WaveNet Link AX
ATM-25 U-NII Band
Digital Radio System
Installation and Operations Manual

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Welcome!

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

The Link AX is intended for **professional installation only**. This manual, however, is also designed for personnel who plan, operate and administrate the Link AX communication system. Please review the entire manual before powering up or deploying any Link AX.

Updates to this manual will be posted on the Wireless, Inc. Customer Service Website at *http://www.wire-less-inc.com*. Registered Wireless customers can access Wireless' on-line information and support service, available 24 hours a day, 7 days a week. Our on-line service provides users with a wealth of up-to-date information, with documents being added or updated each month.

Radiation Warnings

Microwave Radio Radiation Warning

Under normal operating conditions, Link AX radio equipment complies with the limits for human exposure to radio frequency (RF) fields adopted by the Federal Communications Commission (FCC). All Wireless, 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 open end of a Waveguide 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.

Microwave Antenna Radiation Warning

Designed for point-to-point operation, a Link AX microwave radio system uses directional antennas to transmit and receive microwave signals. These directional antennas are usually circular or rectangular in shape, and are usually mounted outdoors on a tower or mast, well above ground level.

Referencing OET Bulletin 65 (Edition 97-01, August 1997) from the Federal Communication Commission's Office of Engineering & Technology, limits for maximum permissible exposure (MPE) to microwave signals have been adopted by the FCC for General Population/Uncontrolled environments. This limit is 1.0 mW/cm^2, with averaging times of thirty-minutes.

The closer you are to the front center-point of a microwave antenna, the greater the power density of its transmitted microwave signal. Unless you are very close, however, microwave exposure levels will fall far below the MPE limits. To determine how close to a microwave antenna you can be and still remain below the MPE limits noted above, "worst case" predictions of the field strength and power density levels in the vicinity of an Link AX™ microwave antenna can be made from the following calculations. The equation is generally accurate in the far-field of an antenna, and will **over-predict** power density in the near-field (i.e. close to the antenna).

$$S = PG/4\pi R^2$$

where:

S = power density (in mW/cm^2)
P = power input to the antenna (mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (cm)

Note that G, the power gain factor, is usually expressed in logarithmic terms (i.e., dB), and must be converted using the following equation:

$$G = 10^{dB/10}$$

For example, a logarithmic power gain of 17.5 dB is equal to a numeric gain of 56.23.

Assuming (1) maximum output power from the Link AX (+12 dBm [15.8 mW]), (2) no signal loss in the cable connecting the Link AX to the antenna, and (3) the use of a 17.5 dBi gain flat panel antenna, the 1.0 mW/cm^2 MPE power density limit would be reached at a distance of approximately 8.4 cm. The Link AX is classified as a fixed installation product, and per FCC policy guidelines regarding MPE, antennas used for this Wireless Inc. transmitter must be installed to provide a separation distance of 2 meters (6 feet) or more from all persons during normal operation to satisfy FCC RF exposure compliance.

Wireless, Inc. fully supports the FCC's adopted MPE limits, and recommends that personnel maintain appropriate distances from the front of all directional microwave antennas. Should you have questions about Link AX microwave signal radiation, please contact the Wireless, Inc. Customer Service Department.

Point-to-Point Radio Operation

The Link AX microwave radio system is intended for point-to-point, line-of-sight applications only. The antennas utilized in these applications are high gain, highly directive antennas, and are intended for professional installation. Antennas should be mounted on permanent structures such as masts or towers, which are not accessible to the general public.

The installer shall mount the antennas as to comply with the limits for human exposure to radio frequency (RF) fields per paragraph 1.1307 of the Federal Communication Commission (FCC) Regulations. The FCC requirements incorporate limits for Maximum Permissable Exposure (MPE) in terms of electric field strength, magnetic field strength, and power density.

It is the responsibility of the installer to ensure the antennas are used with the Link AX radio, are designed for fixed point-to-point operations, and their use with the radio complies with FCC limits stated in Part 15.407.

The following information is supplied pursuant to FCC Regulations (Part 15.407) for unlicensed intentional radiators:

The Link AX conforms to the regulations in CFR 47, Part 15.407 pertaining to unlicensed point-to-point use. Modifications to the equipment, which would alter the conditions of the Equipment Grant of Authorization are strictly prohibited, and may void the user's right to operate the equipment.

Notice Regarding Operation pursuant to FCC part 15 Rules

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

1.0 General Overview

1.1 WaveNet Link Series Product Family

All Link AX radios are members of the WaveNet Link Series radio product family. The WaveNet Link Series is designed to provide an economical wireless solution for local access telecommunication requirements.

This manual addresses, in detail, the operation of the Link AX. For detailed information on other members of the WaveNet Link Series, please refer to the appropriate Operation Manual(s).

1.2 Introduction to the Link AX

The Link AX is a digital radio designed for use as a point-to-point communications system. The Link AX is used in the following applications:

Wireless DSL
Point-to-point (building to building)
Internet Service Providers (ISPs)
Local Exchange Carriers (LECs)
Wireless Local Loop (WLL)
Backup Solutions
Temporary Links

The Link AX radio is designed for operation in two of the Unlicensed National Information Infrastructure (U-NII) bands at frequencies of 5.250 - 5.350 GHz and 5.725 - 5.825 GHz.

Each Link AX is comprised of a pole mounted RF/antenna unit. Each radio is powered by means of a DC power supply (optional AC-DC power supply available) which is fed to the unit through a power/data cable. The system has a total data transmission capacity of 8 Mps full-duplex. Refer to the Link AX data sheets for detailed information relating to product offerings and specifications.

1.3 Regulatory Information

In January 1997, the FCC made available 300 MHz of spectrum for Unlicensed National Information Infrastructure (U-NII) devices. The FCC believes that the creation of the U-NII band will stimulate the development of new unlicensed digital products which will provide efficient and less expensive solutions for local access applications.

The U-NII band is divided into three sub bands at 5.15 - 5.25, 5.25 - 5.35 and 5.725 - 5.825 GHz. The first band is strictly allocated for indoor use and is consistent with the European High Performance Local Area Network (HIPERLAN). The second and third bands are intended for high speed digital local access products for “campus” and “short haul” microwave applications.

Table 1.1 - FCC U-NII Bands

	Band 1	Band 2	Band 3
Frequency	5.15 to 5.25 GHz	5.25 to 5.35 GHz	5.725 to 5.825 GHz
Power (Max)	200 milliwatts EIRP	1 watt (EIRP) +30 dBm	4 watts (EIRP) +36 dBm
Intended Use	Indoor Use Only	Campus	Approx 10 miles

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* Note: An FCC memorandum opinion and order (M00) revised on June 24, 1998 allows the use of a directional antenna with 23 dBi gain and a maximum transmitter output power of 1 watt in the 5.725 - 5.825 U-NII band.

2.0 WaveNet Link AX Product Profile

2.1 General Overview

The Link AX microwave radio provides digital capacities for 16 Mb/s data rates (8Mb/s full-duplex) for distance of up to 15 km. The radio terminal operates in the Unlicensed National Information Infrastructure (U-NII) spectrum with a Split Modulation system architecture that provides full duplex operation in the 5.3/5.7 GHz U-NII frequency bands.

The product uses two separate 100 MHz bands within the U-NII frequency spectrum. Within these bands, the Link AX series operates in one of many independent channels providing for frequency reuse and network flexibility, ideal for dense network applications.

Synthesized RF channel selection is field configurable, as are the power output options for the selection of antenna sizes.

Complying with all aspects of FCC Rules Subpart 15.401-15.407, the transmission characteristics of the Link AX series are designed to meet the peak power spectral density requirements of the U-NII 5.250 - 5.350 and 5.725 - 5.825 GHz bands.

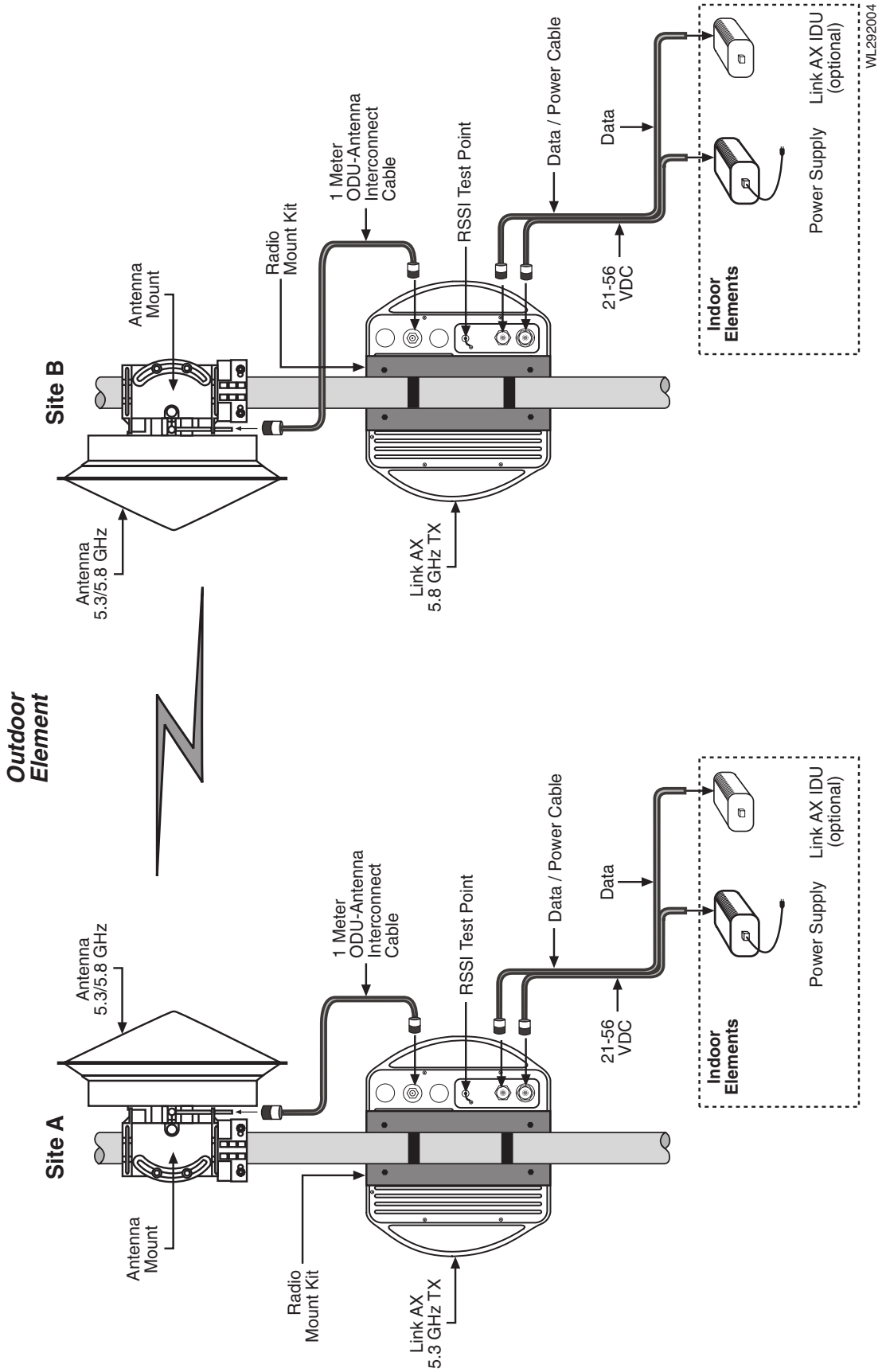
The Link AX has been designed for easy access to all interfaces, controls, and displays. Information in this manual will familiarize you with all of these items. Figure 2.1 illustrates two (2) Link AX terminals in a point-to-point configuration.

The Link AX is avaialble with two types of Outdoor Unit/Antenna configurations:

External Antennas : Requires the use of an external antenna (parabolic or flat panel type), and the connection between ODU and antenna is performed via the use of a 2-meter (6 feet) piece of RG8 type cable. Typically this can be used for longer link distances up to 9 miles (15 km).

Integral Antennas: A 9” flat panel antenna is integrated into the ODU housing, and is internally connected. Typically this can be used for short link distances up to 4 miles (6 km).

Figure 2.1 - Typical Deployment of a Link AX in a Point-to-Point External Antenna Configuration



2.2 Specifications

2.2.1 General Specifications

Frequency Range:	5.250 - 5.350 GHz and 5.725 - 5.825 GHz
RF Channel Bandwidth:	12 MHz
Channel Increments:	10.24 MHz
Radio Operation:	Full duplex
Antenna Port Impedance:	50 ohms nominal
Ethernet Data Rate:	8 Mbps full duplex

2.2.2 ATM Interface

Type:	ATM-25
Distance:	100 meters (330 ft) max
Termination:	100 ohm or 120 ohm RJ45 (user device per ATM 25.6 forum specification af-phy-0040.000)

ATM Traffic Parameters:

Parameter	Description	Min	Typical	Max	Unit
PCR	Peak Cell Rate			59259	Cps
SCR	Sustained Cell Rate	15645	19200	19555	Cps
MBS	Maximum Burst Size			3	Cell
MCR	Minimum Cell Rate	0			Cps

2.2.3 Transmitter Specifications

Frequency Range:	5.250 - 5.350 GHz and 5.725 - 5.825 GHz
Channel Increments:	10.24 MHz
Modulation:	BPSK
Power Output:	0, +4, +8, and +12 dBm
Transmit Duty Cycle:	100%
Emission Mask:	Per FCC 15.407
Frequency Stability:	± 5 ppm
Data Rate:	8 Mbps

2.2.4 Receiver Specifications

Type:	Coherent Detection
Sensitivity for $1x10^{-6}$ BER:	-83 dBm
Receiver Overload for $1x10^{-6}$ BER	-30 dBm
Maximum RF Input (no damage):	-20 dBm
Data Rate:	8 Mbps
Channel Increments:	10.24 MHz

2.2.5 Digital Interface

ATM Interference on ODU

The 8-pin CircularMil (ATM interface/ODU status signals) connector pin assignments are shown in Table 2.1.

2.2.6 Power Supply Input Connector on ODU

Table 2.1 - Connector Pin Assignment, ATM Connector on ODU

Pin	LEAD	DESCRIPTION
1	TX+	Twisted Pair Transmit +
2	TX-	Twisted Pair Transmit -
3	PWR/ALM	Signal that drives "Power/Local Alarm" LED on IDU
4	RSSI	Analog voltage indicatng signal strength
5	AGND	Ground for RSSI
6	DGND	Ground for Power/Alarm LED
7	RX+	Twisted Pair Receive +
8	RX-	Twisted Pair Receive -

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Note: Pins 3-6 are used in conjunction with the Indoor Unit for test and maintenance purposes only. Refer to DIP switch settings on page 34 for details. When connecting to a Network device, only pins 1,2,7, and 8 are used.

The 4-pin CircularMil power supply input connector pin assignments are shown in Table 2.2.

Note: The white lead of the power side of the Data/Power cable connects to Pin 1, thus it should be connected to the negative lead of the power source. The red lead of the power side of the Data/Power cable connects to Pin 2, thus it should be connected to the positive lead of the power source.

2.2.7 Antennas

Table 2.2 - Connector Pin Assignment, Power Supply Input Connector on ODU

Pin	Lead	Function	Color
1	Negative Input (-)	Connection to negative lead of power supply.	White
2	Positive Input (+)	Connection to positive lead of power supply.	Red
3	Not Used		
4	Not Used		

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The antennas shown in Table 2.3 are recommended for use with Link AX. With the exception of the 4' dishes, all antennas have been tested with Link AX to verify compliance with applicable FCC rules.

2.2.8 Power Requirements

Table 2.3 - Recommended Antennas

Type	Manufacturer and Part Number
9" Intergrated Flat Panel, Plne Polarized, 18 dBi	RadioWaves WFP.75-5.2
6" Flat Panel, Plane Polarized, 17.5 dBi	Gabriel DFPD.5-52
12" Flat Panel, Plane Polarized, 23 dBi	Gabriel DFPD1-52
12" diameter dish, Plane Polarized 23.3 dBi	RadioWaves SPI-5.2NL
24" Flat Panel, Plane Polarized, 27.5 dBi	Gabriel DFPD2-52
24" diameter dish, Plane Polarized, 28.1 dBi	Gabriel SSP2-52ARI
24" diameter dish, Dual Polarized, 28.1 dBi	Gabriel SSD2-52ARI
*48" diameter dish, Plane Polarized, 33.5 dBi	Gabriel SSP4-52A
*48" diameter dish, Dual Polarized, 33.5 dBi	Gabriel SSD4-52A

* The 48" dish antennas are for use outside the USA only, and are not FCC compliant. WL202005

Primary power supply	
DC	±21 to ±56 V
AC	100 to 240V 50/60 Hz (with optional external power supply).
Power Consumption	Maximum 17 Watts

2.2.9 Environmental Specifications

Outdoor Unit	Operating Temperature Range: -30°C to +60°C Storage Temperature Range: -40°C to +85°C Altitude: 4,500 meters max. Humidity: Outdoor, all-weather enclosure

2.2.10 Mechanical

Dimensions

ODU	310mm x 351mm x 73mm (HxWxD) 12.2" x 13.8" x 2.9"

Weight

ODU	5 kg 11 lbs

2.3 User Interfaces

The Link AX provides user interfaces for fused DC power connection, electrical grounding, radio frequency (RF) antenna connection, ATM25 connection, configuration and RSSI output. The following provides information on each interface.

Outdoor Unit

- **Data/Power Cable** - Siamesed CAT-5 ATM25 and power cables.
- **RSSI** - BNC type connector for RSSI measurement.
- **Antenna (RF) Connector** - N-type female connector used for connection with antenna. Note: There is no N-Type RF connector used on ODUs with integral antennas.

- **Main Power** - The Link AX is designed to work from a power input of 21 to 56 VDC.
- **Grounding Connector** - The ODU is equipped with an M5 ground screw and associated washers. This ground screw serves as the proper chassis-ground connection point for an external ground source. The Link AX must be grounded in accordance with the electrical codes, standards, and practices governing the local installation.
- **Configuration Switch -** Configuration of the Link AX is performed via a DIP switch on the ODU. The 10-position DIP switch is accessible by removing the water-tight dust cap on the ODU. Once exposed, each of the 10 switches can be manipulated using tool that is provided with the mounting kit.

2.4 ODU Performance Monitoring

RSSI (Receive Signal Strength Indicator) - A voltage provided through a BNC connector on the outside of the ODU. The RSSI port is used for antenna alignment during installation and for periodic measurement of Receiver/Path performance. The RSSI voltage in relation to the receive signal level ranges from -30 dBm to -90 dBm.

2.5 Theory of Operation

General Overview

The Link AX is a point to point Wireless ATM-25 Extender operating in the 5.3/5.7 GHz U-NII band as authorized in rule sections 15.401 through 15.407. The unit is enclosed in a weather proof outdoor enclosure and is intended to provide data links over distances up to 15 km. The radio in the unit operates full duplex, transmitting and receiving data at the rate of 8.192 Mbps. The radio is modulated using BPSK.

Circuit Description

The following circuit description is intended to explain the operation of the radio at the block diagram level. This text is written with the idea that the reader has the block diagram readily available, as it will aid in understanding the signal flow in the radio.

2.5.1 Link AX Transmitter

The physical interface to the radio consists of ATM-25 cells that are routed to ATM physical interface (PHY) chip. The PHY chip stores the data cells, and then converts them into a synchronous 8.448 Mbps data stream that is fed into the transmitter. To mark cell boundries, a SYNC byte (01111110) is inserted at the beginning of every cell. Zero insertion circuitry, inserts a zero after five consecutive ones, guaranteeing SYNC byte uniqueness while transmiting the cell's content.

