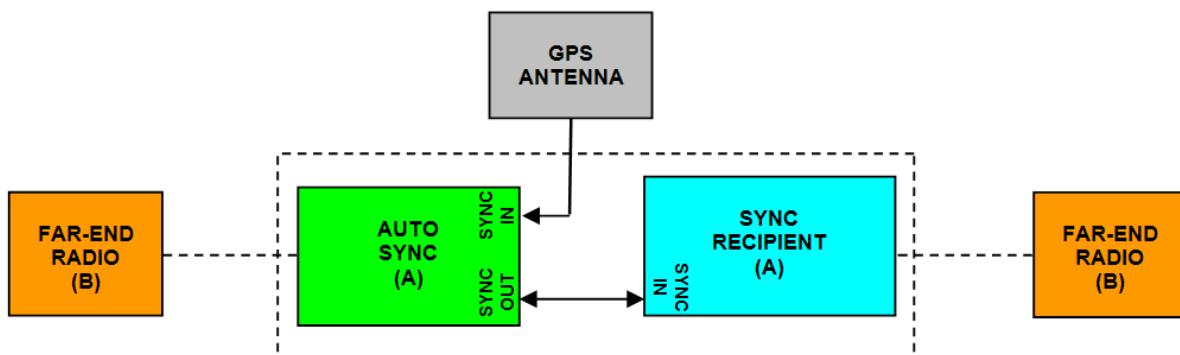


Figure 7 GPS as primary sync source using AUTO SYNC

Figure 8 illustrates two separate radio locations benefiting from synchronized GPS sources.

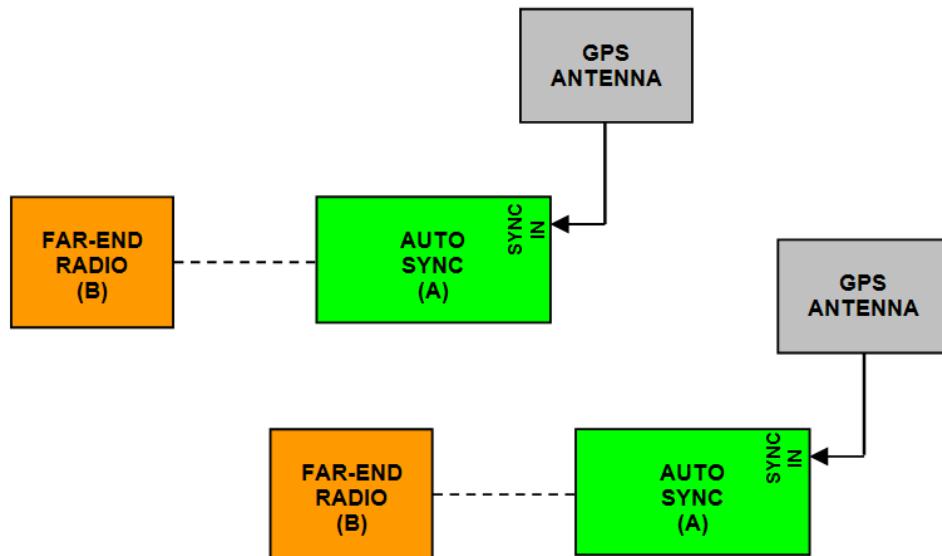


Figure 8 Synchronized GPS sources using AUTO SYNC

Offset Timing

Manual control of offset timing is also allowed. This provides a means to delay the synchronization signal using a user-defined offset. This is helpful when Exalt radios are near other devices operating in the same frequency band that also use a timing source, such as GPS. The timing source to the Exalt radios can be adjusted to match the other radio system timing source mechanism.

Offset timing can also optimize timing intervals for repeaters and backbones. As the distance of each link results in a unique factor for speed-of-light transmission of the radio signal, a subsequent radio can be delayed in timing so that the overall synchronization of radios is precisely maintained.

Offset timing can be adjusted in 1-ms intervals, from zero to the radio's frame length setting. For example, if using a 2-ms frame length, the offset timing can be set from zero up to 1999 ms.



Note: Offset timing is not supported in all models at the time of this writing. Consult your Exalt representative for details.

When Sync is Lost

If the primary sync source (for example, the sync source radio or GPS source) signal is lost due to equipment failure, a disconnected sync cable, or other conditions, the first radio in the daisy-chain configuration set to AUTO SYNC resumes the sync function for the remaining connected radios.

If a radio is configured as SYNC RECIPIENT, transmission ceases if the sync signal does not appear at the SYNC IN connector.

A radio running in AUTO SYNC (without the sync source) is said to be *flywheeling*. That is, the clock is free-running off internal clocking and is no longer synchronized to any source.

If the original sync source is restored to the flywheeling radio configuration, the flywheeling radio attempts to synchronize to this signal without causing transmission interruption. All interconnected radios receiving sync from the flywheeling radio also continue to operate without interruption.

When the flywheeling radio runs independently for long periods of time, the synchronization signal can be too far outside of the capture range of the synchronization loop, and portions of transmission frames can be lost during the re-synchronization process. This condition is temporary and all interconnected radios re-synchronize to the sync source, as necessary.

For GPS synchronization, the wiring inside the Exalt radio carries the GPS signal to the next radio cabled in the system, even when power is removed from the SYNC SOURCE radio or during radio failures. This provides redundancy for catastrophic failure of the SYNC SOURCE and maintains GPS synchronization. If the GPS source is lost (for example, due to failure of the GPS unit, a disconnected cable, or satellite blockage), the AUTO SYNC radio resumes synchronization duties for all collocated radios.

LEDs

There are two LEDs on both the SYNC OUT and SYNC IN ports. Table 3 describes the two SYNC IN and two SYNC OUT LEDs.

Virtual Local Area Network (VLAN)

VLAN segments information in a single connection and creates multiple separate connections to secure information of one type or for one set of users from other information types or for other sets of users. Exalt's VLAN communications implementation adheres to the IEEE standard 802.1q.

In most cases, an Exalt radio acting as a Layer 2 bridge between two locations is only required to pass traffic with VLAN tagging. Without additional configuration, all Exalt radios support frame sizes in excess of 1900 bytes, which currently supports all defined VLAN packet sizes.



Note: If an application only requires the transparent passing of VLAN traffic, disable the VLAN function.

Some situations require Exalt radios to act upon VLAN traffic and perform any or all of the following functions:

- Connect specific traffic, using VLAN tagging, to a specific port on the radio, such as management traffic to the AUX port.

- Allow only traffic with specifically assigned VLANs to pass across the link, blocking all other VLANs or any non-VLAN traffic.
- Allow management access only through a VLAN connection, leaving the main traffic transparent.
- Allow management access without a VLAN connection, but flowing only specific VLAN traffic across the link.

Link Symmetry

The default configuration of i-Series radios provides 50/50 symmetrical throughput. The Tx/Rx Throughput Ratio setting enables programming different symmetry for applications where significantly higher throughput in one direction is anticipated such as for video broadcast, video aggregation, or remote server/storage WANs.

Exalt does not recommend placing two links with asymmetry back-to-back in a serial configuration due to the TDD cycle of the radios. This configuration requires that one radio transmits in an overlapping time period while another radio is receiving. Physical antenna isolation and/or frequency channel spacing may accommodate this configuration. Asymmetry is, however, ideal for single-hop, multi-link hub/spoke architectures, or simply single independent links.



Note: Asymmetry is only supported for a specific subset of system configurations that are optimized for typical asymmetric applications.

TDD frame sizes of 2ms and 5ms are supported. The 5ms configuration maximizes the aggregate throughput of the radio for every situation. The 2ms configuration reduces latency to meet latency-critical applications, especially for multi-link and TDM circuit support. The following RF BW mode combinations are supported for these two configurations:

- 16MHz/Mode1
- 16MHz/Mode2
- 32MHz/Mode1
- 32MHz/Mode2
- 64MHz/Mode1 (64MHz requires a license key)

The following Tx/Rx ratios are supported for these two configurations:

- 65/35 and 35/65
- 80/20 and 20/80

For example, a radio configuration of 32MHz/Mode2 with a 5ms TDD frame size supports up to 110Mbps user capacity or 55Mbps full-duplex. By selecting 80/20 on one side of the link and 20/80 on the other side, the radio allows up to 88Mbps in one direction, and 22Mbps in the opposite direction.



Note: Internal and GPS sync is supported with asymmetric settings, but in addition to the other requirements for sync, all radios tied to sync must be set with matching ratios.

T1/E1 is supported with asymmetric settings. However, based on the BW/mode setting (and in some cases, TDD frame size and distance), the direction with the limited throughput limits the number of T1 or E1 connections obtained. For example, the 16MHz/Mode1 setting typically supports up to 27Mbps aggregate throughput. In the 80/20 ratio configuration, one direction is limited to 5.4Mbps, which is less than 3xE1 and less than 4xT1. Since TDM connections must be symmetrical, this setting therefore limits throughput to no more than 2xE1 or 3xT1.

Simple Network Management Protocol (SNMP)

The Exalt radios primarily use a browser-based graphical user interface (GUI) for radio configuration and management, as described in [Exalt Graphical User Interface \(GUI\)](#). In addition, a command line interface (CLI) is provided for serial and/or Telnet access, as described in [Command Line Interface \(CLI\)](#). SNMP is often used for management of larger networks as described here. Use SNMP to manage networked devices and execute the following functions:

- GET: Obtain information from the device, such as a configuration setting or parameter.
- SET: Change a configuration setting on the device.
- TRAP: The device proactively informs the management station of a change of state, usually used for critical alarms or warnings.

One feature of the SNMP implementation is that system configuration changes do not take effect using the SET command. Instead, groups of configuration settings can be preconfigured for global change, and a single 'Save' (Commit) command implements all changes.

When some parameters are changed, a link may drop and/or management control lost. MIB files allow many parameters to be set at once, allowing only a temporarily dropped link or management control issue. The opposite end radio can be quickly reconfigured, with little downtime for the link and management control. The save (Commit) command is similar to the Update button.

Dropped links or management control issues do not occur with every parameter change. Many configuration changes do not impact traffic or management access.

Exalt radios utilize SNMPv3, a high security version of SNMP, to ensure secure access to and storing of management data. The SNMPv3 security string matches the admin and user passwords. Passwords must be eight characters or longer.

Some Exalt radio models also allow for “legacy” SNMP support for SNMPv1 and SNMPv2. Configuration of all passwords and community strings is performed from a separate [Simple Network Management Protocol \(SNMP\) Configuration](#) page.

System Installation and Initiation Process

The tasks required for radio installation and initiation are outlined in the following figure.

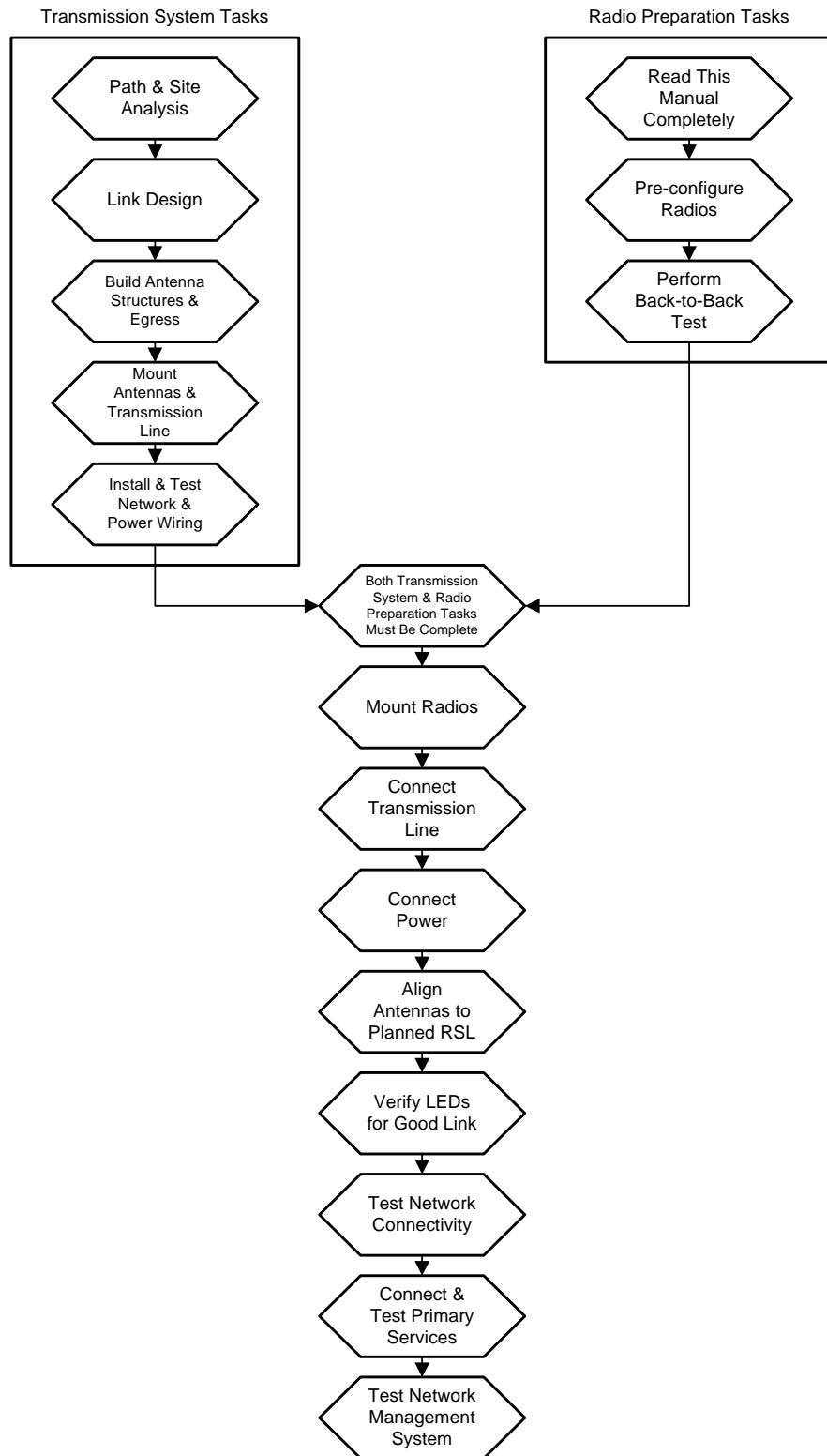


Figure 9 Radio installation tasks

Record Keeping

After installation, record the following items for ongoing maintenance and future troubleshooting. Keep a record for each end of the radio link and store a copy of these records at the radio location, at the opposite end radio location, and a central record storage location.

- GPS coordinates for antenna locations at each site
- Antenna heights above ground level (AGL), as mounted
- Antenna model numbers, serial numbers, and specifications
- Antenna polarization as mounted
- Length/type of primary transmission lines at each site
- Model number and serial number of RF lightning arrestors
- Length/type of secondary transmission line(s)
- Transmitter output power setting as installed at each site
- RSL as measured after antenna alignment at each site
- Designed RSL per original design at each site
- RSL reading with far-end power off (from each end)
- Spectrum analyzer plot with far end off at each site
- Voltage standing wave ratio (VSWR)/return loss at radio's antenna connector at each site
- Radio's network management IP address at each site
- Radio's network management gateway address at each site
- Radio's operating frequency, bandwidth setting, and mode of operation
- Optionally purchased extended warranty and/or emergency service contract details

In addition, certain information may be desired for central record-keeping only:

- Link security codes and log in passwords (stored in a secure place)
- Photographs of complete installation
- End-user sign-off/acceptance documentation (if any)
- Photo of product identification label (part number, serial number, MAC address information)
- Electronic copy of radio's configuration file
- Electronic copy of radio's installed software

Installation

This section presents all tasks required to install the Exalt Digital Microwave Radio.

Mechanical Configuration and Mounting

The i-Series radios are one-piece designs intended for deployment in a telecom equipment rack indoors or in an appropriate environmental enclosure. The device must be deployed within an ambient temperature range as specified, and properly ventilated with no obstructions to the air intake and exhaust. The standard models occupy 1 rack unit (1RU = 1.75"/4.5cm) height in a typical telecom rack. The -16 and -DS3 models occupy 1.5 RU (2.625"/6.7cm).

In most cases, additional racked equipment can be placed directly above and/or below the device with no empty spaces in the rack. However, depending on power consumption and ventilation for adjoining devices, they may pass heat to the device, not allowing the radio to cool properly and increasing the risk of malfunction. Heat dissipation from the radio may also affect adjoining devices. Provide air space above and below the device, where possible. If not possible, a thermal analysis may be required by a professional engineer to determine the impact of thermal transfer between all adjoining units.

Provide proper clearance for all cables and connectors attached to the device. Notably, the RF cable connector may require significant clearance for the bend radius of the coaxial cable assembly. Use a properly specified 90° RF connector to minimize clearance requirements, which may be necessary in enclosure implementations. All RF connectors, cables, and adapters must be rated for operation within the radio's frequency range (2400–2483.5 MHz for EX-2.4i; 4940–4990 MHz for EX-4.9i; 5250–5850 MHz for EX-5i). RF connector losses must be accounted for within the link engineering design and output power settings.

Rack Mounting

Rack mounting hardware for a standard 19" (48cm) rack is included in the accessory kit. Attach the rack mounting brackets to the sides of the unit with the provided screws. The radio can be mounted in one of four configurations:

- Front flush mount (front panel even with the rack mounting surface)



Figure 10 Front flush mount configuration

- Front projection mount (front panel extended forward from the rack mounting surface)



Figure 11 Front projection mount configuration

- Rear flush mount (rear panel even with the rack mounting surface)
- Rear projection mount (rear panel extended forward from the rack mounting surface)



Figure 12 Rear-mount locations

The rack mounting brackets accommodate identical mounting configurations as shown in the previous figures, and can be mounted three different ways with respect to the vertical orientation in the rack:

- 1 Projecting down, using one full rack space and half of the space below, and leaving a half-space gap below.
- 2 Projecting up, using one full rack space and half of the space above, and leaving a half-space gap above.
- 3 Centered within two spaces, with $\frac{1}{4}$ rack space gap above and below.

Two radios mounted in the same rack can be mounted in adjoining spaces, utilizing a total of three rack spaces.



Note: Screws for attaching the radio to the telecom rack are not provided; use the appropriate screw type that matches the equipment rack.

Table or Rack Shelf Mounting the System

Affix rubber feet or adhesive-backed non-slip pads (not included) near the corners of the unit along the bottom panel when mounting on a table or a rack shelf. These pads help keep the radio stable on a wooden or metal surface.



In many areas, it is necessary to strap the equipment to a table or rack shelf if mounting in this manner. In case of earthquake or other shock or vibration, or an accidental pull of a cable, the unit should be secured from falling. It may also be necessary to secure the AC adapter, if it is used.

Radio Ports and Indicators

This section provides a brief overview of the connectors, controls, and indicators on the device. Details about each item are in other sections of this document.

The EX-2.4i front panel is shown in Figure 13. The EX-4.9i and EX-5i front panel are identical to the EX-2.4i model, except for the model number shown in the upper-right corner.



Figure 13 Front panel (EX-2.4i, EX-4.9i, or EX-5i)

The EX-2.4i-16 front panel is shown in Figure 14. The EX-5i-16 front panel is identical, except for the model number shown in the upper-right corner.

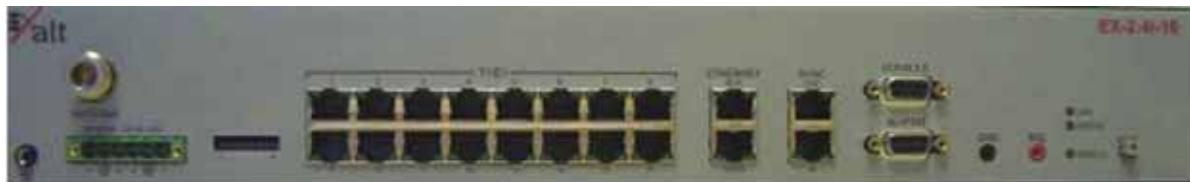


Figure 14 Front panel (EX-2.4i-16 or EX-5i-16)

The EX-5i-DS3 model front panel is shown in Figure 15.



Figure 15 Front panel (EX-5i-DS3)

Connector Overview

The primary user interfaces are shown in Figure 16 provides details of the front panel connectors of the EX-2.4i EX-4.9i, or EX-5i. Detailed pin structures for each connector are in [Interface Connections](#).



Figure 16 Primary front panel connectors (standard models)

Table 2 Connectors

Label	Type	Gender	Function
Antenna	N	F	Transmission line connection to antenna.
T1/E1 (1–4 or 1–16)	RJ-48C	F	Primary ports for User T1 or E1 circuits to traverse link.
DS3 (IN/OUT)	BNC	F	Primary ports for User DS3 circuit to traverse link.
ETHERNET (MAIN/AUX)	RJ-45	F	Primary ports for user Ethernet and/or management data (10BaseT or 100BaseT) to traverse link.
SYNC (IN/OUT)	RJ-45	F	Internal or external radio synchronizing source (for example, GPS) input and output.
CONSOLE	9-pin sub-D	F	Management port (serial) for PC/PDA for Command Line Interface (CLI) communications.
ALARMS	9-pin sub-D	F	External alarm inputs and outputs.

Table 2 Connectors (Continued)

Label	Type	Gender	Function
GND (Ground)	Bantam	F	Common (return) volt meter test point for measuring RSL.
RSL	Bantam	F	Voltmeter test point for measuring received signal level.
24–48VDC	6-pin modular	M	DC power input from DC source or AC adapter.
 (Ground)	Threaded (M5) receptacle	F	Chassis ground connection (M5 x 0.8 threads).

DS3 IN and DS3 OUT connections (Figure 17) may be independently grounded or ungrounded to the chassis using a small DIP switch between the connectors. Ground loops to connected equipment must be avoided. Set the DIP switches accordingly.



Figure 17 EX-5i-DS3 connectors and grounding switches

LED Indicators

Table 3 provides details of the LED indicators on all models.

Table 3 LED indicators

Location/Label	Type	Function
LINK	3-color LED	Indicates RF link status: Green Solid = Error-free connection (BER<10e-6) Yellow Solid = Errored connection (10e-3>BER >10e-6) Red Solid = No link (BER>10e-3) Red Flash= No remote information available (when RMT is pressed and held) Off = Improperly powered or fatal system failure
STATUS	3-color LED	Indicates system status: Green Solid = No alarm conditions (normal operation) Yellow Solid = Alarm conditions, not traffic effecting Yellow Slow Flash = In loopback (from this end) Yellow Fast Flash = In loopback (at this end) Red Solid = Alarm conditions; traffic effecting Red Flash = No remote information available (when RMT is pressed and held) Off = Improperly powered or fatal system failure

Table 3 LED indicators (Continued)

Location/Label	Type	Function
DS3	3-color LED	Indicates DS3 connection status: Green Solid = No alarm conditions (normal operation) Yellow Solid = DS3 signal present, but DS3 is not enabled Red Solid = DS3 enabled, but not present Off = DS3 not in use
RADIO A	3-color LED	Indicates radio orientation: Green Solid = Radio is configured as Radio A, based on software setting Off = Radio is configured as Radio B
ETHERNET MAIN/AUX Left Corner	Green LED	Solid/Flashing = Data present Off = No data present
ETHERNET MAIN/AUX Right Corner	Green LED	Solid = Negotiated @ 100Mbps Flash = Negotiated @ 10Mbps Off = No connection negotiated
T1/E1 Left Corner	Green LED	Solid = Connection present (clocking confirmed) Fast Flash = Connection present; coding/clock problem Slow Flash = Connection present, but unexpected Off = No connection/clock
T1/E1 Right Corner	Green LED	Solid = In a loopback state Fast Flash = Automatic indication signal (AIS) is active Off = No loopback; no AIS activity
RMT (LED inside button)	Amber LED	Off = Remote end LINK and STATUS LEDs are both green Solid = No remote end status available Flash = Alarm conditions at the remote end (LINK and/or STATUS LEDs are non-green)
SYNC IN Left Corner	Green LED	Solid on = GPS is normal (no alarms) Flash = GPS is in alarm Off = No GPS source detected
SYNC IN Right Corner	Green LED	Solid on = Sync locked, no alarms Flash = Sync signal detected, but not locked Off = No input sync signals detected
SYNC OUT Left Corner	Green LED	Solid on = Radio configured as SYNC SOURCE Flash = Radio configured as AUTO SYNC Off = Radio configured as SYNC RECIPIENT or sync is disabled
SYNC OUT Right Corner	Green LED	Solid on = SYNC SOURCE is external (GPS 1 pps) Off = SYNC SOURCE is internal

Table 3 LED indicators (Continued)

Location/Label	Type	Function
(Unmarked LED on rear panel)	2-color LED	Indicates overall status (from the rear panel): Green = LINK and STATUS LEDs are both green Red Flash = LINK and/or STATUS are in a yellow state; no red states exist Red Solid = LINK and/or STATUS are in a red state Off = Improperly powered or fatal system failure

RMT (Remote) Button

The RMT button is the only external control on the radios. This button allows easy and quick evaluation of the status of the remote-end radio. When the RMT LED is amber flashes, this is an alert that the remote end has an alarm condition. Press the RMT button to determine the alarm conditions.

When the RMT button is pressed and held and local LEDs flash, this indicates that no remote-end information is available. This indicates that the remote radio is either not powered, is booting, or is not linked in the direction towards the local radio, or the local radio is receiving excessive errors in this direction. It could also indicate a serious failure of either radio.

Local-end LEDs (when this button is not pressed) in combination with remote-end information (from a technician located at the far end, and/or when the button is pressed) can substantially aid in rapid troubleshooting analysis.

Power

The radio requires a DC power source within specifications. The DC can be provided from a DC battery source, central lab/rack supply, or from the supplied AC adapter.



Read this section completely before applying power.

Terminating the RF Connector

Before applying power, the device's RF connector must be properly terminated into a 50-Ohm load. If this is not performed, the radio may be damaged by simply applying power. Also, there are human safety factors to consider regarding potentially harmful RF radiation.

There are a few simple means to accommodate proper termination:

- Connect a 50-Ohm coaxial termination device to the RF port of the radio. The termination must be rated to 1W (or more). Example(s) include:
 - Broadwave Technologies P/N 552-200-002, or similar
- Connect the complete transmission system. That is, the RF cabling including the antenna. The cabled antenna provides a proper termination for the RF output.
- Connect a fixed (or a series of fixed) 50-Ohm attenuator(s) to the RF connector, either directly or at the end of an RF transmission line. The attenuator must be at least 30dB as specified at the operating frequency (~2400 MHz for the EX-2.4i; ~4950 MHz for the EX-4.9i; ~5700 MHz for the EX-5i), and rated for a minimum of 1W input power. Examples include:
 - Broadwave Technologies P/N 352-103-xxx

- Bird 2-A-MFN-xx
- JFW Industries 50FP-xxx-H6-N

AC Power

The AC adapter easily connects to the device. The AC rating of the adapter accepts most standard voltages and frequencies worldwide. Refer to the input voltage requirements stated on the label affixed to the adapter to ensure that the adapter can be used with the AC mains supply.

The AC plug outlet provided with the adapter may need to be replaced to match the country configuration. The adapter cable uses a standard connector for this cable for use of a pre-wired cable appropriate to the outlet configuration. If the appropriate cable is not available, the existing AC plug end can be severed and a replacement plug affixed. Consult a qualified electrician for this activity.

Do not plug the adapter into the mains power. First, verify that the RF connector is properly terminated (see [Power](#)), and then plug in the radio-side connector from the AC adapter to the radio. If the AC mains can be turned off using a switch, disable the power, plug the AC side of the adapter into the AC mains socket, and then enable power to the circuit. If the AC mains cannot be turned off, plug in to the AC main socket to apply power.

Verify that the radio is active by observing LED activity. All LEDs on the radio flash at initial power cycle.

It is strongly encouraged that the AC mains supply be fused or on a separate breaker to ensure against over-voltage and/or over-current situations and to provide some form of protection to the radio electronics and other devices connected to the same supply. In addition, if the AC power is subject to significant spikes or variation, power conditioning is a worthwhile investment, as the quality of mains power may have a direct impact on the device operation, performance and/or reliability. An Uninterruptible Power Source (UPS) or other form of battery-backed system protects against brown-out and black-out conditions, and condition the power presented to the adapter.

Evaluate the opportunity for lightning or other similar surges to be present on the powering system, including the ability for surges to couple to the power wiring system. If an evaluation indicates that there is a potential likelihood for these conditions to occur, additional surge protection is recommended for the input power wiring, especially to protect the radio electronics between the adapter and the radio's DC input connector.

The above statement is similarly true for every wired connection to the device. While the configuration for surge suppression or line conditioning is of a different type for each kind of signal interface, the opportunity for damage to the device, loss of communications and property is significant. In some cases, there can also be a risk to human life by not protecting against lightning entering a building through wiring or improper grounding. If you do not have experience in this type of installation practice, consult a qualified electrician and/or telecoms professional during the installation and wiring of the equipment.

DC Power

The device accepts DC power within the voltage specifications. For some EX-2.4i terminals, the DC voltage is 48 volts, nominal. For all other i-Series models, the DC voltage input accepts either 24 volts or 48 volts, nominal. Ensure that the power source is specified for the proper amount of current delivery capacity. The DC power may be connected as a positive or negative voltage supply, and be referenced to ground or 'floating' (differential voltage). There are different system grounding considerations depending on the nature of the DC supply grounding, and consult a qualified electrician or telecoms professional on the proper wiring and grounding process.

To connect a DC source, with the power disabled on the DC supply, connect proper gauge wiring to the DC supply. For most (short) power cable runs, 18AWG or 24AWG wire can be typically used. Strip the ends just long enough for enclosure to the DC radio connector (approximately 0.25 inches/6mm). If using stranded wire, the stripped ends inserted into the DC terminal connector must be solder-tipped. If using solid wire, a solder tip is not necessary. Ensure that the power wiring is long enough to neatly traverse, when properly dressed, between the source supply and the radio mounting location. If DC wires are to be exposed to outdoor environments, use wire in the proper weatherproof wiring jacket.

For longer runs of DC wiring, use a higher gauge wire and/or higher current source supply to overcome the additional resistance of the DC wiring. However, the DC connector for the radio may not be able to accept a high diameter wire, transition to thinner gauge near the end of the wiring run or use the maximum diameter wire for the entire wiring run, as long as it meets the powering requirements considering total resistance of the wiring and the power source current load capacity.

Insert the wiring ends into the DC mating connector (supplied) and tighten the terminal screws to secure the wire into the connector. Do *not* connect the mating connector to the radio system and disable the power system.

Pay close attention to the polarization of the DC signals coming from the DC supply and the ground conductor (if any), and ensure that they are connected to the proper pins of the DC mating connector. The connector mate on the radio is clearly marked on the front panel for proper polarization and for ground connection.

Wire across the plus (+) and minus (-) terminals from the DC supply. In addition, place a separate jumper between the proper terminal and the ground terminal to reference one side of the power supply line to the radio chassis ground. In some cases, the DC system may need to be floating and this ground jumper is not necessary; however, many configurations require one side to be grounded for proper electrical safety.



Warning! Consult a qualified electrician if uncertain about how to properly ground the system and connect power.



Figure 18 DC connector

Once the wires are connected to the mating connector, do not connect to the radio. First test the DC connection to the connector from the DC supply. Engage power on the DC supply, and use a volt meter to verify proper voltage level and polarity.

Verify that the RF connector is properly terminated, as described in [Terminating the RF Connector](#). Disengage power once again on the DC source, and connect the mating connector to the radio device. Engage power on the DC source. Verify radio is active by observing LED activity. All LEDs flash during the initial power cycle to verify that they are operational. Secure the DC connector using the integral captive screws at each end. This prevents accidental disconnection.

See [Power](#) regarding fusing, breakers, lightning protection, surge protection and power conditioning. Follow these recommendations for a DC supply.

Reset to Critical Factory Settings

If necessary, the radio terminal may be reset to critical factory settings. This may be necessary if the IP address and/or passwords for the system are not known. All other configurations are left at their current settings. If a complete default factory configuration is desired, load the Default Configuration File into the system, as described in [File Activation Page](#).

The following parameters are configured after a reset to critical factory settings:

- IP Address = 10.0.0.1
- IP Mask = 255.0.0.0
- IP Gateway = 0.0.0.0
- Administration password = password (or ‘admin’¹)
- User password = password (or ‘user’¹)
- Endpoint Identifier = Radio B (on some models, depending on firmware version and/or DIP switch position)
- VLAN disabled
- Disabled management interfaces are enabled



Note: Models that have the access security management feature that also have DIP switches on the front panel ignore DIP switch configurations after any reset. See the [Access Security Page](#).

To perform a reset to critical factory settings:

- 1 Remove power.
- 2 Remove connections to the **ALARMS** port.
- 3 Hold the **RMT** button on the front panel while applying power.
Continue to hold the **RMT** button through the entire boot cycle (approximately 45 seconds).
The front-panel LEDs toggle during the boot cycle.
- 4 Release the **RMT** button when LED behavior stabilizes.

Antenna/Transmission System

This section provides guidance to mounting and connecting the RF transmission system, which consists of the antenna, RF cabling, and RF lightning arrestors. Consult the manufacturer's instructions for proper mounting, grounding, and wiring of these devices, and for definitive direction. These manufacturer's instructions supersede any information in this section. See [Antennas](#) for a list of supported antennas.

