LGC WIRELESS®

InterReach™ Unison

Installation, Operation, and Reference Manual

PN 8700-10
620003-0 Rev. B

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SECTION 1

General Information

This section contains the following subsections:

1.1 Purpose and Scope

This document describes the InterReach™ Unison system components.

- Section 2 InterReach™ Unison System Description

  An overview of the Unison hardware and OA&M capabilities is provided in this section. This section also contains system specifications and RF end-to-end performance tables.

- Section 3 Unison Main Hub

  The Main Hub is illustrated and described in this section. Connector and LED descriptions, communication cable (serial and null modem) pin outs, and unit specifications are included.

- Section 4 Unison Expansion Hub

  The Expansion Hub is illustrated and described in this section. Connector and LED descriptions, and unit specifications are included.

- Section 5 Unison Remote Access Unit

  The Remote Access Unit is illustrated and described in this section. Connector and LED descriptions, and unit specifications are included.

- Section 6 Designing a Unison Solution

  This section provides tools to aid you in designing your Unison 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 7 Installing Unison

  Installation procedures, requirements, safety precautions, and checklists are provided in this section. The installation procedures include guidelines for troubleshooting using the LEDs as you install the units.

- Section 8 Replacing Unison Components in an Operational System

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

- Section 9 Maintenance, Troubleshooting, and Technical Assistance

  Contact information and troubleshooting tables are provided in this section.

- Appendix A Cables and Connectors

  Connector and cable descriptions and requirements are provided in this section. Additionally, cable pin outs and diagrams are given.

- Appendix B InterReach Unison Property Sheet

  This section contains a form that you can use during installation to record serial numbers, gain settings, system band, RAU attenuation, and unit installation location. This information is required for the final As-Built documentation.

- Appendix C Compliance

  Safety and Radio/EMC approvals are listed in this section.

- Appendix D Release Notes

  A hardware/firmware/software compatibility table is provided in this section.

- Appendix E Glossary

  The Glossary provides definitions of commonly-used RF and wireless networking terms.

1.2 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	AdminManager window buttons

Measurements are listed first in metric units, followed by U.S. Customary System of units in parentheses. For example:

0° to 45°C (32° to 113°F)

The following symbols are used to highlight certain information as described.

NOTE: This format is used to emphasize text with special significance or importance, and to provide supplemental information.

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

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

Procedure

This format is used to highlight a procedure.

1.3 Acronyms in this Manual

Acronym	Definition
AGC	automatic gain control
ALC	automatic level control
AMPS	Advanced Mobile Phone Service
BTS	base transceiver station
Cat-5/6	Category 5 or Category 6 (twisted pair cable)
CDMA	code division multiple access
CDPD	cellular digital packet data
DAS	distributed antenna system
dB	decibel
dBm	decibels relative to 1 milliwatt
DC	direct current
DCS	Digital Communications System
DL	downlink
EDGE	Enhanced Data Rates for Global Evolution
EGSM	Extended Global Standard for Mobile Communications
EH	Expansion Hub
GHz	gigahertz
GPRS	General Packet Radio Service
GSM	Groupe Speciale Mobile (now translated in English as Global Standard for Mobile Communications)
Hz	hertz
IF	intermediate frequency
iDEN	Integrated Digital Enhanced Network (Motorola variant of TDMA wireless)
LAN	local area network
LO	local oscillator
mA	milliamps
MBS	microcellular base station
MH	Main Hub
MHz	megahertz
MMF	multi-mode fiber
MTBF	mean time between failures
NF	noise figure
nm	nanometer

Acronym	Definition
OA&M	operation, administration, and maintenance
PCS	Personal Communication Services
PLL	phase-locked loop
PLS	path loss slope
RAU	Remote Access Unit
RF	radio frequency
RSSI	received signal strength indicator
SC/APC	fiber optic connector complying with NTT SC standard, angle-polished
SMA	sub-miniature A connector (coaxial cable connector type)
SMF	single-mode fiber
ST	straight tip (fiber optic cable connector type)
ScTP	screened twisted pair
TDMA	time division multiple access
UL	uplink; Underwriters Laboratories
uW	microwatts
UMTS	Universal Mobile Telecommunications System
UPS	uninterruptable power supply
W	watt
WCDMA	wideband code division multiple access

1.4 Standards Conformance

- Utilizes the TIA/EIA 568-A Ethernet cabling standards for ease of installation.
- See Appendix C for compliance information.

1.5 Related Publications

- *AdminManager User Manual,* LGC Wireless part number 8810-10
- *OpsConsole User Manual*; LGC Wireless part number 8800-10
- *MetroReach Focus Configuration, Installation, and Reference Manual*; LGC Wireless part number 8500-10
- *LGCell Version 4.0 Installation, Operation, and Reference Manual*; LGC Wireless part number 8100-50
- *LGC Wireless Accessories Catalog*; LGC Wireless part number 8600-10
- *Neutral Host System Planning Guide*; LGC Wireless part number 9000-10

SECTION 2

InterReach™ Unison System Description

InterReach™ Unison is an intelligent fiber optic/Cat-5/6 wireless networking system that is designed to handle both wireless voice and data communications and provide high-quality, ubiquitous, seamless access to the wireless network in any public or private facility, including:

- Campus environments
- Airports
- Office buildings
- Shopping malls
- Hospitals
- Subways
- Public facilities (convention centers, sports venues, etc.)

Unlike other wireless distribution alternatives, Unison is an intelligent active system, using 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 Unison system supports major wireless standards and air interface protocols in use around the world, including:

- Frequencies: 800 MHz, 900 MHz, 1800 MHz, 1900 MHz, 2100 MHz
- Protocols: AMPS, TDMA, CDMA, GSM, iDEN, CDPD, EDGE, GPRS, WCDMA, CDMA2000, Paging

Key System Features

- **Superior RF performance**, particularly in the areas of IP3 and noise figure.
- **High downlink composite power** and **low uplink noise figure** enables support of a large number of channels and larger coverage footprint per antenna.
- **Software configurable** Main and Expansion Hubs. Thus, the frequency band can be configured in the field.
- **Either single-mode or multi-mode fiber** can be used, supporting flexible cabling alternatives (in addition to standard Cat-5 or Cat-6 [Cat-5/6] screened twisted pair [ScTP]). Cabling type can be selected to meet the resident cabling infrastructure of the facility and unique building topologies.
- **Extended system "reach."** Using single-mode fiber, fiber runs can be as long as 6 kilometers (creating a total system "wingspan" of 12 kilometers). Alternately, with multi-mode fiber, fiber runs can be as long as 1.5 kilometers. The Cat-5/6 ScTP cable run can be up to 100 meters recommended maximum (150 meters with RF performance degradation).
- **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.
    - 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 (all RAUs except UMTS).
- **Firmware Updates** are downloaded (either locally or remotely) to operating systems when any modifications are made to the product, including the addition of new software capabilities/services.
- **Extensive OA&M capabilities**, including fault isolation to the field replaceable unit, automatic reporting of all fault and warning conditions, and user-friendly graphical-user interface OA&M software packages.

2.1 System Hardware

The InterReach Unison system consists of three modular components:

- 19" rack-mountable **Main Hub** *(connects to up to 4 Expansion Hubs)*
  - Converts RF signals to optical on the downlink; optical to RF on the uplink
  - Microprocessor controlled (for alarms, monitoring, and control)
  - Software configurable band
  - Simplex interface to RF source
  - System master – periodically polls all downstream units (Expansion Hubs/RAUs) for system status, and automatically reports any fault or warning conditions
- 19" rack-mountable **Expansion Hub** *(connects to up to 8 Remote Access Units)*
  - Converts optical signals to electrical on the downlink; electrical to optical on the uplink
  - Microprocessor controlled (for alarms, monitoring, and control)
  - Software configurable band (based on command from Main Hub)
  - Supplies DC power to RAU
- **Remote Access Unit** (RAU)
  - Converts electrical signals to RF on the downlink; RF to electrical on the uplink
  - Microprocessor controlled (for alarms, monitoring, and control)
  - Protocol/band specific units

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

Figure 2-1 Unison System Hardware

2.2 System OA&M Capabilities

The InterReach Unison is microprocessor controlled and contains firmware which enables much of the OA&M functionality.

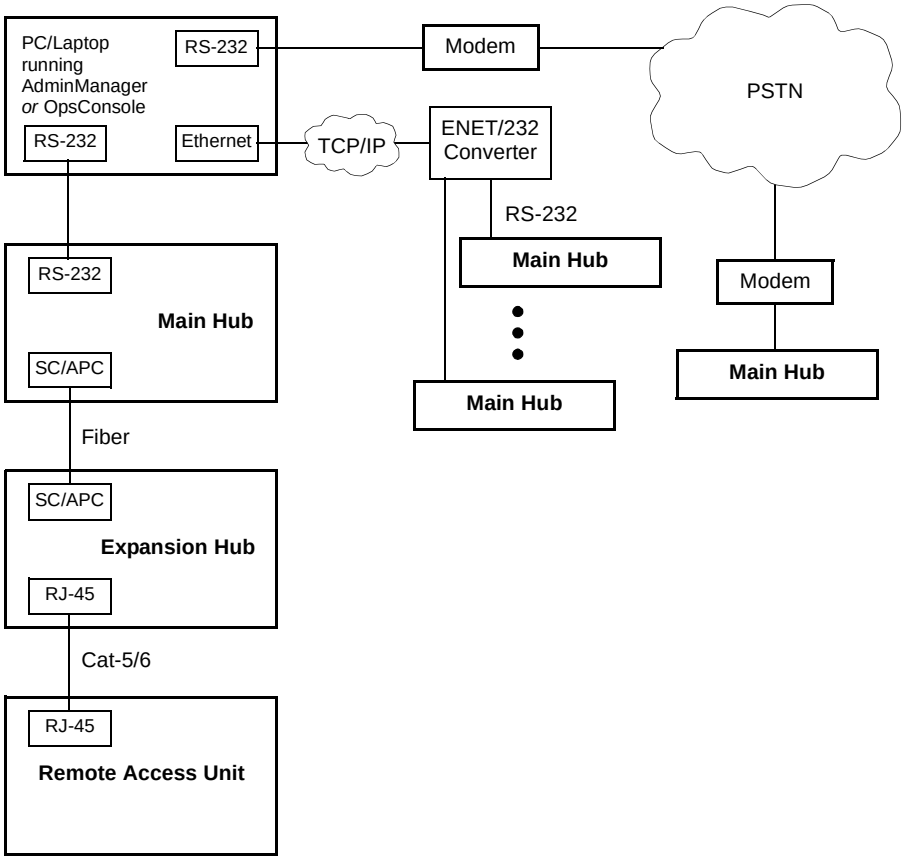
Complete alarming, down to the field replaceable unit (i.e., Main Hub, Expansion Hub, Remote Access Unit) and the cabling infrastructure, is available. All events occurring in a system, defined as a Main Hub and all of its associated Expansion Hubs and Remote Access Units, are automatically reported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

- Normally closed (NC) alarm contact closures can be tied to standard NC alarm monitoring systems or directly to a base station for alarm monitoring.
- The Main Hub's front panel serial port connects directly to a PC (for local access) or to a modem (for remote access).

Figure 2-2 OA&M Communications

Use AdminManager to configure or monitor a local Unison system. Remotely, AdminManager can only check system status, it cannot receive modem calls.

Use OpsConsole to monitor and receive communications from remote or local Unison systems.



LGC Wireless offers two OA&M packages AdminManager and OpsConsole.

- The AdminManager software is provided with Unison. It runs on a PC/laptop and communicates with one Main Hub, and its downstream units, at a time.
  - Connected directly to the Main Hub's front panel RS-232 connector, you can access the Installation Wizard which lets you configure a newly installed system, or you can access the Configuration & Maintenance panel which lets you query system status, configure a newly added or swapped unit, or change system parameters.
  - Connected remotely using a modem, AdminManager initiates communications with the Main Hub. You can access a read-only Configuration & Maintenance panel which lets you query system status to help you determine if an on-site visit is required.

  Refer to the *AdminManager User Manual* (PN 8810-10) for information about installing and using the AdminManager software.
- Alternately, OpsConsole OA&M software is available separately. OpsConsole lets you manage, monitor, and maintain multiple sites and systems from a centralized remote location. This software is described in the *OpsConsole User Guide* (PN 8800-10).

The following table lists the functional differences between AdminManager and OpsConsole.

Table 2-1 AdminManager and OpsConsole Functional Differences

Feature	AdminManager	OpsConsole
Installation Wizard	Yes	No
Local System Configuration	Yes	Yes
Remote System Configuration	No	Yes
Local Firmware Updating	Yes	Yes
Save unit information in a database	No	Yes
Network view of installed systems	Yes	Yes
Send dispatch message	No	Yes
Monitor multiple units	No	Yes
Scheduled polling	No	Yes
Windows-based GUI application	Yes	Yes
Runs on Windows 98 SE	Yes	No
Runs on Windows 2000	Yes	Yes
Installation and configuration tool	Yes	No
Operation, Administration, and Management tool	No	Yes

Connectivity differences between AdminManager and OpsConsole are listed in the following table.

Table 2-2 AdminManager and OpsConsole Connectivity Differences

Connectivity	AdminManager	OpsConsole
Direct RS-232	Yes (COM1 through COM16)	Yes
RS-232 Expansion Board	Yes, if the expansion port is in the range of COM1 through COM16	Yes
Modem (including RF modem)	Yes (read only)	Yes
Ethernet/232 serial hub	Yes, if the remote COM port is in the range of COM1 through COM16	Yes
Line Sharing Switch after POTS	Yes (read only)	Yes

2.2.1 OA&M Software

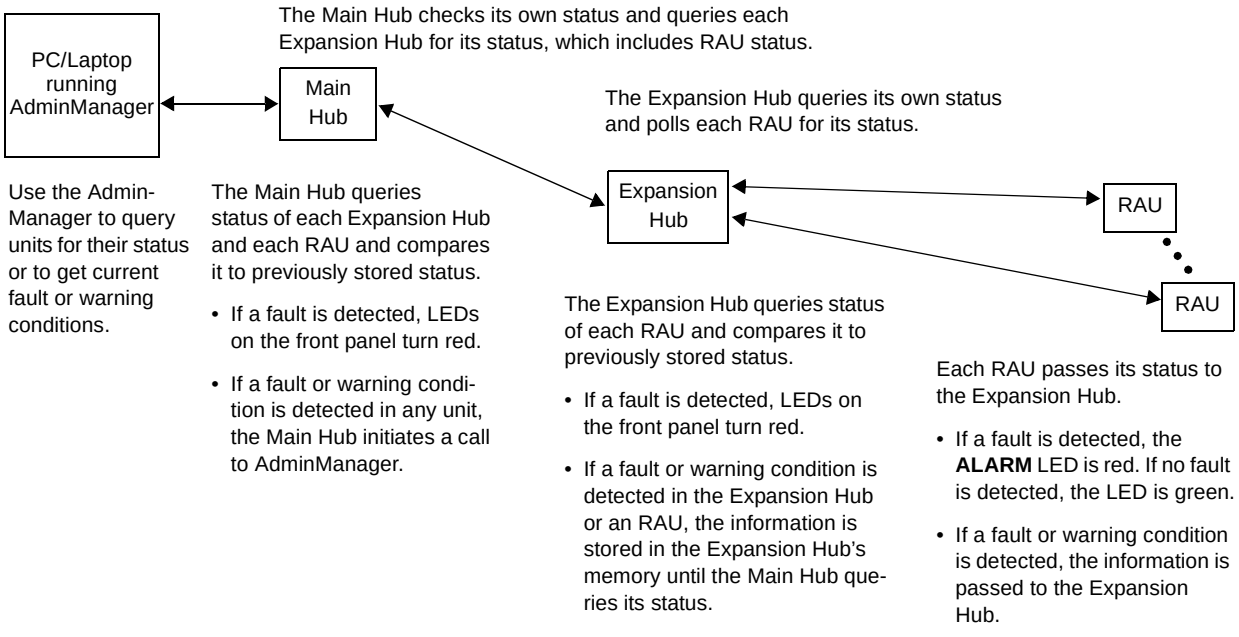
2.2.1.1 Configuring, Maintaining, and Monitoring Unison Locally

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

The Expansion Hubs monitor their RAUs and store their status in memory. The Main Hub monitors its Expansion Hubs and stores their status and the status of the RAUs in its memory. When a unit detects a change in status, a fault or warning is reported. Faults are indicated locally by red status LEDs, and both faults and warnings are reported to the Main Hub and displayed on a PC/laptop, via the Main Hub's serial port, that is running the AdminManager software. Passive antennas that are connected to the RAUs are not monitored automatically. Perform the System Test in order to retrieve status information about antennas.

Using AdminManager locally, you can install a new system or new components, change system parameters, and query system status. The following figure illustrates how the system reports its status to AdminManager.

Figure 2-3 Local System Monitoring and Reporting



2.2.1.2 Monitoring and Maintaining Unison Remotely

- **Using AdminManager Remotely**

  You can use AdminManager to query Unison status via a read-only Configuration & Maintenance panel. You cannot change system parameters or configure system components remotely with AdminManager. (Refer to Figure 2-2 on page 2-4.)

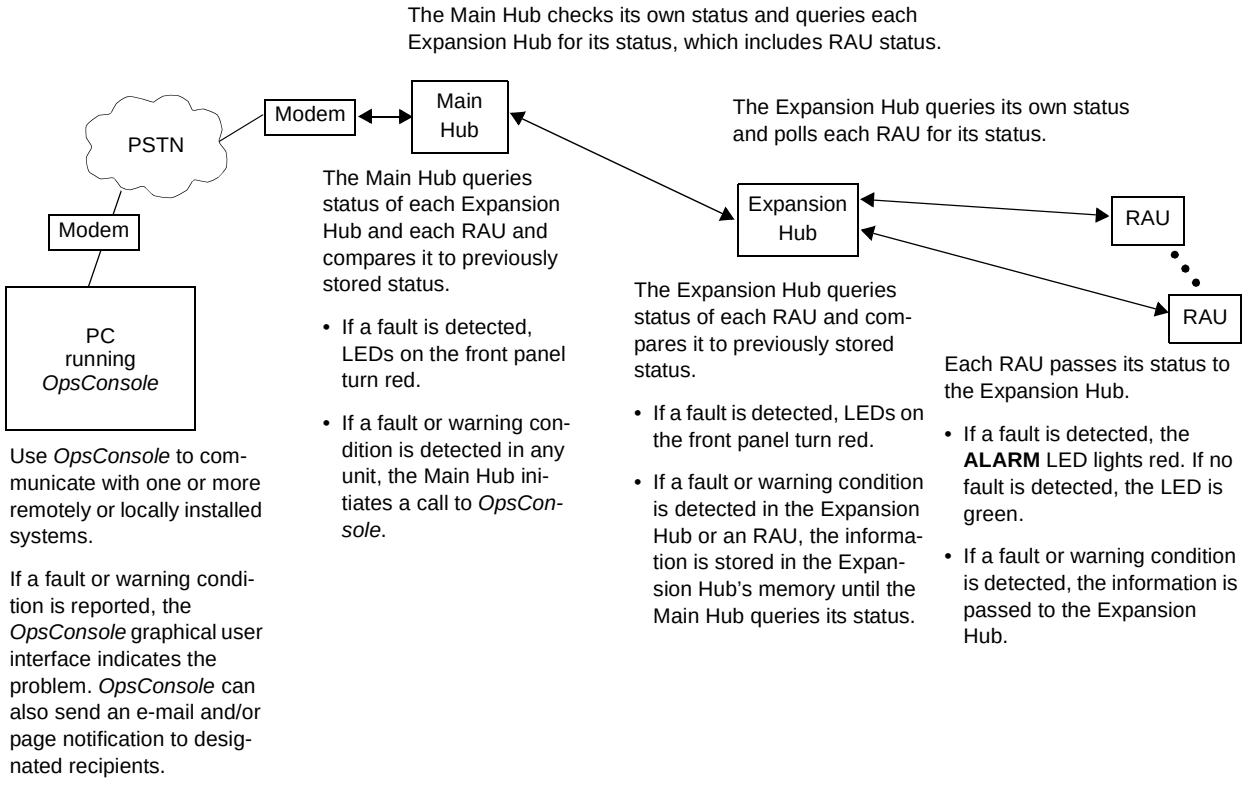
- **Using OpsConsole Remotely**

  When monitoring the system remotely, any change of state within the system causes the Main Hub to initiate an automatic call-out and report the system status to the OpsConsole. The Main Hub calls out three times, each with a 45 second interval. If the call is not acknowledged in these three tries, the Main Hub waits 15 minutes and continues the above sequence until the call is acknowledged.

  Refer to the *OpsConsole User Manual* (PN 8800-10) for more information about using OpsConsole for remote system monitoring.

Figure 2-4 illustrates how the system reports its status to AdminManager and the OpsConsole.

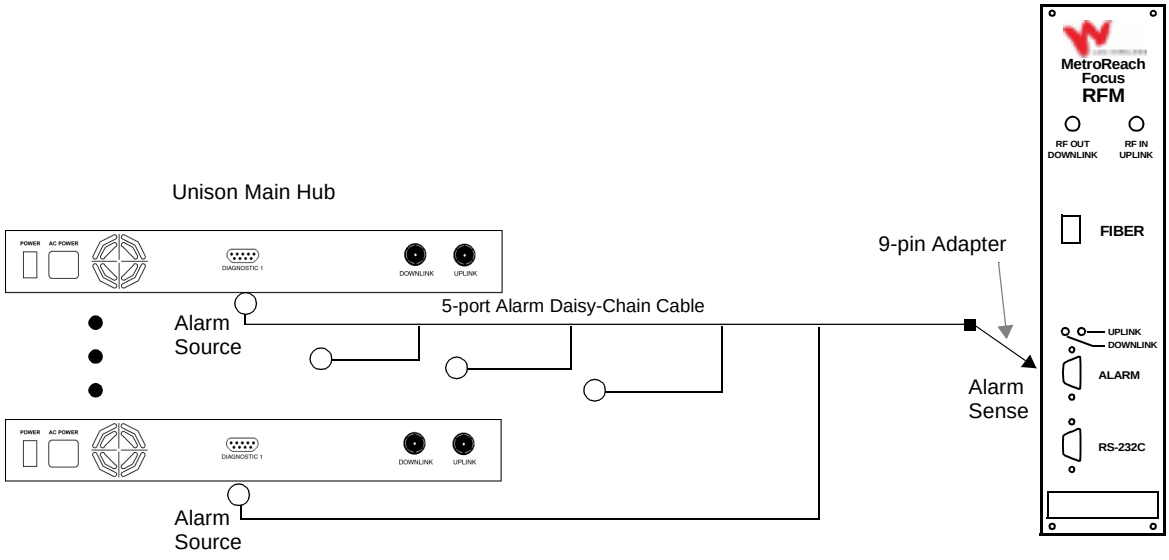
Figure 2-4 Remote System Monitoring and Reporting



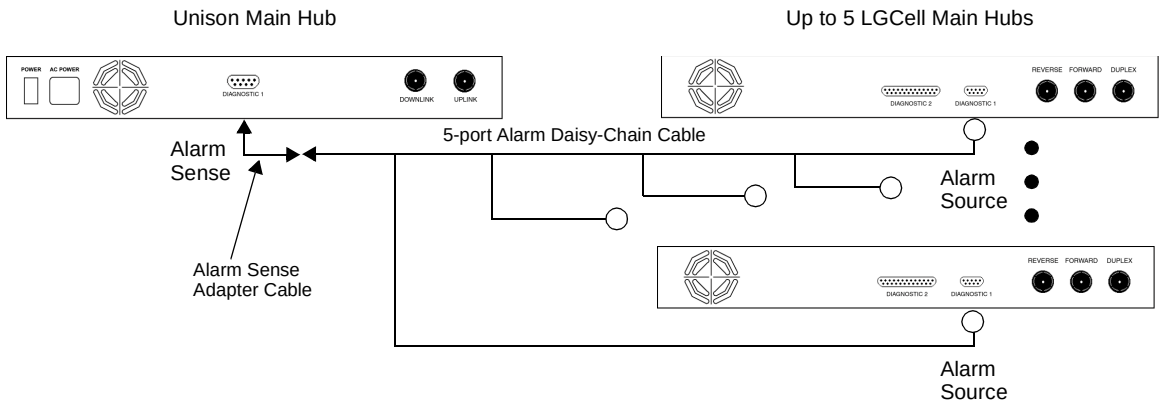
2.2.2 Using Alarm Contact Closures

The DB-9 female connector on the rear panel of the Main Hub can be connected to a local base station or to a daisy-chained series of Unison, LGCell, and/or MetroReach Focus systems.

- When you connect MetroReach Focus or a BTS to Unison, the Unison Main Hub is the output of the alarms (alarm source) and MetroReach Focus or the BTS is the input (alarm sense). This is described in Section 7.7.1 on page 7-42. The following figure shows using MetroReach Focus as the input of Unison contact closures.



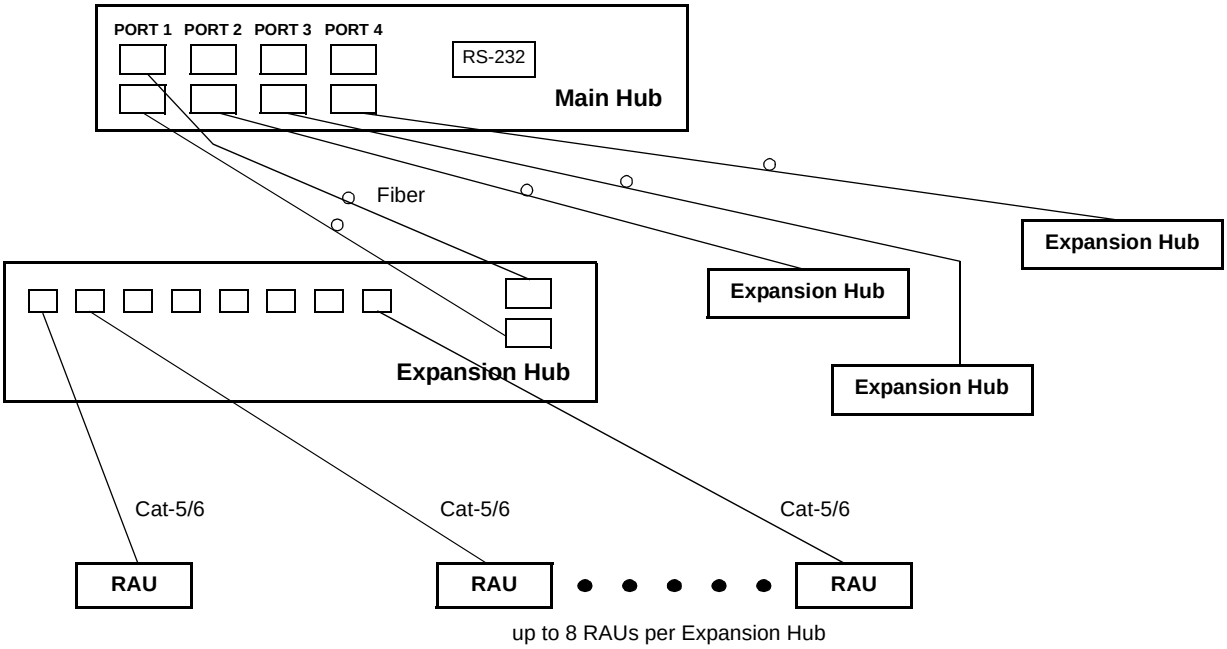
- When you connect LGCell to Unison, the Unison Main Hub is the input of the alarms (alarm sense) and LGCell is the output (alarm source). This is described in Section 7.7.2 on page 7-45.



2.3 System Connectivity

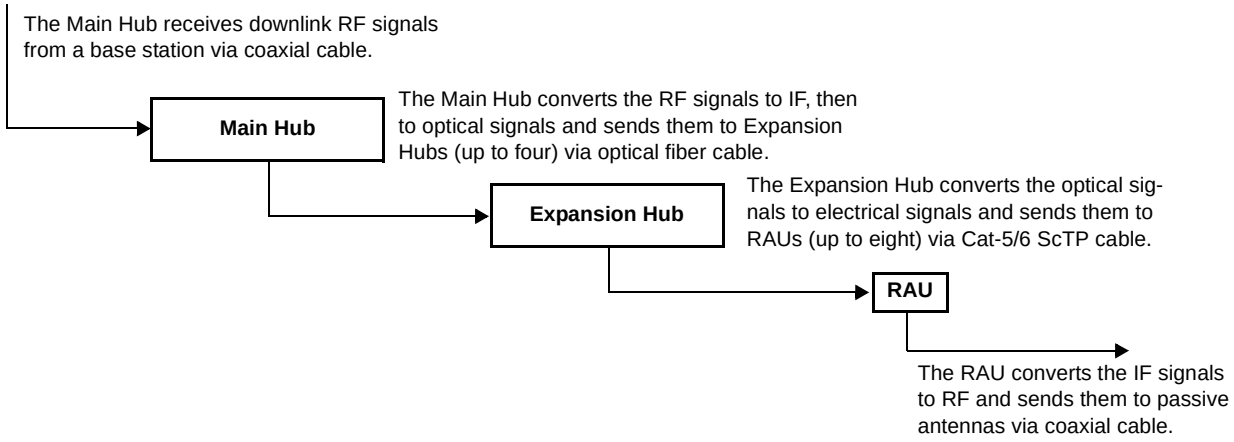
The double star architecture of the Unison system, illustrated in the following figure, provides excellent system scalability and reliability. The system requires only one pair of fibers for 8 antenna points. This makes any system expansion, such as adding an extra antenna for additional coverage, potentially as easy as pulling an extra twisted pair.

Figure 2-5 Unison's Double Star Architecture

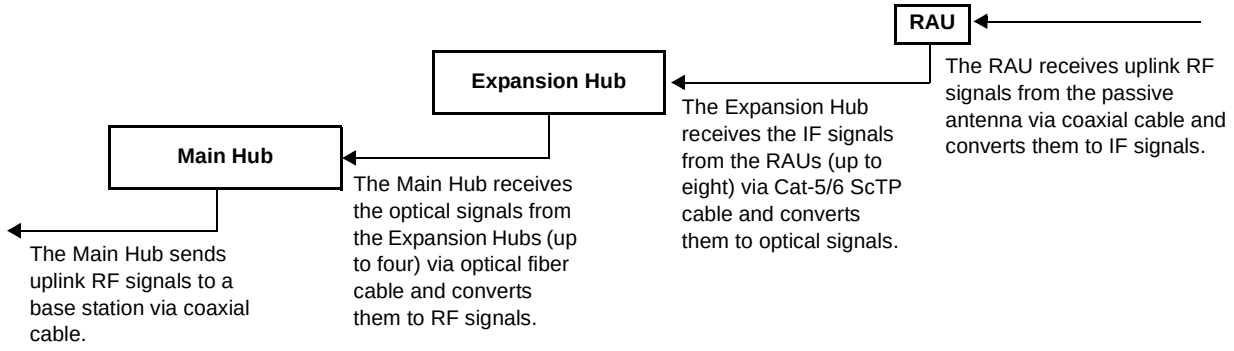


2.4 System Operation

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



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



2.5 System Specifications

2.5.1 Physical Specifications

Parameter	Main Hub	Expansion Hub	Remote Antenna Unit
RF Connectors	2 N-type, female	8 shielded RJ-45, female (Cat-5/6)	1 shielded RJ-45, female (Cat-5/6) 1 SMA, male (coaxial)
External Alarm Connector (contact closure)	1 9-pin D-sub, female	—	—
Serial Interface Connector	1 RS-232 9-pin D-sub, male	—	—
Fiber Connectors*	4 Pair, SC/APC	1 Pair, SC/APC	—
LED Alarm and Status Indicators	Unit Status (1 pair): • Power • Main Hub Status Downstream Unit Status (1 pair per fiber port): • Link • E-Hub/RAU	Unit Status (1 pair): • Power • E-Hub Status Fiber Link Status (1 pair): • DL Status • UL Status RAU/Link Status (1 pair per RJ-45 port): • Link • RAU	Unit Status (1 pair): • Link • Alarm
AC Power (Volts)	Rating: 100–240V, 0.5A, 50–60 Hz Operating Range: 85–250V, 2.4–0.8A, 47–63 Hz	Rating: 115/230V, 5/2.5A, 50–60 Hz Operating Range: 90–132V/170–250V auto-ranging, 2.2–1.5A/1.2–0.8A, 47–63 Hz	—
DC Power (Volts)	—	—	36V (from the Expansion Hub)
Power Consumption (W)	30	260 (includes 8 RAUs)	11
Enclosure Dimensions† (height × width × depth)	44.5 mm × 438 mm × 305 mm (1.75 in. × 17.25 in. × 12 in.)	89 mm × 438 mm × 305 mm (3.5 in. × 17.25 in. × 12 in.)	44 mm × 305 mm × 158 mm (1.7 in. × 12 in. × 6.2 in.)
Weight	< 3 kg (< 6.5 lb)	< 5 kg (< 11 lb)	< 1 kg (< 2 lb)
MTBF	106,272 hours	78,998 hours	282,207 hours

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

†Excluding angle-brackets for 19" rack mounting of hubs.

