LG*Cell*™

Installation and Reference Manual

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Revision 1.0

Your comments are welcome – they help us improve our products and documentation. Please address your comments to LGC Wireless corporate headquarters in San Jose, CA, or call us at 1-800-530-9960 (U.S. customers) or +1-408-487-2400 (international customers).

Trademarks

Limited Warranty

Seller warrants articles of its manufacture against defective materials or workmanship for a period of one year from the date of shipment to Purchaser, except as provided in any warranty applicable to Purchaser on or in the package containing the Goods (which warranty takes precedence over the following warranty). The liability of Seller under the foregoing warranty is limited, at Seller's option, solely to repair or replacement with equivalent Goods, or an appropriate adjustment not to exceed the sales price to Purchaser, provided that (a) Seller is notified in writing by Purchaser, within the one year warranty period, promptly upon discovery of defects, with a detailed description of such defects, (b) Purchaser has obtained a Return Materials Authorization ("RMA") from Seller, which RMA Seller agrees to provide Purchaser promptly upon request, (c) the defective Goods are returned to Seller, transportation and other applicable charges prepaid by the Purchaser, and (d) Seller's examination of such Goods discloses to its reasonable satisfaction that defects were not caused by negligence, misuse, improper installation, improper maintenance, accident or unauthorized repair or alteration or any other cause outside the scope of Purchaser's warranty made hereunder. Notwithstanding the foregoing, Seller shall have the option to repair any defective Goods at Purchaser's facility. The original warranty period for any Goods that have been repaired or replaced by seller will not thereby be extended. In addition, all sales will be subject to standard terms and conditions on the sales contract.

LGC Wireless

LGC Wireless is a leading supplier of wireless solutions that enable mobile voice and data communications and wireless Internet access throughout any facility. The company's wireless system, the LGC*ell*™, provides mobile users with highly reliable access to high-quality voice and wireless data via cellular and PCS networks throughout any private (corporation, university, hospital) or public (airport, convention center, subway) facility.

LGC Wireless has received all type approvals for the LGC*ell*, including the European CE Mark, and is currently shipping product to more than 12 countries. The LGC*ell* supports all global wireless access standards including TDMA, CDMA, AMPS, GSM and iDEN. LGC Wireless also offers a full range of professional services to ensure cost effective and timely deployment of wireless networks.

Your comments can assist us in improving our products and documentation. Please address them to LGC Wireless, Inc.

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LGC*ell* Installation Procedure

This section shows the steps involved in installing an LGC*ell* system.

For a detailed description of LGC*ell* installation procedures, refer to *Section 4, LGCell Installation*.

If you plan to connect your LG*Cell* system to more than one radio or base station, you also need the *Integration Module Installation and Reference Manual*.

Install LGC*ell* equipment in the wiring, telecom, or electrical closet(s) indicated on your site installation plan. LGC Wireless provides the following equipment and supplies for installation:

- LGC*ell* Main Hub(s), each with two rack mount elbow brackets and four rack mount screws
- LGC*ell* Expansion Hub(s), each with two rack mount elbow brackets and four rack mount screws
- Remote Antenna Unit(s) (RAUs) and in-building antenna(s), with four mounting screws for each RAU
- *LG*Cell *Installation and Reference Guide*
- Optionally, *Integration Module Installation and Reference Manual*

You also need the following equipment and supplies:

- Cable and connectors already installed and terminated. LGC Wireless recommends plenum-rated Category 5 (CAT 5) or better, Unshielded Twisted Pair or Shielded Twisted Pair (UTP/STP) and Multi-Mode Fiber (MMF) cable.
- AC power supply (100-240 VAC at 1.6 A and 50/60 Hz) available for each Main Hub
- 19” equipment rack space in the wiring closet
- Phillips screwdriver
- MMF cleaner recommended by the cable manufacturer

Inspect the equipment and supplies before you start the LGC*ell* installation. Make sure that the UTP/STP and MMF cables are terminated correctly and that the connectors are clean and free of dust or oil (use recommended cleaner as necessary). If you have any problems, call LGC Wireless at 1-800-530-9960 (U.S. customers) or +1-408-487-2400 (international customers).

The procedure for installing the LGC*ell* system follows. *Section 4, LGCell Installation*, describes the installation procedure in detail.

A. Main Hub Installation

1. Mount one or more LG*Cell* Main Hubs in an equipment rack in the assigned wiring closet location, using the four screws provided for each hub.
2. Connect the AC power to each Main Hub and power up the hub.
3. Connect two clean MMF cables to each Main Hub port.
4. Check the Main Hub Sync and Link Status LEDs (connected = green, not connected = red).
5. Connect the RF cable from the antenna(s) to the Main Hub(s) (for a roof-mounted antenna, insert a lightning arrestor or surge protector).

