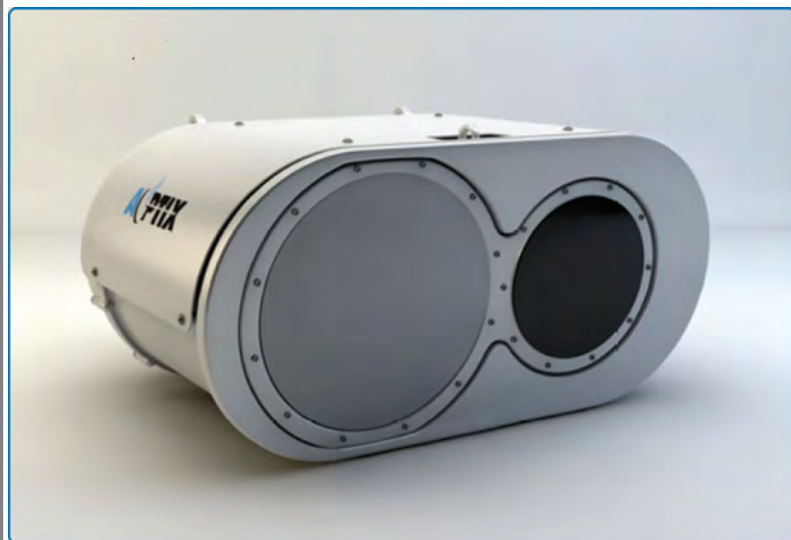




Intellimax™ ULL-3000

Ultra-High Bandwidth Wireless
Communication Link



Installation Guide

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ULL-3000 Installation Guide Part Number: 84-0014-0000

Table of Contents

Chapter 1	About this Manual	3
	Manual Scope	3
	Typographical Conventions	3
Chapter 2	Safety Precautions	5
	Warning, Caution and Note Definitions	5
	Safety Overview	6
	Electrical Safety	6
	Mechanical Safety	8
	Lightning protection	9
	Laser safety	9
	Laser safety interlock switch	10
	Risk of Personal Injury from Laser radiation	10
	RF exposure protection	11
	RF Regulatory compliance information	11
	Regulatory Compliance	12
	Grounding and Bonding	15
	Pole-Mounted Antennas	16
	Protective devices	16
	Conductors	16
	Connectors	16
Chapter 3	System Overview.....	17
	Overview	17
	System components	20
	ULL-3000	20
	System configuration	20
	Node types and configurations	20
	Single-hop configuration	20
	Multi-hop configuration	21
	Red node	22
	Blue Node	22
	Head Node	22
	Back-end node	22
	End node	22
	Repeater node	23
	System specifications	23
Chapter 4	Prerequisites	25
	Permits	25
	Site Survey	25
	Planning	25
Chapter 5	Typical Installations	27
	Tower installation	27
	Accessories	28

Chapter 6	Installation Procedure.....	29
	Overview	29
	Installation prerequisites	29
	Link Installation	32
	Mounting	32
	Cable connections	36
	Power connections	37
	Data connections	45
	Coarse alignment	54
	Fine alignment	57
	Two installation teams	58
	Single installation team	61
	Link verification	62
	Multi-hop network configuration	62
	Time and Date Setting	63
Chapter 7	Troubleshooting and technical support.....	65
Chapter 8	Mechanical drawings	67
Appendix A	Acronyms	69
	Index	i

About this Manual

This **About this Manual** chapter contains the following sections:

- *Manual Scope*
- *Typographical Conventions*

Manual Scope

This manual provides descriptions and procedures supporting the installation, verification, operation, diagnostic evaluation and alignment of the ULL-3000 system.

Typographical Conventions

Table 1-1 **Interface Conventions**

Reference	Example
Keyboard chords	Ctrl-Alt-Delete
Keyboard input	content you type
Keyboard keys	ENTER
User-interface components	Cancel
Cross-Reference	See <i>Figure 4-1</i>

Safety Precautions

This **Safety Precautions** chapter provides information necessary for the safe operation of the Aoptix ULL-3000 and contains the following sections:

- *Warning, Caution and Note Definitions*
- *Safety Overview*
- *Regulatory Compliance*
- *Grounding and Bonding*

Observe the following general safety precautions during all ULL-3000 phases of operation. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of intended ULL-3000 usage and may impair the protection provided by the equipment. Aoptix, Inc. assumes no liability for failure to comply with these requirements.

Warning, Caution and Note Definitions

Table 2-1 Danger Hazard Alert



	<div data-bbox="511 1089 828 1144">  DANGER </div> <p>DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations. The icon shown in the left column displays the specific Warning concern, in this case, an electric shock</p>
---	--

Table 2-2 Warning Hazard Alert





	<div data-bbox="500 1459 839 1514">  WARNING </div> <p>WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury. The icon shown in the left column displays the specific Warning concern, in this case, an electric shock.</p>
---	---

Table 2-3 Caution Hazard Alert

	<div style="background-color: yellow; text-align: center; padding: 5px;">  CAUTION </div> <p>CAUTION indicates a potentially hazardous situation which may result in minor or moderate injury. It may also be used to alert against unsafe practices. The icon shown in the left column displays the specific caution concern, in this case, a hot surface.</p>
---	---



Note: The Note statement indicates important information. It calls attention to an operating procedure or practice which may enhance user interaction with the product. Notes may also be used to prevent information loss or product damage.

Safety Overview

Electrical Safety

The ULL-3000 is DC powered by a -48Vdc, (2A typical, 6A max) with input voltage tolerance of +/-20% (from -38Vdc to -58Vdc max). For -48Vdc 10A max. power, use the Lightning Protection Box part number 10-1746-0001 which provides a connector-plug to mate with the connector-receptacles on the ULL-3000. The ULL-3000 supports dual -48Vdc inputs. *Figure 2-2* shows the ULL-3000 power connections.

Note: It is recommended to use Lightning Protection boxes at both the mounted ULL-3000 location and at the ground.

	<div style="background-color: yellow; text-align: center; padding: 5px;">  CAUTION </div> <p>Exposure to electrical circuits may cause electrocution and result in minor or moderate injury. Disconnect all power supplies prior to servicing.</p>
---	--

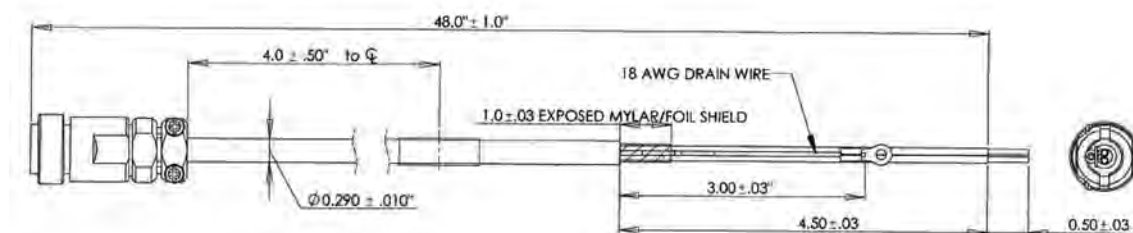
Note: Read the installation instructions before connecting to the ULL-3000 to the power supply.

This product requires a surge protector device (SPD) or surge arrester as part of the installation to address transient over-voltages exceeding Overvoltage Category II, 2500 V_{peak}. Connecting the supplemental ground to the unit in accordance with the NESC is essential before connecting input supply cable.

The equipment is suitable for installation outdoors. The equipment is intended for installation and service by trained personnel only (no operator access). This product was evaluated for mounting with specific mounting brackets as noted in this manual.

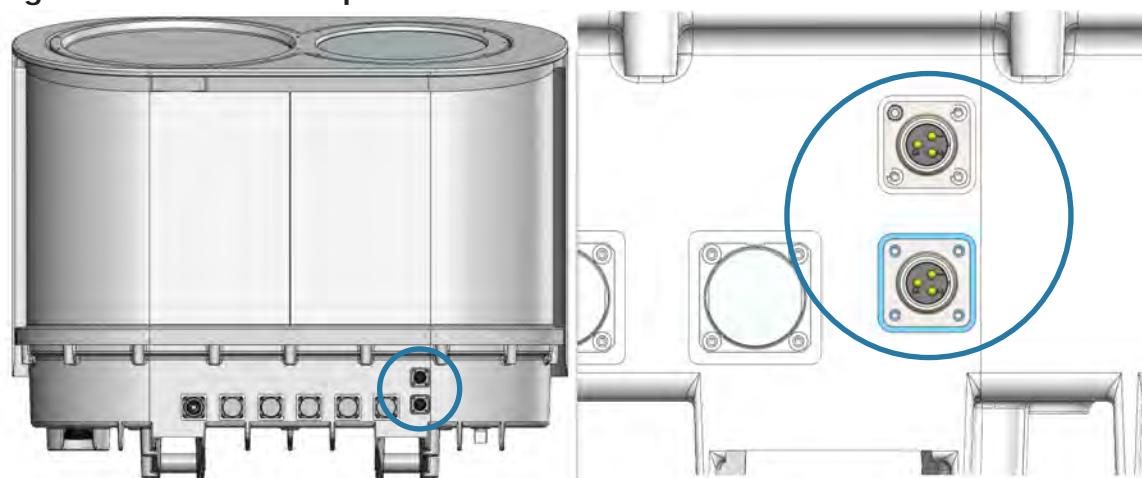
	<div style="background-color: #e67e22; color: white; padding: 5px; text-align: center;"> WARNING </div> <p>Due to the potential presence of radio frequency energy, electrical shock and laser radiation hazards, only authorized service personnel should attempt to repair this equipment.</p>
--	---

Figure 2-1 Cable and connector from the Lightning Protection Box



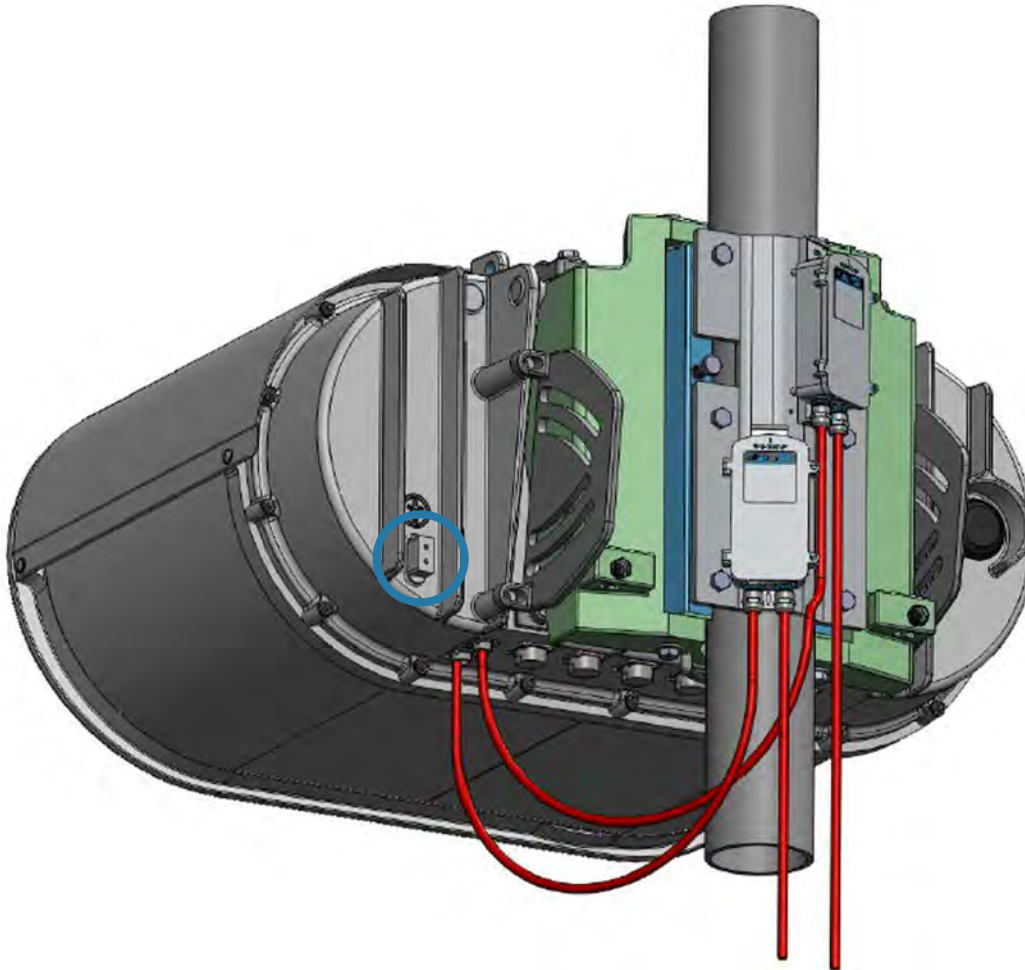
There are two power connections on the bottom of the ULL-3000. These are two separate DC power feeds from the power supplies. Only one of these connections is required. The second connection provides an input for a redundant power supply. Either connector can be used as the primary or the redundant power connection.

Figure 2-2 ULL-3000 power connections



A #8 AWG wire (green color per IEC) is used to connect the ULL-3000 to earth ground. A through-hole screw and nuts is in the enclosure for the direct connection between the internal common ground and the external earth ground. *Figure 2-3* shows the ULL-3000 ground connection.



Figure 2-3 Ground connection



Mechanical Safety

	CAUTION
<p>You can be crushed by falling assemblies. Adhere to all applicable safety regulations when working on or near the tower.</p>	

Lightning protection

	 CAUTION
	<p>Lightning protection is required by the AOptix Warranty Statement. Failure to provide proper lightning protection using recommended components will result in the Product Warranty being void. Lightning protection regulations and standards for proper protection are covered under the national or regional electrical safety codes such as the National Electrical Code in the United States. Follow your national or regional electrical safety codes! The outdoor components are to be grounded, and lightning arrestors are to be connected in accordance with local, regional and national codes. All local building and electrical codes specified by local civil authorities must be followed. Standard safety procedures for installing and working with this type of equipment must also be followed.</p>

AOptix Part Number	Description
10-1746-0000	48Vdc Lightning Protection Box
10-1566-0001 (optional)	Installation Kit (weatherized)



Laser safety

This device complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007".

The ULL-3000 includes a Class 1 laser utilized as a free space optical driver. Never look at the transmit LED/laser through a magnifying device while it is powered on. Never look directly at the fiber TX port and fiber cable ends when they are powered on.

Note: The ULL-3000 is a CLASS 1 LASER PRODUCT when fully enclosed. The product was tested and found in compliant to the IEC 60825-1 Ed. 2 (2007) standard. This product is not field serviceable.

Laser safety interlock switch

	 CAUTION
	<p>System interlock overrides can expose personnel to laser exposure and electrocution injuries and should be only utilized by trained and authorized personnel.</p>



It is recommended that maintenance or service personnel should never look at an open fiber end or connector that is carrying a live signal.