2.5.2 InterReach Unison Wavelength and Laser Power

The following table shows wavelength and laser power according to UL testing per IEC 60 825-1.

	Measured Output Power	
Wavelength	**Main Hub**	**Expansion Hub**
1310 nm ±20 nm	458 uW	1.8 mW

2.5.3 Environmental Specifications

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

2.5.4 Operating Frequencies

			RF Passband	
Freq. Band	**Unison Band**	**Description**	**Downlink (MHz)**	**Uplink (MHz)**
PCS	PCS1	A & D Band	1930–1950	1850–1870
PCS	PCS2	D & B Band	1945–1965	1865–1885
PCS	PCS3	B & E Band	1950–1970	1870–1890
PCS	PCS4	E & F Band	1965–1975	1885–1895
PCS	PCS5	F & C Band	1970–1990	1890–1910
DCS	DCS1	DCS1 Band	1805–1842.5	1710–1747.5
DCS	DCS2	DCS2 Band	1842.5–1880	1747.5–1785
DCS	DCS3	DCS3 Band	1840–1875	1745–1780
DCS	DCS4	DCS4 Band	1815–1850	1720–1755
Cellular	CELL	–	869–894	824–849
iDEN	iDEN	–	851–869	806–824
EGSM	EGSM	–	925–960	880–915
GSM	GSM	–	935–960	890–915
UMTS	UMTS1	–	2110–2145	1920–1955
UMTS	UMTS2	–	2125–2160	1935–1970
UMTS	UMTS3	–	2135–2170	1945–1980

2.5.5 RF End-to-End Performance

The following tables list the RF end-to-end performance of each protocol when using 2 km of single-mode fiber or 1 km of multi-mode fiber.

Cellular 800 MHz

Table 2-3 Cellular RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F)*	15 dB	15 dB	15 dB	15 dB
Ripple with 75 m Cat-5/6	3 dB	3.5 dB	3 dB	3.5 dB
Output IP3	40 dBm		37 dBm	
Input IP3		–7 dBm		–10 dBm
Output 1 dB Compression Point	27 dBm		27 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAUs configuration		15 dB		15 dB
Noise Figure with 1 MH – 4 EHs – 32 RAUs configuration		21 dB		21 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

iDEN 800 MHz

Table 2-4 iDEN RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F)*	15 dB	15 dB	15 dB	15 dB
Ripple with 75 m Cat-5/6	2 dB	3 dB	2 dB	3 dB
Output IP3	38 dBm		38 dBm	
Input IP3		–7 dBm		–10 dBm
Output 1 dB Compression Point	26 dBm		26 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAUs configuration		17 dB		17 dB
Noise Figure with 1 MH – 4 EHs – 32 RAUs configuration		23 dB		23 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

GSM/EGSM 900 MHz

Table 2-5 GSM/EGSM RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F)*	15 dB	15 dB	15 dB	15 dB
Ripple with 75 m Cat-5/6	3 dB	4 dB	3 dB	4 dB
Output IP3	38 dBm		38 dBm	
Input IP3		–7 dBm		–10 dBm
Output 1 dB Compression Point	26 dBm		26 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAU configuration		16 dB		16 dB
Noise Figure with 1 MH – 4 EH – 32 RAU configuration		22 dB		22 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

DCS 1800 MHz

Table 2-6 DCS RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F)*	15 dB	15 dB	15 dB	15 dB
Downlink ripple with 75 m Cat-5/6	2 dB		2 dB	
Uplink ripple for center 35 MHz of DCS1 and DCS2, Full band for DCS3 & DCS4 with 75 m Cat-5/6		2 dB		2 dB
Uplink gain roll off for Full band of DCS1 and DCS2 with 75 m Cat-5/6		2 dB		2 dB
Output IP3	38 dBm		37 dBm	
Input IP3		–12 dBm		–14 dBm
Output 1 dB Compression Point	26 dBm		26 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAU configuration		17 dB		17 dB
Noise Figure with 1 MH – 4 EH – 32 RAU configuration		23 dB		23 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

PCS 1900 MHz

Table 2-7 PCS RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F)*	15 dB	15 dB	15 dB	15 dB
Ripple with 75 m Cat-5/6	2.5 dB	3 dB	2.5 dB	3 dB
Output IP3	38 dBm		36.5 dBm	
Input IP3		–12 dBm		–14 dBm
Output 1 dB Compression Point	26 dBm		26 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAUs configuration		16 dB		16 dB
Noise Figure with 1 MH – 4 EHs – 32 RAUs configuration		22 dB		22 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

UMTS 2.1 GHz

Table 2-8 UMTS RF End-to-End Performance

	2 km of SMF Typical		1 km of MMF Typical	
Parameter	**Downlink**	**Uplink**	**Downlink**	**Uplink**
Average gain with 75 m Cat-5/6 at 25°C (77°F) *	15 dB	15 dB	15 dB	15 dB
Ripple with 75 m Cat-5/6	2.5 dB	4 dB	2.5 dB	4 dB
Output IP3	37 dBm		36 dBm	
Input IP3		–12 dBm		–12 dBm
Output 1 dB Compression Point	26 dBm		26 dBm	
Noise Figure with 1 MH – 1 EH – 8 RAUs configuration		16 dB		16 dB
Noise Figure with 1 MH – 4 EHs – 32 RAUs configuration		22 dB		22 dB

*The system gain is adjustable in 1 dB steps from 0 to 15 dB, and the gain of each RAU can be attenuated 10 dB in one step.

SECTION 3

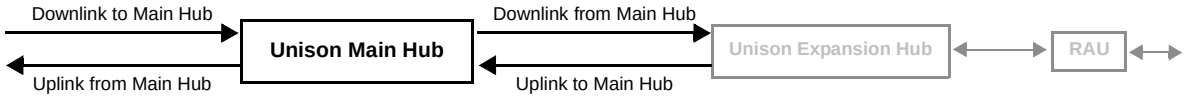
Unison Main Hub

The Main Hub distributes downlink RF signals from a base station, repeater, or MetroReach Focus system to up to four Expansion Hubs, which in turn distribute the signals to up to 32 Remote Access Units. The Main Hub also combines uplink signals from the associated Expansion Hubs.

Figure 3-1 Main Hub in a Unison System

Downlink Path: The Main Hub receives downlink RF signals from a base station, repeater, or MetroReach Focus system via coaxial cable. It converts the signals to IF then to optical and sends them to up to four Expansion Hubs via fiber optic cable.

The Main Hub also sends OA&M communication to the Expansion Hubs via the fiber optic cable. The Expansion Hubs, in turn, communicate the OA&M information to the RAUs via Cat-5/6 cable.

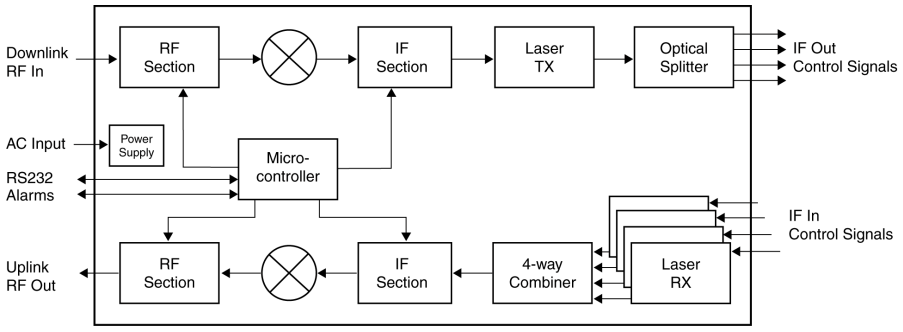


Uplink Path: The Main Hub receives uplink optical signals from up to four Expansion Hubs via fiber optic cables. It converts the signals to IF then to RF and sends them to a base station, repeater, or MetroReach Focus system via coaxial cable.

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

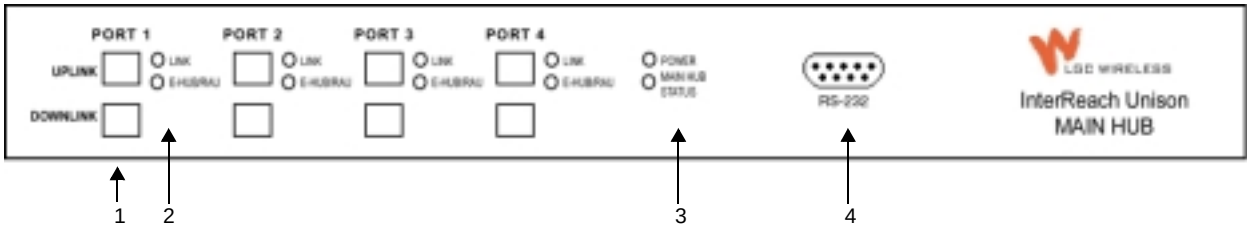
Figure 3-2 gives a detailed view of the major RF and optical functional blocks of the Main Hub.

Figure 3-2 Main Hub Block Diagram



3.1 Main Hub Front Panel

Figure 3-3 Main Hub Front Panel



1. Four fiber optic ports (labeled **PORT 1**, **PORT 2**, **PORT 3**, **PORT 4**)
   - One standard female SC/APC connector per port for MMF/SMF input (labeled **UPLINK**)
   - One standard female SC/APC connector per port for MMF/SMF output (labeled **DOWNLINK**)
2. Four sets of fiber port LEDs (one set per port)
   - One LED per port for port link status (labeled **LINK**)
   - One LED per port for downstream unit status (labeled **E-HUB/RAU**)
3. One set of unit status LEDs
   - One LED for unit power status (labeled **POWER**)
   - One LED for unit status (labeled **MAIN HUB STATUS**)
4. One 9-pin D-sub male connector for system communication and diagnostics using a PC/laptop or modem (labeled **RS-232**)

3.1.1 Optical Fiber Uplink/Downlink Ports

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

- **Optical Fiber Uplink Connector**

  This connector (labeled **UPLINK**) is used to receive the uplink optical signals from an Expansion Hub.

- **Optical Fiber Downlink Connector**

  This connector (labeled **DOWNLINK**) is used to transmit the downlink optical signals to an Expansion Hub.

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

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

Local Monitoring

Use a null modem cable to connect a laptop or PC to the 9-pin D-sub male serial connector for local monitoring or configuring. The cable typically has a DB-9 female connector on both ends. See Appendix A.5 on page A-4 for the cable pinout.

3.1.3 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. Only use the LEDs to provide basic information or as a backup when you are not using AdminManager.

Upon power up, a Main Hub that has a band programmed into it goes through a five-second test to check the LED lamps. During this time, the LEDs blink through the states shown in Table 3-2, letting you visually verify that the LED lamps and the firmware are functioning properly.

Main Hubs are shipped without a band programmed into them. Upon power up of an unprogrammed Main Hub, its LEDs blink continuously. **If upon initial power up the LEDs do not blink continuously, then there is a band programmed in the Main Hub and you should check that it is the correct band before connecting any Expansion Hubs to it** (refer to the *AdminManager User Manual*, PN 8810-10). Otherwise, the Main Hub will automatically send the program band command to all connected Expansion Hubs and RAUs. A mismatched band will cause an error message to be displayed in AdminManager and the RAU will have a fault condition.

NOTE: Refer to Section 9 for troubleshooting using the LEDs.

Unit Status LEDs

The Main Hub status LEDs can be in one of the states shown in Table 3-1. These LEDs can be:

- steady green
- steady red
- blinking green/red (alternating green/red)

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

Table 3-1 Main Hub Status LED States

	LED State	Indicates
POWER MAIN HUB STATUS	Green Green	• Main Hub is connected to power • Main Hub is not reporting a fault; but the system test may need to be performed or a warning could exist (use AdminManager to determine)
POWER MAIN HUB STATUS	Green Red	• Main Hub is connected to power • Main Hub is reporting a fault or lockout condition
POWER MAIN HUB STATUS	Green Alternating Green/Red	• Main Hub is connected to power • Main Hub input signal level too high; or, Main Hub does not have a band programmed into it if the continuous blinking lasts longer than 5 seconds and the Port LEDs are also blinking

Port LEDs

The Main Hub has one pair of fiber port LEDs for each of the four fiber optic ports. The LED pairs can be in one of the states shown in Table 3-2. These LEDs can be:

- ○ off
- ● steady green
- ● steady red
- ● ● blinking green/red (alternating green/red)

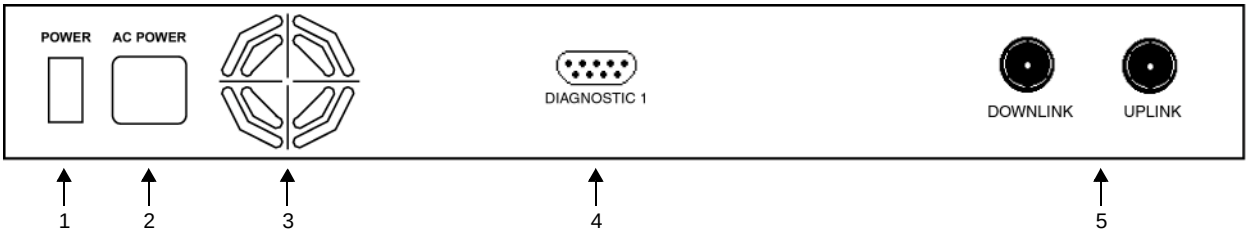
The port LEDs indicate the status of the Expansion Hub and RAUs; however, they do not indicate which particular unit has a fault (i.e., the Expansion Hub vs. one of its RAUs).

Table 3-2 Main Hub Port LED States

	LED State	Indicates
LINK ○ **E-HUB/RAU** ○	Off Off	• Expansion Hub not connected
LINK ● **E-HUB/RAU** ●	Green Green	• Expansion Hub connected, communications normal • No faults from Expansion Hub or any connected RAU
LINK ● **E-HUB/RAU** ○	Red Off	• Loss of communications with Expansion Hub
LINK ● **E-HUB/RAU** ●	Green Red	• Expansion Hub connected • Fault or lockout reported by Expansion Hub or any connected RAU
LINK ● ● **E-HUB/RAU** ● ●	Continuous Blinking	• Main Hub does not have a band programmed into it if the continuous blinking lasts longer than 5 seconds and the Main Hub Status LED is also blinking,

3.2 Main Hub Rear Panel

Figure 3-4 Main Hub Rear Panel



1. Power on/off switch
2. AC power cord connector
3. Fan exhaust vent
4. One 9-pin D-sub female connector for contact closure monitoring (labeled **DIAGNOSTIC 1**)
5. Two N-type, female connectors:
   - Downlink (labeled **DOWNLINK**)
   - Uplink (labeled **UPLINK**)

3.2.1 Main Hub Rear Panel Connectors

3.2.1.1 9-pin D-sub Connector

The 9-pin D-sub connector (labeled **DIAGNOSTIC 1**) provides contact closure for major and minor error system alarm monitoring.

The following table lists the function of each pin on the 9-pin D-sub connector.

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

This interface can either generate contact alarms or sense a single external alarm contact.

3.2.1.2 N-type Female Connectors

There are two N-type female connectors on the rear panel of the Main 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.

3.3 Faults and Warnings

The Main Hub monitors and reports changes in system performance to:

- Ensure that the fiber receivers, amplifiers, and IF/RF path in the Main Hub are functioning properly.
- Ensure that Expansion Hubs and Remote Access Units are connected and functioning properly.

The Main Hub periodically queries attached Expansion Hubs and their Remote Access Units for their status. Both faults and warnings are reported to a connected PC/laptop that is running the AdminManager software or to the optional remote OpsConsole. Only faults are indicated by LEDs.

For more information, see:

- page 9-4 for Main Hub faults.
- page 9-11 for Main Hub warnings.
- page 9-12 for Main Hub status messages.
- page 9-16 for troubleshooting Main Hub LEDs.

3.4 Main Hub Specifications

Table 3-3 Main Hub Specifications

Specification	Description
Enclosure Dimensions (H × W × D):	44.5 mm × 438 mm × 305 mm (1.75 in. × 17.25 in. × 12 in.)
Weight	< 3 kg (< 6.5 lb)
Operating Temperature	0° to +45°C (+32° to +113°F)
Non-operating Temperature	–20° to +85°C (–4° to +185°F)
Operating Humidity, non-condensing	5% to 95%
External Alarm Connector (contact closure)	1 9-pin D-sub, female Maximum: 40 mA @ 40V DC Typical: 4 mA @ 12V DC
Serial Interface Connector	1 RS-232 9-pin D-sub, male
Fiber Connectors	4 Pair, SC/APC[a]
RF Connectors	2 N-type, female
LED Fault and Status Indicators	Unit Status (1 pair): • Power • Main Hub Status Downstream Unit/Link Status (1 pair per fiber port): • Link • E-Hub/RAU
AC Power	Rating: 100–240V, 0.5A, 50–60 Hz Operating Range: 85–250V, 2.4–0.8A, 47–63 Hz
Power Consumption (W)	30
MTBF	106,272 hours

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

SECTION 4

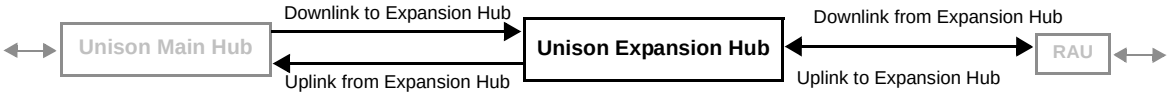
Unison Expansion Hub

The Expansion Hub interfaces between the Main Hub and the Remote Access Unit(s) by converting optical signals to electrical signals and vice versa. It also supplies control signals and DC power to operate the Remote Access Unit(s) as well as passes status information from the RAUs to the Main Hub.

Figure 4-1 Expansion Hub in a Unison System

Downlink Path: The Expansion Hub receives downlink optical signals from the Main Hub via fiber optic cable. It converts the signals to electrical and sends them to up to eight Remote Access Units (RAUs) via Cat-5/6 cables.

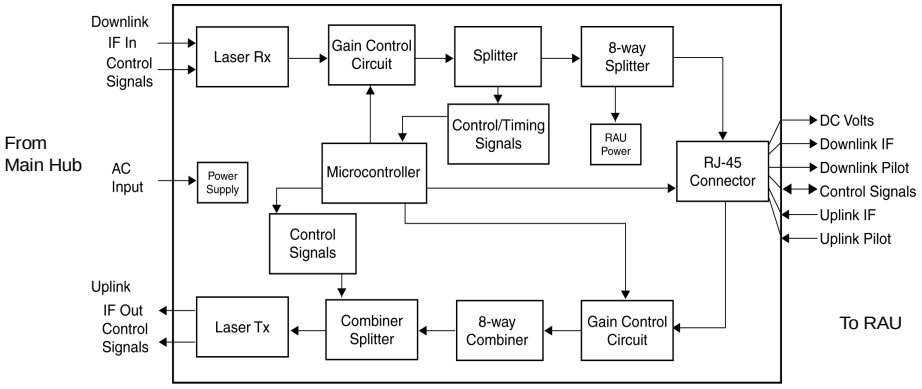
Also, the Expansion Hub receives configuration information from the Main Hub via the fiber optic cable and relays it to the RAUs via the Cat-5/6 cable.



Uplink Path: The Expansion Hub receives uplink IF signals from up to eight RAUs via Cat-5/6 cables. It converts the signals to optical and sends them to a Main Hub via fiber optic cable.

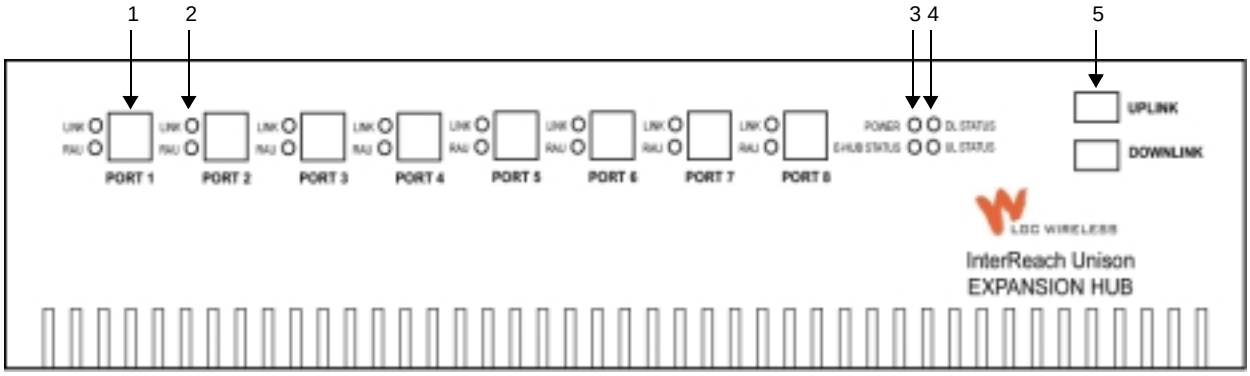
Also, the Expansion Hub receives RAU status information via the Cat-5/6 cable and sends it and its own status information to the Main Hub via the fiber optic cable.

Figure 4-2 Expansion Hub Block Diagram



4.1 Expansion Hub Front Panel

Figure 4-3 Expansion Hub Front Panel



1. Eight standard Cat-5/6 ScTP cable RJ-45 connectors (labeled **PORT 1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**)
2. Eight sets of RJ-45 port LEDs (one set per port)
   - One LED per port for link status (labeled **LINK**)
   - One LED per port for downstream unit status (labeled **RAU**)
3. One set of unit status LEDs
   - One LED for unit power status (labeled **POWER**)
   - One LED for unit status (labeled **E-HUB STATUS**)
4. One set of fiber connection status LEDs
   - One LED for fiber downlink status (labeled **DL STATUS**)
   - One LED for fiber uplink status (labeled **UL STATUS**)
5. One fiber optic port which has two connectors
   - One standard female SC/APC connector for MMF/SMF output (labeled **UPLINK**)
   - One standard female SC/APC connector for MMF/SMF input (labeled **DOWNLINK**)

4.1.1 RJ-45 Connectors

The eight RJ-45 connectors on the Expansion Hub are for the Cat-5/6 ScTP cables that are used to transmit and receive signals to and from RAUs. Use shielded RJ-45 connectors on the Cat-5/6 cable.

NOTE: For system performance, it is important that you use only Cat-5/6 ScTP (screened twisted pair) cable with shielded RJ-45 connectors.

The Cat-5/6 cable also delivers DC electrical power to the RAUs. The Expansion Hub's DC voltage output is 36V DC nominal. A current limiting circuit is used to protect the Expansion Hub if any port draws excessive power.

4.1.2 Optical Fiber Uplink/Downlink Connectors

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

- **Optical Fiber Uplink Connector**

  This connector (labeled **UPLINK**) is used to transmit (output) uplink optical signals to the Main Hub.

- **Optical Fiber Downlink Connector**

  This connector (labeled **DOWNLINK**) is used to receive (input) downlink optical signals from the Main Hub.

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

4.1.3 LED Indicators

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

Upon power up, the Expansion Hub goes through a five-second test to check the LED lamps. During this time, the LEDs blink through the states shown in Table 4-2, letting you visually verify that the LED lamps and the firmware are functioning properly.

NOTE: Refer to Section 9 for troubleshooting using the LEDs.

Unit Status and DL/UL Status LEDs

The Expansion Hub unit status and DL/UL status LEDs can be in one of the states shown in Table 4-1. These LEDs can be:

- steady green
- steady red

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

Table 4-1 Expansion Hub Unit Status and DL/UL Status LED States

	LED State	Indicates
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Green Green / Green	• Expansion Hub is connected to power • Expansion Hub is not reporting a fault or lockout condition; but the system test may need to be performed or a warning condition could exist (use AdminManager to determine) • Optical power in is above minimum (Main Hub is connected) although the cable optical loss may be greater than recommended maximum • Optical power out (uplink laser) is normal and communications with the Main Hub are normal
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Green Red / Green	• Optical power in is above minimum (Main Hub is connected) although the cable optical loss may be greater than recommended maximum • Optical power out (uplink laser) is normal and communications with the Main Hub are normal • Expansion Hub is reporting a fault or commanded lockout
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Red Red / Green	• Fault condition detected, optical power in is below minimum. (Main Hub is not connected, is not powered, or Main Hub's downlink laser has failed, or the downlink fiber is disconnected or damaged.)
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Green Red / Red	• Expansion Hub is reporting a fault condition • Optical power in is above minimum (Main Hub is connected) although the cable optical loss may be greater than recommended maximum • Optical power out is below minimum (Expansion Hub uplink laser has failed; unable to communicate with Main Hub). **UL STATUS** LED state must be checked within the first 90 seconds after power on. If initially green, then red after 90 seconds, it means that there is no communication with the Main Hub. If red on power up, replace the Expansion Hub.
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Red Red / Red	• Optical power in is below minimum (Main Hub is not connected, is not powered, or Main Hub's downlink laser has failed, or the down-link fiber is disconnected or damaged.) • Optical power out is below minimum (Expansion Hub uplink laser has failed; unable to communicate with Main Hub). **UL STATUS** LED state must be checked within the first 90 seconds after power on. If initially green, then red after 90 seconds, it means that there is no communication with the Main Hub. If red on power up, the uplink laser has failed, replace the Expansion Hub.
POWER ● ● **DL STATUS** **E-HUB STATUS** ● ● **UL STATUS**	Green / Red Green / Red	• Expansion Hub is in factory test mode, return it to the factory

Port LEDs

The Expansion Hub has one pair of port LEDs for each of the eight RJ-45 ports. The port LEDs can be in one of the states shown in Table 4-2. These LEDs can be:

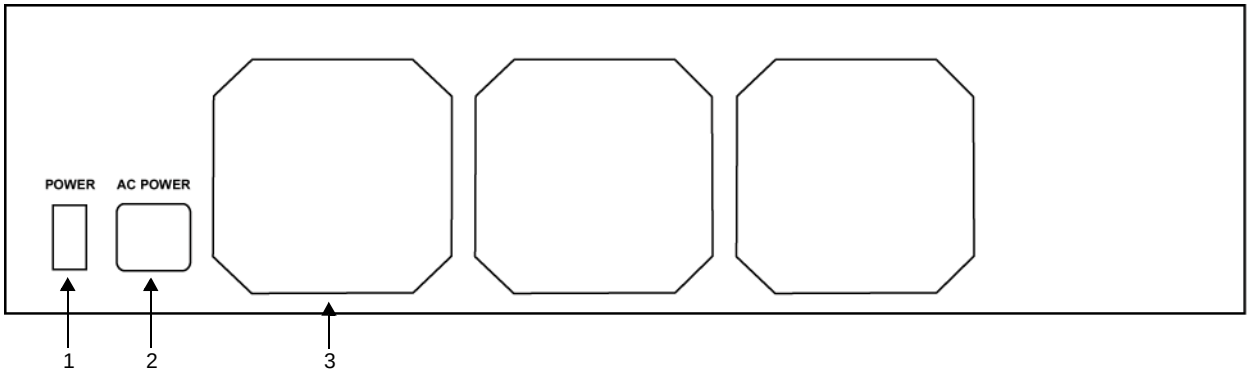
- ○ off
- ● steady green
- ● steady red

Table 4-2 Expansion Hub Port LED States

	LED State	Indicates
LINK ○ RAU ○	Off Off	• RAU is not connected
LINK ● RAU ●	Green Green	• RAU is connected • No faults from RAU
LINK ● RAU ○	Red Off	• Loss of communications to RAU
LINK ● RAU ●	Green Red	• RAU is connected • RAU is reporting a fault or lockout condition

4.2 Expansion Hub Rear Panel

Figure 4-4 Expansion Hub Rear Panel



1. Power on/off switch
2. AC power cord connector
3. Three air exhaust vents

4.3 Faults and Warnings

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

For more information, see:

- page 9-7 for Expansion Hub faults.
- page 9-11 for Expansion Hub warnings.
- page 9-13 for Expansion Hub status messages.
- page 9-18 for troubleshooting Expansion Hub LEDs.

4.4 Expansion Hub Specifications

Table 4-3 Expansion Hub Specifications

Specification	Description
Enclosure Dimensions (H × W × D)	89 mm × 438 mm × 305 mm (3.5 in. × 17.25 in. × 12 in.)
Weight	< 5 kg (< 11 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%
Cat-5/6 Connectors[a]	8 shielded RJ-45, female (Cat-5/6)
Fiber Connectors[b]	1 Pair, SC/APC
LED Alarm and Status Indicators	Unit Status (1 pair): • Power • E-Hub Status Fiber Link Status (1 pair): • DL Status • UL Status RAU/Link Status (1 pair per RJ-45 port): • Link • RAU
AC Power (Volts) (47–63 Hz)	Rating: 115/230V, 5/2.5A, 50–60 Hz Operating Range: 90–132V/170–250V auto-ranging, 2.2–1.5A/1.2–0.8A, 47–63 Hz
Power Consumption (W)	260 (includes 8 RAUs)
MTBF	78,998 hours

a. It is important that you use only Cat-5/6 ScTP cable with shielded RJ-45 connectors.

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

SECTION 5

Unison Remote Access Unit

The Remote Access Unit (RAU) is an active transceiver that connects to an Expansion Hub using industry-standard Cat-5/6 screened twisted pair (ScTP) cable, which delivers RF signals, configuration information, and electrical power to the RAU.

An RAU passes RF signals between an Expansion Hub and an attached passive antenna where the signals are transmitted to wireless devices.

Figure 5-1 Remote Access Unit in a Unison System

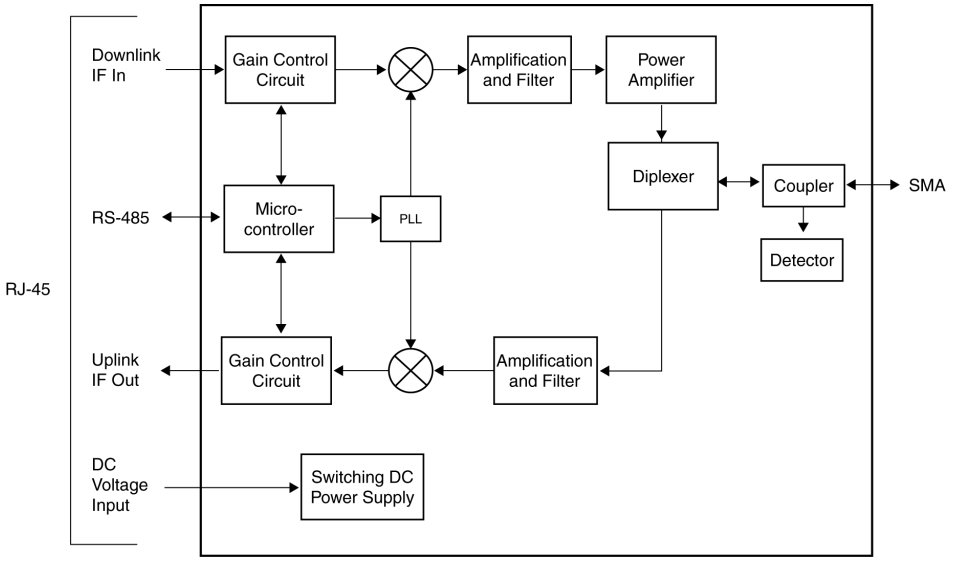
Downlink Path: The RAU receives downlink IF signals from an Expansion Hub via Cat-5/6 cable. It converts the signals to RF and sends them to a passive RF antenna via coaxial cable.

Also, the RAU receives configuration information from the Main Hub via the Cat-5/6 cable.