1. Some firmware versions use the passwords **admin** and **user** instead of the global password of password.

Initial Antenna Mounting

The antenna must be an exact model recommended by the path and site planning engineer(s). Mount the antenna at the proper height, mast/mounting location and polarization orientation as determined by the path and site planning engineer(s). The model type, location, and orientation of the antenna is critical with respect to achieving proper path clearance, as well as to mitigate external or self- interference from nearby or collocated systems operating in or near the same frequency band.



Warning! Mount the antenna in a restricted area and in a manner preventing long-term human exposure to the transmitted RF energy. To comply with FCC and Industry Canada regulations, the minimum safe distance from the antenna for continuous human exposure for the EX-2.4i models is 10'/3m, 3.3' (1m) for EX-4.9i models, and 10.5'/3.2m for EX-5i models.

The antenna structure must be secure and safe with respect to the mounting of the antenna, transmission system weight, and the combined weight of any personnel that may climb or attach to the structure. The combined weight of items and forces on the structure must be carefully considered in the design and construction of the structure. This must include the weight bearing on the structure in the highest wind conditions possible in the region, and with respect to all objects affixed to the structure.

If additional objects are affixed to the structure in the future, it may be important to evaluate both the mechanical impact of these planned additions (with respect to wind and weight loading), as well as the potential impact to RF interference and frequency coordination (if additional radio equipment is anticipated). This is especially important if future equipment is likely to operate within the same frequency band.

Once the antenna is mounted, cabled, and aligned, your goal is to never require modification. This prior planning is important in the path and site planning stages and in construction of the antenna structure.

Follow the antenna manufacturer's instructions for mechanical mounting of the antenna. Ensure that there is enough room around the antenna for alignment activities (moving the antenna in vertical and horizontal arcs), and for the RF transmission line to connect to the antenna connector unobstructed and within the specified bend radius requirements of the transmission line.

At this point, the antenna mounts should be fully secure to the structure, the feed of the antenna securely mounted to the antenna (if the feed is a separate assembly), and the azimuth and elevation adjustments not completely tightened in preparation of the antenna alignment activity. It is a good practice to connect the transmission line to the antenna connector as early in the process as possible, to reduce the opportunity for debris or moisture to enter either the antenna connector or the transmission line connector. Use a connector cover or other temporary measures to ensure that the connector is kept clear. Take extra care if the antenna is installed during inclement weather to ensure that no moisture gets inside the antenna connector at any time.

Now the antenna can be aimed in the general direction required for the link. Use a compass, a reference bearing, binoculars or any other similar device to point the antenna in the direction (generally) of the far end radio, and then slightly tighten the azimuth and elevation adjustments so that the antenna maintains its general position and is safe to be left without additional securing. Refer to the Exalt white paper, *Antenna Alignment*, for more information on antenna alignment techniques.

Transmission Line from Antenna to Egress

Most installations use coaxial transmission line for the connection between the antenna and the radio device. Coaxial transmission line can either have a solid or braided shield. Solid-shield cables are more resistant to external signal coupling and interference, but are generally stiffer than braided cables.

Consult the path or site engineer(s) to ensure that the proper materials are chosen for the installation and that all factors were considered. Refer to the Exalt white paper, *Transmission Line for Exalt Indoor Radio Systems*.

Generally, the larger the diameter of the transmission line, the lower the loss. So for longer runs of transmission line, larger diameter cables are highly advised. However, at every frequency, there is a maximum diameter cable that supports the operating frequency. Verify the specifications. This is determined in the path and site planning process.

In some cases, the choice of transmission line is not coaxial cable, but is instead air-dielectric waveguide. This is an expensive solution and is generally not necessary, but may be required for very long transmission line runs, and/or very long link distances, and/or for systems requiring extremely high reliability.

Table 4 lists representative samples of transmission line types recommended for the Exalt Digital Microwave Radio.

Table 4 Recommended transmission line

Manufacturer	Type	Description	Loss at 2.4GHz	Loss at 4.9GHz	Loss at 5.3GHz	Loss at 5.8GHz
Andrew	LDF4-50	1/2-inch solid shield	3.3dB/100ft.	5.6dB/100ft.	5.7dB/100ft.	6.0dB/100ft.
Andrew	LDF4.5-50	5/8-inch solid shield	2.5dB/100ft.	4.3dB/100ft.	4.4dB/100ft.	4.7dB/100ft.
Times	LMR-600	1/2-inch braided shield	4.3dB/100ft.	6.8dB/100ft.	6.9dB/100ft.	7.3dB/100ft.
Times	LMR-900	5/8-inch braided shield	2.9dB/100ft.	4.5dB/100ft.	4.6dB/100ft.	4.9dB/100ft.
RFS	LCF12-50J	1/2-inch solid shield	3.5dB/100ft.	5.5dB/100ft.	5.6dB/100ft.	5.9dB/100ft.
RFS	LCF12-58J	5/8-inch solid shield	2.8dB/100ft.	4.4dB/100ft.	4.5dB/100ft.	4.8dB/100ft.

There are several other brands and models of transmission line that are perfectly acceptable. However, for extremely long transmission lines and/or extremely long radio paths, it may be necessary to use waveguide transmission line instead of coaxial transmission line. In these cases, waveguide type EW20 is recommended for EX-2.4i models (0.45dB/100ft. loss at 2.4GHz), type EW52 for the EX-4.9i and EX-5i models (1.2dB/100ft. loss at 5.8GHz, 1.35dB/100ft. loss at 5.3GHz).

It is critical that the transmission line and antenna be capable of supporting the same type of connector, or easily adapted. It can be important to minimize the number of connectors and adapters, and it is ideal that they match directly without adaptation. In most cases, transmission line allows for N-type male connectors and antennas have N-type female connectors. For waveguide, the waveguide flange can typically accommodate a direct adapter to an N connector, or alternatively, the antenna can be purchased with a direct waveguide connection. But often a flexible coaxial jumper is required to connect between the waveguide and antenna, as waveguide is generally inflexible and can be mechanically challenging to align to the exact antenna connector location.

If possible, connect the primary transmission line directly to the antenna. It is desired to have the fewest possible pieces of transmission line in the system, to minimize losses and points of failure from connectors. The antenna can typically accommodate a direct connection if planned in advance. Use a 90° adapter for the connection to the antenna, if necessary, but confirm that all connectors and transmission lines are properly specified for the operating frequency with minimum loss, proper impedance (50 Ohm) and proper VSWR characteristics.

Transmission line connector termination is a critical element of the installation. Many ‘factory built’ RF transmission lines do not provide the proper characteristics for proper transmission, despite their published specifications, often due to the fully or semi-automated process of factory termination, which may not have considered the frequency of your system. When buying pre-terminated transmission line, it is strongly advised to obtain the documentation of test measurements on the connected transmission

line showing that the loss characteristics and VSWR are within the specified limits specifically at your operating frequency. In addition to factory-built transmission line, self-terminated transmission line can suffer the same issues.



Caution! Always follow the manufacturer's termination process EXACTLY, and only use the manufacturer's authorized tools and connectors for a given transmission line type.

The manufacturers of transmission line typically offer instruction and certification for transmission line termination, and may also provide videos illustrating the process. There is no amount of extra care, education, precision, and effort that can be overstated for this process.

Once the transmission line is connected to the antenna, traverse the exact route provided by the site planner. There is often a need for a small excess of transmission line near the antenna to accommodate both the need for extra slack as the antenna is loosened and moved for the alignment process, and to accommodate a drip loop for the transmission line and the initial transmission line securing hardware and grounding near the antenna. In addition, the transmission line is typically very stiff, and can provide undue pulling force on the antenna connector. Take care to align the cable with the connector so that it does not provide any torque or strain on the connector.

Consult your transmission line manufacturer for the proper transportation, hoisting, securing, and grounding process. Always be very mindful of the entire length of transmission line to ensure that the transmission line is never twisted, kinked, or over-bent beyond the specified bend radius. Once a transmission line is over-bent or kinked, it will likely never recover its specified characteristics, even after straightening, and will often be completely unusable.

The opposite end of this primary transmission line typically terminates at the building or enclosure egress point. This is where to locate the RF lightning arrestor. Ensure that a proper termination to the connector-type of the lightning arrestor is made at this location. A drip loop may be required and proper securing hardware and grounding must be accommodated.

As soon as practical, weatherproof the connected ends of the transmission line to the antenna and lightning arrestor. This process should be delayed as long as possible to ensure that all systems are working properly before applying the weatherproofing. Once weatherproofing is applied, it may have to be removed for testing or installation modification. With this in mind, if the installation is occurring during inclement weather, take extra care at all times to ensure that no moisture enters any connector at any time. If moisture is suspected to have compromised the antenna or transmission line, it may render those devices useless without any means for remedy except for full replacement.

Indoor Mounting

On rare occasions the antenna can be mounted indoors behind a window. In these cases, there would not be a need for drip loops or an RF lightning arrestor. Use a very short transmission line connected directly between the antenna and the radio mounted nearby. The weatherproofing process can also be omitted.

RF Lightning Arrestor

RF lightning arrestors provide a direct path to ground for lightning strikes that may couple to or directly hit the outdoor transmission system or antenna structure. The RF lightning arrestor prevents any associated voltage and current from entering the building or enclosure, where it might harm the radio equipment, other equipment, or humans.

The following lightning arrestors are examples of proper devices for Exalt Digital Microwave Radios:

- Polyphaser AL-LSXM
- Citel PRC5800

Mount and ground the RF lightning arrestor in accordance to the manufacturer's recommendations. Place it as close as possible to the egress point where the next piece of transmission line enters the building or enclosure. Minimize the distance to the egress to lessen the opportunity for lightning to couple to or strike the unprotected section of transmission line (if any). Where possible, use a bulkhead connector to eliminate any opportunity of this risk. Keep cable lengths behind the arrestor and into the egress substantially short (less than 3'/1m) as a safe practice. Consult a qualified electrician or installer in all cases of grounding and lightning arrestor implementation.

Transmission Line from Egress to Radio

A single transmission line section from the egress to the radio RF connection is always desired. Minimize the number of connectors and adapters. For indoor runs, a cable ladder or tray may be needed to properly secure the cable. In some cases, a short flexible jumper allows ease of connection to the radio's RF connector. A properly specified 90° connector can often eliminate this need. An installation with space around the radio to accommodate a gentle bend radius of the transmission line is also good for a direct connection. In all cases, ensure that the transmission line is not a pulling force of the RF connector on the radio. Transmission lines can be very stiff and can damage the connector if not dressed properly. Also, follow the transmission line manufacturer's instructions for the proper use of cable securing devices.

Antenna Alignment

Antennas must be installed at both ends of the planned link to commence precision alignment. Refer to the Exalt white paper, *Antenna Alignment*.

Antennas are typically aligned using the radio hardware for precise alignment. However, there are many very useful tools available to aid in this process, inclusive of devices specifically designed for the purpose of aligning antennas. Some examples are:

- XL Microwave Path Align-R
- Teletronics 17-402

Use of these devices may be extremely advantageous as compared to using the radio, because they employ many unique facilities to aid in this process. Using these tools also makes it possible to align the antennas before the radio equipment is delivered. However, many installers successfully use the radios as the means for antenna alignment.

There are two primary facilities when using the radio to align the antenna:

- RSL voltage test point using a volt meter (recommended)

The RSL test point DC voltage is inversely proportional and numerically calibrated to the received signal level. The voltage rises as the antennas are less in alignment, and falls as antennas are more in alignment. The voltage measurement corresponds to the received signal level in measurements of dBm (a negative number for RSL measurements). For example, an RSL of -60dBm yields an RSL voltage measurement of 0.60VDC; an RSL of -45dBm measures 0.45VDC.

- GUI RSL reading indicates the current RSL in dBm.

Alignment of the antennas using the RSL test point can be accomplished in the following ways:

- Radio near or at antenna location

- Temporarily connect the radio to the antenna using a short piece of transmission line, so that the radio is very close to the antenna location
- Run wires, as necessary, from the RSL test point to the volt meter so that the antenna installer can directly view the volt meter



Note: Using this method, the final RSL voltage readings during alignment may be different (better) than the planned RSL, due to the short RF transmission line. Use the path calculation tool to determine the RSL that should result in this temporary configuration to ensure proper ideal alignment.

- Run separate wires from radio mounted location to antenna location
 - Temporarily connect a set of wires from the RSL test point to the antenna location, to allow the radio installer to use a local volt meter



Note: Due to the resistance of the cable, the RSL readings might be impacted. Use the thickest wiring possible. Test the impact of the voltage reading due to the wiring by comparing a direct measurement at the RSL test point as opposed to the end of the wiring.

- RF/DC coupler
 - Install a temporary DC coupling device at the radio antenna port and at the antenna connector. Connect the RSL test point to the radio antenna port coupler, and the volt meter to the antenna connector coupler. See [DC Coupler for Antenna Alignment](#) for more information
- Verbal relay/walkie-talkie/mobile radio/cell phone
 - A person located at the radio front panel can use a short-range communication device or verbal relay to communicate to the antenna installer and read off RSL voltage measurements

Only use the browser-based GUI for antenna alignment if there is no other means available. If this method is required, refer to [Exalt Graphical User Interface \(GUI\)](#). The RSL reading can be read on a PC or any handheld computing device that supports an HTML browser and Ethernet connectivity.



Note: There is a slight delay in RSL readings in the GUI as the RSL levels change. In this case, fine alignment can be done in small adjustments allowing a small gap of time so that the impact of the adjustment on the GUI display catches up to real time.

Configuration and Management

This section describes the command line interface (CLI) and Exalt graphical user interface (GUI).

Command Line Interface (CLI)

Exalt Digital Microwave Radios provide a CLI to set key parameters on the system. Use the Console port for serial devices, or use the Ethernet MAIN or AUX ports for a Telnet session over a network connection.

Connect to the Radio with a Serial Connection

For serial interface to the CONSOLE port, on your PC, PDA, dumb terminal, or any other device with a serial interface and text input capabilities, use Hyperterminal or a similar application with the following settings:

Bits per second:	9600
Data bits:	8
Parity:	None
Stop bits:	1
Flow Control:	None

Use a standard straight-through serial cable to connect between most computer serial ports and the Console port on the radio. A null modem cable is not properly wired for this interface. See [Interface Connections](#) for wiring details.

After establishing the serial connection, press ENTER to display the login prompt.

Telnet into the Command Line Interface (CLI)

Use a Telnet connection to access the CLI in the Exalt Digital Microwave Radios. Use the CLI to set key parameters on the system.

Connect to the Radio in a Telnet Session

Make the Telnet connection to the radio through the Ethernet port. Use Windows and perform the following steps:

- 1 Open a command prompt or MS-DOS prompt (**Start>Run**).
- 2 Type **C:\>Telnet <IP Address>** at the command line:

The default IP address is **10.0.0.1**



Note: The accessing computer must be on the same IP subnet as the radio. If the radio supports DHCP and DHCP is enabled (see [Ethernet Interface Configuration Page](#)), which is the default setting for a radio shipped from Exalt (for the models with this feature), and your computer's Ethernet port is set for DHCP addressing, the radio will configure your computer to an IP address value which is either 2 or 10 higher than the radio's current IP address (for example, if the radio is set to 10.0.0.1, the computer will be set to 10.0.0.3 or 10.0.0.11, depending on the radio model and the software version running on the radio).

Use Telnet when prompted to enter the administration level login and password. The default administration login is *admin* and password is *password*. It is recommended that the default administration password be reset by performing a radio reset (see [Reset to Critical Factory Settings](#)).

Figure 19 shows the menu choices available after log in.

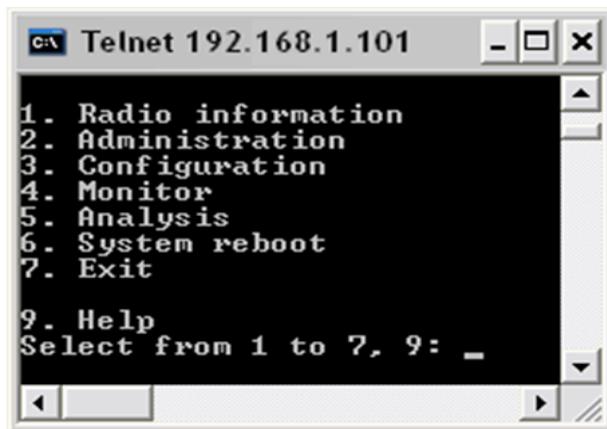


Figure 19 CLI root menu

The following selections can be made on all screens:

- 0 = back to previous screen
- 9 = help
- Ctrl+\ (control and backslash keys) = exit session

Exalt Graphical User Interface (GUI)

The Exalt GUI is the primary user interface for configuring and troubleshooting the radio and radio system. A computer or hand-held device with a conventional HTML browser and Ethernet port is required. Microsoft Internet Explorer is the preferred browser. Netscape, Mozilla, and Firefox are also supported.

Preparing to Connect

If the radios are new, both radios are preconfigured as Radio B, and have the same IP address. The initial priority is to configure one radio to Radio A and assign different IP addresses, unique to each radio. There are two ways to change the IP address:

- 1 Reset the radio to the critical default factory settings (see [Reset to Critical Factory Settings](#)).
- 2 Connect to the GUI using the default IP address (10.0.0.1), and change the IP address through the GUI interface.



Note: To connect to the radio's Ethernet port and use the GUI interface, the accessing computer must match the radio's IP address subnet. It is therefore necessary to either change the radio's IP address through the CLI to match the subnet of the computer, or change the computer's IP address to match the subnet of the radio (such as, a computer IP address of 10.0.0.10 if trying to connect to a radio set to the factory default IP address of 10.0.0.1).

If the radio supports DHCP and DHCP is enabled (see [Ethernet Interface Configuration Page](#)), which is the default setting for a radio shipped from Exalt (for the models with this feature), and your computer's Ethernet port is set for DHCP addressing, the radio will configure your computer to an IP address value which is either 2 or 10 higher than the radio's current IP address (for example, if the radio is set to 10.0.0.1, the computer will be set to 10.0.0.3 or 10.0.0.11, depending on the radio model and the software version running on the radio).

To configure a radio as Radio A, connect to the GUI and change the configuration, as discussed in this section.

Log In

Use the following steps to log in to the Exalt GUI.

1 Open a browser window.

Microsoft Internet Explorer is the recommended browser. Netscape, Mozilla, and Firefox are also supported. If there are issues with your browser, please report it to Exalt Customer Care. You may be required to use a different browser to immediately overcome issues.

2 Type the IP address of the radio in the address bar.

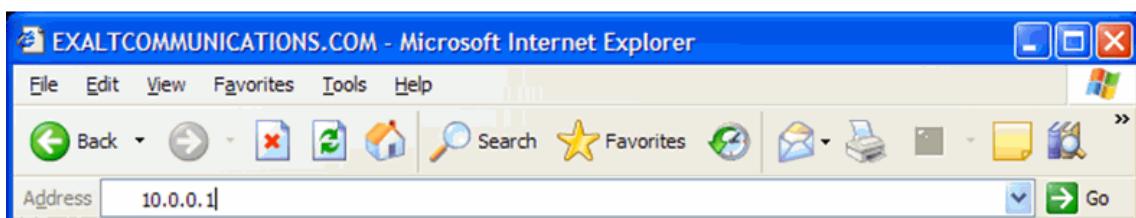


Figure 20 Initiating the browser connection

The following window displays after pressing the Enter key or clicking the Go button in the browser window.

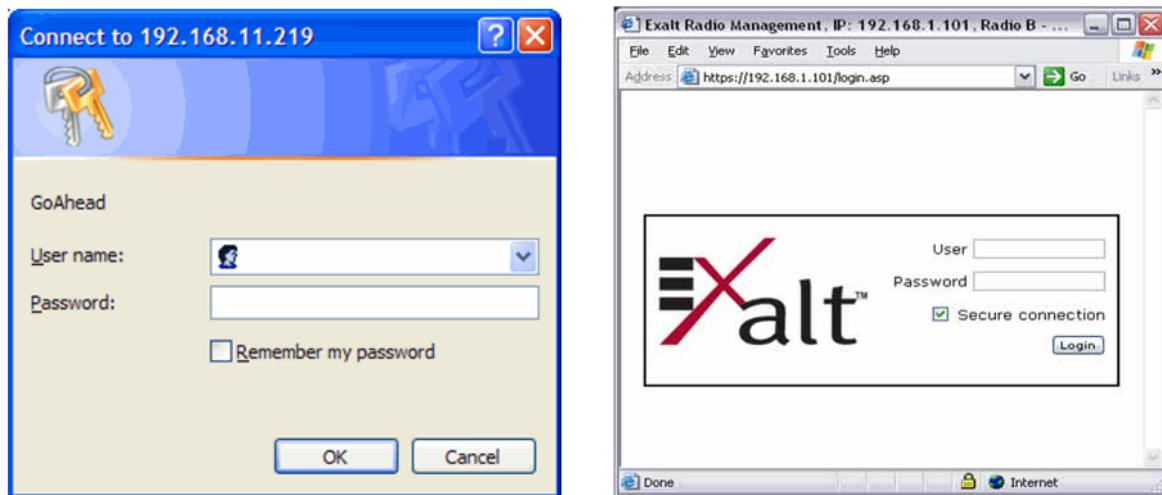


Figure 21 Browser Login screens—model dependent



Note: Some models support SSL/SSH secure browser management, and display the login screen on the right. Browser security can be enabled or disabled for these models.

Login Privileges

There are two levels of login privileges:

- Administrator (admin) – assigned complete permissions to view, edit, and configure
- User (user) – assigned limited, view-only permissions with no edit or configuration rights

The default login names and passwords are as follows:

Table 5 Default login information

Privilege level	User name	Default password	Alternate password ^a
Administrator	admin	password	Admin
User	user	password	User

a. Early firmware versions use the alternate passwords.

Administrator login credentials are required for configuration purposes. Type the user name and passwords for Administrator level and click OK. The following screen displays.

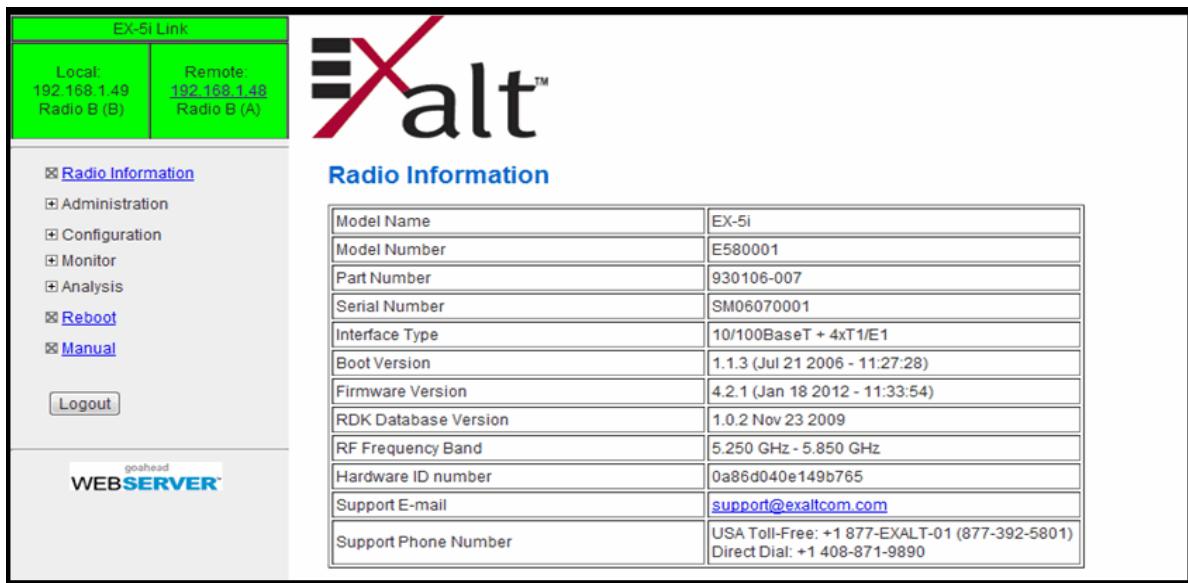


Figure 22 Radio Information page

Quick Start

To establish a link on the bench, apply the following basic configurations to the radio terminal. Use the steps in the *Quick Start Guide* included with the radio. A summary of the items that need to be configured are:

- Radio IP address for each end.
 - Each end must have a different IP address and cannot match the accessing computer's IP address or any address assigned if radios are part of a larger network.
 - It may be required to change the IP address of the accessing computer after changing the IP address of the radio so that the IP subnet matches.
 - The radio IP address is listed on the Administration Settings page.
- Install the Regulatory Domain Key (RDK) for RDK-enabled radios only.
 - The radio is non-functional without the RDK.
 - RDK is entered on the [Administration Settings Page](#).
 - RDK references the unit's serial number and the country/region where the radio will be deployed.
 - RDK is obtained through your Exalt Authorized reseller or distributor.
- Set one radio as Radio A.
 - The radio selected as Radio A must be configured.
 - Radio A/B selection is the Endpoint Identifier parameter on the System Configuration page.
 - Even though both radios are set as Radio B by default, confirm this configuration on the radio intended to be Radio B.

If all other parameters are still configured at their factory default settings, the radios can now be connected back-to-back to verify that the link is communicating and perform any other desired tests. See [Back-to-back Bench Testing](#) for test information.

[Navigating the GUI](#) describes each page of the GUI. Most configuration parameter settings are intuitive. The following link parameters must match at both ends for the link to communicate:

- Link Security Key ([Administration Settings Page](#))
- Bandwidth ([File Transfer Page](#))
- RF Frequency (System Configuration page)
- Link Distance (System Configuration page)
- TDD Frame Size (System Configuration page)



Note: Changing any of these parameters causes a temporary loss of link. The GUI displays a warning and provides an opportunity to cancel changes.

Navigating the GUI

The GUI provides the primary interface for all configuration and management. There are three sections of the main GUI window:

- Summary status information section (upper-left corner)
- Navigation panel
- Main window

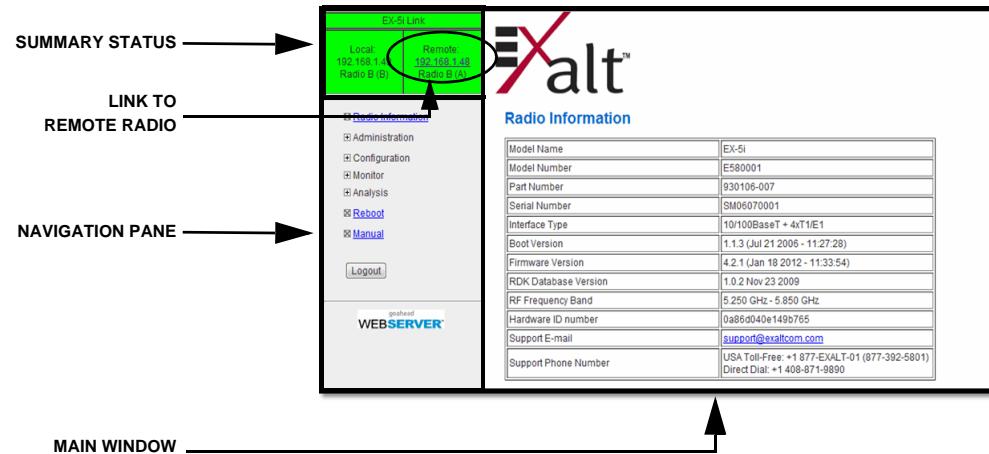


Figure 23 Exalt GUI window description

Summary Status Section

This section of the Exalt GUI provides a review of the system status.



Note: Click the radio IP address link to access that radio for management.

In the screens in Figure 23, the top bar illustrates the alarm condition of the link. The information inside the bar is equivalent to the entry of the Link Name set by the administrator in the Administration Settings page.

The color of the panel indicates alarm status:

- Green indicates the system is communicating and all functions are normal

- Yellow indicates a minor non-traffic affecting alarm condition
- Red indicates a major traffic affecting alarm condition

The left panel summarizes the alarm conditions of the local radio (the radio that matches the IP address). The information displayed is the IP address and the endpoint identifier (Radio A or Radio B). The right panel summarizes the alarm conditions of the remote radio (the radio linked to the local radio).



Note: The ‘local’ radio might be the near-end or the far-end radio, depending on the management interface connection. The terms local and remote refer to the orientation of the radio terminals relative to the IP address you are managing. When making certain changes to a near-end radio without first making changes to the far-end radio, the link may become disconnected unless configuration changes are reverted to their original settings. When making changes that may disrupt the link, always change the far-end radio first, and then the near-end radio to match.

The Summary Status Section allows the Exalt GUI to be a rudimentary management system. Minimize the browser window to display just the top bar or the top bar and radio information, and open several browsers on the desktop. When a window status changes to yellow or red, you can quickly maximize that window to determine the issues.

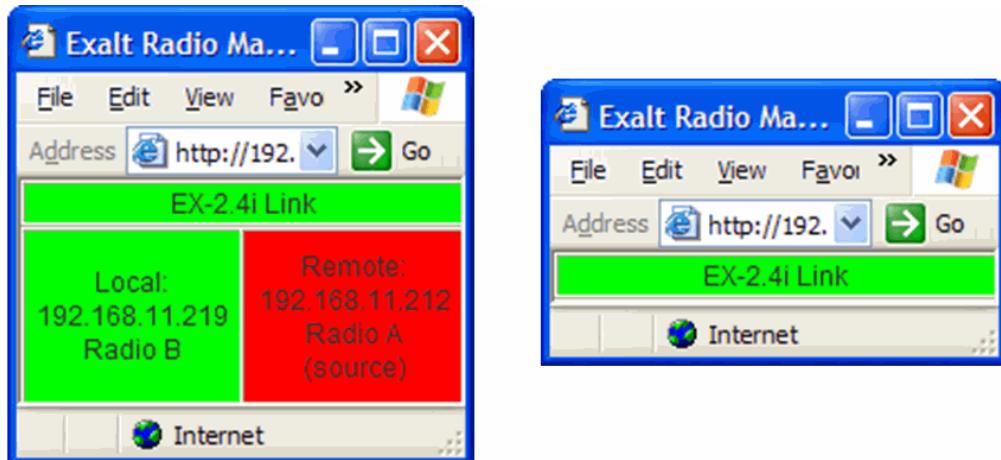


Figure 24 Summary status information

Navigation Panel

In the navigation panel, pages with sub-pages have a plus (+) to the left of the page link. Click the plus sign or page name title to view sub-page titles. The pages can be collapsed to hide the sub-pages when a minus (-) sign appears to the left of the page link.

Management pages are indicated with an X to the left of the page name. Click the X or page name to display the page within the main window.



Note: The ‘local’ radio might be the near-end or the far-end radio, depending on the management interface connection. The terms local and remote refer to the orientation of the radio terminals relative to the IP address you are managing. When making certain changes to a near-end radio without first making changes to the far-end radio, the link may become disconnected unless configuration changes are reverted to their original settings. When making changes that may disrupt the link, always change the far-end radio first, and then the near-end radio to match.

Radio Information Page

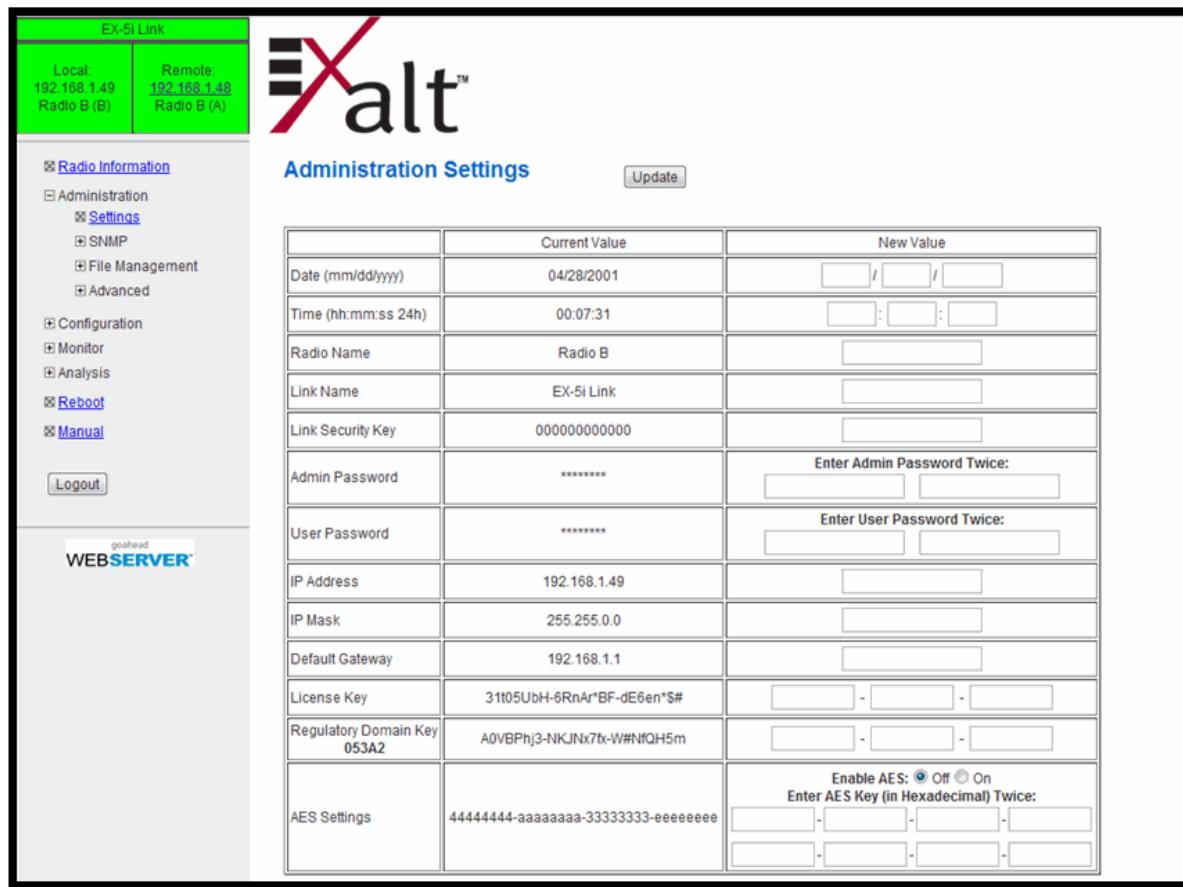
This page provides general information about the local radio terminal. This information is helpful for troubleshooting and for record keeping.