During use, this optical fiber communications system is completely enclosed except if an accidental break occurs in the system cable, or if the patch cable becomes accidentally disconnected from the demarcation box. There are no controls or adjustments other than power ON/OFF that may be accessed by the user.

The ULL-3000 utilizes 1550nm laser, an invisible light beam, transmitting data through air via Transmitter Optical Sub-Assembly (TOSA) combined with Erbium Doped Fiber Amplifier (EDFA) in the circuit.

EDFA is a Class 4 component. Rated wavelength is 1535 - 1565 nm. Rated output power is +27dBm (500mW). TOSA is a Class 3b component. Rated wavelength is 1528.7 - 1563.9 nm. Rated output power is 10mW

Risk of Personal Injury from Laser radiation

	 DANGER
	<p>Invisible laser radiation. Avoid direct eye exposure to the end of a fiber, fiber cord, or fiber pigtail. The infrared light used in fiber optics systems is invisible, but can cause serious injury to the eye. There are no user serviceable parts inside and there are Class IV laser hazard exist when the product is powered up without an enclosure.</p>

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



	 CAUTION	
	Avoid eye or skin exposure to direct or scattered radiation. Class 4 invisible Laser radiation is present when open and interlocks defeated.	

Table 2-4 Laser safety report

Model	IEC60825-1CB		Test Report References
ULL-3000	US-19774-UL	UL File#: E328284	12CA34769 (2012-09-17)

RF exposure protection

It is hazardous to look into or stand in front (2m or 6ft) of an active millimeter wave antenna aperture. Do not stand in front of or look into an antenna without first ensuring the associated transmitter or transmitters are switched off. Do not look into the waveguide port when the radio is active.

The ULL-3000 utilizes microwave e-band frequency spectrum, the RF exposure must comply to the MPE limits specified by FCC Rules and Regulations for either:

1. Occupational/Controlled Exposures or
2. General Population/Uncontrolled Exposures

Per FCC, MPE limit for ULL-3000 RF exposure safety limits are:

1. 5mW/cm² averaged over 6 minutes for Occupational/Controlled Exposure, or
2. 1mW/cm² averaged over 30 minutes for General Population.

RF Regulatory compliance information

The ULL-3000, in accordance with FCC Title 47 CFR Part 2, complies with Part 15 Subpart J, Part 101, Subpart Q of the Federal Communication Commission rules.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

In the U. S. millimeter wave radio transmission equipment operating in the 71-76 and 81-86 GHz frequency ranges must be registered with the FCC as provided for in Part 101 of the FCC regulations. Proper operating licenses must be obtained to operate in the U.S.A., and most countries. Check with your country's wireless regulatory body for licensing in your area. For additional information on licensing or regulatory information contact your local AOptix sales and support team.

Model	Eband - FCC Approval Number		Test Report References
	71-76GHz	81-86GHz	

Model	Eband - FCC Approval Number		Test Report References
ULL-3000	Tbd	Tbd	Tbd
	Tbd	Tbd	Tbd
	Finisar FTLF1318P2BCL 1310nm 1000Base-LX		Tbd
	Sumitomo part FTM-3012C-SLG 1310nm 1000Base-LX		

Regulatory Compliance

Table 2-5 Operational Characteristics

Region	Standard	Scope of Testing
US	CFR 1040.10, 1040.11	Class 1 Laser Safety
US	ANSI Z136.6	Laser Safety for Outdoor Use
US	FCC 47CFR 101, Subpart Q	Eband (Intentional)
US	FCC 47CFR 15B, Subpart J	EMI, EMC (Unintentional)
US	UL 60950-1	ITE Safety
US	UL 60950-22	ITE Safety for Outdoor Use
CAN	CSA C22.2 #60950-1	ITE Safety for Canada
CAN	ICES 003	EMI/EMC for Canada
CAN	RSS-210, Subpart C	Eband (Intentional) for Canada
EU	EN/IEC 60825-1	Class 1 Laser Safety
EU	EN/IEC 60825-12	Class 1 Laser Safety for Outdoor Use
EU	Optical Directive 2006/25/EC	European Optical Radiation Directive
EU	LVD 2006/95/EC	European Low Voltage Directive
EU	RoHS Directive 2002/95/EC	European RoHS Directive
EU	R&TTE Directive 1999/05/EEC	European Radio & Telecommunications Terminal Equipment Directive
EU	EMC Directive 2004/108/EC	European Electromagnetic Compatibility Directive
EU	EN 55022: 2010	EMI (Emission)
EU	EN 55024: 2010	EMC (Immunity)

Region	Standard	Scope of Testing
EU	EN 61000-4-2	ESD immunity
EU	EN 61000-4-3	RF field strength susceptibility
EU	EN 61000-4-4	Electrical Fast Transients (EFT)/B (Burst)
EU	EN 61000-4-5	Surge immunity
EU	EN 61000-4-6	Conducted Immunity
EU	EN 301 489-4	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for point-to-point equipment and services.
EU	EN 302 217-3	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas.

Table 2-6 Industrial Standard Compliance

Industrial Standard Compliance		
Telcordia	GR-3108	Generic Requirements for Network Equipment in the Outside Plant
Telcordia	GR-63	Physical Protection - Generic Criteria for Network Telecommunications Equipment
Telcordia	GR-1089	Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment
Telcordia	GR-487	Generic Requirement for Electronic Equipment Cabinets
AT&T	ATT-TP-76200	Energy Efficiency Requirements for Telecommunications Equipment
Verizon	VZ.TPR.9205	Energy Efficiency Requirements for Telecommunications Equipment
AT&T	ATT-TP-76200	Network Equipment and Power Grounding, Environmental, and Physical Design Requirements
Verizon	VZ.TPR.9305	Bonding & Grounding
PT&T (Europe)	ETSI EN 300 019-2-1	Storage Tests, Class T1.2
PT&T (Europe)	ETSI EN 300 019-2-2	Transportation Tests, Class T2.3

Industrial Standard Compliance		
PT&T (Europe)	ETSI EN 300 019-2-4	Operational Tests, Class T4.1E, Non-Weather-Protected
PT&T (Europe)	ETSI EN 300 753	Acoustic Noise

Grounding and Bonding

This section provides grounding requirements for the ULL-3000.

The ULL-3000 bonding conductor shall be a minimum #8 AWG.

The grounding and bonding system is a fundamental part of the protection scheme for a radio site and radio equipment. However, other elements, not covered in this section, must be considered including:

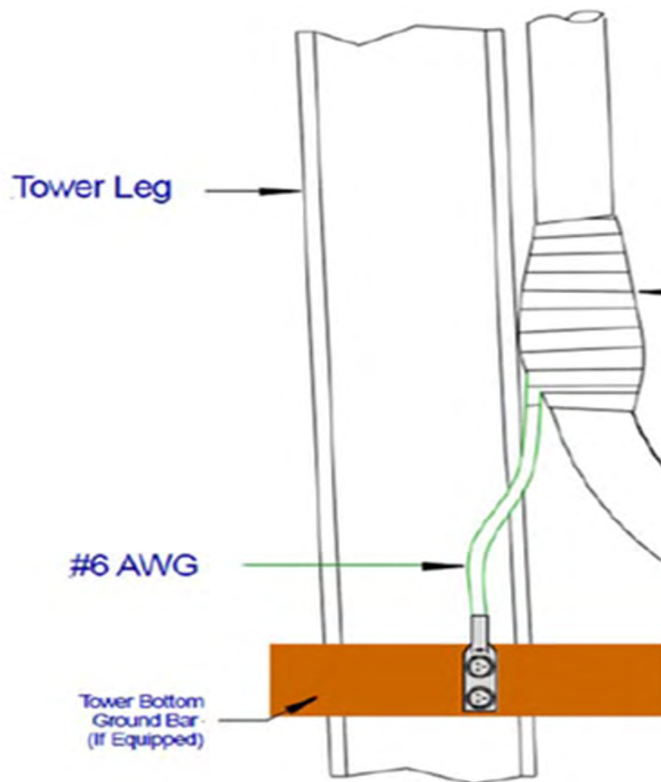
- Electrical protection of the ac service
- Electrical protection of all other copper and fiber optic cables (with metallic sheaths) entering the structure by either aerial or underground means

The intent of a grounding and bonding system for a radio site and its equipment is to establish low impedance paths to earth and low impedance bonds between nearby metallic objects. This reduces the voltage differential between objects and the earth, and between nearby objects within a structure during a lightning strike.

During a lightning strike, extreme voltage differential may develop between points on a conductor. Inductive reactance is the major component of the lightning current path impedance. An increase in the size of a conductor reduces its dc resistance but does not significantly reduce the voltage differential between points along this path. Reducing a path's dc resistance by using conductors larger than #2 AWG results in little reduction in impedance. A #2 AWG conductor carries substantial current without thermal damage, and it is resistant to mechanical damage.

Voltage differential can be minimized by ensuring that the path is of lowest practical impedance and/or by providing parallel paths of minimum impedance. A straight conductor of shortest possible length is the path of lowest impedance.

Figure 2-4 Bond to Tower Leg



Pole-Mounted Antennas

A pole-mounted antenna shall be equipped with a minimum of one down conductor, which may serve more than one antenna or pole-mounted radio equipment units.

Protective devices

Protective devices are required for the ULL-3000. See the *Lightning protection* section. Every protective device must be bonded.

Conductors

Except where expressly stated, grounding and bonding conductors may be either stranded or solid copper.

Connectors

All terminals should be 2-hole circumferential crimp type.

System Overview

This **System Overview** chapter provides detailed information about the implemented ULL-3000 hardware and software components and contains the following sections:

- *Overview*
- *System components*
- *System configuration*
- *System specifications*

Overview

The ULL-3000 provides ultra-low latency, high availability, 2Gbps Committed information rate (CIR), wireless solution for low-latency market, with single hop distances up to 8 km.

It consists in a hybrid link combining a Free Space Optical (FSO) link using 1.5 μm infra-red wavelength and a radio Frequency (RF) E-Band link (73/83 GHz), enabling the committed 2Gbps data rate through the heaviest rain and fog conditions.

The standard software support includes platform core and node management through WEB, command-line interface (CLI) and SNMP. In addition, the ULL-3000 supports management of multi-hop links through end nodes, eliminating the need for management interfaces at each repeater node.

Figure 3-1 ULL-3000



Table 3-1 System Component Functionality

Item	Description
1.	E-Band antenna
2.	FSO telescope

Figure 3-2 ULL-3000 Power and data connections

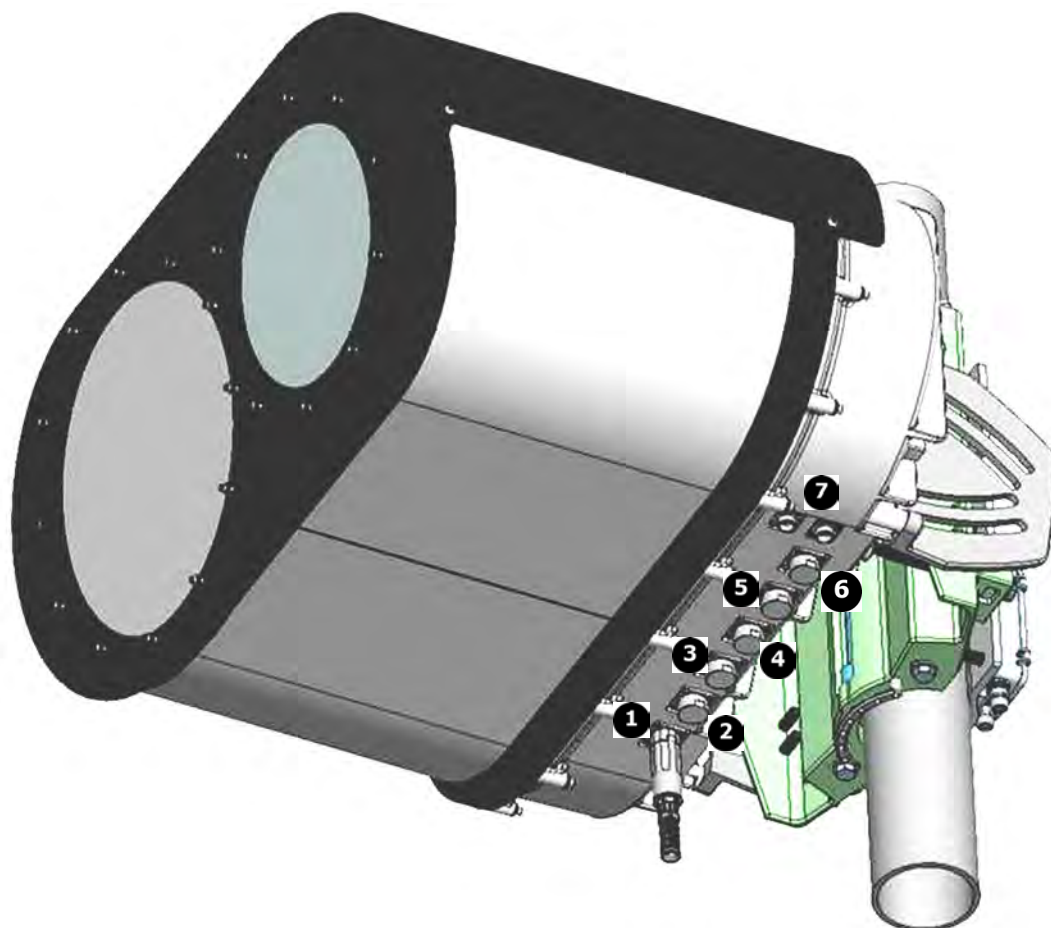


Table 3-2 ULL-3000 data and power connections

Item	Description
1.	Reserved for future use.
2.	DATA-1 - used for Ethernet client data 1. In repeater configuration, it is used to carry the data between the two units on the same tower.
3.	DATA-2 - used for Ethernet client data 2. In repeater configuration, it is used to carry the data between the two units on the same tower.
4.	Management - used for Network Management traffic between two units on the same tower.
5.	Reserved for future use.
6.	Reserved for future use.
7.	Power - Connection points for the power supply and the optional redundant power supply. It does not matter which connection is used.

System components

ULL-3000

- Recommended SFPs
- Power Supply
- Lightning Protection Unit
- Fiber Optic Cables
- Power Cables
- Radial connector assemblies

System configuration

Note: The shipped ULL-3000 systems are configured as End Nodes for the installation. The nodes need to be configured as end nodes to enable the Bit Error Rate Test (BERT) testing.

Two ULL-3000 systems communicating with each other constitute a link. A link always consists of a Red Node and a Blue Node. More than one ULL-3000 links connected together, back to back constitute a network.