B. Expansion Hub Installation

1. Mount one or more LG*Cell* Expansion Hubs in the equipment rack, using the four screws provided for each hub.
2. Connect the AC power to each Expansion Hub and power up the hub.
3. Connect all MMF cables from the Main Hub(s) to the Expansion Hub(s).
4. Check the Expansion Hub Sync and Link Status LEDs (connected = green, not connected = red)
5. Connect CAT 5 cable to the respective ports

C. RAU and Antenna Installation

1. Mount the RAU(s) and antenna(s).
2. Connect the UTP/STP cables from the Expansion Hubs to the RJ-45 connectors on the RAU(s).
3. Connect an accessory antenna to each RAU SMA connector.
4. Check the LEDs on the RAU(s). If not connected properly or sync is not achieved, then one LED will be red. When connected, one LED should be green and the other not lit.

D. System Monitoring using the ARM (if provisioned)

1. Install the Alarm Report Monitor (ARM) panel adjacent to the Main Hubs.
2. Connect the octopus cable to the connector on the ARM.
3. Connect one DB9 connector from the octopus cable to each ARM unit.
4. Set the dip switch in the ARM to the appropriate ID number.
5. Connect the ARM unit to a local PSTN line.
6. Install the ARM system software on a PC at the NOC.
7. Configure the software and dial into the ARM unit to set its parameters (dial-in number, and so on).

About This Manual

This *Installation and Reference Manual* describes the following LGC*ell* products:

- LGC*ell* 800 MHz AMPS/TDMA/CDMA/iDEN
- LGC*ell* 900 MHz GSM
- LGC*ell* 1800 MHz DCS
- LGC*ell* 1800 MHz Korean PCS
- LGC*ell* 1900 MHz TDMA/CDMA/GSM
- LGC*ell* Dual Band 900 GSM/1800 DCS

System operation for these products is identical. The only differences between the products are the operating frequency range, access scheme (TDMA, GSM, etc.) and certain operating parameters (gain, etc.). In this manual, distinctions between different systems are clearly indicated.

This section provides an overview of this *Installation and Reference Manual*, describes conventions, and provides other useful information.

If you plan to connect your LG*Cell* system to more than one radio or base station, you also need the *Integration Module Installation and Reference Manual*.

Overview

This manual provides information to prepare for and install the LGC*ell* equipment. The following steps need to be taken:

- RF engineering and system design
- Equipment purchasing
- Cable preparation
- Equipment installation and commissioning

This manual has six sections and five appendixes:

1 About LGC*ell*	Describes the LGC*ell's* functions, applications, components and its advantages.
2 LGC*ell* Equipment	Describes the standard LGC*ell* equipment and operation and provides System Specifications.
3 LGC*ell* Site Planning and Design	Contains information about pre-installation preparation and project management from site planning through LG*Cell* installation. The tasks involved and an estimated timetable are provided.
4 LGC*ell* Installation	Describes system requirements, lists standard equipment, and gives LGC*ell* equipment installation procedures.
5 Connectivity	Contains Maximum Input/Output RF Power and RF Power per Carrier tables and describes how to connect multiple LGC*ell* systems.
6 Common Problems, Troubleshooting, and Frequently Asked Questions	Describes how to diagnose and solve operational problems and gives answers to questions that customers ask frequently.
Appendix A – Cables, Connectors and Accessories	Contains information about cables, connectors, and accessories for LG*Cell* applications.
Appendix B – TIA/EIA 568-A Cabling Standards	Contains information about standards for in-building cabling.
Appendix C – Compliance Information	Provides system approval status and regulatory notices for various countries.
Appendix D – Services	Lists the services that LGC Wireless can provide for customers.
Appendix E – Alarm Report Monitor (ARM2000)	Describes the ARM2000 system, which can be used to monitor LG*Cell* alarms.

Terminology

This manual uses the following acronyms.

Acronym	Description
AMPS	Advanced Mobile Phone System
ARM	Alarm Report Monitor
BTS	Macrocellular base station
CAT 5	Category 5 unshielded or shielded twisted pair cable
CDMA	Code Division Multiple Access
EH	Expansion Hub
GSM	Global Systems for Mobile Communications
iDEN	integrated Digital Enhanced Network
IM	Integration Module
LED	Light emitting diode
MBS	Microcellular base station
MH	Main Hub
MMF	Multi-mode fiber
PCS	Personal Communications Services
RAU	Remote Antenna Unit
RF	Radio Frequency signals
TDMA	Time Division Multiple Access
UTP/STP	Unshielded twisted pair or shielded twisted pair (cable)

Conventions

This manual uses the following conventions as described:

Words in *italicized* type	Used for cross-references to other places in the manual
Words in **boldface** type	Used for emphasis
Words in **THIS TYPEFACE**	Identifies labels on Main Hubs, Expansion Hubs, and Remote Antenna Units

This manual uses the following symbols as described.

This symbol represents additional INFORMATION.

It is used to emphasize text with unusual importance, special significance, or to provide supplemental information.

This symbol represents CAUTION.

It alerts users that a given action or omitted action can cause or contribute to a hazardous condition. Damage to the equipment can occur.

This symbol represents WARNING.

