



| InterReach Fusion Wideband

Installation, Operation, and Reference Manual

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REVISION HISTORY

ISSUE	DATE	REASON FOR CHANGE
1	7/2008	First release
2	10/2008	Add Fusion Wideband 1900/AWS product content
3	8/2009	Add Fusion Wideband 700/AWS and 700 MIMO product content
4	5/2010	Add Fusion Wideband 700 (Lower ABC) MIMO product content
5	9/2011	Add Fusion Wideband 2600 MIMO product content
6	11/2012	Add Fusion Wideband 700 ABC/AWS HP/AWS HP and Fusion Wideband 700 UC/AWS HP/AWS HP product content
7	11/2013	Add Fusion Wideband 2100 HP/1800 HP and Fusion Wideband 850/1900 HP/AWP HP product content
8	7/2014	Add Fusion Wideband 2100 HP/2600 HP product content
9	3/2015	Add Fusion Wideband 2500/2500 product content.

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PURPOSE AND SCOPE

This document describes the InterReach Fusion Wideband system.

- [“InterReach Fusion Wideband System Description” on page 5](#)
This chapter provides an overview of the Fusion Wideband hardware and OA&M capabilities. This chapter also contains system specifications and RF end-to-end performance tables.
- [“Fusion Wideband Main Hub” on page 29](#)
This chapter illustrates and describes the Fusion Wideband Main Hub, including connector and LED descriptions, and unit specifications.
- [“Fusion Wideband Expansion Hub” on page 41](#)
This chapter illustrates and describes the Expansion Hub, including connector and LED descriptions, and unit specification.
- [“Remote Access Unit” on page 51](#)
This chapter illustrates and describes the Remote Access Unit, including connector and LED descriptions, and unit specifications.
- [“Designing a Fusion Wideband Solution” on page 61](#)
This chapter provides tools to aid you in designing your Fusion Wideband system, including tables of the maximum output Power Per Carrier at the RAU and formulas and tables for calculating path loss, coverage distance, and link budget.
- [“Installing Fusion Wideband” on page 105](#)
This chapter provides installation procedures, requirements, safety precautions, and checklists. The installation procedures include guidelines for troubleshooting using the LEDs as you install the units.
- [“Replacing Fusion Wideband Components” on page 175](#)
This chapter provides installation procedures and considerations when you are replacing an Fusion Wideband component in an operating system.
- [“Maintenance and Troubleshooting” on page 181](#)
This chapter provides contact information and troubleshooting tables.
- [“Appendix A: Cables and Connectors” on page 191](#)
This appendix provides connector and cable descriptions and requirements. It also includes cable strapping, connector crimping tools, and diagrams.
- [“Appendix B: Compliance” on page 203](#)
This appendix lists safety and radio/EMC approvals.
- [“Appendix C: Faults, Warnings, Status Tables for Fusion, Fusion Wideband, Fusion SingleStar” on page 209](#)
This appendix lists all system alarm messages.

CONVENTIONS USED IN THIS MANUAL

The following table lists the type style conventions used in this manual.

Measurements

This manual lists measurements first in metric units, and then in U. S. Customary System of units in parentheses. For example: < 5.5 kg (< 12 lbs.) or 0° to 45°C (32° to 113°F).

Document Cautions and Notes

Two types of messages, identified below, appear in the text:

CAUTION! Caution text indicates operations or steps that could cause personal injury, induce a safety problem in a managed device, destroy or corrupt information, or interrupt or stop services.

NOTE: Note text contains information about special circumstances.

Document Fonts

You will find the following font conventions in use throughout the document.

- **This font** represents a reference to an EMS dialog box, menu item, configuration option, or other parameter.
- **<This Font>** in angle brackets represents a reference to an EMS dialog box, menu item, configuration option, or other parameter that is a variable. The text within the angle brackets changes according to a **get** or **set** command. For example:
 - The **Password for <username> has been changed** message displays.
 - The **Password for JohnSmith has been changed** message displays.
- **This font** represents non-variable text that you type at a prompt.
- **THIS FONT** represents keys that you need to press on your keyboard.

RELATED PUBLICATIONS

- *AdminBrowser User Manual*, TE part number D-620607-0-20
- *FlexWave Focus Configuration, Installation, and Reference Manual*; TE part number 8500-10
- *InterReach Unison Installation, Operation, and Reference Manual*; TE part number 8700-50

You can download Fusion user documentation from the TE Customer Portal (see [“Accessing the TE Customer Portal”](#) on page 230).

INTERREACH FUSION WIDEBAND SYSTEM DESCRIPTION

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SYSTEM OVERVIEW

InterReach Fusion Wideband is an intelligent fiber optics/CATV, multi-band wireless networking system designed to handle both wireless voice and data communications over licensed frequencies. It provides high-quality, ubiquitous, seamless access to the wireless network in large buildings.

Fusion Wideband provides RF characteristics designed for large public and private facilities such as campus environments, airports, shopping malls, subways, convention centers, sports venues, and so on. Fusion Wideband uses microprocessors to enable key capabilities such as software-selectable band settings, automatic gain control, ability to incrementally adjust downlink/uplink gain, end-to-end alarming of all components and the associated cable infrastructure, and a host of additional capabilities.

Wireless Standards and Air Interface Protocols

The Fusion Wideband system supports major wireless standards and air interface protocols in use around the world, including:

- **Frequencies**—700 MHz, 800 MHz, 850 MHz, 1700 MHz, 1800 MHz, 1900 MHz, 2100 MHz, 2500 MHz, 2600 MHz
- **Voice Protocols**—AMPS, CDMA, GSM/EGSM, LTE, TDMA, WCDMA
- **Data Protocols**—1xRTT, CDPD, CDMA2000, EDGE, EV-DO, GPRS, LTE, Paging, WCDMA.

Configurable Bands

The Fusion Wideband system supports three configurable bands:

- **Band 1** in 60 MHz—can be configured for 700 MHz, 800 MHz, 1900 MHz, 2100 MHz, 2500 MHz, or 2600 MHz
- **Band 2** in 75 MHz—can be configured for 1700 MHz, 1800 MHz, 1900 MHz, 2100 MHz, 2500 MHz, or 2600 MHz
- **Band 3** (only used for North America: FSN-W2-808519-1, FSN-W2-7021-1, FSN-W2-7070-1, FSN-W2-7575-1, FSN-W4-702121-1-HP, FSN-W4-752121-1-HP, and FSN-W5-851921-1-HP). For example, the FSN-W2-808519-1 RAU Band 3 is a 25 MHz sub-band of the 60 MHz Band and Band 1 is an 18 MHz sub-band of the 60 MHz Band.

Band 1, Band 2, and Band 3 support all protocols.

Fusion Wideband Remote Access Units (RAUs) contain combinations of Band 1, Band 2, and Band 3 frequencies to support various world areas. These frequencies are 1800 MHz/2100 MHz for Europe, the Middle East, and Asia, or 800 MHz/850 MHz/1900 MHz for North America. Refer to [Table 4 on page 16](#) for a specific list of supported RAUs.

Key System Features

The Fusion Wideband system has the following key system features.

- **Multi-Band**, supports two or more full-band frequencies for spectrum growth.
- **Superior RF performance**, particularly in the areas of IP3 and noise figure.
- **High downlink composite power and low uplink noise figure** enables support of a large number of channels and larger coverage footprint per antenna.
- **Software configurable Main and Expansion Hubs**, allow the frequency bands to be configured in the field.
- **Either single-mode or multi-mode fiber** can be used, supporting flexible cabling alternatives (in addition to standard CATV 75 Ohm cabling). You can select the cabling type to meet the resident cabling infrastructure of the facility and unique building topologies.
- **Extended system “reach.”** Using single-mode fiber, fiber runs can be as long as 6 kilometers (creating a total system “wingspan” of 12 kilometers). Alternatively, with multi-mode fiber, fiber runs can be as long as 500 meters.

-
- **Standard 75 Ohm CATV cable**, if using CommScope 2065V, 2279V, and 2293K cables (or equivalent), can be run up to
 - 130 meters for RG-59 cable
 - 140 meters for RG-6 cable
 - 235 meters for RG-11 cable.
 - **Flexible RF configuration capabilities**, including:
 - System gain, with the ability to manually set gain in 1 dB steps, from 0 to 15 dB, on both downlink and uplink.
 - RAU:
 - RAU uplink and downlink gain can be independently attenuated at 0 or 10 dB.
 - Uplink level control protects the system from input overload and can be optimized for either a single operator or multiple operators/protocols.
 - VSWR check on RAU reports if there is a disconnected antenna.
 - **Firmware updates** are downloaded (either locally or remotely) to the system when any modifications are made to the product, including the addition of new software capabilities and services.
 - **OA&M capabilities**, including fault isolation to the field replaceable unit, reporting of all fault and warning conditions, and user-friendly web browser user interface OA&M software package.

SYSTEM HARDWARE

The InterReach Fusion Wideband system consists of three modular components:

- 19" rack-mountable Main Hub
 - connects to up to four Expansion Hubs (except for the One Port Main Hub configuration that supports 1 Expansion Hub)
 - converts RF signals to optical IF on the downlink; optical IF-to-RF on the uplink
 - microprocessor controlled (for alarms, monitoring, and control)
 - auto-configurable bands
 - simplex interface to RF source
 - periodically polls all downstream RAUs for system status, and automatically reports any fault or warning conditions.
- 19" rack mountable Expansion Hub
 - connects to up to eight Remote Access Units
 - optical signal conversion to electrical on the downlink; electrical to optical on the uplink
 - microprocessor controlled (for alarms, monitoring, and control)
 - software configurable band (based on commands from the Main Hub)
 - supplies DC power to RAUs over CATV cable.
- Remote Access Unit (RAU)
 - converts IF signals to RF on the downlink; RF-to-IF on the uplink
 - microprocessor controlled (for alarms, monitoring, and control)
 - multi-band protocol independent, frequency specific units.

The minimum configuration of a Fusion Wideband system is one Main Hub, one Expansion Hub, and one RAU (1-1-1). The maximum configuration of a system is one Main Hub, four Expansion Hubs, and 32 RAUs (1-4-32). Multiple systems can be combined to provide larger configurations.

NOTE: The Fusion Wideband One Port Main Hub (PN: FSN-W1-MH-2-1P, FSN-W1-MH-3-1P, FSN-W2-MH-3-1P, FSN-W3-MH-1P, FSN-W4-MH-1P, and FSN-W5-MH-1P) configuration is a cost-reduced version of the Fusion Wideband Main Hub and supports only one Expansion Hub (up to 8 RAUs).

CAUTION! The Fusion Wideband One Port Main Hub is "software locked" to 1 port 2 fiber ports. Additional ports are disabled internally. Do not attempt to remove the front panel fiber port plate, as doing so voids the product warranty.



Figure 1. Fusion Wideband System Hardware



Figure 2. Fusion Wideband One Port System Hardware

SYSTEM OA&M CAPABILITIES

InterReach Fusion Wideband is microprocessor controlled and contains firmware to enable much of the operations, administration, and maintenance (OA&M) functionality.

Complete alarming, from each unit in the system (defined as a Fusion Wideband Main Hub and all of its associated Expansion Hubs and Remote Access Units) and the cabling infrastructure is available. All events occurring in a system are automatically reported to the Main Hub. The Main Hub monitors system status and communicates that status using the following methods:

- Normally closed (NC) alarm contact closures can be tied to standard NC alarm monitoring systems or directly to a Base Station (BTS) for basic alarm monitoring.
- Connection Methods:
 - The Main Hub’s front panel RJ-45 port connects directly to a PC (for local Ethernet access).
 - The Main Hub’s front panel RS-232 serial port connects directly to a modem (for remote access).
 - Remote access is also available with an optional 100BASE-T LAN switch connection to the RJ-45 port.

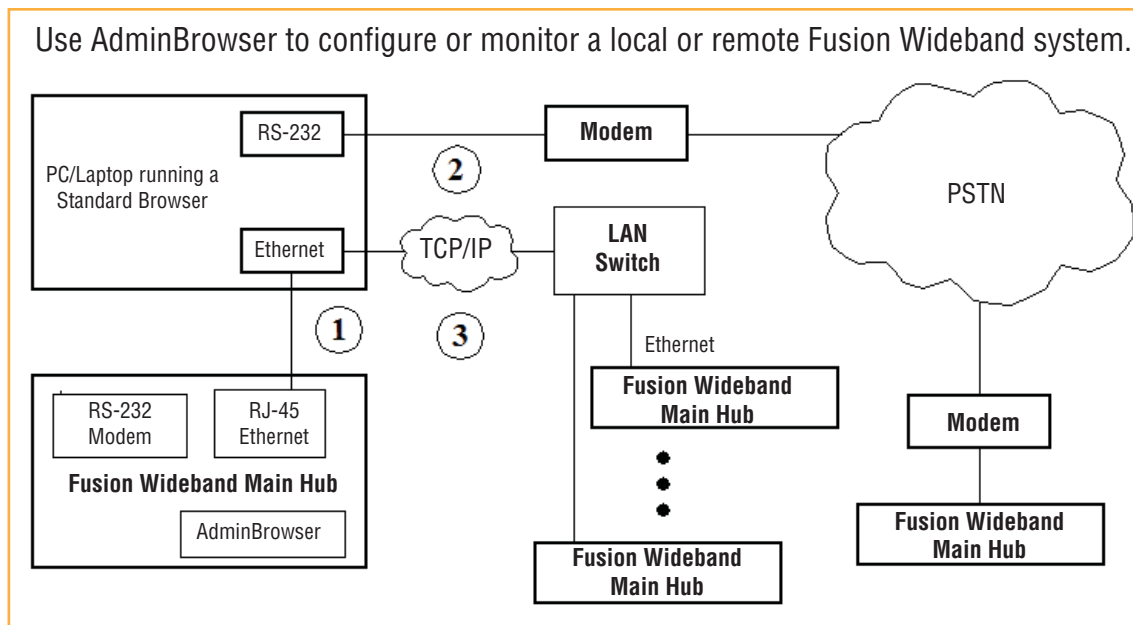


Figure 3. Three Methods for OA&M Communications

AdminBrowser OA&M software runs on the Fusion Wideband Main Hub microprocessor and communicates to its downstream Expansion Hubs and associated RAUs. Using AdminBrowser, you can perform the following from any standard web browser (such as Internet Explorer) running on your PC/laptop system:

- configure a newly installed system
- change system parameters
- perform an end-to-end system test
- query system status.

Refer to the *AdminBrowser User Manual* (D-620607-0-20) for information about installing and using the AdminBrowser software.

System Monitoring and Reporting

Each Fusion Wideband Main Hub in the system constantly monitors itself, its Expansion Hubs, and their downstream RAUs for internal fault and warning conditions. The results of this monitoring are stored in memory and compared against new results.

When a Main or Expansion Hub detects a change in status, it reports a fault or warning alarm. Faults are also indicated locally by red STATUS LEDs. Both faults and warnings are reported to the AdminBrowser software and displayed on a PC/laptop connected to the Main Hub's RJ-45 port. Passive antennas connected to the RAUs are not monitored automatically (perform a System Test to retrieve status information about antennas).

Using AdminBrowser, you can install a new system or new components, change system parameters, and query system status. [Figure 4](#) illustrates how the system reports its status to AdminBrowser.

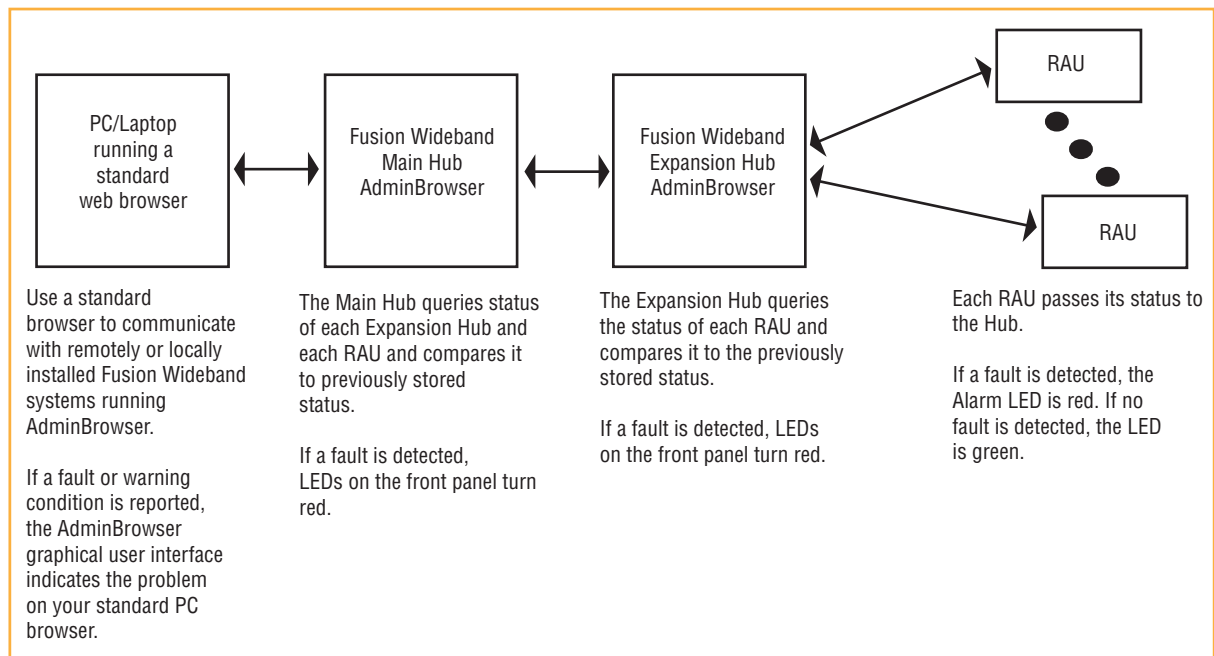


Figure 4. System Monitoring and Reporting

Using Alarm Contacts

You can connect the DB-9 female connector on the rear panel of the Fusion Wideband Main Hub to a local BTS or to a daisy-chained series of Fusion and/or FlexWave Focus systems.

When you connect FlexWave Focus or a BTS to the Fusion Wideband, the Fusion Wideband Main Hub outputs the alarms (alarm source), and then FlexWave Focus or the BTS receives the alarms (alarm sense). This is described in [“Alarm Source” on page 157](#).

SYSTEM CONNECTIVITY

The double-star architecture of the Fusion Wideband system, illustrated in [Figure 5](#), provides excellent system scalability and reliability. The system requires only one pair of fibers for eight antenna points. This makes any system expansion, such as adding an extra antenna for additional coverage, potentially as easy as pulling an extra CATV cable.

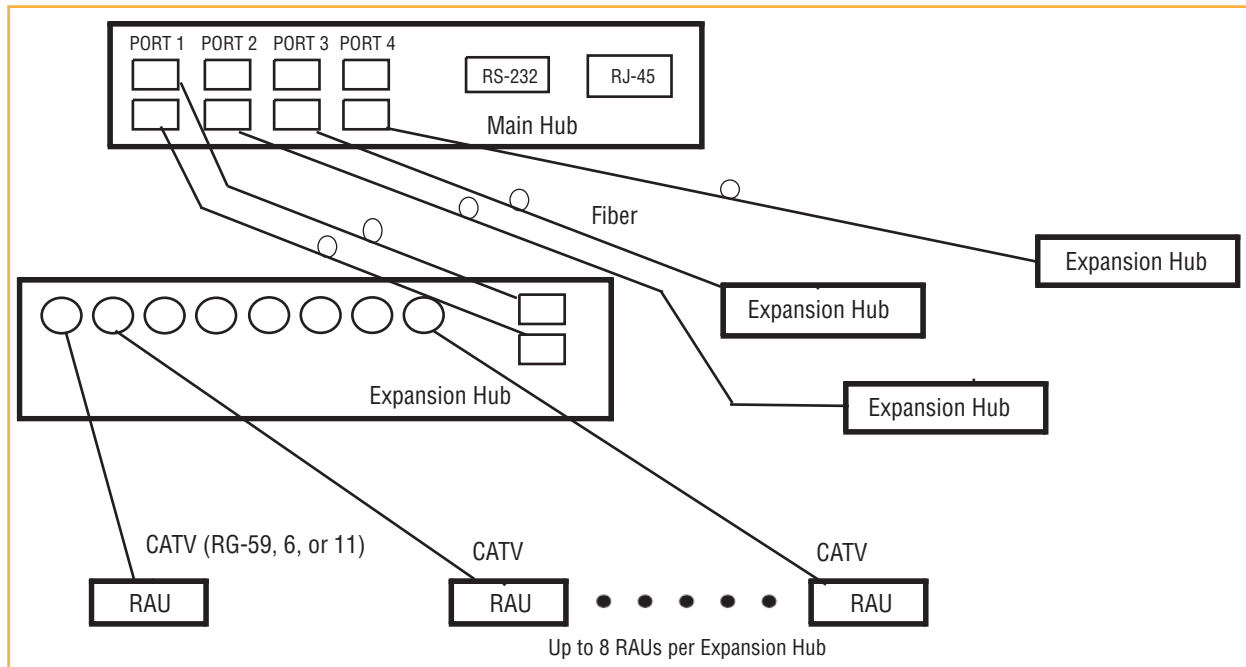


Figure 5. Fusion Wideband's Double Star Architecture

SYSTEM OPERATION

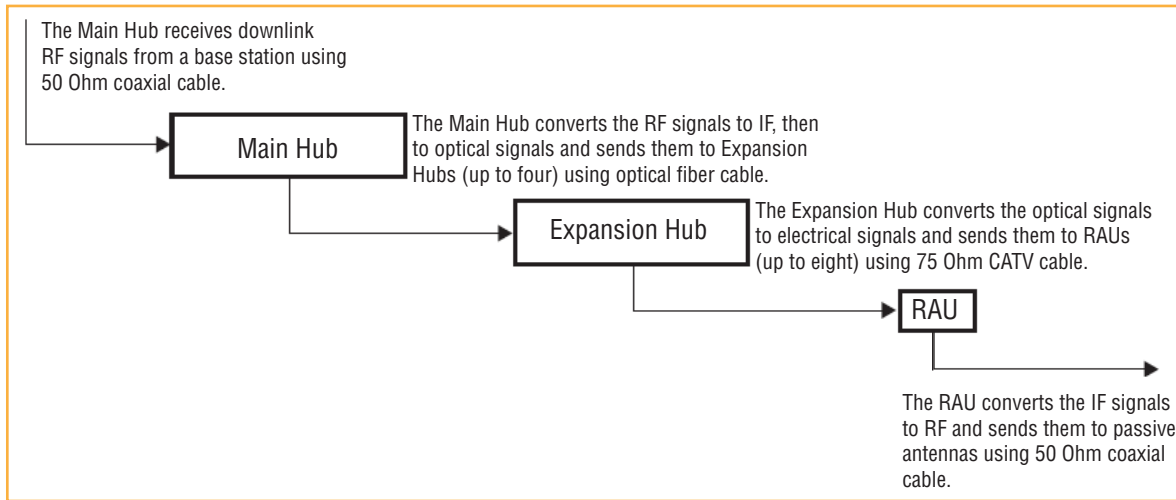


Figure 6. Downlink (BTS to Wireless Devices)

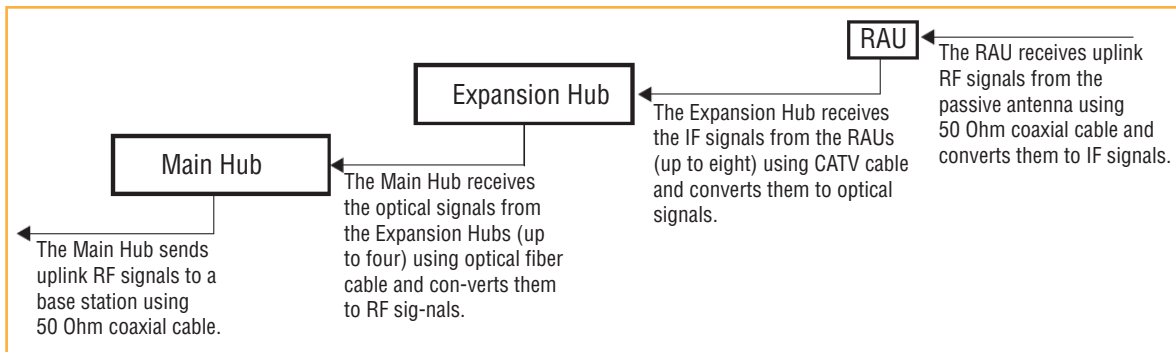


Figure 7. Uplink (Wireless Devices to BTS)

SYSTEM SPECIFICATIONS

Table 1. Physical Specifications

Parameter	Main Hub	Expansion Hub	Remote Access Unit
IF/RF Connectors	4-type "N" female ^(a) (50 Ohm), 1 Downlink/Uplink pair per band	8-type "F", female (CATV 75 Ohm)	One F, female (CATV -75 Ohm) One N, female ^(b) (antenna-50 Ohm)
External Alarm Connector (contact source)	One, 9-pin D-sub, female	One, 9-pin D-sub, female	—
ADMIN/LAN Interface Connectors	One RJ-45, female One 9-pin D-sub, male for optional modem	One RJ-45, female One 9-pin D-sub, male	—
Fiber Connectors ^(c)	4 pair, SC/APC ^(d)	One pair, SC/APC	—
LED Alarm and Status Indicators	Unit Status (One pair): <ul style="list-style-type: none"> Power Main Hub Status Downstream Unit Status (One per fiber port): <ul style="list-style-type: none"> Expansion Hub/RAU 	Unit Status (One pair): <ul style="list-style-type: none"> Power Expansion Hub Status Fiber Link Status (One pair): <ul style="list-style-type: none"> DL Status UL Status Port Status: <ul style="list-style-type: none"> One per F connector port Link/RAU 	Unit Status (One pair): <ul style="list-style-type: none"> Link Alarm
Power (AC Option)	Rating: 100–240V AC, 1A, 50–60 Hz Operating Range: 90–132V AC/170-250V AC auto-ranging	Rating: 100–240V AC, 6A, 50–60 Hz Operating Range: 90–132V AC/170-250V AC auto-ranging	—
Power (DC Option)	Rating: 38–64V DC, 2.5A	Rating: 38–64V DC, 14A	—
Power Consumption (W)	30	4 RAUs: 290 typical, 360 max. 8 RAUs: 500 typical, 630 Max.	—
Enclosure Dimensions ^(e) (height ´ width ´ depth)	89 mm × 438 mm × 381 mm (3.5 in. × 17.25 in. × 15 in.) 2U	89 mm × 438 mm × 381 mm (3.5 in. × 17.25 in. × 15 in.) 2U	54 mm x 286 mm x 281 mm (2.13 in. × 11.25 in. × 11.13 in.)
Weight	< 5.5 kg (< 12 lbs.)	< 6.6 kg (< 14.5 lbs.)	< 2.1 kg (< 4.6 lbs.)
<p>a 6-type N, female connectors for FSN-W2-MH-1, FSN-W2-MH-3, FSN-W4-MH-1, and FSN-W5-MH-1 Main Hub.</p> <p>b 2-type N, female connectors for FSN-W1-1921-1, FSN-W2-808519-1, FSN-W2-7575-1, FSN-W2-7070-1, FSN-W3-2626-1, FSN-W4-702121-1-HP, FSN-W4-752121-1-HP, FSN-W5-851921-1-HP, and FSN-2525-1-TDD RAUs.</p> <p>c It is critical to system performance that only SC/APC fiber connectors are used throughout the fiber network, including fiber distribution panels.</p> <p>d FSN-W1-MH-2-1P, FSN-W1-MH-3-1P, FSN-W2-MH-3-1P, FSN-W3-MH-1P, FSN-W4-MH-1P, and FSN-W5-MH-1P support only one pair, SP/APC fibers.</p> <p>e Excluding angle-brackets for 19" rack hub mounting of the hub.</p>			

NOTE: **Note: The Fusion Wideband Main Hub's typical power consumption assumes that the CATV RG-59 cable length is no more than 130 meters, the RG-6 cable length is no more than 140 meters, and RG-11 cable length is no more than 235 meters using CommScope 2065V, 2279V, and 2293K cables.**

Table 2. Wavelength and Laser Power Specifications

Wavelength	Measured Output Power	
	Main Hub	Expansion Hub
1310 nm \pm 20 nm	890 μ W	3.8 mW

Table 3. Environmental Specifications

Parameter	Main Hub and Expansion Hub	RAU
Operating Temperature	0° to +45°C (+32° to +113°F)	-25° to +45°C (-13° to +113°F)
Non-operating Temperature	-20° to +85°C (-4° to +185°F)	-25° to +85°C (-13° to +185°F)
Operating Humidity; non-condensing	5% to 95%	5% to 95%

Table 4. Frequency Bands Covered by Fusion Wideband RAUs

Fusion RAU	Part Number	Fusion Band	RF Passband		MAIN HUB/ RAU Band	RAU Bandwidth
			Downlink (MHz)	Uplink (MHz)		
2100/1800	FSN-W1-2118-1	2100	2110-2170	1920-1980	1	60 MHz
2100 HP/1800 HP	FSN-W1-2118-1-HP	1800	1805-1880	1710-1785	2	75 MHz
2100 HP/2600 HP	FSN-W1-2126-1-HP	2100	2110-2170	1920-1980	1	60 MHz
		2600	2620-2690	2500-2570	2	70 MHz
2100 High Power (single-band RAU)	FSN-W1-21HP-1	2100	2110-2170	1920-1980	1	60 MHz
1900/AWS	FSN-W1-1921-1	1900 (A-F)	1930-1990	1850-1910	1	60 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
800/850/1900	FSN-W2-808519-1	800	851-869	806-824	1 (sub-band 1A)	18 MHz
		850	869-894	824-849	3 (sub-band 1B)	25 MHz
		1900 (A - F)	1930-1990	1850-1910	2	60 MHz
700/AWS	FSN-W2-7021-1	700 (Upper C)	746-757	776-787	1 (sub-band 1A)	11 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
700/700 MIMO (Upper C)	FSN-W2-7575-1	700 (Upper C)	746-757	776-787	1 (sub-band 1A)	11 MHz
		700 (Upper C)	746-757	776-787	3 (sub-band 1B)	11 MHz
700/700 MIMO (Lower ABC)	FSN-W2-7070-1	700 (Lower ABC)	728-746	698-716	1 (sub-band 1A)	18 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz

Table 4. Frequency Bands Covered by Fusion Wideband RAUs (Cont.)

Fusion RAU	Part Number	Fusion Band	RF Passband		MAIN HUB/ RAU Band	RAU Bandwidth
			Downlink (MHz)	Uplink (MHz)		
700 ABC/AWS HP/ AWS HP	FSN-W4-702121-1- HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
700 UC/AWS HP/ AWS HP	FSN-W4-752121-1- HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		700 (Upper C)	746-757	776-787	3 (sub-band 1B)	11 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
850/1900 HP/ AWS HP	FSN-W5-851921-1- HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		850	869-894	824-849	3 (sub-band 1B)	25 MHz
		1900 (A - G)	1930-1995	1850-1915	2	65 MHz
2500/2500	FSN-2525-1-TDD	2500	2496-2690	2496-2690	1	66 MHz
		2500	2496-2690	2496-2690	2	66 MHz
2600/2600	FSN-W3-2626-1	2600	2620-2690	2500-2570	1	70 MHz
		2600	2620-2690	2500-2570	2	70 MHz

RF END-TO-END PERFORMANCE

The following tables list the RF end-to-end performance for each protocol.

NOTE: The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated at 0 or 10 dB.

2100/1800 RAU (FSN-W1-2118-1)

Table 5. 2100 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 6. 1800 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

2100 HP/1800 HP (FSN-W1-2118-1-HP)

Table 7. 2100 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	42	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	30	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 8. 1800 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	18	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	42	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	30	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

2100 HP/2600 HP (FSN-W1-2126-1-HP)

Table 9. 2100 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	42	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	30	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 10. 2600 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	4.5	4.5
Output IP3 (dBm)	42	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	30	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

2100 High Power RAU (FSN-W1-21HP-1)

Table 11. 2100 MHz High Power RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB) ^{a,b}	22	15
Ripple with 130 m RG-59 (dB)	4.5	5
Output IP3 (dBm)	44	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	33	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23
<p>a The system Downlink gain is adjustable in 1 dB steps from 7 to 22 dB (the High Power RAU adds 7 dB of Downlink gain).</p> <p>b The system Uplink gain is adjustable in 1 dB steps from 0 to 15 dB.</p>		

1900/AWS RAU (FSN-W1-1921-1)

Table 12. 1900 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 13. AWS RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

800/850/1900 RAU (FSN-W2-808519-1)**Table 14.** 800 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	37	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	25	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 15. 850 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	37	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	25	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 16. 1900 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

700/AWS RAU (FSN-W2-7021-1)

Table 17. 700 MHz (Lower ABC) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	34	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	22	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		20
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		26

Table 18. 700 MHz (Upper C) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	34	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	22	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		20
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		26

Table 19. AWS RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

700/700 (Upper C) MIMO RAU (FSN-W2-7575-1)

Table 20. 700 MHz (Upper C) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

700/700 (Lower ABC) MIMO RAU (FSN-W2-7070-1)

Table 21. 700 MHz (Lower ABC) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

700 ABC/AWS HP/AWS HP RAU (FSN-W4-702121-1-HP)

Table 22. 700 MHz (Lower ABC) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		16
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		22

Table 23. AWS RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	43	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	31	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

700 UC/AWS HP/AWS HP RAU (FSN-W4-752121-1-HP)

Table 24. 700 MHz (Upper C) RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		16
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		22

Table 25. AWS RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	43	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	31	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

850/1900 HP/AWS HP RAU (FSN-W5-851921-1-HP)

Table 26. 850 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	2.5	3
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		16
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		22

Table 27. 1900 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	43	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	31	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

Table 28. AWS RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	3.5	4
Output IP3 (dBm)	43	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	31	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

2500/2500 RAU (FSN-2525-1-TDD)

Table 29. 2500 MHz TDD RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	20	15
Ripple with 130 m RG-59 (dB)	5.0	5.0
Output IP3 (dBm)	42.5	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	32	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

2600/2600 RAU (FSN-W3-2626-1)

Table 30. 2600 MHz RF End-to-End Performance

Parameter	Typical	
	Downlink	Uplink
Average gain with 130 m RG-59 at 25°C (77°F) (dB)	15	15
Ripple with 130 m RG-59 (dB)	4.5	5
Output IP3 (dBm)	38	
Input IP3 (dBm)		-5
Output 1 dB Compression Point (dBm)	26	
Noise Figure 1 MH, 1 EH, 8 RAUs (dB)		17
Noise Figure 1 MH, 4 EH, 32 RAUs (dB)		23

FUSION WIDEBAND MAIN HUB

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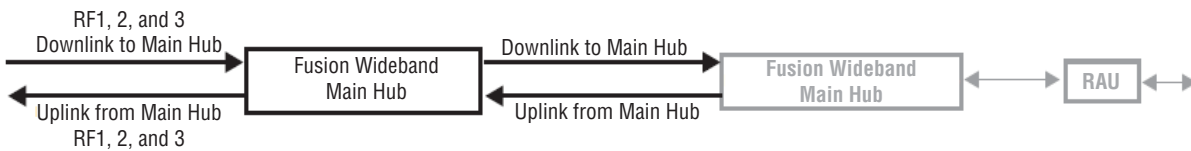
FUSION WIDEBAND MAIN HUB OVERVIEW

The Fusion Wideband Main Hub (shown in [Figure 8](#)) distributes up to three individual (Band 1, 2, and 3) downlink RF signals from a Base Station, repeater, or FlexWave Focus system to up to four Expansion Hubs, which in turn distribute the signals to up to 32 Remote Access Units. The Main Hub also combines uplink signals from the associated Expansion Hubs.

Fusion Wideband is a multi-band system. One RF source (Band 1 or RF1) goes to the 60 MHz band and the other RF source (Band 2 or RF2) goes to the 75 MHz band. Band 3 (or RF3) goes to a 25 MHz sub-band of the 60 MHz band and is functional only with the following RAUs: 800/850/1900, 700/AWS, 700/700 (Upper C) MIMO, 700/700 (Lower ABC) MIMO, 700 ABC/AWS HP/AWS HP, 700 UC/AWS HP/AWS HP, and 850/1900 HP/AWS HP RAU. The system installs in a 19" equipment rack and is usually co-located with the RF source in a telecommunications closet.

Downlink Path: The Main Hub receives up to 3 individual (Band1, 2, or 3) downlink RF signals from a base station, repeater, or FlexWave Focus system using 50 Ohm coaxial cable. It converts the signals to IF then to optical and sends them to up to four Expansion Hubs using fiber optic cable.

The Main Hub also sends OA&M communication to the Expansion Hubs using the fiber optic cable. The Expansion Hubs, in turn, communicate the OA&M information to the RAUs using CATV cable.



Uplink Path: The Main Hub receives uplink optical signals from up to four Expansion Hubs using fiber optic cables. It converts the signals to IF then to RF and sends them to the respective Band1, 2, or 3 base station, repeater, or FlexWave Focus system using 50 Ohm coaxial cable.

The Main Hub also receives status information from the Expansion Hubs and all RAUs using the fiber optic cable.

Figure 8. Main Hub in a Fusion Wideband System

[Figure 9 on page 31](#) shows a detailed view of the major RF and optical functional blocks of the Main Hub.

NOTE: The Fusion Wideband One Port Main Hub (PNs: FSN-W1-MH-2-1P, FSN-W2-MH-3-1P, FSN-W3-MH-1P, FSN-W4-MH-1P, and FSN-W5-MH-1P) is a cost reduced version of the Fusion Wideband Main Hub and supports only one Expansion Hub (up to 8 RAUs).

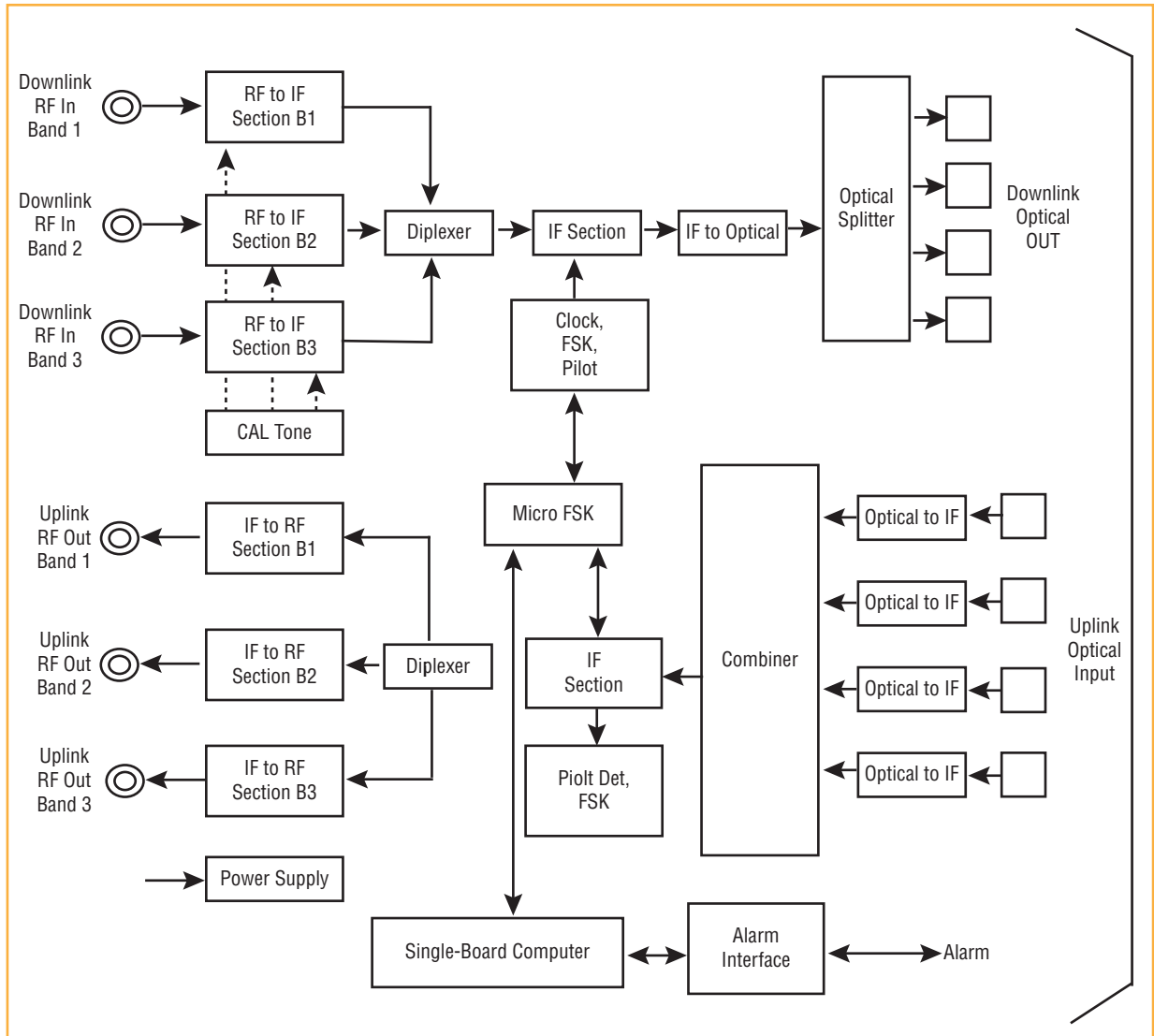
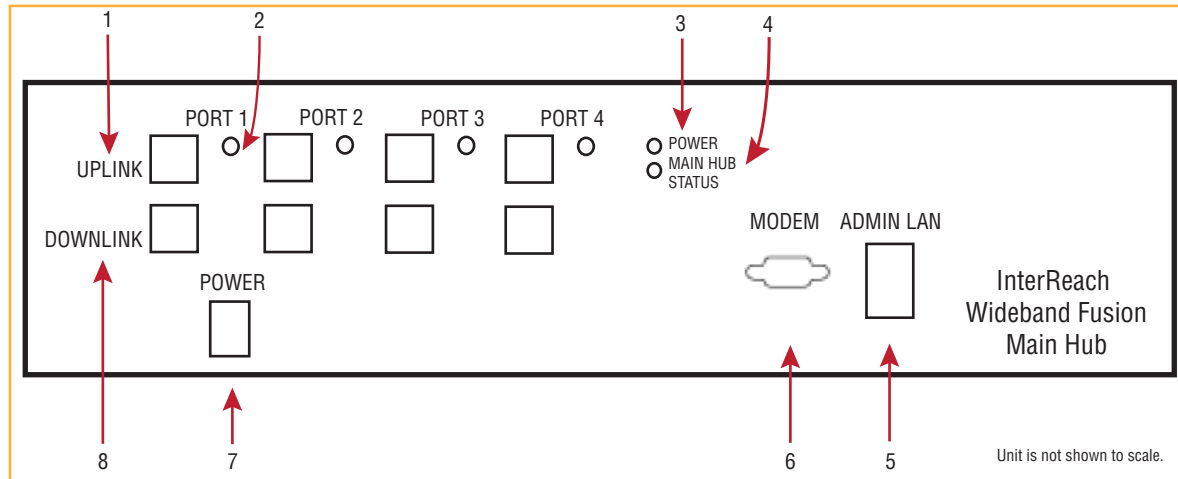


Figure 9. Main Hub Block Diagram

FUSION WIDEBAND MAIN HUB FRONT PANEL



Ref #	Component	Function
1, 8	Port 1 - Port 4 UPLINK and DOWNLINK ports	Four fiber optic ports with corresponding fiber port LEDs (one LED per port) One standard female SC/APC connector per port for MMF/SMF input (UPLINK) and one standard female SC/APC connector per port for MMF/SMF output (DOWNLINK). See “Uplink/Downlink Optical-Fiber Ports” on page 33.
2	STATUS LED (unlabeled)	One LED per port for port link status and downstream unit status; see “Fiber Port LEDs” on page 35.
3	POWER LED	See “Main Hub LED Indicators” on page 33.
4	MAIN HUB STATUS LED	
5	ADMIN/LAN connector	One RJ-45 female connector for system communication and diagnostics using a PC/laptop with direct connect or using a LAN switch; see “Communications RS-232 Serial Connector” on page 35.
6	Modem connector	One 9-pin D-sub male connector for system remote dial-up communication and diagnostics using a modem; see “Communications RS-232 Serial Connector” on page 35.
7	Power switch	Turns the Fusion Wideband Main Hub on or off.

Uplink/Downlink Optical-Fiber Ports

The uplink/downlink optical-fiber ports transmit and receive optical signals between the Main Hub and up to four Expansion Hubs using industry-standard SMF or MMF cable. There are four fiber ports on the front panel of the Main Hub—one port per Expansion Hub. Each optical-fiber port has two female SC/APC connectors:

- **UPLINK Connector**—receives the uplink optical signals from an Expansion Hub.
- **DOWNLINK Connector**—transmits the downlink optical signals to an Expansion Hub.

CAUTION! To avoid damaging the Main Hub's fiber connector ports, use only SC/APC fiber cable connectors when using either single-mode or multi-mode fiber. Additionally, it is critical to system performance that only SC/APC fiber connectors are used throughout the fiber network, including fiber distribution panels.

Main Hub LED Indicators

The unit's front panel LEDs indicate faults and commanded or fault lockouts. The LEDs do not indicate warnings or whether the system test has been performed. Use the LEDs to provide basic information only, or as a backup when you are not using AdminBrowser.

Upon power up, the Main Hub goes through a 20-second test to check the LED lamps. During this time, the LEDs blink through the states shown in [Table 31 on page 34](#), letting you visually verify that the LED lamps and the firmware are functioning properly. Upon completion of initialization, the LEDs stay in one of the first two states shown in [Table 31 on page 34](#).

The Main Hub automatically sends the program bands command to all connected RAUs. A mismatched band causes a fault message to be displayed in AdminBrowser and places the RAU in a disabled condition.

NOTE: Refer to [“Troubleshooting Using LEDs” on page 185](#) for troubleshooting using the LEDs.

NOTE: AdminBrowser should be used for troubleshooting the system. Only use LEDs for backup or confirmation. However, if there are communication problems within the system, the LEDs may provide additional information that is not available using AdminBrowser.

Unit STATUS LEDs

The Main Hub has one pair of STATUS LEDs, labeled POWER and MAIN HUB STATUS, that can be in one of the states shown in [Table 31](#). These LEDs can be:

- Steady green ●
- Steady red ●
- Off—no color (valid only during 90 second power cycle) ○
- Flashing red at 60 Pulses per Minute (PPM) ●

There is no off state when the unit’s power is on.

