LGC WIRELESS®

# InterReach Fusion™ SingleStar

## Installation, Operation, and Reference Manual


D-620605-0-20
Rev A

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SECTION 1

# General Information

This section contains the following subsections:

## 1.1 Firmware Release

For the latest Software and Firmware Release and associated documentation, access the LGC Wireless customer portal at lgcwireless.com.

## 1.2 Purpose and Scope

This document describes the InterReach Fusion SingleStar system.

- Section 2 InterReach Fusion SingleStar System Description

  This section provides an overview of the Fusion SingleStar hardware and OA&M capabilities. This section also contains system specifications and RF end-to-end performance tables.

- Section 3 Fusion SingleStar Hub

  This section illustrates and describes the Fusion SingleStar Hub. This section includes connector and LED descriptions, and unit specifications.

- Section 4 Remote Access Unit

  This section illustrates and describes the Remote Access Unit. This section also includes connector and LED descriptions, and unit specifications.

- Section 5 Designing a Fusion SingleStar Solution

  This section provides tools to aid you in designing your Fusion SingleStar 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.

- Section 6 Installing Fusion SingleStar

  This section provides installation procedures, requirements, safety precautions, and checklists. The installation procedures include guidelines for troubleshooting using the LEDs as you install the units.

- Section 7 Replacing Fusion SingleStar Components

  This section provides installation procedures and considerations when you are replacing an Fusion SingleStar component in an operating system.

- Section 8 Maintenance, Troubleshooting, and Technical Assistance

  This section provides contact information and troubleshooting tables.

- Appendix A Cables and Connectors

  This appendix provides connector and cable descriptions and requirements. It also includes cable strapping, connector crimping tools, and diagrams.

- Appendix B Compliance

  This section lists safety and radio/EMC approvals.

## 1.3 Conventions in this Manual

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

| Convention | Description |
|---|---|
| **bold** | Used for emphasis |
| **BOLD CAPS** | Labels on equipment |
| SMALL CAPS | Software menu and window selections |

This manual lists measurements first in metric units, and then in U.S. Customary System of units in parentheses. For example:

0° to 45°C (32° to 113°F)

This manual uses the following symbols to highlight certain information as described.

**NOTE:** This format emphasizes text with special significance or importance, and provides supplemental information.

**CAUTION:** This format indicates when a given action or omitted action can cause or contribute to a hazardous condition. Damage to the equipment can occur.

**WARNING: This format indicates when a given action or omitted action can result in catastrophic damage to the equipment or cause injury to the user.**

### Procedure

This format highlights a procedure.

## 1.4 Standards Conformance

- Fusion SingleStar uses the TIA/EIA 568 and 570 cabling standards for ease of installation.
- Refer to Appendix B for compliance information.

## 1.5 Related Publications

- *AdminBrowser User Manual*, LGC Wireless part number D-620607-0-20 Rev. A

SECTION 2

# InterReach Fusion SingleStar System Description

InterReach Fusion SingleStar is a multi-band (frequencies) 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 smaller buildings.

Fusion SingleStar provides the same RF characteristics as InterReach Fusion, which is designed for large public and private facilities such as campus environments, airports, shopping malls, subways, convention centers, sports venues, and so on. Fusion SingleStar 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.

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

- Frequencies: 800 MHz, 850 MHz, 900 MHz, 1800 MHz, 1900 MHz, 2100 MHz
- Voice Protocols: AMPS, TDMA, CDMA, GSM/EGSM
- Data Protocols: CDPD, EDGE, GPRS, WCDMA, CDMA2000, 1xRTT, EV-DO, and Paging

The Fusion SingleStar system supports two configurable bands:

- Band 1 in 35 MHz and can be configured for 850 MHz, or 900 MHz.
- Band 2 in 75 MHz and can be configured for 1800 MHz, 1900 MHz, or 2100 MHz

Both bands support all protocols.

Fusion remote access units contain combinations of Band 1 and Band 2 frequenciesto support various world areas, that is 850 MHz/1900MHz for North America or 900 MHz/2100 MHz for Europe and Asia. Refer to Table 4-1 on page 4-3 for a specific list of these RAU frequency combinations.

## 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** Hub allows the frequency bands to be configured in the field.
- **Standard 75 CATV Ohm cable,** can be run up to 150 meters for RG-59 cable (170 meters for RG-6; 275 meters for RG-11).
- **Flexible RF configuration capabilities**, including:
  - System gain:
    - 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 10 dB in 1 dB steps.
    - 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.

## 2.1 System Hardware Description

The InterReach Fusion SingleStar system consists of two modular components:

- 19" rack-mountable **Hub** *(connects to up to 8 Remote Access Units)*
  - Converts RF signals to IF on the downlink; 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
  - 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 SingleStar system is one Hub and one RAU (1-1). The maximum configuration of a system is one Hub and 8 RAUs (1-8). Multiple systems can be combined to provide larger configurations.

**Figure 2-1 Fusion SingleStar System Hardware**

## 2.2 System OA&M Capabilities Overview

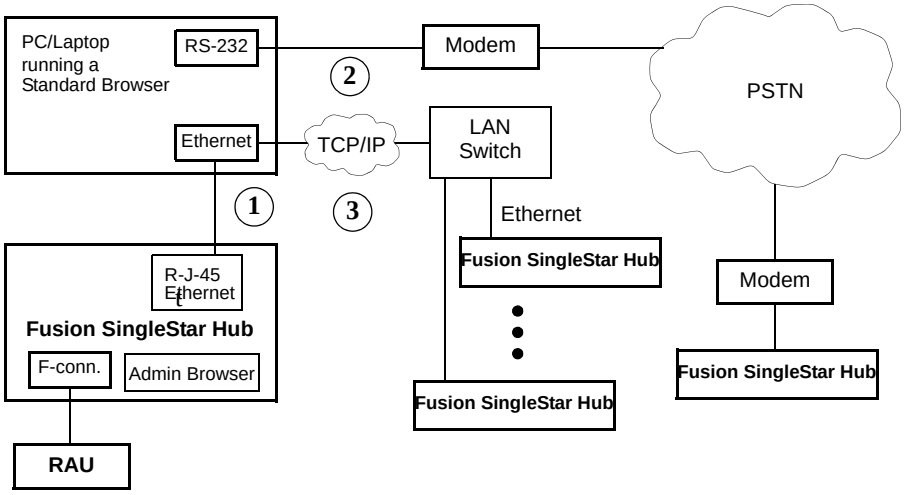
InterReach Fusion SingleStar is microprocessor controlled and contains firmware which enables much of the operations, administration, and maintenance (OA&M) functionality.

Complete alarming, down to the field replaceable unit (that is, Fusion SingleStar Hub and Remote Access Unit) and the cabling infrastructure, is available. All events occurring in a system, defined as a Fusion SingleStar Hub and all of its associated Remote Access Units, are automatically reported to the Hub. The 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 for basic alarm monitoring.
- Connection Methods:
  - The Hub's front panel RJ-45 port connects directly to a PC (for local Ethernet access).
  - The 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 connections to the RJ-45 port.

**Figure 2-2 Three Methods for OA&M Communications**

Use AdminBrowser to configure or monitor a local or a remote Fusion SingleStar system.




AdminBrowser OA&M software runs on the Fusion SingleStar Hub microprocessor and communicates to its downstream RAUs. Using AdminBrowser, you can configure a newly installed system, change system parameters, perform an end-to-end system test, or query system status from any standard web browser (Internet Explorer) running on your PC/laptop system.

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

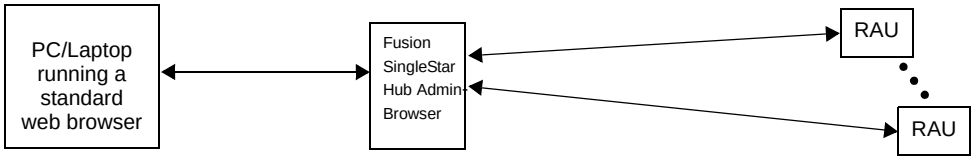
### 2.2.1 System Monitoring and Reporting

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

When a Hub detects a change in status, it reports a fault or warning. Faults are indicated locally by red status LEDs. Both faults and warnings are reported to AdminBrowser software and displayed on a PC/laptop connected to the Hub's RJ-45 port. Passive antennas connected to the RAUs are not monitored automatically. Perform the System Test in order 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 2-3 illustrates how the system reports its status to AdminBrowser.

**Figure 2-3 System Monitoring and Reporting**




Use a standard browser to communicate with remotely or locally installed SingleStarsystems running AdminBrowser.

If a fault or warning condition is reported, the AdminBrowser graphical user interface indicates the problem on your standard PC browser.

The Hub queries the status of each RAU and compares it to the previously stored status.

If a fault is detected, LEDs on the front panel turn red.

Each RAU passes its status to the Hub.

If a fault is detected, the **ALARM** LED is red. If no fault is detected, the LED is green.

### 2.2.2 Using Alarm Contact Closures

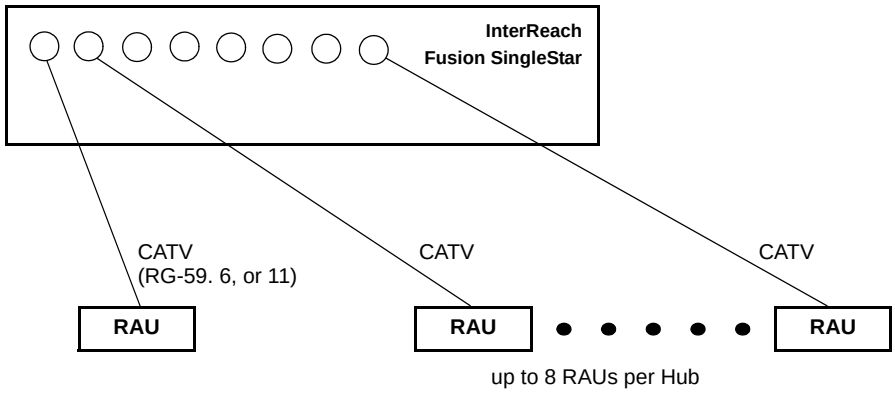
You can connect the DB-9 female connector on the rear panel of the Fusion SingleStar Hub to a local base station or to a daisy-chained series of Fusion, Unison, LGCell, and/or MetroReach Focus systems.

- When you connect MetroReach Focus or a BTS to the Fusion SingleStar, the Fusion SingleStar Hub outputs the alarms (alarm source) and MetroReach Focus or the BTS receives the alarms (alarm sense). This is described in Section 6.6.1 on page 6-33.
- When you connect LGCell to the Fusion SingleStar, the Fusion SingleStar Hub receives the alarms (alarm sense) from LGCell (alarm source). This is described in Section 6.6.2 on page 6-36.

## 2.3 System Connectivity

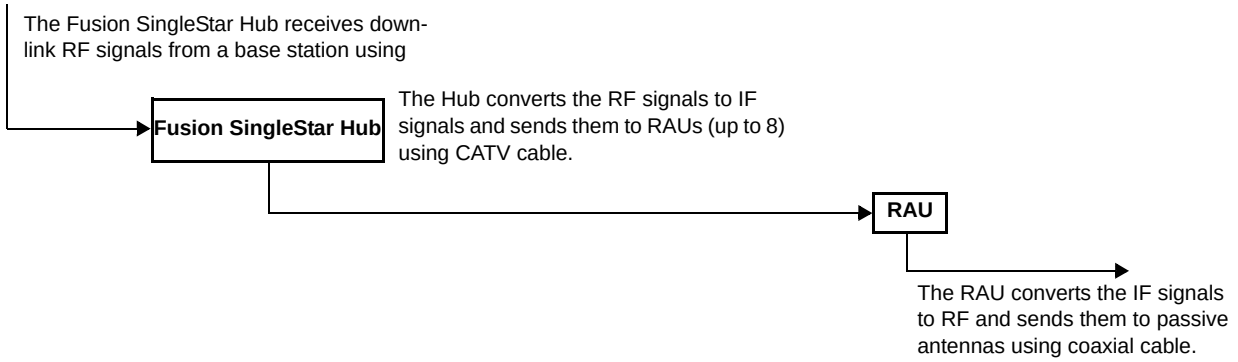
The system uses standard 75 Ohm CATV cable. This makes any system expansion, such as adding an extra antenna for additional coverage, as easy as pulling thin Ethernet cable.

**Figure 2-4 Fusion SingleStar's Architecture**

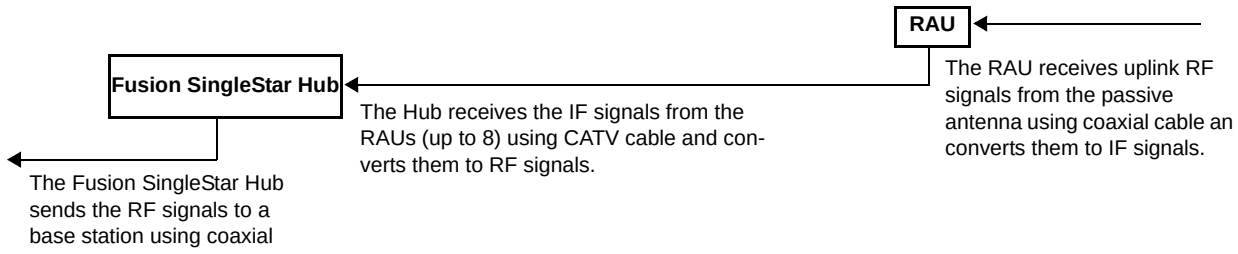


## 2.4 System Operation

- **Downlink (Base Station to Wireless Devices)**




- **Uplink (Wireless Devices to Base Station)**



## 2.5 System Specifications

**Table 2-1 Physical Specifications**

| Parameter | Fusion SingleStar Hub | Remote Access Unit |
|---|---|---|
| IF/RF Connectors | 4N, female (50 ohms), 1 Downlink/Uplink pair per band<br>8 F, female (CATV 75 Ohm) | 1 F, female (CATV -75 Ohm)<br>1 N, female (coaxial) - 50 Ohm |
| External Alarm Connector (contact closure) | 1 9-pin D-sub, female<br>Maximum: 400 mA @ 60V AC/DC<br>Typical: 4 mA @ 12V DC | — |
| ADMIN/LAN Interface Connectors | 1 RJ-45, female<br>1 9-pin D-sub, male for optional modem | — |
| LED Alarm and Status Indicators | Unit Status (1 pair):<br>• Power<br>• Status<br>Port Status (1 per SF connector port):<br>• Link/RAU | Unit Status (1 pair):<br>• Link<br>• Alarm |
| AC Power (Volts) | Rating: 115/230V, 6/3A, 50–60 Hz<br>Operating Range: 90–132V/170–250V auto-ranging | — |
| DC Power (Volts) | — | 54V (from the Hub) |
| Power Consumption (W)** | 4 RAUs: 350 typical<br>8 RAUs: 5300 typical | 64 max (from the Hub) |
| Enclosure Dimensions* (height × width × depth) | 133.5 mm × 438 mm × 381 mm<br>(5.25 in. × 17.25 in. × 15 in.) (3U) | 54 mm x 286 mm x 281 mm<br>(2.13 in. × 11.25 in. × 11.13 in.) |
| Weight | < 9.5 kg (< 21 lbs.) | < 2.1 kg (< 4.6 lbs.) |

*Excluding angle-brackets for 19" rack mounting of hub.

**The Fusion SingleStar Hub's typical power consumption assumes that the CATV RG-59 cable length is no more than 150 meters, the RG-6 cable length is no more than 170 meters, and RG-11 cable length is no more than 270 meters.

**Table 2-2 Environmental Specifications**

| Parameter | Unison Accel 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 2-3 Operating Frequencies**

| Fusion RAU | Part Number | Fusion Band | RF Passband | |
|---|---|---|---|---|
| | | | Downlink (MHz) | Uplink (MHz) |
| 850/1900 | FSN-8519-1 | 850 | 869–894 | 824–849 |
| | | 1900 | 1930–1990 | 1850–1910 |
| 900//1800 | FSN-9018-1 | 900 | 925–960 | 880–915 |
| | | 1800 | 1805–1880 | 1710–1785 |
| 900/2100 | FSN-9021-1 | 900 | 925–960 | 830–715 |

## 2.5.1 RF End-to-End Performance

The following tables list the RF end-to-end performance of 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 up to 10 dB in 1dB steps.

### 850/1900 RAU

**Table 2-4 850 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average gain with 75 m RG-59 at 25°C (77°F) (dB) | 15 | 15 |
| Ripple with 150 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 Hub-8 RAUs (dB) | | 16 |

**Table 2-5 1900 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average gain with 75 m RG-59 at 25°C (77°F) (dB) | 15 | 15 |
| Ripple with 150 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 Hub-8 RAUs (dB) | | 17 |

## 900/1800 RAU

**Table 2-6 900 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average Downlink gain with 75 m RG-59 at 25°C (77°F) (dB) | 15 | 15 |
| Ripple with 75 m RG-59 (dB) | 3 | 4 |
| Output IP3 (dBm) | 38 | |
| Input IP3 (dBm) | | –5 |
| Output 1 dB Compression Point (dBm) | 26 | |
| Noise Figure 1 Hub-8 RAUs (dB) | | 16 |

**Table 2-7 1800 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average gain with 75 m RG-59 at 25°C (77°F) (dB) | 15 | 15 |
| Downlink ripple with 75 m Cat-5/5E/6 (dB) | 2 | |
| Uplink ripple with 75 m RG-59 (dB) | | 2 |
| Uplink gain roll off with 75 m RG-59 (dB)* | | 2 |
| Output IP3 (dBm) | 38 | |
| Input IP3 (dBm) | | –12 |
| Output 1 dB Compression Point (dBm) | 26 | |
| Noise Figure 1 Hub-8 RAUs (dB) | | 17 |

*Outside the center 60 MHz

## 900/2100 RAU

**Table 2-8 900 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average Downlink gain with 75 m RG-59 at 25°C (77°F) (dB) | 15 | 15 |
| Ripple with 75 m RG-59 (dB) | 3 | 4 |
| Output IP3 (dBm) | 38 | |
| Input IP3 (dBm) | | –5 |
| Output 1 dB Compression Point (dBm) | 26 | |
| Noise Figure 1 Hub-8 RAUs (dB) | | 16 |

**Table 2-9 2100 MHz RF End-to-End Performance**

| Parameter | Typical | |
|---|---|---|
| | Downlink | Uplink |
| Average gain w/ 75 meters RG-59 @ 25°C (dB) | 15 | 15 |
| Ripple with 75 m RG-59 (dB) | 2.5 | 4 |
| Spurious Output Levels (dBm) | <–30 | |
| UMTS TDD Band Spurious Output Level<br>1900–1920 MHz, 2010–2025 MHz (dBm/MHz) | <–52 | |
| Output IP3 (dBm) | 37 | |
| Input IP3 (dBm) | | –12 |
| Output 1 dB Compression Point (dBm) | 26 | |
| Noise Figure 1 Hub-8 RAUs (dB) | | 17 |

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SECTION 3

# Fusion SingleStar Hub

The Fusion SingleStar Hub interfaces between two individual RF sources (being base station, repeater, or MetroReach Focus system) and up to eight Remote Access Units. The Fusion SingleStar is a multi-band system. One RF source (Band 1 or RF1) goes to the 35 MHz band and the other RF source (Band 2 or RF2) goes to the 75 MHz band. The system installs in a 19" equipment rack and is usually collocated with the RF source in a telecommunications closet.

- **Downlink Path**

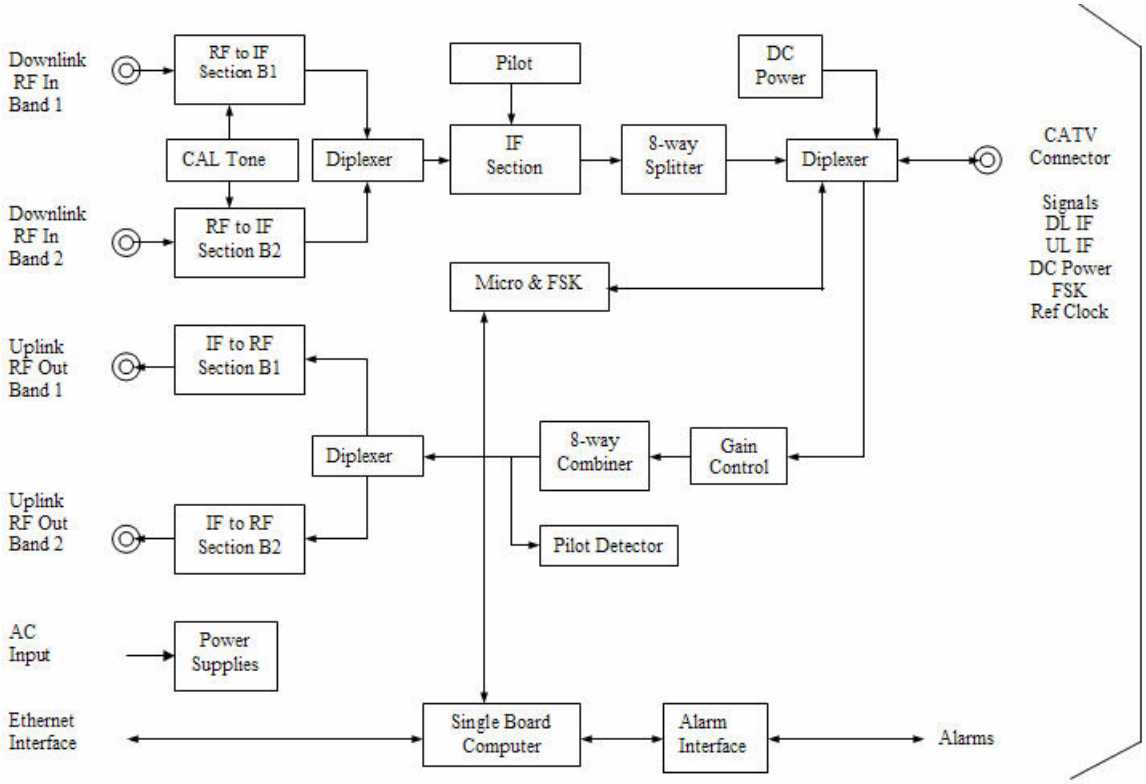
  The Fusion SingleStar Hub receives downlink RF signals from each RF source (RF1, RF2) using coaxial cable. It converts the signals to IF and sends them to up to eight RAUs using CATV cable. The Hub also sends OA&M communication to the RAUs using the CATV cable.

- **Uplink Path**

  The Fusion SingleStar Hub receives uplink IF signals from up to eight RAUs using CATV cable. It converts the signals to RF and sends them to an RF source (RF1, RF2) using coaxial cable. The Hub also receives status information from the RAUs using the CATV cable.