Model Name	EX-5i
Model Number	E580001
Part Number	930106-007
Serial Number	SM06070001
Interface Type	10/100BaseT + 4xT1/E1
Boot Version	1.1.3 (Jul 21 2006 - 11:27:28)
Firmware Version	4.2.1 (Jan 18 2012 - 11:33:54)
RDK Database Version	1.0.2 Nov 23 2009
RF Frequency Band	5.250 GHz - 5.850 GHz
Hardware ID number	0a86d040e149b765
Support E-mail	support@exaltcom.com
Support Phone Number	USA Toll-Free: +1 877-EXALT-01 (877-392-5801) Direct Dial: +1 408-871-9890

Figure 25 Radio Information page

Administration Settings Page

This page allows contains general parameters for the radio system. The Current Value column lists entries actual settings. Desired changes are entered in the New Value column.

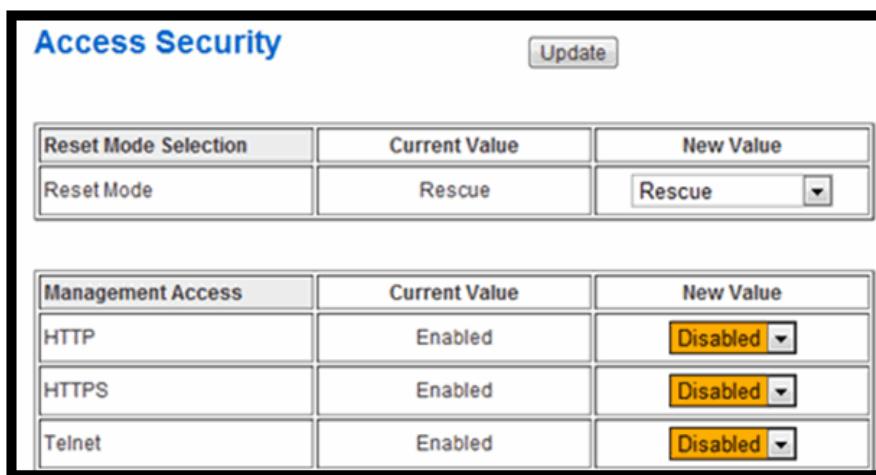


The screenshot shows the 'Administration Settings' page of the Exalt web interface. The left sidebar contains a navigation tree with sections like Radio Information, Administration, Settings, SNMP, File Management, Advanced, Configuration, Monitor, Analysis, Reboot, and Manual. A 'Logout' button is also present. The main content area features the 'Exalt' logo and the title 'Administration Settings' with an 'Update' button. Below this is a table with columns for 'Current Value' and 'New Value'. The table includes fields for Date, Time, Radio Name, Link Name, Link Security Key, Admin Password, User Password, IP Address, IP Mask, Default Gateway, License Key, Regulatory Domain Key, and AES Settings. The 'AES Settings' row includes checkboxes for 'Enable AES' (Off or On) and 'Enter AES Key (in Hexadecimal) Twice'.

	Current Value	New Value
Date (mm/dd/yyyy)	04/28/2001	<input type="text"/> / <input type="text"/> / <input type="text"/>
Time (hh:mm:ss 24h)	00:07:31	<input type="text"/> : <input type="text"/> : <input type="text"/>
Radio Name	Radio B	<input type="text"/>
Link Name	EX-5i Link	<input type="text"/>
Link Security Key	000000000000	<input type="text"/>
Admin Password	*****	Enter Admin Password Twice: <input type="text"/> <input type="text"/>
User Password	*****	Enter User Password Twice: <input type="text"/> <input type="text"/>
IP Address	192.168.1.49	<input type="text"/>
IP Mask	255.255.0.0	<input type="text"/>
Default Gateway	192.168.1.1	<input type="text"/>
License Key	31t05UbH-6RnAr*BF-dE6en*\$#	<input type="text"/> - <input type="text"/> - <input type="text"/>
Regulatory Domain Key 053A2	A0VBPhj3-NKJNx7fx-W#NfQH5m	<input type="text"/> - <input type="text"/> - <input type="text"/>
AES Settings	44444444-aaaaaaaa-33333333-eeeeeeee	Enable AES: <input type="radio"/> Off <input checked="" type="radio"/> On Enter AES Key (in Hexadecimal) Twice: <input type="text"/> - <input type="text"/> - <input type="text"/> - <input type="text"/> <input type="text"/> - <input type="text"/> - <input type="text"/> - <input type="text"/>

Figure 26 Administration Settings page

As shown in Figure 27, on all pages changed fields display with an orange background. After all desired changes are entered, click the **Update** button to accept and enable changes.



The screenshot shows the 'Access Security' page. The top section is titled 'Access Security' with an 'Update' button. It contains a table for 'Reset Mode Selection' with a single row for 'Reset Mode' set to 'Rescue'. The bottom section contains a table for 'Management Access' with three rows: 'HTTP' (Current Value: Enabled, New Value: **Disabled**), 'HTTPS' (Current Value: Enabled, New Value: **Disabled**), and 'Telnet' (Current Value: Enabled, New Value: **Disabled**).

Reset Mode Selection	Current Value	New Value
Reset Mode	Rescue	Rescue

Management Access	Current Value	New Value
HTTP	Enabled	Disabled
HTTPS	Enabled	Disabled
Telnet	Enabled	Disabled

Figure 27 Changed fields and Update button

Most entries on this page are self-explanatory. The following lists unique or important parameters.

- Fill in the date and time fields as soon as practical. Events are captured with time/date stamps, which is valuable information for troubleshooting.
- Set the Link Security Key to something other than the factory default setting (12 characters, all zeros) at each end. The link security key must match at both sides of the link. If the security key remains at the factory setting, the radio link is open to sabotage by a party with the same radio model. Each link should have a unique security key. If using the same security key for every link in the network, the radio could link to any other radio with the same security key. This is problematic in multi-radio networks.
 - Note that the security key must be exactly 12 characters. Any alphanumeric character can be used. The link security key is case sensitive.



Note: Changing the link security key interrupts transmission until the opposite end is changed to match. Always change the far-end radio first, and then change the near-end radio.

- Reset the admin and user passwords. These passwords should not match. If the admin password remains at the factory default setting, it provides an opportunity for random reassignment by a network-connected user.
 - The new password must be entered twice. If the passwords do not match and the Update button clicked, the password is not changed and remains set to the previous password.
- Enter the license key provided by Exalt to access extended features or diagnostic capabilities. Click Update to accept the changes and enable the new features. License keys are issued by radio serial number, so ensure that the license key used was issued for this particular radio.
- The Regulatory Domain Key establishes the frequency bands, tuning frequencies, bandwidths, output power and Dynamic Frequency Selection (DFS) requirements, in accordance with the regulations that apply in the country where the product is deployed. The RDK must be typed in to enable ANY functionality for the radio. The RDK is issued to the Exalt Authorized distributor or reseller, and is paired to the specific serial number of the radio.
- AES (Advance Encryption Standard) can be implemented to provide additional data security for the wireless link. This function requires an upgrade license key (purchased separately). Both radios in the link must have a valid AES upgrade license key to implement AES. Different bit-length encryption license keys (for example, 128-bit and 256-bit) are also available, depending on model type. If the required upgrade license key is present, simply insert a matching hexadecimal string on both terminals and select the Enable AES On option for AES encryption. Note that similar to the administration and user passwords, the AES string must be entered twice for each terminal.

Simple Network Management Protocol (SNMP) Configuration

This page allows the enabling and disabling of the Simple Network Management Protocol (SNMP) functions. Use SNMP to manage networked devices and execute the following functions:

- GET: Obtain information from the device, such as a configuration setting or parameter.
- SET: Change a configuration setting on the device.
- TRAP: The device proactively informs the management station of a change of state, usually used for critical alarms or warnings. See [SNMP Traps](#).

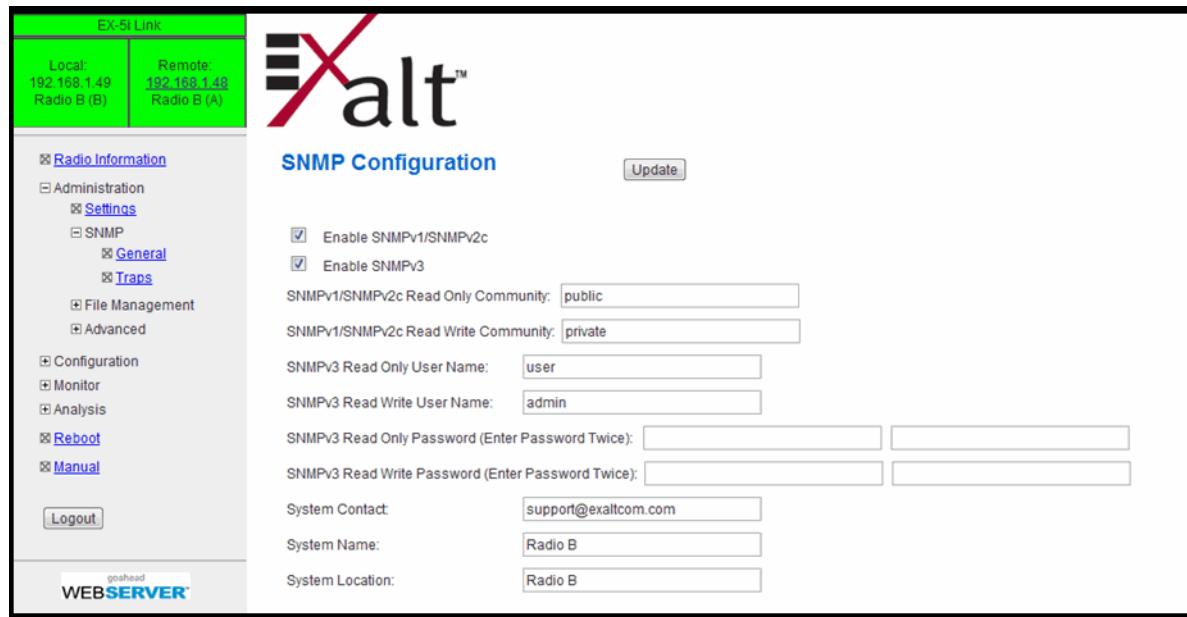


Figure 28 SNMP Configuration page

One feature of the SNMP implementation is that system configuration changes do not take effect using the SET command. Instead, groups of configuration settings can be preconfigured for global change, and a single 'Save' (Commit) command implements all changes.

When some parameters are changed, a link may drop and/or management control lost. MIB files allow many parameters to be set at once, allowing only a temporarily dropped link or management control issue. The opposite end radio can be quickly reconfigured, with little downtime for the link and management control. The save (Commit) command is similar to the Update button.

Dropped links or management control issues do not occur with every parameter change. Many configuration changes do not impact traffic or management access.

EX-i Series (TDD) utilize SNMPv3, a high security version of SNMP, to ensure secure access to and storing of management data. The SNMPv3 security string matches the admin and user passwords. Passwords must be eight characters or longer.

The SNMP MIBs are organized similar to the GUI. Become familiar with the GUI before using the SNMP function.

SNMP v1/v2c/v3 Support Options

Enable the SNMPv1/v2c options to allow entering read and read/write community strings.



Note: Users are encouraged to avoid enabling SNMPv1/V2c support due to known security loopholes in these protocols.

Enable the SNMPv3 options to allow entering read and read/write user names and passwords. These entries are de-coupled from the standard radio user names and passwords. SNMPv3 provides full management security.

SNMP Traps

SNMP traps alert the central network management system with important issues about the radio system. Trap filters are set on the Traps Configuration page (Figure 29). Not all i-Series radios support SNMP traps. Consult the release notes for more information.

Trap support for all versions of SNMP are provided and can be independently enabled. Enter the IP address(es) to which the traps are directed in the Trap Destination IP Address field. The AUX port (or the MAIN port when using in-band management) must be connected to the network to allow trap information to reach the designated IP address. In a bridged network, this may not require special network settings. In a routed network, the connected router must have a defined path for the IP address.

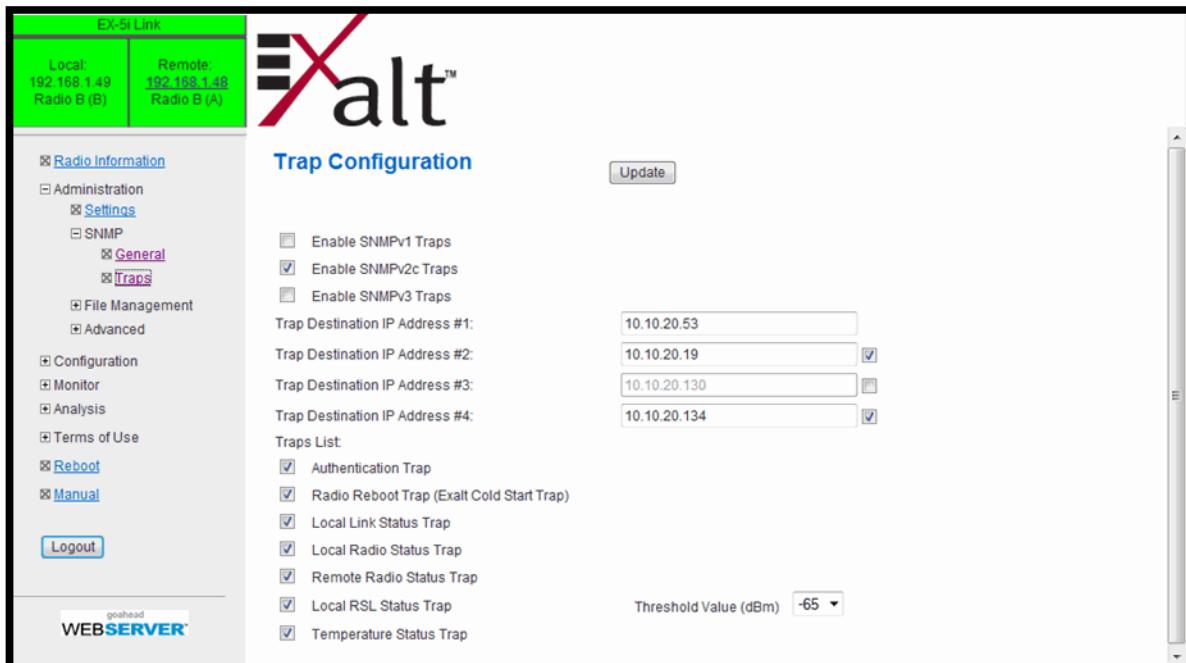


Figure 29 Trap Configuration page



Note: The **Update** button must be clicked to save any changes to this page.

The following traps are available:

- Authentication Trap: This is an SNMP standard trap when password information for SNMP is incorrect. This can help identify unwanted intrusions into the management system and for diagnosis of SNMP issues for valid users.
- Radio Reboot Trap: This trap is sent after any radio reboot to inform the manager of the reboot status.
- Local/Remote Link Status Trap: This trap is sent when Link is in errored state (equivalent to the Link LED on the radio front panel or the Link status bar in the upper-left of the Exalt GUI window).
- Local/Remote Status Trap: This trap is sent when Status is in errored state (equivalent to the Status LED on the front panel or the radio status box in the upper-left of the Exalt GUI window).
- Local RSL Status Trap: This trap is sent when the local RSL drops below the value set in the Threshold Value (dBm) field. Buffers are provided so that continuous traps are not sent if the RSL is bouncing near the set threshold value. This trap is reset only if the RSL rises to 3dBm above the set threshold value and then drops below that value. Exalt recommends that this trap be set to a value 5dBm or 10dBm above the threshold as a warning that the system has faded and may be approaching an outage.
- Temperature Status Trap: This trap is sent when the internal temperature reaches the warning point. This conveys that the external temperature control is in a fault state. Buffers are applied to this trap to avoid multiple traps when the temperature remains near the warning point.

File Transfer Page

This page allows the administrator to upload and download files to and from the radio. Three types of files can be uploaded: configuration, radio firmware, and Regulatory Domain Database (RDD). When uploading Configuration Files, current configuration parameters are immediately overwritten, and the unit automatically reboots. When uploading radio firmware files, the file is placed into reserve memory space. After the new radio firmware file uploads, use the File Activation page to enable the files (see [File Activation Page](#)).

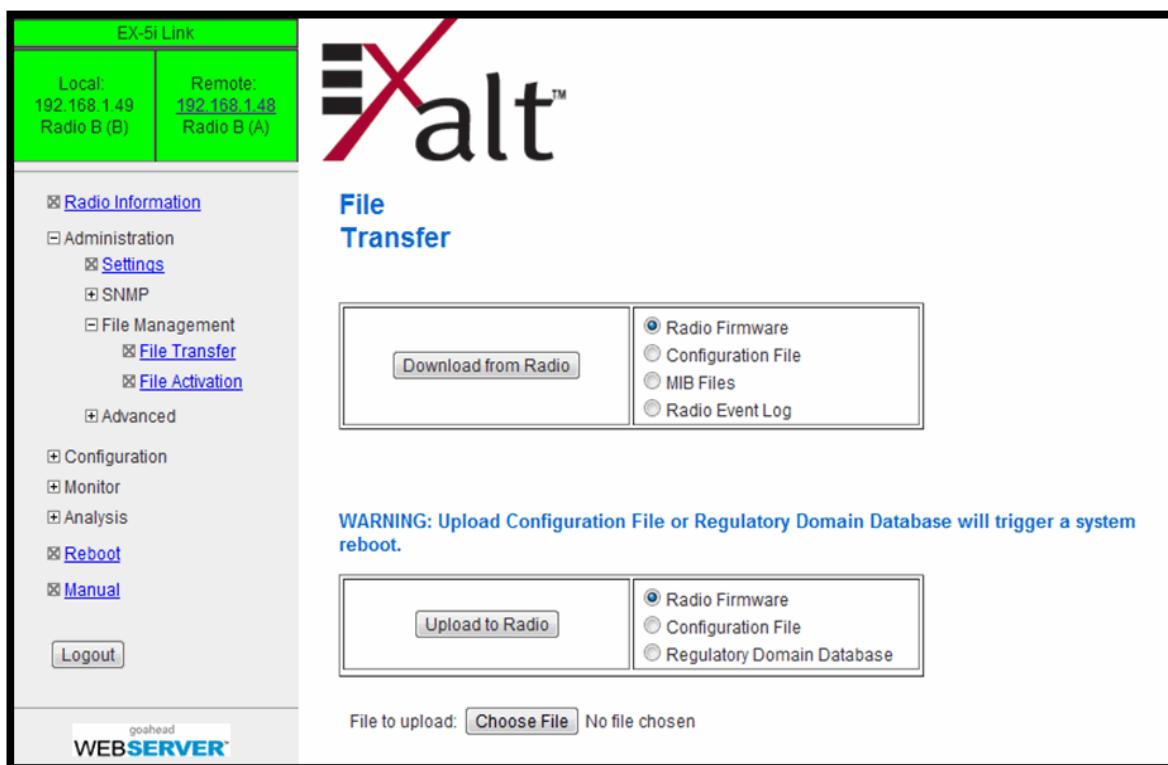


Figure 30 File Transfer page

Up to four types of files can be downloaded: radio firmware, configuration, MIB, and event log. The MIB file refers to the Management Information Base related to the Simple Network Management Protocol (SNMP) function, and is only available on models which support SNMP. See Simple Network Management Protocol (SNMP) Configuration for more information.



Note: Check the File Activation page before uploading radio firmware files. New file uploads overwrite the secondary file location. If important files reside in the primary or secondary file location, download them before uploading the new files. Only the active radio firmware file can be downloaded. Therefore, to download the reserve file, it must first be activated (using the Swap button). The current radio firmware and RDD versions can be viewed on the [Radio Information Page](#).



Note: Issues with the RDK may be caused when the Regulatory Domain Database (RDD) is not up to date. Go to the Exalt Web site to [download the current RDD](#).

Use the following steps to download a file.

- 1 Select the type of file to download (configuration or radio firmware).
- 2 Click the Download button and wait for the radio to prepare the file for download.
- 3 For the MIB file download, a second page/link appears.
- 4 Left-click the link on the page to download the file to a desired location.

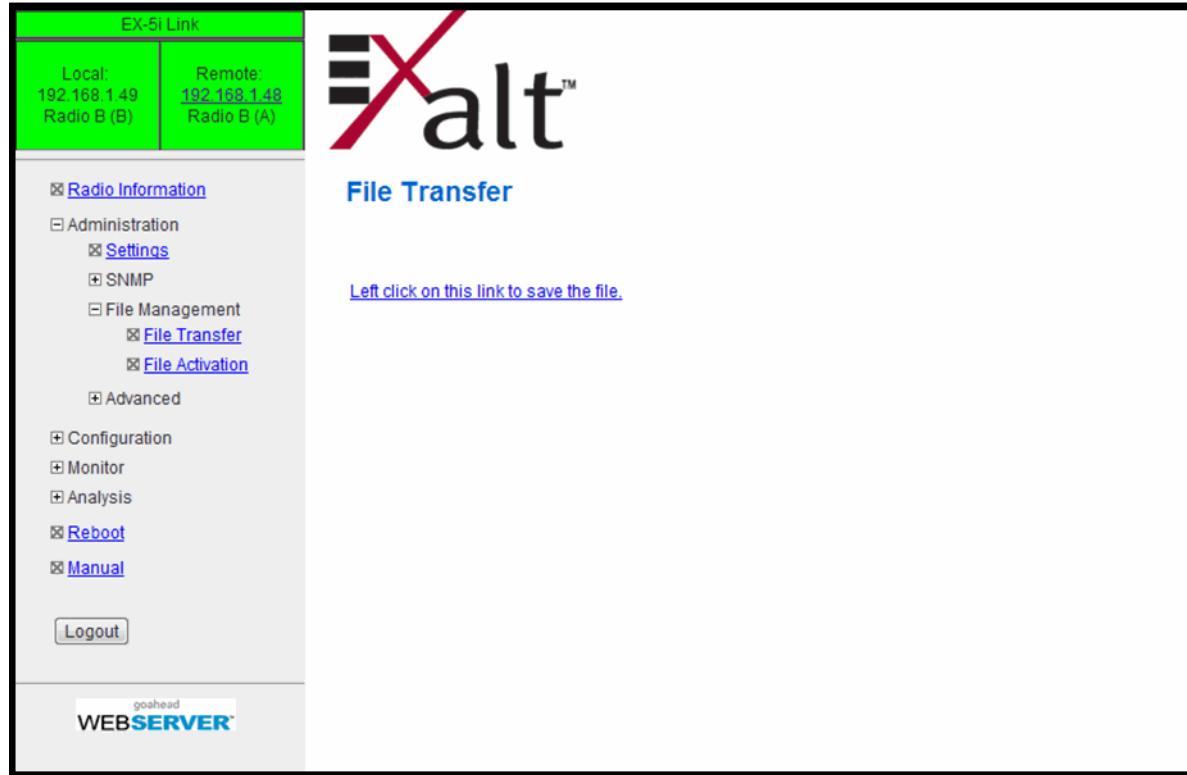


Figure 31 File Transfer page—download file link

File download and upload is useful when configuring several radios with similar settings. A copy of the configuration file can also help restore radio settings. In addition, a copy of the Exalt default configuration file is helpful to restore the radio to factory settings.



Note: Do not change the name of any download file. The configuration file must be named config.nv. To keep track of multiple configuration files, use a folder naming system or temporarily rename the file, however, it must be named config.nv before it can be uploaded to a radio. Never change radio firmware file names under any circumstances.

If copying the same configuration file into multiple radios, take as some parameters will match and that may be undesirable. However, it may be easier to change just a subset of parameters rather than every parameter. The following parameters can cause problems or confusion if they match at each of a link:

- Radio Name
- Endpoint Identifier
- IP Address

- IP Subnet Mask
- Default Gateway

The following parameters can match at both ends of the link:

- Link Name
- Link Security Key (although each link should be different)
- Admin and User passwords
- Bandwidth
- RF Frequency
- Link Distance
- Ethernet configurations

File Activation Page

Use this page to move stored or uploaded files for use on the radio. The page indicates which file is currently in use, and which file is available for use. Click the Swap button to place the file in the Alternative File column into the active state and move the file in the Current File column to the Alternative File column.

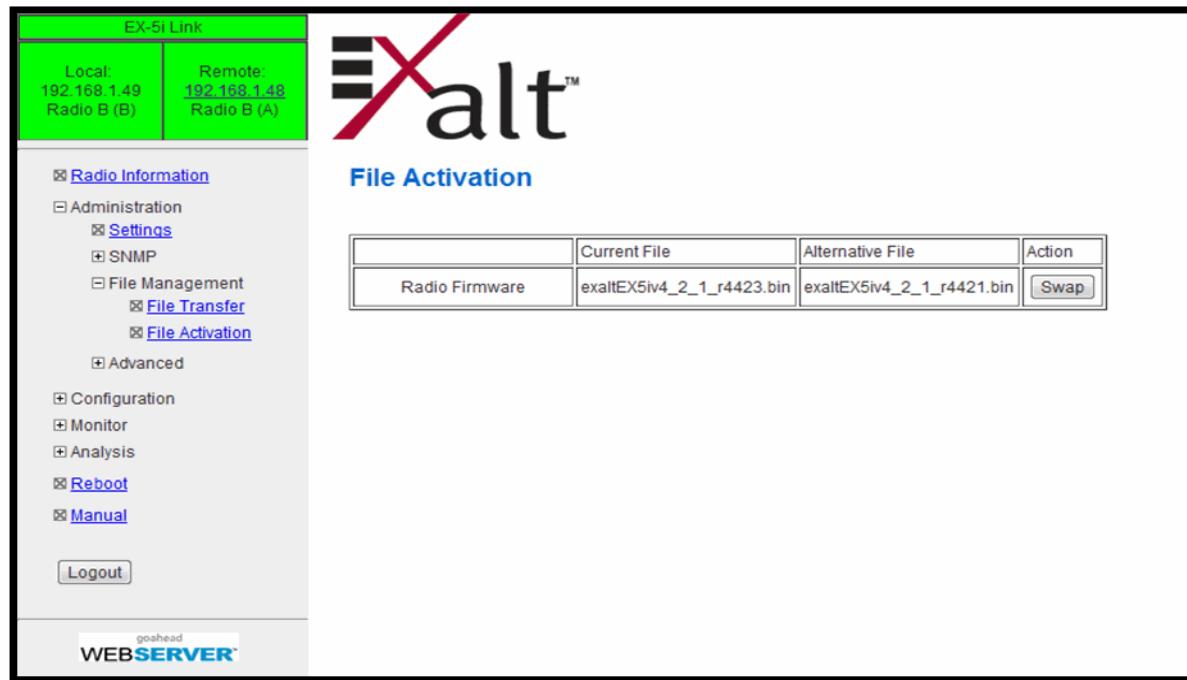


Figure 32 File Activation page



Note: In all cases, the radio reboots after a new file is selected using the Swap function. This places the radio out of service for a short time.

Access Security Page



Note: As of this writing, this feature is not yet released on all models.

This feature allows all radio management interfaces such as HTTP, HTTPS, SSH, Telnet, and serial to be independently disabled/enabled. The default is all interfaces are enabled. Note that SNMP interfaces are independently enabled/disabled on the [Simple Network Management Protocol \(SNMP\) Configuration](#) page.

One management interface must be enabled at all times and the internal software ensures that one interface is always available.

Reset Mode Selection	Current Value	New Value
Reset Mode	Rescue	Rescue Factory Defaults

Management Access	Current Value	New Value
HTTP	Enabled	Enabled
HTTPS	Enabled	Enabled
Telnet	Enabled	Enabled
SSH	Enabled	Enabled
Serial	Enabled	Enabled
SNMP v1/SNMPv2c	Enabled	Enabled
SNMPv3	Enabled	Enabled

ETH Ports Access	Current Value	New Value
Main Port	Enabled	Enabled
Aux Port	Enabled	Enabled

Root Access Selection	Current Value	New Value
Root Access	Enabled	Enabled

Figure 33 Access Security page

The ‘reset to critical factory defaults’ procedure is labeled ‘Rescue’ on this page, and restores only those configurations required to access the radio (such as the IP address, mask, passwords, disables VLANs, and so on).

This feature also ensures that all management interfaces are enabled after reset. Note that ‘Rescue’ is the standard reset function and is recommended to retain all other configurations of the radio after a reset. The reset feature can then be changed to reset *all* configurations to factory defaults. When this feature is used, the entire radio configuration is changed back to the settings in the radio at

manufacture, except for installed License Keys and/or Regulatory Domain Keys, which are retained even after a factory default reset.

For additional security, the Ethernet interfaces (MAIN and AUX) can be individually disabled. If both interfaces are disabled, no Ethernet traffic can pass across the radio link and Ethernet cannot be used for management. In this case, HTTP, HTTPS, Telnet, SSH, and all forms of SNMP are not available; the only available management interface is Serial. This is only appropriate for radios exclusively running TDM traffic (T1, E1, DS3), where serial access is sufficient. This feature is not available on all models.

Root access is used by Exalt for remote software diagnosis (if the radio is accessible over the Internet to Exalt and login credentials were provided). Root access is enabled by default.



Note: If root access is disabled, there are conditions where Exalt may not be able to address remotely that result in an RMA return that otherwise may not have been necessary had root access been enabled. For this reason, it is advised to leave root access enabled, unless there are significant concerns about access to the radio's management ports where 'hacking' may try to attack the Telnet or serial interfaces to gain access to the radio's root directory. To allay these types of issues, use private networks (such as VPN or VLAN) for management access.

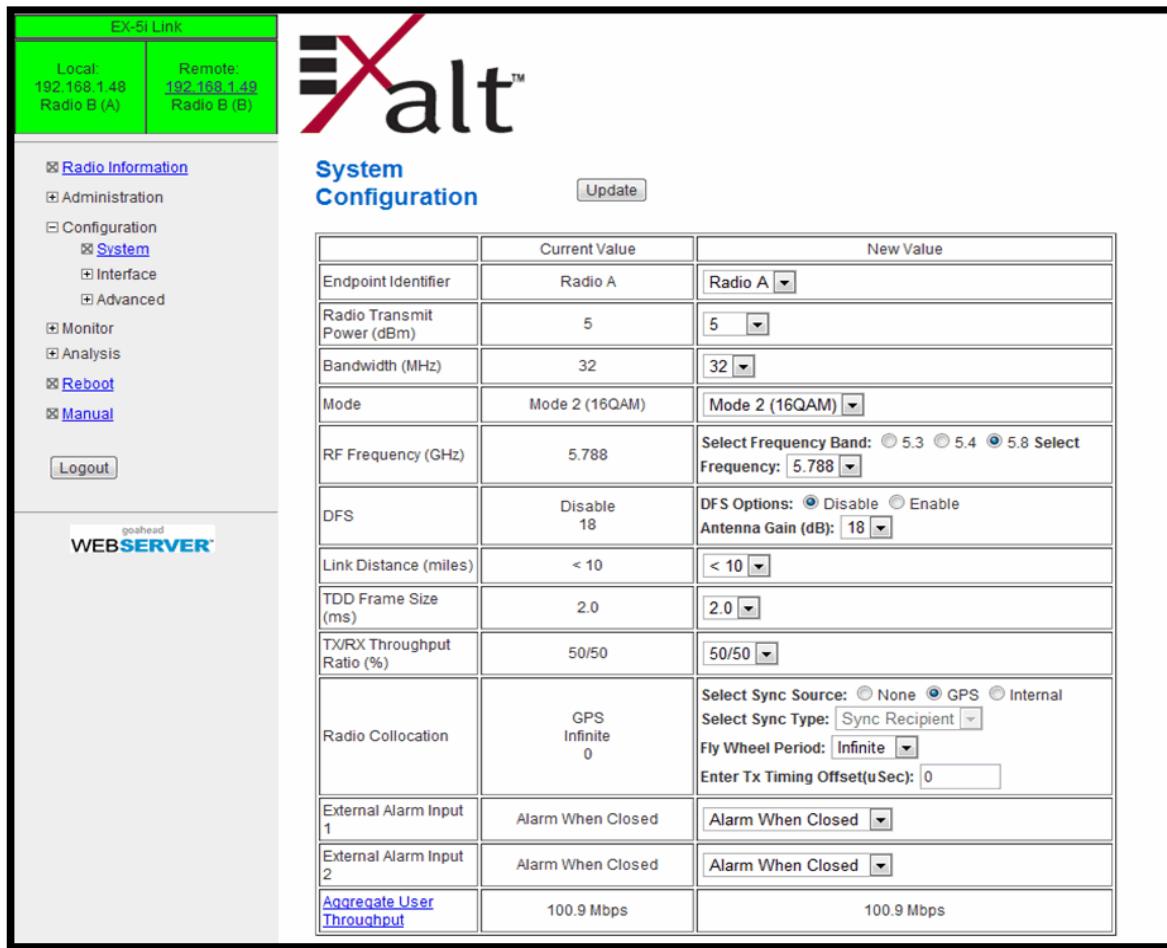
If management security features on this page are used, then the management security features must be manually reconfigured after any reset. Alternatively, after a reset you can upload a configuration file to restore settings.