It appears when a given action or omitted action can result in catastrophic damage to the equipment or cause injury to the user.

Precautions

This section describes general safety precautions for LGC*ell* products and safety precautions for Fiber Ports on the hubs.

General Safety Precautions

The following precautions apply to LGC*ell* products.

- LGC*ell* has no user-serviceable parts. Faulty or failed units are fully replaceable through LGC Wireless. Please contact us at 1-800-530-9960. For international customers, please contact us at +1-408-487-2400.
- Never input an RF signal to the Main Hub Duplex port that is higher than those defined on page 17 in *Section 2, LGCell Equipment.*
- Although modeled after an Ethernet/LAN-like architecture and connectivity, LGC*ell* units (Main Hub, Expansion Hub, and the Remote Antenna Unit) are not intended to connect to Ethernet data hubs, routers, cards or other similar data equipment.
- For improved air circulation, be sure to leave at least one inch (25 mm) of space between all hubs and between any other equipment in the rack. If mounting a hub on the rack's bottom shelf, also leave at least a one inch of clearance from the bottom.

- When you connect the Multi-Mode Fiber (MMF) Optical Cable, take the same precaution as if installing Ethernet network equipment. All optical fiber ST 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.

To reduce the risk of fire or electric shock, do not expose this equipment to rain or moisture.

Fiber Port Safety Precautions

Suggested safety precautions for working with LG*Cell* Fiber Ports follow. For information about LG*Cell* compliance with safety standards, see *Appendix C – Compliance Information*.

- **Viewing fiber:** 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 Expansion Hub. Do not remove the Fiber Port dust cover unless the port is in use. Do not stare directly into a Fiber Port.

- **Test fiber cables:** When you use test fiber optical cables, connect the optical power source last and disconnect it first.
- **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. Report any broken fiber cables and have them replaced.
- **Cleaning:** Use only approved methods for cleaning optical fiber connectors.
- **Modifications:** Do not make any unauthorized modifications to this fiber optical system or associated equipment.
- **Live work:** Live work is permitted on the LG*Cell* as it is a Class 1 hazard.
- **Signs:** No warning signs are required.
- **Test equipment:** Use Class 1 test equipment.

1 About LGC*ell*

This section is an overview of the LGC*ell*. It gives a brief description of the system and applications, the LGC*ell* equipment, how it works, why it's better than the competition, and what you need to do to install the system.

Later sections of this *Installation and Reference Manual* contain a detailed description of the LG*Cell* system.

Contents

What LGC*ell* Is

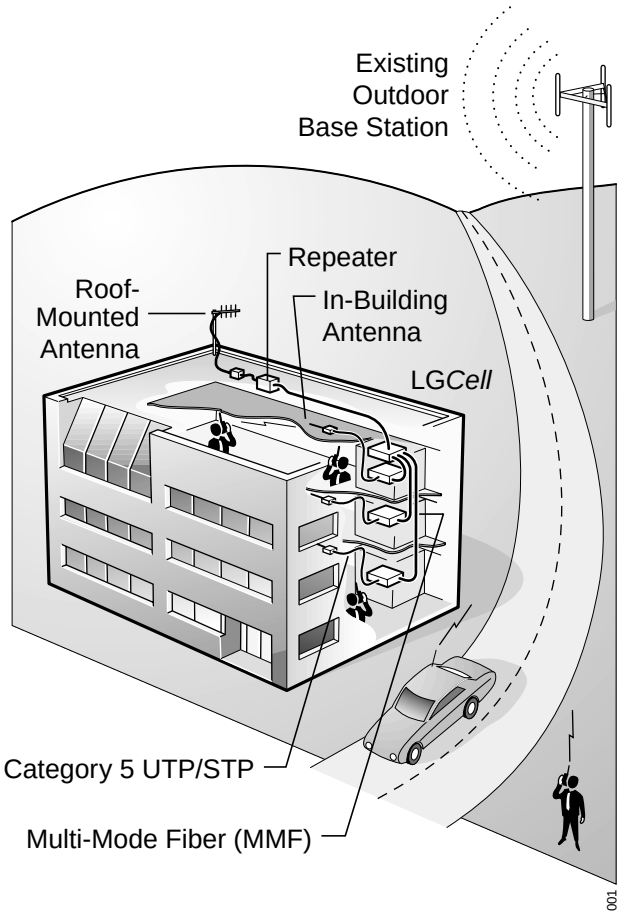
LGC*ell* is a “plug-and-play” in-building distributed antenna system (DAS) that enables highly reliable, high-quality wireless communications.

This one-person-one-phone capability gives a wireless phone user the ability to use their wireless phone in any location throughout the enterprise and beyond.

Seamless coverage lets wireless phone users roam freely between buildings as well as indoors and outdoors without changing phones.

An LG*Cell* system has the following equipment:

- Main Hub (MH)
- Expansion Hub (EH)
- Remote Antenna Unit (RAU)



Double-Star Topology for Easy, Cost-Effective Growth

The LG*Cell* system uses a double-star topology, which allows for easy, cost-effective growth of coverage and/or capacity. Each Main Hub supports up to four Expansion Hubs. Each Expansion Hub, in turn, supports up to four RAUs.