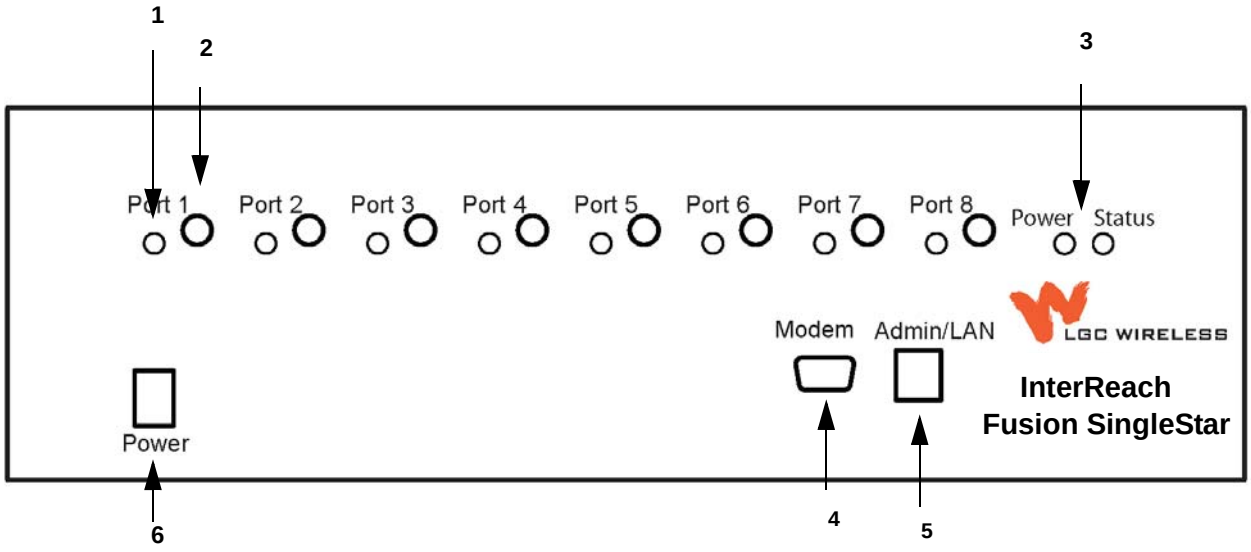
Figure 3-1 shows a detailed view of the major RF and functional blocks of the Hub.

**Figure 3-1 Fusion SingleStar Hub Block Diagram**



## 3.1 Fusion SingleStar Hub Front Panel

**Figure 3-2 Fusion SingleStar Hub Front Panel**




1. One port LED per F connector port for link status and downstream RAU status (8 pair total).
2. Eight CATV cable F connectors (labeled **PORT 1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**)
3. One pair of unit status LEDs
   - One LED for unit power status (labeled **POWER**)
   - One LED for unit status (labeled **STATUS**)
4. One 9-pin D-sub male connector for system remote dial-up communication and diagnostics using a modem (labeled **MODEM**)
5. One RJ-45 female connector for system communication and diagnostics using a PC/laptop with direct connect or using a LAN switch (labeled **ADMIN/LAN**)
6. Power switch

### 3.1.1 F Connectors

The eight F connectors on the Hub are for the CATV cables used to transmit and receive signals to and from RAUs. Use only 75 ohm F connectors on the CATV cable.

The CATV cable also delivers DC electrical power to the RAUs. The Hub's DC voltage output is 54V DC nominal. A current limiting circuit protects the Hub if any port draws excessive power.

**NOTE:** For system performance, it is important to use only low loss solid copper center conductor CATV cable with quality F connectors that use captive centerpin connectors. Refer to Appendix A for approved cables and connectors.

### 3.1.2 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-25 male connector. Refer to Appendix A.3 on page A-3 for the cable pinout

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 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 Appendix A.4 on page A-3 for the cable pinout.

### 3.1.3 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 Hub goes through a 20-second test to check the LED lamps. During this time, the LEDs blink through the states shown in Table 3-1, 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 3-1.

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

**NOTE:** Refer to Section 8.3.2 for troubleshooting using the LEDs.

**NOTE:** AdminBrowser must 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.

## Status LEDs

The Hub has one pair of status LEDs, labeled **POWER** and **STATUS**, which can be in one of the states shown in Table 3-1. These LEDs can be:

- steady green
- steady red
- orange

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

**Table 3-1 Fusion SingleStar Hub Status LED States**

| | LED State | Indicates |
|---|---|---|
| **POWER**<br>**STATUS** | Green<br>Green | • The Hub is connected to power and all power supplies are operating.<br>• The 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**<br>**STATUS** | Green<br>Red | • The Hub is connected to power and all power supplies are operating.<br>• The Hub is reporting a fault or lockout condition. |
| **POWER**<br>**STATUS** | Green<br>Orange | • The Hub is connected to power and all power supplies are operating.<br>• The Hub DL input signal level is too high. |
| **POWER**<br>**STATUS** | Red<br>Red | • One or more power supplies are out-of-specification. |

## RJ-45 Port LEDs

The Hub has a port LED, labeled **PORT**, for each of the eight RJ-45 ports. The port LEDs can be in one of the states shown in Table 3-2. These LEDs can be:

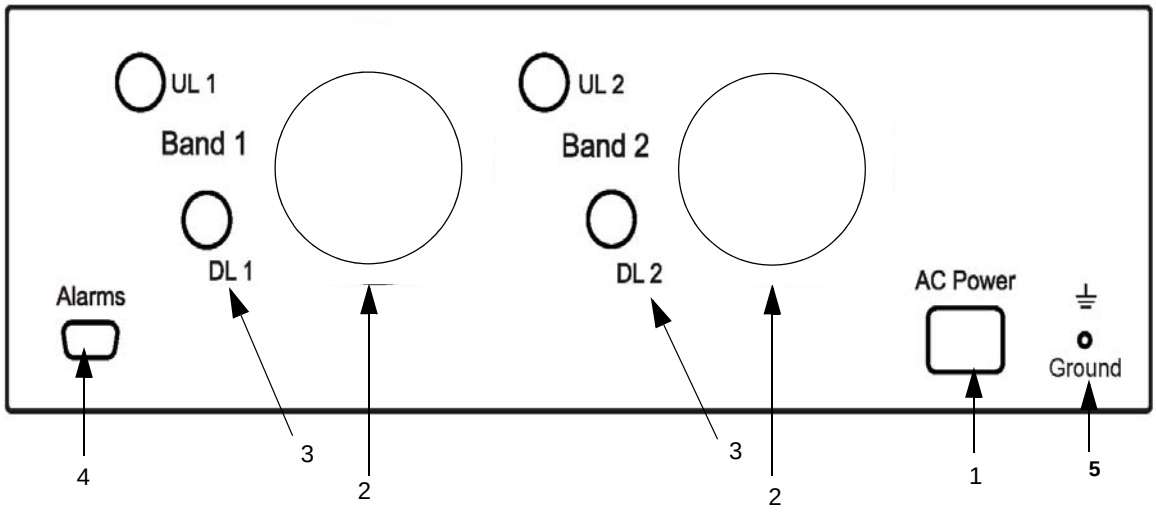
- ○ off
- ● steady green
- ● flashing red (60 pulses per minute [PPM])

**Table 3-2 Fusion SingleStar Hub Port LED States**

| | LED State | Indicates |
|---|---|---|
| **PORT** ○ | Off | • The RAU is not connected. |
| **PORT** ● | Green | • The RAU is connected.<br>• No faults from the RAU. |
| **PORT** ● | Red (60 PPM) | • The RAU was disconnected.<br>• The RAU is not communicating.<br>• The RAU port power is tripped.<br>• 54 VDC is shutdown due to an EH over-temperature condition. |
| **PORT** ● | Red (Steady) | • The RAU is connected.<br>• The RAU is reporting a fault or lockout condition. |

## 3.2 Fusion SingleStar Hub Rear Panel

**Figure 3-3 Fusion SingleStar Hub Rear Panel**




1. AC power cord connector
2. Two air exhaust vents
3. Two N-type, female connectors fore each band (Band 1 and Band 2):
   - Uplink (labeled **UL 1** and **UL 2**)
   - Downlink (labeled **DL '1** and **DL 2**)
4. One 9-pin D-sub female connector for contact alarm monitoring (labeled **ALARMS**)
5. Ground lug for connecting unit to frame ground (labeled **GROUND**)

### 3.2.1 Fusion SingleStar Hub Rear Panel Connectors

#### 3.2.1.1 9-pin D-sub Connector

The 9-pin D-sub connector (labeled **DIAGNOSTIC 1**) provides a contact alarm for fault and warning system alarm monitoring.

Table 3-3 lists the function of each pin on the 9-pin D-sub connector.

**Table 3-3 9-pin D-sub Pin Connector Functions**

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

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).

#### 3.2.1.2 N-type Female Connectors

There are two N-type female connectors on the rear panel of the Hub:

- The **DOWNLINK** connector receives downlink RF signals from a repeater, local base station, or MetroReach Focus system.
- The **UPLINK** connector transmits uplink RF signals to a repeater, local base station, or MetroReach Focus system.

**CAUTION:** The **UPLINK** and **DOWNLINK** ports cannot handle a DC power feed from the local base station. If the DC power is present, a DC block must be used or the Fusion SingleStar hub may be damaged.

# 3.3 Faults, Warnings, and Status Messages

## 3.3.1 Description

The Fusion SingleStar Hub monitors and reports changes or events in system performance to:

- Ensure that its amplifiers and IF/RF paths are functioning properly.
- Ensure that Remote Access Units are connected and functioning properly.

An event is classified as fault, warning, or status message.

- Faults are service impacting.
- Warnings indicate a possible service impact.
- Status messages are generally not service impacting.

The Fusion SingleStar Hub periodically queries attached 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 LEDs.

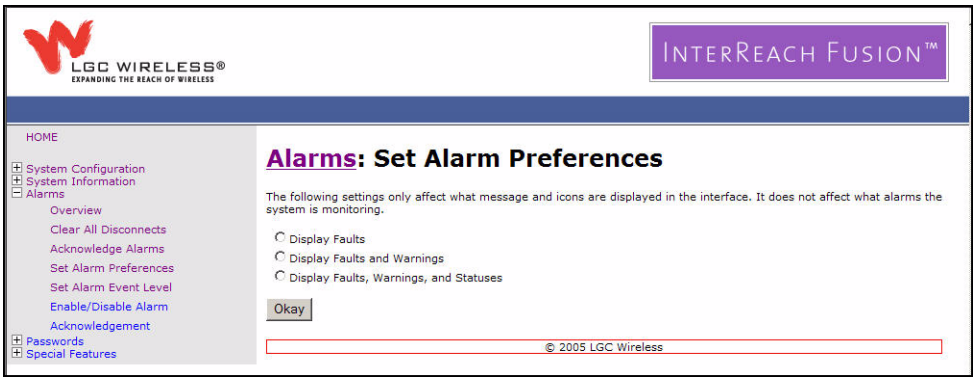
For more information regarding the events, refer to:

- page 8-5 for Hub faults.
- page 8-13 for Hub warnings.
- page 8-15 for Hub status messages.
- page 8-19 for troubleshooting Hub LEDs.

## 3.3.2 View Preference

AdminBrowser 1.0 or higher enables you to select (using the screen shown in Figure 3-4) the type of events to be displayed.

**Figure 3-4 Preferences Check Boxes**




To modify the setting, using AdminBrowser, select Alarms → Set Alarm Preference and select the desired choice. After you click OK, 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 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.

## 3.4 Fusion SingleStar Hub Specifications

**Table 3-4 Fusion SingleStar Hub Specifications**

| Specification | Description |
|---|---|
| Enclosure Dimensions (H × W × D) | 133.5 mm × 438 mm × 381 mm<br>(5.25 in. × 17.25 in. × 15 in.) (3U) |
| Weight | < 9.5 kg (< 21 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<br>(contact closure) | 1 9-pin D-sub, female<br>Maximum: 400 mA @ 60V AC/DC<br>Typical: 4 mA @ 12V DC |
| ADMIN/LAN Interface Connector | 1 RJ-45, female<br>1 9-pin D-sub, male for optional modem |
| RF Connectors | 4N, female (50 ohms), 1 Downlink/Uplink pair per band<br>8 F, female (CATV 75 ohm)[a] |
| LED Fault and Status Indicators | Unit Status (1 pair):<br>• Power<br>• Status<br>Port Status (1 pair per SF-connector port):<br>• Link/RAU |
| AC Power | Rating: 115/230V, 6/3A, 50–60 Hz<br>Operating Range: 90–132V/170–250V auto-ranging |
| Power Consumption (W) | 4 RAUs: 305 typical<br>8 RAUs: 530 typical |
| MTBF | 45,040 hours |

a. For system performance, it is important that you use only 75 Ohm CATV cable with solid copper center conductor.

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SECTION 4

# Remote Access Unit

The Remote Access Unit (RAU) is an active transceiver that interfaces between a Fusion SingleStar Hub and passive antennas, which transmit the RF signals to wireless devices. The RAU is installed above ceiling tiles or attached to a wall or pole. It is located at the site where RF is to be delivered.

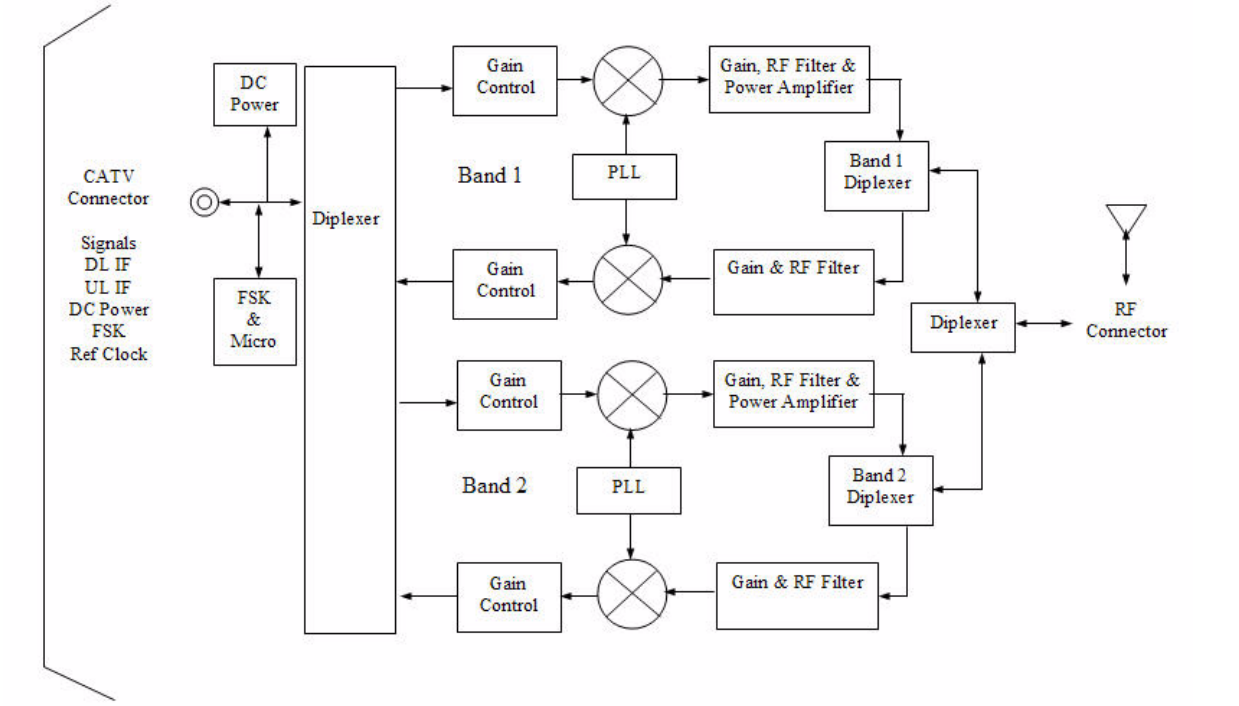
- **Downlink Path**

  The RAU receives downlink IF signals from a Fusion SingleStar Hub using CATV cable. It converts the signals to RF and sends them to a passive RF antenna using coaxial cable. Also, the RAU receives configuration information from the Fusion SingleStar Hub using the CATV cable.

- **Uplink Path**

  The RAU receives uplink RF signals from a passive RF antenna using coaxial cable. It converts the signals to IF and sends them to a Fusion SingleStar Hub using CATV cable. Also, the RAU sends its status information to the Fusion SingleStar Hub using CATV cable.

**Figure 4-1 Remote Access Unit Block Diagram**



The Fusion SingleStar RAUs are manufactured to a specific set of bands (one 35 MHz-Band 1, one 75 MHz-Band 2). Table 4-1 lists the Fusion RAUs, the Fusion Band, and the frequency bands they cover.

**Table 4-1 Frequency Bands Covered by Fusion RAUs**

| Fusion RAU | Part Number | Fusion Band | RF Passband | | RAU Band | RAU Bandwidth |
|---|---|---|---|---|---|---|
| | | | Downlink (MHz) | Uplink (MHz) | | |
| 850/1900 | FSN-8519-1 | 850 | 869–894 | 824–849 | 1 | 25 MHz |
| | | 1900 | 1930–1990 | 1850–1910 | 2 | 60 MHz |
| 900//1800 | FSN-9018-1 | 900 | 925–960 | 880–915 | 1 | 35 MHz |
| | | 1800 | 1805–1880 | 1710–1785 | 2 | 75 MHz |
| 900/2100 | FSN-9021-1 | 900 | 925–960 | 830–715 | 1 | 35 MHz |
| | | 2100 | 2110–2170 | 1920–1980 | 2 | 60 MHz |

## 4.1 Remote Access Unit Connectors

### 4.1.1 N Connector

The RAU has one female N connector. The connector is a duplexed RF input/output port that connects to a standard 50Ω passive antenna using coaxial cable.

### 4.1.2 F Connector

The RAU has one F female connector that connects it to a Fusion SingleStar 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 capture centerpin conductors. Refer to Appendix A for more information.

## 4.2 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 Section 8 for troubleshooting using the LEDs.

### Status LEDs

The RAU status LEDs can be in one of the states shown in Table 4-2. These LEDs can be:

- ○ off
- ● steady green
- ● steady red

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

**Table 4-2 Remote Access Unit LED States**

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

## 4.3 Faults and Warnings

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

For more information, refer to:

- page 8-11 for RAU faults.
- page 8-14 for RAU warnings.
- page 8-17 for RAU status messages.

## 4.4 Remote Access Unit Specifications

**Table 4-3 Remote Access Unit Specifications**

| Specification | Description |
|---|---|
| Dimensions (H × W × D) | 133.5 mm × 438 mm × 381 mm<br>(5.25 in. × 17.25 in. × 15 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 | 1 F, female (CATV - 75 ohms)<br>1 N, female (coaxial 50 ohms) |
| LED Alarm and Status Indicators | Unit Status (1 pair):<br>• Link<br>• Alarm |
| Maximum Heat Dissipation (W) | 50 typical, 64 max (from the Hub) |
| MTBF | 211,600 hours |

**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 capture centerpin conductors. Refer to Appendix A for more information.

SECTION 5

# Designing a Fusion SingleStar Solution

Designing a Fusion SingleStar 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 Section 5.1, "Downlink RSSI Design Goal," on page 5-3.**

   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, COMA, GSM, 1xRTT, GPRS, and so on)
   - Number of sectors and peak capacity per sector (translates to the umber 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 BDA), type of equipment if possible.

2. **Determine the downlink power per carrier from the RF source through the DAS: Refer to Section 5.2, "Maximum Output Power per Carrier," on page 5-4.**

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

3. **Develop an RF link budget: Refer to Section 5.4, "Estimating RF Coverage," on page 5-13.**

   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 an RAU's antenna to the wireless handset.

   *allowable path loss = power per carrier + antenna gain – design goal*

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

4. **Determine the in-building environment: Refer to Section 5.4, "Estimating RF Coverage," on page 5-13.**
   - Determine which areas of the building require coverage (entire building, public areas, parking levels, and so on.)
   - Obtain floor plans to determine floor space of 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 Section 5.4, "Estimating RF Coverage," on page 5-13.**

   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 SingleStar 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 Section 5.6, "Connecting a Hub to a Base Station," on page 5-23.**

   Once you know the quantities of Fusion SingleStar 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 SingleStar solution are explained in the following sections.

**NOTE:** Access the LGC Wireless portal at LGCWireless.com for on-line dimensioning and design tools.

## 5.1 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 RSSI design goal calculations for the TDMA protocol are shown below for a 95% area coverage confidence factor.

| | | | |
|---|---|---|---|
| Noise Power<br>10 Log (KT)+10 Log (30 KHz); K=1.38X10$^{-23}$, T=300 degrees Kelvin | | –129 | dBm |
| Wireless Handset Noise Figure | | 7 | dB |
| Required SNR | | 17 | dB |
| Multipath Fade Margin<br>95% Reliability for Rician K=7 dB | | 6 | dB |
| Log-normal Fade Margin<br>95% Area/88% Edge Reliability for 35 dB PLS and 9.5 dB Sigma | | 11 | dB |
| Body Attenuation | + | 3 | dB |
| Downlink RSSI Design Goal ($P_{DesignGoal}$)<br>Signal level received by wireless handset at edge of coverage area | | –85 | dBm |

Downlink design goals on the order of –85 dBm are typical for protocols, such as GSM and iDEN. 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.

## 5.2 Maximum Output Power per Carrier

The following tables show the recommended maximum power per carrier out of the RAU 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 reduced by 10 dB in 1 dB steps.