Table 31. Fusion Wideband Hub STATUS LED States

	LED State	Indicates
● POWER ● STATUS	<ul style="list-style-type: none"> • Green • Green 	<ul style="list-style-type: none"> • The Main Hub is connected to power and all power supplies are operating. • The Main Hub is not reporting a fault; however, the system test may need to be performed or a warning condition may exist. Use AdminBrowser to determine this.
● POWER ● STATUS	<ul style="list-style-type: none"> • Green • Red 	<ul style="list-style-type: none"> • The Main Hub is connected to power and all power supplies are operating. Use AdminBrowser to power status. • The Main Hub is reporting a fault.
● POWER ● STATUS	<ul style="list-style-type: none"> • Green • Flashing green 	<ul style="list-style-type: none"> • The Main Hub is connected to power and all power supplies are operating. Use Admin Browser to determine power status. • The Main Hub is reporting a lockout condition; flashes green at 60 Pulses per Minute (PPM).
● POWER ● STATUS	<ul style="list-style-type: none"> • Green • Red 	<ul style="list-style-type: none"> • The Main Hub is connected to power and all power supplies are operating. • The Main Hub DL input signal level is too high; flashes red at 60 Pulses per Minute (PPM).
● POWER ● STATUS	<ul style="list-style-type: none"> • Red • Red 	<ul style="list-style-type: none"> • One or more power supplies are out-of-specification.
● POWER ● STATUS	<ul style="list-style-type: none"> • Green • Red/Green (alternating) 	<ul style="list-style-type: none"> • After the System CPU is rebooted, the MH STATUS LED blinks red/green while the system tree data is built, power up system test is executed, and all units have their current status updated. • Should the MH STATUS LED blink red/green after initial power up, either the System CPU has rebooted or a component of the software has reset.

Fiber Port LEDs

The Main Hub has one fiber port LED for each of the four fiber ports. The LED can be in one of the states shown in [Table 32 on page 35](#). This LED can be:

- Off ○
- Steady green ●
- Steady red ●
- Flashing red (60 ppm) ●

Table 32. Fusion Wideband Hub Port LED States

	LED State	Indicates
PORT ○	Off	<ul style="list-style-type: none"> • The Expansion Hub is not connected.
PORT ●	Green	<ul style="list-style-type: none"> • The Expansion Hub is connected. • There are no faults from the Expansion Hub or any connected RAU.
PORT ●	Red (60 PPM)	<ul style="list-style-type: none"> • There was a loss of communications with the Expansion Hub.
PORT ●	Red (Steady)	<ul style="list-style-type: none"> • The Expansion Hub is disconnected. • The Expansion Hub or any connected RAU reported a fault.
PORT ●	Green (60-ppm)	<ul style="list-style-type: none"> • The Expansion Hub or any connected RAU reported a lockout condition.

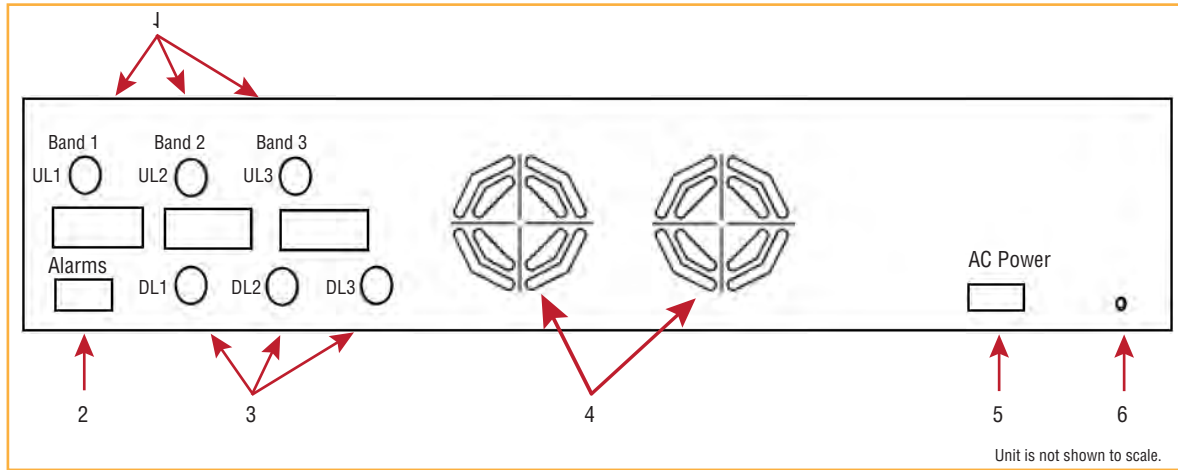
Communications RS-232 Serial Connector

- **Remote Monitoring**—Use a standard serial cable to connect a modem to the 9-pin D-sub male serial connector for remote monitoring or configuring. The cable typically has a DB-9 female and a DB-9 female connector. Refer [“DB-9 to DB-9 Null Modem Cable” on page 201](#) to for the cable pinout diagram.

Remote monitoring is also available by connecting the RJ-45 (ADMIN/LAN) port to a LAN switch for remote Ethernet LAN access or direct dial-up router access.

- **Local Monitoring**—Use a crossover Ethernet cable (PN-4069-ADB) to connect a laptop or PC to the RJ-45 female connector for local monitoring or configuring using the AdminBrowser resident software. The cable typically has a RJ-45 male connector on both ends. Refer to [“TCP/IP Cross-Over Cable” on page 200](#) for the cable pinout.

Fusion Wideband Main Hub Rear Panel



Ref #	Component	Function
1	UL1 - UL3 connectors	Three 50 Ohm N-type connector pairs for each of the 3 bands that transmits uplink RF signals to a repeater, local Base Station, or FlexWave Focus system.
2	Alarms connector	A 9-pin D-sub female connector that provides a contact alarm for fault and warning system alarm monitoring. Table 33 lists the pin function on the 9-pin D-sub connector. This interface can both generate two source contact alarms (Fault and Warning) and sense 3 single external alarm contacts (Alarm Sense Input 1 through 3).
3	DL1 - DL3 connectors	Three 50 Ohm N-type connector pairs for each of the 3 bands that receives downlink RF signals from a repeater, local Base Station, or FlexWave Focus system.
4	Air-exhaust vents	Two vents that allows air to circulate through the unit.
5	AC Power connector	AC power cord connector.
6	Ground lug	Connects the unit to frame ground.

CAUTION! The uplink (UL1 - UL3) and downlink (DL1 - DL3) ports cannot handle a DC power feed from the local Base Station. If DC power is present, a DC block must be used or the Fusion Wideband hub may be damaged.

Table 33. Alarm Connector Functions

Pin	Function
1	Alarm Sense Input (DC Ground)
2	Alarm Sense Input 3
3	Alarm Sense Input 2
4	Warning Source Contact (positive connection)
5	Warning Source Contact (negative connection)
6	DC Ground (common)
7	Fault Source Contact (positive connection)
8	Alarm Sense Input 1
9	Fault Source Contact (negative connection)

MAIN HUB SPECIFICATIONS

Table 34. Main Hub Specifications

Specification	Description
Enclosure Dimensions ^(a) (H x W x D)	89 mm x 438 mm x 381 mm 3.5 in. x 17.25 in. x 15 in. 2U
Weight	<5.5 kg <12 lb
Operating Temperature	0° to +45°C +32° to +113°F
Non-operating Temperature	-20° to +85°C -4° to +185°F
Operating Humidity, non-condensing	5% to 95%
External Alarm Connector (contact closure)	One 9-pin D-sub, female Maximum: 40 mA @ 40V DC Typical: 4 mA @ 12V DC
ADMIN/LAN Interface Connector	One RJ-45, female One 9-pin D-sub, male for optional modem
Fiber Connectors	Four Pair, SC/APC ^(b)
RF Connectors	Four N ^(c) , female (50 Ohm), 1 Downlink/Uplink pair per band
LED Fault and Status Indicators	Unit Status (One pair): <ul style="list-style-type: none"> • Power • Main Hub Status Downstream Unit/Link Status (One per fiber port): <ul style="list-style-type: none"> • Link/E-Hub/RAU
AC Power	Rating 100/240V AC, 1A, 50-60 Hz Operating Range: 90-132V AC/170-250V AC auto-ranging
Power Consumption	30 Watts
MTBF	133,829 hours
<p>a Excluding angle brackets for the 19" rack mounting of the Hub.</p> <p>b It is critical to system performance that only SC/APC fiber connectors are used throughout the fiber network, including fiber distribution panels.</p> <p>c 6 N, female connectors for FSN-W2-MH-1, FSN-W2-MH-3, FSN-W4-MH-1, and FSN-W5-MH-1</p>	

NOTE: The Fusion Wideband One Port Main Hub (PNs: FSN-W1-MH-2-1P, FSN-W2-MH-3-1P, FSN-W3-MH-1P, FSN-W4-MH-1P, and FSN-W5-MH-1P) configuration is a cost reduced version of the Fusion Wideband Main Hub and supports *only one* Expansion Hub (up to 8 RAUs).

FAULTS, WARNINGS, AND STATUS MESSAGES

The Fusion Wideband Main Hub monitors and reports changes or events in system performance to ensure that:

- fiber receivers, amplifiers and IF/RF paths are functioning properly
- Expansion Hubs and Remote Access Units are connected and functioning properly.

Events

An event is classified as fault, warning, or status message, in which

- faults are service impacting
- warnings indicate a possible service impact
- status and informational messages are generally not service impacting.

The Fusion Wideband Main Hub periodically queries attached Expansion Hub and Remote Access Units for their status. Both faults and warnings are reported to a connected PC/laptop running a standard browser communicating with the AdminBrowser software. Only faults are indicated by the POWER, MAIN HUB STATUS, and fiber-optic port LEDs.

For more information regarding the events, refer to:

- [“Appendix C: Faults, Warnings, Status Tables for Fusion, Fusion Wideband, Fusion SingleStar” on page 209](#) for Main Hub
 - faults
 - warnings
 - status messages
- [“Maintenance and Troubleshooting” on page 181](#) for troubleshooting Main Hub LEDs.

View Alarm Preferences

In AdminBrowser 1.0 or higher, use the **Set Alarm Display Preferences** page (shown below) to select the type of events to be displayed.

The screenshot shows the AdminBrowser interface. At the top left is the ADC logo, and at the top right is the INTERREACH FUSION logo. The main header reads "Alarms: Set Alarm Display Preferences". Below this, a note states: "The following settings only affect what messages and icons are displayed. It does not affect what alarms the system is monitoring." There are three radio button options: "Display Faults", "Display Faults and Warnings", and "Display Faults, Warnings, and Statuses". The third option is selected. A button labeled "Set Alarm Display Preferences" is located below the options. At the bottom of the page, there is a copyright notice "© 2008 ADC".

To modify alarm display settings:

- 1 In AdminBrowser, select **Alarms > Set Alarm Display Preferences**.
- 2 Select the desired choice.
- 3 Click **Set Alarm Display Preferences**.

AdminBrowser refreshes and updates the tree view according to the new setting.

NOTE: The setting is strictly visual and only in AdminBrowser. There is no affect on the hardware itself. By default, the event filtering is set to "Enable viewing of Faults only".

The only exception to when the event filtering is ignored is during the Install/Configure command. All events are displayed regardless of the event filtering setting. This ensures a smooth installation.

FUSION WIDEBAND EXPANSION HUB

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EXPANSION HUB OVERVIEW

The Expansion Hub acts an interface between the Main Hub and the Remote Access Unit(s) by converting optical signals to electrical signals and vice versa, as shown in [Figure 10](#). It also supplies control signals and DC power to operate the RAUs, and passes status information from the RAUs to the Main Hub.

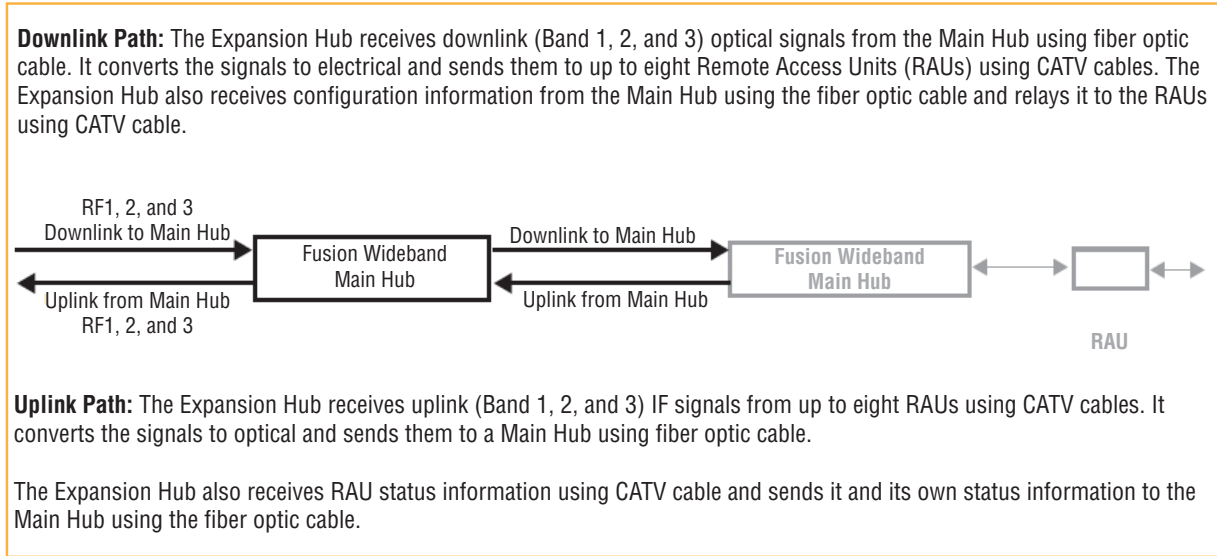


Figure 10. Expansion Hub in a Fusion Wideband System

[Figure 11 on page 43](#) shows a block diagram for the Expansion Hub within a Fusion system.

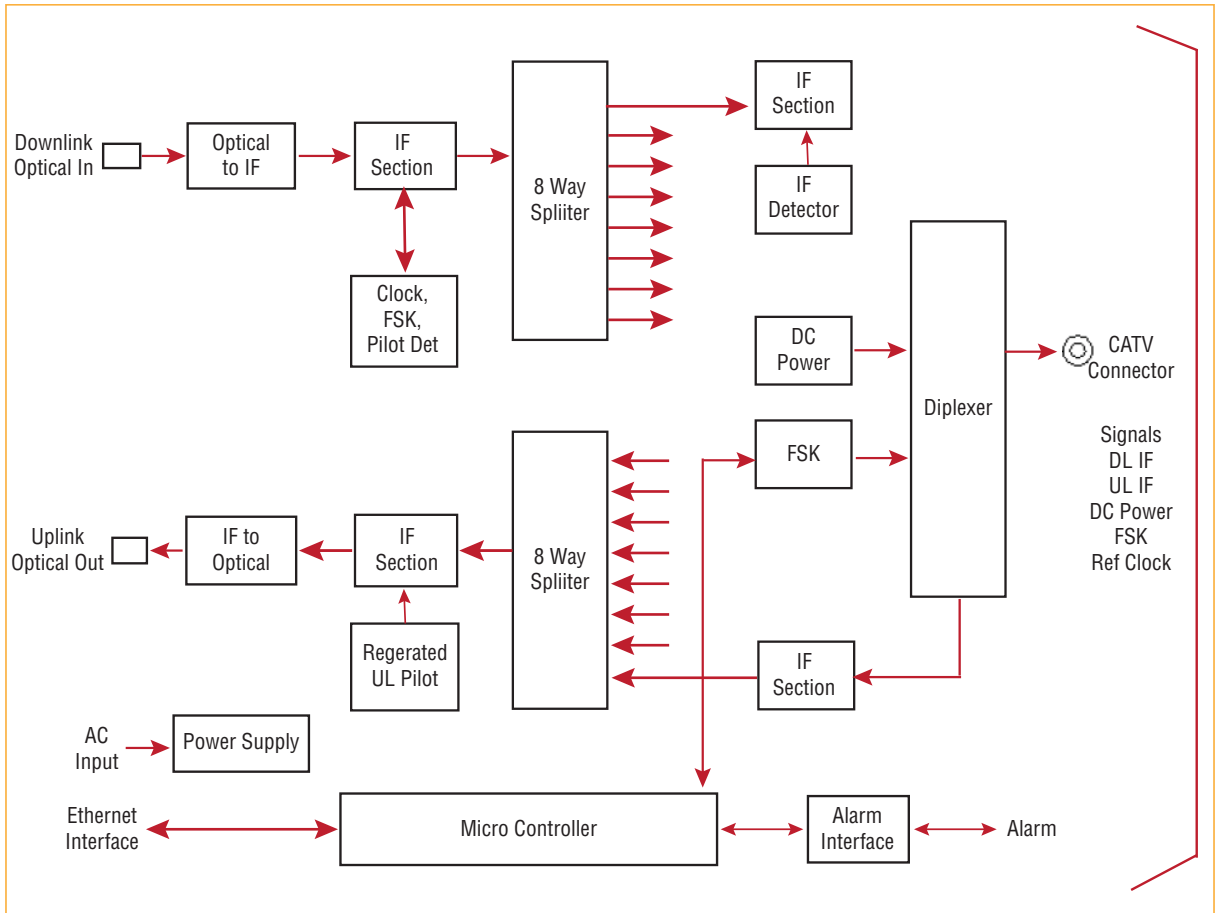
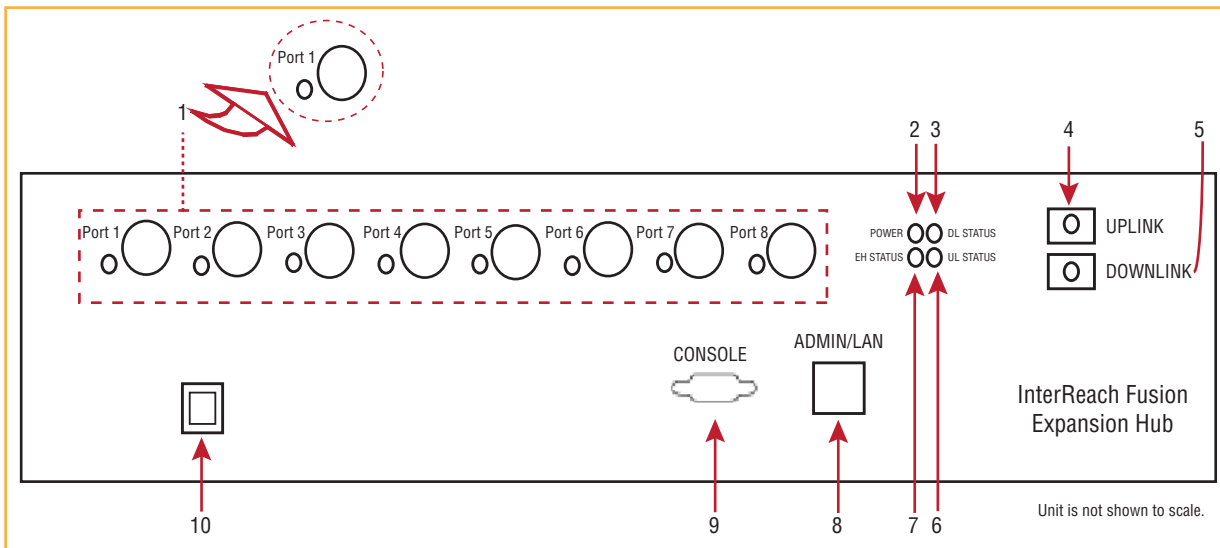


Figure 11. Expansion Hub Block Diagram

Expansion Hub Front Panel



Ref #		Description
1	One port LED and connector pair for eight ports, labeled Port n , where $n = 1 - 8$	<ul style="list-style-type: none"> One port LED per type F connector port for link status and downstream RAU status (8 pair total). See “Unit Status and DL/UL STATUS LEDs” on page 45. Eight CATV cable, type F connectors for the CATV cables used to transmit and receive signals to and from RAUs. Use only 75 ohm type F connectors on the CATV cable. The CATV cable also delivers DC electrical power to the RAUs. The Expansion Hub’s DC voltage output is 54V DC nominal. A current limiting circuit protects the Hub if any port draws excessive power. <p>Note: For system performance, it is important to use only low loss solid copper center conductor CATV cable with quality type F connectors that use captive centerpin connectors. Refer to “Appendix A: Cables and Connectors” on page 191 for approved cables and connectors.</p> <ul style="list-style-type: none"> For information on the Port LEDs, see “Port STATUS LEDs” on page 47.
2	POWER LED	
3	DL STATUS LED	See “Unit Status and DL/UL STATUS LEDs” on page 45.
4, 5	UPLINK and DOWNLINK fiber-optic ports	One standard female SC/APC connector for MMF/SMF output (UPLINK), and one standard female SC/APC connector for MMF/SMF input (DOWNLINK). See “Optical Fiber Uplink/Downlink Connectors” on page 45.
6	UL STATUS LED	See “Unit Status and DL/UL STATUS LEDs” on page 45.
7	EH STATUS LED	
8	ADMIN/LAN connector	One RJ-45 female connector for system communication and diagnostics using a PC/laptop with direct connect or using a LAN switch. Use a crossover Ethernet cable (PN-4069-ADB) to directly connect a laptop or PC to the RJ-45 female connector for local monitoring or configuring the Expansion Hub and associated RAUs using the AdminBrowser-EH resident software. The cable typically has a RJ-45 male connector on both ends. Refer to “TCP/IP Cross-Over Cable” on page 200 for the cable pinout and the AdminBrowser manual.
9	CONSOLE connector	This console port is only used by TE manufacturing test purposes. DO NOT CONNECT ANYTHING TO IT.
10	Power switch	Turns the Expansion Hub on or off.

Optical Fiber Uplink/Downlink Connectors

The optical fiber uplink/downlink port transmits and receives optical signals between the Expansion Hub and the Main Hub using industry-standard SMF or MMF cable. The fiber port has two female SC/APC connectors:

- **Optical Fiber Uplink Connector**—The UPLINK connector transmits (output) uplink optical signals to the Main Hub.
- **Optical Fiber Downlink Connector**—The DOWNLINK connector receives (input) downlink optical signals from the Main Hub.

CAUTION! To avoid damaging the Expansion Hub’s fiber connector ports, use only SC/APC fiber cable connectors. Additionally, use only SC/APC fiber connectors throughout the fiber network, including fiber distribution panels. This is critical for ensuring system performance.

LED Indicators

The unit’s front panel LEDs indicate fault conditions and commanded or fault lockouts. The LEDs do not indicate warnings or whether the system test has been performed. Only use the LEDs to provide basic information or as a backup when you are not using AdminBrowser.

Upon power up, the Expansion Hub goes through a five-second test to check the LED lamps. During this time, the LEDs blink through the states shown in [Table 35](#), letting you visually verify that the LED lamps and the firmware are functioning properly.

NOTE: Refer to “[Maintenance and Troubleshooting](#)” on [page 181](#) for troubleshooting using the LEDs.

Unit Status and DL/UL STATUS LEDs

The Expansion Hub unit status and DL/UL STATUS LEDs can be in one of the states shown in [Table 35](#). These LEDs can be:

- Steady green
- Steady red
- Off

Table 35. Expansion Hub Unit Status and DL/UL STATUS LED States

	LED State	Indicates
POWER ● ● DL STATUS EH STATUS ● ● UL STATUS	Green/Green Green/Green	<ul style="list-style-type: none"> • The Expansion Hub is connected to power and all power supplies are operating. • The Expansion Hub is not reporting a fault or lockout condition; but the system test may need to be performed or a warning condition could exist (use AdminManager to determine this). • Optical power received is above minimum (the Main Hub is connected) although the cable optical loss may be greater than recommended maximum. • Optical power transmitted (uplink laser) is normal and communications with the Main Hub are normal.

Table 35. Expansion Hub Unit Status and DL/UL STATUS LED States (Cont.)

	LED State	Indicates
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Green Red/Green	<ul style="list-style-type: none"> Optical power received is above minimum (the Main Hub is connected) although the cable optical loss may be greater than recommended maximum. Optical power transmitted (uplink laser) is normal and communications with the Main Hub are normal. The Expansion Hub is reporting a fault.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Green Green/Green (60-ppm)	<ul style="list-style-type: none"> Optical power received is above minimum (the Main Hub is connected) although the cable optical loss may be greater than recommended maximum. Optical power transmitted (uplink laser) is normal and communications with the Main Hub are normal. The Expansion Hub is reporting a commanded lockout.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Red Red/Green	<ul style="list-style-type: none"> A fault condition was detected; optical power received is below minimum. (The Main Hub is not connected, is not powered, or the Main Hub's downlink laser has failed, or the downlink fiber is disconnected or damaged.)
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Green Red/Red	<ul style="list-style-type: none"> The Expansion Hub is reporting a fault condition. Optical power received is above minimum (Main Hub is connected) although the cable optical loss may be greater than recommended maximum. Optical power transmitted is below minimum (Expansion Hub uplink laser has failed; unable to communicate with Main Hub). UL STATUS LED state must be checked within the first 90 seconds after power on. If initially green, then red after 90 seconds, it means that there is no communication with the Main Hub. If red on power up, replace the Expansion Hub.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Red Red/Red	<ul style="list-style-type: none"> Optical power received is below minimum (the Main Hub is not connected, is not powered, or the Main Hub's downlink laser has failed, or the downlink fiber is disconnected or damaged.) Optical power transmitted is below minimum (the Expansion Hub uplink laser has failed; is unable to communicate with the Main Hub). UL STATUS LED state must be checked within the first 90 seconds after power on. If initially green, then red after 90 seconds, it means that there is no communication with the Main Hub. If red on power up, the uplink laser has failed, replace the Expansion Hub.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Off Green/Off	<ul style="list-style-type: none"> Expansion Hub is in factory test mode, return it to the factory.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Red/Don't Care Red/Don't Care	<ul style="list-style-type: none"> One or more power supplies are out of specification. The hub needs to be replaced.
POWER ●● DL STATUS EH STATUS ●● UL STATUS	Green/Red Off/Off	<ul style="list-style-type: none"> Expansion Hub failure. The Hub must be replaced.

Port STATUS LEDs

The Expansion Hub has a PORT LED for each of the eight 75 Ohm, Type F ports. The PORT LEDs can be in one of the states shown in [Table 36](#). These LEDs can be:

- Off
- Steady green
- Steady red
- Off—no color (valid only during 90 second power cycle)
- Flashing red at 60 Pulses per Minute (PPM)

Table 36. Fusion Expansion Hub Port LED States

	LED State	Indicates
PORT ○	Off	The RAU is not connected.
PORT ●	Green	The RAU is connected or there are no faults from the RAU.
PORT ●	Flashing red	Flashing red at 60 Pulses per Minute (PPM). <ul style="list-style-type: none"> ● The RAU was disconnected. ● The RAU is not communicating. ● The RAU port power is tripped.
PORT ●	Red	The RAU is disconnected or the RAU is reporting a fault.
PORT ●	Flashing green	Flashing green at 60 Pulses per Minute (PPM). <ul style="list-style-type: none"> ● The RAU is disconnected. ● The RAU is reporting a lockout condition.

EXPANSION HUB REAR PANEL

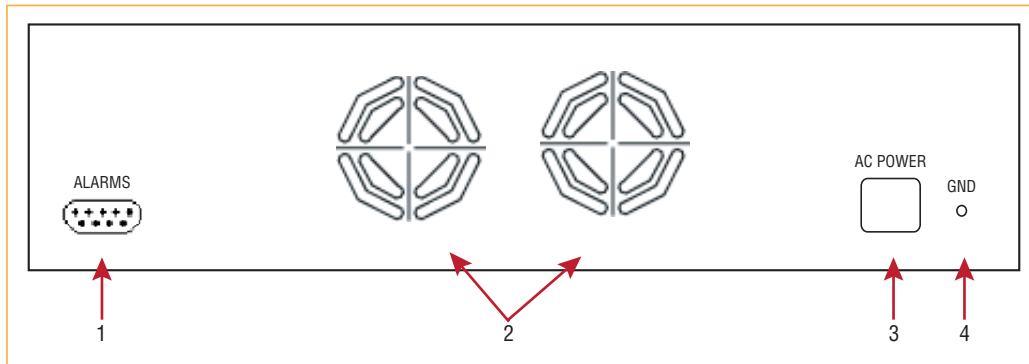


Figure 12. Expansion Hub Rear Panel

Ref #	Description
1	AC power cord connector
2	Two air exhaust vents
3	One 9-pin D-sub female connector labeled ALARMS for contact alarm monitoring; for pinouts, see Table 37 . This interface can monitor three single external alarm contacts (Alarm Sense Input 1). This interface monitors the output contact closures from a Universal Power Supply (UPS). Verify the output contact closure state (normally closed or normally open) of the UPS, and set the appropriate contact definition using AdminBrowser. <ul style="list-style-type: none"> • Faults are service impacting. • Warnings indicate a possible service impact. • Status messages are generally not service impacting.
4	Ground lug labeled GROUND for connecting unit to frame ground

Table 37. 9-Pin D-Sub Pin Connector Functions

Pin	Function
1	Alarm Sense Input (DC Ground)
2	Alarm Sense Input 3
3	Alarm Sense Input 2
4	N/C
5	N/C
6	DC Ground (common)
7	N/C
8	Alarm Sense Input 1
9	N/C

FAULTS, WARNINGS, AND STATUS MESSAGES

Both fault and warning conditions of the Expansion Hub and attached RAUs are reported to the Main Hub. Only faults are indicated by LEDs.

For more information, refer to [“Appendix C: Faults, Warnings, Status Tables for Fusion, Fusion Wideband, Fusion SingleStar”](#) on page 209.

NOTE: You can select what type of events AdminBrowser displays. Refer to [“View Alarm Preferences”](#) on page 39.

EXPANSION HUB SPECIFICATIONS

Table 38. Expansion Hub Specifications

Specification	Description
Enclosure Dimensions (H × W × D)	89 mm x 438 mm x 381 mm 3.5 in. x 17.25 in. x 15 in. 2U
Weight	< 6.6 kg < 14.5 lb.
Operating Temperature	0° to +45°C +32° to +113°F
Non-operating Temperature	-20° to +85°C -4° to +185°F
Operating Humidity, non-condensing	5% to 95%
CATV Connectors ^(a)	8 F, female (CATV - 75 Ohm)
Fiber Connectors ^(b)	1 Pair, SC/APC
LED Alarm and Status Indicators	Unit Status (1 pair): <ul style="list-style-type: none"> • POWER • E-HUB STATUS Fiber Link Status (1 pair): <ul style="list-style-type: none"> • DL STATUS • UL STATUS Port Status (1 pair per CATV port): <ul style="list-style-type: none"> • Link/RAU
External Alarm Connector (contact sense monitor)	1 9-pin D-sub, female
AC Power (Volts) (47–63 Hz)	Rating: 100/240V AC, 6A, 50-60 Hz Operating Range: 90-132V AC/170-250V AC auto-ranging
Power Consumption (W)	4 RAUs: 290 typical, 360 maximum 8 RAUs: 500 typical, 630 maximum
MTBF	54,477 hours
a It is important that you use only recommended CATV 75 Ohm cable with quality F connectors. b It is critical to system performance that only SC/APC fiber connectors are used throughout the fiber network, including fiber distribution panels.	

REMOTE ACCESS UNIT

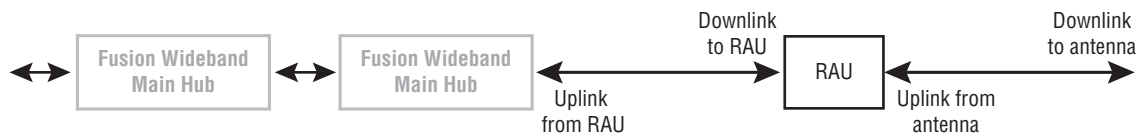
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OVERVIEW

The Remote Access Unit (RAU) is an active transceiver that connects to an Expansion Hub using industry-standard CATV cable, which delivers RF signals, configuration information, and electrical power to the RAU.

RAUs pass converted IF to RF (Downlink) and converted RF to IF (Uplink) signals between an Expansion Hub and an attached passive antenna, where the signals are transmitted to wireless devices as shown in [Figure 13](#). [Figure 14](#) shows the RAU block diagram.

Downlink Path: The RAU receives downlink IF signals from a Fusion Wideband Hub using 75 Ohm CATV cable. It converts the signals to RF and sends them to a passive RF antenna using 50 Ohm coaxial cable. Also, the RAU receives configuration information from the Fusion Wideband Hub using the 75 Ohm CATV cable.



Uplink Path: The RAU receives uplink RF signals from a passive RF antenna using 50 Ohm coaxial cable. It converts the signals to IF and sends them to a Fusion Wideband Hub using 75 Ohm CATV cable. Also, the RAU sends its status information to the Fusion Wideband Hub using CATV cable.

The RAU receives 54VDC power from the Fusion Wideband Hub port through the 75 Ohm CATV cable center pin.

Figure 13. Remote Access Unit in a Fusion Wideband System

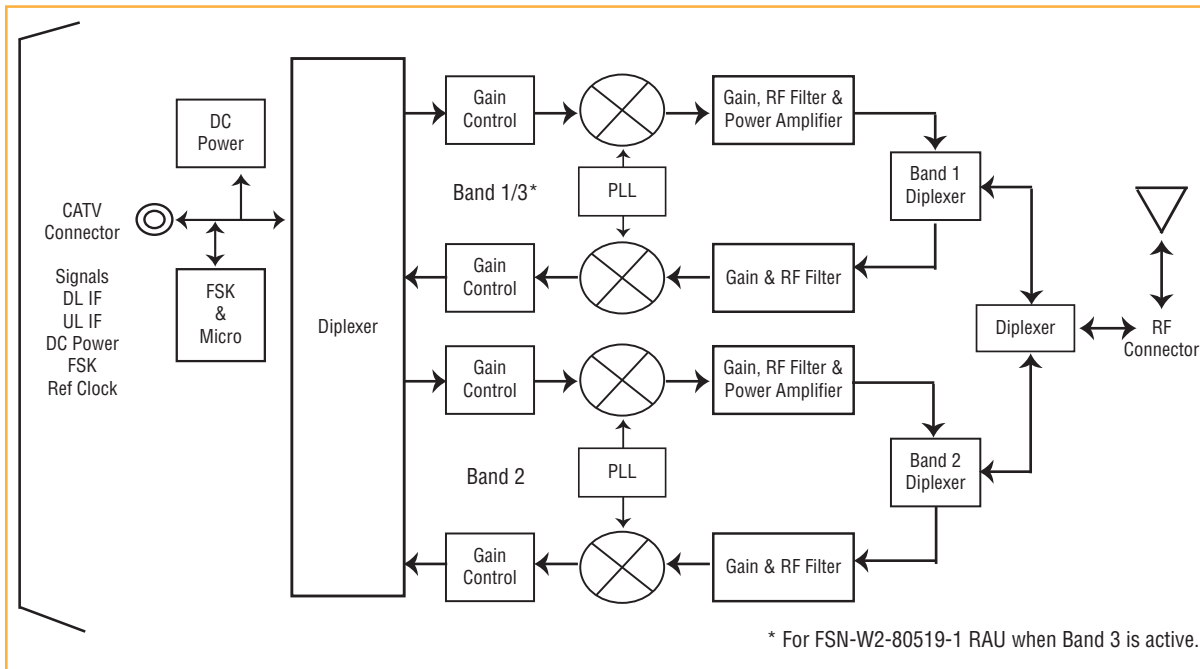


Figure 14. Remote Access Unit Block Diagram (Multiband)

The Fusion Wideband RAUs are manufactured to a specific set of bands: one 60 MHz Band 1 (split into two sub-bands 1A and 1B for the FSN-W2-808519-1 RAU), and one 75 MHz Band 2. [Table 39](#) lists the Fusion Wideband RAUs, the Fusion Wideband Band, and the frequency bands they cover.

Table 39. Frequency Bands Covered by Fusion Wideband RAUs

Fusion Wideband RAU	Part Number	Fusion Wide-band Band	RF Passband			
			Downlink (MHz)	Uplink (MHz)	MAIN HUB/RAU Band	RAU Band-width
2100/1800 2100 HP/1800 HP	FSN-W1-2118-1	2100	2110-2170	1920-1980	1	60 MHz
	FSN-W1-2118-1-HP	1800	1805-1880	1710-1785	2	75 MHz
2100 HP/2600 HP	FSN-W1-2126-1-HP	2100	2110-2170	1920-1980	1	60 MHz
		2600	2620-2690	2500-2570	2	70 MHz
2100 High Power (single-band RAU)	FSN-W1-21HP-1	2100	2110-2170	1920-1980	1	60 MHz
1900/AWS	FSN-W1-1921-1	1900 (A-F)	1930-1990	1850-1910	1	60 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
800/850/1900	FSN-W2-808519-1	800	851-869	806-824	1 (sub-band 1A)	18 MHz
		850	869-894	824-849	3 (sub-band 1B)	25 MHz
		1900 (A-F)	1930-1990	1850-1910	2	60 MHz
700/AWS	FSN-W2-7021-1	700 (Upper C)	746-757	776-787	1 (sub-band 1A)	11 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
700/700 MIMO (Upper C)	FSN-W2-7575-1	700 (Upper C)	746-757	776-787	1 (sub-band 1A)	11 MHz
		700 (Upper C)	746-757	776-787	3 (sub-band 1B)	11 MHz
700/700 MIMO (Lower ABC)	FSN-W2-7070-1	700 (Lower ABC)	728-746	698-716	1 (sub-band 1A)	18 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz
700 ABC/AWS HP/AWS HP	FSN-W4-702121-1-HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		700 (Lower ABC)	728-746	698-716	3 (sub-band 1B)	18 MHz
		AWS	2110-2155	1710-1755	2	45 MHz
700 UC/AWS HP/AWS HP	FSN-W4-752121-1-HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		700 (Upper C)	746-757	776-787	3 (sub-band 1B)	11 MHz
		AWS	2110-2155	1710-1755	2	45 MHz

Table 39. Frequency Bands Covered by Fusion Wideband RAUs (Cont.)

Fusion Wideband RAU	Part Number	Fusion Wide-band Band	RF Passband			
			Downlink (MHz)	Uplink (MHz)	MAIN HUB/RAU Band	RAU Band-width
850/1900 HP/AWS HP	FSN-W5-851921-1-HP	AWS	2110-2155	1710-1755	1 (sub-band 1A)	45 MHz
		850	869-894	824-849	3 (sub-band 1B)	25 MHz
		1900 (A - G)	1930-1995	1850-1915	2	65 MHz
2500/2500	FSN-2525-1-TDD	2500	2496-2690	2496-2690	1	66 MHz
		2500	2496-2690	2496-2690	2	66 MHz
2600/2600	FSN-W3-2626-1	2600	2620-2690	2500-2570	1	70 MHz
		2600	2620-2690	2500-2570	2	70 MHz

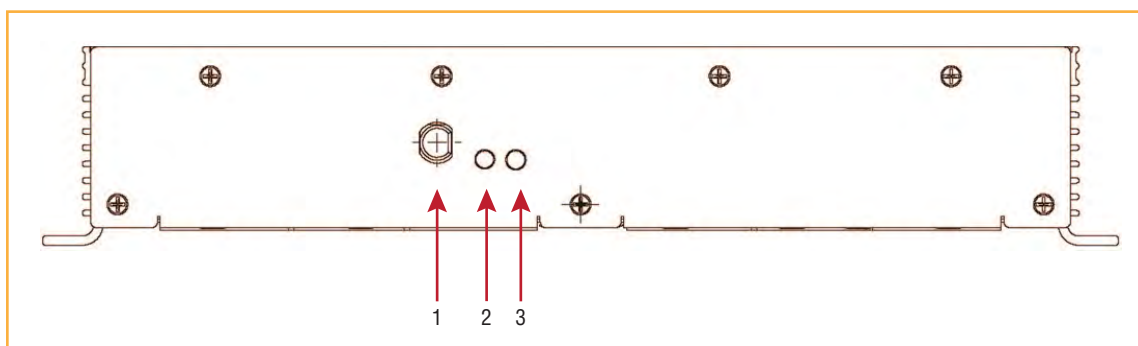
Table 40 lists the system gain as it pertains to different CATV cable lengths.

Table 40. System Gain (Loss) Relative to CATV Cable Length

Cable Type	CommScope Part Number	Plenum Rated	Solid Copper Conductor	Copper Clad Conductor	Zero-loss RF Maximum Length (meters)	Distance RF is 10dB Below Input RF (meters)
RG-59	2065V	Yes	X		130	180
	2022V	Yes		X	100	100*
	5572R	No		X	95	95*
	5565	No	X		130	180
RG-6	2279V	Yes	X		140	190
	2275V	Yes		X	140	150*
	5726	No		X	140	140*
	5765	No	X		140	190
RG-11	2293K	Yes	X		235	320
	2285K	Yes		X	235	300*
	5913	No		X	235	300*

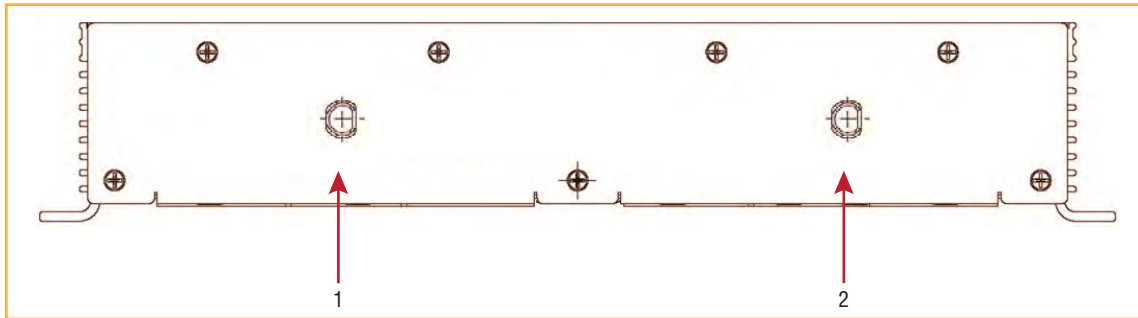
* Exceeding the distance of copper-clad cable will result in the attached RAU becoming non-functional. If the distance of a cable run is at its maximum and is of concern, TE recommends the use of solid copper cable to ensure successful operation

RAU Front Panel



Ref #		Description
1	75 Ohm Type-F Connector	The RAU has one type-F female connector on its front panel that connects it to a Fusion Wideband Hub using CATV 75 Ohm cable. Use RG-59, 6, or 11 solid copper center conductor cables. Note: For system performance, it is important that you use only low loss, solid copper center conductor CATV cable with quality F connectors that use captive centerpin conductors. Refer to “Appendix A: Cables and Connectors” on page 191 for specific information.
2	LINK LED	Indicates whether the RAU is receiving power and communications from the Fusion Wideband Main Hub.
3	ALARM LED	Indicates whether the RAU has any active alarm states.

RAU Back Panel



Ref #		Description
1, 2	50 Ohm Type-N Connector	<p>The RAU has one or two female type-N connectors, that is a duplexed RF input/output port that connects to a standard 50W passive antenna using coaxial cable. When there is only one N connector, it will be on the right (in the position of reference item 2 above). The following RAUs have two female type-N connectors:</p> <ul style="list-style-type: none"> • FSN-W1-1921-1 • FSN-W2-808519-1 • FSN-W2-7070-1 • FSN-W2-7575-1 • FSN-W3-2626-1 • FSN-W4-702121-1-HP • FSN-W4-752121-1-HP • FSN-W5-851921-1-HP • FSN-2525-1-TDD.

RAU LED INDICATORS

Upon power up, the RAU goes through a two-second test to check the LED lamps. During this time, the LEDs blink green/green red/red, letting you visually verify that the LED lamps and the firmware are functioning properly.

NOTE: Refer to “Maintenance and Troubleshooting” on page 181 for troubleshooting using the LEDs.

STATUS LEDs

The RAU LEDs can be in one of the states shown in Table 41. These LEDs can be:

- Steady green
- Steady red
- Off

Table 41. Remote Access Unit LED States

	LED State	Indicates
LINK ○ ALARM ○	Off Off	The RAU is not receiving DC power.
LINK ● ALARM ●	Green Green	The RAU is powered and is not indicating a fault condition. Communication with the Fusion Wideband Hub is normal; however, the system test may need to be performed or a warning condition may exist (use AdminBrowser to determine this).
LINK ● ALARM ●	Green Red	The RAU is indicating a fault or lockout condition, but communication with the Fusion Wideband Hub is normal.
LINK ● ALARM ●	Red Red	The RAU is reporting a fault and is not able to communicate with the Fusion Wideband Hub.
LINK ● ALARM ●	Green (60-ppm) Green (60-ppm)	The RAU is reporting a lockout condition, but communication with the Fusion Wideband Hub is normal.

FAULTS AND WARNINGS

Both fault and warning conditions are reported to the Fusion Wideband Hub where they are stored. Only faults are indicated by the RAU STATUS LEDs.

For more information, refer to [“Appendix C: Faults, Warnings, Status Tables for Fusion, Fusion Wideband, Fusion SingleStar”](#) on page 209.

REMOTE ACCESS UNIT SPECIFICATIONS

Table 42. Remote Access Unit Specifications

Specification	Description
Dimensions (H × W × D)	54 mm × 286 mm × 281 mm (2.13 in. × 11.25 in. × 11.13 in.)
Weight	< 2.1 kg (< 4.6 lb.)
Operating Temperature	–25° to +45°C (–13° to +113°F)
Non-operating Temperature	–25° to +85°C (–13° to +185°F)
Operating Humidity, non-condensing	5% to 95%
RF Connectors	One Type-F, female (CATV - 75 ohms) One Type-N, female* (coaxial 50 ohms)
LED Alarm and Status Indicators	Unit Status (1 pair): <ul style="list-style-type: none"> • Link • Alarm
Maximum Heat Dissipation (W)	50 typical, 64 max (from the Hub)
MTBF	202,684 hours
* Two type N female connectors for FSN-W1-1921-1, FSN-W2-808519-1, FSN-W2-7070-1, FSN-W2-7575-1, FSN-W3-2626-1, FSN-W4-702121-1-HP, FSN-W4-752121-1-HP, FSN-W5-851921-1-HP, and FSN-2525-1-TDD RAUs	

NOTE: For system performance, it is important that you use only low loss, solid copper center conductor CATV cable with quality F connectors that use captive centerpin conductors. Refer to [“Appendix A: Cables and Connectors”](#) on page 191 for more information.

