WaveNet Link CX User Manual

(FCC Certified Version)
Part Number 100757-001
5/02 Version A

Trademark Acknowledgment

United States Federal Communications Commission Required User Documentation

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by interWAVE in writing can void the user's authority to operate this equipment.

This device must be professionally installed.

This device is to be exclusively used for fixed point-to-point operation with directional antennas.

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Preface

Welcome!

This manual is intended for the technical personnel who will install and operate the U-NII (Unlicensed National Information Infrastructure) and ISM (Industrial, Scientific and Medical) Link CX. Such personnel are typically experienced and skilled technicians familiar with on site, physical installation and connection of equipment, including maintenance work. It is also intended for system administration personnel performing initial configuration and subsequent system reconfiguration, as well as current system maintenance activities.

Document Organization

This manual provides a detailed description of the Link CX components, and operating, installation and management procedures.

- Chapter 1 provides an overview and briefly describes typical applications.
- Chapter 2 provides an installation steering guide with references to subsequent installation sections.
- Chapter 3 describes how to plan the Link CX network, radio links, and remote element and network management links, and individual Link CX radios.
- Chapter 4 provides detailed hardware installation and acceptance test procedures.
- Chapter 5 describes final configuration procedures and the Web browser user interface.
- Chapter 6 presents procedures for monitoring and performing trend analysis on the Link CX.
- Chapter 7 provides instructions for troubleshooting the Link CX.
- Appendixes provide detailed technical information for carrying out the installation and maintenance activities described in the other chapters of this manual.

Microwave Radiation Warnings

Radio Warning

Under normal operating conditions, Link CX radio equipment complies with the limits for human exposure to radio frequency (RF) fields adopted by the Federal Communications Commission (FCC). All interWAVE Communications, Inc. microwave radio equipment is designed so that under normal working conditions, microwave radiation directly from the radio is negligible when compared with the permissible limit of continuous daily exposure recommended in the United States by ANSI/IEEE C95.1-1991 (R1997), Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

Microwave signal levels that give rise to hazardous radiation levels can exist within transmitter power amplifiers, associated RF multiplexers, and antenna systems.

Never look into the front of an open RF connection or RF antenna as eyes are particularly vulnerable to radiation. Do not disconnect RF coaxial connectors, open microwave units, or break down any microwave screening while the radio equipment is operating.

Antenna Warning

Designed for point-to-point operation, the Link CX microwave radio system uses directional antennas to transmit and receive microwave signals. These directional antennas are usually circular or rectangular, are generally located outdoors, and are usually mounted with the Link CX on a tower or mast.

The Link CX is classified as a fixed installation product, and per FCC policy guidelines regarding maximum permissible exposure (MPE), antennas used for this interWAVE radio must be installed to provide a separation distance of 2 m (79 in.) or more from all persons during normal operation to satisfy FCC RF exposure limits. As the Link CX is typically mounted on a building or mast high enough to clear ground-level path obstructions, the general population will be further than 2 m (79 in.) from the radio antenna, and the FCC RF exposure limits will be met.

interWAVE Communications, Inc. fully supports the FCC's adopted MPE limits, and recommends that personnel stay 2 m (79 in.) or more from the front of all directional microwave antennas. Should you have questions about Link CX microwave signal radiation, please contact interWAVE Customer Support.

FCC Regulatory Information

The Link CX is certified for use in the 5.3 GHz and 5.8 GHz unlicensed bands in the United States.

The 5.3 GHz version of the Link CX is certified under FCC part 15.407, U-NII regulations covering the frequency band of 5250-5350 MHz.

5.3 GHz (5.25-5.35 GHz)

5.3 GHz Link CX radios are equipped with an integral antenna only, and operate under the FCC Part 15, subpart E, U-NII license-exempt regulations, which certify the radios for –1.0 dBm average, or +7.4 dBm peak transmit power. The 5.3 GHz Link CX radios have been certified in the following configuration:

- Link CX, 5.3 GHz, integral antenna

The following table summarizes the technical specifications of the 5.3 GHz version of the Link CX.

Table 1 5.3 GHz Link CX Specifications

Parameter	Description
FCC Identifier	OEWCX-DS3-53G
Frequency Band	5250 – 5350 MHz, U-NII per 15.407
Mode of Operation	Full Duplex, 100% duty cycle
Channel Spacing	16 MHz
Transmit / Receive Separation	60 MHz
Number of Channel Pairs	2
Channel Pair 1	5262 MHz / 5322 MHz
Channel Pair 2	5278 MHz / 5338 MHz
Modulation	16 QAM, $\alpha = 0.15$
Emission Bandwidth (26 dB)	13.9 MHz
Frequency Stability	+/- 5.0 PPM
Maximum Output Power	-1.0 dBm average (+7.4 dBm peak)
Antenna Type	Integral flat panel
Antenna Gain	21 dBi
User Interfaces	DSX3 coaxial, 10/100 base-T Ethernet, Craft PC RS-232 interface

5.8 GHz (5.725-5.825 GHz)

The 5.8 GHz Link CX radios operate under the FCC Part 15.247 band regulations, which certify the radios for +16 dBm average or +24.1 dBm peak transmit power for intentional radiators in a point-to-point configuration. The 5.8 GHz Link CX radios are equipped with an integral or an external antenna. The 5.8 GHz Link CX radios have been FCC certified in the following configurations:

- Link CX, 5.8 GHz, integral antenna
- Link CX, 5.8 GHz, 2 ft. (61 cm) external Radio Waves, Inc. Model SP2-5.2 parabolic antenna
- Link CX, 5.8 GHz, 2 ft. (61 cm) external Gabriel Electronics, Inc. Model SSP2-52B parabolic antenna
- Link CX, 5.8 GHz, 4 ft. (122 cm) external Gabriel Electronics, Inc. Model SSP4-52B parabolic antenna

See the following table summarizing the technical specifications for the 5.8 GHz version of the Link CX.

Table 2 5.8 GHz Link CX Specifications

Parameter	Description
FCC Identifier	OEWCX-DS3-58G
Frequency Band	5725 – 5850 MHz, per 15.247, revised 5/16/02
Mode of Operation	Full Duplex, 100% duty cycle
Channel Spacing	16 MHz
Transmit / Receive Separation	60 MHz
Number of Channel Pairs	2
Channel Pair 1	5737 MHz / 5797 MHz
Channel Pair 2	5753 MHz / 5813 MHz
Modulation	16 QAM, $\alpha = 0.15$
Emission Bandwidth (26 dB)	13.9 MHz
Frequency Stability	+/- 5.0 PPM
Maximum Output Power	+16 dBm average (+24.1 dBm peak)
Antenna Types	Integral flat panel, 2 ft. parabolic – Radio Waves, Inc. Model SP2-5.2, 2 ft. parabolic – Gabriel Electronics, Inc. Model SSP2-52B 4 ft. parabolic – Gabriel Electronics, Inc. Model SSP4-52B
Antenna Gains	21 dBi, 28.3 dBi, and 34.6 dBi
User Interfaces	DSX-3 coaxial, 10/100 base-T Ethernet, Craft PC RS-232 interface

Note that any references in this manual referring to external antennas, or external antenna mounting only apply to the 5.8 GHz version of the Link CX. The 5.3The 5.8 GHz Link CX radios are equipped with an integral or an external antenna, GHz version is certified for use with the integral antenna only.

Related Documentation

All interWAVE manuals are available in an online format on our protected Internet site. To order documentation, please contact interWAVE Communications, Inc. Sales department online at http://www.iwv.com.

Updates to this manual will be posted on the interWAVE Communications, Inc. Customer Support website at http://www.iwv.com/custsupport. Registered interWAVE customers can access the interWAVE online information and support service, available 24 hours a day, seven days a week. The interWAVE online service provides users with a wealth of up-to-date information, with documents being added or updated each month.

Customer Support Services

interWAVE has regional Customer Support centers that handle day-to-day customer issues. Each center is staffed with a local technical support group. The exact services to be performed by the interWAVE Customer Support department are specified in a support contract. Below is an example of the types of services available:

- Telephone support
- Site surveys
- Installations
- Off-line and online commissioning
- Network integration activities
- Troubleshooting and fault isolation
- Escalation of problems to appropriate interWAVE technical departments

interWAVE can physically perform all or a portion of these processes for the operator, as specified in the support contract. The Customer Support department can also provide documentation outlining corrective and preventive maintenance procedures and troubleshooting guides for fault isolation.

Contact your local Sales Support office, or interWAVE headquarters directly via the Internet at http://www.iwv.com.

If possible, please have the following information available when making a call:

- Site number or name
- Full description of product(s) (e.g., model and part number) and configuration
- Serial number of product(s)
- Purchase order number
- Contact name and telephone number
- Ship to address
- Bill to address

For support on installing or configuring all interWAVE equipment, contact your Regional interWAVE Customer Support Center at:

- +852.2574.1922 or asia_support@iwv.com.hk -- Asia and Pacific Rim
- +1.866.306.1263 or usa_support@iwv.com -- North and South America, Europe, Africa, and Middle East

or via the Internet at http://www.iwv.com/custsupport.

Return Materials Authorization

In the event that a depot repair or hardware replacement is required after contacting Customer Support, please contact interWAVE for return authorization. The following information is required by interWAVE:

- Full description of the product(s): model and part number
- Serial number of the product(s)
- Purchase order number
- Quantity that needs to be returned to interWAVE, if applicable
- Description of observed problem

All interWAVE products carry a one year manufacturing warranty from the date of shipment. At the time of a request for a return authorization, if the product has exceeded the warranty period, interWAVE will require a new purchase order number to cover the cost of non-warranty repair.

Contact Sales Operations via the Internet at http://www.iwv.com or email at rma@iwv.com.

Training

interWAVE has developed an extensive series of training courses designed to teach you how to use our products. The courses are developed by a combination of subject matter experts and training specialists in order to create highly technical materials in modern training format. Each of our course offerings are designed around specific learning objectives that keep our classes on track to learning specific job skills related to interWAVE products.

The interWAVE training catalog contains a listing of the interWAVE training services available along with descriptions of each course. Our training materials are divided into specific subsystem training series, depending upon the topic and job requirements.

Contact Customer Support via the Internet at http://www.iwv.com or email at training@iwv.com.

Conventions Used in this Manual

The following type and style conventions are used in this manual:

Table 3 Conventions Used in This Manual

Convention	Meaning
Body text	Used for regular body text
Bold	Indicates a menu or button choice
`Command`	Indicates computer generated text and prompts
`User Input`	Indicates user input
`<hostname>`	In command syntax, indicates user-specified command line parameters
`<variable>`	In body text, indicates user-specified command line parameters
`[BRACKETS]`	Indicates a key on the keyboard or instrument
	Provides relevant additional information
	Provides important warning information that may affect operation of or maybe a potential threat to the system
	Used to tell the reader to **STOP** what they are doing and to read important instructions that are vital to prevent equipment or software damage

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One

System Description

This chapter contains a functional description of the Link CX product family, and contains the following sections:

- Section 1-1, General
- Section 1-2, System Overview
- Section 1-3, Features
- Section 1-4, Link CX Basic Structure
- Section 1-5, Typical Applications

Welcome to the interWAVE WaveNet Link Series product family. This manual is designed to introduce you to the Link CX products, and to provide you with information necessary to plan, install, operate and maintain a Link CX wireless communication system.

The Link CX is intended for professional installation only. However, this manual is also designed for personnel who plan, operate and administer the Link CX communication system. Please review the entire manual before powering up or deploying any Link CX.

1-1 General

1-1.1 Products

The Link CX products are cost-effective, all-outdoor, pole-mounted, high-capacity, line-of-sight (LOS) digital radio transmission systems, each operating in the license-exempt 5.25-5.35 GHz (5.3 GHz) or 5.725-5.825 GHz (5.8 GHz) frequency bands. The Link CX can be used for the following applications: point-to-point or building-to-building, WLL (wireless local loop), backup solutions, temporary links, and mesh cellular backhaul.

- The 5.3 GHz Link CX-DSX DS-3 and 10/100 versions conform to the FCC (Federal Communications Commission) Part 15.407 Subpart E describing U-NII (Unlicensed National Information Infrastructure) operation. It operates at up to -1.0 dBm average transmit power, and is intended for short-distance use.
- The 5.8 GHz Link CX-DSX DS-3 and 10/100 versions conform to the FCC Part 15.247 describing intentional radiators. It operates at up to +16 dBm average power, and is intended for use over longer distances.

Both Link CX-DSX versions provide either a standard DS-3 (44.736 Mbps) interface adhering to Bellcore GR-499-CORE (DSX-3) standards, or provides two Ethernet 10/100Base-T interfaces adhering to IEEE 802.3 standards, with a combined nominal line rate of 45 Mbps.

Each Link CX is powered by an external ±21 to ±60 VDC power supply.

1-1.2 Applications

The Link CX product line is designed to serve the following communications markets:

- Internet Access and Backhaul Systems: Used by Internet Service Providers (ISPs).
- Private Networks: Wireless Bridged LANs and WANs.
- PCS/PCN and Cellular Networks: High speed links between base stations.
- Wireless Local Loop Networks: Fixed wireless, used by Local Exchange Carriers (LECs).
- Business Bypass or Local Exchange Bypass: Provided by Competitive Access Providers (CAPs) and Competitive Local Exchange Carriers (CLECs).
- When used with interWAVE StreamNet ATM Switches, the Link CX can provide the radio links in a self-healing wireless mesh backhaul network to support broadband communications, including DSL (Digital Subscriber Line) and Cellular over ATM (Asynchronous Transfer Mode).

1-2 System Overview

Each Link CX consists of a Link CX radio, with integral antenna (5.3 GHz or 5.8 GHz versions) or an optional external antenna (5.8 GHz versions), as shown in Figure 1-1, along with external power and data cabling. In a typical installation, the Link CX radio and antenna are mounted outdoors, usually on a tower or building. If so equipped, the external antenna connects to the Link CX radio through a factory-supplied coaxial cable.

See Figure 1-1. A radio system, or link, contains two Link CX radios each equipped with either an integral or external antenna, installed at each end of the link, separated by a line of sight transmission path. Frequency band, terrain, actual line-of-sight and environmental conditions influence the range of operation and path performance.

The Link CX carries one full-duplex DS-3 or Ethernet channel, and is powered by a 30-watt external ±21 to ±60 VDC power supply.

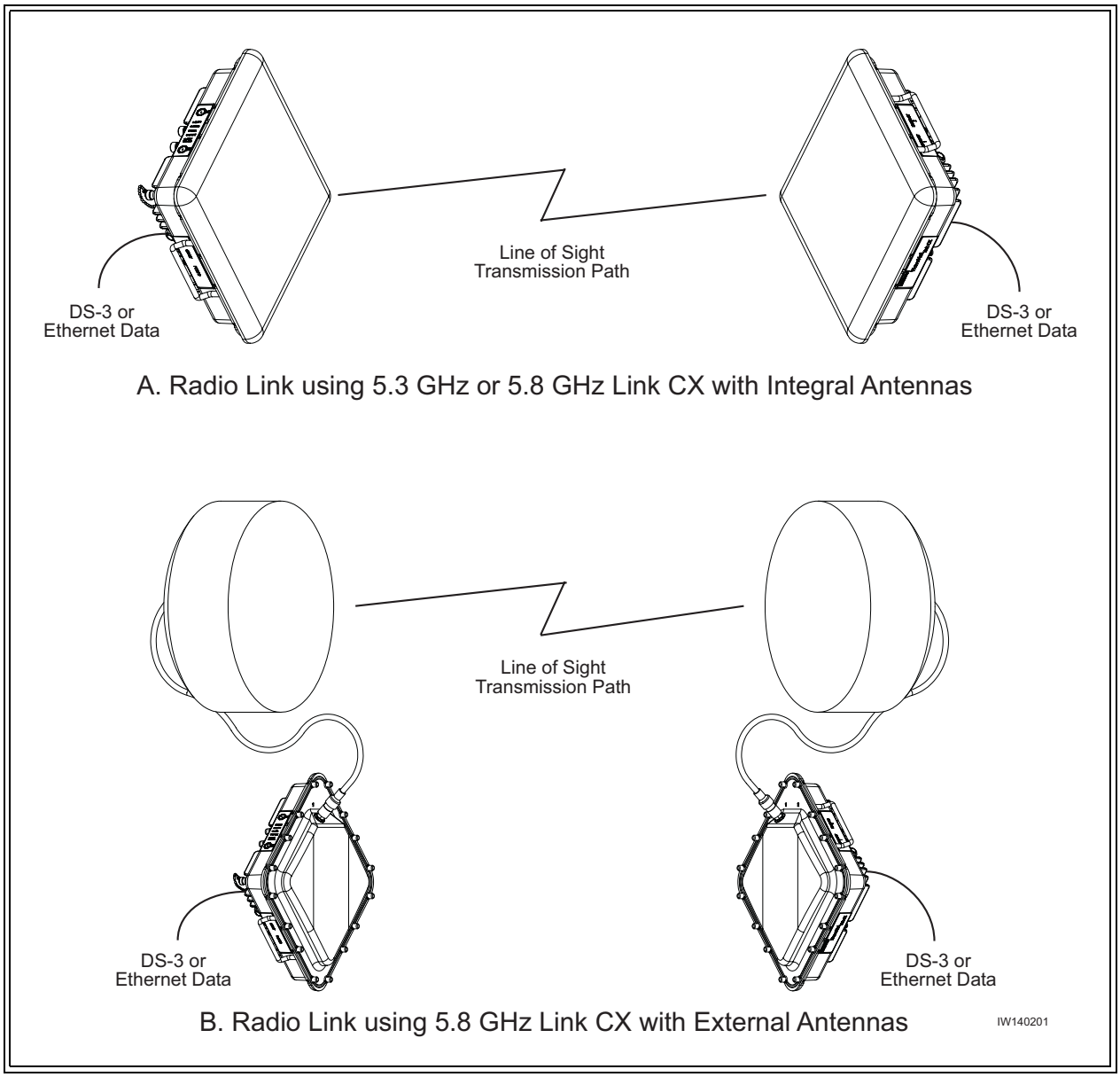


Figure 1-1 Typical Radio Link Configurations

Because the Link CX can be ordered in two different bands, with high and low channels, and can be installed with horizontal or vertical polarization, up to eight Link CXs can be mounted at a each hub, or node, to form part of a star or mesh network. See Figure 1-2.

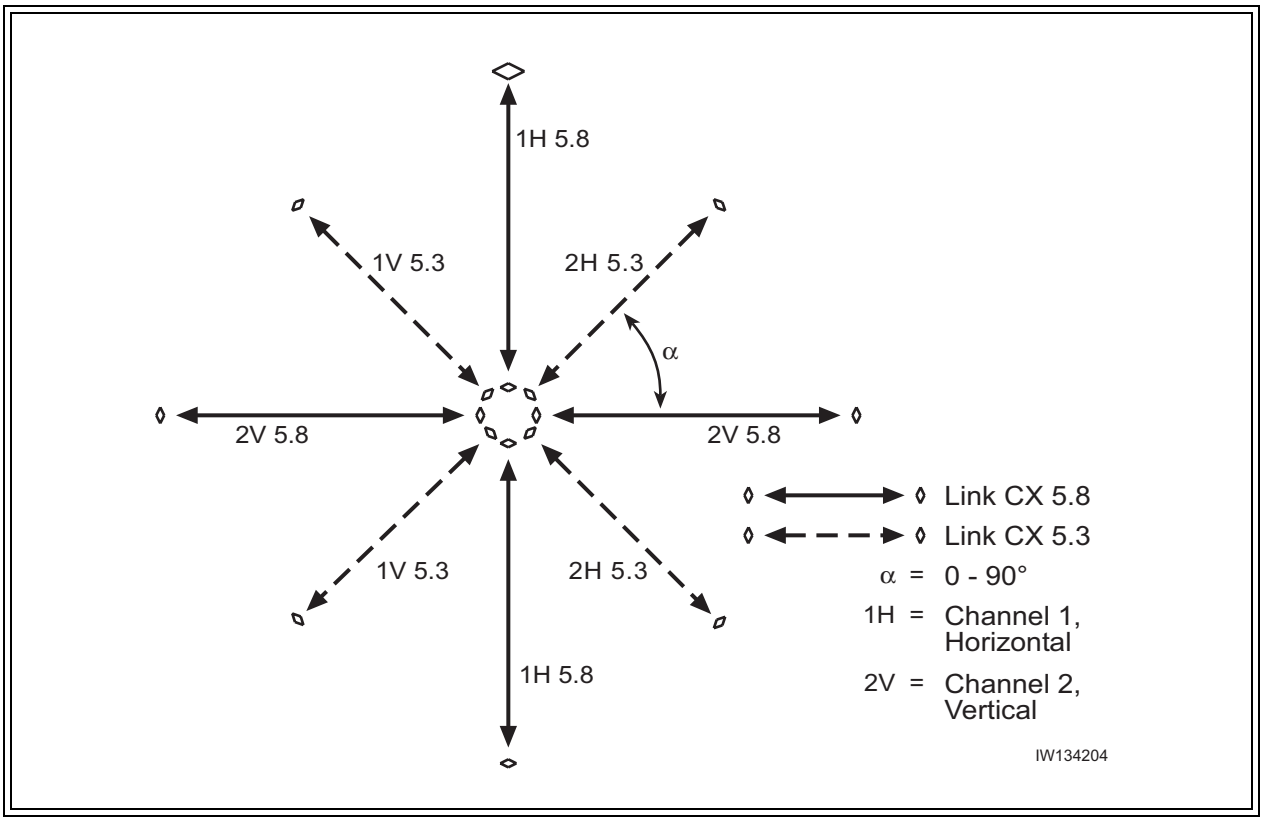


Figure 1-2 CX-UNII and CX-ISM Star Network

1-3 Features

The Link CX offers the following features:

- Robust outdoor all-outdoor enclosure.
- Integral or external antenna.
- Sturdy radio mounting systems for quick, accurate and reliable integral antenna alignment.
- Operates in the license-exempt 5.25-5.35 GHz (5.3 GHz) or 5.725-5.825 GHz (5.8 GHz) bands.
- Conforms with FCC Part 15.247 rules (5.725-5.825 GHz) or Part 15.407 rules (5.25-5.35 GHz).
- Full-duplex transmission:
  - DS-3 (DSX-3, per Bellcore GR-499-CORE)
  - Ethernet 10/100Base-T (per IEEE 802.3)
- Easy configuration, installation, operation, and maintenance.
- Integral web server for configuring, operating, and monitoring using an HTML-based web browser GUI.
- Ethernet interface used with NMSs (Network Management Systems) or EMSs (Element Management Systems) using SNMP (Simple Network Management Protocol) traps. Supports MIB-II (Management Information Base II) and interWAVE enterprise MIB.
- ATPC (Automatic Transmit Power Control).
- Self Test, BER test mode, RF and digital loopbacks.
- Reed Salomon Forward Error Correction (FEC).
- Operating and backup software versions contained in Link CX memory, operator-selectable.

1-4 Link CX Basic Structure

1-4.1 Radio Links

Each radio link includes two Link CX terminals. Each terminal consists of a Link CX radio with an integral flat-panel antenna, or a Link CX radio with an external antenna (see Figure 1-1). Generally, the Link CX terminals are mounted outdoors on a tower or building.

1-4.2 Data Stream

The DS-3 or Ethernet data signals enter the Link CX, and are modulated into the RF data stream. The RF radio signal radiates from the local antenna and propagates to the remote antenna. At the remote terminal, the received signal is demodulated and demultiplexed, separating the payload data and the overhead management data.

1-4.3 Link CX Models

The Link CX is manufactured in many configurations:

- Versions with DS-3 or Ethernet carried over 5.3 GHz or 5.8 GHz links.
- Each version available with either an integral 30 x 30 cm (12 x 12 in.) antenna, or with an N-type connector for a factory-supplied 61 cm (2 ft.) or 122 cm (4 ft.) external antenna, or an N-type connector for a customer-supplied external antenna.

Link CX models are described in Table 1-1.

Table 1-1 Link CX Models

Model	Transmit Band	Frequency Band	Link Carries	Antenna
M100746-101 M100747-101	Low High	5.25-5.35 GHz	DS-3	Integral
M100748-101 M100749-101	Low High	5.725-5.825 GHz	DS-3	Integral
M100748-102 M100749-102	Low High	5.725-5.825 GHz	DS-3	External, 61 or 122 cm (2 or 4 ft.)
M100746-201 M100747-201	Low High	5.25-5.35 GHz	Ethernet (45 Mbps)	Integral
M100748-201 M100749-201	Low High	5.725-5.825 GHz	Ethernet (45 Mbps)	Integral
M100748-202 M100749-202	Low High	5.725-5.825 GHz	Ethernet (45 Mbps)	External, 61 or 122 cm (2 or 4 ft.)

1-4.4 Mounting and Antenna Alignment

To ensure proper mounting and antenna alignment interWAVE sells mounting brackets designed for use with the Link CX. The single bracket mounts one Link CX, while the dual bracket mounts two Link CXs back-to-back. Both brackets are designed to provide rugged mounting for the Link CX, while allowing fine adjustment for antenna alignment.

1-4.5 Interface Connectors and Indicators

See Figure 1-3 for a view of the Link CX external connectors and indicators. The Link CX connectors and indicators are described in Table 1-2.

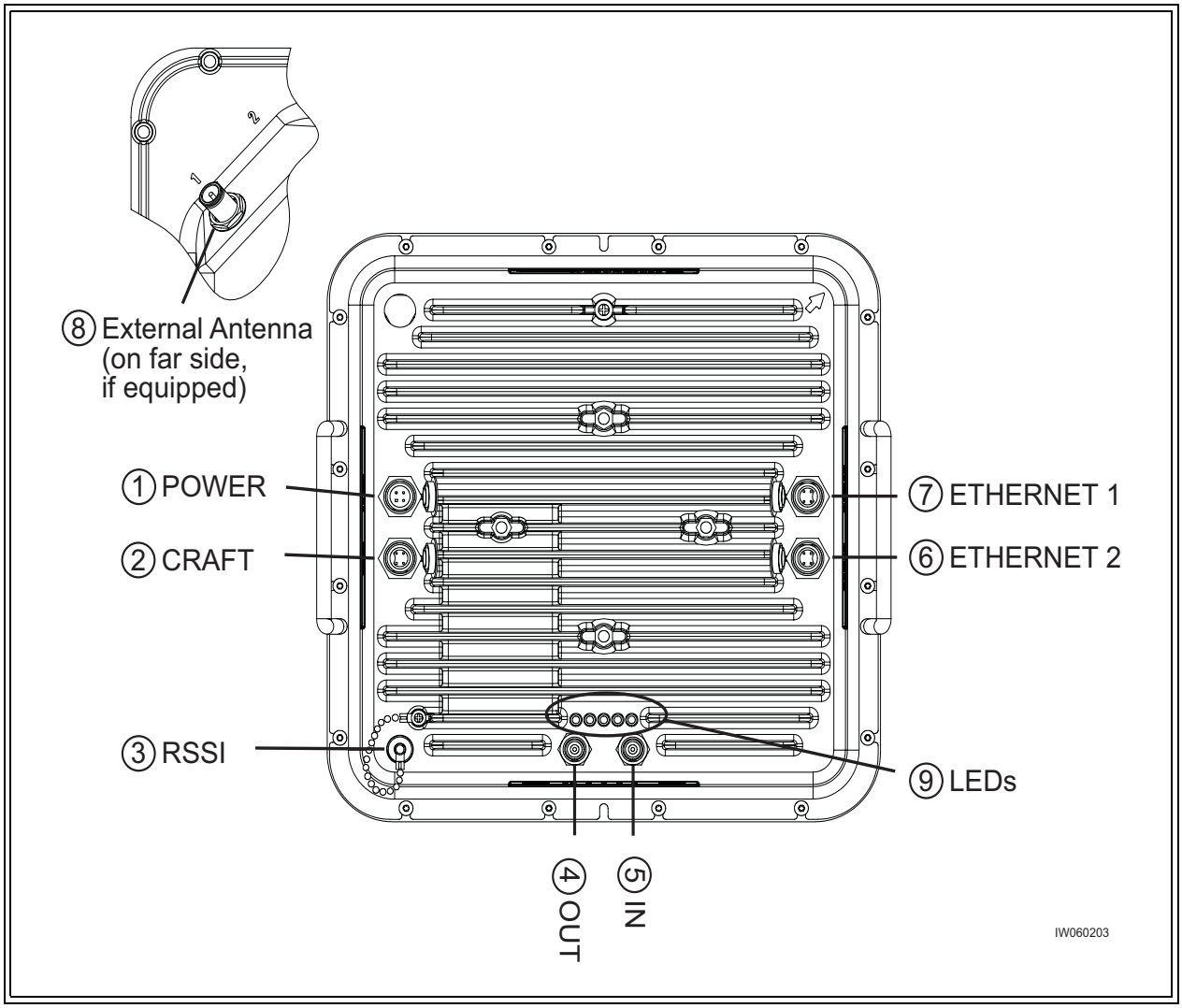


Figure 1-3 Link CX Interface Connectors and Indicators

Table 1-2 Link CX Interface Connectors and Indicators

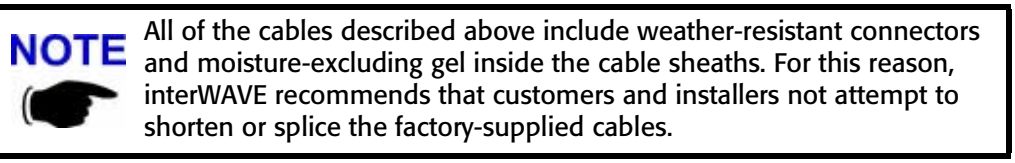
No.	Name	Component	Description	From	Note
1	POWER	Male 4-Pin Circular Connector	Power input plug	Power Supply	Accepts ±21 to ±60 VDC
2	CRAFT	Female 4-Pin Circular Connector	RS-232 receptacle	Asynchronous laptop port	1200 to 115,200 baud, used only for tech support troubleshooting
3	RSSI	Female BNC Connector	Receive Signal Level Indicator	Voltmeter	Verifies RF signal strength, used to align antenna
4	OUT	Female TNC Connector	DS-3 data from the radio link	DS-3 data equipment	--
5	IN	Female TNC Connector	DS-3 data to the radio link	DS-3 data equipment	--
6	ETHERNET 2	Female 4-Pin Circular Connector	10/100Base-T transmit and receive receptacle	Ethernet equipment	For Ethernet data or link to SNMP or Web manager, or use to daisy-chain Ethernet port to next Link CX in cascade
7	ETHERNET 1	Female 4-Pin Circular Connector	10/100Base-T transmit and receive receptacle	Ethernet equipment	(Same as ETHERNET 2)
8	ANTENNA PORT (Opt.)	Female N-type Connector	50 Ohm RF receptacle	External antenna	Only equipped on external-antenna models, on far side of chassis
9	PWR/LCL ALM	Green LED	Power/Local Alarm Status	--	ON = Power OK, no alarm, Flashing = Local alarm, OFF = Power off.
	RF LINK	Green LED	Radio Link Status		ON = Rcv. OK, OFF = Link Alarm.
	DATA	Green LED	DS-3 Status		ON = OK (no LOS), OFF = LOS.
	ENET 2	Green LED	Ethernet Status		ON = OK, Flashing = data, OFF = No conn.
	ENET 1	Green LED	Ethernet Status		ON = OK, Flashing = data, OFF = No conn.

Note: For connector pinouts, refer to Appendix 1.

1-4.6 Cables

To ensure longevity in a outdoor environment, interWAVE sells various cables designed for use with the Link CX. interWAVE offers the following weather-resistant cables:

- DS-3 and Ethernet data cables and the power cables are offered in 25 m (82 ft.), 50 m (164 ft.), and 100 m (328 ft.) lengths.
- A 6 m (19.7 ft.) Ethernet cable is available to route the Ethernet signal between two Link CXs in the same location, or when you are configuring the Link CX from a Craft PC.
- For models to be used with external antennas, a 2 m (6.6 ft.) N-to-N RF cable is available to connect the external antenna to the Link CX.
- A 6 m (19.7 ft.) RS-232 4-pin Circular-to-DB9 Craft cable is available to connect a Craft PC to a Link CX for future CLI applications.
- When the Link CX is to be used with a StreamNet ATM Switch for a mesh backhaul network, a 6 m (19.7 ft.) dual TNC-to-TNC cable is available to connect each StreamNet ATM Switch to a Link CX.



1-4.7 Integral Antenna

The integral antenna is a 30 cm x 30 cm (12 in. x 12 in.) flat-panel antenna mounted directly on the 5.3 GHz or 5.8 GHz Link CX radio chassis, as shown in Figure 1-4. All RF connections between the integral antenna and the Link CX radio are made internally, eliminating the need for external coaxial cabling. Because the integral antenna is sealed onto the Link CX chassis, the Link CX and integral antenna are mounted as a unit, and share the same environmental protection. An arrow on the connector side of the Link CX chassis indicates the antenna polarization (either vertical or horizontal).