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

**WARNING: 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).

### 5.2.1 850 MHz Cellular

**Table 5-1 Cellular Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) | | | | | |
|---|---|---|---|---|---|---|
| | AMPS | TDMA | GSM | EDGE | CDMA | WCDMA |
| **1** | **16.5** | **16.5** | **16.5** | **16.5** | **16** | **15** |
| 2 | 16.5 | 16.5 | 13.5 | 13.5 | 13 | 11 |
| 3 | 16.5 | 15.0 | 11.5 | 11.5 | 11 | 8 |
| 4 | 13.5 | 13 | 10.0 | 10.0 | 10.0 | 6.5 |
| 5 | 12.0 | 11.5 | 9.0 | 9.0 | 9.0 | 5.0 |
| 6 | 10.5 | 10.5 | 8.5 | 8.5 | 8.0 | |
| 7 | 9.5 | 9.5 | 8.0 | 8.0 | 7.5 | |
| 8 | 8.5 | 8.5 | 7.5 | 7.5 | 7.0 | |
| 9 | 8.0 | 8.0 | 7.0 | 7.0 | | |
| 10 | 7.0 | 7.5 | 6.5 | 6.5 | | |
| 11 | 7.0 | 7.0 | 6.5 | 6.5 | | |
| 12 | 6.5 | 6.5 | 6.0 | 6.0 | | |
| 13 | 6.0 | 6.5 | 6.5 | 5.5 | | |
| 14 | 5.5 | 6.0 | 5.5 | 5.5 | | |
| 15 | 5.5 | 5.5 | 5.0 | 5.0 | | |
| 16 | 5.0 | 5.5 | 5.0 | 5.0 | | |
| 20 | 4.0 | 4.5 | 4.5 | 4.0 | | |
| 30 | 2.0 | 2.5 | 3.0 | 2.0 | | |

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

### 5.2.2 900 MHz EGSM and EDGE

**Table 5-2 GSM/EGSM and EDGE Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) | |
|---|---|---|
| | GSM | EDGE |
| **1** | **16.0** | **16.0** |
| 2 | 13.0 | 13.0 |
| 3 | 11.0 | 11.0 |
| 4 | 10.0 | 10.0 |
| 5 | 9.0 | 9.0 |
| 6 | 8.0 | 8.0 |
| 7 | 7.5 | 7.5 |
| 8 | 7.0 | 7.0 |
| 9 | 6.5 | 6.5 |
| 10 | 6.0 | 6.0 |
| 11 | 5.5 | 5.5 |
| 12 | 5.0 | 5.0 |
| 13 | 5.0 | 5.0 |
| 14 | 4.5 | 4.5 |
| 15 | 4.0 | 4.0 |
| 16 | 4.0 | 4.0 |
| 20 | 3 | 3 |
| 30 | 1 | 1 |

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

### 5.2.3 1800 MHz DCS

**Table 5-3 DCS Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) | |
|---|---|---|
| | GSM | EDGE |
| **1** | **16.5** | **16.5** |
| 2 | 14.5 | 14.5 |
| 3 | 12.5 | 12.5 |
| 4 | 11.5 | 11.5 |
| 5 | 10.5 | 10.5 |
| 6 | 9.5 | 9.5 |
| 7 | 9.0 | 9.0 |
| 8 | 8.5 | 8.0 |
| 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 SingleStar from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements.

### 5.2.4 1900 MHz PCS

**Table 5-4 PCS Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) | | | | |
|---|---|---|---|---|---|
| | TDMA | GSM | EDGE | CDMA | WCDMA |
| **1** | **16.5** | **16.5** | **16.5** | **16.0** | **15.0** |
| 2 | 16.5 | 15.5 | 15.5 | 13.0 | 11.0 |
| 3 | 15.0 | 13.5 | 13.5 | 11.0 | 8.0 |
| 4 | 13.0 | 12.0 | 12.0 | 10.0 | 6.5 |
| 5 | 11.5 | 11.0 | 10.5 | 9.0 | 5.0 |
| 6 | 10.5 | 10.5 | 9.5 | 8.0 | |
| 7 | 9.5 | 10.0 | 9.0 | 7.5 | |
| 8 | 8.5 | 9.0 | 8.0 | 7.0 | |
| 9 | 8.0 | 8.5 | 7.5 | | |
| 10 | 7.5 | 8.0 | 7.0 | | |
| 11 | 7.0 | 7.5 | 6.5 | | |
| 12 | 6.5 | 7.0 | 6.0 | | |
| 13 | 6.5 | 6.5 | 6.0 | | |
| 14 | 6.0 | 6.5 | 5.5 | | |
| 15 | 5.5 | 6.0 | 5.0 | | |
| 16 | 5.5 | 5.5 | 5.0 | | |
| 20 | 4.5 | 4.5 | 4.0 | | |
| 30 | 2.5 | 3.0 | 2.0 | | |

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

### 5.2.5 2.1 GHz UMTS

**Table 5-5 UMTS Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) WCDMA |
|---|---|
| 1 | **15.0** |
| 2 | 11.0 |
| 3 | 8.0 |
| 4 | 6.5 |
| 5 | 5.0 |
| 6 | 4.0 |
| 7 | 3.0 |

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

## 900 MHz Paging/SMR

**Table 5-6 Paging/SMR Power per Carrier**

| No. of Carriers | Power per Carrier (dBm) | | | | | |
|---|---|---|---|---|---|---|
| | iDEN | Analog FM | CQPSK | C4FM | Mobitex | POCSAG/ REFLEX |
| **1** | **17.5** | **26.0** | **22.0** | **26.0** | **26.0** | **26.0** |
| 2 | 14.0 | 19.5 | 17.0 | 19.5 | 19.5 | 19.5 |
| 3 | 11.5 | 16.5 | 14.5 | 16.0 | 16.0 | 16.0 |
| 4 | 10.0 | 13.5 | 12.5 | 13.5 | 13.5 | 13.5 |
| 5 | 9.0 | 12.0 | 11.0 | 11.5 | | |
| 6 | 8.0 | 10.5 | 9.5 | 10.0 | | |
| 7 | 7.0 | 9.5 | 9.0 | 9.0 | | |
| 8 | 6.5 | 8.5 | 8.0 | 8.5 | | |
| 9 | 6.0 | 8.0 | 7.5 | 7.5 | | |
| 10 | 5.5 | 7.0 | 7.0 | 7.0 | | |

Note: Operation at or above these output power levels may prevent Fusion SingleStar from meeting RF performance specifications or FCC Part 15 and EN55022 emissions requirements. Refer to the Fusion SingleStar Installation, Operation, and Reference manual for system design information.

## Designing for Capacity Growth

Fusion SingleStar 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 SingleStar 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 this scenario:

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.

## 5.3 System Gain

The system gain of the Fusion SingleStar 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 decreased by 10 dB in one dB steps using AdminBrowser.

### 5.3.1 System Gain (Loss) Relative to CATV Cable Type Length

The recommended minimum length of CATV cable is 10 meters (33 ft) and the recommended maximum lengths are as follows:

- For RG-59 cable 150 meters (492 ft).
- For RG-6 cable 200 meters (656 ft).
- For RG-6 cable 300 meters (984 ft).

If the system is operated with CATV cable less than 10 meters (33 ft) in length, system performance will be greatly compromised.

If the CATV cable is longer than the recommended distance per cable type, the gain of the system will decrease, as shown in Table 5-7.

**Table 5-7 System Gain (Loss) Relative to CATV Cable Length**

| | Typical change in system gain (dB) | |
|---|---|---|
| **RG-59** | **Downlink** | **Uplink** |
| **800 MHz iDEN, 850 MHz GSM and CDMA; 900 MHz GSM and EGSM, and iDEN** | | |
| 180 m | –1.0 | –0.7 |
| 190 m | –3.2 | –2.4 |
| 200 m | –5.3 | –4.1 |
| 220 m | –7.5 | –5.8 |
| 240 m | –9.7 | –7.6 |
| **1800 MHz GSM (DCS); 1900 MHz TDMA, CDMA, and GSM** | | |
| 180 m | –1.0 | –0.7 |
| 190 m | –4.0 | –2.4 |
| 200 m | –6.4 | –4.1 |
| 220 m | –8.8 | –5.8 |
| 240 m | –11.3 | –7.6 |
| **2.1 GHz UMTS** | | |
| 180 m | –1.0 | –0.7 |
| 190 m | –3.2 | –2.4 |

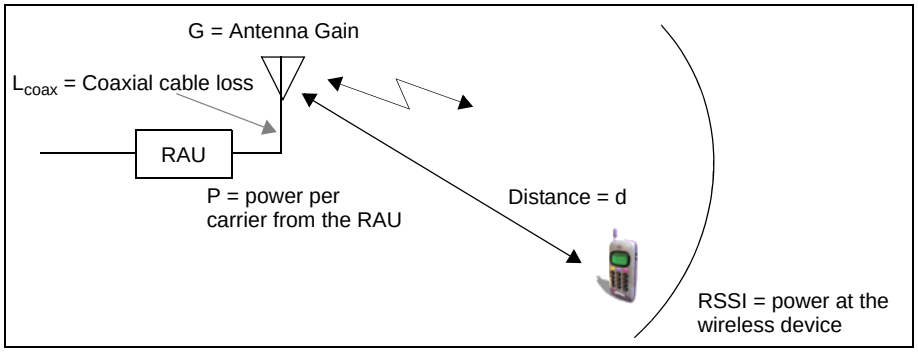
**Table 5-7 System Gain (Loss) Relative to CATV Cable Length**

| | Typical change in system gain (dB) | |
|---|---|---|
| **RG-59** | **Downlink** | **Uplink** |
| 200 m | –5.3 | –4.1 |
| 220 m | –7.5 | –5.8 |
| 240 m | –9.7 | –7.6 |

## 5.4 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 SS, are generally downlink-limited, this approach is applicable in the majority of deployments.

**Figure 5-1 Determining APL between the Antenna and the Wireless Device**




$$APL = (P - L_{coax} + G) - RSSI \quad (1)$$

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 5-8 lists coaxial cable loss for various cable lengths.

**Table 5-8 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.

### 5.4.1 Path Loss Equation

In-building path loss obeys the distance power law[1] in equation (2):

$$PL = 20\log_{10}(4\pi d_0 f/c) + 10n\log_{10}(d/d_0) + X_s \quad (2)$$

where:

- PL is the path loss at a distance, d, from the antenna
- d = the distance expressed in meters
- $d_0$ = free-space path loss distance in meters
- f = the operating frequency in Hertz.
- c = the speed of light in a vacuum ($3.0 \times 10^8$ 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 5-9 provides estimates of signal loss for some RF barriers[1].

**Table 5-9 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.

### 5.4.2 RAU Coverage Distance

Use equations (1) and (2), on pages 5-13 and 5-14, respectively, to estimate the distance from the antenna to where the RF signal decreases to the minimum acceptable level at the wireless device.

With $d_0$ set to one meter and path loss slope (PLS) defined as $10n$, Equation (2) can be simplified to:

$$PL(d) = 20\log_{10}(4\pi f/c) + PLS \cdot \log_{10}(d) \quad (3)$$

Table 5-10 gives the value of the first term of Equation (3) (that is., $(20\log_{10}(4\pi f/c))$ for various frequency bands.

**Table 5-10 Frequency Bands and the Value of the First Term in Equation (3)**

| Frequency | Band (MHz) Uplink | Band (MHz) Downlink | Mid-Band Frequency (MHz) | $20\log_{10}(4\pi f/c)$ |
|---|---|---|---|---|
| 850 MHz Cellular | 824–849 | 869–894 | 859 | 31.1 |
| 900 MHz GSM | 890–915 | 935–960 | 92.5 | 31.8 |
| 900 MHz EGSM | 880–915 | 925–960 | 920 | 31.7 |
| 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 |

Table 5-11 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.).

**Table 5-11 Estimated Path Loss Slope for Different In-Building Environments**

| Environment Type | Example | PLS for 800/850/900 MHz | PLS for 1800/1900 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 |

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 an RAU, for a given frequency and type of in-building environment.

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

For reference, Tables 5-12 through 5-16 show the distance covered by an antenna for various in-building environments. The following assumptions were made:

- Path loss Equation (4)
- 6 dBm output per carrier at the RAU output
- 3 dBi antenna gain
- RSSI design goal = –85 dBm (typical for narrowband protocols, but not for spread-spectrum protocols)

**Table 5-12 Approximate Radiated Distance from Antenna for 850 MHz Cellular Applications**

| | Distance from Antenna | |
|---|---|---|
| **Environment Type** | **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 5-13 Approximate Radiated Distance from Antenna for 900 MHz GSM Applications**

| | Distance from Antenna | |
|---|---|---|
| **Facility** | **Meters** | **Feet** |
| Open Environment | 70 | 230 |
| Moderately Open Environment | 60 | 197 |
| Mildly Dense Environment | 53 | 174 |
| Moderately Dense Environment | 45 | 148 |
| Dense Environment | 38 | 125 |

**Table 5-14 Approximate Radiated Distance from Antenna for 900 MHz EGSM Applications**

| Facility | Distance from Antenna | |
|---|---|---|
| | Meters | Feet |
| Open Environment | 70 | 231 |
| Moderately Open Environment | 60 | 197 |
| Mildly Dense Environment | 53 | 174 |
| Moderately Dense Environment | 45 | 149 |
| Dense Environment | 38 | 125 |

**Table 5-15 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 5-16 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 5-17 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 |

## 5.4.3 Examples of Design Estimates

### Example Design Estimate for an 850 MHz TDMA Application

1. **Wireless service provider's requirements**:
   - Cellular (859 MHz = average of the lowest uplink and the highest downlink frequency in 850 MHz Cellular band)
   - TDMA provider
   - 12 TDMA carriers in the system
   - –85 dBm design goal and 95% area coverage
   - Base station with simplex RF connections
2. **Power Per Carrier**: The tables in Section 5.2, "Maximum Output Power per Carrier," on page 5-4 provide maximum power per carrier information. The 800 MHz TDMA table (on page 5-5) indicates that Fusion SingleStar can support 12 carriers with a recommended maximum power per carrier of +7.5 dBm. The input power should be set to the desired output power minus the system gain.
3. **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 95.5 dB (+7.5 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 derived by 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 drop the signal level beneath the design goal.*

4. **Building information**:
   - Two floor building with 9,290 sq. meters (100,000 sq. ft.) per floor; total 18,580 sq. meters (200,000 sq. ft.)
   - Walls are sheetrock construction; suspended ceiling tiles
   - Antennas used will be omni-directional, ceiling mounted
   - Standard office environment, 50% hard wall offices and 50% cubicles
5. **Path Loss Slope**: For a rough estimate, Table 5-11, "Estimated Path Loss Slope for Different In-Building Environments" on page 5-16, shows that a building with 50% hard wall offices and 50% cubicles, at 859 MHz, has an approximate path loss slope (PLS) of 37.6. Given the RF link budget of 95.5 dB, the distance of coverage from each RAU will be 52 meters (170.6 ft). This corresponds to a coverage area of 8,494 sq. meters (91,425 sq. ft.) per RAU (refer to Section 5.4.1 for details on path loss estimation). For this case, assume a circular radiation pattern, though the actual area covered will depend 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 SingleStar equipment quantities needed. Before any RF levels are tested in the building, you can estimate that two antennas per level will be needed. This assumes no propagation between floors. If there is propagation, you may not need antennas on every floor.
   a. 2 antennas per floor × 2 floors = 4 RAUs
   b. 4 RAUs ÷ 8 (maximum 8 RAUs per Fusion SingleStar Hub) = 1 Hub

   Check that the CATV cable distances are as recommended. If the distances differ, use the tables in Section 5.3, "System Gain," on page 5-11 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 RAUs cannot be placed within reach of the Hub, then the InterReach Fusion SingleStar system, with its longer reach, should be considered.

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

## Example Design Estimate for a 1900 MHz CDMA Application

1. **Wireless service provider's requirements:**
   - PCS (1920 MHz = average of the lowest uplink and the highest downlink frequency in 1900 MHz PCS band)
   - CDMA provider
   - 3 CDMA carriers in the system
   - –75 dBm design goal and 95% area coverage
   - Base station with simplex RF connections
2. **Power Per Carrier**: The tables in Section 5.2, "Maximum Output Power per Carrier," on page 5-4 provide maximum power per carrier information. The 1900 MHz CDMA table (on page 5-8) indicates that Fusion SingleStar can support 3 carriers with a recommended maximum power per carrier of +11.0 dBm. The input power should be set to the desired output power minus the system gain.
3. **Building information**:
   - Two floor building with 4,645 sq. meters (50,000 sq. ft.) per floor; total 9,290 sq. meters (100,000 sq. ft.)
   - Walls are sheetrock construction; suspended ceiling tiles
   - Antennas used will be omni-directional, ceiling mounted
   - Standard office environment, 80% hard wall offices and 20% cubicles
4. **Link Budget**: In this example, a design goal of –75 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 89.0 dB (11.0 dBm + 3 dBi + 75 dBm) over 95% of the area being covered. *It is important to note that a design goal such as –75 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.*
5. **Path Loss Slope**: For a rough estimate, Table 5-11, "Estimated Path Loss Slope for Different In-Building Environments" on page 5-16, shows that a building with 80% hard wall offices and 20% cubicles, at 1900 MHz, has an approximate path loss slope (PLS) of 38.1. Given the RF link budget of 89 dB, the distance of coverage from each RAU will be 21.8 meters (71.5 ft). This corresponds to a coverage area of 1492 sq. meters (16,050 sq. ft.) per RAU (refer to Section 5.4.1 for details on path loss estimation). For this case assume a circular radiation pattern, though the actual area covered will depend 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 SingleStar equipment quantities needed. Before any RF levels are tested in the building, you can estimate that 3 antennas per level will be needed. This assumes no propagation between floors. If there is propagation, you may not need antennas on every floor.
   a. 3 antennas per floor × 2 floors = 6 RAUs

**b.** 6 RAUs ÷ 8 (maximum 8 RAUs per Fusion SingleStar Hub) = 1 Hub

Check that the CATV cable distances are as recommended. If the distances differ, use the tables in Section 5.3, “System Gain,” on page 5-11 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 RAUs cannot be placed within reach of the Hub, then the InterReach Fusion SingleStar system, with its longer reach, should be considered.

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

## 5.5 Designing for a Neutral Host System

A “neutral host” system supports more than one wireless service provider and typically supports more than one frequency band and/or protocol. The wireless networking equipment is often owned, installed, and managed by a third or “neutral” party that serves as the “host” by leasing the equipment to the providers.

Designing for a neutral host system uses the same design rules previously explained. Since a neutral host system typically uses multiple base stations (BTS). Refer to Section 6.5, “Interfacing the Fusion SingleStar to an RF Source,” on page 6-22 for connection options.

## 5.6 Connecting a Hub to a Base Station

The Fusion SingleStar system supports two RF sources: one for Band 1 and one for Band 2. This section explains how each band can be connected to its associated base station.

Each Fusion SingleStar 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 SingleStar Hub bands to its base station, the following equipment may be required: circulators, filter diplexers, directional couplers, combiner/splitters, attenuators, coax cables, and connectors. In addition, use the following considerations to achieve optimal performance:

1. 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 Section 5.2, “Maximum Output Power per Carrier,” on page 5-4.
2. The uplink attenuation should be small enough that the sensitivity of the overall system is limited by Fusion SingleStar, 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 SingleStar hub may be damaged.

If, in an area covered by Fusion SingleStar, a mobile phone indicates good signal strength but consistently has difficulty completing calls, it is possible that the attenuation between Fusion SingleStar 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 SingleStar 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.

### 5.6.1 Uplink Attenuation

The attenuation between the Hub’s uplink port and the associated band’s base station reduces both the noise level and the desired signals out of Fusion SingleStar. Setting the attenuation on the uplink is a trade-off between keeping the noise and maximum signal levels transmitted from Fusion SingleStar 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 can not be better than the SNR of Fusion SingleStar by itself, although it can be significantly worse.

A good rule of thumb is to set the uplink attenuation such that the noise level out of Fusion SingleStar is within 10 dB of the base station's sensitivity.

### 5.6.2 RAU Attenuation and ALC

The RAU attenuation and ALC are set using the AdminBrowser Advanced RAU Settings command.

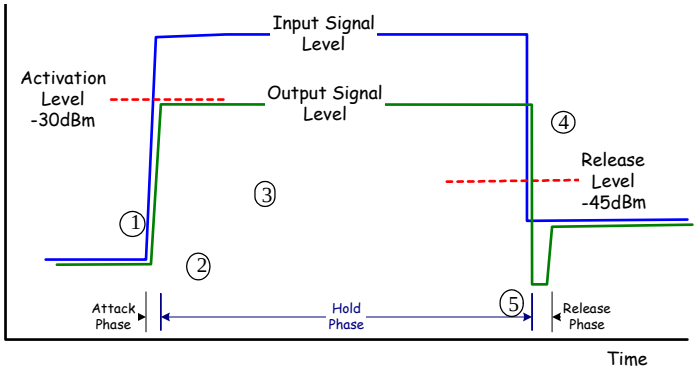
Embedded within the uplink RF front-end of each Fusion Remote Access Unit Band is an ALC circuit. This ALC circuit protects the Fusion SingleStar system from overload and excessive intermodulation products due to high-powered mobiles or other signal sources that are within the supported frequency band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

Each individual Band of the Fusion SingleStar 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 5-2.

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 5-2 ALC Operation**




### 5.6.2.1 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 10dB in 1dB steps for each RAU band. This is accomplished by selecting the check boxes in the Advanced RAU Settings dialog box. There are two check boxes: one for setting the downlink attenuation and another for setting the uplink attenuation for each band.

- **Downlink Attenuation:** The downlink attenuator provides a mechanism to reduce the signal strength from an RAU band. For instance, this could be for an 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 an 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 an 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).

#### 5.6.2.2 Using the Uplink ALC Setting

Uplink automatic level control (UL ALC) circuitry for each band within the RAU provides automatic level control 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 SingleStar 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 SingleStar system's configured and adjacent frequency bands. This setting is seldom used.

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SECTION 6

# Installing Fusion SingleStar

## 6.1 Installation Requirements

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

- Fault cabling/connector
- Malfunction of one or more Fusion SingleStar 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/EIA 570-A specifications.

### 6.1.1 Component Location Requirements

Fusion SingleStar components are intended to be installed in indoor locations only.

### 6.1.2 Cable and Connector Requirements

Fusion SingleStar equipment operates over CATV 75 Ohm cable with F connectors. These cables are widely-used, industry standards for the cable TV industry. The regulations and guidelines for Fusion SingleStar cable installation are identical to those specified by the TIA/EIA 568-B standard and the TIA/EIA/570-A standards.

LGC Wireless recommends solid copper center conductor, plenum-rated CATV cable and connectors for conformity to building codes, standards, and to ensure stated performance of 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:** In order to meet FCC and CE Mark emissions requirements, the CATV cable must be screened and it must be grounded using shielded F connectors at both ends.

LGC Wireless recommends connectors with fixed centerpins to ensure proper seating and to eliminage oxidation, which occurs with bare center conductors. Recommended conductors are as follows:

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

### 6.1.3 Distance Requirements

Table 6-1 shows the distances between Unison components and related equipment.

**Table 6-1 Distance Requirements**

| Equipment Combination | Cable Type | Cable Length | Additional Information |
|---|---|---|---|
| Repeater/BTS to Fusion SingleStar Hub | Coaxial; N male connectors | 3–6 m (10–20 ft) typical | Limited by loss and noise.<br>Refer to your link budget calculation. |
| | | 10 m (33 ft) maximum | Limited by CE Mark requirements. |

**Table 6-1 Distance Requirements**

| Equipment Combination | Cable Type | Cable Length | Additional Information |
|---|---|---|---|
| Fusion SingleStar Hub to RAU | CATV 75 Ohm; shielded F male connectors | • Minimum: 10 meters (33 ft)<br>• Maximum:<br>150 meters (492 ft) for RG-59;<br>170 meters (558 ft) for RG-6;<br>275 meters (902 ft) for RG-11<br>Refer to "System Gain (Loss) Relative to CATV Cable Type Length" on page 5-11. | Refer to "System Gain (Loss) Relative to CATV Cable Type Length" on page 5-11. |
| RAU to passive antenna | Coaxial; N male connectors | 1–3.5 m (3–12 ft) typical | Limited by loss and noise.<br>Refer to your link budget calculation. |

# 6.2 Safety Precautions

## 6.2.1 Installation Guidelines

Use the following guidelines when installing LGC Wireless 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.