DESIGNING A FUSION WIDEBAND SOLUTION

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DESIGN OVERVIEW

Designing a Fusion Wideband solution is a matter of determining coverage and capacity needs. This requires the following steps:

1 Determine the wireless service provider's requirements; refer to "Downlink RSSI Design Goal" on page 64.

The following information is typically provided by the service provider:

- Frequency (for example, 1900 MHz)
- Band (for example, "A-F" band in the PCS spectrum)
- Protocol (for example, CDMA, GSM, 1xRTT, GPRS, and so on)
- Number of sectors and peak capacity per sector (translates to the number of RF carriers that the system will have to transmit)
- Downlink RSSI design goal (RSSI, received signal strength at the wireless handset, for example, -85 dBm)

The design goal is always a stronger signal than the mobile phone needs. It includes inherent factors which affect performance.

- RF source (Base Station or bidirectional amplifier or repeater), type of equipment if possible.

2 Determine the downlink Power Per Carrier from the RF source through the DAS; refer to "Maximum Output Power Per Carrier" on page 65.

The maximum Power Per Carrier is a function of modulation type, the number of RF carriers, signal quality issues, regulatory emissions requirements, and Fusion Wideband's RF performance. Power Per Carrier decreases as the number of carriers increases.

3 Develop an RF link budget; refer to "Estimating RF Coverage" on page 83.

Knowing both the Power Per Carrier and RSSI design goal, you can develop an RF downlink link budget which estimates the allowable path loss from a RAU's antenna to the wireless handset.

$$\text{allowable path loss} = \text{Power Per Carrier} + \text{antenna gain} - \text{design goal}$$

Satisfactory performance can be expected as long as path loss is below this level.

4 Determine the in-building environment; refer to “Estimating RF Coverage” on page 83.

- Determine which areas of the building require coverage (entire building, public areas, parking levels, and so on).
- Obtain floor plans to determine floor space in a building and the wall layout of the proposed areas to be covered. Floor plans are also useful when you are selecting antenna locations.
- If possible, determine the building’s construction materials (sheetrock, metal, concrete, and so on).
- Determine the type of environment:
 - open layout (for example, a convention center)
 - dense, close walls (for example, a hospital)
 - mixed use (for example, an office building with hard wall offices and cubicles).

5 Determine the appropriate estimated path loss slope that corresponds to the type of building and its layout, and estimate the coverage distance for each RAU; refer to “Estimating RF Coverage” on page 83.

Use the Path Loss Slope (PLS), which gives a value to the RF propagation characteristics within the building, to convert the RF link budget into an estimate of the coverage distance per antenna. This helps establish the quantities of Fusion Wideband equipment you need. The actual path loss slope that corresponds to the specific RF environment inside the building can also be determined empirically by performing an RF site-survey of the building. This involves transmitting a calibrated tone for a fixed antenna and making measurements with a mobile antenna throughout the area surrounding the transmitter.

6 Determine the items required to connect to the Base Station; refer to “Connecting a Main Hub to a Base Station” on page 101.

Once you know the quantities of Fusion Wideband equipment to be used, you can determine the accessories (combiners/dividers, surge suppressors, repeaters, attenuators, circulators, and so on.) required to connect the system to the Base Station.

The individual elements that must be considered in designing a Fusion Wideband solution are explained in the following sections.

NOTE: Access the TE Customer Portal for on-line dimensioning and design tools; see “Accessing the TE Customer Portal” on page 230.

DOWNLINK RSSI DESIGN GOAL

Wireless service providers typically provide a minimum downlink signal level and an associated confidence factor when specifying coverage requirements. These two figures of merit are a function of wireless handset sensitivity and margins for fading and body loss. Wireless handset sensitivity is the weakest signal that the handset can process reliably and is a combination of the thermal noise in the channel, noise figure of the handset receiver front end and minimum required SNR. Fade margins for multipath fading (fast or small-scale) and log-normal shadow fading (slow or large-scale) are determined by the desired confidence factor, and other factors. Downlink Received Signal Strength Indicator (RSSI) design goal calculations for the GSM protocol are shown below for a 95% area coverage confidence factor.

Noise Power	-121 dBm
10 Log (KT)+10 Log (200 kHz); K=1.38X10 ⁻²³ , T=300 degrees Kelvin	
Wireless Handset Noise Figure	8 dB
Required SNR	9 dB
Multipath Fade Margin	6 dB
95% Reliability for Rician K=6 dB	
Log-normal Fade Margin	10 dB
95% Area/87% Edge Reliability for 35 dB PLS and 9 dB Sigma	
Body Attenuation	+ 3 dB
Downlink RSSI Design Goal (P _{DesignGoal})	-85 dBm
Signal level received by wireless handset at edge of coverage area	

Downlink design goals on the order of -85 dBm are typical for protocols such as GSM. Wireless service providers may choose a higher level to ensure that in-building signal dominates any macro signal that may be leaking into the building.

MAXIMUM OUTPUT POWER PER CARRIER

The following tables show the recommended maximum Power Per Carrier out of the RAU 50 Ohm Type-N connector for different frequencies, protocols, and numbers of carriers. These maximum levels are dictated by RF signal quality and regulatory emissions issues. In general, as the number of RF carrier increases, the maximum Power Per Carrier decreases. If these levels are exceeded, signal quality will be degraded and/or regulator requirements will be violated. The maximum input power to the Hub is determined by subtracting the system gain from the maximum output power of the RAU. System gain is software selectable from 0 dB to 15 dB in 1 dB steps. Additionally, both the uplink and downlink gain of each RAU can be attenuated 0 or 10 dB.

When connecting a Hub to a Base Station or repeater, attenuation on the downlink is typically required to avoid exceeding Fusion Wideband's maximum output power recommendations.

CAUTION! Exceeding the maximum input power may cause permanent damage to the Hub. Do not exceed the maximum composite input power of 1W (+30 dBm) to the Hub at any time.

NOTE: These specifications are for downlink power at the RAU output (excluding antenna).

700/AWS RAU (FSN-W2-7021-1)

Table 43. 700 MHz (Lower A, B, C) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	14.0	14.0
2	11.0	11.0
3	9.0	9.0
4	8.0	8.0
5	7.0	7.0
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.		

Table 44. 700 MHz (Upper C) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)
	LTE
1	14.0
2	11.0
3	9.0
4	8.0
5	7.0
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.	

Table 45. AWS Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	18.0	18.0
2	15.0	15.0
3	13.0	13.0
4	12.0	12.0
5	11.0	11.0
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.		

700 MHz (Upper C) MIMO RAU (FSN-W2-7575-1)

Table 46. 700 MHz (Upper C) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)
	LTE
1	18.0
2	15.0
3	13.0
4	12.0
5	11.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

700 MHz (Lower ABC) MIMO RAU (FSN-W2-7070-1)

Table 47. 700 MHz (Lower ABC) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	18.0	18.0
2	15.0	15.0
3	13.0	13.0
4	12.0	12.0
5	11.0	11.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

700 ABC/AWS HP/AWS HP RAU (FSN-W4-702121-1-HP)

Table 48. 700 MHz (Lower A, B, C) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)
	LTE
1	18.0
2	15.0
3	13.0
4	12.0
5	11.0
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.	

Table 49. AWS Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	23.0	23.0
2	20.0	20.0
3	18.0	18.0
4	17.0	17.0
5	16.0	16.0
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.		

700 UC/AWS HP/AWS HP RAU (FSN-W4-752121-1-HP)

Table 50. 700 MHz (Upper C) Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)
	LTE
1	18.0
2	15.0
3	13.0
4	12.0
5	11.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 51. AWS Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	23.0	23.0
2	20.0	20.0
3	18.0	18.0
4	17.0	17.0
5	16.0	16.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

800/850/1900 RAU (FSN-W2-808519-1)

Table 52. 800 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)					
	CDMA 2000	LTE	iDEN	Analog FM	APCO 25 CQPSK	APCO 25 C4FM
1	17.0	17.0	16.5	24.0	21.0	24.0
2	14.0	14.0	13.0	19.0	16.0	18.5
3	12.0	12.0	10.5	15.5	13.5	15.0
4	11.0	11.0	9.0	12.5	11.5	12.5
5	10.0	10.0	8.0	11.0	10.0	10.5
6	9.0		7.0	9.5	8.5	9.0
7	8.5		6.0	8.5	8.0	8.0
8	8.0		5.5	7.5	7.0	7.5
9			5.0	7.0	6.5	6.5
10			4.5	6.0	6.0	6.0
11			4.0			
12			3.5			
13			3.0			
14			3.0			
15			2.5			
16		2.0				

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 53. 850 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	25.0	22.0	18.0	18.0	18.0
2	19.0	16.5	15.0	15.0	15.0
3	15.5	13.0	13.0	13.0	13.0
4	13.0	11.0	12.0	12.0	12.0
5	11.0	9.5	11.0	11.0	11.0
6	10.0	8.5	10.0		
7	9.0	8.0	9.5		
8	8.0	7.0	9.0		
9	7.5	6.5			
10	7.0	6.0			
11	6.5	5.5			
12	6.0	5.0			
13	5.5	4.5			
14	5.5	4.5			
15	5.0	4.0			
16	4.5	4.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 54. 1900 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	26.0	23.0	18.0	18.0	18.0
2	20.0	17.5	15.0	15.0	15.0
3	16.5	14.0	13.0	13.0	13.0
4	14.0	12.0	12.0	12.0	12.0
5	12.0	10.5	11.0	11.0	11.0
6	11.0	9.5	10.0		
7	10.0	9.0	9.5		
8	9.0	8.0	9.0		
9	8.5	7.5			
10	8.0	7.0			
11	7.5	6.5			
12	7.0	6.0			
13	6.5	5.5			
14	6.5	5.5			
15	6.0	5.0			
16	5.5	5.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

850/1900 HP/AWS HP RAU (FSN-W5-851921-1-HP)**Table 55.** 850 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	26.0	23.0	18.0	18.0	18.0
2	20.0	17.5	15.0	15.0	15.0
3	16.5	14.0	13.0	13.0	13.0
4	14.0	12.0	12.0	12.0	12.0
5	12.0	10.5	11.0	11.0	11.0
6	11.0	9.5	10.0		
7	10.0	9.0	9.5		
8	9.0	8.0	9.0		
9	8.5	7.5			
10	8.0	7.0			
11	7.5	6.5			
12	7.0	6.0			
13	6.5	5.5			
14	6.5	5.5			
15	6.0	5.0			
16	5.5	5.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 56. 1900 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	26.0	26.0	23.0	23.0	23.0
2	23.0	22.5	20.0	20.0	20.0
3	21.0	19.0	18.0	18.0	18.0
4	19.0	17.0	17.0	17.0	17.0
5	17.0	15.5	16.0	16.0	16.0
6	16.0	14.5	15.0		
7	15.0	14.0	14.5		
8	14.0	13.0	14.0		
9	13.5	12.5			
10	13.0	12.0			
11	12.5	11.5			
12	12.0	11.0			
13	11.5	11.0			
14	11.5	10.5			
15	11.0	10.0			
16	10.5	10.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 57. AWS Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	23.0	23.0
2	20.0	20.0
3	18.0	18.0
4	17.0	17.0
5	16.0	16.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

1900/AWS RAU (FSN-W1-1921-1)

Table 58. 1900 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	26.0	23.0	18.0	18.0	18.0
2	20.0	17.5	15.0	15.0	15.0
3	16.5	14.0	13.0	13.0	13.0
4	14.0	12.0	12.0	12.0	12.0
5	12.0	10.5	11.0	11.0	11.0
6	11.0	9.5	10.0		
7	10.0	9.0	9.5		
8	9.0	8.0	9.0		
9	8.5	7.5			
10	8.0	7.0			
11	7.5	6.5			
12	7.0	6.0			
13	6.5	5.5			
14	6.5	5.5			
15	6.0	5.0			
16	5.5	5.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 59. AWS Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)				
	GSM	EDGE	CDMA 2000	WCDMA	LTE
1	26.0	23.0	18.0	18.0	18.0
2	20.0	17.5	15.0	15.0	15.0
3	16.5	14.0	13.0	13.0	13.0
4	14.0	12.0	12.0	12.0	12.0
5	12.0	10.5	11.0	11.0	11.0
6	11.0	9.5	10.0		
7	10.0	9.0	9.5		
8	9.0	8.0	9.0		
9	8.5	7.5			
10	8.0	7.0			
11	7.5	6.5			
12	7.0	6.0			
13	6.5	5.5			
14	6.5	5.5			
15	6.0	5.0			
16	5.5	5.0			

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2100/1800 RAU (FSN-W1-2118-1)

Table 60. 1800 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)		
	GSM	EDGE	LTE
1	16.5	16.5	15.0
2	14.5	14.5	12.0
3	12.5	12.5	10.0
4	11.5	11.5	9.0
5	10.5	10.5	8.0
6	9.5	9.5	7.0
7	9.0	9.0	6.5
8	8.5	8.0	6.0
9	8.0	7.5	
10	7.5	7.0	
11	7.0	6.5	
12	6.5	6.0	
13	6.5	6.0	
14	6.0	5.5	
15	5.5	5.0	
16	5.5	5.0	
20	4.5	4.0	
30	2.5	2.0	

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 61. 2100MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	15.0	15.0
2	12.0	12.0
3	10.0	10.0
4	9.0	9.0
5	8.0	8.0
6	7.0	7.0
7	6.5	6.5
8	6.0	6.0

Note: Measurements were taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2100 HP/1800 HP RAU (FSN-W1-2118-1-HP)

Table 62. 1800 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)		
	GSM	EDGE	LTE
1	20.0	20.0	20.0
2	17.0	17.0	17.0
3	15.0	15.0	15.0
4	14.0	14.0	14.0
5	13.0	13.0	13.0
6	12.0	12.0	12.0
7	11.5	11.5	11.5
8	11.0	11.0	11.0
9	10.5	10.5	
10	10.0	10.0	
11	9.5	9.5	
12	9.0	9.0	
13	8.5	8.5	
14	8.5	8.5	
15	8.0	8.0	
16	7.5	7.5	
20	6.5	6.5	
30	5.0	5.0	

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 63. 2100MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	20.0	20.0
2	17.0	17.0
3	15.0	15.0
4	14.0	14.0
5	13.0	13.0
6	12.0	12.0
7	11.5	11.5
8	11.0	11.0

Note: Measurements were taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2100 HP/2600 HP RAU (FSN-W1-2126-1-HP)

Table 64. 2100MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	23.0	23.0
2	20.0	20.0
3	18.0	18.0
4	17.0	17.0
5	16.0	16.0
6	15.0	15.0
7	14.5	14.5
8	14.0	14.0

Note: Measurements were taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Table 65. 2600MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	23.0	23.0
2	20.0	20.0
3	18.0	18.0
4	17.0	17.0
5	16.0	16.0
6	15.0	15.0
7	14.5	14.5
8	14.0	14.0

Note: Measurements were taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2100 High Power RAU (FSN-W1-21HP-1)

Table 66. 2100 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm) WCDMA
1	22.0
2	19.0
3	17.0
4	16.0
5	15.0
6	14.0
7	13.5
8	13.0

Note: Measurements were taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2500/2500 TDD RAU (FSN-2525-1-TDD)

Table 67. 2500 MHz TDD LTE Power Per Carrier per MIMO Port

Number of Carriers	Power Per Carrier (dBm) WCDMA
1	22.0
2	19.0
3	17.0

Note: Measurements taken with no baseband clipping.
Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

2600 MHz MIMO RAU (FSN-W3-2626-1)

Table 68. 2600 MHz Power Per Carrier

Number of Carriers	Power Per Carrier (dBm)	
	WCDMA	LTE
1	18.0	18.0
2	15.0	15.0
3	13.0	13.0
4	12.0	12.0
5	11.0	11.0

Note: Operation at or above these output power levels may prevent Fusion Wideband from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

Designing for Capacity Growth

Fusion Wideband systems are deployed to enhance in-building coverage and/or to off-load capacity from a macro cell site. In many instances, subscriber usage increases with time and the wireless provider responds by increasing the load on the installed Fusion Wideband system. For example, the initial deployment might only require two RF carriers, but four RF carriers may be needed in the future based on capacity growth forecasts. There are two options for dealing with capacity growth needs:

- 1** Design the initial coverage with a maximum Power Per Carrier for four RF carriers. This will likely result in additional RAUs.
- 2** Design the initial coverage for two RF carriers, but reserve RAU ports on the Hub for future use. These ports can be used to fill potential coverage holes once the Power Per Carrier is lowered to accommodate the two additional carriers.

SYSTEM GAIN

The system gain of the Fusion Wideband defaults to 0 dB or can be set up to 15 dB in 1 dB increments. In addition, uplink and downlink gains of each RAU can be independently attenuated by 0 or 10 dB using AdminBrowser.

The recommended maximum lengths of CATV cable are as follows:

- For RG-59 cable 130 meters for CommScope PN 2065V
- For RG-6 cable 140 meters for CommScope PN 2279V
- For RG-11 cable 235 meters for CommScope PN 2293K.

If the maximum distance is not required, then copper-clad over steel center-conductor cable may be used to reduce cable costs.

If the CATV cable is longer than the recommended distance per cable type, the gain of the system will decrease, as shown in [Table 69](#).

Table 69. System Gain (Loss) Relative to CATV Cable Length

Cable Type	Comm-Scope Part Number	Plenum Rated	Solid Copper Conductor	Copper Clad Conductor	Zero-loss RF Maximum Length (meters)	Distance Where RF is 10dB Below Input RF (meters)
RG-59	2065V	Yes	X		130	180
	2022V	Yes		X	100	100*
	5572R	No		X	95	95*
	5565	No	X		130	180
RG-6	2279V	Yes	X		140	190
	2275V	Yes		X	140	150*
	5726	No		X	140	140*
	5765	No	X		140	190
RG-11	2293K	Yes	X		235	320
	2285K	Yes		X	235	300*
	5913	No		X	235	300*

* Exceeding the distance of copper-clad cable will result in the connected RAU becoming non-functional. If the distance of a cable run is at its maximum and is of concern, use solid copper cable to ensure successful operation.

ESTIMATING RF COVERAGE

The maximum output Power Per Carrier (based on the number and type of RF carriers being transmitted) and the minimum acceptable received power at the wireless device (that is, the RSSI design goal) essentially establish the RF downlink budget and, consequently, the maximum Allowable Path Loss (APL) between the RAU's antenna and the wireless device. Since in-building systems, such as the Fusion Wideband, are generally downlink-limited, this approach is applicable in the majority of deployments.

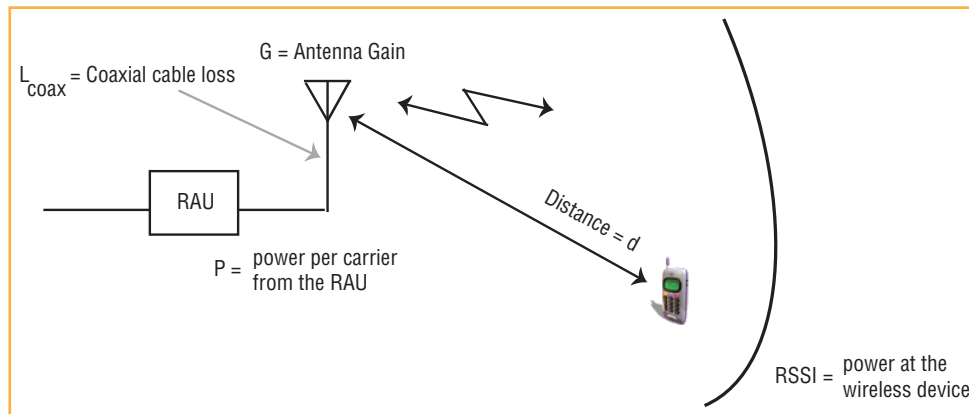


Figure 15. Determining APL between the Antenna and the Wireless Device

Equation 1

Equation 1 is as follows:

$$\text{APL} = (P - L_{\text{coax}} + G) - \text{RSSI}$$

where:

- APL = the maximum allowable path loss in dB
- P = the Power Per Carrier transmitted by the RAU in dBm
- L_{coax} = the coaxial cable loss between the RAU and passive antenna in dB
- G = the gain of the passive antenna in dBi

Coaxial cable is used to connect the RAU to an antenna. [Table 70](#) lists coaxial cable loss for various cable lengths.

Table 70. Coaxial Cable Losses (L_{coax})

Length of Cable (.195 in. diameter)	Loss at 850 MHz (dB)	Loss at 1900 MHz (dB)
0.9 m (3 ft)	0.6	0.8
1.8 m (6 ft)	1.0	1.5
3.0 m (10 ft)	1.5	2.3

You can calculate the distance (d), corresponding to the maximum allowable path loss using equations introduced in the following sections.

Equation 2—Path Loss Equation

In-building path loss obeys the distance power law in Equation 2:

$$PL = 20\log_{10}(4\pi d_0 f/c) + 10n\log_{10}(d/d_0) + X_s$$

where:

- PL is the path loss at a distance, d, from the antenna
- d = the distance expressed in meters
- d₀ = free-space path loss distance in meters
- f = the operating frequency in Hertz.
- c = the speed of light in a vacuum (3.0 × 10⁸ m/sec).
- n = the path loss exponent and depends on the building “clutter” and frequency of operation
- X_s = a normal random variable that depends on partition material and geometries inside the building and is accounted for by the log-normal fade margin used in the downlink RSSI design goal calculation.

As a reference, [Table 71](#) provides estimates of signal loss for some RF barriers¹.

Table 71. Average Signal Loss of Common Building Materials

Partition Type	Loss (dB)	Frequency (MHz)
Metal wall	26	815
Aluminum siding	20	815
Foil insulation	4	815
Cubicle walls	1.4	900
Concrete block wall	13	1300
Concrete floor	10	1300
Sheetrock	1 to 2	1300
Light machinery	3	1300
General machinery	7	1300
Heavy machinery	11	1300
Equipment racks	7	1300
Assembly line	6	1300
Ceiling duct	5	1300
Metal stairs	5	1300

1 Rappaport, Theodore S. *Wireless Communications, Principles, and Practice*. Prentice Hall PTR, 1996.

Equation 3—RAU Coverage Distance

Use “Equation 1” on page 83 and “Equation 2—Path Loss Equation” on page 84 to estimate the distance from the antenna to where the RF signal decreases to the minimum acceptable level at the wireless device.

Equation 2 can be simplified to Equation 3, with d_0 set to one meter and Path Loss Slope (PLS) defined as $10n$:

$$PL(d) = 20\log_{10}(4\pi f/c) + PLS \cdot \log_{10}(d)$$

Table 72 gives the value of the first term of Equation 3 (that is, $(20\log_{10}(4\pi f/c))$) for various frequency bands.

Table 72. Frequency Bands and the Value of the First Term in Equation 3

Frequency	Band (MHz)		Mid-Band Frequency (MHz)	20log10(4πf/c)
	Uplink	Downlink		
800 MHz SMR	806-824	851-869	838	30.9
850 MHz Cellular	824-849	869-894	859	31.1
1800 MHz DCS	1710-1785	1805-1880	1795	37.5
1900 MHz PCS	1850-1910	1930-1990	1920	38.1
2.1 GHz UMTS	1920-1980	2110-2170	2045	38.7
1.7/2.1 GHz AWS	1710-1755	2110-2155	2132.5*	39.0
2.5 GHz TDD LTE	2496-2690	2496-2690	2595	40.7
* Due to the wide frequency spread between the Uplink and Downlink bands, the mid-band frequency of the Downlink band was chosen for 1.7/2.1 GHz AWS.				

Table 73 shows estimated PLS for various environments that have different “clutter” (that is, objects that attenuate the RF signals, such as walls, partitions, stairwells, equipment racks, and so forth).

Table 73. Estimated Path Loss Slope for Different In-Building Environments

Environment Type	Example	PLS for 850/900 MHz	PLS for 1800/1900/2100/2500 MHz
Open Environment very few RF obstructions	Parking Garage, Convention Center	33.7	30.1
Moderately Open Environment low-to-medium amount of RF obstructions	Warehouse, Airport, Manufacturing	35	32
Mildly Dense Environment medium-to-high amount of RF obstructions	Retail, Office Space with approximately 80% cubicles and 20% hard walled offices	36.1	33.1
Moderately Dense Environment medium-to-high amount of RF obstructions	Office Space with approximately 50% cubicles and 50% hard walled offices	37.6	34.8
Dense Environment large amount of RF obstructions	Hospital, Office Space with approximately 20% cubicles and 80% hard walled offices	39.4	38.1

Equation 4—Maximum Antenna Coverage

By setting the path loss to the maximum allowable level (PL = APL), Equation 3 can be used to estimate the maximum coverage distance of an antenna connected to a RAU, for a given frequency and type of in-building environment.

$$d = 10^{((APL - 20\log_{10}(4\pi f/c))/PLS)}$$

For reference, [Table 74](#) through [Table 80 on page 88](#) show the distance covered by an antenna for various in-building environments, in which the following assumptions were made:

- 6 dBm output per carrier at the RAU output
- 3 dBi antenna gain
- RSSI design goal is equal to -85 dBm, which is typical for narrowband protocols, but not for spread-spectrum protocols.

Table 74. *Approximate Radiated Distance from Antenna for 800 MHz SMR Applications*

Environment Type	Distance from Antenna	
	Meters	Feet
Open Environment	75	244
Moderately Open Environment	64	208
Mildly Dense Environment	56	184
Moderately Dense Environment	48	156
Dense Environment	40	131

Table 75. *Approximate Radiated Distance from Antenna for 850 MHz Cellular Applications*

Environment Type	Distance from Antenna	
	Meters	Feet
Open Environment	73	241
Moderately Open Environment	63	205
Mildly Dense Environment	55	181
Moderately Dense Environment	47	154
Dense Environment	39	129

Table 76. *Approximate Radiated Distance from Antenna for 1800 MHz DCS Applications*

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	75	246
Moderately Open Environment	58	191
Mildly Dense Environment	50	166
Moderately Dense Environment	42	137
Dense Environment	30	100

Table 77. *Approximate Radiated Distance from Antenna for 1900 MHz PCS Applications*

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	72	236
Moderately Open Environment	56	183
Mildly Dense Environment	49	160
Moderately Dense Environment	40	132
Dense Environment	29	96

Table 78. *Approximate Radiated Distance from Antenna for 2.1 GHz UMTS Applications*

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	69	226
Moderately Open Environment	54	176
Mildly Dense Environment	47	154
Moderately Dense Environment	39	128
Dense Environment	28	93

Table 79. *Approximate Radiated Distance from Antenna for 1.7/2.1 GHz AWS Applications*

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	67	220
Moderately Open Environment	52	172
Mildly Dense Environment	46	150
Moderately Dense Environment	38	125
Dense Environment	28	91

Table 80. Approximate Radiated Distance from Antenna for 2.5 GHz TDD LTE Applications

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	59	194
Moderately Open Environment	47	152
Mildly Dense Environment	41	134
Moderately Dense Environment	35	112
Dense Environment	25	83

Example Design Estimate for an 1900 MHz CDMA Application

1 Design goals:

- PCS
(1920 MHz = average of the lowest uplink and the highest downlink frequency in 1900 MHz PCS band)
- CDMA provider
- eight CDMA carriers in the system
- -85 dBm design goal (to 95% of the building); the minimum received power at the wireless device
- Base station with simplex RF connections.

2 Power Per Carrier: The tables in “Maximum Output Power Per Carrier” on page 65 provide maximum Power Per Carrier information. Table 58 on page 75 indicates that Fusion Wideband can support eight carriers with a recommended maximum Power Per Carrier of 9.0 dBm. The input power should be set to the desired output power minus the system gain.

3 Building information:

- 16 floor building with 9,290 sq. meters (100,000 sq. ft.) per floor; total 148,640 sq. meters (1,600,000 sq. ft.)
- walls are sheetrock construction, suspended ceiling tiles
- antennas used are omni-directional, ceiling mounted
- standard office environment, 80% hard wall offices and 20% cubicles.

4 Link Budget: In this example, a design goal of -85 dBm is used. Suppose 3 dBi omni-directional antennas are used in the design. Then, the maximum RF propagation loss should be no more than 97.0 dB (9.0 dBm + 3 dBi + 85 dBm) over 95% of the area being covered. *It is important to note that a design goal such as -85 dBm is usually derived taking into account multipath fading and log-normal shadowing characteristics. Thus, this design goal will only be met “on average” over 95% of the area being covered. At any given point, a fade may bring the signal level underneath the design goal.*

Note that this method of calculating a link budget is only for the downlink path. For information to calculate link budgets for both the downlink and uplink paths, refer to “Link Budget Analysis” on page 90.

- 5 Path Loss Slope:** For a rough estimate, [Table 73 on page 85](#) shows that a building with 80% hard wall offices and 20% cubicles, at 1920 MHz, has an approximate path loss slope (PLS) of 38.1. Given the RF link budget of 97.0 dB, the distance of coverage from each RAU will be 30.2 meters (99 ft). This corresponds to a coverage area of 2,868 sq. meters (30,854 sq. ft.) per RAU (refer to [“Equation 2—Path Loss Equation” on page 84](#) for details on path loss estimation). For this case we assumed a circular radiation pattern, though the actual area covered depends upon the pattern of the antenna and the obstructions in the facility.
- 6 Equipment Required:** Since you know the building size, you can now estimate the Fusion Wideband equipment quantities needed. Before you test any RF levels in the building, you can estimate that four antennas per level will be needed. This assumes no propagation between floors. If there is propagation, you may not need antennas on every floor.
- 4 antennas per floor × 16 floors = 64 RAUs
 - 64 RAUs ÷ 8 = 8 Expansion Hubs, as there is a maximum of 8 RAUs per Expansion Hub
 - 8 Expansion Hubs ÷ 4 = 2 Main Hubs, as there is a maximum of 4 Expansion Hubs per Main Hub

Check that the fiber and CATV cable distances are as recommended. If the distances differ, use the tables in [“System Gain” on page 82](#) to determine system gains or losses. The path loss may need to be recalculated to assure adequate signal levels in the required coverage distance.

The above estimates assume that all cable length requirements are met. If Expansion Hubs cannot be placed so that the RAUs are within the distance requirement, additional Expansion Hubs may need to be placed closer to the required RAUs locations.

An RF Site Survey and Building Evaluation is required to accurately establish the Fusion Wideband equipment quantities required for the building. The site survey measures the RF losses within the building to determine the actual PLS, used in the final path loss formula to determine the actual requirements of the Fusion Wideband system.

LINK BUDGET ANALYSIS

A link budget is a methodical way to account for the gains and losses in an RF system so that the quality of coverage can be predicted. The end result can often be stated as a “design goal” in which the coverage is determined by the maximum distance from each RAU before the signal strength falls beneath that goal.

One key feature of the link budget is the maximum Power Per Carrier explained in [“Maximum Output Power Per Carrier” on page 65](#).

CAUTION! While the maximum Power Per Carrier is important as far as emissions and signal quality requirements are concerned, it is critical that the maximum signal into the Main Hub never exceed 1W (+30 dBm). Composite power levels above this limit could cause permanent damage to the Main Hub.

NOTE: To obtain the on-line Link Budget Tool, go the TE Customer Portal; see [“Accessing the TE Customer Portal” on page 230](#).

Elements of a Link Budget for Narrowband Standards

The link budget represents a typical calculation that might be used to determine how much path loss can be afforded in a Fusion Wideband design. This link budget analyzes both the downlink and uplink paths. For most configurations, the downlink requires lower path loss and is therefore the limiting factor in the system design. It is for this reason that a predetermined “design goal” for the downlink is sufficient to predict coverage distance.

The link budget is organized in a simple manner: the transmitted power is calculated, the airlink losses due to fading and body loss are summed, and the receiver sensitivity (minimum level a signal can be received for acceptable call quality) is calculated. The maximum allowable path loss (in dB) is the difference between the transmitted power, less the airlink losses, and the receiver sensitivity. From the path loss, the maximum coverage distance can be estimated using the path loss formula presented in [“Equation 2—Path Loss Equation” on page 84](#).

[Table 81 on page 91](#) provides link budget considerations for narrowband systems.

Table 81. Link Budget Considerations for Narrowband Systems

Consideration	Description												
BTS Transmit Power	The Power Per Carrier transmitted from the Base Station output.												
Attenuation between BTS and Fusion Wideband	This includes all losses: cable, attenuator, splitter/combiner, and so forth. On the downlink, attenuation must be chosen so that the maximum Power Per Carrier going into the Main Hub does not exceed the levels given in “Maximum Output Power Per Carrier” on page 65 . On the uplink, attenuation is chosen to keep the maximum uplink signal and noise level low enough to prevent Base Station alarms but small enough not to cause degradation in the system sensitivity. If the Fusion Wideband noise figure minus the attenuation is at least 10 dB higher than the BTS noise figure, the system noise figure is approximately that of Fusion Wideband alone. Refer to “Connecting a Main Hub to a Base Station” on page 101 for ways to independently set the uplink and downlink attenuations between the Base Station and Fusion Wideband.												
Antenna Gain	The radiated output power includes antenna gain. For example, if you use a 3 dBi antenna at the RAU that is transmitting 0 dBm per carrier, the effective radiated power (relative to an isotropic radiator) is 3 dBm per carrier.												
BTS Noise Figure	This is the effective noise floor of the Base Station input (usually Base Station sensitivity is this effective noise floor plus a certain C/I ratio).												
Fusion Wideband Noise Figure	This is Fusion Wideband’s uplink noise figure, which varies depending on the number of Expansion Hubs and RAUs, and the frequency band. Fusion Wideband’s uplink noise figure is specified for a 1-1-8 configuration. Thus, the noise figure for a Fusion Wideband system (or multiple systems whose uplink ports are power combined) is $NF(1-1-8) + 10 * \log(\# \text{ of Expansion Hubs})$. This represents an upper-bound because the noise figure is lower if any of the Expansion Hub’s RAU ports are not used.												
Thermal Noise	This is the noise level in the signal bandwidth (BW). Thermal noise power = $-174 \text{ dBm/Hz} + 10 \text{Log}(\text{BW})$. <table border="1" data-bbox="505 1003 1078 1203"> <thead> <tr> <th>Protocol</th> <th>Signal Bandwidth</th> <th>Thermal Noise</th> </tr> </thead> <tbody> <tr> <td>TDMA</td> <td>30 kHz</td> <td>-129 dBm</td> </tr> <tr> <td>GSM</td> <td>200 kHz</td> <td>-121 dBm</td> </tr> <tr> <td>iDEN</td> <td>25 kHz</td> <td>-130 dBm</td> </tr> </tbody> </table>	Protocol	Signal Bandwidth	Thermal Noise	TDMA	30 kHz	-129 dBm	GSM	200 kHz	-121 dBm	iDEN	25 kHz	-130 dBm
Protocol	Signal Bandwidth	Thermal Noise											
TDMA	30 kHz	-129 dBm											
GSM	200 kHz	-121 dBm											
iDEN	25 kHz	-130 dBm											
Required C/I ratio	For each wireless standard, a certain C/I (carrier to interference) ratio is needed to obtain acceptable demodulation performance. For narrowband systems, (TDMA, GSM, EDGE, iDEN, AMPS) this level varies from about 9 dB to 20 dB.												
Mobile Transmit Power	The maximum power the mobile can transmit (power transmitted at highest power level setting).												
Multipath Fade Margin	This margin allows for a certain level of fading due to multipath interference. On the inside of buildings there is often one or more fairly strong signals and many weaker signals arriving from reflections and diffraction. Signals arriving from multiple paths add constructively or destructively. This margin accounts for the possibility of destructive multipath interference. In RF site surveys the effects of multipath fading are typically not accounted for because such fading is averaged out over power level samples taken over many locations.												
Log-Normal Fade Margin	This margin adds an allowance for RF shadowing due to objects obstructing the direct path between the mobile equipment and the RAU. In RF site surveys, the effects of shadowing are partially accounted for since it is characterized by relatively slow changes in power level.												
Body Loss	This accounts for RF attenuation caused by the user’s head and body.												
Minimum Received Signal Level	This is also referred to as the “design goal”. The link budget says that you can achieve adequate coverage if the signal level is, on average, above this level over 95% of the area covered, for example.												

Narrowband Link Budget Analysis for a Microcell Application

Table 82. Narrowband Link Budget Analysis: Downlink

Line	Downlink	
Transmitter		
a.	BTS transmit Power Per Carrier (dBm)	33
b.	Attenuation between BTS and Fusion Wideband (dB)	-23
c.	Power into Fusion Wideband (dBm)	10
d.	Fusion Wideband gain (dB)	0
e.	Antenna gain (dBi)	3
f.	Radiated Power Per Carrier (dBm)	13
Airlink		
g.	Multipath fade margin (dB)	6
h.	Log-normal fade margin with 9 dB std. deviation, 95% area coverage, 87% edge coverage	10
i.	Body loss (dB)	3
j.	Airlink losses (not including facility path loss)	19
Receiver		
k.	Thermal noise (dBm/30 kHz)	-129
l.	Mobile noise figure (dB)	7
m.	Required C/I ratio (dB)	17
n.	Minimum received signal (dBm)	-105
p.	Maximum path loss (dB)	+99

- $c = a + b$
- $f = c + d + e$
- $j = g + h + i$
- $n = k + l + m$
- k: in this example, k represents the thermal noise for a TDMA signal, which has a bandwidth of 30 kHz
- $p = f - j - n$

Table 83. Narrowband Link Budget Analysis: Uplink

Line	Uplink	
Receiver		
a.	BTS noise figure (dB)	4
b.	Attenuation between BTS and Fusion Wideband (dB)	-10
c.	Fusion Wideband gain (dB)	0
d.	Fusion Wideband noise figure (dB) 1-4-32	22
e.	System noise figure (dB)	22.6
f.	Thermal noise (dBm/30 kHz)	-129
g.	Required C/I ratio (dB)	12
h.	Antenna gain (dBi)	3
i.	Receive sensitivity (dBm)	-97.4
Airlink		
j.	Multipath fade margin (dB)	6
k.	Log-normal fade margin with 9 dB std. deviation, 95% area coverage, 87% edge coverage	10
l.	Body loss (dB)	3
m.	Airlink losses (not including facility path loss)	19
Transmitter		
n.	Mobile transmit power (dBm)	28
p.	Maximum path loss (dB)	106.4

- e: enter the noise figure and gain of each system component (a, b, c, and d) into the standard cascaded noise figure formula

$$F_{\text{sys}} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$$

where

$$F = 10^{(\text{Noise Figure}/10)}$$

$$G = 10^{(\text{Gain}/10)}$$

(See Rappaport, Theodore S. *Wireless Communications, Principles, and Practice*. Prentice Hall PTR, 1996.)

- $i = f + e + g - h$
- $m = j + k + l$
- $p = n - m - i$

Therefore, the system is downlink limited but the downlink and uplink are almost balanced, which is a desirable condition.

Elements of a Link Budget for CDMA Standards

A CDMA link budget is slightly more complicated because you must consider the spread spectrum nature of CDMA. Unlike narrowband standards such as TDMA and GSM, CDMA signals are spread over a relatively wide frequency band. Upon reception, the CDMA signal despread. In the despreading process the power in the received signal becomes concentrated into a narrow band, whereas the noise level remains unchanged. Hence, the signal-to-noise ratio of the despread signal is higher than that of the CDMA signal before despreading. This increase is called processing gain. For IS-95 and J-STD-008, the processing gain is 21 dB or 19 dB depending on the user data rate (9.6 Kbps for rate set 1 and 14.4 Kbps for rate set 2, respectively). Because of the processing gain, a CDMA signal (comprising one Walsh code channel within the composite CDMA signal) can be received at a lower level than that required for narrowband signals. A reasonable level is -95 dBm, which results in about -85 dBm composite as shown below.

An important issue to keep in mind is that the downlink CDMA signal is composed of many orthogonal channels: pilot, paging, sync, and traffic. The composite power level is the sum of the powers from the individual channels, of which [Table 84](#) shows an example.

Table 84. *Distribution of Power within a CDMA Signal*

Channel	Walsh Code Number	Relative Power Level	
Pilot	0	20%	-7.0 dB
Sync	32	5%	-13.3 dB
Primary Paging	1	19%	-7.3 dB
Traffic	8-31, 33-63	9% (per traffic channel)	-10.3 dB

[Table 84](#) assumes that there are 15 active traffic channels operating with 50% voice activity (so that the total power adds up to 100%). Notice that the pilot and sync channels together contribute about 25% of the power. When measuring the power in a CDMA signal you must be aware that if only the pilot and sync channels are active, the power level will be about 6 to 7 dB lower than the maximum power level you can expect when all voice channels are active. The implication is that if only the pilot and sync channels are active, and the maximum Power Per Carrier table says, for example, that you should not exceed 10 dBm for a CDMA signal, then you should set the attenuation between the Base Station and the Main Hub so that the Main Hub receives 3 dBm (assuming 0 dB system gain).

An additional consideration for CDMA systems is that the uplink and downlink paths should be gain and noise balanced. This is required for proper operation of soft-handoff to the outdoor network as well as preventing excess interference that is caused by mobiles on the indoor system transmitting at power levels that are not coordinated with the outdoor mobiles. This balance is achieved if the power level transmitted by the mobiles under close-loop power control is similar to the power level transmitted under open-loop power control.

The open-loop power control equations are as follows:

- **for Cellular, IS-95:** $P_{TX} + P_{RX} = -73 \text{ dBm}$

- **for PCS, J-STD-008:** $P_{TX} + P_{RX} = -76 \text{ dBm}$

where P_{TX} is the mobile's transmitted power and P_{RX} is the power received by the mobile.

The power level transmitted under closed-loop power control is adjusted by the Base Station to achieve a certain E_b/N_0 (explained in [Table 85](#)). The difference between these power levels, Δ_p , can be estimated by comparing the power radiated from the RAU, P_{downlink} , to the minimum received signal, P_{uplink} , at the RAU:

for Cellular:
$$\Delta_p = P_{\text{downlink}} + P_{\text{uplink}} + 73 \text{ dBm}$$

for PCS:
$$\Delta_p = P_{\text{downlink}} + P_{\text{uplink}} + 76 \text{ dBm}$$

It's a good idea to keep $-12 \text{ dB} < \Delta_p < 12 \text{ dB}$.

[Table 85](#) provides link budget considerations for CDMA systems.

Table 85. Additional Link Budget Considerations for CDMA

Consideration	Description
Multipath Fade Margin	The multipath fade margin can be reduced (by at least 3 dB) by using different lengths of optical fiber (this is called "delay diversity"). The delay over fiber is approximately $5\mu\text{S}/\text{km}$. If the difference in fiber lengths to Expansion Hubs with overlapping coverage areas produces at least 1 chip ($0.8\mu\text{S}$) delay of one path relative to the other, then the multipaths' signals can be resolved and processed independently by the Base Station's rake receiver. A CDMA signal traveling through 163 meters of MMF cable is delayed by approximately one chip.
Power Per Carrier, downlink	This depends on how many channels are active. For example, the signal is about 7 dB lower if only the pilot, sync, and paging channels are active compared to a fully-loaded CDMA signal. Furthermore, in the CDMA forward link, voice channels are turned off when the user is not speaking. On average this is assumed to be about 50% of the time. So, in the spreadsheet, both the power per Walsh code channel (representing how much signal a mobile will receive on the Walsh code that it is despreading) and the total power are used. The channel power is needed to determine the maximum path loss, and the total power is needed to determine how hard the Fusion Wideband system is being driven. The total power for a fully-loaded CDMA signal is given by (approximately): $\text{total power} = \text{voice channel power} + 13 \text{ dB} + 10\log_{10}(50\%)$ $= \text{voice channel power} + 10 \text{ dB}$
Information Rate	This is simply $10\log_{10}(9.6 \text{ Kbps}) = 40 \text{ dB for rate set 1}$ $10\log_{10}(14.4 \text{ Kbps}) = 42 \text{ dB for rate set 2}$
Process Gain	The process of despreading the desired signal boosts that signal relative to the noise and interference. This gain needs to be included in the link budget. In the following formulas, P_G = process gain: $P_G = 10\log_{10}(1.25 \text{ MHz} / 9.6 \text{ Kbps}) = 21 \text{ dB rate set 1}$ $P_G = 10\log_{10}(1.25 \text{ MHz} / 14.4 \text{ Kbps}) = 19 \text{ dB rate set 2}$ Note that the process gain can also be expressed as $10\log_{10}$ (CDMA bandwidth) minus the information rate.
E_b/N_0	This is the energy-per-bit divided by the received noise and interference. It's the CDMA equivalent of Signal-to-Noise Ratio (SNR). This figure depends on the mobile's receiver and the multipath environment. For example, the multipath delays inside a building are usually too small for a rake receiver in the mobile (or Base Station) to resolve and coherently combine multipath components. However, if artificial delay can be introduced by, for instance, using different lengths of cable, then the required E_b/N_0 is lower and the multipath fade margin in the link budget can be reduced in some cases. If the receiver noise figure is NF (dB), then the receive sensitivity (dBm) is given by: $P_{\text{sensitivity}} = \text{NF} + E_b/N_0 + \text{thermal noise in a 1.25 MHz band} - P_G$ $= \text{NF} + E_b/N_0 - 113 \text{ (dBm/1.25 MHz)} - P_G$

Table 85. Additional Link Budget Considerations for CDMA (Cont.)

Consideration	Description
Noise Rise	<p>On the uplink, the noise floor is determined not only by the Fusion Wideband system, but also by the number of mobiles that are transmitting. This is because when the Base Station attempts to despread a particular mobile's signal, all other mobile signals appear to be noise. Because the noise floor rises as more mobiles try to communicate with a Base Station, the more mobiles there are, the more power they have to transmit. Hence, the noise floor rises rapidly:</p> $\text{noise rise} = 10 \log_{10}(1 / (1 - \text{loading}))$ <p>where <i>loading</i> is the number of users as a percentage of the theoretical maximum number of users. Typically, a Base Station is set to limit the loading to 75%. This noise ratio must be included in the link budget as a worst-case condition for uplink sensitivity. If there are less users than 75% of the maximum, then the uplink coverage will be better than predicted.</p>
Hand-off Gain	<p>CDMA supports soft hand-off, a process by which the mobile communicates simultaneously with more than one Base Station or more than one sector of a Base Station. Soft hand-off provides improved receive sensitivity because there are two or more receivers or transmitters involved. A line for hand-off gain is included in the CDMA link budgets worksheet although the gain is set to 0 dB because the in-building system will probably be designed to limit soft-handoff.</p>

Other CDMA Issues

Other CDMA issues are as follows:

- Never combine multiple sectors (more than one CDMA signal at the same frequency) into a Fusion Wideband system. The combined CDMA signals will interfere with each other.
- Try to minimize overlap between in-building coverage areas that utilize different sectors, as well as in-building coverage and outdoor coverage areas. This is important because any area in which more than one dominant pilot signal (at the same frequency) is measured by the mobile will result in soft-handoff. Soft-handoff decreases the overall network capacity by allocating multiple channel resources to a single mobile phone.