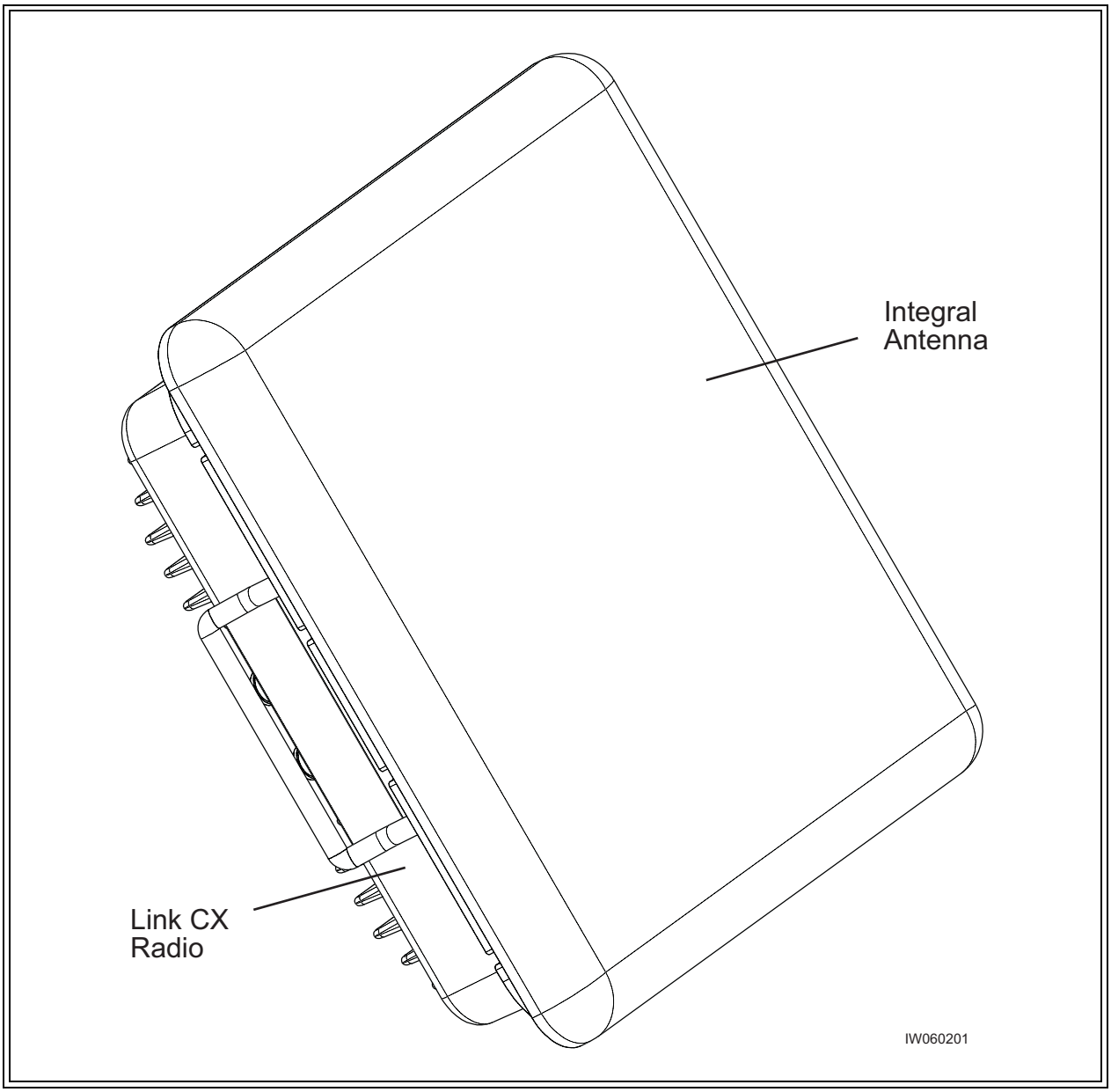


Figure 1-4 Integral Antenna and Link CX Radio

1-4.8 External Antenna

Some 5.8 GHz Link CX models use an external antenna to radiate and receive RF signals. The antenna attaches to the Link CX via a factory-supplied cable. The following sections describe factory- and customer-supplied external antennas.

Factory-Supplied

The following external antennas are offered for use with the Link CX:

- 61 cm (2 ft.) parabolic type
- 122 cm (4 ft.) parabolic type

Figure 1-5 shows a typical 61 cm external antenna with N-type connector cabled to the Link CX radio.

The antenna type should be selected according to local regulatory rules and system gain requirements.

For the available antenna models refer to Table 1-3. Complete antenna specifications are provided in Appendix 2.

Table 1-3 Antenna Models

Model	Description
091-455524-101	Parabolic antenna, 5.725-5.825 GHz, 61 cm (2 feet)
091-455548-101	Parabolic antenna, 5.725-5.825 GHz, 122 cm (4 feet)

Customer-Supplied

The Link CX can be ordered with a coaxial cable to be connected to a customer-supplied external antenna. In this case, refer to the external antenna user documentation for specifications and model numbers.

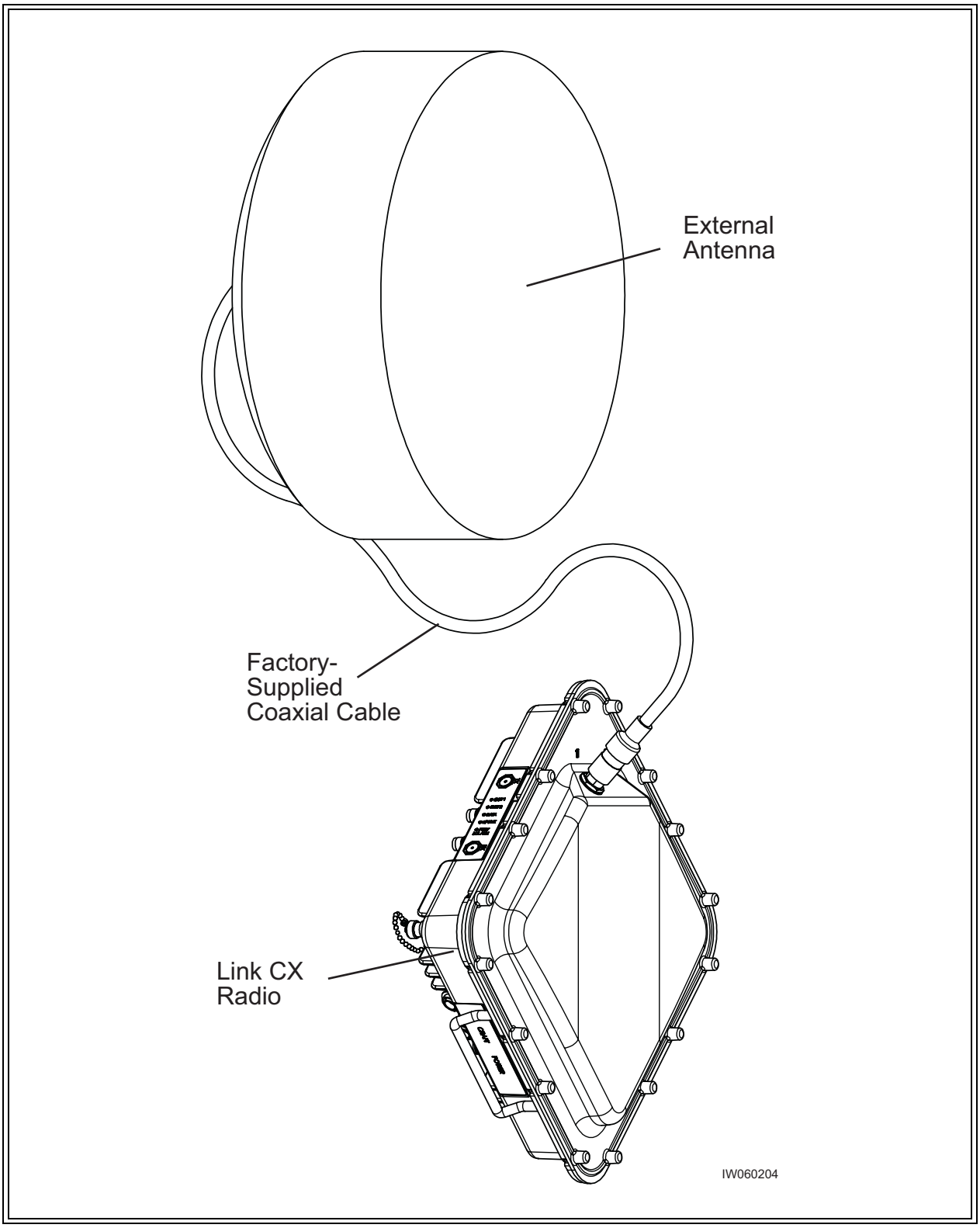


Figure 1-5 Typical Factory-Supplied External Antenna and 5.8 GHz Link CX Radio

1-4.9 Configuration, Operation, and Monitoring

The Link CX and radio link are configured, operated and monitored through one of five user interfaces. The five interfaces are:

- A built-in web server GUI hosted by the Link CX, which can be accessed by any local or remote computer equipped with a web browser. This is the interface most operators will use to interact with the Link CX. The web browser can access the Link CX built-in web server through either the ETHERNET 1 or ETHERNET 2 port.

> **NOTE** Note that the ETHERNET 1 and ETHERNET 2 ports are functionally equivalent, and that they are both served by an onboard Ethernet controller. The controller automatically switches polarity on the transmit and receive pairs when they are reversed, eliminating the need for crossover cables.

- SNMP traps, which communicate with MIB-II compliant NMSs (Network Management Systems) and EMSs (Element Management Systems). This interface is used by operators who want real-time notification of radio problems. The Link CX sends SNMP traps to NMSs and EMSs over Ethernet links through either the ETHERNET 1 or ETHERNET 2 port.
- An ASCII command line interface, accessible through the RS-232 CRAFT port, or through the ETHERNET 1 or ETHERNET 2 port using telnet. This interface is primarily used by operators and interWAVE technical support personnel when performing detailed troubleshooting.
- The RSSI port, providing a DC voltage level proportionate to the received RF signal level, and allowing installers to use a DC voltmeter to fine-tune antenna alignment. This interface is primarily used during installation, but the current RSSI measurement is also available via the Link CX built-in web server or via SNMP polls.
- Five LEDs that provide visual alarm status. They verify proper operation of the Ethernet ports, DS-3 ports, and radio link, and indicate proper power input and radio operation. These LEDs are usually used during installation to provide a quick product verification.

1-4.10 SNMP

The Link CX radio supports SNMP network management. SNMP is a protocol that defines the method of communicating with and controlling network devices.

Devices that support the SNMP protocol can be queried for their status and other device information. Some devices allow changing device settings or configurations using SNMP commands. The device settings and other device data are available as variables. They are defined in the standard Management Information Base (MIB) file, provided by the device manufacturer. The SNMP manager uses a database to hold lists of variables that can be accessed for each device on the network. The device data can be displayed in tables, graphs, or saved in a file.

1-4.11 Link CX Network Management Architecture

Link CX software network management is comprised of two main items:

- SNMP based Network Management System (NMS) application in the network management workstation.

- SNMP agent in the Link CX.

The workstation manages all Link CXs assigned unique IP addresses. The workstation also provides a graphical display of the network objects showing the status, performance, and configuration parameters of each Link CX radio.

The SNMP local agent is a standard MIB-II compliant software module that resides in each Link CX. The agent collects information from different Link CX components as defined in the Management Information Base (MIB) structure. The Link CX incorporates both standard and private MIBs.

Different Link CXs are distinguished by their customer-assigned IP addresses. The Web browser communicates with the Link CX using TCP/IP and HTTP protocol.

The NMS data transfer between the manager and the agents is accomplished using either polling or trapping techniques.

Polling

The NMS polls each Link CX SNMP agent at specific intervals. These are set according to user requirements during SNMP NMS configuration.

Traps

The Link CX agent sends an SNMP trap to the manager whenever a predefined event occurs. Groups of traps can be defined according to their level of severity. The operator can choose to enable or disable any traps or group of traps according to their level of severity (and his or her own security level). Traps can be logged using any standard SNMP manager.

1-4.12 NMS Connectivity

The NMS workstation can access any Link CX using its IP address. The NMS workstation can connect to each Link CX using any of the following methods:

- 10/100 Base-T Ethernet - accessing Link CXs via a LAN through hubs, switches or routers.
- Cascading Ethernet links transport NMS information between colocated Link CXs. This is done by daisy-chaining the ETHERNET 1 and ETHERNET 2 ports between Link CX radios using straight-pinned or crossover Ethernet cables.

1-4.13 Web-Based GUI Access Security

Access to the Web-based GUI (graphical user interface) is limited by username and password, which is available at different levels of security as follows:

- User - Read only privilege.
- Administrator - Read/partial write privilege. The administrator cannot cause an radio link to reset by changing critical parameters.
- Supervisor - Full read/write privilege.

1-4.14 GUI Functions

The Web-based GUI monitors and controls the main functions of the Link CX. These functions are listed below and detailed in the following sections:

- Configuration management
- Status and fault management
- Test activation and monitoring
- Software downloading
- Performance monitoring

Refer to Appendix 3 for Link CX GUI operating instructions.

Configuration Management

The NMS software can be used to configure the parameters of the Link CX radio, although this is normally done using a web browser GUI. This includes the setup of templates with predetermined default values, relating to both the parameters of common element types and the validation of parameter values. It also includes saving and loading configuration files for individual Link CX radios. The NMS also controls the uploading and downloading of individual parameter values, and complete configuration setups.

Parameter configuration is terminal-oriented. Every configuration session deals with the Link CX as accessed by its particular IP address. Some of the parameters, such as RF channel number, link ID, etc. affect the Link CXs on both ends of the radio link. Special care should be taken to activate the new parameter values consistently on both ends of the radio link.

Status and Fault Management

Status and fault management involve a selective display of failures alerting the user to take actions according to a decision making tree.

Some status indications and alarms may report conditions that pertain to both ends of the radio link. These ends are commonly referred to as local and remote.

Note that the 'local' system is the Link CX you are logged into, and the 'remote' Link CX is the one at the far end of the radio link. Thus, when you are logged into the far end Link CX on a radio link that terminates at your current physical location, the far end Link CX is 'local' and the near end Link CX is 'remote'.

Test Activation and Monitoring

Following is a brief description of the tests that can be invoked and monitored by the Web based NMS.

Loopbacks

The loopbacks are incorporated into the radio to assist in detecting equipment/component/cable failure during both installation and normal operations. Loopbacks are user initiated. Link CX supports RF and various interface loopbacks.

BER Test

The following Bit Error Rate (BER) test is provided by Link CX:

- Pseudo random signal generator - capable of inserting a standard test signal for BER measurements, and local- and remote-end loopback functions.
- BER measurements of radio link performance under normal operating conditions.

Software Downloading

The Web-based user interface enables off-line operation and SNMP updates of files. Alternatively, when on-line, configuration can be updated from the NMS to the Link CX agent. Another way to upgrade multiple Link CXs is to use FTP.

Note that the Link CX can hold two software loads in memory, which facilitates upgrading and reverting to a previous software version.

Certain factory default software settings are always retained at the Link CX to safeguard against complete failure of communications caused by equipment restart.

Performance Monitoring

Each Link CX gathers various statistics regarding radio link performance. The Web based user interface can retrieve and analyze these statistics upon demand. In addition, the Web based user interface manager processes its own general statistical data, based on the information that is received. Current BER, Receive Signal Strength Indicator (RSSI), and other performance monitors are available for the radio link.

The Web-based user interface is designed to easily interface with optional graph management software packages for sophisticated performance presentation.

1-5 Typical Applications

Link CX gives the user great flexibility in setting up point-to-point radio links on a very cost effective basis, because it avoids unnecessary outlays in expensive leased lines or fiber optic land-based lines. Low cost of ownership makes return on investment (ROI) attractive compared to leased lines.

Link CX advantages over copper/fiber alternatives include: short installation time, easy maintenance using NMS software, independence of competing PTTs, avoiding the need to secure normal right-of-way and/or physical installation permits, and redeployable depending on changing needs.

The simplicity of the Link CX installation makes it easy for the user to implement Link CX in a variety of applications. It also means that the user can conveniently move a previously installed Link CX to a new location to meet the requirements of a changing system. Link CX enables seamless future software upgradability, protecting customer investment, reducing logistics, spare parts and product stocking. The following sections briefly describe typical applications.

1-5.1 Internet (ISP)

The appetite for higher Internet access speeds require faster ISP access and backhaul and ISP connections to businesses. The Link CX radio is perfectly suitable for both backbone and direct end-user connectivity.

1-5.2 Private Network Wireless Bridged LANs and WANs

Link CX radios are also used to provide communications links for private networks. For companies requiring frequent communications into areas without extensive telecommunications infrastructure or in areas where the cost of local access is high, installing and maintaining a Link CX radio network can be very cost effective. Typical users of private networks include: government agencies such as land management, municipal agencies, and universities; large utilities such as oil, gas, and electric concerns; and companies with widely deployed assets such as railroads and timber resource managers.

1-5.3 PCS/PCN and Cellular Networks

Cellular operators mainly use Link CX radio links for Base Transceiver Station (BTS) interconnections, BTS to Base Station Controller (BSC), and BSC to BSC interconnections.

1-5.4 Wireless Local Loop Networks and Local Exchange Bypass

Wireless systems in emerging markets were originally deployed to provide premium services to a mobile subscriber base. However, middle and lower income countries have driven mobile network providers into a new business - the substitution of wireless service for fixed service, so-called fixed wireless networks, providing a cost-effective solution in situations where no wireless infrastructure exists. Wireless local loop (last mile) networks are implemented mostly by Local Exchange Carriers (LECs).

Alternative carriers, such as Competitive Access Providers (CAPs) and Competitive Local Exchange Carriers (CLECs) use radio links to establish standard telecommunications links between their customers' sites and their own backbone networks. This way CAPs and CLECs provide their customers with cost-effective local area telephone service and cheaper long distance services.

1-5.5 Business Bypass and Local Exchange Bypass

The Link CX radio is a perfect solution for Business Bypass and Local Exchange Bypass applications.

1-5.6 Backhaul for Wireless MTU and MTU Access

The Link CX radio can be used as an infrastructure element in wireless Multiple Tenant Unit (MTU) and Multiple Dwelling Unit (MDU) applications, when used with interWAVE StreamNet products. Figure 1-6 shows a typical wireless MTU/MDU access configuration.

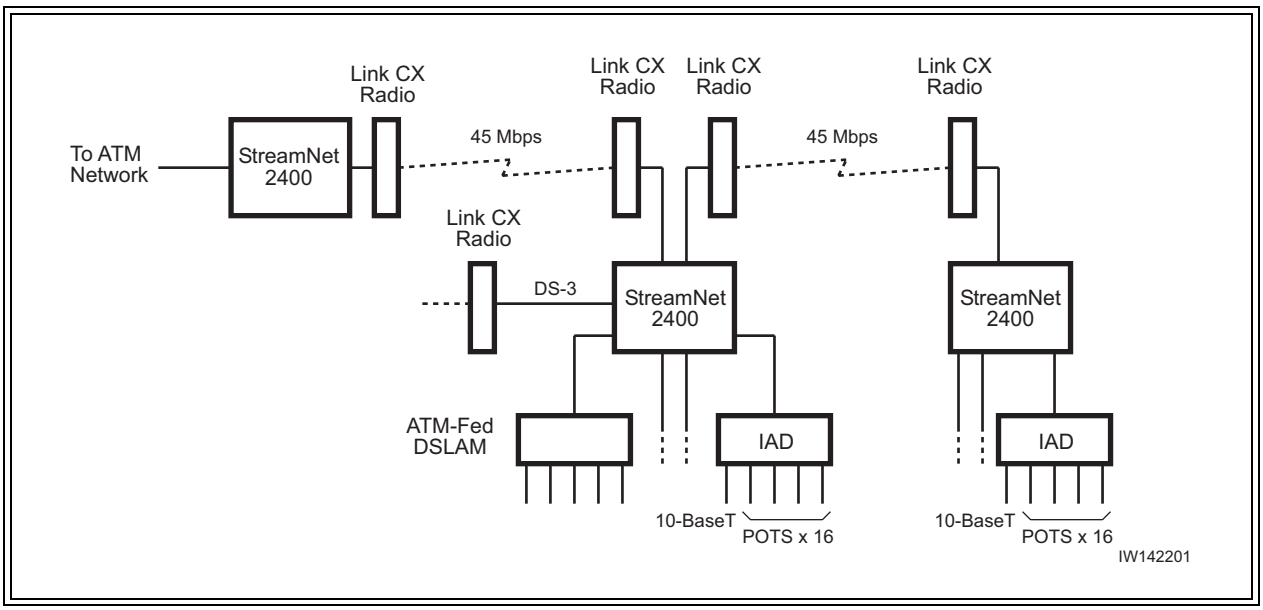


Figure 1-6 Typical Wireless MTU/MDU Access Configuration

1-5.7 Wireless Mesh Backhaul Networks

2.5G and 3G cellular systems, which integrate voice and data, require higher-capacity backhaul, QoS (Quality of Service), BoD (Bandwidth on Demand), ability to dynamically load balance bursty traffic, and provide support for legacy 1G and 2G systems. When used with interWAVE StreamNet ATM Switches, the Link CX can provide the radio links for a self-healing wireless mesh backhaul network to support broadband ATM communications to support this application. These networks feature high reliability, lower maintenance costs, improved scalability, and enhanced interference mitigation.

DSL providers are typically limited by the quality of existing copper lines to a short distance from the CO (Central Office). To serve customers farther from the CO, DSLAMs (DSL Access Modules) must be used closer to the customer site. The backhaul from DSLAMs to the CO has to be robust to reduce or eliminate downtime, and must have sufficient bandwidth to support DSL traffic. When used with StreamNet ATM Switches, the Link CX can provide the radio links for a self-healing wireless DSLAM mesh backhaul network to support these requirements. See Figure 1-7 for a typical wireless mesh backhaul network.

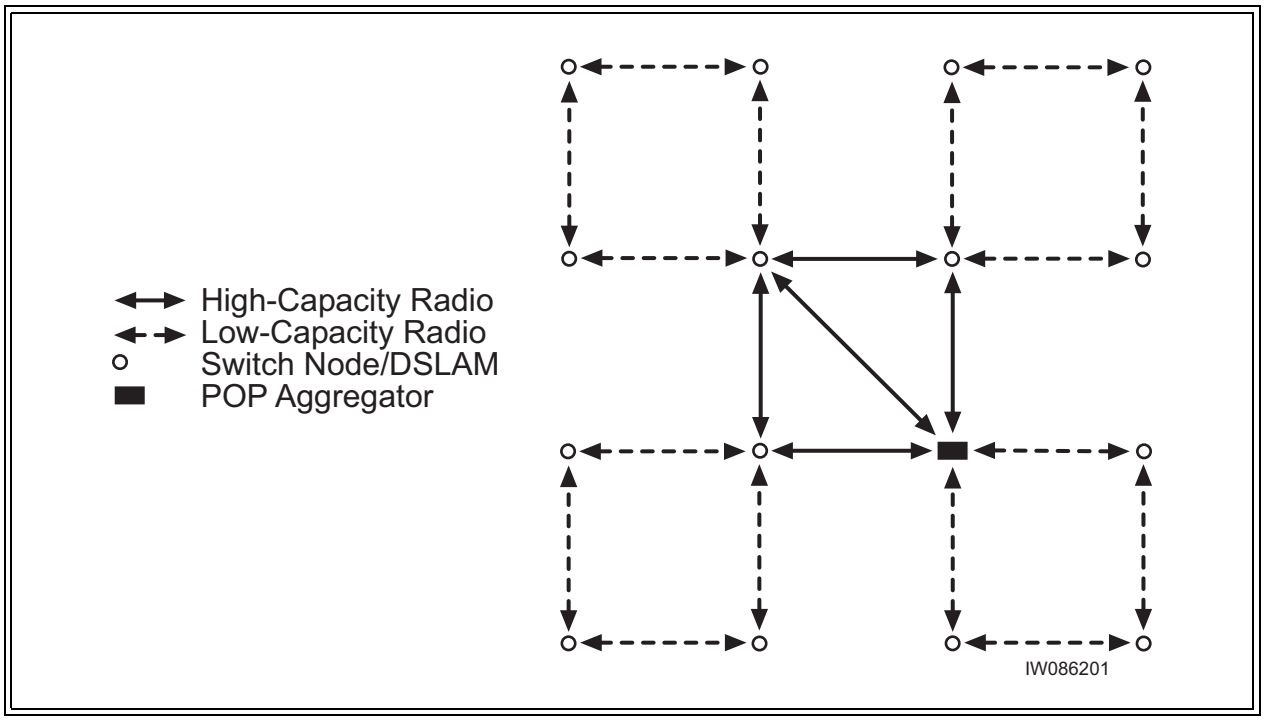


Figure 1-7 Typical Wireless DSLAM Mesh Backhaul Network

1-5.8 Wireless ATM Mesh Distribution with StreamNet

When used with interWAVE StreamNet ATM Switches, the Link CX can provide the radio links for a self-healing wireless ATM mesh backhaul network to support broadband communications. These networks feature high reliability, lower maintenance costs, improved scalability, and enhanced interference mitigation. See Figure 1-8 for a typical wireless ATM mesh backhaul network.

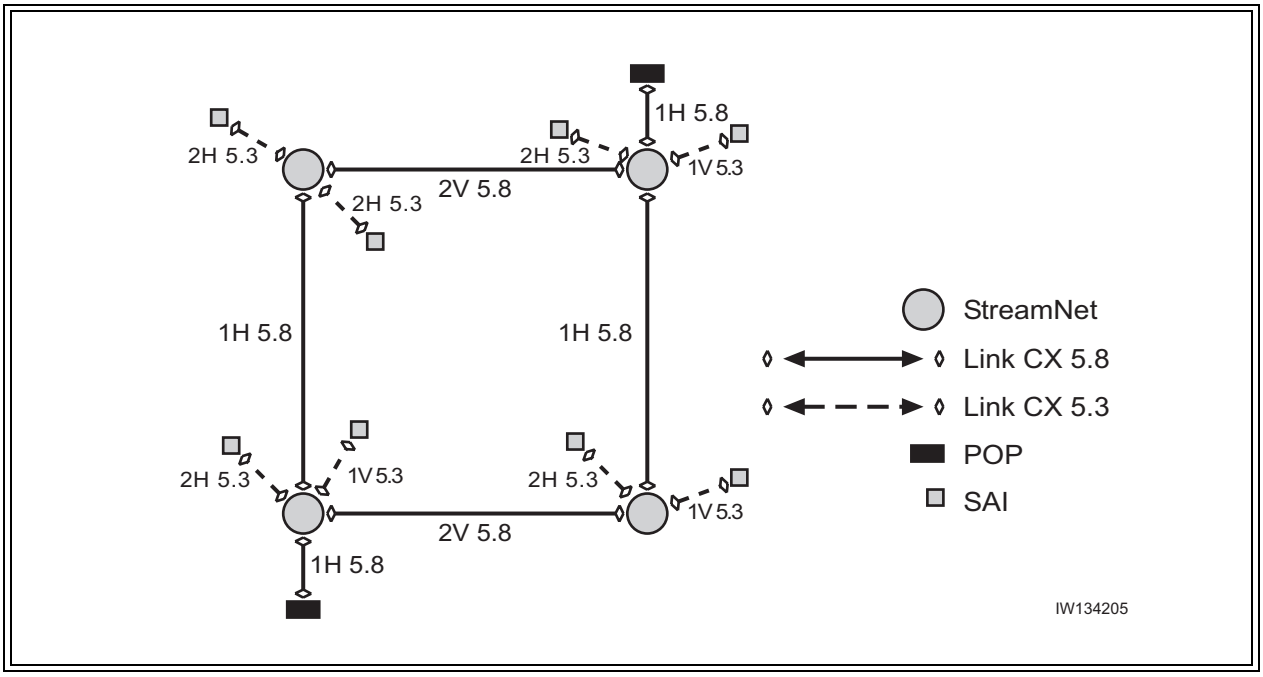


Figure 1-8 Typical Wireless ATM Mesh Backhaul Network

1-6 Specifications

Refer to Appendix 2 for Link CX specifications.

Two

Installation Steering Guide

This chapter briefly outlines the complete installation and configuration procedure for the Link CX, and a flowchart of this process is given. The topics discussed here are presented in detail in subsequent chapters of this manual.

2-1 Installation Flow Chart

The flow chart in Figure 2-1 includes references to the installation and troubleshooting sections in this manual.

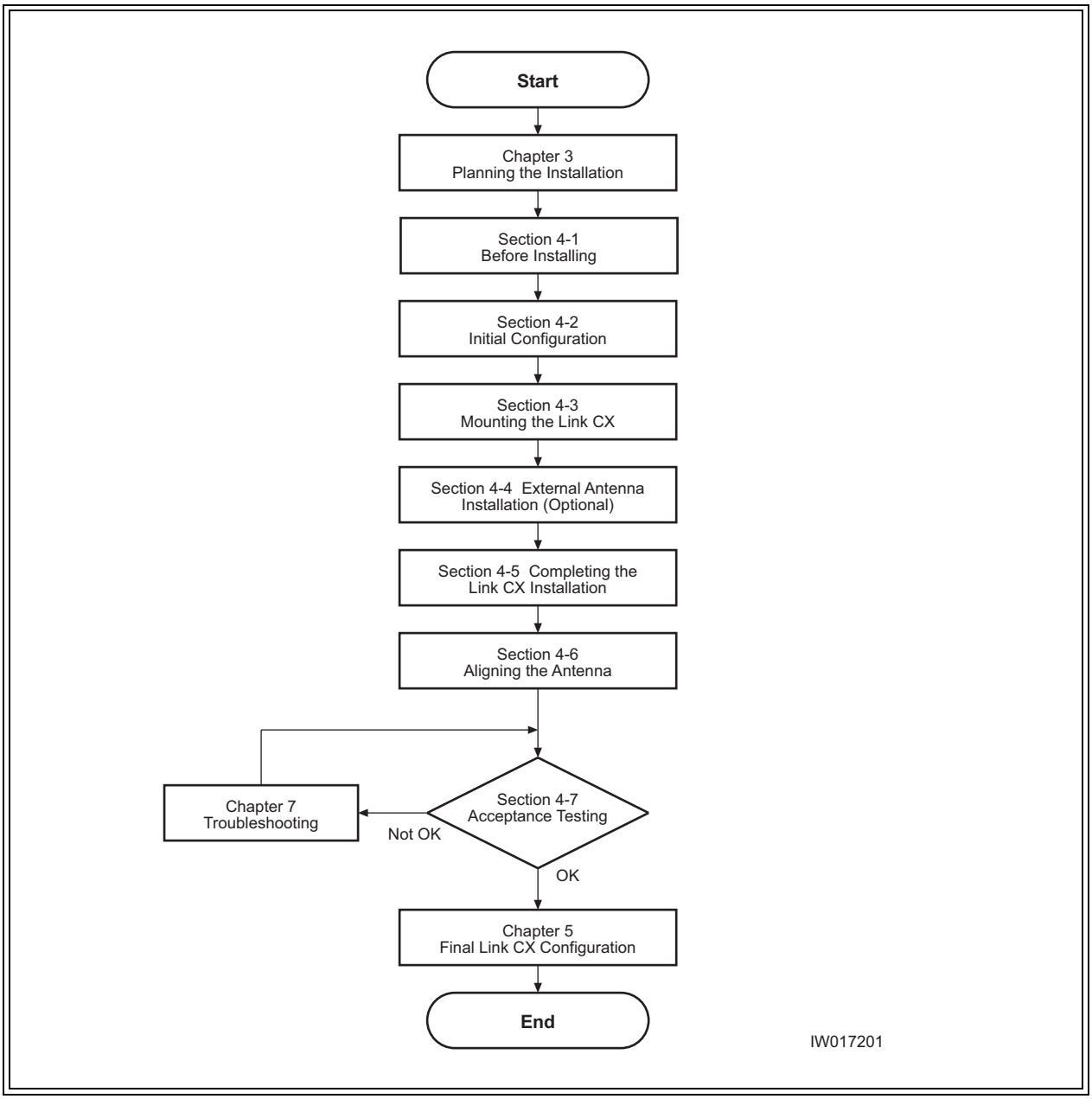


Figure 2-1 Installation Flowchart

Three

Installation Planning

This chapter provides a comprehensive planning guide for Link CX installations, and includes a Radio Link Planning Worksheet that should be filled out for each radio link. Fill out a copy of the Radio Link Planning Worksheet before continuing with Chapter Four.

In addition, this chapter provides an introduction to Network Management System (NMS) software and configuration issues.

This chapter contains the following sections:

- Section 3-1, Planning a Link CX Network
- Section 3-2, Site Planning
- Section 3-3, Planning Element and Network Management Ethernet Links
- Section 3-4, Planning DS-3 Links
- Section 3-5, Power Planning
- Section 3-6, Transmit Power Planning
- Section 3-7, Radio Link Planning

Make sure that you read through this chapter, and make a copy of and fill out the Radio Link Planning Worksheet in Section 3-7 before you continue with the Link CX installation.

3-1 Planning a Link CX Network

As described in Section 1-5, the Link CX can be used to support a number of applications. However, the two most common configurations are point-to-point and mesh network. Point-to-point configurations (Figure 1-1) are easiest to plan and implement, as the radio links merely transmit industry-standard formatted data from one location to another. Mesh network configurations (Figure 1-7) use interWAVE StreamNet ATM Switches to create networks that feature high reliability, low maintenance cost, improved scalability, and enhanced interference mitigation.

Both configurations use common point-to-point radio links, so the point-to-point radio link planning can also be applied to mesh network configurations. Generally, the common points to consider when planning a Link CX network are:

- **Line of Sight:** Unlike some frequency bands, the Link CX radios must be within line of sight of each other. That is, the far-end antenna must be visible from the near-end antenna. If there are trees, buildings, mountains, or other obstructions between the two antennas, the

Link CXs on each end of the radio link will be unable to communicate with each other. Make sure the Link CX radios used in each radio link are within line of sight of each other. Refer also to the Fresnel Zone Clearance section that follows.

- **Fresnel Zone Clearance:** There must be sufficient open space around the direct line of sight to minimize interference with the radio beam. At a minimum, 60% of the first Fresnel zone of the path should be clear.