The Main Hub is located in an equipment closet and the Expansion Hubs are distributed out into other equipment closets throughout a building. The RAUs are then distributed off each Expansion Hub to provide coverage.

Bringing Outside In – Increases Wireless Network Coverage

Outdoor macrocellular base stations (BTSs) transmit and receive Radio Frequency (RF) signals, which enable communications with wireless phones. The RF signals are not always available or adequate inside a building, campus, tunnel, subway, or other hard-to-reach location. The LGC*ell* system delivers high-quality wireless

communications when a user is within range of an LGC*ell* Remote Antenna Unit (RAU).

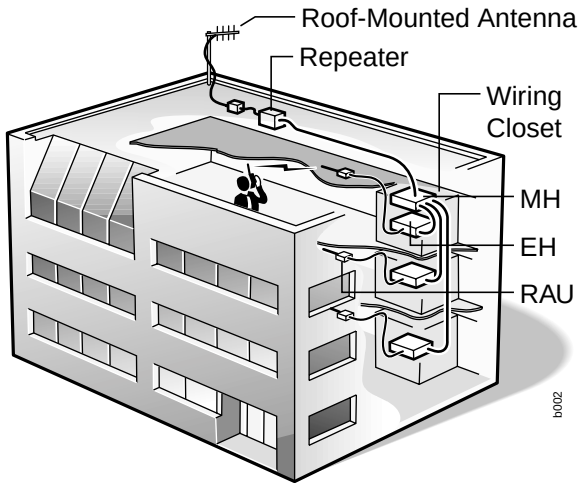
LG*Cell* Increases In-Building Coverage

LGC*ell* operates in the cellular or PCS frequency bands and can act as an extension to the cellular or PCS network.

LGC*ell* extends RF signal coverage in places where the coverage is unacceptable.

This extended coverage allows users to roam between buildings and the outside world while maintaining wireless phone conversations without changing phones.

LGC*ell* provides coverage for a variety of applications including single and multiple floor buildings, campus environments, tunnels, subways, and public facilities.



LGC*ell* can be connected to a separate repeater for a power boost or when line of sight is poor.

- **Increase In-Building Coverage with Multiple LGC*ells***

  Use multiple LGC*ell* systems to increase coverage in very tall buildings or large facilities.

- **Increase Coverage for Separate Service Providers**

  Use one or more LGC*ell* systems for cellular networks and use one or more for PCS networks.

- **Increase Coverage for Separate Networks**

  Use one or more LGC*ell* system for public networks and use one or more for private networks.

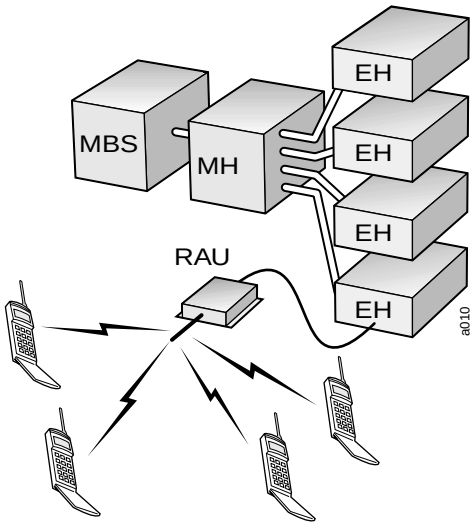
Expanding Inside – Increases In-Building Capacity and Capability

Increased in-building wireless coverage from the outdoor wireless networks does not always fully address in-building needs. Coverage is only beneficial if all potential users can access the network.

Microcellular Base Station (MBS) for Increased Capacity

Connecting the LGC*ell* to a local, centralized MBS provides additional capacity, as well as enhanced coverage.

This in-building microcellular wireless network increases the number of in-building users able to communicate through their wireless phones.



- LGC*ell* provides coverage
- MBS provides voice channel capacity
- Protocol independent
- Calls can be charged at a flat rate versus cellular or PCS rate inside the building
- Provides completely uniform radio coverage at low cost
- MBS capacity is dynamically allocated as needed
- Maintenance and control of the wireless network are centralized

The LG*Cell*/MBS connection allocates capacity to various locations within the enterprise as user traffic patterns change over the course of a day.