CDMA Link Budget Analysis for a Microcell Application

Table 86. CDMA Link Budget Analysis: Downlink

Line	Downlink	
	Transmitter	
a.	BTS transmit power per traffic channel (dBm)	30.0
b.	Voice activity factor	50%
c.	Composite power (dBm)	40.0
d.	Attenuation between BTS and Fusion Wideband (dB)	-24
e.	Power per channel into Fusion Wideband (dBm)	9.0
f.	Composite power into Fusion Wideband (dBm)	16.0
g.	Fusion Wideband gain (dB)	0.0
h.	Antenna gain (dBi)	3.0
i.	Radiated power per channel (dBm)	12.0
j.	Composite radiated power (dBm)	19.0

Table 86. CDMA Link Budget Analysis: Downlink (Cont.)

Line	Downlink	
Airlink		
k.	Handoff gain (dB)	0.0
l.	Multipath fade margin (dB)	6.0
m.	Log-normal fade margin with 9 dB std. deviation, 95% area coverage, 87% edge coverage	10.0
n.	Additional loss (dB)	0.0
o.	Body loss (dB)	3.0
p.	Airlink losses (not including facility path loss)	19.0
Receiver		
q.	Mobile noise figure (dB)	7.0
r.	Thermal noise (dBm/Hz)	-174.0
s.	Receiver interference density (dBm/Hz)	-167.0
t.	Information ratio (dB/Hz)	41.6
u.	Required $E_b/(N_o+I_o)$	7.0
v.	Minimum received signal (dBm)	-118.4
w.	Maximum path loss (dB)	+99.4

- b and c: see notes in Table 6-34 regarding Power Per Carrier, downlink
- $e = a + d$
- $f = c + d$
- $i = e + g + h$
- $j = f + g + h$
- $p = -k + l + m + n + o$
- $s = q + r$
- $v = s + t + u$
- $w = j - p - v$
- $x = j$ (downlink) + m (uplink) + P

where

$$P = P_{tx} + P_{rx} = -73 \text{ dB for Cellular}$$

$$-76 \text{ dB for PCS}$$

Table 87. CDMA Link Budget Analysis: Uplink

Line	Uplink	
Receiver		
a.	BTS noise figure (dB)	3.0
b.	Attenuation between BTS and Fusion Wideband (dB)	-30.0
c.	Fusion Wideband gain (dB)	0.0
d.	Fusion Wideband noise figure (dB)	22.0
e.	System noise figure (dB)	33.3
f.	Thermal noise (dBm/Hz)	-174.0
g.	Noise rise 75% loading (dB)	6.0
h.	Receiver interference density (dBm/Hz)	-134.6
i.	Information rate (dB/Hz)	41.6
j.	Required Eb/(N ₀ +I ₀)	5.0
k.	Handoff gain (dB)	0.0
l.	Antenna gain (dBi)	3.0
m.	Minimum received signal (dBm)	-91.1
Airlink		
n.	Multipath fade margin (dB)	6.0
o.	Log-normal fade margin with 9 dB std. deviation, 95% area coverage, 87% edge coverage	10.0
p.	Additional loss (dB)	0.0
q.	Body loss (dB)	3.0
r.	Airlink losses (not including facility path loss)	19.0
Transmitter		
s.	Mobile transmit power (dBm)	28.0
t.	Maximum path loss (dB)	100.1

- e: enter the noise figure and gain of each system component (a, b, c, and d) into the standard cascaded noise figure formula

$$F_{sys} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$$

where

$$F = 10^{(\text{Noise Figure}/10)}$$

$$G = 10^{(\text{Gain}/10)}$$

(See Rappaport, Theodore S. *Wireless Communications, Principles, and Practice*. Prentice Hall PTR, 1996.)

- $h = e + f + g$
- $m = h + i + j - k - l$
- $r = n + o + p + q$
- $t = s - r - m$

Considerations for Re-Radiation (Over-the-Air) Systems

Fusion Wideband can be used to extend the coverage of the outdoor network by connecting to a roof-top donor antenna pointed toward an outdoor Base Station. Additional considerations for such an application of Fusion Wideband are:

- sizing the gain and output power requirements for a bi-directional amplifier (repeater)
- ensuring that noise radiated on the uplink from the in-building system does not cause the outdoor Base Station to become desensitized to wireless handsets in the outdoor network
- filtering out signals that lie in adjacent frequency bands. For instance, if you are providing coverage for Cellular B-band operation it may be necessary to filter out the A, A' and A'' bands which may contain strong signals from other outdoor Base Stations.

Further information on these issues can be found in TE application notes for re-radiation applications.

OPTICAL POWER BUDGET

Fusion Wideband uses SC/APC connectors. The connector losses associated with mating to these connectors is accounted for in the design and should not be included as elements of the optical power budget. The reason is that when the optical power budget is defined, measurements are taken with these connectors in place.

The Fusion Wideband optical power budget for both multi-mode and single-mode fiber cable is 3.0 dB (optical).

The maximum loss through the fiber can not exceed 3 dB (optical). The maximum lengths of the fiber cable should not exceed 500m (1,640 ft) for multi-mode and 6 km (19,685 ft) for single-mode. Both the optical budget and the maximum cable length must be taken into consideration when designing the system.

NOTE: It is critical to system performance that only SC/APC fiber connectors be used throughout the fiber network, including fiber distribution panels.

CONNECTING A MAIN HUB TO A BASE STATION

The Fusion Wideband system supports up to three RF sources: one for Band 1, one for Band 2 and one for Band 3. This section explains how each band can be connected to its associated Base Station.

Each Fusion Main Hub band has separate system gain parameters. For example, Band 1 can be set for +5 dB of downlink system gain while Band 2 can have +15 dB of downlink system gain. Thus, each band can be configured as a separate system to allow for full integration to its associated Base Station.

When connecting each of the Fusion Wideband Main Hub bands to its Base Station, the following equipment may be required:

- circulators
- filter diplexers
- directional couplers
- combiner/splitters
- attenuators
- coax cables
- connectors.

In addition, use the following considerations to achieve optimal performance:

- The downlink power from the Base Stations must be attenuated enough so that the power radiated by the RAU does not exceed the maximum Power Per Carrier listed in [“Maximum Output Power Per Carrier” on page 65](#).
- The uplink attenuation should be small enough that the sensitivity of the overall system is limited by Fusion Wideband, not by the attenuator. However, some Base Stations trigger alarms if the noise or signal levels are too high. In this case the attenuation must be large enough to prevent this from happening.

CAUTION! The UPLINK and DOWNLINK ports cannot handle a DC power feed from a BTS. If DC power is present, a DC block must be used or the Fusion Wideband Main Hub may be damaged.

If, in an area covered by Fusion Wideband, a mobile phone indicates good signal strength but consistently has difficulty completing calls, it is possible that the attenuation between Fusion Wideband and the Base Station needs to be adjusted. In other words, it is possible that if the uplink is over-attenuated, the downlink power will provide good coverage, but the uplink coverage distance will be small.

When there is an excessive amount of loss between the Fusion Wideband Main Hub uplink and its associated band's Base Station, the uplink system gain can be increased to as much as 15 dB to prevent a reduction in the overall system sensitivity.

Uplink Attenuation

The attenuation between the Main Hub's uplink port and the associated band's Base Station reduces both the noise level and the desired signals out of Fusion Wideband. Setting the attenuation on the uplink is a trade-off between keeping the noise and maximum signal levels transmitted from Fusion Wideband to the Base Station receiver low while not reducing the SNR (Signal-to-Noise Ratio) of the path from the RAU inputs to the Base Station inputs. This SNR cannot be better than the SNR of Fusion Wideband by itself, although it can be significantly worse.

A good rule of thumb is to set the uplink attenuation so that the noise level out of Fusion Wideband is within 10 dB of the Base Station's sensitivity.

RAU Attenuation and ALC

The RAU attenuation and ALC are set using the AdminBrowser **Edit Unit Properties** screen.

Embedded within the uplink RF front-end of each Fusion Wideband RAU band is an ALC circuit. This ALC circuit protects the Fusion Wideband system from overload and excessive intermodulation products due to high-powered mobiles or other signal sources that are within the supported frequency band and are in close proximity to the RAU.

Each individual Band (1 or 2) of a Fusion Wideband RAU has an uplink ALC circuit that operates as a feedback loop. A power detector measures the level of each band's uplink RF input and if that level exceeds -30 dBm, an RF attenuator is activated. The level of attenuation is equal to the amount that the input exceeds -30 dBm. The following sequence describes the operation of the ALC circuit, as illustrated in [Figure 16 on page 103](#).

- 1 The RF signal level into either Band of the RAU rises above the activation threshold (-30 dBm), causing that ALC loop to enter into the attack phase.
- 2 During the attack phase, the ALC loop increases the attenuation (0 to 30 dB) until the detector reading is reduced to the activation threshold. The duration of this attack phase is called the attack time.
- 3 After the attack time, the ALC loop enters the hold phase and maintains a fixed attenuation so long as the high-level RF signal is present.
- 4 The RF signal level drops below the release threshold (-45 dBm) and the ALC loop enters the release phase.
- 5 During the release phase, the ALC loop holds the attenuation for a fixed period then quickly releases the attenuation.

An important feature of the ALC loop is that in [Step 3](#), the attenuation is maintained at a fixed level until the signal drops by a significant amount. This prevents the ALC loop from tracking variations in the RF signal itself and distorting the waveform modulation.

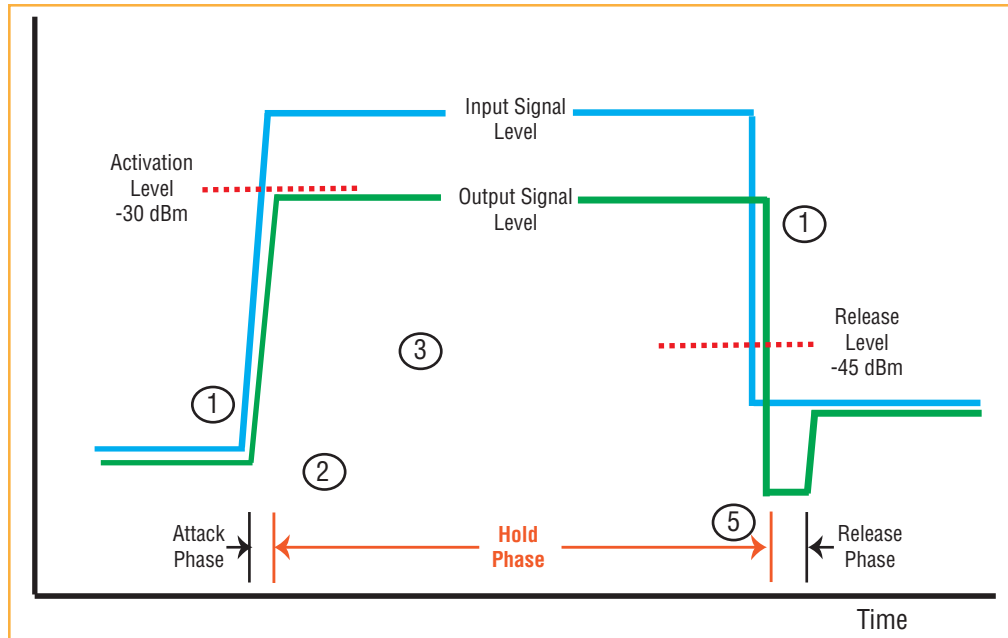


Figure 16. ALC Operation

Using the RAU 10 dB Attenuation Setting

Each RAU band can, independently of the other RAUs in a system, have its uplink or downlink gain attenuated by 0 or 10 dB for each RAU band (1, 2 or 3). This is accomplished by selecting the appropriate UPLINK and/or DOWNLINK attenuation for each RAU band in the **Edit Unit Properties** screen of AdminBrowser for the selected RAU.

- Downlink Attenuation:** The downlink attenuator provides a mechanism to reduce the signal strength from a RAU band. For instance, this could be for a RAU band located near a window in a tall building that is causing excessive leakage to the macro-network. In such a case it is important to attenuate the downlink only. The uplink should not be attenuated. If the uplink is attenuated, the uplink sensitivity is reduced and mobile phones in the area of that RAU band will have to transmit at a higher power. This would increase interference to the outdoor network from such mobiles.
- Uplink Attenuation:** The uplink attenuator attenuates environmental noise picked up by a RAU band located in an area where heavy electrical machinery is operating. In such environments the electrical noise can be quite high and it is useful to reduce the amount of such noise that gets propagated through the distributed antenna system. Attenuating the uplink of a RAU band located in areas of high electrical noise helps preserve the sensitivity of the rest of the system.

The effect of activating the uplink or downlink attenuators is to reduce the coverage area of the adjusted RAU band. The coverage radius will be reduced by roughly a factor of 2. More specifically, if d is the coverage distance without attenuation and d' is the coverage radius with the attenuation, then

$$\frac{d}{d'} = 10^{10dB / PLS}$$

where PLS is Path Loss Slope (dBm).

Using the Uplink ALC Setting

Uplink Automatic Level Control (UL ALC) circuitry for each band within the RAU provides ALC on high-power signals in the uplink path. This functionality is required to prevent RF signal compression caused by a single or multiple wireless devices in very close proximity to the RAU band. Compression causes signal degradation and, ultimately, dropped calls and data errors, and should be prevented. Two settings are available to optimize UL ALC performance:

- **Multiple Operators:** Use when more than one operator and/or protocol is present in the Fusion Wideband system's band frequency or adjacent frequency bands. This setting is most commonly used.
- **Single Operator and Protocol:** Use when only one operator and protocol is on-the-air within the Fusion Wideband system's configured and adjacent frequency bands. This setting is seldom used.

INSTALLING FUSION WIDEBAND

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INSTALLATION REQUIREMENTS

Before and during installation, keep in mind these sources of potential problems:

- faulty cabling/connector
- dirty connectors and ports
- malfunction of one or more Fusion Wideband components
- antenna, Base Station, or repeater problem
- external RF interface
- tripped circuit breaker
- equipment is not grounded
- using a crossover Ethernet cable that does not support full hardware handshaking when using AdminBrowser.

NOTE: Faulty cabling is the cause of a vast majority of problems. All CATV cable should be tested to TIA-570-B specifications.

Component Location Requirements

CAUTION! Fusion Wideband components are intended to be installed in indoor locations only. If outdoor installation is desired, such as in a parking garage, the Fusion Wideband components must be installed in the appropriate environmental enclosures.

Cable and Connector Requirements

Fusion Wideband equipment operates over the following:

- CATV 75 Ohm cable with F connectors
- Single-mode fiber (SMF) or multi-mode (MMF) cable with SC/APC fiber connectors throughout the fiber network, including fiber distribution panels

These cables are widely-used, industry standards for the cable TV industry. The regulations and guidelines for Fusion Wideband cable installation are identical to those specified by the TIA/EIA 568-B standard and the TIA/EIA/570-A standards.

TE recommends solid copper center conductor, plenum-rated CATV cable and connectors for conformity to building codes, standards, and to ensure stated performance of maximum distance and RF specifications.

CommScope 2065V cable or equivalent is required for RG-59.

CommScope 2279V cable or equivalent is required for RG-6.

CommScope 2293K cable may also be used for RG-11.

NOTE: Refer to [“Appendix A: Cables and Connectors”](#) on page 191 for more information related to 75 Ohm CATV.

TE recommends connectors with fixed centerpins to ensure proper seating and to eliminate oxidation, which occurs with bare center conductors. TE recommends the following CANARE connectors:

- FP-C4F for CommScope 2065V cable
- FP-C55A for CommScope 2279V cable
- FP-C71A for CommScope 2293K cable

CAUTION! The proper crimp tool and die must be matched by the connector type.

Distance Requirements

Table 88 shows the distances between Fusion Wideband components and related equipment.

Table 88. *Distance Requirements*

Equipment Combination	Cable Type	Cable Length	Additional Information
Repeater/BTS to Fusion Wideband Main Hub	Coaxial; N male connectors	3–6 m (10–20 ft) typical 10 m (33 ft) maximum	Limited by loss and noise. Refer to your link budget calculation. Limited by CE Mark requirements.
Fusion Wideband Expansion Hub to RAU	CATV 75 Ohm; shielded F male connectors	Minimum: 10 meters (33 ft) Maximum: 150 meters (492 ft) for RG-59; 170 meters (558 ft) for RG-6; 275 meters (902 ft) for RG-11 Refer to Table 39 on page 53 and Table 40 on page 54 .	Refer to “System Gain” on page 82 .
Main Hub to Expansion Hub	Multi-mode fiber: Single-mode fiber: SC/APC male connectors	500 m (1640 ft.) maximum 6 km (19,685 ft.) maximum	Limited by 3 dB optical attenuation
RAU to passive antenna	Coaxial; N male connectors	1–3.5 m (3–12 ft) typical	Limited by loss and noise. Refer to your link budget calculation.

SAFETY PRECAUTIONS

Installation Guidelines

Use the following guidelines when installing TE equipment:

- 1 Provide sufficient airflow and cooling to the equipment to prevent heat build-up from exceeding the maximum ambient air temperature specification. Do not compromise the amount of airflow required for safe operation of the equipment.
- 2 If you are removing the system, turn it off and remove the power cord first. There are no user-serviceable parts inside the components.
- 3 The internal power supplies have internal fuses that are not user replaceable. Consider the worst-case power consumption shown on the product labels when provisioning the equipment's AC power source and distribution.
- 4 Verify that the Hub is grounded properly using the AC power cord third wire ground.

CAUTION! Be careful with the mechanical loading of the rack mounted hub. Mount the equipment in the rack in such a way that a hazardous condition, due to uneven mechanical loading, does not result.

General Safety Precautions

The following precautions apply to TE products:

- The units have no user-serviceable parts. Faulty or failed units are fully replaceable through TE, see [“Appendix D: Contacting TE Connectivity” on page 229](#).
- When you connect the fiber optic cable, clean all optical fiber SC/APC connectors according to the cable manufacturer's instructions.
- When you connect a radiating antenna to a RAU, firmly hand-tighten the N connector. **DO NOT over-tighten the connector.**

CAUTION! To reduce the risk of fire or electric shock, do not expose this equipment to rain or moisture. The components are intended for indoor use only. Do not install the RAU outdoors. Do not connect a RAU to an antenna that is located outdoors where it could be subject to lightning strikes, power crosses, or wind.

- The Expansion Hub and RAU units are designed for intra-building cabling only. Outdoor routing of any cabling to these units shall not exceed 140 feet.

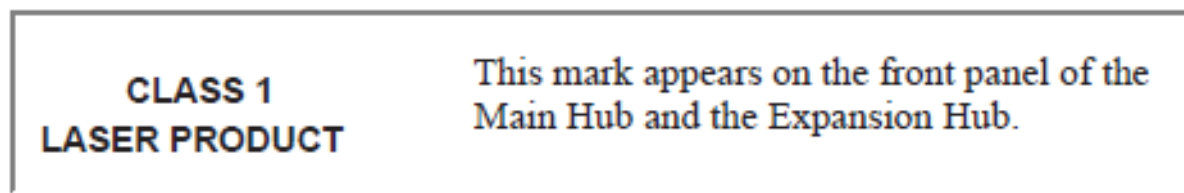
CAUTION! Outdoor cables farther than 140 feet must be installed with proper lightning protection.

Fiber Port Safety Precautions

The following are suggested safety precautions for working with fiber ports. For information about system compliance with safety standards, refer to [“Appendix B: Compliance” on page 203](#).

CAUTION! Observe the following warning about viewing fiber ends in ports. Do not stare directly into a fiber port. Do not stare with unprotected eyes at the connector ends of the fibers or the ports of the hubs. Invisible infrared radiation is present at the front panel of the Main Hub and the Expansion Hub. Do not remove the fiber port dust caps unless the port is going to be used.

- **Test fiber cables:** When you test fiber optic cables, connect the optical power source last and disconnect it first. Use Class 1 test equipment.
- **Fiber ends:** Cover any unconnected fiber ends with an approved cap. Do not use tape.
- **Broken fiber cables:** Do not stare with unprotected eyes at any broken ends of the fibers. Laser light emitted from fiber sources can cause eye injury. Avoid contact with broken fibers; they are sharp and can pierce the skin. Report any broken fiber cables and have them replaced.
- **Cleaning:** Be sure the connectors are clean and free of dust or oils. Use only approved methods for cleaning optical fiber connectors.
- **Modifications:** Do not make any unauthorized modifications to this fiber optic system or associated equipment.
- **Live work:** Live work is permitted because TE equipment is a Class 1 hazard.
- **Signs:** No warning signs are required.
- **Class 1 laser product:** The system meets the criteria for a Class 1 laser product per IEC 60825-1: 1993+A1:+A2:2001 and IEC106825-2.



Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.

The hazard level at all locations within the equipment is Hazard Level 1.

CAUTION! Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

PREPARING FOR SYSTEM INSTALLATION

Pre-Installation Inspection

Follow this procedure before installing Fusion Wideband equipment.

- 1 Verify the number of packages received against the packing list.
- 2 Check all packages for external damage; report any external damage to the shipping carrier. If there is damage, a shipping agent should be present before you unpack and inspect the contents because damage caused during transit is the responsibility of the shipping agent.
- 3 Open and check each package against the packing list. If any items are missing, contact TE customer service (see [“Appendix D: Contacting TE Connectivity”](#) on page 229).
- 4 If damage is discovered at the time of installation, contact the shipping agent.

Installation Checklist

Table 89. *Installation Checklist*

✓	Installation Requirement	Consideration
	Floor Plans	Installation location of equipment clearly marked
	System Design	Used to verify frequency bands after installation
	Power available: Fusion Wideband Main Hub (AC) Fusion Wideband Expansion Hub (AC) To RAU (DC) Fusion Wideband Main Hub (DC) Fusion Wideband Expansion Hub (DC)	Hub's power cord is 2 m (6.5 ft) long. 115/230V, 2/1A, 50–60 Hz 115/230V, 6/3A, 50–60 Hz 54V (from the Hub) 38–64VDC, 2.5A 38–64VDC, 14A
	Rack space available (Main and Expansion Hub)	89 mm (3.5 in.) high (2U)
	Wall-Mount Fusion Wideband Main Hub	Hub must be mounted on 3/4-inch plywood backboard.
	Clearance for air circulation: Fusion Wideband Main or Expansion Hub RAU	76 mm (3 in.) front and rear, 51 mm (2 in.) sides 76 mm (3 in.) all around
	Suitable operating environment: Fusion Wideband Main or Expansion Hub	Indoor location only 0° to +45°C (+32° to +113°F) 5% to 95% non-condensing humidity
	RAUs	–25° to +45°C (–13° to +113°F) 5% to 95% non-condensing humidity

Table 89. *Installation Checklist (Cont.)*

✓	Installation Requirement	Consideration
Donor Antenna-to-Fusion Wideband Configuration (for each Fusion Wideband Band)		
	Donor Antenna	Installed, inspected; N-male to N-male coaxial cable to lightning arrester/surge suppressor
	Lightning Arrester or Surge Suppressor	Installed between roof-top antenna and repeater; N-male to N-male 50 Ohm coaxial cable and outdoor cables longer than 140 feet.
	Repeater	Installed between lightning arrester/surge suppressor and Hub; N-male to N-male coaxial cable. The Repeater must be a UL listed product.
	Attenuator	Installed between the circulator and the Hub downlink port to prevent overload. Optionally, it may be installed between the uplink port and the circulator.
	Circulator or Duplexer	Installed between the repeater and the Hub uplink and downlink ports.
Base Station-to-Fusion Wideband Configuration (for each Fusion Wideband Band)		
	Base Station	Installed, inspected; verify RF power (see tables in “Maximum Output Power Per Carrier” on page 65); N-male to N-male coaxial cable.
	Attenuator	Attenuation may be required to achieve the desired RF output at the RAU, and the desired uplink noise floor level.
	Circulator or Duplexer	When using a duplex BTS: Installed between the BTS and the Hub uplink and downlink ports. Not used with a simplex BTS.
Connecting Multiple Fusion Wideband Main Hubs Together		
	5-port Alarm Daisy-Chain Cable (PN 4024-3)	For contact alarm monitoring of fault and warning alarms. Used to feed the alarms from multiple Fusion Wideband Main Hubs into a BTS or FlexWave Focus. N.C. Operation.
Cabling		
	Coaxial: repeater, Base Station, Smart Source to Fusion Wideband Main Hub	Coax approved; N-type male connectors.
	Coaxial: RAU to passive antennas	Use low-loss cable; N male connector; typical 1 m (3.3 ft) using RG142 coaxial cable.
	Fiber: Main Hub to Expansion Hubs	SC/APC (angle-polished) male connectors for entire fiber run (can use SC/APC pigtails, PN 4012SCAPC-10 for MMF or 4013SCAPC-10 for SMF); Use jumper fiber cables for collocated Main and Expansion Hubs (3 m/10 ft.): Multi-mode: PN 4017SCAPC-10 Single-mode: PN 4018SCAPC-10 Distance limited by optical loss of 3 dB Multi-mode up to 500 m (1640 ft.) Single-mode up to 6 km (19,685 ft.)
	CATV	TIA-570-B approved; centerpin F male connectors. CATV connectors must be connected to the shield at both ends. The RAU will be damaged if it is mis-wired. Tie-off cables to avoid damaging the connectors because of cable strain.
	Fusion Wideband Expansion Hub to RAUs	<ul style="list-style-type: none"> • Minimum: 0 meters (0 ft) • Maximum: RG-59: 150 meters (492 ft) RG-6: 170 meters (557 ft) RG-11: 275 meters (902 ft) For cable requirements, see “Appendix A: Cables and Connectors” on page 191 .

Table 89. *Installation Checklist (Cont.)*

✓	Installation Requirement	Consideration
Configuring the System		
	PC/laptop running standard browser software	Refer to the <i>AdminBrowser User Manual</i> (PN D-620607-0-20)
Miscellaneous		
	Cross-over Ethernet cable	Male connectors; Fusion Wideband Main Hub to a PC/laptop running a standard browser to the Fusion Wideband AdminBrowser software; local connection or LAN switch connector for remote connections.
	Straight-through cable	Female/male connectors; Fusion Wideband Main Hub to a modem for a remote connection.
Distances		
	Fusion Wideband Main Hub is within 3–6m (10–20 ft) of connecting repeater/BTS/FlexWave	If longer distance, determine the loss of the cable used for this connection and adjust the RF signal for each Band into the Fusion Wideband Main Hub accordingly. This can be done by readjusting the power from the Base Station, or by changing the attenuation value between the Base Station/repeater and the Hub Bands (1 and 2).

Tools and Materials Required

Table 90. *Tools and Materials Required for Component Installation*

✓	Description
	Cable ties
	Screwdriver
	Mounting screws and spring nuts
	Screws, anchors (for mounting RAUs)
	Drill
	Fiber connector cleaning kit
	Fusion Wideband splicer
	Splicing tool kit (including snips, cladding strippers, fiber cleaver, isopropyl alcohol, lint-free wipes)
	Fusion Wideband splicing sleeves

Optional Accessories

Table 91. *Optional Accessories for Component Installation*

✓	Description
	Wall-mount bracket (PN 4712) When using this bracket with an Fusion Wideband Main Hub, the Hub's mounting bracket must be moved to the alternate mounting position (refer to "Installing a Fusion Wideband Main Hub in a Rack" on page 115).
	Cable management (Cable manager: PN 4759; Tie wrap bar: PN 4757)
	Splice trays
	Pigtails with SC/APC connectors, 3 m (10 ft.) Multi-mode fiber SC/APC pigtail: PN 4012SCAPC-10 Single-mode fiber SC/APC pigtail: PN 4013SCAPC-10
	Jumper cable when Main and Expansion Hubs are collocated, 3 m (10 ft.) Multi-mode fiber SC/APC: PN 4018SCAPC-10
	Line Sharing Switch: When using a single POTS line with multiple Fusion Wideband Main Hubs, connect up to four or eight modems to a line sharing switch: 4-port (240031-0) 8-port (240052-0)
	Alarm Cables: 5-port Alarm Daisy-Chain Cable (PN 4024-3) Alarm Sense Adapter Cable (PN 4025-1)

INSTALLING A FUSION WIDEBAND MAIN HUB

CAUTION! Install Fusion Wideband Main Hubs in indoor locations only.

NOTE: The following procedure assumes that the system is new from the factory and that it has not been programmed with bands. If you are replacing components in a pre-installed system with either new units or units that may already be programmed (for example, re-using units from another system), refer to [“Replacing Fusion Wideband Components”](#) on page 175.

Installing a Fusion Wideband Main Hub in a Rack

The Fusion Wideband Main Hub (2U high) mounts in a standard 19 in. (483 mm) equipment rack. Allow clearance of 76 mm (3 in.) front and rear, and 51 mm (2 in.) on both sides for air circulation. No top or bottom clearance is required. [Figure 17](#) shows the mounting bracket that secures the Hub to the equipment rack.



Figure 17. Mounting Bracket Detail

Do the following to install the Hub in a rack:

- 1 Confirm that the mounting screws match the rack's threads. (The Fusion Wideband Main Hub ships with #10-32 mounting screws; another common rack thread is #12-24.)
- 2 Insert spring nuts into rack where needed or use existing threaded holes.
- 3 Insert the Hub into the rack from the front.
- 4 Align the flange holes with the spring nuts installed in [Step 2](#).
- 5 Insert the mounting screws in the appropriate positions in the rack.
- 6 Tighten the mounting screws.

Installing an Optional Cable Manager in the Rack

Use the screws provided to fasten the cable manager to the rack, immediately above or below the Main Hub.

Installing a Main Hub Using the 12" Wall-Mounted Rack (PN 4712)

CAUTION! The maximum weight the bracket can hold is 22.5 kg (50 lbs).

NOTE: The bracket is designed to accommodate a Fusion Wideband Main Hub (12 lbs.) or an Expansion Hub (14.5 lbs.).

NOTE: The wall mount bracket should be securely mounted to wall, using the four key slot mounting holes on the bracket.

NOTE: This installation requires that you attach the Fusion Wideband Main Hub to wall studs with 16-inch spacing. If wall stud spacing of 16" is not available, follow the steps in ["Installing a Fusion Wideband Main Hub Directly to the Wall"](#) on page 117.

Do the following to install a Hub using the 12" wall-mounted rack (PN 4712):

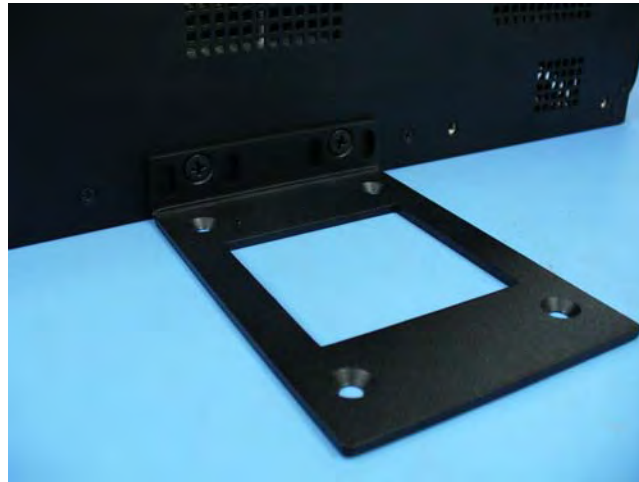
- 1 Attach the wall bracket (PN 4712) to wall studs spaced 16-inches apart, using #10 Pan Head wood screws, 1-1/2-inch minimum length for mounting in wood studs. Position the bracket so that the Hub will be in a horizontal position when it is installed.
- 2 Remove both of the rack mounting brackets from the Hub.
- 3 Move the rack-mounting brackets on the Fusion Wideband Main Hub to the recessed mounting position to allow for the required 3-inch (76 mm) rear clearance.



- 4 Insert the Hub in the rack.
- 5 Use the rack mounting screws to secure the Hub to the rack.

Installing a Fusion Wideband Main Hub Directly to the Wall

- 1 Pre-install 3/4-inch plywood to the wall. The plywood must be big enough to accommodate the Fusion Wideband Main Hub (17.25-inch tall × 15-inch wide / 438 mm × 381 mm).
- 2 Use #10-32 machine screws to mount both of the rack mounting brackets to the Hub:



- 3 Attach the Hub to the wall so the mounting brackets are orientated at the top and bottom of the wall mounted hub, as shown below:



Use two #10 Pan Head wood screws, 1-1/2" length, to secure each bracket to the plywood. In this orientation the enclosure fans will face to the left.

Connecting the Fiber Cables to the Main Hub

CAUTION! Observe all Fiber Port Safety Precautions listed in [“Safety Precautions” on page 109](#).

Prepare the Fiber Cables

Do the following before connecting the fiber cables:

- 1 Confirm that their optical loss does not exceed the 3 dB optical budget.
- 2 If using fiber distribution panels, confirm that the total optical loss of fiber cable, from the Main Hub through distribution panels and patch cords to the Expansion Hub, does not exceed the optical budget.
- 3 Make sure the fiber cable’s connectors are SC/APC (angle-polished). **Using any other connector type will result in degraded system performance and may damage the equipment.** (You can use an SC/APC pigtail if the fiber cable’s connectors are not SC/APC. Refer to [“Splicing Fiber Optic Cable” on page 146](#). Or, you can change the fiber’s connector to SC/APC.)

Clean the Fiber Ports

You can clean the Hub’s fiber ports using canned compressed air or isopropyl alcohol and foam tipped swabs.

- If using compressed air, the air must be free of dust, water, and oil, and hold the can level during use.
- If using isopropyl alcohol and foam tipped swabs, use only 98% pure or more alcohol.

Using Compressed Air

- 1 Remove the port’s dust cap.
- 2 Spray the compressed air away from the unit for a few seconds to clean out the nozzle and then blow dust particles out of each fiber port.

Using Isopropyl Alcohol

- 1 Remove the connector’s dust cap.
- 2 Dip a 2.5mm lint-free, foam-tipped swab in isopropyl alcohol and slowly insert the tip into the connector.
- 3 Gently twist the swab to clean the port.
- 4 Insert a dry swab into the port to dry it.
- 5 Additionally, you can use compressed air after the alcohol has completely evaporated.

Cleaning the Fiber Ends

Be sure that the fiber cable's SC/APC connectors are clean and free of dust and oils. You need lint-free cloths, isopropyl alcohol, and compressed air.

- 1 Moisten a lint-free cloth with isopropyl alcohol.
- 2 Gently wipe the fiber end with the moistened cloth.
- 3 Using a dry lint-free cloth, gently wipe the fiber end.
- 4 Spray the compressed air away from the connector for a few seconds to clean out the nozzle and then use it to completely dry the connector.

Testing the Fiber Cables

Perform cable testing and record the results. Test results are required for the final As-Built Document.

Connecting the Fiber Cables

The fiber cable is labeled with either **1** or **2**, or is color-coded. In addition to these labels, you should add a code that identifies which port on the Main Hub is being used and which Expansion Hub the cables are intended for. This differentiates the connectors for proper connection between the Main Hub and Expansion Hubs.

For example:

First pair to Main Hub port 1: 11 (uplink), 12 (downlink);
Second pair to Main Hub port 2: 21 (uplink), 22 (downlink);
Third pair to Main Hub port 3: 31 (uplink), 32 (downlink); and so on.

NOTE: The Fusion Wideband One Port Main Hub (PN: FSN-1-MH-1P and FSN-2-MH-2-1P) configuration is a cost reduced version of the Fusion Wideband Main Hub and supports *only* one Expansion Hub (up to 8 RAUs).

If the fiber jumper is labeled with **1** or **2**

- 1 Connect 1s to UPLINK ports on the Main Hub.
- 2 Connect 2s to DOWNLINK ports on the Main Hub.
- 3 Record which cable number and port number you connected to UPLINK and DOWNLINK. (This information is needed when connecting the other end of the fiber cable to the Expansion Hub's fiber ports.)

The fiber port LEDs should be off, indicating that the Expansion Hub(s) are not connected.

If the Fiber Jumper is Color-Coded

- 1 Connect “blue” to UPLINK ports on the Main Hub.
- 2 Connect “red” to DOWNLINK ports on the Main Hub.
- 3 Record which color and port number you connected to UPLINK and DOWNLINK.

This information is needed when connecting the other end of the fiber cable to the Expansion Hub’s fiber ports.

The fiber port LEDs should be off, indicating that the Expansion Hub(s) are not connected.

Making Power Connections

CAUTION! Only trained and qualified personnel should install or replace this equipment.

Follow the procedure that corresponds to your system design:

- [AC Powered Main Hub](#)
- [DC Powered Main Hub and Expansion Hub.](#)

AC Powered Main Hub

- 1 Connect the AC power cord to the Main Hub.
- 2 Plug the power cord into an AC power outlet.

DC Powered Main Hub and Expansion Hub

CAUTION! The protective earth connection should be connected before proceeding with power connections. Confirm the DC power source is powered off during installation. Damage to hubs may result if power is connected improperly.

The DC powered Main Hub and Expansion Hub are intended to be powered by a +48VDC power source. The hubs are designed for 14AWG to 6AWG wire size connections. Use only UL listed AWM wire, rated 600V and 90°C.

If wires larger than 6AWG are needed from the DC power source, follow local codes for reducing the wire size at hub connection point.

Follow local codes for routing of power cables to power source.

The unit should be connected to a DC branch circuit breaker. A suitable disconnect device must be provided in the DC branch, either a circuit breaker or switch, that can be employed to disconnect power to the system during servicing.

[Figure 18](#) illustrates the recommended routing of hub wires.

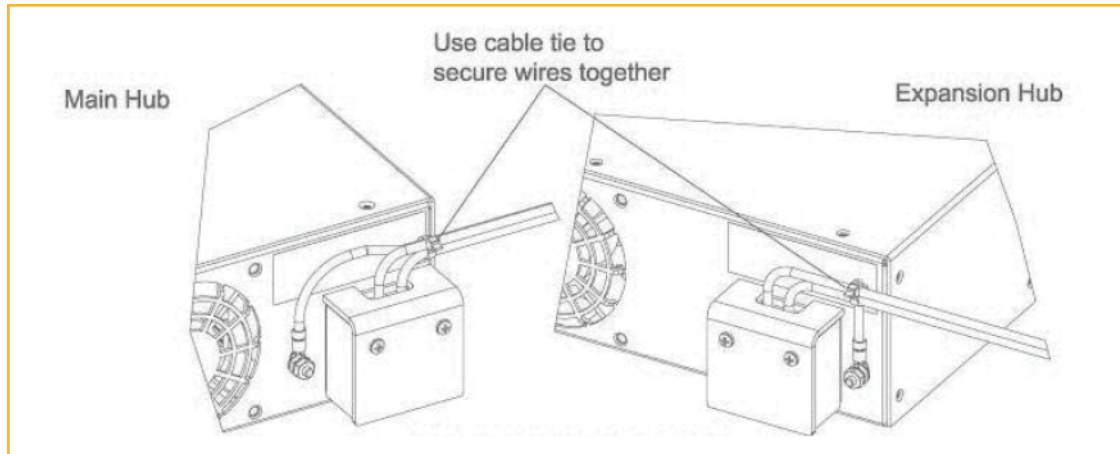


Figure 18. Recommended Hub-Wire Routing

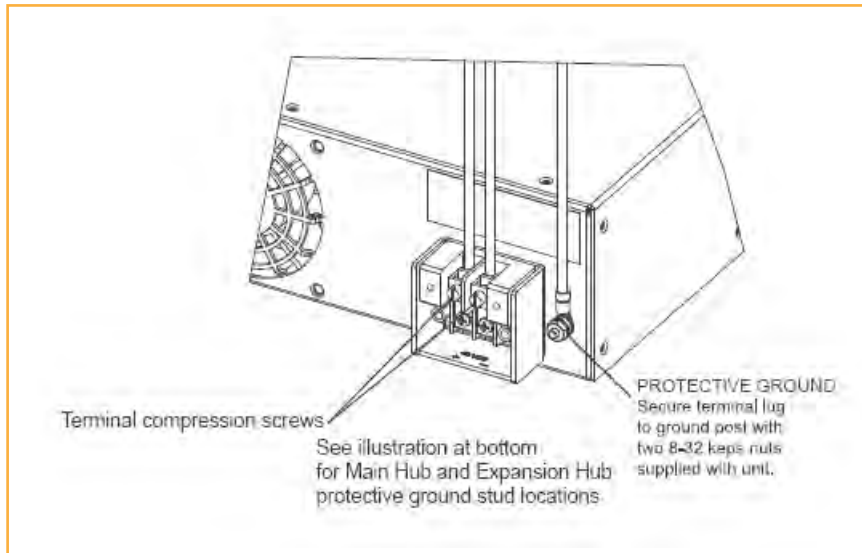
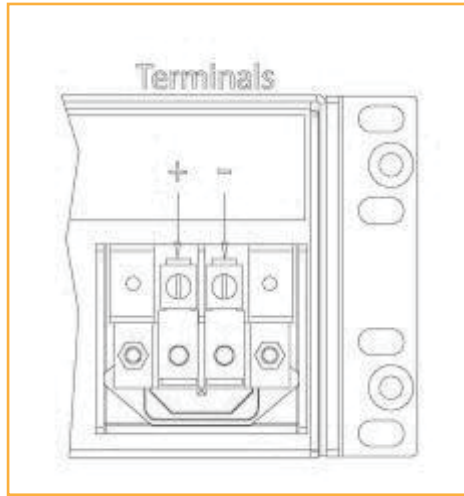
To connect DC power to a Main Hub or Expansion Hub:

- 1 Strip 5/8" (16mm) of wire insulation material off each power wire.
- 2 Insert the +48VDC wire into the compression terminal at the "+" location.
- 3 Insert the -48VDC wire into the compression terminal at the "-" location.
- 4 Bare wire ends should be fully inserted into terminal.
- 5 Use a flat blade screw driver to fasten the wire inside the compression terminal.
- 6 For the Protective Ground Wire, use 14AWG minimum wire with a #8-32 stud size ring lug, as shown below.

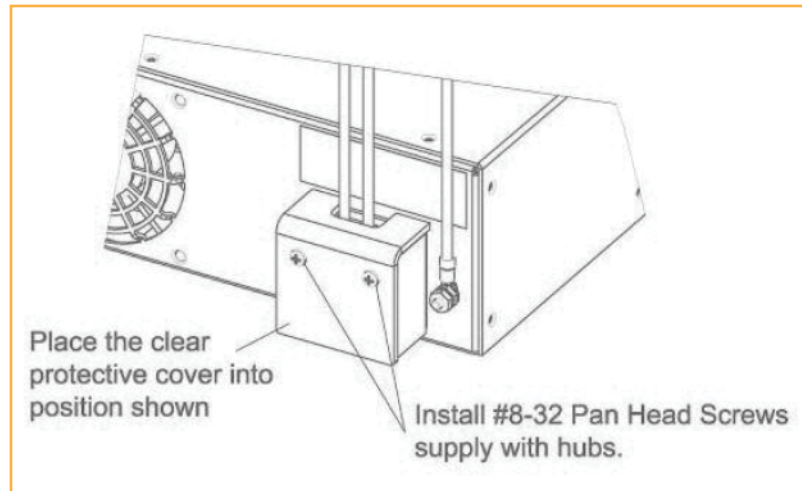


CAUTION! The warning color code of the power cables depends on the color coding of the DC power source installed at your site. Color code standards for DC wiring do not exist. To ensure that the correct polarity is connected to the hubs, confirm the connection of the power cables to the + (positive) and - (negative) leads at the power source.

7 Use the following illustrations in the order shown to connect the power.



- 8 Install the clear protective cover with the pan head screws:

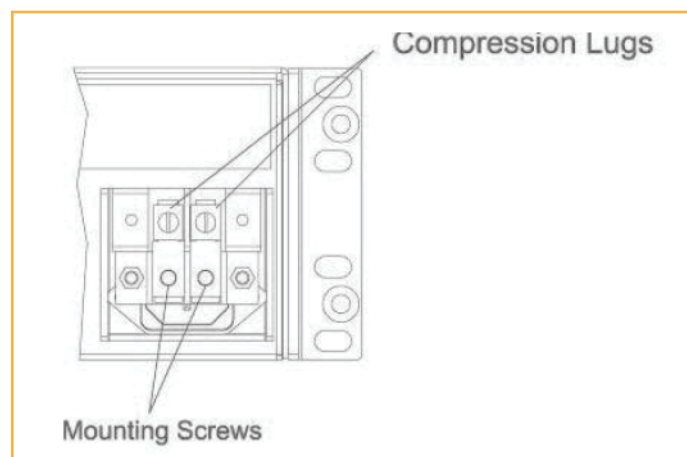


Optional Connection to DC Power Source

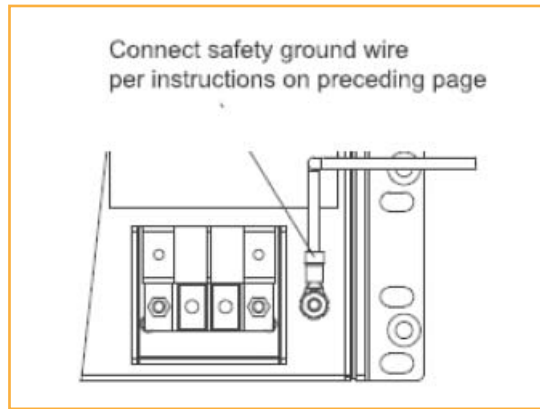
This is an optional connection method using ring-tongue lugs instead of the compression lugs that are pre-mounted on the terminal block. Use wire selection instructions in [“Making Power Connections”](#) on page 120.

CAUTION! Before connecting power wires, be sure the power source is shut off, and the power switch of the hubs are in the OFF position. Connect the ground wires before connecting the power wires.