  Even with clear line-of-sight, objects still may be near enough to the transmission path to cause problems. Obviously, objects that stand directly in the transmission path obstruct the beam, causing a drop in signal strength at the receiving end; in addition, objects and reflective surfaces that are in near proximity to the path can cause signal interference and attenuation of the received signal.

  Fresnel zones define the amount of clearance required for obstacles. These zones are series of concentric ellipsoid surfaces that surround the straight-line path between the two antennas. The first Fresnel zone is defined as the surface containing every point for which the distance from the transmitter to any reflection point on the surface and then on to the receiver is one-half wavelength longer than the direct signal path.

  The following equation shows that Fresnel zones are a function of the transmission frequency, path length, and location along the path:

$$F1 = 17.3\sqrt{\frac{d1d2}{fD}}$$ Fresnel Zones formula

  Where:

  Fl = First Fresnel zone radius in meters
  d1= Distance from transmitter to reflection point in kilometers
  d2 = Distance from reflection point to receiver in kilometers
  D = Length of direct signal path in kilometers
  f = Transmission frequency in GHz.

  An envelope at six-tenths of the first Fresnel zone (referred to simply as the Fresnel Zone Clearance) defines the minimum acceptable clearance of an obstacle (see Figure 3-1). The formula for the Fresnel Zone Clearance is shown after Figure 3-1.

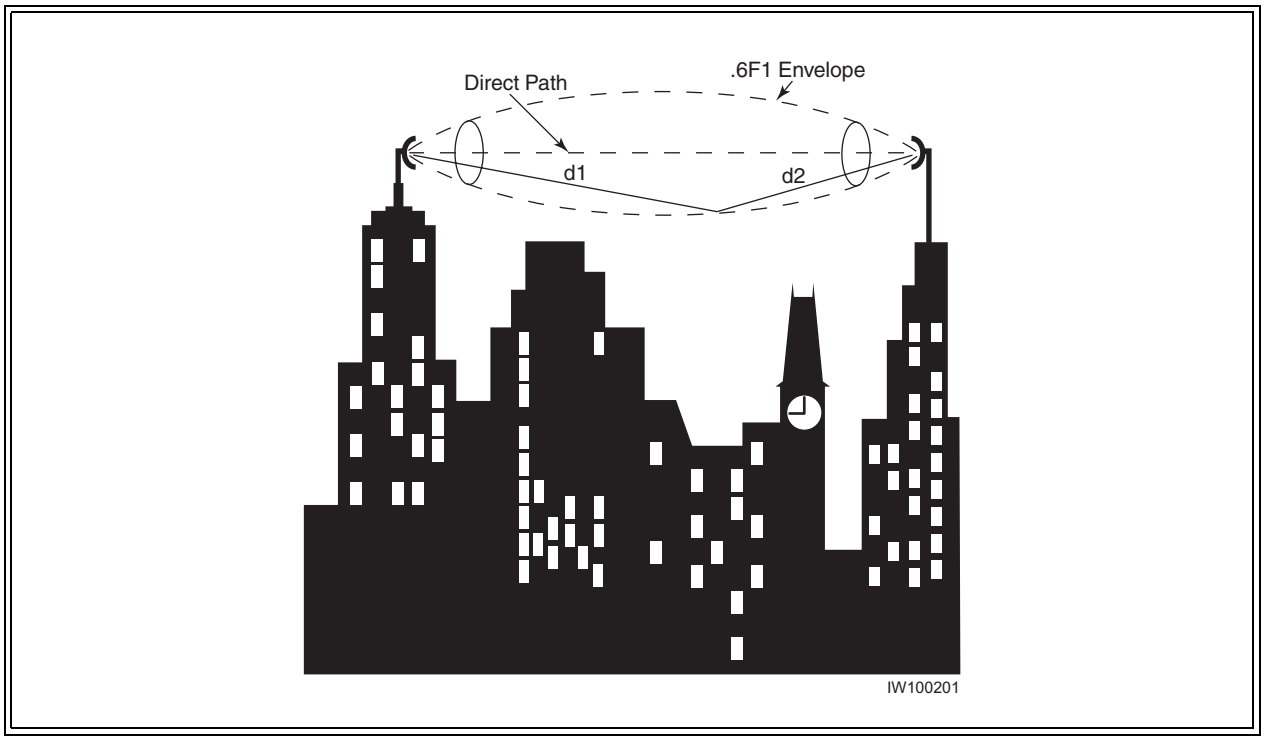


Figure 3-1 Fresnel Zone Clearance

$$0.6F1 = 10.4\sqrt{\frac{d1d2}{fD}}$$ Fresnel Zone Clearance formula

Where:

Fl = First Fresnel zone radius in meters
d1= Distance from transmitter to reflection point in kilometers
D = Length of direct signal path in kilometers
d2 = D - d1
f = Transmission frequency in GHz.

Figure 3-1 shows that the Fresnel zone radius is greatest at midpath. It is at this point that the required obstacle clearance is greatest. The equation given previously yields the 0.6F1 minimum beam clearance envelope values at midpath as shown in Table 3-1. Also use the equation to calculate the necessary minimum beam clearance envelope for other obstacles along the path, especially near both endpoints of the path.

Table 3-1 Beam Clearance Envelope at Midpath

Path Distance	Midpath Minimum Beam Clearance Envelope (Note)
2 km	7 m
5 km	11 m
10 km	15 m
20 km	21 m
32 km	27 m
1 mile	20 ft
3 miles	34 ft
6 miles	48 ft
12 miles	69 ft
20 miles	88 ft
Note: The minimum beam clearance envelope is defined by the radius around the direct path shown in Figure 3-1, within which there must be no obstacles.	

The Fresnel zone surrounds the direct signal path, so it affects objects to the side of the path as well as objects directly in the path.

- **Multipath Fading:** See Figure 3-2. Because a Link CX terminal typically transmits its strongest signals in a cone-shaped pattern, some of the signal may be reflected from a nearby building, from water under the signal path, or from other RF reflectors. This reflected signal can then be received by the far-end Link CX and superimposed on the main signal, usually degrading the signal strength. To avoid multipath fading, interWAVE recommends that you install the Link CX antenna on the back, rather than the front, of buildings to avoid multipath fading from water or other ground-level surfaces, and that you plan radio links away from nearby buildings.

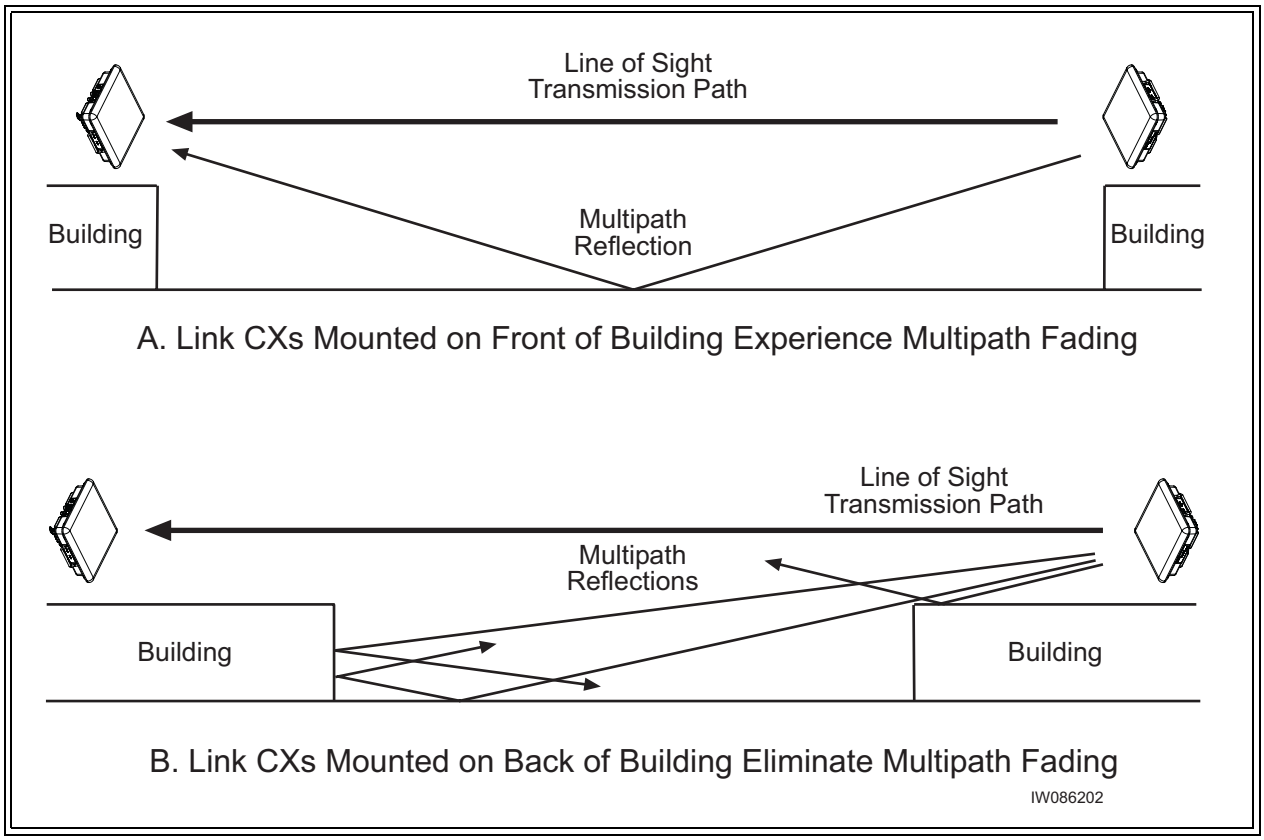


Figure 3-2 Preventing Multipath Fading from Ground-Level Surfaces

- **External Interference:** Because the Link CX operates in an unlicensed band, interWAVE strongly recommends that you use a spectrum analyzer at both ends of planned radio links, with the receiving antenna as close to the proposed Link CX antenna mounting spot as possible. Use a polarized antenna, and scan for both horizontally- and vertically-polarized interfering radiation. If you find external interference in either of the two (High or Low) bands, configure the Link CX for the least-impacted band. Refer to Table 3-3 for the High and Low bands for the Link CX radio.

3-2 Site Planning

Each proposed Link CX terminal site requires a site survey and plan for the following:

- **Power:** The Link CX radio requires a +/-21 to +/-60 VDC power source. Make sure required power supply is available before installing the Link CX.
- **Mounting Point:** The Link CX is usually mounted on a vertical mast or pole mounted on a building or a tower. The Link CX mounting bracket can accommodate a 4.5- to 11.5-cm (1.75- to 4.5-in.) diameter mast or pole.

  When the Link CX is equipped with an external antenna, the antenna and the Link CX radio should be mounted so the factory-supplied 2 m (79 in.) can be used to connect the antenna to the Link CX.
- **Grounding and Lightning Protection:** The Link CX radio requires adequate grounding and lightning protection. If the mounting point described above provides adequate lightning protection, the Link CX radio will still need a good earth ground to a bare-metal earth ground. Refer to Appendix 4 for detailed grounding and lightning protection recommendations.
- **Cable Routing:** The Link CX DS-3 and/or Ethernet data cables connect associated external equipment to the Link CX radio. Before installation, procure cable ties and/or standoffs to route and to create service loops for these cables.
- **Physical Security:** The Link CX radio is typically mounted high enough to prevent casual tampering. The Link CX radio is further protected by anti-tampering chassis screws that prevent most casual attempts to open the chassis.

3-3 Planning Element and Network Management Ethernet Links

The Link CX communicates with SNMP-based Element Management Systems and Network Management Systems over Ethernet communication links. Because the Link CX contains two independent switched Ethernet ports, each Link CX can be connected directly to an Ethernet switch or router, and colocated Link CXs can be cascaded. Figure 3-3 shows some common arrangements for the EMS and/or NMS Ethernet links.

The cable run from the Ethernet switch or router to the Link CX must be 100 m (328 ft.) or less, and can be straight-through or crossover, because the Link CX Ethernet ports automatically detect the transmit and receive pairs and switch them if necessary. interWAVE sells 25 m (82 ft.), 50 m (14 ft.), and 100 m (328 ft.) Ethernet cables with the correct connectors for these links, as described in Section 1-4.6.

Alternatively, when Link CXs are to be cascaded as shown in Figure 3-3 (B), interWAVE sells a 6 m (20 ft.) Ethernet cable with the correct connectors for the Link CX-to-Link CX links, as described in Section 1-4.6.

Note that the EMS or NMS must be within eight or fewer Ethernet hops of the Link CX for proper communications.

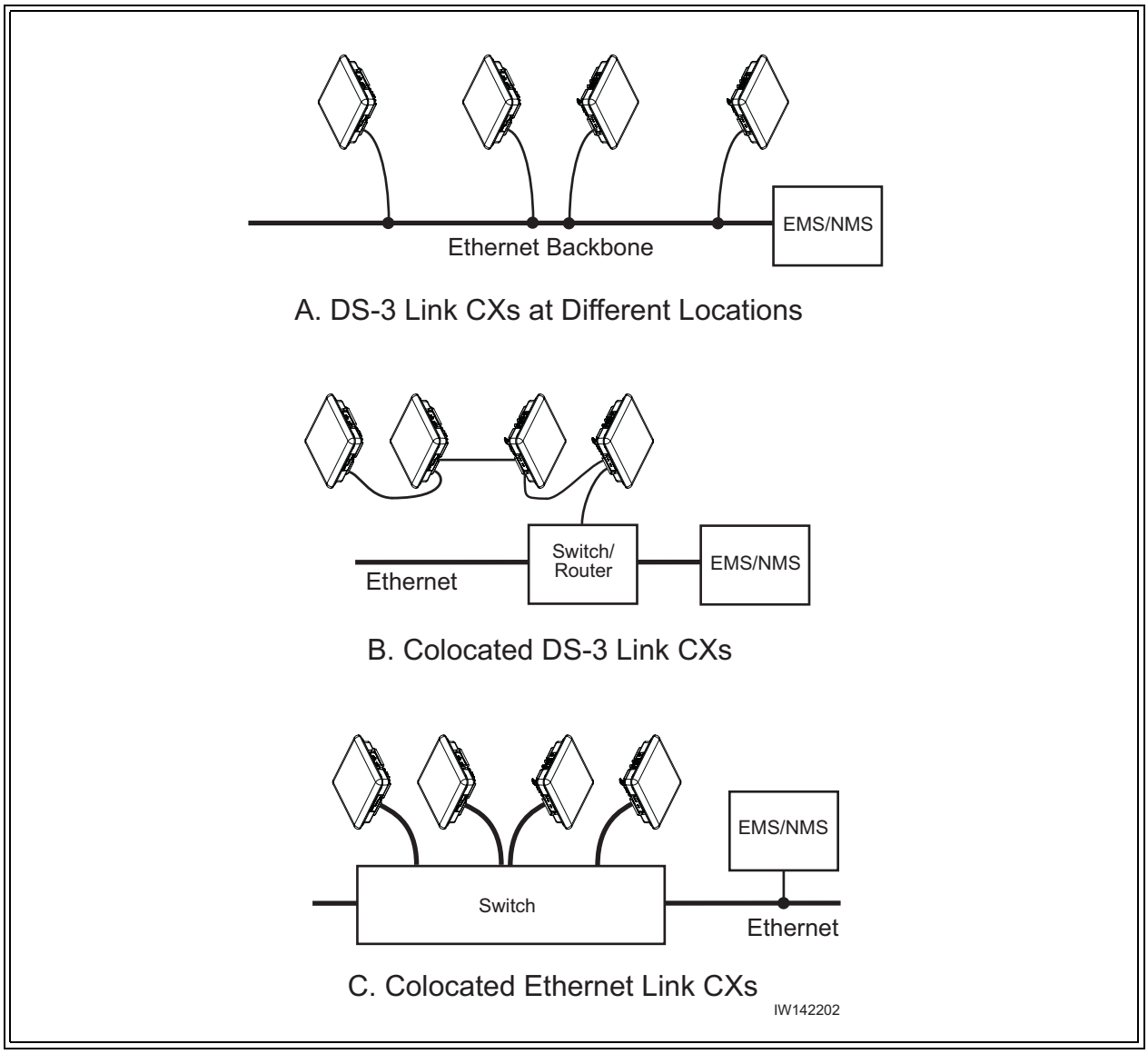


Figure 3-3 Typical EMS/NMS Ethernet Connections

3-4 Planning DS-3 Links

The Link CX DS-3 versions use paired 75 Ohm cables with male TNC connectors for the transmit and receive data from external DS-3 equipment. interWAVE sells 25 m (82 ft.), 50 m (14 ft.), and 100 m (328 ft.) DS-3 cables with the correct connectors for these links, as described in Section 1-4.6.

Alternatively, when a StreamNet ATM Switch is connected to the Link CX, interWAVE sells a 6 m (20 ft.) DS-3 cable with the correct connectors for this link, as described in Section 1-4.6.

3-5 Power Planning

interWAVE sells 25 m (82 ft.), 50 m (14 ft.), and 100 m (328 ft.) power cables with the correct connectors for Link CX power, as described in Section 1-4.6.

3-6 Transmit Power Planning

The Link CX normally uses a manually-set output power level. When Automatic Transmit Power Control (ATPC) is enabled, the far-end Link CX terminal provides feedback to the near-end Link CX to lower the transmit power to the lowest level required for clear data transmission.

Transmit power can be attenuated by 40 dB for initial configuration and interference isolation. Also, a maximum transmit power level can be set (whether or not ATPC is enabled) to prevent interference with other RF receivers.

3-6.1 Maximum Link CX Power Output

Since the Link CX can be ordered in a number of configurations, with different gains for each of the associated antennas, use the Table 3-2 to determine the maximum power output. Note that the factory-supplied external antenna attenuates the maximum power output by approximately 0.5 dB.

Table 3-2 Maximum Power Output by Model Configuration

Model	Frequency Band	Link Carries	Antenna	Max Tx Power
M100746-101 M100747-101 M100746-201 M100747-201	5.25-5.35 GHz	DS-3 or Ethernet (45 Mbps)	Integral	-1 dBm +21 dBi = +20 dBm Average EIRP
M100748-101 M100749-101 M100748-201 M100749-201	5.725-5.825 GHz	DS-3 or Ethernet (45 Mbps)	Integral	+16 dBm +21 dBi = 37 dBm EIRP
M100748-102 M100749-102 M100748-202 M100749-202			External, 61 cm (2 ft.)	+16 dBm +28 dBi -0.5 dB = 43.5 dBm EIRP
M100748-102 M100749-102 M100748-202 M100749-202			External, 122 cm (4 ft.)	+16 dBm +34.6 dBi -0.5 dB = 50.1 dBm EIRP

3-6.2 Calculating the Required Transmit Power

The Link CX will normally use the maximum transmit power listed in Table 3-2, but may need to be attenuated when there are other receivers beyond the remote Link CX terminal (for instance, in a mesh network). In this case, the professional installer must use the free-space calculation to determine the actual Maximum Transmit Power to prevent interference.

3-7 Radio Link Planning

As described in Section 1-4, each radio link requires one Link CX at each end of the link. Before you start installing your Link CXs, fill in the following information for both ends of the radio link:

Table 3-3 Radio Link Planning Worksheet

	Link CX 1 - High Band	**Link CX 2 - Low Band**
Information Common to Both Link CX Radios		
Radio Link Name:		
Radio Link Information:		
Radio Link Polarization (pick one, must be the same for both): HORIZONTAL VERTICAL		
Radio Link Payload (as ordered, must be the same for both): DS-3 Ethernet		
Information Unique to Each Link CX Radio		
Model Number (see Link CX Label & Table 1-1)	M1007 _ _ - _ 0 _ (high band)	M1007 _ _ - _ 0 _ (low band)
Antenna Type (pick one)	Integral 61 cm (2 ft.) 122 cm (4 ft.)	Integral 61 cm (2 ft.) 122 cm (4 ft.)
Radio Link Channel and Band Center Frequency (pick one pair, must be different)	Channel 1 High Band, 5.3 GHz: Tx--5.322 GHz/ Rx--5.262 GHz (default)	Channel 1 Low Band, 5.3 GHz: Tx--5.262 GHz/ Rx--5.322 GHz
	Channel 2 High Band, 5.3 GHz: Tx--5.338 GHz/ Rx--5.278 GHz	Channel 2 Low Band, 5.3 GHz: Tx--5.278 GHz/ Rx--5.338 GHz
	Channel 1 High Band, 5.8 GHz: Tx--5.797 GHz/ Rx--5.737 GHz (default)	Channel 1 Low Band, 5.8 GHz: Tx--5.737 GHz/ Rx--5.797 GHz
	Channel 2 High Band, 5.8 GHz: Tx--5.813 GHz/ Rx--5.753 GHz	Channel 2 Low Band, 5.8 GHz: Tx--5.753 GHz/ Rx--5.813 GHz
Transmit Attenuation (default = Disable)	Enable Disable	Enabled Disable
Maximum Transmit Power (refer to Section 3-6.2)	__ dBm	__ dBm
Automatic Tx Power Control (refer to Section 3-6)	Enable Disable	Enabled Disable

Table 3-3 Radio Link Planning Worksheet (continued)

	Link CX 1 - High Band	**Link CX 2 - Low Band**
IP Address (must be different, obtain from IP network planner)	_ _ _ . _ _ _ . _ _ _ . _ _ _	_ _ _ . _ _ _ . _ _ _ . _ _ _
Subnet Mask (obtain from IP network planner)	_ _ _ . _ _ _ . _ _ _ . _ _ _	_ _ _ . _ _ _ . _ _ _ . _ _ _
Default Gateway (obtain from IP network planner)	_ _ _ . _ _ _ . _ _ _ . _ _ _	_ _ _ . _ _ _ . _ _ _ . _ _ _
RSSI Alarm Level (default = -70 dBm)	- __ dBm	- __ dBm
Alarm on Loss of DS-3 or Ethernet Input Signal	Enabled Disable	Enabled Disable
Login Name (up to 19 ASCII characters, including numbers and ! $ ‘ * + - _)		
Login Password (8 - 19 ASCII characters, including numbers and ! $ ‘ * + - _)		
Allow Login From IP Addresses (don’t forget Craft PC)	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _
SNMP Trap Community (default = public, up to 19 ASCII characters starting with an alpha character, including numbers and - _ .)		
Send SNMP Traps to	_ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _	_ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _
Read/Write Community (default = public, up to 19 ASCII characters starting with an alpha character, including numbers and - _ .)		
Allow Read/Write Access From	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _ _ _ _ . _ _ _ . _ _ _ . _ _ _

Table 3-3 Radio Link Planning Worksheet (continued)

	Link CX 1 - High Band	**Link CX 2 - Low Band**
Read-Only Community (default = public, up to 19 ASCII characters starting with an alpha character, including numbers and - _ .)		
Allow Read-Only Access From	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _	Any (default) -OR- _ _ _ . _ _ _ . _ _ _ . _ _ _
System Name (optional, up to 255 ASCII characters)		
System Contact Information (optional, up to 255 ASCII characters)		
System Location (optional, up to 255 ASCII characters)		

Four

Installing the Link CX

This chapter describes the physical installation of the Link CX. Each Link CX consists of an outdoor pole-mounted radio with integral antenna or optional external antenna. If so equipped, the Link CX radio is connected to the external antenna with a factory-supplied coaxial cable.

> **NOTE** For faster installation, make sure you have a filled-out copy of the Radio Link Planning Worksheet from Chapter Three before continuing with the rest of this chapter.

This chapter covers the following topics:

- Section 4-1, Before Installing, includes general guidelines, equipment unpacking, inventory and tools
- Section 4-2, Initial Configuration, includes all the steps necessary to configure the Link CX radio before mounting it (and its optional external antenna) on the pole
- Section 4-3, Mounting the Link CX, includes steps for installing the Link CX (and its optional external antenna) on the pole
- Section 4-4, External Antenna Installation (Optional), includes optional external antenna installation steps
- Section 4-5, Completing the Link CX Installation, describes installed Link CX cabling and grounding
- Section 4-6, Aligning the Antenna, includes Link CX antenna alignment steps
- Section 4-7, Acceptance Testing, includes Link CX acceptance tests

This chapter describes initial configuration and installation of the Link CX hardware. After completing this chapter, the installer should proceed to Chapter Five to perform a final configuration on the Link CX radio after hardware installation.

> **NOTE** This device must be professionally installed.

NOTE This device is to be exclusively used for fixed point-to-point operation with directional antennas.

4-1 Before Installing

Before you continue with this installation, make sure you have a filled-out copy of the Radio Link Planning Worksheet found in Section 3-7.

4-1.1 General Guidelines

The installation, maintenance, or removal of antenna systems requires qualified, experienced personnel. Link CX installation instructions have been written for such personnel.

NOTE Before installing the Link CX radio, it is recommended that installation personnel read this chapter in its entirety. If installation personnel are unfamiliar with the radio components, we recommend reading Chapter One. After reading through the full installation procedure, installation personnel may proceed to the relevant sections in this chapter.

Since Link CX is easy to install, a previously installed Link CX can be conveniently moved to a new location. Re-deployment allows the user to meet the requirements of a changing system with minimal effort and expense. Thus, installation personnel should assume that the activities described in this chapter are not one-time procedures but will have to be repeated from time to time.

This manual assumes that the site power and grounding have already been installed. This manual also assumes that the antenna mounting pole has been installed before installing the Link CX. When installing and aligning a Link CX radio or associated radio link, the user should always have on hand the required tools, test equipment and any other required miscellaneous installation devices and materials.

NOTE The Link CX electronics have been designed to be maintenance free, and the outdoor components are very rugged. However, because of continued exposure to weather, it is recommended that qualified personnel inspect antenna systems once a year to verify proper installation, maintenance, and condition of equipment.

interWAVE disclaims any liability or responsibility for the results of improper or unsafe installation practices.

4-1.2 Equipment and Unpacking

> **NOTE** interWAVE suggests that the user retain at least one (1) of each packing carton with all its packing materials. In the event that it is necessary to return a unit, the user will have the required packing material for safe shipment.

Each Link CX radio is shipped with the Link CX User's Manual on CD-ROM, and a separate box contains the optional 5.8 GHz external Antenna Mount Assembly, U-bolts and antenna with tube attachment. Unpack each box and examine the exterior of each unit for any visible damage. If visible damage is detected, immediately contact your sales representative or interWAVE Customer Support.

The equipment shipped (Link CX radio with or without external antenna) depends on the specific purchase order as described in Table 1-1.

4-1.3 Packing Lists and Orderable Parts

Each packing carton is accompanied by a packing list. Verify the contents of the carton against the packing list. Regardless of the packing list parts described here, the shipped packing list is binding.

Note the warranty sticker on the Link CX. The Link CX radio is sealed at the factory. Tampering with these seals voids the warranty.

See Figure 4-1 for a picture of the orderable Link CX parts, and see Table 4-1 for a high-level description of the orderable parts.

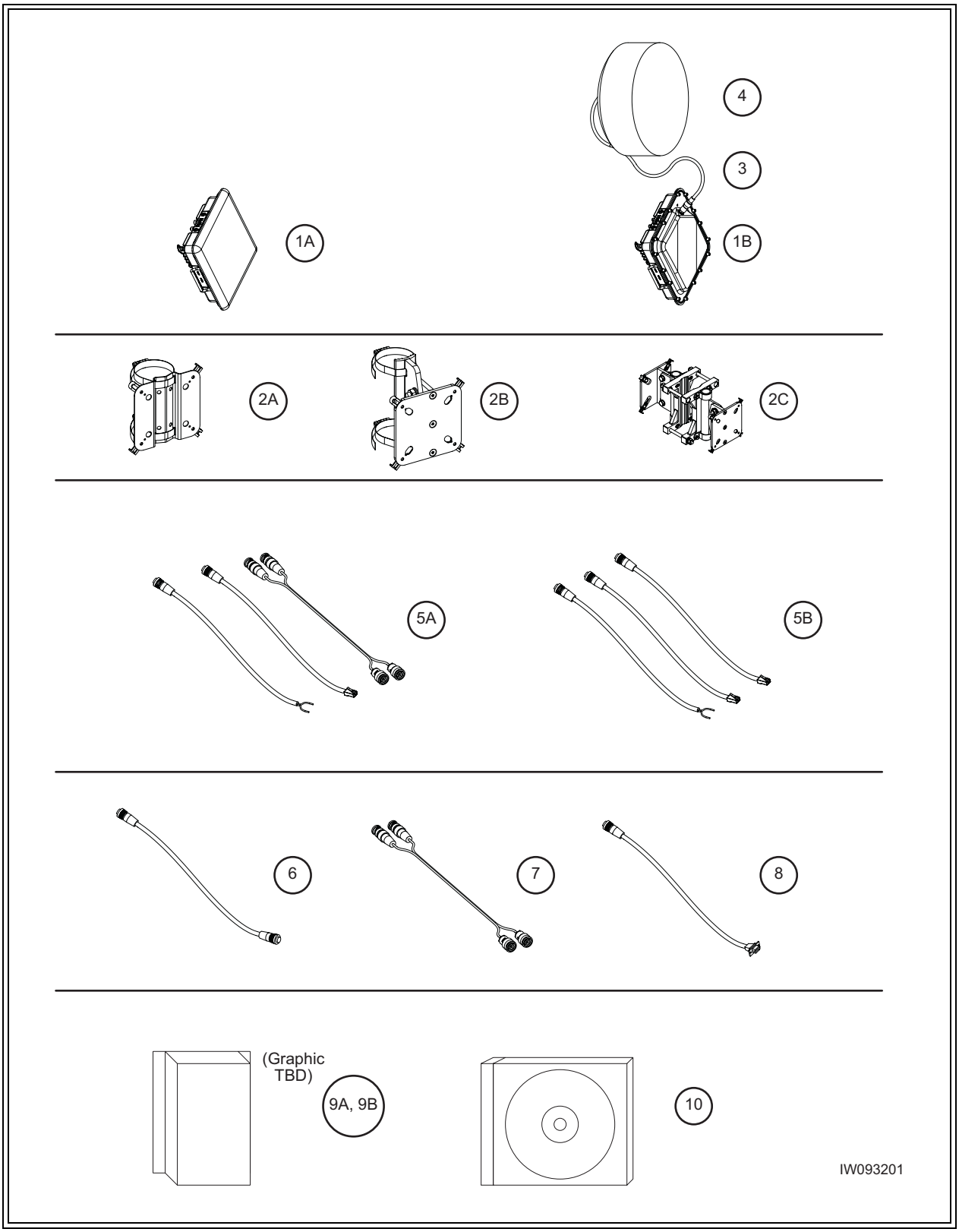


Figure 4-1 Link CX Orderable Parts

Table 4-1 Link CX Radio Orderable Parts

Item	Qty	Part Number	Description		See Also
1A	1	See Table 1-1	Link CX Radio, Integral Antenna		Section 1-4.3
1B	1	See Table 1-1	Link CX Radio, External Antenna		Section 1-4.3
2A	1	100607-001	Non-Adjustable Elevation Single Link CX Radio Bracket		Section 1-4.4
2B	1	100680-001	Adjustable Elevation Single Link CX Radio Brackets		Section 1-4.4
2C	1	100694-001	Adjustable Elevation Dual Link CX Radio Brackets		Section 1-4.4
3	1	AC100008	Optional 2 m (6.5 ft.) N-to-N External Antenna RF Cable (required for some 5.8 GHz Link CX models)		Section 1-4.6
4	1	TBD TBD	61 cm (2 ft.) 122 cm (4 ft.)	Optional Single Polarization External Parabolic Antenna with Mounting Bracket	Section 1-4.6
5A	1	100763-001 100764-001 100765-001	25 m (82 ft.) 50 m (164 ft.) 100 m (328 ft.)	DS-3 Payload Data Cables and Power Cable Kit	Section 1-4.6
5B	1	100766-001 100767-001 100768-001	25 m (82 ft.) 50 m (164 ft.) 100 m (328 ft.)	10/100 Ethernet Payload Data Cable and Power Cable Kit	Section 1-4.6
6	1	100655-001	6 m (19.7 ft.) Link CX-to-Link CX 10/100 Ethernet Crossover Cable		Section 1-4.6
7	1	100588-003	6 m (19.7 ft.) Dual 75 Ohm DS-3 TNC-to-TNC StreamNet ATM Switch Ethernet Cable		Section 1-4.6
8	1	100586-001	Optional 6 m (19.7 ft.) Craft PC 4-pin Circular-to-DB9 RS-232 CLI Cable		Section 1-4.6
9A	1	TBD	Optional Transtector Lightning Arrestor Kit used at the cable entry to the Power, DS-3 and Ethernet Equipment Structure		Appendix 4
9B	1	TBD	Optional Transtector Lightning Arrestor Kit used at the cable entry to the 10/100 Ethernet and Power Equipment Structure		Appendix 4
10	1	100757-001	User Manual CD-ROM		Preface

4-1.4 Installation Tools and Materials

Tools

The user should have at least the following tools on hand before installing the Link CX radio:

Table 4-2 Required Installation Tools

Tools	Purpose
13 mm (11/16 in.) and YY mm (XX in.) and RR mm (SS in.) torque wrench	Tighten the pole mount assembly to the pole and tighten the alignment lockdown bolts
Optical aid or compass (optional)	For coarse antenna azimuth alignment
Vertical level (optional)	For coarse antenna elevation alignment
Hand-held voltmeter, including cable with BNC adapter	Fine-tune the antenna alignment
Large Flat-Blade Screwdriver	Tighten the steel band clamps, when required

Materials

Refer to Section 4-1.3 and collect the following materials:

- For DS-3 models:
  - DS-3 coaxial cables to the Link CX.
  - Ethernet data interface cables to the Link CX.
- For Ethernet models:
  - Ethernet data interface cables to the Link CX.
- For all models:
  - Power cable to the Link CX.
  - Dual DS-3 coaxial cables to the StreamNet ATM Switch or other equipment.
  - Optional RS-232 cable to Craft PC command line interface. (Future option.)
  - Standoffs and/or tie wraps (or similar) for fastening cables.
  - Vinyl (or equivalent) electrical tape.
  - Butyl rubber amalgamating connector sealing tape.
  - Customer-supplied solid wire or tape (not braided) grounding wire.
  - Lightning arrestors.
  - Optional 2 W, 50 Ohm load with N-Type connector used during initial configuration of Link CXs with external antennas.

