Litenna™

Installation Guide

Notice

Trademark Acknowledgement

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1. Front Chapter

1.1. Policy for Warranty and Repair

Foxcom Wireless tests and inspects all its products to verify their quality and reliability. Foxcom Wireless uses every reasonable precaution to ensure that each unit meets their declared specifications before shipment. Customers should advise their incoming inspection, assembly, and test personnel about the precautions required in handling and testing our products. Many of these precautions can be found in this manual.

The products are covered by the following warranties:

1. General Warranty

Foxcom Wireless warrants to the original purchaser all standard products sold by Foxcom Wireless to be free of defects in material and workmanship for one (1) year from date of shipment from Foxcom Wireless. During the warranty period, Foxcom Wireless will repair or replace any product that Foxcom Wireless proves to be defective. This warranty does not apply to any product which has been subject to alteration, abuse, improper installation or application, accident, electrical or environmental over-stress, negligence in use, storage, transportation or handling.

2. Specific Product Warranty Instructions

All Foxcom Wireless products are warranted against defects in workmanship, materials and construction, and to no further extent. Any claim for repair or replacement of units found to be defective on incoming inspection by a customer must be made within 30 days of receipt of shipment, or within 30 days of discovery of a defect within the warranty period.

This warranty is the only warranty made by Foxcom Wireless and is in lieu of all other warranties, expressed or implied. Foxcom Wireless sales agents or representatives are not authorized to make commitments on warranty returns.

3. Returns

In the event that it is necessary to return any product against above warranty, the following procedure shall be followed:

a. Return authorization is to be received from Foxcom Wireless prior to returning any unit. Advise Foxcom Wireless of the model, serial number, and discrepancy. The unit may then be forwarded to Foxcom Wireless, transportation prepaid. Devices returned collect or without authorization may not be accepted.

b. Prior to repair, Foxcom Wireless will advise the customer of our test results and any charges for repairing customer-caused problems or out-of-warranty conditions etc.

c. Repaired products are warranted for the balance of the original warranty period, or at least 90 days from date of shipment.

4. Limitations of Liabilities

Foxcom Wireless's liability on any claim, of any kind, including negligence for any loss or damage arising from, connected with, or resulting from the purchase order, contract, quotation, or from the performance or breach thereof, or from the design, manufacture, sale, delivery, installation, inspection, operation or use of any equipment covered by or furnished under this contact, shall in no case exceed the purchase price of the device which gives rise to the claim.

EXCEPT AS EXPRESSLY PROVIDED HEREIN, FOXCOM WIRELESS MAKES NO WARRANTY, EXPRESSED OR IMPLIED, WITH RESPECT TO ANY GOODS, PARTS AND SERVICES PROVIDED IN CONNECTION WITH THIS AGREEMENT INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. FOXCOM WIRELESS SHALL NOT BE LIABLE FOR ANY OTHER DAMAGE INCLUDING, BUT NOT LIMITED TO, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH FURNISHING OF GOODS, PARTS AND SERVICE HEREUNDER, OR THE PERFORMANCE, USE OF, OR INABILITY TO USE THE GOODS, PARTS AND SERVICE.

1.2. Reporting Defects

The units were inspected before shipment and found to be free of mechanical and electrical defects.
Examine the units for any damage which may have been caused in transit. If damage is discovered, file a claim with the freight carrier immediately. Notify Foxcom Wireless as soon as possible.
Refer to Policy for Warranty and Repair for further details.

Note

Keep all packing material until you have completed the inspection.

1.3. RF Exposure Compliance

To comply with FCC RF exposure compliance requirements, antennas used for this product must be fixed mounted on indoor permanent structures, providing a separation distance of at least 20 cm from all persons during normal operation.

Antenna gain should not exceed 10dBi.

Note

Each individual antenna used for this transmitter must be installed to provide a minimum separation distance of 20 cm or more from all persons and must not be co-located with any other antenna for meeting RF exposure requirements.

1.4. Conventions

In this manual the following special formats are used:

Note

Notes contain information detailing the current topic.

CAUTION

Cautions contain information regarding situations or materials which could damage your product.

WARNING

WARNINGS CONTAIN INFORMATION REGARDING DANGEROUS FUNCTIONS.

1.5. Precautions

1.5.1. Personal Safety

WARNING

APPLYING POWER TO THE BASE UNIT AND REMOTE HUB UNIT WILL CREATE A LASER ENERGY SOURCE OPERATING IN CLASS I AS DEFINED BY IEC 825-1. USE EITHER AN INFRARED VIEWER, OPTICAL POWER METER OR FLUORESCENT SCREEN FOR OPTICAL OUTPUT VERIFICATION.

WARNING

COMPLIANCE WITH RF SAFETY REQUIREMENTS

THE LITENNA HAS NO INHERENT SIGNIFICANT RF RADIATION.

THE RF LEVEL ON THE DOWN LINK IS VERY LOW AT THE REMOTE HUB UNIT DOWNLINK PORTS. THEREFORE, THERE IS NO DANGEROUS RF RADIATION WHEN THE ANTENNA IS NOT CONNECTED.

THE DESIGN OF THE ANTENNA INSTALLATION NEEDS TO BE IMPLEMENTED IN SUCH A WAY SO AS TO ENSURE RF RADIATION SAFETY LEVELS AND NON ENVIRONMENTAL POLLUTION DURING OPERATION.

1.5.2. Equipment Safety

To avoid damaging your product, please observe the following:

1. Always keep the optical connector covered. Use the fiberoptic cable or a protective cover. Do not allow any dirt and/or foreign material to get on the optical connector bulkheads.
2. The optical fiber jumper cable bend radius is 3 cm. Smaller radii can cause excessive optical loss and/or fiber breakage.

2. Introduction to Litenna

The Litenna™, a high performance fiberoptic In-Building RF Distribution System, allows cellular & PCS services to be extended into *shadow* areas. With Litenna™ services can be cost-effectively broadened into BTS, micro and pico cell markets, such as airports, buildings, underground parking and shopping malls. The Litenna™ system means mobile communication that works everywhere, and satisfied customers getting the service that they demand.

The Litenna™ products can accommodate a plurality of services and transmission standards. The **Litenna™** consists of a fiberoptic backbone which carries signals over singlemode fiberoptic cables. Singlemode optical technology offers the following advantages:

- **Low attenuation:** Singlemode fiberoptic cables have virtually no attenuation (0.38dB/Km), relieving the need to install amplifiers or any other signal enhancing in-line devices. This factor alone greatly reduces the engineering and installation costs.
- **Low noise:** High bandwidth signals can be set over singlemode fibers without encountering noise problems, and transmitted over great distances.
- **Multi Services:** Same infrastructure is used either supporting single service or multiple services, due to the pseudo infinite bandwidth of singlemode fiberoptic cable.

The **Litenna™ a**ddresses both public and private markets in order to provide RF distribution solutions for various structure types.

- Typical Public Market
  - Malls
  - Airports
  - Conventions Centers
- Typical Private Market
  - Office Buildings
  - Business Centers
  - Campus

Three types of applications are very common for both markets:

- High Rise Buildings
- Horizontal Structures
- Campus type

Foxcom Wireless addresses these application types with a powerful answer, while still flexible and future expandable. No limitations for building height or structure spread.

2.1. Litenna™ Models

Litenna™ products come in various models, each model covering a different frequency spectrum and standard.

Table 1 – Litenna™ Models

Product	Frequency Range		Service
	Uplink	Downlink	
Single Band Family			
	824-849	869-894	AMPS/TDMA 800
	806-824	851-869	LMR/iDEN 800
	824-849	869-894	CDMA 800
	890-915	935-960	SMR 900
	890-915	935-960	GSM 900
	890-915	935-960	Paging 900
	1710-1785	1805-1880	GSM 1800
	1710-1785	1805-1880	CDMA 1800
	1850-1910	1930-1990	TDMA 1900
	1850-1910	1930-1990	GSM 1900
	1850-1910	1930-1990	CDMA 1900
Dual Band Family			
	890-915 1710-1785	935-960 1805-1880	Dual Band GSM 900/1800
	890-915 1710-1785	925-960 1805-1880	Dual Band E- GSM 900/1800
	806-824 1850-1910	851-869 930-1990	Dual Band iDEN/LMR 800/PCS 1900
	896-902 1850-1910	935-941 930-1990	Dual Band SMR 900/PCS 9800
	824-849 1850-1910	869-894 930-1990	Dual Band Cellular 800/ PCS 1900
	899-902 1850-1910	928-941 930-1990	Dual Band Paging 900/ PCS 1900