- 1 Remove the existing compression lugs by first removing the mounting screws:



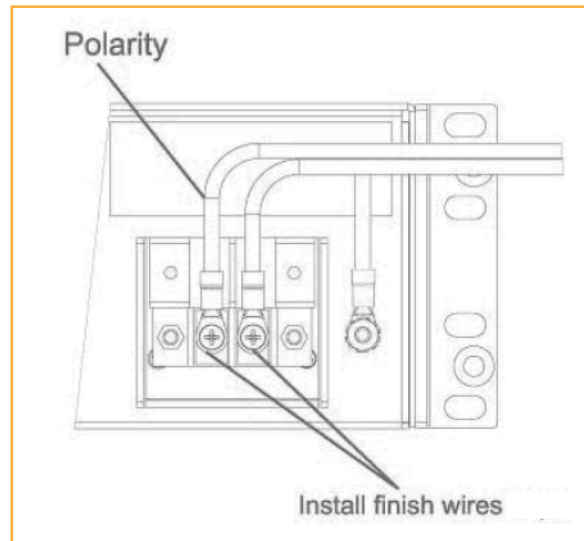
- 2 Connect the safety ground wire as previously explained and shown below.



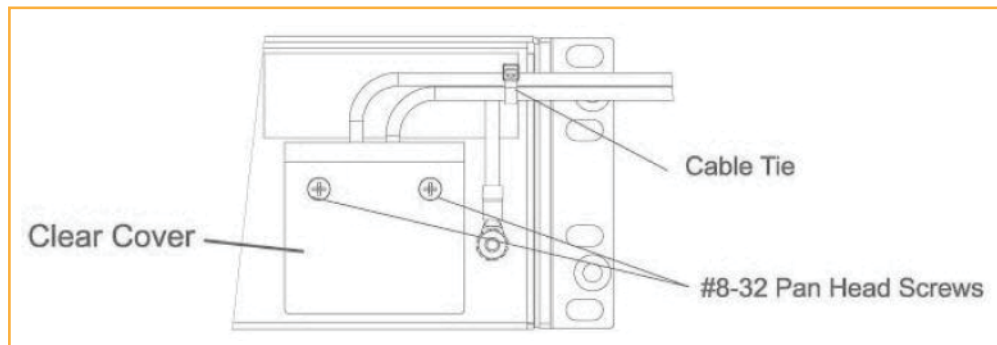
- 3 Use 14AWG minimum wire with a #8-32 stud size ring lug as shown below.



- 4 Install the finish wires using the proper polarity and secure them with #8-32 pan head screws previously removed in [Step 1 on page 123](#).



- 5 Attach the clear protective cover and secure it with the two #8-32 pan head screws supplied with the Hub.



Power on the Main Hub

- 1 Connect the AC or DC power as explained in “[Making Power Connections](#)” on page 120.
- 2 Turn on the power to the Main Hub and check that all the LED lamps are functioning properly.

Upon power-up, the LEDs blink for five seconds as a visual check that they are functioning. After the five-second test, LED states during power on will vary, depending on whether Expansion Hubs are connected. Refer to [Table 92](#) for possible combinations.

Table 92. Troubleshooting Main Hub LEDs During Installation

During Installation Power On	LED	State	Action	Impact
1 Main Hub power is On with no Expansion Hubs connected.	POWER	Off	Check AC power; check that the Main Hub power-on switch is on; replace the Main Hub	The Main Hub is not powering on.
	POWER	Red	Replace the Main Hub	The power supply is out-of-specification.
	PORT	LEDs are on but didn't blink through all states	Replace the Main Hub.	The micro controller is not resetting properly; flash memory corrupted.
	PORT	Red Off	The port is unusable; replace the Main Hub when possible.	Fiber sensor fault, do not use the port.
2 Main Hub power is On with Expansion Hubs connected and powered on.	PORT	Off	<ul style="list-style-type: none"> • If the port LEDs do not illuminate, check the fiber uplink for excessive optical loss. • If Expansion Hub's DL STATUS LED is red: <ul style="list-style-type: none"> • Verify that the fiber is connected to the correct port (that is, uplink/downlink) • Swap the uplink and downlink cables. • Connect the fiber pair to another port. If the second port's LEDs do not illuminate Green/Red, replace the Main Hub. <ul style="list-style-type: none"> • If the second port works, flag the first port as unusable; replace the Main Hub when possible. 	No uplink optical power, the Expansion Hub is not recognized as being present. No communication with the Expansion Hub.
	PORT	Red (60 ppm)	<ul style="list-style-type: none"> • If the Expansion Hub DL STATUS LED is red, check the downlink fiber cable for excessive optical loss. • Connect the fiber pair to another port. If the second port's LEDs do not illuminate Green/Red, replace the Main Hub. <ul style="list-style-type: none"> • If the second port works, flag the first port as unusable; replace the Main Hub when possible. 	No communication with the Expansion Hub.
	PORT	Red	The Expansion Hub or connected RAU reports a fault. Use AdminManager to determine the problem.	The Expansion Hub or one or more RAUs are off-line.

INSTALLING EXPANSION HUBS

The Expansion Hub (2U high) can be installed in a standard 19" (483 mm) equipment rack or in a wall-mountable equipment rack that is available from TE. Allow the following clearances:

- 3" (76 mm) front and rear
- 2" (51 mm) sides for air circulation
- no clearance is required for the top and bottom.

CAUTION! Install Expansion Hubs in indoor locations only.

NOTE: The following procedures assume that the system is new from the factory and that it has not been programmed with bands. If you are replacing components in a pre-installed system with either new units or units that may already be programmed (for example, re-using units from another system), refer to ["Replacing Fusion Wideband Components" on page 175](#).

Installing the Expansion Hub in a Rack

- 1 Confirm that the mounting screws match the rack's threads. (The Expansion Hub is shipped with #10-32 mounting screws; another common rack thread is #12-24.)
- 2 Insert spring nuts into the rack where needed or use existing threaded holes.
- 3 Insert the Expansion Hub into the rack from the front.
- 4 Align the flange holes with the spring nuts installed in [Step 2](#).
- 5 Insert the mounting screws in the appropriate positions in the rack.
- 6 Tighten the mounting screws.

Installing an Expansion Hub Using the 12" Wall-Mounted Rack

CAUTION! The maximum weight the rack can hold is 22.5 kg (50 lbs).

NOTE: The rack (PN4712) is 305 mm (12 in.) deep. The Expansion Hub is 381 mm (15 in.) deep.

NOTE: If wall stud spacing of 16" is not available, TE recommends that 3/4-inch plywood be pre-installed to the wall. You can then attach the bracket to the plywood using the wood screws.

- 1 Move the rack mounting brackets on the Expansion Hub, as shown below, to the center mounting position to allow for the 76 mm (3 in.) rear clearance that is required.



- 2 Attach the equipment rack to the wall using the screws that are provided.
- 3 The rack must be positioned so that the Expansion Hub will be in a horizontal position when it is installed.
- 4 Remove both of the rack mounting brackets from the Hub.
- 5 Reattach each of the rack mounting brackets to the recessed wall mount position.
- 6 Install the Hub in the rack using the rack mounting screws.
- 7 Tighten the mounting screws.

Installing an Expansion Hub Directly to the Wall

- 1 Pre-install 3/4-inch plywood to the wall.
- 2 Mount both of the rack mounting brackets using #10-32 machine screws:



- 3 Attach the Hub to the wall so the mounting brackets are orientated at the top and bottom of the wall mounted hub:



- 4 Leave the dust caps on the fiber ports until you are ready to connect the fiber optic cables.

Installing an Optional Cable Manager in the Rack

Use the screws provided to fasten the cable manager to the rack, immediately above or below the Expansion Hub.

Powering on the Expansion Hub

- 1 Connect the AC or DC power as explained in [“Making Power Connections” on page 120](#).
- 2 Turn on the power to the Expansion Hub and check that all the LED lamps are functioning properly.

Upon power-up, the LEDs blink for five seconds as a visual check that they are functioning. After the five-second test:

- The POWER and UL STATUS LEDs should be green.
- If the uplink fiber is not connected, the UL STATUS LED turns red indicating that there is no communication with the Main Hub.
- The E-HUB STATUS and DL STATUS LEDs should be red.
- All port LEDs should be off, as no RAUs have been connected yet.

Connecting the Fiber Cables to the Expansion Hub

CAUTION! Observe all Fiber Port Safety Precautions listed in [“Safety Precautions” on page 109](#).

Prepare the Fiber Cables

- 1 Confirm that their optical loss does not exceed 3 dB optical budget. RL is less than -60dB.
- 2 If fiber distribution panels are used, confirm that the total optical loss of fiber cable—from the Main Hub through distribution panels and patch cords to the Expansion Hub—does not exceed the optical budget.
- 3 Make sure the fiber cable’s connectors are SC/APC (angle-polished). **Using any other connector type will result in degraded system performance and may damage the equipment.** (You can use an SC/APC pigtail if the fiber cable’s connectors are not SC/APC, refer to [“Splicing Fiber Optic Cable” on page 146](#), or replace the connectors.)

Connect the Fiber Cables

The fiber cable is labeled with either 1 or 2, or is color-coded. For proper connection between the Main Hub ports and the Expansion Hub ports, refer to the numbering or color-coded connections you recorded when installing the Main Hub(s).

If the Fiber Jumper Is Labeled with 1 or 2

- 1 Connect 2 to DOWNLINK on the Expansion Hub.
The DL STATUS LED should turn green as soon as you connect the fiber. If it does not, there is a downlink problem. Make sure you are connecting the correct cable to the port.
- 2 Connect 1 to UPLINK on Expansion Hub.
The UL STATUS LED turns green on the first Main Hub communication. It may take up to 20 seconds to establish communication.
The Expansion Hub’s E-HUB STATUS LED turns green when the Main Hub sends it the frequency band command.

- 3 If the UL STATUS and E-HUB STATUS LEDs do not turn green/green, check the Main Hub LEDs; see Step 2 in [Table 92 on page 126](#).

If the Fiber Jumper Is Color-Coded

- 1 Connect “red” to DOWNLINK on Expansion Hub.
The DL STATUS LED should turn green as soon as you connect the fiber. If it does not, there is a downlink problem. Make sure you are connecting the correct cable to the port.
- 2 Connect “blue” to UPLINK on Expansion Hub.
The UL STATUS LED turns green on the first Main Hub communication. It may take up to 20 seconds to establish communication.
The Expansion Hub’s E-HUB STATUS LED turns green when the Main Hub sends it the frequency band command.
- 3 If the UL STATUS AND E-HUB STATUS LEDs do not turn green/green, check the Main Hub LEDs; see Step 2 in [Table 92 on page 126](#).

Connecting the 75 Ohm CATV Cables

- 1 Verify that the cable has been tested and the test results have been recorded. This information is required for the As-Built Document.
- 2 Verify that only the captive centerpin F connectors are used on the solid copper center conductor CATV cable from CommScope (or equivalent).
- 3 Verify that the CATV cable is labeled with:
 - Fusion Wideband Expansion Hub port number being used
 - RAU identifier
 - carrier (for multiple operator systems).
- 4 Connect the CATV cables to the F ports according to the labels on the cables.
The STATUS LEDs should be off because the RAUs are not connected yet at the other end of the CATV cable.
- 5 Use the label on the cable to record which cable you are connecting to which port. This information is required for the As-Built Document.
- 6 Tie-off the cables or use the optional cable manager to avoid damaging the connectors due to cable strain.

Troubleshooting Expansion Hub LEDs During Installation

- For all Expansion Hub with RAUs connected, the corresponding PORT LED should be Green/Red, which indicates that the RAU is powered on and communication has been established.
- The Expansion Hub UL STATUS LED should be Green.

Table 93. Troubleshooting Expansion Hub LEDs During Installation

During Installation	LED	State	Action	Impact
1 Expansion Hub power is on and no RAUs are connected	POWER	Off	Check AC power; make sure the Expansion Hub power-on switch is on; replace the Expansion Hub.	The Expansion Hub is not powering on.
	PORT	LEDs are on but didn't blink through all states.	Replace the Expansion Hub.	The Microcontroller is not resetting properly; flash memory corrupted.
	PORT	Flashing Red (6 PPM)	Port unusable; replace the Expansion Hub when possible.	Current sensor fault; do not use the port.
	UL STATUS	Red, after power-up blink	Replace the Expansion Hub.	The Expansion Hub laser is not operational; no uplink between the Expansion Hub and Main Hub.
	UL STATUS	Red	Check the Main Hub LEDs—refer to Step 2 in Table 92 on page 126 . Use AdminBrowser to determine the problem.	No communication with Main Hub.
	DL STATUS	Red	Check the downlink fiber for optical power; verify that the cables are connected to correct ports (that is, uplink/downlink) Check the Main Hub LEDs—refer to Step 2 in Table 92 on page 126 .	No downlink between the Expansion Hub and Main Hub.
2 Expansion Hub power is On and RAUs are connected	PORT	Off	Check the CATV cable.	Power is not getting to the RAU.
	PORT	Flashing Red (60 PPM)	Test the CATV cable. If the cable tests OK, try another port. If the second port's LEDs are Red/Off, replace the RAU. If the second RAU doesn't work; replace the Expansion Hub.	Power levels to RAU are not correct; communications are not established. If the second port works, flag the first port as unusable; replace EH when possible.
	PORT	Red	Use AdminBrowser to determine the problem.	RAU is off-line.

INSTALLING RAUs

CAUTION! Install RAUs in indoor locations only. Do not connect an antenna that is installed in an outdoor location to a RAU. For outdoor installations, a protective enclosure is required.

NOTE: The following procedures assume that the system is new from the factory and that it has not been programmed with bands. If you are replacing components in a pre-installed system with either new units or units that may already be programmed (for example, re-using units from another system), refer to [“Replacing Fusion Wideband Components” on page 175](#).

RAU Installation Notes

- Mount all RAUs in the locations marked on the floor plans.
- Install 800 iDEN and 850/1900 MHz RAUs so that their antennas will be separated by enough space to reduce signal interference between the 800 and 850 bands. Refer to [“800/850 MHz Isolation Requirements” on page 134](#) for recommended distance between antennas.
- You can place a RAU without its fastening hardware on a flat surface such as a shelf, desk, cabinet, or any other horizontal surface that allows stable placement with the mounting base facing down to the mounting surface.
- To mount a RAU to a location such as a wall, ceiling, or pole, the RAU must be securely mounted using the four slotted mounting holes on the #6 diameter fasteners. **The mounting location must be able to securely hold a minimum 7-pound load.**
- For proper ventilation:
 - Keep at least 3-inch clearance (76 mm) around the RAU to ensure proper venting.
 - Do not stack RAUs on top of each other.
 - Always mount the RAU with the solid face (containing the mounting holes) against the mounting surface.

Installing Passive Antennas

Refer to the manufacturer’s installation instructions to install passive antennas.

Location

Passive antennas are usually installed below the ceiling. If they are installed above the ceiling, you must consider the additional loss due to the ceiling material when estimating the antenna coverage area.

800/850 MHz Isolation Requirements

When deploying any RF system, give special attention to preventing receiver blocking or desensitization by out-of-band transmitters. Typically, sharp filters in the receiver front-end will reduce the interfering transmitters to tolerable levels. In select cases, the interferers may occupy a frequency band that is directly adjacent to the receiving band and cannot be adequately rejected by filtering. The only recourse in these situations is to provide sufficient isolation by physically separating the interfering transmitters and receivers.

iDEN occupies spectrum at:

- 800 MHz
 - Tx is 851–869
 - Rx is 806–824
- 900 MHz
 - T is 935–941
 - Rx:896–902).

The Cellular A and B carriers share a single 850 MHz block:

- Tx is 869–894
- Rx is 824–849.

The combination of these frequency bands, 800/900 MHz iDEN and 850 MHz Cellular, result in uplink (BTS receive) bands that are adjacent to downlink (BTS transmit) bands. [Figure 19](#) depicts these nearly contiguous bands, with arrows indicating the interfering downlink and receiving uplink bands.

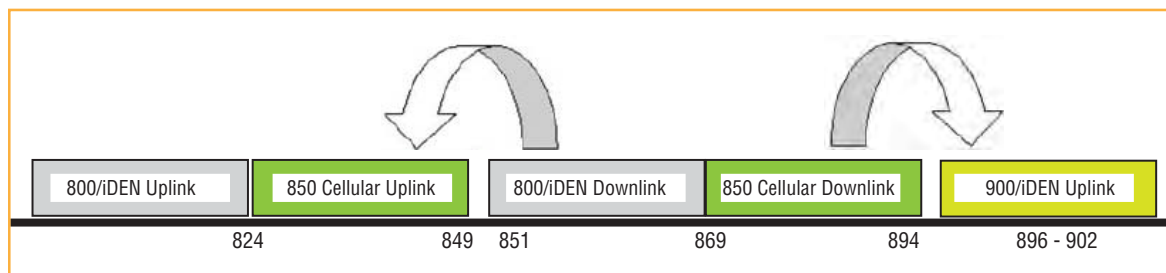


Figure 19. 800/850 MHz Spectrum

Installation of an in-building distributed antenna system (DAS) to provide coverage for both 800/900 MHz iDEN and 850 MHz Cellular must account for these downlink-to-uplink interference issues and provide adequate isolation ([Figure 20 on page 135](#)).

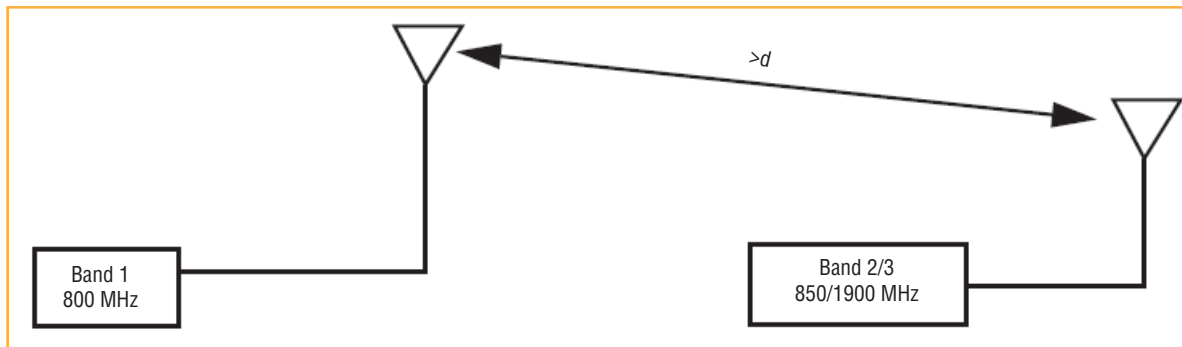


Figure 20. Fusion Wideband 800/850/1900 MHz RAU Antenna Placement Guideline

TE offers the following guidelines toward achieving the proper amount of isolation when deploying TE Fusion Wideband DAS products.

800 MHz iDEN Downlink and 850 MHz Cellular Uplink

A 2 MHz frequency gap (851 – 849 MHz) separates the 800 iDEN downlink and 850 Cellular uplink frequency bands. Because of this narrow spacing, 800 iDEN downlink intermodulation products may fall within the 850 Cellular uplink band. In addition, 800 iDEN downlink signals near the lower edge of the band at 851 MHz may cause the 850 Cellular uplink automatic level control (ALC) circuitry in the RAU to engage and thereby reduce uplink gain.

To prevent either of these conditions, use the following guidelines:

- In-band 800 iDEN intermodulation products < -90dBm
- Lower frequency 800 iDEN signals < -30dBm for Fusion Wideband

Given a typical DAS configuration (four iDEN carriers, omni-directional antennas, line of sight), these guidelines translate to an antenna spacing (d_1) of 6 – 9 meters.

850 MHz Cellular Downlink and 900 MHz iDEN Uplink

A 2 MHz frequency gap (896 – 894 MHz) separates the 850 Cellular downlink and 900 iDEN uplink frequency bands. Because of this narrow spacing, 850 Cellular downlink intermodulation products may fall within the 900 iDEN uplink band. In addition, 850 Cellular downlink signals near the upper edge of the band at 894 MHz may cause the 900 iDEN uplink ALC to engage and thereby reduce uplink gain.

To prevent either of these conditions, use the following guidelines:

- In-band 850 Cellular intermodulation products < -90dBm
- Upper frequency 850 Cellular signals < -30dBm for Fusion Wideband

Given a typical DAS configuration (six CDMA carriers for Fusion Wideband, omni-directional antennas, line of sight), these guidelines translate to an antenna spacing (d_2) of 8-14 meters.

Spacing between RAUs FSN-8519-1 and FSN-809019-2 should be in a range of from 8 to 14 meters.

Connecting the Antenna to the RAU

Connect a passive multi-band antenna to the N connector on the RAU using coaxial cable with the least amount of loss possible.

CAUTION! Firmly hand-tighten the N connector. **DO NOT** over-tighten the connector.

Connecting the CATV Cable

- 1 Verify that the cable has been tested and the test results are recorded. This information is required for the As-Built Document.
- 2 Verify that only captive centerpin 75 Ohm Type-F connectors are used on the solid copper center conductor CATV 75 Ohm cable.
- 3 Verify that the CATV cable is labeled with:
 - Fusion Wideband Main Hub port number being used
 - RAU identifier
 - carrier (for multiple operator systems).
- 4 Connect the CATV cables to the F female port on the RAU according to the label on the cable. Power is supplied by the Fusion Wideband Main Hub over the CATV cable conductors. Upon power up, the LEDs will blink for two seconds as a visual check that they are functioning. After the two-second test:
 - The LINK LED should be green indicating it is receiving power and communications from the Fusion Wideband Main Hub.
 - The ALARM LED should be red until the Fusion Wideband Main Hub issues the band command, within about 20 seconds, then it should be green.
- 5 Record which cable you are connecting to the RAU (from the label on the cable). This information is required for the As-Built Document.
- 6 Tie-off cables or use the optional cable manager to avoid damaging the connectors due to cable strain.

Troubleshooting Using RAU LEDs During Installation

The LINK LED should be green and remain green for longer than 90 seconds. The ALARM LEDs are red when the system band has not been programmed.

Table 94. Troubleshooting RAU LEDs During Installation

During Installation	LED	State	Action	Impact		
The RAU is connected to the Fusion Wideband Expansion Hub, which is powered on	LINK	Off	Check CATV cable.	No power to the RAU.		
	ALARM	Off				
	LINK	Green	<ul style="list-style-type: none"> • Check CATV cable • Check the Main Hub LEDs—refer to Step 2 in Table 92 on page 126. • Use AdminBrowser to determine the problem. 	The RAU is off-line.		
	ALARM	Red				
	LINK	Red from green, after cables are connected for 60 seconds			<ul style="list-style-type: none"> • Check CATV cable. • Check the Hub LEDs. • Use AdminBrowser to determine the problem. 	No communications between the RAU and the Hub.
	ALARM	Red				

CONFIGURING THE FUSION WIDEBAND SYSTEM

Before the system can operate properly, use AdminBrowser to program the Fusion Wideband Main Hub with the frequency bands that are to be distributed. The Hub must be programmed with the same frequencies as the RAU used.

The AdminBrowser software, described in the *AdminBrowser User Manual* (PN D-620607-0-20), must be running on a PC/laptop.

NOTE: The frequency bands should automatically be set on power up and this step should not be required.

NOTE: Crossover Ethernet cable with male connectors required.

NOTE: The following procedures assume that the system is new from the factory and that it has not been programmed with bands. If you are replacing components in a pre-installed system with either new units or units that may already be programmed (for example, re-using units from another system), refer to [“Replacing Fusion Wideband Components” on page 175](#).

Connecting the PC to the Main Hub to Run AdminBrowser

- 1 Connect the AC power cord to the Hub.

CAUTION! Make sure the Hub is grounded through the ground lug on the AC power and the frame ground lug as required. The warranty does not cover damage caused when an ungrounded Hub is powered on.

- 2 Plug the power cord into an AC power outlet.
- 3 Verify that all cables are properly connected on the Hub.
- 4 Turn on the power to the Hub.

All LEDs blink through the power up sequence. At each port where a RAU is detected (drawing current), the port LEDs turn green. The Fusion Wideband STATUS LED is orange during system boot and should turn green after about 90 seconds if it finds no faults. This state indicates the band's are not programmed and provides feedback on the status of the RAU connections.

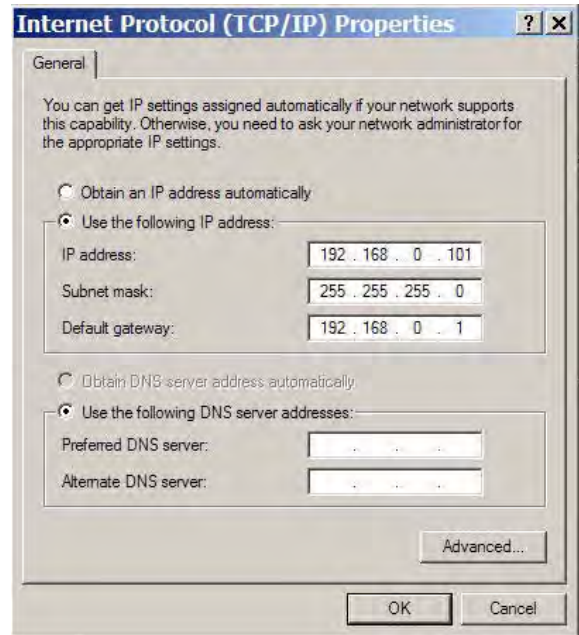
The LEDs blink for 20 seconds as a visual check that they are functioning.

- 5 Connect the cross-over Ethernet cable to the PC/laptop and then to the RJ-45 100-BASE-T port on the Hub's front panel.

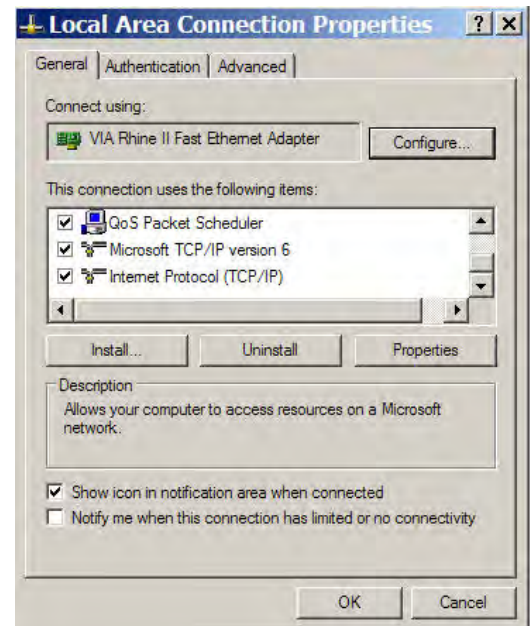
Programming the Main Hub Using AdminBrowser

- 1 Connect the provided TCP/IP crossover cable to the laptop and then to the Admin/LAN RJ-45 port on the Fusion Wideband Main Hub's front panel.
- 2 Turn on the laptop and start the Fusion Wideband Main Hub.
- 3 Do one of the following:

- **For Windows 2000:**
 - a Right-click **My Network Places** and select **Properties**.
 - b Highlight **Internet Protocol (TCP/IP)** and click **Properties**. A screen similar to the one shown to the right opens.



- **For windows XP:**
 - a Click **Start > Settings > Network Connections > Local Area Connection**. The window shown to the right opens.
 - b In the **This connection uses the following items**, scroll down to and select **Internet Protocol (TCP/IP)** and click **Properties**.



- 4 Make note of the current IP address, Subnet mask, and Default gateway, if they are configured. You will need to re-enter them after you have configured the Fusion Wideband Main Hub.
- 5 Select **Use the following IP address**.
- 6 Change the **IP address** to **192.168.0.101**
- 7 Change the **Subnet mask** to **255.255.255.0**
- 8 Change the **Default gateway** to **192.168.0.1**
- 9 Click **OK** twice. If asked if you want to reboot your computer, click **Yes**.

Using AdminBrowser

Do the following to access Fusion Wideband using AdminBrowser:

- 1 Make sure the Main Hub STATUS LED is green.
- 2 Type the following in the URL line:
`https://192.168.0.100`
- 3 Click **Go**.
- 4 When AdminBrowser appears, log in using
 - the default user ID: **operator**
 - the default password: **password**
- 5 When AdminBrowser appears, log in using
 - the default user ID: **operator**
 - the default password: **password**
- 6 Click **System Configuration** and then click **Set Date/Time**. A page similar to one shown below opens.

Old System Date and Time
Date 04/25/2006
Time 13:40:54

New System Date and Time
Date 04/25/2006 (MM/DD/YYYY)
Time 13:40:54 (hh:mm:ss)

Set Date/Time

- 7 Enter the desired time and date in the indicated format, and then click **Set Date/Time**. A page appears requiring you to reboot the system for the new date and time to take effect.

- 8 Select the Fusion Main Hub and click **Install/Configure System**. A screen similar to the one shown below opens.

The screenshot shows a configuration window with the following sections:

- Label:** A text box containing "FUSION_SINGLESTAR_LCC_SanJ".
- System Date and Time:** A section showing "Date: 02/23/2006" and "Time: 18:04:54".
- Schedule System Test:** A section with a warning "Warning: A system test will take the system offline." and several controls:
 - Enable:** An unchecked checkbox.
 - System test on power up:** A checked checkbox.
 - Date:** A text box containing "00/00/0000".
 - Time:** A text box containing "00:00:00".
 - Recurrence:** Radio buttons for "Day" (selected) and "Week", with a text box containing "1" next to "Day".
- Bands:** A section with a dropdown menu set to "850+1900". Below it are two columns of controls for "050MHz" and "1900MHz":
 - Uplink Gain:** Dropdown menus set to "0".
 - Downlink Gain:** Dropdown menus set to "9" for 050MHz and "0" for 1900MHz.
 - Uplink Automatic Level Control:** Dropdown menus set to "Multiple".

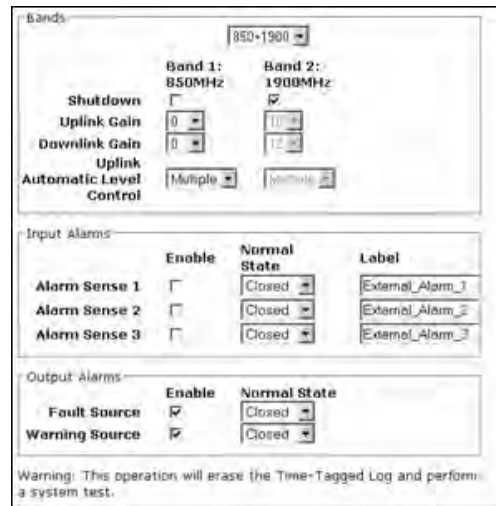
- 9 If desired, type in a **Label**, which is the system name displayed next to the icons and used in messages. It can be up to 32 characters long depending upon the firmware version. The default system label is **Fusion**, and will be used if you enter nothing.
- 10 Use the parameters in the **Schedule System Test** panel to schedule a system test.

CAUTION! **Schedule System Test** allows periodic, automatic execution of the system end-to-end test. Just like **Perform System Test**, a **Schedule System Test** suspends normal service for the duration of the test; calls are dropped, and no new calls can be established during the test. Test duration depends on the configuration (number of RAUs) and requires one or two minutes to complete.

- Select the **Enable** check box to enable this feature.
- Select the **System test on power up** check box to cause system test on power up.
- In the **Date** box, enter the date the test is to run. Enter the date in the **MM/DD/YYYY** format.
- In the **Time** box, enter the time the system test should run.
- Use the **Recurrence Day** and **Week** radio buttons to select if the system test should rerun on a daily or weekly schedule, and the corresponding text box to enter the interval between tests.

After completion of the system test, the scheduled system test time is updated to the next test time, and an event log entry is made.

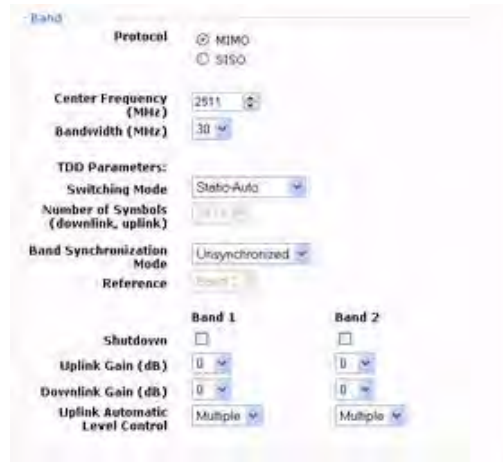
- 11 Use the scroll bar on the left side of the page to scroll down to view the rest of the page as shown below.



Bands			
	850-1900		
	Band 1: 850MHz	Band 2: 1900MHz	
Shutdown	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Uplink Gain	0	10	
Downlink Gain	0	10	
Uplink Automatic Level Control	Multiple	Multiple	
Input Alarms			
	Enable	Normal State	Label
Alarm Sense 1	<input type="checkbox"/>	Closed	External_Alarm_1
Alarm Sense 2	<input type="checkbox"/>	Closed	External_Alarm_2
Alarm Sense 3	<input type="checkbox"/>	Closed	External_Alarm_3
Output Alarms			
	Enable	Normal State	
Fault Source	<input checked="" type="checkbox"/>	Closed	
Warning Source	<input checked="" type="checkbox"/>	Closed	
Warning: This operation will erase the Time-Tagged Log and perform a system test.			

- 12 In the **Bands** panel, do the following:
- You should not have to use the **Bands** menu to select the bands. The system self configures the band by validating that all the RAUs connected are the same type.
 - When both bands are not configured, use the **Shutdown** check boxes. The system will ignore any alarms generated from the bands that have been shutdown.
 - Use the **Uplink Gain** and **Downlink Gain** menus to select the gain for each band. You can set system gain within the specified range in 1 dB increments.
 - Use the **Uplink Automatic Level Control** menu to select either **Single** or **Multiple** (default) for each band in the system.

- **FOR 2.5 GHz TDD (FSN-2525-1-TDD) INSTALLATIONS ONLY:** Use the scroll bar on the left side of the page to scroll down to view the next part of the window shown below.

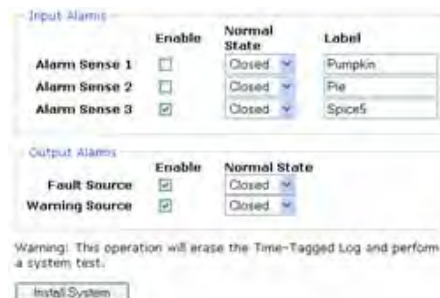


- Select the Protocol mode.
 - **MIMO** (multiple in-multiple out), which is the default setting
 - **SISO** (single in-single out).
- Select the **Center Frequency (MHz)** and **Bandwidth (MHz)**. The **Center Frequency** is the frequency of TDD LTE radios being used for Band 1 and Band 2.

NOTE: In MIMO mode, the frequencies are the same. The system can be configured to support 2-SISO radios, one per band, across any 66 MHz within the 2.5 GHz TDD band.

- For any unconfigured band, use the **Shutdown** check box, which instructs the system to ignore any alarms generated from the shutdown band(s).
- Use the **Uplink Gain (dB)** and **Downlink Gain (dB)** menus to set the gain for each band. You set system gain within the specified range in 1 dB increments.
- Use the **Uplink Automatic Level Control** menu to set each band in the system to **Single** or **Multiple** (default).

- 13 Use the scroll bar on the left side of the window to scroll down to view the rest of the window, which is shown below.



- 14 In the **Input/Output Alarms** panel, do the following for each Alarm Sense:
 - Select the corresponding **Alarm Sense 1 - 3** check box to enable or disable Alarm Sense, where a check mark indicates that the Alarm Sense is enabled.

- Use the **Normal State** menu to set the alarm state to **Closed** (default) or **Opened**.
- Use the **Label** box to create a unique label for the corresponding Alarm Sense.

15 Click **Install System** to configure the system.

The following happens during configuration:

- all disconnect statuses are cleared for attached RAUs
- the frequency band, gain, and system label are set
- logs are cleared
- System Test is performed
- the System Tree is refreshed.

The icons should be:



Indicates that the band is correctly set on the Main Hub.



Indicates that the band is correctly set on the Expansion Hub.



Indicates that communications are OK.

If there are problems, the icons will be different and a message is displayed in the Messages panel.

16 Connect the Main Hub to the RF source (for example, BTS or BDA).

CAUTION! Do not exceed the maximum input RF power (1 Watt) to the Fusion Wideband Main Hub. Exceeding the limit could cause permanent damage to the Hub.

CAUTION! Only carriers and their approved installers or TE-authorized installers are allowed to connect to the RF source. Serious damage to the equipment can occur if it is over-driven.

The Fusion Wideband system should now be operational.

- 17 Walk the site and use a mobile phone to test the signal strength.
- 18 Make sure to change the TCP/IP setting in your laptop back to their original values.

NOTE: TE equipment is designed to operate in the licensed frequency bands of mobile operators. In the USA, the EU, and most countries this equipment may only be used by the licensee, his authorized agents or those with written authorization to do so. Similarly, unauthorized use is illegal, and subjects the owner to the corresponding legal sanctions of the national jurisdiction involved. Ownership of TE equipment carries no automatic right of use.

SPlicing FIBER OPTIC CABLE

The fiber cable must have SC/APC connectors for the entire run. If it does not, you can splice a pigtail, which has SC/APC connectors, to the fiber cable.

TE offers two pigtails:

- one for single-mode fiber (PN 4013SCAPC-3)
- one for multi-mode fiber (PN 4012SCAPC-3).

TE recommends Fusion Wideband splices because they have the lowest splice loss and return loss. Mechanical splices have higher losses and higher back reflection than Fusion Wideband splices and are not recommended.

Using a Fusion Wideband splicer involves fusing together two butted and cleaved ends of fiber. The Fusion Wideband splicer aligns the fibers and maintains alignment during the Fusion Wideband process. Fusion Wideband splices have very low loss (typically less than 0.05 dB) and very low back reflection (return loss).

Organize Fusion Wideband splices in a splice tray designed to store and protect the splices.

NOTE: The following procedures assume that the system is new from the factory and that it has not been programmed with bands. If you are replacing components in a pre-installed system with either new units or units that may already be programmed (for example, re-using units from another system), refer to [“Replacing Fusion Wideband Components” on page 175](#).

Complete one of the following procedures as appropriate to the system design:

- [“Option A: Fusion Wideband Splice the Fiber-Optic Cable to the SC/APC Pigtail” on page 146](#)
- [“Option B: Fusion Wideband Splice the Fiber-Optic Cable to the SC/APC Pigtail” on page 147](#).

Option A: Fusion Wideband Splice the Fiber-Optic Cable to the SC/APC Pigtail

- 1 Make sure the Fusion Wideband splicer is set to the proper mode (that is, single- or multi-mode).
- 2 Secure both the fiber cable and the SC/APC pigtail in a splice tray that is installed immediately adjacent to the Hub.
- 3 Prepare the fiber end by cutting back the polyethylene jacket, the kevlar or fiberglass strength members, the extruded coating, and the buffer coating in order to expose the “bare fiber” (cladding plus core).
- 4 Ensure that sufficient slack is maintained that can reach the Fusion Wideband splicer.
- 5 Clean the unclad fiber core using isopropyl alcohol and lint-free wipes.
- 6 Cleave the unclad fiber to the length prescribed by the Fusion Wideband splicer’s specification sheets.
- 7 Repeat [Step 4](#) through [Step 6](#) for the SC/APC pigtail.
- 8 Pass the splice sleeve onto the fiber strand.
- 9 Position both fiber ends in the Fusion Wideband splicer and complete the splice in accordance with the Fusion Wideband splicer’s operation instructions.

- 10 Ensure that the estimated loss for the splice as measured by the Fusion Wideband splicer is 0.10 dB or better.
- 11 Slide the Fusion Wideband splicing sleeve over the point of the Fusion Wideband splice.
- 12 Place the sleeve and fused fiber into the Fusion Wideband splicer's heater.
- 13 Allow time for the splice sleeve to cure.
- 14 Return fiber splice to the splice tray, store the sleeve in a splice holder within the tray, and store excess cable length in accordance with the tray manufacturer's directions.
- 15 After successfully testing the fiber, plug the SC/APC pigtail into the proper optical port on the Hub.

Option B: Fusion Wideband Splice the Fiber-Optic Cable to the SC/APC Pigtail

- 1 Make sure the Fusion Wideband splicer is set to the proper mode (that is, single- or multi-mode).
- 2 Secure both the fiber cable and the SC/APC pigtail in a splice tray portion of a fiber distribution panel.
- 3 Prepare the fiber end by cutting back the polyethylene jacket, the kevlar or fiberglass strength members, the extruded coating, and the buffer coating in order to expose the "bare fiber" (cladding plus core).
- 4 Ensure that sufficient slack is maintained in order to be able to reach the Fusion Wideband splicer.
- 5 Clean the unclad fiber core using isopropyl alcohol and lint-free wipes.
- 6 Cleave the unclad fiber to the length prescribed by the Fusion Wideband splicer's specification sheets.
- 7 Repeat [Step 3](#) through [Step 6](#) for the SC/APC pigtail.
- 8 Pass the splice sleeve onto the fiber strand.
- 9 Position both fiber ends in the Fusion Wideband splicer and complete splice in accordance with the Fusion Wideband splicer's operation instructions.
- 10 Ensure that the estimated loss for the splice as measured by the Fusion Wideband splicer is 0.10 dB or better.
- 11 Slide the Fusion Wideband splicing sleeve over the point of the Fusion Wideband splice.
- 12 Place the sleeve and fused fiber into the Fusion Wideband splicer's heater.
- 13 Allow time for the splice sleeve to cure.
- 14 Return fiber splice to the splice tray, store the sleeve in a splice holder within the tray, and store excess cable length in accordance with the tray manufacturer's directions.
- 15 After successfully testing the fiber cable, plug the SC/APC pigtail into the back side of the SC/APC bulkhead in the Fiber Distribution Panel.
- 16 Install a SC/APC patch cord between the front side of the SC/APC bulkhead and the proper optical port on the Hub.

NOTE: For information on troubleshooting, see ["Maintenance and Troubleshooting"](#) on page 181.

INTERFACING THE FUSION WIDEBAND MAIN HUB TO AN RF SOURCE

CAUTION! Only TE personnel or TE-authorized installation personnel should connect the Fusion Wideband Main Hub to its Band associated Base Station or repeater. Exceeding the maximum input power could cause failure of the Fusion Wideband Main Hub (refer to “Appendix A: Cables and Connectors” on page 191 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

NOTE: The following procedures assume that the system is installed and has been programmed with bands.

Connecting a Fusion Wideband Main Hub to an In-Building BTS

CAUTION! Only TE personnel or TE-authorized installation personnel should connect the Fusion Wideband Main Hub to a Base Station or repeater. Exceeding the maximum input power could cause failure of the Fusion Wideband Main Hub (refer to “Appendix A: Cables and Connectors” on page 191 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

CAUTION! The UPLINK and DOWNLINK ports cannot handle a DC power feed from the Base Station. If DC power is present, a DC block must be used or the hub may be damaged.

Do the following to connect a Simplex Base Station to a Fusion Wideband Main Hub RF Band:

- 1 Connect an N-male to N-male coaxial cable to the transmit simplex connector on the Base Station.
- 2 Connect the other end of the N-male to N-male coaxial cable to the DOWNLINK connector on the Hub for the corresponding Band 1, Band 2, or Band 3.
- 3 Connect an N-male to N-male coaxial cable to the receive simplex connector on the Base Station.
- 4 Connect the other end of the N-male to N-male coaxial cable to the UPLINK connector on the Hub for the corresponding Band 1, Band 2, or Band 3.

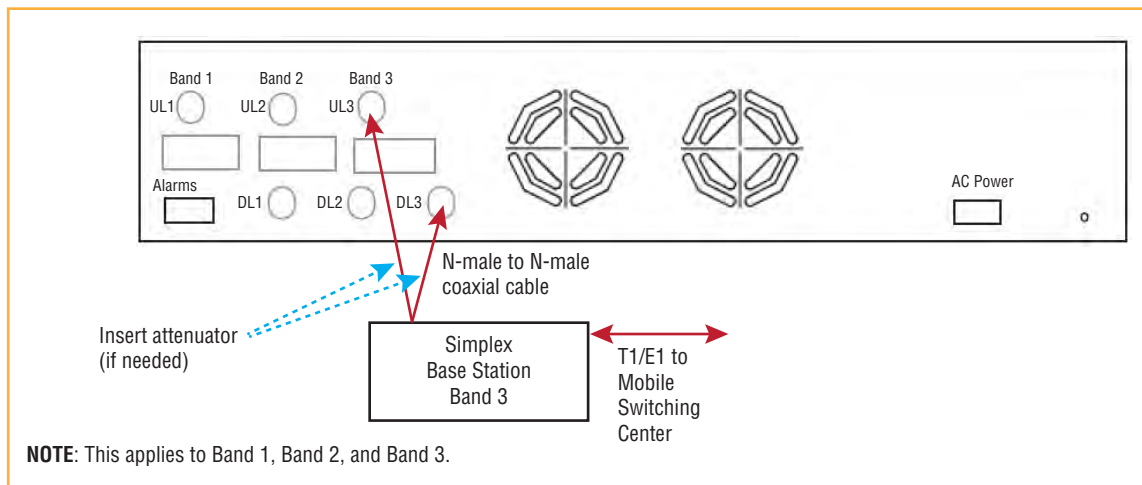


Figure 21. Simplex Base Station to a Fusion Wideband Main Hub

Connecting a Duplex Base Station to a Fusion Wideband Main Hub

NOTE: When connecting to a duplex Base Station, use a circulator or duplexer between it and the Fusion Wideband Main Hub.

NOTE: You can insert attenuators between the circulator or duplexer and Hub as needed.

- 1 Connect an N-male to N-male coaxial cable to the duplex connector on the Base Station.
- 2 Connect the other N-male connector or duplexer to a circulator.
- 3 Connect an N-male to N-male coaxial cable to the DOWNLINK connector on the Hub for Band 1, Band 2, and Band 3.
- 4 Connect the other end of the N-male coaxial cable to the transmit connector on the circulator.
- 5 Connect an N-male to N-male coaxial cable to the UPLINK connector on the Hub for Band 1, Band 2, and Band 3.
- 6 Connect the other end of the N-male coaxial cable to the receive connector on the circulator.