**NOTE:** 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, .

## 6.2.2 General Safety Precautions

The following precautions apply to LGC Wireless products:

- The units have no user-serviceable parts. Faulty or failed units are fully replaceable through LGC Wireless. Please contact us at:

  1-800-530-9960 (U.S. only)
  +1-408-952-2400 (International)

- Although modeled after an Ethernet/LAN architecture and connectivity, the units are not intended to connect to Ethernet data hubs, routers, cards, or other similar data equipment.
- When you connect a radiating antenna to an RAU, firmly hand-tighten the N connector – DO NOT over-tighten the connector.

**WARNING: 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 an RAU to an antenna that is located outdoors where it could be subject to lightning strikes, power crosses, or wind.**

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

# 6.3 Preparing for System Installation

## 6.3.1 Pre-Installation Inspection

Follow this procedure before installing Fusion SingleStar 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 LGC Wireless customer service (refer to Section 6.2.2 on page 6-4).
4. If damage is discovered at the time of installation, contact the shipping agent.

## 6.3.2 Installation Checklist

**Table 6-2 Installation Checklist**

| ✓ | Installation Requirement | Consideration |
|---|---|---|
| | Floor Plans | Installation location of equipment clearly marked |
| | System Design | Used to verify frequency bands after installation |
| | Power available:<br>Fusion SingleStar Hub (AC)<br>To RAU (DC) | Hub's power cord is 2 m (6.5 ft) long.<br>115/230V, 6/3A, 50–60 Hz<br>54V (from the Hub) |
| | Rack space available | 133.5 mm (5.25 in.) high (3U) |
| | Clearance for air circulation:<br>Fusion SingleStar Hub<br>RAU | <br>76 mm (3 in.) front and rear, 51 mm (2 in.) sides<br>76 mm (3 in.) all around |
| | Suitable operating environment:<br>Fusion SingleStar Hub<br><br>RAUs | Indoor location only<br>0° to +45°C (+32° to +113°F)<br>5% to 95% non-condensing humidity<br>–25° to +45°C (–13° to +113°F)<br>5% to 95% non-condensing humidity |
| | **Donor Antenna-to-Fusion SingleStar Configuration (for each Fusion Band)** | |
| | Donor Antenna | Installed, inspected; N-male to N-male coaxial cable to lightning arrestor/surge suppressor |
| | Lightning Arrestor or<br>Surge Suppressor | Installed between roof-top antenna and repeater; N-male to N-male coaxial cable |
| | Repeater | Installed between lightning arrestor/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. |

**Table 6-2 Installation Checklist (continued)**

| ✓ | Installation Requirement | Consideration |
|---|---|---|
| | Circulator or Duplexer | Installed between the repeater and the Hub uplink and downlink ports |
| | **Base Station-to-Fusion SingleStar Configuration (for each Fusion Band)** | |
| | Base Station | Installed, inspected; verify RF power (see tables in Section 5.2 on page 5-4); 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 LGCell Main Hub(s) to an Fusion SingleStar Hub** | |
| | 5-port Alarm Daisy-Chain Cable (PN 4024-3) | For contact alarm monitoring: connecting 2 to 21 LGCell Main Hubs to an Fusion SingleStar Hub. N.C. operation only.<br>If connecting LGCell to Fusion SingleStar, the Alarm Sense Adapter Cable is required to connect the daisy-chain cable to Fusion SingleStar.Do not combine LGCell Main Hubs with Fusion SingleStar Hubs in the same chain. |
| | Alarm Sense Adapter Cable (PN 4025-1) | Use with 5-port Alarm Daisy-Chain Cable to connect 2 to 21 LGCell Main Hubs to a Fusion SingleStar Hub; Use alone to connect 1 LGCell Main Hubs to a Fusion SingleStar Hub. |
| | **Connecting Multiple Fusion SingleStar 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 SingleStar Hubs into a BTS or MetroReach Focus. N.C. Operation. |
| | **Cabling** | |
| | Coaxial: repeater, base station, Smart Source to Fusion Single-Star 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. |
| | CATV | TIA/EIA 568-A and 570-A approved; centerpin F male connectors. CATV cable must be screened and it must be grounded at both connector ends. The RAU will be damaged if it is mis-wired.<br>Tie-off cables to avoid damaging the connectors because of cable strain. |
| | Fusion SingleStar Hub to RAUs | • Minimum: 0 meters (0 ft)<br>• Maximum: RG-59: 150 meters (472 ft)<br>RG-8: 170 meters (558 ft)<br>RG-11: 275 meters (902 ft) |
| | **Configuring System** | |
| | PC/laptop running standard browser software | Refer to the *AdminBrowser User Manual* (PN D-620607-0020) |

**Table 6-2 Installation Checklist (continued)**

| ✓ | Installation Requirement | Consideration |
|---|---|---|
| | **Miscellaneous** | |
| | Cross-over Ethernet cable | Male connectors; Fusion SingleStar Hub to a PC/laptop running a standard browser to the Fusion SingleStar AdminBrowser software; local connection or LAN switch connector for remote connections. |
| | Straight-through cable | Female/male connectors; Fusion SingleStar Hub to a modem for a remote connection. |
| | **Distances** | |
| | Fusion SingleStar Hub is within 3–6m (10–20 ft) of connecting repeater/BTS/MetroReach | If longer distance, determine the loss of the cable used for this connection and adjust the RF signal for each Band into the Fusion SingleStar 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). |

### 6.3.3 Tools and Materials Required

**Table 6-3 Tools and Materials Required for Component Installation**

| ✓ | Description |
|---|---|
| | Cable ties |
| | Screwdriver |
| | Mounting screws and spring nuts |
| | Screws, anchors (for mounting RAUs) |
| | Drill |

### 6.3.4 Optional Accessories

**Table 6-4 Optional Accessories for Component Installation**

| ✓ | Description |
|---|---|
| | Wall-mount bracket (PN 4712)<br>When using this bracket with an Fusion SS Hub, the Hub's mounting bracket must be moved to the alternate mounting position (refer to the procedure on page page 6-9). |
| | Cable management (Cable manager: PN 4759; Tie wrap bar: PN 4757) |
| | Teltone Line Sharing Switch (M-394-B-01)<br>When using a single POTS line with multiple Fusion SingleStar Hub/Modems: Connect up to four modems to a line sharing switch; switches can be cascaded to accommodate up to 16 modems per POTS line |
| | Alarm Cables:<br>5-port Alarm Daisy-Chain Cable (PN 4024-3)<br>Alarm Sense Adapter Cable (PN 4025-1) |

## 6.4 Fusion SingleStar Installation Procedures

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 Section 7.



The following procedures assume that the system is installed and programmed.

## 6.4.1 Installing a Fusion SingleStar Hub

**CAUTION:** Install Fusion SingleStar Hubs in indoor locations only.

### Installing a Fusion SingleStar Hub in a Rack

The Fusion SingleStar Hub (3U 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.

**Consideration:**

- The Fusion SingleStar Hub is shipped with #10-32 mounting screws. Another common rack thread is #12-24. Confirm that the mounting screws match the rack's threads.

**To install the Hub in a rack:**

1. Insert spring nuts into rack where needed or use existing threaded holes.
2. Place the Hub into the rack from the front.
3. Align the flange holes with the spring nuts installed in Step 1.
4. Insert the mounting screws in the appropriate positions in the rack.
5. Tighten the mounting screws.

## Installing a Fusion SingleStar Hub Using the 12” Wall-Mounted Bracket

**Considerations:**

- The rack-mounting brackets on the Fusion SS Hub must be moved to the recessed mounting position to allow for the required 76 mm (3 in.) rear clearance.
- • The maximum weight the bracket can hold is 22.5 kg (50 lbs).
- • The bracket is designed to accommodate a Fusion SS Hub (21 lbs.) and a Smart-Source Adaptive Processor Unit.
- The wall mount bracket should be securely mounted to wall, using the four key slot mounting holes on the bracket.

**To install the Hub directly to the wall:**

1. Attach the wall bracket (PN 4712) to wall the using #10 Pan Head wood screws, 1-1/2” minimum length for mounting in wood studs or 3/4“ thick plywood.

   The bracket must be positioned so that the Hub will be in a horizontal position when it is installed. (Refer to Figure 6-1.)

**Figure 6-1 Installing in the Recessed Mounting Position**

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

2. Remove both of the rack mounting brackets from the Hub.
3. Reattach each of the rack mounting brackets to the wall mount position.
4. Attach the Hub to the plywood with wood screws.

## Installing a Fusion SingleStar Hub Directly to the Wall

**To install the Hub directly to the wall:**

1. Pre-install 3/4” plywood to the wall.
2. Mount both of the rack mounting brackets using #10-32 machine screws (refer to illustration Figure 6-2).
3. Attach the Hub to the wall so the mounting brackets are orientated at the top and bottom of the wall mounted hub.

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

**Figure 6-2 Mounting of Rack Mounting Brackets for Hub Wall Mounting**

## Installing an Optional Cable Manager in the Rack

- Using the screws provided, fasten the cable manager to the rack, immediately above or below the Fusion SingleStar Hub.

## Connecting the CATV Cables

**Considerations:**

- Verify that the cable has been tested and the test results are recorded. This information is required for the As-Built Document.
- Verify that only captive centerpin F connectors are used on the solid copper center conductor CATV cable from CommScope (or equivalent).
- Verify that the CATV cable is labeled with:
  - Fusion SingleStar Hub port number being used
  - RAU identifier

- Carrier (for multiple operator systems)

**To connect the CATV cables:**

1. 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 at the other end of the CATV cable.

2. Record which cable you are connecting to which port (that is, from the label on the cable).

   This information is required for the As-Built Document.

3. Tie-off the cables or use the optional cable manager to avoid damaging the connectors because of cable strain.

#### 6.4.1.1 Troubleshooting with Hub LEDs During Installation

- All Fusion SingleStar Hub **PORT** LEDs, with corresponding RAUs connected, should indicate Green, which indicates that the RAU is powered on and communication has been established.
- The Fusion SingleStar Hub **STATUS** LED should be red if the band has not been programmed.

**Table 6-5 Troubleshooting Fusion SingleStar Hub LEDs During Installation**

| During Installation | LED | State | Action | Impact |
|---|---|---|---|---|
| 1. Fusion SingleStar Hub power is On and no RAUs are connected | **POWER** | Off | Check AC power; check that the Hub power-on switch is on; replace the Hub. | The Hub is not powering on. |
| | | Red | Replace the Hub | One or more power supplies are out of specification. |
| | **PORT** | LEDs on but didn't blink through all states | Replace the Hub. | The Microcontroller is not resetting properly; flash memory is corrupted. |
| | **PORT** | Red (60 ppm flashing) | Port unusable; replace the Hub when possible. | Current sensor fault; do not use the port. |
| | **PORT** | Red | Use AdminBrowser to determine the problem. | The Hub is off-line. |

**Table 6-5 Troubleshooting Fusion SingleStar Hub LEDs During Installation**

| During Installation | LED | State | Action | Impact |
|---|---|---|---|---|
| **2.** Fusion SingleStar Hub power is On and RAUs are connected | **PORT** | Off | Check the CATV cable. | Power is not getting to the RAU. |
| | **PORT** | Red (60 ppm flashing)<br>Off | 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 Fusion SingleStar Hub. | Power levels to the RAU are not correct; communications are not established.<br>If the second port works, flag the first port as unusable; replace the Hub when possible. |
| | **PORT** | Red | Use AdminBrowser to determine the problem. | The RAU is off-line. |

## 6.4.2 Installing RAUs

**CAUTION:** Install RAUs in indoor locations only. Do not connect an antenna that is installed in an outdoor location to an RAU.

### Installing RAUs

Mount all RAUs in the locations marked on the floor plans.

**Considerations:**

- Install iDEN and 850/1900 MHz RAUs so that their antennas will be separated by enough space to reduce signal interference between the two bands. Refer to Section , “800/850 MHz Isolation Requirements,” on page 6-15 for recommended distance between antennas.
- You can place the unit, 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. For mounting to other locations ( that is, walls, ceilings, poles) the RAU must be securely mounted using the 4 sloted mounting holes provided with #6 diameter fasteners. This method of mounting must securely hold a minimum of 7 lbs. load.
- Attach the RAU securely to a stationary object (that is, a wall, pole, or ceiling tile).
- For proper ventilation:
  - Keep at least 76 mm (3 in.) clearance around the RAU to ensure proper venting.
  - Do not stack RAUs on top of each other.
  - Always mount the RAU with the solid face against the mounting surface.

### Installing Passive Antennas

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

#### Location

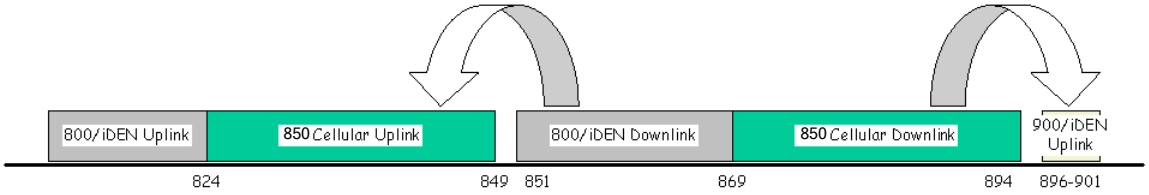
Passive antennas are usually installed below the ceiling. If they are installed above the ceiling, you must consider the additional loss due to the ceiling material when estimating the antenna coverage area.

#### 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 both 800 MHz and 900 MHz (Tx:806–825/Rx:851–870 and Tx:896–901/Rx:935–940), while the Cellular A and B carriers share a single 850 MHz block (Tx:869–894/Rx: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 6-3 depicts these nearly contiguous bands, with arrows indicating the interfering downlink and receiving uplink bands.

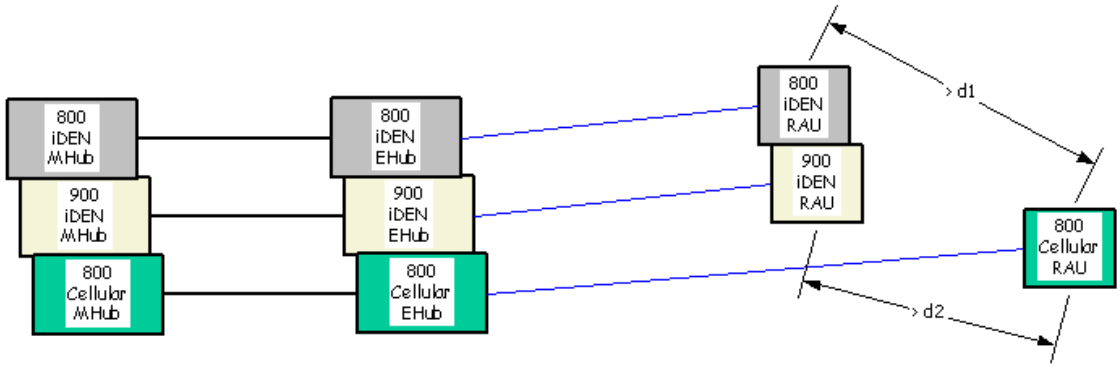
**Figure 6-3 800/850 MHz Spectrum**




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.

LGC offers the following guidelines toward achieving the proper amount of isolation when deploying LGC Wireless Unison DAS products.

**Figure 6-4 Guideline for Unison RAU Antenna Placement**




### 800 MHz iDEN Downlink & 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 Unison

Given a typical DAS configuration (4 iDEN carriers, omni-directional antennas, line of sight), these guidelines translate to an antenna spacing (d1) of 6 – 9 meters.

**850 MHz Cellular Downlink & 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 Unison

Given a typical DAS configuration (6 CDMA carriers for Unison, omni-directional antennas, line of sight), these guidelines translate to an antenna spacing (d2) of 8-14 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

**Considerations:**

- Verify that the cable has been tested and the test results are recorded. This information is required for the As-Built Document.
- Verify that only captive centerpin F connectors are used on the solid copper center conductor CATV 75 Ohm cable.
- Verify that the CATV cable is labeled with:
  - Fusion SingleStar Hub port number being used
  - RAU identifier
  - Carrier (for multiple operator systems)

**To connect the CATV cable:**

1. 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 SingleStar 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 SingleStar Hub.
   - The **ALARM** LED should be red until the Fusion SingleStar Hub issues the band command, within about 20 seconds, then it should be green.
2. Record which cable you are connecting to the RAU (from the label on the cable).

   This information is required for the As-Built Document.
3. Tie-off cables or use the optional cable manager to avoid damaging the connectors because of cable strain.

### 6.4.2.1 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 6-6 Troubleshooting RAU LEDs During Installation**

| During Installation | LED | State | Action | Impact |
|---|---|---|---|---|
| The RAU is connected to the Fusion SingleStar Hub, which is powered on | **LINK** | Off | Check CATV cable. | No power to the RAU. |
| | **ALARM** | Off | | |
| | **LINK** | Green | • Check CATV cable<br>• Check Hub LEDs<br>Refer to page 6-13, item 2 in Table 6-5.<br>• Use AdminBrowser to determine the problem. | The RAU is off-line. |
| | **ALARM** | Red | | |
| | **LINK** | Red from green, after cables are connected for 60 seconds | • Check CATV cable.<br>• Check the Hub LEDs.<br>• Use AdminBrowser to determine the problem. | No communications between the RAU and the Hub. |
| | **ALARM** | Red | | |

#### 6.4.2.2 Installing RAUs in a Multiple Operator System

When installing both iDEN and Cellular systems in parallel, either as dual-band or multiple operator systems, you must take special provision to assure that the individual RAUs do not interfere with each other.

**The 850/1900 MHz and iDEN RAU's antennas must be separated by at least 6 meters (20 feet) to assure that the iDEN downlink signals do not interfere with the Cellular uplink signals.**

### 6.4.3 Configuring the System

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

**Considerations:**

- The AdminBrowser software, described in the *AdminBrowser User Manual* (PN D-620607-0-20), must be running on a PC/laptop.
- Crossover Ethernet cable with male connectors required.

#### Connecting the PC to the Fusion SingleStar Hub to Run AdminBrowser

1. Connect the AC power cord to the Hub.

   **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 an RAU is detected (drawing current), the port LEDs lights green. The Fusion SingleStar **STATUS** LED should be green. 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 Fusion SingleStar Hub Using AdminBrowser

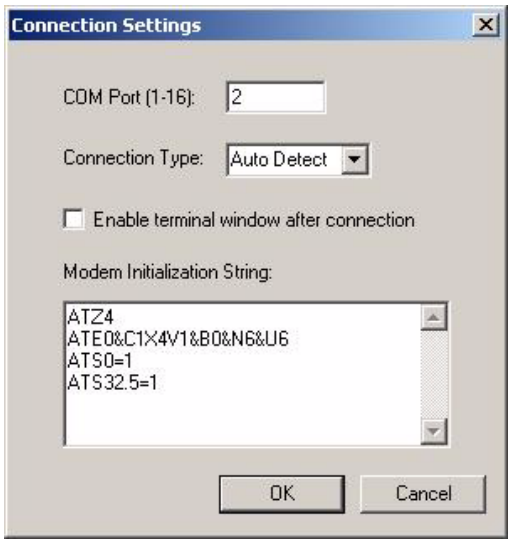
1. Turn on the PC and start you Internet browser. Type in the AdminBrowser IP address and press ENTER.

   The AdminBrowser main window is displayed.

2. Disable alarm filtering. Use View, Preferences and select “Enable faults, warnings, and status messages.”
3. Select Settings from the Connection menu item.

   The Connection Settings dialog box is displayed.

**Figure 6-5 Connection Settings Dialog Box**




4. Enter the COM Port in the text box.
5. Select the Connection Type from the drop-down menu. LGC recommends using Auto Detect if unsure.
6. Click OK.
7. Press the Enter key to initiate the connection.

   When the connection is made, a hierarchical system tree is displayed in the left pane of the window. The following icons indicate that the frequency band is not programmed:

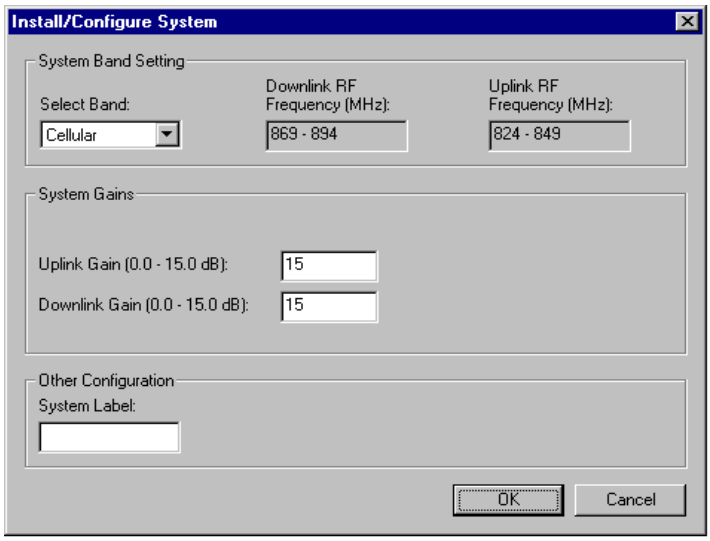
   

   The system tree is not displayed, press F5 key to refresh the tree display.

8. Right-click on the Fusion SingleStar Hub icon and select Install/Configure System.

   The System Configuration window is displayed.

**Figure 6-6 System Configuration Window**




9. Select the operating bands from the Select Band pull down menu.

   The operating bands must match the band of the RAUs that are used in the system.

10. Change the System Gain in the text boxes, if desired.

    The default is 0 dB for both the uplink and downlink.

11. Change the System Label, if desired.

    The default is “Fusion”.

12. Click OK.

    During configuration, which can take several minutes for a fully-loaded system (that is, 8 RAUs), all disconnect status are cleared; the frequency band, gain, and system label are set; logs are cleared; the system test is performed; and finally the status tree is refreshed. The icons should be:

     Indicating that the bands are correctly set.

     Indicating that communications are OK.

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

**NOTE:** Refer to Section 8 for troubleshooting.

# 6.5 Interfacing the Fusion SingleStar to an RF Source

**WARNING: Only LGC personnel or LGC-authorized installation personnel should connect the Fusion SingleStar Hub to its Band associated base station or repeater. Exceeding the maximum input power could cause failure of the Fusion SingleStar Hub (refer to Section 5.2 on page 5-4 for maximum power specifications). If the maximum composite power is too high, attenuation is required.**

## 6.5.1 Connecting a Single Fusion SingleStar Hub to an RF Source

The Fusion SingleStar system supports two RF sources, one for Band 1 and one for Band 2. This section explains how each Band can be connected to its associated RF source.