The data is differentially encoded and scrambled before it is routed through the transmit baseband filter to provide spectral shaping. The baseband filter is a five pole low pass filter. After amplification, the baseband signal is fed to the modulator consisting of a doubly balanced mixer. The modulator is running directly at the transmitter frequency of 5.775 GHz $\pm$ 50 MHz. The local oscillator signal of the mixer is supplied from the frequency synthesizer section, with the frequency dependant on the RF channel selected.

From the output of the modulator, the signal is amplified and then passed through a 150 MHz wide bandpass filter to remove any local oscillator products from the output spectrum. After filtering, the signal is passed through a series of amplifier and attenuator stages that are used to control the output power level. With a combination of fixed and variable attenuation the output power can be set to one of four different levels to accommodate different antennas used with the product.

The power setting is maintained by an active ALC circuit that samples the transmitter output power and then adjusts the variable attenuator to keep the output power constant over the operating temperature of the unit. The power level is controlled to within +1/-2 dB of the set point.

Following the attenuators the signal is fed through additional amplification to bring the output level to a maximum of +14 dBm at the output of power amplifier. A lowpass matching section follows the power amplifier to aid in filtering harmonics of the signal. After passing through the duplexer, the power level at the antenna port is a maximum of +12 dBm.

Figure 2.2a - Outdoor Unit, Front View, External Antenna

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Figure 2.2b - Outdoor Unit, Back View, External Antenna

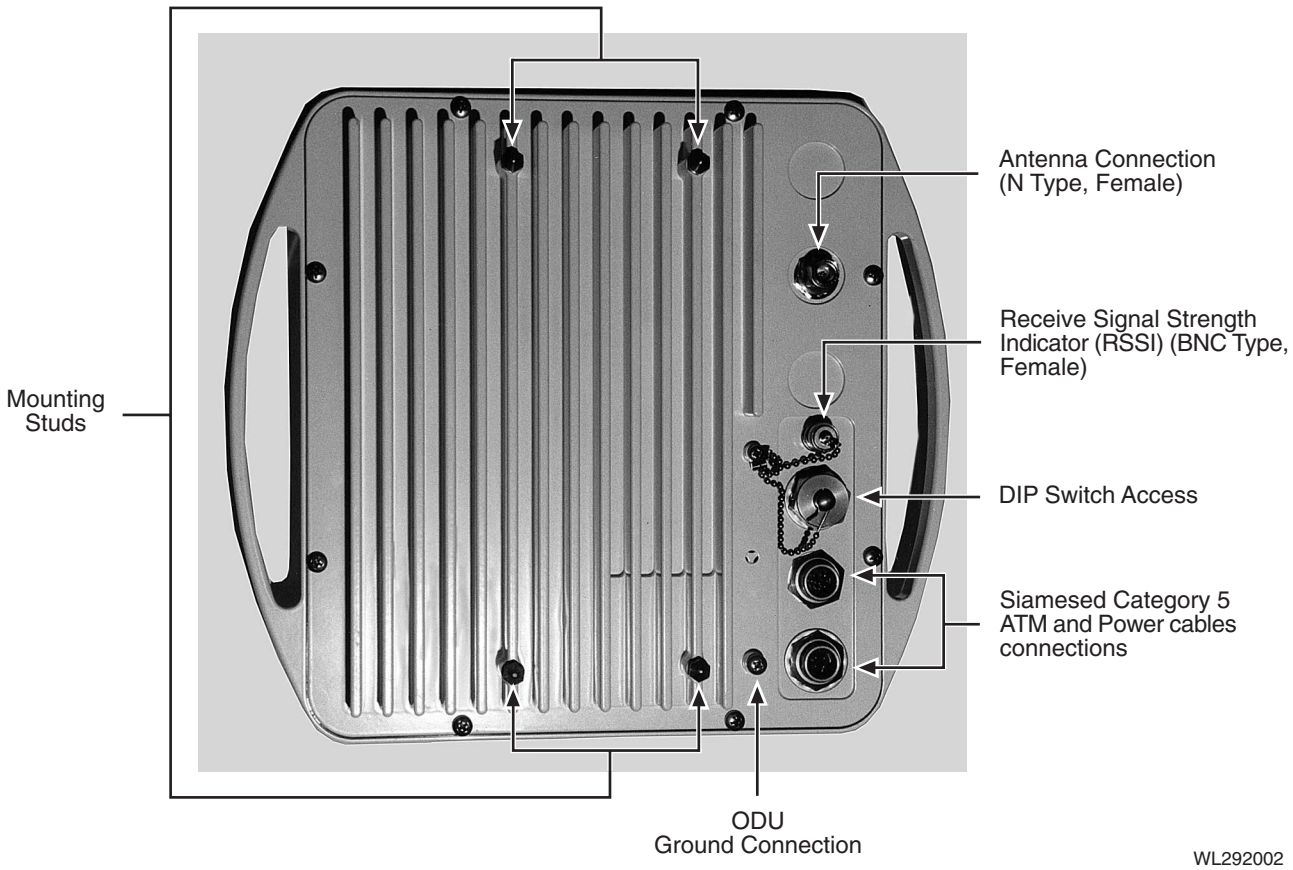

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Figure 2.2c - Outdoor Unit, Front View, Integral Antenna

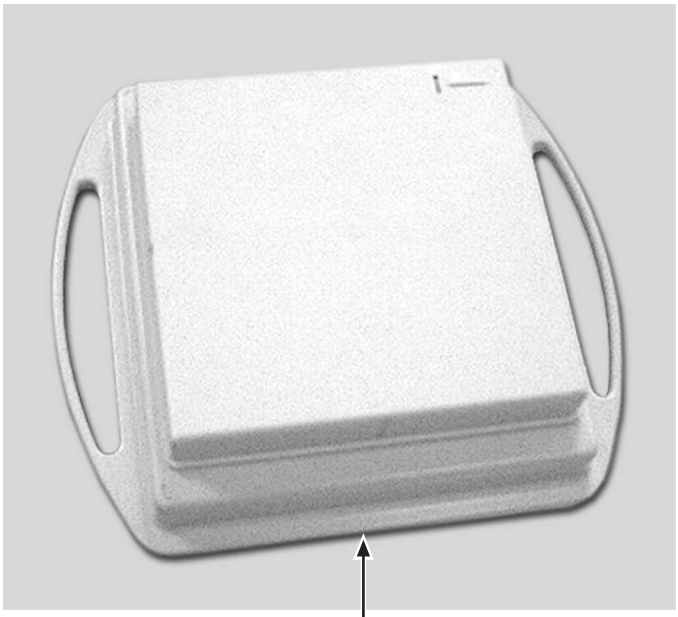
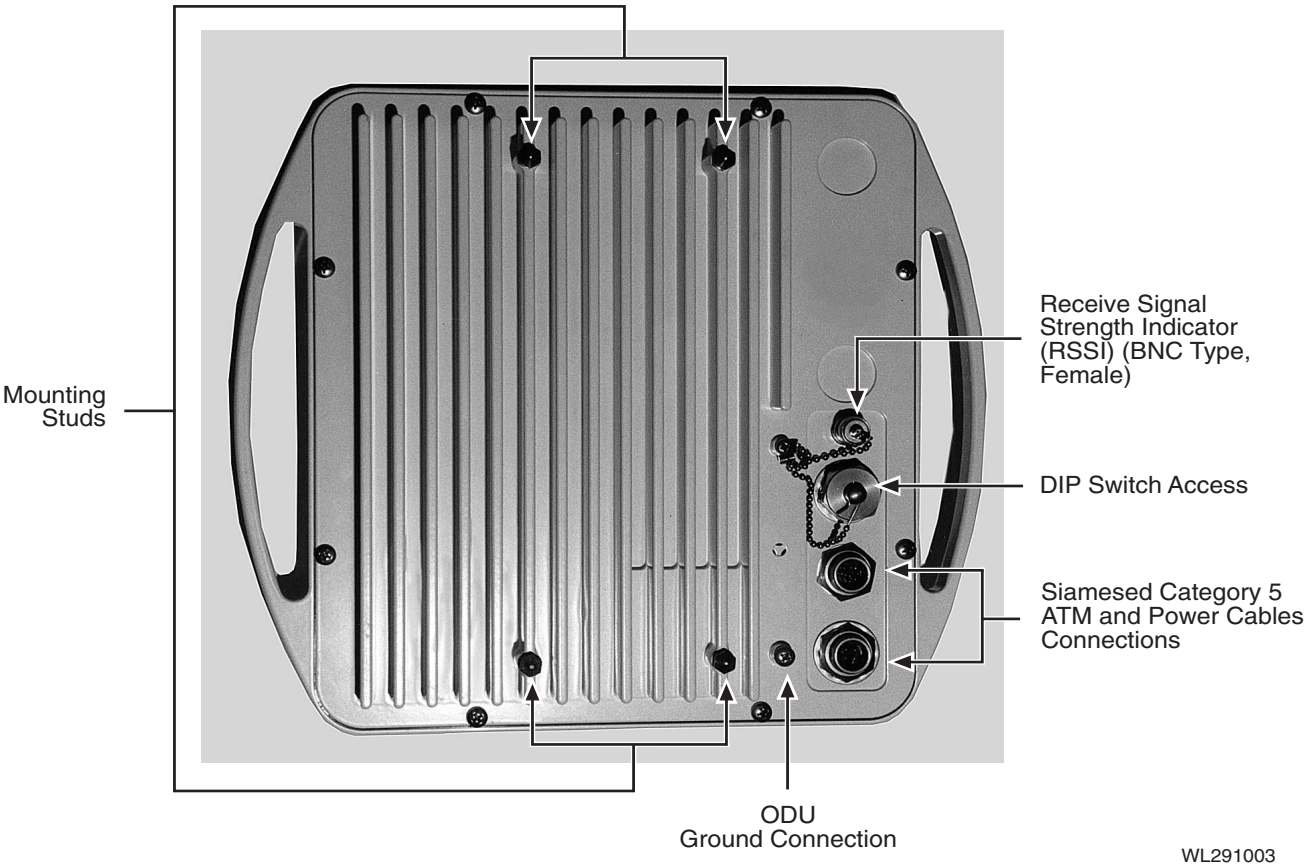


Figure 2.2d - Outdoor Unit, Back View, Integral Antenna



2.5.2 Link AX Receiver

The receiver in theLink AX is a conventional dual conversion design with IF frequencies of 474.88 MHz and 70 MHz.

From the receive port of the duplexer, the low level input signal is passed through a low noise preamplifier that provides 25 dB of gain. Following the preamplifier the signal is passed through a 200 MHz wide bandpass filter to provide image rejection for the first mixer.

The signal is then mixed with the first LO to convert the signal to 474.88 MHz. Following further amplification the signal is passed through a five pole, 20 MHz wide bandpass filter. This filter provides image filtering for the second mixer, and also helps attenuate signals on the adjacent receive channels. After filtering, the signal is further amplified and then passed through a variable attenuator stage before it is applied to the second mixer.

The output of the second mixer is at 70 MHz. The 70 MHz IF stages provide additional gain along with two sections of variable attenuation for the AGC function. The primary adjacent channel filtering is also at 70 MHz where the signal is passed through a 12 MHz wide SAW filter. The combination of filters provide a minimum of 47 dB of attenuation at the adjacent receive channels (±10.24 MHz).

At the end of the 70 MHz IF chain the signal is fed into a quadrature demodulator. The carrier recovery loop consists of a four quadrant multiplier that multiplies I and Q baseband signals to create an error voltage. This error voltage is then amplified and fed back to the 70 MHz VCO. This forms a phase locked loop that is locked to the received carrier frequency.

The 70 MHz output is also fed into a wide band logarithmic amplifier that provides a DC voltage output proportional to the 70 MHz signal strength. The DC voltage is then integrated and fed back to the variable attenuator stages to form an AGC control loop. This control loop keeps the signal level at the input to the demodulator chip constant over the entire operating range of the receiver.

Data recovery from the I baseband signal begins by passing the I signal through a slicer. The output of the slicer is a digital signal that contains both data and clocking information. A clock recovery circuit recovers receive timing information that is needed to clock the data through the descrambler, and differential decoder.

This 8.448 Mb bit stream is then converted into ATM cells. The SYNC bytes and the inserted zeros are stripped form the cells prior to their delivery to the ATM25 PHY. This method provides worst case cell rate of 15645 cells per second (cps) and typical cell rates of approximately 19200 cps.

2.5.3 Synthesizer

The FPGA provides four 22-bit streams in a serial format loaded to the synthesizer. This data provides all of the possible frequencies at which the system can operate. Depending upon the dip switch settings selected, the actual frequency being used is selected. When the reset button is pressed, the FPGA will reload this data to the synthesizer.

Frequency Synthesis

The local oscillator frequencies used in the Link AX are all synthesized from a 19.2 MHz, ± 2.5 PPM reference oscillator. The overall frequency stability of the radio is ± 2.5 PPM, directly reflecting the reference oscillator stability.

A dual frequency synthesizer chip is used to control both the first and second local oscillator loops. This chip supports one high frequency oscillator, up to 1.5 GHz, and one lower frequency oscillator to be used as a second LO.

The first local oscillator VCO operates at one half the transmitter output frequency, and changes with the transmit channel selected. The first LO consists of a bipolar VCO operating at 2.887 GHz ±25 MHz. The output of this VCO is buffered and then passed through a X2 prescaler chip before being fed back to the synthesizer chip. The phase comparison frequency for the first LO is 320 kHz.

After amplification the 2.887 GHz signal is passed through a frequency doubler to create the 5.775 GHz signal that is applied to the mixer stages.

The second local oscillator consists of a VCO that is phase locked to 404.88 MHz. This auxiliary synthesizer is operating with a phase comparison frequency of 240 kHz.

2.6 Indoor Unit

An optional Indoor Unit (IDU) can be used with the Link AX to provide diagnostics and troubleshooting aid to maintenance personnel. The IDU contains a single LED that illuminates with the presence of ATM25 data and power. Additionally a BNC connector is provided so that maintenance personnel can view RSSI voltage inside the building. The IDU is NOT required for operation of the Link AX radio system. Figure 2.3 shows the Link AX IDU.

Figure 2-3 Link AX Indoor Unit (IDU)

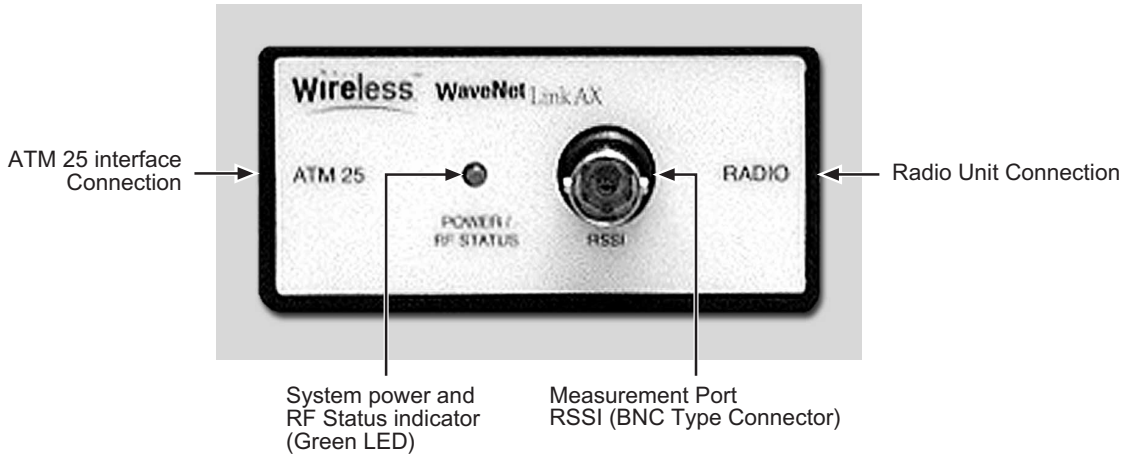
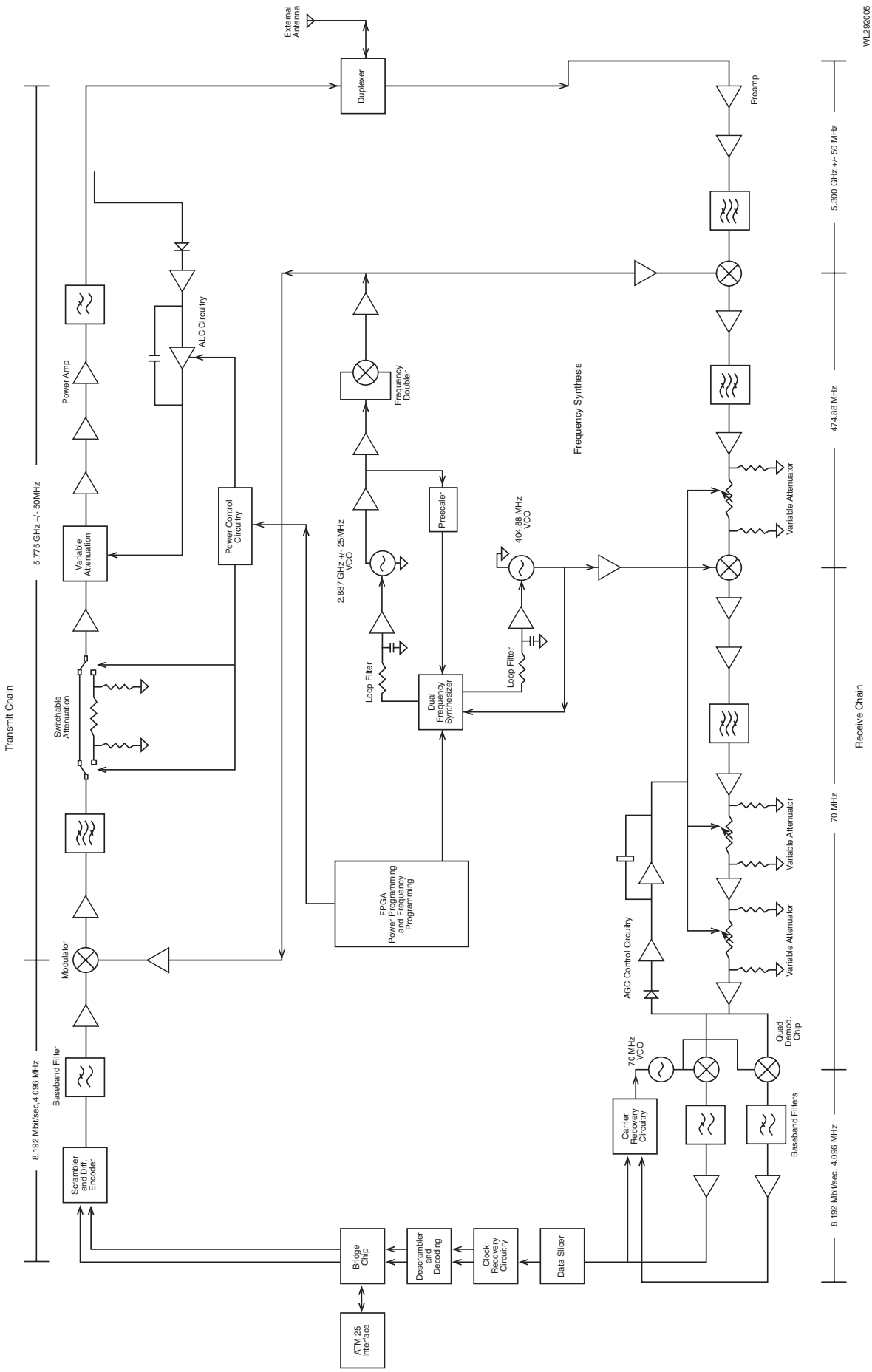


Figure 2.4 - Link AX Block Diagram



3.0 Equipment Installation and Commissioning

3.1 Installation

The Link AX microwave radio system is intended for professional installation only. Prior to installing the radio, both a site survey and path survey should be performed.