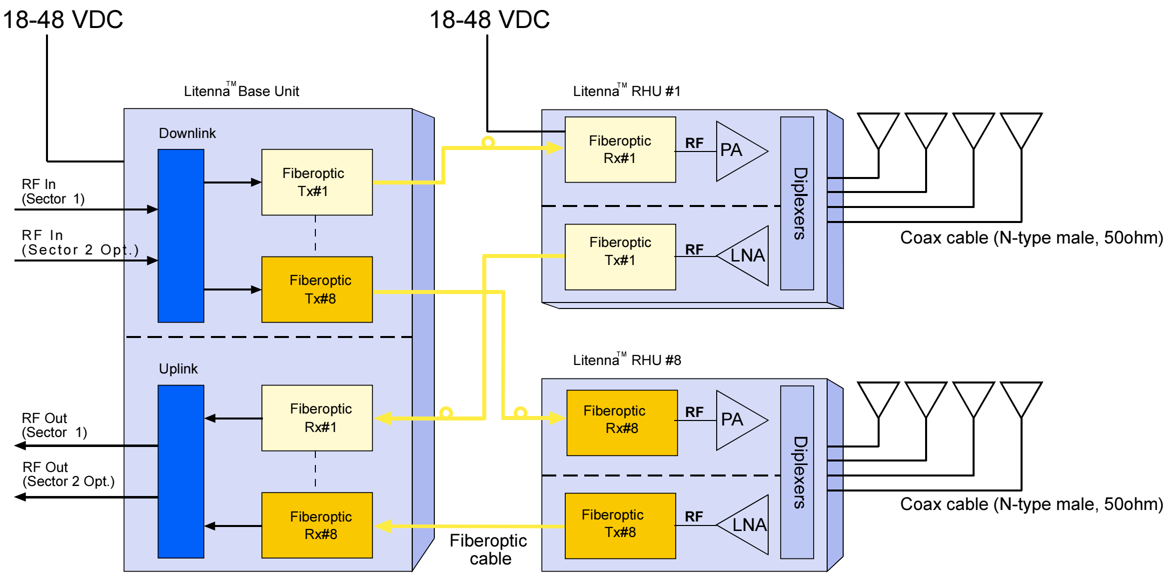


Figure 1 Litenna™ Block Diagram

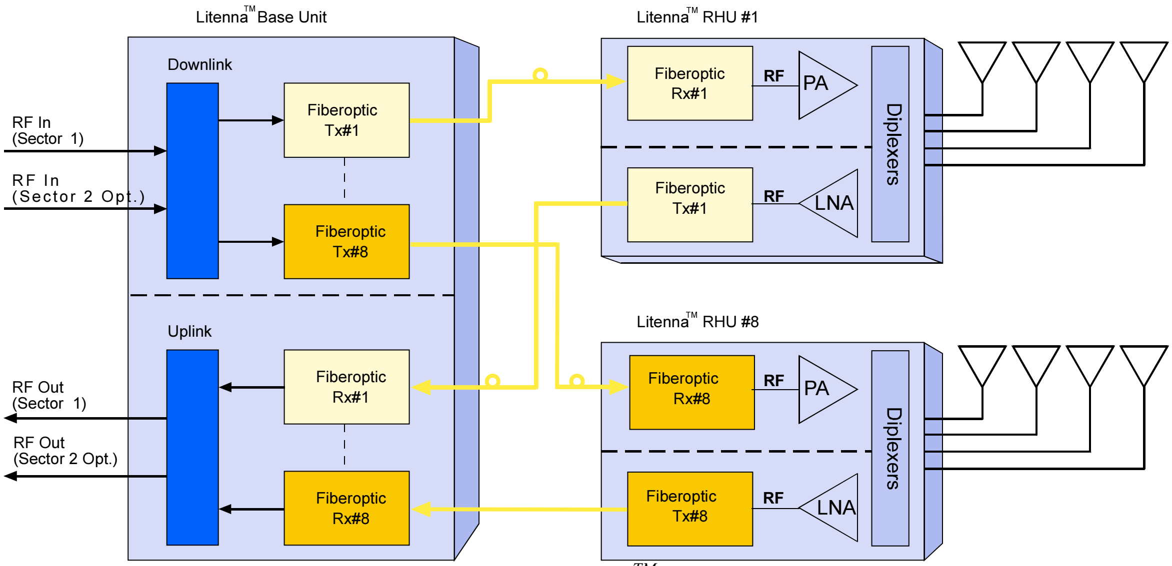


Figure 2 Litenna™ Block Diagram

2.2. Features

The Litenna™ series features the following:

- Wide DC input range.
- Slow start optical power control protects the laser from DC transients upon turn-on.
- Alarm Interface with open collector and dry contact alarms – the alarm loopback is activated when there is a broken or faulty optical fiber, or no power in system.
- LEDs that indicate status of individual optical links and sets of links.
- Can be installed as a wallmount unit or in a 19” rack

2.3. Product Drawings

The following drawings show sample front and rear panels of the Litenna™ units.