### Connecting a Fusion SingleStar Hub to an In-Building BTS

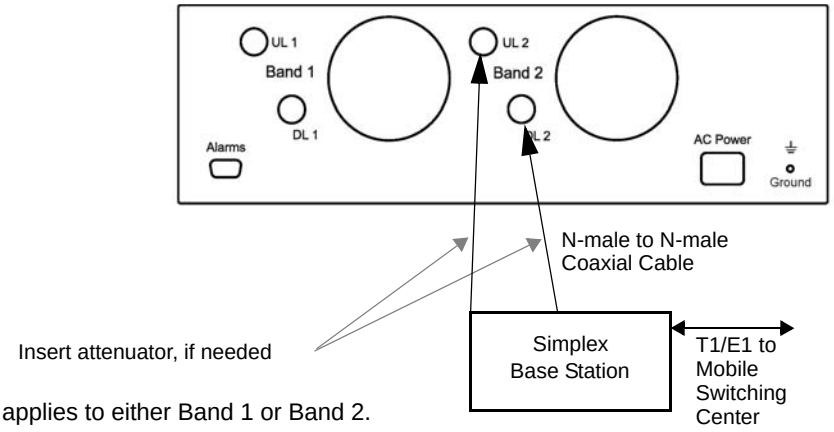
**WARNING: Only LGC personnel or LGC-authorized installation personnel should connect the Fusion SingleStar Hub to a base station or repeater. Exceeding the maximum input power could cause failure of the Fusion SingleStar Hub (refer to Section 5.2 on page 5-4 for maximum power specifications). If the 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.

**Connecting a Simplex Base Station to a Fusion SingleStar 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 either Band 1 or Band 2.
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 either Band 1 or Band 2.

**Figure 6-7 Simplex Base Station to a Fusion SingleStar Hub**




Note: This applies to either Band 1 or Band 2.

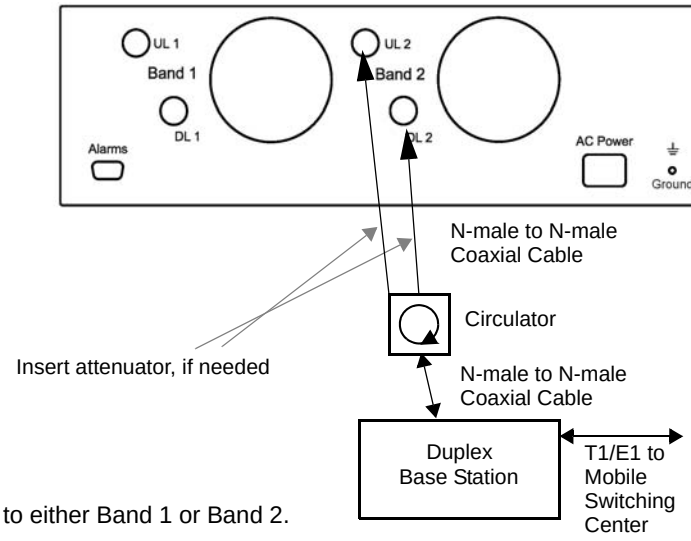
### Connecting a Duplex Base Station to a Fusion SingleStar Hub:

When connecting to a duplex base station, use a circulator or duplexer between it and the Fusion SingleStar Hub.

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 either Band 1 or Band 2.
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 either Band 1 or Band 2.
6. Connect the other end of the N-male coaxial cable to the receive connector on the circulator.

**Figure 6-8 Duplex Base Station to a Fusion SingleStar Hub**



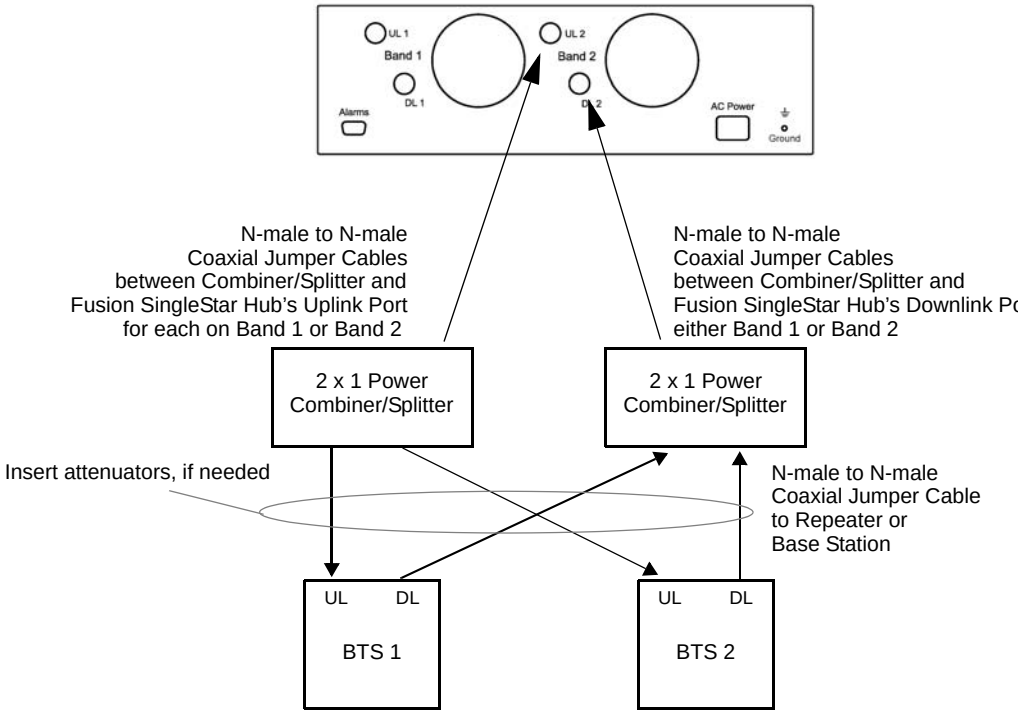

Note: This applies to either Band 1 or Band 2.

## Connecting a Fusion SingleStar Hub RF Band to Multiple BTSs

**WARNING: Only LGC personnel or LGC-authorized installation personnel should connect the Fusion SingleStar Hub to a base station or repeater. Exceeding the maximum input power could cause failure of the Fusion SingleStar Hub (refer to Section 5.2 on page 5-4 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 SingleStar Hub RF Band to multiple base stations, as shown in Figure 6-9.

**Figure 6-9 Connecting a Fusion SingleStar Hub to Multiple Base Stations**



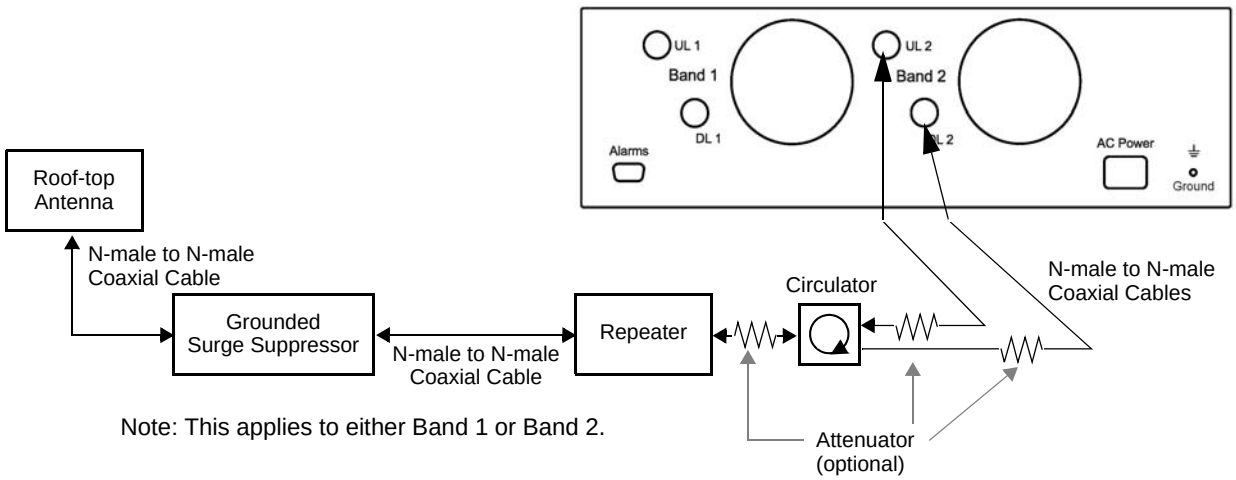
## Connecting a Fusion SingleStar Hub to a Roof-top Antenna

LGC Wireless 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 SingleStar 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 or Band 2.

   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 or Band 2.

**Figure 6-10 Connecting a Fusion SingleStar Hub to a Roof-top Antenna**




## Connecting a Fusion SingleStar Hub to MetroReach Focus

Refer to the MetroReach Focus manual for information.

### 6.5.2 Connecting Multiple Fusion SingleStar Hubs to an RF Source

You can use power combiner/splitters as splitters to connect multiple Fusion SingleStar 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 SingleStar Hubs to a Simplex Repeater or BTS

**WARNING: Only LGC personnel or LGC-authorized installation personnel should connect the Fusion SingleStar Hub to a base station or repeater. Exceeding the maximum input power could cause failure of the Fusion SingleStar Hub (refer to Section 5.2 on page 5-4 for maximum power specifications). If the maximum composite power is too high, attenuation is required.**

**Considerations:**

- 2 hybrid power combiner/splitters; one for uplink and one for downlink (2x1 for two Fusion SingleStar 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 SingleStar Hub RF Band (either Band 1 or Band 2)

**Procedure:**

1. Connect the power combiner/splitters to the repeater or base station using N-male to N-male coaxial jumper cables:
   a. From the first power combiner/splitter to the repeater or base station **UPLINK**
   b. From the second power combiner/splitter to the repeater or base station **DOWNLINK**
2. Connect the power combiner/splitters to the Hubs:
   a. From the first Hub's **UPLINK** port (Band 1 or Band 2) to the first power combiner/splitter
   b. From the first Hub's **DOWNLINK** port (Band 1 or Band 2) to the second power combiner/splitter
   c. From the second Hub's **UPLINK** port (Band 1 or Band 2) to the first power combiner/splitter
   d. From the second Hub's **DOWNLINK** port (Band 1 or Band 2) to the second power combiner/splitter

**NOTE:** 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.

3. Check Hub LEDs.

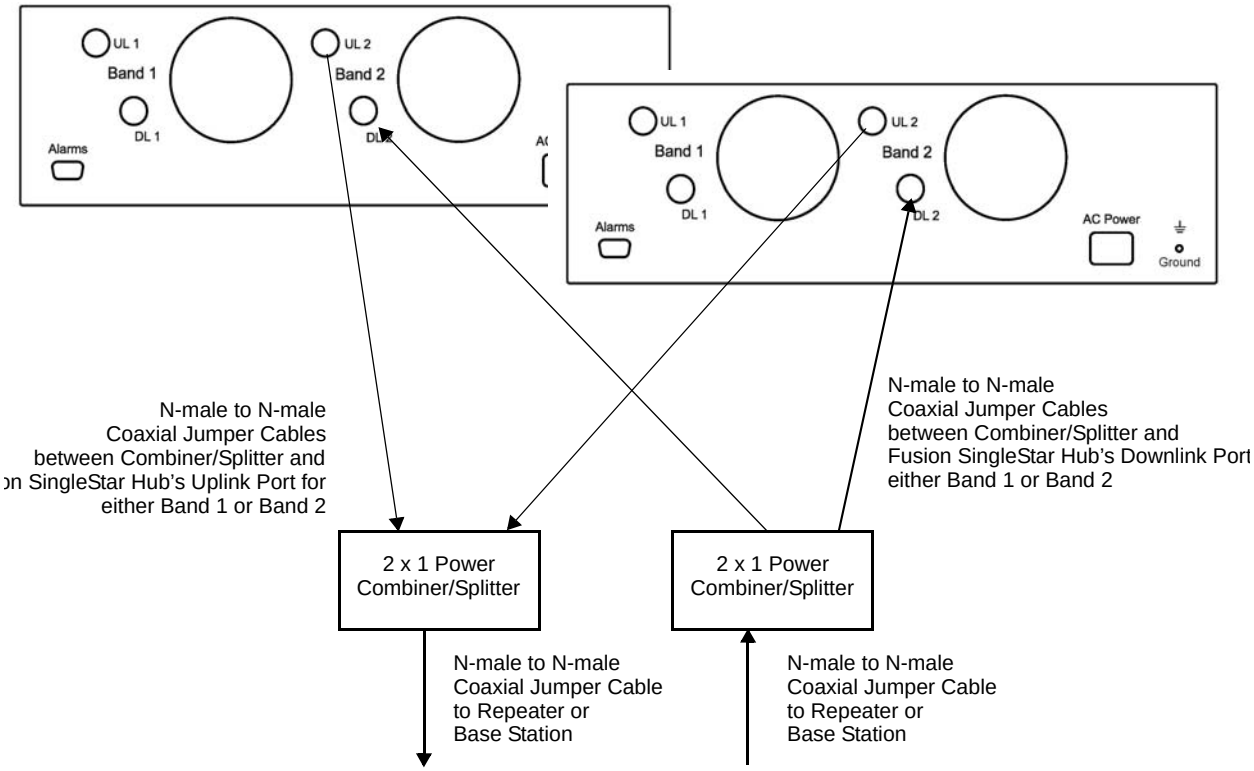
   After connecting and powering on the Hub, check all LEDs to ensure that the system is operating properly.

   **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 6-11 shows how to connect two Hubs to a simplex repeater or base station. Connecting two Hubs increases the total number of supportable RAUs from 8 to 16.

**Figure 6-11 Connecting Two Fusion SingleStar Hub's RF Band Ports to a Simplex Repeater or Base Station**



## Connecting Multiple Fusion SingleStar Hubs to a Duplex Repeater or BTS

**WARNING: Only LGC personnel or LGC-authorized installation personnel should connect the Fusion SingleStar Hub to a base station or repeater. Exceeding the maximum input power could cause failure of the Fusion SingleStar Hub (refer to Section 5.2 on page 5-4 for maximum power specifications). If the maximum composite power is too high, attenuation is required.**

**Considerations:**

- 2 hybrid power combiner/splitters; one for uplink and one for downlink (2x1 for two Fusion SingleStar Hubs, 3x1 for three, 4x1 for four, and so.)
- 2 N-male to N-male coaxial jumper cables to connect each Fusion SingleStar Hub's RF Band to the power combiner/splitters
- 1 circulator
- 1 N-male to N-male coaxial jumper cable between each circulator and the repeater or base station
- 1 N-male to N-male coaxial jumper cable between each circulator and power combiner/splitter

**Procedure:**

1. Connect the circulator to the repeater or base station using one N-male to N-male coaxial jumper cable.
2. Connect each power combiner/splitter to the circulator using one N-male to N-male coaxial jumper cable per combiner/splitter.
3. Connect the power combiner/splitter to the Hubs using N-male to N-male coaxial jumper cable:
   a. From the first Hub's **UPLINK** (Band 1 or Band 2) port to the first power combiner/splitter
   b. From the first Hub's **DOWNLINK** (Band 1 or Band 2) port to the second power combiner/splitter
   c. From the second Hub's **UPLINK** (Band 1 or Band 2) port to the first power combiner/splitter
   d. From the second Hub's **DOWNLINK** (Band 1 or Band 2) port to the second power combiner/splitter

**NOTE:** 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. Check Hub LEDs.

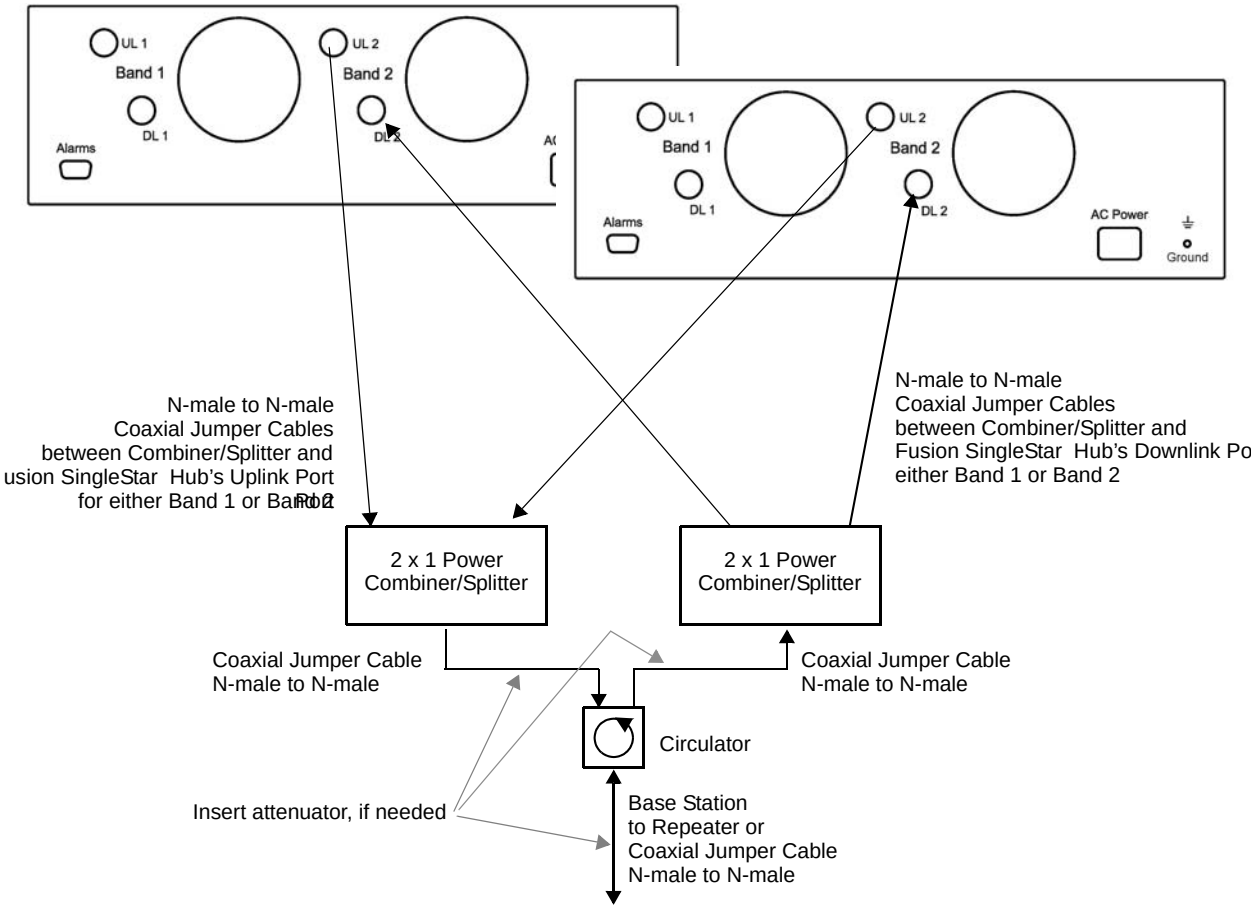
   After connecting and powering on the Hub, check all LEDs to ensure that the system is operating properly.

   **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 6-12 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 6-12 Connecting Two Fusion SingleStar Hub's RF Band Ports to a Duplex Repeater or Base Station**



## 6.6 Connecting Contact Alarms to a Fusion SingleStar System

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

- **Alarm Source (refer to Section 6.6.1 on page 6-33)**

  The Fusion SingleStar 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.

**NOTE:** The contact can be changed to normally-open (NO) with AdminBrowser. This is not recommended since no alarm would be sent if power to the Fusion SingleStar 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 (refer to Section 6.6.2 on page 6-36)**

  The Fusion SingleStar Hub can monitor a 3 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.

Table 6-7 lists the alarm types, equipment to which the Fusion SingleStar is connected, cable(s) used, and the faults and warnings that are detected.

**Table 6-7 Alarm Types**

| Alarm Type | Fusion SingleStar Connected to | Cable(s) Used | Errors Detected |
|---|---|---|---|
| Source | MetroReach | 5-port Alarm Daisy-Chain Cable | Faults |
| Source | BTS | 5-port Alarm Daisy-Chain Cable | Faults and Warnings |
| | | 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. | |
| Sense | LGCell/Unison | 5-port Alarm Daisy-Chain Cable and the Alarm Sense Adapter Cable | Faults |

Note that LGCell, Unison, and MetroReach Focus support only faults (major errors).

Do not mix LGCell, Unison, and Fusion SingleStar Hubs in the same daisy-chain. You can daisy-chain multiple LGCell Main Hubs or Unison Hubs together and use the Alarm Sense Adapter Cable to connect the chain to a Fusion SingleStar Hub, which will act as an alarm sensor.

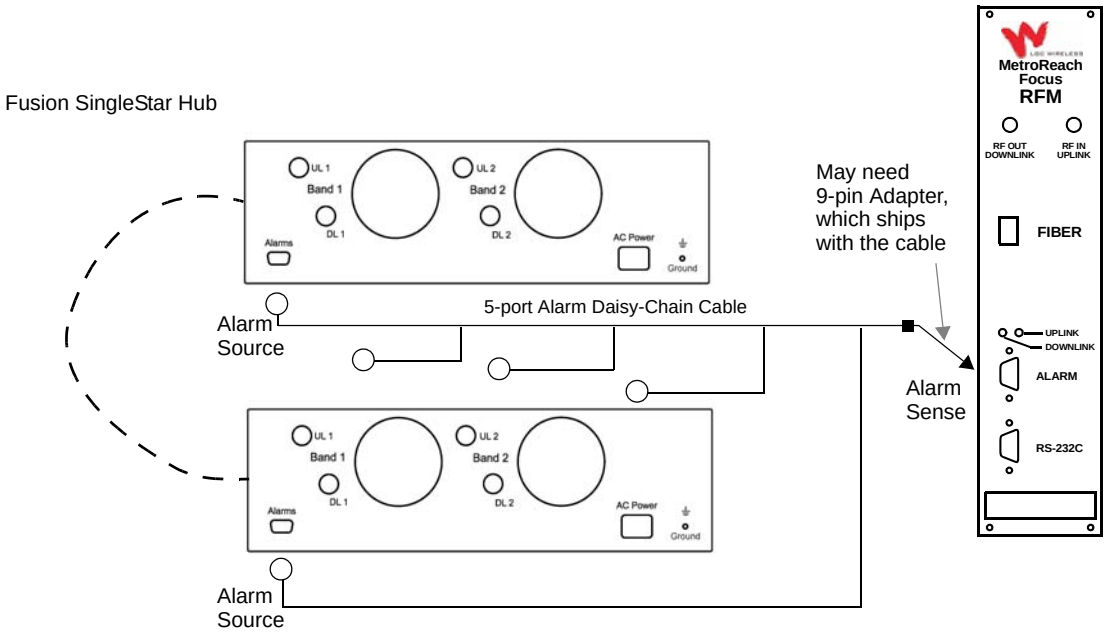
### 6.6.1 Alarm Source

Fusion SingleStar always acts as an alarm source, no matter what type of equipment you are connecting to. Refer to Section 6.6.2 on page 6-36 if you want Fusion SingleStar to sense Unison or LGCell contact closures or other external alarms.