Uplink Path: The RAU receives uplink RF signals from a passive RF antenna via coaxial cable. It converts the signals to IF and sends them to an Expansion Hub via Cat-5/6 cable.

Also, the RAU sends its status information to the Expansion Hub via the Cat-5/6 cable.

Figure 5-2 Remote Access Unit Block Diagram



The Unison RAUs are manufactured to a specific band or set of bands (i.e., there is one PCS RAU which can be used for A/D, B/E, E/F, B/D, or F/C). Table 5-1 lists the six Unison RAUs, the Unison Band, and the frequency band(s) they cover.

Table 5-1 Frequency Bands covered by Unison RAUs

Unison RAU	Unison Band	RF Passband	
		Downlink (MHz)	Uplink (MHz)
Cellular	Cellular	869–894	824–849
DCS	DCS1	1805–1842.5	1710–1747.5
	DCS2	1842.5–1880	1747.5–1785
	DCS3	1840–1875	1745–1780
	DCS4	1815–1850	1720–1755
GSM	GSM	925–960	880–915
	EGSM	935–960	890–915
iDEN	iDEN	851–869	806–824
PCS	PCS A&D	1930–1950	1850–1870
	PCS B&E	1945–1965	1865–1885
	PCS D&B	1950–1970	1870–1890
	PCS E&F	1965–1975	1885–1895
	PCS F&C	1970–1990	1890–1910
UMTS	UMTS 1	2110–2145	1920–1955
	UMTS 2	2125–2160	1935–1970
	UMTS 3	2135–2170	1945–1980

5.1 Remote Access Unit Connectors

5.1.1 SMA Connector

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

5.1.2 RJ-45 Connector

The RAU has one RJ-45 connector that connects it to an Expansion Hub using Cat-5/6 ScTP cable. Use shielded RJ-45 connectors on the Cat-5/6 cable.

NOTE: For system performance, it is important that you use only Cat-5/6 ScTP cable with shielded RJ-45 connectors.

5.2 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 9 for troubleshooting using the LEDs.

Status LEDs

The RAU status LEDs can be in one of the states shown in Table 5-2. These LEDs can be:

- ○ off
- ● steady green
- ● steady red

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

Table 5-2 Remote Access Unit LED States

	LED State	Indicates
LINK ○ **ALARM** ○	Off Off	• RAU is not receiving DC power
LINK ● **ALARM** ●	Green Green	• RAU is powered and is not indicating a fault condition. Communication with Expansion Hub is normal; but the system test may need to be performed or a warning condition could exist (use AdminManager to determine)
LINK ● **ALARM** ●	Green Red	• RAU is indicating a fault or lockout condition, but communication with the Expansion Hub is normal
LINK ● **ALARM** ●	Red Red	• RAU is reporting a fault or lockout condition, and it is not able to communicate with the Expansion Hub

5.3 Faults and Warnings

Both fault and warning conditions are reported to the Expansion Hub where they are stored until the Main Hub queries system status. Only faults are indicated by LEDs.

For more information, see:

- page 9-10 for RAU faults.
- page 9-11 for RAU warnings.
- page 9-14 for RAU status messages.

5.4 Remote Access Unit Specifications

Table 5-3 Remote Access Unit Specifications

Specification	Description
Dimensions (H × W × D)	44 mm × 305 mm × 158 mm (1.7 in. × 12 in. × 6.2 in.)
Weight	< 1 kg (< 2 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 shielded RJ-45, female (Cat-5/6)[a] 1 SMA, male (coaxial)
LED Alarm and Status Indicators	Unit Status (1 pair): • Link • Alarm
Maximum Heat Dissipation (W)	11
MTBF	282,207 hours

a. For system performance, it is important that you use only Cat-5/6 ScTP cable with shielded RJ-45 connectors.

SECTION 6

Designing a Unison Solution

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

1. **Determine the wireless service provider's requirements.**

   This information is usually determined by the service provider:

   - Frequency (i.e., 850 MHz)
   - Band (i.e., "A" band in the Cellular spectrum)
   - Protocol (i.e., TDMA, CDMA, GSM, iDEN)
   - Peak capacity requirement (this, and whether or not the building will be split into sectors, determines the number of carriers that the system will have to transmit)
   - Design goal (RSSI, received signal strength at the wireless handset, i.e., –85 dBm)

     The design goal is always a stronger signal than the cell phone needs. It includes inherent factors which will affect performance (see Section 6.4.1 on page 6-29).
   - RF source (base station or BDA), type of equipment if possible

2. **Determine the power per carrier and input power from the base station or BDA into the Main Hub: Section 6.1, "Maximum Output Power per Carrier at RAU," on page 6-3.**

   The maximum power per carrier is a function of the number of RF carriers, the carrier headroom requirement, signal quality issues, regulatory emissions requirements, and Unison's RF performance. Typically, the power per carrier decreases as the number of carriers increases.

3. **Determine the in-building environment: Section 6.2, "Estimating RF Coverage," on page 6-16.**

   - Determine which areas of the building require coverage (entire building, public areas, parking levels, etc.)

- Obtain floor plans to determine floor space of building and the wall layout of the proposed areas to be covered. Floor plans will also be useful when you are selecting antenna locations.
- If possible, determine the building's construction materials (sheetrock, metal, concrete, etc.)
- Determine type of environment
  - Open layout (e.g., a convention center)
  - Dense, close walls (e.g., a hospital)
  - Mixed use (e.g., an office building with hard wall offices and cubicles)

4. **Develop an RF link budget: Section 6.4, "Link Budget Analysis," on page 6-28.**

   Knowing the power per carrier, you can calculate an RF link budget which is used to predict how much propagation loss can be allowed in the system, while still providing satisfactory performance throughout the area being covered. The link budget is a methodical way to derive a "design goal". If the design goal is provided in advance, the link budget is simply: *allowable RF loss = maximum power per carrier – design goal.*

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: Section 6.2, "Estimating RF Coverage," on page 6-16.**

   The path loss slope (PLS), which gives a value to the RF propagation characteristics within the building, is used to convert the RF link budget into an estimate of the coverage distance per antenna. This will help establish the Unison equipment quantities you will 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: Section 6.6, "Connecting a Main Hub to a Base Station," on page 6-42.**

   Once you know the quantities of Unison equipment you will use, you can determine the accessories (combiners/dividers, surge suppressors, repeaters, attenuators, circulators, etc.) that are required to connect the system to the base station.

The individual elements that must be considered in designing a Unison solution are discussed in the following sections.

6.1 Maximum Output Power per Carrier at RAU

The following tables show the recommended maximum power per carrier out of the RAU SMA connector for different frequencies, formats, and numbers of carriers. These limits are dictated by RF signal quality and regulatory emissions issues. The maximum input power to the Main 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 of each RAU gain can be reduced by 10 dB.

When you connect a Main Hub to a base station or repeater, the RF power per carrier usually needs to be attenuated in order to avoid exceeding Unison's maximum output power recommendations.

Refer to Section 6.7, "Designing for a Neutral Host System," on page 6-46 when combining frequencies or protocols on a single Main Hub.

WARNING: Exceeding the maximum input power could cause permanent damage to the Main Hub. Do not exceed the maximum composite input power of 1W (+30 dBm) to the Main Hub at any time.

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

800 MHz AMPS

Table 6-1 800 MHz (AMPS) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	10.0
6	10.0	10.0
7	10.0	10.0
8	9.5	9.5
9	9.0	9.0
10	8.0	8.0
11	8.0	8.0
12	7.5	7.5
13	7.0	7.0
14	6.5	6.5
15	6.5	6.5
16	6.0	6.0
20	5.0	5.0
30	3.0	3.0

800 MHz TDMA

Table 6-2 800 MHz (TDMA) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	10.0
6	10.0	10.0
7	10.0	10.0
8	9.5	9.5
9	9.0	9.0
10	8.5	8.5
11	8.0	8.0
12	7.5	7.5
13	7.5	7.5
14	7.0	7.0
15	6.5	6.5
16	6.5	6.5
20	5.5	5.5
30	3.5	3.5

800 MHz CDMA

Table 6-3 800 MHz (CDMA) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	16.0	16.0
2	14.0	14.0
3	12.0	12.0
4	11.0	11.0
5	10.0	10.0
6	9.0	9.0
7	8.5	8.5
8	8.0	8.0

800 MHz iDEN

Table 6-4 800 MHz (iDEN) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	9.0	9.0
6	8.0	8.0
7	7.0	7.0
8	6.5	6.5
9	6.0	6.0
10	5.5	5.5
11	5.0	5.0
12	4.5	4.5
13	4.0	4.0
14	4.0	4.0
15	3.5	3.5
16	3.0	3.0

900 MHz GSM or EGSM

Table 6-5 900 MHz (GSM or EGSM) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	9.5
4	10.0	8.0
5	9.0	7.0
6	8.5	6.5
7	8.0	6.0
8	7.5	5.5
9	7.0	5.0
10	6.5	4.5
11	6.5	4.5
12	6.0	4.0
13	5.5	3.5
14	5.5	3.5
15	5.0	3.0
16	5.0	3.0

900 MHz EDGE

Table 6-6 900 MHz (EDGE) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	9.0
5	9.0	8.0
6	8.5	7.0
7	8.0	6.5
8	7.5	6.0
9	7.0	5.5
10	6.5	5.5
11	6.5	5.0
12	6.0	4.5
13	5.5	4.5
14	5.5	4.0
15	5.0	4.0
16	5.0	3.5

1800 MHz DCS

Table 6-7 1800 MHz (DCS) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	9.0
6	10.0	8.5
7	10.0	8.0
8	9.0	7.5
9	8.5	7.0
10	8.0	6.5
11	7.5	6.5
12	7.0	6.0
13	6.5	5.5
14	6.5	5.5
15	6.0	5.0
16	5.5	5.0

1800 MHz EDGE

Table 6-8 1800 MHz (EDGE) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	10.0
6	9.5	9.0
7	9.0	8.5
8	8.0	8.0
9	7.5	7.5
10	7.0	7.0
11	6.5	6.5
12	6.0	6.0
13	6.0	6.0
14	5.5	5.5
15	5.0	5.0
16	5.0	5.0

1800 MHz CDMA Korea

Table 6-9 1800 MHz (CDMA Korea) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
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

1900 MHz TDMA

Table 6-10 1900 MHz (TDMA) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	10.0
6	10.0	10.0
7	9.5	9.5
8	8.5	8.5
9	8.0	8.0
10	7.5	7.5
11	7.0	7.0
12	6.5	6.5
13	6.5	6.5
14	6.0	6.0
15	5.5	5.5
16	5.5	5.5
20	4.5	4.5
30	2.5	2.5

1900 MHz GSM

Table 6-11 1900 MHz (GSM) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	9.0
6	10.0	8.5
7	10.0	8.0
8	9.0	7.5
9	8.5	7.0
10	8.0	6.5
11	7.5	6.5
12	7.0	6.0
13	6.5	5.5
14	6.5	5.5
15	6.0	5.0
16	5.5	5.0

1900 MHz CDMA

Table 6-12 1900 MHz (CDMA) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
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

1900 MHz EDGE

Table 6-13 1900 MHz (EDGE) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	10.0	10.0
2	10.0	10.0
3	10.0	10.0
4	10.0	10.0
5	10.0	10.0
6	9.5	9.0
7	9.0	8.5
8	8.0	8.0
9	7.5	7.5
10	7.0	7.0
11	6.5	6.5
12	6.0	6.0
13	6.0	6.0
14	5.5	5.5
15	5.0	5.0
16	5.0	5.0

2.1 GHz UMTS

Table 6-14 2.1 GHz (UMTS) Power per Carrier

No. of Carriers	Power per Carrier (dBm)	
	2 km SMF	1 km MMF
1	15.0	15.0
2	11.0	11.0
3	8.0	8.0
4	6.5	6.5
5	5.0	5.0
6	4.0	4.0
7	3.0	3.0

Note: measurements taken with no baseband clipping.

Paging/SMR

Table 6-15 Paging/SMR Power per Carrier: Analog FM, CQPSK, C4FM

Analog FM			CQPSK			C4FM		
	Power per Carrier (dBm)			Power per Carrier (dBm)			Power per Carrier (dBm)	
No. of Carriers	2 km SMF	1 km MMF	No. of Carriers	2 km SMF	1 km MMF	No. of Carriers	2 km SMF	1 km MMF
1	10.0	10.0	1	10.0	10.0	1	10.0	10.0
2	10.0	10.0	2	10.0	10.0	2	10.0	10.0
3	10.0	10.0	3	10.0	10.0	3	10.0	10.0
4	10.0	10.0	4	10.0	10.0	4	10.0	10.0
5	10.0	10.0	5	10.0	10.0	5	10.0	10.0
6	10.0	10.0	6	9.5	9.5	6	10.0	10.0
7	9.5	9.5	7	9.0	9.0	7	9.0	9.0
8	8.5	8.5	8	8.0	8.0	8	8.5	8.5
9	8.0	8.0	9	7.5	7.5	9	7.5	7.5
10	7.0	7.0	10	7.0	7.0	10	7.0	7.0

Table 6-16 Paging/SMR Power per Carrier: Mobitex, POCSAG/Reflex

Mobitex			POCSAG/Reflex		
	Power per Carrier (dBm)			Power per Carrier (dBm)	
No. of Carriers	2 km SMF	1 km MMF	No. of Carriers	2 km SMF	1 km MMF
1	10.0	10.0	1	10.0	10.0
2	10.0	10.0	2	10.0	10.0
3	10.0	10.0	3	10.0	10.0
4	10.0	10.0	4	10.0	10.0

Allowing for Future Capacity Growth

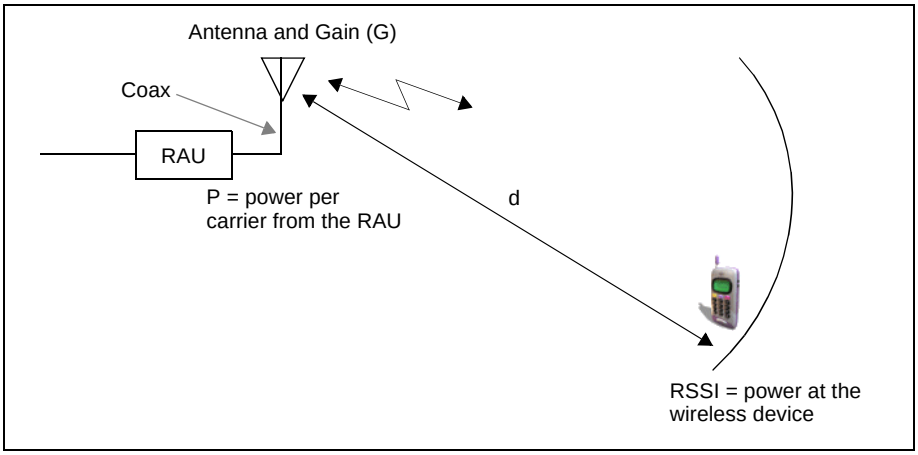
Sometimes a Unison deployment initially is used to enhance coverage. Later that same system may also need to provide increased capacity. Thus, the initial deployment might only transmit two carriers but need to transmit four carriers later. There are two options for dealing with this scenario:

1. Design the initial coverage with a maximum power per carrier for four carriers.
2. Design the initial coverage for two carriers but leave RAU ports on the Expansion Hubs unused. These ports can be used later if coverage holes are discovered once the power per carrier is lowered to accommodate the two additional carriers.

6.2 Estimating RF Coverage

The maximum power per carrier (based on the number and type of RF carriers that are being transmitted) and the minimum acceptable received power at the wireless device (i.e., RSSI, the design goal) establish the RF link budget, and consequently the maximum acceptable path loss between the antenna and the wireless device.

Figure 6-1 Determining Path Loss between the Antenna and the Wireless Device



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

The path loss (PL) is the loss in decibels (dB) between the antenna and the wireless device. The distance, d, from the antenna corresponding to this path loss can be calculated using the path loss equations in Section 6.2.1 and in Section 6.2.2.

Coaxial cable is used to connect the RAU to an antenna. The following table lists coaxial cable loss for various cable lengths.

Table 6-17 Coaxial Cable Losses

Length of Cable (.195 in. diameter)	Loss at 800 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

6.2.1 Path Loss Equation

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

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

where:

- PL is the path loss at a distance, d, from the antenna (the distance between the antenna that is connected to the RAU and the point where the RF signal decreases to the minimum acceptable level at the wireless device).
- d is the distance expressed in meters
- d_0 is usually taken as 1 meter of free-space.
- f is the operating frequency in hertz.
- c is the speed of light in a vacuum (3.0×10^8 m/sec).
- n is the path loss exponent and depends on the building "clutter".
- X_s is a normal random variable that depends on partition losses inside the building, and therefore, depends on the frequency of operation.

As a reference, the following table gives estimates of signal loss for some RF barriers.[1]

Table 6-18 Average Signal Loss of Common Building Materials

Partition Type	Loss (dB) @ <2 GHz	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.

6.2.2 Coverage Distance

Equations (1) and (2), on pages 6-16 and 6-17, respectively, can be used to estimate the distance from the antenna to where the RF signal decreases to the minimum acceptable level at the wireless device.

Equation (2) can be simplified to:

$$PL(d) = 20\log(4\pi f/c) + PLS\log(d) \quad (3)$$

where PLS (path loss slope) is chosen to account for the building's environment. Because different frequencies penetrate partitions with different losses, the value of PLS will vary depending on the frequency.

Table 6-19 shows estimated path loss slope (PLS) for various environments that have different "clutter" (i.e., objects that attenuate the RF signals, such as walls, partitions, stairwells, equipment racks, etc.)

Table 6-19 Estimated Path Loss Slope for Different In-Building Environments

Environment Type	Example	PLS for 800/900 MHz	PLS for 1800/1900 MHz
Open Environment with very few RF obstructions	Parking Garage, Convention Center	33.7	30.1
Moderately Open Environment with low-to-medium amount of RF obstructions	Warehouse, Airport, Manufacturing	35	32
Mildly Dense Environment with 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 with medium-to-high amount of RF obstructions	Office Space with approximately 50% cubicles and 50% hard walled offices	37.6	34.8
Dense Environment with large amount of RF obstructions	Hospital, Office Space with approximately 20% cubicles and 80% hard walled offices	39.4	38.1

For simplicity, Equation (3) can be used to estimate the coverage distance of an antenna that is connected to an RAU, for a given path loss, frequency, and type of in-building environment.

Table 6-20 gives the value of the first term of Equation (3) (i.e., (20log(4πf/c)) for various frequency bands.

Table 6-20 Frequency Bands and the Value of the first Term in Equation (3)

	Band (MHz)		Mid-Band Frequency (MHz)	20log(4πf/c)
	Uplink	Downlink		
800 MHz Cellular	824–849	869–894	859	31.1
800 MHz iDEN	806–824	851–869	837.5	30.9
900 MHz GSM	890–915	935–960	925	31.8
900 MHz EGSM	880–915	925–960	920	31.7
1800 MHz DCS	1710–1785	1805–1880	1795	37.5
1800 MHz CDMA (Korea)	1750–1780	1840–1870	1810	37.6
1900 MHz PCS	1850–1910	1930–1990	1920	38.1
2.1 GHz UMTS	1920–1980	2110–2170	2045	38.7

For reference, Tables 6-21 through 6-27 show the distance covered by an antenna for various in-building environments. The following assumptions were made:

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

Table 6-21 Approximate Radiated Distance from Antenna for 800 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 6-22 Approximate Radiated Distance from Antenna for 800 MHz iDEN Applications

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

Table 6-23 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 6-24 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 6-25 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 6-26 Approximate Radiated Distance from Antenna for 1800 MHz CDMA (Korea) Applications

Facility	Distance from Antenna	
	Meters	Feet
Open Environment	75	247
Moderately Open Environment	58	191
Mildly Dense Environment	51	167
Moderately Dense Environment	42	138
Dense Environment	30	100

Table 6-27 Approximate Radiated Distance from Antenna for 1900 MHz PCS Applications

	Distance from Antenna	
Facility	**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 6-28 Approximate Radiated Distance from Antenna for 2.1 GHz UMTS Applications

	Distance from Antenna	
Facility	**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

6.2.3 Examples of Design Estimates

Example Design Estimate for an 800 MHz TDMA Application

1. **Design goals**:
   - Cellular (859 MHz = average of the lowest uplink and the highest downlink frequency in 800 MHz Cellular band)
   - TDMA provider
   - 12 TDMA carriers in the system
   - –85 dBm design goal (to 95% of the building) — the minimum received power at the wireless device
   - Base station with simplex RF connections
2. **Power Per Carrier**: The tables in Section 6.1, "Maximum Output Power per Carrier at RAU," on page 6-3 provide maximum power per carrier information. The 800 MHz TDMA table (on page 6-5) indicates that Unison 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. **Building information**:
   - 8 floor building with 9,290 sq. meters (100,000 sq. ft.) per floor; total 74,322 sq. meters (800,000 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
4. **Link Budget**: In this example, a design goal of –85 dBm is used. Suppose 3 dBi omni-directional antennas are used in the design. Then, the maximum RF propagation loss should be no more than 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 usually derived taking into account multipath fading and log-normal shadowing characteristics. Thus, this design goal will only be met "on average" over 95% of the area being covered. At any given point, a fade may bring the signal level underneath the design goal.*

   Note that this method of calculating a link budget is only for the downlink path. For information to calculate link budgets for both the downlink and uplink paths, see Section 6.4 on page 6-28.
5. **Path Loss Slope**: For a rough estimate, Table 6-19, "Estimated Path Loss Slope for Different In-Building Environments" on page 6-18, 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 (see Section 6.2.1 for details on path loss estimation). For this case we assumed a circular radiation pattern, though the actual area covered will depend upon the pattern of the antenna and the obstructions in the facility.

Equipment Required: Since you know the building size, you can now estimate the Unison equipment quantities that will be needed. Before any RF levels are tested in the building, you can estimate that 2 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 × 8 floors = 16 RAUs

b. 16 RAUs ÷ 8 (maximum 8 RAUs per Expansion Hub) = 2 Expansion Hubs

c. 2 Expansion Hubs ÷ 4 (maximum 4 Expansion Hubs per Main Hub) = 1 Main Hub

Check that the fiber and Cat-5 cable distances are as recommended. If the distances differ, use the tables in Section 6.3, "System Gain," on page 6-27 to determine system gains or losses. The path loss may need to be recalculated to assure adequate signal levels in the required coverage distance.

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

An RF Site Survey and Building Evaluation is required to accurately establish the Unison 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 Unison system.

Example Design Estimate for an 1900 MHz CDMA Application

1. **Design goals**:
   - PCS (1920 MHz = average of the lowest uplink and the highest downlink frequency in 1900 MHz PCS band)
   - CDMA provider
   - 8 CDMA carriers in the system
   - –85 dBm design goal (to 95% of the building) — the minimum received power at the wireless device
   - Base station with simplex RF connections
2. **Power Per Carrier**: The tables in Section 6.1, "Maximum Output Power per Carrier at RAU," on page 6-3 provide maximum power per carrier information. The 1900 MHz CDMA table (on page 6-12) indicates that Unison can support 8 carriers with a recommended maximum power per carrier of 6.5 dBm. The input power should be set to the desired output power minus the system gain.
3. **Building information**:
   - 16 floor building with 9,290 sq. meters (100,000 sq. ft.) per floor; total 148,640 sq. meters (1,600,000 sq. ft.)
   - Walls are sheetrock construction; suspended ceiling tiles
   - Antennas used 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 –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 94.5 dB (6.5 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 usually derived taking into account multipath fading and log-normal shadowing characteristics. Thus, this design goal will only be met "on average" over 95% of the area being covered. At any given point, a fade may bring the signal level underneath the design goal.*

   Note that this method of calculating a link budget is only for the downlink path. For information to calculate link budgets for both the downlink and uplink paths, see Section 6.4 on page 6-28.
5. **Path Loss Slope**: For a rough estimate, Table 6-19, "Estimated Path Loss Slope for Different In-Building Environments" on page 6-18, shows that a building with 80% hard wall offices and 20% cubicles, at 1920 MHz, has an approximate path loss slope (PLS) of 38.1. Given the RF link budget of 94.5 dB, the distance of coverage from each RAU will be 30.2 meters (99 ft). This corresponds to a coverage area of 2,868 sq. meters (30,854 sq. ft.) per RAU (see Section 6.2.1 for details on path loss estimation). For this case we assumed 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 Unison equipment quantities that will be needed. Before any RF levels are tested in the building, you can estimate that 2 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 × 16 floors = 32 RAUs

   b. 32 RAUs ÷ 8 (maximum 8 RAUs per Expansion Hub) = 4 Expansion Hubs

   c. 4 Expansion Hubs ÷ 4 (maximum 4 Expansion Hubs per Main Hub) = 1 Main Hub

   Check that the MMF and Cat-5 cable distances are as recommended. If the distances differ, use the tables in Section 6.3, "System Gain," on page 6-27 to determine system gains or losses. The path loss may need to be recalculated to assure adequate signal levels in the required coverage distance.

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

An RF Site Survey and Building Evaluation is required to accurately establish the Unison 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 Unison system.

6.3 System Gain

The system gain can be decreased from 15 dB to 0 dB gain in 1 dB increments and the uplink and downlink gains of each RAU can be independently decreased by 10 dB in one step using AdminManager or OpsConsole.

6.3.1 System Gain (Loss) Relative to ScTP Cable Length

The recommended minimum length of ScTP cable is 10 meters (33 ft) and the recommended maximum length is 100 meters (328 ft). The system should not be operated with ScTP cable that is less than 10 meters (33 ft) in length, system performance will be greatly compromised. If the ScTP cable is longer than 100 meters (328 ft), the gain of the system will decrease, as shown in Table 6-29.

Table 6-29 System Gain (Loss) Relative to ScTP Cable Length

ScTP Cable Length	Typical change in system gain (dB)	
	Downlink	Uplink
800 MHz TDMA/AMPS and CDMA; 900 MHz GSM and EGSM; and iDEN		
110 m / 361 ft	–1.0	–0.7
120 m / 394 ft	–3.2	–2.4
130 m / 426 ft	–5.3	–4.1
140 m / 459 ft	–7.5	–5.8
150 m / 492 ft	–9.7	–7.6
1800 MHz GSM (DCS); 1900 MHz TDMA, CDMA, and GSM		
110 m / 361 ft	–1.0	–0.7
120 m / 394 ft	–4.0	–2.4
130 m / 426 ft	–6.4	–4.1
140 m / 459 ft	–8.8	–5.8
150 m / 492 ft	–11.3	–7.6
2.1 GHz UMTS		
110 m / 361 ft	–1.0	–0.7
120 m / 394 ft	–3.2	–2.4
130 m / 426 ft	–5.3	–4.1
140 m / 459 ft	–7.5	–5.8
150 m / 492 ft	–9.7	–7.6

6.4 Link Budget Analysis

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

One key feature of the link budget is the maximum power per carrier discussed in Section 6.1. While the maximum power per carrier is important as far as emissions and signal quality requirements are concerned, it is critical that the maximum signal into the Main Hub never exceed 1W (+30 dBm). Composite power levels above this limit will cause damage to the Main Hub.

WARNING: Exceeding the maximum input power of 1W (+30 dBm) could cause permanent damage to the Main Hub.

6.4.1 Elements of a Link Budget for Narrowband Standards

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

The link budget is organized in a simple manner: the transmitted power is calculated, the airlink losses due to fading and body loss are summed, and the receiver sensitivity (minimum level a signal can be received for acceptable call quality) is calculated. The maximum allowable path loss (in dB) is the difference between the transmitted power, less the airlink losses, and the receiver sensitivity. From the path loss, the maximum coverage distance can be estimated using the path loss formula presented in Section 6.2.1.

Table 6-30 provides link budget considerations for narrowband systems.

Table 6-30 Link Budget Considerations for Narrowband Systems

Consideration	Description
BTS Transmit Power	The power per carrier transmitted from the base station output
Attenuation between BTS and Unison	This includes all losses: cable, attenuator, splitter/combiner, and so forth. On the downlink, attenuation must be chosen so that the maximum power per carrier going into the Main Hub does not exceed the levels given in Section 6.1. On the uplink, attenuation is chosen to keep the maximum uplink signal and noise level low enough to prevent base station alarms but small enough not to cause degradation in the system sensitivity. If the Unison noise figure minus the attenuation is at least 10 dB higher than the BTS noise figure, the system noise figure will be approximately that of Unison alone. See Section 6.6 for ways to independently set the uplink and downlink attenuations between the base station and Unison.
Antenna Gain	The radiated output power includes antenna gain. For example, if you use a 3 dBi antenna at the RAU that is transmitting 0 dBm per carrier, the effective radiated power (relative to an isotropic radiator) is 3 dBm per carrier.
BTS Noise Figure	This is the effective noise floor of the base station input (usually base station sensitivity is this effective noise floor plus a certain C/I ratio).
Unison Noise Figure	This is Unison’s uplink noise figure, which varies depending on the number of Expansion Hubs and RAUs, and the frequency band. Unison’s uplink noise figure is specified for a 1-1-4 configuration. Thus, the noise figure for a Unison system (or multiple systems whose uplink ports are power combined) will be *NF(1-1-4) + 10*log(# of Expansion Hubs).* This represents an upper-bound because the noise figure is lower if any of the Expansion Hub’s RAU ports are **not** used.

Table 6-30 Link Budget Considerations for Narrowband Systems (continued)

<table>
<tr><th>Consideration</th><th>Description</th></tr>
<tr><td>Thermal Noise</td><td>This is the noise level in the signal bandwidth (BW).
Thermal noise power = –174 dBm/Hz + 10Log(BW).
<table><tr><th>Protocol</th><th>Signal Bandwidth</th><th>Thermal Noise</th></tr><tr><td>TDMA</td><td>30 kHz</td><td>–129 dBm</td></tr><tr><td>GSM</td><td>200 kHz</td><td>–121 dBm</td></tr><tr><td>iDEN</td><td>25 kHz</td><td>–130 dBm</td></tr></table></td></tr>
<tr><td>Required C/I ratio</td><td>For each wireless standard a certain C/I (carrier to interference) ratio is needed to obtain acceptable demodulation performance. For narrowband systems, (TDMA, GSM, EDGE, iDEN, AMPS) this level varies from about 9 dB to 20 dB.</td></tr>
<tr><td>Mobile Transmit Power</td><td>The maximum power the mobile can transmit (power transmitted at highest power level setting).</td></tr>
<tr><td>Multipath Fade Margin</td><td>This margin allows for a certain level of fading due to multipath interference. Inside buildings there is often one or more fairly strong signals and many weaker signals arriving from reflections and diffraction. Signals arriving from multiple paths add constructively or destructively. This margin accounts for the possibility of destructive multipath interference. In RF site surveys this margin will not appear because it will be averaged out over power level samples taken over many locations.</td></tr>
<tr><td>Log-normal Fade Margin</td><td>This margin adds an allowance for RF shadowing due to objects obstructing the direct path between the mobile equipment and the RAU. In RF site surveys, this shadowing will not appear because it will be averaged out over power level samples taken over many locations.</td></tr>
<tr><td>Body Loss</td><td>This accounts for RF attenuation caused by the user’s head and body.</td></tr>
<tr><td>Minimum Received Signal Level</td><td>This is also referred to as the “design goal”. The link budget says that you can achieve adequate coverage if the signal level is, on average, above this level over 95% of the area covered, for example.</td></tr>
</table>

6.4.2 Narrowband Link Budget Analysis for a Microcell Application

Narrowband Link Budget Analysis: Downlink

Line	Downlink	
	Transmitter	
a.	BTS transmit power per carrier (dBm)	33
b.	Attenuation between BTS and Unison (dB)	–23
c.	Power into Unison (dBm)	10
d.	Unison gain (dB)	0
e.	Antenna gain (dBi)	3
f.	Radiated power per carrier (dBm)	**13**
	Airlink	
g.	Multipath fade margin (dB)	6
h.	Log-normal fade margin with 8 dB std. deviation, edge reliability 90% (dB)	10
i.	Body loss (dB)	3
j.	Airlink losses (not including facility path loss)	**19**
	Receiver	
k.	Thermal noise (dBm/30 kHz)	–129
l.	Mobile noise figure (dB)	7
m.	Required C/I ratio (dB)	12
n.	Minimum received signal (dBm)	**–110**
p.	**Maximum path loss** (dB)	**104**

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

Narrowband Link Budget Analysis: Uplink

Line	Uplink	
	Receiver	
a.	BTS noise figure (dB)	4
b.	Attenuation between BTS and Unison (dB)	–10
c.	Unison gain (dB)	0
d.	Unison noise figure (dB) 1-4-32	22
e.	System noise figure (dB)	22.6
f.	Thermal noise (dBm/30 kHz)	–129
g.	Required C/I ratio (dB)	12
h.	Antenna gain (dBi)	3
i.	Receive sensitivity (dBm)	**–97.4**
	Airlink	
j.	Multipath fade margin (dB)	6
k.	Log-normal fade margin with 8 dB std. deviation, edge reliability 90% (dB)	10
l.	Body loss (dB)	3
m.	Airlink losses (not including facility path loss)	**19**
	Transmitter	
n.	Mobile transmit power (dBm)	28
p.	**Maximum path loss** (dB)	**106.4**

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

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

where

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

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

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

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

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

6.4.3 Elements of a Link Budget for CDMA Standards

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

An important issue to keep in mind is that the downlink CDMA signal is composed of many orthogonal channels: pilot, paging, sync, and traffic. The composite power level is the sum of the powers from the individual channels. An example is given in the following table.