A network consists of end-nodes and repeater nodes. The end nodes interface with the client network through 1Gbps Ethernet connections. The repeater nodes are directly connected to each other using AOptix proprietary format and protocol.

There are 2 types of end nodes:

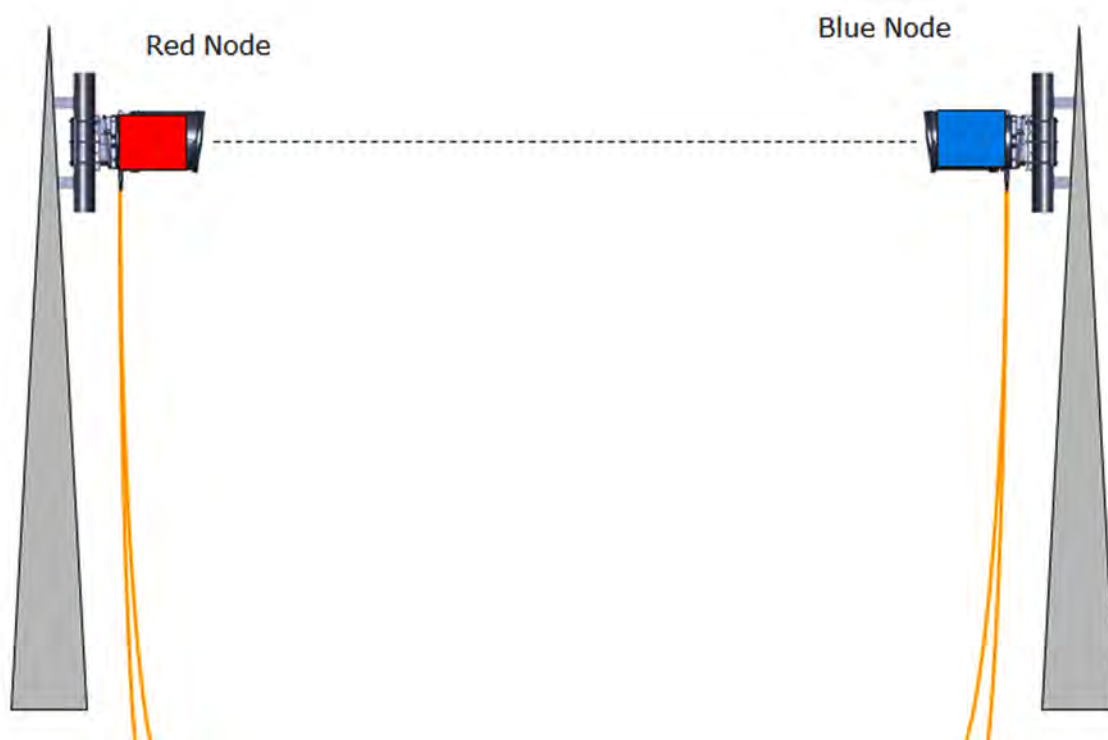
- Head-end node: It is the master node for the Network management. It is the only entry point of the network for the network management. It is connected to the client NMS server.
- Back-end node: It is at the other end of the network. It is also connected to the client NMS, but provides only limited network information, used to locate a failing node/link, when the network is down.

Node types and configurations

Single-hop configuration

The single-hop configuration consists of two ULL-3000 nodes. One Head node and one Back End node. One node is a blue node and one node is a red node. See *Figure 3-3*.

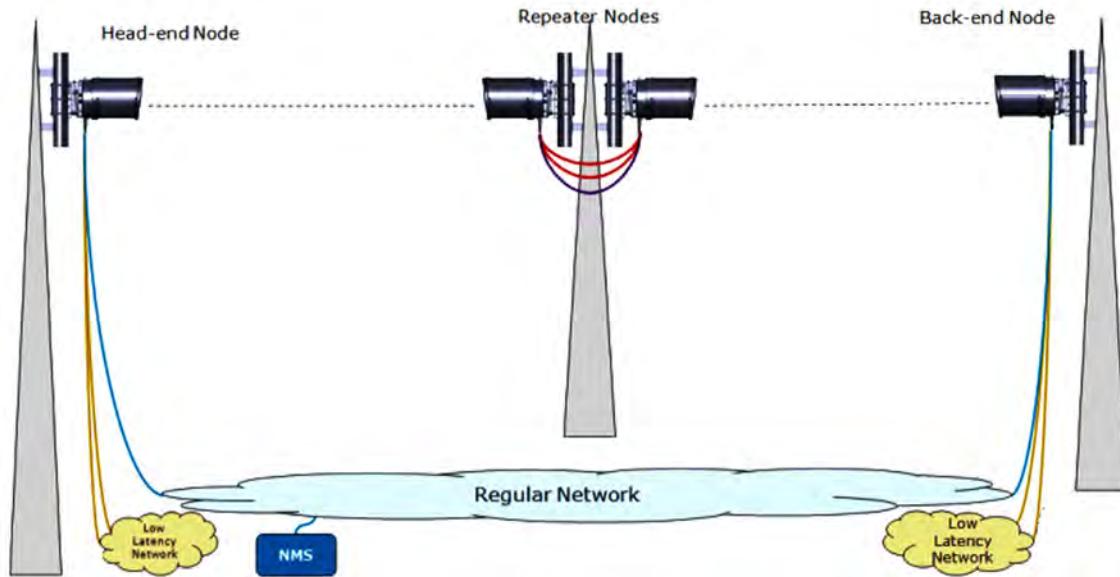
Figure 3-3 Single hop link



Multi-hop configuration

A Multi-hop configuration consists of two or more ULL-3000 links connected to each other, back-to-back. This configuration constitutes a network. See *Figure 3-4*.

Figure 3-4 Multi-hop network



Red node

The Red terminal is one of the constituent components of an ULL-3000 data link and transmits the long wavelength (around 1563nm), and receives the short wavelength (around 1535 nm) for FSO, and transmits the 73GHz and receives the 83GHz for the E-Band.

Blue Node

The Blue terminal is the second constituent component in the ULL-3000 data link and transmits the short wavelength (around 1535nm), and receives the long wavelength (around 1563nm) for FSO, and transmits the 83GHz and receives the 73GHz for E-Band.

Head Node

The Head Node is the master node for the Network management. It is the only entry point of the network for the network management. It is connected to the client NMS server.

Back-end node

The Back end node is at the other end of the network. It is also connected to the client NMS, but provides only limited network information, used to locate a failing node/link, when the network is down.

End node

The end nodes interface with the client network through 1Gbps Ethernet connections. There are two types of end nodes; Head nodes and Back End nodes.

Repeater node

The repeater nodes are directly connected to each other using AOptix proprietary format and protocol and enable connection between links in the network.

System specifications

Performance parameter	Optical	Millimeter wave
Wavelength/Frequency Band	1550nm +/- 20nm	71-76 GHz and 81-86 GHz
Channel Tunability (Software Configurable)	N/A	250 MHz Increments
Data Rate	2 Gbps Committed Information Rate (CIR)	
Ethernet Frame Length (802.3)	64 to 1600 Bytes, Jumbo frame up to 9600	
Modulation Format	OOK	QPSK
Transmit Power (Max.)	500 mW (27 dBm)	100 mW (20 dBm)
Receiver Sensitivity (10^{-9} BER)	-33 dBm Typ.	-64 dBm Typ.
Latency	200ns Max. Per Node	
Packet Jitter	25 ns Max.	

Network management (NMS)	Description
Alarm Management	SNMP Traps, Enterprise MIBs
NMS Compatibility	Any SNMP Based Network Manager
EMS	Web Based Management System, HTTP

Physical interface	Description
2 - Physical Interface Ports (Payload) 1 - Out-of-Band Management Port	Options: SFP, 1000 BaseSX - MM Fiber LC Connector SFP, 1000 BaseLX - SM Fiber LC Connector
Interface Connectors	Radial Model: R2CT Receptacle
Power	-48 VDC, Supports Redundant Power Feeds
Power consumption	80 W (Typical)

Physical interface	Description
Dimensions	91 cm (36") x 43 cm (17") x 74 cm (29")
Weight	73 Kg. (160 lbs.)

Environmental parameter	Specifications
Operating Temperature	-40°C to +55°C (-40°F to 131°F) per EN 300 019 Class 4.1
Storage Temperature	-40°C to +85°C
Altitude	3700 m (12,000 ft.) Max.
Wind Speed (Operational)	96 km/h (50 mph) Max.
Wind Speed (Survival)	200 km/h (125 mph) Max.
Tower Twist and Sway	± 3 Degrees Max.
Enclosure Rating	IP65

Regulatory compliance	Specifications
Regulatory Safety	UL Listed, CE Mark, IEC 60950-1 and -22 (outdoor)
Laser Safety	Class 1 Laser - IEC 60825-1 Ed. 2 (2007) (Eye Safe)
EMC/EMI	FCC 47CFR Part 15, EN 301 489
Certifications	FCC Part 101, EN 302 217
Environmental	Telcordia NEBS-3, GR-3108, ETSI EN 300 019
Industry Compliance	RoHS 6 Lead Free

Prerequisites

This **Prerequisites** chapter provides information regarding operations and tasks requiring completion before beginning the installation process and consists of the following sections:

- *Permits*
- *Site Survey*

Permits

This information to be provided.

Site Survey

Planning

When installing an FSO link, proper planning is essential. The following issues should be addressed for installation planning:

- Laser and RF path planning
- Site preparation, including power and LAN connections
- Installation issues for outdoor units including modem and Radio
- Governing body licensing issues (FCC, etc)
- Check local, regional, and national building and electrical codes
- Lightning, ground and surge protection
- Proper cabling
- Same frequency radio system interference

The following site considerations should be examined:

- Install the system as high as possible to maximize the link connection range
- Establish a clear line-of-sight between FSO terminals. Obstructions reduce performance or limit ability to transmit or receive data. Reduced signal strength could affect performance
- Maintain maximum path clearance at both link ends

Examine all potential objects performance restrictions, such as:

- Roof mounted objects
- Conductive metal surface
- Roof edges

- Buildings
- Trees
- Equipment

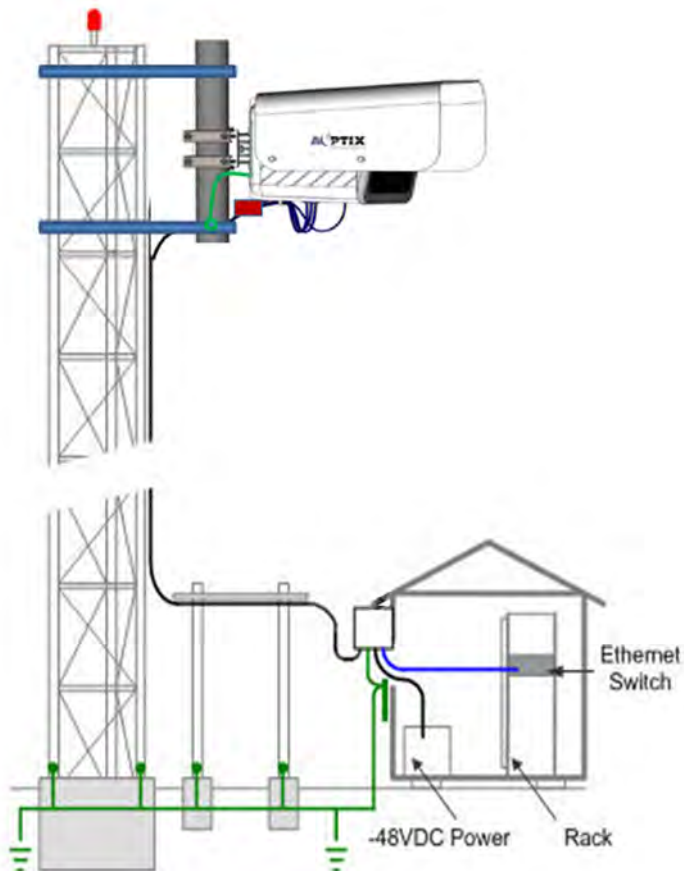
Typical Installations

This **Typical Installations** chapter provides a description of typical ULL-3000 installations and contains the following sections:

- *Tower installation*
- *Accessories*

Tower installation

Figure 5-1 ULL-3000 and Facilities Hut



Accessories

Table 5-1 Accessories

Part number	Item
CF4001	Connector Plug Housing, SFP Customer Interface
CF4002	SFP Transceiver Module - Single-Mode SR
TBD	SFP Transceiver Module - Single-Mode MR
TBD	SFP Transceiver Module - Single-Mode ...
TBD	SFP Transceiver Module - Single-Mode...
TBD	SFP Transceiver Module - Single-Mode ...
CF4003	SFP Transceiver Module - Multi-Mode
TBD	SFP Transceiver Module - Multi-Mode
CF4004	Mounting Kit, 4.5 inch Diameter Vertical Pole
CF4006	Lighting Protection Module
CF4007	Power Cord Set
TBD	Ethernet Connector cap
TBD	Power connector cap

Installation Procedure

This **Installation Procedure** document provides information regarding the ULL-3000 installation process and contains the following sections:

- *Overview*
- *Installation prerequisites*
- *Link Installation*
 - *Mounting*
 - *Cable connections*
 - *Power connections*
 - *Data connections*
 - *Coarse alignment*
 - *Fine alignment*
 - *Link verification*
- *Multi-hop network configuration*
- *Time and Date Setting*

Overview

The purpose of this document is to provide the installation procedure for the ULL-3000. The installation of a ULL-3000 based link is typically performed by two crews (one at each node). However, the system enables installation by only one crew going back and forth between the two nodes.

- The installation software is laptop-based and used by the installer on the ground who relays instructions to the installer on the tower via phone or walkie-talkie.
- The laptop is connected to the ULL-3000 out-of-band management port typically, on the ground-based Ethernet switch.

Installation prerequisites

Pre-installation Checklist

1. Verify radio license has been obtained.
2. Ensure clear Line-of-Sight exists between endpoints.
3. Mounting location and height has been determined. Ensure no near-field interference.
4. Mounting type has been determined and ordered.
5. Ensure sufficient room is available on the mast for mounting the ULL-3000 IntelliMax™.

6. Ensure GPS co-ordinates and bearing have been recorded for each endpoint.
7. Record distance between endpoints.
8. Ensure a grounding point is available for the mast (lightning ground) or install a new ground point.
9. Ensure grounding point is available at building entry point. (ground bar, ground plane) or install a new ground point.
10. Ensure lightning and surge arrestor unit is available.
11. Verify total length of Ethernet and power cable runs.
12. Verify the network equipment connects to the ULL-3000 IntelliMax™.
13. Verify a network equipment port is available, programmed, and enabled.
14. Ensure building/tower rights and permits, and building access details are obtained.