The site survey allows the installer to determine the best location for the radio, antenna, and supporting structure, as well as determine antenna orientation, and cable route to the indoor equipment. It is extremely important to mount the structure in such a manner that minimizes foot traffic in front of the antenna (if installed on a roof, for example).

A path survey is completed to ensure that the radio will perform based on a given distance, and in keeping with the EIRP limits, provides the installer with a target receive signal level which is verified during antenna alignment. A sample calculation is provided in Figure 3.9.

The Link AX has been specifically designed for ease of installation. The following installation instructions should be followed.

1. **Plan the installation** - Decide where each component of the Link AX will be placed prior to commencement of any installation activity. Installation considerations for each component in general are as follows:

   a. **Outdoor RF Unit** - Mount as close as practical to the Antenna assembly. The maximum distance is determined by the included interconnect cable. The installed cable is 2-meters in length. Determine pole mounting details for the Outdoor Unit and Antenna.

      Table 3.1 identifies the maximum transmit power level setting that can be used with each antenna while maintaining compliance with FCC EIRP regulations. Power levels are referenced to the antenna port of the radio and are average power levels indicating what would be measured using an average power meter. The FCC expresses limits as peak power numbers. To convert from the average power numbers to peak power numbers, add 1.8 dB to the average power numbers.

If external antennas are utilized, and connected with the 2 meter cable mentioned in (a), then factor in 2.6 dB for the loss in the coaxial cable when calculating EIRP figures.

If the product is being deployed in a country not governed by FCC regulations, the installer should select a transmit power level setting appropriate for the antenna that is deployed to maintain compliance with regulations employed by that country.

Refer to Table 2.6 for Configuration Switch setting information.

b. **Antenna Unit -** See Appendix B.

3.1.1 EIRP Calculations in the 5.3 GHz Band

The following is an excerpt from CFR 47 Part 15.407 (a)(1):

For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm+10logB, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Based on the above rules, the Link AX (for the 5.3 GHz radio) must be configured by the installer to operate using the conditions in Table 3.1 below. These values assume a nominal loss of 1.0 dB cable loss for the Wireless Inc. supplied RF cable (6 foot length) that connects the ODU to the external antenna.

Table 3.1 - Maximum Transmit Power Level Setting vs. Antenna Type (for compliance with FCC EIRP limits) in the 5.3 GHz Band

Antenna Type	Manufacturer P/N	Maximum Transmit Power Setting (dBm)
6" External, Flat Panel, Plane Polarized, 17.5 dBi	Gabriel DFPD.5-52	0 dBi
9" Integrated, Flat Panel, Plane Polarized, 18 dBi	RadioWaves WFP.75-5.2	0 dBi

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3.1.2 EIRP Calculations in the 5.7 GHz Band

The following is an excerpt from CFR 47 Part 15.407 (a)(2):

For the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 1 W or 17 dBm+10logB, where B is the 26-dB emission bandwith in MHz. In addition, the peak power spectral density shall not exceed 17 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23 dBi without any corresponding reduction in the transmitter peak output power or peak power spectral density. For fixed point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and peak power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omni directional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Based on the above rules, the Link AX (for the 5.7 GHz radio) must be configured by the installer to operate using the conditions in Table 3.2 below. These values assume a nominal loss of 1.0 dB cable loss for the Wireless Inc. supplied RF cable (6 foot length) that connects the ODU to the external antenna.

Table 3.2 - Maximum Transmit Power Level Setting vs. Antenna Type (for compliance with FCC EIRP limits) in the 5.7 GHz Band, Orignial and July 31, 1998 rules

Antenna Type	Manufacturer P/N	Maximum Transmit Power Setting (dBm)
6" External, Flat Panel, Plane Polarized, 17.5 dBi	Gabriel DFPD.5-52	+12
9" Integrated, Flat Panel, Plane Polarized, 18 dBi	RadioWaves WFP.75-5.2	+12
12" External, Flat Panel, Plane Polarized, 23 dBi	Gabriel DFPD1-52	+12
12" External, Parabolic, Plane Polarized, 23.3 dBi	Radiowaves SPI-5.2NL	+12
24" External, Flat Panel, Plane Polarized, 27.5 dBi	Gabriel DFPD2-52	+12
24" External, Parabolic, Plane Polarized, 28.1 dBi	Gabriel SSP2-52ARI	+12
24" External, Parabolic, Dual Polarized, 28.1 dBi	Gabriel SSD2-52ARI	+12

WL300002

2. **Inventory your equipment and installation materials.**
   To install one (1) terminal you should have the items shown in Table 3.3.

3. **The following tools should be on hand:**

Table 3.3 - List of Tools

Tool	Purpose
Wire Stripper/Cutter	General wire stripping and cutting purposes
Utility Knife	General cable preperation
Hand-Held Digital Voltmeter (DMM) equipped with standard probes BNC to Dual-Banana plug and 3' coax cable with BNC connectors (antenna alignment)	Confirms magnitude, polarity, continuity
Adjustable Wrenches	Antenna Mounting, Outdoor Unit up to 22 mm
#2 Phillips Screwdriver	Outdoor Unit Grounding
#2 Flat Blade Screwdriver	Antenna Mounting
Spade Lug Crimp Tool	ODU Ground Preperation
RJ45 Crimp Connector	Cable Preperation

WL294001

3.2 ATM25 Data Connector

The ATM25 connections are made to the data side of the power/data cable assembly, normally it is supplied with an RJ45 connector. Pin-Outs for the RJ45 cable are as follows:

Table 3.4 - Inventory of Equipment and Installation Materials

Qty	Description
1	Link AX
1	Pole, Wall, or tilt Mounted Bracket and associated fasteners
1	Siamesed ATM/Power Cable
1	N-Male to N-Male Coaxial Cable Assembly (External Antenna Only)
1	AC to DC Power Adapter
1	Antenna (External Antenna Systems only)

WL202012

3.3 Connect the Power Supply

3.3.1 DC Power Supply

Table 3.5 - Connector Pin Assignment, ATM Connector on ODU

Pin	LEAD	DESCRIPTION
1	TX+	Twisted Pair Transmit +
2	TX-	Twisted Pair Transmit -
3	PWR/ALM	Signal that drives "Power/Local Alarm" LED on IDU
4	RSSI	Analog voltage indicatng signal strength
5	AGND	Ground for RSSI
6	DGND	Ground for Power/Alarm LED
7	RX+	Twisted Pair Receive +
8	RX-	Twisted Pair Receive -

WL202003

The white lead of the power side of the Data/Power cable connects to Pin 1, thus it should be connected to the negative lead of the power source. The red lead of the power side of the Data/Power cable connects to Pin 2, thus it should be connected to the positive lead of the power source.

3.3.2 Optional AC Power Supply

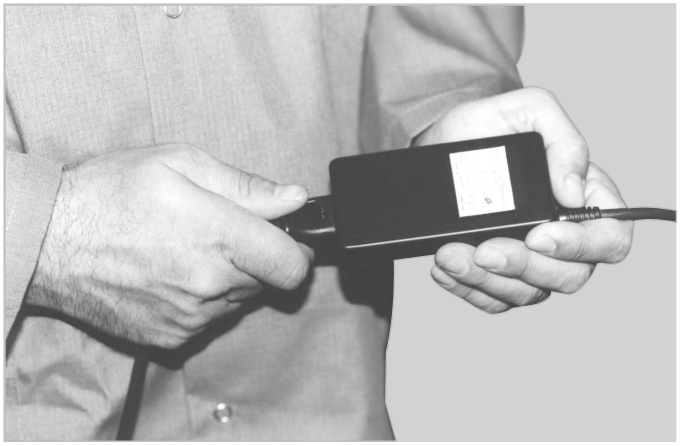
The AC-DC power supply is connected to an AC outlet by means of an IEC type power cord. Connect the power cord to the supply as shown in Figure 3.1. The output of the supply should be connected to the power side of the Data/Power cable using guidelines shown in Table 2.2.

3.4 Outdoor RF Unit Installation

General

The outdoor unit is installed by means of a pole mount adaptor bracket (wall mount optional)

Figure 3.1- Power Cord Connection



WL202013

that is secured to the pole using two metal hose type clamps. Figure 3.2 shows the hardware provided to mount the Outdoor RF Unit.

1. Ensure DIP
2. Install the outdoor unit pole mount adaptor bracket using the supplied metal hose type clamps. See Figure 3.3.
3. Align the four mounting studs on the outdoor unit with the bracket holes (See Figure 3.4) and secure to the bracket by pushing down the latches as shown in Figures 3.5a and 3.5b.
4. Connect the Siamesed Category 5 ATM/Power cable, the N-type antenna, the coaxial cable, and the ground connections as shown in Figures 3.6a and 3.6b.

3.7.2 Aligning the Link AX System Antennas

With the Link AX at each site properly configured for operation, antenna alignment must be performed at both sites. Proper antenna alignment is crucial to the proper operation of an Link

Figure 3.2 - Outdoor Unit Mounting Hardware

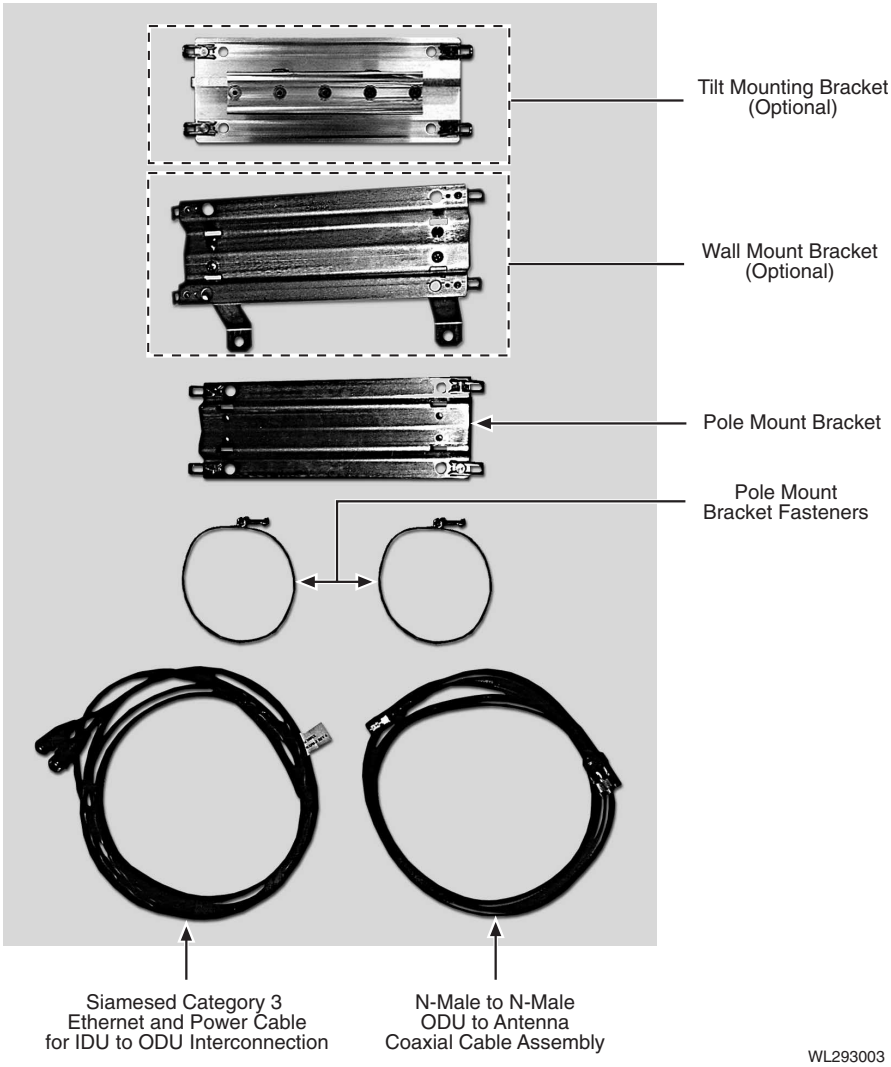
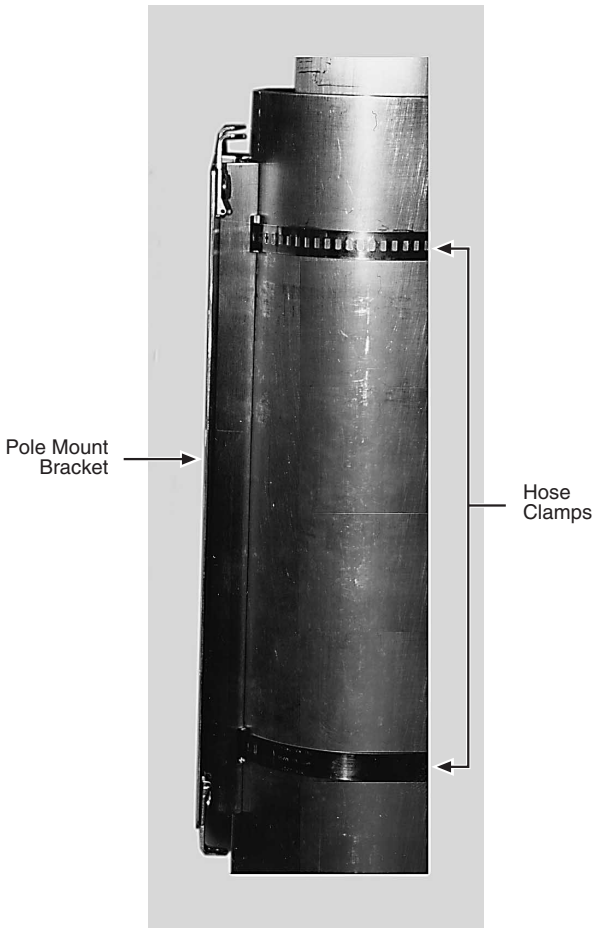