Table 6-31 Distribution of Power within a CDMA Signal

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

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

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

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

$P_{TX} + P_{RX} = -76$ dBm (for PCS, J-STD-008)

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

The power level transmitted under closed-loop power control is adjusted by the base station to achieve a certain E_b/N_0 (explained in Table 6-32 on page 6-34). The difference between these power levels, Δ_P, can be estimated by comparing the power radiated from the RAU, $P_{downink}$, to the minimum received signal, P_{uplink}, at the RAU:

$\Delta_P = P_{downink} + P_{uplink} + 73$ dBm (for Cellular)

$\Delta_P = P_{downink} + P_{uplink} + 76$ dBm (for PCS)

It's a good idea to keep -12 dB $< \Delta_P < 12$ dB.

Table 6-32 provides link budget considerations for CDMA systems.

Table 6-32 Additional Link Budget Considerations for CDMA

Consideration	Description
Multipath Fade Margin	The multipath fade margin can be reduced (by at least 3 dB) by using different lengths of optical fiber (this is called "delay diversity"). The delay over fiber is approximately 5µS/km. If the difference in fiber lengths to Expansion Hubs with overlapping coverage areas produces at least 1 chip (0.8µS) delay of one path relative to the other, then the multipaths' signals can be resolved and processed independently by the base station's rake receiver. A CDMA signal traveling through 163 meters of MMF cable will be delayed by approximately one chip.
Power per carrier, downlink	This depends on how many channels are active. For example, the signal will be about 7 dB lower if only the pilot, sync, and paging channels are active compared to a fully-loaded CDMA signal. Furthermore, in the CDMA forward link, voice channels are turned off when the user is not speaking. On average this is assumed to be about 50% of the time. So, in the spreadsheet, both the power per Walsh code channel (representing how much signal a mobile will receive on the Walsh code that it is de-spreading) and the total power are used. The channel power is needed to determine the maximum path loss, and the total power is needed to determine how hard the Unison system is being driven. The total power for a fully-loaded CDMA signal is given by (approximately): total power = voice channel power + 13 dB + $10log_{10}(50\%)$ = voice channel power + 10 dB
Information Rate	This is simply $10log_{10}$(9.6 Kbps) = 40 dB for rate set 1 $10log_{10}$(14.4 Kbps) = 42 dB for rate set 2
Process Gain	The process of de-spreading the desired signal boosts that signal relative to the noise and interference. This gain needs to be included in the link budget. In the following formulas, P_G = process gain: $P_G = 10log_{10}(1.25\ MHz / 9.6\ Kbps) = 21$ dB rate set 1 $P_G = 10log_{10}(1.25\ MHz / 14.4\ Kbps) = 19$ dB rate set 2 Note that the process gain can also be expressed as $10log_{10}$ (CDMA bandwidth) minus the information rate.

Table 6-32 Additional Link Budget Considerations for CDMA (continued)

Consideration	Description
Eb/No	This is the energy-per-bit divided by the received noise and interference. It's the CDMA equivalent of signal-to-noise ratio (SNR). This figure depends on the mobile's receiver and the multipath environment. For example, the multipath delays inside a building are usually too small for a rake receiver in the mobile (or base station) to resolve and coherently combine multipath components. However, if artificial delay can be introduced by, for instance, using different lengths of cable, then the required E_b/N_o will be lower and the multipath fade margin in the link budget can be reduced in some cases. If the receiver noise figure is NF (dB), then the receive sensitivity (dBm) is given by: $P_{sensitivity} = NF + E_b/N_o$ + thermal noise in a 1.25 MHz band $- P_G$ $=$ NF $+ E_b/N_o - 113$ ($dBm/1.25\ MHz$) $- P_G$
Noise Rise	On the uplink, the noise floor is determined not only by the Unison system, but also by the number of mobiles that are transmitting. This is because when the base station attempts to de-spread a particular mobile's signal, all other mobile signals appear to be noise. Because the noise floor rises as more mobiles try to communicate with a base station, the more mobiles there are, the more power they have to transmit. Hence, the noise floor rises rapidly: $noise\ rise = 10log_{10}(1 / (1 - loading))$ where *loading* is the number of users as a percentage of the theoretical maximum number of users. Typically, a base station is set to limit the loading to 75%. This noise ratio must be included in the link budget as a worst-case condition for uplink sensitivity. If there are less users than 75% of the maximum, then the uplink coverage will be better than predicted.
Hand-off Gain	CDMA supports soft hand-off, a process by which the mobile communicates simultaneously with more than one base station or more than one sector of a base station. Soft hand-off provides improved receive sensitivity because there are two or more receivers or transmitters involved. A line for hand-off gain is included in the CDMA link budgets worksheet although the gain is set to 0 dB because the in-building system will probably be designed to limit soft-handoff.

Other CDMA Issues

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

6.4.4 Spread Spectrum Link Budget Analysis for a Microcell Application

Spread Spectrum Link Budget Analysis: Downlink

Line	Downlink	
	Transmitter	
a.	BTS transmit power per traffic channel (dBm)	30.0
b.	Voice activity factor	50%
c.	Composite power (dBm)	40.0
d.	Attenuation between BTS and Unison (dB)	–24
e.	Power per channel into Unison (dBm)	9.0
f.	Composite power into Unison (dBm)	16.0
g.	Unison gain (dB)	0.0
h.	Antenna gain (dBi)	3.0
i.	Radiated power per channel (dBm)	12.0
j.	Composite radiated power (dBm)	**19.0**
	Airlink	
k.	Handoff gain (dB)	0.0
l.	Multipath fade margin (dB)	6.0
m.	Log-normal fade margin with 8 dB std. deviation, edge reliability 90% (dB)	10.0
n.	Additional loss (dB)	0.0
o.	Body loss (dB)	3.0
p.	Airlink losses (not including facility path loss)	**19.0**
	Receiver	
q.	Mobile noise figure (dB)	7.0
r.	Thermal noise (dBm/Hz)	–174.0
s.	Receiver interference density (dBm/Hz)	–167.0
t.	Information ratio (dB/Hz)	41.6
u.	Required $Eb/(N_o+l_o)$	7.0
v.	Receive Sensitivity (dBm)	–118.4
w.	Minimum received signal (dBm)	**–99.4**
x.	**Maximum path loss** (dB)	**–99.4**

- b and c: see notes in Table 6-32 regarding power per carrier, downlink
- e = a + d
- f = c + d
- i = e + g + h
- j = f + g + h
- p = –k + l + m + n + o
- s = q + r
- v = s + t + u
- w = p + v
- x = j – w
- y = j (downlink) + m (uplink) + P

  where

  P = Ptx + Prx = –73 dB for Cellular
  –76 dB for PCS

Spread Spectrum Link Budget Analysis: Uplink

Line	Uplink	
	Receiver	
a.	BTS noise figure (dB)	3.0
b.	Attenuation between BTS and Unison (dB)	–30.0
c.	Unison gain (dB)	0.0
d.	Unison noise figure (dB)	22.0
e.	System noise figure (dB)	33.3
f.	Thermal noise (dBm/Hz)	–174.0
g.	Noise rise 75% loading (dB)	6.0
h.	Receiver interference density (dBm/Hz)	–134.6
i.	Information rate (dB/Hz)	41.6
j.	Required $Eb/(N_o+I_o)$	5.0
k.	Handoff gain (dB)	0.0
l.	Antenna gain (dBi)	3.0
m.	Minimum received signal (dBm)	**–91.1**
	Airlink	
n.	Multipath fade margin (dB)	6.0
o.	Log-normal fade margin with 8 dB std. deviation, edge reliability 90% (dB)	10.0
p.	Additional loss (dB)	0.0
q.	Body loss (dB)	3.0
r.	Airlink losses (not including facility path loss)	**19.0**
	Transmitter	
s.	Mobile transmit power (dBm)	28.0
t.	**Maximum path loss** (dB)	**100.1**

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

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

  where

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

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

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

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

6.4.5 Considerations for Re-Radiation (over-the-air) Systems

Unison can be used to extend the coverage of the outdoor network by connecting to a roof-top donor antenna that is pointed toward an outdoor base station. Additional considerations for such an application of Unison are:

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

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

6.5 Optical Power Budget

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

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

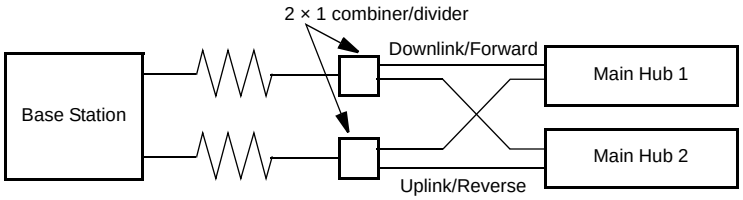
The maximum loss through the fiber can not exceed 3 dB (optical). The maximum lengths of the fiber cable should not exceed 1.5 km (4,921 ft) for multi-mode and 6 km (19,685 ft) for single-mode. Both the optical budget and the maximum cable length must be taken into consideration when designing the system.

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

6.6 Connecting a Main Hub to a Base Station

The first consideration when connecting Unison Main Hubs to a base station is to ensure there is an equal amount of loss through cables, combiners, etc. from the base station to the Main Hubs. For this example, assume that the base station will have simplex connections, one uplink and one downlink. Each of these connections will need to be divided to equilibrate power for each Main Hub. For example, two Main Hubs will require a 2×1 combiner/divider; four Main Hubs will require a 4×1 combiner/divider; and so on.

Figure 6-2 Connecting Main Hubs to a Simplex Base Station



When connecting a Unison Main Hub to a base station, also consider the following:

1. The downlink power from the base station must be attenuated enough so that the power radiated by the RAU does not exceed the maximum power per carrier listed in Section 6.1, “Maximum Output Power per Carrier at RAU,” on page 6-3.
2. The uplink attenuation should be small enough that the sensitivity of the overall system is limited by Unison, not by the attenuator. However, some base stations will trigger alarms if the noise or signal levels are too high. In this case the attenuation will have to be large enough to prevent this from happening.

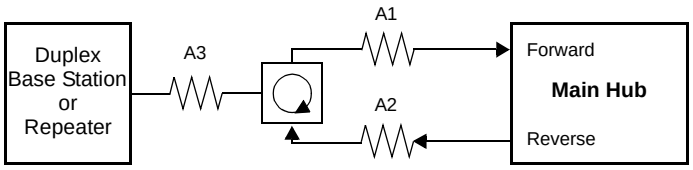
If, in an area covered by Unison, a mobile phone indicates good signal strength but consistently has difficulty completing calls, it is possible that the attenuation between Unison and the base station needs to be adjusted. In other words, it is possible that if the uplink is over-attenuated, the downlink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

When there is an excessive amount of loss between the Main Hub uplink and the base station, the uplink system gain can be increased to as much as 15 dB to prevent a reduction in the overall system sensitivity.

6.6.1 Attenuation

Figure 6-3 shows a typical setup wherein a duplex base station is connected to a Main Hub. For a simplex base station, eliminate the circulator and connect the simplex ports of the base station to the simplex ports of the Main Hub. Add attenuators to regulate the power appropriately.

Figure 6-3 Main Hub to Duplex Base Station or Repeater Connections



- A typical circulator has an IP3 of +70dBm. If you drive the circulator too hard it will produce intermods that are bigger than the intermods produced by Unison. The IP3 at the Forward port input of the Main Hub is approximately +38 dBm. The IP3 of the circulator at that same point (i.e., following attenuator A1) is +70dBm – A1. Thus, to keep the system IP3 from being adversely affected by the circulator, attenuator A1 should be no more than approximately +30 dB.
- A filter diplexer can be used in place of the circulator. The IP3 of the diplexer can be assumed to be greater than +100 dBm. If a diplexer is used, A3 can be omitted.
- A1+A3 should be chosen so that the output power per carrier at the RAU's output is correct for the number of carriers being transmitted. Suppose the base station transmits 36 dBm per carrier and it is desired that the RAU output be 6 dBm per carrier and the forward port gain is 0 dB. Then A1+A3=30 dB.
- A2+A3 should, ideally, be at least 10 dB less than the noise figure plus the gain of the Unison system. For example, if the reverse port has a 0 dB gain and if there are 32 RAUs, the noise figure is approximately 22 dB. So A2+A3 should be about 10 dB. If A2+A3 is too large, the uplink coverage can be severely reduced.
- Given these three equations:
  A1 < 30 dB
  A1+A3 = 30 dB (in this example)
  A2+A3 < 10 dB (in this example)
  we could choose A1=20 dB, A2=0 dB, A3=10 dB

6.6.2 Uplink Attenuation

The attenuation between the Main Hub's uplink port and the base station does two things:

1. It attenuates the noise coming out of Unison.
2. It attenuates the desired signals coming out of Unison.

Setting the attenuation on the uplink is a trade-off between keeping the noise and maximum signal levels transmitted from Unison 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 Unison by itself, although it can be significantly worse.

For example, suppose we have a GSM Unison system consisting of one Main Hub, four Expansion Hubs, and 32 RAUs (1-4-32) with uplink NF=22 dB. (See Table 6-32 on page 6-34.) If we use 30 dB of attenuation between the Main Hub's uplink port and the base station (which has its own noise figure of about 4 dB), the overall noise figure will be 34.3 dB (refer to the formula on page 6-32) which is 12.3 dB worse than Unison by itself. That causes a 12.3 dB reduction in the uplink coverage distance. Now, if the attenuation instead is 10 dB, the cascaded noise figure is NF=22.6 dB, which implies that the uplink sensitivity is limited by Unison, a desirable condition.

Rule of Thumb

A good rule of thumb is to set the uplink attenuation, A2+A3 in Figure 6-3 on page 6-43, as follows:

$$A2+A3 \approx \text{Unison uplink NF} + \text{uplink gain (0 dB for reverse port)} - \text{BTS NF} - 10\text{dB}$$

and round A2 *down* to the nearest convenient attenuation value.

6.6.2.1 Uplink Attenuation Exception: CDMA

In CDMA systems, the power transmitted by the mobile is determined by the characteristics of both the uplink and downlink paths. The power transmitted by the mobile should be similar in open-loop control (as determined by the downlink path) as during closed-loop control (as determined by the uplink and downlink paths). In addition, the mobile's transmit power when it communicates with a base station through Unison should be similar to the power transmitted when it communicates with a base station in the outdoor network (during soft hand-off). Because of these considerations, you should not allow the downlink and uplink gains to vary widely.

Open-loop power control:

$P_{TX} = -76$ dBm (for PCS) $- P_{RX}$

where P_{TX} is the power transmitted and P_{RX} is the power received by the mobile. If PL is the path loss (in dB) between the RAU and the mobile, and P_{DN} is the downlink power radiated by the RAU, then

$P_{TX} = -76$ dBm (for PCS) $- P_{DN} + PL$

Closed-loop power control:

P_{TX} = noise floor + uplink NF – process gain + Eb/No + PL

= –113 dBm/1.25 Mhz + NF – 19 dB + 7 dB + PL

where Eb/No = 7 dB is a rough estimate, and NF is the cascaded noise figure of the Unison uplink, the uplink attenuation, and the base station noise figure. Equating P_{TX} for the open-loop and closed-loop we see that

$NF = 49 - P_{DN}$

where P_{DN} is determined by the downlink attenuation. Since P_{DN} for Unison is about 10 dBm, we see that the cascaded noise figure is about 39 dB, which is considerably higher than that of Unison itself. This implies that we should use a fairly large attenuation on the uplink. This case suggests using as much attenuation on the downlink as on the uplink. The drawback of doing this is that the uplink coverage sensitivity is reduced. A link budget analysis will clarify these issues. Typically, the uplink attenuation between the Main Hub and the base station will be the same as, or maybe 10 dB less than, the downlink attenuation.

6.7 Designing for a Neutral Host System

Designing for a neutral host system uses the same design rules previously discussed. Since a neutral host system typically uses *multiple systems in parallel* with common equipment locations, we find it best to design according to the minimum among the systems' RAU coverage distances so that there will not be holes in the coverage area, and so that the economies of a single installation can be achieved. For example, as indicated in Section 7.1, the 1900 MHz RF signals do not propagate throughout a building as well as the 800 MHz signals. Therefore, we design using the 1900 MHz radiated distance, calculated with the path loss slope formula.

The example neutral host system described below consists of one iDEN, one 800 MHz, and two 1900 MHz systems and can support up to seven separate service providers in the following manner:

- 1 on iDEN
- 2 on 800 MHz, A band and B band
- 2 in each of the two 1900 MHz frequency sub-bands

Example Unison Neutral Host System

The following example configuration was designed to provide:

- Similar coverage per band in an office environment that is 80% cubicles and 20% offices.
- Similar capacity.
- Support for up to 7 Operators, where equipment has been shared to minimize the number of parallel systems.

Example Configuration:

- 800 MHz iDEN: 16 channels (3 dBm)
- 800 MHz Cellular (3 dBm)

  TDMA Band: 14 channels (shared)

  CDMA Band: 3 channels (shared)
- 1900 MHz PCS (6 dBm)

  TDMA Band: 14 channels

  CDMA Band: 3 channels (shared)

  GSM Band: 6 channels (shared)

Similar coverage is achieved by setting the transmit power per carrier of the 800 MHz systems to 3 dBm per carrier and those of the 1900 MHz systems to 6 dBm per carrier.

The numbers of RF carriers were selected in order to match subscriber capacity approximately. Because each protocol in the example supports a different number of voice channels, the RF carrier numbers also differ. As the following table indicates, the 800 MHz Cellular and shared 1900 MHz systems can support additional RF carriers without decreasing the power per carrier figures.

For logistical reasons, Operators involved in a neutral host system sometimes prefer not to share equipment with other Operators. From technical and economic perspectives, too, this can be a prudent practice in medium to high-capacity installations. Though deploying parallel systems appears to increase the amount of equipment needed as well as the system cost, the trade-off between capacity and coverage must be considered because, in short, as capacity increases, coverage area per RAU decreases. Therefore, more RAUs (and perhaps Expansion Hubs and Main Hubs) are needed to cover a given floor space.

The following table shows the capacities of both 800 and 1900 MHz Unison systems used for single and multiple protocol applications. The power per carrier for each system is based on providing equal coverage areas for both systems when they are used in an office building that is 80% cubicles and 20% offices.

Table 1 Unison Capacity: Equal Coverage Areas

Operator #1				Operator #2			
Protocol	**RF Chs**	**Voice Chs**	**Subscribers**	**Protocol**	**RF Chs**	**Voice Chs**	**Subscribers**
800 MHz Cellular A/B (Unison); 3 dBm power per carrier							
TDMA only	35	104	1837	**N/A**	—	—	—
CDMA only	12	180–240	3327–4517	**N/A**	—	—	—
TDMA (combining with CDMA: Operator #2)	15	44	694	**CDMA** (combining with TDMA: Operator #1)	10	150–200	2736–3723
	20	59	974		7	105–140	1856–2540
	25	74	1259		4	60–80	993–1374
	28	83	1431		2	30–40	439–620
800 MHz iDEN (Unison); 3 dBm power per carrier							
iDEN only	16	47	749	**N/A**	—	—	—
1900 MHz PCS (Unison); 6 dBm power per carrier							
TDMA only	14	41	638	**N/A**	—	—	—
CDMA only	10	150–200	2736–3723	**N/A**	—	—	—
GSM only	14	111	1973	**N/A**	—	—	—
TDMA (combining with CDMA: Operator #2)	6	17	213	**CDMA** (combining with TDMA: Operator #1)	4	60–80	993–1374
	8	23	315		3	45–60	712–993
	10	29	421		2	30–40	439–620
	11	32	474		1	15–20	180–264
TDMA (combining with GSM: Operator #2)	6	17	213	**GSM** (combining with TDMA: Operator #1)	7	55	899
	8	23	315		5	39	602
	10	29	421		3	23	315
	11	32	474		2	15	180
CDMA (combining with GSM: Operator #2)	2	30–40	439–620	**GSM** (combining with CDMA: Operator #1)	10	79	1355
	4	60–80	993–1374		7	55	899
	6	90–120	1566–2148		4	31	457
	8	120–200	2148–2933		1	7	59

Note 1

The RF channel capacity limits are based on the Unison data sheets' "typical" specifications for fiber length, Cat-5 length, and RF performance.

Note 2

The subscriber capacity limits are based on the Erlang B traffic model with a 2% GOS. Each user has a 50mErlangs, which is higher than the standard 35mErlangs.

SECTION 7

Installing Unison

7.1 Installation Requirements

7.1.1 Component Location Requirements

Unison components are intended to be installed in indoor locations only.

7.1.2 Cable and Connector Requirements

The Unison equipment operates over:

- Category 5 or 6 (Cat-5/6) screened twisted pair (ScTP) cable with shielded RJ-45 connectors
- Single-mode fiber (SMF) or multi-mode fiber (MMF) cable with SC/APC fiber connectors throughout the fiber network, including fiber distribution panels

These cables are widely used industry standards for Local Area Networks (LANs). The regulations and guidelines for Unison cable installation are identical to those specified by the TIA/EIA 568-A standard and the TIA/EIA/IS-729 supplement for LANs.

LGC Wireless recommends plenum-rated Cat-5/6 ScTP and fiber cable and connectors for conformity to building codes and standards.

Mohawk/CDT 55986 or Belden 1624P DataTwist® Five ScTP cable, or equivalent is required.

NOTE: In order to meet FCC and CE Mark emissions requirements, the Cat-5/6 cable must be screened (ScTP) and it must be grounded using shielded RJ-45 connectors at both ends.

7.1.3 Multiple Operator System Recommendations

As in any Unison system, a multiple operator (neutral host) system requires one pair of fiber strands between each Main Hub and each Expansion Hub, and one Cat-5/6 cable between each Expansion Hub and each RAU. In situations where Hubs and/or RAUs will be installed in the future to support the addition of frequency bands and/or wireless Operators, it is advantageous to install the necessary cabling initially. Such deployment typically leads to substantial cost savings over installing parallel cabling at separate times.

7.1.4 Distance Requirements

The following table shows the distances between Unison components and related equipment.

Table 7-1 Unison Distance Requirements

Equipment Combination	Cable Type	Distance	Additional Information
Repeater to Main Hub	Coaxial; N male connectors	3–6 m (10–20 ft) typical	Limited by loss and noise. Refer to your link budget calculation.
		10 m (33 ft) maximum	Limited by CE Mark requirements.
Base Station to Main Hub	Coaxial; N male connectors	3–6 m (10–20 ft) typical	Limited by loss and noise. Refer to your link budget calculation.
		10 m (33 ft) maximum	Limited by CE Mark requirements.
Main Hub to Expansion Hub	Multi-mode Fiber: Single-mode Fiber: SC/APC male connectors	1.5 km (4,921 ft) max. 6 km (19,685 ft) max.	Limited by 3 dB optical loss.
Expansion Hub to RAU	Cat-5/6 ScTP; shielded RJ-45 male connectors	• Minimum: 10 meters (33 ft) • Recommended Max.: 100 meters (328 ft) • Absolute Max.: 150 meters (492 ft)	See “System Gain (Loss) Relative to ScTP Cable Length” on page 6-27.
RAU to passive antenna	Coaxial; SMA male connectors	1–3.5 m (3–12 ft) typical	Limited by loss and noise. Refer to your link budget calculation.

7.2 Safety Precautions

7.2.1 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 supply has 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.

7.2.2 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)
  +44(0) 1223 597812 (Europe)

- 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 the fiber optic cable, take the same precaution as if installing Ethernet network equipment. All optical fiber SC/APC connectors should be cleaned according to the cable manufacturer's instructions.
- When you connect a radiating antenna to an RAU, **DO NOT** over-tighten the SMA connector. Firmly hand-tightening the connector is adequate.

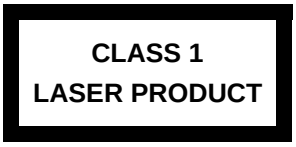
WARNING: To reduce the risk of fire or electric shock, do not expose this equipment to rain or moisture. The components are intended for indoor use only. Do not install the RAU outdoors. Do not connect an RAU to an antenna that is located outside where it could be subject to lightning strikes, power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

7.2.3 Fiber Port Safety Precautions

The following are suggested safety precautions for working with fiber ports. For information about system compliance with safety standards, see Appendix C.

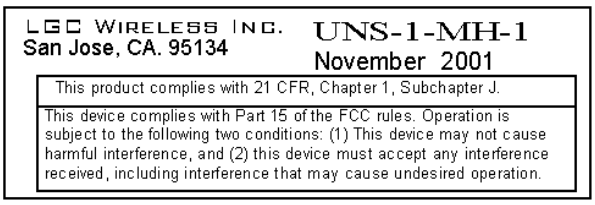
WARNING: Observe the following warning about viewing fiber ends in ports. Do not stare with unprotected eyes at the connector ends of the fibers or the ports of the hubs. Invisible infrared radiation is present at the front panel of the Main Hub and the Expansion Hub. Do not remove the fiber port dust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

- **Test fiber cables:** When you test fiber optic cables, connect the optical power source last and disconnect it first. Use Class 1 test equipment.
- **Fiber ends:** Cover any unconnected fiber ends with an approved cap. Do not use tape.
- **Broken fiber cables:** Do not stare with unprotected eyes at any broken ends of the fibers. Laser light emitted from fiber sources can cause eye injury. Avoid contact with broken fibers; they are sharp and can pierce the skin. Report any broken fiber cables and have them replaced.
- **Cleaning:** Be sure the connectors are clean and free of dust or oils. Use only approved methods for cleaning optical fiber connectors.
- **Modifications:** Do not make any unauthorized modifications to this fiber optic system or associated equipment.
- **Live work:** Live work is permitted because LGC Wireless equipment is a Class 1 hazard.
- **Signs:** No warning signs are required.
- **Class 1 laser product:** The system meets the criteria for a Class 1 laser product per IEC 60825-1:1998-01 and IEC 60825-2:2000-05.



This label appears on the front panel of the Main Hub and the Expansion Hub.

In addition, it is certified by the FDA to meet 21CFR, Chapter 1, Subchapter J.



This label appears on the bottom of the Main Hub and a similar one appears on the bottom of the Expansion Hub

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

7.3 Preparing for System Installation

7.3.1 Pre-Installation Inspection

Follow this procedure before installing Unison 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 slip. If any items are missing, contact LGC Wireless customer service.
4. If damage is discovered at the time of installation, contact the shipping agent.

7.3.2 Installation Checklist

Table 7-2 Installation Checklist

✓	Installation Requirement	Consideration
	Floor Plans	Installation location of equipment clearly marked
	Power available: Main Hub (AC) Expansion Hub (AC) To RAU (DC)	Power cord is 2 m (6.5 ft) long. Rating: 100–240V, 0.5A, 50–60 Hz Rating: 115/230V, 5/2.5A, 50–60 Hz 36V (from the Expansion Hub)
	Rack space available: Main Hub Expansion Hub	 44 mm (1.75 in.) high (1U) 89 mm (3.5 in.) high (2U)
	Clearance for air circulation: Main and Expansion Hubs RAU	 76 mm (3 in.) front and rear, 51 mm (2 in.) sides 76 mm (3 in.) all around
	Suitable operating environment: Main and Expansion Hubs RAUs	Indoor location only 0° to +45°C (+32° to +113°F) 5% to 95% non-condensing humidity –25° to +45°C (–13° to +113°F) 5% to 95% non-condensing humidity
	Donor Antenna-to-Unison Configuration	
	Donor Antenna	Installed, inspected; N-male to N-male coaxial cable to lightning arrestor/surge suppressor
	Lightning Arrestor or Surge Suppressor	Installed between roof-top antenna and repeater; N-male to N-male coaxial cable
	Repeater	Installed between lightning arrestor/surge suppressor and Main Hub; N-male to N-male coaxial cable
	Attenuator	Installed between the circulator and the Main Hub downlink port to prevent overload. Optionally, it may be installed between the uplink port and the circulator
	Circulator or Duplexer	Installed between the repeater and the Main Hub uplink and downlink ports
	Base Station-to-Unison Configuration	
	Base Station	Verify RF power (see tables in Section 6.1 on page 6-3); N-male to N-male coaxial cable; installed, inspected
	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 Main Hub uplink and downlink ports. Not used with a simplex BTS

Table 7-2 Installation Checklist (continued)

✓	Installation Requirement	Consideration
	Connecting LGCell Main Hub(s) to a Unison Main Hub	
	5-port Alarm Daisy-Chain Cable (PN 4024-3)	For contact alarm monitoring: connecting 2 to 21 LGCell Main Hubs to a Unison Main Hub If connecting LGCell to Unison, the Alarm Sense Adapter Cable is required to connect the daisy-chain cable to Unison Do not combine LGCell Main Hubs with Unison Main Hubs in the same daisy chain
	Alarm Sense Adapter Cable (PN 4024-3)	Use with 5-port Alarm Daisy-Chain Cable to connect up to 21 LGCell Main Hubs to a Unison Main Hub Also, use to connect a single LGCell Main Hub to a Unison Main Hub
	Connecting Multiple Unison Main Hubs Together	
	5-port Alarm Daisy-Chain Cable (PN 4024-3)	For contact alarm monitoring of major and minor alarms. Use to feed the alarms from multiple Unison Main Hubs into a BTS or MetroReach Focus Do not combine Unison Main Hubs with LGCell Main Hubs in the same daisy chain.
	Cabling	
	Coaxial: repeater or base station to Main Hub	Coax approved; N-type male connectors
	Coaxial: RAU to passive antennas	Use low-loss cable; SMA male connector; typical 1 m (3.3 ft) using RG142 coaxial cable
	Fiber: Main Hub to Expansion Hubs	SC/APC (angle-polished) male connectors for entire fiber run (can use SC/APC pigtails, PN 4012SCAPC-10 for MMF or 4013SCAPC-10 for SMF); Use jumper fiber cables for collocated Main and Expansion Hubs (3 m/10 ft): Multi-mode: PN 4010SCAPC-10 Single-mode: PN: 4018SCAPC-10 Distance limited by optical loss of 3 dB: Multi-mode: up to 1.5 km (4,921 ft); Single-mode: up to 6 km (19,685 ft)
	Cat-5/6 ScTP: Expansion Hub to RAUs	TIA/EIA 568-A approved; shielded RJ-45 male connectors • Minimum: 10 meters (33 ft) • Recommended Maximum: 100 meters (328 ft) • Absolute Maximum: 150 meters (492 ft) ScTP cable must be screened and it must be grounded at both connector ends (i.e., Expansion Hub and RAU) Tie-off cables to avoid damaging the connectors because of cable strain
	Configuring System	
	PC/laptop running AdminManager software	Refer to the *AdminManager User Manual* (PN 8810-10)

Table 7-2 Installation Checklist (continued)

✓	Installation Requirement	Consideration
	Miscellaneous	
	Null modem cable	Female connectors; Main Hub to a PC/laptop that is running the AdminManager software; local connection
	Straight-through cable	Female/male connectors; Main Hub to a modem; remote connection
	Distances	
	Main Hub is within 3–6m (10–20 ft) of connecting repeater	If longer distance, determine the loss of the cable used for this connection and adjust the RF signal into the Main Hub accordingly. This can be done by readjusting the power from the base station, or by changing the attenuation value between the base station/repeater and the Main Hub
	Main Hub is within 3–6m (10–20 ft) of connecting base station	
	Main Hub is within correct distance of Expansion Hub(s); SMF and MMF optical link budget: 3 dB	

7.3.3 Tools and Materials Required

Table 7-3 Tools and Materials Required for Component Installation

✓	Description
	Cable ties
	Philips screwdriver
	Mounting screws and spring nuts
	Fiber cleaning supplies: compressed air, isopropyl alcohol, cotton swabs, lint-free cloths
	Compressed air
	Screws, anchors (for mounting RAUs)
	Drill
	Fiber connector cleaning kit
	Fusion splicer
	Splicing tool kit (including: snips, cladding strippers, fiber cleaver, isopropyl alcohol, lint-free wipes)
	Fusion splicing sleeves

7.3.4 Optional Accessories

Table 7-4 Optional Accessories for Component Installation

✓	Description
	Wall-mount equipment rack(s) (PN 4712) Note that if using this rack with an Expansion Hub, the Hub's mounting bracket must be moved to the center mounting position.
	Cable management (Cable manager: PN 4759; Tie wrap bar: PN 4757)
	Splice trays
	Pigtails with SC/APC connectors, 3 m (10 ft): Multi-mode Fiber SC/APC Pigtail (PN 4012SCAPC-10) Single-mode Fiber SC/APC Pigtail (PN 4013SCAPC-10)
	Jumper cable when Main and Expansion Hubs are collocated, 3 m (10 ft): Single-mode Fiber SC/APC (PN 4018SCAPC-10)
	Teltone Line Sharing Switch (M-394-B-01) When using a single POTS line with multiple Main Hub/Modems: Connect up to four modems to a line sharing switch; can cascade switches to accommodate up to 16 modems per POTS line
	Alarm Cables: 5-port Alarm Daisy-Chain Cable (PN 4024-3) Alarm Sense Adapter Cable (PN 4025-1)
	RAU Dust Cover (PN UNS-1RDP-1)

7.4 Unison Component Installation Procedures

The following procedures assume that the system is new from the factory and that it has not been programmed with a band.