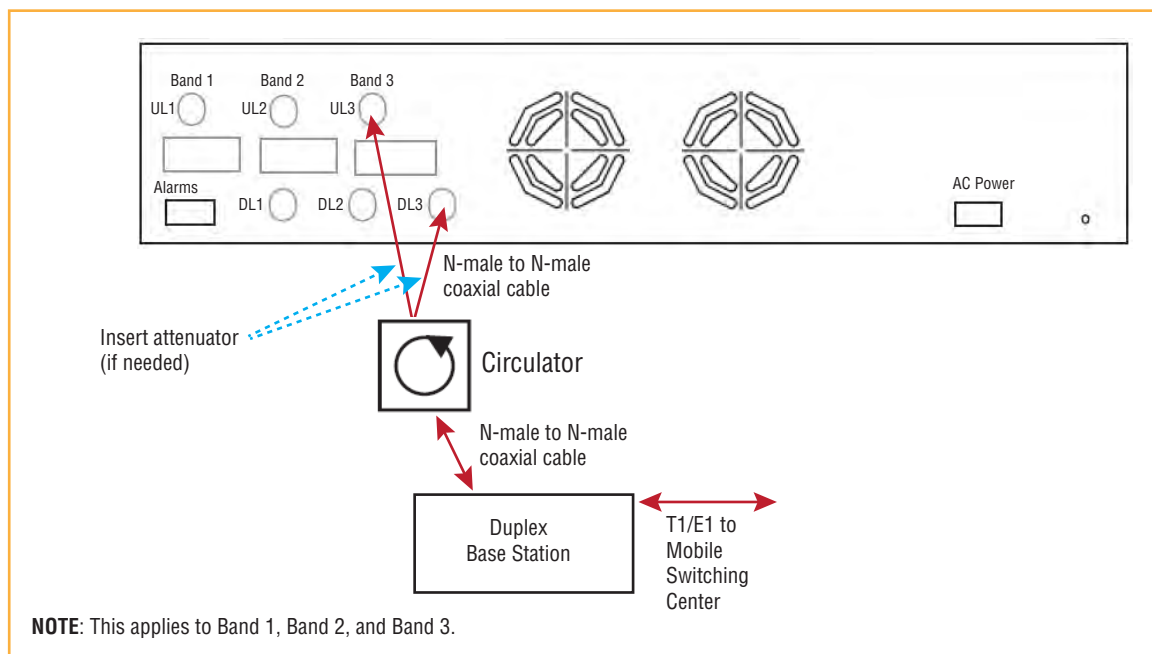


Figure 22. Duplex Base Station to a Fusion Wideband Main Hub

Connecting a Fusion Wideband Main Hub RF Band to Multiple BTSs

CAUTION! Only TE personnel or TE-authorized installation personnel should connect the Fusion Wideband Main Hub to a Base Station or repeater. Exceeding the maximum input power could cause failure of the Fusion Wideband Main Hub (refer to [“Appendix A: Cables and Connectors”](#) on page 191 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

You can use power combiner/splitters to connect a Fusion Wideband Main Hub RF Band to multiple Base Stations, as shown in [Figure 23](#) on page 150.

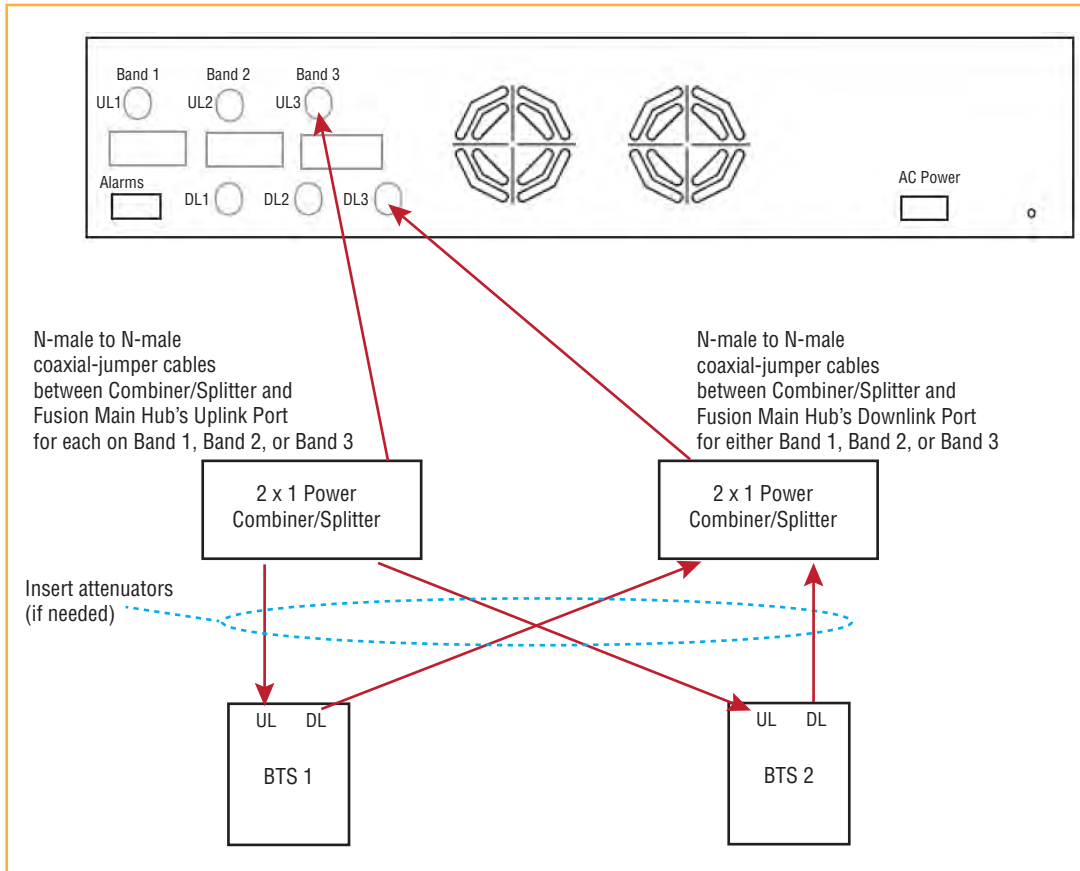


Figure 23. Connecting a Fusion Wideband Main Hub to Multiple Base Stations

Connecting a Fusion Wideband Main Hub to a Roof-Top Antenna

CAUTION! TE recommends that you use a lightning arrestor or surge protector in a roof-top antenna configuration. Insert the lightning arrestor or surge protector between the roof-top antenna and the repeater connected to the Fusion Wideband Main Hub RF Band.

- 1 Connect an N-male to N-male coaxial cable to the roof-top antenna.
- 2 Connect the other end of the N-male to N-male coaxial cable to the grounded surge suppressor.
- 3 Connect an N-male to N-male coaxial cable to the grounded surge suppressor.
- 4 Connect the other end of the N-male to N-male coaxial cable to the repeater.
- 5 Connect an N-male to N-male coaxial cable to the repeater.
- 6 Connect the other end of the N-male to N-male coaxial cable to the circulator 1 connector.
- 7 Connect an N-male to N-male coaxial cable to the circulator 2 connector.
- 8 Connect the other end of the N-male to N-male coaxial cable to the DOWNLINK connector on the Hub for either Band 1, Band 2, or Band 3. (Attenuation may be required to achieve the desired RF output at the RAU.)
- 9 Connect an N-male to N-male coaxial cable to the circulator 3 connector.
- 10 Connect the other end of the N-male to N-male coaxial cable to the UPLINK connector on the Hub for either Band 1, Band 2, or Band 3.

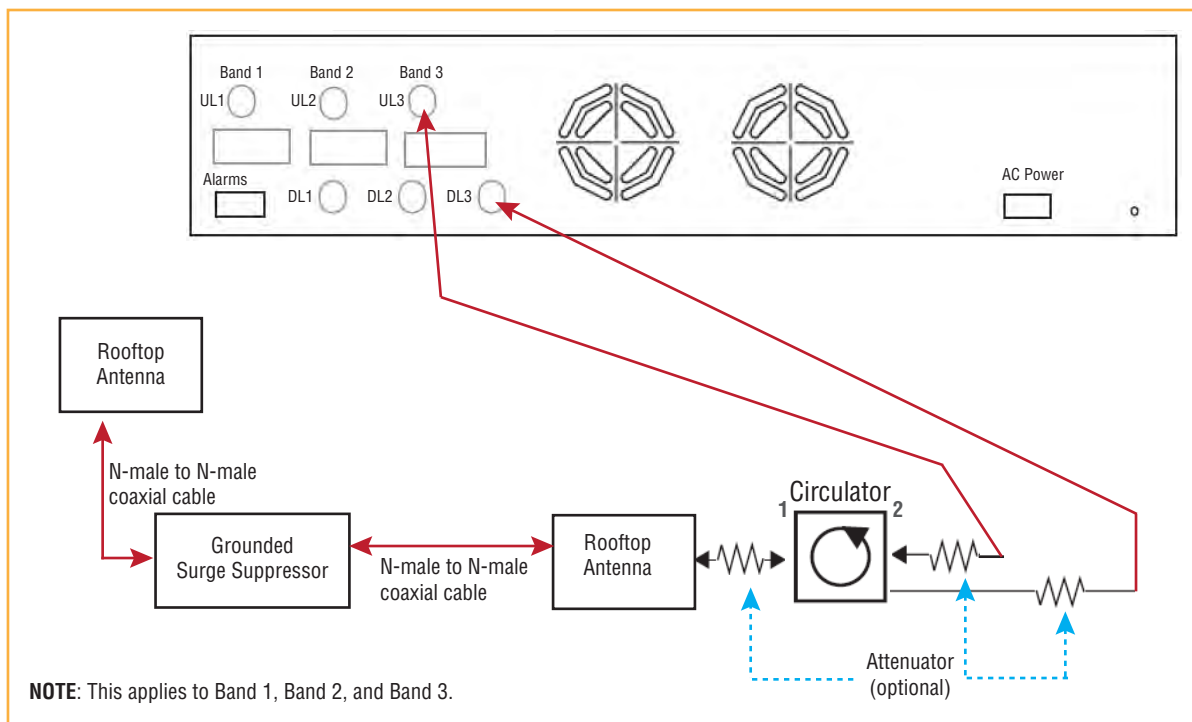


Figure 24. Connecting a Fusion Wideband Main Hub to a Roof-top Antenna

Connecting a Fusion Wideband Main Hub to Flexwave Focus

Refer to the FlexWave Focus manual for information.

Connecting Multiple Fusion Wideband Main Hubs to an RF Source

You can use power combiner/splitters as splitters to connect multiple Fusion Wideband Main Hubs in order to increase the total number of RAUs in a system. You can also use power combiner/splitters to combine Base Station channels in order to increase the number of RF carriers the system transports.

Connecting Multiple Fusion Wideband Main Hubs to a Simplex Repeater or BTS

CAUTION! Only TE personnel or TE-authorized installation personnel should connect the Fusion Wideband Main Hub to a Base Station or repeater. Exceeding the maximum input power could cause failure of the Fusion Wideband Main Hub (refer to [“Appendix A: Cables and Connectors”](#) on page 191 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

- 1 Make sure you have the following components:

Quantity	Item
2	Hybrid power combiner/splitters—one for uplink and one for downlink (2x1 for two Fusion Wideband Main Hubs, 3x1 for three, 4x1 for four, and so on)
1	N-male to N-male coaxial jumper cable between each power combiner/splitter and the Base Station
2	N-male to N-male coaxial jumper cables between each power combiner/splitter and each Fusion Wideband Main Hub RF Band (either Band 1 or Band 2)

- 2 Connect the power combiner/splitters to the repeater or Base Station using N-male to N-male coaxial jumper cables, in the following order:

- from the first power combiner/splitter to the repeater or Base Station UPLINK
- from the second power combiner/splitter to the repeater or Base Station DOWNLINK.

- 3 Connect the power combiner/splitters to the Hubs, in the following order:

- from the first Hub’s UPLINK port (Band 1, Band 2, or Band 3) to the first power combiner/splitter
- from the first Hub’s DOWNLINK port (Band 1, Band 2, or Band 3) to the second power combiner/splitter
- from the second Hub’s UPLINK port (Band 1, Band 2, or Band 3) to the first power combiner/splitter
- from the second Hub’s DOWNLINK port (Band 1, Band 2, or Band 3) to the second power combiner/splitter.

CAUTION! Connections should not cross Bands. For example, all Band 1 connections should be made to the same hybrid power combiner/splitter connected to the repeater BTS that matches the Band 1 frequency.

- 4 After connecting and powering on the Hub, check all Hub LEDs to ensure that the system is operating properly.
- 5 Make sure the Hub is grounded. **The warranty does not cover damage caused when an ungrounded Hub is powered on.**

NOTE: Use a 50 ohm terminator on any unused power combiner/splitter ports.

Figure 25 shows how to connect two Main Hubs to a simplex repeater or Base Station. Connecting two Hubs increases the total number of supportable RAUs from 8 to 16.

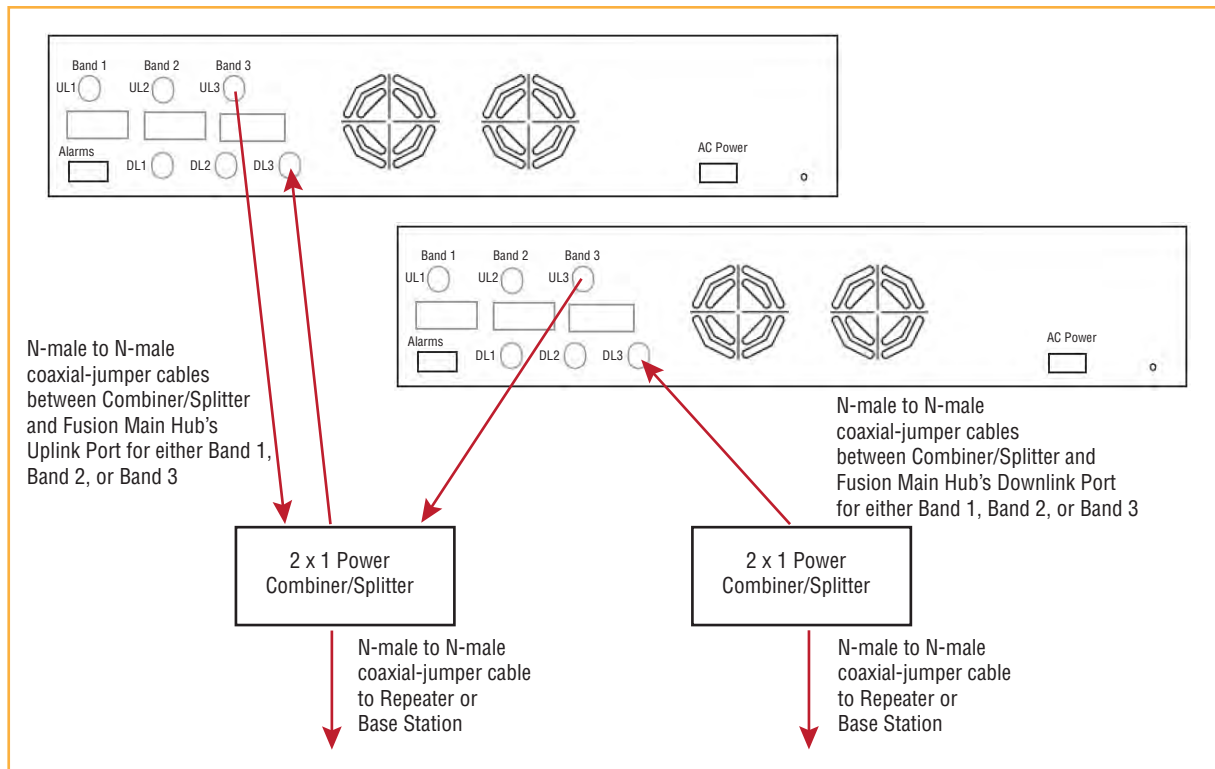


Figure 25. Connecting Two Fusion Wideband Main Hub's RF Band Ports to a Simplex Repeater or Base Station

Connecting Multiple Fusion Wideband Main Hubs to a Duplex Repeater or BTS

CAUTION! Only TE personnel or TE-authorized installation personnel should connect the Fusion Wideband Main Hub to a Base Station or repeater. Exceeding the maximum input power could cause failure of the Fusion Wideband Main Hub (refer to “Appendix A: Cables and Connectors” on page 191 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

- 1 Make sure you have the following components:

Quantity	Item
2	Hybrid power combiner/splitters—one for uplink and one for downlink (2x1 for two Fusion Wideband Main Hubs, 3x1 for three, 4x1 for four, and so on)
1	N-male to N-male coaxial jumper cables to connect each Fusion Wideband Main Hub’s RF Band to the power combiner/splitters
2	Circulator
1	N-male to N-male coaxial jumper cable between each circulator and the repeater or Base Station N-male to N-male coaxial jumper cable between each circulator and power combiner/splitter

- 2 Connect the circulator to the repeater or Base Station using one N-male to N-male coaxial jumper cable.
- 3 Connect each power combiner/splitter to the circulator using one N-male to N-male coaxial jumper cable per combiner/splitter.
- 4 Connect the power combiner/splitter to the Hubs using N-male to N-male coaxial jumper cable, in the following order:
 - from the first Hub’s Uplink (Band 1, Band 2, or Band 3) port to the first power combiner/splitter
 - from the first Hub’s DOWNLINK (Band 1, Band 2, or Band 3) port to the second power combiner/splitter
 - from the second Hub’s UPLINK (Band 1, Band 2, or Band 3) port to the first power combiner/splitter
 - from the second Hub’s DOWNLINK (Band 1, Band 2, or Band 3) port to the second power combiner/splitter

CAUTION! Connections should not cross Bands. For example, all Band 1 connections should be made to the same hybrid power combiner/splitter connected to the repeater BTS that matches the Band 1 frequency.

- 5 After connecting and powering on the Hub, check all Hub LEDs to ensure that the system is operating properly.
- 6 Make sure the Main Hub is grounded. **The warranty does not cover damage caused when an ungrounded Hub is powered on.**

NOTE: Use a 50 ohm terminator on any unused power combiner/splitter ports.

Figure 26 shows how to connect two Hubs to a duplex repeater or Base Station. You need to use one circulator and one more coaxial jumper cable, as shown.

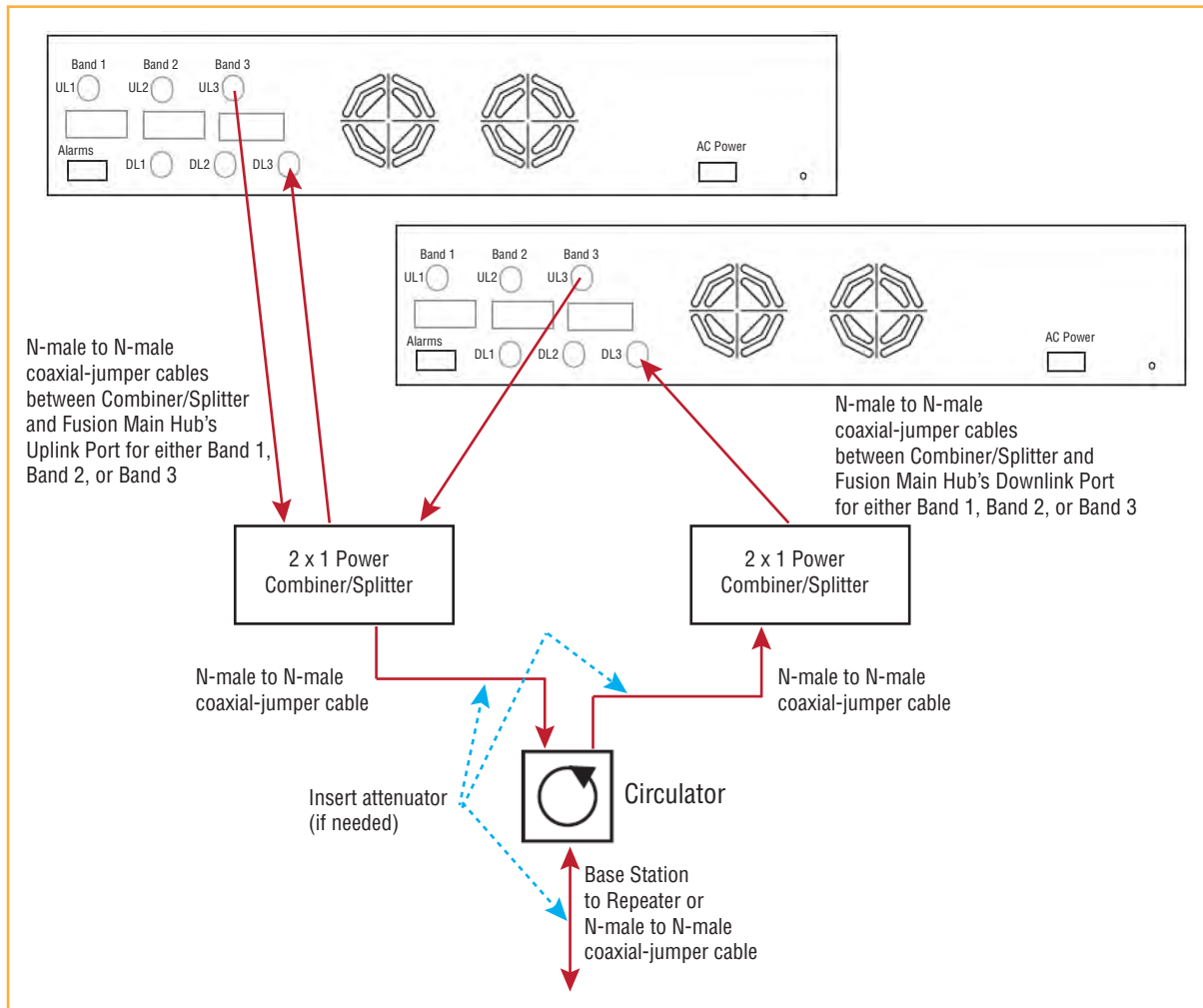


Figure 26. Connecting Two Fusion Wideband Main Hub's RF Band Ports to a Duplex Repeater or Base Station

CONNECTING CONTACT ALARMS TO A FUSION WIDEBAND SYSTEM

The Fusion Wideband Main Hub can generate (source) two contact alarms as well as sense three external contact alarm.

- **Alarm Source**—The Fusion Wideband Main Hub has two alarm contacts, fault (major) and warning (minor). These contacts are normally-closed (NC) and will open when an internal alarm is detected. For further information, see [“Alarm Source” on page 157](#).

NOTE: The contact can be changed to normally-open (NO) with AdminBrowser, however, this is not recommended since no alarm would be sent if power to the Fusion Wideband Main Hub fails.

- Fault is activated when any faults or disconnects are detected.
- Warning is activated when any warning conditions are detected except lockout or when the end-to-end system test is not valid.

- **Alarm Sense**—The Fusion Wideband Main Hub can monitor three external alarm contacts. Each port can be configured for normally-open (NO) or normally-closed (NC) contacts. The interface expects a set of floating contacts, and an external voltage source is not required for this interface. Use AdminBrowser to monitor the port status. For further information, see [“Alarm Sense” on page 160](#).

[Table 95](#) lists the alarm types, equipment to which the Fusion Wideband Main Hub is connected, cable(s) used, and the faults and warnings that are detected.

Table 95. Alarm Types

Alarm Type	Fusion Wideband Connected to	Cable(s) Used	Errors Detected
Source	FlexWave	5-port Alarm Daisy-Chain Cable	Faults
Source	BTS	5-port Alarm Daisy-Chain Cable In addition, a custom daisy-chain cable-to-BTS interface cable is required. Make this interface cable to the desired length and with the appropriate pin placement.	Faults and Warnings
Sense	Unison	5-port Alarm Daisy-Chain Cable and the Alarm Sense Adapter Cable	Faults

NOTE: FlexWave Focus supports only faults (major errors).

Alarm Source

Fusion Wideband always acts as an alarm source, no matter what type of equipment is connected to it. Refer to [“Alarm Sense” on page 160](#) if you want Fusion Wideband to sense Unison contact closures or other external alarms.

NOTE: The following procedures assume that the system is installed and has been programmed with bands.

Using FlexWave Focus to Monitor Fusion Wideband

When you connect FlexWave Focus to the Fusion Wideband, the Fusion Wideband Main Hub is the output of the alarms (alarm source) and Focus is the input (alarm sense), as shown in [Figure 27](#).

NOTE: Focus supports only faults (major errors).

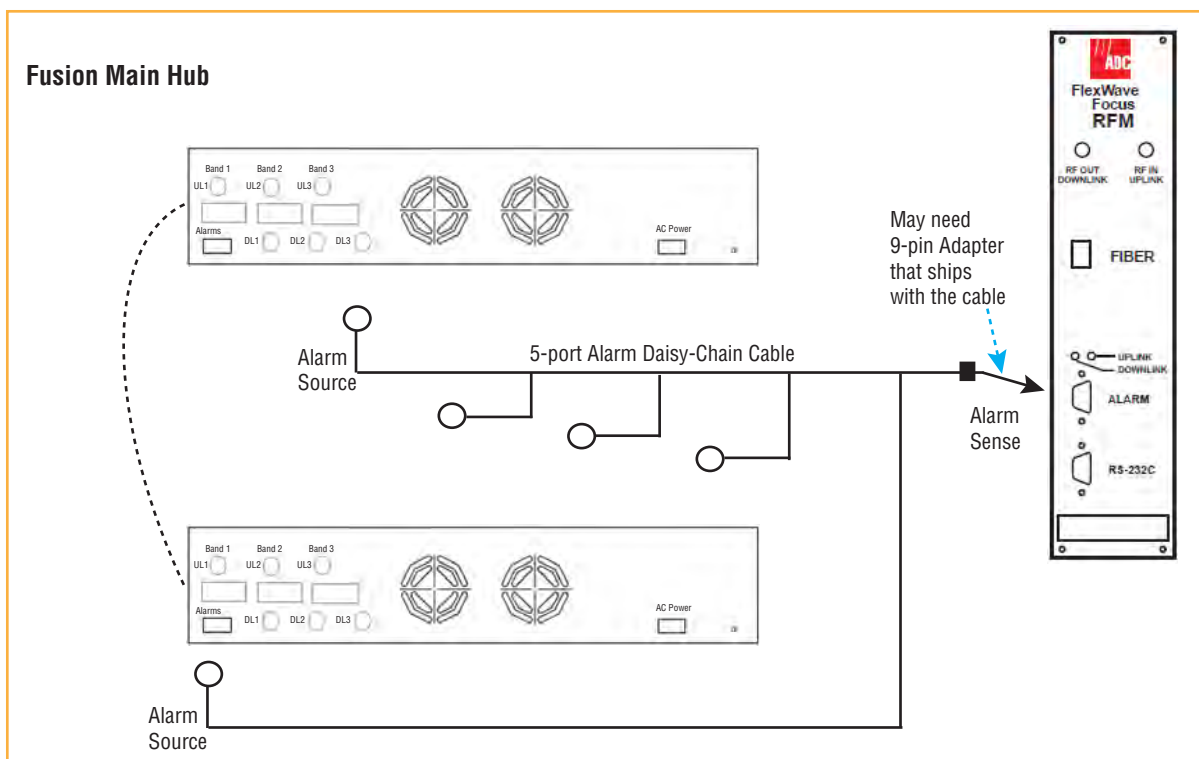


Figure 27. Connecting FlexWave to Fusion Wideband

Using a Base Station to Monitor Fusion Wideband

NOTE: Prior to connecting a Fusion Wideband Main Hub to a BTS, the carrier must configure the BTS for contact closure monitoring.

When you connect a BTS to Fusion Wideband, the Fusion Wideband Main Hub is the alarm source (output) and the BTS is the alarm sense (input), as shown in [Figure 28](#). An interface cable is required between the daisy-chain cable and the BTS. Because BTS alarm interface pinouts and Fusion Wideband-to-BTS distances vary, this cable is often custom and wired on-site. Refer to [“Uplink/Downlink Optical-Fiber Ports” on page 33](#) for Alarm Contact details (Normally Closed).

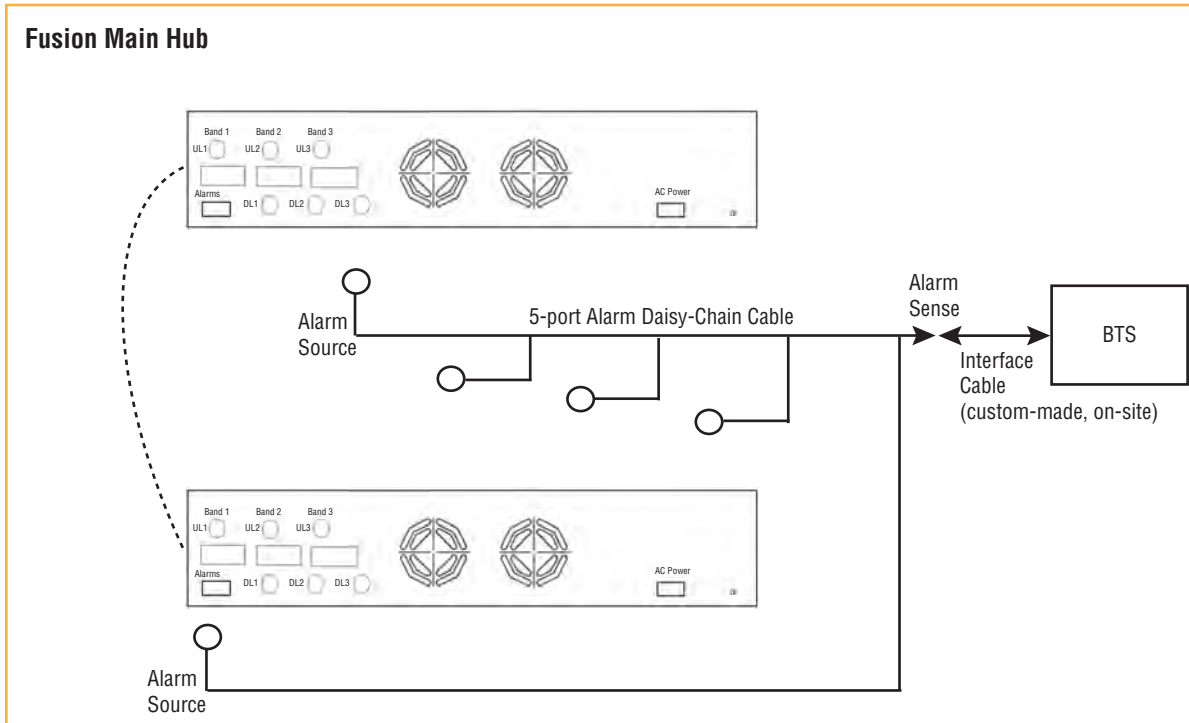


Figure 28. Using a BTS to Monitor Fusion Wideband

NOTE: For normally open contacts, the fault and warning contacts need to be wired in parallel with other Main Hubs.

NOTE: TE does not recommend using normally open contacts.

Using a Base Station and AdminBrowser to Monitor Fusion Wideband

NOTE: Prior to connecting a Fusion Wideband Main Hub to a BTS, the carrier must configure the BTS for contact closure monitoring.

To take full advantage of Fusion Wideband's OA&M capabilities, use the TE AdminBrowser software in addition to a BTS to monitor the system, as shown in [Figure 29](#). Refer to "SNMP Interface" on page 172 for SNMP optional feature capabilities.

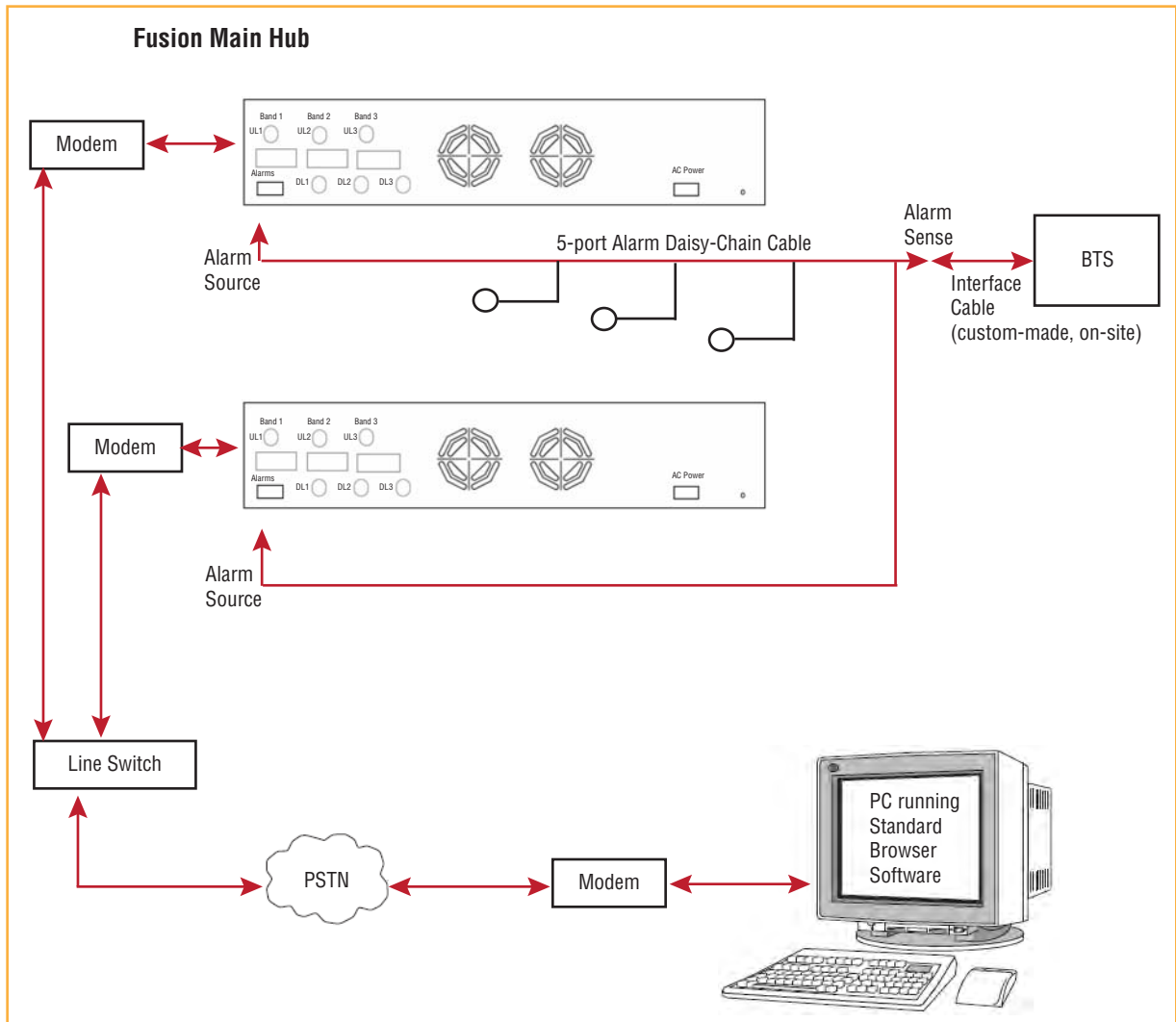


Figure 29. Using a BTS and AdminBrowser to Monitor Fusion Wideband

Alarm Sense

Use AdminBrowser to enable the Fusion Wideband system for “alarm sense” when connecting to the contact closure of Unison Main Hubs or other external alarms (refer to “Set Contact Sense Properties” in the *AdminBrowser User Manual*).

NOTE: This procedure assumes that the system is installed and that has been programmed with bands.

When you connect Unison to Fusion Wideband, the Fusion Wideband Main Hub is the alarm sense (input) and the Unison is the alarm source (output), as shown in Figure 30. The input alarm sense needs to be set to normally closed (NC).

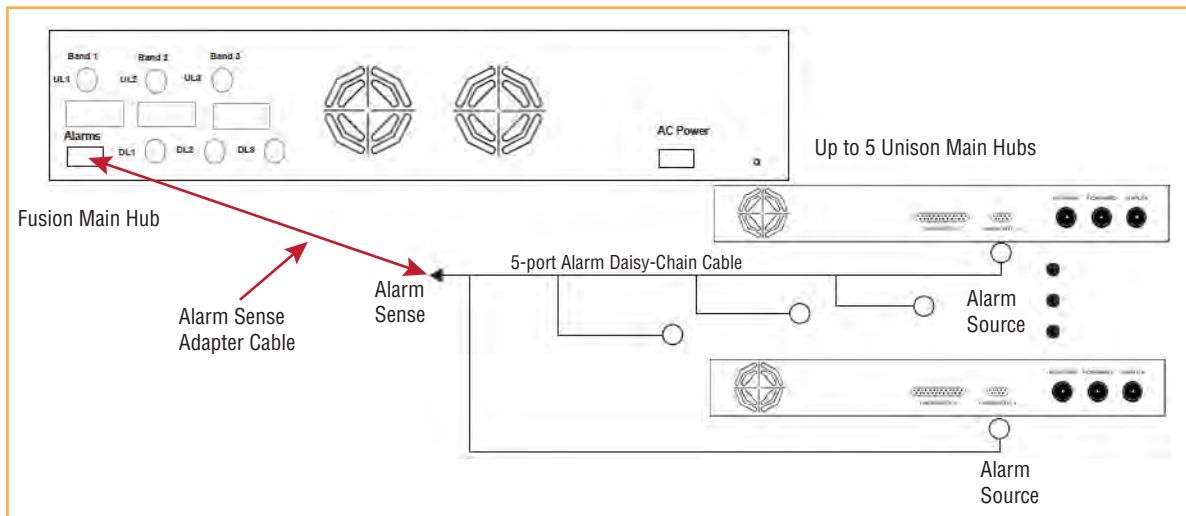


Figure 30. Using Fusion Wideband to Monitor Unison

Unison supports only faults. You must use the Alarm Sense Adapter Cable to interface the daisy-chain cable to Fusion Wideband (see Figure 31). The adapter cable is required because it translates the Unison fault pinout to the sense input pins on the Fusion Wideband Main Hub.

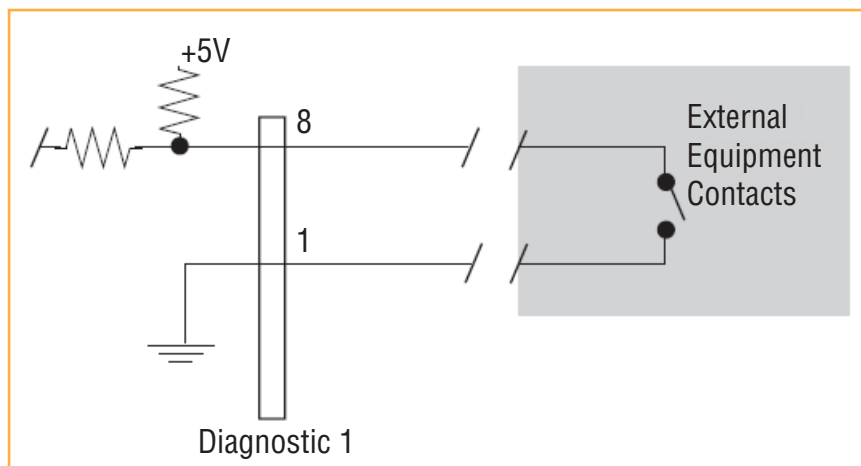


Figure 31. Alarm Sense Contacts

Alarm Cables

Figure 32 shows the 5-port Alarm Daisy-Chain Cable (PN 4024-3), which supports fault and warning conditions.

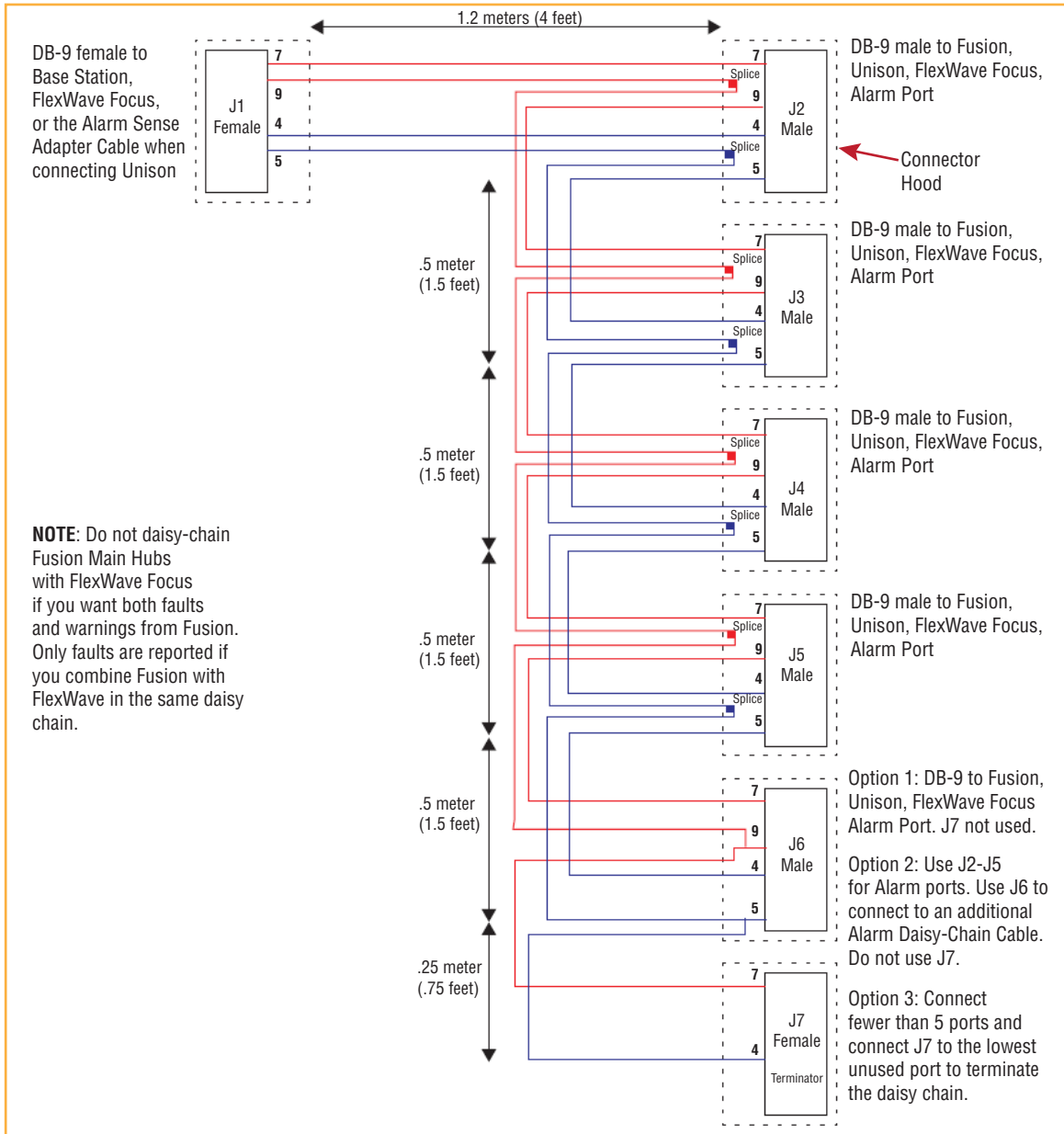


Figure 32. 5-port Alarm Daisy-Chain Cable

ALARM MONITORING CONNECTIVITY OPTIONS

NOTE: The following procedures assume that the system is installed and has been programmed with bands.

Direct Connection

In the configuration shown in [Figure 33](#), the PC connects directly to the RJ-45 100 BASE-T port on the Fusion Wideband Main Hub's front panel using an Ethernet cross-over cable.

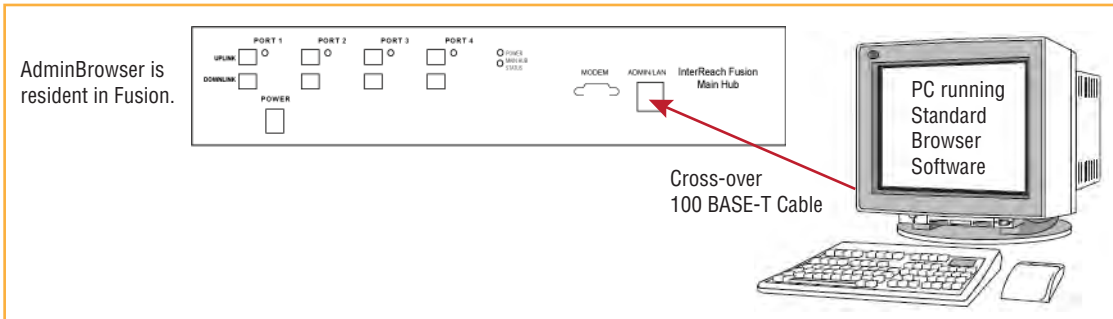


Figure 33. OA&M Direct Connection

Modem Connection

In the configuration shown in [Figure 34](#), the PC and the Fusion Wideband Main Hub connect to analog modems and communicate using a standard dial-up telephone connection.

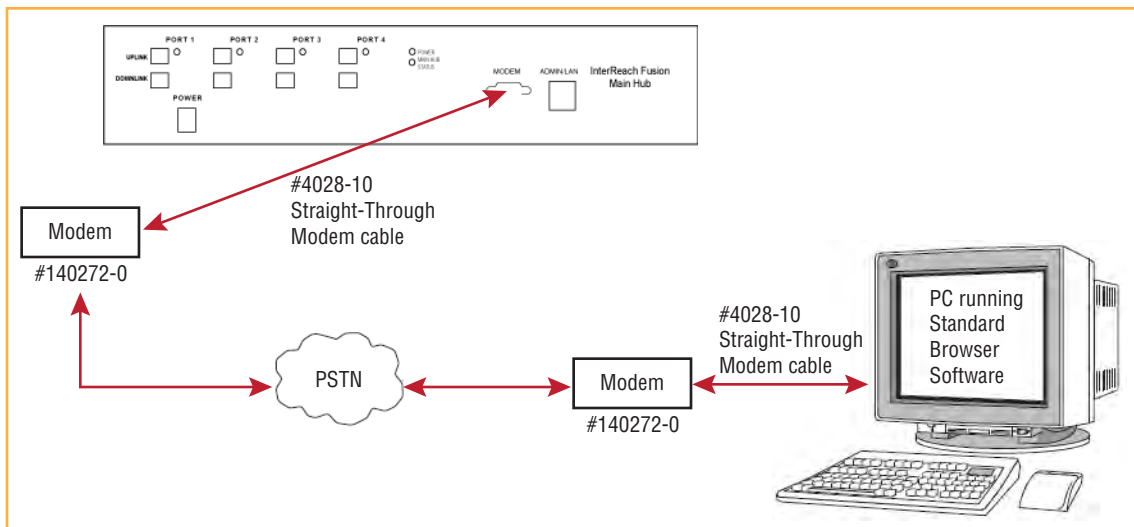


Figure 34. OA&M Modem Connection

NOTE: Refer to [“Coaxial Cable” on page 198](#) for the modem cable wiring information.