Note: Models with this management security feature that also have DIP switches on the front panel ignore DIP switch configuration after any reset.

System Configuration Page

This page contains several critical system parameters.



	Current Value	New Value
Endpoint Identifier	Radio A	Radio A
Radio Transmit Power (dBm)	5	5
Bandwidth (MHz)	32	32
Mode	Mode 2 (16QAM)	Mode 2 (16QAM)
RF Frequency (GHz)	5.788	Select Frequency Band: <input type="radio"/> 5.3 <input type="radio"/> 5.4 <input checked="" type="radio"/> 5.8 Select Frequency: 5.788
DFS	Disable 18	DFS Options: <input checked="" type="radio"/> Disable <input type="radio"/> Enable Antenna Gain (dB): 18
Link Distance (miles)	< 10	< 10
TDD Frame Size (ms)	2.0	2.0
TX/RX Throughput Ratio (%)	50/50	50/50
Radio Collocation	GPS Infinite 0	Select Sync Source: <input type="radio"/> None <input checked="" type="radio"/> GPS <input type="radio"/> Internal Select Sync Type: Sync Recipient Fly Wheel Period: Infinite Enter Tx Timing Offset(uSec): 0
External Alarm Input 1	Alarm When Closed	Alarm When Closed
External Alarm Input 2	Alarm When Closed	Alarm When Closed
Aggregate User Throughput	100.9 Mbps	100.9 Mbps

Figure 34 System Configuration page



Note: For models requiring a Regulatory Domain Key (RDK), you must enter a valid RDK to edit this page.

Most entries on this page are self-explanatory. The following lists unique or important parameters.

- Set the Radio Transmit Power (dBm) parameter to the designed level. The professional installer sets this value or dictates the value of this setting to the system administrator following the system design and local regulations. In many cases, this value must be set to a proper value to comply with legal restrictions. Improper values can result in liability to the user and/or installer.



Note: Changing Radio Transmit Power *may* temporarily interrupt traffic. Small changes in output power do not normally interrupt traffic, but larger changes may.

- Do not adjust the Radio Transmit Power parameter to a value higher than is legally allowed.
- Do not adjust the Radio Transmit Power parameter lower than the link budget and fade margin can afford.



Note: The link may be lost and unrecoverable through GUI control. If the link is lost due to reduction of Radio Transmit Power, travel to the radio location(s) may be required to reset the value.

- Set the Bandwidth (MHz) parameter to the designed level. The value of this is determined in the design/engineering stage. The Bandwidth parameter must also match at both ends of the link. In conjunction with the Mode parameter, the Bandwidth parameter directly relates to the capacity, latency, and the number of TDM circuits supported. The transmitter and receiver bandwidth are modified using this parameter, making it critical that it be set with respect to the local RF noise and interference profile, and/or in relation to any multi-link network design.



Note: Changing Bandwidth will temporarily interrupt traffic. The Bandwidth parameter must match at each end. Adjust the far-end radio first, and then the near-end radio. Changing Bandwidth changes the radio's threshold. A narrower bandwidth has better threshold performance and improved interference immunity, therefore if changing to a wider bandwidth, there is an opportunity that the link may be lost and unrecoverable through GUI control. Check the available fade margin and interference profile to determine if the impact to threshold and increased bandwidth is acceptable to maintain the link and the desired performance. If the link is lost due to increasing the Bandwidth parameter, travel to the radio location(s) may be required to reset the value.

- Set the Mode parameter to the designed selection. The value of this setting is determined in the design/engineering stage. The Mode parameter must match at both ends of the link. In conjunction with the Bandwidth parameter, the Mode parameter setting directly relates to the capacity of the system, as well as critical RF parameters, including receiver threshold, carrier-to-interference ratio, and in some cases, maximum radio transmit power.



Note: Changing Mode will temporarily interrupt traffic. The Mode setting must match at each end. Adjust the far-end radio first, and then the near-end radio. Changing Mode changes the radio's threshold, carrier-to-interference ratio, and also may have impact on the Radio Transmit Power. A lower mode has better threshold performance and carrier-to-interference ratio, and in some cases, higher output power, therefore if changing to a higher mode (for example, from Mode 1 to Mode 2), there is an opportunity that the link may be lost and unrecoverable through GUI control. Check the available fade margin and interference profile, and determine if the impact to RF performance is sufficient to maintain the link and desired performance. If the link is lost due to increasing the Mode parameter, travel to the radio location(s) may be required to reset the value.

- Set the RF Frequency (GHz) parameter to the designed point. The value of this setting is determined in the design/engineering stage. RF Frequency must match at both ends of the link. It may be critical to set RF Frequency with respect to the local RF noise and interference profiles, and/or in relation to any multi-link network design.

The frequency selection section includes the ability to select from either the complete list of frequencies (“All”) that can be tuned for the selected band and bandwidth, or, in some cases, a pre-selected list of non-overlapping center frequencies (“Preferred”) that Exalt determined provides the most flexible collocation opportunities for large networks of Exalt radios

The frequency selection section includes a band selection button that must be enabled for the frequency band of operation for which the link was engineered. Some bands may not be selectable due to regulatory constraints. Some bands also require Dynamic Frequency Selection (DFS), based

on the active RDK. DFS is automatically enabled for these bands and is selectable for all other bands.



Note: Changing RF Frequency *will* temporarily interrupt traffic. The RF Frequency parameter setting must match at each end. Adjust the far-end radio first, and then the near-end radio. If the RF Frequency parameter is changed to a frequency with interference, the link may be lost and unrecoverable through GUI control. If the link is lost due to changing the RF Frequency parameter, travel to the radio location(s) may be required to reset the value.

- Set the Endpoint Identifier so that one end of the link is set to Radio A and the opposite end set to Radio B. In single-link networks, it is unimportant which end is designated A or B. In multi-link networks, however, it may be important to orient the links so that at any collocation site (where there are multiple radios of the same type at the same site), all radios are set to the same Endpoint Identifier (A or B). See [Link Orientation and Synchronization](#).



Note: Changing the Endpoint Identifier parameter requires a reboot of the radio to take effect. The reboot temporarily interrupts traffic.

- DFS is automatically enabled for any band where required based on the regulations that match the active RDK. For bands where DFS is not required, it can still be selected. For DFS to operate properly, set the antenna gain figure to match the installed transmission system gain (that is, the gain of the antenna minus all losses between the radio and the antenna).



Note: When DFS is enabled, the radio temporarily stops transmitting for at least 60 seconds to ensure that no radar interference is present. This is called “Channel Availability Check (CAC).” The DFS status displays on the [Alarms Page](#). Once CAC passes, the radio resumes normal operation. If at any time during CAC or regular operation a qualifying radar signature is detected, the radio shuts down communications for a minimum of 30 minutes. This is the Non-Occupancy Period (NOP). Transmission only resumes after the NOP completes and then only after a successful CAC.

- Set the Link Distance (miles) parameter to the range that is equal to or greater than the actual link distance. The value of this setting is determined in the design/engineering stage.



Note: Changing the Link Distance parameter *will* temporarily interrupt traffic. The Link Distance setting must match at each end and must not be less than the actual link distance. Adjust the far-end radio first, and then the near-end radio. If the Link Distance parameter is changed to a setting less than the actual distance, the link may be lost and unrecoverable through GUI control. If the link is lost due to this situation, travel to the radio location(s) may be required to reset the value. If the Link Distance parameter setting is set to a distance unnecessarily higher than the actual link distance, the radio may have substantially reduced performance with respect to throughput and latency.

- Set the TDD Frame Size (ms) parameter to the designed level. The value of this setting is determined in the design/engineering stage. The TDD Frame Size parameter must match at both ends of the link. The TDD Frame Size parameter setting directly relates to the capacity, latency, and number of TDM circuits that can be supported over the given link distance. In multi-link networks, especially where there are collocated links, it is also important to set all radios to the same TDD Frame Size setting to avoid self-interference. Future enhancement: The GPS or internal sync function may be necessary for these networks. See [RF Output Power Setting](#) and [Link Orientation and Synchronization](#) for more information.



Note: Changing the TDD Frame Size parameter *will* temporarily interrupt traffic. TDD Frame Size parameters must match at each end. Adjust the far-end radio first, and then the near-end radio. If the TDD Frame Size parameter is set to a value that cannot be supported for the link distance, the link may be lost and unrecoverable through GUI control. If the link is lost due to this situation, travel to the radio location(s) may be required to reset the value.

- Set the TX/RX Throughput Ratio (%) parameter to program radio symmetry. The default setting is 50/50 for symmetrical, full-duplex throughput. Other throughput ratio options are 20/80, 80/20, and 65/35, 35/65. See [Link Symmetry](#).

For asymmetric throughput, only TDD frame size settings of 2ms and 5ms and RF Bandwidth settings of 16MHz and higher are supported. The 64MHz/Mode2 configuration does not support asymmetry due to capacity limitations of the 100BaseT interface.

- Radio Collocation enables the Sync feature. See [Radio Synchronization](#).
- The External Alarm Inputs parameter can be ignored unless connecting external alarm sources to the radio for monitoring the status of these external alarms through the radio management system (see [Interface Connections](#)).
- Aggregate User Throughput parameter provides information about user capacity of the wireless link, in the current configuration. The ‘new value’ column reflects throughput if changes are made to Bandwidth, Mode, Link Distance, and/or TDD Frame Size. Click the “Aggregate User Throughput” link for details on aggregate capacity.

MHS Configuration Page

The -16 versions provide the Monitored Hot Standby (MHS) feature. The MHS kit is sold separately and requires a valid license key, which is included with the kit. The radio system can be configured for hardware redundancy at either end or both ends of the radio link. This configuration uses two radio terminals per end with special hardware and cabling that switches the standby radio into the path when the primary radio or its interfaces go offline. This minimizes any down-time for the link — especially for hard-to-reach radio locations or critical traffic applications. Figure 35 shows the MHS configuration screen.

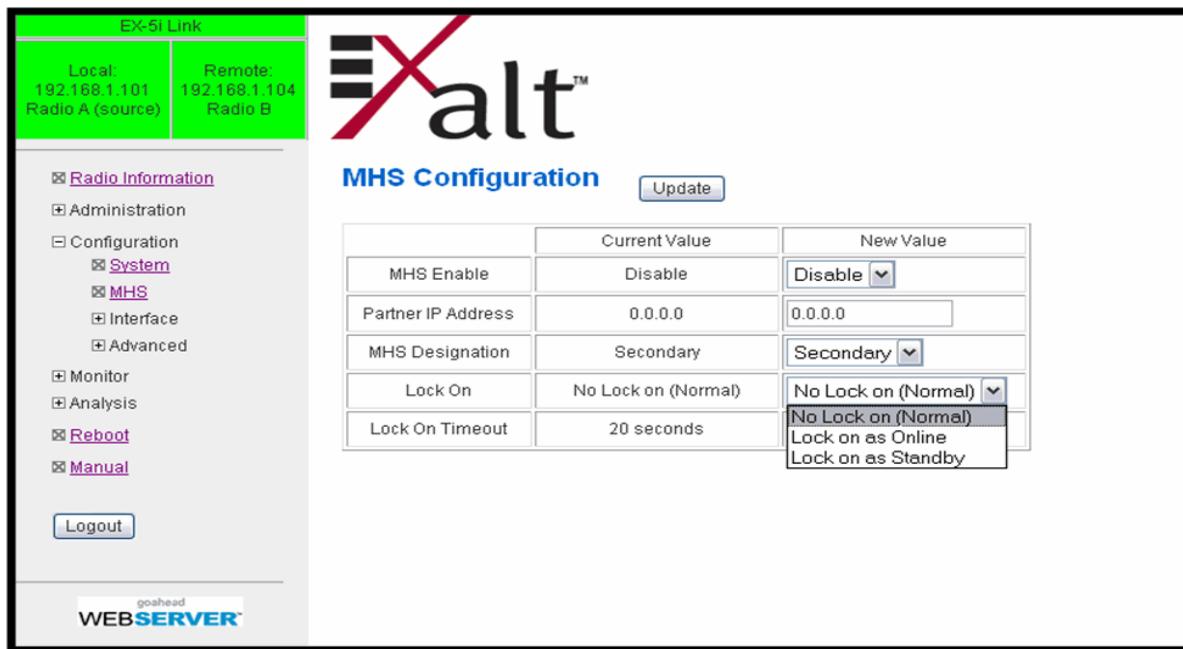


Figure 35 MHS Configuration page

Refer to the *MHS Implementation Guide* for more information.

Ethernet Interface Configuration Page

This page allows the administrator to set the muting, alarm, and duplex settings of both the ETHERNET MAIN and AUX connections.

It also allows determination of the management information for in-band (carried over the air and available from both the MAIN and AUX connectors on either end of the link) or out-of-band (not carried over the air and only available from the local AUX connector).

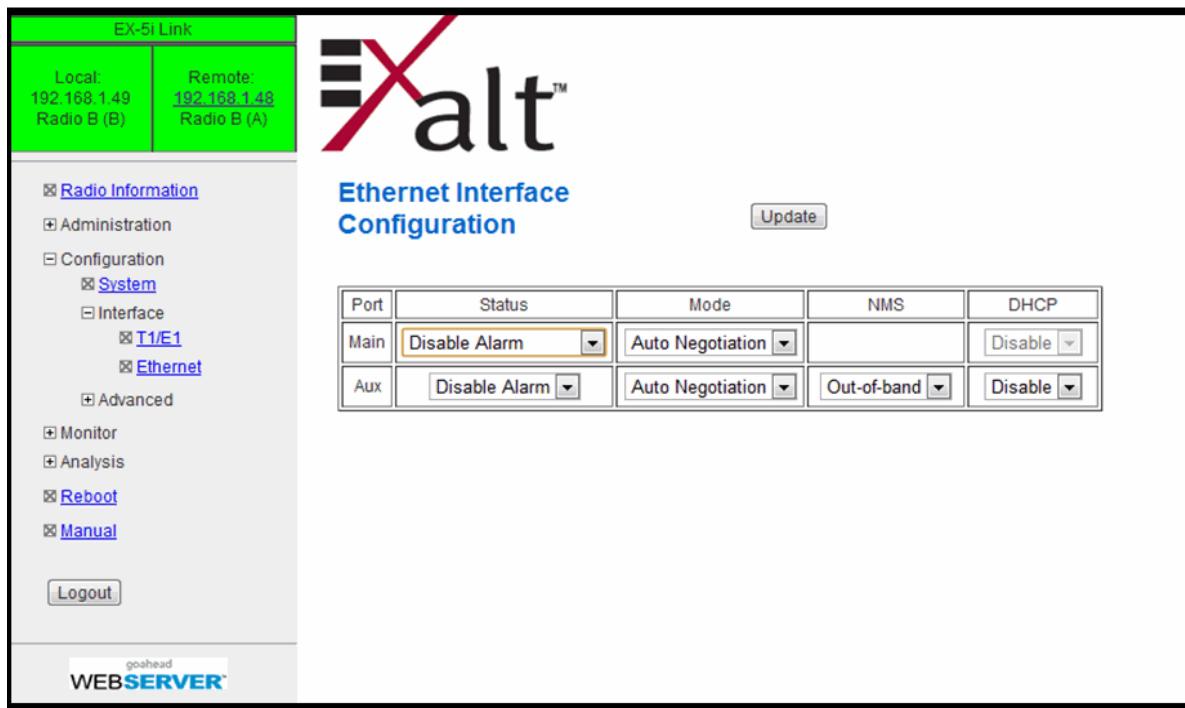


Figure 36 Ethernet Interface Configuration page

To ignore Ethernet alarms, disable the alarming of the MAIN and/or connector. Muting the MAIN connection is desirable when connected equipment senses Ethernet signaling and makes decisions (such as, spanning tree protocol enable) based on the Ethernet signal. If the MAIN connection has muting enabled, the port is muted when the link is not active.

It may be desirable to disable the alarming of the AUX connector if it is not used.

Set the Ethernet interfaces on the radio and connected equipment to 100/full-duplex for best performance. If the Ethernet ports are set to auto-negotiation, poor throughput performance may be a result, as well as intermittent disconnections of the Ethernet connection.

Some models support the DHCP feature. When enabled, DHCP provides basic DHCP functions to ease interfacing with a computer. By default DHCP is enabled for models that support it. If the Ethernet port on the computer is set for DHCP addressing, on radio bootup (for up to 10 minutes) the radio provides an IP address to the computer that is either 2 or 10 higher than the radio's current IP address (for example, if the radio's IP address is 10.0.0.1, the computer will be set to 10.0.0.3 or 10.0.0.11, depending on the radio model and the software version running on the radio). The radio also senses any DHCP server on the network and, if detected, mutes its own internal DHCP function.

VLAN Configuration Page

VLAN is disabled as the default setting for Exalt radios. The Exalt radios still pass VLAN and non-VLAN traffic across the link, but do not examine the VLAN traffic or act upon it. Enable VLAN using the Exalt GUI for expanded VLAN support.

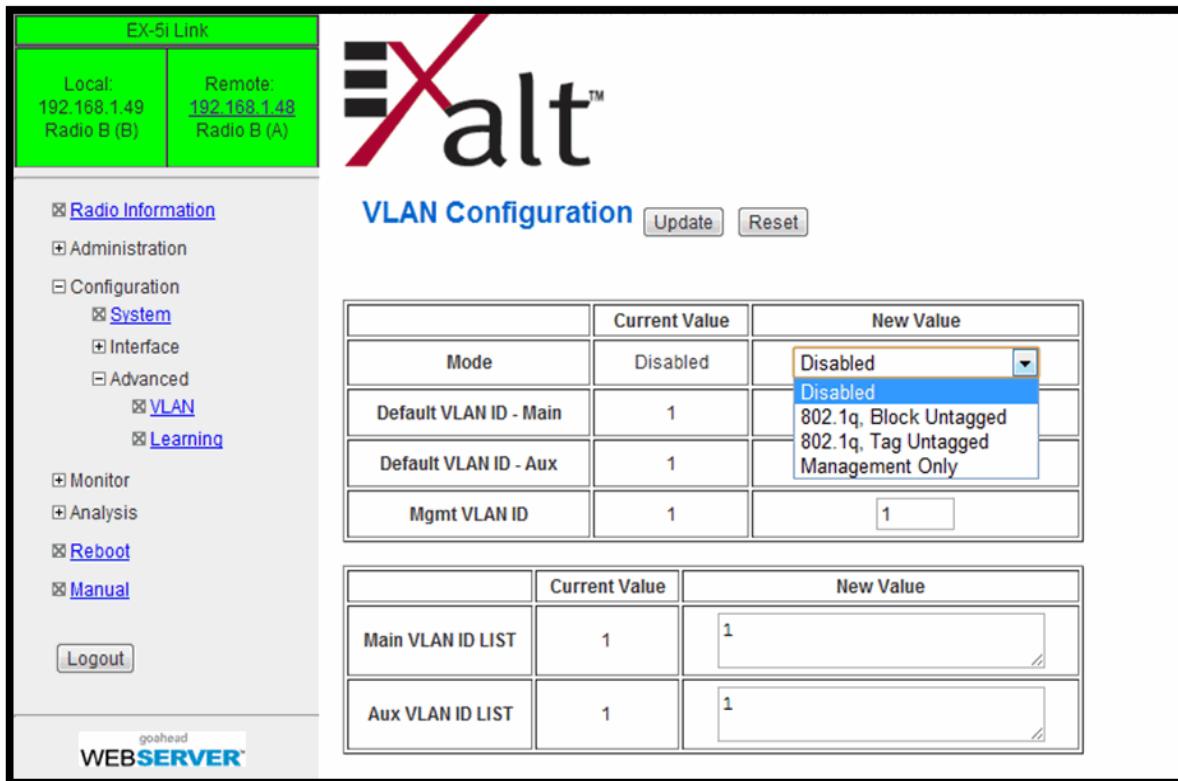


Figure 37 VLAN Configuration page

When VLAN is first enabled, all Ethernet interface ports (Aux and Main) are assigned as *Default VLAN*, until the ports are configured with specific VLAN IDs. For example, a specific VLAN for management access to the radio must be manually configured.



Note: Once a management VLAN is configured or modified and the Update button clicked, the management connection will likely be lost. The management connection to the radio must follow the configuration to the assigned VLAN. After configuring and enabling the management VLAN on the radio, reconfigure your network's management access to match the settings on the radio.

If any VLANs are configured in addition to the management VLAN, the radio automatically discards traffic that not matching a configured VLAN. Non-tagged traffic, or traffic with tags matching VLANs that are not configured, do *not* flow across the radio link.

Up to 16 unique VLANs can be configured. VLAN ID numbering ranges from 1 to 4094. The Native (default) VLAN ID can be changed from the default setting. Every configured VLAN can also have a logical name to help track the function of each VLAN.

VLAN configurations are maintained even when VLAN is disabled. That is, the VLANs can be configured and the configuration saved, even though they are not active until VLAN is enabled. Use

the following methods to restore the management connection if a mistake was made assigning the management VLAN and access cannot be restored:

- Reset the radio to the critical factory defaults (see [Reset to Critical Factory Settings](#)).
- Connect to the Console port using a serial interface and the CLI, as described in [Command Line Interface \(CLI\)](#), and reconfigure the VLAN settings.



Note: Only one entry per VLAN ID is allowed. If the same VLAN ID is entered into the table more than once, the radio uses the first assignment found in the table and ignores duplicate entries.

Four VLAN configurations are provided:

- 802.1q Block Untagged: To pass desired VLANs across the radio, they must be listed in the lower tables per their respective interfaces. All other traffic, including untagged traffic, is not passed across the link. The radio must be managed on a VLAN whose ID is set in the upper table. This management VLAN ID is available to any interface IDs listed in this lower table.
- 802.1q Pass Untagged: To pass desired VLANs across the radio, they must be listed in the lower tables per their respective interfaces. All other VLAN traffic is not passed across the link, and untagged traffic is passed across the link with no changes. The radio must be managed on a VLAN whose ID is set in the upper table. This management VLAN ID is available to any interface IDs listed in this lower table.
- 802.1q Tag Untagged: To pass desired VLANs across the radio, they must be listed in the lower tables per their respective interfaces. All other VLAN traffic is not passed across the link, and untagged traffic is tagged with the programmed Default VLAN, per interface, as set in the upper table. Any interface requiring the default VLAN ID to pass must have the Default VLAN ID listed in the table below. The radio must be managed on a VLAN whose ID is set in the upper table. This management VLAN ID is available to any interface IDs listed in the lower table.
- Management only: All traffic is passed transparently, except the radio is managed on an assigned Management VLAN ID, as programmed in the upper table.

T1/E1 Configuration Pages

These pages allow the administrator to selectively enable or disable the T1 or E1 circuits, one at a time. For enabled T1/E1 circuits, additional configuration, including loopback functions, are available.

Disable the unused T1 or E1 so that the alarms are turned off and more throughput is allocated to the Ethernet interface. Every enabled T1 or E1 input, even if there is no T1 or E1 signal present, reduces the aggregate throughput of the Ethernet interface by roughly 3Mbps (for T1) or 4Mbps (for E1).

This page toggles between T1 and E1, as required, by clicking the Set to T1 or Set to E1 button. A warning displays that a reboot is necessary, and the radio reboots if the administrator continues. *This will interrupt traffic.* It may be necessary to re-login to the radio after the reboot completes. T1/E1 mode self-coordinates across the link if the link is active. This means that it only needs to be set while connected at one end. In addition, enabling and disabling T1/E1 circuits also self-coordinates across the link if the link is active. If a link is not active and T1/E1 enabling is a mismatch when a link is first created, the Radio A configuration for T1/E1 enabling supersedes the settings on the Radio B configuration, and changes the settings on Radio B.



Note: Certain combinations of the TDD Frame Size, Link Distance, Mode, and Bandwidth parameter settings limit the number of T1/E1 circuits that can be carried by the radio. In these cases, certain fields on the T1/E1 Interface Configuration pages are not available, starting with the highest port number. For example, for a 4x T1/E1 radio version, if only three (3) circuits can be carried, port 4 is not available for configuration and is disabled. If only two circuits can be carried, both ports 3 and 4 are not available. Increasing the TDD frame size and Mode parameters, and/or increasing the Bandwidth parameter results in an increase in the supported number of T1/E1 circuits.

T1 Interface Configuration Page

This page allows the administrator to enable/disable each individual T1 channel, set the Line Build Out (LBO), Line Code (either AMI or B8ZS), and AIS enabling/disabling for each input. If enabled, the radio places an AIS code on the output of the associated interface if and when the link fails or when there is no T1 signal available from the far end to provide the user at the local end. Loopback controls are also provided (see [T1/E1 Loopback](#)).

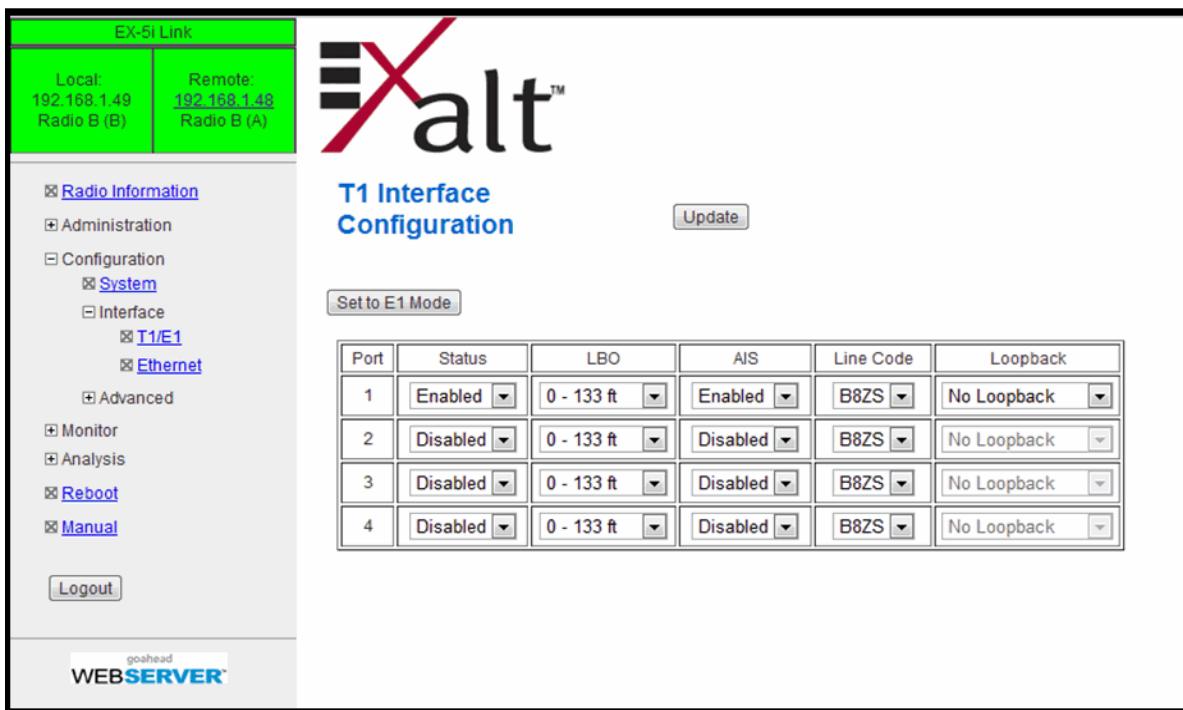


Figure 38 T1 Interface Configuration page

E1 Interface Configuration Page

This page allows the administrator to enable/disable each individual E1 channel. The AIS can also be enabled and disabled for each input. If enabled, the radio places an AIS code on the output of the associated interface if and when the link fails or when there is no E1 signal available from the far end to provide the user at the local end. Loopback controls are also provided (see [T1/E1 Loopback](#)).

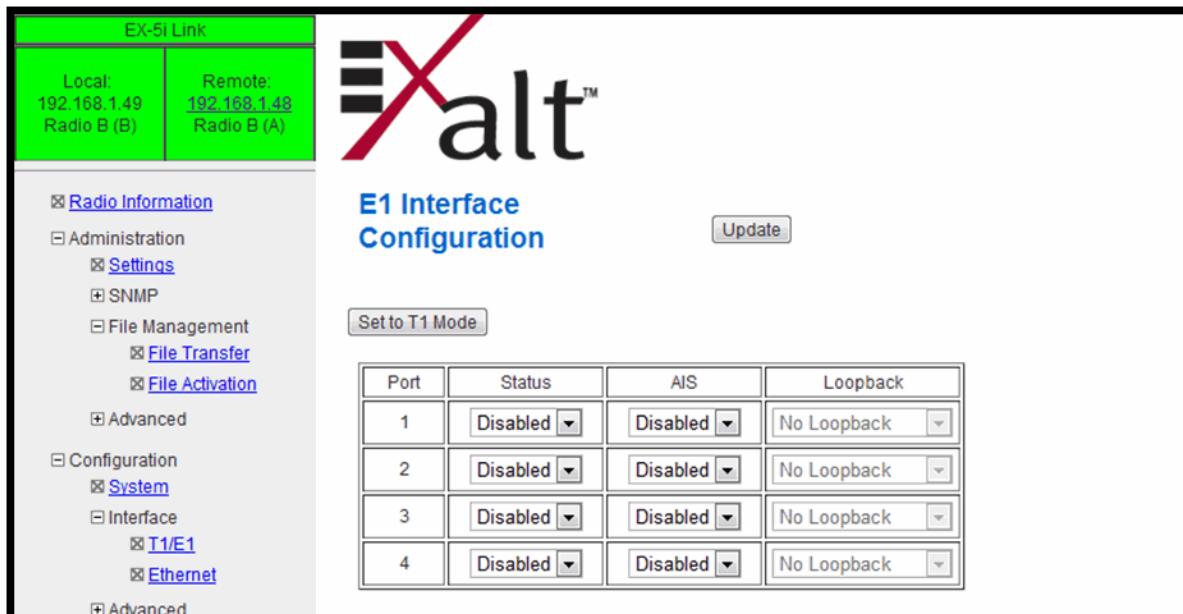


Figure 39 E1 Interface Configuration page

T1/E1 Loopback

Loopback is provided for any enabled T1 or E1 port. As shown in Figure 38 and Figure 39, the choices are:

- No Loopback (default)
- External (local)
- External (remote)
- Internal



Note: Only one Internal loopback can be enabled at any time.

All loopback configurations control the loop at the Line Interface integrated circuit, which is the device wired directly to the front panel ports.

External loopback modes are used in conjunction with an external test source. The designation of 'local' or 'remote' refers to where the loopback is occurring relative to the location where the loopback is implemented. That is, on the radio being accessed, if External (remote) is selected, this loops the signal back at the remote radio interface back towards the local radio. Likewise, if External (local) is selected, the signal loops back at the local interface towards the remote radio (Figure 40 and Figure 41).

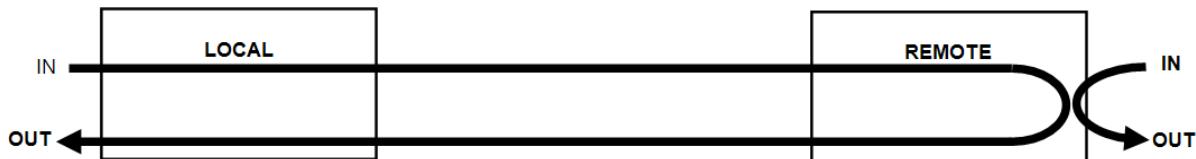


Figure 40 External (remote) loopback

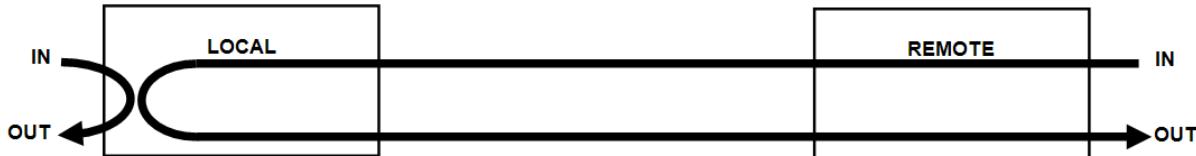


Figure 41 External (local) loopback

When a local T1/E1 port is configured for External (remote) loopback, it is the same as configuring the remote radio for External (local) loopback.

DS3 Configuration Page

This page allows the administrator to configure the DS3 interface (EX-5i-DS3 model only). The interface should be disabled if there is no DS3 connected. The associated throughput is then allocated to T1/E1 and/or Ethernet.