2.3.1. Base Unit- Four Ports

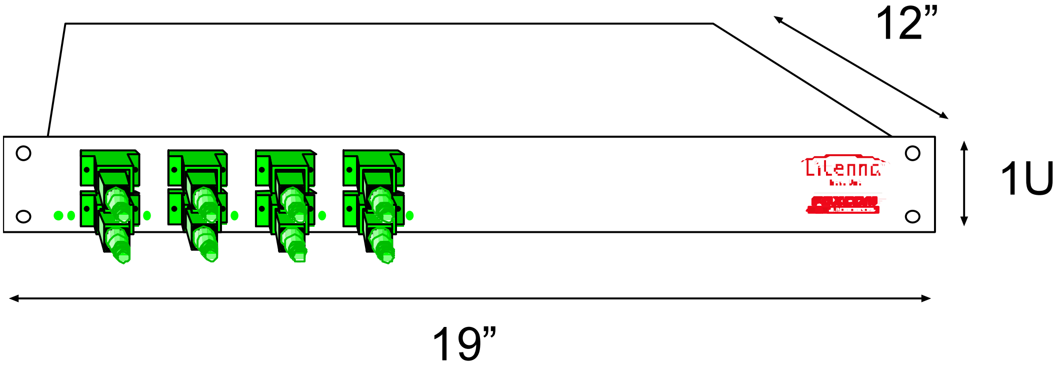


Figure 3 - Base Unit 4 Ports

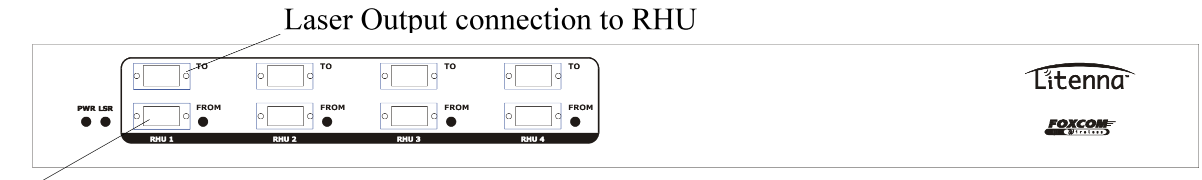


Figure 4 – Base 4 Unit Front Panels

Figure 5 - Base 4 Unit Back Panel

2.3.2. Base Unit- Eight Ports

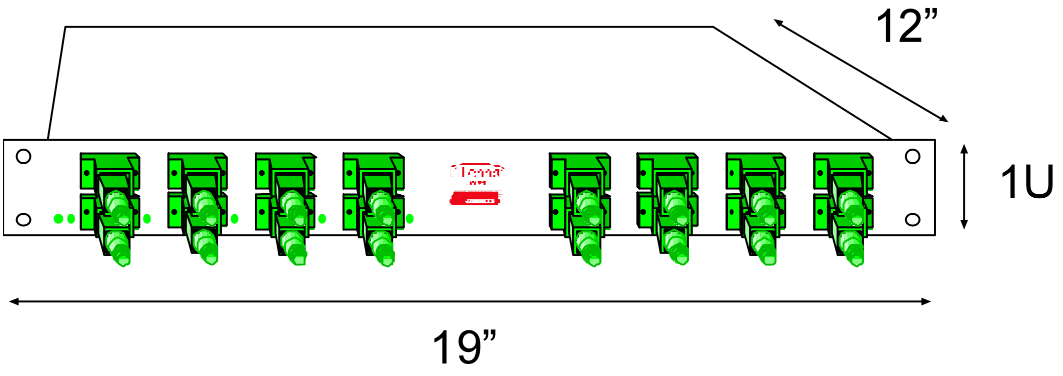


Figure 6 - Base Unit 8 Ports

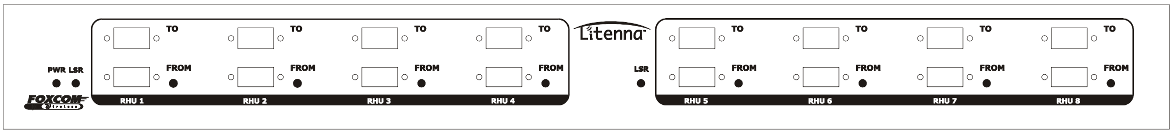


Figure 7 – Base8 Unit Front Panels

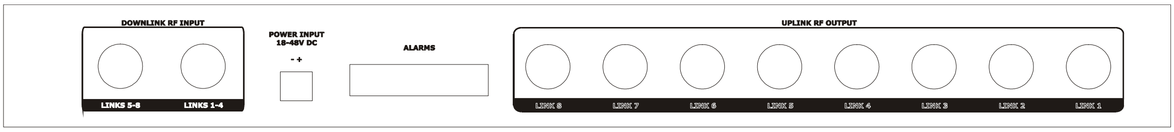


Figure 8 – Base 8 Unit Back Panels

2.3.3. Remote Hub Unit

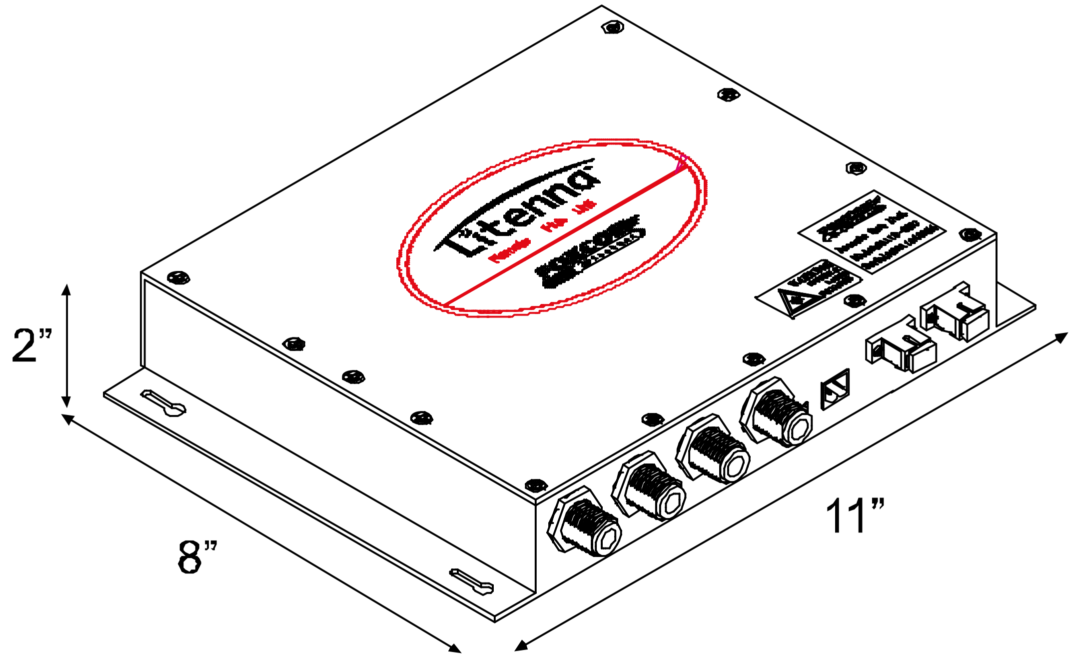


Figure 9 - Remote Hub Unit

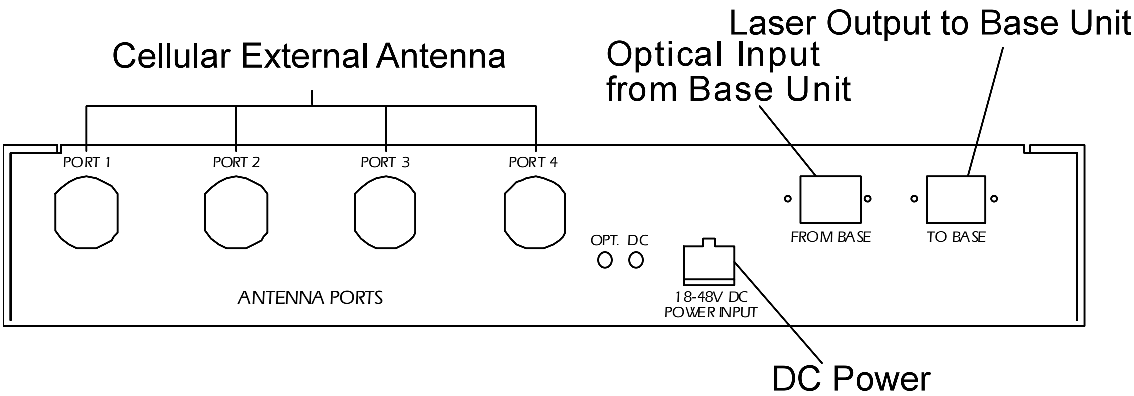


Figure 10 - Remote Hub Unit Front Panel

Figure 11 - Remote Hub Unit Front Panel One Antenna Port

3. Required Equipment

The following describes the equipment required for testing the system at setup.

Table 2 – Required Equipment List

Required Setup Equipment	Quantity
HP8753C Network Analyzer or equivalent	**1**
HP85046A S Parameter test set or equivalent	**1**
HP8594E Spectrum Analyzer or equivalent	**1**
Power supply 18/48 @ 1A	**1**
Signal generator HP8648B or equivalent	**2**
Amplifier Mini-circuit ZKL-2 or equivalent	**1**
Digital Multi-meter	**1**
RF Combiner Mini-Circuit ZAPD-21 or equivalent with N connectors	**1**
High-grade 50-ohm phase matched cables: **N to N cables** **N to SMA cables (in N remote type)** **SMA to SMA cables (in SMA remote type)**	 **4** **2** **3**
Optical power meter (1310 nm) for minimum 3 mW	**1**
Singlemode duplex fiberoptic cable with SC/APC connectors	**3m**
Singlemode fiberoptic cable SC/APC connectors	**3m**
Calibration kit, including **Through (N-female to N-female)** **Short (N-female)** **50 ohm (N-female)**	

3.1. Test Procedures

This section explains the following test procedures:

- Pre RF Test
- Flatness Test
- Gain/IP3 Test
- Uplink Network Test

In order to carry out the tests, the following connections need to be made.

Connect the Base Unit optical output to the RHU optical input via fiberoptic cable.

Connect power to all units being tested (18V-48V DC).

Use the relevant setup for every test.

3.1.1. Pre RF Test

To carry out the Pre RF Test, the following procedure needs to be carried out.

1. Make sure all DC LEDs are lit on both units.
2. Measure Tx optical output power for all lasers.
3. Output power should be 1.5-2.4mW (with optical power meter).
4. On the RHU, Make sure that the optical LED is lit.
5. On the BU, make sure the Rx optical LEDs are lit.

3.1.2. Flatness Test

To carry out the Flatness Test, the following procedure needs to be carried out.

1. Connect the Network Analyzer to the designated Base Unit.
   On the Network Analyzer, Base Unit connects to port 2.
   On the Network Analyzer RHU connects to port 1 (see Figure 12).
2. After calibrating the network, set Network Analyzer to:

Measure	S21
Format	Log
Scale	1db/div

3. Apply with the required F1 and F2 should be according to Product Spec.
4. Measure the difference between the highest and the lowest signal point, which should be as specified in the data sheet.

3.1.3. Gain/IP3 Test

To carry out the Gain/IP3 Test, the following procedure needs to be carried out.

1. Set the 2 tone signal from the 2 signal generators.
   RF signals F1 and F2 should be according to Product Spec.
2. Combine the signals with ZAPD-21 combiner or equivalent.
3. Connect the 2-tone signal to the input of the base (see Figure 13).

4. Set Spectrum Analyzer to:

Video BW	10khz
RBW	100khz
Attenuation	20db
Span	30Mhz
Center freq.	Refer to Product Spec.
Ref level	10dbm

5. Connect RF cable from the RHU output to the Spectrum Analyzer.
6. Measure output Gain/IP3 from all test RHUs DownLink outputs.
7. IP3 is determine by:
   IP3= power tone + (power tone – power IM3)/2.