Components Provided by Aoptix

1. A ULL-3000 system.
2. Packaging to protect the ULL-3000 during hoisting.
3. ULL-3000 mounting bracket and accessories.
4. Lightning protection boxes. One or two depending upon if redundant power is supplied to the ULL-3000.
5. Power pigtail (Lightning box to ULL-3000). One or two depending upon the implementation of redundant power supplies to the ULL-3000.
6. Sighting apparatus.
7. Three 1-GbE Optical SFP Modules. These are installed (insert into the SFP cages of the ULL-3000) during the system configuration. One SFP for the data management port and the other two for the data ports.

Components Provided by the customer

1. A 4½" mounting pole.
2. Pole mounting accessories to mount the pole on the tower.
3. -48V Power supply with 5 Amp fuse/breaker.
4. Power Cable. One or two depending upon if there is a redundant power supply for the ULL-3000.
5. Two data cables (2 fibers per cable) (Single Mode or Multi Mode with duplex LC/PC connectors).
6. A laptop.

Note: Aoptix recommends the following vendors to supply hardware for tower mounting components:

- Valmont

-
- Sabres
 - Tally
 - SitePro1
-

Link Installation

The installation is performed in three major steps:

- ULL-3000 mounting and cabling
- Coarse alignment (± 3 deg), visual only, with the system off
- Fine alignment ($< \pm 0.5$ deg), with system feed-back through the installer laptop GUI.

Perform the installation under good visibility (No Rain and no Fog), and moderate wind conditions.

Mounting

Note: The ULL-3000 system can compensate for tower twist and sway of ± 3 deg (at very low frequency), and ± 0.75 deg. up to 3Hz. The ± 3 deg. range is relative to the tower position when the system was installed, assuming the system nominal position is within ± 0.5 degree of the tower nominal position. During the installation, if the tower is not in its nominal/average position (due to sun loading, or ice/snow build up for example), this reduces the ULL-3000 range of tower twist and sway compensation.

1. Mount the 4 1/2" pole to the Tower. See *Figure 6-1*.

The mounting is typically performed using catalog parts from the tower manufacturer's recommended vendor.

Figure 6-1

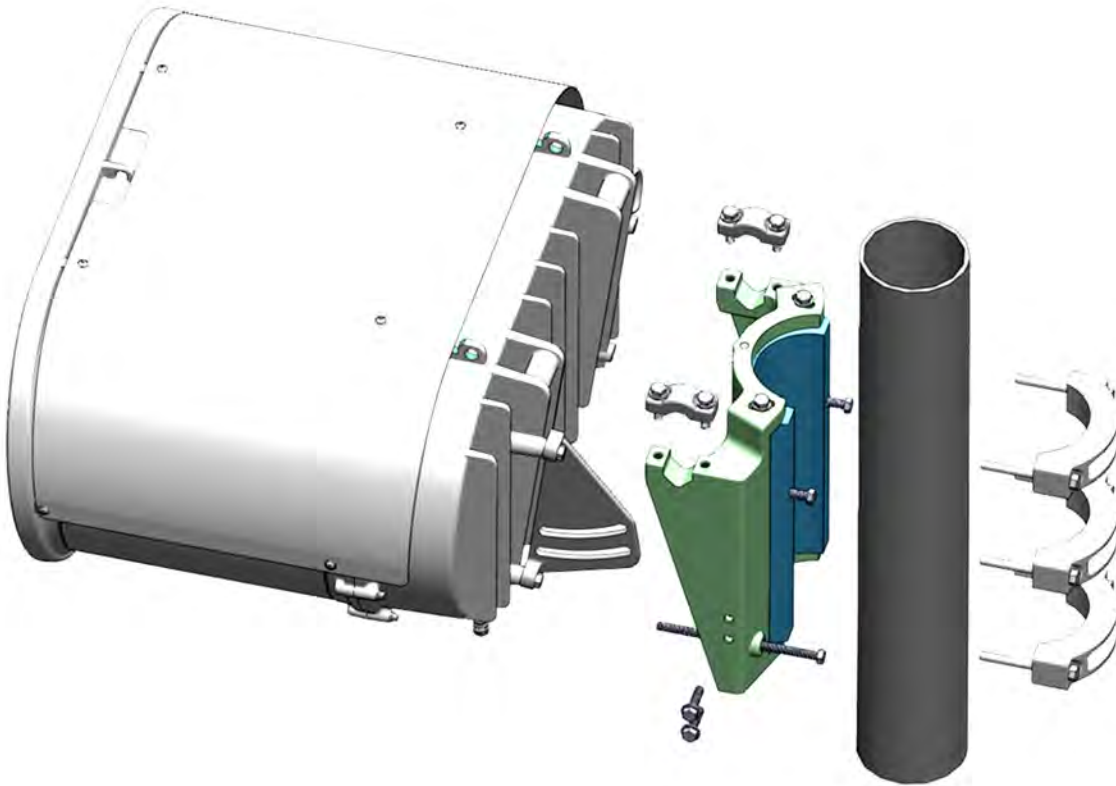


2. Hoist the mounting bracket up to the mounting location.
3. Secure the mounting bracket to the tower.

Note: The bracket should point generally in the target direction.

4. Hoist the ULL-3000 up to the tower mounting position.
5. Secure the ULL-3000 on the bracket. See *(Figure 6-2)*

Figure 6-2 Mounting Bracket (exploded diagram)



6. Remove the ULL-3000 packaging protection.
7. Mount the Lightning Protection Box mounting plate to the ULL-3000 mount rear side.
8. Mount the Lightning Protection Boxes (LPBs) on the lightning protection box mounting plate. See *Figure 6-3* and *Figure 6-4*.

Figure 6-3 Lightning Protection Box mounted (two LPBs)

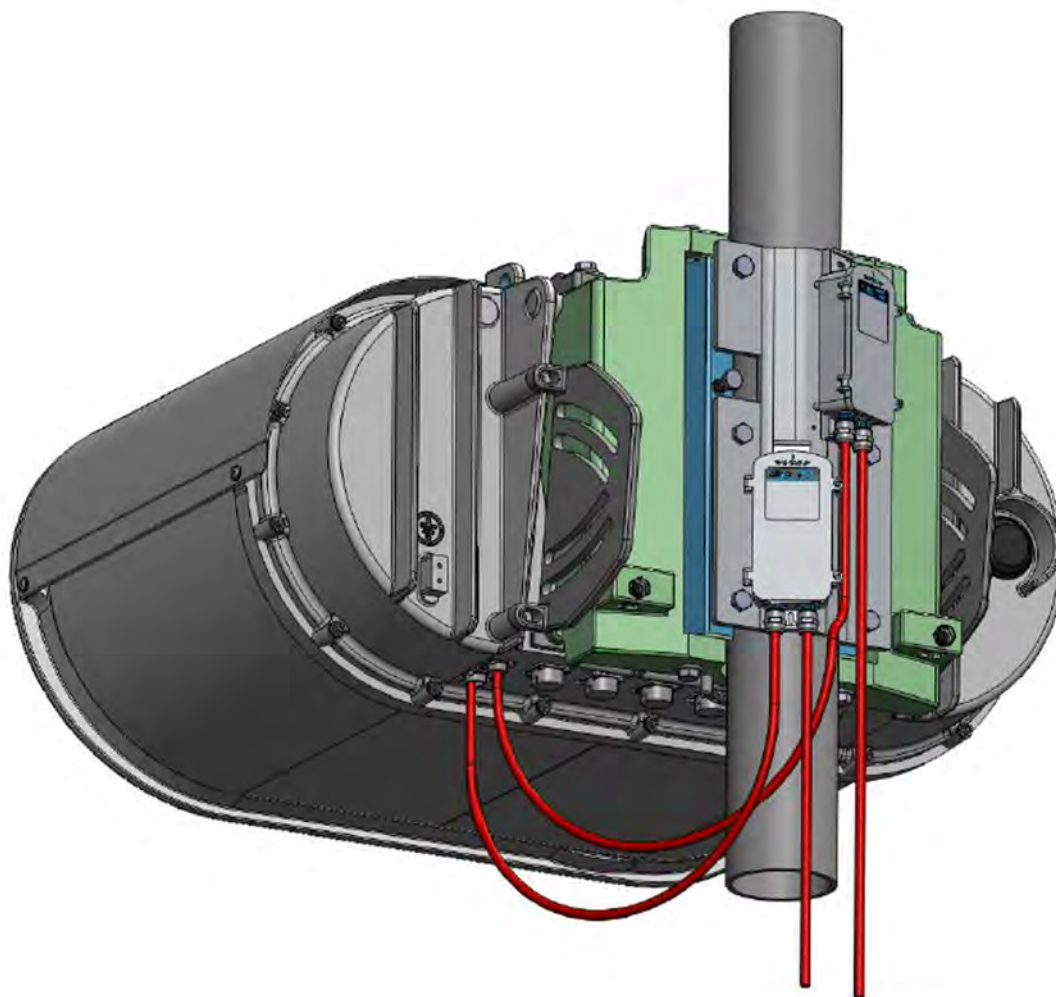
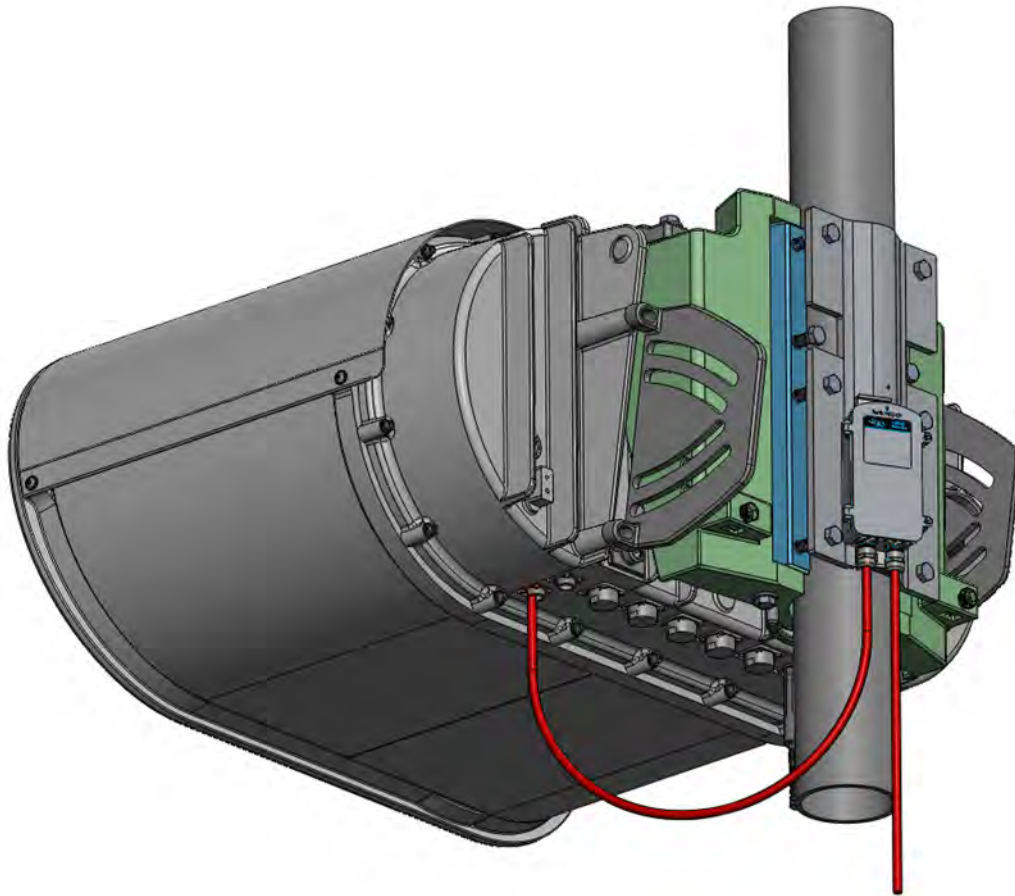


Figure 6-4 Lightning Protection Box mounted (one LPB)



Cable connections

The ULL-3000 has three types of connections:

- Grounding
 - ULL-3000 grounding
 - Lightning Protection Box grounding (one ground for each LPB)
- Power
- Data
 - End Nodes - two data cables and one management cable
 - Repeater Nodes - three data cables

The power and data cables used for the ULL-3000 should have their length determined and the cables and connectors prepared on the ground before routing the cables from the hut to the tower mounting position. Both types of cables have the same length. Ensure there is enough cable length to enable a drip loop at the ULL-3000 connection point.

Note: Ensure the ground connections between the Lightning Protection Box(es), the ULL-3000 and the tower are completed before connecting the ULL-3000 power and data cables.

Figure 6-5 Ground connection

To be provided

Power connections

Aoptix recommends the use of power cable with equivalent specifications to the shielded 48Vdc, 10A power cable **HW153 01202** sold by Houston Wire and Cable Company for power connections on the ULL-3000 system.

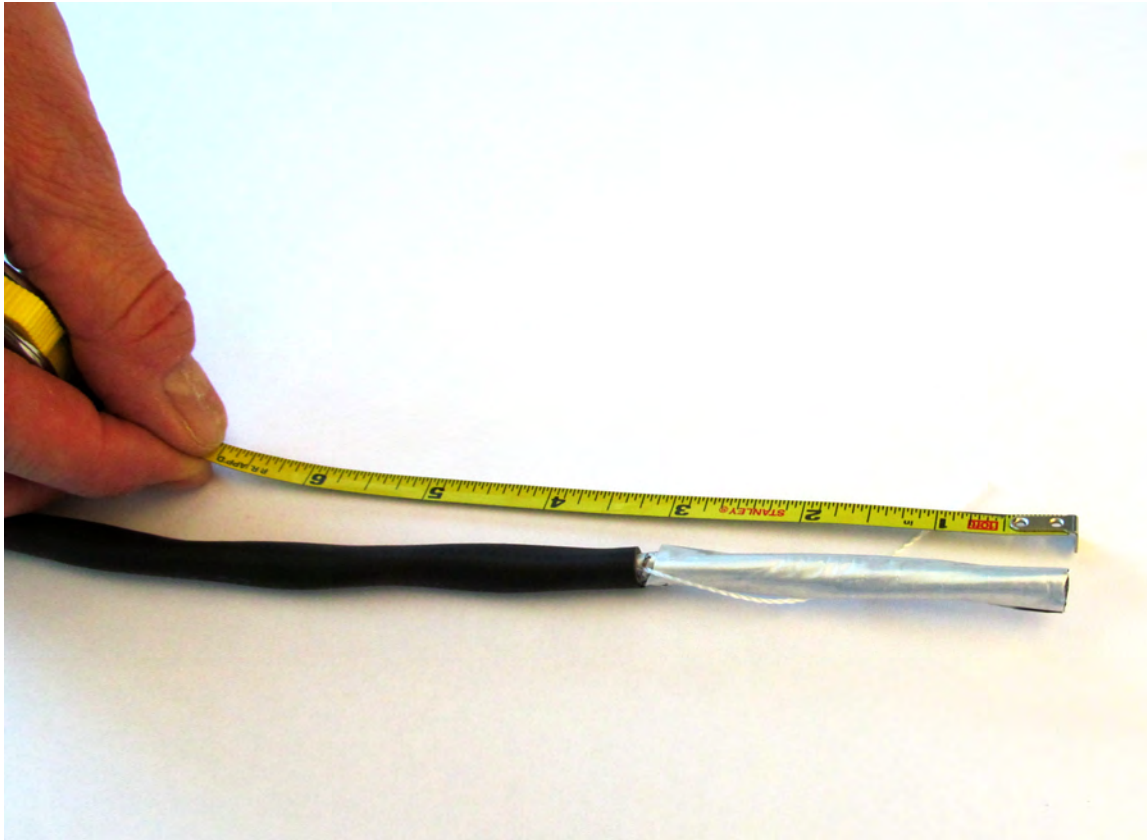
Note: The ULL-3000 requires only one LPB and power supply. Two LPBs and power supplies are used when a redundant power supply is installed. The LPB part number is: 10-1746-0001

Note: Repeat the Lightning Protection Box power cable connector preparation on the second Lightning Protection Box power cable connector, if your installation requires redundant power supplies.