#### Using MetroReach Focus to Monitor Fusion SS

When you connect MetroReach Focus to the Fusion SS, the Fusion SingleStar Hub is the output of the alarms (alarm source) and Focus is the input (alarm sense), as shown in Figure 6-13. Focus supports only faults (major errors).

**Figure 6-13 Connecting MetroReach to Fusion SS**

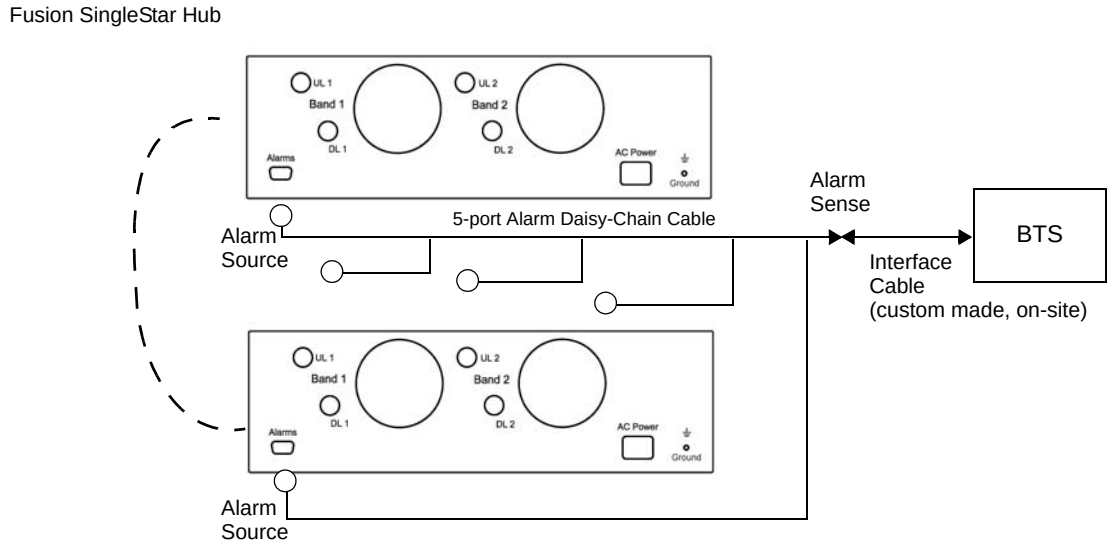


## Using a Base Station to Monitor Fusion SS

**NOTE:** The BTS must be configured, by the carrier, for contact closure monitoring prior to connecting a Fusion SingleStar Hub to it.

When you connect a BTS to Fusion SS, the Fusion SingleStar Hub is the output of the alarms (alarm source) and the BTS is the input (alarm sense), as shown in Figure 6-14. An interface cable is required between the daisy-chain cable and the BTS. Because BTS alarm interface pinouts and Fusion SS-to-BTS distances vary, this cable is often custom and wired on-site. Refer to Section 3.2.1 for Alarm Contact details (Normally Closed).

**Figure 6-14 Using a BTS to Monitor Fusion SS**




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

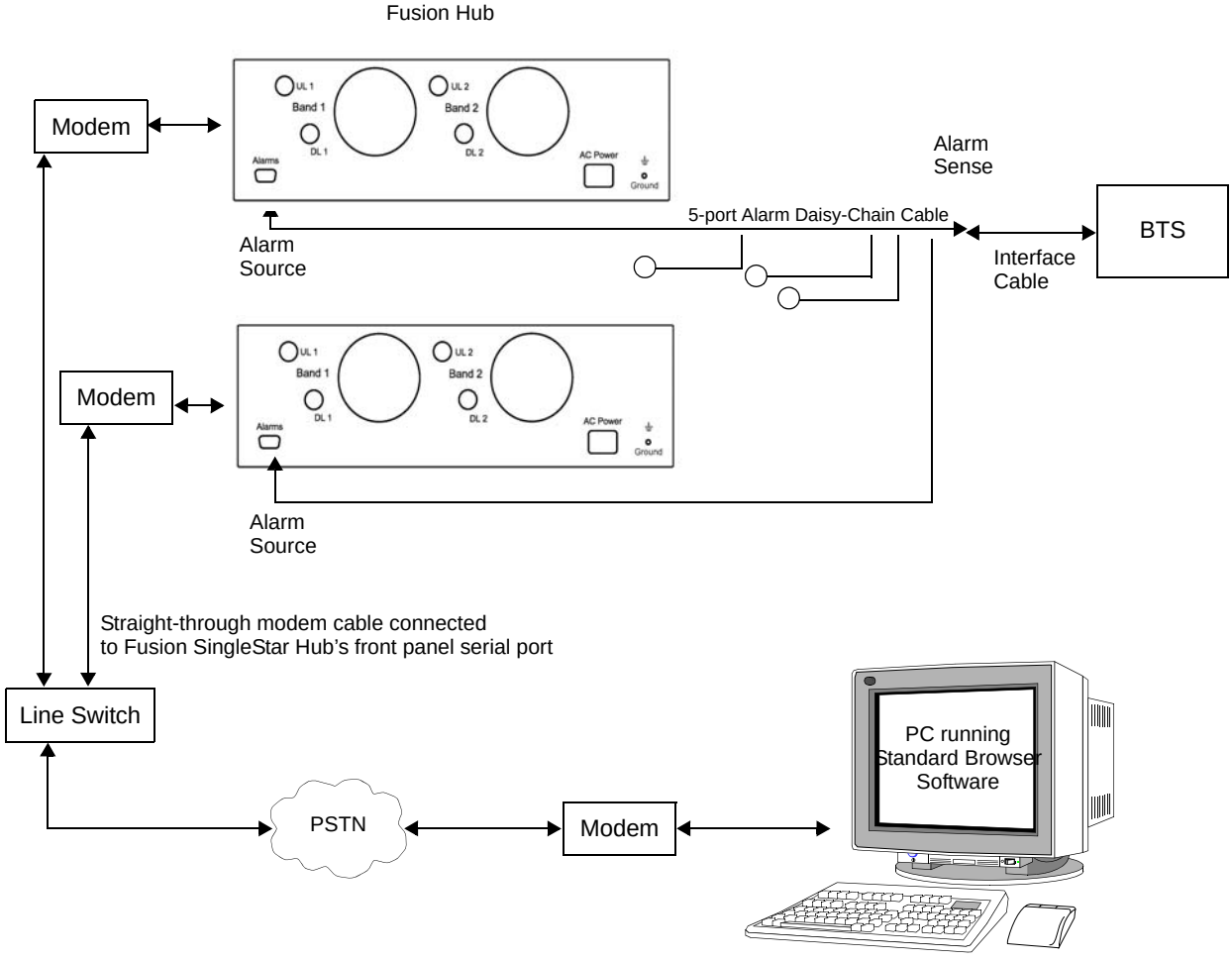
**NOTE:** LGC Wireless does not recommend using normally open contacts.

## Using a Base Station and AdminBrowser to Monitor Fusion SS

**NOTE:** The BTS must be configured, by the carrier, for contact closure monitoring prior to connecting a Fusion SingleStar Hub to it.

In order to take full advantage of Fusion SS's OA&M capabilities you can use LGC Wireless' AdminBrowser software in addition to a BTS to monitor the system, as shown in Figure 6-15.

**Figure 6-15 Using a BTS and AdminBrowser to Monitor Fusion SS**



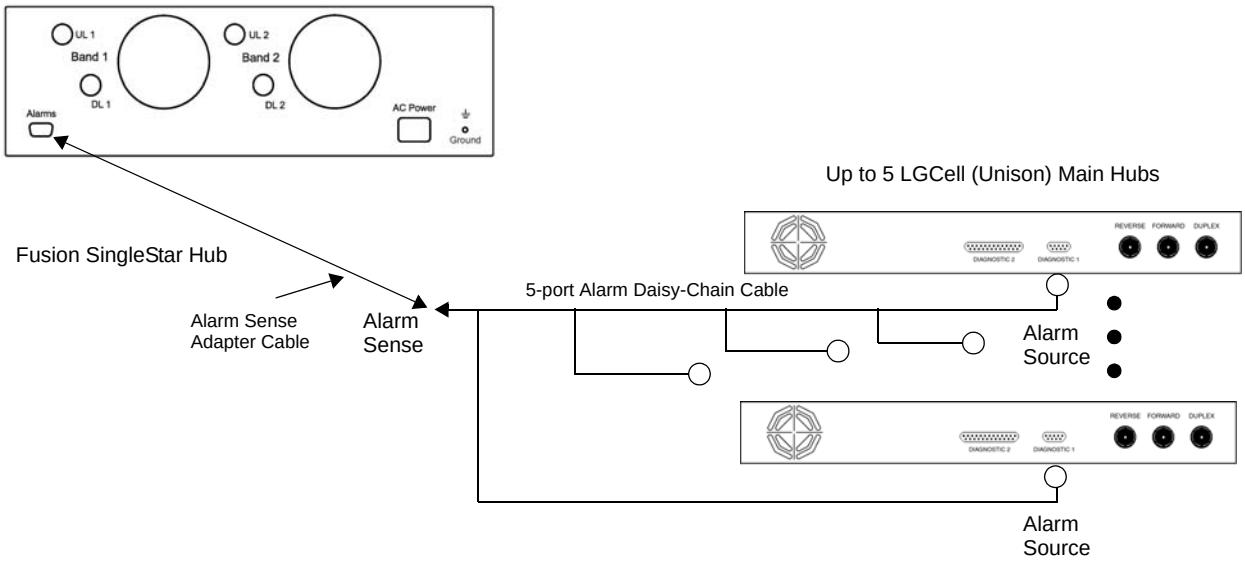
### 6.6.2 Alarm Sense

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

#### Using Fusion SingleStar to Monitor LGCells

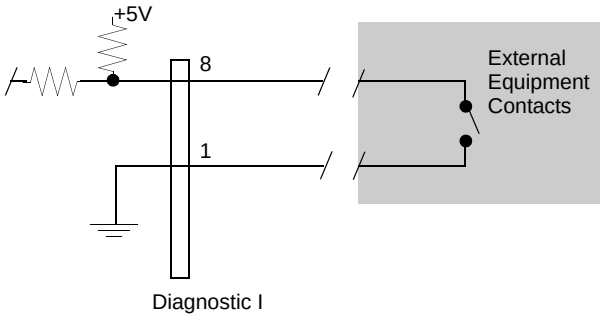
When you connect LGCell to Fusion SS, the Fusion SingleStar Hub is the input of the alarms (alarm sense) and the LGCell is the output (alarm source), as shown in Figure 6-16. The input alarm sense needs to be set to normally closed (NC).

**Figure 6-16 Using Fusion SingleStar to Monitor LGCell or Unison**




LGCell or Unison supports only faults. You must use the Alarm Sense Adapter Cable (refer to page 6-38) to interface the daisy-chain cable to Fusion SS. The adapter cable is required because it translates the LGCell fault pinout to the sense input pins on the Fusion SingleStar Hub.

**Figure 6-17 Alarm Sense Contacts**

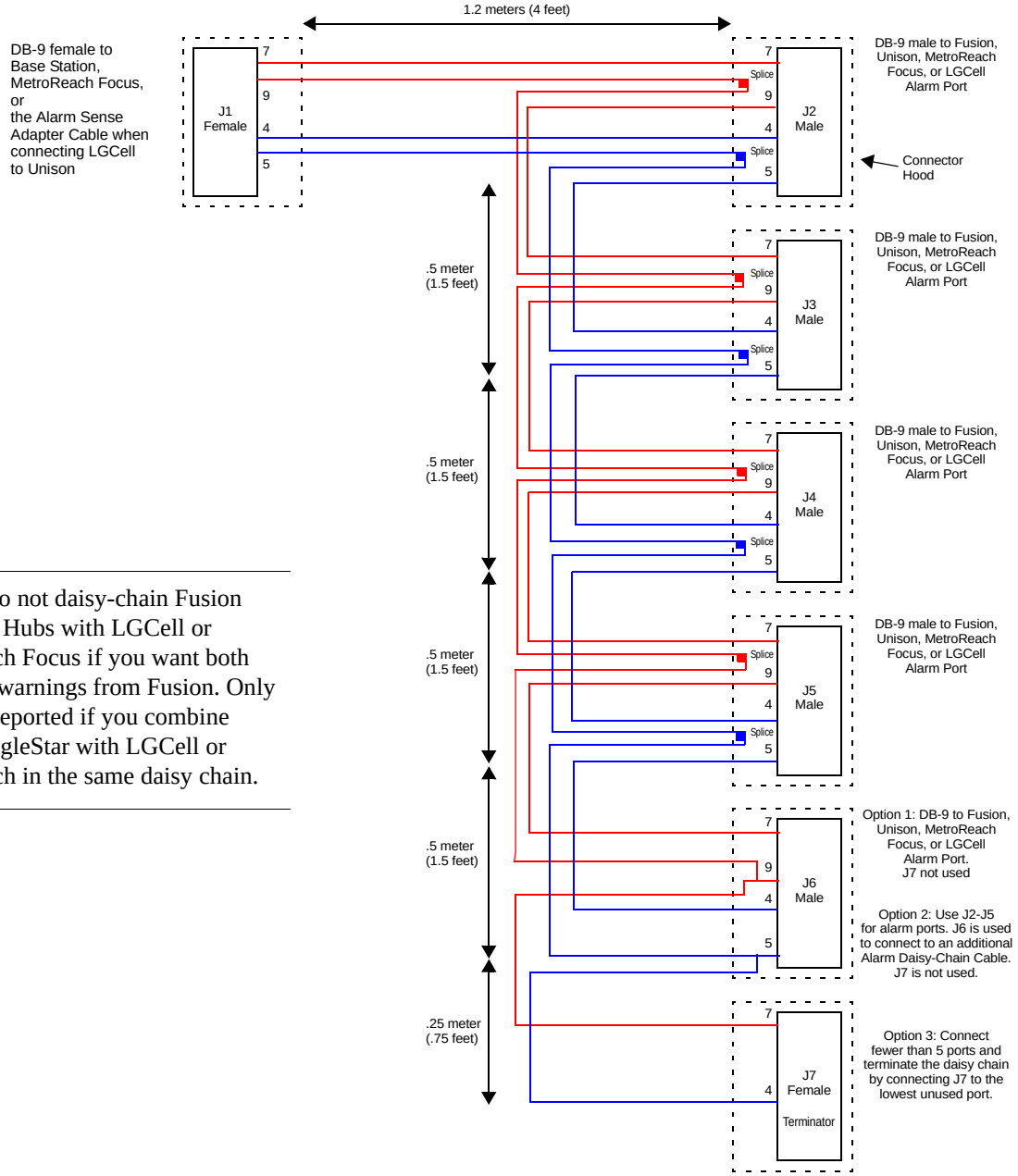


## 6.6.3 Alarm Cables

### 5-port Alarm Daisy-Chain Cable

Figure 6-18 shows the 5-port Alarm Daisy-Chain Cable (PN 4024-3), which supports fault and warning conditions.

**Figure 6-18 5-port Alarm Daisy-Chain Cable**

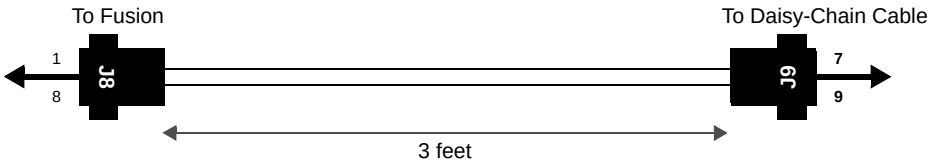



**NOTE:** Do not daisy-chain Fusion SingleStar Hubs with LGCell or MetroReach Focus if you want both faults and warnings from Fusion. Only faults are reported if you combine Fusion SingleStar with LGCell or MetroReach in the same daisy chain.

## Alarm Sense Adapter Cable

The alarm sense adapter cable (PN 4025-1) translates the LGCell fault pinout to the sense input pins on the Fusion SingleStar Hub. You must use this adapter cable, illustrated in Figure 6-19, with the 5-port Alarm Daisy-Chain Cable when connecting LGCell to Fusion SS.

**Figure 6-19 Alarm Sense Adapter Cable**



## 6.7 Alarm Monitoring Connectivity Options

The following connectivity options are described:

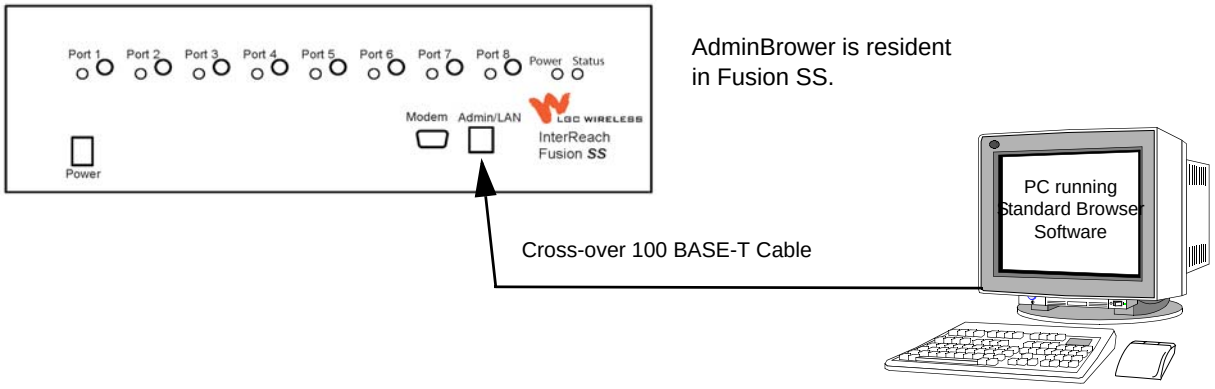


Note that the only accessory available through LGC Wireless is the Ethernet cross-over 100 BASE-T cable, which is provided with AdminBrowser.

### 6.7.1 Direct Connection

In this configuration, the PC connects directly to the **RJ-45 100 BASE-T** port on the Fusion SingleStar Hub's front panel using a cross-over cable.

**Figure 6-20 OA&M Direct Connection**

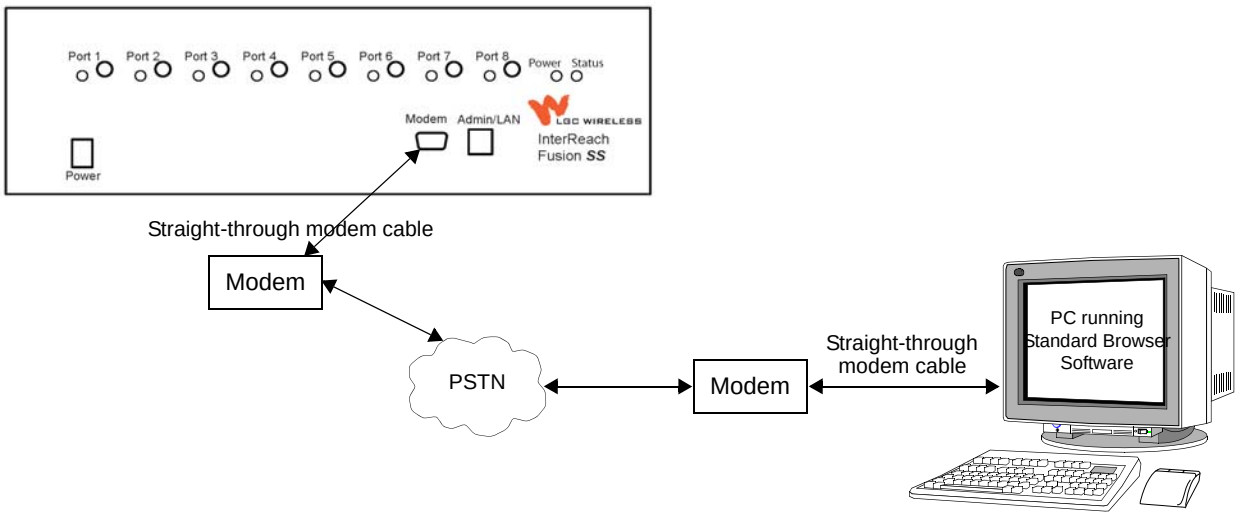



**NOTE:** The cross-over cable provided with the Fusion SingleStar Hub supports full hardware handshaking, which is required. Refer to Appendix A.4 on page A-3 for cable wiring information.

### 6.7.2 Modem Connection

In this configuration, the PC and the Fusion SingleStar Hub connect to modems and communicate using a standard dial-up telephone connection.

**Figure 6-21 OA&M Modem Connection**

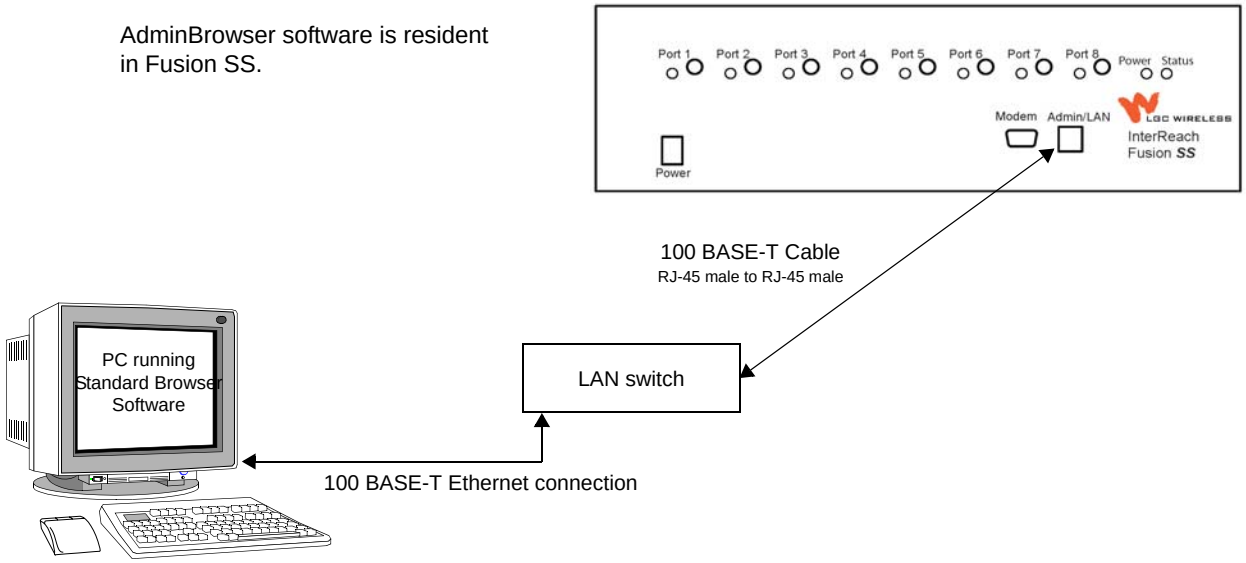



**NOTE:** Refer to Appendix A.3 on page A-3 for the modem cable wiring information.

### 6.7.3 100 BASE-T Port Expander Connection

In this configuration 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. A standard RJ-45 Ethernet cable must be made to connect the LAN switch to the Fusion SingleStar Hub.