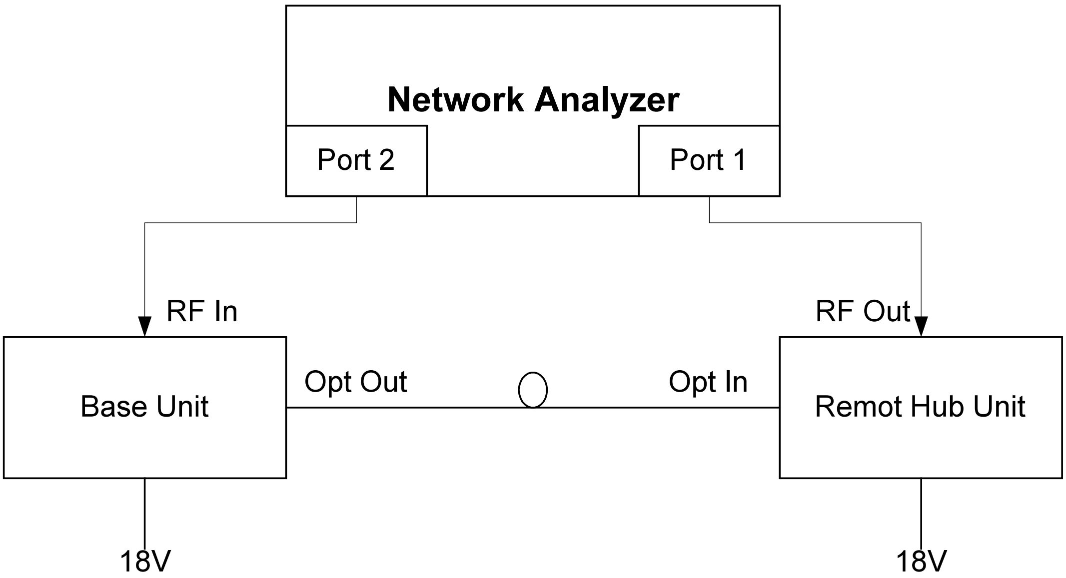


Figure 12 – Network Analyzer Setup Test

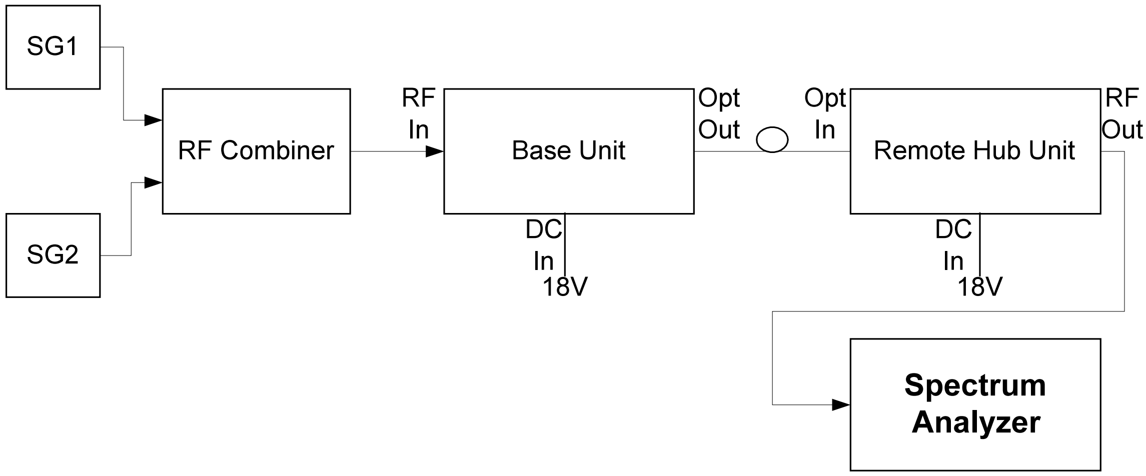


Figure 13 – Spectrum Analyzer Setup Test

3.1.4. Uplink Network Test

To carry out the Noise Floor test, the following procedure needs to be carried out.

1. Connect the Spectrum Analyzer to the Base Unit uplink port.
   Connect 50ohm terminators to the RHU ports, and to all Base Unit uplink ports except for the tested port (see Figure 14).
2. Extra amplification (25db) is applied between Base Unit and Spectrum Analyzer in order to measure the noise floor.
3. Set Spectrum Analyzer to:

Video BW	300hz
RBW	1khz
Attenuation	0db
Span	0hz
Center freq.	Refer to Product Spec.
Ref level	-50dbm
Marker noise	ON

4. The noise figure is formulated as: -174 + Gsystem + noise floor
   (On the RHU, all unused ports must be terminated with 50ohm load.)

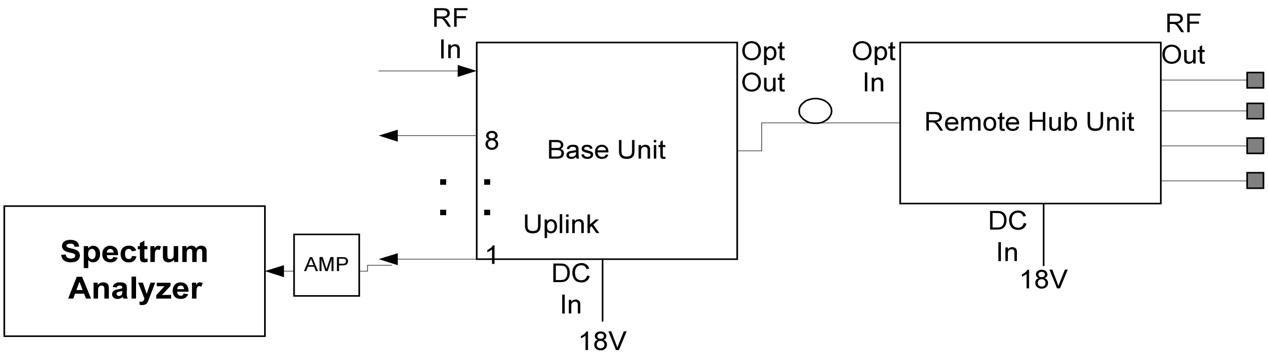


Figure 14 – Uplink Network Test

4. Installation

The following sections describe the Litenna™ installation.

- General Installation.
- Fiber Installation.
- Hi Rise Installation.
- Horizontal Layout Installation.

4.1. General Installation

The Litenna™ components need to be set up, followed by performance verification before installing the system. Foxcom Wireless suggests that a 19" rack-mountable Splice Tray be used at the Base Unit to facilitate optical fiber splicing. In the rack, the Splice Tray is mounted above or below the Base Unit (depending on direction of the incoming cables). Set up procedures for the Litenna™ Base and Remote units are for the following installations:

- High rise installation.
- Horizontal Layout installation.

For both installations, setting up the Litenna™ Base and Remote units consists of the following steps:

1. Determine antenna placement by system engineer.
2. Pull composite cable or separate fiber and copper cables through building.
3. Install Base Unit in 19" rack, or wall mount (up to 3 Base Units).
4. Install Splice Tray for Base Unit in 19" rack (optional within the patch panel).
5. Install patch panel cabinet with SC/APC adaptors in a 19" rack or wall mount.
6. Fiber contractor splices fiber cable to SC/APC connectorized pigtails.
7. Connect Microcell to Base Unit via ½" coax cable or RG223 or similar with 50Ω connector.
8. Connect fiber from Remote Hub Unit to Base Unit.
9. Connect Antennas to Remote Hub Unit ½" or 3/8" or similar coax cable and similar with 50Ω connector.
10. Connect power supply to Base Unit and Remote Hub Unit (refer to power planning).

4.2. Fiber Installation

The following procedure describes the process for setting up fiberoptic cable for the system (see Figure 15).

1. Pull fiberoptic cable and DC cable through building structure
2. Install splice tray (in 19" rack when used) near Base Unit.
3. Near Base Unit, install patch panel cabinet (SC/APC adaptors) for fiberoptic cable connections.
4. Connect (3/125/900) pigtail between splice tray and patch panel cabinet.
5. Connect SC/APC jumpers between the corresponding Base Unit and patch panel.
6. Install splice box near RHU (refer to optic planning).
7. Connect fiberoptic cable to splice box and (3/125/3000) pigtails to RHU.

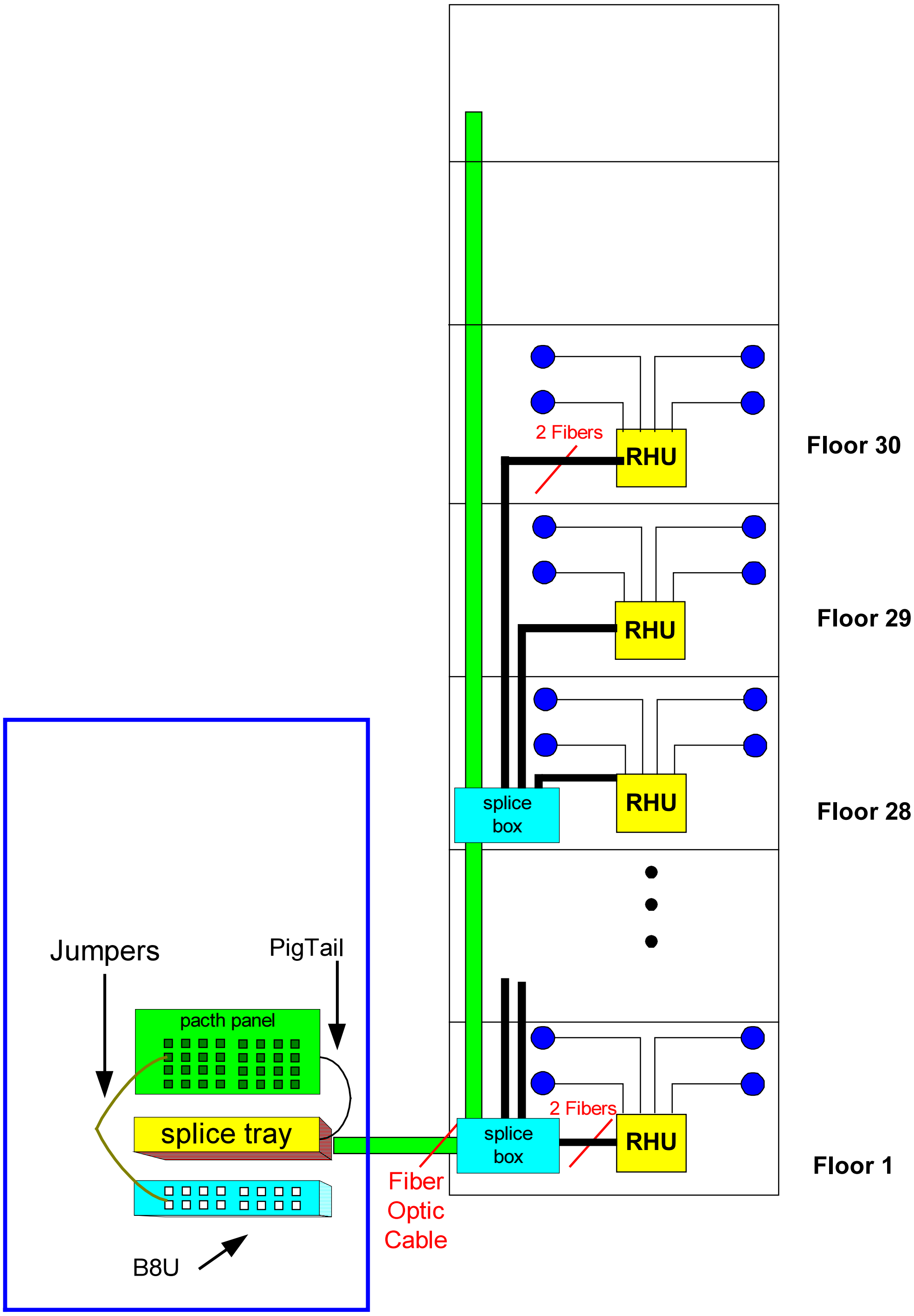


Figure 15 – Example: Litenna™ Installation (fiber and xoax)