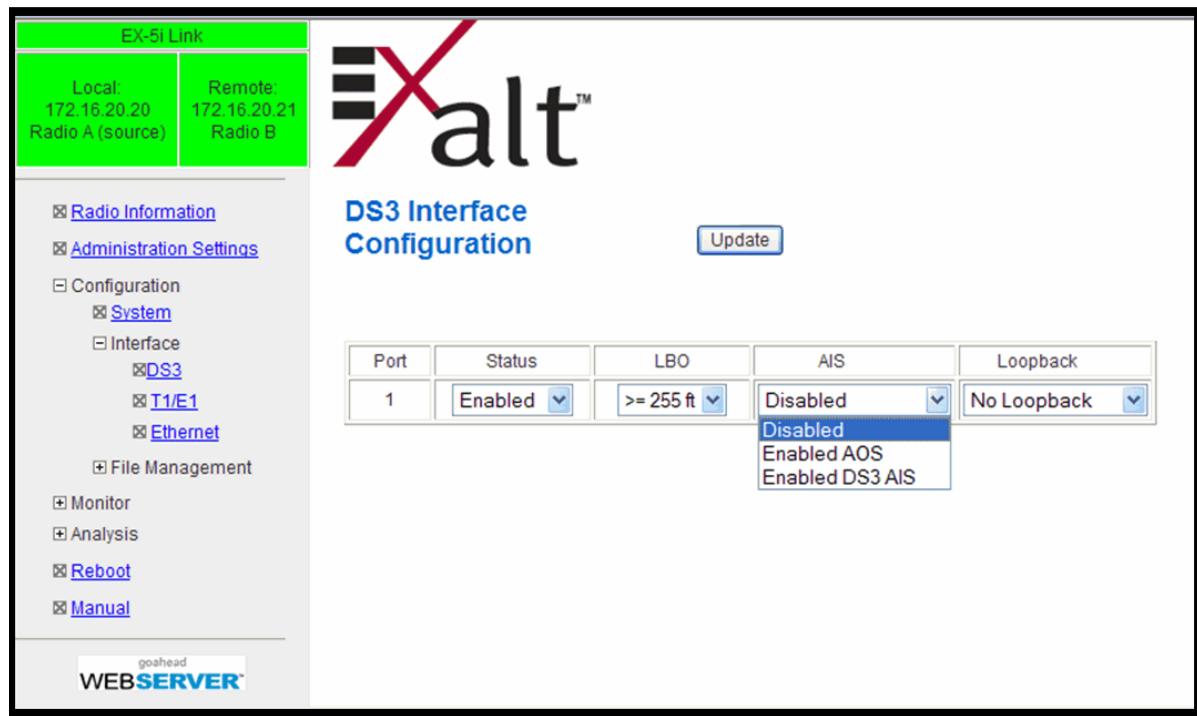


Figure 42 DS3 Configuration page

The Line Build Out (LBO) can be set for this interface. Also, the Automatic Insertion Signal (AIS) can be disabled, or set to an All-Ones (AIS) or All-Zeros (AOS) signal type. In addition, some loopback functions are provided, similar to the T1/E1 loopbacks described in [T1/E1 Loopback](#).

GPS Information Page

This page provides information on how many GPS satellites are within the view of the Exalt GPS receiver. This page is active for implementations that include the GPS receiver connection for synchronization. This information can be helpful for troubleshooting GPS issues.



Figure 43 GPS Information page

Alarms Page

This page provides an easy-to-read summary of the alarm status of both local and remote radios. The colors on this page reflect the color of the alarms displayed on the radio front panel. However, additional detail displays on this page to aid in quick assessment of issues and status.

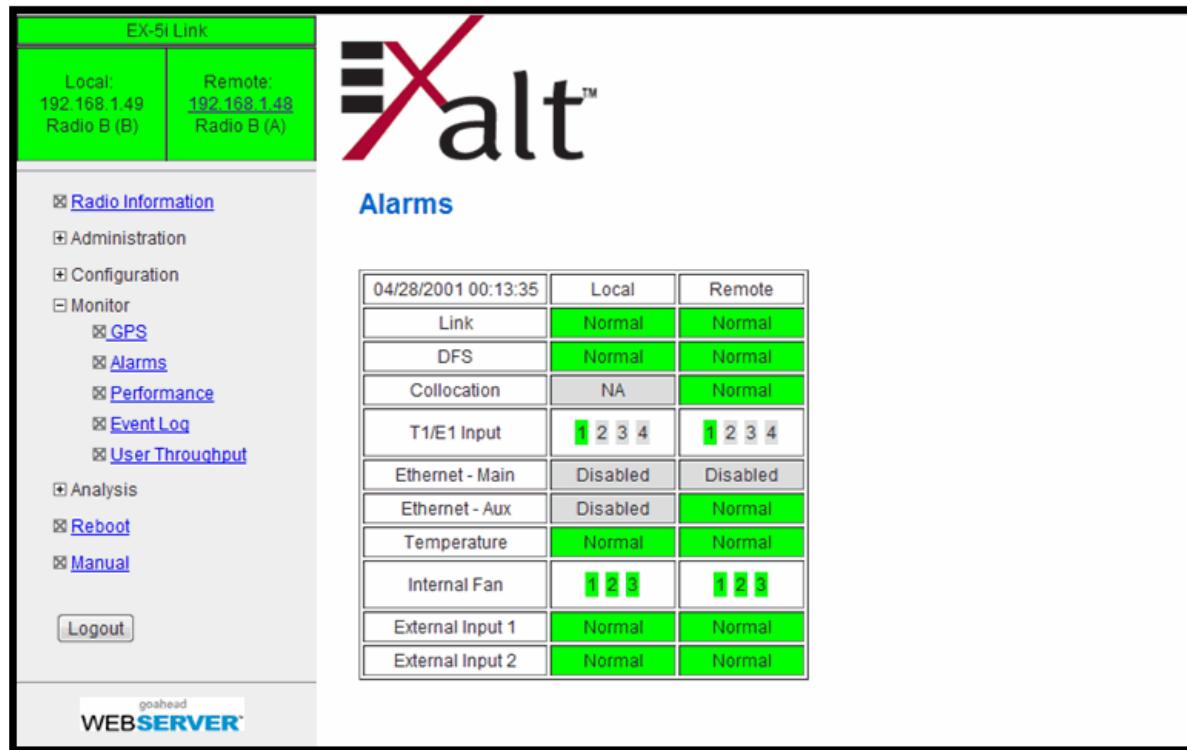


Figure 44 Alarms page

Table 6 lists alarm status conditions that appear on this page.

Table 6 Alarm status indicators

Label	Status
Link	Indicates RF link status: Green Solid = Error-free connection (BER<10e-6) Yellow Solid = Errored connection (10e-3>BER >10e-6) Red Solid = No link (BER>10e-3)
DFS	Indicates the status of the Dynamic Frequency Selection (DFS). Green = No DFS activity, normal transmission Red = Either CAC or NOP is in progress.
Collocation	Indicates the enabled/disabled status with Internal or GPS sync and current alarm status. Green Solid = Sync enabled and sync input present Yellow Solid = Sync enabled and missing proper sync input signal Grey = Disabled

Table 6 Alarm status indicators (Continued)

Label	Status
DS3	Indicates the status of the DS3 interface. Green = Enabled and connection present Yellow = Disabled and connection present Red = Enabled and no connection present Grey = Disabled or unavailable due to configuration
Ethernet – Main	Green Solid = Data present Grey = Disabled Red Solid = No data present (and alarms are enabled)
Ethernet – Aux	Green Solid = Alarm enabled and connection present Yellow Solid = Alarm enabled and connection not present Grey = Alarm disabled Red Solid = No data present (and alarms are enabled)
T1/E1 Input	Green = Enabled and connection present (clocking confirmed) Red = Enabled and no connection present Grey = Disabled or unavailable due to configuration
Temperature	Green Solid = Normal temperature range Yellow Solid = Exceeding normal temperature range
Internal Fan	Indicates the internal fan status. There are 3 fans for redundancy Green = Fan OK Yellow = Fan in alarm
External Inputs (1 and 2)	Indicates the status of the external alarm inputs from the ALARMS connector, in accordance with the open/closed logic defined on the System Configuration Page . Green = Normal Yellow = In alarm
DIP Switch	Indicates the status of the front panel DIP switch for models without Access Security. Yellow = Enabled Grey = Disabled

MHS Status Page



Note: MHS is a future enhancement.

For -16 models with the MHS option, the MHS Status page shows the present alarm status of the MHS functions. Figure 45 shows the MHS Status page.

The screenshot shows the MHS Status page. The left sidebar contains a navigation menu with the following items:

- EX-5i Link
- Local: 192.168.1.101 Radio A (source)
- Remote: 192.168.1.104 Radio B
- [Radio Information](#)
- [Administration](#)
- [Configuration](#)
- [Monitor](#)
 - [Alarms](#)
 - [MHS](#)
 - [Performance](#)
 - [Event Log](#)
 - [User Throughput](#)
- [Analysis](#)
- [Reboot](#)
- [Manual](#)
- [Logout](#)

The main content area features the Exalt logo and the title "MHS Status". Below the title is a table showing MHS status information:

11/20/2009 14:00:12	Local	Partner
Partner IP Address	0.0.0.0	0.0.0.0
Designation	Secondary	Primary
Radio Status	MHS Radio status: online	MHS Radio status: not defined
Protection Link Status	Both protection links not defined	Both protection links not defined
Configuration Status	MHS Config status not determined	MHS Config status not determined

At the bottom of the page, the "goahead WEB SERVER" logo is visible.

Figure 45 MHS Status page

Refer to the *MHS Implementation Guide* for more information.

Performance Page

This page provides statistical information about the performance of the system in relation to the integrity of the user data and the RF link.

04/28/2001 00:13:45	Local	Remote
Current BER	0.00e+00	0.00e+00
Current RSL (dBm)	-40	-33
Errorred Seconds	15	2
Unavailable Seconds	772	31
Min. RSL (dBm)	-99	-99
Min. RSL Timestamp	04/27/2001 19:03:03	01/19/2012 11:31:53
Max. RSL (dBm)	-1	-29
Time Since Reset (d:h:m:s)	000:05:10:40	000:03:14:08

Figure 46 Performance page

- The Current BER field indicates the current bit error rate of the link. If the link is operating perfectly, this should indicate zero. Generally, the link should remain at a BER less than 1×10^{-6} (1 bit out of every million bits errored). This is the threshold performance specification and the standard to which the link was engineered. However, radio links can and are affected by weather, interference, and other external sources and will occasionally have a higher error rate. A link remains operational unless the BER exceeds 1×10^{-3} (1 bit out of every hundred bits errored). Consult the link design engineer for an understanding of the predicted error rate of the radio link as it has been designed.

Many applications are unaffected by bit errors, but TDM circuits (for example, T1 or E1) are more sensitive. Also, if the link operator is providing a service guarantee, this value may need to be monitored or examined in cases of service issues. The behavior of BER in relation to other alarms or measurements and external events can be very helpful in troubleshooting activities.

- Current RSL is the measurement of the received signal level at the radio antenna port. This is the measured level of the RF signal coming from the opposite end of the radio link. The link was engineered to a specific RSL by the link design engineer, and this RSL should be obtained during installation and remain relatively stable during the operation of the link. RSL can and will vary as a result of weather changes and other external sources, such as path obstructions. Once again, this variation was part of the original design to achieve a certain level of performance over time. Bit errors occur when the RSL falls to a level within roughly 3dB of the threshold specification. When the RSL falls below the threshold specification, the link disconnects and will not reconnect until the RSL is above the threshold specification. The behavior of RSL in relation to other alarms or measurements and external events can be very helpful in troubleshooting activities.

- Errorred Seconds (ES) indicates the total number of seconds that occurred where there was at least one bit error since the last time that the radio statistics counter was reset. Generally, ES are not a significant concern, so long as they are not continuous or above the anticipated performance based on the original link engineering goals. If ES are continuous or at a high rate, this is normally an indication of poor link performance due to poor RSL or interference, or severe impact by weather or other environmental factors. However, similar to the performance factors previously listed, ES can and will occur in any radio link. Once again, consult the link engineer to determine the original design goals, and compare actual performance to these expectations to determine if any improvements are necessary or if other problems may be causing excessive ES.



Note: Unavailable Seconds do not register as ES. In other words, the ES counter counts all seconds that are errored NOT INCLUDING the seconds that were classified as unavailable. The total number of seconds with errors or outages is the sum of ES and Unavailable Seconds.

- Unavailable Seconds (also called UAS) are similar to ES, but this counter keeps track of every second where the bit error rate equals or exceeds 1×10^{-3} , as well as any seconds where there is a complete loss of radio communication, over the period since the last counter reset. If Unavailable Seconds are continuous or at a high rate, this is normally an indication of poor link performance due to poor RSL or interference, or severe impact by weather or other environmental factors. However, similar to the performance factors listed above, Unavailable Seconds can and do occur in any radio link. Consult the link engineer to determine the original design goals, and compare actual performance to these expectations to determine if any improvements are necessary or if other problems may be causing excessive Unavailable Seconds.
- Minimum RSL indicates the worst (lowest) received signal level that occurred since the last counter reset. It is helpful to know if the RSL dropped significantly from the normal level, or has reached a level near or below threshold.
- Minimum RSL Timestamp indicates the date and time when the Minimum RSL occurred. This is helpful for general troubleshooting, and especially comparing to items in the event log or diagnostic charts from the same time period.
- Maximum RSL indicates the best (highest) RSL that occurred since the last counter reset. This indicates the best performance of the radio link, which is normally equal to the installed value, and is usually the designed value.
- Time Since Reset indicates the amount of time passed since the last counter reset. This helps to quantify the seriousness of other statistics, such as ES and Unavailable Seconds, if there have been high numbers of ES and/or Unavailable Seconds over a relatively short period of time.

All end-of-link statistics can be independently reset using the respective reset statistics button. It is good practice to reset the statistics during link commissioning (after all antenna alignment is complete and stable RSL at designed levels is achieved, and no more system reboots are anticipated). Regularly review this page to record performance and reset the statistics so that the counters can more precisely pinpoint issues.



Note: Resetting statistics from one end also resets the statistics for the same radio at the opposite end. That is, if the Local statistics are reset, logging into the remote end shows the Remote statistics on that end (which is the local radio in the first condition) as being reset at the same time.

Event Log Page

Use this page to review a list of the events logged by the radio. The following items are listed in the event log:

- Alarms
- Alarms clearing (normal)
- Radio reboots
- Radio configuration changes
- System logins

Every event is tagged with the time that the event occurred, and a severity and type. The event log also allows filtering to limit the view of the log to only the level(s) of desired information.

The log contains the last 1000 events. Events are deleted on a FIFO basis, erasing the oldest entries to make room for the newest entries. The event log can be cleared and downloaded from the file transfer page (some models may require a software upgrade to enable this feature).

ID	Date/Time	Description	Severity	Status
2	4/28/2001 0:9:12	Request for download of MIB file	Info	
1	4/27/2001 21:9:54	Cleared event log	Info	

Figure 47 Event Log page

User Throughput Page

This page illustrates the user throughput of the radio, as configured.

EX-5i Link

Local: 192.168.1.49 Radio B (B)	Remote: 192.168.1.48 Radio B (A)
---------------------------------------	--

Exalt™	
User Throughput	
Ethernet packet size	1518 bytes
Aggregate User Throughput	100.8 Mbps
Inbound Ethernet Throughput	48.9 Mbps
Outbound Ethernet Throughput	48.9 Mbps
# of enabled T1 channels	1
Recalculate	?

Radio Information

Administration

Configuration

Monitor

GPS

Alarms

Performance

Event Log

User Throughput

Analysis

Reboot

Manual

Logout

goahead
WEB SERVER™

Figure 48 User Throughput page

Click the help icon () to go to page on how this information is determined (Figure 49).

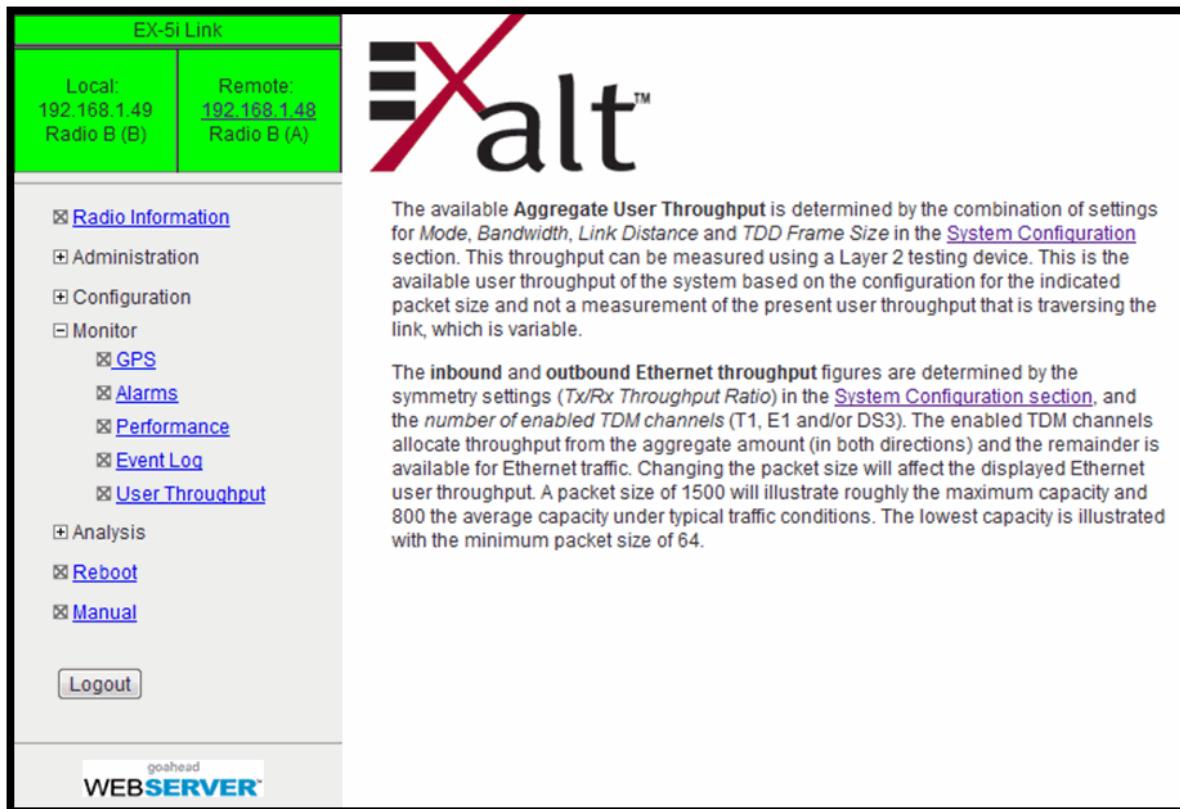


Figure 49 Aggregate User Throughput Help page

Diagnostic Charts Page

Use this page as an aid in troubleshooting. This page illustrates the historical (and current) performance for three parameters: RSL, Radio Temperature, and BER.

The horizontal scale illustrates 120 points of time measurement and is synchronized on all three graphs. The scale displays in minutes, hours, or days from the last two hours (120 minutes), five days (120 hours), or four months (120 days). All information is stored, so all of these periods are available for short- and long-term performance analysis. The right side of a graph represents the most recent measurement, and data ‘marches’ from the right-to-left at every interval.

The vertical scale of each chart independently scales to show the maximum resolution based on the maximum variation of the data over the selected time measurement.

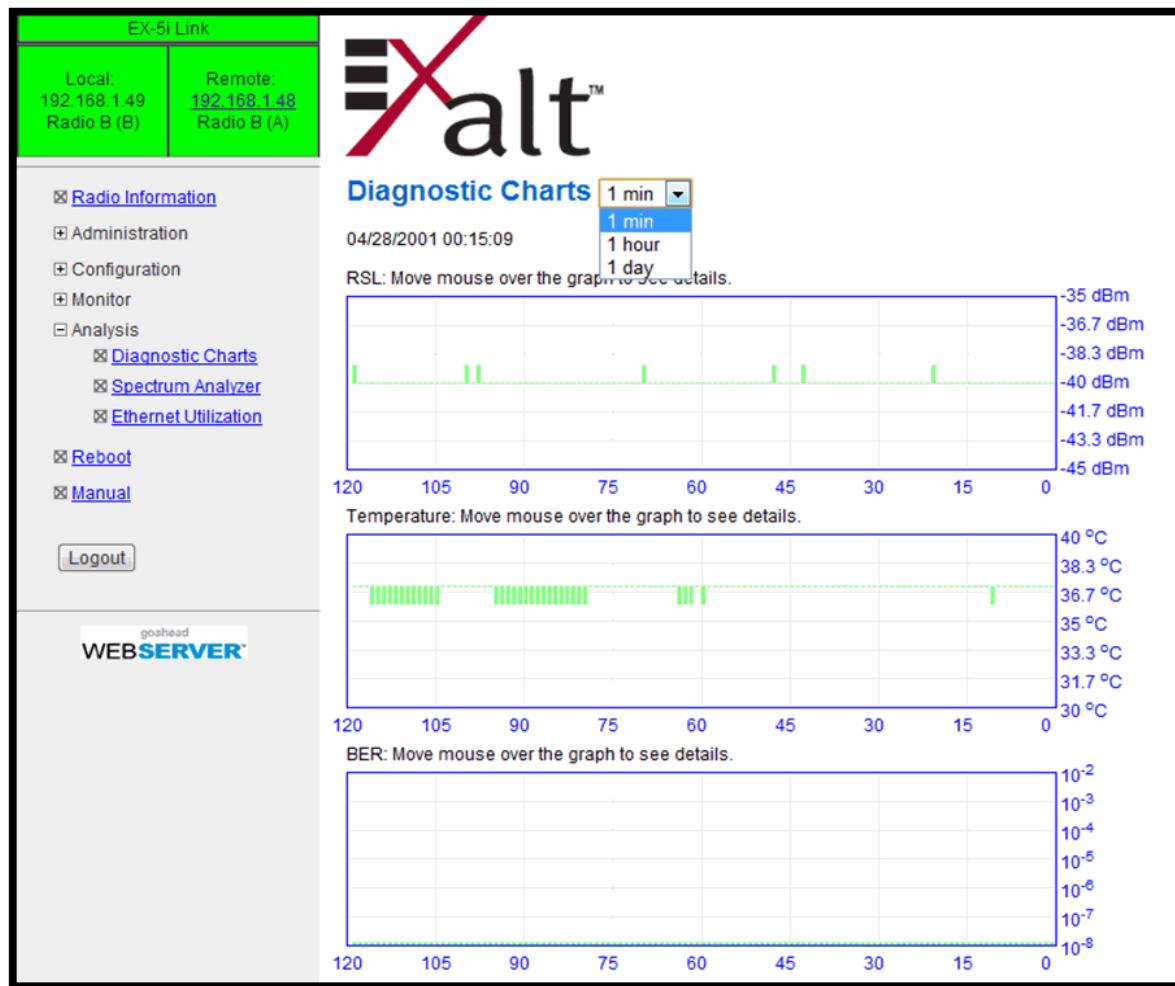


Figure 50 Diagnostic Charts page

Use the cursor to point to any spot on any of the three charts, and all three charts illustrate the measurements taken for that time interval in the upper-left corner of each chart. The time interval is indicated by $T=(value)$. This is followed by the value of the measurement, listing the highest value, lowest value and average value measured over that time interval.

For example, if the displayed time interval is minutes, and the cursor is held at the $T=17$ mark on the horizontal axis, the measurements shown indicate performance from 17 minutes ago. The high/low/average values shown on each chart are measurements made across that specific one-minute interval.

Changes in RSL often have an impact on BER, and this can be confirmed by looking for synchronized events. When BER events occur without corresponding changes in RSL, this normally indicates interference, atmospheric changes, transmission system issues (such as problems with cables, connectors, or antennas), or possibly radio hardware problems.

Spectrum Analyzer Page

The spectrum analyzer feature provides a useful pre-planning and troubleshooting tool. This feature is only available on radios with firmware supporting the spectrum analyzer. Perform a spectrum analysis after deployment and just before commissioning to maintain a record of the spectrum at the time of deployment. Figure 51 shows the Spectrum Analyzer page.

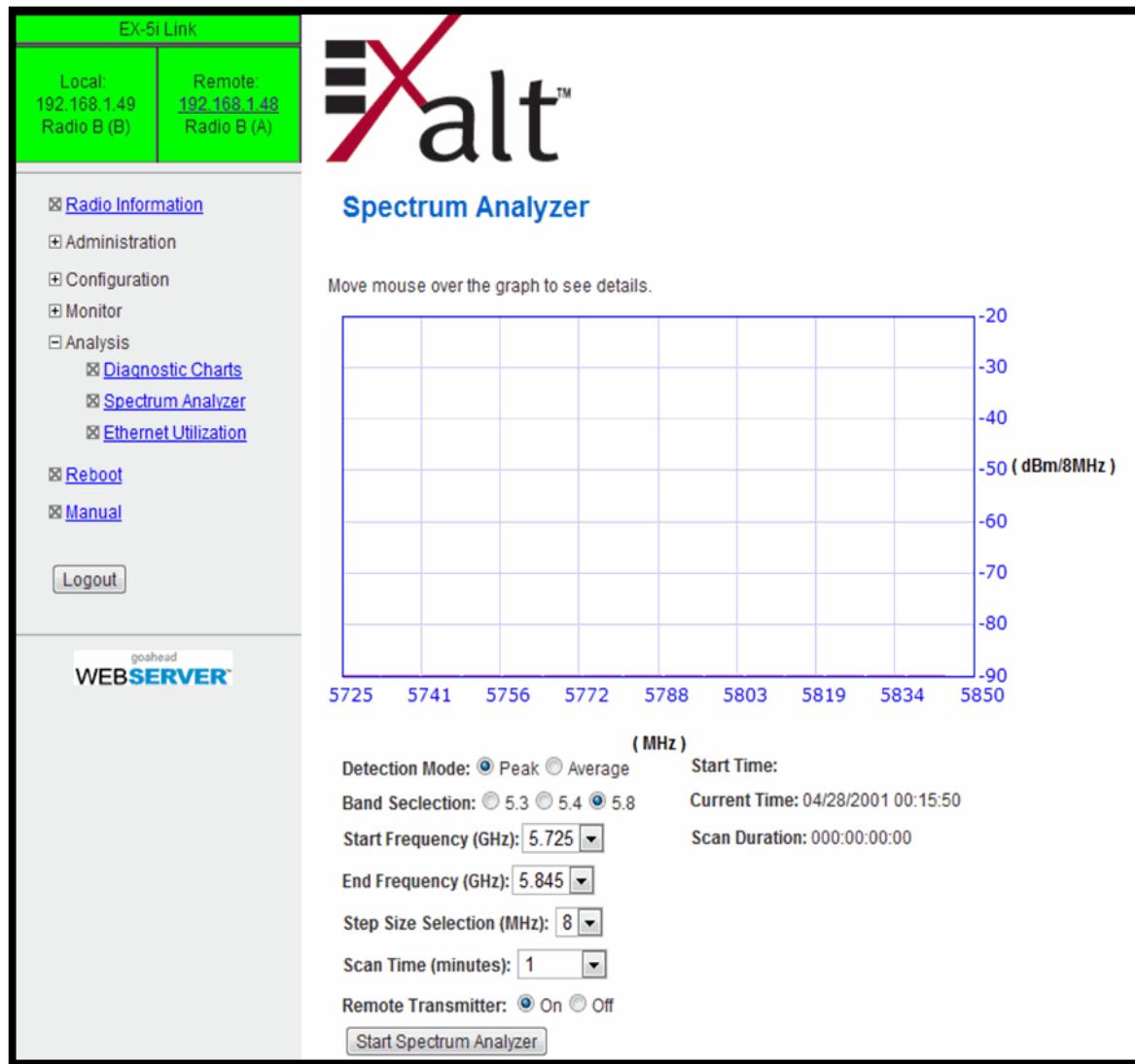


Figure 51 Spectrum Analyzer page

While a professional spectrum analyzer provides higher levels of control and precision for pre-planning, the Spectrum Analyzer page allows evaluation of the RF spectrum as seen at the radio's RF input port prior to deployment. This is useful for pre-planning the center frequency and occupied bandwidth, and to determine polarization and antenna type and mounting locations.

For troubleshooting, enable the spectrum analyzer to scan the desired segment or full band of the frequency range. Select the step size and set the remote radio transmitter ON or OFF. This allows viewing of the *clean* spectrum without the remote transmitter on and a comparison of the remote transmitter in the midst of other signals.



Note: Enabling the spectrum analyzer interrupts all radio traffic for the duration of the analysis. In addition, access to the radio's GUI may also be interrupted, depending on the location of the interfaced computer relative to the radio where the spectrum analysis is occurring. The GUI is available at the completion of the spectrum analysis.

Use the smallest step size to obtain the finest view of the spectrum. The spectrum analyzer can be set to match the start and stop frequency for a *dwell* mode. Peak and average detection modes are also available. Peak detection is helpful for capturing intermittent events such as pulsed emissions.

It is best to set the Scan Time option to a time value as opposed to using the 'infinity' setting. If your management computer is connected to the radio through the radio link, access to the GUI is interrupted during the duration of the analysis.



Note: The result of selecting infinity may be complete loss of contact to that radio and may require a physical visit to the radio location to disable the spectrum analyzer.

The spectrum analyzer graph displays received signals in red, gray, or green (Figure 52), normalized in dBm to the resolution bandwidth of the analyzer. Red indicates the highest level detected during the entire scan. Gray indicates the lowest value seen during the scan. Green indicates the last value measured at that frequency.

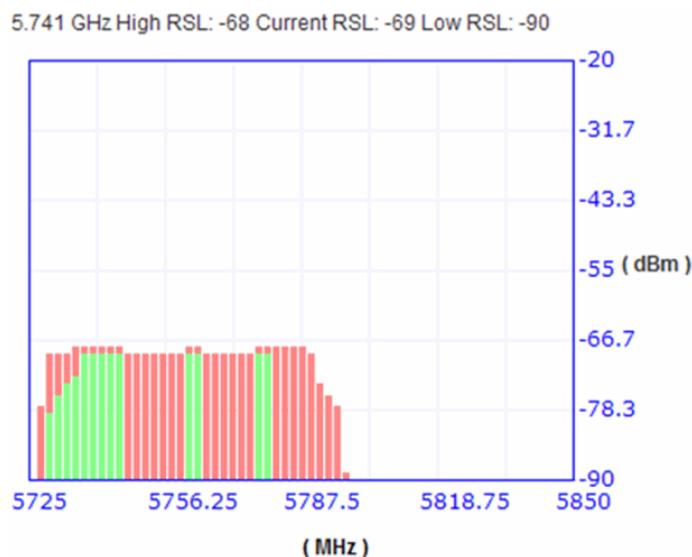


Figure 52 Spectrum analyzer graph example

A completely green vertical box indicates that the signal maintained a steady level for the entire scan or that the last scan measured at a strong or stronger level than the rest of the analysis. A completely red vertical box indicates that there was a signal at some point during the scan, but that the signal was not detected at the last scan. A graph displaying green on the lower part and red at the upper part indicates that at some time during the scan, a signal was detected at a higher level than was detected during the last scan. A gray bar usually has a small green and/or red dot at the top or a green and/or red bar extending above it. The top of a gray bar indicates the lowest value seen during the scan.

The last spectrum analyzer scan performed displays in this page until the radio is rebooted. You can do a screen capture for record keeping and for comparison to future analyses. The time and date of the analysis displays on the page, which is handy as a reference in a screen capture.

Ethernet Utilization Page

This page shows a chart for each Ethernet interface to illustrate inbound and outbound packet utilization. This is shown as a percentage of the interface configuration (that is, if your interface is set for 100BaseT, then 100% represents 100Mbps). Compare offered load (inbound) to delivered load (outbound) to determine if radio capacity is a bottleneck for the data transfer. This chart can illustrate inbound and/or outbound utilization, and uses different colors for data entry. The legend can be hidden.