4-2 Initial Configuration

interWAVE strongly recommends that the installer configure the Link CX at a depot or on-site before it is mounted in its final location. This section includes instructions on how to configure the Link CX before it is installed.

Because you can expose yourself to harmful RF radiation any time the Link CX is powered up, do not stand within 2 m (79 in.) of the antenna during Link CX operation. The installer is responsible for ensuring that the antenna is mounted in a place inaccessible to the public.

4-2.1 Connecting a Craft PC to the Link CX

For faster configuration, make sure you have a filled-out copy of the Radio Link Planning Worksheet from Chapter Three before continuing with the rest of this section.

The equipment used to configure the Link CX is a Craft PC with 10/100 Ethernet port and cable, equipped with any current web browser and Adobe Acrobat Reader software. Figure 4-2 shows how to connect the Craft PC and power to the Link CX for initial configuration.

Perform the following steps:

1. (Only for Link CXs with external antennas.) When you are configuring a Link CX with an external antenna, connect the external antenna or a 2 W, 50 Ohm load to the antenna port. This prevents harm to the Link CX internal circuits should full RF power be applied without a load.
2. If necessary, use the instructions provided with your Craft PC operating system to change the Craft PC ethernet address to 10.0.0.1.
3. Turn off power to the Craft PC to prevent damage to the Ethernet port receive circuitry.
4. Using a factory-supplied ethernet cable, connect an Ethernet-port equipped Craft PC to the Link CX as shown in Figure 4-2.
5. MAKE SURE the antenna is pointing away from your work area before you apply power to the Link CX, and MAKE SURE you stay at least 2 m (79 in.) from the front of the antenna while the Link CX is connected to power.
6. Using a factory-supplied power cable, connect an external power supply to the Link CX as shown in Figure 4-2.
7. Turn on power to the Craft PC and verify that the Ethernet port is active. Note that the Link CX Ethernet switch will auto-detect transmit and receive pairs, and you should detect an Ethernet connection within a few seconds of port activation.

The Link CX is now powered on and transmitting RF, and the Craft PC is now ready to log onto the Link CX internal web main page.

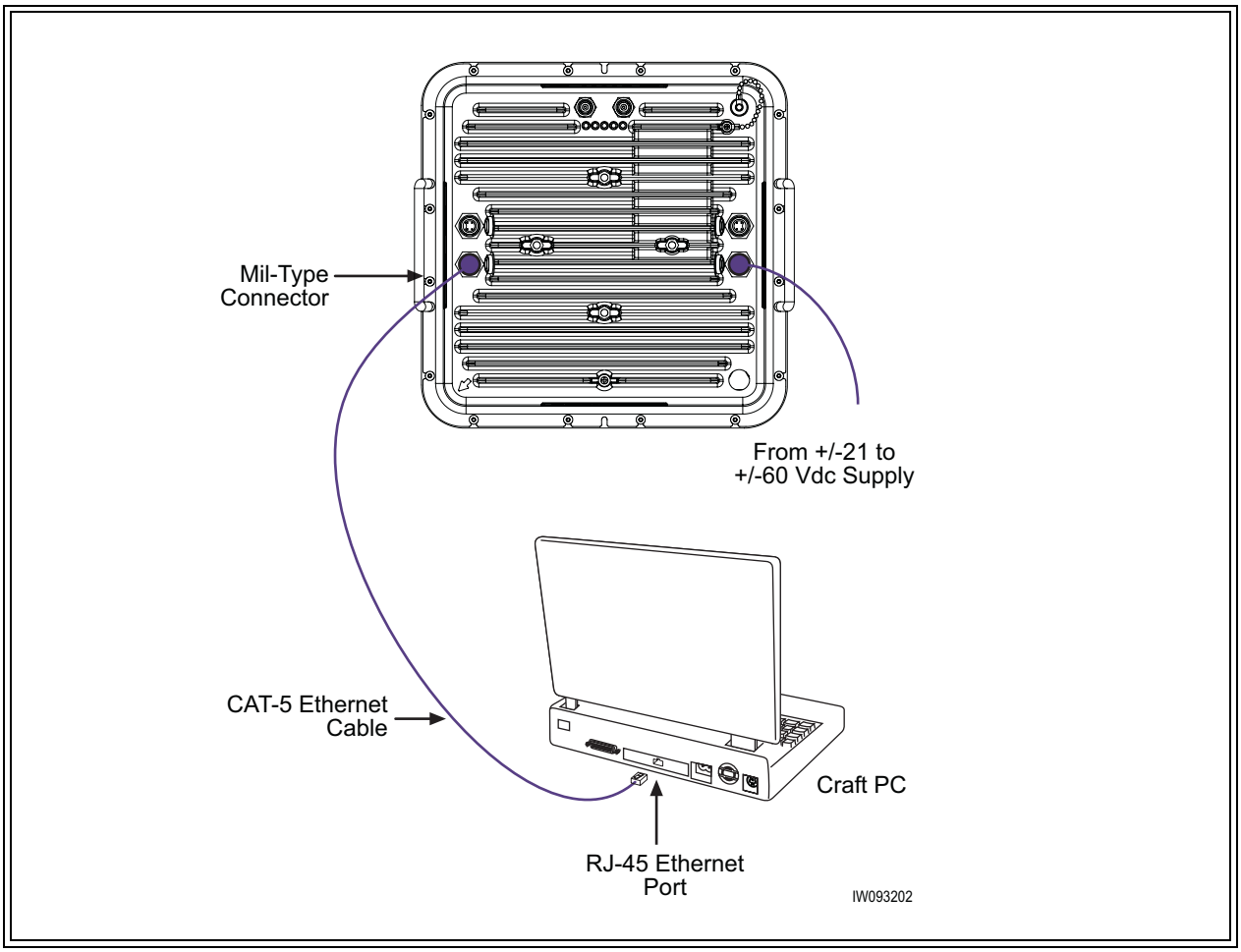


Figure 4-2 Link CX Configuration Setup

4-2.2 Logging In to the Link CX Built-In Web Server

After you have connected and powered up the Link CX and the Craft PC as described in Section 4-2.1, use the web browser on the Craft PC to log into the Link CX built-in web server as follows:

8 Launch the web browser per the manufacturer's instructions.

9 Open the web page at ethernet address 10.0.0.2 (transmit low models) or 10.0.0.3 (transmit high models) in the web browser.

If the web browser ethernet address has been changed, use the replacement ethernet address instead of 10.0.0.x..

10 If the Link CX has not been configured for a login and password, continue with Step 11. If the Link CX has already been configured for a login and password, enter both and continue with Step 11.

11 The web browser displays the Monitor Page, similar to the one shown in Figure 4-3. Note that the values shown for each of the parameters will vary, depending on the state of the Link CX.

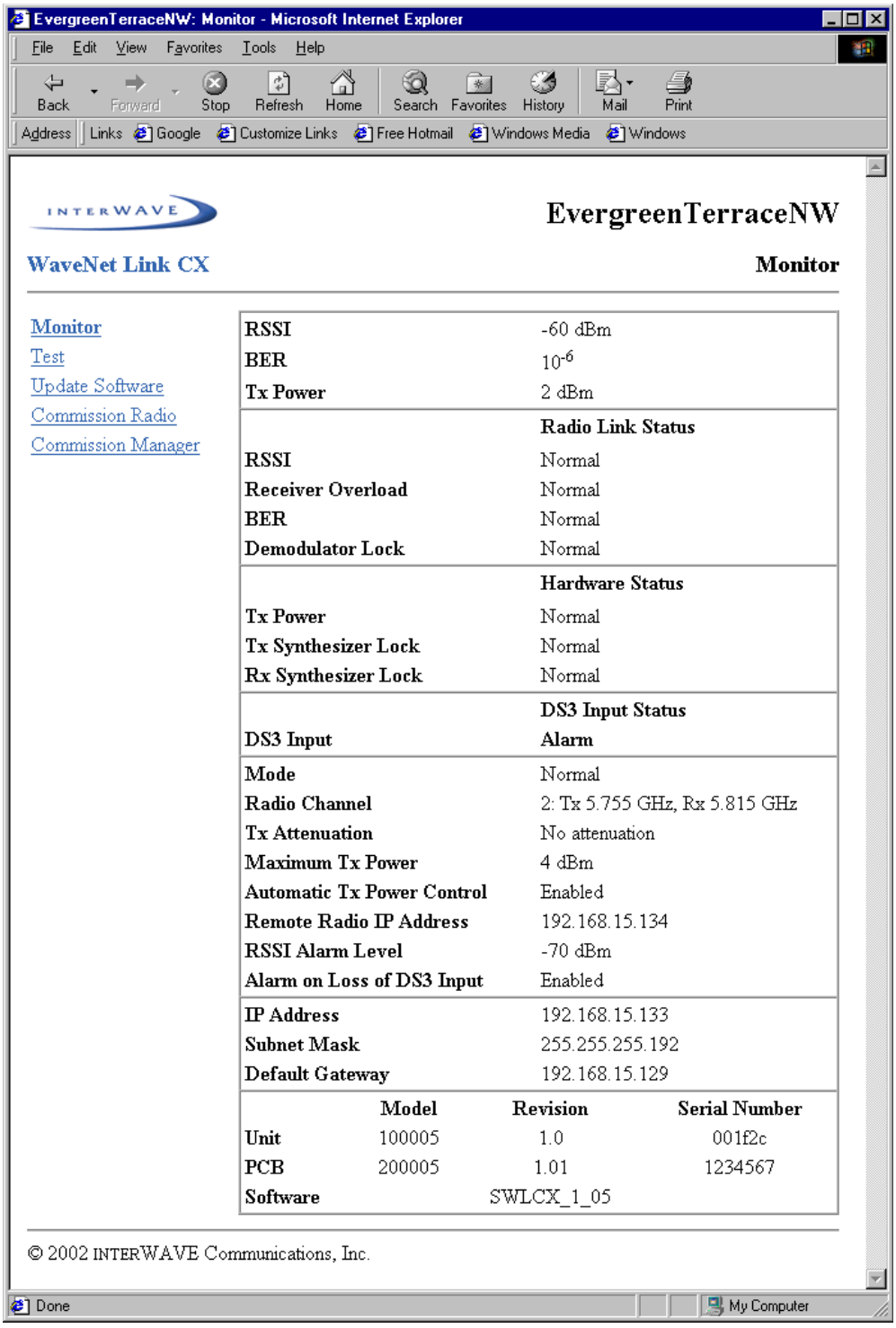


Figure 4-3 Typical 5.8 GHz Link CX Monitor Web Page

12 On the Monitor page, select the link for the Commission Radio page. The web browser displays the Commission Radio page, similar to the sample shown in Figure 4-4.

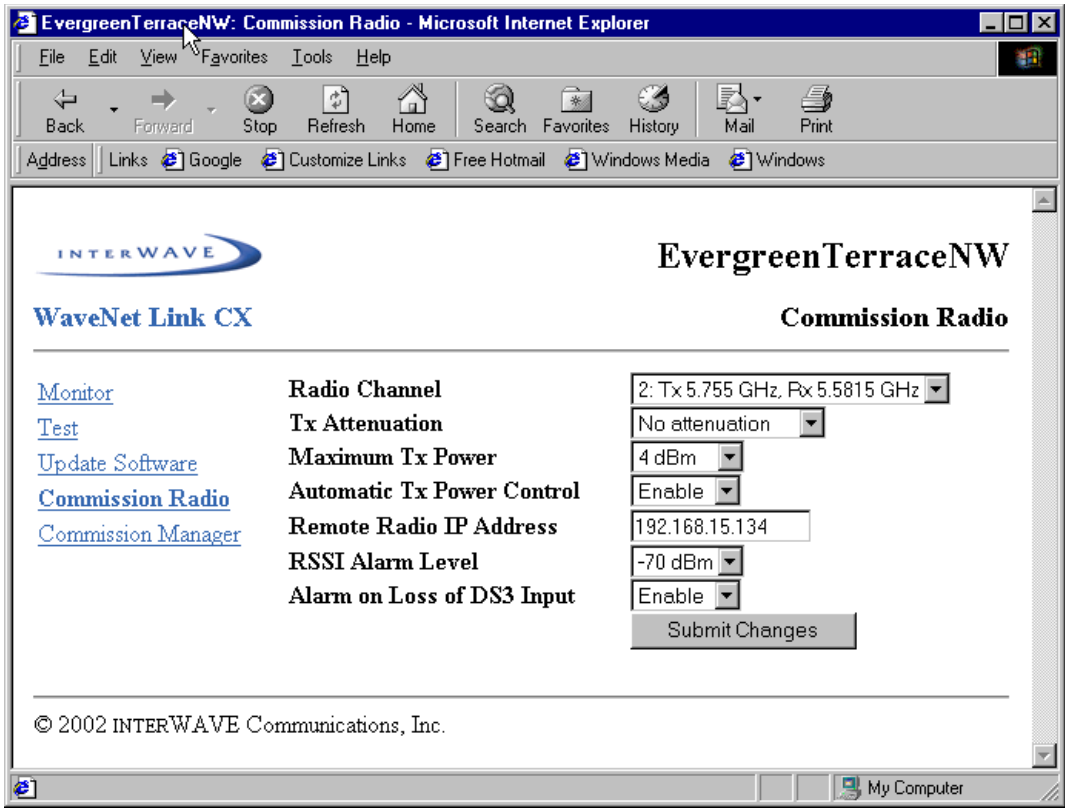


Figure 4-4 Typical 5.8 GHz Link CX Commission Radio Web Page

NOTE The Link CX is shipped with Tx Attenuation disabled. Enable Tx Attenuation until the rest of the Link CX configuration steps are completed.

13 Using the data entered on the filled-out copy of the Radio Link Planning Worksheet from Chapter Three, select the planned configuration choices available on this page, except the final Tx Attenuation and the Automatic Tx Power Control values. Enable the Tx Attenuation and disable the Automatic Tx Power Control for now.

14 Click Submit Changes to upload changes to the Link CX.

15 On the Commission Radio page, select the link for the Commission Interfaces page. The web browser displays the Commission Manager Interfaces page, similar to the sample shown in Figure 4-5.

16 Using the data entered on the filled-out copy of the Radio Link Planning Worksheet from Chapter Three, select the planned configuration choices available on this page.

17 Click Submit Changes to upload changes to the Link CX.

18 On the Commission Manager Interfaces page, select the link for the Test page. The web browser displays the Test page, similar to the sample shown in Figure 4-6.

19 On the Test page, select the BERT + Radio Loopback test, and select One Minute. Select Start Test to verify the internal Link CX circuitry before installation.

When the BERT + Radio Loopback test is complete, the Link CX has been configured, and the internal signal generation, transmit, receive, and detecting circuitry of the Link CX has been tested. Continue with Step 18.

20 On the Test page, select the link for the Commission Radio page. The web browser again displays the Commission Radio page, similar to the sample shown in Figure 4-4.

Do not stand within 2 m (79 in.) of the front of the antenna during Link CX operation to avoid harmful RF radiation.

21 On the Commission Radio page, set the Tx Attenuation to disabled. This causes the Link CX to transmit at the level set by the Maximum Transmit Power parameter.

22 Disconnect power from the Link CX to prepare it for mounting in its final location.

23 Disconnect the Craft PC from the Link CX.

24 (Only for Link CXs with external antennas.) When you have configured a Link CX with an external antenna, disconnect the external antenna or 50 Ohm load from the antenna port. This makes it easier to mount the Link CX and the external antenna in their final locations.

After completing this section, the Link CX radio is configured and partially tested, and is ready to install as described in Section 4-3.

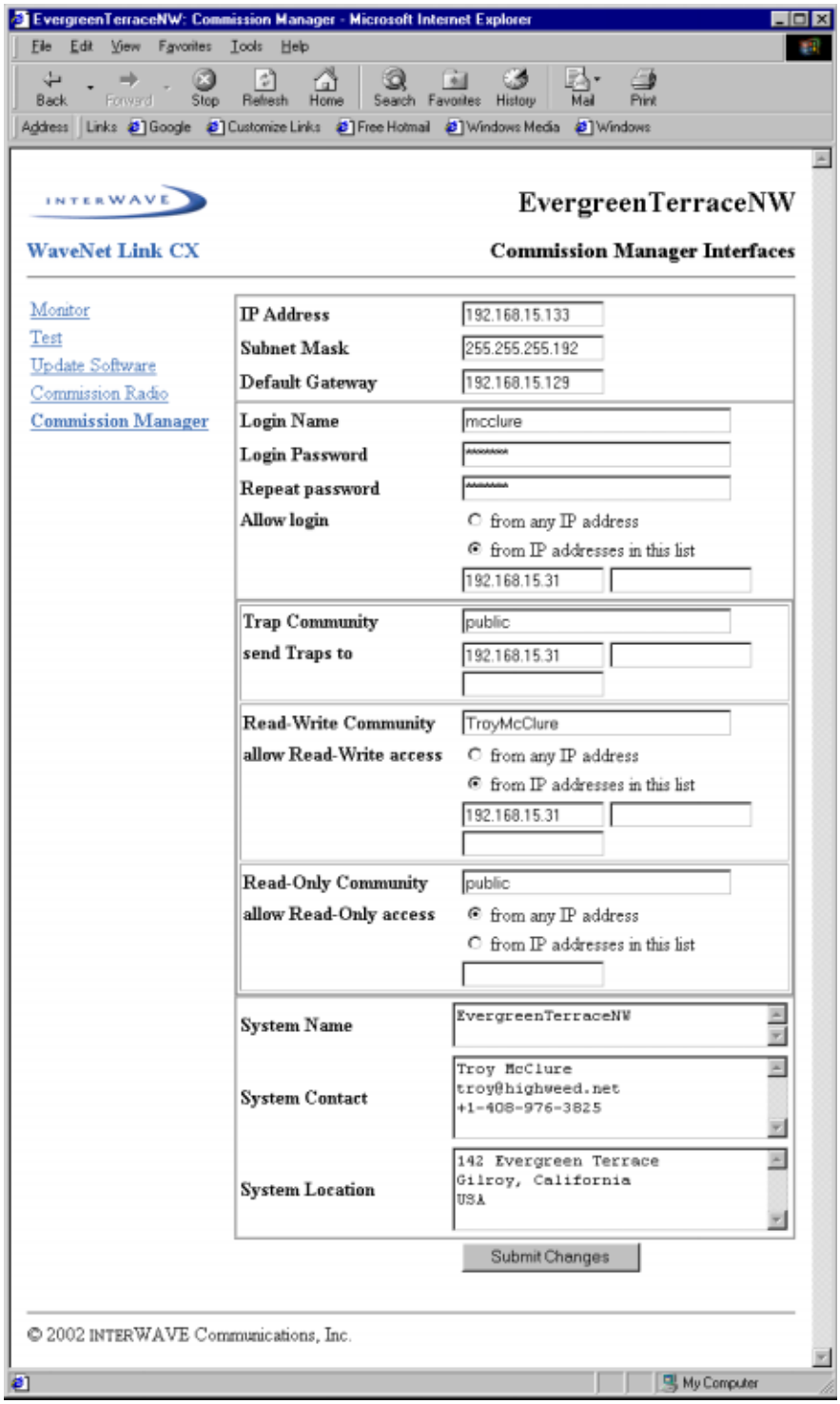


Figure 4-5 Link CX Commission Manager Web Page

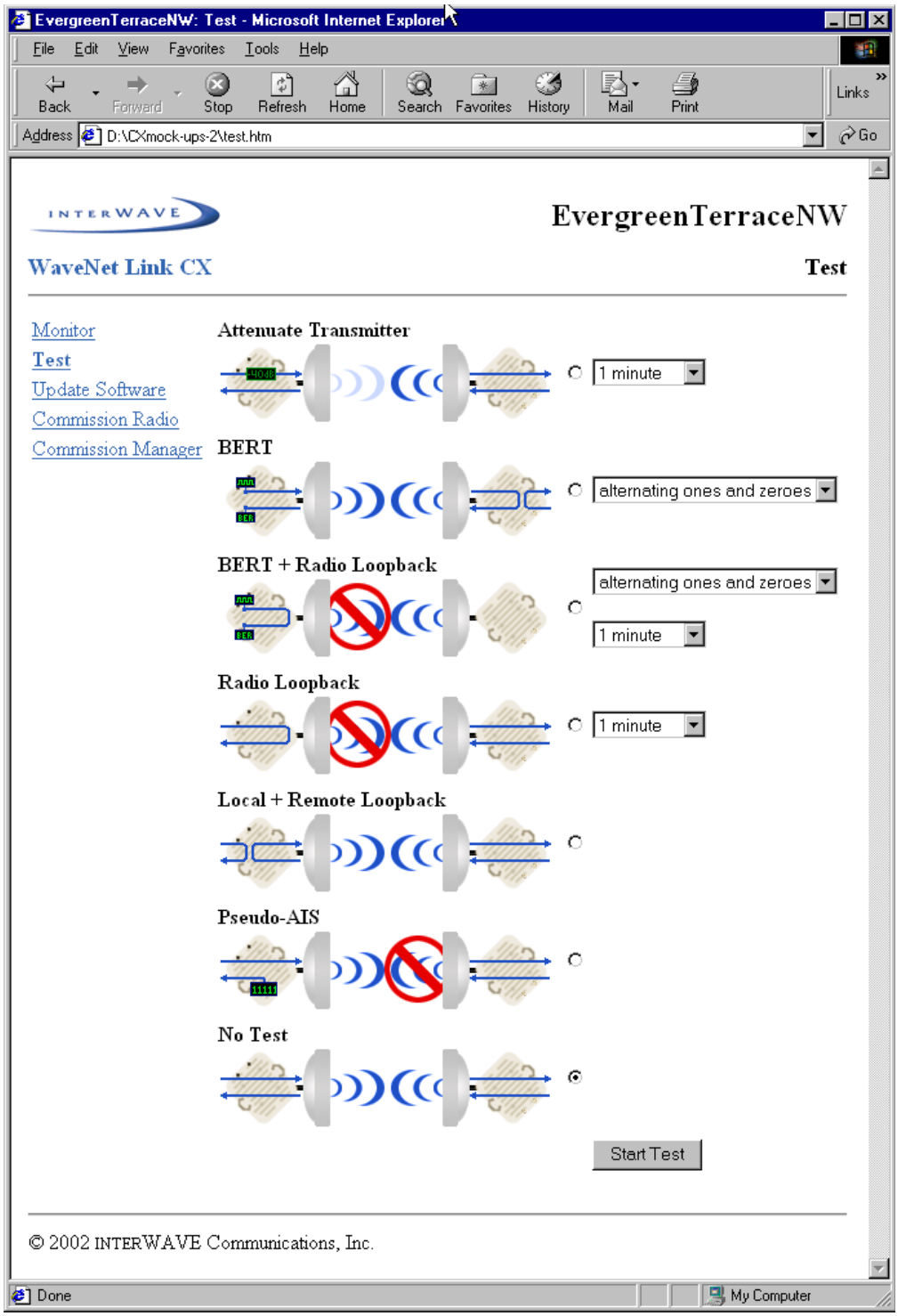


Figure 4-6 Link CX Test Web Page

4-3 Mounting the Link CX

The Link CX radio is a sealed unit that installs on a pole. When the Link CX is equipped with an integral antenna, there is no need to install an external antenna. When the Link CX is equipped with an external antenna, you will mount the Link CX as described in this section, then you will install the optional external antenna as described in Section 4-4.

> **NOTE** A pole is not supplied with the Link CX and should be in place before attempting installation.

After completing the configuration steps in Section 4-2, continue with the following steps to mount the Link CX on a pole.

> **STOP** The body performing the installation is the responsible for preventing any contact or induction with mains lines at any voltage.

> **STOP** To comply with FCC RF exposure requirements, antennas used with Link CXs must be rigidly mounted on permanent outdoor structures to provide 2 m (79 in.) or more separation from all persons during Link CX operation. Installers should refer to Table 3-2 when installing factory-supplied antennas, or the contact the customer-supplied antenna manufacturer for applicable gain and type restrictions to ensure compliance.

4-3.1 Installing the Link CX Mounting Bracket

> **NOTE** When the Link CX is to be installed with an external antenna, make sure that the Link CX and the antenna are mounted close enough to use the factory-supplied 2 m (6.5 ft.) RF cable to connect them. Also make sure that the Link CX and external antenna are not so close that they interfere with each other during antenna alignment.

25 Install the pole-mount bracket as described in the appropriate section below.

Non-Adjustable Elevation Single Link CX Bracket

A See Figure 4-7. Assemble the two steel band clamps to the pole mount bracket.

B Wrap the clamps around the pole and finger tighten their clamp screws. The bracket should be able to pivot around the pole, allowing horizontal alignment.

C Install the pole-mount bracket.

- When you are installing a Link CX with an integral antenna, use a compass or optical aid to coarsely align the pole mount bracket with the far-end antenna location. Continue with Section 4-3.2.
- When you are installing a Link CX with an external antenna, position the bracket near enough to the planned antenna location so that the Link CX does not interfere with antenna alignment and so the factory-supplied 2 m (6.5 ft.) antenna cable can be connected to both units. Continue with Section 4-3.2.

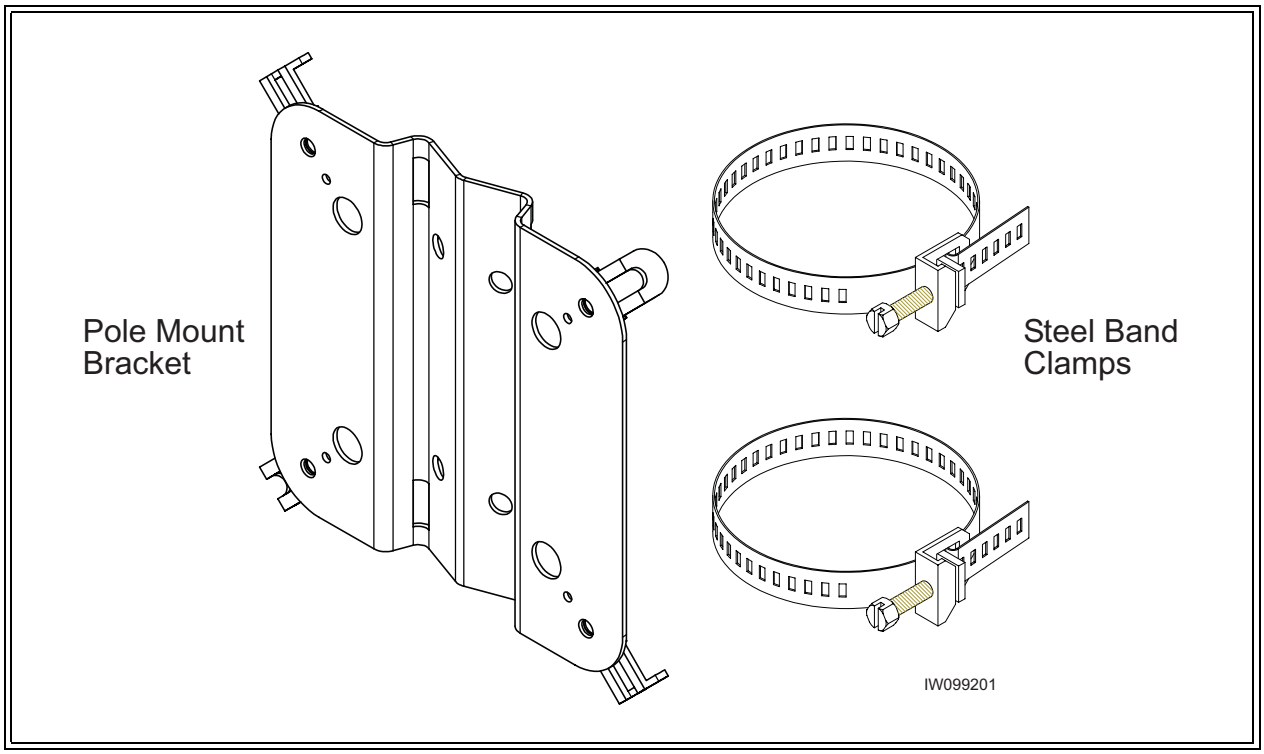


Figure 4-7 Non-Adjustable Elevation Single Link CX Bracket

Adjustable Elevation Single Link CX Bracket

A See Figure 4-8. Assemble the two steel band clamps to the pole mount bracket.

B Wrap the clamps around the pole and finger tighten their clamp screws. The bracket should be able to pivot around the pole, allowing horizontal alignment.

C Install the pole-mount bracket. Use a compass or optical aid to coarsely align the pole mount bracket with the far-end antenna location.

D Assemble the rest of the bracket parts as shown in Figure 4-8. Use a level to ensure that the coarse elevation is 0°. Continue with Section 4-3.2.

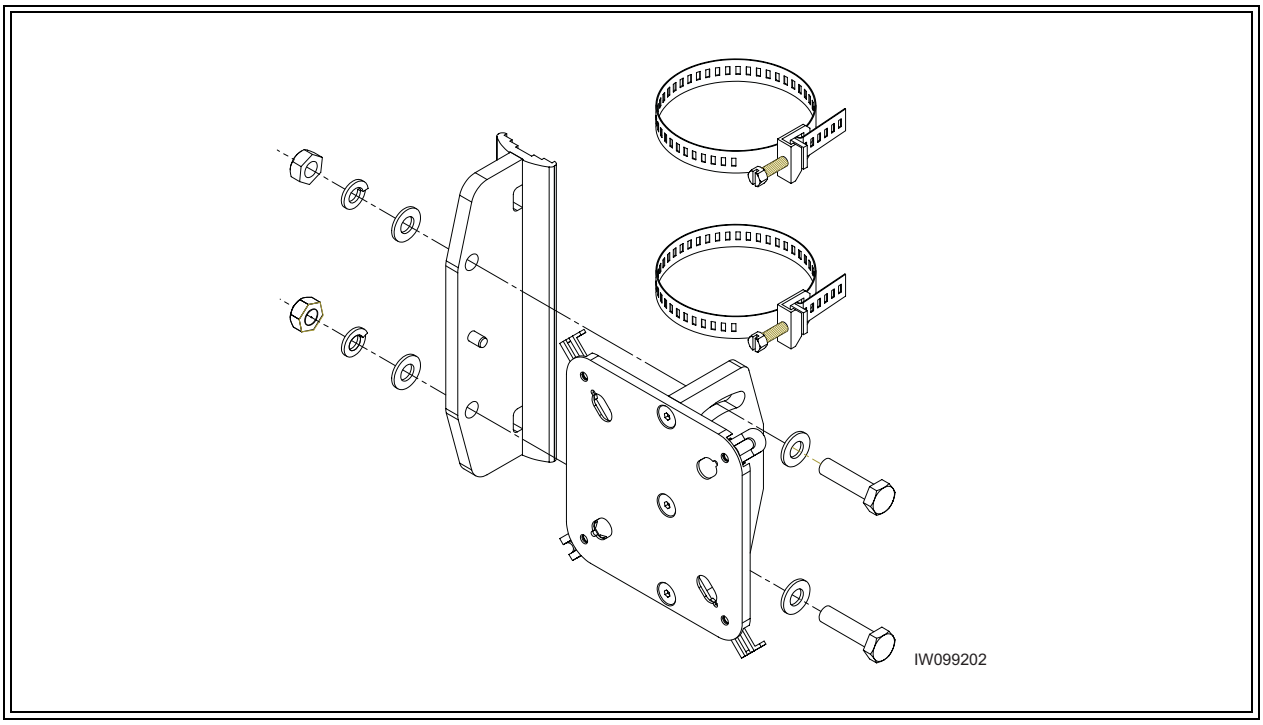


Figure 4-8 Adjustable Elevation Single Link CX Bracket

Adjustable Elevation Dual Link CX Bracket

A Assemble the pole mount brackets and associated nuts, bolts, and washers on the pole as shown in Figure 4-9. Finger tighten the four nuts. The pole mount bracket assembly should be able to pivot around the pole, allowing coarse horizontal alignment.

B Use a compass or optical aid to coarsely align the pole mount bracket assembly between the far-end antenna locations.

NOTE The pole mount bracket assembly does not have to be closely aligned with either of the far-end antennas, as the Link CX mounting bracket assemblies allow a wide range of elevation and azimuth alignment.

C Tighten the four pole mount bracket assembly bolts to 20-25 foot-pounds (27-34 n.m).