Figure 3.3 - Attaching the Pole or Tilt Mount Adaptor Bracket



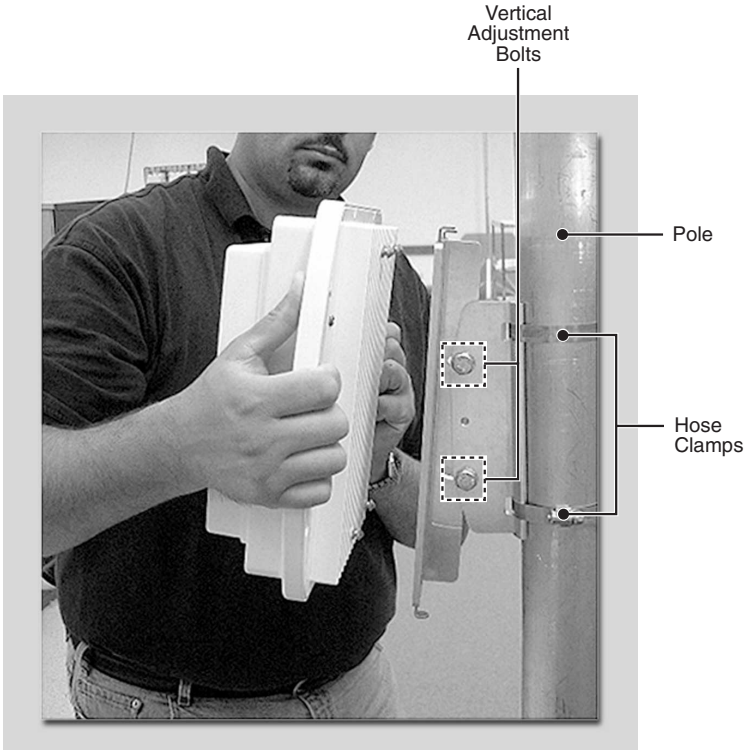


Figure 3.4 - Mounting the Outdoor RF Unit to the Bracket

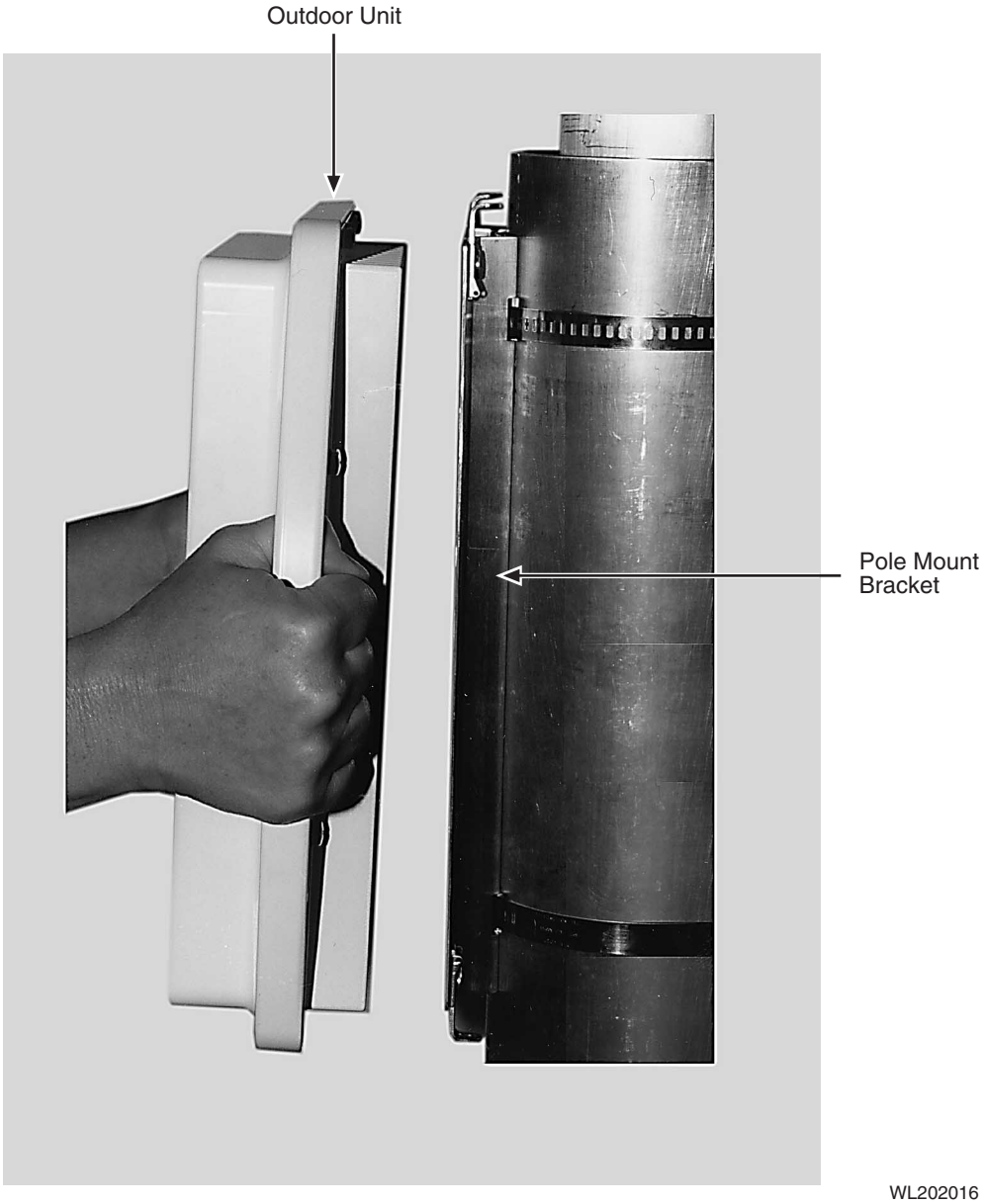


Figure 3.5a - Mounting Bracket Latch and Stud Mount Detail

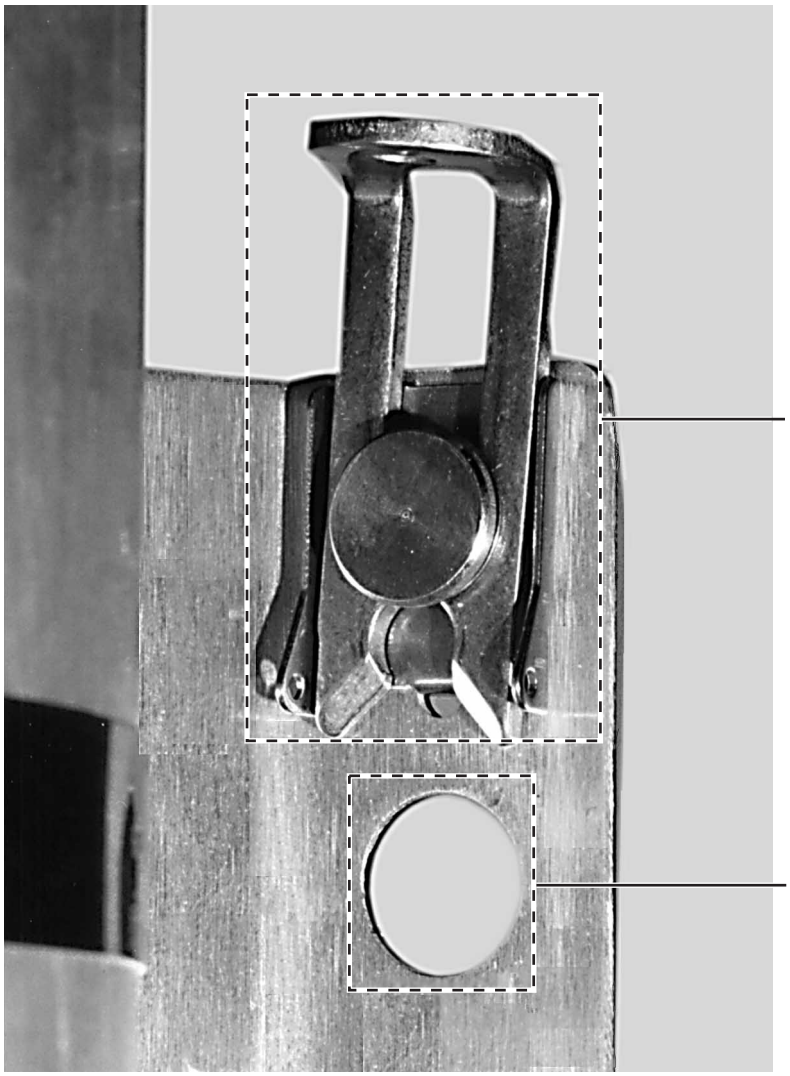


Figure 3.5b - Locking the Mounting Hardware

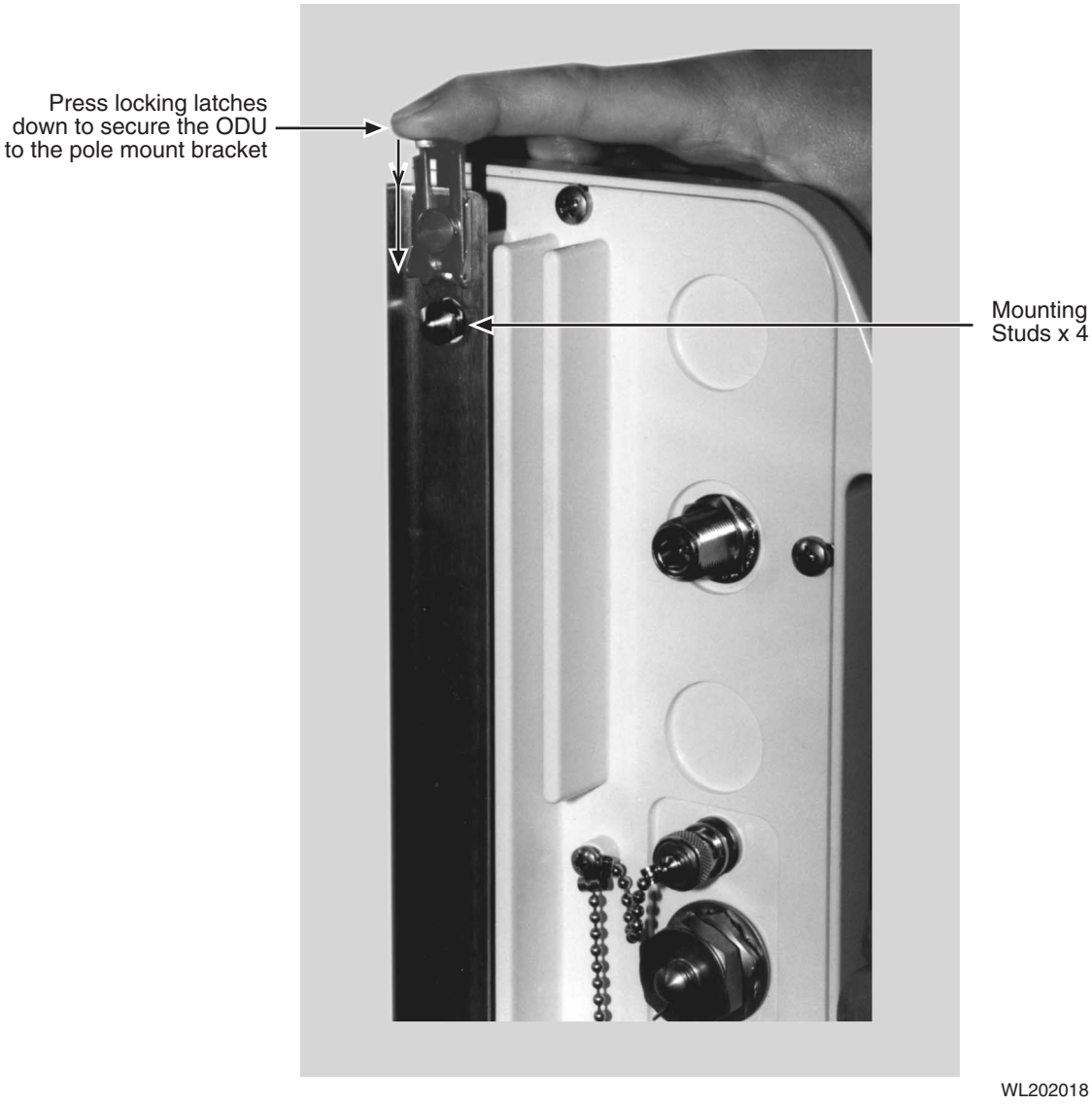


Figure 3.6a - N-Type Antenna and Siamesed Ethernet/Power Connections

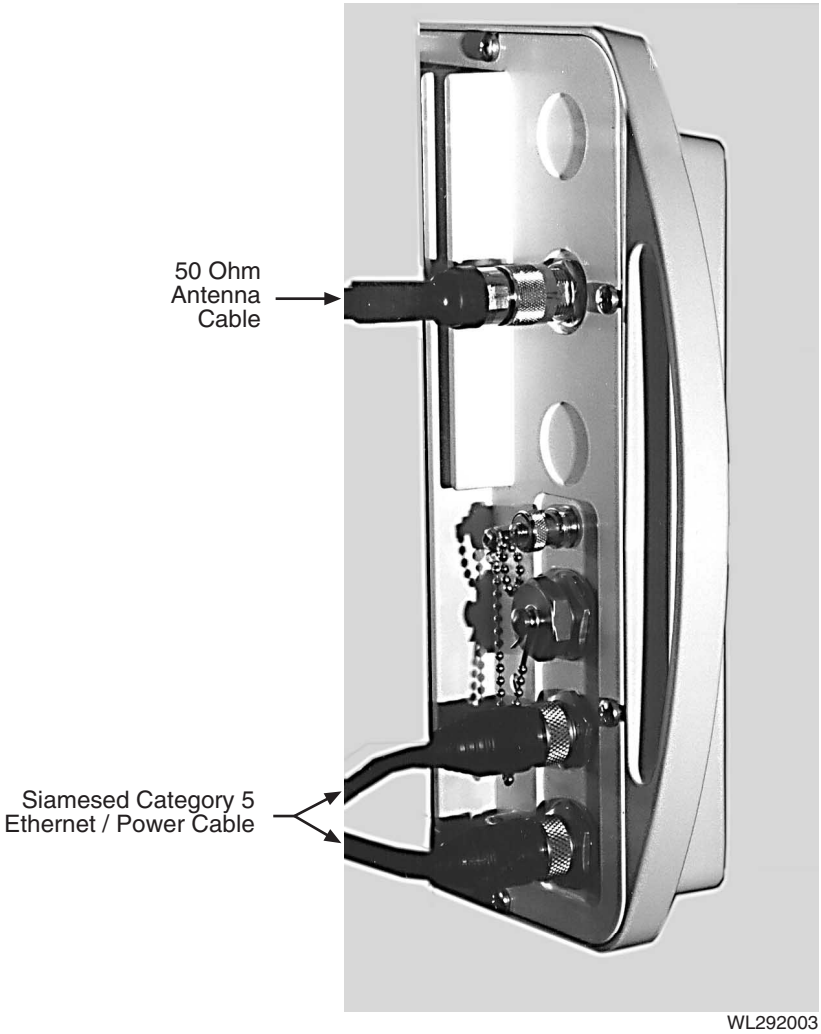
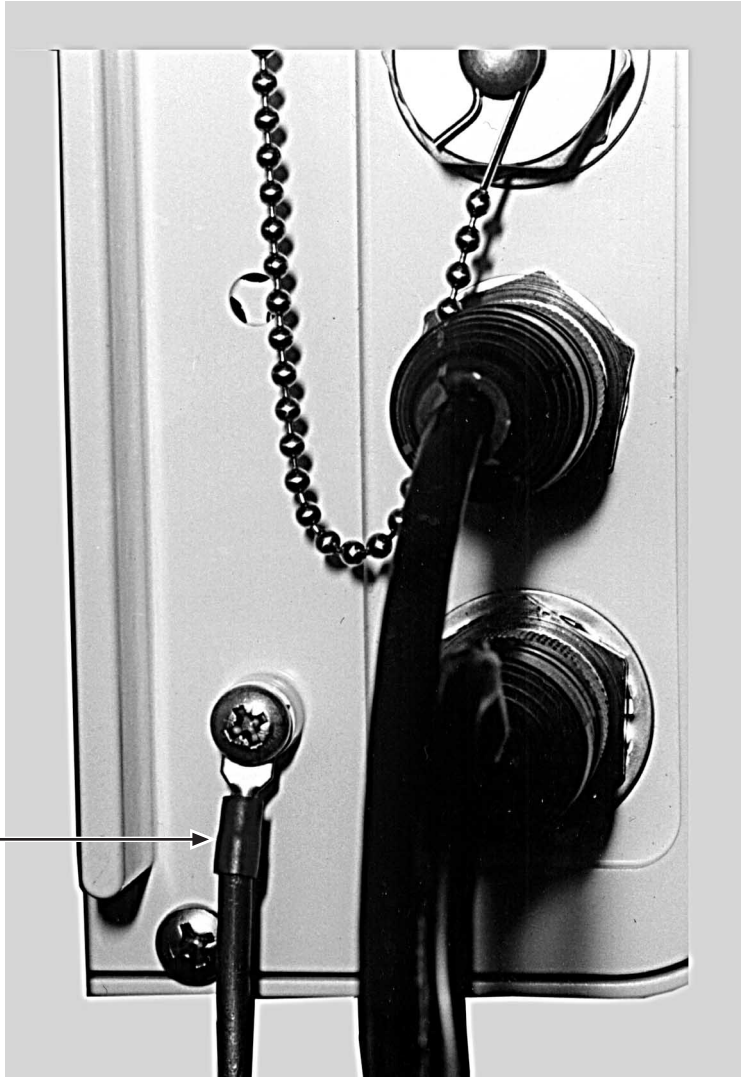


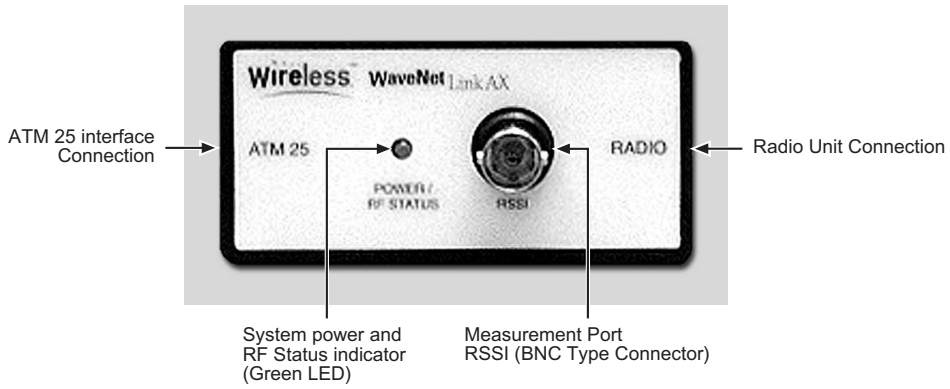
Figure 3.6b - Ground Connection



WL202020

3.5 Indoor Unit

Figure 3.7 - Link AX Indoor Unit (IDU)



WL238005

An optional Indoor Unit (IDU) can be used with the Link AX to provide diagnostics and troubleshooting aid to maintenance personnel. The IDU contains a single LED that illuminates with the presence of ATM25 data and power. Additionally a BNC connector is provided so that maintenance personnel can view RSSI voltage inside the building. The IDU is NOT required for operation of the Link AX radio system. Figure3.7 shows the Link AX IDU.

Tables 3.6a and 3.6b show the connector Pin Assignment for the Radio Port and the ATM25 Port.

Table 3.6a and Table 3.6b - Connector Pin Assignment, ATM Connector on ODU

Radio Port

Pin	LEAD	DESCRIPTION
1	TX+	Twisted Pair Transmit +
2	TX-	Twisted Pair Transmit -
3	PWR/ALM	Signal that drives "Power/Local Alarm" LED on IDU
4	RSSI	Analog voltage indicatng signal strength
5	AGND	Ground for RSSI
6	DGND	Ground for Power/Alarm LED
7	RX+	Twisted Pair Receive +
8	RX-	Twisted Pair Receive -

WL202003

ATM25 Port

Pin	LEAD	DESCRIPTION
1	TX+	Twisted Pair Transmit +
2	TX-	Twisted Pair -
3		Not Used
4		Not Used
5		Not Used
6		Not Used
7	RX+	Twisted Pair Receive +
8	RX-	Twisted Pair Receive -

WL293004

Table 3.6c explains the IDU LED staus.

Table 3.6c - IDU LED Status

Power/RF Status LED	Description
ON (solid)	Power to ODU is okay, No alarms
OFF	No power to ODU
ON (Blinking)	- Local alarm condition - Loss of ATM input - ATM errors (high link BER)

WL293005

3.6 DIP Switch Function and Configuration

Refer to Table 3.7 below. Switches 1, 2 and 3 control Frequency and Channel selection. Switches 4 and 5 are used for Transmit Power control. Switch 6 is not used. Switches 7-10 are used only when the optional Indoor Unit (IDU) is placed in-line between the ODU and the ATM terminating device.

Note: After the last switch has been set, the radio will learn its new configuration in five seconds. There is no requirement to power cycle the radio after dip switches are changed.

Table 3.7 - DIP Switch Configuration

<table>
<tr><td>Switch</td><td colspan="6">Function</td></tr>
<tr><td rowspan="10">1,2, and 3</td><td colspan="6">Frequency and Channel Selection</td></tr>
<tr><td>Switch 1</td><td>Switch 2</td><td>Switch 3</td><td>Ch.</td><td colspan="2">Frequency Pair (GHz)</td></tr>
<tr><td>On</td><td>On</td><td>On</td><td>1</td><td>5.26080</td><td>5.73568</td></tr>
<tr><td>Off</td><td>On</td><td>On</td><td>2</td><td>5.27104</td><td>5.74592</td></tr>
<tr><td>On</td><td>Off</td><td>On</td><td>3</td><td>5.28128</td><td>5.75616</td></tr>
<tr><td>Off</td><td>Off</td><td>On</td><td>4</td><td>5.29152</td><td>5.76640</td></tr>
<tr><td>On</td><td>On</td><td>Off</td><td>5</td><td>5.30176</td><td>5.77664</td></tr>
<tr><td>Off</td><td>On</td><td>Off</td><td>6</td><td>5.31200</td><td>5.78688</td></tr>
<tr><td>On</td><td>Off</td><td>Off</td><td>7</td><td>5.32224</td><td>5.79712</td></tr>
<tr><td>Off</td><td>Off</td><td>Off</td><td>8</td><td>5.33248</td><td>5.80736</td></tr>
<tr><td rowspan="5">4 and 5</td><td colspan="6">Transmit Power Control</td></tr>
<tr><td>Switch 4</td><td>Switch5</td><td colspan="4">Tx Power at Antenna Port 5.3 GHz/5.7 GHz</td></tr>
<tr><td>Off</td><td>Off</td><td colspan="4">0 dBm</td></tr>
<tr><td>Off</td><td>On</td><td colspan="4">+4 dBm</td></tr>
<tr><td>On</td><td>Off</td><td colspan="4">+8 dBm</td></tr>
<tr><td>On</td><td>On</td><td colspan="4">+12 dBm</td></tr>
<tr><td>6</td><td colspan="6">Not Used</td></tr>
<tr><td>7, 8, 9, and 10</td><td colspan="6">IDU Disable
On= ODU will be connected to IDU
Off=ODU will NOT be connected to IDU
Note: In order to prevent potential damage to external equipment, it is imperative that switch 7 through 10 are set to Off position.</td></tr>
</table>

Note: Factory default DIP switch settings are shown in **bold** typeface.

WL202008

Figure 3.8 - DIP Switch Access and Configuration Information

WL202026

3.7 Commissioning

1. Visually verify that the Link AX is properly mounted
2. Verify that the DC power input to the Link AX is on.

Refer to Table 3.8.

3.7.1 Configuring Link AX System Antennas

External Antennas:

The antennas used on an Link AX radio system are generally configurated for either vertical or horizontal polarization. It is extremely important to verify that both antennas are configured for the same polarization, and that the appropriate antenna polarization has been selected for the specific radio link.

Integral Antennas:

The integral antennas are set at the factory for either vertical or horizontal polarization, and cannot be changed in the field. If a different polarization is required, contact the distributor or Wireless, Inc. for an exchange or replacement. As with external antennas, the installer must verify that both ends of the link are configured for the same polarization.

Failure to observe same polarity on both ends of the link will result in at least a 25 to 30 dBi reduction in receive signal level.

Table 3.8 - Installation Checklist

Installation Checklist	
Is proper voltage provided and connected correctly? (21-56 VDC, 16 Watts nominal draw per terminal)	
Is the ODU properly grounded?	
Is the antenna properly connected to the ODU?	
Is the data connection (ATM-25) in place and correct?	
Is the mounting structure (Mast, Pole) properly grounded?	
Are the Antennas oriented in the same plane (both vertical, or both horizontal)?	
Verify antenna pointed in general azimuth of remote end.	
Verify proper weatherseal of N-Type connectors on ODU and antenna.	

WL213059

AX radio system, and should only be accomplished by experienced professionals.