If you are replacing components in a pre-installed system with either new units or units that may already be programmed (i.e., re-using units from another system), refer to Section 8.

The following procedure is for splicing pigtails to fiber cable.

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

7.4.1 Installing a Main Hub

CAUTION: Install Main Hubs in indoor locations only.

Installing a Main Hub in a Rack

The Main Hub (1U 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 and bottom clearance is required.

Consideration:

- The Main 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 Main 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.

NOTE: Do not turn on the Main Hub until you have started the AdminManager software (see Section 7.4.4 on page 7-30).

Rack-mounting Option

You can flip the rack mounting brackets, as shown in the following figure, so the hub can be mounted 76 mm (3 in.) forward in the rack.

Installing an Optional Cable Manager in the Rack

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

Connecting the AdminManager PC to the Main Hub

Considerations:

- The AdminManager software, described in the *AdminManager User Manual* (PN 8810-10), must be running on a PC/laptop that is connected to the Main Hub's front panel **RS-232** port.
- Null modem cable with female connectors is needed.

To connect the PC/laptop, start AdminManager, and power on the Main Hub:

1. Connect the null modem cable to the PC/laptop and then to the **RS-232** port on the Main Hub's front panel.
2. Turn on the PC and start AdminManager.

   The AdminManager main window is displayed with the Installation Wizard option selected.
3. Connect the AC power cord to the Main Hub.
4. Plug the power cord into an AC power outlet.
5. Turn on the power to the Main Hub.

   Upon initial power-up, the Main Hub LEDs should blink continuously to indicate that there is no frequency band programmed into the Main Hub.

   On subsequent power ups, after a band is programmed, the LEDs will blink for five seconds as a visual check that they are functioning.

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

Programming a Frequency Band into the Main Hub

To program a band into the Unison Main Hub:

1. Start AdminManager.
2. Select the Installation Wizard (Local) radio button and click RUN.

   The Step 1, Verify Hardware window is displayed. The Main Hub will be the only device listed.
3. Click NEXT.

   The Step 2, Set Operation Band window is displayed.
4. Select the desired frequency band from the pull-down list and click APPLY.

   A message is displayed indicating that the system test was not performed and to check the Expansion Hub(s) and RAU(s) for faults.

   - The Power LED should be steady green.
   - The Main Hub Status LED should be steady green.
   - All fiber port LEDs should be off, indicating that no fiber cables are connected.
5. Click NEXT.

   The Step 3, Configure System Parameters window is displayed.
6. Leave the default settings and click NEXT.

   The Step 4, Final System Test window is displayed.
7. Click APPLY.

   A message is displayed indicating the system test was not performed because there are no Expansion Hubs or RAUs connected.
8. Click NEXT.

   The Finish window is displayed.
9. Click FINISH.

   The AdminManager session ends and the window closes.

NOTE: Refer to Section 9 for troubleshooting.

Connecting the Fiber Cables to the Main Hub

Considerations:

- Before connecting the fiber cables, confirm that their optical loss does not exceed the 3 dB optical budget.
- If fiber distribution panels are used, confirm that the total optical loss of fiber cable, from the Main Hub through distribution panels and patch cords to the Expansion Hub, does not exceed the optical budget.
- Make sure the fiber cable's connectors are SC/APC (angle-polished). Using any other connector type will result in degraded system performance and may damage the equipment. (You can use an SC/APC pigtail if the fiber cable's connectors are not SC/APC, see "Fusion Splicing of Fiber and Pigtail" on page 7-31. Or, you can change the fiber's connector to SC/APC.)

NOTE: Observe all Fiber Port Safety Precautions listed in Section 7.2.3 on page 7-4.

To clean the fiber ports:

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

Considerations:

- If using compressed air:
  - The air must be free of dust, water, and oil.
  - Hold the can level during use.
- If using isopropyl alcohol and cotton swabs:
  - Use only 98% pure or more alcohol

Procedure using compressed air:

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

Procedure using isopropyl alcohol:

1. Remove the connector's dust cap.
2. Dip a cotton swap in isopropyl alcohol and slowly insert the tip into the connector.
3. Gently twist the swab to clean the port.
4. Insert a dry swab into the port to dry it.

   Additionally, you can use compressed air after the alcohol has completely evaporated.

To clean the fiber ends:

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

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

To test the fiber cables:

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

To connect the fiber cables:

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

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

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

1. Connect **1**s to **UPLINK** ports on the Main Hub.
2. Connect **2**s to **DOWNLINK** ports on the Main Hub.
3. Record which cable number and port number you connected to **UPLINK** and **DOWNLINK**.

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

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

If the fiber jumper is color-coded (for example, "blue" or "red"):

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

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

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

7.4.1.1 Troubleshooting Main Hub LEDs During Installation

Table 7-5 Troubleshooting Main Hub LEDs During Installation

During Installation Power On	LED	State	Action	Impact
1. Main Hub power is On with no Expansion Hubs connected.	**POWER**	Off	Check AC power; check that the Main Hub power-on switch is on; replace Main Hub	Main Hub is not powering on.
	LINK **E-HUB/RAU**	LEDs on but they didn't blink through all states	Replace the Main Hub.	Microcontroller not resetting properly; flash memory corrupted.
	LINK	Red	The port is unusable; replace the Main Hub when possible.	Fiber sensor fault, do not use the port.
	E-HUB/RAU	Off		

2. Main Hub power is On with Expansion Hubs connected and powered on.	**LINK**	Off	• If the port LEDs do not illuminate, check the fiber uplink for excessive optical loss.
			• If Expansion Hub's DL status LED is red:
			  • Verify that the fiber is connected to the correct port (i.e., uplink/downlink)
			  • Swap the uplink and downlink cables.
			• Connect the fiber pair to another port. If the second port's LEDs do not illuminate Green/Red, replace the Main Hub.
			  • If the second port works, flag the first port as unusable; replace the Main Hub when possible.
				No uplink optical power, Expansion Hub is not recognized as being present.
				No communication with the Expansion Hub.

	E-HUB/RAU	Off		
	LINK	Red	• If the Expansion Hub **DL STATUS** LED is red, check the downlink fiber cable for excessive optical loss. • Connect the fiber pair to another port. If the second port's LEDs do not illuminate Green/Red, replace the Main Hub. • If the second port works, flag the first port as unusable; replace the Main Hub when possible.	No communication with the Expansion Hub.
	E-HUB/RAU	Off		
	LINK	Green	Expansion Hub or connected RAU reports a fault Use AdminManager to determine the problem.	Expansion Hub or one or more RAUs are off-line.
	E-HUB/RAU	Red		

7.4.1.2 Installing Main Hubs in a Multiple Operator System

Installing Main Hubs in a multiple operator system is the same as described in Section 7.4.1 on page 7-12.

We recommend mounting all multiple operator system Main Hubs in the same rack(s), grouped by frequency or wireless carrier. For example, group the Main Hubs for the 800 MHz cellular bands together, and so on.

Connecting to base stations and repeaters is the same as described in Section 7.6 on page 7-33 and Section 7.6.1 on page 7-37.

7.4.2 Installing Expansion Hubs

The Expansion Hub (2U high) can mount in a standard 19 in. (483 mm) equipment rack or in a wall-mountable equipment rack that is available from LGC Wireless. Allow clearance of 76 mm (3 in.) front and rear and 51 mm (2 in.) sides for air circulation. No top and bottom clearance is required.

Install the Expansion Hub in a horizontal position only.

CAUTION: Install Expansion Hubs in indoor locations only.

Installing an Expansion Hub in a Rack

Consideration:

- The Expansion 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.
- If you want to move the mounting brackets to a mid-mounting position, see Installing an Expansion Hub in a Wall-Mounted Rack on page 7-20.

To install the hub in a rack:

1. Insert spring nuts into the rack where needed or use existing threaded holes.
2. Place the Expansion 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 an Expansion Hub in a Wall-Mounted Rack

Considerations:

- The rack and the Expansion Hub are both 305 mm (12 in.) deep. The rack mounting brackets on the Expansion Hub must be moved to the center mounting position to allow for the 76 mm (3 in.) rear clearance that is required.
- The maximum weight the rack can hold is 22.5 kg (50 lbs).

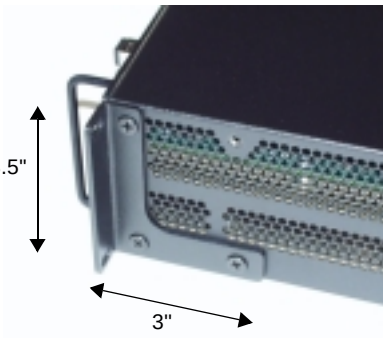
To install the hub in a wall-mounted rack:

1. Attach the equipment rack to the wall using the screws that are provided.

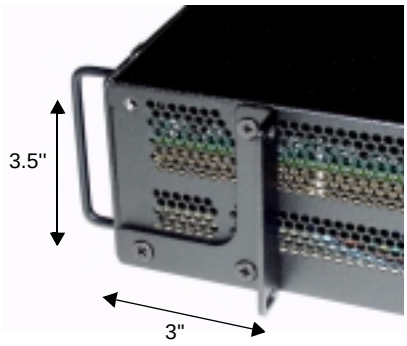
   The rack must be positioned so that the Expansion Hub will be in a horizontal position when it is installed.
2. Remove both of the rack mounting brackets from the hub.
3. Reattach each of the rack mounting brackets to the opposite side of the hub from which it came.

   Refer to the following figure for bracket placement.

Right Rack Mounting Bracket as installed from the factory.



Left Rack Mounting Bracket installed on the right side of the hub.



4. Attach the Expansion Hub to the rack.

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

Installing an Optional Cable Manager in the Rack

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

Powering On the Expansion Hub

1. Connect the AC power cord to the Expansion Hub.
2. Plug the power cord into an AC power outlet.
3. Turn on the power to the Expansion Hub and check that all the LED lamps are functioning properly.

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

   - The **POWER** and **UL STATUS** LEDs should be green.
     - If the uplink fiber is not connected within 90 seconds after the test, the **UL STATUS** LED will turn red indicating that there is no communication with the Main Hub.
   - The **E-HUB STATUS** and **DL STATUS** LEDs should be red.
   - All port LEDs should be off because no RAUs are connected yet.

Connecting the Fiber Cables to the Expansion Hub

Considerations:

- Before connecting the fiber cables, confirm that their optical loss does not exceed 3 dB optical budget.
- If fiber distribution panels are used, confirm that the total optical loss of fiber cable, from the Main Hub through distribution panels and patch cords to the Expansion Hub, does not exceed the optical budget.
- Make sure the fiber cable's connectors are SC/APC (angle-polished).Using any other connector type will result in degraded system performance and may damage the equipment. (You can use an SC/APC pigtail if the fiber cable's connectors are not SC/APC, see "Fusion Splicing of Fiber and Pigtail" on page 7-31, or replace the connectors.)

NOTE: Observe all Fiber Port Safety Precautions listed in Section 7.2.3 on page 7-4.

To clean the fiber ports:

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

Considerations:

- If using compressed air:
  - The air must be free of dust, water, and oil.
  - Hold the can level during use.
- If using isopropyl alcohol and cotton swabs:
  - Use only 98% pure or more alcohol

Procedure using compressed air:

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

Procedure using isopropyl alcohol:

1. Remove the connector's dust cap.
2. Dip a cotton swap in isopropyl alcohol and slowly insert the tip into the connector.
3. Gently twist the swab to clean the connector.
4. Insert a dry swab to dry the connector.

   Additionally, you can use compressed air after the alcohol has completely evaporated.

To clean the fiber ends:

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

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

To connect the fiber cables:

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

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

1. Connect **1** to **DOWNLINK** on Expansion Hub.

   The **DL STATUS** LED should turn green as soon as you connect the fiber. If it does not, there is a downlink problem. Make sure you are connecting the correct cable to the port.

2. Connect **2** to **UPLINK** on Expansion Hub.

   The **UL STATUS** LED will turn green on the first Main Hub communication. It may take up to 20 seconds to establish communication.

   The Expansion Hub's **E-HUB STATUS** LED will turn green when the Main Hub sends it the frequency band command.

   If the **UL STATUS** and **E-HUB STATUS** LEDs do not turn green/green, check the Main Hub LEDs. See page 7-17, item 2 in Table 7-5.

If the fiber jumper is color-coded (for example, "blue" or "red"):

1. Connect "blue" to **DOWNLINK** on Expansion Hub.

   The **DL STATUS** LED should turn green as soon as you connect the fiber. If it does not, there is a downlink problem. Make sure you are connecting the correct cable to the port.

2. Connect "red" to **UPLINK** on Expansion Hub.

   The **UL STATUS** LED will turn green on the first Main Hub communication. It may take up to 20 seconds to establish communication.

   The Expansion Hub's **E-HUB STATUS** LED will turn green when the Main Hub sends it the frequency band command.

   If the **UL STATUS** and **E-HUB STATUS** LEDs do not turn green/green, check the Main Hub LEDs. See page 7-17, item 2 in Table 7-5.

Connecting the ScTP Cables

Consideration:

- Verify that the cable has been tested and the test results are recorded.

To test and connect the ScTP cable:

1. Perform cable testing.

   Test results are required for the final As-Built Document.

   Cable length:

   – Minimum: 10 m (33 ft)

   – Recommended Maximum: 100 m (328 ft)

   – Absolute Maximum: 150 m (492 ft)
2. Label both ends of each cable with which RJ-45 port you're using.
3. Connect the ScTP cables to any available RJ-45 port on the Expansion Hub.

   The **LINK** and **RAU** LEDs should be off because the RAU is not connected.
4. Record which cable you are connecting to which port.

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

7.4.2.1 Troubleshooting Expansion Hub LEDs During Installation

- All Expansion Hub **LINK** and **E-HUB/RAU** LEDs with RAUs connected should indicate Green/Red, which indicates that the RAU is powered on and communication has been established.
- The Expansion Hub **UL STATUS** LED should be Green.

Table 7-6 Troubleshooting Expansion Hub LEDs During Installation

During Installation	LED	State	Action	Impact
1. Expansion Hub power is On and no RAUs are connected	**POWER**	Off	Check AC power; check that the Expansion Hub power-on switch is on; replace the Expansion Hub.	Expansion Hub is not powering on.
	LINK **RAU**	LEDs on but didn't blink through all states	Replace the Expansion Hub.	Microcontroller not resetting properly; flash memory corrupted.
	LINK	Red	Port unusable; replace the Expansion Hub when possible.	Current sensor fault; do not use the port.
	RAU	Off		
	UL STATUS	Red, after power-up blink	Replace the Expansion Hub.	The Expansion Hub laser is not operational; no uplink between the Expansion Hub and Main Hub.
	UL STATUS	Red from green after 90 seconds of power-up blink, cable was connected within 90 seconds of power up	Check Main Hub LEDs See page 7-17, item 2 in Table 7-5.	No communication with Main Hub.
	DL STATUS	Red	Check downlink fiber for optical power; verify that cables are connected to correct ports (i.e., uplink/downlink) Check Main Hub LEDs See page 7-17, item 2 in Table 7-5.	No downlink between the Expansion Hub and Main Hub.
2. Expansion Hub power is On and RAUs are connected	**LINK** **RAU**	Off Off	Check the Cat-5/6 cable.	Power is not getting to the RAU.
	LINK **RAU**	Red Off	Test the Cat-5/6 cable. If the cable tests OK, try another port. If the second port's LEDs are Red/Off, replace the RAU. If the second RAU doesn't work; replace the Expansion Hub.	Power levels to RAU are not correct; communications are not established. If the second port works, flag the first port as unusable; replace EH when possible.
	LINK **RAU**	Green Red	Use AdminManager to determine the problem.	RAU is off-line.

7.4.2.2 Installing Expansion Hubs in a Multiple Operator System

Installing Expansion Hubs in a multiple operator system is the same as described in Section 7.4.2 on page 7-19.

If rack-mounting the Expansion Hubs, we recommend mounting all multiple operator system hubs in the same rack(s) or location, grouped by frequency or carrier. For example, group the Expansion Hubs for iDEN together, then the 800 MHz cellular bands, and so on.

7.4.3 Installing RAUs and Passive Antennas

CAUTION: Install RAUs in indoor locations only.

Installing RAUs

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

Considerations:

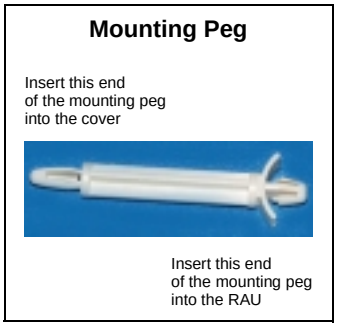
- **Install iDEN and 800 MHz cellular RAUs so that their antennas will be at least 6 to 8 meters (20 to 26 feet) apart. Separation is required to reduce signal interference between the two frequency bands.**
- Keep at least 76 mm (3 in.) clearance around the RAU to ensure proper venting
- Always mount the RAU with the unpainted mounting face against the mounting surface

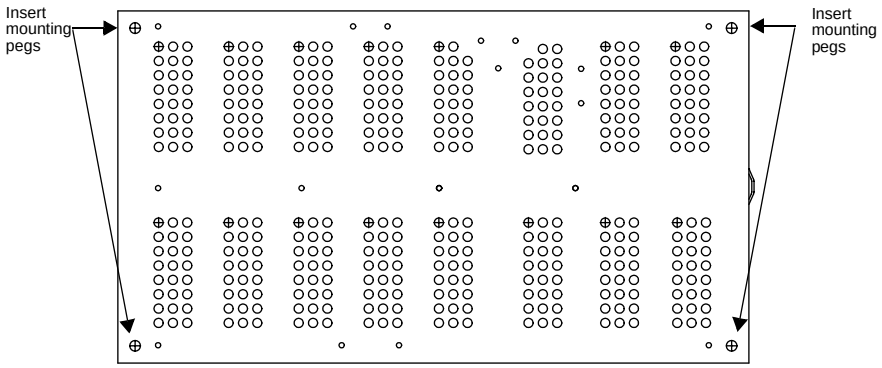
Attaching the Optional RAU Dust Cover

Use the optional RAU dust cover (PN UNS-1RDP-1) when installing the RAU in an area where excessive dust or debris could enter its venting holes.

To attach the optional RAU dust cover:

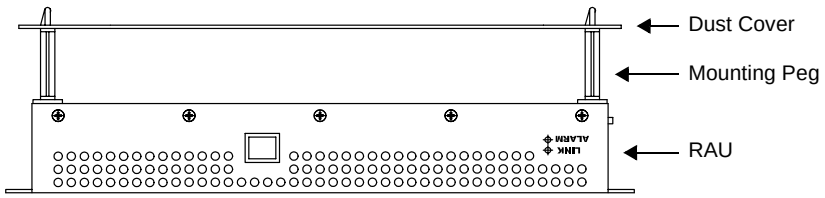
1. Firmly insert the four mounting pegs into the four corners on the top side of the RAU, as shown in the following diagram.





2. Position the dust cover over the mounting pegs and press to snap into place.

   The following diagram shows a side view of the dust cover attached to the RAU.



Installing Passive Antennas

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

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

Considerations:

- Use coaxial cable with the least amount of loss possible.
- **Install iDEN and 800 MHz cellular RAUs so that their antennas will be at least 6 to 8 meters (20 to 26 feet) apart. Separation is required to reduce signal interference between the two frequency bands.**

Connecting the Antenna to the RAU

Connect a passive antenna to the SMA male connector on the RAU using coaxial cable.

CAUTION: When connecting to the SMA female connector on the RAU and passive antenna, **DO NOT** over-tighten the connector. Firmly hand-tightening the connector is adequate.

CAUTION: Do not connect an antenna that is installed in an outdoor location to an RAU.

Connecting the ScTP Cable

Consideration:

- Verify that the cable has been tested and the test results are recorded.

To connect the ScTP cable:

- Connect the cable to the RJ-45 female port on the RAU.

  Power is supplied by the Expansion Hub. 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 that it is receiving power and communications from the Expansion Hub.
  - The **ALARM** LED should be red until the Main Hub issues the band command, within about 20 seconds, then it should be green.

7.4.3.1 Troubleshooting RAU LEDs During Installation

- The **LINK** and **ALARM** LEDs should be green.

Table 7-7 Troubleshooting RAU LEDs During Installation

During Installation	LED	State	Action	Impact
1. RAU is connected to Expansion Hub, which is powered on	**LINK**	Off	Check Cat-5/6 cable.	No power to RAU.
	ALARM	Off		
	LINK	Green	• Check Cat-5/6 cable • Check Expansion Hub LEDs See page 7-25, item 2 in Table 7-6. • Use AdminManager to determine the problem.	RAU is off-line.
	ALARM	Red		
	LINK	Red from green, after cables are connected for 60 seconds	• Check Cat-5/6 cable • Check Expansion Hub LEDs See page 7-25, item 2 in Table 7-6. • Use AdminManager to determine the problem.	No communications between the RAU and the Expansion Hub.
	ALARM	Red		

7.4.3.2 Installing RAUs in a Multiple Operator System

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

The 800 MHz Cellular and iDEN RAU's antennas must be separated by 6 to 8 meters (20 to 26 feet) to assure that the iDEN downlink signals do not interfere with the Cellular uplink signals.

7.4.4 Configuring the System

Configuring the Installed System

Considerations:

- The AdminManager PC/laptop is connected to the Main Hub.
- The AdminManager software is started.
- All system components are installed and powered on.

To configure an installed system:

1. Select the Installation Wizard (Local) radio button from the AdminManager main window and click RUN.

   The Step 1, Verify Hardware window is displayed.
2. Verify that all system devices are displayed in the System Status box and click NEXT.

   The Step 2, Set Operation Band window is displayed.
3. Click NEXT.

   The frequency band was programmed when the Main Hub was installed.

   The Step 3, Configure System Parameters window is displayed.
4. Enter the desired parameters and click APPLY.
5. Click NEXT if the message that is displayed indicates that the parameter setting is successful.

   The Step 4, Final System Test window is displayed.
6. Click APPLY to initiate the final system test.

   During testing the system is off-line and a center band tone is being transmitted.
7. Click NEXT if the message that is displayed indicates that the testing is successful.

   The Finish window is displayed.
8. Click FINISH.

   The AdminManager session is ended and the window closes.

   All of the Main Hub's LEDs should be green.

7.5 Splicing Fiber Optic Cable

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

LGC offers two pigtails: 1 for single-mode fiber (PN 4013SCAPC-3) and 1 for multi-mode fiber (PN 4012SCAPC-3).

Two methods of splicing are described here: fusion and mechanical. We recommend fusion splices because they have the lowest splice loss and return loss.

7.5.1 Fusion Splices

Using a fusion splicer, this splicing method involves fusing together two butted and cleaved ends of fiber. The fusion splicer aligns the fibers and maintains alignment during the fusion process. Fusion splices have very low loss (typically less than 0.05 dB) and very low back reflection (return loss). Fusion splices should be organized in a splice tray designed to store and protect the splices.

Mechanical splices have higher losses and higher back reflection than fusion splices and are not recommended.

Fusion Splicing of Fiber and Pigtail

To fusion splice the fiber optic cable to the SC/APC pigtail: Option A

1. Secure both the fiber cable and the SC/APC pigtail in a splice tray that is installed immediately adjacent to the Hub.
2. Prepare the fiber end by cutting back the polyethylene jacket, the kevlar or fiber-glass strength members, the extruded coating, and the buffer coating in order to expose the “bare fiber” – cladding plus core.

   Ensure that sufficient slack is maintained in order to be able to reach the fusion splicer.
3. Clean the unclad fiber core using isopropyl alcohol and lint-free wipes.
4. Cleave the unclad fiber to the length prescribed by the fusion splicer’s specification sheets.
5. Repeat steps 2 through 4 for the SC/APC pigtail.
6. Pass the splice sleeve onto the fiber strand.
7. Position both fiber ends in the fusion splicer and complete splice in accordance with the fusion splicer’s operation instructions.
8. Ensure that the estimated loss for the splice as measured by the fusion splicer is 0.10 dB or better.
9. Slide the fusion splicing sleeve over the point of the fusion splice.
10. Place the sleeve and fused fiber into the fusion splicer’s heater.

11. Allow time for the splice sleeve to cure.
12. Return fiber splice to the splice tray, store the sleeve in a splice holder within the tray, and store excess cable length in accordance with the tray manufacture's directions.

    After successfully testing the fiber, plug the SC/APC pigtail into the proper optical port on the Hub.

To fusion splice the fiber optic cable to the SC/APC pigtail: Option B

1. Secure both the fiber cable and the SC/APC pigtail in a splice tray portion of a fiber distribution panel.
2. Prepare the fiber end by cutting back the polyethylene jacket, the kevlar or fiberglass strength members, the extruded coating, and the buffer coating in order to expose the "bare fiber" – cladding plus core.

   Ensure that sufficient slack is maintained in order to be able to reach the fusion splicer.
3. Clean the unclad fiber core using isopropyl alcohol and lint-free wipes.
4. Cleave the unclad fiber to the length prescribed by the fusion splicer's specification sheets.
5. Repeat steps 2 through 4 for the SC/APC pigtail.
6. Pass the splice sleeve onto the fiber strand.
7. Position both fiber ends in the fusion splicer and complete splice in accordance with the fusion splicer's operation instructions.
8. Ensure that the estimated loss for the splice as measured by the fusion splicer is 0.10 dB or better.
9. Slide the fusion splicing sleeve over the point of the fusion splice.
10. Place the sleeve and fused fiber into the fusion splicer's heater.
11. Allow time for the splice sleeve to cure.
12. Return fiber splice to the splice tray, store the sleeve in a splice holder within the tray, and store excess cable length in accordance with the tray manufacture's directions.
13. After successfully testing the fiber cable, plug the SC/APC pigtail into the back side of the SC/APC bulkhead in the Fiber Distribution Panel.

    Install a SC/APC patch cord between the front side of the SC/APC bulkhead and the proper optical port on the Hub.

7.6 Interfacing a Main Hub to a Base Station or a Roof-top Antenna

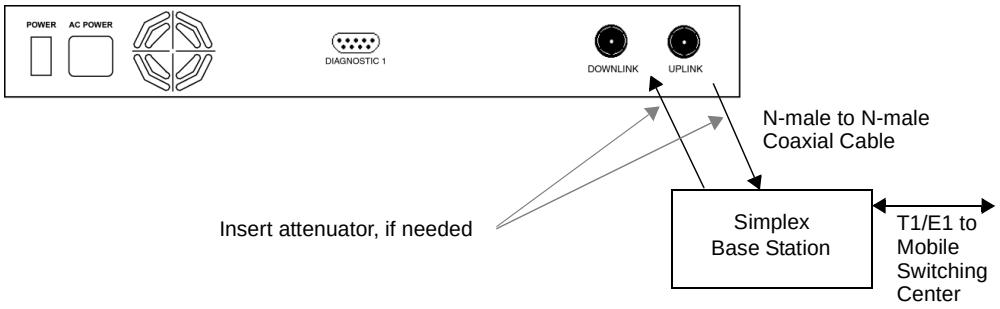
WARNING: Exceeding the maximum input power could cause failure of the Main Hub (refer to Section 6.1 on page 6-3 for maximum power specifications). If the maximum composite power is too high, attenuation is required.

Connecting a Main Hub to an In-Building Base Station

Connecting a Simplex Base Station to a Main Hub:

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 Main Hub.
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 Main Hub.

Figure 7-1 Simplex Base Station to a Main Hub



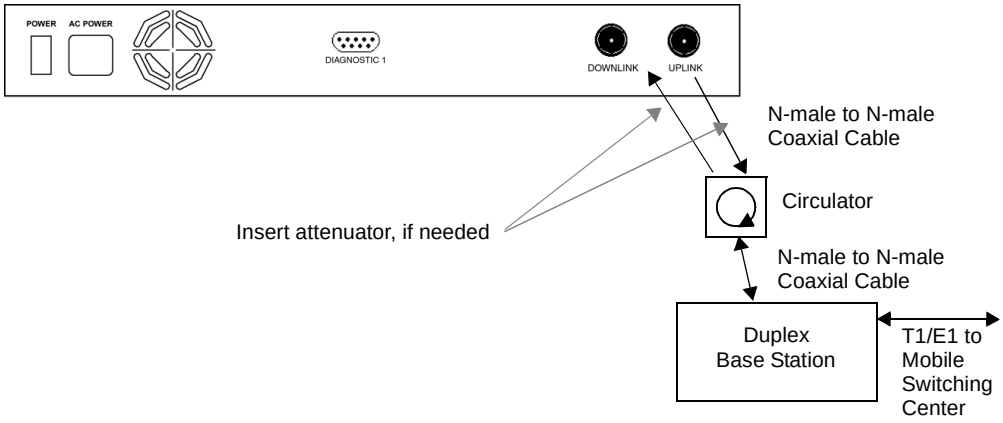
Connecting a Duplex Base Station to a Main Hub:

When connecting to a duplex base station, use a circulator between it and the Main Hub.

You can insert attenuators between the circulator and Main Hub as needed; refer to Section 6.6.1 on page 6-43 for more information.

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 to a circulator.
3. Connect an N-male to N-male coaxial cable to the **DOWNLINK** connector on the Main Hub.
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 Main Hub.
6. Connect the other end of the N-male coaxial cable to the receive connector on the circulator.

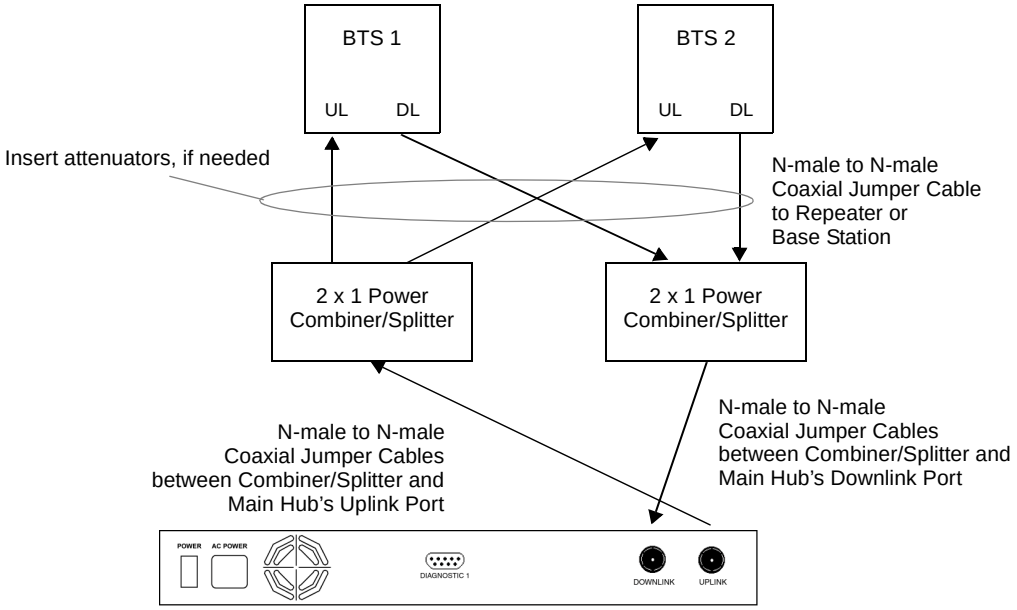
Figure 7-2 Duplex Base Station to a Main Hub



Connecting a Main Hub to Multiple Base Stations

You can use power combiner/splitters to connect a Main Hub to multiple base stations, as shown in the following figure.