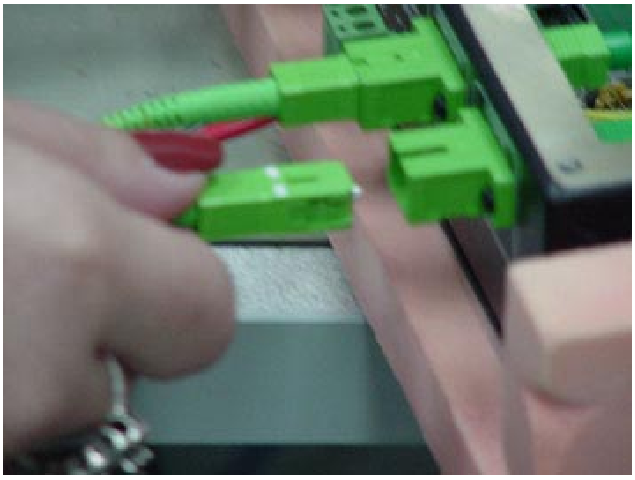
4.2.1. Fiberoptic Cable

Before connecting the cable:

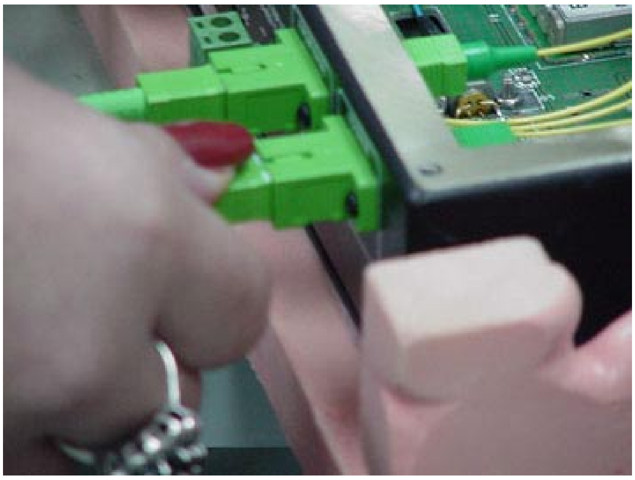
1. Wipe the connector using Easy Clean.
2. Note the polarity key of the optical connector before inserting.

To connect the cable:

1. Line Up the Polarity Key.



2. Insert the connector.



4.2.2. Litenna™ Installation Parts List

The following parts are needed for setting up the Litenna™ Base and Remote Hub Units. A fiber contractor handles cable splicing in order to connect the units. The fiber contractor needs to use the parts list from Table 3 to arrange all equipment necessary for setting up and installing the Litenna™.

Table 3 - Litenna™ Installation Parts List

The following tables refer to a 46 floor building.

Equipment	Description	Quantity	Comment
Coax cable (per 1m)	Connect RHU to antenna.	As needed	
Antenna		As planned	
Optical cable 2 x 50(fibers)	Optic cable for short distance & protected environments (tight buffer type).	Total=500m	
Patch panel cabinet with SC/APC adaptors.	Connect jumpers to base and pigtails to splice tray.	2	
Splice box	Connects optic cable from Cabinet and pigtails to RHU.	15	1 per 3 floors
Splice tray	Tray-1*50 connects cable optic and pigtails near base unit.	2	In some cases in patch panel
2m optical jumpers with SC/APC connector.	Connect patch panel to base unit.	92	
3/125/900 5m Pigtail with SC/APC connectors (B)	Connect patch panel and splice tray.	92	
3/125/900 5m Pigtail with SC/APC connectors (B)	Connect patch panel and splice tray.	92	
15mPigtail with SC/APC connectors(R)	Connects RHU and splice box.	92	
Electricity cables (per 1m)	Delivers power to units.	According to length.	
Electricity ducts (per 1m)	Ducts for moving cables though building.	According to length.	If needed
Coax connectors n-type	Cable connectors	as needed	

Table 4 - Litenna™ Installation Labor List

Labor	Description	Quantity	Comment
Installing splice box + splicing fibers	Installing the box and opening fibers at RHU.	92	
Installing patch panel cabinet + splicing fibers	Installation of the box and opening fibers at base.	92	
Installing Foxcom	Installing Base Units and		

Wireless equipment	RHUs.		
Installing optic cable (per 1m)	Pull and install optic cable through building.		
Installing coax cable	Install cable on floors		
Installing electricity ducts (per 1m)	Install cables through ducts in building.		If needed
Installing electricity cables	Install cables through ducts in building.		
System checking and report.	Trouble shooting and walk test.		1day

4.3. High Rise Installation

In a high rise installation all Base Units are placed in the same location. The Base Units are connected to the BTS/RBS, see BTS/RBS connection (page 32). An RHU is located on every floor. The fiberoptic cable runs from the Base Unit to every floor and terminates at the splice box located on every three floors of the building. Normally every splice box connects three RHUs. From the splice box, the fiberoptic jumpers connects to the associated RHU. From each RHU a coax cable delivers the signal to the antenna.

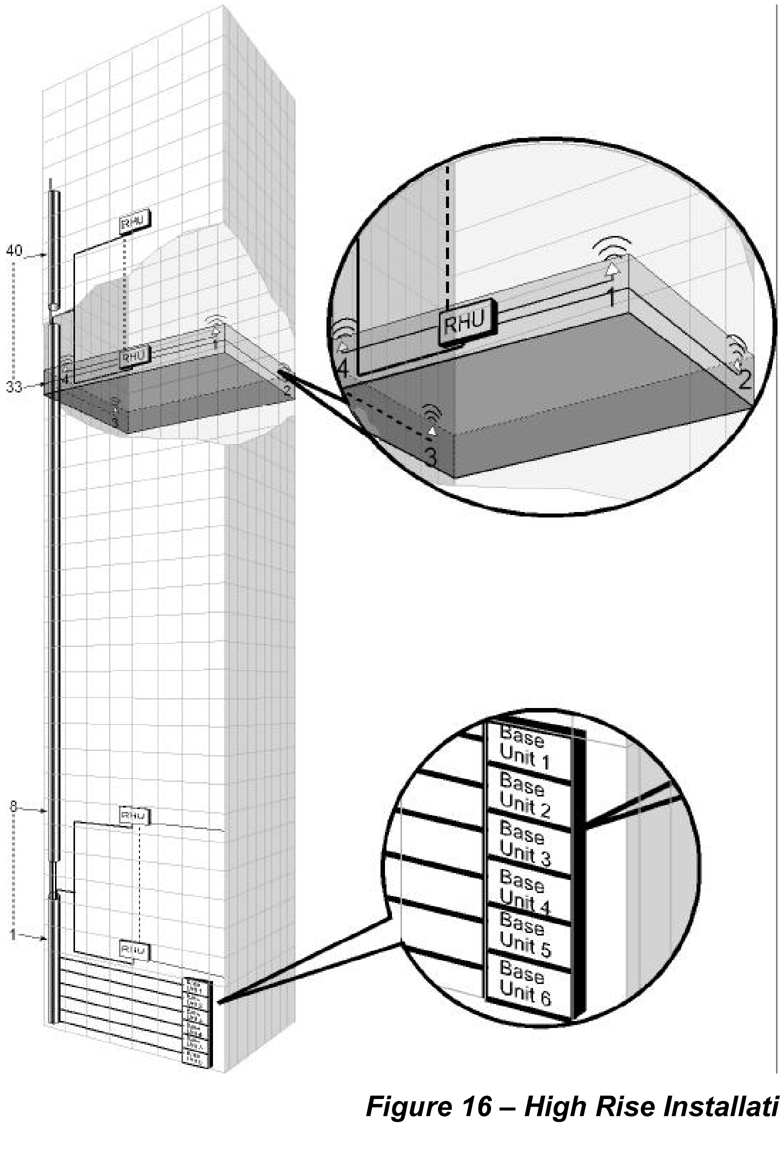


Figure 16 – High Rise Installation

4.4. Horizontal Layout Installation

In a horizontal layout installation, one fiberoptic cable connects the Base Unit to every installed RHU. The fiberoptic cable terminates at a splice box located near the RHU and from the splice box connects to the associated RHU.