Modem switch settings are as follows for US Robotics modem:

- PC-side: 1, 2 and 6 Up
- Fusion Wideband Hub-side: 2 and 6 Up.

Setting Up Fusion Wideband Modem (USR Modem) Using AdminBrowser

Use the following steps to set up a PPP Dial-In on Fusion Wideband.

- 1 Start AdminBrowser as explained in the AdminBrowser manual.
- 2 Select **System Configuration**.
- 3 Select **Setup Modem Connection**. The window shown below opens:

The screenshot shows the 'System Configuration: Setup (Serial) Modem Connection' window. On the left is a navigation menu with options like 'System Configuration', 'System Information', 'Alarms', 'Users', 'Updates', 'Diagnostics', and 'Special Features'. The main area contains the following configuration fields:

- Modem Initialization String:** A text area containing the string: `\d\d\d+++d\d\dAT&ATS0=0&ATF1E0QOV1X4&D0&H0&I0&R1&B1&C1&N0&U0`
- Dial-In:** A section with four fields:
 - Server Address:** 192.168.1.100
 - Client Address:** 192.168.1.200
 - User Name:** ppp_user
 - Password:** password
- Dial-Out:** A section with four fields:
 - Enable:** An unchecked checkbox.
 - Phone Number:** 12345
 - User Name:** (empty)
 - Password:** (empty)

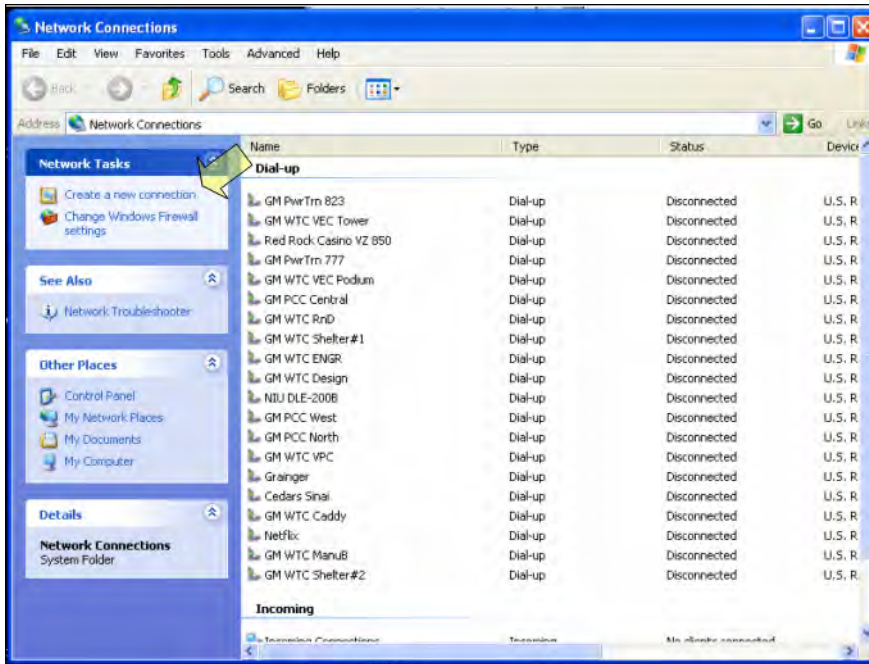
At the bottom of the main area is a 'Setup Connection' button. The footer of the window displays '© 2008 LGC Wir TE'.

- 4 Make sure the modem type is: **None**.
 - The modem init string is for a USR modem.
 - The server address is the IP address of the MH.
- 5 Click **Setup Connection**.

Setting Up a PC Modem Using Windows

Use the following sets to set up a dial-up connection on your PC.

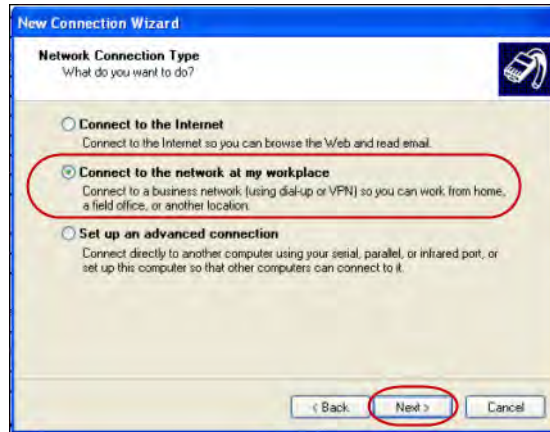
- 1 Click **Start, Settings, Network Connections**.
- 2 In the **Network Connection** window, click **Create a new connection**.



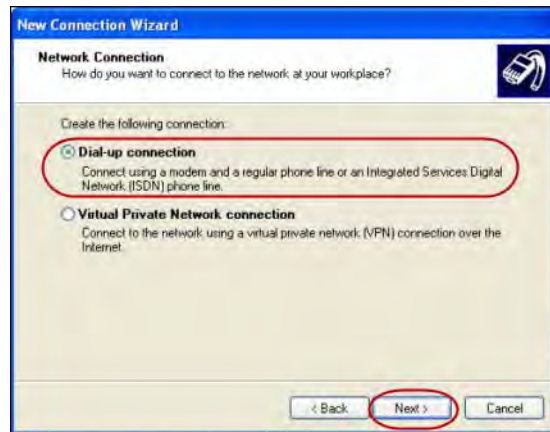
- 3 In the **New Connection Wizard** window, click **Next**.



- 4 In the **Network Connection Type** dialog, select **Connect to the network at my workplace**, and then click **Next**.



- 5 In the **Network Connection** dialog, select **Dial-up connection**, and then click **Next**.



- 6 In the **Connection Name** dialog, type a name for this connection, and then click **Next**.



- 7 In the **Phone Number to Dial** dialog, type the desired dial in **Phone number**, and then click **Next**.



- 8 In the **Connection Availability** dialog, select **Anyone's use**, and then click **Next**.



- 9 In the **Completing the New Connection Wizard** window, click **Finish**.



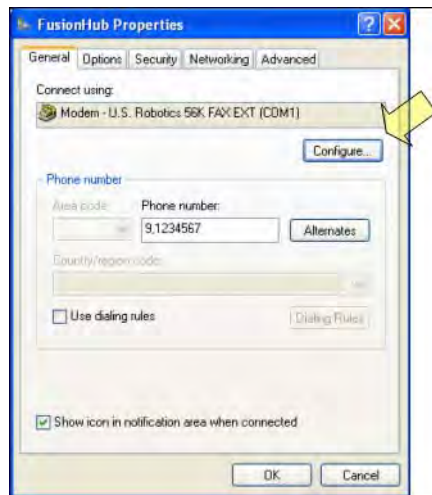
10 In the **Connect FusionHub** window, type a password as indicated, and then click **Properties**.



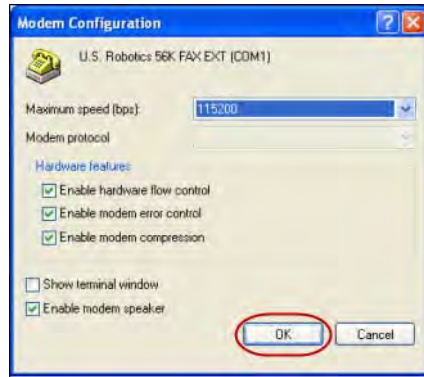
The default parameters are:

- User name: **ppp_user**
- Password (one word, all lower case): **password**

11 In the **FusionHub Properties** window, click **Configure...**



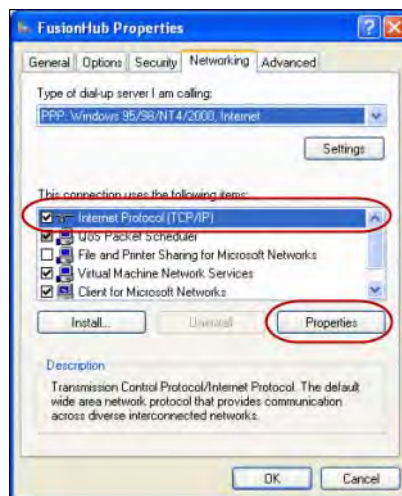
- 12 In the **Modem Configuration** window, select the modem speed and other parameters for your modem, and then click **OK**.



- 13 In the **FusionHub Properties** window, select the **Security** tab, and then select **Typical**.



- 14 Click the **Networking** tab, select **Internet Protocol (TCP/IP)**, and then click **Properties**.



- 15 In the **General** tab, select **Obtain an IP address automatically** and **Obtain DNS server address automatically**, and then click **OK**.



- 16 To connect to the Fusion Wideband Hub over the Dial-up connection, start your web browser and then in the address bar, type the server IP address configured in [“Setting Up Fusion Wideband Modem \(USR Modem\) Using AdminBrowser”](#) on page 163.

100 BASE-T Port Expander Connection

In configuration shown in [Figure 35](#), a LAN switch is used to allow the connection of multiple devices to a single PC with a 100 BASE-T port. Testing was performed with a Linksys 4-port switch. Each Fusion Wideband MH must have a unique IP address.

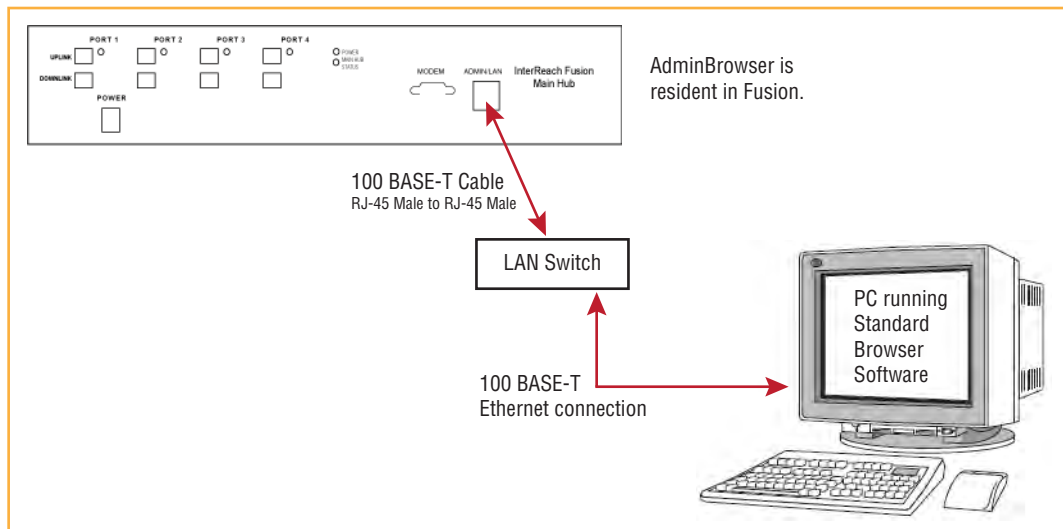


Figure 35. OA&M Connection using a 232 Port Expander

POTS Line Sharing Switch Connection

Using a POTS line sharing switch (Figure 36), you can connect two or more modems to a single telephone line. Figure 37 shows a cascade.

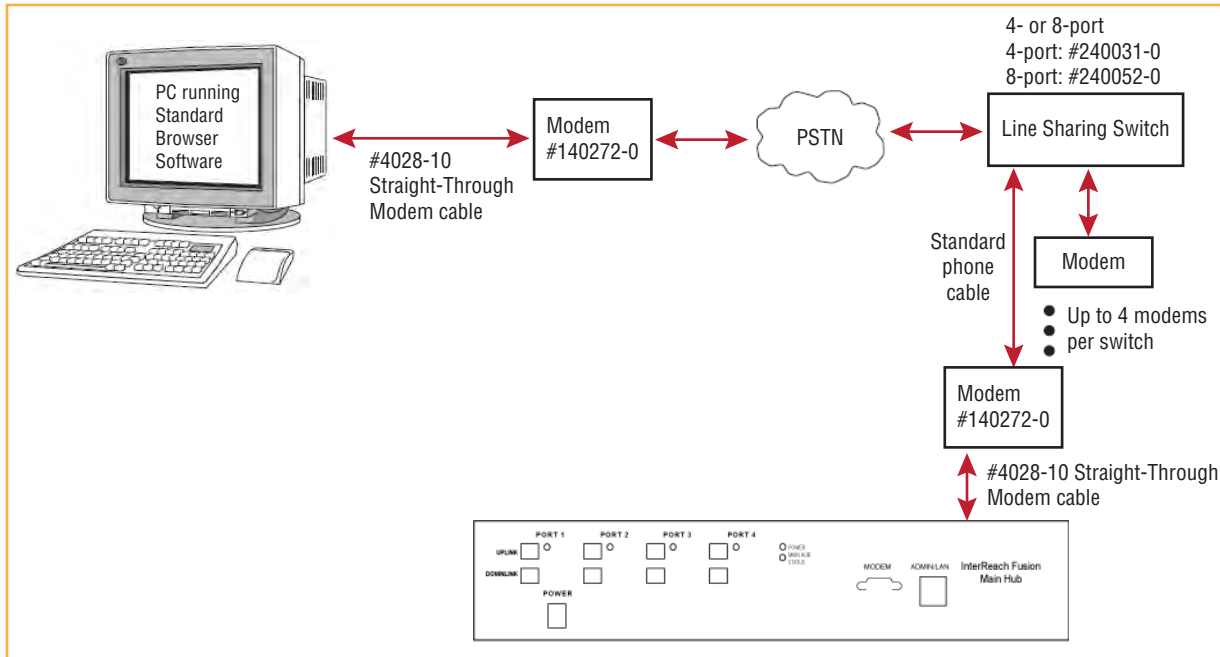


Figure 36. OA&M Connection Using a POTS Line Sharing Switch

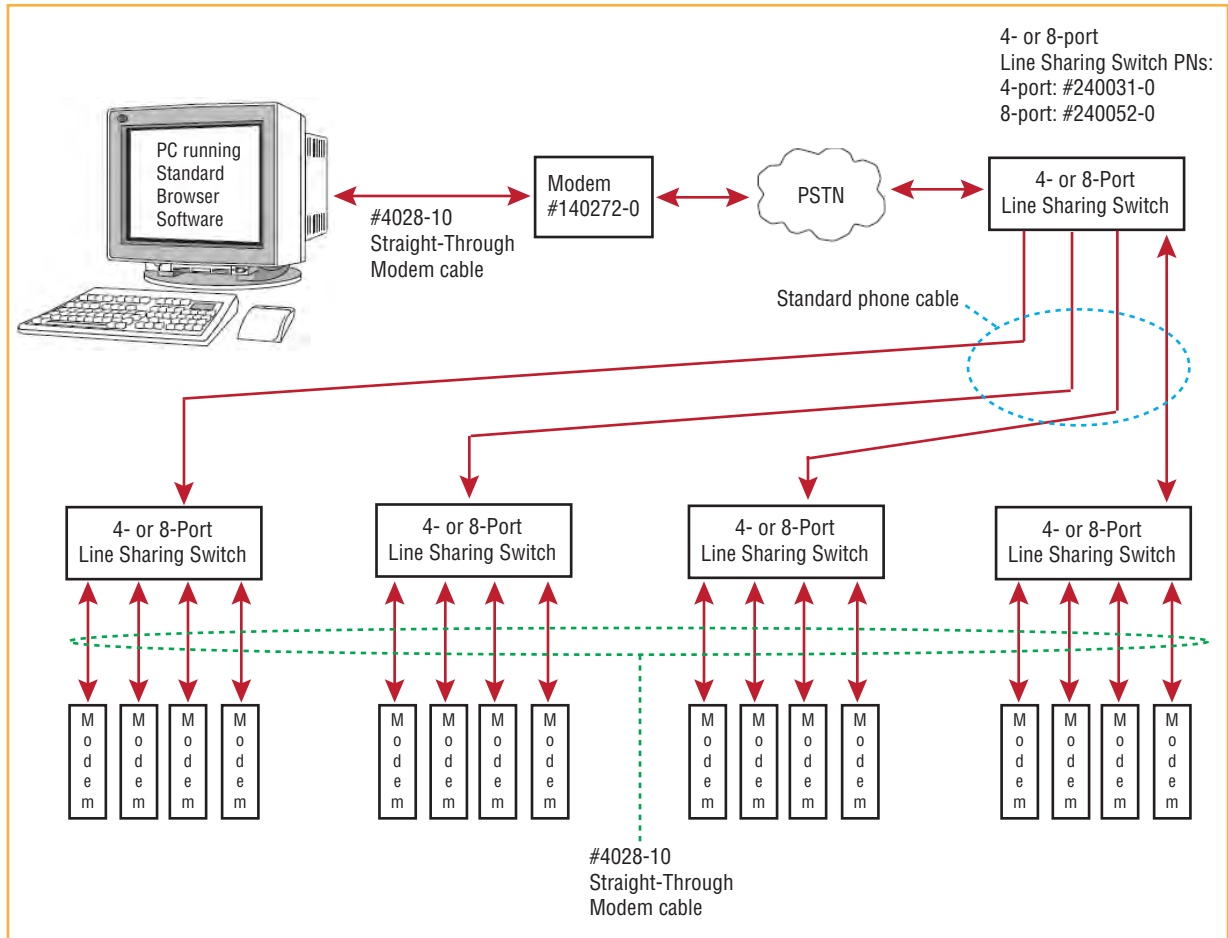


Figure 37. Cascading Line Sharing Switches

Ethernet RF Modem

Fusion Wideband can also use an Ethernet-based RF modem. Almost any RF modem will work, although modems that support Port Address Translation are best.

Ethernet LAN Connection

An Ethernet LAN connection can be used to communicate between the PC and Fusion Wideband (Figure 38).

NOTE: Testing was performed with a Linksys 4-port LAN switch.

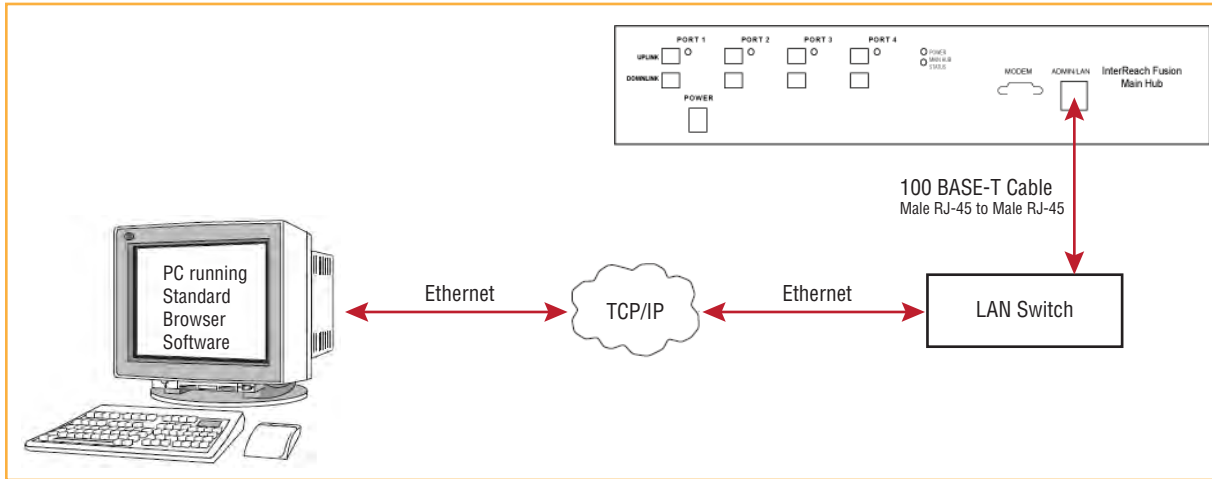


Figure 38. OA&M Connection Using Ethernet and ENET/232 Serial Hub

SNMP Interface

Faults and warnings can optionally also be diagnosed with SNMP using a standard Network Management System (NMS), as shown in Figure 39 on page 173. SNMP resident software in Fusion Wideband provides SNMP interactions for Traps and Notification.

The Fusion Wideband SNMP includes a MIB for integrating into the Network Management System (NMS) and supports SNMPv1 and SNMPv2c.

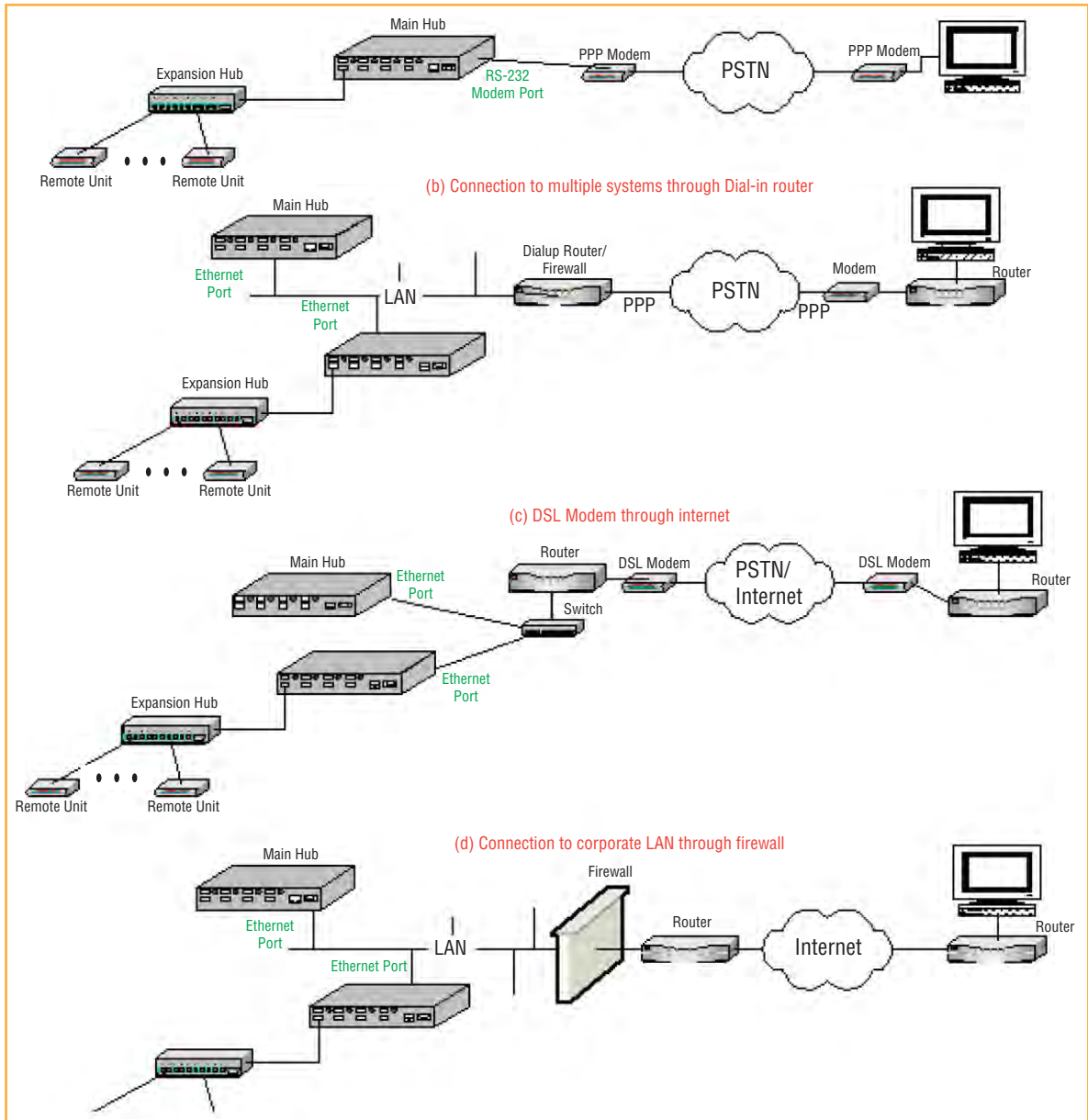


Figure 39. Fusion Wideband SNMP Configuration Options

REPLACING FUSION WIDEBAND COMPONENTS

Topics	Page
Replacing a RAU.....	176
Replacing a Fusion Wideband Expansion Hub	177
Replacing a Fusion Wideband Main Hub	178

REPLACING A RAU

CAUTION! The new RAU must support the same bands as the one you are replacing. If the RAU is of the wrong band combination, it will not operate properly in the system.

- 1 Log in to AdminBrowser, and then do the following:
 - a Click **System Information**.
 - b Click **Show System Tree**.
 - c Select **Fusion Wideband Main Hub**.
 - d Click **Get System Information**.
 - e All system settings for Hubs and RAUs will display. Write down or save the Uplink and Downlink Attenuation setting so you can set the new RAU with the same settings.
 - f Click **Cancel** to close the window.
- 2 Verify that the new RAU is of the same frequency bands as the one replaced.
- 3 Disconnect the CATV cable and antenna cable from the unit to be replaced.
- 4 Install the new RAU.
- 5 Connect the antenna cable and then the CATV cable to the new RAU.
- 6 Click **System Configuration**.
- 7 Click **Show System Tree**.
- 8 Select the new Fusion Wideband RAU, and then click **Edit Unit Properties**.
- 9 Set the attenuation of each band as the old RAU was programmed, and then click **Save Properties**.
- 10 When convenient, perform System Test to optimize performance.

CAUTION! During System Test, the entire system is temporarily off-line and no RF is being transmitted.

- 11 The RAU's LINK and ALARM LEDs should blink (green/red) on power up.
If the LEDs do not blink on power up, replace the RAU.
- 12 After several seconds both LEDs should change to green, which indicates that the unit has been successfully replaced, there is communication with the Hub, and the RAU band is correct.
 - If the LINK LED remains green and the ALARM LED remains red, verify that the RAU model is correct for the intended frequency band.

Disconnect the cable and then reconnect it once; doing this more than once will not change the result.
 - If both LEDs still don't change to green, use AdminBrowser to determine the exact nature of the fault and see a recommendation of how to correct it.
 - If both LEDs turn red (after 90 seconds), the Hub has terminated communications.

REPLACING A FUSION WIDEBAND EXPANSION HUB

- 1 Turn off the power to the Expansion Hub.
- 2 Disconnect all CATV cables, both fiber cables, and the AC power cord.
- 3 Replace the Expansion Hub with a new one.
- 4 Connect the AC power cord, all CATV cables, and both fiber cables – remembering to clean and correctly connect the uplink and downlink fiber.
- 5 Turn on the power to the Expansion Hub.
The Main Hub automatically issues the band setting.
- 6 When convenient, use AdminBrowser to perform System Test in order to optimize performance.

CAUTION! During System Test, the entire system is temporarily off-line and no RF is being transmitted. For a fully loaded system (one Main Hub, four Expansion Hubs, and 32 RAUs), it can take up to 90 seconds to complete the test.

- 7 Check the Expansion Hub LEDs.
 - The LEDs should blink through all states on power up.
 - If the LEDs do not blink on power up, replace the Expansion Hub.
 - If the LEDs do not illuminate at all, make sure the AC power cable is connected.
 - The UL status and DL STATUS LEDs should be green.
 - The e-HUB status and power LEDs should be green.
 - For each CATV port that has a connected RAU, the LEDs should be green.

It can take several seconds for each CATV connection before the LEDs to display properly.

NOTE: Refer to [“Troubleshooting Using LEDs”](#) on page 185 for troubleshooting using the LEDs.

REPLACING A FUSION WIDEBAND MAIN HUB

You must record the system configuration settings from the old Fusion Wideband Main Hub's memory before replacing the unit. You will program the new Main Hub with this information. If the Main Hub is programmed incorrectly, the system will not work. If the Hub to be replaced is not functioning and you cannot use AdminBrowser, get the configuration settings from the As-Built Document that was created as part of the original installation.

Do the following to replace a Fusion Wideband Main Hub:

- 1 Log in to AdminBrowser, and then do the following:
 - a Click **System Information**.
 - b Click **Show System Tree**.
 - c Select **Fusion Wideband Main Hub**.
 - d Click **Get System Information**.
- 2 Turn off the power to the Fusion Wideband Main Hub.
- 3 Disconnect all cables and the AC power cord.
- 4 Replace the Main Hub with a new one.
- 5 Connect the AC power cord and all cables.
- 6 Connect the crossover Ethernet cable to the PC and then to the Main Hub's front panel 100Base-T connector. ADMIN/LAN port)
- 7 Start the standard browser on the PC to communicate with AdminBrowser software.
- 8 Turn on the power to the Main Hub.
- 9 Observe the LEDs after turning on the power.

All the LEDs blink during the initial power up sequence. All LEDs should turn green after the power on sequence is complete. Power up sequence takes between 1 and 2 minutes depending on the number of RAUs.

- 10 Configure the New Fusion Wideband Main Hub.

CAUTION! During System Test, the entire system is temporarily off-line and no RF is being transmitted.

- a Use AdminBrowser to log in to the Main Hub.
- b Click **System Configuration**.
- c Click **Set Date/Time** and enter the current date and time.
- d Click **Set Date/Time**.
- e Follow the instructions to reboot the system.
- f Log back into AdminBrowser.
- g Click **System Configuration**.
- h Click **Install System**.
- i Set the new Main Hub parameters from the old Main Hub (that is, uplink and downlink gain, system labels, and so on), and then click **Install System**.
- j Follow the instructions to perform a System Test.
- k Click **System Configuration**.

-
- I Do one of the following:
 - Click **Setup Network Connection**.
 - Click **Modem Connection** if the Main Hub has Network or Modem equipment connected to it.
 - 11 Check the LEDs on the new Main Hub.
 - The LEDs should blink through a 5-second test on power up.
 - If the LEDs do not blink on power up, replace the Main Hub.
 - If the LEDs do not illuminate at all, make sure the AC power cable is connected.
 - For each fiber optic port that has a connected Expansion Hub, which has been programmed with a band, the PORT LED should be green.
 - Refer to [“Troubleshooting Using LEDs” on page 185](#) for more LED states.

NOTE: If there is no communication between the Main Hub and the Expansion Hubs, use AdminBrowser to isolate system problems.

MAINTENANCE AND TROUBLESHOOTING

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MAINTENANCE

Keep the fiber ports clean and free of dust. No other periodic maintenance of the Fusion equipment is required.

Cleaning the Fiber Ports

You can clean the Hub's fiber ports using canned compressed air or isopropyl alcohol and cotton swabs.

Using Compressed Air

NOTE: If you use compressed air, the air must be free of dust, water, and oil.

- 1 Remove the connector's dust cap.
- 2 **Holding the can level during use**, spray the compressed air away from the unit for a few seconds to clean out the nozzle, and then blow dust particles out of each fiber port.

Using Isopropyl Alcohol

NOTE: Use only 98% pure or more alcohol.

- 1 Remove the connector's dust cap.
- 2 Dip a 2.5mm lint-free, foam-tipped swab in isopropyl alcohol and slowly insert the tip into the connector.
- 3 Gently twist the swab to clean the connector.
- 4 Insert a dry swab to dry the connector.
- 5 (Optional) Use compressed air after the alcohol has completely evaporated.

TROUBLESHOOTING

NOTE: Fusion has no user-serviceable parts. Faulty or failed units are fully replaceable through TE; see [“Appendix D: Contacting TE Connectivity” on page 229](#).

Sources of potential problems include:

- faulty cabling/connector
- malfunction of one or more Fusion components
- antenna, Base Station, or repeater problem
- external RF interface
- tripped circuit breaker
- equipment is not grounded
- using an Ethernet crossover cable that does not support full hardware handshaking when using AdminBrowser.

NOTE: Faulty cabling is the cause of a vast majority of problems. All CATV 75 Ohm cable should be tested to TIA-570-B specifications. The RAU will be damaged if the cable connector is not installed properly.

Use AdminBrowser for troubleshooting the system. Only use the LEDs as backup or for confirmation.

If you cannot determine the cause of a problem after following the recommended procedures, call the TE Customer Support Team (see [“Appendix D: Contacting TE Connectivity” on page 229](#)).

Please be prepared to provide the following information:

- serial number of the unit
- description of the problem
- the length of the CATV cable and what type is it (for example RG-6)
- status of the LEDs on the unit
- when the unit was last power cycled.

Use AdminBrowser 1.00 to access Special Features, and then use the **Get Service Information** window to generate a service file. Save and email this file to TE.

Troubleshooting Using AdminBrowser

Use AdminBrowser software to determine the current faults and warnings for all of the units in the system. To troubleshoot, start with the Fusion Main Hub's faults AND warnings, then proceed to each of the Expansion Hubs, finishing with each of the RAUs.

NOTE: AdminBrowser v1.00 displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to [“View Alarm Preferences” on page 39](#).

System Troubleshooting



Do the following to get a list of warnings and system status:

- 1 Log in to AdminBrowser.
- 2 Click **System Information**.
- 3 Click **Get Faults, Warnings and Statuses**.

This gives the present status of the system, which is dependent on the **View Preferences** for all components.

Faults usually impact service; warnings may impact service; status messages contain information that should not be ignored, but indicate conditions that do not generally impact service.

NOTE: System commands can take longer to execute compared to component commands.

NOTE: This RAU icon  indicates there is a fault on the RAU. This icon  indicates a disconnected device. You cannot request status on a disconnected device.

Troubleshooting Recommendations

Some actions that you can take, depending on the device fault or warning include, are as follows:

- Hardware faults on Expansion Hub.
 - Try swapping fiber with another Expansion Hub at the Main Hub.
 - Try cleaning the fiber and the fiber ports with alcohol foam tip swab and compressed air; see [“Cleaning the Fiber Ports” on page 182](#).
 - Power cycle the Expansion Hub.
- In AdminBrowser, under Alarms, click **CLEAR ALL DISCONNECTS** at the Fusion Main Hub.
- Power cycle the Fusion Main Hub.
- For RAU hardware faults, try moving a working CATV to the suspect port and verifying that the RAU comes up OK.
- Try isolating the system components:
 - Check to see if the whole system is effected or a portion of the system.
 - If the whole system is effected, disconnect the DAS system from the RF source and see if the RF source is working.
 - Continue to isolate by disabling portions of the system. In AdminBrowser, under **System Configuration**, click **Show System Tree**, select a component, and then click **Set Out of Service/Set in Service**.

Fault/Warning/Status Indications

Once all of the units are powered on and the cable connections are made, the faults from each unit can be requested using AdminBrowser. Start with the Fusion Main Hub and work downstream.

Resolve all faults first and then check the warnings. Take appropriate action to resolve the faults, as indicated in the following tables. In cases where there is more than one possible cause, they are listed from the “most likely” to the “least likely” cause. Actions are listed in the order that they should be performed; not all actions may need to be done.

NOTE: If you have a red STATUS LED without a fault message, it probably indicates that the unit is locked out.

Refer to [“Appendix C: Faults, Warnings, Status Tables for Fusion, Fusion Wideband, Fusion SingleStar” on page 209](#) for tables containing Fault, Warning, and Status messages and their meanings.

Troubleshooting Using LEDs

The following troubleshooting information is from the perspective that all Fusion equipment is installed, their cables are connected, and they are powered on. It is also assumed that the system was operating normally before the problem to be diagnosed occurred.

NOTE: Always use AdminBrowser, if possible, to troubleshoot the system. The Fusion Main Hub and Expansion Hub LEDs are for backup troubleshooting. The RAU LEDs probably will not provide additional information for troubleshooting.

Troubleshooting Main Hub LEDs During Normal Operation

All of the Main Hub’s LEDs should be green during normal operation. If any LEDs are red, get status using AdminBrowser to determine the exact cause and recommendations.

Table 96. Troubleshooting Main Hub Port LEDs During Normal Operation

During Normal Operation	Main Hub Port LEDs	State	Impact	Action
Expansion Hub Not Connected	Port	Red	The Expansion Hub was previously connected, but it is not currently connected; the Expansion Hub uplink cable disconnected. AdminBrowser clears all disconnects caused by installation as part of the clean-up process. After installation, power cycle the Main Hub or use the AdminBrowser Clear All Disconnect Status command. Changes the Main Hub's port LEDs to Off/Off.	If the Expansion Hub was disconnected accidentally, re-connect the cables. The LEDs should change to Green/Red, and then Green/Green, after 20 seconds (if the Main Hub band has been programmed). When the Expansion Hub is to be removed from service permanently, use the AdminBrowser Clear All Disconnect Status command to clear all disconnect states.
Expansion Hub Connected	Port	Flashing Red (60 ppm)	Lost communication with Expansion Hub; could be a problem with the Expansion Hub or the fiber cable. The Expansion Hub communication problems delay Main Hub's response to AdminBrowser commands, resulting in command time-outs. You can initially disconnect the offending Expansion Hub to obtain status from the rest of the system, then reconnect the Expansion Hub and resolve the communication problem.	Use AdminBrowser to determine the exact cause of the Main Hub's faults.
	Port	Red	Unit may have degraded performance or go off-line, which is dependent on the fault condition.	The Expansion Hub or connected RAU reports a fault condition; use AdminBrowser to determine the exact cause of the corresponding unit's faults.

Table 97. Troubleshooting Main Hub STATUS LEDs During Normal Operation

During Normal Operation	Main Hub STATUS LEDs	State	Impact	Action
At Any Time	Main Hub Status	Red	Internal Main Hub fault.	Use AdminBrowser to determine the exact cause of the fault. Power cycle one time. If the fault remains, replace the Main Hub.
			The Main Hub and all downstream units are off-line.	Use AdminBrowser to check if the Main Hub is commanded Out-of-Service (every Expansion Hub port STATUS LED will be red as well). A power cycle will not clear a commanded Out-of-Service, you must use AdminBrowser to clear this state.
	Main Hub Status	Flashing Red (60ppm)	Signal compression.	Reduce input signal power.
At Any Time	Power	Red	One or more power supplies are out of specification.	Replace the Main Hub.

Troubleshooting Expansion Hub LEDs During Normal Operation

For all of the Expansion Hub that have RAUs connected:

- the LINK and E-HUB/RAU LEDs should be Green/Green, indicating that the RAU is powered on, communication is established, and operation is normal
- the POWER, E-HUB STATUS, DL STATUS, and UL STATUS LEDs should all be Green.

Table 98. Troubleshooting Expansion Hub Port LEDs During Normal Operation

During Normal Operation	Expansion Hub Port LEDs	State	Impact	Action
RAU is not connected	Port	Off	The RAU was previously connected, but it is not currently connected; the RAU cable is disconnected.	If the RAU was disconnected accidentally, re-connect the CATV cable. The Expansion Hub's port LEDs should change to Green/Red, and then Green/Green after 20 seconds (if the Main Hub is connected, powered on, and has band programmed). Use the AdminBrowser Clear All Disconnect Status command if you are permanently removing the RAU from service. The Expansion Hub's PORT LEDs should change to Off/Off.
RAU is connected	Port	Red	Lost communications with the RAU. The RAU could have powered down due to over current; cable could have been damaged.	Disconnect/reconnect the CATV cable to force power-on reset to the RAU. If the PORT LEDs remain red, use AdminBrowser to check for the exact cause of the Expansion Hub faults.
	Port	Flashing Red (60 ppm)	Depends on the fault condition.	The RAU reports a fault condition; use AdminBrowser to check for the exact cause of the Expansion Hub and RAU faults.
	Port	Flashing Red (60 ppm)	The Expansion Hub reports no connection with the RAU, cable shorts, or a current port trap condition.	The Expansion Hub is not communicating with the RAU; the Expansion Hub is at fault. The cable could have been damaged. The cable leads may be shorted.

Table 99. *Troubleshooting Expansion Hub STATUS LEDs During Normal Operation*





During Normal Operation	Expansion Hub STATUS LEDs	State	Impact	Action
At Any Time	UL STATUS	Red	No communications between the Main Hub and the Expansion Hub. Uplink laser failure.	Check uplink fiber for optical loss. Power cycle Expansion Hub one time to check uplink laser.
	DL STATUS	Red	No communications with the Main Hub.	Check the downlink fiber for optical loss
	E-H STATUS	Red	Internal Expansion Hub fault (including either of the above UL STATUS or DL STATUS states).	If either the UL STATUS or the DL STATUS are also red, see above. Cycle power on the Expansion Hub. If fault remains, replace the Expansion Hub.

TROUBLESHOOTING CATV

Table 100 summarizes CATV problems, as reported by AdminBrowser, if a cable is cut or miswired.

NOTE: Recommended minimum and maximum CATV cable lengths vary depending upon the type of CATV cable used. Refer to [“Cable and Connector Requirements” on page 107](#).

Table 100. Summary of CATV Cable Wiring Problems

Problem Type	Message	Icon	Impact
Loose connector, shorted conductor or improper connection to the shield.	None		High phase noise, degraded signal on both Downlink and Uplink (high bit error rate)
	No communication with RAUn		RAU unable to communicate with Hub, degraded performance or RAU off-line
	Portn UL RF path loss is too high		Increased ripple in the uplink path, decreased UL gain, or no UL gain
	The DL RF path loss is too high		Increased ripple in the downlink path, RAU off-line
	RAUn over current or port short		RAU will not power on.

APPENDIX A: CABLES AND CONNECTORS

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DB-9 to DB-9 Null Modem Cable	201

75 OHM CATV CABLE

General Specifications

- Connects the Expansion Hub to the RAU(s)
- Transmits multiband (downlink) and receives (uplink) IF signals
- Delivers DC electrical power to the RAUs. The Fusion Hub's DC voltage output is 54V DC nominal. A current limiting circuit is used to protect the Hub if it reaches its current limit
- Carries configuration and status information
- Use 75 Ohm type-F connectors with captive centerpins
- Lengths
 - RG-59:
 - • Minimum: 0 meters (0 ft.)
 - • Maximum: 150 meters (492 ft.)
 - RG-6:
 - • Minimum: 0 meters (0 ft.)
 - • Maximum: 170 meters (558 ft.)
 - RG-11:
 - • Minimum: 0 meters (0 ft.)
 - • Maximum: 275 meters (902 ft.)

Recommended CATV Cable Lengths

Recommended minimum and maximum CATV cable lengths vary depending upon which CATV cable you use. (Be sure to test cable termination before installing the cable.)

- CommScope CATV cable or equivalent is required:
- CommScope 20655V for RG-59 (see [Figure 40 on page 193](#)).
- CommScope 2279V for RG-6 (see [Figure 41 on page 194](#)).
- CommScope 2293K for RG-11 (see [Figure 42 on page 195](#)).
- CommScope 2065V for RG-59
- CommScope 2279V for RG-6
- CommScope 2293K for RG-11



Figure 40. CommScope 2065V for RG-59



Figure 41. CommScope 2079V for RG-6



Figure 42. CommScope 2293K for RG-11

NOTE: TE requires solid copper center conductor CATV cable for proper DC voltage to the RAU and maximum distances.

Connectors and Tools for Cable Ends

Use the following connectors and tools to prepare the cable ends:

- CommScope cable part number: 2065V
- Canare part number: F connector FP-C4F
- Crimp Tool TC-1, Crimp Die TCD-4C, Cable Strip preparation tool TS100E
- CommScope cable part number: 2279V
- Canare part number: F connector FP-C55A
- Crimp Tool TC-1, Crimp Die TCD-35CA, Cable Strip preparation tool TS100E
- CommScope cable part number: 2293V
- Canare part number: F connector FP-C71A
- Crimp Tool TC-1, Crimp Die TCD-7CA, Cable Strip preparation tool TS100E

If the maximum distance is not required, then copper-clad over steel-center conductor cable may be used to reduce cable costs.

Table 101 show CommScope cable choices of plenum, non-plenum, solid copper conductor, and copper-clad over-steel conductor cable with their part numbers and maximum distances.

Table 101. System Gain (Loss) Relative to CATV Cable Length

Cable Type	CommScope Part Number	Plenum Rated	Solid Copper Conductor	Copper Clad Conductor	Zero-loss RF Maximum Length (meters)	Distance Where RF is 10dB Below Input RF (meters)
RG-59	2065V	Yes	X		130	180
	2022V	Yes		X	100	100*
	5572R	No		X	95	95*
	5565	No	X		130	180
RG-6	2279V	Yes	X		140	190
	2275V	Yes		X	140	150*
	5726	No		X	140	140*
	5765	No	X		140	190
RG-11	2293K	Yes	X		235	320
	2285K	Yes		X	235	300*
	5913	No		X	235	300*
* Exceeding the distance of copper-clad cable will result in the attached RAU becoming non-functional. If the distance of a cable run is at its maximum and is of concern, TE recommends the use of solid copper cable to ensure successful operation.						

FIBER OPTICAL CABLES

- Connects the Main Hub to Expansion Hub(s)
- Transmits (downlink) and receives (uplink) optical signals
- Carries configuration and status information
- Use industry-standard 62.5 μ m/125 μ m MMF or Corning SMF-28 fiber, or equivalent.
- SC/APC (angle-polished) connectors are required throughout the fiber network (port-to-port), including fiber distribution panels
- Distances:
 - Multi-mode Fiber: up to 500 m (1,640 ft) – 3 dB optical loss maximum
 - Single-mode Fiber: up to 6 km (19,685 ft) – 3 dB optical loss maximum

COAXIAL CABLE

- Connects a Fusion Hub to a repeater or Base Station (N-type connectors)
- Connects a RAU to a passive antenna (N-type connectors)

STANDARD MODEM CABLE

Cable (PN 4028-10) shown in [Figure 43](#) connects a modem to the Fusion Hub's front panel serial port.

DB-9 Connector Pin	DB-25 Connector Pin
1	8
2	3
3	2
4	20
5	7
6	6
7	4
8	5
9	22

Figure 43. Standard Modem Cable Pinouts

TCP/IP CROSS-OVER CABLE

A TCP/IP cross-over cable (PN 4069-ADB) is used to connect a standard browser PC to the AdminBrowser with a Fusion Hub. A cable is included with the Fusion Hub. The pinouts for this cable are illustrated in [Figure 44](#).