Integration Modules for Dynamic Allocation of Radio Capacity

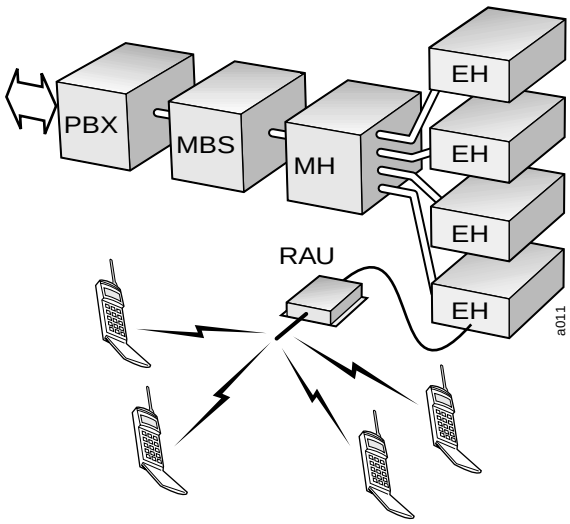
LGC Wireless provides Integration Modules that can be used with the LG*Cell* to efficiently centralize additional radio capacity inside a facility. These Modules provide the connection between the radios for the facility and the LG*Cell* system. Because the Integration Modules distribute all available capacity automatically throughout all antennas within a cell, available capacity is dynamically allocated throughout the entire coverage area, thus providing an improved grade of service without the need to conduct ongoing traffic monitoring and analysis.

Specific installation information on all available Integration Modules is in the *Integration Module Installation and Reference Manual*.

LG*Cell*, MBS, PBX* for Increased Coverage, Capacity, and Functionality

Interfacing the LGC*ell* with an MBS/PBX network gives wireless phone users PBX functionality through their wireless phones, anytime, anywhere.

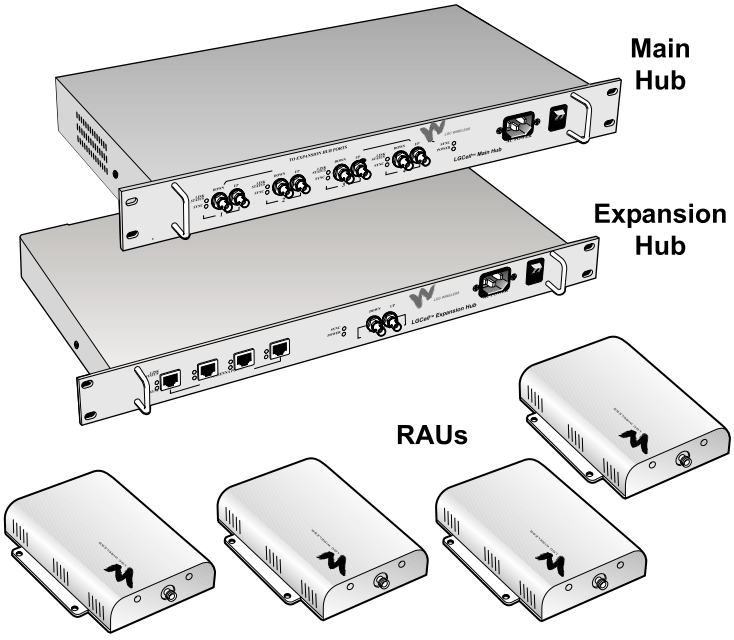
*Check with PBX manufacturer/vendor for compatibility, connection, and operation.



With the LG*Cell*/MBS/PBX solution, employees can use a wireless phone in place of a wireline desk phone to access the PBX while inside the building and use the same phone for wireless communications while outside the building. The MBS private wireless network transmits RF signals indoors, and the macrocellular network takes over outdoors.

- Access PBX features such as four-digit dialing, call delivery, call forwarding, call-waiting, conferencing, and voice mail
- Billed at discounted local calling rates or a flat enterprise rate for calls made inside the LGC*ell* vicinity
- Users can maintain the same telephone number inside and outside of the building, enabling anytime, anywhere communication

LGC*ell* Equipment



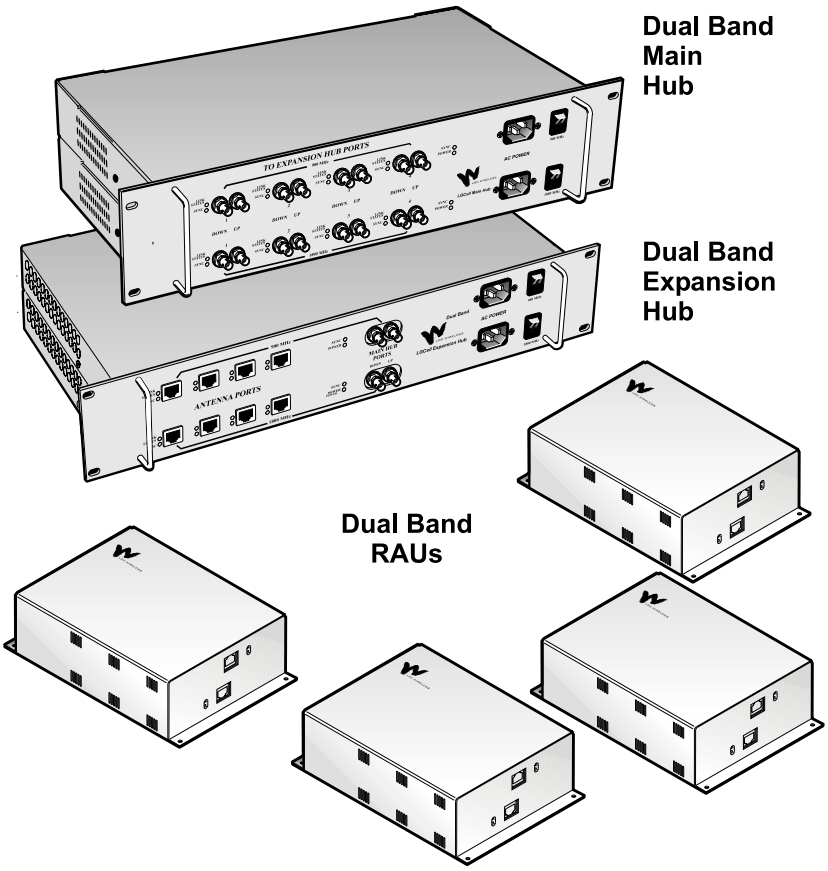
One fully equipped LGC*ell* system consists of the following parts:

- One Main Hub
- Up to four Expansion Hubs
- Up to 16 RAUs (four per Expansion Hub)

Multiple LGC*ell* systems can be stacked for various applications. (See *Section 5, Connectivity*.)

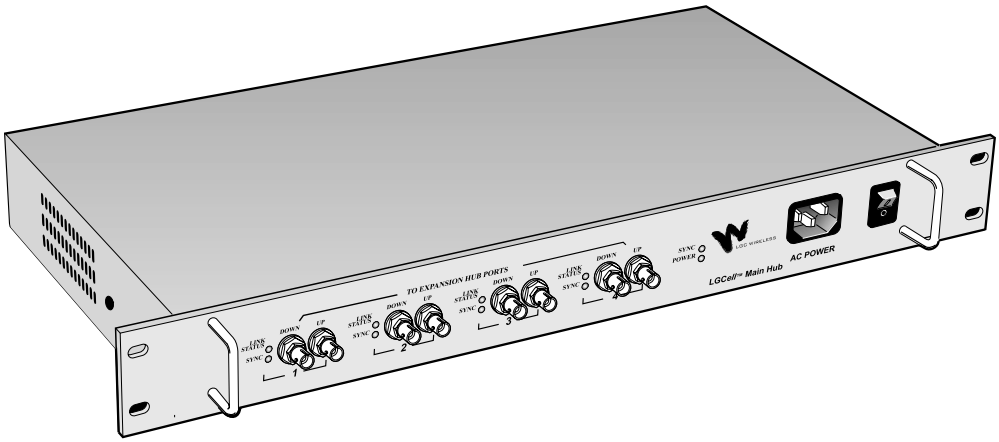
A Dual Band LG*Cell* system has two Main Hubs and at least two Expansion Hubs. A Dual Band system is a combination of single bands. The following illustration shows a Dual Band 900/1800 LG*Cell* system.

Dual Band LG*Cell* System



The following sections provide a brief overview of *LGCell* equipment. For a detailed description of the equipment, see *Section 2, LGCell Equipment.*

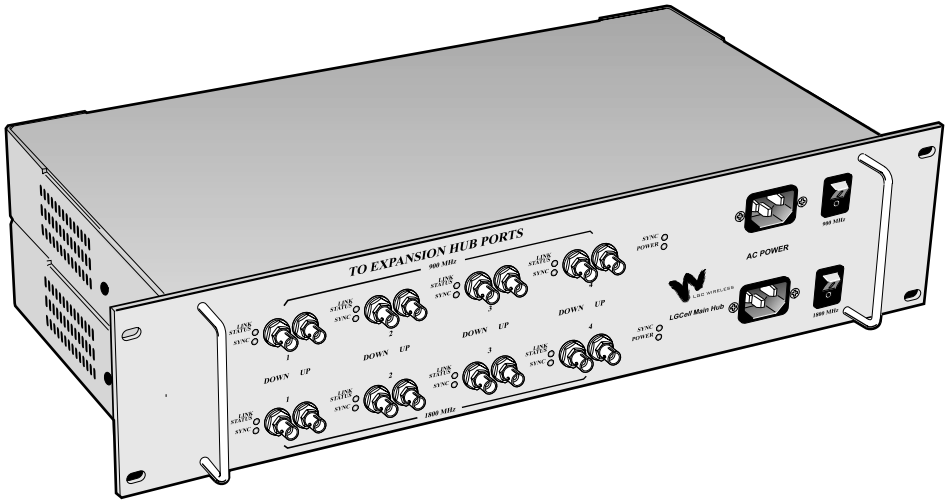
The Main Hub



The Main Hub mounts into a standard 19" equipment rack commonly found in wiring closets or equipment rooms (Main Hub width is 17.25”, or 438 mm).