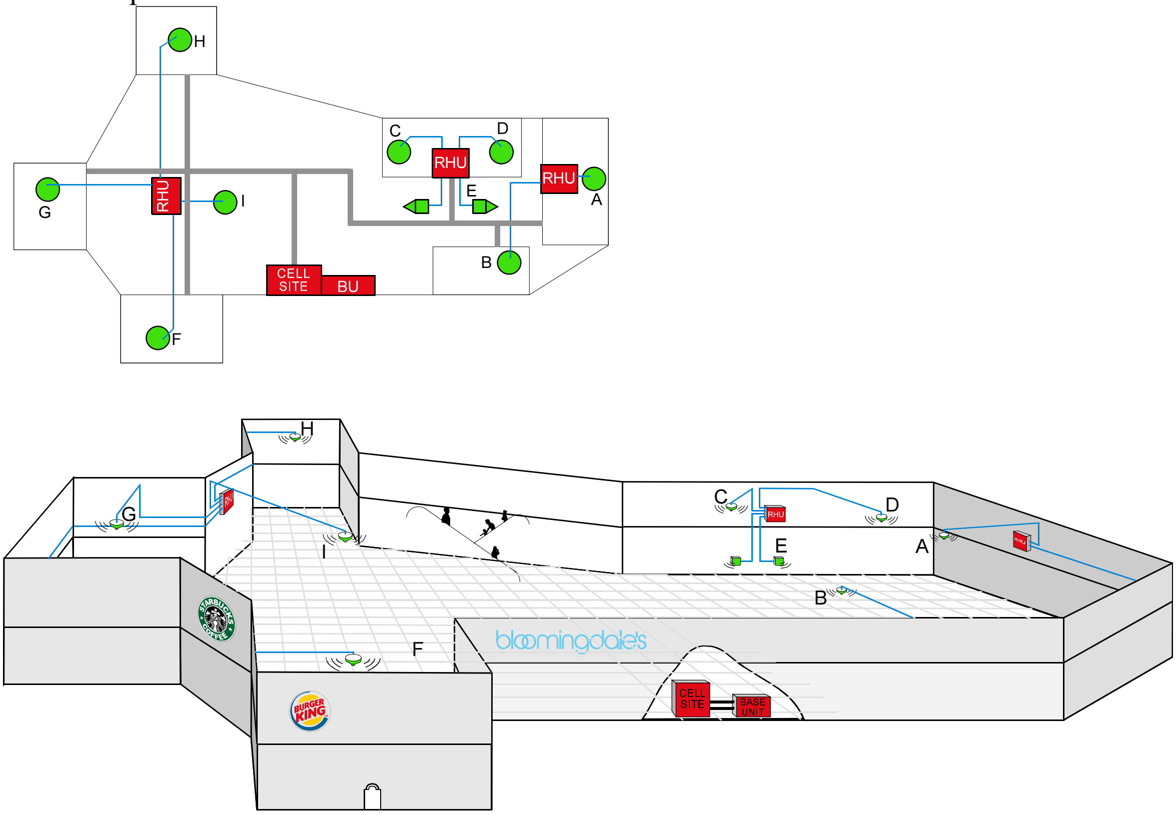


Figure 17 – Horizontal Layout Installation

5. Optical and RF Connections

The following sections describe the Litenna™ optical and RF connections.

- Base Unit
- Remote Hub Unit

5.1. Base Unit

There are two set-up options for the Base Unit:

- BTS/RBS with one port
- BTS/RBS with two ports

5.1.1. BTS/RBS with one port

1. BTS/RBS must be connected to a duplexer (standard).
2. The downlink port is connected through attenuators to the input on the Base Unit, according to the required input power.
3. When more than one Base 4 Unit is used, splitters are required to connect to the other Base Unit inputs.
   The uplink will only combine the required ports and connected to the duplexer uplink port.
4. Connect the fiberoptic cables from the Base Unit to the RHUs through the patch panel cabinet.
5. Connect the power supply to the units, according to power design planning.

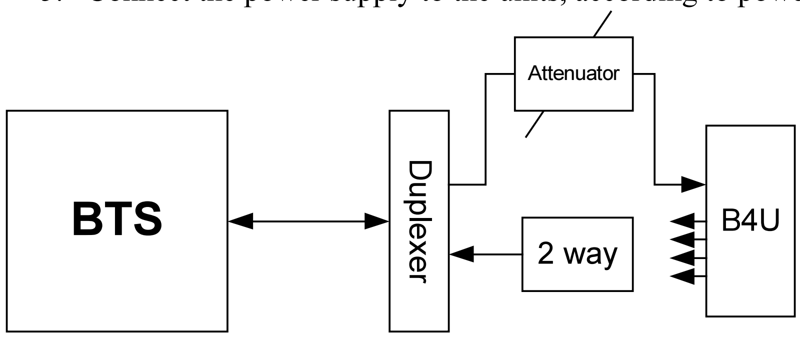


Figure 18 – BTS/RBS with One Port

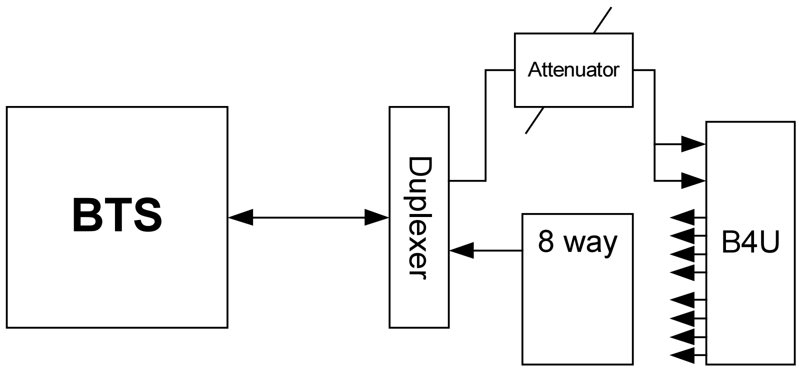


Figure 19 – BTS/RBS with Two Ports

5.1.2. BTS/RBS with one port

1. The BTS/RBS downlink port should be connected via 50Ω (RG223) coax cable to the Base Unit input.
2. The coax cable coming from the BTS/RBS should be split to all Base Unit input ports.
3. The input power for the Base Unit should be calculated to meet the product specifications.
4. For the uplink only the necessary ports will be combined and connected to the BTS/RBS uplink port

* all cables are coax jumpers (male to male 50Ω)

BLOCK DIAGRAM

5.2. Remote Hub Unit

1. For Downlink, connect the fiberoptic cable pigtails from splice box coming from the Base Unit port to the corresponding Remote Hub Unit port.
2. Connect the Remote Hub Unit to antennas according to the RF engineers design. (up to 4 antennas per RHU).
3. For Uplink, connect the fiberoptic cable pigtails from splice box from the Remote Hub Unit to the uplink port that connects to the Base Unit.
4. Connect the power supply to each RHU according to power design planning.

6. Alarm Monitoring

The BU has a 25 pin D-type connector that is connected to 8 dry contact relays (B8U). Each of the relays indicates the status of the link between the BU and one of the RHUs. This capability provides the status of the optical communications. The relay connections on the 25 pin D-type connector can be connected directly to the BTS alarm relays and can be controlled from the remote end.
In order to transmit the Litenna system as a “major alarm”, all dry contact pins need to be connected in a serial (cascade) formation, for Normally Closed alarm.
All dry contacts need to be connected in parallel formation, for Normally Open alarm.

Note

For further information contact Foxcom Wireless

Table 5 - 25 Pin Alarm Pinouts

Pin	Type of Alarm	Port
1	Dry Contact 4	1
2	Dry Contact 4	2
3	Open Collector	4
4	Dry Contact 1	1
5	Dry Contact 1	2
6	Open Collector	1
7	Dry Contact 2	1
8	Dry Contact 2	2
9	Open Collector	2
10	Dry Contact 3	1
11	Dry Contact 3	2
12	Open Collector	3
13	Dry Contact 8	1
14	Dry Contact 8	2
15	Open Collector	8
16	Dry Contact 5	1
17	Dry Contact 5	2
18	Open Collector	5
19	Dry Contact 6	1
20	Dry Contact 6	2
21	Open Collector	6
22	Dry Contact 7	1
23	Dry Contact 7	2
24	Open Collector	7
25	-	-

7. Power Supply for Litenna

The power supplies to drive the Litenna can be purchased from FoxcomWireless. The power supplies will be installed into a rack or mounted on a wall and will provide power for both the Base Units and Remote Hub Units.
100W/ 48VDC AC/DC converters provide power for the Litenna system as shown in the example in Figure 20.