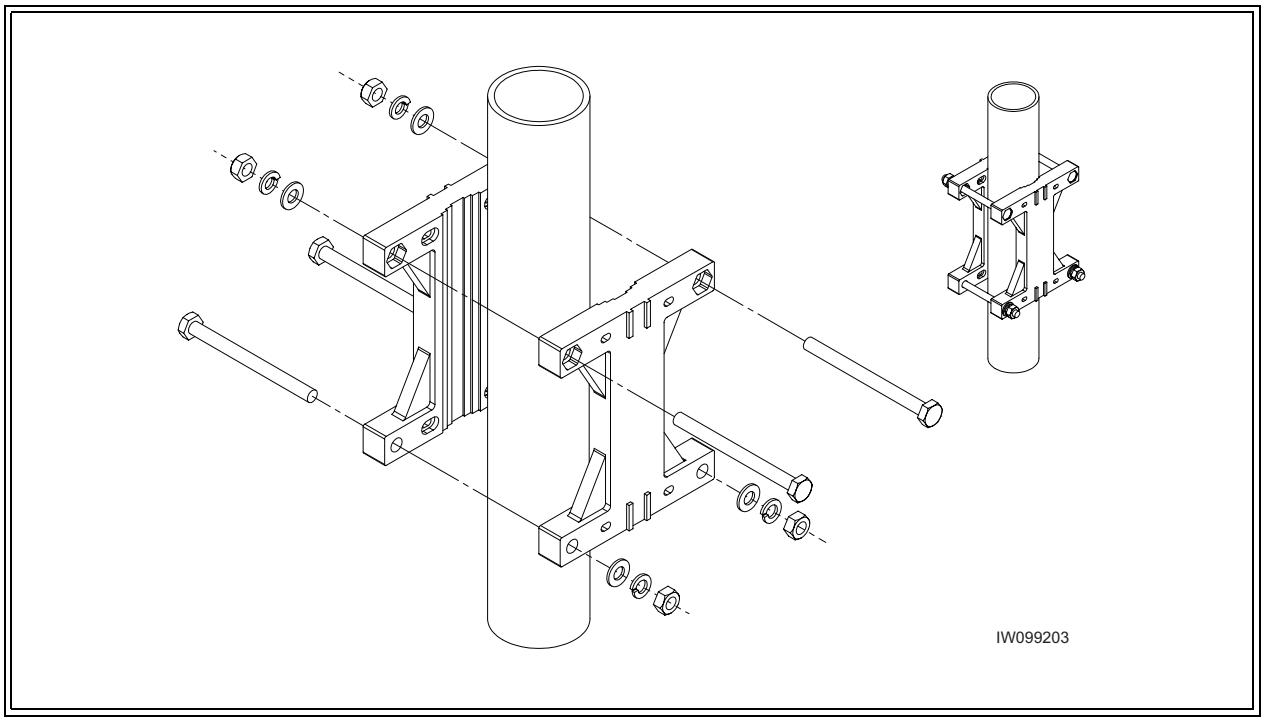


Figure 4-9 Adjustable Elevation Dual Link CX Pole Mount Bracket Assembly

D On each side of the pole mount bracket assembly, assemble the rest of the Link CX mounting bracket assembly parts as shown in Figure 4-10.

E Finger tighten the six bolts on each Link CX mounting bracket assembly. Each Link CX mounting bracket assembly should be able to pivot around the pole and elevate up and down, allowing fine azimuth and elevation alignment.

F Use a level to ensure that the coarse elevation for each Link CX mounting bracket assembly is 0°.

G Continue with Section 4-3.2.

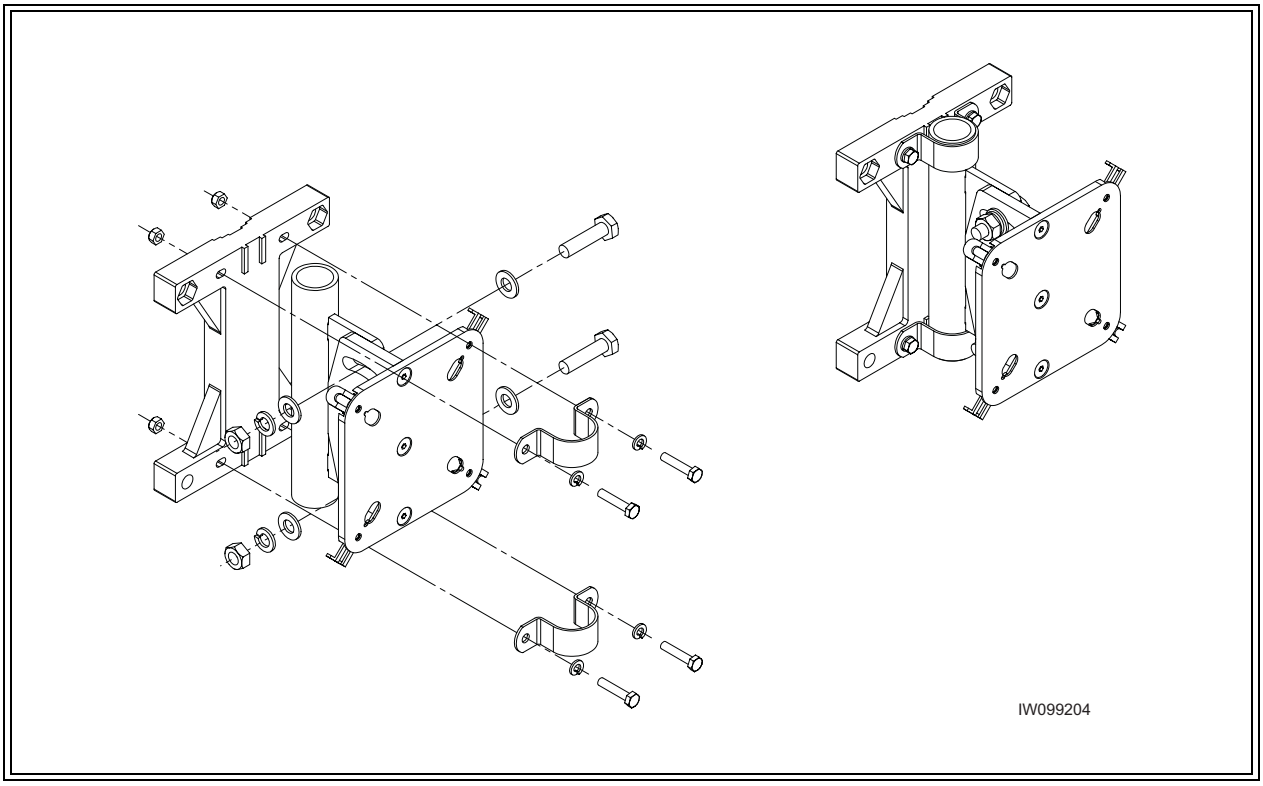


Figure 4-10 Adjustable Elevation Dual Link CX Mounting Bracket Assembly (one side only)

4-3.2 Attaching the Link CX to the Mounting Bracket

Selecting the Link CX Integral Antenna Polarization

> **NOTE** Both ends of the radio link must be identically polarized. The planned polarization is available from the filled-out copy of the Radio Link Planning Worksheet from Chapter Three.

When the Link CX is equipped with an integral antenna, how it is mounted determines the horizontal or vertical polarization. The Link CX mounting brackets are designed to preserve the selected polarization until the Link CX is removed from its bracket.

- When the Link CX is equipped with an external antenna, skip this section and continue with Step 24.
- See Figure 4-11. The Link CX case is embossed with an arrow indicating the integral antenna polarization. Point the arrow up for vertical, and sideways for horizontal polarization.

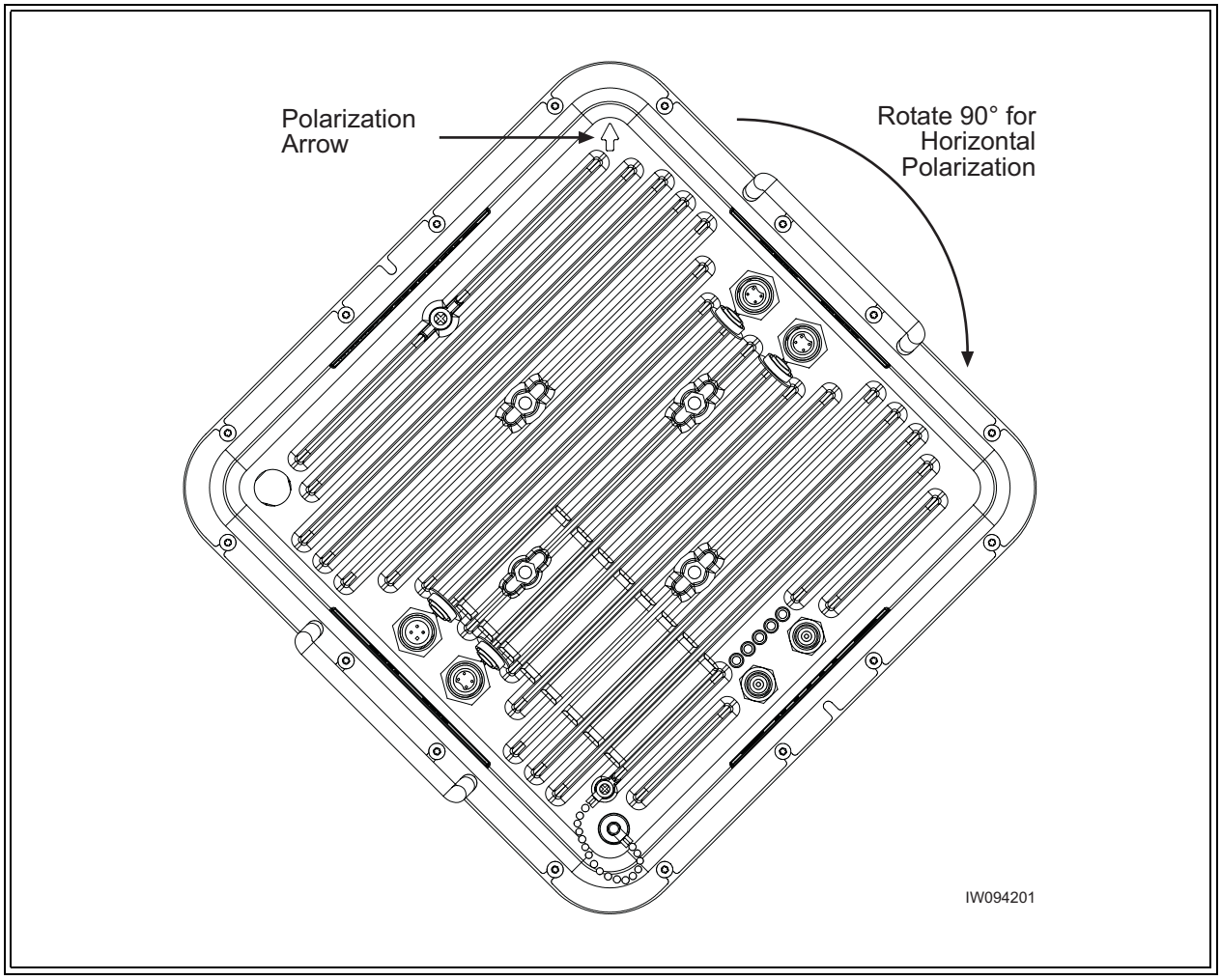


Figure 4-11 Setting the Link CX Polarization -- Vertical Polarization Shown

Attaching the Link CX

26 See Figure 4-11, Figure 4-12 and Figure 4-13.

27 Orient the Link CX as shown in Figure 4-11, and align it with the mounting bracket as shown in Figure 4-12. Note that the four mounting studs on the Link CX should line up with the four slide clips on the bracket as shown in Figure 4-13.

NOTE When the Link CX is equipped with an integral antenna, make sure that the antenna is properly polarized as described in the previous section.

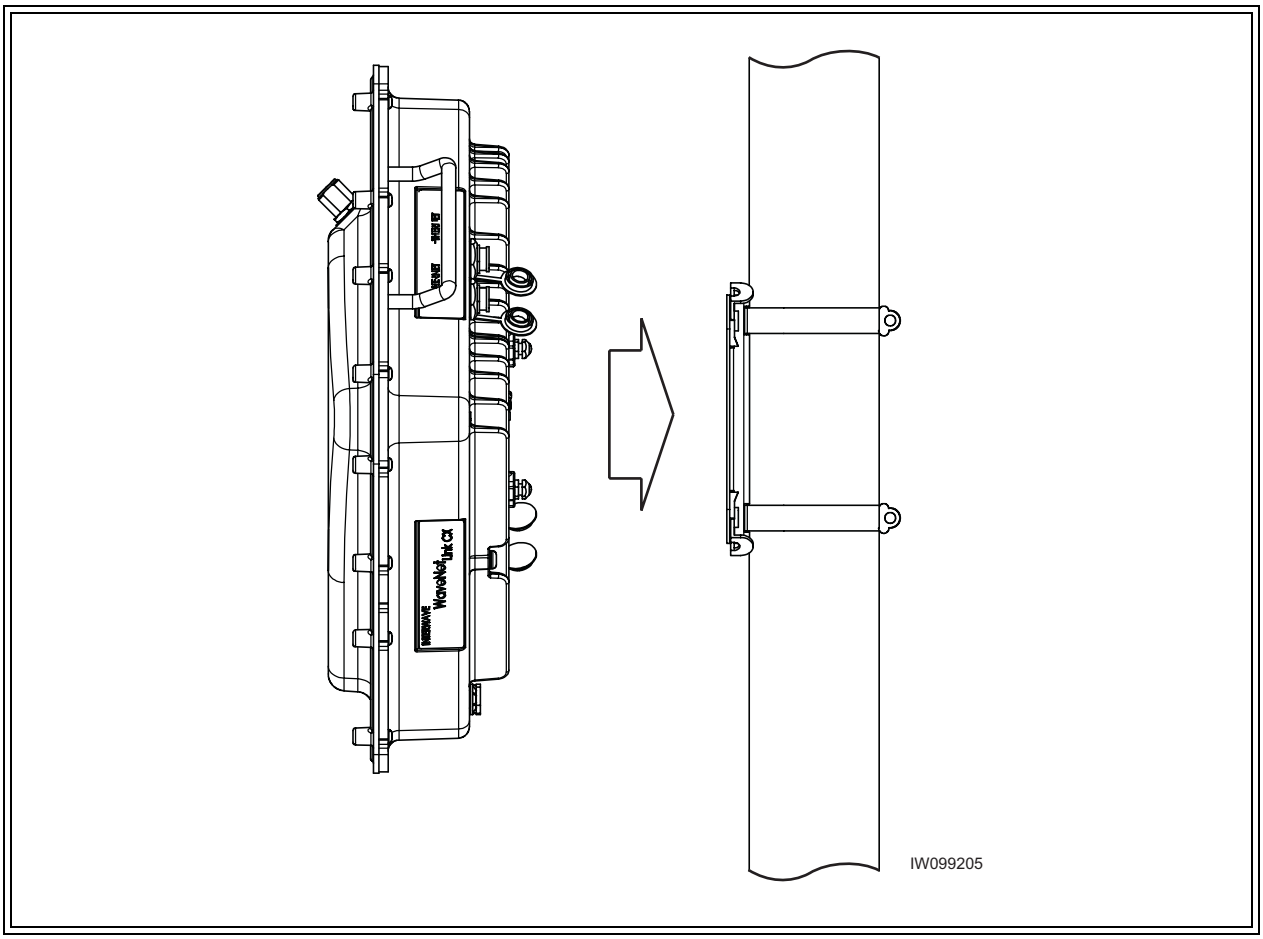


Figure 4-12 Attaching a 5.8 GHz Link CX to a Typical Mounting Bracket

28 Secure the Link CX to the bracket using the four (4) slide clips on the bracket as shown in Figure 4-13.

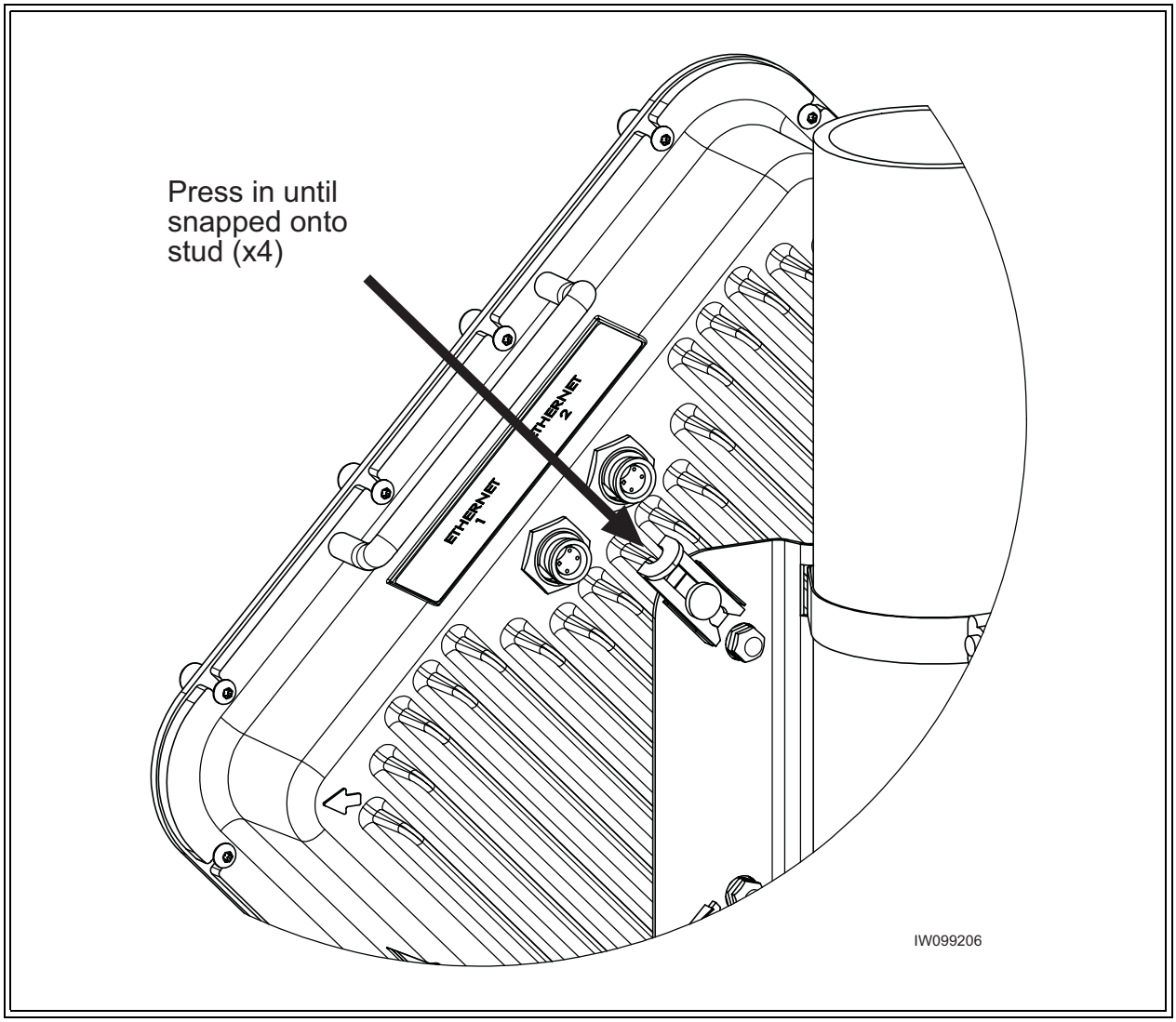


Figure 4-13 Locking the Slide Clips

The Link CX is now connected to the mounting pole and coarsely aligned, if equipped with an integral antenna. Continue with Section 4-4.

4-4 External Antenna Installation (Optional)

This section is only used when you are installing a Link CX with an external antenna. If you are installing a Link CX with an integral antenna, skip this section and continue with Section 4-5.

> **NOTE** Installation, maintenance and removal of antenna systems requires qualified, experienced personnel. interWAVE installation instructions have been written for such personnel. interWAVE disclaims any liability or responsibility for the results of improper or unsafe installation practices.

Factory-Supplied Antennas

The factory-supplied antenna consists of a 61 cm (24 in.) or 122 cm (48 in.) solid parabolic reflector assembly, radome, band clamp, and Pole Mount. The Pole Mount is designed to attach the antenna to a vertical tower pipe of diameter 44 to 115 mm (1.75 to 4.5 in.). It also provides adjustment ranges of ±30° (fine) Elevation and ±20° (fine) Azimuth.

For the factory-supplied antenna specifications, refer to Appendix 2.

The Link CX is usually attached to the same pole as the external antenna, as mounting the Link CX close to the antenna preserves the low (0.5 dBm) attenuation of the factory-supplied antenna cable. Continue with Section 4-4.1 to install the factory-supplied antenna mounting bracket and the external antenna.

Customer-Supplied Antennas

> **NOTE** The Link CX may be shipped without an integral or external antenna. For instance, the customer may wish to use a larger external antenna for increased gain. If this is the case, mount the Link CX as detailed in Section 4-3, and mount the customer-supplied antenna as described in the manufacturer's instructions.

4-4.1 Installing a Factory-Supplied 4 Foot (122 cm) Antenna Mounting Bracket

> **STOP** To comply with FCC RF exposure requirements, antennas used with Link CXs must be rigidly mounted on permanent outdoor structures to provide 2 m (79 in.) or more separation from all persons during Link CX operation. Installers should contact the antenna manufacturer for applicable gain and type restrictions to ensure compliance.

Site Planning

29 For antenna mounting and planning dimensions, see Figure 4-14 and Table 4-3.

30 The antenna is normally assembled with an elevation adjustment range of +50 degrees to -5 degrees. By inverting the mount, it can be assembled with a +5 degree to -50 degree range. In either configuration, the antenna centerline can be offset right or left, relative to the vertical mast pipe (see Figure 4-15) by inverting the Horizontal Tube Assembly.

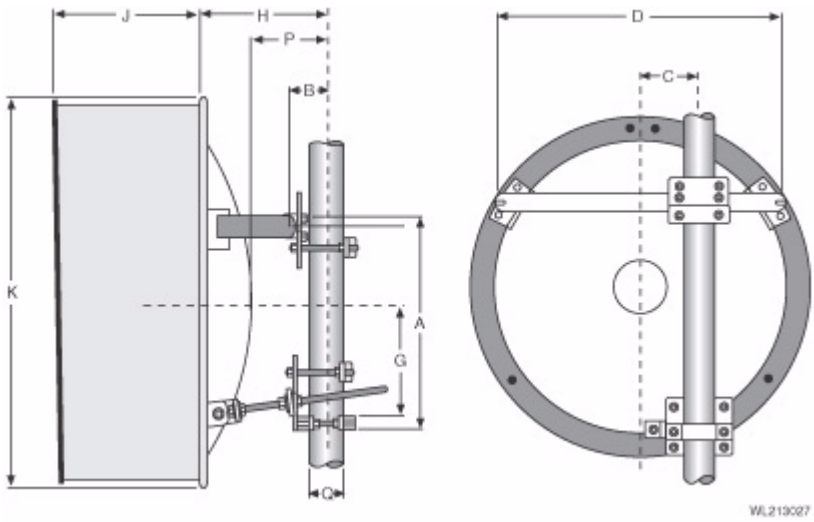


Figure 4-14 Four Foot (122 cm) Antenna

Dimension	Description	2ft. (0.6m) Antenna
A	Mount Length	22.4" (570mm)
B	Pivot Point	4.2" (105mm)
C	Center Line Offset	5.0" (125mm)
D	Horizontal Mount Strut	N/A
E	Pvt. Pt. Vertical Mount Strut	8.8" (175mm)
F	Horizontal Fixed Side Strut	N/A
G	Antenna Centerline	13.6" (345mm)
H	Reflector Length	12.3" (315mm)
J	Short Shroud Length	12.5" (320mm)
	Long Shroud Length	15.1" (385mm)
K	Antenna Diameter	24.0" (610mm)
L	Radome Length (Standard)	13.4" (340mm)
N	Mount Strut Depth	N/A
P	Reflector Vertex	7.6" (190mm)
Q	Mast Diameter	2.4" 4.5" (60-115mm)
	Azimuth Adjustable Range	±5°
	Elevation Adjustment Ranges	+50°/-5°

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Table 4-3 Four Foot Diameter Antenna Dimensions

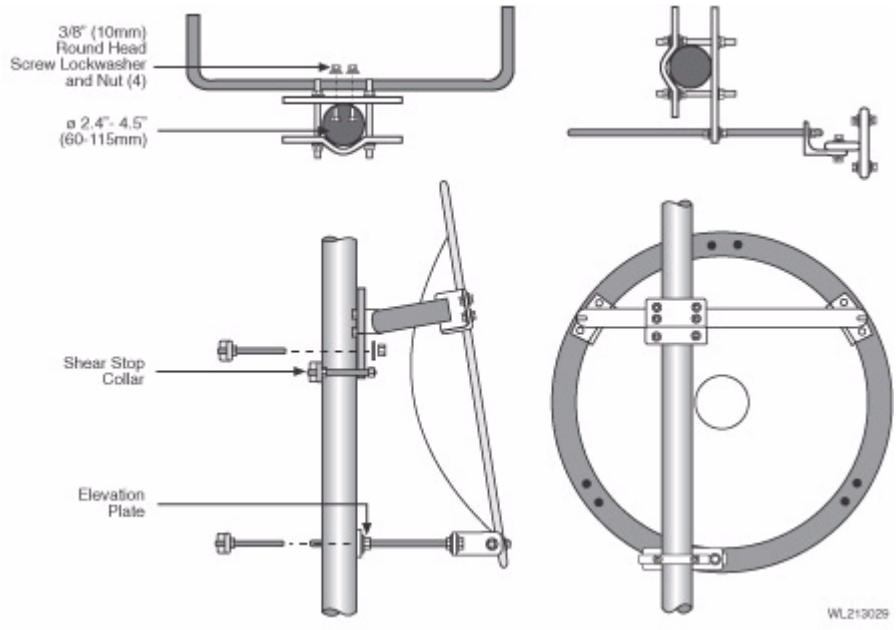

Figure 4-15 Mount Configuration

Unpacking and Preparation

31 Carefully unpack the reflector, mount, shroud (if any), radome (if any) and feed from the crate. For correct antenna performance, handle all components with care. Set aside the packaged feed and any shroud or radome. See Figure 4-16 through Figure 4-19.

Caution: The reflector spinning has been formed to a very close-toleranced parabolic shape. Careful handling and assembly is required to avoid denting or deforming the reflector, which would degrade the antenna's performance.

32 Inspect for any damaged parts. See Table 4-4 through Table 4-7 for an inventory of the parts and hardware shipped with the antenna.

Shroud Attachment

Attach the shroud assembly that is provided with high-performance antennas to the reflector. The installation procedure is covered by another instruction sheet supplied with the shroud.

Note: Some models have the shroud factory installed.

Part Number	Description	Qty.	Check
23832-3	Refl. Assy. SE 2' Open-2A	1	

WL213030

Table 4-4 Contents List, Reflector Assembly

Part Number	Description	Qty.
25736-1	Feed Mounting Clamp	4
26716-503	Feed S/A 5.250-5.850	1
AD T5170	RR Track Butyl 3/16x7//8x40'DSS170	1
FW X0050	Washer 1/4" W 0.734x.065	4
II-221	Installation Instructions	1
NU X0060	Hex Nut	4
SW X0050	Split Washer	4

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Table 4-5 Contents List, Feed Assembly

Figure 4-16 Mounting Hardware Packed

Figure 4-17 Mounting Hardware Unpacked

Part Number	Description	Qty
25675-501	**Horizantial Pipe Assembly**	1
25725-505	**Mast Clamping Assembly**	1
22316-2	Threaded Rod Galv	2
24525-5	Mast Clamp Half 1"	1
FW G0121	Washer Galv	2
NU G0121	Washer Galv	6
23725-509	Split Washer Galv	4
23725-509	**Mast Clamping Assy**	1
22316-2	Threaded Rod Galv	2
24525-8	Mast Clamp Half	1
FW G0120	Washer Galv	2
NU G0120	Hex Nut	6
SW G0090	Split Washer Galv	4
25727-504	**Shear Stop Assy**	1
2385-3	Threaded Rod	2
24525-2	AZ Clamp Half-Short	2
NU X0130	Hex Nut	6
SW G0090	Split Washer Galv	4
25730-503	**Elevation Rod Assy**	1
23611-6	Elevation Rod	1
23842-501	Elevation Rod Brkt Assy	1
25666-1	Elevation Support Angle	1
BO G0080	Hex Bolt Galv	1
FW G0120	Washer Galv	1
FW G0140	Washer Galv	1
NU G0120	Hex Nut Galv	1
NU X0195	Hex Nut SS	4
SW G0090	Split Washer Galv	1
SW G0100	Split Washer Galv	1

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Table 4-6 Contents List, Mount Assembly

Part Number	Description	Qty.
25733-501	Mount Hardware Kit	1
10749-54	U-Bolt Galv.	2
23561-2	Spacer	2
AD M0005	Anti-Seize 1 oz. Tube	1
BO X0921	Hex Bolt	6
FW G0120	Washer	4
FW X00050	Washer	12
NU G0120	Hex Nut Galv.	4
NU X0060	Hex Nut Galv.	6
PN G0090	Palnut	4
SW X0050	Split Washer Galv.	6
26590-1	Elevation Plate	1
26591-1	Azimuth Plate	1
BO X1186	RND HD Screw	4
NU X0130	Hex Nut	4
SW X0080	Split Washer	4
II-232	Installation Instructions	1

WL213035

Table 4-7 Contents List, Mount Assembly

Figure 4-18 Parabolic Reflector

Figure 4-19 Unpacking the Radome

Mount Assembly and Attachment

33 The reflector should be placed face down, either on the shroud or blocked up on packing lumber. Locate the Top and Bottom markings stenciled onto the back of the reflector.

34 Loosely attach Top Support Angles to the Horizontal Tube Assembly as shown in Figure 4-20 and Figure 4-21.

35 For desired mount configuration (see Figure 4-15), attach the Vertical Tube Assembly to the Horizontal Tube Assembly as shown in Figure 4-20 and Figure 4-21.

36 Verify proper assembly of the elevation rod hardware as shown in Figure 4-22. Remove outer hardware and insert rod through elevation plate.

Important: For elevation angles grater than ±20°, the Beveled Washers shown in Figure 4-22 must be used. However, beveled washers may be used for elevation angles greater than ±10°.

37 Carefully place mount assembly onto antenna backring, taking care not to damage the reflector. Loosely fasten the Top Support Angles and the Elevation Support Angle to the antenna backring using 1/2" hardware as shown in Figure 4-20.

38 Verify alignment of the Vertical Assembly with the vertical axis of the reflector and secure the Top Support Angles and the Elevation Support Angle to the ring.

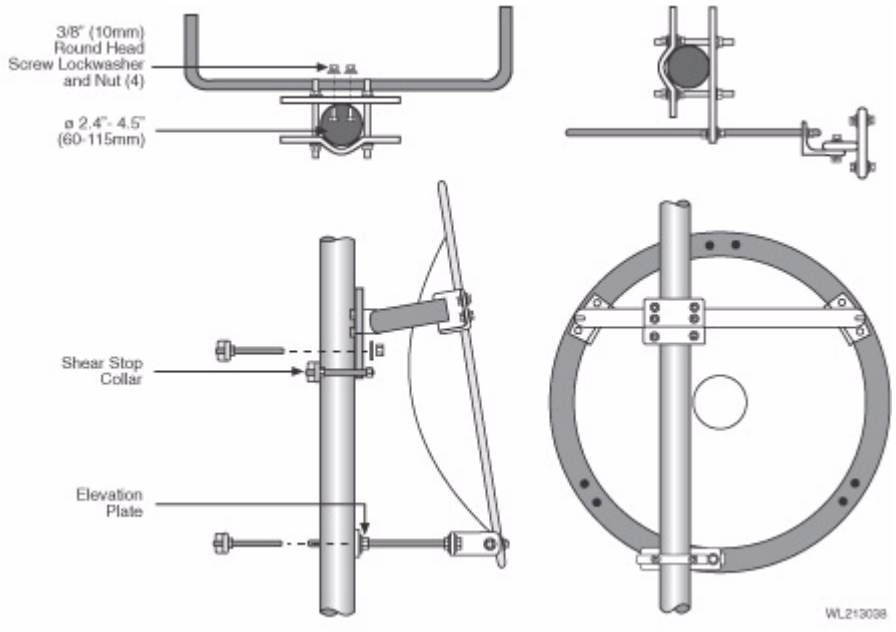

Figure 4-20 Antenna Mount Assembly

Figure 4-21 Antenna Mount Assembly

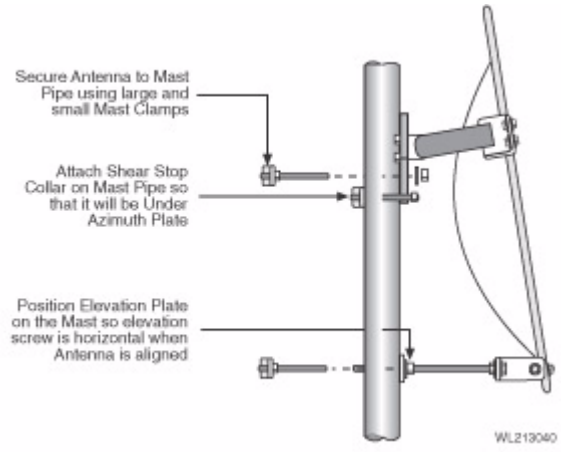

Figure 4-22 Elevation Rod Assembly

Feed Installation

Following the instructions provided with the feed assembly, install the feed in the reflector. See Figure 4-23 through Figure 4-27.