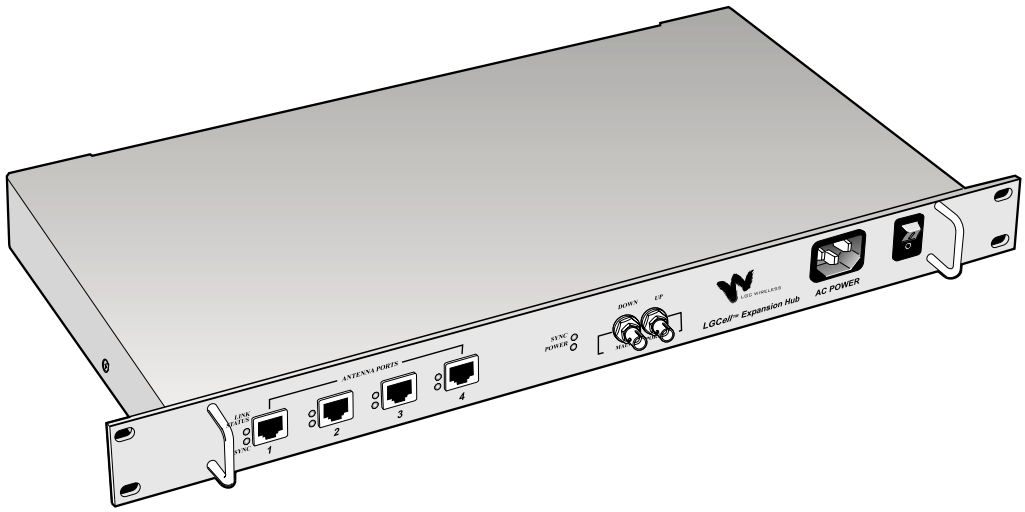
- Interfaces to the wireless network
- Height is 1.7" (44.5 mm)
- Connects to a roof-mounted antenna, repeater, or MBS via standard coaxial cable or low-loss coaxial cable with N-type male connectors

Dual Band Main Hub



The Main Hub for a Dual Band LG*Cell* system is a pair of Main Hubs, one for each band.

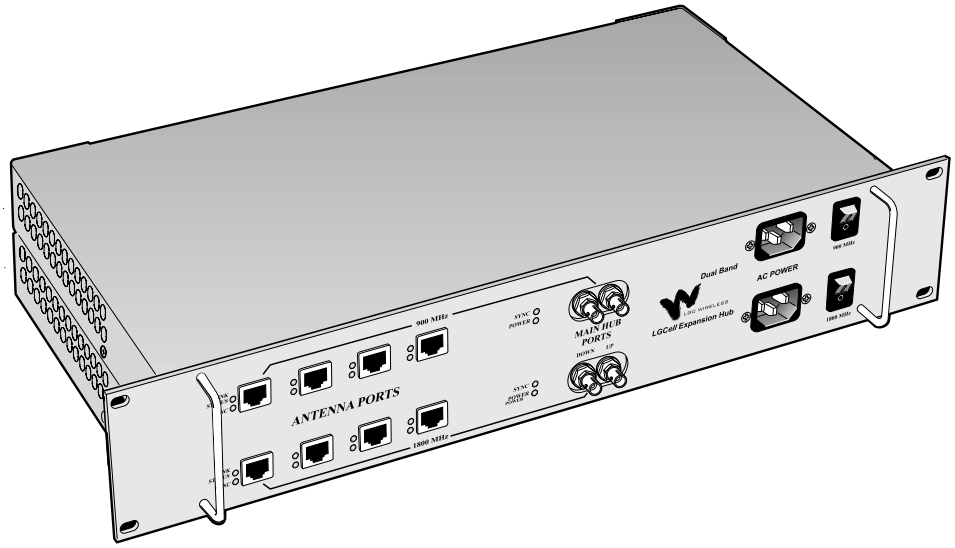
The Expansion Hub



The Expansion Hub also mounts into a standard 19" equipment rack (width 17.25”, or 438 mm).

- Height is 1.7" (44.5 mm)
- Connects to the Main Hub via standard Multi-Mode Fiber (MMF) cable (up to 1.5 dB optical loss, approximately 1 kilometer without jumpers).
- Hubs can be located in wiring closets anywhere in the building

Dual Band Expansion Hub



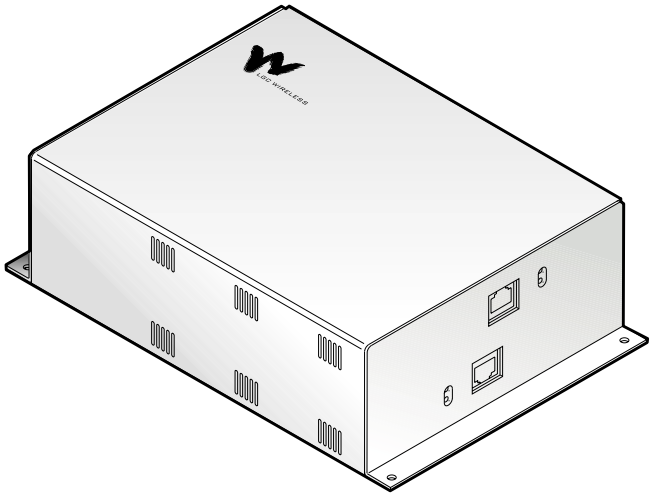
An Expansion Hub for a Dual Band LG*Cell* system is a pair of Expansion Hubs, one for each band.