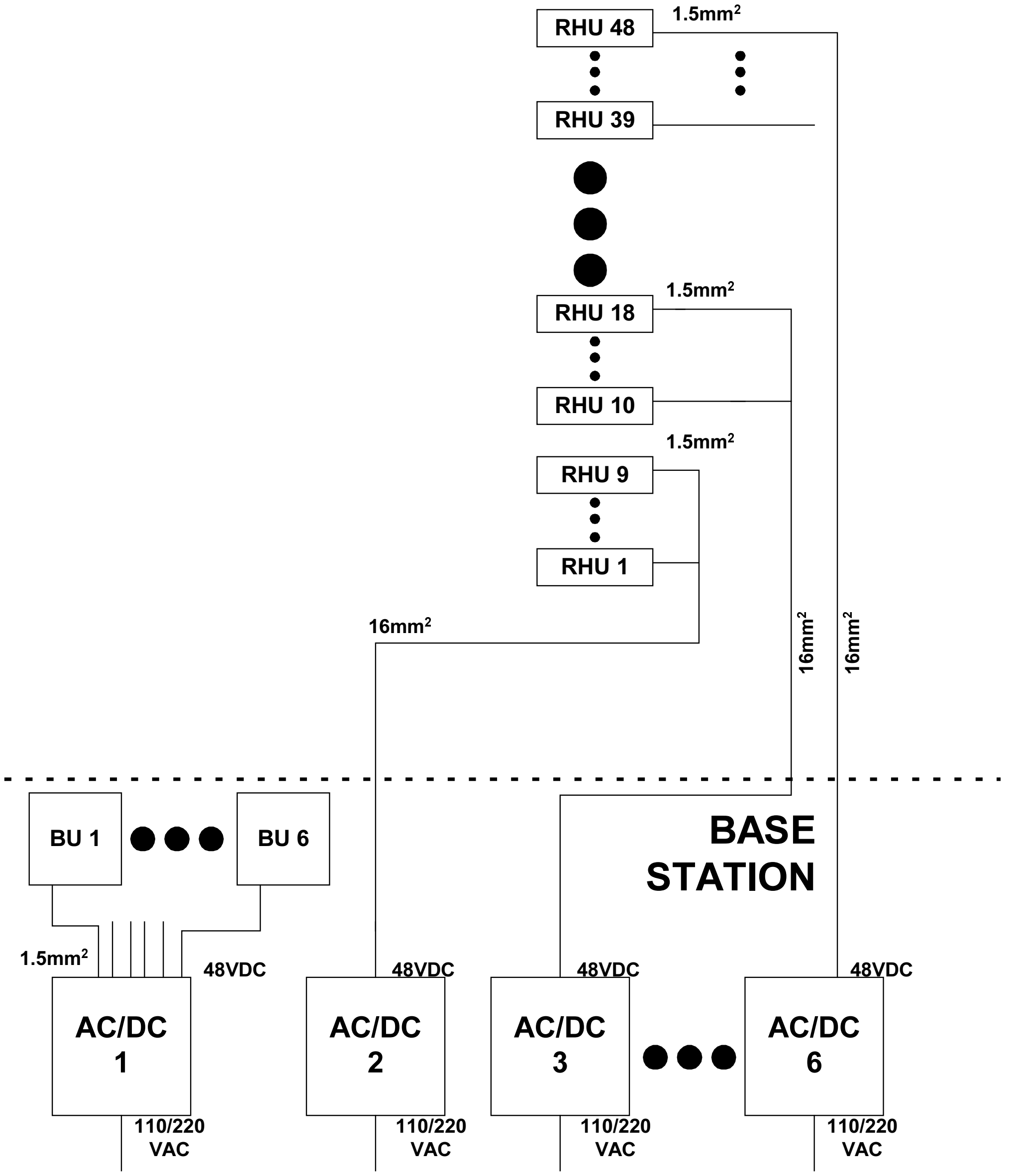


Figure 20 –* EXAMPLE *DC Power Supply in High Rise Installation

The power supply that drives the Litenna™ system can be purchased from Foxcom Wireless. Four power supply options are available.

7.1. Option One

In this option the BU is connected to the power supply via electrical cables. In order to power the RHU from the Power supply, two copper electrical wires running through the building (separately from the fiberoptic cables) supply power to each RHU in parallel. For this configuration, electrical power calculations need to be made. This option is shown in Figure 20.

7.2. Option Two

This power supply is located near the BU. The Power supply will drive the BU and RHUs. To provide power, the BU is connected to the power supply via electrical cables. To supply power to the RHU, a composite cable is used (composite cable contains two fiber cables and two copper electrical wires in the same jacket). For this configuration, electrical power calculations need to be made. See example in Figure 17.

7.3. Option Three

In this option the power supply type is a stand alone configuration. Power for both the BU and RHUs will be supplied separately. In this configuration each unit will be co-located with a power supply. This will not require long electrical cable runs.

Table 6 - Power Supply Options

Materials	**Model**
Local power supply	LPS-24-1A
Remote power supply (no redundancy)	RPS-200-N-48
Remote power supply (fully redundant)	RPS-500-R-48
Remote power supply (fully redundant)	RPS-1000-R-48

8. Optical Test Procedure

This section describes the methods applied to test fiberoptic cable's optical insertion loss and return loss.

8.1. Fiberoptic Cable Test

Due to the extended distances that analog signal transmissions travel on cable, the major challenge is to determine the status of the cable.
In order to determine that the cables are functioning, technical personnel need to perform optical power tests.
The optical power tests covered in this document are:

- Optical insertion loss measurement test
- Optical return loss measurement test

In order to explain the testing procedures, the terms related to these tests need to be explained.

8.2. Fiberoptic Cable – Terms

Fiberoptic cable is produced in a variety of formats with different characteristics. The following terms define the various aspects of fiberoptic cable:

- Fiberoptic cable
    - Jacket
    - Buffer
    - Fiber
- Optical fiber
    - Core
    - Clad
    - Singlemode
    - Multimode
- Fiberoptic connection
    - Splice
        - ♦ Fusion
        - ♦ Mechanical
    - Connector
- Bending Loss
    - Minimum bending radius
- Coupler

8.2.1. Optical Fiber

Fiberoptic cable is described by the amount of fibers contained within.
The cable described by the following terms:

- Glass
- Buffer
- Jacket

Glass

Glass is the middle fiber in the cable. The data sent over the cable travels through the glass.

Buffer

The buffer is the plastic coating that covers the fiberoptic cable. The buffer protects the glass from moisture and other damage.

Jacket

The jacket covers the buffer, providing greater protection to the glass.

The fiber consists of:

- Core
- Clad

The central part of a fiber is known as the core, and the material surrounding the core is know as the clad. The clad has a lower index of refraction than the core, allowing light to be completely reflected off the surface between the core and the clad. As a result, propagated light remains entirely within the core. The cross-section of the cable is expressed as the core diameter followed by the clad diameter. For example, a 9/125 fiber has a core diameter of 9μm and a clad diameter of 125μm.

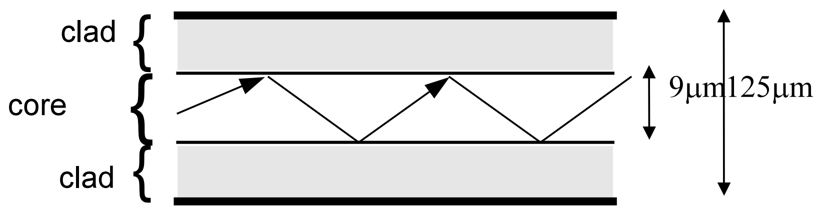
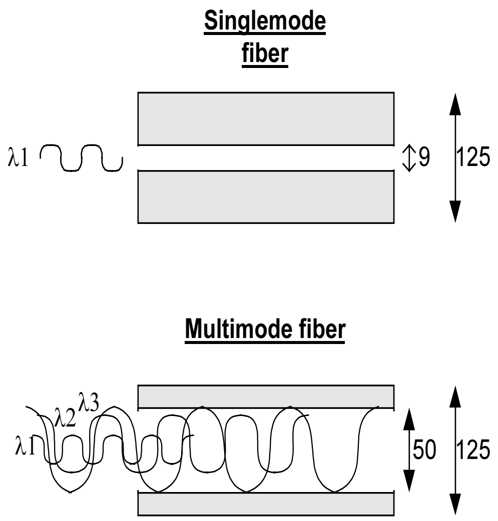


Figure 21 – Fiberoptic Cable Structure

The cables are available in two different modes, each with different propagation properties:

Property	**Core**	**Clad**	**Attenuation**
Singlemode	9 µm	125 µm	.38 dB/Km
Multimode	50 µm	125 µm	1 dB/Km
Multimode	62.5 µm	125 µm	

@1310nm



(For illustration only)

Figure 22 – Singlemode - Multimode Fibers

8.2.2. Connecting Fiberoptic Cable

The following are needed in order to carry out a fiberoptic connection:

- Splice
- Connector

Splice

A splice consists of cutting the fiberoptic cable across the cable's diameter and combining the opening with another fiberoptic cable.
A splice can be carried out in the following methods:
Fusion – following the splice, the cables are warmed and the two fiberoptic cables are melted together.
Mechanical – following the splice, a hard connection is made between the two fiberoptic cables.

Connector

In order to add or connect additional fiberoptic cable, a connector is used to make the connection. There are several types of connectors:

- FC/PC
- SC/PC
- SC/APC (used by Litenna)

8.2.3. Fiberoptic Cable Bending Loss

When the cable has bends or interior irregularities, then the optical signal becomes weaker, known as Bending Loss.

The sharper the bend, the higher the loss. Such losses increase the cable's attenuation.