The Link AX is equipped with a ODU mounted BNC-(f) RSSI connector to which an analog or digital voltmeter can be connected. The voltage range at the test point, between the center conductor of the connector and ground, varies from approximately two VDC to four VDC, serving as a receive signal strength indicator (RSSI). The stronger the receive signal, the higher the RSSI voltage. Refer to Table 3.5.

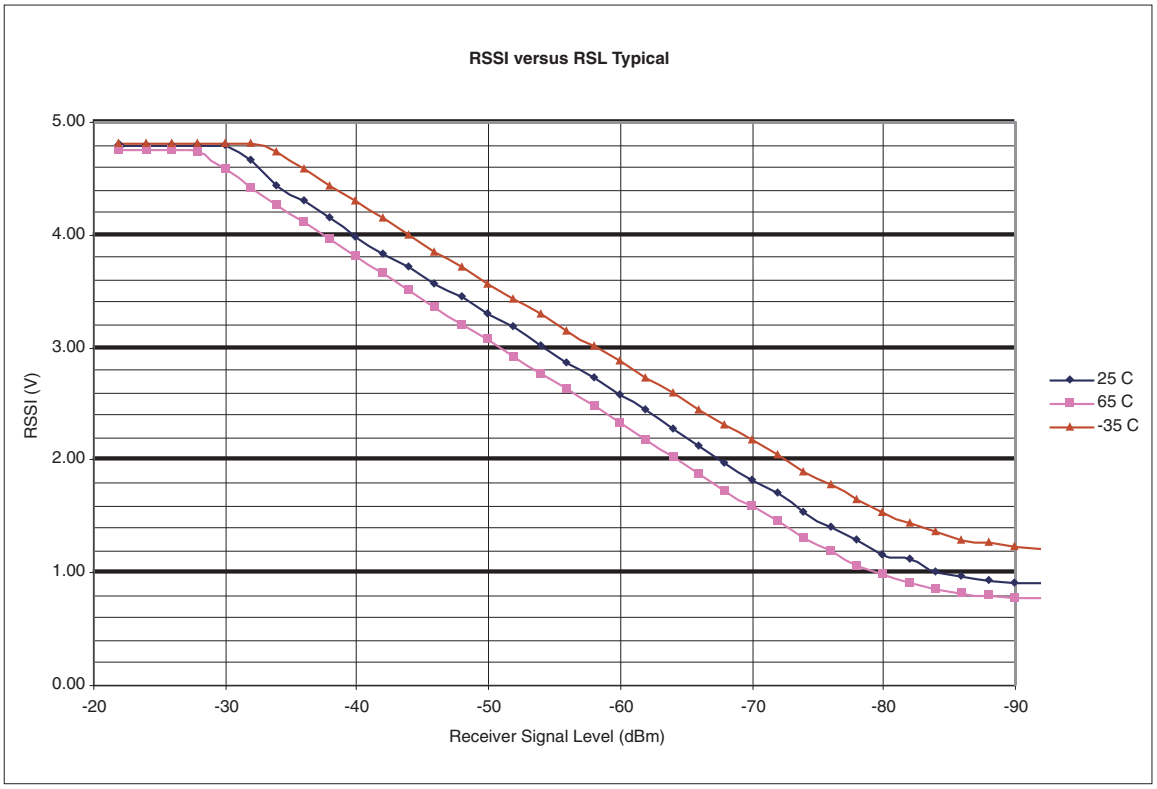
Emanating from a microwave antenna is a main beam (or lobe) of RF energy, surrounded by RF side lobes. The beamwidth of the main beam varies with the size and type of antenna, as well as the specific frequency of the RF signal, and is generally defined by the nominal total width of the main beam at the half-power (-3 dB) points. Side lobes surround the main beam at specific angle distances, and will be lower in power than the main beam.

When aligning an antenna system, it is extremely important to verify that the antennas are both aligned on the main beam, not on a side lobe. Referencing Table 3.6, the first side lobe will generally be located at an angle slightly less than twice the antenna beamwidth.

Following the course alignment of an antenna system, a common practice when performing a fine alignment is to slowly swing each antenna (one at a time!) in both vertical (elevation) and horizontal (azimuth) planes to verify that the main beam and first side lobe can be accurately identified. This insures that accurate alignment of the antenna system on the main beam has been accomplished.

Each Link AX is shipped with an RSSI test sheet, showing the relationship between the receive signal strength level (in dBm) and the RSSI level (in VDC). These RSSI test sheets are often referred to as AGC Curves. The RSSI test sheets can be used to verify that the calculated receive signal levels match up with the actual receive signal levels. Substantial differences between calculated and actual levels could point to transmission system problems, side lobe alignment, path obstructions, etc.

Table 3.9 - RSSI Voltage vs. Receive Signal Level



WL205001

Table 3.10 - Approximation Table

Antenna Diameter and Style	Gain (dBi)	3 dB Beamwidth (degrees)
6" flat panel	17.5	19.0
12" flat panel	23	9.4
12" Parabolic	23.3	11.8
24" parabolic	28.1	6.1
24" flat panel	27.5	4.7
48" parabolic*	30.2	3.1

* The 48 dish antenna is for use outside the USA only, and are not FCC compliant.

WL202023

3.7.3 Verifying Antenna Alignment

Wireless Inc. recommends that the installer verify the alignment of the antennas by performing a simple calculation. Verifying proper antenna alignment is critical to the installation of the equipment, as it ensures that the desired signal is being received, as well as ensures that the transmitter is sending data to the desired remote location. A sample calculation is provided below:

1) Determine Tx Power Outpour +4 dBm

2) Determine coax cable loss (if external antenna) -2.6 dB

3) Determine Tx Antenna Size and Gain (from table 3.6) +23 dBi
   1' parabolic

4) Determine Free Space Loss
   Distance is 3 miles = 20log(3) +111.72 -121.3 dB

5) Determine Rx Antenna Size and Gain (from table 3.6) +23 dBi
   1' parabolic

6) Determine coax cable loss (if external antenna) -2.6 dB

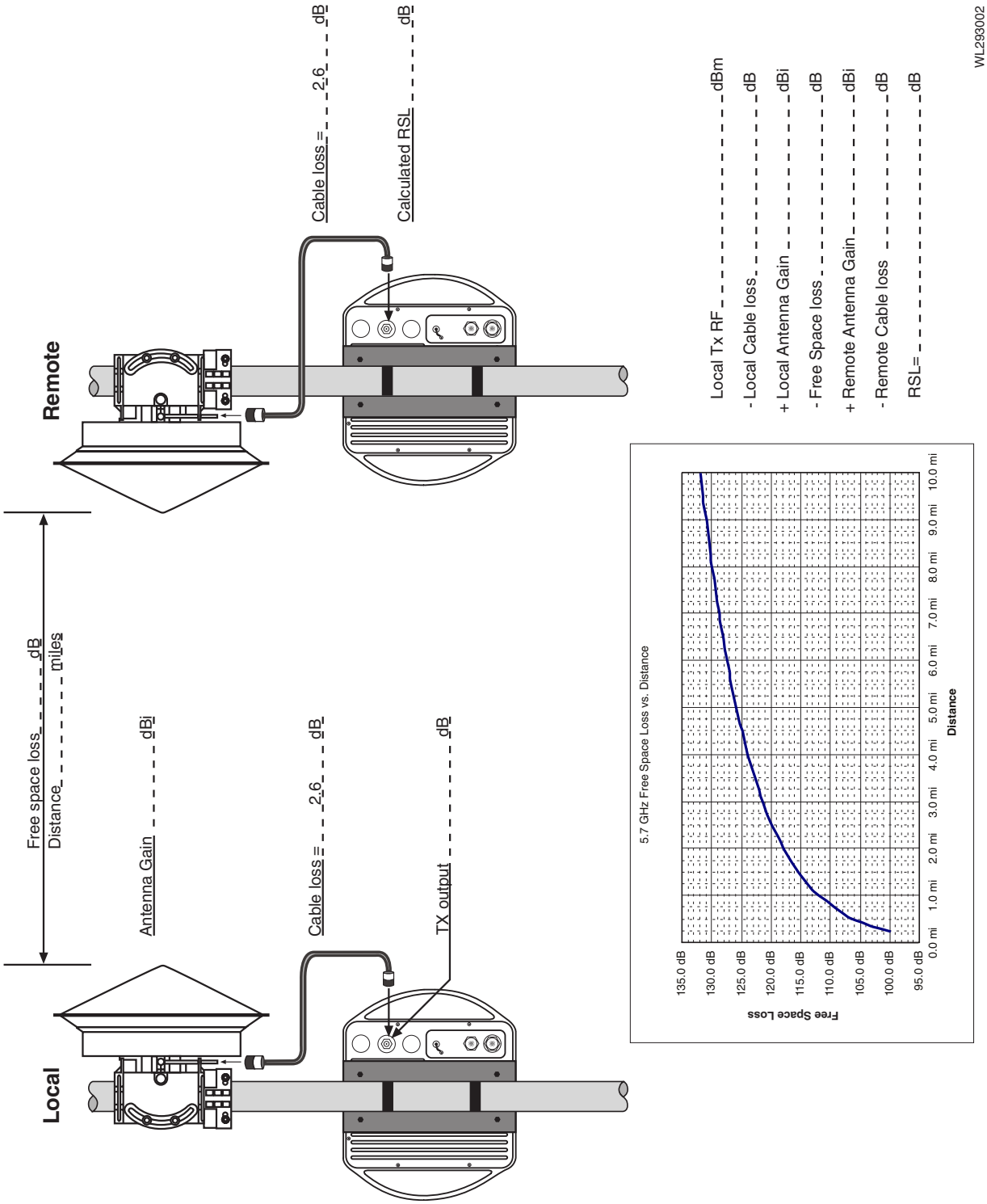
7) Add Gains and Losses to determine RSL -76.5 dBm

Referring to table 3.9, a Receive Signal Level of -76.5 dBm is roughly equivalent to 1.3V. The installer should refer to the RSSI test sheet supplied with each ODU to determine the correct voltage for the ODU.

Figure 3.9 - Receive Signal Level

miles	FSL
0.25 mi	99.68 dB
0.50 mi	105.70 dB
0.75 mi	109.22 dB
1.00 mi	111.72 dB
1.25 mi	113.66 dB
1.50 mi	115.24 dB
1.75 mi	116.58 dB
2.00 mi	117.74 dB
2.25 mi	118.76 dB
2.50 mi	119.69 dB
2.75 mi	120.50 dB
3.00 mi	121.26 dB
3.25 mi	121.96 dB
3.50 mi	122.60 dB
3.75 mi	123.20 dB
4.00 mi	123.76 dB
4.25 mi	124.29 dB
4.50 mi	124.78 dB
4.75 mi	125.25 dB
5.00 mi	125.70 dB
5.25 mi	126.12 dB
5.50 mi	126.52 dB
5.75 mi	126.91 dB
6.00 mi	127.28 dB
6.25 mi	127.64 dB
6.50 mi	127.98 dB
6.75 mi	128.30 dB
7.00 mi	128.62 dB
7.25 mi	128.92 dB
7.50 mi	129.22 dB
7.75 mi	129.50 dB
8.00 mi	129.78 dB
8.25 mi	130.05 dB
8.50 mi	130.31 dB
8.75 mi	130.56 dB
9.00 mi	130.80 dB
9.25 mi	131.04 dB
9.50 mi	131.27 dB
9.75 mi	131.50 dB
10.00 mi	131.72 dB

WL262003



4.0 Antenna Installation

The following section describes the installation details of various antennas offered in a pictorial format.

4.1 Equipment Inventory List

Table 4.1 - Inventory of Equipment and Installation Materials

Item	Description	Part Number	Qty
1	5.3 GHz TX Unit (Low Band)		1
	a) External Antenna	100070-001	
	b) Internal Antenna, Vertical Polarity	100086-001	
	c) Integral Antenna, Horizontal Polarity	100081-001	
2	5.7 GHz TX Unit (High Band)		1
	a) External Antenna	100075-001	
	b) Integral Antenna, Vertical Polarity	100087-001	
	c) Integral Antenna, Horizontal Polarity	100082-001	
3	Antenna		2
	a) 12" (30 cm) Flat Panel, 21 dBi	091-475512-101	
	b) 12" (30cm) Parabolic, 23 dBi	AC100045	
	c) 24" (60 cm) Parabolic, 28 dBi	091-455524-101	
4	Mounting Kit		2
	a) Pole Mount Kit	KIT00077 Pole	
	b) Wall Mount Kit	KIT000017 Wall	
5	LAN Protector (optional, Indoor Use only)	100088-001	2
6	Coaxial Cable, 1 meter	AC100008	2
7	Data Power Cable		2
	a) Siamese (combo) Data and Power, 4m (12')	AC1000043	
	b) Siamese (combo) Data and Power, 25m (75')	AC1000040	
	c) Siamese (combo) Data and Power, 50m (150')	AC1000041	
	d) Siamese (combo) Data and Power, 100m (300')	AC1000042	
	e) Repeater Cable, 1m (3') Back-to-Back Repeater	100151-001	note 3
	f) Repeater Cable, 1m (3') Back-to-Back Repeater	100151-002	note 3
	g) Power Cable, 3m, Repeater Application	100152-001	
	h) Power Cable, 25m, Repeater Application	100152-002	
	j) Power Cable, 50m, Repeater Application	100152-003	
	k) Power Cable, 100m, Repeater Application	100152-004	
	l) StarPort Interface Cable, Xm	T.B.D.	
	m) StreamNet Interface Cable, Xm	T.B.D.	
8	Power Supply, 110/220 VAC 50/60 Hz to 24 VDC		2
	North American Plug	AC1000044-1	
	European Plug	AC1000044-2	

Notes:
1) Unless otherwise noted as optional, all items are required to complete one link of Link AX radio.
2) If integral antennas are ordered, both ends of the link must have the same polarity, i.e. both vertical or both horizontal.
3) For repeater applications, only one Repeater cable is required at the repeater site (items 7e or 7f). Two power cables are required at the repeater site (items 7g-k).

WL272003

4.2 Antenna Install and Rough Alignment

Read the instructions completely before assembling or installing the antenna. This installation can be dangerous and requires qualified personnel familiar with microwave assembly and installation.

4.2.1 Flat Panel Type Antennas, 6", 12", and 24"

Table 4.2 reflects the different flat panel antenna dimensions. Assemble the panel mount according to Figure 4.1. Orient Antenna using instructions supplied with the antenna. Antenna models used with this mount may be circular, square or diamond shaped. To change the offset of the antenna, unbolt the mount from the antenna, invert the mount and reattach to the antenna.

Table 4.2 - Approximation Table of Flat Panel Antennas

Antenna Diameter and Style	Gain (dBi)	3 dB Beamwidth (degrees)
6" flat panel	17.5	19.0
12" flat panel	23	9.4
24" flat panel	27.5	4.7

WL284001

Figure 4.1 - Antenna Mount

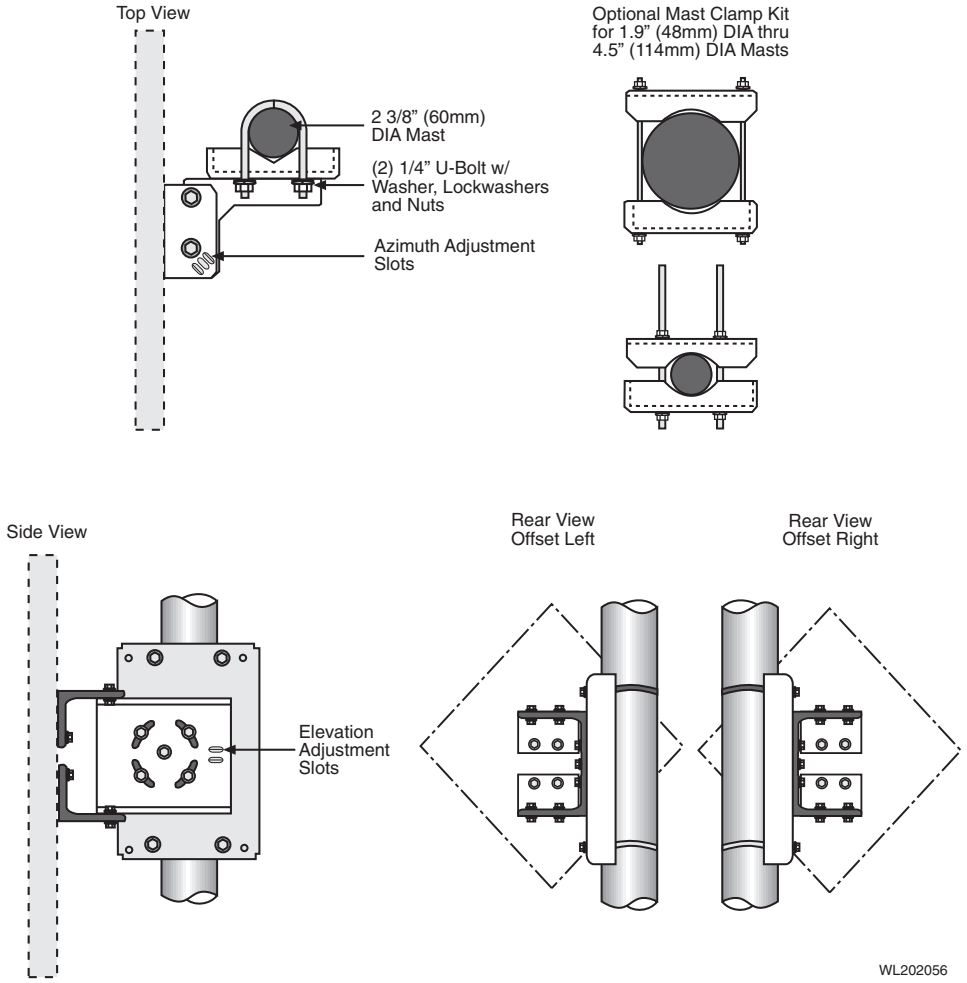
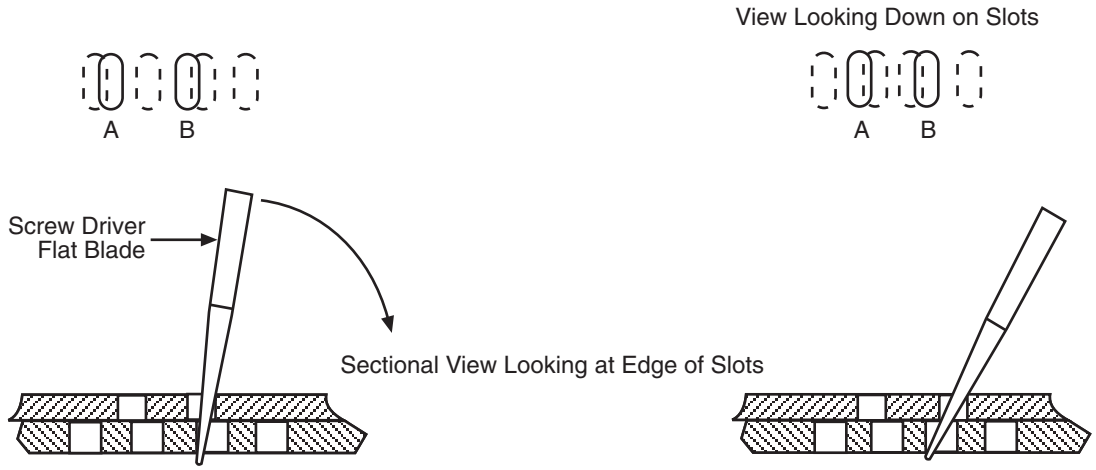


Figure 4.2 - Adjustable Panel Antenna Mount

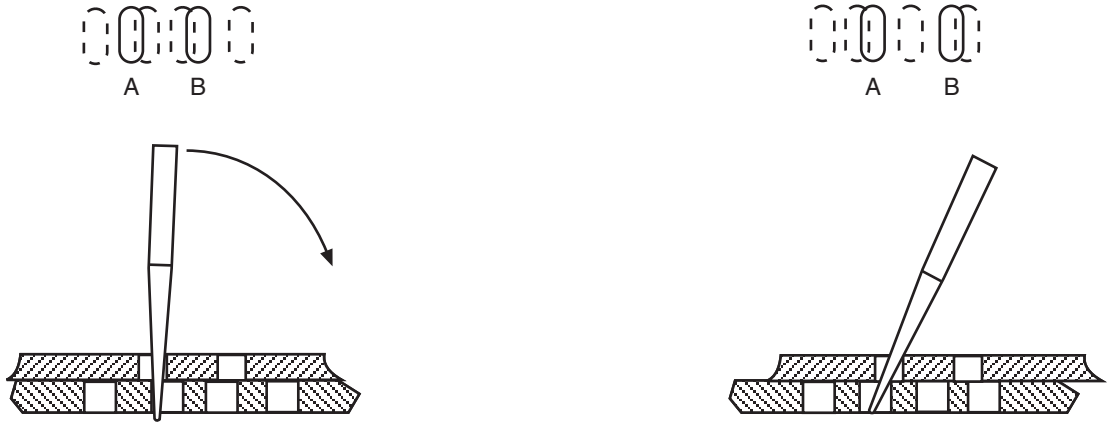
Azimuth and Elevation Panning

1) Loosen the Azimuth or Elevation Locking Hardware while maintaining sufficient friction to prevent unwanted slippage.