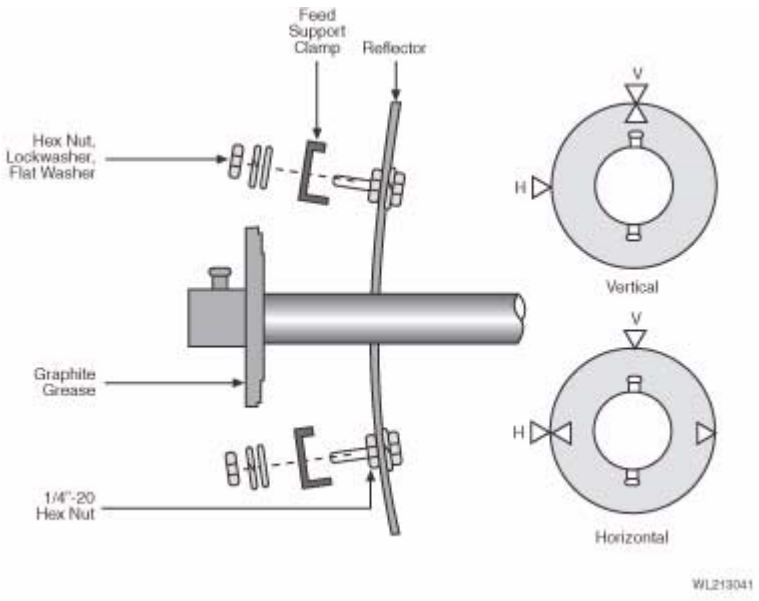

Figure 4-23 Feed Horn Installation

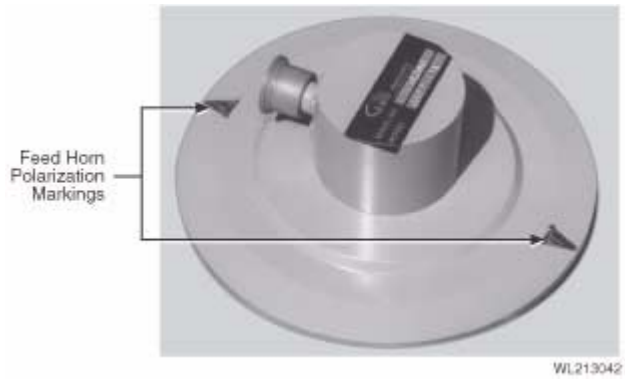

Figure 4-24 Feed Horn Polarization Markings

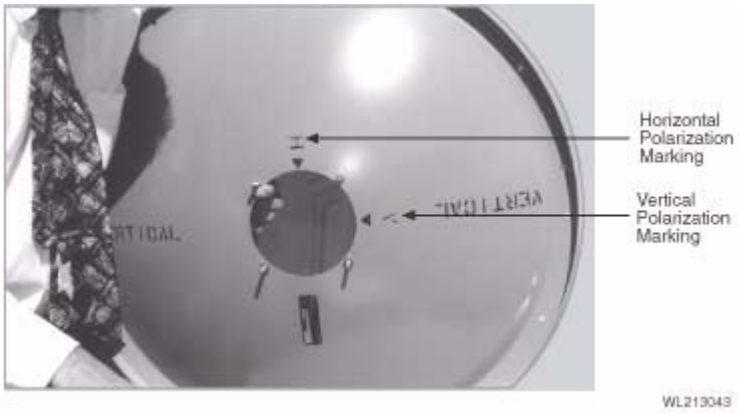

Figure 4-25 Parabola Rear View Showing Polarization Reference Markers

Figure 4-26 Feed Horn Installation

Figure 4-27 Feed Horn Installation for Vertical Polarized Operation

Radome Installation

Molded radomes (normally optional on standard antennas) should be installed following the instructions provided.

Azimuth Adjustment Clamp/Shear Stop Installation

39 Verify proper assembly of the azimuth clamp/shear stop clamp as shown in Figure 4-28 and Figure 4-29. Securely attach the shear stop clamp to the mast pipe as shown, orienting it as nearly as possible to the antenna boresight direction, and square to the mast axis. Note that the shear stop clamp used on the two foot antennas also provides the azimuth adjustment.

40 Refer to Figure 4-14 for the position of the antenna centerline relative to the shear stop clamp. The clamp must be mounted to provide support during installation and azimuth adjustment.

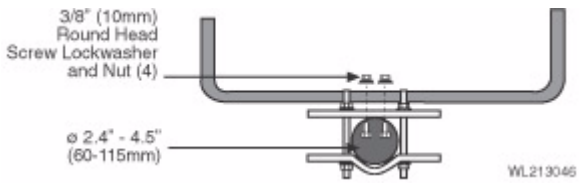

Figure 4-28 Azimuth Clamp/Shear Stop Assembly

Figure 4-29 Azimuth Adjustment Clamp Assembly

Antenna Hoisting and Installation

41 Attach a hoist strap around the vertical assembly or the horizontal assembly as shown in Figure 4-30. Do not hoist by the elevation rod. Make sure that the vertical assembly is unobstructed where it will mount against the mast pipe.

42 Attach tag lines and carefully lift the antenna into position, resting the vertical assembly on the shear stop clamp.

43 Fasten the mount to the mast pipe with 1/2" U-bolts. The antenna must be free to rotate during azimuth adjustment, so tighten only enough to close the gap between the mast and vertical channel. Do not leave the antenna loose for any extended period of time, not even overnight.

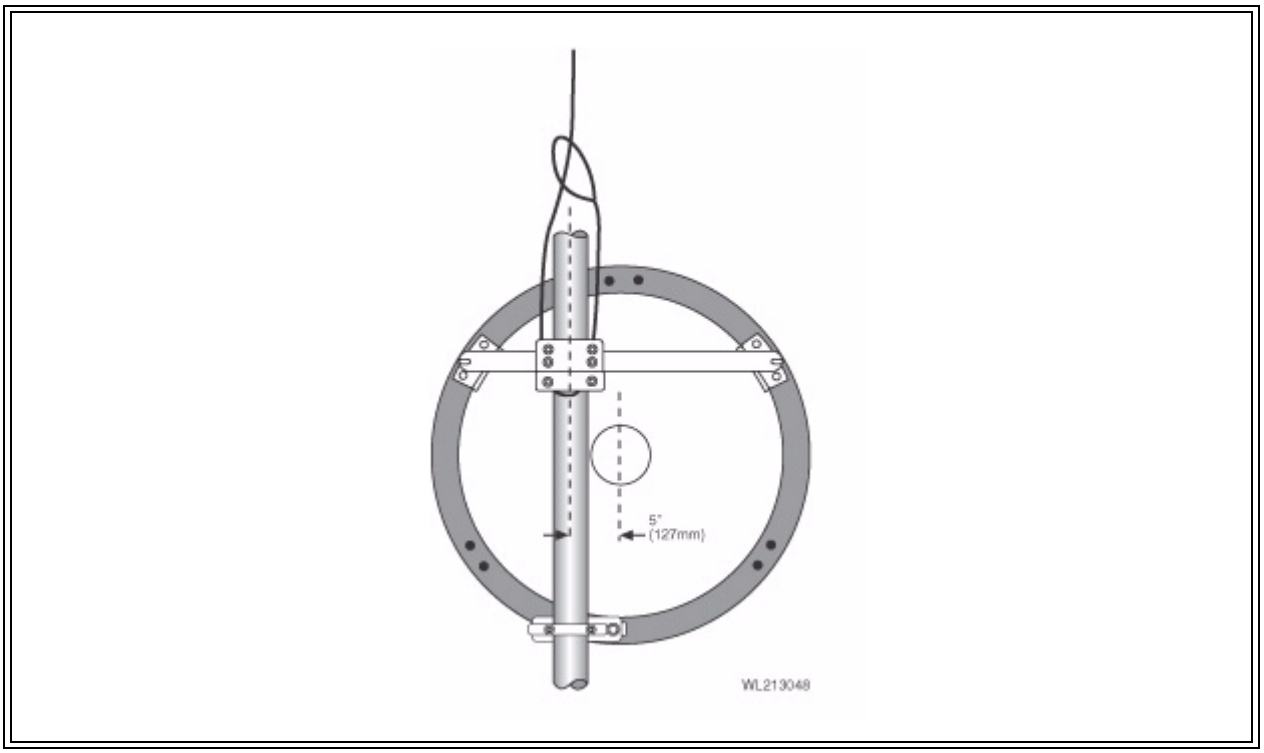

Figure 4-30 Hoisting the Antenna

44 Radome Panel Rotation -- Ensure that the radome drain and lock nut are oriented downward for proper drainage (refer to Figure 4-31). When finished, fasten the locking nut(s).

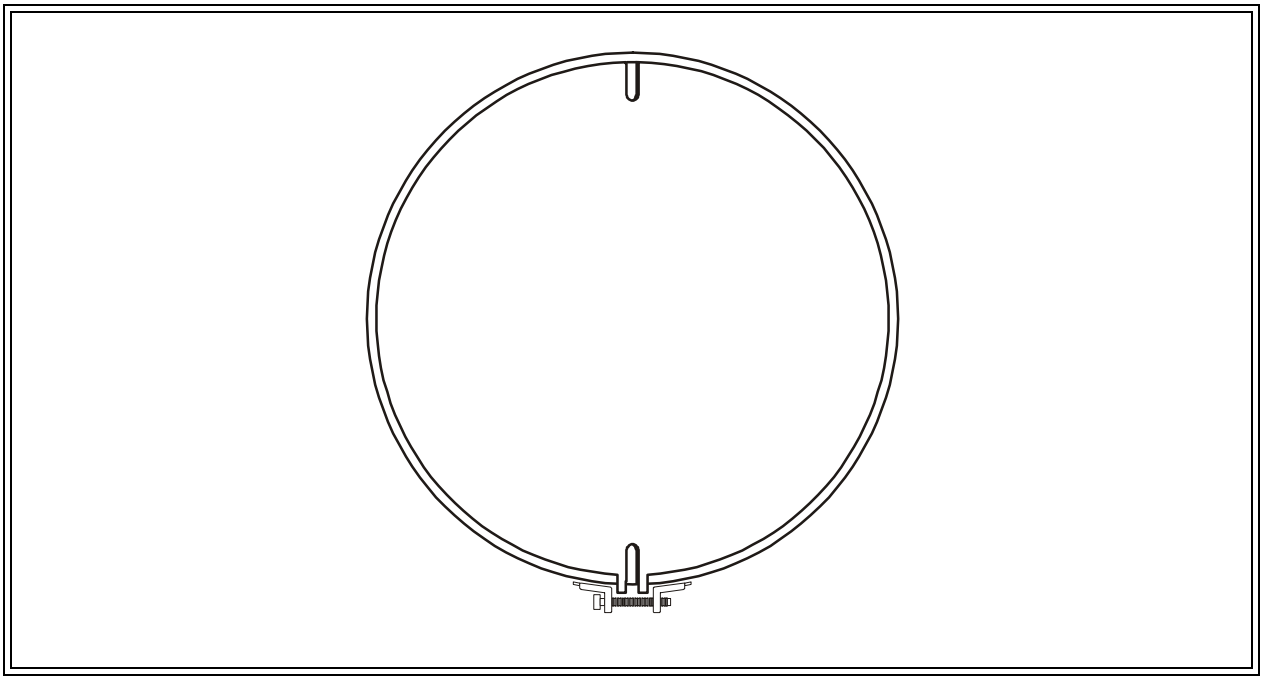

Figure 4-31 Setting Radome Panel Rotation

Inspection and Maintenance

45 Before leaving the installation, check that all hardware on the mount, shroud, radome, and feed is tight and that nuts are locked in place.

46 Inspect the antenna at least once a year to check its condition and to insure safe operation and maintenance. Qualified personnel, knowledgeable and experienced in antenna installations, are required for this inspection.

Supplemental Information

Table 4-8 is provided for installers unfamiliar with adequate nut tightening procedures for use on stainless steel bolts, U-bolts, galvanized bolts or any bolts without the ASTM-A325 marking on the head. Disregard these recommendations when specific tightening requirements are given.

Note: It is not recommended to reuse a palnut that has already been fully tightened or deformed in any way. It should be replaced with a new palnut.

Weatherproofing the Type N Female Connector on Feeds

Remove the protective cover from the end of the feed and mate the connectors, screwing the male connector firmly onto the feed.

Important: After connecting the coaxial cable, wrap the Type N connector with the gray butyl rubber, squeezing it firmly around all joints to make a continuous seal. Finish the weatherproofing by wrapping the butyl rubber with several layers of black PVC tape (not supplied).

Nominal Bolt Size	Nut Torque	Palnut Locknut Torque
1/4 "	50 in./lb.	40 in./lb.
5/16 "	102 in./lb.	60 in./lb.
3/8 "	15 ft./lb.	85 in./lb.
7/16 "	24 ft./lb.	15 ft./lb.
1/2 "	37 ft./lb.	16 ft./lb.
5/8 "	74 ft./lb.	28 ft./lb.
3/4"	175 ft./lb.	44 ft./lb.
7/8 "	212 ft./lb.	51 ft./lb.
1 "	318 ft./lb.	59 ft./lb.

WL213049

Table 4-8 Nut Tightening Specifications

Continue with Section 4-5 to complete the Link CX installation.

4-5 Completing the Link CX Installation

The Link CX and associated antenna are now mounted on the pole, and coarse-aligned with the far-end antenna. Continue with the following steps to complete the Link CX installation.

4-5.1 Mounting the Lightning Arrestor

interWAVE strongly recommends that you use a lightning arrestor, such as the Transtector Lightning Arrestor Kit, at the cable entry to the power, DS-3 and/or Ethernet equipment structure.

47 Install the lightning arrestor according to the manufacturer's instructions, and according to the guidelines in Appendix 4 to lessen the chance of damage from lightning strikes.

4-5.2 Routing the Data and Power Cables from the Lightning Arrestor

48 Route cables from the lightning arrestor through the cable entry to the power, DS-3 and/or Ethernet equipment.

Leave a minimum of 38 cm (15 inches) of service loop in the cables where they attach to the lightning arrestor. Avoid tight bends during cable routing and fastening.

49 Connect the power, DS-3 and/or Ethernet cables to the power, DS-3 and/or Ethernet equipment and the lightning arrestor.

50 Route power, DS-3 and/or Ethernet cables from the lightning arrestor to the Link CX.

Using cable ties and/or standoffs, fasten these cables to the structure at 3 m (10 ft.) intervals. Leave a minimum of 38 cm (15 inches) of service loop in the cables where they attach to the Link CX and the lightning arrestor. Avoid tight bends during cable routing and fastening.

The Link CX has two ethernet ports, and includes and internal ethernet switch. However, typical ethernet hubs and switches do not have spanning tree capability. MAKE SURE that you make only ONE ethernet connection from a hub or switch to the Link CX to prevent broadcast storms.

51 Connect the power, DS-3 and/or Ethernet cables to the lightning arrestor.

When you apply power to the Link CX, it starts transmitting. Do not stand within 2 m (79 in.) of the front of the antenna during Link CX operation to avoid harmful RF radiation.

52 Connect the power, DS-3 and/or Ethernet cables to the Link CX. See Figure 4-1 and Table 4-1 for the locations and descriptions of the Link CX connectors.

53 Check the LEDs for proper operation. See Figure 4-1 and Table 4-1 for the locations and descriptions of the Link CX LEDs.

- When power is properly applied to the Link CX, the PWR/LCL ALARM LED will be on.

- Because the radio link has not yet been established, the RF LINK LED should be off.
- When the DS-3 equipment is or is not transmitting data to the Link CX, the DATA LED should be on or off, respectively.
- When the Ethernet equipment is transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be on or flashing. When the Ethernet equipment is not transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be off or flashing as local data is received.

If any of these conditions is not true, troubleshoot the associated equipment and cables.

4-5.3 Grounding the Link CX and Antenna

The Link CX and the optional external antenna have grounding lugs. Make sure they are connected to a good earth ground using the guidelines in Appendix 4.

54 Following the guidelines in Appendix 4, connect a customer-supplied solid wire or tape (not braided) grounding wire to the grounding lug on the back of the Link CX. See Figure 4-32 for the grounding lug location.

Connect the other end of this cable to a proper grounding point.

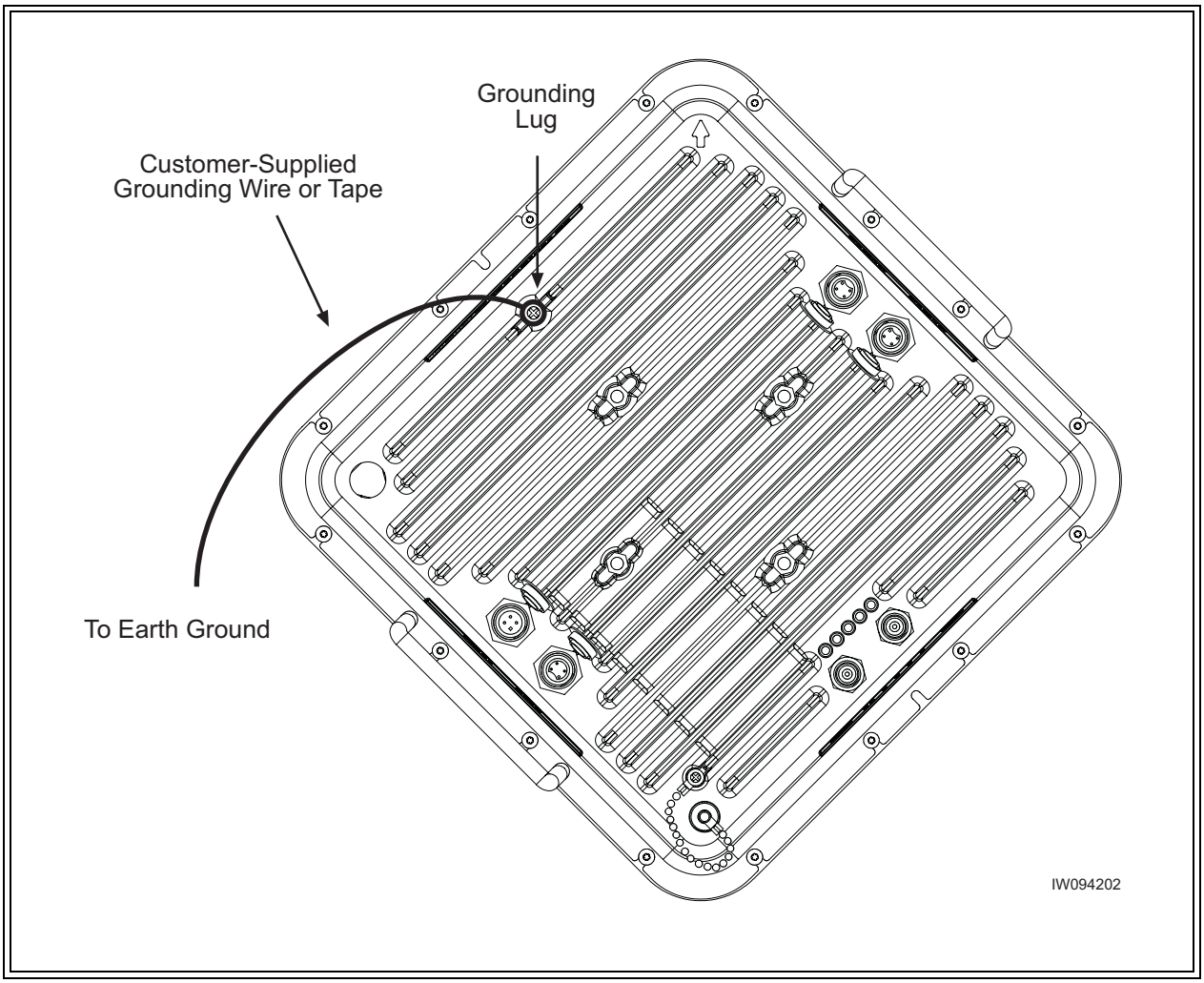

Figure 4-32 Connecting an Earth Ground to the Link CX

55 If the Link CX is equipped with an external antenna, follow the guidelines in Appendix 4 and connect a customer-supplied solid wire or tape (not braided) grounding wire to the grounding lug on the back of the antenna.

Connect the other end of this wire to a proper grounding point.

4-5.4 Sealing the Data and Power Cable Connectors

The cables that are terminated outdoors must be sealed at each exposed end to prevent moisture incursion and damage. For all exposed connectors, including those between an external antenna and the Link CX, perform the following:

56 Wrap each connector with vinyl or plastic electrical tape.

57 Wrap the vinyl or plastic electrical tape with butyl rubber amalgamating tape to prevent moisture from permeating the connector.

58 Wrap the butyl rubber amalgamating tape with vinyl or plastic electrical tape.

Continue with Section 4-6 to fine tune the antenna's azimuth and elevation.

4-6 Aligning the Antenna

This section includes steps used to fine tune the antenna alignment using RSSI as measured using a voltmeter. This part of the installation procedure is most easily accomplished with installers at each end of the radio link who are in communication with one another.

Failure to follow this antenna alignment procedure may damage your equipment and may render the radio unusable. Read through the entire procedure before attempting adjustment. Contact interWAVE with any questions.

When you are aligning a Link CX with an integral antenna on a single adjustable elevation pole mount, continue with Section 4-6.1. When you are aligning a Link CX with an integral antenna on a dual adjustable elevation pole mount, continue with Section 4-6.2. When you are aligning a Link CX with an external antenna, continue with Section 4-6.3.

When you apply power to the Link CX, it starts transmitting. Do not stand within 2 m (79 in.) of the front of the antenna during Link CX operation to avoid harmful RF radiation.

The Link CX with integral antenna is normally mounted on one of the adjustable elevation pole mounts to allow most accurate alignment and best system gain. If you are attempting to align a Link CX with integral antenna on a non-adjustable pole mount, adapt the following procedure, or contact interWAVE for fully-adjustable mounts.

4-6.1 Integral Antenna on a Single Adjustable Elevation Mount

Perform Step 57 through Step 62 on the local radio. Then, repeat these steps for the remote radio. See Figure 4-8 for the Single Pole Mount illustration.

59 Remove the cap from the BNC connector of the remote antenna. Attach the hand-held voltmeter and BNC test lead to the test point.

60 Fine Azimuth Alignment -- Rotate the Link CX mounting bracket on the pole until the proper azimuth alignment is achieved. Torque the steel band clamps on the single Link CX non-adjustable elevation pole mount to RR foot-pounds (SS n.m). Peak the alignment for maximum voltage at the remote antenna. Expected voltage is more than +1 VDC. The adjustment should be slowly tuned through the peak, and reset at the absolute maximum before tightening the straps.

61 Fine Elevation Alignment -- Rotate the Link CX mounting bracket until the proper elevation alignment is achieved. Torque the two elevation locking bolts to 20 to 25 foot-pounds (27 to

34 n.m). Peak the alignment for maximum voltage at the remote antenna. Expected voltage is more than +1 VDC. The adjustment should be slowly tuned through the peak, and reset at the absolute maximum before tightening the bolts.

NOTE Alignment for each antenna should be alternated at least twice before confirming the final setting.

62 Disconnect the hand-held voltmeter and BNC test lead from the RSSI port.

63 Finger-tighten the RSSI port cap to seal the Link CX case.

64 Recheck the Link CX LEDs. See Figure 4-1 and Table 4-1 for the locations and descriptions of the Link CX LEDs.

- When power is properly applied to the Link CX, the PWR/LCL ALARM LED will be on.
- Because the radio link has been established, the RF LINK LED should be on.
- When the DS-3 equipment is or is not transmitting data to the Link CX, the DATA LED should be on or off, respectively.
- When the Ethernet equipment is transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be on or flashing. When the Ethernet equipment is not transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be off.

If any of these conditions is not true, troubleshoot the associated equipment and cables.

The Link CX is now mounted and aligned. Continue with Section 4-7 for acceptance tests.

4-6.2 Integral Antenna on a Dual Adjustable Elevation Mount

Perform Step 63 through Step 68 on the local radio. Then, repeat these steps for the remote radio. See Figure 4-10 for the Dual Pole Mount illustration.

65 Remove the Link CX cap from the BNC connector of the remote radio. Attach the hand-held voltmeter and BNC test lead to the test point.

66 Fine Azimuth Alignment -- Rotate the Link CX on its mounting bracket until the proper azimuth alignment is achieved. Torque the four small azimuth locking bolts to 4 to 6 foot-pounds (5.5 to 8 n.m). Peak the alignment for maximum voltage at the remote antenna. Expected voltage is more than +1 VDC. The adjustment should be slowly tuned through the peak, and reset at the absolute maximum before tightening the bolts.

67 Fine Elevation Alignment -- Rotate the Link CX mounting bracket until the proper elevation alignment is achieved. Torque the two large elevation locking bolts to 20 to 25 foot-pounds (27 to 34 n.m). Peak the alignment for maximum voltage at the remote antenna. Expected voltage is more than +1 VDC. The adjustment should be slowly tuned through the peak, and reset at the absolute maximum before tightening the bolts.

NOTE Alignment for each antenna should be alternated at least twice before confirming the final setting.

68 Disconnect the hand-held voltmeter and BNC test lead from the RSSI port.

69 Finger-tighten the RSSI port cap to seal the Link CX case.

70 Recheck the Link CX LEDs. See Figure 4-1 and Table 4-1 for the locations and descriptions of the Link CX LEDs.

- When power is properly applied to the Link CX, the PWR/LCL ALARM LED will be on.
- Because the radio link has been established, the RF LINK LED should be on.
- When the DS-3 equipment is or is not transmitting data to the Link CX, the DATA LED should be on or off, respectively.
- When the Ethernet equipment is transmitting data to the Link CX, the ENET 1 or ENET 2 LEDs should be on or flashing. When the Ethernet equipment is not transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be off.

If any of these conditions is not true, troubleshoot the associated equipment and cables.

The Link CX is now mounted and aligned. Continue with Section 4-7 for acceptance tests.

4-6.3 External Antenna on Antenna-Specific Mount

Perform Step 69 through Step 79 on the local radio. Then, repeat these steps for the remote radio. See Figure 4-14 for the antenna assembly and Pole Mount illustration.

Normally the antenna is aligned by performing azimuth and elevation adjustments and elevation adjustments as necessary until the peak signal is obtained. It may be helpful to re-peak one adjustment before finalizing or locking down the other.

Warning: Damage to the antenna can occur if azimuth or elevation adjustments are attempted without loosening the proper connections as described in the following steps.

71 Remove the BNC cap from the RSSI connector of the remote radio. Attach the hand-held voltmeter and BNC test lead to the test point.

72 Be sure the mast pipe U-bolts are just loose enough to allow mount rotation while maintaining complete contact between the mount and the mast pipe.

73 Turn the long stainless steel azimuth screws against the mounting channel. By alternately turning one azimuth adjustment screw out and the other in, the antenna can be rotated to the desired azimuth angle. Approximately one turn changes the azimuth direction by 1°. Avoid adjusting the antenna beyond the ±5° provided by the azimuth clamp as this can damage the adjusting hardware. Fasten the antenna to the mast pipe and reposition the clamp if needed.

Note: By securing the mount to the mast pipe and realigning the azimuth clamp with the antenna boresight, more reliable and precise azimuth adjustments can be achieved.

After all adjustments are made, tighten both of the azimuth screws against the channel and secure with the lock nuts provided.

74 Tighten the mast pipe U-bolts while maintaining the peak signal by alternating from left to right in 1/4 turn intervals.

75 Insure that both of the bolts connecting the mount to the Top Support Angles and the pivoting Elevation Angle (refer to Figure 4-20 and Figure 4-22) are just loose enough to allow resisted rotation.

76 Back the outer nuts on the elevation rod away from the bottom mount plate to allow some fine adjustment range.

77 Turn the inside nut (with flat washer) on the elevation rod to adjust the elevation angle. Approximately five turns changes the elevation by 1°. Remember, for elevation greater than 20°, install the two beveled washers as shown in Figure 4-22.

Alignment for each antenna should be alternated at least twice before confirming the final setting.

78 After all adjustments are made, lock the nut against the bottom mount plate. Tighten the angle pivot bolt and support bracket bolts to the specifications listed in Table 4-8.

Important: Be sure to tighten all hardware after final adjustments and insure that split lockwashers, palnuts, or jam nuts are used where provided.

79 Disconnect the hand-held voltmeter and BNC test lead from the RSSI port.

80 Finger-tighten the RSSI port cap to seal the Link CX case.

81 Recheck the Link CX LEDs. See Figure 4-1 and Table 4-1 for the locations and descriptions of the Link CX LEDs.

- When power is properly applied to the Link CX, the PWR/LCL ALARM LED will be on.
- Because the radio link has been established, the RF LINK LED should be on.
- When the DS-3 equipment is or is not transmitting data to the Link CX, the DATA LED should be on or off, respectively.
- When the Ethernet equipment is transmitting data to the Link CX, the ENET 1 or ENET 2 LEDs should be on or flashing. When the Ethernet equipment is not transmitting data to the Link CX, the ENET 1 and/or ENET 2 LEDs should be off.

If any of these conditions is not true, troubleshoot the associated equipment and cables.

4-7 Acceptance Testing

This section describes the tests used to verify that the Link CX data input circuitry, near-end Link CX radio, radio link, and far-end Link CX radio are installed properly and operating correctly.

82 Verify that the physical installation is correct. Use Table 4-9 to sign off the individual checks.

Table 4-9 Physical Installation Checklist

Checklist Item	Verified	Inspector	Date
Is the mounting pipe securely connected to the mounting structure?			
Is the Link CX securely connected to the mounting pipe?			
If equipped, is the external antenna securely connected to the mounting pipe?			
Is the lightning protection above the Link CX and antenna properly grounded?			
Is the Link CX properly grounded?			
If equipped, is the external antenna properly grounded?			
Is the lightning arrestor at the entry to the equipment enclosure properly grounded?			
Is all cabling to the Link CX properly routed (no sharp bends and properly attached)?			
Are all exposed connectors properly sealed against moisture?			
Are all unused connectors capped off or otherwise sealed against moisture?			
Is the internal or external antenna polarization correct (as indicated on the back of the unit)?			

83 Verify that the electrical connections are correct. Use Table 4-10 to sign off the individual checks.

Table 4-10 Electrical Connection Checklist

Checklist Item	Verified	Inspector	Date
Is the proper voltage supplied to the Link CX (PWR/LCL ALM LED on)?			
Is the Link CX receiving signal from the radio link (RF LINK LED on)?			
When the Link CX is connected to DS-3 equipment, is the Link CX receiving the expected signal (DATA LED on)?			
When the Link CX is connected to Ethernet equipment on port ETHERNET 1, is the Link CX receiving the expected signal (ENET 1 LED on or flashing)?			
When the Link CX is connected to Ethernet equipment on port ETHERNET 2, is the Link CX receiving the expected signal (ENET 2 LED on or flashing)?			

The next series of acceptance tests requires you to log in to the built-in web server with a computer equipped with a web browser.

84 Connect your computer to the Link CX through the Ethernet equipment connected to the ETHERNET 1 or ETHERNET 2 port.

85 Log in to the Link CX built-in web server to display the Monitor page as described in Section 4-2.2.

86 Make sure the Automatic Tx Power Control indicated in the lower half of the Monitor page is set to Disabled.

87 Record the RSSI indicated at the top of the Monitor page. Save this number for later troubleshooting.

88 Go to the Test page and verify that the Link CX passes the tests in Table 4-11.

Table 4-11 Internal Circuit and Radio Link Checklist

Checklist Item	Verified	Inspector	Date
Does the Link CX input circuitry and DS-3/ Ethernet cabling work properly? (Set up Local + Remote Loopback and verify that the DS-3/ Ethernet equipment is receiving the looped-back signal it is transmitting to the Link CX.)			
Does the Link CX radio circuitry work properly? (Set up Radio Loopback and verify that the DS-3/Ethernet equipment is receiving the looped-back signal it is transmitting to the Link CX.)			
Do the near-end and far-end Link CX radio circuits and radio paths work properly? (Set up BER Test and verify that the near-end Link CX is receiving the looped-back BER test signal it is transmitting to the far-end Link CX.)			
Does the end-to-end radio link work properly? (Select No Test and verify that the DS-3/Ethernet equipment at both ends of the radio link are receiving the signal transmitted to it by the remote DS-3/Ethernet equipment.)			

When all of the acceptance tests in this section have been completed and all Checklist items have been verified, the Link CX radio link has been verified. The Inspector marks for all tested items constitute acceptance of the Link CX equipment and the associated radio link.

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Five

Final Link CX Setup

The user is required to finish configuring the Link CX after physical installation. The Link CX includes a built-in HTML-based web server, which includes configuration, operating, monitoring and test pages. This web server can be accessed locally using a Web browser on a Craft PC, or remotely using any Web browser on the same Ethernet network as the Link CX. The initial configuration has already been done using a Craft PC at the Link CX site, and all other operation and maintenance tasks can be performed remotely or locally, as required.

This chapter deals only with final Link CX setup using a Craft PC, and provides step-by-step configuration instructions.

This section assumes that the Link CX has already been installed and acceptance-tested as described in Chapter Four. If all the steps in Chapter Four have not been completed, complete them before starting this section.

Post Acceptance Test Configuration

This section includes instructions on how to finish the Link CX configuration after it is installed, as described in Chapter Four. The Link CX should be in the following state:

- Powered on.
- Antenna aligned with far end antenna.
- Acceptance tested.
- No loopbacks or other tests active.
- Carrying, or capable of carrying, payload data.
- Transmit attenuation disabled.
- Transmitting at minimum required transmit power (Automatic Tx Power Control disabled, unless required).

Final Link CX Configuration

Obtain a copy of the information entered in Table 3-3, Radio Link Planning Worksheet, and continue with the following steps:

1. Record the RSSI level from Step 85 in Chapter Four for future reference. The Step 85 value is the RSSI level with Automatic Tx Power Control disabled.
2. Connect your computer to the Link CX through the Ethernet equipment connected to the ETHERNET 1 or ETHERNET 2 port.
3. Log in to the Link CX built-in web server to display the Monitor page as described in Section 4-2.2.
4. Go to the Test page, and verify that No Test is selected.
5. Go to the Commission Radio page, and verify that the entries on this page match the entries in Table 3-3, Radio Link Planning Worksheet. Make sure the Tx Attenuation is set to No attenuation, and that Automatic Tx Power Control is set to Enable.
6. Go to the Commission Manager Interfaces page, and verify that the entries on this page match the entries in Table 3-3, Radio Link Planning Worksheet.