Note

When installing fiberoptic cable, the minimum bending radius needs to be noted in order to prevent excessive bending of the cable, causing additional lossc

8.2.4. Coupler

Light from the cable can be split or combined, using a **Coupler**. Couplers split light with minimal loss, from one to two fibers or combine light from two fibers into a single fiber.

8.3. Foxcom Wireless System Characteristics

The Litenna™ system consists of the following characteristics:

- Singlemode fiber
- Wavelength 1310nm

8.4. Fiberoptic Cable Measurement Tests

Cable can be measured through several procedures. This document describes the following tests:

- Optical insertion loss measurement test
- Optical return loss measurement test

These tests are intended to be performed by technical personnel that deal with Foxcom Wireless systems.

Other equipment can be used to perform these tests, however the results have to be the same as will appear in the fiberoptic cable test results table (Table 7), at the end of this document.

The insertion loss measurement determines whether the optical signal power travelling the cable length is strong enough to be received by the photo diode, in the receiver.

Following the completion of the insertion loss test, the return loss test determines the optical signal power that returns to the laser. The return power affects the laser, changing the laser's base current.

8.4.1. Test Equipment

In order to perform these tests, the following equipment is necessary:

- Light source (for wavelength 1310nm , 0dbm)
- Optical power meter
- Optical coupler (hosed and connectorized)
- Fiberoptic jumper
- Adapter parts for the cable connectors

For information about equipment suppliers, contact Foxcom Wireless.

8.5. Optical Insertion Loss Measurement Test

The optical insertion loss measurement tests the attenuation of the cable. The insertion loss' value should be minimal and remain in scale to 0.4dB/Km.
The insertion loss measurement can be performed in two methods:

- Two point test
- Single point test

8.5.1. Method #1: Two Point Test

Connection description: Light source connected at one end of the cable and an optical power meter at the other end.

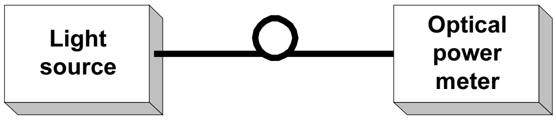


Figure 23 – Two Point Test

Connect light source directly to the optical power meter.

Measure light source signal power, verifying power of 0dBm.

Connect light source to cable end.

Connect optical power meter to cable at other end.

Measure light source signal power using the optical power meter.

Calculate the difference between two signals (dB):

(Insertion loss)dB = (Light source signal at one end)dBm – (Measured signal at other end)dBm

8.5.2. Method #2: Single Point Test

Connection description: This method assumes that there are two parallel fibers on the path to be tested. Connect fiber jumper at end of the cable being tested to another parallel cable. Connect the light source, optical power meter and optical jumper as shown in Figure 24. This measurement can test two cables simultaneously.

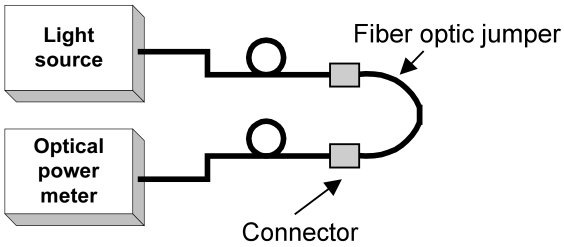


Figure 24 – Single Point Test

Use optic jumper to connect the two cables.

Connect light source directly to the optical power meter.

Measure the power of light source signal , verify power of 0dBm.

Connect a light source and optical power meter to one end of each cable.

Measure the power of the signal.

Calculate the difference between the two signals in dB

(Insertion loss)dB =(Light source signal)dBm– (Measure signal)dBm

8.5.3. Other Test Equipment

The optical insertion loss measurement test can be performed with more sophisticated measurement equipment.

For information on other types of test equipment contact Foxcom Wireless.

8.6. Optical Return Loss Measurement Test

Connection description: Connect a light source and optical power to the inputs. If the coupler has one output, connect the tested cable to this output. If the coupler has two outputs make a pigtail at the second output.

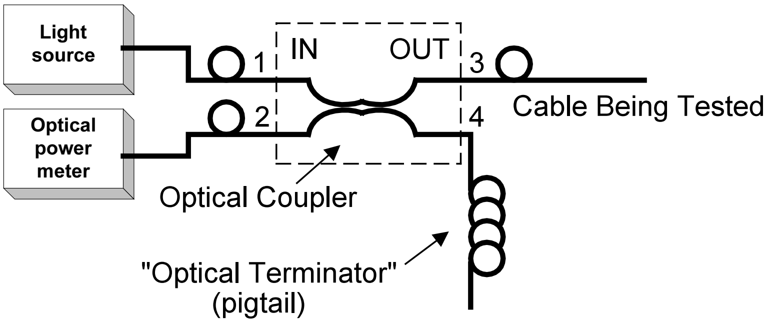


Figure 25 – Optical Return Loss Measurement

8.6.1. Measurement Procedure

Measuring Power Input To Cable Being Tested

1. Verify that light source power is at 0dBm.
2. Connect a light source to connector #1.
3. Connect optical power meter to connector #3.
4. Measure signal power (P3), power should be approximately –4dBm.

Measuring Coupler Power Loss

1. Move power meter from connector #3 to connector #2.
2. Move light source from connector #1 to connector #3.
3. Measure power loss of coupler (Lc).

Measuring Return Power

1. Move light source from connector #3 to connector #1.
2. Connect cable being tested to output connector #3.
3. If coupler has two outputs, then make a pigtail at second output.
4. If cable is longer than 100 meter, then cable needs to be isolated.

To isolate cable:

3. Find place near test point where winding the cable into a pigtail is possible.
4. Make pigtail.
5. If cable is shorter than 100 meter, then verify that cable is disconnected at end.
6. Measure the return light power (P2), connector #2.

Calculating Return Loss

Calculate the difference between the signals in dB.

(Return loss)dB = (P2)dBm – (P3)dBm + (Lc)dB

8.7. Results

The following table is filled in by technical personnel testing the fiberoptic cables.

Table 7 - Fiberoptic Cable Test Results

Test	Measurement	Pass Range	Pass/Fail
Optical Insertion loss		<0.5 dB/Km	
Optical return loss		< -50 dB	

8.8. Summary

If the fiber fails in the optical insertion loss or optical return loss tests, then the connector needs to be cleaned. Connector cleaning is carried out according to a standard cleaning procedure. Following cleaning, the fiber needs to be tested again. If the failure continues in the fiber following cleaning, then the technical personnel need to refer to the fiberoptic cable manufacturer's troubleshooting guide.

If the fiber passes the optical insertion loss and optical return loss tests, then the tested fiberoptic cable is considered suitable for use with Foxcom Wireless equipment.

9. Final Test

The following checklist should be consulted when reviewing the system's setup.

- Check power supplies.
- Check that all LEDs are lit.
- Carry out Walk Test, checking all antenna locations, and checking the RSSI power levels at those locations.

9.1. Base Unit and Remote Hub Unit Connections

When the Litenna™ is being installed the LEDs on the units can verify that the optical fibers are performing correctly, and that proper connections have been made. Foxcom Wireless recommends checking the status of all connections in the Litenna™ system in order to make sure that the installation was carried out correctly. Verification is done by checking the LEDs on the Base and Remote Hub Units. See Table 8 for an explanation of the possible optical LED performance states and how to deal with problems.

Note

When the RHU not receiving light signal from Base Unit, power to laser is disconnected.

10. Maintenance / Mechanical Adjustment

No maintenance required.
No fine tuning required.

11. Troubleshooting

The following table should be consulted to verify proper operations of all optical connections.

Table 8 - Optical LED States

Optical Out	Optical In				
Base Unit Laser	**Base Unit Link**	**RHU**	**State**	**Reasons**	**Troubleshooting**
+	+	+	Both units performing.		
+	-	+	Base Unit sending light and Base Unit not receiving signal from RHU.	1. Defective fiber connection from RHU to Base Unit. 2. Failure in RHU.	1. Check connection from RHU to Base. Check fiber for break or crimp test. 2. Contact Customer Service at Foxcom Wireless.
+	-	-	RHU not receiving signal from Base Unit.	Defective fiber connection from Base Unit to RHU.	Check connections To RHU. Switch the cable connections, to make sure connected properly.
-	-	-	System not active.	Power not reaching any unit.	Check power connections. If LEDs on, then LEDS have failed at the Base Unit.

\+ Optical connection performing correctly (Optical LED lit).
\- Optical connection not performing correctly (Optical LED not lit).

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12. Appendix A Link Measurements Form

To smoothly carry out link measurements, use the table that appears below. All relevant parameters are listed. This table aids system evaluation and provides necessary feedback to Foxcom Wireless.

The following issues should be taken into account:

- Measure the optical power for every link with an optical meter and light source, according to the number of links or RHUs.
- Measure the typical signal strength (RSSI) for every installed antennas.
- Check coax cable connection between RHU and every installed antenna.

Table 9 - Link Measurement Table

System Link	Power Meter (mW)	RSSI (dBm)				Coax Cable (OK/Fail)			
		Ant1	Ant2	Ant3	Ant4	Ant1	Ant2	Ant3	Ant4
RHU1									
RHU2									
RHU3									
RHU4									
•									
•									
•									
•									
•									
•									

Return this form to Foxcom Wireless (fax: 972-8-918-3844).