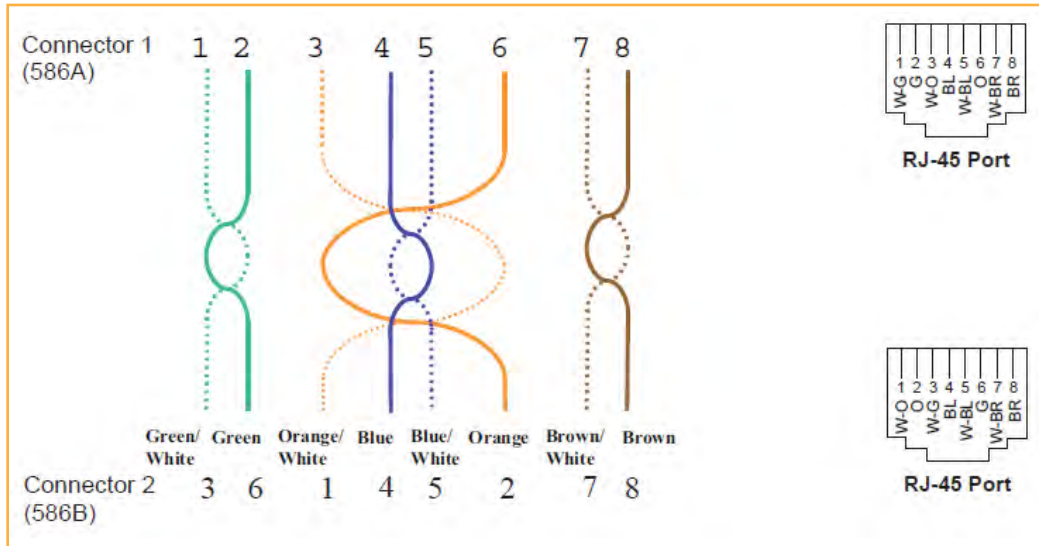


Figure 44. Wiring Map for TCP/IP Cable

DB-9 TO DB-9 NULL MODEM CABLE

Use a DB-9 female to DB-9 female null modem cable to connect the craft person's PC/Laptop to the RS-232 port on the front of the Fusion Hub for IP address configuration. [Table 102](#) lists the cable pinout and [Figure 45](#) shows a diagram of its wiring.

Table 102. DB-9 Female to DB-9 Female Null Modem Cable Pinout

From	Signal	To	Signal
P1-4	DTR	P2-6, P2-1	DSR, DCD
P1-6	DSR	P1-1, P2-4	DCD, DTR
P1-3	TXD	P2-2	RXD
P1-2	RXD	P2-3	TXD
P1-5	GND	P2-5	GND
P1-7	RTS	P2-8	CTS
P1-8	CTS	P2-7	RTS
P1-9	N/C	N/C	N/C

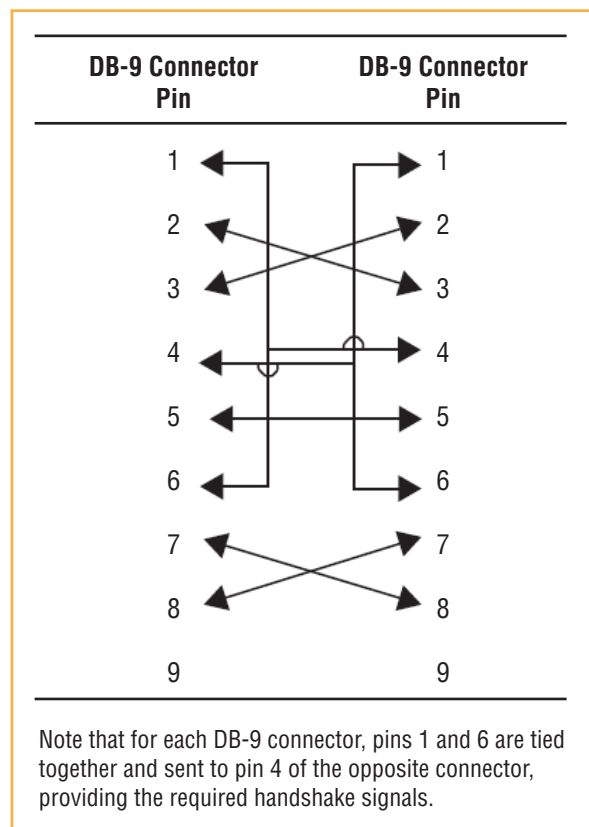


Figure 45. DB-9 Female to DB-9 Female Null Modem Cable Diagram

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STANDARDS CONFORMANCE

Fusion Wideband uses the TIA-570-B cabling standards for ease of installation.

CAUTION! The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

WARNING. This is NOT a CONSUMER device. It is designated for installation by FCC LICENSEES and QUALIFIED INSTALLERS. You MUST have an FCC LICENSE or express Consent of an FCC Licensee to operate this device. Unauthorized use may result in Significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.

FUSION WIDEBAND SYSTEM APPROVAL STATUS

InterReach Fusion Wideband has been approved as shown below.

700 MHz LTE Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 27

800 SMR/iDEN Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 90

850 Cellular Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 22

1800 DCS Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: EN 301 489-8 V1.2.1
- Radio: EN 300 609-4 V9.2.1

1900 PCS Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 24

2100 UMTS Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: EN 301 489-23 V1.2.1
- Radio: EN 301 908-11 V2.3.1

1700/2100 AWS Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 27

2500 TDD LTE Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: FCC part 15 class A
- Radio: FCC part 27

2600 MHz LTE Products

- Safety: UL, CSA, CB Scheme certificate to IEC 60950, 3rd Edition, and IEC 60950-1, 1st Edition, with all national deviations.
- EMC: EN 301 489-23 V1.2.1
- Radio: EN 301 908-11 V2.3.1

InterReach Fusion Wideband Main Hub and Expansion Hub

- Safety: UL, CSA, CB Scheme certificate to IEC 60950-1, First Edition, with all national deviations.
- EMC: CISPR 22A
- EMC: CISPR 24

NOTE: For Canadian customers, the Manufacturer's rated output power¹ of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.

NOTE: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

This equipment complies with the FCC radiation exposure limits for general population/uncontrolled exposure environments.

Changes or modifications not approved and performed by TE may void the user's authority to operate the equipment.

WARNING. This is **NOT** a **CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC License** or express consent of an FCC licensee to operate this device. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.

Part 90 Signal Boosters

WARNING. This is **NOT** a **CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC License** or express consent of an FCC licensee to operate this device. You **MUST** register Class B signal boosters (as defined in 47 CFR 90.219) online at www.fcc.gov/signal-boosters/registration. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.

¹"Manufacturer's rated output power" refers to Fusion Wideband's downlink P1dB. The Power Per Carrier tables take into account this power reduction for multiple carriers.

HUMAN EXPOSURE TO RF

The U.S. Federal Communications Commission (FCC) has developed guidelines for evaluation of human exposure to RF emissions. The guidelines incorporate limits for Maximum Permissible Exposure (MPE) for power density of transmitters operating at frequencies between 300 kHz and 100 GHz. Limits have been set for portable, mobile, and fixed equipment. TE products fall in the category of fixed equipment; products intended to be permanently secured and exposures are evaluated for distances greater than 20cm (7 7/8"). Portable devices fall into exposures of less than 20cm, are SAR evaluations are used.

Antenna gain is restricted to 1.5 W ERP (2.49 W EIRP) in order to satisfy RF exposure compliance requirements. If higher than 1.5 W ERP, routine MPE evaluation is needed. The antennas should be installed to provide at least 20 cm from all persons to satisfy MPE requirements of FCC Part 2, 2.1091.

Basic MPE evaluation is performed by taking the maximum power output of the equipment, the gain of the antenna to be used, and distance from the antenna, referenced in FCC OET Bulletin 65 "Evaluation Compliance with FCC Guidelines for Human Exposure to Radio Frequency for Electric Fields".

TE products transmit well below the FCC power density limits. FCC defines power output limits at 20cm distance for various frequency ranges:

- Over 300 MHz to 1.5 GHz the limit is determined by frequency/1500
- Above 1.5 GHz the limit is 1mW/cm²

The basic equation for determining power density is:

$$S = PG / 4\pi R^2$$

Where **S** is power density in mW/cm²

PG, the transmitted power from the antenna identified as EIRP (Equivalent Isotropically Radiated Power), is the product of power output of device and antenna gain, in mW.

R is the distance of interest from the antenna.

Typical Installation Example:

Assuming an antenna is placed on a 10 foot ceiling, for a person 6 feet tall, the distance from antenna to body is 4 feet (112 cm.).

For a PCS 1900 remote unit, the maximum power output, according to the power table in "Maximum Output Power Per Carrier" on page 65, is 16.5 dB.

Assuming a 7 dBi antenna is used, PG in the equation is equal to 23.5 dB (224 mW) EIRP.

Using $S = PG/4\pi R^2$

$$S = 224 / (4 \times 3.14) \times (122)^2 = 0.001 \text{ mW/cm}^2$$

Also, assuming a minimum distance of 20 cm according to FCC regulations:

$$S = 224 / (4 \times 3.14) \times (20)^2 = 0.04 \text{ mW/cm}^2$$

APPENDIX C: FAULTS, WARNINGS, STATUS TABLES FOR FUSION, FUSION WIDEBAND, FUSION SINGLESTAR

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The following tables contain messages for all versions of firmware, but all messages are not displayed by a given firmware version.

FAULTS REPORTED BY MAIN HUBS

Faults indicate service-impacting conditions and should be given immediate attention.

Once all of the units are powered on and the cable connections are made, the faults from each unit can be requested using AdminBrowser. Start with the Fusion or Fusion Wideband Main Hub and work downstream.

Resolve all faults first and then check the warnings. Take appropriate action to resolve the faults, as indicated in the following tables. In cases where there is more than one possible cause, they are listed from the “most likely” to the “least likely” cause. Actions are listed in the order that they should be performed; not all actions may need to be done.

NOTE: If you have a red STATUS LED without a fault message, it probably indicates that the unit is locked out.

Table 103. Fault Messages for Main Hubs

Message Number	Description	Reason/Action
{MF01}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{MF02}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{MF03}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{MF04}	Software reset occurred and recovered, or firmware download.	If this happens repeatedly, replace the Hub.
{MF05}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{MF06}	Problem detected in the Hub. Internal communication reset.	Contact TE Support for more information.
{MF07}	Hub power cycle.	Hub power cycle.
{MF08}	Internal communications failure.	No internal communications in preceding 15 minutes.
{MF09}	Hardware Reset.	Commanded hardware power on reset
{MF10}	Band not programmed.	Use AdminBrowser to program the band.
{MF11}	Hardware failure (DL Pilot PLL).	Cycle power once. If fault persists, replace the Hub
{MF12}	Hardware failure (DL Pilot Too High).	Cycle power once. If fault persists, replace the Hub.
{MF13}	Hardware failure (DL Pilot Too Low).	Cycle power once. If fault persists, replace the Hub.
{MF14}	Hardware failure (54 VDC).	54 VDC power supply is out of range, replace the Hub
{MF15}	Hardware failure (RF VDC Power).	Loss of DC power to RF circuits, replace the Hub.
{MF16}	Self Lockout (All Bands).	Hub has shutdown the system due to an internal fault. System is offline.
{MF17}	Hardware failure (DL PLL Band 1).	Cycle power once. If fault persists, replace the Hub.
{MF18}	Hardware failure (UL PLL Band 1).	Cycle power once. If fault persists, replace the Hub
{ML19}	Commanded Out-of-service (Band 1).	Band 1 commanded out-of-service by User.
{MF20}	Hardware failure (UL1 LO2 Band 1).	Cycle power once. If the fault persists, replace the Hub.
{MF21}	Problem detected in the Hub.	Contact TE Support for more information.
{MF22}	Problem detected in the Hub.	Contact TE Support for more information.
{MF23}	Problem detected in the Hub	Contact TE Support for more information.
{MF24}	Problem detected in the Hub.	Contact TE Support for more information.
{MF25}	Hardware failure (DL PLL Band 2).	Cycle power once. If fault persists, replace the Hub.

Table 103. *Fault Messages for Main Hubs (Cont.)*

Message Number	Description	Reason/Action
{MF26}	Hardware failure (UL PLL Band 2).	Cycle power once. If fault persists, replace the Hub.
{ML27}	Commanded Out-of-service (Band 2).	Band 2 commanded out-of-service by User.
{MF28}	Problem detected in the Hub.	Contact TE Support for more information.
{MF29}	Problem detected in the Hub.	Contact TE Support for more information.
{MF30}	Problem detected in the Hub.	Contact TE Support for more information.
{MF31}	Problem detected in the Hub.	Contact TE Support for more information.
{MF32}	Problem detected in the Hub.	Contact TE Support for more information.
{MF33}	Hardware failure (DL PLL Band 3).	Cycle power once. If fault persists, replace the Hub.
{MF34}	Hardware failure (UL PLL Band 3).	Cycle power once. If fault persists, replace the Hub.
{ML35}	Commanded Out-of-service (Band 3).	Band 3 commanded out-of-service by User.
{MF36}	Hardware failure (638 MHz PLL).	Cycle power once. If fault persists, replace the Hub.
{MF37}	Hardware failure (638 MHz PLL).	Cycle power once. If fault persists, replace the Hub.
{MF38}	Problem detected in the Hub.	Contact TE Support for more information.
{MF39}	Problem detected in the Hub.	Contact TE Support for more information.
{MF40}	Problem detected in the Hub.	Contact TE Support for more information.
{MF41}	Hardware failure (Optical Power Out).	Cycle power once. If the fault persists, replace the Hub.
{MF42}	Unable to sync with TDD frame (Band 1).	Check input signal and/or user TDD settings.
{MF43}	Unable to sync with TDD frame (Band 2).	Check input signal and/or user TDD settings.
{MF44}	Problem detected in the Hub.	Contact TE Support for more information
{MF45}	Problem detected in the Hub.	Contact TE Support for more information.
{MF46}	Problem detected in the Hub.	Contact TE Support for more information.
{MF47}	Problem detected in the Hub	Contact TE Support for more information.
{MF48}	Problem detected in the Hub.	Contact TE Support for more information.
{MD129}	Port 1 Disconnected.	Unit is disconnected.
{MD130}	Port 2 Disconnected.	Unit is disconnected.
{MD131}	Port 3 Disconnected.	Unit is disconnected.
{MD132}	Port 4 Disconnected.	Unit is disconnected.
{MD133}	Port 5 Disconnected.	Unit is disconnected.
{MD134}	Port 6 Disconnected.	Unit is disconnected.
{MD135}	Port 7 Disconnected.	Unit is disconnected.
{MD136}	Port 8 Disconnected.	Unit is disconnected.
{MC137}	Port 1 No Communications.	No communications with remote unit.
{MC138}	Port 2 No Communications.	No communications with remote unit.
{MC139}	Port 3 No Communications.	No communications with remote unit.
{MC140}	Port 4 No Communications.	No communications with remote unit.
{MC141}	Port 5 No Communications.	No communications with remote unit.
{MC142}	Port 6 No Communications.	No communications with remote unit.
{MC143}	Port 7 No Communications.	No communications with remote unit.
{MC144}	Port 8 No Communications.	No communications with remote unit.
{MT145}	Port 1 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.

Table 103. Fault Messages for Main Hubs (Cont.)

Message Number	Description	Reason/Action
{MT146}	Port 2 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT147}	Port 3 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT148}	Port 4 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT149}	Port 5 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT150}	Port 6 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT151}	Port 7 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT152}	Port 8 Cable Fault.	Possible electrical short in the coax cable, or RAU problem.
{MT153}	Port 1 Trip.	Remote Unit is drawing too much current.
{MT154}	Port 2 Trip.	Remote Unit is drawing too much current.
{MT155}	Port 3 Trip.	Remote Unit is drawing too much current.
{MT156}	Port 4 Trip.	Remote Unit is drawing too much current.
{MT157}	Port 5 Trip.	Remote Unit is drawing too much current.
{MT158}	Port 6 Trip.	Remote Unit is drawing too much current.
{MT159}	Port 7 Trip.	Remote Unit is drawing too much current.
{MT160}	Port 8 Trip.	Remote Unit is drawing too much current.
{MF161}	Problem detected in the Hub.	Contact TE Support for more information.
{MF162}	Problem detected in the Hub.	Contact TE Support for more information.
{MF163}	Problem detected in the Hub.	Contact TE Support for more information.
{MF164}	Problem detected in the Hub.	Contact TE Support for more information.
{MF165}	Problem detected in the Hub.	Contact TE Support for more information.
{MF166}	Problem detected in the Hub.	Contact TE Support for more information.
{MF167}	Problem detected in the Hub.	Contact TE Support for more information.
{MF168}	Problem detected in the Hub.	Contact TE Support for more information.
{MF169}	Problem detected in the Hub.	Contact TE Support for more information.
{MF170}	Problem detected in the Hub.	Contact TE Support for more information.
{MF171}	Problem detected in the Hub.	Contact TE Support for more information.
{MF172}	Problem detected in the Hub.	Contact TE Support for more information.
{MF173}	Problem detected in the Hub.	Contact TE Support for more information.
{MF174}	Problem detected in the Hub.	Contact TE Support for more information.
{MF175}	Problem detected in the Hub.	Contact TE Support for more information.
{MF176}	Problem detected in the Hub.	Contact TE Support for more information.

FAULTS REPORTED FOR SYSTEM CPU

Table 104. *Faults for System CPU*

Message Number	Description	Reason/Action
{SF01}	No internal communications.	No internal communications in preceding 2 minutes. Power cycle to clear.
{SF02}	Unable to open file (sysinfo).	System CPU rebooted.
{SF03}	Unable to open file (sysstat).	System CPU rebooted.
{SF04}	Invalid internal response.	System CPU rebooted, internal command does not return valid response after 4 retries.
{SF05}	No MAC address.	System CPU rebooted, unable to read MAC address from the Ethernet driver.
{SF06}	Unable to open file (sysinfo_org).	System CPU rebooted.
{SF07}	Unable to open file (sbc_status).	System CPU rebooted.
{SF08}	Invalid internal field response.	System CPU rebooted, internal command format invalid.
{SF09}	Unable to open file (fileTTL).	System CPU rebooted.
{SF10}	Invalid internal ASCII response.	System CPU rebooted, illegal number of bytes.
{SF11}	Unable to open file (sysalarm).	System CPU rebooted.
{SF12}	Unable to open file (password_etb).	System CPU rebooted.
{SF13}	Unable to open file (CRC).	System CPU rebooted.
{SF14}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF15}	pThread not executing.	System CPU rebooted.
{SF16}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF17}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF18}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF19}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF20}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF21}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF22}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF23}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF24}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF25}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF26}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF27}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF28}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF29}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF30}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF31}	Problem detected in the System CPU.	Contact TE Support for more information.
{SF32}	Problem detected in the System CPU.	Contact TE Support for more information.

FAULTS FOR EXPANSION HUBS

Table 105. *Fault Messages for Expansion Hubs*

Message Number	Description	Reason/Action
{EF01}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{EF02}	Software reset occurred and recovered, or firmware download.	If this happens repeatedly, replace the Hub.
{EF03}	Software reset occurred and recovered.	If this happens repeatedly, replace the Hub.
{EF04}	Software reset occurred and recovered.	If this happens repeatedly, replace the Hub.
{EF05}	Software error occurred and recovered.	If this happens repeatedly, replace the Hub.
{EF06}	Firmware download.	Firmware download.
{EF07}	Hub power cycle.	Hub power cycle.
{EF08}	MH communications failure.	No communications from MH in THE preceding 90 seconds.
{EF09}	MH communications failure.	EH uplink messages not getting to the MH.
{EF10}	Hardware failure (PLL).	Cycle power once. If the fault persists, replace the Hub.
{EF11}	Hardware failure (54 VDC).	54 VDC power supply is out of range, replace the Hub.
{EF12}	Problem detected in the EH.	Contact TE Support for more information.
{EF13}	Band not programmed.	Cycle power once. If the fault persists, replace the Hub.
{EF14}	Low optical input power.	Check downlink fiber connections.
{EF15}	Hardware failure (Optical Output Power).	Cycle power once. If the fault persists, replace the Hub.
{EF16}	Self Lockout (All Bands).	The Hub has shutdown the system due to an internal fault. The system is offline.
{EF17}	Commanded Out-of-service (Band 1).	Band 1 commanded out-of-service by the user.
{EF18}	Fault lockout (Band 1).	Band 1 out-of-service due to an MH fault.
{EF19}	Problem detected in the EH.	Contact TE Support for more information.
{EF20}	Problem detected in the EH.	Contact TE Support for more information.
{EF21}	Problem detected in the EH.	Contact TE Support for more information.
{EF22}	Problem detected in the EH.	Contact TE Support for more information.
{EF23}	Problem detected in the EH.	Contact TE Support for more information.
{EF24}	Problem detected in the EH.	Contact TE Support for more information.
{EF25}	Commanded Out-of-service (Band 2).	Band 2 commanded out-of-service by the user.
{EF26}	Fault lockout (Band 2).	Band 2 out-of-service due to MH fault.
{EF27}	Problem detected in the EH.	Contact TE Support for more information.
{EF28}	Problem detected in the EH.	Contact TE Support for more information.
{EF29}	Problem detected in the EH.	Contact TE Support for more information.
{EF30}	Problem detected in the EH.	Contact TE Support for more information.
{EF31}	Problem detected in the EH.	Contact TE Support for more information.
{EF32}	Problem detected in the EH.	Contact TE Support for more information.
{EF33}	Commanded Out-of-service (Band 3).	Band 3 commanded out-of-service by the user.
{EF34}	Fault lockout (Band 3).	Band 3 out-of-service due to an MH fault.
{EF35}	Problem detected in the EH.	Contact TE Support for more information.
{EF36}	Problem detected in the EH.	Contact TE Support for more information.

Table 105. *Fault Messages for Expansion Hubs (Cont.)*

Message Number	Description	Reason/Action
{EF37}	Problem detected in the EH.	Contact TE Support for more information.
{EF38}	Problem detected in the EH.	Contact TE Support for more information.
{EF39}	Problem detected in the EH.	Contact TE Support for more information.
{EF40}	Problem detected in the EH.	Contact TE Support for more information.
{ED129}	Port 1 Disconnected.	Unit is disconnected.
{ED130}	Port 2 Disconnected.	Unit is disconnected.
{ED131}	Port 3 Disconnected.	Unit is disconnected.
{ED132}	Port 4 Disconnected.	Unit is disconnected.
{ED133}	Port 5 Disconnected.	Unit is disconnected.
{ED134}	Port 6 Disconnected.	Unit is disconnected.
{ED135}	Port 7 Disconnected.	Unit is disconnected.
{ED136}	Port 8 Disconnected.	Unit is disconnected.
{EC137}	Port 1 No Communications.	No communications with remote unit.
{EC138}	Port 2 No Communications.	No communications with remote unit.
{EC139}	Port 3 No Communications.	No communications with remote unit.
{EC140}	Port 4 No Communications.	No communications with remote unit.
{EC141}	Port 5 No Communications.	No communications with remote unit.
{EC142}	Port 6 No Communications.	No communications with remote unit.
{EC143}	Port 7 No Communications.	No communications with remote unit.
{EC144}	Port 8 No Communications.	No communications with remote unit.
{ET145}	Port 1 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET146}	Port 2 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET147}	Port 3 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET148}	Port 4 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET149}	Port 5 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET150}	Port 6 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET151}	Port 7 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET152}	Port 8 Cable Fault.	Possible electrical short in the coaxial cable, or a RAU problem.
{ET153}	Port 1 Trip.	The Remote Unit is drawing too much current.
{ET154}	Port 2 Trip.	The Remote Unit is drawing too much current.
{ET155}	Port 3 Trip.	The Remote Unit is drawing too much current.
{ET156}	Port 4 Trip.	The Remote Unit is drawing too much current.
{ET157}	Port 5 Trip.	The Remote Unit is drawing too much current.
{ET158}	Port 6 Trip.	The Remote Unit is drawing too much current.
{ET159}	Port 7 Trip.	The Remote Unit is drawing too much current.
{ET160}	Port 8 Trip.	The Remote Unit is drawing too much current.

FAULTS FOR RAUS

Table 106. *Faults for RAUs*

Message Number	Description	Reason/Action
{RF01}	Software error occurred and recovered.	If this happens repeatedly, replace the RAU.
{RF02}	Software error occurred and recovered.	If this happens repeatedly, replace the RAU.
{RF03}	Software error occurred and recovered.	If this happens repeatedly, replace the RAU.
{RF04}	Software reset occurred and recovered, or firmware download.	If this happens repeatedly, replace the RAU.
{RF05}	Software error occurred and recovered.	If this happens repeatedly, replace the RAU.
{RF06}	Problem detected in the RAU.	Contact TE Support for more information.
{RF07}	RAU power cycle.	RAU power cycle.
{RF08}	Problem detected in the RAU.	Contact TE Support for more information.
{RF09}	Invalid band.	The RAU doesn't support programmed band. Check the RAU type against the band programmed in the hub.
{RF10}	Low input DC voltage.	Check the coaxial cable for high RF loss. Try another Hub port. If the fault persists, replace the RAU. If the fault clears, mark the Hub port as unusable and replace the Hub when possible.
{RF11}	Hardware Failure (DL PLL Band 1).	Cycle power once. If the fault persists, replace the RAU.
{RF12}	Hardware Failure (DL PLL Band 2).	Cycle power once. If the fault persists, replace the RAU.
{RF13}	Hardware Failure (DL PLL Band 3).	Cycle power once. If the fault persists, replace the RAU.
{RF14}	Hardware Failure (UL PLL Band 1).	Cycle power once. If the fault persists, replace the RAU.
{RF15}	Hardware Failure (UL PLL Band 2).	Cycle power once. If the fault persists, replace the RAU.
{RF16}	Hardware Failure (UL PLL Band 3).	Cycle power once. If the fault persists, replace the RAU.
{RF17}	Hardware Failure (PA Band 1).	Cycle power once. If the fault persists, replace the RAU.
{RF18}	Hardware Failure (PA Band 2).	Cycle power once. If the fault persists, replace the RAU.
{RF19}	Hardware Failure (PA Band 3).	Cycle power once. If the fault persists, replace the RAU.
{RF20}	Hardware Failure (UL Pilot).	Cycle power once. If the fault persists, replace the RAU.
{RL21}	Commanded Out-of-service (Band 1).	Band 1 commanded out-of-service by User. Command In-Service on Band 1 to restore service.
{RL22}	Commanded Out-of-service (Band 2).	Band 2 commanded out-of-service by User. Command In-Service on Band 2 to restore service.
{RL23}	Commanded Out-of-service (Band 3).	Band 3 commanded out-of-service by User. Command In-Service on Band 3 to restore service.
{RF24}	Problem detected in the RAU.	Contact TE Support for more information.
{RX25}	Commanded shutdown (Band 1).	Check the status of hub to which the RAU is connected.
{RX26}	Commanded shutdown (Band 2).	Check the status of hub to which the RAU is connected.
{RX27}	Commanded shutdown (Band 3).	Check the status of the hub to which the RAU is connected.
{RF28}	Internal shutdown (Band 1).	RAU Fault condition in band 1 path (or common path).
{RF29}	Internal shutdown (Band 2).	RAU Fault condition in band 2 path (or common path).
{RF30}	Internal shutdown (Band 3).	RAU Fault condition in band 3 path (or common path).
{RF31}	Problem detected in the system.	Contact TE Support for more information.
{RF32}	Problem detected in the RAU.	Contact TE Support for more information.

MESSAGES FOR MAIN HUBS

Warning Messages

Warnings alert you to conditions that indicate possible service impact. Warnings are displayed in the Messages pane in red lettering.

Before addressing warnings, ensure that all faults are resolved. Take appropriate action to resolve the warnings, as indicated in the following tables.

NOTE: AdminBrowser v000007 or higher displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to Section 3.5, “Faults, Warnings, and Status Messages” of the Fusion Installation, Operation, and Maintenance Manual.

Status Messages

Status messages alert you to conditions that are important, but generally do not impact service. Status messages alert you to conditions that are important, but generally do not impact service. Status messages are displayed in the Messages pane in blue lettering.

NOTE: AdminBrowser v000007 or higher displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to Section 3.5, “Faults, Warnings, and Status Messages” of the Fusion Installation, Operation, and Maintenance Manual.

NOTE: The icons displayed in the system status tree assume that there are no other faults, warnings, or status present.

In [Table 107 on page 218](#), the message number is in the following form:

[Mnn]/X

where

- **nn** equals the message number
- **X** equals the default of one of the following
 - **S**—Status
 - **W**—Warning.

Table 107. Warnings/Status Messages for Main Hubs

Message Number/Default	Description	Reason/Action
[M01]/S	Fan 1 failure.	Check the fan for rotation, air flow blockage, and dust. Replace the Hub on high temperature warning.
[M02]/S	Fan 2 failure.	Check the fan for rotation, air flow blockage, and dust. Replace the Hub on high temperature warning.
[M03]/S	54 VDC Pwr Supply Fan failure.	Check the fan for rotation, air flow blockage, and dust. Replace the Hub on high temperature warning.
[M04]/W	5 VDC Monitor.	DC power out of range, replace the Hub.
[M05]/W	9 VDC Monitor.	DC power out of range, replace the Hub.
[M06]/W	54 VDC Monitor.	DC power out of range, replace the Hub.
[M07]/W	3 VDC Monitor.	DC power out of range, replace the Hub.
[M08]/W	12 VDC Monitor.	DC power out of range, replace the Hub.
[M09]/W	Temperature High.	Reduce ambient temperature, check for air flow blockage, fan rotation.
[M10]/W	-5 VDC Monitor.	DC power is out of range, replace the Hub.
[M11]/W	High laser current.	Output laser failure possible, replace the Hub when possible.
[M12]/W	DL path loss is too high	Replace the Hub.
[M13]/S	Low input optical (Port 1).	Check the uplink fiber.
[M14]/S	Low input optical (Port 2).	Check the uplink fiber.
[M15]/S	Low input optical (Port 3).	Check the uplink fiber.
[M16]/S	Low input optical (Port 4).	Check the uplink fiber.
[M17]/S	Hardware failure (Test Tone PLL Band 1).	Unable to perform DL system test.
[M18]/S	Hardware failure (Test Tone Too High Band 1).	Unable to perform DL system test.
[M19]/S	Hardware failure (Test Tone Too Low Band 1).	Unable to perform DL system test.
[M20]/W	Overdrive limiter active (Band 1).	Reduce input signal power to avoid potential component damage.
[M21]/W	CEMark limiter at maximum (Band 1).	Reduce input signal power to avoid drop in system gain.
[M22]/W	No DL test tone (Band 1).	Hub DL gain is low.
[M23]/S	No UL test tone (Band 1).	Hub UL path gain is low.
[M24]/S	Problem detected in the system.	Contact TE Support for more information.
[M25]/S	Hardware failure (Test Tone PLL Band 2).	Unable to perform DL system test. Replace the hub when possible.
[M26]/S	Hardware failure (Test Tone Too High Band 2).	Unable to perform DL system test. Replace the hub when possible.
[M27]/S	Hardware failure (Test Tone Too Low Band 2).	Unable to perform DL system test. Replace the hub when possible.
[M28]/W	Overdrive limiter active (Band 2).	Reduce input signal power to avoid potential component damage.
[M29]/W	CEMark limiter at maximum (Band 2).	Reduce input signal power to avoid drop in system gain.
[M30]/W	No DL test tone (Band 2).	Hub DL path gain is low.
[M31]/S	No UL test tone (Band 2).	Hub UL path gain is low.
[M32]/S	Problem detected in the system.	Contact TE Support for more information.
[M33]/S	Hardware failure (Test Tone PLL Band 3).	Unable to perform DL system test.
[M34]/S	Hardware failure (Test Tone Too High Band 3).	Unable to perform DL system test.
[M35]/S	Hardware failure (Test Tone Too Low Band 3).	Unable to perform DL system test.
[M36]/W	Overdrive limiter active (Band 3).	Reduce input signal power to avoid potential component damage.

Table 107. Warnings/Status Messages for Main Hubs (Cont.)

Message Number/Default	Description	Reason/Action
[M37]/W	CEMark limiter at maximum (Band 3).	Reduce input signal power to avoid drop in system gain.
[M38]/W	No DL test tone (Band 3).	Hub DL path gain is low.
[M39]/S	No UL test tone (Band 3).	Hub UL path gain is low.
[M40]/S	Problem detected in the Hub.	Contact TE Support for more information.
[M41]/W	Port 1 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M42]/W	Port 2 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M43]/W	Port 3 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M44]/W	Port 4 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M45]/W	Port 5 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M46]/W	Port 6 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M47]/W	Port 7 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M48]/W	Port 8 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[M49]/W	Port 1 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M50]/W	Port 2 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M51]/W	Port 3 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M52]/W	Port 4 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M53]/W	Port 5 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M54]/W	Port 6 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M55]/W	Port 7 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M56]/W	Port 8 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[M57]/W	Port 1 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M58]/W	Port 2 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M59]/W	Port 3 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M60]/W	Port 4 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M61]/W	Port 5 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M62]/W	Port 6 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M63]/W	Port 7 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M64]/W	Port 8 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[M65]/S	No UL test tone Port 1 (Band 1).	Hub/Port UL path gain is low.
[M66]/S	No UL test tone Port 2 (Band 1).	Hub/Port UL path gain is low.
[M67]/S	No UL test tone Port 3 (Band 1).	Hub/Port UL path gain is low.
[M68]/S	No UL test tone Port 4 (Band 1).	Hub/Port UL path gain is low.
[M69]/S	No UL test tone Port 1 (Band 2).	Hub/Port UL path gain is low.
[M70]/S	No UL test tone Port 2 (Band 2).	Hub/Port UL path gain is low.
[M71]/S	No UL test tone Port 3 (Band 2).	Hub/Port UL path gain is low.
[M72]/S	No UL test tone Port 4 (Band 2).	Hub/Port UL path gain is low.
[M73]/S	No UL test tone Port 1 (Band 3).	Hub/Port UL path gain is low.
[M74]/S	No UL test tone Port 2 (Band 3).	Hub/Port UL path gain is low.
[M75]/S	No UL test tone Port 3 (Band 3).	Hub/Port UL path gain is low.

Table 107. Warnings/Status Messages for Main Hubs (Cont.)

Message Number/Default	Description	Reason/Action
[M76]/S	No UL test tone Port 4 (Band 3).	Hub/Port UL path gain is low.
[M77]/S	Problem detected in the Hub.	Contact TE Support for more information.
[M78]/S	Problem detected in the Hub.	Contact TE Support for more information.
[M79]/S	Problem detected in the Hub.	Contact TE Support for more information.
[M80]/S	Problem detected in the Hub.	Contact TE Support for more information.
[M81]/W	Port 1 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M82]/W	Port 2 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M83]/W	Port 3 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M84]/W	Port 4 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M85]/W	Port 5 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M86]/W	Port 6 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M87]/W	Port 7 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M88]/W	Port 8 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[M89]/W	Port 1 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M90]/W	Port 2 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M91]/W	Port 3 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M92]/W	Port 4 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M93]/W	Port 5 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.

Table 107. Warnings/Status Messages for Main Hubs (Cont.)

Message Number/Default	Description	Reason/Action
[M94]/W	Port 6 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M95]/W	Port 7 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M96]/W	Port 8 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[M97]/W	Port 1 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M98]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M99]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M100]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M101]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M102]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M103]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M104]/W	Port 8 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check the RAU.
[M105]/W	Port 1 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M106]/W	Port 2 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M107]/W	Port 3 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M108]/W	Port 4 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M109]/W	Port 5 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M110]/W	Port 6 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M111]/W	Port 7 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[M112]/W	Port 8 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.

MESSAGES FOR SYSTEM CPUs

In [Table 108](#), the message number is in the following form:

[Snn]/X

where

- **nn** equals the message number
- **X** equals the default of one of the following
 - **S**—Status
 - **W**—Warning.

Table 108. *Warning/Status Messages for System CPUs*

Message Number/Default	Description	Reason/Action
[S01]/W	Alarm Input 1.	Check equipment connected to alarm input 1.
[S02]/W	Alarm Input 2.	Check equipment connected to alarm input 2.
[S03]/W	Alarm Input 3.	Check equipment connected to alarm input 3.
[S04]/S	Performed System Test	System has just performed system test.
[S05]/S	Problem detected in the System CPU.	Contact TE Support for more information.
[S06]/S	Loaded default etb file.	Contact TE Support for more information.
[S07]/S	Loaded default SBC status file.	Contact TE Support for more information.
[S08]/S	Problem detected in the System CPU.	Contact TE Support for more information.
[S09]/S	TTL is full.	Retrieve the TTL and erase.
[S10]/S	Problem detected in the System CPU.	Contact TE Support for more information.
[S11]/S	Problem detected in the System CPU.	Contact TE Support for more information.
[S12]/S	Loaded default Password file.	Contact TE Support for more information.
[S13]/S	Loaded default sys config file.	Contact TE Support for more information.
[S14]/S	Communication retries exceeded.	Attempted command three times without response.
[S15]/S	Problem detected in the System CPU.	Contact TE Support for more information.
[S16]/S	Problem detected in the System CPU.	Contact TE Support for more information.

MESSAGES FOR EXPANSION HUBS

Table 109. Warning/Status Message for Expansion Hubs

Message Number/Default	Description	Reason/Action
[E01]/W	Alarm Input 1.	Check the equipment connected to alarm input 1.
[E02]/W	Alarm Input 2.	Check the equipment connected to alarm input 2.
[E03]/W	Alarm Input 3.	Check the equipment connected to alarm input 3.
[E04]/S	Problem detected in the EH.	Contact TE Support for more information.
[E05]/W	SNMP Trap #1.	TBD.
[E06]/W	SNMP Trap #2.	TBD.
[E07]/W	SNMP Trap #3.	TBD.
[E08]/S	Problem detected in the EH.	Contact TE Support for more information.
[E09]/S	Fan 1 failure.	Check the fan for proper rotation, air flow blockage, and dust accumulation. Replace the Hub on high temperature warning.
[E10]/S	Fan 2 failure.	Check the fan for proper rotation, air flow blockage, and dust accumulation. Replace the Hub on high temperature warning.
[E11]/W	-5 VDC Monitor.	DC power out of range, replace the Hub.
[E12]/W	5 VDC Monitor.	DC power out of range, replace the Hub.
[E13]/W	9 VDC Monitor.	DC power out of range, replace the Hub.
[E14]/W	54 VDC Pwr Supply failure.	DC port power supply out of range, replace the Hub.
[E15]/W	3 VDC Monitor.	DC power out of range, replace the Hub.
[E16]/W	12 VDC Monitor.	DC power out of range, replace the Hub.
[E17]/W	Temperature High.	Reduce the ambient temperature, check for air flow blockage, fan rotation.
[E18]/W	DL path exceeds maximum gain.	If the problem is common to more than one port, replace the MH, otherwise check the EH.
[E19]/W	DL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different MH port. If the problem is on more than one port, replace the EH, otherwise replace the RAU.
[E20]/W	Hardware Failure (High UL Pilot).	Cycle power once. If the fault persists, replace the EH.
[E21]/W	Hardware Failure (Low UL Pilot).	Cycle power once. If the fault persists, replace the EH.
[E22]/W	Low optical input power.	Check the downlink fiber connection.
[E23]/W	High laser current.	Contact TE Support for more information.
[E24]/S	Problem detected in the EH.	Contact TE Support for more information.
[E25]/W	Port 1 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E26]/W	Port 2 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E27]/W	Port 3 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E28]/W	Port 4 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E29]/W	Port 5 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E30]/W	Port 6 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E31]/W	Port 7 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E32]/W	Port 8 No DL test tone (Band 1).	Hub/Port DL path gain is low.
[E33]/W	Port 1 No DL test tone (Band 2).	Hub/Port DL path gain is low.

Table 109. *Warning/Status Message for Expansion Hubs (Cont.)*

Message Number/Default	Description	Reason/Action
[E34]/W	Port 2 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E35]/W	Port 3 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E36]/W	Port 4 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E37]/W	Port 5 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E38]/W	Port 6 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E39]/W	Port 7 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E40]/W	Port 8 No DL test tone (Band 2).	Hub/Port DL path gain is low.
[E41]/W	Port 1 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E42]/W	Port 2 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E43]/W	Port 3 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E44]/W	Port 4 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E45]/W	Port 5 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E46]/W	Port 6 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E47]/W	Port 7 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E48]/W	Port 8 No DL test tone (Band 3).	Hub/Port DL path gain is low.
[E49]/W	Port 1 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E50]/W	Port 2 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E51]/W	Port 3 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E52]/W	Port 4 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E53]/W	Port 5 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E54]/W	Port 6 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E55]/W	Port 7 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E56]/W	Port 8 DL path loss is high.	If the problem is on more than one port, replace the Hub. Switch the cable connection to a different hub port until the Hub can be replaced.
[E57]/W	Port 1 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E58]/W	Port 2 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E59]/W	Port 3 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E60]/W	Port 4 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.

Table 109. *Warning/Status Message for Expansion Hubs (Cont.)*

Message Number/Default	Description	Reason/Action
[E61]/W	Port 5 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E62]/W	Port 6 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E63]/W	Port 7 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E64]/W	Port 8 UL path loss is high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem is on more than one port, replace the Hub, otherwise replace the RAU.
[E65]/W	Port 1 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E66]/W	Port 2 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E67]/W	Port 3 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E68]/W	Port 4 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E69]/W	Port 5 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E70]/W	Port 6 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E71]/W	Port 7 UL path exceeds maximum gain.	If problem is common to more than one port, replace the Hub, otherwise check RAU.
[E72]/W	Port 8 UL path exceeds maximum gain.	If the problem is common to more than one port, replace the Hub, otherwise check RAU.
[E73]/W	Port 1 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E74]/W	Port 2 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E75]/W	Port 3 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E76]/W	Port 4 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E77]/W	Port 5 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E78]/W	Port 6 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E79]/W	Port 7 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.
[E80]/W	Port 8 54 VDC Power Enabled.	Caution: Port 54 VDC power may be present at the output.

MESSAGES FOR RAUs

In [Table 110](#), the message number is in the following form:

[Rnn]/X

where

- **nn** equals the message number
- **X** equals the default of one of the following
 - **S**—Status
 - **W**—Warning.

Table 110. *Warning/Status Messages for RAUs*

Message Number Default	Description	Reason/Action
[R01]/W	Temperature High.	Check RAU location for excessive temperature; check for air flow blockage and/or incorrect installation. Move the RAU to a cooler environment.
[R02]/W	No communications from Hub.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem persists, replace the RAU.
[R03]/W	DL RF path loss is too high.	Check the cable for high RF loss. Switch the cable connection to a different hub port. If the problem persists, replace the RAU.
[R04]/W	DL RF path exceeds maximum gain.	Check the Hub for proper operation; switch the cable connection to a different hub port. If the problem persists, replace the RAU.
[R05]/S	DL RF path problem (Band 1).	Unable to complete the DL system end-to-end test, replace the RAU when possible.
[R06]/S	DL RF path problem (Band 2).	Unable to complete the DL system end-to-end test, replace the RAU when possible.
[R07]/S	DL RF path problem (Band 3).	Unable to complete the DL system end-to-end test, replace the RAU when possible.
[R08]/S	System test required.	Run system test.
[R09]/W	Antenna Disconnected.	Check RAU antenna connection; re-run system test.
[R10]/S	UL RF path problem (Band 1).	Unable to complete the UL system end-to-end test, replace the RAU when possible.
[R11]/S	UL RF path problem (Band 2).	Unable to complete the UL system end-to-end test, replace the RAU when possible.
[R12]/S	UL RF path problem (Band 3).	Unable to complete the UL system end-to-end test, replace the RAU when possible.
[R13]/S	Problem detected in the RAU.	Contact TE Support for more information.
[R14]/S	Problem detected in the RAU.	Contact TE Support for more information.
[R15]/S	Problem detected in the RAU.	Contact TE Support for more information.
[R16]/S	Problem detected in the RAU.	Contact TE Support for more information.
[R17]/S	Antenna disconnected (Band 1).	Check the RAU Band 1 antenna, then rerun the system test.
[R18]/S	Antenna disconnected (Band 2).	Check the RAU Band 2 antenna, then rerun the system test.
[R19]/S	Hardware Failure (UL FD PLL Band 1).	Unable to complete a UL system end-to-end test. Replace the RAU when possible.
[R20]/W	TDD signaling tone outside valid range (Band 1).	If the Main Hub and Expansion Hub are okay, replace the RAU.

Table 110. *Warning/Status Messages for RAUs (Cont.)*

Message Number Default	Description	Reason/Action
[R21]/W	TDD signaling tone outside valid range (Band 2).	If the Main Hub and Expansion Hub are okay, replace the RAU.
[R22]/S	High PA current (Band 1).	The unit is operating with reduced gain. Verify that the input signal is at the appropriate level. If the problem persists, replace the RAU when possible.
[R23]/S	High PA current (Band 2).	The unit is operating with reduced gain. Verify that the input signal is at the appropriate level. If the problem persists, replace the RAU when possible.

APPENDIX D: CONTACTING TE CONNECTIVITY

Topics	Page
Accessing the TE Customer Portal	230
Technical Assistance	231
Contacting TE Connectivity	232

The information in this appendix tells you how to access the TE Connectivity Customer Portal, from which you can download user documentation and data sheets. It also tells you how you can contact TE Connectivity.

ACCESSING THE TE CUSTOMER PORTAL

You can access additional user documentation on the TE Customer Portal, as described below.

- 1 Click on the following URL link:

<https://www.te.com/portal/wireless/>

(Alternatively, enter the preceding URL into your web browser, and then press **ENTER** on your keyboard.)

- 2 Access to the Customer Portal requires a user account and password. On the **Sign In** page, do one of the following:
 - If you have an account, in the **Already Registered? Sign In Now** panel, enter your **Email** and **Password**, and then click **Sign In**.
 - If you don't have an account, under **Create an Account**, click **Register Now** and follow the prompts.
- 3 On the **Wireless Customer Portal** home page in the **Knowledge Center** panel, click the **Manuals and Data Sheets** link.
- 4 On the **Manuals and Data Sheets** page, do the following:
 - a In the **Document Repository** panel, scroll to the section for the product line of the document that you want to access.
 - b Click on the title of the manual that you wish to open.
 - c (Optional) Save the PDF to your computer.

TECHNICAL ASSISTANCE

Call our help hot line for technical assistance; see [“Contacting TE Connectivity 232” on page 229](#).

Please provide your name, phone number, and e-mail address, along with the following information:

- company name
- end user name
- type of system, model number, frequency
- approximate time in service (warranty), sales order number
- description of problem
- LED status
- AdminBrowser faults, warnings, and status messages

A TE customer service representative will contact you with assistance.

CONTACTING TE CONNECTIVITY

Telephone Numbers

Sales

Asia Pacific	+65-6294-9948
France	0800 914032
Germany	0180 2232923
Italy	0800 782374
Spain	900 983291
United Kingdom	0800 960236
USA or Canada	1-800-366-3891
Extension	73000
Connectivity Extension	73475
Wireless Extension	73476

Technical Support

USA or Canada	1-800-530-9960
Elsewhere	+1-952-917-0761

Online Access

Customer Portal

<https://www.te.com/portal/wireless/>

Technical Support for Wireless Products

<http://www.te.com/WirelessSupport>

Mailing Address

541 E. Trimble Road
San Jose, California
95131-1224 USA



www.te.com/wireless