   You can upgrade the login security of the Link CX at this time. If you want to restrict access to the Link CX, consider the following:

   - If the Link CX does not have a Login Name and Password, you can assign one now.
   - If the Link CX allows login from any IP address, you may want to restrict login to only one or two IP addresses. MAKE SURE the Craft PC IP address is included if you select this option.
   - If the Link CX is set to broadcast SNMP traps to the Public community, you can restrict broadcasts to a different community.
   - If the Link CX is set to broadcast SNMP traps to multiple IP addresses, you can restrict broadcasts to fewer IP addresses.
   - If the Link CX is set to allow read-write access from the Public community, you can restrict read-write access to a different community.
   - If the Link CX is set to allow read-write access from any or multiple IP addresses, you can restrict read-write access to fewer IP addresses.
   - If the Link CX is set to allow read-only access from the Public community, you can restrict read-only access to a different community.
   - If the Link CX is set to allow read-only access from any IP address, you can restrict read-only access to fewer IP addresses.
7. When required, make any security upgrades as described in Step 6.

The Link CX is now fully configured, tested, and operational, and should continue to operate unattended. Continue with Chapter Six for monitoring and trend analysis, and refer to Chapter Seven for troubleshooting information.

Six

Monitoring and Trend Analysis

Each Link CX and radio link can be monitored through either the built-in Web server or SNMP agent interfaces.

6-1 Built-In Web Server Interface

A subset of the SNMP-accessible statistics is available through the Web server interface connected to a web browser over an Ethernet link. These statistics can be read by logging in to display the Monitor page, as shown in Appendix 3. Statistics can be repeatedly sampled using the Web browser reload or refresh feature.

The easiest indicator to monitor is the RSSI. Keep a record of the RSSI levels measured in Step 87 in Chapter Four. The Step 87 value is the RSSI level with Automatic Tx Power Control disabled (transmitting at maximum power).

A properly designed radio link with a 20 dB or greater fade margin should indicate receive levels in the area of -60 dBm at Link CX sites. The accuracy of the indicated RSSI is approximately ±5 dB over a range of -90 dBm to -65 dBm.

6-2 SNMP Network and Element Management Systems

All monitored statistics are available through SNMP queries. In addition to MIB-II variables, product-specific variables are available through the Link CX enterprise MIB, which can be retrieved via FTP from F:/PUB/link_cx.mib (text file) in the Link CX file system. Most commercial SNMP NMSs and EMSs have the ability to sample variables over time and display trends and raise alarms based on defined thresholds. In addition, applicable SNMP traps are supported and can be used to raise alarms on the NMS and/or EMS.

Any standard SNMP NMS or EMS can be used to monitor and control the Link CX network and individual Link CX radios.

The Link CX has an enterprise MIB provided in standard ASCII format, which can be accessed for printing. When a software upgrade is performed, the self-extracting file places all directories and associated files necessary for the upgrade in a location specified by the operator at the time the self-extracting file is executed. One of the directories created is /PUB, which contains the printable enterprise ASCII text MIB file named link_cx.mib.

The enterprise MIB file is also stored in FLASH memory on the Link CX in F:/PUB. A copy of the link_cx.mib file can be extracted from the Link CX using an ASCII FTP file transfer.

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Seven

Troubleshooting the Link CX

This chapter explains how to troubleshoot a Link CX and associated radio link using the LEDs, a local or remote Web browser, or any other method.

This chapter includes:

- Section 7-1, Troubleshooting Tables
- Section 7-2, Using the Link CX LEDs
- Section 7-3, Using RSSI
- Section 7-4, Using a Web Browser

7-1 Troubleshooting Tables

This section includes a troubleshooting table for different symptoms:

Table 7-1 Symptoms and Probable Causes

Symptoms	Probable Cause
No response from Link CX, No payload data being transmitted	Power loss to Link CX, New obstructions (leafy trees and/or buildings, for example), Antenna no longer in alignment, Damaged cables, Defective transmission equipment
Reduced RSSI, High BER, Reduced payload data transmission rate	New obstructions (leafy trees and/or buildings, for example), Antenna no longer in alignment, Damaged or degraded cables, New interferers (multipath reflections from flooded fields or new buildings, or new consumer applications, for example)
Intermittent transmissions	ATPC unable to block a frequency hopping transmitter or other intermittent interferer -- disable ATPC

7-2 Using the Link CX LEDs

Link CX operation can be monitored using the LEDs. The LEDs show general radio link status at a glance. See Figure 1-3 for LED locations on the Link CX radio. The LEDs operate in the following modes.

Table 7-2 LEDs and Alarm Indication Modes

LED	Normal State	Alarm State
PWR/LCL ALM	ON -- Power on and no alarm	Flashing -- Local alarm OFF -- Power off
RF LINK	ON -- Receive RF OK	OFF -- Receive radio link alarm
DATA	ON -- DS-3 input OK	OFF -- DS-3 input LOS
ENET 2	ON -- Ethernet input OK Flashing -- Receiving Ethernet data	OFF -- No Ethernet input
ENET 1	ON -- Ethernet input OK Flashing -- Receiving Ethernet data	OFF -- No Ethernet input

7-3 Using RSSI

When you connect a voltmeter with BNC adapter to the Link CX RSSI port, you can measure an indication of the received RF signal level. When the Receive Level falls below -70 dBm, see Table 7-1 for a list of possible causes.

Make sure you replace the Link CX RSSI connector cover when done troubleshooting the radio link.

7-4 Using a Web Browser

As described in Appendix 3, most of the Link CX configuring, operating, and maintenance are performed using the Link CX Web pages. Use the error indications in the web server interface and Table 7-1 to troubleshoot alarm indications.

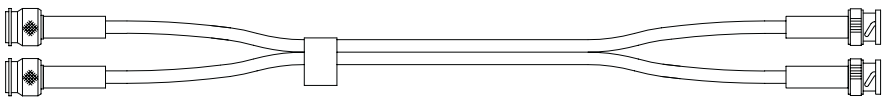
Appendix 1

Interface Cable Pinouts

A1-1 DS-3 Cable

Table A1-1 DS-3 Cable (100587-00X)

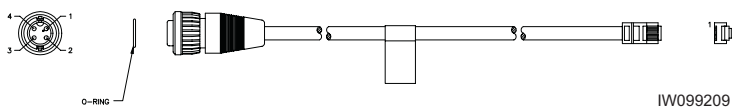
Link CX IN/OUT TNC Connectors		Wire Color	DS-3 Equipment BNC Port	
Pin	**Function**		**Function**	**Pin**
1	DATA IN	--	TX	1
Shield	GND	Foil	GND	Shield
2	DATA OUT	--	RX	2
Shield	GND	Foil	GND	Shield



A1-2 Ethernet Data Cable

Table A1-2 10/100 Ethernet Data Cable (100652-00X)

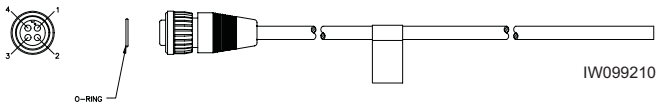
Link CX ETHERNET 1/2 Connectors		Wire Color	Ethernet Equipment RJ-45 Port	
Pin	**Function**		**Function**	**Pin**
1	RX+	White/Orange	TX+	1
2	RX-	Orange	TX-	2
3	TX+	White/Green	RX+	3
4	TX-	Green	RX-	6



A1-3 DC Power Cable

Table A1-3 DC Power Cable (100653-00X)

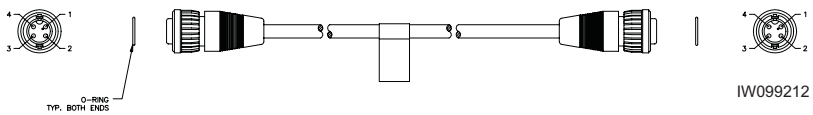
To Link CX POWER (4-pin Circular)		Wire Color	To DC Power Supply	
Pin	**Function**		**Function**	**Wire**
1	-V in	White	-V out	White
2	--	--	RS-232 TX	--
3	--	--	RS-232 RX	--
4	+V in	Red	RS-232 GND	Red



A1-4 Ethernet Crossover Cable

Table A1-4 10/100 Ethernet Crossover Cable (100655-001)

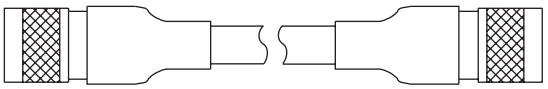
Link CX ETHERNET 1/2 Connectors		Wire Color	Link CX ETHERNET 1/2 Connectors	
Pin	**Function**		**Function**	**Pin**
1	RX+	White/Orange	TX+	3
2	RX-	Orange	TX-	4
3	TX+	White/Green	RX+	1
4	TX-	Green	RX-	2



A1-5 External Antenna Cable

Table A1-5 Antenna Cable (AC100008)

Link CX N-Type Connector		Wire Color	Antenna N-Type Connector	
Pin	**Function**		**Function**	**Pin**
1	TX/RX	--	TX/RX	1
Shield	GND	--	GND	Shield



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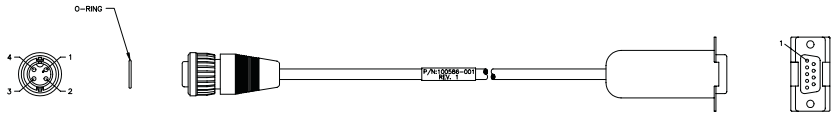
A1-6 RS-232 Craft Cable

Table A1-6 RS-232 CLI Craft PC Cable (100586-001)

To Link CX TEST (4-pin Circular)		Wire Color	To Craft PC Serial DB-9 Port	
Pin	**Function**		**Function**	**Pin**
1	N/C	--	N/C	--
2	RS-232 RX	Red	RS-232 TX	3
3	RS-232 TX	Black	RS-232 RX	2
4	RS-232 GND	Yellow	RS-232 GND	5

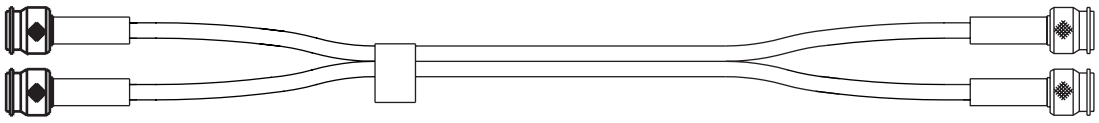


IW099207

A1-7 StreamNet ATM Switch Cable

Table A1-7 StreamNet DS-3 Cable (100588-003)

Link CX IN/OUT TNC Connectors		Wire Color	StreamNet DS-3 TNC Port	
Pin	**Function**		**Function**	**Pin**
1	DATA IN	--	TX	1
Shield	GND	Foil	GND	Shield
2	DATA OUT	--	RX	2
Shield	GND	Foil	GND	Shield



Appendix 2

Technical Specifications

A2-1 Link CX Radio

Table A2-1 Link CX-DSX DS-3 or Ethernet Version (5.3 GHz)

General	
Frequency Range	5.25-5.35 GHz
Compliance (USA)	FCC Rules Part 15.407, U-NII
Capacity	Full-duplex DS-3, per Bellcore GR-499-CORE, or 45 Mbps Ethernet, per IEEE 802.3
Emission Bandwidth (at 26 dB)	13.9 MHz
Channel Center Frequencies • Channel 1 (Tx Low/Rx High) • Channel 1 (Tx High/Rx Low) • Channel 2 (Tx Low/Rx High) • Channel 2 (Tx High/Rx Low)	 Transmit--5.262 GHz/Receive--5.322 GHz Transmit--5.322 GHz/Receive--5.262 GHz Transmit--5.278 GHz/Receive--5.338 GHz Transmit--5.338 GHz/Receive--5.278 GHz
Modulation Type	16 QAM
Transmitter	
Maximum RMS Power Output	-1.0 dBm
Power Output Stability	+/- 2 dB
Frequency Stability	+/- 5 ppm
Transmit Duty Cycle	100%
Emissions Mask & Spurious and Harmonic Output	Per FCC CFR 47 Part 15.407
Channel Frequency Selection	Software-controlled
Automatic Tx Power Control (ATPC)	Maintains a constant Carrier-to-Noise Ratio at both ends of a link, operator enabled ON or OFF
Transmitter Attenuation Range	0-30.0 dB in 1 dB steps, and Mute 40 dB, operator controlled

Table A2-1 Link CX-DSX DS-3 or Ethernet Version (5.3 GHz) (continued)

Receiver	
Type	Double Heterodyne
Error Correction	FEC Reed Solomon Decoding
Sensitivity at 10^{-6} BER	-78 dBm state guaranteed
Typical Unfaded BER	10^{-10}
Frequency Stability	+/- 5 ppm
Channel Frequency Selection	Software-controlled
Maximum Receive Level without Receiver Degradation	-35 dBm
Maximum Receive Level without Receiver Damage	-30 dBm
DS-3 Interface	
Type	Full-duplex DS-3, per Bellcore GR-499-CORE
Line Rate	44.736 Mbps
Line Code	B3ZS
Tx and Rx Electrical Interfaces	75 Ohm unbalanced
Tx and Rx Physical Connectors	Female TNC coaxial with grounded outer conductor
Ethernet Interfaces	
Number	Two, with independent transmit and receive pair sensing
Type	Full-duplex 10/100 Base-T per IEEE 802.3
Line Rate	45 Mbps
Max Distance between CPE and Link CX	100 m (328 ft.)
Electrical Interfaces	100 Ohm UTP
Physical Connectors	Female four-pin Circular
External Antenna to Link CX Antenna Port (Optional)	
Connector Type	50 Ohm Coaxial N-Type Female
Antenna Port Return Loss	>=12 dB
Other Interfaces	
Craft Port	Male four-pin Circular, RS-232 asynchronous data port (TXD, RXD, GND)

Table A2-1 Link CX-DSX DS-3 or Ethernet Version (5.3 GHz) (continued)

RSSI	Female BNC, DC voltage level proportionate to Received Signal Strength
Power Requirements	
DC Source	+/- 21 to +/- 60 VDC
Power Consumption	30 watts nominal
Undervoltage Protection Circuit	> +/- 18 VDC to power up the Link CX
Physical Connector	Male four-pin Circular
Environmental	
Ambient Temperature Range • Operational • Storage	 -33 to +60°C (-27 to +140°F) -40 to +85°C (-40 to +185°F)
Relative Humidity • Operational • Storage	 100%, all weather protection 95%, noncondensing
Altitude • Operational • Storage	 15,000 ft. AMSL (4,500m) 50,000 ft. AMSL (15,000m)
Mechanical	
Height (HxWxD) • With External Antenna • With Integral Connector	 30 x 30 x 10 cm (12 x 12 x 4 in.) 30 x 30 x 10.6 cm (12 x 12 x 4.25 in.)
Weight • With Integral Antenna • With External Antenna Connector	 (TBD) kg (lb.); Shipping Weight: kg (lb.) (TBD) kg (lb.); Shipping Weight: kg (lb.)

Table A2-2 Link CX-DSX DS-3 or Ethernet Version (5.8 GHz)

General	
Frequency Range	5.725-5.825 GHz
Compliance	Complies with FCC Ruling Part 15.247
Capacity	Full-duplex DS-3, per Bellcore GR-499-CORE, or 45 Mbps Ethernet, per IEEE 802.3
Emission Bandwidth	16 MHz
Channel Center Frequencies • Channel 1 (Tx Low/Rx High) • Channel 1 (Tx High/Rx Low) • Channel 2 (Tx Low/Rx High) • Channel 2 (Tx High/Rx Low)	 Transmit--5.737 GHz/Receive--5.797 GHz Transmit--5.797 GHz/Receive--5.737 GHz Transmit--5.753 GHz/Receive--5.813 GHz Transmit--5.813 GHz/Receive--5.753 GHz
Modulation Type	16 QAM
Factory-Supplied Coaxial Cable	2 m (6.6 ft.) N-Type Male to N-Type Male
Transmitter	
Maximum RMS Power Output	+16.0 dBm
Power Output Stability	+/- 2 dB
Frequency Stability	+/- 5 ppm
Transmit Duty Cycle	100%
Emissions Mask & Spurious and Harmonic Output	Per FCC CFR 47 Part 15.407b3
Channel Frequency Selection	Software-controlled
Automatic Tx Power Control (ATPC)	Maintains a constant Carrier-to-Noise Ratio at both ends of a link, operator enabled ON or OFF
Transmitter Attenuation Range	0-30.0 dB in 1 dB steps, and Mute 40 dB, operator controlled
Receiver	
Type	Double Heterodyne
Error Correction	FEC Reed Solomon Decoding
Sensitivity at 10^{-6} BER	-78 dBm state guaranteed
Typical Unfaded BER	10^{-10}
Frequency Stability	+/- 5 ppm
Channel Frequency Selection	Software-controlled

Table A2-2 Link CX-DSX DS-3 or Ethernet Version (5.8 GHz) (continued)

Maximum Receive Level without Receiver Degradation	-35 dBm
Maximum Receive Level without Receiver Damage	-30 dBm
DS-3 Interface	
Type	Full-duplex DS-3, per Bellcore GR-499-CORE
Line Rate	44.736 Mbps
Line Code	B3ZS
Tx and Rx Electrical Interfaces	75 Ohm unbalanced
Tx and Rx Physical Connectors	Female TNC coaxial with grounded outer conductor
Ethernet Interfaces	
Number	Two, with independent transmit and receive pair sensing
Type	Full-duplex 10/100 Base-T per IEEE 802.3
Line Rate	45 Mbps
Max Distance between CPE and Link CX	100 m (328 ft.)
Electrical Interfaces	100 Ohm UTP
Physical Connectors	Female four-pin Circular
External Antenna to Link CX Antenna Port (Optional)	
Connector Type	50 Ohm Coaxial N-Type Female
Antenna Port Return Loss	>=12 dB
Other Interfaces	
Craft Port	Male four-pin Circular, RS-232 asynchronous data port (TXD, RXD, GND)
RSSI	Female BNC, DC voltage level proportionate to Received Signal Strength
Power Requirements	
DC Source	+/- 21 to +/- 60 VDC
Power Consumption	30 watts nominal
Undervoltage Protection Circuit	> +/- 18 VDC to power up the Link CX
Physical Connector	Male four-pin Circular

Table A2-2 Link CX-DSX DS-3 or Ethernet Version (5.8 GHz) (continued)

Environmental	
Ambient Temperature Range • Operational • Storage	 -33 to +60°C (-27 to +140°F) -40 to +85°C (-40 to +185°F)
Relative Humidity • Operational • Storage	 100%, all weather protection 95%, noncondensing
Altitude • Operational • Storage	 15,000 ft. AMSL (4,500m) 50,000 ft. AMSL (15,000m)
Mechanical	
Height (HxWxD) • With External Antenna • With Integral Connector	 30 x 30 x 10 cm (12 x 12 x 4 in.) 30 x 30 x 10.6 cm (12 x 12 x 4.25 in.)
Weight • With Integral Antenna • With External Antenna Connector	 (TBD) kg (lb.); Shipping Weight: kg (lb.) (TBD) kg (lb.); Shipping Weight: kg (lb.)

A2-2 Factory-Supplied Antennas

This chapter describes specifications for the integral Link CX antenna, and the three factory-supplied antennas. Specifications for customer-supplied antennas are to be supplied by the antenna manufacturer.

Table A2-3 5.3 GHz and 5.8 GHz Integral Flat Panel Antenna

Size	30 x 30 x 1.9 cm (12 x 12 x 0.75 in.)
Mounting	Permanently attached to the Link CX radio; Gasketed to prevent moisture intrusion
Polarization	Horizontal or vertical, depending on Link CX mounting position
Forward Gain	21 dBi
Front/Back Ratio	30 dB
Beam Width	12°
Elevation Adjustment	± 15°
Azimuth Adjustment	360°
Mounting Bracket Pole Capacity • Single Link CX • Dual Link CX	 4.43 - 11.4 cm (1.75 - 4.5 in.) 4.43 - 11.4 cm (1.75 - 4.5 in.)

Table A2-4 61 cm (2 ft.) 5.8 GHz Parabolic Antenna (Note)

Size	61 cm (2 ft.) round parabolic with integral radome
Mounting	Independent mounting
Polarization	Horizontal or vertical, depending on mounting position
Forward Gain	28.1 dBi
Front/Back Ratio	38 dB
Beam Width	6°
Elevation Adjustment	± 15°
Azimuth Adjustment	360°
Mounting Bracket Pole Capacity	4.43 - 11.4 cm (1.75 - 4.5 in.)
Connector to Link CX	Coaxial 50 Ohm Female N-Type
Factory-Supplied Coaxial Cable to Link CX	2 m (6.6 ft.) N-Type Male to N-Type Male
Note: This antenna is not FCC certified for use with the 5.3 GHz Link CX.	

Table A2-5 122 cm (4 ft.) 5.8 GHz Parabolic Antenna (Note)

Size	122 cm (4 ft.) round parabolic with integral radome
Mounting	Independent mounting
Polarization	Horizontal or vertical, depending on mounting position
Forward Gain	34 dBi
Front/Back Ratio	46 dB
Beam Width	(TBD) °
Elevation Adjustment	± 15°
Azimuth Adjustment	360°
Mounting Bracket Pole Capacity	4.43 - 11.4 cm (1.75 - 4.5 in.)
Connector to Link CX	Coaxial 50 Ohm Female N-Type
Factory-Supplied Coaxial Cable to Link CX	2 m (6.6 ft.) N-Type Male to N-Type Male
Note: This antenna is not FCC certified for use with the 5.3 GHz Link CX.	

Appendix 3

Using the Web-Based GUI User Interface

The Link CX includes its own HTML-based installation, operation and test Web pages, which can be accessed locally using a Web browser on a Craft PC, or remotely using any Web browser on the same network as the Link CX.

The rest of this Appendix includes information on:

- Section A3-1, Web Browser Requirements
- Section A3-2, Connecting A Web Browser
- Section A3-3, Accessing the Link CX Web Pages
- Section A3-4, Link CX Web Pages

A3-1 Web Browser Requirements

The Web browser used to install, operate, and maintain the Link CX must have an HTML-enabled interface.

A3-2 Connecting A Web Browser

You must connect your Web browser to the Link CX; either locally using a Craft PC, or remotely using any Web browser on the same Ethernet network as the Link CX. The web browser platform must have an Ethernet adapter for connecting to the Link CX directly, or to the Link CX though other Ethernet equipment.

A3-3 Accessing the Link CX Web Pages

Once your Web browser is connected to the Link CX as described in Section A3-2, you can access and move through the configuration and maintenance pages as you would any other Web site. The rest of this paragraph will describe how to access the Link CX Web pages.

A3-4 Link CX Web Pages

The following figures show the Link CX Web pages, and Chapter Four through Chapter Seven describe how to use the Link CX Web pages to configure, install, and maintain the Link CX.

Following each figure will be a table describing individual parameter defaults and definitions.

There may be a password required to access the Web pages, if enabled by the owner.