Figure 7-3 Connecting a Main Hub to Multiple Base Stations

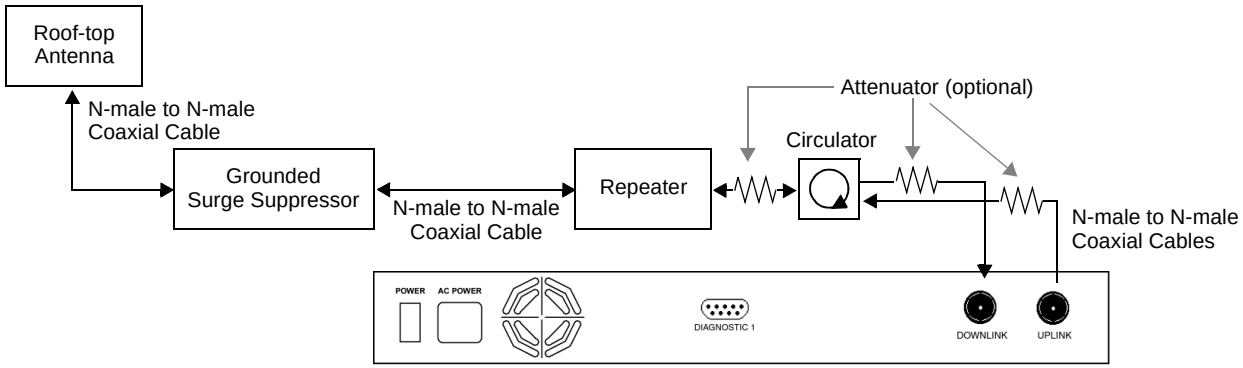


Connecting a Main Hub to a Roof-top Antenna

It is recommended 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 that is connected to the Main Hub.

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 Main Hub.

   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 Main Hub.



7.6.1 Connecting Multiple Main Hubs

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

Connecting Multiple Main Hubs to a Simplex Repeater or Base Station

Considerations:

- 2 hybrid power combiner/splitters; one for uplink and one for downlink (2x1 for two Main Hubs, 3x1 for three, 4x1 for four, etc.)
- 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 Main Hub

Procedure:

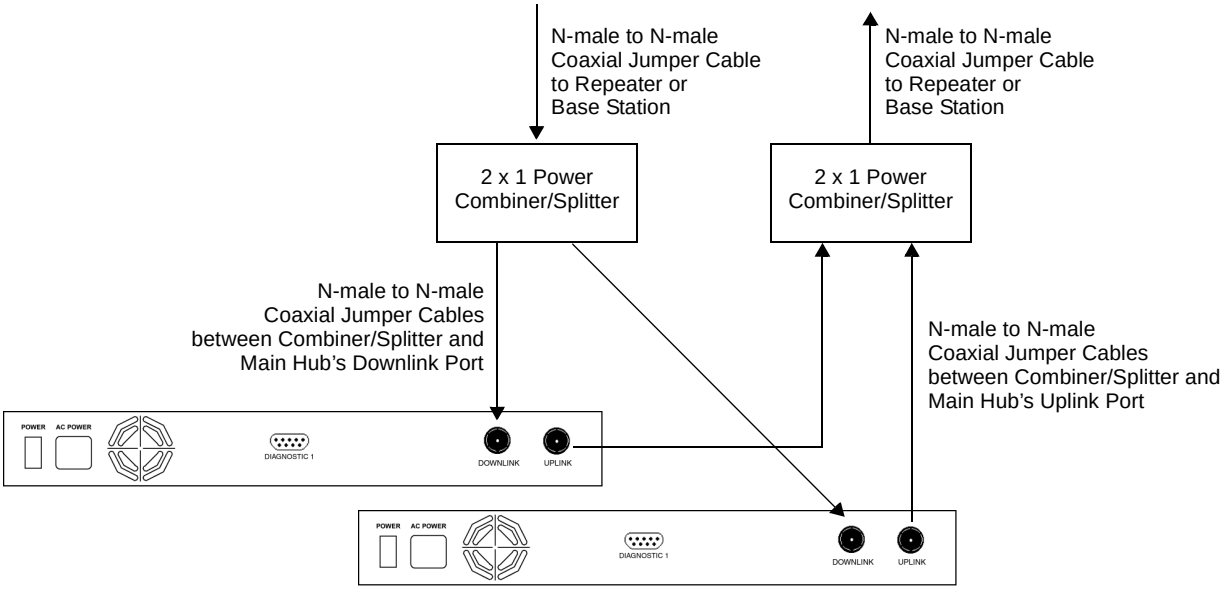
1. Connect the power combiner/splitters to the repeater or base station using N-male to N-male coaxial jumper cables:
   a. From the first power combiner/splitter to the repeater or base station
   b. From the second power combiner/splitter to the repeater or base station
2. Connect the power combiner/splitters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

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

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

The following figure shows connecting two Main Hubs to a simplex repeater or base station. Connecting two Main Hubs increases the total number of supportable RAUs from 32 to 64. Two Main Hubs support up to 8 Expansion Hubs which in turn support up to 64 RAUs.

Figure 7-4 Connecting Two Main Hubs to a Simplex Repeater or Base Station



Connecting Multiple Main Hubs to a Duplex Repeater or Base Station

Considerations:

- 2 hybrid power combiner/splitters; one for uplink and one for downlink (2x1 for two Main Hubs, 3x1 for three, 4x1 for four, etc.)
- 2 N-male to N-male coaxial jumper cables to connect each Main Hub 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 cable1 between each circulator and power combiner/splitter

Procedure:

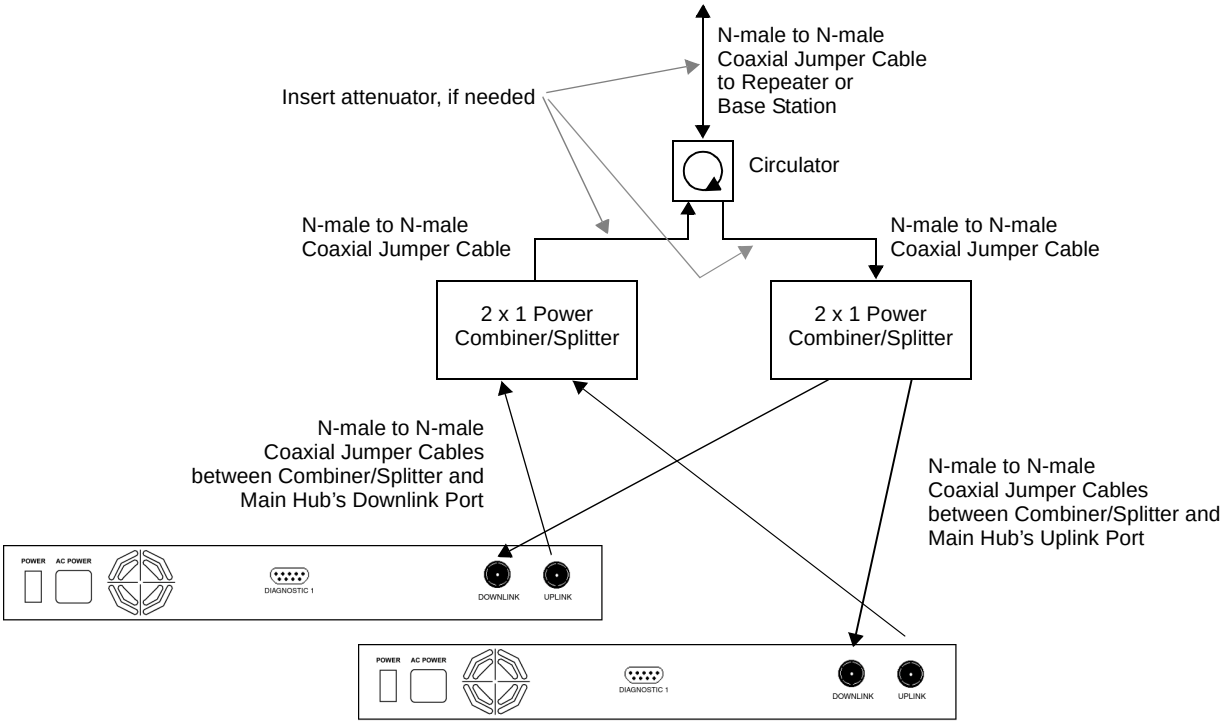
1. Connect the Circulator to the power combiner/splitters and to the repeater or base station using one N-male to N-male coaxial jumper cable.
2. Connect each power combiner/splitter to the circulator using one N-male to N-male coaxial jumper cable.
3. Connect the power combiner/splitter to the Main Hubs:
   a. From the first Main Hub's **UPLINK** port to the first power combiner/splitter
   b. From the first Main Hub's **DOWNLINK** port to the second power combiner/splitter
   c. From the second Main Hub's **UPLINK** port to the first power combiner/splitter
   d. From the second Main Hub's **DOWNLINK** port to the second power combiner/splitter
4. Check Main Hub LEDs.

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

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

To connect two Main Hubs to a duplex repeater or base station, you need to use one circulator and one more coaxial jumper cable, as shown in the following figure.

Figure 7-5 Connecting Two Main Hubs to a Duplex Repeater or Base Station



7.7 Connecting Contact Alarms to a Unison System

The Unison Main Hub can generate (source) two contact alarms as well as sense an external contact alarm.

- **Alarm Source (see Section 7.7.1 on page 7-42)**

  The Main Hub has two alarm contacts, fault (major) and warning (minor). These contact are normally-closed (NC) and will open when an internal alarm is detected.

  - 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 (see Section 7.7.2 on page 7-45)**

  The Main Hub can monitor an external alarm contact. The 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. AdminManager or OpsConsole is used to monitor the port status.

The following table lists the alarm types, equipment that Unison is connected to, cable(s) used, and the errors (major and/or minor) that are detected.

Alarm Type	Unison 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	5-port Alarm Daisy-Chain Cable and the Alarm Sense Adapter Cable	Faults

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

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

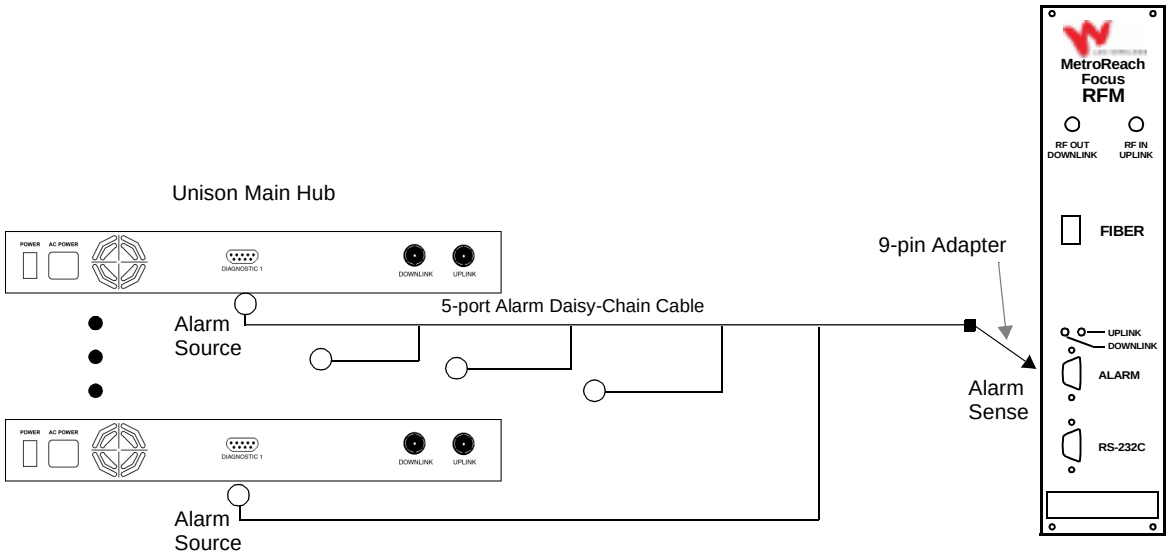
7.7.1 Alarm Source

Unison always acts an alarm source, no matter what type of equipment you are connecting to. Refer to Section 7.7.2 on page 7-45 if you want Unison to sense LGCell contact closures or other external alarms.

Using MetroReach Focus to Monitor Unison

When you connect MetroReach Focus to Unison, the Unison Main Hub is the output of the alarms (alarm source) and Focus is the input (alarm sense), as shown in the following figure. Focus supports only faults (major errors).

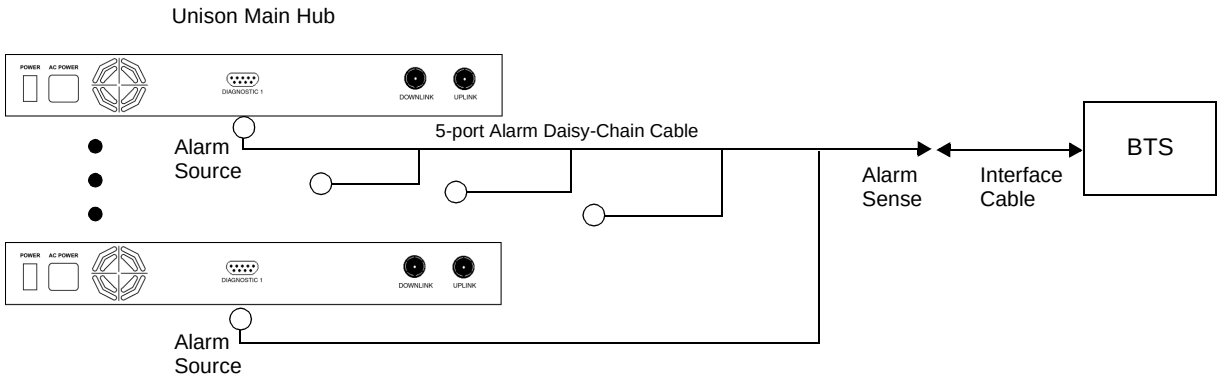
Figure 7-6 Connecting MetroReach to Unison



Using a Base Station to Monitor Unison

When you connect a BTS to Unison, the Unison Main Hub is the output of the alarms (alarm source) and the BTS is the input (alarm sense), as shown in the following figure. An interface cable is required between the daisy-chain cable and the BTS. Because BTS alarm interface pinouts and Unison-to-BTS distances vary, this cable often is custom and wired on-site.

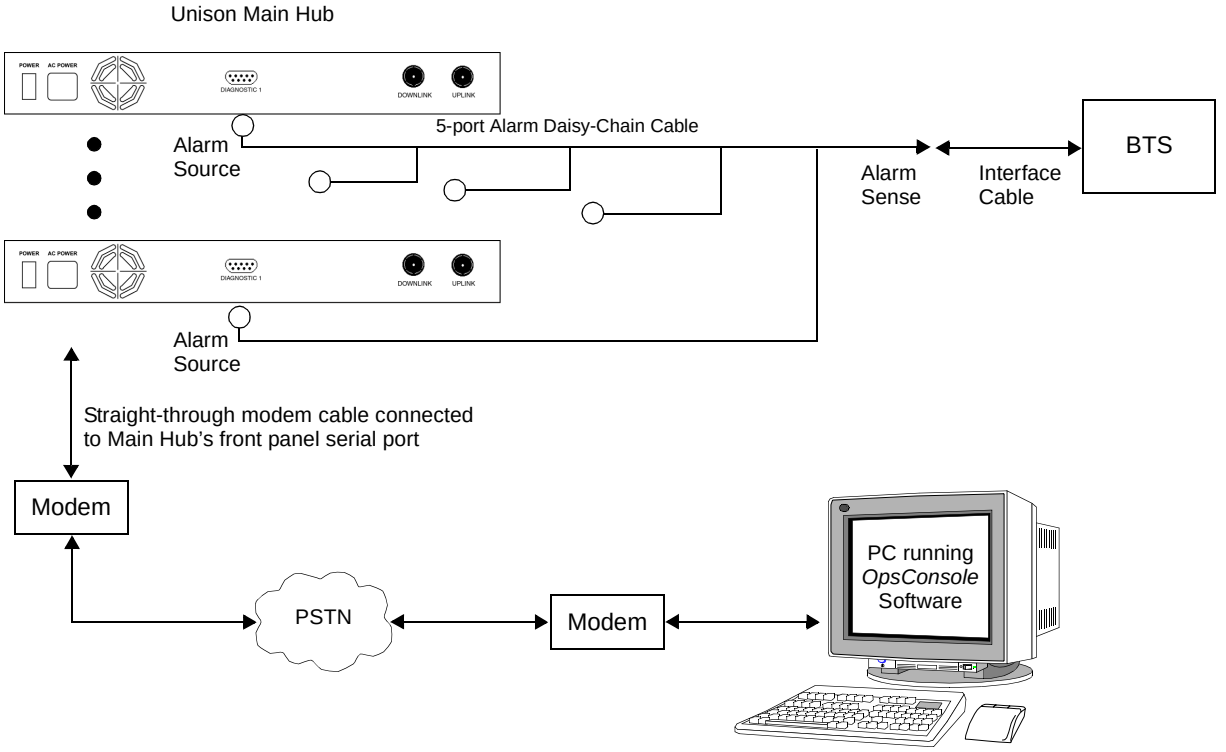
Figure 7-7 Using a BTS to Monitor Unison



Using a Base Station and *OpsConsole* to Monitor Unison

In order to take full advantage of Unison's OA&M capabilities you can use LGC Wireless *OpsConsole* software in addition to a BTS to monitor the system, as shown in Figure 7-8.

Figure 7-8 Using a BTS and *OpsConsole* to Monitor Unison



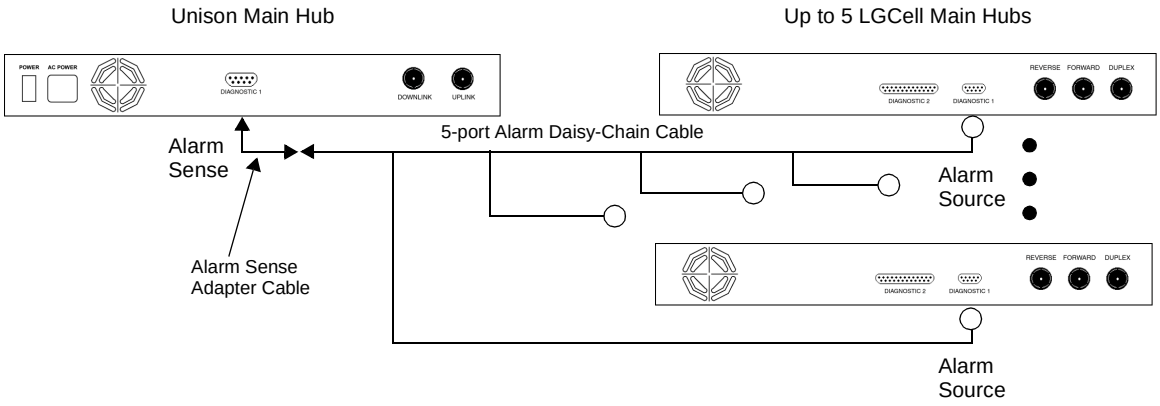
7.7.2 Alarm Sense

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

Using Unison to Monitor LGCells

When you connect LGCell to Unison, the Unison Main Hub is the input of the alarms (alarm sense) and the LGCell is the output (alarm source), as shown in the following figure.

Figure 7-9 Connecting LGCell to Unison



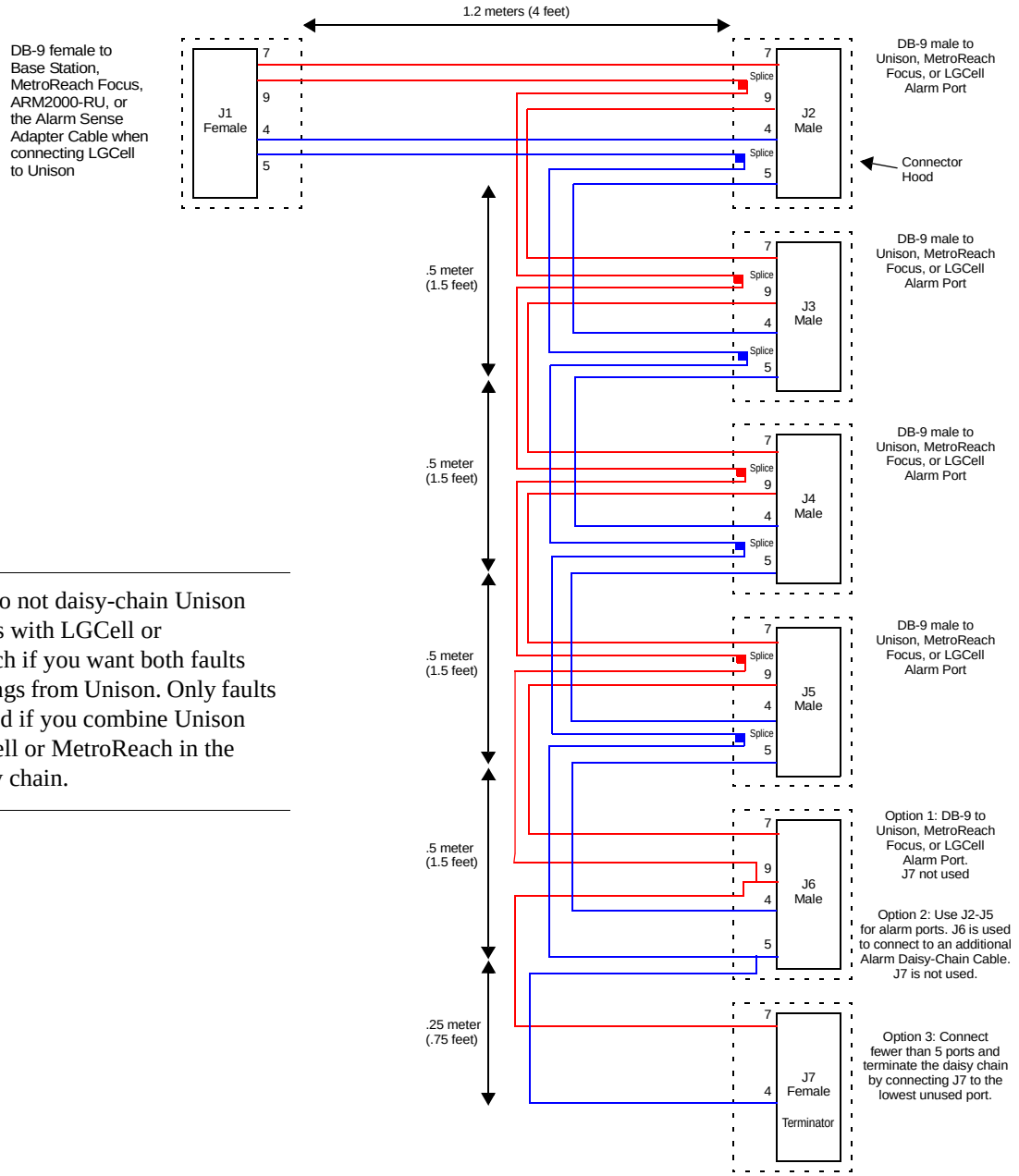
LGCell supports only faults (major errors). You must use the Alarm Sense Adapter Cable (see page 7-47) to interface the daisy-chain cable to Unison. The adapter cable is required because it translates the LGCell fault pinout to the sense input pins on the Unison Main Hub.

7.7.3 Alarm Cables

5-port Alarm Daisy-Chain Cable

Figure 7-10 shows the 5-port Alarm Daisy-Chain Cable (PN 4024-3), which supports fault and warning conditions (i.e., major and minor errors).

Figure 7-10 5-port Alarm Daisy-Chain Cable

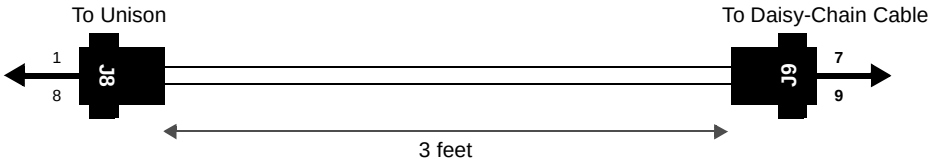


NOTE: Do not daisy-chain Unison Main Hubs with LGCell or MetroReach if you want both faults and warnings from Unison. Only faults are reported if you combine Unison with LGCell or MetroReach in the same daisy chain.

Alarm Sense Adapter Cable

The alarm sense adapter cable (PN 4025-1) translates the LGCell fault pinout to the sense input pins on the Unison Main Hub. You must use this adapter cable, as illustrated in Figure 7-11, with the 5-port Alarm Daisy-Chain Cable when connecting LGCell to Unison.

Figure 7-11 Alarm Sense Adapter Cable



7.8 Alarm Monitoring Connectivity Options

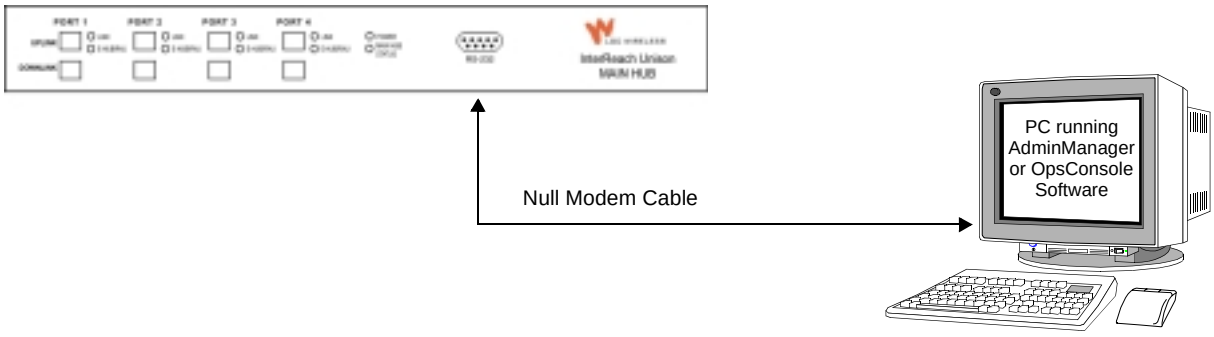
The following connectivity options are described here:

Note that the only accessory that is available through LGC Wireless is the DB-9 to DB-9 null modem cable, which is provided with AdminManager.

7.8.1 Direct Connection

In this configuration, the AdminManager or OpsConsole PC connects directly to the **RS-232** serial port on the Main Hub's front panel using a null modem cable.

Figure 7-12 OA&M Direct Connection

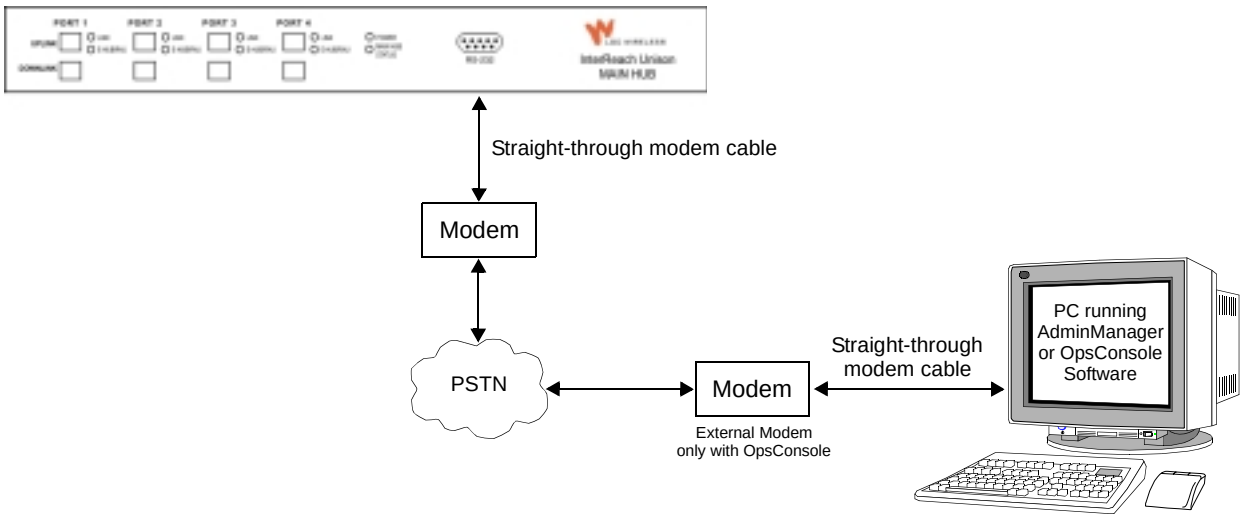


NOTE: The null modem cable must support full hardware handshaking. See Appendix A.5 on page A-4 for cable wiring information.

7.8.2 Modem Connection

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

Figure 7-13 OA&M Modem Connection

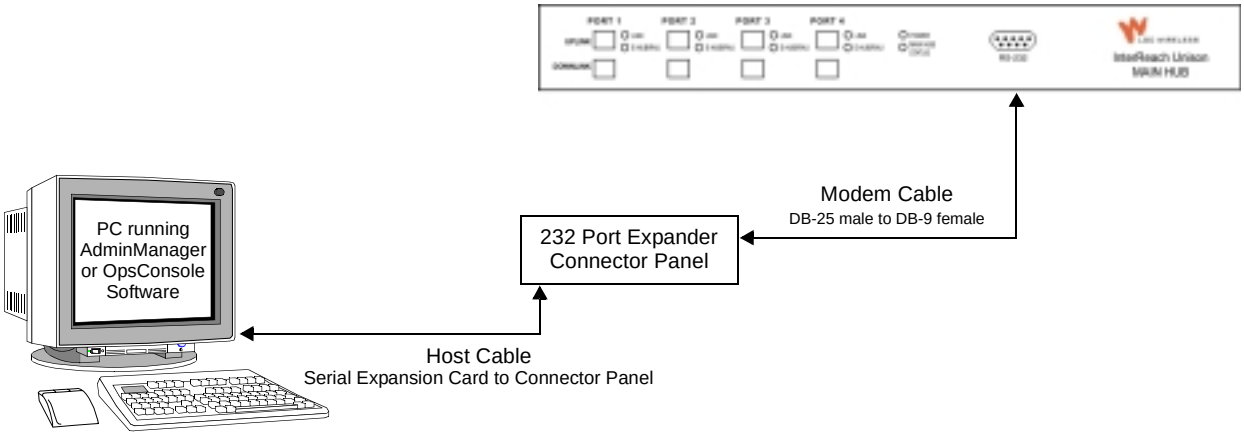


NOTE: See Appendix A.4 on page A-3 for the modem cable wiring information.

7.8.3 232 Port Expander Connection

In this configuration a port expander is used to allow the connection of multiple devices to a single PC serial port. Testing was performed with an Equinox SST-16P Multiport Board. A DB-25 male to DB-9 female modem cable must be made to connect the connector panel to the Main Hub (refer to Appendix A.6 on page A-5). Or, you can use a DB-25 male/DB-9 male adapter with a DB-9 female to DB-9 female null modem cable.