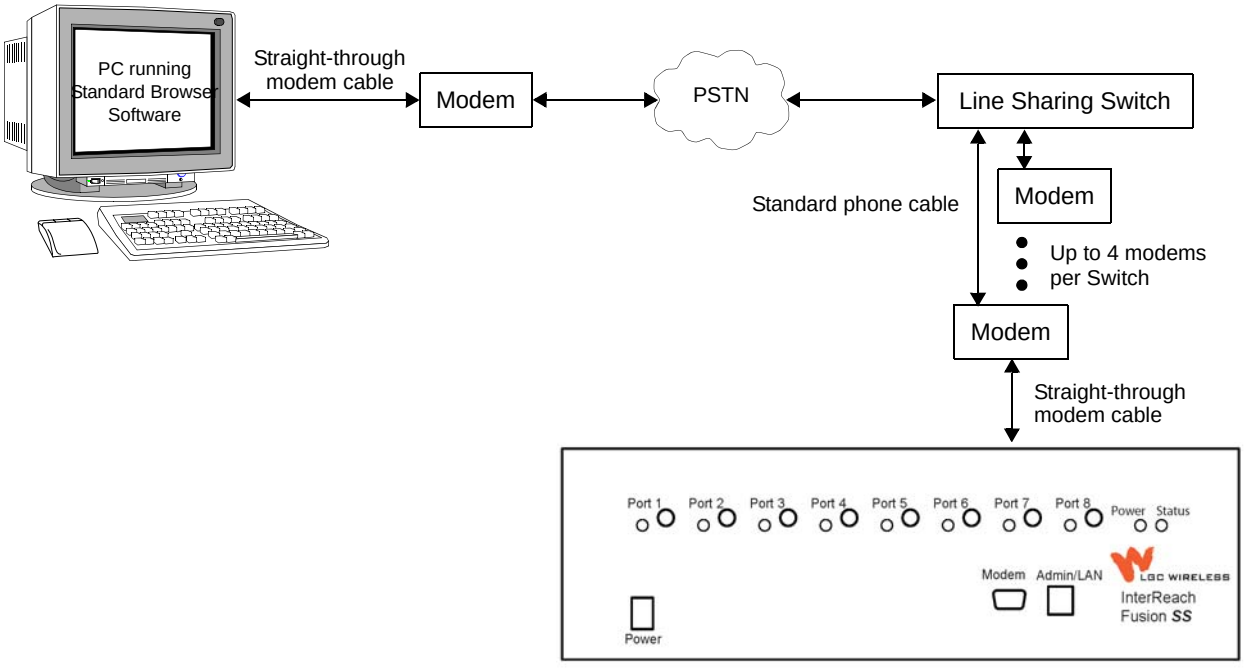
**Figure 6-22 OA&M Connection using a 232 Port Expander**



### 6.7.4 POTS Line Sharing Switch Connection

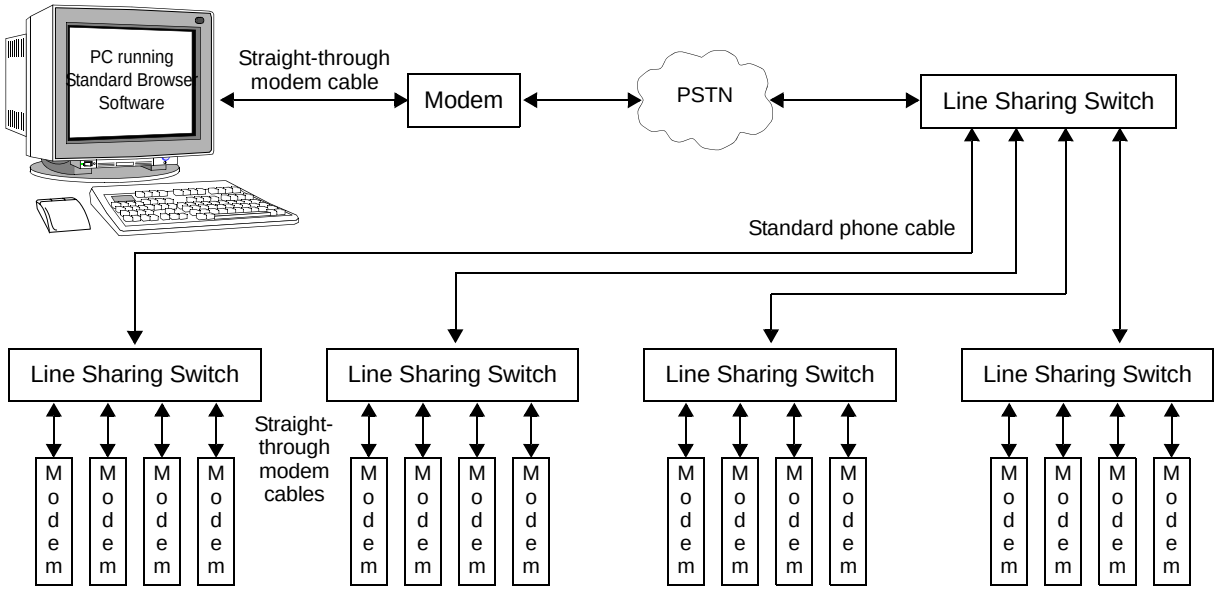
Using a line sharing switch, you can connect up to four modems to a single telephone line. Testing was performed with a Teltone Line Sharing Switch, model number M-394-B-01.

**Figure 6-23 OA&M Connection Using a POTS Line Sharing Switch**




Up to 16 modems can be monitored using a single telephone line by cascading line sharing switches, as shown in Figure 6-24.

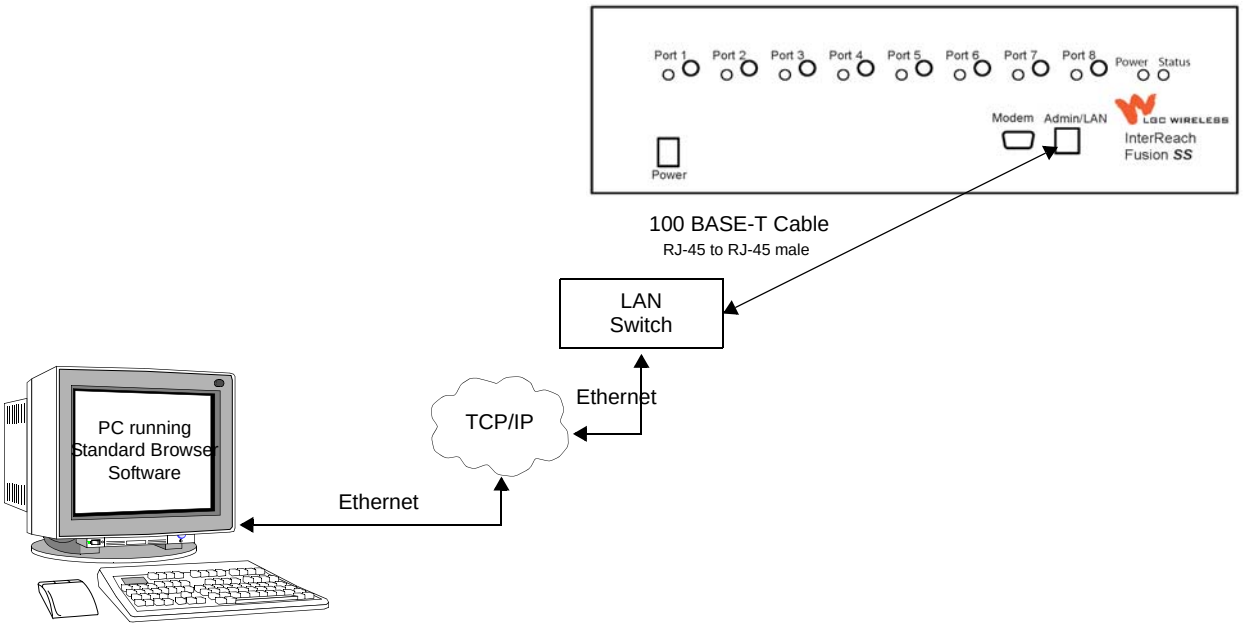
**Figure 6-24 Cascading Line Sharing Switches**



### 6.7.5 Ethernet LAN Connection

An Ethernet LAN connection can be used to communicate between the PC and Fusion SS. Testing was performed with an Linksys 4-port LAN switch.

**Figure 6-25 OA&M Connection Using Ethernet and ENET/232 Serial Hub**

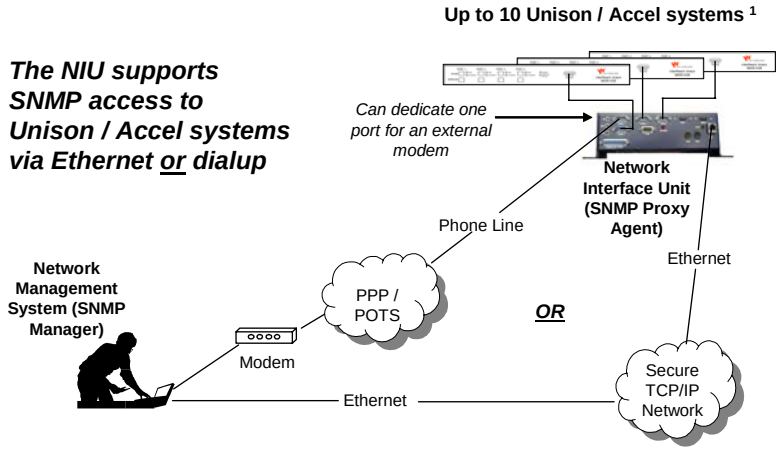


### 6.7.6 SNMP Interface

Faults and warnings can also be diagnosed with SNMP using a standard network management system (NMS). SNMP resident in Fusion SingleStar provides complete SNMP interactions, that is, Gets, Sets, and Traps/Notification.

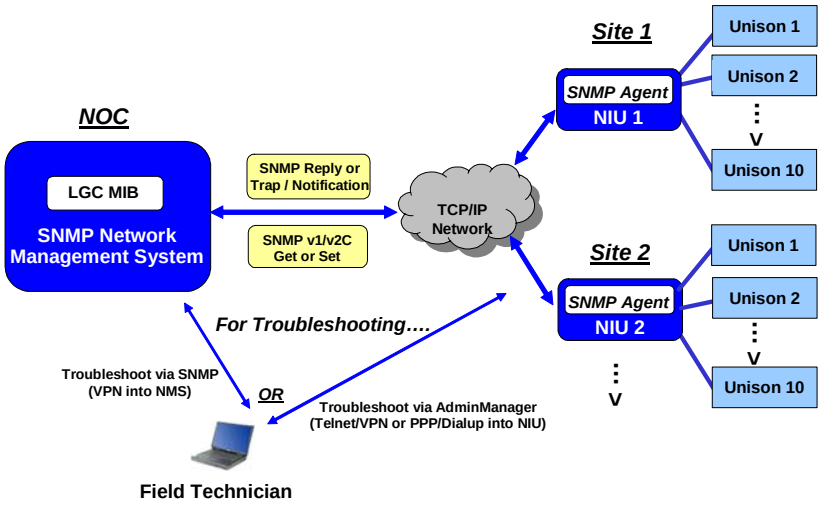
The Fusion SingleStar SNMP includes a MIB for integrating into the Network Management System (NMS) and supports SNMPv1 and SNMPv2c.

**Figure 6-26 Fusion SingleStar SNMP Configuration Options**




[1] **NIU-10P-NM-1 supports up to 10 Unison/Accel systems**
**NIU-4P-NM-1 supports up to 4 Unison/Accel systems (not expandable)**

**Figure 6-27 Multiple Unison Systems Monitored by a Single Network Management System**



SECTION 7

# Replacing Fusion SingleStar Components

## 7.1 Replacing an RAU

Be aware that the new RAU must be 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.

The Fusion SingleStar Hub automatically checks the bands of a replaced RAU and configures it to the system's operating frequency.

### Replacing an RAU

1. Using AdminBrowser, right-click on the RAU's icon and select Advanced RAU Settings from the Unit Commands menu item.

   The Advanced RAU Settings window is displayed. Write down the settings so you can set the new RAU with the same settings.
2. Click CANCEL to close the window.
3. Verify that the new RAU is of the same frequency bands as the one replaced.
4. Disconnect the CATV cable and antenna cable from the unit to be replaced.
5. Install the new RAU.
6. Connect the antenna cable and then the CATV cable to the new RAU.
7. Right-click on the RAU icon and select Advanced RAU Settings from the Unit Commands menu item.

   The Advanced RAU Settings window is displayed.
8. Set the attenuation and UL ALC for each band as the old RAU was programmed and click OK.

### Perform System Test

When convenient, perform System Test to optimize performance.

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

### Checking the RAU's LEDs

1. 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.
2. 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.
   a. 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.
   b. 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.
   c. If both LEDs turn red (after 90 seconds), the Hub has terminated communications.

## 7.2 Replacing a Fusion SingleStar Hub

You must record the system configuration settings from the old Fusion SingleStar Hub's memory before replacing the unit. You will program the new Hub with this information. If the 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.

### Replacing a Fusion SingleStar Hub

1. Using AdminBrowser, right-click on the Hub's icon and select Get Parameters from the System Commands menu item.

   The system's configuration is displayed in the Messages pane.
2. Turn off the power to the Fusion SingleStar Hub.
3. Disconnect all cables and the AC power cord.
4. Replace the 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 Hub's front panel 100Base-T connector.

7. Start the standard browser on the PC to communicate with AdminBrowser software.
8. Turn on the power to the Hub.
9. Observe the LEDs after turning on the power.

   All the LEDs blink during the initial power up sequence. If the Hub has been programmed with a band, 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.

## Configure the New Fusion SingleStar Hub

1. Right-click the Fusion SingleStar Hub's icon and select Install/Configure System from the menu.

   The System Configuration window is displayed.
2. Select the operating bands from the Select Bands drop down menu.
3. Enter the uplink and downlink gain in the text boxes.
4. Enter the system label.
5. Click OK.
6. Set the Callback Number and Contact Sense Properties if they are used.
7. Perform System Test. If OK is clicked in the Install/Configure window, system test is performed automatically and does not need to be executed again in this step. Step 7 should be executed only if the system test is NOT executed as part of the Install/Configure process.

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

   Always perform the system test if the band was changed.

## Checking the Fusion SingleStar Hub's LEDs

- The LEDs should blink through a 20-second test on power up.
  - If the LEDs do not blink on power up, replace the Hub.
  - If the LEDs do not illuminate at all, make sure the AC power cable is connected.
- For each CATV port that has a connected RAU:
  - The **PORT** LED should be green indicating the RAU is functioning
- Refer to Section 8.3, "Troubleshooting," on page 8-2 for more LED states.

his page is intentionally left blank.

SECTION 8

# Maintenance, Troubleshooting, and Technical Assistance

There are no user-serviceable parts in any of the Fusion SingleStar components. Faulty or failed components are fully replaceable through LGC Wireless.

| | |
|---|---|
| Address | 2540 Junction Avenue<br>San Jose, California<br>95134-1902 USA |
| Phone | 1-408-952-2400 |
| Fax | 1-408-952-2410 |
| Help Hot Line | 1-800-530-9960 (U.S. only)<br>+1-408-952-2400 (International) |
| Web Address | http://www.lgcwireless.com |
| e-mail | service@lgcwireless.com |

## 8.1 Service

There are no user-serviceable parts in the Fusion SingleStar system. All units should be replaced and returned to the factory for service if needed.

## 8.2 Maintenance

No periodic maintenance of Fusion SingleStar equipment is required.

## 8.3 Troubleshooting

**NOTE:** Fusion SingleStar has no user-serviceable parts. Faulty or failed units are fully replaceable through LGC Wireless.

Sources of potential problems include:

- Faulty cabling/connector
- Malfunction of one or more Fusion SingleStar components
- Antenna, base station, or repeater problem
- External RF interface
- Tripped circuit breaker
- Equipment is not grounded
- Using n 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/EIA 568-B and 570-A specifications. **The RAU will be damaged if the cable is not wired correctly**.

You must use AdminBrowser for troubleshooting the system, use the LEDs only as backup or for confirmation.

If you cannot determine the cause of a problem after following the recommended procedures, call LGC Wireless customer help hot line:

1-800-530-9960 (U.S. only)
+1-408-952-2400 (International)

Or, email us at support@lgcwireless.com.

Please provide the following information:

- Serial number of the unit
- Description of the problem
- Using AdminBrowser 1.00 or higher, execute the “Tools →Get Service Information” command Save and email this file to us.
- What is the length of the CATV cable? Is it screened?
- Status of the LEDs on the unit
- Was the unit power cycled?

### 8.3.1 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 SingleStar Hub's faults and warnings, then proceed to each of the RAUs.

**NOTE:** AdminBrowser v1.00 or higher displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to Section 3.3.2, "View Preference," on page 3-9.

#### System Troubleshooting

Use Get System Command → Get All Current Faults (or Get Current Faults and Warnings; or Get Current Faults, Warnings, and Status Messages). This gives the present status of the system, depending on view preferences. To do this, point to the top most icon or the Fusion SingleStar Hub in the hierarchical tree, then right click to see the Pull down menu. Select: SYSTEM COMMANDS/GET FAULTS (OR GET CURRENT FAULTS AND WARNINGS; OR GET CURRENT FAULTS, WARNINGS, AND STATUS MESSAGES).

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 fault on the RAU. This icon  indicates a disconnected device. You cannot request status on a disconnected device.

## Component Troubleshooting

If a device has faults, select it, right click on it to get the pull down menu, then execute UNIT COMMANDS/ GET FAULTS AND WARNINGS.

### 8.3.1.1 Troubleshooting Recommendations

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

**a.** Issue a CLEAR ALL DISCONNECTS at the Fusion SingleStar Hub.

**b.** Power cycle the Fusion SingleStar Hub.

**c.** RAU hardware faults. Try swapping the CATV at the Fusion SingleStar Hub with a good CATV cable.

**d.** 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. Use the UNIT COMMANDS/SET OUT-OF-SERVICE and SET IN-SERVICE.

### 8.3.1.2 Fault 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 SingleStar 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.

**NOTE:** Recommended minimum and maximum CATV cable lengths vary depending upon which CATV cable you use.

RG-59:
- Minimum: 10 meters (33 ft.)
- Maximum: 150 meters (492 ft.)

RG-6:
- Minimum: 10 meters (33 ft.)
- Maximum: 200 meters (656 ft.)

RG-11:
- Minimum: 10 meters (33 ft.)
- Maximum: 300 meters (984 ft.)

**NOTE:** The following tables contain messages for all versions of firmware, but all messages are not displayed by a given firmware version.

## Faults Reported by the Fusion SingleStar Hub

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {MF01}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {MF02}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {MF03}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {MF04}Software reset occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {MF05}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {MF06}Hub power cycle | If AC mains not cycled, replace the Hub. |
| {MF09}Temperature is high | Replace Hub if fan failure. Check fan for rotation, airflow blockage, and dust. Check room environmental controls. |
| {MF10} System Error Lockout | Check for Hub faults. The system is out of service due to a main board internal fault. |
| {MF11}Commanded Out-of-Service | Command In-Service to restore operation. |
| {MF13}Hardware failure (Power Supply) | Replace the Hub. |
| {MF17}Hardware failure (SPI) | Cycle power once. If the fault persists, replace the Hub. |
| {MF18}Hardware failure (DL PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |
| {MF19}Hardware failure (DL PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {MF20}Hardware failure (DL Pilot PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |
| {MF21}Hardware failure (UL PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |
| {MF22}Hardware failure (UL PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |
| {MF23}Hardware failure (UL PLL Unlock) | Cycle power once. If the fault persists, replace the Hub. |
| {MF24}Frequency band not programmed | Use AdminBrowser to program the frequency band. |
| {MF25}Hardware failure (DL Pilot AGC) | Cycle power once. If the fault persists, replace the Hub. |
| {MF26}Hardware failure (DL Pilot AGC) | Cycle power once. If the fault persists, replace the Hub. |
| {MF30}Hardware failure (UL Path) | Re-run system test. If the fault persists, swap positions of the last two RAUs, and re-run the system test. If the fault persists, replace the Hub. |
| {MF41}Hardware failure (No communications with auxiliary board) | Replace the Hub. |
| {EF01}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {EF02}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {EF03}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {EF04}Software reset occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {EF05}Software error occurred and recovered | If this happens repeatedly, replace the Hub. (Log entry only.) |
| {EF06}Hardware failure (SPI) | Cycle power once. If the fault persists, replace the Hub. |
| {EF07}Temperature is too high | Replace the Hub if fan failure. Check the fan for rotation, air flow blockage, and dust. Check the room environmental controls. |
| {EF08}Frequency band not programmed | Use AdminBrowser to program the frequency band. |
| {EF16}Hardware failure (No communications with the main board) | Replace the Hub. |
| {EF17}RAU 1 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF18}RAU 2 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF19}RAU 3 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {EF20}RAU 4 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF21}RAU 5 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF22}RAU 6 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF23}RAU 7 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF24}RAU 8 disconnected | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or physically connect the RAU. |
| {EF25}Port 1 UL RF path loss is too high | Check the CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF26}Port 2 UL RF path loss is too high | Check the CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF27}Port 3 UL RF path loss is too high | Check the CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF28}Port 4 UL RF path loss is too high | Check the CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {EF29}Port 5 UL RF path loss is too high | Check CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF30}Port 6 UL RF path loss is too high | Check CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF31}Port 7 UL RF path loss is too high | Check CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF32}Port 8 UL RF path loss is too high | Check CATV cable loss, especially on new installations. If the fault is present on all hub ports, replace the hub. Otherwise, try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise replace the RAU. |
| {EF33}Port 1 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF34}Port 2 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF35}Port 3 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF36}Port 4 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF37}RAU 5 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF38}RAU 6 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF39}RAU 7 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF40}RAU 8 DL RF port too low | Try another hub port. If the fault persists replace the Hub. Otherwise, flag the previous port as unusable and replace the hub when possible. |
| {EF41}No communication with RAU 1 | Check Cat-5E/6 cable for shorts/opens, especially on new install. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF42}No communication with RAU 2 | Check the CATV cable for shorts/opens, especially on new installation. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {EF43}No communication with RAU 3 | Check the CATV cable for shorts/opens, especially on new installation. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF44}No communication with RAU 4 | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF45}No communication with RAU 5 | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF46}No communication with RAU 6 | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF47}No communication with RAU 7 | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF48}No communication with RAU 8 | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. |
| {EF49}RAU 1 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF50}RAU 2 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF51}RAU 3 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF52}RAU 4 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |

**Table 8-1 Faults Reported by the Fusion SingleStar Hub**

| Fault Message | Action |
|---|---|
| {EF53}RAU 5 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF54}RAU 6 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF55}RAU 7 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF56}RAU 8 over current | Check the CATV cable for shorts/opens, especially on new installations. Try another hub port. If no fault is reported, flag the previous port as unusable and replace the hub when possible. Otherwise, replace the RAU. Use “Clear All Disconnect Status” command to clear fault, or power-cycle the hub. |
| {EF60}Internal fault lockout | Check the Hub for faults. RAUs are out of service on command of the auxiliary board. |
| {EF61}External fault lockout | Check the Hub for faults. RAUs are out of service on command of the main board. |
| {EF62}Commanded Out-of-Service | Command In-Service to restore service. |
| {EF63}36 VDC Shutdown | 54 VDC shutdown to the Hub being over temperature. Automatic recovery is possible when the internal temperature drops below 65 degrees Centigrade ambient. |

## Remote Access Unit Faults

**Table 8-2 Faults Reported by the RAU**

| Alarm Message | Action |
|---|---|
| {RF01}Software error occurred and recovered | If this happens repeatedly, replace the RAU. (Log entry only.) |
| {RF02}Software error occurred and recovered | If this happens repeatedly, replace the RAU. (Log entry only.) |
| {RF03}Software error occurred and recovered | If this happens repeatedly, replace the RAU. (Log entry only.) |
| {RF04}Software reset occurred and recovered | If this happens repeatedly, replace the RAU. (Log entry only.) |
| {RF05}Software error occurred and recovered | If this happens repeatedly, replace the RAU. (Log entry only.) |
| {RF06}Hardware failure (SPI) | Cycle power once. If fault persists, replace the RAU |
| {RF09}Temperature is too high | Check for proper installation. Check environmental controls, move RAU to cooler environment. |
| {RF10}DC Power supplied by the EH/Fusion SingleStar Hub is too low | If the fault is common to more than one RAU, replace the Fusion SingleStar Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF11}DC Power supplied by the EH/Fusion SingleStar Hub is too high | If the fault is common to more than one RAU, replace the Fusion SingleStar Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF12}Hardware failure (PA) | Replace the RAU. |
| {RF13}Hardware failure (PA) | Replace the RAU. |
| {RF14}Hardware failure (PLL Unlock) | If the fault is common to more than one RAU, replace the Fusion SingleStar Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF15}The DL RF path loss is too high | If the fault is common to more than one RAU, replace the Fusion SingleStar Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF16} The DL RF path operating at minimum gain | Check the CATV cable loss, especially on new installations. Validate that minimum cable length requirements are met. If the fault is common to more than one RAU, replace the Expansion/Fusion SingleStar Hub when possible. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU when possible. |
| {RF17}Hardware failure | Replace the RAU. |
| {RF18}Potential failure in the UL RF path | Unable to complete system end-to-end. Replace the RAU when possible. |
| {RF19}Potential failure in the DL RF path | Unable to complete system end-to-end test. Check RAU termination at THE SMA connector and re-test. Replace the RAU if there are no Hub alarms. |

| | |
|---|---|
| {RF20}No communications with the EH/Fusion SingleStar Hub | Check the CATV cable for shorts/opens, especially on new installations. If the fault is common to more than one RAU, replace the Expansion/Fusion Single-Star Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF21}The DL RF path loss is above the recommended limit | Check the CATV cable for shorts/opens, especially on new installations. If the fault is common to more than one RAU, replace the Expansion/Fusion Single-Star Hub. Try another port. If no fault is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU. |
| {RF22}Frequency band not programmed | Use AdminBrowser to check band support in the RAU. Cycle power once. If the fault persists, replace the RAU. |
| {RF23}Commanded Out-of-Service | Command In-Service to restore operation. |
| {RF24}External fault lockout | Check the Hubs for faults. The RAU is out of service on command from the Hub. |
| {RF25}Internal fault lockout | Check RAU faults. The RAU is Out-of-Service. |

### 8.3.1.3 Warning Indications

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 v1.00 or higher displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to Section 3.3.2, “View Preference,” on page 3-9.

#### Fusion SingleStar Hub Warnings

**Table 8-3 Warnings Reported by the Fusion SingleStar Hub**

| Warning Message | Action |
|---|---|
| {MW01}DL signal from RF source is excessive | Reduce DL signal from RF source (base station or bi-directional amplifier). |
| {MW02}Temperature is high | Replace the Hub if there is fan failure. Check for fan rotation, airflow blockage, and dust. Check room environmental controls. |
| {MW21}Hardware failure (UL Path) | Re-run system test. If the warning persists, swap last two RAUs and re-run system test. If the warning persists, replace the Hub when possible. |
| {MW22}Hardware failure (DL Pilot too low) | Cycle power once. If the warning persists, replace the Hub when possible. |

### Remote Access Unit Warnings

**Table 8-4 Warnings Reported by the RAU**

| Warning Message | Action |
|---|---|
| {RW17}The DL RF path loss is too high | Check the CATV cable for shorts/opens, especially on new installations. If the warning is common to more than one RAU, replace the Expansion/Fusion SingleStar Hub when possible. Try another port. If no warning is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU when possible. |
| {RW18}DL RF path operating at minimum gain | Check the CATV cable loss, especially on new installations. Validate that minimum cable length requirements are met. If the warning is common to more than one RAU, replace the Expansion/Fusion SingleStar Hub when possible. Try another port. If no warning is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU when possible. |
| {RW19}Antenna disconnected | Check the antenna connection and re-run the system test. (The antenna disconnect reporting level is user selectable between warning and status.) |

#### 8.3.1.4 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 v1.00 or higher displays events (faults, warnings, or status messages) depending on your view preference. To change your view preference, refer to Section 3.3.2, “View Preference,” on page 3-9.

**NOTE:** The icons displayed in the system status tree assume that there are no other faults, warnings, or status present.

**NOTE:** Recommended minimum and maximum CATV cable lengths vary depending which CATV cable type is used. Refer to the note on page 8-5.

Note: *denotes applicable only to Firmware Version 5.0 and 5.1

## Fusion SingleStar Hub Status Messages

**Table 8-5 Status Messages Reported by the Fusion SingleStar Hub**

| Status Message | Action |
|---|---|
| [MS49]Hub/RAUs report fault condition | Check Hub and RAU status. |
| [MS05]Commanded Out-of-Service | Command In-service to restore operation. |
| [MS06]Factory special test mode | Cycle power to clear test mode. |
| [MS07]System Lockout | Check the Hub for faults. |
| [MS08]Unable to perform system test on power up | Check the Hub and RAUs for faults. Re-run system test. |
| [MS09]Auxiliary Board/RAUs report warning condition | Check the Hub and RAUs for warnings. |
| [MS17]Failed to perform system test (PLL unlock) | Unable to perform system end-to-end test. Replace Hub when possible. |
| [MS18]Failed to perform system test (Test tone too high) | Unable to perform system end-to-end test. Replace Hub when possible. |
| [MS19]Failed to perform system test (Test tone too low) | Unable to perform system end-to-end test. Replace Hub when possible. |
| [MS23]Scheduled System Test complete | Scheduled system test competed. (Log entry only.) |
| [MS33]Time Tagged Log Full | Use AdminManger to dump and save the Time Tagged Log, then erase it. |
| [MS34]Time of Day not initialized | Use AdminBrowser to initialize the time and date. |
| [MS36]Maximum auto recovery limit | Maximum number of fault/warning auto-recovery attempts. Use AdminBrowser “Set-in-Service” to allow the MH to attempt additional auto-recovery attempts. |
| [ES04]System test is required | Run system test. |
| [ES05]Temperature is high | Check fan rotation, air flow blockage, and dust. Check room environmental controls. |
| [ES06]Fan 1 failure | Check fan rotation, air flow blockage, dust. Replace the Hub on temperature fault. |
| [ES07]Fan 2 failure | Check fan rotation, air flow blockage, dust. Replace the Hub on temperature fault. |
| [ES08]Fan 3 failure | Check fan rotation, air flow blockage, dust. Replace the Hub on temperature fault. |
| [ES09]Port 1 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES10]Port 2 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES11]Port 3 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES12]Port 4 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |

| | |
|---|---|
| [ES13]Port 5 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES14]Port 6 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations.Use a larger size CATV cable to improve coverage. |
| [ES15]Port 7 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES16]Port 8 UL RF path loss is above the recommended limit | Check the CATV cable, especially on new installations. Use a larger size CATV cable to improve coverage. |
| [ES17]Commanded Out-of-Service | Command In-service to restore operation. |
| [ES18]External fault lockout | Check the Hub for faults. |
| [ES20]Factory special test mode | Cycle power to clear test mode |
| [ES25]Port 1 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 2 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 3 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 4 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 5 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 6 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 7 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |
| [ES25]Port 8 DL RF path too low | Try another port. If status persists, replace the Hub. Otherwise, flag the previous port as unusable and replace the Hub when possible. |

## Remote Access Unit Status Messages

**Table 8-6 Status Messages Reported by the RAU**

| Status Message | Action |
|---|---|
| [RS01]Temperature is high | Check for proper installation. Check environmental controls, move the RAU to a cooler environment. |
| [RS02]DC voltage is low | Check the CATV cable. Replace the RAU when possible. |
| [RS03]Power amplifier is failing | Replace the RAU when possible. |
| [RS05]The cable loss between the EH/Fusion SingleStar Hub and RAU is above the recommended limit | Check the CATV cable for shorts/opens, especially on new install. If the status is common to more than one RAU, replace the Expansion/Fusion SingleStar Hub when possible. Use a larger size CATV cable to improve coverage. |
| [RS06]System test required | Run the system test. |
| [RS07]Antenna disconnected | Check the antenna connection and rerun the system test. (Antenna disconnect reporting level is user selectable between warnings and status.) |
| [RS09]Commanded Out-of-Service | Command In-service to restore operation. |
| [RS10]External fault lockout | Check the Hub for faults. |
| [RS11]Internal fault lockout | Check the RAU faults. The RAU is Out-of-Service. |
| [RS13]DC Power supplied by the EH/Fusion SingleStar Hub is too high | Check the CATV cable for shorts/opens, especially on new installations. If status common to more than one RAU, replace the Expansion/Fusion SingleStar Hub when possible. Try another port. If no status is reported, flag the previous port as unusable and replace the Hub when possible. Otherwise, replace the RAU when possible. |
| [RS14]Potential failure in the UL RF path | Unable to complete system end-to-end test. Replace the RAU when possible |
| [RS15]Potential failure in the DL RF path | Unable to complete system end-to-end test. Check the RAU termination at SMA connector and re-test. Replace the RAU if no Hub alarms. |

### 8.3.2 Troubleshooting Using LEDs

The following troubleshooting guide is from the perspective that all Fusion SingleStar equipment is installed, their cables are connected, and they are powered on; it is assumed that the system was operating normally before the problem to be diagnosed occurred. (Refer to Section 6.4.1.1, "Troubleshooting with Hub LEDs During Installation," on page 6-13.)

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

#### 8.3.2.1 Troubleshooting Fusion SingleStar Hub LEDs During Installation

**Table 8-7 Troubleshooting Using Fusion SingleStar Hub LEDs During Installation**

| During Installation | Fusion Hub Port LEDs | State | Action | Impact |
|---|---|---|---|---|
| At Any Time | **PORT** | Red (60ppm) flashing | Program band using AdminBrowser, refer to Section 6.4.3, "Configuring the System," on page 6-19. | The band is not programmed into the Hub. |
| | **STATUS** | Red | | |
| At Any Time | **POWER** | Red | Replace the Hub. | One or more power supplies are out-of-spec.ification. |

### 8.3.2.2 Troubleshooting Fusion SingleStar Hub LEDs During Normal Operation

- All of the Fusion SingleStar Hub's **PORT** LEDs that have RAUs connected should be Green, indicating that the RAU is powered on, communication is established, and operation is normal.
- The **POWER** and **STATUS** LEDs should both be Green.

**Table 8-8 Troubleshooting Using the Fusion SingleStar Hub Port LEDs During Normal Operation**

| During Normal Operation | Fusion Hub Port LEDs | State | Action | Impact |
|---|---|---|---|---|
| RAU is not connected | **PORT** | Red flashing (30 ppm) | If the RAU was disconnected accidentally, re-connect the CATV cable. The Hub's port LEDs should change to Green (Link)/Red (RAU) (then Green/Green, after 20 seconds, if the Hub is connected and has band programmed).<br>Use AdminBrowser to perform system end-to-end test when possible to achieve the best performance.<br>Use AdminBrowser's "Clear All Disconnect Status" command if you are permanently removing the RAU from service. The Hub's port LEDs should change to Off/Off. | The RAU was previously connected, but it is not currently connected; the RAU cable is disconnected. |
| RAU is connected | **PORT** | Red flashing (30 ppm) | Disconnect/reconnect the CATV cable to force power-on reset to the RAU. If the port LEDs remain Red/Off, check for the exact cause of Hub faults using AdminBrowser. | Lost communications with the RAU. The RAU could have powered down due to over current; cable could have been damaged. |
| | **PORT** | Red flashing (30 ppm) | The RAU reports a fault condition; check for the exact cause of Hub and RAU faults using AdminBrowser. | Depends on the fault condition. |

**Table 8-9 Troubleshooting Using the Fusion SingleStar Hub Status LEDs During Normal Operation**

| During Normal Operation | Fusion Hub Status LEDs | State | Action | Impact |
|---|---|---|---|---|
| At Any Time | **STATUS** | Red | Use AdminBrowser to determine the exact cause of the fault.<br>Power cycle one time. If the fault remains, replace the Hub. | Internal Hub fault. |
| | | | Use AdminBrowser to check if the Hub is commanded Out-of-Service (every Hub port **RAU** LED, that has an RAU connected to the port, will be red as well).<br>A power cycle will not clear a commanded Out-of-Service, you must use AdminBrowser to clear this state. | Main Hub and all downstream units are off-line. |
| | **STATUS** | Alternating Red/Green | Reduce input signal power; reduce system gain. | Signal compression. |
| | **POWER** | Red | Replace the Hub. | One or more power supplies are out-of-specification. |

## 8.4 Troubleshooting CATV

Refer to Table A-1 on page A-3 for a description of the CATV cable connectivity. The following table 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 the note on page 8-5.

**Table 8-10 Summary of CATV Cable Wiring Problems**

| Type of problem | Message | Icon | Icon[a] | Impact |
|---|---|---|---|---|
| Wire 1 or 2 cut | None | | | High phase noise, degraded signal on both Downlink and Uplink (high bit error rate) |
| Wire 3 or 6 cut | • No communication with RAU*n* |  |  | RAU unable to communicate with Hub, degraded performance or RAU off-line |
| Wire 4 or 5 cut | • Port*n* UL RF path loss is too high |  |  | Increased ripple in the uplink path, decreased UL gain, or no UL gain |
| | • Port*n* UL RF path loss is higher than recommended |  |  | |
| Wire 7 or 8 cut | • The DL RF path loss is too high |  |  | Increased ripple in the downlink path, RAU off-line |
| | • The DL RF path loss is higher than recommended |  |  | |
| Wire 1 to RJ-45 pin 3 or 6 | • No communication with RAU*n* |  |  | RAU unable to communicate with Hub, RAU's RS-485 port damaged, degraded performance or RAU off-line |
| Wire 1 to RJ-45 pin 4, 5, 7 or 8 | • RAU*n* over current |  |  | RAU will not power on. |
| Wire 2 to RJ-45 pin 3 or 6 | • No communication with RAU*n* |  |  | RAU unable to communicate with Hub, RAU's RS-485 port damaged, degraded performance or RAU off-line |
| Wire 2 to RJ-45 pin 4, 5, 7 or 8 | • RAU*n* over current |  |  | RAU will not power on |
| Wire 3 to RJ-45 pin 4, 5, 7 or 8 | • No communication with RAU*n* |  |  | RAU unable to communicate with Hub, degraded performance or RAU off-line |
| Wire 6 to RJ-45 pin 4, 5, 7 or 8 | • No communication with RAU*n* |  |  | RAU unable to communicate with Hub, degraded performance or RAU off-line |

**Table 8-10 Summary of CATV Cable Wiring Problems (continued)**

| Type of problem | Message | Icon | Icon[a] | Impact |
|---|---|---|---|---|
| Wire 4 to RJ-45 pin 7 or 8 | • Port*n* UL RF path loss is too high |  |  | Increased ripple in the downlink and uplink path, degraded performance or RAU off-line. |
| | • The DL RF path loss is too high |  |  | |
| | • The DL RF path loss is higher than recommended |  |  | |
| Wire 5 to RJ-45 pin 7 or 8 | • Port*n* UL RF path loss is too high |  |  | Increased ripple in the downlink and uplink path, degraded performance or RAU off-line. |
| | • Port*n* UL RF path loss is higher than recommended |  |  | |
| | • The DL RF path loss is too high |  |  | |
| | • The DL RF path loss is higher than recommended |  |  | |

a. Applies to earlier Firmware versions.

## 8.5 Technical Assistance

Call our help hot line for technical assistance:

1-800-530-9960 (U.S. only)
+1-408-952-2400 (International)

Leave your name and phone number and an LGC Wireless customer service representative will return your call within an hour. Be prepared to provide the following information when you receive the return call:

- 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

APPENDIX A

# Cables and Connectors

## A.1 CATV Cable

- Connects the Fusion SingleStar Hub to the RAU(s)
- Transmits multiband (downlink) and receives (uplink) IF signals
- Delivers DC electrical power to the RAUs. The Fusion SingleStar 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 shielded F connectors
- Lengths:
  RG-59:
  - Minimum: 10 meters (33 ft.)
  - Maximum: 150 meters (492 ft.)

  RG-6:
  - Minimum: 10 meters (33 ft.)
  - Maximum: 200 meters (656 ft.)

  RG-11:
  - Minimum: 10 meters (33 ft.)
  - Maximum: 300 meters (984 ft.)

**NOTE:** Recommended minimum and maximum CATV cable lengths vary depending upon which CATV cable you use.

The nominal DC impedance of the CATV cable is 0.08 ohm/meter and the nominal RF impedance is 100 ohm.

**NOTE:** Be sure to test cable termination before installing the cable.

**NOTE:** Commscope CATV cable or equivalent is required:
Commscope 20655V for RG-59.
Commscope 2279V for RG-6.
Commscope 2293K for RG-11.

**NOTE:** LGC Wireless requires solid copper center conductor CATV cable for proper DC voltage to the RAU.

Use the following connectors and tools to prepare the 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

## A.2 Coaxial Cable

- Connects a Fusion SingleStar Hub to a repeater, base station, or SmartSource APU (N-type connectors)
- Connects an RAU to a passive antenna (N connectors)

## A.3 Standard Modem Cable

This cable connects a modem to the Fusion SingleStar Hub's front panel serial port.

## A.4 RJ-45 100 BASE-T 100 Cross-over Cable

An RJ-45 100 BASE-T cross-over cable is used to connect a standard browser PC to to the AdminBrowser with a Fusion SingleStar Hub. A cable is included with the Fusion SingleStar Hub.

**Table A-1 RJ-45 Cross-over 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 |

APPENDIX B

# Compliance

## B.1 Fusion SingleStar System Approval Status

InterReach Fusion SingleStar has been approved as shown below.

### 900 Paging/SMR

- Safety: UL 60950 3rd Edition
- EMC: FCC part 15 class A
- Radio: FCC Part 90

### 850 Cellular Products

- Safety: UL 60950 3rd Edition
- EMC: FCC part 15 class A
- Radio: FCC Part 22

### 1800 DCS Products

- Safety: CB scheme evaluation to IEC 950, 3rd Edition with all national deviations
- EMC: EN 301 489-8 V.1.1.1 (2000-09), CISPR 24: 1998
- Radio: ETS 300 609-4 V.8.0.2 (2000-10)

### 900 GSM/EGSM Products

- Safety: CB scheme evaluation to IEC 950, 3rd Edition with all national deviations
- Radio: EN 301 502 V.7.0.1 (2000-08)
- EMC: EN 301 489-8 V.1.1.1 (2000-09), CISPR 24: 1998

### 800 iDEN Products

- Safety: UL 60950, 3rd Edition
- EMC: FCC part 15 class A
- Radio: FCC part 90

### 1900 PCS Products

- Safety: UL 60950 3rd Edition
- EMC: FCC part 15 class A
- Radio: FCC part 24

### 2100 UMTS Products

- Safety: CB scheme evaluation to IEC 950, 3rd Edition with all national deviations
- EMC: ETSI TS 125 113 125 113: V4.3.0 (2002-09)
- Radio: ETSI TS 125 143 125 143: V5.2.0 (2002-09)

**NOTE:** for Canadian customers, the Manufacturer's rated output power[1] 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.

1. "Manufacturer's rated output power" refers to Fusion's downlink P1dB. The power per carrier tables take into account this power reduction for multiple carriers.

## B.2 Human Exposure to RF

The U.S. Federal Communications Commission (FCC) has adopted limits of human exposure to radio frequency (RF) emissions from portable or fixed RF systems that are regulated by the FCC. The exposure limits on the incident electric and magnetic fields and power densities are based on ANSI/IEEE and NCRP RF Safety Guidelines. The limits are also prescribed in terms of the mass-normalized rates of internal energy absorption by tissues (specific absorption rates or SARs) which should not exceed 0.08 W/kg as averaged over the whole body and 1.6 W/kg for any 1-g of tissue.

Similarly, the U.K. National Radiological Protection Board (NRPB) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) have both established guidelines for maximum RF exposure levels that are likely to not pose health risks. For the general public, ICNIRP recommends maximum exposure levels of 2.0 W/kg for any 10-g of tissue. This recommendation is 5 times lower than that of NRPB.

The specific absorption rate (SAR) was measured for a radiated power of 20 dBm (100 mW) which is the maximum radiated for both of the antennas. The highest SAR regions for each of the antennas for separation distances of 0, 1, 2, and 3 cm to the tissue-simulant model were determined in the first instance by using a coarser sampling with a step size of 8.0 mm over three overlapping scan areas for a total scan area of $8.0 \times 9.6$ cm. After identifying the regions of the highest SAR for each of the cases, the SAR distributions were measured with a resolution of 2 mm in order to obtain the peak 1 cm 3 or 1-g SAR.

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.

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