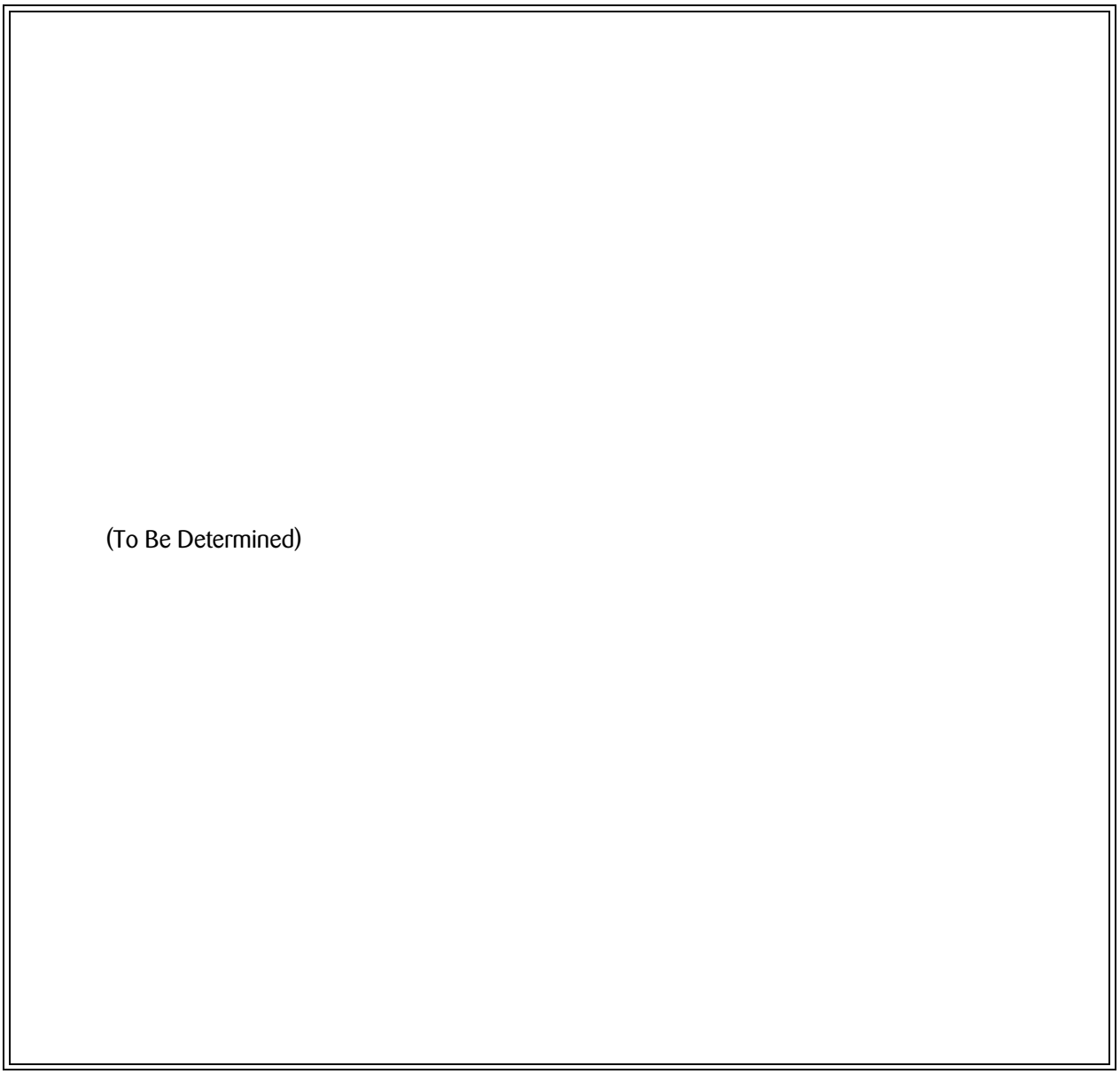


Figure A3-1 Link CX Welcome Web Page

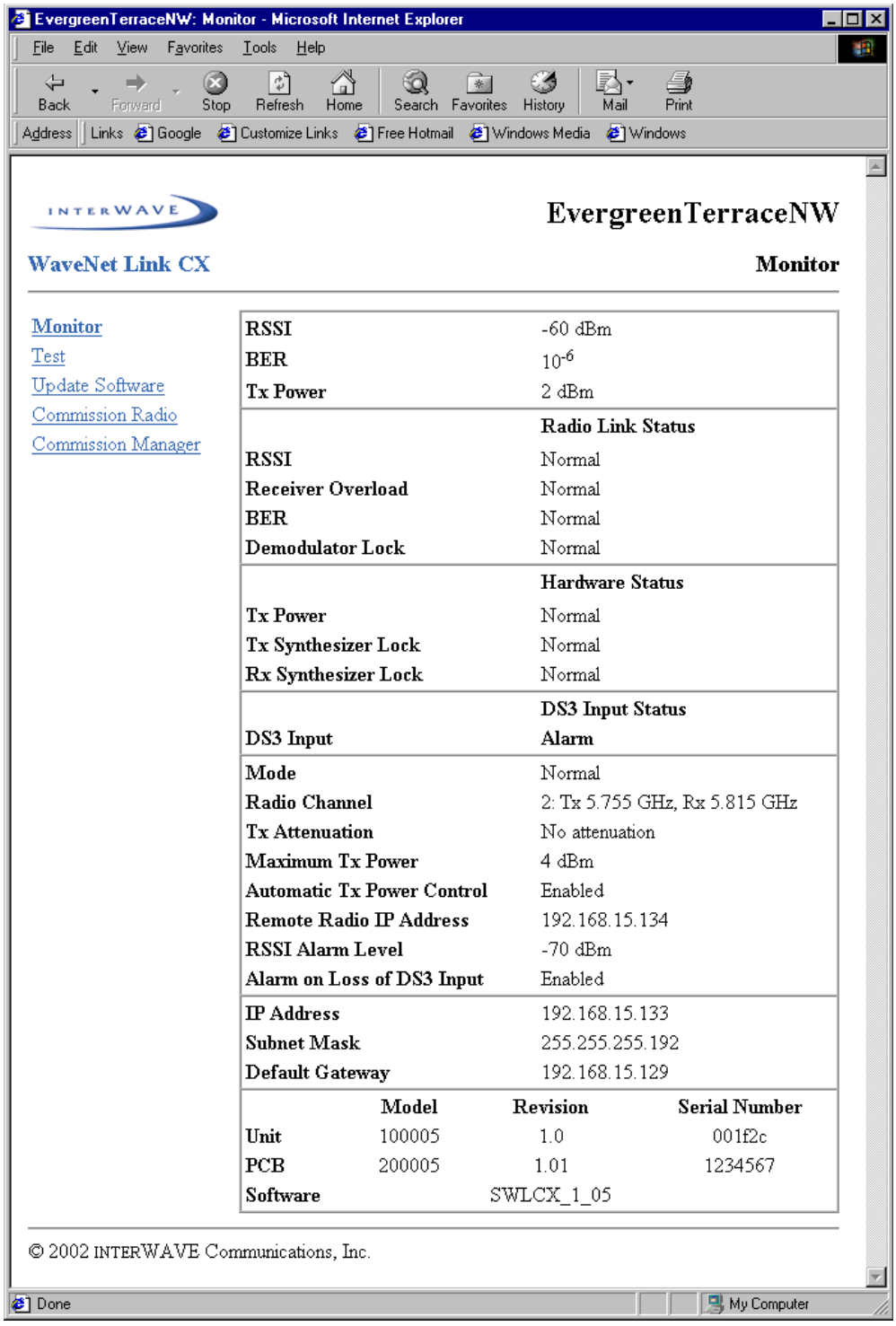


Figure A3-2 Link CX Monitor Web Page

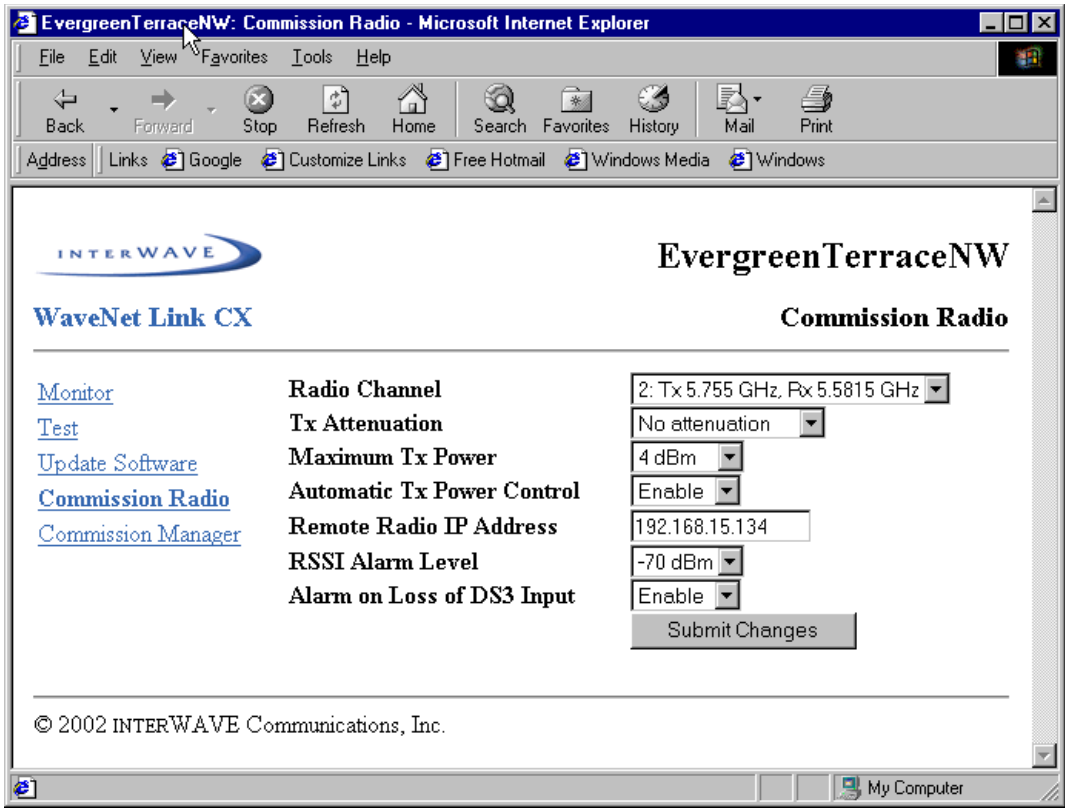


Figure A3-3 Link CX Commission Radio Web Page

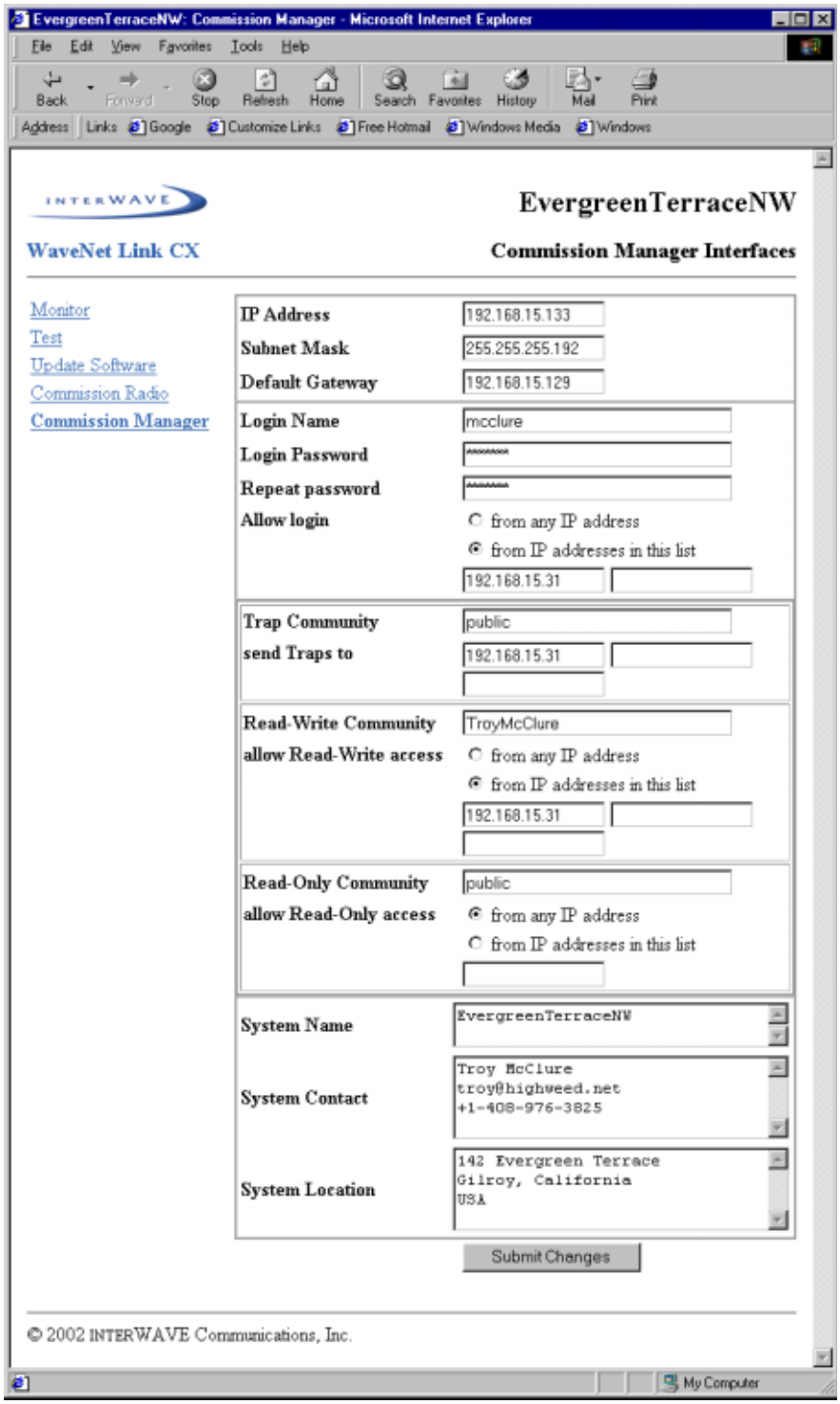


Figure A3-4 Link CX Commission Manager Web Page

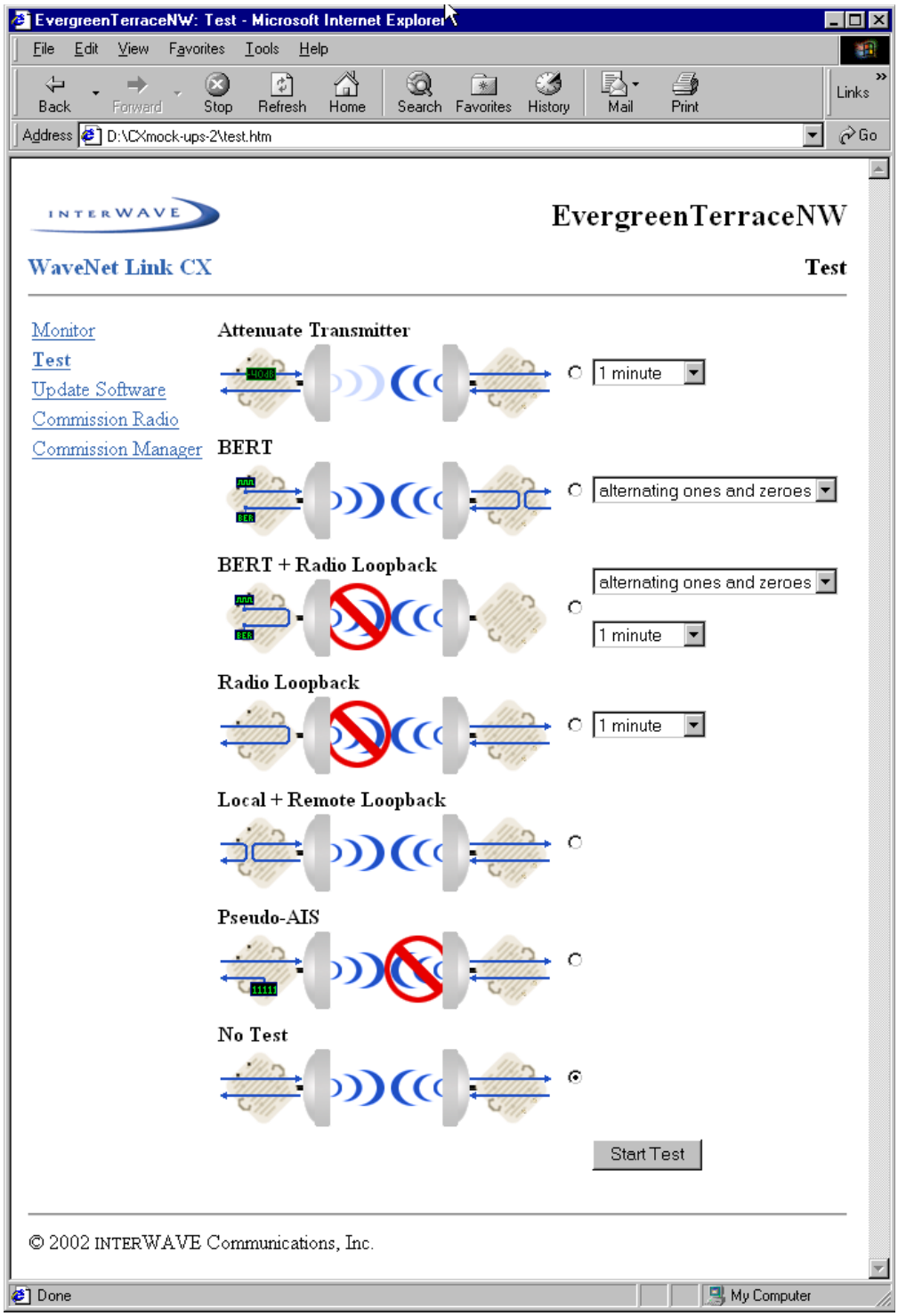


Figure A3-5 Link CX Test Web Page

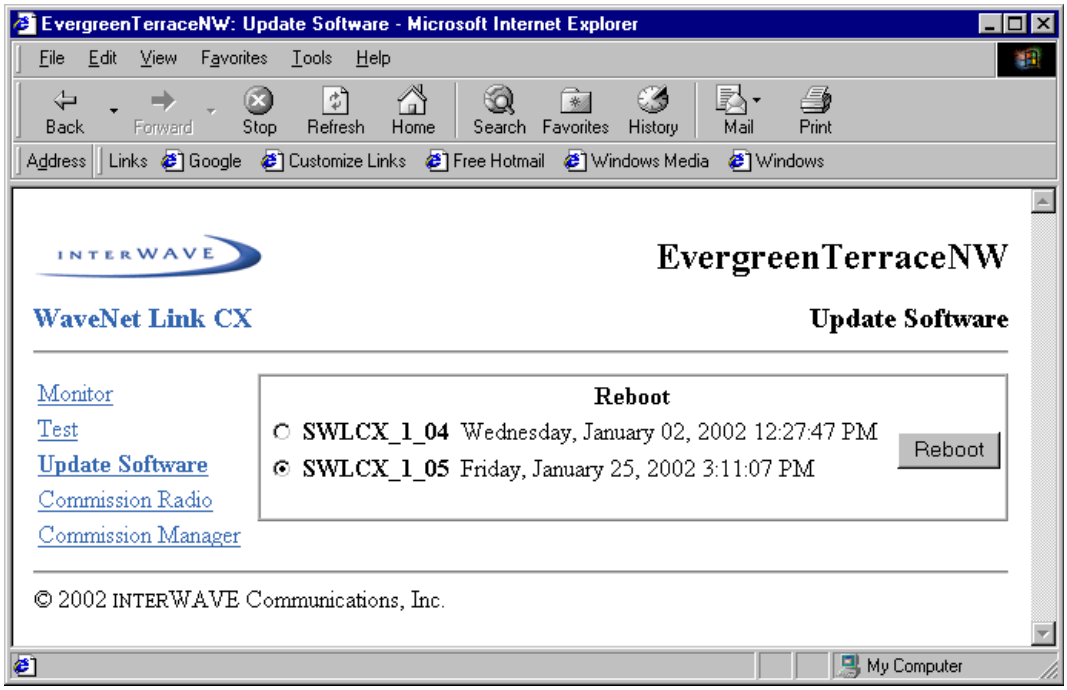


Figure A3-6 Link CX Update Software Web Page

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Appendix 4

Grounding and Lightning Protection

This appendix explains how to properly set up the Link CX radio and associated antenna for grounding and lightning protection. It contains the following sections:

- Section A4-1, Overview
- Section A4-2, Grounding
- Section A4-3, Lightning Protection
- Section A4-4, Bibliography

> **NOTE** interWAVE strongly recommends that you install a Transtector Lightning Arrestor or equivalent at the cable entry to the Ethernet, Power, and/or DS-3 equipment structure.

A4-1 Overview

When used in telecommunications, good grounding practices have some direct benefits that can help users maximize system uptime as well as ensure the safety of those people working on the system. Among these benefits are:

- Protection of personnel from electric shock and fire hazards
- Reduction of radiated and conducted electromagnetic susceptibility
- Improved system tolerance to discharge of electrostatic energy and lightning interference
- Minimized service interruptions and service damage

No practice or formula can completely eliminate the above risks, but interWAVE believes that good grounding and bonding practices can significantly reduce the risk of many of these hazards. This appendix includes a bibliography that contains several publications that are readily available and provide detailed information on many aspects of grounding systems and their design, implementation, measurement, and maintenance.

Please note that every telecommunication site is unique and must be evaluated accordingly. The following information is provided for generic reference and educational purposes only. The grounding plans and practices for a given site should be established and implemented only by trained professionals, working in accordance with local practices and regulations.

NOTE In most cases, following the local code requirements for grounding and lightning protection will be adequate.

A4-2 Grounding

A4-2.1 Making a Grounding Plan

A grounding plan should be developed at the outset of site design to provide the best grounding procedures and to minimize ground loop currents. Grounding should be achieved by connecting the outer conductors of the cables through a large-section copper strap to a central grounding point, and the size of the conductor should be increased as each branch path is added. The final conductor should be connected directly to the grounding system. For a radio site, a single copper grounding rod is insufficient, because its impedance is likely to be too high.

A4-2.2 Grounding Antenna Feeders

All antenna feeders should be bonded to the tower at the upper and lower ends and grounded at the point of entry into the building. Weatherproof grounding kits are available from antenna manufacturers.

NOTE Many of the cables used by interWAVE have braided rather than solid outer conductors; this type of grounding is not appropriate. In these cases surge arrestors approved by interWAVE should be used. For information on surge arrestors, please contact the interWAVE Customer Support department.

A4-2.3 Grounding Buildings

Ideally, a ground ring should surround the building and be connected to individual grounds associated with feeder entry, antenna support structure, the building lightning conductor, the equipment room, the main AC supply, and other facilities. Each connection should be made by the most direct route to minimize interaction between the different grounding functions.

The ground ring should consist of copper cable or tape with electrodes two meters or longer, buried to a depth of 0.6 m and at a distance from the building not to exceed 1 m.

Buildings may require lightning rods if they are not within the zone of another protected structure.

To construct a good ground, ground rods should penetrate the earth to a depth of about 2 m (6 feet). Where the ground is in rocky terrain, make sure that the ground rods penetrate into loose soil. In sandy soil, use more ground rods to make sure that the ground has sufficient contact with water-bearing material.

Use 4 to 6 AWG wire to connect each ground rod to the equipment to be grounded. The cables should be free of sharp bends. Each ground cable should be at least 2 m in length with at least 1 m separation between each. Refer to local and national electrical codes to determine acceptable grounding methods.

The Link CX chassis should be directly connected to ground to ensure that it functions correctly.

A4-3 Lightning Protection

Radio sites can be particularly prone to lightning strikes by virtue of their normally exposed locations and the presence of relatively tall antenna support structures.

> **NOTE** It is not possible to provide and guarantee complete protection from the effects of lightning; however, risks of this sort can be significantly reduced by careful attention to grounding, protection devices, and the layout of the site itself.

Reference should also be made to various publications, some of which are listed in the bibliography. Any site owner or user in doubt about the protection requirements for a particular location should contact the appropriate authority.

A4-3.1 Purposes

The purposes of any protection arrangement should be to:

- Provide a suitable path to ground for the lightning current.
- Ensure adequate bonding between structures and all metalwork on the site and the common grounding system in order to reduce side flashing.
- Prevent the entry of flashes or surges into the building.

The resistance to ground should be kept to a minimum; a value of less than 10 Ohms is recommended. Ideally, and most important, the system should be at equal potential across the entire site.

Certain authorities and service providers have their own particular practices that have to be followed where applicable.

Protection arrangements vary considerably, from very simple sites to complicated sites with multiple buildings, antenna support structures, and associated equipment. Ensuring adequate protection may also involve integration with and upgrading of existing systems.

A4-3.2 Lightning Conductors

Down conductors, bonding interconnections, ground rings, and radial tapes should be of uninsulated 000 AWG copper cable or solid copper tape with a minimum cross section of 25 mm by 3 mm, with all connections protected by nonreactive paste.

Protected test points should be included if appropriate, and sacrificial ground lugs should be clearly marked and easily accessible for periodic inspection.

A4-3.3 Grounding Antenna Support Structures

A structure generally acts as its own lightning conductor and, therefore, does not require an additional conductor from the top to the base. A lightning rod may be required to extend the zone of protection to equipment mounted on the top of the structure. The lightning rod should extend 2.5 m above the highest equipment.

Ground-mounted support structures should be connected at their base to a ground ring through sacrificial ground lugs. Towers should have a connection from each leg.

A ground ring should consist of copper cable or solid copper tape, with ground rods equally spaced at 2-m intervals around the base of the structure as close to it as possible. The ground ring is buried approximately 0.6 m deep where soil conditions allow. An alternative method using radials rather than rings is detailed in The "Grounds" for Lightning and EMP Protection, published by PolyPhaser Corporation.

The ground ring should be connected to the main building ground by the most direct route, and should be buried as appropriate.

Roof-mounted structures should be connected to the main building ground by the most direct route, using sacrificial lugs and copper cable or tape as appropriate. Tower guy wires should be directly bonded at their lowest point to a suitable ground electrode or connected to the site ground by the most direct route.

A4-4 Bibliography

ITU - T K.40
Protection against LEMP in telecommunications centres

ITU - T K.27
Bonding configurations and earthing inside a telecommunication building

ITU - T K.35
Bonding configurations and earthing at remote electronic sites

ITU - T K.39
Risk assessment of damages to telecommunications sites due to lightning discharges

ITU - T Lightning Handbook
The protection of telecommunication lines and equipment against lightning discharges

IEEE Emerald Book
Powering and Grounding

The "Grounds" for Lightning and EMP Protection, second edition
Published by PolyPhaser Corporation

Appendix 5

Enterprise MIBs and Traps

This appendix contains information about the three different sets of Link CX Management Information Bases (MIBs), their current listings, and where to find the most current versions.

A5-1 Enterprise MIB

A5-1.1 Overview

The Link CX Enterprise MIB consists of the following groups of objects:

- link_cx_identity group: Model, revision, serial numbers, and channel frequency table. Configured in the factory. Read-only by the customer.
- link_cx_configuration group: Channel number and other read-write parameters that the customer chooses. This group is the system's persistent state. It is preserved across reboots.
- link_cx_status group: Performance and alarm status, read-only. Not preserved across reboots.
- link_cx_test group: BERT, loopback, and other temporary state that the customer might use in a test procedure. Read-write. Not preserved across reboots.
- link_cx_reboot group: Identifies the software versions that are available and controls reboot.
- link_cx_trap group: There is only one trap-related variable, trapSentCounter. It is not preserved across reboots.

A5-1.2 Details

```
WN_LINK_CX-MIB DEFINITIONS ::= BEGIN

IMPORTS
  enterprises, Counter
    FROM RFC1155-SMI
  OBJECT-TYPE
    FROM RFC-1212;

interWAVE             OBJECT IDENTIFIER ::= { enterprises  792  }
wavenet_link_cx       OBJECT IDENTIFIER ::= { interWAVE     5   }
link_cx_identity      OBJECT IDENTIFIER ::= { wavenet_link_cx 1 }
link_cx_configuration  OBJECT IDENTIFIER ::= { wavenet_link_cx 2}
link_cx_status        OBJECT IDENTIFIER ::= { wavenet_link_cx 3}
link_cx_test          OBJECT IDENTIFIER ::= { wavenet_link_cx 4}
```

```
link_cx_reboot        OBJECT IDENTIFIER ::= { wavenet_link_cx 5}
link_cx_trap          OBJECT IDENTIFIER ::= { wavenet_link_cx 6}

-- link_cx_identity group

unitModelNumber OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The model number of the unit as a whole."
  ::= { link_cx_identity 1}

unitRevisionNumber  OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The revision number of the unit as a whole."
  ::= { link_cx_identity 2}

unitSerialNumber   OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The serial number of the unit as a whole."
  ::= { link_cx_identity 3}

boardModelNumber OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The model number of the PCB board assembly."
  ::= { link_cx_identity 4}

boardRevisionNumber  OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The revision number of the PCB board assembly."
  ::= { link_cx_identity 5}

boardSerialNumber   OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The serial number of the PCB board assembly."
  ::= { link_cx_identity 6}
```

```
rfFrequencyTable OBJECT-TYPE
  SYNTAX  SEQUENCE OF RfChannelFreqEntry
  ACCESS not-accessible
  STATUS mandatory
  DESCRIPTION
      "The table of 2 selectable Tx/Rx frequency channel pairs, in MHz. The
      receive frequency on a Tx-high unit is lower than the transmit frequency
      by the amount of the Tx/Rx separation. Conversely, the receive frequency
      on a Tx-low unit is higher than the transmit frequency by the amount of
      the Tx/Rx separation."
  ::= { link_cx_identity 7}

rfFrequencyEntry OBJECT-TYPE
  SYNTAX  RfFrequencyEntry
  ACCESS  not-accessible
  STATUS  mandatory
  DESCRIPTION
      "Channel frequency entry."
  INDEX   { rfChannelIndex}
  ::= { rfFrequencyTable 1}

RfFrequencyEntry ::=
  SEQUENCE {
    rfChannelIndex
      INTEGER,
    rfTxFrequency
      INTEGER,
    rfRxFrequency
      INTEGER
  }

rfChannelIndex OBJECT-TYPE
  SYNTAX  INTEGER (1..2)
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The RF channel number."
  ::= { rfFrequencyEntry 1}

rfTxFrequency OBJECT-TYPE
  SYNTAX  INTEGER
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The transmit frequency in MHz."
  ::= { rfFrequencyEntry 2}

rfRxFrequency OBJECT-TYPE
  SYNTAX  INTEGER
  ACCESS  read-only
  STATUS  mandatory
```

```
  DESCRIPTION
      "The receive frequency in MHz."
  ::= { rfFrequencyEntry 3}

-- link_cx_configuration group

rfTxAttenuateControl OBJECT-TYPE
  SYNTAX  INTEGER {
      enabled(1),
      disabled(2)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "If enabled, attenuates the transmit output level by 40 dB."
  ::= }link_cx_configuration 1}

rfAtpcControl   OBJECT-TYPE
  SYNTAX  INTEGER {
      enabled(1),
      disabled(2)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "Automatic Tx Power Control mode can be enabled or disabled.
      If enabled, the two Link CX radios at opposite ends of the
      radio link send each other feedback messages that they use
      to adjust their Tx power down to the lowest level that is
      consistent with good signal quality."
  ::= }link_cx_configuration 2}

rfTxPowerLimit   OBJECT-TYPE
  SYNTAX  INTEGER (-14..16)
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "Maximum transmit power level limit at the antenna port, in dBm.
      The Tx power limit can be set in 1 dB steps within the range
      of -14 dBm to +16 dBm. If Automatic Tx Power Control is enabled
      the measured Tx power may be lower than this limit. If Automatic
      Tx Power Control is disabled the measured Tx power should be
      exactly the same as this target value."
  ::= }link_cx_configuration 3}

rfAtpcAddress   OBJECT-TYPE
  SYNTAX IpAddress
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "The IP Address of the peer radio with which this radio exchanges
```

```
        Automatic Tx Power Control information."
    ::= }link_cx_configuration 4}

rfChannel     OBJECT-TYPE
    SYNTAX  INTEGER (1..2)
    ACCESS  read-write
    STATUS  mandatory
    DESCRIPTION
        "The current transmit channel of the local unit. The transmit
        frequency in MHz for each channel can be read in the rfFrequencyTable."
    ::= }link_cx_configuration 5}

rfRssiAlarmThresholdSetting   OBJECT-TYPE
    SYNTAX  INTEGER (-80..-40)
    ACCESS  read-write
    STATUS  mandatory
    DESCRIPTION

        "A RSSI Alarm will be generated if the level of RSSI goes below
        the set threshold. The threshold can be set in 1 dB steps
        within the range of -80 to -40 dBm."
    ::= }link_cx_configuration 6}

ds3LosAlarmControl   OBJECT-TYPE
    SYNTAX  INTEGER {
          enabled(1),
          disabled(2)
        }
    ACCESS  read-write
    STATUS  mandatory
    DESCRIPTION
        "DS3 LOS alarm control. When enabled, the alarm will be generated.
        When disabled, the alarm will not be generated even if
        LOS condition is detected."
    ::= }link_cx_configuration 7}

-- link_cx_status group

rfPowerOutputLevel OBJECT-TYPE
    SYNTAX  INTEGER
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The measured radio Tx power level in dBm."
    ::= }link_cx_status 1}

rfRssiLevel OBJECT-TYPE
    SYNTAX  INTEGER
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The measured RSSI of the active channel in dBm. -110 dBm
```

```
        indicates the receive signal level is below the detection level."
    ::= }link_cx_status 2}

bitErrorRate OBJECT-TYPE
    SYNTAX  INTEGER
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The estimated bit error rate (BER), in errors per 10^8 bits.
        A returned value of 0 indicates zero bit errors in 10^8 bits.
        A returned value of 1 indicates an estimated BER of 1x10^-8.
        A returned value of 10 indicates an estimated BER of 1x10^-7,
        and so on."
    ::= }link_cx_status 3}

losAlarmStatus OBJECT-TYPE    -- DS3 interface alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "A value of 1 indicates a DS3 connection is present.
        A value of 2 indicates the DS3 connection has been lost.
        If ds3LosAlarmControl = disabled, losAlarmStatus will
        always be normal."
    ::= }link_cx_status 4}

txSynthLockAlarmStatus OBJECT-TYPE    -- local alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The Tx synthesizer lock status.
        A value of 1 indicates the Tx synthesizer is locked.
        A value of 2 indicates the Tx synthesizer is unlocked"
    ::= }link_cx_status 5}

rxSynthLockAlarmStatus OBJECT-TYPE  -- local alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The Rx synthesizer lock status.
```

```
        A value of 1 indicates the Rx synthesizer is locked.
        A value of 2 indicates the Rx synthesizer is unlocked"
    ::= }link_cx_status 6}

lowTxPowerAlarmStatus OBJECT-TYPE   -- local alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "A value of 1 indicates the Tx power at the antenna port
        is greater than or equal to -14 dBm. A value of 2 indicates
        the Tx power at the antenna port is less than -14 dBm."
    ::= }link_cx_status 7}

demodLockAlarmStatus OBJECT-TYPE    -- link alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "The demodulator lock status.
        A value of 1 indicates the demodulator is locked.
        A value of 2 indicates the demodulator is unlocked"
    ::= }link_cx_status 8}

lowRssiLevelAlarmStatus OBJECT-TYPE -- link alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
    ACCESS  read-only
    STATUS  mandatory
    DESCRIPTION
        "A RSSI alarm will be generated if the level of RSSI goes below
        the user configured RSSI alarm level, rfRssiAlarmThresholdSetting.
        A value of 1 indicates the received signal level is above the RSSI
        alarm threshold. A value of 2 indicates the received signal level
        is at or below the user configured RSSI alarm level.
        This alarm is valid only if the Rx synthesizer is locked."
    ::= }link_cx_status 9}

receiverOverloadAlarmStatus OBJECT-TYPE -- link alarm condition
    SYNTAX  INTEGER {
          normal(1),
          alarm(2)
          }
```

```
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "A receiver overload alarm will be generated if the level
      of RSSI is at or above -40 dBm. A value of 1 indicates the
      received signal level is below -40 dBm. A value of 2 indicates
      the received signal level is at or above -40 dBm.
      This alarm is only valid if the Rx synthesizer is locked."
  ::= }link_cx_status 10}

bitErrorRateAlarmStatus OBJECT-TYPE -- link alarm condition
  SYNTAX  INTEGER {
       normal(1),
       alarm(2)
      }
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "A bit error rate alarm will be generated if the level
      of BER is at or above 10^-3, i.e. if bitErrorRate is
      equal to or greater than 100000."
  ::= }link_cx_status 11}

-- link_cx_test group

rfTxAttenuateTimer   OBJECT-TYPE
  SYNTAX  INTEGER (0..1800)
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "To temporarily enable Tx attenuation by 40 dB, write the number of
      seconds to this timer. When the timer counts down to 0, Tx attenuation
      will return to its normal unattenuated state. Writing to this timer
      has no effect if rfTxAttenuateControl is set to enable because in
      that case the transmitter is already attenuated."
  ::= }link_cx_test 1}

ds3LocalLoopbackControl OBJECT-TYPE
  SYNTAX  INTEGER {
       enabled(1),
       disabled(2)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "The DS3 local loopback control. When enabled, DS3 data on the
      local interface is looped back through the local interface.
      When disabled, DS3 data on the local interface is sent over
      the radio link to the remote unit."
  ::= }link_cx_test 2}
```

```
rfLocalLoopbackTimer   OBJECT-TYPE
  SYNTAX  INTEGER (0..1800)
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "When this value is greater than zero, the radio is in the local
      loopback mode. The RF transmit signal on the local unit is
      converted to the receive frequency of the local unit so it can
      be received by the local unit, for the chosen period of time in
      seconds. When this timer counts down to 0 the unit reverts to
      normal operation in which the RF transmit signal on the local unit
      is transmitted over the radio link to the remote unit. The duration
      is selectable in 1 second intervals from 0 seconds to a maximum of
      1800 seconds."
  ::= }link_cx_test 3}

ds3RemoteLoopbackControl OBJECT-TYPE
  SYNTAX  INTEGER {
       enabled(1),
       disabled(2)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "The DS3 remote loopback control. When enabled, DS3 data on the remote
      interface is looped back through the remote interface. When disabled,
      DS3 data on the remote interface is sent over the radio link to the
      local unit."
  ::= }link_cx_test 4}

ds3BerTestControl   OBJECT-TYPE
  SYNTAX  INTEGER {
       alternatingOnesZeros(1),
       allOnes(2),
       allZeros(3),
       disabled(4)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "BER test mode control. The BER test is enabled by selecting one of
      three different data patterns. The patterns are:
      (1) alternating 1's and 0's, (2) all 1's, and (3) all 0's.
      The BER test is disabled by setting the BER test control to 4."
  ::= }link_cx_test 5}

pseudoAisControl   OBJECT-TYPE
  SYNTAX  INTEGER {
       enabled(1),
       disabled(2)
      }
```

```
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "When enabled, pseudo-AIS (constant mark or all ones at the DS3
      interface) will be generated."
  ::= }link_cx_test 6}

-- link_cx_reboot group

softwareVersionBank1 OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The software version in bank one."
  ::= }link_cx_reboot 1}

softwareVersionBank2 OBJECT-TYPE
  SYNTAX  DisplayString (SIZE (0..15))
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The software version in bank two."
  ::= }link_cx_reboot 2}

bootedUsingBankNumber OBJECT-TYPE
  SYNTAX  INTEGER {
      bankOne(1),
      bankTwo(2)
      }
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "The software bank from which the unit booted."
  ::= }link_cx_reboot 3}

bootUsingBankNumber OBJECT-TYPE
  SYNTAX  INTEGER {

      bankOne(1),
      bankTwo(2)
      }
  ACCESS  read-write
  STATUS  mandatory
  DESCRIPTION
      "Selects the software bank and causes reboot."
  ::= }link_cx_reboot 4}

-- traps

trapSentCounter OBJECT-TYPE
  SYNTAX  Counter
```

```
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION
      "Total number of enterprise traps sent since last reboot."
  ::= }link_cx_trap 1}

link_cx_unit OBJECT IDENTIFIER ::= }wavenet_link_cx 101}

alarmTrap  TRAP-TYPE
  ENTERPRISE  link_cx_unit
  VARIABLES  }rfPowerOutputLevel,
             rfRssiLevel,
             bitErrorRate,
             losAlarmStatus,
             txSynthLockAlarmStatus,
             rxSynthLockAlarmStatus,
             lowTxPowerAlarmStatus,
             demodLockAlarmStatus,
             lowRssiLevelAlarmStatus,
             receiverOverloadAlarmStatus,
             bitErrorRateAlarmStatus,
             trapSentCounter}
  DESCRIPTION
      "A trap that indicates a change in one or more of the alarm conditions."
  ::= 1

configurationChangeTrap  TRAP-TYPE
  ENTERPRISE  link_cx_unit
  VARIABLES  }rfTxAttenuateControl,
             rfAtpcControl,
             rfTxPowerLimit,
             rfAtpcAddress,
             rfChannel,
             rfRssiAlarmThresholdSetting,
             ds3LosAlarmControl,
             trapSentCounter}
  DESCRIPTION
      "A trap that indicates a configuration change."
  ::= 2

unitTestTrap  TRAP-TYPE
  ENTERPRISE  link_cx_unit
  VARIABLES  }rfTxAttenuateTimer,
             ds3LocalLoopbackControl,
             rfLocalLoopbackTimer,
             ds3RemoteLoopbackControl,
             ds3BerTestControl,|
             pseudoAisControl,
             trapSentCounter }
  DESCRIPTION
      "A trap that indicates the beginning or end of a test procedure.
```

An alarmTrap trap might result from this procedure."
::= 3

END

A5-2 Enterprise Traps

Link CX supports three enterpriseSpecific traps - alarmTrap, configurationChangeTrap, and unitTest-Trap. Each of these traps contains all the relevant variables for that particular trap, in order to minimize polling. One variable that is in each of the traps is a counter, so that the network management application can detect loss of traps.

A5-2.1 alarmTrap

Link CX sends this trap when any of the alarm variables changes, either going into or out of an alarm condition. All of the relevant alarm conditions and performance data are contained in the trap PDU, along with a counter of enterprise traps sent. The variables include:

- trap counter
- DS3 LOS status (DS3 input absent/present)
- Tx Power status (under/over minimum power)
- Tx Synthesizer lock status (unlocked/locked)
- Rx Synthesizer lock status (unlocked/locked)
- RSSI level status (under minimum level)
- Rx overload status (over maximum level)
- BER status (over threshold)
- demodulator lock status (unlocked/locked)
- BER
- RSSI
- Tx Power

A5-2.2 configurationChangeTrap

Link CX sends this trap when the persistent state of the Link CX changes. This trap alerts the network management application that it must refresh its database. If all management is through SNMP exclusively, this trap is redundant. If on the other hand, management is a mixture of HTTP and SNMP this will keep the SNMP side completely consistent. All the relevant persistent state variables are contained in the trap PDU, along with the trap counter. The variables include:

- trap counter
- Tx control (attenuated/unattenuated)
- ATPC control (ATPC enabled/disabled)

- Tx power setting
- ATPC peer IP address (IP address of the CX at the other end of the radio link)
- channel number
- RSSI alarm threshold
- DS3 LOS control (enable/disable alarm for LOS)

A5-2.3 unitTestTrap

Link CX sends this trap when any of the test variables change, either at the start or at completion of a test. All the test state variables are contained in the trap PDU, along with the trap counter. This trap alerts the management application that a change has taken place that will probably result in an alarmTrap before too long (in case it doesn't already know, and in case it wants to distinguish between this case and spontaneous alarmTraps). The state variables in the trap PDU include:

- trap counter
- DS3 local loopback
- DS3 remote loopback
- radio loopback
- pseudoAIS
- BERT
- temporary Tx attenuation

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Notes:

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and ensures the reader is working from a complete document.

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