Figure 7-14 OA&M Connection using a 232 Port Expander

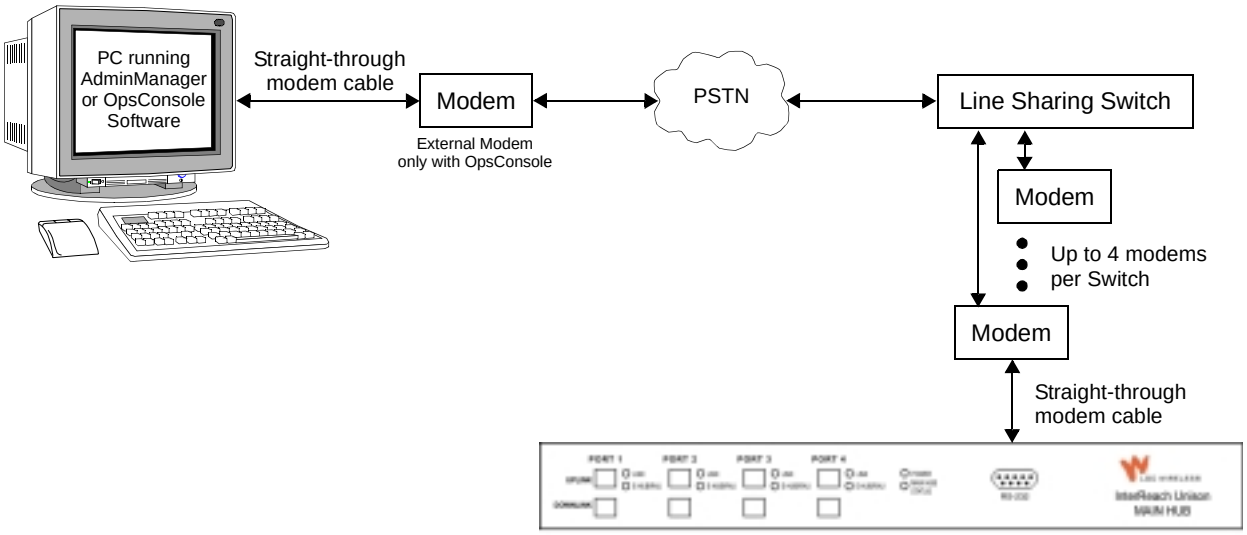


NOTE: See Appendix A.6 on page A-5 for the modem cable wiring information.

7.8.4 POTS Line Sharing Switch Connection

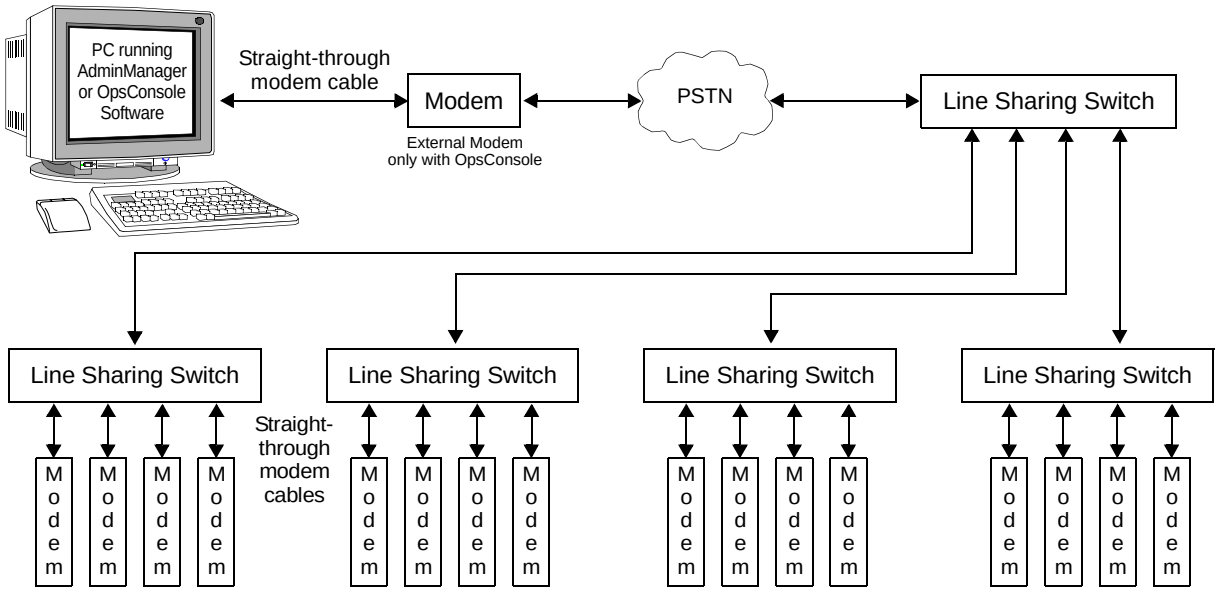
Using a line sharing switch you can connect up to four modems to a single telephone line. Testing was performed with a Teltone Line Sharing Switch, model number M-394-B-01.

Figure 7-15 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 7-16.

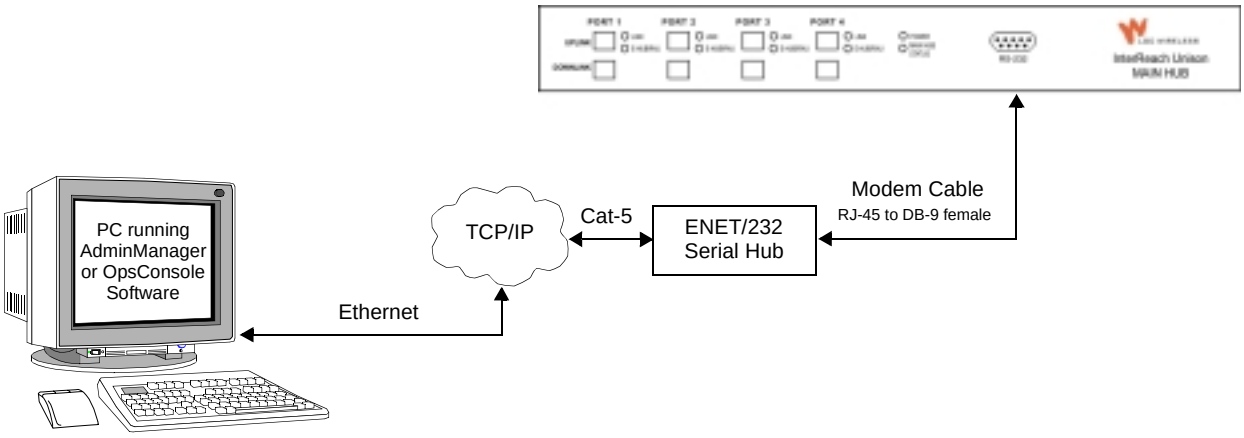
Figure 7-16 Cascading Line Sharing Switches



7.8.5 Ethernet and ENET/232 Serial Hub Connection

An Ethernet-to-RS-232 serial hub or converter box can be used to communicate between the PC and Unison. Testing was performed with an Equinox SST Ethernet Serial Provider.

Figure 7-17 OA&M Connection using Ethernet and ENET/232 Serial Hub



SECTION 8

Replacing Unison Components in an Operational System

8.1 Replacing an RAU

Be aware that the new RAU must be the same band as the one you are replacing. If you replace an RAU with one that is of the wrong band, it will not work.

The Main Hub automatically checks the band of a replaced RAU. There is no need to issue commands directly from the Main Hub. Therefore, as long as the RAU is of the correct band, the system will operate properly.

Replacing an RAU

1. Use AdminManager or refer to the As-Built Document to review the current RAU's configuration. To use AdminManager:
   a. Select Get Unit Info command from the Configuration and Maintenance Panel.

      The Options dialog box is displayed (see Get Unit Info in the *AdminManager User Manual*, PN 8810-10).
   b. Select Remote Access Unit radio button.
   c. Enter the hierarchy of the RAU in the text box.

      For example, for RAU number 4 that is connected to Expansion Hub number 1, enter 1-4.
   d. Click OK.

      Information for the RAU is displayed in the Configuration and Maintenance Panel window.
5. Disconnect the Cat-5/6 cable and antenna from the unit to be replaced.
6. Install the new RAU.
7. Connect the antenna and then the Cat-5/6 cable to the new RAU.
8. Repeat Step 1 to verify that the new RAU is of the same frequency band as the one replaced.

AdminManager Tasks

- Use the Advanced RAU Settings option on the Configuration & Maintenance panel to set the RAU's 10 dB attenuation and UL ALC settings.
- When convenient, perform System Test to optimize performance.

  During System Test, the entire system is temporarily off-line and no RF is being transmitted. For a fully loaded system (one Main Hub, four Expansion Hubs, and 32 RAUs), it can take up to 1.5 minutes to complete the test.

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 Expansion 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 the AdminManager to determine the exact nature of the fault and see a recommendation of how to correct it.
   c. If both LEDs turn red (after 45 seconds), the Expansion Hub has terminated communications.

8.2 Replacing an Expansion Hub

Replacing an Expansion Hub

1. Turn off the power to the Expansion Hub.
2. Disconnect all Cat-5/6 cables, both fiber cables, and the AC power cord.
3. Replace the Expansion Hub with a new one.
4. Connect the AC power cord, all Cat-5/6 cables, and both fiber cables – remembering to clean and correctly connect the uplink and downlink fiber.
5. Turn on the power to the Expansion Hub.

AdminManager Tasks

- The Main Hub automatically issues the band setting.
- When convenient, use AdminManager to perform System Test in order to optimize performance.

  During System Test, the entire system is temporarily off-line and no RF is being transmitted. For a fully loaded system (one Main Hub, four Expansion Hubs, and 32 RAUs), it can take up to 1.5 minutes to complete the test.

Checking the Expansion Hub's LEDs

- The LEDs should blink through all states on power up.
  - If the LEDs do not blink on power up, replace the Expansion Hub.
  - If the LEDs do not illuminate at all, make sure the AC power cable is connected.
- The **UL STATUS** and **DL STATUS** LEDs should be green.
- The **E-HUB STATUS** and **POWER** LEDs should be green.
- For each RJ-45 port that has an RAU connected:
  - The **E-HUB/RAU** LEDs should be green.
  - The **LINK** LEDs should be green.

  It can take several seconds for each Cat-5/6 connection for the LEDs to display properly.

NOTE: Refer to Section 9 for troubleshooting using the LEDs.

8.3 Replacing a Main Hub

You must record the system configuration settings from the old Main Hub's memory before replacing the unit (see Get System Configuration Settings below). You will program the new Main Hub with this information. If the Main Hub is programmed incorrectly, the system will not work. If the Main Hub is not functioning, get the configuration settings from the As-Built Document that was created as part of the original installation.

Get System Configuration Settings

1. Connect the null modem cable to the PC/laptop and the Main Hub.
2. Start the AdminManager software.
3. Select the Configuration & Maintenance Panel option from the AdminManager main window.
4. Click the SAVE CONFIG button.

   The Save Configuration Notes dialog box is displayed.
5. Type any notes you want to save with the configuration settings into the dialog box and click OK.

   The configuration settings are saved in a text file, for example:

```
Begin Notes ****************************************
LGC HQ
05/23/01 MH configuration L010MH11
System configuration
End Notes ******************************************

Frequency Band is DCS Low.
System Gain: UL = 12 dB, DL = 4 dB.
Callback Number is 1234567.
System label is LGC.

Main Hub Information:
Serial Number: L010BMH1
Part Number: 7405101
Revision Number: 03
Firmware Revision: 010526

Expansion Hub LGC-1 Information:
Serial Number: L010BEH9
Part Number: 7405101
Revision Number: 03
Firmware Revision: 010513

RAU LGC-1-5 Information:
Serial Number: L010BRU1
Part Number: 7405101
Revision Number: 03

Firmware Revision: 010021
```

Replacing a Main Hub

1. Turn off the power to the Main Hub.
2. Disconnect all fiber cables and the AC power cord.
3. Replace the Main Hub with a new one.
4. Connect the AC power cord and all fiber cables – remembering to clean and correctly connect the uplink and downlink fiber cables.
5. Connect the null modem cable to the PC and then to the Main Hub's front panel DB-9 serial connector.
6. Start the AdminManager software.
7. Select the Installation Wizard option from the AdminManager main window.
8. Turn on the power to the Main Hub.
9. Observe the LEDs after turning on the power.

   If there is no band programmed in the Main Hub, the LEDs will blink continuously and there is no communication with connected Expansion Hubs or their RAUs.

   If there is a band programmed, the LEDs blink for a 5-second test. The programmed band is then issued to all Expansion Hubs and their RAUs, and a system test is performed. It can take up to 1.5 minutes to complete the test. **During System Test, the entire system is temporarily off-line and no RF is being transmitted.**

AdminManager Tasks

- Use the Installation Wizard to:
  - Set the Operation Band
- Use the Configuration & Maintenance panel to:
  - Set Callback Number
  - Set Contact Sense Properties
  - Set System Parameters
  - Perform System Test

    During System Test, the entire system is temporarily off-line and no RF is being transmitted. For a fully-loaded system (one Main Hub, four Expansion Hubs, and 32 RAUs), it can take up to 1.5 minutes to complete the test.

    Always perform the system test if the band was changed.

Checking the Main Hub's LEDs

- The LEDs should blink through a 5-second test on power up.
  - If the LEDs do not blink on power up, replace the Main Hub.
  - If the LEDs do not illuminate at all, make sure the AC power cable is connected.
  - If the LEDs blink continuously, there is no band programmed in the Main Hub and there is no communication with connected Expansion Hubs or their RAUs.

- For each fiber optic port that has a connected Expansion Hub, which has been programmed with a band:
  - The **LINK** LED should be green.
  - The **E-HUB/RAU** LED should be green indicating that all downstream units are functioning

- Refer to Section 9.3, "Troubleshooting," on page 9-3 for more LED states.

NOTE: If there is communication between the Main Hub and the Expansion Hubs, use the AdminManager software's Configuration & Maintenance panel to isolate system problems.

SECTION 9

Maintenance, Troubleshooting, and Technical Assistance

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

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

9.1 Service

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

9.2 Maintenance

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

To clean the fiber ports:

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

Considerations:

- If using compressed air:
  - The air must be free of dust, water, and oil.
  - Hold the can level during use.
- If using isopropyl alcohol and cotton swabs:
  - Use only 98% pure or more alcohol.

Procedure using compressed air:

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

Procedure using isopropyl alcohol:

1. Remove the connector's dust cap.
2. Dip a cotton swap in isopropyl alcohol and slowly insert the tip into the connector.
3. Gently twist the swab to clean the connector.
4. Insert a dry swab to dry the connector.

   Additionally, you can use compressed air after the alcohol has completely evaporated.

9.3 Troubleshooting

NOTE: Unison 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 Unison components
- Antenna, base station, or repeater problem
- External RF interface
- Tripped circuit breaker
- Using a Null modem cable that does not support full hardware handshaking when using AdminManager

NOTE: Faulty cabling is the cause of a vast majority of problems. All Cat-5/6 cable should be tested to TIA/EIA 568-A specifications.

You must use AdminManager or OpsConsole for troubleshooting the system, only use the LEDs as backup or for confirmation. However, if there are communication problems within the system, the LEDs may provide additional information that is not available using AdminManager. The only problem that is indicated solely by the LEDs is when a band is not programed in the Main Hub. In that case, the LEDs flash continuously, beyond the normal system check flashing upon power up.

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)

9.3.1 Troubleshooting using AdminManager

To begin troubleshooting, use AdminManager software to determine the current faults and warnings for all of the units in the system. To troubleshoot, start with the Main Hub's faults and warnings, then proceed to each of the Expansion Hubs, finishing with each of the RAUs.

9.3.1.1 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 AdminManager. Start with the Main Hub and work downstream.

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

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

Faults Reported by the Main Hub

Table 9-1 Faults Reported by the Main Hub

Fault Message & Icon	LED	State	Possible Causes	Action	Impact
Main Hub Faults					
Hardware failure 	**STATUS**	Red	Internal hardware failure.	Replace the Main Hub.	System off-line.
Frequency band not programmed 	All LEDs (except **POWER**)	Continuous blinking	Factory default.	Program the frequency band using AdminManager's Installation Wizard.	System off-line.
Failed to perform system test 	**STATUS**	Red	Internal failure.	Replace the Main Hub when possible.	Degraded performance.

Table 9-1 Faults Reported by the Main Hub (continued)

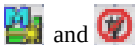
Fault Message & Icon	LED	State	Possible Causes	Action	Impact
EH*n* uplink AGC failure 	**STATUS**	Red	Uplink fiber has high optical loss.	Measure UL optical fiber loss. Clean the Main and Expansion Hub's uplink fiber ports. (Refer to Section 9.2.)	EH*n* degraded uplink performance; or EH*n* and connected RAUs are off-line.
			Main Hub uplink port failure.	Move fiber pair to another port. If fault is not reported, fiber is okay and Main Hub port is dirty or bad. Use AdminManager to 'Clear All Disconnect Status' to clear the disconnect fault on the original port.	
			Main Hub internal failure.	If more than one Expansion Hub connected to the same Main Hub reports this failure, replace the Main Hub.	
			Expansion Hub internal failure.	Swap suspect Expansion Hub with working Expansion Hub. If fault persists, replace Main Hub; otherwise, replace the Expansion Hub.	
Expansion Hub Faults					
EH*n* disconnected 	**LINK** **E-HUB/RAU**	Red Off	The Expansion Hub was connected and is now disconnected.	If EH*n* is disconnected, reconnect it or clear the disconnect fault using AdminManager's "Clear All Disconnect Status" command.	EH*n* and connected RAUs are off-line.
			The uplink fiber optical loss exceeds minimum threshold.	Check the uplink fiber cable's optical loss. Clean the uplink fiber connectors. (Refer to Section 9.2.) Clean the Main and Expansion Hubs' uplink ports. (Refer to Section 9.2.)	
			Expansion Hub uplink laser failure.	Check that EH*n*'s uplink laser is operational. (**UL STATUS** LED is green.) Power cycle the Expansion Hub and confirm the **UL STATUS** LED is green for 60–90 seconds after power up.	
			Main Hub uplink port failure	Move fiber pair to another port. If fault persists, there is a problem with the Expansion Hub. Otherwise, the Main Hub port is bad.	

Table 9-1 Faults Reported by the Main Hub (continued)

Fault Message & Icon	LED	State	Possible Causes	Action	Impact
No communication with EH*n*  and 	**LINK**	Red	Downlink fiber has high optical loss.	Measure downlink optical fiber loss. Clean the Expansion Hub's downlink fiber port. (Refer to Section 9.2.) Clean the Main Hub's downlink fiber port. (Refer to Section 9.2.)	EH*n* and/or RAU degraded performance, or EH*n* and connected RAUs are off-line.
	E-HUB/RAU	Off			
			Uplink fiber has high optical loss.	Measure uplink optical fiber loss. Clean uplink fiber connectors. (Refer to Section 9.2.) Clean uplink fiber ports. (Refer to Section 9.2.)	
			Main Hub downlink port failure.	Move the Main Hub fiber pair to another port. If fault is not reported, fiber is okay and the Main Hub port is bad. Use AdminManager's "Clear All Disconnect Status" command to clear the disconnect fault on the original port.	
			Main Hub internal failure.	If more than one Expansion Hub connected to the same Main Hub reports this failure, replace the Main Hub.	
			Expansion Hub downlink port failure.	Swap suspect Expansion Hub with working Expansion Hub. If fault persists, replace the Main Hub; otherwise, replace the Expansion Hub.	

Faults Reported by the Expansion Hub

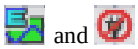
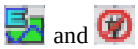
Table 9-2 Faults Reported by the Expansion Hub

Fault Message	LED	State	Possible Causes	Action	Impact
Expansion Hub Faults					
Hardware failure 	**STATUS**	Red	Downlink fiber has high optical loss.	Measure downlink optical fiber loss. Clean the downlink fiber connectors. (Refer to Section 9.2.) Clean the Main and Expansion Hubs' downlink fiber ports. (Refer to Section 9.2.)	Degraded performance or Expansion Hub and connected RAUs are off-line.
			Main Hub internal hardware failure.	If more than one Expansion Hub connected to the same Main Hub reports this failure, replace the Main Hub.	
			Expansion Hub internal hardware failure.	Replace the Expansion Hub.	
PLL unlock 	**STATUS**	Red	Downlink fiber has high optical loss.	Measure downlink optical fiber loss. Clean the downlink fiber connectors. (Refer to Section 9.2.) Clean the Main and Expansion Hubs' downlink fiber ports. (Refer to Section 9.2.)	Expansion Hub and connected RAUs are off-line.
			Main Hub internal hardware failure.	If more than one Expansion Hub connected to the same Main Hub reports this failure, replace the Main Hub.	
			Expansion Hub internal hardware failure.	Replace the Expansion Hub.	
Frequency band not programmed 	**STATUS**	Red	Downlink fiber has high optical loss.	Measure downlink optical fiber loss. Clean the downlink fiber connectors. (Refer to Section 9.2.) Clean the Main and Expansion Hubs' downlink fiber ports. (Refer to Section 9.2.)	Expansion Hub and connected RAUs are off-line.
			Expansion Hub internal hardware failure.	Replace the Expansion Hub.	

Table 9-2 Faults Reported by the Expansion Hub (continued)

Fault Message	LED	State	Possible Causes	Action	Impact
Downlink pilot failure 	**STATUS**	Red	Downlink fiber has high optical loss.	Measure downlink optical fiber loss. Clean downlink fiber connectors. (Refer to Section 9.2.) Clean the Main and Expansion Hubs' downlink fiber ports. (Refer to Section 9.2.)	Degraded performance or Expansion Hub and connected RAUs are off-line.
			Main Hub internal hardware failure.	If more than one Expansion Hub connected to the same Main Hub reports this failure, replace the Main Hub.	
			Main Hub downlink port failure.	Move fiber pair to another port. If fault is not reported, fiber is okay and the Main Hub port is bad. Use AdminManager's "Clear All Disconnect Status" command to clear the disconnect fault on the original port.	
			Expansion Hub downlink port failure.	Swap suspect Expansion Hub with working Expansion Hub. If fault persists, replace the Main Hub; otherwise, replace the Expansion Hub.	
RAU*n* uplink AGC failure 	**LINK**	Green	Cat-5/6 cable length.	Check Cat-5/6 cable length.	Degraded performance.
	RAU	Red	Expansion Hub uplink port failure or RAU failure.	Move RAU to another port. If no fault reported, replace the Expansion Hub. If fault reported, replace RAU.	
			Expansion Hub internal failure.	If more than one RAU connected to the same Expansion Hub reports this failure, replace the Expansion Hub.	
RAU*n* downlink port failure 	**STATUS**	Red	Expansion Hub internal failure.	Move the RAU to another port. If fault persists, replace the Expansion Hub. If no fault, flag previous port as unusable and replace the Expansion Hub when possible.	Degraded performance.

Table 9-2 Faults Reported by the Expansion Hub (continued)

Fault Message	LED	State	Possible Causes	Action	Impact
RAU Faults					
RAU*n* disconnected 	**LINK**	Red	RAU was connected and is now disconnected.	If RAUn is disconnected, reconnect it or use AdminManager's "Clear All Disconnect Status" command to clear the disconnect fault.	RAU*n* is off-line.
	RAU	Off	Cat-5/6 cable failure.	Check Cat-5/6 cable for shorts or opens.	
			RAU internal failure or Expansion Hub port bad.	Move the RAU to another port. If fault persists, replace the RAU. If no fault, flag previous port as unusable and replace the Expansion Hub when possible.	
No communication with RAU*n* 	**LINK**	Red	Cat-5/6 cable failure.	Verify that the Cat-5/6 cable has no shorts or opens.	Degraded performance.
	RAU	Off	RAU internal failure. *or* Expansion Hub port failure.	Move the RAU cables to another port. If fault persists, replace the RAU; otherwise, the Expansion Hub port is bad, mark the port as unusable and replace the Expansion Hub when possible.	
RAU*n* over current 	**LINK**	Green	Cat-5/6 cable failure.	Verify Cat-5/6 cable has no shorts or opens.	RAU*n* is off-line.
	RAU	Red	RAU internal failure.	Move RAU to another port. If fault persists, replace the RAU. If no fault reported, remove the RAU, power cycle the Expansion Hub, connect known good RAU to port. If fault reported, replace the Expansion Hub.	

Remote Access Unit Faults

Table 9-3 Remote Access Unit Faults

Fault Message	LED	State	Possible Causes	Action	Impact
Hardware failure	**ALARM**	Red	Internal hardware failure.	Replace the RAU.	RAU is off-line.
Frequency band not programmed	**ALARM**	Red	Wrong version of RAU for frequency band desired.	Replace the RAU if not valid for desired frequency band.	RAU is off-line.
RAU is over temperature	**ALARM**	Red	Ambient temperature above maximum.	Check environmental controls; move the RAU to cooler environment.	RAU is off-line.
Power supplied by Expansion Hub is too low	**ALARM**	Red	Cat-5/6 cable failure.	Verify Cat-5/6 cable has no shorts or opens.	RAU is off-line.
			RAU internal failure. *or* Expansion Hub port failure.	Move the RAU cable to another Expansion Hub port. If fault persists, replace the RAU; otherwise, the Expansion Hub port is bad, mark the port as unusable and replace the Expansion Hub when possible.	
			Expansion Hub internal failure.	If more than one RAU connected to the same Expansion Hub reports this failure, replace the Expansion Hub.	
Downlink pilot failure	**ALARM**	Red	Cat-5/6 cable failure.	Verify that the Cat-5/6 cable has no shorts or opens. Verify maximum Cat-5/6 cable length of 150 meters. Verify minimum Cat-5/6 cable length of 10 meters.	Degraded performance or RAU is off-line.
			RAU internal failure. *or* Expansion Hub port failure.	Move the RAU cable to another Expansion Hub port. If fault persists, replace the RAU; otherwise, the Expansion Hub port is bad, mark the port as unusable and replace the Expansion Hub when possible.	
			Expansion Hub internal failure.	If more than one RAU connected to the same Expansion Hub reports this failure, replace the Expansion Hub.	

9.3.1.2 Warning Indications

Warnings alert you to conditions that indicate potential system failure. 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.

Main Hub Warnings

Table 9-4 Main Hub Warnings

Warning Message	Action	Impact
Temperature is high	Check room environmental controls.	Potential Main Hub failure.
Input signal above limiter	Reduce input signal strength.	Can only occur for DCS, GSM, or UMTS configurations

Expansion Hub Warnings

Table 9-5 Expansion Hub Warnings

Warning Message	Action	Impact
Temperature is high	Check room environmental controls.	Potential Expansion Hub failure.
Downlink pilot low	Check fiber cable for recommended maximum loss.	Degraded performance.

Remote Access Unit Warnings

Table 9-6 Remote Access Unit Warnings

Warning Message	Action	Impact
Temperature is high	Move the RAU to cooler environment.	Potential RAU failure.
Power amplifier is failing	Replace the RAU when possible.	Potential RAU failure.

9.3.1.3 Status Messages

Status messages alert you to conditions that may impact system performance. Status messages are displayed in the Messages pane in blue lettering.

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

Main Hub Status Messages

Table 9-7 Main Hub Status Messages

Message	Icon	Action	Impact
Downlink laser is failing		Replace the Main Hub when possible.	The downlink laser will eventually fail and the system will be off-line.
Fan failure		Use AdminManager to check Main Hub status. Check the Main Hub fan for rotation, air flow blockage, dust. If fan is not operating, replace the Main Hub. If fan is operating, check room environmental controls.	Temperature may rise to fault level resulting in Main Hub and connected Expansion Hub(s) and RAU(s) being off-line.
Command out of service		Command unit into service using AdminManager.	System is off-line.
Unable to perform system test on power up		Check Expansion Hubs and RAUs for faults and warnings.	Degraded system performance.
EH*n* or RAU reports a warning status		Check Expansion Hubs and RAUs for warnings.	Degraded system performance.
EH*n* uplink fiber optical loss greater than recommended maximum		Check the uplink fiber cable for optical loss. Clean the cable connector. (Refer to Section 9.2.) Clean the fiber ports. (Refer to Section 9.2.)	Degraded system performance.
Unable to perform system end-to-end test		Replace Main Hub when possible.	Degraded system performance.

NOTE: If your equipment is using release 3.1 firmware, the  icon is displayed instead of  , except for “unable to perform system test on power up”.

Expansion Hub Status Messages

Table 9-8 Expansion Hub Status Messages

Message	Icon	Action	Impact
Downlink fiber optical loss greater than recommended maximum		Check the downlink fiber cable for excessive optical loss. Clean the cable connector. (Refer to Section 9.2.) Clean the fiber ports. (Refer to Section 9.2.)	Degraded system performance.
Uplink laser is failing		Replace the Expansion Hub when possible.	The uplink laser will eventually fail resulting in the Expansion Hub and connected RAUs being off-line.
Unit not system tested		Use AdminManager to command System Test. Note that the system will be off-line for 30 seconds during test.	System not operating at optimum performance.
Fan*n* failure		Check the Expansion Hub fans for rotation, air flow blockage, dust Use AdminManager to check Expansion Hub status. If fans are not operating, replace the Expansion Hub. If fans are operating, check room environmental controls.	Temperature may rise to fault level resulting in the Expansion Hub and connected RAUs being off-line.
Cat-5/6 cable between RAU*n* and Expansion Hub is longer than recommended maximum		Check that the Cat-5/6 cable does not exceed the recommended maximum length.	Degraded system performance.
Command out of service		Command unit into service using AdminManager	Expansion Hub and connected RAUs are off-line.
MH Commanded Fault Lockout		Use AdminManager to check Main Hub faults and replace Main Hub as required.	Expansion Hub and connected RAUs are off-line.

NOTE: If your equipment is using release 3.1 firmware, the  icon is displayed instead of  , except for “unit not system tested”.

Remote Access Unit Status Messages

Table 9-9 Remote Access Unit Status Messages

Message	Icon	Action	Impact
DC voltage is low		Check the Cat-5/6 cable for shorts and opens. Replace the RAU when possible.	Unreliable operation.
Cat-5/6 cable between Expansion Hub and RAU is longer than recommended maximum		Check that the Cat-5/6 cable does not exceed the recommended maximum length.	Degraded system performance.
Unit not system tested		Use AdminManager to command System Test. Note that the system will be off-line for 30 seconds during test.	System not operating at optimum performance.
Antenna disconnected		Check that the antenna is connected to the RAU; check coax cable between RAU and antenna.	Antenna may be disconnected. If it is connected, then the antenna/cable measure higher return loss than optimum configuration.
RAU Commanded Out-of-Service		Command unit into service using AdminManager.	RAU is off-line.
MH/EH Commanded Fault Lockout		Use AdminManager to check Main Hub and Expansion Hub faults and replace units as required.	RAU is off-line.
Power supplied by Expansion Hub is too high		Check the Cat-5/6 cable for opens and shorts. Move RAU cable to another Expansion Hub port. Replace RAU when possible.	Unreliable operation.
System test uplink failure		Unable to complete system test.	Degraded system performance.
Can’t calibrate downlink		Unable to complete system test.	Degraded system performance.

NOTE: If your equipment is using release 3.1 firmware, the  icon is displayed instead of  , except for “unit not system tested”.

9.3.2 Troubleshooting using LEDs

The following troubleshooting guide is from the perspective that all Unison 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 7 for information on troubleshooting during initial installation of the system.)

Always use AdminManager, if possible, to troubleshoot the system. The LEDs are for backup troubleshooting; although, an Expansion Hub uplink laser failure can only be resolved using the **EH UL STATUS** LED.

Begin with troubleshooting the Main Hub's LEDs and then the Expansion Hub's LEDs. The RAU LEDs probably will not provide additional information for troubleshooting.