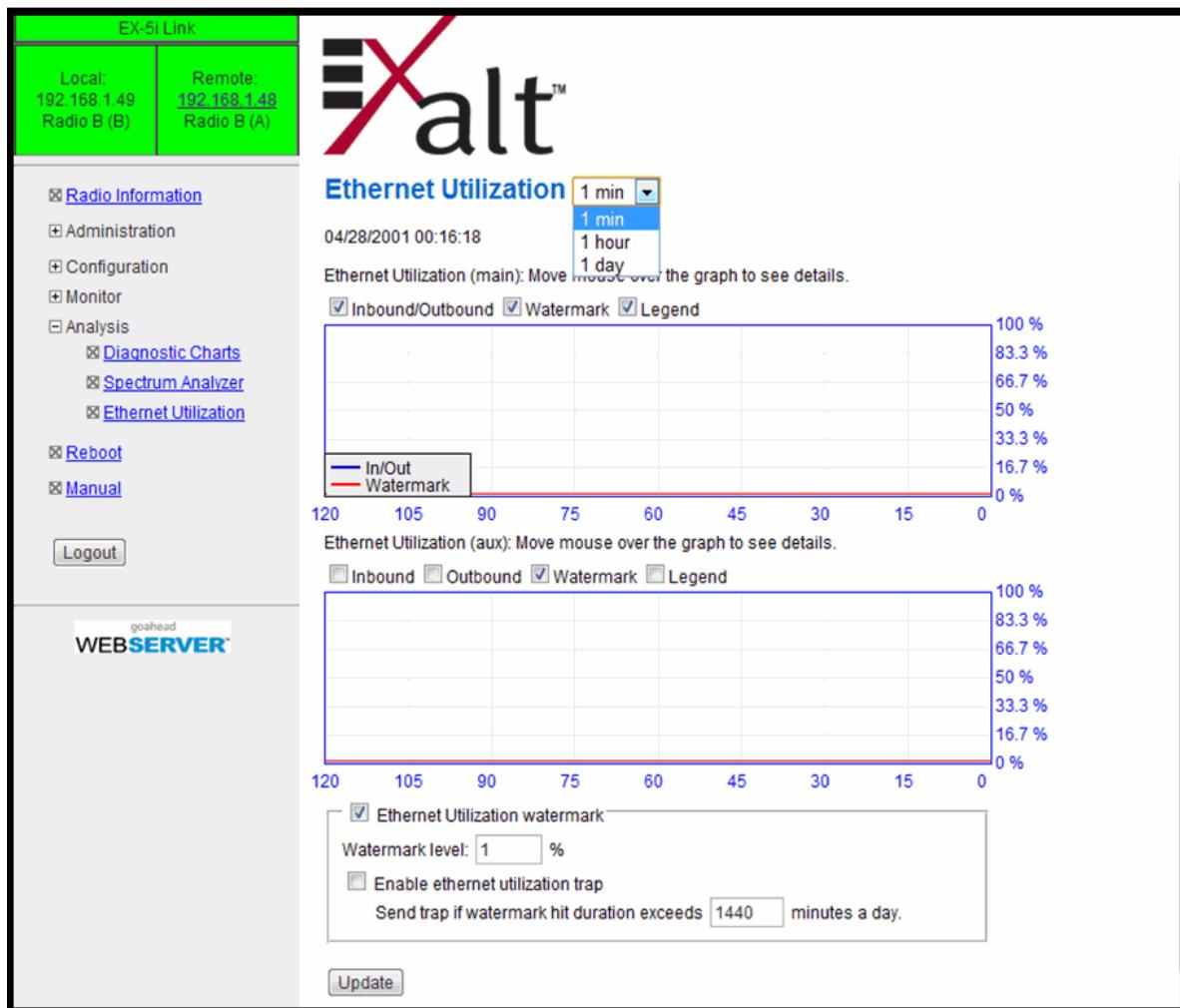


Figure 53 Ethernet Utilization page

Note that outbound utilization never exceeds the rate where a radio is configured. For example, if the radio is configured for a 55 Mbps capacity, outbound utilization will never exceed 55 Mbps at 100BaseT.

The Ethernet Utilization Watermark level function allows administrators to receive an SNMP trap when watermark conditions are exceeded. For example, if a radio is configured for 55 Mbps capacity, the administrator may wish to be warned if the radio exceeds 50 Mbps for more than 1 hour per day. In this case, set the Watermark level to 50% and the trap duration to 60 minutes. Traps must be enabled to activate this function.

When the watermark level function is enabled, a line on the chart appears for data comparison to the watermark.

Reboot Page

Use this page to reboot the radio. The function may never be required, but can be used in emergencies. All configurations that require a reboot automatically reboot on administrator confirmation.

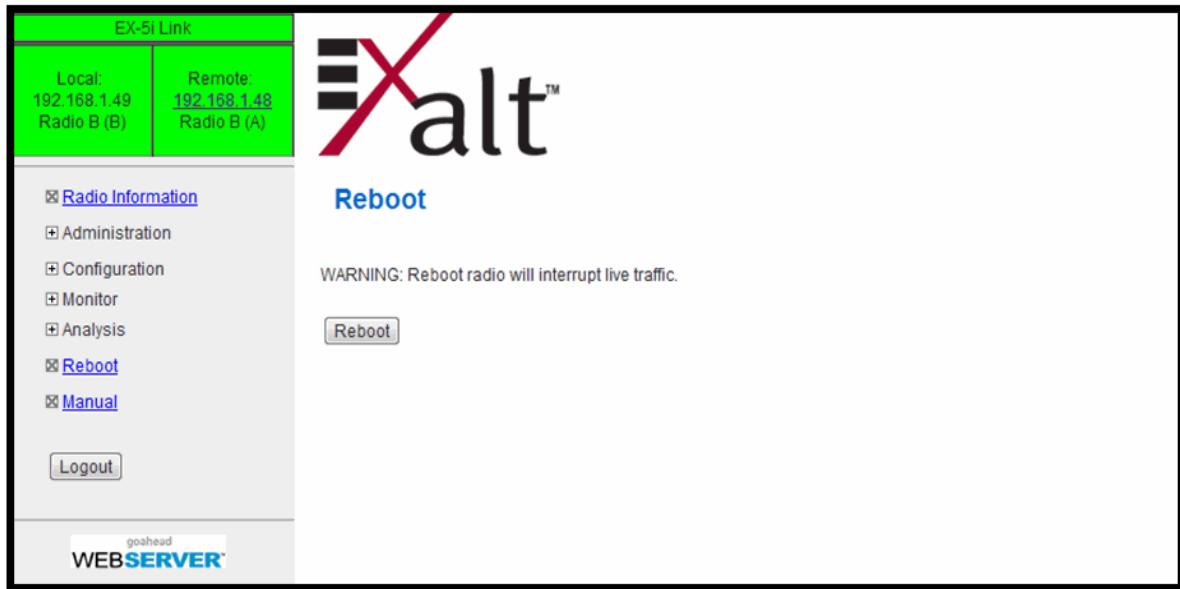


Figure 54 Reboot page

Manual Page

The manual (this document or the version that matches the installed firmware) is available within the GUI. Adobe Acrobat Reader 5.5 or higher is required (go to www.adobe.com to download Acrobat Reader). Click the Manual link to display the manual within the browser window. Once the manual displays, click the save button on the PDF toolbar to download the manual locally.



Figure 55 Manual page

Specifications

This section presents specifications for the i-Series of Digital Microwave Radios.

Physical Specifications

Physical Configuration	Single-piece Indoor Unit (IDU)
Dimensions (HxWxD), (std models)	1RU: 1.75" x 17" x 14" / 4.5 x 43.2 x 35.6 cm
Dimensions (HxWxD), (-16 models)	1.5RU: 2.63" x 17" x 14" / 6.7 x 43.2 x 35.6 cm
Weight (std models)	11.3 lbs/5.1 kg
Weight (-16 models)	12 lbs/5.5kg
Operating Temperature	-13° +149°F / -25° to +65°C
Altitude	15,000'/4.6 km
Humidity	95% non-condensing
Safety	EN 60950-1, IEC 60950-1
EMC	EN 301 489-17 (EX-5i and EX-2.4i series), FCC Part 15, IC Part 15

Common System Specifications

Tuning Resolution	1MHz; 5MHz for EX-4.9i and some regulatory domains															
Power Control Step Size	0.5dB															
Selectable Modulation Modes	Mode 1 (QPSK); Mode 2 (16QAM)															
Selectable Channel Bandwidths	8MHz, 16MHz, 32MHz, 64MHz ^a															
	EX-4.9i and some regulatory domains: 10MHz, 20MHz, 40MHz															
Selectable Frame Lengths (ms)	0.5, 1, 2, 2.5, 4, 5															
Maximum Aggregate User Capacity	<table border="1"><thead><tr><th>Mbps</th><th>Mode 1</th><th>Mode 2</th></tr></thead><tbody><tr><td>8 / 10</td><td>13</td><td>27</td></tr><tr><td>16 / 20MHz</td><td>27</td><td>55</td></tr><tr><td>32/40MHz</td><td>55</td><td>110</td></tr><tr><td>64MHz¹</td><td>110</td><td>216</td></tr></tbody></table>	Mbps	Mode 1	Mode 2	8 / 10	13	27	16 / 20MHz	27	55	32/40MHz	55	110	64MHz ¹	110	216
Mbps	Mode 1	Mode 2														
8 / 10	13	27														
16 / 20MHz	27	55														
32/40MHz	55	110														
64MHz ¹	110	216														
Error Floor	10 ⁻¹²															
Frequency Stability	±7 ppm															
Link Security	96-bit Security Code, optional NIST FIPS-197 compliant 128-bit or 256-bit AES encryption.															

a. Not all bandwidth and mode combinations are available on all radio models. Some radios may require specific software license keys, which can be purchased from your authorized Exalt representative.

EX-2.4i System Specifications

Frequency Band	2400 to 2483.5MHz
Tunable Range	2406 to 2468MHz
Output Power (at full power)	+27dBm (0.5W), Mode 1 +24dBm (0.25W), Mode 2
Output Power (at minimum power)	+7dBm
Selectable Channel Bandwidths	8MHz, 16MHz, 32MHz, 64MHz ^a
Receiver Threshold (BER=10 ⁻⁶)	

dBm	Mode 1	Mode 2
8MHz	-88	-80
16MHz	-85	-77
32MHz	-82	-74
64MHz ¹	-79	-71

Maximum RSL	Mode 1: -25dBm error-free; 0dBm no damage
Non-overlapping channels	8MHz: 8; 16MHz: 4; 32MHz: 2; 64 ¹ : 1
Regulatory Compliance	FCC 15.247; IC RSS-210
FCC ID	TTM-102P40I
IC ID	6254A-102P40I
Emission Designator(s)	

	Mode 1	Mode 2
8MHz	10M2W7D	9M9W7D
16MHz	17M3W7D	19M0W7D
32MHz	34M7W7D	36M0W7D
64MHz*	60M7W7D	61M3W7D

a. 64MHz BW is enabled for the EX-2.4i though a firmware option. 64MHz BW is enabled for the EX-2.4i-16 when the 16xT1/E1 license key is enabled.

EX-4.9i System Specifications

Frequency Band	4940 to 4990 MHz
Tunable Range	4945 to 4985 MHz
Output Power (at full power, Mode 1)	+24dBm (20MHz BW) +22dBm (10MHz BW)
Output Power (at minimum power)	+4dBm
Selectable Channel Bandwidths	10MHz, 20MHz ^a
Receiver Threshold (BER=10 ⁻⁶)	

dBm	Mode 1	Mode 2
10MHz	-86	-78
20MHz	-83	-75 ¹

Maximum RSL	Mode 1: -25dBm error-free; 0dBm no damage
Non-overlapping channels	10MHz: 5; 20MHz: 2
Regulatory Compliance	FCC Part 90; IC RSS-111
FCC ID	TTM-104P90I
IC ID	6254A-104P90I
Emission Designator(s)	

10MHz	8M72W7D
20MHz	19M0W7D

a. Mode 2 for 20MHz BW is enabled through firmware options for the EX-4.9i.

EX-5i System Specifications, 5.3GHz Band

Frequency Band	5250 to 5350 MHz
Tunable Range	5260 to 5332 MHz
Output Power (at full power)	+13dBm (0.02W)
Output Power (at minimum power)	-7dBm
Receiver Threshold (BER=10 ⁻⁶)	

dBm	Mode 1	Mode 2
8/10MHz	-86	-78
16/20MHz	-83	-75
32/40MHz	-80	-72
64MHz ¹	-77	-69

Maximum RSL	Mode 1: -25dBm error-free; 0dBm no damage
Non-overlapping channels	8MHz: 10; 16MHz: 5; 32MHz: 2; 64MHz ^a : 1
Regulatory Compliance	FCC 15.407; IC RSS-210
FCC ID	TTM-105P25M
IC ID	6254A-105P25I
Emission Designator(s)	

8MHz	7M8W7D
16MHz	15M7W7D
32MHz	30M9W7D
64MHz ¹	60M8W7D

a. 64MHz BW is enabled through a firmware option for the EX-5i. 64MHz BW is enabled when the 16xT1/E1 license key is enabled for the EX-5i-16.

EX-5i System Specifications, 5.4GHz Band

Frequency Band	5470 to 5725 MHz
Tunable Range	5488 to 5715 MHz
Output Power (at full power)	+13dBm (0.02W)
Output Power (at minimum power)	-7dBm
Receiver Threshold (BER=10 ⁻⁶)	

dBm	Mode 1	Mode 2
8/10MHz	-86	-78
16/20MHz	-83	-75
32/40MHz	-80	-72
64MHz ¹	-77	-69

Maximum RSL	Mode 1: -25dBm error-free; 0dBm no damage
Non-overlapping channels	8MHz: 29; 16MHz: 14; 32MHz: 7; 64MHz ^a : 3
Regulatory Compliance	FCC 15.407; IC RSS-210
FCC ID:	TTM-105P25M
IC ID:	6254A-105P25I
Emission Designator(s)	

8MHz	8M27W7D
16MHz	16M7W7D
32MHz	33M0W7D
64MHz ¹	65M0W7D

a. 64MHz BW is enabled through a firmware option for the EX-5i. 64MHz BW is enabled when the 16xT1/E1 license key is enabled for the EX-5i-16.

EX-5i System Specifications, 5.8GHz Band

Frequency Band	5725 to 5850 MHz
Tunable Range	5731 to 5844 MHz
Output Power (at full power)	+24dBm (0.25W), Mode 1
	+21dBm (0.13W), Mode 2
Output Power (at minimum power)	+4dBm
Receiver Threshold (BER=10 ⁻⁶)	

(dBm)	Mode 1	Mode 2
8/10MHz	-86	-78
16/20MHz	-83	-75
32MHz	-80	-72
64MHz ¹	-77	-69

Maximum RSL	Mode 1: -25dBm error-free; 0dBm no damage
Non-overlapping channels	8MHz: 15; 16MHz: 7; 32MHz: 3; 64MHz ^a : 1
Regulatory Compliance	FCC 15.407 (b) (4) (ii); IC RSS-210
FCC ID	TTM-105P25M
IC ID	6254A-105P25I
Emission Designator(s)	

8MHz	8M4W7D
16MHz	16M7W7D
32MHz	33M1W7D
64MHz ¹	64M5W7D

a. 64MHz BW is enabled through a firmware option for the EX-5i. 64MHz BW is enabled when the 16xT1/E1 license key is enabled for the EX-5i-16.

Interfaces

RF

Connector	N-type female
Impedance	50 Ohms

T1/E1 (x4 or x16)

Connector	RJ-45 (RJ48C), female
T1 Impedance	100 Ohms, balanced
T1 Line Codes	AMI, B8ZS, selectable
T1 LBO Settings (in ft.)	0-133, 133-266, 266-399, 399-533, 533-655
T1 Clocking Speed	1.544 Mbps
T1 Compliance	ANSI T1.102-1987; ITU-T; G.823; GR-49T-CORE
E1 Impedance	120 Ohms, balanced
E1 Line Codes	HDB3
E1 Clocking Speed	2.048 Mbps
E1 Compliance	CEPT-1; G.703; ITU-T-G703

DS3

Connector	BNC, female (x2, In/Out)
DS3 Impedance	75 Ohms, unbalanced
DS3 Line Code	B3ZS
DS3 LBO Settings (in ft.)	0-133, 133-266, 266-399, 399-533, 533-655
DS3 Clocking Speed	44.736 Mbps
DS3 Compliance	ANSI T1.102-1993; GR-499-CORE

Ethernet (x2)

Connectors	RJ-45, female, auto-MDIX
Interface Speed	10 or 100 Mbps
Duplex	Half, full, auto, selectable
Compliance	802.3

Console (Serial)

Connector	9-pin sub-D, female
Interface Speed	9600 bps
Compliance	EIA-574 DTE (RS-232)

Alarm

Connector	9-pin sub-D, female
Inputs	(2) TTL/Closure
Outputs	(2) Relay (Form C)

Sync (In and Out)

Connector	RJ45, female
Signal	1 pps (GPS)

Power

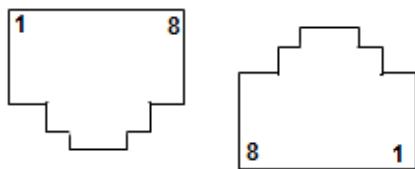
Connector	6-pin barrier strip
Input Voltage (EX-2.4i)	40–60VDC (most EX-2.4i radios conform to the same power as EX-5i below, the front panel of the radio indicates the proper input per the manufacturing date of the radio)
Consumption (EX-2.4i)	<34W (0.7A @ 48V)
Input Voltage (EX-5i and EX-4.9i)	20–60VDC
Consumption (EX-5i and EX-4.9i)	<38.5W (0.8A @ 48V; 1.6A @ 24V)
Input Voltage (-16 models and DS3 models)	20–60VDC
Consumption (-16 models and DS3 models)	<45W (0.9A @ 48V; 1.8A @ 24V)

Interface Connections

This section provides the pin number assignment and wiring information for the connectors on the i-Series radios. All connectors are shown as viewed from the radio front panel.

T1/E1 Connections

There are two orientations of T1/E1 connections. Channels 1 and 2 have the securing tab towards the top of the connector while Channels 3 and 4 have the securing tab towards the bottom of the connector. Figure 56 illustrates the pin orientation and functionality of these connectors.

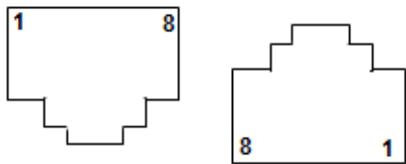


Pin	Function
1	Tip Out (from radio)
2	Ring Out (from radio)
3	Ground
4	Tip In (to radio)
5	Ring In (to radio)
6	Ground
7	Unused
8	Unused

Figure 56 T1/E1 connectors

Ethernet Connections

There are two orientations of Ethernet connections. AUX has the securing tab towards the top of the connector while MAIN has the securing tab towards the bottom of the connector. Figure 57 illustrates the pin orientation and functionality of these connectors.



Pin	Function
1	Paired with Pin 2
2	Paired with Pin 1
3	Paired with Pin 6
4	Unused
5	Unused
6	Paired with Pin 3
7	Unused
8	Unused

Figure 57 Ethernet connectors (MAIN and AUX)

The Ethernet connections implement Auto-MDIX, and therefore either ‘straight’ or ‘crossover’ Ethernet cables can be used, independent of the wiring of the connected device.

Depending on the settings of in-band or out-of-band NMS, both the MAIN and AUX ports can access the far-end radio (if in-band) or not (out-of-band). In the case of out-of-band setting, only the AUX port can access the GUI, while only the MAIN port carries Ethernet traffic across the link.

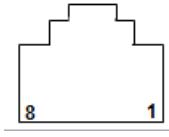
Sync Connections

There are two sync connectors: Sync In and Sync Out. The Sync In connector is normally connected to a (custom) GPS antenna system, or to the Sync Out connector of a collocated radio.



Pin	Function
1	+5V Power Out (to GPS antenna)
2	Ground
3	Tx Data (to GPS antenna)
4	Enable (to GPS antenna)
5	Rx Data (from GPS antenna)
6	1 pps Timing Signal (from GPS antenna)
7	Unused
8	Unused

Figure 58 Sync In connector



Pin	Function
1	+5V Power In (from connected radio)
2	Ground
3	Tx Data (to connected radio)
4	Unused
5	Rx Data (from connected radio)
6	1 pps Timing Signal (to connected radio)
7	Unused
8	Unused

Figure 59 Sync Out connector

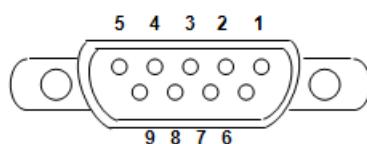
For **internal sync**, connect pins 2 and 6 and cross over pins 3 and 5.

For **GPS** connections, the interconnection cable between radios must cross over pins 3 and 5, with all other pins wired straight through.

All configurations do not require connections on pins 4, 7, and 8.

Alarm Connector

The Alarm connector provides two alarm outputs that can be connected to external alarm collection equipment. The connector also allows connection of up to two external alarm sources, where the radio will report the status of these connections through the radio network management. Output alarm connections are 'Form C' style connections, performing alarm logic based on either Normally Opened (NO) or Normally Closed (NC) connections compared to a Common (C) pin. Input alarm connections can be TTL logic or NO/NC style relay closures.



Pin	Function
1	Alarm Output 1 - NC
2	Alarm Output 1 - NO
3	Ground (for Alarm Inputs)
4	Alarm Output 2 - NC
5	Alarm Output 2 - NO
6	Alarm Output 1 – Common
7	Alarm Input 1
8	Alarm Input 2
9	Alarm Output 2 – Common

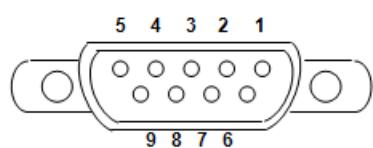
Figure 60 Alarm Connector

Alarm Output 1 is in alarm any time that there is a traffic-impacting alarm condition (Major). Alarm Output 2 is in alarm any time that there is an alarm that is not traffic-impacting (Minor).

The administrator can set the polarity of the alarm inputs.

Console Connector

The Console connector provides a serial interface for the Command Line Interface (CLI) functions. Typically, a straight-through serial cable is used between a computer's serial port and the Console connector.

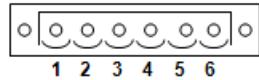


Pin	Function
1	Unused
2	Tx (from radio)
3	Rx (into radio)
4	Unused
5	Ground
6	Unused
7	Unused
8	Unused
9	Unused

Figure 61 Console Connector

DC Power Connector

The nominal voltage of the DC connector is 48V for the EX-2.4i, all other i-Series radios accept either 24VDC or 48VDC input.



Pin	Function
1	Power Return (-)
2	Ground
3	Power (+)
4	Power (+)
5	Ground
6	Power Return (-)

Figure 62 DC Power connector

DIP Switch Settings (-16 Models Only)



Note: Models with the Access Security management feature ignore DIP switch configurations after any reset. See the [Access Security Page](#).

The ‘-16’ models incorporate a front panel DIP switch. Use the DIP switch for emergency configuration or restoration for installations where there is no computer available for complete radio configuration. Only use the DIP switch for temporary purposes, for the purpose of a bench test or antenna alignment. Use the Exalt GUI for complete system configuration, as required before final system deployment.

The DIP switch is only read when the critical factory reset procedure is implemented (see [Reset to Critical Factory Settings](#)). That is, when the RMT button is pressed and held during power up, and held through the boot cycle (approximately 45 seconds, until LED behavior stabilizes). If changes are made while the radio is already powered or when power is not applied, the changes are not executed until a reset is executed.

depicts DIP switch positions 1 through 8, left to right, when facing the front panel. Also, the switch is considered in the ‘One’ position when it is toggled upward, and in the ‘Zero’ position when it is toggled downward (default).

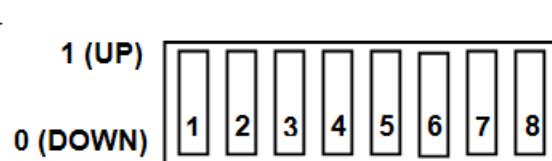


Figure 63 DIP Switch Orientation

Figure 7 describes the function of each switch when placed in either position.

Table 7 DIP Switch Functions

Switch	0 (DOWN)	1 (UP)
Position 1	Ignore all DIP switch positions	If RMT button is held during boot cycle (reset to critical factory defaults procedure), reset to factory defaults, except IP address and password information, and make changes as described in this table.
Position 2	Radio B	Radio A
Position 3*	TDM circuits = T1	TDM circuits = E1
Position 4	Standard factory defaults	Standard factory defaults, except <50miles link distance and full transmit power.
Positions 5–8	Unused	Unused

Figure 8 provides the standard factory defaults for the ‘-16’ models.

Table 8 Standard Factory Defaults (-16 Models)

Parameter	EX-2.4i-16	EX-5i-16
Frequency	2441 MHz	5788 MHz
Transmit Power	+7 dBm	+4dBm

Table 8 Standard Factory Defaults (-16 Models) (Continued)

Parameter	EX-2.4i-16	EX-5i-16
Link Distance	<10 miles	
Bandwidth	8 MHz	
Mode	Mode 1	
TDD Frame Size	2ms	
Ethernet Interfaces	Enabled, 100/Full	
AUX port NMS Access	In-Band	
T1/E1 Settings	All Enabled, T1, B8ZS, AIS	

There are several scenarios for using the DIP switches. Figure 9 describes common configurations and related applications.

Table 9 Common DIP Switch Applications

Application	Switch Positions	Comments
Reset all critical factory defaults	0xxxxxxx	If the IP address and/or passwords are forgotten or lost, use this setting and execute the critical reset procedure (RMT button held through boot cycle).
Reset complete factory defaults except for IP information and passwords	1x00xxxx	If the IP address and/or passwords are already reset or are known but the configuration of the radio parameters is unknown, use this setting to restore all parameters to factory defaults. Execute the critical reset procedure with these settings. If trying to establish a link, configure one radio as Radio A, the other as Radio B using position 2.
Configure the radio as Radio A while resetting.	11xxxxxx	Choose the desired reset function using position 4. Reset one radio as Radio A with position 2 up, so that a link can be established.
Change TDM interfaces to E1	1x1xxxxx	Choose the desired reset function using position 4. Reset both radios with position 3 up to configure E1 at each end. One radio must be Radio B, and the other Radio A (using position 2).
Configure for ideal antenna alignment configuration	1xx1xxxx	Reset the radio with position 4 up to configure for the best setting to optimize antenna alignment. One radio must be configured as Radio A, the other as Radio B (using position 2).

Antennas

The following tables list antennas recommended for use with the EX-2.4i Series and EX-5i Series radios. The EX-4.9i may use any antenna. In some countries, antennas exceeding a certain level of gain may be unlawful. Refer to [RF Output Power Setting](#) for details on regulatory limits.

Table 10 EX-2.4i supported antennas

Manufacturer	Model #	Description	Mid-band Gain (dBi)	3dB (Azimuth/Elevation) Beamwidth (degrees)
Andrew	19T-2440-1	16-inch Solid Parabolic Dish	19	16/17
Andrew	21T-2441-1	24-inch Solid Parabolic Dish	21	10/11
Andrew	18T-2400-1	Semi-parabolic Grid	17	14/13
Andrew	26T-2400-1	Semi-parabolic Grid	23	7.5/10
Andrew	P2F-23	2-foot Solid Parabolic Dish	21.6	12/13.3
Andrew	P4F-23	4-foot Solid Parabolic Dish	27.3	6.9
Andrew	KP3F-23	3-foot Grid Parabolic Dish	25.1	8.1
Andrew	KP4F-23	4-foot Grid Parabolic Dish	27.5	6.9
Andrew	KPR3F-23	2-foot Grid Parabolic Dish	23.6	7.9/8.7
Andrew	KPR4F-23	4-foot Grid Parabolic Dish	27.3	6.2/6.7
Andrew	QD-2402	11-inch Panel	16	27
Gabriel	DFPS.5-23	6-inch Panel	10.3	35/53
Gabriel	DFPS1-23	1-foot Panel	16.5	36
Gabriel	P-24A36	3-foot Grid Parabolic Dish	25.7	8.4
Gabriel	P-24A48	4-foot Grid Parabolic Dish	27.7	6.5
Gabriel	SSP2-23	2-foot Solid Parabolic Dish	20.7	14.5
Gabriel	SSP4-23	4-foot Solid Parabolic Dish	26.7	7.2
Gabriel	SSP6-23	6-foot Solid Parabolic Dish	30.3	4.8
Gabriel	HSSP2-23	2-foot Solid HP Parabolic Dish	20.5	14.5
Gabriel	HSSP4-23	4-foot Solid HP Parabolic Dish	26.3	7.2
Gabriel	HSSP6-23	6-foot Solid HP Parabolic Dish	30.0	4.8
RadioWaves	SP1-2.4	1-foot Solid Parabolic Dish	14	28
RadioWaves	SP2-2.4	2-foot Solid Parabolic Dish	21.3	14
RadioWaves	SP3-2.4	3-foot Solid Parabolic Dish	24.3	9.5
RadioWaves	SP4-2.4	4-foot Solid Parabolic Dish	27.2	7.3
RadioWaves	SP6-2.4	6-foot Solid Parabolic Dish	30.3	4.8
RadioWaves	G3-2.4	3-foot Grid Parabolic Dish	24.5	9.2
RadioWaves	G4-2.4	4-foot Grid Parabolic Dish	27	7.1
RadioWaves	G6-2.4	6-foot Grid Parabolic Dish	30.3	4.6
RFS	MGAR2-23	2-foot Grid Parabolic Dish	20.8	13.7
RFS	MGAR3-23	3-foot Grid Parabolic Dish	24.2	8.6
RFS	MGAR4-23	4-foot Grid Parabolic Dish	27.2	7
RFS	SPF2-23	2-foot Solid Parabolic Dish	20.5	13.8
RFS	SPF3-23	3-foot Solid Parabolic Dish	24.2	9.2
RFS	SPF4-23	4-foot Solid Parabolic Dish	27.1	6.9

Table 11 lists antennas supported by the EX-5i family of Digital Microwave Radios.

Table 11 EX-5i supported antennas

Manufacturer	Model #	Description	Mid-band Gain dBi (mid-band)	3dB (Azimuth/Elevation) Beamwidth (degrees)
Andrew	P2F-52-N	2-foot Dish	29.4	5.4
Andrew	P3F-52-N	3-foot Dish	33.4	3.8
Andrew	P4F-52-NXA	4-foot Dish	34.9	3.0
Andrew	P6F-52-NXA	6-foot Dish	37.6	1.8
Andrew	HP2F-52-NPA	2-foot HP Dish	29.0	5.4
Andrew	HP3F-52-NPA	3-foot HP Dish	33.0	3.8
Andrew	HP4F-52-NPA	4-foot HP Dish	34.5	3.0
Andrew	HP6F-52-NPA	6-foot HP Dish	37.2	1.8
Andrew	FPA5250D12-N	1-foot Panel	23.6	9.6
Gabriel	DFPD1-52	1-foot Panel	23.5	9.4
Gabriel	DFPD2-52	2-foot Panel	28.0	4.6
Gabriel	QF2-52-N	2-foot Dish	28.5	5.6
Gabriel	QF2.5-52-N	2.5-foot Dish	31.2	4.4
Gabriel	QF4-52-N	4-foot Dish	34.8	2.7
Gabriel	QF6-52N	6-foot Dish	37.8	1.9
Gabriel	HQF2-52-N	2-foot HP Dish	28.2	5.7
Gabriel	HQF4-52-N	4-foot HP Dish	34.4	2.8
Gabriel	HQF6-52-N	6-foot HP Dish	37.4	1.9
MTI	MT-486004	18-inch Panel	26.0	6.0
MTI	MT-486001	2-foot Panel	28.0	4.5
Radio Waves	FP1-5-24	1-foot Panel	23.8	10.0
Radio Waves	FP2-5-28	2-foot Panel	28.0	4.5
Radio Waves	SP2-5.2	2-foot Dish	29.0	6.1
Radio Waves	HP2-5.2	2-foot HP Dish	28.6	6.1
Radio Waves	SP3-5.2	3-foot Dish	32.0	4.0
Radio Waves	SP4-5.2	4-foot Dish	34.8	3.0
Radio Waves	SP6-5.2	6-foot Dish	37.9	2.0
RFS	SPF2-52A	2-foot Dish	27.9	6.2
RFS	SPF3-52A	3-foot Dish	31.4	4.2
RFS	SPF4-52A	4-foot Dish	33.9	3.1
RFS	SPF6-52A	6-foot Dish	37.4	2.1
RFS	SDF4-52A	4-foot HP Dish	33.9	3.1
RFS	SDF6-52A	6-foot HP Dish	37.4	2.1
RFS	MA0528-28AN	2-foot Panel	28.0	4.5

DC Coupler for Antenna Alignment

One challenge associated with an all-indoor radio construction is the alignment of the antennas. It can sometimes be challenging to place the radio near the antenna alignment personnel, and can also be challenging to run a separate set of wires for the voltmeter to be in view of the alignment personnel. If any of the conventional methods mentioned in the manual are difficult to achieve, one of the simplest methods to use is to employ the use of a DC coupling system as a temporary test configuration exclusively for the purpose of aligning the antennas.

This type of system simply couples the DC voltage associated with RSL measurement at the radio location, over the RF transmission line, up to the antenna port.



Warning! Remove all DC-blocked lightning arrestors in the transmission system prior to applying the DC coupler system. Failure to do so can result in electric shock and/or damage to the lightning arrestors and/or other equipment.

Required Items

The following items are needed for the DC coupling system, per radio end (double the quantities of these items for a complete link for simultaneous use at both ends):

- 2ea DC couplers: mini-circuits ZNBT-60-1W
- 1ea BNC male-male extension cable: Pomona 2249
- 1ea BNC female-to-mini Bantam (stackable Pin-tip plugs): Pomona 3221
- 1ea BNC female-to-banana male: Pomona 5268¹
- 1ea digital volt meter

Interconnections

Connect the items as shown in Figure 64. For the coupler installation, ensure that the DC side of the coupler is facing away from the radio and away from the antenna – towards the RF transmission line system. Using the BNC adapters and cables, attach the radio end DC coupler to the RSL port on the radio, and the antenna end DC coupler to the DVM that the antenna alignment personnel will use.

The DC voltage from the RSL port is now coupled to the transmission line system between the radio and the antenna, and is available at the antenna location. This allows the antenna alignment personnel to view the DVM output directly while adjusting the antenna.