2) Insert flat blade screw driver into slot "B" and pry in direction of arrow or into slot "A" and pry in opposite direction.

3) Stop prying approximately at position shown as new overlapping slot in bottom plate becomes sufficiently visible when viewed through slot "A".



4) Insert screw driver into slot "A" and pry in direction of arrow.

5) Stop prying approximately at position shown as new slot in bottom plate becomes sufficiently visible when viewed through slot "B". Continue alternating slots and prying in either direction until desired alignment is obtained. Lock down hardware securely before leaving site.

WL266002

Attach the antenna to the mount as shown in Figure 4.4. For antenna polarization, assemble the antenna to the mount using four sets of nuts and washers after desired polarization is selected. In horizontal polarization the arrow sticker should be pointed in a horizontal direction. Likewise, in vertical polarization the arrow sticker should be pointed in a vertical position.

Important: After cable connection is completed, wrap connection with Butyl or other waterproof tape, supplied by the customer.

Each panel antenna has four factory sealed drain holes located on the back of the antenna. After orienting the antenna to its proper polarization, the lower most sealed drain hole(s) must be punctured with a pointed tool. See Figure 4.4.

Caution: Do not allow the tool to protrude into the drain hole more than 1/4" (7mm) or damage to the antenna may result.

Figure 4.3 - Flat Panel Antenna

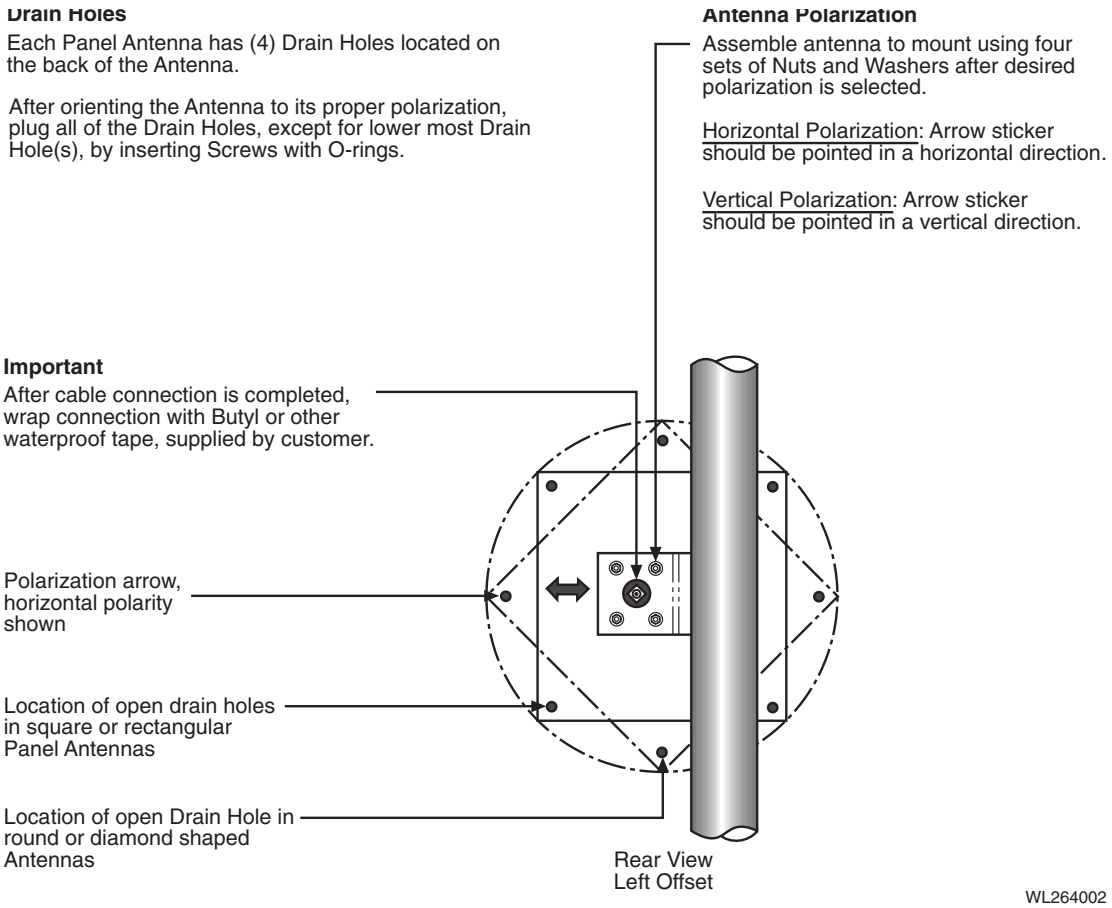
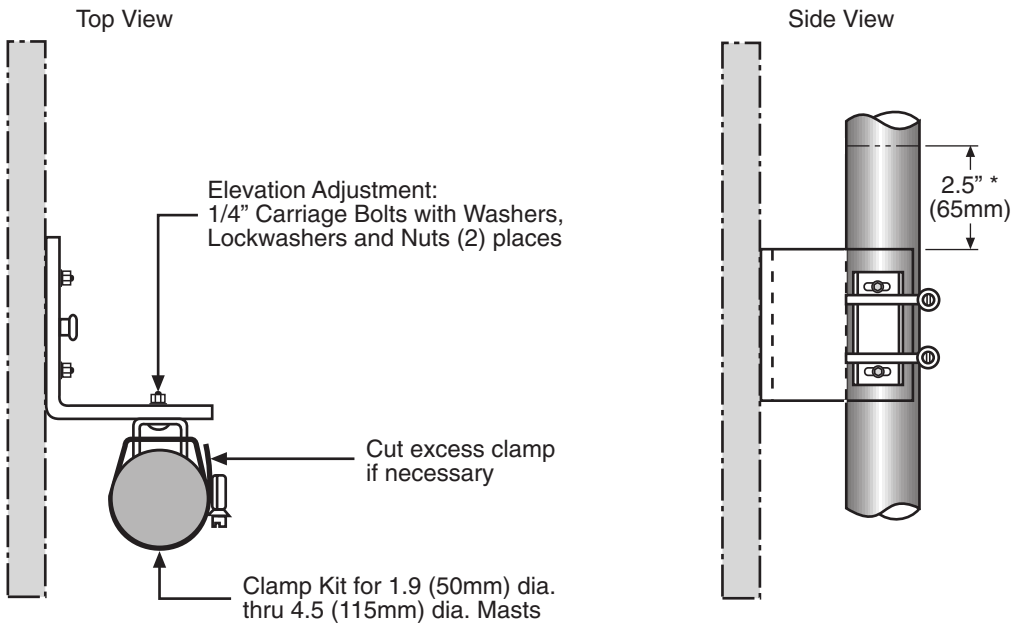
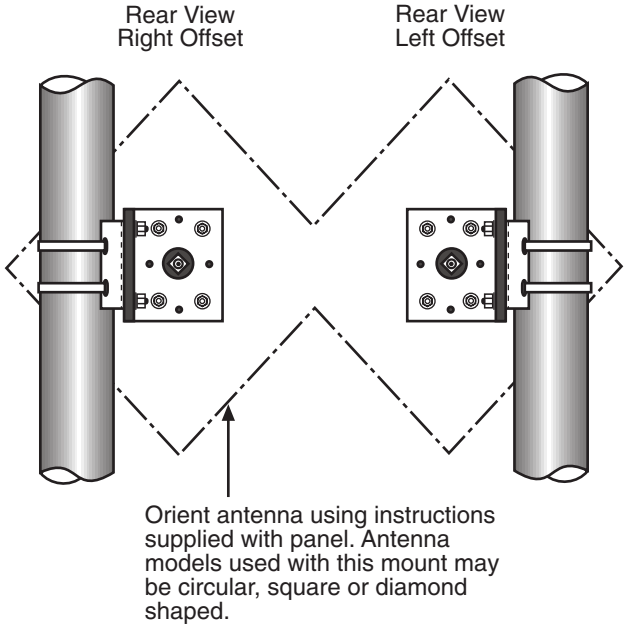


Figure 4.4 - Adjustable Panel Antenna Mount



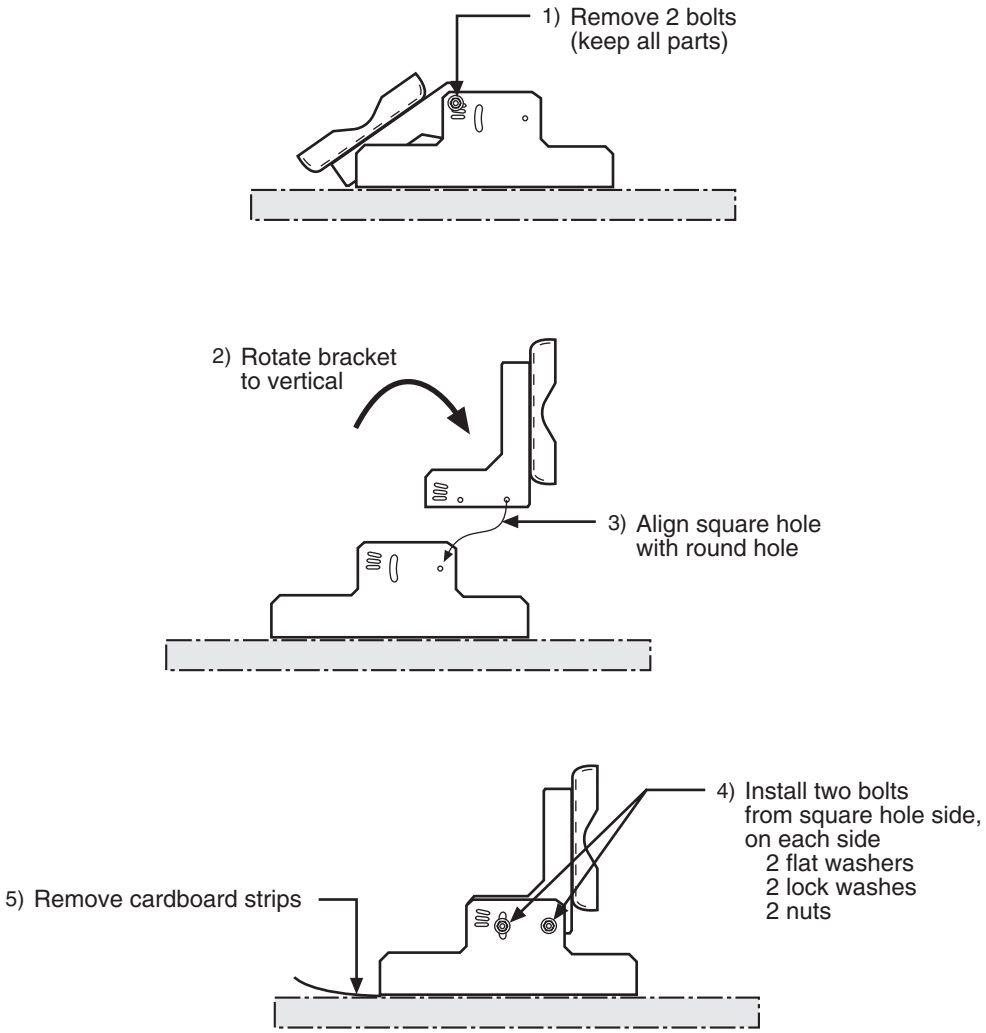


* To obtain ±20˚ elevation on a 1' (.3m) Antenna, with Mast diameters > 2.4" (60mm) the Mast must not extend beyond 2.5" (65mm).

To change offset:
Unbolt mount from Antenna, invert mount and reattach to Antenna.

WL266001

Figure 4.5 - 24" Flat Panel Quick Align Mount



4.2.2 Parabolic Type Antennas, 12”, 24” and 48”

Site Planning

1. For antenna mounting and planning dimensions, see Figure 4.6 and Table 4.4.
2. 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 4.6) by inverting the Horizontal Tube Assembly.

Table 3.3 reflects the different parabolic antenna dimensions.

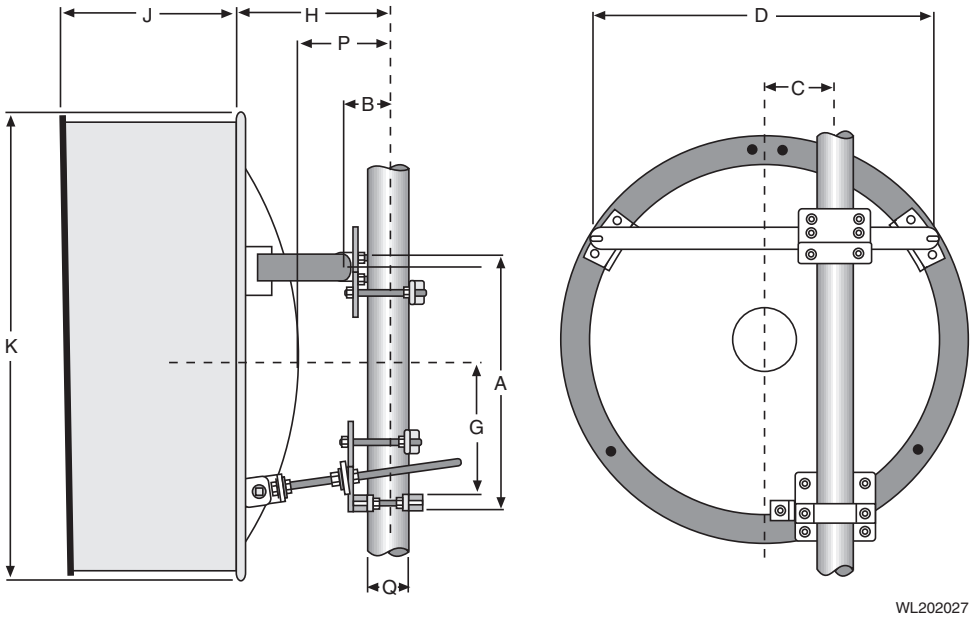
Table 4.3 - Approximation Table of Parabolic Antennas

Antenna Diameter and Style	Gain (dBi)	3 dB Beamwidth (degrees)
12" parabolic		
24" parabolic	28.1	6.1
48" parabolic*	30.2	3.1

* The 48" dish antennas are for use outside the USA only, and are not FCC compliant.

WL284002

Figure 4.6- 24” Diameter Antenna



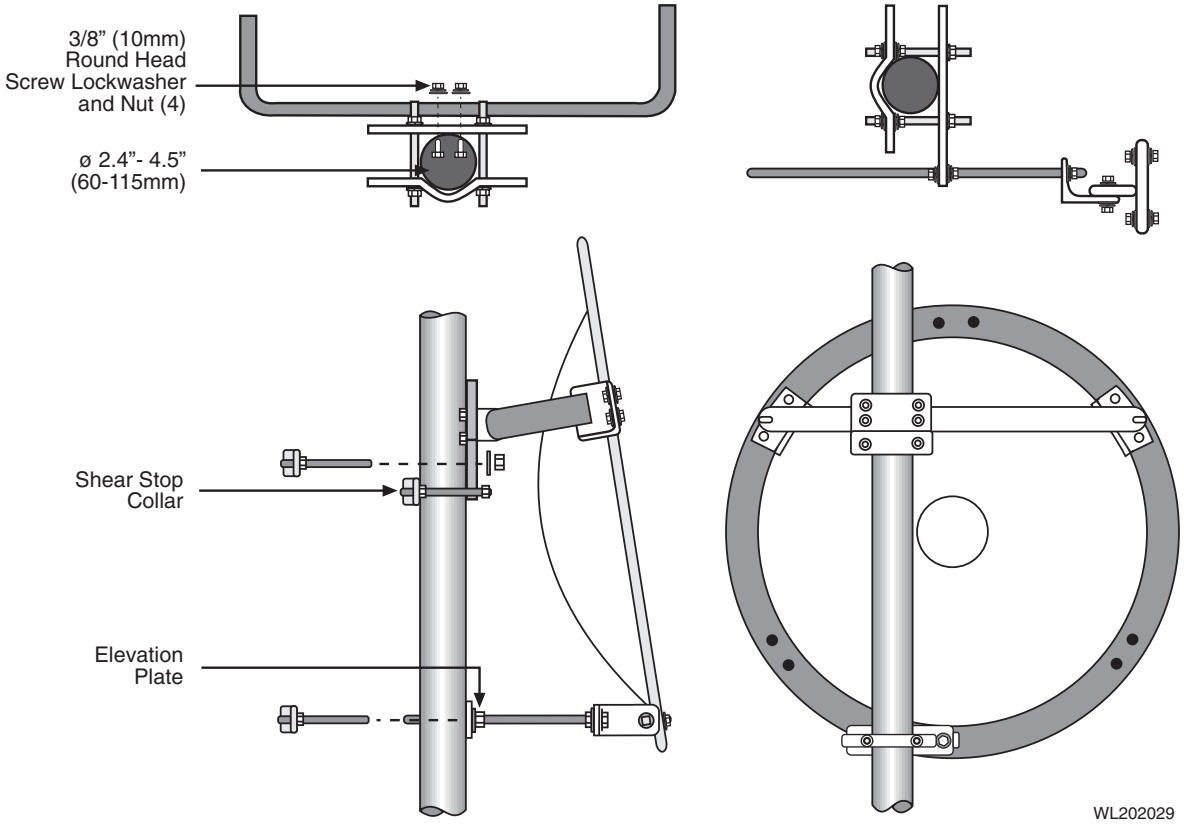
WL202027

Table 4.4 - 24" Diameter Antenna Dimensions

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°

WL202028

Figure 4.7 - Mount Configuration



Unpacking and Preparation

1. 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 Figures 4.8 through 4.11.