9.3.2.1 Troubleshooting Main Hub LEDs During Normal Operation

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

Table 9-10 Troubleshooting Main Hub Port LEDs During Normal Operation

During Normal Operation	Main Hub Port LEDs	State	Action	Impact
Expansion Hub Not Connected	**LINK**	Red	If the Expansion Hub was disconnected accidentally, re-connect the cables. The LEDs should change to Green/Red (then Green/Green, after 20 seconds, if the Main Hub band has been programmed). If the Expansion Hub is to be removed from service permanently, then use AdminManager's 'Clear All Disconnect Status' command to clear all disconnect states to no connect states. The Main Hub's port LEDs should change to Off/Off.	Expansion Hub was previously connected, but it is not currently connected; Expansion Hub cable disconnect. AdminManager will clear all disconnects caused by installation as part of the clean-up process. After installation, power cycle the Main Hub or use AdminManager's "Clear All Disconnect Status" command.
	E-HUB/RAU	Off		
Expansion Hub Connected	**LINK**	Red	Use AdminManager to determine the exact cause of the Main Hub's faults.	Lost communication with Expansion Hub; could be Expansion Hub problem or fiber cable problem.
	E-HUB/RAU	Off		
	LINK	Green	Expansion Hub or connected RAU reports a fault condition; use AdminManager to determine the exact cause of the Expansion Hub and RAU's faults.	Degraded performance or unit may be off-line. Depends on fault condition.
	E-HUB/RAU	Red		

Table 9-11 Troubleshooting Main Hub Status LEDs During Normal Operation

During Normal Operation	Main Hub Status LEDs	State	Action	Impact
At Any Time	**MAIN HUB STATUS**	Red	Use AdminManager to determine the exact cause of the fault. Power cycle one time. If fault remains, replace the Main Hub.	Internal Main Hub fault.
			Use AdminManager to check if the Main Hub is commanded Out-of-Service (every Expansion Hub port status LED will be red as well). A power cycle will not clear a commanded Out-of-Serivce, you must use AdminManager to clear this state.	Main Hub and all downstream units are off-line.
	MAIN HUB STATUS	Alternating Red/Green	Reduce input signal power; reduce system gain.	Signal compression.

9.3.2.2 Troubleshooting Expansion Hub LEDs During Normal Operation

- All of the Expansion Hub **LINK** and **E-HUB/RAU** LEDs that have RAUs connected should be Green/Green, indicating that the RAU is powered on, communication is established, and operation is normal.
- The **POWER**, **EHUB STATUS**, **DL STATUS**, and **UL STATUS** LEDs should all be Green.

Table 9-12 Troubleshooting Expansion Hub Port LEDs During Normal Operation

During Normal Operation	Expansion Hub Port LEDs	State	Action	Impact
RAU is not connected	**LINK**	Red	If the RAU was disconnected accidentally, re-connect the Cat-5/6 cable. The Expansion Hub's port LEDs should change to Green/Red (then Green/Green, after 20 seconds, if the Main Hub is connected, powered on, and has band programmed). Use AdminManager's "Clear All Disconnect Status" command if you are permanently removing the RAU from service. The Expansion Hub's port LEDs should change to Off/Off.	RAU was previously connected, but it is not currently connected; RAU cable is disconnected.
	RAU	Off		
RAU is connected	**LINK**	Red	Disconnect/reconnect the Cat-5/6 cable to force power-on reset to the RAU. If the port LEDs remain Red/Off, check for the exact cause of Expansion Hub faults using AdminManager.	Lost communications with the RAU. The RAU could have powered down due to over current; cable could have been damaged.
	RAU	Off		
	LINK	Green	RAU reports a fault condition; check for the exact cause of Expansion Hub and RAU faults using AdminManager.	Depends on the fault condition.
	RAU	Red		

Table 9-13 Troubleshooting Expansion Hub Status LEDs During Normal Operation

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

NOTE: When you power cycle the Expansion Hub the **UL STATUS** LED should be green for approximately 90 seconds before it turns red. If it isn't, replace the Expansion Hub.

9.4 Troublshooting Cat-5/6

Refer to Table A-1 on page A-1 for a description of the Cat-5/6 wire assignment. The following table summarizes Cat-5/6 problems if a wire is cut or miswired.

Table 9-14 Summary of Cat-5/6 Cable Wiring Problems

Type of problem	Message	Icon	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 EH
Wire 4 or 5 cut	• RAU*n* uplink AGC failure		Increased ripple in the uplink path
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		
Wire 7 or 8 cut	• Downlink pilot failure		Increased ripple in the downlink path
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		
Wire 1 to RJ-45 pin 3 or 6	• No communication with RAU*n*		RAU unable to communicate with EH, RAU's RS-485 port damaged
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 EH, RAU's RS-485 port damaged
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 EH
Wire 6 to RJ-45 pin 4, 5, 7 or 8	• No communication with RAU*n*		RAU unable to communicate with EH
Wire 4 to RJ-45 pin 7 or 8	• RAU*n* uplink AGC failure		Increased ripple in the downlink and uplink path
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		
	• Downlink pilot failure		
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		

Table 9-14 Summary of Cat-5/6 Cable Wiring Problems (continued)

Type of problem	Message	Icon	Impact
Wire 5 to RJ-45 pin 7 or 8	• RAU*n* uplink AGC failure		Increased ripple in the downlink and uplink path
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		
	• Downlink pilot failure		
	• Cat-5/6 cable between RAU*n* and EH is longer than recommended		

9.5 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
- AdminManager faults, warnings, and status messages

APPENDIX A

Cables and Connectors

A.1 Cat-5/6 Cable (ScTP)

- Connects the Expansion Hub to the RAU(s)
- Transmits (downlink) and receives (uplink) IF signals
- Delivers DC electrical power to the RAUs. The Expansion Hub's DC voltage output is 36V DC nominal. A current limiting circuit is used to protect the Expansion Hub if it reaches its current limit
- Carries configuration and status information
- Use shielded RJ-45 connectors
- Distances:
  - Minimum: 10 meters (33 ft)
  - Recommended Maximum: 100 meters (328 ft)
  - Absolute Maximum: 150 meters (492 ft)

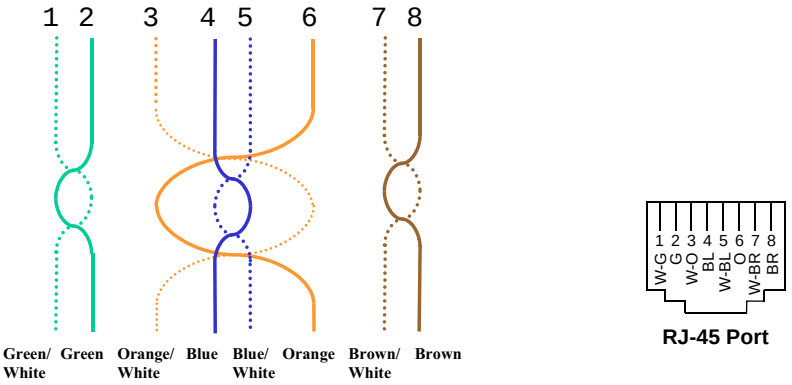
There are four separate twisted pairs in one Cat-5/6 screened twisted pair (ScTP) cable. The ScTP cable loss described in this document is for Cat-5 Mohawk/CDT 55986 or Belden 1624P DataTwist Five cable, or equivalent. The following table lists the functional assignment of the pairs:

Table A-1 Cat-5/6 Twisted Pair Assignment

Pair (wire number)	Function
1 & 2	Clock and Input Voltage
3 & 6	RS-485
4 & 5	Uplink IF, UL Pilot and Ground
7 & 8	Downlink IF, DL Pilot and Ground

All Cat-5/6 cable must be terminated according to the TIA/EIA 568-A standard. The following diagram shows the top view of the wiring map for the cable and how the four pairs should be terminated.

Figure A-1 Wiring Map for Cat-5/6 Cable



The nominal DC impedance of the Cat-5/6 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: Mohawk/CDT 55986 or Belden 1624P DataTwist® Five ScTP cable, or equivalent is required. In order to meet FCC and CE Mark emissions requirements, the Cat-5/6 cable must be screened (ScTP) and it must be grounded to the units at both ends (i.e., RAU and Expansion Hub) using shielded RJ-45 connectors.

A.2 Fiber Optical Cables

- Connects Main Hub to Expansion Hub(s)
- Transmits (downlink) and receives (uplink) optical signals
- Carries configuration and status information
- Use industry-standard 62.5µm/125µm MMF or Corning SMF-28 fiber, or equivalent.
- SC/APC (angle-polished) connectors are required throughout the fiber network (port-to-port), including fiber distribution panels
- Distances:
  - Multi-mode Fiber: up to 1.5 km (4,921 ft) – 3 dB optical loss maximum
  - Single-mode Fiber: up to 6 km (19,685 ft) – 3 dB optical loss maximum

A.3 Coaxial Cable

- Connects a Main Hub to a repeater or base station (N-type connectors)
- Connects an RAU to a passive antenna (SMA connectors)

A.4 Standard Modem Cable

- Connects a modem to the Main Hub's front panel serial port

Figure A-2 Standard Modem Cable Pinout

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

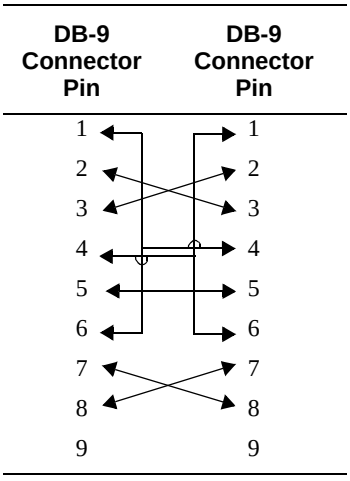
A.5 DB-9 to DB-9 Null Modem Cable

A DB-9 female to DB-9 female null modem cable is used to connect the AdminManager PC to a Unison Main Hub. A cable is included with AdminManager. Table A-2 lists the cable pinout and Figure A-3 shows a diagram of its wiring.

Table A-2 DB-9 Female to DB-9 Female Null Modem Cable Pinout

From	Signal	To	Signal
P1-4	DTR	P2-6, P2-1	DSR, DCD
P1-6	DSR	P1-1, P2-4	DCD, DTR
P1-3	TXD	P2-2	RXD
P1-2	RXD	P2-3	TXD
P1-5	GND	P2-5	GND
P1-7	RTS	P2-8	CTS
P1-8	CTS	P2-7	RTS
P1-9	N/C	N/C	N/C

Figure A-3 DB-9 Female to DB-9 Female Null Modem Cable Diagram



Note that for each DB-9 connector, pins 1 and 6 are tied together and sent to pin 4 of the opposite connector; thus, providing the required handshake signals.

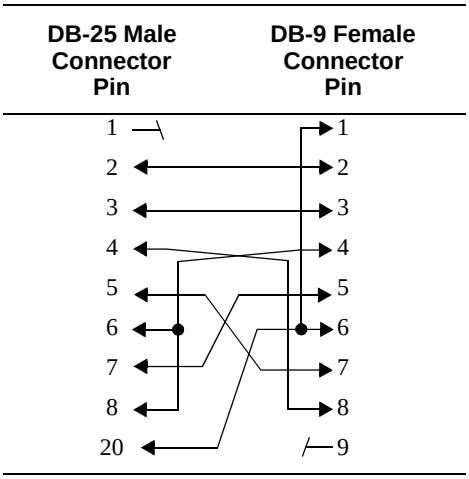
A.6 DB-25 to DB-9 Null Modem Cable

A DB-25 male to DB-9 female Null modem cable is used to connect a 232 Port Expander to a Unison Main Hub, or to connect a modem to the Main Hub when using OpsConsole to monitor the system. Table A-3 lists the pinout of the cable for Unison and Figure A-4 shows a diagram of its wiring.

Table A-3 DB-25 Male to DB-9 Female Null Modem Cable Pinout

25-Pin	Signal	9-Pin	Signal
20	DTR	1, 6	DSR, DCD
2	TX	2	RX
3	RX	3	TX
6,8	DSR, DCD	4	DTR
7	GND	5	GND
5	CTS	7	RTS
4	RTS	8	CTS

Figure A-4 DB-25 Male to DB-9 Female Null Modem Modem Cable Diagram



APPENDIX B

InterReach Unison Property Sheet

Use the "InterReach Unison Property Sheet" form, which is provided on the following page, to document a system configuration. The completed form can be used for future reference when the system is being maintained or components are added or exchanged. An example of a completed form is shown below.

LGC WIRELESS

InterReach™ Unison Property Sheet

Installer:			Date:		Main Hub Serial Number:
J. Smith			10/10/10		L010BMH1
System Label:	**System Gain:**		**Alarm Sense:**		**System Band:**
AB	**UL:**	**DL:**	☐ Yes ☐ No	☐ Normally-Closed ☐ Normally-Open	DCS 2

Unit MH - EH - RAU		RAU Attenuation? Yes/No	Unit Serial No.	Unit Installation Location
AB-1-n	(EH 1)	—	L010BEH9	2nd floor Telecom closet
AB-1-1	(RAU 1)	no	L010BRU1	Hallway, outside Boardroom
AB-1-2	(RAU 2)	no	L120BRU1	Hallway, outside #230
AB-1-3	(RAU 3)	yes	L007BRU1	Hallway, atrium north side
AB-1-4	(RAU 4)	no	L111BRU6	Hallway, outside #207
1-1-5	(RAU 5)			
1-1-6	(RAU 6)			
1-1-7	(RAU 7)			
1-1-8	(RAU 8)			
1-2-n	(EH 2)	—		
1-2-1	(RAU 1)			
1-2-2	(RAU 2)			
1-2-3	(RAU 3)			
1-2-4	(RAU 4)			
1-2-5	(RAU 5)			
1-2-6	(RAU 6)			
1-2-7	(RAU 7)			
1-2-8	(RAU 8)			
1-3-n	(EH 3)	—		
1-3-1	(RAU 1)			
1-3-2	(RAU 2)			
1-3-3	(RAU 3)			
1-3-4	(RAU 4)			
1-3-5	(RAU 5)			
1-3-6	(RAU 6)			
1-3-7	(RAU 7)			
1-3-8	(RAU 8)			
1-4-n	(EH 4)	—		
1-4-1	(RAU 1)			

LGC WIRELESS

InterReach™ Unison Property Sheet

Installer:	Date:	Main Hub Serial Number:

System Label:	System Gain: UL:	System Gain: DL:	Alarm Sense: ☐ Yes ☐ No	Alarm Sense: ☐ Normally-Closed ☐ Normally-Open	System Band:

Unit MH - EH - RAU		RAU Attenuation? Yes/No	Unit Serial No.	Unit Installation Location
1-1-n	(EH 1)			
1-1-1	(RAU 1)			
1-1-2	(RAU 2)			
1-1-3	(RAU 3)			
1-1-4	(RAU 4)			
1-1-5	(RAU 5)			
1-1-6	(RAU 6)			
1-1-7	(RAU 7)			
1-1-8	(RAU 8)			
1-2-n	(EH 2)			
1-2-1	(RAU 1)			
1-2-2	(RAU 2)			
1-2-3	(RAU 3)			
1-2-4	(RAU 4)			
1-2-5	(RAU 5)			
1-2-6	(RAU 6)			
1-2-7	(RAU 7)			
1-2-8	(RAU 8)			
1-3-n	(EH 3)			
1-3-1	(RAU 1)			
1-3-2	(RAU 2)			
1-3-3	(RAU 3)			
1-3-4	(RAU 4)			
1-3-5	(RAU 5)			
1-3-6	(RAU 6)			
1-3-7	(RAU 7)			
1-3-8	(RAU 8)			
1-4-n	(EH 4)			
1-4-1	(RAU 1)			
1-4-2	(RAU 2)			
1-4-3	(RAU 3)			
1-4-4	(RAU 4)			
1-4-5	(RAU 5)			
1-4-6	(RAU 6)			
1-4-7	(RAU 7)			
1-4-8	(RAU 8)			

APPENDIX C

Compliance

900 Paging/SMR

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

Cellular Products

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

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)

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

iDEN Products

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

PCS Products

- Safety: UL 60950 3rd Edition
- EMC: FCC part 15 class A
- Radio: FCC part 24
- Radio: FCC part 22

UMTS Products

- Safety: CB scheme evaluation to IEC 950, 3rd Edition with all national deviations
- EMC: ETSI TS 125 113 V.4.1.0 (2001-06)
- Radio: ETSI TS 125 143 V.4.0.0 (2001-03)

APPENDIX D

Release Notes

D.1 Unison Release 4

This document is for the Unison Release 4 products listed in the following table.

Table D-1 Unison Release 4 Line-up

Unison Component	EPN*	Hardware Revision**	Firmware (FW) or Software (SW) Release*
Main Hub	740510-2	C	010559 (FW)
Expansion Hub	740530-2	C	01054E (FW)
RAU:			
PCS	740552-2	C	01053C (FW)
DCS	740553-1	D	01053C (FW)
GSM	740554-1	E	01052B (FW)
Cellular	740550-1	B	01052B (FW)
iDEN	740551-0	A	01052B (FW)
UMTS	740560-1	B	01052B (FW)
AdminManager	750001-0	N/A	v1.08 (SW)
OpsConsole	750002-0	N/A	v1.02 (SW)

* Use the Get Unit Info command in the AdminManager's Configuration & Maintenance Panel to verify the EPN and Firmware/Software Version of the component

** The hardware revision number is on a label on the back panel of the component

D.2 Compatibility

The following table provides compatibility information for the Unison firmware (FW) and hardware (HW) (i.e., Main Hub (MHub), Expansion Hub (EHub), and low (Lo) and high (Hi) band RAUs).

Table D-2 Hardware/Firmware/Software Release Compatibility

Past Firmware Release	Component	Release 4 Firmware				AdminManager Version 1.08	OpsConsole Version 1.02
		Main Hub FW	Expansion Hub FW	Lo Band RAU[a] FW	Hi Band RAU[b] FW		
Release 3.1 Firmware	MHub HW	c				c	c
	EHub HW		c			c	c
	Lo RAU HW			c		c	c
	Hi RAU HW				c	c	c
	MHub FW		c	pc, 2	pc, 2	pc, 2, 5	pc, 2, 5
	EHub FW	c		c	c	pc, 5	pc, 5
	Lo RAU FW	pc, 2, 4	c			pc, 2, 5	pc, 2, 5
	Hi RAU FW	pc, 2, 4	c			pc, 2, 5	pc, 2, 5
	AdminMgr 1.06	pc, 2, 3	pc, 2, 3	pc, 2, 3	pc, 2, 3		
Release 3 Firmware	MHub HW	c				c	c
	EHub HW		c			c	c
	Lo RAU HW			c		c	c
	Hi RAU HW				c	c	c
	MHub FW		c	pc, 2	pc, 2	pc, 2, 5	pc, 2, 5
	EHub FW	c		c	c	pc, 5	pc, 5
	Lo RAU FW	pc, 2, 4	c			pc, 2, 5	pc, 2, 5
	Hi RAU FW	pc, 2, 4	c			pc, 2, 5	pc, 2, 5
	AdminMgr v1.06	pc, 2, 3	pc, 2, 3	pc, 2, 3	pc, 2, 3		
Release 2 Firmware Does not support: • iDEN • GSM • EGSM • UMTS	MHub HW	c					
	EHub HW		c				
	Lo RAU HW			c			
	Hi RAU HW				c		
	MHub FW		nc	nc	pc	nc	nc
	EHub FW	c		c	c	nc	nc
	Lo RAU FW	pc, 2, 4	c			nc	nc
	Hi RAU FW	pc, 2, 4	c			nc	nc
	AdminMgr v1.06	nc	nc	nc	nc		
OpsConsole							

a. iDEN, GSM, Cellular, and UMTS
b. PCS and DCS

Appendix D-2 Notes:

1. c – compatible; pc – partially compatible; nc – not compatible
2. Does not support DCS4 and GSM
3. Downstream lockout due to fault is incorrectly indicated as a lockout
4. Main Hub issues band command to RAU on first “F” detect (causes RAU to attempt alarm recovery where Release 4 won’t)
5. Release 3.1 and 3 will flag most “warnings” as an error, which will open warning contact closure and display warning icons in AdminManager, while Release 4 will flag most as “system status” and display status icons.

Warning Icons	Status Icons
 Main Hub	 Main Hub
 Expansion Hub	 Expansion Hub
 RAU	 RAU

D.3 New Capabilites

- Supports GSM and EGSM frequency bands using the GSM RAU
- Supports the DCS4 band

  Frequencies: DL 1815–1850 MHz, UL 1720–1755 MHz
- Supports globally downloading firmware updates to multiple units at the same time (i.e., all RAUs in a system, then all of the Expansion Hubs, and finally the Main Hub)
- Supports reclassification of status messages

APPENDIX E

Glossary

Air Interface A method for formatting data and voice onto radio waves. Common air interfaces include AMPS, TDMA, CDMA, and GSM.

AIN Advanced Intelligent Network. AINs allow a wireless user to make and receive phone calls while roaming outside the user's "home" network. These networks, which rely on computers and sophisticated switching techniques, also provide many Personal Communications Service (PCS) features.

Amplitude The distance between high and low points of a waveform or signal.

AMPS Advanced Mobile Phone Service. AMPS is an analog cellular FDMA system. It was the basis of the first commercial wireless communication system in the U.S and has been used in more than 35 other countries worldwide.

Analog The original method of modulating radio signals so they can carry information which involves transmitting a continuously variable signal. Amplitude Modification (AM) and Frequency Modulation (FM) are the most common methods of analog modulation.

ANSI The American National Standards Institute. A nonprofit, privately funded membership organization founded in 1918 that reviews and approves standards developed by other organizations.

Antenna A device for transmitting and/or receiving signals.

Attenuation The decrease in power that occurs when any signal is transmitted. Attenuation is measured in decibels (dB).

Backhaul A term applied to the process of carrying wireless traffic between the MSC and the base station.

Base Station The radio transmitter/receiver that maintains communications with mobile devices within a specific area.

BSC Base Station Controller. A GSM term referring to the device in charge of managing the radio interface in a GSM system, including the allocation and release of radio channels and hand-off of active calls within the system.

BTA Basic Trading Area. The U.S. and its territories are divided into 493 areas, called BTAs. These BTAs are composed of a specific list of counties, based on a system originally developed by Rand McNally. The FCC grants licenses to wireless operators to provide service within these BTAs and/or MTAs. (See MTA.)

BTS Base Transceiver Station. A GSM term referring to the group of network devices that provide radio transmission and reception, including antennas.

C/I Carrier to interference ratio. The ratio of the desired signal strength to the combined interference of all mobile phones using the system. Usually, the interference of most concern is that provided by mobile phones using the same channel in the system. These are referred to as "co-channel interferers."

CCITT Consultative Committee on International Telephone and Telegraph. This organization sets international communications standards. The CCITT is now known as ITU (the parent organization).

CDMA Code Division Multiple Access. A digital wireless access technology that uses spread-spectrum techniques. Unlike alternative systems, such as GSM, that use time-division multiplexing (TDM), CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are assigned a unique code which allows the conversation to be spread out over multiple channels; transmitted to the far end; and re-assembled for the recipient using a specific code.

CDPD Cellular Digital Packet Data. CDPD allows data transmission over the analog wireless network. CDPD breaks data into packets and transmits these packets on idle portions of the network.

Cell A cell defines a specific, physical area of coverage of a portion of a wireless system. It is the basic "building block" of all modern wireless communications systems.

Cell Site A term which refers to the location of the transmission equipment (e.g., basestation) within the cell.

CEPT Conference of European Postal and Telecommunications Administrations. This organization's mandate is to define pan-European wireless communications standards. In 1982, CEPT mandated GSM as the access protocol for public wireless communications systems across Europe.

Channel The path along which a communications signal is transmitted. Channels may be simplex (communication occurs in only one direction), duplex (communication occurs in both directions) or full duplex (communication occurs in both directions simultaneously).

Circuit A communication connection between two or more points. A circuit can transmit either voice or data.

CO Central Office. The main switching facility for a telecommunications system.

CTIA Cellular Telecommunications Industry Association. The CTIA is an industry association made up of most of the wireless carriers and other industry players. It was formed in 1984 to promote the cellular industry and cellular technology.

D-AMPS Digital Advanced Mobile Phone Service. See IS-54.

dB Decibel. A unit for expressing the ratio of two amounts of power. It is often used in wireless to describe the amount of power loss in a system (i.e., the ratio of transmitted power to received power).

DCS Digital Communications System. DCS is often called "upbanded GSM" since it is the GSM access scheme adopted to operate in the 1700–1800 MHz portion of the spectrum.

Digital A method of storing, processing, and transmitting information by representing information as "0s" and "1s" via electrical pulses. Digital systems have largely replaced analog systems because they can carry more data at higher speed than analog transmission systems.

Electromagnetic Spectrum Electrical wave forms in frequency ranges as low as 535 kHz (AM radio) and as high as 29 GHz (cable TV).

ESMR Enhanced Specialized Mobile Radio. Digital mobile telephone services offered to the public over channels previously used for two-way analog dispatch services. ESMR provides digital mobile radio and telephone service as well as messaging and dispatch features.

ETSI European Telecommunications Standards Institute. ETSI was established in 1988 to set standards for Europe in telecommunications, broadcasting and office information technology.

FCC Federal Communications Commission. In the United States, the FCC is responsible for the management and regulation of communication policy for all public communications services, including wireless.

FDMA Frequency Division Multiple Access. A wireless access protocol that assigns each user a specific radio channel for use. Since FDMA only supports one user (or conversation) on each channel, it does not maximize use of the spectrum and is therefore largely been superseded by other access protocols (such as CDMA, TDMA, GSM, iDEN) that support multiple users on a single channel.

Frequency Hopping A wireless signal transmission technique whereby the frequency used to carry a signal is periodically changed, according to a predetermined code, to another frequency.

Fixed An ITU definition for radio communications between specified fixed points. Point-to-point high-frequency circuits and microwave links are two examples of fixed applications.

FM Frequency Modulation. A method of transmitting information in which the frequency of the carrier is modified according to a plan agreed to by the transmitter and the receiver. FM can be either analog or digital.

Forward Channel Refers to the radio channel that sends information from the base station to the mobile station. (See Reverse Channel.)

Frequency The number of times an electrical signal repeats an identical cycle in a unit of time, normally one second. One Hertz (Hz) is one cycle per second.

Frequency re-use The ability to use the same frequencies repeatedly across a cellular system. Because each cell is designed to use radio frequencies only within its boundaries, the same frequencies can be reused in other cells not far away with little potential for interference. The reuse of frequencies is what enables a cellular system to handle a huge number of calls with a limited number of channels.

Gain The increase in power that occurs when any signal is amplified, usually through an amplifier or antenna.

GHz Gigahertz. A measure of frequency equal to one billion hertz.

GSM Groupe Speciale Mobile (now translated in English as Global Standard for Mobile Communications). GSM is the digital wireless standard used throughout Europe, in much of Asia, as well as by some operators in the U.S. and South America.

Handoff The process by which the wireless system passes a wireless phone conversation from one radio frequency in one cell to another radio frequency in another as the caller moves between two cells. In most systems today, this handoff is performed so quickly that callers don't notice.

Hertz A measurement of electromagnetic energy, equivalent to one "wave" per second. Hertz is abbreviated as "Hz".

iDEN Integrated Digital Enhanced Network. A TDMA-based wireless access technology that combines two-way radio, telephone, text message, and data transmission into one network. This system was developed by Motorola. In the U.S., iDEN is used by Nextel in its network.

IEEE The Institute of Electrical and Electronics Engineers. The world's largest technical professional society with members from more than 130 countries. The IEEE works to advance the theory and practice of electrical, electronics, computer engineering and computer science.

Infrastructure A term used to encompass all of the equipment, including both hardware and software, used in a communications network.

IS-54 Interim Standard-54. A U.S. TDMA cellular standard that operates in the 800 MHz or 1900 MHz band. IS-54 was the first U.S. digital cellular standard. It was adopted by the CTIA in 1990.

IS-95 Interim Standard-95. A U.S. CDMA cellular standard that operates in the 800 MHz or 1900 MHz band. This standard was developed by Qualcomm and adopted by the CTIA in 1993.

IS-136 Interim Standard-136. A U.S. TDMA cellular standard based on IS-54 that operates in the 800 MHz or 1900 MHz band.

IS-553 Interim Standard-533. The U.S. analog cellular (AMPS) air interface standard.

ITU International Telecommunications Union. The ITU is the principal international standards organization. It is charted by the United Nations and it establishes international regulations governing global telecommunications networks and services. Its headquarters are in Geneva, Switzerland.

LMDS Local Multipoint Distribution Services. LMDS provides line-of-sight coverage over distances up to 3–5 kilometers and operates in the 28 GHz portion of the spectrum. It can deliver high speed, high bandwidth services such as data and video applications.

Local Loop A communication channel (usually a physical phone line) between a subscriber's location and the network's Central Office.

MHz Megahertz. One million Hertz. One MHz equals one million cycles per second.

Microcell A network cell designed to serve a smaller area than larger macrocells. Microcells are smaller and lower powered than macrocells. As the subscriber base increases, operators must continue to increase the number of cells in their network to maximize channel re-use. This has led to an increasing number of microcells being deployed in wireless networks.

Microwave Electromagnetic waves with frequencies above 1 GHz. Microwave communications are used for line-of-sight, point-to-point, or point-to-multipoint communications.

MSA Metropolitan Statistical Area. The FCC has established 306 MSAs in the U.S. The MSAs represent the largest population centers in the U.S. At least two wireless operators are licensed in each MSA.

MSC Mobile Services Switching Center. A generic term for the main cellular switching center in the wireless communications network.

MSS Mobile Satellite Service. Communications transmission service provided by satellites. A single satellite can provide coverage to the entire United States.

MTA Major Trading Area. The U.S. and its territories are divided into 51 MTAs. Each MTA is composed of a specific number of BTAs. The FCC grants licenses to wireless operators to provide service within these MTAs and/or BTAs. (See BTA.)

Multiplexing The simultaneous transmission of two or more signals on the same radio (or other) transmission facility.

N-AMPS Narrowband Advanced Mobile Phone Service.

PCMCIA Personal Computer Memory Card International Association. This acronym is used to refer to credit card sized packages containing memory, I/O devices and other capabilities for use in Personal Computers, handheld computers and other devices.

PCS Personal Communications Service. A vague label applied to new-generation mobile communication technology that uses the narrow band and broadband spectrum recently allocated in the 1.9 GHz band.

PDA Personal Digital Assistant. Portable computing devices that are extremely portable and that offer a variety of wireless communication capabilities, including paging, electronic mail, stock quotations, handwriting recognition, facsimile, calendar, and other information handling capabilities.

PDC Personal Digital Cellular (formerly Japanese Digital Cellular). A TDMA-based digital cellular standard that operates in the 1500 MHz band.

Phase The particular angle of inflection of a wave at a precise moment in time. It is normally measured in terms of degrees.

PHS Personal Handyphone System. A wireless telephone standard, developed and first deployed in Japan. It is a low mobility, small-cell system.

POP Short for “population”. One person equals one POP.

POTS Plain Old Telephone Service.

PSTN Public Switched Telephone Network. Refers to the international telephone system and includes both local and long distance networks.

Reverse Channel Refers to the radio channel that sends information from a mobile station to a base station. (See Forward Channel.)

RF Radio Frequency. Those frequencies in the electromagnetic spectrum that are associated with radio wave propagation.

Roaming The ability to use a wireless phone to make and receive calls in places outside one's home calling area.

RSA Rural Service Area. One of the 428 FCC-designated rural markets across the United States used as license areas for cellular licenses. (See MTAs and BTAs.)

Sector A portion of a cell. Often, different sectors within the same cell will each use a different set of frequencies to maximize spectrum utilization.

Signal to Noise Ratio The ratio of signal power to noise power at a given point in a given system.

Smart Antenna Refers to an antenna whose signal handling characteristics change as signal conditions change.

Soft Handoff Virtually undetectable by the user, soft handoff allows both the original cell and a new cell to serve a call temporarily during the handoff transition.

Spectrum The range of electromagnetic frequencies.

Spread Spectrum A method of transmitting a signal over a broad range of frequencies and then re-assembling the transmission at the far end. This technique reduces interference and increases the number of simultaneous conversations within a given radio frequency band.

T-1 A North American commercial digital transmission standard. A T-1 connection uses time division multiplexing to carry 24 digital voice or data channels over copper wire.

TDMA Time Division Multiple Access. A method of digital wireless communications that allows multiple users to access (in sequence) a single radio frequency channel without interference by allocating unique time slots to each user within each channel.

TIA Telecommunications Industry Association.

TR-45 One of six committees of the Telecommunications Industry Association. TR-45 oversees the standard making process for wireless telecommunications.

Upbanded A service or technology that has been re-engineered to operate at a higher frequency than originally designed.

Wireless Describes any radio-based system that allows transmission of voice and/or data signals through the air without a physical connection, such as a metal wire or fiber optic cable.

Wireline Wire paths that use metallic conductors to provide electrical connections between components of a system, such as a communication system.

WLANs Wireless Local Area Networks. Technology that provides wireless communications to Portable Computer users over short distances.