1. This type of plug is typical for most professional hand-held digital volt meters (DVMs). However, verify that your DVM can accept this type of Bantam connector. If not, a different part number or adapter may be required to connect to the DVM.

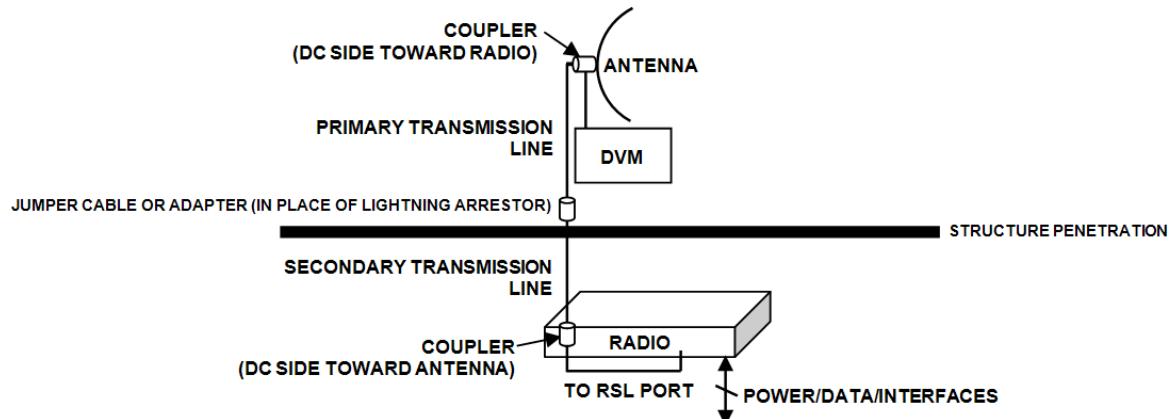


Figure 64 DC coupler interconnection



Note: After completing antenna alignment, remove the DC couplers and associated wiring at both radio and antenna ends.

Troubleshooting

This section provides information regarding troubleshooting of common issues and alarms on these radios. Exalt Digital Microwave Radio systems are designed by Exalt's expert engineers with extensive experience through multiple generations of microwave radio design. These new-generation systems contain extensive diagnostic tools, alarm indications, and troubleshooting aids. And, as compared to other systems in their class, are easier to install, maintain, and troubleshoot. The GUI provides information to aid in troubleshooting (see [Diagnostic Charts Page](#)).

Contact Exalt Customer Care for further assistance with issues with your Exalt radio and with suggestions on how the radio and documentation can be improved.

General Practices

Troubleshooting a microwave radio link can be a complex task. Approach troubleshooting as a process of elimination, and first determine which portions of the system are operating properly.

In a vast majority of cases, failures or poor performance of microwave links is attributed to something other than the microwave radio hardware. In this respect, the back-to-back bench test (see [Back-to-back Bench Testing](#)) is very important to determine if radio hardware is operating properly and eliminate many variables in the troubleshooting process.

If a back-to-back bench test fails, then the radio hardware is either broken or the radios are improperly configured. Upgrade the radio to the most current release of firmware, and/or reset the radio to its critical factory settings, following the quick start guide instructions and those in [Configuration and Management](#), helps to confirm if configuration issues cause failure. The most common issues with microwave radio links are:

- An improperly terminated RF cable
- Multipath propagation
- RF interference
- Path obstruction
- Misaligned antenna
- Faulty antenna
- Improper grounding
- Insufficient link margin in the design/implementation
- Moisture in the transmission system (antenna feed and/or RF cable)

If the radio link has been operating without issues and is exhibiting new poor performance behavior or becomes completely inoperative, the troubleshooting process should pay close attention to any conditions that may have changed between the time when the system was working without issue and the time when the issues started.

Also, it can be helpful to compare some performance parameters of the system before and after the presence of issues. Often the source of the issues can be determined by thoughtful consideration of changes, such as:

- Changes in weather, including high winds
- Changes made to the radio equipment, transmission system, or connected equipment
- New radio systems or electronic equipment the nearby radio or transmission system

- New construction nearby either end of the link, or along the path
- Tree growth, flooded fields, or changes in rivers/lakes along the path

Verify that configurations are set as follows:

- RF matches at each end of the link
- Bandwidth matches at each end of the link
- Link distance matches at each end of the link
- TDD Frame Length matches at each end of the link
- Endpoint Identifier is different at each end of the link (one end Radio A, one end Radio B)
- Ethernet interfaces are enabled, as desired
- AUX Ethernet is set for in-band or out-of-band NMS, as desired
- T1/E1 enabling matches at each end of the link
- Link security key matches at each end of the link

Also, in the design phase determine the optimum setting for the Bandwidth and TDD Frame Length parameters for the given link distance, and provides guidance to the expected RF link performance, as well as throughput, latency, and number of supported T1/E1 circuits.

Typical Indications of Issues

In many cases, microwave radio users do not notice changes or degradation to the radio system until the radio system fails completely or becomes highly errored or significantly intermittent. However, regular management of the radio system can help indicate changes in performance that have not yet impacted user performance, but may impact performance at a later date if left unchecked or unaddressed. The administrator can use this as an opportunity to be proactive and monitor the radio link performance regularly, watching for unexplained or unexpected changes in performance and trends in performance changes.

Most importantly, monitoring radio system RSL over time indicates the performance of the radio system. Address any long-term drop in RSL and erratic or unsteady RSL. Some RSL changes are expected and weather patterns and the related multipath can cause dramatic RSL changes resulting in system outage. However, that outage should not occur at a significantly greater rate than the designed long-term performance. Consult the path design engineer for more information about link reliability expectations and anticipated RSL deviation.

In addition, regular inspection of the transmission system (RF cables and antennas) and paying close attention to changes along the path, such as construction or tree height, or new microwave radio installations nearby, can be extremely helpful and proactive.

When link performance is very poor, alarms on the radio front panel and within the radio's management system indicates particular failures. Consult this manual for more information on the specific alarms and diagnostics, or contact Exalt Customer Care for assistance.

Exalt Customer Care is primarily motivated to determine if the radio hardware is faulty and require return for repair, and to help execute an effective and efficient repair and return process for radio terminals believed to be faulty. However, Exalt Customer Care provides advice regarding the total radio system and RF path engineering and environment, and advises on troubleshooting.

End users should first contact the installer and/or designer of the system. In many cases, an in-depth understanding of RF design is required, and on-site analysis and special test equipment, may be

necessary. Compared to phone support from Exalt Customer Care, troubleshooting is much more expeditious if the professional installer and/or link designer examines the system and reviews the management information in the GUI. In turn, if the professional installer and/or link designer contacts Exalt Customer Care, the process to rectify the system is much more expedient due to the in-depth knowledge related to the implementation and the RF environment.

Improper RF Cable Termination

Improper RF cable termination is a very common problem. In many cases, this is a problem that occurs during installation and is not a problem that suddenly appears. However, if cables are moved or flexed, especially near the termination points, and radio errors, changes in RSL, or other performance issues occur, this is a certain sign of this issue.

Another relatively easy method to test for this condition is to decrease the output power of the radio system (at each end, one end at a time). A poor RF cable termination may be reflecting too much RF energy back into the radio system, and reducing output power reduces the reflected energy at a faster rate than the transmitted energy towards the far end. Be careful not to reduce the output power to the point where the radio's threshold is reached. Typically, a reduction of just 3 to 6dB is enough to determine if this is the issue. If the reduction of output power clears the error condition, this is the likely cause.

Use a reflectometer or meter that can read VSWR at the operating frequency to identify poor terminations as well as poor antenna feeds.



Note: The Praxsym VSWR meter is an excellent tool for this purpose.

Multipath Propagation

Multipath propagation is a term that encompasses changes to the RF path, such as reflections and/or refraction, causing partial or complete destruction of the radio signal, and thus excessive bit errors and/or system outages.

Rapid changes in temperature, inversion layers, humidity, air pressure, water evaporation, as well as standing water or moisture on objects along the path are all examples of changes that can cause multipath propagation. New building construction near either end of the path or along the path can cause new reflection characteristics.

If your system has been operating without issue and is suddenly experiencing issues that are symptomatic of a certain time of day or related to change in climatic events or some of the external factors listed above, this is likely the cause. Consult a professional RF path engineer in these cases. Often, minor repositioning of the antennas at either or both ends can reduce or eliminate these problems.

RF Interference

RF interference is usually indicative of another radio system nearby either end of your radio system or aimed towards one or both ends of your radio system – usually at or near the same frequency and usually with a similar signal level.

Other forms of RF interference also exist, such as electronic equipment placed close to the radio chassis or transmitters that couple onto the cabling or grounding system of the radio. Microwave ovens and wireless communication devices used near the equipment or cabling are examples of electronic equipment interference.



Note: Exalt Digital Microwave Radios operate in license-exempt bands. Microwave ovens, wireless Internet devices and cordless phone technology may also use this frequency band. It may be necessary to separate the radio chassis, cabling system and antenna from these devices.

RF interference, like most other causes of problems, is indicated by significant bit errors and/or system outages.

One means to determine presence of interference is the use of a spectrum analyzer that covers the same range as the radio system. A professional RF engineer can use a spectrum analyzer to locate sources of interference, measure these sources, and determine potential remedies to take to operate in the presence of interference.

If a spectrum analyzer is not available, the radio's RSL port can help determine RSL levels of interfering signals. By turning the far-end radio off, the residual RSL measured by the radio indicates the level of interference seen by the radio. It is possible that interference levels below that which can be measured still have an impact on the radio system – especially if the radio system has low fade margin or is using a high order modulation.

Exalt Digital Microwave Radios provides considerable flexibility to tune to different frequencies across the bands within which they operate. This is the easiest method to use to try to avoid existing interference. In addition, the occupied bandwidth of the radio can be reduced. This, along with re-tuning, can be very effective, however throughput is reduced.

Repositioning the antenna and/or changing polarization, or upgrading the antenna to a higher gain, and/or using a high-performance antenna, are all secondary means that can be used. It may be necessary to perform combinations of both radio changes (retuning, occupied bandwidth reduction) and antenna system changes (position, polarization, upgrade).

The EX-4.9i radio operates under licensed regulations. If interference is suspected, the local frequency coordination organization, or other users of the spectrum should be consulted before re-tuning the radio to a different frequency channel.

Path Obstruction

A path obstruction is defined as an object, such as a building or tree, impeding the proper path of the radio system. If the system design was proper at the time of installation and issues arise at a later date, an updated path profile and survey may be necessary to identify changes in path clearance.

Misaligned Antenna

At the time of initial installation, it is critical that the antennas at each end are properly aligned and that the designed RSL is achieved. However, antennas may become misaligned due to high winds, changes in the guy-wiring systems keeping the antenna mast stable, or loosening of the antenna mounting hardware. A reduction in the RSL of the link is symptomatic of this condition, but this condition is not the only condition that results in a reduction of RSL. However, if conditions occur where the antenna alignment may be suspected, the mechanics must be inspected and the antennas realigned.

Faulty Antenna

A faulty antenna is rare, but is still a possibility. In some cases, the mechanics of the antenna feed can get moisture inside, or a bad or weak connection in the pin and connector structure of the antenna may occur. A VSWR measurement of the antenna connection can be made to verify this condition.

Improper Grounding

In addition to being a potential human safety issue, improper system grounding is a somewhat common condition that can cause continuous bit errors or bit errors when metal objects come in contact with the radio, transmission system, or racking system. If touching the radio causes errors, grounding is the cause. It can be difficult to identify grounding problems, but a professional electrician can normally inspect a system and identify if there are deficiencies in the grounding system.

Insufficient Link Margin

Ideally, the link was designed with enough link margin (fade margin) to allow for multipath propagation and atmospheric fading and still remain reliable. In some cases, link margin is compromised by economic factors, such as using low-cost RF cabling or lower-cost antennas that have less gain or deficient performance compared to higher cost transmission system components. In some cases, there may be antenna size restrictions that forced the design to not have the desired amount of link margin.

If the link was designed with poor link margin, there are likely many cases of bit errors and outages. The antenna system and transmission line can be upgraded to help reduce this. If the link design was installed with sufficient margin, but RSL is reduced, the remaining link margin may no longer be enough to maintain a reliable link. The causes of RSL reduction were previously described, but are usually due to new path obstruction(s) or antenna misalignment due to wind or mechanical factors. The antenna height or location can be changed to overcome new obstructions. Realignment of the antenna, and/or improvement to mechanical structures can help overcome antenna misalignment.

Moisture in the Transmission System

If the connectors on cables and antennas and egress junctions are not properly weatherproofed, moisture can get into the transmission system and cause significant error conditions and erratic performance. In many cases, the transmission system must be replaced. A VSWR meter is one means to identify such issues. Conduct physical inspections often. If changes to the weatherproofing (such as cracking) are noticed, replace the weatherproofing before leakage occurs.

Back-to-back Bench Testing

Use back-to-back bench testing to test the radio before installation, pre-configure the radio and connected equipment before installation, or in the troubleshooting process to identify if the radio hardware is the source of a system issue. It is a critical process, and often required or highly desirable for any installation or troubleshooting exercise. This section describes how to properly configure the radio hardware and accessories for a proper back-to-back bench test.

For radio testing, there are two types of back-to-back configurations:

- 1 Basic test (test general operation)
- 2 Specification performance verification

Basic Test

The basic test is a simple test of radio functionality. It verifies that the radios are properly configured to communicate to one another, and verifies general radio performance as operational.

For the basic test, the following items are needed:

- Radio pair
- Powering source
- RF interconnect cable(s) (any length – short is best)
- Fixed or variable attenuation, between 60 and 90dB (note: attenuation for basic test does not to be calibrated or precise)
- Computer/terminal with either serial or Ethernet port

Connect the items as follows:

- 1 Connect attenuation and (known-good) RF cable(s) between radio pair, shown in Figure 65.
- 2 Configure one radio as Radio A; the other as Radio B
- 3 Power on radio pair

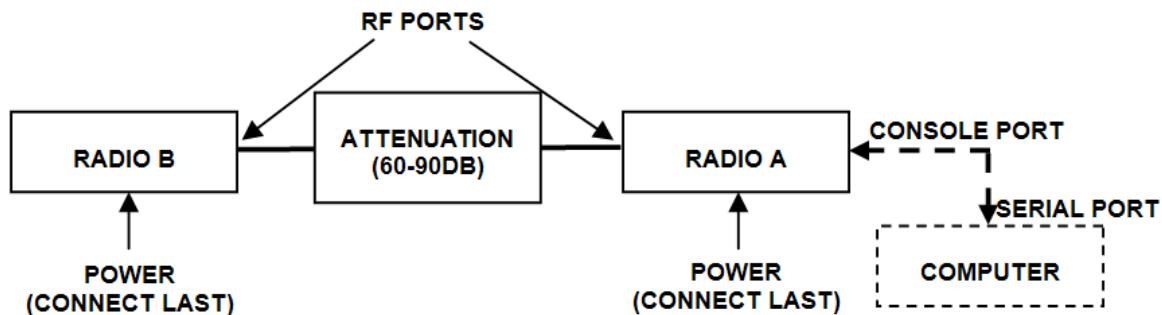


Figure 65 Basic back-to-back bench test configuration

After connecting and powering on, observe the front panel LEDs to verify that the LINK and STATUS LEDs are green. If so, the radios are communicating and all radio-related alarm conditions are normal.

It can be beneficial to have a computer to verify configuration in case of red LEDs or to pre-configure the radio as desired for operation. Follow the instructions in [Configuration and Management](#).

Specification Performance Verification

The specification performance verification is a more detailed test that allows you to verify that the radio's output power and threshold specifications are being met. This is typically a test that would only be performed in a troubleshooting scenario, but can be performed before installation to provide a detailed record or ensure radio performance before installation.

This test is identical to the basic test, but in place of the fixed attenuation, it requires the use of calibrated variable attenuation, or a set of calibrated fixed attenuators, or a combination of both, adding to a total attenuation value of 120dB, as measured at the operating frequency of the radio. In addition, a volt meter or computer is also required.

Connect the system as shown in Figure 65, using the combination of fixed and variable attenuation between the radio's RF ports. Connect the volt meter to either radio's RSL test point and associated reference ground connection.

In this test, it is desirable to use pre-tested RF cables, known to be good, and the insertion loss is known at the operating frequency. If the cables are short (6'/2m or less), you can estimate the loss, including connectors, to be less than 1dB each. The estimate of cable loss is critical to the overall confidence of the measurements made in this test.

There are two critical specifications that can be tested in this configuration:

- RF output power
- Radio receiver threshold

To measure transmitter output power, simply insert any value of attenuation between the radios between 60 and 90dB. Ensure that both RF output power settings are at maximum. Use the volt meter to measure RSL in both directions. The RSL measured value should match the appropriate value according to the inserted attenuation, such as:

$$RSL = RF\ Output\ Power - cabling\ losses - total\ attenuation$$

Verify output power by adjusting output power using the Exalt GUI (in administration mode) and evaluate the corresponding change to the RSL measurement.

For threshold testing, the key is to insert a measured amount of loss that is close to, but not exceeding the radio's specified system gain. System gain is the difference between RF output power and receiver threshold. At your selected modulation and bandwidth settings, determine the specified threshold performance, and choose a value of attenuation (including cable losses) that adds to roughly 5 to 15dB less than the system gain.

For example, for the EX-2.4i, if the threshold for your measurement is -85dBm, the output power is +27dBm, so the system gain is 112dB. Choose a value of total attenuation in the range of roughly 100–105dB. Once this attenuation is inserted, verify RSL readings as in the first step, and then, using the GUI, reduce radio output power in 1dB steps until the receiving radio (the one whose output power not being adjusted) Link LED turns from green to yellow. This indicates that threshold has been reached. At this point, verify the equation for system gain using the new output power level setting and verify that the threshold performance is meeting or exceeding the published specification.



Note: Due to the variation of measurements and accuracies involved in this test, you may read a measurement that is 1dB to as much as 2dB off of the expected value. It should be of no concern unless the value is more than 3dB worse than expected.

Once threshold is verified in this direction, repeat the process in the opposite direction by adjusting RF output power of the radio at the opposite end. Return the first radio to its original power setting before adjusting the second radio.

General Compliance and Safety

The usage of radio transmission devices is subject to specific regulatory requirements governed by regional legislation. In most cases, the specific device must be authorized for use in a given country and must be installed and adjusted in accordance with specific radio-frequency settings and in a manner that has been authorized specific to the device itself in accordance with the specific location of the device. Some users may be completely or partially restricted from use of the device. Please consult local governmental agency/agencies for regulatory requirements before use, or contact Exalt or your Exalt authorized dealer for assistance.

Do not modify this device in any way without the express written consent of Exalt. Modification voids the manufacturer warranty, and may also be illegal in accordance to government regulations. In addition, there are no user-serviceable parts or assemblies inside the product housing. There may also be voltages, signals, and mechanisms within the device that could be harmful to human safety.

The mounting of this device and associated peripherals and connections (inclusive of antenna mast, antenna, cabling, egress, lightning protection devices, grounding, power, and so on) may be subject to regional requirements for health and human safety. A qualified professional installer and an electrician are highly recommended, and may be required by law.

Dynamic Frequency Selection

Dynamic Frequency Selection (DFS) may be required by regional legislation in some frequency bands to avoid causing interference to radar systems. Prior to the start of any transmission, the device equipped with DFS monitors the spectrum and is not permitted to transmit on a part of the spectrum that is already in use for radar transmissions for a period of 30 minutes. During operation of the device, the spectrum is continually monitored by the DFS to detect if radar begins transmission on a frequency that is being used by the device to transmit on. If the DFS software detects radar, the device must move off channel within a specified time period so that the device transmission does not interfere with the radar transmission. The device equipped with DFS is required to stay off that part of the spectrum for a minimum of 30 minutes, after which time the device may then check the spectrum for radar transmissions and begin transmitting if no radar is detected.

Safety Notices

- 1 Review this entire guide for important installation instructions BEFORE attempting to install this product.
- 2 This product is intended to be installed, used, and maintained by experienced telecommunications personnel only.
- 3 Employ a properly licensed or authorized electrician to install or evaluate/certify the installation of all power and grounding related to the use of this equipment and all connected devices.
- 4 The device(s) shall only be connected to AC power sources provided by the supplier or to DC sources within the device specifications. Use a separate breaker circuit at the power source.
- 5 Lightning, surge protection devices, and earth grounding are required for most installations to ensure human safety. Consult a qualified electrician.
- 6 Servicing of this device should be performed by authorized personnel only. Do not disassemble this device. By opening or removing any covers you may expose yourself to hazardous energy parts. Incorrect reassembly of this product can cause a malfunction, and/or electrical shock, when the unit is subsequently used.
- 7 Do not connect or disconnect the power connection to the device when the power supply is plugged into an AC outlet. To connect, first connect the power connection to the device, and then apply power (or plug in) at the outlet. To disconnect, disengage power at the outlet or unplug, and then disconnect the direct connection to the device.
- 8 Do not insert any object of any shape or size inside this product at any time, whether powered or not. Objects may contact hazardous energy components that could result in a risk of fire or personal injury.
- 9 Liquids shall not come in contact with, or enter the inside of the device at any time.
- 10 Proper ventilation and/or airflow shall be provided surrounding the equipment. Items shall not come in contact with heat-sinking materials. Ensure that ambient operational and storage temperature specifications are maintained at all times.
- 11 Equipment is suitable for mounting on noncombustible surfaces only.
- 12 Do not move or alter the marking labels.
- 13 A CSU or similar isolating device is necessary between the equipment and the public telecommunications network. The equipment has not been evaluated for direct connection to the public telecommunications network.

Regulatory Notices

This section presents the Regulatory Compliance Regulations for your country.

4.9GHz Model

The EX-4.9i is a licensed-band product operating within Part 90 of the FCC regulations and RSS-111 of Industry Canada. These bands are specifically reserved for Public Safety applications and related agencies, in accordance with these regulations.

Transmitter power reduction may be required, depending on transmission system gains and losses, in accordance with instructions found in this appendix.

The transmitter power of the device must be reduced by 1 dB for every 1 dB that the antenna gain exceeds 26 dBi (inclusive of transmission system losses).

United States Compliance

The EX-2.4i and EX-5i product families operate under FCC Rule Parts 15.247 and/or 15.407 as a license-exempt device. The EX-4.9i products operate under FCC Rule Part 90 as a licensed device. They may only be used as a point-to-point transmission device for fixed or temporary-fixed (non-mobile) installations. The devices are subject to the following restrictions:

- Do not use external amplifiers to boost the power or overcome transmission system losses, unless the specific amplifier/cable/antenna combination has expressly been authorized by the FCC. The output power must never exceed +30 dBm.
- Cross-border transmissions are expressly prohibited, except with written permission from both the FCC and the governing body of the neighboring country (Cofetel for Mexico; Industry Canada for Canada).
- Use only parabolic dish antennas or directional flat-panel antennas. No other types of antennas (omni-directional, yagi, and so on) are authorized. Parabolic dishes of either grid or solid type are allowed. Maximum mid-band gain of each type of antenna certified is:
 - EX-2.4i models:
 - Parabolic dish: 30.3 dBi (6'/1.8m diameter)
 - Directional flat panel: 20.5 dBi (~2'/61cm square)
 - EX-4.9i models:
 - Parabolic dish: 26dBi (larger gains are allowed, with Tx power reduction)
 - Directional flat panel: 26 dBi (larger gains are allowed, with Tx power reduction)
 - EX-5i models:
 - Parabolic dish: 37.9 dBi (6'/1.8m diameter)
 - Directional flat panel: 28 dBi (~2'/61cm square)



Note: The 5GHz model is approved under FCC Rule Part 15.407(b)(4)(ii) for antenna gains greater than 10dBi.

The 5GHz model cannot be manufactured, marketed, or sold after March 2, 2018 unless it is re-certified under FCC Rule Part 15.407(b)(4)(i).

Check with Exalt Wireless for status of re-certification.

Federal Communications Commission (FCC), United States

The device is allowed to be used provided it does not cause interference to other devices. It is not guaranteed to provide protection against interference from other electronic and radio devices.

The system has been tested and found to comply with the limits of a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Shielded cables and I/O cords must be used for this equipment to comply with the relevant FCC regulations.

Changes or modifications not expressly approved in writing by Exalt may void the user's authority to operate this equipment.

This device must be professionally installed.

To comply with regulations, the output power of this device may need to be adjusted in accordance to the associated transmission system. See [RF Output Power Setting](#) for details.

The antenna associated with EX-2.4i family shall be mounted in a location that is at least 10 feet away from humans that may be subject to long-term or continuous exposure. The antenna associated with the EX-5i family shall be mounted in a location that is at least 10'/3m away from humans that may be subject to long-term or continuous exposure.

Important: *Where required by regional regulations, DFS is enabled by the system keys and cannot be disabled.*

Canada Compliance

The EX-2.4i and EX-5i models operate under RSS-210 of Industry Canada regulations. The EX-4.9i model operates under RSS-111 of Industry Canada regulations. Operation is subject to the following conditions, unless express permission is granted by Industry Canada to operate in a different manner:

- External amplifiers cannot be used to boost the power or to overcome transmission system losses, unless the specific amplifier/cable/antenna combination is expressly authorized by Industry Canada.
- Cross-border transmissions are expressly prohibited, except with written permission from both Industry Canada and the governing body of the neighboring country (FCC for USA)
- Only parabolic dish antennas or directional flat-panel antennas may be used. No other types of antennas (omni-directional, yagi, and so on) are authorized. Parabolic dishes of either grid or solid type are allowed. Maximum gain of each type of antenna allowed is:
 - EX-2.4i models:
 - Parabolic dish: 30.3 dBi (6'/1.8m diameter)
 - Directional flat panel: 20.5 dBi (~2'/61cm square)
 - EX-4.9i models:
 - Parabolic dish: 26 dBi (larger gains are allowed with Tx power reduction)
 - Directional flat panel: 26 dBi (larger gains are allowed with Tx power reduction)
 - EX-5i models:
 - Parabolic dish: 37.9 dBi (6'/1.8m diameter)
 - Directional flat panel: 28 dBi (~2'/61cm square)

Industry Canada (IC), Canada

This device complies with RSS-210 of Industry Canada. Operation is subject to the following two conditions:

- 1 this device may not cause interference, and
- 2 this device must accept any interference, including interference that may cause undesired operation of the device.

Antennas Supported in Canada

The EX-2.4i is designed to operate with the antennas listed in [Table 10](#), which have a maximum gain of 30.3 dBi. Antennas not included in the list or having a gain greater than 30.3 dBi are prohibited for use with this device. The required antenna impedance is 50 Ohms.

The antenna associated with the EX-2.4i family shall be mounted in a location that is at least 10 feet away from humans that may be subject to long-term or continuous exposure.

The EX-5i family has been designed to operate with the antennas listed in [Table 11](#), which have a maximum gain of 37.9 dBi. Antennas not included in the list or having a gain greater than 37.9 dBi are prohibited for use with this device. The required antenna impedance is 50 Ohms.

The antenna associated with the EX-5i family shall be mounted in a location that is at least 10'/3m away from humans that may be subject to long-term or continuous exposure.

Important: *Where required by regional regulations, DFS is enabled by the system keys and cannot be disabled.*

Europe and ITU Country Compliance

All of these permitted devices must be professionally installed. They can only be used as a point-to-point transmission device for fixed or temporary-fixed (non-mobile) installations.



Note: Do not use external amplifiers to boost the power or overcome transmission system losses, unless the specific amplifier/cable/antenna combination has expressly been authorized by the specific country regulations. The output power must never exceed that specified in [Specifications](#).

The EX-2.4i product family operates under EN 300 328 rules as a license-exempt device. The 2.4 GHz band is not yet harmonized in all countries recognizing ETSI or ITU band assignments. There is a +20dBm EIRP limit applied to this band. Transmitter power must be adjusted accordingly with respect to the RF cabling losses and antenna gains associated with each terminal.

The EX-4.9i devices are currently not permitted in any EU member or affiliate countries.

The EX-5i product family operates under EN 301 893 and EN 302 502 rules as a license-exempt device.

The EX-5i product family complies with ETS 301 893 for the 5.3 and 5.47 GHz bands for license-exempt use for most countries recognizing ETSI or ITU band assignments. This band is not yet harmonized for all countries recognizing ETSI or ITU band assignments. These bands require Dynamic Frequency Selection (DFS) and Transmitter Power Control (TPC) for radar-detection and avoidance. There is a +30dBm EIRP limit applied to this band. Transmitter power must be adjusted accordingly with respect to the RF cabling losses and antenna gains associated with each terminal.

The EX-5i product family complies with ETS 302 502 for the 5.8 GHz band. This band is not yet harmonized for all countries recognizing ETSI or ITU band assignments. Consult the individual country regulations or your Exalt Wireless representative for details. This band requires DFS and TPC for radar-detection and avoidance. There is a +33dBm EIRP limit for use of the 10 MHz BW setting, and a +36dBm EIRP limit for use of the 20 MHz BW setting. Some countries limit the EIRP to +5dBm for all bandwidths in this band.

All models comply with the requirements for CE Mark (EN 60950-1 and IEC 60950-1) and EMC (EN 301 489-17). No substitutions shall be made, and all wiring and grounding instructions contained in this manual must be followed to ensure safety in accordance to the standards and local rules.

Regulatory Compliance

As of this printing, Exalt Wireless, Inc. has approvals for the products that are covered by this manual, as indicated in Table 12. If your application or country is not listed, check with your Sales Representative for the current status.

Table 12 Product approvals

Country	EX-2.4i Series	EX-4.9i Series	EX-5i Series, 5.3 GHz	EX-5i Series, 5.4 GHz	EX-5i Series, 5.8 GHz
Austria	✗		✗	✗	✗
Australia				✗	✗
Belgium	✗			✗	
Canada	✗	✗	✗	✗	✗
Cyprus	✗		✗	✗	
Czech Republic	✗			✗	
Denmark	✗		✗	✗	✗
Estonia	✗		✗	✗	
Finland	✗		✗	✗	
France	✗		✗	✗	✗
Germany	✗		✗	✗	✗
Ghana	✗		✗	✗	
Great Britain	✗		✗	✗	✗
Hungary	✗		✗	✗	✗
Iceland	✗		✗	✗	✗
Ireland	✗		✗	✗	✗
Italy	✗		✗	✗	✗
Liechtenstein	✗		✗	✗	✗
Lithuania	✗		✗	✗	✗
Luxembourg			✗	✗	
Malta	✗				
Mexico	✗		✗		✗
Netherlands	✗		✗	✗	✗
Norway	✗		✗	✗	✗
Philippines			✗	✗	✗
Poland	✗		✗	✗	✗
Portugal	✗		✗	✗	✗

Table 12 Product approvals (Continued)

Country	EX-2.4i Series	EX-4.9i Series	EX-5i Series, 5.3 GHz	EX-5i Series, 5.4 GHz	EX-5i Series, 5.8 GHz
Romania	✗		✗	✗	✗
Slovak Republic	✗		✗	✗	✗
Slovenia	✗				✗
South Korea	✗				
Sweden	✗		✗	✗	✗
Switzerland	✗		✗	✗	✗
Turkey	✗		✗	✗	✗
United States	✗	✗	✗	✗	✗

Regulatory Domain Keys

Exalt radios are designed to allow the professional installer to select frequency bands, determine signal bandwidths, tune center frequencies, limit output power, and enable or disable DFS options as permitted by regional regulations. For models with the Regulatory Domain Key (RDK) feature, the radios ship with the RDK information empty and the radio cannot be enabled without a valid key. The partner, distributor, or installer is responsible for installing the RDK based on the final installation country of the radio. Exalt issues RDK information to their distributors when ship-to country information is provided. Consult your local Exalt distributor or reseller to obtain the RDK.

RDK 053A8 is supported in firmware 4.0.0 and later, and is the same as ETSI 053A4 with the 40 MHz bandwidth added in UNII bands.

Countries are assigned to different regulatory domains based on current regulatory requirements. Each regulatory domain has the parameters set to ensure that when the radio is turned on, the default settings are complaint for local laws.



Caution: It is critical that the RDK be set to the correct default setting so that the local regulations for the installation requirements are met.

Regulatory Domain Keys are assigned by regulatory domain based on the local regulations.

Table 13 Regulatory Domain Keys

Regulatory Domain Key Name	Frequency Band(s)	Countries
024A0	2.4GHz	USA, Canada, EU, Ghana, Mexico
049A0	4.9GHz	USA, Canada
053A0	5.3GHz, 5.4GHz, 5.8GHz	USA (prior to July 20, 2007), Canada (prior to May 08, 2008), Singapore, Philippines
053A1	5.3GHz, 5.4GHz, 5.8GHz	USA (after July 20, 2007), Canada (after May 08, 2008)
053A2	5.8GHz	China
053A3	5.3GHz, 5.8GHz	Mexico
053A4	5.3GHz, 5.4GHz, 5.8GHz	EU, Ghana
053A5	5.4GHz, 5.8GHz	Australia
053A6	5.3GHz, 5.4GHz, 5.8GHz	Philippines
053A7	5.3GHz 5.4GHz 5.8GHz	Unrestricted (for countries without specific band and/or DFS regulations)
053A8	5.3GHz 5.4GHz 5.8GHz	EU, adding 40MHz bandwidth channel support for 5.3GHz and 5.4GHz bands

EIRP Limits for the United States and Canada



Note: The professional installer is responsible to ensure that RF output power is properly adjusted to not exceed the regulatory limit.