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

2. Inspect for any damaged parts. See Tables 4.5a-4.5d 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.

Table 4.5a - Contents List, Mount Assembly

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 4.5b - 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

WL202035

Table 4.5c - Contents List, Feed 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

WL202031

Table 4.5d - Contents List, Reflector Assembly

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

WL202030

Figure 4.8 - Mounting Hardware Packed

WL202032

Figure 4.9 - Mounting Hardware Unpacked

WL202033

Figure 4.10 - Parabolic Reflector

WL202036

Figure 4.11 - Unpacking the Radome

WL202037

Mount Assembly and Attachment

1. 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.
2. Loosely attach Top Support Angles to the Horizontal Tube Assembly as shown in Figure 4.12 and 4.13.
3. For desired mount configuration (refer to Figure 4.7), attach the Vertical Tube Assembly to the Horizontal Tube Assembly as shown in Figure 4.12 and 4.13.
4. Verify proper assembly of the elevation rod hardware as shown in Figure 4.14. Remove outer hardware and insert rod through elevation plate.

Important: For elevation angles grater than ±20°, Beveled Washers, shown in Figure 4.14, must be used. However, beveled washers may be used for elevation angles greater than ±10°.

5. 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 4.12.
6. 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 4.12 - Antenna Mount Assembly

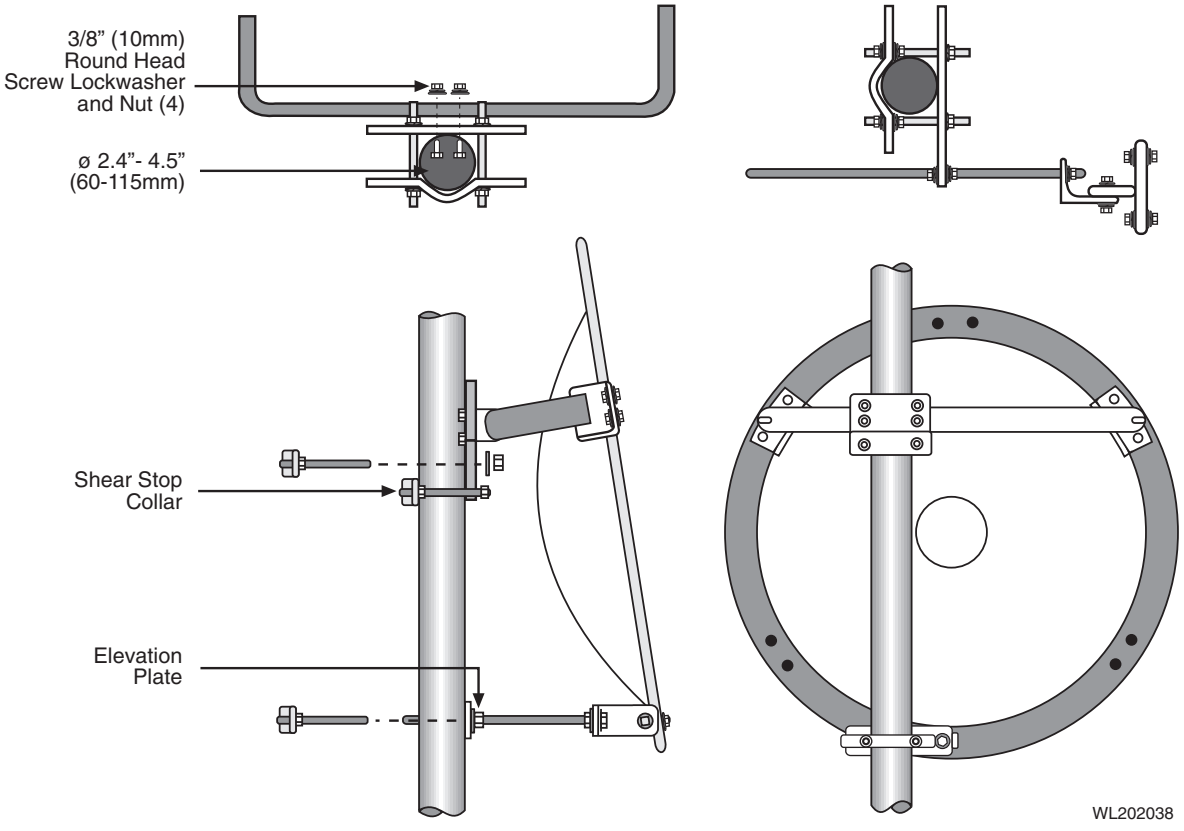
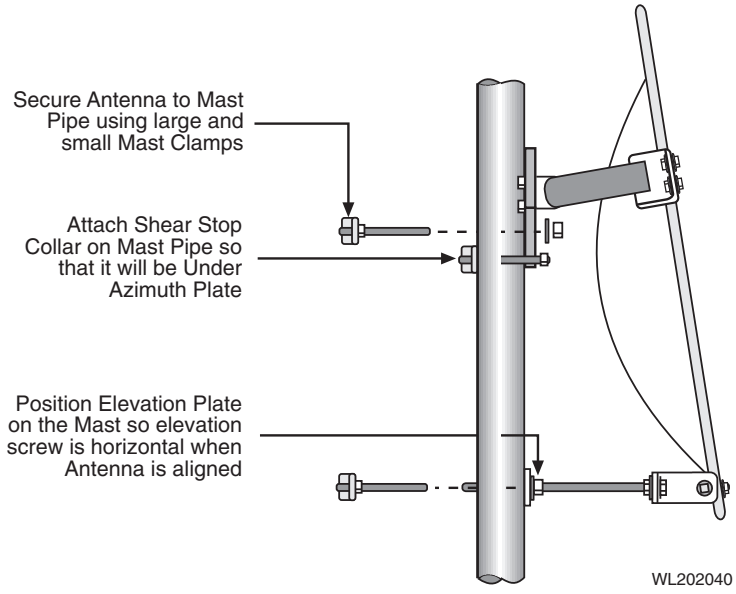


Figure 4.13 - Antenna Mount Assembly

WL202039

Figure 4.14 - Elevation Rod Assembly



WL202040

Feed Installation

Following the instructions provided with the feed assembly, install the feed in the reflector. Refer to Figures 4.15 through 4.20.

Figure 4.15 - Feed Horn Installation

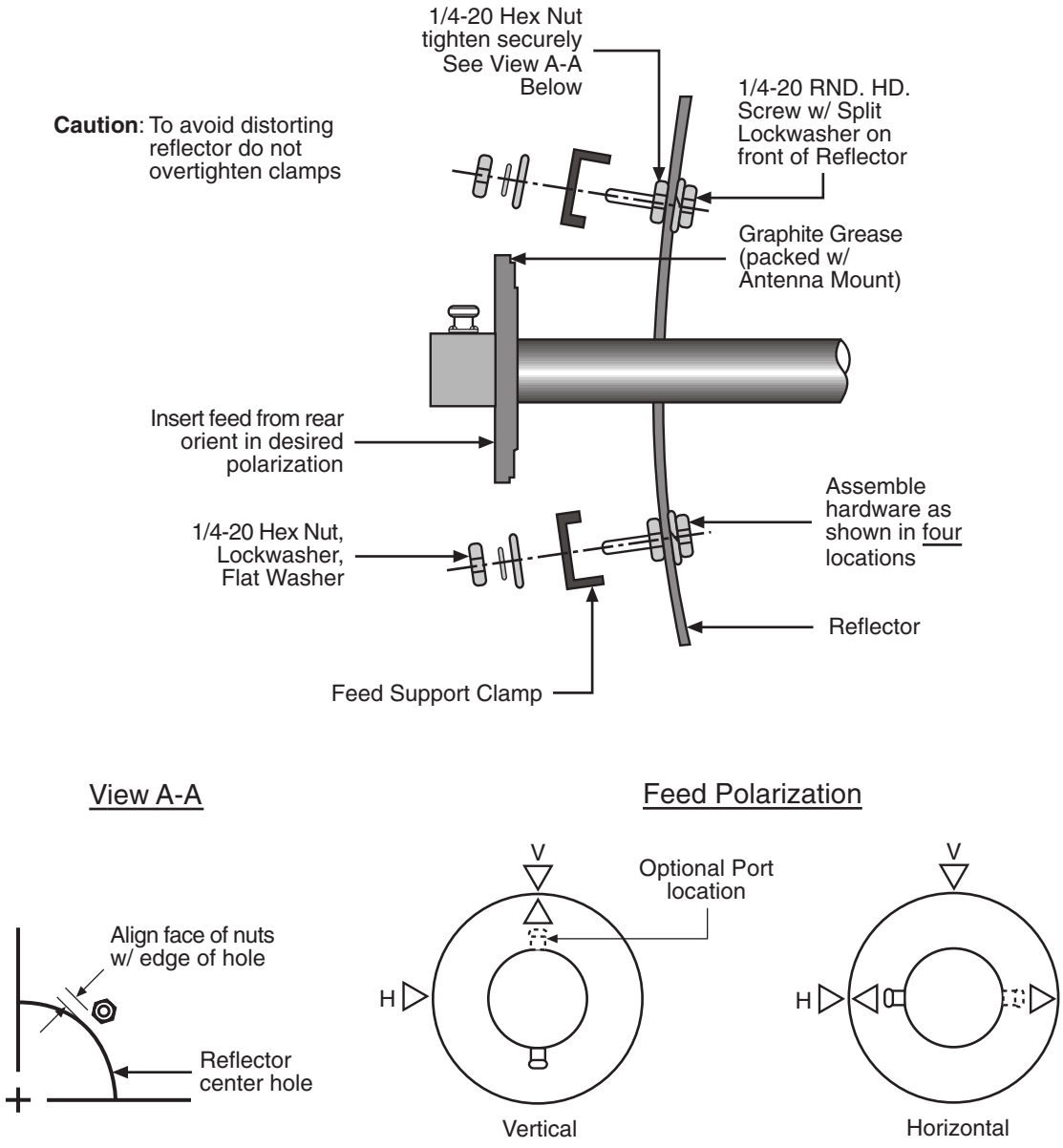
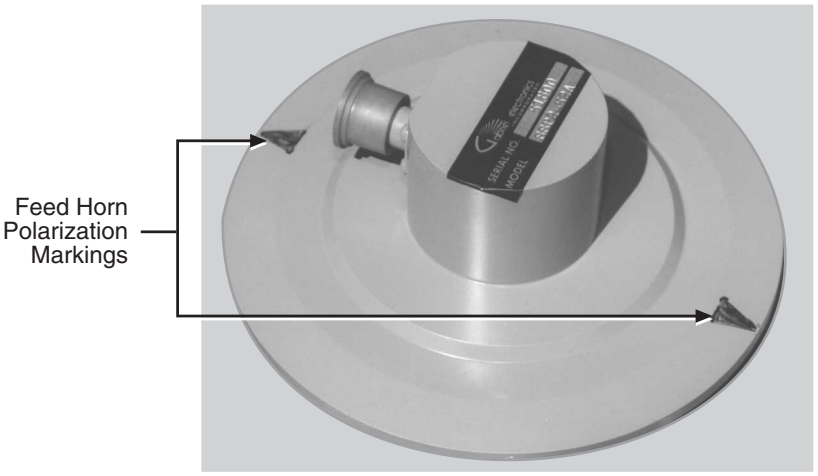
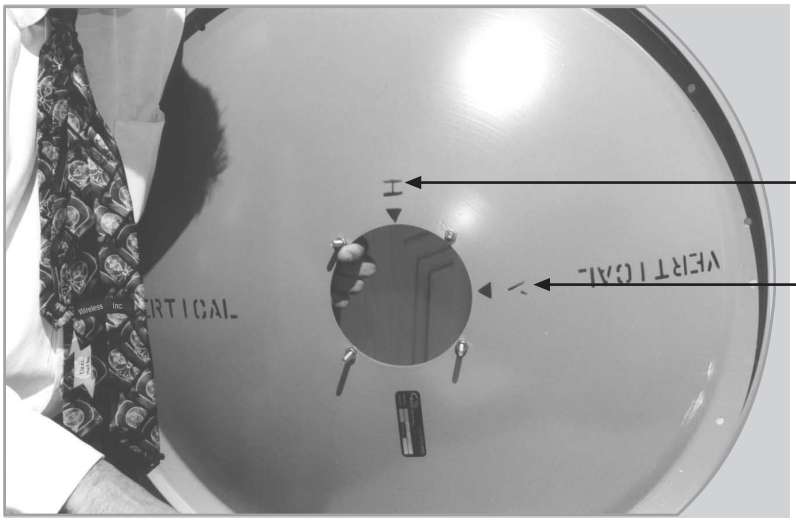


Figure 4.16 - Feed Horn Polarization Markings



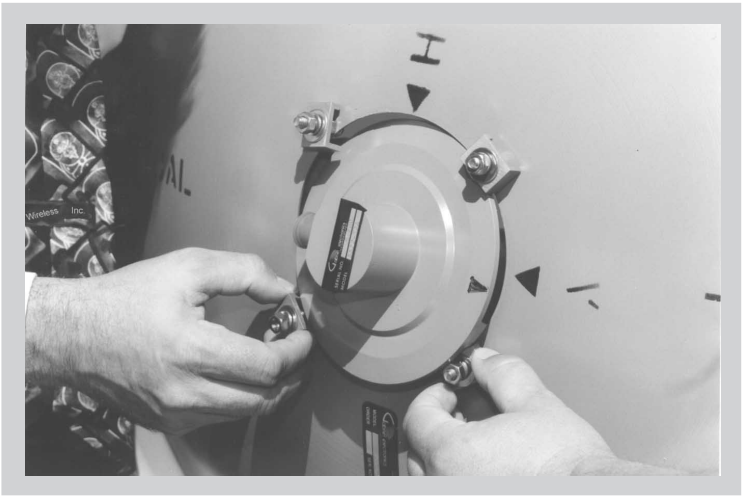
WL202042

Figure 4.17 - Parabola Rear View Showing Polarization Reference Markers



WL202043

Figure 4.18 - Feed Horn Installation



WL202044

Figure 4.19 - Feed Horn Installation for Vertical Polarized Operation

WL202045

Radome Installation

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

Azimuth Adjustment Clamp/Shear Stop Installation

1. Verify proper assembly of the azimuth clamp/shear stop clamp as shown in Figure 4.20 and 4.21. 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.
2. Refer to Figure 4.6 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 4.20 - Azimuth Clamp/Shear Stop Assembly

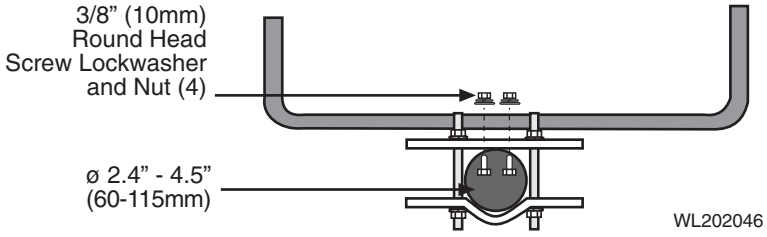


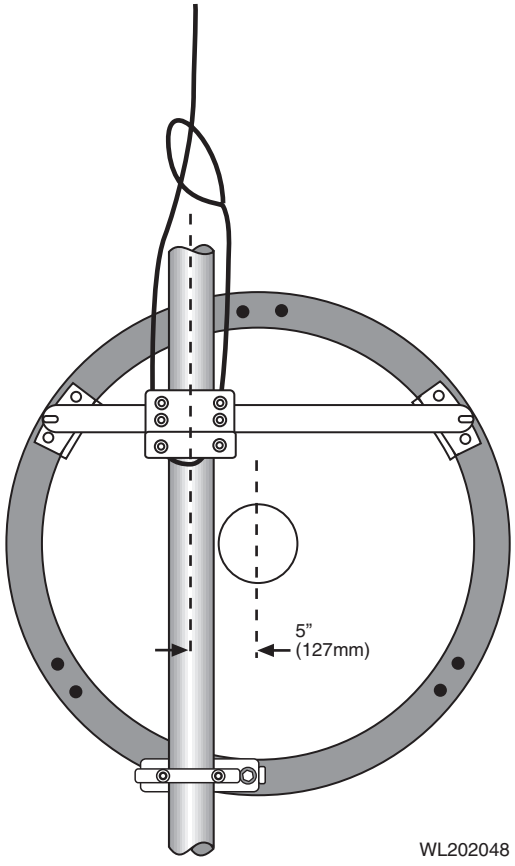
Figure 4.21 - Azimuth Adjustment Clamp Assembly

WL202047

Antenna Hoisting and Installation

1. Attach a hoist strap around the vertical assembly or the horizontal assembly as shown in Figure 4.22. Do not hoist by the elevation rod. Make sure that the vertical assembly is unobstructed where it will mount against the mast pipe.
2. Attach tag lines and carefully lift the antenna into position, resting the vertical assembly on the shear stop clamp.
3. 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, i.e. overnight.

Figure 4.22 - Hoisting the Antenna



General Antenna Alignment Procedures

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.

Azimuth Adjustment

1. 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.
2. 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 1 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.

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

Elevation Adjustment

1. Insure that both of the bolts connecting the mount to the Top Support Angles and the pivoting Elevation Angle (refer to Figures 4.12 and 4.14) are just loose enough to allow resisted rotation.
2. Back the outer nuts on the elevation rod away from the bottom mount plate to allow some fine adjustment range.
3. Turn the inside nut (with flat washer) on the elevation rod to adjust the elevation angle. Approximately 5 turns changes the elevation by 1°. Remember, for elevation greater than 20°, install the two beveled washers as shown in Figure 4.14.
4. After all adjustments are made, lock the nut against the bottom mount plate. Tighten the angle pivot bolt and support bracket bolts.

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

Inspection and Maintenance

1. Before leaving the installation, check that all hardware on the mount, shroud, radome, and feed is tight and that nuts are locked in place.
2. Inspection of the antenna should be performed at lease 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 4.6 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 by a new palnut.

Weather Proofing 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).

Table 4.6 - Nut Tightening Procedures

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.