1. Preparing the Lightning Protection Box power cable connector.

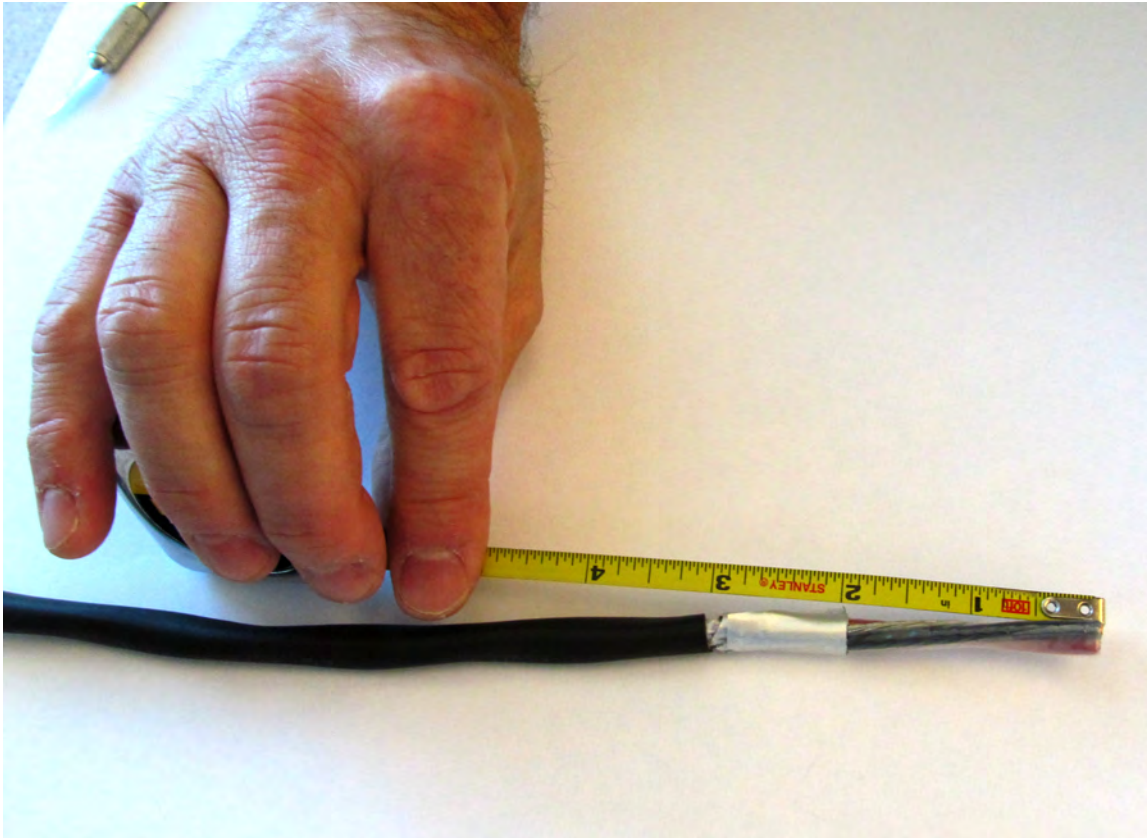
- a.** Remove three inches of outer insulation from the power cable. See *Figure 6-6*.

Figure 6-6 Removing outer insulation



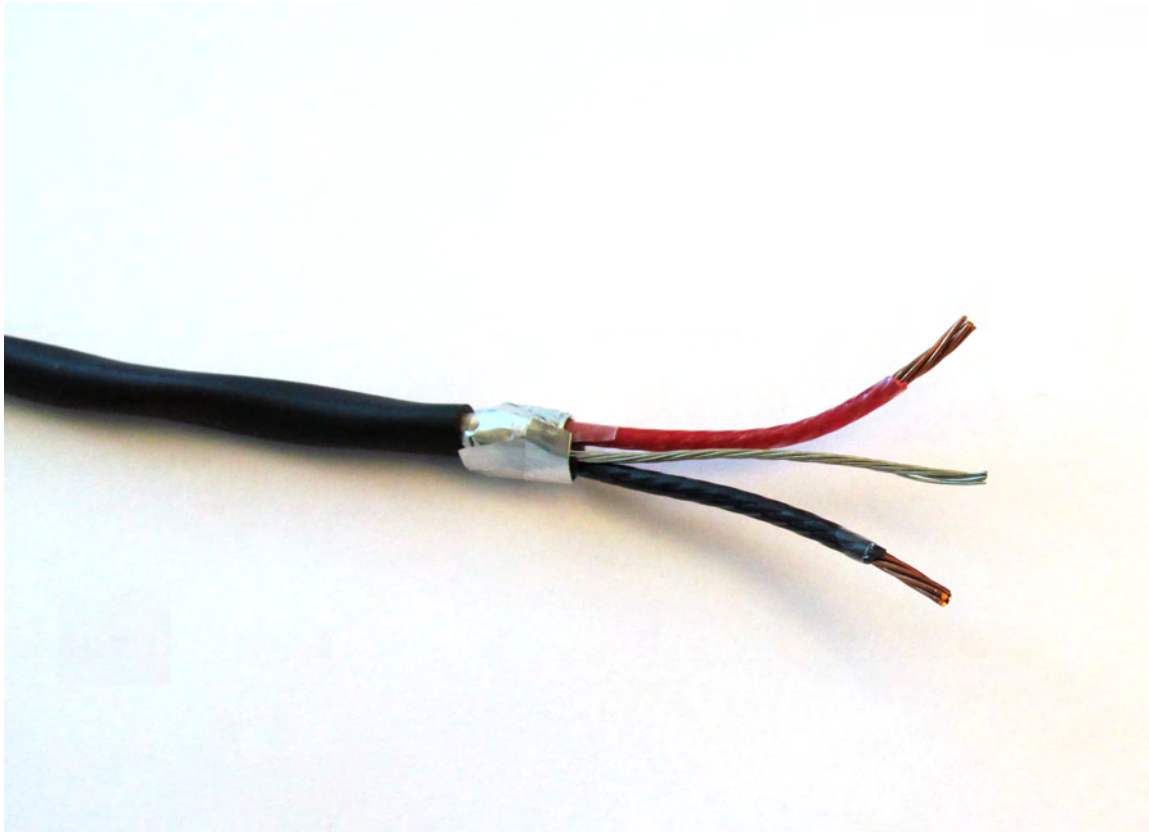
- b.** Remove two inches of drain foil from the cable end. See *Figure 6-7*.

Figure 6-7 Removing drain foil



- c. Strip 1/2 inch off the cable conductor wires. See *Figure 6-8*.
- d. Fold back the drain foil over the cable insulation end. See *Figure 6-8*.

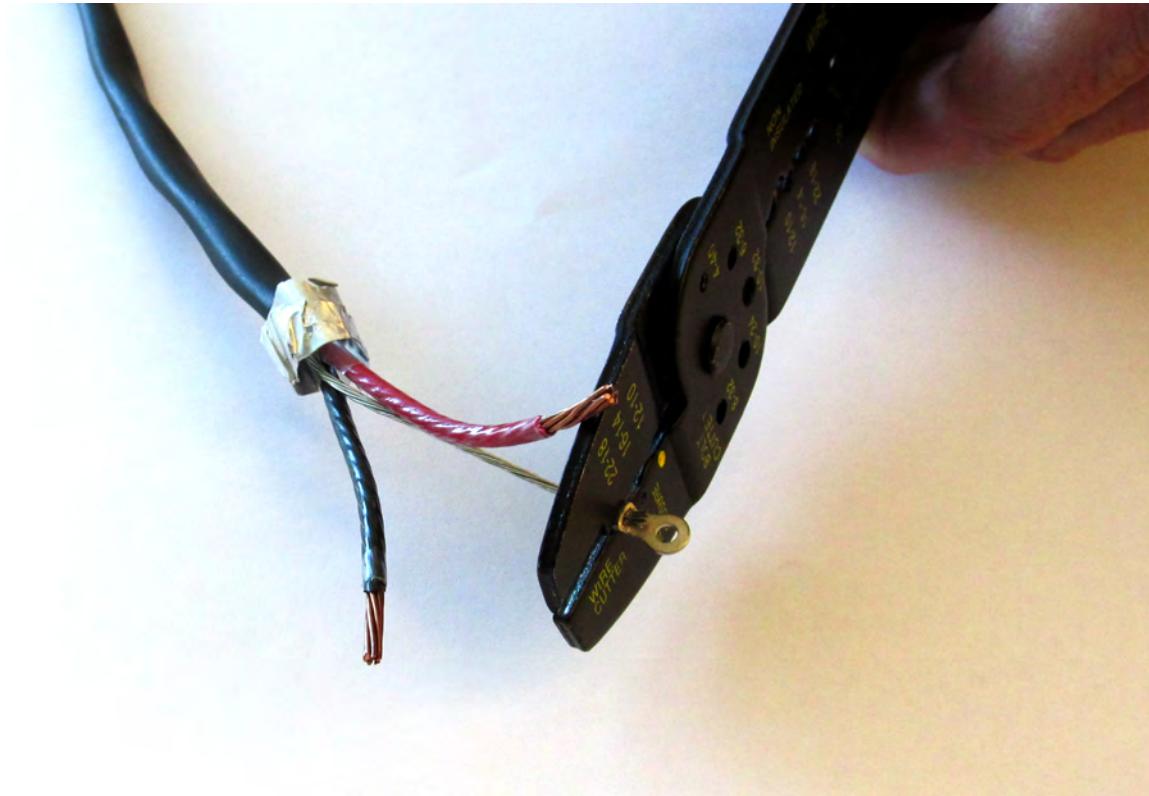
Figure 6-8 Stripping cable conductor wires



- e. Remove the grounding lug and screw from the Lightning Protection Box interior and crimp the lug on the power cable ground wire end. See *Figure 6-9*.

Note: Keep the screw and ground lug for later use.

Figure 6-9 Ground lug crimping



- f. Remove the LPB cable connector nut and ferule and place them over the cable conductors.
- g. Insert the cable end into the LPB connector, place the conductors in the compression lugs and tighten the screws to secure the cable conductors. See *Figure 6-10*.

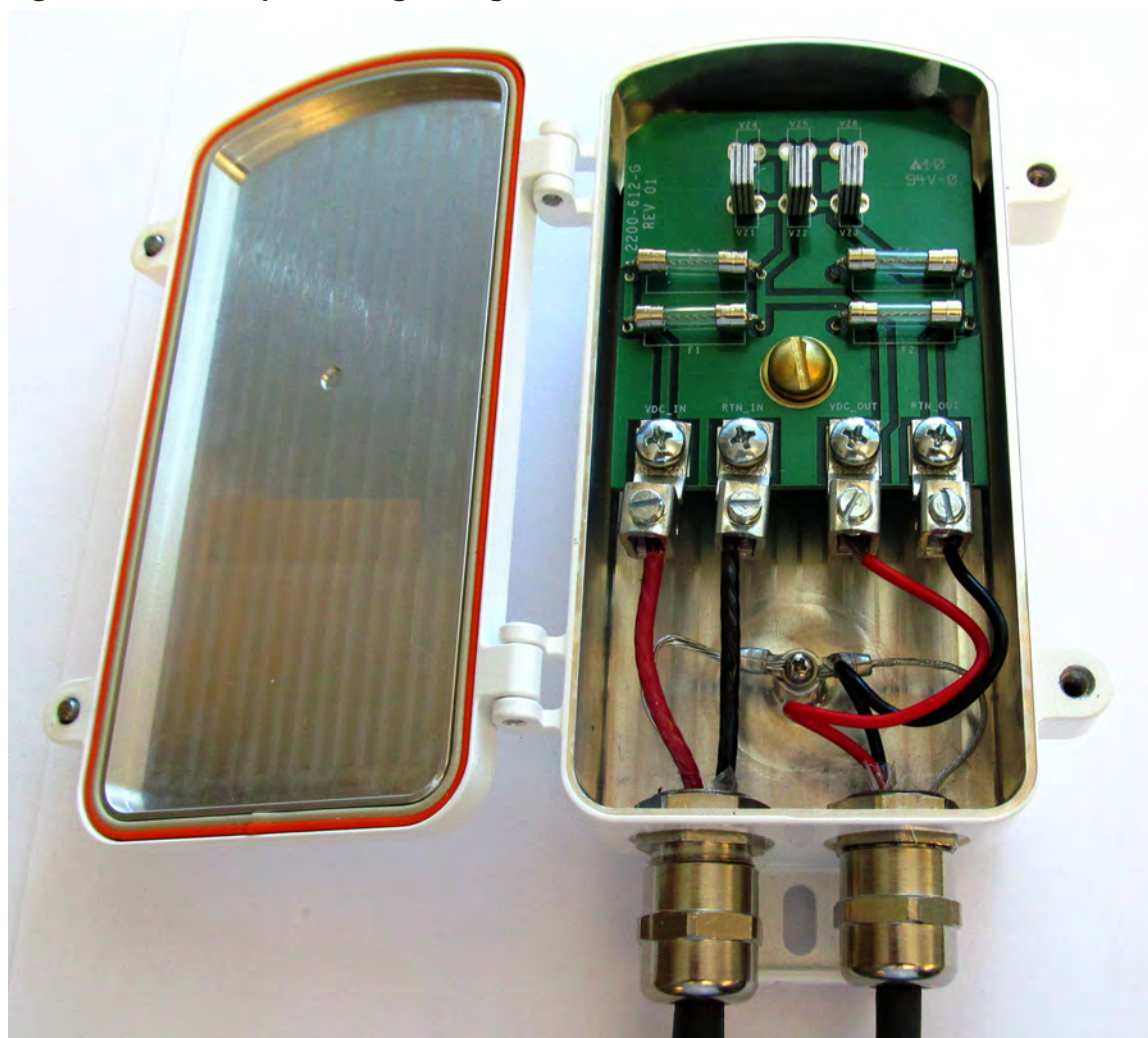
Figure 6-10 Inserting power cable into the LPB



Note: Ensure the drain foil is in contact with the power cable ferule for electrical connection.