EX-2.4i EIRP for the USA and Canada

For EX-2.4i models, the maximum EIRP allowed is +52.2 dBm. The maximum conducted power of the radio is +27 dBm for Mode 1 and +24 dBm for Mode 2. The following formula is used to determine the output power:

$$P = 30 - [(G-6)/3] + L$$

where:

P = Maximum transmitter output Power of radio, in dBm.
 G = Specified gain of antenna, in dBi, from 2400 to 2483.5 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, and lightning suppressors), in dB, as specified or measured between 2400 and 2483.5 MHz.

EX-4.9i EIRP for the USA and Canada

For the EX-4.9i models, within the 4940–4990 MHz band, the maximum EIRP allowed is +50dBm. The maximum output power of the radio shall never exceed +24dBm.

For the EX-4.9i models, the transmit power must be reduced from maximum (+24dBm for 20MHz BW; +22dBm for 10MHz) by 1 dB for every 1dB that the antenna gain exceeds 26dBi (including transmission system losses)

EX-5i Series EIRP for the US and Canada

5250–5350 MHz Band

For EX-5i models within the 5250–5350 MHz band, the maximum EIRP is 30 dBm. The maximum output of the radio is +13 dBm.

$$P = 30 - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
 G = Specified gain of antenna, in dBi, from 5250 to 5350 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5250 and 5350 MHz.

5470–5725 MHz Band

For EX-5i models within the 5470–5725 MHz band, the maximum EIRP allowed is 30 dBm. The maximum output power of the radio is +13 dBm.

$$P = 30 - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
G = Specified gain of antenna, in dBi, from 5470 to 5725 MHz.
L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5470 and 5725 MHz.

5725–5850 MHz Band

For the EX-5i models within the 5725–5850 MHz band, the maximum EIRP allowed is 61.9 dBm. The maximum output power of the radio is +24 dBm in Mode 1 and +21 dBm in Mode 2.

$$P = 61.9 - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
G = Specified gain of antenna, in dBi, from 5725 to 5850 MHz.
L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5725 and 5850 MHz.

EIRP Limits for the European Union and ITU Countries

The countries that are covered by this Regulatory Domain are: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ghana, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Netherlands, Switzerland, and Turkey.



Note: The professional installer is responsible to ensure that RF output power is properly adjusted to not exceed the regulatory limit.

- Use only parabolic dish antennas or directional flat-panel antennas. No other types of antennas (omni-directional, yagi, and so on) are authorized. Parabolic dishes of either grid or solid type are allowed. Maximum mid-band gain of each type of antenna certified is:
 - EX-2.4i models:
 - Parabolic dish: 30.3 dBi (6'/1.8m diameter)
 - Directional flat panel: 20.5 dBi (~2'/61cm square)
 - EX-5i models:
 - Parabolic dish: 37.9 dBi (6'/1.8m diameter)
 - Directional flat panel: 28 dBi (~2'/61cm square)

EX-2.4i-Series EIRP

For EX-2.4i models within the 2400–2483.5 MHz band, the maximum EIRP allowed is summarized in Table 14. The maximum output power of the radio is +27dBm in Mode 1 and +24dBm in Mode 2.

$$P = ME - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
ME = Maximum EIRP, as specified in Table 14.
G = Specified gain of antenna, in dBi, from 2400 to 2483.5 MHz.
L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 2400 and 2483.5 MHz.

Table 14 EU and ITU Country-Specific EIRP Levels for the EX-2.4i Series

Country	Maximum EIRP
Austria	20 dBm
Belgium	20 dBm
Cyprus	20 dBm
Czech Republic	20 dBm
Denmark	20 dBm
Estonia	20 dBm
Finland	20 dBm

Table 14 EU and ITU Country-Specific EIRP Levels for the EX-2.4i Series (Continued)

Country	Maximum EIRP
France	20 dBm
Germany	20 dBm
Great Britain	20 dBm
Hungary	20 dBm
Iceland	20 dBm
Ireland	20 dBm
Italy	20 dBm
Liechtenstein	20 dBm
Lithuania	20 dBm
Malta	20 dBm
Netherlands	20 dBm
Norway	20 dBm
Poland	20 dBm
Portugal	20 dBm
Romania	20 dBm
Slovak Republic	20 dBm
Slovenia	20 dBm
Sweden	20 dBm
Switzerland	20 dBm
Turkey	20 dBm

EX-5i Series EIRP

Table 15 summarizes the maximum power by band and country for EX-5i Series radios.

5250–5350 MHz band

For EX-5i models within the 5250–5350 MHz band, the maximum EIRP is specified in Table 15. The maximum output of the radio is +13 dBm.

$$P = ME - G + L$$

where:

- P = Maximum transmitter output power of radio, in dBm.
- ME = Maximum EIRP, as specified in Table 15.
- G = Specified gain of antenna, in dBi, from 5250 to 5350 MHz.
- L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5250 and 5350 MHz.

5470–5725 MHz band

For EX-5i models within the 5470–5725 MHz band, the maximum EIRP allowed is specified in Table 15. The maximum output power of the radio is +13 dBm.

$$P = ME - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
 ME = Maximum EIRP, as specified in Table 15.
 G = Specified gain of antenna, in dBi, from 5470 to 5725 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5470 and 5725 MHz.

5725–5850 MHz band

For EX-5i models within the 5725–5850 MHz band, the maximum transmit power with respect to specific country EIRP regulations is determined based on the channel bandwidth. The EIRP power limit is specified in Table 15. The Exalt EX-5i series radios maximum transmitter conducted power is +24 dBm. Use the following equation to determine the maximum transmitter power for the radio:

$$P = ME - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
 ME = Maximum EIRP, as specified in Table 15.
 G = Specified gain of antenna, in dBi, from 5725 to 5850 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5725 and 5850 MHz.

Table 15 EU and ITU Country Specific EIRP Levels for EX-5i Series

Country	Maximum EIRP 5.3 GHz band	Maximum EIRP 5.4 GHz band	Maximum EIRP 5.8 GHz band (BW dependent) ^a
Austria	23 dBm	30 dBm	5 dBm
Belgium		30 dBm	
Cyprus	23 dBm	30 dBm	
Czech Republic		30 dBm	
Denmark	23 dBm	30 dBm	33/36 dBm
Estonia	23 dBm	30 dBm	
Finland	23 dBm	30 dBm	
France	23 dBm	30 dBm	33/36 dBm
Germany	23 dBm	30 dBm	33/36 dBm
Ghana	23 dBm	30 dBm	33/36 dBm

Table 15 EU and ITU Country Specific EIRP Levels for EX-5i Series (Continued)

Country	Maximum EIRP 5.3 GHz band	Maximum EIRP 5.4 GHz band	Maximum EIRP 5.8 GHz band (BW dependent)^a
Great Britain	23 dBm	30 dBm	33/36 dBm
Hungary	23 dBm	30 dBm	33/36 dBm
Iceland	23 dBm	30 dBm	33/36 dBm
Ireland	23 dBm	30 dBm	33/36 dBm
Italy	23 dBm	30 dBm	33/36 dBm
Liechtenstein	23 dBm	30 dBm	5 dBm
Lithuania	23 dBm	30 dBm	33/36 dBm
Luxembourg	23 dBm	30 dBm	
Netherlands	23 dBm	30 dBm	33/36 dBm
Norway	23 dBm	30 dBm	33/36 dBm
Poland	23 dBm	30 dBm	33/36 dBm
Portugal	23 dBm	30 dBm	5 dBm
Romania	23 dBm	30 dBm	33/36 dBm
Slovak Republic	23 dBm	30 dBm	5 dBm
Slovenia			33/36 dBm
Sweden	23 dBm	30 dBm	33/36 dBm
Switzerland	23 dBm	30 dBm	5 dBm
Turkey	23 dBm	30 dBm	33/36 dBm

a. If the output power is designated as 33/36 dBm, the EIRP is limited to 33 dBm for 10 MHz bandwidth transmissions and 36 dBm for 20 MHz bandwidth transmissions.

EIRP Limits for Australia



Note: The professional installer is responsible to ensure that RF output power is properly adjusted to not exceed the regulatory limit.

EX-5i Series EIRP for Australia

5470–5725 MHz Band



Note: Australian regulations have a no-transmit band from 5600–5650 MHz, adjust the transmitter to avoid this range.

For EX-5i models within the 5470–5725 MHz band, the maximum EIRP allowed is 30 dBm. The maximum output power of the radio is +13 dBm.

$$P = 30 - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
 G = Specified gain of antenna, in dBi, from 5470 to 5725 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5470 and 5725 MHz.

5725–5850 MHz Band

For the EX-5i models within the 5725–5850 MHz band, the maximum EIRP allowed is 36 dBm. The maximum output power of the radio is +24 dBm in Mode 1 and +21 dBm in Mode 2.

$$P = 36 - G + L$$

where:

P = Maximum transmitter output power of radio, in dBm.
 G = Specified gain of antenna, in dBi, from 5725 to 5850 MHz.
 L = Total transmission system losses of all elements between the radio's RF connector and the antenna's RF connector (all cables, connectors, lightning suppressors), in dB, as specified or measured between 5725 and 5850 MHz.

Declaration of Conformity to the R&TTE Directive 1999/5/EC

English:	This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Deutsch:	Dieses Gerät entspricht den grundlegenden Anforderungen und den weiteren entsprechenen Vorgaben der Richtlinie 1999/5/EU.
Dansk:	Dette udstyr er i overensstemmelse med de væsentlige krav og andre relevante bestemmelser i Directiv 1999/5/EF.
Español:	Este equipo cumple con los requisitos esenciales así como con otras disposiciones de la Directiva 1999/5/EC.
Ελληνικά:	Αυτός ο εξοπλισμός είναι σε συμμόρφωση με τις ουσιώδεις απαιτήσεις και άλλες σχετικές διατάξεις της Οδηγίας 1999/5/EC.
Français:	Cet appareil est conforme aux exigences essentielles et aux autres dispositions pertinentes de la Directive 1999/5/EC.
Íslenska:	Pessi búnaður samrýmist lögboðnum kröfum og öðrum ákvæðum tilskipunar 1999/5/ESB.
Italiano:	Questo apparato è conforme ai requisiti essenziali ed agli altri principi sanciti dalla Direttiva 1999/5/EC.
Nederlands:	Deze apparatuur voldoet aan de belangrijkste eisen en andere voorzieningen van richtlijn 1999/5/EC.
Norsk:	Dette utstyret er i samsvar med de grunnleggende krav og andre relevante bestemmelser i EU-directiv 1999/5/EC.
Português:	Este equipamento satisfaz os requisitos essenciais e outras provisões da Directiva 1999/5/EC.
Suomalainen:	Tämä laite täyttää direktiivin 1999/5/EY oleelliset vaatimukset ja on siinä asetettujen muidenkin ehtojen mukainen.
Svenska:	Denna utrustning är i överensstämmelse med de väsentliga kraven och andra relevanta bestämmelser i Direktiv 1999/5/EC.

For 2.4 GHz radios, the following standards were applied:

- Radio: EN 300 328-1, EN 300 328-2
- EMC: EN 301 489-1, EN 301 489-17
- Safety: EN 60950, IEC 60950, IEC 60950-1

For 5 GHz radios, the following standards were applied:

- Radio: EN 301 893, EN 302 502
- EMC: EN 301 489-1, EN 301 489-17
- Safety: EN 60950-1, IEC 60950-1

The following CE mark is affixed to the product:



EU WEEE

Exalt is committed to meeting the requirements of the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive. The Directives require producers of electrical and electronic equipment to finance the take-back for re-use or recycling of their products placed on the EU market after 13 August 2005.

Exalt products that are within the scope of the Directives are labeled with a crossed-out "wheelie-bin" symbol as required by the Directives. This indicates that the product was placed on the market after 13 August 2005 and that end-users should segregate the product from other wastes at end-of-life.

The WEEE Directives are being implemented in each of the 28 EU and European Economic Area (EEA) countries through national legislation. This has resulted in considerable variation in the detailed requirements across the EU, many of which require presence in the EU. As a result, Exalt's WEEE compliance approach is to require the distributors and/or resellers in the EU to comply with each country's national legislation by registration of the distributor or reseller as the producer and for the reseller/distributor to carry out and fulfill the legislative requirements of each national compliance scheme.

Below is the crossed out wheelie bin symbol as required by the WEEE Directive.



EU RoHS

RoHS is the acronym used to refer to the European Union (EU) Directive 2002/95/EC on the Restriction of the use of certain hazardous substances in electrical and electronic equipment. Hazardous materials are those chemicals and substances that are legislatively, market, or customer banned or restricted for use in products and/or manufacturing. There are six (6) RoHS substances: lead (Pb), cadmium (Cd), mercury (Hg), hexavalent chromium (Cr+6), polybrominated biphenyls (PBB) and polybrominated diphenylethers (PBDE). Other countries may be introducing legislation that results in similar restrictions of hazardous substances. Many Exalt products will continue to use lead-based solder under the exemption allowed for network infrastructure equipment. Small amounts of lead, cadmium, mercury, hexavalent chromium, PBB, and PBDE can also be found in a few electrical and electrical components.

END USER AGREEMENT

(including Limited Hardware Warranty, Software License and RMA Procedure)

THIS IS AN AGREEMENT BETWEEN YOU (AS ORIGINAL END USER PURCHASER OF AN EXALT PRODUCT) AND EXALT WIRELESS, INC. ("EXALT"). THE END USER AGREEMENT APPLICABLE TO YOUR EXALT PRODUCT IS THE END USER AGREEMENT THAT IS PRE-LOADED ON THE EXALT PRODUCT, OR IF NONE IS PRE-LOADED, IT IS THE END USER AGREEMENT AVAILABLE ON THE EXALT WEBSITE @ WWW.EXALTCOM.COM/EULA ON THE DATE OF YOUR PURCHASE OF THE EXALT PRODUCT OR OTHERWISE DIRECTLY AVAILABLE FROM EXALT UPON REQUEST. BY ACCEPTING THIS AGREEMENT OR BY USING THE EXALT PRODUCT WITH OR FOR WHICH THIS AGREEMENT IS PROVIDED ("PRODUCT"), YOU ARE AGREEING TO ALL OF THE BELOW TERMS AND CONDITIONS. IF YOU DO NOT AGREE WITH THESE TERMS AND CONDITIONS, YOU SHOULD NOT USE THE PRODUCT AND PROMPTLY RETURN IT TO YOUR PLACE OF PURCHASE FOR A REFUND. "YOU" MEANS THE LEGAL END USER ENTITY THAT PURCHASED THE PRODUCT FOR ITS OWN USE.

1 Exalt Limited Hardware Warranty

- a. Exalt warrants solely to the original purchaser ("Purchaser") that the Exalt hardware product that this Agreement is provided with or for (the "Hardware Product") will substantially conform in all material respects to the relevant Exalt published specifications that apply at the time of manufacture of such Hardware Product for two (2) years from the date of purchase of Hardware Product by Purchaser (the "Warranty Period"). Proof-of-purchase in the form of an invoice, payment of invoice, or delivery waybill must be supplied, if requested by Exalt, in case of any dispute of warranty start date.
- b. In the event Purchaser notifies Exalt during the Warranty Period of a defective Hardware Product (material nonconformance with the published specifications), Exalt shall within the Warranty Period, at its own option either: (A) use reasonable efforts to remedy any reproducible Hardware Product defect covered by this limited warranty within a reasonable period of time; (B) replace the defective Hardware Product with a functionally equivalent product (repair parts and products may be either reconditioned or new, but, if reconditioned, shall be of the same quality as new parts or products); or (C) if Exalt determines that it is unable to repair or replace such Hardware Product, Exalt (or its applicable reseller) will refund to Purchaser the amount actually paid by Purchaser for the applicable Hardware Product. All replaced parts and products become the property of Exalt.
- c. The Exalt warranty does not cover any defective Hardware Product that (i) is subject to the exclusions set forth below in Section 3; (ii) cannot be demonstrated to have a defect of the types of defects covered by the Exalt warranty, or (iii) Purchaser is unable to provide adequate information describing how the Hardware Product failed that would allow Exalt to determine that the defect is covered by the Exalt warranty. Any Hardware Product that is returned by the Purchaser to Exalt and Exalt determines that such product is not covered by the Exalt warranty, will be, at Purchaser's option and expense (including any applicable shipping, handling, evaluation, repair, replacement and disposal fees), either be: (a) returned to Purchaser in the state received, (b) repaired or replaced, as applicable, and returned to Purchaser, or disposed of in accordance with Purchaser's instructions. Repaired or replaced Hardware Product will be warranted for the remainder of the original Warranty Period, but not less than ninety (90) days.

2 Warranty Registration

In order to facilitate warranty service and communication with Exalt, Exalt recommends that the Purchaser registers the Hardware Product with Exalt promptly following the Hardware Product purchase by providing to Exalt the requested registration information. *Product registration may be performed by completing and submitting the product registration form on www.exaltcom.com/ProductRegistration.*

3 Limited Hardware Warranty Exclusions

This limited warranty will not apply to: (A) any Hardware Product that: (i) has been modified or altered by any party other than Exalt; (ii) has been subject to accident, misuse, neglect, or mistreatment; (iii) has been damaged during installation of the Hardware Product; (iv) has been damaged by failure of Purchaser or its agents to follow Exalt's instructions or specifications; (v) has been damaged by the equipment or system with which the Hardware Product is used; (vi) has sustained damage to the Hardware Products' interface or power connectors; (vii) is determined to be stolen; or (viii) has been damaged by water, fire, power changes, other hazards, or acts of God (including without limitation lightning); (B) any Software included in any such Hardware Product (see Software License below), or (C) any consumables. The warranty applies only to Hardware Products manufactured by or for Exalt and that can be identified by the Exalt trademark, trade name, serial number or logo affixed to them. Other products, including any third-party manufacturer products sold by Exalt on a resale basis, are subject to the applicable third-party manufacturer's warranty and end user agreement and are not warranted by Exalt. The Hardware Products covered by this warranty are not consumer products and are not intended for personal, family, or household purposes, nor are they intended for high-risk activities as described in Section 5 below.

4 Hardware Product RMA Procedure

A return material authorization (RMA) is required prior to returning Hardware Product to Exalt for in-warranty or out-of-warranty repair/evaluation. As such, Purchaser must use the then current Exalt RMA procedure. Such procedure is available on the Exalt website @ www.exaltcom.com/RMA or directly from Exalt upon request.

PRODUCTS RETURNED WITHOUT A DULY ISSUED RMA NUMBER WILL BE RETURNED TO PURCHASER BY EXALT AT PURCHASER'S EXPENSE.

5 PRODUCT WARRANTY DISCLAIMER AND LIMITATION OF LIABILITY

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Index

A

- AC adapter 25, 26
- accessory kit contents 7
- Administration Settings page 43
- administrator privileges 37
- Advance Encryption Standard 44
- AES 44
- AIS enabling//disabling 62
- alarm conditions 40
- Alarm connector 93
- alarms 67, 72, 88
 - clearing 72
- Alarms page 67
- AMI 62
- antennas
 - alignment 32, 105
 - EX-2.4i
 - Canada 115
 - EX-5i
 - Canada 115
 - US 99
 - mounting 29
 - indoor 31
 - mounting height 6
 - polarization orientation 6
 - site preparation considerations 6
 - system grounding 6
 - transmission line 29
 - troubleshooting 105
- AUTO SYNC mode 12

B

- B8ZS 62
- back-to-back bench test 8, 107
- back-to-back bench test configuration 107
- bandwidth 6
- Bandwidth parameter 50, 55
- battery source 25
- BER 75
- browsers 35

C

- cables
 - RF 6
- troubleshooting
 - improper RF cable termination 104
- carrier-to-interference tolerance 6
- CLI 34

- menu options 35
- root menu 35
- clock 15
- connectors
 - Alarm 93
 - CONSOLE 34, 94
 - DC 27
 - DC Power 95
 - Ethernet 91
 - front panel 22
 - Sync (In//Out) 92
 - T1/E1 90
- Console connector 94
- console interface 88
- Current BER field 70
- Current RSL field 70

D

- date and time 44
- DC connector 27
- DC coupler 33, 100
- DC Power connector 95
- DC power source 25
- DFS 56
- Diagnostic Charts page 75
- dimensions 82
- DIP switch 11
- DIP switch (-16 and -DS3 models only) 7
- DIP switch (-16 models only) 96
- Dynamic Frequency Selection (DFS) 8, 111

E

- E1 channels 63
- E1 Interface Configuration page 63
- effective isotropic radiated power (EIRP) 9
- Endpoint Identifier 38, 49, 56
- Errored Seconds (ES) field 71
- Ethernet 6
- Ethernet configuration parameters 50
- Ethernet connectors 91
- Ethernet interface 88
 - throughput settings 62
- Ethernet Interface Configuration page 59
- Event Log page 72
- External Alarm Inputs parameter 57
- external GPS source 13
- external loopback modes 64

F

factory default settings 28, 49
fade margin 6, 106
File Activation page 51
files
 activating stored 51
 default configuration file 49

frame length See TDD frame

frequency
 center 6

G

gateway (default) 50
Global Positioning System (GPS) kit 12
GPS Information page 66
GPS sync features 10
GPS synchronization 66
grounding 106
GUI
 Access Security page 52
 Administration Settings page 43
 Alarms page 67
 browsers supported 35
 description 35
 Diagnostic Charts page 75
 E1 Interface Configuration page 63
 Ethernet Interface Configuration page 59
 Event Log page 72
 File Activation page 51
 GPS Information page 66
 IP address (default) 35
 log in 36
 login privileges 37
 navigation panel 39, 40
 Performance page 70
 Radio A configuration 36
 Radio Information page 42
 Reboot page 80
 Spectrum Analyzer page 77
 summary status information 39
 T1 Interface Configuration page 62
 T1/E1 Configuration page 62
 VLAN page 60

H

hop 7
hub 13

I

interfaces

alarm 88
Ethernet 88
power 89
RF 88
serial console 88
Sync (In/Out) 89
T1/E1 88
interference 71
interference profile 6
IP address 49
IP subnet mask 50

K

keys
 Regulatory Domain Key (RDK) 8, 38, 54

L

License Key 44
lightning arrestor 6
lightning arrestors 31
Line Build Out (LBO) 62
Line Code 62
link 6
 orientation 10
 synchronization 10
Link Distance parameter 50, 56
link margin 106
Link Name parameter 50
link parameters 39
Link Security Key 44
Link Security Key parameter 50
login names 37
login privileges 37
loopback 62, 63, 64
 external (local) 64
 external (remote) 64
 internal 64

M

master timing 12
Maximum RSL field 71
Minimum RSL field 71
Minimum RSL Timestamp field 71
Mode parameter 55
modes
 AUTO SYNC 12
multi-link backbone 13
multi-link network 13
multipath 103
multipath propagation 104

muting 59

N

noise profile 6

O

offset timing 14

P

passwords 37, 50

path obstruction 105

performance degradation 103

Performance page 70

ports

 SYNC IN 15

 SYNC OUT 15

power

 AC adapter 26

 DC specifications 26

 DC wiring 27

 system LEDs and 26

power interface 89

R

rack mounting

 hardware 20

 temperature considerations 20

radio

 default settings 11

 grounding 6, 106

 initiation tasks 18

 installation tasks 18

 maximum transmit power setting 55

 mounting 6, 20

 rebooting 72, 80

 transmitter output power 6

Radio A 11

Radio A configuration 7

radio configuration 7

Radio Information page 42

Radio Name parameter 49

Radio Transmit Power parameter 54

Reboot page 80

received signal level (RSL) See RSL

receiver threshold 6

record keeping 19

Regulatory Domain Key (RDK) 8, 38, 119

regulatory requirements

 Canada 114

 EX-2.4i FCC EIRP 120, 122

 EX-4.9i FCC EIRP 120

EX-5i FCC EIRP 121, 126

US 113

repeater 13

RF connector 32

RF connector termination 25

RF Frequency parameter 50, 55

RF interface 88

RF interference 104

RF lightning arrestor 31

RF output power 9

RMT button 25

RSL 9

 current RSL readings 70

 diagnostics 75

 Maximum RSL field 71

 Minimum RSL Timestamp field 71

 monitor for performance 103

RSL voltage 32

S

safety 110

serial connection settings 34

serial console interface 88

Set to E1 button 62

Set to T1 button 62

shipping box contents 7

site preparation 6

SNMP 17, 45

SNMP Traps 46

specifications 82

Spectrum Analyzer page 77

Swap button 51

Sync (In//Out) connectors 92

Sync (In//Out) interface 89

SYNC RECIPIENT radio 12

SYNC SOURCE radios 12

synchronization 12

 internal 12

system latency 6

system parameters

 default settings 28

system performance 70

system reboot 72

system settings

 Current BER field 70

 Errored Seconds (ES) field 71

 grounding 106

 Maximum RSL 71

- Minimum RSL field 71
- Time Since Reset field 71
- Unavailable Seconds field 71
- system specifications 82
- system synchronization 13
- T**
 - T1 Interface Configuration page 62
 - T1/E1 circuits 62
 - T1/E1 Configuration page 62
 - T1/E1 connections 90
 - T1/E1 connectors 90
 - T1/E1 interfaces 88
 - T1/E1 loopback 64
 - TDD factors 9
 - TDD frame length 6
 - TDD Frame Size parameter 56
 - TDM circuit 6
 - TDM circuits 55
 - TDM interfaces 10
 - Telnet session 34
 - temperature 75, 82
 - testing 107
 - back-to-back bench 8
 - threshold 108
 - threshold testing 108
 - time division duplex (TDD) See TDD frame
 - Time Since Reset 71
 - timing
 - lost signal 15
 - master timing 12
 - offset timing 14
 - using an external GPS source 13
 - transmission line
 - coaxial 29
 - egress 32
 - transmitter output power 6
 - traps 46
 - troubleshooting 75, 102
- U**
 - Unavailable Seconds (UAS) 71
 - Update button 43
 - user privileges 37
- V**
 - VLAN 15
 - tagging 15
 - VLAN page 60
 - voltage test 32
- VSWR 104

Table 1	Factory default settings	11
Table 2	Connectors	22
Table 3	LED indicators	23
Table 4	Recommended transmission line	30
Table 5	Default login information	37
Table 6	Alarm status indicators	67
Table 7	DIP Switch Functions	96
Table 8	Standard Factory Defaults (-16 Models)	96
Table 9	Common DIP Switch Applications	97
Table 10	EX-2.4i supported antennas	98
Table 11	EX-5i supported antennas	99
Table 12	Product approvals	117
Table 13	Regulatory Domain Keys	119
Table 14	EU and ITU Country-Specific EIRP Levels for the EX-2.4i Series	122
Table 15	EU and ITU Country Specific EIRP Levels for EX-5i Series	124

Figure 1	EX-2.4i Digital Microwave Radio	1
Figure 2	Indoor mount interconnection	4
Figure 3	Enclosure mount interconnection	4
Figure 4	Basic radio interconnectivity using internal synchronization	12
Figure 5	Collocated radios, one in AUTO SYNC mode to provide redundancy	13
Figure 6	Multiple-link site configuration, using AUTO SYNC for redundancy	13
Figure 7	GPS as primary sync source using AUTO SYNC	14
Figure 8	Synchronized GPS sources using AUTO SYNC	14
Figure 9	Radio installation tasks	18
Figure 10	Front flush mount configuration	20
Figure 11	Front projection mount configuration	20
Figure 12	Rear-mount locations	21
Figure 13	Front panel (EX-2.4i, EX-4.9i, or EX-5i)	21
Figure 14	Front panel (EX-2.4i-16 or EX-5i-16)	22
Figure 15	Front panel (EX-5i-DS3)	22
Figure 16	Primary front panel connectors (standard models)	22
Figure 17	EX-5i-DS3 connectors and grounding switches	23
Figure 18	DC connector	27
Figure 19	CLI root menu	35
Figure 20	Initiating the browser connection	36
Figure 21	Browser Login screens—model dependent	37
Figure 22	Radio Information page	38
Figure 23	Exalt GUI window description	39
Figure 24	Summary status information	40
Figure 25	Radio Information page	42
Figure 26	Administration Settings page	43
Figure 27	Changed fields and Update button	43
Figure 28	SNMP Configuration page	45
Figure 29	Trap Configuration page	46
Figure 30	File Transfer page	48
Figure 31	File Transfer page—download file link	49
Figure 32	File Activation page	51
Figure 33	Access Security page	52
Figure 34	System Configuration page	54
Figure 35	MHS Configuration page	58
Figure 36	Ethernet Interface Configuration page	59
Figure 37	VLAN Configuration page	60
Figure 38	T1 Interface Configuration page	63
Figure 39	E1 Interface Configuration page	63
Figure 40	External (remote) loopback	64
Figure 41	External (local) loopback	64
Figure 42	DS3 Configuration page	65
Figure 43	GPS Information page	66
Figure 44	Alarms page	67
Figure 45	MHS Status page	69
Figure 46	Performance page	70
Figure 47	Event Log page	72
Figure 48	User Throughput page	73
Figure 49	Aggregate User Throughput Help page	74
Figure 50	Diagnostic Charts page	75
Figure 51	Spectrum Analyzer page	77

Figure 52	Spectrum analyzer graph example	78
Figure 53	Ethernet Utilization page	79
Figure 54	Reboot page	80
Figure 55	Manual page	81
Figure 56	T1/E1 connectors	90
Figure 57	Ethernet connectors (MAIN and AUX)	91
Figure 58	Sync In connector	92
Figure 59	Sync Out connector	92
Figure 60	Alarm Connector	93
Figure 61	Console Connector	94
Figure 62	DC Power connector	95
Figure 63	DIP Switch Orientation	96
Figure 64	DC coupler interconnection	101
Figure 65	Basic back-to-back bench test configuration	107

24i_radio.gif @ 300 dpi 1
24i_radio.gif @ 300 dpi i
cover.gif i
enclosure_mount.gif @ 150 dpi 4
euro_conformity.gif 128
euro_no_trash.gif 128
Exalt_logo_RGB.gif 143
fig10.jpg @ 300 dpi 20
fig11.jpg @ 300 dpi 20
fig12.jpg @ 300 dpi 21
fig13.jpg @ 300 dpi 21
fig14.jpg @ 300 dpi 22
fig15.jpg @ 300 dpi 22
fig16.jpg @ 300 dpi 22
fig17.jpg @ 300 dpi 23
fig18.jpg @ 300 dpi 27
fig19.gif @ 300 dpi 35
fig23.gif @ 300 dpi 39
fig24.gif @ 300 dpi 40
fig35.gif @ 300 dpi 63
fig36.gif @ 300 dpi 63
fig4.gif @ 300 dpi 12
fig5.gif @ 300 dpi 13
fig51.gif @ 300 dpi 89
fig51.gif @ 300 dpi 90
fig53.gif @ 300 dpi 91
fig54.gif @ 300 dpi 91
fig55.gif @ 300 dpi 92
fig55.gif @ 300 dpi 93
fig57.gif @ 300 dpi 94
fig58.gif @ 300 dpi 95
fig59.gif @ 300 dpi 101
fig6.gif @ 300 dpi 13
fig60.gif @ 300 dpi 107
fig7.gif @ 300 dpi 14
fig8.gif @ 300 dpi 14
ground_icon.gif @ 300 dpi 23
GUI_access_security_page.gif @ 300 dpi 51
GUI_address_bar.gif @ 300 dpi 36
GUI_admin_settings_page.gif @ 300 dpi 42
GUI_aggregate_user_throughput_page.gif @ 150 dpi 73
GUI_alarms_page.gif @ 300 dpi 66
GUI_diagnostic_charts_page.gif @ 300 dpi 74

GUI_DS3_interface_config_page.gif @ 300 dpi 64
GUI_E1_interface_config_page.gif @ 300 dpi 62
GUI_ethernet_interface_config_page.gif @ 300 dpi 58
GUI_ethernet_utilization_page.gif @ 150 dpi 78
GUI_event_log_page.gif @ 300 dpi 71
GUI_file_activation_page.gif @ 300 dpi 50
GUI_file_transfer_link_page.gif @ 300 dpi 48
GUI_file_transfer_page.gif @ 300 dpi 47
GUI_GPS_info_page.gif @ 300 dpi 65
GUI_login.gif @ 300 dpi 37
GUI_login1.gif @ 150 dpi 37
GUI_manual_page.gif @ 150 dpi 80
GUI_MHS_config_page.gif @ 300 dpi 57
GUI_MHS_status_page.gif @ 300 dpi 68
GUI_performance_page.gif @ 300 dpi 69
GUI_radio_info_page.gif @ 150 dpi 41
GUI_radio_info_page.gif @ 300 dpi 38
GUI_reboot_page.gif @ 300 dpi 79
GUI_snmp_config_page.gif @ 300 dpi 44
GUI_spectrum_analyzer_example.gif @ 300 dpi 77
GUI_spectrum_analyzer_page.gif @ 300 dpi 76
GUI_system_config_page.gif @ 300 dpi 53
GUI_T1_interface_config_page.gif @ 300 dpi 62
GUI_trap_config_page.gif @ 300 dpi 45
GUI_user_throughput_page.gif @ 150 dpi 72
GUI_VLAN_config_page.gif @ 300 dpi 59
help_icon.gif @ 150 dpi 72
indoor_mount.gif @ 150 dpi 4