The Remote Antenna Unit (RAU)

The RAUs a re strategically positioned in and around a building to provide high-quality reception for wireless services.

- Connects to the Expansion Hubs via standard CAT 5 (or better) unshielded or shielded twisted pair (UTP/STP) cable (up to 60 meters) (TIA/EIA 568-A standard)
- Mounts onto a variety of building materials. Can be placed anywhere – above or below the ceiling, on the wall, or in other locations.
- Connects to any external antenna, dipole, directional, omnidirectional, panel, or other antenna

Dual Band RAU



The RAU for a Dual Band LG*Cell* system is a pair of RAUs, one for each band.

How LGC*ell* Works

LGC*ell* connects in an Ethernet, LAN-like architecture, using a double-star topology. It uses proprietary technology to provide wireless access within buildings, subways, tunnels and other locations where reception is poor.

System Operation

System operation for all of the LGC*ell* DAS products is identical. The only differences between the products are the operating frequency range, access scheme (TDMA, GSM, etc.) and certain operating parameters (gain, etc.).

The Main Hub connects to an RF source:

- a roof-mounted antenna or repeater for coverage applications; or
- an MBS for capacity or wireless PBX applications, or both.

LGC*ell* distributes cellular and PCS signals through standard MMF and standard UTP/STP cable found in most buildings. This allows installation of in-building wireless services with minimal installation time and cost.

Transmit/Forward/Downlink (BTS to Phone)

The incoming RF signal into the Main Hub is split into several fiber optic transceivers that convert the RF signal to an optical signal. The Main Hub transmits the converted signal over the fiber to the Expansion Hub. The Expansion Hub converts the optical signal to an RF signal and transmits the RF signals to the RAUs. The RAUs then transmit the RF signals to the antenna and then to wireless phones.

Receive/Reverse/Uplink (Phone to BTS)

The RAUs transmit RF signals from wireless phones back through the antenna and to the Expansion Hubs. The Expansion Hubs transmit the RF signals back to the Main Hub in optical form. The Main hub converts the optical signals back to electrical signals and sends them to an MBS, a repeater, or a roof-mounted antenna. For a detailed description of system operation, see *Section 2, LGCell Equipment*.

LGC*ell* Advantages

The LGC*ell* solution is based on a fundamentally new approach that has cost and engineering advantages not found in competitive systems.

Competitive systems offer similar capabilities but require sophisticated RF engineering and take a long time to install. They typically use specialty cables that require expensive, difficult, time-consuming, and potentially disruptive installations.

LGC*ell*'s plug-and-play design requires minimal RF engineering and planning. Its unique double-star architecture keeps service and maintenance to a minimum, unlike cascaded antenna systems. The flexible architecture permits deployment in the most difficult RF environments.

LGC*ell*'s low cost and simple installation effectively provide both coverage and capacity enhancements to meet the demands of the growing wireless network.

LGC*ell* Uses Industry Standards

LG*Cell*'s use of industry standards and standard equipment offers high reliability and low cost.

- Complies with industry standards for IS-19-B/AMPS, J-std-8, IS-136/TDMA, IS-95/CDMA, ETSI 300 609-4/GSM (CE marked), and iDEN.
- Utilizes the TIA/EIA 568-A Ethernet cabling standards for ease of installation (see *Appendix A – Cables, Connectors, and Accessories).*
- Distributes signals over a building's existing industry-standard cable infrastructure of MMF and UTP/STP cable.
- Complies with UL and FCC or CE mark requirements.
- Primarily constructed with highly reliable industry-standard components produced in high-volume for the LAN and wireless industries. High quality and reliability are assured.

Minimal Design, Installation, Maintenance, and Troubleshooting

- Site engineering is simplified since compensation for cable loss and amplifiers do not need to be designed into the system, which saves precious RF Engineering time and support.
- Using standard cabling reduces installation to simple equipment mounting and cable connection.
- Centralized hub locations facilitate maintenance, upgrades, and adaptability to new standards.
- The LGC*ell*'s star configuration eases troubleshooting – it is immediately clear if an RAU is faulty.
- LGC*ell* provides full Operations Alarm Maintenance and Provisioning (OAM&P). The Main Hub senses major alarms through contact closure. These alarms can be sent to remote locations. (For information on the Alarm Report Monitor, see *Appendix E – Alarm Report Monitor (ARM2000)*.)

What You Need to Do

Assess the installation site, prepare the site, install the LG*Cell* equipment, install and connectorize the cables, and mount the Hubs and RAUs. A typical installation consists of three components:

- Site Planning — See *Section 3, LGCell Site Planning and Design*
- Cable Installation — See *Section 3, LGCell Site Planning and Design*
- LG*Cell* Installation — See *Section 4, LGCell Installation*