- h.** Thread the power cable nut onto the LPB and tighten until the cable cannot easily be pulled out of the cable nut.
- i.** The power connection to the Lightning Protection Box is now complete.
- j.** Close the Lightning Protection Box cover and tighten the two captive cover screws.

Figure 6-11 Completed Lightning Protection Box connections



2. Connect the LPB power cable connector to the ULL-3000. If there are two LPBs, connect the second power cable connector to the ULL-3000.

Note: The LPB power cables can connect to either of the two ULL-3000 power connectors.

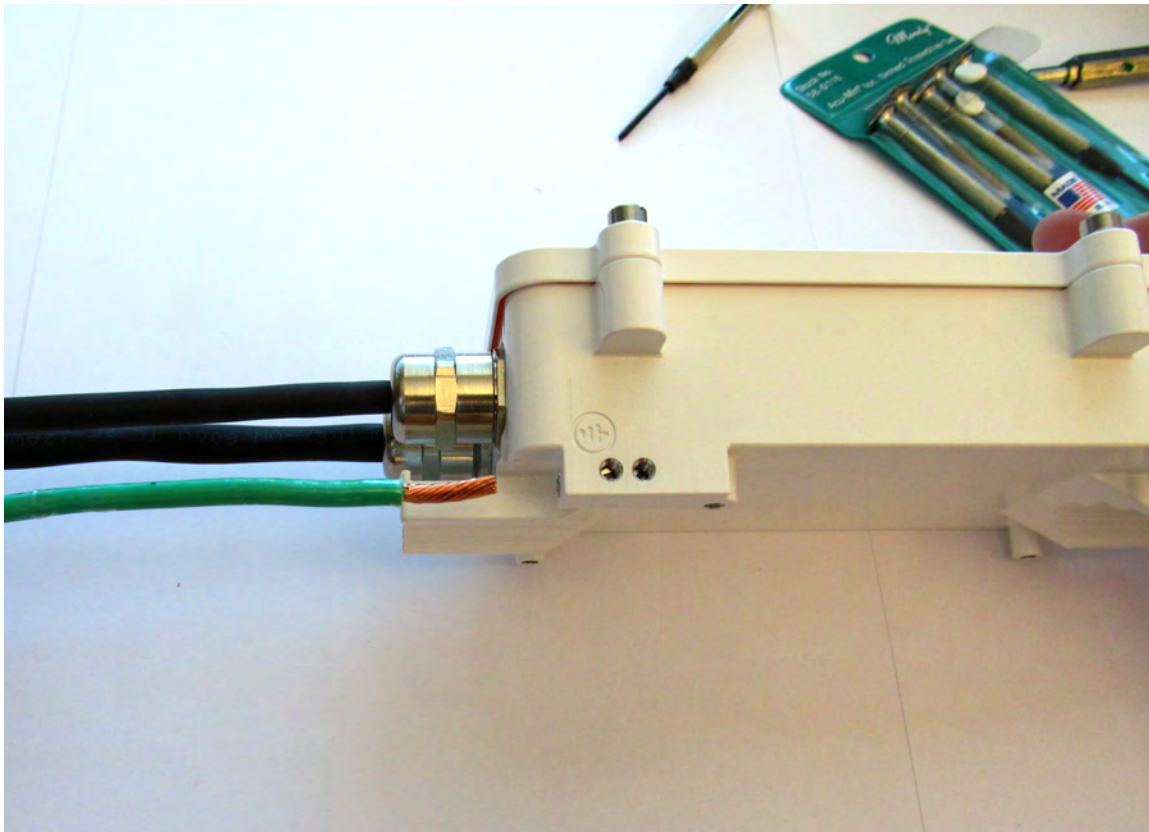
3. Strip 5/8 to 3/4 inch of insulation off a ground wire end. See *Figure 6-12*.

Note: The stripped ground wire end must be long enough for the second set screw to contact the stripped conductor.

4. Connect a chassis ground wire to the LPB ground connection. See *Figure 6-12*.
 5. Tighten the LPB ground connection using a jewelers screw driver.
-

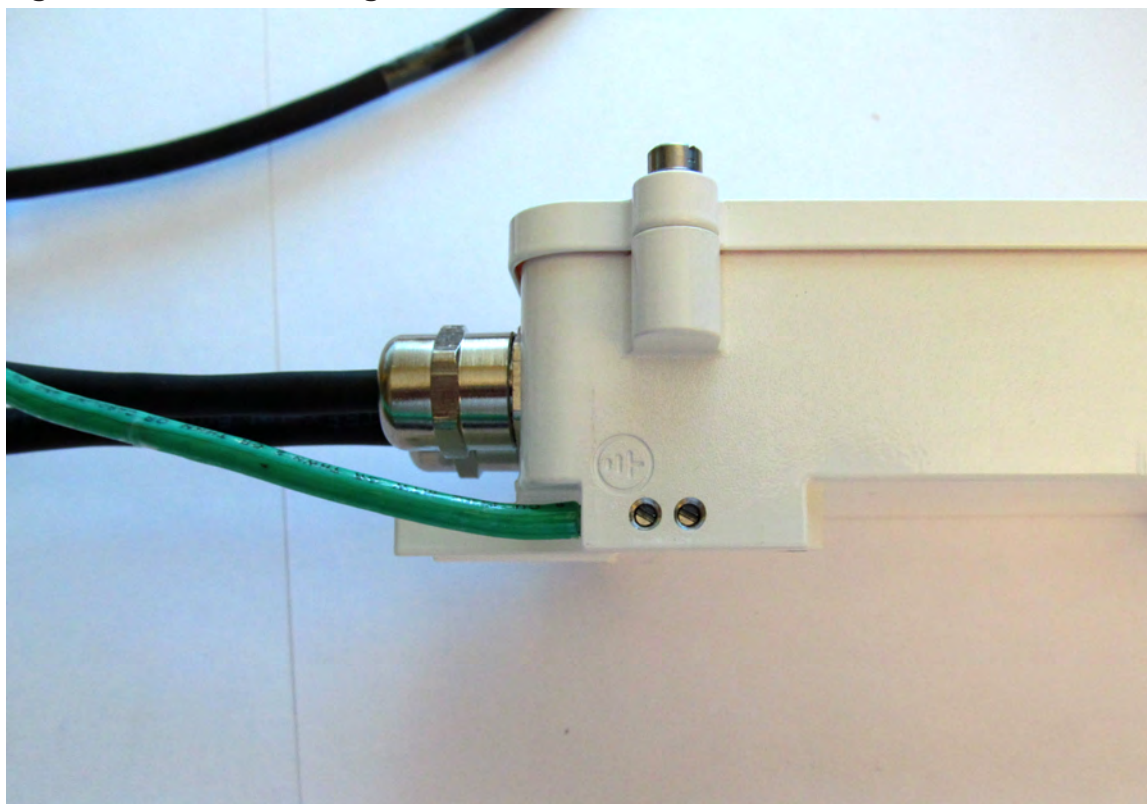
6. Mount the LPB to the pole mounting plate

Figure 6-12 Lightning Protection Box ground connection



7. The ground wire is now connected. See *Figure 6-13*.

Figure 6-13 Connected ground wire



8. Mount the LPB to the pole mounting plate using two screws through the LPB top and bottom mounting flanges.

Note: There are alternative methods of attaching the LPBs. The LPB can be secured to the mounting pole using a hose clamp around the LPB top and bottom mounting flanges. The LPBs can also be attached using four 8-32 screws threaded into the LPB rear side.

9. Connect the ground wire opposite end to an appropriate tower ground connection point.

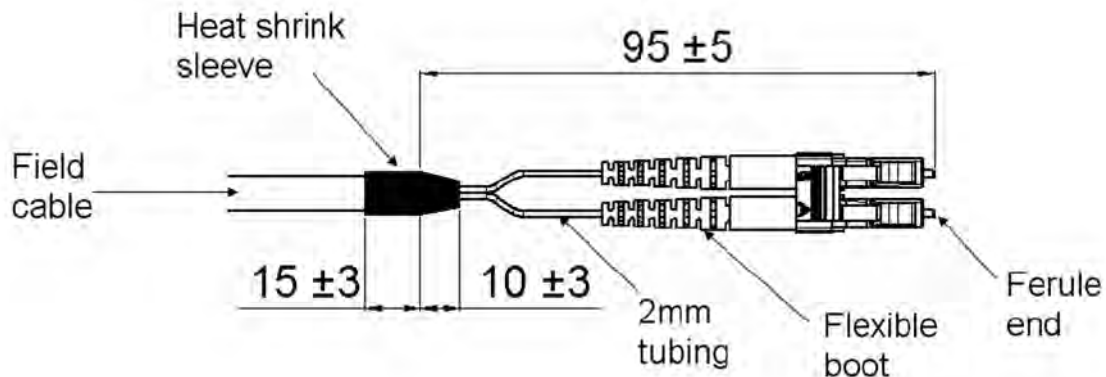
Data connections

The ULL-3000 data connections utilize a Radiall (PN: R2CT 115 000) plug assembly to securely connect to the ULL-3000 and provide an IP65 enclosure rating. You should assemble the Radiall plug assembly before pulling the cable up the tower.

Note: The two optical Ethernet data cables must have a protective jacket over them. The ULL-3000 end of the cable must have shrink wrap placed over the protective jacket and the two Ethernet fiber optic data cables before assembling the Radiall plug assembly.

The specification for constructing the data cable to integrate with the Radiall R2CT plug assembly are provided below. See *Figure 6-14*.

Figure 6-14 Radiall Plug Assembly dimensions



Note: The field cable (including a cable jacket) should have a diameter between 5.0mm and 7mm. The connectors used for the fiber are Duplex LC.

1. If present, turn and remove the conical protective cap from the Radiall connector plug body. See *Figure 6-15*.

Figure 6-15 Conical protective cap



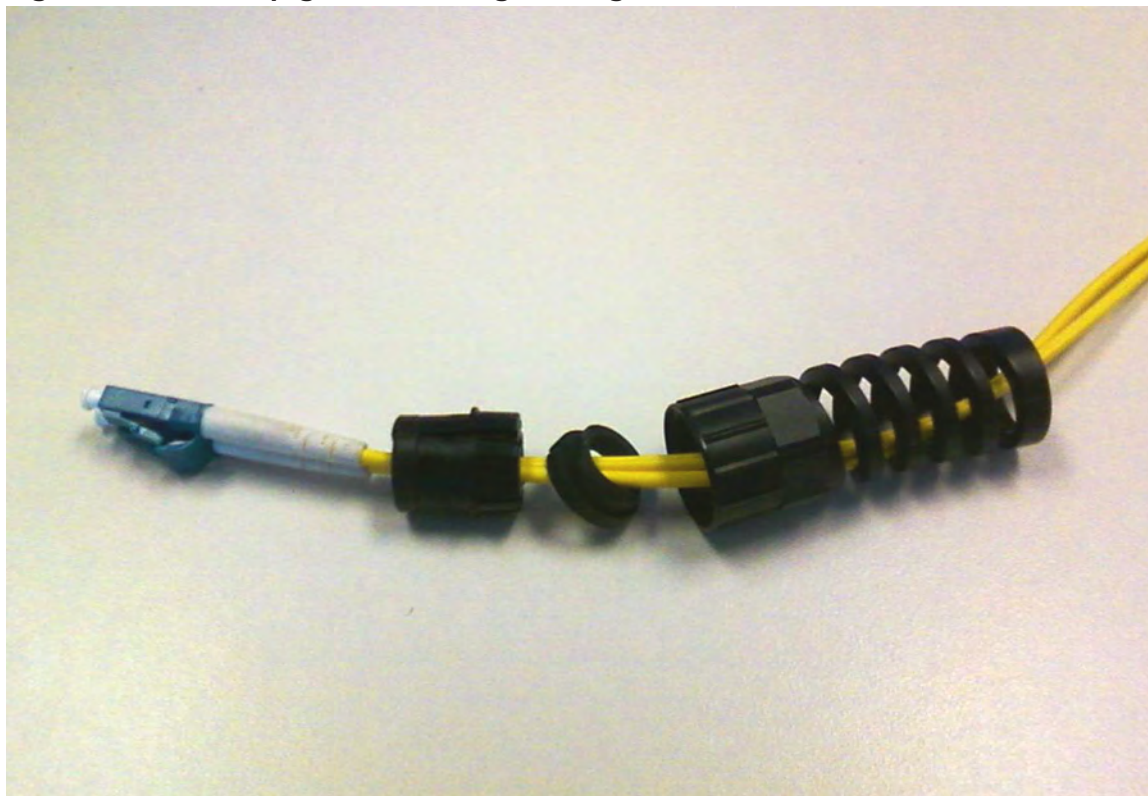
2. Insert the LC data cable connectors through the nut spiral. See *Figure 6-16*.

Figure 6-16 Nut spiral



3. Place the split tightening cone over the fiber optic cables with the narrower end towards the nut spiral. See *Figure 6-17*.

Figure 6-17 Clamp gasket and tightening cone



4. Place the clamp split gasket over the fiber optic cables.
5. Place the elastic shell over the clamp split gasket.
6. Insert the fiber optic cables LC connectors into the plug body and insert the tightening cone into the nut spiral.
7. Insert the clamp split gasket and elastic shell assembly into the plug body. See *Figure 6-18*.

Figure 6-18 Inserting assemblies into the plug body



8. Thread the nut spiral onto the plug body.
9. The Plug body is now ready to be connected to the ULL-3000 data port SFP.
10. Place the conical protective cap onto the plug body end and rotate it until hand tight.

Note: The cone is placed on the plug end to provide protection during the tower cable routing process. You remove the cone once the cable has been routed to the ULL-3000 tower mount location.

11. Complete the cable routing and securing process from the ground to the ULL-3000 tower position.
12. Unscrew (CCW) the metal cap on the data port of the ULL-3000.
13. Remove the conical protective cap from the Radiall connector plug body.
14. Remove the fiber optic cable LC protection caps.
15. Align and insert the LC connectors into the ULL-3000 SFP until you hear them click into place. See *Figure 6-19*.