WL202049

Figure 4.23 - Adjustable Parabolic Antenna Mount

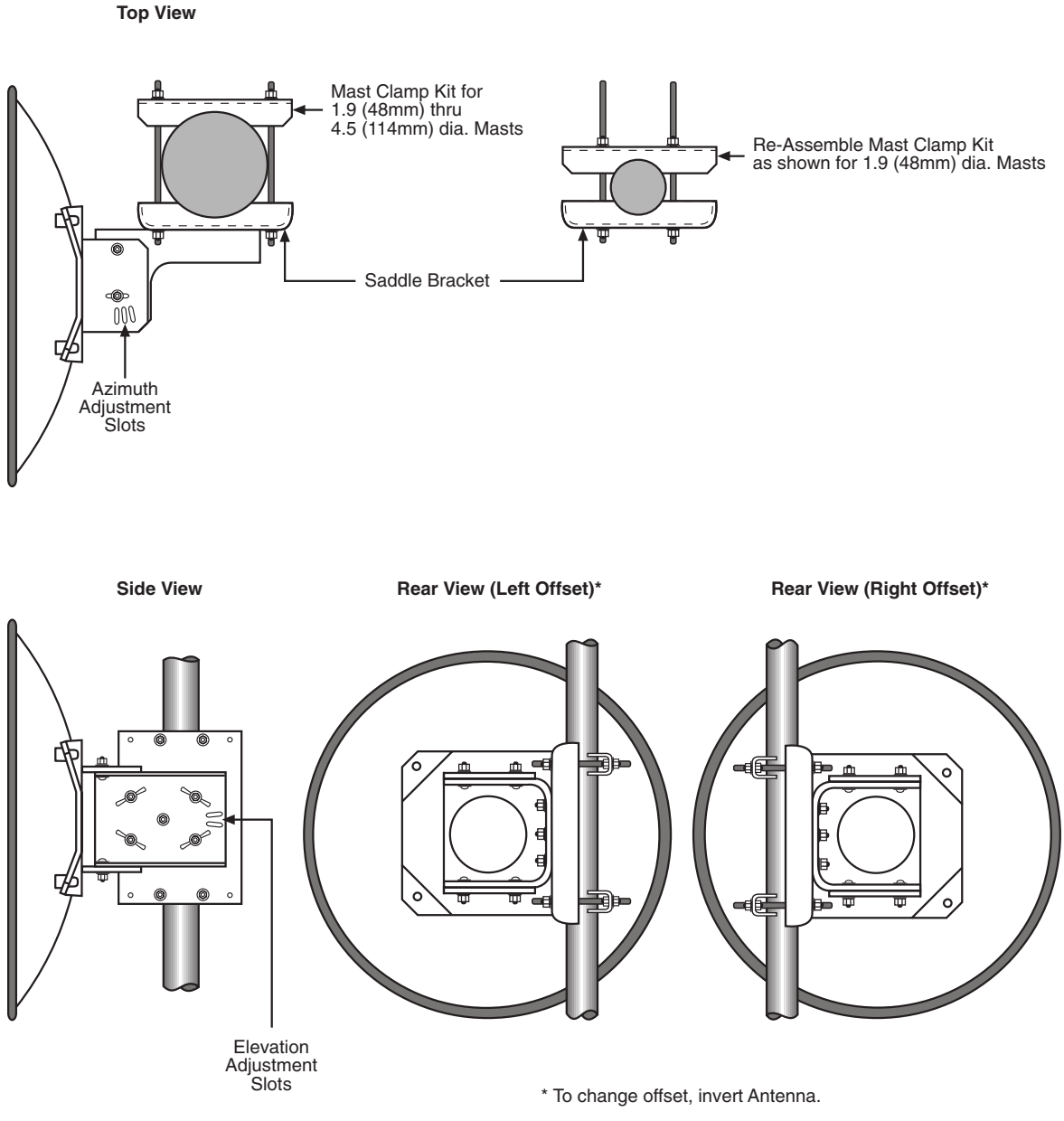
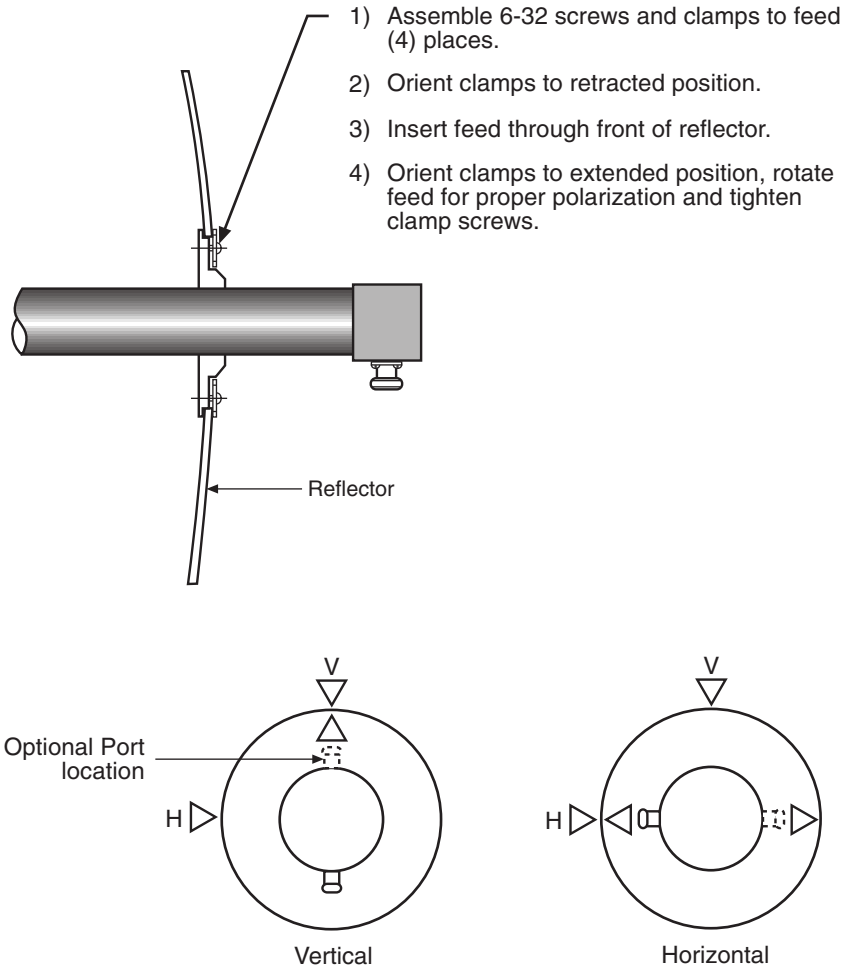


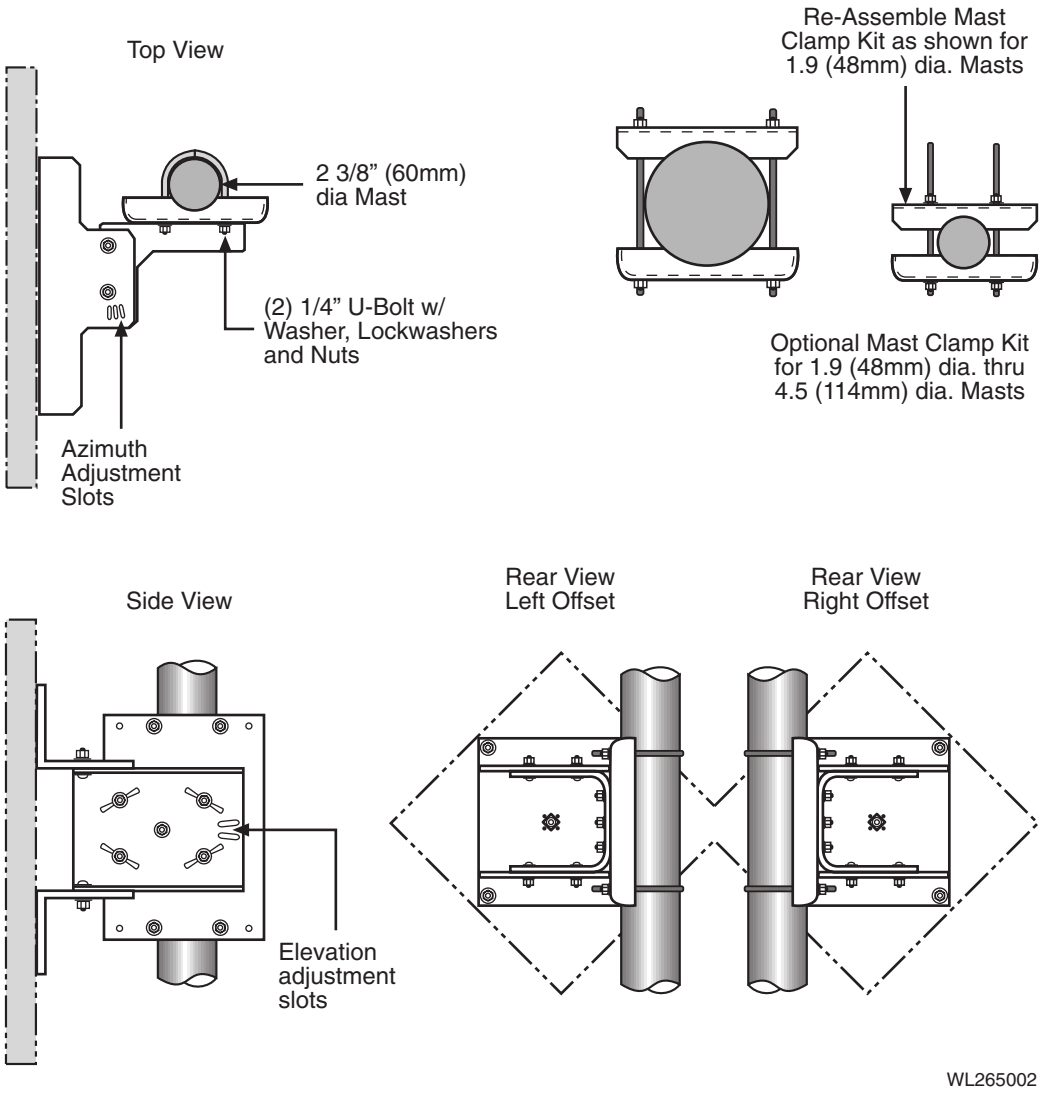
Figure 4.24a - Feed Assembly Plane Polarized



Feed Polarization
Rear View of Feed

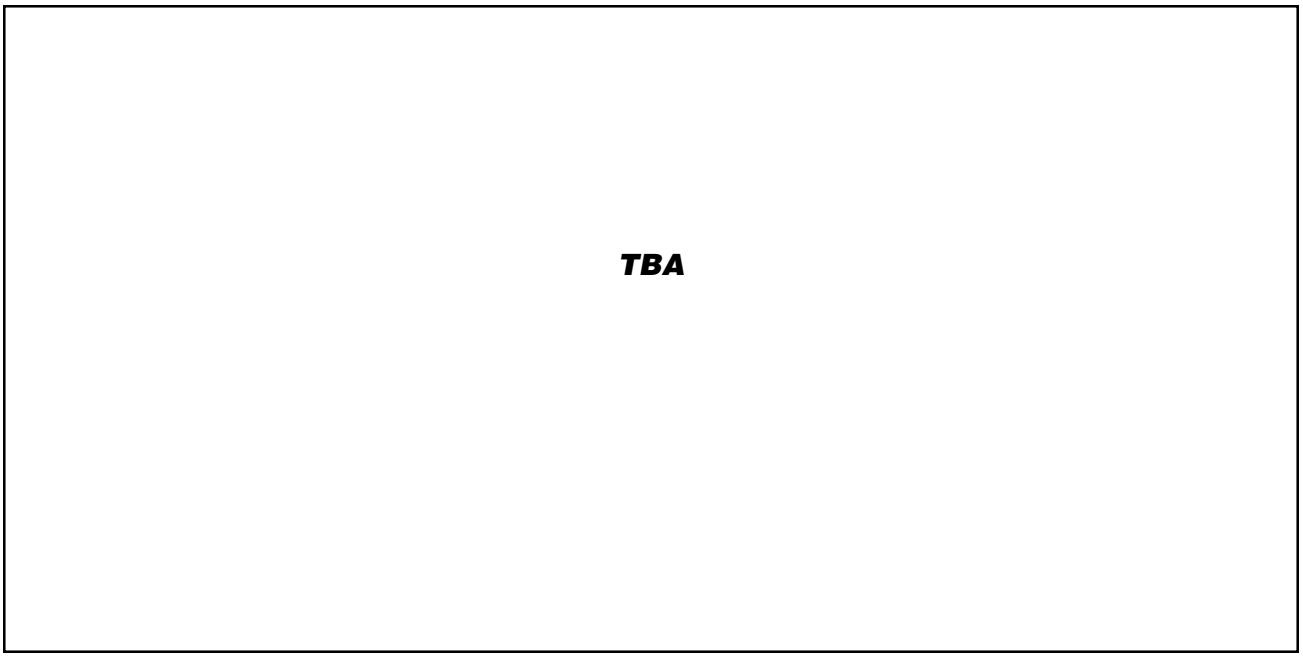
WL265001

Figure 4.24b- Feed Assembly Plane Polarized



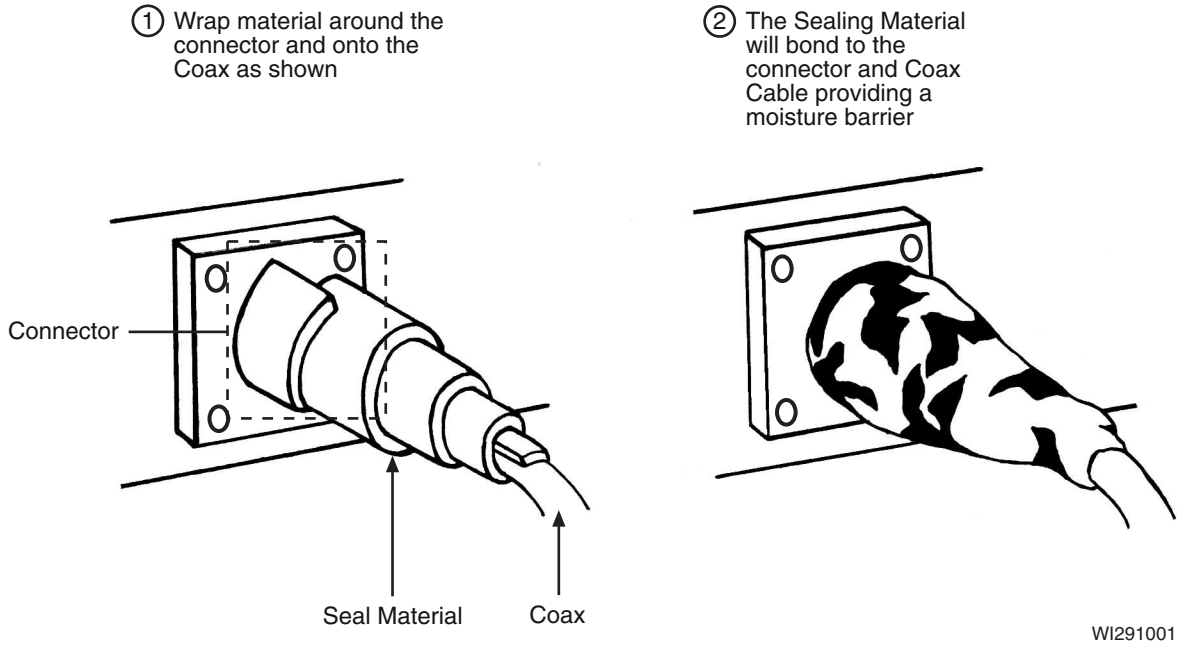
4.2.2 Wall Mount

Figure 4.25 - Ground Connection



4.3 RF Cable Install and Seal

Figure 4.26 - RF Cable Install and Seal



5.0 Maintenance and Troubleshooting

The Link AX contains static sensitive components, and has no user-serviceable parts.

5.1 Link AX Maintenance

The Link AX is designed to operate with no scheduled maintenance activities. Wireless Inc. recommends a bi-annual inspection of the following to ensure peak operating performance:

a) Verification of RSSI voltage
b) Examination of the antenna mount and ensure mounting hardware is secure
c) Examination of “siamesed” cable for signs of unusual wear or tear
d) Check all connections and verify all are secure
e) Verify power supply voltages are within tolerance

5.1.1 RSSI Voltage

The Wireless Customer Service department recommends a quarterly check of the Link AX’s RSSI voltage. Variations in the RSSI voltage could be an indicator of antenna or antenna feed movement, loose or improper RF cabling or connectorization, path obstructions or reflections, etc.

5.2 Where To Get Further Assistance

Your primary source of assistance is the support staff of the organization from which you purchased this product. The Wireless, Inc. support staff should only be contacted directly if you purchased this product directly from Wireless, Inc., or if you are unable to obtain sufficient assistance from your primary support contact.

General Product and Company Information

Wireless, Inc.
5452 Betsy Ross Drive
Santa Clara, CA 95454-1101
USA
Tel.: +408 727 8383
Fax: +408 727 1259
E-mail: info@wire-less-inc.com
Website: www.wire-less-inc.com

Detailed Product Information, Sales/Pricing Information and Pre-Sales Technical Support

Wireless, Inc.
Sales Department
5452 Betsy Ross Drive
Santa Clara, CA 95054-1101
USA
Tel: +408 727 8383
Fax: +408 727 0990
E-mail: sales@wire-less-inc.com
Website: www.wire-less-inc.com

Post-Sales Technical Support (Customer Service)

To assist you with field issues and, if necessary, to arrange for repair services, Wireless, Inc.'s Customer Service department can be reached via telephone, facsimile, e-mail, mail, or through our Website.

5.3 Return Procedure

All material returned to Wireless, Inc. must be accompanied by a Return Material Authorization (RMA) number from Wireless, Inc.'s Customer Service department. If you purchased your Wireless, Inc. product through a distributor, the Wireless RMA number should be obtained through the distributor. An RMA number is necessary to assure proper tracking and handling of returned material at the factory. Wireless, Inc. reserves the right to refuse shipments not accompanied by an RMA number. Refused shipments will be returned to the shipper via collect freight.

To obtain an RMA number, contact Wireless, Inc. as follows:

Telephone: +408 727 8383
Fax: +408 727 1259
E-mail: customerservice@wire-less-inc.com

The following information will be required to issue an RMA number:

- Part Number
- Serial Number
- Failure Description
- Contact person, telephone, and fax numbers
- Ship-to address
- Bill-to address*
- Customer purchase order* (P.O.) or reference number

* Required for non-warranty repair services. For non-warranty repair services, an RMA number will be issued when Wireless, Inc. acknowledges the purchase order.

Important - All non-U.S. returns must include 5 copies of proforma/customs invoice for each shipment which lists:

- RMA number
- Value of items
- Description of items (including the Wireless model or part number)

Please send all returns to:

Wireless, Inc.
Attn: RMA Department
5452 Betsy Ross Drive
Santa Clara, CA 95054-1101
USA
RMA No. _____

The customer is responsible to properly label and package repairs and prepay shipping to Wireless, Inc. If possible, the original packaging material should be used to return electronic parts. The RMA number must be visible on the outside of all packages returned. Unless other arrangements have been made, all repairs are shipped back to the customer prepaid via ground carrier.

Appendix A Grounding Practices and Lightning Protection Information

General

Good grounding ("earthing") practices, when used in telecommunications, have some direct benefits which can help you maximize the up time of your system as well as ensure the safety of those people working on the system. Among these benefits are:

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

There is no practice or formula which can completely eliminate the above risks, but we at Wireless, Inc. believe that good grounding and bonding practices can significantly reduce the risk of many of these hazards. We have included a bibliography at the end of this appendix which contains several publications that are readily available and contain 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 only be established and accomplished by trained professionals, working in accordance with local practices and regulations.

Ground Connections

There should be a grounding plan designed at the outset of site design in order to provide the best grounding procedures and to minimize ground loop currents. This 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.

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.

It is not possible to provide and guarantee complete protection from the effects of lightning; however, they 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. Where any site owner or user is in doubt about the protection requirements for any particular location, the appropriate authority should be consulted.

Protection Arrangements

The purpose of any protection arrangement should be to provide a suitable path to ground for the lightning current, to ensure adequate bonding between structures and all metalwork on the site and the common grounding system in order to reduce the side flashing, and to attempt to prevent the entry of flashes or surges into the building.

The resistance to ground should be kept to a minimum and a value of less than 10-ohms is recommended. The most important feature is that the system should ideally be at equal potential across the entire site.

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

Arrangements will vary considerably from very simple sites to complicated sites with multiple buildings, antenna support structures and associated equipment, and may involve integration with existing systems. Such systems may require upgrading.

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 x 3 mm with all connections protected by non reactive paste.

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

Grounding of antenna support structures

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

Ground mounted support structures should be connected at their base to a ground ring via 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-meter intervals around the base of the structure as close to it as possible, buried approximately 0.6-meters deep where soil conditions allow. An alternative method using radials rather than rings is detailed in “The ‘Grounds’ for Lightning and EMP Protection”, second edition, published by PolyPhaser Corporation.

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

Grounding of 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 Wireless, Inc. have braided rather than solid outer conductors; this type of grounding is not appropriate. In these cases we recommend the use of Wireless, Inc. approved lightning arrestors. For information on lightning arrestors, please contact Wireless, Inc.'s Customer Service department.

Grounding of buildings

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

The ground ring should consist of copper cable or tape with electrodes 2- meters or greater in length, buried to a depth of 0.6-meters and at a distance from the building not to exceed 1-meter.

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

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