Figure 6-19 Inserting LC connectors



16. Insert the plug body into the receptacle and rotate it clockwise (CW) until it clicks.

Figure 6-20 Inserting plug body



17. Push and rotate the Radiall connector plug body clockwise (CW) until it clicks and is secured onto the ULL-3000 connector receptacle. See *Figure 6-21*.

Figure 6-21 Inserting and rotating the plug body

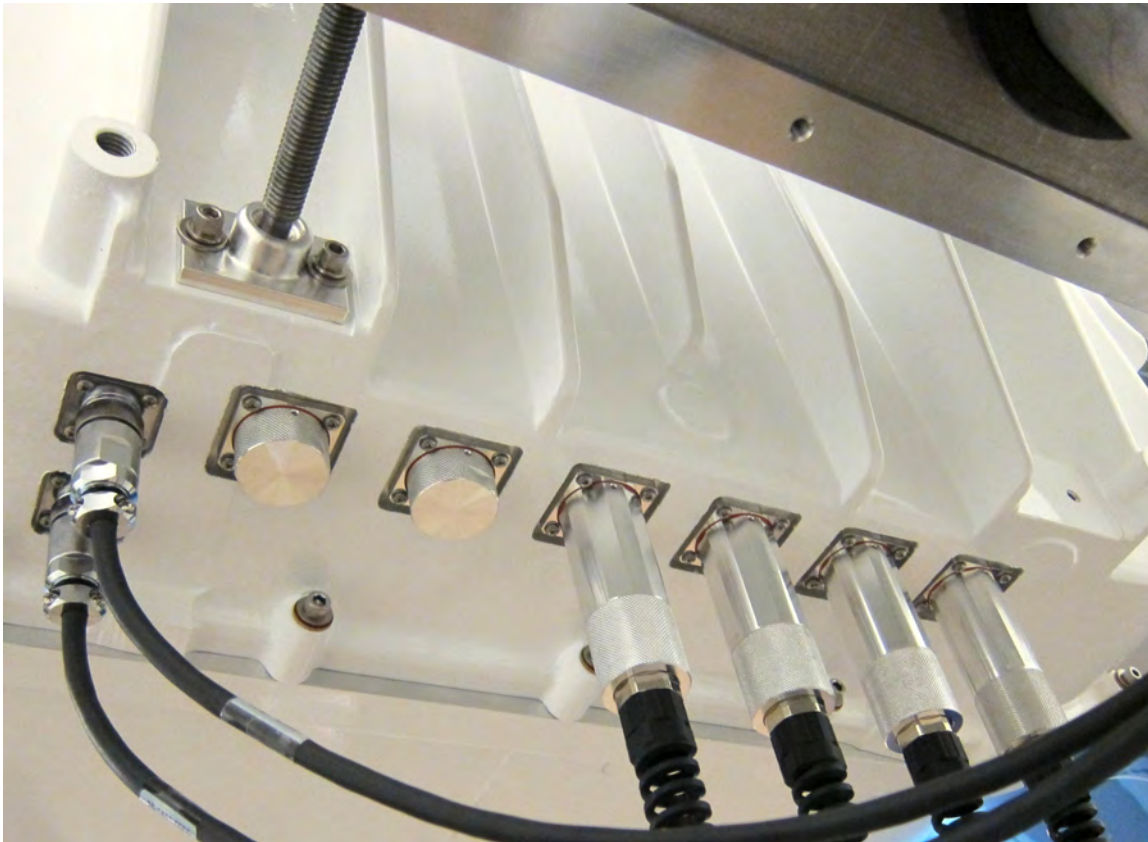


18. Rotate the nut end of the nut spiral (CW) to achieve 3.5Nm of tightening torque.

Note: Tightening the Nut Spiral on the plug body compresses the split nut over the cable jacket and creates the seal providing the IP65 protection.

19. The completed connection of the ULL-3000 data port is shown in *Figure 6-22*.

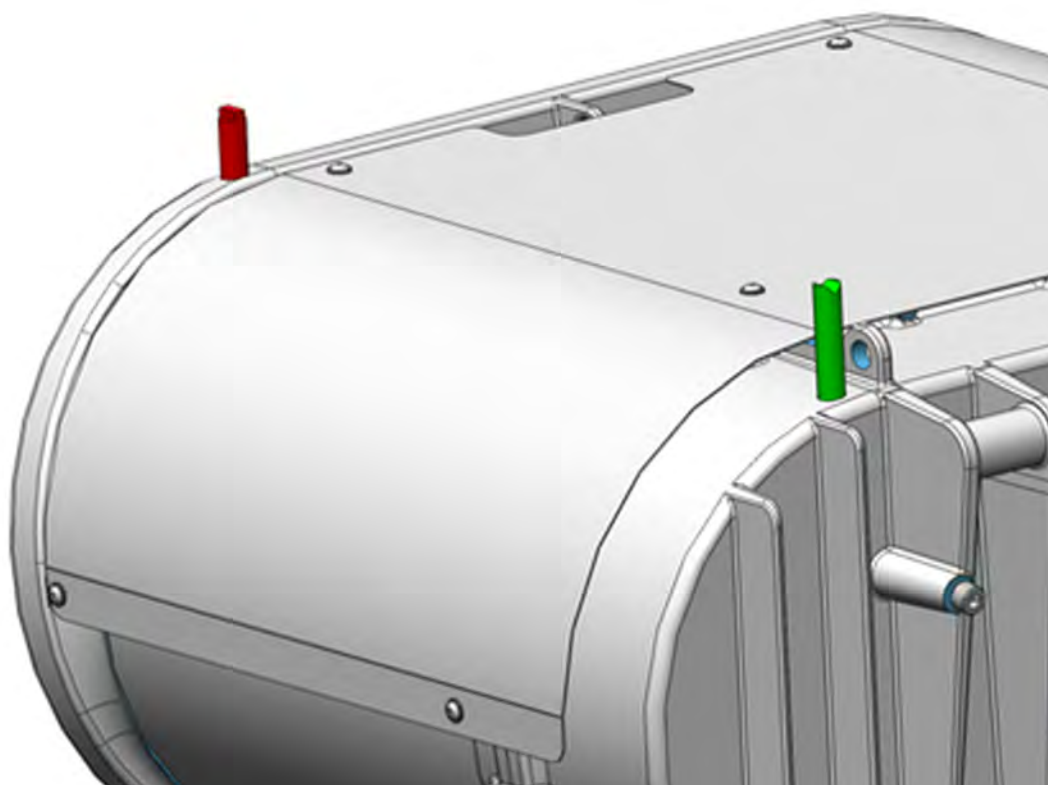
Figure 6-22 ULL-3000 data ports



Coarse alignment

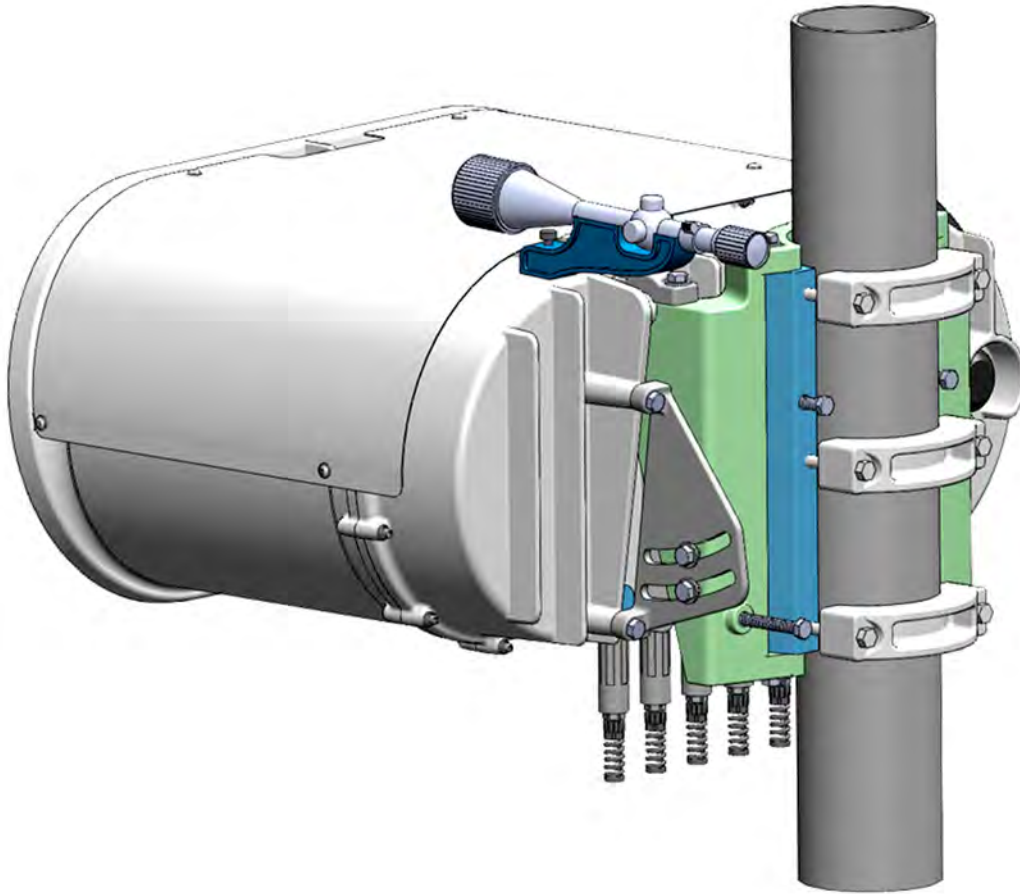
1. Insert the sighting apparatus on the ULL-3000 enclosure side as shown in *Figure 6-23* or the optional spotting scope as shown in *Figure 6-24*.

Figure 6-23 Sighting Apparatus



Note: A spotting Scope is optional. See *Figure 6-24*.

Figure 6-24 Spotting Scope



2. Adjust the ULL-3000 by manually adjusting alignment screws. Do not lock the alignment screws yet.

Using only the indication provided by the sighting apparatus or spotting scope and possibly an aid from a signaling mirror from the opposite end, perform the coarse alignment.

Note: Required coarse alignment accuracy is ± 3 deg, which is very easily achieved.

Fine alignment

After the initial coarse alignment with the sighting apparatus or the spotting scope the $\pm 3^\circ$ pointing accuracy is sufficient to ensure the nodes can acquire each other.

On both ends of the link, the RF and Laser components move towards the peak of their signal center lobe. As they move, the installation software provides the installers a GUI display on the laptop, using a bubble moving over cross hairs to indicate directional position needed to adjust the node alignment screws. See *Figure 6-25*.

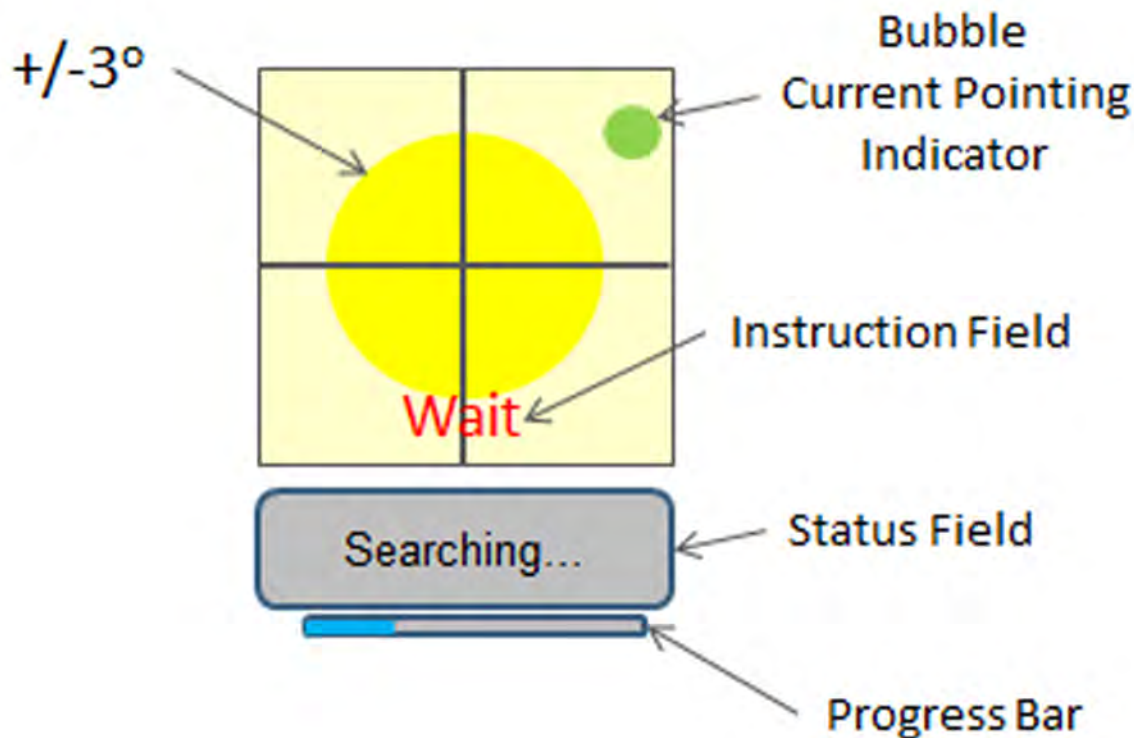
Fine alignment is the process of aligning the transmitting node end with the receiving node end using automated Pointing, Acquisition and Tracking (PAT) functionality and an installation application. The purpose of the installation application is to assist the operator in performing the fine alignment by providing visual feed-back via the GUI. The installer is using a two axis adjustment to perform the fine alignment.

The installation application resides in the ULL-3000, and the GUI application is automatically loaded into the GUI device when it is connected to the ULL-3000. The interface between these devices and the ULL-3000 is an Ethernet cable, plugged into the management port. *Figure 6-25* shows the system GUI, as displayed on the laptop.

The installation routine guides the installer to align the system with the required accuracy of $\pm 0.5^\circ$

Note: Every time the system is powered on, a Power On Self Test (POST) is automatically run and the result (Pass/Fail) is displayed on the installation GUI. Power ON the system before hoisting it up to the tower installation point, to verify the system is properly functioning after shipping. The POST operation may be manually executed at any time to verify system functionality.

Figure 6-25 System GUI



There are two scenarios for performing the fine alignment procedure:

- *Two installation teams* – two installation teams, each team installing one link end
- *Single installation team* – one team installing both link ends

Two installation teams

In the two team installation there is no need to travel back and forth between the nodes. In the two team installation the both nodes are mounted, coarse aligned, powered up and begin searching for the other node at about the same time. With two teams the fine alignment procedure can immediately begin with personnel at each end to lock the ULL-3000 position adjustment screws, without traveling between the nodes.

1. Connect a Laptop to the ULL-3000 Ethernet management port SFP at both link ends.
2. Turn the system Power ON at each link end. (on the ground)
3. The alignment GUI application is loaded into the device connected to the ULL-3000s.
4. The operator at each link end selects **Connect**.
5. The operator at each link end selects **Align** and the alignment sequence starts.
6. The systems begin searching for the opposite link end node and displays **Searching** in the status field, and **Wait** in the instruction field.

Note: The alignment sequence is controlled by the system software and the fine alignment adjustments are only performed on one node at a time. The software displays a **Wait** message on the node waiting for the fine alignment procedure. When the first node is locked and confirmed the system software proceeds to prompt the installer to align the opposite link node.

7. The system begins searching for the opposite link end node and displays the **Wait** message.

Figure 6-26 Both nodes waiting



8. The system displays the **Acquired Pointing...** status message.

Figure 6-27 Both nodes acquired and pointing



9. The system locates the main signal lobe by moving the positioning assembly within the ULL-3000.

10. When the main signal lobe is located the system displays the **Tracking...** status message.

11. The GUI display shows the location of the signal beam on the alignment screen as a green dot.

Figure 6-28 Tracking



12. The **Align** message instructs the installer to adjust the ULL-3000 mounting alignment screws to move the green dot on the GUI until it is directly over the crosshair center shown on the GUI display. See *Figure 6-29*.

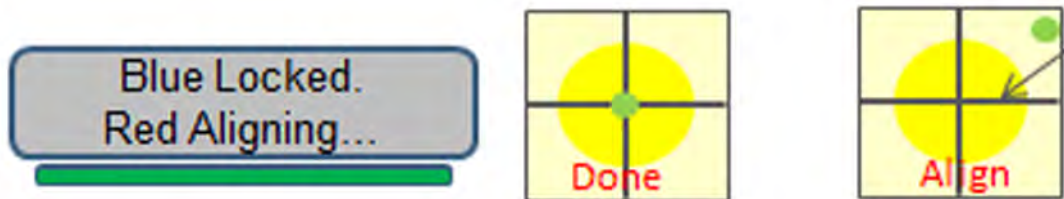
13. When the system displays the status message **Blue Aligned...**, the installer locks the ULL-3000 adjustment screws.

Figure 6-29 Blue node aligned



14. The system prompts the installer to confirm the lock.
15. The installer confirms the node adjustment lock status on the GUI.
16. The system displays the **Blue Locked Red Aligning** message. See Figure 6-30.

Figure 6-30 Blue locked red aligning



17. The team at the other node is prompted to begin the fine alignment procedure.
18. The installer adjusts the ULL-3000 mounting alignment screws to move the green dot on the GUI until it is directly over the center crosshairs shown on the GUI display.
19. When the system displays the status message **Red Aligned...**, the installer locks the ULL-3000 adjustment screws.

Figure 6-31 Installer locks the adjustment screws



20. The system displays the **Confirm Lock** on the GUI.
21. The installer confirms the node adjustment lock status on the GUI.
22. The system displays the **Blue Locked Red Locked** message. See Figure 6-32.

Figure 6-32 Blue Locked Red Locked



23. This completes the Fine Alignment procedure.

Single installation team

In the one team installation the team must travel back and forth between the nodes. In the single team installation the first node is locked after the coarse alignment, and is searching all the time it takes for the team to travel to the other end node, mount the other system, perform the coarse alignment and power on the system. Also, after the fine alignment has been performed on the second node, the team must go back to the first node, unlock it, and perform the fine alignment in order to complete the link alignment.

1. Connect a Laptop to the ULL-3000 Ethernet management port SFP on the link end.
2. Turn the system Power ON. (on the ground)
3. The alignment GUI application is loaded into the device connected to the ULL-3000.
4. The operator selects **Connect**.
5. The operator selects **Align** and the alignment sequence starts.
6. The system begins searching for the opposite link end node and displays the **Waiting for RSSI** message.
7. Travel to the opposite end of the link.
8. Connect a Laptop to the ULL-3000 Ethernet management port SFP on the link end.
9. Turn the system Power ON. (on the ground)
10. The alignment GUI application is loaded into the device connected to the ULL-3000.
11. The operator selects **Connect**.
12. The operator selects **Align** and the alignment sequence starts.

Note: The alignment sequence only performed on one node at a time. Complete the alignment sequence on one link end node before starting the alignment sequence on the link opposite End Node.

13. The system begins searching for the opposite link end node and displays the **Waiting for RSSI** message.
 14. The system displays the **Acquired Pointing...** status message.
 15. The system locates the main signal lobe by moving the positioning assembly within the ULL-3000.
-

16. When the main signal lobe is located the system displays the **Tracking...** status message.
17. The GUI display shows the signal beam location on the alignment screen as a green dot.
18. The installer adjusts the ULL-3000 mounting alignment screws to move the green dot on the GUI until it is directly over the center crosshairs shown on the GUI display.
19. When the system displays the status message **Blue Aligned...** or **Red Aligned...** (depending on which node you are aligning)
20. The installer locks the ULL-3000 adjustment screws.
21. The system displays the **Confirm Lock** on the GUI.
22. The installer confirms the node adjustment lock status on the GUI.
23. The team travels to the other node to begin the fine alignment procedure.
24. Repeat *Step 14.* through *Step 22.* for this link End Node.
25. This completes the Fine Alignment procedure.

Link verification

The link verification process is performed by the installer using their own network testing equipment, in order to measure the link performance characteristics, such as:

- Bit Error Rate
- Packet Error rate
- Throughput

Multi-hop network configuration

Multi-hop configuration is the process of setting the functional operation of each network node. The configuration process requires the link being configured to have completed the installation process which includes coarse and fine alignment.

Note: The configuration process can start after the fine alignment and link verification processes are completed.

The configuration process consists of the following tasks, which are performed on each link before moving on to the next link within the network:

- Configuration (setting node type, IP address, etc.)
- Connecting repeater cables (between repeater nodes)

Note: By default all nodes are shipped as End Nodes.

First hop configuration

1. Using the laptop configure the link Head end node and assign its IP address.
-

2. Using the laptop configure the link Repeater node and assign its IP address.
3. Verify the customer network management system can communicate with both the Head End and the Repeater nodes.
4. This completes the first link hop configuration.

Second hop configuration

1. Using the laptop configure the link Repeater node and assign its IP address.
2. Using the laptop configure the link Repeater/Back End node and assign its IP address.

Note: If the link only has two hops, the node in *Step 2.* of the Second hop configuration procedure is setup as a Back End node. If there are additional link hops, it is configured as a Repeater node. The last node in the link network is configured as a Back End node.

Network management verification

1. Verify the customer network management system can communicate with both the Back End and the Repeater nodes.
2. Disconnect the laptop from the repeater node.
3. Connect the two Repeater nodes using two fiber cables and one management port cable.
4. Verify the customer network management system can communicate with both the Head End and all the other multi-hop link nodes.
5. This completes the second link hop configuration.

Time and Date Setting

The time and date is set by the system installer on the Head Node. The Head node propagates the time and date to the other network nodes.

Troubleshooting and technical support

This **troubleshooting and technical support** document provides information on recovering from system failures and technical support contact information.

This **troubleshooting and technical support** document contains the following sections:

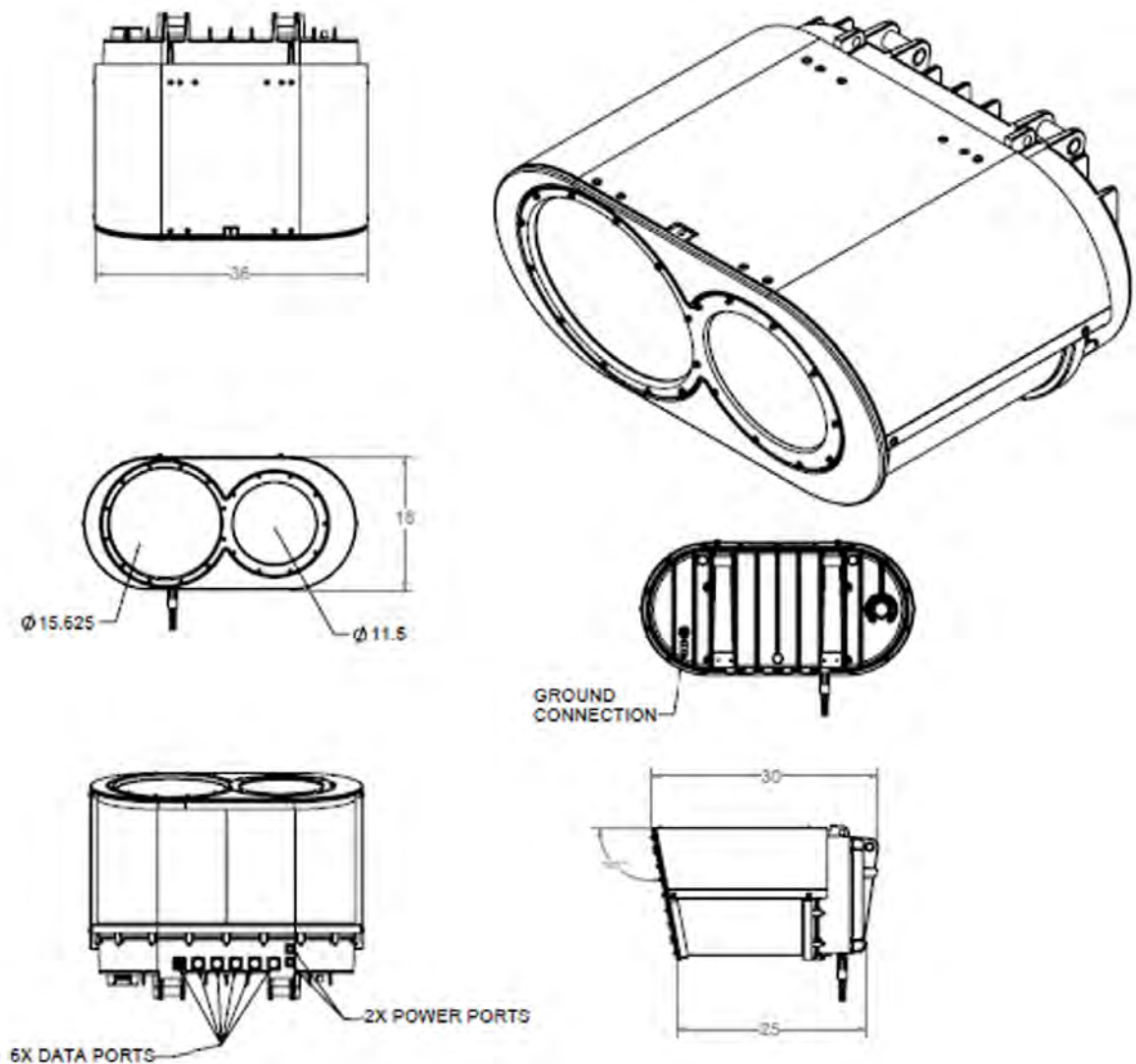
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This information is to be provided.

Mechanical drawings

This **Mechanical Drawings** chapter provides system drawings and dimensions.

Figure 8-1 System Dimensions (in inches)



Acronyms

This **Acronyms List** Appendix provides the definitions of the acronyms used in this manual.

Acronym	Definition
ANSI	American National Standards Institute
APP	Application
AWG	American wire gauge
BER	Bit Error Rate
BERT	Bit Error Rate Test
CFR	Code of Federal Regulations
CIR	Committed Information Rate
CLI	Command Line Interface
COW	Cell on wheels
E-band	Range of radio frequencies from 2 GHz to 3 GHz
EDFA	Erbium Doped Fiber Amplifier
EMC	Electro Magnetic Compliance
EMI	Electro Magnetic Interference
EMS	Element Management System
EN	European Norm
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FSO	Free Space Optics/Optical
GbE	Gigabit Ethernet (or 1GigE)

Acronym	Definition
Gbps	Gigabit per second
GPS	Global positioning system
GUI	Graphical User Interface
HTTPS	Hyper Text Transfer Protocol Secured
I/O	Input/Output
LC	Lucent connector
IEC	International Electro-technical Commission
LPB	Lightning protection box
Mbps	Megabits per second
MBps	Megabytes per second
MRD	Marketing Requirements Document
NEBS	Network Equipment - Building System
NMS	Network Manager System
MPE	Maximum permissible exposure
PAT	Pointing, Acquisition and Tracking
POST	Power-On Self-Test
PVC	Poly vinyl chloride
RSSI	Received Signal Strength Indicator
SFP	Small Form Pluggable
SNMP	Simple Network Management Protocol
TBC	To Be Confirmed
TBD	To Be Discussed / Decided / Determined
TOSA	Transmit Optical Sub-Assembly
UL	Underwriters Laboratory

Index

A

About this Manual 3
Accessories 28
Acronyms 69

B

Back-end node 22
Blue Node 22

C

Cable connections 36
Components Provided by Aoptix 30
Components Provided by the customer 30

E

Electrical Safety 6
End Node 22
Environmental parameter 24

F

Facilities Connections 65
First hop configuration 62

G

Grounding and Bonding 15

H

Head Node 22

I

Installation prerequisites 29

Installation Procedure 29
Installation prerequisites 29
Link Installation 32
Multi-hop network configuration 62
Overview 29

L

Laser safety 9
Laser safety interlock switch 10
Lightning protection 9
Lightning Protection Box mounted 35
Link Installation 32
cable connections 36
Coarse alignment 54
Fine alignment 57
Link verification 62
Mounting 32
Power connections 37
Single installation team 61
Two installation teams 58

M

Manual Scope 3
Mechanical Drawings 67
System dimensions 67
Mechanical Safety 8
Mounting 32
Mounting Bracket 34
Multi-hop configuration 21
Multi-hop network configuration
First hop configuration 62
Network management verification 63
Second hop configuration 63

N

Network management (NMS) 23
Network management verification 63
Node types
Back-end node 22
Blue node 22
End node 22
Head node 22
Red node 22

Repeater node	23
Node types and configurations	20
Multi-hop configuration	21
Single-hop configuration	20

P

Performance parameter	23
Permits	25
Physical interface	23
Pole-Mounted Antennas	16
Conductors	16
Connectors	16
Protective devices	16
Power connections	37

R

Red node	22
Regulatory Compliance	12
Regulatory compliance	24
Repeater node	23
RF exposure protection	11
RF Regulatory compliance information	11

S

Safety Overview	6
Safety Precautions	5
Second hop configuration	63
Single installation team	61
Single-hop configuration	20
Site Planning	25
Site Survey	25
Specifications	
Operational Characteristics	12, 13, 28
Physical Characteristics	9, 11, 69
System configuration	20
System Dimensions	67
System Operation	25
System Overview	17
Overview	17
System Components	20
System specifications	23

T

Time and Date Setting	63
Tower installation	27
Two installation teams	58
Typical Installations	27

Typographical Conventions	3
---------------------------	---

W

Warning, Caution and Note Definitions	5
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